APPENDIX G
Site-Specific Design of Stabilization Measures in Selected High-Hazard Portions of the Route of the Proposed Mountain Valley Pipeline Project in the Jefferson National Forest

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Introduction

The following analyses are in response to the October 24, 2016, *Request for Site-Specific Design of Stabilization Measures in Selected High-Hazard Portions of the Route of the proposed Mountain Valley Pipeline Project in the Jefferson National Forest* letter. The report was updated in February 2018, in response to comments from Jefferson National Forest personnel regarding narrowed workspace width in areas of undulating right of way and clarification of the existing report.

Six JNF Priority Sites were identified in the letter and are addressed herein. These sites are shown on the Jefferson National Forest Priority Sites map of Figure 1.

Potential hazards and associated mitigations are discussed on an individual basis for each Priority Site. Monitoring strategies are discussed following the site-specific discussion.

Mitigation measures prescribed in this document are comparable to those recommended in *Mitigation of Land Movement in Steep and Rugged Terrain for Pipeline Projects* by the Interstate Natural Gas Association of America (INGAA) published in May 2016. The mitigation measures described in the INGAA report have been successfully implemented on numerous pipeline projects in the Appalachian region.

Figures depicting the ground surface during construction show a soil swell of 25 percent for topsoil and 50 percent for spoil (based on bedrock as the primary excavated material), which will actually be less as the spoil piles will be compacted. Nonetheless, a conservative swell volume was chosen to depict worst-case conditions during construction. The original ground surface contours will be restored as practicable during reclamation activities and the replaced soil/rock fragments will be graded to meet the existing contours at the edge of the right of way. Topsoil will be placed on top of the graded surface. Any excess soil or rock fragments generated due to soil/rock swell will be hauled to an approved offsite location for disposal.

In general, fill material should not contain topsoil, organics, frozen materials, or rock fragments larger than 6 inches in diameter. Fill material should be compacted in loose lifts not exceeding 12 inches in thickness. Each lift should be tracked in with a CAT D6 dozer or equivalent making no fewer than three passes per lift. Saturated materials or those exhibiting signs of pumping and rutting during compaction should be amended by mixing with drier materials, spreading and drying, or other drying methods prior to fill placement.

During construction, Mountain Valley will deploy a landslide inspection team to identify geohazards encountered along the pipeline alignment. The landslide inspection team will develop mitigation schemes for the identified geohazards using Mountain Valley's landslide mitigation typical drawings. These drawings are included in Appendix B. The use of all included typical drawings is not prescribed herein, but Mountain Valley's landslide inspection team may implement these schemes as necessitated by subsurface conditions revealed during construction. If subsurface conditions are not conducive to the use of the included typical drawings, additional mitigation schemes will be developed by the landslide inspection team for use in the field.

1.0 JNF Priority Site #1

Coordinates: (37.384428, -80.679174) to (37.381628, -80.677097)

1.1 Site Description and Geology

This site is located on the lowest downslope National Forest Service lands and on private property adjacent to National Forest Service lands, on the lower downslope south side of Peters Mountain, approximately between milepost (MP) 198.15 to 198.35 on the October 2016 Proposed Route.

Slopes within the temporary right-of-way (ROW) in the near vicinity of the JNF Priority Site #1 range from 16 to 85 percent , and generally become more gradual further downslope. As shown on the plan view slope map of Figure 2, the steepest part of the proposed right of way in the JNF Priority Site #1 area is approximately between MP 198.2 and 198.3

A profile of the site is shown on Figure 3. The pipeline will be approximately three feet below grade at this location, with the bottom of the pipeline trench located approximately seven feet below grade. The trench will be backfilled with select backfill, which will be shaker bucket material from the native soil and rock. Cross section 1A is shown on Figures 4, 5, and 6, and cross section 1B is shown on Figures 35, 36, and 37, showing the anticipated extent of trenching and stockpiled material before, during, and after construction, respectively.

According to Rader and Gathright (1986) and Schultz and Stanley (2001) the geology of general area of the JNF Priority Site #1 area is highly folded and thrust-faulted, northeast striking and steeply dipping (generally 50-60^{o}) Silurian to Cambro-Ordovician age bedrock. The upslope vicinity of the JNF #1 area is underlain by the undivided Tonoloway Limestone and Keefer Sandstone. A splay fault of the Narrows thrust fault is mapped in the upslope vicinity of the JNF Priority Site #1 location. Colluvial overburden obscures bedrock outcrop in the vicinity of the JNF Priority Site #1 area, where underlying bedrock is mapped as Silurian age Rose Hill and Tuscarora Formations (red shales, mudstone, fine to medium red to gray to white sandstones and quartzite) conformably overlying upper Ordovician age Juniata Formation bedrock further downslope. The Juniata Formation conformably contacts Ordovician age undivided Reedsville Shale and Trenton Limestone (interbedded gray calcareous shale, fossiliferous limestone and minor calcareous sandstone, thin gray shale beds). The ancient, inactive Narrows thrust fault is an unconformable contact between the Ordovician Reedsville and Trenton strata and older Cambro-Ordovician age Knox Group (predominantly dolostone) that underlies the valley floor.

Photo 1: Red and brown sandstones characteristic of the Rose Hill Formation were observed as float upslope of the JNF Priority Site #1 area (view is toward north-northwest)

Photo 2: White to gray sandstone talus blocks characteristic of the Tuscarora Formation observed as abundant float near the vicinity of the JNF Priority Site #1 (view is upslope toward the west)

Photo 3: The JNF Priority Site #1 situated on an ancient colluvial fan composed primarily of Tuscarora sandstone (view is sideslope to the southwest)

Schultz et al (1986) map these characteristic areas as “Colluvium undifferentiated: boulders, gravel, sand and silt; includes rock fall, talus, debris train, and block field deposits”.

1.2 Potential Slope Failure Hazards

Potential slope failure hazards that were considered for this area included rock failure, debris flow, remobilization of colluvial deposits, shallow failure of stockpiled trench/topsoil, slope failure subjacent to stockpiles, failure of cut slopes created during construction, post-construction erosion of the reclaimed right of way, shallow sloughing failure of the trench backfill, and water intrusion from seeps and springs encountered in the trench.

A slope failure in this vicinity could impact streams S-Q10 and S-Q11, which are tributaries to Big Stony Creek and are at least 275 feet east-southeast from the proposed temporary right of way.

These slope failure hazards and associated mitigation and avoidance strategies are discussed below.

1.2.1 Rock Failure

Rock-block failure involves gravity-induced movement of large, relatively intact blocks of bedrock on steep slopes. The bedrock mass is typically a complex geological body resulting from variable lithology, tectonic stresses and weathering that lead to differential loading and unloading. Rock-block failures typically occur where stronger bedrock units transition to weaker or weathered units and become undercut. Rock falls or topples entail abrupt movements of bedrock mass or boulders that detach along discontinuities (fractures, joints, bedding planes) or the forward rotation of a unit or units about some pivotal point. Movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water. Field reconnaissance of the JNF Priority Site #1 did not reveal conditions that would lead to potential rock block failure. Bedrock is not exposed as over-steepened cliffs or ledges, is covered by soil overburden, and is likely stable in-place. Therefore, based on field observations of the JNF Priority Site #1 and planned construction activities, Mountain Valley considers the potential for rock failure to be so remote as to be negligible. No mitigation measures for rock failure are prescribed at JNF Priority Site #1.

1.2.2 Debris Flow / Colluvial Deposit

Debris flows are generally considered to be high-energy, rapid downslope movement of earth material that can entrain trees and other large objects in the flow path. A debris flow differs from rock-block slide in that there are no well-defined blocks moving along shear surfaces. Instead, the mass flows downhill, with shear strains present everywhere. Debris flows generally occur during intense precipitation events, and travel rapidly downslope along existing drainage channels or stream valleys, transporting and depositing mud, sand, gravel, and boulders where the slope gradient flattens. Multiple debris flows may coalesce into a central channel downslope from the points of initiation.

Colluvial deposits observed in the vicinity of the JNF Priority Site #1 may be derived from past debris flow(s), or other forms of mass wasting. However, this analysis groups debris flow with colluvial deposits because pipeline construction within, or in the vicinity of an observed colluvial deposit entails similar precautions to that for a debris flow.

Major controls on the potential to initiate a debris flow include topographic gradient and orientation of the slope, bedrock structure, and the accumulation of historic debris flows in topographic drainage features that concentrate surface and subsurface water during intense precipitation events. Field observations of the JNF Priority Site #1 suggest that topographic and bedrock conditions are not likely susceptible to generating a new debris flow at the JNF Priority #1 site. However, colluvial deposit(s) observed at, and in the near vicinity of, the site (as described above), coupled with the potential for extreme precipitation events, warrant consideration for construction and long-term operation of the pipeline.

Field observations indicated that the colluvium in the vicinity of the JNF Priority Site #1 generally accumulates in topographic drainage features below the south-sloping ridgeline where the proposed alignment is situated. The pipeline trench in the vicinity of JNF Priority Site #1 will be located in thin overburden overlying bedrock forming a downslope ridge. Nonetheless, adjacent colluvial deposit(s) may be encountered within the overall limit of disturbance (LOD) during construction, and is therefore being evaluated for slope stability. The landslide mitigation specialists deployed by Mountain Valley during construction will determine if additional mitigation measures need to be implemented based on the depth of the colluvial deposit and its position relative to the pipeline. If the pipeline must be located within the colluvial deposit due to the deposit's depth, the implementation of additional measures will be dependent upon the direction of the mass movement and steepness, where encountered. If movement follows the pipeline longitudinally, no additional measures will be required to protect the pipe. If movement is transverse or oblique to pipeline orientation, the trench may be backfilled with deformable material or wrapped in a protective sleeve to attenuate potential strain on the pipeline.

Slope Stability and Pipeline Integrity Analyses

As discussed above, the JNF Priority Site #1 is situated adjacent to colluvial deposits overlying clastic sedimentary bedrock. Activities within the LOD may encounter the colluvial deposit. Soil test pits conducted in the vicinity of the JNF Priority Site #1 indicated that bedrock is more than three feet deep, and based on field observations (e.g., incised drainages, local road cuts) depth to bedrock increases toward the central portion of the drainage where colluvium tends to accumulate.

Existing slope stability at the JNF Priority Site #1 was evaluated by establishing safety factors using a numerical model with input from field observations, probabilistic analysis of material properties and analyst experience. Slope failure risk analysis was approximated using the peer-reviewed slope stability program SLIDE (RocScience, Inc.). This model incorporates Bishop, Janbu and Spencer methods, generates circular, non-circular, and optimized shaped failure planes with seismic and boundary loads.

Observations of historical slope failures in other areas suggest that the likely slip plane will occur at the overburden-bedrock interface resembling an infinite slope failure. However, the depth of the slip surface within the colluvium material has a minimal effect on the Factor of Safety (FoS) (i.e., difference of less than 0.05). Therefore, the model simulates a failure surface near the overburden-bedrock interface to represent a failure with an adverse effect and not shallow, surficial sloughs.

A probabilistic model was applied to the colluvial soil's shear strength (friction angle) and unit weight using highest and lowest conceivable values (Duncan, 2000). Stability analyses were run for slope angles ranging from 15% (9 degrees) to 76% (37 degrees).. While limited areas of slope exceeding this range exist at JNF Priority Site #1, they are likely composed of rocky outcrops and not colluvium. Modeling also accounted for saturated conditions and seismic loading (0.16 g; see Mountain Valley Pipeline Resource Report #6, seismic hazards analysis). Examples of the sensitivity analysis are shown below for a 30 percent slope with saturated soils.

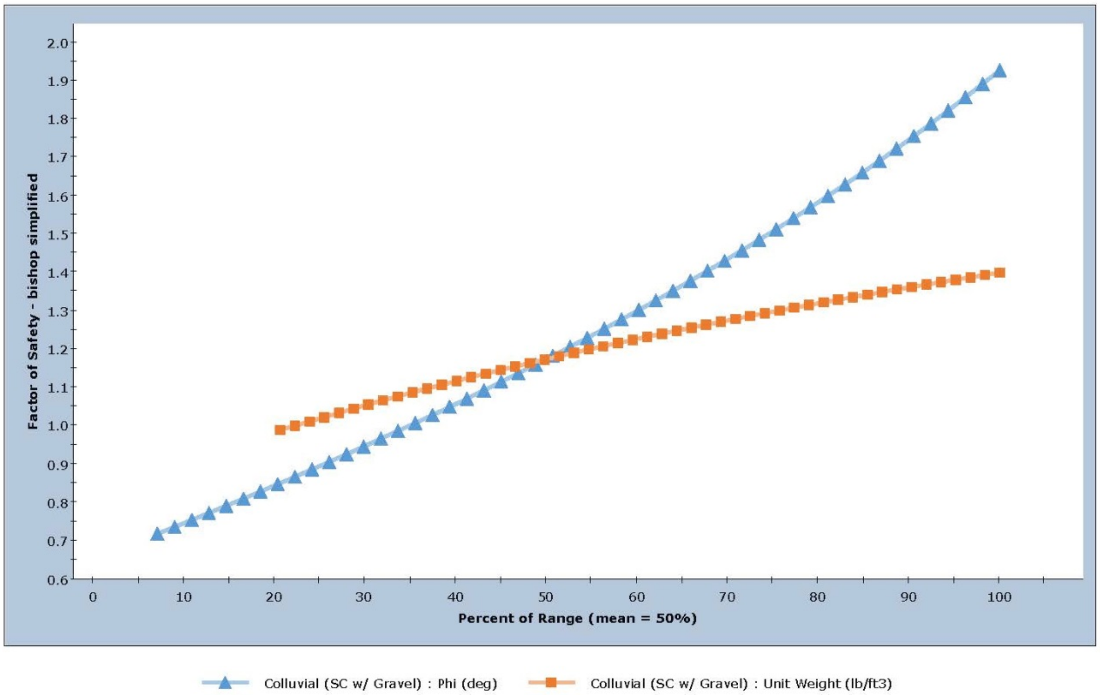


Photo 4: Example of sensitivity plot for the shear strength and unit weight of colluvium versus factor of safety

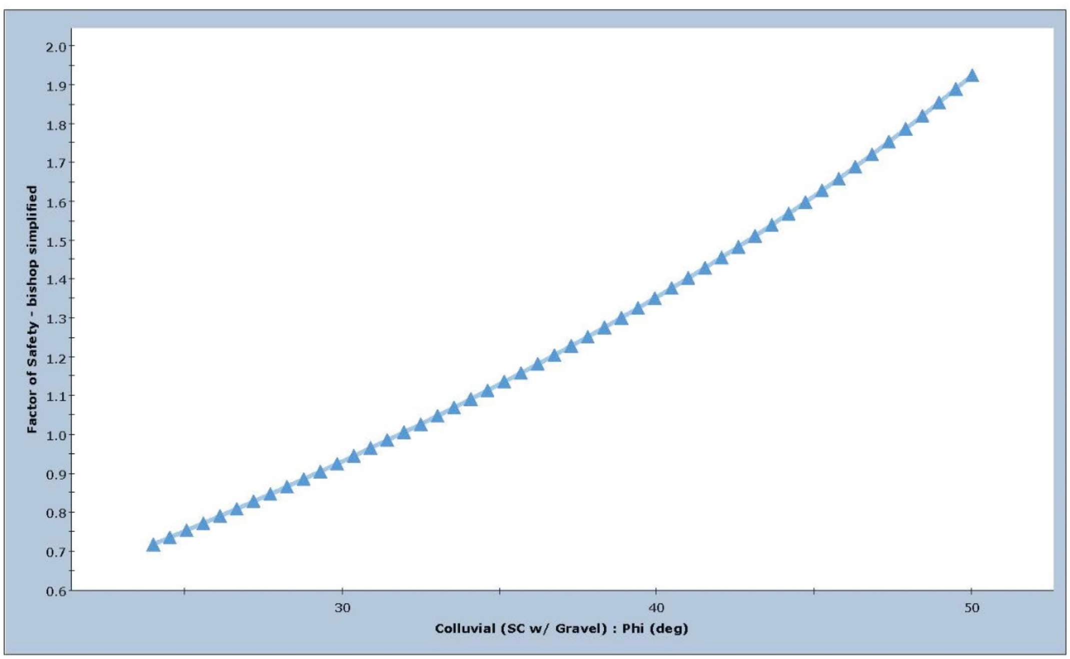


Photo 5: Example sensitivity plot for the shear strength of the colluvium versus factor of safety (likely (mean) phi=36°, lower limit=24°, upper limit=50°)

The output files for results of each analysis at the likely soil parameters are included in Appendix C. Table C-1 in Appendix C summarizes the full range of stability analysis results given the probabilistic analyses for input parameters soil density and friction angle, under increasing slope, saturated and unsaturated conditions, and with and without seismic loading.

In summary from Table C-1, based on likely colluvial material density and friction angle values, the existing colluvial deposit slopes at JNF Priority Site #1 are stable (minimum FoS of 1.1) up to at least 65% (33 degrees) native slopes under unsaturated conditions with no seismic loading, and 45% (24 degrees) native slopes with seismic loading. Under saturated conditions, risk for slope failure increases substantially.

The slope stability model suggests that colluvial slopes in the near vicinity of the JNF Priority Site #1 are stable within FoS values under unsaturated conditions. The model also confirms what Mountain Valley has already accounted for in construction practices, that the largest effect on the FoS is soil saturation from groundwater intrusion, or surface water infiltration, to the colluvial deposit (i.e., as soils become saturated, stability decreases). As discussed, Mountain Valley is aware of the need to prevent accumulation of storm water during construction, permanently divert subsurface springs or seeps from the pipeline bedding and near vicinity if encountered during construction, and to properly grade and reclaim the ground surface in the LOD after construction. Preventing saturated conditions on these steep slope environments is a critical factor in maintaining slope stability. The project stormwater management plans and subsurface drains implemented during construction will address the issue of overburden saturation.

The analysis suggests there is minimal risk of ground displacement. From the perspective of pipeline integrity and safety, D. G. Honegger Consulting (2015) indicated that slope displacements parallel to the proposed alignment can be screened out as not representing a significant hazard if the length of pipeline exposed to ground displacement is less than 1,150 feet (Class 1 pipe) to 1,640 feet (Class 3 pipe) from the top of the slope (screening approach assumes a relatively straight line with no connections or insulated joints in the screening distance). While Mountain Valley does not anticipate any slope failure to occur, it is even more unlikely that failure on the magnitude of 1,000's of feet will occur. Thus the effects of displacement on the pipeline have not been analyzed. As discussed later in this document, Mountain Valley will implement a post-construction slope monitoring program. If future monitoring observations suggest slope movement is occurring, Mountain Valley will take appropriate actions to stabilize the slope and will evaluate pipeline response to the nature and degree of observed ground displacement using the recommendations provided in PRCI (2009).

1.2.3 Soil Stockpile and Subjacent Slope Failure

Soil stockpiles will be compacted with tracked equipment. Excavation and backfilling will be completed as quickly as possible to minimize the duration of stockpiling. At JNF Priority Site #1, the contractor will install a temporary backstop below the toe of the stockpiled material, such as reinforced silt fence, to prevent rocks from and stockpiled material from rolling/sliding off of the ROW.

Mountain Valley completed additional slope stability and sensitivity analysis in February 2018, that shows that no spoil materials should be stored on slopes exceeding 77 percent. Spoil materials resembling the strength parameters for USCS soil type GP should not be stockpiled on slopes exceeding 63 percent; spoil materials resembling the strength parameters for USCS soil type GC should not be stockpiled on slopes exceeding 77 percent. Supporting slope stability analyses are included in Appendix C. A slope map depicting the slope conditions discussed above is included as Figure 48.

In areas of the ROW steeper than 63%, spoil will be evaluated by Mountain Valley's field geologist to determine which soil type it most closely resembles. If the spoil resembles the strength parameters for GP material, it will be moved to a flatter area temporarily during construction, then moved back during final restoration. No spoil will be stored on slopes exceeding 77 percent.

In steeper areas of the ROW, spoil stockpiles will be stored on bedrock with little soil overburden. Thus, overloading the slope in the steeper regions of the JNF Priority Site #1 does not present a technical concern for construction in these steeper areas. Temporary spoil stockpiles stored on rock will be internally stable with a factor of safety of at least 1.2 as demonstrated in Appendix C.

Colluvial deposits were observed in the flatter portions of the site. Stability of the native material underlying spoil stockpiles is of concern. The spoil will be spread out across the workspace to the extent practicable to avoid overloading the in-situ colluvial soils. Stockpiles will be compacted with tracked equipment to prevent water infiltration and saturation of the material and thus minimize the weight of the stockpiled soil.

A geologist from the landslide inspection team deployed by Mountain Valley during construction will evaluate the subgrade to determine whether or not it is appropriate to stockpile soils in the vicinity of the colluvial deposit. The exact thickness of the colluvial deposit will not be fully determined until excavation is initiated, but as previously described, as colluvial debris generally follow ravines and drainage paths and the pipeline ROW is located on a ridge, it is unlikely that the colluvial deposit is extremely thick in the workspace area. Therefore, soils may be sufficiently thin that instability due to stockpiled material is not a concern. If the colluvial deposit is well-consolidated and relatively dry, material may be stored on top of it, at the discretion of the geologist. If colluvial deposits exceed about five feet, spoil stockpiles will be moved up or downslope to a more stable area to avoid overloading the colluvial deposit and initiating a failure.

1.2.4 Temporary Cut Failures

Cut slopes created during construction at JNF Priority Site #1 are anticipated to be minor (less than about five feet in height) and located in rock. Cut slopes will not exceed the maximum safe angle per OSHA standards for the type of material being excavated. Temporary rock cuts are anticipated to be stable in the long-term following reclamation as they will be protected from weathering by compacted native material placed to original contours as practicable.

1.2.5 Erosion

Erosion hazards will be mitigated by following the project Erosion and Sediment Control Plan (E&SCP). Refer to the E&SCP for details.

1.2.6 Trench Backfill Failures

The pipeline trench will be provided with trench breakers at locations specified in the project E&SCP. These trench breakers will act as gravity retaining walls within the trench to hold the backfill in place during construction and will slow the velocity of water running through the trench, preventing subsurface erosion. Every third trench breaker at this location will be provided with daylight drains, as shown on typical drawing MVP-35, discharging water building up in the trench to water dissipation devices at the ground surface. All trench breakers not provided with daylight drains will be provided with pass-through drains as shown on typical drawing MVP-43.

As the trench backfill will be placed in compacted lifts, the trench backfill will be at least as stable as the distal extent of in-situ colluvial deposits, if encountered. Slope stability analysis of the trench backfill is included in Appendix C. Up to approximately 65 percent slope, backfill is anticipated to be stable with a safety factor of at least 1.5. In areas steeper than 65 percent (which are likely rock outcrop areas), additional slope breakers should be installed in the trench backfill, spaced a maximum of 25 feet apart. Larger rocks from the excavation should be placed in the upper two feet of backfill at these steep areas to armor the backfill between the trench breakers.

1.2.7 Seeps and Springs

As the presence of seeps/springs encountered in the pipeline trench will not be known until the trench is excavated, their location and extent cannot be determined at this time. At JNF Priority Site #1, seepage (if any is encountered) will be captured by daylight drains behind the trench breakers, as shown on typical drawing MVP-35. These drains will outlet to energy dissipation devices at the right-of-way ground surface and any resulting discharge will be directed downslope to prevent accumulation within the LOD. Trench breaker locations are shown on the project E&SCP.

1.3 Mitigation Measures

Overall best management practices include:

- controlling surface runoff from the limit of disturbance and the reclaimed construction area to prevent direct flow into exposed debris flow or colluvial deposit;
- intercepting and controlling subsurface drainage from the excavation during construction and post-construction to prevent subsurface infiltration into the underlying debris flow or colluvial deposit;
- constructing in a timely fashion to reduce the amount of time when the limit of disturbance is exposed to the elements and not under final grade;
- and installing additional trench breakers (minimum 25-foot spacing) in areas steeper than 65 percent slope and armoring the ground surface in these steep areas with larger rocks from the trench excavation.

Subsurface conditions observed during construction may dictate the use of enhanced mitigation measures. Site-specific observations made by the Mountain Valley landslide inspection team during construction may result in the team's recommendation for deployment of additional specific mitigation measures, which consider potential native ground movement around or below the ROW, disturbed temporary ground surface movement from initial grading and subsequent construction work and finished and restored ROW surface.

Based on field observations during construction, Mountain Valley may implement slope breakers, water bars, additional grading, French drains, armored slopes and/or ditches as enhanced drainage control measures to promote slope stability. Mountain Valley does not anticipate that structures will be required to stabilize bedrock within the trench excavation, or adjacent native soils or colluvium, however highwall/steep slope revetments or geogrid may be implemented to increase the stability of backfilled areas if soils do not exhibit the strength parameters modeled herein.

1.4 Post-Construction Monitoring and Intervention

See the discussion on post-construction monitoring and potential for intervention for the JNF Priority Sites that is presented in the last section of this document. Slope monitoring is a critical element of post-construction operations of the pipeline and the recommended procedures (including potential reclamation measures) are applicable to all of the JNF Priority Sites.

2.0 JNF Priority Site #2

*Coordinates: (*37.30601, -80.397099*) to (*37.30346, -80.394457*)*

2.1 Site Description and Geology

This site is on the north side of Brush Mountain from approximately MP 220.5 to MP 220.75 as shown on the October 2016 Proposed Route. The October 24, 2016, *Request for Site-Specific Design of Stabilization Measures in Selected High-Hazard Portions of the Route of the proposed Mountain Valley Pipeline Project in the Jefferson National Forest* letter requested that "the route variation to another ridge on the north side of Brush Mountain" be addressed in addition to the area described above. This ridge is not addressed herein; however, it exhibits similar geologic features to the ridge analyzed in this document.

Slopes within the temporary right of way range from nearly flat to 92 percent, and are generally steeper in the middle portion of the site. As shown on the plan view slope map of Figure 7, the pipeline route follows a narrow ridge in this area. East of the permanent ROW, the temporary ROW slopes steeply, exceeding 60 percent slope throughout much of the area of concern. The site is immediately subjacent to FR 188 – Brush Mountain Road.

A profile of the site is shown on Figure 8. The pipeline will be approximately 4 feet below grade, with the bottom of the pipeline trench located approximately 8 feet below grade. The trench will be backfilled with select backfill, which will be shaker bucket material from the native soil and rock. Cross section 2A is shown on Figures 9, 10, and 11, depicting the anticipated extent of trenching and stockpiled material before, during, and after construction. Cross Sections 2-1, 2-2, 2-3, and 2-4 are depicted on Figures 38 through 41. These cross sections depict construction-phase conditions and include the locations of trees left in place to create an undulating right of way edge. Mountain Valley has elected to leave an additional buffer of trees in the easternmost 6 feet of the temporary right of way along the steepest sideslope portions of this Priority Site.

Mountain Valley will employ stovepipe construction techniques throughout the steep sideslope portion of JNF Priority Site 2, whereby the pipe is welded in the ditch along a limited length of open trench and less working space is required. The pipeline will be installed along the western edge of the 50-foot permanent ROW and the ridgetop will be used to stage the equipment. This minimizes the amount of spoil generated. As this construction practice will proceed in a linear fashion, the minor amount of spoil generated will be spread across the ROW (on portions of the ROW not exceeding the slope thresholds derived from the slope stability analysis described below) north or south of the segment being constructed.

According to the Geologic Map of Virginia (1993) the geology of the general vicinity of the JNF Priority Site #2 is highly folded and thrust-faulted, northeast striking and steeply dipping (generally 50-60^o) Mississippian to Devonian age clastic sedimentary bedrock. The Mississippian Age Price Formation sandstone, conglomeratic sandstone and shale typically forms the Brush Mountain ridge line. West-northwest and downslope from the ridgeline, the proposed alignment overlies Devonian age Chemung Formation sandstone, shale, thin quartz-pebble conglomerates and red beds. Field reconnaissance confirmed that there are no observed bedrock outcrops below the ridgeline in the vicinity of JNF Priority Site #2 and further downslope until the valley floor. Residual soil overburden is present on the northwest slope of Brush Mountain and is likely 10 feet thick or less near the JNF Priority Site #2.

Photo 6: Exposure of the Price sandstone outcrop at the ridge line near JNF Priority Site #2

Photo 7: Downslope exposure of bedrock was not observed, but the steep slopes in the vicinity of the JNF Priority Site #2 suggest only a thin overburden mantle overlies the downslope Devonian age bedrock (view is to the north)

2.2 Potential Slope Failure Hazards

At this site, potential slope failure hazards that were considered included rock failure, unconsolidated overburden failure, shallow failures of the stockpiled trench/topsoil, slope failures subjacent to stockpiles, failure of temporary slopes created during construction, post-construction erosion of the reclaimed right of way, shallow sloughing failures of the trench backfill, and water intrusion from seeps and springs encountered in the trench.

No jurisdictional waters have been identified in the vicinity of Priority Site #2, however two drainage areas are located to the east and west of this ridge.

These hazards and associated mitigation and avoidance strategies are discussed in detail below.

2.2.1 Rock Failure

Rock-block failure involves gravity-induced movement of large, relatively intact blocks of bedrock on steep slopes. The bedrock mass is typically a complex geological body resulting from variable lithology, tectonic stresses and weathering that lead to differential loading and unloading. Rock-block failures typically occur where stronger bedrock units transition to weaker or weathered units and become undercut. Rock falls or topples entail abrupt movements of bedrock mass or boulders that detach along discontinuities (fractures, joints, bedding planes) or the forward rotation of a unit or units about some pivotal point. Movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water. Field reconnaissance of the JNF Priority Site #2 did not reveal conditions that would lead to potential rock block failure. Bedrock is not exposed as over-steepened cliffs or ledges, is covered by soil overburden, and is likely stable in-place.

Therefore, based on field observations of the JNF Priority Site #2 and planned construction activities, Mountain Valley considers the potential for rock failure to be so remote as to be negligible. No mitigation measures for rock failure are anticipated at JNF Priority Site #2.

2.2.2 Unconsolidated Overburden Failure

Field observations and geologic mapping indicate that the JNF Priority Site #2 is underlain by a residual soil mantle that overlies clastic sedimentary bedrock. Based on field observations overburden is likely 10 feet thick or less. As discussed above, the pipeline trench in the vicinity of JNF Priority Site #2 will be located as deep as 4 feet below grade, likely below the residual overburden and into the upper reaches of stable shallow bedrock. This will be further evaluated by Mountain Valley's geologist when subsurface conditions become apparent during construction.

Major controls on the potential to initiate a landslide (unconsolidated overburden failure) include topographic gradient and orientation of the slope, bedrock structure, and topographic drainage features that concentrate surface and subsurface water during intense precipitation events. Mountain Valley evaluated overburden observed (as described above) at the JNF Priority Site #2, coupled with the potential for extreme precipitation events, for consideration of failure risk during construction and long-term operation of the pipeline.

Slope Stability and Pipeline Integrity Analyses

Existing slope stability at the JNF Priority Site #2 was evaluated by establishing safety factors using a numerical model with input from field observations, probabilistic analysis of material properties and analyst experience. Slope failure risk analysis was approximated using the peer-reviewed slope stability program SLIDE (RocScience, Inc.). This model incorporates Bishop, Janbu and Spencer methods, generates circular, non-circular, and optimized shaped failure planes with seismic and boundary loads.

Observations of historical slope failures in other areas suggest that the likely slip plane will occur at the overburden-bedrock interface resembling an infinite slope failure. However, the depth of the slip surface within the colluvium material has a minimal effect on the Factor of Safety (FoS) (i.e., difference of less than 0.05). Therefore, the model simulates a failure surface near the overburden-bedrock interface to represent a failure with an adverse effect and not shallow, surficial sloughs.

A probabilistic model was applied to the colluvial soil shear strength (friction angle) and unit weight using highest and lowest conceivable values (Duncan, 2000). Stability analyses were run for slope angles ranging from 15% (9 degrees) to 76% (37 degrees)... While limited areas of slope exceeding this range exist, they are likely composed of rocky outcrops and not colluvium. Modeling also accounted for saturated conditions and seismic loading (0.16 g; see Mountain Valley Pipeline Resource Report #6, seismic hazards analysis). Slope stability model output is provided in Appendix C. Table C-1 in Appendix C summarizes the full range of stability analysis results given the probabilistic analyses for input parameters soil density and friction angle, under increasing slope, saturated and unsaturated conditions, and with and without seismic loading.

In summary from Table C-1, based on likely residual soil density and friction angle values, the existing native overburden slopes at JNF Priority Site #2 are stable (minimum FoS of 1.1) up to at least 65% (33 degrees) native slopes under unsaturated conditions with no seismic loading, and 45% (24 degrees) native slopes with seismic loading. The analysis results suggest the slopes are stable at an acceptable FoS under unsaturated conditions.

Under saturated conditions, risk for slope failure increases substantially. The model confirms what Mountain Valley has already accounted for in construction practices, that the largest effect on the FoS is soil saturation from groundwater intrusion, or surface water infiltration, to the colluvial deposit (i.e., as soils become saturated, stability decreases). As discussed, Mountain Valley is aware of the need to prevent accumulation of storm water during construction, permanently divert subsurface springs or seeps from the pipeline bedding and near vicinity if encountered during construction, and to properly grade and reclaim the ground surface in the LOD after construction. Preventing saturated conditions on these steep slope environments is a critical factor in maintaining slope stability. The project stormwater management plans and subsurface drains implemented during construction will address the issue of overburden saturation.

The analysis suggests there is minimal risk of ground displacement. From the perspective of pipeline integrity and safety, D. G. Honegger Consulting (2015) indicated that slope displacements parallel to the proposed alignment can be screened out as not representing a significant hazard if the length of pipeline exposed to ground displacement is less than 1,150 feet (Class 1 pipe) to 1,640 feet (Class 3 pipe) from the top of the slope (screening approach assumes a relatively straight line with no connections or insulated joints in the screening distance). While Mountain Valley does not anticipate any slope failure to occur, it is even more unlikely that failure on the magnitude of 1,000's of feet will occur. Thus the effects of displacement on the pipeline have not been analyzed. As discussed later in this document, Mountain Valley will implement a post-construction slope monitoring program. If future monitoring observations suggest slope movement is occurring, Mountain Valley will take appropriate actions to stabilize the slope and will evaluate pipeline response to the nature and degree of observed ground displacement using the recommendations provided in PRCI (2009).

2.2.3 Soil Stockpile and Subjacent Slope Failure

Temporary spoil will be stockpiled across the temporary right of way north or south of the limited trench excavation length. Spoil will only be stockpiled in areas meeting the slope stability requirements described below, mostly within the permanent right of way. Soil stockpiles will be compacted with tracked equipment. Excavation and backfilling will be completed as quickly as possible to minimize the duration of stockpiling. At JNF Priority Site #2, the contractor will install a temporary backstop, such as reinforced silt fence, to prevent rocks and stockpiled material from rolling/sliding off of the ROW.

Mountain Valley completed additional slope stability and sensitivity analysis in February, 2018, that shows that no spoil materials should be stored on slopes exceeding 77 percent. Spoil materials resembling the strength parameters for USCS soil type GP should not be stockpiled on slopes exceeding 63 percent; spoil materials resembling the strength parameters for USCS soil type GC should not be stockpiled on slopes exceeding 77 percent. Supporting slope stability analyses are included in Appendix C. A slope map depicting the slope conditions discussed above is included as Figure 49.

Field observations indicate the likelihood of a thin soil mantle at the site and spoil stockpiles will be stored on rock. Thus, overloading the subjacent slope at JNF Priority Site #2 does not present a technical concern for construction in this area. Temporary spoil stockpiles stored at the slopes described above will be stable with a factor of safety of at least 1.2 as demonstrated in Appendix C.

2.2.4 Temporary Cut Failures

Cut slopes created during construction at JNF Priority Site #2 are anticipated to be cut into rock. Cut slopes will not exceed the maximum safe angle per OSHA standards for the type of material being excavated, and as such are expected to be stable during construction. As any cuts made temporarily during construction will be reclaimed with native material (buttressing the cut slope) placed to original contours as practicable, cut slopes are anticipated to be stable in the long term.

2.2.5 Erosion

Erosion hazards will be mitigated by following the project E&SCP. Refer to the E&SCP for details.

2.2.6 Trench Backfill and Reclaimed Sideslope Failures

The pipeline trench will be provided with trench breakers at locations specified in the project E&SCP. These trench breakers will act as gravity retaining walls within the trench to hold the backfill in place during construction and will slow the velocity of water running through the trench, preventing subsurface erosion. Every third trench breaker at this location will be provided with daylight drains, as shown on typical drawing MVP-35, discharging water building up in the trench to water dissipation devices at the ground surface. All trench breakers not provided with daylight drains will be provided with pass-through drains as shown on typical drawing MVP-43.

Trench backfill is anticipated to be stable with a factor of safety of at least 1.5 as demonstrated in Appendix C.

To maintain long-term stability of the backfill, the fill should be kept as dry as possible by means of subsurface drains. Transverse trench drains, as shown on typical drawing MVP-38, will be installed at 100-foot intervals throughout JNF Priority Site #2.

A thin residuum overburden mantle overlies bedrock in the vicinity of the JNF Priority Site #2, such that Mountain Valley anticipates the proposed pipeline trench will be installed in bedrock (if practical). In the unlikely event of a slope failure, the thin unconsolidated mantle would release parallel to the pipeline and trench axes (i.e., downslope) and there would be no anticipated effect to the bedrock hosting the pipeline.

2.2.7 Seeps and Springs

As the presence of seeps/springs encountered in the pipeline trench or temporary construction excavation will not be known until the trench is excavated, their location and extent cannot be determined at this time. At JNF Priority Site #2, seepage (if any is encountered) will be captured by daylight drains behind the trench breakers, as shown on typical drawing MVP-35, or with transverse trench drains as shown on typical drawing MVP-38. These drains will outlet to energy dissipation devices at the right-of-way ground surface. Trench breaker locations are shown on the E&SCP.

2.3 Mitigation Measures

Overall best management practices include:

- controlling surface runoff from the limit of disturbance and the reclaimed construction area to prevent direct flow into exposed debris flow or colluvial deposit;
- intercepting and controlling subsurface drainage from the excavation during construction and post-construction to prevent subsurface infiltration into the underlying debris flow or colluvial deposit;
- constructing in a timely fashion to reduce the amount of time when the limit of disturbance is exposed to the elements and not under final grade.
- and embedding the pipeline completely with in the bedrock trench, as practical.

Subsurface conditions observed during construction may dictate the use of enhanced mitigation measures. Site-specific observations made by the Mountain Valley landslide inspection team during construction may result in the team's recommendation for deployment of additional specific mitigation measures, which consider potential native ground movement around or below the ROW, disturbed temporary ground surface movement from initial grading and subsequent construction work and finished and restored ROW surface.

Based on field observations during construction, Mountain Valley may implement slope breakers, water bars, additional grading, French drains, armored slopes and/or ditches as enhanced drainage control measures to promote slope stability. Mountain Valley does not anticipate that structures will be required to stabilize bedrock within the trench excavation, or adjacent native soils or colluvium, however highwall/steep slope revetments or geogrid may be implemented to increase the stability of backfilled areas if soils do not exhibit the strength parameters modeled herein.

2.4 Post-Construction Monitoring and Intervention

See the discussion on post-construction monitoring and potential for intervention for the JNF Priority Sites that is presented in the last section of this document. Slope monitoring is a critical element of post-construction operations of the pipeline and the recommended procedures (including potential reclamation measures) are applicable to all of the JNF Priority Sites.

3.0 JNF Priority Site #3

Coordinates: (37.401887, -80.689491) to (37.400977, -80.687575)

3.1 Site Description and Geology

This site is located on the southeast slope of Peters Mountain, downslope from the bore pit from approximately MP 196.4 to 196.55 as shown on the October 2016 Proposed Route.

Slopes within the temporary right of way range from 26 to 51 percent, and are generally steeper at the northern portion of the site near the bore pit. As shown on the plan view slope map of Figure 12, the pipeline route runs generally east-west and slightly sidehill upon exiting the bore pit and then turns south, where the ground surface slopes gently.

A profile of the site is shown on Figure 13. The pipeline will be approximately three feet below grade. The trench will be backfilled with select backfill, which will be shaker bucket material from the native soil and rock. Cross section 3A is shown on Figures 14, 15, and 16, depicting the anticipated extent of trenching and stockpiled material before, during, and after construction in the sidehill portion of JNF

Priority Site #3. Cross Sections 3-1, 3-2, 2-3, and 2-4 are depicted on Figures 42 and 43. These cross sections depict construction-phase conditions and include the locations of trees left in place to create an undulating right of way edge.

According to Rader and Gathright (1986) and Schultz and Stanley (2001) the geology in the general vicinity of the JNF Priority Site #3 vicinity is highly folded and thrust-faulted sedimentary bedrock. Underlying the site is the Silurian age Rose Hill Formation (red shales, mudstone, fine to medium sandstones), striking northeast-southwest with a moderate southeast dip of (generally 30^{o}). North of the JNF Priority Site #3 the slope becomes steeper as it ascends to the ridgeline (i.e., thin soil mantle over weather-resistant bedrock outcrop with southeast dip). Downslope from the site, a large colluvial deposit is mapped (Schultz and Stanley, 2001), and observed in the field to be predominantly comprised of Rose Hill bedrock float that has weathered and sloughed from the outcrop on the topographically higher ridge. The colluvial overburden obscures bedrock outcrop on the slope at JNF Priority Site #3.

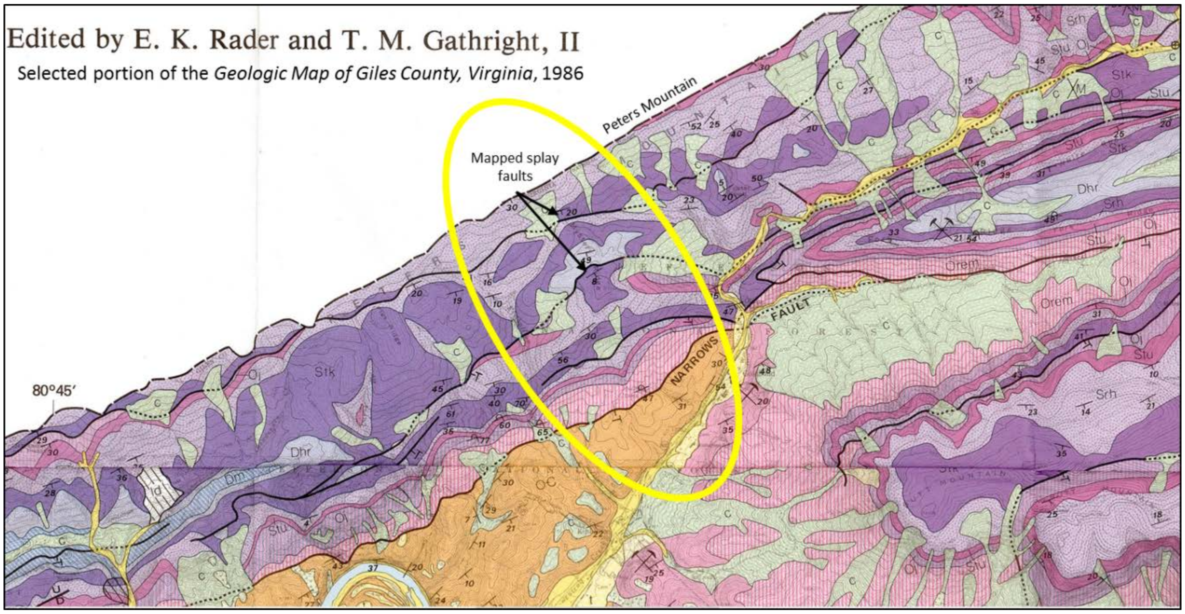
Photo 8: Rose Hill sandstone outcrop on ridge top north of the JNF Priority Site #3, dipping to the south (view to northeast)

Photo 9: Rose Hill sandstone outcrop on ridge top north of the JNF Priority Site #3, dipping to the south (view to the southwest)

Photo 10: Slope approximately 800 feet south of the ridge line

Photo 11: Colluvial deposit float (predominantly Rose Hill sandstone) at ground surface in the near vicinity of the JNF Priority Site #3 (view is to the west toward the upslope ridgeline)

The exhibit presented below was excerpted from Rader and Gathright (1986) showing the mapped geology of the Mystery Ridge area of Giles County, Virginia (encompassing JNF Priority Sites #1, #4, #3 and #5) and is intended to highlight the following discussion.



The yellow ellipse in the image above demarks the general area of the proposed alignment (not shown). The mapped locations of three splay faults of the Narrows thrust fault, and the fault itself, are mapped downslope (southeast) of JNF Priority Site #3. The fault zone is no longer active as the tectonic processes that led to thrust faulting are no longer active on the eastern margin of North America. However, the remnant fault zone may have some measure of effect on surface and groundwater flow rate and direction, and may also be comprised of relatively weak brecciated bedrock. Also, the proposed alignment in this area passes over and near colluvial deposits, which are indicative of ancient (Pleistocene) mass movement.

In general, on steep slopes on JNF property, regardless of the specific geologic conditions, Mountain Valley recognizes that a key factor in maintaining slope stability is to control surface and subsurface water flow such that saturated soil and overburden conditions do not occur. Mountain Valley will take all appropriate actions during construction and after reclamation to manage surface and subsurface water to prevent saturated conditions on native and engineered slopes. Caution will be used to avoid reactivation of unstable deposits, and appropriate management of surface and subsurface drainage is crucial. The extent and character of the breccia zones, if observable at the ground surface, will be investigated by the landslide inspection team during initial land clearing and grubbing, and appropriate recommendations made to ensure construction stability and long-term pipeline integrity.

3.2 Potential Slope Failure Hazards

At this site, potential slope failure hazards that were considered included rock failure, debris flow, remobilization of colluvial deposits, shallow failures of the stockpiled trench/topsoil, slope failures subjacent to stockpiles, failure of temporary slopes created during construction, post-construction erosion of the reclaimed right of way, shallow sloughing failures of the trench backfill, and water intrusion from seeps and springs encountered in the trench.

Stream S-KL24 is located immediately southwest of the temporary LOD and could be impacted in the event of a failure.

These hazards and associated mitigation and avoidance strategies are discussed in detail below.

3.2.1 Rock Failure

Rock-block failure involves gravity-induced movement of large, relatively intact blocks of bedrock on steep slopes. The bedrock mass is typically a complex geological body resulting from variable lithology, tectonic stresses and weathering that lead to differential loading and unloading. Rock-block failures typically occur where stronger bedrock units transition to weaker or weathered units and become undercut. Rock falls or topples entail abrupt movements of bedrock mass or boulders that detach along discontinuities (fractures, joints, bedding planes) or the forward rotation of a unit or units about some pivotal point. Movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water. Field reconnaissance of the JNF Priority Site #3 did not reveal conditions that would lead to potential rock block failure. Bedrock is not exposed as over-steepened cliffs or ledges, is covered by soil overburden, and is likely stable in-place. Therefore, based on field observations of the JNF Priority Site #3 and planned construction activities, Mountain Valley considers the potential for rock failure to be so remote as to be negligible. No mitigation measures for rock failure are anticipated at JNF Priority Site #3.

3.2.2 Debris Flow / Colluvial Deposit

Debris flows are generally considered to be high-energy, rapid downslope movement of earth material that can entrain trees and other large objects in the flow path. A debris flow differs from rock-block slide in that there are no well-defined blocks moving along shear surfaces. Instead, the mass flows downhill, with shear strains present everywhere. Debris flows generally occur during intense precipitation events, and travel rapidly downslope along existing drainage channels or stream valleys, transporting and depositing mud, sand, gravel, and boulders where the slope gradient flattens. Multiple debris flows may coalesce into a central channel downslope from the points of initiation.

Colluvial deposits observed in the vicinity of the JNF Priority Site #3 may be derived from past debris flow(s), or other forms of mass wasting. However, debris flows are grouped with colluvial deposits for this analysis because pipeline construction and boring within, or in the vicinity of an observed colluvial deposit entails similar precautions to that for a debris flow.

Major controls on the potential to initiate a debris flow include topographic gradient and orientation of the slope, bedrock structure, and the accumulation of historic debris flows in topographic drainage features that concentrate surface and subsurface water during intense precipitation events. As noted above, pipeline construction in the vicinity of the JNF Priority Site #3 will be as much as 10 feet below grade. Field observations of the JNF Priority Site #3 suggest that pipeline construction will possibly remain within the colluvial deposits, but may encounter the upper reaches of shallow, stable bedrock. Topographic and bedrock conditions are likely not susceptible to generating a new debris flow at the JNF Priority #3 site. However, colluvial deposit(s) observed at, and in the near vicinity of, the site (as described above), coupled with the potential for extreme precipitation events, warrant consideration for construction, boring and long-term operation of the pipeline.

Slope Stability and Pipeline Integrity Analyses

Existing slope stability at the JNF Priority Site #3 was evaluated by establishing safety factors using a numerical model with input from field observations, probabilistic analysis of material properties and analyst experience. Slope failure risk analysis was approximated using the peer-reviewed slope stability program SLIDE (RocScience, Inc.). This model incorporates Bishop, Janbu and Spencer methods, generates circular, non-circular, and optimized shaped failure planes with seismic and boundary loads.

Observations of historical slope failures in other areas suggest that the likely slip plane will occur at the overburden-bedrock interface resembling an infinite slope failure. However, the depth of the slip surface within the colluvium material has a minimal effect on the Factor of Safety (FoS) (i.e., difference of less than 0.05). Therefore, the model simulates a failure surface near the overburden-bedrock interface to represent a failure with an adverse effect and not shallow, surficial sloughs.

A probabilistic model was applied to the colluvial soil shear strength (friction angle) and unit weight using highest and lowest conceivable values (Duncan, 2000). Stability analyses were run for slope angles ranging from 15% (9 degrees) to 76% (37 degrees), which bracket the range of existing slopes observed at and near the JNF Priority Site #3. Modeling also accounted for saturated conditions and seismic loading (0.16 g; see Mountain Valley Pipeline Resource Report #6, seismic hazards analysis). Slope stability model output is provided in Appendix C. Table C-1 in Appendix C summarizes the full range of stability analysis results given the probabilistic analyses for input parameters soil density and friction angle, under increasing slope, saturated and unsaturated conditions, and with and without seismic loading. In summary from Table C-1, based on likely residual soil density and friction angle values, the existing native overburden slopes at JNF Priority Site #3 are stable (minimum FoS of 1.1) up to at least 65% (33 degrees) native slopes under unsaturated conditions with no seismic loading, and 45% (24 degrees) native slopes with seismic loading. The analysis results suggest the slopes are stable at an acceptable FoS under unsaturated conditions.

Under saturated conditions, risk for slope failure increases substantially. The model confirms what Mountain Valley has already accounted for in construction practices, that the largest effect on the FoS is soil saturation from groundwater intrusion, or surface water infiltration, to the colluvial deposit (i.e., as soils become saturated, stability decreases). As discussed, Mountain Valley is aware of the need to prevent accumulation of storm water during construction, permanently divert subsurface springs or seeps from the pipeline bedding and near vicinity if encountered during construction, and to properly grade and reclaim the ground surface in the limit of disturbance after construction. Preventing saturated conditions on these steep slope environments is a critical factor in maintaining slope stability. The project stormwater management plans and subsurface drains implemented during construction will address the issue of overburden saturation.

The analysis suggests there is minimal risk of ground displacement. From the perspective of pipeline integrity and safety, D. G. Honegger Consulting (2015) indicated that slope displacements parallel to the proposed alignment can be screened out as not representing a significant hazard if the length of pipeline exposed to ground displacement is less than 1,150 feet (Class 1 pipe) to 1,640 feet (Class 3 pipe) from the top of the slope (screening approach assumes a relatively straight line with no connections or insulated joints in the screening distance). While Mountain Valley does not anticipate any slope failure to occur, it is even more unlikely that failure on the magnitude of 1,000's of feet will occur. Thus the effects of displacement on the pipeline have not been analyzed. As discussed later in this document, Mountain Valley will implement a post-construction slope monitoring program. If future monitoring observations suggest slope movement is occurring, Mountain Valley will take appropriate actions to stabilize the slope and will evaluate pipeline response to the nature and degree of observed ground displacement using the recommendations provided in PRCI (2009).

3.2.3 Soil Stockpile and Subjacent Slope Failure

Soil stockpiles will be compacted with tracked equipment. Excavation and backfilling will be completed as quickly as possible to minimize the duration of stockpiling. At JNF Priority Site #3, the contractor will install a temporary diversion, such as reinforced silt fence, to prevent rocks from rolling off of the ROW.

Mountain Valley completed additional slope stability and sensitivity analysis in February, 2018, that shows that no spoil materials should be stored on slopes exceeding 77 percent. Spoil materials resembling the strength parameters for USCS soil type GP should not be stockpiled on slopes exceeding 63 percent; spoil materials resembling the strength parameters for USCS soil type GC should not be stockpiled on slopes exceeding 77 percent. Supporting slope stability analyses are included in Appendix C. A slope map depicting the slope conditions discussed above is included as Figure 50. No slopes exceeding 63 percent exist at JNF Priority Site #3.

Colluvial deposits were observed in the flatter portions of the site. Stability of the native material underlying spoil stockpiles is of concern. The spoil will be spread out across the workspace to the extent practicable to avoid overloading the in-situ colluvial soils. Stockpiles will be compacted with tracked equipment to prevent water infiltration and saturation of the material and thus minimize the weight of the stockpiled soil.

A geologist from the landslide inspection team deployed by Mountain Valley during construction will evaluate the subgrade to determine whether or not it is appropriate to stockpile soils in the vicinity of the colluvial deposit. The exact thickness of the colluvial deposit will not be fully determined until excavation is initiated, but as previously described, as colluvial debris generally follow ravines and drainage paths and the pipeline ROW is located on a ridge, it is unlikely that the colluvial deposit is extremely thick in the workspace area. Therefore, soils may be sufficiently thin that instability due to stockpiled material is not a concern. If the colluvial deposit is well-consolidated and relatively dry, material may be stored on top of it, at the discretion of the geologist. If colluvial deposits exceed about five feet, spoil stockpiles will be moved up or downslope to a more stable area to avoid overloading the colluvial deposit and initiating a failure.

3.2.4 Temporary Cut Failures

Cut slopes created during construction at JNF Priority Site #3 may approach 10 feet in height and are anticipated to be cut into rock. Cut slopes will not exceed the maximum safe angle per OSHA standards for the type of material being excavated, and as such are expected to be stable during construction. As any cuts made temporarily during construction will be reclaimed with native material (buttressing the cut slope) placed to original contours as practicable, cut slopes are expected to be stable in the long term.

3.2.5 Erosion

Erosion hazards will be mitigated by following the project Erosion and Sediment Control Plan (E&SCP). Refer to the E&SCP for details.

3.2.6 Trench Backfill and Reclaimed Sideslope Failures

The pipeline trench will be provided with trench breakers at locations specified in the project E&SCP. These trench breakers will act as gravity retaining walls within the trench to hold the backfill in place during construction and will slow the velocity of water running through the trench, preventing subsurface erosion. Every third trench breaker at this location will be provided with daylight drains, as shown on typical drawing MVP-35, discharging water building up in the trench to water dissipation devices at the ground surface. All trench breakers not provided with daylight drains will be provided with pass-through drains as shown on typical drawing MVP-43.

Trench backfill is anticipated to be stable with a factor of safety of at least 1.5 as demonstrated in Appendix C.

Through the sidehill portion of JNF Priority Site #3, the excavated material will be replaced in compacted lifts not exceeding 12 inches in thickness. The stability of the reclaimed slope was modeled using GSTABL7 software. Slope stability analysis presented in Appendix C show that the backfill is stable with a factor of safety of at least 1.5. The landslide inspection team will evaluate this area during reclamation and may prescribe the use of geogrid (as shown on typical drawing MVP-42) to further stabilize areas of the hillside if the excavated and replaced material does not demonstrate the strength parameters modeled herein.

To maintain long-term stability of the backfill, the fill should be kept as dry as possible by means of subsurface drains. Transverse trench drains, as shown on typical drawing MVP-38, will be installed at 100-foot intervals throughout JNF Priority Site #3.

3.2.7 Seeps and Springs

As the presence of seeps/springs encountered in the pipeline trench or temporary construction excavation will not be known until the trench is excavated, their location and extent cannot be determined at this time. At JNF Priority Site #3, seepage (if any is encountered) will be captured by daylight drains behind the trench breakers, as shown on typical drawing MVP-35, or with transverse trench drains as shown on typical drawing MVP-38. These drains will outlet to energy dissipation devices at the right-of-way ground surface. Trench breaker locations are shown on the E&SCP.

3.3 Bore Pit

It should be noted that stability of the bore pit is not considered herein. Temporary shoring will be developed by the bore contractor to all applicable safety standards to protect both the open bore pit and the stockpiled spoil material excavated from the bore pit. The landslide inspection team will evaluate the site to determine if any mitigation measures, in addition to those proposed by the contractor, are necessary.

3.4 Mitigation Measures

Overall best management practices include:

- controlling surface runoff from the limit of disturbance and the reclaimed construction area to prevent direct flow into exposed debris flow or colluvial deposit;
- intercepting and controlling subsurface drainage from the excavation during construction and post-construction to prevent subsurface infiltration into the underlying debris flow or colluvial deposit;
- constructing in a timely fashion to reduce the amount of time when the limit of disturbance is exposed to the elements and not under final grade;
- and embedding the pipeline completely with in the bedrock trench, if practical.

Subsurface conditions observed during construction may dictate the use of enhanced mitigation measures. Site-specific observations made by the Mountain Valley landslide inspection team during construction may result in the team's recommendation for deployment of additional specific mitigation measures, which consider potential native ground movement around or below the ROW, disturbed temporary ground surface movement from initial grading and subsequent construction work and finished and restored ROW surface.

Based on field observations during construction, Mountain Valley may implement slope breakers, water bars, additional grading, French drains, armored slopes and/or ditches as enhanced drainage control measures to promote slope stability. Mountain Valley does not anticipate that structures will be required to stabilize bedrock within the trench excavation, or adjacent native soils or colluvium, however highwall/steep slope revetments or geogrid may be implemented to increase the stability of backfilled areas if soils do not exhibit the strength parameters modeled herein.

3.5 Post-Construction Monitoring and Intervention

See the discussion on post-construction monitoring and potential for intervention for the JNF Priority Sites that is presented in the last section of this document. Slope monitoring is a critical element of post-construction operations of the pipeline and the recommended procedures (including potential reclamation measures) are applicable to all of the JNF Priority Sites.

4.0 JNF Priority Site #4

Coordinates: (37.387563, -80.682672) to (37.38578, -80.681428)

4.1 Site Description and Geology

This site is located on the steepest slopes downslope from the bore pit on the south side of Peters Mountain from approximately MP 197.75 to 197.95 on the October 2016 Proposed Route. This portion of the right of way is located at the southern extent of Mystery Ridge.

Slopes along this portion of the right of way range from seven to 70 percent, and are generally steeper in the vicinity of MP 198.0. As shown on the plan view slope map of Figure 17, the pipeline in this area parallels and then crosses Mystery Ridge Road on a gentle sidehill, then turns southeast.

A profile of the site is shown on Figure 18. The pipeline will be up to approximately seven feet below grade, with the bottom of the pipeline trench located approximately eleven feet below grade. The trench will be backfilled with select backfill, which will be shaker bucket material from the native soil and rock. Cross section 4A is shown on Figures 19, 20, and 21, and cross section 4B is shown on Figures 22, 23, and 24, depicting the anticipated extent of trenching and stockpiled material before, during, and after construction. Figure 44 depicts the construction-phase geometry of cross section 4-1, including trees left to create the undulating right of way edge.

According to Rader and Gathright (1986) and Schultz and Stanley (2001) the geology of the JNF Priority Site #4 vicinity is highly folded and thrust-faulted sedimentary bedrock (typical of the Valley and Ridge geologic province of Virginia). Bedrock underlying the JNF Priority #4 site is mapped to be northeast striking and moderately dipping (generally 30-40^{o}) upper Silurian age undivided Tonoloway Limestone and Keefer Sandstone. A splay fault of the Narrows thrust fault is mapped downslope of the JNF Priority Site #4, as an unconformable contact between the Tonoloway and Keefer bedrock and Silurian age Rose Hill sandstone. JNF Priority Site #4 is located approximately 1,000 feet upslope from JNF Priority Site #1 (downslope and older bedrock was described previously for the JNF Priority Site #1). Bedrock outcrops of the Tonoloway Limestone or Keefer Sandstone were not observed during field reconnaissance of the JNF Priority Site #4.

4.2 Potential Slope Failure Hazards

At this site, potential slope failure hazards that were considered included rock failure, debris flow, remobilization of colluvial deposits, shallow failures of the stockpiled trench/topsoil, slope failures subjacent to stockpiles, failure of temporary slopes created during construction, post-construction erosion of the reclaimed right of way, shallow sloughing failures of the trench backfill, and water intrusion from seeps and springs encountered in the trench.

No jurisdictional waters have been identified in the vicinity of JNF Priority Site 4.

These hazards and associated mitigation and avoidance strategies are discussed in detail below.

4.2.1 Rock Failure

Rock-block failure involves gravity-induced movement of large, relatively intact blocks of bedrock on steep slopes. The bedrock mass is typically a complex geological body resulting from variable lithology, tectonic stresses and weathering that lead to differential loading and unloading. Rock-block failures typically occur where stronger bedrock units transition to weaker or weathered units and become undercut. Rock falls or topples entail abrupt movements of bedrock mass or boulders that detach along discontinuities (fractures, joints, bedding planes) or the forward rotation of a unit or units about some pivotal point. Movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water. Field reconnaissance of the JNF Priority Site #4 did not reveal conditions that would lead to potential rock block failure. Bedrock is not exposed as over-steepened cliffs or ledges, is covered by soil overburden, and is likely stable in-place. Therefore, based on field observations of the JNF Priority Site #4 and planned construction activities, Mountain Valley considers the potential for rock failure to be so remote as to be negligible. No mitigation measures for rock failure are prescribed at JNF Priority Site #4.

4.2.2 Unconsolidated Overburden Failure

Field reconnaissance of the JNF Priority Site #4 and vicinity revealed bedrock outcrops, thin soil mantle and no notable topographically overlying overburden or bedrock exposure, which indicate negligible potential for debris flow activation. Based on field observations, the residual overburden is less than 10 feet deep. As discussed above, the pipeline trench in the vicinity of JNF Priority Site #4 will be approximately 7 to 11 feet below grade, likely below the residual overburden and into the upper reaches of stable shallow bedrock.

Major controls on the potential to initiate a landslide (unconsolidated overburden failure) include topographic gradient and orientation of the slope, bedrock structure, and topographic drainage features that concentrate surface and subsurface water during intense precipitation events. Mountain Valley evaluated overburden observed (as described above) at the JNF Priority Site #4, coupled with the potential for extreme precipitation events, for consideration of failure risk during construction and long-term operation of the pipeline.

Slope Stability and Pipeline Integrity Analyses

Existing slope stability at the JNF Priority Site #4 was evaluated by establishing safety factors using a numerical model with input from field observations, probabilistic analysis of material properties and analyst experience. Slope failure risk analysis was approximated using the peer-reviewed slope stability program SLIDE (RocScience, Inc.). This model incorporates Bishop, Janbu and Spencer methods, generates circular, non-circular, and optimized shaped failure planes with seismic and boundary loads.

Observations of historical slope failures in other areas suggest that the likely slip plane will occur at the overburden-bedrock interface resembling an infinite slope failure. However, the depth of the slip surface within the colluvium material has a minimal effect on the Factor of Safety (FoS) (i.e., difference of less than 0.05). Therefore, the model simulates a failure surface near the overburden-bedrock interface to represent a failure with an adverse effect and not shallow, surficial sloughs.

A probabilistic model was applied to the colluvial soil shear strength (friction angle) and unit weight using highest and lowest conceivable values (Duncan, 2000). Stability analyses were run for slope angles ranging from 15% (9 degrees) to 76% (37 degrees). Modeling also accounted for saturated conditions and seismic loading (0.16 g; see Mountain Valley Pipeline Resource Report #6, seismic hazards analysis). Slope stability model output is provided in Appendix C. Table C-1 in Appendix C summarizes the full range of stability analysis results given the probabilistic analyses for input parameters soil density and friction angle, under increasing slope, saturated and unsaturated conditions, and with and without seismic loading.

In summary from Table C-1, based on likely residual soil density and friction angle values, the existing native overburden slopes at JNF Priority Site #4 are stable (minimum FoS of 1.1) up to at least 65% (33 degrees) native slopes under unsaturated conditions with no seismic loading, and 45% (24 degrees) native slopes with seismic loading. The analysis results suggest the slopes are stable at an acceptable FoS under unsaturated conditions, and given that the pipeline will be bedded in stable bedrock with negligible risk for slope failure under seismic loading.

Under saturated conditions, risk for slope failure increases substantially. The model confirms what Mountain Valley has already accounted for in construction practices, that the largest effect on the FoS is soil saturation from groundwater intrusion, or surface water infiltration, to the colluvial deposit (i.e., as soils become saturated, stability decreases). As discussed, Mountain Valley is aware of the need to prevent accumulation of storm water during construction, permanently divert subsurface springs or seeps from the pipeline bedding and near vicinity if encountered during construction, and to properly grade and reclaim the ground surface in the LOD after construction. Preventing saturated conditions on these steep slope environments is a critical factor in maintaining slope stability. The project stormwater management plans and subsurface drains implemented during construction will address the issue of overburden saturation.

The analysis suggests there is minimal risk of ground displacement. From the perspective of pipeline integrity and safety, D. G. Honegger Consulting (2015) indicated that slope displacements parallel to the proposed alignment can be screened out as not representing a significant hazard if the length of pipeline exposed to ground displacement is less than 1,150 feet (Class 1 pipe) to 1,640 feet (Class 3 pipe) from the top of the slope (screening approach assumes a relatively straight line with no connections or insulated joints in the screening distance). While Mountain Valley does not anticipate any slope failure to occur, it is even more unlikely that failure on the magnitude of 1,000's of feet will occur. Thus the effects of displacement on the pipeline have not been analyzed. As discussed later in this document, Mountain Valley will implement a post-construction slope monitoring program. If future monitoring observations suggest slope movement is occurring, Mountain Valley will take appropriate actions to stabilize the slope and will evaluate pipeline response to the nature and degree of observed ground displacement using the recommendations provided in PRCI (2009).

4.2.3 Soil Stockpile and Subjacent Slope Failure

Soil stockpiles will be compacted with tracked equipment. Excavation and backfilling will be completed as quickly as possible to minimize the duration of stockpiling. At JNF Priority Site #4, the contractor will install a temporary backstop, such as reinforced silt fence, to prevent rocks from rolling/sliding off of the ROW.

Mountain Valley completed additional slope stability and sensitivity analysis in February, 2018, that shows that no spoil materials should be stored on slopes exceeding 77 percent. Spoil materials resembling the strength parameters for USCS soil type GP should not be stockpiled on slopes exceeding 63 percent; spoil materials resembling the strength parameters for USCS soil type GC should not be stockpiled on slopes exceeding 77 percent. Supporting slope stability analyses are included in Appendix C. A slope map depicting the slope conditions discussed above is included as Figure 51.

In areas of the ROW steeper than 63%, spoil will be evaluated by Mountain Valley's field geologist to determine which soil type it most closely resembles. If the spoil resembles the strength parameters for GP material, it will be moved to a flatter area temporarily during construction, then moved back during final restoration. No slopes exceeding 70 percent exist at JNF Priority Site #4, thus no areas are excluded from spoil storage.

Field observations revealed a thin soil mantle and spoil stockpiles will be stored on bedrock. Thus, overloading the subjacent slope at JNF Priority Site #4 is not anticipated to occur and does not present a technical concern for construction in this area. Temporary spoil stockpiles stored on rock will be internally stable with a factor of safety of at least 1.2 as demonstrated in Appendix C.

4.2.4 Temporary Cut Failures

Cut slopes created during construction at JNF Priority Site #4 may approach 15 feet in height and are anticipated to be cut into rock. Cut slopes will not exceed the maximum safe angle per OSHA standards for the type of material being excavated, and as such are expected to be stable during construction. As any cuts made temporarily during construction will be reclaimed with native material (buttressing the cut slope) placed to original contours as practicable, cut slopes are expected to be stable in the long term.

4.2.5 Erosion

Erosion hazards will be mitigated by following the project Erosion and Sediment Control Plan (E&SCP). Refer to the E&SCP for details.

4.2.6 Trench Backfill and Reclaimed Sideslope Failures

The pipeline trench will be provided with trench breakers at locations specified in the project E&SCP. These trench breakers will act as gravity retaining walls within the trench to hold the backfill in place during construction and will slow the velocity of water running through the trench, preventing subsurface erosion. Every third trench breaker at this location will be provided with daylight drains, as shown on typical drawing MVP-35, discharging water building up in the trench to water dissipation devices at the ground surface. All trench breakers not provided with daylight drains will be provided with pass-through drains as shown on typical drawing MVP-43.

Trench backfill is anticipated to be stable with a factor of safety of at least 1.5 as demonstrated in Appendix C.

The excavated material will be replaced in compacted lifts not exceeding 12 inches in thickness. The stability of the reclaimed slope was modeled using GSTABL7 software. Slope stability analysis presented in Appendix C show that the backfill is stable with a factor of safety of at least 1.5. The landslide inspection team will evaluate this area during reclamation and may prescribe the use of geogrid (as shown on typical drawing MVP-42) to further stabilize areas of the hillside if the excavated and replaced material does not demonstrate the strength parameters modeled herein.

To maintain long-term stability of the backfill, the fill should be kept as dry as possible by means of subsurface drains. Transverse trench drains, as shown on typical drawing MVP-38, will be installed at 100-foot intervals throughout JNF Priority Site #4.

In this area, the pipeline should be fully embedded in the bedrock trench to prevent damage to the pipeline in the unanticipated event of a slope failure.

4.2.7 Seeps and Springs

As the presence of seeps/springs encountered in the pipeline trench or temporary construction excavation will not be known until the trench is excavated, their location and extent cannot be determined at this time. At JNF Priority Site #4, seepage (if any is encountered) will be captured by daylight drains behind the trench breakers, as shown on typical drawing MVP-35, or with transverse trench drains as shown on typical drawing MVP-38. These drains will outlet to energy dissipation devices at the right-of-way ground surface. Trench breaker locations are shown on the E&SCP.

4.3 Mitigation Measures

Overall best management practices include:

- controlling surface runoff from the limit of disturbance and the reclaimed construction area to prevent direct flow into exposed debris flow or colluvial deposit;
- intercepting and controlling subsurface drainage from the excavation during construction and post-construction to prevent subsurface infiltration into the underlying debris flow or colluvial deposit;
- constructing in a timely fashion to reduce the amount of time when the limit of disturbance is exposed to the elements and not under final grade;
- and embedding the pipeline completely within the bedrock trench, as practicable.

Subsurface conditions observed during construction may dictate the use of enhanced mitigation measures. Site-specific observations made by the Mountain Valley landslide inspection team during construction may result in the team's recommendation for deployment of additional specific mitigation measures, which consider potential native ground movement around or below the ROW, disturbed temporary ground surface movement from initial grading and subsequent construction work and finished and restored ROW surface.

Based on field observations during construction, Mountain Valley may implement slope breakers, water bars, additional grading, French drains, armored slopes and/or ditches as enhanced drainage control measures to promote slope stability. Mountain Valley does not anticipate that structures will be required to stabilize bedrock within the trench excavation, or adjacent native soils or colluvium, however highwall/steep slope revetments or geogrid may be implemented to increase the stability of backfilled areas if soils do not exhibit the strength parameters modeled herein.

4.4 Post-Construction Monitoring and Intervention

See the discussion on post-construction monitoring and potential for intervention for the JNF Priority Sites that is presented in the last section of this document. Slope monitoring is a critical element of post-construction operations of the pipeline and the recommended procedures (including potential reclamation measures) are applicable to all of the JNF Priority Sites.

5.0 JNF Priority Site #5

Coordinates: (37.406782, -80.693608) to (37.403354, -80.690408)

5.1 Site Description and Geology

This site is located on the northwest side of Peters Mountain downslope from the bore pit, mostly subjacent to US Forest Service property on private lands, from approximately MP 196.0 to 196.3 on the October 2016 Proposed Route.

Slopes along this portion of the right of way range from 13 to 66 percent, and are generally steeper at the southern portion of the site, approaching the crest of Peters Mountain. The ridge is relatively wide with gentle side slopes. As shown on the plan view slope map of Figure 25, the pipeline in this area follows a wide ridge with gentle side slopes up Peters Mountain.

A profile of the site is shown on Figure 26. The pipeline will be approximately three feet below grade, with the bottom of the pipeline trench located approximately seven feet below grade. The trench will be backfilled with select backfill, which will be shaker bucket material from the native soil and rock. Cross section 5A is shown on Figures 27, 28, and 29, depicting the anticipated extent of trenching and stockpiled material before, during, and after construction. Figures 45 and 46 depict the construction-phase geometry of cross sections 4-1 and 4-2, including trees left to create the undulating right of way edge.

While separated by less than approximately 1,500 feet, the JNF Priority Site #3 is located in Virginia while the JNF Priority Site #5 is in West Virginia. Geologic mapping of Monroe County, West Virginia is not as well developed as that for Virginia. According to the Geologic and Economic Map of Monroe County, West Virginia (1925), the JNF Priority Site #5, located on the north-northwest facing slope of Peters Mountain within approximately 800 feet of the ridgeline, is underlain by the upper Ordovician Age Red Medina Formation and Martinsburg Series, which correspond to the Juniata Formation and undivided Reedsville Shale / Trenton Limestone, respectively, in Virginia. Closer to the ridge line, the White Medina and Red Medina Formation (corresponding to the Silurian Tuscarora and Rose Hill Formations in Virginia) form a series of steep slope benches. Consistent with the conditions observed at JNF Priority Site #3, bedrock strike is to the northeast (parallel to the Peters Mountain ridgeline), dipping to the south-southeast toward Virginia. In a general but not exact analog, JNF Priority Site #5 is consistent with JNF Priority Site #2, where the area is located north-northwest and downslope from the ridge line on bedrock that dips back into the mountain to the south-southeast.

Photo 12: White Medina (Tuscarora) sandstone forming ridgeline, dipping south-southeast back into the ridge (view is to the north)

Photo 13: Downslope to the north-northwest from the ridgeline near where slopes are reduced toward JNF Priority Site #5 (below bore pit), underlain by Martinsburg Series bedrock (view is to the west-southwest)

As noted above, the JNF Priority Site #5 is located downslope from the ridge line and downslope from the bore pit. This site is analogous to JNF Priority Site #2, with relatively thin residual soil overburden overlying clastic sedimentary bedrock.

5.2 Potential Slope Failure Hazards

At this site, potential slope failure hazards that were considered included rock failure, debris flow, remobilization of colluvial deposits, shallow failures of the stockpiled trench/topsoil, slope failures subjacent to stockpiles, failure of temporary slopes created during construction, post-construction erosion of the reclaimed right of way, shallow sloughing failures of the trench backfill, and water intrusion from seeps and springs encountered in the trench.

No jurisdictional waters have been identified in the vicinity of JNF Priority Site 5.

These hazards and associated mitigation and avoidance strategies are discussed in detail below.

5.2.1 Rock Failure

Rock-block failure involves gravity-induced movement of large, relatively intact blocks of bedrock on steep slopes. The bedrock mass is typically a complex geological body resulting from variable lithology, tectonic stresses and weathering that lead to differential loading and unloading. Rock-block failures typically occur where stronger bedrock units transition to weaker or weathered units and become undercut. Rock falls or topples entail abrupt movements of bedrock mass or boulders that detach along discontinuities (fractures, joints, bedding planes) or the forward rotation of a unit or units about some pivotal point. Movement occurs by free-fall, bouncing, and rolling. Falls are strongly influenced by gravity, mechanical weathering, and the presence of interstitial water. Field reconnaissance of the JNF Priority Site #5 did not reveal conditions that would lead to potential rock block failure. Bedrock is not exposed as over-steepened cliffs or ledges, is covered by soil overburden, and is likely stable in-place. Therefore, based on field observations of the JNF Priority Site #5 and planned construction activities, Mountain Valley considers the potential for rock failure to be so remote as to be negligible. No mitigation measures for rock failure are prescribed at JNF Priority Site #5.

5.2.2 Unconsolidated Overburden Failure

Field observations and geologic mapping indicate that the JNF Priority Site #5 is underlain by a residual soil mantle that overlies clastic sedimentary bedrock, generally similar to conditions observed at JNF Priority Site #2. As discussed above, the pipeline trench in the vicinity of JNF Priority Site #5 will be approximately seven feet below grade, likely within residual overburden and possibly upper reaches of stable shallow bedrock.

Major controls on the potential to initiate a landslide (unconsolidated overburden failure) include topographic gradient and orientation of the slope, bedrock structure, and topographic drainage features that concentrate surface and subsurface water during intense precipitation events. Mountain Valley evaluated overburden observed (as described above) at JNF Priority Site #5, coupled with the potential for extreme precipitation events, for consideration of failure risk during construction and long-term operation of the pipeline.

Slope Stability and Pipeline Integrity Analyses

Existing slope stability at the JNF Priority Site #5 was evaluated by establishing safety factors using a numerical model with input from field observations, probabilistic analysis of material properties and analyst experience. Slope failure risk analysis was approximated using the peer-reviewed slope stability program SLIDE (RocScience, Inc.). This model incorporates Bishop, Janbu and Spencer methods, generates circular, non-circular, and optimized shaped failure planes with seismic and boundary loads.

Observations of historical slope failures in other areas suggest that the likely slip plane will occur at the overburden-bedrock interface resembling an infinite slope failure. However, the depth of the slip surface within the colluvium material has a minimal effect on the Factor of Safety (FoS) (i.e., difference of less than 0.05). Therefore, the model simulates a failure surface near the overburden-bedrock interface to represent a failure with an adverse effect and not shallow, surficial sloughs.

A probabilistic model was applied to the colluvial soil shear strength (friction angle) and unit weight using highest and lowest conceivable values (Duncan, 2000). Stability analyses were run for slope angles ranging from 15% (9 degrees) to 76% (37 degrees). Modeling also accounted for saturated conditions and seismic loading (0.16 g; see Mountain Valley Pipeline Resource Report #6, seismic hazards analysis). Slope stability model output is provided in Appendix C. Table C-1 in Appendix C summarizes the full range of stability analysis results given the probabilistic analyses for input parameters soil density and friction angle, under increasing slope, saturated and unsaturated conditions, and with and without seismic loading.

In summary from Table C-1, based on likely residual soil density and friction angle values, the existing native overburden slopes at JNF Priority Site #5 are stable (minimum FoS of 1.1) up to at least 65% (33 degrees) native slopes under unsaturated conditions with no seismic loading, and 45% (24 degrees) native slopes with seismic loading. The analysis results suggest that average slopes at JNF Priority Site #5 are stable at an acceptable FoS under unsaturated conditions.

Under saturated conditions, risk for slope failure increases substantially. The model confirms what Mountain Valley has already accounted for in construction practices, that the largest effect on the FoS is soil saturation from groundwater intrusion, or surface water infiltration, to the colluvial deposit (i.e., as soils become saturated, stability decreases). As discussed, Mountain Valley is aware of the need to prevent accumulation of storm water during construction, permanently divert subsurface springs or seeps from the pipeline bedding and near vicinity if encountered during construction, and to properly grade and reclaim the ground surface in the LOD after construction. Preventing saturated conditions on these steep slope environments is a critical factor in maintaining slope stability. The project stormwater management plans and subsurface drains implemented during construction will address the issue of overburden saturation.

The analysis suggests there is minimal risk of ground displacement, thus the effects of displacement on the pipeline have not been analyzed. As discussed later in this document, Mountain Valley will implement a post-construction slope monitoring program. If future monitoring observations suggest slope movement is occurring, Mountain Valley will take appropriate actions to stabilize the slope and will evaluate pipeline response to the nature and degree of observed ground displacement using the recommendations provided in PRCI (2009).

5.2.3 Soil Stockpile and Subjacent Slope Failure

Soil stockpiles will be compacted with tracked equipment. Excavation and backfilling will be completed as quickly as possible to minimize the duration of stockpiling. At JNF Priority Site #5, the contractor will install a temporary backstop, such as reinforced silt fence, to prevent rocks from rolling/sliding off of the ROW.

Mountain Valley completed additional slope stability and sensitivity analysis in February, 2018, that shows that no spoil materials should be stored on slopes exceeding 77 percent. Spoil materials resembling the strength parameters for USCS soil type GP should not be stockpiled on slopes exceeding 63 percent; spoil materials resembling the strength parameters for USCS soil type GC should not be stockpiled on slopes exceeding 77 percent. Supporting slope stability analyses are included in Appendix C. A slope map depicting the slope conditions discussed above is included as Figure 52.

In areas of the ROW steeper than 63 percent, spoil will be evaluated by Mountain Valley's field geologist to determine which soil type it most closely resembles. If the spoil resembles the strength parameters for GP material, it will be moved to a flatter area temporarily during construction, then moved back during final restoration. No slopes exceeding 66 percent exist at JNF Priority Site #5, thus no areas are excluded from spoil storage.

Field observations revealed a thin soil mantle and spoil stockpiles will be stored on bedrock. Thus, overloading the subjacent slope at JNF Priority Site #5 is not anticipated to occur and does not present a technical concern for construction in this area. Temporary spoil stockpiles stored on rock will be internally stable with a factor of safety of at least 1.2 as demonstrated in Appendix C.

5.2.4 Temporary Cut Failures

Cut slopes created during construction at JNF Priority Site #5 are limited to the pipeline trench and associated side slopes. Cut slopes will not exceed the maximum safe angle per OSHA standards for the type of material being excavated. As any cuts made temporarily during construction will be reclaimed with native material (buttressing the cut slope) placed to original contours as practicable, cut slopes are expected to be stable in the long term.

5.2.5 Erosion

Erosion hazards will be mitigated by following the project Erosion and Sediment Control Plan (E&SCP). Refer to the E&SCP for details.

5.2.6 Trench Backfill Failures

The pipeline trench will be provided with trench breakers at locations specified in the project E&SCP. These trench breakers will act as gravity retaining walls within the trench to hold the backfill in place during construction and will slow the velocity of water running through the trench, preventing subsurface erosion. Every third trench breaker at this location will be provided with daylight drains, as shown on typical drawing MVP-35, discharging water building up in the trench to water dissipation devices at the ground surface. All trench breakers not provided with daylight drains will be provided with pass-through drains as shown on typical drawing MVP-43. Trench backfill is anticipated to be stable with a factor of safety of at least 1.5 as demonstrated in the slope stability analysis in Appendix C.

5.2.7 Seeps and Springs

As the presence of seeps/springs encountered in the pipeline trench or temporary construction excavation will not be known until the trench is excavated, their location and extent cannot be determined at this time. At JNF Priority Site #5, seepage (if any is encountered) will be captured by daylight drains behind the trench breakers, as shown on typical drawing MVP-35, or with transverse trench drains as shown on typical drawing MVP-38. These drains will outlet to energy dissipation devices at the right-of-way ground surface. Trench breaker locations are shown on the E&SCP.

5.3 Bore Pit

It should be noted that stability of the bore pit is not considered herein. Temporary shoring will be developed by the bore contractor to all applicable safety standards to protect both the open bore pit and the stockpiled spoil material excavated from the bore pit. The landslide inspection team will evaluate the site to determine if any mitigation measures, in addition to those proposed by the contractor, are necessary.

5.4 Mitigation Measures

Overall best management practices include:

- controlling surface runoff from the limit of disturbance and the reclaimed construction area to prevent direct flow into exposed debris flow or colluvial deposit;
- intercepting and controlling subsurface drainage from the excavation during construction and post-construction to prevent subsurface infiltration into the underlying debris flow or colluvial deposit;
- and constructing in a timely fashion to reduce the amount of time when the limit of disturbance is exposed to the elements and not under final grade.

Subsurface conditions observed during construction may dictate the use of enhanced mitigation measures. Site-specific observations made by the Mountain Valley landslide inspection team during construction may result in the team's recommendation for deployment of additional specific mitigation measures, which consider potential native ground movement around or below the ROW, disturbed temporary ground surface movement from initial grading and subsequent construction work and finished and restored ROW surface.

Based on field observations during construction, Mountain Valley may implement slope breakers, water bars, additional grading, French drains, armored slopes and/or ditches as enhanced drainage control measures to promote slope stability. Mountain Valley does not anticipate that structures will be required to stabilize bedrock within the trench excavation, or adjacent native soils or colluvium, however highwall/steep slope revetments or geogrid may be implemented to increase the stability of backfilled areas if soils do not exhibit the strength parameters modeled herein.

5.5 Post-Construction Monitoring and Intervention

See the discussion on post-construction monitoring and potential for intervention for the JNF Priority Sites that is presented in the last section of this document. Slope monitoring is a critical element of post-construction operations of the pipeline and the recommended procedures (including potential reclamation measures) are applicable to all of the JNF Priority Sites.

6.0 JNF Priority Site #6

Coordinates: (37.324447, -80.415421) to (37.320149, -80.412061)

6.1 Site Description and Geology

This site is located near the crest of Sinking Creek Mountain from approximately MP 218.5 to 218.9 on the October 2016 Proposed Route.

Slopes along this portion of the right of way range from nearly flat to 81 percent , and are generally steepest approaching the crest of Sinking Creek Mountain. As shown on the plan view slope map of Figure 30, the pipeline follows a ridge just downslope of the mountain's crest.

A profile of the site is shown on Figure 31. The pipeline will be approximately three feet below grade, with the bottom of the pipeline trench located approximately seven feet below grade. The trench will be backfilled with select backfill, which will be shaker bucket material from the native soil and rock. Cross section 6A is shown on Figures 32, 33, and 34, depicting the anticipated extent of trenching and stockpiled material before, during, and after construction. Figure 47 depicts the construction-phase geometry of cross section 6-1, including trees left to create the undulating right of way edge.

According to Rader and Gathright (1986) the geology of the JNF Priority Site #6 vicinity is highly folded and thrust-faulted sedimentary bedrock (typical of the Valley and Ridge geologic province of Virginia). Bedrock underlying the JNF Priority #6 site is mapped as northeast striking and moderately-to-steeply dipping (generally 45-50^{o}) Silurian age Rose Hill Formation conformably in contact with the older Tuscarora Formation (red shales, mudstone, fine to medium red to gray to white sandstones and quartzite). Both the Rose Hill and Tuscarora Formations were observed to outcrop on the ridge line in different exposures (see Photo 15 and Photo 16, below). The older Tuscarora Formation is conformably in contact with the Rose Hill downslope to the south-southeast.

Photo 14: Tuscarora Formation sandstone observed to outcrop at the ridge line (view is to the southwest)

Photo 15: Further to the southwest, the Rose Hill Formation sandstones outcrop at the ridge line (view is to the southwest)

Field reconnaissance of the JNF Priority Site #6 confirmed a near-horizontal portion of the slope within approximately 800 feet downslope (south) of the ridge line that corresponds to the rock-block slump, and a steep slope leading up to the ridge line (north-northwest) that is primarily the result of a release of the rock-block when it slumped.

Photo 17: View of the shallow slope apparently formed by rock-block slump, viewed toward the ridge line that is somewhat visible by trees in background defined by skyline approximately 800 feet to the west (view is to the west-southwest)

Photo 16: South extent of the shallow slope formed by an apparent rock-block slump downslope from the ridge line (view is to the northeast)

The rock-block slump is mapped as Tuscarora Formation sandstone by Schultz (1993). See the exhibit presented below, excerpted from Schultz (1993), showing the proposed alignment as the red dashed line, crossing the approximately 1,500 by 500 feet ancient rock-block slump (Stk) on the southeast slope of Sinking Creek mountain.

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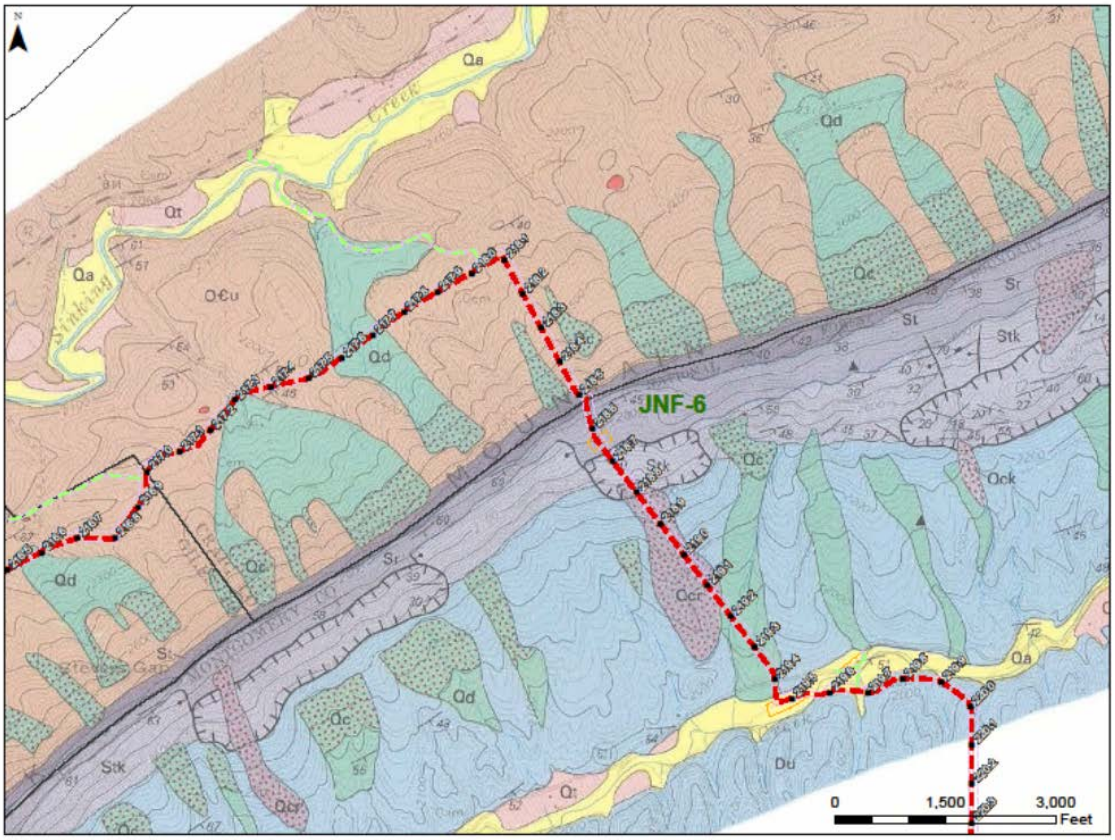


Base map: Schultz, 1993

Continuing downslope, the pipeline is mapped as crossing colluvium (Qcr in the exhibit above), derived from the Rose Hill Formation and consisting of debris transported downslope from the ridgeline and rock-block slide. Field reconnaissance revealed hummocky terrain, abundant Rose Hill and Tuscarora float at the ground surface and a well graded agglomeration of fine-to-coarse sand, pebbles, cobbles and boulders of Rose Hill and Tuscarora (observed in tree-fall root balls) that are characteristic of the ancient debris flow (see Photo 19, below).

Photo 17: Hummocky ground with variable size float (boulders, cobbles, pebbles, sand, silt) that corresponds to a mapped debris flow downslope (to the south-southeast) from the rock-block slump feature (view is to the south-southeast)

6.2 Potential Slope Failure Hazards

At this site, potential slope failure hazards that were considered included continued rock-block slumping, debris flow, remobilization of colluvial deposits, shallow failures of the stockpiled trench/topsoil, slope failures subjacent to stockpiles, failure of temporary slopes created during construction, post-construction erosion of the reclaimed right of way, shallow sloughing failures of the trench backfill, and water intrusion from seeps and springs encountered in the trench.

Stream S-PP22 has been delineated near the southern portion of the site.

These hazards and associated mitigation and avoidance strategies are discussed in detail below.

6.2.1 Rock Failure

Rock-block failure involves gravity-induced movement of relatively intact blocks of bedrock overlying weaker or weathered units on critical slopes. The bedrock mass is typically a complex geological body resulting from variable lithology, tectonic stresses and weathering that lead to differential loading and unloading. Rock-block failure is commonly controlled by discontinuities or failure planes (e.g., bedding, folds, joints, and faults) within the rock mass. The distribution of discontinuities affects the mechanical strength of the rock mass (i.e., bonding force and friction coefficient). Trigger events for rock falls are primarily associated with pore pressure effects from sustained long-duration or short-duration intense precipitation events, and freeze-thaw weathering (Schultz and Southworth, 1987, 1989; Wieczorek and Snyder, 2009). Some researchers postulate that seismic shaking may trigger slope failure, but no direct evidence is available to support this suggestion. D.G. Honegger Consulting (2015) presents an analysis and recommendations for mitigating seismic-induced risks to the pipeline.

Field reconnaissance of the JNF Priority Site #6 reveal conditions that confirm the presence of an ancient rock-block failure structure. Pipeline construction in the vicinity of the slumped rock-block will entail trenching to approximately seven feet below grade and will likely remain within overlying residual overburden or possibly encounter the upper reaches of the weathered bedrock. The particular rock-block near JNF Priority Site #6 is approximately 1,500 feet by 500 feet in dimension, and these blocks are typically dozens of feet think. It is not anticipated that pipeline construction will affect the stability of the rock-block, given that failure conditions have already occurred (in ancient times) and the rock-block is likely stable at its current repose. Therefore, Mountain Valley considers the risk for activation of the rock-block to be negligible, and no further analysis was conducted.

Upslope of the rock-block, in the vicinity of JNF Priority Site #6, pipeline construction will encounter the Silurian Age ridge-forming sandstones (Rose Hill and Tuscarora Formations). As noted, pipeline construction at the ridge line will likely only be seven feet below grade, and Mountain Valley anticipates being able to rip these jointed, dipping bedrock exposures. Under this relatively controlled construction practice, Mountain Valley does not anticipate increased risks for rock fall or tumble at this location.

6.2.2 Debris Flow / Colluvial Deposit

Schultz (1993) mapped a debris flow downslope (south-southwest) of the JNF Priority Site #6. Debris flows are generally considered to be high-energy, rapid downslope movement of earth material that can entrain trees and other large objects in the flow path. A debris flow differs from rock-block slide in that there are no well-defined blocks moving along shear surfaces. Instead, the mass flows downhill, with shear strains present everywhere. Debris flows generally occur during intense precipitation events, and travel rapidly downslope along existing drainage channels or stream valleys, transporting and depositing mud, sand, gravel, and boulders where the slope gradient flattens. Multiple debris flows may coalesce into a central channel downslope from the points of initiation.

Colluvial deposits are also mapped downslope of the JNF Priority Site #6, which may be derived from past debris flow(s), or other forms of mass wasting. Debris flows are grouped with colluvial deposits for this analysis because pipeline construction within, or in the vicinity of an observed colluvial deposit entails similar precautions to that for a debris flow.

Major controls on the potential to initiate a debris flow include topographic gradient and orientation of the slope, bedrock structure, and the accumulation of historic debris flows in topographic drainage features that concentrate surface and subsurface water during intense precipitation events. Field observations of the JNF Priority Site #6 suggest that topographic and bedrock conditions are not susceptible for generating a new debris flow at the JNF Priority #6 site. However, debris flow and colluvial deposit(s) observed at, and in the near vicinity of, the site (as described above), coupled with the potential for extreme precipitation events, warrant consideration for construction and long-term operation of the pipeline.

Slope Stability and Pipeline Integrity Analyses

Existing slope stability at the JNF Priority Site #6 was evaluated for potential debris flow conditions, and colluvial deposit failure, by establishing safety factors using a numerical model with input from field observations, probabilistic analysis of material properties and analyst experience. Slope failure risk analysis was approximated using the peer-reviewed slope stability program SLIDE (RocScience, Inc.). This model incorporates Bishop, Janbu and Spencer methods, generates circular, non-circular, and optimized shaped failure planes with seismic and boundary loads.

As discussed above, the JNF Priority Site #6 is situated near an ancient debris flow mapped downslope of a rock-block slump. The debris flow and what is interpreted to be either related or younger colluvial deposits, overlie clastic sedimentary bedrock. Pipeline trenching in the vicinity of JNF Priority Site #6 will be approximately seven feet below grade, and is anticipated to remain within the debris flow (i.e., we anticipate that the debris flow is deeper than seven feet; no bedrock outcrops were observed in the vicinity). Observations of historical slope failures in other areas suggest that the likely slip plane will occur at the overburden-bedrock interface resembling an infinite slope failure. However, the depth of the slip surface within the debris flow and related colluvium has a minimal effect on the FoS (i.e., difference of less than 0.05). Therefore, the model simulates a failure surface near the overburden-bedrock interface to represent a failure with an adverse effect and not shallow, surficial sloughs.

A probabilistic model was applied to the debris flow and colluvial soil shear strength (friction angle) and unit weight using highest and lowest conceivable values (Duncan, 2000). Stability analyses were run for slope angles ranging from 15% (9 degrees) to 76% (37 degrees). While limited areas of slope exceeding this range exist at JNF Priority Site #6, they are likely composed of rocky outcrops and not colluvium. Modeling also accounted for saturated conditions and seismic loading (0.16 g; see Mountain Valley Pipeline Resource Report #6, seismic hazards analysis).

The output files for results of each analysis at the likely soil parameters are included in Appendix C. Table C-1 in Appendix C summarizes the full range of stability analysis results given the probabilistic analyses for input parameters soil density and friction angle, under increasing slope, saturated and unsaturated conditions, and with and without seismic loading.

In summary from Table C-1, based on likely colluvial material density and friction angle values, the existing colluvial deposit slopes at JNF Priority Site #6 are stable (minimum FoS of 1.1) up to at least 65% (33 degrees) native slopes under unsaturated conditions with no seismic loading (the maximum slope near JNF Priority Site #6 is 63%, with an average of 34%). Under seismic loading, unsaturated native slopes are stable (minimum FoS of 1.1) up to 45% (24 degrees). See discussion below on post-construction monitoring of native slopes.

Under saturated conditions, risk for slope failure increases substantially. The model confirms what Mountain Valley has already accounted for in construction practices, that the largest effect on the FoS is saturation from groundwater intrusion, or surface water infiltration, to the colluvial deposit (i.e., as soils become saturated, stability decreases). As discussed, Mountain Valley is aware of the need to prevent accumulation of storm water during construction, permanently divert subsurface springs or seeps from the pipeline bedding and near vicinity if encountered during construction, and to properly grade and reclaim the ground surface in the LOD after construction. Preventing saturated conditions on these steep slope environments, particularly under conditions of an ancient debris flow, is a critical factor in maintaining slope stability. The project stormwater management plans and subsurface drains implemented during construction will address the issue of overburden saturation.

The analysis suggests there is minimal risk of ground displacement. From the perspective of pipeline integrity and safety, D. G. Honegger Consulting (2015) indicated that slope displacements parallel to the proposed alignment can be screened out as not representing a significant hazard if the length of pipeline exposed to ground displacement is less than 1,150 feet (Class 1 pipe) to 1,640 feet (Class 3 pipe) from the top of the slope (screening approach assumes a relatively straight line with no connections or insulated joints in the screening distance). While Mountain Valley does not anticipate any slope failure to occur, it is even more unlikely that failure on the magnitude of 1,000’s of feet. Thus the effects of displacement on the pipeline have not been analyzed. As discussed later in this document, Mountain Valley will implement a post-construction slope monitoring program. If future monitoring observations suggest slope movement is occurring, Mountain Valley will take appropriate actions to stabilize the slope and will evaluate pipeline response to the nature and degree of observed ground displacement using the recommendations provided in PRCI (2009).

6.2.3 Soil Stockpile and Subjacent Slope Failure

Soil stockpiles will be compacted with tracked equipment. Excavation and backfilling will be completed as quickly as possible to minimize the duration of stockpiling. At JNF Priority Site #6, the contractor will install a temporary backstop, such as reinforced silt fence, to prevent rocks from rolling/sliding off of the ROW.

Mountain Valley completed additional slope stability and sensitivity analysis in February, 2018, that shows that no spoil materials should be stored on slopes exceeding 77 percent. Spoil materials resembling the strength parameters for USCS soil type GP should not be stockpiled on slopes exceeding 63 percent; spoil materials resembling the strength parameters for USCS soil type GC should not be stockpiled on slopes exceeding 77 percent. Supporting slope stability analyses are included in Appendix C. A slope map depicting the slope conditions discussed above is included as Figure 53.

In areas of the ROW steeper than 63%, spoil will be evaluated by Mountain Valley's field geologist to determine which soil type it most closely resembles. If the spoil resembles the strength parameters for GP material, it will be moved to a flatter area temporarily during construction, then moved back during final restoration. No spoil will be stored on slopes exceeding 77 percent.

In steeper areas of the ROW, spoil stockpiles will be stored on bedrock with little soil overburden. Thus, overloading the slope in the steeper regions of the JNF Priority Site #6 does not present a technical concern for construction in these steeper areas. Temporary spoil stockpiles stored on rock will be internally stable with a factor of safety of at least 1.2 as demonstrated in Appendix C.

Colluvial deposits were observed in the flatter portions of the site. Stability of the native material underlying spoil stockpiles is of concern. The spoil will be spread out across the workspace to the extent practicable to avoid overloading the in-situ colluvial soils. Stockpiles will be compacted via rolling with dozers to prevent water infiltration and saturation of the material and thus minimize the weight of the stockpiled soil.

A geologist from the landslide inspection team deployed by Mountain Valley during construction will evaluate the subgrade to determine whether or not it is appropriate to stockpile soils in the vicinity of the colluvial deposit. The exact thickness of the colluvial deposit will not be fully determined until excavation is initiated, but as previously described, as colluvial debris generally follow ravines and drainage paths and the pipeline ROW is located on a ridge, it is unlikely that the colluvial deposit is extremely thick in the workspace area. Therefore, soils may be sufficiently thin that instability due to stockpiled material is not a concern. If the colluvial deposit is well-consolidated and relatively dry, material may be stored on top of it, at the discretion of the geologist. If colluvial deposits exceed about five feet, spoil stockpiles will be moved up or downslope to a more stable area to avoid overloading the colluvial deposit and initiating a failure.

6.2.4 Temporary Cut Failures

Cut slopes created during construction at JNF Priority Site #6 are anticipated to be minor (less than about five feet in height) and located in rock. Cut slopes will not exceed the maximum safe angle per OSHA standards for the type of material being excavated. If temporary cut slopes encounter colluvium, the slopes will be appropriately sloped to mitigate slope failure. Temporary rock cuts are anticipated to be stable in the long-term following reclamation as they will be protected by compacted native material placed to original contours as practicable.

6.2.5 Erosion

Erosion hazards will be mitigated by following the project Erosion and Sediment Control Plan E&SCP. Refer to the E&SCP for details.

6.2.6 Trench Backfill Failures

The pipeline trench will be provided with trench breakers at locations specified in the project E&SCP. These trench breakers will act as gravity retaining walls within the trench to hold the backfill in place during construction and will slow the velocity of water running through the trench, preventing subsurface erosion. Every third trench breaker at this location will be provided with daylight drains, as shown on typical drawing MVP-35, discharging water building up in the trench to water dissipation devices at the ground surface. All trench breakers not provided with daylight drains will be provided with pass-through drains as shown on typical drawing MVP-43.

As the trench backfill will be placed in compacted lifts, Mountain Valley anticipates that the trench backfill will be at least as stable as the distal extent of in-situ colluvial deposits, if encountered. Backfill is anticipated to be stable with a safety factor of at least 1.5 as demonstrated in the slope stability analysis of Appendix C. The landslide inspection team may recommend installing additional slope breakers or steep slope revetments in the trench backfill in steeper portions of the site if backfill does not exhibit the strength parameters used in the slope stability model.

6.2.7 Seeps and Springs

As the presence of seeps/springs encountered in the pipeline trench will not be known until the trench is excavated, their location and extent cannot be determined at this time. At JNF Priority Site #6, seepage (if any is encountered) will be captured by daylight drains behind the trench breakers, as shown on the typical drawing MVP-35. These drains will outlet to energy dissipation devices at the right-of-way ground surface and any resulting discharge will be directed downslope to prevent accumulation within the limit of disturbance. Trench breaker locations are shown on the project E&SCP.

6.3 Mitigation Measures

Overall best management practices include:

- controlling surface runoff from the limit of disturbance and the reclaimed construction area to prevent direct flow into exposed debris flow or colluvial deposit;
- intercepting and controlling subsurface drainage from the excavation during construction and post-construction to prevent subsurface infiltration into the underlying debris flow or colluvial deposit;
- and constructing in a timely fashion to reduce the amount of time when the limit of disturbance is exposed to the elements and not under final grade.

Subsurface conditions observed during construction may dictate the use of enhanced mitigation measures. Site-specific observations made by the Mountain Valley landslide inspection team during construction may result in the team's recommendation for deployment of additional specific mitigation measures, which consider potential native ground movement around or below the ROW, disturbed temporary ground surface movement from initial grading and subsequent construction work and finished and restored ROW surface.

Based on field observations during construction, Mountain Valley may implement slope breakers, water bars, additional grading, French drains, armored slopes and/or ditches as enhanced drainage control measures to promote slope stability. Mountain Valley does not anticipate that structures will be required to stabilize bedrock within the trench excavation, or adjacent native soils or colluvium, however highwall/steep slope revetments or geogrid may be implemented to increase the stability of backfilled areas if soils do not exhibit the strength parameters modeled herein.

6.4 Post-Construction Monitoring and Intervention

See the discussion on post-construction monitoring and potential for intervention for the JNF Priority Sites that is presented in the last section of this document. Slope monitoring is a critical element of post-construction operations of the pipeline and the recommended procedures (including potential reclamation measures) are applicable to all of the JNF Priority Sites.

7.0 Topsoil

During construction, topsoil will be segregated throughout the Jefferson National Forest. It will be stockpiled along the edge of the temporary workspace. Spoil piles will be temporarily stabilized with seed and mulch in accordance with the USFS guidance documents (*Suggested Seed Mixes for Pipeline Right-of-Ways and Associated Disturbances on the Monongahela and George Washington – Jefferson National Forests* – November 2016; and *Suggested Seeding Techniques for Pipeline Right-of-Ways and Associated Disturbances on the Monongahela and George Washington – Jefferson National Forests* – November 2016). Stockpiled soils and areas to remain inactive (excluding the travel lane) for a period exceeding 30 days shall be stabilized within 14 days of initial disturbance. During final restoration, the temporary workspace ground surface will be roughened and the topsoil will be replaced across it. The surface will be seeded within 14 days of final reclamation to stabilize the topsoil and promote vegetation growth. Mountain Valley has received recommended seed mixes from the USFS and plans to implement those mixes throughout the JNF.

8.0 Slope Stability Monitoring Program

After pipeline construction and land reclamation are completed, Mountain Valley will implement a monitoring program to verify slope stability and provide Mountain Valley with early-warning detection of subtle ground movement that may indicate incipient slope failure. If subtle ground movement is detected, the monitoring program will trigger Mountain Valley's post-construction slope evaluation and mitigation, described below. Recommendations for slope failure mitigation are discussed in Section 8.3, below. More specific mitigation measures will depend upon the results of the monitoring program, and the landslide inspection team's field observations on actual conditions.

Mountain Valley will construct the pipeline with safeguards to prevent slope failure under the various potential mechanisms addressed at the Priority Sites. Mountain Valley does not consider it sound practice to establish a construction area that requires repeated interim measures to maintain slope stability.

8.1 LiDAR Surveys

Given the remote access and steep slopes in the vicinity of the Jefferson National Forest, Mountain Valley proposes to utilize aerial LiDAR surveys on a prescribed periodic basis (discussed below) to monitor the ROW for changes in ground topography that could be indicators of potential slope movement.

LiDAR works by emitting multiple laser pulses over the same area, such that some pulses are reflected off intermediate surfaces (i.e. variable height vegetation, buildings, power lines, etc.) and some of the pulses find the underlying ground surface. The resulting data are processed to classify data that represent the ground surface (i.e., generate a bare Earth model), providing a detailed topographic and geomorphic landform model to detect subtle ground morphologies that define natural and human-triggered landslide and erosion hazards (i.e. scarps, settlement, hummocky terrain, depletion zones, accumulation zones, sag ponds, disrupted drainage, etc.).

A progression of LiDAR data collected over time on a slope of concern will be compared to historical data in order to identify whether subtle landform changes are occurring that could correspond with possible land movement or subsidence. The sequential LiDAR models of the area of concern will be configured as a "heat map" to more clearly identify slope changes.

8.2 Monitoring Schedule

Mountain Valley's monitoring program will use LiDAR data to provide detailed ground surface mapping on slopes after construction is complete. LiDAR data detects subtle ground movement that can be used to surveille for potential impending slope failure. If ground movement is perceived via LiDAR monitoring (analysis is discussed below), direct slope inspection will take place. The intent is to mitigate subtle slope movements before larger failures occur.

Mountain Valley will conduct semiannual aerial LiDAR monitoring during an initial two-year period after construction is complete. This spans a critical period of time post-construction to confirm that land reclamation is established, and that slopes are stable through two freeze-thaw cycles. Continued monitoring described below will be used to confirm these conclusions.

If the slopes in the area of concern are demonstrated to be stable by sequential LiDAR monitoring data for the initial two years of semiannual monitoring (described above), the frequency of LiDAR survey will be reduced to annually for another two consecutive years. This will provide six LiDAR monitoring events over the span of four years in order to detect potential subtle slope movement.

If the slopes are demonstrated to be stable by sequential LiDAR monitoring data for the combined four years of monitoring (i.e., the initial two years of semiannual monitoring, followed by two years of annual monitoring), the frequency of LiDAR surveys will be further reduced to a five-year periodicity throughout the life of the pipeline.

As each new sequential LiDAR survey is completed (see monitoring schedule above), the data will be processed and compared to all historical LiDAR data (i.e., to produce a "heat map" of slope movement) to evaluate for potential ground movement over time.

If slope reclamation is required in the area of concern, Mountain Valley will remediate the area per the landslide inspection team's recommendations, and re-start the six-month / annual / five-year monitoring frequency to document that slope stability is achieved.

8.3 Slope Stability Mitigation Measures

If slope movement is detected by the LiDAR monitoring program, Mountain Valley will notify the appropriate U.S. Forest Service representative, and then engage a landslide inspection team to complete field verification and confirm actual conditions and governing reasons for the topographic changes. Recommendations for slope stability remedial measures will be provided to Mountain Valley based on the landslide inspection team's observations.

Once Mountain Valley has received recommendations from the landslide inspection team, Mountain Valley will notify the U.S. Forest Service of planned remediation activities, and offer the proposed remediation to the U.S. Forest Service for review.

Examples of potential redial measures:

- If slope movement is confirmed in surficial backfill in the ROW, enhanced backfill compaction (or replacement with engineered materials), enhanced water management, and aggressive revegetation will be implemented.
- If slope movement in native earth material outside of the ROW is confirmed, the landslide inspection team will provide recommendations to Mountain Valley for remediation measures.
- If the movement may have stressed the pipe, a stress relief excavation may be required to allow the pipeline to rebound to the non-stress condition prior to slope movement. Stress relief excavations typically start in the middle of the area where slope movement is observed, and extend in either direction until no rebound is observed, and generally continue for a minimum of an additional 50 feet. Surveys may be required during the excavation work to track pipeline rebound, and to confirm before and after pipeline location and elevation. Stress relief excavations would only be contemplated for relatively large-scale movement scenarios.
- Mountain Valley may also consider installing strain gauges on the pipeline during stress-relief excavation. The strain gauges would monitor potential accumulated pipeline strain in the future if differential ground movement continues. Strain gauge monitoring would be conducted manually on a yearly basis, unless LiDAR monitoring under the post-remediation timeframe continues to identify large-scale slope movement, in which case the strain gauges will be monitored on a six-month basis. Strain gauges would only be contemplated for relatively large-scale movement scenarios.

9.0 References:

Duncan, M. J. (2000). Factors of Safety and Reliability in Geotechnical Engineering, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 126, No. 4, April, 2000, pp 307-316.

D.G. Honegger Consulting (2015). Review of Potential Seismic Hazards Along the Proposed Route of the Mountain Valley Pipeline. Letter dated September 19, 2015 from D.G. Honegger Consulting to Mountain Valley Pipeline LLC.

Geologic Map of Virginia (1993). Commonwealth of Virginia, Department of Mines, Minerals, and Energy, Division of Mineral Resources, Charlottesville, VA.

Geology and Economic Geology (1925). Map IV, Monroe County, West Virginia. David B. Reger. West Virginia Geological Survey. 1925.

The INGAA Foundation, Inc. (2016). Mitigation of Land Movement in Steep and Rugged Terrain for Pipeline Projects: Lessons Learned from Constructing Pipelines in West Virginia.

PRCI (2009). Guideline for Constructing Natural Gas and Liquid Hydrocarbon Pipelines Through Areas Prone to Landslide and Subsidence Hazards. Final Report deliverable for Pipeline Research Council International Project ENV-1 Pipeline Integrity Management for Geohazards. Authors include C-CORE, D.G. Honegger Consulting, and SSD, Inc.

Rader, E. K. and Gathright, T. M (1986). Geologic Map of Giles County, Virginia. Virginia Division of Mineral Resources, Publication 69, Commonwealth of Virginia, Department of Mines, Minerals, and Energy, Division of Mineral Resources, Charlottesville, VA.

Schultz, A. P. (1993). Geologic Map of Large Rock Block Slides at Sinking Creek Mountain, Appalachian Valley and Ridge Province, Southwestern Virginia, and Comparison with the Colorado Front Range. U.S. Geological Survey, Miscellaneous Investigation Series, Map I-2370. U.S. Department of the Interior.

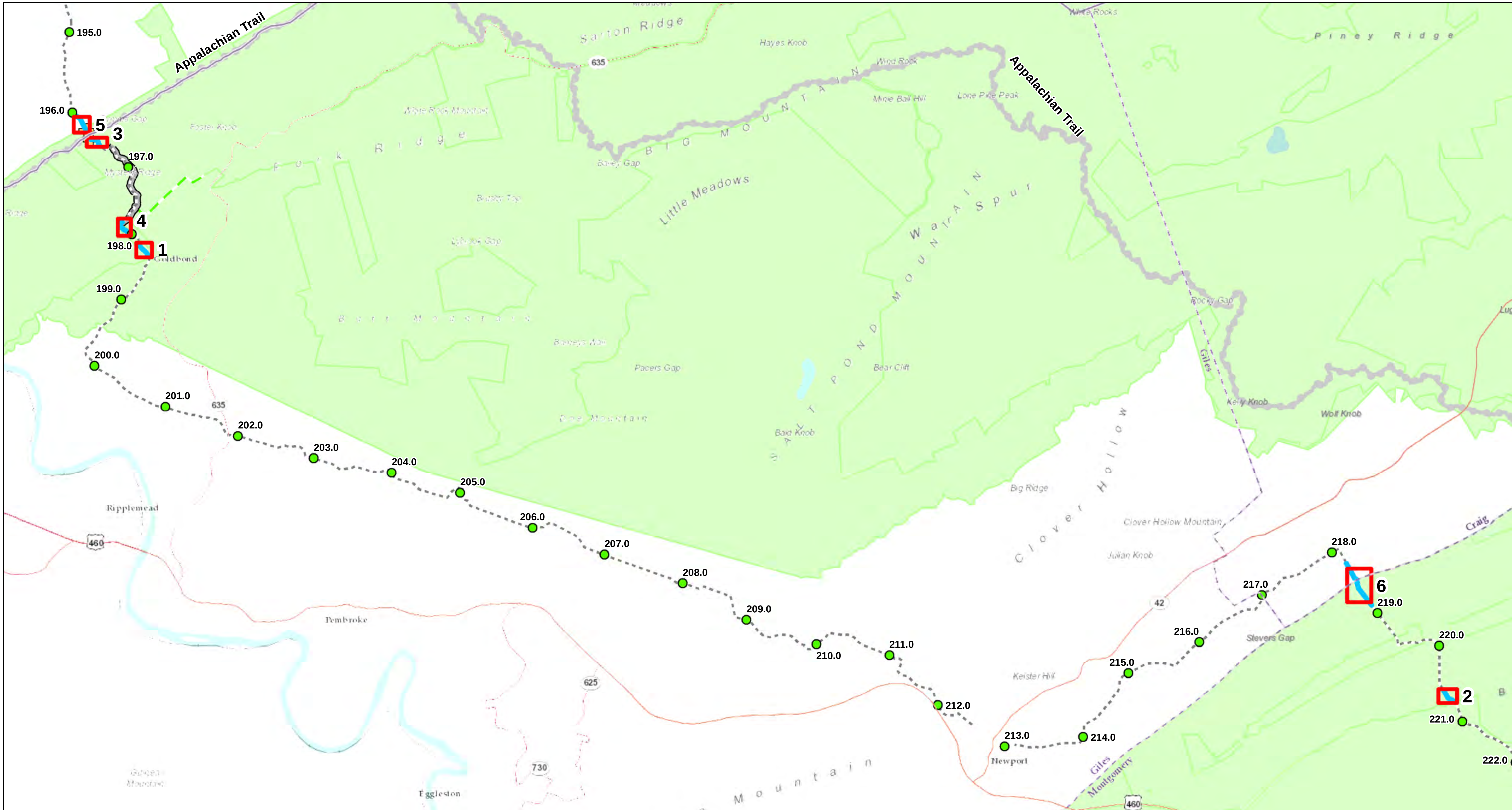
Schultz, A. P., and Southworth, C. S. (1987). Landslides of Eastern North America. Papers presented at the Southeastern Section Geological Society of America Symposium, March 26, 1987. U.S. Geological Survey Circular 1008.

Schultz, A. P., and Southworth, C. S. (1989). Large Bedrock Landslides of the Appalachian Valley and Ridge Province of Eastern North America. Geological Society of America Special Paper 236, p 57-74.

Schultz, A. P. and Stanley, C. B. (2001). Geologic map of the Virginia portion of the Lindside Quadrangle, Virginia. Publication 160 Virginia Division of Mineral Resources; Cooperative Geological Mapping Program, U.S. Geological Survey.

Wieczorek, G. F. and Snyder, J. B. (2009). Monitoring Slope Movements. in Young, R., and Norby, L., Geological Monitoring: Boulder, Colorado, Geological Society of America, p. 245-271.

Appendix A – Figures



Mountain Valley PIPELINE

SLOPE MAP - FIGURE 1
JEFFERSON NATIONAL FOREST
PRIORITY SITE OVERVIEW

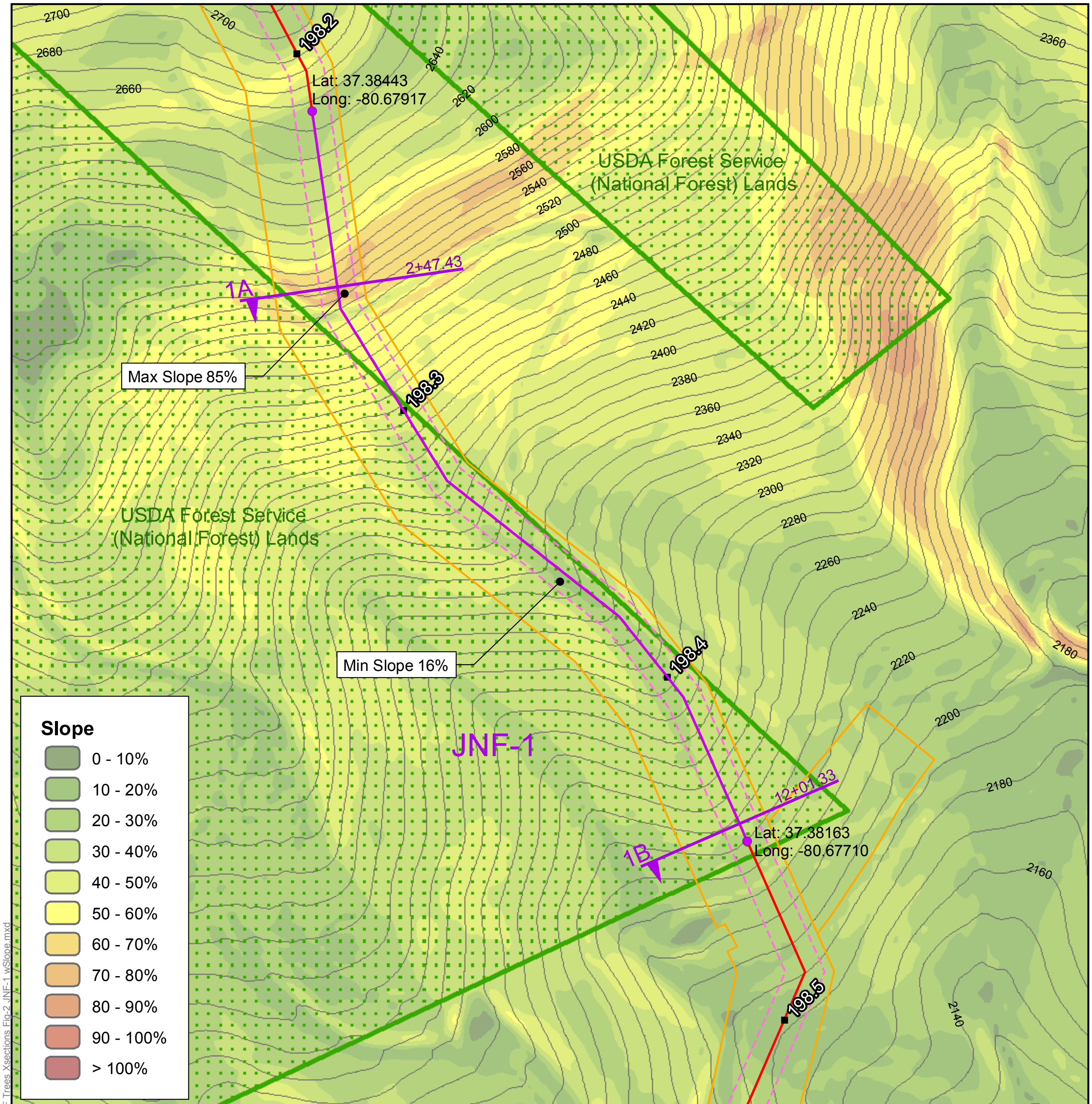
0 1 2 3 Miles

11/30/2016

N S E W

LEGEND

- Jefferson National Forest Review Sites
- October 2016 Proposed Route Milepost
- October 2016 Proposed Route



Mountain Valley Pipeline Project

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1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 2, Site 1

Jefferson National Forest

Slope Map and
Representitive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

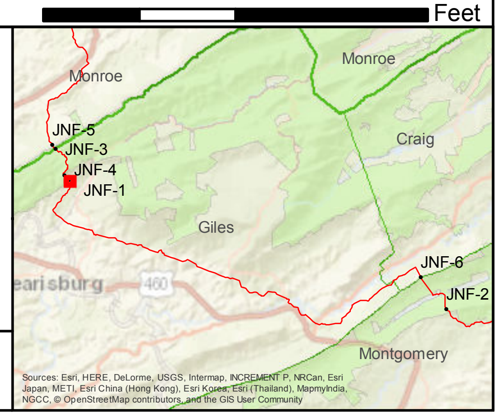
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees) (none)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate



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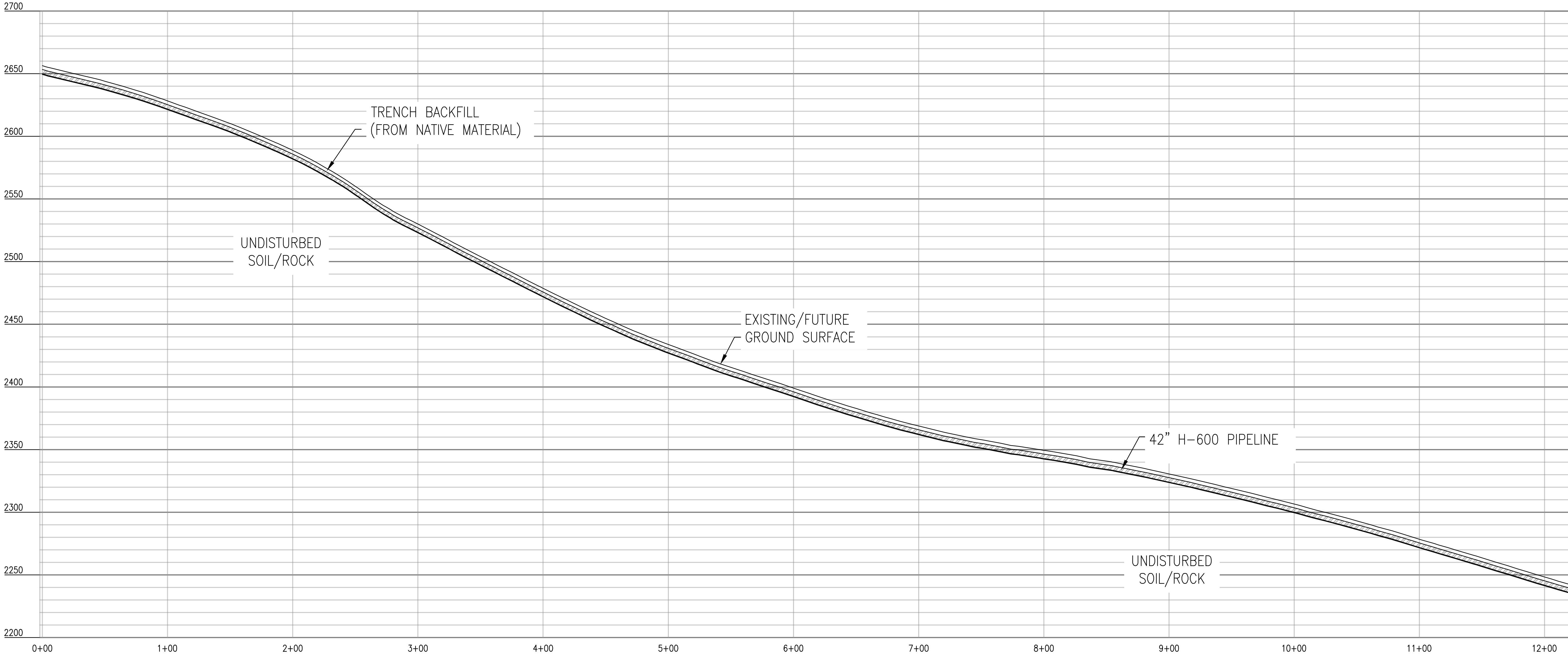
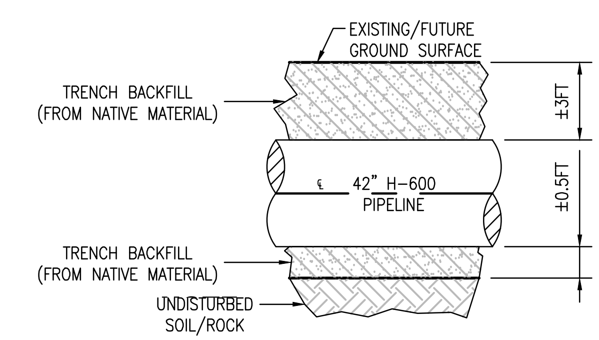


PROFILE

(STATIONING IS RELATIVE TO START OF JNF PRIORITY SITE #1)

NOTES:
1. EVERY THIRD TRENCH BREAKER AT PRIORITY SITE #1 SHALL BE PROVIDED WITH DAYLIGHT DRAINS AS SHOWN ON TYPICAL DRAWING MVP-35.
2. ALL TRENCH BREAKERS AT PRIORITY SITE #1 NOT PROVIDED WITH DAYLIGHT DRAINS SHALL BE PROVIDED WITH PASS-THROUGH DRAINS AS SHOWN ON TYPICAL DRAWING MVP-43.



TYPICAL TRENCH BACKFILL

(NOT TO SCALE)

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER — – DATE

– ELECTRICAL DESIGN ENGINEER — – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID: –

DRAWING SCALE: 1"=80'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #1 PROFILE – FIGURE 3

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

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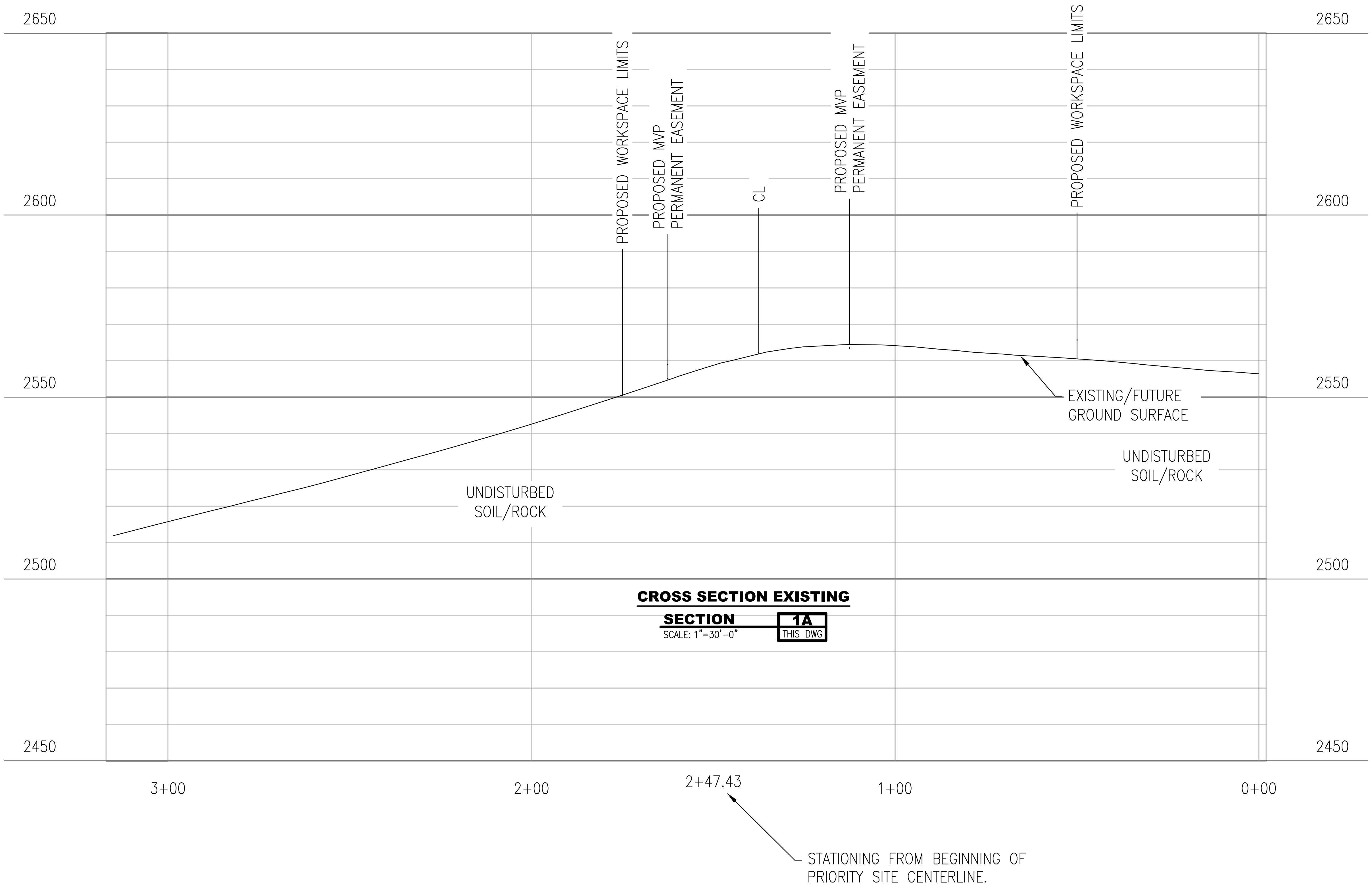

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID: –

DRAWING SCALE: 1"=50'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #1
CROSS SECTION EXISTING – FIGURE 4

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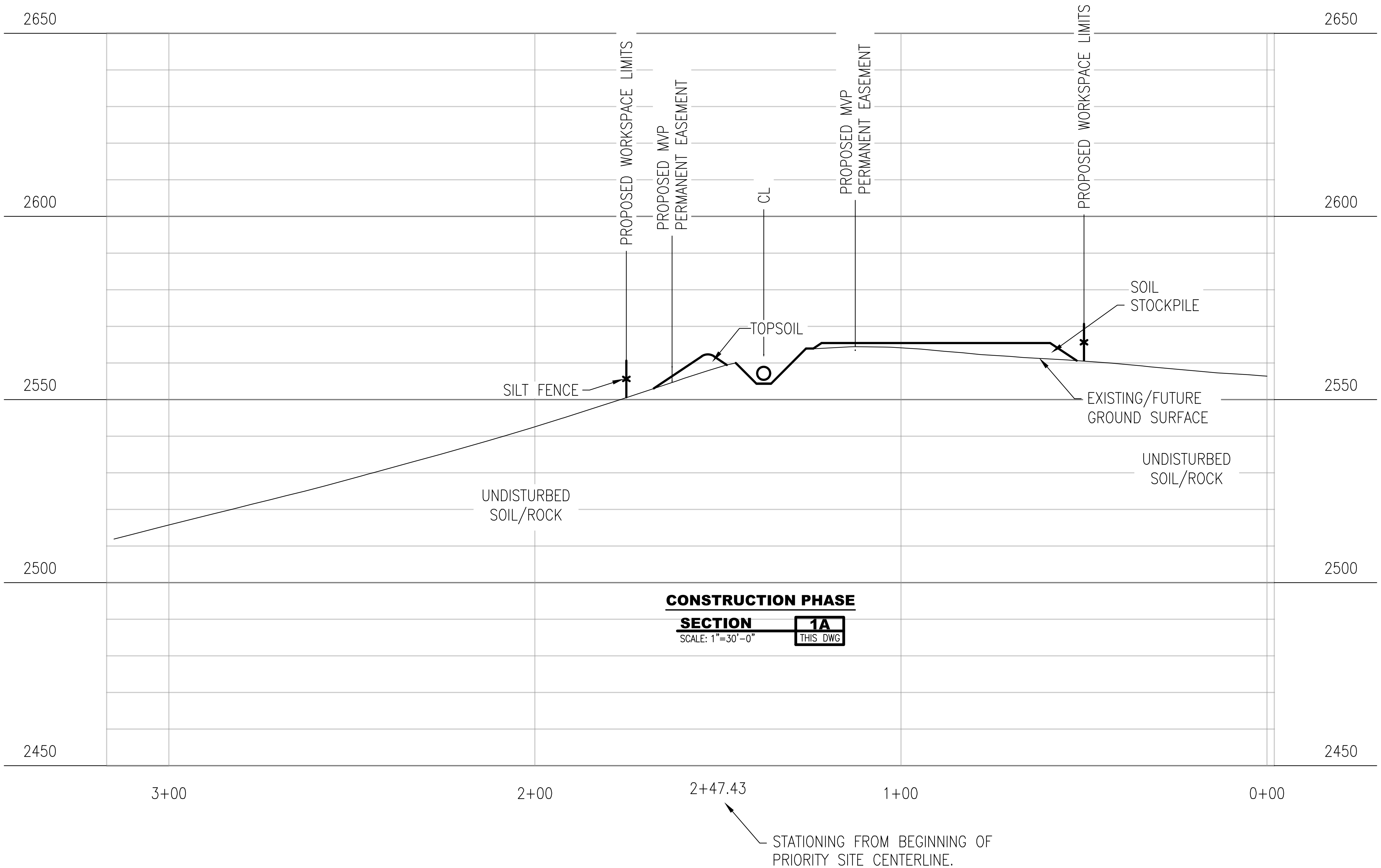

CONSTRUCTION PHASE

SECTION 1A

SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID: –

DRAWING SCALE: 1"=50'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #1
CONSTRUCTION PHASE SECTION – FIGURE 5

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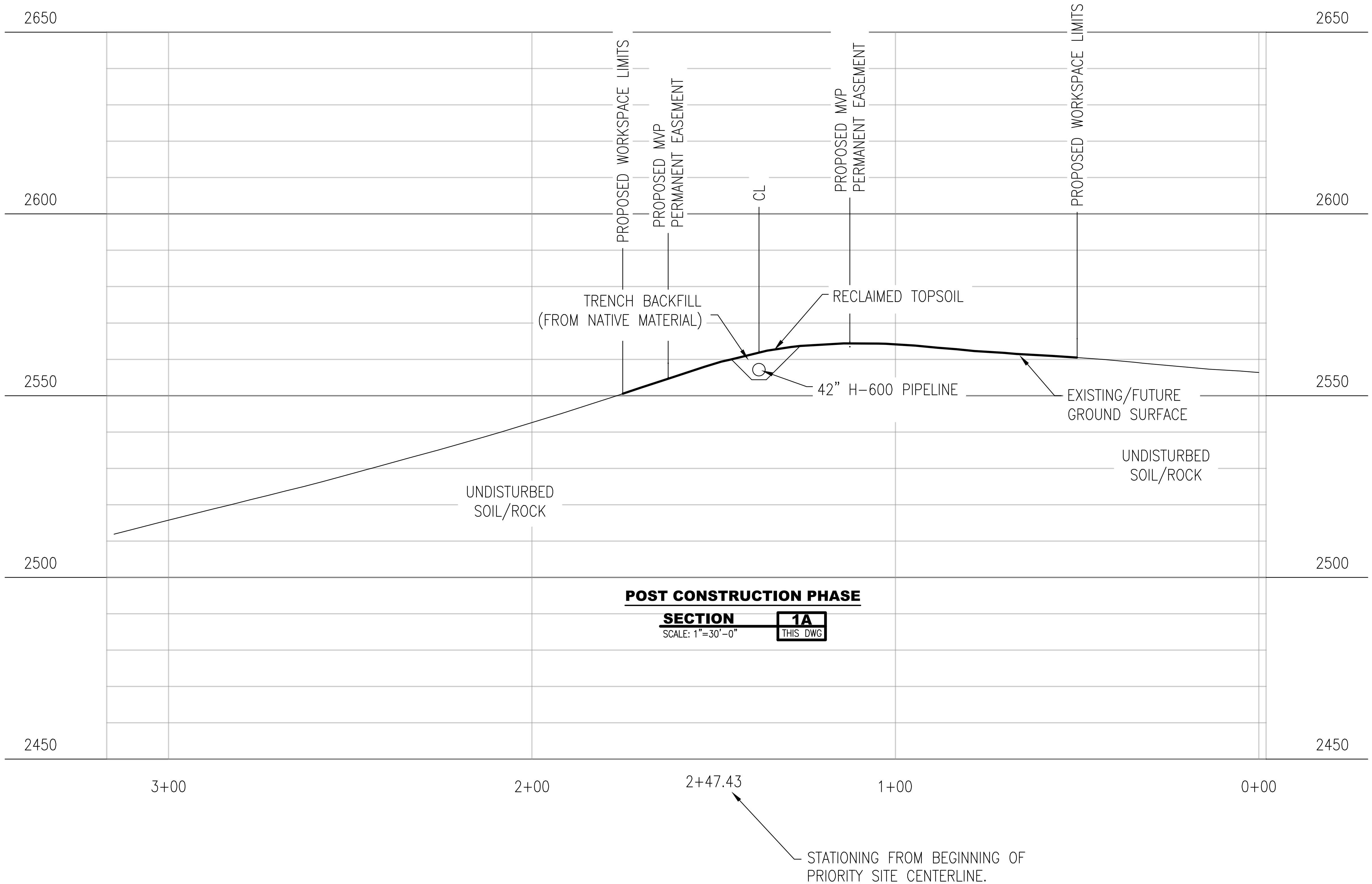

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID: –

DRAWING SCALE: 1"=50'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #1 CROSS SECTION POST CONSTRUCTION – FIGURE 6

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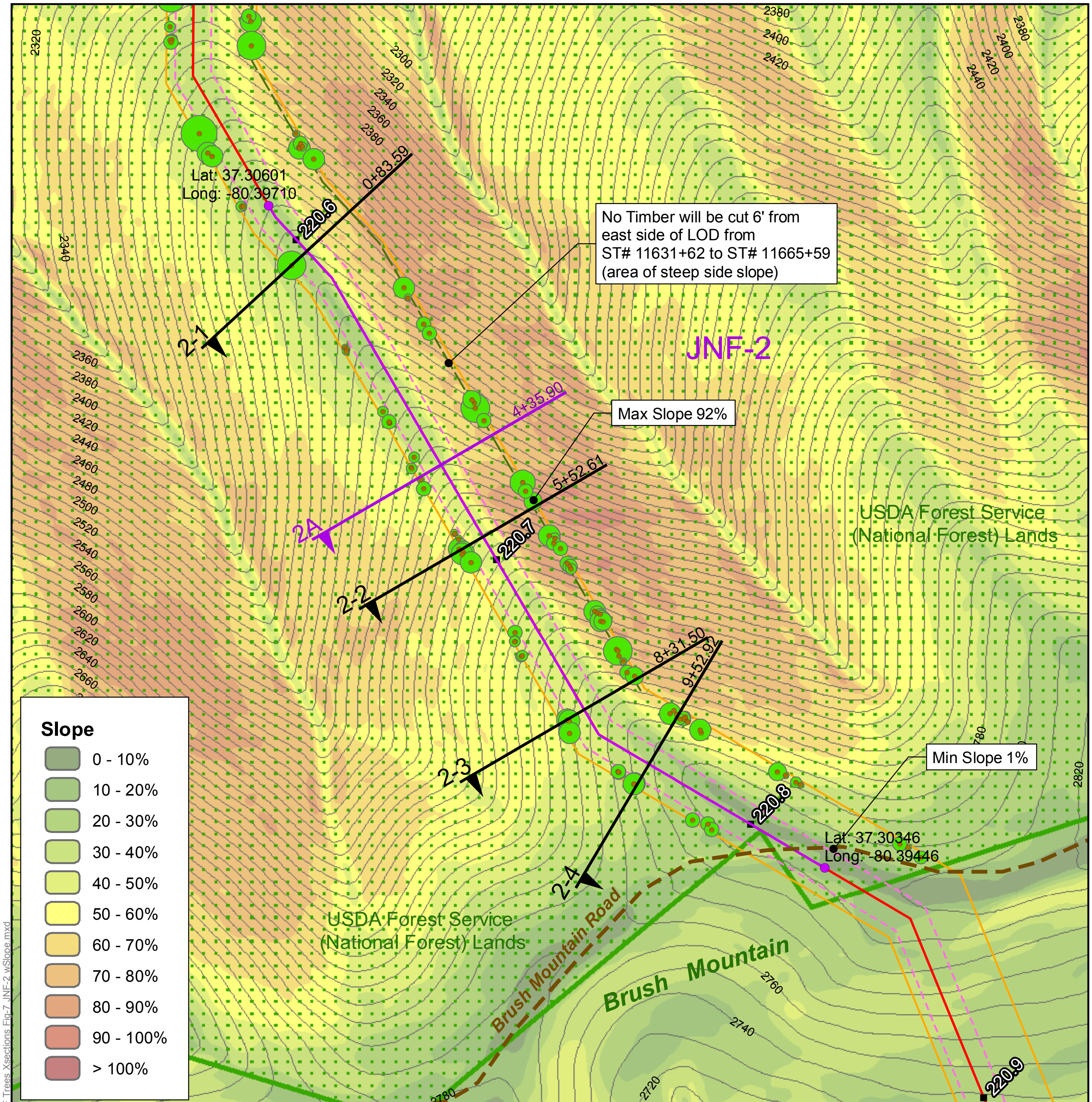

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Mountain Valley Pipeline Project

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1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 7, Site 2

Jefferson National Forest

Slope Map and Representitive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

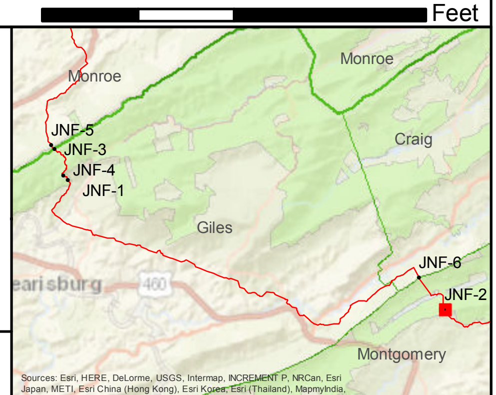
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

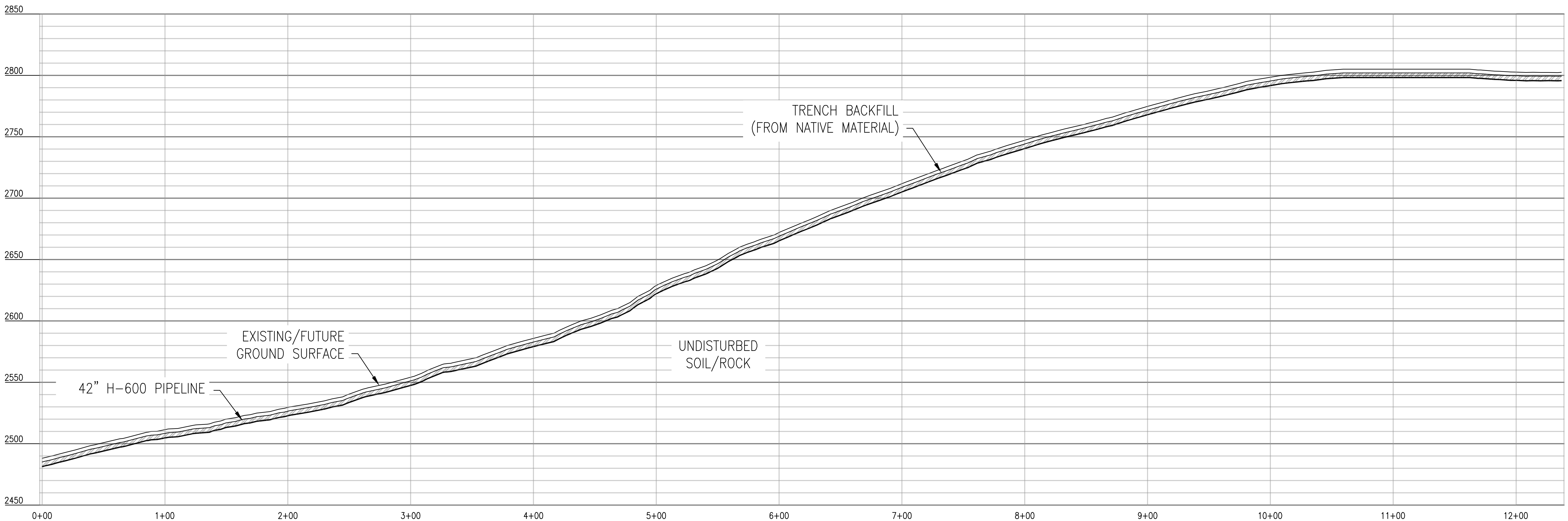
- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate



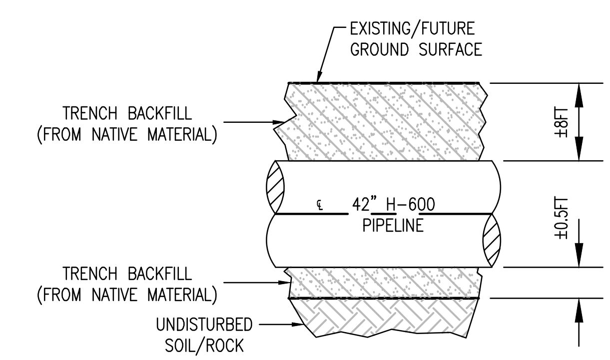
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community



(STATIONING IS RELATIVE TO START OF JNF PRIORITY SITE #2)

PROFILE

NOTES:
1. TRANSVERSE TRENCH DRAINS AS SHOWN ON TYPICAL DRAWING MVP-38 OR TRENCH BREAKER DAYLIGHT DRAINS AS SHOWN ON TYPICAL DRAWING MVP-35 SHALL BE INSTALLED THROUGHOUT PRIORITY SITE #2 AT 100-FT INTERVALS.



TYPICAL TRENCH BACKFILL

(NOT TO SCALE)

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
DWG NUMBER	DRAWING TITLE	–						–					
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

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MECHANICAL DESIGN ENGINEER	DATE
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ELECTRICAL DESIGN ENGINEER	DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

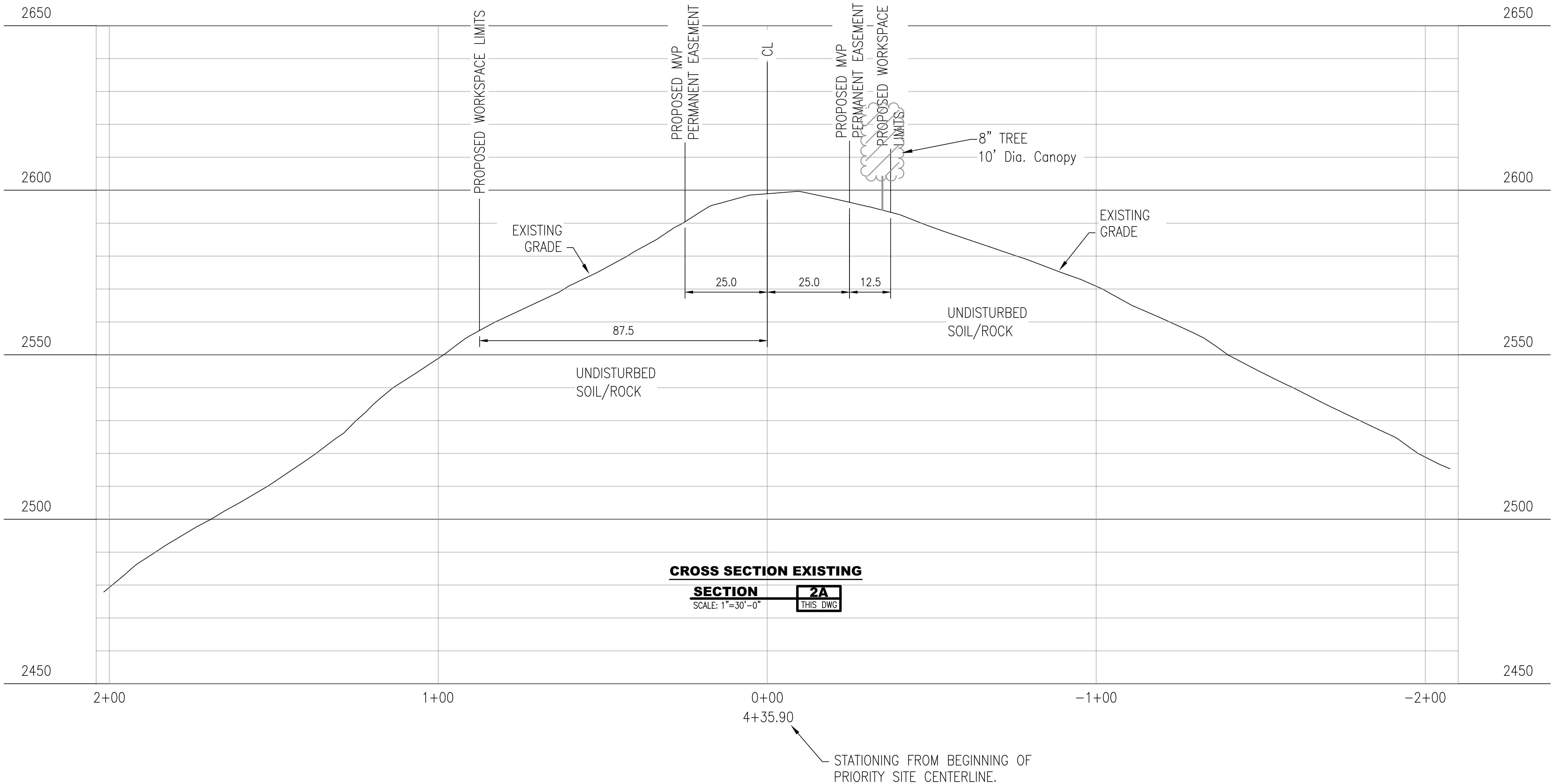
PROJECT ID: –

DRAWING SCALE: 1"=80'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #2
PROFILE – FIGURE 8

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS2-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
DWG NUMBER	DRAWING TITLE	-						-					
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

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MECHANICAL DESIGN ENGINEER	DATE
-	-
ELECTRICAL DESIGN ENGINEER	DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

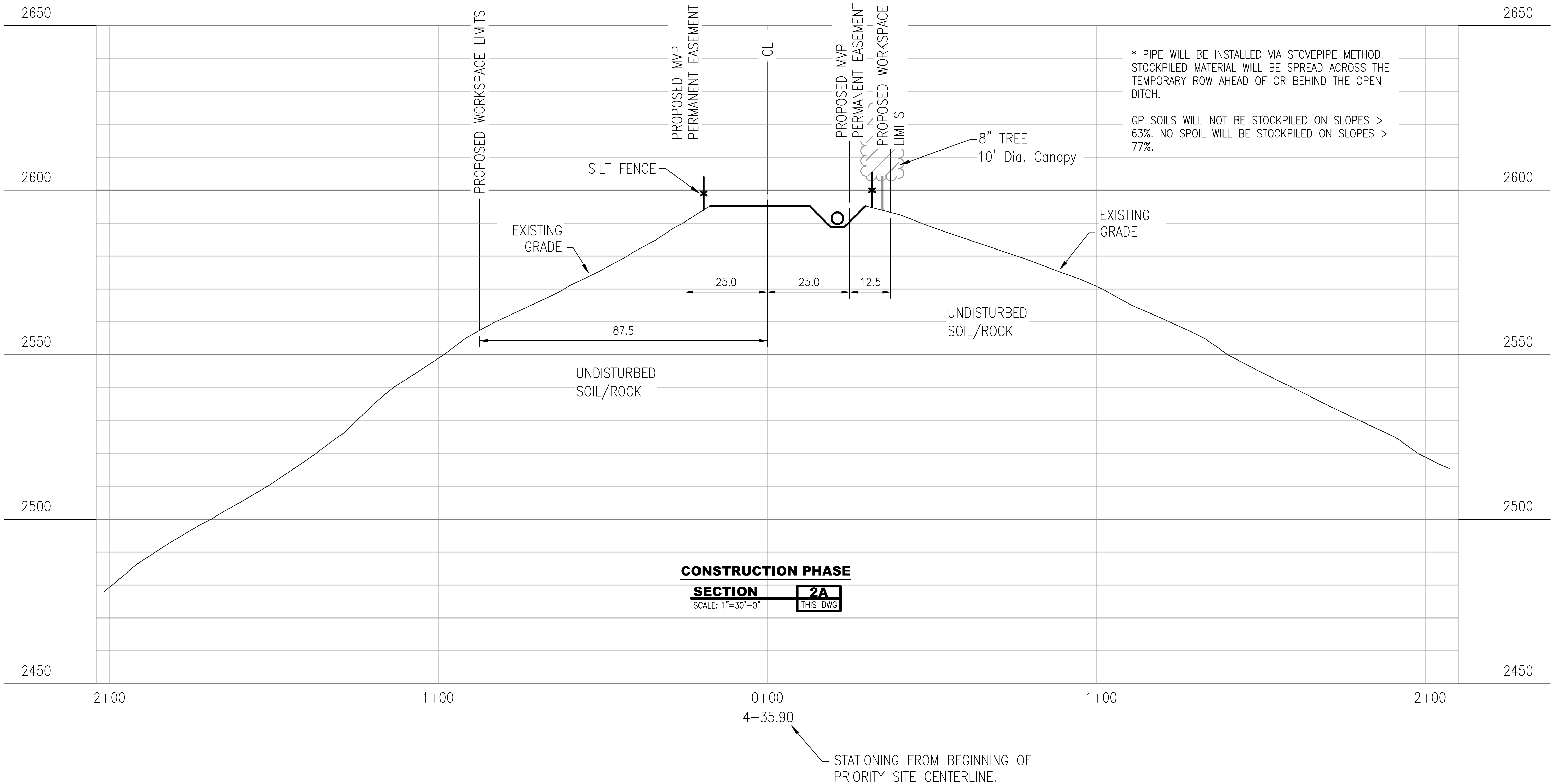
PROJECT ID: -

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #2
CROSS SECTION EXISTING – FIGURE 9

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS2-01cross section work.dwg



CONSTRUCTION PHASE

SECTION 2A

SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS	
DWG NUMBER	DRAWING TITLE
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE

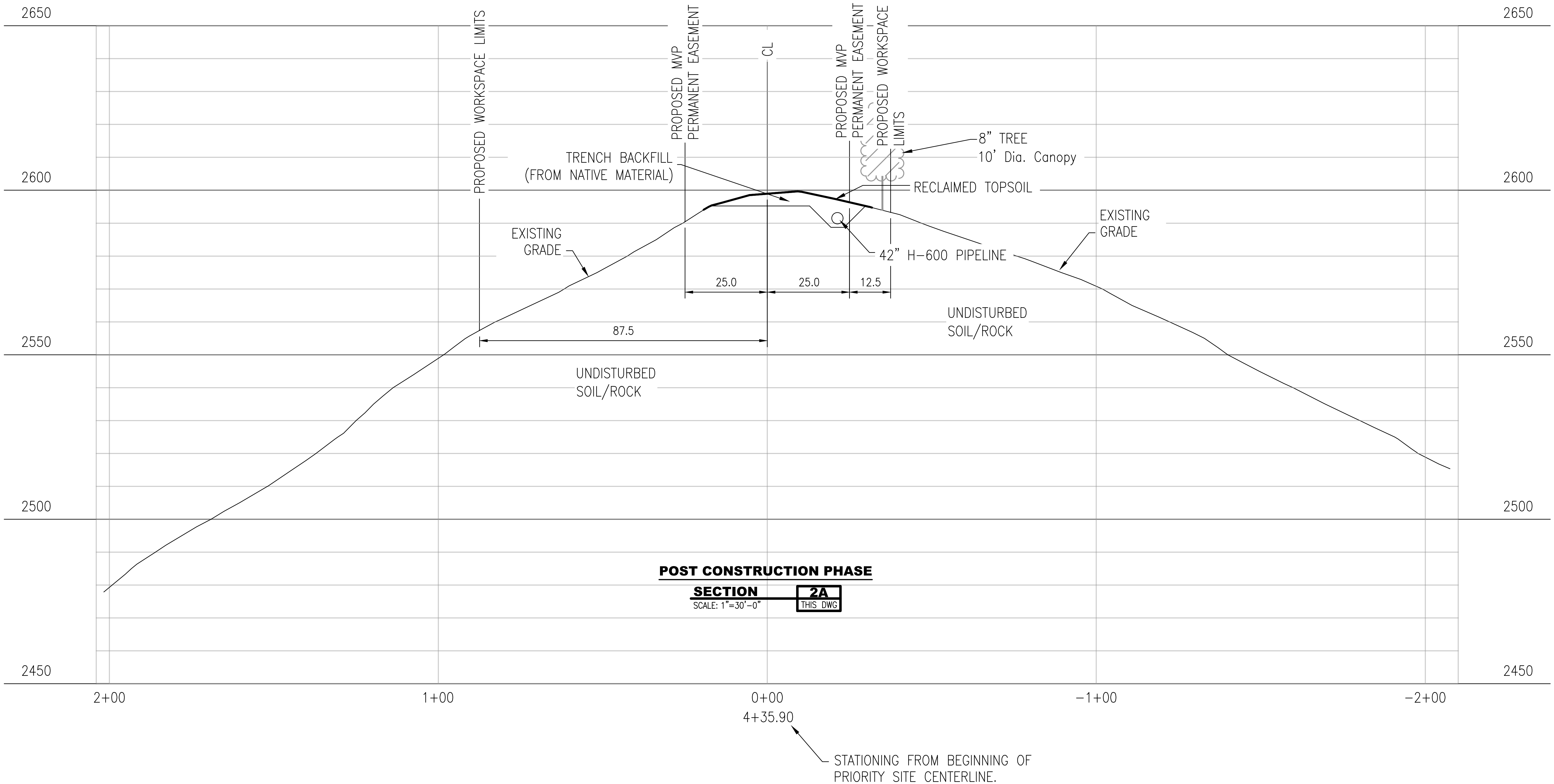
PROJECT ID: –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #2 CONSTRUCTION PHASE SECTION – FIGURE 10

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS2-01cross section work.dwg



POST CONSTRUCTION PHASE

SECTION 2A
SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
DWG NUMBER	DRAWING TITLE	–						–					
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER — – DATE

– ELECTRICAL DESIGN ENGINEER — – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

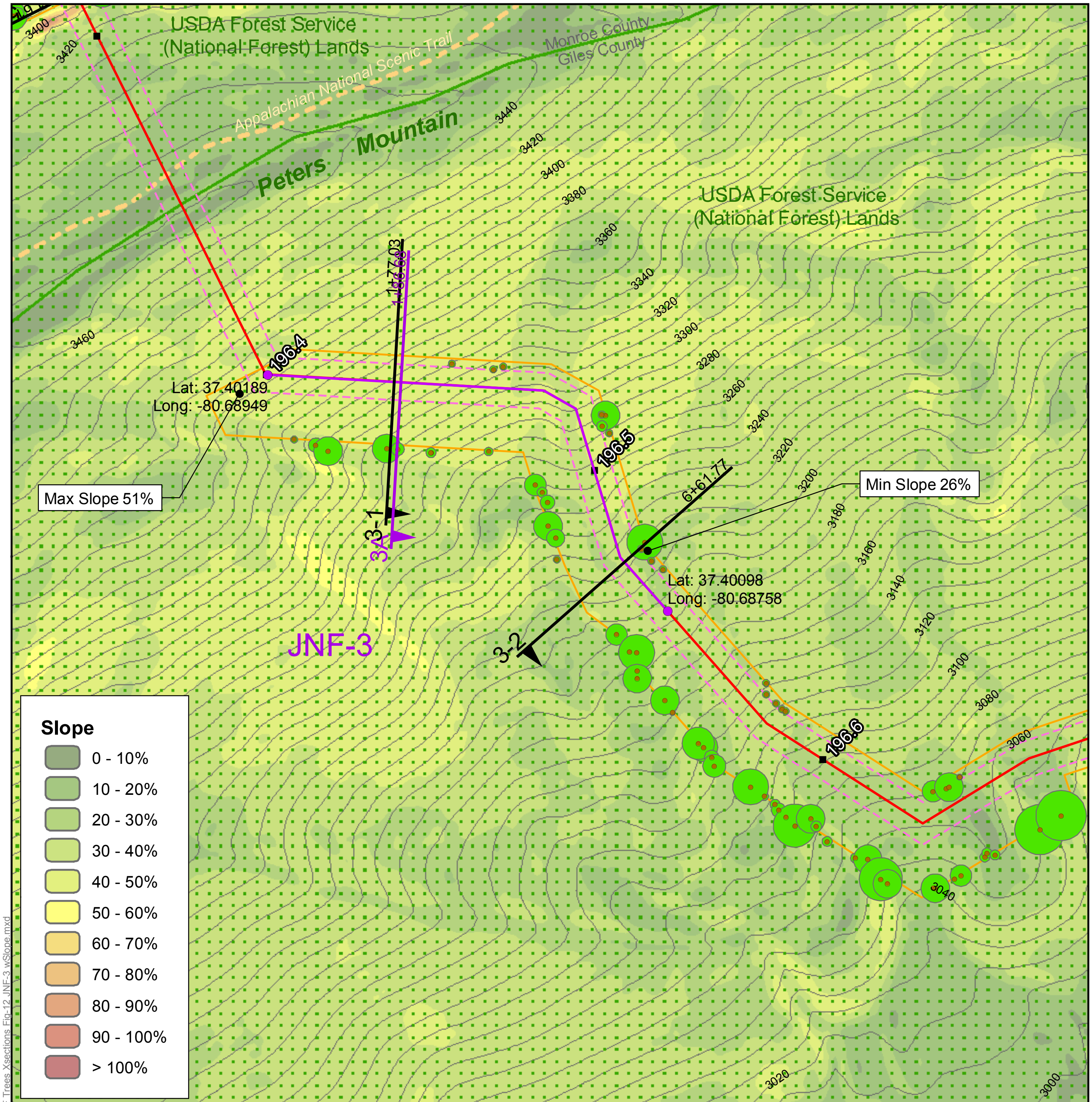
PROJECT ID: –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #2
CROSS SECTION POST CONSTRUCTION – FIGURE 11

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS2-01cross section work.dwg



Mountain Valley Pipeline Project

N

1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 12, Site 3

Jefferson National Forest

Slope Map and
Representitive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

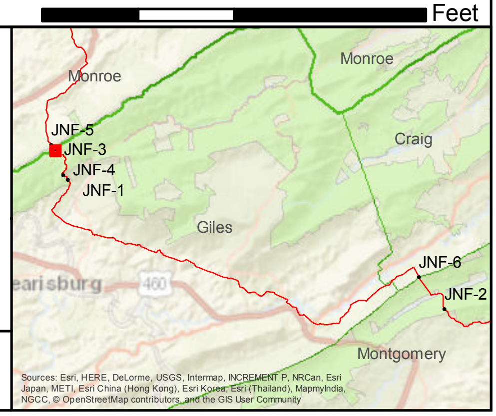
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate



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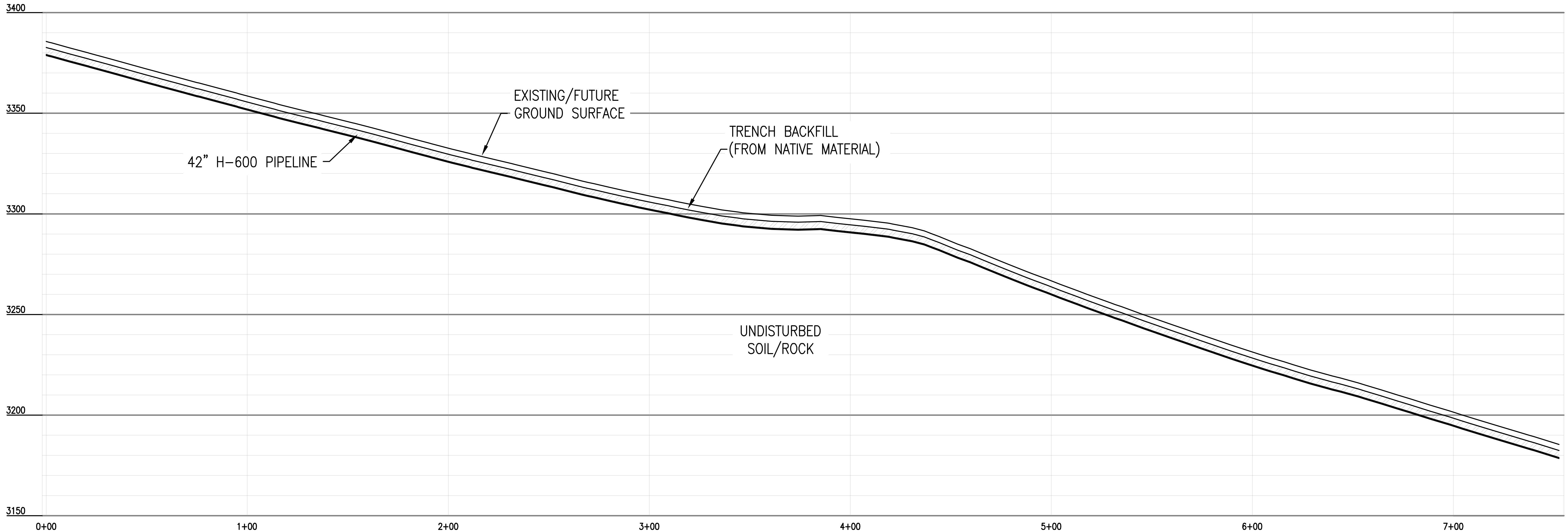
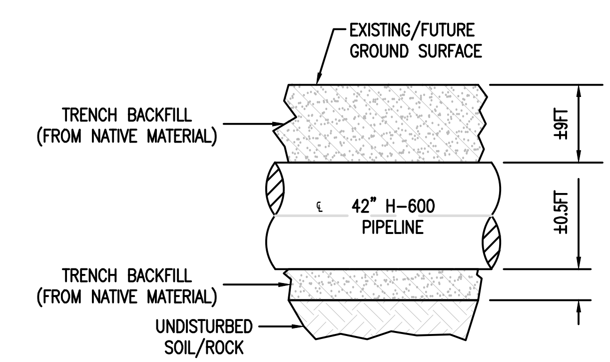


(STATIONING IS RELATIVE TO START OF JNF PRIORITY SITE #3)

PROFILE

NOTES:
1. EVERY THIRD TRENCH BREAKER AT PRIORITY SITE #3 SHALL BE PROVIDED WITH DAYLIGHT DRAINS AS SHOWN ON TYPICAL DRAWING MVP-35.
2. ALL TRENCH BREAKERS AT PRIORITY SITE #3 NOT PROVIDED WITH DAYLIGHT DRAINS SHALL BE PROVIDED WITH PASS-THROUGH DRAINS AS SHOWN ON TYPICAL DRAWING MVP-43.



TYPICAL TRENCH BACKFILL
(NOT TO SCALE)

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
DWG NUMBER	DRAWING TITLE	–						–					
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER — – DATE

– ELECTRICAL DESIGN ENGINEER — – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

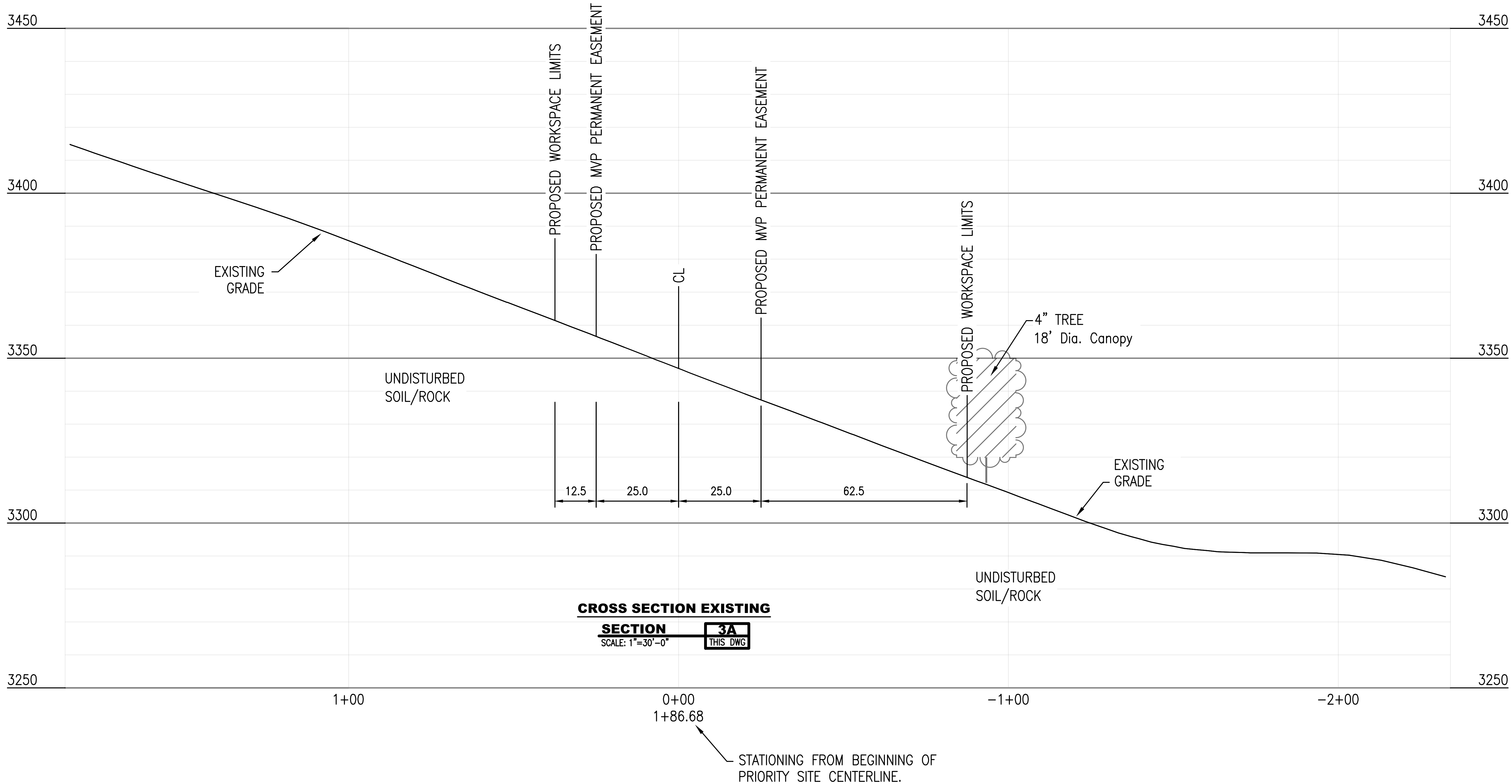
PROJECT ID: –

DRAWING SCALE: 1"=50'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #3 PROFILE – FIGURE 13

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS3-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
DWG NUMBER	DRAWING TITLE	–						–					
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

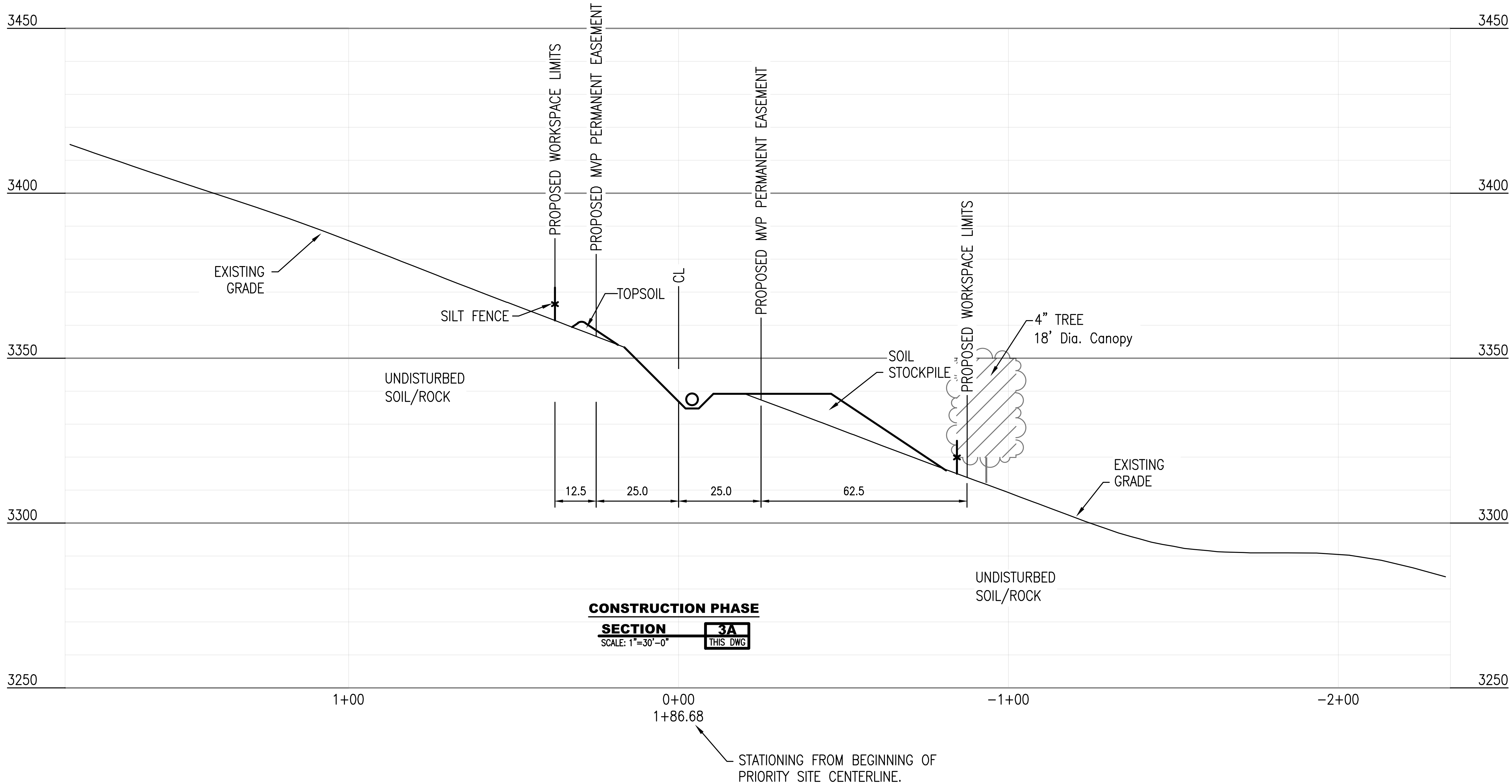
PROJECT ID –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #3
CROSS SECTION EXISTING – FIGURE 14

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS3-01cross section work.dwg



CONSTRUCTION PHASE

SECTION 3A
SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER — – DATE

– ELECTRICAL DESIGN ENGINEER — – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

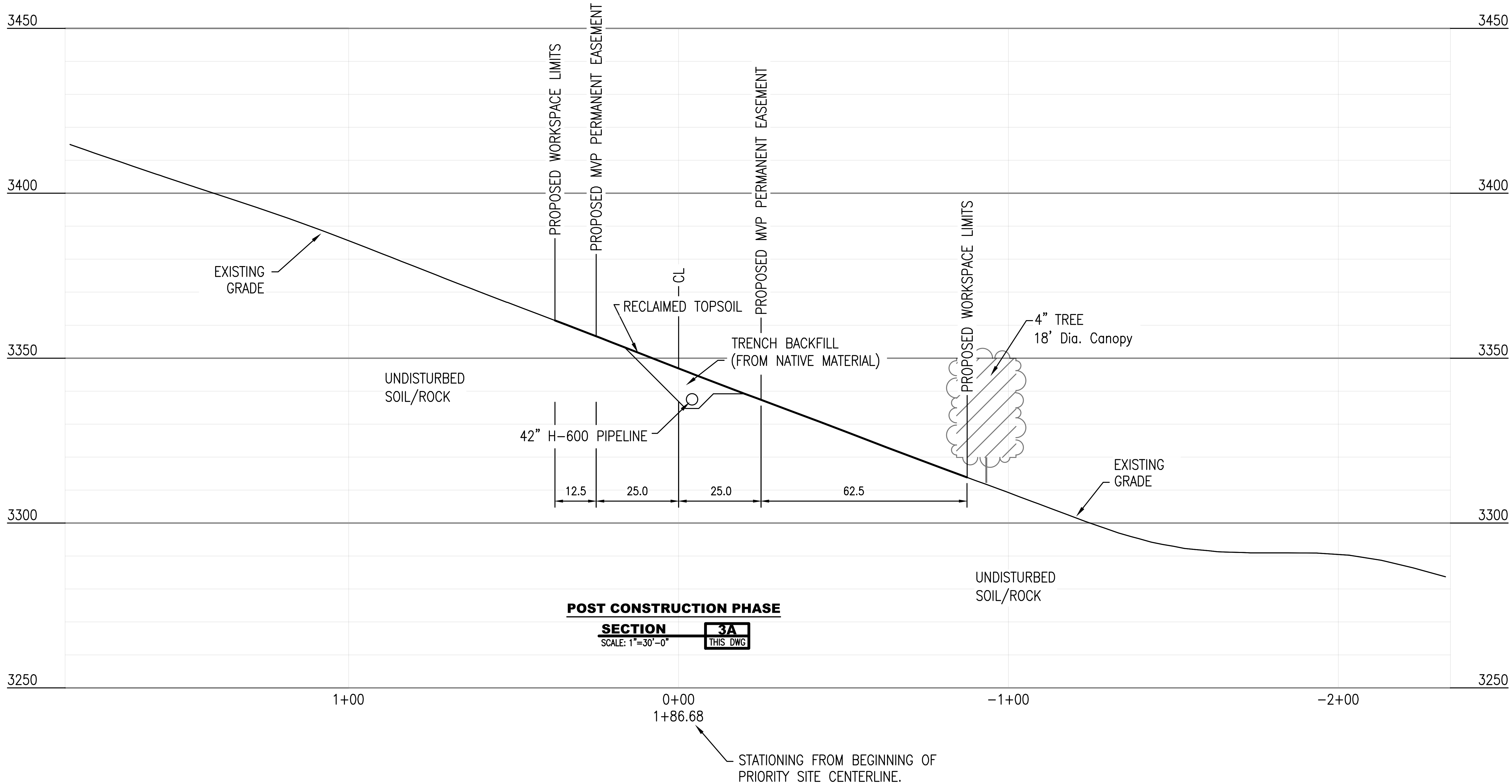
PROJECT ID –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #3
CONSTRUCTION PHASE SECTION – FIGURE 15

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS3-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

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MECHANICAL DESIGN ENGINEER	DATE
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ELECTRICAL DESIGN ENGINEER	DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

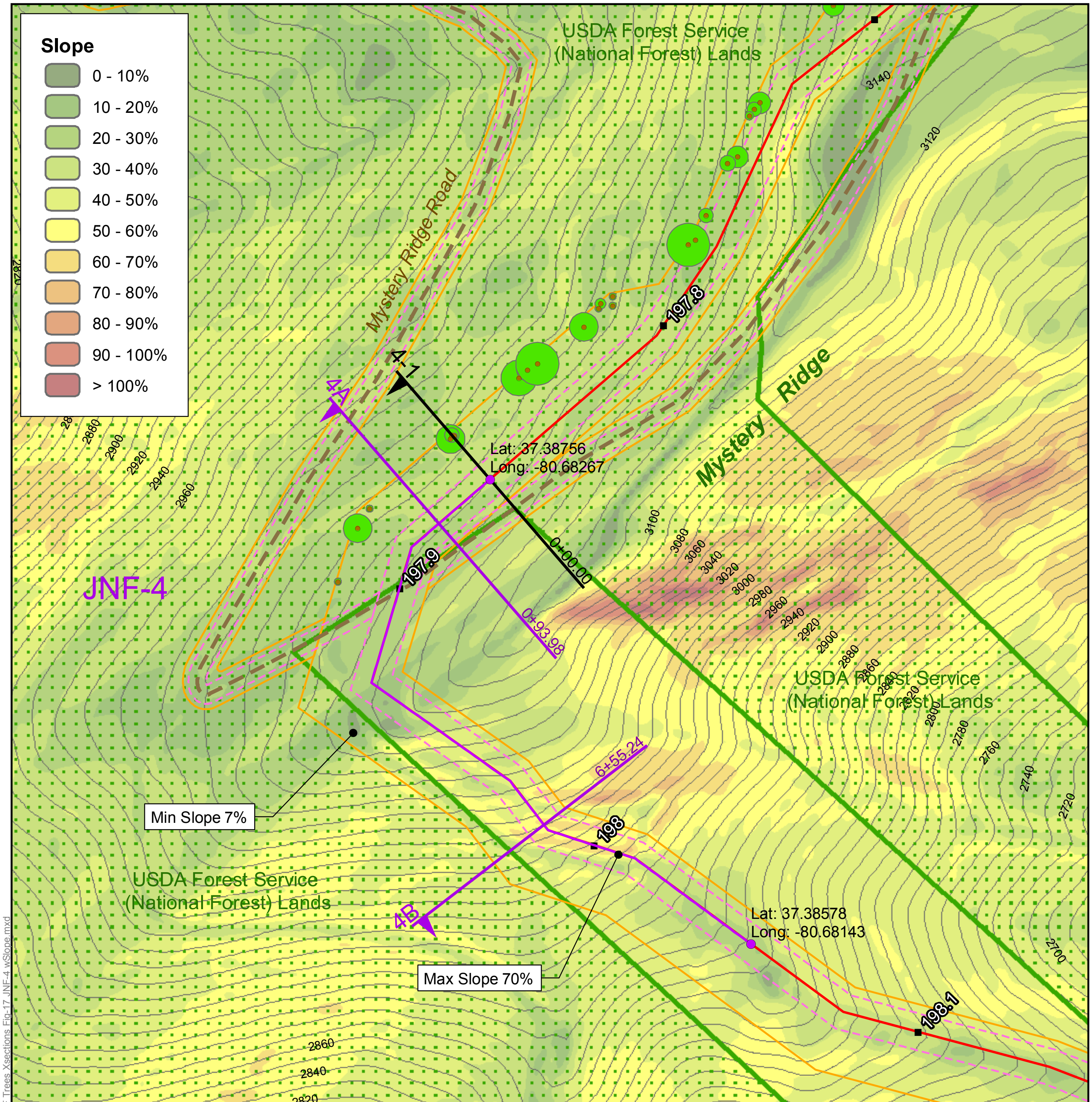
PROJECT ID: -

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #3
CROSS SECTION POST CONSTRUCTION - FIGURE 16

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS3-01cross section work.dwg



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Mountain Valley Pipeline Project

N

1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 17, Site 4

Jefferson National Forest

Slope Map and
Representitive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

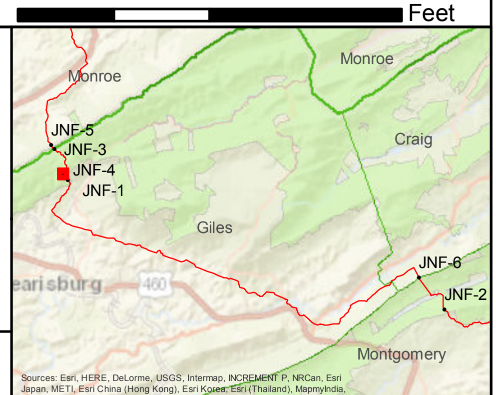
Draper Aden Associates
Engineering • Surveying • Environmental Services

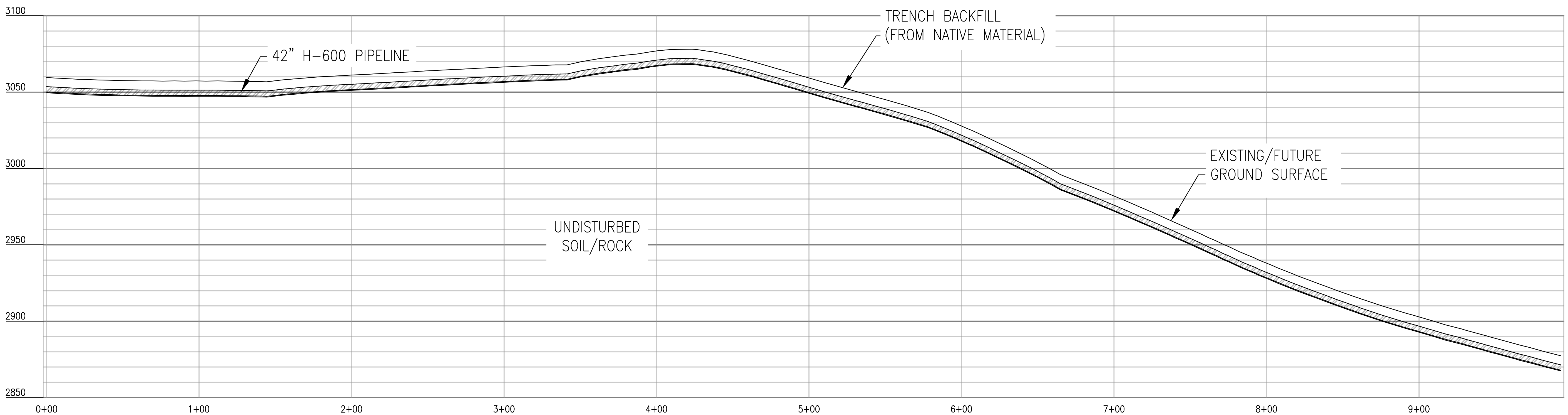
Legend

- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate

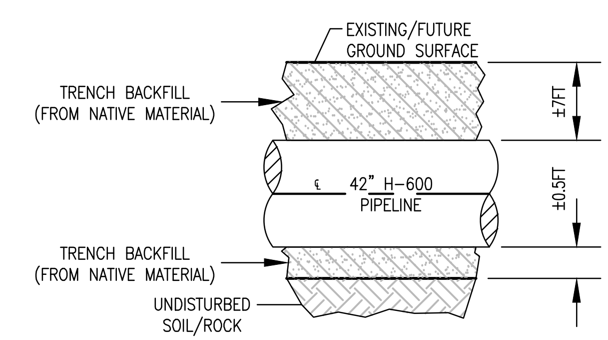




(STATIONING IS RELATIVE TO START OF JNF PRIORITY SITE #4)

NOTES:
1. EVERY THIRD TRENCH BREAKER AT PRIORITY SITE #4 SHALL BE PROVIDED WITH DAYLIGHT DRAINS AS SHOWN ON TYPICAL DRAWING MVP-35.
2. ALL TRENCH BREAKERS AT PRIORITY SITE #4 NOT PROVIDED WITH DAYLIGHT DRAINS SHALL BE PROVIDED WITH PASS-THROUGH DRAINS AS SHOWN ON TYPICAL DRAWING MVP-43.
3. TRANSVERSE TRENCH DRAINS AS SHOWN ON TYPICAL DRAWING MVP-38 SHALL BE INSTALLED IN FLATTER PORTIONS OF PRIORITY SITE #4.

PROFILE



TYPICAL TRENCH BACKFILL

(NOT TO SCALE)

REFERENCE DRAWINGS	
DWG NUMBER	DRAWING TITLE
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER — – DATE

– ELECTRICAL DESIGN ENGINEER — – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

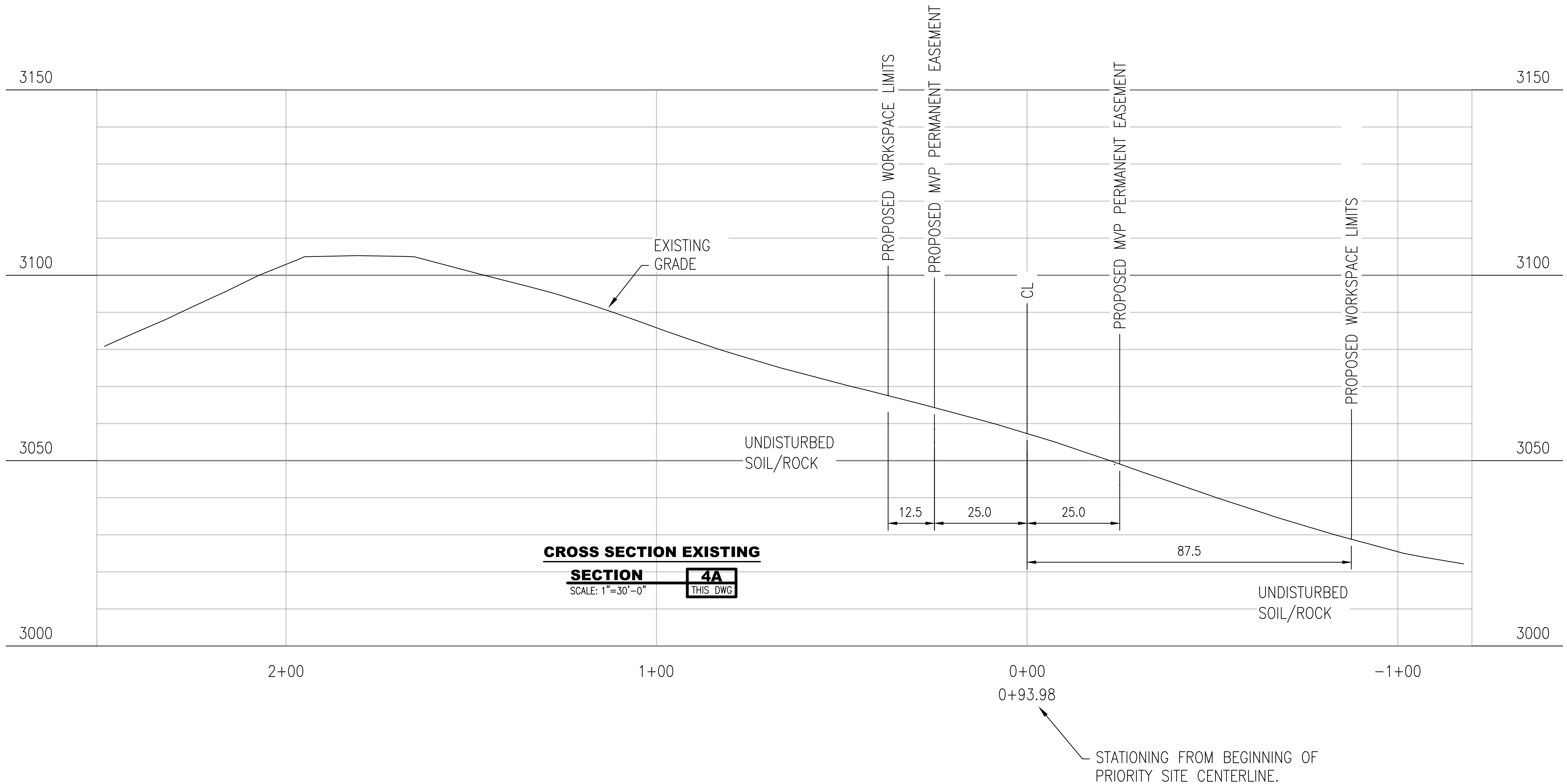
PROJECT ID: –

DRAWING SCALE: 1"=70'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #4 PROFILE – FIGURE 18

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS4-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS	
DWG NUMBER	DRAWING TITLE
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

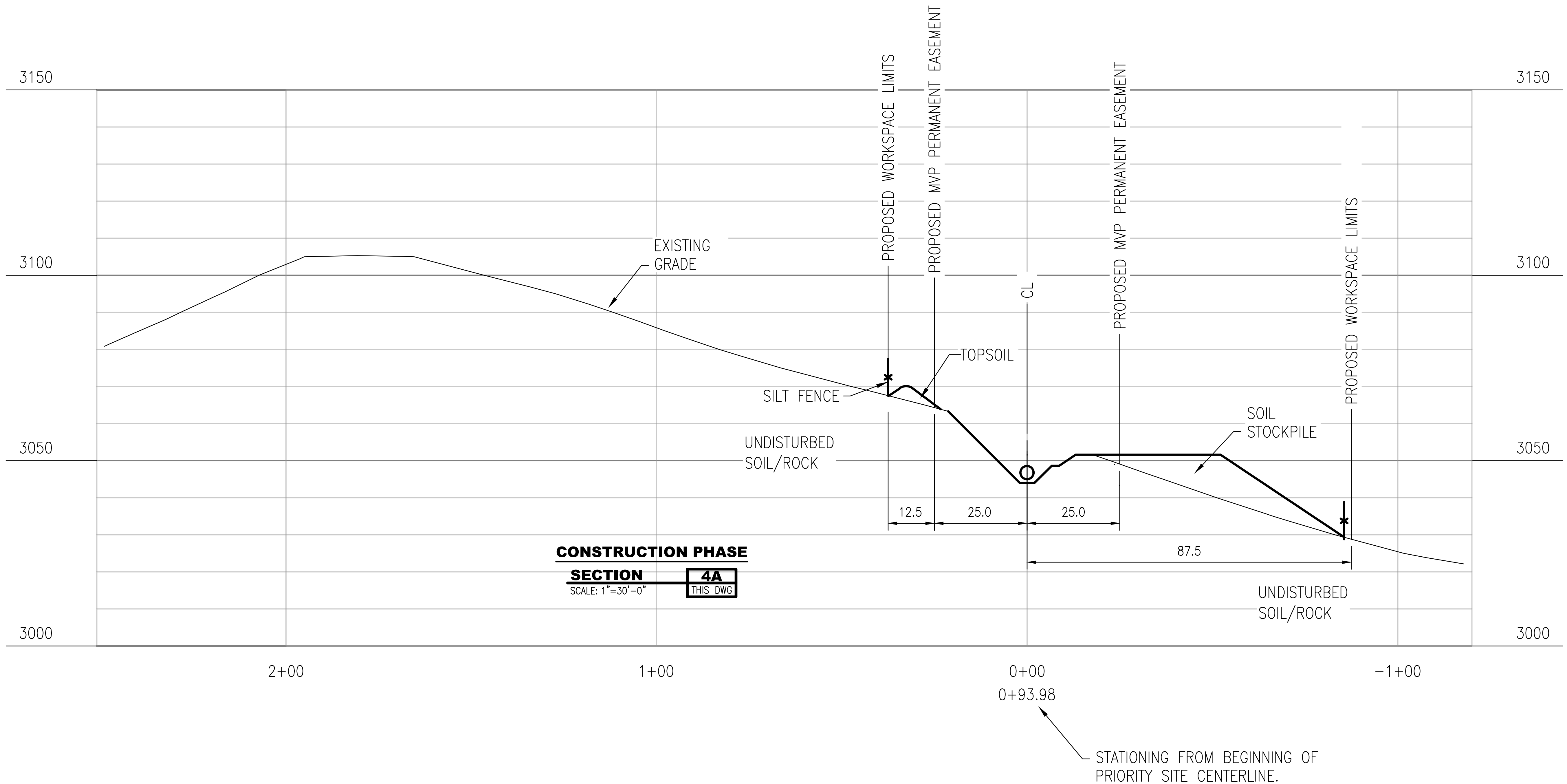
PROJECT ID: –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #4 CROSS SECTION EXISTING – FIGURE 19

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS4-01cross section work.dwg



CONSTRUCTION PHASE

SECTION 4A
SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
DWG NUMBER	DRAWING TITLE							–					
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

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MECHANICAL DESIGN ENGINEER	DATE
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ELECTRICAL DESIGN ENGINEER	DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

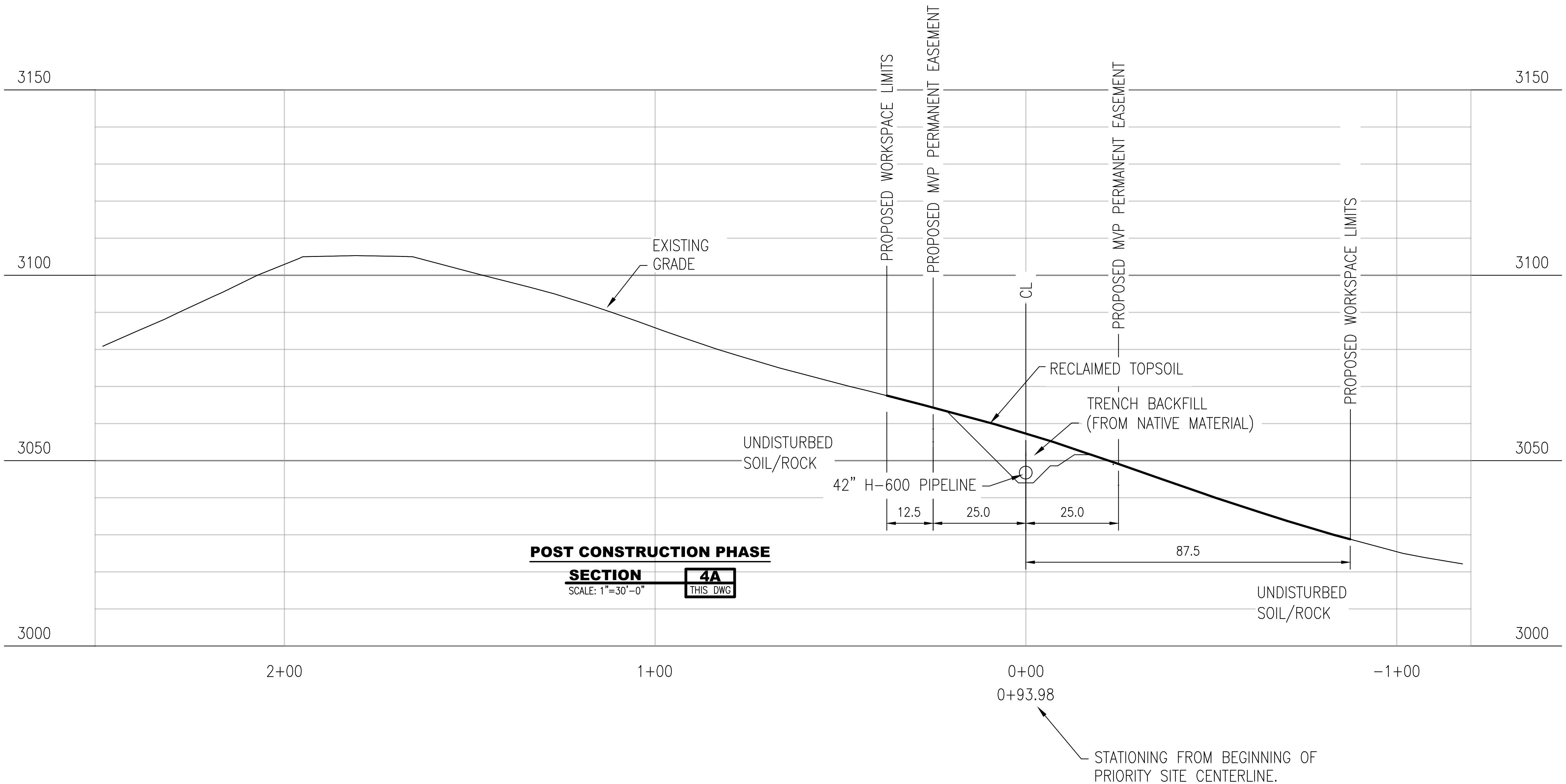
PROJECT ID: –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #4
CONSTRUCTION PHASE SECTION – FIGURE 20

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS4-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

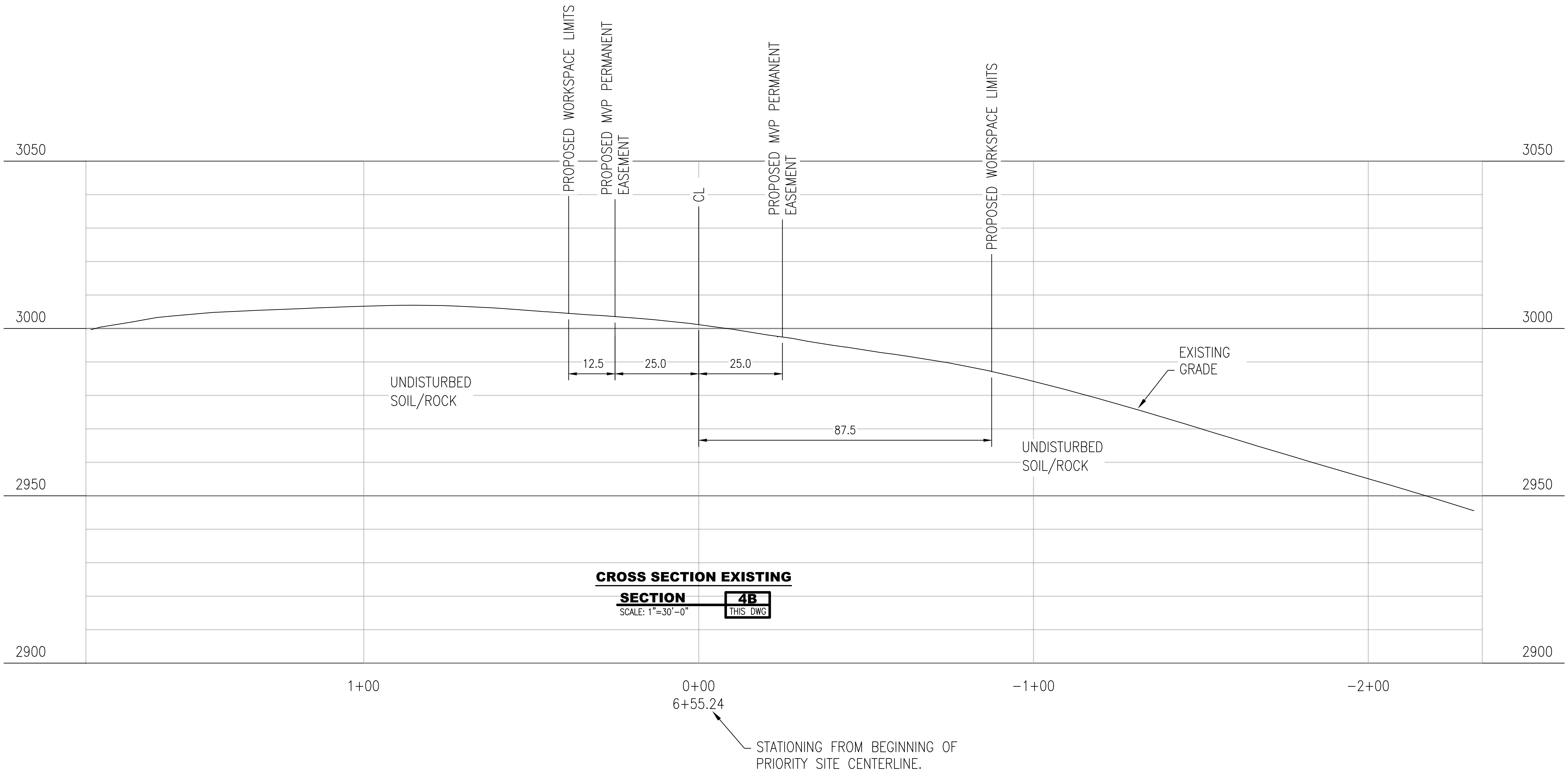
PROJECT ID: –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #4 CROSS SECTION POST CONSTRUCTION – FIGURE 21

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS4-01cross section work.dwg



CROSS SECTION EXISTING

SECTION 4B THIS DWG

SCALE: 1"=30'-0"

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

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MECHANICAL DESIGN ENGINEER	DATE
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ELECTRICAL DESIGN ENGINEER	DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

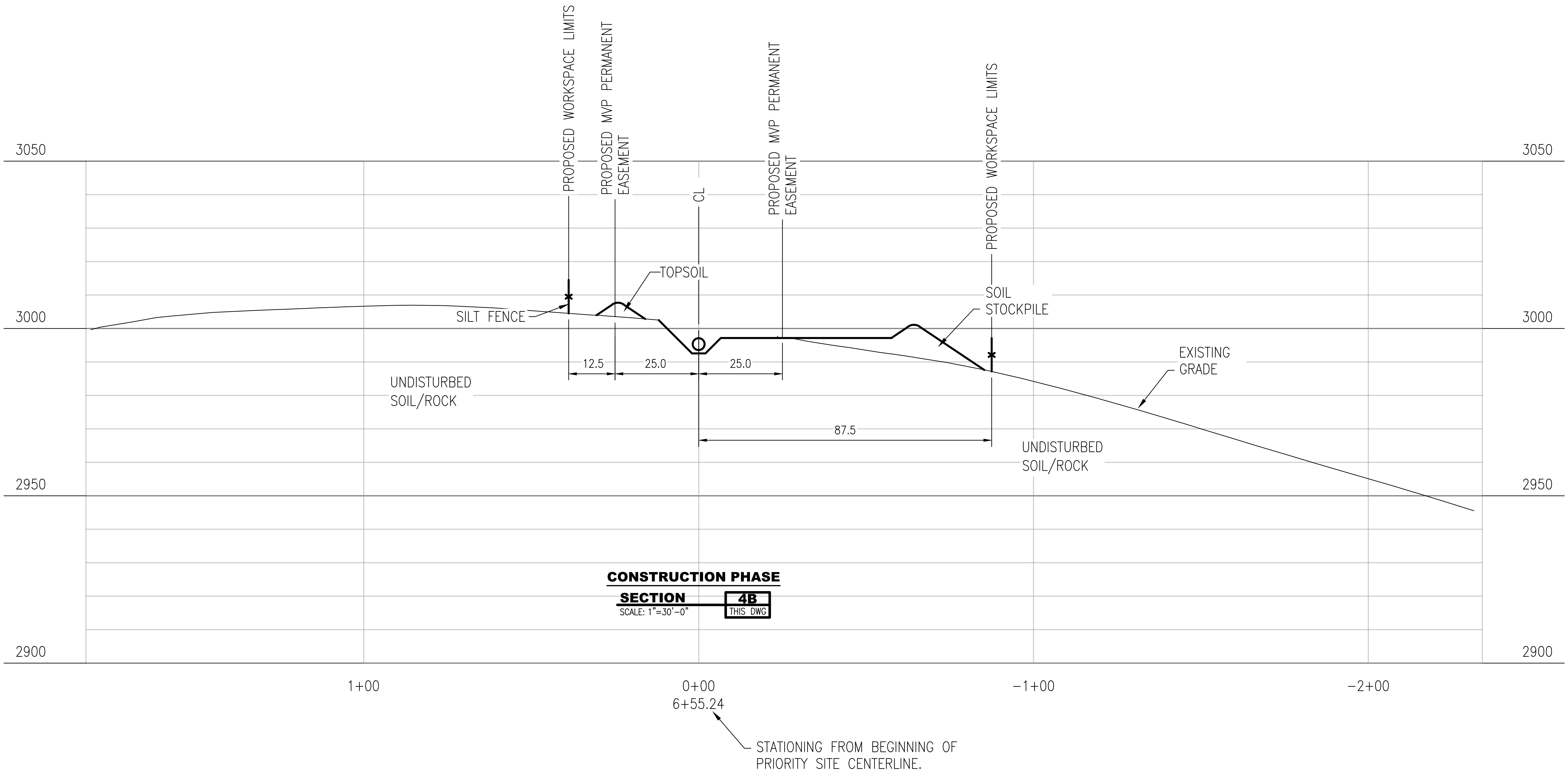
PROJECT ID: -

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #4
CROSS SECTION EXISTING - FIGURE 22

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS4-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER — – DATE

– ELECTRICAL DESIGN ENGINEER — – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

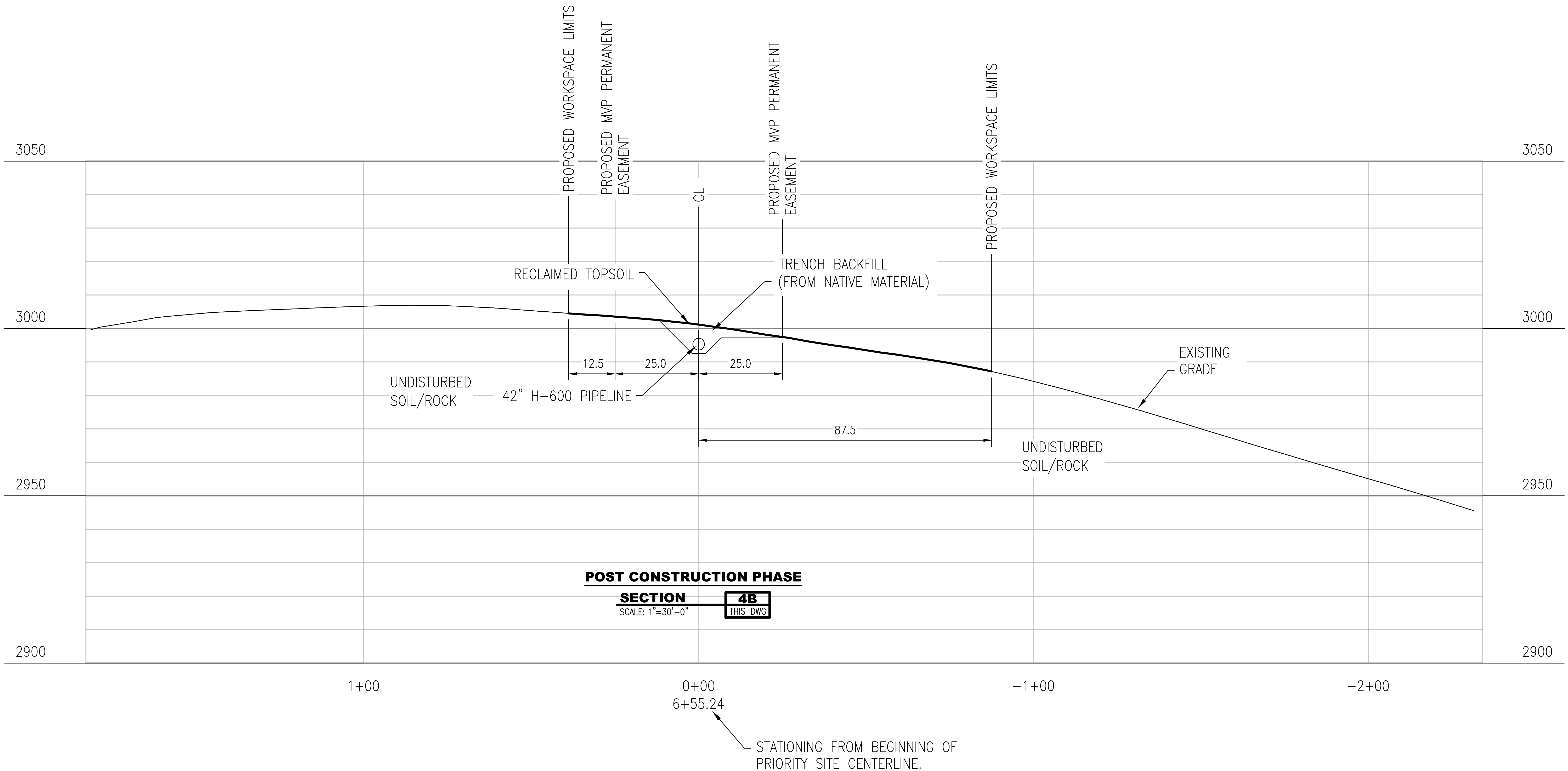
PROJECT ID: –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #4
CONSTRUCTION PHASE SECTION – FIGURE 23

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS4-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER — – DATE

– ELECTRICAL DESIGN ENGINEER — – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

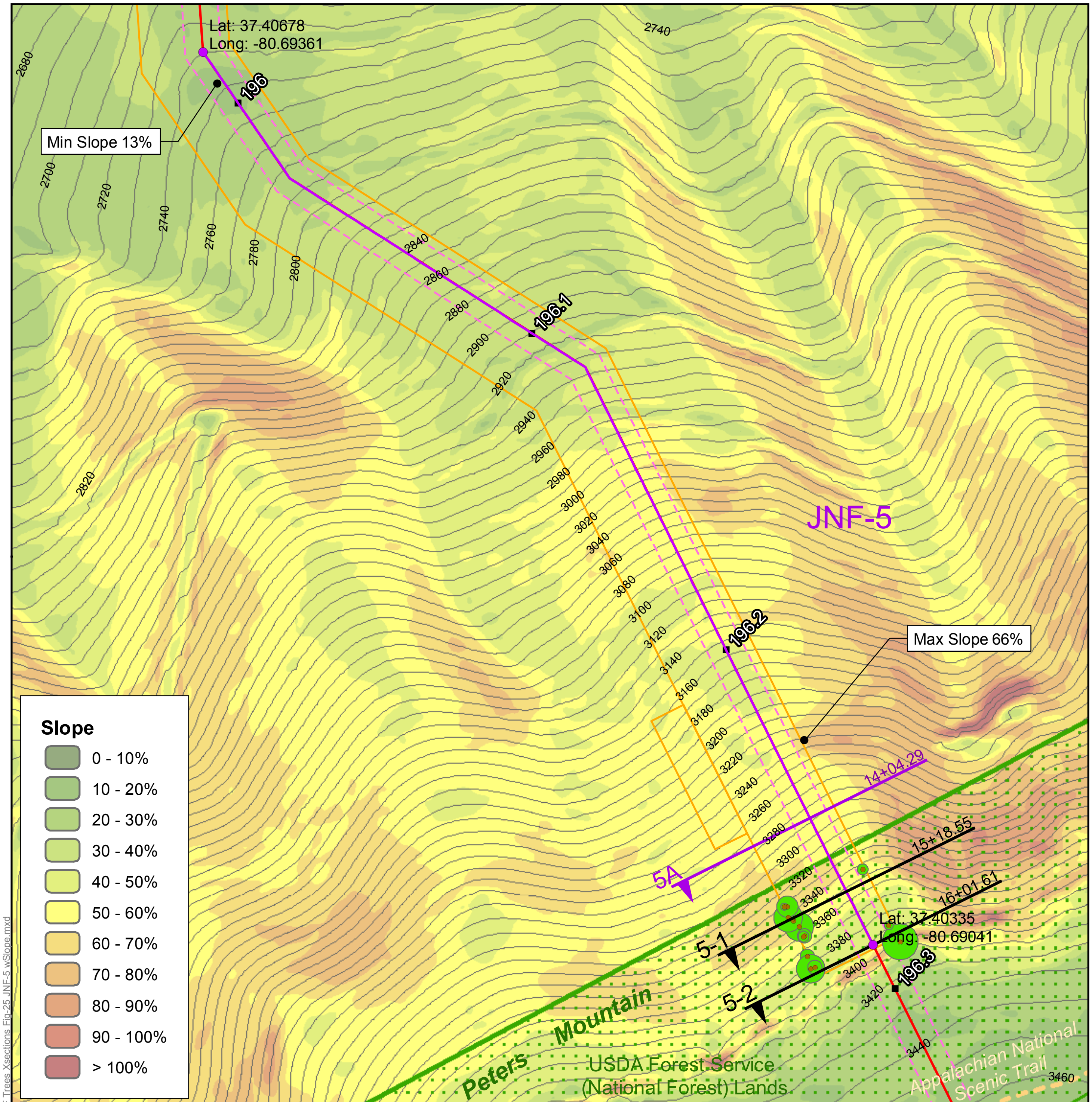
PROJECT ID: –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #4 CROSS SECTION POST CONSTRUCTION – FIGURE 24

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS4-01cross section work.dwg



Mountain Valley Pipeline Project

N

1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 25, Site 5

Jefferson National Forest

Slope Map and
Representitive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

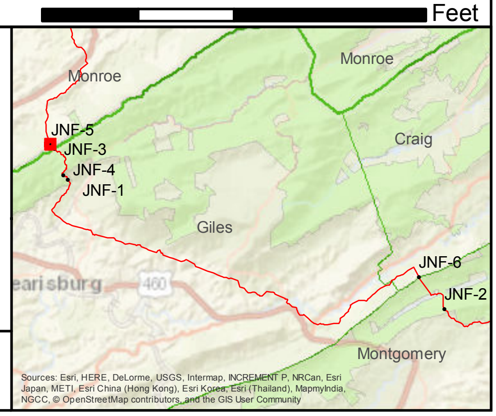
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate



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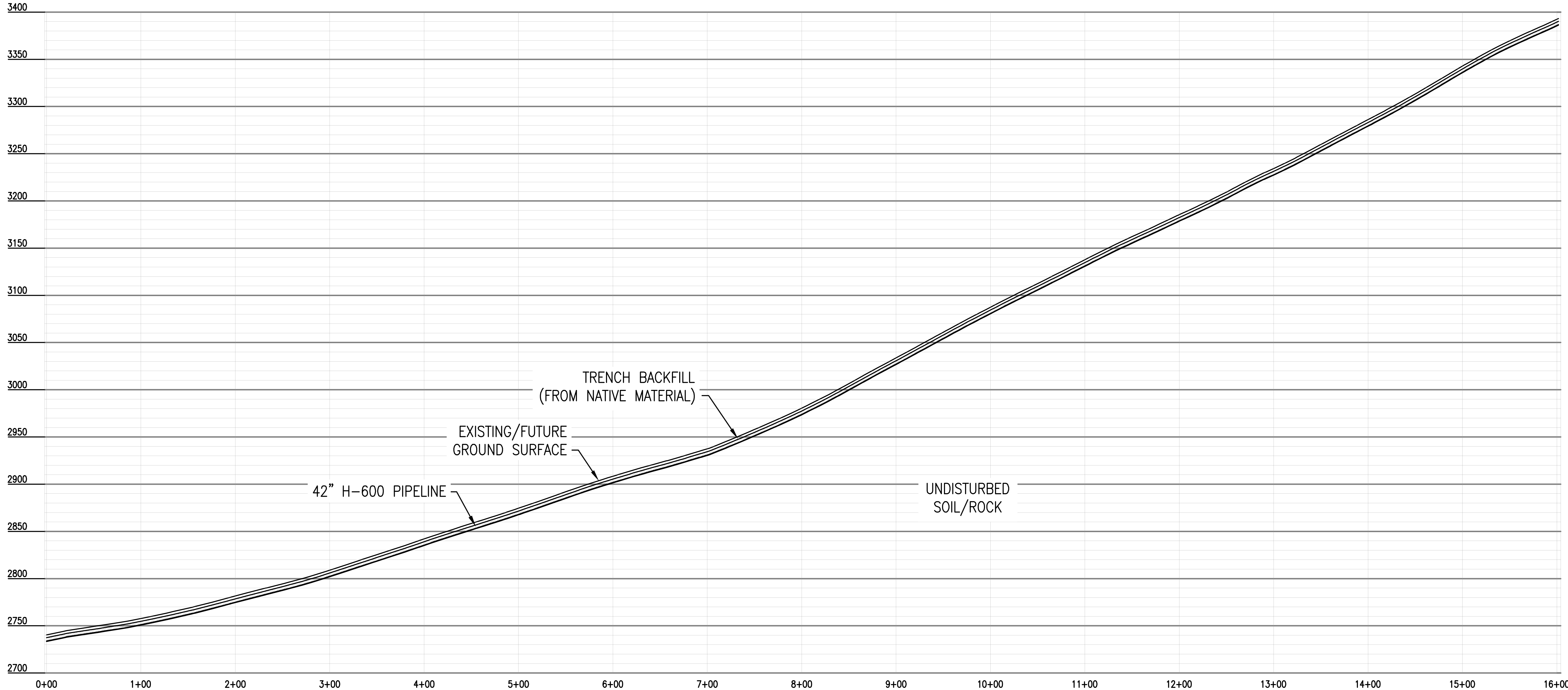
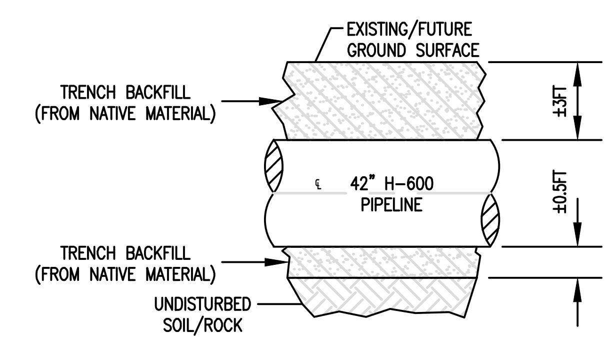


(STATIONING IS RELATIVE TO START OF JNF PRIORITY SITE #5)

PROFILE

NOTES:

1. EVERY THIRD TRENCH BREAKER AT PRIORITY SITE #5 SHALL BE PROVIDED WITH DAYLIGHT DRAINS AS SHOWN ON TYPICAL DRAWING MVP-35.
2. ALL TRENCH BREAKERS AT PRIORITY SITE #5 NOT PROVIDED WITH DAYLIGHT DRAINS SHALL BE PROVIDED WITH PASS-THROUGH DRAINS AS SHOWN ON TYPICAL DRAWING MVP-43.



TYPICAL TRENCH BACKFILL

(NOT TO SCALE)

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER — – DATE

– ELECTRICAL DESIGN ENGINEER — – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID: –

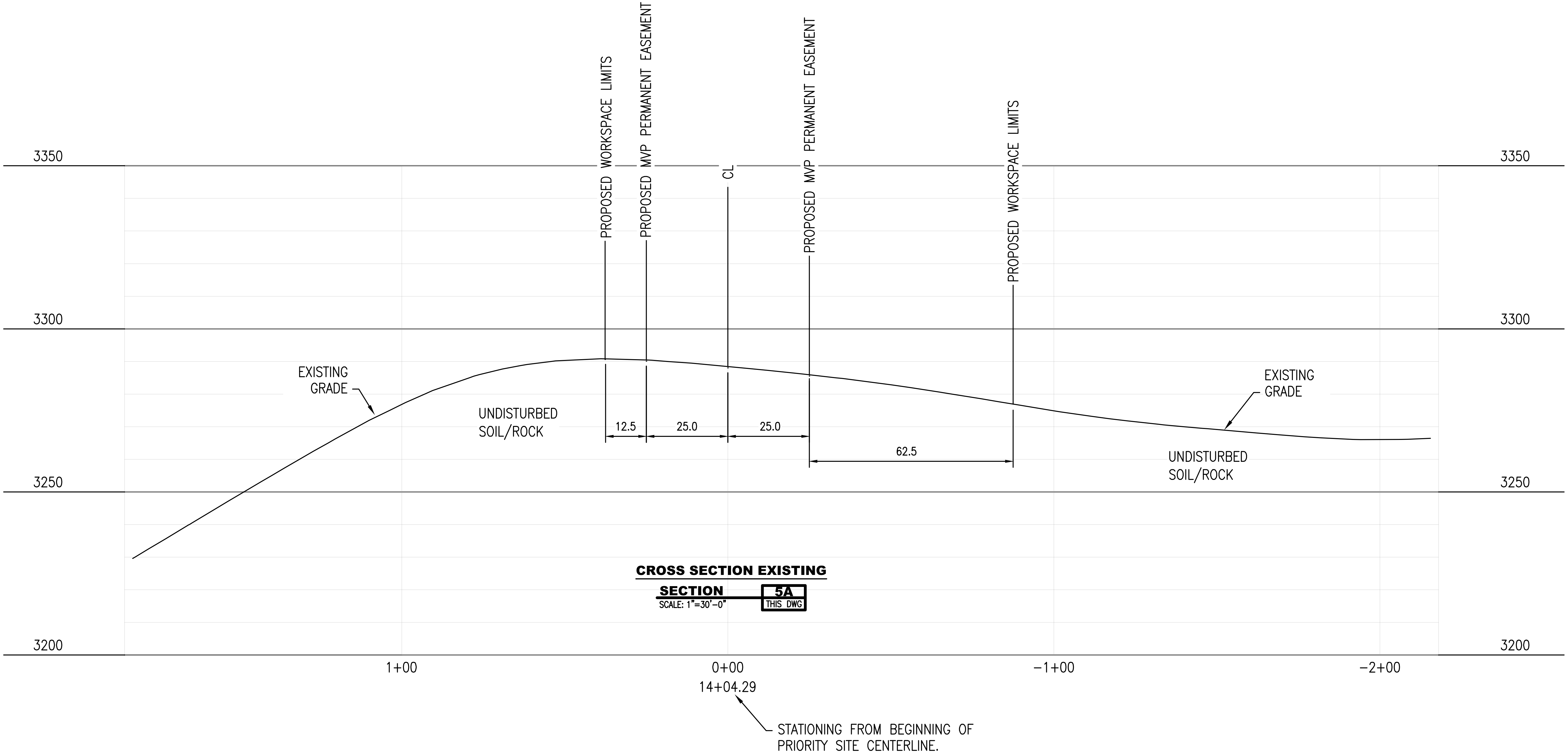
DRAWING SCALE: 1"=110'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #5
PROFILE – FIGURE 26

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

Plotted by: Darrell Dalton on: March 6, 2018 - 3:17 PM

File Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS5-01cross sections work.dwg



CROSS SECTION EXISTING

SECTION 5A
SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID –

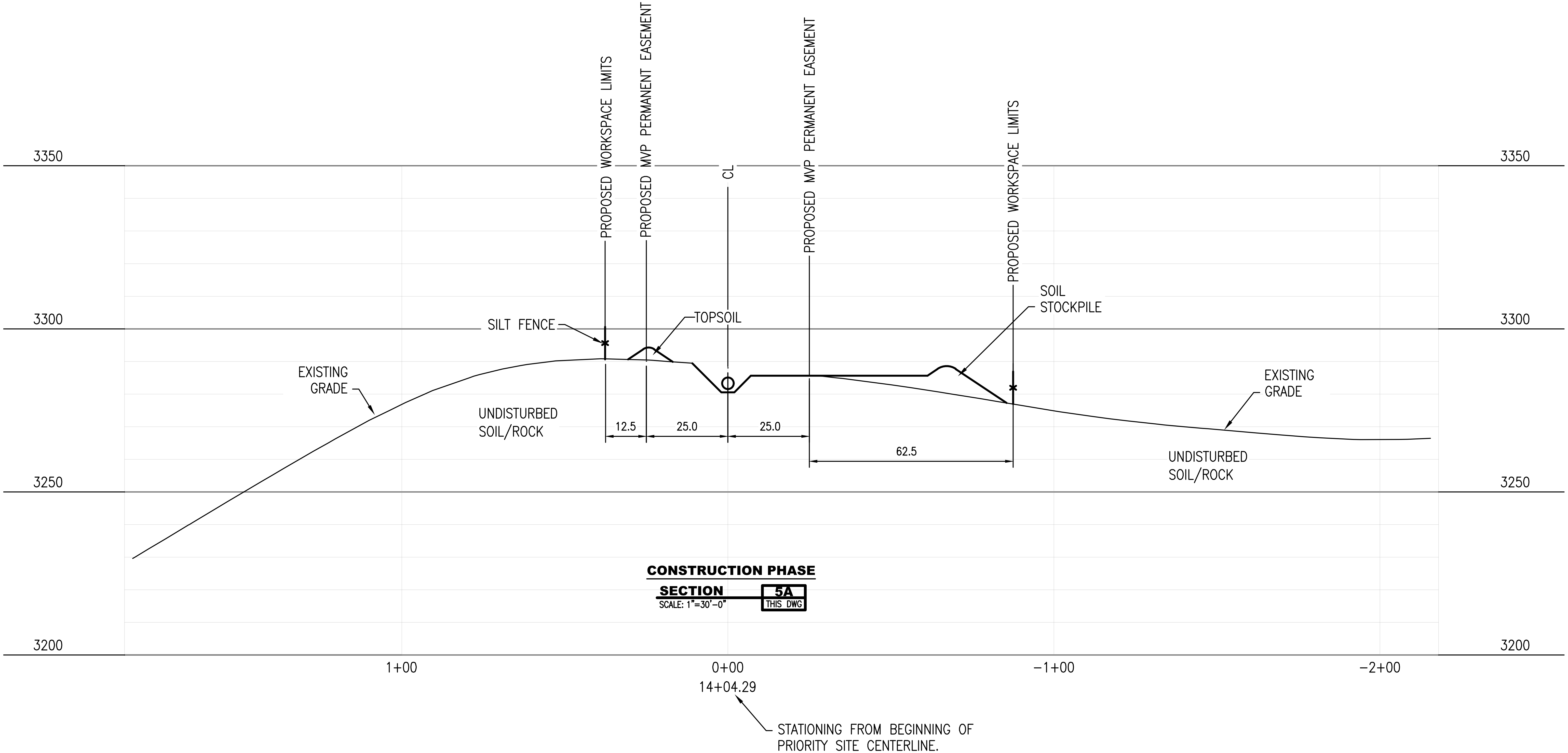
DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #5
CROSS SECTION EXISTING – FIGURE 27

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

Plotted by: Darrell Dalton on: March 6, 2018 - 3:19 PM

File Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS5-01cross sections work.dwg



CONSTRUCTION PHASE

SECTION 5A THIS DWG

SCALE: 1"=30'-0"

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

- MECHANICAL DESIGN ENGINEER — DATE -

- ELECTRICAL DESIGN ENGINEER — DATE -

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID: -

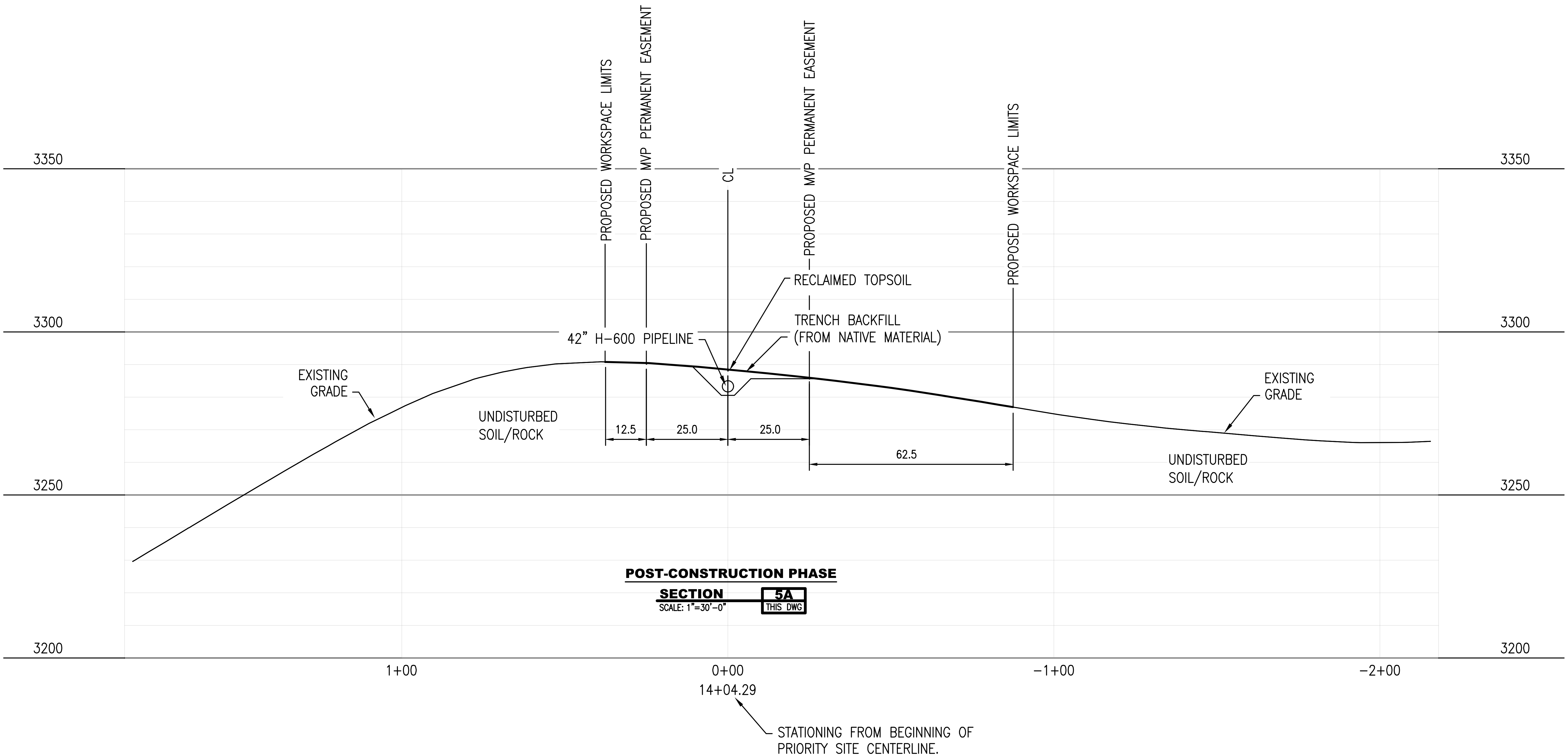
DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #5
CONSTRUCTION PHASE SECTION - FIGURE 28

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

Plotted by: Darrell Dalton on: March 6, 2018 - 3:24 PM

File Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS5-01cross sections work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID –

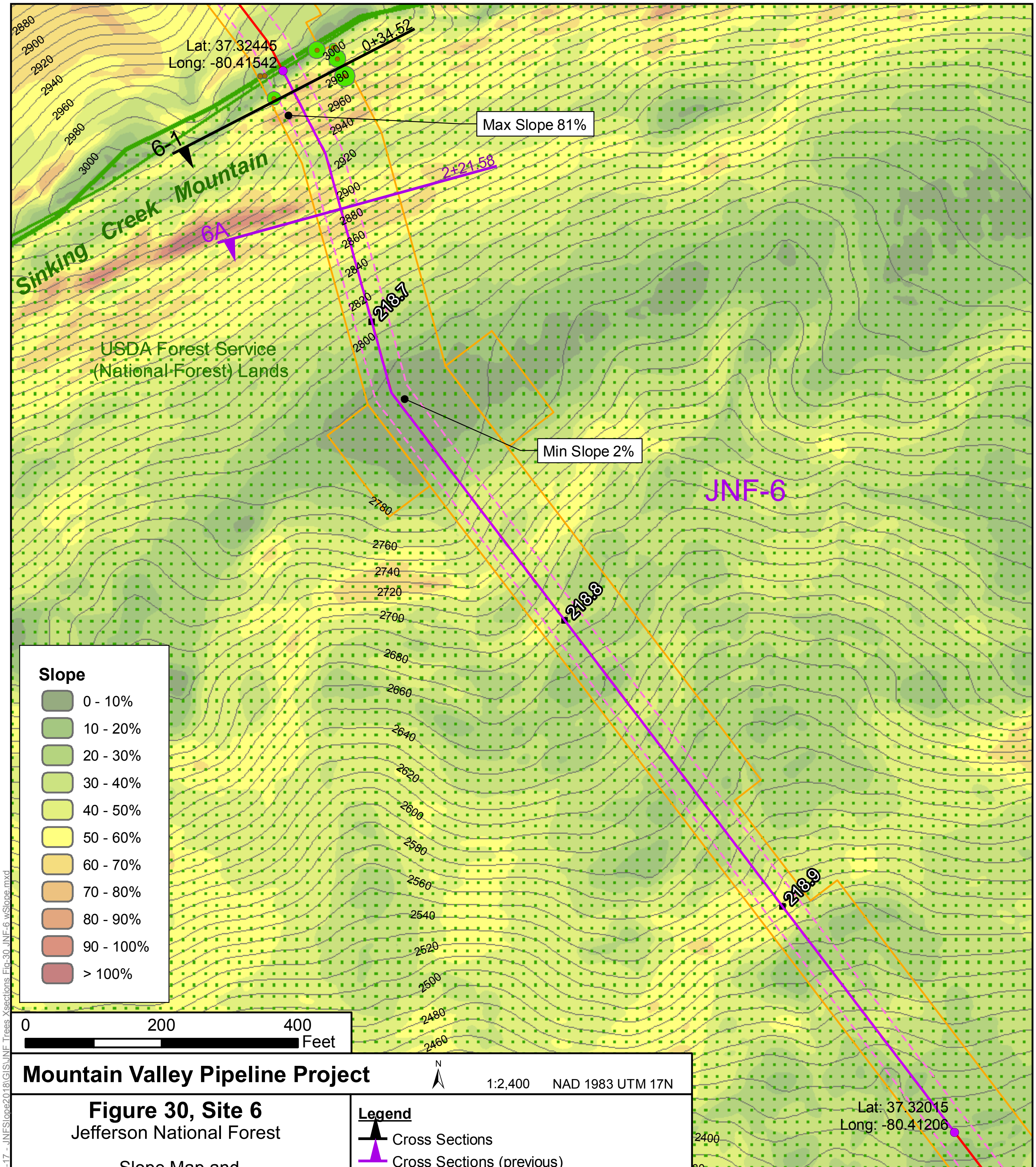
DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #5
CROSS SECTION POST CONSTRUCTION – FIGURE 29

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

Plotted by: Darrell Dalton on: March 6, 2018 - 3:30 PM

File Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS5-01cross sections work.dwg



Mountain Valley Pipeline Project

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1:2,400 NAD 1983 UTM 17N

Figure 30, Site 6

Jefferson National Forest

Slope Map and
Representitive Cross Section Locations

03-12-18

Mountain Valley
PIPELINE

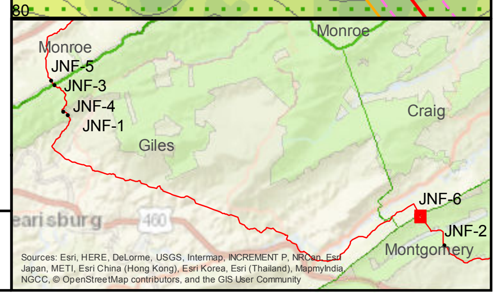
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate



Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

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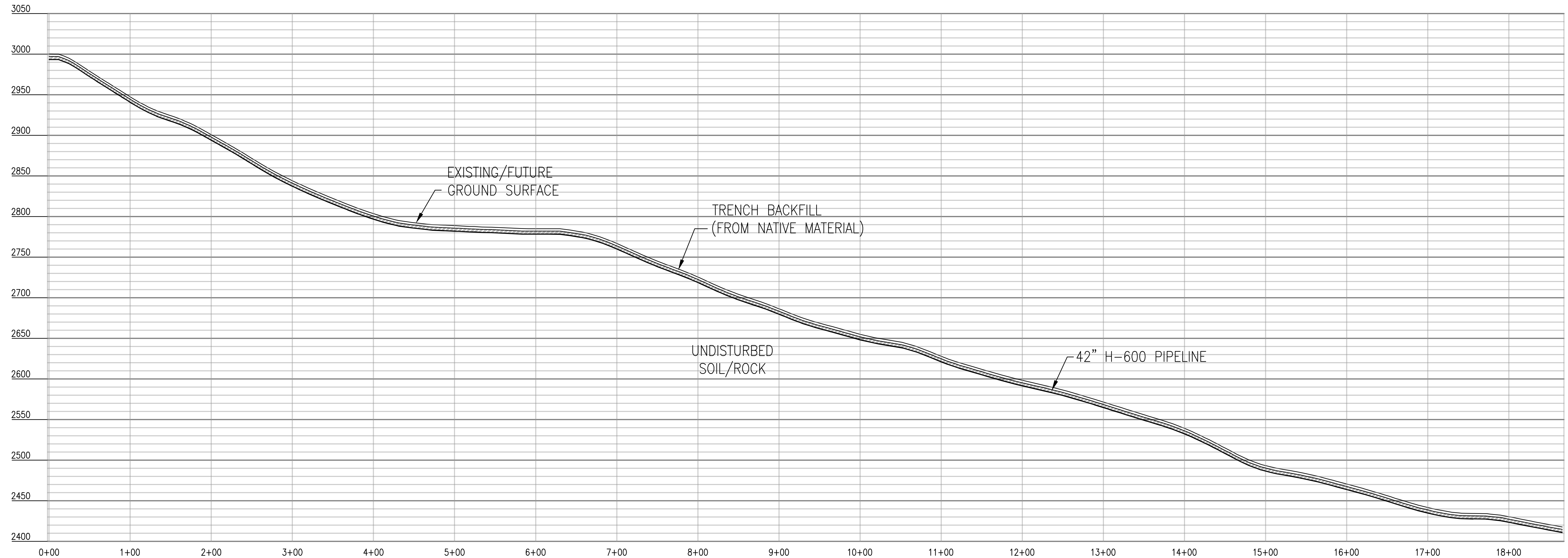
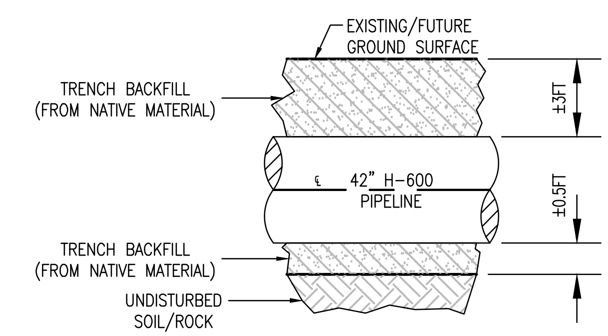


(STATIONING IS RELATIVE TO START OF JNF PRIORITY SITE #6)

PROFILE

NOTES:
1. EVERY THIRD TRENCH BREAKER AT PRIORITY SITE #6 SHALL BE PROVIDED WITH DAYLIGHT DRAINS AS SHOWN ON TYPICAL DRAWING MVP-35.
2. ALL TRENCH BREAKERS AT PRIORITY SITE #6 NOT PROVIDED WITH DAYLIGHT DRAINS SHALL BE PROVIDED WITH PASS-THROUGH DRAINS AS SHOWN ON TYPICAL DRAWING MVP-43.



TYPICAL TRENCH BACKFILL

(NOT TO SCALE)

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER — – DATE

– ELECTRICAL DESIGN ENGINEER — – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

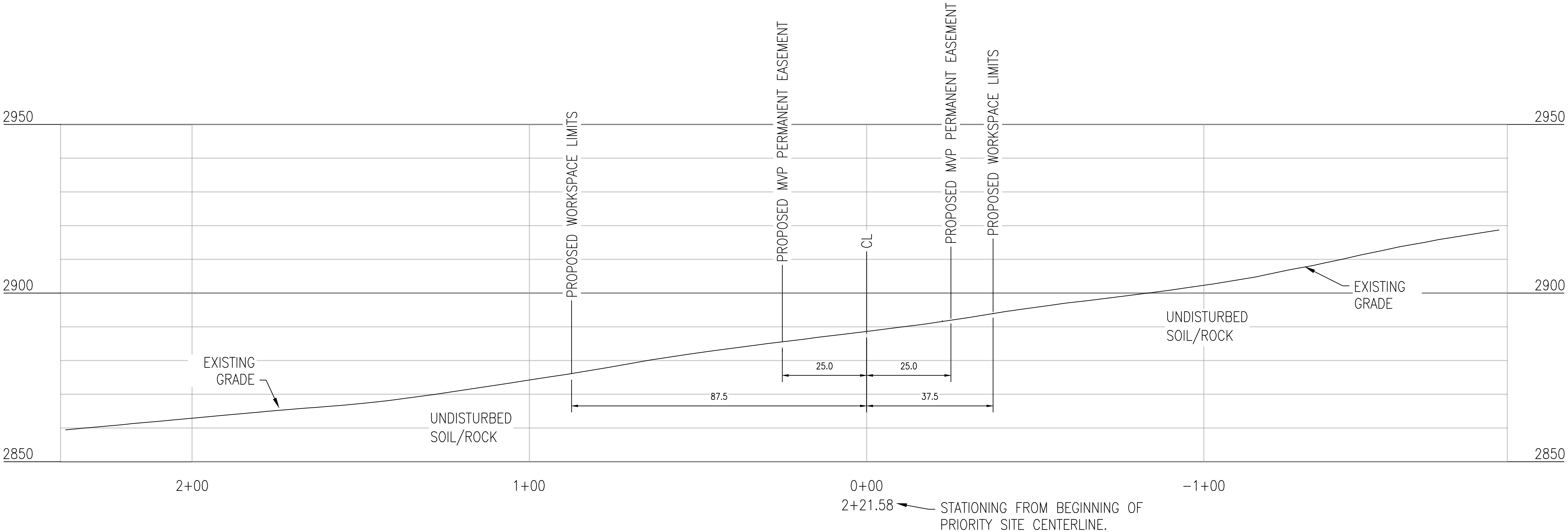
PROJECT ID: –

DRAWING SCALE: 1"=125'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #6 PROFILE – FIGURE 31

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS6-01cross sections work.dwg



CROSS SECTION EXISTING

SECTION 6A THIS DWG
SCALE: 1"=30'-0"

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE

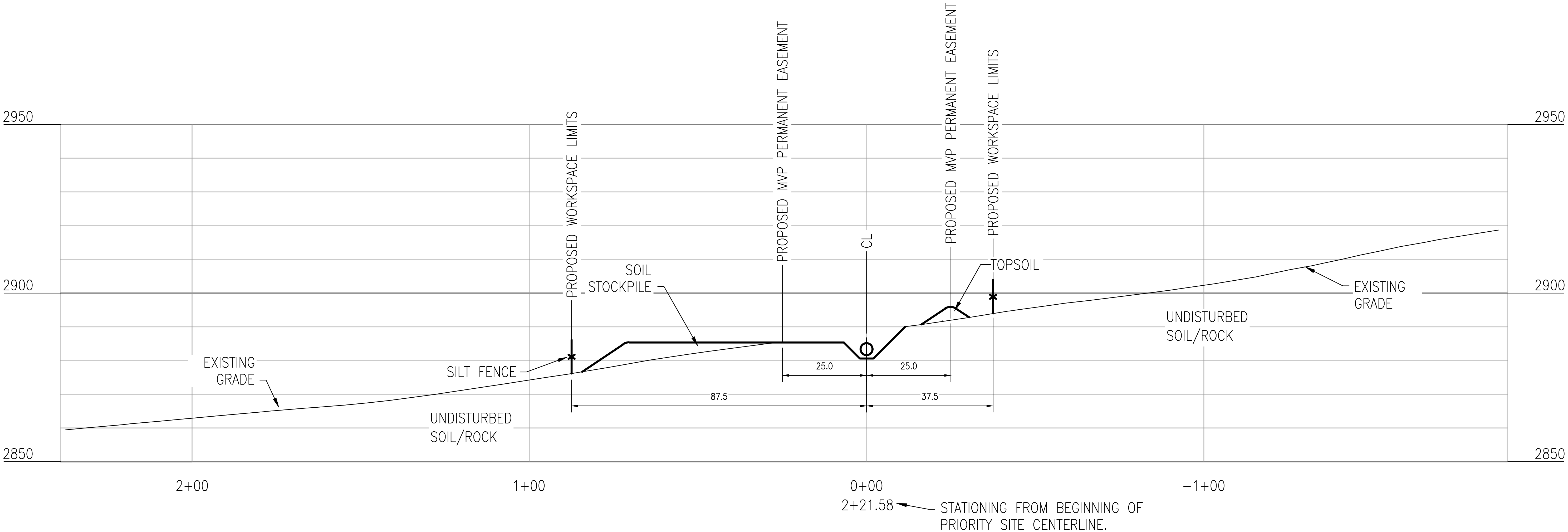
PROJECT ID –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #6
CROSS SECTION EXISTING – FIGURE 32

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS6-01cross sections work.dwg



CONSTRUCTION PHASE

SECTION 6A
SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

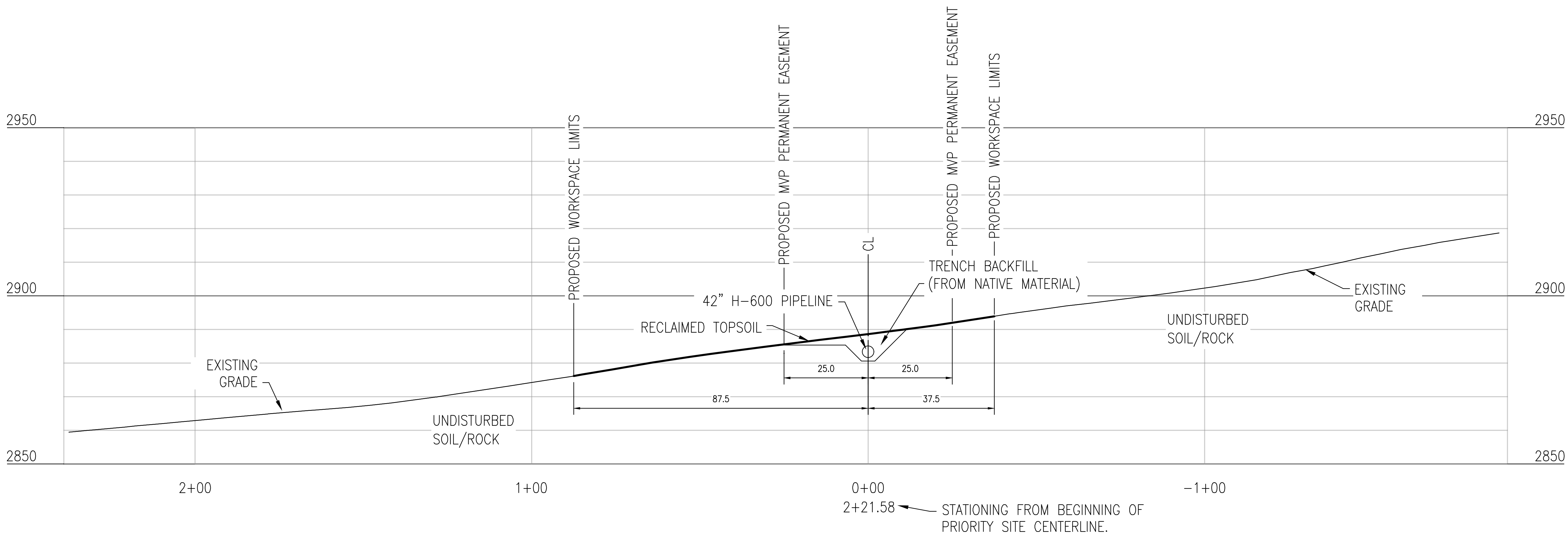
PROJECT ID –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #6
CONSTRUCTION PHASE SECTION – FIGURE 33

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS6-01cross sections work.dwg



POST CONSTRUCTION PHASE

SECTION 6A THIS DWG
SCALE: 1"=30'-0"

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

- MECHANICAL DESIGN ENGINEER — DATE -
- ELECTRICAL DESIGN ENGINEER — DATE -

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE, LLC

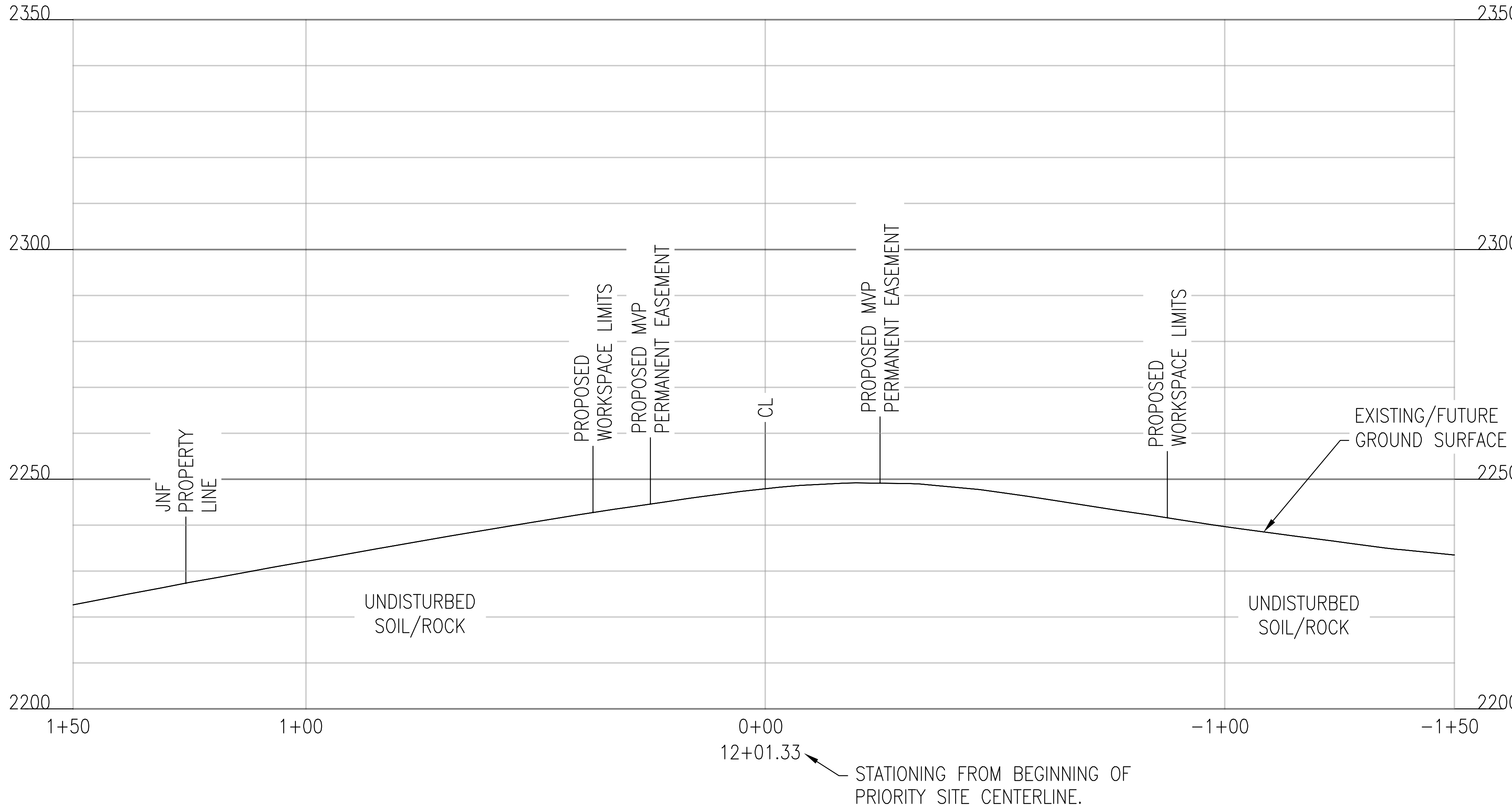
PROJECT ID: -

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #6
CROSS SECTION POST CONSTRUCTION - FIGURE 34

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS6-01cross sections work.dwg



CROSS SECTION EXISTING

SECTION 1B
SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS	
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

- MECHANICAL DESIGN ENGINEER — DATE -

- ELECTRICAL DESIGN ENGINEER — DATE -

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

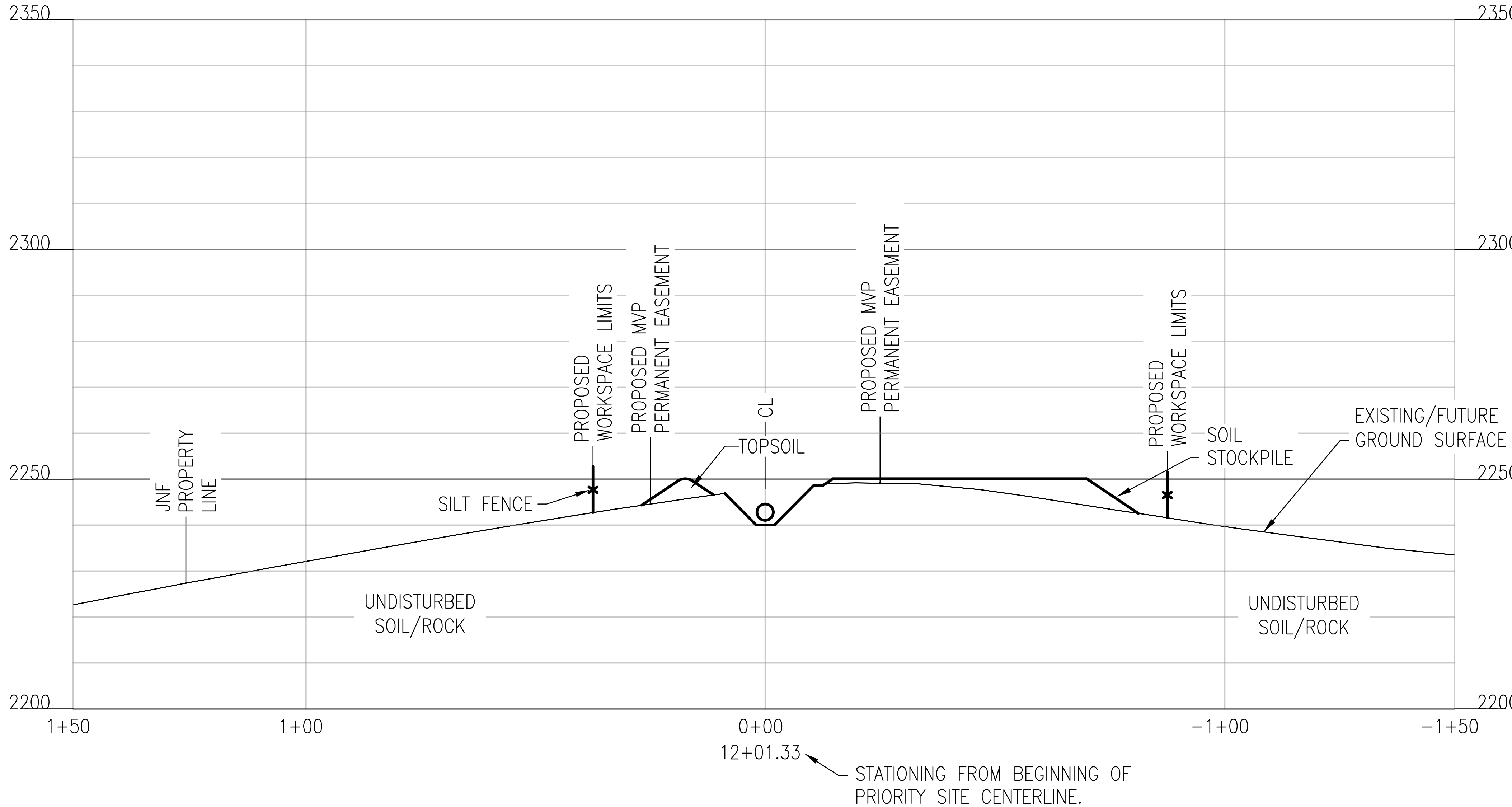
PROJECT ID: -

DRAWING SCALE: 1"=50'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #1
CROSS SECTION EXISTING - FIGURE 35

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS1-01 cross section work.dwg



CONSTRUCTION PHASE

SECTION 1B
SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE, LLC

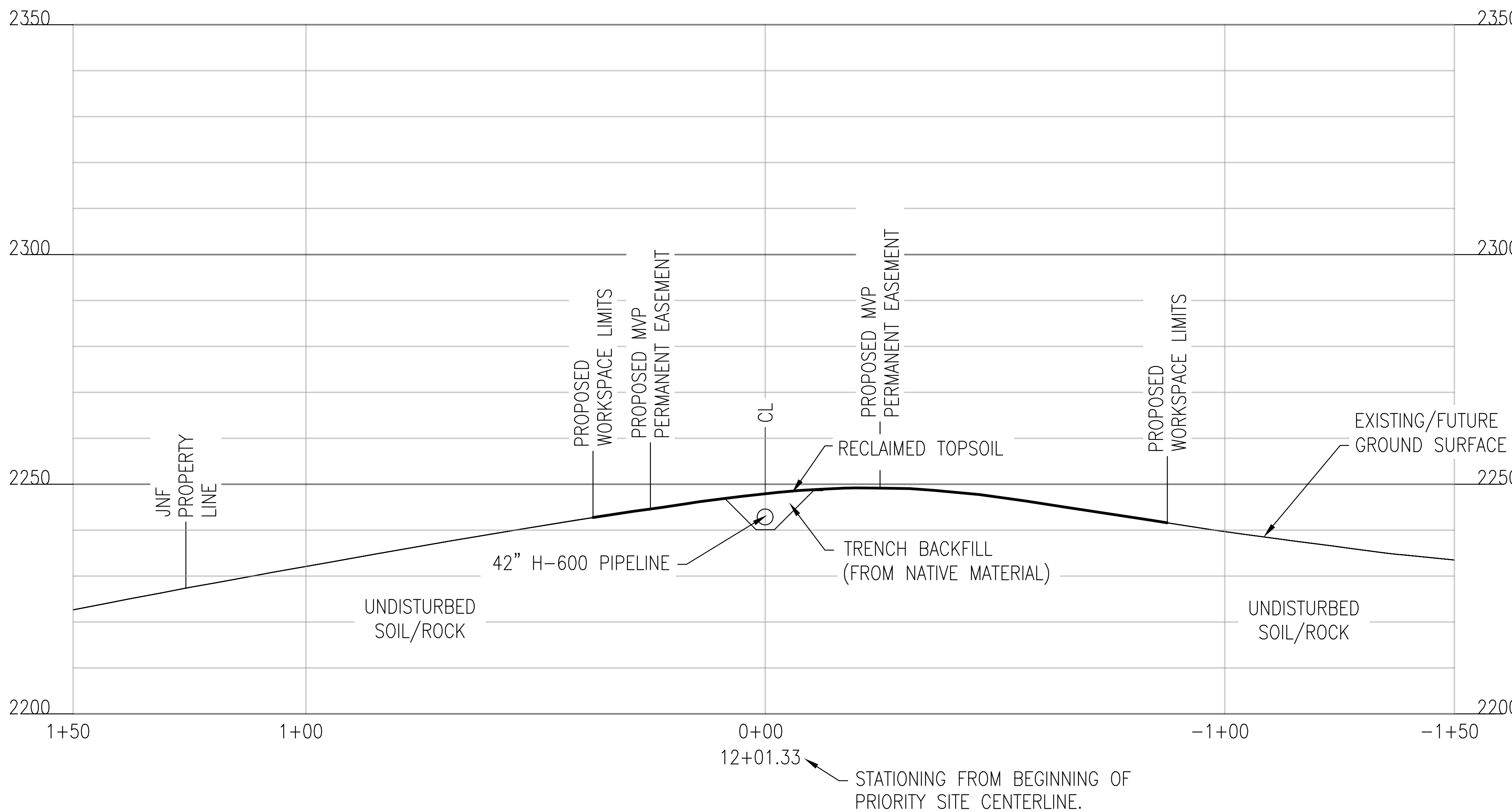
PROJECT ID: –

DRAWING SCALE: 1"=50'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #1
CONSTRUCTION PHASE SECTION – FIGURE 36

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS1-01 cross section work.dwg



POST CONSTRUCTION PHASE

SECTION 1B
SCALE: 1"=30'-0" THIS DWG

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE, LLC

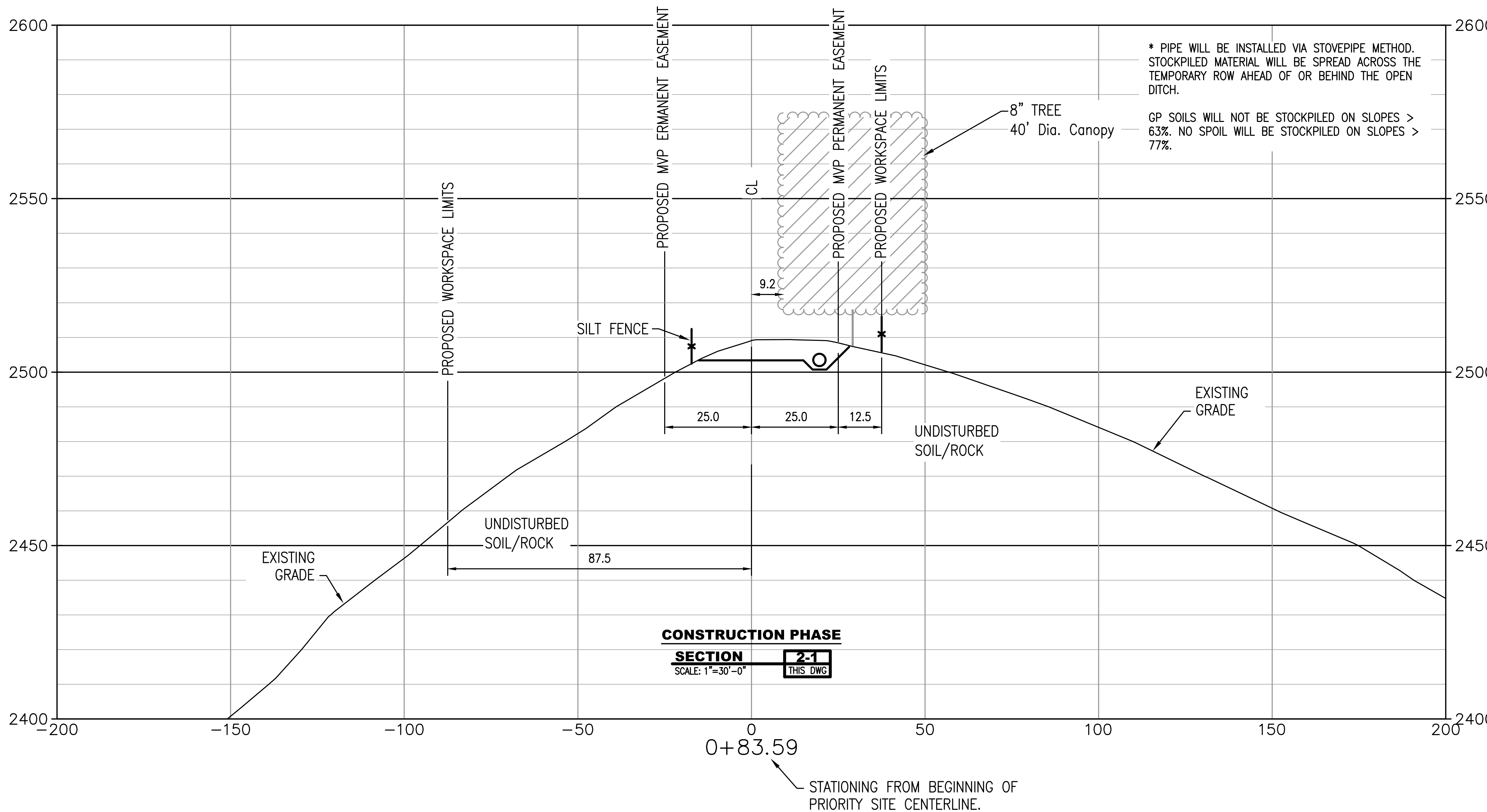
PROJECT ID –

DRAWING SCALE: 1"=50'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #1 CROSS SECTION POST CONSTRUCTION – FIGURE 37

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS1-01 cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

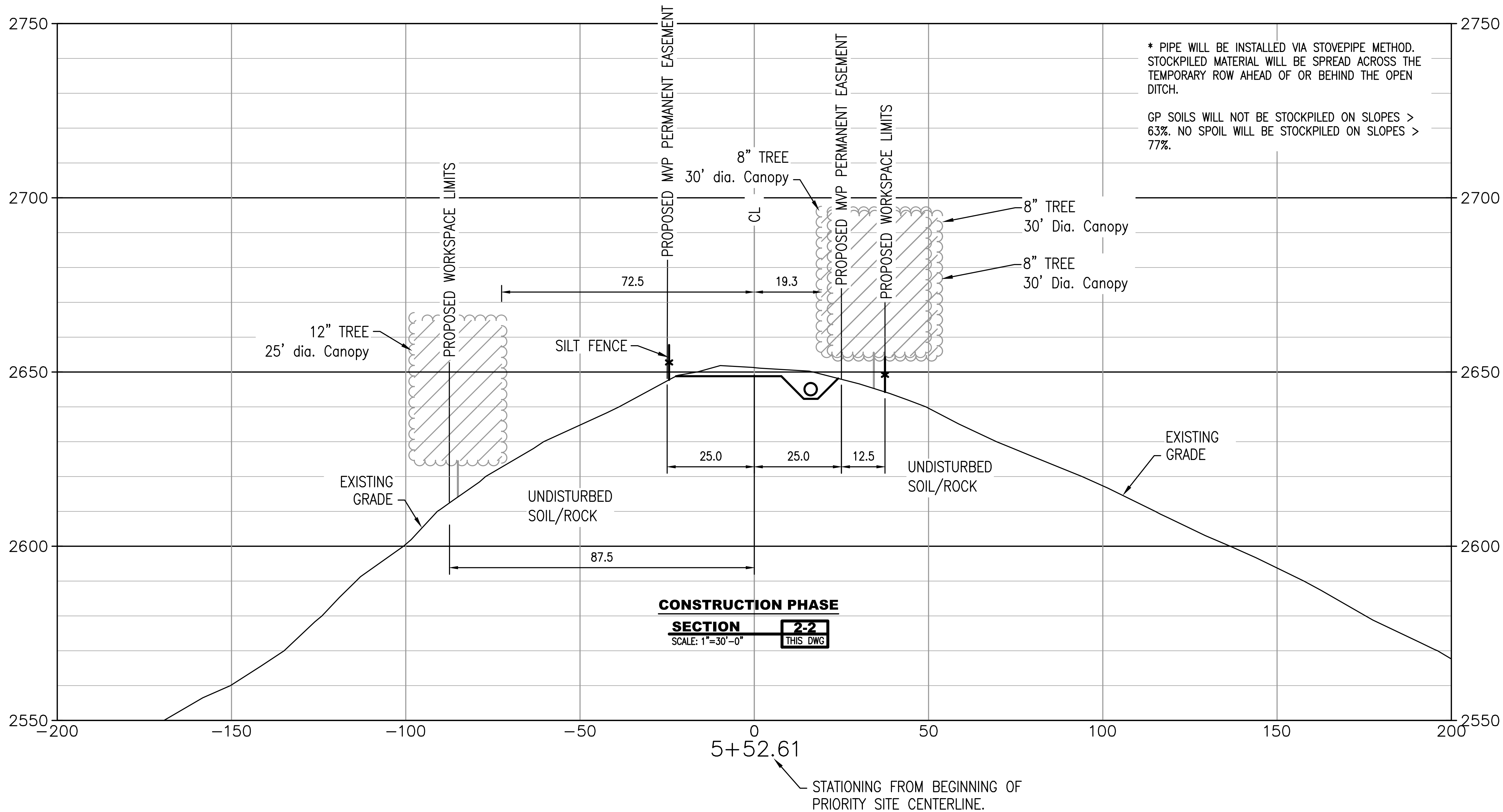
PROJECT ID: –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #2
CONSTRUCTION PHASE SECTION – FIGURE 38

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS2-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

- MECHANICAL DESIGN ENGINEER — DATE -

- ELECTRICAL DESIGN ENGINEER — DATE -

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

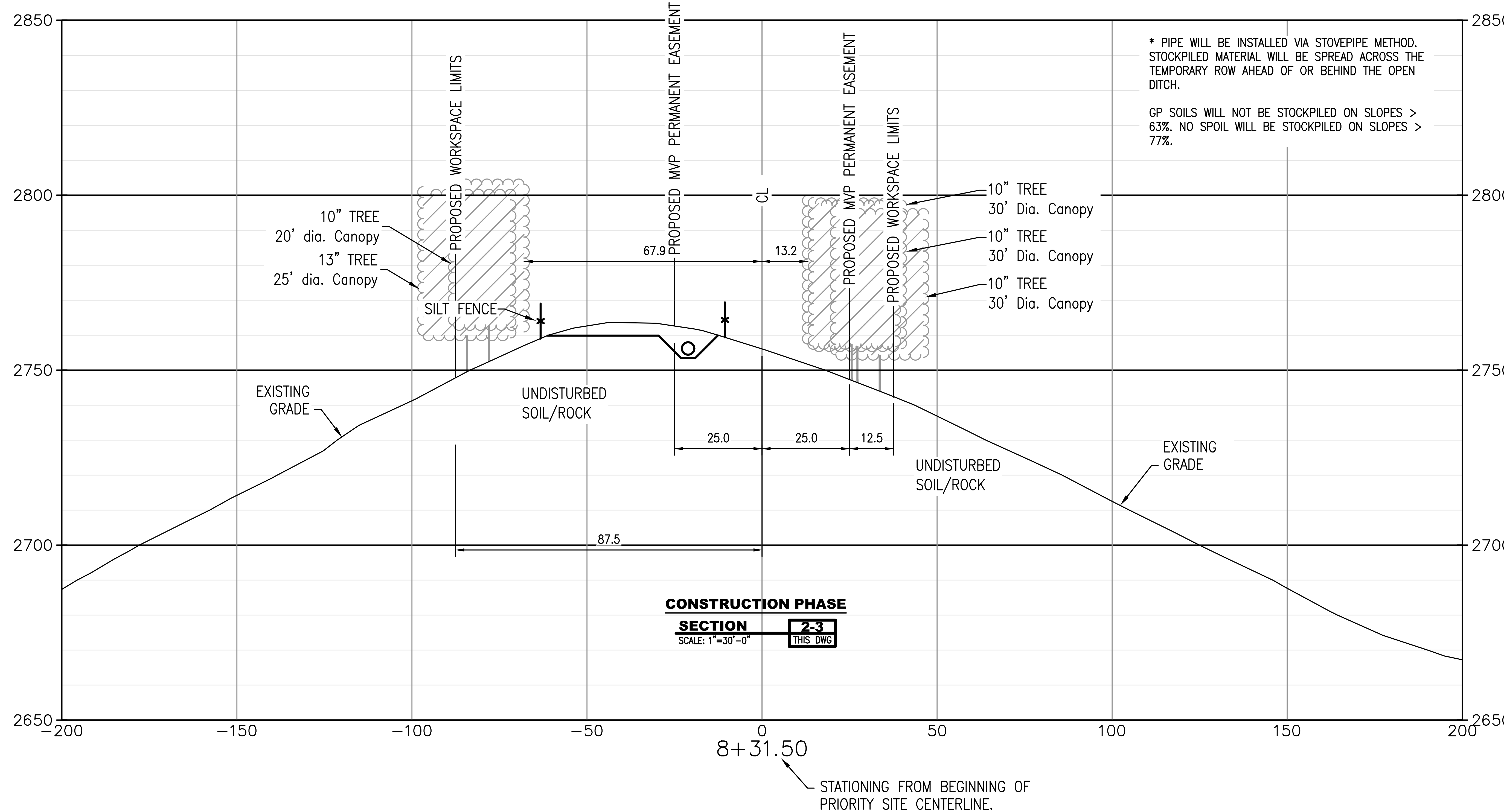
PROJECT ID: -

DRAWING SCALE: 1"=30'

DRAWING TITLE:
MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #2
CONSTRUCTION PHASE SECTION – FIGURE 39

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS2-01cross section work.dwg



* PIPE WILL BE INSTALLED VIA STOVEPIPE METHOD. STOCKPILED MATERIAL WILL BE SPREAD ACROSS THE TEMPORARY ROW AHEAD OF OR BEHIND THE OPEN DITCH.

GP SOILS WILL NOT BE STOCKPILED ON SLOPES > 63%. NO SPOIL WILL BE STOCKPILED ON SLOPES > 77%.

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE

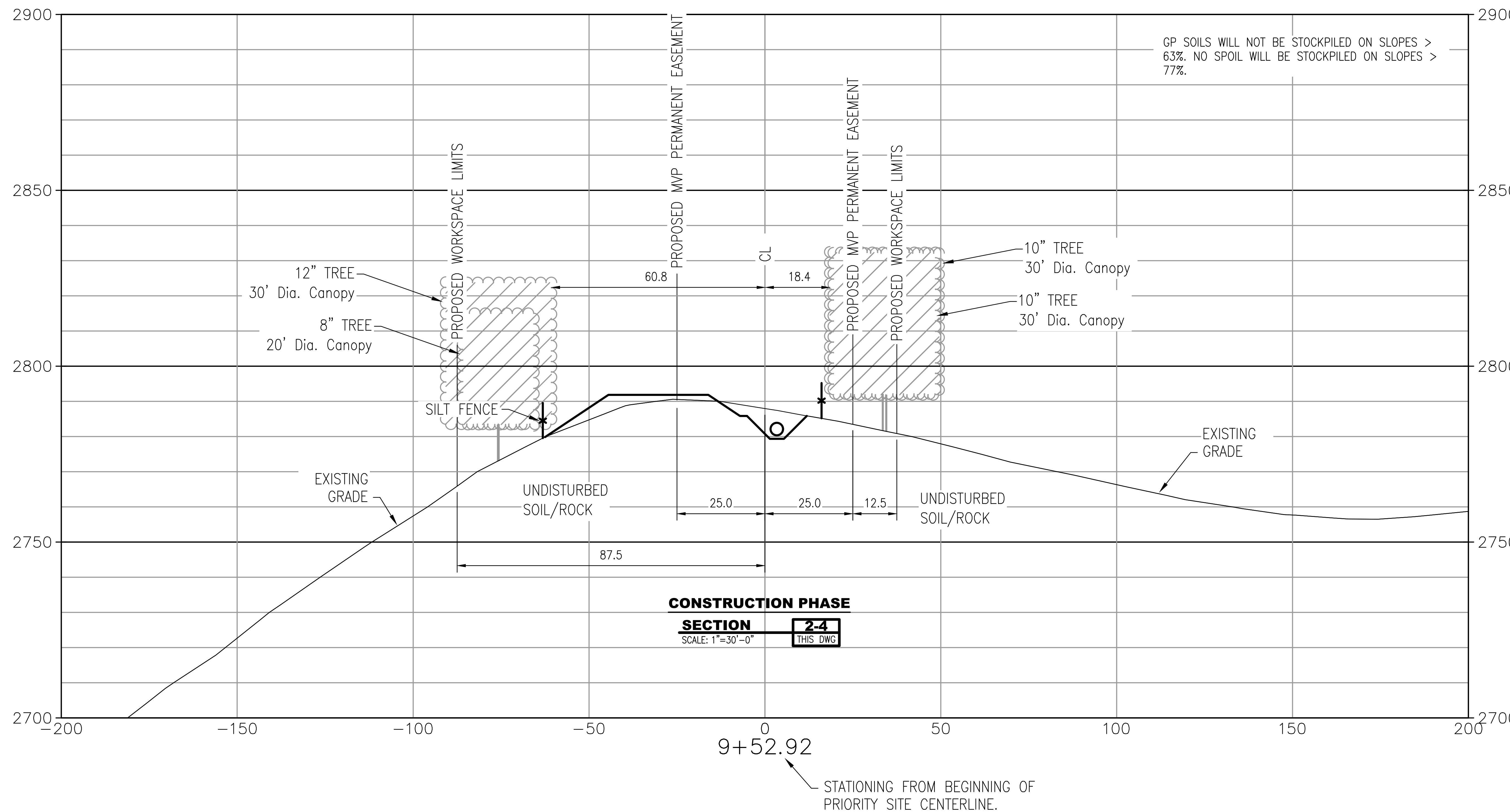
PROJECT ID: –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #2 CONSTRUCTION PHASE SECTION – FIGURE 40

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS2-01cross section work.dwg



CONSTRUCTION PHASE

SECTION 2-4 THIS DWG

SCALE: 1"=30'-0"

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE

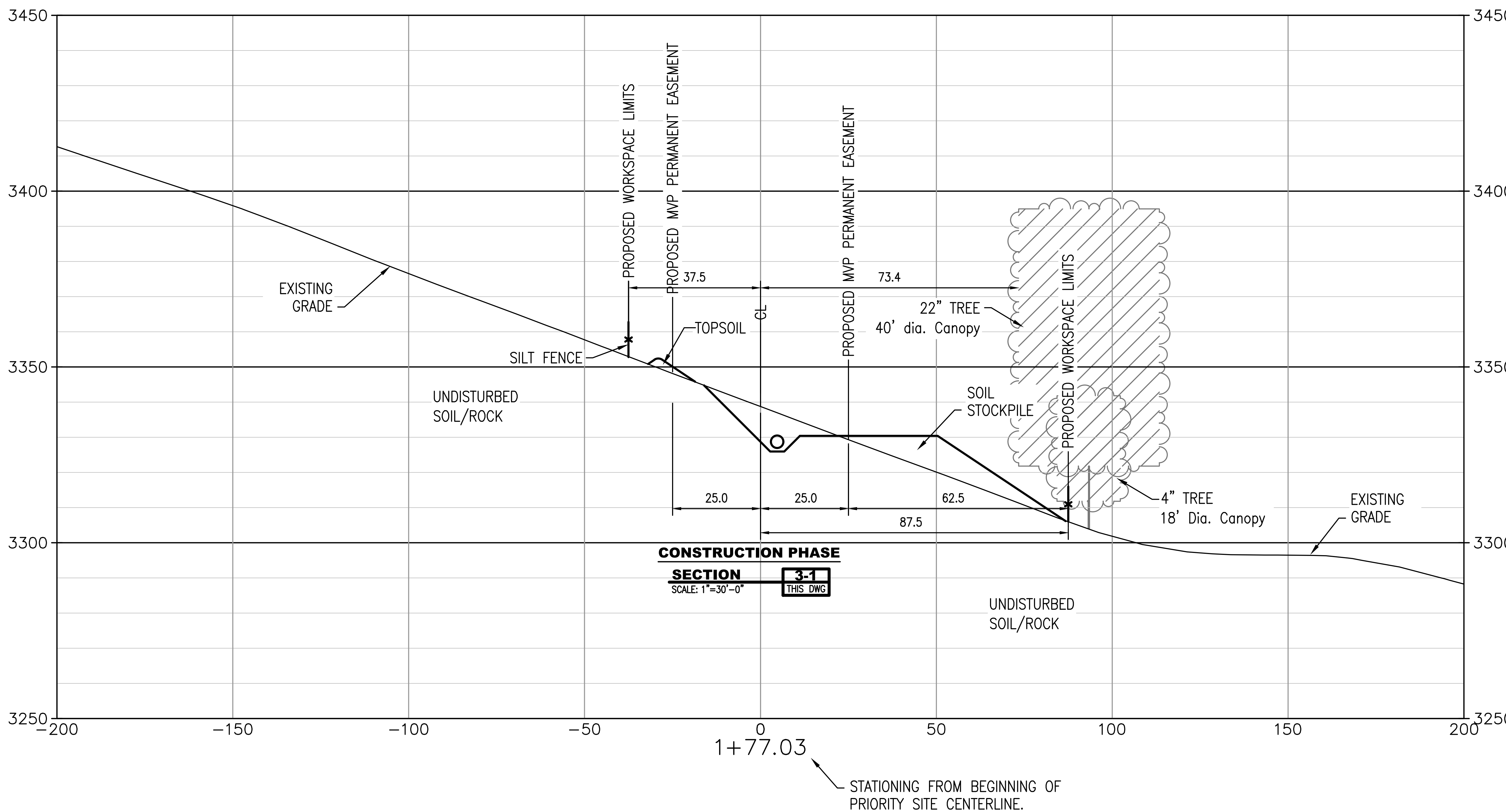
PROJECT ID –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #2 CONSTRUCTION PHASE SECTION – FIGURE 41

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS2-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

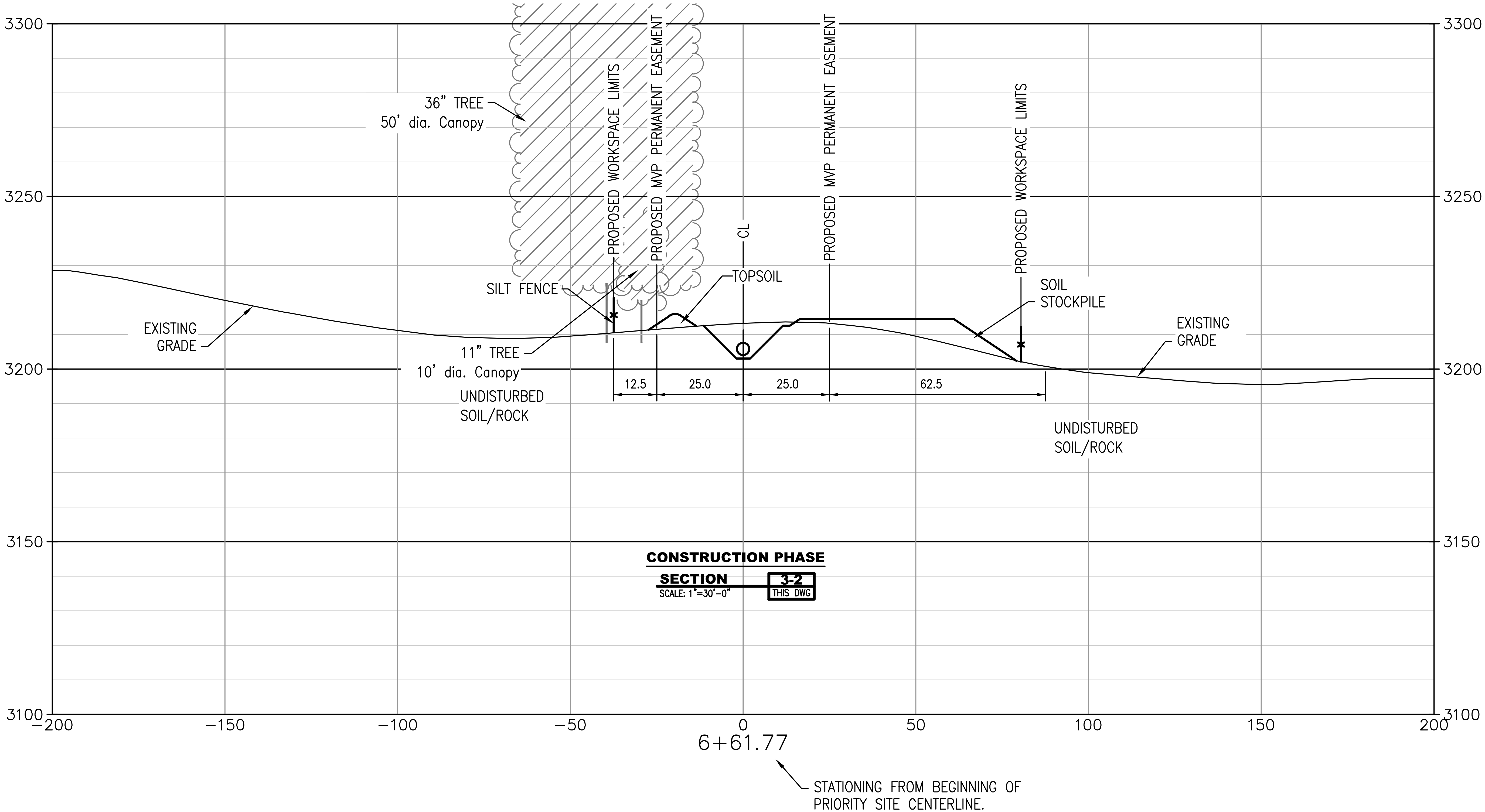
PROJECT ID –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #3
CONSTRUCTION PHASE SECTION – FIGURE 42

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS3-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

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ELECTRICAL DESIGN ENGINEER	DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

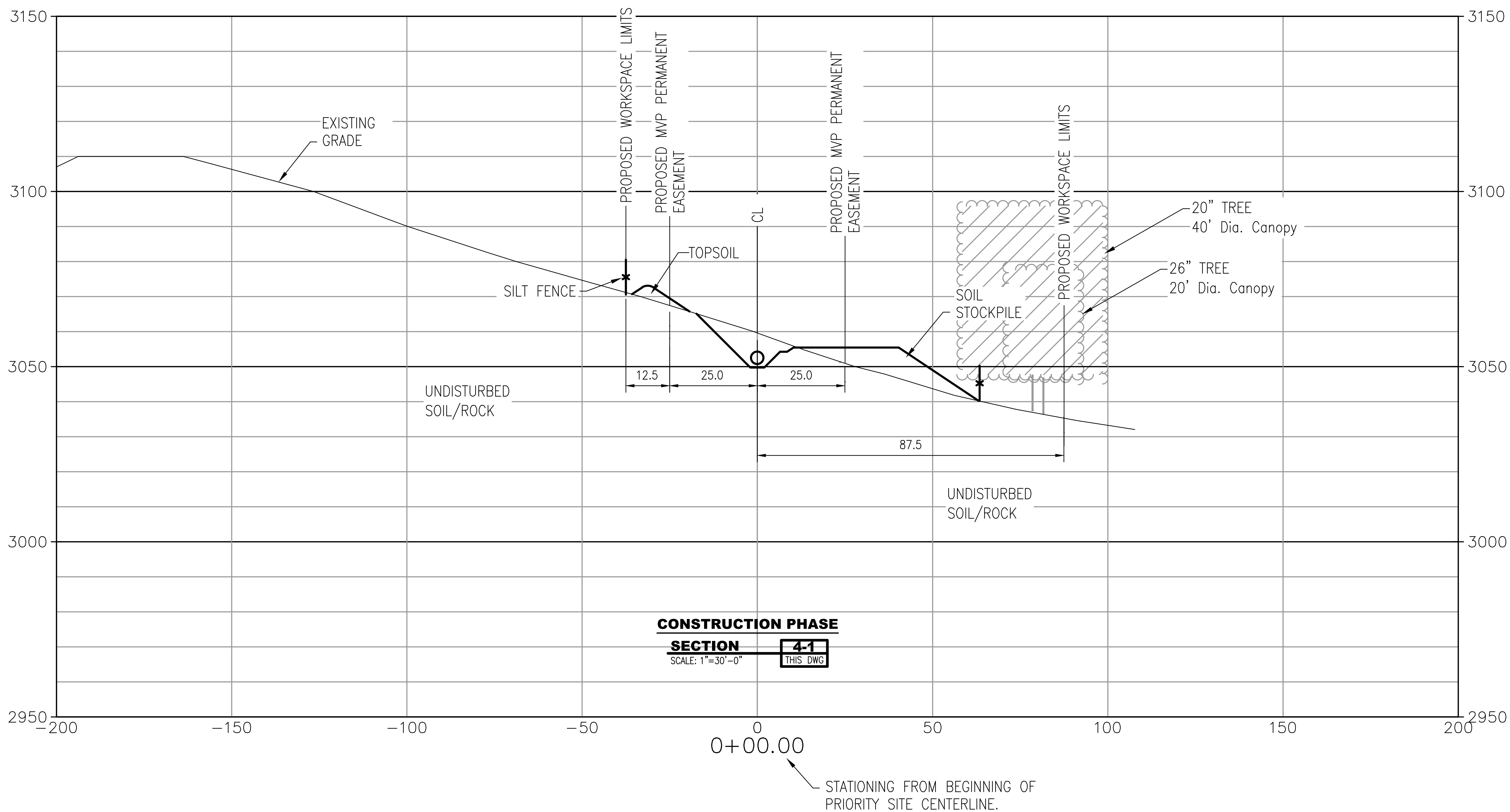
PROJECT ID –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE JEFFERSON NATIONAL FOREST PRIORITY SITE #3 CONSTRUCTION PHASE SECTION – FIGURE 43

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS3-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

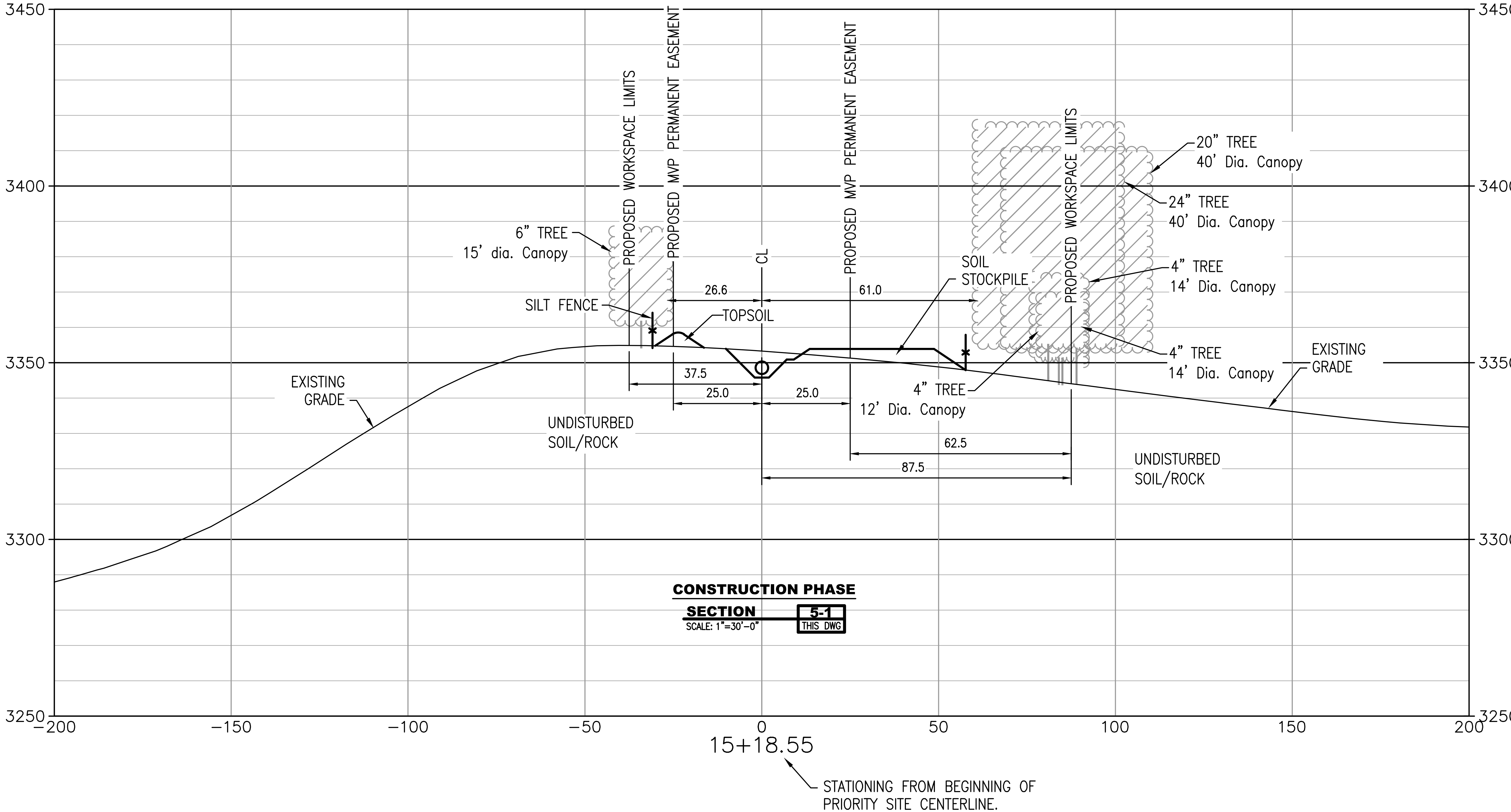
PROJECT ID –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #4
CONSTRUCTION PHASE SECTION – FIGURE 44

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS4-01cross section work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID –

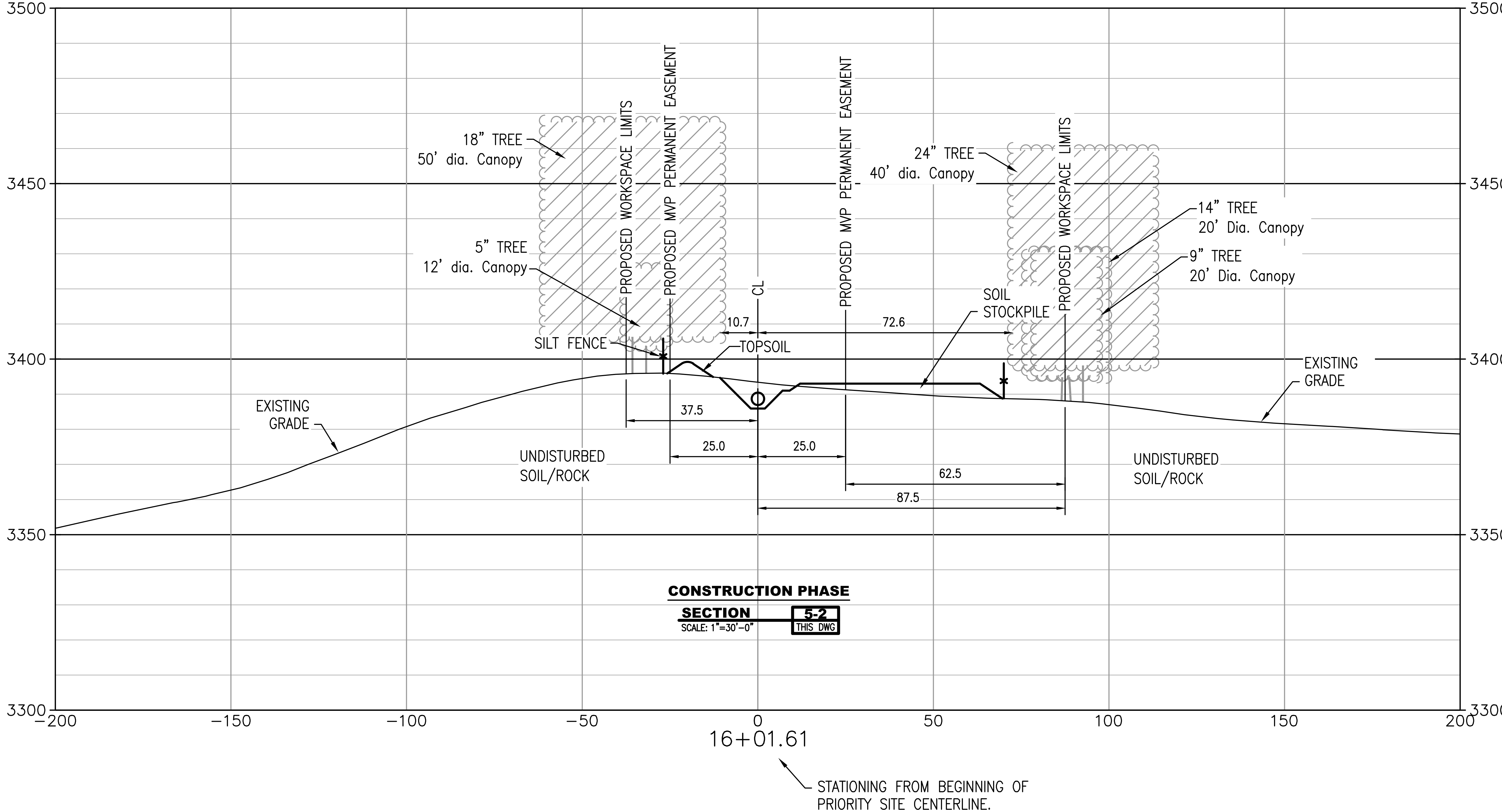
DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #5
CONSTRUCTION PHASE SECTION – FIGURE 45

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

Plotted by: Darrell Dalton on: March 5, 2018 – 9:54 AM

File Path: P:\B14\100\B14188B\B14188B-17 – JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS5-01cross sections work.dwg



CONSTRUCTION PHASE

SECTION 5-2 THIS DWG

SCALE: 1"=30'-0"

NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS	
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

– MECHANICAL DESIGN ENGINEER – DATE

– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

PROJECT ID –

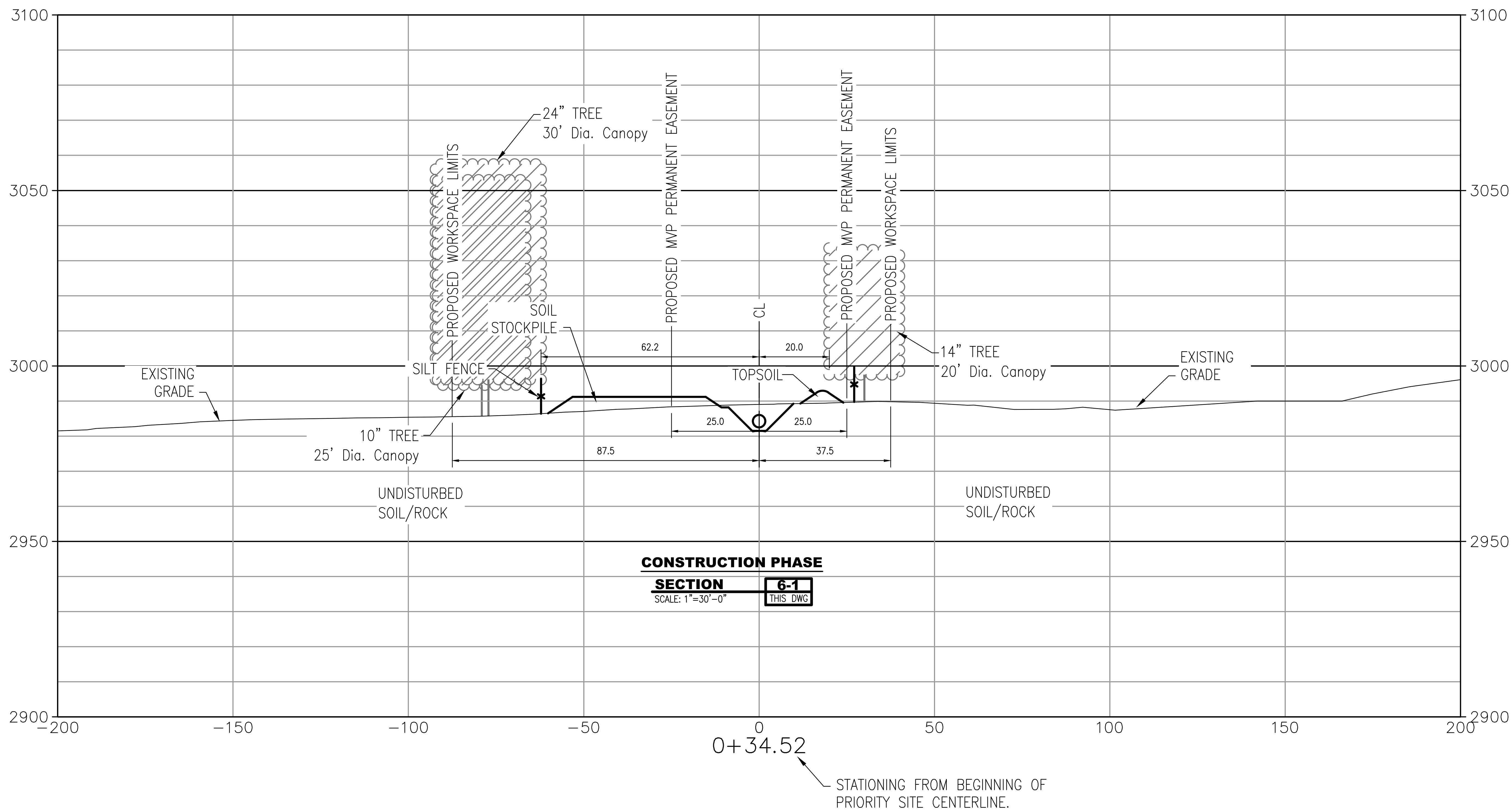
DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #5
CONSTRUCTION PHASE SECTION – FIGURE 46

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

Plotted by: Darrell Dalton on: March 5, 2018 – 9:55 AM

File Path: P:\B14\100\B14188B\B14188B-17 – JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS5-01cross sections work.dwg



NOTE:

1. ALL DIMENSIONS ARE APPROXIMATE AND DEPENDENT ON PIPELINE FIELD LOCATION.

REFERENCE DRAWINGS		NO.	DATE	REVISION	BY	CHK	APPD	NO.	DATE	REVISION	BY	CHK	APPD
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TO THE BEST OF MY KNOWLEDGE, ALL COMPONENTS OF THIS DRAWING ARE DESIGNED IN ACCORDANCE WITH APPLICABLE GUIDELINES AND SPECIFICATIONS

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– ELECTRICAL DESIGN ENGINEER – DATE

NOTE: ANY CHANGES TO THE DESIGN SHOWN ON THIS DRAWING MUST BE APPROVED BY THE DESIGN ENGINEER.

Mountain Valley PIPELINE LLC

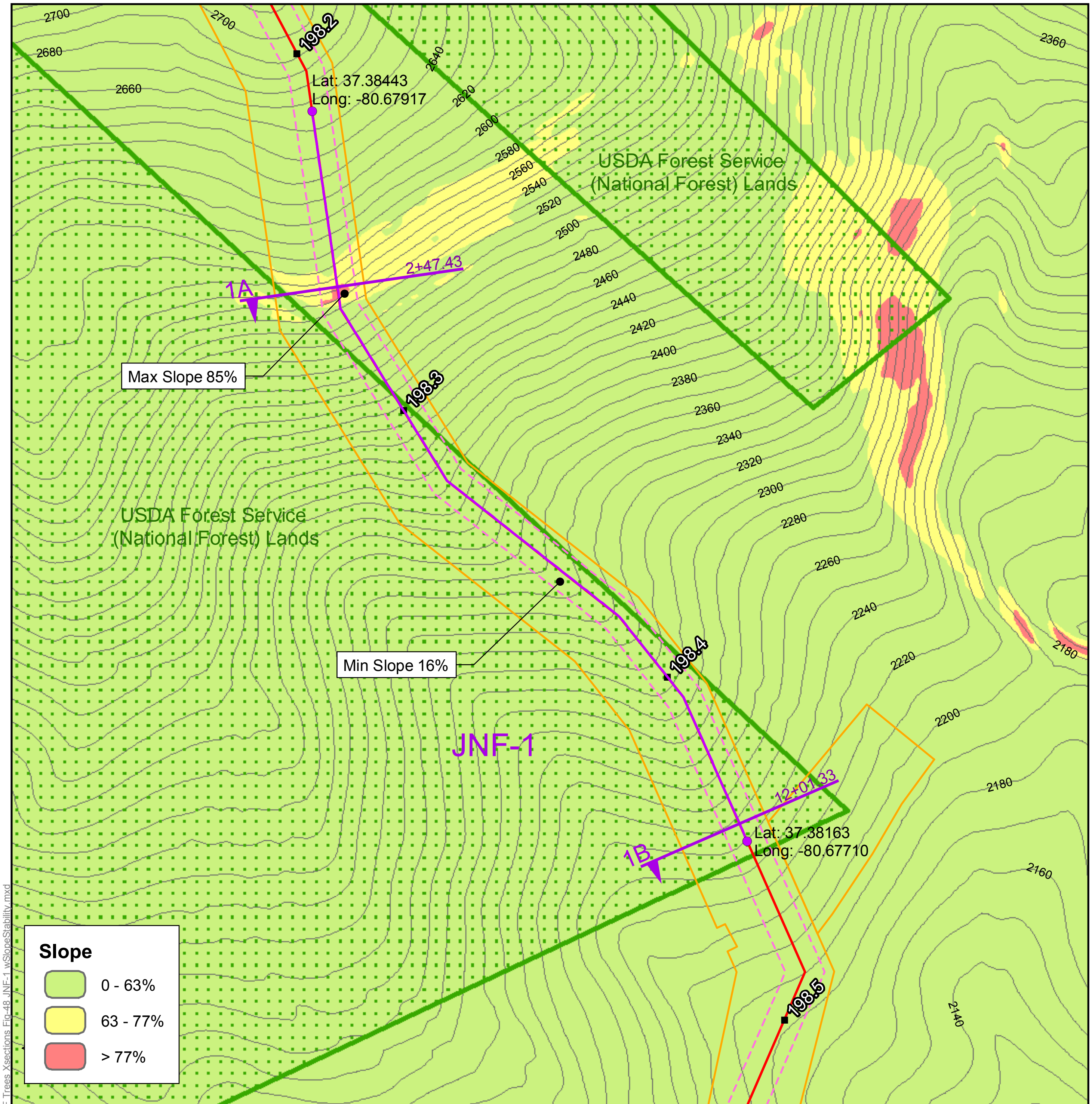
PROJECT ID –

DRAWING SCALE: 1"=30'

DRAWING TITLE: MOUNTAIN VALLEY PIPELINE
JEFFERSON NATIONAL FOREST
PRIORITY SITE #6
CONSTRUCTION PHASE SECTION – FIGURE 47

FACILITY	STATE	IDENTIFICATION	SERIES	SHEET	REVISION
		H600			

le Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\CAD\B14188B-17\DWG\P-V-H600-PS6-01cross sections work.dwg



Mountain Valley Pipeline Project

1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 48, Site 1

Jefferson National Forest

Slope Stability Map and Representitive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

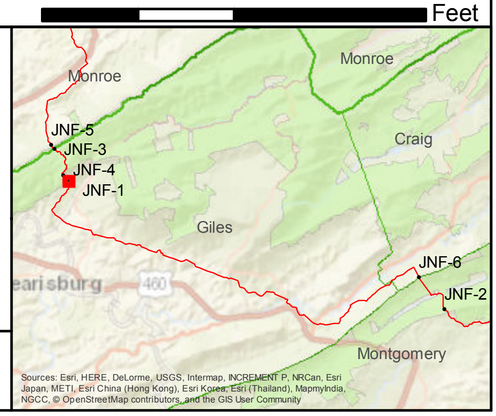
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees) (none)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate



Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

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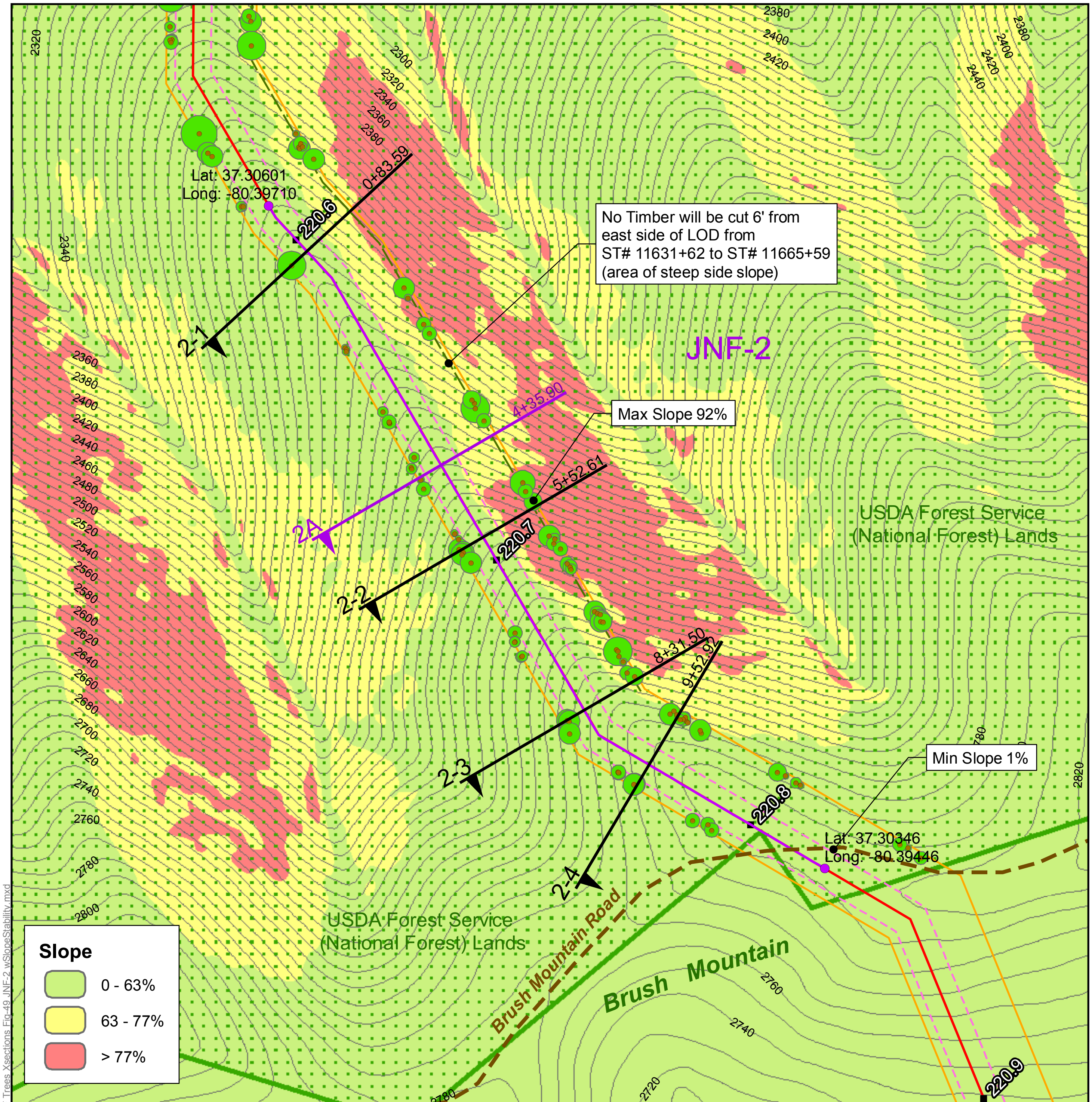

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Mountain Valley Pipeline Project

N

1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 49, Site 2

Jefferson National Forest

Slope Stability Map and Representive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

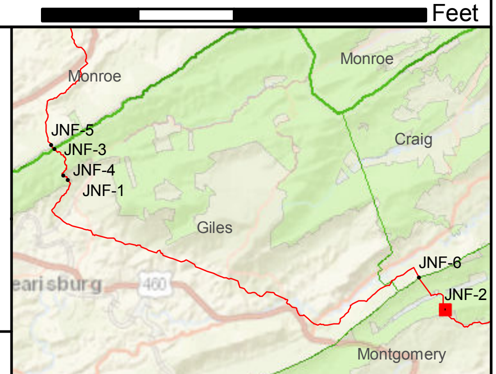
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

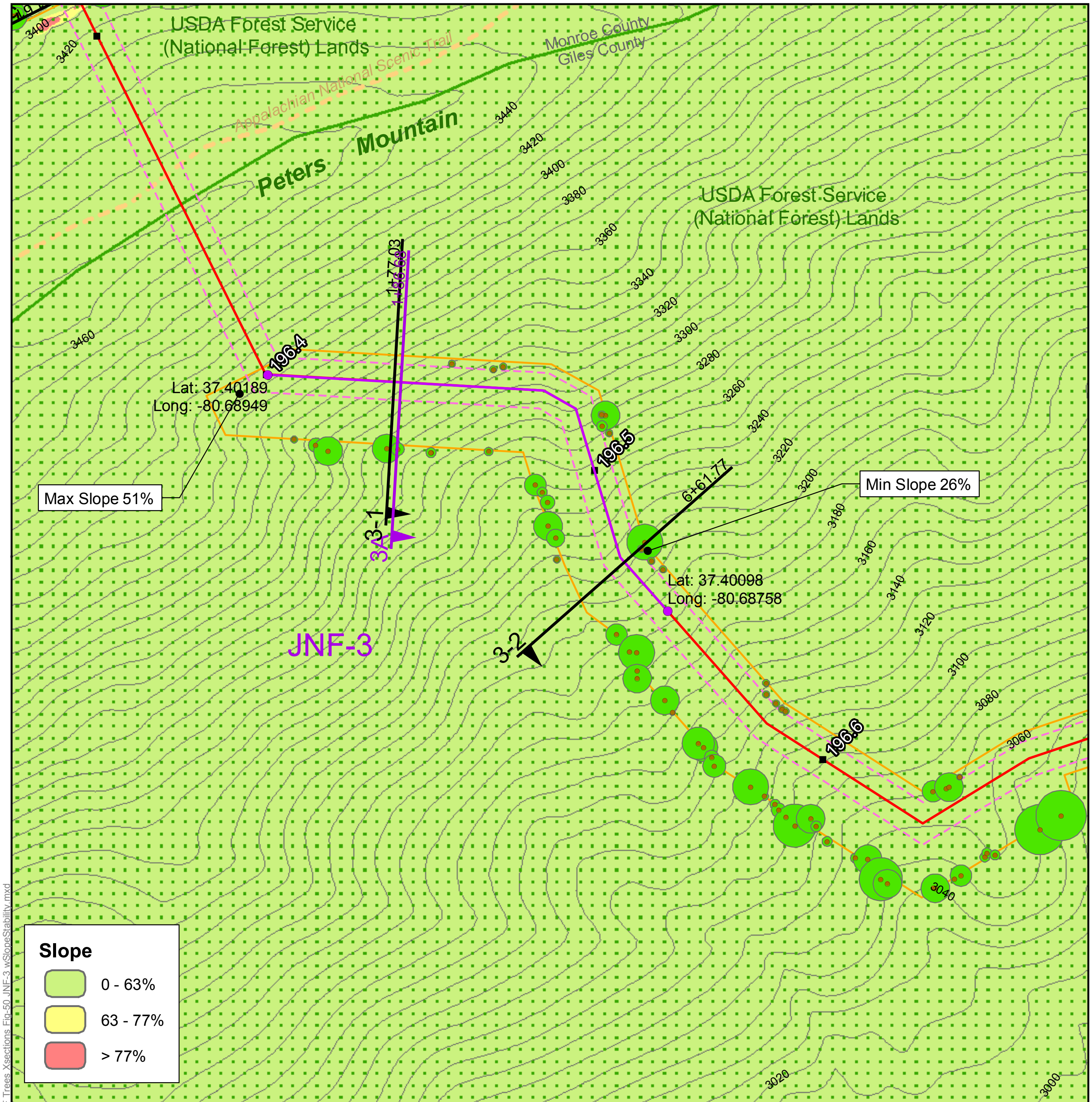
- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate



Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community



Mountain Valley Pipeline Project

1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 50, Site 3

Jefferson National Forest

Slope Stability Map and
Representitive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

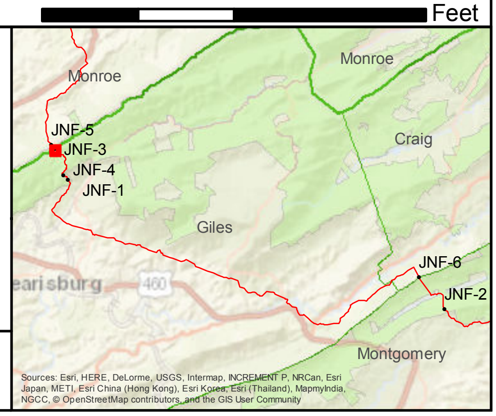
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

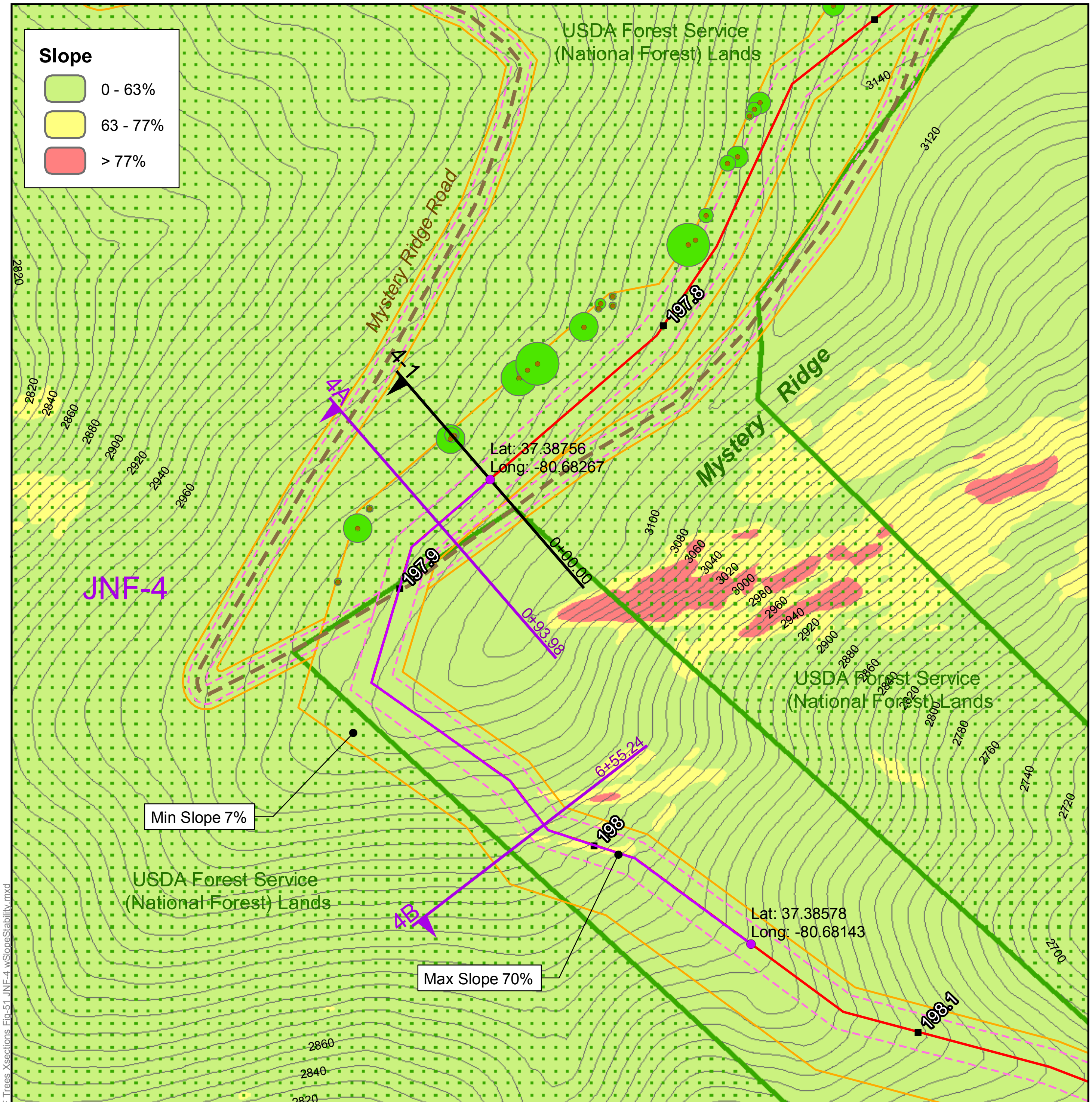
- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate



Document Path: P:\B14\100\B14188B\B14188B-17 - JNFSlope2018\GIS\JNF Trees Xsections Fig-50 JNF-3 wSlopeStability.mxd



Mountain Valley Pipeline Project

N

1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 51, Site 4

Jefferson National Forest

Slope Stability Map and Representive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

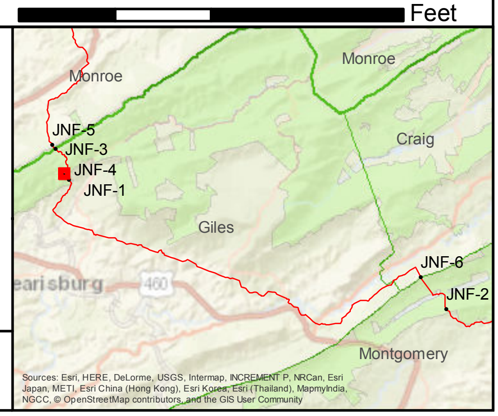
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate



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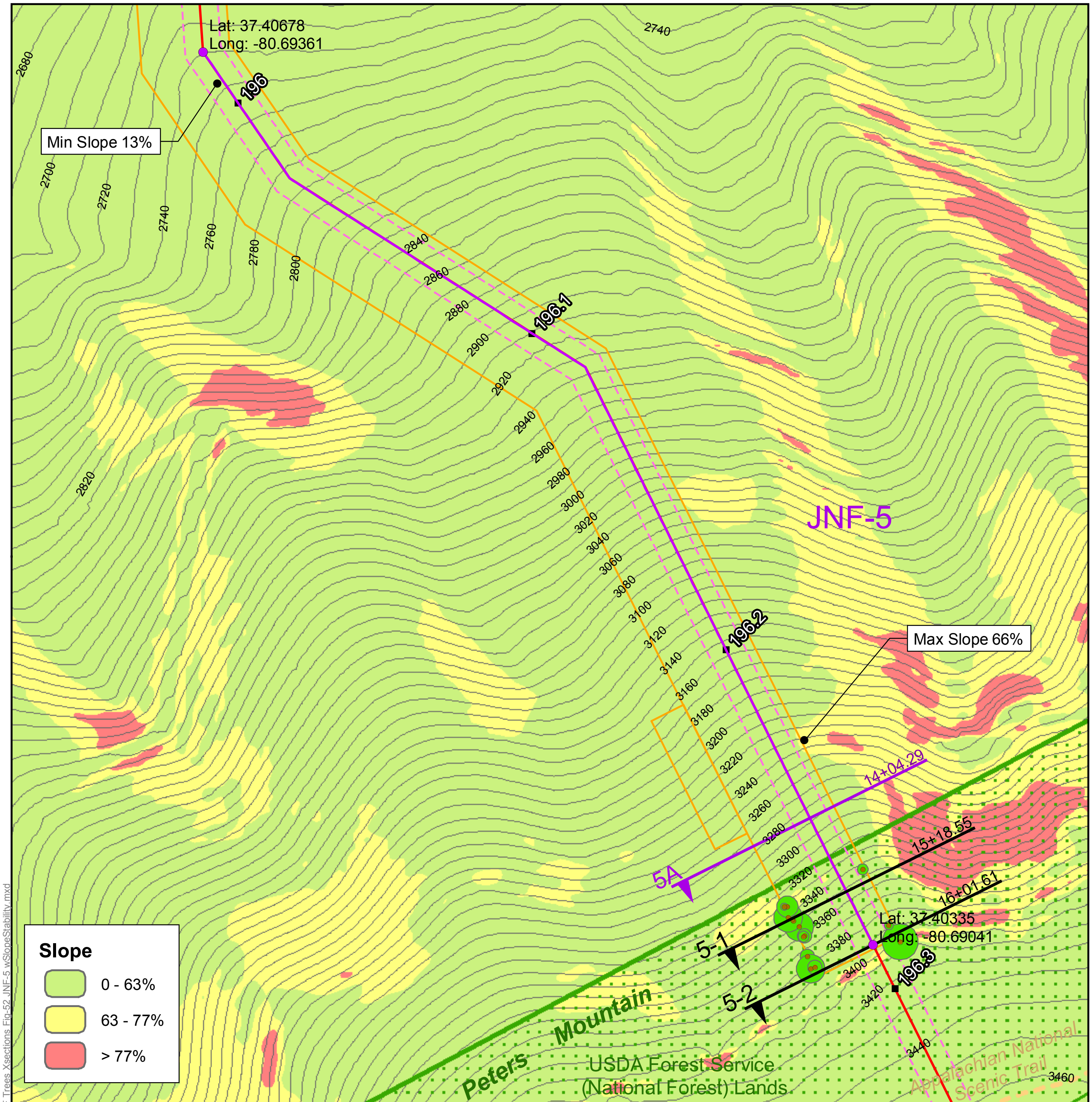


Document Path: P:\B14\100\B\B14188B\B14188B-17 - JNFSlope2018\GIS\JNF Trees Xsections Fig-52 JNF-5 wSlopeStability.mxd

Mountain Valley Pipeline Project

N

1:2,400 NAD 1983 UTM 17N

0 200 400 Feet

Figure 52, Site 5

Jefferson National Forest

Slope Stability Map and Representitive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

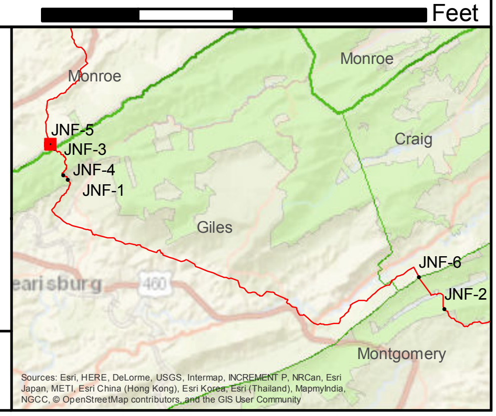
Draper Aden Associates
Engineering • Surveying • Environmental Services

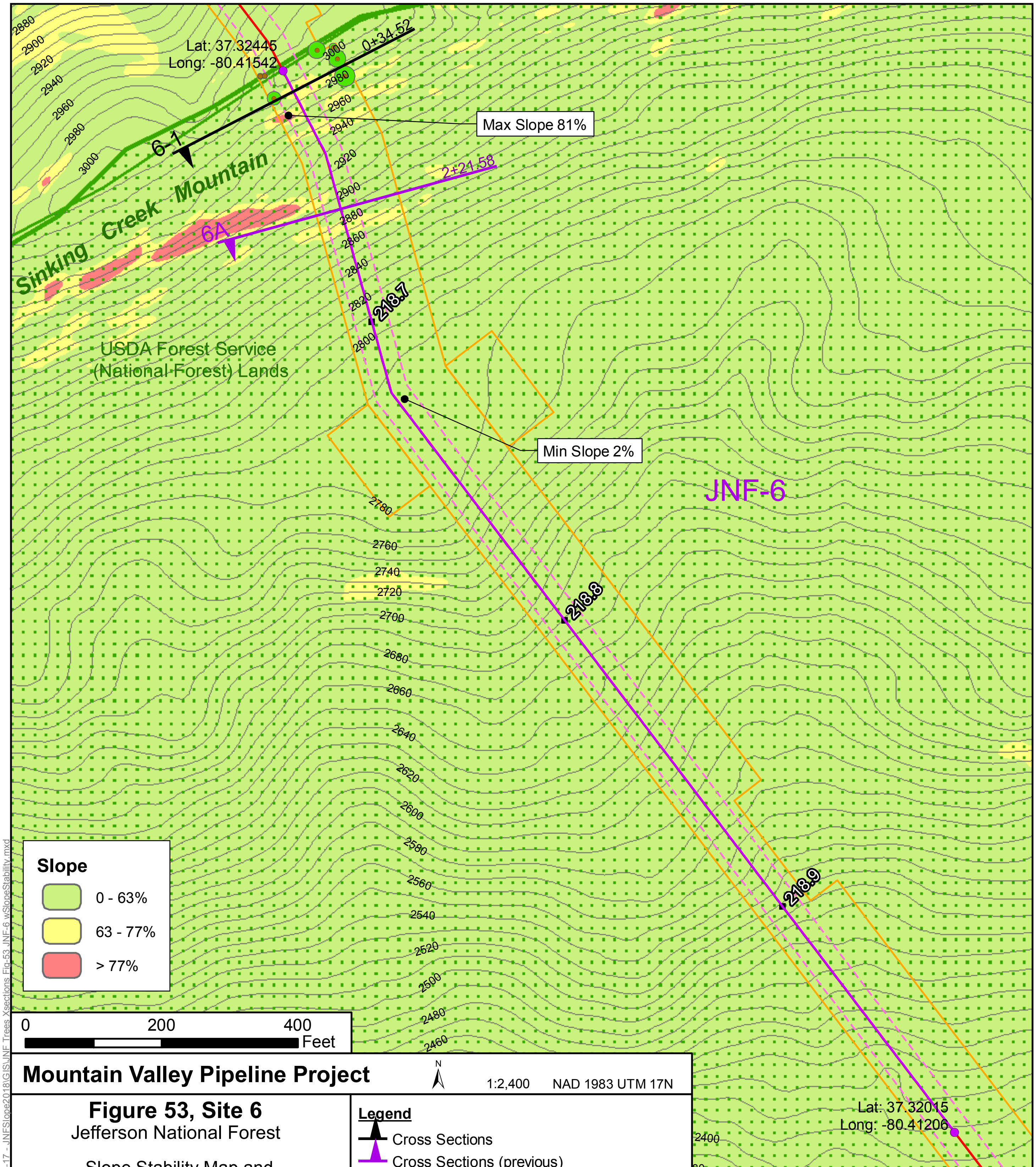
Legend

- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate





Mountain Valley Pipeline Project

N

1:2,400 NAD 1983 UTM 17N

Figure 53, Site 6

Jefferson National Forest

Slope Stability Map and
Representitive Cross Section Locations

03-12-18

Mountain Valley PIPELINE

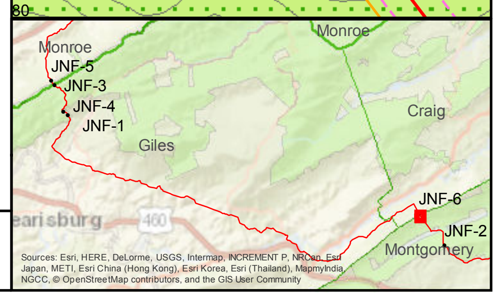
Draper Aden Associates
Engineering • Surveying • Environmental Services

Legend

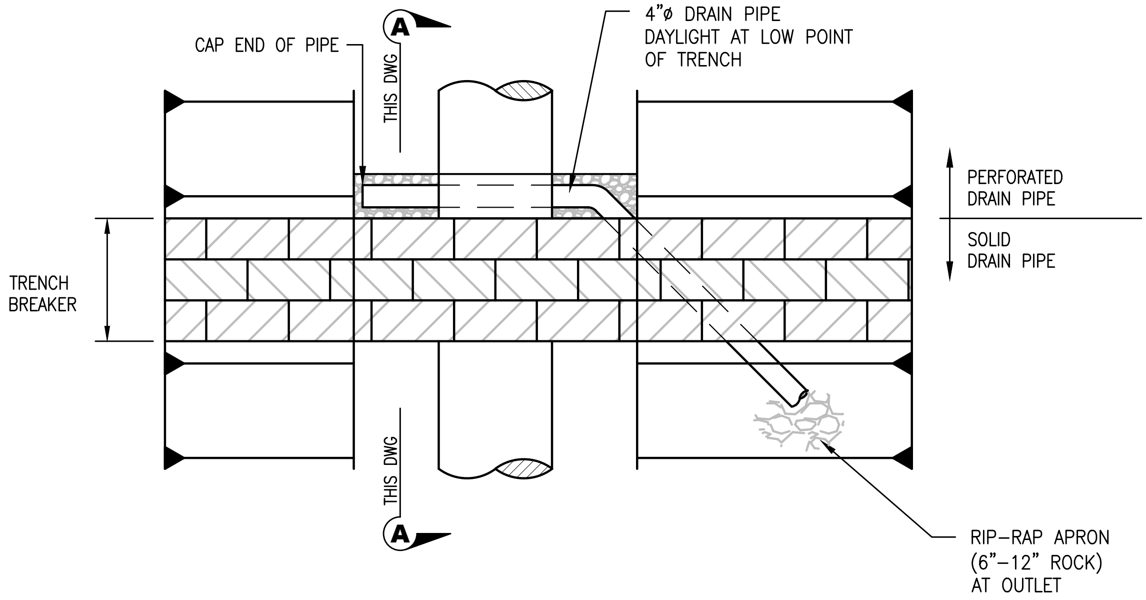
- Cross Sections
- Cross Sections (previous)
- JNF Priority Site
- Tree Canopy (select trees)
- MVP Approved Route
- MVP Approved Permanent Easement
- MVP Approved Temporary Work Space
- USDA Forest Service Boundary

10-foot contour and slope representations are based on MVP lidar data and are presented for visualization purposes only.

All Locations are Approximate

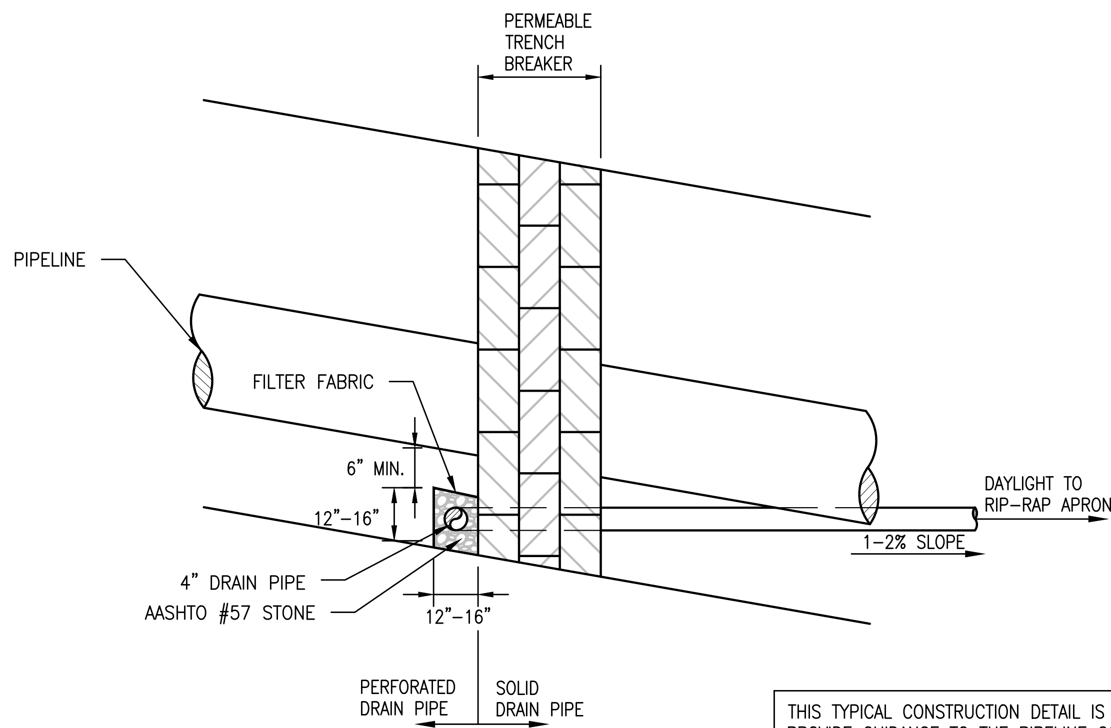


Appendix B – Typical Drawings



PLAN

SCALE: NOT TO SCALE



SECTION A-A

SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN	TDD	DATE	2/03/2016
CHECKED	MMF	DATE	2/03/2016
APP'D		DATE	
SCALE	N.T.S.	SHEET	1 OF 1
JOB NO.			
PROJECT ID: PXXXX			

Mountain Valley PIPELINE

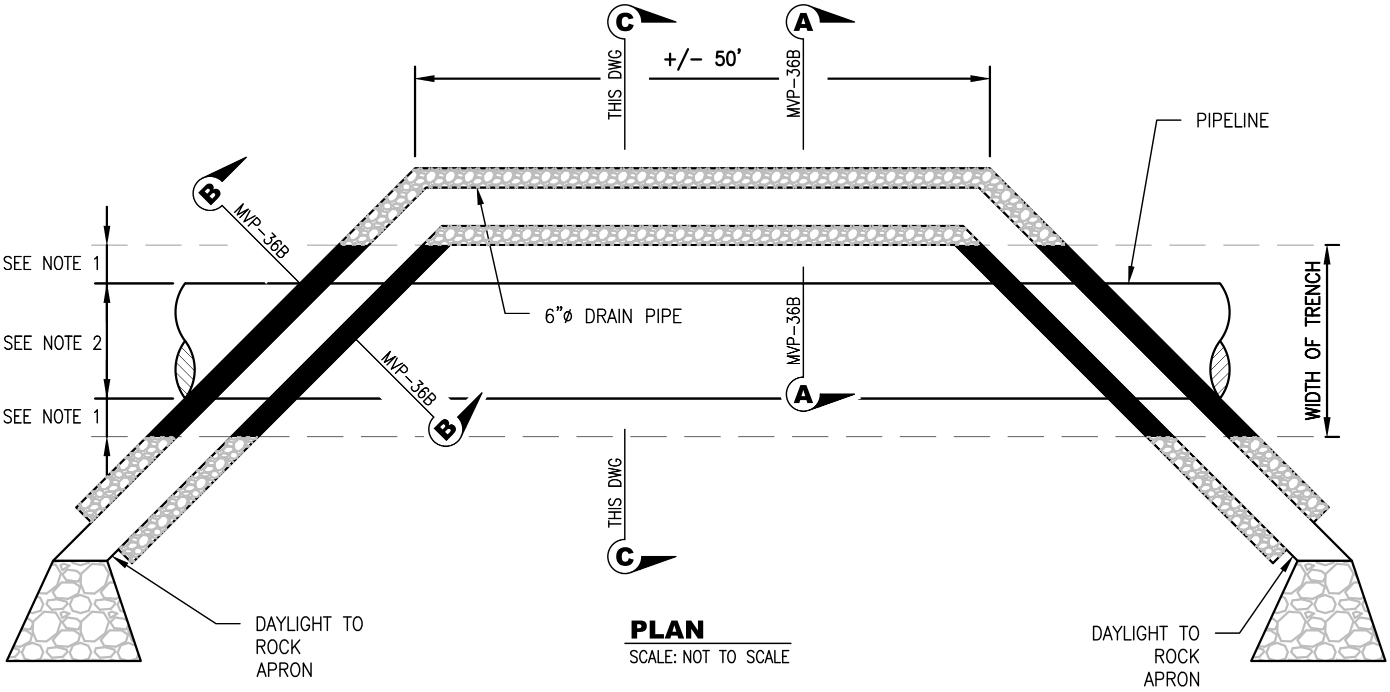
DESIGN ENGINEERING

TYPICAL CONSTRUCTION DETAIL

TRENCH BREAKER DAYLIGHT DRAIN

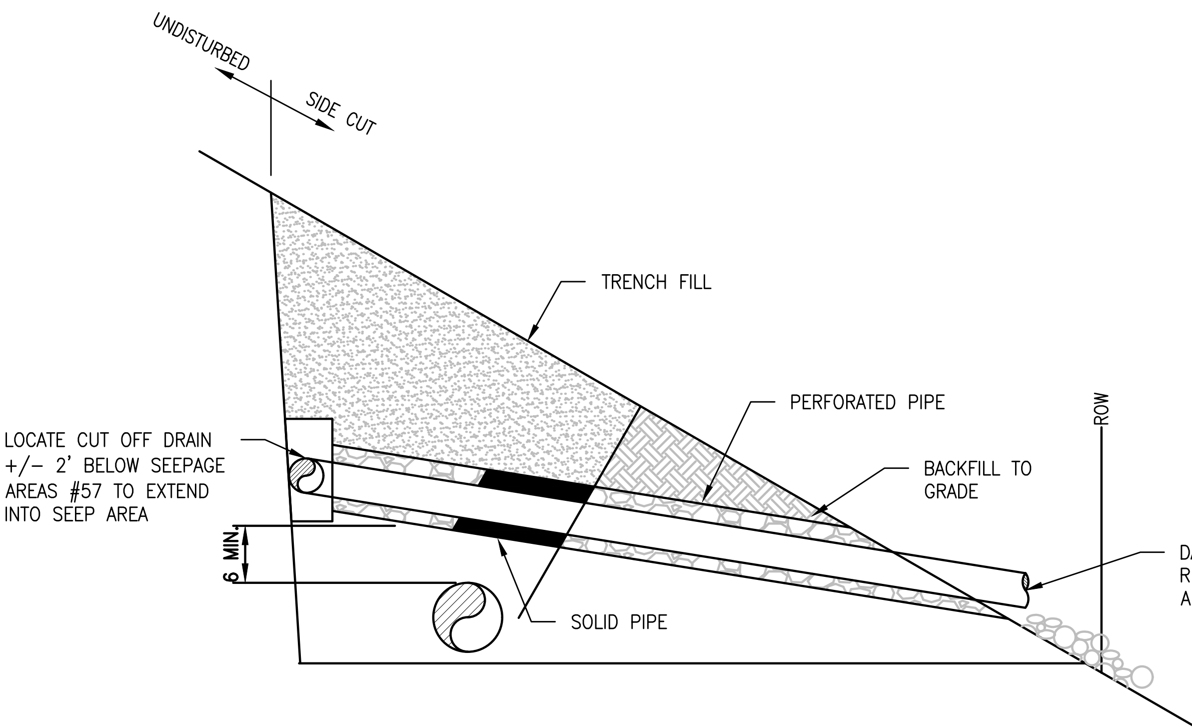
DRAWING NO. MVP–35

REV. 0



PLAN

SCALE: NOT TO SCALE



SECTION C-C

SCALE: NOT TO SCALE

NOTES:

1. PERFORATED PIPE SURROUNDED BY #57 STONE.
2. SOLID PIPE (IN TRENCH) SURROUNDED BY TRENCH BACKFILL.

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016
CHECKED MMF	DATE 2/03/2016
APP'D	DATE
SCALE N.T.S.	SHEET 1 OF 2
JOB NO.	
PROJECT ID: PXXXX	

Mountain Valley PIPELINE

DESIGN ENGINEERING

TYPICAL CONSTRUCTION DETAIL

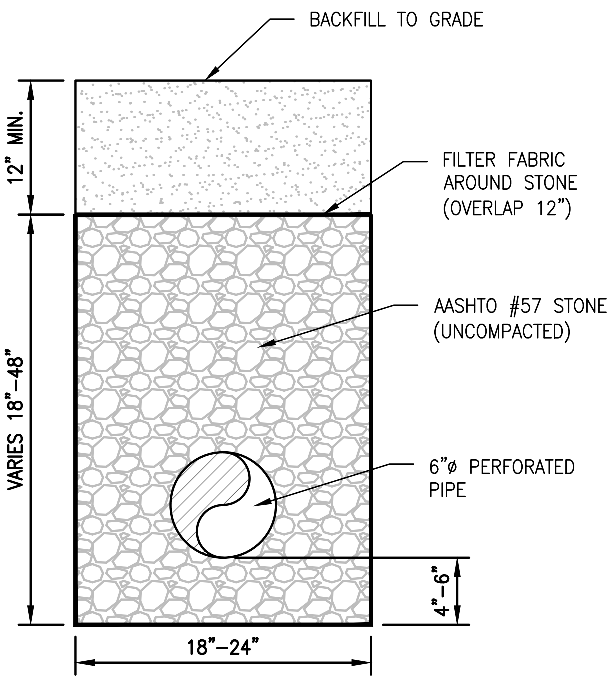
CUTOFF DRAIN–SIDEHILL

DRAWING NO. MVP–36A

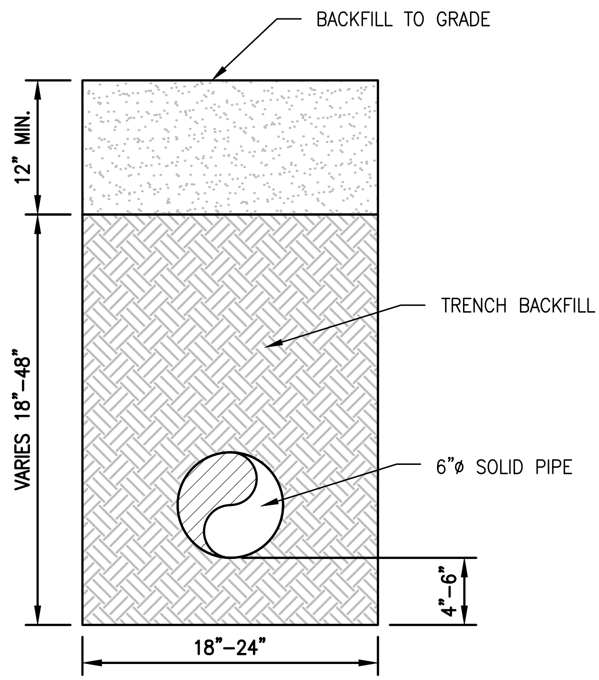
REV. 0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:30 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-36a.dwg



SECTION A-A
SCALE: NOT TO SCALE
FROM MVP–36A



SECTION B-B
SCALE: NOT TO SCALE
FROM MVP–36A

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016
CHECKED MMF	DATE 2/03/2016
APP'D	DATE
SCALE N.T.S.	SHEET 2 OF 2
JOB NO.	
PROJECT ID: PXXXX	

Mountain Valley PIPELINE

DESIGN ENGINEERING

TYPICAL CONSTRUCTION DETAIL

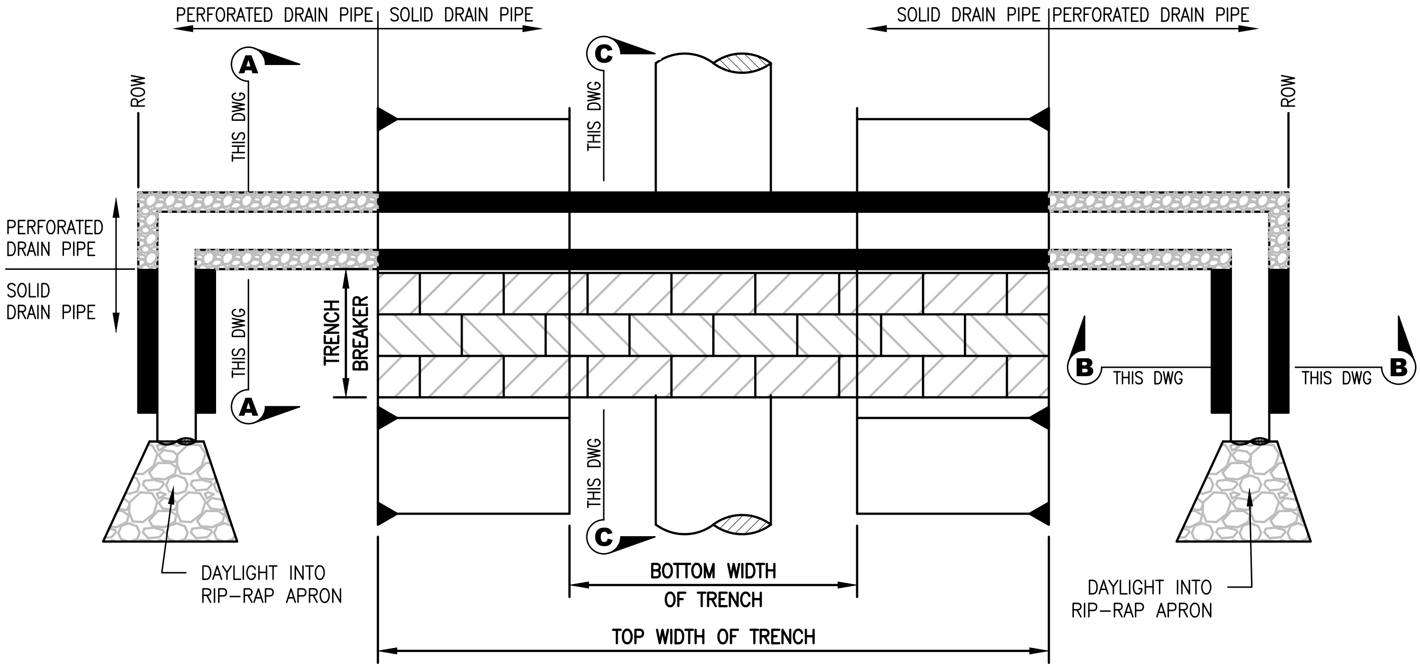
CUTOFF DRAIN–SIDEHILL

DRAWING NO. MVP–36B

REV. 0

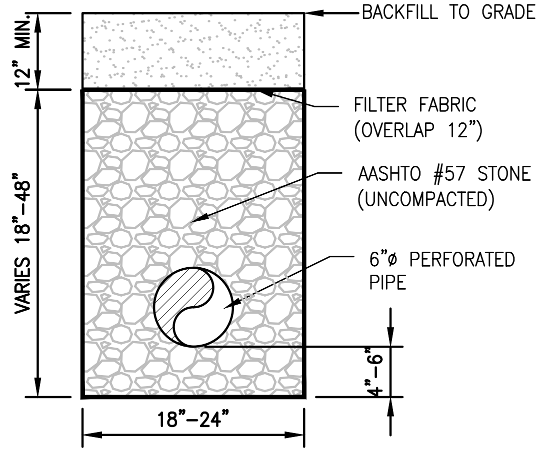
Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:31 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-36b.dwg



PLAN
SCALE: NOT TO SCALE

NOTES:
1. EACH CUTOFF DRAIN SHALL UTILIZE A TRENCH BREAKER DRAIN (SEE MVP-43A) TO DRAIN THE TRENCH.



SECTION A-A
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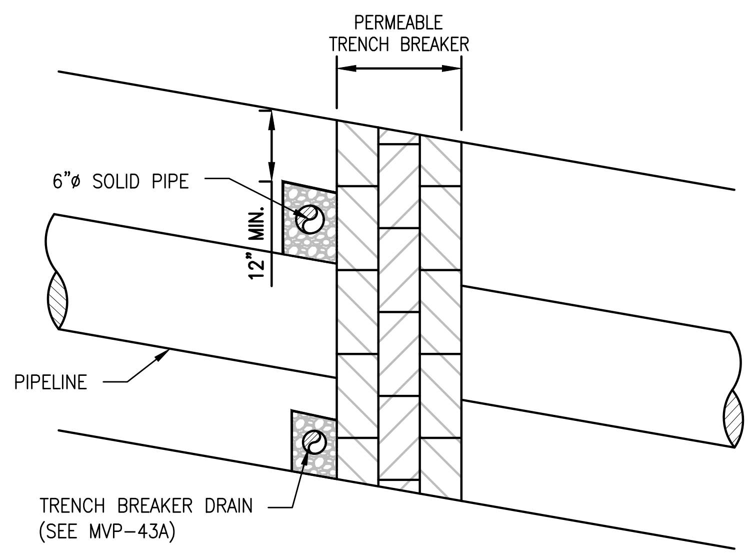
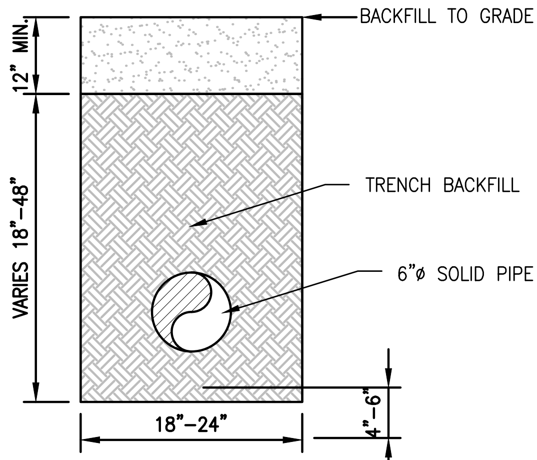


SECTION C-C
SCALE: NOT TO SCALE



SECTION B-B
SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016
CHECKED MMF	DATE 2/03/2016
APP'D	DATE
SCALE N.T.S.	SHEET 1 OF 1
JOB NO.	
PROJECT ID: PXXXX	

Mountain Valley PIPELINE

DESIGN ENGINEERING

TYPICAL CONSTRUCTION DETAIL

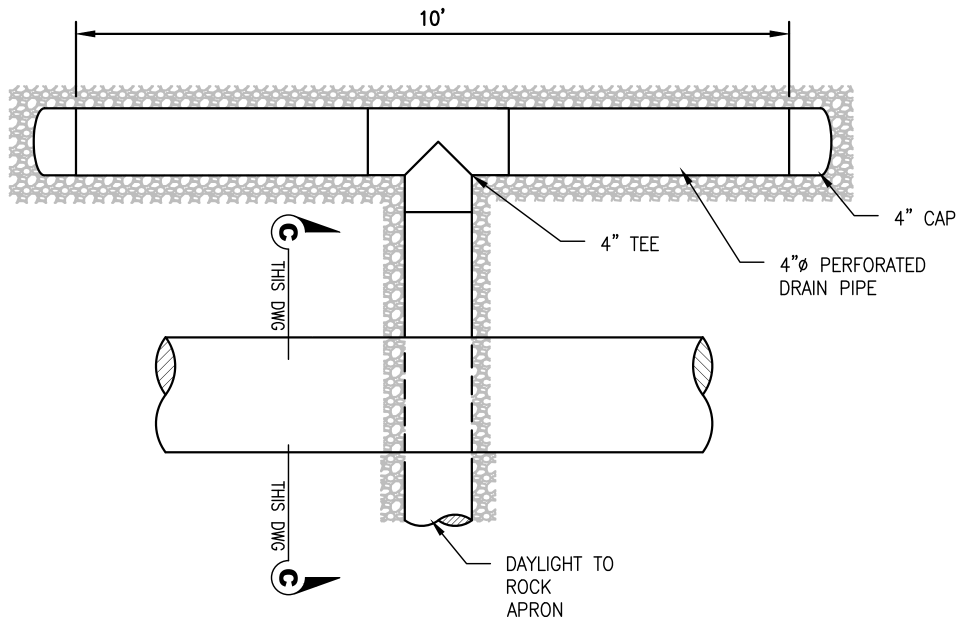
CUTOFF DRAIN–PLANAR

DRAWING NO. MVP–37

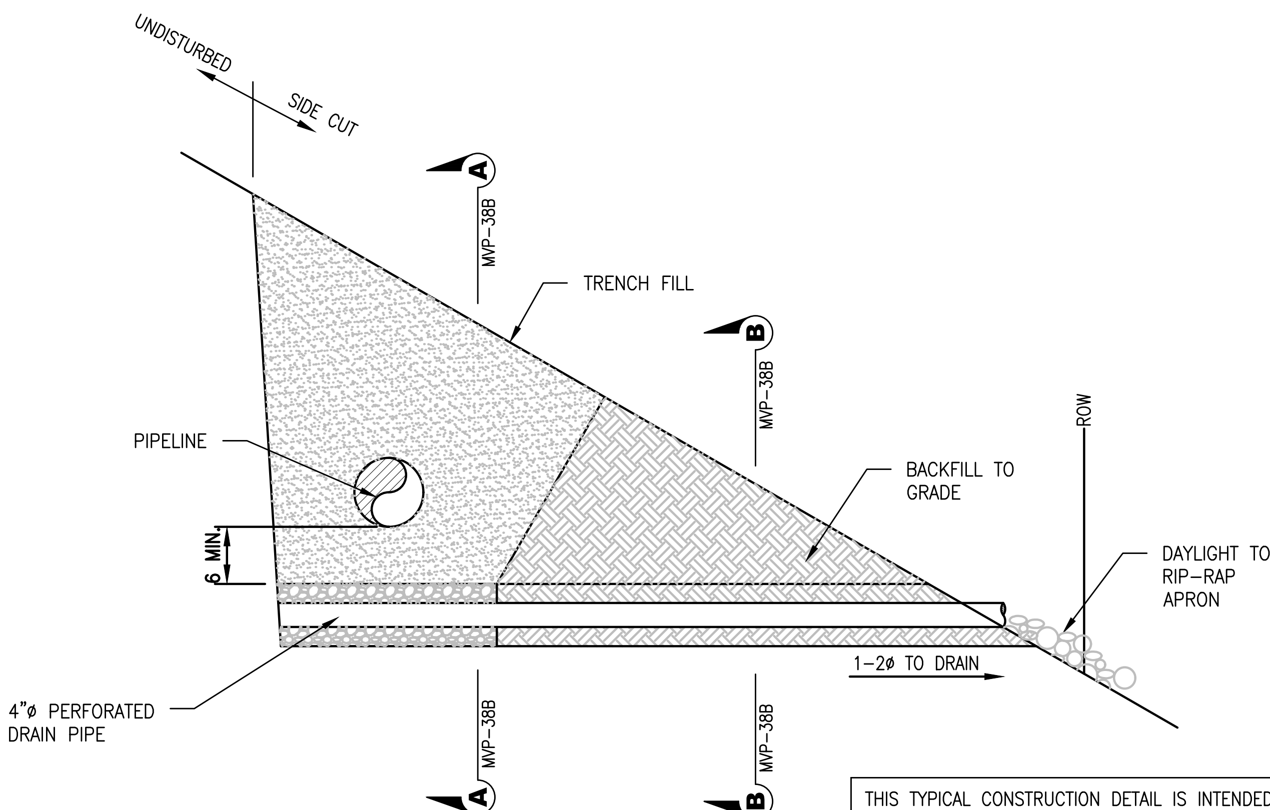
REV. 0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:31 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-37.dwg



PLAN
SCALE: NOT TO SCALE



SECTION C-C
SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016
CHECKED MMF	DATE 2/03/2016
APP'D	DATE
SCALE N.T.S.	SHEET 1 OF 2
JOB NO.	
PROJECT ID: PXXXX	

Mountain Valley PIPELINE

DESIGN ENGINEERING

TYPICAL CONSTRUCTION DETAIL

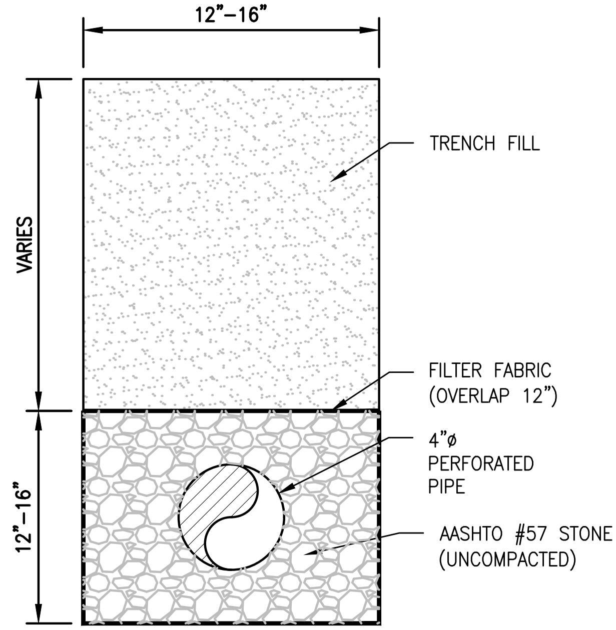
TRANSVERSE TRENCH DRAIN

DRAWING NO. MVP-38A

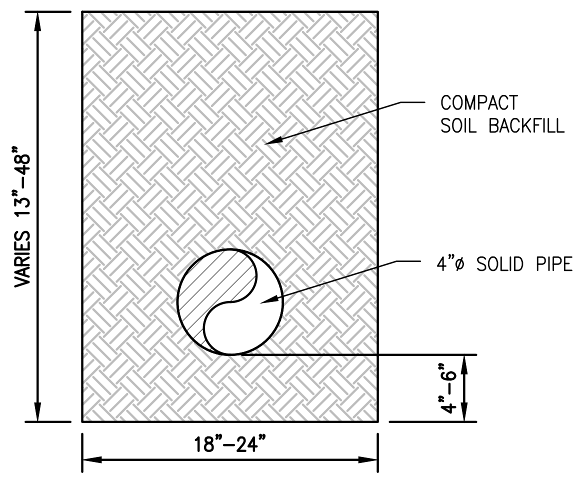
REV. 0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:31 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-38A.dwg



SECTION A-A
SCALE: NOT TO SCALE
FROM MVP–38A



SECTION B-B
SCALE: NOT TO SCALE
FROM MVP–38A

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016
CHECKED MMF	DATE 2/03/2016
APP'D	DATE
SCALE N.T.S.	SHEET 2 OF 2
JOB NO.	
PROJECT ID: PXXXX	

Mountain Valley PIPELINE

DESIGN ENGINEERING

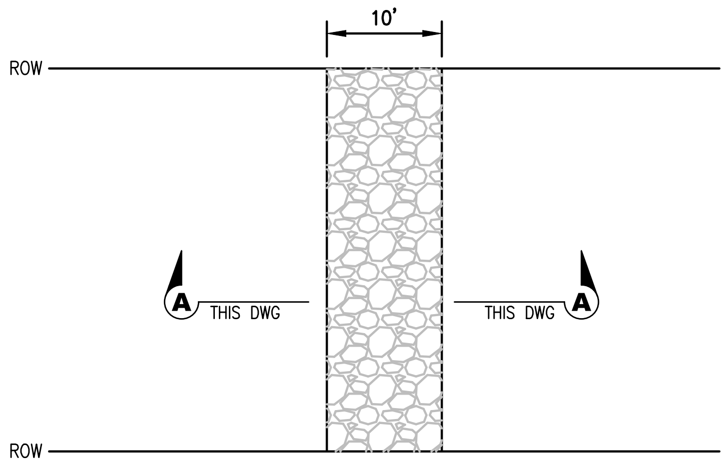
TYPICAL CONSTRUCTION DETAIL

TRANSVERSE TRENCH DRAIN

DRAWING NO.	REV.
MVP–38B	0

Plotted by: McCarthy, Matthew on: May 16, 2017 – 10:31 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-38B.dwg



PLAN
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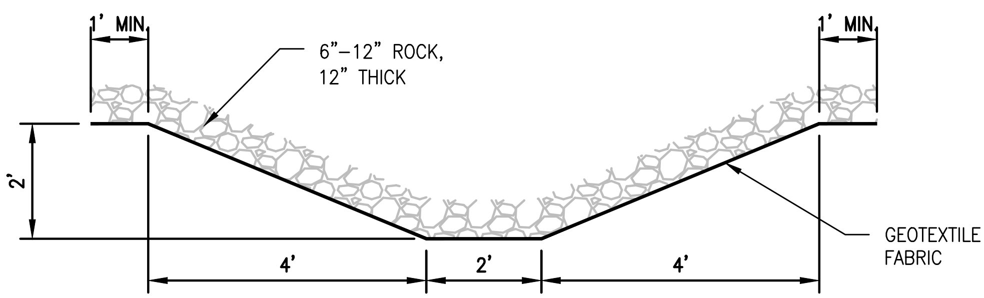


SECTION A-A
SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016
CHECKED MMF	DATE 2/03/2016
APP'D	DATE
SCALE N.T.S.	SHEET 1 OF 1
JOB NO.	
PROJECT ID: PXXXX	

Mountain Valley PIPELINE

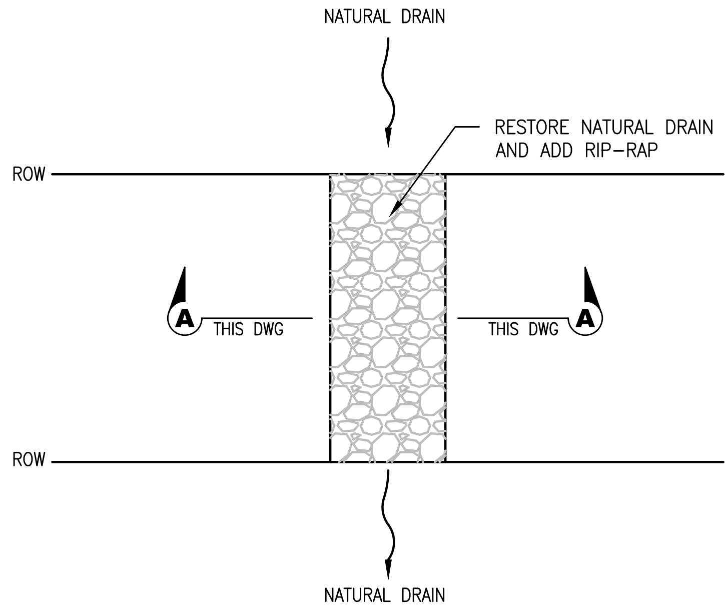
DESIGN ENGINEERING

TYPICAL CONSTRUCTION DETAIL

ROCK LINED SWALE

DRAWING NO. MVP–39

REV. 0



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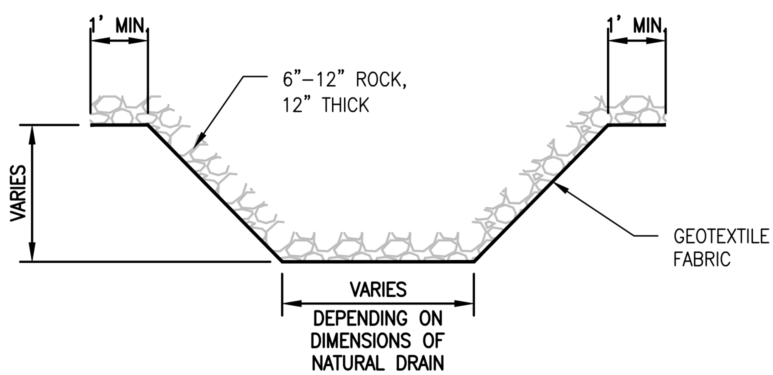
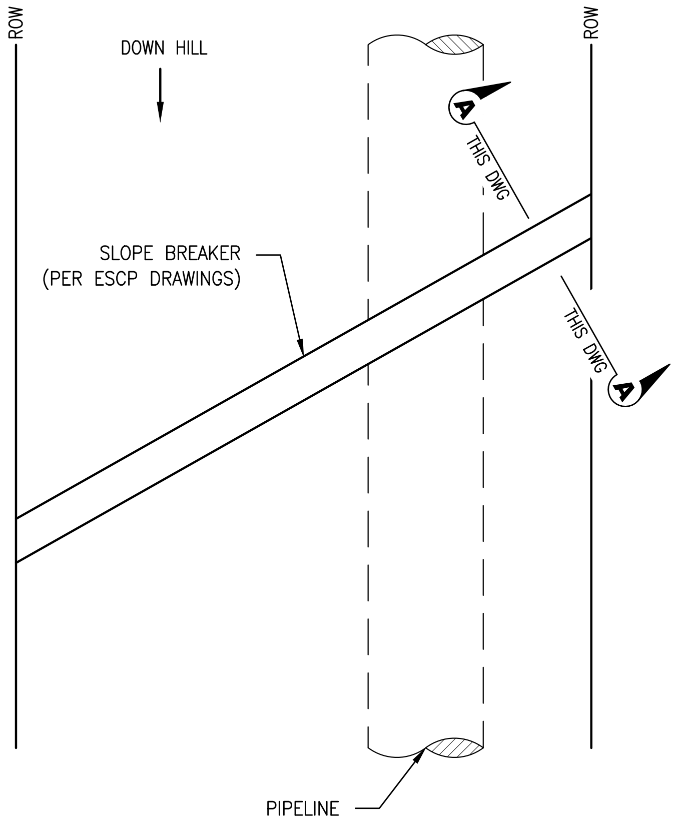


SECTION A-A
SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016	Mountain Valley PIPELINE	TYPICAL CONSTRUCTION DETAIL
CHECKED MMF	DATE 2/03/2016		RIP-RAP NATURAL DRAIN
APP'D	DATE		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.			
PROJECT ID: PXXXX		DESIGN ENGINEERING	DRAWING NO. MVP-40 / REV. 0



PLAN
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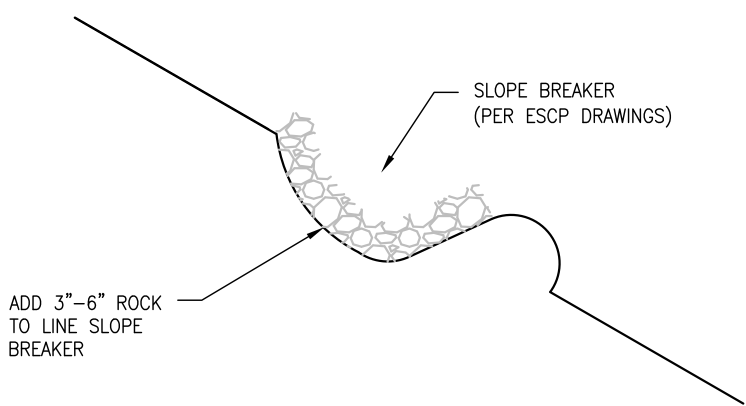


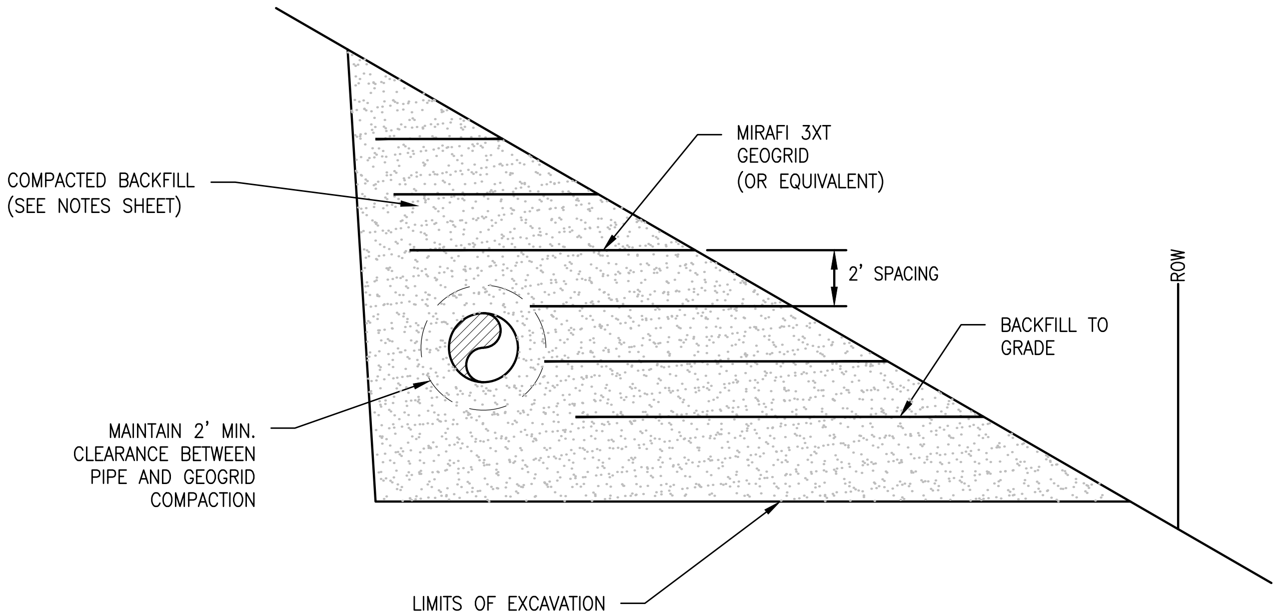
SECTION A-A
SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016	Mountain Valley PIPELINE	TYPICAL CONSTRUCTION DETAIL
CHECKED MMF	DATE 2/03/2016		RIP–RAP SLOPE BREAKERS
APP'D	DATE		
SCALE N.T.S.	SHEET 1 OF 1		
JOB NO.			
PROJECT ID: PXXXX		DESIGN ENGINEERING	DRAWING NO. MVP–41 / REV. 0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:31 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-41.dwg

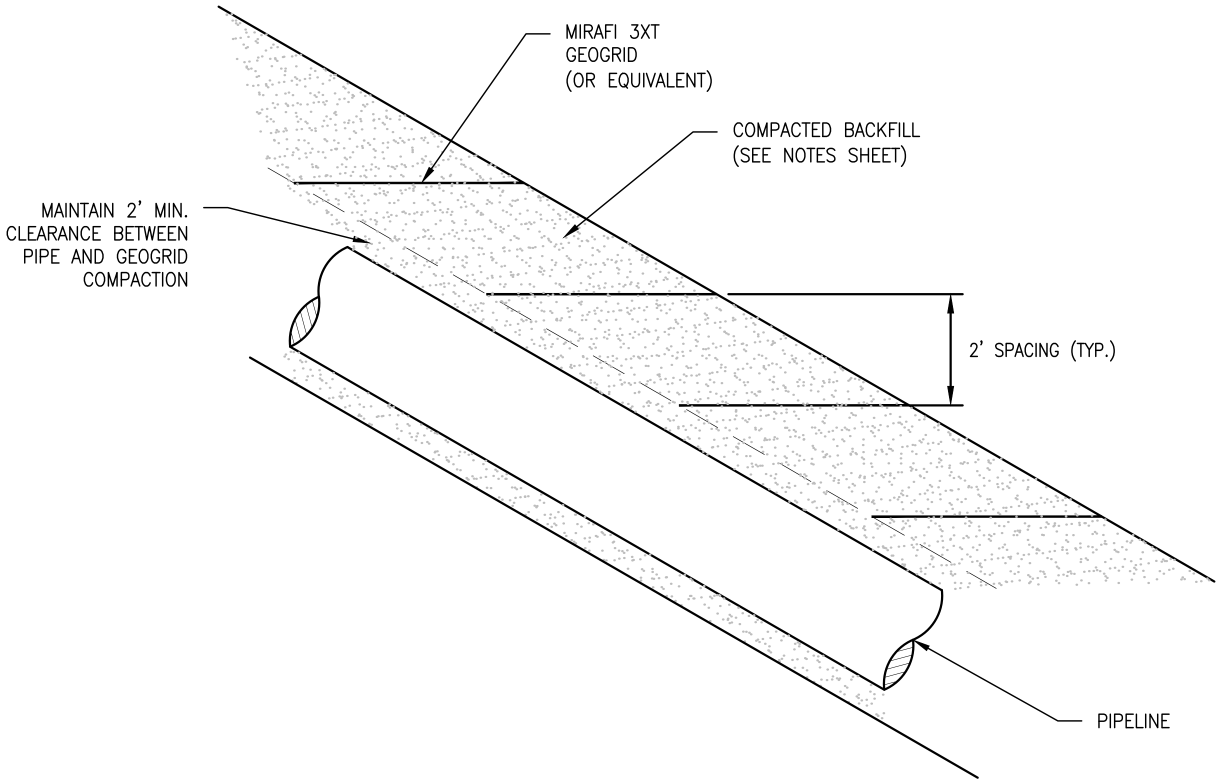


THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016	Mountain Valley PIPELINE	TYPICAL CONSTRUCTION DETAIL
CHECKED MMF	DATE 2/03/2016		GEOGRID–SIDEHILL
APP'D	DATE		
SCALE N.T.S.	SHEET 1 OF 3		
JOB NO.			
PROJECT ID: PXXXX		DESIGN ENGINEERING	DRAWING NO. MVP–42A / REV. 0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:31 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-42A.dwg



SECTION VIEW
SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN	TDD	DATE	2/03/2016
CHECKED	MMF	DATE	2/03/2016
APP'D		DATE	
SCALE	N.T.S.	SHEET	2 OF 3
JOB NO.			
PROJECT ID:	PXXXX		

Mountain Valley PIPELINE

DESIGN ENGINEERING

SLIDE MITIGATION DETAIL

GEOGRID—PLANAR

DRAWING NO. MVP—42B

REV. 0

COMPACTION NOTES

1) ALL ROCKS LARGER THAN 6 INCHES IN SIZE, AND MORE THAN 10 PERCENT BY VOLUME SHOULD BE REMOVED AND PROPERLY DISPOSED FROM THE BACKFILL MATERIAL.
2) THE SUBGRADE AT THE BASE OF THE EXCAVATION SHOULD BE PROOFROLLED WITH A PNEUMATIC TIRED ROLLER OR VEHICLE.
3) THE EXCAVATED AREA SHALL BE BACKFILLED WITH THE CLEANED EXCAVATED SOIL MATERIAL AND COMPACTED IN PLACE.
4) BACKFILL OPERATIONS SHALL BE PERFORMED WHEN SOIL IS SUITABLE FOR COMPACTION (I.E., NOT IMMEDIATELY FOLLOWING A LARGE RAIN, SNOW, OR ICE EVENT). FROZEN FILL SHALL NOT BE USED.
5) THE BACKFILL SHALL BE PLACED IN COMPACTED LIFTS NO GREATER THAN 12 INCHES.
6) MAINTAIN A MINIMUM 2FT CLEARANCE BETWEEN COMPACTION ACTIVITY AND THE GAS PIPELINE.

GEOGRID NOTES

1) GEOGRID REINFORCEMENT SHALL BE TENCATE MIRAFI 3XT OR APPROVED EQUIVALENT.
2) THE GEOGRID MATERIAL SHALL BE STORED UNDAMAGED PURSUANT TO MANUFACTURERS RECOMMENDATIONS.
3) GEOGRID SHALL BE PLACED HORIZONTALLY ON THE BACKFILL WITH THE PRINCIPAL STRENGTH DIRECTION PERPENDICULAR TO THE FACE OF THE SLOPE. ADJACENT PIECES OF PRIMARY GEOGRID SHALL NOT OVERLAP BUT ARE TO BE BUTTED SIDE TO SIDE.
4) REMOVE ALL SLACK IN THE GEOGRID MATERIAL AND ANCHOR AS NECESSARY WITH PINS, OR BAGS TO PREVENT SLACK FROM DEVELOPMENT DURING FILL PLACEMENT AND COMPACTION.
5) FILL IS TO BE PLACED AND SPREAD DIRECTLY ON THE GEOGRID MATERIAL WITH RUBBER TIRED EQUIPMENT ONLY. SPEEDS ARE TO BE KEPT SLOW WITH AS FEW STOPS AND TURNS AS PRACTICAL.
6) DO NOT OPERATE TRACKED EQUIPMENT DIRECTLY ON THE GEOGRID MATERIAL.
7) MAINTAIN A MINIMUM 2FT CLEARANCE BETWEEN GEOGRID MATERIAL AND THE GAS PIPELINE.

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016
CHECKED MMF	DATE 2/03/2016
APP'D	DATE
SCALE N.T.S.	SHEET 3 OF 3
JOB NO.	
PROJECT ID: PXXXX	

Mountain Valley PIPELINE

DESIGN ENGINEERING

TYPICAL CONSTRUCTION DETAIL

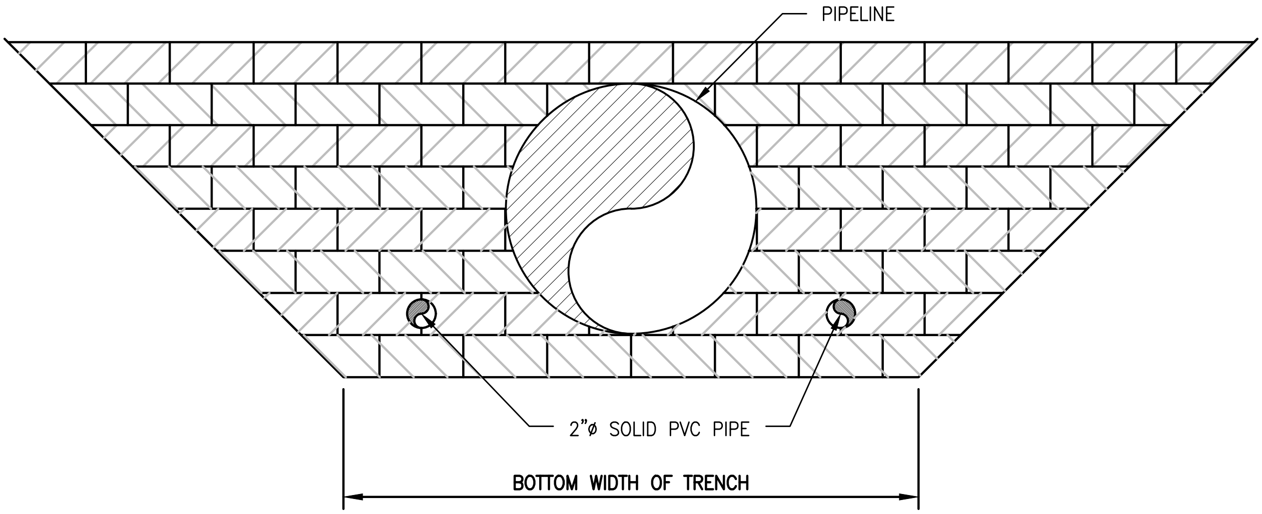
GEOGRID NOTES

DRAWING NO. MVP–42C

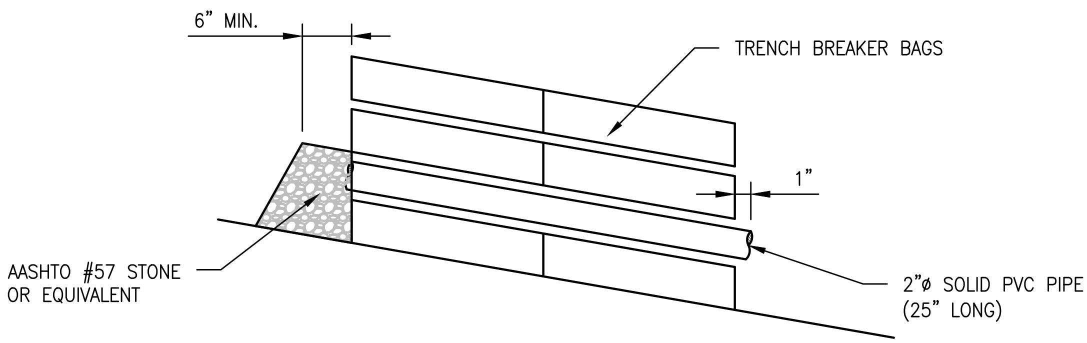
REV. 0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:31 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-42C.dwg



FRONT VIEW
SCALE: NOT TO SCALE



SECTION VIEW
SCALE: NOT TO SCALE

NOTES:
1. PLACE PVC DRAIN PIPE ON FIRST LAYER OF TRENCH BREAKER BAGS.
2. PLACE PVC DRAIN PIPE EQUIDISTANT FROM THE OUTSIDE EDGE OF THE 42" GAS PIPE AND THE BOTTOM LIMITS OF THE TRENCH.
3. EXTEND PVC PIPE THROUGH ENTIRE TRENCH BREAKER AND EXTEND APPROX. 1" PAST END OF BREAKER.
4. AASHTO#57 STONE SHALL BE PLACED TO A MINIMUM 6" THICKNESS UPSLOPE OF THE DRAIN PIPE.

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN	TDD	DATE	4/14/2016
CHECKED	MMF	DATE	4/14/2016
APP'D		DATE	
SCALE	N.T.S.	SHEET	1 OF 2
JOB NO.			
PROJECT ID:	PXXXX		

Mountain Valley PIPELINE

DESIGN ENGINEERING

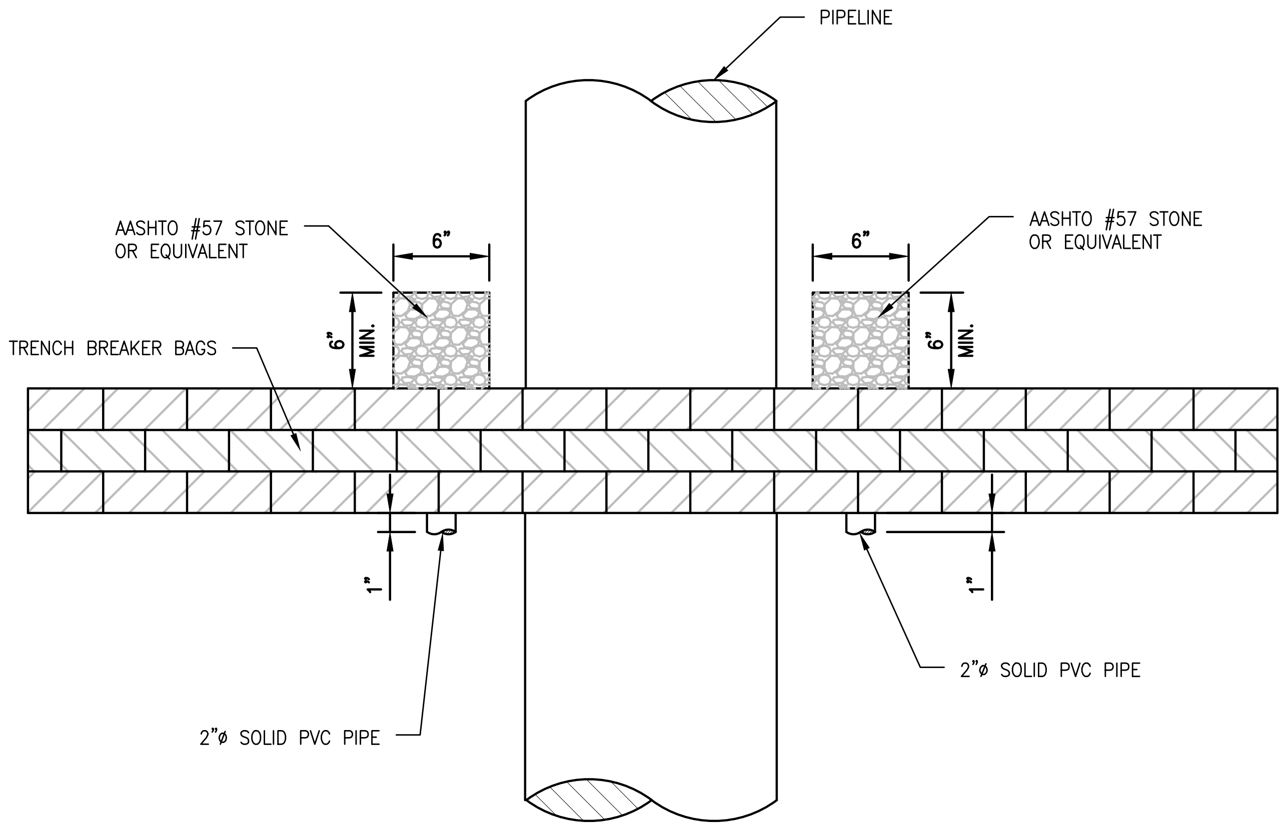
TYPICAL CONSTRUCTION DETAIL

TRENCH BREAKER
PASS–THROUGH DRAIN

DRAWING NO.	REV.
MVP–43A	0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:31 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-43A.dwg



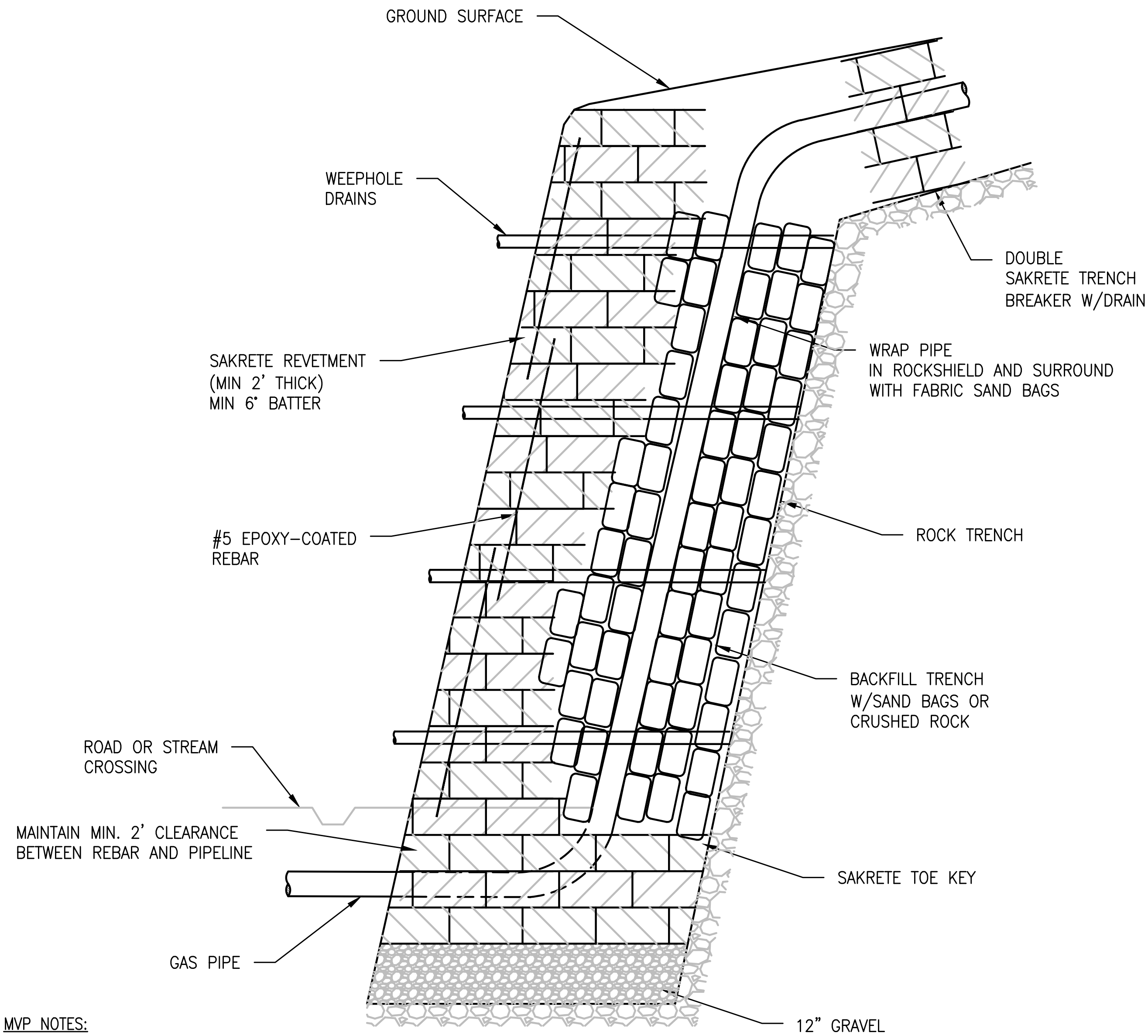
PLAN VIEW
SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 4/14/2016	Mountain Valley PIPELINE	TYPICAL CONSTRUCTION DETAIL
CHECKED MMF	DATE 4/14/2016		TRENCH BREAKER PASS-THROUGH DRAIN
APP'D	DATE		
SCALE N.T.S.	SHEET 2 OF 2		
JOB NO.			
PROJECT ID: PXXXX		DESIGN ENGINEERING	DRAWING NO. MVP-43B / REV. 0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:31 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-43B.dwg



MVP NOTES:

1. SAKRETE BAGS SHOULD EXTEND 4 BAGS DEEP, PIPE SHOULD BE COMPLETELY SURROUNDED BY SAND BAGS, OR CRUSHED ROCK (MAX 6").
2. SAKRETE BAGS SHOULD BE STAGGERED IN A MASONRY FASHION. THE FACE OF THE WALL SHALL BE INCLINED 6°-10° FROM VERTICAL.
3. #5 REBAR SHOULD BE DRIVEN THROUGH THE SAKRETE BAGS.
4. 2"ø PVC WEEPHOLE DRAINS SHALL BE INSTALLED EVERY 15 FT.

SIDE VIEW

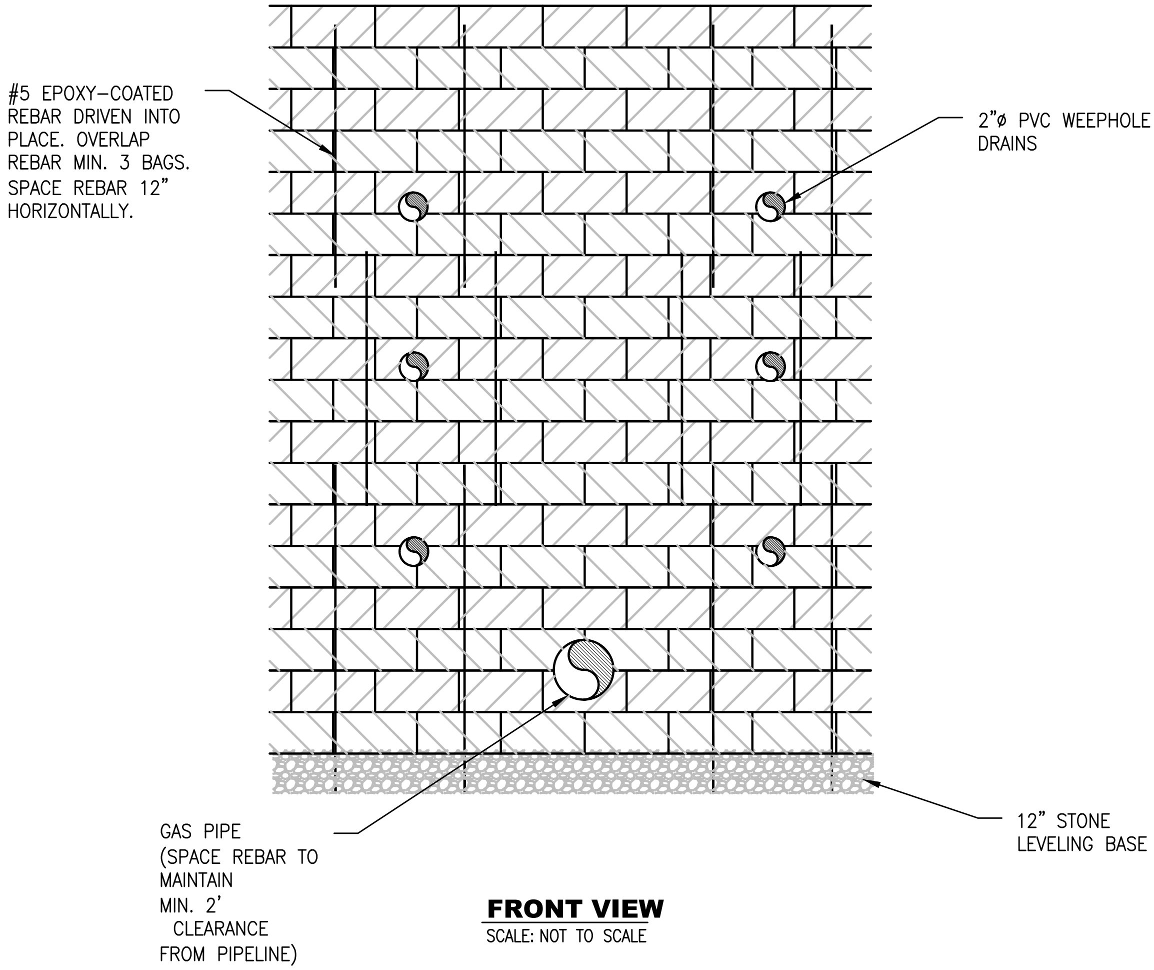
SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

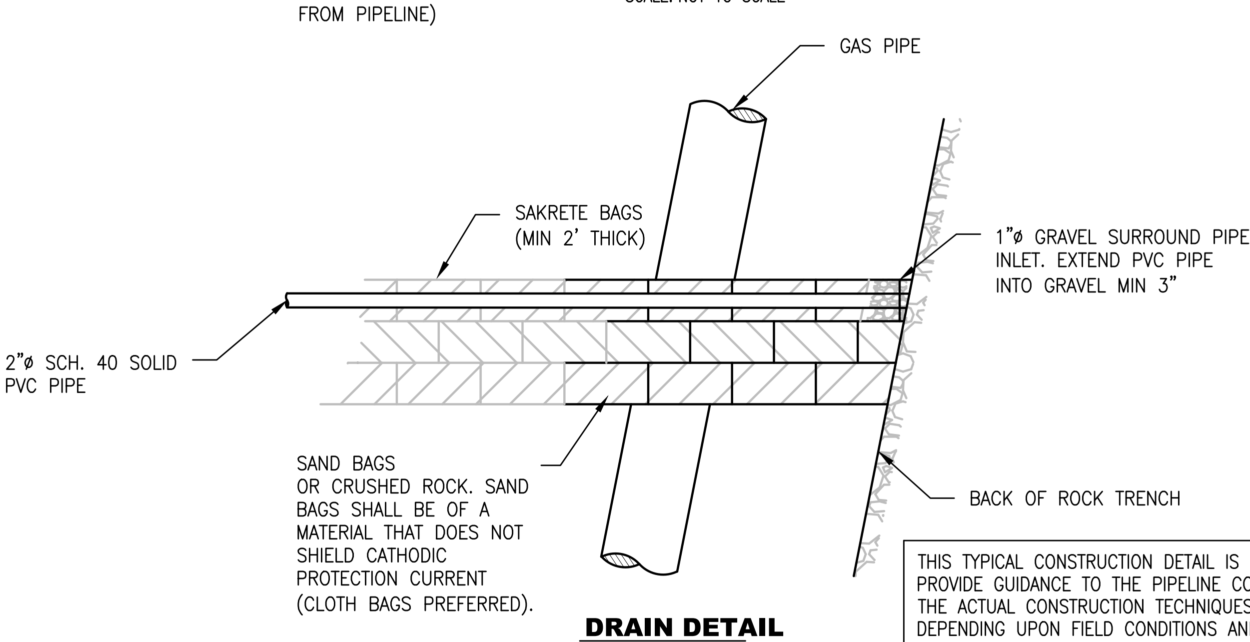
DRAWN OL	DATE 6/29/2016	Mountain Valley PIPELINE	**TYPICAL CONSTRUCTION DETAIL**
CHECKED MMF	DATE –		SLIDE MITIGATION HIGHWALL REVETMENT SIDE VIEW
APP'D	DATE		
SCALE N.T.S.	SHEET 1 OF 2		
JOB NO.		DESIGN ENGINEERING	DRAWING NO. MVP-44A
PROJECT ID: PXXXX			REV. 0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:32 AM

File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-44A.dwg



FRONT VIEW
SCALE: NOT TO SCALE



DRAIN DETAIL
SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN OL	DATE 6/29/2016
CHECKED MMF	DATE –
APP'D	DATE
SCALE N.T.S.	SHEET 2 OF 2
JOB NO.	
PROJECT ID: PXXXX	

Mountain Valley PIPELINE

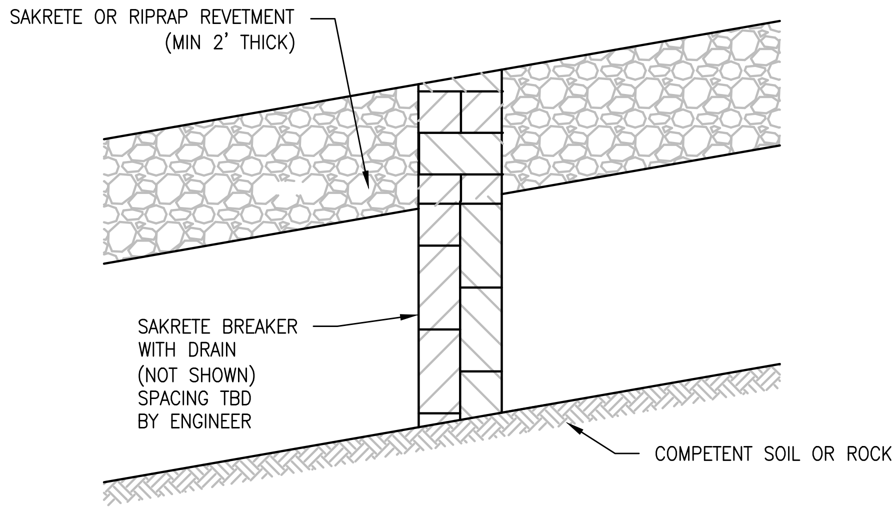
DESIGN ENGINEERING

TYPICAL CONSTRUCTION DETAIL

SLIDE MITIGATION
HIGHWALL REVETMENT
FRONT VIEW AND DRAIN DETAIL

DRAWING NO. MVP–44B

REV. 0



SIDE VIEW

SCALE: NOT TO SCALE

THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 2/03/2016
CHECKED MMF	DATE 2/03/2016
APP'D	DATE
SCALE N.T.S.	SHEET 1 OF 1
JOB NO.	
PROJECT ID: PXXXX	

Mountain Valley PIPELINE

DESIGN ENGINEERING

TYPICAL CONSTRUCTION DETAIL

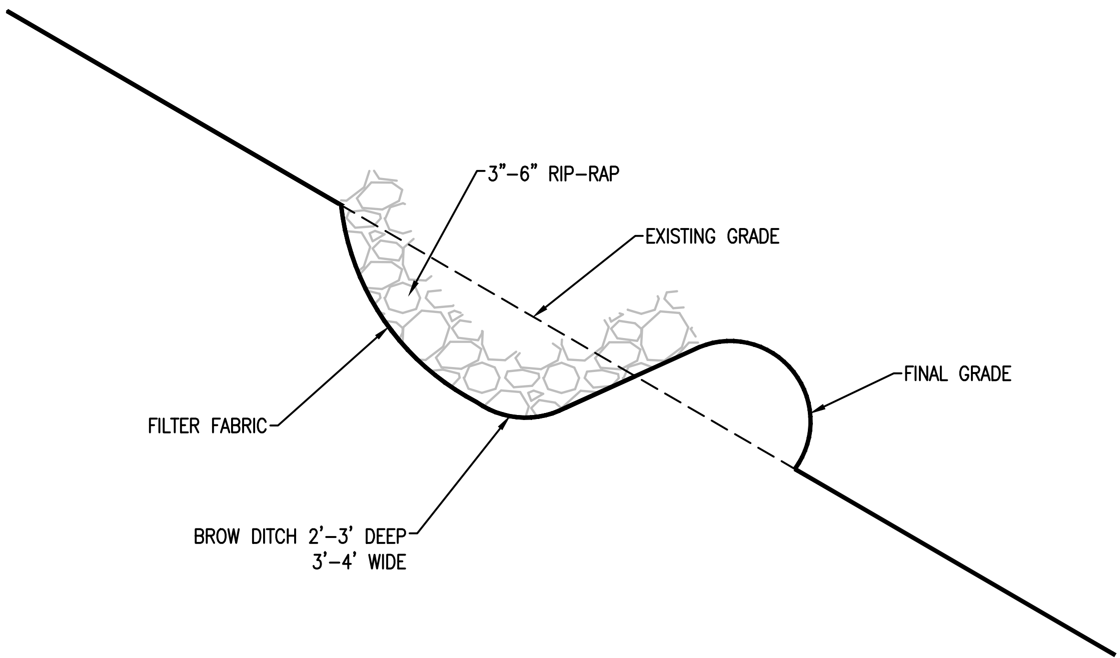
STEEP SLOPE REVETMENT

DRAWING NO. MVP–45

REV. 0

Plotted by: McCarthy, Matthew on: May 16, 2017 - 10:32 AM

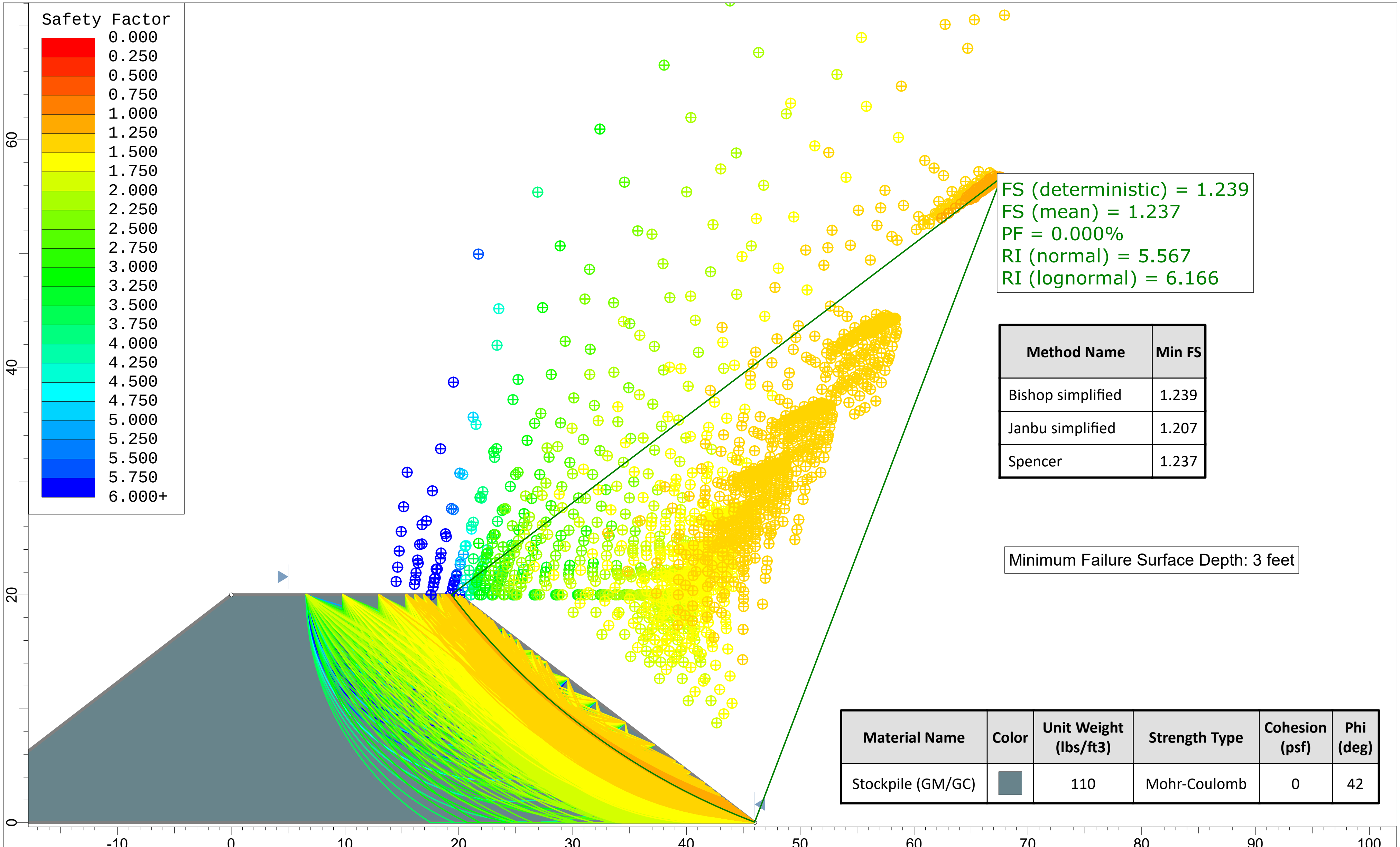
File Path: C:\Vault Working\Systems\MVP\H-600\H-600 Bid Package\Drawing Files\Design Files\Mechanical\Construction Typicals\MVP-45.dwg



THIS TYPICAL CONSTRUCTION DETAIL IS INTENDED TO PROVIDE GUIDANCE TO THE PIPELINE CONTRACTOR. THE ACTUAL CONSTRUCTION TECHNIQUES MAY DIFFER DEPENDING UPON FIELD CONDITIONS AND OR REGULATORY REQUIREMENTS.

DRAWN TDD	DATE 7/12/2016	Mountain Valley PIPELINE	TYPICAL CONSTRUCTION DETAIL	
CHECKED MMF	DATE 7/12/2016			
APP'D	DATE		BROW DITCH DETAIL	
SCALE N.T.S.	SHEET 1 OF 1			
JOB NO.				
PROJECT ID: PXXXX		DESIGN ENGINEERING	DRAWING NO. MVP–46	REV. 0

Appendix C – Slope Stability Output



Method Name	Min FS
Bishop simplified	1.239
Janbu simplified	1.207
Spencer	1.237

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Stockpile (GM/GC)		110	Mohr-Coulomb	0	42

SLIDEINTERPRET 7.029

Project MVP NFS

Analysis Description 1.3H:1V Stockpile Clayey Gravel

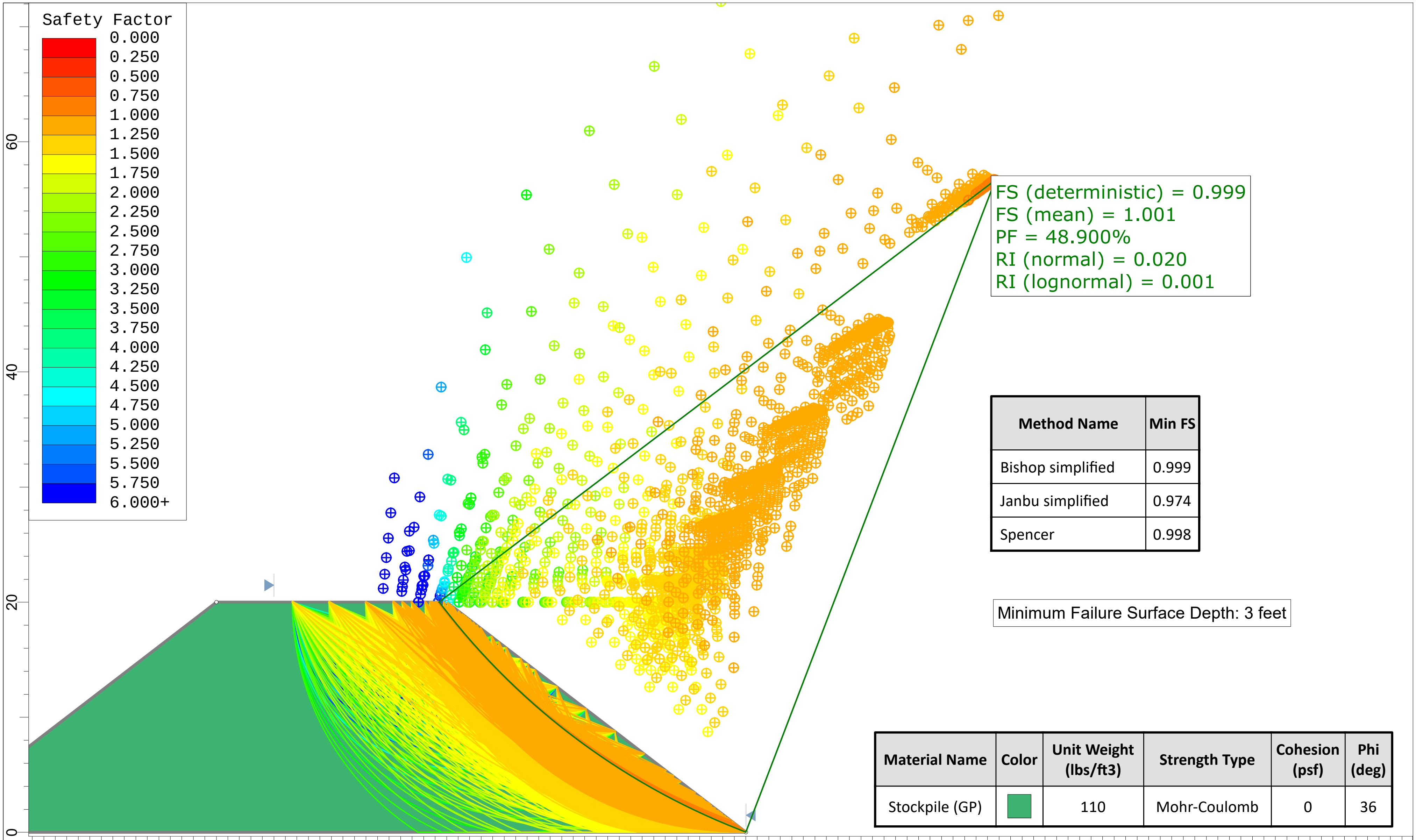
Drawn By

Scale 1:140

Company

Date 2/22/2018

File Name MVP Stockpile - 1.3H to 1V.slmd



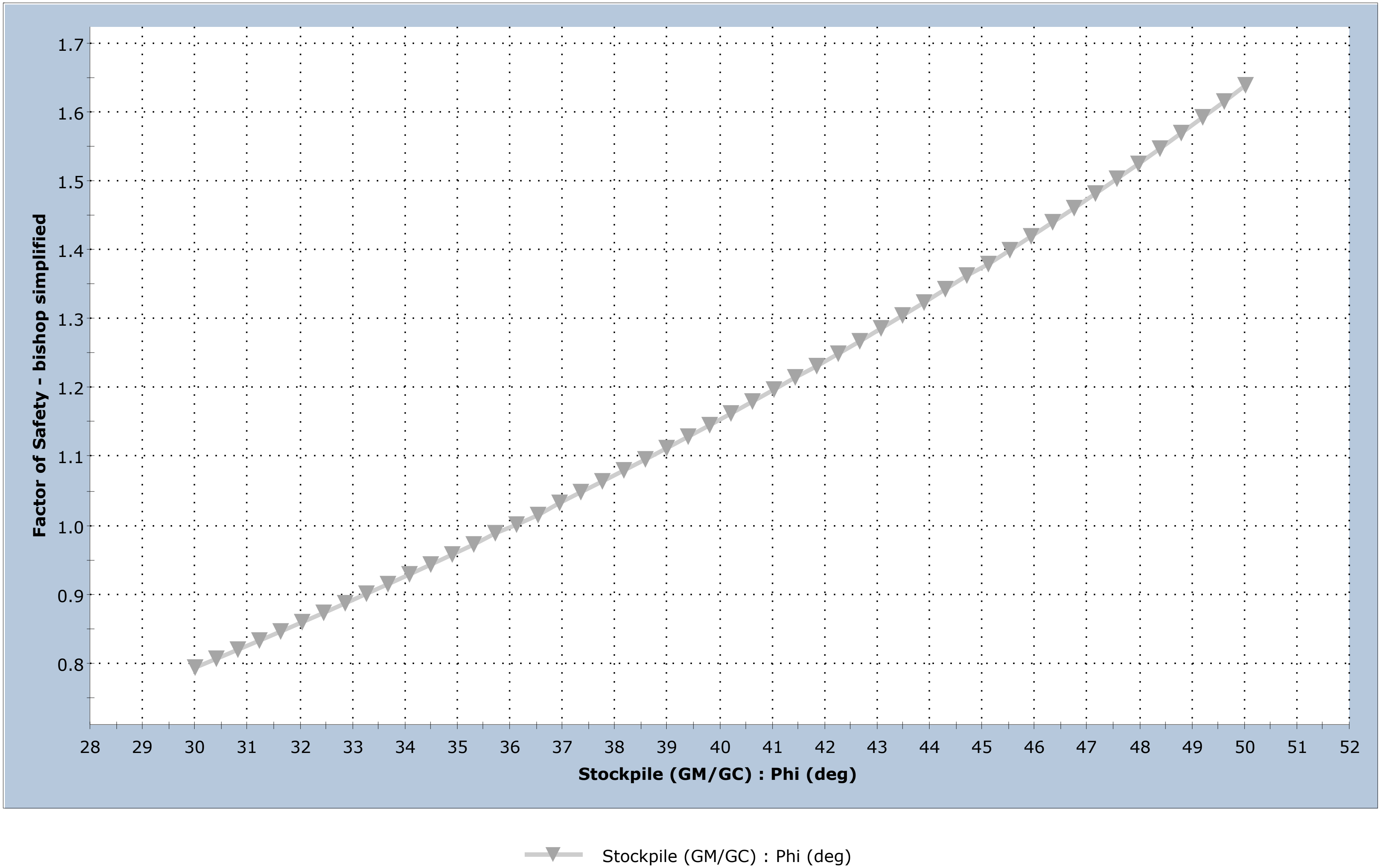
Method Name	Min FS
Bishop simplified	0.999
Janbu simplified	0.974
Spencer	0.998

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Stockpile (GP)		110	Mohr-Coulomb	0	36

rocscience

SLIDEINTERPRET 7.029

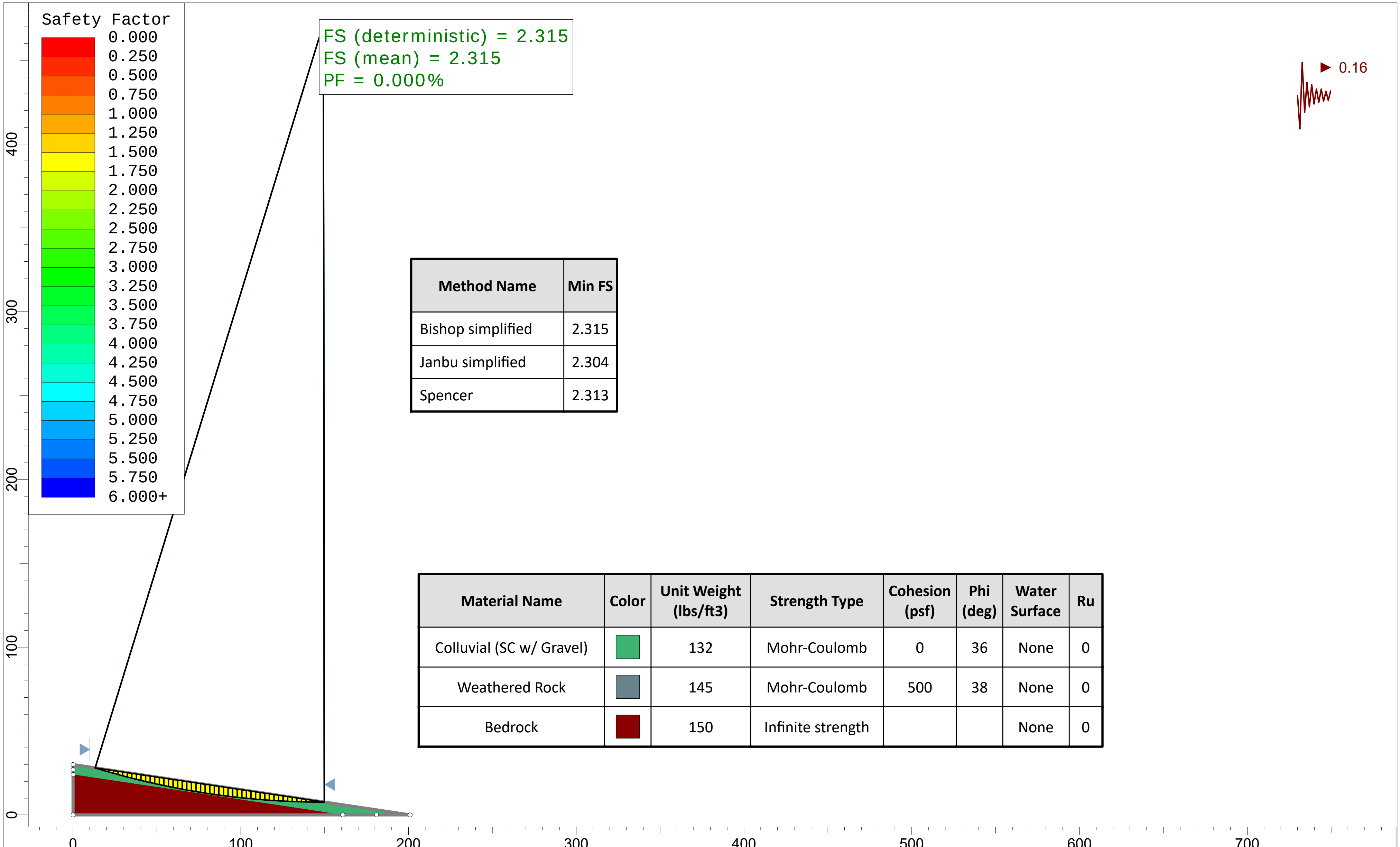
Project	MVP NFS		
Analysis Description	1.3H:1V Stockpile Crushed Rock		
Drawn By		*Scale* 1:140	*Company*
Date 2/22/2018		*File Name* MVP Stockpile - 1.3H to 1V.slmd	



SLIDEINTERPRET 7.029	*Project* MVP NFS		
	Analysis Description 1.3H:1V Stockpile Clayey Gravel		
	Drawn By	*Scale*	*Company*
	Date 2/22/2018		*File Name* MVP Stockpile - 1.3H to 1V.slmd

Table C-1. Summary of Slope Stability Analysis

Slope (% and Ratio)	Groundwater / Precipitation Model	Seismic Load Applied (g)	Density (pcf)			Friction Angle (°)			**FS (Bishop)**
			Low 115	Likely 132	High 161	Low 24	Likely 36	High 50	
15% 6.7:1	Saturated (Perpindicular & h_w=h)	0		X			X		**2.6**
		0.16		X			X		**1.2**
	No GW	0		X			X		**4.9**
		0.16		X			X		**2.3**
30% 3.3:1	Saturated (Perpindicular & h_w=h)	0		X			X		**1.2**
			X				X		1.0
					X			X	1.4
				X		X			0.7
				X				X	1.9
		0.16		X			X		**0.7**
			X				X		0.6
					X			X	0.8
				X		X			0.4
				X				X	1.1
	No GW	0		X			X		**2.4**
		0.16		X			X	X	**1.5**
45% 2.2:1	Saturated (Perpindicular & h_w=h)	0		X			X		**0.7**
			X				X		0.6
					X			X	0.9
				X		X			0.5
				X				X	1.2
		0.16		X			X		**0.4**
			X				X		0.4
					X			X	0.6
				X		X			0.3
				X				X	0.8
	No GW	0		X			X		**1.6**
			X				X		1.6
					X			X	
				X		X			0.7
				X				X	1.9
		0.16		X			X		**1.1**
			X				X		1.1
					X			X	
				X		X			1.0
				X				X	2.7
65% 1.5:1	Saturated (Perpindicular & h_w=h)	0		X			X		**0.4**
		0.16		X			X		**0.2**
	No GW	0		X			X		**1.1**
			X				X		1.1
					X			X	
				X		X			0.7
				X				X	1.8
		0.16		X			X		**0.8**
			X				X		0.8
					X			X	
				X		X			0.5
				X				X	1.3
76% 1.3:1	Saturated (Perpindicular & h_w=h)	0		X			X		**0.3**
		0.16		X			X		**0.1**
	No GW	0		X			X		**1.0**
			X				X		1.0
					X			X	
				X		X			0.6
				X				X	1.6
		0.16		X			X		**0.7**
			X				X		0.7
					X			X	
				X		X			0.4
				X				X	1.1

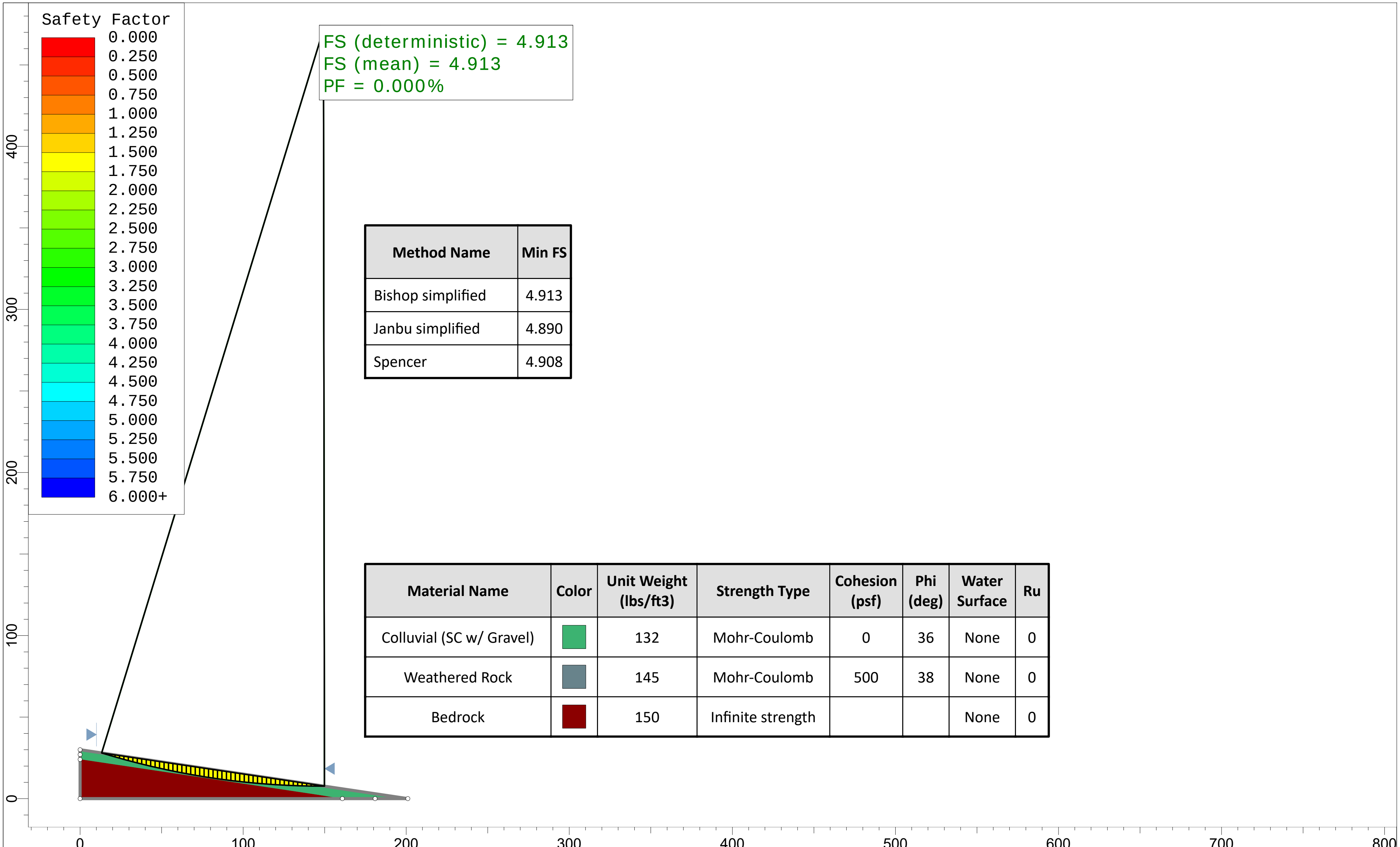


Method Name	Min FS
Bishop simplified	2.315
Janbu simplified	2.304
Spencer	2.313

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Weathered Rock		145	Mohr-Coulomb	500	38	None	0
Bedrock		150	Infinite strength			None	0

Project	MVP Debris Stability
Analysis Description	15% Slope - Moist with 0.16g Seismic Load
Drawn By	PTJ
Scale	1:950
Company	DAA
Date	11/30/2016, 4:07:45 PM
File Name	MVP Debri - 15 Slope.slmd

SLIDEINTERPRET 7.018

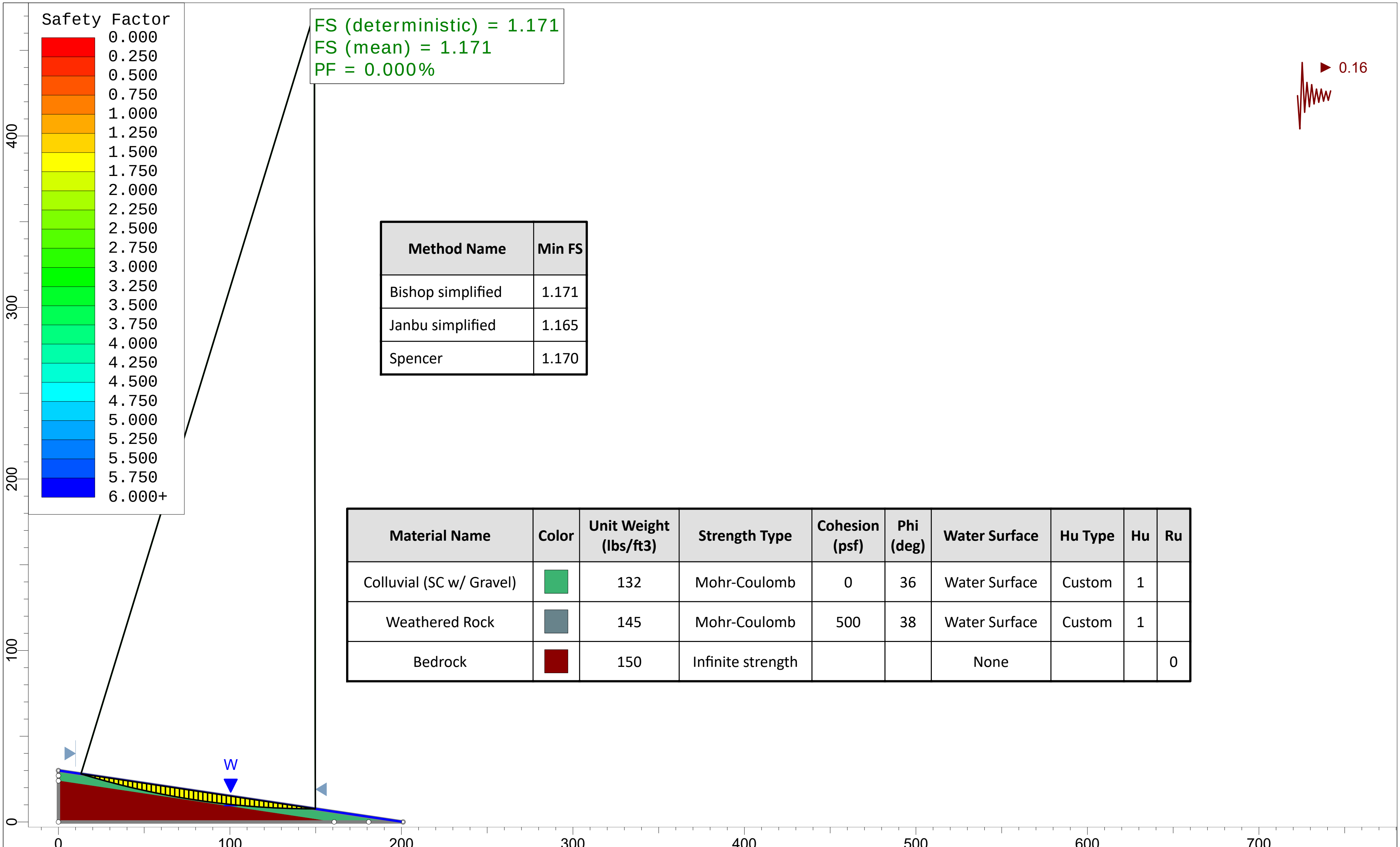


Method Name	Min FS
Bishop simplified	4.913
Janbu simplified	4.890
Spencer	4.908

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Weathered Rock		145	Mohr-Coulomb	500	38	None	0
Bedrock		150	Infinite strength			None	0

Project	MVP Debris Stability		
Analysis Description	15% Slope - Moist Soils		
Drawn By	PTJ	*Scale*	1:977
Company	DAA		
Date	11/30/2016, 4:07:45 PM	*File Name*	MVP Debri - 15 Slope.slmd

SLIDEINTERPRET 7.018

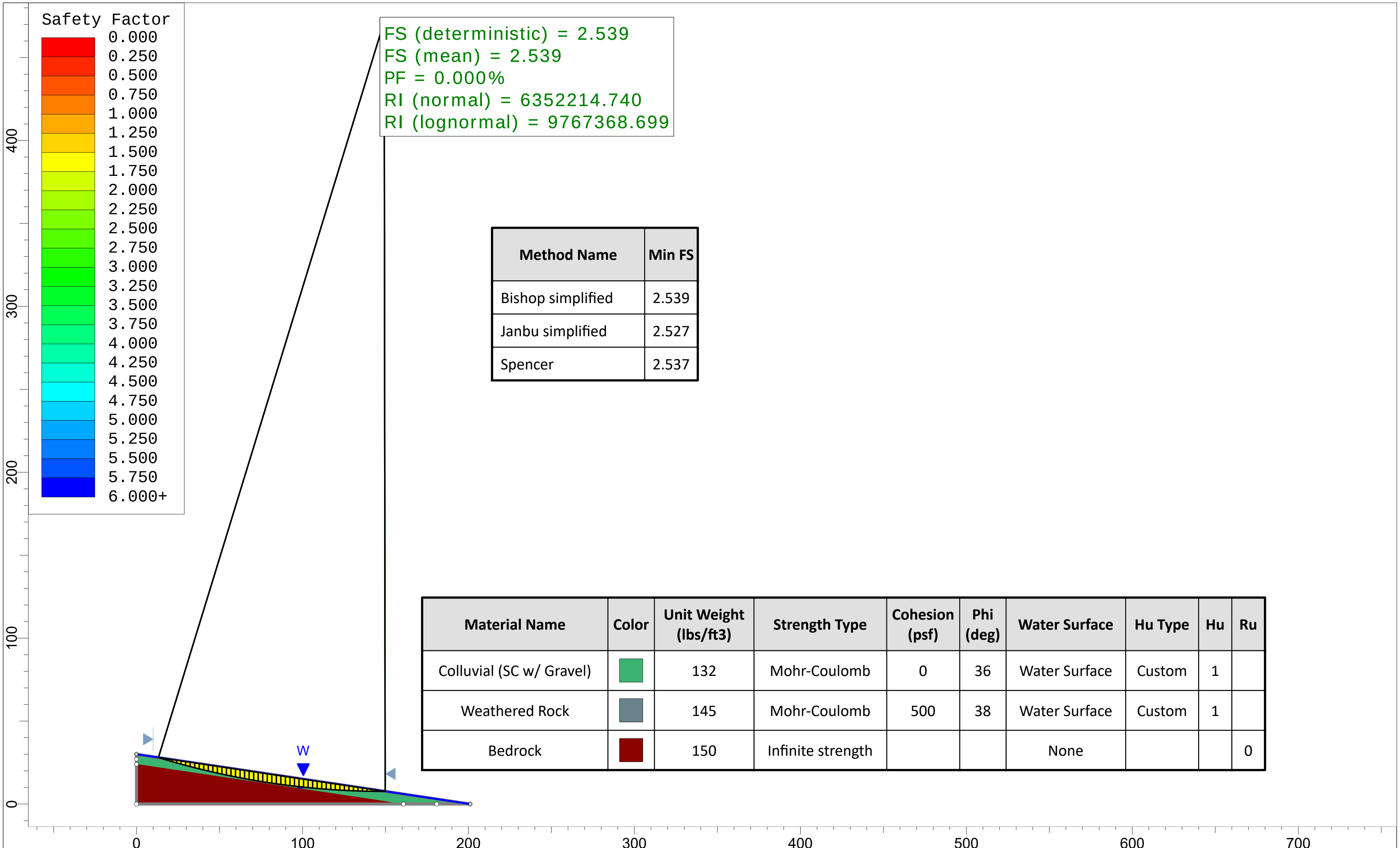


Method Name	Min FS
Bishop simplified	1.171
Janbu simplified	1.165
Spencer	1.170

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Weathered Rock		145	Mohr-Coulomb	500	38	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

Project	MVP Debris Stability
Analysis Description	15% Slope - Saturated Soils with 0.16g Seismic Load
Drawn By	PTJ
Scale	1:929
Company	DAA
Date	11/30/2016, 4:07:45 PM
File Name	MVP Debri - 15 Slope.slmd

SLIDEINTERPRET 7.018

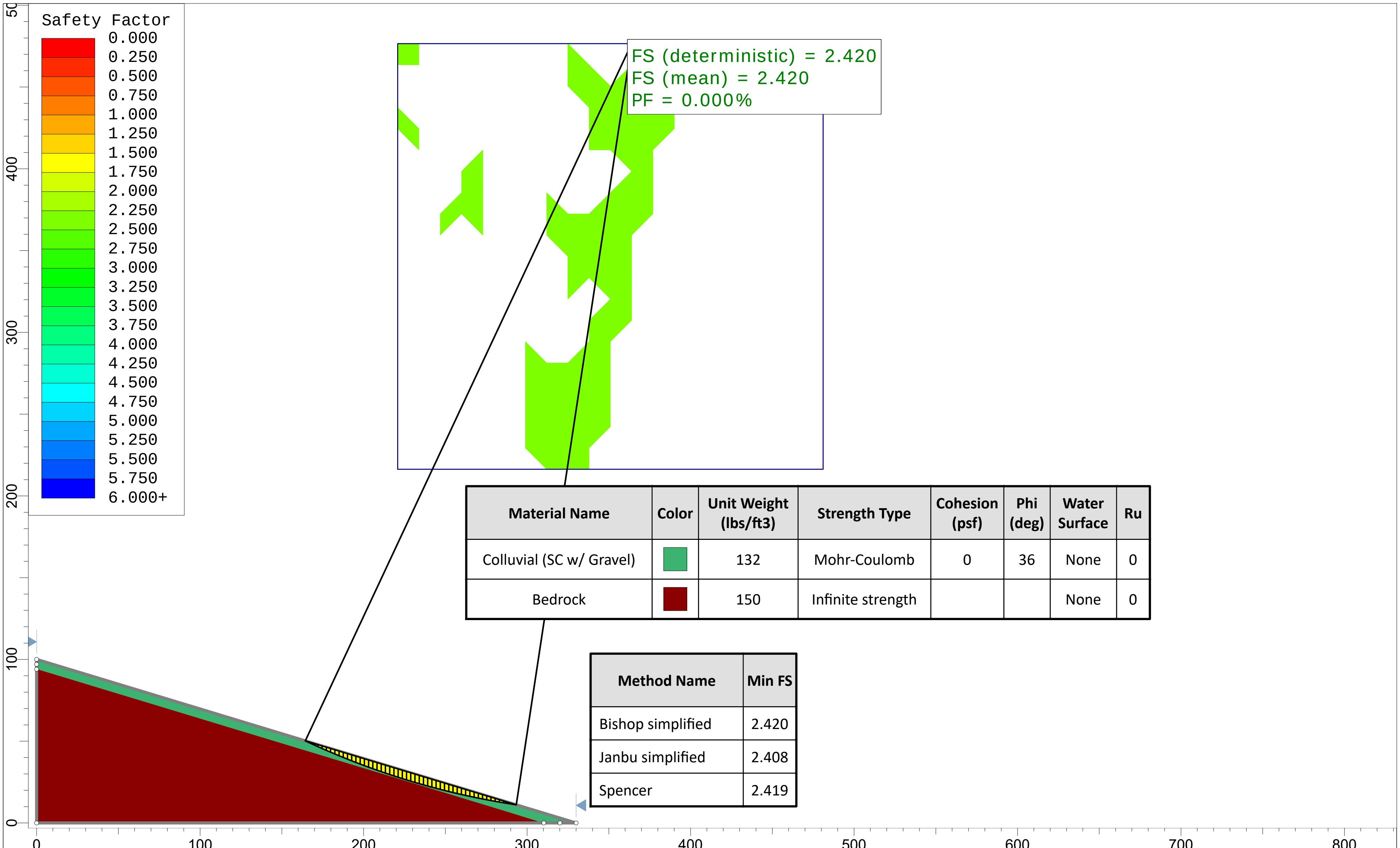


Method Name	Min FS
Bishop simplified	2.539
Janbu simplified	2.527
Spencer	2.537

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Weathered Rock		145	Mohr-Coulomb	500	38	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

SLIDEINTERPRET 7.018

Project	MVP Debris Stability		
Analysis Description	15% Slope - Saturated Soils		
Drawn By	PTJ	*Scale* 1:960	*Company* DAA
Date	11/30/2016, 4:07:45 PM	*File Name*	MVP Debri - 15 Slope.slmd



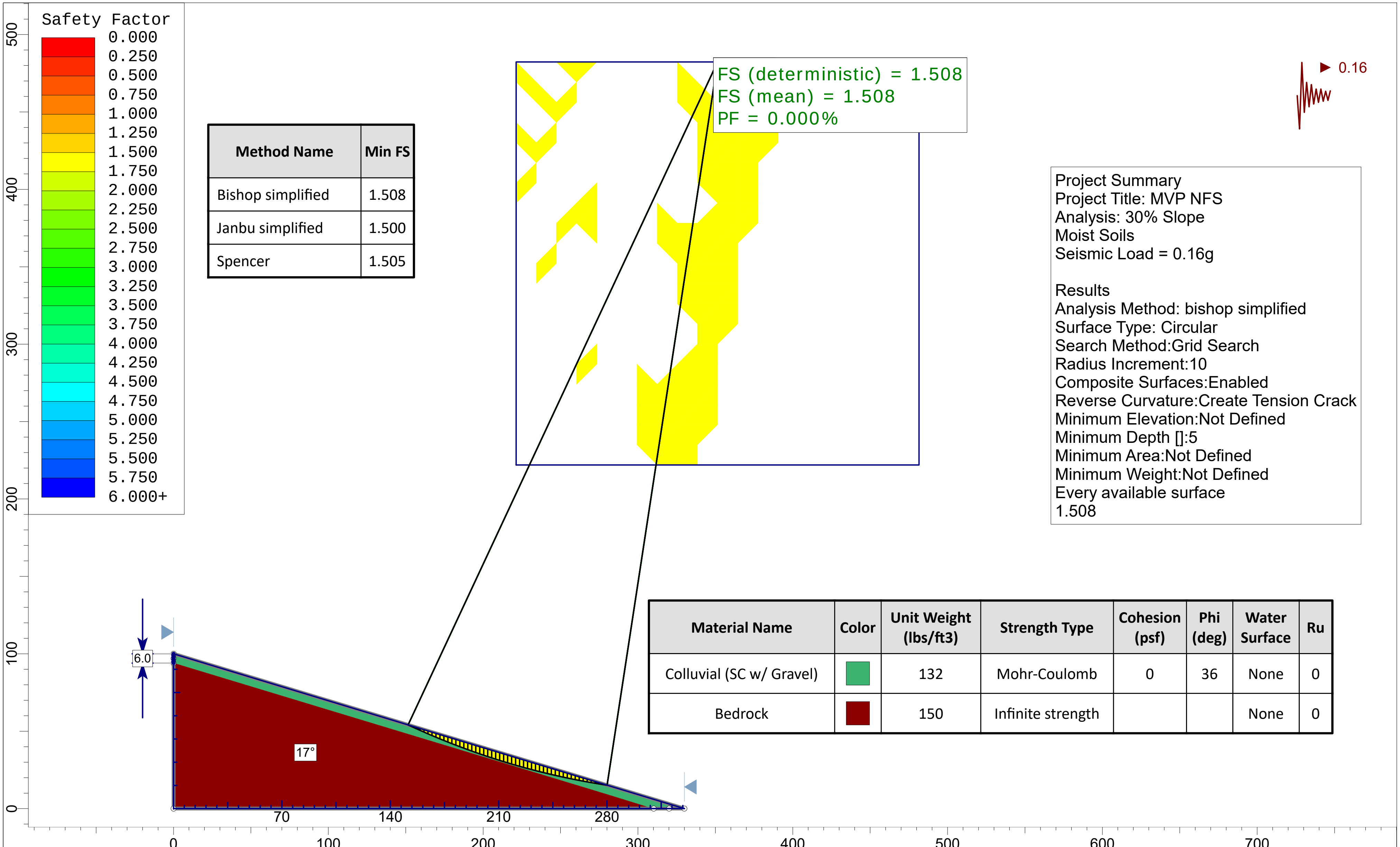
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Bedrock		150	Infinite strength			None	0

Method Name	Min FS
Bishop simplified	2.420
Janbu simplified	2.408
Spencer	2.419

rocscience

SLIDEINTERPRET 7.018

Project	MVP Debris Stability		
Analysis Description	30% Slope - Moist Soils		
Drawn By	PTJ	*Scale* 1:974	*Company* DAA
Date	11/30/2016, 4:07:45 PM	*File Name*	MVP Debri - 30 Slope.slmd



Method Name	Min FS
Bishop simplified	1.508
Janbu simplified	1.500
Spencer	1.505

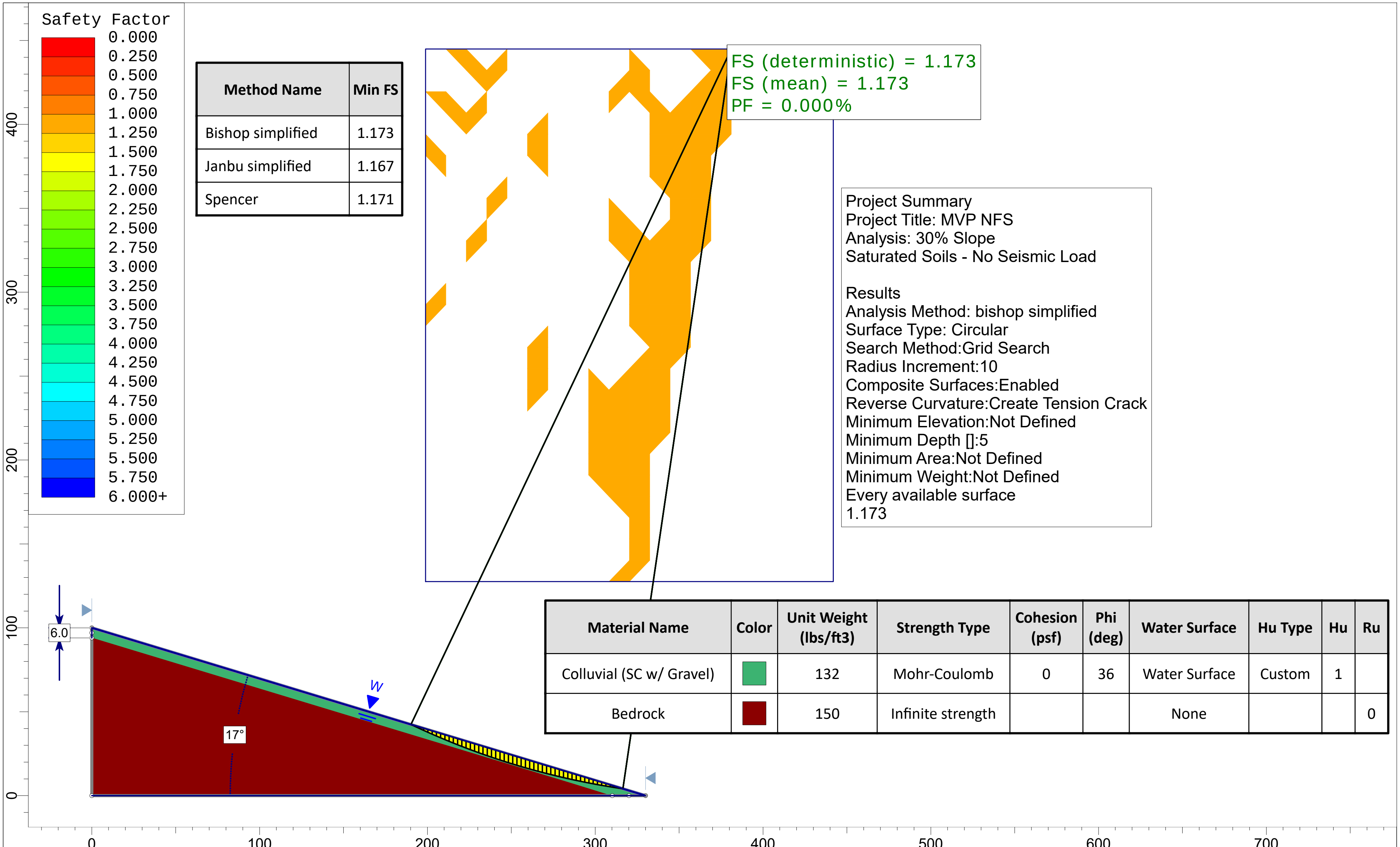
Project Summary
Project Title: MVP NFS
Analysis: 30% Slope
Moist Soils
Seismic Load = 0.16g

Results
Analysis Method: bishop simplified
Surface Type: Circular
Search Method:Grid Search
Radius Increment:10
Composite Surfaces:Enabled
Reverse Curvature:Create Tension Crack
Minimum Elevation:Not Defined
Minimum Depth []:5
Minimum Area:Not Defined
Minimum Weight:Not Defined
Every available surface
1.508

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Bedrock		150	Infinite strength			None	0

SLIDEINTERPRET 7.018

Project	MVP Debris Stability
Analysis Description	30% Slope - Moist Soils with 0.16g Seismic Load
Drawn By	PTJ
Scale	1:1029
Company	DAA
Date	11/30/2016, 4:07:45 PM
File Name	MVP Debri - 30 Slope.slmd



Method Name	Min FS
Bishop simplified	1.173
Janbu simplified	1.167
Spencer	1.171

FS (deterministic) = 1.173
FS (mean) = 1.173
PF = 0.000%

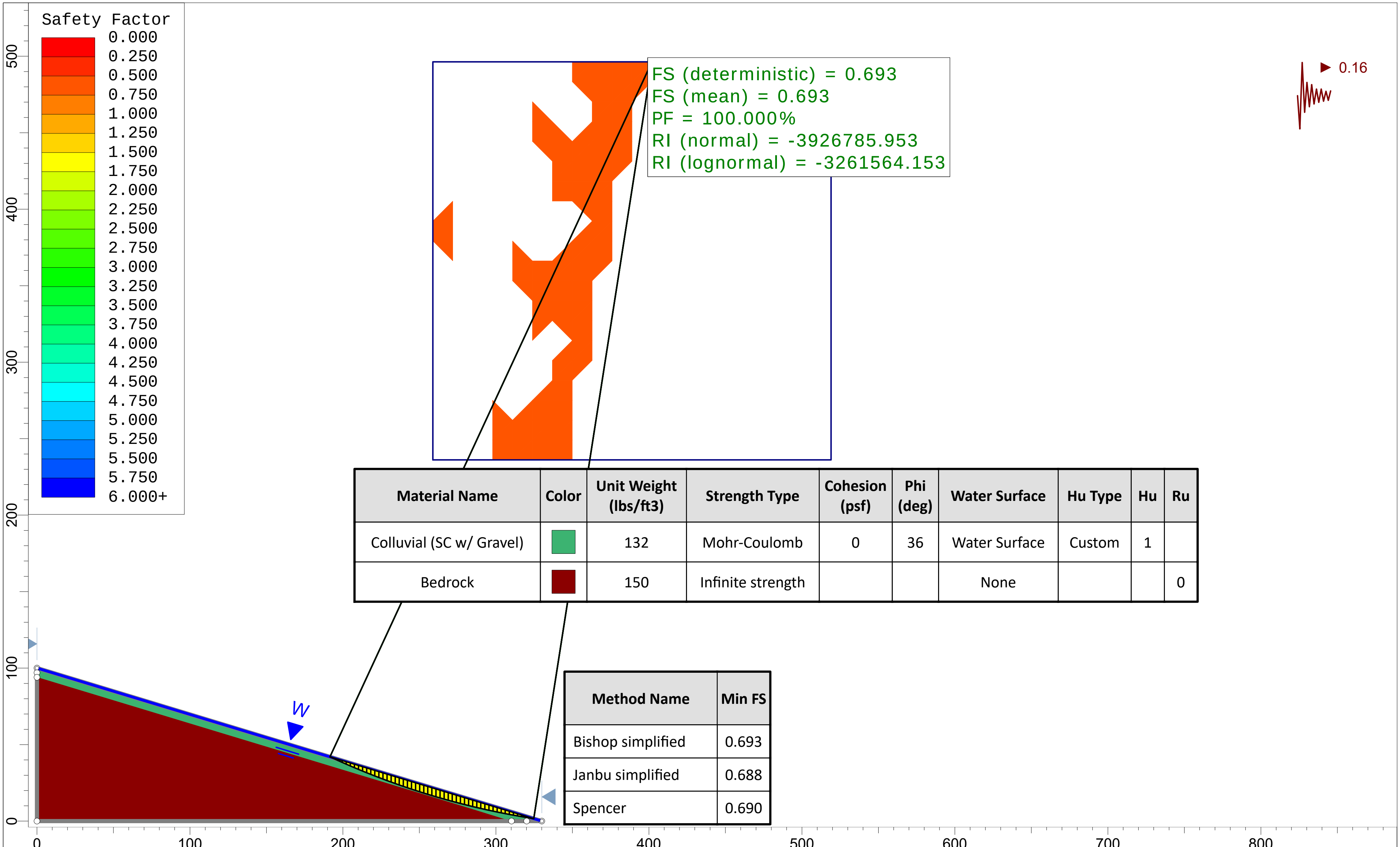
Project Summary
Project Title: MVP NFS
Analysis: 30% Slope
Saturated Soils - No Seismic Load

Results
Analysis Method: bishop simplified
Surface Type: Circular
Search Method:Grid Search
Radius Increment:10
Composite Surfaces:Enabled
Reverse Curvature:Create Tension Crack
Minimum Elevation:Not Defined
Minimum Depth []:5
Minimum Area:Not Defined
Minimum Weight:Not Defined
Every available surface
1.173

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

Project	MVP Debris Stability		
Analysis Description	30% Slope - Saturated Soils with No Seismic Loading		
Drawn By PTJ	*Scale* 1:949	*Company*	DAA
Date 11/30/2016		*File Name*	MVP Debri - 30 Slope.slmd

SLIDEINTERPRET 7.018

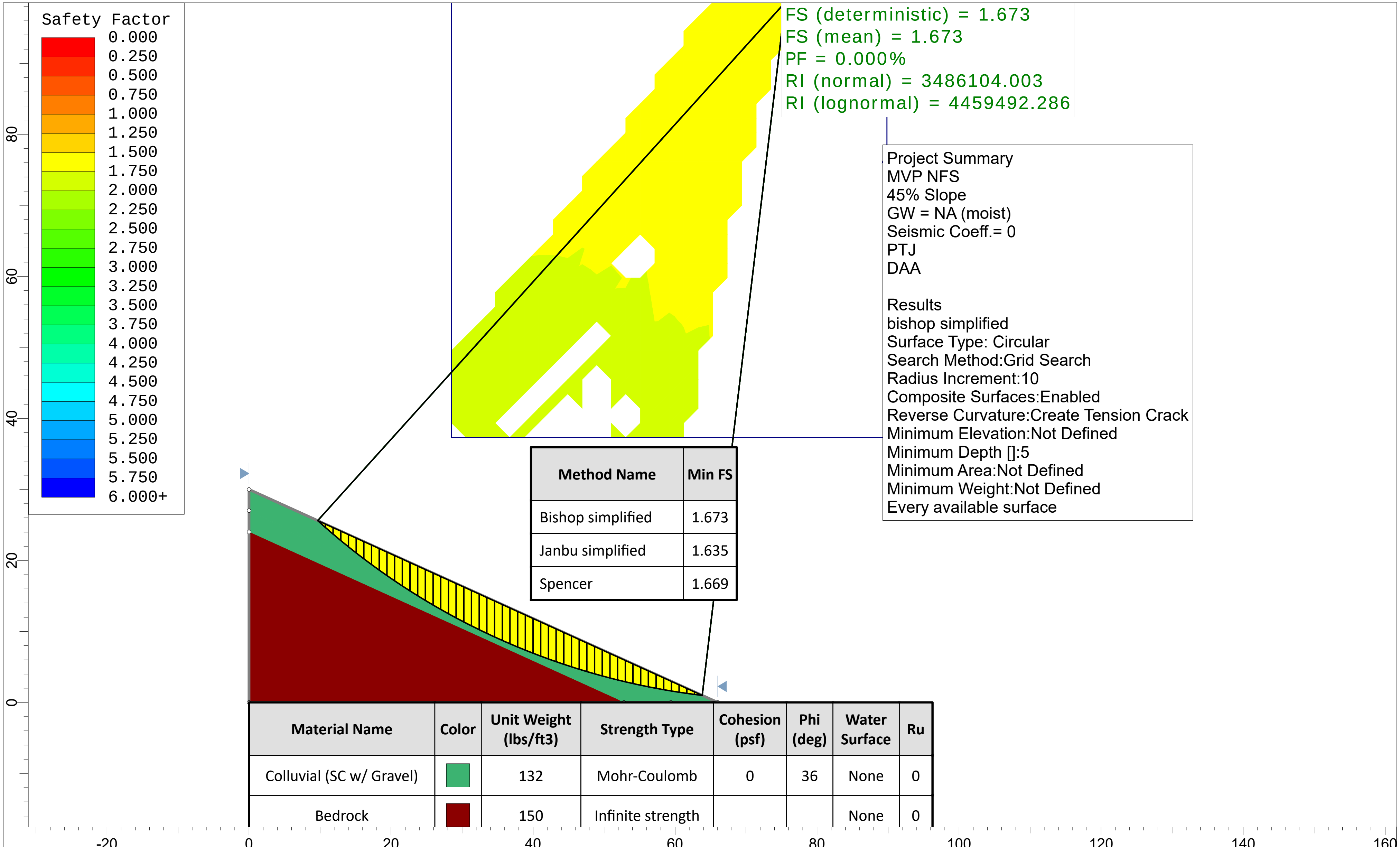


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

Method Name	Min FS
Bishop simplified	0.693
Janbu simplified	0.688
Spencer	0.690

Project	MVP Debris Stability
Analysis Description	30% Slope - Saturated Soils with 0.16g Seismic Load
Drawn By	PTJ
Scale	1:1041
Company	DAA
Date	11/30/2016, 4:07:45 PM
File Name	MVP Debri - 30 Slope.slmd

SLIDEINTERPRET 7.018

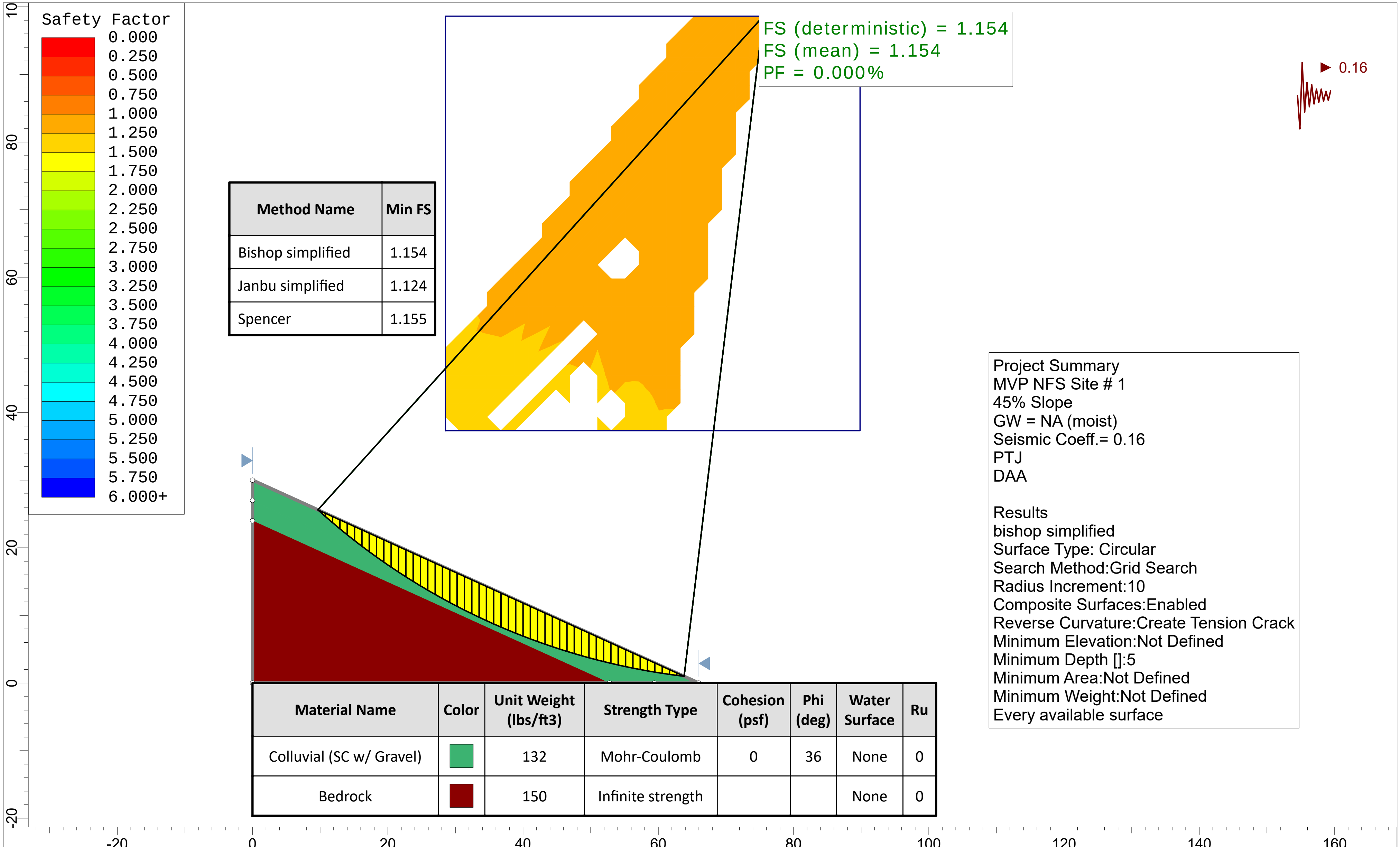


Method Name	Min FS
Bishop simplified	1.673
Janbu simplified	1.635
Spencer	1.669

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Bedrock		150	Infinite strength			None	0

Project	MVP Debris Stability
Analysis Description	45% Slope - Moist Soils
Drawn By	PTJ
Scale	1:224
Company	DAA
Date	11/30/2016
File Name	MVP Debri - 45 Slope.slmd

SLIDEINTERPRET 7.018



Method Name	Min FS
Bishop simplified	1.154
Janbu simplified	1.124
Spencer	1.155

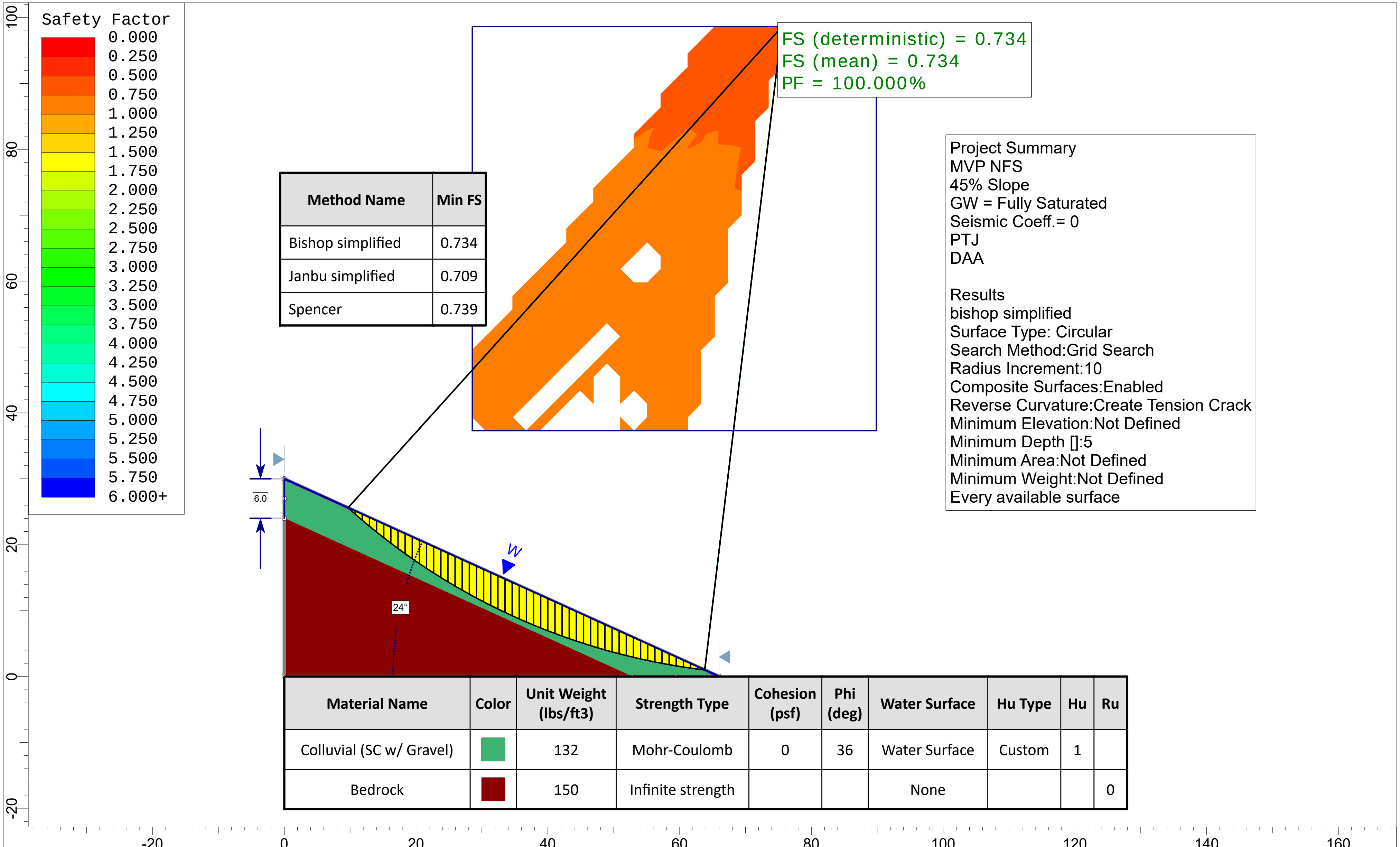
Project Summary
MVP NFS Site # 1
45% Slope
GW = NA (moist)
Seismic Coeff.= 0.16
PTJ
DAA

Results
bishop simplified
Surface Type: Circular
Search Method:Grid Search
Radius Increment:10
Composite Surfaces:Enabled
Reverse Curvature:Create Tension Crack
Minimum Elevation:Not Defined
Minimum Depth []:5
Minimum Area:Not Defined
Minimum Weight:Not Defined
Every available surface

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Bedrock		150	Infinite strength			None	0

SLIDEINTERPRET 7.018

Project	MVP Debris Stability
Analysis Description	45% Slope - Moist Soils with 0.16g Seismic Load
Drawn By	PTJ
Scale	1:236
Company	DAA
Date	11/30/2016, 4:07:45 PM
File Name	MVP Debri - 45 Slope.slmd



Method Name	Min FS
Bishop simplified	0.734
Janbu simplified	0.709
Spencer	0.739

Project Summary
MVP NFS
45% Slope
GW = Fully Saturated
Seismic Coeff.= 0
PTJ
DAA

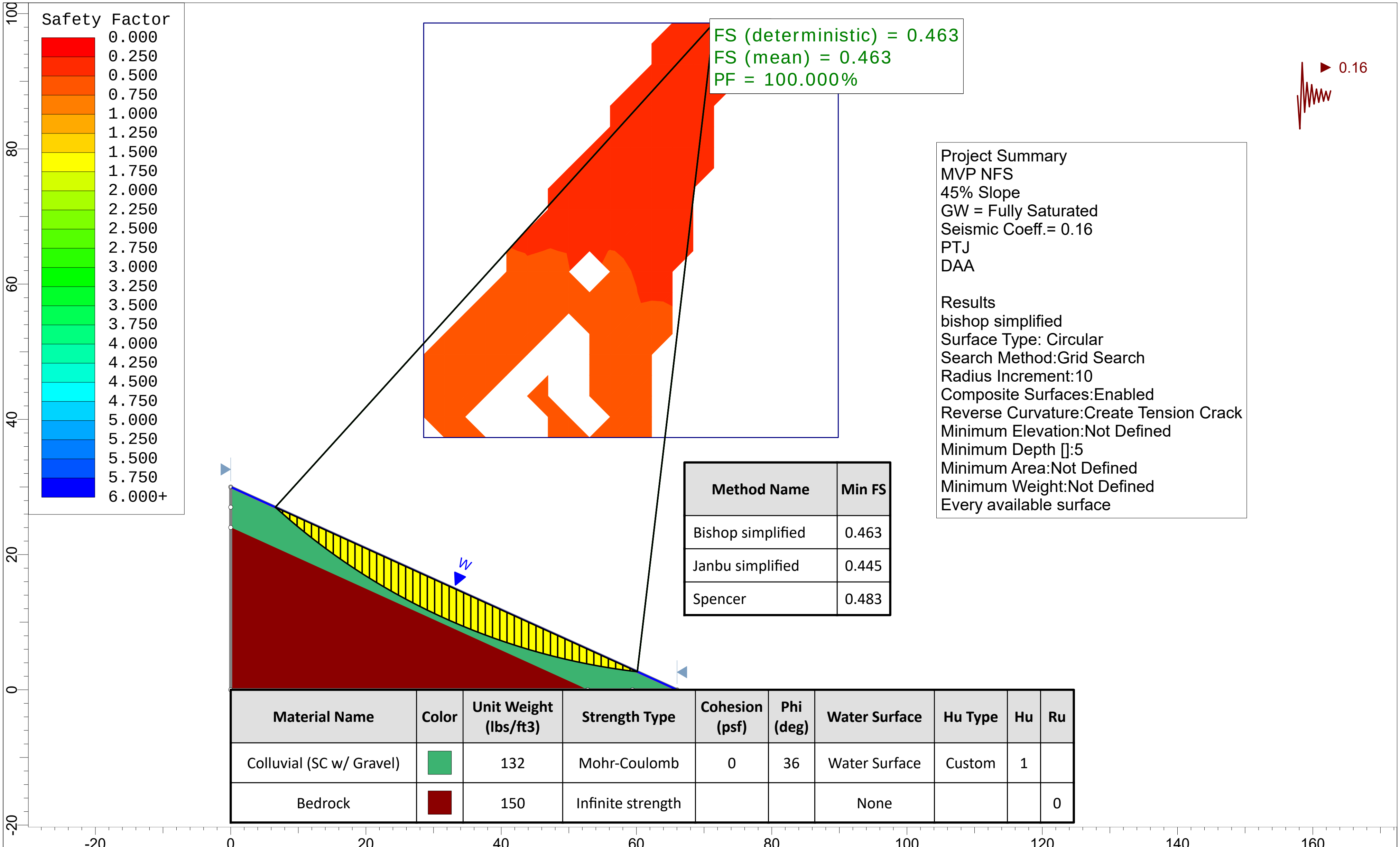
Results
bishop simplified
Surface Type: Circular
Search Method:Grid Search
Radius Increment:10
Composite Surfaces:Enabled
Reverse Curvature:Create Tension Crack
Minimum Elevation:Not Defined
Minimum Depth []:5
Minimum Area:Not Defined
Minimum Weight:Not Defined
Every available surface

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

rocscience

SLIDEINTERPRET 7.018

Project	MVP Debris Stability
Analysis Description	45% Slope - Saturated Soils
Drawn By	PTJ
Scale	1:242
Company	DAA
Date	11/30/2016, 4:07:45 PM
File Name	MVP Debri - 45 Slope.slmd



Project Summary
MVP NFS
45% Slope
GW = Fully Saturated
Seismic Coeff.= 0.16
PTJ
DAA

Results
bishop simplified
Surface Type: Circular
Search Method:Grid Search
Radius Increment:10
Composite Surfaces:Enabled
Reverse Curvature:Create Tension Crack
Minimum Elevation:Not Defined
Minimum Depth []:5
Minimum Area:Not Defined
Minimum Weight:Not Defined
Every available surface

Method Name	Min FS
Bishop simplified	0.463
Janbu simplified	0.445
Spencer	0.483

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

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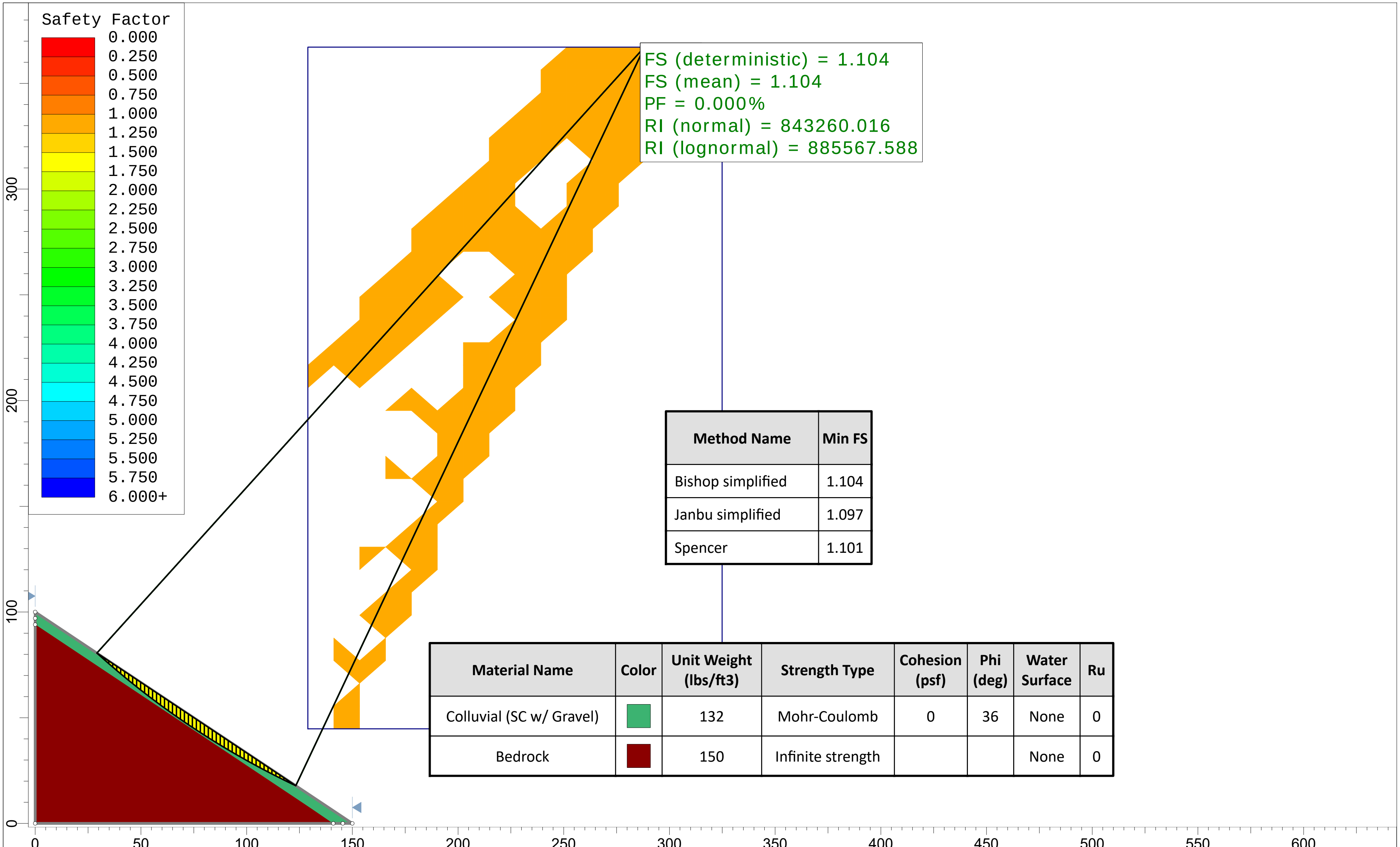
SLIDEINTERPRET 7.018

Project	MVP Debris Stability		
Analysis Description	45% Slope - Saturated Soils with 0.16g Seismic Load		
Drawn By PTJ	*Scale* 1:236	*Company*	DAA
Date 11/30/2016, 4:07:45 PM		*File Name*	MVP Debri - 45 Slope.slmd



Method Name	Min FS
Bishop simplified	1.104
Janbu simplified	1.097
Spencer	1.101

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Bedrock		150	Infinite strength			None	0

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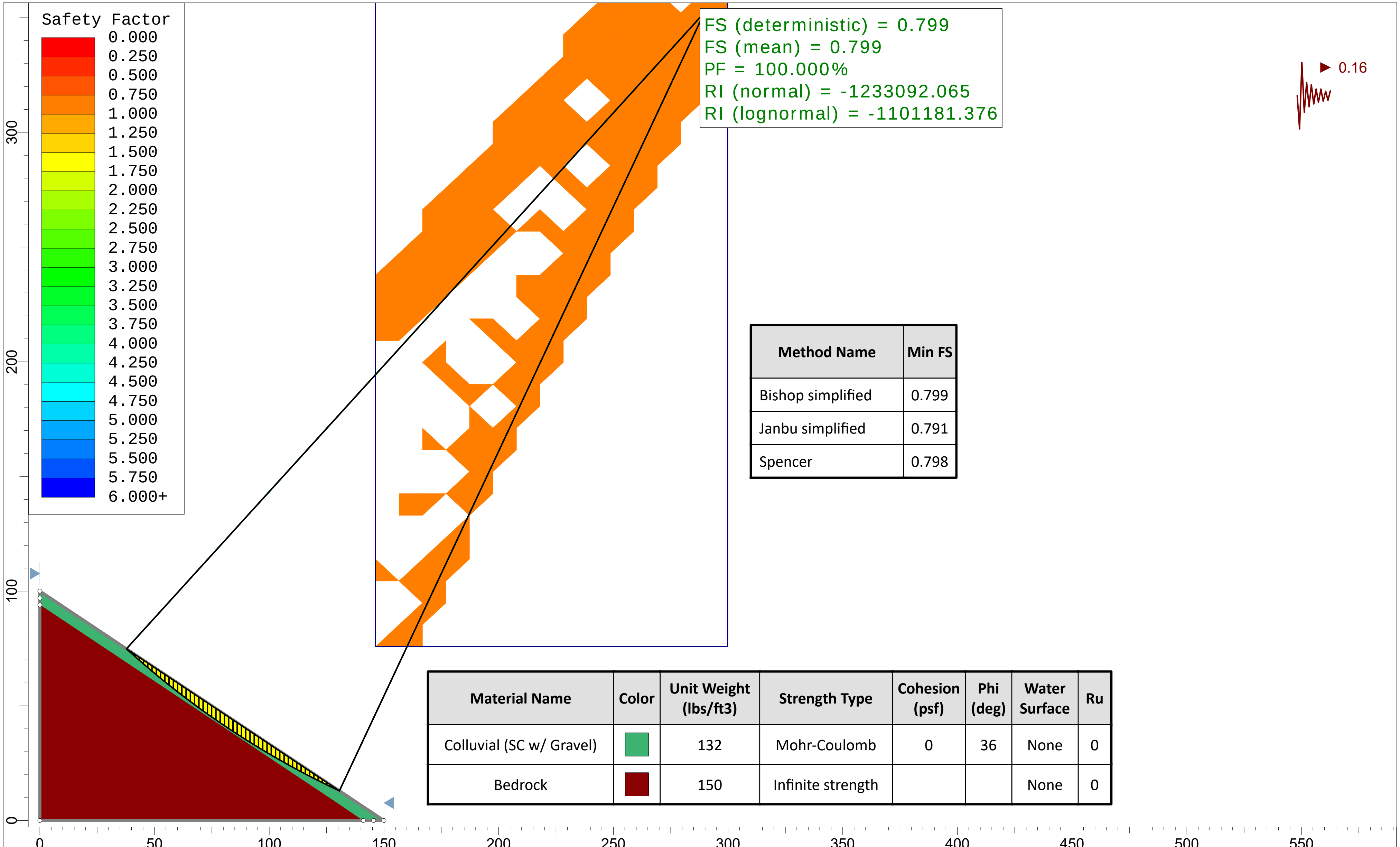
SLIDEINTERPRET 7.018

Project	MVP Debris Stability
Analysis Description	65% Slope - Moist Soils
Drawn By	PTJ
Scale	1:754
Company	DAA
Date	11/30/2016, 4:07:45 PM
File Name	MVP Debri - 65 Slope.slmd

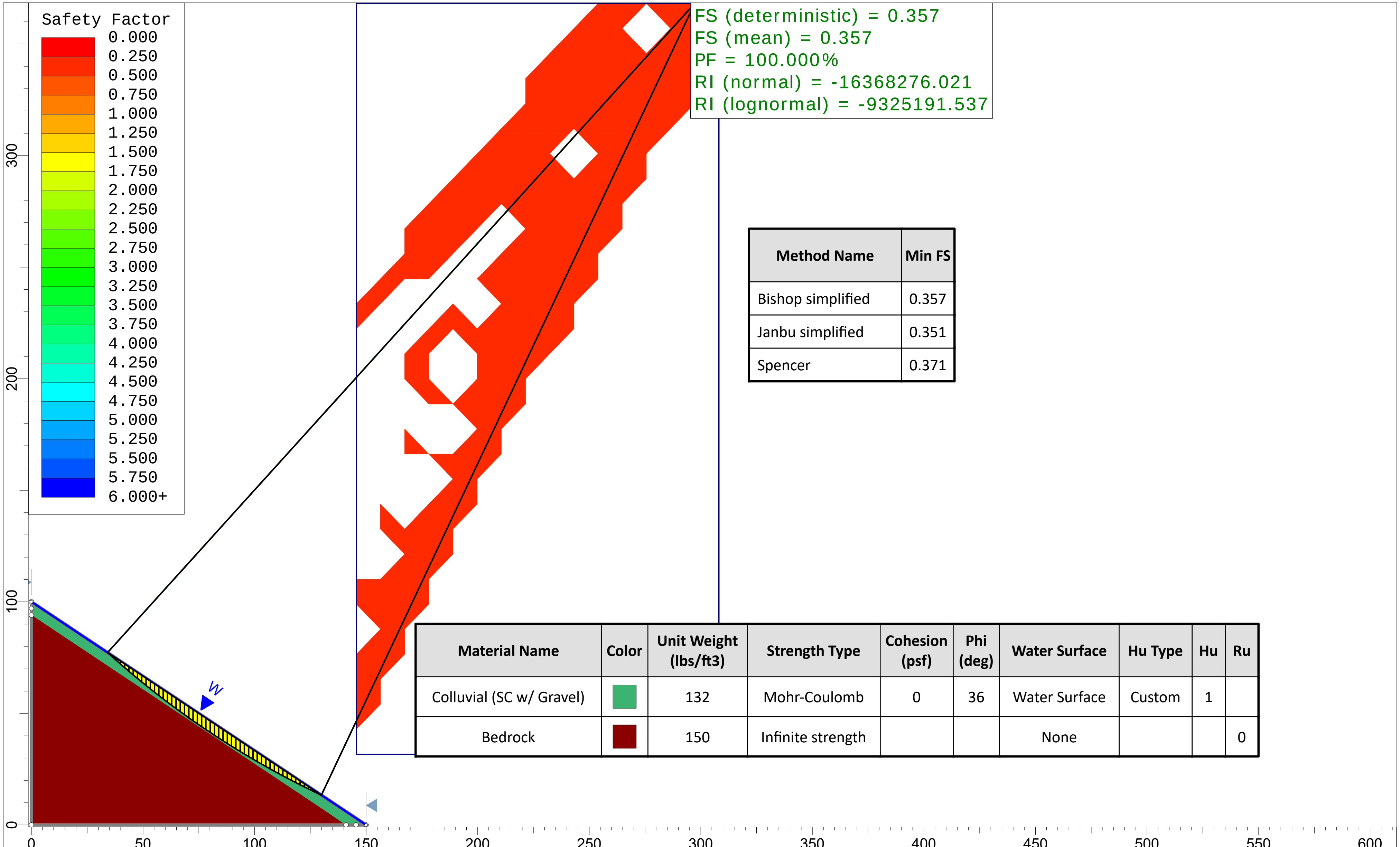


Method Name	Min FS
Bishop simplified	0.799
Janbu simplified	0.791
Spencer	0.798

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Bedrock		150	Infinite strength			None	0

Project	MVP Debris Stability		
Analysis Description	65% Slope - Moist Soils with 0.16g Seismic Load		
Drawn By	PTJ	*Scale*	1:694
Company	DAA		
Date	11/30/2016, 4:07:45 PM	*File Name*	MVP Debri - 65 Slope.slmd

SLIDEINTERPRET 7.018



Method Name	Min FS
Bishop simplified	0.357
Janbu simplified	0.351
Spencer	0.371

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

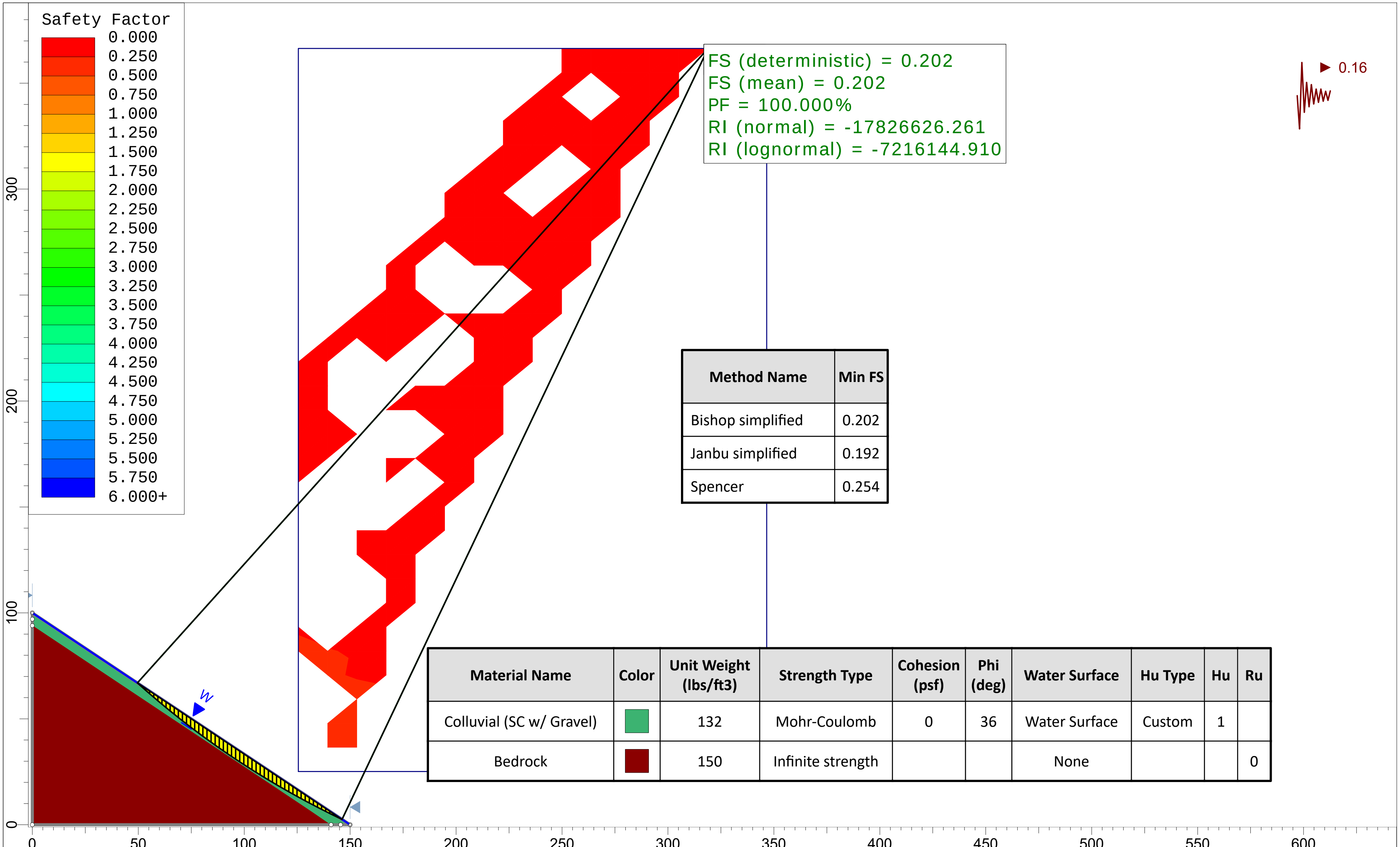
SLIDEINTERPRET 7.018

Project MVP Debris Stability

Analysis Description 65% Slope - Saturated Soils

Drawn By PTJ | *Scale* 1:714 | *Company* DAA

Date 11/30/2016, 4:07:45 PM | *File Name* MVP Debri - 65 Slope.slmd

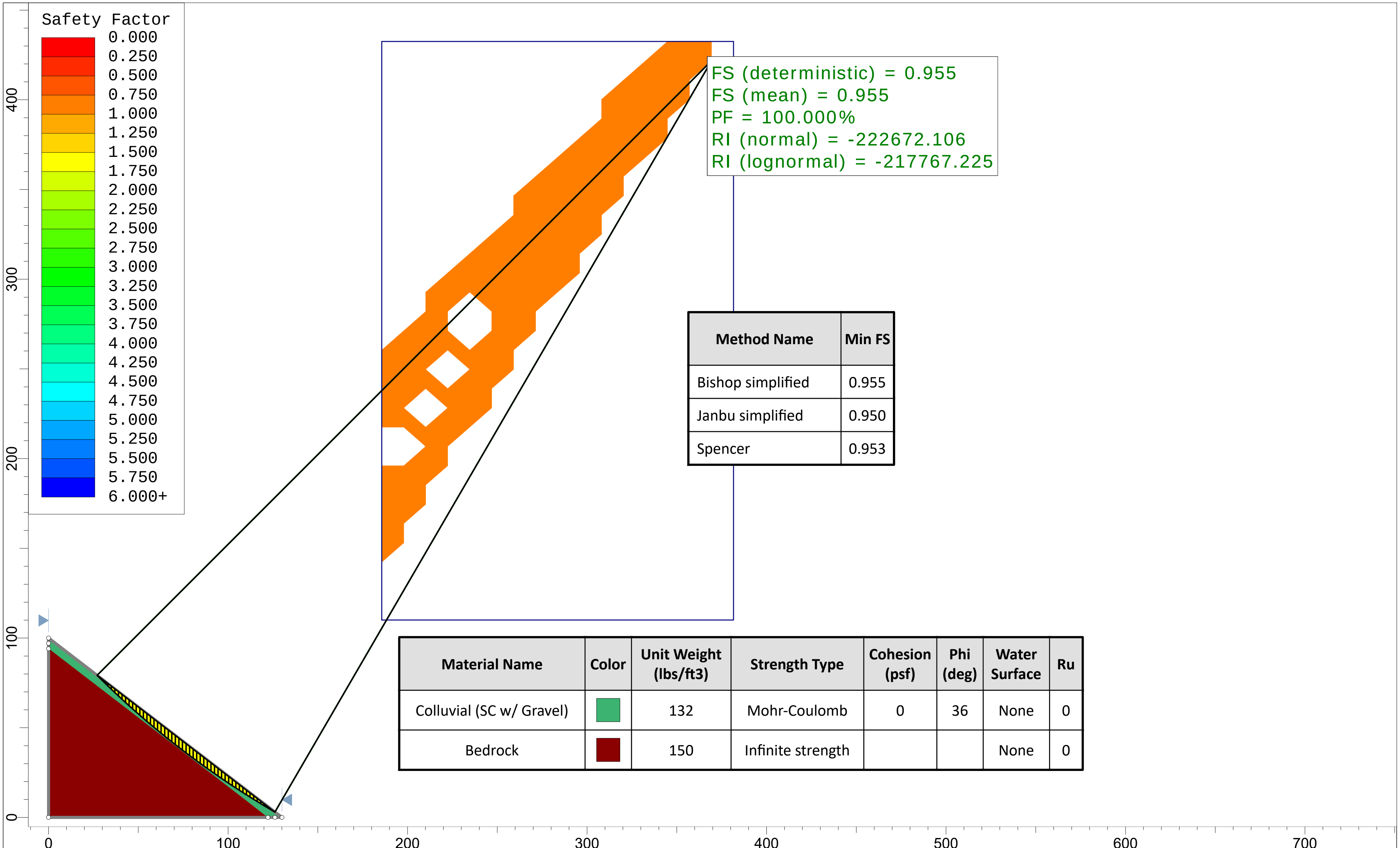


Method Name	Min FS
Bishop simplified	0.202
Janbu simplified	0.192
Spencer	0.254

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

Project	MVP Debris Stability		
Analysis Description	65% Slope - Saturated Soils with 0.16g Seismic Load		
Drawn By	PTJ	*Scale* 1:752	*Company* DAA
Date	11/30/2016, 4:07:45 PM	*File Name*	MVP Debri - 65 Slope.slmd

SLIDEINTERPRET 7.018

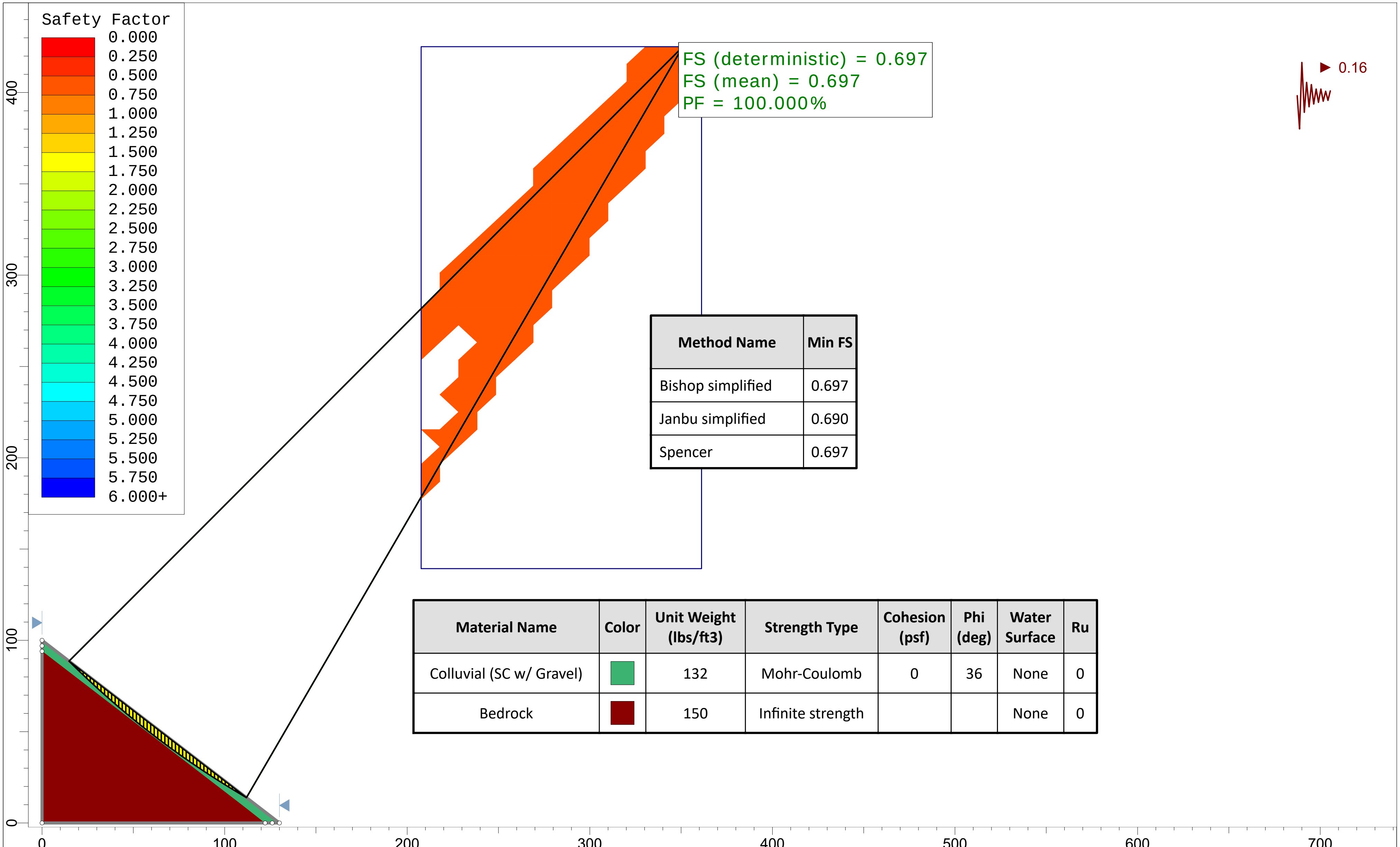


Method Name	Min FS
Bishop simplified	0.955
Janbu simplified	0.950
Spencer	0.953

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Bedrock		150	Infinite strength			None	0

Project	MVP Debris Stability		
Analysis Description	76% Slope - Moist Soils		
Drawn By	PTJ	*Scale*	1:887
Company	DAA		
Date	12/02/2016	*File Name*	MVP Debri - 76 Slope.slmd

SLIDEINTERPRET 7.018



Method Name	Min FS
Bishop simplified	0.697
Janbu simplified	0.690
Spencer	0.697

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	None	0
Bedrock		150	Infinite strength			None	0

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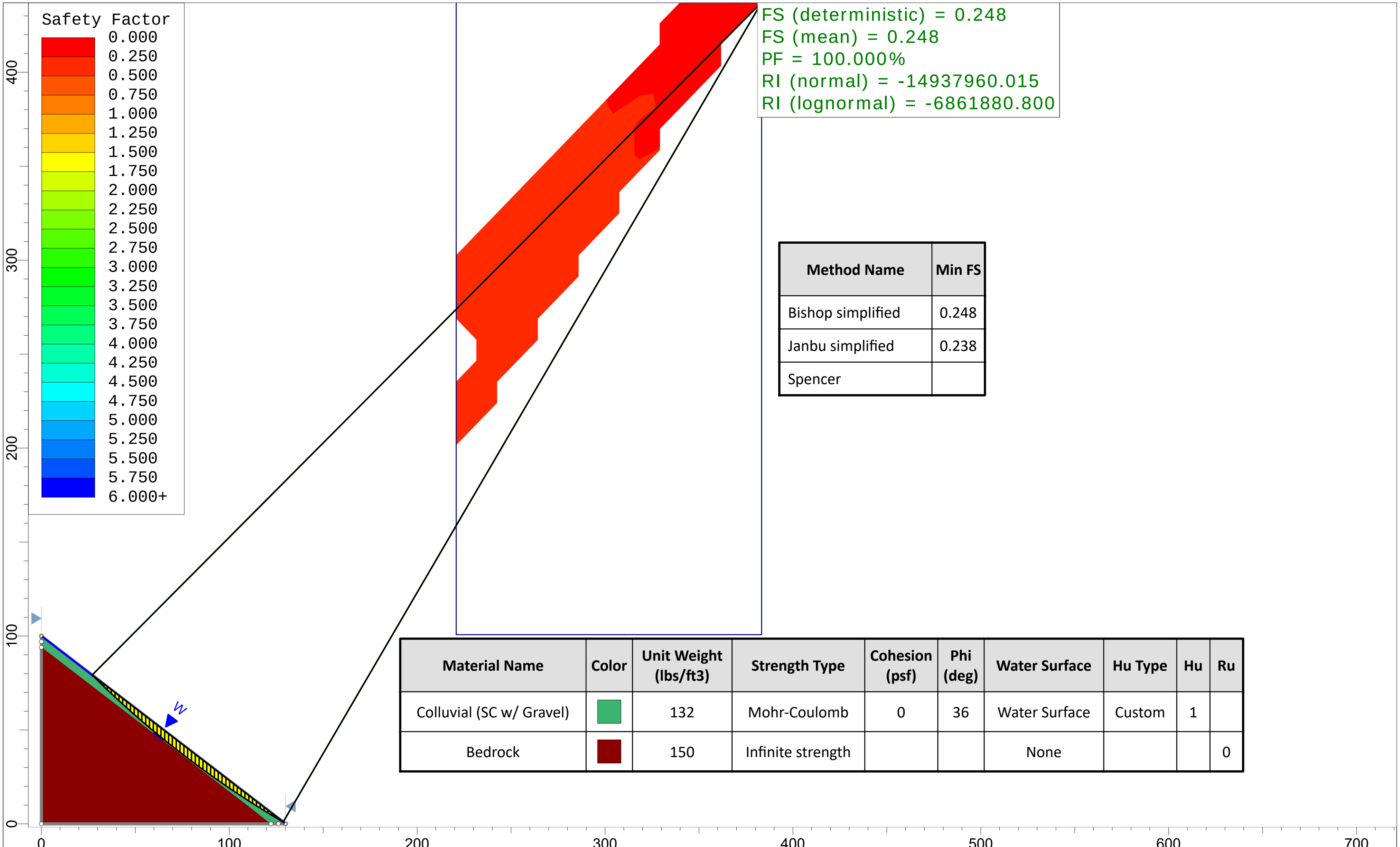
SLIDEINTERPRET 7.018

Project	MVP Debris Stability		
Analysis Description	76% Slope - Moist Soils with 0.16g Seismic Load		
Drawn By	PTJ	*Scale* 1:872	*Company* DAA
Date	11/30/2016, 4:07:45 PM	*File Name*	MVP Debri - 76 Slope.slmd

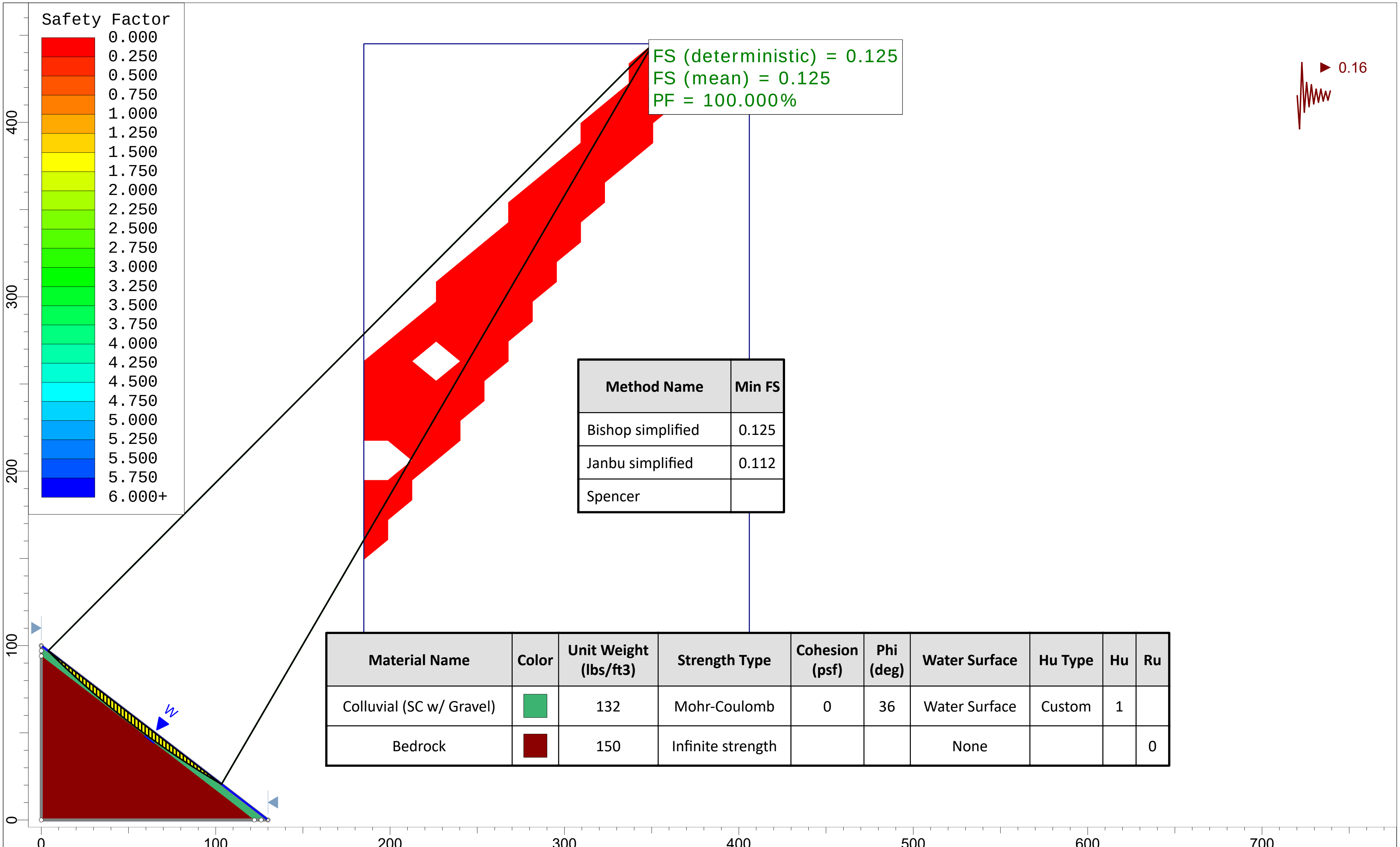


Method Name	Min FS
Bishop simplified	0.248
Janbu simplified	0.238
Spencer	

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

Project	MVP Debris Stability		
Analysis Description	76% Slope - Saturated Soils		
Drawn By	PTJ	*Scale* 1:848	*Company* DAA
Date	11/30/2016, 4:07:45 PM	*File Name*	MVP Debri - 76 Slope.slmd

SLIDEINTERPRET 7.018



Method Name	Min FS
Bishop simplified	0.125
Janbu simplified	0.112
Spencer	

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Hu Type	Hu	Ru
Colluvial (SC w/ Gravel)		132	Mohr-Coulomb	0	36	Water Surface	Custom	1	
Bedrock		150	Infinite strength			None			0

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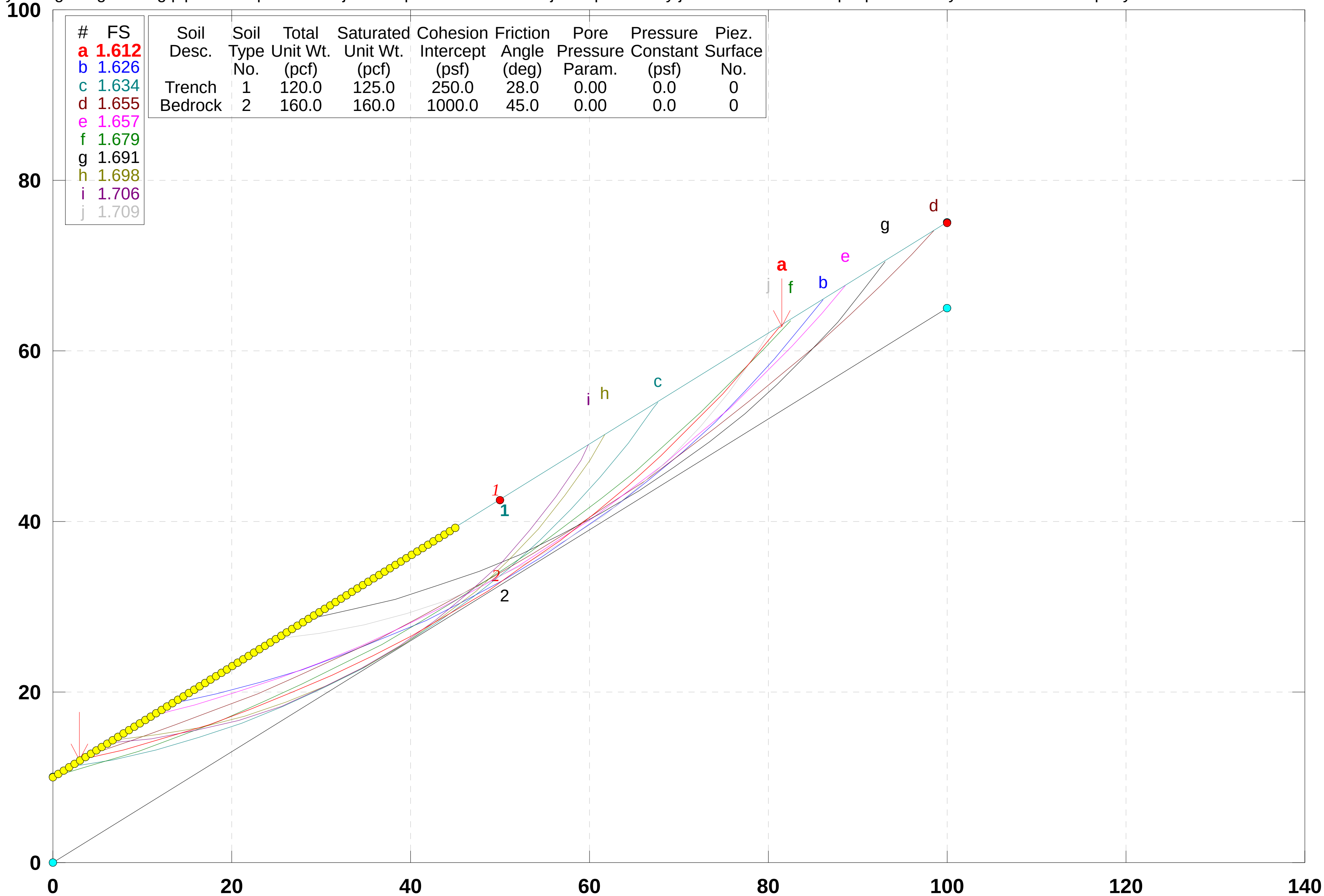
SLIDEINTERPRET 7.018

Project	MVP Debris Stability
Analysis Description	76% Slope - Saturated Soils with 0.16g Seismic Load
Drawn By	PTJ
Scale	1:913
Company	DAA
Date	11/30/2016, 4:07:45 PM
File Name	MVP Debri - 76 Slope.slmd

JNF1: Trench Backfill Stability - 65% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf1 trench backfill 65pct.pl2 Run By: Insert Name/company Here 12/16/2016 11:38AM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Trench	1	120.0	125.0	250.0	28.0	0.00	0.0	0
Bedrock	2	160.0	160.0	1000.0	45.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.612

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

```
                ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
      ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
                 (All Rights Reserved-Unauthorized Use Prohibited)
    *********************************************************************************
                       SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    *********************************************************************************
    Analysis Run Date:          12/16/2016
    Time of Run:                11:38AM
    Run By:                     Insert Name/company Here
    Input Data Filename:        y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf1 trench backfill 65pct.in
    Output Filename:            y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf1 trench backfill 65pct.OUT
    Unit System:                English
    Plotted Output Filename:  y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf1 trench backfill 65pct.PLT
    PROBLEM DESCRIPTION:  JNF1: Trench Backfill Stability -
                          65% Slope
    BOUNDARY COORDINATES
```

```
       1 Top   Boundaries
       2 Total Boundaries
   Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
      No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
       1          0.00      10.00     100.00      75.00        1
       2          0.00       0.00     100.00      65.00        2
   Default Y-Origin = 0.00(ft)
   Default X-Plus Value = 0.00(ft)
   User Specified Y-Plus Value =   25.00(ft)
  ISOTROPIC SOIL PARAMETERS
    2 Type(s) of Soil
   Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
   Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
    No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
     1   120.0    125.0     250.0     28.0    0.00       0.0      0
     2   160.0    160.0    1000.0     45.0    0.00       0.0      0
   A Critical Failure Surface Searching Method, Using A Random
   Technique For Generating Circular Surfaces, Has Been Specified.
    750 Trial Surfaces Have Been Generated.
     10 Surface(s) Initiate(s) From Each Of    75 Points Equally Spaced
   Along The Ground Surface Between  X =   0.00(ft)
                                   and  X =  45.00(ft)
   Each Surface Terminates Between   X =  50.00(ft)
                                   and   X = 100.00(ft)
   Unless Further Limitations Were Imposed, The Minimum Elevation
   At Which A Surface Extends Is  Y =      0.00(ft)
    5.00(ft) Line Segments Define Each Trial Failure Surface.
   Following Are Displayed The Ten Most Critical Of The Trial
         Failure Surfaces Evaluated. They Are
         Ordered - Most Critical First.
         * * Safety Factors Are Calculated By The Modified Bishop Method * *
         Total Number of Trial Surfaces Attempted =   750
         Number of Trial Surfaces With Valid FS =  750
         Statistical Data On All Valid FS Values:
            FS Max =  18.190   FS Min =   1.612   FS Ave =   3.149
            Standard Deviation =    1.219   Coefficient of Variation =   38.69 %
         Failure Surface Specified By 21 Coordinate Points
           Point      X-Surf      Y-Surf
            No.        (ft)        (ft)
             1          3.041      11.976
             2          7.884      13.216
             3         12.680      14.630
             4         17.422      16.215
             5         22.104      17.971
             6         26.720      19.894
             7         31.263      21.982
             8         35.728      24.232
             9         40.109      26.641
            10         44.400      29.207
            11         48.597      31.926
            12         52.692      34.794
            13         56.682      37.808
            14         60.560      40.964
            15         64.322      44.257
            16         67.963      47.684
            17         71.479      51.239
            18         74.864      54.919
            19         78.114      58.719
            20         81.225      62.633
            21         81.457      62.947
         Circle Center At X =   -28.946 ; Y =   147.009 ; and Radius =   138.769
                Factor of Safety
               ***    1.612   ***
              Individual data on the    20  slices
                      Water  Water     Tie      Tie     Earthquake
                      Force  Force    Force    Force       Force   Surcharge
Slice  Width   Weight  Top    Bot     Norm     Tan      Hor      Ver    Load
 No.    (ft)    (lbs)  (lbs)  (lbs)    (lbs)   (lbs)    (lbs)    (lbs)   (lbs)
  1      4.8    554.7    0.0    0.0       0.      0.     0.0     0.0      0.0
  2      4.8   1588.7    0.0    0.0       0.      0.     0.0     0.0      0.0
```

3	4.7	2481.3	0.0	0.0	0.	0.	0.0	0.0	0.0
4	4.7	3232.0	0.0	0.0	0.	0.	0.0	0.0	0.0
5	4.6	3841.2	0.0	0.0	0.	0.	0.0	0.0	0.0
6	4.5	4310.6	0.0	0.0	0.	0.	0.0	0.0	0.0
7	4.5	4642.9	0.0	0.0	0.	0.	0.0	0.0	0.0
8	4.4	4842.2	0.0	0.0	0.	0.	0.0	0.0	0.0
9	4.3	4913.5	0.0	0.0	0.	0.	0.0	0.0	0.0
10	4.2	4863.0	0.0	0.0	0.	0.	0.0	0.0	0.0
11	4.1	4697.8	0.0	0.0	0.	0.	0.0	0.0	0.0
12	4.0	4426.3	0.0	0.0	0.	0.	0.0	0.0	0.0
13	3.9	4057.3	0.0	0.0	0.	0.	0.0	0.0	0.0
14	3.8	3601.1	0.0	0.0	0.	0.	0.0	0.0	0.0
15	3.6	3068.4	0.0	0.0	0.	0.	0.0	0.0	0.0
16	3.5	2470.8	0.0	0.0	0.	0.	0.0	0.0	0.0
17	3.4	1820.6	0.0	0.0	0.	0.	0.0	0.0	0.0
18	3.3	1130.6	0.0	0.0	0.	0.	0.0	0.0	0.0
19	3.1	414.2	0.0	0.0	0.	0.	0.0	0.0	0.0
20	0.2	2.3	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	13.378	18.696
2	18.250	19.822
3	23.070	21.149
4	27.831	22.677
5	32.525	24.402
6	37.142	26.321
7	41.675	28.430
8	46.116	30.727
9	50.458	33.207
10	54.692	35.866
11	58.812	38.699
12	62.810	41.701
13	66.680	44.867
14	70.414	48.192
15	74.007	51.670
16	77.451	55.294
17	80.742	59.059
18	83.872	62.958
19	86.076	65.949

Circle Center At X = -11.180 ; Y = 136.076 ; and Radius = 119.921

Factor of Safety

*** 1.626 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.824	11.186
2	6.741	12.097
3	11.603	13.261
4	16.399	14.676
5	21.115	16.336
6	25.739	18.239
7	30.258	20.378
8	34.661	22.747
9	38.935	25.342
10	43.070	28.154
11	47.053	31.176
12	50.874	34.401
13	54.524	37.818
14	57.992	41.420
15	61.269	45.197
16	64.346	49.138
17	67.215	53.233
18	67.698	54.004

Circle Center At X = -13.280 ; Y = 106.504 ; and Radius = 96.507

Factor of Safety

*** 1.634 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	4.257	12.767
2	8.987	14.386
3	13.680	16.113
4	18.332	17.945
5	22.941	19.882
6	27.506	21.924
7	32.023	24.068
8	36.490	26.314
9	40.905	28.661
10	45.265	31.107
11	49.570	33.652
12	53.815	36.293
13	57.999	39.030
14	62.120	41.861
15	66.176	44.785
16	70.165	47.800
17	74.084	50.905
18	77.932	54.097
19	81.707	57.376
20	85.406	60.740
21	89.028	64.187
22	92.571	67.715
23	96.033	71.323
24	98.528	74.043

Circle Center At X = -64.740 ; Y = 222.071 ; and Radius = 220.383

Factor of Safety

*** 1.655 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.946	17.115
2	15.764	18.452
3	20.533	19.953
4	25.249	21.616
5	29.904	23.440
6	34.494	25.422
7	39.014	27.560
8	43.458	29.851
9	47.821	32.293
10	52.098	34.883
11	56.284	37.618
12	60.374	40.494
13	64.363	43.509
14	68.246	46.659
15	72.019	49.939
16	75.678	53.347
17	79.218	56.878
18	82.635	60.528
19	85.925	64.293
20	88.628	67.608

Circle Center At X = -25.655 ; Y = 158.427 ; and Radius = 145.975

Factor of Safety

*** 1.657 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.000	10.000
2	4.777	11.477
3	9.509	13.092
4	14.191	14.846
5	18.821	16.735
6	23.393	18.758
7	27.904	20.914
8	32.351	23.200
9	36.729	25.616
10	41.034	28.158
11	45.264	30.825
12	49.413	33.614
13	53.480	36.523
14	57.460	39.550

15	61.350	42.691
16	65.146	45.945
17	68.846	49.308
18	72.446	52.778
19	75.944	56.351
20	79.335	60.025
21	82.428	63.578

Circle Center At X = -48.194 ; Y = 174.353 ; and Radius = 171.274

Factor of Safety

*** 1.679 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.581	28.578
2	33.470	29.628
3	38.300	30.918
4	43.061	32.445
5	47.741	34.206
6	52.329	36.195
7	56.812	38.407
8	61.181	40.839
9	65.425	43.483
10	69.533	46.333
11	73.496	49.382
12	77.303	52.624
13	80.945	56.049
14	84.414	59.649
15	87.702	63.417
16	90.799	67.342
17	93.022	70.464

Circle Center At X = 9.751 ; Y = 128.113 ; and Radius = 101.301

Factor of Safety

*** 1.691 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.689	14.348
2	11.653	14.951
3	16.560	15.909
4	21.386	17.217
5	26.105	18.868
6	30.694	20.854
7	35.128	23.164
8	39.385	25.787
9	43.443	28.709
10	47.280	31.914
11	50.877	35.387
12	54.216	39.109
13	57.278	43.062
14	60.049	47.224
15	61.670	50.085

Circle Center At X = 0.785 ; Y = 83.671 ; and Radius = 69.574

Factor of Safety

*** 1.698 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.081	13.953
2	11.049	14.515
3	15.962	15.446
4	20.791	16.742
5	25.510	18.393
6	30.093	20.393
7	34.514	22.728
8	38.749	25.387
9	42.773	28.355
10	46.564	31.614
11	50.102	35.147
12	53.367	38.935
13	56.340	42.955

14	59.004	47.186
15	59.948	48.966

Circle Center At X = 1.039 ; Y = 80.739 ; and Radius = 66.977

Factor of Safety

*** 1.706 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.932	26.206
2	29.888	26.874
3	34.784	27.885
4	39.598	29.237
5	44.306	30.920
6	48.885	32.929
7	53.313	35.252
8	57.567	37.879
9	61.628	40.796
10	65.475	43.989
11	69.090	47.443
12	72.455	51.142
13	75.554	55.066
14	78.371	59.197
15	80.014	62.009

Circle Center At X = 17.860 ; Y = 97.438 ; and Radius = 71.582

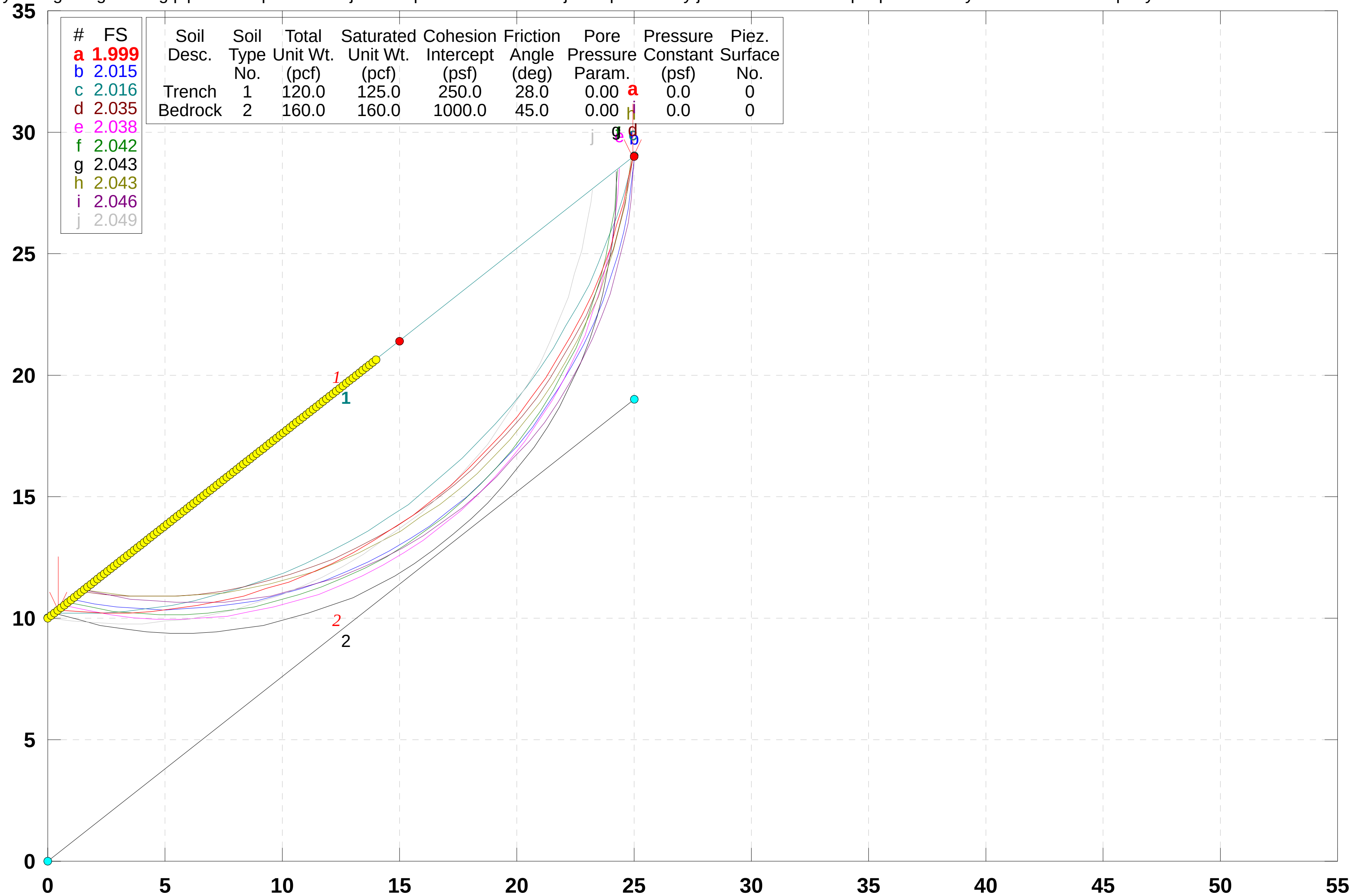
Factor of Safety

*** 1.709 ***

**** END OF GSTABL7 OUTPUT ****

JNF1: Trench Backfill Stability - 25' Breaker Spacing, 76% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf1 25f breakers 76pct.pl2 Run By: Insert Name/company Here 12/15/2016 04:27PM



GSTABL7 v.2 FSmin=1.999

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

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          ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
    ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
              (All Rights Reserved-Unauthorized Use Prohibited)
    *********************************************************************************
                        SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    *********************************************************************************
    Analysis Run Date:        12/15/2016
    Time of Run:              04:27PM
    Run By:                   Insert Name/company Here
    Input Data Filename:      y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf1 25f breakers 76pct.in
    Output Filename:          y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf1 25f breakers 76pct.OUT
    Unit System:              English
    Plotted Output Filename:  y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf1 25f breakers 76pct.PLT
    PROBLEM DESCRIPTION:  JNF1: Trench Backfill Stability -
                          25' Breaker Spacing, 76% Slope
    BOUNDARY COORDINATES
        1 Top   Boundaries
        2 Total Boundaries
```

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	10.00	25.00	29.00	1
2	0.00	0.00	25.00	19.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	250.0	28.0	0.00	0.0	0
2	160.0	160.0	1000.0	45.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
1000 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 0.00(ft)
and X = 14.00(ft)
Each Surface Terminates Between X = 15.00(ft)
and X = 25.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
1.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 55.443 FS Min = 1.999 FS Ave = 4.973
Standard Deviation = 4.905 Coefficient of Variation = 98.62 %
Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.424	10.322
2	1.421	10.244
3	2.421	10.209
4	3.421	10.219
5	4.419	10.273
6	5.414	10.372
7	6.404	10.514
8	7.387	10.700
9	8.360	10.929
10	9.322	11.201
11	10.271	11.516
12	11.206	11.872
13	12.124	12.269
14	13.023	12.707
15	13.902	13.184
16	14.759	13.699
17	15.592	14.252
18	16.400	14.841
19	17.181	15.466
20	17.934	16.124
21	18.656	16.815
22	19.348	17.538
23	20.007	18.290
24	20.632	19.071
25	21.221	19.878
26	21.775	20.711
27	22.290	21.568
28	22.768	22.447
29	23.206	23.345
30	23.604	24.263
31	23.961	25.197
32	24.276	26.146
33	24.548	27.108

34	24.778	28.082
35	24.945	28.958

Circle Center At X = 2.698 ; Y = 32.783 ; and Radius = 22.575

Factor of Safety

*** 1.999 ***

Individual data on the 34 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.0	50.0	0.0	0.0	0.	0.	0.0	0.0	0.0
2	1.0	147.9	0.0	0.0	0.	0.	0.0	0.0	0.0
3	1.0	240.6	0.0	0.0	0.	0.	0.0	0.0	0.0
4	1.0	327.5	0.0	0.0	0.	0.	0.0	0.0	0.0
5	1.0	407.7	0.0	0.0	0.	0.	0.0	0.0	0.0
6	1.0	480.8	0.0	0.0	0.	0.	0.0	0.0	0.0
7	1.0	546.3	0.0	0.0	0.	0.	0.0	0.0	0.0
8	1.0	603.8	0.0	0.0	0.	0.	0.0	0.0	0.0
9	1.0	652.9	0.0	0.0	0.	0.	0.0	0.0	0.0
10	0.9	693.4	0.0	0.0	0.	0.	0.0	0.0	0.0
11	0.9	725.2	0.0	0.0	0.	0.	0.0	0.0	0.0
12	0.9	748.2	0.0	0.0	0.	0.	0.0	0.0	0.0
13	0.9	762.6	0.0	0.0	0.	0.	0.0	0.0	0.0
14	0.9	768.5	0.0	0.0	0.	0.	0.0	0.0	0.0
15	0.9	766.1	0.0	0.0	0.	0.	0.0	0.0	0.0
16	0.8	755.7	0.0	0.0	0.	0.	0.0	0.0	0.0
17	0.8	737.9	0.0	0.0	0.	0.	0.0	0.0	0.0
18	0.8	713.0	0.0	0.0	0.	0.	0.0	0.0	0.0
19	0.8	681.8	0.0	0.0	0.	0.	0.0	0.0	0.0
20	0.7	644.8	0.0	0.0	0.	0.	0.0	0.0	0.0
21	0.7	602.9	0.0	0.0	0.	0.	0.0	0.0	0.0
22	0.7	556.7	0.0	0.0	0.	0.	0.0	0.0	0.0
23	0.6	507.1	0.0	0.0	0.	0.	0.0	0.0	0.0
24	0.6	455.0	0.0	0.0	0.	0.	0.0	0.0	0.0
25	0.6	401.3	0.0	0.0	0.	0.	0.0	0.0	0.0
26	0.5	347.0	0.0	0.0	0.	0.	0.0	0.0	0.0
27	0.5	293.0	0.0	0.0	0.	0.	0.0	0.0	0.0
28	0.4	240.4	0.0	0.0	0.	0.	0.0	0.0	0.0
29	0.4	190.2	0.0	0.0	0.	0.	0.0	0.0	0.0
30	0.4	143.2	0.0	0.0	0.	0.	0.0	0.0	0.0
31	0.3	100.5	0.0	0.0	0.	0.	0.0	0.0	0.0
32	0.3	63.0	0.0	0.0	0.	0.	0.0	0.0	0.0
33	0.2	31.7	0.0	0.0	0.	0.	0.0	0.0	0.0
34	0.2	7.5	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.990	10.752
2	1.974	10.577
3	2.966	10.451
4	3.963	10.374
5	4.963	10.347
6	5.963	10.370
7	6.960	10.443
8	7.953	10.566
9	8.938	10.738
10	9.913	10.958
11	10.876	11.227
12	11.825	11.544
13	12.756	11.908
14	13.668	12.318
15	14.559	12.773
16	15.426	13.271
17	16.267	13.812
18	17.080	14.395
19	17.862	15.017
20	18.613	15.678
21	19.330	16.375
22	20.011	17.107
23	20.655	17.872

24	21.260	18.668
25	21.825	19.493
26	22.347	20.346
27	22.827	21.224
28	23.262	22.124
29	23.652	23.045
30	23.995	23.984
31	24.291	24.939
32	24.539	25.908
33	24.738	26.888
34	24.889	27.877
35	24.990	28.872
36	24.996	28.997

Circle Center At X = 5.001 ; Y = 30.390 ; and Radius = 20.043

Factor of Safety

*** 2.015 ***

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.283	10.215
2	1.283	10.197
3	2.282	10.221
4	3.280	10.285
5	4.275	10.391
6	5.264	10.536
7	6.247	10.723
8	7.221	10.949
9	8.185	11.215
10	9.137	11.520
11	10.076	11.864
12	11.000	12.247
13	11.908	12.666
14	12.797	13.123
15	13.668	13.615
16	14.517	14.143
17	15.344	14.705
18	16.147	15.301
19	16.926	15.929
20	17.677	16.588
21	18.402	17.278
22	19.097	17.996
23	19.762	18.743
24	20.397	19.516
25	20.999	20.314
26	21.568	21.137
27	22.102	21.982
28	22.602	22.848
29	23.066	23.734
30	23.493	24.638
31	23.883	25.559
32	24.234	26.495
33	24.547	27.445
34	24.821	28.407
35	24.956	28.967

Circle Center At X = 1.209 ; Y = 34.611 ; and Radius = 24.414

Factor of Safety

*** 2.016 ***

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.414	11.075
2	2.408	10.963
3	3.406	10.900
4	4.406	10.884
5	5.405	10.915
6	6.402	10.995
7	7.394	11.122
8	8.379	11.296
9	9.354	11.518
10	10.317	11.785

11	11.267	12.099
12	12.201	12.457
13	13.116	12.860
14	14.011	13.306
15	14.884	13.794
16	15.732	14.324
17	16.554	14.893
18	17.348	15.501
19	18.112	16.146
20	18.844	16.827
21	19.543	17.543
22	20.207	18.291
23	20.834	19.069
24	21.423	19.877
25	21.973	20.712
26	22.483	21.573
27	22.951	22.457
28	23.376	23.362
29	23.757	24.286
30	24.093	25.228
31	24.385	26.185
32	24.630	27.154
33	24.828	28.134
34	24.956	28.966

Circle Center At X = 4.242 ; Y = 31.788 ; and Radius = 20.905
Factor of Safety
*** 2.035 ***
Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.707	10.537
2	1.683	10.319
3	2.669	10.153
4	3.662	10.038
5	4.661	9.976
6	5.660	9.967
7	6.660	10.010
8	7.655	10.105
9	8.644	10.253
10	9.624	10.452
11	10.592	10.703
12	11.546	11.004
13	12.482	11.355
14	13.399	11.755
15	14.293	12.202
16	15.163	12.696
17	16.005	13.235
18	16.818	13.817
19	17.600	14.441
20	18.347	15.105
21	19.058	15.808
22	19.732	16.547
23	20.366	17.321
24	20.958	18.126
25	21.507	18.962
26	22.011	19.826
27	22.470	20.715
28	22.881	21.626
29	23.243	22.558
30	23.556	23.508
31	23.819	24.473
32	24.030	25.450
33	24.190	26.437
34	24.298	27.432
35	24.353	28.430
36	24.354	28.509

Circle Center At X = 5.342 ; Y = 28.981 ; and Radius = 19.017
Factor of Safety
*** 2.038 ***
Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.848	10.645
2	1.828	10.444
3	2.817	10.294
4	3.812	10.196
5	4.811	10.151
6	5.811	10.158
7	6.809	10.216
8	7.803	10.327
9	8.790	10.490
10	9.767	10.704
11	10.731	10.969
12	11.680	11.284
13	12.611	11.648
14	13.522	12.060
15	14.411	12.519
16	15.274	13.024
17	16.109	13.574
18	16.915	14.166
19	17.689	14.800
20	18.428	15.473
21	19.132	16.184
22	19.797	16.930
23	20.422	17.711
24	21.006	18.523
25	21.546	19.364
26	22.042	20.233
27	22.491	21.126
28	22.894	22.042
29	23.248	22.977
30	23.552	23.929
31	23.807	24.896
32	24.010	25.875
33	24.162	26.864
34	24.263	27.859
35	24.292	28.462

Circle Center At X = 5.184 ; Y = 29.279 ; and Radius = 19.132

Factor of Safety

*** 2.042 ***

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.283	10.215
2	1.246	9.946
3	2.222	9.729
4	3.209	9.566
5	4.203	9.456
6	5.201	9.400
7	6.201	9.397
8	7.200	9.449
9	8.194	9.555
10	9.181	9.715
11	10.159	9.927
12	11.123	10.192
13	12.071	10.509
14	13.001	10.876
15	13.910	11.293
16	14.795	11.759
17	15.654	12.272
18	16.483	12.830
19	17.281	13.433
20	18.046	14.078
21	18.774	14.763
22	19.464	15.486
23	20.115	16.246
24	20.723	17.040
25	21.288	17.865
26	21.807	18.720
27	22.279	19.601

28	22.703	20.507
29	23.077	21.434
30	23.400	22.381
31	23.672	23.343
32	23.892	24.318
33	24.059	25.304
34	24.172	26.298
35	24.231	27.296
36	24.237	28.420

Circle Center At X = 5.739 ; Y = 27.897 ; and Radius = 18.505

Factor of Safety

*** 2.043 ***

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.556	11.182
2	2.545	11.035
3	3.540	10.938
4	4.539	10.890
5	5.539	10.893
6	6.537	10.946
7	7.532	11.048
8	8.520	11.200
9	9.500	11.402
10	10.468	11.652
11	11.423	11.950
12	12.361	12.296
13	13.281	12.688
14	14.180	13.126
15	15.056	13.608
16	15.907	14.134
17	16.730	14.701
18	17.524	15.309
19	18.287	15.956
20	19.016	16.640
21	19.710	17.360
22	20.367	18.114
23	20.986	18.899
24	21.565	19.715
25	22.102	20.559
26	22.596	21.428
27	23.046	22.321
28	23.451	23.235
29	23.809	24.169
30	24.121	25.119
31	24.384	26.084
32	24.599	27.060
33	24.765	28.047
34	24.864	28.897

Circle Center At X = 4.988 ; Y = 30.858 ; and Radius = 19.973

Factor of Safety

*** 2.043 ***

Failure Surface Specified By 35 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.556	11.182
2	2.532	10.967
3	3.519	10.803
4	4.512	10.692
5	5.511	10.634
6	6.511	10.629
7	7.510	10.676
8	8.505	10.776
9	9.493	10.929
10	10.472	11.134
11	11.438	11.391
12	12.390	11.698
13	13.324	12.055
14	14.238	12.461
15	15.129	12.915

16	15.995	13.415
17	16.833	13.960
18	17.641	14.549
19	18.417	15.180
20	19.158	15.851
21	19.863	16.561
22	20.530	17.306
23	21.155	18.086
24	21.739	18.898
25	22.279	19.740
26	22.774	20.609
27	23.222	21.503
28	23.622	22.419
29	23.973	23.355
30	24.274	24.309
31	24.525	25.277
32	24.723	26.257
33	24.870	27.247
34	24.964	28.242
35	24.995	28.996

Circle Center At X = 6.113 ; Y = 29.519 ; and Radius = 18.894

Factor of Safety

*** 2.046 ***

Failure Surface Specified By 34 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.000	10.000
2	0.992	9.874
3	1.989	9.796
4	2.989	9.768
5	3.988	9.790
6	4.986	9.860
7	5.979	9.980
8	6.964	10.148
9	7.941	10.365
10	8.905	10.629
11	9.855	10.941
12	10.789	11.299
13	11.704	11.702
14	12.598	12.151
15	13.469	12.642
16	14.314	13.176
17	15.132	13.751
18	15.921	14.366
19	16.679	15.019
20	17.403	15.708
21	18.093	16.432
22	18.746	17.189
23	19.361	17.978
24	19.936	18.796
25	20.471	19.641
26	20.963	20.511
27	21.412	21.405
28	21.816	22.320
29	22.175	23.253
30	22.487	24.203
31	22.752	25.167
32	22.969	26.144
33	23.138	27.129
34	23.199	27.631

Circle Center At X = 3.060 ; Y = 30.051 ; and Radius = 20.283

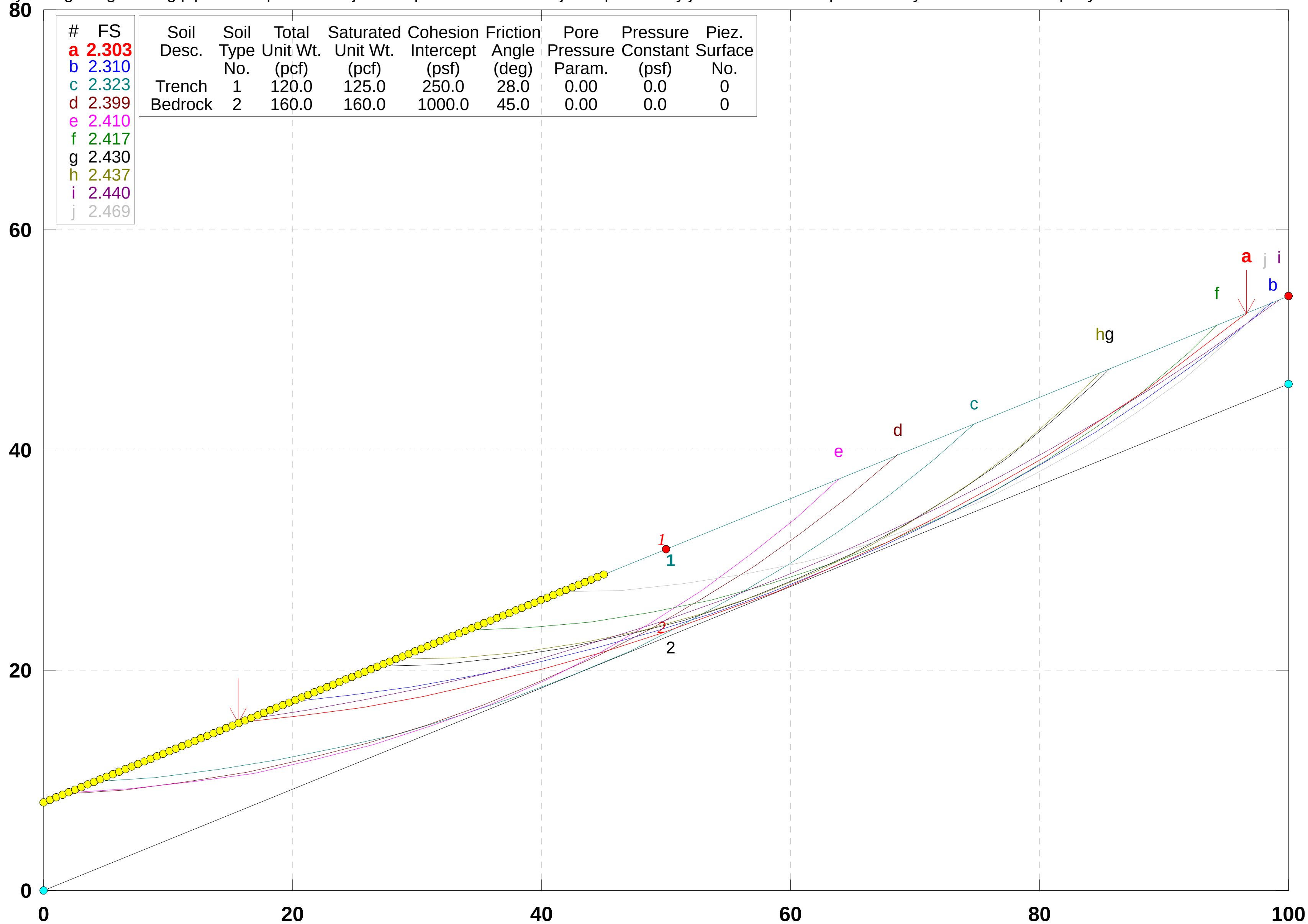
Factor of Safety

*** 2.049 ***

**** END OF GSTABL7 OUTPUT ****

JNF2: Trench Backfill Stability - 46% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf2 trench backfill.pl2 Run By: Insert Name/company Here 12/16/2016 11:46AM



GSTABL7 v.2 FSmin=2.303

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

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SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
****

Analysis Run Date: 12/16/2016
Time of Run: 11:46AM
Run By: Insert Name/company Here
Input Data Filename: y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf2 trench backfill.in
Output Filename: y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf2 trench backfill.OUT
Unit System: English
Plotted Output Filename: y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf2 trench backfill.PLT
PROBLEM DESCRIPTION: JNF2: Trench Backfill Stability -
46% Slope

BOUNDARY COORDINATES
1 Top Boundaries
2 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	8.00	100.00	54.00	1
2	0.00	0.00	100.00	46.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
User Specified Y-Plus Value = 25.00(ft)

ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	250.0	28.0	0.00	0.0	0
2	160.0	160.0	1000.0	45.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.
900 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 90 Points Equally Spaced
Along The Ground Surface Between X = 0.00(ft)
and X = 45.00(ft)
Each Surface Terminates Between X = 50.00(ft)
and X = 100.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
5.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 900
Number of Trial Surfaces With Valid FS = 900
Statistical Data On All Valid FS Values:
FS Max = 13.970 FS Min = 2.303 FS Ave = 4.620
Standard Deviation = 1.191 Coefficient of Variation = 25.78 %
Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	15.674	15.210
2	20.632	15.857
3	25.564	16.678
4	30.464	17.672
5	35.327	18.838
6	40.145	20.174

7	44.913	21.680
8	49.625	23.351
9	54.275	25.188
10	58.858	27.187
11	63.368	29.347
12	67.799	31.663
13	72.146	34.134
14	76.403	36.757
15	80.565	39.528
16	84.627	42.443
17	88.583	45.500
18	92.430	48.694
19	96.162	52.022
20	96.591	52.432

Circle Center At X =   -0.200 ; Y =   156.283 ; and Radius =   141.963

Factor of Safety

*** 2.303 ***

Individual data on the 19 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	5.0	486.0	0.0	0.0	0.	0.	0.0	0.0	0.0
2	4.9	1395.4	0.0	0.0	0.	0.	0.0	0.0	0.0
3	4.9	2182.4	0.0	0.0	0.	0.	0.0	0.0	0.0
4	4.9	2845.4	0.0	0.0	0.	0.	0.0	0.0	0.0
5	4.8	3383.5	0.0	0.0	0.	0.	0.0	0.0	0.0
6	4.8	3797.1	0.0	0.0	0.	0.	0.0	0.0	0.0
7	4.7	4087.3	0.0	0.0	0.	0.	0.0	0.0	0.0
8	4.7	4256.4	0.0	0.0	0.	0.	0.0	0.0	0.0
9	4.6	4307.7	0.0	0.0	0.	0.	0.0	0.0	0.0
10	4.5	4245.5	0.0	0.0	0.	0.	0.0	0.0	0.0
11	4.4	4074.7	0.0	0.0	0.	0.	0.0	0.0	0.0
12	4.3	3801.6	0.0	0.0	0.	0.	0.0	0.0	0.0
13	4.3	3433.0	0.0	0.0	0.	0.	0.0	0.0	0.0
14	4.2	2976.7	0.0	0.0	0.	0.	0.0	0.0	0.0
15	4.1	2441.3	0.0	0.0	0.	0.	0.0	0.0	0.0
16	4.0	1835.9	0.0	0.0	0.	0.	0.0	0.0	0.0
17	3.8	1170.7	0.0	0.0	0.	0.	0.0	0.0	0.0
18	3.7	456.1	0.0	0.0	0.	0.	0.0	0.0	0.0
19	0.4	5.5	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	19.719	17.071
2	24.680	17.691
3	29.616	18.494
4	34.518	19.476
5	39.381	20.638
6	44.199	21.976
7	48.964	23.491
8	53.670	25.179
9	58.312	27.039
10	62.882	29.068
11	67.374	31.262
12	71.783	33.620
13	76.103	36.138
14	80.328	38.813
15	84.451	41.640
16	88.468	44.617
17	92.374	47.739
18	96.162	51.002
19	98.799	53.448

Circle Center At X =   5.272 ; Y =   152.692 ; and Radius =   136.388

Factor of Safety

*** 2.310 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.045	9.861

2	9.027	10.287
3	13.983	10.943
4	18.905	11.828
5	23.779	12.940
6	28.597	14.277
7	33.349	15.834
8	38.023	17.610
9	42.609	19.601
10	47.099	21.801
11	51.482	24.207
12	55.749	26.813
13	59.891	29.614
14	63.899	32.604
15	67.764	35.776
16	71.478	39.123
17	74.800	42.408

Circle Center At X = -2.671 ; Y = 117.665 ; and Radius = 108.013

Factor of Safety

*** 2.323 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.517	8.698
2	6.495	9.160
3	11.446	9.861
4	16.357	10.799
5	21.218	11.971
6	26.017	13.375
7	30.743	15.008
8	35.385	16.865
9	39.933	18.943
10	44.375	21.237
11	48.703	23.742
12	52.905	26.451
13	56.973	29.359
14	60.896	32.458
15	64.666	35.742
16	68.275	39.204
17	68.614	39.563

Circle Center At X = -5.628 ; Y = 112.632 ; and Radius = 104.179

Factor of Safety

*** 2.399 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.022	8.930
2	7.013	9.232
3	11.979	9.818
4	16.903	10.687
5	21.769	11.835
6	26.562	13.259
7	31.266	14.954
8	35.865	16.915
9	40.345	19.136
10	44.691	21.608
11	48.889	24.325
12	52.925	27.276
13	56.785	30.454
14	60.458	33.846
15	63.872	37.381

Circle Center At X = -0.762 ; Y = 96.445 ; and Radius = 87.559

Factor of Safety

*** 2.410 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.876	23.583
2	38.869	23.847
3	43.838	24.409
4	48.764	25.266

5	53.630	26.415
6	58.419	27.852
7	63.114	29.572
8	67.698	31.569
9	72.154	33.835
10	76.468	36.364
11	80.623	39.145
12	84.605	42.169
13	88.400	45.425
14	91.993	48.901
15	94.240	51.350

Circle Center At X =   31.945 ; Y =   107.379 ; and Radius =   83.818
Factor of Safety
*** 2.417 ***
Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.798	20.327
2	31.792	20.556
3	36.763	21.096
4	41.691	21.946
5	46.555	23.101
6	51.339	24.557
7	56.022	26.308
8	60.587	28.348
9	65.015	30.669
10	69.291	33.262
11	73.396	36.116
12	77.315	39.221
13	81.033	42.564
14	84.536	46.132
15	85.621	47.386

Circle Center At X =   25.624 ; Y =   100.450 ; and Radius =   80.131
Factor of Safety
*** 2.430 ***
Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	28.315	21.025
2	33.313	21.157
3	38.290	21.631
4	43.224	22.442
5	48.091	23.588
6	52.868	25.063
7	57.534	26.861
8	62.066	28.972
9	66.444	31.388
10	70.647	34.097
11	74.655	37.085
12	78.451	40.341
13	82.015	43.847
14	84.830	47.022

Circle Center At X =   28.892 ; Y =   94.197 ; and Radius =   73.175
Factor of Safety
*** 2.437 ***
Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	16.180	15.443
2	21.102	16.319
3	25.997	17.339
4	30.861	18.500
5	35.688	19.803
6	40.475	21.245
7	45.219	22.825
8	49.915	24.543
9	54.558	26.397
10	59.146	28.385
11	63.674	30.506
12	68.139	32.757

13	72.536	35.137
14	76.862	37.644
15	81.113	40.276
16	85.286	43.030
17	89.377	45.905
18	93.383	48.897
19	97.300	52.005
20	99.273	53.666

Circle Center At X = -11.431 ; Y = 184.897 ; and Radius = 171.689

Factor of Safety

*** 2.440 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	41.461	27.072
2	46.456	27.289
3	51.426	27.831
4	56.351	28.698
5	61.208	29.884
6	65.977	31.385
7	70.638	33.195
8	75.171	35.305
9	79.556	37.707
10	83.775	40.391
11	87.809	43.345
12	91.642	46.556
13	95.257	50.010
14	98.129	53.139

Circle Center At X = 40.671 ; Y = 103.419 ; and Radius = 76.351

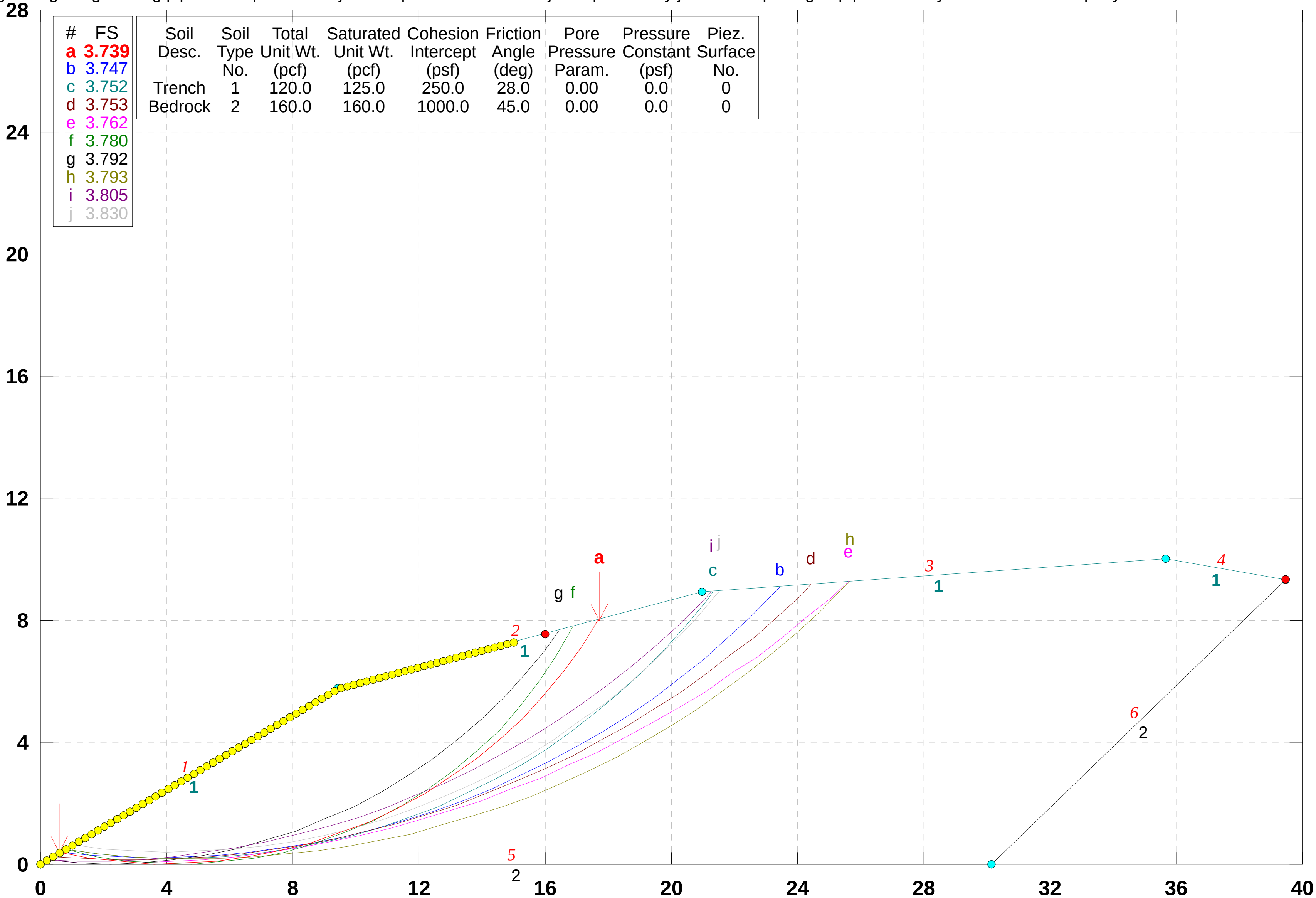
Factor of Safety

*** 2.469 ***

**** END OF GSTABL7 OUTPUT ****

JNF2: Sideslope Stability - 1.5H:1V

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf2 sideslope ridgetop.pl2 Run By: Insert Name/company Here 12/16/2016 11:42AM



GSTABL7 v.2 FSmin=3.739

Safety Factors Are Calculated By The Modified Bishop Method

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                              ***  GSTABL7  ***
          ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
    ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
            (All Rights Reserved-Unauthorized Use Prohibited)
*********************************************************************************
                  SLOPE STABILITY ANALYSIS SYSTEM
      Modified Bishop, Simplified Janbu, or GLE Method of Slices.
      (Includes Spencer & Morgenstern-Price Type Analysis)
      Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
      Nonlinear Undrained Shear Strength, Curved Phi Envelope,
      Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
      Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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    Analysis Run Date:         12/16/2016
    Time of Run:               11:42AM
    Run By:                    Insert Name/company Here
    Input Data Filename:       y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf2 sideslope ridgetop.in
    Output Filename:           y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf2 sideslope ridgetop.OUT
    Unit System:               English
    Plotted Output Filename:   y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf2 sideslope ridgetop.PLT
    PROBLEM DESCRIPTION:   JNF2: Sideslope Stability -
                           1.5H:1V
    BOUNDARY COORDINATES
        4 Top   Boundaries
        6 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00       0.00       9.44       5.75        1
        2          9.44       5.75      20.99       8.91        1
        3         20.99       8.91      35.67      10.01        1
        4         35.67      10.01      39.47       9.34        1
        5          0.00       0.00      30.15       0.00        2
        6         30.15       0.00      39.47       9.34        2
    Default Y-Origin = 0.00(ft)
    Default X-Plus Value = 0.00(ft)
    Default Y-Plus Value = 0.00(ft)
   ISOTROPIC SOIL PARAMETERS
     2 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0     250.0     28.0    0.00       0.0      0
      2   160.0    160.0    1000.0     45.0    0.00       0.0      0
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
     750 Trial Surfaces Have Been Generated.
      10 Surface(s) Initiate(s) From Each Of    75 Points Equally Spaced
    Along The Ground Surface Between  X =   0.00(ft)
                                 and  X =  15.00(ft)
    Each Surface Terminates Between   X =  16.00(ft)
                                and   X =  39.47(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =      0.00(ft)
     1.00(ft) Line Segments Define Each Trial Failure Surface.
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Evaluated. They Are
          Ordered - Most Critical First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Total Number of Trial Surfaces Attempted =   750
          Number of Trial Surfaces With Valid FS =  750
          Statistical Data On All Valid FS Values:
             FS Max = 100.310   FS Min =   3.739   FS Ave =  10.939
             Standard Deviation =   10.009   Coefficient of Variation =   91.50 %
          Failure Surface Specified By 22 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1          0.608       0.370
```

2	1.592	0.191
3	2.585	0.075
4	3.584	0.021
5	4.584	0.030
6	5.581	0.102
7	6.572	0.238
8	7.552	0.435
9	8.518	0.694
10	9.466	1.013
11	10.391	1.391
12	11.291	1.827
13	12.162	2.319
14	13.000	2.865
15	13.802	3.462
16	14.564	4.109
17	15.284	4.803
18	15.959	5.541
19	16.587	6.320
20	17.163	7.137
21	17.687	7.989
22	17.698	8.009

Circle Center At X = 3.937 ; Y = 15.860 ; and Radius = 15.844

Factor of Safety

*** 3.739 ***

Individual data on the 22 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.0	45.9	0.0	0.0	0.	0.	0.0	0.0	0.0
2	1.0	135.8	0.0	0.0	0.	0.	0.0	0.0	0.0
3	1.0	219.4	0.0	0.0	0.	0.	0.0	0.0	0.0
4	1.0	295.4	0.0	0.0	0.	0.	0.0	0.0	0.0
5	1.0	362.6	0.0	0.0	0.	0.	0.0	0.0	0.0
6	1.0	419.9	0.0	0.0	0.	0.	0.0	0.0	0.0
7	1.0	466.5	0.0	0.0	0.	0.	0.0	0.0	0.0
8	1.0	501.9	0.0	0.0	0.	0.	0.0	0.0	0.0
9	0.9	511.1	0.0	0.0	0.	0.	0.0	0.0	0.0
10	0.0	14.7	0.0	0.0	0.	0.	0.0	0.0	0.0
11	0.9	520.0	0.0	0.0	0.	0.	0.0	0.0	0.0
12	0.9	488.6	0.0	0.0	0.	0.	0.0	0.0	0.0
13	0.9	449.5	0.0	0.0	0.	0.	0.0	0.0	0.0
14	0.8	403.9	0.0	0.0	0.	0.	0.0	0.0	0.0
15	0.8	353.1	0.0	0.0	0.	0.	0.0	0.0	0.0
16	0.8	298.5	0.0	0.0	0.	0.	0.0	0.0	0.0
17	0.7	241.5	0.0	0.0	0.	0.	0.0	0.0	0.0
18	0.7	183.8	0.0	0.0	0.	0.	0.0	0.0	0.0
19	0.6	127.1	0.0	0.0	0.	0.	0.0	0.0	0.0
20	0.6	73.1	0.0	0.0	0.	0.	0.0	0.0	0.0
21	0.5	23.4	0.0	0.0	0.	0.	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 27 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.608	0.370
2	1.604	0.279
3	2.603	0.226
4	3.602	0.209
5	4.602	0.231
6	5.600	0.289
7	6.596	0.385
8	7.587	0.518
9	8.572	0.689
10	9.551	0.896
11	10.521	1.139
12	11.481	1.419
13	12.430	1.734
14	13.366	2.085
15	14.289	2.470
16	15.196	2.890

17	16.088	3.344
18	16.961	3.830
19	17.816	4.349
20	18.651	4.900
21	19.464	5.482
22	20.255	6.093
23	21.023	6.734
24	21.766	7.403
25	22.484	8.100
26	23.175	8.822
27	23.414	9.092

Circle Center At X = 3.537 ; Y = 26.904 ; and Radius = 26.694

Factor of Safety

*** 3.747 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.811	0.494
2	1.800	0.350
3	2.796	0.254
4	3.795	0.205
5	4.795	0.204
6	5.793	0.251
7	6.789	0.345
8	7.779	0.487
9	8.761	0.676
10	9.733	0.912
11	10.692	1.194
12	11.637	1.522
13	12.565	1.894
14	13.474	2.310
15	14.362	2.770
16	15.228	3.271
17	16.068	3.813
18	16.882	4.394
19	17.667	5.014
20	18.421	5.671
21	19.143	6.362
22	19.831	7.088
23	20.484	7.846
24	21.099	8.634
25	21.312	8.934

Circle Center At X = 4.315 ; Y = 21.115 ; and Radius = 20.917

Factor of Safety

*** 3.752 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.405	0.247
2	1.403	0.181
3	2.403	0.148
4	3.403	0.147
5	4.402	0.180
6	5.400	0.247
7	6.395	0.346
8	7.386	0.478
9	8.373	0.642
10	9.353	0.839
11	10.326	1.069
12	11.291	1.331
13	12.247	1.624
14	13.193	1.949
15	14.128	2.305
16	15.050	2.692
17	15.959	3.109
18	16.853	3.555
19	17.733	4.032
20	18.596	4.537
21	19.442	5.070
22	20.269	5.631

23	21.078	6.219
24	21.867	6.834
25	22.635	7.474
26	23.382	8.140
27	24.106	8.829
28	24.439	9.168

Circle Center At X = 2.908 ; Y = 30.337 ; and Radius = 30.194

Factor of Safety

*** 3.753 ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.203	0.123
2	1.201	0.073
3	2.201	0.053
4	3.201	0.062
5	4.200	0.100
6	5.198	0.168
7	6.193	0.265
8	7.185	0.392
9	8.173	0.548
10	9.156	0.733
11	10.133	0.947
12	11.103	1.190
13	12.065	1.461
14	13.019	1.761
15	13.964	2.089
16	14.899	2.444
17	15.823	2.827
18	16.735	3.237
19	17.634	3.674
20	18.521	4.137
21	19.393	4.626
22	20.250	5.141
23	21.092	5.680
24	21.918	6.245
25	22.726	6.833
26	23.517	7.445
27	24.289	8.081
28	25.042	8.738
29	25.600	9.255

Circle Center At X = 2.399 ; Y = 33.909 ; and Radius = 33.857

Factor of Safety

*** 3.762 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.811	0.494
2	1.785	0.268
3	2.773	0.113
4	3.769	0.030
5	4.769	0.018
6	5.767	0.079
7	6.759	0.212
8	7.738	0.416
9	8.699	0.690
10	9.639	1.033
11	10.551	1.443
12	11.431	1.918
13	12.275	2.454
14	13.078	3.051
15	13.835	3.703
16	14.544	4.409
17	15.200	5.164
18	15.799	5.964
19	16.339	6.806
20	16.817	7.684
21	16.861	7.780

Circle Center At X = 4.424 ; Y = 13.861 ; and Radius = 13.847

Factor of Safety

***   3.780   ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.203	0.123
2	1.200	0.044
3	2.199	0.023
4	3.199	0.059
5	4.194	0.153
6	5.183	0.304
7	6.161	0.511
8	7.126	0.775
9	8.073	1.094
10	9.001	1.467
11	9.906	1.893
12	10.785	2.370
13	11.634	2.898
14	12.452	3.473
15	13.236	4.095
16	13.982	4.760
17	14.688	5.468
18	15.353	6.215
19	15.974	6.999
20	16.441	7.665

Circle Center At X =   2.075 ; Y =   17.344 ; and Radius =   17.322

Factor of Safety

***   3.792   ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.811	0.494
2	1.802	0.363
3	2.798	0.268
4	3.796	0.209
5	4.796	0.185
6	5.796	0.196
7	6.794	0.243
8	7.791	0.326
9	8.784	0.444
10	9.772	0.597
11	10.754	0.786
12	11.729	1.009
13	12.695	1.267
14	13.652	1.559
15	14.597	1.885
16	15.530	2.244
17	16.450	2.636
18	17.356	3.061
19	18.245	3.517
20	19.118	4.005
21	19.973	4.524
22	20.809	5.073
23	21.625	5.651
24	22.419	6.258
25	23.192	6.893
26	23.942	7.555
27	24.667	8.243
28	25.368	8.957
29	25.644	9.259

Circle Center At X =   4.971 ; Y =   28.281 ; and Radius =   28.097

Factor of Safety

***   3.793   ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.203	0.123
2	1.202	0.101
3	2.202	0.116
4	3.201	0.168
5	4.197	0.256

6	5.189	0.381
7	6.176	0.543
8	7.156	0.742
9	8.128	0.976
10	9.091	1.247
11	10.043	1.552
12	10.983	1.893
13	11.910	2.269
14	12.822	2.678
15	13.719	3.121
16	14.599	3.597
17	15.460	4.104
18	16.302	4.644
19	17.124	5.214
20	17.923	5.814
21	18.700	6.444
22	19.454	7.102
23	20.182	7.787
24	20.885	8.498
25	21.282	8.932

Circle Center At X = 1.306 ; Y = 27.125 ; and Radius = 27.024

Factor of Safety

*** 3.805 ***

Failure Surface Specified By 25 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.014	0.617
2	2.007	0.502
3	3.004	0.432
4	4.004	0.406
5	5.004	0.427
6	6.002	0.492
7	6.996	0.603
8	7.983	0.758
9	8.963	0.959
10	9.933	1.203
11	10.890	1.491
12	11.834	1.822
13	12.762	2.196
14	13.671	2.611
15	14.561	3.067
16	15.430	3.563
17	16.275	4.097
18	17.095	4.670
19	17.888	5.279
20	18.653	5.923
21	19.388	6.601
22	20.091	7.312
23	20.761	8.054
24	21.397	8.826
25	21.489	8.947

Circle Center At X = 4.057 ; Y = 22.473 ; and Radius = 22.066

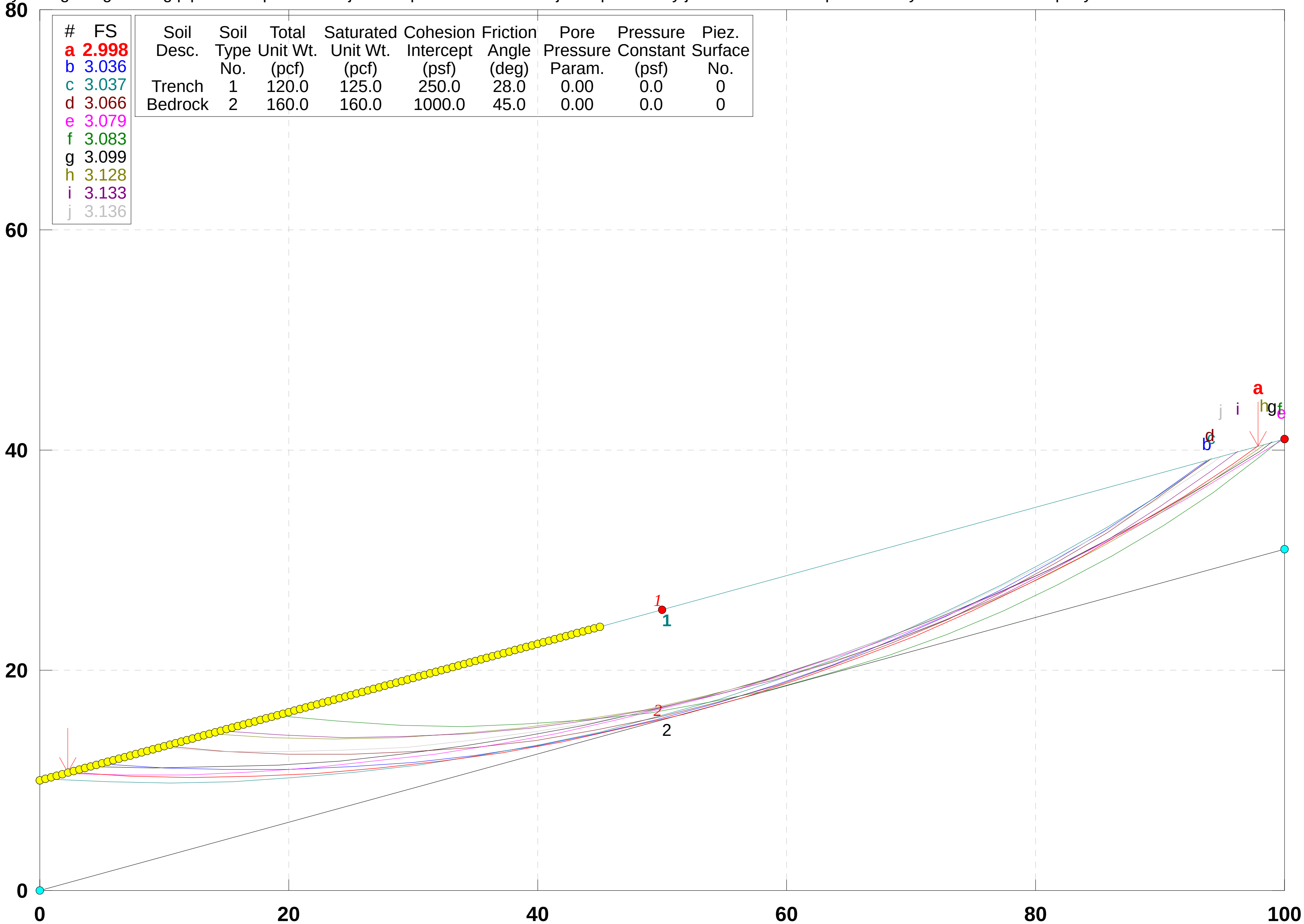
Factor of Safety

*** 3.830 ***

**** END OF GSTABL7 OUTPUT ****

JNF3: Trench Backfill Stability - 41% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf3 trench backfill.pl2 Run By: Insert Name/company Here 12/16/2016 11:48AM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Trench	1	120.0	125.0	250.0	28.0	0.00	0.0	0
Bedrock	2	160.0	160.0	1000.0	45.0	0.00	0.0	0

GSTABL7 v.2 FSmin=2.998

Safety Factors Are Calculated By The Modified Bishop Method

```
                             ***  GSTABL7  ***
            ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
      ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
             (All Rights Reserved-Unauthorized Use Prohibited)
  *********************************************************************************
                      SLOPE STABILITY ANALYSIS SYSTEM
        Modified Bishop, Simplified Janbu, or GLE Method of Slices.
        (Includes Spencer & Morgenstern-Price Type Analysis)
        Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
        Nonlinear Undrained Shear Strength, Curved Phi Envelope,
        Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
        Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
  *********************************************************************************
  Analysis Run Date:         12/16/2016
  Time of Run:               11:48AM
  Run By:                    Insert Name/company Here
  Input Data Filename:       y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf3 trench backfill.in
  Output Filename:           y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf3 trench backfill.OUT
  Unit System:               English
  Plotted Output Filename:   y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf3 trench backfill.PLT
  PROBLEM DESCRIPTION:  JNF3: Trench Backfill Stability -
                        41% Slope
  BOUNDARY COORDINATES
      1 Top   Boundaries
      2 Total Boundaries
  Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
     No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
      1          0.00      10.00     100.00      41.00        1
      2          0.00       0.00     100.00      31.00        2
  Default Y-Origin = 0.00(ft)
  Default X-Plus Value = 0.00(ft)
  User Specified Y-Plus Value =   25.00(ft)
 ISOTROPIC SOIL PARAMETERS
   2 Type(s) of Soil
  Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
  Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
   No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
    1   120.0    125.0     250.0     28.0    0.00       0.0      0
    2   160.0    160.0    1000.0     45.0    0.00       0.0      0
  A Critical Failure Surface Searching Method, Using A Random
  Technique For Generating Circular Surfaces, Has Been Specified.
  1000 Trial Surfaces Have Been Generated.
    10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
  Along The Ground Surface Between  X =   0.00(ft)
                                  and  X =  45.00(ft)
  Each Surface Terminates Between   X =  50.00(ft)
                                 and   X = 100.00(ft)
  Unless Further Limitations Were Imposed, The Minimum Elevation
  At Which A Surface Extends Is  Y =      0.00(ft)
   5.00(ft) Line Segments Define Each Trial Failure Surface.
  Following Are Displayed The Ten Most Critical Of The Trial
        Failure Surfaces Evaluated. They Are
        Ordered - Most Critical First.
        * * Safety Factors Are Calculated By The Modified Bishop Method * *
        Total Number of Trial Surfaces Attempted =  1000
        Number of Trial Surfaces With Valid FS = 1000
        Statistical Data On All Valid FS Values:
           FS Max =  25.578   FS Min =   2.998   FS Ave =   6.488
           Standard Deviation =    1.980   Coefficient of Variation =   30.52 %
        Failure Surface Specified By 22 Coordinate Points
          Point      X-Surf      Y-Surf
           No.        (ft)        (ft)
            1          2.273      10.705
            2          7.264      10.415
            3         12.263      10.309
            4         17.263      10.387
            5         22.256      10.648
            6         27.236      11.093
```

7	32.196	11.721
8	37.131	12.530
9	42.032	13.520
10	46.893	14.689
11	51.708	16.036
12	56.470	17.559
13	61.173	19.257
14	65.811	21.125
15	70.377	23.163
16	74.865	25.368
17	79.269	27.735
18	83.583	30.263
19	87.801	32.948
20	91.917	35.786
21	95.927	38.773
22	97.880	40.343

Circle Center At X = 12.663 ; Y = 146.213 ; and Radius = 135.906

Factor of Safety

*** 2.998 ***

Individual data on the 21 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	5.0	550.1	0.0	0.0	0.	0.	0.0	0.0	0.0
2	5.0	1598.5	0.0	0.0	0.	0.	0.0	0.0	0.0
3	5.0	2536.8	0.0	0.0	0.	0.	0.0	0.0	0.0
4	5.0	3360.0	0.0	0.0	0.	0.	0.0	0.0	0.0
5	5.0	4064.1	0.0	0.0	0.	0.	0.0	0.0	0.0
6	5.0	4646.1	0.0	0.0	0.	0.	0.0	0.0	0.0
7	4.9	5104.1	0.0	0.0	0.	0.	0.0	0.0	0.0
8	4.9	5437.4	0.0	0.0	0.	0.	0.0	0.0	0.0
9	4.9	5646.3	0.0	0.0	0.	0.	0.0	0.0	0.0
10	4.8	5732.1	0.0	0.0	0.	0.	0.0	0.0	0.0
11	4.8	5697.5	0.0	0.0	0.	0.	0.0	0.0	0.0
12	4.7	5546.0	0.0	0.0	0.	0.	0.0	0.0	0.0
13	4.6	5282.2	0.0	0.0	0.	0.	0.0	0.0	0.0
14	4.6	4911.8	0.0	0.0	0.	0.	0.0	0.0	0.0
15	4.5	4441.4	0.0	0.0	0.	0.	0.0	0.0	0.0
16	4.4	3878.6	0.0	0.0	0.	0.	0.0	0.0	0.0
17	4.3	3231.7	0.0	0.0	0.	0.	0.0	0.0	0.0
18	4.2	2510.1	0.0	0.0	0.	0.	0.0	0.0	0.0
19	4.1	1723.8	0.0	0.0	0.	0.	0.0	0.0	0.0
20	4.0	883.7	0.0	0.0	0.	0.	0.0	0.0	0.0
21	2.0	113.0	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.000	11.550
2	9.984	11.151
3	14.981	10.962
4	19.980	10.984
5	24.975	11.215
6	29.956	11.657
7	34.913	12.307
8	39.839	13.165
9	44.724	14.230
10	49.561	15.499
11	54.339	16.970
12	59.052	18.641
13	63.690	20.508
14	68.246	22.569
15	72.711	24.819
16	77.077	27.255
17	81.337	29.873
18	85.483	32.667
19	89.509	35.633
20	93.406	38.766
21	93.741	39.060

Circle Center At X = 16.972 ; Y = 129.855 ; and Radius = 118.909

Factor of Safety
*** 3.036 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.455	10.141
2	5.448	9.883
3	10.447	9.809
4	15.446	9.920
5	20.437	10.215
6	25.414	10.694
7	30.370	11.357
8	35.298	12.202
9	40.192	13.228
10	45.044	14.435
11	49.849	15.819
12	54.599	17.380
13	59.288	19.115
14	63.910	21.023
15	68.458	23.099
16	72.927	25.342
17	77.310	27.748
18	81.601	30.315
19	85.794	33.038
20	89.884	35.914
21	93.866	38.939
22	94.178	39.195

Circle Center At X = 9.952 ; Y = 145.199 ; and Radius = 135.391

Factor of Safety
*** 3.037 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.000	13.100
2	14.977	12.618
3	19.970	12.368
4	24.970	12.349
5	29.966	12.563
6	34.946	13.008
7	39.900	13.683
8	44.818	14.588
9	49.688	15.720
10	54.500	17.077
11	59.244	18.655
12	63.910	20.452
13	68.488	22.464
14	72.967	24.686
15	77.338	27.113
16	81.593	29.740
17	85.720	32.562
18	89.712	35.573
19	93.560	38.765
20	93.957	39.127

Circle Center At X = 22.875 ; Y = 119.997 ; and Radius = 107.669

Factor of Safety
*** 3.066 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.818	10.564
2	6.817	10.472
3	11.817	10.541
4	16.812	10.770
5	21.796	11.159
6	26.766	11.708
7	31.716	12.415
8	36.640	13.281
9	41.535	14.305
10	46.393	15.484
11	51.212	16.819

12	55.985	18.308
13	60.708	19.948
14	65.377	21.740
15	69.985	23.680
16	74.529	25.766
17	79.003	27.997
18	83.404	30.371
19	87.726	32.884
20	91.966	35.535
21	96.118	38.320
22	99.736	40.918

Circle Center At X = 7.178 ; Y = 166.383 ; and Radius = 155.911
Factor of Safety
*** 3.079 ***
Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	19.091	15.918
2	24.055	15.322
3	29.044	14.981
4	34.043	14.894
5	39.040	15.063
6	44.022	15.486
7	48.976	16.163
8	53.889	17.092
9	58.748	18.271
10	63.541	19.696
11	68.254	21.364
12	72.877	23.270
13	77.396	25.409
14	81.800	27.776
15	86.078	30.365
16	90.218	33.169
17	94.209	36.180
18	98.042	39.391
19	99.660	40.895

Circle Center At X = 33.239 ; Y = 112.841 ; and Radius = 97.950
Factor of Safety
*** 3.083 ***
Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.091	11.268
2	9.089	11.149
3	14.089	11.198
4	19.085	11.416
5	24.070	11.801
6	29.039	12.354
7	33.987	13.074
8	38.908	13.959
9	43.796	15.010
10	48.646	16.225
11	53.453	17.603
12	58.210	19.141
13	62.913	20.839
14	67.556	22.694
15	72.135	24.704
16	76.642	26.867
17	81.075	29.180
18	85.427	31.642
19	89.694	34.248
20	93.871	36.997
21	97.953	39.884
22	99.024	40.697

Circle Center At X = 10.148 ; Y = 159.562 ; and Radius = 148.417
Factor of Safety
*** 3.099 ***
Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	13.636	14.227
2	18.626	13.909
3	23.625	13.802
4	28.624	13.907
5	33.614	14.223
6	38.586	14.750
7	43.531	15.488
8	48.441	16.434
9	53.306	17.587
10	58.118	18.945
11	62.868	20.506
12	67.548	22.266
13	72.149	24.223
14	76.664	26.373
15	81.083	28.712
16	85.399	31.237
17	89.604	33.941
18	93.691	36.822
19	97.652	39.872
20	98.407	40.506

Circle Center At X = 23.663 ; Y = 131.749 ; and Radius = 117.949

Factor of Safety

*** 3.128 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	14.545	14.509
2	19.529	14.108
3	24.526	13.937
4	29.526	13.994
5	34.518	14.281
6	39.491	14.797
7	44.436	15.540
8	49.341	16.510
9	54.196	17.703
10	58.992	19.118
11	63.718	20.751
12	68.363	22.599
13	72.920	24.659
14	77.377	26.925
15	81.725	29.394
16	85.955	32.059
17	90.059	34.915
18	94.027	37.957
19	96.266	39.843

Circle Center At X = 25.769 ; Y = 122.899 ; and Radius = 108.970

Factor of Safety

*** 3.133 ***

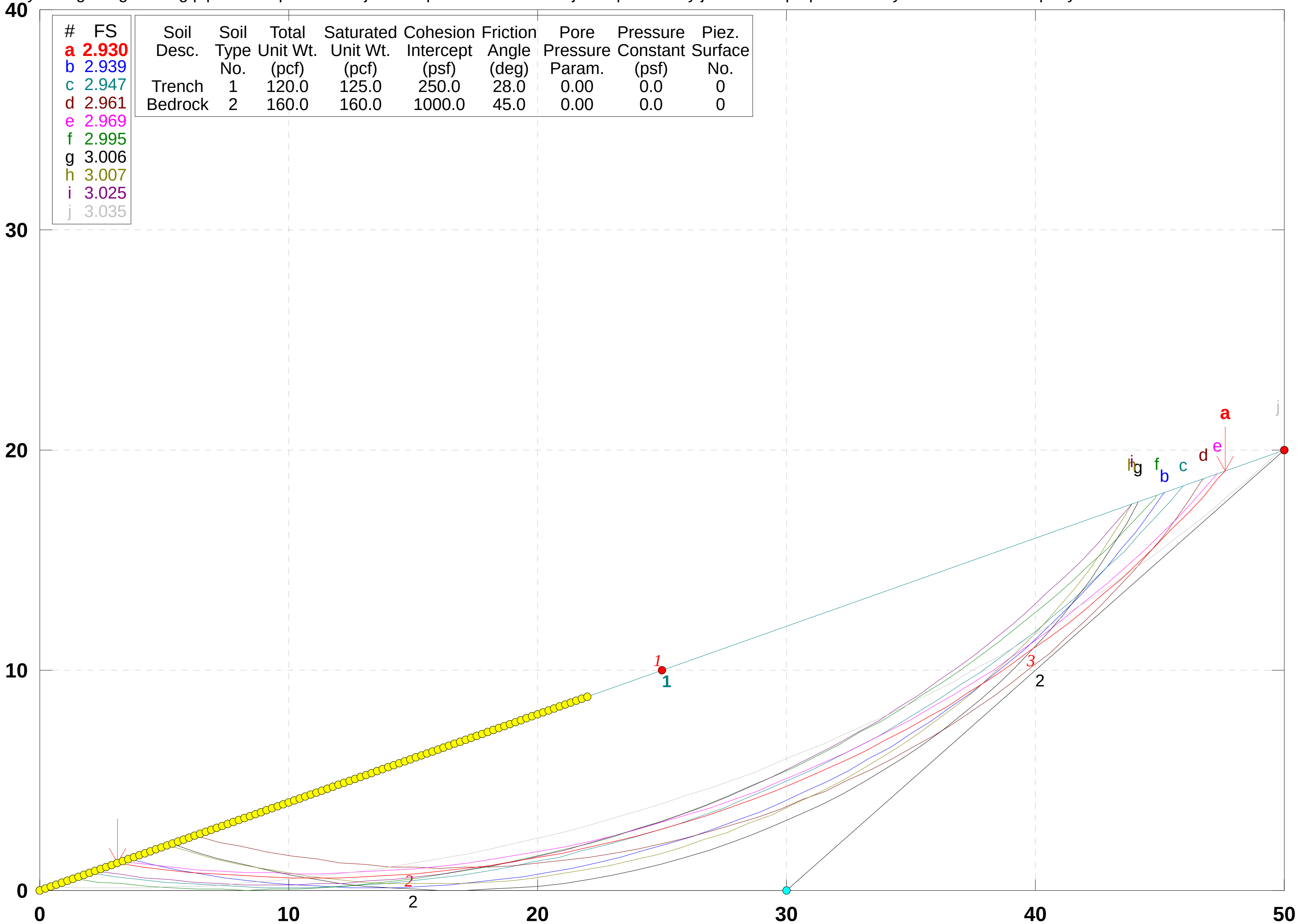
Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	9.545	12.959
2	14.537	12.672
3	19.537	12.591
4	24.535	12.717
5	29.524	13.050
6	34.495	13.590
7	39.439	14.334
8	44.348	15.283
9	49.214	16.433
10	54.028	17.784
11	58.782	19.334
12	63.468	21.078
13	68.077	23.015
14	72.603	25.141
15	77.036	27.453
16	81.370	29.946
17	85.598	32.616
18	89.711	35.459
19	93.703	38.469

```
   20         94.835       39.399
Circle Center At X =    19.001 ; Y =   133.242 ; and Radius =   120.654
       Factor of Safety
      ***    3.136   ***
          **** END OF GSTABL7 OUTPUT ****
```

JNF3: Sideslope Stability - 2.5:1

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf3 sideslope.pl2   Run By: Insert Name/company Here   12/16/2016   11:47AM



GSTABL7 v.2 FSmin=2.930

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/16/2016
Time of Run: 11:47AM
Run By: Insert Name/company Here
Input Data Filename: y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf3 sideslope.in
Output Filename: y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf3 sideslope.OUT
Unit System: English
Plotted Output Filename: y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf3 sideslope.PLT
PROBLEM DESCRIPTION: JNF3: Sideslope Stability -
2.5:1

BOUNDARY COORDINATES
1 Top Boundaries
3 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	50.00	20.00	1
2	0.00	0.00	30.00	0.00	2
3	30.00	0.00	50.00	20.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
User Specified Y-Plus Value = 25.00(ft)

ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	250.0	28.0	0.00	0.0	0
2	160.0	160.0	1000.0	45.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
1000 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 0.00(ft)
and X = 22.00(ft)
Each Surface Terminates Between X = 25.00(ft)
and X = 50.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
1.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 33.889 FS Min = 2.930 FS Ave = 5.617
Standard Deviation = 3.235 Coefficient of Variation = 57.59 %
Failure Surface Specified By 52 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.111	1.244
2	4.098	1.084
3	5.088	0.945
4	6.082	0.828
5	7.077	0.732

6	8.074	0.659
7	9.073	0.607
8	10.073	0.577
9	11.072	0.570
10	12.072	0.584
11	13.072	0.620
12	14.070	0.677
13	15.067	0.757
14	16.062	0.859
15	17.054	0.982
16	18.044	1.127
17	19.030	1.293
18	20.012	1.482
19	20.989	1.691
20	21.962	1.922
21	22.930	2.175
22	23.892	2.448
23	24.848	2.742
24	25.797	3.058
25	26.738	3.394
26	27.673	3.750
27	28.599	4.127
28	29.517	4.525
29	30.425	4.942
30	31.325	5.379
31	32.215	5.835
32	33.094	6.311
33	33.963	6.806
34	34.821	7.320
35	35.667	7.853
36	36.501	8.404
37	37.324	8.974
38	38.133	9.561
39	38.929	10.166
40	39.712	10.788
41	40.482	11.427
42	41.237	12.082
43	41.977	12.755
44	42.702	13.443
45	43.413	14.147
46	44.107	14.866
47	44.786	15.600
48	45.449	16.349
49	46.095	17.113
50	46.724	17.890
51	47.335	18.681
52	47.601	19.040

Circle Center At X = 10.933 ; Y = 46.200 ; and Radius = 45.631

Factor of Safety

*** 2.930 ***

Individual data on the 51 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.0	32.9	0.0	0.0	0.	0.	0.0	0.0	0.0
2	1.0	97.8	0.0	0.0	0.	0.	0.0	0.0	0.0
3	1.0	160.6	0.0	0.0	0.	0.	0.0	0.0	0.0
4	1.0	221.2	0.0	0.0	0.	0.	0.0	0.0	0.0
5	1.0	279.4	0.0	0.0	0.	0.	0.0	0.0	0.0
6	1.0	335.1	0.0	0.0	0.	0.	0.0	0.0	0.0
7	1.0	388.2	0.0	0.0	0.	0.	0.0	0.0	0.0
8	1.0	438.6	0.0	0.0	0.	0.	0.0	0.0	0.0
9	1.0	486.2	0.0	0.0	0.	0.	0.0	0.0	0.0
10	1.0	530.9	0.0	0.0	0.	0.	0.0	0.0	0.0
11	1.0	572.6	0.0	0.0	0.	0.	0.0	0.0	0.0
12	1.0	611.3	0.0	0.0	0.	0.	0.0	0.0	0.0
13	1.0	646.8	0.0	0.0	0.	0.	0.0	0.0	0.0
14	1.0	679.1	0.0	0.0	0.	0.	0.0	0.0	0.0
15	1.0	708.3	0.0	0.0	0.	0.	0.0	0.0	0.0

16	1.0	734.1	0.0	0.0	0.	0.	0.0	0.0	0.0
17	1.0	756.7	0.0	0.0	0.	0.	0.0	0.0	0.0
18	1.0	776.0	0.0	0.0	0.	0.	0.0	0.0	0.0
19	1.0	792.0	0.0	0.0	0.	0.	0.0	0.0	0.0
20	1.0	804.7	0.0	0.0	0.	0.	0.0	0.0	0.0
21	1.0	814.1	0.0	0.0	0.	0.	0.0	0.0	0.0
22	1.0	820.3	0.0	0.0	0.	0.	0.0	0.0	0.0
23	0.9	823.2	0.0	0.0	0.	0.	0.0	0.0	0.0
24	0.9	822.9	0.0	0.0	0.	0.	0.0	0.0	0.0
25	0.9	819.6	0.0	0.0	0.	0.	0.0	0.0	0.0
26	0.9	813.1	0.0	0.0	0.	0.	0.0	0.0	0.0
27	0.9	803.6	0.0	0.0	0.	0.	0.0	0.0	0.0
28	0.9	791.3	0.0	0.0	0.	0.	0.0	0.0	0.0
29	0.9	776.0	0.0	0.0	0.	0.	0.0	0.0	0.0
30	0.9	758.1	0.0	0.0	0.	0.	0.0	0.0	0.0
31	0.9	737.5	0.0	0.0	0.	0.	0.0	0.0	0.0
32	0.9	714.4	0.0	0.0	0.	0.	0.0	0.0	0.0
33	0.9	688.9	0.0	0.0	0.	0.	0.0	0.0	0.0
34	0.8	661.2	0.0	0.0	0.	0.	0.0	0.0	0.0
35	0.8	631.3	0.0	0.0	0.	0.	0.0	0.0	0.0
36	0.8	599.4	0.0	0.0	0.	0.	0.0	0.0	0.0
37	0.8	565.7	0.0	0.0	0.	0.	0.0	0.0	0.0
38	0.8	530.3	0.0	0.0	0.	0.	0.0	0.0	0.0
39	0.8	493.4	0.0	0.0	0.	0.	0.0	0.0	0.0
40	0.8	455.2	0.0	0.0	0.	0.	0.0	0.0	0.0
41	0.8	415.8	0.0	0.0	0.	0.	0.0	0.0	0.0
42	0.7	375.3	0.0	0.0	0.	0.	0.0	0.0	0.0
43	0.7	334.1	0.0	0.0	0.	0.	0.0	0.0	0.0
44	0.7	292.2	0.0	0.0	0.	0.	0.0	0.0	0.0
45	0.7	249.9	0.0	0.0	0.	0.	0.0	0.0	0.0
46	0.7	207.3	0.0	0.0	0.	0.	0.0	0.0	0.0
47	0.7	164.7	0.0	0.0	0.	0.	0.0	0.0	0.0
48	0.6	122.3	0.0	0.0	0.	0.	0.0	0.0	0.0
49	0.6	80.2	0.0	0.0	0.	0.	0.0	0.0	0.0
50	0.6	38.6	0.0	0.0	0.	0.	0.0	0.0	0.0
51	0.3	4.0	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 50 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.556	1.422
2	4.524	1.175
3	5.500	0.953
4	6.480	0.758
5	7.466	0.589
6	8.456	0.447
7	9.449	0.331
8	10.445	0.242
9	11.443	0.180
10	12.443	0.144
11	13.443	0.135
12	14.442	0.153
13	15.441	0.198
14	16.439	0.270
15	17.434	0.368
16	18.426	0.493
17	19.415	0.644
18	20.399	0.822
19	21.378	1.026
20	22.351	1.256
21	23.317	1.512
22	24.277	1.794
23	25.228	2.102
24	26.171	2.435
25	27.105	2.793
26	28.029	3.176
27	28.942	3.584
28	29.844	4.016
29	30.734	4.472
30	31.611	4.951
31	32.475	5.454

32	33.326	5.980
33	34.162	6.529
34	34.983	7.099
35	35.789	7.692
36	36.578	8.306
37	37.351	8.941
38	38.106	9.596
39	38.844	10.271
40	39.563	10.966
41	40.263	11.680
42	40.944	12.413
43	41.605	13.163
44	42.246	13.931
45	42.866	14.715
46	43.464	15.516
47	44.041	16.333
48	44.596	17.165
49	45.128	18.012
50	45.159	18.064

Circle Center At X = 13.273 ; Y = 37.454 ; and Radius = 37.319

Factor of Safety

*** 2.939 ***

Failure Surface Specified By 51 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.000	0.800
2	2.987	0.640
3	3.977	0.502
4	4.971	0.385
5	5.966	0.291
6	6.964	0.219
7	7.962	0.169
8	8.962	0.141
9	9.962	0.136
10	10.962	0.152
11	11.961	0.191
12	12.959	0.251
13	13.956	0.334
14	14.950	0.439
15	15.942	0.566
16	16.931	0.715
17	17.916	0.886
18	18.898	1.079
19	19.874	1.293
20	20.846	1.529
21	21.812	1.787
22	22.773	2.065
23	23.727	2.365
24	24.674	2.687
25	25.613	3.029
26	26.545	3.391
27	27.469	3.775
28	28.384	4.178
29	29.290	4.602
30	30.186	5.046
31	31.072	5.510
32	31.947	5.993
33	32.812	6.495
34	33.665	7.017
35	34.507	7.557
36	35.336	8.116
37	36.153	8.693
38	36.956	9.288
39	37.747	9.901
40	38.523	10.531
41	39.286	11.178
42	40.034	11.842
43	40.766	12.522
44	41.484	13.218
45	42.186	13.930

46	42.872	14.658
47	43.542	15.400
48	44.196	16.157
49	44.832	16.929
50	45.451	17.714
51	45.953	18.381

Circle Center At X = 9.718 ; Y = 45.242 ; and Radius = 45.107
Factor of Safety
*** 2.947 ***
Failure Surface Specified By 49 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.222	2.489
2	7.185	2.217
3	8.154	1.973
4	9.130	1.756
5	10.113	1.567
6	11.100	1.406
7	12.091	1.274
8	13.085	1.169
9	14.082	1.093
10	15.081	1.046
11	16.081	1.026
12	17.081	1.036
13	18.080	1.073
14	19.078	1.139
15	20.074	1.234
16	21.066	1.356
17	22.055	1.507
18	23.038	1.686
19	24.017	1.893
20	24.989	2.128
21	25.954	2.390
22	26.911	2.680
23	27.860	2.996
24	28.799	3.340
25	29.728	3.710
26	30.646	4.106
27	31.552	4.528
28	32.446	4.976
29	33.327	5.450
30	34.195	5.948
31	35.047	6.470
32	35.885	7.017
33	36.706	7.587
34	37.511	8.180
35	38.299	8.796
36	39.069	9.434
37	39.820	10.094
38	40.553	10.775
39	41.265	11.476
40	41.958	12.198
41	42.630	12.939
42	43.280	13.698
43	43.908	14.476
44	44.514	15.271
45	45.098	16.084
46	45.658	16.912
47	46.194	17.756
48	46.705	18.616
49	46.753	18.701

Circle Center At X = 16.257 ; Y = 36.174 ; and Radius = 35.148
Factor of Safety
*** 2.961 ***
Failure Surface Specified By 51 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.333	1.333
2	4.323	1.189
3	5.315	1.066

4	6.310	0.965
5	7.307	0.885
6	8.305	0.826
7	9.305	0.790
8	10.304	0.774
9	11.304	0.780
10	12.304	0.808
11	13.303	0.858
12	14.300	0.928
13	15.296	1.021
14	16.290	1.135
15	17.280	1.270
16	18.268	1.426
17	19.252	1.604
18	20.232	1.803
19	21.208	2.023
20	22.178	2.264
21	23.143	2.526
22	24.102	2.809
23	25.055	3.112
24	26.001	3.436
25	26.940	3.780
26	27.872	4.144
27	28.795	4.528
28	29.710	4.933
29	30.615	5.356
30	31.512	5.799
31	32.399	6.262
32	33.275	6.743
33	34.141	7.243
34	34.996	7.762
35	35.840	8.299
36	36.671	8.854
37	37.491	9.427
38	38.298	10.017
39	39.092	10.625
40	39.873	11.250
41	40.640	11.891
42	41.393	12.549
43	42.132	13.223
44	42.856	13.913
45	43.566	14.618
46	44.259	15.338
47	44.937	16.073
48	45.599	16.822
49	46.245	17.586
50	46.874	18.363
51	47.308	18.923

Circle Center At X = 10.516 ; Y = 47.146 ; and Radius = 46.373

Factor of Safety

*** 2.969 ***

Failure Surface Specified By 51 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.333	0.533
2	2.324	0.397
3	3.317	0.282
4	4.313	0.188
5	5.310	0.115
6	6.309	0.064
7	7.309	0.035
8	8.308	0.027
9	9.308	0.040
10	10.308	0.075
11	11.306	0.131
12	12.303	0.209
13	13.298	0.308
14	14.291	0.429
15	15.281	0.570
16	16.267	0.733

17	17.250	0.918
18	18.229	1.123
19	19.203	1.349
20	20.172	1.596
21	21.136	1.864
22	22.093	2.153
23	23.044	2.462
24	23.988	2.791
25	24.925	3.141
26	25.854	3.510
27	26.775	3.900
28	27.688	4.309
29	28.591	4.738
30	29.485	5.186
31	30.370	5.653
32	31.244	6.139
33	32.107	6.643
34	32.959	7.167
35	33.800	7.708
36	34.629	8.267
37	35.446	8.844
38	36.250	9.438
39	37.041	10.050
40	37.819	10.678
41	38.584	11.323
42	39.334	11.984
43	40.070	12.661
44	40.791	13.354
45	41.497	14.062
46	42.188	14.785
47	42.863	15.523
48	43.522	16.275
49	44.165	17.041
50	44.791	17.821
51	44.897	17.959

Circle Center At X = 8.185 ; Y = 46.577 ; and Radius = 46.550

Factor of Safety

*** 2.995 ***

Failure Surface Specified By 48 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.333	2.133
2	6.269	1.781
3	7.216	1.460
4	8.173	1.170
5	9.139	0.912
6	10.113	0.685
7	11.094	0.491
8	12.081	0.329
9	13.073	0.200
10	14.068	0.103
11	15.066	0.039
12	16.066	0.007
13	17.066	0.009
14	18.065	0.044
15	19.063	0.111
16	20.058	0.211
17	21.049	0.344
18	22.035	0.509
19	23.015	0.706
20	23.989	0.936
21	24.954	1.197
22	25.910	1.490
23	26.856	1.814
24	27.791	2.169
25	28.713	2.555
26	29.623	2.971
27	30.518	3.416
28	31.398	3.891
29	32.263	4.394

30	33.110	4.926
31	33.939	5.484
32	34.749	6.070
33	35.540	6.682
34	36.310	7.320
35	37.059	7.983
36	37.786	8.670
37	38.489	9.381
38	39.169	10.114
39	39.825	10.869
40	40.455	11.645
41	41.060	12.442
42	41.638	13.258
43	42.189	14.093
44	42.712	14.945
45	43.207	15.814
46	43.673	16.699
47	44.109	17.598
48	44.134	17.654

Circle Center At X = 16.517 ; Y = 30.436 ; and Radius = 30.432

Factor of Safety

*** 3.006 ***

Failure Surface Specified By 47 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.111	2.044
2	6.061	1.732
3	7.020	1.449
4	7.988	1.196
5	8.963	0.974
6	9.944	0.782
7	10.931	0.622
8	11.923	0.492
9	12.918	0.394
10	13.916	0.326
11	14.915	0.291
12	15.915	0.286
13	16.915	0.313
14	17.913	0.371
15	18.909	0.461
16	19.902	0.581
17	20.890	0.733
18	21.873	0.916
19	22.850	1.129
20	23.820	1.373
21	24.782	1.647
22	25.734	1.952
23	26.677	2.286
24	27.608	2.649
25	28.528	3.042
26	29.435	3.463
27	30.328	3.912
28	31.207	4.389
29	32.071	4.894
30	32.918	5.425
31	33.748	5.983
32	34.560	6.566
33	35.354	7.175
34	36.128	7.808
35	36.881	8.465
36	37.614	9.145
37	38.325	9.848
38	39.014	10.574
39	39.680	11.320
40	40.322	12.087
41	40.939	12.873
42	41.532	13.679
43	42.099	14.502
44	42.639	15.344
45	43.154	16.201

46	43.641	17.075
47	43.890	17.556

Circle Center At X = 15.558 ; Y = 32.164 ; and Radius = 31.880

Factor of Safety

*** 3.007 ***

Failure Surface Specified By 49 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.222	0.889
2	3.209	0.729
3	4.200	0.592
4	5.194	0.479
5	6.189	0.389
6	7.187	0.322
7	8.186	0.278
8	9.186	0.258
9	10.186	0.262
10	11.186	0.288
11	12.184	0.338
12	13.182	0.412
13	14.177	0.508
14	15.170	0.628
15	16.160	0.771
16	17.146	0.937
17	18.128	1.126
18	19.105	1.339
19	20.077	1.573
20	21.043	1.831
21	22.003	2.111
22	22.956	2.414
23	23.902	2.738
24	24.840	3.085
25	25.770	3.453
26	26.691	3.844
27	27.602	4.255
28	28.503	4.688
29	29.395	5.142
30	30.275	5.616
31	31.144	6.111
32	32.001	6.626
33	32.846	7.161
34	33.678	7.716
35	34.497	8.290
36	35.302	8.882
37	36.093	9.494
38	36.870	10.124
39	37.632	10.772
40	38.378	11.437
41	39.109	12.120
42	39.823	12.820
43	40.521	13.536
44	41.202	14.268
45	41.866	15.016
46	42.511	15.780
47	43.139	16.558
48	43.749	17.351
49	43.903	17.561

Circle Center At X = 9.547 ; Y = 43.019 ; and Radius = 42.762

Factor of Safety

*** 3.025 ***

Failure Surface Specified By 56 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	0.444	0.178
2	1.444	0.145
3	2.444	0.127
4	3.444	0.125
5	4.444	0.139
6	5.443	0.167
7	6.442	0.211

8	7.441	0.271
9	8.438	0.346
10	9.434	0.436
11	10.428	0.541
12	11.421	0.662
13	12.411	0.798
14	13.400	0.949
15	14.386	1.116
16	15.369	1.298
17	16.350	1.494
18	17.327	1.706
19	18.301	1.933
20	19.271	2.175
21	20.238	2.432
22	21.200	2.703
23	22.158	2.990
24	23.112	3.291
25	24.061	3.607
26	25.005	3.937
27	25.943	4.282
28	26.876	4.641
29	27.804	5.015
30	28.726	5.402
31	29.641	5.804
32	30.551	6.220
33	31.454	6.650
34	32.350	7.094
35	33.239	7.552
36	34.121	8.023
37	34.996	8.508
38	35.863	9.006
39	36.722	9.517
40	37.573	10.042
41	38.417	10.580
42	39.251	11.130
43	40.078	11.694
44	40.895	12.270
45	41.703	12.858
46	42.503	13.459
47	43.293	14.072
48	44.073	14.697
49	44.844	15.335
50	45.605	15.984
51	46.355	16.644
52	47.096	17.316
53	47.826	18.000
54	48.545	18.694
55	49.254	19.400
56	49.735	19.894

Circle Center At X = 3.082 ; Y = 65.055 ; and Radius = 64.931

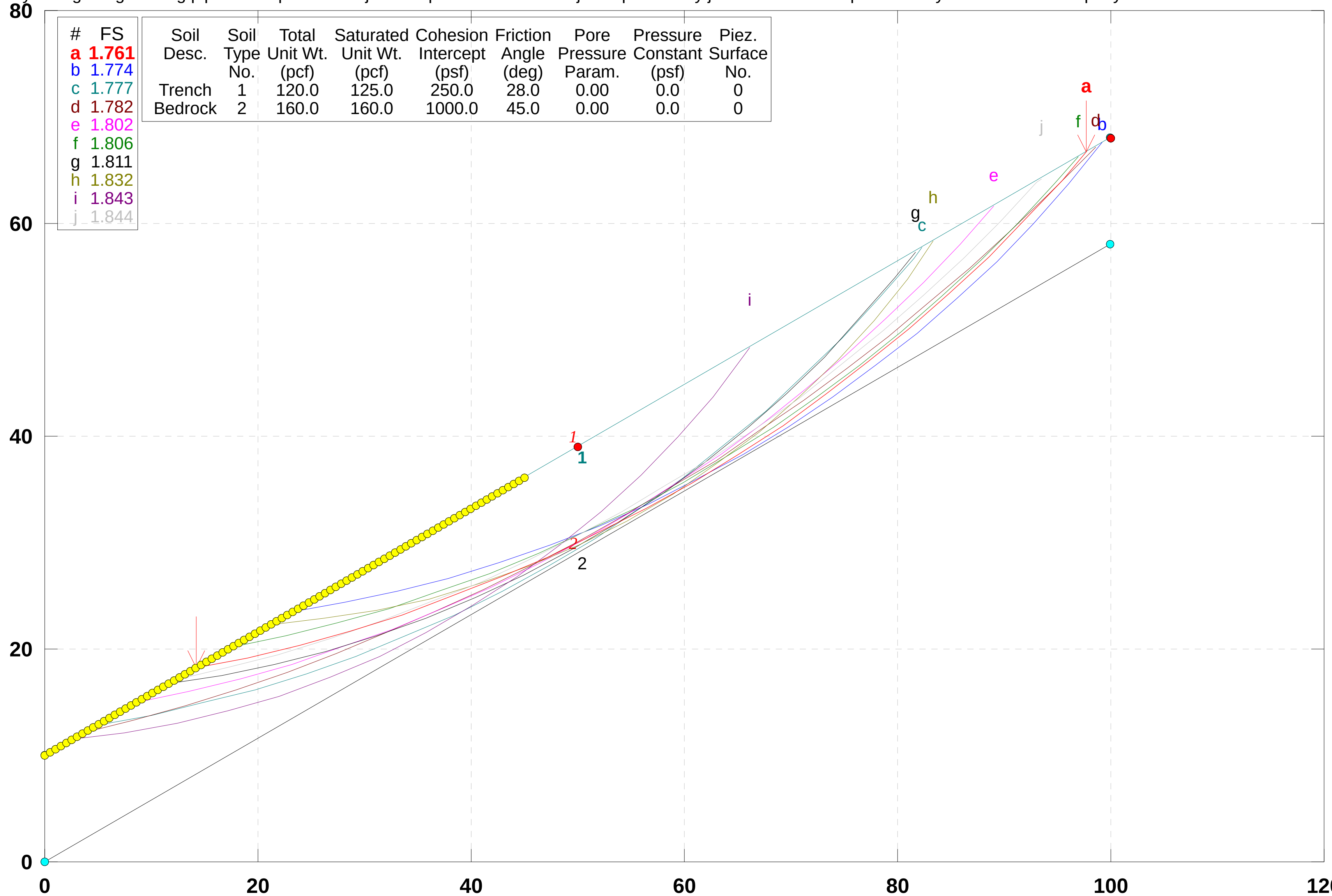
Factor of Safety

*** 3.035 ***

**** END OF GSTABL7 OUTPUT ****

JNF4: Trench Backfill Stability - 58% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf4 trench backfill.pl2 Run By: Insert Name/company Here 12/16/2016 11:52AM



GSTABL7 v.2 FSmin=1.761

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

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    Time of Run:              11:52AM
    Run By:                   Insert Name/company Here
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ic Stabilization\JNF Slope Stability\jnf4 trench backfill.in
    Output Filename:          y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf4 trench backfill.OUT
    Unit System:              English
    Plotted Output Filename:  y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf4 trench backfill.PLT
    PROBLEM DESCRIPTION:  JNF4: Trench Backfill Stability -
                          58% Slope
    BOUNDARY COORDINATES
        1 Top   Boundaries
        2 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00      10.00     100.00      68.00        1
        2          0.00       0.00     100.00      58.00        2
    Default Y-Origin = 0.00(ft)
    Default X-Plus Value = 0.00(ft)
    User Specified Y-Plus Value =   25.00(ft)
   ISOTROPIC SOIL PARAMETERS
     2 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0     250.0     28.0    0.00       0.0      0
      2   160.0    160.0    1000.0     45.0    0.00       0.0      0
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
     900 Trial Surfaces Have Been Generated.
      10 Surface(s) Initiate(s) From Each Of    90 Points Equally Spaced
    Along The Ground Surface Between  X =   0.00(ft)
                                 and  X =  45.00(ft)
    Each Surface Terminates Between   X =  50.00(ft)
                                and   X = 100.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =      0.00(ft)
     5.00(ft) Line Segments Define Each Trial Failure Surface.
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Evaluated. They Are
          Ordered - Most Critical First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Total Number of Trial Surfaces Attempted =   900
          Number of Trial Surfaces With Valid FS =  900
          Statistical Data On All Valid FS Values:
             FS Max =  14.901   FS Min =   1.761   FS Ave =   3.446
             Standard Deviation =    1.103   Coefficient of Variation =   32.01 %
          Failure Surface Specified By 21 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1        14.157      18.211
              2        19.054      19.220
              3        23.914      20.398
              4        28.730      21.742
              5        33.497      23.251
```

6	38.208	24.924
7	42.860	26.758
8	47.445	28.751
9	51.960	30.901
10	56.397	33.206
11	60.752	35.662
12	65.020	38.266
13	69.196	41.016
14	73.274	43.909
15	77.251	46.940
16	81.120	50.107
17	84.878	53.405
18	88.521	56.830
19	92.043	60.379
20	95.440	64.047
21	97.706	66.670

Circle Center At X = -12.669 ; Y = 160.772 ; and Radius = 145.063

Factor of Safety

*** 1.761 ***

Individual data on the 20 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.9	538.0	0.0	0.0	0.	0.	0.0	0.0	0.0
2	4.9	1546.3	0.0	0.0	0.	0.	0.0	0.0	0.0
3	4.8	2425.4	0.0	0.0	0.	0.	0.0	0.0	0.0
4	4.8	3174.1	0.0	0.0	0.	0.	0.0	0.0	0.0
5	4.7	3792.3	0.0	0.0	0.	0.	0.0	0.0	0.0
6	4.7	4280.6	0.0	0.0	0.	0.	0.0	0.0	0.0
7	4.6	4640.9	0.0	0.0	0.	0.	0.0	0.0	0.0
8	4.5	4875.8	0.0	0.0	0.	0.	0.0	0.0	0.0
9	4.4	4989.2	0.0	0.0	0.	0.	0.0	0.0	0.0
10	4.4	4985.6	0.0	0.0	0.	0.	0.0	0.0	0.0
11	4.3	4870.6	0.0	0.0	0.	0.	0.0	0.0	0.0
12	4.2	4650.7	0.0	0.0	0.	0.	0.0	0.0	0.0
13	4.1	4333.2	0.0	0.0	0.	0.	0.0	0.0	0.0
14	4.0	3926.0	0.0	0.0	0.	0.	0.0	0.0	0.0
15	3.9	3438.1	0.0	0.0	0.	0.	0.0	0.0	0.0
16	3.8	2879.0	0.0	0.0	0.	0.	0.0	0.0	0.0
17	3.6	2258.9	0.0	0.0	0.	0.	0.0	0.0	0.0
18	3.5	1588.6	0.0	0.0	0.	0.	0.0	0.0	0.0
19	3.4	879.4	0.0	0.0	0.	0.	0.0	0.0	0.0
20	2.3	177.8	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.258	23.490
2	28.187	24.334
3	33.075	25.385
4	37.915	26.639
5	42.699	28.094
6	47.417	29.749
7	52.062	31.600
8	56.625	33.644
9	61.099	35.877
10	65.475	38.295
11	69.746	40.895
12	73.904	43.671
13	77.943	46.619
14	81.854	49.733
15	85.632	53.009
16	89.269	56.440
17	92.759	60.020
18	96.097	63.743
19	99.238	67.558

Circle Center At X = 5.565 ; Y = 141.532 ; and Radius = 119.360

Factor of Safety

*** 1.774 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.056	12.933
2	9.976	13.824
3	14.856	14.912
4	19.689	16.195
5	24.466	17.670
6	29.181	19.336
7	33.825	21.189
8	38.391	23.227
9	42.871	25.446
10	47.259	27.843
11	51.548	30.413
12	55.730	33.154
13	59.798	36.060
14	63.747	39.127
15	67.570	42.349
16	71.261	45.723
17	74.814	49.241
18	78.222	52.899
19	81.482	56.691
20	82.315	57.743

Circle Center At X = -14.670 ; Y = 135.951 ; and Radius = 124.590
Factor of Safety
*** 1.777 ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.539	12.053
2	8.375	13.324
3	13.177	14.717
4	17.943	16.230
5	22.668	17.864
6	27.351	19.616
7	31.988	21.486
8	36.577	23.473
9	41.113	25.574
10	45.596	27.790
11	50.021	30.118
12	54.385	32.557
13	58.687	35.106
14	62.923	37.763
15	67.090	40.525
16	71.187	43.392
17	75.209	46.362
18	79.156	49.432
19	83.023	52.601
20	86.810	55.866
21	90.512	59.226
22	94.129	62.679
23	97.657	66.222
24	98.538	67.152

Circle Center At X = -44.304 ; Y = 203.987 ; and Radius = 197.807
Factor of Safety
*** 1.782 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	8.596	14.985
2	13.487	16.021
3	18.339	17.228
4	23.145	18.607
5	27.900	20.154
6	32.597	21.869
7	37.230	23.748
8	41.794	25.790
9	46.283	27.992
10	50.691	30.352
11	55.013	32.866
12	59.244	35.530

```
   13        63.378       38.343
   14        67.410       41.300
   15        71.334       44.398
   16        75.147       47.633
   17        78.843       51.000
   18        82.418       54.496
   19        85.867       58.116
   20        88.953       61.593
Circle Center At X =   -18.227 ; Y =   153.808 ; and Radius =   141.390
       Factor of Safety
      ***    1.802   ***
Failure Surface Specified By 20 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        17.697       20.264
    2        22.591       21.285
    3        27.446       22.481
    4        32.254       23.853
    5        37.010       25.398
    6        41.706       27.114
    7        46.337       28.998
    8        50.897       31.049
    9        55.380       33.263
   10        59.780       35.639
   11        64.091       38.171
   12        68.308       40.858
   13        72.424       43.696
   14        76.436       46.681
   15        80.336       49.809
   16        84.121       53.076
   17        87.785       56.478
   18        91.324       60.010
   19        94.733       63.668
   20        96.957       66.235
Circle Center At X =    -7.998 ; Y =   155.878 ; and Radius =   138.027
       Factor of Safety
      ***    1.806   ***
Failure Surface Specified By 18 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        11.629       16.745
    2        16.570       17.510
    3        21.469       18.509
    4        26.315       19.741
    5        31.097       21.201
    6        35.804       22.888
    7        40.426       24.796
    8        44.951       26.923
    9        49.370       29.262
   10        53.673       31.809
   11        57.849       34.558
   12        61.890       37.503
   13        65.786       40.637
   14        69.529       43.952
   15        73.109       47.442
   16        76.520       51.098
   17        79.752       54.913
   18        81.616       57.337
Circle Center At X =    -1.907 ; Y =   120.713 ; and Radius =   104.846
       Factor of Safety
      ***    1.811   ***
Failure Surface Specified By 16 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        21.236       22.317
    2        26.211       22.815
    3        31.146       23.618
    4        36.023       24.721
    5        40.823       26.121
    6        45.528       27.813
```

7	50.121	29.789
8	54.584	32.044
9	58.900	34.567
10	63.054	37.350
11	67.030	40.382
12	70.812	43.653
13	74.387	47.148
14	77.741	50.857
15	80.861	54.763
16	83.396	58.370

Circle Center At X = 15.614 ; Y = 103.623 ; and Radius = 81.501
Factor of Safety
*** 1.832 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.528	11.466
2	7.490	12.083
3	12.409	12.981
4	17.269	14.155
5	22.055	15.602
6	26.751	17.319
7	31.342	19.298
8	35.814	21.534
9	40.153	24.020
10	44.343	26.748
11	48.372	29.709
12	52.228	32.893
13	55.896	36.290
14	59.367	39.889
15	62.627	43.680
16	65.669	47.648
17	66.162	48.374

Circle Center At X = -5.880 ; Y = 99.322 ; and Radius = 88.257
Factor of Safety
*** 1.843 ***

Failure Surface Specified By 21 Coordinate Points

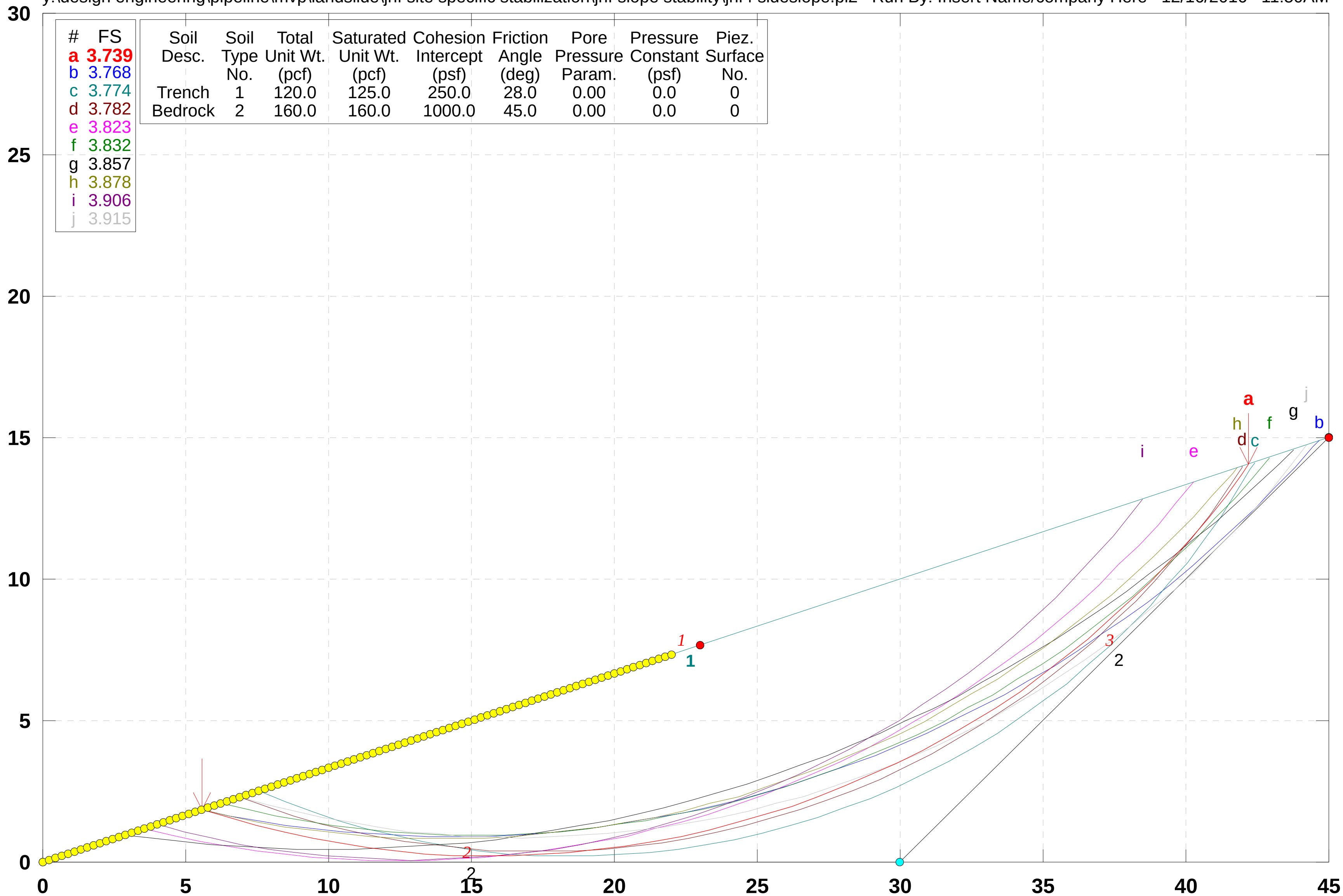
Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.135	17.038
2	17.002	18.184
3	21.829	19.487
4	26.611	20.947
5	31.343	22.561
6	36.021	24.329
7	40.638	26.247
8	45.190	28.315
9	49.673	30.529
10	54.082	32.888
11	58.411	35.389
12	62.657	38.030
13	66.815	40.807
14	70.880	43.718
15	74.849	46.759
16	78.717	49.928
17	82.479	53.221
18	86.133	56.634
19	89.673	60.165
20	93.097	63.809
21	93.435	64.192

Circle Center At X = -20.669 ; Y = 167.285 ; and Radius = 153.786
Factor of Safety
*** 1.844 ***

**** END OF GSTABL7 OUTPUT ****

JNF4: Sideslope Stability - 3:1

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf4 sideslope.pl2 Run By: Insert Name/company Here 12/16/2016 11:50AM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Trench	1	120.0	125.0	250.0	28.0	0.00	0.0	0
Bedrock	2	160.0	160.0	1000.0	45.0	0.00	0.0	0

GSTABL7 v.2 FSmin=3.739
Safety Factors Are Calculated By The Modified Bishop Method

```
                          ***  GSTABL7  ***
              ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
       ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
                (All Rights Reserved-Unauthorized Use Prohibited)
  *********************************************************************************
                     SLOPE STABILITY ANALYSIS SYSTEM
         Modified Bishop, Simplified Janbu, or GLE Method of Slices.
         (Includes Spencer & Morgenstern-Price Type Analysis)
         Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
         Nonlinear Undrained Shear Strength, Curved Phi Envelope,
         Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
         Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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    Output Filename:           y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf4 sideslope.OUT
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ic Stabilization\JNF Slope Stability\jnf4 sideslope.PLT
    PROBLEM DESCRIPTION:  JNF4: Sideslope Stability -
                          3:1
    BOUNDARY COORDINATES
        1 Top   Boundaries
        3 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00       0.00      45.00      15.00        1
        2          0.00       0.00      30.00       0.00        2
        3         30.00       0.00      45.00      15.00        2
    Default Y-Origin = 0.00(ft)
    Default X-Plus Value = 0.00(ft)
    User Specified Y-Plus Value =   25.00(ft)
   ISOTROPIC SOIL PARAMETERS
     2 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0     250.0     28.0    0.00       0.0      0
      2   160.0    160.0    1000.0     45.0    0.00       0.0      0
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
    1000 Trial Surfaces Have Been Generated.
      10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
    Along The Ground Surface Between  X =   0.00(ft)
                                 and  X =  22.00(ft)
    Each Surface Terminates Between   X =  23.00(ft)
                                 and  X =  45.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =      0.00(ft)
     1.00(ft) Line Segments Define Each Trial Failure Surface.
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Evaluated. They Are
          Ordered - Most Critical First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Total Number of Trial Surfaces Attempted =  1000
          Number of Trial Surfaces With Valid FS = 1000
          Statistical Data On All Valid FS Values:
             FS Max =  90.049   FS Min =   3.739   FS Ave =   7.836
             Standard Deviation =    6.648   Coefficient of Variation =   84.83 %
          Failure Surface Specified By 43 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1          5.556       1.852
              2          6.510       1.553
              3          7.473       1.285
              4          8.444       1.046
```

5	9.422	0.837
6	10.406	0.658
7	11.395	0.511
8	12.388	0.393
9	13.384	0.307
10	14.383	0.251
11	15.383	0.226
12	16.383	0.232
13	17.382	0.269
14	18.380	0.337
15	19.375	0.436
16	20.366	0.566
17	21.353	0.726
18	22.335	0.916
19	23.310	1.137
20	24.278	1.388
21	25.238	1.668
22	26.189	1.979
23	27.130	2.318
24	28.059	2.686
25	28.977	3.083
26	29.882	3.508
27	30.774	3.961
28	31.651	4.442
29	32.513	4.949
30	33.359	5.482
31	34.188	6.042
32	34.999	6.626
33	35.791	7.236
34	36.565	7.870
35	37.318	8.527
36	38.051	9.208
37	38.763	9.910
38	39.452	10.635
39	40.119	11.380
40	40.762	12.146
41	41.381	12.931
42	41.976	13.735
43	42.208	14.069

Circle Center At X = 15.684 ; Y = 32.564 ; and Radius = 32.339

Factor of Safety

*** 3.739 ***

Individual data on the 42 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.0	35.3	0.0	0.0	0.	0.	0.0	0.0	0.0
2	1.0	105.4	0.0	0.0	0.	0.	0.0	0.0	0.0
3	1.0	173.4	0.0	0.0	0.	0.	0.0	0.0	0.0
4	1.0	239.0	0.0	0.0	0.	0.	0.0	0.0	0.0
5	1.0	301.9	0.0	0.0	0.	0.	0.0	0.0	0.0
6	1.0	361.9	0.0	0.0	0.	0.	0.0	0.0	0.0
7	1.0	418.5	0.0	0.0	0.	0.	0.0	0.0	0.0
8	1.0	471.7	0.0	0.0	0.	0.	0.0	0.0	0.0
9	1.0	521.1	0.0	0.0	0.	0.	0.0	0.0	0.0
10	1.0	566.5	0.0	0.0	0.	0.	0.0	0.0	0.0
11	1.0	607.8	0.0	0.0	0.	0.	0.0	0.0	0.0
12	1.0	644.7	0.0	0.0	0.	0.	0.0	0.0	0.0
13	1.0	677.2	0.0	0.0	0.	0.	0.0	0.0	0.0
14	1.0	705.2	0.0	0.0	0.	0.	0.0	0.0	0.0
15	1.0	728.5	0.0	0.0	0.	0.	0.0	0.0	0.0
16	1.0	747.2	0.0	0.0	0.	0.	0.0	0.0	0.0
17	1.0	761.1	0.0	0.0	0.	0.	0.0	0.0	0.0
18	1.0	770.2	0.0	0.0	0.	0.	0.0	0.0	0.0
19	1.0	774.7	0.0	0.0	0.	0.	0.0	0.0	0.0
20	1.0	774.5	0.0	0.0	0.	0.	0.0	0.0	0.0
21	1.0	769.8	0.0	0.0	0.	0.	0.0	0.0	0.0
22	0.9	760.6	0.0	0.0	0.	0.	0.0	0.0	0.0
23	0.9	747.0	0.0	0.0	0.	0.	0.0	0.0	0.0

24	0.9	729.3	0.0	0.0	0.	0.	0.0	0.0	0.0
25	0.9	707.5	0.0	0.0	0.	0.	0.0	0.0	0.0
26	0.9	682.0	0.0	0.0	0.	0.	0.0	0.0	0.0
27	0.9	652.9	0.0	0.0	0.	0.	0.0	0.0	0.0
28	0.9	620.4	0.0	0.0	0.	0.	0.0	0.0	0.0
29	0.8	584.9	0.0	0.0	0.	0.	0.0	0.0	0.0
30	0.8	546.6	0.0	0.0	0.	0.	0.0	0.0	0.0
31	0.8	505.9	0.0	0.0	0.	0.	0.0	0.0	0.0
32	0.8	463.0	0.0	0.0	0.	0.	0.0	0.0	0.0
33	0.8	418.3	0.0	0.0	0.	0.	0.0	0.0	0.0
34	0.8	372.1	0.0	0.0	0.	0.	0.0	0.0	0.0
35	0.7	324.9	0.0	0.0	0.	0.	0.0	0.0	0.0
36	0.7	276.9	0.0	0.0	0.	0.	0.0	0.0	0.0
37	0.7	228.6	0.0	0.0	0.	0.	0.0	0.0	0.0
38	0.7	180.4	0.0	0.0	0.	0.	0.0	0.0	0.0
39	0.6	132.6	0.0	0.0	0.	0.	0.0	0.0	0.0
40	0.6	85.6	0.0	0.0	0.	0.	0.0	0.0	0.0
41	0.6	40.0	0.0	0.0	0.	0.	0.0	0.0	0.0
42	0.2	3.6	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.556	1.852
2	6.534	1.647
3	7.518	1.467
4	8.506	1.311
5	9.497	1.180
6	10.492	1.074
7	11.488	0.993
8	12.487	0.937
9	13.486	0.905
10	14.486	0.899
11	15.486	0.918
12	16.485	0.961
13	17.483	1.030
14	18.478	1.123
15	19.471	1.241
16	20.461	1.384
17	21.447	1.552
18	22.428	1.744
19	23.404	1.961
20	24.375	2.202
21	25.339	2.467
22	26.297	2.756
23	27.246	3.069
24	28.188	3.405
25	29.121	3.765
26	30.045	4.149
27	30.958	4.555
28	31.862	4.983
29	32.754	5.435
30	33.635	5.908
31	34.504	6.403
32	35.360	6.920
33	36.203	7.458
34	37.032	8.017
35	37.847	8.596
36	38.648	9.196
37	39.433	9.815
38	40.202	10.454
39	40.955	11.112
40	41.692	11.788
41	42.411	12.483
42	43.113	13.195
43	43.797	13.925
44	44.462	14.671
45	44.639	14.880

Circle Center At X = 14.242 ; Y = 40.939 ; and Radius = 40.041

Factor of Safety

*** 3.768 ***

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	7.556	2.519
2	8.478	2.133
3	9.414	1.781
4	10.363	1.464
5	11.322	1.181
6	12.291	0.934
7	13.268	0.722
8	14.252	0.546
9	15.243	0.407
10	16.237	0.303
11	17.235	0.236
12	18.235	0.206
13	19.235	0.212
14	20.234	0.254
15	21.231	0.333
16	22.224	0.449
17	23.212	0.600
18	24.195	0.788
19	25.169	1.011
20	26.135	1.270
21	27.091	1.564
22	28.035	1.893
23	28.967	2.256
24	29.885	2.653
25	30.788	3.083
26	31.674	3.546
27	32.543	4.041
28	33.393	4.567
29	34.224	5.124
30	35.033	5.711
31	35.821	6.327
32	36.586	6.972
33	37.326	7.644
34	38.041	8.343
35	38.731	9.067
36	39.393	9.816
37	40.028	10.589
38	40.634	11.385
39	41.210	12.202
40	41.757	13.039
41	42.272	13.897
42	42.403	14.134

Circle Center At X = 18.570 ; Y = 27.556 ; and Radius = 27.353

Factor of Safety

*** 3.774 ***

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.889	2.296
2	7.829	1.955
3	8.780	1.646
4	9.741	1.369
5	10.711	1.126
6	11.689	0.917
7	12.673	0.741
8	13.663	0.599
9	14.657	0.491
10	15.654	0.417
11	16.654	0.377
12	17.654	0.372
13	18.653	0.401
14	19.651	0.464
15	20.646	0.562
16	21.638	0.693
17	22.624	0.859
18	23.604	1.058
19	24.576	1.291

20	25.540	1.557
21	26.494	1.856
22	27.438	2.188
23	28.369	2.551
24	29.288	2.947
25	30.192	3.374
26	31.081	3.831
27	31.954	4.319
28	32.810	4.837
29	33.647	5.383
30	34.466	5.958
31	35.264	6.561
32	36.040	7.191
33	36.795	7.847
34	37.527	8.528
35	38.235	9.235
36	38.918	9.965
37	39.576	10.718
38	40.208	11.493
39	40.812	12.290
40	41.389	13.106
41	41.938	13.943
42	41.966	13.989

Circle Center At X =   17.307 ; Y =   29.502 ; and Radius =   29.132

Factor of Safety

*** 3.782 ***

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.556	1.185
2	4.527	0.947
3	5.504	0.735
4	6.487	0.552
5	7.475	0.396
6	8.467	0.268
7	9.462	0.169
8	10.459	0.097
9	11.458	0.053
10	12.458	0.038
11	13.458	0.051
12	14.457	0.092
13	15.455	0.161
14	16.450	0.258
15	17.442	0.383
16	18.430	0.536
17	19.414	0.717
18	20.392	0.926
19	21.364	1.162
20	22.328	1.425
21	23.285	1.715
22	24.234	2.033
23	25.173	2.376
24	26.102	2.747
25	27.020	3.143
26	27.926	3.565
27	28.821	4.012
28	29.702	4.485
29	30.570	4.982
30	31.423	5.503
31	32.262	6.048
32	33.084	6.616
33	33.891	7.208
34	34.680	7.822
35	35.452	8.458
36	36.205	9.115
37	36.940	9.794
38	37.655	10.493
39	38.350	11.212
40	39.025	11.950
41	39.678	12.707

42	40.260	13.420

Circle Center At X = 12.505 ; Y = 35.511 ; and Radius = 35.473

Factor of Safety

*** 3.823 ***

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.222	2.074
2	7.195	1.840
3	8.173	1.634
4	9.157	1.455
5	10.145	1.304
6	11.138	1.180
7	12.133	1.084
8	13.131	1.016
9	14.130	0.976
10	15.130	0.964
11	16.130	0.980
12	17.129	1.024
13	18.126	1.096
14	19.121	1.195
15	20.113	1.323
16	21.101	1.478
17	22.084	1.660
18	23.062	1.870
19	24.033	2.108
20	24.998	2.372
21	25.954	2.663
22	26.902	2.981
23	27.841	3.326
24	28.770	3.696
25	29.688	4.092
26	30.595	4.514
27	31.490	4.961
28	32.371	5.433
29	33.240	5.929
30	34.093	6.449
31	34.933	6.993
32	35.756	7.561
33	36.563	8.151
34	37.354	8.763
35	38.127	9.398
36	38.882	10.053
37	39.619	10.730
38	40.336	11.427
39	41.033	12.143
40	41.710	12.879
41	42.367	13.634
42	42.920	14.307

Circle Center At X = 15.062 ; Y = 36.717 ; and Radius = 35.753

Factor of Safety

*** 3.832 ***

Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.889	0.963
2	3.879	0.826
3	4.873	0.710
4	5.868	0.614
5	6.865	0.540
6	7.864	0.487
7	8.863	0.454
8	9.863	0.443
9	10.863	0.453
10	11.863	0.483
11	12.861	0.535
12	13.859	0.607
13	14.854	0.701
14	15.848	0.815
15	16.839	0.951

16	17.826	1.107
17	18.811	1.283
18	19.791	1.481
19	20.767	1.699
20	21.738	1.937
21	22.704	2.196
22	23.664	2.475
23	24.619	2.774
24	25.566	3.093
25	26.507	3.432
26	27.441	3.791
27	28.366	4.169
28	29.284	4.567
29	30.193	4.983
30	31.093	5.419
31	31.984	5.874
32	32.865	6.347
33	33.736	6.838
34	34.596	7.348
35	35.445	7.876
36	36.283	8.421
37	37.110	8.984
38	37.924	9.564
39	38.727	10.162
40	39.516	10.775
41	40.292	11.406
42	41.055	12.052
43	41.804	12.715
44	42.539	13.393
45	43.260	14.086
46	43.759	14.586

Circle Center At X = 9.907 ; Y = 48.026 ; and Radius = 47.584

Factor of Safety

*** 3.857 ***

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.556	1.852
2	6.530	1.628
3	7.511	1.432
4	8.496	1.263
5	9.486	1.121
6	10.480	1.008
7	11.476	0.922
8	12.474	0.864
9	13.474	0.833
10	14.474	0.831
11	15.474	0.856
12	16.472	0.909
13	17.469	0.991
14	18.463	1.099
15	19.454	1.236
16	20.440	1.400
17	21.422	1.592
18	22.397	1.810
19	23.367	2.056
20	24.329	2.329
21	25.283	2.629
22	26.228	2.955
23	27.164	3.307
24	28.090	3.686
25	29.004	4.089
26	29.908	4.519
27	30.798	4.973
28	31.676	5.452
29	32.540	5.955
30	33.390	6.482
31	34.225	7.033
32	35.044	7.607
33	35.847	8.203

34	36.633	8.821
35	37.401	9.462
36	38.151	10.123
37	38.882	10.805
38	39.594	11.507
39	40.287	12.229
40	40.959	12.969
41	41.609	13.728
42	41.766	13.922

Circle Center At X =   14.063 ; Y =   36.682 ; and Radius =   35.854

Factor of Safety

*** 3.878 ***

Failure Surface Specified By 40 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.000	1.333
2	4.965	1.072
3	5.938	0.841
4	6.918	0.640
5	7.903	0.470
6	8.894	0.331
7	9.888	0.222
8	10.885	0.145
9	11.884	0.099
10	12.883	0.083
11	13.883	0.099
12	14.882	0.146
13	15.879	0.224
14	16.873	0.333
15	17.863	0.473
16	18.849	0.644
17	19.828	0.845
18	20.801	1.076
19	21.766	1.338
20	22.723	1.630
21	23.670	1.951
22	24.606	2.302
23	25.531	2.682
24	26.444	3.090
25	27.344	3.526
26	28.230	3.991
27	29.100	4.482
28	29.955	5.001
29	30.794	5.545
30	31.615	6.116
31	32.418	6.712
32	33.202	7.333
33	33.967	7.978
34	34.711	8.646
35	35.433	9.337
36	36.134	10.050
37	36.813	10.785
38	37.468	11.540
39	38.099	12.316
40	38.493	12.831

Circle Center At X =   12.875 ; Y =   32.198 ; and Radius =   32.115

Factor of Safety

*** 3.906 ***

Failure Surface Specified By 43 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.889	2.296
2	7.851	2.024
3	8.821	1.781
4	9.798	1.566
5	10.780	1.379
6	11.768	1.221
7	12.759	1.092
8	13.754	0.992
9	14.752	0.921

10	15.751	0.879
11	16.751	0.866
12	17.751	0.883
13	18.750	0.929
14	19.747	1.003
15	20.741	1.107
16	21.732	1.240
17	22.719	1.402
18	23.701	1.592
19	24.677	1.811
20	25.646	2.059
21	26.607	2.334
22	27.560	2.638
23	28.503	2.969
24	29.437	3.327
25	30.360	3.713
26	31.271	4.125
27	32.169	4.564
28	33.055	5.029
29	33.926	5.519
30	34.783	6.035
31	35.624	6.575
32	36.449	7.140
33	37.258	7.729
34	38.049	8.341
35	38.822	8.975
36	39.575	9.632
37	40.310	10.311
38	41.024	11.011
39	41.718	11.731
40	42.390	12.472
41	43.040	13.231
42	43.668	14.010
43	44.224	14.741

Circle Center At X = 16.685 ; Y = 35.136 ; and Radius = 34.270

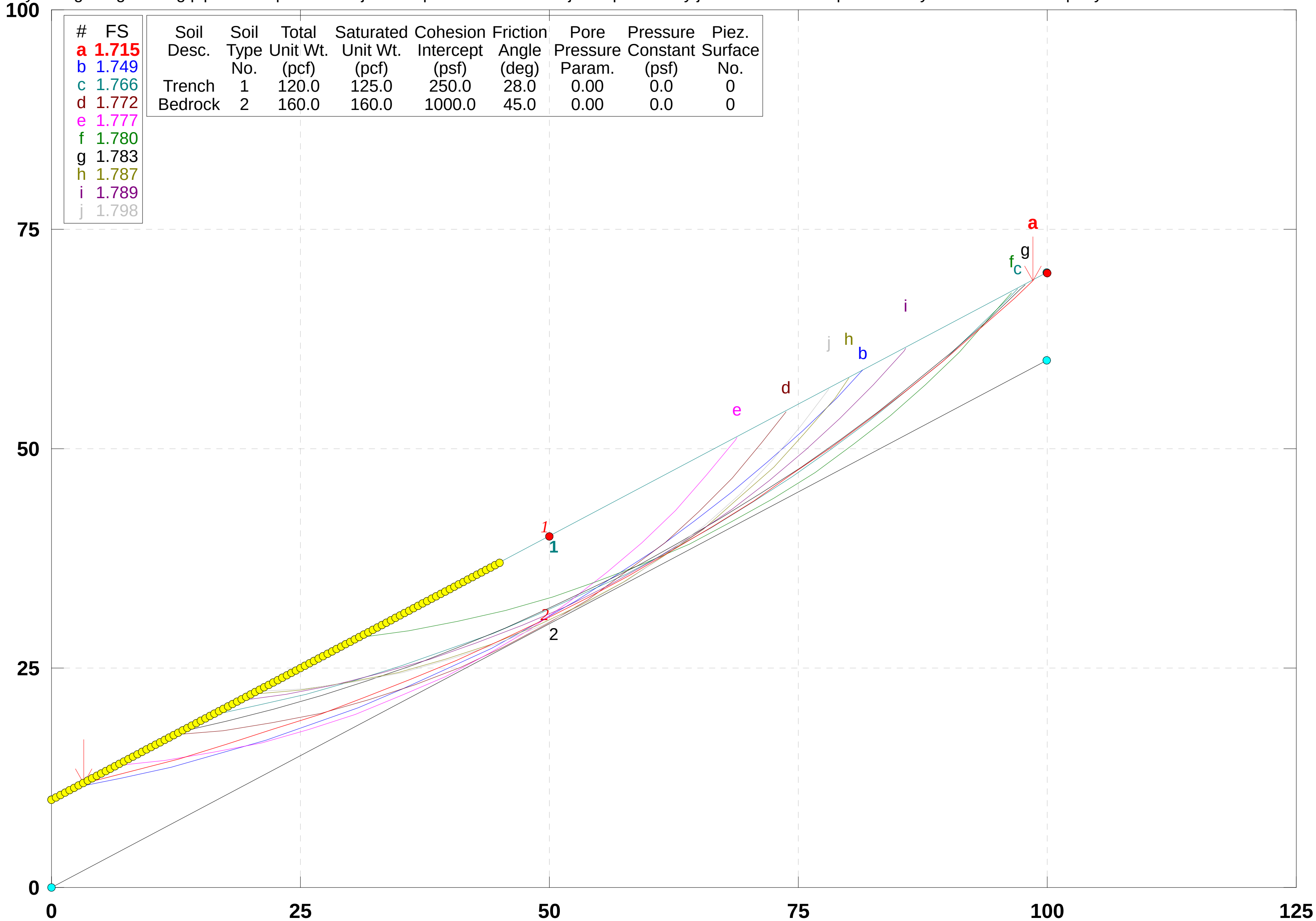
Factor of Safety

*** 3.915 ***

**** END OF GSTABL7 OUTPUT ****

JNF5: Trench Backfill Stability - 60% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf5 trench backfill.pl2 Run By: Insert Name/company Here 12/16/2016 11:53AM



GSTABL7 v.2 FSmin=1.715

Safety Factors Are Calculated By The Modified Bishop Method

```
                              ***  GSTABL7  ***
             ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
        ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
               (All Rights Reserved-Unauthorized Use Prohibited)
    *********************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
           Modified Bishop, Simplified Janbu, or GLE Method of Slices.
           (Includes Spencer & Morgenstern-Price Type Analysis)
           Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
           Nonlinear Undrained Shear Strength, Curved Phi Envelope,
           Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
           Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
    *********************************************************************************
    Analysis Run Date:        12/16/2016
    Time of Run:              11:53AM
    Run By:                   Insert Name/company Here
    Input Data Filename:      y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf5 trench backfill.in
    Output Filename:          y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf5 trench backfill.OUT
    Unit System:              English
    Plotted Output Filename:  y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf5 trench backfill.PLT
    PROBLEM DESCRIPTION:  JNF5: Trench Backfill Stability -
                          60% Slope
    BOUNDARY COORDINATES
        1 Top   Boundaries
        2 Total Boundaries
    Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
       No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
        1          0.00      10.00     100.00      70.00        1
        2          0.00       0.00     100.00      60.00        2
    Default Y-Origin = 0.00(ft)
    Default X-Plus Value = 0.00(ft)
    User Specified Y-Plus Value =   25.00(ft)
   ISOTROPIC SOIL PARAMETERS
     2 Type(s) of Soil
    Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
    Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
     No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
      1   120.0    125.0     250.0     28.0    0.00       0.0      0
      2   160.0    160.0    1000.0     45.0    0.00       0.0      0
    A Critical Failure Surface Searching Method, Using A Random
    Technique For Generating Circular Surfaces, Has Been Specified.
    1000 Trial Surfaces Have Been Generated.
      10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
    Along The Ground Surface Between  X =   0.00(ft)
                                 and  X =  45.00(ft)
    Each Surface Terminates Between   X =  50.00(ft)
                                and   X = 100.00(ft)
    Unless Further Limitations Were Imposed, The Minimum Elevation
    At Which A Surface Extends Is  Y =      0.00(ft)
     5.00(ft) Line Segments Define Each Trial Failure Surface.
    Following Are Displayed The Ten Most Critical Of The Trial
          Failure Surfaces Evaluated. They Are
          Ordered - Most Critical First.
          * * Safety Factors Are Calculated By The Modified Bishop Method * *
          Total Number of Trial Surfaces Attempted =  1000
          Number of Trial Surfaces With Valid FS = 1000
          Statistical Data On All Valid FS Values:
             FS Max =  13.762   FS Min =   1.715   FS Ave =   3.331
             Standard Deviation =    1.081   Coefficient of Variation =   32.44 %
          Failure Surface Specified By 24 Coordinate Points
            Point      X-Surf      Y-Surf
             No.        (ft)        (ft)
              1          3.182       11.909
              2          8.001       13.241
              3         12.785       14.694
              4         17.532       16.266
              5         22.237       17.958
```

6	26.898	19.766
7	31.513	21.692
8	36.077	23.733
9	40.589	25.887
10	45.045	28.155
11	49.443	30.534
12	53.780	33.022
13	58.053	35.619
14	62.259	38.322
15	66.396	41.130
16	70.462	44.041
17	74.452	47.053
18	78.366	50.165
19	82.201	53.374
20	85.953	56.678
21	89.622	60.075
22	93.204	63.564
23	96.697	67.141
24	98.534	69.121

Circle Center At X = -47.345 ; Y = 204.186 ; and Radius = 198.805

Factor of Safety

*** 1.715 ***

Individual data on the 23 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.8	450.9	0.0	0.0	0.	0.	0.0	0.0	0.0
2	4.8	1302.4	0.0	0.0	0.	0.	0.0	0.0	0.0
3	4.7	2059.0	0.0	0.0	0.	0.	0.0	0.0	0.0
4	4.7	2720.8	0.0	0.0	0.	0.	0.0	0.0	0.0
5	4.7	3288.3	0.0	0.0	0.	0.	0.0	0.0	0.0
6	4.6	3762.1	0.0	0.0	0.	0.	0.0	0.0	0.0
7	4.6	4143.6	0.0	0.0	0.	0.	0.0	0.0	0.0
8	4.5	4434.2	0.0	0.0	0.	0.	0.0	0.0	0.0
9	4.5	4635.9	0.0	0.0	0.	0.	0.0	0.0	0.0
10	4.4	4751.0	0.0	0.0	0.	0.	0.0	0.0	0.0
11	4.3	4782.2	0.0	0.0	0.	0.	0.0	0.0	0.0
12	4.3	4732.4	0.0	0.0	0.	0.	0.0	0.0	0.0
13	4.2	4605.1	0.0	0.0	0.	0.	0.0	0.0	0.0
14	4.1	4403.9	0.0	0.0	0.	0.	0.0	0.0	0.0
15	4.1	4132.9	0.0	0.0	0.	0.	0.0	0.0	0.0
16	4.0	3796.3	0.0	0.0	0.	0.	0.0	0.0	0.0
17	3.9	3398.8	0.0	0.0	0.	0.	0.0	0.0	0.0
18	3.8	2945.3	0.0	0.0	0.	0.	0.0	0.0	0.0
19	3.8	2440.9	0.0	0.0	0.	0.	0.0	0.0	0.0
20	3.7	1891.1	0.0	0.0	0.	0.	0.0	0.0	0.0
21	3.6	1301.5	0.0	0.0	0.	0.	0.0	0.0	0.0
22	3.5	678.0	0.0	0.0	0.	0.	0.0	0.0	0.0
23	1.8	96.7	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	2.273	11.364
2	7.151	12.462
3	11.986	13.733
4	16.773	15.177
5	21.506	16.790
6	26.178	18.572
7	30.783	20.520
8	35.315	22.631
9	39.769	24.903
10	44.139	27.332
11	48.420	29.916
12	52.605	32.652
13	56.690	35.535
14	60.669	38.562
15	64.538	41.730
16	68.291	45.034
17	71.923	48.470

18	75.430	52.034
19	78.808	55.720
20	81.538	58.923

Circle Center At X = -25.959 ; Y = 148.250 ; and Radius = 139.767

Factor of Safety

*** 1.749 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	15.909	19.545
2	20.768	20.726
3	25.585	22.067
4	30.355	23.566
5	35.072	25.222
6	39.733	27.033
7	44.331	28.997
8	48.861	31.113
9	53.319	33.377
10	57.700	35.787
11	61.999	38.340
12	66.211	41.035
13	70.331	43.867
14	74.356	46.834
15	78.280	49.933
16	82.099	53.159
17	85.810	56.511
18	89.408	59.983
19	92.889	63.572
20	96.250	67.274
21	97.073	68.244

Circle Center At X = -17.348 ; Y = 167.009 ; and Radius = 151.167

Factor of Safety

*** 1.766 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.273	17.364
2	17.244	17.897
3	22.173	18.740
4	27.039	19.888
5	31.824	21.339
6	36.509	23.085
7	41.076	25.121
8	45.507	27.437
9	49.784	30.026
10	53.892	32.877
11	57.814	35.979
12	61.534	39.319
13	65.038	42.886
14	68.313	46.664
15	71.346	50.639
16	73.765	54.259

Circle Center At X = 6.249 ; Y = 97.095 ; and Radius = 79.958

Factor of Safety

*** 1.772 ***

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	6.364	13.818
2	11.327	14.426
3	16.245	15.327
4	21.100	16.519
5	25.877	17.998
6	30.557	19.758
7	35.124	21.794
8	39.561	24.097
9	43.855	26.660
10	47.988	29.474
11	51.946	32.529
12	55.716	35.813

```
   13         59.283       39.317
   14         62.637       43.025
   15         65.763       46.927
   16         68.652       51.008
   17         68.834       51.301
Circle Center At X =    -1.360 ; Y =    97.512 ; and Radius =    84.049
       Factor of Safety
      ***    1.777   ***
Failure Surface Specified By 17 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         30.909       28.545
    2         35.851       29.307
    3         40.746       30.327
    4         45.580       31.603
    5         50.340       33.132
    6         55.014       34.910
    7         59.587       36.930
    8         64.048       39.189
    9         68.384       41.679
   10         72.583       44.394
   11         76.633       47.326
   12         80.523       50.467
   13         84.242       53.809
   14         87.781       57.341
   15         91.129       61.055
   16         94.277       64.940
   17         96.371       67.823
Circle Center At X =    18.921 ; Y =   122.780 ; and Radius =    94.994
       Factor of Safety
      ***    1.780   ***
Failure Surface Specified By 22 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         12.727       17.636
    2         17.558       18.926
    3         22.349       20.357
    4         27.096       21.927
    5         31.795       23.635
    6         36.443       25.479
    7         41.034       27.458
    8         45.566       29.571
    9         50.034       31.815
   10         54.435       34.189
   11         58.764       36.690
   12         63.019       39.317
   13         67.195       42.066
   14         71.289       44.937
   15         75.297       47.926
   16         79.216       51.031
   17         83.043       54.249
   18         86.774       57.577
   19         90.407       61.013
   20         93.937       64.553
   21         97.363       68.195
   22         97.785       68.671
Circle Center At X =   -28.975 ; Y =   183.540 ; and Radius =   171.065
       Factor of Safety
      ***    1.783   ***
Failure Surface Specified By 16 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         20.000       22.000
    2         24.972       22.526
    3         29.901       23.369
    4         34.765       24.528
    5         39.544       25.996
    6         44.220       27.768
    7         48.772       29.836
    8         53.182       32.192
```

9	57.432	34.826
10	61.504	37.728
11	65.381	40.884
12	69.048	44.284
13	72.489	47.911
14	75.690	51.752
15	78.639	55.790
16	80.071	58.042

Circle Center At X = 14.357 ; Y = 99.486 ; and Radius = 77.691

Factor of Safety

*** 1.787 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	18.636	21.182
2	23.563	22.035
3	28.442	23.127
4	33.262	24.457
5	38.011	26.021
6	42.678	27.816
7	47.252	29.836
8	51.721	32.078
9	56.075	34.536
10	60.304	37.203
11	64.397	40.075
12	68.345	43.143
13	72.139	46.400
14	75.768	49.839
15	79.225	53.452
16	82.501	57.229
17	85.588	61.162
18	85.824	61.494

Circle Center At X = 3.695 ; Y = 122.231 ; and Radius = 102.148

Factor of Safety

*** 1.789 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	20.455	22.273
2	25.438	22.682
3	30.380	23.441
4	35.256	24.547
5	40.042	25.994
6	44.714	27.774
7	49.249	29.880
8	53.624	32.301
9	57.818	35.024
10	61.809	38.036
11	65.577	41.322
12	69.105	44.865
13	72.374	48.648
14	75.368	52.653
15	78.056	56.834

Circle Center At X = 17.156 ; Y = 93.054 ; and Radius = 70.858

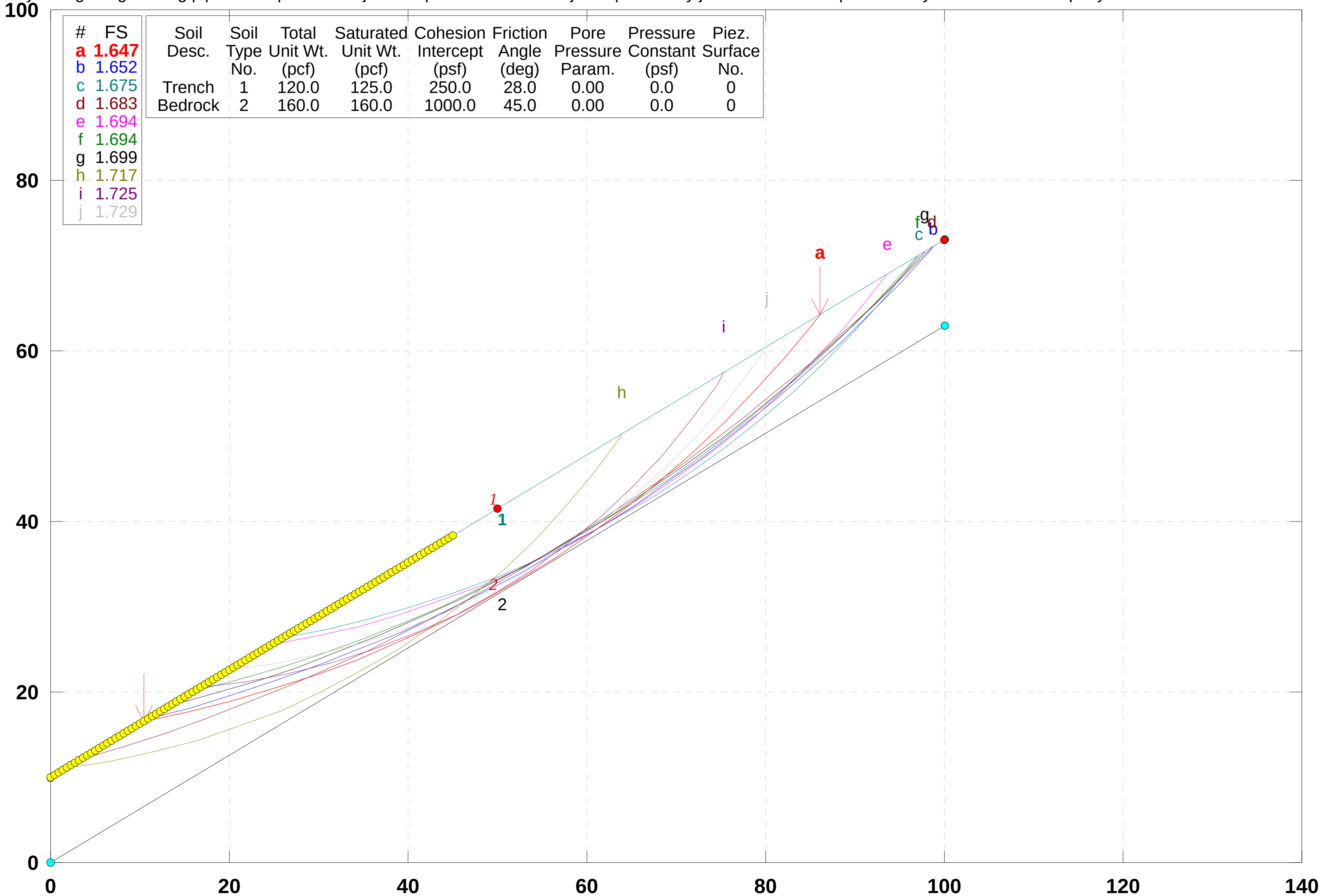
Factor of Safety

*** 1.798 ***

**** END OF GSTABL7 OUTPUT ****

JNF6: Trench Backfill Stability - 63% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf6 trench backfill.pl2 Run By: Insert Name/company Here 12/16/2016 11:54AM



GSTABL7 v.2 FSmin=1.647

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****
SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
****

Analysis Run Date: 12/16/2016
Time of Run: 11:54AM
Run By: Insert Name/company Here
Input Data Filename: y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf6 trench backfill.in
Output Filename: y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf6 trench backfill.OUT
Unit System: English
Plotted Output Filename: y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf6 trench backfill.PLT
PROBLEM DESCRIPTION: JNF6: Trench Backfill Stability - 63% Slope

BOUNDARY COORDINATES
1 Top Boundaries
2 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	10.00	100.00	73.00	1
2	0.00	0.00	100.00	63.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
User Specified Y-Plus Value = 25.00(ft)

ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	120.0	125.0	250.0	28.0	0.00	0.0	0
2	160.0	160.0	1000.0	45.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.
1000 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 0.00(ft)
and X = 45.00(ft)
Each Surface Terminates Between X = 50.00(ft)
and X = 100.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
5.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 14.523 FS Min = 1.647 FS Ave = 3.160
Standard Deviation = 1.055 Coefficient of Variation = 33.39 %
Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.455	16.586
2	15.342	17.642
3	20.183	18.894
4	24.969	20.340
5	29.693	21.979

6	34.347	23.806
7	38.923	25.820
8	43.415	28.017
9	47.814	30.394
10	52.113	32.946
11	56.306	35.670
12	60.386	38.560
13	64.346	41.613
14	68.179	44.824
15	71.880	48.186
16	75.442	51.695
17	78.859	55.345
18	82.126	59.130
19	85.238	63.043
20	86.128	64.261

Circle Center At X = -13.187 ; Y = 138.008 ; and Radius = 123.702

Factor of Safety

*** 1.647 ***

Individual data on the 19 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.9	593.3	0.0	0.0	0.	0.	0.0	0.0	0.0
2	4.8	1697.5	0.0	0.0	0.	0.	0.0	0.0	0.0
3	4.8	2645.2	0.0	0.0	0.	0.	0.0	0.0	0.0
4	4.7	3434.7	0.0	0.0	0.	0.	0.0	0.0	0.0
5	4.7	4065.8	0.0	0.0	0.	0.	0.0	0.0	0.0
6	4.6	4539.9	0.0	0.0	0.	0.	0.0	0.0	0.0
7	4.5	4860.3	0.0	0.0	0.	0.	0.0	0.0	0.0
8	4.4	5031.5	0.0	0.0	0.	0.	0.0	0.0	0.0
9	4.3	5060.0	0.0	0.0	0.	0.	0.0	0.0	0.0
10	4.2	4953.4	0.0	0.0	0.	0.	0.0	0.0	0.0
11	4.1	4721.0	0.0	0.0	0.	0.	0.0	0.0	0.0
12	4.0	4373.3	0.0	0.0	0.	0.	0.0	0.0	0.0
13	3.8	3922.4	0.0	0.0	0.	0.	0.0	0.0	0.0
14	3.7	3381.1	0.0	0.0	0.	0.	0.0	0.0	0.0
15	3.6	2763.6	0.0	0.0	0.	0.	0.0	0.0	0.0
16	3.4	2085.2	0.0	0.0	0.	0.	0.0	0.0	0.0
17	3.3	1361.7	0.0	0.0	0.	0.	0.0	0.0	0.0
18	3.1	609.9	0.0	0.0	0.	0.	0.0	0.0	0.0
19	0.9	35.1	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.909	16.873
2	15.724	18.221
3	20.498	19.708
4	25.227	21.331
5	29.907	23.090
6	34.536	24.982
7	39.107	27.007
8	43.619	29.162
9	48.067	31.446
10	52.447	33.857
11	56.756	36.393
12	60.990	39.052
13	65.146	41.832
14	69.221	44.730
15	73.210	47.744
16	77.112	50.871
17	80.921	54.110
18	84.636	57.456
19	88.253	60.908
20	91.770	64.463
21	95.182	68.117
22	98.488	71.868
23	98.802	72.245

Circle Center At X = -33.570 ; Y = 184.937 ; and Radius = 173.850

Factor of Safety

***   1.652   ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	25.909	26.323
2	30.807	27.329
3	35.655	28.551
4	40.445	29.985
5	45.167	31.631
6	49.811	33.483
7	54.369	35.539
8	58.831	37.794
9	63.190	40.244
10	67.436	42.884
11	71.561	45.710
12	75.557	48.715
13	79.416	51.894
14	83.131	55.240
15	86.695	58.748
16	90.100	62.409
17	93.340	66.217
18	96.408	70.165
19	97.140	71.198

Circle Center At X =   5.606 ; Y =   137.573 ; and Radius =   113.088

Factor of Safety

***   1.675   ***

Failure Surface Specified By 24 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	3.182	12.005
2	7.942	13.533
3	12.667	15.171
4	17.352	16.917
5	21.995	18.771
6	26.595	20.731
7	31.148	22.797
8	35.653	24.968
9	40.106	27.242
10	44.505	29.617
11	48.849	32.094
12	53.134	34.670
13	57.359	37.345
14	61.520	40.116
15	65.617	42.982
16	69.647	45.942
17	73.607	48.994
18	77.496	52.137
19	81.312	55.368
20	85.052	58.687
21	88.714	62.091
22	92.297	65.578
23	95.798	69.148
24	98.553	72.089

Circle Center At X =   -60.651 ; Y =   219.061 ; and Radius =   216.672

Factor of Safety

***   1.683   ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	24.545	25.464
2	29.445	26.460
3	34.294	27.681
4	39.082	29.122
5	43.798	30.782
6	48.434	32.655
7	52.979	34.740
8	57.423	37.030
9	61.758	39.522
10	65.974	42.210
11	70.062	45.089

12	74.014	48.151
13	77.822	51.392
14	81.477	54.804
15	84.972	58.380
16	88.299	62.112
17	91.451	65.993
18	93.691	69.026

Circle Center At X =   5.314 ; Y =   132.649 ; and Radius =   108.897

Factor of Safety

*** 1.694 ***

Failure Surface Specified By 21 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	15.909	20.023
2	20.734	21.334
3	25.514	22.800
4	30.245	24.418
5	34.922	26.187
6	39.539	28.105
7	44.093	30.170
8	48.578	32.380
9	52.990	34.732
10	57.325	37.225
11	61.577	39.855
12	65.743	42.620
13	69.817	45.518
14	73.797	48.544
15	77.678	51.697
16	81.456	54.972
17	85.127	58.367
18	88.687	61.878
19	92.133	65.501
20	95.461	69.233
21	97.063	71.150

Circle Center At X =   -22.585 ; Y =   171.157 ; and Radius =   155.959

Factor of Safety

*** 1.694 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	13.182	18.305
2	17.986	19.689
3	22.748	21.214
4	27.464	22.876
5	32.129	24.676
6	36.739	26.611
7	41.291	28.680
8	45.781	30.880
9	50.204	33.211
10	54.558	35.670
11	58.838	38.254
12	63.041	40.963
13	67.163	43.793
14	71.201	46.742
15	75.150	49.808
16	79.009	52.987
17	82.774	56.278
18	86.440	59.677
19	90.006	63.182
20	93.468	66.790
21	96.824	70.497
22	97.751	71.583

Circle Center At X =   -31.793 ; Y =   183.451 ; and Radius =   171.161

Factor of Safety

*** 1.699 ***

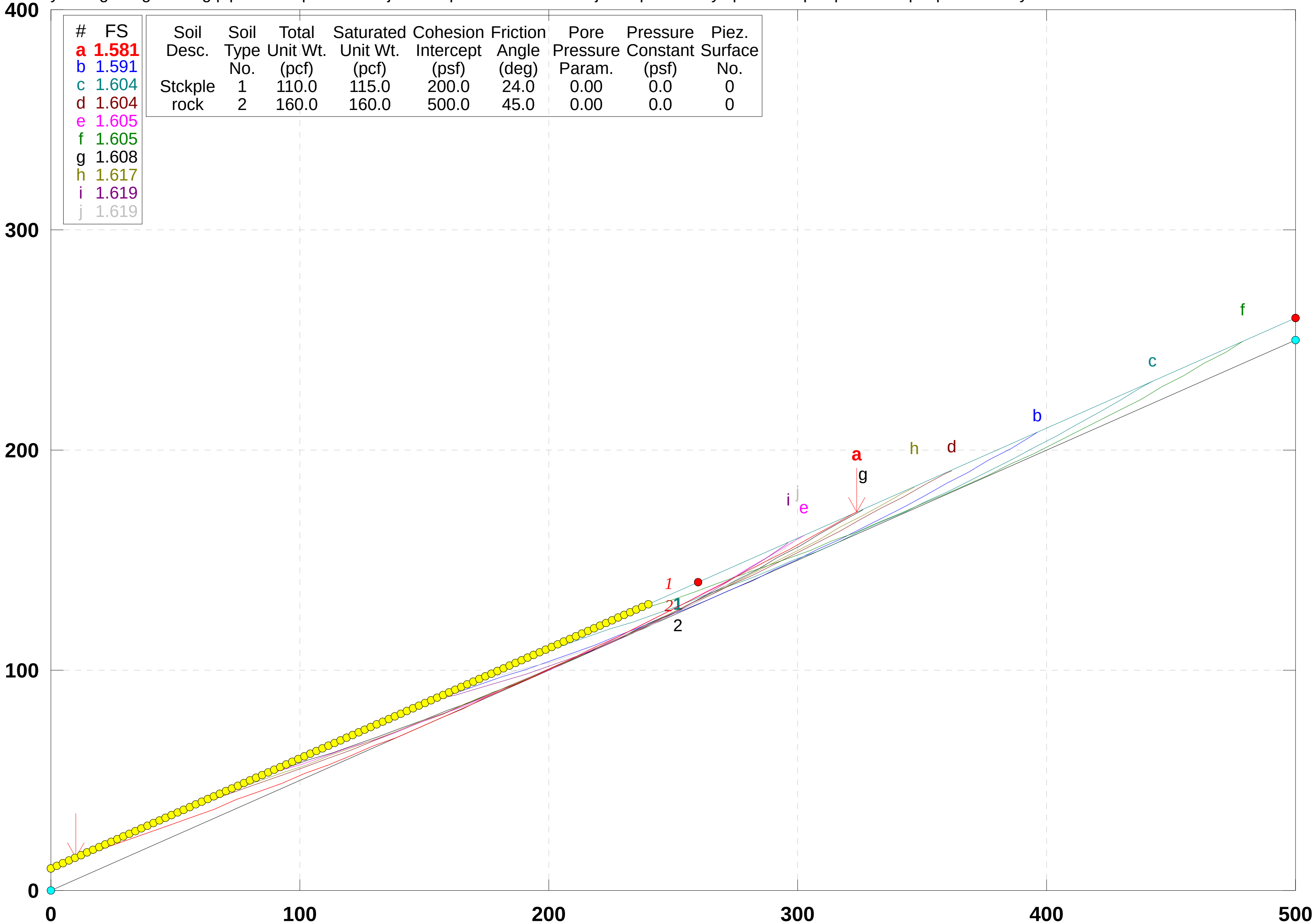
Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	1.818	11.145
2	6.755	11.938

```
     3          11.639        13.011
     4          16.453        14.360
     5          21.183        15.980
     6          25.813        17.868
     7          30.328        20.016
     8          34.714        22.417
     9          38.956        25.064
    10          43.040        27.949
    11          46.953        31.061
    12          50.683        34.391
    13          54.217        37.928
    14          57.544        41.660
    15          60.654        45.576
    16          63.535        49.662
    17          63.909        50.263
Circle Center At X =    -9.628 ; Y =    98.191 ; and Radius =    87.795
       Factor of Safety
      ***    1.717   ***
Failure Surface Specified By 16 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1          16.818        20.595
     2          21.777        21.238
     3          26.683        22.200
     4          31.517        23.478
     5          36.258        25.066
     6          40.886        26.958
     7          45.382        29.146
     8          49.727        31.621
     9          53.902        34.372
    10          57.890        37.388
    11          61.675        40.655
    12          65.239        44.162
    13          68.569        47.891
    14          71.651        51.829
    15          74.471        55.958
    16          75.375        57.487
Circle Center At X =     9.452 ; Y =    97.207 ; and Radius =    76.965
       Factor of Safety
      ***    1.725   ***
Failure Surface Specified By 16 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
     1          20.000        22.600
     2          24.944        23.344
     3          29.835        24.385
     4          34.653        25.719
     5          39.383        27.341
     6          44.007        29.245
     7          48.507        31.424
     8          52.868        33.870
     9          57.073        36.574
    10          61.108        39.527
    11          64.958        42.718
    12          68.608        46.135
    13          72.046        49.765
    14          75.259        53.597
    15          78.235        57.614
    16          80.083        60.452
Circle Center At X =    10.183 ; Y =   104.794 ; and Radius =    82.778
       Factor of Safety
      ***    1.729   ***
          **** END OF GSTABL7 OUTPUT ****
```

Spoil Stockpile Profile - 50% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\spoil stockpile profile 50 pct.pl2   Run By: Username   12/20/2016   02:30PM



GSTABL7 v.2 FSmin=1.581

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
****

Analysis Run Date: 12/20/2016
Time of Run: 02:30PM
Run By: Username
Input Data Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\spoil stockpile profile 50 pct.in
Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\spoil stockpile profile 50 pct.OUT
Unit System: English
Plotted Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\spoil stockpile profile 50 pct.PLT
PROBLEM DESCRIPTION: Spoil Stockpile Profile - 50% Slope
BOUNDARY COORDINATES
1 Top Boundaries
2 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	10.00	500.00	260.00	1
2	0.00	0.00	500.00	250.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)
ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	115.0	200.0	24.0	0.00	0.0	0
2	160.0	160.0	500.0	45.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
5000 Trial Surfaces Have Been Generated.
50 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 0.00(ft)
and X = 240.00(ft)
Each Surface Terminates Between X = 260.00(ft)
and X = 500.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
10.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 5000
Number of Trial Surfaces With Valid FS = 5000
Statistical Data On All Valid FS Values:
FS Max = 6.363 FS Min = 1.581 FS Ave = 2.973
Standard Deviation = 0.518 Coefficient of Variation = 17.41 %
Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	9.697	14.848
2	19.038	18.417
3	28.359	22.040
4	37.659	25.716
5	46.937	29.446
6	56.194	33.230

7	65.428	37.067
8	74.641	40.957
9	83.830	44.901
10	92.997	48.897
11	102.140	52.947
12	111.260	57.049
13	120.356	61.204
14	129.428	65.411
15	138.476	69.670
16	147.498	73.982
17	156.496	78.346
18	165.468	82.761
19	174.415	87.229
20	183.336	91.748
21	192.230	96.318
22	201.098	100.940
23	209.939	105.613
24	218.753	110.337
25	227.539	115.112
26	236.298	119.937
27	245.029	124.813
28	253.731	129.739
29	262.405	134.716
30	271.050	139.742
31	279.665	144.819
32	288.252	149.945
33	296.808	155.120
34	305.335	160.345
35	313.831	165.619
36	322.296	170.942
37	323.802	171.901

Circle Center At X = -603.454 ; Y = 1633.829 ; and Radius = 1731.200

Factor of Safety

*** 1.581 ***

Individual data on the 36 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	9.3	566.2	0.0	0.0	0.	0.	0.0	0.0	0.0
2	9.3	1661.8	0.0	0.0	0.	0.	0.0	0.0	0.0
3	9.3	2686.7	0.0	0.0	0.	0.	0.0	0.0	0.0
4	9.3	3641.1	0.0	0.0	0.	0.	0.0	0.0	0.0
5	9.3	4525.4	0.0	0.0	0.	0.	0.0	0.0	0.0
6	9.2	5340.0	0.0	0.0	0.	0.	0.0	0.0	0.0
7	9.2	6085.1	0.0	0.0	0.	0.	0.0	0.0	0.0
8	9.2	6761.1	0.0	0.0	0.	0.	0.0	0.0	0.0
9	9.2	7368.5	0.0	0.0	0.	0.	0.0	0.0	0.0
10	9.1	7907.6	0.0	0.0	0.	0.	0.0	0.0	0.0
11	9.1	8378.9	0.0	0.0	0.	0.	0.0	0.0	0.0
12	9.1	8782.8	0.0	0.0	0.	0.	0.0	0.0	0.0
13	9.1	9119.8	0.0	0.0	0.	0.	0.0	0.0	0.0
14	9.0	9390.3	0.0	0.0	0.	0.	0.0	0.0	0.0
15	9.0	9594.8	0.0	0.0	0.	0.	0.0	0.0	0.0
16	9.0	9733.7	0.0	0.0	0.	0.	0.0	0.0	0.0
17	9.0	9807.8	0.0	0.0	0.	0.	0.0	0.0	0.0
18	8.9	9817.3	0.0	0.0	0.	0.	0.0	0.0	0.0
19	8.9	9762.9	0.0	0.0	0.	0.	0.0	0.0	0.0
20	8.9	9645.2	0.0	0.0	0.	0.	0.0	0.0	0.0
21	8.9	9464.6	0.0	0.0	0.	0.	0.0	0.0	0.0
22	8.8	9221.9	0.0	0.0	0.	0.	0.0	0.0	0.0
23	8.8	8917.6	0.0	0.0	0.	0.	0.0	0.0	0.0
24	8.8	8552.3	0.0	0.0	0.	0.	0.0	0.0	0.0
25	8.8	8126.6	0.0	0.0	0.	0.	0.0	0.0	0.0
26	8.7	7641.3	0.0	0.0	0.	0.	0.0	0.0	0.0
27	8.7	7096.9	0.0	0.0	0.	0.	0.0	0.0	0.0
28	8.7	6494.1	0.0	0.0	0.	0.	0.0	0.0	0.0
29	8.6	5833.6	0.0	0.0	0.	0.	0.0	0.0	0.0
30	8.6	5116.2	0.0	0.0	0.	0.	0.0	0.0	0.0
31	8.6	4342.4	0.0	0.0	0.	0.	0.0	0.0	0.0

32	8.6	3513.1	0.0	0.0	0.	0.	0.0	0.0	0.0
33	8.5	2629.1	0.0	0.0	0.	0.	0.0	0.0	0.0
34	8.5	1690.9	0.0	0.0	0.	0.	0.0	0.0	0.0
35	8.5	699.5	0.0	0.0	0.	0.	0.0	0.0	0.0
36	1.5	17.1	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	152.727	86.364
2	162.161	89.682
3	171.562	93.090
4	180.930	96.588
5	190.265	100.175
6	199.565	103.851
7	208.829	107.615
8	218.057	111.468
9	227.248	115.409
10	236.401	119.437
11	245.515	123.552
12	254.589	127.754
13	263.623	132.042
14	272.615	136.416
15	281.566	140.876
16	290.473	145.421
17	299.337	150.051
18	308.156	154.765
19	316.930	159.563
20	325.657	164.445
21	334.338	169.410
22	342.971	174.457
23	351.555	179.586
24	360.090	184.797
25	368.575	190.089
26	377.009	195.462
27	385.391	200.915
28	393.721	206.448
29	396.038	208.019

Circle Center At X = -190.392 ; Y = 1076.825 ; and Radius = 1048.210

Factor of Safety
***   1.591   ***

Failure Surface Specified By 29 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	196.364	108.182
2	205.784	111.537
3	215.173	114.977
4	224.531	118.504
5	233.856	122.115
6	243.148	125.812
7	252.405	129.593
8	261.628	133.459
9	270.815	137.409
10	279.965	141.442
11	289.079	145.559
12	298.154	149.759
13	307.190	154.041
14	316.188	158.406
15	325.144	162.853
16	334.060	167.381
17	342.935	171.991
18	351.766	176.682
19	360.555	181.453
20	369.299	186.304
21	377.999	191.234
22	386.654	196.244
23	395.262	201.333
24	403.824	206.500
25	412.338	211.745
26	420.804	217.068
27	429.221	222.467

28	437.588	227.943
29	442.661	231.331

Circle Center At X = -166.333 ; Y = 1141.543 ; and Radius = 1095.164

Factor of Safety

*** 1.604 ***

Failure Surface Specified By 36 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	55.758	37.879
2	65.096	41.455
3	74.414	45.086
4	83.710	48.771
5	92.984	52.511
6	102.236	56.306
7	111.466	60.155
8	120.672	64.059
9	129.856	68.016
10	139.016	72.028
11	148.152	76.093
12	157.265	80.212
13	166.352	84.385
14	175.416	88.611
15	184.454	92.890
16	193.466	97.223
17	202.454	101.608
18	211.415	106.046
19	220.350	110.537
20	229.258	115.081
21	238.139	119.677
22	246.993	124.325
23	255.820	129.025
24	264.619	133.776
25	273.390	138.580
26	282.132	143.435
27	290.845	148.342
28	299.530	153.299
29	308.185	158.308
30	316.811	163.368
31	325.406	168.478
32	333.972	173.639
33	342.507	178.850
34	351.011	184.111
35	359.484	189.422
36	361.851	190.926

Circle Center At X = -546.883 ; Y = 1625.777 ; and Radius = 1698.410

Factor of Safety

*** 1.604 ***

Failure Surface Specified By 26 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	82.424	51.212
2	91.891	54.434
3	101.320	57.765
4	110.710	61.203
5	120.061	64.748
6	129.370	68.399
7	138.638	72.157
8	147.861	76.020
9	157.040	79.989
10	166.173	84.062
11	175.259	88.239
12	184.296	92.520
13	193.284	96.904
14	202.221	101.390
15	211.106	105.979
16	219.939	110.668
17	228.717	115.458
18	237.439	120.348
19	246.106	125.338
20	254.715	130.426

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   21        263.265      135.612
   22        271.755      140.895
   23        280.184      146.276
   24        288.551      151.752
   25        296.856      157.323
   26        302.741      161.371
Circle Center At X =  -194.572 ; Y =   880.601 ; and Radius =   874.421
       Factor of Safety
      ***    1.605   ***
Failure Surface Specified By 29 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        230.303      125.151
    2        239.719      128.519
    3        249.105      131.970
    4        258.459      135.505
    5        267.781      139.124
    6        277.071      142.826
    7        286.327      146.611
    8        295.548      150.479
    9        304.735      154.429
   10        313.886      158.461
   11        323.001      162.575
   12        332.078      166.771
   13        341.117      171.047
   14        350.118      175.405
   15        359.079      179.842
   16        368.001      184.360
   17        376.881      188.958
   18        385.720      193.635
   19        394.517      198.390
   20        403.271      203.225
   21        411.981      208.137
   22        420.647      213.127
   23        429.268      218.195
   24        437.843      223.340
   25        446.371      228.561
   26        454.853      233.858
   27        463.287      239.231
   28        471.672      244.680
   29        478.786      249.393
Circle Center At X =  -141.077 ; Y =  1178.565 ; and Radius =  1116.961
       Factor of Safety
      ***    1.605   ***
Failure Surface Specified By 29 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         84.848       52.424
    2         94.275       55.762
    3        103.670       59.189
    4        113.031       62.704
    5        122.359       66.308
    6        131.653       70.001
    7        140.911       73.781
    8        150.132       77.648
    9        159.317       81.603
   10        168.464       85.645
   11        177.572       89.773
   12        186.641       93.988
   13        195.669       98.288
   14        204.656      102.673
   15        213.601      107.143
   16        222.504      111.698
   17        231.363      116.337
   18        240.177      121.060
   19        248.946      125.866
   20        257.670      130.755
   21        266.347      135.726
   22        274.976      140.779
   23        283.557      145.914
```

24	292.089	151.130
25	300.571	156.426
26	309.003	161.802
27	317.383	167.259
28	325.712	172.794
29	326.059	173.030

Circle Center At X = -262.745 ; Y = 1049.142 ; and Radius = 1055.589

Factor of Safety

*** 1.608 ***

Failure Surface Specified By 33 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	65.455	42.727
2	74.816	46.242
3	84.154	49.822
4	93.467	53.465
5	102.754	57.171
6	112.016	60.942
7	121.252	64.775
8	130.462	68.672
9	139.645	72.631
10	148.800	76.654
11	157.928	80.739
12	167.027	84.886
13	176.098	89.096
14	185.140	93.367
15	194.152	97.701
16	203.134	102.096
17	212.086	106.552
18	221.008	111.070
19	229.898	115.648
20	238.757	120.288
21	247.583	124.988
22	256.378	129.748
23	265.139	134.568
24	273.868	139.448
25	282.562	144.388
26	291.223	149.387
27	299.849	154.446
28	308.441	159.563
29	316.997	164.739
30	325.518	169.974
31	334.002	175.266
32	342.450	180.617
33	346.703	183.352

Circle Center At X = -443.274 ; Y = 1411.833 ; and Radius = 1460.567

Factor of Safety

*** 1.617 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	152.727	86.364
2	162.394	88.923
3	171.989	91.741
4	181.504	94.817
5	190.933	98.149
6	200.268	101.733
7	209.504	105.567
8	218.633	109.649
9	227.648	113.976
10	236.544	118.544
11	245.314	123.350
12	253.950	128.390
13	262.448	133.662
14	270.801	139.161
15	279.002	144.882
16	287.046	150.823
17	294.927	156.978
18	296.420	158.210

Circle Center At X = 62.771 ; Y = 445.892 ; and Radius = 370.611

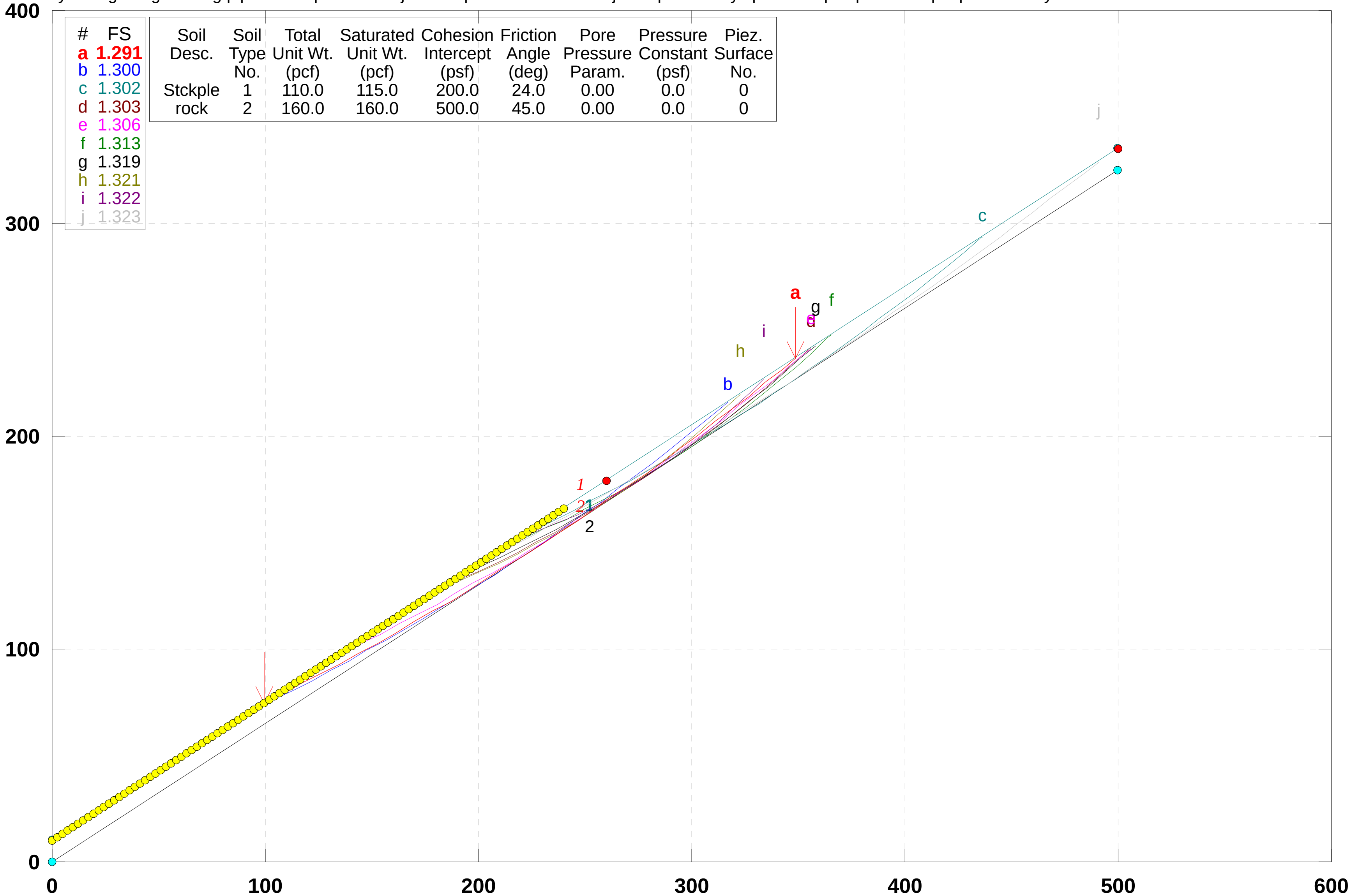
Factor of Safety
*** 1.619 ***
Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	172.121	96.061
2	181.854	98.358
3	191.501	100.989
4	201.052	103.953
5	210.495	107.244
6	219.819	110.859
7	229.012	114.794
8	238.064	119.044
9	246.964	123.604
10	255.701	128.468
11	264.265	133.632
12	272.645	139.087
13	280.832	144.829
14	288.817	150.851
15	296.588	157.144
16	299.709	159.854

Circle Center At X = 110.689 ; Y = 378.408 ; and Radius = 288.954
Factor of Safety
*** 1.619 ***
**** END OF GSTABL7 OUTPUT ****

Spoil Stockpile Profile - 65% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\spoil stockpile profile 65 pct.pl2 Run By: Username 12/20/2016 02:27PM



GSTABL7 v.2 FSmin=1.291

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/20/2016
Time of Run: 02:27PM
Run By: Username
Input Data Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\spoil stockpile profile 65 pct.in
Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\spoil stockpile profile 65 pct.OUT
Unit System: English
Plotted Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\spoil stockpile profile 65 pct.PLT
PROBLEM DESCRIPTION: Spoil Stockpile Profile - 65% Slope

BOUNDARY COORDINATES
1 Top Boundaries
2 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	10.00	500.00	335.00	1
2	0.00	0.00	500.00	325.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	115.0	200.0	24.0	0.00	0.0	0
2	160.0	160.0	500.0	45.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
5000 Trial Surfaces Have Been Generated.
50 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 0.00(ft)
and X = 240.00(ft)
Each Surface Terminates Between X = 260.00(ft)
and X = 500.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
10.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 5000
Number of Trial Surfaces With Valid FS = 5000
Statistical Data On All Valid FS Values:
FS Max = 5.955 FS Min = 1.291 FS Ave = 2.253
Standard Deviation = 0.328 Coefficient of Variation = 14.53 %
Failure Surface Specified By 31 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	99.394	74.606
2	108.321	79.113
3	117.213	83.688
4	126.070	88.329
5	134.893	93.038
6	143.679	97.813

7	152.429	102.654
8	161.142	107.561
9	169.818	112.533
10	178.457	117.571
11	187.056	122.675
12	195.617	127.843
13	204.139	133.075
14	212.621	138.372
15	221.063	143.732
16	229.464	149.157
17	237.824	154.644
18	246.142	160.195
19	254.418	165.808
20	262.652	171.483
21	270.842	177.221
22	278.989	183.020
23	287.091	188.881
24	295.150	194.802
25	303.163	200.784
26	311.131	206.827
27	319.053	212.930
28	326.928	219.092
29	334.757	225.314
30	342.539	231.594
31	348.763	236.696

Circle Center At X = -492.910 ; Y = 1258.759 ; and Radius = 1324.025

Factor of Safety

*** 1.291 ***

Individual data on the 30 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	8.9	635.8	0.0	0.0	0.	0.	0.0	0.0	0.0
2	8.9	1856.3	0.0	0.0	0.	0.	0.0	0.0	0.0
3	8.9	2979.9	0.0	0.0	0.	0.	0.0	0.0	0.0
4	8.8	4007.3	0.0	0.0	0.	0.	0.0	0.0	0.0
5	8.8	4939.4	0.0	0.0	0.	0.	0.0	0.0	0.0
6	8.8	5777.0	0.0	0.0	0.	0.	0.0	0.0	0.0
7	8.7	6521.0	0.0	0.0	0.	0.	0.0	0.0	0.0
8	8.7	7172.2	0.0	0.0	0.	0.	0.0	0.0	0.0
9	8.6	7731.7	0.0	0.0	0.	0.	0.0	0.0	0.0
10	8.6	8200.5	0.0	0.0	0.	0.	0.0	0.0	0.0
11	8.6	8579.5	0.0	0.0	0.	0.	0.0	0.0	0.0
12	8.5	8869.8	0.0	0.0	0.	0.	0.0	0.0	0.0
13	8.5	9072.6	0.0	0.0	0.	0.	0.0	0.0	0.0
14	8.4	9188.9	0.0	0.0	0.	0.	0.0	0.0	0.0
15	8.4	9219.9	0.0	0.0	0.	0.	0.0	0.0	0.0
16	8.4	9166.8	0.0	0.0	0.	0.	0.0	0.0	0.0
17	8.3	9030.8	0.0	0.0	0.	0.	0.0	0.0	0.0
18	8.3	8813.3	0.0	0.0	0.	0.	0.0	0.0	0.0
19	8.2	8515.4	0.0	0.0	0.	0.	0.0	0.0	0.0
20	8.2	8138.5	0.0	0.0	0.	0.	0.0	0.0	0.0
21	8.1	7684.0	0.0	0.0	0.	0.	0.0	0.0	0.0
22	8.1	7153.3	0.0	0.0	0.	0.	0.0	0.0	0.0
23	8.1	6547.8	0.0	0.0	0.	0.	0.0	0.0	0.0
24	8.0	5868.9	0.0	0.0	0.	0.	0.0	0.0	0.0
25	8.0	5118.2	0.0	0.0	0.	0.	0.0	0.0	0.0
26	7.9	4297.1	0.0	0.0	0.	0.	0.0	0.0	0.0
27	7.9	3407.1	0.0	0.0	0.	0.	0.0	0.0	0.0
28	7.8	2449.9	0.0	0.0	0.	0.	0.0	0.0	0.0
29	7.8	1427.1	0.0	0.0	0.	0.	0.0	0.0	0.0
30	6.2	361.5	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	94.545	71.455
2	103.523	75.859
3	112.459	80.349
4	121.352	84.922

5	130.202	89.578
6	139.007	94.317
7	147.768	99.139
8	156.483	104.044
9	165.151	109.030
10	173.772	114.097
11	182.345	119.245
12	190.869	124.473
13	199.344	129.782
14	207.769	135.169
15	216.142	140.636
16	224.464	146.181
17	232.733	151.805
18	240.949	157.505
19	249.111	163.283
20	257.218	169.138
21	265.270	175.068
22	273.266	181.074
23	281.205	187.154
24	289.086	193.309
25	296.909	199.538
26	304.673	205.840
27	312.378	212.215
28	316.674	215.838

Circle Center At X = -369.056 ; Y = 1027.748 ; and Radius = 1062.743

Factor of Safety

*** 1.300 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	218.182	151.818
2	227.167	156.208
3	236.109	160.684
4	245.007	165.247
5	253.860	169.897
6	262.668	174.632
7	271.429	179.453
8	280.143	184.359
9	288.809	189.349
10	297.426	194.423
11	305.994	199.581
12	314.510	204.822
13	322.976	210.145
14	331.389	215.550
15	339.749	221.037
16	348.056	226.605
17	356.308	232.253
18	364.505	237.981
19	372.645	243.789
20	380.729	249.675
21	388.756	255.640
22	396.723	261.683
23	404.632	267.802
24	412.481	273.999
25	420.270	280.271
26	427.997	286.619
27	435.662	293.041
28	436.340	293.621

Circle Center At X = -228.778 ; Y = 1078.164 ; and Radius = 1028.537

Factor of Safety

*** 1.302 ***

Failure Surface Specified By 22 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	181.818	128.182
2	190.933	132.295
3	199.983	136.548
4	208.968	140.940
5	217.883	145.468
6	226.729	150.133

7	235.501	154.933
8	244.199	159.867
9	252.821	164.934
10	261.363	170.133
11	269.825	175.462
12	278.204	180.920
13	286.498	186.506
14	294.706	192.219
15	302.825	198.057
16	310.853	204.019
17	318.789	210.103
18	326.631	216.308
19	334.377	222.633
20	342.024	229.076
21	349.572	235.636
22	356.010	241.406

Circle Center At X = -81.569 ; Y = 723.998 ; and Radius = 651.437

Factor of Safety

*** 1.303 ***

Failure Surface Specified By 28 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	135.758	98.242
2	144.735	102.648
3	153.670	107.139
4	162.562	111.714
5	171.410	116.373
6	180.214	121.116
7	188.972	125.942
8	197.684	130.852
9	206.349	135.843
10	214.966	140.917
11	223.535	146.072
12	232.054	151.309
13	240.524	156.626
14	248.942	162.023
15	257.309	167.499
16	265.624	173.055
17	273.885	178.690
18	282.093	184.402
19	290.246	190.192
20	298.344	196.060
21	306.386	202.004
22	314.371	208.023
23	322.298	214.119
24	330.168	220.289
25	337.978	226.534
26	345.729	232.853
27	353.420	239.244
28	355.844	241.299

Circle Center At X = -323.732 ; Y = 1045.975 ; and Radius = 1053.246

Factor of Safety

*** 1.306 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	213.333	148.667
2	222.527	152.601
3	231.640	156.718
4	240.669	161.016
5	249.611	165.494
6	258.461	170.149
7	267.216	174.981
8	275.874	179.986
9	284.429	185.163
10	292.880	190.510
11	301.222	196.024
12	309.452	201.705
13	317.567	207.548
14	325.564	213.552

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   15        333.439      219.715
   16        341.190      226.034
   17        348.812      232.506
   18        356.305      239.130
   19        363.663      245.901
   20        365.220      247.393
Circle Center At X =    21.198 ; Y =   610.459 ; and Radius =   500.169
       Factor of Safety
      ***    1.313   ***
Failure Surface Specified By 21 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        191.515      134.485
    2        200.641      138.574
    3        209.698      142.812
    4        218.685      147.198
    5        227.599      151.730
    6        236.438      156.407
    7        245.200      161.227
    8        253.881      166.191
    9        262.480      171.296
   10        270.994      176.540
   11        279.422      181.923
   12        287.760      187.443
   13        296.007      193.099
   14        304.160      198.889
   15        312.218      204.811
   16        320.178      210.865
   17        328.038      217.047
   18        335.795      223.357
   19        343.449      229.794
   20        350.996      236.354
   21        358.215      242.840
Circle Center At X =   -54.046 ; Y =   694.693 ; and Radius =   611.664
       Factor of Safety
      ***    1.319   ***
Failure Surface Specified By 18 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        181.818      128.182
    2        191.054      132.015
    3        200.200      136.059
    4        209.251      140.312
    5        218.201      144.772
    6        227.046      149.437
    7        235.782      154.304
    8        244.403      159.370
    9        252.906      164.634
   10        261.286      170.091
   11        269.538      175.740
   12        277.657      181.576
   13        285.641      187.598
   14        293.484      193.802
   15        301.182      200.185
   16        308.732      206.743
   17        316.128      213.472
   18        322.771      219.801
Circle Center At X =    19.839 ; Y =   531.615 ; and Radius =   434.736
       Factor of Safety
      ***    1.321   ***
Failure Surface Specified By 15 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1        218.182      151.818
    2        227.571      155.260
    3        236.834      159.027
    4        245.960      163.115
    5        254.938      167.519
    6        263.757      172.234
    7        272.406      177.253
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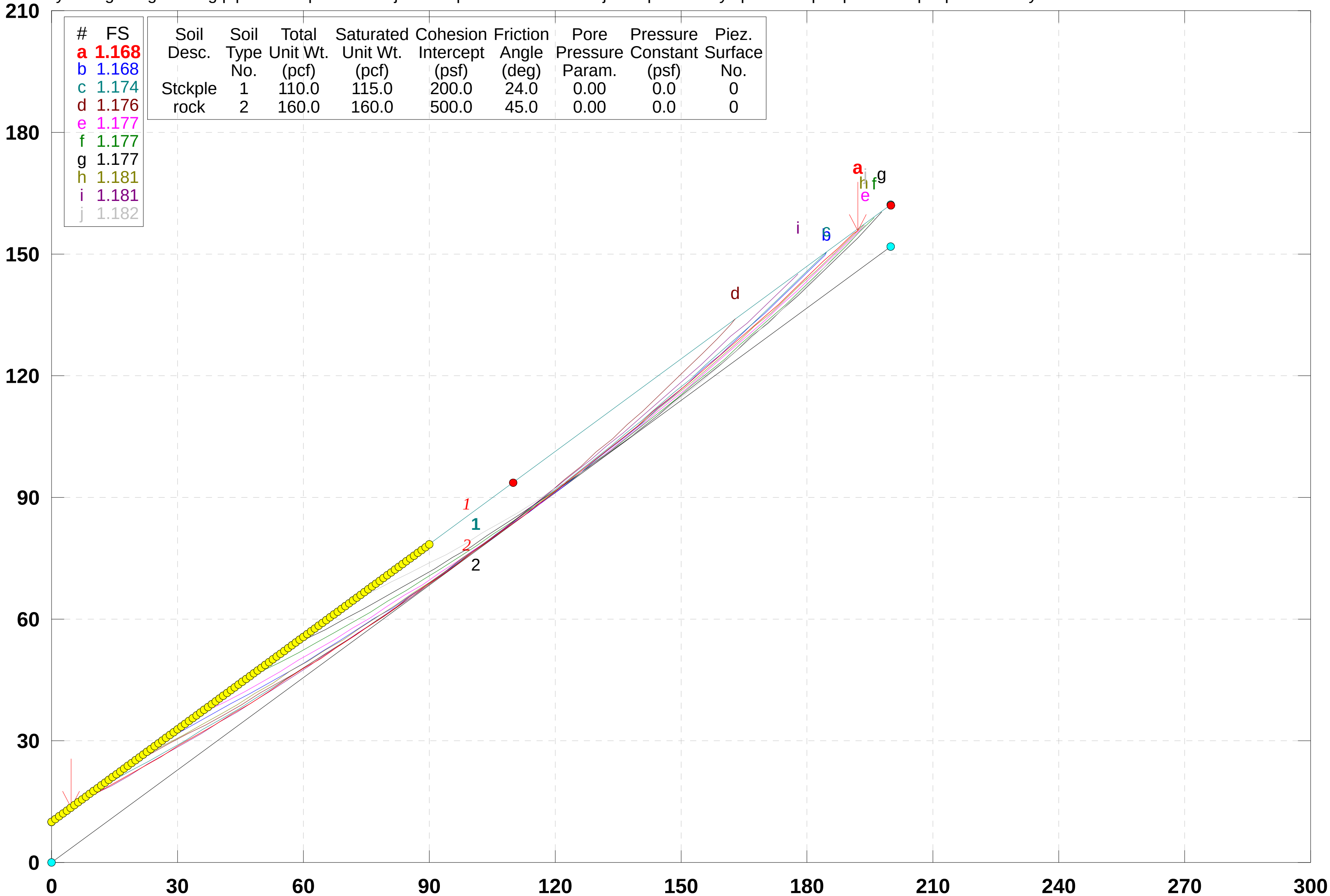
    8        280.875      182.571
    9        289.153      188.181
   10        297.230      194.077
   11        305.097      200.251
   12        312.743      206.695
   13        320.160      213.402
   14        327.339      220.364
   15        333.508      226.780
 Circle Center At X =   124.253 ; Y =   422.582 ; and Radius =   286.593
       Factor of Safety
      ***    1.322   ***
 Failure Surface Specified By 36 Coordinate Points
   Point      X-Surf      Y-Surf
    No.        (ft)        (ft)
    1        198.788      139.212
    2        207.620      143.901
    3        216.428      148.637
    4        225.211      153.418
    5        233.969      158.245
    6        242.701      163.117
    7        251.409      168.035
    8        260.090      172.998
    9        268.745      178.007
   10        277.374      183.060
   11        285.977      188.159
   12        294.553      193.302
   13        303.102      198.490
   14        311.624      203.722
   15        320.119      208.999
   16        328.585      214.320
   17        337.024      219.685
   18        345.435      225.094
   19        353.818      230.546
   20        362.172      236.042
   21        370.497      241.582
   22        378.794      247.165
   23        387.061      252.792
   24        395.299      258.461
   25        403.507      264.173
   26        411.685      269.928
   27        419.833      275.725
   28        427.950      281.565
   29        436.037      287.447
   30        444.094      293.371
   31        452.119      299.338
   32        460.113      305.345
   33        468.076      311.395
   34        476.007      317.486
   35        483.906      323.618
   36        490.745      328.984
 Circle Center At X =  -696.103 ; Y =  1835.436 ; and Radius =  1917.812
       Factor of Safety
      ***    1.323   ***
          **** END OF GSTABL7 OUTPUT ****
```

Spoil Stockpile Profile - 76% Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\spoil stockpile profile 76 pct.pl2   Run By: Username   12/20/2016   02:23PM



GSTABL7 v.2 FSmin=1.168

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****
SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
****
Analysis Run Date: 12/20/2016
Time of Run: 02:23PM
Run By: Username
Input Data Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\spoil stockpile profile 76 pct.in
Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\spoil stockpile profile 76 pct.OUT
Unit System: English
Plotted Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\spoil stockpile profile 76 pct.PLT
PROBLEM DESCRIPTION: Spoil Stockpile Profile - 76% Slope
BOUNDARY COORDINATES
1 Top Boundaries

2 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	10.00	200.00	162.00	1
2	0.00	0.00	200.00	152.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	115.0	200.0	24.0	0.00	0.0	0
2	160.0	160.0	500.0	45.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.
5000 Trial Surfaces Have Been Generated.
50 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced Along The Ground Surface Between X = 0.00(ft) and X = 90.00(ft)
Each Surface Terminates Between X = 110.00(ft) and X = 200.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = 0.00(ft)
5.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Evaluated. They Are Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 5000
Number of Trial Surfaces With Valid FS = 5000
Statistical Data On All Valid FS Values:
FS Max = 5.846 FS Min = 1.168 FS Ave = 2.030
Standard Deviation = 0.308 Coefficient of Variation = 15.16 %
Failure Surface Specified By 49 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	4.545	13.455
2	8.887	15.934
3	13.215	18.439
4	17.528	20.967
5	21.827	23.520
6	26.112	26.098
7	30.382	28.700
8	34.637	31.325
9	38.877	33.975
10	43.102	36.649
11	47.311	39.347
12	51.506	42.068
13	55.685	44.814
14	59.848	47.583
15	63.996	50.375
16	68.127	53.191
17	72.243	56.030
18	76.342	58.893
19	80.426	61.778
20	84.492	64.687
21	88.543	67.619
22	92.576	70.574
23	96.593	73.551
24	100.593	76.551
25	104.576	79.574
26	108.541	82.619
27	112.490	85.687
28	116.421	88.777
29	120.334	91.889
30	124.229	95.024
31	128.107	98.180
32	131.967	101.359

33	135.809	104.559
34	139.632	107.781
35	143.438	111.024
36	147.225	114.289
37	150.993	117.575
38	154.742	120.883
39	158.473	124.212
40	162.185	127.562
41	165.878	130.933
42	169.552	134.324
43	173.206	137.737
44	176.841	141.170
45	180.457	144.624
46	184.052	148.098
47	187.629	151.592
48	191.185	155.107
49	191.993	155.915

Circle Center At X = -431.011 ; Y = 781.121 ; and Radius = 882.622

Factor of Safety

*** 1.168 ***

Individual data on the 48 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.3	195.8	0.0	0.0	0.	0.	0.0	0.0	0.0
2	4.3	577.2	0.0	0.0	0.	0.	0.0	0.0	0.0
3	4.3	939.2	0.0	0.0	0.	0.	0.0	0.0	0.0
4	4.3	1282.2	0.0	0.0	0.	0.	0.0	0.0	0.0
5	4.3	1606.0	0.0	0.0	0.	0.	0.0	0.0	0.0
6	4.3	1911.0	0.0	0.0	0.	0.	0.0	0.0	0.0
7	4.3	2197.3	0.0	0.0	0.	0.	0.0	0.0	0.0
8	4.2	2464.8	0.0	0.0	0.	0.	0.0	0.0	0.0
9	4.2	2713.9	0.0	0.0	0.	0.	0.0	0.0	0.0
10	4.2	2944.7	0.0	0.0	0.	0.	0.0	0.0	0.0
11	4.2	3157.2	0.0	0.0	0.	0.	0.0	0.0	0.0
12	4.2	3351.7	0.0	0.0	0.	0.	0.0	0.0	0.0
13	4.2	3528.3	0.0	0.0	0.	0.	0.0	0.0	0.0
14	4.1	3687.2	0.0	0.0	0.	0.	0.0	0.0	0.0
15	4.1	3828.5	0.0	0.0	0.	0.	0.0	0.0	0.0
16	4.1	3952.3	0.0	0.0	0.	0.	0.0	0.0	0.0
17	4.1	4059.0	0.0	0.0	0.	0.	0.0	0.0	0.0
18	4.1	4148.5	0.0	0.0	0.	0.	0.0	0.0	0.0
19	4.1	4221.2	0.0	0.0	0.	0.	0.0	0.0	0.0
20	4.1	4277.2	0.0	0.0	0.	0.	0.0	0.0	0.0
21	4.0	4316.7	0.0	0.0	0.	0.	0.0	0.0	0.0
22	4.0	4339.8	0.0	0.0	0.	0.	0.0	0.0	0.0
23	4.0	4346.8	0.0	0.0	0.	0.	0.0	0.0	0.0
24	4.0	4337.9	0.0	0.0	0.	0.	0.0	0.0	0.0
25	4.0	4313.2	0.0	0.0	0.	0.	0.0	0.0	0.0
26	3.9	4273.0	0.0	0.0	0.	0.	0.0	0.0	0.0
27	3.9	4217.5	0.0	0.0	0.	0.	0.0	0.0	0.0
28	3.9	4146.8	0.0	0.0	0.	0.	0.0	0.0	0.0
29	3.9	4061.2	0.0	0.0	0.	0.	0.0	0.0	0.0
30	3.9	3960.9	0.0	0.0	0.	0.	0.0	0.0	0.0
31	3.9	3846.2	0.0	0.0	0.	0.	0.0	0.0	0.0
32	3.8	3717.2	0.0	0.0	0.	0.	0.0	0.0	0.0
33	3.8	3574.2	0.0	0.0	0.	0.	0.0	0.0	0.0
34	3.8	3417.4	0.0	0.0	0.	0.	0.0	0.0	0.0
35	3.8	3247.1	0.0	0.0	0.	0.	0.0	0.0	0.0
36	3.8	3063.4	0.0	0.0	0.	0.	0.0	0.0	0.0
37	3.7	2866.7	0.0	0.0	0.	0.	0.0	0.0	0.0
38	3.7	2657.1	0.0	0.0	0.	0.	0.0	0.0	0.0
39	3.7	2434.9	0.0	0.0	0.	0.	0.0	0.0	0.0
40	3.7	2200.4	0.0	0.0	0.	0.	0.0	0.0	0.0
41	3.7	1953.7	0.0	0.0	0.	0.	0.0	0.0	0.0
42	3.7	1695.3	0.0	0.0	0.	0.	0.0	0.0	0.0
43	3.6	1425.2	0.0	0.0	0.	0.	0.0	0.0	0.0
44	3.6	1143.9	0.0	0.0	0.	0.	0.0	0.0	0.0
45	3.6	851.5	0.0	0.0	0.	0.	0.0	0.0	0.0

46	3.6	548.3	0.0	0.0	0.	0.	0.0	0.0	0.0
47	3.6	234.5	0.0	0.0	0.	0.	0.0	0.0	0.0
48	0.8	8.6	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	25.455	29.345
2	29.854	31.721
3	34.234	34.132
4	38.596	36.577
5	42.937	39.057
6	47.260	41.571
7	51.562	44.119
8	55.843	46.701
9	60.105	49.316
10	64.345	51.966
11	68.565	54.648
12	72.763	57.364
13	76.939	60.113
14	81.094	62.895
15	85.226	65.710
16	89.337	68.557
17	93.424	71.436
18	97.489	74.348
19	101.530	77.292
20	105.548	80.268
21	109.543	83.275
22	113.514	86.314
23	117.460	89.384
24	121.382	92.485
25	125.280	95.617
26	129.152	98.780
27	133.000	101.973
28	136.822	105.197
29	140.618	108.450
30	144.389	111.734
31	148.134	115.047
32	151.852	118.390
33	155.544	121.762
34	159.209	125.163
35	162.847	128.593
36	166.458	132.051
37	170.041	135.539
38	173.597	139.054
39	177.125	142.597
40	180.624	146.168
41	184.096	149.766
42	184.596	150.293

Circle Center At X = -272.977 ; Y = 587.189 ; and Radius = 632.654

Factor of Safety

*** 1.168 ***

Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	10.000	17.600
2	14.362	20.043
3	18.709	22.515
4	23.039	25.015
5	27.353	27.543
6	31.650	30.098
7	35.931	32.682
8	40.195	35.293
9	44.442	37.932
10	48.672	40.598
11	52.885	43.291
12	57.080	46.012
13	61.257	48.760
14	65.416	51.535
15	69.557	54.337
16	73.680	57.165

17	77.785	60.020
18	81.871	62.902
19	85.938	65.810
20	89.987	68.745
21	94.016	71.705
22	98.026	74.692
23	102.016	77.705
24	105.987	80.743
25	109.938	83.807
26	113.870	86.897
27	117.781	90.012
28	121.672	93.152
29	125.542	96.317
30	129.392	99.508
31	133.221	102.723
32	137.029	105.963
33	140.816	109.227
34	144.582	112.517
35	148.327	115.830
36	152.050	119.168
37	155.751	122.529
38	159.430	125.915
39	163.088	129.324
40	166.723	132.757
41	170.336	136.214
42	173.926	139.693
43	177.494	143.196
44	181.039	146.722
45	184.542	150.252

Circle Center At X = -364.951 ; Y = 692.114 ; and Radius = 771.723

Factor of Safety

*** 1.174 ***

Failure Surface Specified By 38 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	19.091	24.509
2	23.524	26.821
3	27.935	29.176
4	32.323	31.573
5	36.688	34.012
6	41.029	36.492
7	45.347	39.014
8	49.640	41.577
9	53.908	44.181
10	58.151	46.826
11	62.369	49.511
12	66.561	52.237
13	70.727	55.002
14	74.866	57.807
15	78.977	60.652
16	83.062	63.536
17	87.119	66.459
18	91.147	69.420
19	95.147	72.420
20	99.118	75.459
21	103.060	78.535
22	106.972	81.648
23	110.854	84.799
24	114.706	87.987
25	118.528	91.212
26	122.318	94.473
27	126.076	97.770
28	129.804	101.103
29	133.498	104.472
30	137.161	107.875
31	140.791	111.314
32	144.388	114.787
33	147.951	118.295
34	151.480	121.836
35	154.976	125.412

36	158.437	129.020
37	161.864	132.661
38	162.962	133.851

Circle Center At X = -220.191 ; Y = 488.676 ; and Radius = 522.213

Factor of Safety

*** 1.176 ***

Failure Surface Specified By 42 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	32.727	34.873
2	37.117	37.267
3	41.488	39.694
4	45.841	42.155
5	50.174	44.649
6	54.489	47.175
7	58.784	49.735
8	63.060	52.326
9	67.316	54.951
10	71.552	57.607
11	75.768	60.296
12	79.963	63.016
13	84.137	65.769
14	88.290	68.553
15	92.422	71.368
16	96.532	74.215
17	100.621	77.093
18	104.688	80.002
19	108.732	82.942
20	112.754	85.913
21	116.753	88.913
22	120.730	91.945
23	124.683	95.006
24	128.613	98.097
25	132.519	101.219
26	136.402	104.369
27	140.260	107.549
28	144.094	110.759
29	147.903	113.997
30	151.688	117.264
31	155.448	120.560
32	159.183	123.885
33	162.892	127.238
34	166.576	130.618
35	170.234	134.027
36	173.866	137.463
37	177.472	140.927
38	181.051	144.419
39	184.604	147.937
40	188.130	151.482
41	191.628	155.054
42	193.739	157.241

Circle Center At X = -280.006 ; Y = 613.477 ; and Radius = 657.712

Factor of Safety

*** 1.177 ***

Failure Surface Specified By 39 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	45.455	44.545
2	49.869	46.893
3	54.263	49.280
4	58.636	51.704
5	62.987	54.166
6	67.317	56.667
7	71.625	59.204
8	75.911	61.780
9	80.175	64.392
10	84.415	67.041
11	88.632	69.728
12	92.826	72.451
13	96.995	75.210

14	101.141	78.005
15	105.262	80.837
16	109.358	83.704
17	113.429	86.607
18	117.475	89.545
19	121.495	92.518
20	125.489	95.526
21	129.456	98.569
22	133.397	101.646
23	137.311	104.758
24	141.198	107.903
25	145.057	111.082
26	148.888	114.295
27	152.692	117.541
28	156.466	120.819
29	160.213	124.131
30	163.930	127.475
31	167.618	130.851
32	171.276	134.259
33	174.905	137.699
34	178.503	141.171
35	182.071	144.673
36	185.609	148.207
37	189.115	151.771
38	192.591	155.366
39	196.020	158.975

Circle Center At X = -222.000 ; Y = 552.731 ; and Radius = 574.269

Factor of Safety

*** 1.177 ***

Failure Surface Specified By 37 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	56.364	52.836
2	60.803	55.137
3	65.219	57.482
4	69.612	59.870
5	73.981	62.301
6	78.325	64.776
7	82.646	67.293
8	86.940	69.853
9	91.210	72.456
10	95.453	75.100
11	99.670	77.787
12	103.861	80.514
13	108.024	83.284
14	112.159	86.094
15	116.267	88.945
16	120.346	91.836
17	124.396	94.768
18	128.418	97.740
19	132.409	100.751
20	136.371	103.801
21	140.302	106.891
22	144.202	110.019
23	148.072	113.186
24	151.910	116.391
25	155.716	119.633
26	159.489	122.913
27	163.230	126.231
28	166.939	129.585
29	170.613	132.975
30	174.254	136.402
31	177.861	139.865
32	181.434	143.363
33	184.972	146.896
34	188.474	150.464
35	191.942	154.067
36	195.373	157.703
37	197.803	160.331

Circle Center At X = -174.062 ; Y = 502.852 ; and Radius = 505.579

Factor of Safety
*** 1.177 ***

Failure Surface Specified By 46 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	18.182	23.818
2	22.539	26.271
3	26.880	28.752
4	31.205	31.260
5	35.514	33.796
6	39.808	36.359
7	44.084	38.949
8	48.345	41.567
9	52.588	44.211
10	56.815	46.882
11	61.025	49.580
12	65.217	52.305
13	69.392	55.056
14	73.550	57.833
15	77.689	60.637
16	81.811	63.468
17	85.915	66.324
18	90.001	69.206
19	94.068	72.114
20	98.117	75.048
21	102.147	78.008
22	106.158	80.993
23	110.150	84.003
24	114.123	87.039
25	118.076	90.100
26	122.010	93.186
27	125.925	96.297
28	129.819	99.433
29	133.694	102.593
30	137.548	105.778
31	141.383	108.987
32	145.196	112.221
33	148.989	115.478
34	152.762	118.760
35	156.513	122.065
36	160.243	125.395
37	163.953	128.748
38	167.640	132.124
39	171.307	135.524
40	174.951	138.947
41	178.574	142.393
42	182.175	145.862
43	185.754	149.354
44	189.310	152.868
45	192.845	156.405
46	193.463	157.032

Circle Center At X = -366.013 ; Y = 711.262 ; and Radius = 787.518

Factor of Safety
*** 1.181 ***

Failure Surface Specified By 45 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	5.455	14.145
2	9.817	16.589
3	14.163	19.061
4	18.493	21.561
5	22.806	24.090
6	27.103	26.647
7	31.383	29.232
8	35.646	31.845
9	39.891	34.486
10	44.119	37.156
11	48.330	39.852
12	52.522	42.577
13	56.697	45.328

14	60.853	48.108
15	64.991	50.914
16	69.111	53.747
17	73.212	56.608
18	77.294	59.495
19	81.357	62.409
20	85.401	65.350
21	89.425	68.317
22	93.430	71.311
23	97.415	74.331
24	101.380	77.377
25	105.325	80.449
26	109.250	83.547
27	113.154	86.670
28	117.038	89.819
29	120.901	92.994
30	124.743	96.193
31	128.564	99.418
32	132.364	102.668
33	136.142	105.943
34	139.899	109.243
35	143.633	112.567
36	147.346	115.916
37	151.037	119.289
38	154.706	122.686
39	158.352	126.107
40	161.976	129.552
41	165.577	133.021
42	169.155	136.513
43	172.711	140.029
44	176.243	143.568
45	177.718	145.065

Circle Center At X = -364.385 ; Y =   679.591 ; and Radius =   761.314

Factor of Safety

*** 1.181 ***

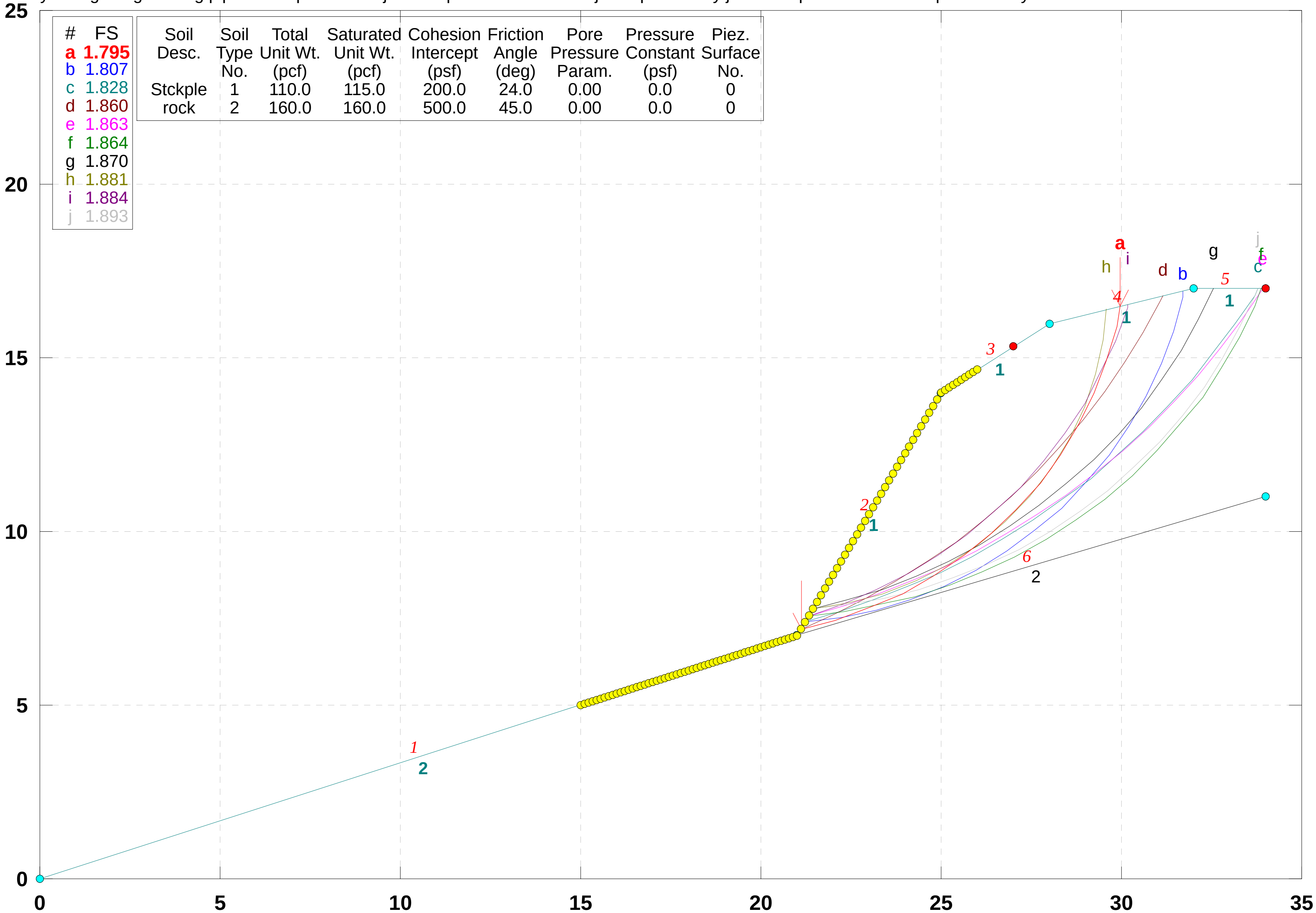
Failure Surface Specified By 32 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	71.818	64.582
2	76.318	66.762
3	80.788	69.002
4	85.228	71.301
5	89.637	73.659
6	94.014	76.076
7	98.359	78.550
8	102.670	81.082
9	106.948	83.672
10	111.190	86.317
11	115.397	89.020
12	119.568	91.777
13	123.702	94.591
14	127.797	97.458
15	131.855	100.380
16	135.873	103.356
17	139.851	106.385
18	143.788	109.467
19	147.685	112.600
20	151.539	115.786
21	155.350	119.022
22	159.118	122.309
23	162.842	125.645
24	166.521	129.031
25	170.155	132.465
26	173.743	135.948
27	177.284	139.477
28	180.778	143.054
29	184.224	146.677
30	187.622	150.345
31	190.970	154.059
32	193.816	157.300

```
Circle Center At X =   -89.770 ; Y =   403.819 ; and Radius =   375.756
       Factor of Safety
      ***    1.182   ***
          **** END OF GSTABL7 OUTPUT ****
```

Spoil Stockpile Cross Section - Trench Material on Gentle Slope

y:\design engineering\pipeline\mvp\landslide\jnf site specific stabilization\jnf slope stability\jnf1 stockpile cross section.pl2 Run By: Username 12/20/2016 11:22AM



Soil Desc.	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Stckple	1	110.0	115.0	200.0	24.0	0.00	0.0	0
rock	2	160.0	160.0	500.0	45.0	0.00	0.0	0

GSTABL7 v.2 FSmin=1.795

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****

SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.

****

Analysis Run Date: 12/20/2016
Time of Run: 11:22AM
Run By: Username
Input Data Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf1 stockpile cross section.in
Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf1 stockpile cross section.OUT
Unit System: English
Plotted Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf1 stockpile cross section.PLT
PROBLEM DESCRIPTION: Spoil Stockpile Cross Section - Trench Material on Gentle Slope

BOUNDARY COORDINATES
5 Top Boundaries
6 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	21.00	7.00	2
2	21.00	7.00	25.00	14.00	1
3	25.00	14.00	28.00	16.00	1
4	28.00	16.00	32.00	17.00	1
5	32.00	17.00	34.00	17.00	1
6	21.00	7.00	34.00	11.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	115.0	200.0	24.0	0.00	0.0	0
2	160.0	160.0	500.0	45.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.
1000 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 15.00(ft)
and X = 26.00(ft)
Each Surface Terminates Between X = 27.00(ft)
and X = 34.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
1.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 68.316 FS Min = 1.795 FS Ave = 4.265
Standard Deviation = 3.300 Coefficient of Variation = 77.37 %
Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.111	7.194
2	22.076	7.456

3	23.016	7.799
4	23.922	8.222
5	24.788	8.722
6	25.608	9.294
7	26.376	9.935
8	27.085	10.639
9	27.732	11.403
10	28.310	12.218
11	28.815	13.081
12	29.245	13.984
13	29.595	14.921
14	29.863	15.884
15	29.977	16.494

Circle Center At X = 18.567 ; Y = 18.509 ; and Radius = 11.597
Factor of Safety
*** 1.795 ***
Individual data on the 16 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.0	75.8	0.0	0.0	0.	0.	0.0	0.0	0.0
2	0.9	214.7	0.0	0.0	0.	0.	0.0	0.0	0.0
3	0.9	329.9	0.0	0.0	0.	0.	0.0	0.0	0.0
4	0.9	419.2	0.0	0.0	0.	0.	0.0	0.0	0.0
5	0.2	117.1	0.0	0.0	0.	0.	0.0	0.0	0.0
6	0.6	342.5	0.0	0.0	0.	0.	0.0	0.0	0.0
7	0.8	426.2	0.0	0.0	0.	0.	0.0	0.0	0.0
8	0.7	379.9	0.0	0.0	0.	0.	0.0	0.0	0.0
9	0.6	325.9	0.0	0.0	0.	0.	0.0	0.0	0.0
10	0.3	127.5	0.0	0.0	0.	0.	0.0	0.0	0.0
11	0.3	137.6	0.0	0.0	0.	0.	0.0	0.0	0.0
12	0.5	194.2	0.0	0.0	0.	0.	0.0	0.0	0.0
13	0.4	128.7	0.0	0.0	0.	0.	0.0	0.0	0.0
14	0.4	73.3	0.0	0.0	0.	0.	0.0	0.0	0.0
15	0.3	30.4	0.0	0.0	0.	0.	0.0	0.0	0.0
16	0.1	3.7	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 17 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.222	7.389
2	22.213	7.527
3	23.188	7.748
4	24.141	8.051
5	25.065	8.432
6	25.954	8.890
7	26.801	9.422
8	27.601	10.022
9	28.347	10.688
10	29.035	11.414
11	29.658	12.196
12	30.214	13.027
13	30.698	13.902
14	31.107	14.815
15	31.437	15.759
16	31.687	16.727
17	31.721	16.930

Circle Center At X = 20.078 ; Y = 19.204 ; and Radius = 11.870
Factor of Safety
*** 1.807 ***
Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.222	7.389
2	22.179	7.680
3	23.121	8.015
4	24.046	8.394
5	24.953	8.816
6	25.839	9.280
7	26.702	9.785

8	27.540	10.330
9	28.352	10.914
10	29.136	11.535
11	29.889	12.193
12	30.611	12.885
13	31.300	13.609
14	31.954	14.366
15	32.572	15.152
16	33.152	15.967
17	33.694	16.807
18	33.806	17.000

Circle Center At X = 15.515 ; Y = 27.903 ; and Radius = 21.294
Factor of Safety
*** 1.828 ***
Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.111	7.194
2	22.022	7.607
3	22.910	8.067
4	23.774	8.571
5	24.611	9.118
6	25.418	9.708
7	26.195	10.338
8	26.938	11.007
9	27.646	11.713
10	28.317	12.454
11	28.950	13.229
12	29.542	14.035
13	30.091	14.870
14	30.598	15.733
15	31.059	16.620
16	31.134	16.784

Circle Center At X = 13.511 ; Y = 25.172 ; and Radius = 19.518
Factor of Safety
*** 1.860 ***
Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.333	7.583
2	22.292	7.867
3	23.237	8.196
4	24.165	8.568
5	25.074	8.983
6	25.964	9.441
7	26.830	9.940
8	27.673	10.478
9	28.489	11.056
10	29.277	11.671
11	30.036	12.323
12	30.763	13.009
13	31.458	13.729
14	32.118	14.480
15	32.742	15.261
16	33.329	16.071
17	33.877	16.908
18	33.931	17.000

Circle Center At X = 15.762 ; Y = 28.172 ; and Radius = 21.329
Factor of Safety
*** 1.863 ***
Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.333	7.583
2	22.326	7.701
3	23.309	7.885
4	24.277	8.136
5	25.226	8.451
6	26.152	8.830
7	27.050	9.270

8	27.916	9.770
9	28.746	10.327
10	29.537	10.939
11	30.285	11.603
12	30.986	12.316
13	31.638	13.074
14	32.236	13.875
15	32.780	14.715
16	33.265	15.589
17	33.691	16.494
18	33.888	17.000

Circle Center At X = 20.098 ; Y = 22.307 ; and Radius = 14.776

Factor of Safety

*** 1.864 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.444	7.778
2	22.413	8.028
3	23.363	8.338
4	24.293	8.707
5	25.197	9.134
6	26.073	9.617
7	26.916	10.154
8	27.725	10.743
9	28.494	11.381
10	29.222	12.066
11	29.906	12.796
12	30.543	13.567
13	31.129	14.377
14	31.664	15.222
15	32.145	16.099
16	32.568	17.000

Circle Center At X = 17.952 ; Y = 23.309 ; and Radius = 15.919

Factor of Safety

*** 1.870 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.444	7.778
2	22.431	7.942
3	23.394	8.212
4	24.321	8.586
5	25.202	9.059
6	26.027	9.625
7	26.785	10.277
8	27.467	11.008
9	28.065	11.810
10	28.572	12.671
11	28.983	13.583
12	29.291	14.534
13	29.495	15.514
14	29.579	16.395

Circle Center At X = 20.444 ; Y = 16.870 ; and Radius = 9.147

Factor of Safety

*** 1.881 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.333	7.583
2	22.277	7.914
3	23.193	8.315
4	24.077	8.783
5	24.923	9.316
6	25.727	9.911
7	26.484	10.564
8	27.190	11.272
9	27.842	12.031
10	28.434	12.836
11	28.965	13.684

12	29.431	14.569
13	29.829	15.486
14	30.158	16.430
15	30.189	16.547

Circle Center At X = 17.385 ; Y = 20.346 ; and Radius = 13.360

Factor of Safety

*** 1.884 ***

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	21.444	7.778
2	22.437	7.899
3	23.419	8.088
4	24.386	8.343
5	25.333	8.664
6	26.256	9.048
7	27.151	9.495
8	28.013	10.001
9	28.839	10.566
10	29.624	11.185
11	30.365	11.856
12	31.059	12.576
13	31.702	13.342
14	32.291	14.150
15	32.824	14.996
16	33.298	15.877
17	33.710	16.788
18	33.790	17.000

Circle Center At X = 20.170 ; Y = 22.357 ; and Radius = 14.635

Factor of Safety

*** 1.893 ***

**** END OF GSTABL7 OUTPUT ****

Spoil Stockpile Cross Section - Narrow Ridge

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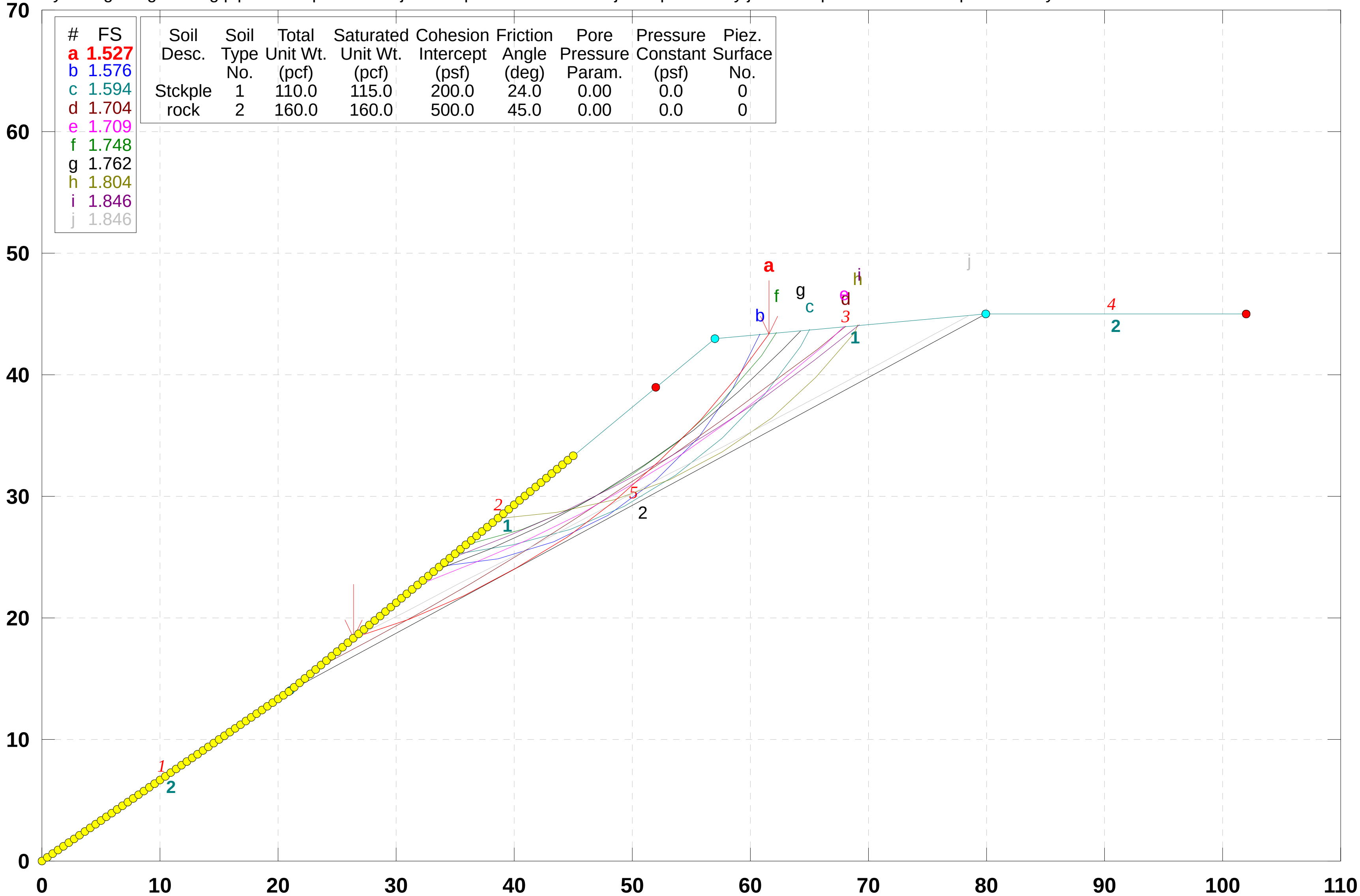

GSTABL7 v.2 FSmin=1.527

Safety Factors Are Calculated By The Modified Bishop Method

***** GSTABL7 *****

** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **

****
SLOPE STABILITY ANALYSIS SYSTEM
Modified Bishop, Simplified Janbu, or GLE Method of Slices.
(Includes Spencer & Morgenstern-Price Type Analysis)
Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
Nonlinear Undrained Shear Strength, Curved Phi Envelope,
Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
****

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Time of Run: 11:22AM
Run By: Username
Input Data Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf2 stockpile cross section.in
Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf2 stockpile cross section.OUT
Unit System: English
Plotted Output Filename: Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specific Stabilization\JNF Slope Stability\jnf2 stockpile cross section.PLT
PROBLEM DESCRIPTION: Spoil Stockpile Cross Section -
Narrow Ridge

BOUNDARY COORDINATES
4 Top Boundaries
5 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	0.00	0.00	21.00	14.00	2
2	21.00	14.00	57.00	43.00	1
3	57.00	43.00	80.00	45.00	1
4	80.00	45.00	102.00	45.00	2
5	21.00	14.00	80.00	45.00	2

Default Y-Origin = 0.00(ft)
Default X-Plus Value = 0.00(ft)
Default Y-Plus Value = 0.00(ft)

ISOTROPIC SOIL PARAMETERS
2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	110.0	115.0	200.0	24.0	0.00	0.0	0
2	160.0	160.0	500.0	45.0	0.00	0.0	0

A Critical Failure Surface Searching Method, Using A Random
Technique For Generating Circular Surfaces, Has Been Specified.
1000 Trial Surfaces Have Been Generated.
10 Surface(s) Initiate(s) From Each Of 100 Points Equally Spaced
Along The Ground Surface Between X = 0.00(ft)
and X = 45.00(ft)
Each Surface Terminates Between X = 52.00(ft)
and X = 102.00(ft)
Unless Further Limitations Were Imposed, The Minimum Elevation
At Which A Surface Extends Is Y = 0.00(ft)
5.00(ft) Line Segments Define Each Trial Failure Surface.
Following Are Displayed The Ten Most Critical Of The Trial
Failure Surfaces Evaluated. They Are
Ordered - Most Critical First.
* * Safety Factors Are Calculated By The Modified Bishop Method * *
Total Number of Trial Surfaces Attempted = 1000
Number of Trial Surfaces With Valid FS = 1000
Statistical Data On All Valid FS Values:
FS Max = 10.047 FS Min = 1.527 FS Ave = 4.097
Standard Deviation = 1.593 Coefficient of Variation = 38.89 %
Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.364	18.321
2	31.113	19.885

3	35.728	21.808
4	40.182	24.080
5	44.449	26.687
6	48.503	29.614
7	52.320	32.843
8	55.879	36.355
9	59.157	40.130
10	61.583	43.398

Circle Center At X = 8.482 ; Y = 80.703 ; and Radius = 64.894
Factor of Safety
*** 1.527 ***
Individual data on the 10 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	4.7	590.8	0.0	0.0	0.	0.	0.0	0.0	0.0
2	4.6	1603.7	0.0	0.0	0.	0.	0.0	0.0	0.0
3	4.5	2309.6	0.0	0.0	0.	0.	0.0	0.0	0.0
4	4.3	2716.0	0.0	0.0	0.	0.	0.0	0.0	0.0
5	4.1	2841.3	0.0	0.0	0.	0.	0.0	0.0	0.0
6	3.8	2714.5	0.0	0.0	0.	0.	0.0	0.0	0.0
7	3.6	2373.9	0.0	0.0	0.	0.	0.0	0.0	0.0
8	1.1	684.3	0.0	0.0	0.	0.	0.0	0.0	0.0
9	2.2	998.1	0.0	0.0	0.	0.	0.0	0.0	0.0
10	2.4	407.8	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	33.636	24.179
2	38.594	24.828
3	43.383	26.265
4	47.879	28.454
5	51.964	31.337
6	55.533	34.839
7	58.492	38.869
8	60.765	43.322
9	60.767	43.328

Circle Center At X = 32.106 ; Y = 55.142 ; and Radius = 31.001
Factor of Safety
*** 1.576 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	35.000	25.278
2	39.953	25.959
3	44.777	27.277
4	49.388	29.209
5	53.710	31.723
6	57.670	34.776
7	61.200	38.317
8	64.241	42.286
9	65.058	43.701

Circle Center At X = 32.244 ; Y = 63.656 ; and Radius = 38.477
Factor of Safety
*** 1.594 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	23.182	15.758
2	27.623	18.054
3	32.024	20.428
4	36.382	22.878
5	40.698	25.403
6	44.968	28.004
7	49.193	30.678
8	53.370	33.426
9	57.499	36.246
10	61.578	39.138
11	65.606	42.100

```
   12         68.044       43.960
Circle Center At X =  -105.757 ; Y =   270.646 ; and Radius =   285.645
       Factor of Safety
      ***    1.704   ***
Failure Surface Specified By 10 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         31.818       22.715
    2         36.502       24.465
    3         41.099       26.431
    4         45.599       28.610
    5         49.993       30.996
    6         54.271       33.584
    7         58.424       36.369
    8         62.442       39.344
    9         66.318       42.504
   10         67.933       43.951
Circle Center At X =    -3.069 ; Y =   123.372 ; and Radius =   106.532
       Factor of Safety
      ***    1.709   ***
Failure Surface Specified By  8 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         35.909       26.010
    2         40.730       27.338
    3         45.366       29.209
    4         49.758       31.600
    5         53.846       34.478
    6         57.578       37.806
    7         60.903       41.539
    8         62.251       43.457
Circle Center At X =    26.961 ; Y =    68.131 ; and Radius =    43.061
       Factor of Safety
      ***    1.748   ***
Failure Surface Specified By  9 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         33.182       23.813
    2         37.864       25.566
    3         42.424       27.618
    4         46.842       29.960
    5         51.099       32.583
    6         55.177       35.475
    7         59.060       38.625
    8         62.732       42.019
    9         64.265       43.632
Circle Center At X =     8.424 ; Y =    97.083 ; and Radius =    77.340
       Factor of Safety
      ***    1.762   ***
Failure Surface Specified By  9 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         38.636       28.207
    2         43.619       28.627
    3         48.506       29.683
    4         53.217       31.357
    5         57.675       33.622
    6         61.805       36.440
    7         65.540       39.764
    8         68.818       43.540
    9         69.161       44.057
Circle Center At X =    37.866 ; Y =    67.093 ; and Radius =    38.894
       Factor of Safety
      ***    1.804   ***
Failure Surface Specified By  9 Coordinate Points
  Point      X-Surf      Y-Surf
   No.        (ft)        (ft)
    1         34.545       24.912
    2         39.230       26.659
    3         43.837       28.602
```

4	48.358	30.739
5	52.784	33.064
6	57.108	35.575
7	61.322	38.266
8	65.419	41.132
9	69.254	44.066

Circle Center At X = -4.442 ; Y = 136.608 ; and Radius = 118.305

Factor of Safety

*** 1.846 ***

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	26.364	18.321
2	30.835	20.559
3	35.303	22.802
4	39.769	25.050
5	44.233	27.304
6	48.693	29.563
7	53.151	31.827
8	57.607	34.096
9	62.059	36.371
10	66.509	38.651
11	70.956	40.936
12	75.401	43.227
13	78.596	44.878

Circle Center At X = -1871.535 ; Y = 3815.827 ; and Radius = 4245.359

Factor of Safety

*** 1.846 ***

**** END OF GSTABL7 OUTPUT ****

Spoil Stockpile Cross Section - Sidehill

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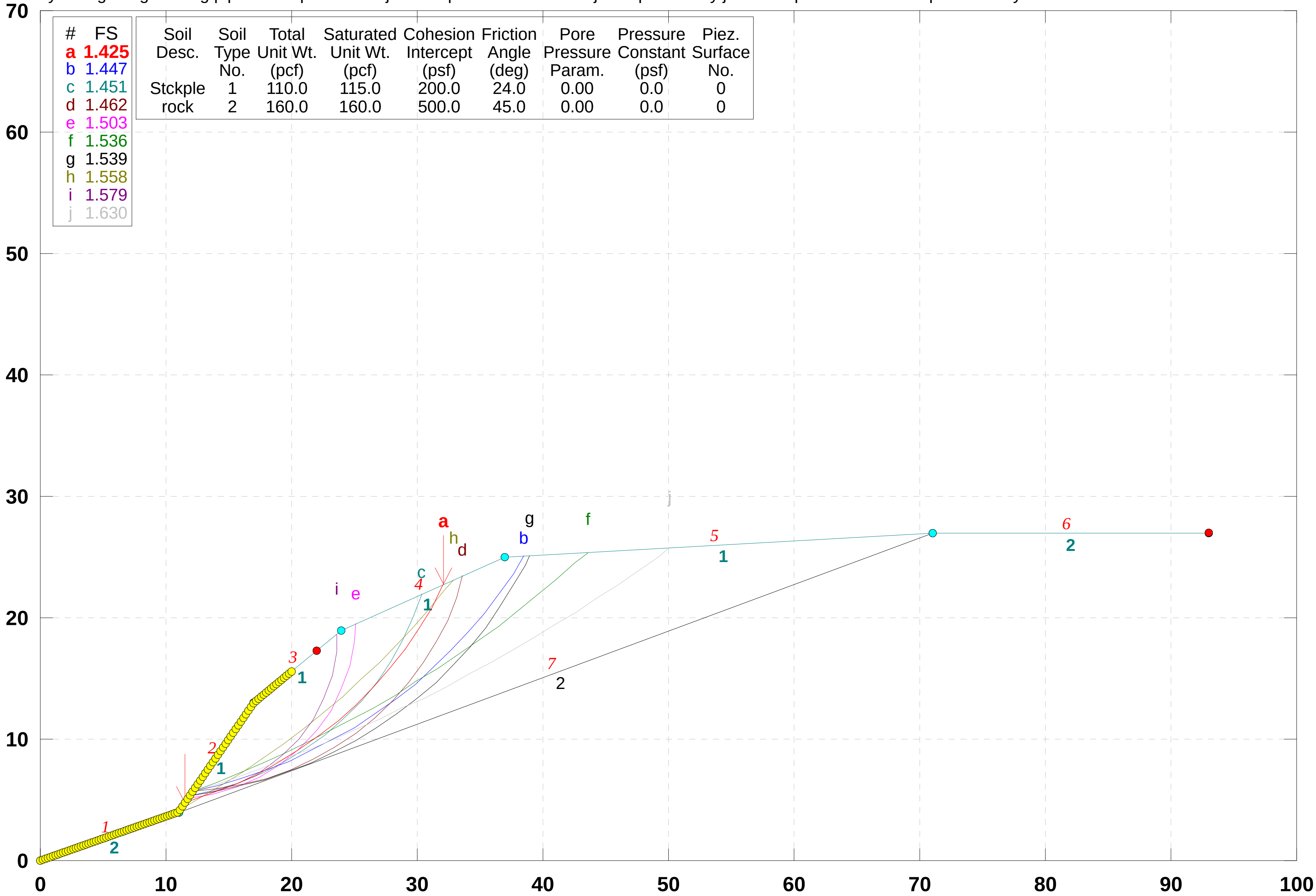

GSTABL7 v.2 FSmin=1.425

Safety Factors Are Calculated By The Modified Bishop Method

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                         ***  GSTABL7  ***
             ** GSTABL7 by Dr. Garry H. Gregory, Ph.D.,P.E.,D.GE **
      ** Original Version 1.0, January 1996; Current Ver. 2.005.3, Feb. 2013 **
               (All Rights Reserved-Unauthorized Use Prohibited)
  *********************************************************************************
                    SLOPE STABILITY ANALYSIS SYSTEM
         Modified Bishop, Simplified Janbu, or GLE Method of Slices.
         (Includes Spencer & Morgenstern-Price Type Analysis)
         Including Pier/Pile, Reinforcement, Soil Nail, Tieback,
         Nonlinear Undrained Shear Strength, Curved Phi Envelope,
         Anisotropic Soil, Fiber-Reinforced Soil, Boundary Loads, Water
         Surfaces, Pseudo-Static & Newmark Earthquake, and Applied Forces.
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  Run By:                    Username
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ic Stabilization\JNF Slope Stability\jnf3 stockpile cross section.in
  Output Filename:           Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf3 stockpile cross section.OUT
  Unit System:               English
  Plotted Output Filename:   Y:\Design Engineering\Pipeline\MVP\Landslide\JNF Site Specif
ic Stabilization\JNF Slope Stability\jnf3 stockpile cross section.PLT
  PROBLEM DESCRIPTION:  Spoil Stockpile Cross Section -
                        Sidehill
  BOUNDARY COORDINATES
      6 Top   Boundaries
      7 Total Boundaries
  Boundary     X-Left     Y-Left    X-Right    Y-Right    Soil Type
     No.        (ft)       (ft)       (ft)       (ft)     Below Bnd
      1          0.00       0.00      11.00       4.00        2
      2         11.00       4.00      17.00      13.00        1
      3         17.00      13.00      24.00      19.00        1
      4         24.00      19.00      37.00      25.00        1
      5         37.00      25.00      71.00      27.00        1
      6         71.00      27.00      93.00      27.00        2
      7         11.00       4.00      71.00      27.00        2
  Default Y-Origin = 0.00(ft)
  Default X-Plus Value = 0.00(ft)
  Default Y-Plus Value = 0.00(ft)
 ISOTROPIC SOIL PARAMETERS
   2 Type(s) of Soil
  Soil  Total  Saturated  Cohesion Friction   Pore   Pressure   Piez.
  Type Unit Wt. Unit Wt. Intercept   Angle  Pressure Constant Surface
   No.  (pcf)    (pcf)     (psf)     (deg)    Param.   (psf)     No.
    1   110.0    115.0     200.0     24.0    0.00       0.0      0
    2   160.0    160.0     500.0     45.0    0.00       0.0      0
  A Critical Failure Surface Searching Method, Using A Random
  Technique For Generating Circular Surfaces, Has Been Specified.
  1000 Trial Surfaces Have Been Generated.
    10 Surface(s) Initiate(s) From Each Of   100 Points Equally Spaced
  Along The Ground Surface Between  X =   0.00(ft)
                               and  X =  20.00(ft)
  Each Surface Terminates Between   X =  22.00(ft)
                              and   X =  93.00(ft)
  Unless Further Limitations Were Imposed, The Minimum Elevation
  At Which A Surface Extends Is  Y =      0.00(ft)
   2.00(ft) Line Segments Define Each Trial Failure Surface.
  Following Are Displayed The Ten Most Critical Of The Trial
        Failure Surfaces Evaluated. They Are
        Ordered - Most Critical First.
        * * Safety Factors Are Calculated By The Modified Bishop Method * *
        Total Number of Trial Surfaces Attempted =  1000
        Number of Trial Surfaces With Valid FS = 1000
        Statistical Data On All Valid FS Values:
           FS Max =  46.336   FS Min =   1.425   FS Ave =   4.405
           Standard Deviation =    2.364   Coefficient of Variation =   53.66 %
        Failure Surface Specified By 16 Coordinate Points
          Point      X-Surf      Y-Surf
           No.        (ft)        (ft)
```

1	11.515	4.773
2	13.412	5.407
3	15.267	6.155
4	17.073	7.013
5	18.824	7.979
6	20.514	9.049
7	22.136	10.219
8	23.685	11.485
9	25.154	12.842
10	26.538	14.286
11	27.833	15.810
12	29.034	17.410
13	30.135	19.079
14	31.134	20.812
15	32.026	22.601
16	32.081	22.730

Circle Center At X = 1.979 ; Y = 36.450 ; and Radius = 33.081

Factor of Safety

*** 1.425 ***

Individual data on the 17 slices

Slice No.	Width (ft)	Weight (lbs)	Water Force Top (lbs)	Water Force Bot (lbs)	Tie Force Norm (lbs)	Tie Force Tan (lbs)	Earthquake Force Hor (lbs)	Earthquake Force Ver (lbs)	Surcharge Load (lbs)
1	1.9	230.6	0.0	0.0	0.	0.	0.0	0.0	0.0
2	1.9	658.7	0.0	0.0	0.	0.	0.0	0.0	0.0
3	1.7	978.7	0.0	0.0	0.	0.	0.0	0.0	0.0
4	0.1	48.6	0.0	0.0	0.	0.	0.0	0.0	0.0
5	1.8	1216.9	0.0	0.0	0.	0.	0.0	0.0	0.0
6	1.7	1259.0	0.0	0.0	0.	0.	0.0	0.0	0.0
7	1.6	1262.0	0.0	0.0	0.	0.	0.0	0.0	0.0
8	1.5	1228.7	0.0	0.0	0.	0.	0.0	0.0	0.0
9	0.3	250.9	0.0	0.0	0.	0.	0.0	0.0	0.0
10	1.2	883.0	0.0	0.0	0.	0.	0.0	0.0	0.0
11	1.4	957.7	0.0	0.0	0.	0.	0.0	0.0	0.0
12	1.3	772.4	0.0	0.0	0.	0.	0.0	0.0	0.0
13	1.2	585.8	0.0	0.0	0.	0.	0.0	0.0	0.0
14	1.1	403.9	0.0	0.0	0.	0.	0.0	0.0	0.0
15	1.0	232.6	0.0	0.0	0.	0.	0.0	0.0	0.0
16	0.9	77.7	0.0	0.0	0.	0.	0.0	0.0	0.0
17	0.1	0.3	0.0	0.0	0.	0.	0.0	0.0	0.0

Failure Surface Specified By 18 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.121	5.682
2	14.063	6.160
3	15.979	6.735
4	17.864	7.403
5	19.714	8.164
6	21.523	9.016
7	23.288	9.956
8	25.005	10.982
9	26.669	12.092
10	28.275	13.283
11	29.821	14.552
12	31.302	15.896
13	32.715	17.312
14	34.055	18.796
15	35.321	20.345
16	36.508	21.954
17	37.615	23.620
18	38.487	25.087

Circle Center At X = 3.445 ; Y = 45.085 ; and Radius = 40.347

Factor of Safety

*** 1.447 ***

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	11.919	5.379
2	13.868	5.826

3	15.773	6.436
4	17.620	7.203
5	19.396	8.123
6	21.089	9.188
7	22.686	10.392
8	24.177	11.725
9	25.550	13.179
10	26.797	14.743
11	27.908	16.406
12	28.876	18.156
13	29.693	19.982
14	30.354	21.869
15	30.373	21.941

Circle Center At X = 7.569 ; Y = 28.791 ; and Radius = 23.813

Factor of Safety

*** 1.451 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.121	5.682
2	14.111	5.880
3	16.077	6.247
4	18.005	6.779
5	19.881	7.472
6	21.692	8.322
7	23.423	9.323
8	25.064	10.467
9	26.602	11.745
10	28.026	13.150
11	29.325	14.670
12	30.492	16.295
13	31.516	18.013
14	32.390	19.811
15	33.109	21.678
16	33.622	23.441

Circle Center At X = 10.785 ; Y = 29.194 ; and Radius = 23.551

Factor of Safety

*** 1.462 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	11.717	5.076
2	13.689	5.409
3	15.599	6.003
4	17.411	6.849
5	19.095	7.929
6	20.617	9.225
7	21.953	10.714
8	23.077	12.369
9	23.969	14.159
10	24.613	16.052
11	24.997	18.015
12	25.085	19.501

Circle Center At X = 10.251 ; Y = 19.841 ; and Radius = 14.838

Factor of Safety

*** 1.503 ***

Failure Surface Specified By 20 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.121	5.682
2	13.982	6.415
3	15.827	7.187
4	17.655	7.997
5	19.467	8.846
6	21.260	9.732
7	23.034	10.655
8	24.788	11.616
9	26.522	12.612
10	28.235	13.645
11	29.925	14.713

12	31.594	15.817
13	33.238	16.955
14	34.859	18.127
15	36.454	19.333
16	38.024	20.572
17	39.568	21.843
18	41.085	23.147
19	42.574	24.482
20	43.540	25.385

Circle Center At X =   -21.966 ; Y =   94.941 ; and Radius =   95.546

Factor of Safety

*** 1.536 ***

Failure Surface Specified By 19 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	11.919	5.379
2	13.895	5.690
3	15.849	6.115
4	17.776	6.651
5	19.668	7.298
6	21.520	8.053
7	23.326	8.913
8	25.079	9.876
9	26.773	10.939
10	28.404	12.097
11	29.965	13.348
12	31.451	14.686
13	32.857	16.108
14	34.180	17.608
15	35.413	19.183
16	36.554	20.825
17	37.598	22.531
18	38.542	24.294
19	38.922	25.113

Circle Center At X =   7.512 ; Y =   39.776 ; and Radius =   34.678

Factor of Safety

*** 1.539 ***

Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	11.111	4.167
2	12.836	5.178
3	14.533	6.237
4	16.201	7.342
5	17.837	8.492
6	19.441	9.686
7	21.011	10.925
8	22.547	12.206
9	24.047	13.528
10	25.510	14.892
11	26.936	16.295
12	28.322	17.737
13	29.668	19.216
14	30.972	20.732
15	32.235	22.283
16	32.853	23.086

Circle Center At X =   -24.734 ; Y =   67.312 ; and Radius =   72.609

Factor of Safety

*** 1.558 ***

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	11.919	5.379
2	13.885	5.746
3	15.772	6.408
4	17.537	7.350
5	19.138	8.549
6	20.538	9.977
7	21.704	11.602
8	22.610	13.385

9	23.234	15.285
10	23.561	17.258
11	23.578	18.638

Circle Center At X = 10.501 ; Y = 18.414 ; and Radius = 13.112

Factor of Safety

*** 1.579 ***

Failure Surface Specified By 23 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	12.121	5.682
2	14.014	6.328
3	15.897	7.002
4	17.769	7.706
5	19.630	8.437
6	21.480	9.198
7	23.318	9.986
8	25.144	10.802
9	26.957	11.646
10	28.757	12.518
11	30.544	13.417
12	32.316	14.344
13	34.075	15.297
14	35.818	16.277
15	37.546	17.283
16	39.259	18.316
17	40.956	19.375
18	42.636	20.460
19	44.299	21.570
20	45.946	22.706
21	47.575	23.866
22	49.186	25.052
23	50.135	25.773

Circle Center At X = -29.200 ; Y = 129.898 ; and Radius = 130.909

Factor of Safety

*** 1.630 ***

**** END OF GSTABL7 OUTPUT ****