Dam 2 Stability Evaluation

Dam Crest Elevation 1,248 feet

Prepared for
Northshore Mining Company
Silver Bay, Minnesota

June 2016

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Certifications

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

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1.0 Introduction

1.1 Introduction

This report presents the seepage and slope stability analyses performed by Barr Engineering Co. (Barr) for the raise of the Dam 2 embankment at the Northshore Mining Company (NSM) Milepost 7 Tailing Basin (Milepost 7) facility in Silver Bay, Minnesota. Barr previously performed a detailed slope stability and seepage analysis for the raise of Dam 2 to elevation 1,230 feet in 2009. As part of the engineering effort in 2009, preliminary analyses were also performed on dam raises to elevations 1,245 and 1,315 feet. Barr has recently completed detailed analyses for the raise of Dam 2 to elevation 1,248 feet to determine the seepage and slope stability characteristics. A plan view showing the location of Dam 2 is included in the Dam 2 construction plans, attached in Appendix A.

NSM staff and equipment are planned to be utilized to construct the Dam 2 raises to 1,243 feet at this time. The dam was originally planned to be subsequently raised to 1,248 feet; however, long range planning at the end of 2015 resulted in a potential raise to 1,253 feet after the analyses were completed. Due to a plant shutdown between December 2015 and April 2016, an adjustment will be required to the long range plan, anticipated in the fall of 2016, which will likely change the required dam construction elevations. As a result of the changes, analyses for dam crest elevations other than 1,248 feet will be performed at a later date.

1.2 Background

The following sections provide a brief summary of the dam construction background and previous subsurface investigations and laboratory testing.

1.2.1 Dam Construction

Dam 2 is located at the northern end of the Milepost 7 tailings basin and is approximately 5,700 feet long. Dam 2 was initially constructed as a sand and gravel starter dam with a glacial till cutoff incorporated as the central core in the starter dam. The starter dam was constructed on natural soils consisting of approximately 10 to 20 feet of lacustrine clay overlying glacial till soils. The fill material placed on natural ground to the existing dam elevation consists of plant aggregate, which extends upstream of the starter dam about 500 to 600 feet. After completion of the plant aggregate placement, fine tailings were discharged into the basin creating beaches,

The original intent was for Dam 2 to be raised using downstream construction methods. In about 2003, however, the dam raises were changed to upstream construction, with a filter berm constructed about 800 feet upstream of the starter dam. A seepage collection trench was also constructed immediately upstream of the glacial till seepage cutoff in 2003 and 2004 to collect and route seepage to the ends of the dam. Before the filter berm was constructed, the mode of dam construction was to create beaches by discharging tailings into the basin. In this area, however, about 10-15 feet of plant aggregate was used to cover the previously deposited fine tailings, which is about 30 feet thick, in accordance with the Closure Consensus Plan. The area downstream of the filter berm is raised using only plant aggregate, and presently, approximately 50 to 60 feet of plant aggregate exists over the fine tailings. The downstream slope for Dam 2 (above about elevation 1,200 feet) will be 6 horizontal to 1 vertical (6H:1V) up to the ultimate height of the dam at elevation 1,315 feet using the existing cross section.

A peat deposit overlying the lacustrine clay and glacial till is present in the approximate middle portion of the dam cross section. The peat has been compressed from its original 10 foot thickness to a thickness of about 3 to 5 feet. Previous investigations identify an alluvial channel cut into the underlying glacial till in the center of the dam site near the middle of the dam cross section. A toe berm consisting of plant aggregate was constructed in 1997 along the downstream toe of Dam 2 in the area of the lowest natural ground and where the dam section will be highest. The purpose of the toe berm was to increase the dam's stability by providing a means for drainage of seepage and additional weight along the toe of the dam.

A seepage cutoff was constructed in the northeastern corner of Dam 2 in May 2012. The seepage cutoff was constructed beyond the eastern extent of the clay core to reduce the potential for a significant amount of seepage to flow along the hillside, through more permeable plant aggregate zones located in this area of the dam. The first stage consisted of a soil-cement-bentonite cutoff to elevation 1,216 feet, with the second stage consisting of compacted clay till to a present surface elevation of 1,240 feet. The cutoff will be extended vertically with glacial till as part of subsequent dam raises to the ultimate dam height.

Long range planning was undertaken in 2014 and completed in 2015. As a result of developing seepage and stability models prior to completion of planning, the dam configurations in the models vary slightly in elevation from the next anticipated raise. The elevations shown in Table 1 correspond to the planned construction process over the next few years. It can also be seen from Table 1 that the modeled dam scenario at the filter berm and backer area is actually greater than planned for 2017 and represents a conservative loading analysis. This report supports the dam construction until 2017 or the elevations represented within that time frame as shown.

Table 1 Proposed Dam 2 Construction

Year	Construction Zone	Proposed Elevation (feet)	Model Scenario
2015-2016	Filter and backer material	1243	1248
2017	Dam Crest	1243	1248
2018	New Railroad Fill	1270	To be completed at a later date
2019	Filter and backer material Remaining Railroad fill	1253 1270	To be completed at a later date
2021	Filter and Backer material	1260	To be completed at a later date
2023	Dam Crest	1260	To be completed at a later date

1.2.2 Previous Investigations

Extensive subsurface investigation and laboratory testing has been performed since the 1970s at Milepost 7. Klohn-Leonoff (Klohn) of Calgary, Alberta, performed numerous test borings and laboratory testing, and presented the data in several reports from 1974 through 1987. Sitka Corp. (Sitka) performed a field investigation, including test borings with instrumentation installations, cone penetration test (CPT) soundings, field vane shear testing (FVST), and laboratory testing in 1996, presenting this information in reports submitted in 1997. Sitka also submitted a report in 1998 discussing the instrumentation installed in 1997. Barr performed a geotechnical investigation and laboratory testing to further augment subsurface information in 2005, 2006, and 2007, as well. These efforts included CPT soundings, testing borings with instrumentation installations, FVST, and laboratory testing. Most recently, four test borings were performed at Dam 2 in 2015 to allow installation of nests of vibrating wire piezometers, including two borings at the crest of the dam and two borings at the toe of the dam at stations 34+75 and 42+00.

2.0 Methods

2.1 Analysis Software

GeoStudio, a limit equilibrium slope stability and seepage modeling software, was used to analyze the Dam 2 raise to elevation 1,248 feet. The 2012 version of the software, produced by GEO-SLOPE International, Ltd. of Calgary, Alberta, was utilized to determine the factors of safety for the downstream slopes. Spencer's Method was used to calculate the factor of safety of the dam for the slope stability analyses. This method is considered adequate because it satisfies conditions of static equilibrium and provides a factor of safety based on both force and moment equilibrium.

2.2 Model Geometry

The geometry of the existing dam surface was based upon 2014 LiDAR data, which is the latest available, and discussion with Northshore staff along with limited survey. The dam raise geometry is based upon a continued downstream slope of 6H:1V and an upstream filter berm slope of 1.5H:1V.

The stratigraphy configuration of the models incorporated the results of previous test borings performed within the dam and CPT soundings performed in the fine tailings adjacent to the dam, as well as records of construction.

As presented in Table 1, the crest elevation for the next Dam 2 raise was originally set by NSM at 1,248 feet and was based on models developed prior to the completion of the long range planning which resulted in differing crest elevations based on updated review of production. However this elevation is conservative since the dam raise will likely be constructed in 2 stages, with the first at 1,243 feet and the second potentially at 1,248 feet. Two cross sections (identified as 34+75 and 42+00) have historically been identified as critical areas of study during the initial phases of design at Dam 2. These cross sections are near the middle of the eastern portion of the dam in the area of the highest potential dam raise, also identified as the lowest natural ground foundation area where soft lacustrine clay deposits are present. As part of the 2009 analysis, Barr developed a semi-hybrid cross section, using cross sections for each station developed by Klohn and Sitka as a basis. This cross section more closely resembles conditions at station 34+75, although some features from the cross section at station 42+00 have been incorporated, as well.

As part of the analysis for the raise of the Dam 2 crest to elevation 1,248 feet, the historic test borings performed at and near stations 34+75 and 42+00 by Klohn, Sitka, and Barr were again reviewed to further refine the lacustrine clay thicknesses and general model geometry. CPT soundings performed by Barr were also reviewed again for model refinement. Additionally, stratigraphy updates were made based on the 2015 borings completed at the dam, although little adjustment was required since the 2015 and historic borings reported similar stratigraphy. **Figure 1** depicts the location of test borings along the model cross section that were recently reviewed for geometry adjustments.

The geometry for the 2015 model was also extended upstream further than previous models as part of additional refinement. Part of the extension includes the addition of a layer of plant aggregate placed south of Dam 2 in the early 2000s, which is visible on aerial photographs and an aerometric survey from

2003. These “hoosier” piles, as they are called by NSM staff, were placed on the beach. At the time, basin personnel were instructed to start placing the piles out on the beach in accordance with the Consensus Closure Plan.

The piles were each about eight to ten feet high and represented one truckload of plant aggregate. The piles were placed adjacent to each other within a continuous zone upstream of the current filter tailings. Although the tops of the hoosier piles were typically flattened with the dozer and the lift compacted prior to placing other fill, this did not occur on the hoosier piles inside the basin. Fine tailings have been discharged off the dam in the new construction configuration over the years since placement of the hoosier piles, which are no longer visible. The fine tailings flowed around and over the piles, subsequently covering this layer of plant aggregate which now forms a relatively thin (possibly about 8 to 15 feet) high permeability zone upstream of the dam.

2.3 Loading Conditions

The Dam 2 raise was modeled for four strength scenarios including three types of undrained strength stability analyses (USSA) and one drained or effective stress stability analysis (ESSA), which will be discussed in the following sections. Since it can be common for failure surfaces to occur along the interface between lacustrine clay and glacial till soils, scenarios where the till layer is considered impenetrable to force a block failure were evaluated as well.

2.3.1 Drained Conditions (ESSA)

If shear stress is applied to a soil at such a rate and/or the drainage conditions are such that excess pore water pressure is zero when failure occurs, failure is said to occur under drained conditions, or the effective stress shear strength of the soil has been mobilized. This case is typically applied to long-term, steady-state seepage conditions, where any excess pore water pressures generated due to loading have dissipated. The drained condition also applies to granular materials for short-term conditions. When such materials have a high enough permeability, any excess pore water pressure is nearly immediately dissipated. The drained strength is most often described in terms of a strength envelope. The failure envelope may be linear, using the Mohr-Coulomb model to provide a drained friction angle (ϕ') and effective cohesion intercept, or it may be represented as a non-linear failure envelope.

2.3.2 Undrained Conditions (USSA)

If shear stress is applied to a soil quickly and/or if the drainage conditions are such that no shear-induced pore water pressure can dissipate when failure occurs, failure is said to occur in an undrained condition, or the undrained shear strength of the sample has been mobilized. The undrained shear strength is typically applied to short-term conditions for saturated soils, for example during or immediately after construction when construction proceeds at a fast enough rate that excess pore water pressure develops. Failure in undrained conditions may also occur for permeable, granular soils during seismic events or other events where loads are applied or shearing occurs so quickly that shear-induced excess pore water pressures cannot dissipate. The following sections present three different USSA analyses that were performed.

2.3.2.1 Undrained Conditions – Operational Conditions

During the Dam 2 raise up to elevation 1,248 feet, it is assumed that the fine tailings, peat, and clay (materials that can potentially consolidate and gain strength) will not have the time for strength gain during or immediately after construction of the raise. Therefore, the vertical effective stresses for the fine tailings, peat, and clay before the raise is constructed (current operational conditions) were estimated and the shear strengths corresponding to the current effective stresses were applied to each material. It is assumed that under these conditions, the pore-pressures have not yet dissipated. This case is typically referred to as the 'end of construction' (EOC) case; however, since construction at the basin consists of intermittent time periods of dam raises that will not end until the basin reaches the ultimate elevation, this case is considered operational conditions. For purposes of this report, operational and EOC are used interchangeably.

2.3.2.2 Undrained Conditions – Yield Strength

It has been observed in soft soils that the undrained shear strength is often a function of effective stress. When the undrained shear strength increases linearly with increasing effective stress, the Undrained Shear Strength Ratio (*USSR*) is generally preferred to model the material strength. The *USSR* is defined as the undrained shear strength, s_u, divided by the initial effective vertical stress, σ'_{vo}. For the undrained analyses in which a *USSR* is applied, shear strength was modeled as a function of the overburden, hence the strength of the material increases linearly with respect to overburden (or effective stress). Shear strength represented by a *USSR* is applicable to the fine tailings, peat, glacial till, and lacustrine clay materials.

In the case of the fine tailings, the nomenclature for the USSR is further modified to $USSR_{yield}$, which refers the yield strength of the material as presented in Olson and Stark (2003). For the glacial till, clays, and peat, this *USSR* relates to the peak strength. In the analysis presented, these strengths were used to represent the condition called End of Primary, which is the point in time where primary consolidation has been achieved due to load placement.

2.3.2.3 Undrained Conditions – Liquefied Strength

It is anticipated that most of the time, loading or change in loading within the fine tailings at MP7 will be slow enough for the fine tailings to be sheared under drained conditions. However, there are circumstances during which rapid changes in load and/or local stress may occur that can lead to undrained loading. Examples include rapid fill placement, significant erosion, rapid water level changes, a seismic event, etc. that change the state of stress within the fine tailings over a short time period. As a result, liquefaction potential needs to be evaluated to determine if the fine tailings can be reduced to the liquefied strength through some triggering event.

The state of a soil dictates its response to undrained loading. If the soil is in a compacted or dense state, it will exhibit dilative behavior and the particles will have to roll over each other, thereby increasing the volume of the soil mass when sheared. If drainage is not permitted, negative pore water pressures will develop. A contractive soil is in a loose state, and when loaded and sheared, the material will compress and become more compact, decreasing the volume of the soil mass. If drainage is not permitted, positive pore water pressures will develop. Flow liquefaction can only be triggered in contractive soils.

Liquefaction has been observed in saturated mine tailings, which are hydraulically deposited and often exhibit contractive response (Castro, Walberg, and Perlea, 2003); therefore, the state of fine tailings and their potential to liquefy should be analyzed. Dilative materials at MP7, including glacial till, clay core, lacustrine clay, plant aggregate, and filter material are not considered subject to liquefaction, so they were not evaluated for liquefied shear strength.

The liquefied condition is a special case within the undrained condition where a contractive soil is sheared beyond the yield strength to a minimum shear stress, the liquefied strength. The liquefied shear strength is the shear strength mobilized at large deformation by a saturated contractive soil following the triggering of a strain-softening response. The terms "steady state" (SS) or "residual" are also used to describe this case. This strength reduction can be induced in the laboratory with either cyclic triaxial (followed by monotonic loading) or undrained monotonic triaxial testing. However, preparing a contractive specimen is challenging for some soils. Many triaxial tests must be conducted to obtain one that is contractive. The liquefied strength has also been correlated to various field data. The liquefied shear strength is presented herein either in terms of undrained shear strength or when appropriate as a function of overburden ($USSR_{liq}$). The $USSR_{liq}$ is defined as the ratio of the liquefied undrained shear strength, $s_{u(liq)}$, to the effective overburden stress, σ'_{vo}.

The potential for seismic triggering of liquefaction should also be evaluated, and is assessed in two steps. The first step is to determine whether the potential for seismic triggering exists. This evaluation is performed using site-specific data including the anticipated seismic events (the potential driver for liquefaction) and in-situ soil data (the soils' resistance to liquefaction). The screening analysis is based on procedures laid out by Boulanger and Idriss (2004) and a summary report from the 1996 NCEER and 1998 NCEER/NSF Workshop (Youd et al, 2001) that discusses the evaluation of liquefaction resistance of soils using data from in-situ testing, such as SPT and CPT. If this screening procedure indicates that the design seismic event at the site could trigger liquefaction, then an analysis using a geomechanical model would be used as part of further evaluations of stability.

3.0 Groundwater

Groundwater and seepage conditions at Dam 2 were evaluated using SEEP/W. The SEEP/W module of the GeoStudio software has the ability to perform finite element groundwater flow calculations. Prior to performing seepage and stability analyses for the new raise, a seepage calibration of the model was performed. The calibration is important because it attempted to match the measured spring 2014 heads from monitoring locations (piezometers) to the predicted heads from the models. Since the latest available LiDAR data is from the spring of 2014, the spring 2014 monitoring data was used to allow the closest comparison of dam geometry conditions to piezometric conditions.

As part of the seepage calibration, hydraulic conductivities are adjusted until relative agreement occurs between observations (measured heads) and predictions (modeled heads). This is important because hydraulic conductivities and stratigraphy can vary significantly on a dam cross section from the assumed configurations based on limited geotechnical information. The permeability values derived and presented in the "Geotechnical Evaluation Report for Dam Construction and Foundation Materials" by Barr dated July 2009 (July 2009 report) and initially incorporated into the most recent Dam 2 models are shown in Table 2.

Table 2 Initial Permeability Parameters (Barr, 2009)

Material	Vertical Permeability (feet/second)	Permeability Anisotropy (k_H/k_V)
Foundation Till	4.43×10^{-7}	9.00
Lacustrine Clay (Normally Consolidated)	7.35×10^{-8}	0.9 ± (Varies)
Lacustrine Clay (Overconsolidated)	1.19×10^{-9}	65 ± (Varies)
Glacial Till Cutoff	1.25×10^{-8}	1.00
Filter Material	6.56×10^{-5}	1.00
Peat	7.35×10^{-8}	1.00
Plant Aggregate	2.62×10^{-3}	1.00
Fine Tailings/Slimes	1.31×10^{-6}	1.00
Bedrock	3.00×10^{-10}	1.00

Analyses were conducted for future conditions including an increase of the upstream tailings pond to elevation 1,238 feet, which is the maximum tailings pond level when the dam crest is raised to elevation 1,248 feet because it allows for the minimum required 10 feet of freeboard at the maximum normal operating pond condition. Seepage and stability models were reviewed for the occurrence of a tailings basin flood (maximum surcharge pool) condition, as well. This situation is considered to transpire when the tailings pond water rises, reducing the freeboard to 3 feet (approximate wave run up). For the Dam 2 raise to elevation 1,248 feet, this corresponds to an upstream tailings pond elevation of 1,245 feet. The results of these seepage analyses are discussed in subsequent sections.

4.0 Strength Parameters

Barr previously evaluated data from test borings, cone penetration test (CPT) soundings, field vane shear testing (FVST), and laboratory testing performed for Milepost 7 to derive parameters for the previous dam raise. These values were again reviewed as part of the analysis for the 2013 Dam 1 raise and presented in the “Dam 1 Stability Evaluation, Dam Crest Elevation 1,245 Feet” by Barr dated September 2013 (Barr, 2013), with a focus on data from the Dam 1 area. Plant aggregate strength was updated to include the envelope developed as part of the “Reclaim Dam Slope Stability Analysis” by Barr dated October 9, 2015 (Barr, 2015). Undrained and drained shear strength data for the lacustrine clays as well as undrained shear strength data for the fine tailings were again reviewed for further refinement with Dam 2 focused data. Table 3 and Table 4 present the updated strength parameters used in the slope stability models, and the following sections discuss derivation of these updated parameters for the lacustrine clays and fine tailings.

As has been incorporated for previous analyses, the method of representing the undrained shear strength for foundation till, lacustrine clay, and fine tailings with USSR values was continued for the Dam 2 raise, though the methods of deriving USSRs for the normally consolidated lacustrine clays and fine tailings were updated.

Table 3 Dam 2 Strength Parameters

<table>
<tr><th rowspan="3">Soil Type</th><th rowspan="3">Moist Unit Weight[1] (pcf)</th><th rowspan="3">Drained (ESSA) (Φ' degrees)</th><th colspan="3">Undrained (USSA)[9]</th></tr>
<tr><th>USSR [2]</th><th colspan="2">Mohr-Coulomb</th></tr>
<tr><th>s_u/σ'_v</th><th>Cohesion or Undrained Shear Strength (psf)</th><th>Friction Angle (deg)</th></tr>
<tr><td>Foundation Till</td><td>145</td><td>28 [1]</td><td>0.29 [1]</td><td>--</td><td>--</td></tr>
<tr><td>Plant Aggregate</td><td>144</td><td colspan="4">15th percentile non-linear function [3]</td></tr>
<tr><td>Clay Core</td><td>145</td><td>31 [1]</td><td>--</td><td>0</td><td>31 [1]</td></tr>
<tr><td>Filter Material</td><td>130</td><td>38 [1]</td><td>--</td><td>0</td><td>38 [1]</td></tr>
<tr><td>Peat</td><td>85</td><td colspan="4">assume values of Lacustrine Clay (NC)</td></tr>
<tr><td>Lacustrine Clay, Normally Consolidated (NC)</td><td>113</td><td>33rd percentile non-linear function [4]</td><td>0.21 [5]</td><td>--</td><td>--</td></tr>
<tr><td>Lacustrine Clay, Overconsolidated (OC)</td><td>113</td><td>33rd percentile non-linear function [4]</td><td>--</td><td>680 [6]</td><td>0</td></tr>
<tr><td>Fine Tailings - Yield Strength</td><td>130</td><td>24 [1]</td><td>0.24 [7]</td><td>--</td><td>--</td></tr>
<tr><td>Fine Tailings - Liquefied Strength</td><td>130</td><td>--</td><td>0.10 [8]</td><td>--</td><td>--</td></tr>
<tr><td>Bedrock</td><td>--</td><td colspan="4">Impenetrable</td></tr>
</table>

[1] Based on values from Barr (2009) and Barr (2013)

[2] Undrained Shear Strength Ratio

[3] Refer to Figure 2 and Table 4

[4] Refer to Figure 7 and Table 4

[5] Refer to Figure 4

[6] Refer to Figure 5

[7] Based on 33rd percentile yield strength from CPT and triaxial data – Figures 8 and 9

[8] Based on 33rd percentile liquefied strength from CPT and triaxial data – Figures 12 and 13

[9] End of Construction (EOC) strengths derived as discussed in Sections 4.1.2 and 4.2.3

Table 4 Curvilinear Functions Summary

Plant Aggregate Strength[1]		Lacustrine Clay[2]	
Effective Normal Stress	Shear Stress	Effective Normal Stress	Shear Stress
σ' [psf]	τ' [psf]	σ' [psf]	τ' [psf]
0	0	0	0
600	680	1,000	770
1,200	1,080	2,000	1,163
1,800	1,550	3,000	1,595
2,600	2,200	4,000	1,961
3,900	3,350	5,280	2,313
5,000	4,500	8,000	2,789
7,500	7,050	17,000	4,148
10,000	9,700		
15,000	14,500		
19,000	17,500		
26,200	22,200		

(1) This function is shown graphically in Figure 2

(2) This function is shown graphically in Figure 7

4.1 Lacustrine Clay

4.1.1 Undrained Shear Strength

Extensive field and laboratory testing of lacustrine clays has been performed by Klohn, Sitka, and Barr to evaluate undrained strength parameters for the lacustrine clays at the site. The testing considered most applicable for undrained shear strength of the normally consolidated lacustrine clays, and thus incorporated into the design undrained shear strength for the Dam 2 crest raise, includes field vane shear testing (FVST), cone penetration testing (CPT), consolidated-undrained (CIU) triaxial testing, unconsolidated-undrained (UU) triaxial testing, and direct simple shear (DSS) testing.

Lacustrine clay data was revisited and direct simple shear data was updated to include testing that was conducted by Barr in late 2013. Similar to the analysis for the 2013 Dam 1 raise, data from DSS, CIU triaxial, and FVST testing were plotted as confining pressure, normal stress, or preconsolidation stress vs. shear stress on the same graph for comparison as shown in **Figure 3**. Since the DSS test is the closest to representing the anticipated failure mode of undrained clays, yet also falls within the overall range of CIU triaxial and FVST data, the peak *USSR* for the 33rd percentile envelope for the DSS data (**Figure 4**) was incorporated into the model for the undrained shear strength of normally consolidated clays. The updated envelope incorporating the 2013 DSS data consists of an *USSR* of 0.21.

The transition zone from normally consolidated clay to overconsolidated clay was also revisited to aid in updating the model geometry and review the undrained shear strength for overconsolidated clay. As the lacustrine clays at the site have been subjected to glacial loading, the clay is typically overconsolidated prior to and during the initial stages of loading from dams. However, as the dam continues to be raised, the dam load eventually exceeds the preconsolidation stress and the clay beneath the higher portions of the dam becomes normally consolidated. Reviewing undrained shear strength data from CPT and lab testing and the dam configuration, this transition is estimated to occur in the zone where the effective overburden stress on the clay is approximately 3,100 psf, which occurs just downstream of the clay core. Revisiting the unconsolidated undrained shear strength data in the stress range of 0 to 3,100 psf (**Figure 5**), strength parameters incorporated in past analyses including of 680 psf and a friction angle of 0 degrees are considered appropriate. Strengths at pressures above the preconsolidation pressure are then estimated by multiplying the USSR by the existing overburden pressure.

4.1.2 End of Construction Shear Strength

To derive the end of construction (EOC) shear strength functions for the normally consolidated lacustrine clays, the SIGMA/W module of Geostudio was utilized. SIGMA/W uses finite element methods to calculate soil stresses. Using SIGMA/W, the vertical effective stresses within the lacustrine clays relative to node locations within the finite element geometry mesh were calculated for the existing dam conditions (i.e. dam crest at 1,230 feet and pond at 1,215.3 feet). The vertical effective stresses were multiplied by *USSR* to calculate the associated undrained shear strength for each node coordinate. The node coordinates and associated undrained shear strengths were then input as a spatial function into SLOPE/W for the EOC cases.

4.1.3 Drained Shear Strength

For evaluating drained shear strength of the lacustrine clays, the approach for the Dam 1 2013 raise was followed. Direct shear and drained CIU triaxial data were plotted as confining pressure/normal stress vs. shear stress as shown in **Figure 6**. Since the direct shear (DS) test is the closest to mimicking the anticipated plane-strain failure mode of drained clays but also falls within the range of the CIU triaxial testing data, a 33rd percentile non-linear design envelope based on the DS testing results (**Figure 7**) was incorporated into the analyses.

4.2 Fine Tailings

4.2.1 Undrained Shear Strength

4.2.1.1 Cone Penetration Resistance

The undrained shear strength of the fine tailings from CPT data collected in 2005 and 2006, recorded with pore water pressure measurements, was re-processed using methods updated since the original data analysis was performed in 2005 through 2008 and are based on Olson and Stark (2003). The field cone penetration resistance measured at the cone tip is q_c for fine grained soils, which may also be converted to the total cone resistance by the following equation:

$$q_t = q_c + (1 - a)u$$

Where:

a = unequal end area ratio of the cone

u = pore water pressure measured between the tip and the friction sleeve

The total cone resistance is corrected to a standard effective overburden pressure of one atmosphere (p_a, typically 1 tsf) as presented in Olson and Stark (2002) by:

$$q_{t1} = q_t \left(\frac{1.8}{0.8 + \frac{\sigma'_{vo}}{P_a}}\right)$$

Calculation of the undrained yield (peak) shear strength of the fine tailings from the CPT data was performed using the equation below from the method by Olson and Stark (2003). This method uses the corrected cone penetration tip resistance (q_{c1}) for q_{c1} values less than 6.5 MPa. The method also includes the replacement of q_{c1} by q_{t1} where pore pressure develops within the materials during penetration.

$$s_u = [0.205 + 0.0143(q_{t1})] * \sigma'_{vo}$$

By dividing the resulting undrained shear strength by the corresponding effective overburden stress, σ'_{vo}, the $USSR_{yield}$ for each relevant data point (where q_{t1} was less than 6.5 MPa) was calculated. Statistical information was subsequently calculated for the $USSR_{yield}$ values, including the 33rd percentile $USSR_{yield}$ incorporated into the overall design $USSR_{yield}$.

The calculated undrained shear strengths versus the corresponding effective overburden stress for all of the CPT soundings performed in Dam 2 in 2005 and 2006, as well as the 33rd percentile $USSR_{yield}$ for this CPT data, are summarized graphically in **Figure 8**.

4.2.1.2 Undrained Shear Strength – CIU Testing

In addition to the CPT soundings, undrained shear strength from CIU triaxial data for fine tailings were also reviewed for the 2015 Dam 2 raise. CIU triaxial data processed per the methods discussed in the Barr (2009) report were assembled for comparison with the updated CPT results.

The effective vertical stress was plotted versus the undrained shear strength data from CIU triaxial tests as shown in **Figure 9**. The 33rd percentile USSR value of 0.23 for peak (yield) conditions used in the design value calculation is also plotted.

4.2.1.3 Undrained Shear Strength – Design Value

Selection of the design value combines the evidence from all testing methods with engineering judgment. A summary of the yield USSRs from field and laboratory testing are shown in Table 5. The 33rd percentile yield USSRs from the field and laboratory data were averaged to result in the design $USSR_{yield}$ of 0.24. The resulting design value is based on both the triaxial tests and the CPT correlation which tested the finest portion of the fine tailings material. There are many layers of stronger tailings interspersed within the fine tailings deposit which were neglected in the CPT correlation because the tip resistance exceeds 6.5 MPa, which is the upper bound tip resistance for calculation of the yield undrained strength.

Table 5 Yield Undrained Shear Strength for Fine Tailings

Tests	Field CPT	Lab CIU Triaxial
Number of Tests	13 Soundings	18
33rd Percentile USSR	0.25	0.23
Design $USSR_{yield}$ Value(1)	**0.24**	

1 Value rounded to the nearest hundredth

4.2.2 Liquefied Undrained Shear Strength

As discussed previously, fine tailings can behave in a contractive manner, although the behavior can be variable (sometimes dilative) with depth and location. Therefore it is necessary to evaluate the liquefied strength of the fine tailings. The following sections present an analysis of the liquefied strength of the fine tailings using field and laboratory testing techniques and correlations.

4.2.2.1 Strength Characterization

Cone penetration resistance and CIU triaxial data for fine tailings were as part of the Dam 2 raise for the liquefied undrained shear strength.

4.2.2.1.1 Cone Penetration Resistance

Two methods were used to determine if fine tailings materials are susceptible to liquefaction. The first method used behavior plots showing normalized excess pore pressure difference to determine if the dynamic pore pressure response above hydrostatic conditions has a potential for contractive behavior and is susceptible to liquefaction. The second method was developed by Fear and Robertson (1995) to determine if materials are contractive, susceptible to liquefaction, or dilative by plotting CPT tip resistance. These methods are discussed in greater detail below.

Evaluation of the undrained liquefied shear strength of the fine tailings for each data point of the CPT data was performed using the method by Olson and Stark (2003). The relationship was developed based on back analysis of data from case histories of failed slopes comprised of sands, silty sands, and mine tailings. Olson has updated the correlation such that it utilizes the corrected tip resistance, q_{t1}, rather than q_{c1} as was originally proposed by Olson and Stark (2002). The Olson method filters out data from materials that should not be characterized with a liquefied undrained shear strength (i.e. dilative), specifying that the calculation should include only data from soils that are classified as contractive using the Olson contractive/dilative screening criteria (2009), as discussed in Section 2.3.2.3, which corresponds to a tip resistance of about 6.5 MPa for many sites.

$$S_{u(liq)} = [0.03 + 0.0143\,(q_{t1})]*\sigma'_{vo}$$

Similar to the calculation of the USSR for the yield strength in the previous section, the $USSR_{liq}$ for each relevant data point is calculated by dividing the resulting liquefied undrained shear strength by the corresponding effective overburden stress. Statistical information was subsequently calculated for the $USSR_{liq}$ values, including the average $USSR_{liq}$ used as part of the calculation for the overall design $USSR_{liq}$.

4.2.2.1.1.1 Behavior Plots

Behavior plots related to the development of the liquefied shear strength from CPT data are provided in Appendix B. **Figure 10** presents the results of one such analysis. The dynamic pore pressure shown on **Figure 10** represents the pore pressure as the cone is advanced through the tailings. Dissipation tests, where available, are presented as purple dots. They indicate an "equilibrium" water level reading at the probe depth.

The normalized excess pore pressure difference, also shown on **Figure 10** (and the other CPT behavior plots), aids in identification of contractive and dilative layers. The normalized excess pore pressure difference is the difference between the dynamic pore pressure developed during cone advancement and the estimated hydrostatic conditions interpreted from the dissipation tests normalized by dividing by the effective overburden stress (σ'_{vo}). Where the normalized pore pressure difference is positive, which is the result of dynamic pore pressure response above hydrostatic conditions, that material has a potential for contractive behavior and is susceptible to liquefaction. Where the normalized pore pressure difference is negative, the dynamic pore water pressure is less than the existing groundwater conditions, and that soil is considered potentially dilative and will not liquefy. Analysis of the CPT behavior plots for the most recent six CPT soundings performed in 2006 along Dam 2 indicates the percentage (per sounding) of potentially contractive fine tailings ranges mainly between approximately 60 and 99 percent.

4.2.2.1.1.2 CPT Tip Resistance and Compressibility

The CPT behavior plots are one way to determine which materials are susceptible to liquefaction; another way is to plot CPT tip resistance relative to the medium compressibility boundary as developed by Fear and Robertson (1995) and updated by Olson (2009) for medium compressibility materials. **Figure 11** shows the corrected tip resistance (q_{c1}) versus calculated pre-failure effective stress. Points that plot to the left of the medium compressibility boundary are potentially contractive, and points that plot to the right are potentially dilative. **Figure 11** shows that this method of analysis indicates the majority of fine tailings from the CPT tests are potentially contractive.

4.2.2.1.1.3 Contractive/Dilative Results

The material behavior evaluation used the CPT behavior plots to: (1) establish which material types are contractive and susceptible to liquefaction; and (2) identify tests that may have evaluated more dilative layers within generally contractive zones so that those results could be excluded from liquefied shear strength calculations. It can be seen from these plots that the fine tailings behave in both a contractive and dilative manner. Using the established criteria presented, **Figure 12** shows the liquefied strength of the fine tailings. The average strength ratio using the strength determination methodology by Olson and Stark (2003) is 0.08.

4.2.2.1.2 Liquefied Undrained Shear Strength –CIU Triaxial Testing

CIU triaxial data for fine tailings were also reviewed in addition to the CPT data as part of the Dam 2 raise for the liquefied undrained shear strength. CIU triaxial data processed per the methods discussed in Barr (2009) were assembled for comparison with the corresponding updated CPT results.

The effective vertical stress was plotted versus the undrained shear strength data from CIU triaxial tests as shown in **Figure 13**. As some of the CIU data appeared high, a realistic upper bound was identified for the CIU testing and used in calculating the average USSR for liquefied conditions, which was included in the design value calculation.

4.2.2.1.3 Seismic Considerations

4.2.2.1.3.1 Site Specific Seismic Hazard

As discussed briefly in Section 2, the potential for seismic triggering is considered when assessing the liquefied undrained shear strength. A site-specific probabilistic seismic hazard analysis (PSHA) was prepared for the Milepost 7 site (Appendix C). A PSHA is a quantitative estimate of the hazards for ground-shaking at the site analyzed probabilistically to consider uncertainties in earthquake location, size, and frequency of occurrence. The PSHA was used to develop acceleration-time histories for dynamic stability analyses for the Milepost 7 tailings basin. This site-specific analysis assesses the potential local and regional seismic sources that could affect the site, models their attenuation to the site, and provides an estimate of seismic impact at the site.

Seismicity at the site is likely to be governed by one of two conditions: (1) nearfield events, which are low magnitude earthquakes with epicenters in the Midwest, and (2) farfield events, which are higher magnitude earthquakes caused by the New Madrid Seismic Zone. The New Madrid Seismic Zone contains the nearest active fault and is approximately 750 miles south of the site. The zone is named after New Madrid, Missouri, which is close to the northern boundary of the seismic zone.

U.S. Geological Survey (USGS) data was used to evaluate potential earthquake frequency and ground acceleration at the Project site (USGS, 2011). Table 6 summarizes the ground motions for earthquakes with 50 year probability of exceedance of 10%, 5%, and 2%. There is a 2% probability that the Peak Ground Acceleration (PGA) at the site will exceed 0.028g in 50 years. This corresponds to a 0.0004 probability of exceedance per year, or a return period of 2,475 years.

Table 6 Summary of USGS Seismic Risk Calculation

Probability of Exceedance			
Per Annum	0.0021	0.0010	0.0004
In 50 years	10%	5%	2%
Return Period [years]	475	975	2,475
Peak Ground Acceleration [g]	0.008	0.015	0.028

The results of the PSHA include three earthquake records, based on a 2% probability of exceedance in 50 years, related to nearfield sources, farfield sources, and a record that aggregates these two sources.

4.2.2.1.3.2 Seismic Liquefaction Screening Evaluation

Evaluation of the potential for seismic liquefaction requires estimation of the cyclic shear stresses and the soil's ability to resist liquefaction. The analysis used the estimation method determined in workshops jointly held by the National Center for Earthquake Engineering Research (NCEER) and National Science Foundation (NSF) (Youd et al, 2001). This evaluation used the 2,475-year return period event from the PSHA and CPT data to determine a factor of safety against liquefaction triggering. Several parameters were computed.

The *CSR* is the cyclic stress ratio, which represents the seismic demand on a soil layer. The *CSR* is computed as:

$$CSR = 0.65 * \frac{a_{max}}{g} * \frac{\sigma_{vo}}{\sigma'_{vo}} * r_d$$

Where:

a_{max} = peak horizontal ground acceleration at the ground surface due to the design earthquake (2,475-year return period)

g = acceleration due to gravity

r_d = stress reduction coefficient, which accounts for flexibility of the soil profile

0.65 = reduction factor from Youd et al (2001) to produce a *CSR* representative of the most significant cycles over the full loading duration

In Youd et al, 2001, the depth reduction factor (r_d) is a shear stress reduction coefficient (or shear mass participation factor), computed as a function of depth (z) in meters by:

$$r_d = \frac{1.000 - 0.4113z^{0.5} + 0.04052\,z + 0.001753\,z^{1.5}}{1.000 - 0.4177z^{0.5} + 0.05792z - 0.006205z^{1.5} + 0.001210z^2}$$

The *CRR* is the cyclic resistance ratio, indicating the capacity of the soil to resist liquefaction. The *CRR* is computed using the normalized clean-sand cone penetration resistance, $(q_{c1N})_{CS}$, from CPT data as:

$$If\ (q_{c1N})_{cs} < 50,\ \ CRR = 0.833 * \frac{(q_{c1N})_{cs}}{1000} + 0.05$$

$$If\ 50 < (q_{c1N})_{cs} < 160,\ \ CRR = 93 * (\frac{(q_{c1N})_{cs}}{1000})^3 + 0.08$$

Seed and Idriss (1982) analyzed multiple level-ground sites where seismically induced liquefaction did or did not occur. From these analyses, relationships were proposed to identify when materials would or would not liquefy. However, because all of the earthquakes involved different magnitudes (i.e., differences in duration of shaking and frequency content), it is necessary to adjust the earthquake demand (i.e., $\tau_{seismic}$) for earthquake magnitudes higher or lower than 7.5. This adjustment is accomplished using a Magnitude Scaling Factor (*MSF*). Since then, multiple scaling factors have been proposed. Based on the results of the NCEER/NSF workshops, Youd et al (2001) recommends the following MSF relationship:

$$MSF = \left(\frac{M_w}{7.5}\right)^{-2.56}$$

Boulanger and Idriss (2004) and Youd et al (2001) suggest that when the factor of safety against liquefaction triggering is less than 1.0, triggering will occur. The factor of safety against triggering is determined as:

$$FOS_{triggering} = \frac{CRR_{7.5}}{CSR_{7.5}} * MSF * K_\sigma$$

Where:

K_σ = a correction factor to extrapolate the simplified procedure to larger overburden pressure conditions.

4.2.2.1.3.3 Screening Results

The factor of safety values obtained at each CPT point for the test locations were plotted versus depth to determine if any points are susceptible to triggering based on the design earthquake presented in the PSHA. The design event corresponds to a 2,475-year return period with a probability of exceedance of 2% in 50 years (M_w = 5.92, a_{max} = 0.028g). The lowest factor of safety against triggering computed for all CPT locations was 4.8. The applied seismic event was then scaled up to determine what event would trigger liquefaction. It was determined that an earthquake with M_w = 5.0 and a_{max} = 0.3g would be required to trigger liquefaction. This event corresponds to a 170,000-year return period.

Results indicate that the seismic design event would not trigger liquefaction of the fine tailings at Milepost 7. CPT plots showing the liquefaction triggering potential for locations along Dam 2 are provided in Appendix D. This analysis does not preclude the fact that an unknown or combination of triggers could occur causing liquefaction at the site. Therefore it is appropriate to evaluate the liquefied strength of the fine tailings for use in a static liquefaction analysis.

4.2.2.2 Liquefied Undrained Shear Strength – Design Value

Although the CPT plots indicate some zones of the fine tailings may be dilative, all of the fine tailings were considered contractive for the purposes of modeling the scenario including the liquefied undrained shear strength of the fine tailings. This approach is used because it is conservative to assume the shear strength for all of the fine tailings will be reduced to the liquefied strength with the understanding that there is data showing that some materials are dilative. Therefore a single liquefied strength value for fine tailings was calculated, using only the data from the contractive fine tailings.

A summary of the average USSRs from laboratory and field testing are shown in Table 7. To calculate the design $USSR_{liq}$ value of 0.1, the average of the average USSRs from each set of field and laboratory test data was computed.

Table 7 Liquefied Undrained Shear Strength for Fine Tailings

Tests	Field CPT	Lab CU Triaxial
Number of Tests	13 Soundings	14
Average USSR	0.08	0.12
Design $USSR_{liq}$ Value(1)	0.10	

[1] Value rounded to the nearest hundredth

4.2.3 End of Construction Shear Strength

Similar to the lacustrine clays, the vertical effective stresses within the fine tailings relative to node locations within the finite element geometry mesh were calculated for the existing dam conditions (i.e. dam crest at 1,230 feet, existing fine tailings beach, and pond at 1,215.3 feet). The vertical effective stresses were multiplied by $USSR_{yield}$ to calculate the associated undrained shear strength for each node coordinate. A spatial function was then input into SLOPE/W including the node coordinates and associated undrained shear strengths for the EOC cases.

4.2.4 Drained Shear Strength

The drained shear strength for fine tailings was evaluated for the Barr (2009) report by reviewing triaxial data from tests conducted by Barr as well as historical data. The values presented in the Barr (2009) report are considered suitable for representing the fine tailings in the models for the Dam 2 crest elevation raise up to 1,248 feet.

5.0 Dam Stability Analyses

This section of the memo presents the results of the analyses performed, beginning with seepage the model calibration. The stability of the dam will be discussed in subsequent sections.

5.1 Seepage Calibration

The main objective of the seepage analysis is to develop a good understanding of the groundwater flow and the relationship to dam stability. Groundwater plays a major role in the stability and construction sequence of the dam. The seepage simulations presented in this report model groundwater flow for steady-state conditions.

Hydraulic conductivity (permeability) values were assigned to each material type, based on previous testing performed on the materials (Barr, 2009), and the total head was fixed for the upstream pond for the existing dam configuration. The upstream pond head was set at elevation 1,215.3 feet, or the reading of the North Pond (Cell 4) elevation in the spring of 2014 to match the latest available LiDAR dam surface, for model calibration. The hydraulic conductivities initially assigned to each soil type in the final models are presented in Table 2. The values for each of these materials were presented in the Barr (2009) report and were originally incorporated into the model, then adjusted over several model iterations to minimize the difference between the resulting modeled head and measured head of piezometers within Dam 2.

Table 8 shows the difference for the majority of measured head values versus resulting modeled head values is within approximately 3 to 5 feet of head. Piezometers with a larger head difference between modeled and measured values, such as P97-15, 3H-P2, P97-19A, P97-19B, and D2-3475R100B bottom may be malfunctioning or there may be a characteristic of the till that the model is not accounting for. The 2015 monitoring events indicated piezometer 3H-P2 is malfunctioning. A comparison of recent and historical readings with modeled conditions for pneumatic piezometers installed in the tailings (P97-19A and P97-19B) suggest that differences in head of approximately 25 feet have remained the same over many years. Readings recorded in 2015 for D2-3475R100B indicate higher piezometric levels than historic readings, especially prior to the fall of 2014. Limited instrumentation is present in this area to confirm the reading from a companion piezometer.

Additional vibrating wire piezometers were installed in the spring of 2015 near the center of the dam at the same location as 3H-P1 and 3H-P2 as well as at the toe of the dam. The piezometric data from the spring of 2014 for 3H-P2 appears generally anomalous compared to subsequent readings in the fall of 2014 and during both monitoring events in 2015, although levels recorded between the fall of 2013 and fall of 2015 are still somewhat elevated compared to historic data. Data from the new corresponding vibrating wire piezometer is relatively similar.

Readings from P97-15 since about the fall of 2011 have been relatively similar. The difference in the modeled versus measured head for this piezometer may be attributed to a variation in the till in this area that is not able to be accounted for in the model without additional investigation in this area for further material characterization.

Table 8 Measured and Predicted Head from Seepage Evaluation

Instrumentation Designation and Type	Approximate Cross Section Station	Piezometer Tip Elevation (feet)	Material	Spring 2014 Measured Head (feet)	Modeled Head (feet)	Difference*
P97-14 / Pneumatic	34+75	1136.20	Till	1161.6	1163	+1.4
3E-P1 / Pneumatic	34+75	1149.50	Clay	1161.7	1161.5	-0.2
3E-P2 / Pneumatic	34+75	1155.30	Clay	1156.2	1159.8	+3.6
3B-P1 / Casagrande	34+75	1097.30	Till	1172.35	1175	+2.7
3B-P2 / Casagrande	34+75	1135.30	Till	1169	1171	+2.0
3B-P3 / Casagrande	34+75	1149.30	Clay	1165.45	1163	-2.5
3B-P4 / Casagrande	34+75	1152.30	Clay	1164.67	1162	-2.7
3B-P5 / Casagrande	34+75	1159.30	Sand & Gravel	1161.58	1160.7	-0.9
P97-15 / Pneumatic	34+75	1132.80	Till	1173.8	1191	+17.2
3H-P1 / Pneumatic	34+75	1137.30	Clay	1193.8	1193	-0.8
3H-P2 / Pneumatic	34+75	1143.30	Clay	1209.7	1193	-16.7
D2-3475R100B / VW*	34+75	1174.94	Upper Tailings	1194	1194	0.0
D2-3475R100B / VW*	34+75	1161.94	Middle Tailings	1193.9	1194	+0.1
D2-3475R100B / VW*	34+75	1155.94	Lower Tailings	1193.3	1194	+0.7
D2-3475R100B / VW*	34+75	1137.94	Upper Clay	1194	1194	0.0
D2-3475R100B / VW*	34+75	1127.94	Lower Clay	1193.7	1194	+0.3
D2-3475R100B / VW*	34+75	1119.94	Till	1182.8	1194	+11.2
P97-19A	34+75	1178.00	Tailings	1210.3	1194.5	-15.8
P97-19B	34+75	1164.00	Tailings	1183.8	1194.5	+10.7

* Vibrating Wire Piezometer
** Positive difference indicates a model value higher than measured

The measured head values versus resulting modeled head values were within 5 feet of head at the toe and ranged from 3 to 14 feet at the center of the dam. This suggests the model is conservative as the modeled heads at the center of the slope are above the measured heads.

For purposes of this phase of modeling for the Dam 2 crest elevation raise to 1,248 feet, the model head values are considered acceptable. The resulting permeability values estimated from the seepage calibration are presented in Table 9. Values in bold were the recommended changes based on the calibration performed for 2014 seepage conditions.

Table 9 Permeability Values from Seepage Calibration

Material	Resulting Vertical Permeability from Calibration (feet/second)	Permeability Anisotropy (k_h/k_v)
Foundation Till	**$4.43x10^{-8}$**	9.00
Lacustrine Clay (Normally Consolidated)	**$7.35x10^{-7}$**	0.9 ± (Varies)
Lacustrine Clay (Overconsolidated)	**$1.16x10^{-8}$**	65 ± (Varies)
Glacial Till Cutoff	$1.25x10^{-8}$	1.00
Filter Material	$6.56x10^{-5}$	1.00
Peat	**$6.62x10^{-7}$**	1.00
Plant Aggregate	$2.62x10^{-3}$	1.00
Fine Tailings/Slimes	$1.31x10^{-6}$	1.00
Bedrock	$3.00x10^{-10}$	1.00

Note: values is bold are the recommended permeability changes based on the calibration

Comparing Table 9 to Table 2, the calibrated foundation till vertical permeability is lower than the estimated in the Barr (2009) report. The till has been described as containing various amount of clay, sand, and gravel and is generally characterized as a silty sand to sandy silt. The anisotropy ratio of k_h/k_v = 9.0 for the foundation till was not changed from the 2009 analysis. The calibrated permeability values of the lacustrine clay (normally and overconsolidated) and the peat are all an order of magnitude higher in permeability than the value in the 2009 report and are in the higher range of possible permeabilities proposed by Sitka and Klohn. The anisotropy values remain the same for these materials. Previous investigations determined that the permeability of the glacial till cutoff was reasonable and therefore, the cutoff material was not analyzed during the calibration. As the permeabilities of the plant aggregate and filter material are relatively well known due to extensive previous testing, these values were not analyzed as part of the calibration.

5.2 Slope Stability

Slope stability analyses were performed for the proposed Dam 2 crest elevation raise to 1,248 feet geometry by integrating the results of seepage analyses with the slope stability modeling module SLOPE/W within the GeoStudio 2012 software. Analyses were performed for the downstream slope of Dam 2 for eight failure mode configurations including: ESSA, ESSA with a block failure, USSA using end of construction (EOC) strengths with and without block failure, USSA using USSR for yield fine tailings strength with and without block failure, and USSA for liquefied fine tailings strength with and without a block failure.

A minimum factor of safety of 1.3 is considered acceptable for USSA conditions at the MP 7 site. For the ESSA condition, a minimum factor of safety of 1.5 is considered acceptable. The liquefied strength analyses represent an unknown triggering condition which could cause a failure in the dam that could include significant seismic events or a combination of other events which are often difficult to quantify. In this region, seismic triggering is not considered to be a significant contributor to slope instability, and for this site, CPT data indicate the fine tailings are not considered susceptible to liquefaction under seismic conditions as shown in Appendix D. However analyses were carried out assuming an unknown triggering event leads to full liquefaction of all the fine tailings. A factor of safety of 1.05 is considered acceptable for the liquefied strength scenario.

The adjacent upstream pond level was adjusted for each of these material configurations for three scenarios. These pond elevations include a pond level of 1,215.3 feet (representing the spring of 2014), future maximum operating pool of 1,238 feet (allowing 10 feet of freeboard) with the existing fine tailings beach elevation, future maximum operating pond with the future anticipated tailings beach elevation, probable maximum pond flood level of 1,245 feet (allowing 3 feet of freeboard) with the existing tailings beach elevation, and probable maximum pond flood level with the future anticipated beach elevation. The results of the scenarios for stability modeling performed is shown in Table 10 and depicted graphically in Appendix E.

Table 10 Computed Stability Factors of Safety for Various Scenarios

Slope Location and Material Configuration	Factors of Safety for Dam 2 Crest Elevation 1,248 feet				Minimum Acceptable FOS
	Tailings Pond at 1,215.3 feet (Existing Spring 2014)	Tailings Pond at 1,238 feet, Existing Beach (10-foot freeboard)	Tailings Pond at 1,238 feet, Future Beach at 1238 feet (10-foot freeboard)	Tailings Pond at 1,245 feet, Future Beach at 1238 feet (3-foot freeboard)	
Downstream Slope, ESSA	2.85	2.84	2.85	2.84	**1.5**
Downstream Slope, ESSA Block Failure	2.91	2.91	2.91	2.91	**1.5**
Downstream Slope, Operational Conditions	1.75	1.74	1.74	1.74	**1.3**
Downstream Slope, Operational Conditions, Block Failure	1.77	1.76	1.76	1.76	**1.3**
Downstream Slope, USSA	1.77	1.76	1.77	1.76	**1.3**
Downstream Slope, USSA, Block Failure	1.75	1.75	1.75	1.75	**1.3**
Downstream Slope, USSA, Fine Tailings Liquefied Strength	1.76	1.75	1.76	1.75	**1.05**
Downstream Slope, USSA, Fine Tailings Liquefied Strength, Block Failure	1.76	1.76	1.76	1.76	**1.05**

As shown in Table 10, the resulting model factors of safety exceed the corresponding minimum factor of safety for all of the ESSA and USSA scenarios and the dam is considered stable under the conditions that were analyzed. The resulting factors of safety were also all found to be the essentially the same for all four pond/beach scenarios for each material configuration. This is due to the resulting critical failure surfaces in the models being located in the same general area, on the downstream slope of the dam near the toe. This is generally the reason a buttress was constructed in 1997, to improve the stability along the toe of the dam.

6.0 Summary and Recommendations

Seepage analyses were performed for Dam 2 for the following conditions. All seepage analyses are for steady state conditions.

- The dam configuration from 2014 LiDAR data for model calibration based on piezometer readings and the upstream pond level from the spring of 2014 (1,215.3 feet)
- The existing pond elevation (1215.3 feet from spring 2014) with the proposed raised dam crest elevation of 1,248 feet including the existing beach to review pore pressures and to incorporate into slope stability analyses.
- Maximum normal pond operating conditions (elevation 1,238 feet) for the proposed raised dam crest to 1,248 feet including the existing beach configuration to review pore pressures and to incorporate into slope stability analyses.
- Maximum normal operating pond conditions (elevation 1,238 feet) for the proposed raised dam crest to 1,248 feet including the future anticipated beach configuration to review pore pressures and for incorporation into stability analyses.
- Flood conditions (pond elevation of 1,245 feet) for the proposed raised dam crest to 1,248 feet including the future anticipated beach configuration to review pore pressures and for incorporation into slope stability analyses.

Analyses were performed to review the stability of Dam 2 including expanded and refined model geometry as well as updated strength parameters for the lacustrine clays and fine tailings. Analysis scenarios for which the model results indicate acceptable factors of safety include the following:

- ESSA for the downstream slope for normal operating pond conditions with the existing and future anticipated beach, as well as the flood conditions with the future anticipated beach.
- ESSA model simulating a block failure along the interface between the lacustrine clay and till soils for the downstream slope for normal operating pond conditions with the existing and future anticipated beach, as well as the flood conditions with the future anticipated beach.
- USSA incorporating the operational conditions shear strength of fine tailings, peat, and lacustrine clay for the downstream slope for normal operating conditions with the existing beach.
- USSA incorporating the operational conditions shear strength of fine tailings, peat, and lacustrine clays as well as simulating a block failure along the interface between the lacustrine clay and till for the downstream slope for normal operating pond conditions with the existing and future anticipated beach, as well as the flood conditions with the future anticipated beach.

- USSA incorporating the yield strength of fine tailings for the downstream slope for normal operating conditions with the existing and future anticipated beach, as well as the flood conditions with the future anticipated beach.

- USSA incorporating the yield strength of fine tailings as well as simulating a block failure along the interface between the lacustrine clay and till for the downstream slope for normal operating pond conditions with the existing and future anticipated beach, as well as the flood conditions with the future anticipated beach.

- USSA incorporating the liquefied strength of fine tailings for the downstream slope for normal operating pond conditions with the existing and future anticipated beach, as well as the flood conditions with the future anticipated beach.

- USSA incorporating the liquefied strength of fine tailings as well as simulating a block failure along the interface between the lacustrine clay and underlying till for the downstream slope for normal operating pond conditions with the existing and future anticipated beach, as well as the flood conditions with the future anticipated beach

The following are recommendations based on the seepage and stability analyses performed and summarized previously for the project:

- The dam should be raised including a finished downstream slope face of 6 horizontal to 1 vertical in accordance with design plans provided in Appendix A.

- The seepage cutoff in the northeastern corner of Dam 2 should be raised at the same time as the rest of Dam 2.

- Non-functioning instrumentation at Dam 2 should be replaced to evaluate the behavior of the lacustrine clays and glacial till materials found in the foundation of the dam under various pond level and operating conditions. A geotechnical investigation and instrumentation installation was completed in the spring of 2015, which allows for a means to compare data with some instrumentation with suspect readings as well as replace some non-functional instrumentation.

- Dam 2 instruments should continue to be monitored at least bi-annually or as otherwise indicated in monitoring reports and/or required by observed conditions.

- Piezometers should be connected to data loggers to provide a more continuous record of pore pressure conditions in the lacustrine clays, fine tailings, and glacial till soils. The pore pressure response during dam construction and due to precipitation events is an important part of the analysis to evaluate dam stability. A plan to install data loggers should be implemented over the next Five Year Operating Plan.

- A relief well improvement program should be implemented to evaluate the effectiveness of the current relief wells along the toe of Dam 2. Improvements should consist of cleaning and review of flow along with analysis of total head in the foundation along the toe of the dam. This may require substantial effort because the current relief wells are below the water surface in the seepage collection pond and have limited access roads at this time. The effectiveness of these relief wells is important to the overall stability of the dam.

- As Dam 2 has continued to be raised, potential additional critical cross sections have developed east and west of stations 34+75 and 42+00. Additional cross sections will be selected east and west of the central mid-valley area of the dam that has been historically evaluated for seepage and stability analyses due to the significant lacustrine clay deposit in the foundation. Because the dam is rising and extending into areas in the future that have differing foundation conditions, additional sections will include an area near the west end of the dam that is being extended up the hillside. Another section will be located on the eastern end of the dam approximately midway between the east abutment and the mid-valley sections. The exact locations will be identified through a review of the available soils borings and historical dam foundation plans. Additional subsurface investigation and/or instrumentation installation may need to be performed to allow development and analysis of these new cross sections.

7.0 References

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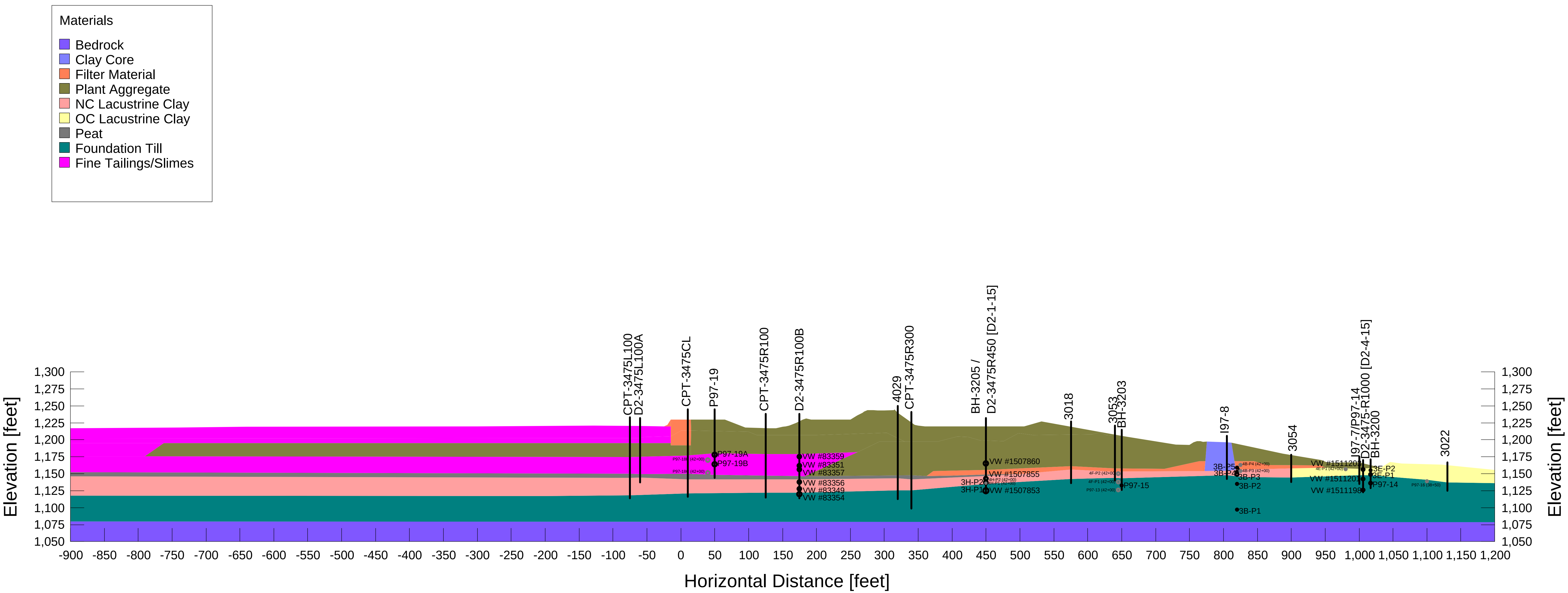
Figures

Figure 1
Northshore Mining Company, Dam 2
Station 34+75, Existing Conditions
Boring and CPT Locations

BARR



P:\Mpls\23 MN\38\2338086\WorkFiles\2014_Work\DS14\Dam 2 Raise\Models

FIGURE 2

Plant Aggregate Direct Shear Data from Sitka (1996) and CPT Data from Barr (2005)

Northshore Mining Milepost 7 Tailings Basin

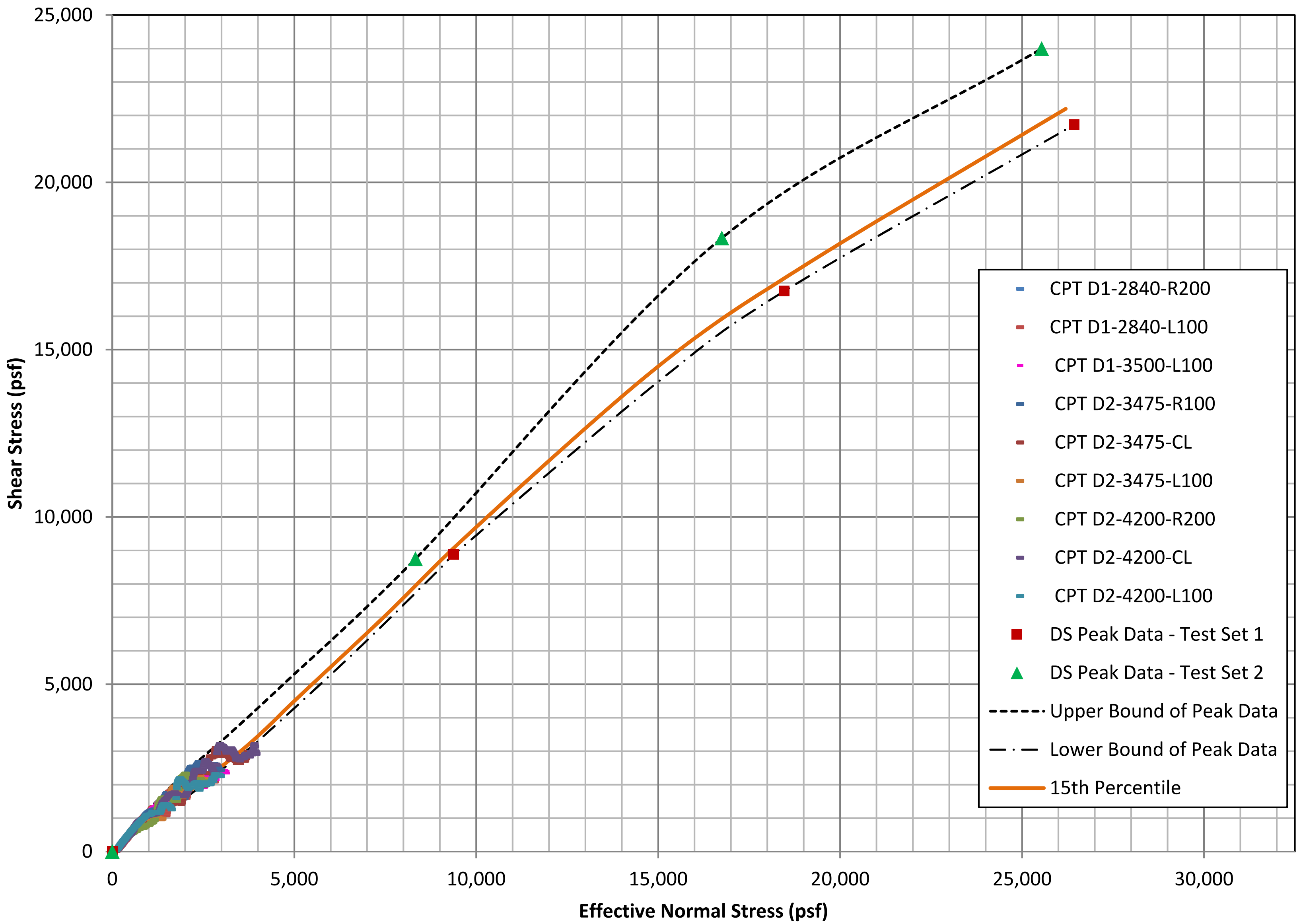


FIGURE 3

Lacustrine Clay Undrained Shear Strength from CIU Triaxial, Direct Simple Shear, and Vane Shear Test Data

Northshore Mining Milepost 7 Tailings Basin

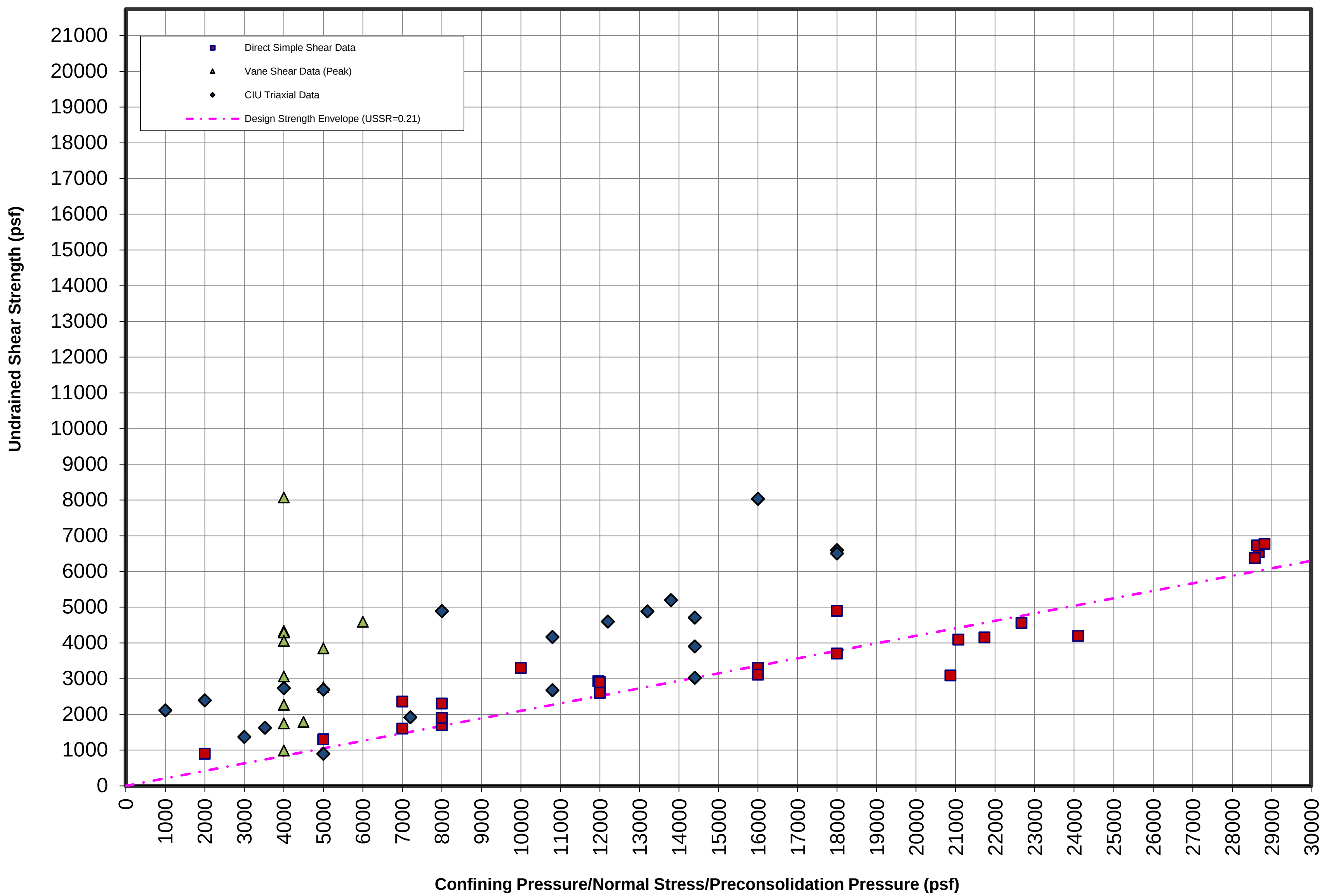


FIGURE 4

Lacustrine Clay Undrained Shear Strength - Direct Simple Shear Data

Northshore Mining Milepost 7 Tailings Basin, Dam 2

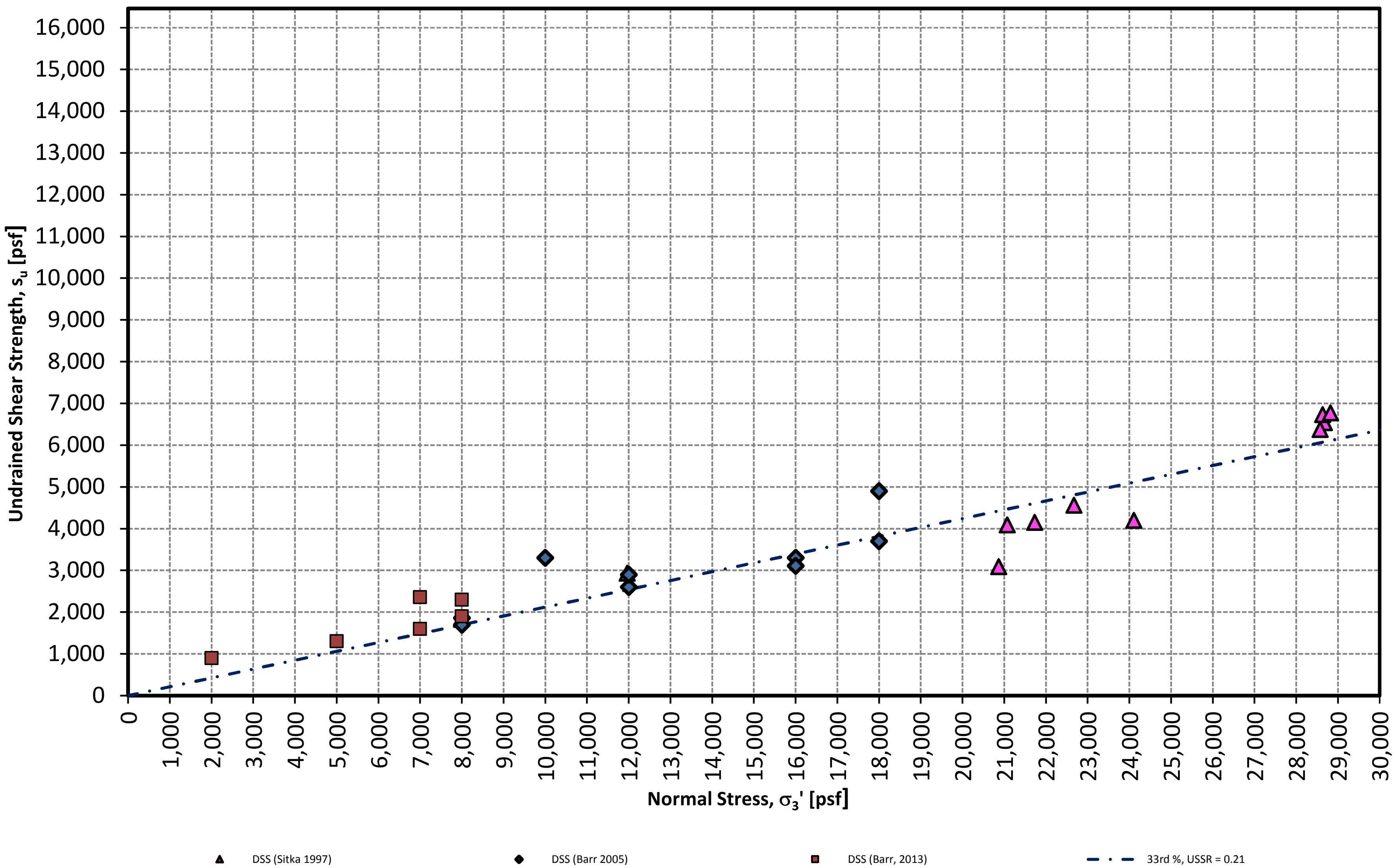


FIGURE 5
Lacustrine Clay Undrained Shear Strength
Northshore Mining Milepost 7 Tailings Basin, Dam 2

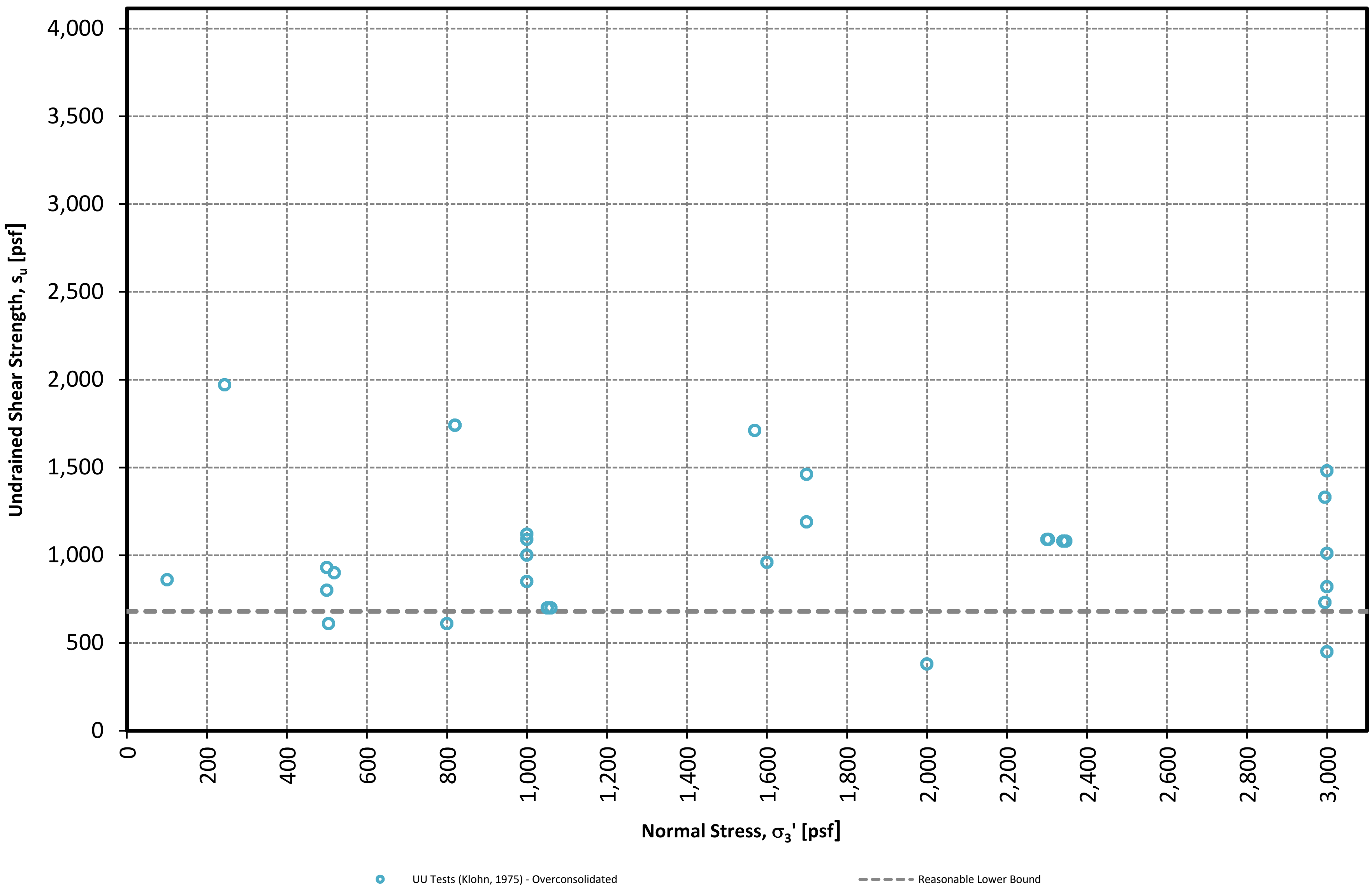


FIGURE 6
Lacustrine Clay Drained Shear Strength - CIU Triaxial and Direct Shear Data
Northshore Mining Milepost 7 Tailings Basin

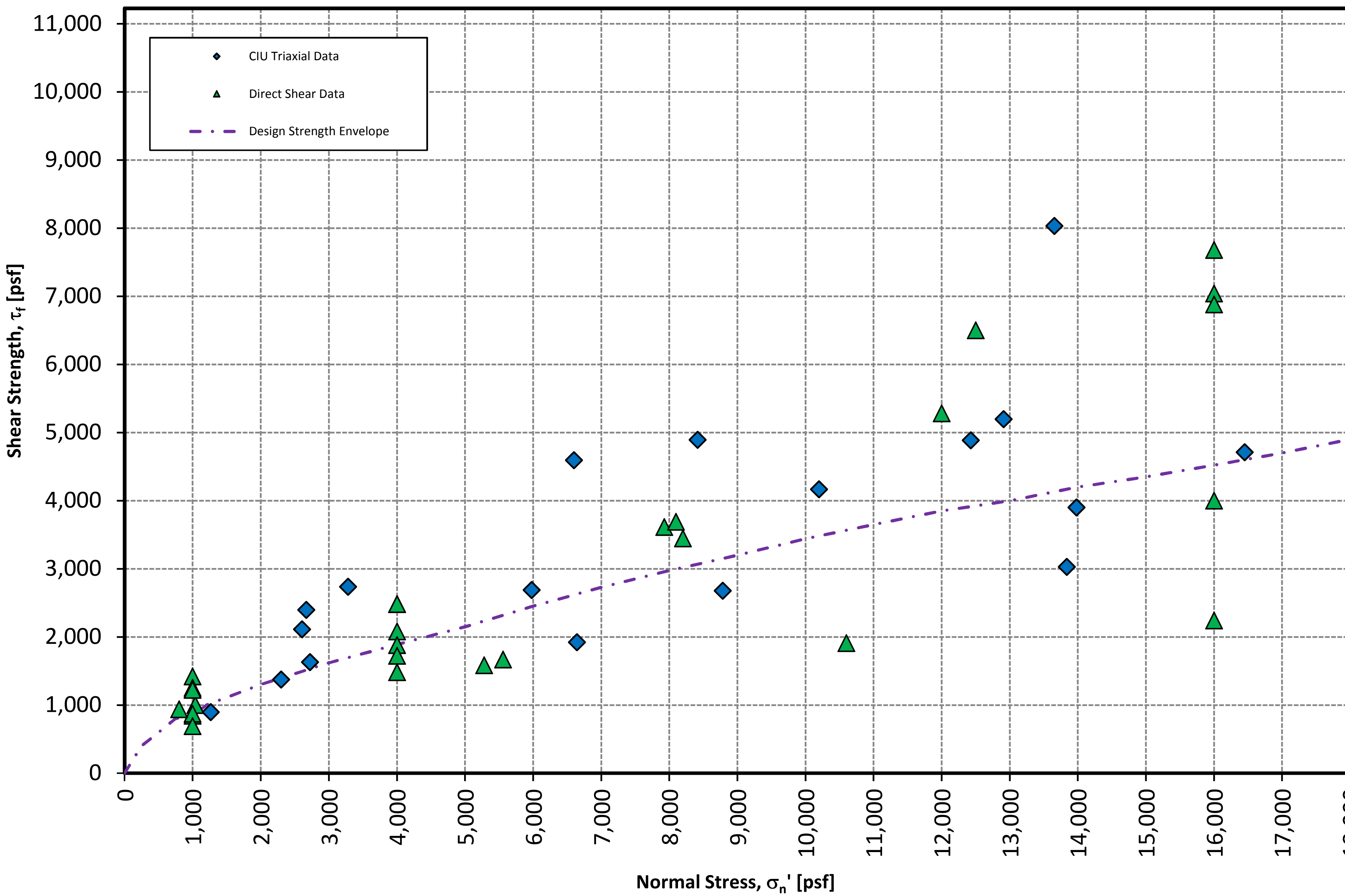


FIGURE 7
Lacustrine Clay Drained Shear Strength - Direct Shear Data
Northshore Mining Milepost 7 Tailings Basin

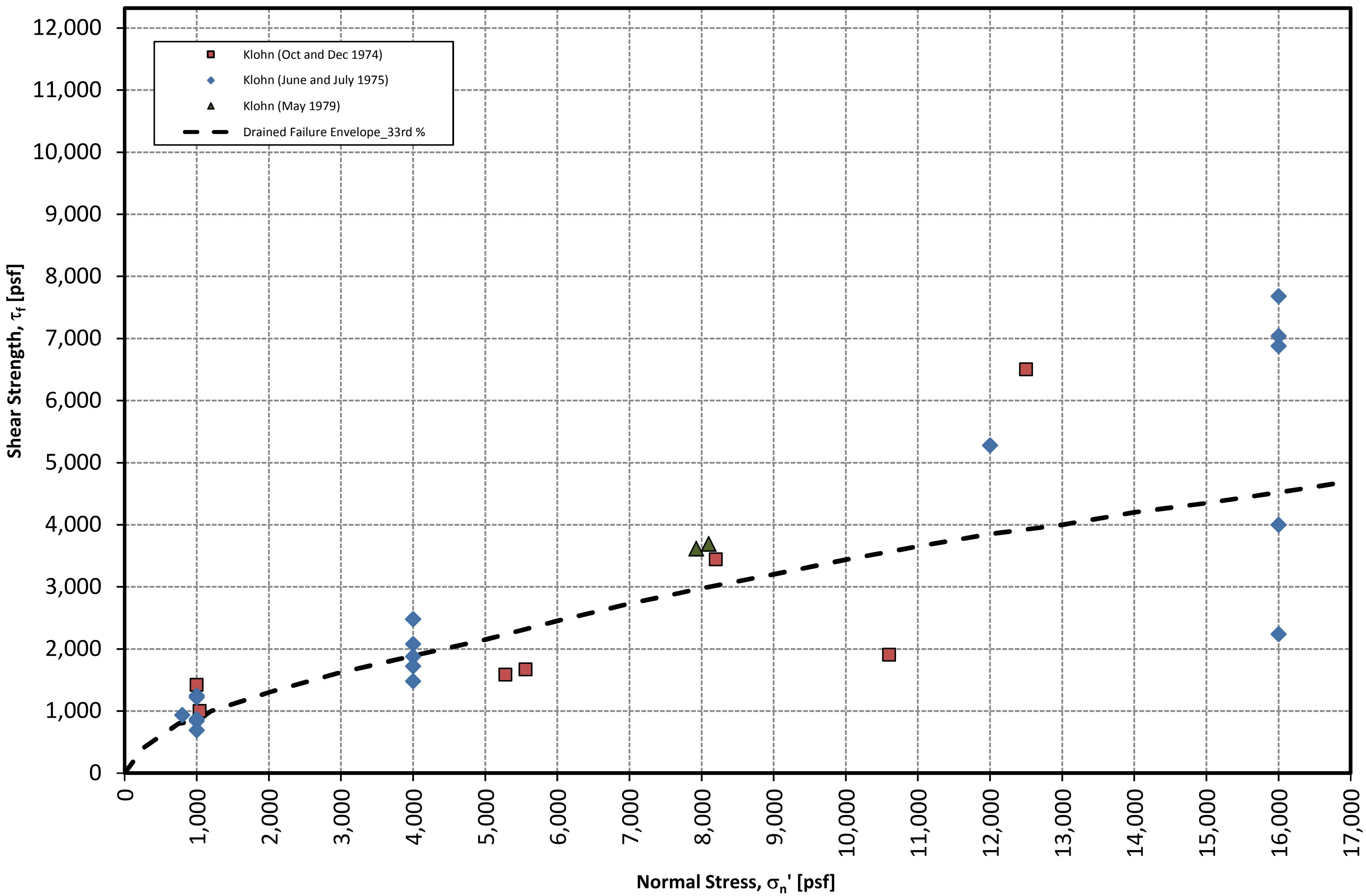


FIGURE 8

CPT Correlated Undrained Yield Shear Strength Envelope - Fine Tailings (Olson and Stark, 2003)

Northshore Mine Milepost 7 Tailings Basin

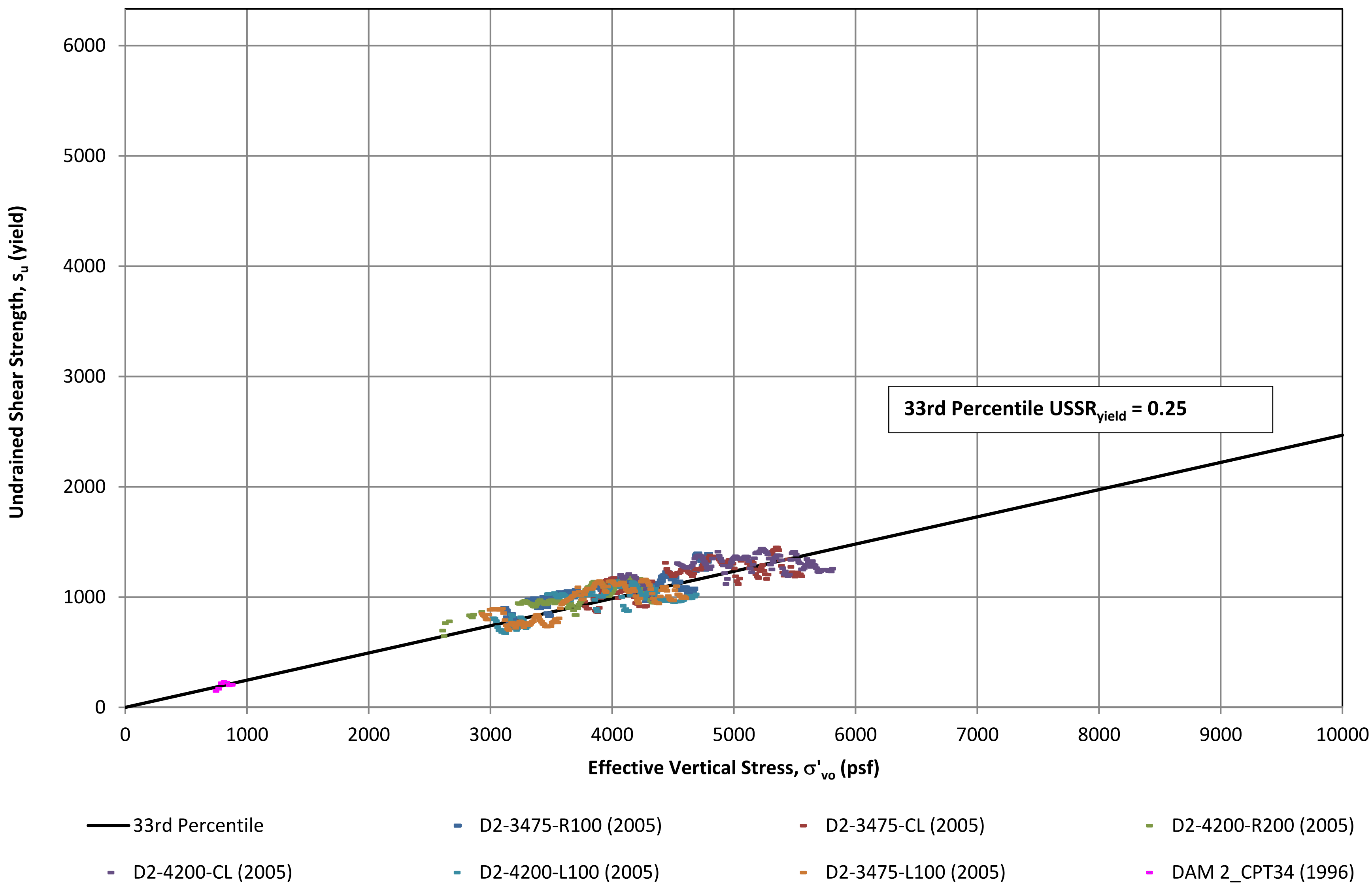
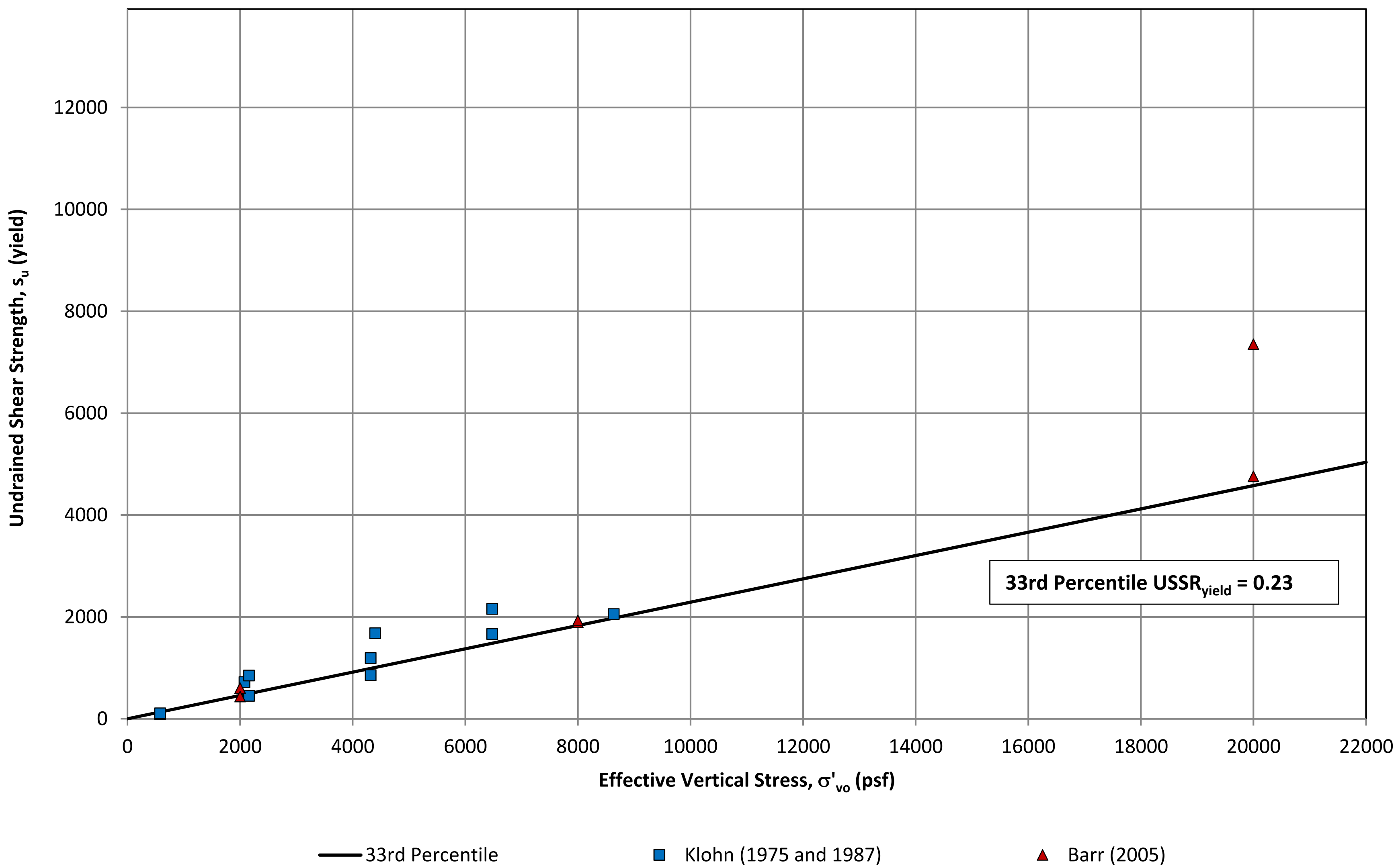


FIGURE 9
CIU Test Undrained Shear Strength Envelope - Fine Tailings, Yield
Northshore Mine Milepost 7 Tailings Basin



Note: Some Klohn 1982 and Barr 2005 data are not presented due to possible cavitation during testing

FIGURE 10 Example Behavior Plots of Tip Resistance, Side Friction, Groundwater, and Compressibility from CPT Data

D2-3475-R100 (2005)

Northshore Mine Milepost 7 Tailings Basin

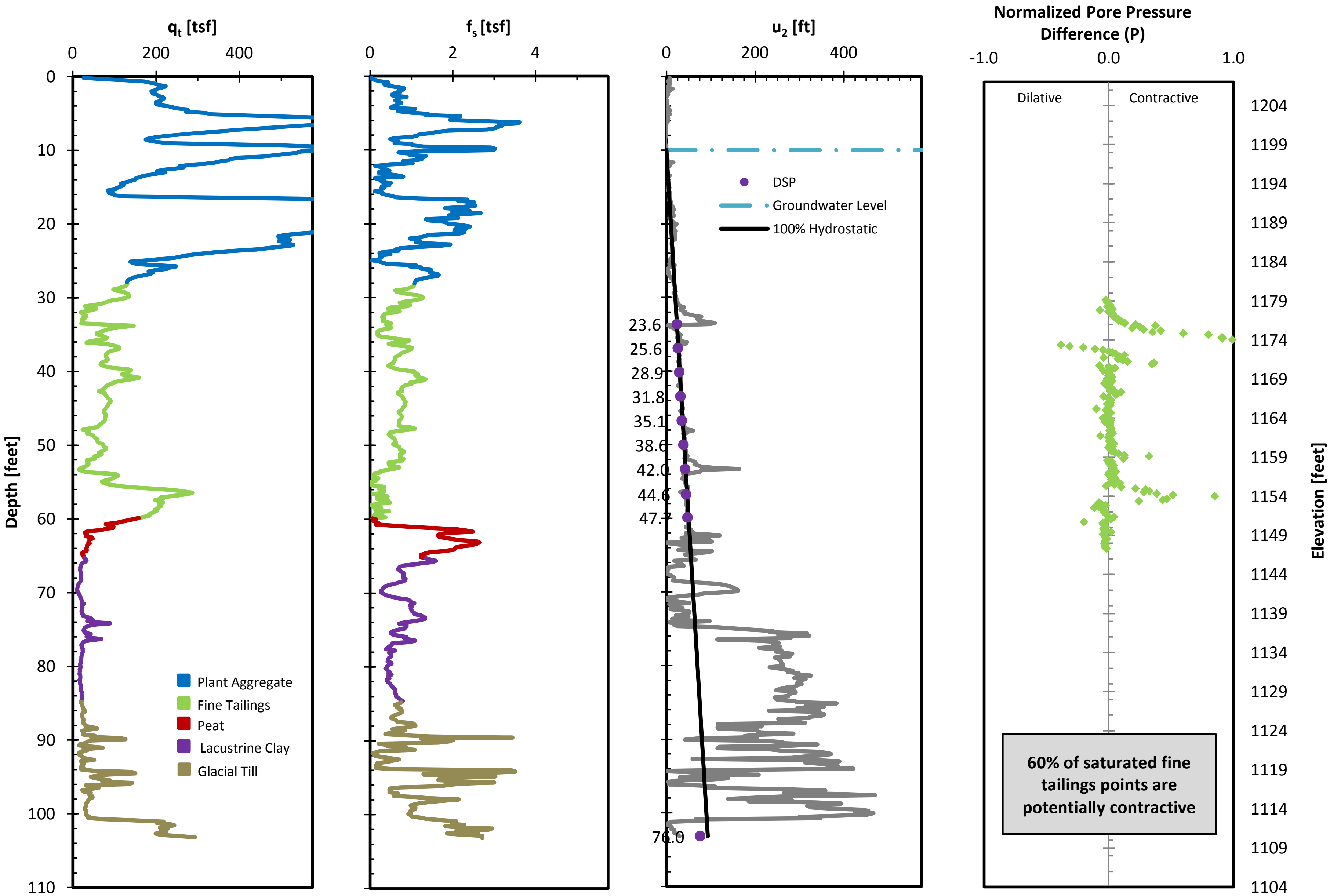


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FIGURE 8
Fine Tailings Contractive/Dilative Behavior (Olson, 2009)
Northshore Mine Milepost 7 Tailings Basin

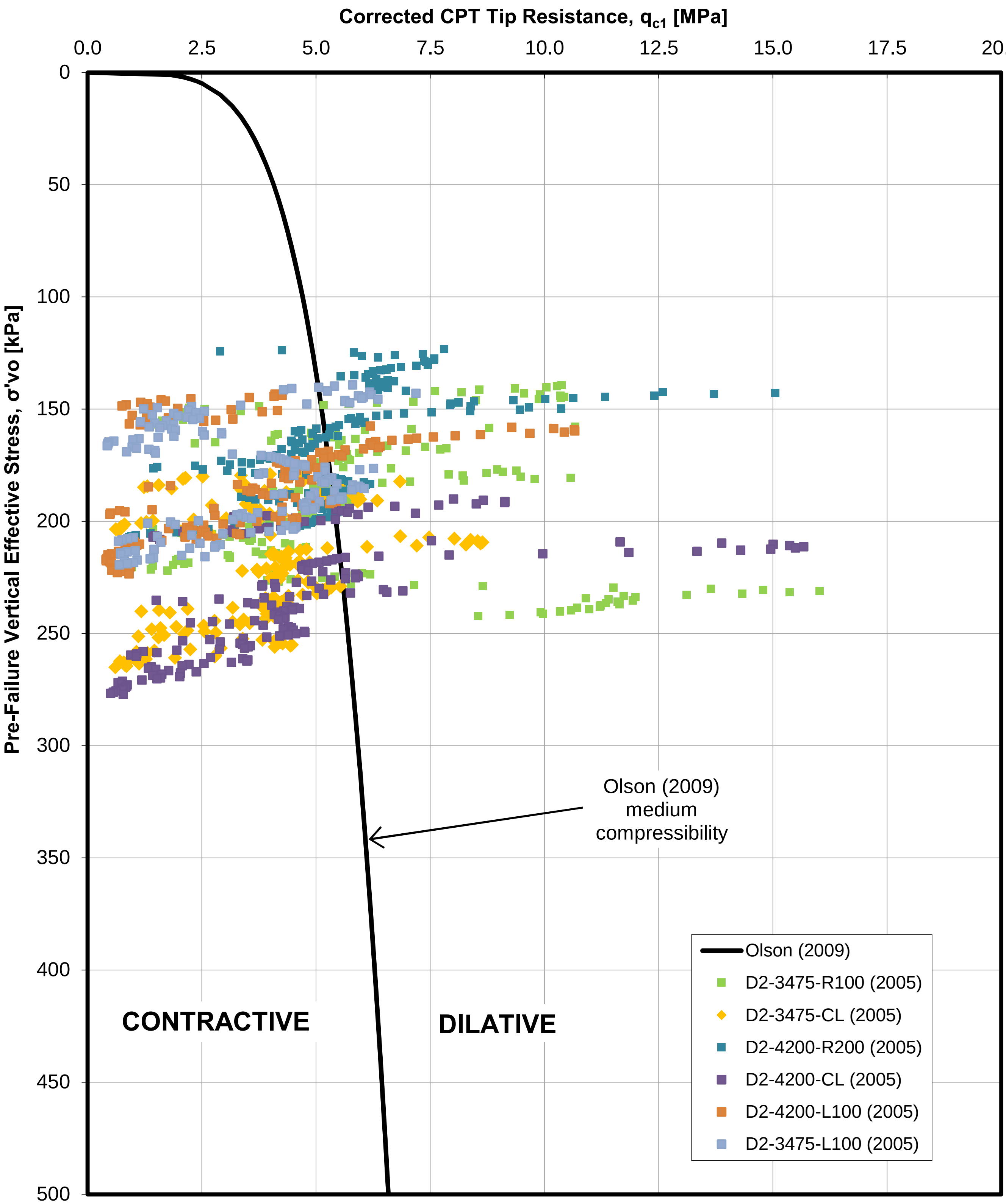


FIGURE 12

CPT Correlated Liquefied Undrained Shear Strength Envelope - Fine Tailings (Olson and Stark, 2003)

Northshore Mine Milepost 7 Tailings Basin

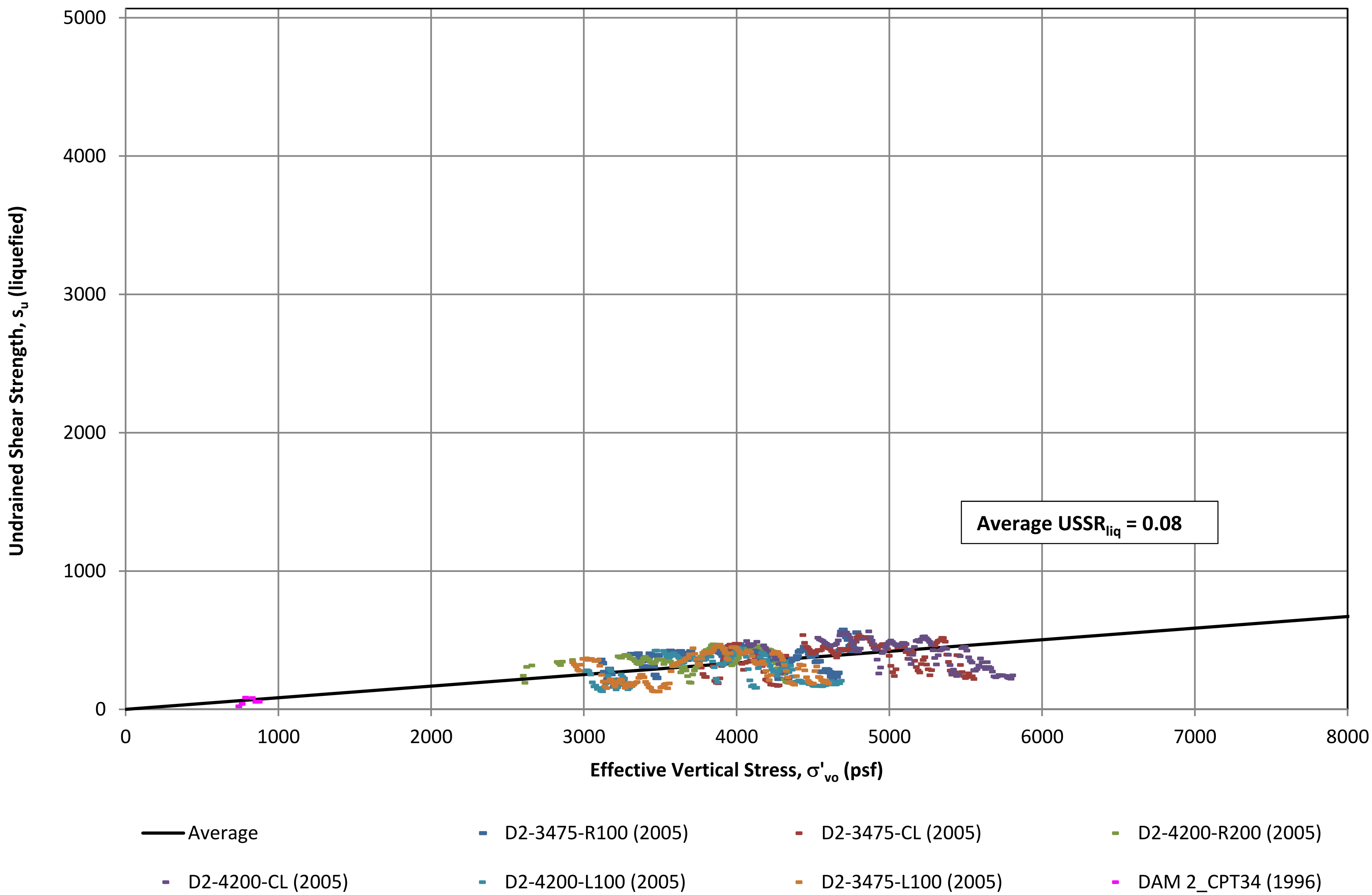
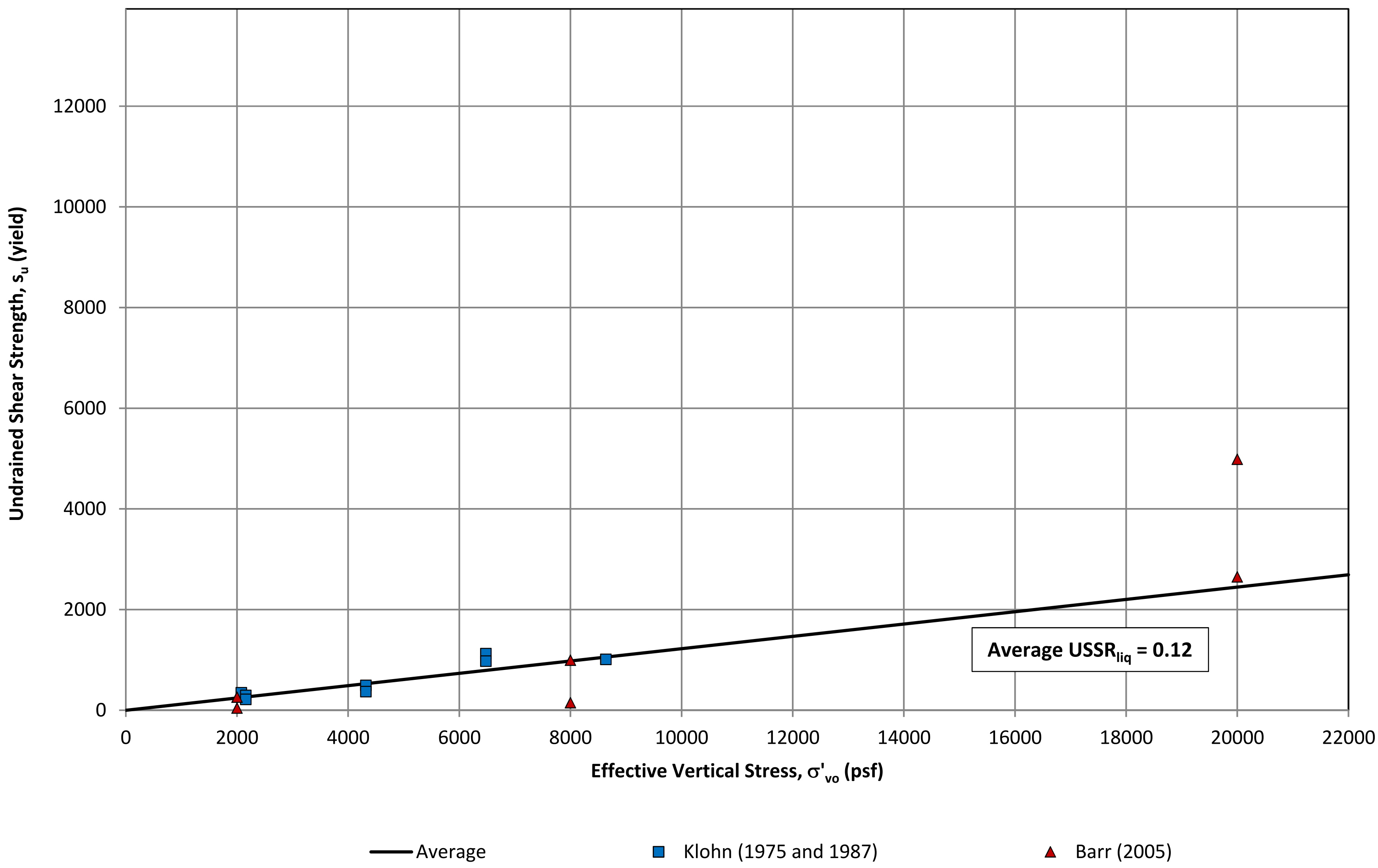


FIGURE 13
CIU Test Undrained Shear Strength Envelope - Fine Tailings, Liquefied
Northshore Mine Milepost 7 Tailings Basin



Note: Some Klohn 1982 and Barr 2005 data are not presented due to possible cavitation during testing

Appendix A

Dam 2 Construction Plans and Memo

Technical Memorandum

To: Mr. Dan Scamehorn and Mr. Lee Davis, Northshore Mining Company
From: Sara Leow, PE
Subject: Dam 2 Raise Construction Recommendations
Date: June 30, 2016
Project: 23380086.69 CO16 110
c: file

INTRODUCTION

Northshore Mining Company (NSM) is in the process of raising the elevation of Dam 2 at the Milepost 7 Tailings Basin near Silver Bay, Minnesota. The raises will initially consist of raising the filter berm and associated plant aggregate backing on the upstream slope crest. Additional material will be placed between the raised filter berm the planned railroad embankment, as well as on the downstream slope crest and between the railroad embankment and downstream slope crest, at a later date. Barr Engineering Company (Barr) completed a seepage and stability analysis for the proposed raise of Dam 2 and provided modeling results, recommendations, and design drawings in the report titled "Dam 2 Stability Evaluation: Dam Crest Elevation 1,248 feet" dated May 2016 (May 2016 report). We understand NSM staff and equipment will be utilized to construct the Dam 2 raises to 1,243 feet at this time. The dam was originally planned to be subsequently raised to 1,248 feet; however after the analyses were completed, long range planning at the end of 2015 resulted in a potential next raise to 1,253 feet. With the shutdown of the plant, an adjustment to the long range plan will be required which will likely change the required dam construction elevations. The adjustment to the plan will occur in the fall of 2016. As a result, of the changes, analyses for dam crest elevations other than 1,248 feet will be performed Analyses at a later date. This memo discusses the material and construction requirements for the raise of Dam 2 up to 1,248 feet to accompany the design drawings presented in the May 2016 report.

MATERIALS

Two types of materials are to be placed for the raise of Dam 2, including plant aggregate and filter. The following paragraphs describe the material characteristic requirements.

Plant Aggregate

Plant aggregate shall be composed of a well graded, granular material consisting of coarse and fine tailings and meeting the gradation denoted in the "Update of Engineering Design for the Reserve Mining Company On-Land Tailings Disposal" by Klohn Leonoff dated May 1985. Plant aggregate shall be used to construct the majority of the raise for the dam embankment, as shown on the construction plans.

Filter

As depicted on the construction plans, a filter berm at least 15 feet wide at the dam crest is to be placed on the upstream face of Dam 2. Filter material placed on the downstream side of the seepage cutoff in the northeastern corner of Dam 2 should also be at least 8 feet wide. Filter material shall consist of well-graded, granular material conforming to the gradation indicated in the "Update of the Engineering Design for the Reserve Mining Company On-Land Tailings Disposal" by Klohn Leonoff dated May 1985.

Clay Cutoff

Clay glacial till used for raising the cutoff in the northeastern corner of Dam 2 shall consist of a clayey soil classified as CL, as defined by ASTM D2488, "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)." The clay till also needs to meet the following conditions:

1) No boulders or cobbles greater than 6 inches in diameter.

2) At least fifty (50) percent of material by dry weight shall pass the 4.75mm sieve and no more than twenty-five (25) percent by dry unit weight shall pass the 0.075mm sieve in their greatest dimension.

3) The fraction of material passing the #40 sieve shall have a plasticity index greater than 7 and shall have a liquid limit less than 50.

DAM RAISE CONSTRUCTION

This section discusses construction considerations for the raise of Dam 2 to elevation 1,243 feet. These considerations are also applicable for a subsequent raise up to crest elevation 1,248 feet.

CONSTRUCTION SEQUENCE

The construction sequence is anticipated to occur in the following order:

1) Survey of Dam 2 centerline, PIs, and control

2) Placement additional markers/flags at instrumentation locations to help avoid damage from construction activities.

3) Marking of all public and private utility lines in the construction area.

4) Establishment of stockpile areas.

5) Establishment of a haul road dust control plan.

6) Performance of clearing, grubbing, and stripping needed in any areas in addition to that which have already been completed at the west abutment.

7) Clearing, grubbing, and scaling to competent rock at the east abutment tie-in area.

8) Rock surface inspection of the east abutment by the dam engineer.

9) Preparation of the existing dam surface for subsequent fill placement.

10) Construction of abutment tie-ins.

11) Placement of filter material to elevation 1,243 or 1,248 feet (as applicable), as shown on the construction drawings. This task also includes implementing provisions for extending instrumentation as necessary.

12) Placement of plant aggregate as shown on the drawings. Similar to the previous step, this task includes implementing necessary provisions for extending instrumentation.

13) Final grading to place material between the future railroad grade and dam slope crests as well as to achieve a final 6 horizontal to 1 vertical (6H:1V) downstream slope, as shown on the construction drawings.

Over the duration of construction, surface water will need to be controlled as necessary to allow placement of embankment materials in the dry. Existing piezometer and inclinometer instrumentation should also be monitored over the entire period of construction to document pore water pressures and any movement, which may indicate a change in dam stability and affect construction activities. NSM's vibrating wire piezometer readout is located in the truck shop.

CLEARING, GRUBBING, STRIPPING, AND/OR SCALING

Clearing, grubbing, stripping, and placement of filter materials will need to be performed in the dam raise construction area. Clearing, grubbing, and scaling will need to be performed for the east abutment tie-in areas prior to placement, as well. The procedures to be followed for abutment/dam foundation preparation are presented in the following sections.

Dam Foundation Areas

1) Clearing, grubbing, and stripping shall consist of the removal of all brush, trees, stumps, boulders, topsoil, and debris from areas where the new embankment/abutment tie-in will be constructed, as necessary.

2) Grubbing shall not be done for fill placed on clay foundation soils to prevent disturbance to the existing clay foundation. Where stumps are to remain in place, the trees shall be cut so that no more than 12 inches extends above the ground surface. Grubbing in all other areas shall include removing all stumps, roots, and logs to a depth of 2 feet below the ground surface.

3) Foundation preparation for embankment material placement shall consist of the removal of soft organic surface soil and mineral soil where recommended by the on-site geotechnical engineer or engineering technician observing dam construction.

4) In areas of clay foundation soil, rubber-tired construction equipment will not be permitted to travel on the original ground or on the prepared foundation. Material to be removed shall be excavated by backhoe working from the first lift of embankment fill. Crawler equipment may be operated on the original ground if the clay foundation will not be significantly disturbed. Organic material and any saturated or soft soils shall be removed to expose firm mineral soil with an unconfined compressive strength of at least 0.5 tons per square foot (tsf), as field tested with a pocket penetrometer. Prepared areas shall be covered as soon as possible after excavation. Prepared foundation areas left exposed may need to be re-prepared if the surface becomes desiccated and cracked, or wet and soft. Grass growth can remain over an acceptable foundation.

Rock Foundation Areas

1) Foundation preparation in rock areas shall consist of removal of all loose or weathered rock under the embankment/abutment areas.

2) Upon completion of the clearing of loose/weathered rock, the rock surface shall be inspected by the dam engineer. If open joints are observed, surface grouting may need to be conducted prior to fill material placement.

Stockpile Areas

Spoil from the clearing, grubbing, and scaling operations shall be placed in the designated spoil area(s). Topsoil from the stripping operation can be placed in the designated spoil area(s) for reuse as random topsoil as desired by NSM.

Borrow Pit Areas

1) Clearing for borrow pits shall proceed a minimum distance ahead of till borrow material excavation to minimize disturbances that allow the till to become overly wet or saturated.

2) Spoil from the clearing and grubbing operation shall be placed in the designated spoil area(s). Topsoil from the stripping operation can be placed in the designated spoil area(s) for reuse as random topsoil as desired by NSM.

EXCAVATIONS

All excavations should conform to MSHA and OSHA regulations. Excavations shall not impact the stability of existing dams in the tailings basin. Water entering excavations should be controlled as necessary for compliance with MSHA and OSHA regulations, as well as to allow placement of embankment materials in dry conditions. Water control methods may consist of ditching, grading, or piping to route water away from stockpile, haul road, and dam construction areas, as well as within the vicinity of existing dam embankments where saturating soil may affect dam stability.

SURFACE PREPARATION

Prior to placement of new embankment materials for the dam raise, the existing surface of Dam 2 must be prepared. Surface preparation shall include the following:

1) Those portions of the existing dam being raised shall be bladed to remove all surface material not meeting the specifications for each individual zone prior to placing fill. Bladed and excavated material shall be hauled and placed in the designated spoil areas.

2) All cavities or depressions caused by the removal of trees or stumps from the existing dam or abutments shall be filled with the same type of specified material as would be incorporated into the overlying portion of the embankment and compacted to the specified density of that material.

3) All vegetation and topsoil shall be removed from existing dam slopes that fill will be placed upon or will be graded, as applicable.

4) The clay till cutoff should be scarified to a depth of 6”, moisture conditioned to the optimum moisture content range, and re-compacted. The existing clay till cutoff surface shall be moistened prior to placing new fill if the surface is drier than the optimum water content as determined by ASTM D 698, “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.”

FILL MATERIAL PLACEMENT

After the abutment tie-in areas and existing dam surface have been prepared, fill material placement for the dam raise can commence. Fill requirements are presented in the following sections.

General Requirements

1) No frozen fill shall be placed, nor shall fill be placed upon frozen subgrade soils.

2) All materials used in the embankment shall be placed in such a manner that mixing of the various materials with other embankment materials will not occur (i.e. mixing of plant aggregate with downstream filter, etc.)

3) During the construction of the dam raise, the surface of the prepared foundation may become too dry or smooth to bond properly with the next succeeding lift, due to equipment operation or weather conditions. Evidence of this condition is a dusting or crusting of the surface. The surface shall be moistened and/or scarified before the successive lift is placed if this condition develops.

4) All designated areas should be finished to the locations and grades shown on the construction drawings. All finish grading shall be accomplished using normal mechanical construction equipment.

Filter Material

1) Filters are to be constructed as shown on the construction drawings. All filters shall conform to the gradation limits specified in the Materials section above. Filter material is required on the upstream face of the dam, as well as between any foundation materials and coarse aggregate.

2) The foundation soils shall not be disturbed during handling and placement of filter material. To help prevent disturbance of foundation soils in abutment tie-in areas, initial placement of filter on the prepared foundation shall be in a 5-foot lift which shall be watered and compacted as a single lift. In some areas, the foundation preparation and the filter placement may be performed concurrently to minimize foundation disturbance. If rutting of the initial lift occurs, foundation soils shall be checked for disturbance. If disturbance has occurred, the foundation shall be re-prepared and a fresh lift of filter material placed.

3) Above the initial 5-foot lift in abutment tie in areas, the filter fill shall be spread in horizontal lifts a maximum of 12 inches thick in a manner such that no segregation occurs and so that the lifts are uniform and reasonably smooth. Each lift shall be watered and compacted to meet 95% of the standard Proctor dry density (ASTM D698). A vibratory roller with a static weight at the drum of at least 15,000 lbs. shall be used to compact the fill. Sufficient passes with the roller shall be made to achieve the specified density, but not less than four passes on any lift.

Coarse Tailings Material

1) Coarse tailings considered plant aggregate can consist of a mixture of coarse tailings, fine tailings, dry cobb tailings, or any combination thereof meeting the requirements discussed in the Materials section above.

2) Plant aggregate shall be placed in the zones designated in the construction drawings. Coarse tailings shall be placed and spread in horizontal lifts with a maximum thickness of 12 inches and without segregation. Coarse tailings shall be watered and compacted to 95% of the standard Proctor dry density (ASTM D698). A vibratory roller with a static weight at the drum of at least 15,000 lbs shall be used to compact each lift. Sufficient passes with the roller shall be made to achieve the specified density but not less than four passes on any lift.

Clay Cutoff Material

1) Local pockets of sandier material encountered in the excavation of the borrow pit, or any other materials not meeting the requirements discussed in the Materials section for clay core materials, shall not be used as fill for clay core construction.

2) The fill shall be spread in approximately horizontal layers at least 8 feet wide in a direction parallel to the cutoff centerline. In some areas, such as at the abutment tie-in, the foundation preparation work and the glacial till placement may be carried out simultaneously. Above the initial lift, the maximum thickness of each lift prior to compaction shall be 12 inches. Spreading equipment shall closely follow the dumping operation.

3) Any surface of the fill made smooth by equipment travel shall be scarified prior to placement of successive lifts. If any layer has deteriorated through excessive drying, softening by surface water, or through the construction operations, it shall be restored to an acceptable standard or replaced. No fill is to be placed over soft or rutted surfaces and any such surfaces encountered shall be repaired prior to placement of glacial till material.

4) Each layer of fill shall be compacted with an approved sheepsfoot roller to a dry density not less than 95 percent of maximum dry density as determined by the Standard Proctor density test ASTM D698. The number of passes by the sheepsfoot roller shall be such that the required density is obtained, but shall not in any case be less than four passes.

5) If additional moisture is required, water shall be sprayed on the material as it is being spread. Water shall be applied by a water truck equipped with spray nozzles and thoroughly mixed into the soil by discing or other suitable method. Placement of material with moisture content higher than that which will allow suitable compaction is unacceptable. Any other wet material encountered in the borrow or at the dam site shall be rejected, or ripped or disced and air-dried to an acceptable moisture content before placement on the fill can begin. Work shall be shut down in the event of rain or snow where an excessively high moisture condition would result.

6) To avoid excessive moisture accumulation on the fill due to the rainfall, the surface shall be sloped to an outside edge to facilitate drainage movement to areas outside the work zone. When work is shut down for rain, the shutdown procedure shall include rolling of the entire exposed lift surface with a smooth drum roller to make a smooth, dense, water-shedding surface. When the surface has subsequently dried, it shall be scarified before recommencement of fill placement.

7) When spreading fill in cutoff trenches or against a sloping face of previously placed clay glacial till fill, a bulldozer or grader shall be used to make a light cut into the slope to blend each lift of new fill to the sloping surface.

Fill Compaction Requirements Summary

Table 1 summarizes the compaction requirements denoted in the Fill Materials Placement section, as well as includes the allowable moisture content range.

Table 1: Compaction Requirements

Material	Allowable Moisture Content Range from Optimum	Minimum Percent Compaction*
Filter	-3% to +3%	95%
Plant Aggregate ("Dry Cobb")	-3% to +3%	95%
Clay Till Cutoff	-2% to +3%	95%

**Percentage of Maximum ASTM D698 Standard Proctor Dry Density*

Compaction of fill shall be achieved with equipment designed for the type of material being placed. In the event that the initial density tests indicate the applicable compaction level is not being achieved, the compaction procedures shall be changed to the extent necessary to achieve the specified moisture content and density. The available procedure change options one or a combination of the following:

1. Increase the number of passes by the compaction equipment of each lift.

2. Decrease the thickness of the lift to be compacted.

3. Adjust the soil moisture content prior to compaction by sprinkling and mixing water if the soil is drier than the specified allowable moisture content range or aerating and drying if the soil is wetter than the specified allowable moisture content range.

4. Select soil at the material source that will have a moisture content closer to the optimum moisture content.

5. Change the type or size of compaction equipment.

6. If the fill is placed and does not meet the compaction requirements, and the above methods have been attempted, the fill shall be removed and replaced with suitable fill.

Tolerances

The dam raises shall be constructed within the following dimensional tolerances:

1) Elevation: within -0.2 to +0.2 feet of elevations depicted on the construction drawings, except adjustments to provide drainage.

2) Alignment: within -0.2 to +0.2 feet of the alignment depicted on the construction drawings.

FIELD QUALITY CONTROL

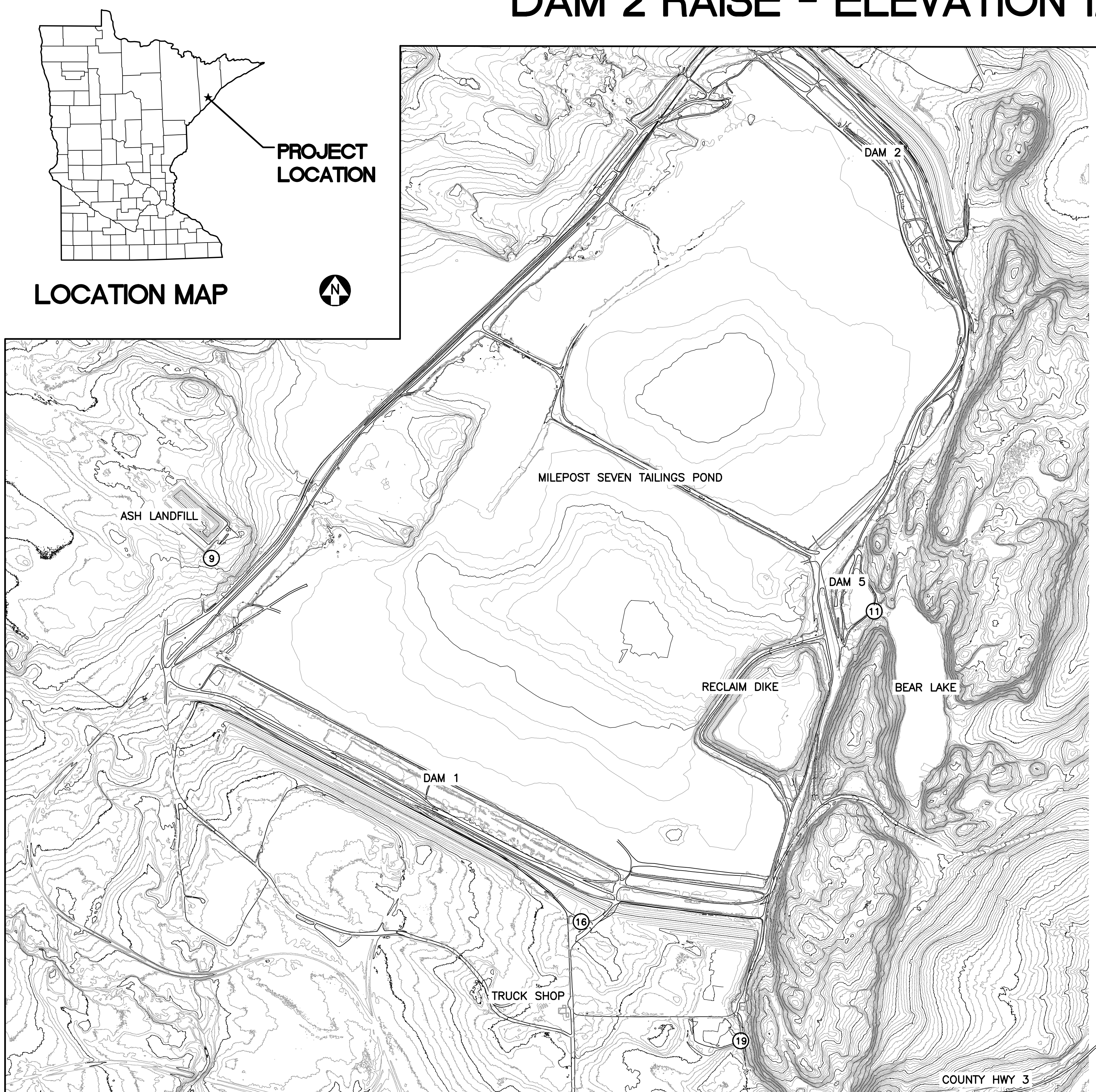
A geotechnical engineer or engineering technician under the supervision of a geotechnical engineer should observe exposed foundation materials for the abutment contact areas and the dam surface prior to fill placement, as well as fill placement and compaction. A materials testing firm should be contracted through Northshore to perform laboratory testing to document that materials meet the requirements in the Materials section, as well as perform field density testing of each of the dam fill materials to document that the material placed meets the compaction requirements in Table 1.

CERTIFICATION

I hereby certify that this specification was prepared by me or under my direct supervision and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

Sara L. Leow, PE
Geotechnical Engineer
License No.: 47103
Date: June 30, 2016

NORTHSHORE MINING COMPANY
DAM 2 RAISE – ELEVATION 1248

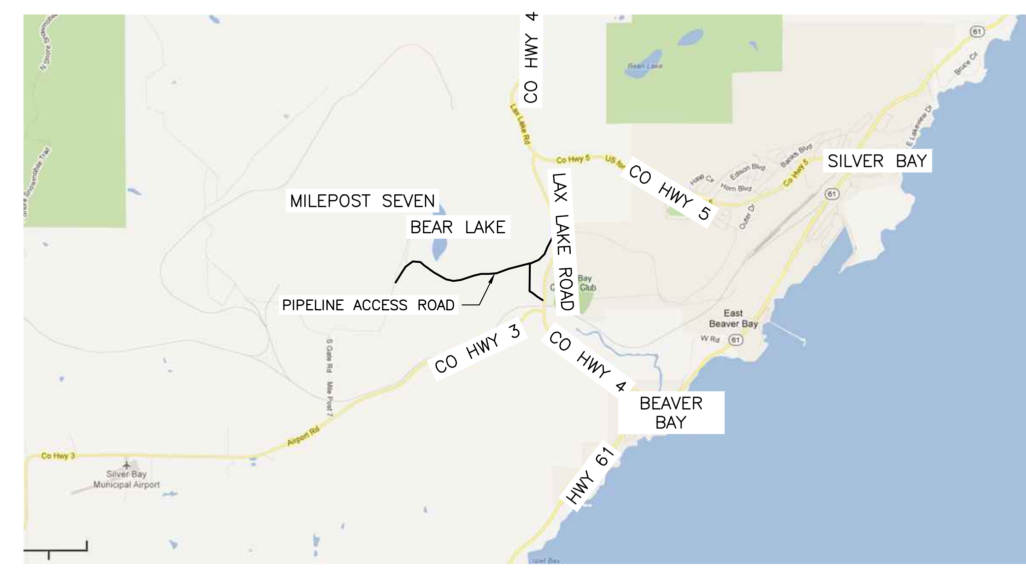


TAILING BASIN CONTROL DATA

BASIN CONTROL

NUMBER	NAME	NORTHING	EASTING	ELEVATION
1	HV–9	621587.4510	3048856.4250	1308.69
2	HV–11	620725.2580	3059623.2150	1201.82
3	HV–16	615676.6820	3054865.0750	1214.85

INDEX OF SHEETS



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SCALE IN FEET

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ISSUED FOR CONSTRUCTION 6/30/2016

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

SIGNATURE ____

PRINTED NAME SARA L. LEOW

DATE 6/30/2016 REG. NO. 47103

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT				12/23	6/30		
BID							
CONSTRUCTION				12/23			
	DATE RELEASED						

BARR

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Scale	AS SHOWN
Date	05/05/2014
Drawn	GSJ
Checked	ATG
Designed	GSJ
Approved	SLL

NORTHSHORE MINING COMPANY
SILVER BAY, MINNESOTA

2016 PROPOSED DAM CONSTRUCTION
MILEPOST SEVEN TAILINGS BASIN

DAM 2 RAISE – ELEVATION 1248
TITLE SHEET, SITE PLAN, AND SHEET INDEX

BARR PROJECT No. 23380086

CLIENT PROJECT No.

DWG. No. CC–001 REV. No. 1

Images in Drawing – K:\Design\23380086.00\local map.tif
gsj K:\Design\23380086.00\23380086 Dam 2_CC-001.dwg Plot at 20 12/03/2015 14:52:51

LAYOUT NOTES:

1. LAYOUT BASED ON CONTOURS DEVELOPED FROM LIDAR BY AERO–METRIC OF SHEYBOYGAN, WISCONSIN COMBINED WITH BATHYMETRY BY BARR ENGINEERING. DATE OF LIDAR MAY, 2014. DATE OF BATHYMETRY MAY 15, 2015. MAPPING BASED ON THE FOLLOWING DATUM:

- VERTICAL DATUM: TWO FOOT CONTOUR INTERVAL BASED ON NORTH AMERICAN VERTICAL DATUM OF 1988.
- HORIZONTAL DATUM: MINNESOTA STATE PLANE COORDINATE SYSTEM, NORTH ZONE, NAD 83/96

(1/–) PLAN: VICINITY MAP

ISSUED FOR CONSTRUCTION 6/30/2016

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION

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SIGNATURE

PRINTED NAME SARA L. LEOW

DATE 6/30/2016 REG. NO. 47103

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT				12/23	6/30		
BID							
CONSTRUCTION				12/23			

DATE RELEASED

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Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1–800–225–1966
Fax: (218) 262–3460
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Scale	AS SHOWN
Date	05/05/2014
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Checked	ATG
Designed	GSJ
Approved	SLL

NORTHSHORE MINING COMPANY
SILVER BAY, MINNESOTA

2016 PROPOSED DAM CONSTRUCTION
MILEPOST SEVEN TAILINGS BASIN

DAM 2 RAISE – ELEVATION 1248
CONSTRUCTION LOCATION MAP

BARR PROJECT No. 23380086

CLIENT PROJECT No.

DWG. No. CC–002 REV. No. 1

CADD USER: Greg Johnson FILE: K:\DESIGN\23380086.00\23380086 DAM 2_CC-002.DWG PLOT SCALE: 1:2 PLOT DATE: 6/30/2016 12:15 PM
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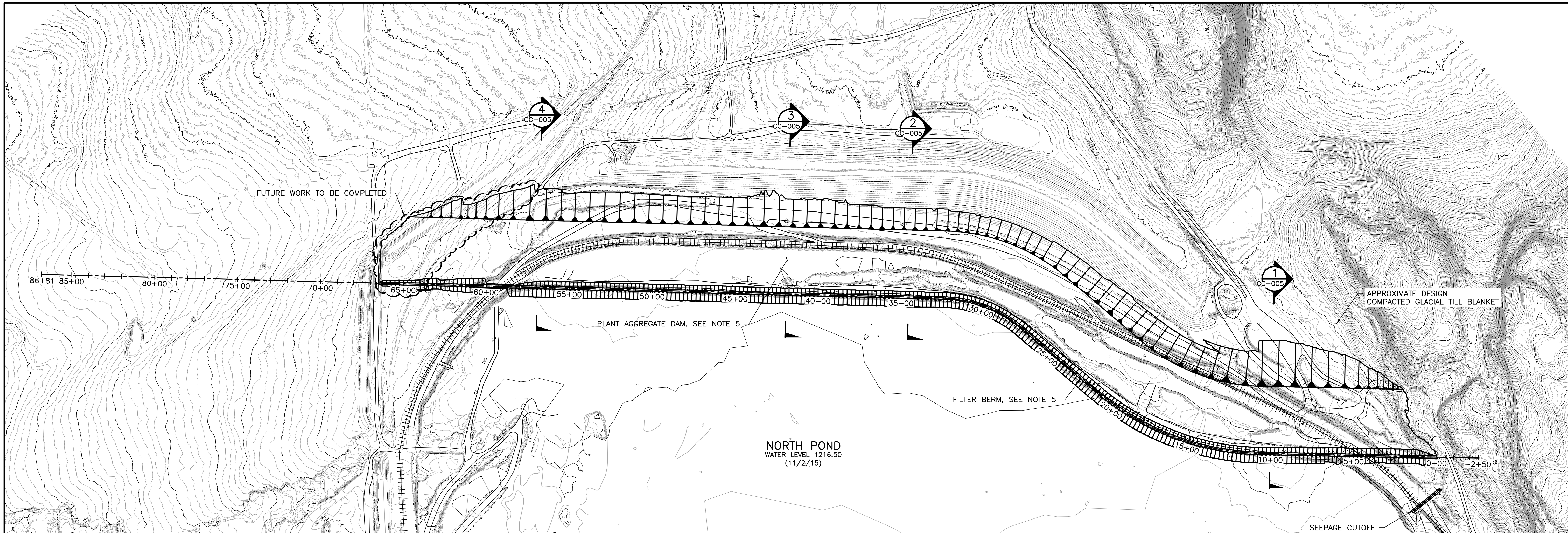

LAYOUT NOTES:

1. LAYOUT BASED ON CONTOURS DEVELOPED FROM LIDAR BY AERO-METRIC OF SHEYBOYGAN, WISCONSIN COMBINED WITH BATHYMETRY BY BARR ENGINEERING. DATE OF LIDAR MAY, 2014. DATE OF BATHYMETRY MAY 15, 2015. MAPPING BASED ON THE FOLLOWING DATUM:

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- HORIZONTAL DATUM: MINNESOTA STATE PLANE COORDINATE SYSTEM, NORTH ZONE, NAD 83/96

1 – PLAN: DAM 2

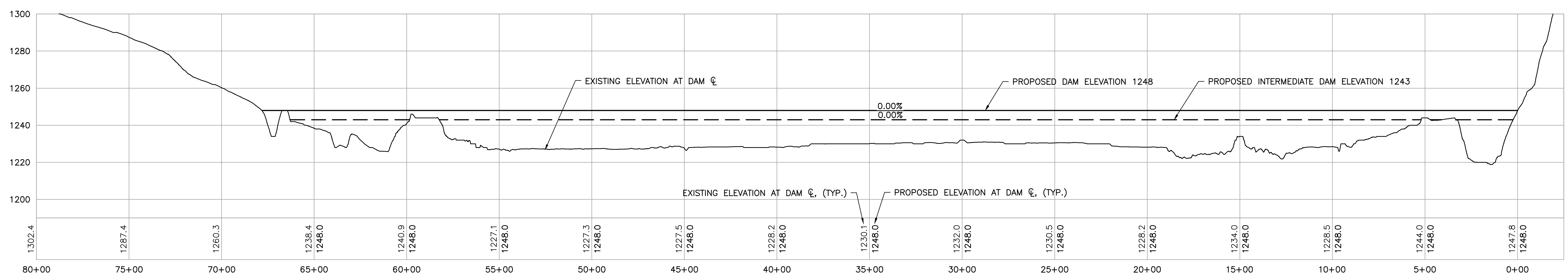
0 300 600
SCALE IN FEET

LEGEND:

- ◇ CASAGRANDE PIEZOMETER
- ○ PNEUMATIC PIEZOMETER
- ⊙ VIBRATING WIRE PIEZOMETER
- △ INCLINOMETER
- □ RELIEF WELL

GENERAL NOTES:

1. ALL INSTRUMENTATION SHALL BE PROTECTED.
2. CONSTRUCTION OF THE DAM HAS BEEN ONGOING BY NSM. CONDITIONS HAVE CHANGED FROM THE TIME OF THE SURVEY.
3. PROTECT TAILINGS PIPE DURING CONSTRUCTION ACTIVITIES.
4. PROVIDE, PLACE, AND COMPACT MATERIALS IN DAMS IN GENERAL ACCORDANCE WITH MATERIALS AND METHODOLOGIES DESCRIBED IN UPDATE OF ENGINEERING DESIGN FOR THE RESERVE MINING COMPANY ON–LAND TAILINGS DISPOSAL FACILITY, MAY 1985, DISCUSSED IN THE MEMO TITLED "DAM 2 RAISE CONSTRUCTION RECOMMENDATIONS," AND DESCRIBED IN THE BARR REPORT TITLED "DAM 2 STABILITY EVALUATION, DAM 2 CREST ELEVATION 1248 FEET."
5. DAM CONSTRUCTION SHOWN DEPICTS FULL DAM CONSTRUCTION EXTENTS TO ELEVATION 1248



1 – PROFILE: DAM 2

HORIZONTAL SCALE: 0 300 600 SCALE IN FEET
VERTICAL SCALE: 0 30 60 SCALE IN FEET

ISSUED FOR CONSTRUCTION 6/30/2016

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DATE 6/30/2016 REG. NO. 47103

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CLIENT			12/23	6/30			
BID							
CONSTRUCTION			12/23				
	DATE RELEASED						

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Scale	AS SHOWN
Date	05/05/2014
Drawn	GSJ
Checked	ATG
Designed	GSJ
Approved	SLL

NORTHSHORE MINING COMPANY
SILVER BAY, MINNESOTA

2016 PROPOSED DAM CONSTRUCTION
MILEPOST SEVEN TAILINGS BASIN, DAM 2

DAM 2 RAISE – ELEVATION 1248
EXISTING CONDITIONS PLAN AND PROFILE

BARR PROJECT No. 23380086
CLIENT PROJECT No.
DWG. No. CC–003
REV. No. 1

CADD USER: Greg Johnson FILE: K:\DESIGN\23380086.00\23380086 DAM 2_CC-003.DWG PLOT SCALE: 1:2 PLOT DATE: 6/30/2016 12:18 PM
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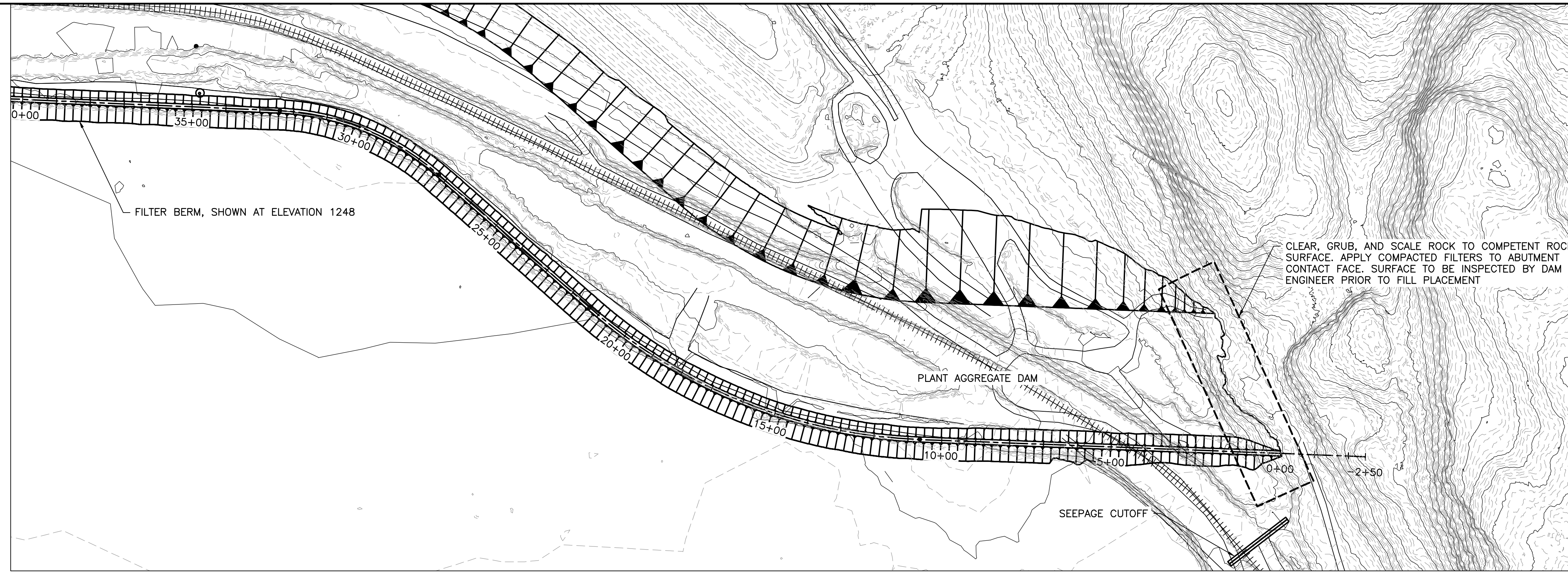
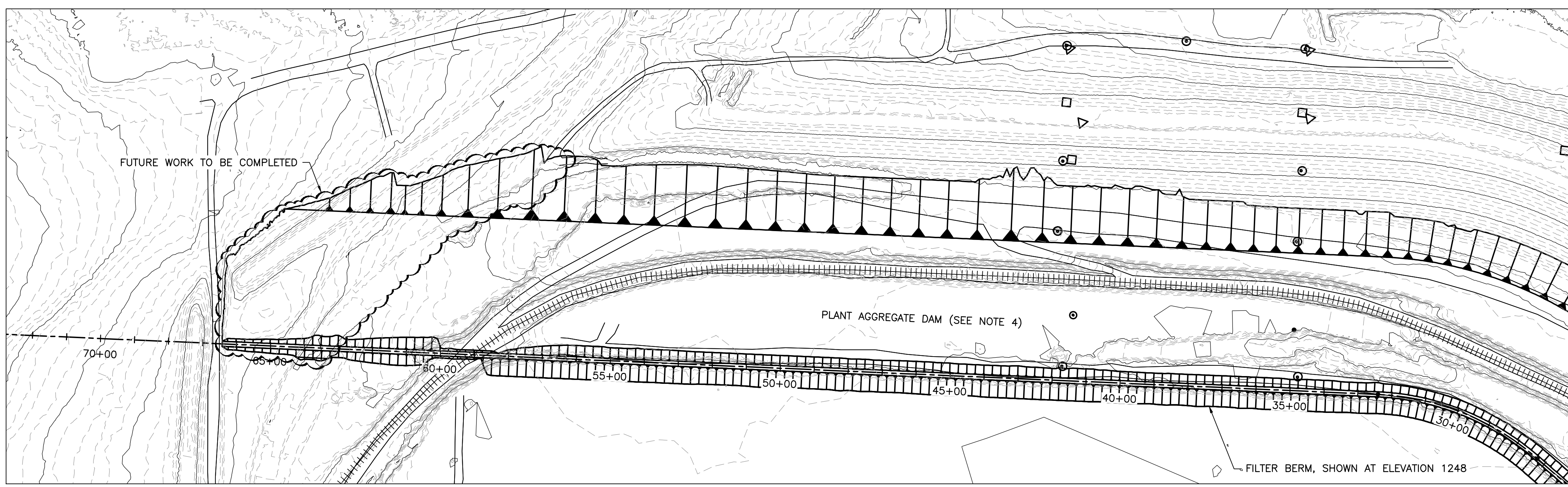


1 PLAN: DAM 2

0 200 400 SCALE IN FEET



2 PLAN: DAM 2

0 200 400 SCALE IN FEET

LAYOUT NOTES:

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- HORIZONTAL DATUM: MINNESOTA STATE PLANE COORDINATE SYSTEM, NORTH ZONE, NAD 83/96

GENERAL NOTES:

1. ALL INSTRUMENTATION SHALL BE PROTECTED.
2. CONSTRUCTION OF THE DAM HAS BEEN ONGOING BY NSM. CONDITIONS HAVE CHANGED FROM THE TIME OF THE SURVEY. ESTIMATED CONSTRUCTION VOLUMES HAVE BEEN CALCULATED AGAINST 2014 CONDITIONS.
3. PROTECT TAILINGS PIPE DURING CONSTRUCTION ACTIVITIES.

	ESTIMATED QUANTITIES	ESTIMATED QUANTITIES
MATERIAL	EXISTING – EL 1243	EL 1243 – EL 1248
FILTER	171,200 CY	105,000 CY
PA – DAM	1,900,000 CY	460,000 CY

ISSUED FOR CONSTRUCTION 6/30/2016

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CLIENT				12/23	6/30		
BID							
CONSTRUCTION				12/23			
	DATE RELEASED						

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Scale	AS SHOWN
Date	05/05/2014
Drawn	GSJ
Checked	ATG
Designed	GSJ
Approved	SLL

NORTHSHORE MINING COMPANY
SILVER BAY, MINNESOTA

2016 PROPOSED DAM CONSTRUCTION
MILEPOST SEVEN TAILINGS BASIN, DAM 2

DAM 2 RAISE – ELEVATION 1248
CONSTRUCTION PLAN

BARR PROJECT No. 23380086
CLIENT PROJECT No.
DWG. No. CC-004
REV. No. 1

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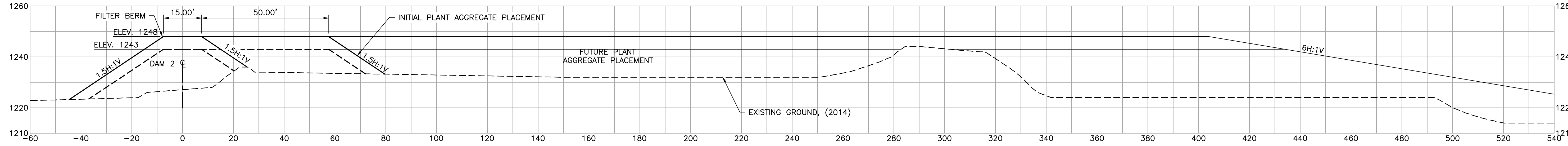

4 CC-003 SECTION: STA 52+00

0 20 40
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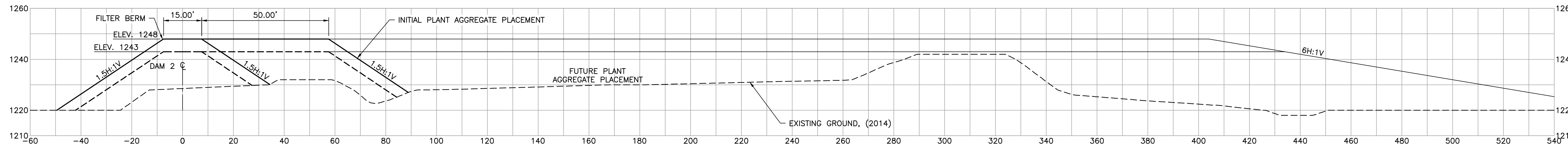

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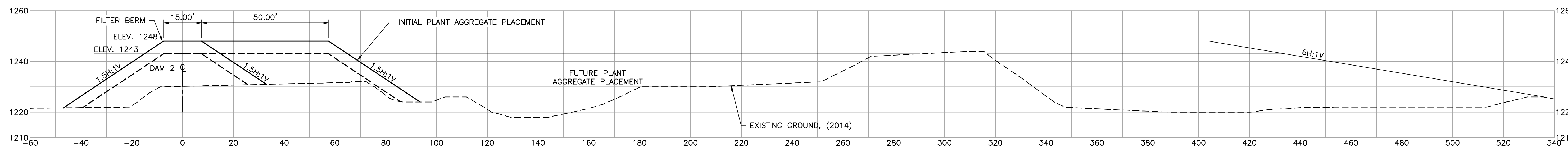
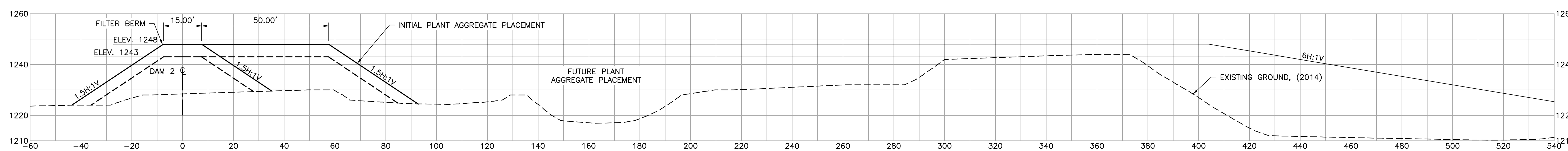
0 20 40
SCALE IN FEET



2 CC-003 SECTION: STA 34+75

0 20 40
SCALE IN FEET



1 CC-003 SECTION: STA 10+00

0 20 40
SCALE IN FEET

GENERAL NOTES:

1. ALL INSTRUMENTATION SHALL BE PROTECTED.

2. CONSTRUCTION OF THE DAM HAS BEEN ONGOING BY NSM. CONDITIONS HAVE CHANGED FROM THE TIME OF THE SURVEY. ESTIMATED CONSTRUCTION VOLUMES SHOWN ON CC-004 HAVE BEEN CALCULATED AGAINST 2014 CONDITIONS.

3. PROTECT TAILINGS PIPE DURING CONSTRUCTION ACTIVITIES.

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PRINTED NAME SARA L. LEOW
DATE 6/30/2016 REG. NO. 47103

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CLIENT				12/23	6/30		
BID							
CONSTRUCTION				12/23			
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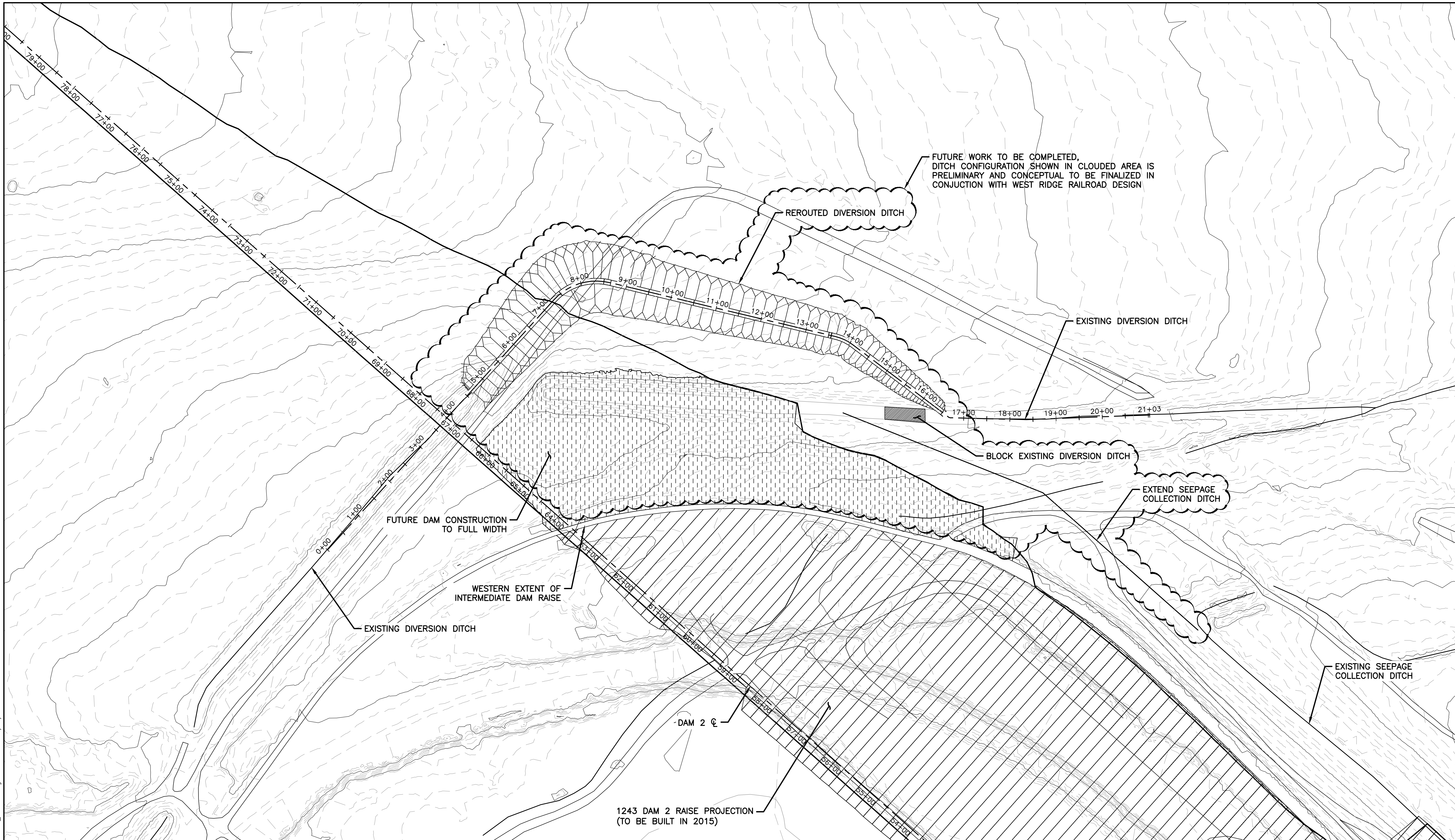
Scale	AS SHOWN
Date	05/05/2014
Drawn	GSJ
Checked	SLL
Designed	GSJ
Approved	SLL

NORTHSHORE MINING COMPANY
SILVER BAY, MINNESOTA

2016 PROPOSED DAM CONTRUCTION
MILEPOST SEVEN TAILINGS BASIN, DAM 2

DAM 2 RAISE – ELEVATION 1248
SECTIONS

BARR PROJECT No. 23380086
CLIENT PROJECT No.
DWG. No. CC-005
REV. No. 1



1 PLAN: DAM 2 DIVERSION DITCH/DAM CONSTRUCTION

0 100 200
SCALE IN FEET

NOTE: "FUTURE WORK TO BE COMPLETED" SHALL BE REQUIRED TO BE COMPLETED WHEN THE WATER LEVEL IS WITHIN 10' OF THE DAM CREST, WHEN RUNOFF FROM THE WEST RIDGE RAILROAD WOULD ENTER THE DIVERSION DITCH, OR WHEN RUNOFF FROM THE DAM WOULD ENTER THE DIVERSION DITCH – WHICHEVER OCCURS FIRST.

ISSUED FOR CONSTRUCTION 6/30/2016

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PRINTED NAME SARA L. LEOW
SIGNATURE
DATE 6/30/2016 LICENSE # 47103

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT				12/23	6/30		
BID							
CONSTRUCTION				12/23			

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Scale	AS SHOWN
Date	11/19/2014
Drawn	GSJ
Checked	SLL
Designed	GSJ
Approved	SLL

NORTHSHORE MINING COMPANY
SILVER BAY, MINNESOTA

2016 PROPOSED DAM CONSTRUCTION
MILEPOST SEVEN TAILINGS BASIN

PLAN
DAM 2 – INTERMEDIATE ELEV 1243

BARR PROJECT No. 23380086
CLIENT PROJECT No.
DWG. No. CC-006
REV. No. 1

CADD USER: Greg Johnson FILE: K:\DESIGN\23380086.00\23380086 DAM 2_CC-006.DWG PLOT SCALE: 1:2 PLOT DATE: 6/30/2016 12:52 PM
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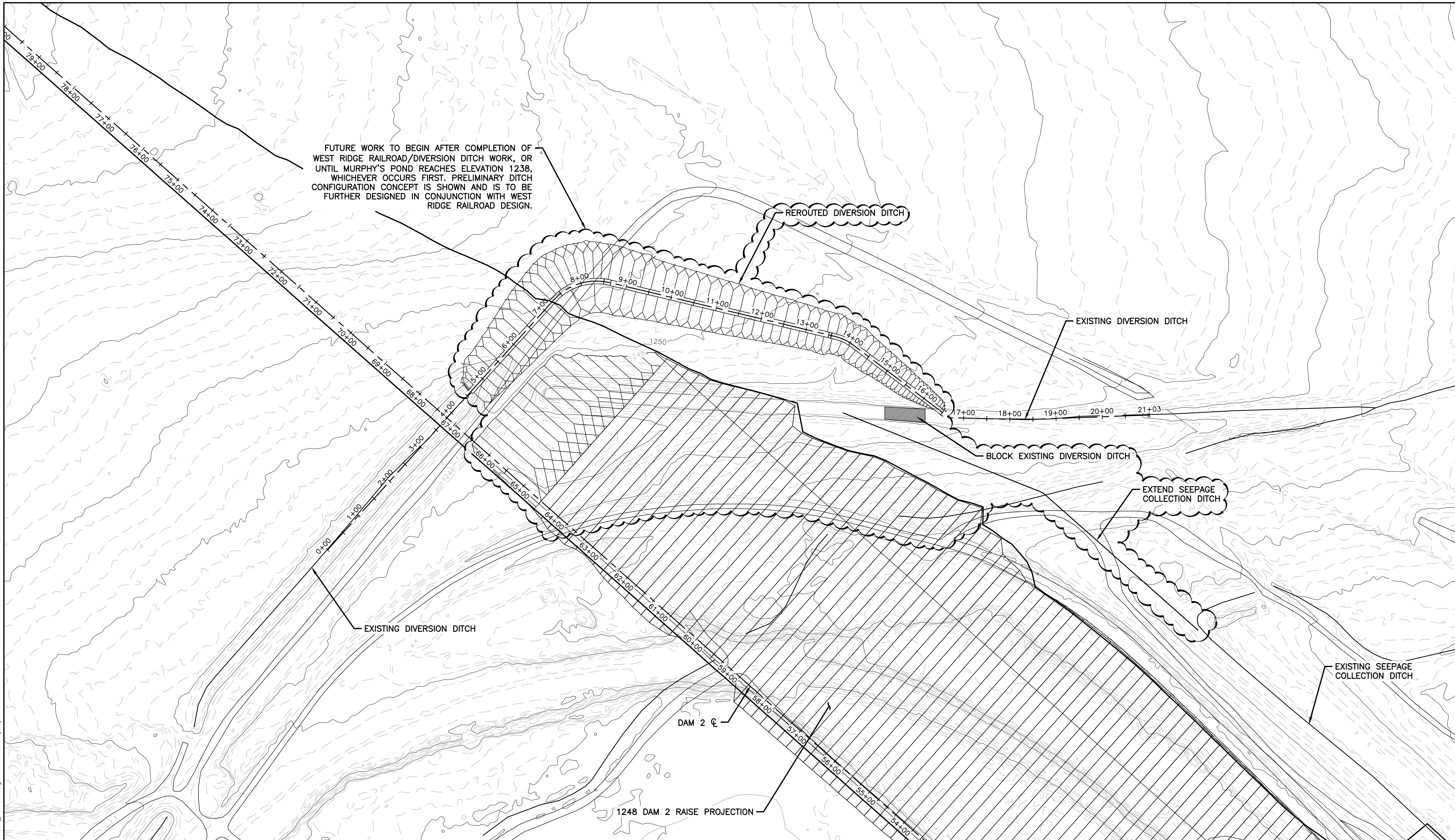

1 PLAN: DAM 2 DIVERSION DITCH/DAM CONSTRUCTION

0 100 200
SCALE IN FEET

ISSUED FOR CONSTRUCTION 6/30/2016

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION

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SIGNATURE
DATE 6/30/2016 LICENSE # 47103

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT				12/23	6/30		
BID							
CONSTRUCTION				12/23			
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Scale	AS SHOWN
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Designed	GSJ
Approved	SLL

NORTHSHORE MINING COMPANY
SILVER BAY, MINNESOTA

2016 PROPOSED DAM CONSTRUCTION
MILEPOST SEVEN TAILINGS BASIN

PLAN
DAM 2 – ELEV 1248

BARR PROJECT No. 23380086
CLIENT PROJECT No.
DWG. No. CC-007
REV. No. 1

CADD USER: Greg Johnson FILE: K:\DESIGN\23380086.00\23380086 DAM 2_CC-007.DWG PLOT SCALE: 1:2 PLOT DATE: 6/30/2016 12:50 PM
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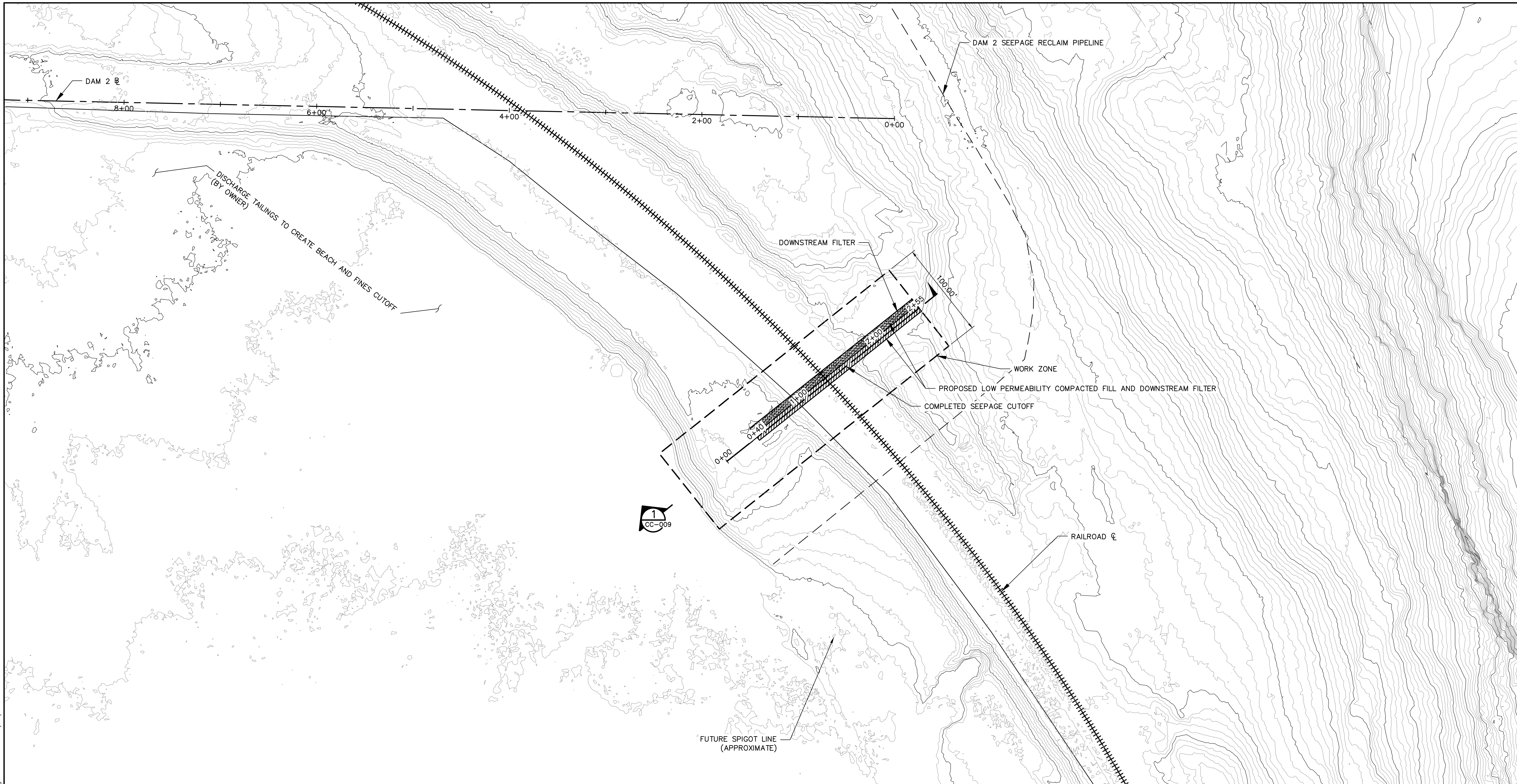

CONSTRUCTION COORDINATES

STATION	NORTHING	EASTING	DESCRIPTION
STA. 0+40	625143.76	3061057.34	LOW PERMEABILITY COMPACTED FILL
STA. 2+55	625138.34	3061272.27	(FIELD VERIFY)

1 / CC-002 PLAN: DAM 2 – SEEPAGE CUTOFF

0 50 100
SCALE IN FEET

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CLIENT			6/30				
BID							
CONSTRUCTION							
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Approved	SLL

NORTHSHORE MINING COMPANY
SILVER BAY, MINNESOTA

2016 PROPOSED DAM CONSTRUCTION
MILEPOST SEVEN TAILINGS BASIN

DAM 2 RAISE – ELEVATION 1248
SEEPAGE CUTOFF

BARR PROJECT No. 23380086
CLIENT PROJECT No.
DWG. No. CC–008 REV. No. 0

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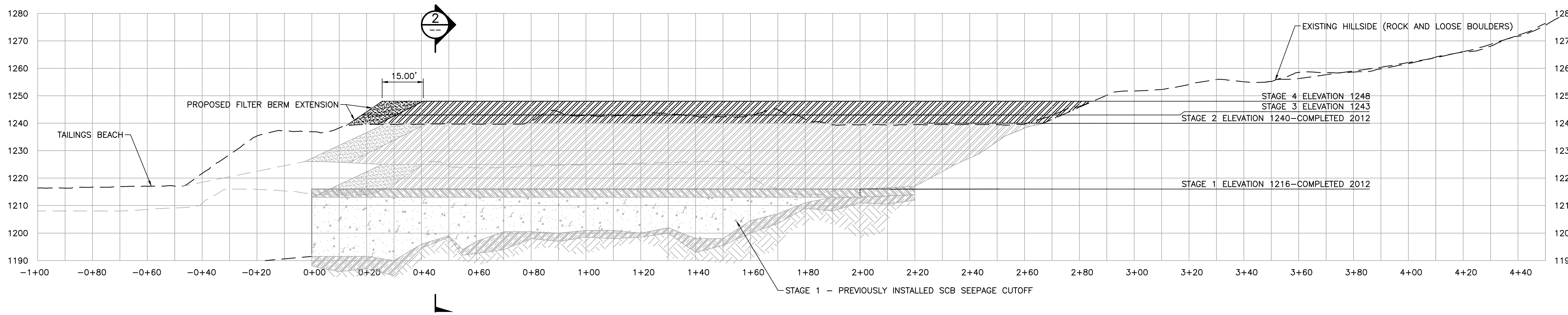

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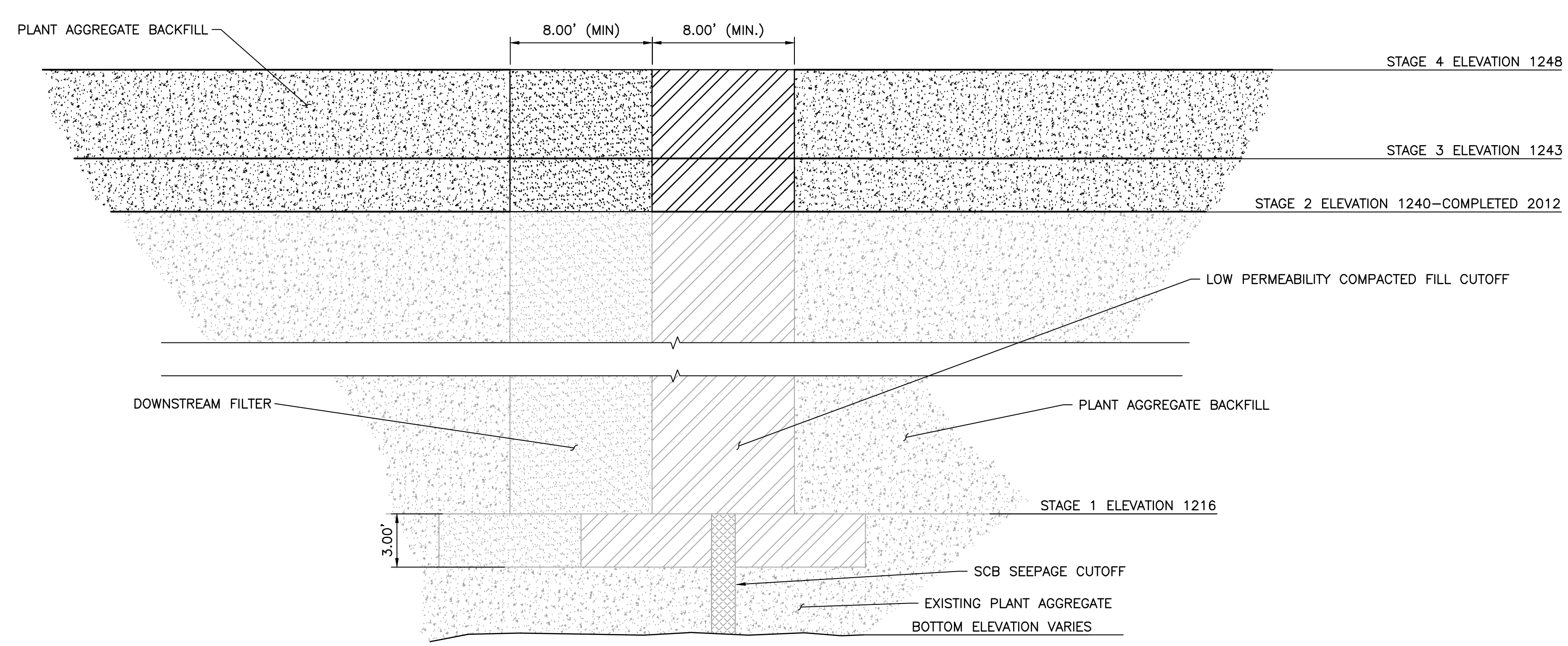

2 SECTION: SEEPAGE CUTOFF
NOT TO SCALE

ISSUED FOR CONSTRUCTION 6/30/2016

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION

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SIGNATURE

PRINTED NAME SARA L. LEOW

DATE 6/30/2016 REG. NO. 47103

CLIENT / BID / CONSTRUCTION / RECORD — RELEASED TO/FOR: CLIENT 6/30

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DATE RELEASED

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NORTHSHORE MINING COMPANY
SILVER BAY, MINNESOTA

2016 PROPOSED DAM CONSTRUCTION
MILEPOST SEVEN TAILINGS BASIN

DAM 2 RAISE – ELEVATION 1248
SEEPAGE CUTOFF DETAILS

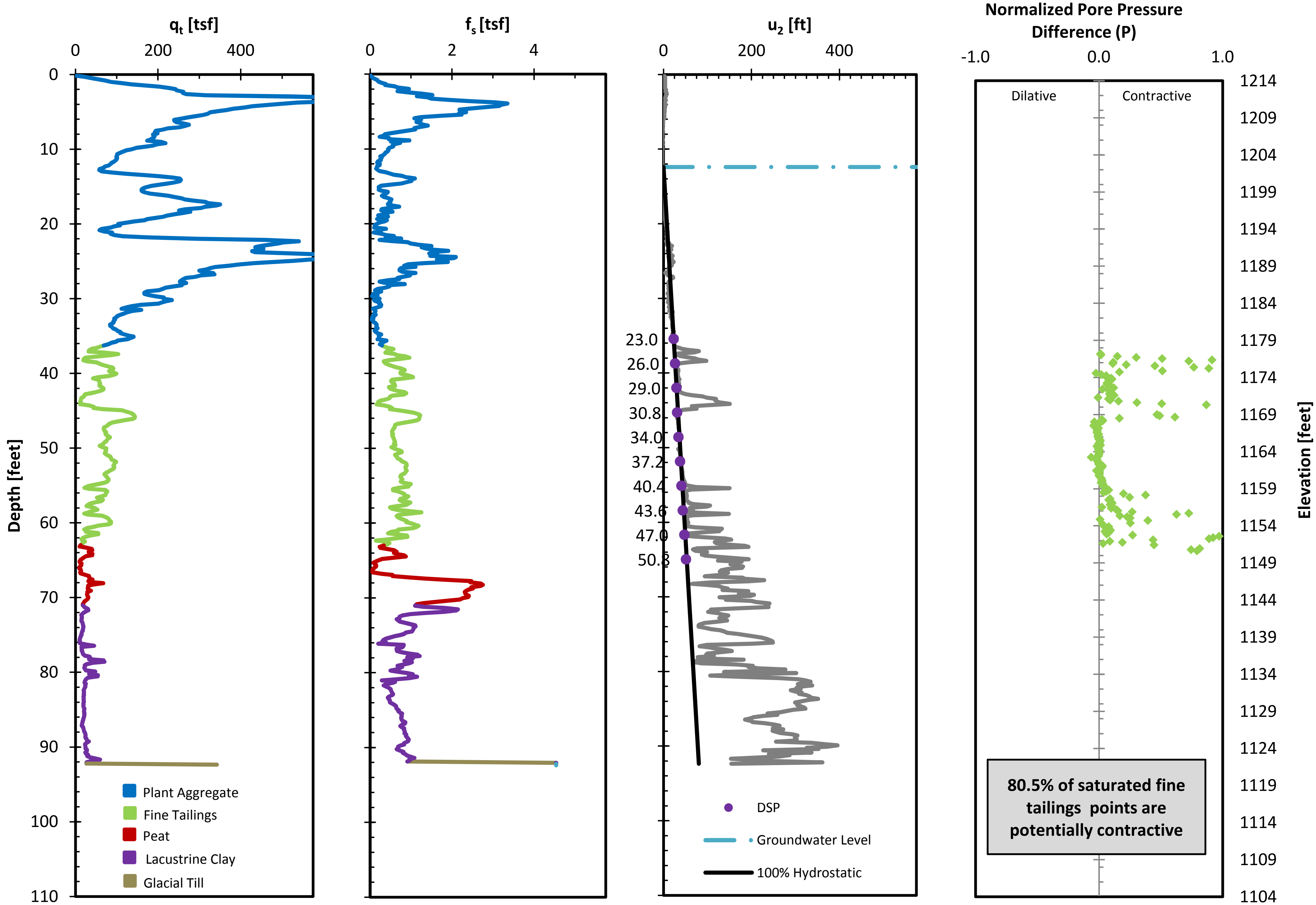
BARR PROJECT No. 23380086
CLIENT PROJECT No.
DWG. No. CC-009
REV. No. 0

CADD USER: Greg Johnson FILE: K:\DESIGN\23380086.00\23380086 DAM 2_CC-009.DWG PLOT SCALE: 1:2 PLOT DATE: 6/30/2016 12:54 PM

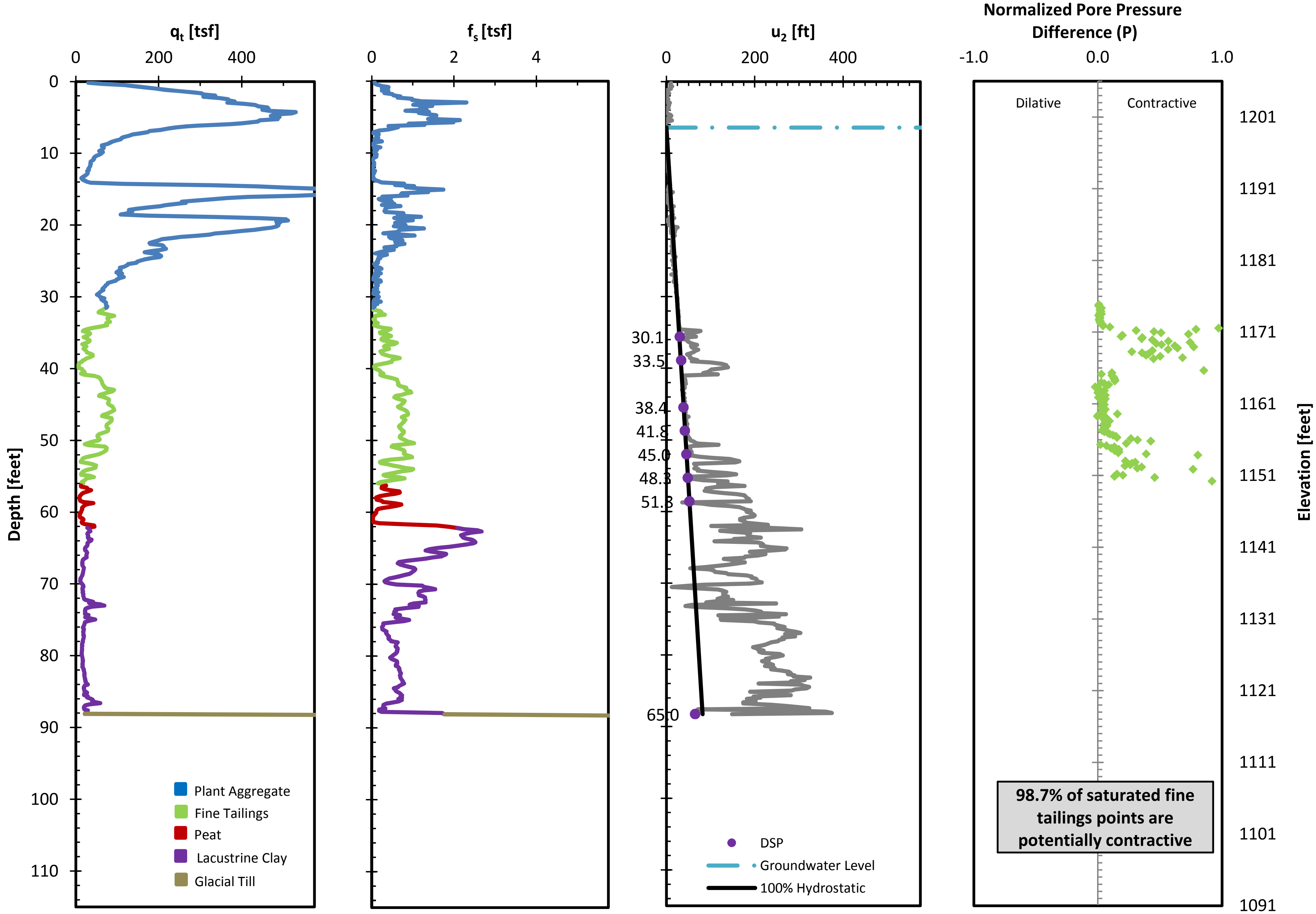
Appendix B

Plots of Tip Resistance, Side Friction, Groundwater, and Compressibility from CPT

D2-3475-CL (2005)
Northshore Mine Milepost 7 Tailings Basin



D2-3475-L100 (2005)
Northshore Mine Milepost 7 Tailings Basin



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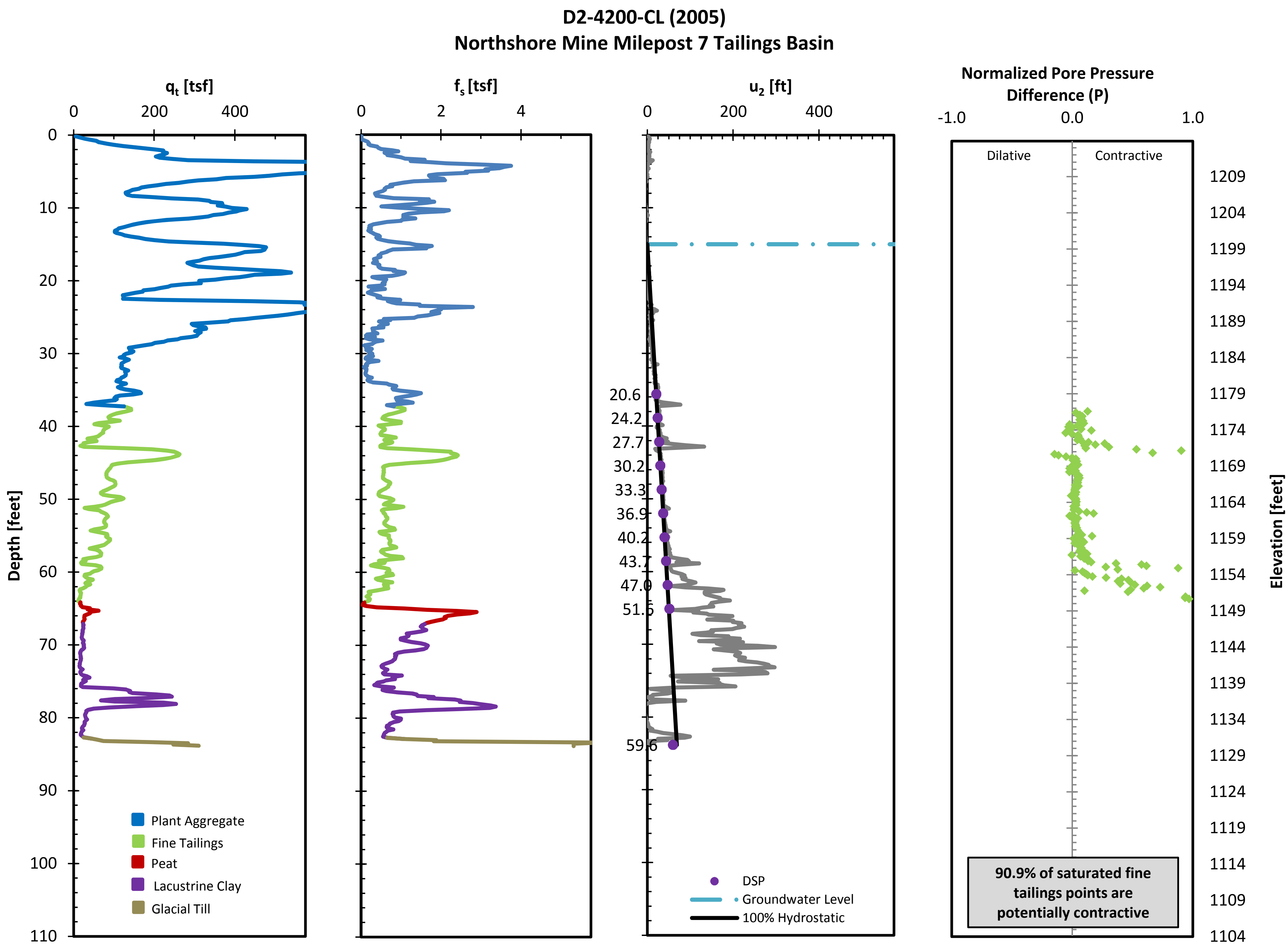
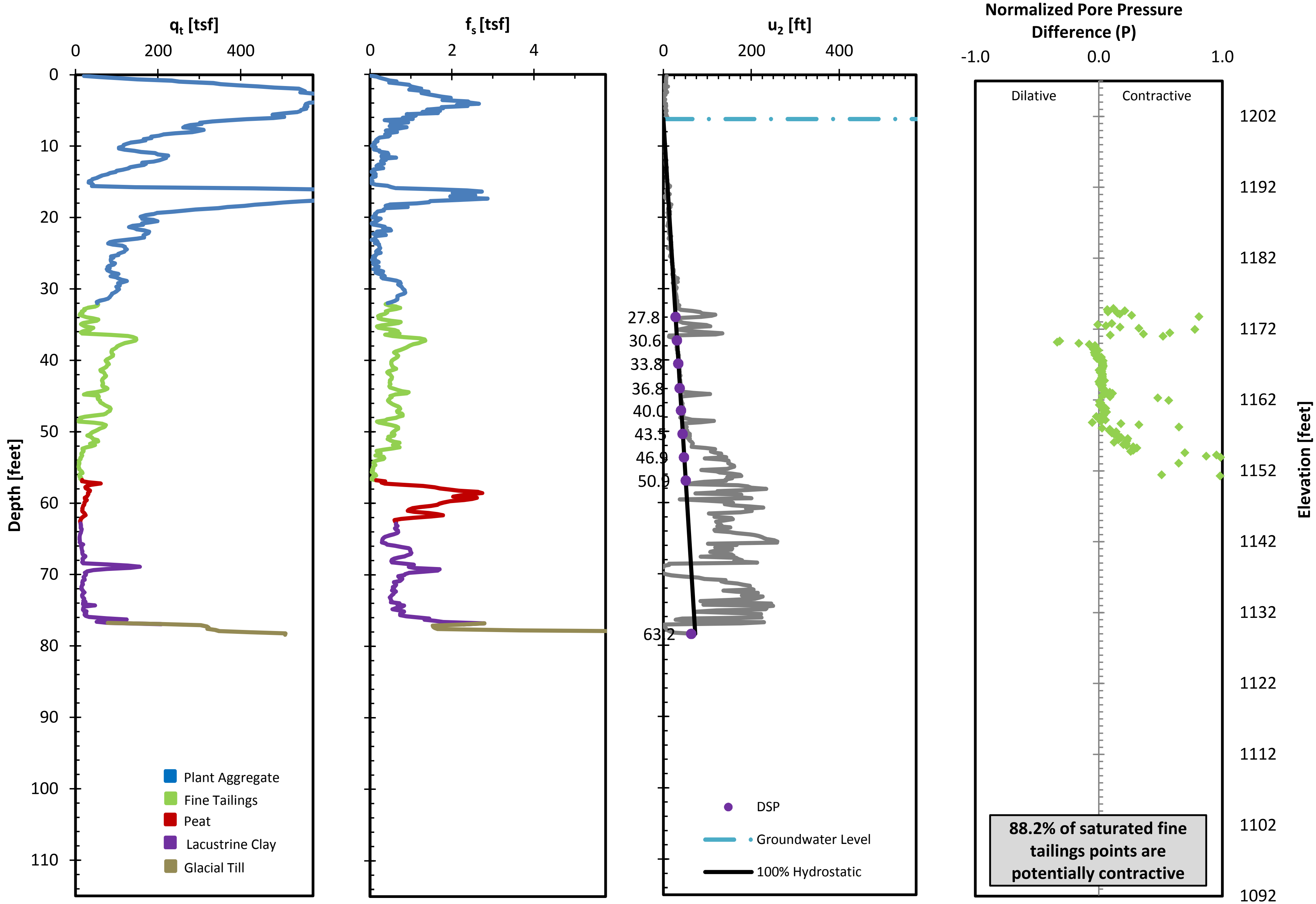
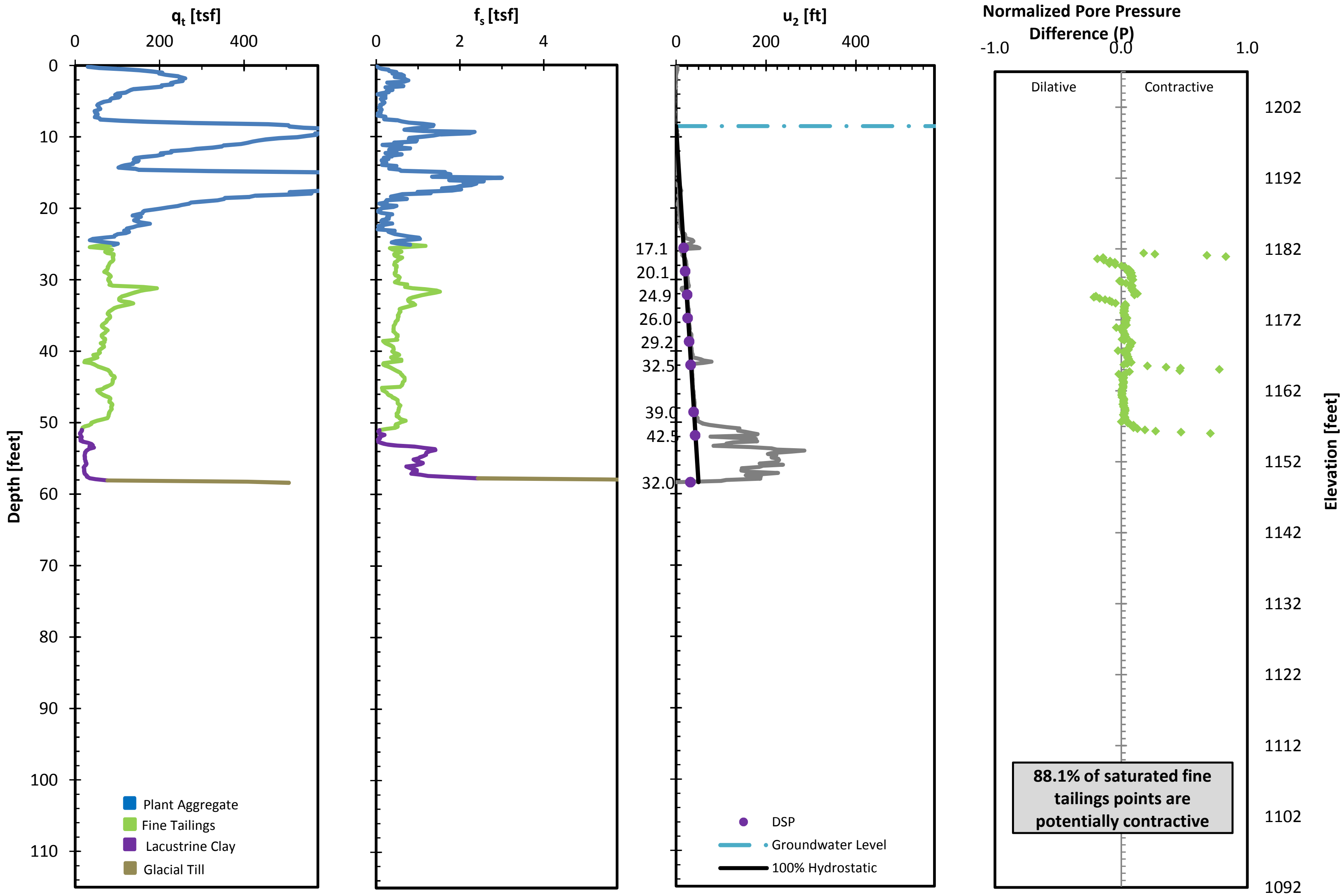

D2-4200-CL (2005)
Northshore Mine Milepost 7 Tailings Basin
qt [tsf]
fs [tsf]
u2 [ft]
Normalized Pore Pressure Difference (P)
Depth [feet]
Elevation [feet]
Dilative
Contractive
Plant Aggregate
Fine Tailings
Peat
Lacustrine Clay
Glacial Till
DSP
Groundwater Level
100% Hydrostatic
20.6
24.2
27.7
30.2
33.3
36.9
40.2
43.7
47.0
51.5
59.6
90.9% of saturated fine tailings points are potentially contractive

D2-4200-L100 (2005)
Northshore Mine Milepost 7 Tailings Basin



P:\Mpls\23 MN\38\2338086\WorkFiles\2013_Work\DS13\Dam 1 Raise\Updated Material Characterization\NSM Dam 1 FT USSR 2013 Review.xlsm

D2-4200-R200 (2005)
Northshore Mine Milepost 7 Tailings Basin



P:\Mpls\23 MN\38\2338086\WorkFiles\2013_Work\DS13\Dam 1 Raise\Updated Material Characterization\NSM Dam 1 FT USSR 2013 Review.xlsm

Appendix C

Probabilistic Seismic Hazard Assessment

```
**********************************************
*****                EZ-FRISK           *****
***** SEISMIC HAZARD ANALYSIS DEFINITION  *****
*****       RISK ENGINEERING, INC.        *****
*****          BOULDER, CO  USA           *****
**********************************************
```

PROGRAM VERSION
EZ-FRISK 7.62 Build 000

ANALYSIS TITLE:
Northshore - Combined

ANALYSIS TYPE:
Single Site Analysis

SITE COORDINATES
Latitude 47.2942
Longitude -91.3598

INTENSITY TYPE: Maximum Rotated Component of Spectral Response @ 5% Damping

HAZARD DEAGGREGATION

```
  Status: ON
  Period: PGA
  Amplitude: 0.02
  Bin Configuration
    Magnitude
      Scale:         Moment Magnitude
      Lowest Value:  4 Mw
      Highest Value: 9 Mw
      Bin Size:      0.1
    Distance
      Lowest Value:  0 km
      Highest Value: 2025 km
      Bin Size:      25 km
    Epsilon
      Lowest Value:  -2.2
      Highest Value: 4.2
      Bin Size:      0.2
```

SOIL AMPLIFICATION
Method: Do not use soil amplification

ATTENUATION EQUATION SITE PARAMETERS

```
  Vs30 (m/s): 450

AMPLITUDES - Acceleration (g)
  0.0001
  0.001
  0.01
  0.02
  0.05
  0.07
  0.1
  0.2
  0.3
  0.4
  0.5
  0.7
  1
  2
  3

PERIODS (s)
  PGA
  0.05
  0.1
  0.2
  0.3
  0.4
  0.5
  0.75
  1
  2
  3
  4

DETERMINISTIC FRACTILES

PLOTTING PARAMETERS
  Period at which to plot PGA: 0.030303

CALCULATIONAL PARAMETERS
  Fault Seismic Sources -
    Maximum inclusion distance           :   2000 km
    Down dip integration increment       :   1 km
    Horizontal integration increment     :   1 km
    Number rupture length per earthquake :   4
  Subduction Interface Seismic Sources -
```

```
    Maximum inclusion distance           :   2000 km
    Down dip integration increment       :   5 km
    Horizontal integration increment     :   20 km
    Number rupture length per earthquake :   1
  Subduction Slab Seismic Sources -
    Maximum inclusion distance           :   2000 km
    Down dip integration increment       :   5 km
    Horizontal integration increment     :   20 km
    Number rupture length per earthquake :   1
  Area Seismic Sources -
    Maximum inclusion distance           :   2000 km
    Vertical integration increment       :   3 km
    Number of rupture azimuths           :   3
    Minimum epicentral distance step     :   0.5 km
    Maximum epicentral distance step     :   10 km
  Gridded Seismic Sources -
    Maximum inclusion distance            :   2000 km
    Default number of rupture azimuths    :   20
    Maximum distance for default azimuths :   40 km
    Minimum distance for one azimuth      :   150
    Use binned calcuations if possible    :   true
    Bins per decade in distance (km)      :   20
  All Seismic Sources -
    Magnitude integration step           :   0.1 M
    Apply magnitude scaling              :   NO
    Include near-source directivity      :   NO
```

ATTENUATION EQUATIONS

```
  Name: Campbell (2003) USGS 2008 MbLg - AB MRC
  Database: C:\Program Files (x86)\EZ-FRISK 7.62\Files\standard.bin-attendb
  Base: FEMA P-750 Table C21.2-1
  Truncation Type: No Truncation
  Truncation Value: 0
  Magnitude Scale: MbLg
  Distance Type: Distance To Rupture

  Name: Silva et al (2002) USGS 2008 MbLg - AB MRC
  Database: C:\Program Files (x86)\EZ-FRISK 7.62\Files\standard.bin-attendb
  Base: FEMA P-750 Table C21.2-1
  Truncation Type: No Truncation
  Truncation Value: 0
  Magnitude Scale: MbLg
  Distance Type: Distance To Rupture
```

Name: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Database: C:\Program Files (x86)\EZ-FRISK 7.62\Files\standard.bin-attendb
Base: FEMA P-750 Table C21.2-1
Truncation Type: No Truncation
Truncation Value: 0
Magnitude Scale: MbLg
Distance Type: Distance To Rupture

SEISMIC SOURCE SUMMARY TABLE

Closest Source Distance	Deterministic Magnitude	Fault Mechanism	Dip Angle	Dips To	Region	Site Lies
CEUS Gridded - AB					USGS 2008 Central and Eastern US	
0.00	7.0000	Strike Slip	90.0000	--		Above
CEUS Gridded - J					USGS 2008 Central and Eastern US	
0.00	7.0000	Strike Slip	90.0000	--		Above
New Madrid - Composite					USGS 2008 New Madrid	
1127.27	7.7000	Reverse	38-89	W,NW		N

SEISMIC SOURCES

Name: CEUS Gridded - AB
Region: USGS 2008 Central and Eastern US
Category:Composite Seismic Source
Database: C:\Users\kna\AppData\Local\Risk Engineering\EZ-FRISK\Regions\USGS2008 Lower 48 v2.00\Files\USGS 2008 Lower 48.bin-ssdb
Magnitude Scale: MbLg
Probability of Activity: 1
------ Start Nested Sources forCEUS Gridded - AB -------
Name: CEUS Gridded - AB.1.N
Region: USGS 2008 Central and Eastern US
Category:Gridded
FileType: USGS2008

General Parameters
Magnitude Scale: MbLg
Probability of Activity: 0.0333
Latitude Increment, degrees: 0.1
Longitude Increment, degrees: 0.1
Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters (Varies point to point?)
Cell Weight: 1

```
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                             Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                     Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - AB.1.Y
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0166
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                             Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                     Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - AB.2.N
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0666
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5
```

```
Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                             Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                     Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - AB.2.Y
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0333
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                             Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                     Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - AB.3.N
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.1666
```

```
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                              Yes
  Rate at Minimum Magnitude, events per year: 0     Yes
  Beta: 2.1875                                      Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - AB.3.Y
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0833
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                              Yes
  Rate at Minimum Magnitude, events per year: 0     Yes
  Beta: 2.1875                                      Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - AB.4.N
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008
```

```
General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0666
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - AB.4.Y
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0333
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

 ------ End Nested Sources for CEUS Gridded - AB -------
```

```
Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
        1      0.333333           Toro (1999) Midcontinent - USGS 2008 MbLg MRC
        1      0.333333           Campbell (2003) USGS 2008 MbLg - AB MRC
        1      0.333333           Silva et al (2002) USGS 2008 MbLg - AB MRC

*******************************************

Name: CEUS Gridded - J
Region: USGS 2008 Central and Eastern US
Category:Composite Seismic Source
Database: C:\Users\kna\AppData\Local\Risk Engineering\EZ-FRISK\Regions\USGS2008
Lower 48 v2.00\Files\USGS 2008 Lower 48.bin-ssdb
Magnitude Scale: MbLg
Probability of Activity: 1
 ------ Start Nested Sources forCEUS Gridded - J -------
Name: CEUS Gridded - J.1.N
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0333
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - J.1.Y
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008
```

```
General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0166
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - J.2.N
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0666
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - J.2.Y
Region: USGS 2008 Central and Eastern US
```

```
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0333
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - J.3.N
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.1666
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike
```

```
Name: CEUS Gridded - J.3.Y
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0833
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - J.4.N
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0666
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
```

```
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

Name: CEUS Gridded - J.4.Y
Region: USGS 2008 Central and Eastern US
Category:Gridded
  FileType: USGS2008

General Parameters
  Magnitude Scale: MbLg
  Probability of Activity: 0.0333
  Latitude Increment, degrees:   0.1
  Longitude Increment, degrees:  0.1
  Magnitude Threshold for Weighting: 6.5

Earthquake Model Parameters               (Varies point to point?)
  Cell Weight: 1
  Fault Mechanism: Strike Slip
  Depth to Top of Rupture, km: 5
  Minimum Magnitude: 5
  Maximum Magnitude: 7                            Yes
  Rate at Minimum Magnitude, events per year: 0   Yes
  Beta: 2.1875                                    Yes
  Horizontal Rupture Length, A parameter: -3.22
  Horizontal Rupture Length, B parameter: 0.69
  Rupture Strike Azimuth Model: Random Strike

 ------ End Nested Sources for CEUS Gridded - J -------

Attenuation Equations for Source:
  Raw Weight  Normalized Weight  Name
        1      0.333333          Toro (1999) Midcontinent - USGS 2008 MbLg MRC
        1      0.333333          Campbell (2003) USGS 2008 MbLg - AB MRC
        1      0.333333          Silva et al (2002) USGS 2008 MbLg - AB MRC

*******************************************

Name: New Madrid - Composite
Region: USGS 2008 New Madrid
Category:Composite Seismic Source
Database: C:\Users\kna\AppData\Local\Risk Engineering\EZ-FRISK\Regions\USGS2008
Lower 48 v2.00\Files\USGS 2008 Lower 48.bin-ssdb
Magnitude Scale: Moment Magnitude
Probability of Activity: 1
```

------ Start Nested Sources forNew Madrid - Composite -------

Name: New Madrid - Central location - Unclustered
Region: USGS 2008 New Madrid
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.34990000
Deterministic Magnitude: 7.7

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	89	10	10.01	25

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.45	Activity	2.000e-003	7.690000	7.700000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.180000	Activity	2.000e-003	7.490000	7.500000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.135000	Activity	2.000e-003	7.990000	8.000000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.135000	Activity	2.000e-003	7.290000	7.300000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.050000	Activity	1.000e-003	7.690000	7.700000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.020000	Activity	1.000e-003	7.490000	7.500000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.015000	Activity	1.000e-003	7.990000	8.000000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.015000	Activity	1.000e-003	7.290000	7.300000	2.300000	0.000000	0.120000	0.000100	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000				

```
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    37.1500   -89.0530
    36.6860   -89.5870
    36.2050   -89.5100
    35.4490   -90.6330

Name: New Madrid - Eastern location - Unclustered
Region: USGS 2008 New Madrid
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.02500000
Deterministic Magnitude: 7.7

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean      Sigma    Delta1    Delta2
   Characteristic      0.45    Activity  2.000e-003  7.690000  7.700000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.180000    Activity  2.000e-003  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.135000    Activity  2.000e-003  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.135000    Activity  2.000e-003  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.050000    Activity  1.000e-003  7.690000  7.700000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.020000    Activity  1.000e-003  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.015000    Activity  1.000e-003  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.015000    Activity  1.000e-003  7.290000  7.300000
```

```
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al         Bl       Sigl         Aw         Bw
Sigw        Aa         Ba       Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --         --         --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --         --         --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --         --         --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --         --         --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --         --         --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --         --         --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --         --         --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --         --         --

Trace Coordinates:
  Latitude   Longitude
    36.9600   -88.9290
    36.6390   -89.2790
    36.1350   -89.1780
    35.2600   -90.4150

Name: New Madrid - Mideastern location - Unclustered
Region: USGS 2008 New Madrid
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.05000000
Deterministic Magnitude: 7.7

Fault Profile Parameters:
        Dip1       Dip2    Depth1    Depth2    Depth3
          90         89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta       Mean     Sigma    Delta1    Delta2
   Characteristic      0.45    Activity  2.000e-003  7.690000  7.700000
```

```
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.180000    Activity  2.000e-003  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.135000    Activity  2.000e-003  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.135000    Activity  2.000e-003  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.050000    Activity  1.000e-003  7.690000  7.700000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.020000    Activity  1.000e-003  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.015000    Activity  1.000e-003  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.015000    Activity  1.000e-003  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    37.0700   -89.0010
    36.6670   -89.4625
    36.1700   -89.3440
    35.3500   -90.5100

Name: New Madrid - Midwestern location - Unclustered
Region: USGS 2008 New Madrid
```

Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.05000000
Deterministic Magnitude: 7.7

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	89	10	10.01	25

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	0.45	Activity	2.000e-003	7.690000	7.700000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.180000	Activity	2.000e-003	7.490000	7.500000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.135000	Activity	2.000e-003	7.990000	8.000000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.135000	Activity	2.000e-003	7.290000	7.300000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.050000	Activity	1.000e-003	7.690000	7.700000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.020000	Activity	1.000e-003	7.490000	7.500000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.015000	Activity	1.000e-003	7.990000	8.000000	2.300000	0.000000	0.120000	0.000100	10.000000
Characteristic	0.015000	Activity	1.000e-003	7.290000	7.300000	2.300000	0.000000	0.120000	0.000100	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--

```
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    37.2050   -89.1814
    36.7040   -89.6991
    36.2700   -89.6575
    35.5400   -90.6725

Name: New Madrid - Western location - Unclustered
Region: USGS 2008 New Madrid
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.02500000
Deterministic Magnitude: 7.7

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic      0.45    Activity  2.000e-003  7.690000  7.700000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.180000    Activity  2.000e-003  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.135000    Activity  2.000e-003  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.135000    Activity  2.000e-003  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.050000    Activity  1.000e-003  7.690000  7.700000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.020000    Activity  1.000e-003  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.015000    Activity  1.000e-003  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000
   Characteristic  0.015000    Activity  1.000e-003  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
```

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.100000	--	--	--

Trace Coordinates:

Latitude	Longitude
37.2630	-89.3230
36.7340	-89.8860
36.3460	-89.8300
35.6470	-90.7190

Name: NMSZ - Clustered - Central - 1000yr - M7.3
Region: USGS 2008 New Madrid
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.00525
Time Independent Cluster Rate (events/year): 0.001
------ Start Nested Sources forNMSZ - Clustered - Central - 1000yr - M7.3 -------
Name: NMSZ - Clustered - Central - 1000yr - M7.3 - Central
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.3

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	38	10	10.01	19.23

```
Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning       Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.6860   -89.5870
    36.2050   -89.5100

Name: NMSZ - Clustered - Central - 1000yr - M7.1 - Northern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.1

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.090000  7.100000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning       Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    37.1500   -89.0530
```

```
    36.6860   -89.5870

Name: NMSZ - Clustered - Central - 1000yr - M7.3 - Southern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.3

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.2050   -89.5100
    35.4490   -90.6330

 ------ End Nested Sources for NMSZ - Clustered - Central - 1000yr - M7.3
-------

Name: NMSZ - Clustered - Central - 1000yr - M7.5
Region: USGS 2008 New Madrid
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.007
Time Independent Cluster Rate (events/year): 0.001
 ------ Start Nested Sources forNMSZ - Clustered - Central - 1000yr - M7.5
-------
Name: NMSZ - Clustered - Central - 1000yr - M7.5 - Central
Region: New Madrid USGS2008
Category:Fault
```

```
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.5

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        38        10     10.01     19.23

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta       Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.6860   -89.5870
    36.2050   -89.5100

Name: NMSZ - Clustered - Central - 1000yr - M7.3 - Northern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.3

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta       Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
```

```
  Rupture Dimensioning        Al        Bl      Sigl         Aw         Bw
Sigw        Aa         Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --         --        --

Trace Coordinates:
  Latitude   Longitude
    37.1500   -89.0530
    36.6860   -89.5870

Name: NMSZ - Clustered - Central - 1000yr - M7.5 - Southern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.5

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl         Aw         Bw
Sigw        Aa         Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --         --        --

Trace Coordinates:
  Latitude   Longitude
    36.2050   -89.5100
    35.4490   -90.6330

 ------ End Nested Sources for NMSZ - Clustered - Central - 1000yr - M7.5
-------

Name: NMSZ - Clustered - Central - 1000yr - M7.7
Region: USGS 2008 New Madrid
Category:Clustered Seismic Source
```

Magnitude Scale: Moment Magnitude
Probability of Activity: 0.0175
Time Independent Cluster Rate (events/year): 0.001
------ Start Nested Sources forNMSZ - Clustered - Central - 1000yr - M7.7 -------
Name: NMSZ - Clustered - Central - 1000yr - M7.7 - Central
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.7

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	38	10	10.01	19.23

Magnitude Recurrence Distributions:

ModelType	Weight	RateType	Rate	MinMag	MaxMag	Beta	Mean	Sigma	Delta1	Delta2
Characteristic	1	Activity	1.000e-003	7.690000	7.700000	2.300000	0.000000	0.120000	0.000100	10.000000

Rupture Length Parameters

Rupture Dimensioning	Al	Bl	Sigl	Aw	Bw	Sigw	Aa	Ba	Sigw
Length and Width	4.000000	0.000000	0.010000	4.000000	0.000000	0.010000	--	--	--

Trace Coordinates:

Latitude	Longitude
36.6860	-89.5870
36.2050	-89.5100

Name: NMSZ - Clustered - Central - 1000yr - M7.5 - Northern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.5

Fault Profile Parameters:

Dip1	Dip2	Depth1	Depth2	Depth3
90	89	10	10.01	25

```
Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning       Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    37.1500   -89.0530
    36.6860   -89.5870

Name: NMSZ - Clustered - Central - 1000yr - M7.7 - Southern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.3

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.690000  7.700000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning       Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.2050   -89.5100
```

```
    35.4490   -90.6330

 ------ End Nested Sources for NMSZ - Clustered - Central - 1000yr - M7.7
-------

Name: NMSZ - Clustered - Central - 1000yr - M8.0
Region: USGS 2008 New Madrid
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.00525
Time Independent Cluster Rate (events/year): 0.001
 ------ Start Nested Sources forNMSZ - Clustered - Central - 1000yr - M8.0
-------
Name: NMSZ - Clustered - Central - 1000yr - M8.0 - Central
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.7

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        38        10     10.01     19.23

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.6860   -89.5870
    36.2050   -89.5100

Name: NMSZ - Clustered - Central - 1000yr - M7.8 - Northern
Region: New Madrid USGS2008
Category:Fault
```

```
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.5

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.790000  7.800000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    37.1500   -89.0530
    36.6860   -89.5870

Name: NMSZ - Clustered - Central - 1000yr - M8.0 - Southern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.7

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  1.000e-003  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
```

```
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.2050   -89.5100
    35.4490   -90.6330

 ------ End Nested Sources for NMSZ - Clustered - Central - 1000yr - M8.0
-------

Name: NMSZ - Clustered - Central - 1500yr - M7.3
Region: USGS 2008 New Madrid
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.023625
Time Independent Cluster Rate (events/year): 0.000666667
 ------ Start Nested Sources forNMSZ - Clustered - Central - 1500yr - M7.3
-------
Name: NMSZ - Clustered - Central - 1500yr - M7.3 - Central
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.3

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        38        10     10.01     19.23

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  6.667e-004  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --
```

```
Trace Coordinates:
  Latitude   Longitude
    36.6860   -89.5870
    36.2050   -89.5100

Name: NMSZ - Clustered - Central - 1500yr - M7.3 - Southern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.3

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  6.667e-004  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.2050   -89.5100
    35.4490   -90.6330

 ------ End Nested Sources for NMSZ - Clustered - Central - 1500yr - M7.3
-------

Name: NMSZ - Clustered - Central - 1500yr - M7.5
Region: USGS 2008 New Madrid
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.0315
Time Independent Cluster Rate (events/year): 0.000666667
 ------ Start Nested Sources forNMSZ - Clustered - Central - 1500yr - M7.5
-------
```

```
Name: NMSZ - Clustered - Central - 1500yr - M7.5 - Central
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.5

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        38        10     10.01     19.23

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  6.667e-004  7.490000  7.500000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.6860   -89.5870
    36.2050   -89.5100

Name: NMSZ - Clustered - Central - 1500yr - M7.5 - Southern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.5

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  6.667e-004  7.490000  7.500000
```

```
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.2050   -89.5100
    35.4490   -90.6330

 ------ End Nested Sources for NMSZ - Clustered - Central - 1500yr - M7.5
-------

Name: NMSZ - Clustered - Central - 1500yr - M7.7
Region: USGS 2008 New Madrid
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.07875
Time Independent Cluster Rate (events/year): 0.000666667
 ------ Start Nested Sources forNMSZ - Clustered - Central - 1500yr - M7.7
-------
Name: NMSZ - Clustered - Central - 1500yr - M7.7 - Central
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.7

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        38        10     10.01     19.23

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  6.667e-004  7.690000  7.700000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
```

```
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.6860   -89.5870
    36.2050   -89.5100

Name: NMSZ - Clustered - Central - 1500yr - M7.7 - Southern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.7

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta       Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  6.667e-004  7.690000  7.700000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning       Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.2050   -89.5100
    35.4490   -90.6330

 ------ End Nested Sources for NMSZ - Clustered - Central - 1500yr - M7.7
-------

Name: NMSZ - Clustered - Central - 1500yr - M8.0
Region: USGS 2008 New Madrid
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.023625
```

```
Time Independent Cluster Rate (events/year): 0.000666667
 ------ Start Nested Sources forNMSZ - Clustered - Central - 1500yr - M8.0
-------
Name: NMSZ - Clustered - Central - 1500yr - M8.0 - Central
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.7

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        38        10     10.01     19.23

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  6.667e-004  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.6860   -89.5870
    36.2050   -89.5100

Name: NMSZ - Clustered - Central - 1500yr - M8.0 - Southern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.7

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
```

```
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  6.667e-004  7.990000  8.000000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.2050   -89.5100
    35.4490   -90.6330

 ------ End Nested Sources for NMSZ - Clustered - Central - 1500yr - M8.0
-------

Name: NMSZ - Clustered - Central - 500yr - M7.3
Region: USGS 2008 New Madrid
Category:Clustered Seismic Source
Magnitude Scale: Moment Magnitude
Probability of Activity: 0.023625
Time Independent Cluster Rate (events/year): 0.002
 ------ Start Nested Sources forNMSZ - Clustered - Central - 500yr - M7.3
-------
Name: NMSZ - Clustered - Central - 500yr - M7.3 - Central
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.3

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        38        10     10.01     19.23

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  2.000e-003  7.290000  7.300000
2.300000  0.000000  0.120000  0.000100 10.000000
```

```
Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.010000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    36.6860   -89.5870
    36.2050   -89.5100

Name: NMSZ - Clustered - Central - 500yr - M7.1 - Northern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
Probability of Activity: 1.00000000
Deterministic Magnitude: 7.1

Fault Profile Parameters:
        Dip1      Dip2    Depth1    Depth2    Depth3
          90        89        10     10.01        25

Magnitude Recurrence Distributions:
        ModelType    Weight    RateType        Rate    MinMag    MaxMag
Beta      Mean     Sigma    Delta1    Delta2
   Characteristic         1    Activity  2.000e-003  7.090000  7.100000
2.300000  0.000000  0.120000  0.000100 10.000000

Rupture Length Parameters
  Rupture Dimensioning        Al        Bl      Sigl        Aw        Bw
Sigw        Aa        Ba      Sigw
      Length and Width  4.000000  0.000000  0.010000  4.000000  0.000000
0.100000        --        --        --

Trace Coordinates:
  Latitude   Longitude
    37.1500   -89.0530
    36.6860   -89.5870

Name: NMSZ - Clustered - Central - 500yr - M7.3 - Southern
Region: New Madrid USGS2008
Category:Fault
Fault Mechanism: Reverse
Magnitude Scale: Moment Magnitude
```

```
Start:  16:47:19 Tuesday, August 02, 2011
******************************************
Start processing input file: G:\KNA\EZ-FRISK_New\Northshore\Combined\Northshore
(Combined) - Northshore - Combined.ezf-shad
Application version: EZ-FRISK 7.62 Build 000
Vs30 (m/s) used in hazard calculations:  450
Analyzing site  Latitude: 47.2942 Longitude: -91.3598
Validating setup.
Input data validated.
Preparing to calculate PSHA and DSHA.
Calculating hazard for each source.
Information: Using parallel processing of sources.
Start loop on sources:  16:47:24 Tuesday, August 02, 2011
Calculating hazard for: CEUS Gridded - J : USGS 2008 Central and Eastern US
Calculating hazard for: CEUS Gridded - AB : USGS 2008 Central and Eastern US
Calculating hazard for nested source: CEUS Gridded - J.1.N of CEUS Gridded - J.
Calculating hazard for nested source: CEUS Gridded - AB.1.N of CEUS Gridded -
AB.
Calculating hazard for: New Madrid - Composite : USGS 2008 New Madrid
Calculating hazard for nested source: CEUS Gridded - J.1.Y of CEUS Gridded - J.
Calculating hazard for nested source: CEUS Gridded - J.2.N of CEUS Gridded - J.
Calculating hazard for nested source: New Madrid - Central location -
Unclustered of New Madrid - Composite.
Done calculating hazard for nested source: New Madrid - Central location -
Unclustered of New Madrid - Composite.
Calculating hazard for nested source: New Madrid - Eastern location -
Unclustered of New Madrid - Composite.
Done calculating hazard for nested source: New Madrid - Eastern location -
Unclustered of New Madrid - Composite.
Calculating hazard for nested source: New Madrid - Mideastern location -
Unclustered of New Madrid - Composite.
Done calculating hazard for nested source: New Madrid - Mideastern location -
Unclustered of New Madrid - Composite.
Calculating hazard for nested source: New Madrid - Midwestern location -
Unclustered of New Madrid - Composite.
Calculating hazard for nested source: CEUS Gridded - J.2.Y of CEUS Gridded - J.
Done calculating hazard for nested source: New Madrid - Midwestern location -
Unclustered of New Madrid - Composite.
Calculating hazard for nested source: New Madrid - Western location -
Unclustered of New Madrid - Composite.
Done calculating hazard for nested source: New Madrid - Western location -
Unclustered of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr -
M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr -
```

**M7.3 - Central of NMSZ - Clustered - Central - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.3 - Central of NMSZ - Clustered - Central - 1000yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.1 - Northern of NMSZ - Clustered - Central - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.1 - Northern of NMSZ - Clustered - Central - 1000yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.3 - Southern of NMSZ - Clustered - Central - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.3 - Southern of NMSZ - Clustered - Central - 1000yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.5 - Central of NMSZ - Clustered - Central - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.5 - Central of NMSZ - Clustered - Central - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.3 - Northern of NMSZ - Clustered - Central - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.3 - Northern of NMSZ - Clustered - Central - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.5 - Southern of NMSZ - Clustered - Central - 1000yr - M7.5
Calculating hazard for nested source: CEUS Gridded - AB.1.Y of CEUS Gridded - AB.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.5 - Southern of NMSZ - Clustered - Central - 1000yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.7 - Central of NMSZ - Clustered - Central - 1000yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.7 - Central of NMSZ - Clustered - Central - 1000yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.5 - Northern of NMSZ - Clustered - Central - 1000yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.5 - Northern of NMSZ - Clustered - Central - 1000yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.7 - Southern of NMSZ - Clustered - Central - 1000yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.7 - Southern of NMSZ - Clustered - Central - 1000yr - M7.7.**

Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M8.0 - Central of NMSZ - Clustered - Central - 1000yr - M8.0
Calculating hazard for nested source: CEUS Gridded - AB.2.N of CEUS Gridded - AB.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M8.0 - Central of NMSZ - Clustered - Central - 1000yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.8 - Northern of NMSZ - Clustered - Central - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M7.8 - Northern of NMSZ - Clustered - Central - 1000yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M8.0 - Southern of NMSZ - Clustered - Central - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr - M8.0 - Southern of NMSZ - Clustered - Central - 1000yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.5 - Central of NMSZ - Clustered - Central - 1500yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.7 - Central of NMSZ - Clustered - Central - 1500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.5 - Central of NMSZ - Clustered - Central - 1500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.5 - Southern of NMSZ - Clustered - Central - 1500yr - M7.5
Calculating hazard for nested source: CEUS Gridded - AB.2.Y of CEUS Gridded - AB.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.3 - Central of NMSZ - Clustered - Central - 1500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.7 - Central of NMSZ - Clustered - Central - 1500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.7 - Southern of NMSZ - Clustered - Central - 1500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.3 - Central of NMSZ - Clustered - Central - 1500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr - M7.3 - Southern of NMSZ - Clustered - Central - 1500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr

```
- M7.5 - Southern of NMSZ - Clustered - Central - 1500yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr
- M7.3 - Southern of NMSZ - Clustered - Central - 1500yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1000yr
- M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr
- M7.7 - Southern of NMSZ - Clustered - Central - 1500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr -
M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr -
M8.0 - Central of NMSZ - Clustered - Central - 1500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr
- M8.0 - Central of NMSZ - Clustered - Central - 1500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr -
M8.0 - Southern of NMSZ - Clustered - Central - 1500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr
- M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.3
of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.3
- Central of NMSZ - Clustered - Central - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr
- M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.5
of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr
- M8.0 - Southern of NMSZ - Clustered - Central - 1500yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr
- M7.5 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr -
M7.3 - Central of NMSZ - Clustered - Central - 500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.1
- Northern of NMSZ - Clustered - Central - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr -
M7.1 - Northern of NMSZ - Clustered - Central - 500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.7
of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.7
- Central of NMSZ - Clustered - Central - 500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Central - 1500yr
- M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.3
- Southern of NMSZ - Clustered - Central - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr -
M7.3 - Southern of NMSZ - Clustered - Central - 500yr - M7.3.
```

**Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.5 - Central of NMSZ - Clustered - Central - 500yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.7 - Central of NMSZ - Clustered - Central - 500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.5 - Northern of NMSZ - Clustered - Central - 500yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M8.0 - Central of NMSZ - Clustered - Central - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.5 - Northern of NMSZ - Clustered - Central - 500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.7 - Southern of NMSZ - Clustered - Central - 500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M8.0 - Central of NMSZ - Clustered - Central - 500yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.8 - Northern of NMSZ - Clustered - Central - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.8 - Northern of NMSZ - Clustered - Central - 500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M8.0 - Southern of NMSZ - Clustered - Central - 500yr - M8.0
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.3 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.5 - Central of NMSZ - Clustered - Central - 500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.3 - Northern of NMSZ - Clustered - Central - 500yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.3 - Central of NMSZ - Clustered - Central - 750yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.3 - Northern of NMSZ - Clustered - Central - 500yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.7 - Southern of NMSZ - Clustered - Central - 500yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.3 - Central of NMSZ - Clustered - Central - 750yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M8.0 - Southern of NMSZ - Clustered - Central - 500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.1 - Northern of NMSZ - Clustered - Central - 750yr - M7.3
Calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.5 - Southern of NMSZ - Clustered - Central - 500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr -**

**M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.5 - Central of NMSZ - Clustered - Central - 750yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.1 - Northern of NMSZ - Clustered - Central - 750yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.3 - Southern of NMSZ - Clustered - Central - 750yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.5 - Southern of NMSZ - Clustered - Central - 500yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.5 - Central of NMSZ - Clustered - Central - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.3 - Northern of NMSZ - Clustered - Central - 750yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.3 - Southern of NMSZ - Clustered - Central - 750yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.7 - Central of NMSZ - Clustered - Central - 750yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Central - 500yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M8.0 - Central of NMSZ - Clustered - Central - 750yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.3 - Northern of NMSZ - Clustered - Central - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.5 - Southern of NMSZ - Clustered - Central - 750yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.3 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.5 - Southern of NMSZ - Clustered - Central - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.3 - Central of NMSZ - Clustered - Eastern - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.7 - Central of NMSZ - Clustered - Central - 750yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.5 - Northern of NMSZ - Clustered - Central - 750yr - M7.7**

**Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.5 - Northern of NMSZ - Clustered - Central - 750yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.7 - Southern of NMSZ - Clustered - Central - 750yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.3 - Central of NMSZ - Clustered - Eastern - 1000yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.1 - North of NMSZ - Clustered - Eastern - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.7 - Southern of NMSZ - Clustered - Central - 750yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.1 - North of NMSZ - Clustered - Eastern - 1000yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M8.0 - Central of NMSZ - Clustered - Central - 750yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.8 - Northern of NMSZ - Clustered - Central - 750yr - M8.0
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.3 - Southern of NMSZ - Clustered - Eastern - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.5 - Central of NMSZ - Clustered - Eastern - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.5 - Central of NMSZ - Clustered - Eastern - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.3 - North of NMSZ - Clustered - Eastern - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.3 - Southern of NMSZ - Clustered - Eastern - 1000yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.8 - Northern of NMSZ - Clustered - Central - 750yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.3 - North of NMSZ - Clustered - Eastern - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M8.0 - Southern of NMSZ - Clustered - Central - 750yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.7 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M8.0 - Southern of NMSZ - Clustered - Central - 750yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.5 - Southern of NMSZ - Clustered - Eastern - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr**

**- M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.7 - Central of NMSZ - Clustered - Eastern - 1000yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.5 - Southern of NMSZ - Clustered - Eastern - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M8.0 - Central of NMSZ - Clustered - Eastern - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M8.0 - Central of NMSZ - Clustered - Eastern - 1000yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.8 - North of NMSZ - Clustered - Eastern - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.8 - North of NMSZ - Clustered - Eastern - 1000yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.7 - Central of NMSZ - Clustered - Eastern - 1000yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.5 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Central - 750yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.5 - North of NMSZ - Clustered - Eastern - 1000yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.3 - Central of NMSZ - Clustered - Eastern - 1500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.5 - North of NMSZ - Clustered - Eastern - 1000yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.7 - Southern of NMSZ - Clustered - Eastern - 1000yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M8.0 - Southern of NMSZ - Clustered - Eastern - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.3 - Central of NMSZ - Clustered - Eastern - 1500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.5 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.7 - Southern of NMSZ - Clustered - Eastern - 1000yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.3 - Southern of NMSZ - Clustered - Eastern - 1500yr - M7.3
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.5 - Central of NMSZ - Clustered - Eastern - 1500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.3 - Southern of NMSZ - Clustered - Eastern - 1500yr - M7.3.**

**Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.5 - Central of NMSZ - Clustered - Eastern - 1500yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M8.0 - Southern of NMSZ - Clustered - Eastern - 1000yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.3 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1000yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.5 - Southern of NMSZ - Clustered - Eastern - 1500yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.7 - Central of NMSZ - Clustered - Eastern - 1500yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M8.0 - Central of NMSZ - Clustered - Eastern - 1500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.7 - Central of NMSZ - Clustered - Eastern - 1500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.3 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M8.0 - Central of NMSZ - Clustered - Eastern - 1500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M8.0 - Southern of NMSZ - Clustered - Eastern - 1500yr - M8.0
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.7 - Southern of NMSZ - Clustered - Eastern - 1500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M8.0 - Southern of NMSZ - Clustered - Eastern - 1500yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.5 - Southern of NMSZ - Clustered - Eastern - 1500yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr - M7.7 - Southern of NMSZ - Clustered - Eastern - 1500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.3 - Central of NMSZ - Clustered - Eastern - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.3 - Central of NMSZ - Clustered - Eastern - 500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.1 - North of NMSZ - Clustered - Eastern - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.1 - North of NMSZ - Clustered - Eastern - 500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.3**

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- Southern of NMSZ - Clustered - Eastern - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr
- M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr
- M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.5
of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 1500yr
- M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.7
of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.5
- Central of NMSZ - Clustered - Eastern - 500yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.7
- Central of NMSZ - Clustered - Eastern - 500yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M8.0
of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M8.0
- Central of NMSZ - Clustered - Eastern - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr -
M7.5 - Central of NMSZ - Clustered - Eastern - 500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.3
- North of NMSZ - Clustered - Eastern - 500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr -
M8.0 - Central of NMSZ - Clustered - Eastern - 500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.8
- North of NMSZ - Clustered - Eastern - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr -
M7.3 - North of NMSZ - Clustered - Eastern - 500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.5
- Southern of NMSZ - Clustered - Eastern - 500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr -
M7.8 - North of NMSZ - Clustered - Eastern - 500yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr -
M7.7 - Central of NMSZ - Clustered - Eastern - 500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M8.0
- Southern of NMSZ - Clustered - Eastern - 500yr - M8.0
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.5
- North of NMSZ - Clustered - Eastern - 500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr -
M7.5 - Southern of NMSZ - Clustered - Eastern - 500yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr -
M7.3 - Southern of NMSZ - Clustered - Eastern - 500yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr -
M8.0 - Southern of NMSZ - Clustered - Eastern - 500yr - M8.0.
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Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.5 - North of NMSZ - Clustered - Eastern - 500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.7 - Southern of NMSZ - Clustered - Eastern - 500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.7 - Southern of NMSZ - Clustered - Eastern - 500yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.5 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.3 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 500yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.3 - Central of NMSZ - Clustered - Eastern - 750yr - M7.3
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.7 - Central of NMSZ - Clustered - Eastern - 750yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.5 - Central of NMSZ - Clustered - Eastern - 750yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.7 - Central of NMSZ - Clustered - Eastern - 750yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.3 - Central of NMSZ - Clustered - Eastern - 750yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.5 - Central of NMSZ - Clustered - Eastern - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.5 - North of NMSZ - Clustered - Eastern - 750yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.3 - North of NMSZ - Clustered - Eastern - 750yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.5 - North of NMSZ - Clustered - Eastern - 750yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.3 - North of NMSZ - Clustered - Eastern - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.7 - Southern of NMSZ - Clustered - Eastern - 750yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.5 - Southern of NMSZ - Clustered - Eastern - 750yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr -

**M7.7 - Southern of NMSZ - Clustered - Eastern - 750yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.5 - Southern of NMSZ - Clustered - Eastern - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.1 - North of NMSZ - Clustered - Eastern - 750yr - M7.3
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M8.0 - Central of NMSZ - Clustered - Eastern - 750yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.3 - Central of NMSZ - Clustered - Mideastern - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.3 - Central of NMSZ - Clustered - Mideastern - 1000yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.1 - North of NMSZ - Clustered - Mideastern - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M8.0 - Central of NMSZ - Clustered - Eastern - 750yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.8 - North of NMSZ - Clustered - Eastern - 750yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.8 - North of NMSZ - Clustered - Eastern - 750yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.1 - North of NMSZ - Clustered - Eastern - 750yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M8.0 - Southern of NMSZ - Clustered - Eastern - 750yr - M8.0
Calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.3 - Southern of NMSZ - Clustered - Eastern - 750yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.1 - North of NMSZ - Clustered - Mideastern - 1000yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.3 - Southern of NMSZ - Clustered - Mideastern - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M8.0 - Southern of NMSZ - Clustered - Eastern - 750yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.3 - Southern of NMSZ - Clustered - Mideastern - 1000yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.3 - Southern of NMSZ - Clustered - Eastern - 750yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.7 of New Madrid - Composite.**

**Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.5 - Central of NMSZ - Clustered - Mideastern - 1000yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.7 - Central of NMSZ - Clustered - Mideastern - 1000yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M8.0 - Central of NMSZ - Clustered - Mideastern - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.5 - Central of NMSZ - Clustered - Mideastern - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.3 - North of NMSZ - Clustered - Mideastern - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.7 - Central of NMSZ - Clustered - Mideastern - 1000yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.3 - North of NMSZ - Clustered - Mideastern - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.5 - North of NMSZ - Clustered - Mideastern - 1000yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.5 - Southern of NMSZ - Clustered - Mideastern - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.5 - North of NMSZ - Clustered - Mideastern - 1000yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Eastern - 750yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.7 - Southern of NMSZ - Clustered - Mideastern - 1000yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M8.0 - Central of NMSZ - Clustered - Mideastern - 1000yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.3 - Central of NMSZ - Clustered - Mideastern - 1500yr - M7.3
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.8 - North of NMSZ - Clustered - Mideastern - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.5 - Southern of NMSZ - Clustered - Mideastern - 1000yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.8 - North of NMSZ - Clustered - Mideastern - 1000yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr -**

M8.0 - Southern of NMSZ - Clustered - Mideastern - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.7 - Southern of NMSZ - Clustered - Mideastern - 1000yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.3 - Central of NMSZ - Clustered - Mideastern - 1500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.3 - Southern of NMSZ - Clustered - Mideastern - 1500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M8.0 - Southern of NMSZ - Clustered - Mideastern - 1000yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.3 - Southern of NMSZ - Clustered - Mideastern - 1500yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.5 - Central of NMSZ - Clustered - Mideastern - 1500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.5 - Central of NMSZ - Clustered - Mideastern - 1500yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.5 - Southern of NMSZ - Clustered - Mideastern - 1500yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.7 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.7 - Central of NMSZ - Clustered - Mideastern - 1500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1000yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M8.0 - Central of NMSZ - Clustered - Mideastern - 1500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.7 - Central of NMSZ - Clustered - Mideastern - 1500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.3 - Central of NMSZ - Clustered - Mideastern - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.5 - Southern of NMSZ - Clustered - Mideastern - 1500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.7 - Southern of NMSZ - Clustered - Mideastern - 1500yr - M7.7

Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M8.0 - Central of NMSZ - Clustered - Mideastern - 1500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M8.0 - Southern of NMSZ - Clustered - Mideastern - 1500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.7 - Southern of NMSZ - Clustered - Mideastern - 1500yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.3 - Central of NMSZ - Clustered - Mideastern - 500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.1 - North of NMSZ - Clustered - Mideastern - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.1 - North of NMSZ - Clustered - Mideastern - 500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.3 - Southern of NMSZ - Clustered - Mideastern - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.3 - Southern of NMSZ - Clustered - Mideastern - 500yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M8.0 - Southern of NMSZ - Clustered - Mideastern - 1500yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.5 - Central of NMSZ - Clustered - Mideastern - 500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.7 - Central of NMSZ - Clustered - Mideastern - 500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.7 - Central of NMSZ - Clustered - Mideastern - 500yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.5 - Central of NMSZ - Clustered - Mideastern - 500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.5 - North of NMSZ - Clustered - Mideastern - 500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M8.0 - Central of NMSZ - Clustered - Mideastern - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 1500yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr -

**M7.3 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.5 - North of NMSZ - Clustered - Mideastern - 500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.7 - Southern of NMSZ - Clustered - Mideastern - 500yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.3 - Central of NMSZ - Clustered - Mideastern - 750yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M8.0 - Central of NMSZ - Clustered - Mideastern - 500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.8 - North of NMSZ - Clustered - Mideastern - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.7 - Southern of NMSZ - Clustered - Mideastern - 500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.3 - North of NMSZ - Clustered - Mideastern - 500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.3 - Central of NMSZ - Clustered - Mideastern - 750yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.8 - North of NMSZ - Clustered - Mideastern - 500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M8.0 - Southern of NMSZ - Clustered - Mideastern - 500yr - M8.0
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.1 - North of NMSZ - Clustered - Mideastern - 750yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.1 - North of NMSZ - Clustered - Mideastern - 750yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.3 - Southern of NMSZ - Clustered - Mideastern - 750yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M8.0 - Southern of NMSZ - Clustered - Mideastern - 500yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.3 - North of NMSZ - Clustered - Mideastern - 500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.5 - Southern of NMSZ - Clustered - Mideastern - 500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.7 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.3 - Southern of NMSZ - Clustered - Mideastern - 750yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.5 - Southern of NMSZ - Clustered - Mideastern - 500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.5 - Central of NMSZ - Clustered - Mideastern - 750yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M7.5 of New Madrid - Composite.**

**Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.7 - Central of NMSZ - Clustered - Mideastern - 750yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 500yr - M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.5 - Central of NMSZ - Clustered - Mideastern - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.3 - North of NMSZ - Clustered - Mideastern - 750yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.7 - Central of NMSZ - Clustered - Mideastern - 750yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.5 - North of NMSZ - Clustered - Mideastern - 750yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.3 - North of NMSZ - Clustered - Mideastern - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.5 - Southern of NMSZ - Clustered - Mideastern - 750yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M8.0 - Central of NMSZ - Clustered - Mideastern - 750yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.3 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.5 - North of NMSZ - Clustered - Mideastern - 750yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.5 - Southern of NMSZ - Clustered - Mideastern - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.3 - Central of NMSZ - Clustered - Midwestern - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.3 - Central of NMSZ - Clustered - Midwestern - 1000yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.1 - North of NMSZ - Clustered - Midwestern - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M8.0 - Central of NMSZ - Clustered - Mideastern - 750yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.1 - North of NMSZ - Clustered - Midwestern - 1000yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.7 - Southern of NMSZ - Clustered - Mideastern - 750yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr - M7.7 - Southern of NMSZ - Clustered - Mideastern - 750yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr -**

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M7.8 - North of NMSZ - Clustered - Mideastern - 750yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern -
750yr - M7.8 - North of NMSZ - Clustered - Mideastern - 750yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Mideastern - 750yr -
M8.0 - Southern of NMSZ - Clustered - Mideastern - 750yr - M8.0
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M7.3 -  Southern of NMSZ - Clustered - Midwestern - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern -
750yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M7.5 - Central of NMSZ - Clustered - Midwestern - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
1000yr - M7.5 - Central of NMSZ - Clustered - Midwestern - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M7.3 - North of NMSZ - Clustered - Midwestern - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern -
750yr - M8.0 - Southern of NMSZ - Clustered - Mideastern - 750yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
1000yr - M7.3 - North of NMSZ - Clustered - Midwestern - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M7.5 -  Southern of NMSZ - Clustered - Midwestern - 1000yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
1000yr - M7.3 -  Southern of NMSZ - Clustered - Midwestern - 1000yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern -
750yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M7.7 - Central of NMSZ - Clustered - Midwestern - 1000yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
1000yr - M7.5 -  Southern of NMSZ - Clustered - Midwestern - 1000yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
1000yr - M7.7 - Central of NMSZ - Clustered - Midwestern - 1000yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M7.5 - North of NMSZ - Clustered - Midwestern - 1000yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
1000yr - M7.5 - North of NMSZ - Clustered - Midwestern - 1000yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M7.7 -  Southern of NMSZ - Clustered - Midwestern - 1000yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Mideastern -
750yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr -
M8.0 of New Madrid - Composite.
```

Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M8.0 - Central of NMSZ - Clustered - Midwestern - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.5 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.7 - Southern of NMSZ - Clustered - Midwestern - 1000yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.3 - Central of NMSZ - Clustered - Midwestern - 1500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.5 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.3 - Central of NMSZ - Clustered - Midwestern - 1500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.5 - Central of NMSZ - Clustered - Midwestern - 1500yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.3 - Southern of NMSZ - Clustered - Midwestern - 1500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.3 - Southern of NMSZ - Clustered - Midwestern - 1500yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M8.0 - Central of NMSZ - Clustered - Midwestern - 1000yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.7 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.5 - Central of NMSZ - Clustered - Midwestern - 1500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.5 - Southern of NMSZ - Clustered - Midwestern - 1500yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.7 - Central of NMSZ - Clustered - Midwestern - 1500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.7 - Central of NMSZ - Clustered - Midwestern - 1500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.7 - Southern of NMSZ - Clustered - Midwestern - 1500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.7 - Southern of NMSZ - Clustered - Midwestern - 1500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr -

**M8.0 - Central of NMSZ - Clustered - Midwestern - 1500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.5 - Southern of NMSZ - Clustered - Midwestern - 1500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.8 - North of NMSZ - Clustered - Midwestern - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M8.0 - Central of NMSZ - Clustered - Midwestern - 1500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M8.0 - Southern of NMSZ - Clustered - Midwestern - 1500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M7.8 - North of NMSZ - Clustered - Midwestern - 1000yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M8.0 - Southern of NMSZ - Clustered - Midwestern - 1000yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M8.0 - Southern of NMSZ - Clustered - Midwestern - 1500yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.3 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.3 - Central of NMSZ - Clustered - Midwestern - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1000yr - M8.0 - Southern of NMSZ - Clustered - Midwestern - 1000yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.5 - Central of NMSZ - Clustered - Midwestern - 500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.3 - Central of NMSZ - Clustered - Midwestern - 500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.1 - North of NMSZ - Clustered - Midwestern - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.5 - Central of NMSZ - Clustered - Midwestern - 500yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.1 - North of NMSZ - Clustered - Midwestern - 500yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.3 - Southern of NMSZ - Clustered - Midwestern - 500yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern - 1500yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr - M7.3 - North of NMSZ - Clustered - Midwestern - 500yr - M7.5**

```
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr -
M7.7 - Central of NMSZ - Clustered - Midwestern - 500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.3 -  Southern of NMSZ - Clustered - Midwestern - 500yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
1000yr - M8.0 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr -
M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.7 - Central of NMSZ - Clustered - Midwestern - 500yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr -
M7.5 - North of NMSZ - Clustered - Midwestern - 500yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.3 - North of NMSZ - Clustered - Midwestern - 500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr -
M7.5 -  Southern of NMSZ - Clustered - Midwestern - 500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.5 -  Southern of NMSZ - Clustered - Midwestern - 500yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr -
M8.0 - Central of NMSZ - Clustered - Midwestern - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M8.0 - Central of NMSZ - Clustered - Midwestern - 500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr -
M7.8 - North of NMSZ - Clustered - Midwestern - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.5 - North of NMSZ - Clustered - Midwestern - 500yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.8 - North of NMSZ - Clustered - Midwestern - 500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr -
M7.7 -  Southern of NMSZ - Clustered - Midwestern - 500yr - M7.7
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 500yr -
M8.0 -  Southern of NMSZ - Clustered - Midwestern - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.7 -  Southern of NMSZ - Clustered - Midwestern - 500yr - M7.7.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M8.0 -  Southern of NMSZ - Clustered - Midwestern - 500yr - M8.0.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M7.3 - Central of NMSZ - Clustered - Midwestern - 750yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
750yr - M7.3 - Central of NMSZ - Clustered - Midwestern - 750yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
```

```
M7.1 - North of NMSZ - Clustered - Midwestern - 750yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M7.5 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M7.5 - Central of NMSZ - Clustered - Midwestern - 750yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
750yr - M7.5 - Central of NMSZ - Clustered - Midwestern - 750yr - M7.5.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
500yr - M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M8.0 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
750yr - M7.1 - North of NMSZ - Clustered - Midwestern - 750yr - M7.3.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M7.3 -  Southern of NMSZ - Clustered - Midwestern - 750yr - M7.3
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M8.0 - Central of NMSZ - Clustered - Midwestern - 750yr - M8.0
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M7.3 - North of NMSZ - Clustered - Midwestern - 750yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M7.7 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M7.7 - Central of NMSZ - Clustered - Midwestern - 750yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
750yr - M7.3 -  Southern of NMSZ - Clustered - Midwestern - 750yr - M7.3.
Done calculating hazard for nested source: NMSZ - Clustered - Midwestern -
750yr - M7.7 - Central of NMSZ - Clustered - Midwestern - 750yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Midwestern - 750yr -
M7.8 - North of NMSZ - Clustered - Midwestern - 750yr - M8.0
Calculating hazard for nested source: NMSZ - Clustered - Western - 1000yr -
M7.1 - North of NMSZ - Clustered - Western - 1000yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Western - 1000yr
- M7.5 - North of NMSZ - Clustered - Western - 1000yr - M7.7.
Calculating hazard for nested source: NMSZ - Clustered - Western - 1000yr -
M7.7 - Southern of NMSZ - Clustered - Western - 1000yr - M7.7
Done calculating hazard for nested source: NMSZ - Clustered - Western - 1000yr
- M7.5 - Southern of NMSZ - Clustered - Western - 1000yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Western - 1500yr -
M7.5 of New Madrid - Composite.
Done calculating hazard for nested source: NMSZ - Clustered - Western - 1500yr
- M8.0 - Southern of NMSZ - Clustered - Western - 1500yr - M8.0.
```

Calculating hazard for nested source: NMSZ - Clustered - Western - 500yr - M7.3 - North of NMSZ - Clustered - Western - 500yr - M7.5
Done calculating hazard for nested source: NMSZ - Clustered - Western - 500yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Western - 750yr - M7.3 of New Madrid - Composite.
Calculating hazard for nested source: NMSZ - Clustered - Western - 750yr - M7.3 - Central of NMSZ - Clustered - Western - 750yr - M7.3
Done calculating hazard for nested source: NMSZ - Clustered - Western - 500yr - M7.8 - North of NMSZ - Clustered - Western - 500yr - M8.0.
Calculating hazard for nested source: NMSZ - Clustered - Western - 500yr - M8.0 - Southern of NMSZ - Clustered - Western - 500yr - M8.0
Done calculating hazard for nested source: NMSZ - Clustered - Western - 750yr - M7.3 - North of NMSZ - Clustered - Western - 750yr - M7.5.
Calculating hazard for nested source: NMSZ - Clustered - Western - 750yr - M7.5 - Southern of NMSZ - Clustered - Western - 750yr - M7.5
Calculating hazard for nested source: NMSZ - Clustered - Western - 750yr - M7.7 - Southern of NMSZ - Clustered - Western - 750yr - M7.7
Done calculating hazard for nested source: CEUS Gridded - J.2.Y of CEUS Gridded - J.
Calculating hazard for nested source: CEUS Gridded - J.3.N of CEUS Gridded - J.
Done calculating hazard for nested source: CEUS Gridded - AB.1.N of CEUS Gridded - AB.
Calculating hazard for nested source: CEUS Gridded - AB.3.N of CEUS Gridded - AB.
Done calculating hazard for nested source: CEUS Gridded - J.1.Y of CEUS Gridded - J.
Calculating hazard for nested source: CEUS Gridded - J.3.Y of CEUS Gridded - J.
Done calculating hazard for nested source: CEUS Gridded - J.2.N of CEUS Gridded - J.
Calculating hazard for nested source: CEUS Gridded - J.4.N of CEUS Gridded - J.
Done calculating hazard for nested source: CEUS Gridded - J.3.N of CEUS Gridded - J.
Calculating hazard for nested source: CEUS Gridded - J.4.Y of CEUS Gridded - J.
Done calculating hazard for nested source: CEUS Gridded - J.1.N of CEUS Gridded - J.
Done calculating hazard for nested source: CEUS Gridded - AB.2.Y of CEUS Gridded - AB.
Calculating hazard for nested source: CEUS Gridded - AB.4.Y of CEUS Gridded - AB.
Done calculating hazard for nested source: CEUS Gridded - AB.3.Y of CEUS Gridded - AB.
Done calculating hazard for nested source: CEUS Gridded - AB.4.N of CEUS Gridded - AB.
Done calculating hazard for nested source: CEUS Gridded - J.4.Y of CEUS Gridded

```
- J.
Done calculating hazard for nested source: CEUS Gridded - J.4.N of CEUS Gridded
- J.
Done calculating hazard for: CEUS Gridded - J : USGS 2008 Central and Eastern
US.
Done calculating hazard for nested source: CEUS Gridded - AB.4.Y of CEUS
Gridded - AB.
Done calculating hazard for: CEUS Gridded - AB : USGS 2008 Central and Eastern
US.
End loop on sources:  16:53:53 Tuesday, August 02, 2011
Combining hazard from sources.
G:\KNA\EZ-FRISK_New\Northshore\Combined\Northshore (Combined) - Northshore -
Combined.ezf-shad calculated successfully
Writing hazard results
Writing TSV Export Report
Writing probabilistic spectra results
Writing source contribution results
Writing activity rate results
Writing deaggregation results
Finish: 16:53:57 Tuesday, August 02, 2011
Total number of ground motion evaluations: 420156
```

Probabilistic Hazard Results for EZ-FRISK 7.62 Build 000

SPECTRAL PERIOD: PGA
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	1.937e-001	1.947e-001	2.116e-001	1.750e-001
1.0e-003	2.240e-002	1.861e-002	2.707e-002	2.153e-002
0.010	1.733e-003	1.327e-003	2.132e-003	1.740e-003
0.020	6.611e-004	5.611e-004	7.883e-004	6.339e-004
0.050	1.642e-004	1.620e-004	1.898e-004	1.408e-004
0.070	9.734e-005	9.989e-005	1.094e-004	8.274e-005
0.100	5.605e-005	5.892e-005	6.116e-005	4.808e-005
0.200	1.910e-005	1.997e-005	2.058e-005	1.674e-005
0.300	9.924e-006	1.007e-005	1.103e-005	8.663e-006
0.400	6.085e-006	5.993e-006	7.004e-006	5.257e-006
0.500	4.082e-006	3.911e-006	4.844e-006	3.490e-006
0.700	2.145e-006	1.962e-006	2.667e-006	1.806e-006
1.000	1.014e-006	8.803e-007	1.315e-006	8.460e-007
2.000	1.815e-007	1.451e-007	2.401e-007	1.593e-007
3.000	5.383e-008	4.228e-008	6.670e-008	5.250e-008

SPECTRAL PERIOD: 0.05
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	2.013e-001	8.604e-002	2.361e-001	2.818e-001
1.0e-003	2.915e-002	1.317e-002	3.149e-002	4.279e-002
0.010	3.044e-003	2.041e-003	3.275e-003	3.815e-003
0.020	1.413e-003	1.021e-003	1.583e-003	1.634e-003
0.050	4.451e-004	3.522e-004	5.828e-004	4.005e-004
0.070	2.787e-004	2.291e-004	3.803e-004	2.265e-004
0.100	1.661e-004	1.421e-004	2.314e-004	1.246e-004
0.200	5.813e-005	5.283e-005	8.017e-005	4.139e-005
0.300	3.079e-005	2.837e-005	4.197e-005	2.202e-005
0.400	1.936e-005	1.781e-005	2.638e-005	1.390e-005
0.500	1.338e-005	1.221e-005	1.833e-005	9.595e-006

0.700	7.491e-006	6.679e-006	1.047e-005	5.328e-006
1.000	3.902e-006	3.345e-006	5.636e-006	2.725e-006
2.000	9.402e-007	7.234e-007	1.471e-006	6.268e-007
3.000	3.569e-007	2.578e-007	5.765e-007	2.365e-007

SPECTRAL PERIOD: 0.1
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	2.005e-001	6.631e-002	2.044e-001	3.306e-001
1.0e-003	3.331e-002	1.222e-002	3.045e-002	5.724e-002
0.010	3.753e-003	2.381e-003	3.644e-003	5.233e-003
0.020	1.819e-003	1.267e-003	1.846e-003	2.344e-003
0.050	5.862e-004	4.727e-004	6.559e-004	6.300e-004
0.070	3.631e-004	3.155e-004	4.141e-004	3.597e-004
0.100	2.124e-004	2.008e-004	2.408e-004	1.954e-004
0.200	7.154e-005	7.805e-005	7.450e-005	6.208e-005
0.300	3.741e-005	4.300e-005	3.647e-005	3.274e-005
0.400	2.345e-005	2.755e-005	2.202e-005	2.078e-005
0.500	1.620e-005	1.921e-005	1.491e-005	1.449e-005
0.700	9.096e-006	1.083e-005	8.231e-006	8.225e-006
1.000	4.743e-006	5.635e-006	4.256e-006	4.337e-006
2.000	1.126e-006	1.338e-006	9.641e-007	1.075e-006
3.000	4.226e-007	5.106e-007	3.299e-007	4.272e-007

SPECTRAL PERIOD: 0.2
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	2.296e-001	1.430e-001	2.292e-001	3.167e-001
1.0e-003	3.818e-002	2.382e-002	3.868e-002	5.204e-002
0.010	4.045e-003	3.336e-003	4.245e-003	4.554e-003
0.020	1.856e-003	1.672e-003	1.931e-003	1.965e-003
0.050	5.330e-004	5.550e-004	5.716e-004	4.725e-004
0.070	3.139e-004	3.505e-004	3.366e-004	2.547e-004
0.100	1.740e-004	2.092e-004	1.831e-004	1.298e-004
0.200	5.294e-005	7.086e-005	5.121e-005	3.676e-005

0.300	2.604e-005	3.591e-005	2.393e-005	1.829e-005
0.400	1.561e-005	2.167e-005	1.402e-005	1.115e-005
0.500	1.042e-005	1.443e-005	9.284e-006	7.535e-006
0.700	5.541e-006	7.599e-006	4.949e-006	4.074e-006
1.000	2.724e-006	3.681e-006	2.454e-006	2.036e-006
2.000	5.703e-007	7.617e-007	4.969e-007	4.523e-007
3.000	1.968e-007	2.672e-007	1.557e-007	1.674e-007

SPECTRAL PERIOD: 0.3

Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	2.304e-001	1.673e-001	2.588e-001	2.652e-001
1.0e-003	3.670e-002	2.609e-002	4.387e-002	4.015e-002
0.010	3.392e-003	2.697e-003	4.036e-003	3.441e-003
0.020	1.402e-003	1.215e-003	1.582e-003	1.410e-003
0.050	3.500e-004	3.636e-004	3.873e-004	2.991e-004
0.070	1.976e-004	2.225e-004	2.158e-004	1.546e-004
0.100	1.054e-004	1.284e-004	1.118e-004	7.608e-005
0.200	3.012e-005	4.077e-005	2.909e-005	2.050e-005
0.300	1.431e-005	1.988e-005	1.316e-005	9.879e-006
0.400	8.367e-006	1.169e-005	7.548e-006	5.867e-006
0.500	5.475e-006	7.638e-006	4.910e-006	3.879e-006
0.700	2.827e-006	3.921e-006	2.533e-006	2.028e-006
1.000	1.345e-006	1.858e-006	1.197e-006	9.781e-007
2.000	2.616e-007	3.716e-007	2.110e-007	2.024e-007
3.000	8.586e-008	1.272e-007	5.897e-008	7.140e-008

SPECTRAL PERIOD: 0.4

Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	2.303e-001	1.927e-001	2.658e-001	2.325e-001
1.0e-003	3.609e-002	2.938e-002	4.401e-002	3.486e-002
0.010	2.981e-003	2.466e-003	3.466e-003	3.011e-003
0.020	1.131e-003	1.021e-003	1.171e-003	1.202e-003
0.050	2.570e-004	2.853e-004	2.487e-004	2.371e-004

0.070	1.414e-004	1.709e-004	1.347e-004	1.185e-004
0.100	7.349e-005	9.640e-005	6.784e-005	5.623e-005
0.200	1.998e-005	2.915e-005	1.658e-005	1.421e-005
0.300	9.232e-006	1.382e-005	7.229e-006	6.652e-006
0.400	5.303e-006	7.975e-006	4.051e-006	3.882e-006
0.500	3.424e-006	5.145e-006	2.590e-006	2.536e-006
0.700	1.734e-006	2.597e-006	1.300e-006	1.305e-006
1.000	8.084e-007	1.212e-006	5.927e-007	6.203e-007
2.000	1.506e-007	2.342e-007	9.285e-008	1.249e-007
3.000	4.799e-008	7.767e-008	2.311e-008	4.319e-008

SPECTRAL PERIOD: 0.5

Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	2.317e-001	2.149e-001	2.711e-001	2.090e-001
1.0e-003	3.631e-002	3.306e-002	4.446e-002	3.140e-002
0.010	2.767e-003	2.422e-003	3.158e-003	2.722e-003
0.020	9.823e-004	9.246e-004	9.592e-004	1.063e-003
0.050	2.069e-004	2.419e-004	1.808e-004	1.981e-004
0.070	1.114e-004	1.423e-004	9.530e-005	9.654e-005
0.100	5.661e-005	7.869e-005	4.658e-005	4.455e-005
0.200	1.477e-005	2.286e-005	1.070e-005	1.075e-005
0.300	6.696e-006	1.060e-005	4.552e-006	4.937e-006
0.400	3.805e-006	6.034e-006	2.529e-006	2.851e-006
0.500	2.439e-006	3.857e-006	1.609e-006	1.850e-006
0.700	1.222e-006	1.923e-006	7.990e-007	9.433e-007
1.000	5.619e-007	8.860e-007	3.554e-007	4.443e-007
2.000	1.008e-007	1.654e-007	4.953e-008	8.748e-008
3.000	3.123e-008	5.310e-008	1.090e-008	2.970e-008

SPECTRAL PERIOD: 0.75

Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	2.288e-001	2.529e-001	2.778e-001	1.557e-001
1.0e-003	3.677e-002	4.077e-002	4.523e-002	2.433e-002

0.010	2.597e-003	2.663e-003	2.953e-003	2.174e-003
0.020	8.401e-004	8.855e-004	8.192e-004	8.154e-004
0.050	1.466e-004	1.904e-004	1.127e-004	1.369e-004
0.070	7.512e-005	1.067e-004	5.536e-005	6.334e-005
0.100	3.653e-005	5.657e-005	2.554e-005	2.750e-005
0.200	8.871e-006	1.530e-005	5.375e-006	5.934e-006
0.300	3.878e-006	6.815e-006	2.216e-006	2.602e-006
0.400	2.147e-006	3.769e-006	1.205e-006	1.465e-006
0.500	1.346e-006	2.354e-006	7.502e-007	9.339e-007
0.700	6.496e-007	1.131e-006	3.547e-007	4.633e-007
1.000	2.854e-007	4.992e-007	1.460e-007	2.110e-007
2.000	4.646e-008	8.502e-008	1.623e-008	3.814e-008
3.000	1.369e-008	2.586e-008	3.018e-009	1.218e-008

SPECTRAL PERIOD: 1
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	2.243e-001	2.817e-001	2.639e-001	1.272e-001
1.0e-003	3.687e-002	4.855e-002	4.145e-002	2.062e-002
0.010	2.542e-003	3.143e-003	2.611e-003	1.873e-003
0.020	7.963e-004	1.012e-003	6.951e-004	6.821e-004
0.050	1.201e-004	1.796e-004	7.357e-005	1.071e-004
0.070	5.836e-005	9.382e-005	3.322e-005	4.803e-005
0.100	2.716e-005	4.697e-005	1.442e-005	2.009e-005
0.200	6.223e-006	1.177e-005	2.869e-006	4.031e-006
0.300	2.646e-006	5.059e-006	1.169e-006	1.709e-006
0.400	1.433e-006	2.729e-006	6.252e-007	9.429e-007
0.500	8.809e-007	1.672e-006	3.794e-007	5.916e-007
0.700	4.113e-007	7.794e-007	1.683e-007	2.862e-007
1.000	1.740e-007	3.329e-007	6.274e-008	1.264e-007
2.000	2.660e-008	5.317e-008	5.319e-009	2.133e-008
3.000	7.649e-009	1.562e-008	8.157e-010	6.514e-009

SPECTRAL PERIOD: 2
Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	1.604e-001	2.093e-001	1.927e-001	7.921e-002
1.0e-003	2.503e-002	3.418e-002	2.639e-002	1.452e-002
0.010	1.742e-003	2.077e-003	1.611e-003	1.540e-003
0.020	5.271e-004	5.918e-004	3.957e-004	5.939e-004
0.050	6.590e-005	6.634e-005	2.483e-005	1.065e-004
0.070	2.844e-005	2.772e-005	8.240e-006	4.937e-005
0.100	1.147e-005	1.122e-005	2.810e-006	2.038e-005
0.200	1.947e-006	2.156e-006	4.786e-007	3.206e-006
0.300	7.003e-007	8.455e-007	1.793e-007	1.076e-006
0.400	3.410e-007	4.298e-007	8.543e-008	5.077e-007
0.500	1.947e-007	2.502e-007	4.588e-008	2.881e-007
0.700	8.245e-008	1.063e-007	1.623e-008	1.249e-007
1.000	3.205e-008	3.998e-008	4.593e-009	5.158e-008
2.000	4.411e-009	4.547e-009	2.246e-010	8.460e-009
3.000	1.243e-009	1.039e-009	2.604e-011	2.664e-009

SPECTRAL PERIOD: 3

Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	1.241e-001	1.661e-001	1.515e-001	5.475e-002
1.0e-003	1.765e-002	2.367e-002	1.904e-002	1.023e-002
0.010	1.084e-003	1.129e-003	9.780e-004	1.146e-003
0.020	2.975e-004	2.644e-004	1.844e-004	4.436e-004
0.050	3.897e-005	2.594e-005	7.605e-006	8.335e-005
0.070	1.769e-005	1.107e-005	2.266e-006	3.974e-005
0.100	7.429e-006	4.667e-006	7.466e-007	1.687e-005
0.200	1.239e-006	9.350e-007	1.233e-007	2.660e-006
0.300	4.112e-007	3.595e-007	4.077e-008	8.332e-007
0.400	1.846e-007	1.768e-007	1.686e-008	3.602e-007
0.500	9.840e-008	9.931e-008	7.914e-009	1.880e-007
0.700	3.763e-008	3.936e-008	2.212e-009	7.131e-008
1.000	1.333e-008	1.351e-008	4.707e-010	2.602e-008
2.000	1.652e-009	1.226e-009	1.227e-011	3.719e-009
3.000	4.616e-010	2.398e-010	9.520e-013	1.144e-009

SPECTRAL PERIOD: 4

Column 1: Acceleration (g)
Column 2: Mean
Column 3: Toro (1999) Midcontinent - USGS 2008 MbLg MRC

Column 4: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
1.0e-004	9.967e-002	1.392e-001	1.170e-001	4.282e-002
1.0e-003	1.330e-002	1.794e-002	1.380e-002	8.152e-003
0.010	7.314e-004	6.892e-004	5.576e-004	9.474e-004
0.020	1.965e-004	1.416e-004	7.868e-005	3.693e-004
0.050	2.939e-005	1.349e-005	2.374e-006	7.229e-005
0.070	1.398e-005	5.918e-006	7.122e-007	3.532e-005
0.100	6.084e-006	2.559e-006	2.476e-007	1.545e-005
0.200	1.037e-006	5.126e-007	3.765e-008	2.559e-006
0.300	3.363e-007	1.911e-007	1.054e-008	8.072e-007
0.400	1.460e-007	9.079e-008	3.752e-009	3.435e-007
0.500	7.512e-008	4.932e-008	1.546e-009	1.745e-007
0.700	2.691e-008	1.840e-008	3.485e-010	6.198e-008
1.000	8.842e-009	5.853e-009	5.794e-011	2.061e-008
2.000	9.756e-010	4.452e-010	8.969e-013	2.481e-009
3.000	2.655e-010	7.743e-011	5.043e-014	7.190e-010

Probabilistic Spectra results for EZ-FRISK 7.62 Build 000

ANNUAL FREQUENCY OF EXCEEDANCE: 4.041e-004
RETURN PERIOD: 2474.9
PROBABILITY OF EXCEEDENCE: 2.0% IN 50.0 YEARS
Column 1: Spectral Period
Column 2: Acceleration (g) for: Mean
Column 3: Acceleration (g) for: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Acceleration (g) for: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Acceleration (g) for: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
PGA	2.765e-002	2.548e-002	3.075e-002	2.631e-002
0.05	5.360e-002	4.442e-002	6.674e-002	4.971e-002
0.1	6.494e-002	5.698e-002	7.114e-002	6.528e-002
0.2	5.963e-002	6.308e-002	6.233e-002	5.445e-002
0.3	4.548e-002	4.615e-002	4.864e-002	4.186e-002
0.4	3.780e-002	3.893e-002	3.753e-002	3.700e-002
0.5	3.373e-002	3.522e-002	3.215e-002	3.390e-002
0.75	2.937e-002	3.193e-002	2.772e-002	2.868e-002
1	2.778e-002	3.253e-002	2.495e-002	2.592e-002
2	2.249e-002	2.347e-002	1.980e-002	2.456e-002
3	1.697e-002	1.633e-002	1.444e-002	2.105e-002
4	1.367e-002	1.263e-002	1.121e-002	1.872e-002

ANNUAL FREQUENCY OF EXCEEDANCE: 1.026e-003
RETURN PERIOD: 974.8
PROBABILITY OF EXCEEDENCE: 5.0% IN 50.0 YEARS
Column 1: Spectral Period
Column 2: Acceleration (g) for: Mean
Column 3: Acceleration (g) for: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Acceleration (g) for: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Acceleration (g) for: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
PGA	1.458e-002	1.230e-002	1.665e-002	1.437e-002
0.05	2.578e-002	1.990e-002	2.977e-002	2.708e-002
0.1	3.179e-002	2.434e-002	3.365e-002	3.559e-002
0.2	3.091e-002	3.001e-002	3.219e-002	3.037e-002
0.3	2.458e-002	2.274e-002	2.652e-002	2.414e-002
0.4	2.125e-002	1.992e-002	2.163e-002	2.187e-002
0.5	1.943e-002	1.856e-002	1.923e-002	2.039e-002
0.75	1.769e-002	1.823e-002	1.771e-002	1.700e-002
1	1.719e-002	1.983e-002	1.631e-002	1.512e-002

2	1.360e-002	1.476e-002	1.250e-002	1.344e-002
3	1.030e-002	1.047e-002	9.636e-003	1.084e-002
4	7.644e-003	7.550e-003	6.457e-003	9.183e-003

ANNUAL FREQUENCY OF EXCEEDANCE: 2.107e-003
RETURN PERIOD: 474.6
PROBABILITY OF EXCEEDENCE: 10.0% IN 50.0 YEARS
Column 1: Spectral Period
Column 2: Acceleration (g) for: Mean
Column 3: Acceleration (g) for: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Column 4: Acceleration (g) for: Campbell (2003) USGS 2008 MbLg - AB MRC
Column 5: Acceleration (g) for: Silva et al (2002) USGS 2008 MbLg - AB MRC

1	2	3	4	5
PGA	8.388e-003	6.683e-003	1.008e-002	8.394e-003
0.05	1.394e-002	9.616e-003	1.523e-002	1.624e-002
0.1	1.737e-002	1.144e-002	1.747e-002	2.154e-002
0.2	1.786e-002	1.585e-002	1.852e-002	1.888e-002
0.3	1.453e-002	1.239e-002	1.618e-002	1.464e-002
0.4	1.282e-002	1.132e-002	1.374e-002	1.309e-002
0.5	1.200e-002	1.105e-002	1.265e-002	1.208e-002
0.75	1.137e-002	1.159e-002	1.200e-002	1.022e-002
1	1.119e-002	1.277e-002	1.119e-002	8.933e-003
2	8.485e-003	9.881e-003	8.015e-003	7.248e-003
3	5.778e-003	6.235e-003	5.514e-003	5.269e-003
4	4.317e-003	4.541e-003	3.852e-003	4.252e-003

Source Contribution results for EZ-FRISK 7.62 Build 000

Source: CEUS Gridded - AB
Region: USGS 2008 Central and Eastern US
Equation: Toro (1999) Midcontinent - USGS 2008 MbLg MRC

Period	Amp=0.0001	Amp=0.001	Amp=0.01	Amp=0.02	Amp=0.05	Amp=0.07	Amp=0.1	Amp=0.2	Amp=0.3	Amp=0.4	Amp=0.5	Amp=0.7	Amp=1	Amp=2	Amp=3
PGA	9.732e-002	8.887e-003	6.808e-004	2.907e-004	8.481e-005	5.249e-005	3.109e-005	1.064e-005	5.409e-006	3.242e-006	2.132e-006	1.085e-006	4.965e-007	8.644e-008	2.621e-008
0.05	4.268e-002	6.484e-003	1.043e-003	5.237e-004	1.824e-004	1.191e-004	7.424e-005	2.786e-005	1.506e-005	9.510e-006	6.551e-006	3.618e-006	1.837e-006	4.132e-007	1.522e-007
0.1	3.271e-002	6.121e-003	1.213e-003	6.482e-004	2.438e-004	1.634e-004	1.044e-004	4.097e-005	2.272e-005	1.463e-005	1.025e-005	5.828e-006	3.067e-006	7.530e-007	2.959e-007
0.2	7.132e-002	1.152e-002	1.703e-003	8.573e-004	2.878e-004	1.828e-004	1.098e-004	3.773e-005	1.929e-005	1.172e-005	7.852e-006	4.177e-006	2.052e-006	4.423e-007	1.604e-007
0.3	8.360e-002	1.257e-002	1.380e-003	6.313e-004	1.926e-004	1.189e-004	6.938e-005	2.249e-005	1.110e-005	6.591e-006	4.343e-006	2.261e-006	1.092e-006	2.291e-007	8.127e-008
0.4	9.637e-002	1.426e-002	1.244e-003	5.342e-004	1.536e-004	9.305e-005	5.316e-005	1.647e-005	7.918e-006	4.619e-006	3.006e-006	1.541e-006	7.334e-007	1.488e-007	5.108e-008
0.5	1.075e-001	1.617e-002	1.186e-003	4.828e-004	1.321e-004	7.872e-005	4.416e-005	1.317e-005	6.198e-006	3.567e-006	2.300e-006	1.165e-006	5.473e-007	1.072e-007	3.560e-008
0.75	1.265e-001	2.017e-002	1.176e-003	4.303e-004	1.049e-004	6.036e-005	3.270e-005	9.129e-006	4.130e-006	2.309e-006	1.455e-006	7.104e-007	3.201e-007	5.733e-008	1.805e-008
1	1.409e-001	2.417e-002	1.299e-003	4.350e-004	9.420e-005	5.225e-005	2.734e-005	7.192e-006	3.146e-006	1.717e-006	1.061e-006	5.027e-007	2.192e-007	3.684e-008	1.120e-008
2	1.047e-001	1.704e-002	7.204e-004	1.888e-004	2.803e-005	1.371e-005	6.385e-006	1.412e-006	5.714e-007	2.954e-007	1.742e-007	7.571e-008	2.927e-008	3.526e-009	8.320e-010
3	8.312e-002	1.170e-002	3.642e-004	8.977e-005	1.298e-005	6.311e-006	2.916e-006	6.302e-007	2.482e-007	1.243e-007	7.089e-008	2.883e-008	1.019e-008	9.788e-010	1.973e-010
4	6.967e-002	8.760e-003	2.192e-004	5.246e-005	7.489e-006	3.622e-006	1.662e-006	3.508e-007	1.340e-007	6.497e-008	3.590e-008	1.377e-008	4.510e-009	3.625e-010	6.486e-011

Equation: Campbell (2003) USGS 2008 MbLg - AB MRC

Period	Amp=0.0001	Amp=0.001	Amp=0.01	Amp=0.02	Amp=0.05	Amp=0.07	Amp=0.1	Amp=0.2	Amp=0.3	Amp=0.4	Amp=0.5	Amp=0.7	Amp=1	Amp=2	Amp=3
PGA	1.059e-001	1.330e-002	9.695e-004	3.978e-004	1.003e-004	5.826e-005	3.273e-005	1.097e-005	5.854e-006	3.713e-006	2.572e-006	1.426e-006	7.120e-007	1.349e-007	3.850e-008
0.05	1.181e-001	1.556e-002	1.525e-003	7.958e-004	2.998e-004	1.964e-004	1.201e-004	4.213e-005	2.217e-005	1.395e-005	9.695e-006	5.537e-006	2.989e-006	7.935e-007	3.167e-007
0.1	1.023e-001	1.489e-002	1.786e-003	9.401e-004	3.380e-004	2.144e-004	1.255e-004	3.949e-005	1.946e-005	1.177e-005	7.962e-006	4.388e-006	2.272e-006	5.244e-007	1.832e-007
0.2	1.147e-001	1.903e-002	2.055e-003	9.856e-004	2.986e-004	1.775e-004	9.770e-005	2.796e-005	1.314e-005	7.688e-006	5.077e-006	2.699e-006	1.343e-006	2.804e-007	9.057e-008
0.3	1.295e-001	2.170e-002	1.888e-003	8.028e-004	2.063e-004	1.166e-004	6.142e-005	1.637e-005	7.412e-006	4.233e-006	2.745e-006	1.417e-006	6.771e-007	1.252e-007	3.646e-008
0.4	1.330e-001	2.184e-002	1.537e-003	5.851e-004	1.361e-004	7.513e-005	3.860e-005	9.642e-006	4.187e-006	2.335e-006	1.491e-006	7.540e-007	3.507e-007	5.841e-008	1.515e-008
0.5	1.356e-001	2.212e-002	1.323e-003	4.649e-004	1.012e-004	5.469e-005	2.731e-005	6.380e-006	2.695e-006	1.491e-006	9.505e-007	4.782e-007	2.181e-007	3.243e-008	7.419e-009
0.75	1.390e-001	2.258e-002	1.093e-003	3.363e-004	6.415e-005	3.319e-005	1.577e-005	3.354e-006	1.369e-006	7.443e-007	4.665e-007	2.252e-007	9.564e-008	1.140e-008	2.203e-009
1	1.320e-001	2.071e-002	8.886e-004	2.474e-004	4.136e-005	2.041e-005	9.229e-006	1.842e-006	7.456e-007	4.008e-007	2.461e-007	1.121e-007	4.326e-008	3.923e-009	6.223e-010
2	9.641e-002	1.316e-002	4.291e-004	9.233e-005	1.005e-005	4.335e-006	1.776e-006	3.335e-007	1.277e-007	6.224e-008	3.413e-008	1.249e-008	3.663e-009	1.903e-010	2.270e-011
3	7.581e-002	9.445e-003	2.080e-004	3.549e-005	2.893e-006	1.183e-006	4.805e-007	8.986e-008	3.090e-008	1.315e-008	6.309e-009	1.819e-009	3.988e-010	1.088e-011	8.622e-013
4	5.856e-002	6.756e-003	9.678e-005	1.359e-005	9.680e-007	4.043e-007	1.692e-007	2.885e-008	8.420e-009	3.078e-009	1.293e-009	2.993e-010	5.097e-011	8.182e-013	4.674e-014

Equation: Silva et al (2002) USGS 2008 MbLg - AB MRC

Period	Amp=0.0001	Amp=0.001	Amp=0.01	Amp=0.02	Amp=0.05	Amp=0.07	Amp=0.1	Amp=0.2	Amp=0.3	Amp=0.4	Amp=0.5	Amp=0.7	Amp=1	Amp=2	Amp=3
PGA	8.755e-002	1.061e-002	5.773e-004	2.172e-004	6.330e-005	4.035e-005	2.475e-005	8.990e-006	4.701e-006	2.872e-006	1.918e-006	1.004e-006			

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4.774e-007  9.369e-008  3.187e-008
      0.05  1.410e-001  2.138e-002  1.458e-003  5.401e-004  1.456e-004  9.161e-
005  5.628e-005  2.139e-005  1.174e-005  7.501e-006  5.214e-006  2.922e-006
1.510e-006  3.581e-007  1.385e-007
       0.1  1.654e-001  2.864e-002  2.153e-003  8.119e-004  2.134e-004  1.325e-
004  8.071e-005  3.079e-005  1.713e-005  1.110e-005  7.817e-006  4.486e-006
2.390e-006  6.083e-007  2.470e-007
       0.2  1.584e-001  2.604e-002  1.812e-003  6.381e-004  1.500e-004  8.942e-
005  5.227e-005  1.841e-005  9.753e-006  6.090e-006  4.165e-006  2.285e-006
1.159e-006  2.669e-007  1.016e-007
       0.3  1.327e-001  2.007e-002  1.271e-003  4.249e-004  9.458e-005  5.540e-
005  3.171e-005  1.060e-005  5.421e-006  3.296e-006  2.209e-006  1.175e-006
5.772e-007  1.247e-007  4.532e-008
       0.4  1.163e-001  1.741e-002  1.065e-003  3.436e-004  7.223e-005  4.143e-
005  2.321e-005  7.462e-006  3.734e-006  2.240e-006  1.487e-006  7.807e-007
3.791e-007  7.994e-008  2.850e-008
       0.5  1.046e-001  1.567e-002  9.305e-004  2.918e-004  5.869e-005  3.314e-
005  1.828e-005  5.720e-006  2.825e-006  1.681e-006  1.110e-006  5.787e-007
2.788e-007  5.757e-008  2.014e-008
      0.75  7.792e-002  1.211e-002  6.820e-004  2.024e-004  3.700e-005  2.019e-
005  1.078e-005  3.212e-006  1.550e-006  9.076e-007  5.910e-007  3.008e-007
1.404e-007  2.665e-008  8.772e-009
         1  6.369e-002  1.023e-002  5.530e-004  1.583e-004  2.726e-005  1.456e-
005  7.623e-006  2.202e-006  1.044e-006  6.026e-007  3.874e-007  1.928e-007
8.738e-008  1.549e-008  4.872e-009
         2  3.967e-002  7.100e-003  4.232e-004  1.238e-004  1.940e-005  9.558e-
006  4.540e-006  1.110e-006  4.915e-007  2.733e-007  1.716e-007  8.298e-008
3.686e-008  6.520e-009  2.112e-009
         3  2.743e-002  4.855e-003  2.785e-004  8.168e-005  1.257e-005  6.028e-
006  2.737e-006  5.949e-007  2.464e-007  1.316e-007  8.046e-008  3.768e-008
1.633e-008  2.824e-009  9.173e-010
         4  2.145e-002  3.758e-003  2.126e-004  6.294e-005  9.734e-006  4.624e-
006  2.056e-006  4.157e-007  1.635e-007  8.441e-008  5.042e-008  2.295e-008
9.741e-009  1.657e-009  5.404e-010
  Weighted Average
    Period  Amp=0.0001  Amp=0.001   Amp=0.01    Amp=0.02    Amp=0.05    Amp=
0.07    Amp=0.1     Amp=0.2     Amp=0.3     Amp=0.4     Amp=0.5     Amp=0.7
Amp=1       Amp=2       Amp=3
       PGA  9.692e-002  1.093e-002  7.425e-004  3.019e-004  8.282e-005  5.037e-
005  2.952e-005  1.020e-005  5.321e-006  3.276e-006  2.207e-006  1.171e-006
5.620e-007  1.050e-007  3.219e-008
      0.05  1.006e-001  1.447e-002  1.342e-003  6.199e-004  2.093e-004  1.357e-
004  8.355e-005  3.046e-005  1.632e-005  1.032e-005  7.153e-006  4.026e-006
2.112e-006  5.216e-007  2.025e-007
       0.1  1.001e-001  1.655e-002  1.718e-003  8.001e-004  2.651e-004  1.701e-
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004  1.036e-004  3.708e-005  1.977e-005  1.250e-005  8.677e-006  4.901e-006
2.576e-006  6.286e-007  2.420e-007
       0.2  1.148e-001  1.887e-002  1.857e-003  8.270e-004  2.455e-004  1.499e-
004  8.660e-005  2.803e-005  1.406e-005  8.499e-006  5.698e-006  3.054e-006
1.518e-006  3.299e-007  1.175e-007
       0.3  1.153e-001  1.811e-002  1.513e-003  6.197e-004  1.645e-004  9.698e-
005  5.417e-005  1.649e-005  7.979e-006  4.707e-006  3.099e-006  1.618e-006
7.819e-007  1.597e-007  5.435e-008
       0.4  1.152e-001  1.784e-002  1.282e-003  4.876e-004  1.206e-004  6.987e-
005  3.832e-005  1.119e-005  5.280e-006  3.064e-006  1.995e-006  1.025e-006
4.877e-007  9.572e-008  3.158e-008
       0.5  1.159e-001  1.799e-002  1.146e-003  4.132e-004  9.733e-005  5.552e-
005  2.992e-005  8.425e-006  3.906e-006  2.246e-006  1.454e-006  7.405e-007
3.481e-007  6.574e-008  2.105e-008
      0.75  1.145e-001  1.829e-002  9.838e-004  3.230e-004  6.869e-005  3.791e-
005  1.975e-005  5.231e-006  2.350e-006  1.320e-006  8.376e-007  4.121e-007
1.854e-007  3.179e-008  9.674e-009
         1  1.122e-001  1.837e-002  9.136e-004  2.803e-004  5.427e-005  2.907e-
005  1.473e-005  3.745e-006  1.645e-006  9.067e-007  5.649e-007  2.692e-007
1.166e-007  1.875e-008  5.565e-009
         2  8.027e-002  1.243e-002  5.242e-004  1.350e-004  1.916e-005  9.201e-
006  4.234e-006  9.517e-007  3.969e-007  2.103e-007  1.267e-007  5.706e-008
2.327e-008  3.412e-009  9.888e-010
         3  6.212e-002  8.666e-003  2.836e-004  6.898e-005  9.482e-006  4.507e-
006  2.044e-006  4.383e-007  1.751e-007  8.967e-008  5.255e-008  2.278e-008
8.973e-009  1.271e-009  3.718e-010
         4  4.989e-002  6.425e-003  1.762e-004  4.300e-005  6.063e-006  2.883e-
006  1.296e-006  2.651e-007  1.020e-007  5.082e-008  2.920e-008  1.234e-008
4.768e-009  6.735e-010  2.018e-010


Source: CEUS Gridded - J
Region: USGS 2008 Central and Eastern US
  Equation: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
    Period  Amp=0.0001  Amp=0.001   Amp=0.01    Amp=0.02    Amp=0.05    Amp=
0.07    Amp=0.1     Amp=0.2     Amp=0.3     Amp=0.4     Amp=0.5     Amp=0.7
Amp=1       Amp=2       Amp=3
       PGA  9.543e-002  8.326e-003  6.392e-004  2.701e-004  7.720e-005  4.740e-
005  2.783e-005  9.332e-006  4.665e-006  2.751e-006  1.780e-006  8.775e-007
3.839e-007  5.864e-008  1.606e-008
      0.05  4.147e-002  6.209e-003  9.987e-004  4.970e-004  1.698e-004  1.100e-
004  6.790e-005  2.497e-005  1.331e-005  8.304e-006  5.657e-006  3.061e-006
1.508e-006  3.101e-007  1.056e-007
       0.1  3.176e-002  5.894e-003  1.168e-003  6.191e-004  2.289e-004  1.522e-
004  9.641e-005  3.708e-005  2.029e-005  1.292e-005  8.961e-006  5.004e-006
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2.568e-006  5.848e-007  2.148e-007
       0.2  6.977e-002  1.103e-002  1.629e-003  8.141e-004  2.672e-004  1.677e-
004  9.934e-005  3.313e-005  1.662e-005  9.950e-006  6.581e-006  3.422e-006
1.629e-006  3.195e-007  1.068e-007
       0.3  8.177e-002  1.186e-002  1.285e-003  5.813e-004  1.710e-004  1.036e-
004  5.907e-005  1.828e-005  8.774e-006  5.096e-006  3.295e-006  1.660e-006
7.667e-007  1.425e-007  4.593e-008
       0.4  9.442e-002  1.333e-002  1.129e-003  4.782e-004  1.316e-004  7.782e-
005  4.325e-005  1.268e-005  5.898e-006  3.356e-006  2.139e-006  1.056e-006
4.788e-007  8.539e-008  2.658e-008
       0.5  1.055e-001  1.504e-002  1.048e-003  4.200e-004  1.094e-004  6.349e-
005  3.453e-005  9.688e-006  4.401e-006  2.467e-006  1.556e-006  7.581e-007
3.387e-007  5.813e-008  1.750e-008
      0.75  1.245e-001  1.871e-002  9.793e-004  3.504e-004  8.113e-005  4.533e-
005  2.371e-005  6.172e-006  2.686e-006  1.460e-006  8.983e-007  4.204e-007
1.792e-007  2.769e-008  7.817e-009
         1  1.389e-001  2.249e-002  1.028e-003  3.324e-004  6.825e-005  3.678e-
005  1.858e-005  4.547e-006  1.910e-006  1.012e-006  6.104e-007  2.767e-007
1.137e-007  1.633e-008  4.419e-009
         2  1.027e-001  1.525e-002  4.627e-004  1.110e-004  1.525e-005  7.275e-
006  3.299e-006  6.923e-007  2.690e-007  1.336e-007  7.572e-008  3.053e-008
1.070e-008  1.021e-009  2.066e-010
         3  8.108e-002  1.010e-002  2.224e-004  5.101e-005  6.874e-006  3.259e-
006  1.467e-006  2.982e-007  1.108e-007  5.247e-008  2.840e-008  1.053e-008
3.318e-009  2.471e-010  4.244e-011
         4  6.763e-002  7.333e-003  1.299e-004  2.921e-005  3.890e-006  1.835e-
006  8.200e-007  1.604e-007  5.696e-008  2.581e-008  1.342e-008  4.635e-009
1.342e-009  8.273e-011  1.257e-011
  Equation: Campbell (2003) USGS 2008 MbLg - AB MRC
    Period  Amp=0.0001  Amp=0.001   Amp=0.01    Amp=0.02    Amp=0.05    Amp=
0.07    Amp=0.1     Amp=0.2     Amp=0.3     Amp=0.4     Amp=0.5     Amp=0.7
Amp=1       Amp=2       Amp=3
       PGA  1.038e-001  1.188e-002  8.829e-004  3.647e-004  8.923e-005  5.109e-
005  2.843e-005  9.611e-006  5.180e-006  3.291e-006  2.272e-006  1.241e-006
6.034e-007  1.052e-007  2.820e-008
      0.05  1.161e-001  1.404e-002  1.424e-003  7.547e-004  2.826e-004  1.839e-
004  1.113e-004  3.804e-005  1.980e-005  1.243e-005  8.632e-006  4.929e-006
2.647e-006  6.771e-007  2.597e-007
       0.1  1.003e-001  1.368e-002  1.686e-003  8.938e-004  3.178e-004  1.997e-
004  1.153e-004  3.501e-005  1.701e-005  1.026e-005  6.952e-006  3.844e-006
1.984e-006  4.397e-007  1.467e-007
       0.2  1.126e-001  1.776e-002  1.911e-003  9.205e-004  2.728e-004  1.591e-
004  8.544e-005  2.325e-005  1.079e-005  6.334e-006  4.208e-006  2.250e-006
1.111e-006  2.165e-007  6.510e-008
       0.3  1.274e-001  2.028e-002  1.716e-003  7.300e-004  1.805e-004  9.911e-
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005  5.036e-005  1.271e-005  5.747e-006  3.315e-006  2.165e-006  1.116e-006
5.204e-007  8.571e-008  2.251e-008
       0.4  1.309e-001  2.028e-002  1.345e-003  5.096e-004  1.118e-004  5.944e-
005  2.923e-005  6.942e-006  3.042e-006  1.717e-006  1.099e-006  5.460e-007
2.420e-007  3.445e-008  7.958e-009
       0.5  1.336e-001  2.045e-002  1.111e-003  3.865e-004  7.836e-005  4.048e-
005  1.926e-005  4.315e-006  1.857e-006  1.038e-006  6.589e-007  3.208e-007
1.373e-007  1.710e-008  3.479e-009
      0.75  1.370e-001  2.075e-002  8.250e-004  2.484e-004  4.373e-005  2.149e-
005  9.705e-006  2.021e-006  8.463e-007  4.607e-007  2.838e-007  1.295e-007
5.034e-008  4.829e-009  8.153e-010
         1  1.300e-001  1.884e-002  6.104e-004  1.640e-004  2.509e-005  1.175e-
005  5.085e-006  1.026e-006  4.239e-007  2.244e-007  1.333e-007  5.619e-008
1.948e-008  1.396e-009  1.934e-010
         2  9.436e-002  1.133e-002  2.203e-004  4.198e-005  4.094e-006  1.740e-
006  7.245e-007  1.418e-007  5.148e-008  2.318e-008  1.174e-008  3.739e-009
9.302e-010  3.434e-011  3.343e-012
         3  7.377e-002  7.700e-003  8.833e-005  1.297e-005  1.026e-006  4.406e-
007  1.876e-007  3.281e-008  9.845e-009  3.708e-009  1.605e-009  3.927e-010
7.196e-011  1.385e-012  8.980e-014
         4  5.652e-002  5.159e-003  3.482e-005  4.251e-006  3.368e-007  1.489e-
007  6.208e-008  8.707e-009  2.122e-009  6.739e-010  2.528e-010  4.919e-011
6.968e-012  7.878e-014  3.691e-015
  Equation: Silva et al (2002) USGS 2008 MbLg - AB MRC
    Period  Amp=0.0001  Amp=0.001   Amp=0.01    Amp=0.02    Amp=0.05    Amp=
0.07    Amp=0.1     Amp=0.2     Amp=0.3     Amp=0.4     Amp=0.5     Amp=0.7
Amp=1       Amp=2       Amp=3
       PGA  8.551e-002  9.049e-003  4.277e-004  1.729e-004  5.378e-005  3.454e-
005  2.123e-005  7.645e-006  3.949e-006  2.382e-006  1.571e-006  8.021e-007
3.685e-007  6.556e-008  2.063e-008
      0.05  1.389e-001  1.951e-002  1.058e-003  3.995e-004  1.180e-004  7.614e-
005  4.754e-005  1.820e-005  9.945e-006  6.308e-006  4.352e-006  2.402e-006
1.214e-006  2.687e-007  9.798e-008
       0.1  1.634e-001  2.670e-002  1.588e-003  5.897e-004  1.677e-004  1.075e-
004  6.715e-005  2.611e-005  1.452e-005  9.358e-006  6.554e-006  3.716e-006
1.944e-006  4.671e-007  1.802e-007
       0.2  1.564e-001  2.410e-002  1.279e-003  4.402e-004  1.127e-004  6.970e-
005  4.186e-005  1.500e-005  7.900e-006  4.888e-006  3.310e-006  1.779e-006
8.761e-007  1.854e-007  6.587e-008
       0.3  1.306e-001  1.818e-002  8.590e-004  2.841e-004  6.955e-005  4.211e-
005  2.463e-005  8.278e-006  4.172e-006  2.496e-006  1.646e-006  8.492e-007
4.004e-007  7.768e-008  2.609e-008
       0.4  1.143e-001  1.555e-002  6.925e-004  2.200e-004  5.086e-005  3.015e-
005  1.723e-005  5.525e-006  2.707e-006  1.588e-006  1.032e-006  5.215e-007
2.409e-007  4.491e-008  1.469e-008
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0.5 1.025e-001 1.383e-002 5.861e-004 1.803e-004 3.983e-005 2.323e-005 1.305e-005 4.045e-006 1.946e-006 1.128e-006 7.266e-007 3.626e-007 1.653e-007 2.991e-008 9.560e-009
0.75 7.588e-002 1.033e-002 3.956e-004 1.133e-004 2.246e-005 1.263e-005 6.850e-006 2.000e-006 9.315e-007 5.275e-007 3.333e-007 1.610e-007 7.040e-008 1.149e-008 3.413e-009
1 6.165e-002 8.504e-003 3.026e-004 8.248e-005 1.521e-005 8.357e-006 4.436e-006 1.248e-006 5.683e-007 3.159e-007 1.964e-007 9.217e-008 3.890e-008 5.839e-009 1.642e-009
2 3.764e-002 5.561e-003 2.087e-004 5.388e-005 7.915e-006 3.930e-006 1.895e-006 4.659e-007 2.010e-007 1.083e-007 6.589e-008 3.012e-008 1.247e-008 1.876e-009 5.457e-010
3 2.542e-002 3.556e-003 1.258e-004 3.193e-005 4.325e-006 2.034e-006 9.172e-007 1.986e-007 8.072e-008 4.201e-008 2.499e-008 1.111e-008 4.503e-009 6.668e-010 1.957e-010
4 1.947e-002 2.625e-003 9.093e-005 2.306e-005 3.023e-006 1.380e-006 5.962e-007 1.172e-007 4.526e-008 2.288e-008 1.336e-008 5.818e-009 2.327e-009 3.431e-010 1.017e-010
Weighted Average
Period Amp=0.0001 Amp=0.001 Amp=0.01 Amp=0.02 Amp=0.05 Amp=0.07 Amp=0.1 Amp=0.2 Amp=0.3 Amp=0.4 Amp=0.5 Amp=0.7 Amp=1 Amp=2 Amp=3
PGA 9.493e-002 9.752e-003 6.499e-004 2.692e-004 7.340e-005 4.434e-005 2.583e-005 8.863e-006 4.598e-006 2.808e-006 1.874e-006 9.735e-007 4.519e-007 7.646e-008 2.163e-008
0.05 9.884e-002 1.325e-002 1.160e-003 5.504e-004 1.902e-004 1.233e-004 7.558e-005 2.707e-005 1.435e-005 9.013e-006 6.214e-006 3.464e-006 1.790e-006 4.186e-007 1.544e-007
0.1 9.845e-002 1.543e-002 1.481e-003 7.009e-004 2.381e-004 1.531e-004 9.295e-005 3.274e-005 1.727e-005 1.084e-005 7.489e-006 4.188e-006 2.165e-006 4.972e-007 1.806e-007
0.2 1.129e-001 1.763e-002 1.606e-003 7.250e-004 2.176e-004 1.322e-004 7.555e-005 2.379e-005 1.177e-005 7.057e-006 4.700e-006 2.484e-006 1.205e-006 2.405e-007 7.926e-008
0.3 1.133e-001 1.677e-002 1.287e-003 5.318e-004 1.403e-004 8.159e-005 4.469e-005 1.309e-005 6.231e-006 3.636e-006 2.369e-006 1.208e-006 5.625e-007 1.020e-007 3.151e-008
0.4 1.132e-001 1.639e-002 1.056e-003 4.026e-004 9.808e-005 5.580e-005 2.990e-005 8.381e-006 3.882e-006 2.220e-006 1.423e-006 7.079e-007 3.206e-007 5.492e-008 1.641e-008
0.5 1.139e-001 1.644e-002 9.147e-004 3.289e-004 7.587e-005 4.240e-005 2.228e-005 6.016e-006 2.735e-006 1.545e-006 9.806e-007 4.805e-007 2.137e-007 3.505e-008 1.018e-008
0.75 1.124e-001 1.660e-002 7.333e-004 2.374e-004 4.911e-005 2.648e-005 1.342e-005 3.398e-006 1.488e-006 8.160e-007 5.051e-007 2.370e-007

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9.996e-008  1.467e-008  4.015e-009
         1  1.102e-001  1.661e-002  6.471e-004  1.929e-004  3.618e-005  1.896e-
005  9.367e-006  2.274e-006  9.674e-007  5.175e-007  3.134e-007  1.417e-007
5.737e-008  7.854e-009  2.085e-009
         2  7.823e-002  1.071e-002  2.972e-004  6.894e-005  9.088e-006  4.315e-
006  1.973e-006  4.333e-007  1.738e-007  8.834e-008  5.112e-008  2.146e-008
8.035e-009  9.771e-010  2.519e-010
         3  6.009e-002  7.118e-003  1.455e-004  3.197e-005  4.075e-006  1.911e-
006  8.572e-007  1.765e-007  6.713e-008  3.273e-008  1.833e-008  7.343e-009
2.631e-009  3.051e-010  7.940e-011
         4  4.788e-002  5.039e-003  8.520e-005  1.884e-005  2.417e-006  1.121e-
006  4.927e-007  9.544e-008  3.478e-008  1.645e-008  9.010e-009  3.501e-009
1.225e-009  1.420e-010  3.811e-011


Source: New Madrid - Composite
Region: USGS 2008 New Madrid
  Equation: Toro (1999) Midcontinent - USGS 2008 MbLg MRC
    Period  Amp=0.0001  Amp=0.001   Amp=0.01    Amp=0.02    Amp=0.05    Amp=
0.07    Amp=0.1     Amp=0.2     Amp=0.3     Amp=0.4     Amp=0.5     Amp=0.7
Amp=1       Amp=2       Amp=3
       PGA  1.899e-003  1.396e-003  7.238e-006  2.873e-007  1.234e-009  1.183e-
010  8.027e-012  2.352e-014  5.339e-016  3.074e-017  3.005e-018  8.154e-020
9.671e-022  1.995e-025  9.477e-028
      0.05  1.885e-003  4.783e-004  1.041e-007  1.602e-009  1.939e-012  1.162e-
013  4.790e-015  5.283e-018  5.528e-020  2.079e-021  1.523e-022  2.514e-024
2.620e-026  1.963e-030  5.146e-033
       0.1  1.853e-003  2.079e-004  1.197e-008  1.228e-010  8.621e-014  4.224e-
015  1.404e-016  9.434e-020  8.416e-022  2.744e-023  1.748e-024  2.337e-026
1.947e-028  9.432e-033  1.915e-035
       0.2  1.899e-003  1.266e-003  4.134e-006  1.471e-007  5.530e-010  5.057e-
011  3.269e-012  8.738e-015  1.883e-016  1.042e-017  9.887e-019  2.013e-020
3.352e-022  6.260e-026  2.806e-028
       0.3  1.900e-003  1.665e-003  3.232e-005  2.021e-006  1.623e-008  1.968e-
009  1.719e-010  8.286e-013  2.526e-014  1.798e-015  2.103e-016  7.072e-018
1.497e-019  4.110e-023  2.641e-025
       0.4  1.900e-003  1.790e-003  9.294e-005  8.181e-006  1.029e-007  1.473e-
008  1.535e-009  1.041e-011  3.880e-013  3.183e-014  4.158e-015  1.650e-016
4.381e-018  1.520e-021  1.200e-023
       0.5  1.900e-003  1.843e-003  1.887e-004  2.182e-005  3.907e-007  6.366e-
008  7.612e-009  6.755e-011  2.945e-012  2.701e-013  3.847e-014  1.738e-015
5.292e-017  2.275e-020  2.107e-022
      0.75  1.900e-003  1.880e-003  5.076e-004  1.048e-004  4.306e-006  9.762e-
007  1.684e-007  3.196e-009  2.238e-010  2.910e-011  5.476e-012  3.811e-013
1.864e-014  2.989e-017  4.582e-019
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         1  1.900e-003  1.891e-003  8.155e-004  2.442e-004  1.711e-005  4.783e-
006  1.040e-006  3.197e-008  3.025e-009  4.910e-010  1.103e-010  1.010e-011
6.675e-013  1.982e-015  4.727e-017
         2  1.900e-003  1.892e-003  8.935e-004  2.920e-004  2.306e-005  6.731e-
006  1.533e-006  5.163e-008  5.159e-009  8.708e-010  2.016e-010  1.933e-011
1.342e-012  4.388e-015  1.107e-016
         3  1.900e-003  1.876e-003  5.421e-004  1.237e-004  6.088e-006  1.497e-
006  2.841e-007  6.675e-009  5.389e-010  7.811e-011  1.606e-011  1.287e-012
7.381e-014  1.660e-016  3.372e-018
         4  1.900e-003  1.852e-003  3.401e-004  5.993e-005  2.116e-006  4.605e-
007  7.667e-008  1.393e-009  9.659e-011  1.256e-011  2.373e-012  1.673e-013
8.373e-015  1.438e-017  2.172e-019
  Equation: Campbell (2003) USGS 2008 MbLg - AB MRC
    Period  Amp=0.0001  Amp=0.001   Amp=0.01    Amp=0.02    Amp=0.05    Amp=
0.07    Amp=0.1     Amp=0.2     Amp=0.3     Amp=0.4     Amp=0.5     Amp=0.7
Amp=1       Amp=2       Amp=3
       PGA  1.900e-003  1.890e-003  2.799e-004  2.582e-005  2.023e-007  2.067e-
008  1.356e-009  2.697e-012  3.967e-014  1.526e-015  1.047e-016  1.419e-018
7.368e-021  2.179e-025  2.645e-028
      0.05  1.900e-003  1.892e-003  3.261e-004  3.288e-005  2.893e-007  3.086e-
008  2.123e-009  4.636e-012  7.210e-014  2.886e-015  2.041e-016  2.892e-018
1.532e-020  5.002e-025  6.435e-028
       0.1  1.900e-003  1.883e-003  1.718e-004  1.184e-005  6.266e-008  5.517e-
009  3.086e-010  4.492e-013  5.503e-015  1.859e-016  1.150e-017  1.322e-019
6.826e-022  1.470e-026  1.482e-029
       0.2  1.900e-003  1.892e-003  2.790e-004  2.446e-005  1.776e-007  1.766e-
008  1.128e-009  2.148e-012  3.101e-014  1.180e-015  8.037e-017  1.074e-018
6.724e-021  1.955e-025  2.353e-028
       0.3  1.900e-003  1.897e-003  4.316e-004  4.914e-005  4.970e-007  5.588e-
008  4.075e-009  1.011e-011  1.709e-013  7.291e-015  5.431e-016  8.395e-018
7.369e-020  2.281e-024  3.259e-027
       0.4  1.900e-003  1.899e-003  5.842e-004  7.650e-005  8.186e-007  9.066e-
008  6.368e-009  1.374e-011  2.051e-013  7.848e-015  5.313e-016  6.980e-018
4.053e-020  9.760e-025  1.017e-027
       0.5  1.900e-003  1.899e-003  7.250e-004  1.077e-004  1.222e-006  1.342e-
007  9.164e-009  1.768e-011  2.384e-013  8.346e-015  5.221e-016  5.998e-018
2.873e-020  4.801e-025  3.835e-028
      0.75  1.900e-003  1.900e-003  1.035e-003  2.346e-004  4.840e-006  6.687e-
007  5.888e-008  1.920e-010  3.584e-012  1.593e-013  1.205e-014  1.860e-016
1.522e-018  3.665e-023  4.380e-026
         1  1.900e-003  1.900e-003  1.112e-003  2.837e-004  7.111e-006  1.064e-
006  1.026e-007  4.074e-010  8.641e-012  4.231e-013  3.460e-014  6.041e-016
5.725e-018  1.735e-022  2.494e-025
         2  1.900e-003  1.899e-003  9.614e-004  2.614e-004  1.069e-005  2.164e-
006  3.100e-007  3.352e-009  1.484e-010  1.311e-011  1.764e-012  6.978e-014
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1.731e-015  5.672e-019  2.050e-021
         3  1.900e-003  1.896e-003  6.817e-004  1.360e-004  3.686e-006  6.429e-
007  7.855e-008  6.208e-010  2.281e-011  1.765e-012  2.142e-013  7.242e-015
1.520e-016  3.726e-020  1.034e-022
         4  1.900e-003  1.889e-003  4.260e-004  6.084e-005  1.069e-006  1.590e-
007  1.638e-008  9.242e-011  2.781e-012  1.866e-013  2.026e-014  5.790e-016
1.017e-017  9.935e-022  3.899e-024
  Equation: Silva et al (2002) USGS 2008 MbLg - AB MRC
    Period  Amp=0.0001  Amp=0.001   Amp=0.01    Amp=0.02    Amp=0.05    Amp=
0.07    Amp=0.1     Amp=0.2     Amp=0.3     Amp=0.4     Amp=0.5     Amp=0.7
Amp=1       Amp=2       Amp=3
       PGA  1.900e-003  1.876e-003  7.354e-004  2.438e-004  2.372e-005  7.854e-
006  2.103e-006  1.051e-007  1.387e-008  2.911e-009  8.074e-010  1.035e-010
1.001e-011  6.645e-014  2.636e-015
      0.05  1.900e-003  1.896e-003  1.299e-003  6.940e-004  1.368e-004  5.879e-
005  2.077e-005  1.795e-006  3.296e-007  8.786e-008  2.940e-008  5.026e-009
6.626e-010  8.160e-012  4.685e-013
       0.1  1.900e-003  1.898e-003  1.492e-003  9.427e-004  2.488e-004  1.196e-
004  4.757e-005  5.180e-006  1.091e-006  3.213e-007  1.163e-007  2.240e-008
3.362e-009  5.359e-011  3.592e-012
       0.2  1.900e-003  1.898e-003  1.463e-003  8.863e-004  2.098e-004  9.558e-
005  3.565e-005  3.357e-006  6.407e-007  1.747e-007  5.935e-008  1.033e-008
1.379e-009  1.709e-011  9.727e-013
       0.3  1.900e-003  1.897e-003  1.312e-003  7.009e-004  1.350e-004  5.709e-
005  1.974e-005  1.618e-006  2.858e-007  7.387e-008  2.409e-008  3.949e-009
4.961e-010  5.496e-012  2.946e-013
       0.4  1.900e-003  1.896e-003  1.253e-003  6.381e-004  1.140e-004  4.693e-
005  1.578e-005  1.228e-006  2.105e-007  5.331e-008  1.711e-008  2.740e-009
3.360e-010  3.562e-012  1.863e-013
       0.5  1.900e-003  1.895e-003  1.206e-003  5.911e-004  9.962e-005  4.017e-
005  1.323e-005  9.884e-007  1.657e-007  4.129e-008  1.309e-008  2.060e-009
2.480e-010  2.540e-012  1.305e-013
      0.75  1.900e-003  1.891e-003  1.096e-003  4.998e-004  7.740e-005  3.052e-
005  9.868e-006  7.228e-007  1.209e-007  3.019e-008  9.617e-009  1.529e-009
1.873e-010  2.021e-012  1.082e-013
         1  1.900e-003  1.888e-003  1.018e-003  4.413e-004  6.462e-005  2.512e-
005  8.028e-006  5.809e-007  9.704e-008  2.430e-008  7.766e-009  1.245e-009
1.544e-010  1.728e-012  9.520e-014
         2  1.900e-003  1.862e-003  9.079e-004  4.162e-004  7.922e-005  3.589e-
005  1.395e-005  1.630e-006  3.837e-007  1.261e-007  5.062e-008  1.177e-008
2.247e-009  6.497e-011  6.687e-012
         3  1.899e-003  1.816e-003  7.417e-004  3.299e-004  6.645e-005  3.168e-
005  1.322e-005  1.866e-006  5.061e-007  1.866e-007  8.254e-008  2.252e-008
5.189e-009  2.281e-010  3.102e-011
         4  1.899e-003  1.769e-003  6.438e-004  2.833e-004  5.954e-005  2.932e-
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005  1.279e-005  2.026e-006  5.984e-007  2.362e-007  1.107e-007  3.321e-008
8.546e-009  4.803e-010  7.684e-011
  Weighted Average
    Period  Amp=0.0001  Amp=0.001   Amp=0.01    Amp=0.02    Amp=0.05    Amp=
0.07    Amp=0.1     Amp=0.2     Amp=0.3     Amp=0.4     Amp=0.5     Amp=0.7
Amp=1       Amp=2       Amp=3
       PGA  1.900e-003  1.721e-003  3.408e-004  8.998e-005  7.974e-006  2.625e-
006  7.014e-007  3.502e-008  4.623e-009  9.705e-010  2.691e-010  3.451e-011
3.336e-012  2.215e-014  8.786e-016
      0.05  1.895e-003  1.422e-003  5.416e-004  2.423e-004  4.569e-005  1.961e-
005  6.923e-006  5.984e-007  1.099e-007  2.929e-008  9.800e-009  1.675e-009
2.209e-010  2.720e-012  1.562e-013
       0.1  1.884e-003  1.330e-003  5.546e-004  3.182e-004  8.297e-005  3.988e-
005  1.586e-005  1.727e-006  3.638e-007  1.071e-007  3.875e-008  7.468e-009
1.121e-009  1.786e-011  1.197e-012
       0.2  1.900e-003  1.686e-003  5.820e-004  3.036e-004  6.999e-005  3.187e-
005  1.188e-005  1.119e-006  2.136e-007  5.824e-008  1.978e-008  3.443e-009
4.598e-010  5.696e-012  3.242e-013
       0.3  1.900e-003  1.819e-003  5.919e-004  2.507e-004  4.516e-005  1.905e-
005  6.583e-006  5.393e-007  9.527e-008  2.462e-008  8.030e-009  1.316e-009
1.654e-010  1.832e-012  9.820e-014
       0.4  1.900e-003  1.861e-003  6.433e-004  2.409e-004  3.830e-005  1.568e-
005  5.264e-006  4.093e-007  7.018e-008  1.777e-008  5.704e-009  9.134e-010
1.120e-010  1.187e-012  6.210e-014
       0.5  1.900e-003  1.879e-003  7.064e-004  2.402e-004  3.374e-005  1.345e-
005  4.414e-006  3.295e-007  5.523e-008  1.376e-008  4.365e-009  6.866e-010
8.265e-011  8.468e-013  4.349e-014
      0.75  1.900e-003  1.890e-003  8.796e-004  2.797e-004  2.885e-005  1.072e-
005  3.365e-006  2.421e-007  4.036e-008  1.007e-008  3.207e-009  5.099e-010
6.245e-011  6.737e-013  3.606e-014
         1  1.900e-003  1.893e-003  9.818e-004  3.231e-004  2.961e-005  1.032e-
005  3.057e-006  2.044e-007  3.336e-008  8.263e-009  2.625e-009  4.184e-010
5.170e-011  5.766e-013  3.175e-014
         2  1.900e-003  1.884e-003  9.209e-004  3.232e-004  3.766e-005  1.493e-
005  5.263e-006  5.616e-007  1.297e-007  4.233e-008  1.694e-008  3.929e-009
7.494e-010  2.166e-011  2.229e-012
         3  1.900e-003  1.863e-003  6.552e-004  1.965e-004  2.541e-005  1.127e-
005  4.527e-006  6.245e-007  1.689e-007  6.222e-008  2.752e-008  7.508e-009
1.730e-009  7.604e-011  1.034e-011
         4  1.899e-003  1.836e-003  4.700e-004  1.347e-004  2.091e-005  9.980e-
006  4.295e-006  6.759e-007  1.995e-007  7.874e-008  3.690e-008  1.107e-008
2.849e-009  1.601e-010  2.561e-011
```

Deaggregation results for EZ-FRISK 7.62 Build 000

DEAGGREGATION: Magnitude
All magnitudes in Moment Magnitude scale.

Spectral Period:	**PGA**
Amplitude:	**0.02**
Annual Frequency of Exceedance:	**6.641e-004**
Mode Magnitude:	**4.75**
Mode Rate (by magnitude):	**4.670e-005**
Mean Magnitude:	**5.93**

Magnitude	Probability Density
4.05	8.942e-292
4.15	8.942e-292
4.25	8.942e-292
4.35	8.942e-292
4.45	8.942e-292
4.55	8.942e-292
4.65	8.942e-292
4.75	7.033e-001
4.85	6.648e-001
4.95	6.287e-001
5.05	5.946e-001
5.15	5.622e-001
5.25	5.327e-001
5.35	8.942e-292
5.45	5.052e-001
5.55	4.786e-001
5.65	4.530e-001
5.75	4.285e-001
5.85	4.051e-001
5.95	8.942e-292
6.05	3.921e-001
6.15	3.720e-001
6.25	3.537e-001
6.35	8.942e-292
6.45	3.374e-001
6.55	3.081e-001
6.65	8.942e-292
6.75	2.682e-001
6.85	1.737e-001
6.95	8.942e-292
7.05	1.825e-001
7.15	1.257e-001
7.25	5.247e-002

7.35	6.083e-002
7.45	2.375e-001
7.55	2.041e-010
7.65	6.344e-001
7.75	7.737e-002
7.85	1.628e-002
7.95	4.512e-001
8.05	8.942e-292
8.15	8.942e-292
8.25	8.942e-292
8.35	8.942e-292
8.45	8.942e-292
8.55	8.942e-292
8.65	8.942e-292
8.75	8.942e-292
8.85	8.942e-292
8.95	8.942e-292

Integral : 1.000e+000

DEAGGREGATION: Distance

Spectral Period:	PGA
Amplitude:	0.02
Annual Frequency of Exceedance:	6.641e-004
Mode Distance:	137.50
Mode Rate (by distance):	7.491e-005
Mean Distance:	317.31

Distance	Probability Density
12.5	1.012e-003
37.5	3.002e-003
62.5	4.488e-003
87.5	3.413e-003
112.5	4.152e-003
137.5	4.512e-003
162.5	2.170e-003
187.5	2.153e-003
212.5	1.997e-003
237.5	1.720e-003
262.5	1.424e-003
287.5	1.110e-003
312.5	2.208e-294
337.5	7.932e-004
362.5	5.755e-004

387.5	2.208e-294
412.5	3.856e-004
437.5	2.208e-294
462.5	2.407e-004
487.5	2.208e-294
512.5	2.208e-294
537.5	1.637e-004
562.5	2.208e-294
587.5	1.438e-004
612.5	2.208e-294
637.5	2.208e-294
662.5	1.281e-004
687.5	2.208e-294
712.5	2.208e-294
737.5	8.844e-005
762.5	2.208e-294
787.5	2.208e-294
812.5	2.208e-294
837.5	6.724e-005
862.5	2.208e-294
887.5	2.208e-294
912.5	2.208e-294
937.5	1.306e-004
962.5	2.208e-294
987.5	2.208e-294
1012.5	2.208e-294
1037.5	2.208e-294
1062.5	1.201e-004
1087.5	2.208e-294
1112.5	2.208e-294
1137.5	2.259e-003
1162.5	3.795e-004
1187.5	1.725e-003
1212.5	7.157e-005
1237.5	1.225e-003
1262.5	7.532e-005
1287.5	2.208e-294
1312.5	2.208e-294
1337.5	1.127e-004
1362.5	2.208e-294
1387.5	2.208e-294
1412.5	2.208e-294
1437.5	2.208e-294
1462.5	2.208e-294
1487.5	1.055e-004

1512.5	2.208e-294
1537.5	2.208e-294
1562.5	2.208e-294
1587.5	2.208e-294
1612.5	2.208e-294
1637.5	2.208e-294
1662.5	4.099e-005
1687.5	2.208e-294
1712.5	2.208e-294
1737.5	2.208e-294
1762.5	2.208e-294
1787.5	2.208e-294
1812.5	2.208e-294
1837.5	2.208e-294
1862.5	2.208e-294
1887.5	1.609e-005
1912.5	2.208e-294
1937.5	2.208e-294
1962.5	2.208e-294
1987.5	2.208e-294
2012.5	1.413e-008

Integral : 1.000e+000

DEAGGREGATION: Epsilon

Spectral Period:	**PGA**
Amplitude:	**0.02**
Annual Frequency of Exceedance:	**6.641e-004**
Mode Epsilon:	**0.90**
Mode Rate (by epsilon):	**5.232e-005**
Mean Epsilon:	**0.15**

Epsilon	Probability Density
-2.1	3.220e-001
-1.9	7.731e-002
-1.7	8.877e-002
-1.5	1.134e-001
-1.3	1.361e-001
-1.1	1.561e-001
-0.9	1.950e-001
-0.7	2.056e-001
-0.5	2.420e-001
-0.3	2.569e-001
-0.1	3.052e-001

0.1	2.882e-001
0.3	3.025e-001
0.5	2.525e-001
0.7	2.782e-001
0.9	3.939e-001
1.1	2.298e-001
1.3	2.708e-001
1.5	2.988e-001
1.7	2.065e-001
1.9	1.138e-001
2.1	9.419e-002
2.3	6.362e-002
2.5	4.245e-002
2.7	2.826e-002
2.9	1.674e-002
3.1	8.837e-003
3.3	5.769e-003
3.5	3.011e-003
3.7	1.654e-003
3.9	1.017e-003
4.1	8.773e-004

Integral : 1.000e+000

DEAGGREGATION: Magnitude - Distance
All magnitudes in Moment Magnitude scale.

Spectral Period:	PGA
Amplitude:	0.02
Annual Frequency of Exceedance:	6.641e-004
Mode Magnitude:	7.65
Mode Distance:	1187.50
Mode Rate (by distance and magnitude):	1.365e-005
Mean Magnitude:	5.93
Mean Distance:	317.31

Magnitude	Distance	Probability Density
4.05	12.5	4.416e-295
4.05	37.5	4.416e-295
4.05	62.5	4.416e-295
4.05	87.5	4.416e-295
4.05	112.5	4.416e-295
4.05	137.5	4.416e-295
4.05	162.5	4.416e-295
4.05	187.5	4.416e-295

4.05	212.5	4.416e-295
4.05	237.5	4.416e-295
4.05	262.5	4.416e-295
4.05	287.5	4.416e-295
4.05	312.5	4.416e-295
4.05	337.5	4.416e-295
4.05	362.5	4.416e-295
4.05	387.5	4.416e-295
4.05	412.5	4.416e-295
4.05	437.5	4.416e-295
4.05	462.5	4.416e-295
4.05	487.5	4.416e-295
4.05	512.5	4.416e-295
4.05	537.5	4.416e-295
4.05	562.5	4.416e-295
4.05	587.5	4.416e-295
4.05	612.5	4.416e-295
4.05	637.5	4.416e-295
4.05	662.5	4.416e-295
4.05	687.5	4.416e-295
4.05	712.5	4.416e-295
4.05	737.5	4.416e-295
4.05	762.5	4.416e-295
4.05	787.5	4.416e-295
4.05	812.5	4.416e-295
4.05	837.5	4.416e-295
4.05	862.5	4.416e-295
4.05	887.5	4.416e-295
4.05	912.5	4.416e-295
4.05	937.5	4.416e-295
4.05	962.5	4.416e-295
4.05	987.5	4.416e-295
4.05	1012.5	4.416e-295
4.05	1037.5	4.416e-295
4.05	1062.5	4.416e-295
4.05	1087.5	4.416e-295
4.05	1112.5	4.416e-295
4.05	1137.5	4.416e-295
4.05	1162.5	4.416e-295
4.05	1187.5	4.416e-295
4.05	1212.5	4.416e-295
4.05	1237.5	4.416e-295
4.05	1262.5	4.416e-295
4.05	1287.5	4.416e-295
4.05	1312.5	4.416e-295

4.05	1337.5	4.416e-295
4.05	1362.5	4.416e-295
4.05	1387.5	4.416e-295
4.05	1412.5	4.416e-295
4.05	1437.5	4.416e-295
4.05	1462.5	4.416e-295
4.05	1487.5	4.416e-295
4.05	1512.5	4.416e-295
4.05	1537.5	4.416e-295
4.05	1562.5	4.416e-295
4.05	1587.5	4.416e-295
4.05	1612.5	4.416e-295
4.05	1637.5	4.416e-295
4.05	1662.5	4.416e-295
4.05	1687.5	4.416e-295
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4.65	1912.5	4.416e-295
4.65	1937.5	4.416e-295
4.65	1962.5	4.416e-295
4.65	1987.5	4.416e-295
4.65	2012.5	4.416e-295
4.75	12.5	1.950e-003
4.75	37.5	5.427e-003
4.75	62.5	6.358e-003
4.75	87.5	3.874e-003
4.75	112.5	3.938e-003
4.75	137.5	3.325e-003
4.75	162.5	1.141e-003
4.75	187.5	8.732e-004
4.75	212.5	5.861e-004
4.75	237.5	3.440e-004
4.75	262.5	1.810e-004
4.75	287.5	8.386e-005
4.75	312.5	4.416e-295
4.75	337.5	3.268e-005
4.75	362.5	1.214e-005
4.75	387.5	4.416e-295
4.75	412.5	3.857e-006
4.75	437.5	4.416e-295
4.75	462.5	1.051e-006
4.75	487.5	4.416e-295
4.75	512.5	4.416e-295
4.75	537.5	2.750e-007
4.75	562.5	4.416e-295
4.75	587.5	7.899e-008
4.75	612.5	4.416e-295
4.75	637.5	4.416e-295

4.75	662.5	2.269e-008
4.75	687.5	4.416e-295
4.75	712.5	4.416e-295
4.75	737.5	3.903e-009
4.75	762.5	4.416e-295
4.75	787.5	4.416e-295
4.75	812.5	4.416e-295
4.75	837.5	4.143e-010
4.75	862.5	4.416e-295
4.75	887.5	4.416e-295
4.75	912.5	4.416e-295
4.75	937.5	5.881e-011
4.75	962.5	4.416e-295
4.75	987.5	4.416e-295
4.75	1012.5	4.416e-295
4.75	1037.5	4.416e-295
4.75	1062.5	5.633e-012
4.75	1087.5	4.416e-295
4.75	1112.5	4.416e-295
4.75	1137.5	4.416e-295
4.75	1162.5	4.416e-295
4.75	1187.5	3.575e-013
4.75	1212.5	4.416e-295
4.75	1237.5	4.416e-295
4.75	1262.5	4.416e-295
4.75	1287.5	4.416e-295
4.75	1312.5	4.416e-295
4.75	1337.5	2.779e-014
4.75	1362.5	4.416e-295
4.75	1387.5	4.416e-295
4.75	1412.5	4.416e-295
4.75	1437.5	4.416e-295
4.75	1462.5	4.416e-295
4.75	1487.5	2.884e-015
4.75	1512.5	4.416e-295
4.75	1537.5	4.416e-295
4.75	1562.5	4.416e-295
4.75	1587.5	4.416e-295
4.75	1612.5	4.416e-295
4.75	1637.5	4.416e-295
4.75	1662.5	2.632e-016
4.75	1687.5	4.416e-295
4.75	1712.5	4.416e-295
4.75	1737.5	4.416e-295
4.75	1762.5	4.416e-295

4.75	1787.5	4.416e-295
4.75	1812.5	4.416e-295
4.75	1837.5	4.416e-295
4.75	1862.5	4.416e-295
4.75	1887.5	1.293e-017
4.75	1912.5	4.416e-295
4.75	1937.5	4.416e-295
4.75	1962.5	4.416e-295
4.75	1987.5	4.416e-295
4.75	2012.5	5.107e-020
4.85	12.5	1.574e-003
4.85	37.5	4.541e-003
4.85	62.5	5.744e-003
4.85	87.5	3.706e-003
4.85	112.5	3.898e-003
4.85	137.5	3.424e-003
4.85	162.5	1.232e-003
4.85	187.5	9.753e-004
4.85	212.5	6.780e-004
4.85	237.5	4.129e-004
4.85	262.5	2.260e-004
4.85	287.5	1.091e-004
4.85	312.5	4.416e-295
4.85	337.5	4.448e-005
4.85	362.5	1.734e-005
4.85	387.5	4.416e-295
4.85	412.5	5.794e-006
4.85	437.5	4.416e-295
4.85	462.5	1.665e-006
4.85	487.5	4.416e-295
4.85	512.5	4.416e-295
4.85	537.5	4.610e-007
4.85	562.5	4.416e-295
4.85	587.5	1.405e-007
4.85	612.5	4.416e-295
4.85	637.5	4.416e-295
4.85	662.5	4.285e-008
4.85	687.5	4.416e-295
4.85	712.5	4.416e-295
4.85	737.5	7.857e-009
4.85	762.5	4.416e-295
4.85	787.5	4.416e-295
4.85	812.5	4.416e-295
4.85	837.5	8.984e-010
4.85	862.5	4.416e-295

4.85	887.5	4.416e-295
4.85	912.5	4.416e-295
4.85	937.5	1.408e-010
4.85	962.5	4.416e-295
4.85	987.5	4.416e-295
4.85	1012.5	4.416e-295
4.85	1037.5	4.416e-295
4.85	1062.5	1.554e-011
4.85	1087.5	4.416e-295
4.85	1112.5	4.416e-295
4.85	1137.5	4.416e-295
4.85	1162.5	4.416e-295
4.85	1187.5	1.284e-012
4.85	1212.5	4.416e-295
4.85	1237.5	4.416e-295
4.85	1262.5	4.416e-295
4.85	1287.5	4.416e-295
4.85	1312.5	4.416e-295
4.85	1337.5	1.314e-013
4.85	1362.5	4.416e-295
4.85	1387.5	4.416e-295
4.85	1412.5	4.416e-295
4.85	1437.5	4.416e-295
4.85	1462.5	4.416e-295
4.85	1487.5	1.590e-014
4.85	1512.5	4.416e-295
4.85	1537.5	4.416e-295
4.85	1562.5	4.416e-295
4.85	1587.5	4.416e-295
4.85	1612.5	4.416e-295
4.85	1637.5	4.416e-295
4.85	1662.5	1.609e-015
4.85	1687.5	4.416e-295
4.85	1712.5	4.416e-295
4.85	1737.5	4.416e-295
4.85	1762.5	4.416e-295
4.85	1787.5	4.416e-295
4.85	1812.5	4.416e-295
4.85	1837.5	4.416e-295
4.85	1862.5	4.416e-295
4.85	1887.5	8.717e-017
4.85	1912.5	4.416e-295
4.85	1937.5	4.416e-295
4.85	1962.5	4.416e-295
4.85	1987.5	4.416e-295

4.85	2012.5	3.650e-019
4.95	12.5	1.269e-003
4.95	37.5	3.775e-003
4.95	62.5	5.127e-003
4.95	87.5	3.497e-003
4.95	112.5	3.810e-003
4.95	137.5	3.487e-003
4.95	162.5	1.317e-003
4.95	187.5	1.078e-003
4.95	212.5	7.768e-004
4.95	237.5	4.911e-004
4.95	262.5	2.796e-004
4.95	287.5	1.407e-004
4.95	312.5	4.416e-295
4.95	337.5	5.991e-005
4.95	362.5	2.446e-005
4.95	387.5	4.416e-295
4.95	412.5	8.583e-006
4.95	437.5	4.416e-295
4.95	462.5	2.596e-006
4.95	487.5	4.416e-295
4.95	512.5	4.416e-295
4.95	537.5	7.592e-007
4.95	562.5	4.416e-295
4.95	587.5	2.453e-007
4.95	612.5	4.416e-295
4.95	637.5	4.416e-295
4.95	662.5	7.939e-008
4.95	687.5	4.416e-295
4.95	712.5	4.416e-295
4.95	737.5	1.555e-008
4.95	762.5	4.416e-295
4.95	787.5	4.416e-295
4.95	812.5	4.416e-295
4.95	837.5	1.926e-009
4.95	862.5	4.416e-295
4.95	887.5	4.416e-295
4.95	912.5	4.416e-295
4.95	937.5	3.384e-010
4.95	962.5	4.416e-295
4.95	987.5	4.416e-295
4.95	1012.5	4.416e-295
4.95	1037.5	4.416e-295
4.95	1062.5	4.429e-011
4.95	1087.5	4.416e-295

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4.95	1137.5	4.416e-295
4.95	1162.5	4.416e-295
4.95	1187.5	4.822e-012
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4.95	1237.5	4.416e-295
4.95	1262.5	4.416e-295
4.95	1287.5	4.416e-295
4.95	1312.5	4.416e-295
4.95	1337.5	6.207e-013
4.95	1362.5	4.416e-295
4.95	1387.5	4.416e-295
4.95	1412.5	4.416e-295
4.95	1437.5	4.416e-295
4.95	1462.5	4.416e-295
4.95	1487.5	8.577e-014
4.95	1512.5	4.416e-295
4.95	1537.5	4.416e-295
4.95	1562.5	4.416e-295
4.95	1587.5	4.416e-295
4.95	1612.5	4.416e-295
4.95	1637.5	4.416e-295
4.95	1662.5	9.596e-015
4.95	1687.5	4.416e-295
4.95	1712.5	4.416e-295
4.95	1737.5	4.416e-295
4.95	1762.5	4.416e-295
4.95	1787.5	4.416e-295
4.95	1812.5	4.416e-295
4.95	1837.5	4.416e-295
4.95	1862.5	4.416e-295
4.95	1887.5	5.734e-016
4.95	1912.5	4.416e-295
4.95	1937.5	4.416e-295
4.95	1962.5	4.416e-295
4.95	1987.5	4.416e-295
4.95	2012.5	2.546e-018
5.05	12.5	1.023e-003
5.05	37.5	3.120e-003
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5.05	87.5	3.254e-003
5.05	112.5	3.674e-003
5.05	137.5	3.507e-003
5.05	162.5	1.391e-003
5.05	187.5	1.179e-003

5.05	212.5	8.805e-004
5.05	237.5	5.781e-004
5.05	262.5	3.424e-004
5.05	287.5	1.796e-004
5.05	312.5	4.416e-295
5.05	337.5	7.980e-005
5.05	362.5	3.408e-005
5.05	387.5	4.416e-295
5.05	412.5	1.254e-005
5.05	437.5	4.416e-295
5.05	462.5	3.985e-006
5.05	487.5	4.416e-295
5.05	512.5	4.416e-295
5.05	537.5	1.229e-006
5.05	562.5	4.416e-295
5.05	587.5	4.207e-007
5.05	612.5	4.416e-295
5.05	637.5	4.416e-295
5.05	662.5	1.447e-007
5.05	687.5	4.416e-295
5.05	712.5	4.416e-295
5.05	737.5	3.036e-008
5.05	762.5	4.416e-295
5.05	787.5	4.416e-295
5.05	812.5	4.416e-295
5.05	837.5	4.106e-009
5.05	862.5	4.416e-295
5.05	887.5	4.416e-295
5.05	912.5	4.416e-295
5.05	937.5	8.252e-010
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5.05	987.5	4.416e-295
5.05	1012.5	4.416e-295
5.05	1037.5	4.416e-295
5.05	1062.5	1.314e-010
5.05	1087.5	4.416e-295
5.05	1112.5	4.416e-295
5.05	1137.5	4.416e-295
5.05	1162.5	4.416e-295
5.05	1187.5	1.864e-011
5.05	1212.5	4.416e-295
5.05	1237.5	4.416e-295
5.05	1262.5	4.416e-295
5.05	1287.5	4.416e-295
5.05	1312.5	4.416e-295

5.05	1337.5	2.893e-012
5.05	1362.5	4.416e-295
5.05	1387.5	4.416e-295
5.05	1412.5	4.416e-295
5.05	1437.5	4.416e-295
5.05	1462.5	4.416e-295
5.05	1487.5	4.502e-013
5.05	1512.5	4.416e-295
5.05	1537.5	4.416e-295
5.05	1562.5	4.416e-295
5.05	1587.5	4.416e-295
5.05	1612.5	4.416e-295
5.05	1637.5	4.416e-295
5.05	1662.5	5.562e-014
5.05	1687.5	4.416e-295
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5.05	1737.5	4.416e-295
5.05	1762.5	4.416e-295
5.05	1787.5	4.416e-295
5.05	1812.5	4.416e-295
5.05	1837.5	4.416e-295
5.05	1862.5	4.416e-295
5.05	1887.5	3.666e-015
5.05	1912.5	4.416e-295
5.05	1937.5	4.416e-295
5.05	1962.5	4.416e-295
5.05	1987.5	4.416e-295
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5.15	62.5	3.944e-003
5.15	87.5	2.984e-003
5.15	112.5	3.492e-003
5.15	137.5	3.479e-003
5.15	162.5	1.450e-003
5.15	187.5	1.272e-003
5.15	212.5	9.860e-004
5.15	237.5	6.727e-004
5.15	262.5	4.146e-004
5.15	287.5	2.265e-004
5.15	312.5	4.416e-295
5.15	337.5	1.050e-004
5.15	362.5	4.689e-005
5.15	387.5	4.416e-295
5.15	412.5	1.806e-005

5.15	437.5	4.416e-295
5.15	462.5	6.024e-006
5.15	487.5	4.416e-295
5.15	512.5	4.416e-295
5.15	537.5	1.958e-006
5.15	562.5	4.416e-295
5.15	587.5	7.103e-007
5.15	612.5	4.416e-295
5.15	637.5	4.416e-295
5.15	662.5	2.600e-007
5.15	687.5	4.416e-295
5.15	712.5	4.416e-295
5.15	737.5	5.878e-008
5.15	762.5	4.416e-295
5.15	787.5	4.416e-295
5.15	812.5	4.416e-295
5.15	837.5	8.779e-009
5.15	862.5	4.416e-295
5.15	887.5	4.416e-295
5.15	912.5	4.416e-295
5.15	937.5	2.063e-009
5.15	962.5	4.416e-295
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5.15	1062.5	4.056e-010
5.15	1087.5	4.416e-295
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5.15	1337.5	1.317e-011
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5.15	1487.5	2.290e-012
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5.15	1862.5	4.416e-295
5.15	1887.5	2.267e-014
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5.15	1962.5	4.416e-295
5.15	1987.5	4.416e-295
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5.25	212.5	1.101e-003
5.25	237.5	7.843e-004
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5.25	287.5	2.892e-004
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5.25	587.5	1.197e-006
5.25	612.5	4.416e-295
5.25	637.5	4.416e-295

5.25	662.5	4.653e-007
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5.25	737.5	1.137e-007
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5.25	962.5	4.416e-295
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5.25	1062.5	1.288e-009
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5.25	1162.5	4.416e-295
5.25	1187.5	2.817e-010
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5.25	1962.5	4.416e-295
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5.35	187.5	4.416e-295
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5.35	762.5	4.416e-295
5.35	787.5	4.416e-295
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5.35	912.5	4.416e-295
5.35	937.5	4.416e-295
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5.35	1362.5	4.416e-295
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5.35	2012.5	4.416e-295
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5.45	112.5	3.007e-003
5.45	137.5	3.274e-003
5.45	162.5	1.514e-003
5.45	187.5	1.437e-003
5.45	212.5	1.212e-003
5.45	237.5	9.052e-004
5.45	262.5	6.130e-004
5.45	287.5	3.687e-004
5.45	312.5	4.416e-295
5.45	337.5	1.881e-004
5.45	362.5	9.219e-005
5.45	387.5	4.416e-295
5.45	412.5	3.877e-005
5.45	437.5	4.416e-295
5.45	462.5	1.410e-005
5.45	487.5	4.416e-295
5.45	512.5	4.416e-295
5.45	537.5	5.018e-006
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5.45	587.5	2.022e-006
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5.45	637.5	4.416e-295
5.45	662.5	8.340e-007
5.45	687.5	4.416e-295
5.45	712.5	4.416e-295
5.45	737.5	2.214e-007
5.45	762.5	4.416e-295
5.45	787.5	4.416e-295
5.45	812.5	4.416e-295
5.45	837.5	4.181e-008
5.45	862.5	4.416e-295
5.45	887.5	4.416e-295
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5.45	1062.5	4.134e-009
5.45	1087.5	4.416e-295

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5.45	1487.5	5.296e-011
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5.45	1787.5	4.416e-295
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5.55	87.5	2.104e-003
5.55	112.5	2.725e-003
5.55	137.5	3.094e-003
5.55	162.5	1.503e-003
5.55	187.5	1.482e-003

5.55	212.5	1.305e-003
5.55	237.5	1.020e-003
5.55	262.5	7.259e-004
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5.55	337.5	2.468e-004
5.55	362.5	1.274e-004
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5.55	437.5	4.416e-295
5.55	462.5	2.145e-005
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5.55	512.5	4.416e-295
5.55	537.5	8.017e-006
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5.55	587.5	3.413e-006
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5.55	712.5	4.416e-295
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5.55	762.5	4.416e-295
5.55	787.5	4.416e-295
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5.65	212.5	1.373e-003
5.65	237.5	1.123e-003
5.65	262.5	8.390e-004
5.65	287.5	5.590e-004
5.65	312.5	4.416e-295
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5.65	387.5	4.416e-295
5.65	412.5	8.051e-005

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5.65	637.5	4.416e-295
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5.65	712.5	4.416e-295
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5.65	787.5	4.416e-295
5.65	812.5	4.416e-295
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5.65	887.5	4.416e-295
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5.75	137.5	2.629e-003
5.75	162.5	1.396e-003
5.75	187.5	1.478e-003
5.75	212.5	1.411e-003
5.75	237.5	1.206e-003
5.75	262.5	9.458e-004
5.75	287.5	6.637e-004
5.75	312.5	4.416e-295
5.75	337.5	3.974e-004
5.75	362.5	2.293e-004
5.75	387.5	4.416e-295
5.75	412.5	1.132e-004
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5.75	462.5	4.816e-005
5.75	487.5	4.416e-295
5.75	512.5	4.416e-295
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5.75	637.5	4.416e-295

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5.75	687.5	4.416e-295
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6.55	462.5	3.110e-004
6.55	487.5	4.416e-295
6.55	512.5	4.416e-295
6.55	537.5	2.081e-004
6.55	562.5	4.416e-295
6.55	587.5	1.666e-004
6.55	612.5	4.416e-295
6.55	637.5	4.416e-295
6.55	662.5	1.347e-004
6.55	687.5	4.416e-295
6.55	712.5	4.416e-295
6.55	737.5	8.004e-005
6.55	762.5	4.416e-295
6.55	787.5	4.416e-295
6.55	812.5	4.416e-295
6.55	837.5	4.044e-005
6.55	862.5	4.416e-295
6.55	887.5	4.416e-295
6.55	912.5	4.416e-295
6.55	937.5	4.395e-005
6.55	962.5	4.416e-295
6.55	987.5	4.416e-295
6.55	1012.5	4.416e-295
6.55	1037.5	4.416e-295
6.55	1062.5	3.268e-005
6.55	1087.5	4.416e-295
6.55	1112.5	4.416e-295
6.55	1137.5	4.416e-295
6.55	1162.5	4.416e-295
6.55	1187.5	2.104e-005
6.55	1212.5	4.416e-295
6.55	1237.5	4.416e-295
6.55	1262.5	4.416e-295
6.55	1287.5	4.416e-295
6.55	1312.5	4.416e-295

6.55	1337.5	1.100e-005
6.55	1362.5	4.416e-295
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6.55	1462.5	4.416e-295
6.55	1487.5	5.652e-006
6.55	1512.5	4.416e-295
6.55	1537.5	4.416e-295
6.55	1562.5	4.416e-295
6.55	1587.5	4.416e-295
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6.55	1637.5	4.416e-295
6.55	1662.5	1.983e-006
6.55	1687.5	4.416e-295
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6.55	1787.5	4.416e-295
6.55	1812.5	4.416e-295
6.55	1837.5	4.416e-295
6.55	1862.5	4.416e-295
6.55	1887.5	4.154e-007
6.55	1912.5	4.416e-295
6.55	1937.5	4.416e-295
6.55	1962.5	4.416e-295
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6.65	87.5	4.416e-295
6.65	112.5	4.416e-295
6.65	137.5	4.416e-295
6.65	162.5	4.416e-295
6.65	187.5	4.416e-295
6.65	212.5	4.416e-295
6.65	237.5	4.416e-295
6.65	262.5	4.416e-295
6.65	287.5	4.416e-295
6.65	312.5	4.416e-295
6.65	337.5	4.416e-295
6.65	362.5	4.416e-295
6.65	387.5	4.416e-295
6.65	412.5	4.416e-295

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6.65	512.5	4.416e-295
6.65	537.5	4.416e-295
6.65	562.5	4.416e-295
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6.65	612.5	4.416e-295
6.65	637.5	4.416e-295
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6.65	762.5	4.416e-295
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6.65	1812.5	4.416e-295
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6.65	1987.5	4.416e-295
6.65	2012.5	4.416e-295
6.75	12.5	8.652e-005
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6.75	112.5	5.838e-004
6.75	137.5	8.698e-004
6.75	162.5	5.818e-004
6.75	187.5	7.098e-004
6.75	212.5	8.324e-004
6.75	237.5	9.140e-004
6.75	262.5	9.194e-004
6.75	287.5	8.823e-004
6.75	312.5	4.416e-295
6.75	337.5	7.770e-004
6.75	362.5	6.565e-004
6.75	387.5	4.416e-295
6.75	412.5	5.033e-004
6.75	437.5	4.416e-295
6.75	462.5	3.464e-004
6.75	487.5	4.416e-295
6.75	512.5	4.416e-295
6.75	537.5	2.459e-004
6.75	562.5	4.416e-295
6.75	587.5	2.179e-004
6.75	612.5	4.416e-295
6.75	637.5	4.416e-295

6.75	662.5	1.886e-004
6.75	687.5	4.416e-295
6.75	712.5	4.416e-295
6.75	737.5	1.200e-004
6.75	762.5	4.416e-295
6.75	787.5	4.416e-295
6.75	812.5	4.416e-295
6.75	837.5	6.683e-005
6.75	862.5	4.416e-295
6.75	887.5	4.416e-295
6.75	912.5	4.416e-295
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6.75	1062.5	6.306e-005
6.75	1087.5	4.416e-295
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6.75	1137.5	4.416e-295
6.75	1162.5	4.416e-295
6.75	1187.5	4.416e-005
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6.75	1237.5	4.416e-295
6.75	1262.5	4.416e-295
6.75	1287.5	4.416e-295
6.75	1312.5	4.416e-295
6.75	1337.5	2.534e-005
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6.75	1387.5	4.416e-295
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6.75	1437.5	4.416e-295
6.75	1462.5	4.416e-295
6.75	1487.5	1.441e-005
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6.75	1537.5	4.416e-295
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6.75	1637.5	4.416e-295
6.75	1662.5	5.283e-006
6.75	1687.5	4.416e-295
6.75	1712.5	4.416e-295
6.75	1737.5	4.416e-295
6.75	1762.5	4.416e-295

6.75	1787.5	4.416e-295
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6.75	1887.5	1.250e-006
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6.75	1962.5	4.416e-295
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6.85	37.5	1.115e-004
6.85	62.5	2.180e-004
6.85	87.5	2.061e-004
6.85	112.5	3.145e-004
6.85	137.5	4.801e-004
6.85	162.5	3.249e-004
6.85	187.5	3.978e-004
6.85	212.5	4.735e-004
6.85	237.5	5.197e-004
6.85	262.5	5.661e-004
6.85	287.5	5.519e-004
6.85	312.5	4.416e-295
6.85	337.5	5.000e-004
6.85	362.5	4.549e-004
6.85	387.5	4.416e-295
6.85	412.5	3.576e-004
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6.85	462.5	2.631e-004
6.85	487.5	4.416e-295
6.85	512.5	4.416e-295
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6.85	587.5	1.958e-004
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6.85	637.5	4.416e-295
6.85	662.5	1.824e-004
6.85	687.5	4.416e-295
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6.85	737.5	1.249e-004
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6.85	787.5	4.416e-295
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6.85	1337.5	4.845e-005
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6.85	1387.5	4.416e-295
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6.85	1437.5	4.416e-295
6.85	1462.5	4.416e-295
6.85	1487.5	3.070e-005
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6.85	1587.5	4.416e-295
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6.85	1762.5	4.416e-295
6.85	1787.5	4.416e-295
6.85	1812.5	4.416e-295
6.85	1837.5	4.416e-295
6.85	1862.5	4.416e-295
6.85	1887.5	3.283e-006
6.85	1912.5	4.416e-295
6.85	1937.5	4.416e-295
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6.85	1987.5	4.416e-295

6.85	2012.5	6.852e-009
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6.95	187.5	4.416e-295
6.95	212.5	4.416e-295
6.95	237.5	4.416e-295
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6.95	287.5	4.416e-295
6.95	312.5	4.416e-295
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6.95	912.5	4.416e-295
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6.95	987.5	4.416e-295
6.95	1012.5	4.416e-295
6.95	1037.5	4.416e-295
6.95	1062.5	4.416e-295
6.95	1087.5	4.416e-295

6.95	1112.5	4.416e-295
6.95	1137.5	4.416e-295
6.95	1162.5	4.416e-295
6.95	1187.5	4.416e-295
6.95	1212.5	4.416e-295
6.95	1237.5	4.416e-295
6.95	1262.5	4.416e-295
6.95	1287.5	4.416e-295
6.95	1312.5	4.416e-295
6.95	1337.5	4.416e-295
6.95	1362.5	4.416e-295
6.95	1387.5	4.416e-295
6.95	1412.5	4.416e-295
6.95	1437.5	4.416e-295
6.95	1462.5	4.416e-295
6.95	1487.5	4.416e-295
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6.95	1662.5	4.416e-295
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6.95	1737.5	4.416e-295
6.95	1762.5	4.416e-295
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6.95	1887.5	4.416e-295
6.95	1912.5	4.416e-295
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6.95	1962.5	4.416e-295
6.95	1987.5	4.416e-295
6.95	2012.5	4.416e-295
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7.05	37.5	9.616e-005
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7.05	112.5	2.626e-004
7.05	137.5	3.999e-004
7.05	162.5	2.744e-004
7.05	187.5	3.504e-004

7.05	212.5	4.055e-004
7.05	237.5	4.707e-004
7.05	262.5	5.114e-004
7.05	287.5	5.123e-004
7.05	312.5	4.416e-295
7.05	337.5	4.936e-004
7.05	362.5	4.557e-004
7.05	387.5	4.416e-295
7.05	412.5	3.863e-004
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7.05	462.5	3.024e-004
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7.05	512.5	4.416e-295
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7.05	562.5	4.416e-295
7.05	587.5	2.635e-004
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7.05	737.5	1.908e-004
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7.05	787.5	4.416e-295
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7.05	1062.5	1.656e-004
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7.05	1162.5	2.585e-005
7.05	1187.5	1.440e-004
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7.05	1287.5	4.416e-295
7.05	1312.5	4.416e-295

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7.05	1387.5	4.416e-295
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7.05	1462.5	4.416e-295
7.05	1487.5	6.902e-005
7.05	1512.5	4.416e-295
7.05	1537.5	4.416e-295
7.05	1562.5	4.416e-295
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7.05	1662.5	2.830e-005
7.05	1687.5	4.416e-295
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7.05	1912.5	4.416e-295
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7.15	12.5	2.622e-005
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7.15	62.5	9.865e-005
7.15	87.5	9.084e-005
7.15	112.5	1.393e-004
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7.15	162.5	1.508e-004
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7.15	212.5	2.263e-004
7.15	237.5	2.590e-004
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7.15	562.5	4.416e-295
7.15	587.5	2.152e-004
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7.15	637.5	4.416e-295
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7.15	737.5	1.738e-004
7.15	762.5	4.416e-295
7.15	787.5	4.416e-295
7.15	812.5	4.416e-295
7.15	837.5	1.350e-004
7.15	862.5	4.416e-295
7.15	887.5	4.416e-295
7.15	912.5	4.416e-295
7.15	937.5	2.308e-004
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7.15	987.5	4.416e-295
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7.15	1037.5	4.416e-295
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7.15	1637.5	4.416e-295
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7.25	612.5	4.416e-295
7.25	637.5	4.416e-295

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8.95	1212.5	4.416e-295
8.95	1237.5	4.416e-295
8.95	1262.5	4.416e-295
8.95	1287.5	4.416e-295
8.95	1312.5	4.416e-295
8.95	1337.5	4.416e-295
8.95	1362.5	4.416e-295
8.95	1387.5	4.416e-295
8.95	1412.5	4.416e-295
8.95	1437.5	4.416e-295
8.95	1462.5	4.416e-295
8.95	1487.5	4.416e-295
8.95	1512.5	4.416e-295
8.95	1537.5	4.416e-295
8.95	1562.5	4.416e-295
8.95	1587.5	4.416e-295
8.95	1612.5	4.416e-295
8.95	1637.5	4.416e-295
8.95	1662.5	4.416e-295
8.95	1687.5	4.416e-295
8.95	1712.5	4.416e-295
8.95	1737.5	4.416e-295
8.95	1762.5	4.416e-295
8.95	1787.5	4.416e-295
8.95	1812.5	4.416e-295
8.95	1837.5	4.416e-295
8.95	1862.5	4.416e-295
8.95	1887.5	4.416e-295
8.95	1912.5	4.416e-295
8.95	1937.5	4.416e-295
8.95	1962.5	4.416e-295
8.95	1987.5	4.416e-295
8.95	2012.5	4.416e-295

Integral: 1.000e+000

DEAGGREGATION: Summary by Source

Spectral Period: PGA
Amplitude: 0.02

Annual Frequency of Exceedance: 6.641e-004

Magnitude Mode	Magnitude Mean	Distance Mode	Distance Mean	Epsilon Mode	Epsilon Mean	Contribution %	Source	Region
4.75	5.71	137.50	194.25	-2.10	-0.04	45.46	CEUS Gridded - AB	USGS 2008 Central and Eastern US
4.75	5.55	62.50	157.90	-2.10	-0.06	40.54	CEUS Gridded - J	USGS 2008 Central and Eastern US
7.65	7.721	137.501	178.90	0.90	1.40	13.99	New Madrid - Composite	USGS 2008 New Madrid

DEAGGREGATION: Conditional Mean Spectrum by Source

Period	0.01	0.05	0.1	0.2	0.3	0.4	0.5	0.75	1	2	3	4
CEUS Gridded - AB (USGS 2008 Central and Eastern US)	0.020000	0.035022	0.042882	0.042153	0.031772	0.025129	0.020966	0.014714	0.011111	0.003883	0.002258	0.001520
CEUS Gridded - J (USGS 2008 Central and Eastern US)	0.020000	0.038037	0.045635	0.041784	0.030189	0.023088	0.018775	0.012709	0.009379	0.003094	0.001811	0.001229
New Madrid - Composite (USGS 2008 New Madrid)	0.020000	0.032510	0.042026	0.038568	0.029203	0.025609	0.023128	0.019089	0.016494	0.012152	0.008457	0.006401
Conditional Mean Spectrum (all sources)	0.020000	0.035893	0.043878	0.041502	0.030771	0.024369	0.020380	0.014514	0.011162	0.004720	0.002944	0.002085

Activity Rate Report for EZ-FRISK 7.62 Build 000

Source: CEUS Gridded - AB
Region: USGS 2008 Central and Eastern US
Magnitude Scale: MbLg

MAGNITUDE, MbLg	RATE
5.000	2.499e-001
5.100	2.006e-001
5.200	1.609e-001
5.300	1.290e-001
5.400	1.033e-001
5.500	8.262e-002
5.600	6.598e-002
5.700	5.259e-002
5.800	4.181e-002
5.900	3.314e-002
6.000	2.616e-002
6.100	2.053e-002
6.200	1.601e-002
6.300	1.236e-002
6.400	9.429e-003
6.500	7.065e-003
6.600	5.162e-003
6.700	3.609e-003
6.800	2.434e-003
6.900	1.515e-003
7.000	8.312e-004
7.100	4.464e-004
7.200	2.179e-004
7.300	4.735e-005

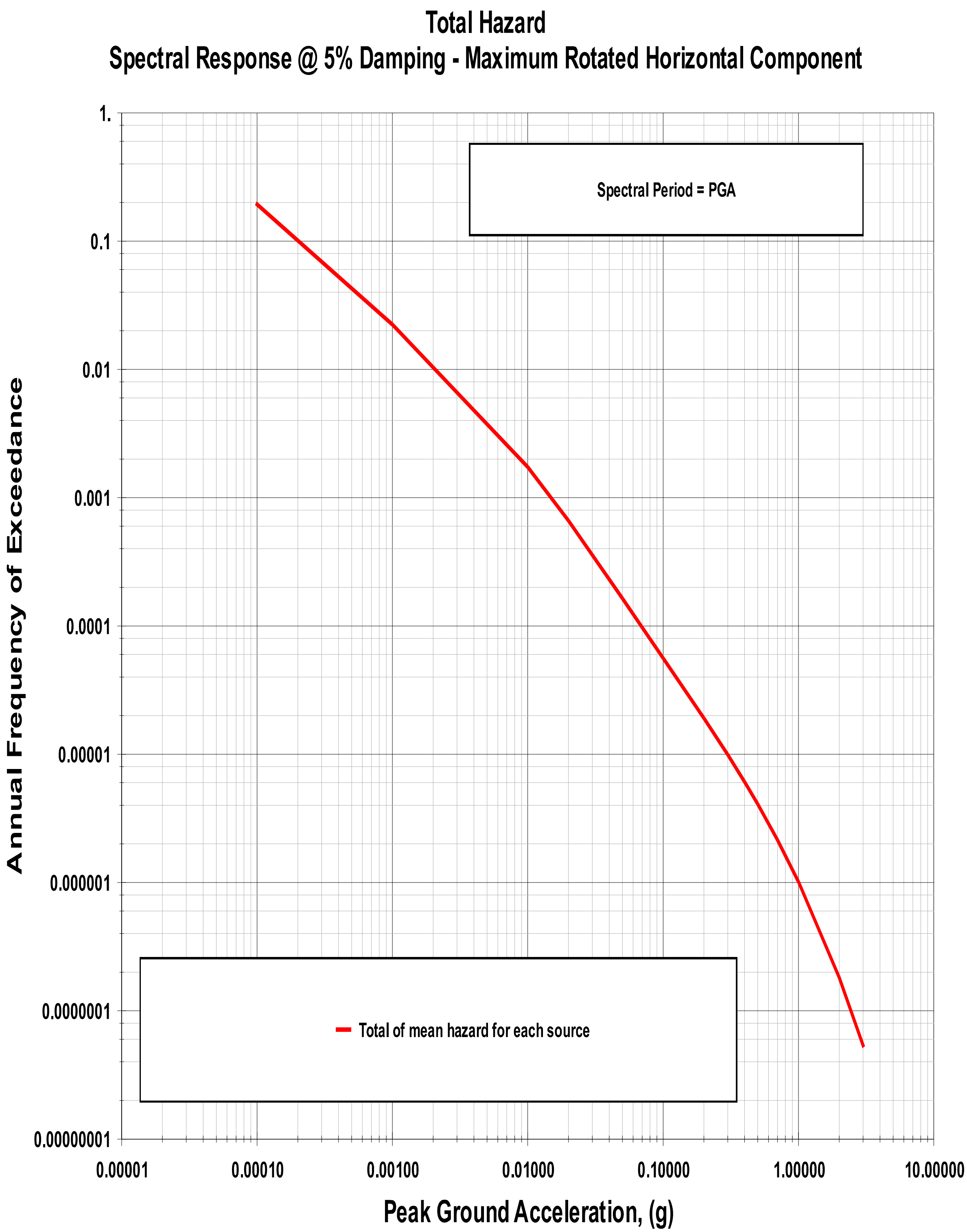
Source: CEUS Gridded - J
Region: USGS 2008 Central and Eastern US
Magnitude Scale: MbLg

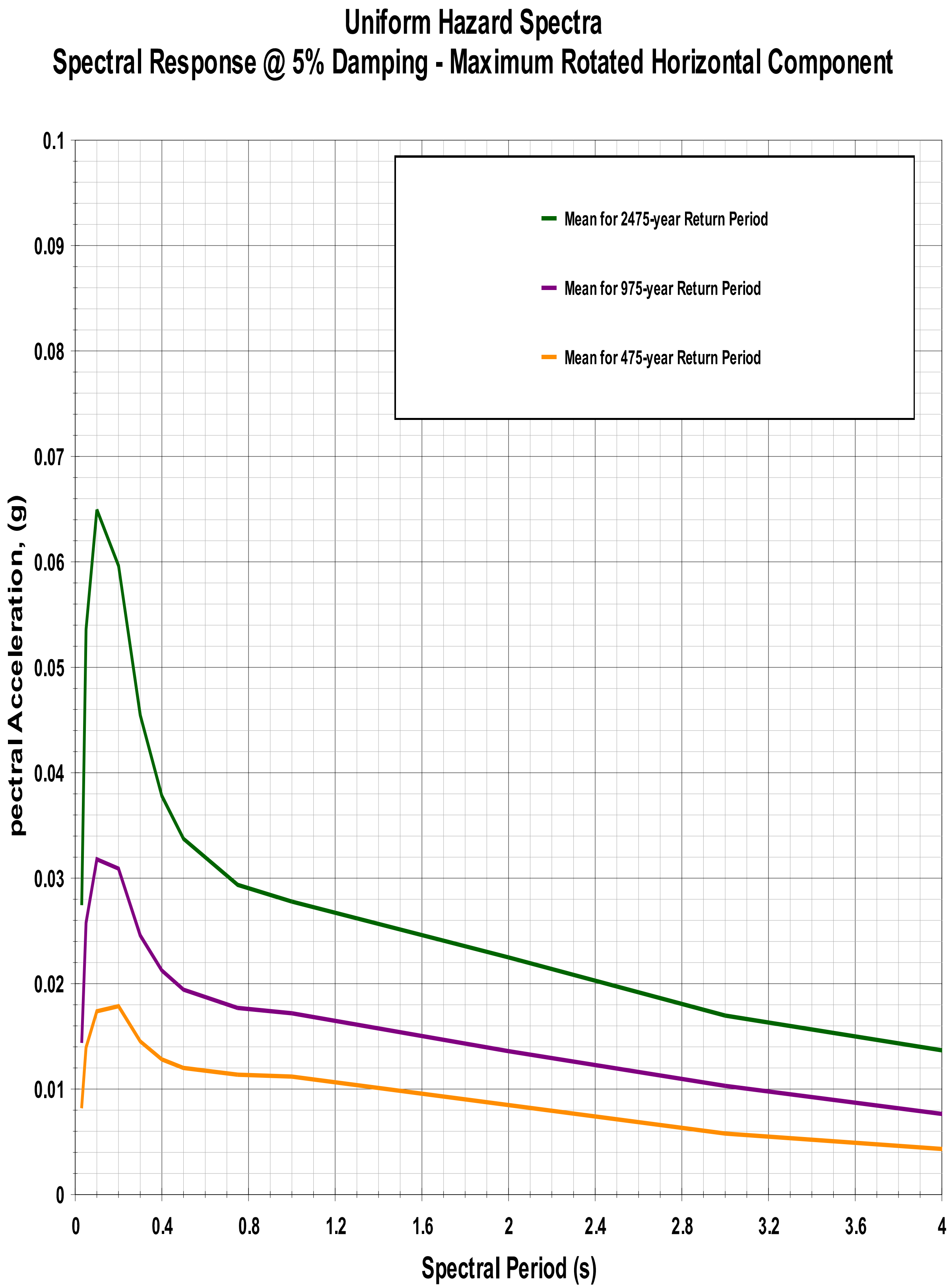
MAGNITUDE, MbLg	RATE
5.000	2.479e-001
5.100	1.986e-001
5.200	1.589e-001
5.300	1.270e-001
5.400	1.013e-001
5.500	8.062e-002
5.600	6.398e-002
5.700	5.059e-002
5.800	3.981e-002
5.900	3.114e-002

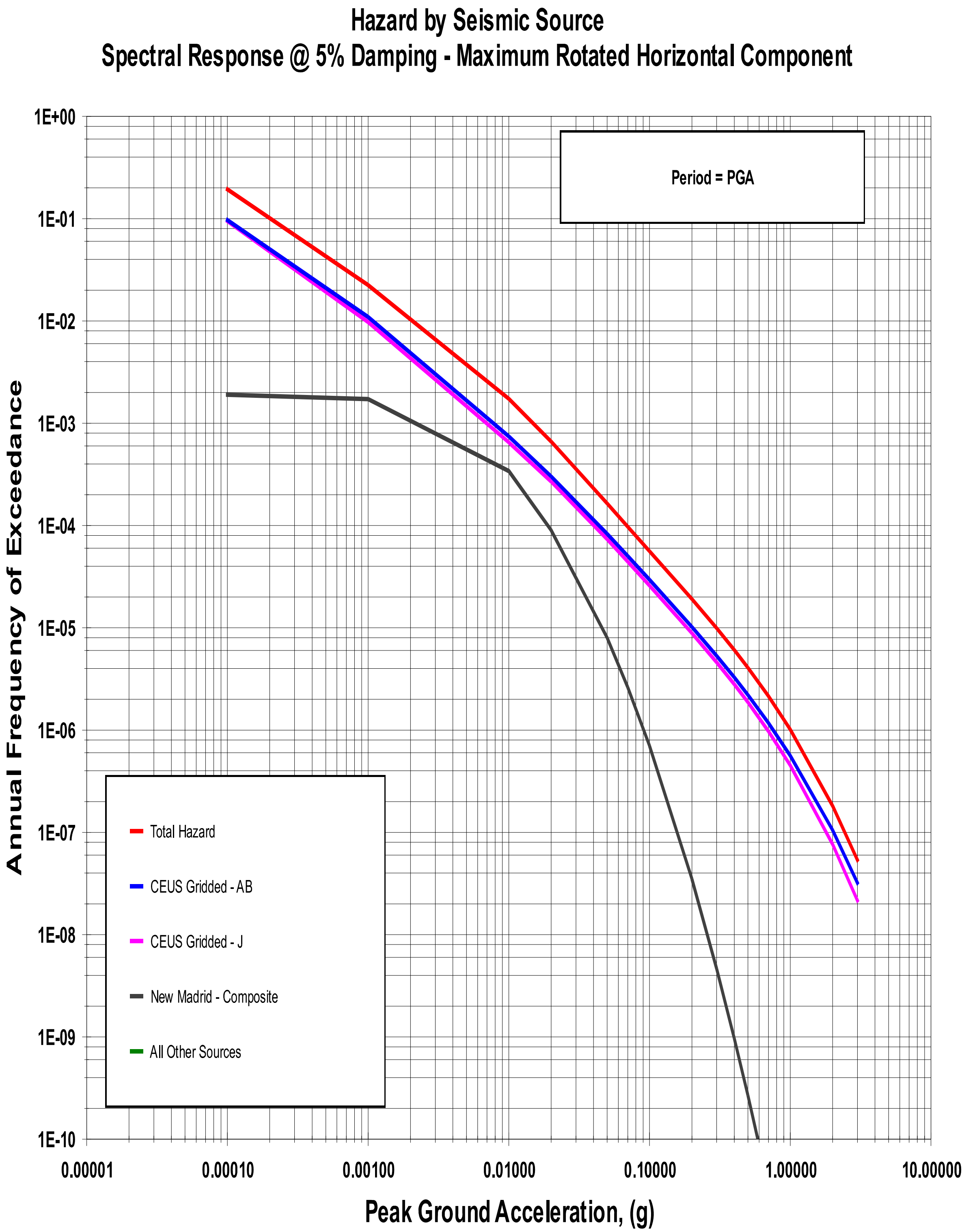
6.000	2.415e-002
6.100	1.853e-002
6.200	1.401e-002
6.300	1.036e-002
6.400	7.428e-003
6.500	5.097e-003
6.600	3.271e-003
6.700	1.835e-003
6.800	1.081e-003
6.900	5.194e-004
7.000	2.270e-004
7.100	5.077e-005

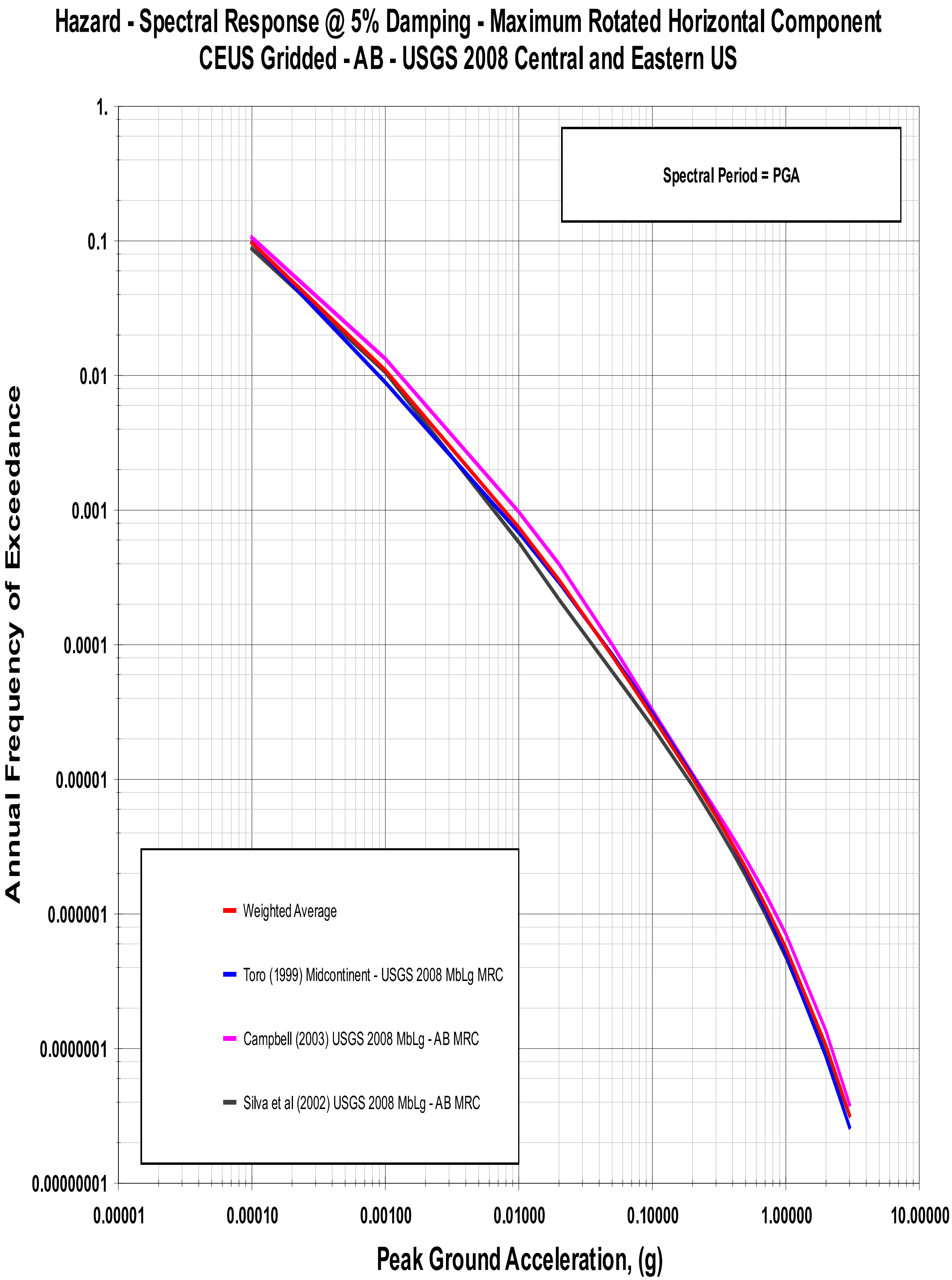
Source: New Madrid - Composite
Region: USGS 2008 New Madrid
Magnitude Scale: Moment Magnitude

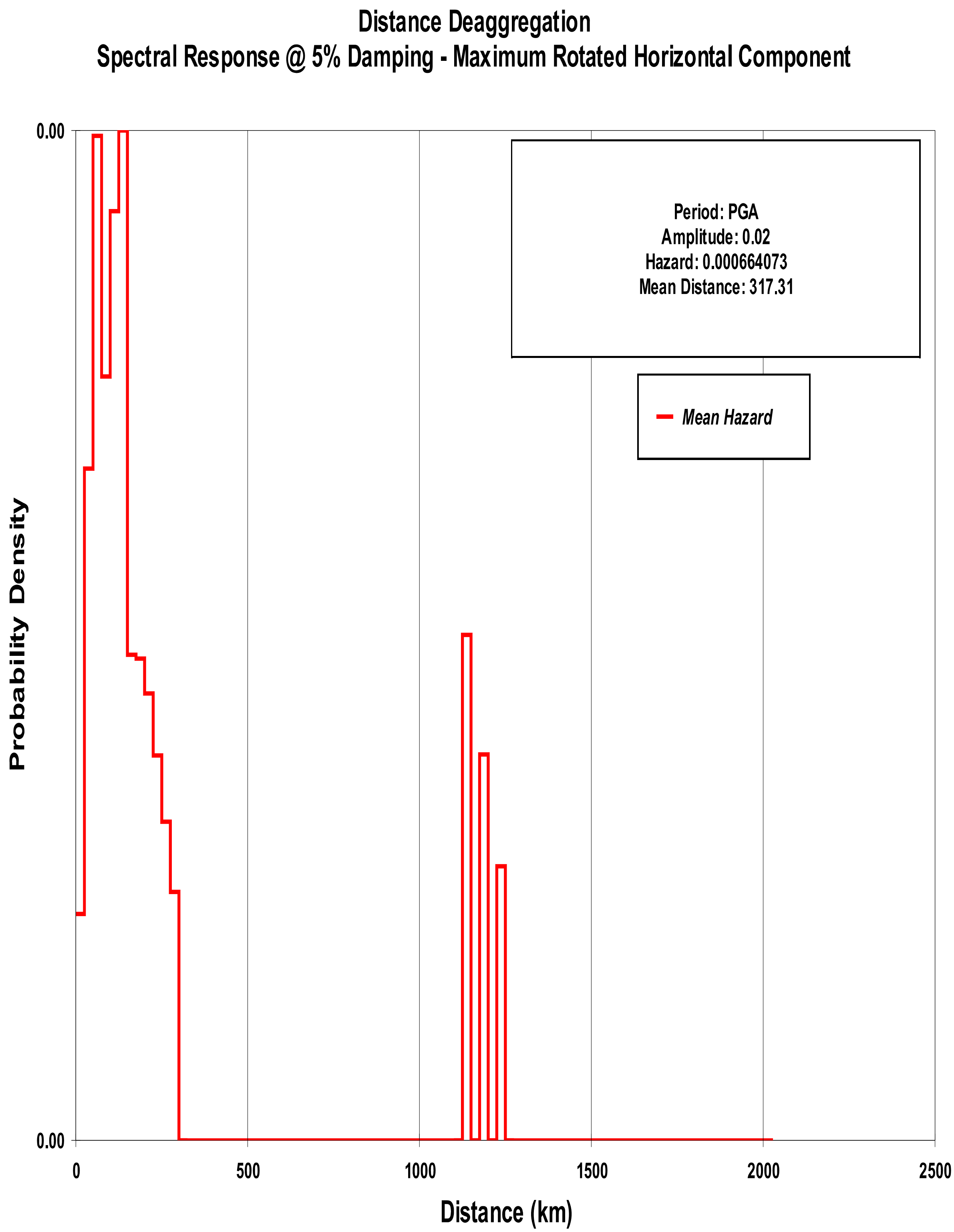
MAGNITUDE, Mw	RATE
7.090	1.900e-003
7.290	1.860e-003
7.490	1.562e-003
7.590	1.103e-003
7.690	1.103e-003
7.790	2.865e-004
7.890	2.465e-004
7.990	2.450e-004

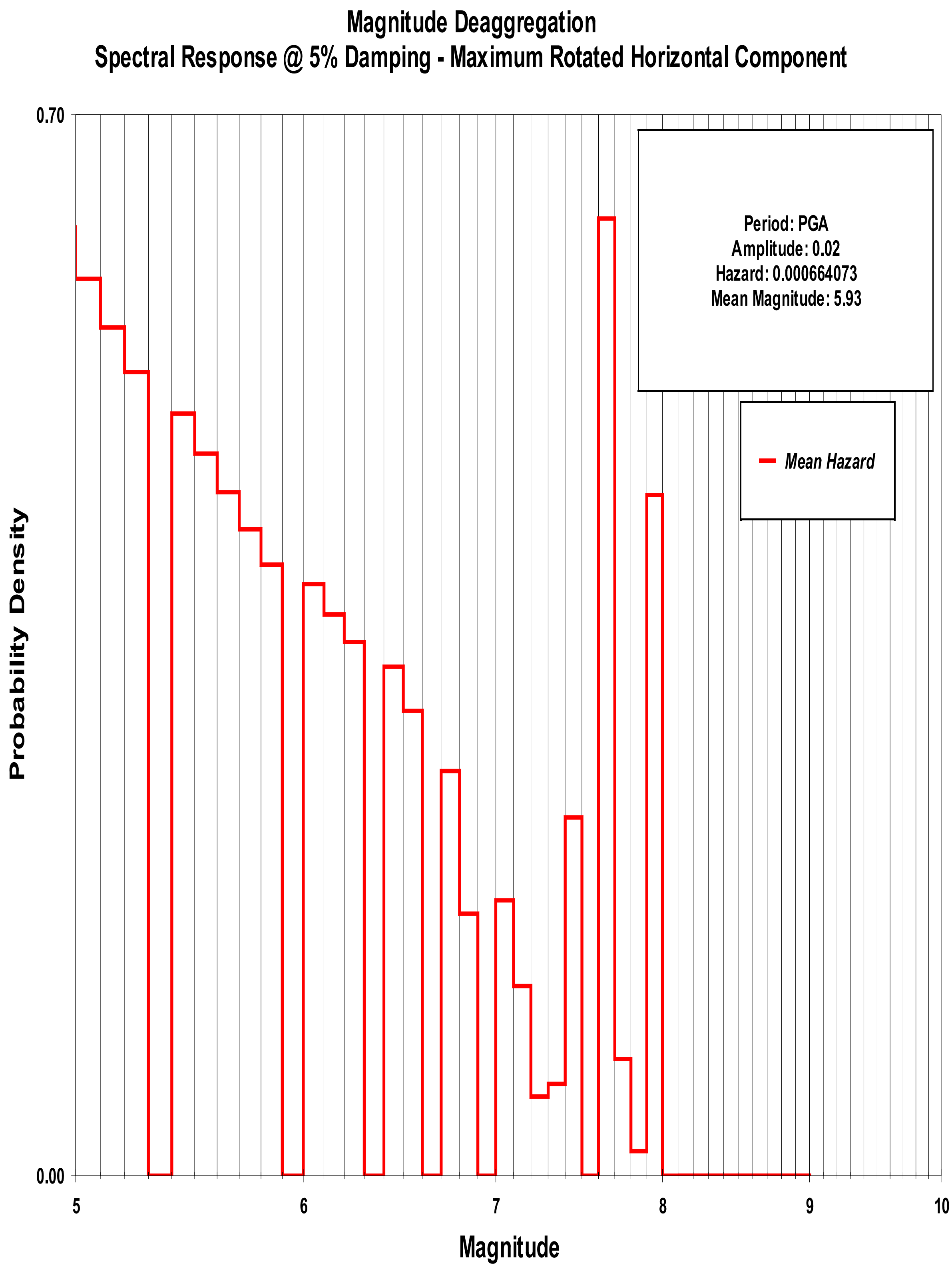

Total Hazard
Spectral Response @ 5% Damping - Maximum Rotated Horizontal Component
Spectral Period = PGA
Total of mean hazard for each source
Annual Frequency of Exceedance
1.
0.1
0.01
0.001
0.0001
0.00001
0.000001
0.0000001
0.00000001
0.00001
0.00010
0.00100
0.01000
0.10000
1.00000
10.00000
Peak Ground Acceleration, (g)


Uniform Hazard Spectra
Spectral Response @ 5% Damping - Maximum Rotated Horizontal Component
Mean for 2475-year Return Period
Mean for 975-year Return Period
Mean for 475-year Return Period
pectral Acceleration, (g)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
3.6
4
Spectral Period (s)

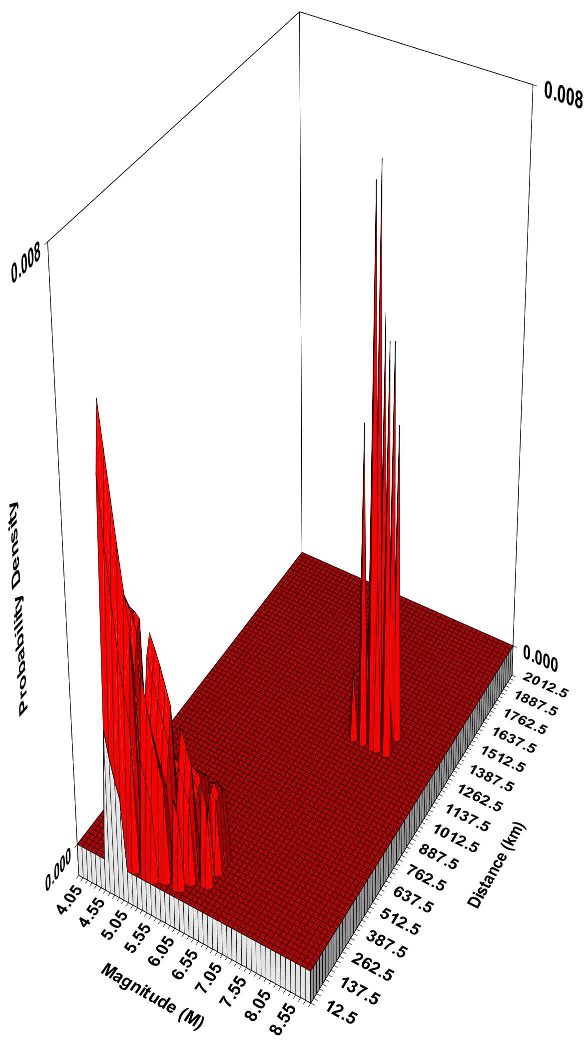

Hazard by Seismic Source
Spectral Response @ 5% Damping - Maximum Rotated Horizontal Component
Period = PGA
Annual Frequency of Exceedance
1E+00
1E-01
1E-02
1E-03
1E-04
1E-05
1E-06
1E-07
1E-08
1E-09
1E-10
Total Hazard
CEUS Gridded - AB
CEUS Gridded - J
New Madrid - Composite
All Other Sources
0.00001
0.00010
0.00100
0.01000
0.10000
1.00000
10.00000
Peak Ground Acceleration, (g)


Hazard - Spectral Response @ 5% Damping - Maximum Rotated Horizontal Component
CEUS Gridded - AB - USGS 2008 Central and Eastern US
Spectral Period = PGA
Annual Frequency of Exceedance
1.
0.1
0.01
0.001
0.0001
0.00001
0.000001
0.0000001
0.00000001
Weighted Average
Toro (1999) Midcontinent - USGS 2008 MbLg MRC
Campbell (2003) USGS 2008 MbLg - AB MRC
Silva et al (2002) USGS 2008 MbLg - AB MRC
0.00001
0.00010
0.00100
0.01000
0.10000
1.00000
10.00000
Peak Ground Acceleration, (g)

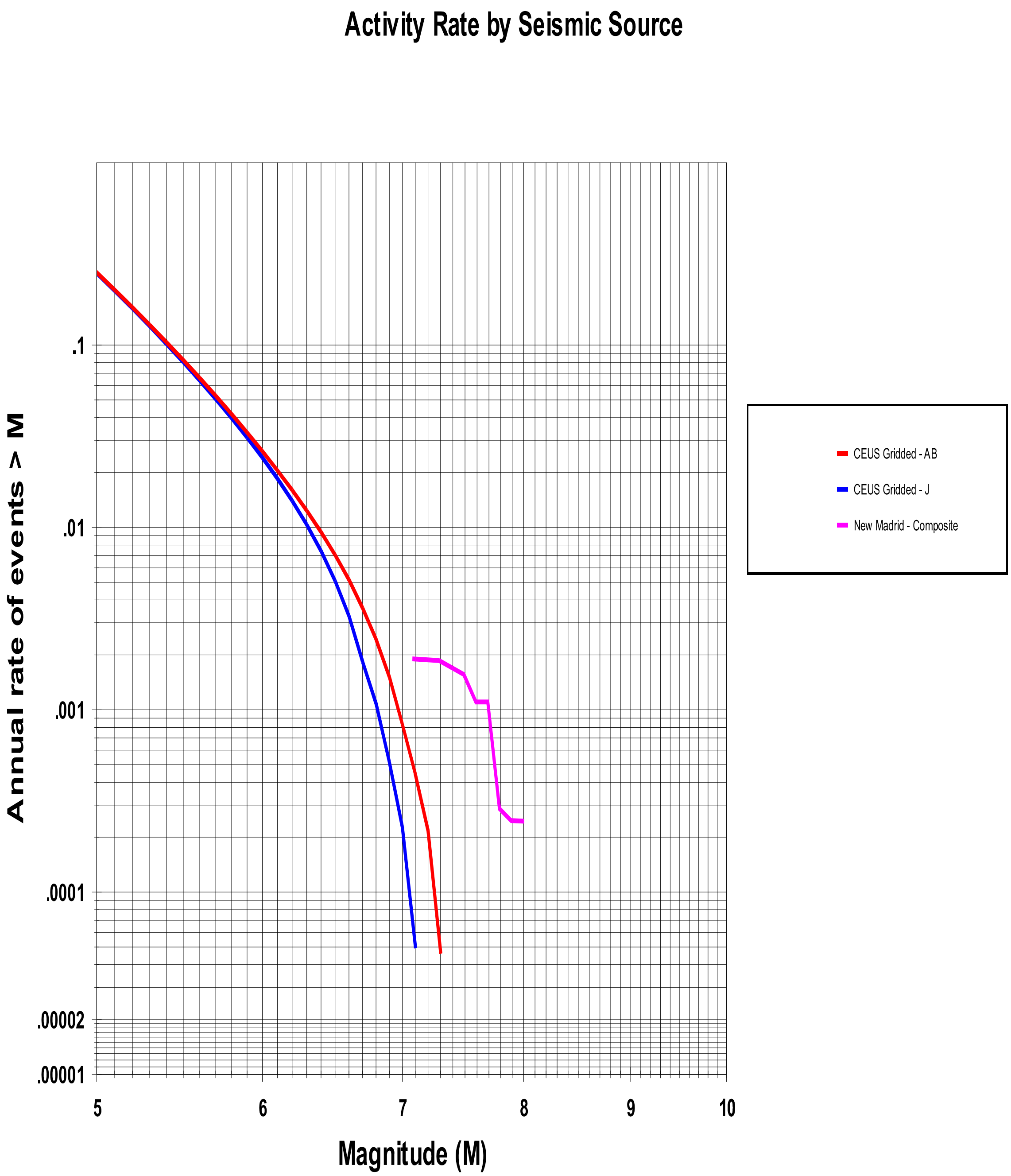

Distance Deaggregation
Spectral Response @ 5% Damping - Maximum Rotated Horizontal Component
Period: PGA
Amplitude: 0.02
Hazard: 0.000664073
Mean Distance: 317.31
Mean Hazard
Probability Density
0.00
0.00
0
500
1000
1500
2000
2500
Distance (km)


Magnitude Deaggregation
Spectral Response @ 5% Damping - Maximum Rotated Horizontal Component
Period: PGA
Amplitude: 0.02
Hazard: 0.000664073
Mean Magnitude: 5.93
Mean Hazard
Probability Density
0.70
0.00
5
6
7
8
9
10
Magnitude

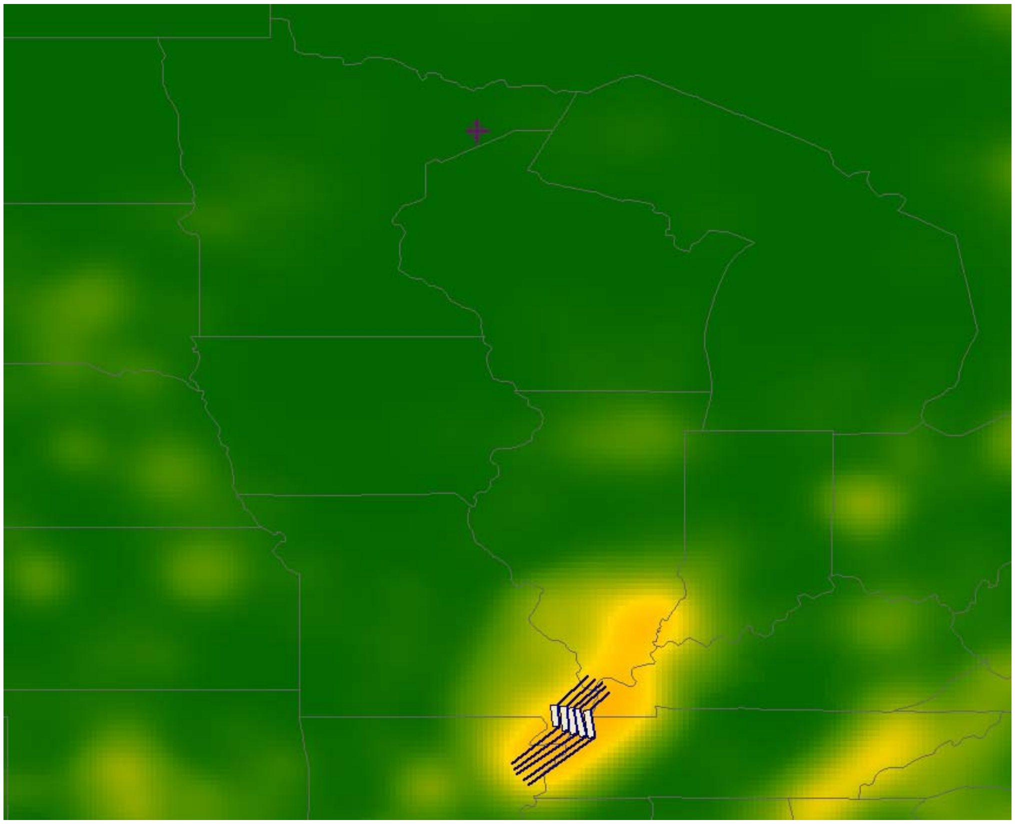
Magnitude-Distance Deaggregation
Spectral Response @ 5% Damping - Maximum Rotated Horizontal Component



Period: PGA
Amplitude: 0.02
Hazard: 0.000664073
Mean Magnitude: 5.93
Mean Distance: 317.31



Note: Magnitudes are shown in the scale used by each source, which do vary.



MAP LEGEND

Site

Faults

Included

Not included

Activity Rate

(rate of M>5

0.0e+000

1.0e-005

5.0e-005

1.0e-004

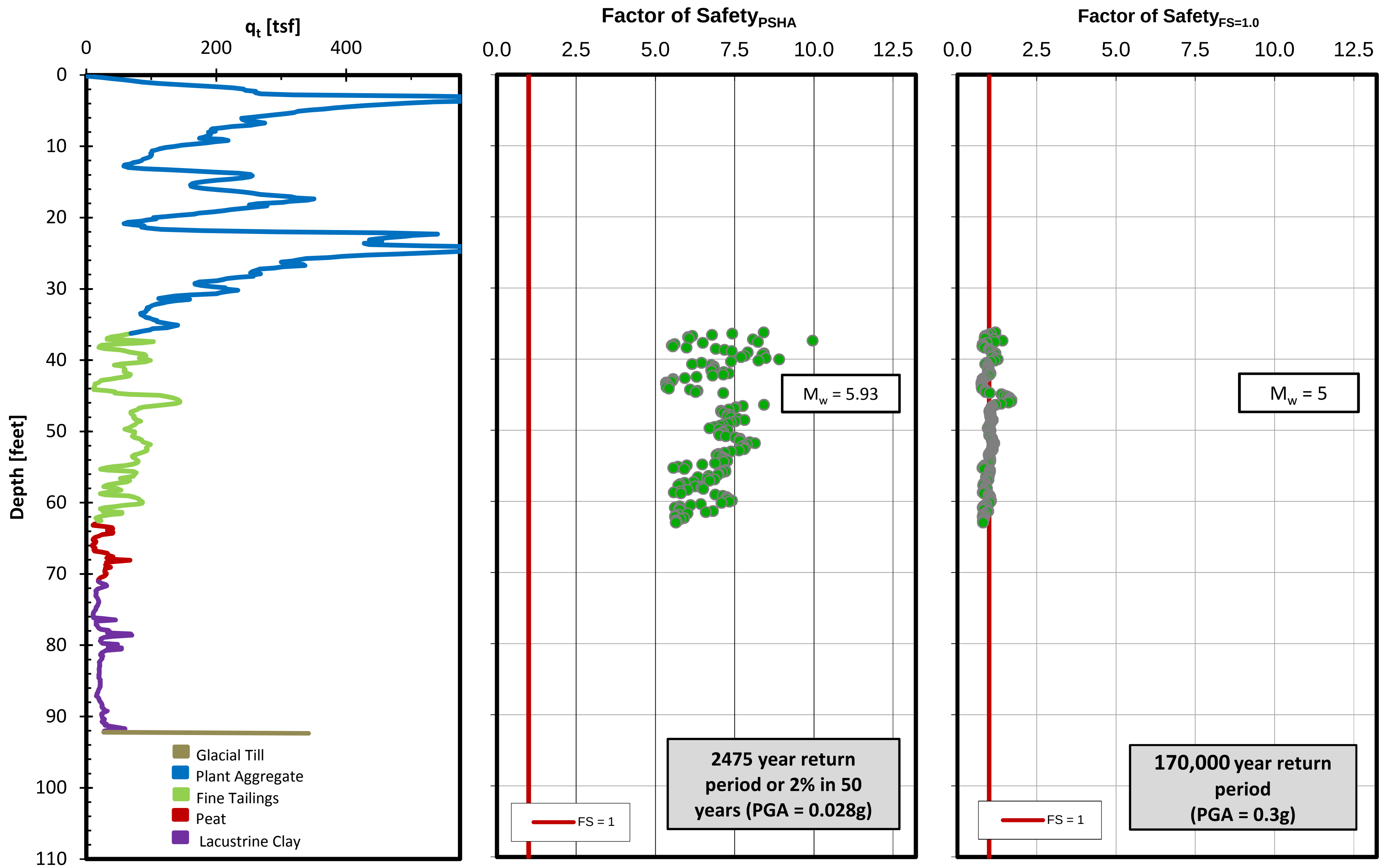
5.0e-004

1.0e+000

Appendix D

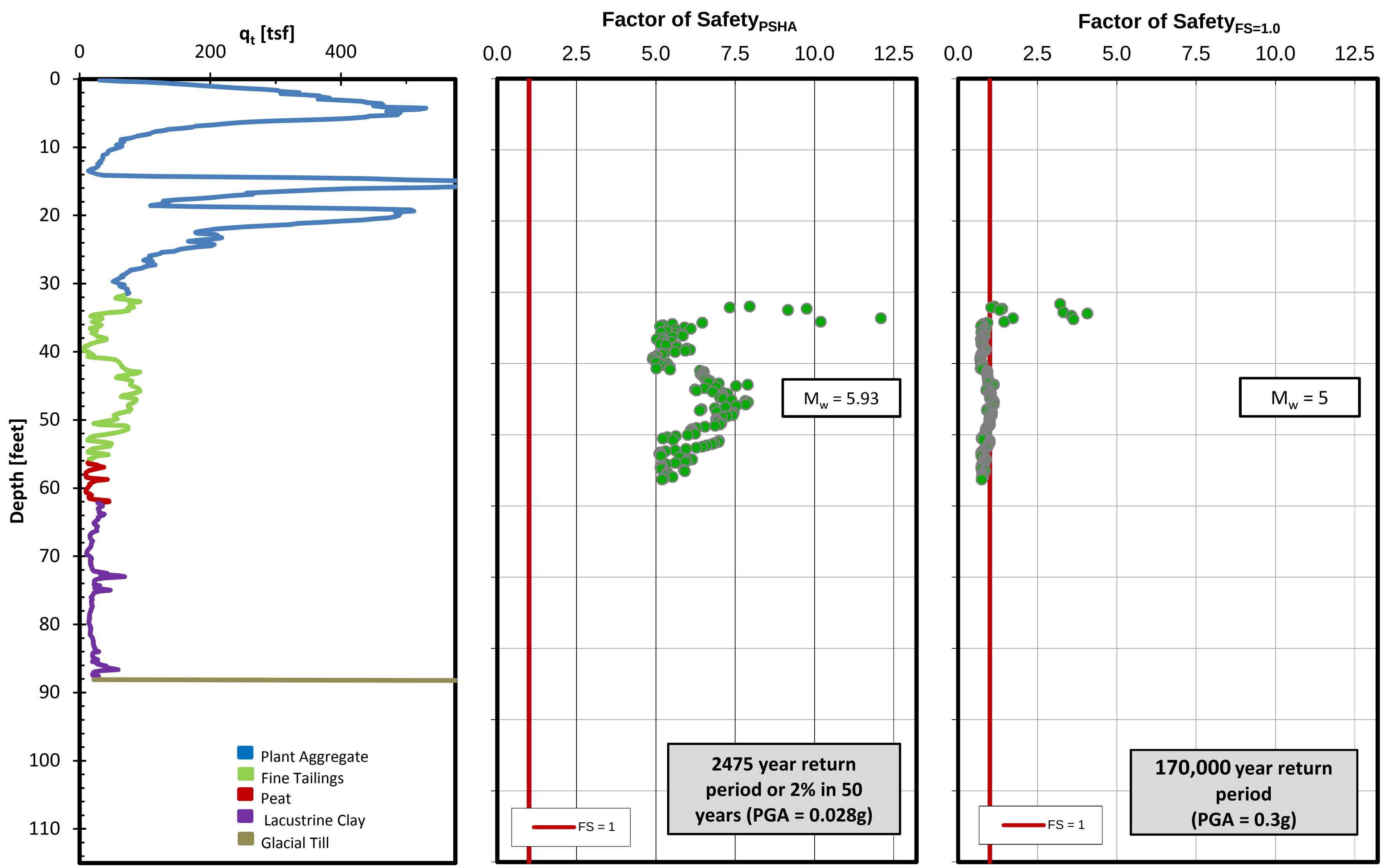
Liquefaction Triggering Potential Plots

Sounding D2-3475-CL (2005) Triggering Potential
Based on CPT Data (Boulanger and Idriss, 2004)
Northshore Mine Milepost 7 Tailings Basin

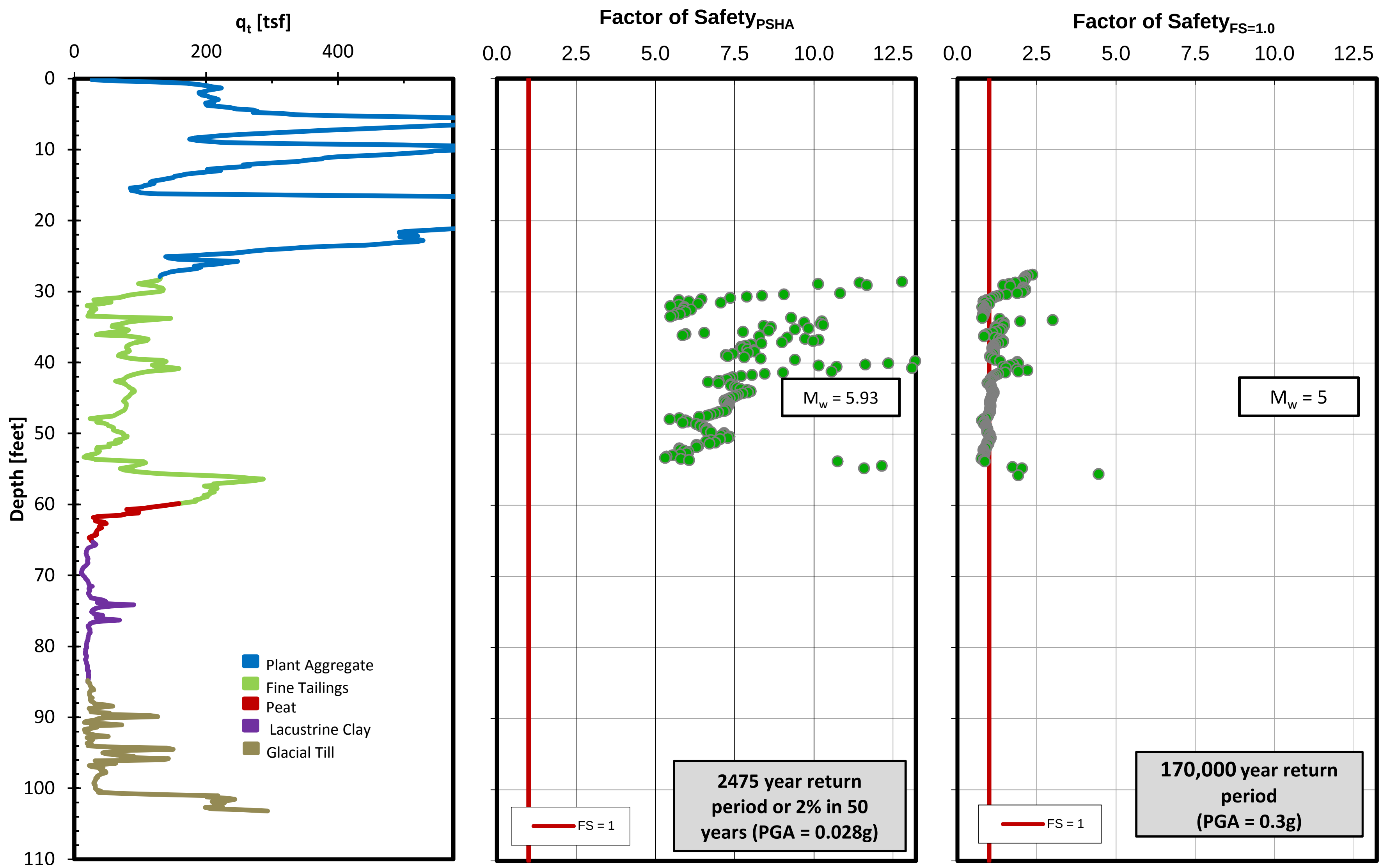


P:\Mpls\23 MN\38\2338086\WorkFiles\2013_Work\DS13\Dam 1 Raise\Updated Material Characterization\NSM Dam 1 FT USSR 2013 Review.xlsm

Sounding D2-3475-L100(2005) Triggering Potential
Based on CPT Data (Boulanger and Idriss, 2004)
Northshore Mine Milepost 7 Tailings Basin



Sounding D2-3475-R100 (2005) Triggering Potential
Based on CPT Data (Boulanger and Idriss, 2004)
Northshore Mine Milepost 7 Tailings Basin



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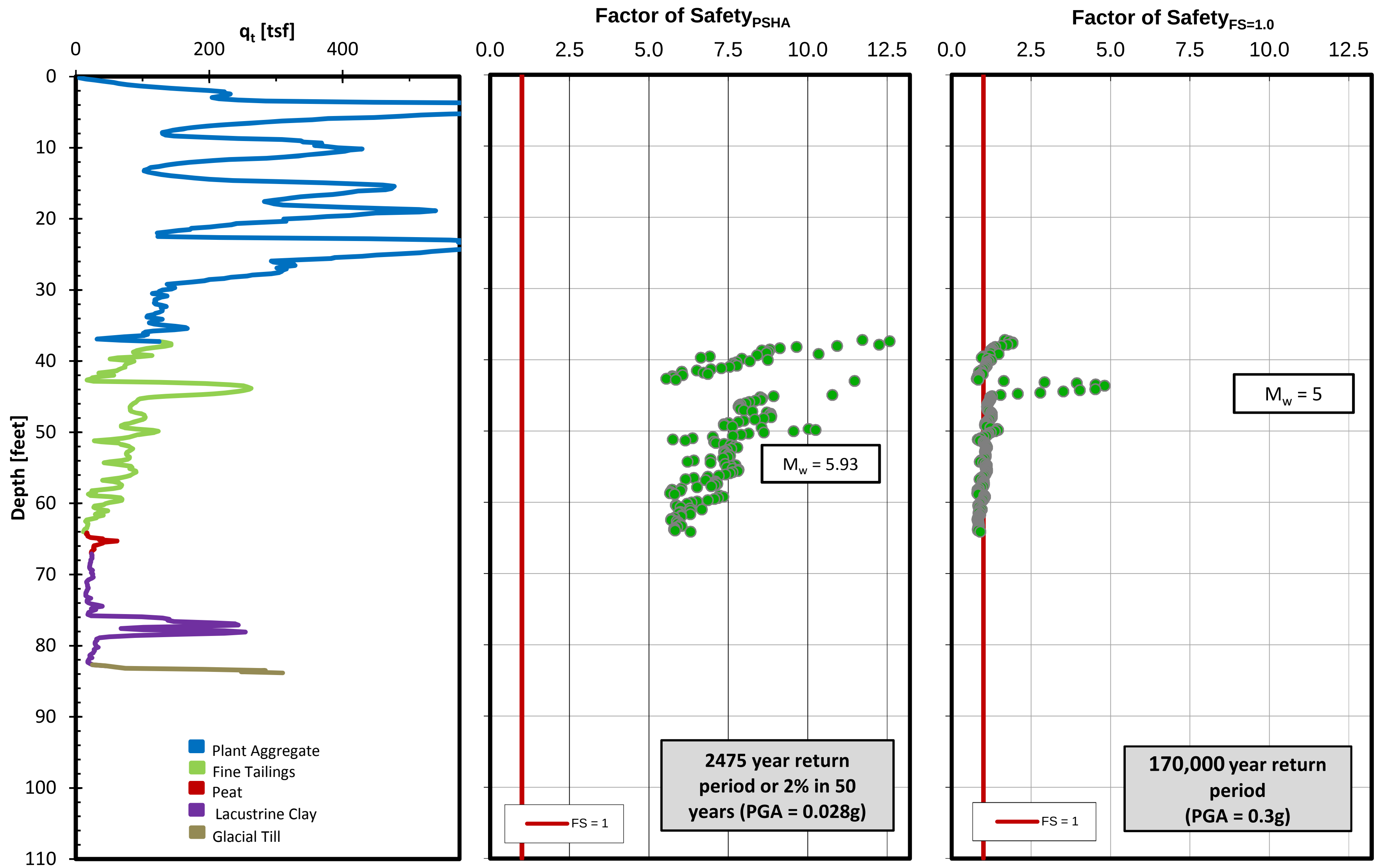
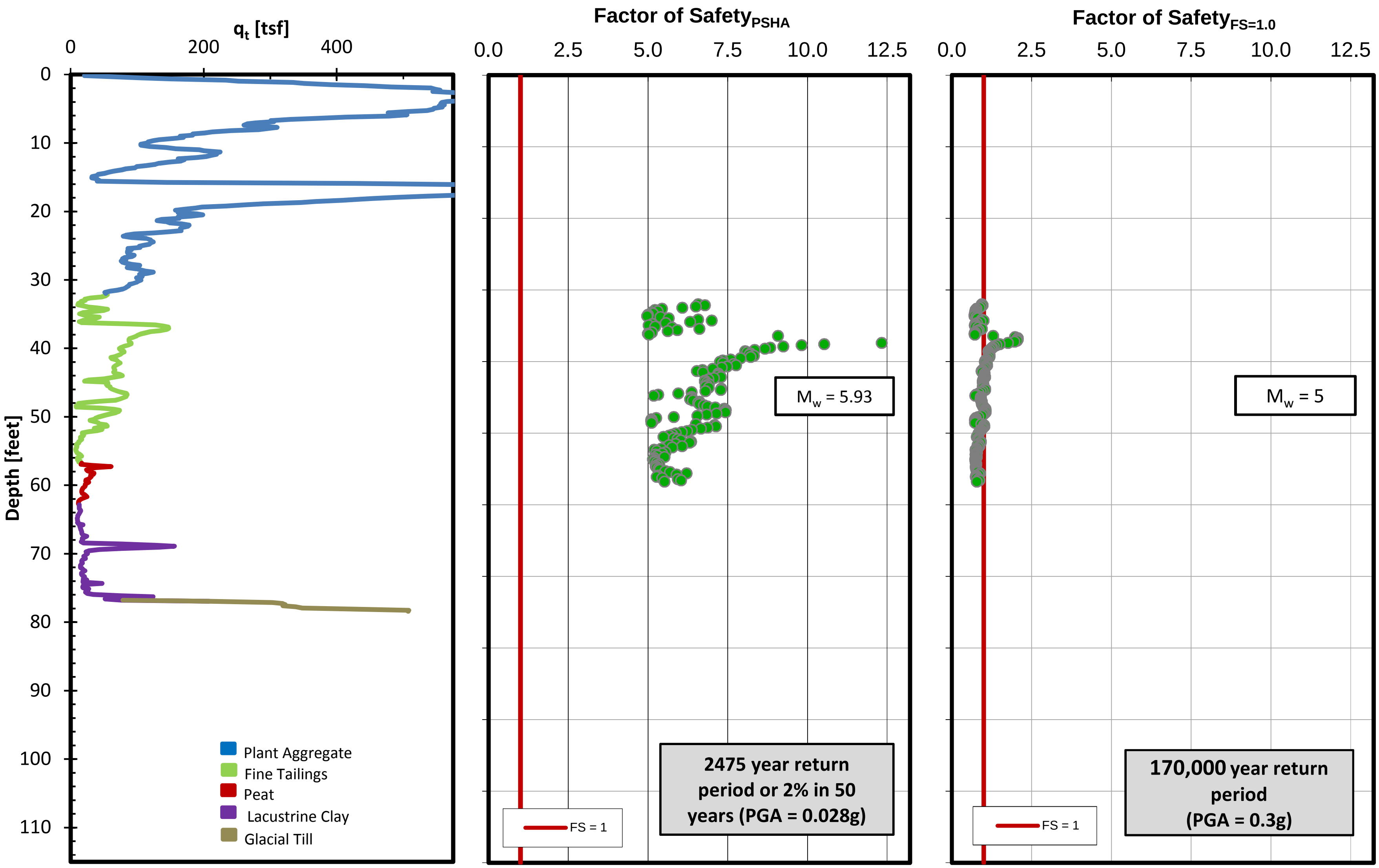
Sounding D2-4200-CL (2005) Triggering Potential
Based on CPT Data (Boulanger and Idriss, 2004)
Northshore Mine Milepost 7 Tailings Basin



P:\Mpls\23 MN\38\2338086\WorkFiles\2013_Work\DS13\Dam 1 Raise\Updated Material Characterization\NSM Dam 1 FT USSR 2013 Review.xlsm

Sounding D2-4200-L100 (2005) Triggering Potential
Based on CPT Data (Boulanger and Idriss, 2004)
Northshore Mine Milepost 7 Tailings Basin



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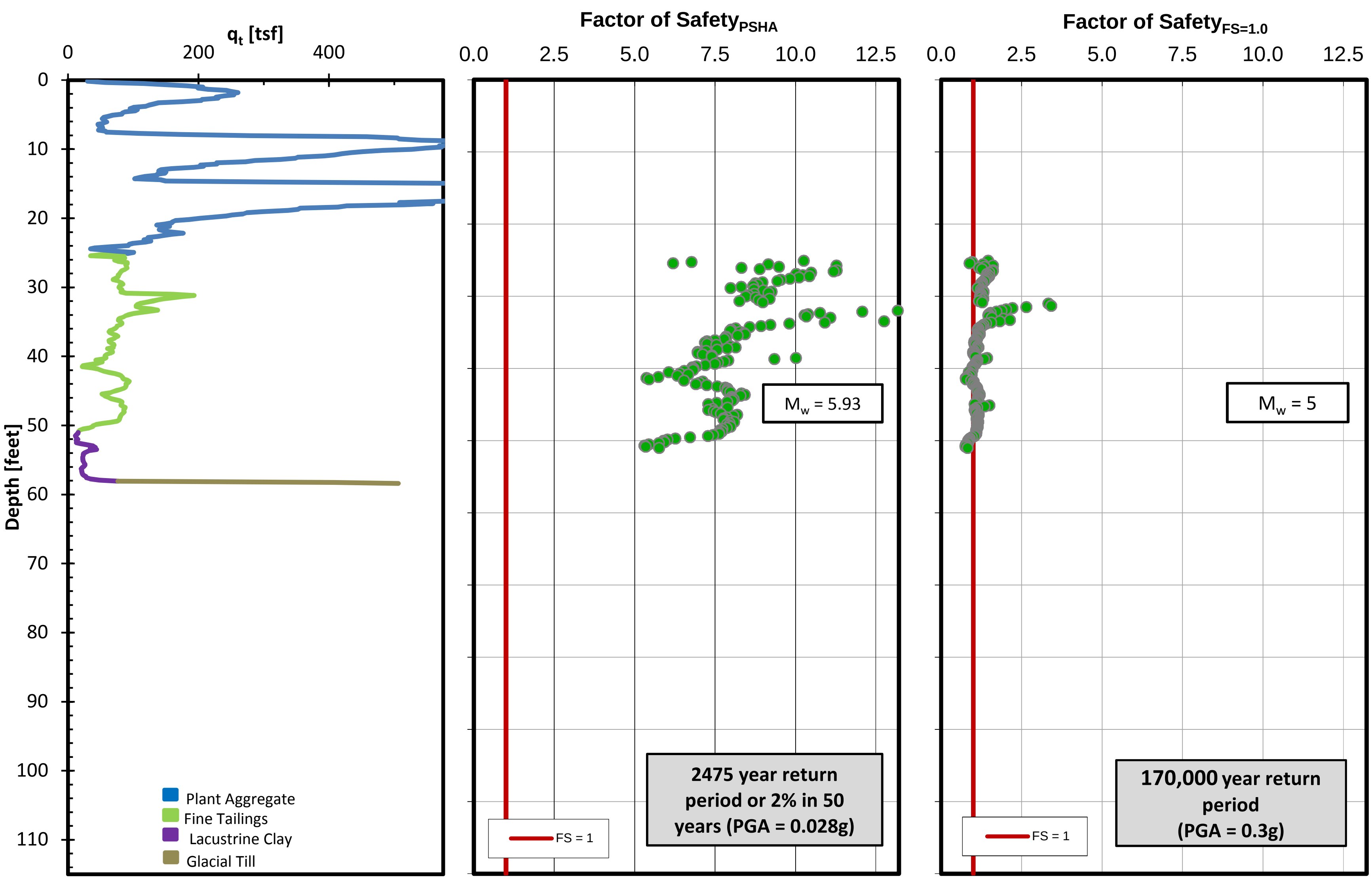
Sounding D2-4200-R200 (2005) Triggering Potential
Based on CPT Data (Boulanger and Idriss, 2004)
Northshore Mine Milepost 7 Tailings Basin



P:\Mpls\23 MN\38\2338086\WorkFiles\2013_Work\DS13\Dam 1 Raise\Updated Material Characterization\NSM Dam 1 FT USSR 2013 Review.xlsm

Appendix E

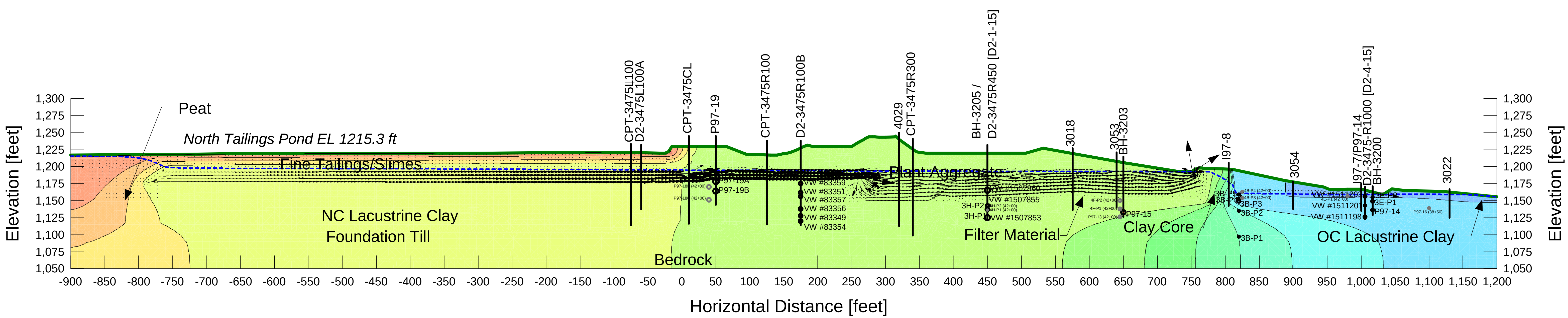
Seepage and Stability Modeling Outputs

Existing Seepage Conditions

Northshore Mining Company, Dam 2
Station 34+75, Existing Conditions
Seepage Analysis - Calibration
Analysis: A.0 Dam 2 Initial_Calibration Model
Last Saved Date: 3/31/2016

Contours shown are Total Head [feet]
Seepage conditions for Fall 2014

Name: Bedrock Model: Saturated Only Sat Kx: 3e-010 ft/sec Ky'/Kx' Ratio: 1 Volumetric Water Content: 0.2 ft³/ft³ Mv: 4.79e-007 /psf
Name: Clay Core Model: Saturated / Unsaturated K-Function: CLAY CORE TILL, Ksat = 1.25e-8 ft/s Ky'/Kx' Ratio: 1
Name: Filter Material Model: Saturated / Unsaturated K-Function: FILTER BERM, Ksat = 6.56e-5 ft/s Ky'/Kx' Ratio: 1
Name: Plant Aggregate Model: Saturated / Unsaturated K-Function: COARSE TAILINGS/PLANT AGG, Ksat = 2.62e-3 ft/s Ky'/Kx' Ratio: 1
Name: NC Lacustrine Clay Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s Ky'/Kx' Ratio: 1.11
Name: OC Lacustrine Clay Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY OC, Horizontal Ksat = 7.74e-7 ft/s Ky'/Kx' Ratio: 0.015
Name: Peat Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s Ky'/Kx' Ratio: 1
Name: Foundation Till Model: Saturated / Unsaturated K-Function: FOUNDATION TILL, Horizontal Ksat = 3.99e-7 ft/s Ky'/Kx' Ratio: 0.111
Name: Fine Tailings/Slimes Model: Saturated / Unsaturated K-Function: FINE TAILINGS, Ksat = 1.31e-6 ft/s Ky'/Kx' Ratio: 1



P:\Mpls\23 MN\38\2338086\WorkFiles\2014_Work\DS14\Dam 2 Raise\Models

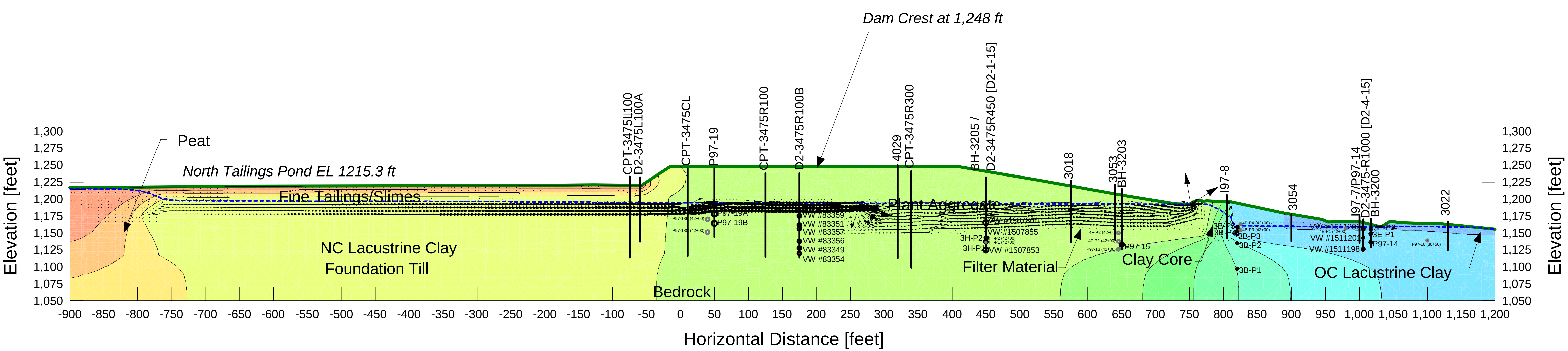
Dam 2 Crest at 1,248 feet, North Pond at 1,215.3 feet, Existing Beach

Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Existing Pond and Beach
Seepage Analysis
Analysis: B.0 Dam 2 Raise_1215.3ft Pond and Existing Beach
Last Saved Date: 3/31/2016

BARR

Contours are Total Head [feet]
Tailings Pond at 1,215.3 feet [Spring 2014 Pond Elevation]
Existing Beach

Name: Bedrock Model: Saturated Only Sat Kx: 3e-010 ft/sec Ky'/Kx' Ratio: 1 Volumetric Water Content: 0.2 ft³/ft³ Mv: 4.79e-007 /psf
Name: Clay Core Model: Saturated / Unsaturated K-Function: CLAY CORE TILL, Ksat = 1.25e-8 ft/s Ky'/Kx' Ratio: 1
Name: Filter Material Model: Saturated / Unsaturated K-Function: FILTER BERM, Ksat = 6.56e-5 ft/s Ky'/Kx' Ratio: 1
Name: Plant Aggregate Model: Saturated / Unsaturated K-Function: COARSE TAILINGS/PLANT AGG, Ksat = 2.62e-3 ft/s Ky'/Kx' Ratio: 1
Name: NC Lacustrine Clay Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s Ky'/Kx' Ratio: 1.11
Name: OC Lacustrine Clay Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY OC, Horizontal Ksat = 7.74e-7 ft/s Ky'/Kx' Ratio: 0.015
Name: Peat Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s Ky'/Kx' Ratio: 1
Name: Foundation Till Model: Saturated / Unsaturated K-Function: FOUNDATION TILL, Horizontal Ksat = 3.99e-7 ft/s Ky'/Kx' Ratio: 0.111
Name: Fine Tailings/Slimes Model: Saturated / Unsaturated K-Function: FINE TAILINGS, Ksat = 1.31e-6 ft/s Ky'/Kx' Ratio: 1



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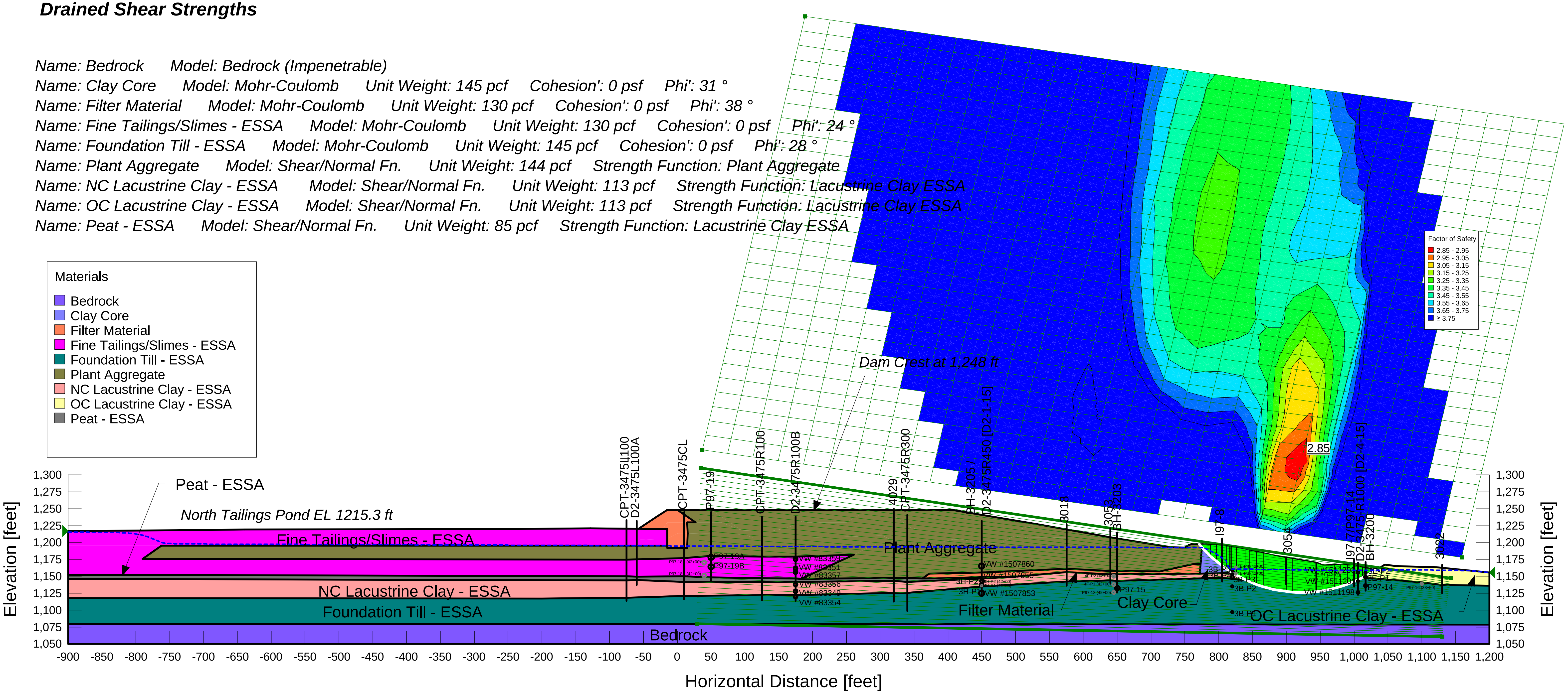
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Existing Pond and Beach
Stability Analysis
_Analysis: b.1.1 Dam 2 Raise_ESSA_
Last Saved Date: 4/5/2016

Factor of Safety: 2.85

BARR

Tailings Pond at 1,215.3 feet
Drained Shear Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Fine Tailings/Slimes - ESSA Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 24 °
Name: Foundation Till - ESSA Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 28 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: OC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: Peat - ESSA Model: Shear/Normal Fn. Unit Weight: 85 pcf Strength Function: Lacustrine Clay ESSA



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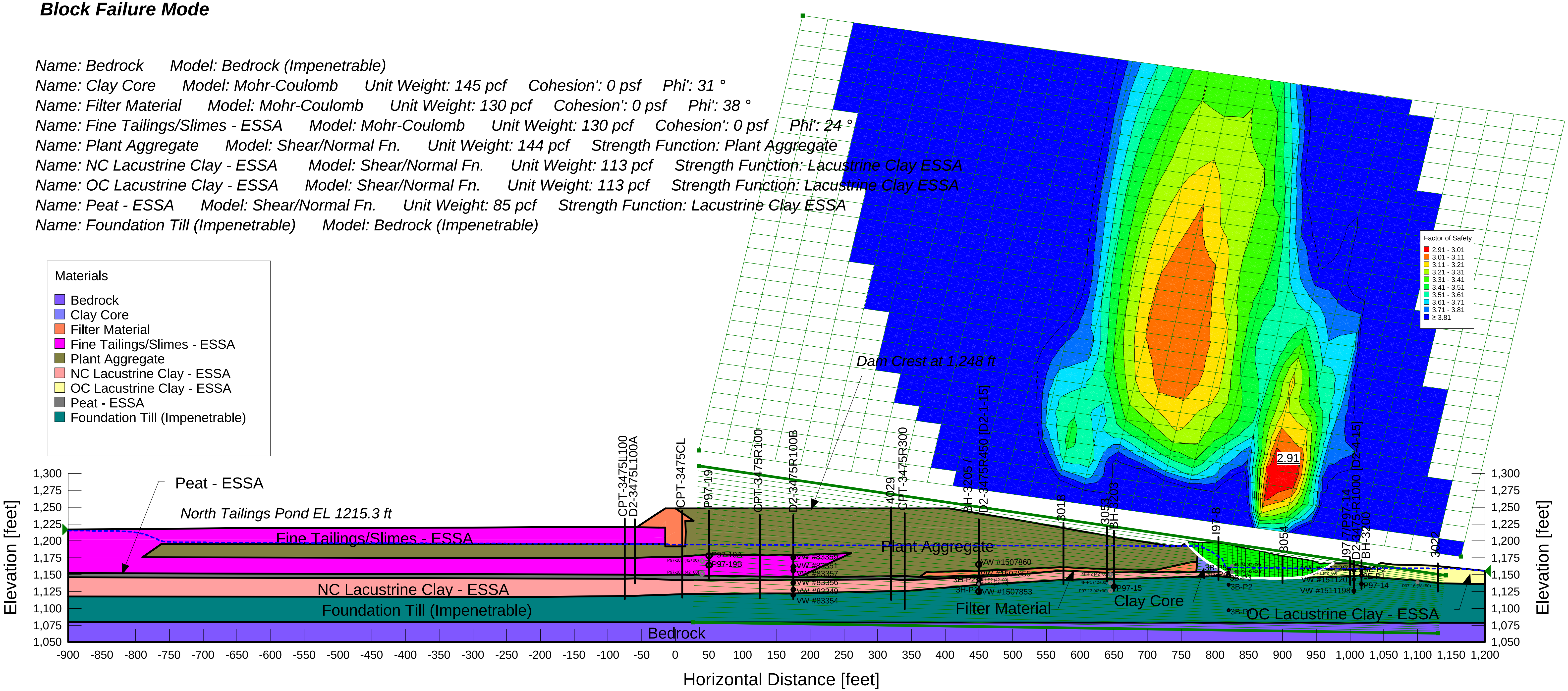
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Existing Pond and Beach
Stability Analysis
Analysis: b.1.2 Dam 2 Raise_ESSA_BF
Last Saved Date: 3/31/2016

Factor of Safety: 2.91

BARR

Tailings Pond at 1,215.3 feet
Drained Shear Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Fine Tailings/Slimes - ESSA Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 24 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: OC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: Peat - ESSA Model: Shear/Normal Fn. Unit Weight: 85 pcf Strength Function: Lacustrine Clay ESSA
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



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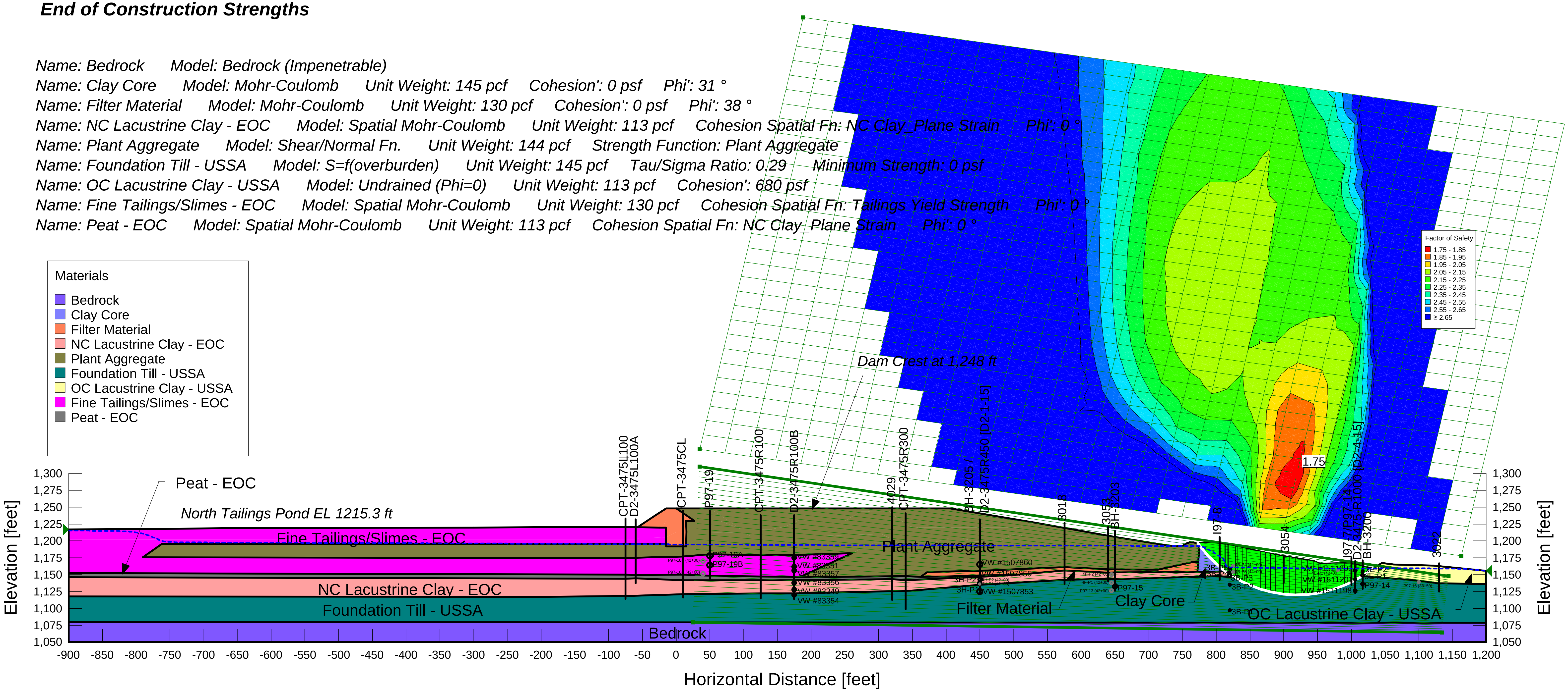
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Existing Pond and Beach Stability Analysis
Analysis: b.2.1 Dam 2 Raise_EOC
Last Saved Date: 3/31/2016

Factor of Safety: 1.75

BARR

Tailings Pond at 1,215.3 feet
End of Construction Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: NC Lacustrine Clay - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - EOC Model: Spatial Mohr-Coulomb Unit Weight: 130 pcf Cohesion Spatial Fn: Tailings Yield Strength Phi': 0 °
Name: Peat - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °



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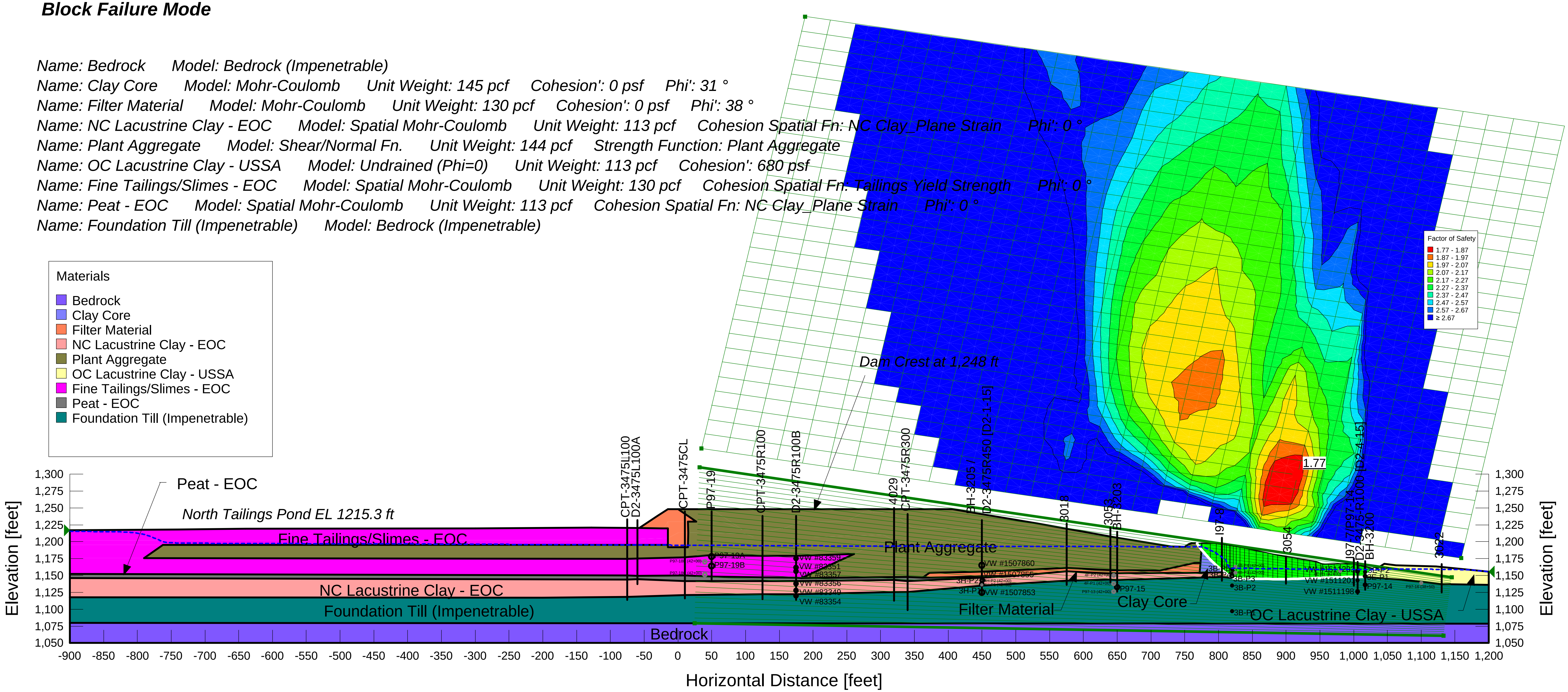
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Existing Pond and Beach
Stability Analysis
Analysis: b.2.2.1 Dam 2 Raise_EOC_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.77

BARR

Tailings Pond at 1,215.3 feet
End of Construction Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: NC Lacustrine Clay - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - EOC Model: Spatial Mohr-Coulomb Unit Weight: 130 pcf Cohesion Spatial Fn: Tailings Yield Strength Phi': 0 °
Name: Peat - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



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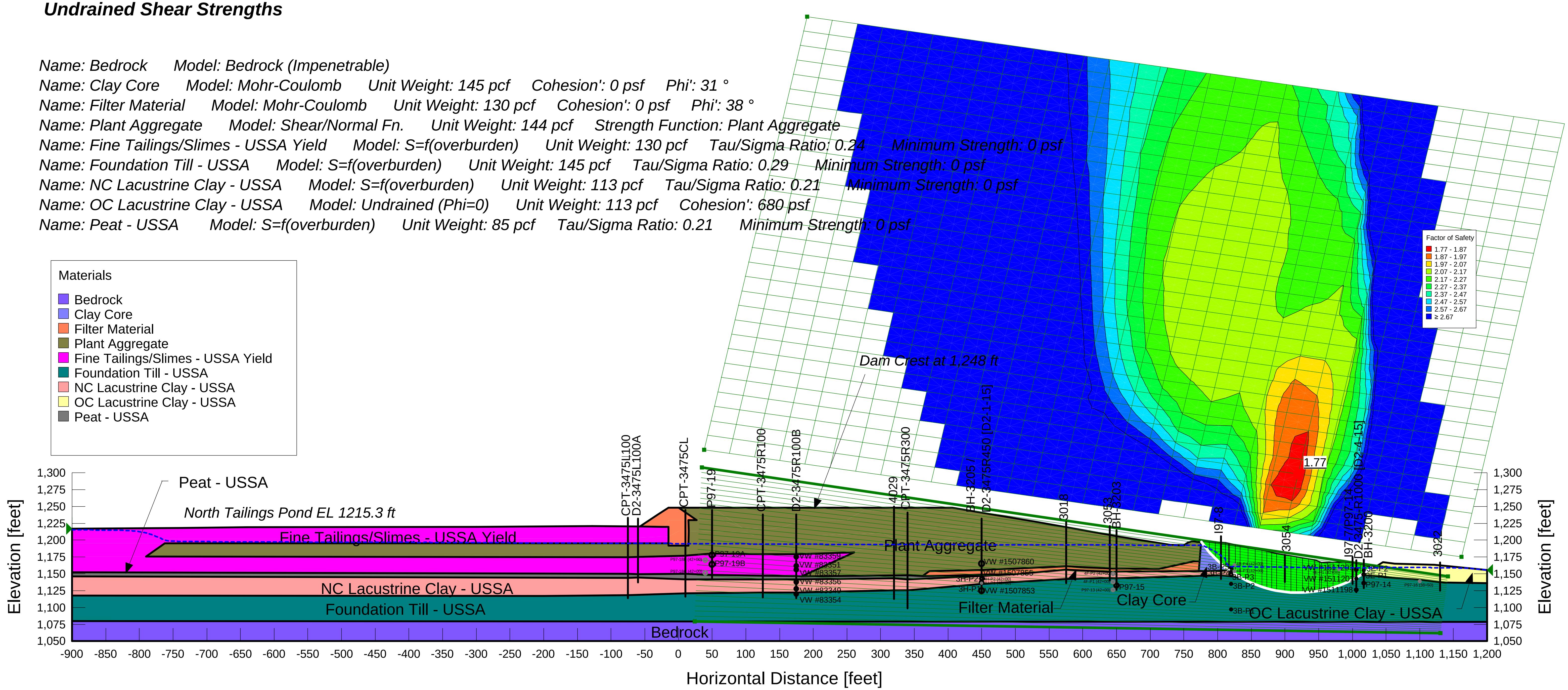
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Existing Pond and Beach
Stability Analysis
Analysis: b.3.1 Dam 2 Raise_FT Yield Strength
Last Saved Date: 3/31/2016

Factor of Safety: 1.77

BARR

Tailings Pond at 1,215.3 feet
Undrained Shear Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Fine Tailings/Slimes - USSA Yield Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.24 Minimum Strength: 0 psf
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf



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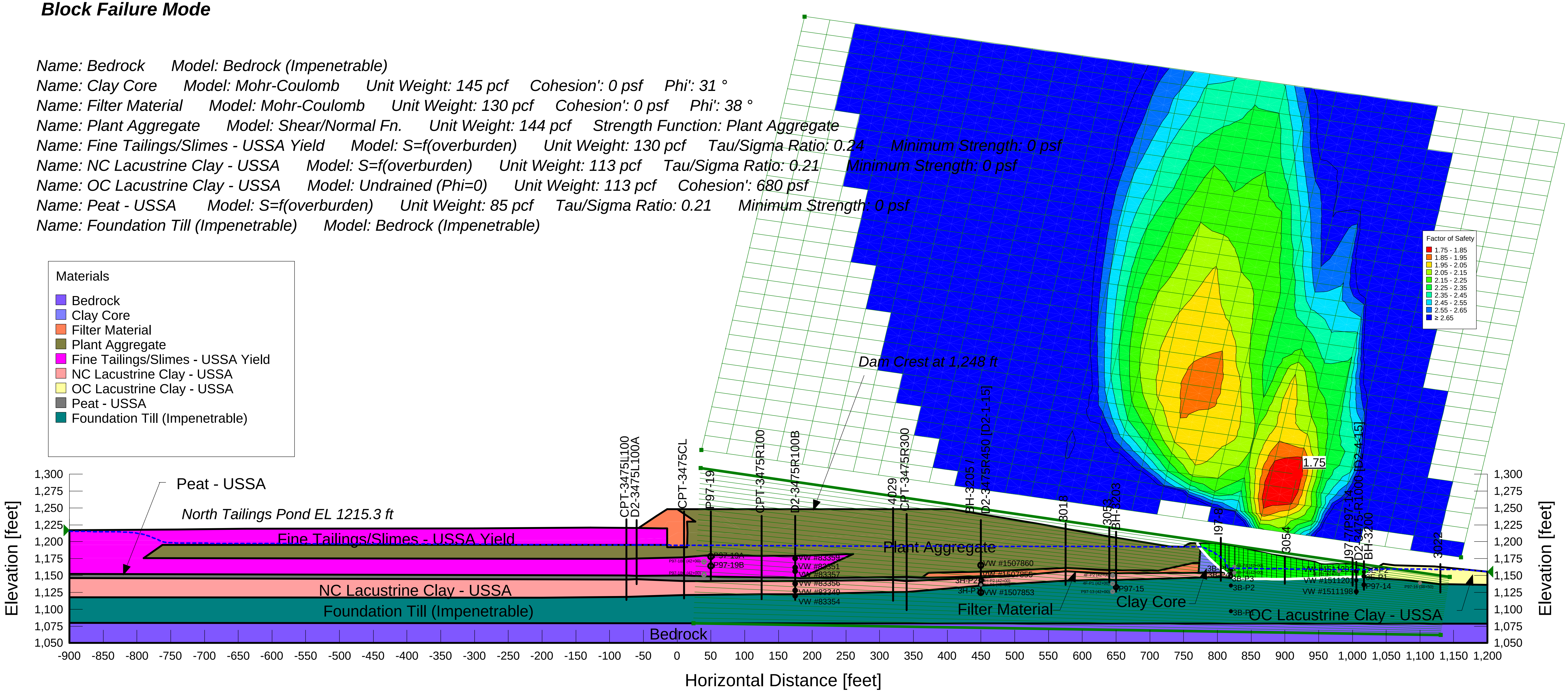
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Existing Pond and Beach
Stability Analysis
Analysis: b.3.2 Dam 2 Raise_FT Yield Strength_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.75

BARR

Tailings Pond at 1,215.3 feet
Undrained Shear Strengths
Block Failure Mode

Name: Bedrock   Model: Bedrock (Impenetrable)
Name: Clay Core   Model: Mohr-Coulomb   Unit Weight: 145 pcf   Cohesion': 0 psf   Phi': 31 °
Name: Filter Material   Model: Mohr-Coulomb   Unit Weight: 130 pcf   Cohesion': 0 psf   Phi': 38 °
Name: Plant Aggregate   Model: Shear/Normal Fn.   Unit Weight: 144 pcf   Strength Function: Plant Aggregate
Name: Fine Tailings/Slimes - USSA Yield   Model: S=f(overburden)   Unit Weight: 130 pcf   Tau/Sigma Ratio: 0.24   Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA   Model: S=f(overburden)   Unit Weight: 113 pcf   Tau/Sigma Ratio: 0.21   Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA   Model: Undrained (Phi=0)   Unit Weight: 113 pcf   Cohesion': 680 psf
Name: Peat - USSA   Model: S=f(overburden)   Unit Weight: 85 pcf   Tau/Sigma Ratio: 0.21   Minimum Strength: 0 psf
Name: Foundation Till (Impenetrable)   Model: Bedrock (Impenetrable)



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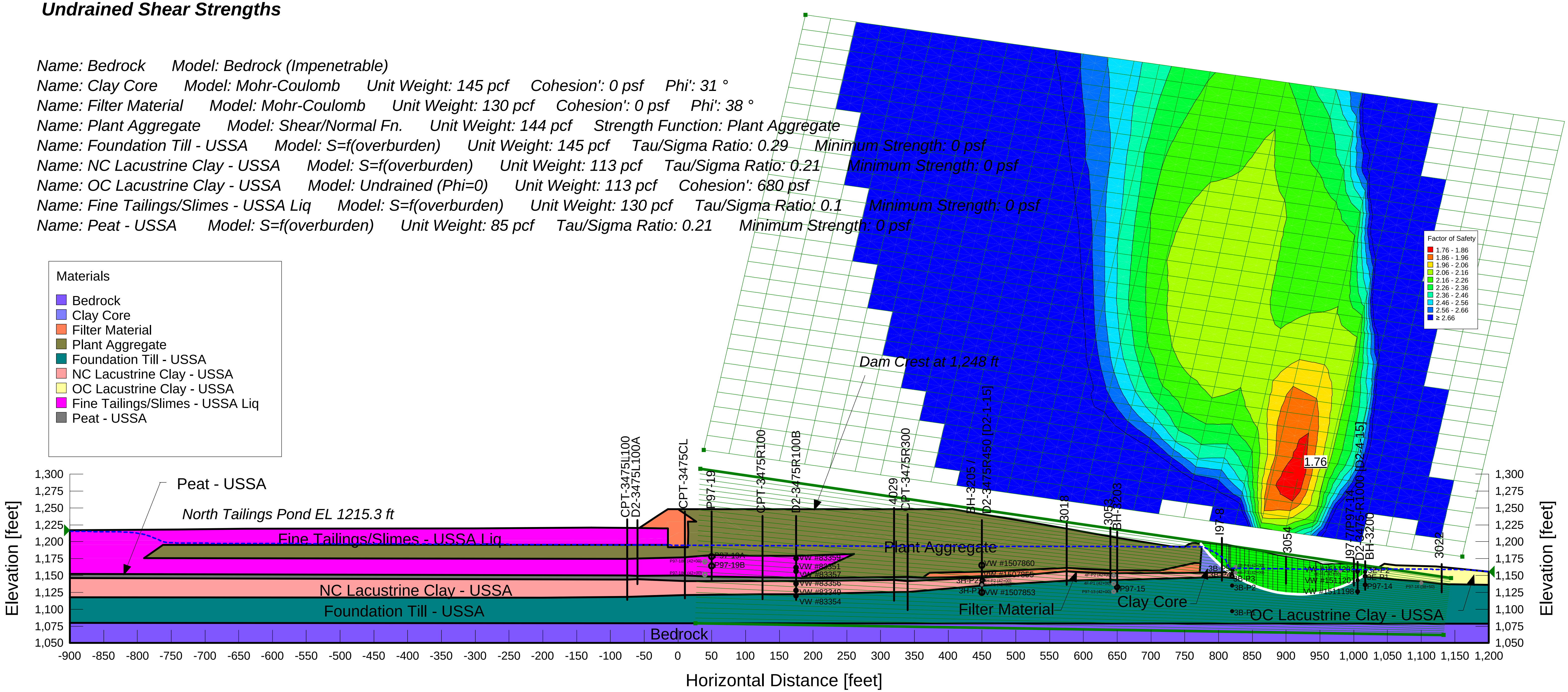
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Existing Pond and Beach
Stability Analysis
Analysis: b.4.1 Dam 2 Raise_FT Liquefied Strength
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,215.3 feet
Undrained Shear Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - USSA Liq Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.1 Minimum Strength: 0 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf



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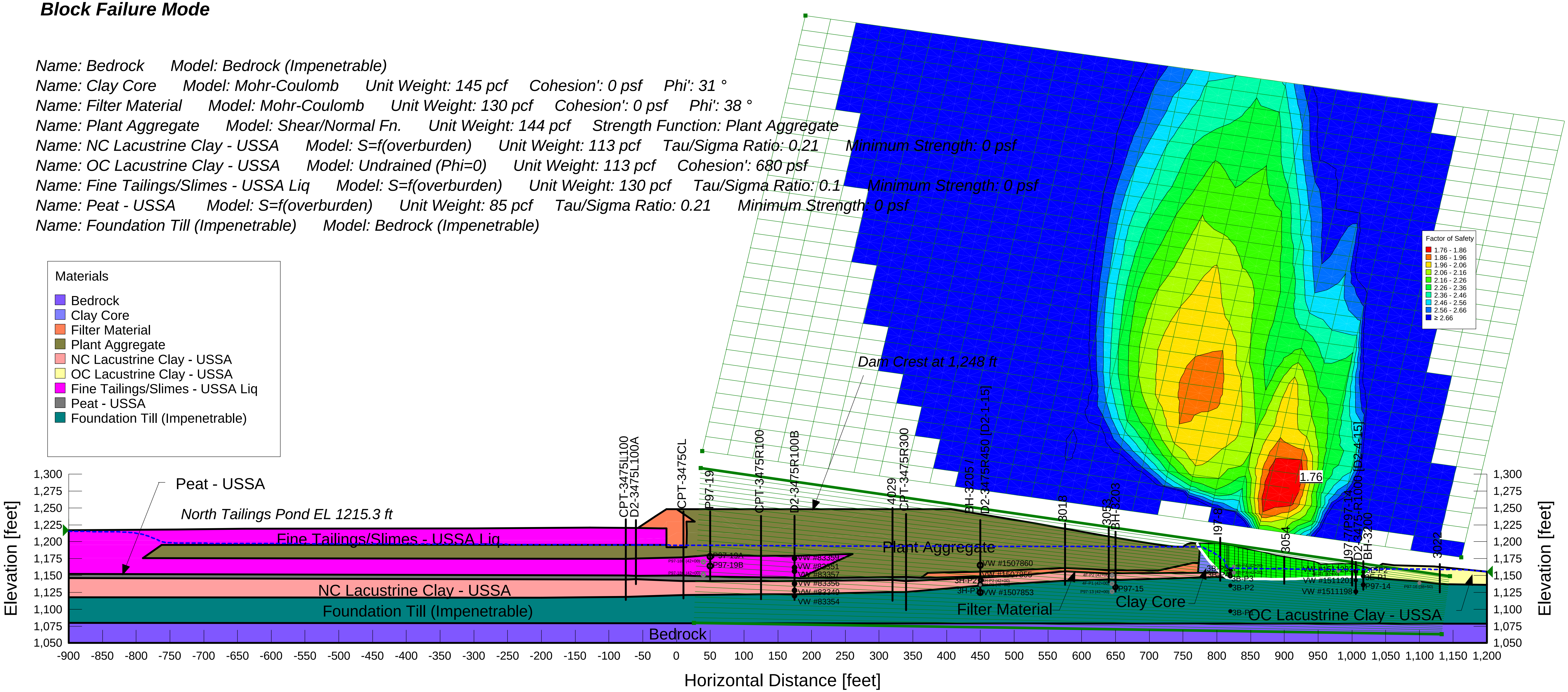
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Existing Pond and Beach
Stability Analysis
Analysis: b.4.2 Dam 2 Raise_FT Liquefied Strength_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,215.3 feet
Undrained Shear Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - USSA Liq Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.1 Minimum Strength: 0 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



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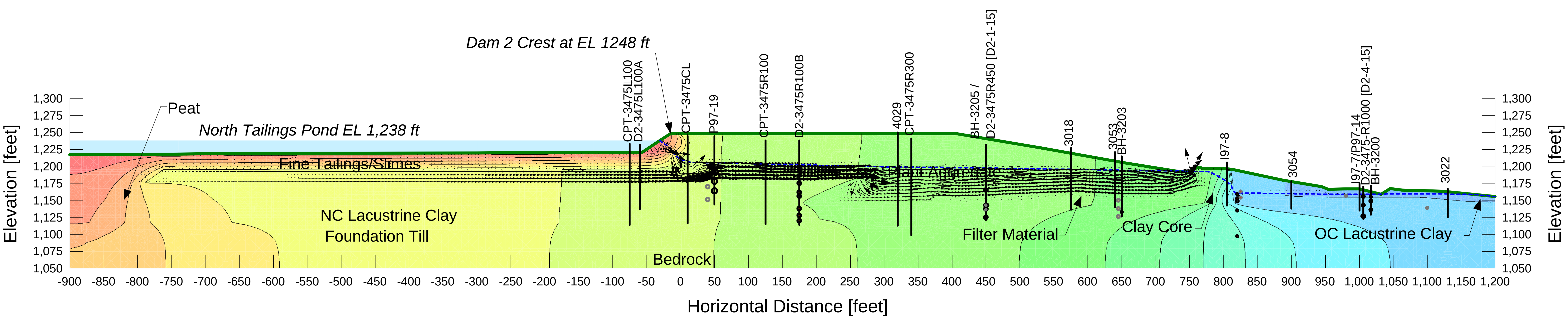
Dam 2 Crest at 1,248 feet, North Pond at 1,238 feet, Existing Beach

Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Existing Beach
Seepage Analysis
Analysis: C.0 Dam 2 Raise_1238ft Pond and Existing Beach
Last Saved Date: 3/31/2016

Contours are Total Head [feet]
Tailings Pond at 1,238 feet Existing Beach

Name: Bedrock Model: Saturated Only Sat Kx: 3e-010 ft/sec Ky'/Kx' Ratio: 1 Volumetric Water Content: 0.2 ft³/ft³ Mv: 4.79e-007 /psf
Name: Clay Core Model: Saturated / Unsaturated K-Function: CLAY CORE TILL, Ksat = 1.25e-8 ft/s Ky'/Kx' Ratio: 1
Name: Filter Material Model: Saturated / Unsaturated K-Function: FILTER BERM, Ksat = 6.56e-5 ft/s Ky'/Kx' Ratio: 1
Name: Plant Aggregate Model: Saturated / Unsaturated K-Function: COARSE TAILINGS/PLANT AGG, Ksat = 2.62e-3 ft/s Ky'/Kx' Ratio: 1
Name: NC Lacustrine Clay Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s Ky'/Kx' Ratio: 1.11
Name: OC Lacustrine Clay Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY OC, Horizontal Ksat = 7.74e-7 ft/s Ky'/Kx' Ratio: 0.015
Name: Peat Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s Ky'/Kx' Ratio: 1
Name: Foundation Till Model: Saturated / Unsaturated K-Function: FOUNDATION TILL, Horizontal Ksat = 3.99e-7 ft/s Ky'/Kx' Ratio: 0.111
Name: Fine Tailings/Slimes Model: Saturated / Unsaturated K-Function: FINE TAILINGS, Ksat = 1.31e-6 ft/s Ky'/Kx' Ratio: 1



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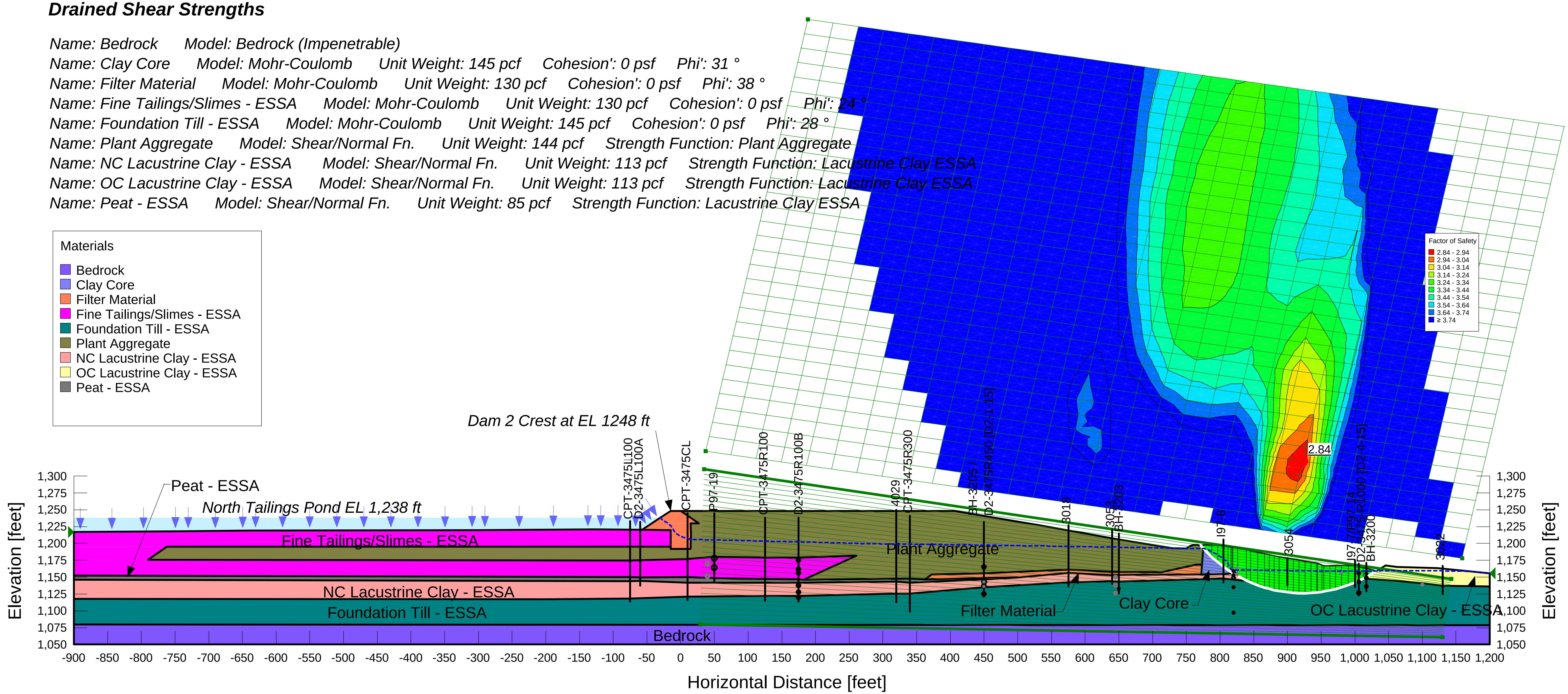
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Existing Beach
Stability Analysis
Analysis: c.1.1 Dam 2 Raise_ESSA
Last Saved Date: 03/31/2016

Factor of Safety: 2.84

BARR

Tailings Pond at 1,238 feet
Drained Shear Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Fine Tailings/Slimes - ESSA Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 24 °
Name: Foundation Till - ESSA Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 28 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: OC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: Peat - ESSA Model: Shear/Normal Fn. Unit Weight: 85 pcf Strength Function: Lacustrine Clay ESSA



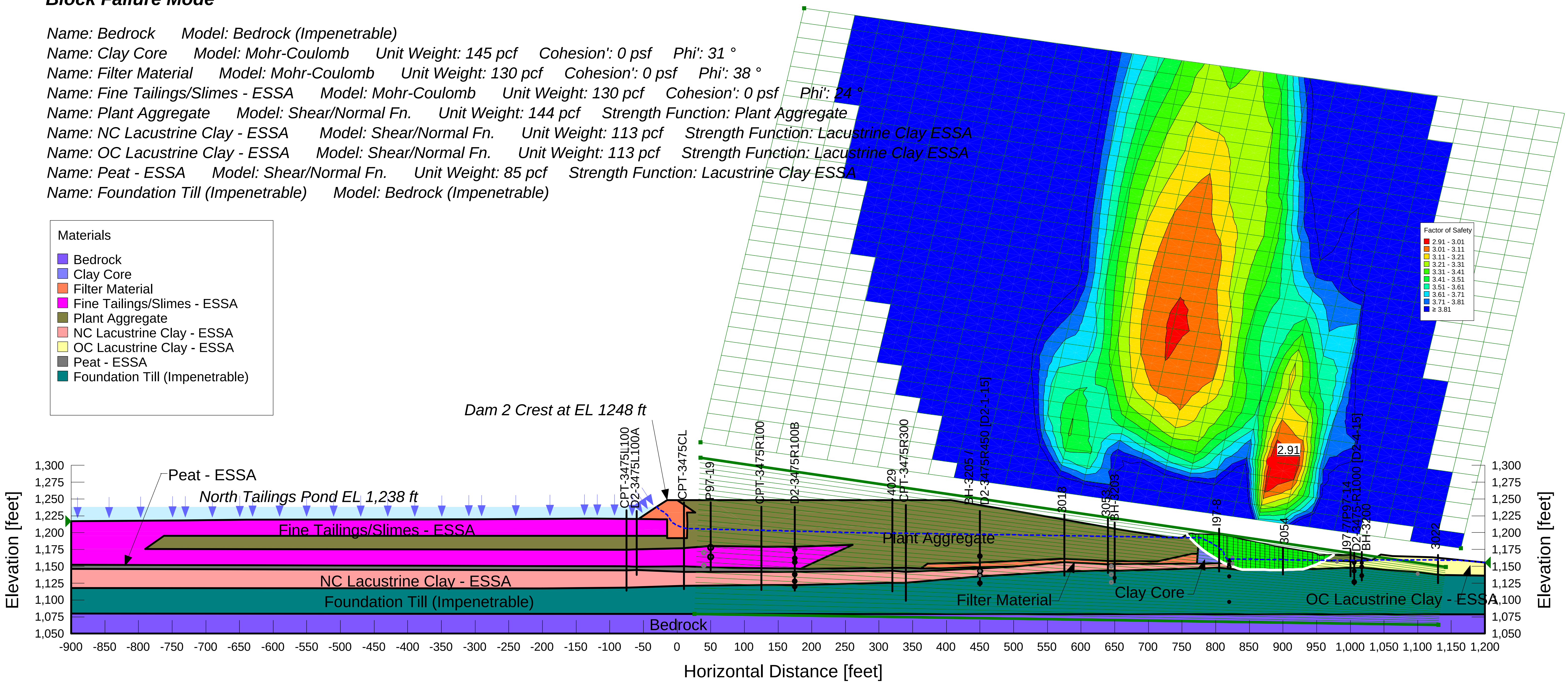
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Existing Beach
Stability Analysis
Analysis: c.1.2 Dam 2 Raise_ESSA_BF
Last Saved Date: 3/31/2016

Factor of Safety: 2.91

BARR

Tailings Pond at 1,238 feet
Drained Shear Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Fine Tailings/Slimes - ESSA Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 24 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: OC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: Peat - ESSA Model: Shear/Normal Fn. Unit Weight: 85 pcf Strength Function: Lacustrine Clay ESSA
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



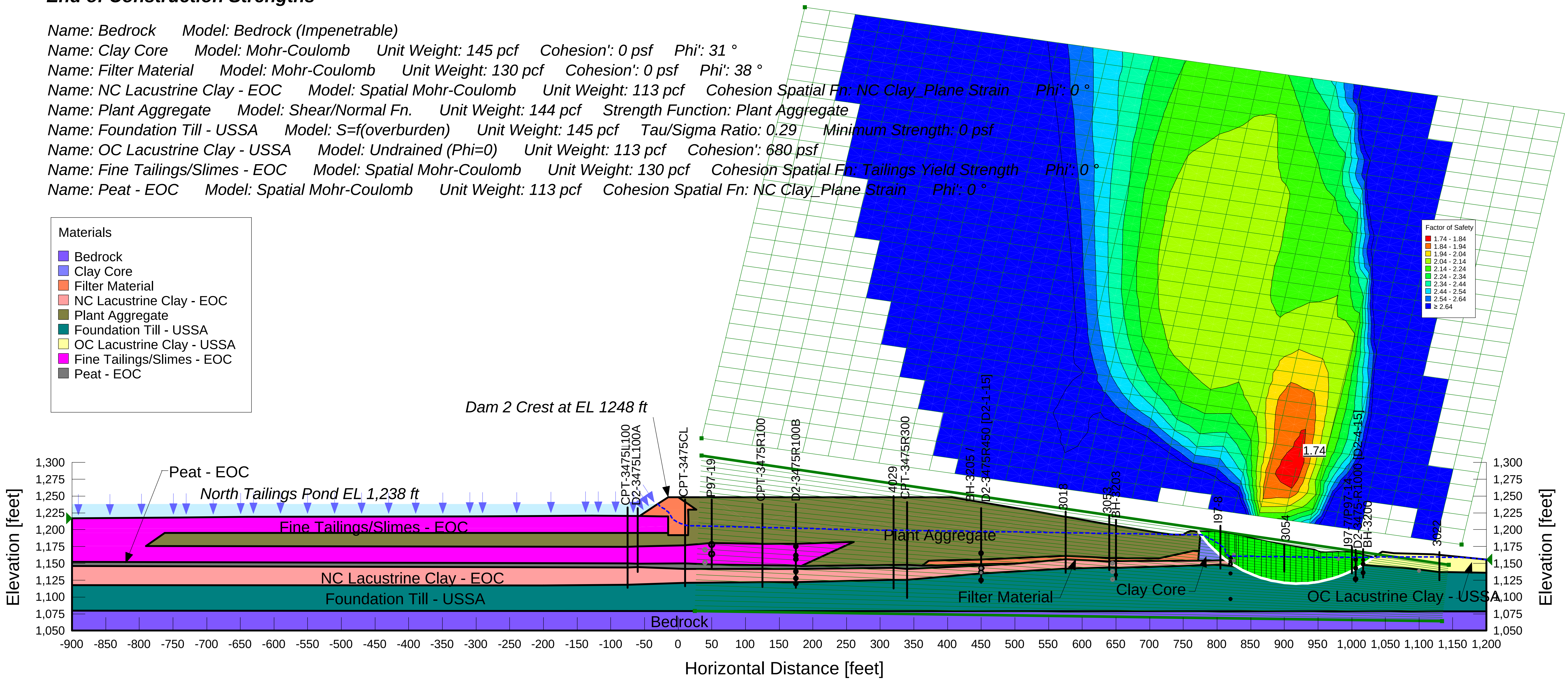
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Existing Beach
Stability Analysis
Analysis: c.2.1 Dam 2 Raise_EOC
Last Saved Date: 3/31/2016

Factor of Safety: 1.74

BARR

Tailings Pond at 1,238 feet
End of Construction Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: NC Lacustrine Clay - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - EOC Model: Spatial Mohr-Coulomb Unit Weight: 130 pcf Cohesion Spatial Fn: Tailings Yield Strength Phi': 0 °
Name: Peat - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °



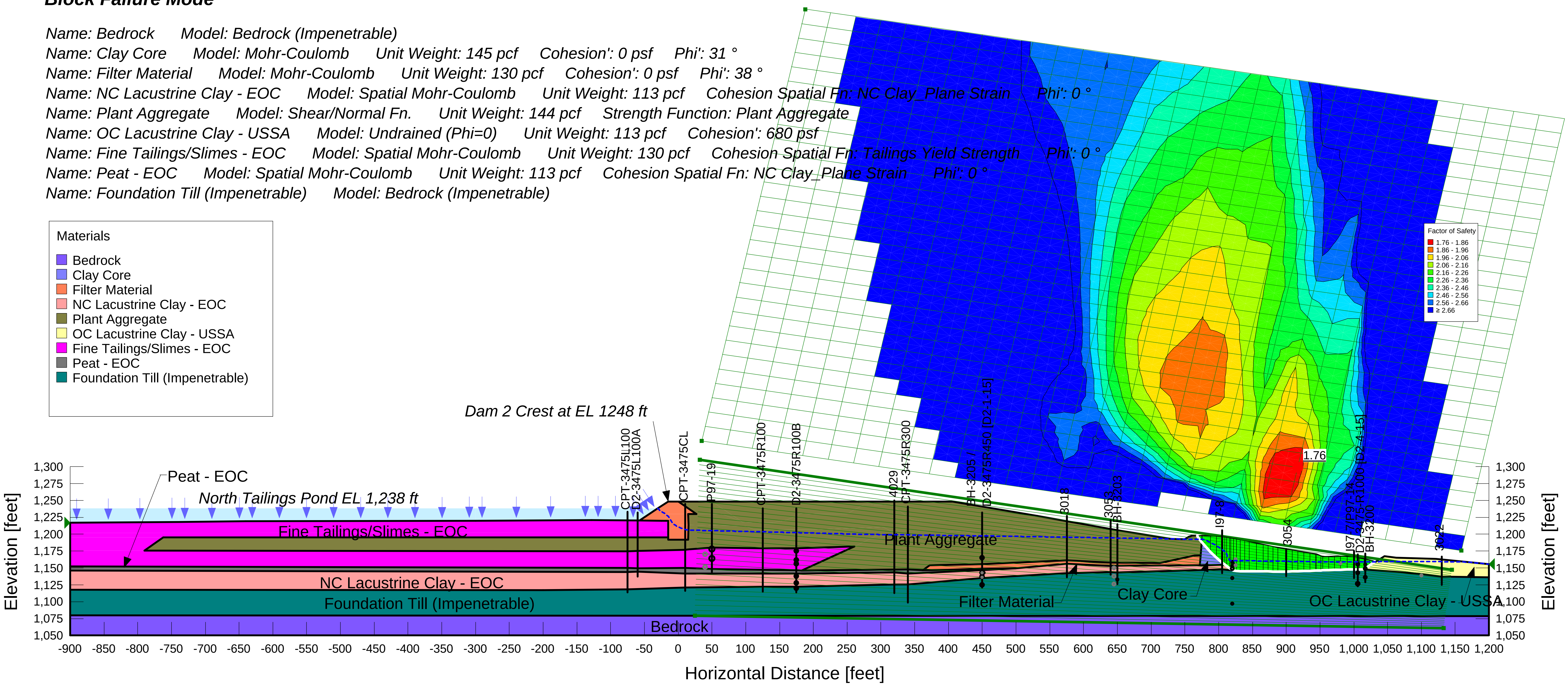
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Existing Beach
Stability Analysis
Analysis: c.2.2.1 Dam 2 Raise_EOC_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,238 feet
End of Construction Strengths
Block Failure Mode

Name: Bedrock   Model: Bedrock (Impenetrable)
Name: Clay Core   Model: Mohr-Coulomb   Unit Weight: 145 pcf   Cohesion': 0 psf   Phi': 31 °
Name: Filter Material   Model: Mohr-Coulomb   Unit Weight: 130 pcf   Cohesion': 0 psf   Phi': 38 °
Name: NC Lacustrine Clay - EOC   Model: Spatial Mohr-Coulomb   Unit Weight: 113 pcf   Cohesion Spatial Fn: NC Clay_Plane Strain   Phi': 0 °
Name: Plant Aggregate   Model: Shear/Normal Fn.   Unit Weight: 144 pcf   Strength Function: Plant Aggregate
Name: OC Lacustrine Clay - USSA   Model: Undrained (Phi=0)   Unit Weight: 113 pcf   Cohesion': 680 psf
Name: Fine Tailings/Slimes - EOC   Model: Spatial Mohr-Coulomb   Unit Weight: 130 pcf   Cohesion Spatial Fn: Tailings Yield Strength   Phi': 0 °
Name: Peat - EOC   Model: Spatial Mohr-Coulomb   Unit Weight: 113 pcf   Cohesion Spatial Fn: NC Clay_Plane Strain   Phi': 0 °
Name: Foundation Till (Impenetrable)   Model: Bedrock (Impenetrable)



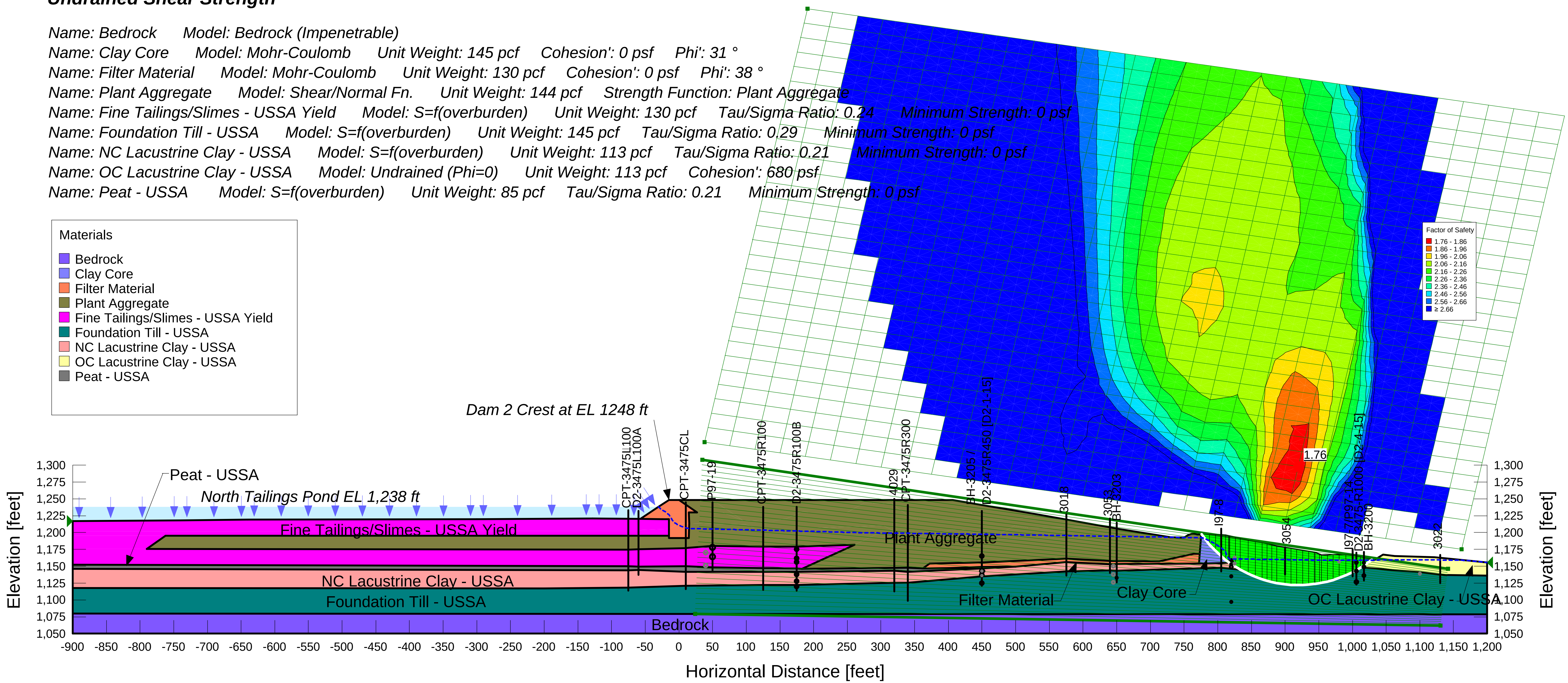
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Existing Beach
Stability Analysis
Analysis: c.3.1 Dam 2 Raise_FT Yield Strength
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,238 feet
Undrained Shear Strength

Name: Bedrock   Model: Bedrock (Impenetrable)
Name: Clay Core   Model: Mohr-Coulomb   Unit Weight: 145 pcf   Cohesion': 0 psf   Phi': 31 °
Name: Filter Material   Model: Mohr-Coulomb   Unit Weight: 130 pcf   Cohesion': 0 psf   Phi': 38 °
Name: Plant Aggregate   Model: Shear/Normal Fn.   Unit Weight: 144 pcf   Strength Function: Plant Aggregate
Name: Fine Tailings/Slimes - USSA Yield   Model: S=f(overburden)   Unit Weight: 130 pcf   Tau/Sigma Ratio: 0.24   Minimum Strength: 0 psf
Name: Foundation Till - USSA   Model: S=f(overburden)   Unit Weight: 145 pcf   Tau/Sigma Ratio: 0.29   Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA   Model: S=f(overburden)   Unit Weight: 113 pcf   Tau/Sigma Ratio: 0.21   Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA   Model: Undrained (Phi=0)   Unit Weight: 113 pcf   Cohesion': 680 psf
Name: Peat - USSA   Model: S=f(overburden)   Unit Weight: 85 pcf   Tau/Sigma Ratio: 0.21   Minimum Strength: 0 psf



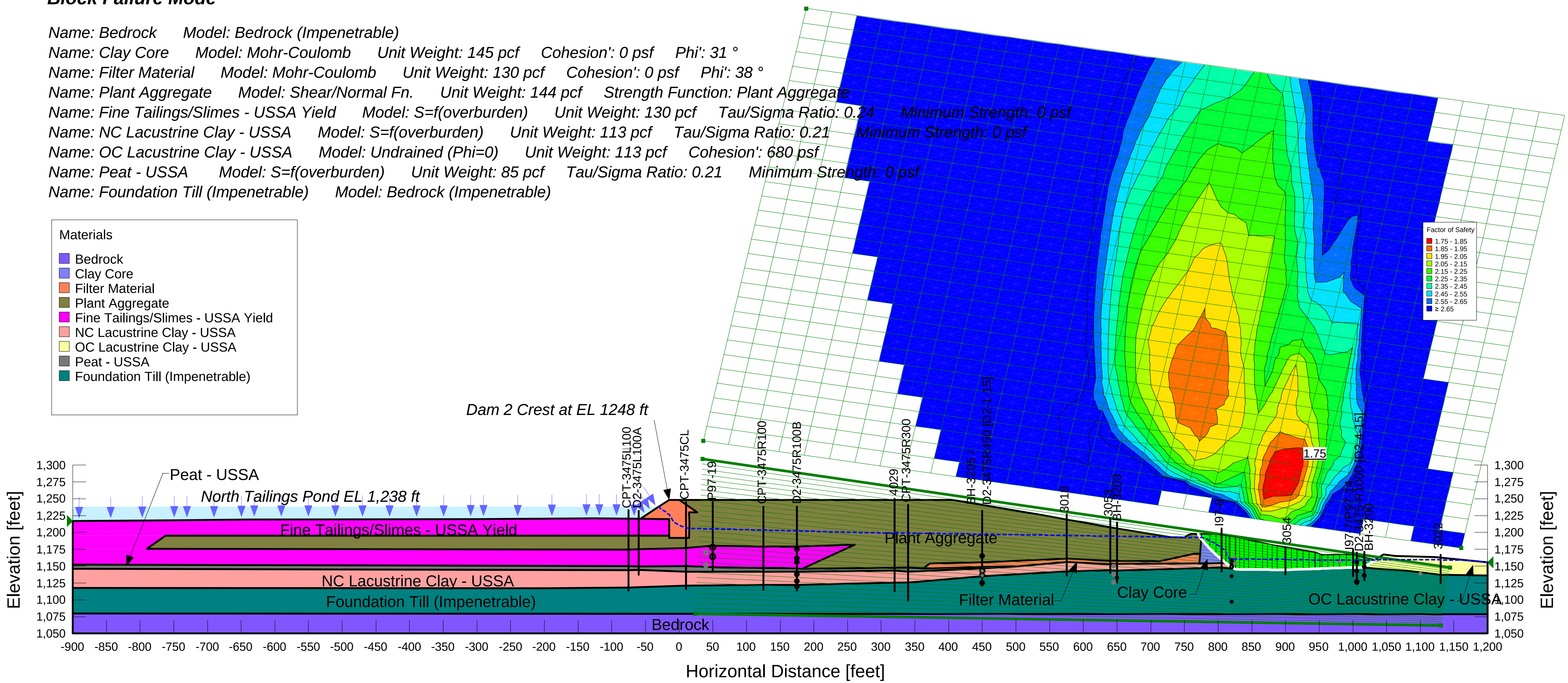
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Existing Beach
Stability Analysis
Analysis: c.3.2 Dam 2 Raise_FT Yield Strength_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.75

BARR

Tailings Pond at 1,238 feet
Undrained Shear Strength
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Fine Tailings/Slimes - USSA Yield Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.24 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)

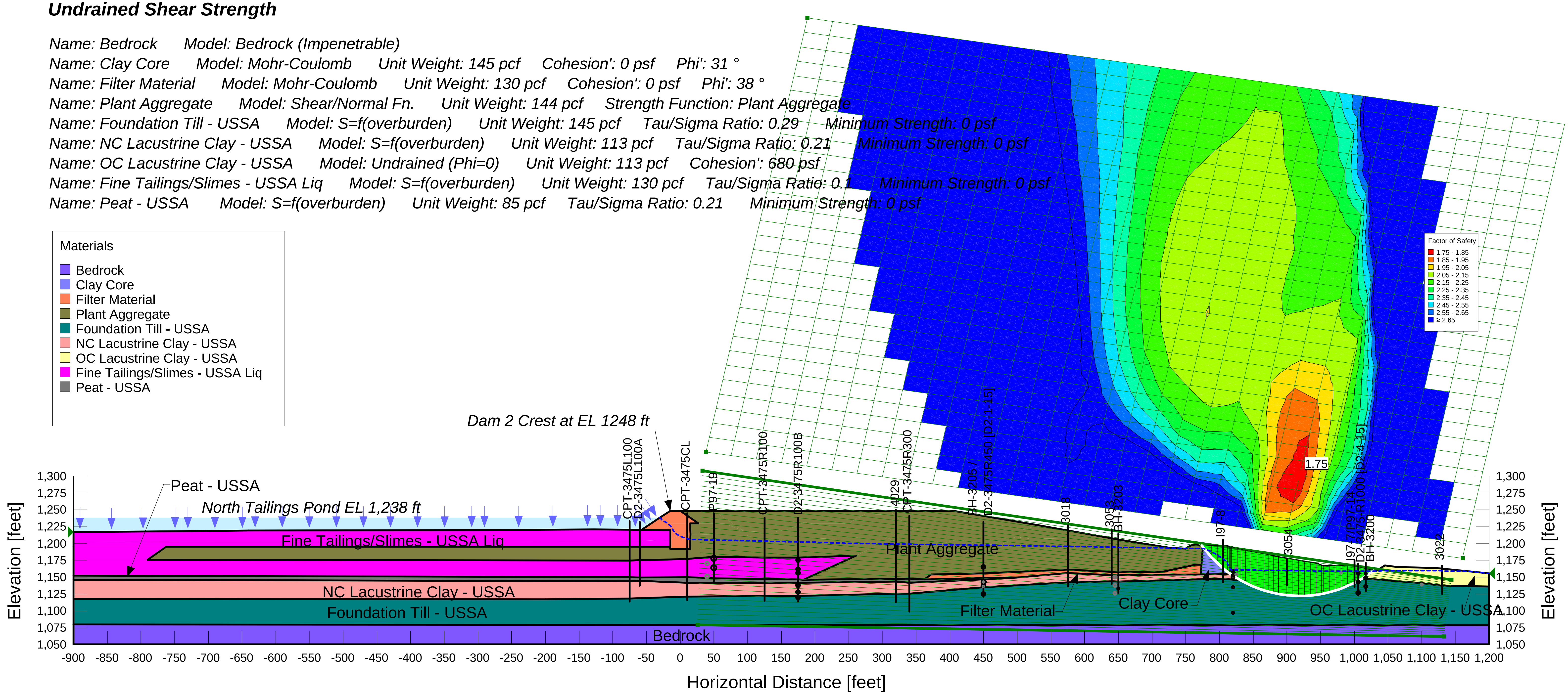


Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Existing Beach
Stability Analysis
Analysis: c.4.1 Dam 2 Raise_FT Liquefied Strength
Last Saved Date: 3/31/2016

Factor of Safety: 1.75

Tailings Pond at 1,238 feet
Undrained Shear Strength

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - USSA Liq Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.1 Minimum Strength: 0 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf



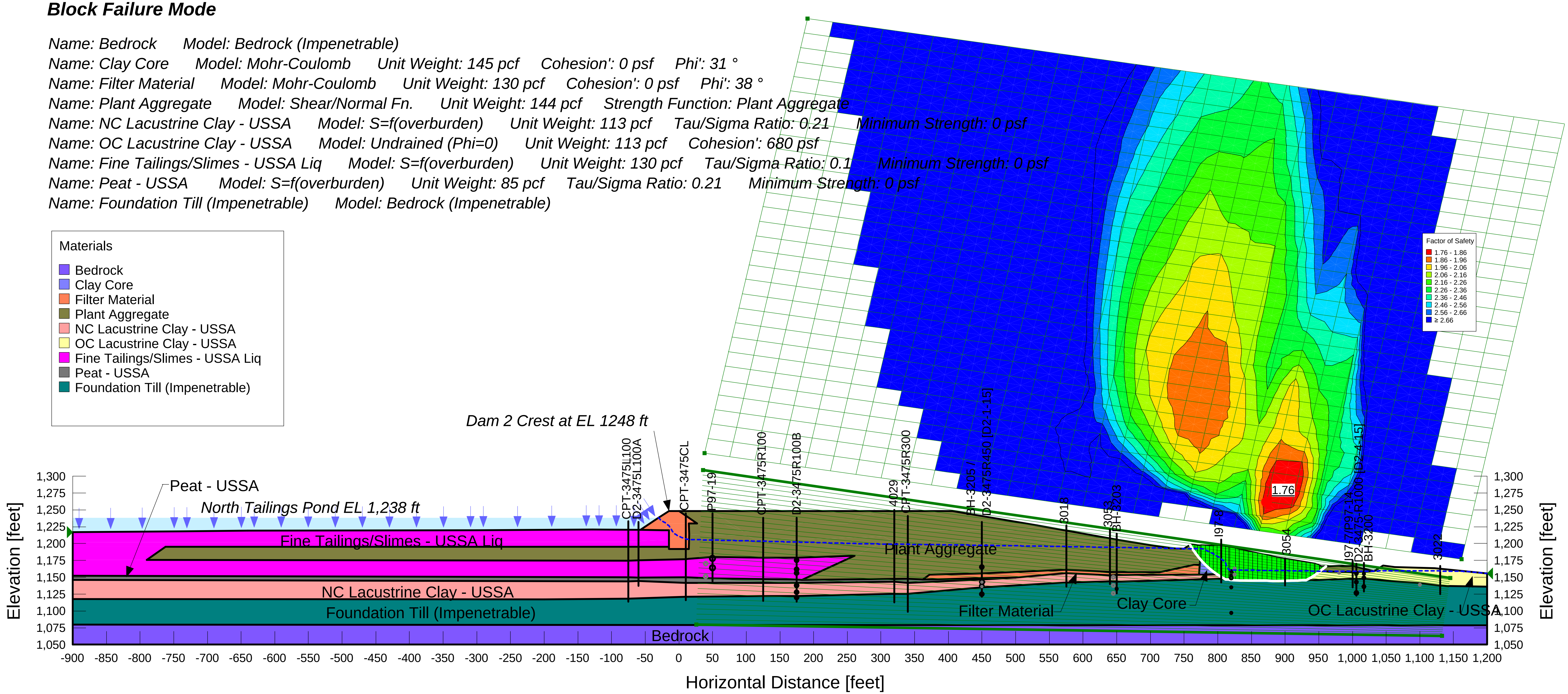
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Existing Beach
Stability Analysis
Analysis: c.4.2 Dam 2 Raise_FT Liquefied Strength_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,238 feet
Undrained Shear Strength Ratio
Block Failure Mode

Name: Bedrock   Model: Bedrock (Impenetrable)
Name: Clay Core   Model: Mohr-Coulomb   Unit Weight: 145 pcf   Cohesion': 0 psf   Phi': 31 °
Name: Filter Material   Model: Mohr-Coulomb   Unit Weight: 130 pcf   Cohesion': 0 psf   Phi': 38 °
Name: Plant Aggregate   Model: Shear/Normal Fn.   Unit Weight: 144 pcf   Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - USSA   Model: S=f(overburden)   Unit Weight: 113 pcf   Tau/Sigma Ratio: 0.21   Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA   Model: Undrained (Phi=0)   Unit Weight: 113 pcf   Cohesion': 680 psf
Name: Fine Tailings/Slimes - USSA Liq   Model: S=f(overburden)   Unit Weight: 130 pcf   Tau/Sigma Ratio: 0.1   Minimum Strength: 0 psf
Name: Peat - USSA   Model: S=f(overburden)   Unit Weight: 85 pcf   Tau/Sigma Ratio: 0.21   Minimum Strength: 0 psf
Name: Foundation Till (Impenetrable)   Model: Bedrock (Impenetrable)

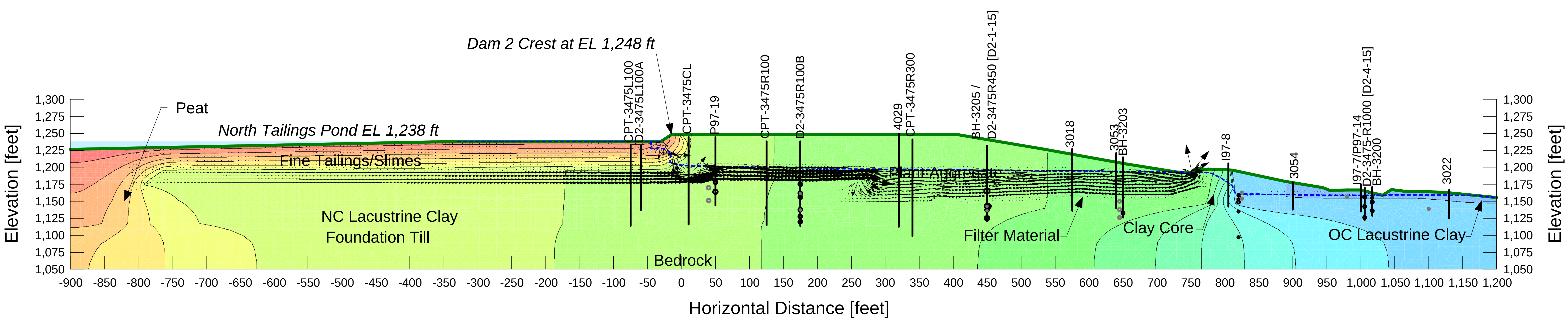


Dam 2 Crest at 1,248 feet, North Pond at 1,238 feet, Future Beach

Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Future Beach
Seepage Analysis
Analysis: D.0 Dam 2 Raise_1,238ft Pond and Future Beach
Last Saved Date: 3/31/2016

Contours are Total Head [feet]
Tailings Pond at 1,238 feet
Future Beach

Name: Bedrock Model: Saturated Only Sat Kx: 3e-010 ft/sec Ky'/Kx' Ratio: 1 Volumetric Water Content: 0.2 ft³/ft³ Mv: 4.79e-007 /psf
Name: Clay Core Model: Saturated / Unsaturated K-Function: CLAY CORE TILL, Ksat = 1.25e-8 ft/s Ky'/Kx' Ratio: 1
Name: Filter Material Model: Saturated / Unsaturated K-Function: FILTER BERM, Ksat = 6.56e-5 ft/s Ky'/Kx' Ratio: 1
Name: Plant Aggregate Model: Saturated / Unsaturated K-Function: COARSE TAILINGS/PLANT AGG, Ksat = 2.62e-3 ft/s Ky'/Kx' Ratio: 1
Name: NC Lacustrine Clay Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s Ky'/Kx' Ratio: 1.11
Name: OC Lacustrine Clay Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY OC, Horizontal Ksat = 7.74e-7 ft/s Ky'/Kx' Ratio: 0.015
Name: Peat Model: Saturated / Unsaturated K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s Ky'/Kx' Ratio: 1
Name: Foundation Till Model: Saturated / Unsaturated K-Function: FOUNDATION TILL, Horizontal Ksat = 3.99e-7 ft/s Ky'/Kx' Ratio: 0.111
Name: Fine Tailings/Slimes Model: Saturated / Unsaturated K-Function: FINE TAILINGS, Ksat = 1.31e-6 ft/s Ky'/Kx' Ratio: 1



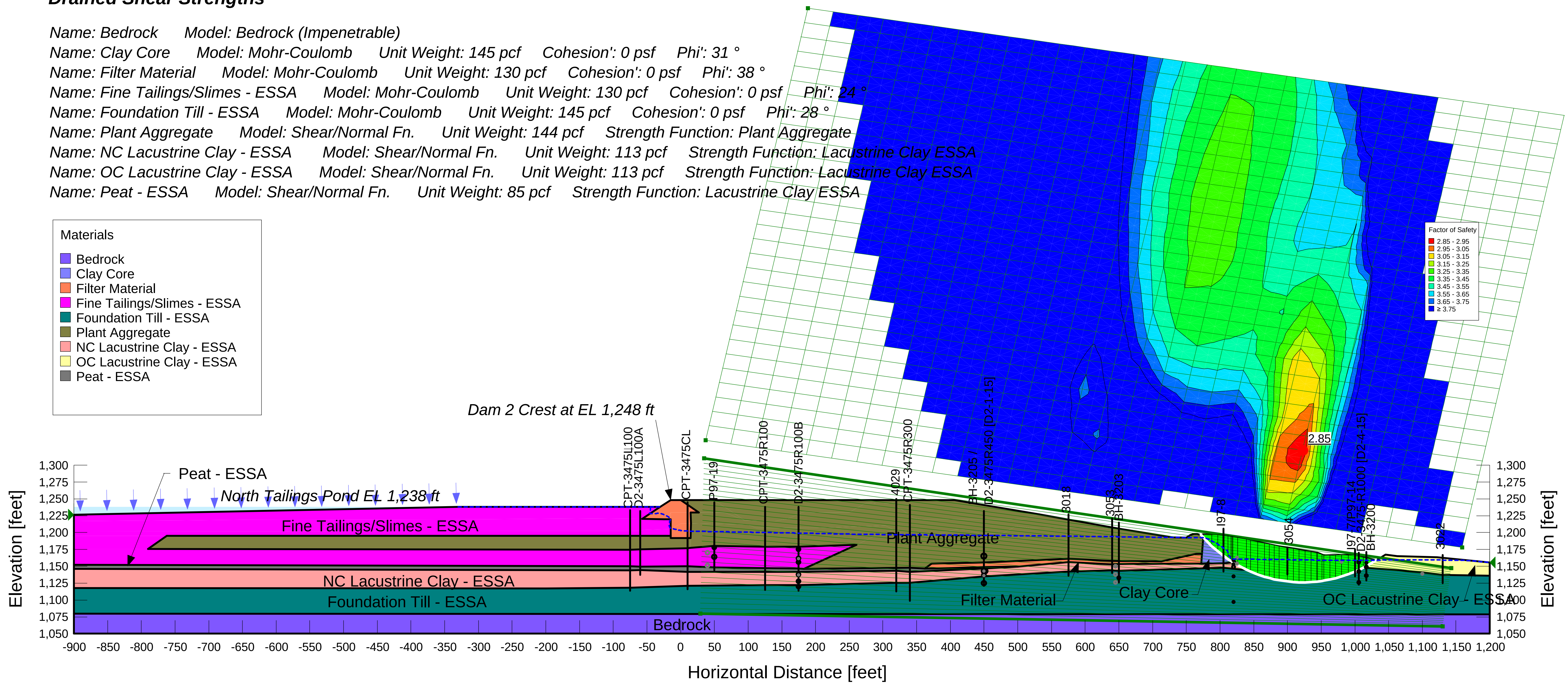
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Future Beach
Stability Analysis
Analysis: d.1.1 Dam 2 Raise_ESSA
Last Saved Date: 03/31/2016

Factor of Safety: 2.85

BARR

Tailings Pond at 1,238 feet
Drained Shear Strengths

Name: Bedrock   Model: Bedrock (Impenetrable)
Name: Clay Core   Model: Mohr-Coulomb   Unit Weight: 145 pcf   Cohesion': 0 psf   Phi': 31 °
Name: Filter Material   Model: Mohr-Coulomb   Unit Weight: 130 pcf   Cohesion': 0 psf   Phi': 38 °
Name: Fine Tailings/Slimes - ESSA   Model: Mohr-Coulomb   Unit Weight: 130 pcf   Cohesion': 0 psf   Phi': 24 °
Name: Foundation Till - ESSA   Model: Mohr-Coulomb   Unit Weight: 145 pcf   Cohesion': 0 psf   Phi': 28 °
Name: Plant Aggregate   Model: Shear/Normal Fn.   Unit Weight: 144 pcf   Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - ESSA   Model: Shear/Normal Fn.   Unit Weight: 113 pcf   Strength Function: Lacustrine Clay ESSA
Name: OC Lacustrine Clay - ESSA   Model: Shear/Normal Fn.   Unit Weight: 113 pcf   Strength Function: Lacustrine Clay ESSA
Name: Peat - ESSA   Model: Shear/Normal Fn.   Unit Weight: 85 pcf   Strength Function: Lacustrine Clay ESSA

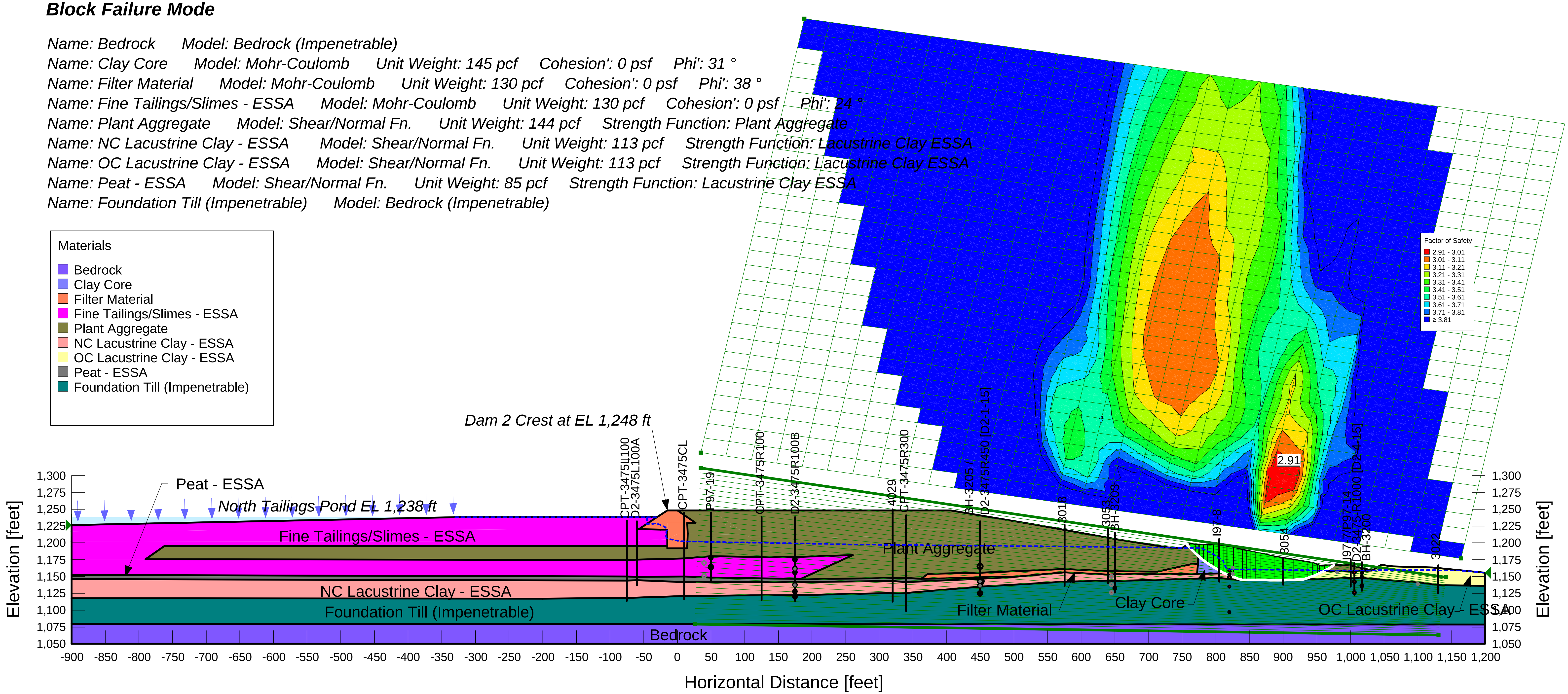


Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Future Beach
Stability Analysis
Analysis: d.1.2 Dam 2 Raise_ESSA_BF
Last Saved Date: 3/31/2016

Factor of Safety: 2.91

Tailings Pond at 1,238 feet
Drained Shear Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Fine Tailings/Slimes - ESSA Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 24 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: OC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: Peat - ESSA Model: Shear/Normal Fn. Unit Weight: 85 pcf Strength Function: Lacustrine Clay ESSA
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



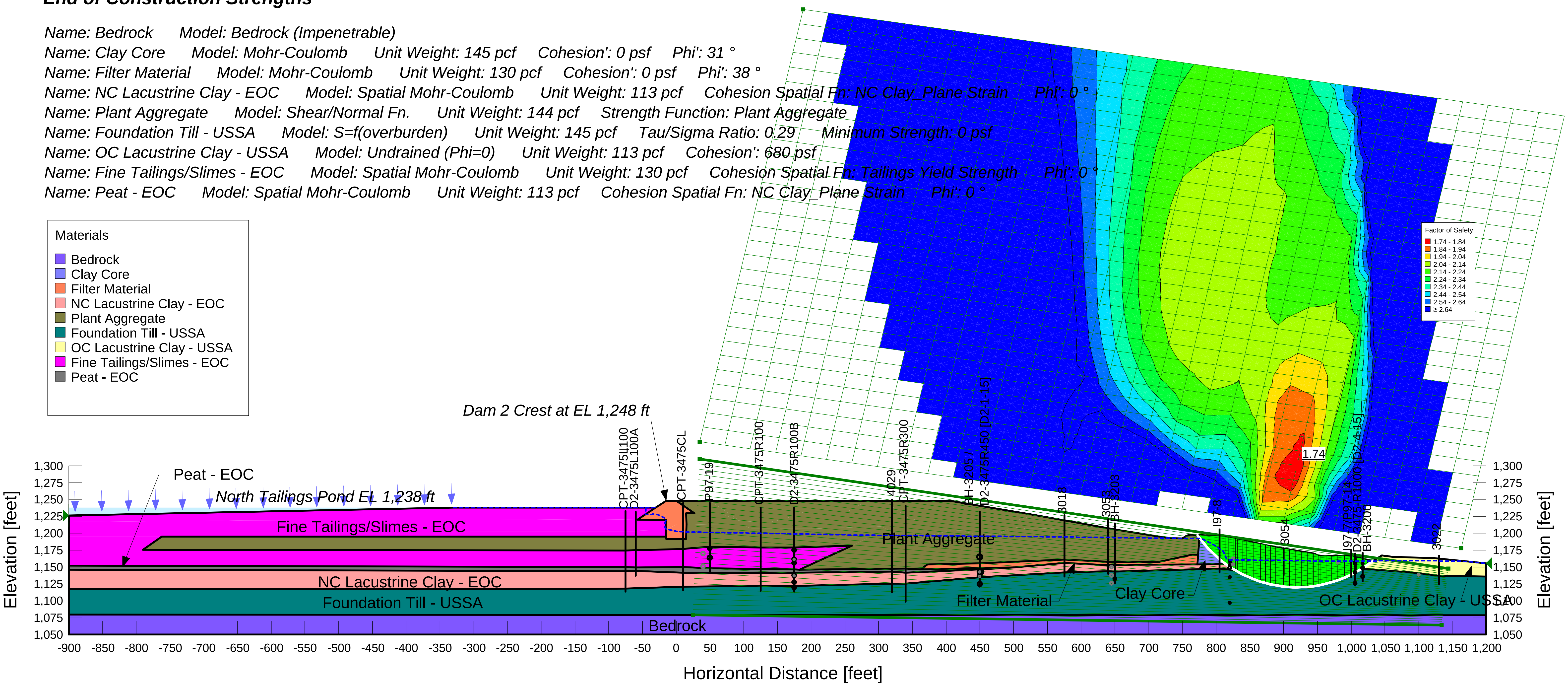
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Future Beach
Stability Analysis
Analysis: d.2.1 Dam 2 Raise_EOC
Last Saved Date: 3/31/2016

Factor of Safety: 1.74

BARR

Tailings Pond at 1,238 feet
End of Construction Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: NC Lacustrine Clay - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - EOC Model: Spatial Mohr-Coulomb Unit Weight: 130 pcf Cohesion Spatial Fn: Tailings Yield Strength Phi': 0 °
Name: Peat - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °



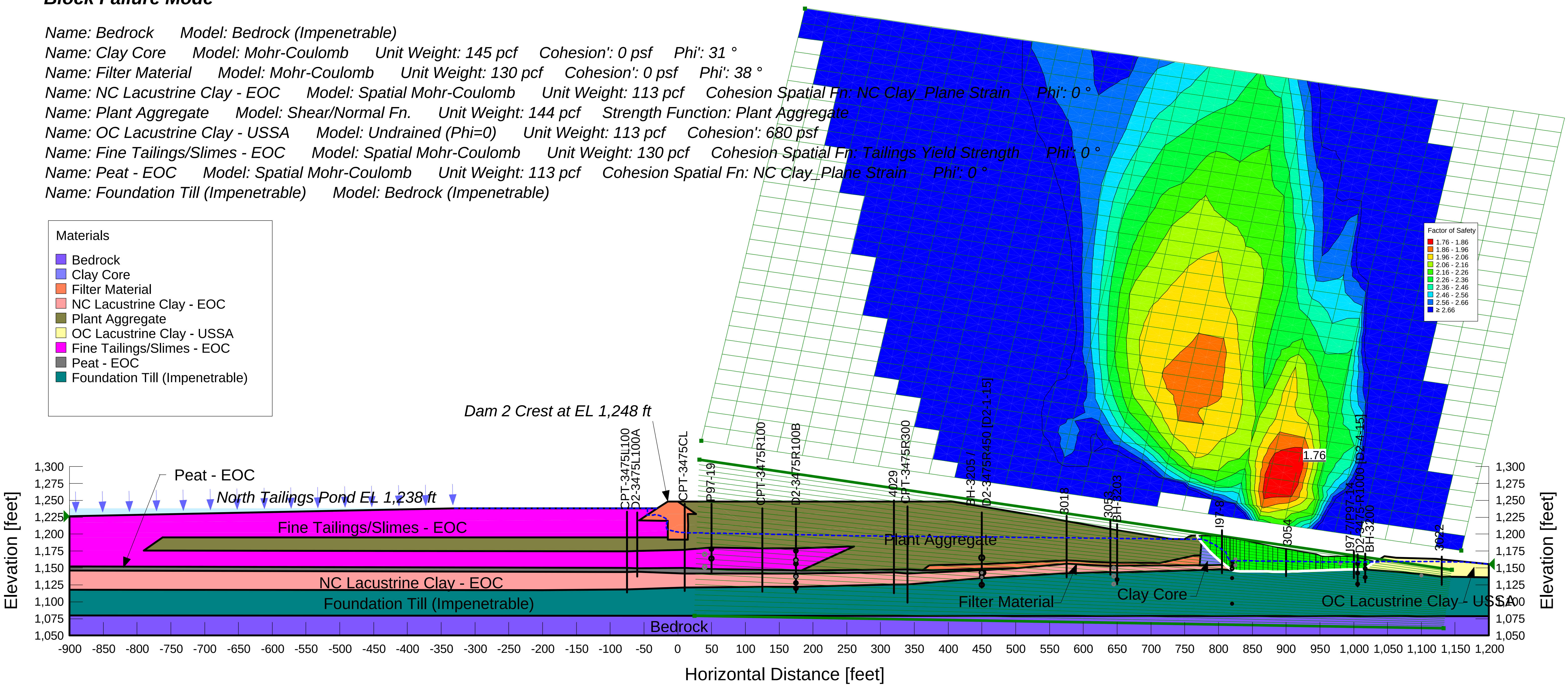
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, North Pond at 1,238 ft, Future Beach
Stability Analysis
Analysis: d.2.2.1 Dam 2 Raise_EOC_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,238 feet
End of Construction Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: NC Lacustrine Clay - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - EOC Model: Spatial Mohr-Coulomb Unit Weight: 130 pcf Cohesion Spatial Fn: Tailings Yield Strength Phi': 0 °
Name: Peat - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



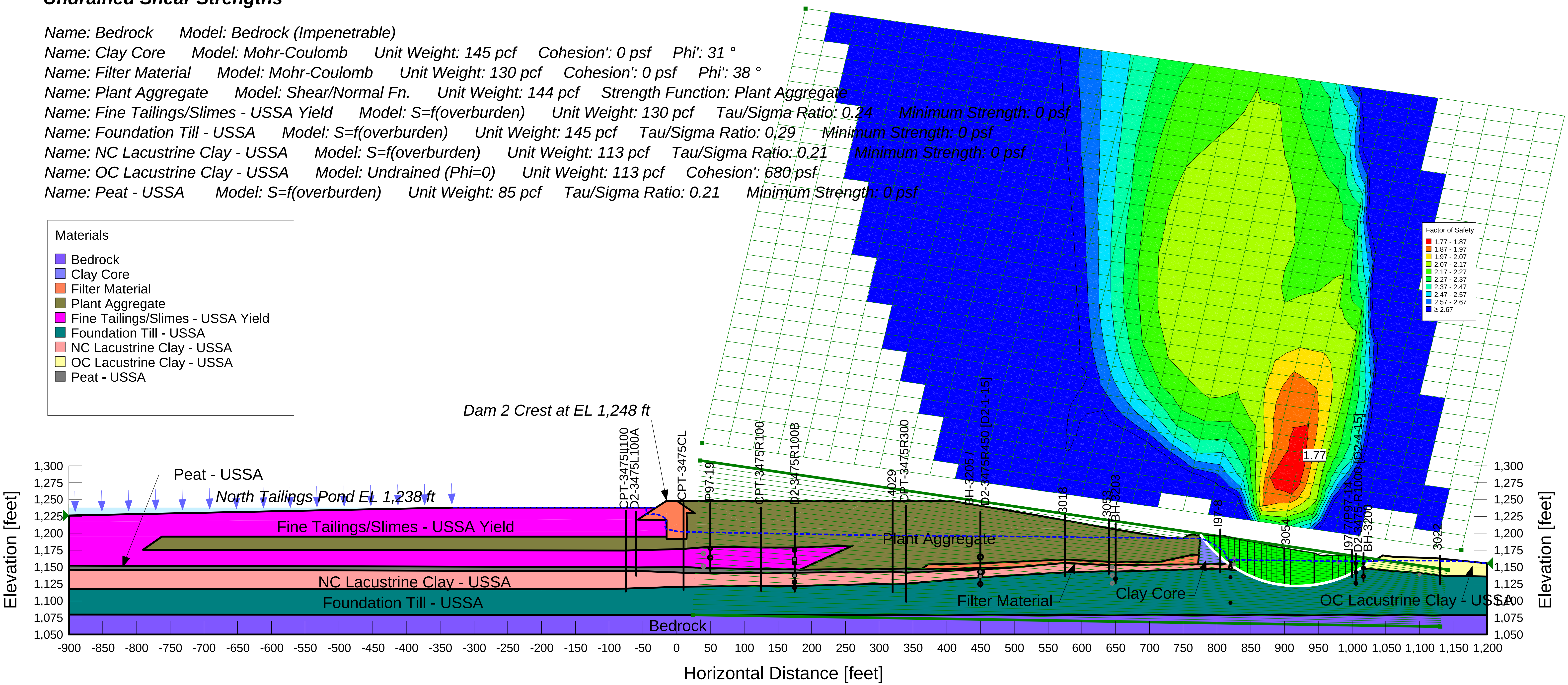
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,238 ft
Stability Analysis
Analysis: d.3.1 Dam 2 Raise_FT Yield Strength
Last Saved Date: 3/31/2016

Factor of Safety: 1.77

BARR

Tailings Pond at 1,238 feet
Undrained Shear Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Fine Tailings/Slimes - USSA Yield Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.24 Minimum Strength: 0 psf
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf



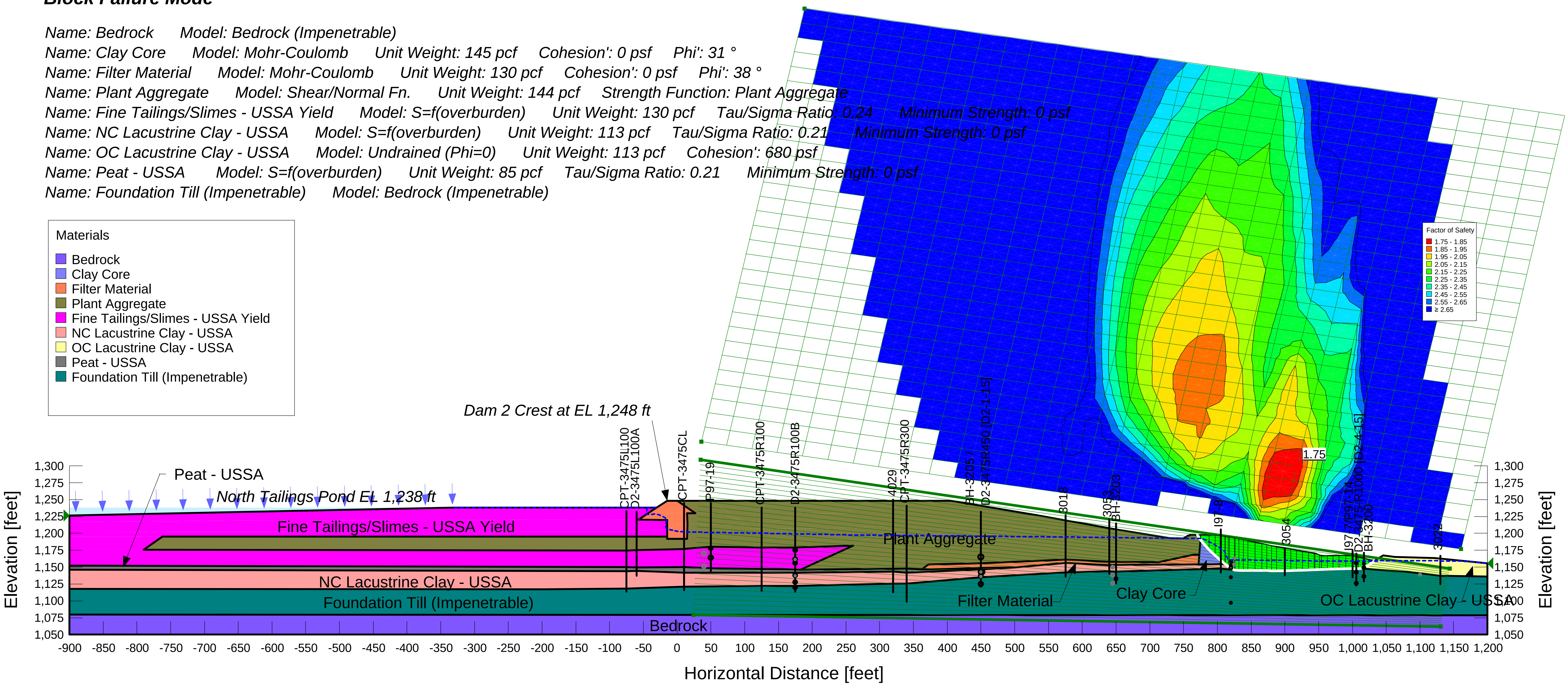
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,238 ft
Stability Analysis
Analysis: d.3.2 Dam 2 Raise_FT Yield Strength_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.75

BARR

Tailings Pond at 1,238 feet
Undrained Shear Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Fine Tailings/Slimes - USSA Yield Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.24 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



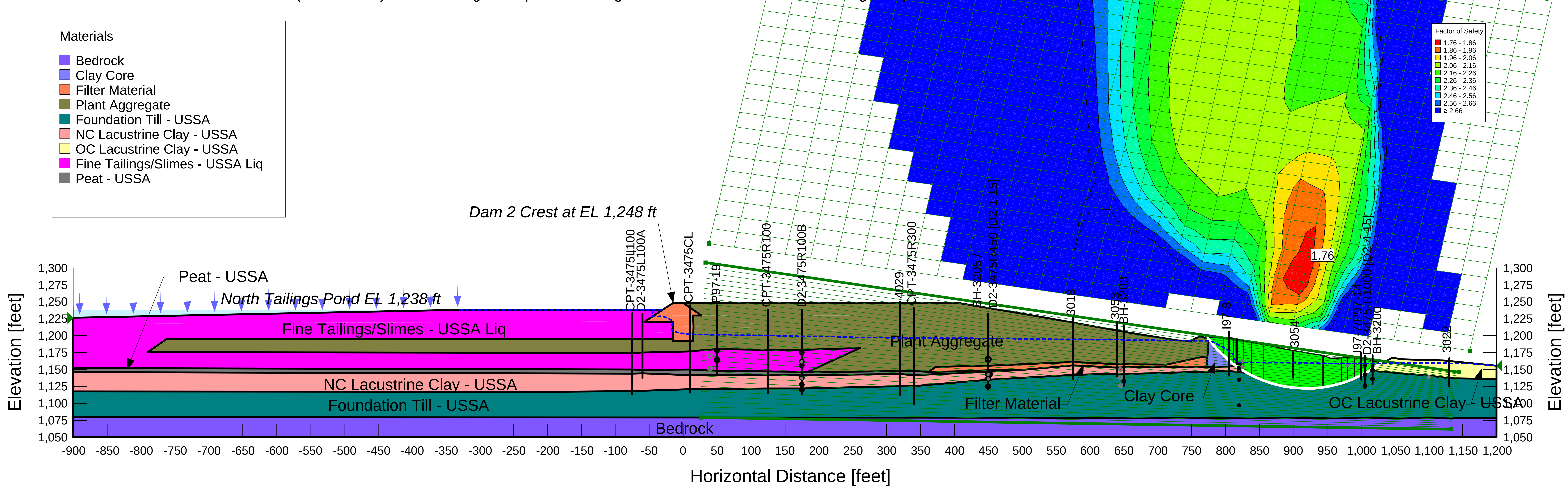
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,238 ft
Stability Analysis
Analysis: d.4.1 Dam 2 Raise_FT Liquefied Strength
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,238 feet
Undrained Shear Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - USSA Liq Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.1 Minimum Strength: 0 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf



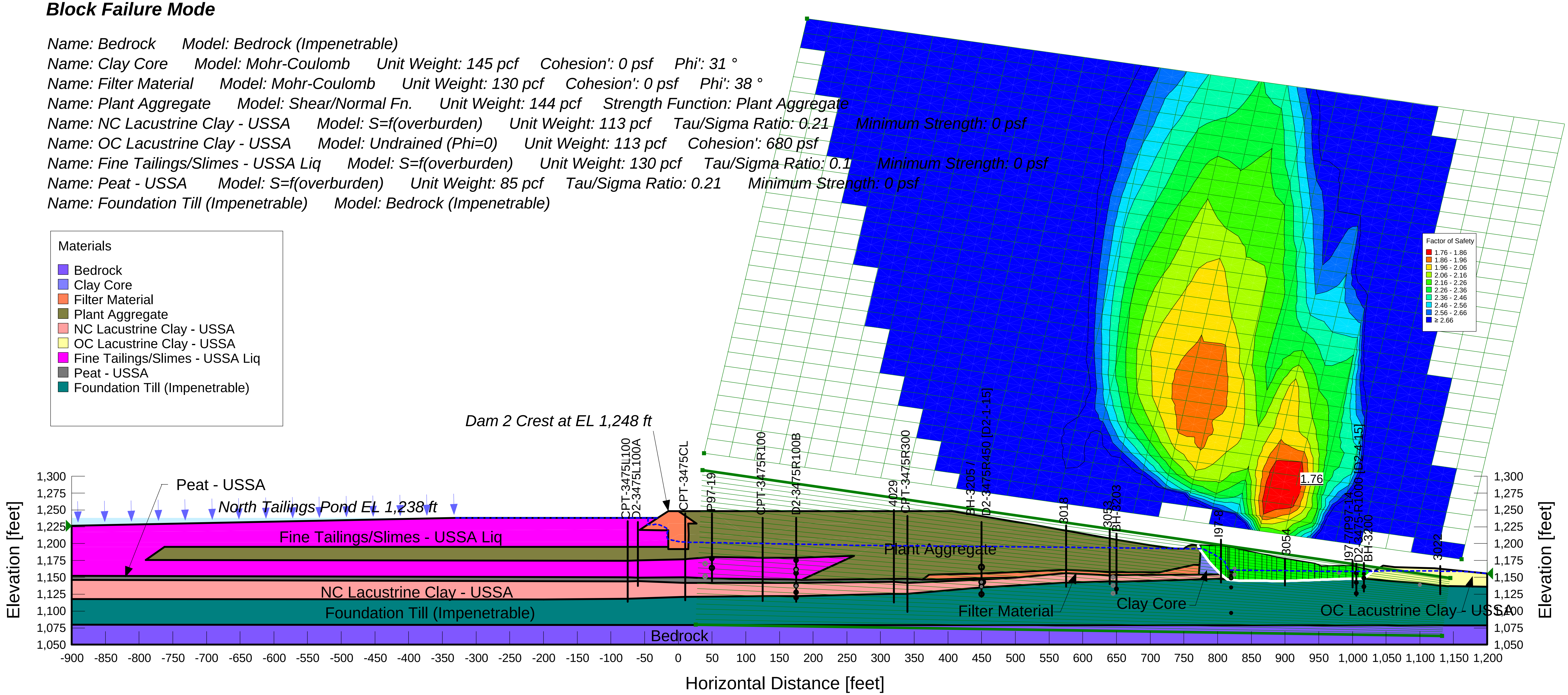
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,238 ft
Stability Analysis
Analysis: d.4.2 Dam 2 Raise_FT Liquefied Strength_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,238 feet
Undrained Shear Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - USSA Liq Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.1 Minimum Strength: 0 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)

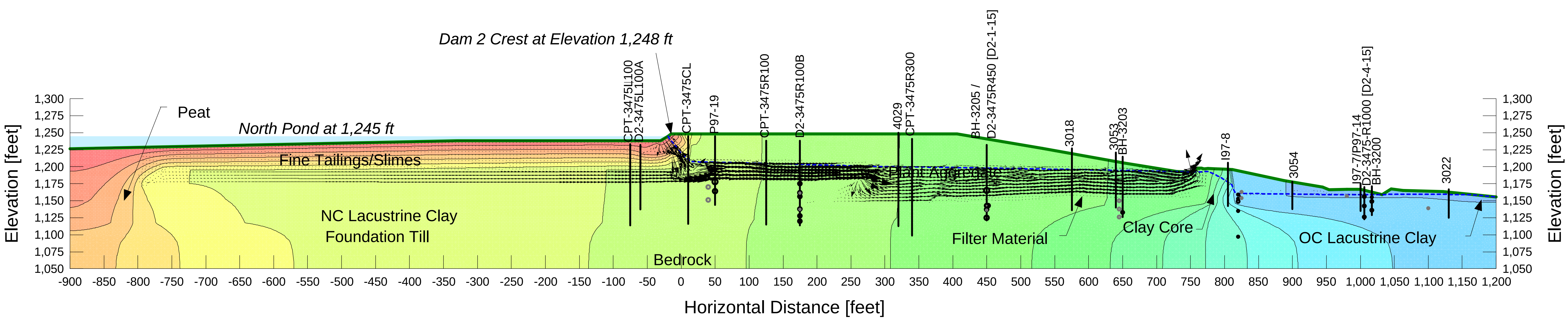


Dam 2 Crest at 1,248 feet, North Pond at 1,245 feet, Future Beach

Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Pond at 1,245 ft, Future Beach
Seepage Analysis
Analysis: E.0 Dam 2 Raise_1,245ft Pond and Future Beach
Last Saved Date: 3/31/2016

Contours are Total Head [feet]
Tailings Pond at 1,245 feet
Future Beach

Name: Bedrock   Model: Saturated Only   Sat Kx: 3e-010 ft/sec   Ky'/Kx' Ratio: 1   Volumetric Water Content: 0.2 ft³/ft³   Mv: 4.79e-007 /psf
Name: Clay Core   Model: Saturated / Unsaturated   K-Function: CLAY CORE TILL, Ksat = 1.25e-8 ft/s   Ky'/Kx' Ratio: 1
Name: Filter Material   Model: Saturated / Unsaturated   K-Function: FILTER BERM, Ksat = 6.56e-5 ft/s   Ky'/Kx' Ratio: 1
Name: Plant Aggregate   Model: Saturated / Unsaturated   K-Function: COARSE TAILINGS/PLANT AGG, Ksat = 2.62e-3 ft/s   Ky'/Kx' Ratio: 1
Name: NC Lacustrine Clay   Model: Saturated / Unsaturated   K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s   Ky'/Kx' Ratio: 1.11
Name: OC Lacustrine Clay   Model: Saturated / Unsaturated   K-Function: LACUSTRINE CLAY OC, Horizontal Ksat = 7.74e-7 ft/s   Ky'/Kx' Ratio: 0.015
Name: Peat   Model: Saturated / Unsaturated   K-Function: LACUSTRINE CLAY NC, Horizontal Ksat = 6.62e-7 ft/s   Ky'/Kx' Ratio: 1
Name: Foundation Till   Model: Saturated / Unsaturated   K-Function: FOUNDATION TILL, Horizontal Ksat = 3.99e-7 ft/s   Ky'/Kx' Ratio: 0.111
Name: Fine Tailings/Slimes   Model: Saturated / Unsaturated   K-Function: FINE TAILINGS, Ksat = 1.31e-6 ft/s   Ky'/Kx' Ratio: 1



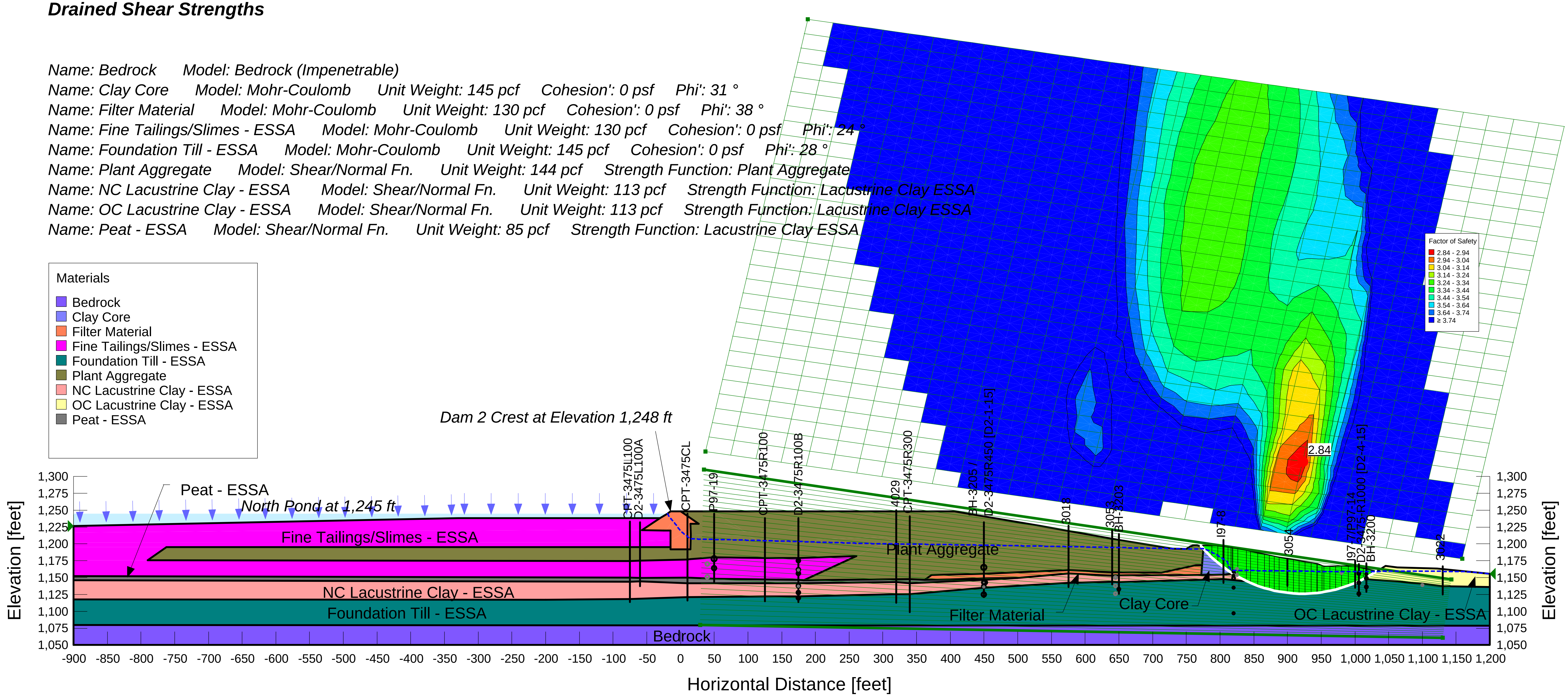
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,245 ft
Stability Analysis
Analysis: e.1.1 Dam 2 Raise_ESSA
Last Saved Date: 03/31/2016

Factor of Safety: 2.84

BARR

Tailings Pond at 1,245 feet
Drained Shear Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Fine Tailings/Slimes - ESSA Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 24 °
Name: Foundation Till - ESSA Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 28 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: OC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: Peat - ESSA Model: Shear/Normal Fn. Unit Weight: 85 pcf Strength Function: Lacustrine Clay ESSA



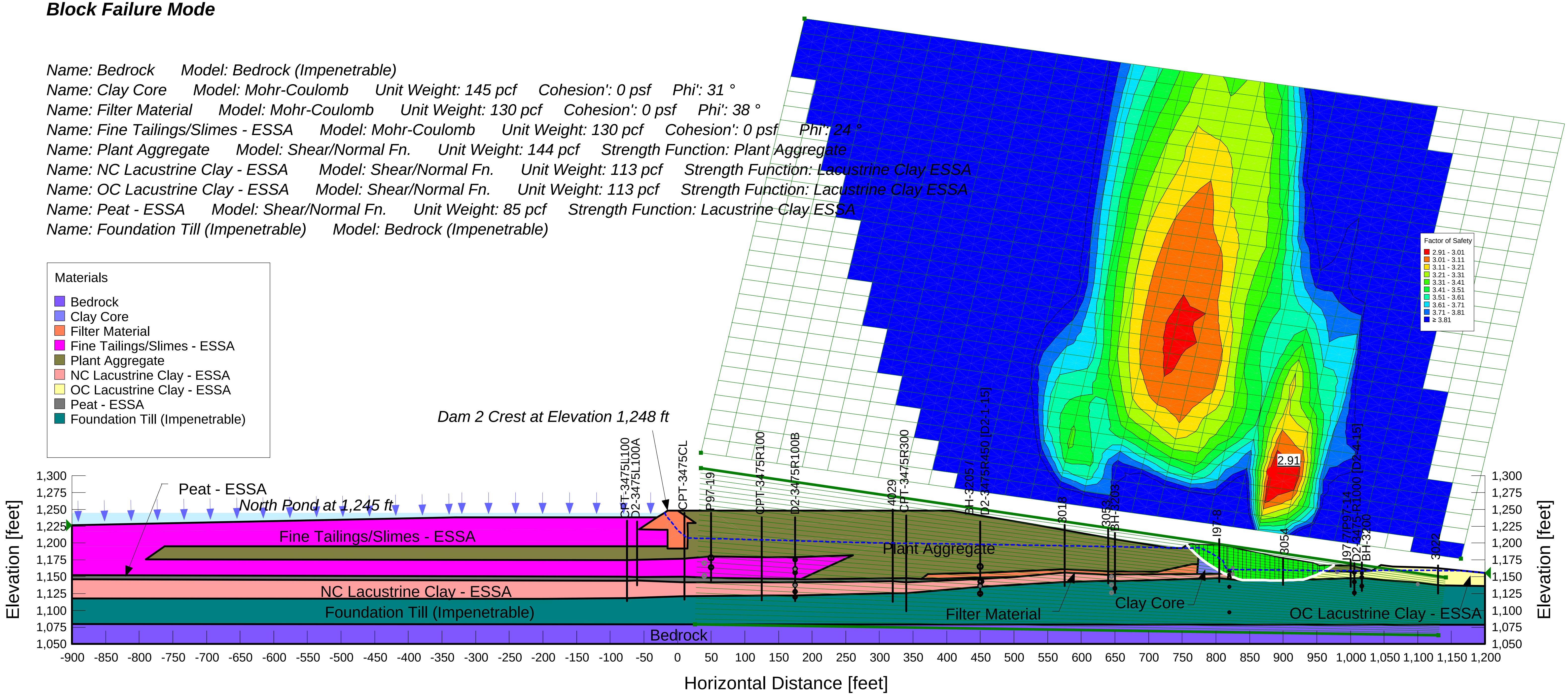
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,245 ft
Stability Analysis
Analysis: e.1.2 Dam 2 Raise_ESSA_BF
Last Saved Date: 3/31/2016

Factor of Safety: 2.91

BARR

Tailings Pond at 1,245 feet
Drained Shear Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Fine Tailings/Slimes - ESSA Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 24 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: OC Lacustrine Clay - ESSA Model: Shear/Normal Fn. Unit Weight: 113 pcf Strength Function: Lacustrine Clay ESSA
Name: Peat - ESSA Model: Shear/Normal Fn. Unit Weight: 85 pcf Strength Function: Lacustrine Clay ESSA
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



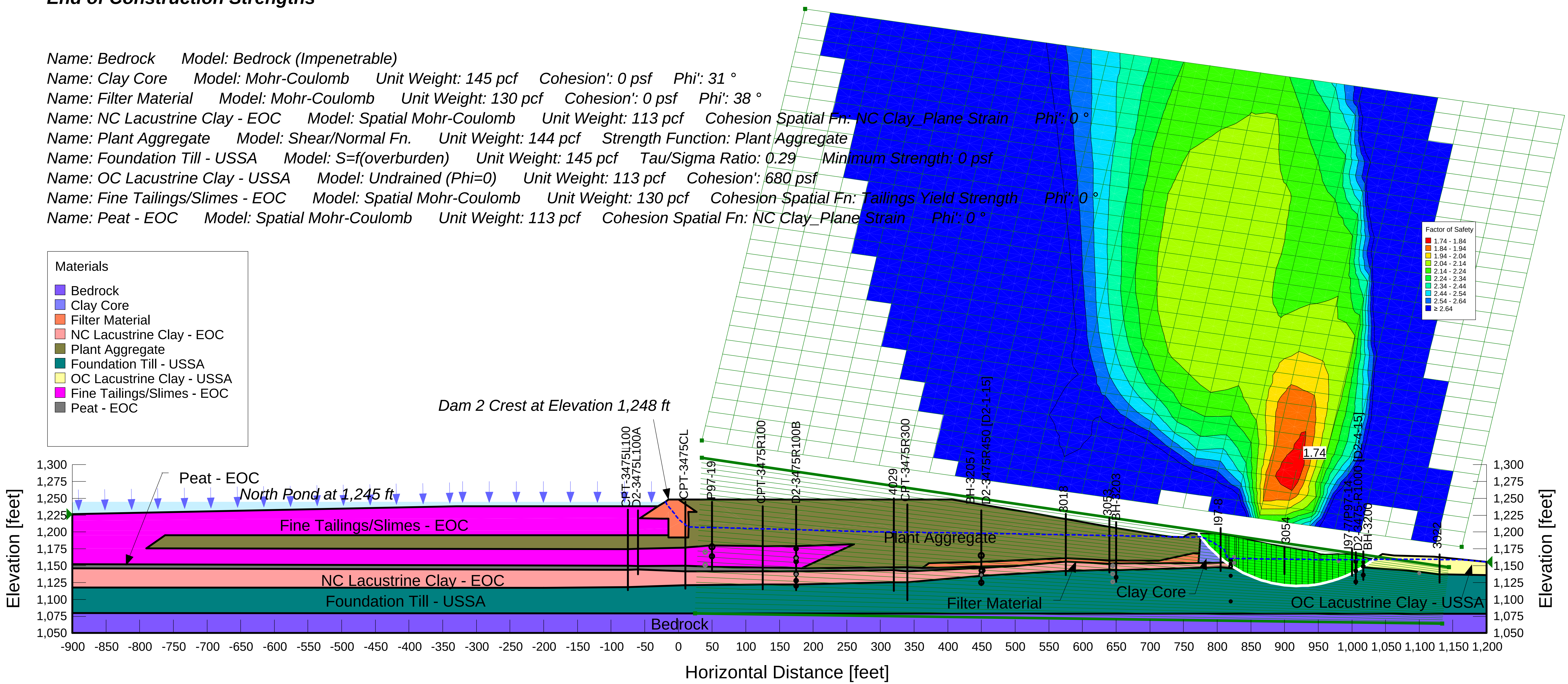
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,245 ft
Stability Analysis
Analysis: e.2.1 Dam 2 Raise_EOC
Last Saved Date: 3/31/2016

Factor of Safety: 1.74

BARR

Tailings Pond at 1,245 feet
End of Construction Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: NC Lacustrine Clay - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - EOC Model: Spatial Mohr-Coulomb Unit Weight: 130 pcf Cohesion Spatial Fn: Tailings Yield Strength Phi': 0 °
Name: Peat - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °



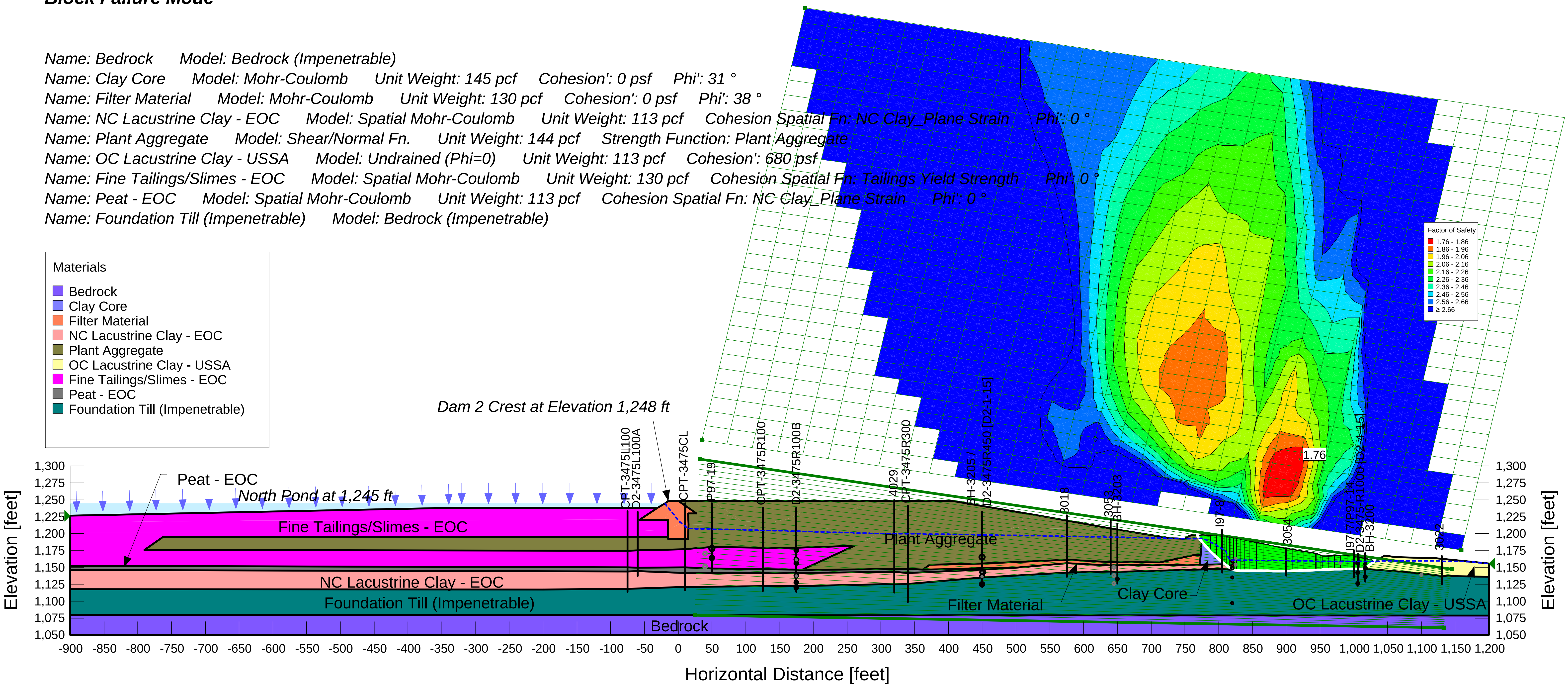
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,245 ft
Stability Analysis
Analysis: e.2.2.1 Dam 2 Raise_EOC_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,245 feet
End of Construction Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: NC Lacustrine Clay - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - EOC Model: Spatial Mohr-Coulomb Unit Weight: 130 pcf Cohesion Spatial Fn: Tailings Yield Strength Phi': 0 °
Name: Peat - EOC Model: Spatial Mohr-Coulomb Unit Weight: 113 pcf Cohesion Spatial Fn: NC Clay_Plane Strain Phi': 0 °
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



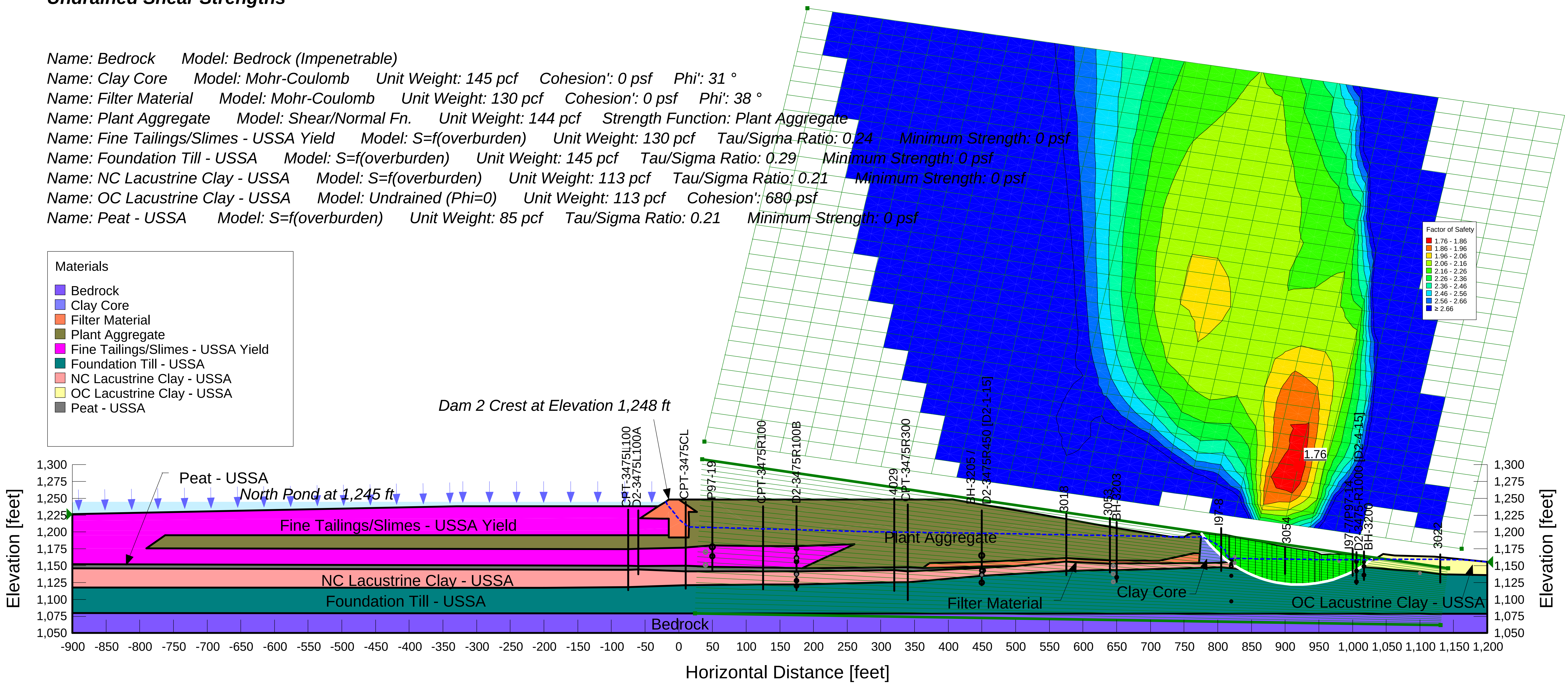
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,245 ft
Stability Analysis
Analysis: e.3.1 Dam 2 Raise_FT Yield Strength
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,245 feet
Undrained Shear Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Fine Tailings/Slimes - USSA Yield Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.24 Minimum Strength: 0 psf
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf



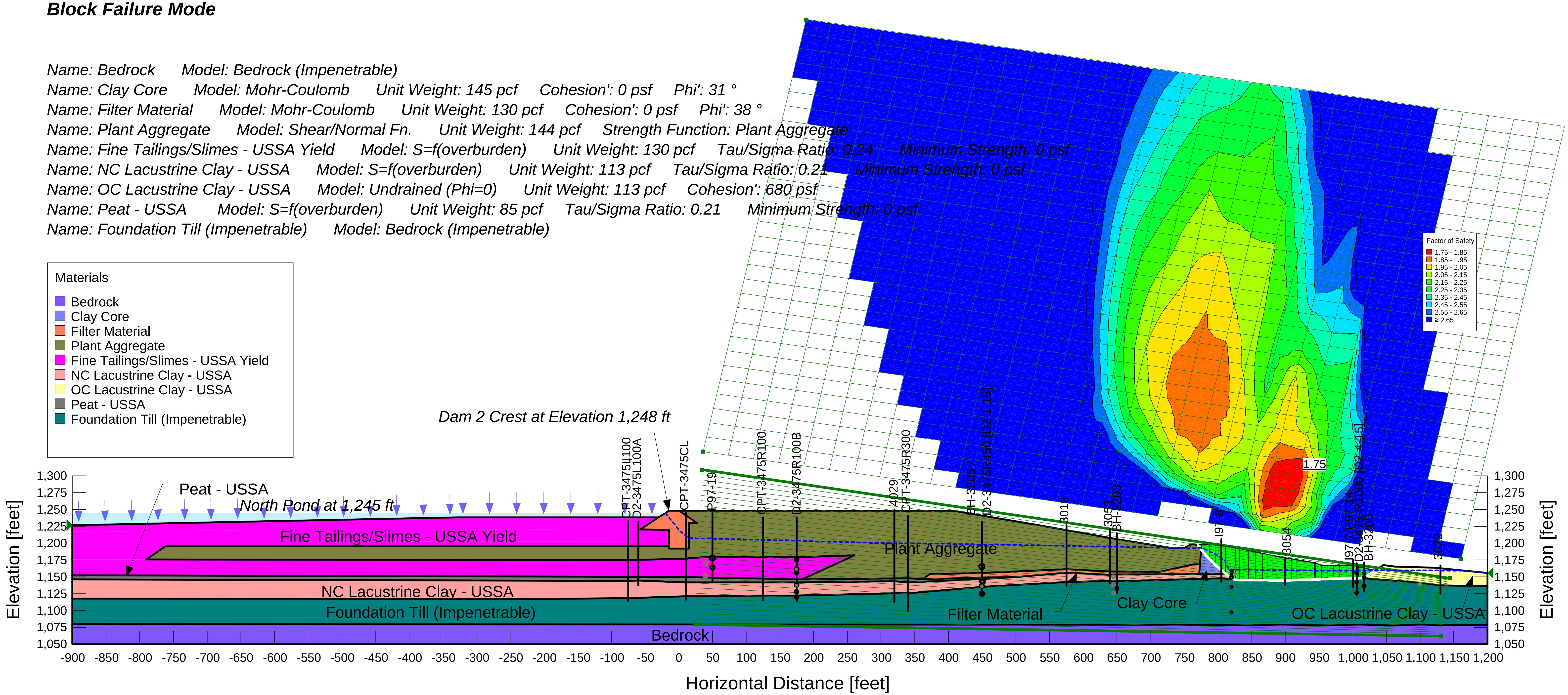
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,245 ft
Stability Analysis
Analysis: e.3.2 Dam 2 Raise_FT Yield Strength_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.75

BARR

Tailings Pond at 1,245 feet
Undrained Shear Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Fine Tailings/Slimes - USSA Yield Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.24 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)



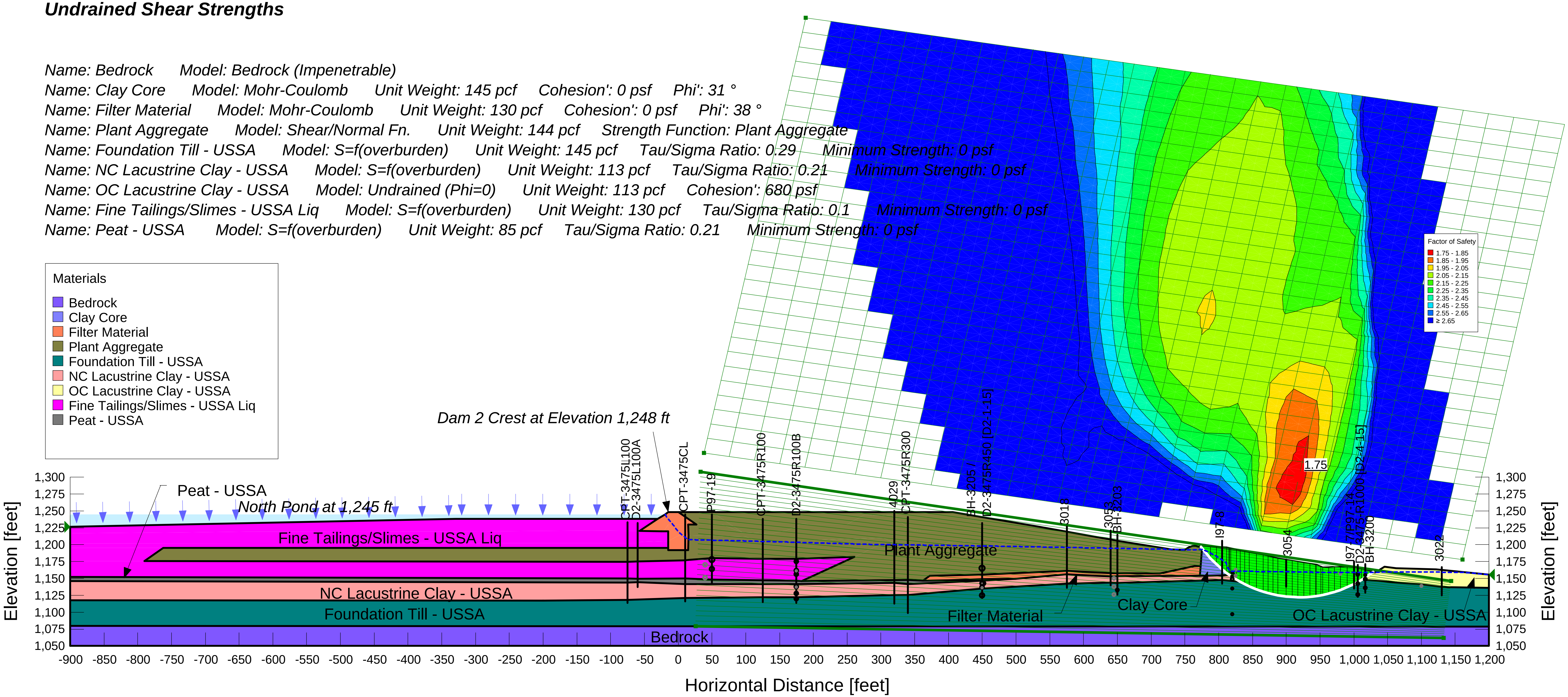
Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,245 ft
Stability Analysis
Analysis: e.4.1 Dam 2 Raise_FT Liquefied Strength
Last Saved Date: 3/31/2016

Factor of Safety: 1.75

BARR

Tailings Pond at 1,245 feet
Undrained Shear Strengths

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: Foundation Till - USSA Model: S=f(overburden) Unit Weight: 145 pcf Tau/Sigma Ratio: 0.29 Minimum Strength: 0 psf
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - USSA Liq Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.1 Minimum Strength: 0 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf



Northshore Mining Company, Dam 2
Station 34+75, Dam Crest at 1,248 ft, Future Beach, Pond at 1,245 ft
Stability Analysis
Analysis: e.4.2 Dam 2 Raise_FT Liquefied Strength_BF
Last Saved Date: 3/31/2016

Factor of Safety: 1.76

BARR

Tailings Pond at 1,245 feet
Undrained Shear Strengths
Block Failure Mode

Name: Bedrock Model: Bedrock (Impenetrable)
Name: Clay Core Model: Mohr-Coulomb Unit Weight: 145 pcf Cohesion': 0 psf Phi': 31 °
Name: Filter Material Model: Mohr-Coulomb Unit Weight: 130 pcf Cohesion': 0 psf Phi': 38 °
Name: Plant Aggregate Model: Shear/Normal Fn. Unit Weight: 144 pcf Strength Function: Plant Aggregate
Name: NC Lacustrine Clay - USSA Model: S=f(overburden) Unit Weight: 113 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: OC Lacustrine Clay - USSA Model: Undrained (Phi=0) Unit Weight: 113 pcf Cohesion': 680 psf
Name: Fine Tailings/Slimes - USSA Liq Model: S=f(overburden) Unit Weight: 130 pcf Tau/Sigma Ratio: 0.1 Minimum Strength: 0 psf
Name: Peat - USSA Model: S=f(overburden) Unit Weight: 85 pcf Tau/Sigma Ratio: 0.21 Minimum Strength: 0 psf
Name: Foundation Till (Impenetrable) Model: Bedrock (Impenetrable)