APPENDIX F
GEOLOGICAL RESOURCES

CHJ Consultants
1355 E. Cooley Drive, Suite C, Colton, CA 92324 ◆ Phone (909) 824-7311 ◆ Fax (909) 503-1136
15345 Anacapa Road, Suite D, Victorville, CA 92392 ◆ Phone (760) 243-0506 ◆ Fax (760) 243-1225
77-564A Country Club Drive, Suite 122, Palm Desert, CA 92211 ◆ Phone (760) 772-8234 ◆ Fax (909) 503-1136

August 21, 2013

Omya California
A Division of Omya, Incorporated
7225 Crystal Creek Road
Lucerne Valley, California 92356
Attention: Mr. Howard Brown

Job No. 12121-8

Dear Mr. Brown:

This letter transmits two copies of the geotechnical consultation services report for the northwest slope of White Knob quarry, prepared for a proposed Amended Plan of Operations for the Omya California, White Knob quarry, located south of Lucerne Valley, California.

We appreciate this opportunity to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact this firm at your convenience.

Respectfully submitted,
CHJ CONSULTANTS

John S. McKeown

John S. McKeown, E.G. 2396
Project Geologist

JMc/JJM:jm/tlw

Distribution: OMYA California, Inc. (2)

UPDATE TO SLOPE STABILITY INVESTIGATION
PROPOSED AMENDED PLAN OF OPERATIONS
FOR THE
WHITE KNOB QUARRY
LUCERNE VALLEY, CALIFORNIA
PREPARED FOR
OMYA CALIFORNIA
A DIVISION OF OMYA, INC.
JOB NO. 12121-8

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1355 E. Cooley Drive, Suite C, Colton, CA 92324 ◆ Phone (909) 824-7311 ◆ Fax (909) 503-1136
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77-564A Country Club Drive, Suite 122, Palm Desert, CA 92211 ◆ Phone (760) 772-8234 ◆ Fax (909) 503-1136

November 21, 2012

Omya California
A Division of Omya, Incorporated
7225 Crystal Creek Road
Lucerne Valley, California 92356
Attention: Mr. Howard Brown

Job No. 12121-8

Dear Mr. Brown:

Attached herewith is the geotechnical consultation services report for the northwest slope of White Knob quarry, prepared for a proposed Amended Plan of Operations for the Omya California, White Knob quarry, located south of Lucerne Valley, California.

This report was based upon a scope of services generally outlined in our proposal, dated September 26, 2012 and other written and verbal communications.

We appreciate this opportunity to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact this firm at your convenience.

Respectfully submitted,
CHJ CONSULTANTS

John S. McKeown

John S. McKeown, E.G.
Project Geologist

JMc/JJM:tlw

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INTRODUCTION

From March to October of 2012, this firm provided geotechnical consultation for an Amended Plan of Operations for the Omya Incorporated White Knob quarry located in the Lucerne Valley area of San Bernardino County, California. Our services included evaluation of an area located northwest of the White Knob quarry area referred to herein as the northwest slope. The purpose of our evaluation is to characterize the stability and condition of the northwest slope and to provide geotechnical recommendations for possible incorporation into the mining plan with regard to mitigation of fines sediment transport within the Western Drainage located below the northwest slope. Future mining operations are planned in the White Knob Annex area, located adjacent to the northwest slope and the White Ridge deposit to the east, and mitigation strategies to limit boulder roll down and fines transport are desired prior to operations in the Annex and White Ridge quarries.

To orient our investigation, we reviewed the following documents:

- Detailed Geologic Map of the White Knob White Ridge area San Bernardino Mountains by Howard Brown, dated June 1989, scale 1" = 50', contour interval = 10 feet

- Topographic map by Digital Mapping, Incorporated from aerial survey dated 2009, scale 1" = 50', 5-foot contour interval

- Draft 1 - Talus Slope Impact on Ruby Springs, Western Drainage, OMYA White Knob Quarry, Lucerne Valley, California, by DCI (Dean Consulting, Incorporated), dated September 12, 2011

- White Knob Haul Road Drainage Study and Plan of Development by Stantec, dated August 2011

- Orthophoto-based contour map - White Knob Placer Claim by American Aerial Surveys, dated June 24, 1983; scale 1" = 100', 25-foot contour interval

- Orthophoto-based contour map - White Knob area, untitled, dated November 7, 1988

- CHJ, Incorporated, Slope Stability Investigation, Proposed South and West Quarry Expansion, OMYA California, Inc. Sentinel Quarry, Lucerne Valley, California, CHJ Job No. 03475-8, report dated July 8, 2003.

- CHJ, Incorporated, Debris Slope at OMYA White Knob Quarry, Lucerne Valley, San Bernardino County, California, CHJ Job No. 051117-8, letter report dated January 5, 2006.

- CHJ, Incorporate, Revised Slope Stability Investigation, Proposed Amended Plan of Operations, for the White Knob Quarry, OMYA California, Inc., Lucerne Valley, California, CHJ Job No. 07539-8, report dated April 30, 2008.

The approximate location of the quarry area is shown on the attached Index Map (Enclosure "A-1").

The results of our evaluation, together with our conclusions and recommendations, are presented in this report.

SCOPE OF SERVICES

The scope of services provided during this geotechnical consultation included the following:

- Review of published and unpublished literature and maps including geologic mapping by Mr. Howard Brown, Omya's geologist

- Review aerial imagery dated 1983, 1988, 2002, 2003, 2005, 2006, 2007 and 2009

- Review of OMYA mine plans

- Review of previous CHJ studies

- Geologic mapping of the northwest slope area

- Geologic evaluation and slope stability calculations of the existing talus rock slopes under static and seismic conditions
- Evaluation of rockfall potential based on field observations and use of a simulation program to estimate velocities and bounce heights
- Evaluation of the geologic data and the results of our slope stability and rockfall evaluations to develop recommendations for mitigation of potential hazards and sedimentation.
- Evaluation of future slopes and embankments

NORTHWEST SLOPE PROJECT CONSIDERATIONS

As we observed during a site visit on December 20, 2012, an approximately 700-foot-high slope on the northwesterly side of the White Knob quarry includes talus created by inadvertent boulder roll down during blasting and excavation in the White Knob quarry area. A formal stability analysis was performed to evaluate the stability conditions of the slope. Potential solutions were suggested to address the slope conditions with regard to rockfall and sediment movement into the Western Drainage from existing talus and during future mining activity at White Knob and White Knob Annex. Enclosure "A-2.1" depicts the geologic conditions in the northwest slope area and general site features. Enclosures "A-2.2" and "A-2.3" present representative cross sections of the northwest slope.

PRIOR INVESTIGATIONS - WHITE KNOB QUARRY:

In a letter report, dated January 5, 2006, we summarized observations made in June 2006 of the northwest slope at the White Knob quarry and provided suggestions for reduction of sediment to the channel located at the toe of the slope. Our suggestions at the time included: (1) containing the debris with gabion-type wire mesh such as those used on rock slopes, (2) the construction of a berm along the toe of the debris or (3) the construction of a debris basin within the channel. As part of the current scope of services, we have re-evaluated these items as discussed herein.

In a reports dated 2006, 2007 and 2008, we presented slope stability studies for a proposed amended plan of operation for the White Knob quarry. The 2007/2008 investigation included geologic mapping, a review and discussion of geologic hazards, including faulting and seismicity, and a review of groundwater conditions. In addition, kinematic evaluation of proposed rock slopes and slope stability calculations and evaluation of proposed rock and fill slopes, were performed.

In the area northwest of the White Knob deposit, a natural talus slope mantled with boulder talus descends to a northeast-trending ephemeral drainage channel (Western Drainage). Inadvertent boulder roll down of white rock materials has occurred on this slope face and is of concern to downstream features. We previously evaluated the conditions of the slope and provided options for mitigation of the boulder roll down in a letter dated January 5, 2006. A modified blasting and mining procedure has been implemented in the area above the talus slope to help mitigate further addition of quarry material on to the talus slope.

Proposed mining plan amendments, general geology and geologic hazards including faulting, seismicity and slope stability for the White Knob quarry were discussed in our prior report dated April 30, 2008. Based on previously-presented stability calculations performed for bedrock slopes at the site, the underlying bedrock is considered grossly stable to landsliding; therefore, our stability evaluation for the northwest slope is limited to the colluvium/talus forming a surficial veneer on the bedrock surface.

SITE DESCRIPTION

The White Knob quarry is located in the northern San Bernardino Mountains, approximately 6 miles southwest of the town of Lucerne Valley. The quarry occupies portions of Sections 7 and 8, Township 3 North, Range 1 West, of San Bernardino Base & Meridian (SBB&M). Access to the quarry is by a haul road extending 6 miles west-southwesterly from the Omya Incorporated processing plant located on Crystal Creek Road. The White Knob quarry produces high-purity calcium carbonate limestone used for numerous commercial and industrial applications, including plastics and paints. The high-purity calcium carbonate limestone deposits required for these applications are typically white in color. The more common gray limestone deposits are not

considered suitable for such applications. The White Knob quarry area includes mining areas designated White Knob and White Knob Annex and a future mining area designated as White Ridge. The White Ridge area is not mined at this time.

REGIONAL GEOLOGIC SETTING:

The Omya Incorporated White Knob quarry lies in the northern portion of the San Bernardino Mountains. The San Bernardino Mountains are part of the Transverse Ranges Geomorphic Province. The San Bernardino Mountains are characterized by remnants of a relatively flat, uplifted geomorphic surface as old as Miocene in age. These discontinuous geomorphic remnants are separated by steep-walled canyons and prominent peaks. The White Knob quarry is located on the north flank of the mountains. The Mojave Desert Geomorphic Province is located to the north of the site. The general geologic structure and lithology of the site region are shown on Enclosure "A-3", Geologic Index Map adapted from Miller et al. (2000).

The following with regard to the regional geology of the mine area is adapted from information provided by Mr. Howard Brown, Exploration and Mining Geologist with Omya Incorporated.

> Brown (1984a, 1984b, 1985a, 1985b, 1986, 1991a, 1991b, 2008a) has presented numerous reports, presentations and papers regarding the regional geologic setting of the San Bernardino Mountains and Mojave Desert area as summarized below. A variety of rocks of Precambrian to recent age are exposed within the San Bernardino Mountains and the White Knob/White Ridge quarry area. Late Precambrian and Paleozoic metasedimentary rocks unconformably overlie older 1.8 b.y. Baldwin Gneiss Precambrian basement.
>
> Late Proterozoic and Paleozoic sequences in the San Bernardino Mountains contain elements of both cratonal and miogeoclinal affinity. The lower part of the sequence is dominated by quartzite of the Stirling Quartzite, Wood Canyon Formation, and Zabriskie quartzite. The Cambrian Carrara Formation contains both clastic and carbonate members. Cambrian strata are dominated by dolomite of the Bonanza King and Nopah Formations. A major unconformity is present between Upper Cambrian and Devonian strata throughout the Mojave region and San Bernardino Mountains. In the San Bernardino Mountains, Upper Precambrian and Lower Cambrian rocks are of miogeoclinal aspect, middle Cambrian strata are of cratonal aspect, and upper Paleozoic rocks are identical to inner miogeoclinal facies of the central and eastern Mojave region.

Upper Paleozoic rocks including upper Devonian, Mississippian and Pennsylvanian through Permian are dominated by limestone. High brightness, high purity crystalline limestone deposits occur in upper Paleozoic miogeoclinal limestone formations in the San Bernardino Mountains and at White Knob quarry. The Mississippian Monte Cristo Limestone is mined for high brightness, high purity calcium carbonate, and the Pennsylvanian Bird Spring Formation is extensively mined for cement grade limestone. Fluorescent minerals at the White Knob quarry occur in the Monte Cristo Limestone.

Several varieties of Permo-Triassic and Mesozoic age intrusive rocks are present in the San Bernardino Mountains, and include Permo-Triassic monzonites, quartz monzonite and granodiorite, Jurassic quartz monzonite, hornblende diorite and gabbro, and leucocratic batholithic quartz monzonites of Cretaceous age. Plutonic rocks form the majority of the mountain range, and the Paleozoic rocks described above were intruded by the plutonic rocks and form roof pendants. At the White Knob quarry, several generations of intrusive rocks are present and cross cutting relationships can be observed.

The Late Proterozoic and Paleozoic rocks have been affected by both regional and contact metamorphism. Regional metamorphism ranges from upper Greenschist to upper Amphibolite facies. At the White Knob quarry the metasedimentary rocks have been metamorphosed to upper amphibolite facies based on the presence of diopside, vesuvianite, wollastonite and garnet bearing calc-silicate minerals. Contact metamorphism is widespread, and numerous small skarn deposits are present along some contacts between metasedimentary and intrusive rocks.

Several major intrusive, metamorphic and tectonic events have been recognized in the San Bernardino Mountains. These include complex multi-phase Permo-Triassic and Mesozoic age folding and thrust faulting, contact and regional metamorphism, and intrusive events.

Cenozoic activity includes several generations of high and low angle faults, and mild folding. The San Bernardino Mountains area continues to be seismically active as evidenced by the significant earthquakes in the area during the last 15 years.

The Old Woman Sandstone consists of massive to weakly bedded arkosic and locally conglomeratic sandstone that crops out discontinuously in the northern San Bernardino Mountains and Mojave Desert region. Shreve (1959) suggests northward deposition of this sandstone in an alluvial-fan environment from an early San Bernardino Mountains highland. Quaternary deposits mapped by Miller et al. (2000) include alluvial fan, axial valley, talus, colluvial, surficial, and landslide deposits ranging in age from very old (Pleistocene) to recent (Holocene) age. Sediments within the mining area are primarily comprised of colluvium and surficial sediments as thin slope mantling soils and in drainage channels as thin veneers on bedrock channels.

At the White Knob Quarry, rocks have been multiply metamorphosed to amphibolite and locally granulite facies, forming exceedingly coarse-grained, very white translucent calcite marble. Individual calcite rhombs are commonly over 1 inch across. The steeply dipping deposit is over 1,500 feet along strike, and is exposed over 1,200 feet vertically.

The complex geologic history of the San Bernardino Mountains has allowed the formation of several large high brightness, high purity limestone deposits which are currently being mined or will be mined in the future.

LOCAL GEOLOGIC SETTING:

The White Knob quarry occupies an east-west oriented resistant and rugged limestone ridge formed in the very steep north-sloping topography of the northern San Bernardino Mountains. Natural slopes descend to the north and northwest from the ridge of the White Knob quarry. Satellite ore deposits occur to the east of the main quarry on an adjacent north-trending ridge (White Ridge area) that appears to be structurally related to the main quarry ridge. Natural slopes descend to the north and northwest from the ridge of the White Knob quarry. The area of the White Ridge deposit located to the east is not mined at this time, and adjacent slopes are in a natural state. An active overburden placement site (OB-1) is located near the east end of White Knob quarry in the Central Drainage area. Existing mine cut-slopes in the quarry are inclined overall at approximately 1(h):1(v) and up to approximately 600 feet in height. The overall inclination of the quarry slopes is controlled by a geologic structure (primarily joints) and locally by pre-splitting blasting.

Prior to mining, metamorphosed limestone outcrops formed very steep to vertical cliffs up to 100 feet high. During blasting and mining activities, rocks and boulders have inadvertently rolled onto the mountain side covering portions of the natural slope to form the existing 'northwest slope'.

FIELD INVESTIGATION:

Mapping and observations of the slope conditions were performed to provide information for slope stability analysis of the northwest slope. The area was accessed on foot via an unmaintained road that traverses westward to the slope below mid-height. The existing northwest slope is approximately 700 feet high and consists of two main areas/chutes of talus separated by a bedrock ridge that bisects the slope along the fall-line axis. The toe of the slope forms the southern flank of a drainage that

trends northeastward through dissected upland terrain. This drainage was the subject of the 2011 Ruby Springs study by DCI. Enclosure "B-1" presents a photo-collage of the northwest slope.

Native slopes in the area of the northwest slope consist of granitic bedrock slopes mantled by a thin veneer of colluvium and locally small talus. Limestone/marble outcrops form cliffs and steep slopes at the top of the northwest slope. Native talus is typically light gray to gray hued matrix-supported talus of small boulder to gravel size in a matrix of fine- to medium-grained silty sand. Talus generated by mining is typically white-colored small to large boulder size, clast-supported talus with a smaller fraction of gravel-to-cobble-size clasts. The mining talus is generally more angular than native talus and exhibits rounded to less common tabular forms were it occurs on the slope face.

SUMMARY OF FIELD OBSERVATIONS - 2012

During observation of the northwest slope we observed the following features that characterize the condition of the existing slope:

- Bedrock of carbonate and granitic compositions underlies the northwest slope and adjacent native slopes at shallow depths. A thin veneer of colluvium is present on slopes where surface outcrops are present and thicker accumulations of colluvium/talus occur below natural cliff faces and in topographic bedrock hollows.

- Where the mid-height road meets the east side of the talus slope, an isolated, approximately 6 x 6 x 3 foot thick boulder of white marble was observed in a furrow line approximately 40 feet long (Enclosure "B-3"). An accumulation of soil and small plants was plowed up at the downhill end of the boulder. New growth of vegetation was not present in the furrow above the boulder indicating relatively recent sliding movement of this isolated clast. The material upon which the boulder rested is a native colluvium present as an approximately 12-inch-thick veneer on underlying bedrock (Location 1 - "A-2.1"). It was evident that the slope angle steepened immediately below the prior resting place of this clast suggesting that the recent movement may have been caused by downhill creep of the underlying soils. This boulder occurs as an outlier to the talus field.

- Inspection of the lower portion of the east half of the northwest slope indicates that this area is in the fall line of rolling boulders and clasts that reach a point on the slope where a slight increase in slope angle causes continued travel to the slope toe (Location 2 - "A-2.1"). Several bounce marks (large hollows or divots) were observed in this fall line. The relatively-recent occurrence of single boulder roll down was indicated by the

presence of crushed small plants within individual bounce marks. The slope and toe of the northwest slope is currently an area of high rock fall occurrence and hazard.

- Isolated patches of native talus/colluvium **(tn)** are present along the slope toe. The presence of grasses and weeds and lack of large clasts on a silty gravelly sand material within these patches suggests a relatively stable substrate condition. Larger shrubs occur where bedrock is exposed in the talus slope face.

- The boulders and matrix of the mining talus unit **(tm)** accumulate to form convex talus cones on either side of a slope parallel bedrock ridge. Where individual clasts achieve a critical momentum during rolling, they accumulate within the head of the Western Drainage at the toe of the northwest slope. Some large boulders were observed to be located up to 40 feet higher than the drainage thalweg elevation on the west side of the drainage indicating uphill rolling or bounding. A topographic terrace formed in very old alluvium (Qvof) is located along the west side of the Western Drainage—several large boulders and associated small angular clasts (possibly collision-generated fly rock) have come to rest on this surface (Location 3 - "A-2.1").

- A debris flow chute is visible on the west side of the northwest slope (Enclosure "B-2"). This chute extends to the area of accumulation of boulders at the bottom of the slope. A gray-hued alluvium consisting of silty gravelly sand was observed as a veneer overlying boulder surfaces in the boulder accumulation zone at the toe of the slope. Some boulders were entirely covered by the alluvium veneer and progressive down-gradient filling and movement of alluvium in flat-lying accumulations was noted. This suggests the active and on-going formation of a step pool system within the boulder accumulation zone (Enclosure "B-4").

- A continuous animal trail traverses from Location 1 across the mid-height of the talus slope to a point up canyon. This suggests a relatively stable slope condition in the northwest slope.

From these observations, we conclude that:

1. Movement of individual boulders may occur where the underlying substrate is subject to downhill creep. Downhill creep is an ongoing natural process in colluvial slope environments and is expected to occur at natural rates in the northwest slope. Where boulders have come to rest on talus deposits, we expect that the interlocking force of the angular materials is sufficient to result in retention of most clasts within the talus fields. Addition of boulders to the talus or undermining by headward erosion may perturb some clasts to induce rolling or sliding movement in the future.

2. Individual boulder roll down by movement of an existing clast located on the slope face has occurred in the recent past—within the last 6 months (no material has been introduced to the northwest slope for several years). The most likely location (fall line) for long run out roll down is at the east flank of the slope where boulder-poor colluvium is exposed. The source area of this fall line is the slope on the west side of the White Knob Annex. The existing boulder fields act as a catchment area for large clasts.

3. Progressive down-gradient filling and movement of alluvium, generated by slope creep and debris flow into flat-lying accumulations between and upon boulders, were noted in the accumulation zone at the toe of the slope. This indicates the active and ongoing formation of a step pool system within the boulder accumulation zone that can act as a sediment/fines filtering area.

4. In the past, some boulders have traveled with sufficient momentum to carry partly up the toe of the opposing slope and generate flying debris from collision. The presence of a few boulders on the topographic terrace surface indicates that rock fall hazard is present in this area as well as at the toe of the northwest slope.

5. Natural slopes in the site area have been subjected to many more precipitation and seismic shaking events than the geologically-young talus slope formed from recent mining of the White Knob area. It is expected that within a relatively-short time, the northwest slope will achieve a state of stability that mimics the erosion/rock fall rate of surrounding natural slopes. The presence of a continuous trail traversing the slope indicates a relatively stable condition at this time. For undisturbed talus slopes, weathering and incremental gravity-induced shifting of boulders to a more stable position will increase boulder stability with time.

SLOPE STABILITY

The term "landslide", as used in this report, refers to deep-seated slope failures with a rupture surface at least 50 feet deep. Landslides are typically related to the underlying structure of the parent material. Surficial failures refer to shallow failures that affect the upper weathered or colluvial horizon of overlying material. Evidence for deep-seated landsliding was not observed in the White Knob quarry walls or on the aerial photographs reviewed during our previous 2007 and 2008 evaluations.

The susceptibility of a geologic unit to landsliding is dependent upon various factors that primarily include: 1) the presence and orientation of weak structures, such as fractures, faults, and/or clay

seams; 2) the height and steepness of the natural and/or cut slope; 3) the presence and quantity of groundwater; and 4) the potential/occurrence of strong seismic shaking.

The coarse-grained calcite marble ore at the site is relatively strong from a slope stability standpoint, with no weak clay or schist interbeds observed in natural or mined exposures. Natural cliffs formed in the calcite material stand vertically near the quarry site. The majority of joints are oriented favorably with respect to the planned quarry wall configuration and the geologic structure was carefully considered in planning the quarry slopes.

The granitic rocks on the margins of the ore body exhibit a similar orientation and spacing of joint sets as observed in the calcite marble. As described in the reclamation plan, road cuts formed in the granitic rocks exhibit joint control of north-south striking faces at inclinations of approximately 57 degrees. Most joints dip at steep angles (between 70 and 90 degrees) as measured during geologic mapping of the existing road cuts in the granitic rock slopes and thus form stable slope configurations at the existing slope angle.

STABILITY OF THE NORTHWEST SLOPE:

The slope-forming bedrock units that underlie the northwest slope consist of strong and grossly stable crystalline rock types that are shown by the overall angle of quarry slopes and calculations performed for our 2007 and 2008 studies to be stable at gradients steeper than that exhibited in the existing slope. In addition, evidence of deep-seated landsliding is not present in the existing terrain or on historic aerial imagery of the site. Therefore, the gross bedrock stability of the slope is not addressed further in this evaluation. Our evaluation is focused on the surficial stability of overlying colluvium/talus materials.

Natural talus slopes are commonly interpreted to exist at angle-of-repose gradients interpreted to indicate static factors of safety near unity (1.0). This may be true for a very limited slope area where applying a point load (a footfall) results in localized shifting of surficial material down slope. However, as a whole unit, the colluvium/talus mantle exhibits higher factors of safety—estimated to range from 1.1 to 1.4 based on the following factors that suggest higher-than-unity FS for talus slopes in the site area:

- Talus slopes in the seismically-active site lack evidence of whole-mantle, long-distance sliding movement. Individual blocks may shift or roll where FS is very close to unity during a seismic event and leave no discernable evidence in a talus field, but large head scarps or exposed bedrock slabs suggestive of large volume slope failures are not evident in the site slope.

- Based on the seismic history and proximity of faults capable of producing strong shaking at the site, it is clear that slopes in the region have been subjected to forces that perturb slope mantling/forming materials at geologically short time intervals.

- A Holocene to late-Pleistocene age landslide deposit is mapped less than 1/3 mile west of the subject slope on a slope of similar aspect but with different rock type. This deposit is formed in granitic rock types that are more susceptible to deep weathering than the limestone and marble underlying the subject talus slope. Landslides of this type are not anticipated for the very durable carbonate rock types in the site area.

- If the seismic FS of talus mantle were close to unity, one would expect widespread evidence of landslides in carbonate rock units in the site region, which is not evident.

As described previously, the northwest slope consists of a relatively thin veneer of very coarse- to coarse-grained mining-generated talus overlying a native colluvium/talus mantle in turn overlying stable bedrock at relatively shallow depths. The colluvium/talus material present on the northwest slope consists of a matrix-supported native colluvium/talus in contact with the underlying bedrock overlain by a predominantly clast-supported to transitional angular cobble-boulder talus layer. Based on the relative age of the native colluvium and presence of vegetation growing upon it prior to mining, as evidenced in aerial imagery from 1988, the native colluvium is expected to range from a thin veneer (1 foot thick) up to 15-feet thick locally in topographic swales and bedrock hollows. It is expected that the thickness of colluvium increases to form a wedge near the slope toe. The bed-rock/native colluvium contact is interpreted to exist as an undulating, relatively rough surface that includes abundant asperities formed by weathering processes (rough bedrock projections). The mining talus is observed at the surface to consist of a coarse- to very coarse-grained (cobble to boulder size) talus accumulation forming a system of interlocking angular blocks. Locally isolated blocks comprise a very small fraction of boulders that are present outside the talus field and rest on finer-grained native colluvium.

The susceptibility of a residual geologic unit to landsliding is dependent upon various factors that primarily include: 1) the height and steepness of the slope, 2) the shear strength and cohesiveness of the material, 3) the presence and quantity of groundwater and 4) the potential for or occurrence of strong seismic shaking.

NORTHWEST SLOPE PROPERTIES AND MODEL:

The subject slope is approximately 700 feet high and exhibits an overall slope angle of approximately 36 degrees with short steeper portions locally exhibiting angles up to 43 degrees. The slope is estimated to have an ultimate finished height of approximately 630 feet based on the Mining Plan dated April 4, 2007. Seeps or springs are not present in the slope face or within the head of the Western Drainage at the toe of the slope. The surficial, coarse-grained colluvium/talus mantling the slope is interpreted to be free draining; therefore long-term hydrostatic conditions are not anticipated to occur.

The North Frontal fault zone (NFFZ) is located approximately 1 mile (1.6 kilometers) north of the slope. Based on the attenuation relations for earthquake shaking by Boore and Atkinson (2008), Campbell and Bozorgnia (2008) and Chiou and Youngs (2008) for magnitude 7 and 1.6 kilometer distance, the NFFZ is capable of producing peak ground acceleration at the site of 0.52g. The seismic stability calculations were performed using a lateral pseudo static coefficient "*k*" of 0.20 due to the proximity of the NFFZ. Based on proximity to a fault zone capable of producing strong ground shaking on a geologically-short time scale and observations of nearby native slope exposures, we interpret the slope to exhibit good stability characteristics with respect to deep-seated and surficial failures. The strength parameters of the slope-forming materials are discussed in a following section.

SLOPE STABILITY CALCULATIONS:

The stability of the talus slope (Cross-Section A-A') was analyzed for static and seismic conditions for non-circular failures utilizing the SLIDE computer program, version 6.0 (Rocscience, Inc., 2011). The seismic stability calculations were performed using a lateral pseudostatic coefficient "k" of 0.20 due to the proximity of the NFFZ. The factor of safety was calculated by Spencer's method which is considered the most conservative of the available methods. We utilized the 'auto-refine' feature to

search for failure surfaces with the lowest factors of safety (FS). Assessment of strength parameters of coarse-grained materials, including gravity-generated talus, for use in slope stability analyses is problematic due to the large grain size relative to the size of typical sampling and testing equipment. Therefore, alternatives to direct measurement of shear strength were required. During this evaluation, we utilized back-calculation/sensitivity analysis to estimate the cohesive strength of the mining talus and native talus materials.

PRE-MINING TALUS SLOPE:

A very steep to vertical cliff up to 100 feet high was present at the head of the northwest slope prior to mining. The presence of this feature in this relatively active seismic region attests to the stability of steep slopes formed in the limestone of the region. We first analyzed the surficial stability of the pre-mining slope based on the geometry of the 1988 contours and modeled thickness of native colluvium/talus varying from 5 feet to 15 feet. We utilized the sensitivity analysis feature of SLIDE to evaluate the range of materials strengths for the native colluvium/talus that resulted in reasonable FS for natural slopes in the site region based on anticipated seismic loading and lack of evidence for large-scale slope failures in the Western Drainage watershed (i.e., straight thalweg with no deflection and consistent stream gradient; lack of waterfalls). For the geologic unit **(Tn)**, our analysis resulted in a range of cohesion values from 160 psf to 355 psf (FS = 1.0 to 1.5, respectively).

Existing Talus Slope

Analysis of the existing slope using the 2009 topography overlain on the 1998 contours, as depicted in section A-A' was used to estimate the existing slope conditions. The material properties were modeled utilizing the Mohr-Coulomb criteria as summarized in the following table.

Table 1: Summary of Materials Properties			
Geologic Unit		**Value**	
		Static	**Seismic†**
(tn) Native Colluvium/Talus	Unit Weight (pcf*)	135	135
	Phi Angle	38	41
	Cohesion (psf)	355	355
(tm) Mining Talus	Unit Weight (pcf*)	130	130
	Phi Angle	40	40
	Cohesion (psf)	350	375
(brx) Bedrock Units	Unit Weight (pcf*)	165	165
	Phi Angle	65	65
	Cohesion (psf)	1500	1500

* pcf = pounds per cubic foot † peak strengths
** psf = pounds per square foot

The above parameters were estimated from the following:

- Published and unpublished results of remolded shear testing of colluvial matrix materials
- Estimates and back calculation of shear strength and cohesion of interlocked angular blocks in talus accumulations
- Assumption of infinite strength in the bedrock unit to force potential failure planes into overlying residuum

The results of our slope stability analyses are summarized in Table 2. Details of stability calculation results including soil type boundaries, strength parameters, sensitivity analysis, and the minimum factor of safety and critical slip surface are included in Enclosures "C-1" through "C-4".

Table 2: Slope Stability Summary		
Cross Section	**Static F.S.**	**Seismic F.S. (k=0.2)**
A-A' pre-mining	--	1.26*
A-A' existing	1.34	1.07

* Sensitivity analysis

As summarized in Table 2, static and seismic factors of safety that mimic the estimated FS for natural slopes in the site region were exhibited in the slope model of the northwest slope. The seismic FS less than unity indicates a potential for seismically induced landslides within the surficial slope material along Section A-A'. However, the lack of evidence for landslides in the Northwest Drainage and interpreted seismic history of the site region imply that seismic FS < 1.0 is not the actual case for this slope and that the actual FS is greater than 1.0 based on field evidence. The length of the slide area identified by the SLIDE program occurs in the thickest area of surficial material and is about 240 feet in length. It may be that features of this small extent are reworked/masked by erosion or slope creep processes and so are not expressed in the contemporary geologic record. However, a scenario in which a strong seismic event causes a failure of this size is consistent with expected natural events for the seismically-active and mountainous region of the site. Based on the results of the slope stability calculations, observations of the existing slope conditions and observations of surrounding terrain and nearby natural slopes, we interpret the current northwest slope configuration to be grossly stable and surficially-stable compared with the expected natural conditions of slopes in the area.

ROCKFALL POTENTIAL AND ANALYSIS:

Rockfall is a type of mass wasting in which blocks of intact rock become mobilized by toppling or falling then roll, bounce or free fall downhill. Rockfall is generally limited to natural slopes steeper than 33 degrees. Rockfall behavior is controlled by slope angle, type of substrate, and rock size and material. The limestone/marble bedrock of the quarry is considered very durable. Site observations

and review of aerial imagery indicate that an accumulation of boulders has formed on the subject slope since mining began at the top of the slope in approximately 1996.

The earliest aerial imagery showing mining talus deposition is dated May 28, 2002. In this image, talus is present as a boulder field at the toe of the slope and as talus fields on the west and east portions of the slope. The extent of talus fields at the time of the 2002 imagery is consistent with the extents that were observed at the time of our field observations indicating little addition to the area of deposition during the past 10 years. Outlier boulders (Location 3 - Enclosure "A-2.1") located beyond the boulder field appear to have been deposited soon after commencement of roll-down activity as the number of clasts in this field is unchanged after 2002. This indicates that the boulder field acts as a catchment for material reaching the field and that future deposition of material beyond the current boulder field is not likely.

In comparing images dated May 28, 2002, June 27, 2003, and October 20, 2003, it is evident that a large boulder (Boulder A - Enclosure "A-2.1") located in the western talus field shifted position approximately 120 feet down-slope during this 17-month time period. This boulder was observed to be at the 2003 location during our field observations in March 2012 - a time period of about 100 months since its position in 2003. The behavior of this boulder suggests that the larger boulders deposited on to the talus slope are initially subject to creep movement then achieve a more stable state of repose relatively rapidly.

For our analysis of the northwest slope, we utilized the Colorado Rockfall Simulation Program (CRSP) - version 4.0 by Jones, et al. (2000) to model the behavior of rolling boulders calibrated to the observed site conditions. The existing slope includes fall lines with different substrate properties. We evaluated Cross Section A-A' for a combined talus and soft soil substrate to model rocks falling along the east side of the subject slope. We evaluated Cross Section B-B' with a soft soil substrate and relatively-smooth surface condition to model rocks falling along the west side of the subject slope. Rock size was varied for each of the two fall lines and 'calibrated' to existing conditions observed during field mapping. Cross Section A-A' includes a talus field comprised of angular boulder-size clasts that form a rough surface compared to the fall line along Cross Section B-B'. Analysis Points (APs) along the slope profile were selected in the program to coincide with

accumulation features observed in the field. The slope models, materials and slope parameters utilized in, and results of the rockfall analysis are presented in Appendix "D". Rockfall simulation results are summarized in Tables 3.1 and 3.2.

Table 3.1: Summary of Rockfall Analysis - Cross Section A-A'

No. of Simulations for Each Rock Size: 500

	No. Passing	Max./Avg. Velocity (ft./sec.)	Max./Avg. Bounce Height (ft.)	Max./Avg. Kinetic Energy (ft.-lb.)	Comments
Boulder Size = 1ft.					
AP1	7	69.3 / 40.5	7.8 / 3.4	7,769 / 3,475	Most rocks retained in zone from 140 to 300 feet along fall line
AP2	0	--	--	--	
AP3	0	--	--	--	
Boulder Size = 2ft.					
AP1	50	76.4 / 38.3	20.3 / 5.5	77,024 / 24,006	A majority retained in zone from 140 to 400 feet along fall line. Few reach as far as 880 feet.
AP2	0	--	--	--	
AP3	0	--	--	--	
Boulder Size = 4ft.					
AP1	489	94.4 / 44.7	30.5 / 6.9	927,278 / 192,886	Few rocks retained before 850 feet, most retained between 870 feet and 1100 feet
AP2	319	88.3 / 34.4	19.9 / 4.1	871,183 / 167,855	
AP3	0	--	--	--	
Boulder Size = 6ft.					
AP1	500	106.9 / 81.3	26.8 / 9.1	3,850,679 / 2,494,354	All rocks reached the toe of the slope
AP2	500	76.9 / 39.9	11.7 / 2.5	2,101,702 / 643,794	
AP3	0	--	--	--	
Boulder Size = 10ft.					
AP1	500	109.1 / 84.9	32.1 / 10.4	18,642,521 / 12,627,327	All rocks reached the toe of the slope
AP2	500	123.9 / 75.9	25.5 / 7.9	24,568,824 / 10,561,619	
AP3	0	--	--	--	

Table 3.2: Summary of Rockfall Analysis - Cross Section B-B'					
No. of Simulations for Each Rock Size: 500					
	No. Passing	Max./Avg. Velocity (ft./sec.)	Max./Avg. Bounce Height (ft.)	Max./Avg. Kinetic Energy (ft.-lb.)	Comments
Boulder Size = 2ft.					
AP1	394	47.7/19.1	6.1/1.1	29,219/5,725	Most rocks retained in zone from 680 to 900 feet along fall line
AP2	143	34.5/15.1	5.0/0.8	15,719/3,852	
AP3	0	--	--	--	
Boulder Size = 4ft.					
AP1	500	58.3/43.8	7.1/2.5	356,924/214,144	All rocks reached the toe of the slope
AP2	500	56.3/40.6	5.3/1.8	338,903/187,113	
AP3	0	--	--	--	
Boulder Size = 10ft.					
AP1	199	59.4/42.0	0.66/0.12	6,187,159/3,315,388	Rocks retained in zone from 100 feet to 700 feet; clustering from 230 feet to 350 feet; few reach bottom of slope
AP2	60	56.8/36.9	0.81/0.16	5,732,076/2,573,235	
AP3	0	--	--	--	

The results of the rockfall simulation indicate the following:

- For talus substrate, larger boulders travel farther down slope and smaller clasts are retained within the talus field
- For soft soil substrate, medium-size boulders tend to travel farther while small and large sizes are retained in the soft slope soils
- Kinetic energy increases rapidly with increase in rock size
- The talus field acts as a catchment for small to medium size clasts
- The soft soil slope acts as a catchment for small and large boulders

With regard to rockfall hazard from existing material on the northwest slope, it is apparent, based on evidence for individual shifted boulders and fresh-appearing bounce marks, that rockfall hazard from

existing individual clasts is high at this time compared with natural rates on adjacent slopes in this area. Therefore, we recommend that personnel be precluded from occupying the northwest slope until such time as protective measures can be emplaced (by remote means) and/or the rate of rockfall from existing material is suitably lower.

It should be noted that boulders bounding down the slope have been estimated to travel at maximum velocities up to approximately 115 feet/second. This rate of travel indicates about 10 seconds for a person to relocate from the path of a rolling boulder on the approximately 1,200 foot-long slope. The likelihood of witnessing a rolling boulder under current slope conditions appears low. However, given the anticipated outcome of a human/boulder interaction, it would be prudent to exercise caution when performing tasks at the base of the western slope. Because of the remote location of the Western Drainage the probability of such an occurrence is very low.

If access to the Western Drainage is necessary, it may be feasible to utilize a dedicated spotter with two-way radio (or other direct means of communication) and selection of "safe" zones for personnel in the rock-fall zone. "Safe" zones may include areas at the base of the slope that lack white-colored boulders indicating no previous accumulation, or are "shielded" by existing large boulders or by elevation (located above the accumulation area). While access to the rockfall zone by the casual traveler is not likely in this remote area, we recommend conspicuous signs warning of rockfall hazard within the Western Drainage be placed on the approach road and in other potential paths of access.

FUTURE MINING CONSIDERATIONS

Future mining is planned in the White Knob Annex area adjacent to the northwest slope. If mining practices similar to those used for the White Knob area are employed in the Annex, some boulder roll down and talus deposition is expected to occur and result in similar rockfall hazard and sedimentation conditions as observed for the northwest slope.

Several potential mitigation or remediation options for the existing or future conditions, including rockfall and sediment control, may include:

1. Scaling or stabilizing individual clasts or talus accumulations in place using rockfall mitigation methods such as rock bolts, dowels, shear pins, steel netting, injectable resin/epoxy, grouting or use of catchment fences or berms.

2. Removing slope materials and boulders to a more stable location.

3. Erecting rockfall barriers or berms at locations along suspected rock fall lines to preclude the largest anticipated boulder from passing. Feasibility of this option would depend on location/cost in conjunction with use of silt fence or sedimentation basins (item no. 5).

4. Relying on natural processes, including creep and weathering and step pool formation in the boulder field (observed and ongoing), to mitigate rockfall and sediment transport while monitoring the Western Drainage sediment transport rates/conditions.

5. Establishing debris control basin(s) in the Western Drainage within the mining boundary, if warranted based on sediment monitoring results.

6. Precluding activity that contributes additional material onto the slope.

7. Placement of signs warning of rockfall hazard within the Western Drainage on the approach road and in other potential paths of access.

Options 1 and 2 are considered impractical due to the low slope angle compared to typical rockfall hazard zones, constructability, aesthetics and life safety issues. If the results of a rock falling do not cause a hazard or damage to public lands, then mitigation may not be necessary. Use of remote methods to dislodge individual boulders or talus accumulations considered hazardous may be feasible but may act to exacerbate movement of already-stable clasts and contribute to sediment transport. Use of remote methods does not appear necessary at this time due to the remoteness of the talus slope area and very limited exposure of the area to the general public. Gravity can perform the function of rockfall mitigation with the passage of time. The overall slope stability of the surficial materials is considered suitable compared to natural stability of talus and colluvium in the site area.

Option 3 is feasible however the need for disturbance of existing native vegetation and terrain should be weighed against the perceived benefit.

Option 4 requires no action but should include monitoring of sediment transport to evaluate the need for debris basin installations.

Option 5 may be feasible if rockfall hazard is determined to be low in the outlier boulder field (Location 3 - Enclosure "A-2.1"). Option 5 may be unnecessary depending on the need for sediment reduction in the Western Drainage. The hydrologic monitoring report by DCI (2011) indicates that no sediment transport was observed between 2005 and 2009 and concludes that under non-catastrophic storm conditions, the conditions within the talus slope and Western Drainage should reduce the amount of bed load that may be transported within the Western Drainage toward downstream features. This suggests that sediment flux in the Western Drainage has established a more stable rate. However, it should be noted that periodic debris flows (discussed in a following section) may introduce sediment loads into the Western Drainage that temporarily increase the sediment input rate.

Option 6 is related to mining practices and may include alteration of the mining plan, use of continuous mining equipment, modification of blasting practices near daylighted cliff faces, use of rockfall mitigation installations or some combination thereof.

Option 7—limiting access to the rock fall zone—is feasible. The remote location of the site and difficulty of access provide a passive boundary to access. The placement of conspicuous signs warning of potential rockfall hazard adds an additional measure of protection. The use of two-way communication, dedicated spotter and selection of "safe" zones may safely allow transient occupation of the Western Drainage below the northwest slope by authorized persons for monitoring purposes. Because of the remote locations, movement of individual boulders or small talus movements on fee land are not expected to damage adjacent public or private land and potential for such damage is very limited.

DEBRIS FLOW POTENTIAL:

Debris flows are a surficial type of mass wasting that may occur in mountainous regions during localized high precipitation events. A debris flow chute was observed on the west side of the northwest slope. The chute extends from the upper slope down to the slope toe, includes a zone of

depletion near its head and zone of accumulation at its lower end and is approximately 2 feet deep. This feature was formed between June 27 and October 20, 2003, based on review of aerial imagery. This time period coincides with the 'early August 2003' intense storm event described in the hydrologic monitoring report by DCI (2011). The source area is located along the contact between the **Tmw** (boulder talus) and **Tmg** units (Enclosure "A-2.1). This feature is formed in the finer-grained gray-colored portion of the talus slope. The 'snout' of the chute merges into the boulder field at the base of the slope. Material shed by this debris flow and the talus slope in general appear to be contributing material to formation of step pools within the boulder field at the base of the slope. Future debris flows may occur on the northwest slope during heavy precipitation events. These types of events are typically associated with localized monsoonal moisture patterns during the summer and early fall months in the Lucerne Valley area. To aid in mitigation of future debris flows, water flow lines should be directed away from the top of the northwest slope. Mitigation measures to prevent formation of debris flows may include grading of top-of-slope areas to direct runoff away from the slope face and maintaining berms along the top of the slope. Mitigation of sediment transport in the Western Drainage as result of debris flows includes Options 4 and 5 as discussed on page 22.

GROUNDWATER

No evidence for springs or perched groundwater conditions was observed at the site during the geologic mapping or on the aerial photographs reviewed.

Depth-to-groundwater data are not available for the site vicinity from the California Department of Water Resources (2007) or the U. S. Geological Survey (2007). The closest data available are from wells in the town of Lucerne Valley, located at a significantly lower elevation north of the site.

Groundwater has not been encountered in exploratory borings drilled to 550 feet bgs (Howard Brown, personal communication). The current depth to groundwater at the site is not known but is expected to be greater than 550 feet bgs. Based on the planned mining excavation depths, the anticipated depth of groundwater and the presence of non-liquefiable bedrock, no potential for liquefaction and other shallow groundwater-related hazards is anticipated.

Mine slopes should continue to be protected with berms and/or levees as necessary to prevent slope erosion in the areas where natural slopes drain onto the reclaimed slopes.

CONCLUSIONS FOR NORTHWEST SLOPE AREA

Based upon our geologic field observations, the results of our slope stability calculations, and rockfall analysis, it is the opinion of this firm that the continued mining in the White Knob quarry above the northwest slope and mining of the White Knob Annex is feasible, provided that suitable conditions can be established to limit addition of material or access to the existing and proposed slopes.

Based upon our prior gross slope stability analyses for limestone/marble mining and our current surficial slope stability analysis, the existing talus/colluvium slopes are considered suitably stable to mass movement with respect to the stability of adjacent natural slopes and anticipated final reclamation condition. It is anticipated that the talus slope will trend toward a more stable condition and achieve a natural state of stability with the passage of time. Additional evaluation of slopes above the Western Drainage may be warranted at the completion of mining and prior to final reclamation.

Based on review of aerial imagery and field observations, a potential rockfall hazard is apparent in the western slope area. Placement of conspicuous signs and/or barriers in the Western Drainage approach, warning of potential rockfall, is warranted based on observation of recent bounce marks and shifted boulders in the northwest slope. Mitigation of rockfall for individual clasts present on the slope by direct means is not considered practical with regard to human life safety at this time. Remote methods may be feasible; however, these may act to exacerbate movement of already stable clasts and contribute to sediment transport.

There is a potential for debris flow activity during localized intense storm activity in the western slope area. Monitoring of sediment transport in the Western Drainage if future debris flow occurs may provide information with regard to sediment transport rates and potential effects on downstream features.

Removal of slope materials or boulders to a more stable configuration is considered impractical at this time due to the potential hazard to human life, constructability, aesthetics and cost.

No evidence of active faulting was observed on the site during this investigation. Several inactive faults traverse the quarry areas. No groundwater barriers are known in this area.

RECOMMENDATIONS

ROCKFALL HAZARD:

Indications of recent rockfall events related to existing slope materials were noted in the northwest tailing slope area - rockfall hazard is considered potentially high relative to adjoining natural slopes. Material has not been added to the northwest slope for several years. The area is remote from developed roadways and not easily accessible; however, we recommend that conspicuous signs or other indicators of rockfall hazard be placed beyond the slope toe to preclude casual entry to this area. Authorized persons accessing the base of the western slope should employ a spotter system to warn of boulder movement should this occur during occupation of the area. Rockfall hazard is expected to decrease with passage of time. Additional measures for life safety are not considered necessary at this time.

SEISMIC SHAKING HAZARDS:

Moderate to severe seismic shaking of the site can be expected to occur during the lifetime of the proposed mining and reclamation. This potential has been considered in our analyses and evaluation of slope stability.

SLOPE AND STREAM PROTECTION:

Monitoring of sediment transport in the Western Drainage is expected to continue. Additional monitoring for debris flow may provide information with regard to sediment transport rates and potential effects on downstream features. Construction of debris basins appears feasible in the area downstream from the northwest slope. Design of such improvements is not within our area of engineering practice. Guidelines for design and construction of debris basins may be available from the jurisdictional flood control agency.

LIMITATIONS

CHJ Consultants has striven to perform our services within the limits prescribed by our client, and in a manner consistent with the usual thoroughness and competence of reputable geotechnical engineers and engineering geologists practicing under similar circumstances. No other representation, expressed or implied, and no warranty or guarantee is included or intended by virtue of the services performed or reports, opinion, documents, or otherwise supplied.

This report reflects the testing and observations conducted on the site as the site existed during the investigation, which is the subject of this report. However, changes in the conditions of a property can occur with the passage of time, due to natural processes or the works of man on this or adjacent properties. Changes in applicable or appropriate standards may also occur whether as a result of legislation, application, or the broadening of knowledge. Therefore, this report is indicative of only those conditions tested and/or observed at the time of the subject investigation, and the findings of this report may be invalidated fully or partially by changes outside of the control of CHJ Consultants. This report is therefore subject to review and should not be relied upon after a period of one year.

The conclusions and recommendations in this report are based upon observations performed and data collected at separate locations, and interpolation between these locations, carried out for the project and the scope of services described. It is assumed and expected that the conditions between locations observed and/or sampled are similar to those encountered at the individual locations where observation and sampling was performed. However, conditions between these locations may vary significantly. Should conditions be encountered in the field, by the client or any firm performing services for the client or the client's assign, that appear different than those described herein, this firm should be contacted immediately in order that we might evaluate their effect.

If this report or portions thereof are provided to contractors or included in specifications, it should be understood by all parties that they are provided for information only and should be used as such.

The report and its contents resulting from this investigation are not intended or represented to be suitable for reuse on extensions or modifications of the project, or for use on any other project.

CLOSURE

We appreciate this opportunity to be of service and trust this report provides the information desired at this time. Should questions arise, please do not hesitate to contact this firm at your convenience.

Respectfully submitted,

CHJ CONSULTANTS

REGISTERED GEOLOGIST
JOHN S. McKEOWN
NO. 2396
CERTIFIED ENGINEERING GEOLOGIST
Exp. 08-30-15
STATE OF CALIFORNIA

John S. McKeown, E.G. 2396
Project Geologist

Jay J. Martin, E.G. 1529
Vice President

PROFESSIONAL GEOLOGIST
JAY J. MARTIN
No. 1529
CERTIFIED ENGINEERING GEOLOGIST
Exp. 8-31-14
STATE OF CALIFORNIA

JMc/JJM:tlw

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AERIAL PHOTOGRAPHS REVIEWED

Google Earth web-based software application, aerial imagery dated October 1, 1995; May 28, 2002; June 27, 2003, October 20, 2003; December 30, 2005; January 30, 2006; January 29, 2007; June 5, 2009.

San Bernardino County Flood Control District, November 18, 1972, black and white aerial photograph No. 30.

U.S.D.A., February 22, 1953, black and white aerial photograph Nos. AXL-47K-117 and -118.

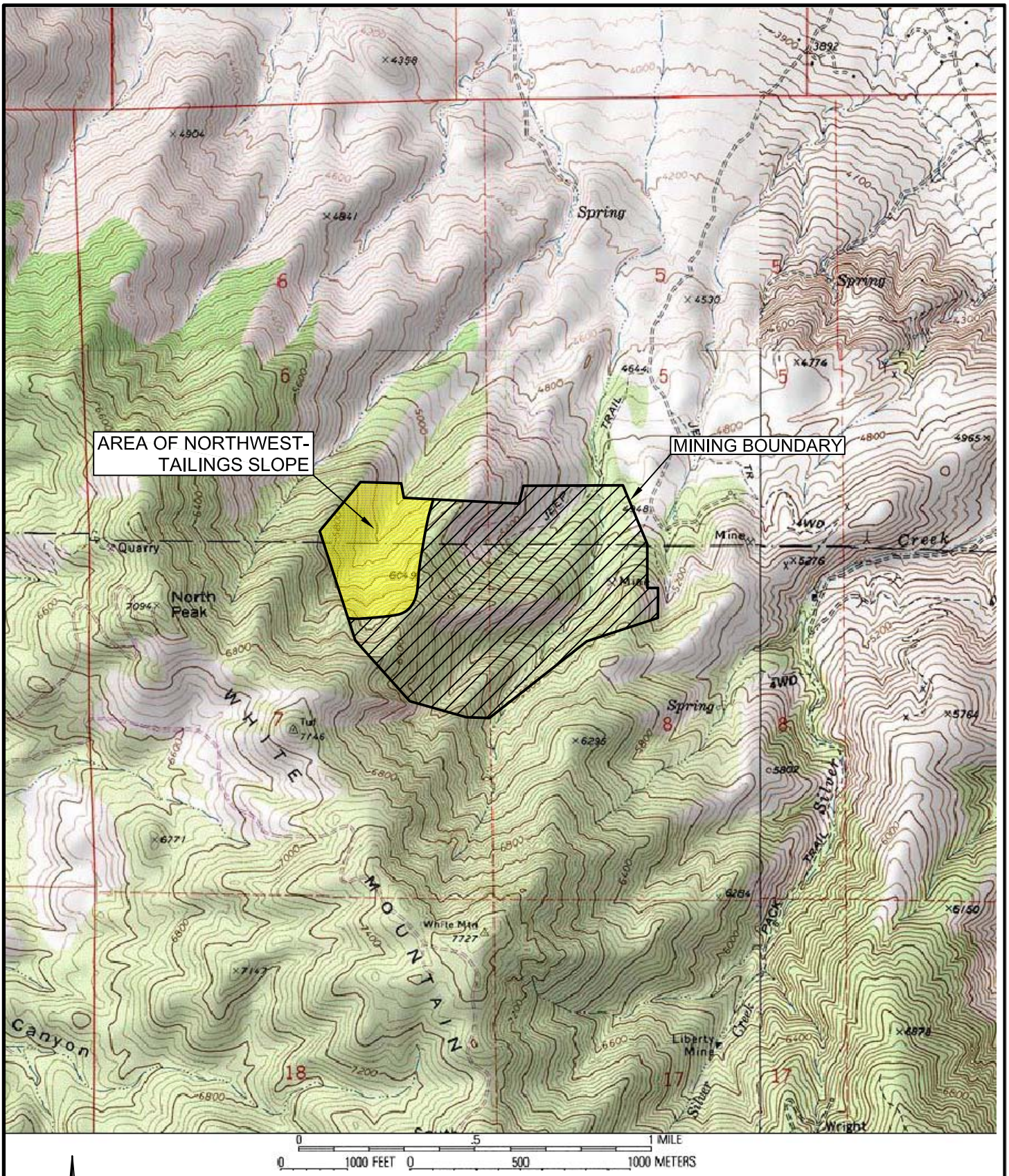
U.S.D.A., February 16, 1953, black and white aerial photograph Nos. AXL-42K-60 and -61.

Orthophoto-based contour map - White Knob Placer Claim by American Aerial Surveys, dated June 24, 1983; scale 1" = 100', 25-foot contour interval.

Orthophoto-based contour map - White Knob area, untitled, dated November 7, 1988.

APPENDIX "A"

GEOLOGIC MAPS



-N-

SCALE: 1" = 2,000'

INDEX MAP

FOR: OMYA	GEOTECHNICAL CONSULTATION PROPOSED AMENDED PLAN OF OPERATIONS FOR THE WHITE KNOB QUARRY OMYA CALIFORNIA, INC. LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "A-1"
DATE: APRIL 2012		JOB NUMBER 12121-8

CHJ Consultants

WHITE KNOB ANNEX CLAIM - UNPATENTED
PATENTED WHITE KNOB CLAIM

LOCATION 3
LOCATION 4
LOCATION 2
LOCATION 1

AP-AA-3
AP-BB-3
AP-AA-2
AP-BB-2
AP-AA-1
AP-BB-1

Tmw
Tn
Tn/brx
Tm/Tn
Tmg
brx
boulder A
BEDROCK RIDGE
WHITE KNOB ANNEX
EXISTING TALUS SLOPE
WHITE KNOB QUARRY

A
A'
B
B'
C
C'
D
D'
E
E'

N

SCALE: 1"=100'
0 100 200

GEOLOGIC UNITS:

Tm - mining talus, w = whitish hue, g = grayish hue rock debris consisting of cobble to large boulder size clasts, fresh appearing surfaces, form clast-supported depris cone on native surfaces & boulder field at head of Western drainage

Tn - native talus/colluvium: silty gravelly sand underlies mining talus

brx - bedrock outcrop: limestone, marble, & granitic rocks of White Knob area

Tn/brx - mixed native talus/colluvium & bedrock

Tm/Tn - area of mining talus (whitish) as vaneere on native talus/colluvium

AP-AA-1 - Approximate location of analysis point used in CRSP rockfall evaluation

Approximate Claim Boundary

B B'

Location of Geologic Cross Section

NORTHWEST SLOPE MAP

FOR: OMYA CALIFORNIA

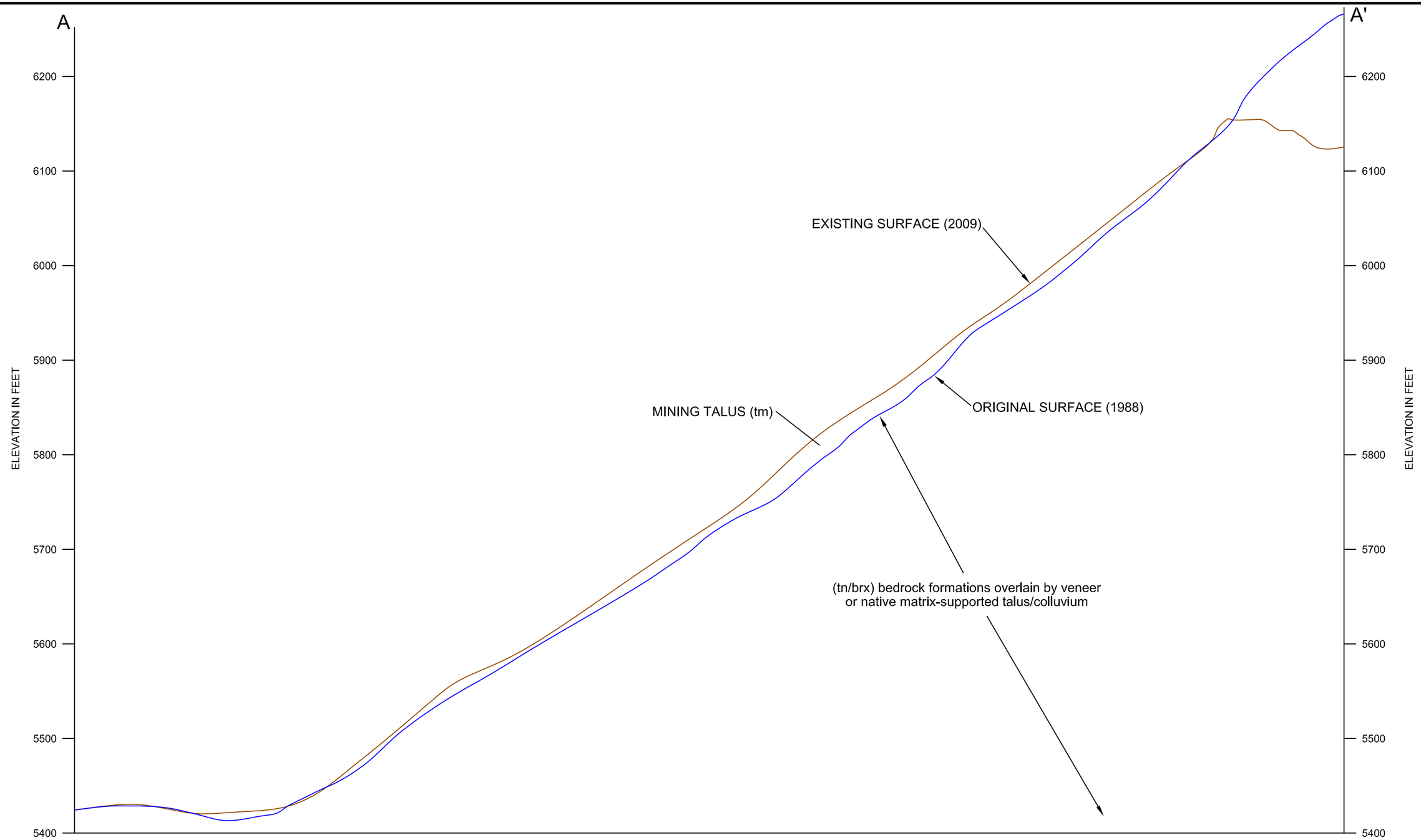
DATE: APRIL 2012

GEOTECHNICAL CONSULTATION
PROPOSED AMENDED PLAN OF OPERATIONS
FOR THE WHITE KNOB QUARRY
OMYA CALIFORNIA
LUCERNE VALLEY, CALIFORNIA

ENCLOSURE "A-2.1"

JOB NUMBER 12121-8

CHJ Consultants

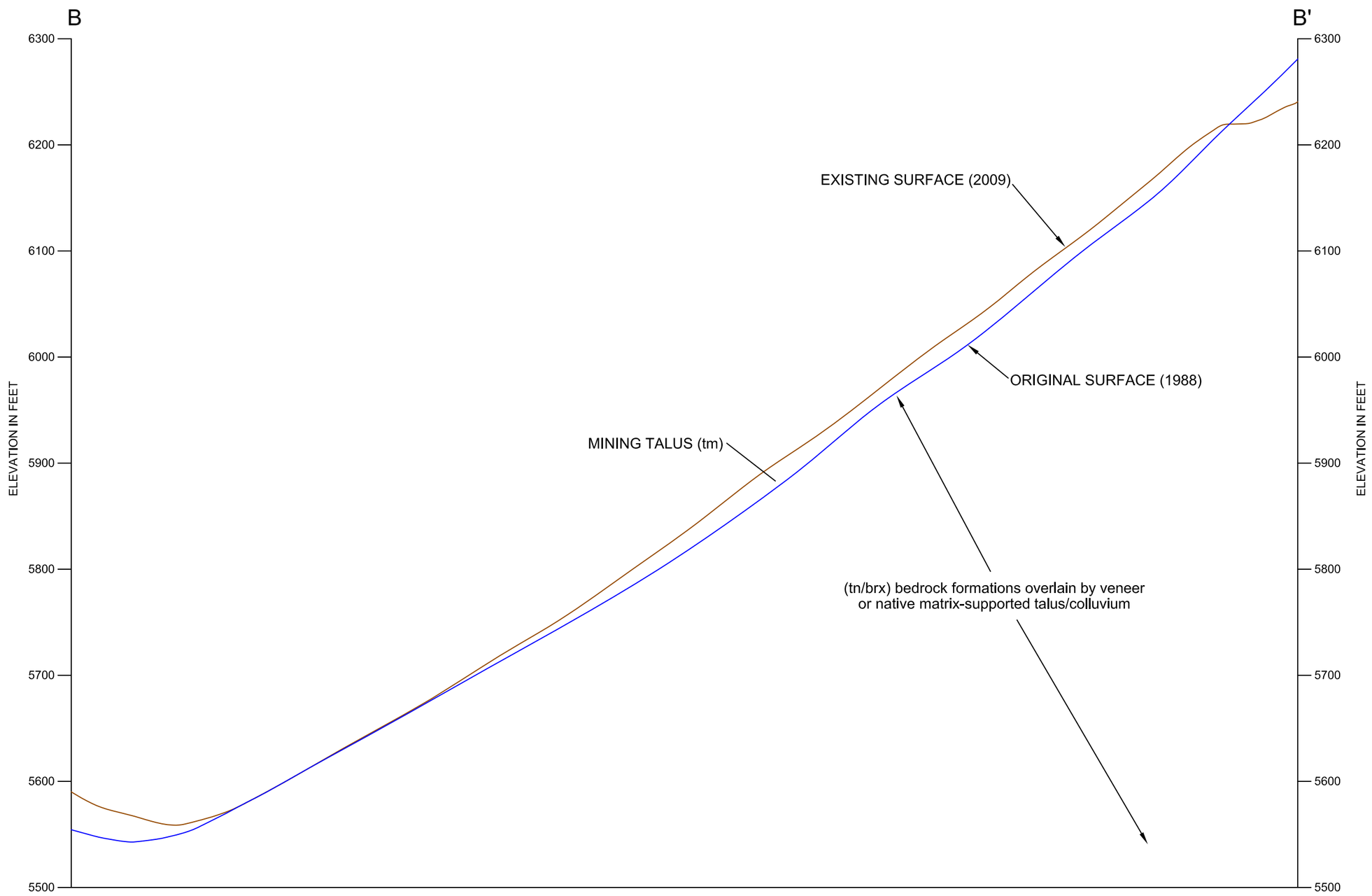


SCALE: 1" = 100'

CROSS SECTION A-A'

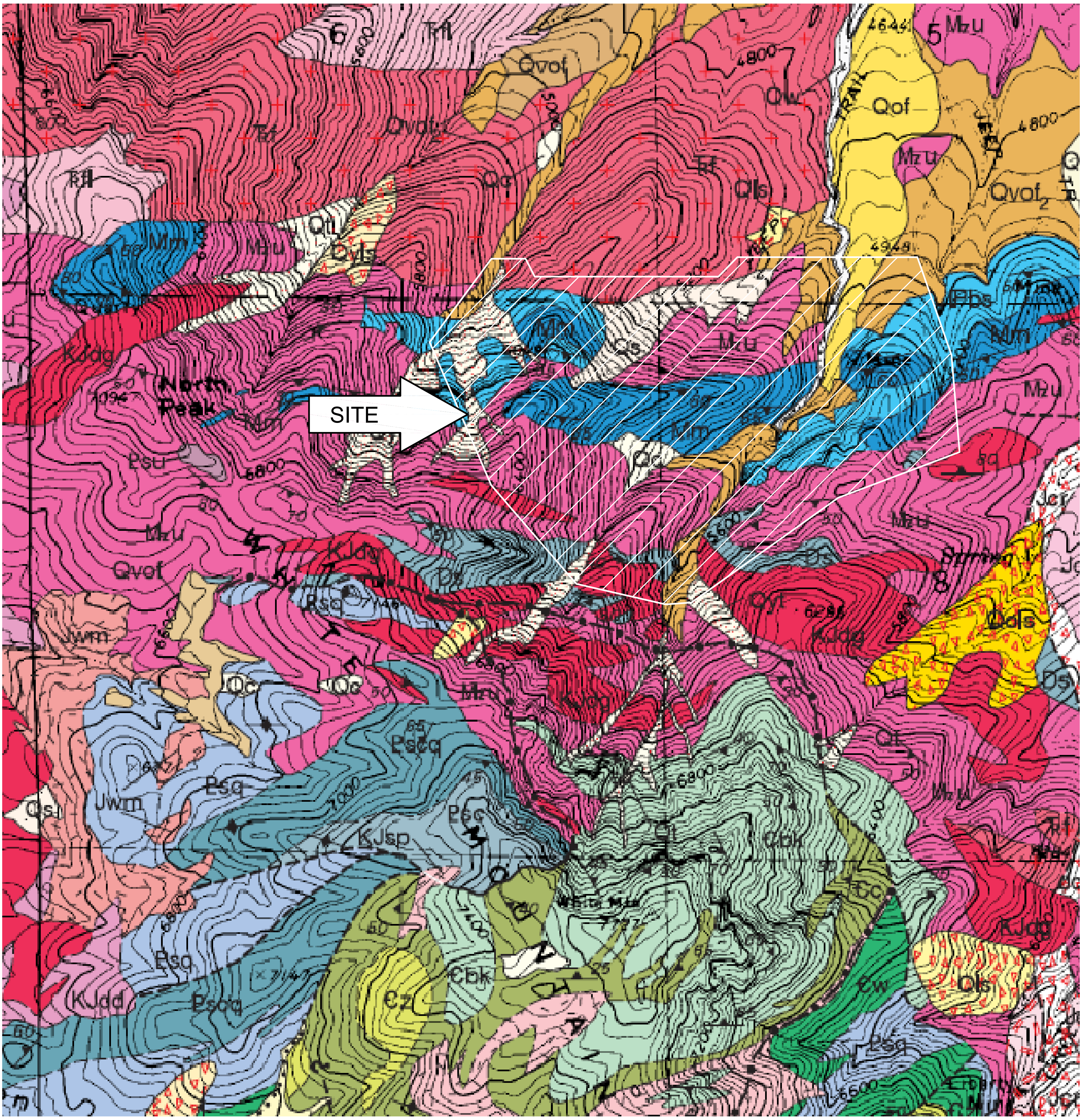
FOR: OMYA	GEOTECHNICAL CONSULTATION PROPOSED AMENDED PLAN OF OPERATIONS FOR THE WHITE KNOB QUARRY OMYA CALIFORNIA, INC. LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "A-2.2"
DATE: APRIL 2012		JOB NUMBER 12121-8

CHJ Consultants



SCALE: 1" = 100'

CROSS SECTION B-B'		
FOR: OMYA	GEOTECHNICAL CONSULTATION PROPOSED AMENDED PLAN OF OPERATIONS FOR THE WHITE KNOB QUARRY OMYA CALIFORNIA, INC. LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "A-2.3"
DATE: APRIL 2012		JOB NUMBER 12121-8
		CHJ Consultants



(Base Map: Miller et al., 2000)

GEOLOGIC UNITS:

Holocene sediments

Qc modern colluvial deposits

Qs undifferentiated surficial deposits

Qyt young talus deposits

$Qvof_2$ very old alluvial fan deposits

Crystalline Rocks

Mzu Mesozoic granitic rocks, undivided. Monzogranite to diorite, including small areas of monzonite. Includes heterogeneous, nondistinctive granitic rocks that cannot be assigned to larger granitic units in Butler Peak quadrangle. Fine- to coarse-grained; massive to foliate and lineate.

KJdg Mixed diorite and gabbro (Cretaceous and Jurassic). Biotite-hornblende diorite and quartz diorite, hornblende-biotite diorite and quartz diorite, pyroxenehornblende gabbro, and hornblende gabbro. Fine- to coarse-grained. Dioritic rocks appear to have possible spatial relation to Paleozoic carbonate rocks and intermediate composition Mesozoic plutons.

Pbs Bird Spring Formation (Pennsylvanian). Upper part of Furnace Limestone of Vaughan (1922) as mapped by Guillou (1953), Richmond (1960); correlated with Bird Spring Formation of southern Great Basin by Cameron (1981) and Brown (1991). Generally light-colored, medium- to thick-bedded, medium to coarsely crystalline calcite marble. Degree of recrystallization in quadrangle precludes confident subdivision of formation, but in Fawnskin quadrangle to east, typical lithologies include white, gray, or mottled marble and cherty, silicified marble. Some chert-bearing calcite marble contains lenses and thin layers of quartz silt and fine sand. Intermittent layers of minor brownweathering dolomite marble, siliceous marble horizons, and dark-gray calcite marble. In Butler Peak quadrangle, due to extreme recrystallization and deformation, layering in much of formation may or may not represent bedding.

Mm Monte Cristo Limestone (Mississippian). Upper part of Furnace Limestone of Vaughan (1922) as mapped by Richmond (1960). Correlated with the Monte Cristo Limestone of the southern Great Basin by Cameron (1981), and mapped by Brown (1984, 1987, and 1991) who recognized several formal stratigraphic members named originally by Hewitt (1931). Degree of recrystallization in quadrangle precludes recognition of detailed subdivisions, but includes heterogeneous, interlayered, light- and dark-gray, calcite and dolomite marble characteristic of Yellowpine Member, and thick-layered, light-gray to white, texturally massive, very pure calcite marble characteristic of Bullion Member.

Ds Sultan Limestone (Devonian). Middle part of Furnace Limestone of Vaughan (1922) as mapped by Richmond (1960); Brown (1991) correlated rocks in this interval with members of Sultan Limestone of Hewitt (1931) in southern Great Basin. Includes: (1) thin- to thick-layered, white calcite marble containing sparse thin layers of dark-gray calcite and dolomite marble characteristic of Crystal Pass Member; in part irregularly dolomitized. (2) Laminated to massive, light-gray, brown, and white, finely crystalline, locally chert-bearing metadolomite characteristic of Valentine Limestone Member.

geologic contact

N

SCALE: 1" = 1,000'

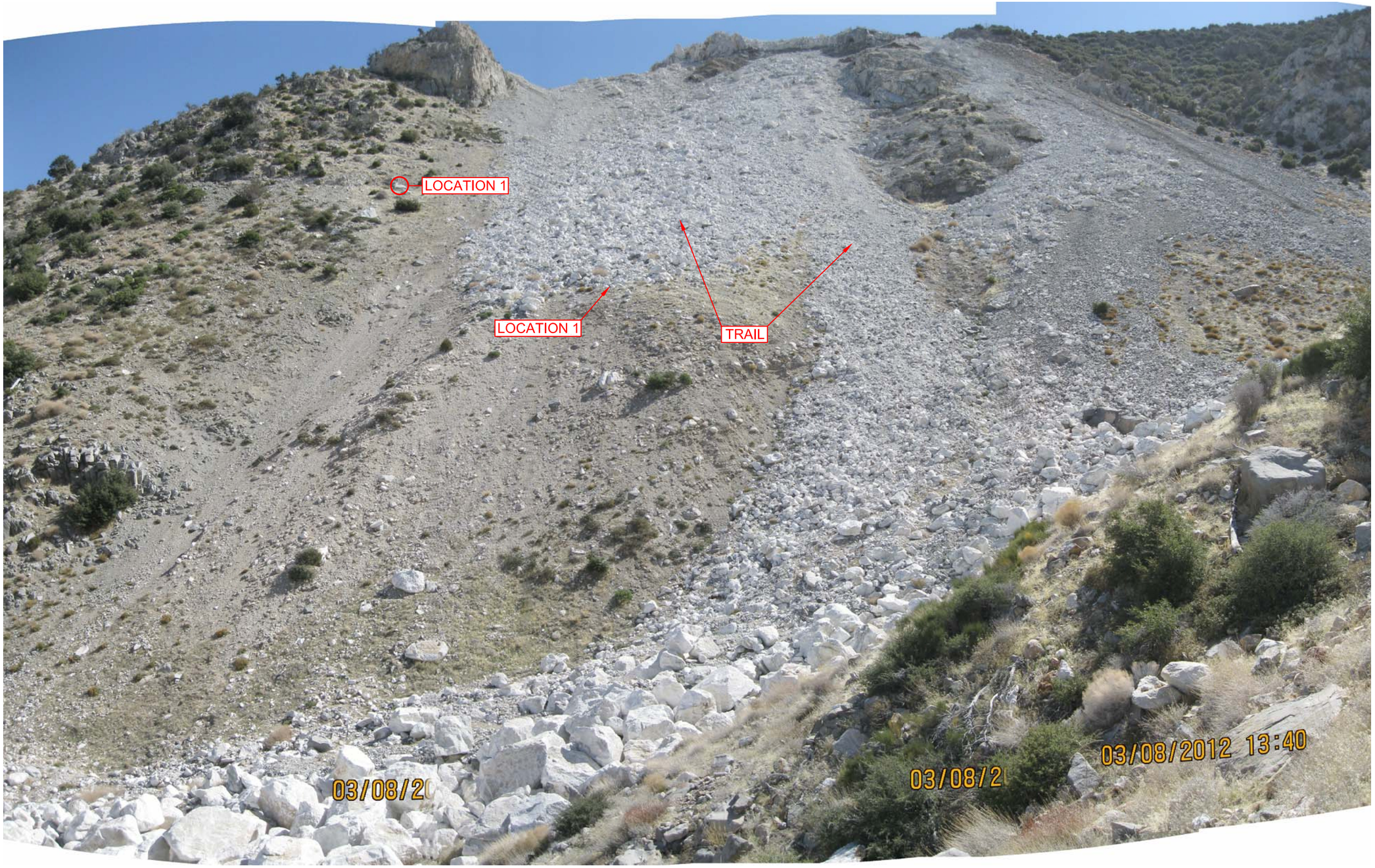
GEOLOGIC INDEX MAP

FOR: OMYA	GEOTECHNICAL CONSULTATION PROPOSED AMENDED PLAN OF OPERATIONS FOR THE WHITE KNOB QUARRY OMYA CALIFORNIA LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "A-3"
DATE: APRIL 2012		JOB NUMBER 12121-8

CHJ Consultants

APPENDIX "B"

SITE PHOTOGRAPHS



NORTHWEST TAILINGS SLOPE		
FOR: OMYA CALIFORNIA	GEOTECHNICAL CONSULTATION PROPOSED AMENDED PLAN OF OPERATIONS FOR THE WHITE KNOB QUARRY OMYA CALIFORNIA, INC. LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-1"
DATE: APRIL 2012		JOB NUMBER 12121-8

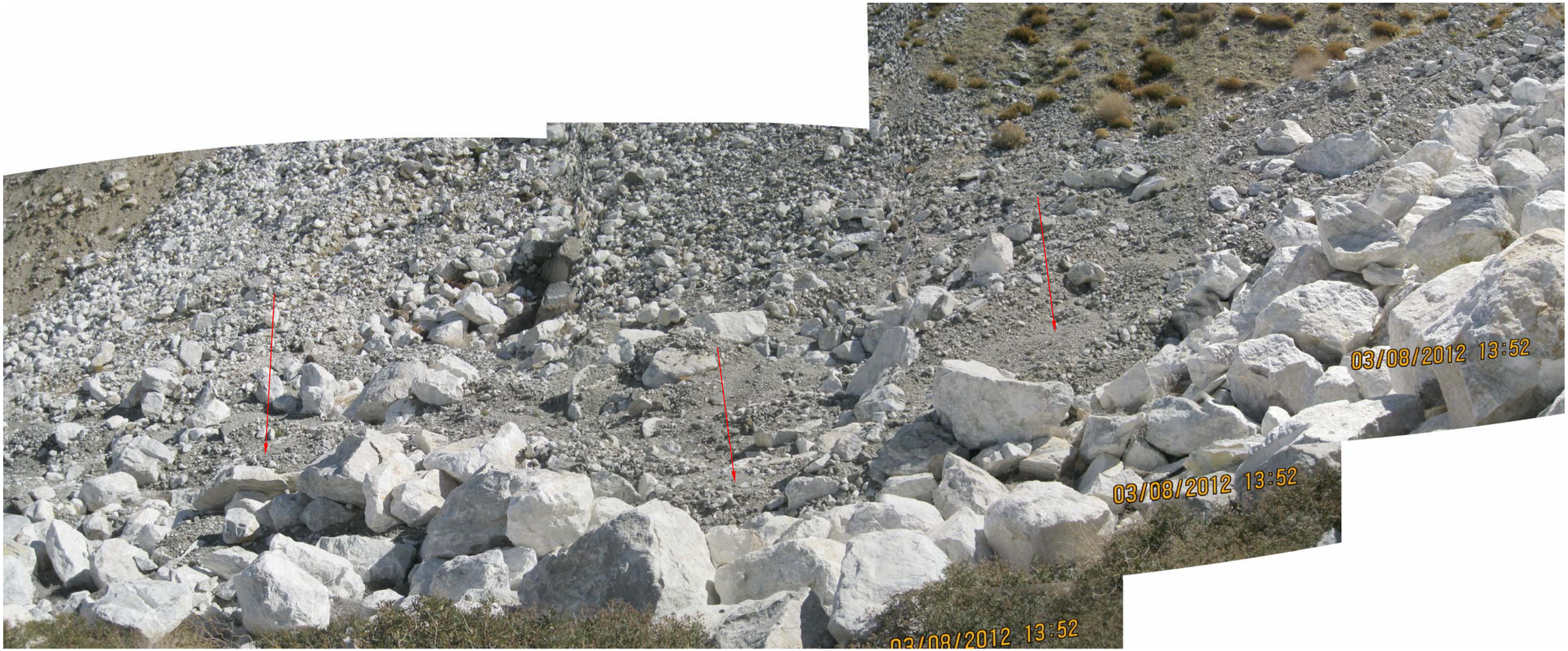
CHJ Consultants

DEBRIS FLOW CHUTE

FOR: OMYA CALIFORNIA	GEOTECHNICAL CONSULTATION PROPOSED AMENDED PLAN OF OPERATIONS FOR THE WHITE KNOB QUARRY OMYA CALIFORNIA, INC. LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-2"
DATE: APRIL 2012		JOB NUMBER 12121-8

CHJ Consultants

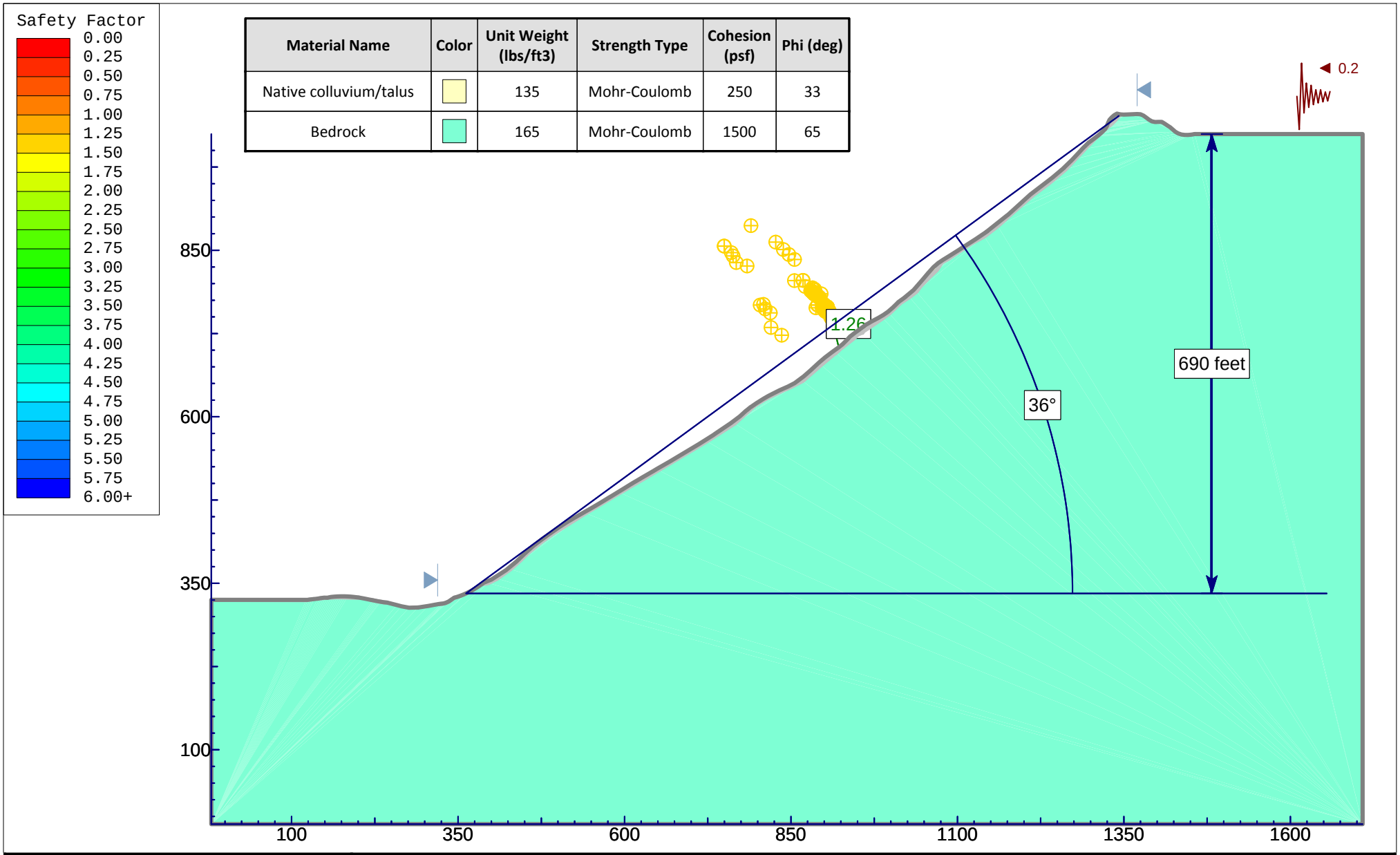
BOULDER AT LOCATION 1		
FOR: OMYA CALIFORNIA	GEOTECHNICAL CONSULTATION PROPOSED AMENDED PLAN OF OPERATIONS FOR THE WHITE KNOB QUARRY OMYA CALIFORNIA, INC. LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-3"
DATE: APRIL 2012		JOB NUMBER 12121-8
		CHJ Consultants



STEP POOLS		
FOR: OMYA CALIFORNIA	GEOTECHNICAL CONSULTATION PROPOSED AMENDED PLAN OF OPERATIONS FOR THE WHITE KNOB QUARRY OMYA CALIFORNIA, INC. LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-4"
DATE: APRIL 2012		JOB NUMBER 12121-8
		CHJ Consultants

APPENDIX "C"

GLOBAL STABILITY CALCULATIONS

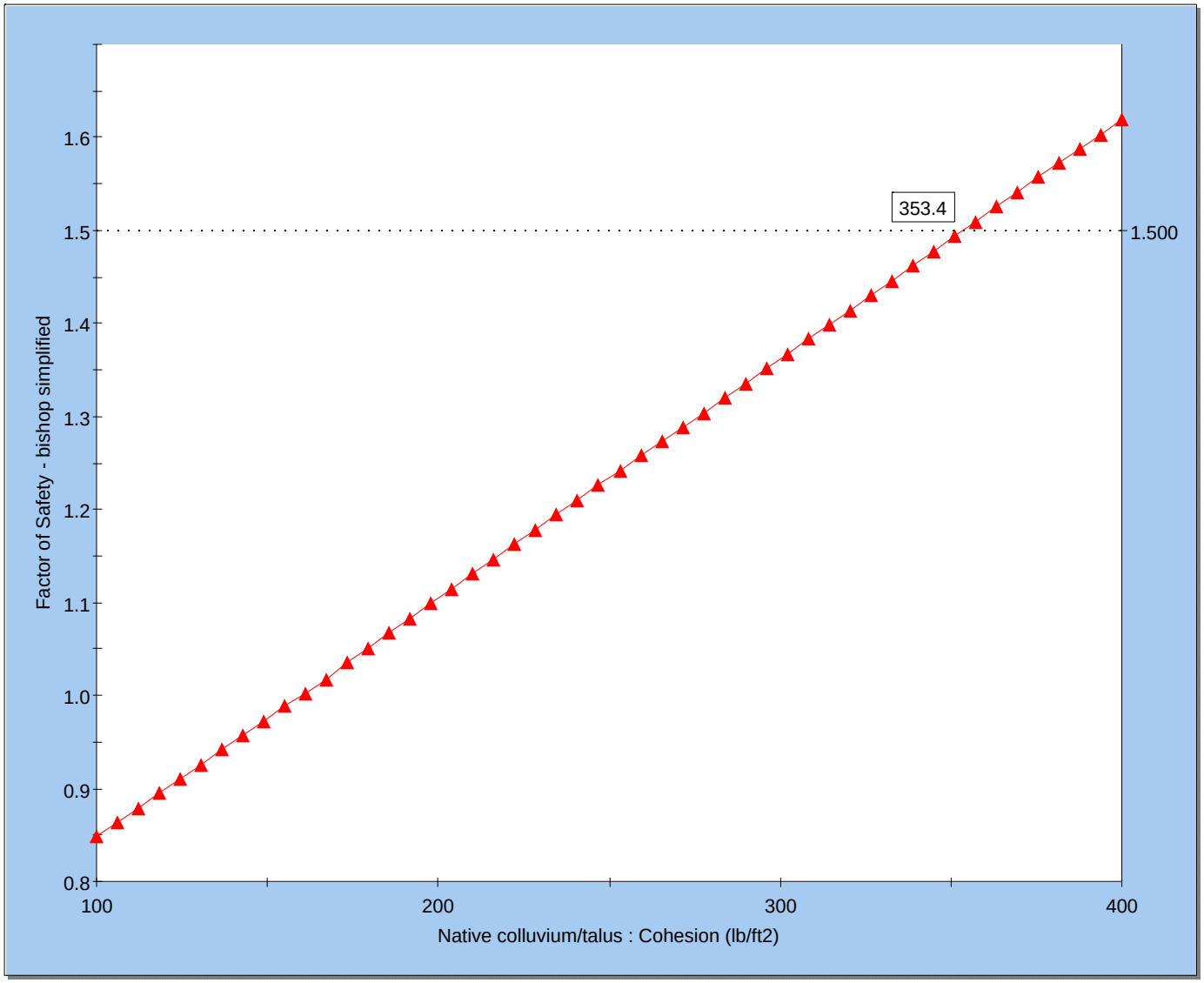


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Native colluvium/talus		135	Mohr-Coulomb	250	33
Bedrock		165	Mohr-Coulomb	1500	65

SLIDEINTERPRET 6.015

OMYA - White Knob Talus Slope

Analysis Description	Section A - A' 1988 Topo				
Drawn By	CHJ	*Author*	JMc	*Scale*	1:2391
File Name	NW talus slope 1988 seis 02.slim	*Date*	4/11/2012	*Enclosure*	C-1



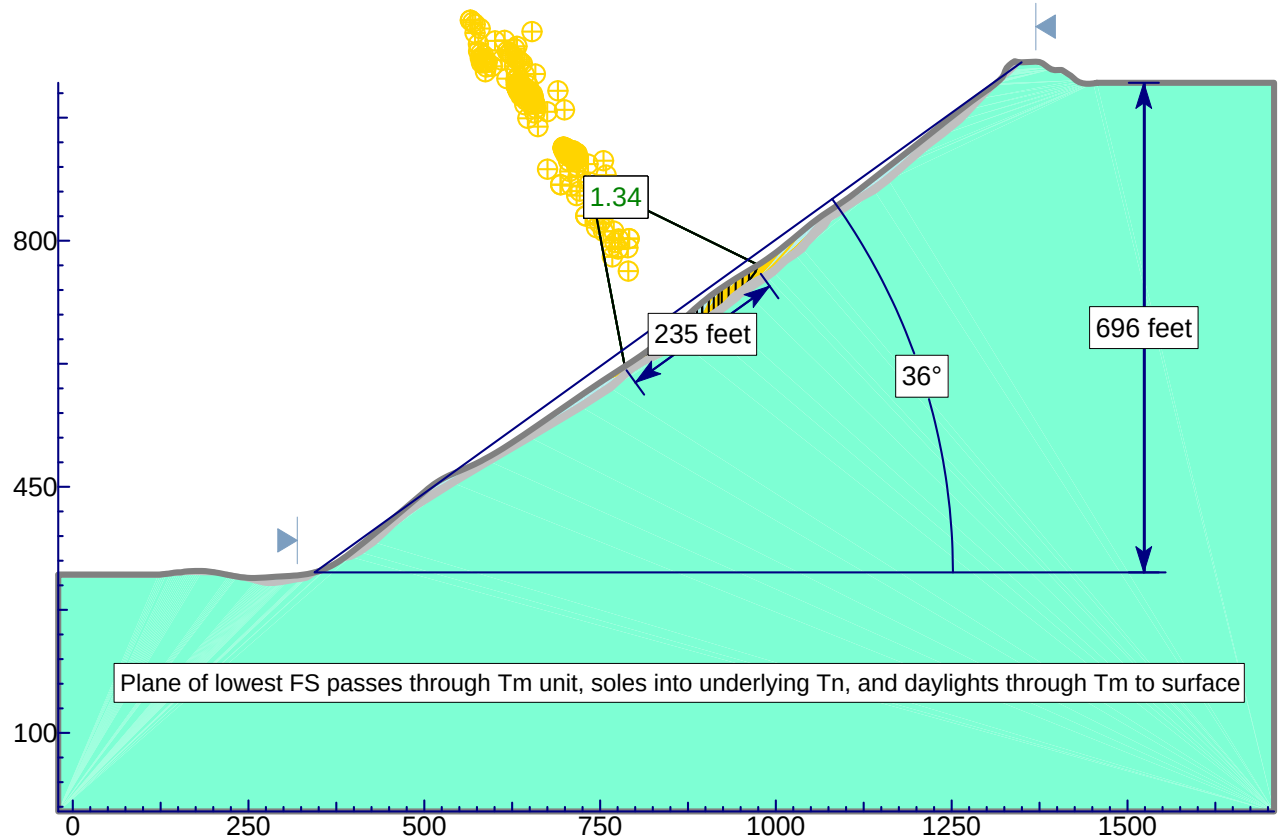
Native colluvium/talus : Cohesion (lb/ft2)

SLIDEINTERPRET 6.015	OMYA - White Knob Talus Slope		
	Analysis Description Section A - A' 1988 Topo		
	Drawn By CHJ	*Author* JMc	*Scale*
	File Name NW talus slope 1988 seis 02.slim	*Date* 4/11/2012	*Enclosure* C-2

Safety Factor

0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
4.50
4.75
5.00
5.25
5.50
5.75
6.00+

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Native colluvium/talus		135	355	38
Mining talus		130	350	40
contact Nat/mine		130	300	40
Bedrock		165	1500	65



SLIDEINTERPRET 6.015

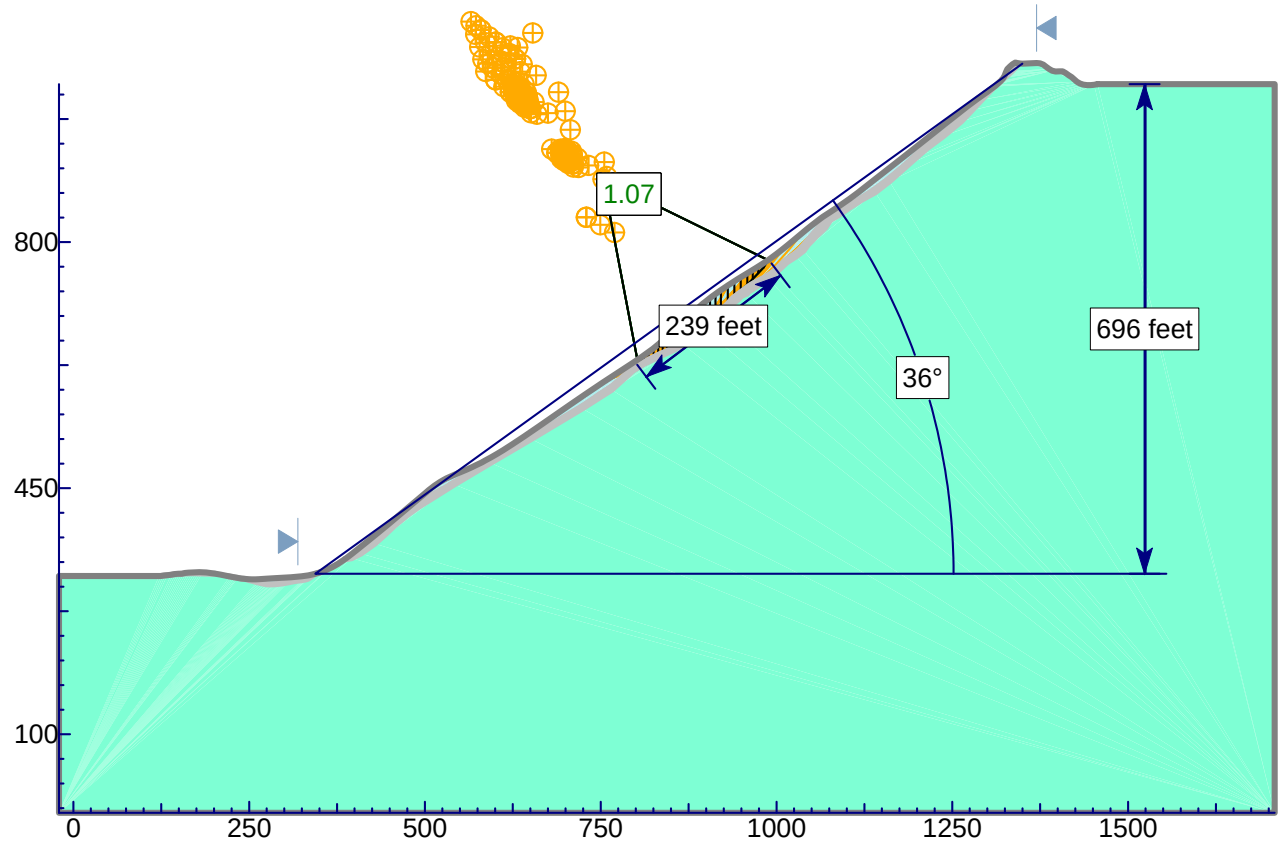
OMYA - White Knob Talus Slope

Analysis Description	Section A - A'		
Drawn By	CHJ	*Author*	JMc	*Scale* 1:3277
File Name	NW talus slope stat.slim	*Date*	4/11/2012	*Enclosure* C-3

Safety Factor

0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00
3.25
3.50
3.75
4.00
4.25
4.50
4.75
5.00
5.25
5.50
5.75
6.00+

Material Name	Color	Unit Weight (lbs/ft3)	Cohesion (psf)	Phi (deg)
Native colluvium/talus		135	355	41
Mining talus		130	375	40
contact Nat/mine		130	340	41
Bedrock		165	1500	65



SLIDEINTERPRET 6.015

OMYA - White Knob Talus Slope

Analysis Description	Section A - A'		
Drawn By	CHJ	*Author* JMc	*Scale* 1:3277
File Name	NW talus slope seis 02.slim	*Date* 4/11/2012	*Enclosure* C-4

APPENDIX "D"

ROCKFALL HAZARD ANALYSIS

CRSP Input File -C:\Program Files\Crsp\WKAA 1fta.DAT

Input File Specifications

Units of Measure: U.S.
Total Number of Cells: 13
Analysis Point 1 X-Coordinate: 560
Analysis Point 2 X-Coordinate: 940
Analysis Point 3 X-Coordinate: 1400
Initial Y-Top Starting Zone Coordinate: 749
Initial Y-Base Starting Zone Coordinate: 730

Remarks: a-a' 1ft bldr on talus & soft slope

Cell Data

Cell No.	S.R.	Tang. C.	Norm. C.	Begin X	Begin Y	End X	End Y
1	.18	.8	.5	0	752	120	750
2	.35	.8	.5	120	750	140	730
3	3	.8	.5	140	730	360	560
4	3	.8	.4	360	560	560	420
5	3	.8	.2	560	420	620	358
6	3	.8	.2	620	358	870	190
7	4	.8	.2	870	190	940	158
8	1	.65	.65	940	158	1070	50
9	.1	.6	.65	1070	50	1110	30
10	.15	.75	.65	1110	30	1130	25
11	4	.8	.25	1130	25	1215	20
12	4	.8	.25	1215	20	1300	30
13	5	.8	.25	1300	30	1400	50

CRSP Simulation Specifications: Used with C:\Program Files\Crsp\WKAA 1fta.DAT

Total Number of Rocks Simulated: 500
Starting Velocity in X-Direction: 1 ft/sec
Starting Velocity in Y-Direction: -1 ft/sec
Starting Cell Number: 1
Ending Cell Number: 13
Rock Density: 165 lb/ft^3
Rock Shape: Spherical
Diameter: 1 ft

CRSP Analysis Point 1 Data - C:\Program Files\Crsp\WKAA 1fta.DAT

Analysis Point 1: X = 560, Y = 420

Total Rocks Passing Analysis Point: 7

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	40.54	3475	1.48
75%	54.64	5435	5.95
90%	67.32	7198	9.97
95%	74.93	8256	12.39
98%	83.48	9444	15.1

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 69.25	Maximum: 7.78	Maximum: 7769
Average: 40.54	Average: 3.44	Average: 3475
Minimum: 9.96	G. Mean: 1.48	Std. Dev.: 2902
Std. Dev.: 20.88	Std. Dev.: 6.63	

Remarks: a-a' 1ft bldr on talus & soft slope

CRSP Analysis Point 2 Data - C:\Program Files\Crsp\WKAA 1fta.DAT

Analysis Point 2: X = 940, Y = 158

NO ROCKS PAST ANALSYSIS POINT 2

CRSP Analysis Point 3 Data - C:\Program Files\Crsp\WKAA 1fta.DAT

Analysis Point 3: X = 1400, Y = 50

NO ROCKS PAST ANALSYSIS POINT 3

CRSP Data Collected at End of Each Cell - C:\Program Files\Crsp\WKAA 1fta.DAT

Velocity Units: ft/sec Bounce Height Units: ft

Cell #	Max. Vel.	Avg. Vel.	S.D. Vel.	Max. Bounce Ht.	Avg. Bounce Ht.
1	No rocks	past end of cell			

2	31	17	5.98	5	1
3	73	44	17.59	20	7
4	69	41	20.88	8	3
5	80	61	17.72	26	14
6	33	33	0	3	2
7	No rocks	past end of cell			
8	No rocks	past end of cell			
9	No rocks	past end of cell			
10	No rocks	past end of cell			
11	No rocks	past end of cell			
12	No rocks	past end of cell			
13	No rocks	past end of cell			

CRSP Rocks Stopped Data - C:\Program Files\Crsp\WKAA 1fta.DAT

X Interval	Rocks Stopped
0 To 10 ft	0
10 To 20 ft	0
20 To 30 ft	0
30 To 40 ft	0
40 To 50 ft	0
50 To 60 ft	0
60 To 70 ft	0
70 To 80 ft	0
80 To 90 ft	0
90 To 100 ft	0
100 To 110 ft	0
110 To 120 ft	0
120 To 130 ft	0
130 To 140 ft	0
140 To 150 ft	130
150 To 160 ft	67
160 To 170 ft	45
170 To 180 ft	34
180 To 190 ft	29
190 To 200 ft	28
200 To 210 ft	18
210 To 220 ft	18
220 To 230 ft	10
230 To 240 ft	13
240 To 250 ft	8
250 To 260 ft	2
260 To 270 ft	14
270 To 280 ft	6
280 To 290 ft	6
290 To 300 ft	8
300 To 310 ft	4
310 To 320 ft	2
320 To 330 ft	2
330 To 340 ft	4
340 To 350 ft	1
350 To 360 ft	4
360 To 370 ft	3

370	To	380	ft	3
380	To	390	ft	3
390	To	400	ft	4
400	To	410	ft	3
410	To	420	ft	0
420	To	430	ft	3
430	To	440	ft	5
440	To	450	ft	0
450	To	460	ft	2
460	To	470	ft	3
470	To	480	ft	2
480	To	490	ft	0
490	To	500	ft	2
500	To	510	ft	1
510	To	520	ft	1
520	To	530	ft	3
530	To	540	ft	1
540	To	550	ft	1
550	To	560	ft	0
560	To	570	ft	1
570	To	580	ft	1
580	To	590	ft	0
590	To	600	ft	0
600	To	610	ft	0
610	To	620	ft	0
620	To	630	ft	0
630	To	640	ft	1
640	To	650	ft	0
650	To	660	ft	1
660	To	670	ft	0
670	To	680	ft	0
680	To	690	ft	0
690	To	700	ft	0
700	To	710	ft	0
710	To	720	ft	0
720	To	730	ft	0
730	To	740	ft	1
740	To	750	ft	1
750	To	760	ft	0
760	To	770	ft	0
770	To	780	ft	0
780	To	790	ft	0
790	To	800	ft	0
800	To	810	ft	0
810	To	820	ft	0
820	To	830	ft	0
830	To	840	ft	0
840	To	850	ft	0
850	To	860	ft	0
860	To	870	ft	0
870	To	880	ft	1
880	To	890	ft	0
890	To	900	ft	0
900	To	910	ft	0
910	To	920	ft	0
920	To	930	ft	0
930	To	940	ft	0

940 To 950 ft	0
950 To 960 ft	0
960 To 970 ft	0
970 To 980 ft	0
980 To 990 ft	0
990 To 1000 ft	0
1000 To 1010 ft	0
1010 To 1020 ft	0
1020 To 1030 ft	0
1030 To 1040 ft	0
1040 To 1050 ft	0
1050 To 1060 ft	0
1060 To 1070 ft	0
1070 To 1080 ft	0
1080 To 1090 ft	0
1090 To 1100 ft	0
1100 To 1110 ft	0
1110 To 1120 ft	0
1120 To 1130 ft	0
1130 To 1140 ft	0
1140 To 1150 ft	0
1150 To 1160 ft	0
1160 To 1170 ft	0
1170 To 1180 ft	0
1180 To 1190 ft	0
1190 To 1200 ft	0
1200 To 1210 ft	0
1210 To 1220 ft	0
1220 To 1230 ft	0
1230 To 1240 ft	0
1240 To 1250 ft	0
1250 To 1260 ft	0
1260 To 1270 ft	0
1270 To 1280 ft	0
1280 To 1290 ft	0
1290 To 1300 ft	0
1300 To 1310 ft	0
1310 To 1320 ft	0
1320 To 1330 ft	0
1330 To 1340 ft	0
1340 To 1350 ft	0
1350 To 1360 ft	0
1360 To 1370 ft	0
1370 To 1380 ft	0
1380 To 1390 ft	0
1390 To 1400 ft	0

CRSP Input File -C:\Program Files\Crsp\WKAA 2fta.DAT

Input File Specifications

Units of Measure: U.S.
Total Number of Cells: 13
Analysis Point 1 X-Coordinate: 560
Analysis Point 2 X-Coordinate: 940
Analysis Point 3 X-Coordinate: 1400
Initial Y-Top Starting Zone Coordinate: 749
Initial Y-Base Starting Zone Coordinate: 730

Remarks: a-a' 2ft bldr on talus & soft slope

Cell Data

Cell No.	S.R.	Tang. C.	Norm. C.	Begin X	Begin Y	End X	End Y
1	.18	.8	.5	0	752	120	750
2	.35	.8	.5	120	750	140	730
3	3	.8	.5	140	730	360	560
4	3	.8	.4	360	560	560	420
5	3	.8	.2	560	420	620	358
6	3	.8	.2	620	358	870	190
7	4	.8	.2	870	190	940	158
8	1	.65	.65	940	158	1070	50
9	.1	.6	.65	1070	50	1110	30
10	.15	.75	.65	1110	30	1130	25
11	4	.8	.25	1130	25	1215	20
12	4	.8	.25	1215	20	1300	30
13	5	.8	.25	1300	30	1400	50

CRSP Simulation Specifications: Used with C:\Program Files\Crsp\WKAA 2fta.DAT

Total Number of Rocks Simulated: 500
Starting Velocity in X-Direction: 1 ft/sec
Starting Velocity in Y-Direction: -1 ft/sec
Starting Cell Number: 1
Ending Cell Number: 13
Rock Density: 165 lb/ft^3
Rock Shape: Spherical
Diameter: 2 ft

CRSP Analysis Point 1 Data - C:\Program Files\Crsp\WKAA 2fta.DAT

Analysis Point 1: X = 560, Y = 420

Total Rocks Passing Analysis Point: 50

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	38.33	24006	3.74
75%	50.03	37788	5.68
90%	60.55	50184	7.42
95%	66.87	57627	8.47
98%	73.96	65979	9.65

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 76.41	Maximum: 20.32	Maximum: 77024
Average: 38.33	Average: 5.46	Average: 24006
Minimum: 15.84	G. Mean: 3.74	Std. Dev.: 20411
Std. Dev.: 17.33	Std. Dev.: 2.87	

Remarks: a-a' 2ft bldr on talus & soft slope

CRSP Analysis Point 2 Data - C:\Program Files\Crsp\WKAA 2fta.DAT

Analysis Point 2: X = 940, Y = 158

NO ROCKS PAST ANALSYSIS POINT 2

CRSP Analysis Point 3 Data - C:\Program Files\Crsp\WKAA 2fta.DAT

Analysis Point 3: X = 1400, Y = 50

NO ROCKS PAST ANALSYSIS POINT 3

CRSP Data Collected at End of Each Cell - C:\Program Files\Crsp\WKAA 2fta.DAT

Velocity Units: ft/sec Bounce Height Units: ft

Cell #	Max. Vel.	Avg. Vel.	S.D. Vel.	Max. Bounce Ht.	Avg. Bounce Ht.
1	No rocks	past end of cell			

2	31	19	6.13	3	0
3	80	41	17.08	26	6
4	76	38	17.33	20	5
5	99	50	21.84	32	7
6	22	21	0	5	2
7	No rocks	past end of cell			
8	No rocks	past end of cell			
9	No rocks	past end of cell			
10	No rocks	past end of cell			
11	No rocks	past end of cell			
12	No rocks	past end of cell			
13	No rocks	past end of cell			

CRSP Rocks Stopped Data - C:\Program Files\Crsp\WKAA 2fta.DAT

X Interval	Rocks Stopped
0 To 10 ft	0
10 To 20 ft	0
20 To 30 ft	0
30 To 40 ft	0
40 To 50 ft	0
50 To 60 ft	0
60 To 70 ft	0
70 To 80 ft	0
80 To 90 ft	0
90 To 100 ft	0
100 To 110 ft	0
110 To 120 ft	0
120 To 130 ft	0
130 To 140 ft	0
140 To 150 ft	62
150 To 160 ft	46
160 To 170 ft	39
170 To 180 ft	45
180 To 190 ft	22
190 To 200 ft	25
200 To 210 ft	18
210 To 220 ft	20
220 To 230 ft	9
230 To 240 ft	7
240 To 250 ft	12
250 To 260 ft	15
260 To 270 ft	11
270 To 280 ft	10
280 To 290 ft	8
290 To 300 ft	4
300 To 310 ft	3
310 To 320 ft	4
320 To 330 ft	6
330 To 340 ft	6
340 To 350 ft	7
350 To 360 ft	5
360 To 370 ft	4

370 To 380 ft	4
380 To 390 ft	2
390 To 400 ft	6
400 To 410 ft	5
410 To 420 ft	3
420 To 430 ft	4
430 To 440 ft	1
440 To 450 ft	3
450 To 460 ft	1
460 To 470 ft	2
470 To 480 ft	4
480 To 490 ft	6
490 To 500 ft	4
500 To 510 ft	2
510 To 520 ft	3
520 To 530 ft	3
530 To 540 ft	5
540 To 550 ft	2
550 To 560 ft	2
560 To 570 ft	0
570 To 580 ft	0
580 To 590 ft	0
590 To 600 ft	1
600 To 610 ft	1
610 To 620 ft	0
620 To 630 ft	4
630 To 640 ft	4
640 To 650 ft	2
650 To 660 ft	3
660 To 670 ft	6
670 To 680 ft	1
680 To 690 ft	3
690 To 700 ft	2
700 To 710 ft	5
710 To 720 ft	2
720 To 730 ft	2
730 To 740 ft	0
740 To 750 ft	5
750 To 760 ft	0
760 To 770 ft	0
770 To 780 ft	2
780 To 790 ft	0
790 To 800 ft	0
800 To 810 ft	0
810 To 820 ft	1
820 To 830 ft	0
830 To 840 ft	0
840 To 850 ft	1
850 To 860 ft	2
860 To 870 ft	0
870 To 880 ft	0
880 To 890 ft	3
890 To 900 ft	0
900 To 910 ft	0
910 To 920 ft	0
920 To 930 ft	0
930 To 940 ft	0

940 To 950 ft	0
950 To 960 ft	0
960 To 970 ft	0
970 To 980 ft	0
980 To 990 ft	0
990 To 1000 ft	0
1000 To 1010 ft	0
1010 To 1020 ft	0
1020 To 1030 ft	0
1030 To 1040 ft	0
1040 To 1050 ft	0
1050 To 1060 ft	0
1060 To 1070 ft	0
1070 To 1080 ft	0
1080 To 1090 ft	0
1090 To 1100 ft	0
1100 To 1110 ft	0
1110 To 1120 ft	0
1120 To 1130 ft	0
1130 To 1140 ft	0
1140 To 1150 ft	0
1150 To 1160 ft	0
1160 To 1170 ft	0
1170 To 1180 ft	0
1180 To 1190 ft	0
1190 To 1200 ft	0
1200 To 1210 ft	0
1210 To 1220 ft	0
1220 To 1230 ft	0
1230 To 1240 ft	0
1240 To 1250 ft	0
1250 To 1260 ft	0
1260 To 1270 ft	0
1270 To 1280 ft	0
1280 To 1290 ft	0
1290 To 1300 ft	0
1300 To 1310 ft	0
1310 To 1320 ft	0
1320 To 1330 ft	0
1330 To 1340 ft	0
1340 To 1350 ft	0
1350 To 1360 ft	0
1360 To 1370 ft	0
1370 To 1380 ft	0
1380 To 1390 ft	0
1390 To 1400 ft	0

CRSP Input File -C:\Program Files\Crsp\WKAA4ft.DAT

Input File Specifications

Units of Measure: U.S.
Total Number of Cells: 13
Analysis Point 1 X-Coordinate: 560
Analysis Point 2 X-Coordinate: 940
Analysis Point 3 X-Coordinate: 1400
Initial Y-Top Starting Zone Coordinate: 749
Initial Y-Base Starting Zone Coordinate: 730

Remarks: a-a' 4ft bldr on talus & soft slope

Cell Data

Cell No.	S.R.	Tang. C.	Norm. C.	Begin X	Begin Y	End X	End Y
1	.2	.8	.5	0	752	120	750
2	.5	.8	.5	120	750	140	730
3	2	.8	.5	140	730	360	560
4	3	.8	.4	360	560	560	420
5	2.5	.8	.4	560	420	620	358
6	3	.8	.4	620	358	870	190
7	3	.8	.4	870	190	940	158
8	.2	.65	.2	940	158	1070	50
9	.1	.6	.2	1070	50	1110	30
10	.2	.75	.2	1110	30	1130	25
11	3.5	.8	.35	1130	25	1215	20
12	3.5	.8	.35	1215	20	1300	30
13	3	.8	.35	1300	30	1400	50

CRSP Simulation Specifications: Used with C:\Program Files\Crsp\WKAA4ft.DAT

Total Number of Rocks Simulated: 500
Starting Velocity in X-Direction: 5 ft/sec
Starting Velocity in Y-Direction: -5 ft/sec
Starting Cell Number: 1
Ending Cell Number: 13
Rock Density: 165 lb/ft^3
Rock Shape: Spherical
Diameter: 4 ft

CRSP Analysis Point 1 Data - C:\Program Files\Crsp\WKAA4ft.DAT

Analysis Point 1: X = 560, Y = 420

Total Rocks Passing Analysis Point: 489

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	44.68	255272	3.55
75%	57.77	385508	7.1
90%	69.54	502648	10.3
95%	76.61	572974	12.21
98%	84.54	651903	14.37

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 94.11	Maximum: 30.48	Maximum: 927278
Average: 44.68	Average: 6.9	Average: 255272
Minimum: 4.94	G. Mean: 3.55	Std. Dev.: 192886
Std. Dev.: 19.39	Std. Dev.: 5.26	

Remarks: a-a' 4ft bldr on talus & soft slope

CRSP Analysis Point 2 Data - C:\Program Files\Crsp\WKAA4ft.DAT

Analysis Point 2: X = 940, Y = 158

Total Rocks Passing Analysis Point: 319

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	34.44	167855	1.93
75%	46.22	275312	5.73
90%	56.81	371964	9.15
95%	63.17	429990	11.2
98%	70.31	495113	13.5

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 88.29	Maximum: 19.93	Maximum: 871183
Average: 34.44	Average: 4.06	Average: 167855
Minimum: 3.85	G. Mean: 1.93	Std. Dev.: 159149
Std. Dev.: 17.45	Std. Dev.: 5.63	

Remarks: a-a' 4ft bldr on talus & soft slope

CRSP Analysis Point 3 Data - C:\Program Files\Crsp\WKAA4ft.DAT

Analysis Point 3: X = 1400, Y = 50

NO ROCKS PAST ANALSYSIS POINT 3

CRSP Data Collected at End of Each Cell - C:\Program Files\Crsp\WKAA4ft.DAT

Velocity Units: ft/sec Bounce Height Units: ft

Cell #	Max. Vel.	Avg. Vel.	S.D. Vel.	Max. Bounce Ht.	Avg. Bounce Ht.
1	No rocks	past end of cell			
2	32	21	5.66	2	0
3	86	53	12.32	27	8
4	94	45	19.39	30	6
5	115	59	18.94	51	12
6	104	41	19.48	34	6
7	88	34	17.45	20	4
8	108	55	12.55	64	1
9	110	56	19.45	54	2
10	114	53	14.48	40	1
11	40	26	10.23	9	4
12	No rocks	past end of cell			
13	No rocks	past end of cell			

CRSP Rocks Stopped Data - C:\Program Files\Crsp\WKAA4ft.DAT

X Interval	Rocks Stopped
0 To 10 ft	0
10 To 20 ft	0
20 To 30 ft	0
30 To 40 ft	0
40 To 50 ft	0
50 To 60 ft	0
60 To 70 ft	0
70 To 80 ft	0
80 To 90 ft	0
90 To 100 ft	0
100 To 110 ft	0
110 To 120 ft	0
120 To 130 ft	0
130 To 140 ft	0
140 To 150 ft	0
150 To 160 ft	0
160 To 170 ft	0
170 To 180 ft	0

180 To 190 ft	0
190 To 200 ft	0
200 To 210 ft	0
210 To 220 ft	0
220 To 230 ft	0
230 To 240 ft	0
240 To 250 ft	0
250 To 260 ft	0
260 To 270 ft	0
270 To 280 ft	0
280 To 290 ft	0
290 To 300 ft	0
300 To 310 ft	0
310 To 320 ft	0
320 To 330 ft	0
330 To 340 ft	0
340 To 350 ft	0
350 To 360 ft	0
360 To 370 ft	0
370 To 380 ft	0
380 To 390 ft	1
390 To 400 ft	1
400 To 410 ft	0
410 To 420 ft	1
420 To 430 ft	1
430 To 440 ft	0
440 To 450 ft	1
450 To 460 ft	0
460 To 470 ft	1
470 To 480 ft	0
480 To 490 ft	0
490 To 500 ft	0
500 To 510 ft	1
510 To 520 ft	2
520 To 530 ft	0
530 To 540 ft	1
540 To 550 ft	1
550 To 560 ft	0
560 To 570 ft	0
570 To 580 ft	0
580 To 590 ft	0
590 To 600 ft	0
600 To 610 ft	0
610 To 620 ft	0
620 To 630 ft	0
630 To 640 ft	0
640 To 650 ft	0
650 To 660 ft	1
660 To 670 ft	1
670 To 680 ft	0
680 To 690 ft	0
690 To 700 ft	2
700 To 710 ft	2
710 To 720 ft	0
720 To 730 ft	2
730 To 740 ft	2
740 To 750 ft	3

750 To 760 ft	1
760 To 770 ft	2
770 To 780 ft	1
780 To 790 ft	0
790 To 800 ft	1
800 To 810 ft	2
810 To 820 ft	3
820 To 830 ft	0
830 To 840 ft	3
840 To 850 ft	1
850 To 860 ft	3
860 To 870 ft	0
870 To 880 ft	20
880 To 890 ft	19
890 To 900 ft	20
900 To 910 ft	25
910 To 920 ft	21
920 To 930 ft	16
930 To 940 ft	19
940 To 950 ft	20
950 To 960 ft	9
960 To 970 ft	6
970 To 980 ft	4
980 To 990 ft	3
990 To 1000 ft	2
1000 To 1010 ft	3
1010 To 1020 ft	2
1020 To 1030 ft	0
1030 To 1040 ft	0
1040 To 1050 ft	0
1050 To 1060 ft	0
1060 To 1070 ft	0
1070 To 1080 ft	38
1080 To 1090 ft	106
1090 To 1100 ft	73
1100 To 1110 ft	25
1110 To 1120 ft	2
1120 To 1130 ft	0
1130 To 1140 ft	0
1140 To 1150 ft	1
1150 To 1160 ft	3
1160 To 1170 ft	4
1170 To 1180 ft	3
1180 To 1190 ft	4
1190 To 1200 ft	3
1200 To 1210 ft	1
1210 To 1220 ft	1
1220 To 1230 ft	2
1230 To 1240 ft	1
1240 To 1250 ft	1
1250 To 1260 ft	1
1260 To 1270 ft	0
1270 To 1280 ft	1
1280 To 1290 ft	0
1290 To 1300 ft	0
1300 To 1310 ft	0
1310 To 1320 ft	0

1320	To	1330	ft	0
1330	To	1340	ft	0
1340	To	1350	ft	0
1350	To	1360	ft	0
1360	To	1370	ft	0
1370	To	1380	ft	0
1380	To	1390	ft	0
1390	To	1400	ft	0

CRSP Input File -C:\Program Files\Crsp\WKAA 6fta.DAT

Input File Specifications

Units of Measure: U.S.
Total Number of Cells: 13
Analysis Point 1 X-Coordinate: 560
Analysis Point 2 X-Coordinate: 940
Analysis Point 3 X-Coordinate: 1400
Initial Y-Top Starting Zone Coordinate: 749
Initial Y-Base Starting Zone Coordinate: 730

Remarks: a-a' 6ft bldr on talus & soft slope

Cell Data

Cell No.	S.R.	Tang. C.	Norm. C.	Begin X	Begin Y	End X	End Y
1	.18	.8	.5	0	752	120	750
2	.35	.8	.5	120	750	140	730
3	1	.8	.5	140	730	360	560
4	1.5	.8	.4	360	560	560	420
5	2.25	.8	.2	560	420	620	358
6	2	.8	.2	620	358	870	190
7	2	.8	.2	870	190	940	158
8	.2	.65	.65	940	158	1070	50
9	.1	.6	.65	1070	50	1110	30
10	.15	.75	.65	1110	30	1130	25
11	3	.8	.25	1130	25	1215	20
12	3	.8	.25	1215	20	1300	30
13	3	.8	.25	1300	30	1400	50

CRSP Simulation Specifications: Used with C:\Program Files\Crsp\WKAA 6fta.DAT

Total Number of Rocks Simulated: 500
Starting Velocity in X-Direction: 1 ft/sec
Starting Velocity in Y-Direction: -1 ft/sec
Starting Cell Number: 1
Ending Cell Number: 13
Rock Density: 165 lb/ft^3
Rock Shape: Spherical
Diameter: 6 ft

CRSP Analysis Point 1 Data - C:\Program Files\Crsp\WKAA 6fta.DAT

Analysis Point 1: X = 560, Y = 420

Total Rocks Passing Analysis Point: 500

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	81.26	2494354	5.4
75%	87.99	2841144	8.83
90%	94.05	3153059	11.91
95%	97.68	3340322	13.76
98%	101.76	3550491	15.84

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 106.92	Maximum: 26.76	Maximum: 3850679
Average: 81.26	Average: 9.1	Average: 2494354
Minimum: 57.3	G. Mean: 5.4	Std. Dev.: 513610
Std. Dev.: 9.97	Std. Dev.: 5.08	

Remarks: a-a' 6ft bldr on talus & soft slope

CRSP Analysis Point 2 Data - C:\Program Files\Crsp\WKAA 6fta.DAT

Analysis Point 2: X = 940, Y = 158

Total Rocks Passing Analysis Point: 500

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	39.86	643794	1.21
75%	46.71	859969	5.4
90%	52.86	1054404	9.17
95%	56.56	1171136	11.44
98%	60.71	1302147	13.98

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 76.85	Maximum: 11.66	Maximum: 2101702
Average: 39.86	Average: 2.51	Average: 643794
Minimum: 15.49	G. Mean: 1.21	Std. Dev.: 320163
Std. Dev.: 10.14	Std. Dev.: 6.21	

Remarks: a-a' 6ft bldr on talus & soft slope

CRSP Analysis Point 3 Data - C:\Program Files\Crsp\WKAA 6fta.DAT

Analysis Point 3: X = 1400, Y = 50

NO ROCKS PAST ANALSYSIS POINT 3

CRSP Data Collected at End of Each Cell - C:\Program Files\Crsp\WKAA 6fta.DAT

Velocity Units: ft/sec Bounce Height Units: ft

Cell #	Max. Vel.	Avg. Vel.	S.D. Vel.	Max. Bounce Ht.	Avg. Bounce Ht.
1	No rocks	past end of cell			
2	31	21	5.65	3	0
3	88	73	5.76	16	5
4	107	81	9.97	27	9
5	120	91	15.22	48	20
6	84	52	11.89	19	4
7	77	40	10.14	12	2
8	103	66	7.96	5	1
9	83	67	6.06	2	0
10	77	64	4.38	2	1
11	61	31	13.02	10	2
12	27	17	8.7	5	0
13	No rocks	past end of cell			

CRSP Rocks Stopped Data - C:\Program Files\Crsp\WKAA 6fta.DAT

X Interval	Rocks Stopped
0 To 10 ft	0
10 To 20 ft	0
20 To 30 ft	0
30 To 40 ft	0
40 To 50 ft	0
50 To 60 ft	0
60 To 70 ft	0
70 To 80 ft	0
80 To 90 ft	0
90 To 100 ft	0
100 To 110 ft	0
110 To 120 ft	0
120 To 130 ft	0
130 To 140 ft	0
140 To 150 ft	0
150 To 160 ft	0
160 To 170 ft	0
170 To 180 ft	0

180 To 190 ft	0
190 To 200 ft	0
200 To 210 ft	0
210 To 220 ft	0
220 To 230 ft	0
230 To 240 ft	0
240 To 250 ft	0
250 To 260 ft	0
260 To 270 ft	0
270 To 280 ft	0
280 To 290 ft	0
290 To 300 ft	0
300 To 310 ft	0
310 To 320 ft	0
320 To 330 ft	0
330 To 340 ft	0
340 To 350 ft	0
350 To 360 ft	0
360 To 370 ft	0
370 To 380 ft	0
380 To 390 ft	0
390 To 400 ft	0
400 To 410 ft	0
410 To 420 ft	0
420 To 430 ft	0
430 To 440 ft	0
440 To 450 ft	0
450 To 460 ft	0
460 To 470 ft	0
470 To 480 ft	0
480 To 490 ft	0
490 To 500 ft	0
500 To 510 ft	0
510 To 520 ft	0
520 To 530 ft	0
530 To 540 ft	0
540 To 550 ft	0
550 To 560 ft	0
560 To 570 ft	0
570 To 580 ft	0
580 To 590 ft	0
590 To 600 ft	0
600 To 610 ft	0
610 To 620 ft	0
620 To 630 ft	0
630 To 640 ft	0
640 To 650 ft	0
650 To 660 ft	0
660 To 670 ft	0
670 To 680 ft	0
680 To 690 ft	0
690 To 700 ft	0
700 To 710 ft	0
710 To 720 ft	0
720 To 730 ft	0
730 To 740 ft	0
740 To 750 ft	0

750 To 760 ft	0
760 To 770 ft	0
770 To 780 ft	0
780 To 790 ft	0
790 To 800 ft	0
800 To 810 ft	0
810 To 820 ft	0
820 To 830 ft	0
830 To 840 ft	0
840 To 850 ft	0
850 To 860 ft	0
860 To 870 ft	0
870 To 880 ft	0
880 To 890 ft	0
890 To 900 ft	0
900 To 910 ft	0
910 To 920 ft	0
920 To 930 ft	0
930 To 940 ft	0
940 To 950 ft	0
950 To 960 ft	0
960 To 970 ft	0
970 To 980 ft	0
980 To 990 ft	0
990 To 1000 ft	0
1000 To 1010 ft	0
1010 To 1020 ft	0
1020 To 1030 ft	0
1030 To 1040 ft	0
1040 To 1050 ft	0
1050 To 1060 ft	0
1060 To 1070 ft	0
1070 To 1080 ft	0
1080 To 1090 ft	7
1090 To 1100 ft	6
1100 To 1110 ft	8
1110 To 1120 ft	0
1120 To 1130 ft	0
1130 To 1140 ft	0
1140 To 1150 ft	0
1150 To 1160 ft	0
1160 To 1170 ft	0
1170 To 1180 ft	5
1180 To 1190 ft	25
1190 To 1200 ft	26
1200 To 1210 ft	43
1210 To 1220 ft	62
1220 To 1230 ft	68
1230 To 1240 ft	71
1240 To 1250 ft	64
1250 To 1260 ft	46
1260 To 1270 ft	31
1270 To 1280 ft	19
1280 To 1290 ft	11
1290 To 1300 ft	2
1300 To 1310 ft	3
1310 To 1320 ft	3

1320	To	1330	ft	0
1330	To	1340	ft	0
1340	To	1350	ft	0
1350	To	1360	ft	0
1360	To	1370	ft	0
1370	To	1380	ft	0
1380	To	1390	ft	0
1390	To	1400	ft	0

CRSP Input File -C:\Program Files\Crsp\AA 10ftb out.doc

Input File Specifications

Units of Measure: U.S.
Total Number of Cells: 13
Analysis Point 1 X-Coordinate: 560
Analysis Point 2 X-Coordinate: 940
Analysis Point 3 X-Coordinate: 1400
Initial Y-Top Starting Zone Coordinate: 749
Initial Y-Base Starting Zone Coordinate: 730

Remarks: a-a' 10ft bldr on talus & soft slope

Cell Data

Cell No.	S.R.	Tang. C.	Norm. C.	Begin X	Begin Y	End X	End Y
1	.2	.8	.5	0	752	120	750
2	.4	.8	.5	120	750	140	730
3	.8	.8	.5	140	730	360	560
4	2.75	.8	.4	360	560	560	420
5	3	.8	.4	560	420	620	358
6	2.75	.8	.4	620	358	870	190
7	3	.8	.4	870	190	940	158
8	1	.65	.2	940	158	1070	50
9	1	.6	.2	1070	50	1110	30
10	1	.75	.2	1110	30	1130	25
11	3	.8	.35	1130	25	1215	20
12	3	.8	.35	1215	20	1300	30
13	3	.8	.35	1300	30	1400	50

CRSP Simulation Specifications: Used with C:\Program Files\Crsp\AA 10ftb out.doc

Total Number of Rocks Simulated: 500
Starting Velocity in X-Direction: 5 ft/sec
Starting Velocity in Y-Direction: -5 ft/sec
Starting Cell Number: 1
Ending Cell Number: 13
Rock Density: 165 lb/ft^3
Rock Shape: Spherical
Diameter: 10 ft

CRSP Analysis Point 1 Data - C:\Program Files\Crsp\AA 10ftb out.doc

Analysis Point 1: X = 560, Y = 420

Total Rocks Passing Analysis Point: 500

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	84.9	12627327	6.33
75%	92.65	14574311	9.14
90%	99.61	16325501	11.67
95%	103.8	17376850	13.18
98%	108.49	18556805	14.89

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 109.07	Maximum: 32.14	Maximum: 18642521
Average: 84.9	Average: 10.37	Average: 12627327
Minimum: 56.89	G. Mean: 6.33	Std. Dev.: 2883566
Std. Dev.: 11.47	Std. Dev.: 4.16	

Remarks: a-a' 10ft bldr on talus & soft slope

CRSP Analysis Point 2 Data - C:\Program Files\Crsp\AA 10ftb out.doc

Analysis Point 2: X = 940, Y = 158

Total Rocks Passing Analysis Point: 500

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	75.86	10561619	4.82
75%	85.29	12989044	7.82
90%	93.78	15172360	10.52
95%	98.88	16483140	12.14
98%	104.6	17954263	13.96

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 123.86	Maximum: 25.5	Maximum: 24568824
Average: 75.86	Average: 7.94	Average: 10561619
Minimum: 45.04	G. Mean: 4.82	Std. Dev.: 3595119
Std. Dev.: 13.98	Std. Dev.: 4.44	

Remarks: a-a' 10ft bldr on talus & soft slope

CRSP Analysis Point 3 Data - C:\Program Files\Crsp\AA 10ftb out.doc

Analysis Point 3: X = 1400, Y = 50

NO ROCKS PAST ANALSYSIS POINT 3

CRSP Data Collected at End of Each Cell - C:\Program Files\Crsp\AA 10ftb out.doc

Velocity Units: ft/sec Bounce Height Units: ft

Cell #	Max. Vel.	Avg. Vel.	S.D. Vel.	Max. Bounce Ht.	Avg. Bounce Ht.
1	No rocks	past end of cell			
2	33	23	5.57	5	0
3	87	77	3.88	7	2
4	109	85	11.47	32	10
5	123	98	11.82	54	21
6	119	88	13.33	36	11
7	124	76	13.98	26	7
8	133	91	18.91	73	14
9	130	73	22.25	64	4
10	129	59	17.93	51	2
11	64	33	11.22	13	2
12	40	17	7.96	6	1
13	No rocks	past end of cell			

CRSP Rocks Stopped Data - C:\Program Files\Crsp\AA 10ftb out.doc

X Interval	Rocks Stopped
0 To 10 ft	0
10 To 20 ft	0
20 To 30 ft	0
30 To 40 ft	0
40 To 50 ft	0
50 To 60 ft	0
60 To 70 ft	0
70 To 80 ft	0
80 To 90 ft	0
90 To 100 ft	0
100 To 110 ft	0
110 To 120 ft	0
120 To 130 ft	0
130 To 140 ft	0
140 To 150 ft	0
150 To 160 ft	0
160 To 170 ft	0

170	To	180	ft	0
180	To	190	ft	0
190	To	200	ft	0
200	To	210	ft	0
210	To	220	ft	0
220	To	230	ft	0
230	To	240	ft	0
240	To	250	ft	0
250	To	260	ft	0
260	To	270	ft	0
270	To	280	ft	0
280	To	290	ft	0
290	To	300	ft	0
300	To	310	ft	0
310	To	320	ft	0
320	To	330	ft	0
330	To	340	ft	0
340	To	350	ft	0
350	To	360	ft	0
360	To	370	ft	0
370	To	380	ft	0
380	To	390	ft	0
390	To	400	ft	0
400	To	410	ft	0
410	To	420	ft	0
420	To	430	ft	0
430	To	440	ft	0
440	To	450	ft	0
450	To	460	ft	0
460	To	470	ft	0
470	To	480	ft	0
480	To	490	ft	0
490	To	500	ft	0
500	To	510	ft	0
510	To	520	ft	0
520	To	530	ft	0
530	To	540	ft	0
540	To	550	ft	0
550	To	560	ft	0
560	To	570	ft	0
570	To	580	ft	0
580	To	590	ft	0
590	To	600	ft	0
600	To	610	ft	0
610	To	620	ft	0
620	To	630	ft	0
630	To	640	ft	0
640	To	650	ft	0
650	To	660	ft	0
660	To	670	ft	0
670	To	680	ft	0
680	To	690	ft	0
690	To	700	ft	0
700	To	710	ft	0
710	To	720	ft	0
720	To	730	ft	0
730	To	740	ft	0

740 To 750 ft	0
750 To 760 ft	0
760 To 770 ft	0
770 To 780 ft	0
780 To 790 ft	0
790 To 800 ft	0
800 To 810 ft	0
810 To 820 ft	0
820 To 830 ft	0
830 To 840 ft	0
840 To 850 ft	0
850 To 860 ft	0
860 To 870 ft	0
870 To 880 ft	0
880 To 890 ft	0
890 To 900 ft	0
900 To 910 ft	0
910 To 920 ft	0
920 To 930 ft	0
930 To 940 ft	0
940 To 950 ft	0
950 To 960 ft	0
960 To 970 ft	0
970 To 980 ft	0
980 To 990 ft	0
990 To 1000 ft	0
1000 To 1010 ft	0
1010 To 1020 ft	0
1020 To 1030 ft	0
1030 To 1040 ft	0
1040 To 1050 ft	0
1050 To 1060 ft	0
1060 To 1070 ft	0
1070 To 1080 ft	0
1080 To 1090 ft	0
1090 To 1100 ft	0
1100 To 1110 ft	0
1110 To 1120 ft	0
1120 To 1130 ft	0
1130 To 1140 ft	0
1140 To 1150 ft	0
1150 To 1160 ft	0
1160 To 1170 ft	0
1170 To 1180 ft	2
1180 To 1190 ft	1
1190 To 1200 ft	4
1200 To 1210 ft	11
1210 To 1220 ft	17
1220 To 1230 ft	38
1230 To 1240 ft	67
1240 To 1250 ft	66
1250 To 1260 ft	75
1260 To 1270 ft	60
1270 To 1280 ft	49
1280 To 1290 ft	32
1290 To 1300 ft	22
1300 To 1310 ft	27

1310	To	1320	ft	15
1320	To	1330	ft	10
1330	To	1340	ft	2
1340	To	1350	ft	1
1350	To	1360	ft	1
1360	To	1370	ft	0
1370	To	1380	ft	0
1380	To	1390	ft	0
1390	To	1400	ft	0

CRSP Input File -C:\Program Files\Crsp\WK BB 2ft.dat

Input File Specifications

Units of Measure: U.S.
Total Number of Cells: 11
Analysis Point 1 X-Coordinate: 480
Analysis Point 2 X-Coordinate: 780
Analysis Point 3 X-Coordinate: 1140
Initial Y-Top Starting Zone Coordinate: 716
Initial Y-Base Starting Zone Coordinate: 710

Remarks: B-B' soft soil slope w SM matrix surface - no talus

Cell Data

Cell No.	S.R.	Tang. C.	Norm. C.	Begin X	Begin Y	End X	End Y
1	1	.55	.15	0	740	70	720
2	1.35	.55	.15	70	720	298	540
3	1.35	.55	.15	298	540	355	500
4	1.3	.55	.15	355	500	439	438
5	1.35	.55	.15	439	438	510	388
6	1.3	.55	.15	510	388	560	350
7	1.35	.55	.15	560	350	678	263
8	1.25	.55	.15	678	263	850	160
9	1.3	.55	.15	850	160	1008	70
10	1	.55	.15	1008	70	1060	58
11	1	.55	.15	1060	58	1200	100

CRSP Simulation Specifications: Used with C:\Program Files\Crsp\WK BB 2ft.dat

Total Number of Rocks Simulated: 500
Starting Velocity in X-Direction: 5 ft/sec
Starting Velocity in Y-Direction: -5 ft/sec
Starting Cell Number: 1
Ending Cell Number: 11
Rock Density: 165 lb/ft^3
Rock Shape: Spherical
Diameter: 2 ft

CRSP Analysis Point 1 Data - C:\Program Files\Crsp\WK BB 2ft.dat

Analysis Point 1: X = 480, Y = 409

Total Rocks Passing Analysis Point: 394

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	19.05	5725	0.48
75%	24.47	8829	4.98
90%	29.34	11620	9.03
95%	32.26	13296	11.46
98%	35.54	15177	14.19

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 47.66	Maximum: 6.08	Maximum: 29219
Average: 19.05	Average: 1.12	Average: 5725
Minimum: 2.67	G. Mean: .48 Std. Dev.: 4596	
Std. Dev.: 8.02	Std. Dev.: 6.67	

Remarks: B-B' soft soil slope w SM matrix surface - no talus

CRSP Analysis Point 2 Data - C:\Program Files\Crsp\WK BB 2ft.dat

Analysis Point 2: X = 780, Y = 202

Total Rocks Passing Analysis Point: 143

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	15.07	3852	0.26
75%	19.97	6180	5.7
90%	24.37	8274	10.59
95%	27.01	9531	13.53
98%	29.98	10942	16.83

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 34.54	Maximum: 5.01	Maximum: 15719
Average: 15.07	Average: .78 Average: 3852	
Minimum: 2.05	G. Mean: .26 Std. Dev.: 3447	
Std. Dev.: 7.25	Std. Dev.: 8.06	

Remarks: B-B' soft soil slope w SM matrix surface - no talus

CRSP Analysis Point 3 Data - C:\Program Files\Crsp\WK BB 2ft.dat

Analysis Point 3: X = 1140, Y = 82

NO ROCKS PAST ANALSYSIS POINT 3

CRSP Data Collected at End of Each Cell - C:\Program Files\Crsp\WK BB 2ft.dat

Velocity Units: ft/sec Bounce Height Units: ft

Cell #	Max. Vel.	Avg. Vel.	S.D. Vel.	Max. Bounce Ht.	Avg. Bounce Ht.
1	No rocks	past end of cell			
2	56	23	8.59	8	1
3	48	20	8.87	5	1
4	50	21	7.99	6	1
5	41	19	7.7	6	1
6	51	21	7.94	7	1
7	46	19	8.81	8	1
8	34	14	6.75	5	0
9	20	20	0	1	0
10	No rocks	past end of cell			
11	No rocks	past end of cell			

CRSP Rocks Stopped Data - C:\Program Files\Crsp\WK BB 2ft.dat

X Interval	Rocks Stopped
0 To 10 ft	0
10 To 20 ft	0
20 To 30 ft	0
30 To 40 ft	0
40 To 50 ft	0
50 To 60 ft	0
60 To 70 ft	0
70 To 80 ft	4
80 To 90 ft	8
90 To 100 ft	4
100 To 110 ft	1
110 To 120 ft	1
120 To 130 ft	1
130 To 140 ft	1
140 To 150 ft	1
150 To 160 ft	0
160 To 170 ft	0
170 To 180 ft	3
180 To 190 ft	1
190 To 200 ft	1
200 To 210 ft	1

210 To 220 ft	2
220 To 230 ft	2
230 To 240 ft	2
240 To 250 ft	1
250 To 260 ft	1
260 To 270 ft	0
270 To 280 ft	1
280 To 290 ft	0
290 To 300 ft	1
300 To 310 ft	7
310 To 320 ft	4
320 To 330 ft	4
330 To 340 ft	5
340 To 350 ft	8
350 To 360 ft	4
360 To 370 ft	4
370 To 380 ft	1
380 To 390 ft	2
390 To 400 ft	0
400 To 410 ft	2
410 To 420 ft	0
420 To 430 ft	2
430 To 440 ft	2
440 To 450 ft	4
450 To 460 ft	5
460 To 470 ft	5
470 To 480 ft	10
480 To 490 ft	8
490 To 500 ft	8
500 To 510 ft	10
510 To 520 ft	1
520 To 530 ft	2
530 To 540 ft	1
540 To 550 ft	0
550 To 560 ft	0
560 To 570 ft	0
570 To 580 ft	2
580 To 590 ft	2
590 To 600 ft	1
600 To 610 ft	1
610 To 620 ft	1
620 To 630 ft	2
630 To 640 ft	1
640 To 650 ft	1
650 To 660 ft	2
660 To 670 ft	3
670 To 680 ft	6
680 To 690 ft	16
690 To 700 ft	26
700 To 710 ft	19
710 To 720 ft	24
720 To 730 ft	26
730 To 740 ft	15
740 To 750 ft	17
750 To 760 ft	16
760 To 770 ft	20
770 To 780 ft	20

780 To 790 ft	15
790 To 800 ft	13
800 To 810 ft	17
810 To 820 ft	13
820 To 830 ft	9
830 To 840 ft	7
840 To 850 ft	6
850 To 860 ft	12
860 To 870 ft	7
870 To 880 ft	6
880 To 890 ft	9
890 To 900 ft	4
900 To 910 ft	2
910 To 920 ft	3
920 To 930 ft	3
930 To 940 ft	3
940 To 950 ft	3
950 To 960 ft	3
960 To 970 ft	2
970 To 980 ft	1
980 To 990 ft	0
990 To 1000 ft	3
1000 To 1010 ft	1
1010 To 1020 ft	0
1020 To 1030 ft	1
1030 To 1040 ft	0
1040 To 1050 ft	0
1050 To 1060 ft	0
1060 To 1070 ft	0
1070 To 1080 ft	0
1080 To 1090 ft	0
1090 To 1100 ft	0
1100 To 1110 ft	0
1110 To 1120 ft	0
1120 To 1130 ft	0
1130 To 1140 ft	0
1140 To 1150 ft	0
1150 To 1160 ft	0
1160 To 1170 ft	0
1170 To 1180 ft	0
1180 To 1190 ft	0
1190 To 1200 ft	0

CRSP Input File -C:\Program Files\Crsp\WK BB 4ft.dat

Input File Specifications

Units of Measure: U.S.
Total Number of Cells: 11
Analysis Point 1 X-Coordinate: 480
Analysis Point 2 X-Coordinate: 780
Analysis Point 3 X-Coordinate: 1140
Initial Y-Top Starting Zone Coordinate: 716
Initial Y-Base Starting Zone Coordinate: 710

Remarks: B-B' soft soil slope w SM matrix surface - no talus

Cell Data

Cell No.	S.R.	Tang. C.	Norm. C.	Begin X	Begin Y	End X	End Y
1	.75	.55	.15	0	740	70	720
2	1	.55	.15	70	720	298	540
3	1	.55	.15	298	540	355	500
4	.95	.55	.15	355	500	439	438
5	1	.55	.15	439	438	510	388
6	.95	.55	.15	510	388	560	350
7	1	.55	.15	560	350	678	263
8	.9	.55	.15	678	263	850	160
9	.95	.55	.15	850	160	1008	70
10	.75	.55	.15	1008	70	1060	58
11	.75	.55	.15	1060	58	1200	100

CRSP Simulation Specifications: Used with C:\Program Files\Crsp\WK BB 2ft.dat

Total Number of Rocks Simulated: 500
Starting Velocity in X-Direction: 5 ft/sec
Starting Velocity in Y-Direction: -5 ft/sec
Starting Cell Number: 1
Ending Cell Number: 11
Rock Density: 165 lb/ft^3
Rock Shape: Spherical
Diameter: 4 ft

CRSP Analysis Point 1 Data - C:\Program Files\Crsp\WK BB 2ft.dat

Analysis Point 1: X = 480, Y = 409

Total Rocks Passing Analysis Point: 500

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	43.81	214144	1.42
75%	47.89	248090	4.58
90%	51.55	278622	7.43
95%	53.75	296953	9.14
98%	56.22	317526	11.06

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 58.3	Maximum: 7.09	Maximum: 356924
Average: 43.81	Average: 2.46	Average: 214144
Minimum: 29.25	G. Mean: 1.42	Std. Dev.: 50275
Std. Dev.: 6.03	Std. Dev.: 4.69	

Remarks: B-B' soft soil slope w SM matrix surface - no talus

CRSP Analysis Point 2 Data - C:\Program Files\Crsp\WK BB 2ft.dat

Analysis Point 2: X = 780, Y = 202

Total Rocks Passing Analysis Point: 500

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	40.6	187113	0.89
75%	43.96	214174	5.34
90%	46.98	238513	9.35
95%	48.8	253126	11.75
98%	50.83	269526	14.45

Velocity (ft/sec)	Bounce Height (ft)	Kinetic Energy (ft-lb)
Maximum: 56.25	Maximum: 5.3	Maximum: 338903
Average: 40.6	Average: 1.77	Average: 187113
Minimum: 29.13	G. Mean: .89	Std. Dev.: 40078
Std. Dev.: 4.98	Std. Dev.: 6.6	

Remarks: B-B' soft soil slope w SM matrix surface - no talus

CRSP Analysis Point 3 Data - C:\Program Files\Crsp\WK BB 2ft.dat

Analysis Point 3: X = 1140, Y = 82

NO ROCKS PAST ANALSYSIS POINT 3

CRSP Data Collected at End of Each Cell - C:\Program Files\Crsp\WK BB 2ft.dat

Velocity Units: ft/sec Bounce Height Units: ft

Cell #	Max. Vel.	Avg. Vel.	S.D. Vel.	Max. Bounce Ht.	Avg. Bounce Ht.
1	No rocks	past end of cell			
2	60	44	5.95	8	2
3	58	42	5.7	7	2
4	64	44	5.86	7	2
5	63	44	6.08	8	2
6	63	45	5.88	7	2
7	63	45	6.04	8	2
8	55	40	4.61	5	1
9	51	37	4.69	5	1
10	35	23	3.94	2	0
11	No rocks	past end of cell			

CRSP Rocks Stopped Data - C:\Program Files\Crsp\WK BB 2ft.dat

X Interval	Rocks Stopped
0 To 10 ft	0
10 To 20 ft	0
20 To 30 ft	0
30 To 40 ft	0
40 To 50 ft	0
50 To 60 ft	0
60 To 70 ft	0
70 To 80 ft	0
80 To 90 ft	0
90 To 100 ft	0
100 To 110 ft	0
110 To 120 ft	0
120 To 130 ft	0
130 To 140 ft	0
140 To 150 ft	0
150 To 160 ft	0
160 To 170 ft	0
170 To 180 ft	0
180 To 190 ft	0
190 To 200 ft	0
200 To 210 ft	0

210 To 220 ft	0
220 To 230 ft	0
230 To 240 ft	0
240 To 250 ft	0
250 To 260 ft	0
260 To 270 ft	0
270 To 280 ft	0
280 To 290 ft	0
290 To 300 ft	0
300 To 310 ft	0
310 To 320 ft	0
320 To 330 ft	0
330 To 340 ft	0
340 To 350 ft	0
350 To 360 ft	0
360 To 370 ft	0
370 To 380 ft	0
380 To 390 ft	0
390 To 400 ft	0
400 To 410 ft	0
410 To 420 ft	0
420 To 430 ft	0
430 To 440 ft	0
440 To 450 ft	0
450 To 460 ft	0
460 To 470 ft	0
470 To 480 ft	0
480 To 490 ft	0
490 To 500 ft	0
500 To 510 ft	0
510 To 520 ft	0
520 To 530 ft	0
530 To 540 ft	0
540 To 550 ft	0
550 To 560 ft	0
560 To 570 ft	0
570 To 580 ft	0
580 To 590 ft	0
590 To 600 ft	0
600 To 610 ft	0
610 To 620 ft	0
620 To 630 ft	0
630 To 640 ft	0
640 To 650 ft	0
650 To 660 ft	0
660 To 670 ft	0
670 To 680 ft	0
680 To 690 ft	0
690 To 700 ft	0
700 To 710 ft	0
710 To 720 ft	0
720 To 730 ft	0
730 To 740 ft	0
740 To 750 ft	0
750 To 760 ft	0
760 To 770 ft	0
770 To 780 ft	0

780 To 790 ft	0
790 To 800 ft	0
800 To 810 ft	0
810 To 820 ft	0
820 To 830 ft	0
830 To 840 ft	0
840 To 850 ft	0
850 To 860 ft	0
860 To 870 ft	0
870 To 880 ft	0
880 To 890 ft	0
890 To 900 ft	0
900 To 910 ft	0
910 To 920 ft	0
920 To 930 ft	0
930 To 940 ft	0
940 To 950 ft	0
950 To 960 ft	0
960 To 970 ft	0
970 To 980 ft	0
980 To 990 ft	0
990 To 1000 ft	0
1000 To 1010 ft	0
1010 To 1020 ft	0
1020 To 1030 ft	0
1030 To 1040 ft	0
1040 To 1050 ft	0
1050 To 1060 ft	0
1060 To 1070 ft	273
1070 To 1080 ft	227
1080 To 1090 ft	0
1090 To 1100 ft	0
1100 To 1110 ft	0
1110 To 1120 ft	0
1120 To 1130 ft	0
1130 To 1140 ft	0
1140 To 1150 ft	0
1150 To 1160 ft	0
1160 To 1170 ft	0
1170 To 1180 ft	0
1180 To 1190 ft	0
1190 To 1200 ft	0

CRSP Input File -C:\Program Files\Crsp\WK BB 10ft.dat

Input File Specifications

Units of Measure: U.S.
Total Number of Cells: 11
Analysis Point 1 X-Coordinate: 480
Analysis Point 2 X-Coordinate: 780
Analysis Point 3 X-Coordinate: 1140
Initial Y-Top Starting Zone Coordinate: 888
Initial Y-Base Starting Zone Coordinate: 880

Remarks: B-B' soft soil slope w SM matrix surface - no talus

Cell Data

Cell No.	S.R.	Tang. C.	Norm. C.	Begin X	Begin Y	End X	End Y
1	.5	.55	.15	0	900	70	720
2	.5	.55	.15	70	720	298	540
3	.5	.55	.15	298	540	355	500
4	.6	.55	.15	355	500	439	438
5	.5	.55	.15	439	438	510	388
6	.5	.55	.15	510	388	560	350
7	.5	.55	.15	560	350	678	263
8	.6	.55	.15	678	263	850	160
9	.5	.55	.15	850	160	1008	70
10	.5	.55	.15	1008	70	1060	58
11	.5	.55	.15	1060	58	1200	100

CRSP Simulation Specifications: Used with C:\Program Files\Crsp\WK BB 10ft.dat

Total Number of Rocks Simulated: 500
Starting Velocity in X-Direction: 10 ft/sec
Starting Velocity in Y-Direction: -10 ft/sec
Starting Cell Number: 1
Ending Cell Number: 11
Rock Density: 165 lb/ft^3
Rock Shape: Spherical
Diameter: 10 ft

CRSP Analysis Point 1 Data - C:\Program Files\Crsp\WK BB 10ft.dat

Analysis Point 1: X = 480, Y = 409

Total Rocks Passing Analysis Point: 199

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	42.01	3315388	0.04
75%	47.34	4111715	6.07
90%	52.13	4827961	11.5
95%	55	5257968	14.76
98%	58.23	5740576	18.42

Velocity (ft/sec)		Bounce Height (ft)		Kinetic Energy (ft-lb)	
Maximum:	59.35	Maximum:	.66	Maximum:	6187159
Average:	42.01	Average:	.12	Average:	3315388
Minimum:	21.56	G. Mean:	.04	Std. Dev.:	1179393
Std. Dev.:	7.88	Std. Dev.:	8.94		

Remarks: B-B' soft soil slope w SM matrix surface - no talus

CRSP Analysis Point 2 Data - C:\Program Files\Crsp\WK BB 10ft.dat

Analysis Point 2: X = 780, Y = 202

Total Rocks Passing Analysis Point: 60

Cumulative Probability	Velocity (ft/sec)	Energy (ft-lb)	Bounce Ht. (ft)
50%	36.86	2573235	0.05
75%	42.19	3291559	7.17
90%	46.98	3937647	13.57
95%	49.86	4325533	17.41
98%	53.09	4760868	21.73

Velocity (ft/sec)		Bounce Height (ft)		Kinetic Energy (ft-lb)	
Maximum:	56.82	Maximum:	.81	Maximum:	5732076
Average:	36.86	Average:	.16	Average:	2573235
Minimum:	19.13	G. Mean:	.05	Std. Dev.:	1063868
Std. Dev.:	7.89	Std. Dev.:	10.54		

Remarks: B-B' soft soil slope w SM matrix surface - no talus

CRSP Analysis Point 3 Data - C:\Program Files\Crsp\WK BB 10ft.dat

Analysis Point 3: X = 1140, Y = 82

NO ROCKS PAST ANALSYSIS POINT 3

CRSP Data Collected at End of Each Cell - C:\Program Files\Crsp\WK BB 10ft.dat

Velocity Units: ft/sec Bounce Height Units: ft

Cell #	Max. Vel.	Avg. Vel.	S.D. Vel.	Max. Bounce Ht.	Avg. Bounce Ht.
1	79	63	10.21	5	1
2	61	43	8.34	1	0
3	61	41	8.37	1	0
4	60	44	8.11	1	0
5	57	41	8.92	1	0
6	59	42	8.63	1	0
7	60	40	8.79	1	0
8	53	36	7.41	1	0
9	46	36	7.28	0	0
10	35	35	0	0	-1
11	No rocks	past end of cell			

CRSP Rocks Stopped Data - C:\Program Files\Crsp\WK BB 10ft.dat

X Interval	Rocks Stopped
0 To 10 ft	0
10 To 20 ft	0
20 To 30 ft	0
30 To 40 ft	0
40 To 50 ft	0
50 To 60 ft	0
60 To 70 ft	0
70 To 80 ft	1
80 To 90 ft	6
90 To 100 ft	5
100 To 110 ft	4
110 To 120 ft	4
120 To 130 ft	5
130 To 140 ft	4
140 To 150 ft	6
150 To 160 ft	6
160 To 170 ft	8
170 To 180 ft	13
180 To 190 ft	9
190 To 200 ft	7
200 To 210 ft	11

210 To 220 ft	8
220 To 230 ft	12
230 To 240 ft	12
240 To 250 ft	7
250 To 260 ft	9
260 To 270 ft	7
270 To 280 ft	12
280 To 290 ft	6
290 To 300 ft	13
300 To 310 ft	14
310 To 320 ft	15
320 To 330 ft	13
330 To 340 ft	18
340 To 350 ft	13
350 To 360 ft	9
360 To 370 ft	5
370 To 380 ft	4
380 To 390 ft	1
390 To 400 ft	1
400 To 410 ft	2
410 To 420 ft	1
420 To 430 ft	2
430 To 440 ft	1
440 To 450 ft	8
450 To 460 ft	6
460 To 470 ft	4
470 To 480 ft	9
480 To 490 ft	9
490 To 500 ft	5
500 To 510 ft	9
510 To 520 ft	12
520 To 530 ft	7
530 To 540 ft	7
540 To 550 ft	7
550 To 560 ft	4
560 To 570 ft	5
570 To 580 ft	9
580 To 590 ft	8
590 To 600 ft	5
600 To 610 ft	3
610 To 620 ft	2
620 To 630 ft	6
630 To 640 ft	7
640 To 650 ft	7
650 To 660 ft	3
660 To 670 ft	5
670 To 680 ft	3
680 To 690 ft	0
690 To 700 ft	3
700 To 710 ft	2
710 To 720 ft	1
720 To 730 ft	1
730 To 740 ft	1
740 To 750 ft	1
750 To 760 ft	3
760 To 770 ft	2
770 To 780 ft	2

780 To 790 ft	1
790 To 800 ft	3
800 To 810 ft	1
810 To 820 ft	1
820 To 830 ft	0
830 To 840 ft	2
840 To 850 ft	3
850 To 860 ft	9
860 To 870 ft	3
870 To 880 ft	5
880 To 890 ft	7
890 To 900 ft	5
900 To 910 ft	3
910 To 920 ft	3
920 To 930 ft	3
930 To 940 ft	0
940 To 950 ft	1
950 To 960 ft	3
960 To 970 ft	1
970 To 980 ft	0
980 To 990 ft	0
990 To 1000 ft	1
1000 To 1010 ft	0
1010 To 1020 ft	0
1020 To 1030 ft	2
1030 To 1040 ft	1
1040 To 1050 ft	0
1050 To 1060 ft	1
1060 To 1070 ft	0
1070 To 1080 ft	1
1080 To 1090 ft	0
1090 To 1100 ft	0
1100 To 1110 ft	0
1110 To 1120 ft	0
1120 To 1130 ft	0
1130 To 1140 ft	0
1140 To 1150 ft	0
1150 To 1160 ft	0
1160 To 1170 ft	0
1170 To 1180 ft	0
1180 To 1190 ft	0
1190 To 1200 ft	0

CHJ Consultants
1355 E. Cooley Drive, Suite C, Colton, CA 92324 ◆ Phone (909) 824-7311 ◆ Fax (909) 503-1136
15345 Anacapa Road, Suite D, Victorville, CA 92392 ◆ Phone (760) 243-0506 ◆ Fax (760) 243-1225
77-564A Country Club Drive, Suite 122, Palm Desert, CA 92211 ◆ Phone (760) 772-8234 ◆ Fax (909) 503-1136

January 14, 2013

Omya California
a Division of Omya, Incorporated
7225 Crystal Creek Road
Lucerne Valley, California 92356
Attention: Mr. Howard Brown

Job No. 12715-8

Dear Mr. Brown:

This letter transmits six copies of the slope stability investigation report for the Amended Plan of Operations for the Omya Incorporated White Knob quarry located south of Lucerne Valley, California.

We appreciate this opportunity to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact this firm at your convenience.

Respectfully submitted,
CHJ CONSULTANTS

John S. McKeown

John S. McKeown, E.G. 2396
Project Geologist

JMc/JJM:jm/lb

Distribution: OMYA Inc. (6)

SLOPE STABILITY INVESTIGATION
PROPOSED AMENDED PLAN OF OPERATIONS
WHITE KNOB QUARRY MINING AND
RECLAMATION PLAN
LUCERNE VALLEY, CALIFORNIA
PREPARED FOR
OMYA CALIFORNIA
A DIVISION OF OMYA, INC.
JOB NO. 12715-8

CHJ Consultants
1355 E. Cooley Drive, Suite C, Colton, CA 92324 ◆ Phone (909) 824-7311 ◆ Fax (909) 503-1136
15345 Anacapa Road, Suite D, Victorville, CA 92392 ◆ Phone (760) 243-0506 ◆ Fax (760) 243-1225
77-564A Country Club Drive, Suite 122, Palm Desert, CA 92211 ◆ Phone (760) 772-8234 ◆ Fax (909) 503-1136

January 14, 2013

Omya California
a Division of Omya, Incorporated
7225 Crystal Creek Road
Lucerne Valley, California 92356
Attention: Mr. Howard Brown

Job No. 12715-8

Dear Mr. Brown:

Attached herewith is the slope stability investigation report for the Amended Plan of Operations for the Omya Incorporated White Knob quarry located in the Lucerne Valley area of San Bernardino County, California.

This revised report was based upon a scope of services generally outlined in our proposal, dated September 26, 2012, and other written and verbal communications.

We appreciate this opportunity to provide geotechnical services for this project. If you have questions or comments concerning this report, please contact this firm at your convenience.

Respectfully submitted,
CHJ CONSULTANTS

John S. McKeown

John S. McKeown, E.G.
Project Geologist

JMc/JJM:lb

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SLOPE STABILITY INVESTIGATION
PROPOSED AMENDED PLAN OF OPERATIONS
WHITE KNOB QUARRY MINING AND RECLAMATION PLAN
LUCERNE VALLEY, CALIFORNIA
PREPARED FOR
OMYA CALIFORNIA
A DIVISION OF OMYA, INC.
JOB NO. 12715-8

INTRODUCTION

This firm provided geotechnical consultation for an Amended Plan of Operations for the Omya Incorporated White Knob quarry located in the Lucerne Valley area of San Bernardino County, California. Our services included evaluation of kinematic and global slope stability for existing and future cut and embankment slopes. The purpose of our evaluation is to characterize the stability and condition of future quarry and embankment slopes. Future mining operations are planned in the White Knob area, White Knob Annex area, and White Ridge quarries. Overburden stockpiles are planned northwest and northeast of the White Ridge area and south of the White Knob area. Information from our prior investigations of the White Knob quarry conducted in 2007 and 2008 including field mapping and laboratory testing were utilized in this evaluation.

To orient our investigation, we reviewed the following documents:

- Omya California White Knob Mining Plan, dated September 22, 2012 (preliminary design)
- Omya California White Knob Mining Plan, dated October 15, 2012
- Omya California White Knob Reclamation Plan, dated October 10, 2012
- Detailed Geologic Map of the White Knob White Ridge area San Bernardino Mountains by Howard Brown, dated June 1989, scale 1" = 50', contour interval = 10 feet
- Topographic map by Digital Mapping, Incorporated from aerial survey dated 2009, scale 1" = 50', 5-foot contour interval
- White Knob Haul Road Drainage Study and Plan of Development by Stantec, dated August 2011

- Orthophoto-based contour map - White Knob Placer Claim by American Aerial Surveys, dated June 24, 1983; scale 1" = 100', 25-foot contour interval
- Orthophoto-based contour map - White Knob area, untitled, dated November 7, 1988
- C.H.J., Incorporated, Revised Slope Stability Investigation, Proposed Amended Plan of Operations, for the White Knob Quarry, OMYA California, Inc., Lucerne Valley, California, CHJ Job No. 07539-8, report dated April 30, 2008.

The approximate location of the quarry area is shown on the attached Index Map (Enclosure "A-1").

The results of our evaluation, together with our conclusions and recommendations, are presented in this report.

SCOPE OF SERVICES

The scope of services provided during this geotechnical consultation included the following:

- Review of published and unpublished literature and maps including geologic mapping by Mr. Howard Brown, Omya's geologist
- Review of aerial imagery dated 1983, 1988, 2002, 2003, 2005, 2006, 2007 and 2009
- Review of OMYA mine and reclamation plans
- Review of previous studies by C.H.J., Incorporated and this firm
- Evaluation of future slopes and overburden stockpiles

PRIOR INVESTIGATIONS

In reports dated 2007 and 2008, C.H.J. Incorporated presented slope stability studies for a proposed amended plan of operation for the White Knob quarry. The prior investigation included geologic

mapping, a review and discussion of geologic hazards, including faulting and seismicity, and a review of groundwater conditions. In addition, kinematic evaluation of proposed rock slopes and slope stability calculations and evaluation of proposed rock and overburden slopes were performed. The results of those investigations indicated that the then-proposed overall approximate 50-degree mine cut slopes up to approximately 450 feet in height formed in limestone and granitic rock are suitably stable against gross failure for the anticipated long-term conditions, including the effects of seismic shaking and that proposed 2(h):1(v) fill slopes meet the factor of safety criteria for static and seismic conditions. This update addresses modifications to the mine plan that include slope configurations and geometry and height of overburden stockpiles.

SITE DESCRIPTION

The White Knob quarry is located in the northern San Bernardino Mountains, approximately 6 miles southwest of the town of Lucerne Valley. The quarry occupies portions of Sections 7 and 8, Township 3 North, Range 1 West, of San Bernardino Base & Meridian (SBB&M). Access to the quarry is by a haul road extending 6 miles west-southwesterly from the Omya Incorporated processing plant located on Crystal Creek Road. Elevations in the quarry area range from approximately 4,800 feet above mean sea level (elevation values listed in this report assume amsl) to 6,300 feet. The White Knob quarry produces high-purity calcium carbonate limestone used for numerous commercial and industrial applications, including plastics and paints. The high-purity calcium carbonate limestone deposits required for these applications are typically white in color. The more common gray limestone deposits are not considered suitable for such applications. The White Knob quarry area includes mining areas designated White Knob and White Knob Annex and a future mining area designated as White Ridge. The White Ridge area is not mined at this time. Enclosure "A-2.1", Geologic Map and Site Plan depicts the topographic and geologic conditions in the quarry areas and general site configuration.

MINING AND RECLAMATION PLANS

According to the Mining Plan dated October 2012, it is proposed to continue mining in the White Knob and White Knob Annex areas to bottom elevations of 5,300 feet and 5,575 feet, respectively. A bottom elevation of approximately 5,050 feet is proposed for the White Ridge quarry. The geometry of final mined slopes is planned to include overall heights up to 975 feet in the White Knob quarry (including the section of natural slope above the mined slope) and 750 feet in the White Ridge quarry. Mined slope angles are planned at approximately 50 degrees overall utilizing 45 foot high intra-bench faces cut at 70 degrees with intervening 25-foot wide safety benches. These slopes will be formed in crystalline rock materials.

Overburden stockpiles currently include materials placed at OB-1 located east of White Knob quarry and west of proposed White Ridge quarry. These materials were previously sampled and tested by C.H.J., Incorporated in 2007. Future stockpile areas are planned south of White Knob quarry (OB-2) and northeast of White Ridge quarry (OB-3). Stockpile fills are planned with intra-bench slope gradients of 2 horizontal (h) to 1 vertical (v) to maximum intra-bench heights of approximately 100 feet. The planned slope angle and bench configuration will result in stockpile slopes that exhibit gradients flatter than 2(h):1(v) overall.

The slope configuration and geometry of selected mine and overburden stockpile slopes, depicted along section lines A-A', B-B' and C-C', is presented in Appendix C. The location of individual section lines is shown on the Mining Plan (Enclosure "A-2.2").

REGIONAL GEOLOGIC SETTING:

The Omya Incorporated White Knob quarry lies in the northern portion of the San Bernardino Mountains. The San Bernardino Mountains are part of the Transverse Ranges Geomorphic Province. The San Bernardino Mountains are characterized by remnants of a relatively flat, uplifted geomorphic surface as old as Miocene in age. These discontinuous geomorphic remnants are

separated by steep-walled canyons and prominent peaks. The White Knob quarry is located on the north flank of the mountains. The Mojave Desert Geomorphic Province is located to the north of the site. The general geologic structure and lithology of the site region are shown on Enclosure "A-3", Geologic Index Map adapted from Miller et al. (2000).

The following with regard to the regional geology of the mine area is adapted from information provided by Mr. Howard Brown, Exploration and Mining Geologist with Omya Incorporated.

> Brown (1984a, 1984b, 1985a, 1985b, 1986, 1991a, 1991b, 2008a) has presented numerous reports, presentations and papers regarding the regional geologic setting of the San Bernardino Mountains and Mojave Desert area as summarized below. A variety of rocks of Precambrian to recent age are exposed within the San Bernardino Mountains and the White Knob/White Ridge quarry area. Late Precambrian and Paleozoic metasedimentary rocks unconformably overlie older 1.8 b.y. Baldwin Gneiss Precambrian basement.
>
> Late Proterozoic and Paleozoic sequences in the San Bernardino Mountains contain elements of both cratonal and miogeoclinal affinity. The lower part of the sequence is dominated by quartzite of the Stirling Quartzite, Wood Canyon Formation, and Zabriskie quartzite. The Cambrian Carrara Formation contains both clastic and carbonate members. Cambrian strata are dominated by dolomite of the Bonanza King and Nopah Formations. A major unconformity is present between Upper Cambrian and Devonian strata throughout the Mojave region and San Bernardino Mountains. In the San Bernardino Mountains, Upper Precambrian and Lower Cambrian rocks are of miogeoclinal aspect, middle Cambrian strata are of cratonal aspect, and upper Paleozoic rocks are identical to inner miogeoclinal facies of the central and eastern Mojave region.
>
> Upper Paleozoic rocks including upper Devonian, Mississippian and Pennsylvanian through Permian are dominated by limestone. High brightness, high purity crystalline limestone deposits occur in upper Paleozoic miogeoclinal limestone formations in the San Bernardino Mountains and at White Knob quarry. The Mississippian Monte Cristo Limestone is mined for high brightness, high purity calcium carbonate, and the Pennsylvanian Bird Spring Formation is extensively mined for cement grade limestone. Fluorescent minerals at the White Knob quarry occur in the Monte Cristo Limestone.
>
> Several varieties of Permo-Triassic and Mesozoic age intrusive rocks are present in the San Bernardino Mountains, and include Permo-Triassic monzonites, quartz monzonite and granodiorite, Jurassic quartz monzonite, hornblende diorite and gabbro, and leucocratic batholithic quartz monzonites of Cretaceous age. Plutonic rocks form the majority of the

mountain range, and the Paleozoic rocks described above were intruded by the plutonic rocks and form roof pendants. At the White Knob quarry, several generations of intrusive rocks are present and cross cutting relationships can be observed.

The Late Proterozoic and Paleozoic rocks have been affected by both regional and contact metamorphism. Regional metamorphism ranges from upper Greenschist to upper Amphibolite facies. At the White Knob quarry the metasedimentary rocks have been metamorphosed to upper amphibolite facies based on the presence of diopside, vesuvianite, wollastonite and garnet bearing calc-silicate minerals. Contact metamorphism is widespread, and numerous small skarn deposits are present along some contacts between metasedimentary and intrusive rocks.

Several major intrusive, metamorphic and tectonic events have been recognized in the San Bernardino Mountains. These include complex multi-phase Permo-Triassic and Mesozoic age folding and thrust faulting, contact and regional metamorphism, and intrusive events.

Cenozoic activity includes several generations of high and low angle faults, and mild folding. The San Bernardino Mountains area continues to be seismically active as evidenced by the significant earthquakes in the area during the last 15 years.

The Old Woman Sandstone consists of massive to weakly bedded arkosic and locally conglomeratic sandstone that crops out discontinuously in the northern San Bernardino Mountains and Mojave Desert region. Shreve (1959) suggests northward deposition of this sandstone in an alluvial-fan environment from an early San Bernardino Mountains highland. Quaternary deposits mapped by Miller et al. (2000) include alluvial fan, axial valley, talus, colluvial, surficial, and landslide deposits ranging in age from very old (Pleistocene) to recent (Holocene) age. Sediments within the mining area are primarily comprised of colluvium and surficial sediments as thin slope mantling soils and in drainage channels as thin veneers on bedrock channels.

At the White Knob Quarry, rocks have been multiply metamorphosed to amphibolite and locally granulite facies, forming exceedingly coarse-grained, very white translucent calcite marble. Individual calcite rhombs are commonly over 1 inch across. The steeply dipping deposit is over 1,500 feet along strike, and is exposed over 1,200 feet vertically.

The complex geologic history of the San Bernardino Mountains has allowed the formation of several large high brightness, high purity limestone deposits which are currently being mined or will be mined in the future.

GEOLOGIC STRUCTURE:

The southern and northern margins of the White Knob ore deposit are formed by contact with steeply south-dipping intrusive rocks that include granitic and foliated schistose rocks. Foliation (bedding) measured within and along the ore body margin generally strikes east-west and dips southward at steep inclinations.

Major contacts between the lithologic (mapping) units include faults as mapped by Mr. Howard Brown. High-angle faults are also mapped trending perpendicular to the east-west trend of the ore body (cross faults).

The bedrock geologic materials observed in the quarry walls exhibit well-developed joint sets and systems, localized shear zones, and localized foliation that were measured with a geologic compass and recorded on a 100-scale topographic map. These data are shown on the Geologic Map and Site Plan (Enclosure "A-2.1"). The discontinuity data was evaluated with a stereonet plotting program as dip vectors and analyzed for kinematic stability based on the anticipated final quarry geometries. Within individual quarry exposures, at least two orthogonal high-angle joint sets were observed. Throughout the quarry area these high-angle joint sets are aligned near north-south and east-west, reflecting the trend of major bedrock faults and contacts. A third joint set exhibiting more shallow dips was locally present. Joint sets are typically widely spaced (12 to 36 inches) and joints are discontinuous (less than 3 feet) to slightly continuous (3 to 10 feet). All joints (fractures) were dry, tight, and lacked infilling. The ore rock is fresh and unstained in the majority of quarry exposures. The potential effect of the geometry of discontinuities on slope stability is addressed later in this report.

An east-northeast trending canyon descends from the current crusher site and contains a haul road that passes between OB-1 and the future White Ridge quarry area. Twenty-year-old cut slopes along the haul road locally expose thick deposits of colluvial sediment derived from natural erosion and down slope migration of coarse clastic (cobble size) debris and silty sand matrix material. Raveling

and/or sloughing was not apparent in these materials that locally stand at steep gradients due to a relatively high degree of cementation and are primarily clast supported. Not all occurrences of colluvium are shown on the Geologic Map and Site Plan (Enclosure "A-2.1").

Fill observed at the site is associated with process material and overburden stockpiles in the area of quarrying, as well as with roadways. The larger areas of fill are shown on the Geologic Map and Site Plan (Enclosure "A-2.1").

LOCAL GEOLOGIC SETTING:

The White Knob quarry occupies an east-west oriented resistant and rugged limestone ridge formed in the very steep north-sloping topography of the northern San Bernardino Mountains. Natural slopes descend to the north and northwest from the ridge of the White Knob quarry. Satellite ore deposits occur to the east of the main quarry on an adjacent north-trending ridge (White Ridge area) that appears to be structurally related to the main quarry ridge. The area of the White Ridge deposit located to the east is not mined at this time, and adjacent slopes are in a natural state. Future mining is planned in this area. An active overburden placement site (OB-1) is located near the east end of White Knob quarry in the Central Drainage area. Existing mine cut-slopes in the quarry are inclined overall at approximately 1(h):1(v) and up to approximately 600 feet in height. The overall inclination of the quarry slopes is controlled by geologic structure (primarily joints) and locally by pre-splitting blasting.

FAULTING AND SEISMICITY

REGIONAL FAULTS:

The tectonics of the Southern California area are dominated by the interaction of the North American and Pacific tectonic plates, which are sliding past each other in transform motion. Although some of the motion may be accommodated by rotation of crustal blocks such as the western Transverse Ranges (Dickinson, 1996), the San Andreas fault zone is thought to represent the major surface

expression of the tectonic boundary and to be accommodating most of the transform slip between the Pacific Plate and the North American Plate. Some of the plate slip is accommodated by other northwest-trending strike-slip faults that are related to the San Andreas system, such as the San Jacinto fault and the Elsinore fault. Local compressional or extensional strain resulting from the transform motion along this boundary is accommodated by left-lateral, reverse and normal faults such as the Cucamonga fault and the nearby North Frontal fault zone (NFFZ).

The most significant fault to the site from a ground shaking standpoint is the North Frontal fault zone, exposed approximately 1 mile north of the site along the range front of the San Bernardino Mountains. This fault is a complex zone of left-lateral, thrust and reverse faults and forms the boundary between the Mojave Desert Geomorphic Province on the north and the Transverse Ranges Geomorphic Province on the south. Since this fault dips at a moderate angle to the south (approximately 49° according to Petersen et al., 2008), the fault plane is about 1 mile beneath the site.

The Eastern California Shear Zone (ECSZ) is a zone of regional deformation traversing the Mojave Desert that includes a system of predominantly northwest-trending strike-slip faults. The ECSZ accommodates strain along the Pacific/North American Plate boundary across a zone approximately 65 miles wide and is thought to transfer as much as 15 percent of the total plate boundary shear into the Great Basin area (Shermer and others, 1996). A number of faults of this system ruptured in combination during the 1992 Landers earthquake east of the site. Rupture of that event extended within approximately 25 miles of the mine area and included several faults (Hauksson, 1993). An earthquake of M 6.4, known as the Big Bear earthquake, occurred a few hours later. The Big Bear quake and its aftershocks occurred along a northeast-trending alignment located approximately 12 miles southeast of the site. The Hector Mine earthquake of 1999 occurred on the Lavic Lake and Bullion faults of the ECSZ. The Helendale fault, Lenwood-Lockhart fault, and Johnson Valley fault of this system are located approximately 4.9 miles northeast, 15-1/2 miles northeast, and 19 miles east-northeast of the site, respectively. These faults are major components of the ECSZ and are considered Holocene active.

The northwest-trending San Andreas fault is located approximately 18 miles southwest of the White Knob quarry site. The toe of the mountain front in the San Bernardino area roughly demarcates the presently active trace of the San Bernardino mountains segment. Youthful fault scarps, vegetational lineaments, springs and offset drainages, characterizes both segments. The Working Group on California Earthquake Probabilities (1995) tentatively assigned a 28 percent (±13 percent) probability to a major earthquake occurring on the San Bernardino Mountains segment of the San Andreas Fault between 1994 and 2024. Enclosure "A-5" depicts faults and their associated status of activity within the site region.

LOCAL FAULTS:

No evidence of active faulting traversing the mine area was found during our review of published and unpublished literature and maps, during our review of stereoscopic aerial photographs, or during prior field mapping. Ground rupture due to active faulting in the quarry area is not anticipated.

Faults (localized shear zones) and folds were observed in existing quarry exposures, and Mr. Howard Brown mapped regional and local high-angle faults that form contacts between geologic formations/units and/or cut oblique to the trend of the east-west oriented ore body axis across the White Knob and White Ridge areas. These faults and folds are typical of the rocks of the northern San Bernardino Mountains, and most or all of these structures are likely to predate or be associated with Cenozoic uplift of the San Bernardino Mountains, or folding of the Paleozoic age rocks during Mesozoic time. Quaternary activity appears to be concentrated on faults along the south margin of the modern mountain range and potential activity along locally mapped faults is considered very low.

Various high-angle faults are mapped in the existing quarry area. These faults strike primarily north and south. It is anticipated that additional high-angle faults may be exposed/mapped during future quarry operations.

REGIONAL SEISMICITY:

Numerous small earthquakes have occurred in the site region in the historic time period. A map of recorded earthquake epicenters is included as Enclosure "A-4" (Epi Software, 2000). The epicenters and magnitudes that are shown are based on data from recording instruments in a California Institute of Technology - Southern California Earthquake Data Center catalogue. This enclosure presents circles as epicenters of earthquakes with magnitude equal to or greater than 4.0 that were recorded from 1932 through 2011. The cluster of small earthquakes in the site area may be partially attributable to quarry blasts.

The most significant fault to the site from a ground shaking standpoint is the NFFZ, mapped approximately 1 mile north of the site along the range front of the San Bernardino Mountains. This fault is a complex zone of left-lateral, thrust, and reverse faults and forms the boundary between the Mojave Desert Geomorphic Province and the Transverse Ranges Geomorphic Province to the south. Since this fault dips at a moderate angle to the south, the projected fault plane is about 1 mile from the site as measured perpendicular to the fault plane.

The regional structure of the Mojave Desert includes major northwest-trending, strike-slip fault zones. Jennings (1994) indicated several of these fault zones with evidence for Holocene fault displacement. Geomorphic evidence for Holocene fault displacement includes sag ponds, fresh fault scarps, or the following features in Holocene deposits: offset drainages, linear scarps, shutter ridges, and faceted spurs. The Helendale fault is the closest of these Holocene active faults and is located approximately 8 miles northeast of the site. Jennings also indicates the Old Woman Springs, Lockhart, Harper, and Camp Rock faults, located at greater distances from the site, as having Holocene fault displacement. Surface rupture occurred on the southeastern end of the Camp Rock fault during the magnitude 7.3 Landers earthquake of June 28, 1992. An earthquake of magnitude 6.4, known as the Big Bear earthquake, occurred a few hours later. The Big Bear quake and its aftershocks occurred along a northeast-trending alignment located approximately 15 miles southeast of the site.

The northwest-trending San Andreas fault is located approximately 14 miles southwest of the site. The toe of the mountain front in the San Bernardino area roughly demarcates the presently active trace of the San Bernardino Mountains segment. Youthful fault scarps, vegetational lineaments, springs and offset drainages characterizes both segments. The Working Group on California Earthquake Probabilities (1995) tentatively assigned a 28 percent (±13 percent) probability to a major earthquake occurring on the San Bernardino Mountains segment of the San Andreas fault between 1994 and 2024.

GROUND-SHAKING HAZARD

SEISMIC DESIGN PARAMETERS:

The 2010 California Building Code (CBC) Design Acceleration Parameters for structures were determined from latitude/longitude coordinates N34.3629, W117.012 using the web-based U.S. Geologic Survey application - http://earthquake.usgs.gov/hazards/designmaps/javacalc.php - and are summarized in the following table. These data are provided for reference only since no CBC structures are addressed by this report. The corresponding value of peak ground acceleration (PGA) from the design acceleration spectrum according to the 2010 CBC is 0.52g.

TABLE 1

2010 CBC - Seismic Parameters	
Mapped Spectral Acceleration Parameters	$S_s = 1.96$ and $S_1 = 0.75$
Site Coefficients (Class B)	$F_a = 1.0$ and $F_v = 1.0$
Adjusted Maximum Considered Earthquake (MCE) Spectral Response Parameters	$S_{MS} = 1.96$ and $S_{M1} = 0.75$
Design Spectral Acceleration Parameters	$S_{DS} = 1.30$ and $S_{D1} = 0.50$

DETERMINISTIC SEISMIC HAZARD ANALYSIS:

A deterministic evaluation of seismic hazard was calculated for the North Frontal fault zone using the attenuation relations of Boore and Atkinson (2008), Campbell and Bozorgnia (2008), and Chiou and

Youngs (2008) and magnitude 7.1 at a distance of 1 mile. A peak ground acceleration of 0.56g is estimated by the deterministic method.

SLOPE STABILITY

The term "landslide", as used in this report, refers to deep-seated slope failures with a rupture surface at least 50 feet deep. Landslides are typically related to the underlying structure of the parent material. Surficial failures refer to shallow failures that affect the upper weathered or colluvial horizon of overlying material. Evidence for deep-seated landsliding was not observed in the White Knob quarry walls or in natural exposures of the White Ridge area during our previous 2007 and 2008 evaluations or on the aerial photographs reviewed.

The susceptibility of a geologic unit to landsliding is dependent upon various factors that primarily include: 1) the degree of continuity and orientation of potentially weak structures, such as fractures, faults, and/or clay seams; 2) the height and steepness of the natural and/or cut slope; 3) the presence and quantity of groundwater; and 4) the potential/occurrence of strong seismic shaking.

The coarse-grained calcite marble ore at the site is relatively strong from a global slope stability standpoint, with no weak clay or schist interbeds observed in natural or mined exposures. Natural cliffs formed in the calcite material stand vertically near the quarry site. The majority of joints are oriented favorably with respect to the planned quarry wall configurations and are typically discontinuous relative to global stability. The geologic structure was carefully considered in planning the quarry slopes.

The granitic rocks on the margins of the ore body exhibit a similar orientation and spacing of joint sets as observed in the calcite marble. As described in the reclamation plan, road cuts formed in the granitic rocks exhibit joint control of north-south striking faces at inclinations of approximately 57 degrees. Most joints dip at steep angles (between 70 and 90 degrees) as measured during geologic mapping of the existing road cuts in the granitic rock slopes and thus form stable slope configurations at existing slope angles.

KINEMATIC SLOPE STABILITY ANALYSIS:

Stereonet analysis for representative mine slopes was performed utilizing the data from mapped geologic structures at the site. During field mapping, the orientation and relative continuity of joints, foliation, dikes, and shear zones were measured and recorded and are shown on the attached Geologic Map (Enclosure "A-2.1"). Kinematic data for the White Knob and White Ridge areas are summarized in Tables "B-1.1" and "B-1.2". The representative rock slopes were evaluated using Markland's Test for both wedge and plane failure types. As previously described, jointing of the exposed bedrock was the predominant structure throughout the mine area. The joints exposed within the quarry exhibited little to no lining and were tight and dry. Additionally, the exposed jointing was widely spaced and non-continuous per Hoek-Brown criteria. The results of our kinematic slope stability analyses are included as Appendix "B". Materials strength parameters utilized in our kinematic analysis were obtained from field and laboratory tests and published data (Hoek, 2000; and Graselli, 2001).

Based on stereonet analysis of the measured joint orientations, a small percentage of joints exhibit a potential to form surfaces that dip out of slope at angles between 35 and 40 degrees. Although factors of safety lower than 1.0 were calculated for planar failures along some joints, the limited continuity of joints in the ore body and wall rocks, relative roughness of surfaces formed in the coarse-grained calcite marble, and lack of empirical evidence for large failures on joints with this orientation indicate that the potential for large failures along such joint features is low. The inclusion of catch benches in cut slope design provides mitigation of potential small, intra-bench scale rock fall debris, which is anticipated to be the primary mode of slope debris generation. In addition, subsequent to blasting of new walls, quarry operations include the use of a large scaling chain to assist in removal of loose or precarious blocks during removal of the ore. Therefore, it appears that consideration of the geologic structure of the ore body and surrounding wall rocks in the planning and practice of quarry operations has resulted in formation of grossly stable slopes within the existing quarry. Future mining in the White Ridge area is anticipated to provide mine slopes similar to that achieved in the White Knob area based on the continuity of the ore body and associated structural character between the existing and planned mine areas. Adherence to the slope benching plan and

consideration of newly-exposed adverse structural features (if present) during future quarry excavation work can result in stable slopes during mining and after completion of quarry reclamation.

The arid environment of the site precludes significant groundwater in the proposed slopes, except on a very sporadic basis where water may be concentrated along geologic structures such as faults following periods of precipitation. Groundwater has not been encountered in exploratory borings drilled to at least 550 feet bgs (Howard Brown, personal communication).

Given the steepness of natural slopes at the site and vicinity and the close proximity to the active NFFZ, the geologic materials at the site display a remarkably low susceptibility to deep-seated landsliding. Due to the purity of the calcite marble, no significant clay seams were observed in existing cut slopes nor are they expected to be exposed in the proposed cut slopes. In general, fracturing/jointing effectively reduces the strength of an overall rock mass by forming discontinuities between individual blocks of rock in the natural and cut slopes; however, the "widely-spaced and non-continuous" joint density, joint roughness, moderate to total healing, and favorable joint orientations exhibited in the White Knob quarry exposures also effectively limit the depth and areal extent of potential slope failures. Based on these data and the results of our investigation, deep-seated landsliding is not anticipated in the proposed slopes. Further analysis of the proposed slopes is presented later in global slope stability calculations.

A few potentially unstable blocks/boulders were observed on the natural slopes above the existing and proposed slopes. These boulders could be mobilized during a major seismic event and roll down slope; however, this rockfall hazard is not affected by the proposed mining.

Raveling processes during quarry operations will result in talus on the benches. This process has already occurred along older existing mine slopes. The talus will be left on the benches to facilitate revegetation and to give the reclaimed slopes a more natural appearance. It is anticipated that any resulting boulders will be angular and relatively resistant to rolling. Large, unstable, rounded blocks/boulders on slopes steeper than approximately 2(h):1(v) within the active mining areas should be removed or stabilized.

GLOBAL SLOPE STABILITY CALCULATIONS:

The global stability of the proposed final mine slopes and reclaimed slopes as depicted in the Mining Plan and Reclamation Plan documents (Cross-Sections A-A', B-B', and C-C') were analyzed under both static and seismic conditions for rotational failures utilizing the SLIDE computer program, version 6.02 (Rocscience, Inc., 2012). The analysis considered the highest and steepest slope sections proposed for the mine. The seismic stability calculations were performed using a lateral pseudostatic coefficient "k" of 0.20 due to the proximity of the NFFZ. The factors of safety were calculated by Spencer's method.

The rock strengths were modeled utilizing the Generalized Hoek-Brown criteria (Hoek, 2000 and Hoek, Carranza-Torres & Corkum, 2002), and the program's built-in parameter calculator with the following conservatively estimated input values:

TABLE 2: MARBLE TYPE ROCKS

	Value	Description
Unit Weight (pcf*)	160	
Intact UCS[1] (psf**)	1,500,000	Specimen requires more than one blow of a geological hammer to fracture it
Geological Strength Index	65	Blocky with good surface conditions
Intact Rock Constant (mi***)	9	Marble
Disturbance Factor	1	Production blasting

* pcf = pounds per cubic foot
** psf = pounds per square foot
*** mi = unitless constant

TABLE 3: GRANITE TYPE ROCKS

	Value	Description
Unit Weight (pcf)	155	
Intact UCS[1] (psf)	1,500,000	Specimen requires more than one blow of a geological hammer to fracture it
Geological Strength Index	55	Very blocky with good surface conditions
Intact Rock Constant (mi)	32	Granite
Disturbance Factor	1	Production blasting

[1] Uniaxial Compressive Strength

The parameters listed above were obtained from testing of hand samples and large exposures of the existing quarry slopes. The Hoek-Brown criteria allows for estimation of rock mass properties based on field criteria such as how easily a specimen can be broken with a rock hammer and mining methods as well as other methods.

The strength of overburden stockpile materials was estimated based on our direct shear testing results performed on samples remolded to 85 percent relative compaction. An internal frictional angle of φ=39 degrees, a cohesive strength of C=150 psf and a unit weight of 125 pcf were utilized to model the shear strength of overburden stockpile materials.

The results of the global slope stability analyses are summarized in Table 4. Details of stability calculation results including material type boundaries, strength parameters, and the minimum factors of safety and critical slip surface are included in Enclosures "C-1" through "C-6" for static and seismic conditions.

TABLE 4: SLOPE STABILITY SUMMARY

Cross Section	Material	Static F.S.	Seismic F.S. (k=0.2)
A-A'	Rock slope	2.33	1.73
B-B'	Fill-over-rock slope	1.93	1.27
C-C'	Rock slope	2.37	1.83

As shown in Table 4, sufficient static factors of safety in excess of 1.5 and seismic factors of safety in excess of 1.1 were calculated for the remaining slope configurations presented and satisfy San Bernardino County and State SMARA Guidelines. Based on the global stability analysis and observations of existing quarry and overburden stockpile slopes, it is anticipated that current and future mining practices will produce final mining and reclaimed quarry and overburden stockpile slopes that are suitably stable with regard to large-scale or deep-seated slope failure.

GROUNDWATER

No evidence for springs or perched groundwater conditions was observed at the site during the geologic mapping or on the aerial photographs reviewed.

Depth-to-groundwater data are not available for the site vicinity from the California Department of Water Resources (2012) or the U. S. Geological Survey (2012). The closest data available are from wells in the town of Lucerne Valley, located at significantly lower elevations in alluvial sediments north of the site.

Groundwater has not been encountered in exploratory borings drilled to 550 feet bgs (Howard Brown, personal communication). The current depth to groundwater at the site is not known but is expected to be greater than 550 feet bgs. Based on the planned mining excavation depths, the anticipated depth of groundwater and the presence of non-liquefiable bedrock, no potential for liquefaction and other shallow groundwater-related hazards is anticipated.

Mine slopes should continue to be protected with berms and/or levees as necessary to prevent slope erosion in the areas where natural slopes drain onto the reclaimed slopes.

RECOMMENDATIONS

SEISMIC SHAKING HAZARDS:

Moderate to severe seismic shaking of the site can be expected to occur during the lifetime of the proposed mining and reclamation. This potential has been considered in our analyses and evaluation of slope stability.

CUT SLOPE CONSTRUCTION:

Overall final cut slopes in the granite and calcite marble should be approximately 1(h):1(v) up to the maximum heights proposed in the mining and reclamation plans. If encountered during future mining, geologic structures that exhibit exceptional continuity and adverse geometry with regard to planned slope aspects or contain significant clay linings, water seepage or other potentially deleterious conditions should be evaluated for potential impacts to reclaimed slopes. Slope design may require adjustment of bench geometry to mitigate potential instability if such features are encountered. Large, unstable boulders on mine slopes should be removed or stabilized prior to the end of reclamation.

FILL SLOPE CONSTRUCTION:

Final reclaimed fill slopes composed of overburden materials and proposed as OB-1, OB-2, and OB-3, should be no steeper than 2(h):1(v) to the maximum proposed heights.

SLOPE PROTECTION:

Slopes should be protected with berms and/or levees as necessary to prevent slope erosion in the areas where natural slopes drain onto the reclaimed slopes.

LIMITATIONS

CHJ Consultants has striven to perform our services within the limits prescribed by our client, and in a manner consistent with the usual thoroughness and competence of reputable geotechnical engineers and engineering geologists practicing under similar circumstances. No other representation, expressed or implied, and no warranty or guarantee is included or intended by virtue of the services performed or reports, opinion, documents, or otherwise supplied.

This report reflects the testing and observations conducted on the site as the site existed during the investigation, which is the subject of this report. However, changes in the conditions of a property can occur with the passage of time, due to natural processes or the works of man on this or adjacent properties. Changes in applicable or appropriate standards may also occur whether as a result of legislation, application, or the broadening of knowledge. Therefore, this report is indicative of only those conditions tested and/or observed at the time of the subject investigation, and the findings of this report may be invalidated fully or partially by changes outside of the control of CHJ Consultants. This report is therefore subject to review and should not be relied upon after a period of one year.

The conclusions and recommendations in this report are based upon observations performed and data collected at separate locations, and interpolation between these locations, carried out for the project and the scope of services described. It is assumed and expected that the conditions between locations observed and/or sampled are similar to those encountered at the individual locations where observation and sampling was performed. However, conditions between these locations may vary significantly. Should conditions be encountered in the field, by the client or any firm performing services for the client or the client's assign, that appear different than those described herein, this firm should be contacted immediately in order that we might evaluate their effect.

If this report or portions thereof are provided to contractors or included in specifications, it should be understood by all parties that they are provided for information only and should be used as such.

The report and its contents resulting from this investigation are not intended or represented to be suitable for reuse on extensions or modifications of the project, or for use on any other project.

CLOSURE

We appreciate this opportunity to be of service and trust this report provides the information desired at this time. Should questions arise, please do not hesitate to contact this firm at your convenience.

REGISTERED GEOLOGIST
JOHN S. McKEOWN
NO. 2396
CERTIFIED ENGINEERING GEOLOGIST
Exp. 06-30-13
STATE OF CALIFORNIA

Respectfully submitted,

CHJ CONSULTANTS

John S. McKeown

John S. McKeown, E.G. 2396
Project Geologist

Jay J. Martin, E.G. 1529
Vice President

PROFESSIONAL GEOLOGIST
JAY J. MARTIN
No. 1529
CERTIFIED ENGINEERING GEOLOGIST
Exp. 8-31-14
STATE OF CALIFORNIA

JMc/JJM:lb

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AERIAL PHOTOGRAPHS REVIEWED

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San Bernardino County Flood Control District, November 18, 1972, black and white aerial photograph No 30.

U.S.D.A., February 22, 1953, black and white aerial photograph Nos. AXL-47K-117 and -118.

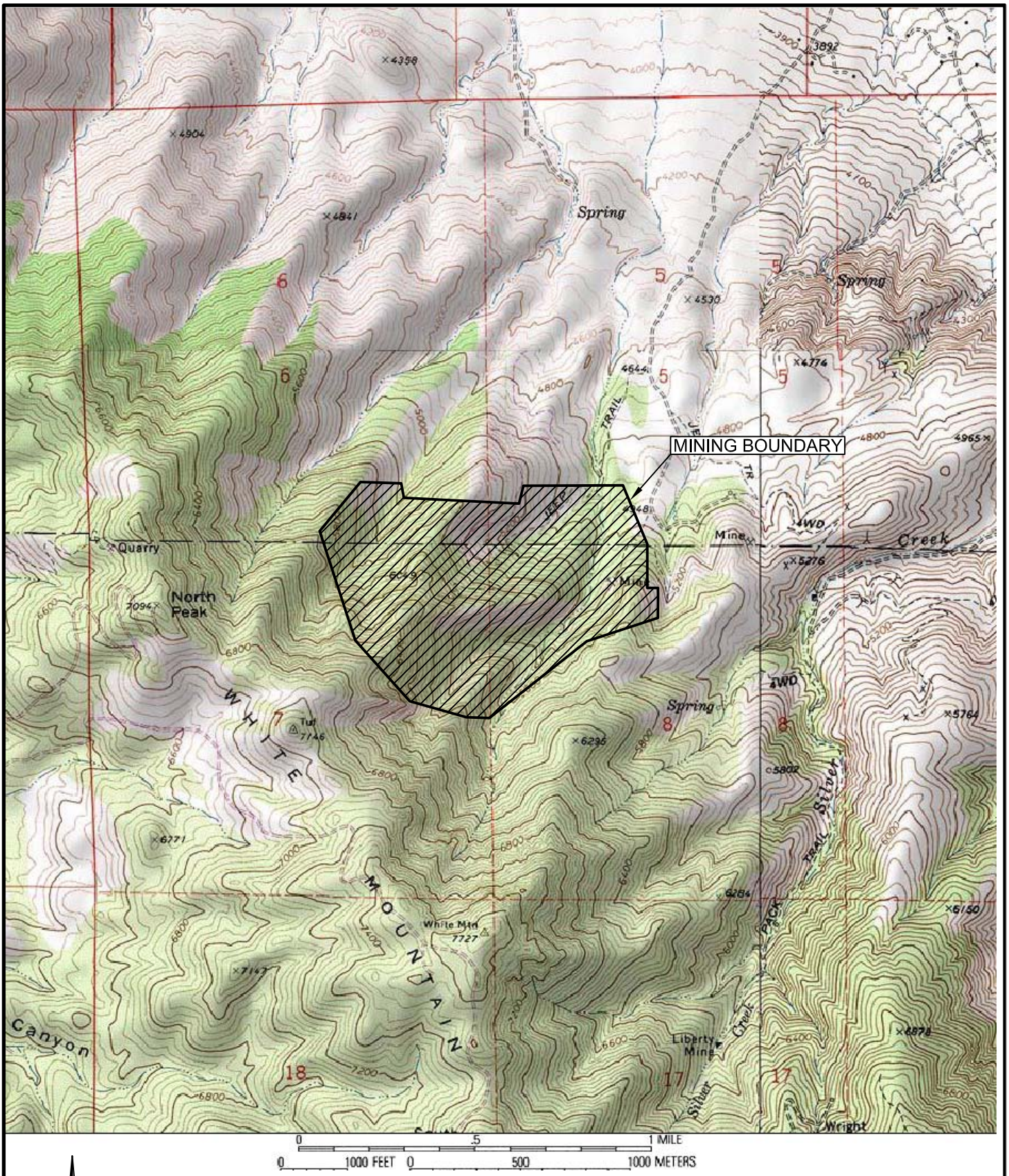
U.S.D.A., February 16, 1953, black and white aerial photograph Nos. AXL-42K-60 and -61.

Orthophoto-based contour map - White Knob Placer Claim by American Aerial Surveys, dated June 24, 1983; scale 1" = 100', 25-foot contour interval.

Orthophoto-based contour map - White Knob area, untitled, dated November 7, 1988.

APPENDIX "A"

GEOLOGIC MAPS



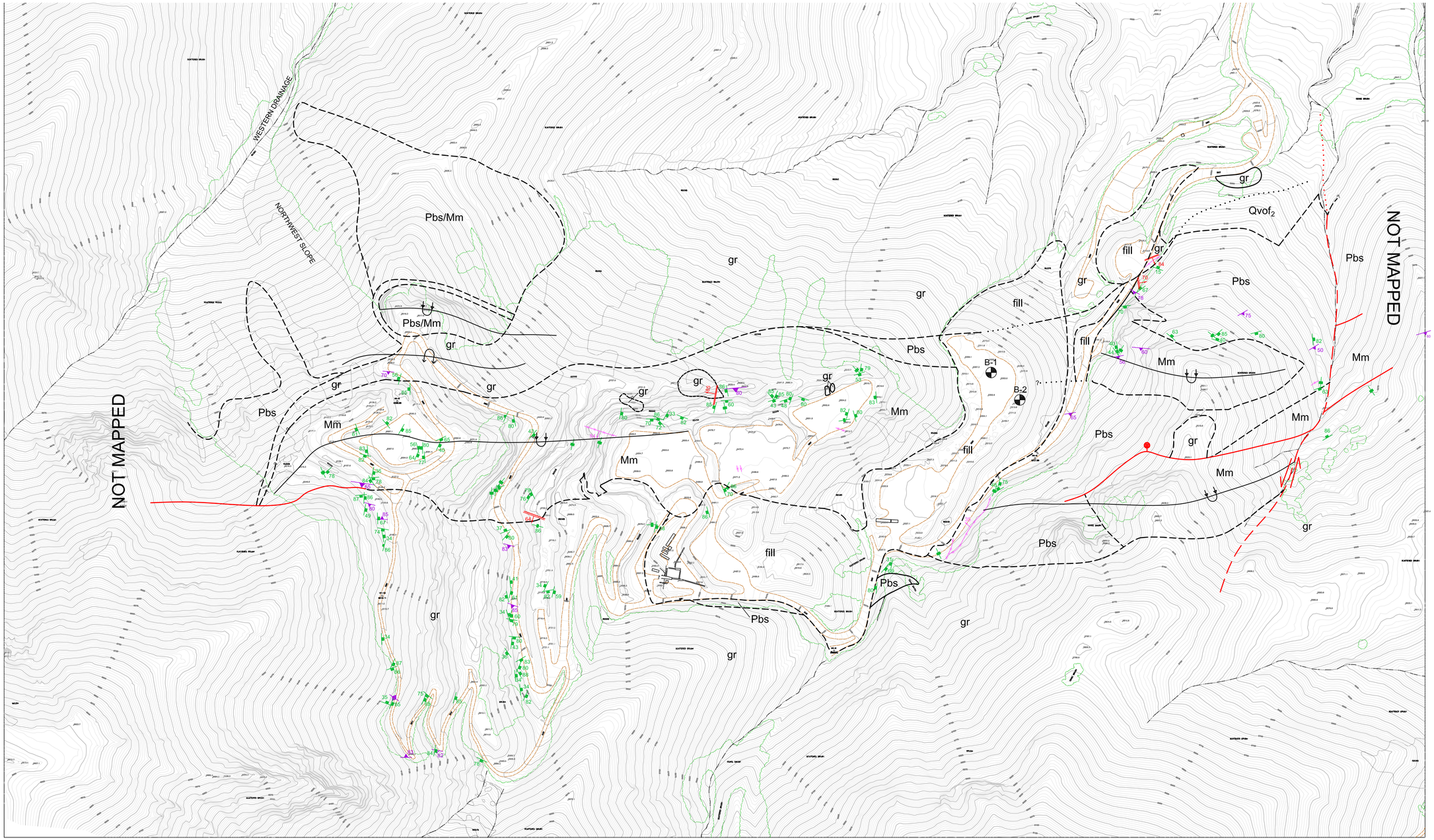
-N-

SCALE: 1" = 2,000'

INDEX MAP

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "A-1"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants



N

SCALE 1"= 200'

GEOLOGIC UNITS:

f - fill
Qvof - very old alluvial fan deposits (Holocene)
gr - undifferentiated granitic rocks (Mesozoic)
Pbs - Bird Spring Formation (Pennsylvanian)
Mm - Monte Cristo Limestone (Mississippian)

B-2 Location of exploratory boring

overturned synform/antiform

fault

? approximate geologic contact - modified from Miller et al. (2000) based on field mapping

mafic dike

strike of vertical foliation

88 strike and dip of foliation

94 strike and dip of joint

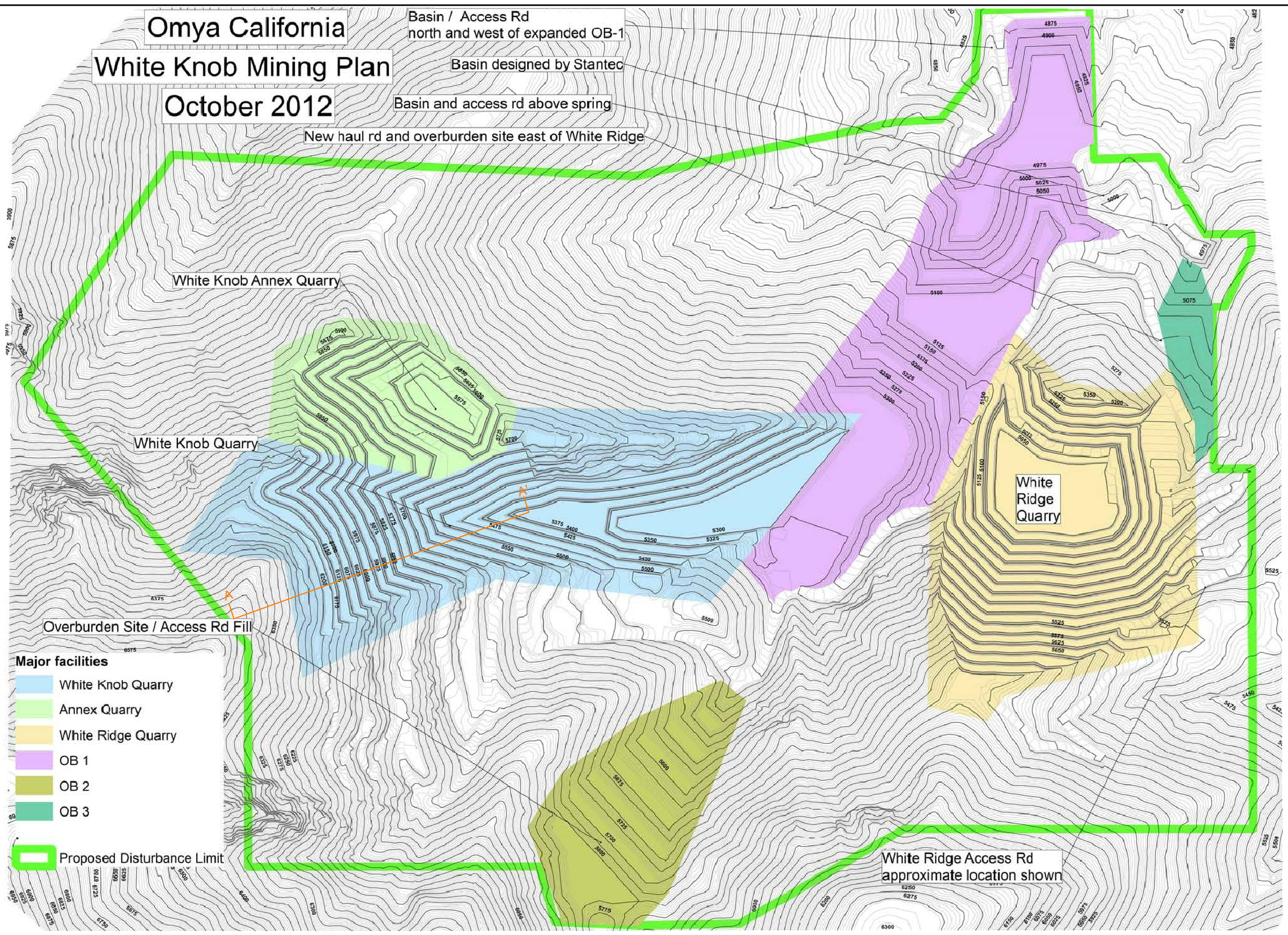
strike and dip of vertical joint

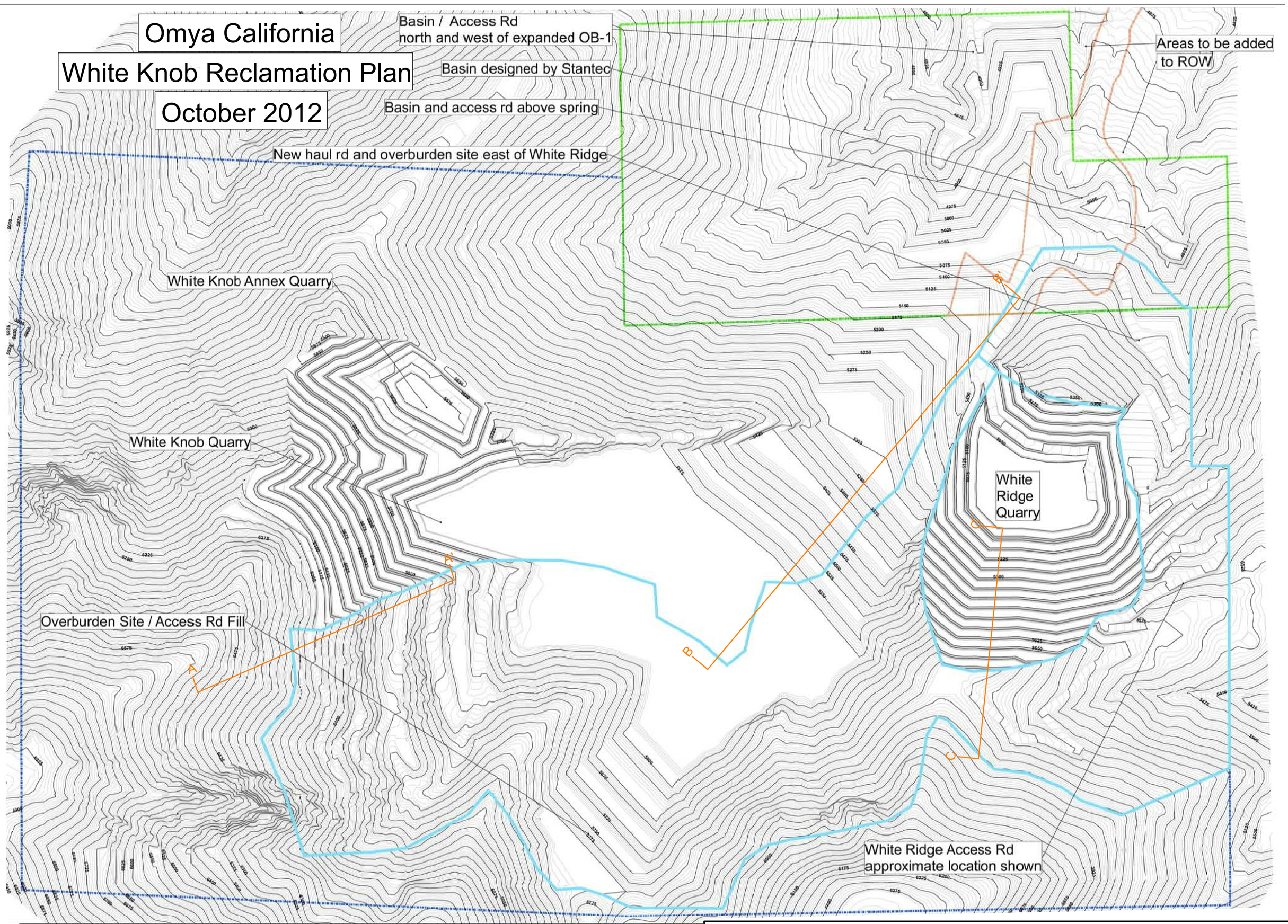
85 strike and dip of shear zone

GEOLOGIC MAP AND SITE PLAN

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "A-2.1"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants





-N-

SCALE 1"= 250'

Area designated for access roads. Specific designs will not be shown to allow for field engineering

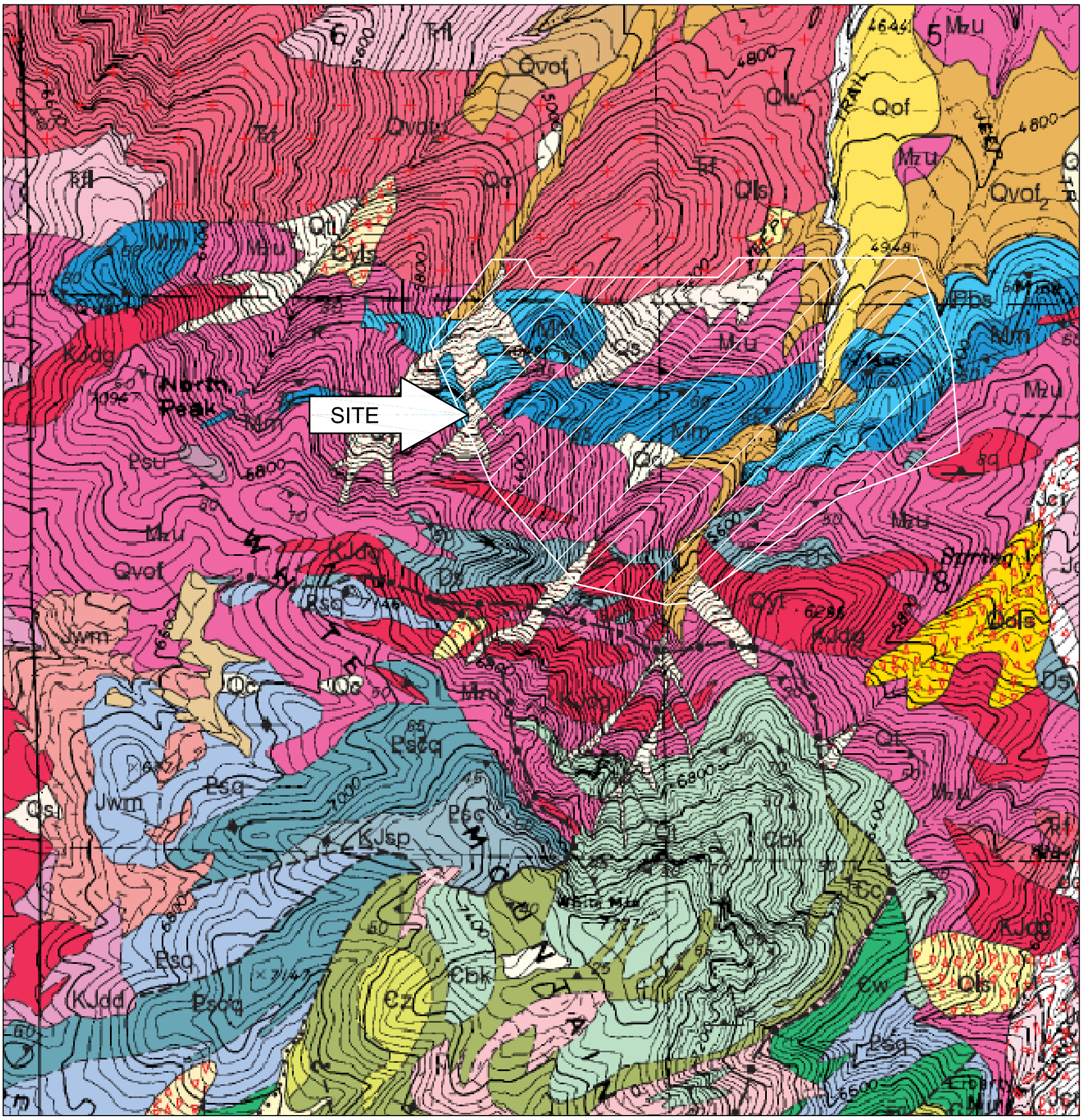
Property Lines

- 70 Acres to be purchased from BLM
- ROW
- Patented Mining Claims Controlled by Omya

MINING AND RECLAMATION PLANS

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "A-2.2"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants



(Base Map: Miller et al., 2000)

GEOLOGIC UNITS:

Holocene sediments

Qc modern colluvial deposits

Qs undifferentiated surficial deposits

Qyt young talus deposits

$Qvof_2$ very old alluvial fan deposits

Crystalline Rocks

Mzu Mesozoic granitic rocks, undivided. Monzogranite to diorite, including small areas of monzonite. Includes heterogeneous, nondistinctive granitic rocks that cannot be assigned to larger granitic units in Butler Peak quadrangle. Fine- to coarse-grained; massive to foliate and lineate.

KJdg Mixed diorite and gabbro (Cretaceous and Jurassic). Biotite-hornblende diorite and quartz diorite, hornblende-biotite diorite and quartz diorite, pyroxenehornblende gabbro, and hornblende gabbro. Fine- to coarse-grained. Dioritic rocks appear to have possible spatial relation to Paleozoic carbonate rocks and intermediate composition Mesozoic plutons.

Pbs Bird Spring Formation (Pennsylvanian). Upper part of Furnace Limestone of Vaughan (1922) as mapped by Guillou (1953), Richmond (1960); correlated with Bird Spring Formation of southern Great Basin by Cameron (1981) and Brown (1991). Generally light-colored, medium- to thick-bedded, medium to coarsely crystalline calcite marble. Degree of recrystallization in quadrangle precludes confident subdivision of formation, but in Fawnskin quadrangle to east, typical lithologies include white, gray, or mottled marble and cherty, silicified marble. Some chert-bearing calcite marble contains lenses and thin layers of quartz silt and fine sand. Intermittent layers of minor brownweathering dolomite marble, siliceous marble horizons, and dark-gray calcite marble. In Butler Peak quadrangle, due to extreme recrystallization and deformation, layering in much of formation may or may not represent bedding.

Mm Monte Cristo Limestone (Mississippian). Upper part of Furnace Limestone of Vaughan (1922) as mapped by Richmond (1960). Correlated with the Monte Cristo Limestone of the southern Great Basin by Cameron (1981), and mapped by Brown (1984, 1987, and 1991) who recognized several formal stratigraphic members named originally by Hewitt (1931). Degree of recrystallization in quadrangle precludes recognition of detailed subdivisions, but includes heterogeneous, interlayered, light- and dark-gray, calcite and dolomite marble characteristic of Yellowpine Member, and thick-layered, light-gray to white, texturally massive, very pure calcite marble characteristic of Bullion Member.

Ds Sultan Limestone (Devonian). Middle part of Furnace Limestone of Vaughan (1922) as mapped by Richmond (1960); Brown (1991) correlated rocks in this interval with members of Sultan Limestone of Hewitt (1931) in southern Great Basin. Includes: (1) thin- to thick-layered, white calcite marble containing sparse thin layers of dark-gray calcite and dolomite marble characteristic of Crystal Pass Member; in part irregularly dolomitized. (2) Laminated to massive, light-gray, brown, and white, finely crystalline, locally chert-bearing metadolomite characteristic of Valentine Limestone Member.

geologic contact

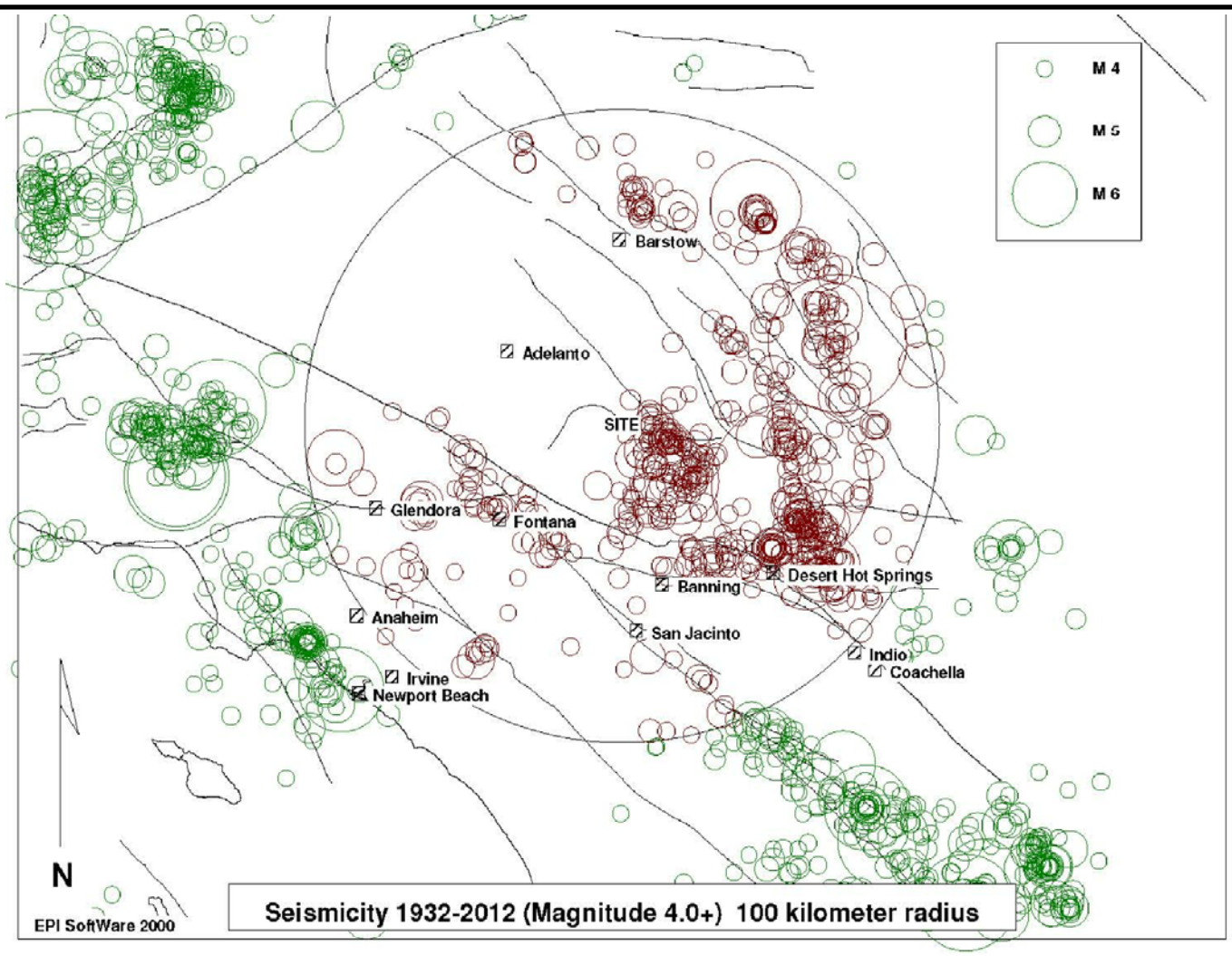
-N-

SCALE: 1" = 1,000'

GEOLOGIC INDEX MAP

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "A-3"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants



SITE LOCATION: 34.3629 LAT. -117.012 LONG.

MINIMUM LOCATION QUALITY: C

TOTAL # OF EVENTS ON PLOT: 1461

TOTAL # OF EVENTS WITHIN SEARCH RADIUS: 587

MAGNITUDE DISTRIBUTION OF SEARCH RADIUS EVENTS:

4.0- 4.9 : 529
5.0- 5.9 : 52
6.0- 6.9 : 4
7.0- 7.9 : 2
8.0- 8.9 : 0

CLOSEST EVENT: 4.0 ON FRIDAY, FEBRUARY 27, 1942 LOCATED APPROX. 3 KILOMETERS SOUTH OF THE SITE

LARGEST 5 EVENTS:

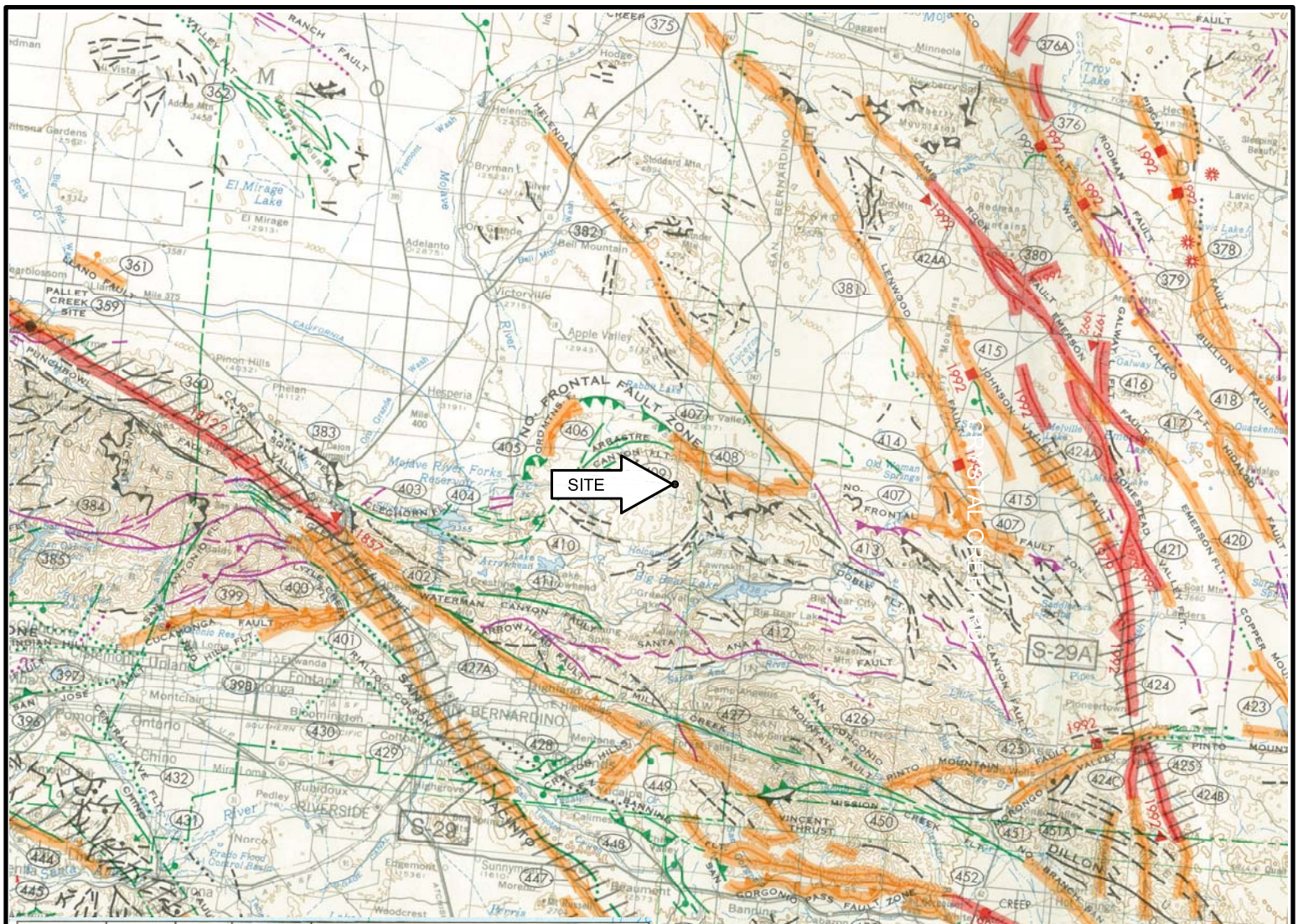
7.3 ON SUNDAY, JUNE 28, 1992 LOCATED APPROX. 55 KILOMETERS EAST OF THE SITE
7.1 ON SATURDAY, OCTOBER 16, 1999 LOCATED APPROX. 72 KILOMETERS NORTHEAST OF THE SITE
6.5 ON THURSDAY, APRIL 10, 1947 LOCATED APPROX. 80 KILOMETERS NORTHEAST OF THE SITE
6.4 ON SUNDAY, JUNE 28, 1992 LOCATED APPROX. 24 KILOMETERS SOUTHEAST OF THE SITE
6.1 ON THURSDAY, APRIL 23, 1992 LOCATED APPROX. 78 KILOMETERS SOUTHEAST OF THE SITE

0 50 100
KILOMETERS

EARTHQUAKE EPICENTER MAP

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "A-4"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants



Geologic Time Scale			Years Before Present (Approx.)	Fault Symbol	Recency of Movement	DESCRIPTION: ON LAND	DESCRIPTION: OFFSHORE
Quaternary	Late Quaternary	Historic				Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.	
		Holocene	200			Displacement during Holocene time.	Fault offsets seafloor sediments or strata of Holocene age.
		Pleistocene	10,000			Faults showing evidence of displacement during late Quaternary time.	Fault cuts strata of Pleistocene age.
	Early Quaternary		700,000			Undivided Quaternary faults – most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age.	Fault cuts strata of Quaternary age.
			1,600,000			Late Cenozoic faults within the Sierra Nevada, including parts of, but not restricted to, the Foothills fault system. These faults may have been active in Quaternary time.	
Pre-Quaternary			4.5 billion (Age of earth)			Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive. Pre-Quaternary faults not shown in Nevada and Oregon.	Fault cuts strata of Pliocene or older age.

-N-

SCALE: 1:750,000

FAULT MAP

FOR: OMYA CALIFORNIA
A DIVISION OF OMYA, INC.

DATE: JANUARY 2013

SLOPE STABILITY INVESTIGATION
PROPOSED AMENDED PLAN OF OPERATIONS
WHITE KNOB QUARRY MINING AND RECLAMATION PLAN
LUCERNE VALLEY, CALIFORNIA

ENCLOSURE "A-5"

JOB NUMBER 12715-8

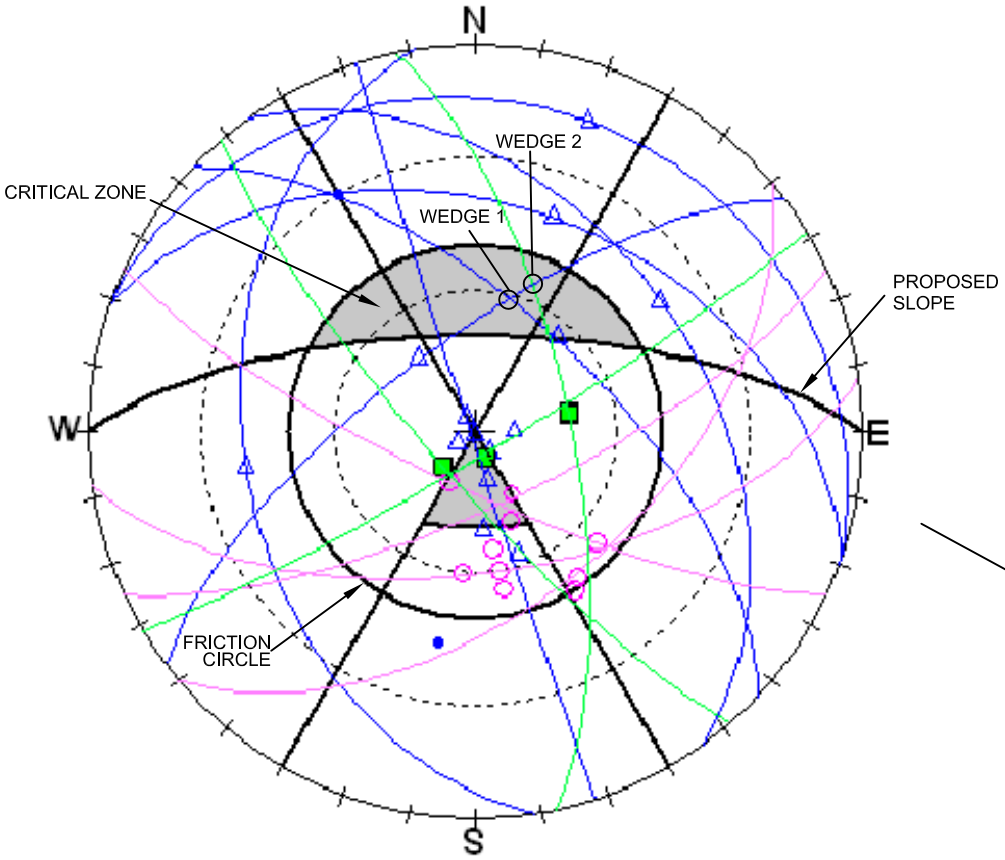
CHJ Consultants

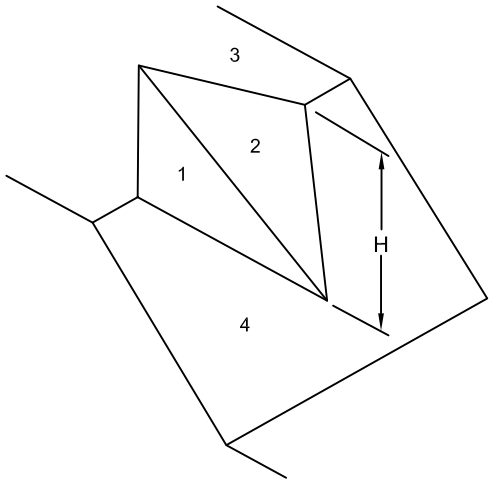
APPENDIX "B"

KINEMATIC STABILITY CALCULATIONS

White Knob - Discontinuity Measurements				
Discontinuity No.	**Geologic Unit**	**Structure Type**	**Dip Direction**	**Dip Value**
1	gr	Joint	148	58
2	gr	Joint	253	86
3	gr	Joint	90	90
4	Mm	Joint	75	80
5	Mm	Joint	75	82
6	Mm	Joint	80	90
7	Mm	Joint	220	83
8	Mm	Joint	162	53
9	Mm	Joint	100	79
10	Mm	Joint	45	90
11	Mm	Joint	200	80
12	Mm	Joint	285	80
13	Mm	Joint	160	48
14	Mm	Joint	162	43
15	Mm	Joint	50	85
16	Mm	Joint	115	85
17	Mm	Joint	260	86
18	Mm	Joint	175	60
19	Mm	Joint	10	90
20	Mm	Joint	285	86
21	gr/Mm	Shear	280	85
22	Mm	Joint	200	62
23	Mm	Joint	120	33
24	Mm	Joint	200	86
25	Mm	Joint	230	72
26	Mm	Joint	180	70
27	Mm	Joint	100	80
28	gr	Dike	200	84
29	Mm	Joint	20	90
30	Mm	Joint	15	90
31	Mm	Joint	300	76
32	Mm	Joint	185	79
33	Mm	Shear	200	64
34	gr	Joint	15	86
35	gr	Joint	295	34
36	gr	Joint	170	82
37	gr	Joint	103	59
38	gr	Joint	282	31
39	gr	Joint	130	66
40	gr	Joint	275	80
41	gr	Joint	25	90
42	gr	Dike	285	34
43	gr	Joint	25	90

44	gr	Joint	330	48
45	gr	Joint	105	75
White Ridge - Discontinuity Measurements				
Discontinuity No.	**Geologic Unit**	**Structure Type**	**Dip Direction**	**Dip Value**
1	gr	Joint	330	86
2	gr	Joint	325	90
3	Mm/Pbs	Joint	160	63
4	Pbs	Joint	275	90
5	Pbs	Dike	330	30
6	gr	Foliation	170	60
7	Pbs	Foliation	148	50
8	Pbs	Foliation	145	52
9	Pbs	Joint	85	82
10	Pbs	Foliation	158	70
11	Pbs	Joint	165	80
12	Pbs	Foliation	150	75
13	Pbs	Joint	240	86
14	Pbs	Joint	50	90
15	Pbs	Joint	140	85
16	Pbs	Joint	20	40
17	Pbs	Joint	40	63
18	Mm	Shear	80	70
19	Mm	Joint	262	40
20	Mm	Joint	54	41
21	Mm	Joint	30	90
22	Mm	Foliation	170	56
23	Mm	Foliation	185	60
24	Pbs	Foliation	172	65
25	Pbs	Dike	190	44
26	Pbs	Shear	158	84
27	Pbs	Foliation	132	55
28	Pbs	Joint	20	15
29	Pbs	Shear	222	80
30	Pbs	Shear	78	70
31	Pbs	Joint	323	70
32	Pbs	Foliation	208	78
33	Pbs	Joint	175	70





Rapid Wedge Failure Analysis Input Data

(GR) Density of Rock = 150 lb(f)/ft ³
(H) Height of Crest Above Intersection = 60 ft

Plane 1 : (D1) Dip Value = 70 °
(E1) Dip Direction = 323 °
Plane 2 : (D2) Dip Value = 63 °
(E2) Dip Direction = 40 °
Plane 3 : (D3) Dip Value = 1 °
(E3) Dip Direction = 0 °
Plane 4 : (D4) Dip Value = 70 °
(E4) Dip Direction = 0 °

Plane 1 : (C1) Cohesion = 800 lb(f)/ft ²
(P1) Friction Angle = 50 °
Plane 2 : (C2) Cohesion = 800 lb(f)/ft ²
(P2) Friction Angle = 50 °

Water Pressure : Cracks Completely Filled (Free Draining)

(GW) Density of Water = 62.4 lb(f)/ft ³

(HW) Overall Vertical Height of Wedge = 0 ft

The slope face DOES NOT hang over the toe of the slope.

Rapid Wedge Failure Analysis Output Data

(F) Factor of Safety = 3.06
Water Pressure on both planes = 0 lb(f)/ft ²

THERE IS CONTACT ON BOTH PLANES.

Rapid Wedge Failure Analysis Input Data

(GR) Density of Rock = 150 lb(f)/ft ³
(H) Height of Crest Above Intersection = 60 ft

Plane 1 : (D1) Dip Value = 70 °
(E1) Dip Direction = 323 °
Plane 2 : (D2) Dip Value = 70 °
(E2) Dip Direction = 78 °
Plane 3 : (D3) Dip Value = 1 °
(E3) Dip Direction = 0 °
Plane 4 : (D4) Dip Value = 70 °
(E4) Dip Direction = 0 °

Plane 1 : (C1) Cohesion = 800 lb(f)/ft ²
(P1) Friction Angle = 50 °
Plane 2 : (C2) Cohesion = 800 lb(f)/ft ²
(P2) Friction Angle = 50 °

Water Pressure : Cracks Completely Filled (Free Draining)

(GW) Density of Water = 62.4 lb(f)/ft ³

(HW) Overall Vertical Height of Wedge = 0 ft

The slope face DOES NOT hang over the toe of the slope.

Rapid Wedge Failure Analysis Output Data

(F) Factor of Safety = 3.53
Water Pressure on both planes = 0 lb(f)/ft ²

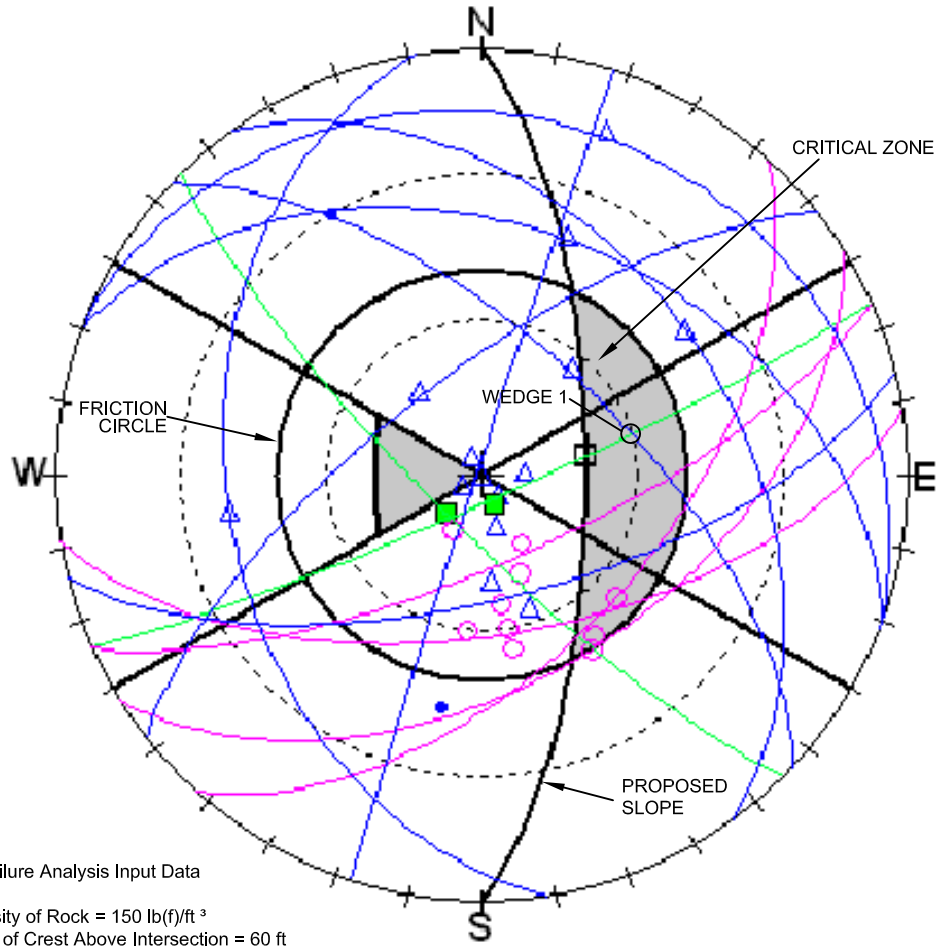
THERE IS CONTACT ON BOTH PLANES.

KEY:
- △ 1-Small Joints
- ■ 2- Faults
- ○ 3- Follations
- ● 4- Dikes

KINEMATIC ANALYSIS

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-2.0"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants



Rapid Wedge Failure Analysis Input Data

(GR) Density of Rock = 150 lb(f)/ft ³
(H) Height of Crest Above Intersection = 60 ft

Plane 1 : (D1) Dip Value = 84 °
(E1) Dip Direction = 158 °
Plane 2 : (D2) Dip Value = 63 °
(E2) Dip Direction = 40 °
Plane 3 : (D3) Dip Value = 1 °
(E3) Dip Direction = 90 °
Plane 4 : (D4) Dip Value = 70 °
(E4) Dip Direction = 90 °

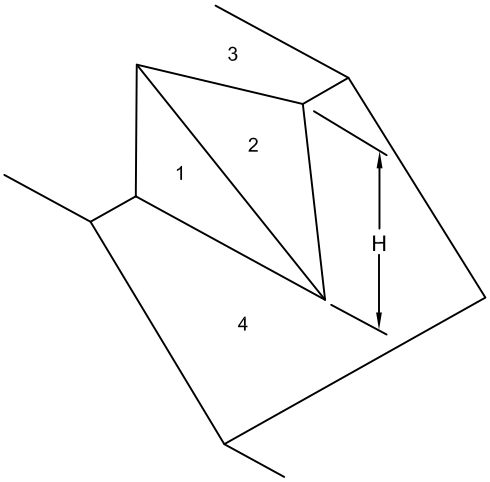
Plane 1 : (C1) Cohesion = 800 lb(f)/ft ²
(P1) Friction Angle = 50 °
Plane 2 : (C2) Cohesion = 800 lb(f)/ft ²
(P2) Friction Angle = 50 °

Water Pressure : Cracks Completely Filled (Free Draining)

(GW) Density of Water = 62.4 lb(f)/ft ³

(HW) Overall Vertical Height of Wedge = 0 ft

The slope face DOES NOT hang over the toe of the slope.



Rapid Wedge Failure Analysis Output Data

(F) Factor of Safety = 3.73
Water Pressure on both planes = 0 lb(f)/ft ²

THERE IS CONTACT ON BOTH PLANES.

KEY:
- △ 1-Small Joints
- ■ 2- Faults
- ○ 3- Follations
- ● 4- Dikes

KINEMATIC ANALYSIS

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-3.0"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 63 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 56.91 ft ²
(W) Weight of Slice = 36023.43 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 4 ft
(Z) Tension Crack Depth = 9.36 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 2.03

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 63 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0.38 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 56.91 ft ²
(W) Weight of Slice = 36023.43 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 4 ft
(Z) Tension Crack Depth = 9.36 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.32

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 60 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0.38 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 55.01 ft ²
(W) Weight of Slice = 51038.68 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 5.67 ft
(Z) Tension Crack Depth = 12.46 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.01

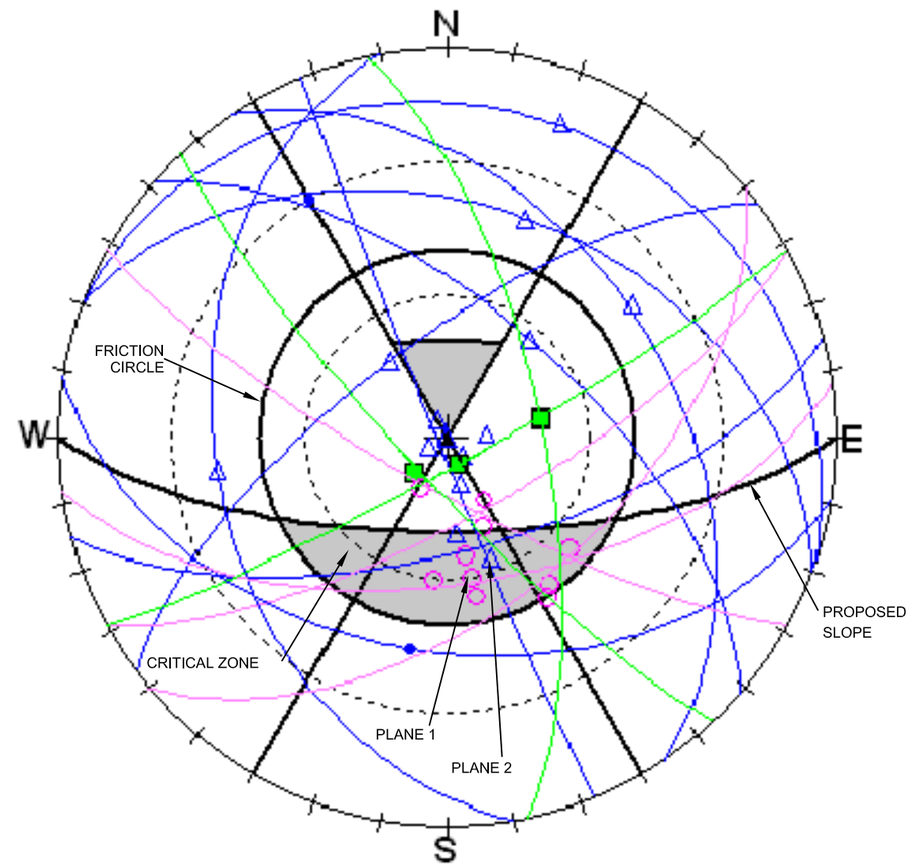
Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 60 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 55.01 ft ²
(W) Weight of Slice = 51038.68 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 5.67 ft
(Z) Tension Crack Depth = 12.46 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.68

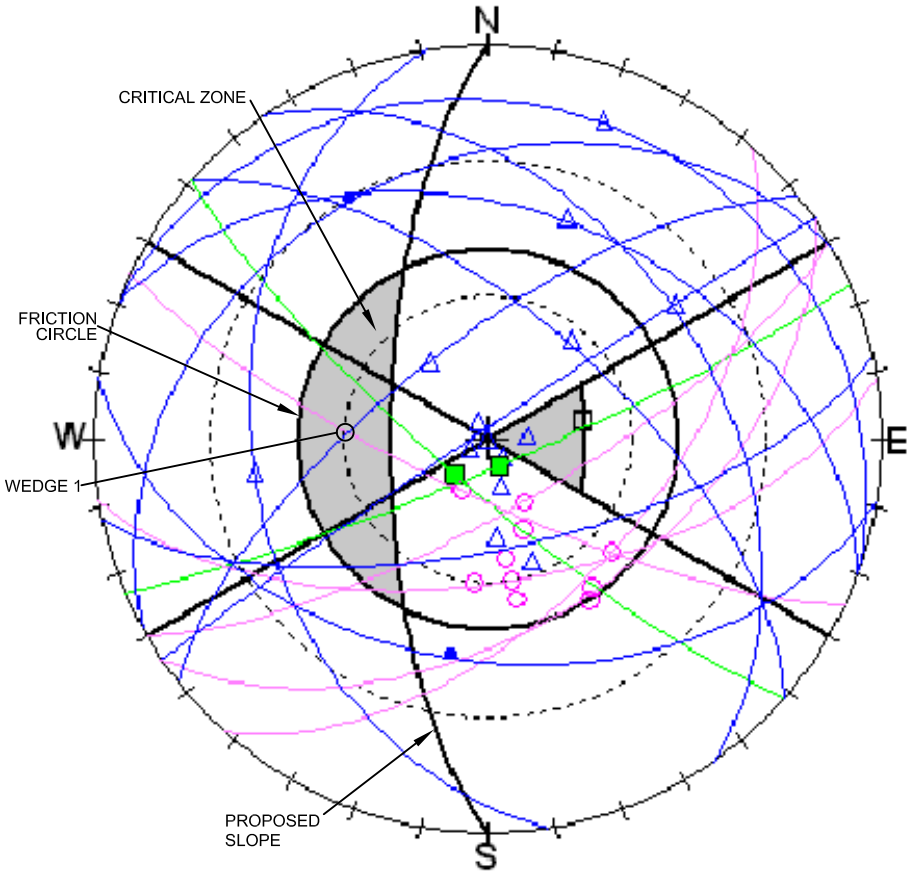


KEY:
- △ 1-Small Joints
- ■ 2- Faults
- ○ 3- Follations
- ● 4- Dikes

KINEMATIC ANALYSIS

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-4.0"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants



Rapid Wedge Failure Analysis Input Data

(GR) Density of Rock = 150 lb(f)/ft ³
(H) Height of Crest Above Intersection = 60 ft

Plane 1 : (D1) Dip Value = 70 °
(E1) Dip Direction = 323 °
Plane 2 : (D2) Dip Value = 78 °
(E2) Dip Direction = 208 °
Plane 3 : (D3) Dip Value = 1 °
(E3) Dip Direction = 270 °
Plane 4 : (D4) Dip Value = 70 °
(E4) Dip Direction = 270 °

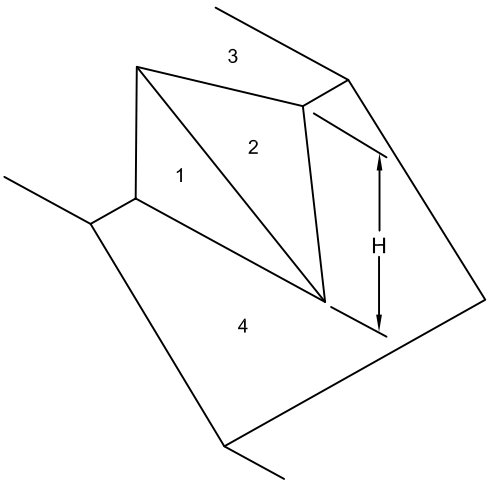
Plane 1 : (C1) Cohesion = 800 lb(f)/ft ²
(P1) Friction Angle = 50 °
Plane 2 : (C2) Cohesion = 800 lb(f)/ft ²
(P2) Friction Angle = 50 °

Water Pressure : Cracks Completely Filled (Free Draining)

(GW) Density of Water = 62.4 lb(f)/ft ³

(HW) Overall Vertical Height of Wedge = 0 ft

The slope face DOES NOT hang over the toe of the slope.



Rapid Wedge Failure Analysis Output Data

(F) Factor of Safety = 4.4
Water Pressure on both planes = 0 lb(f)/ft ²

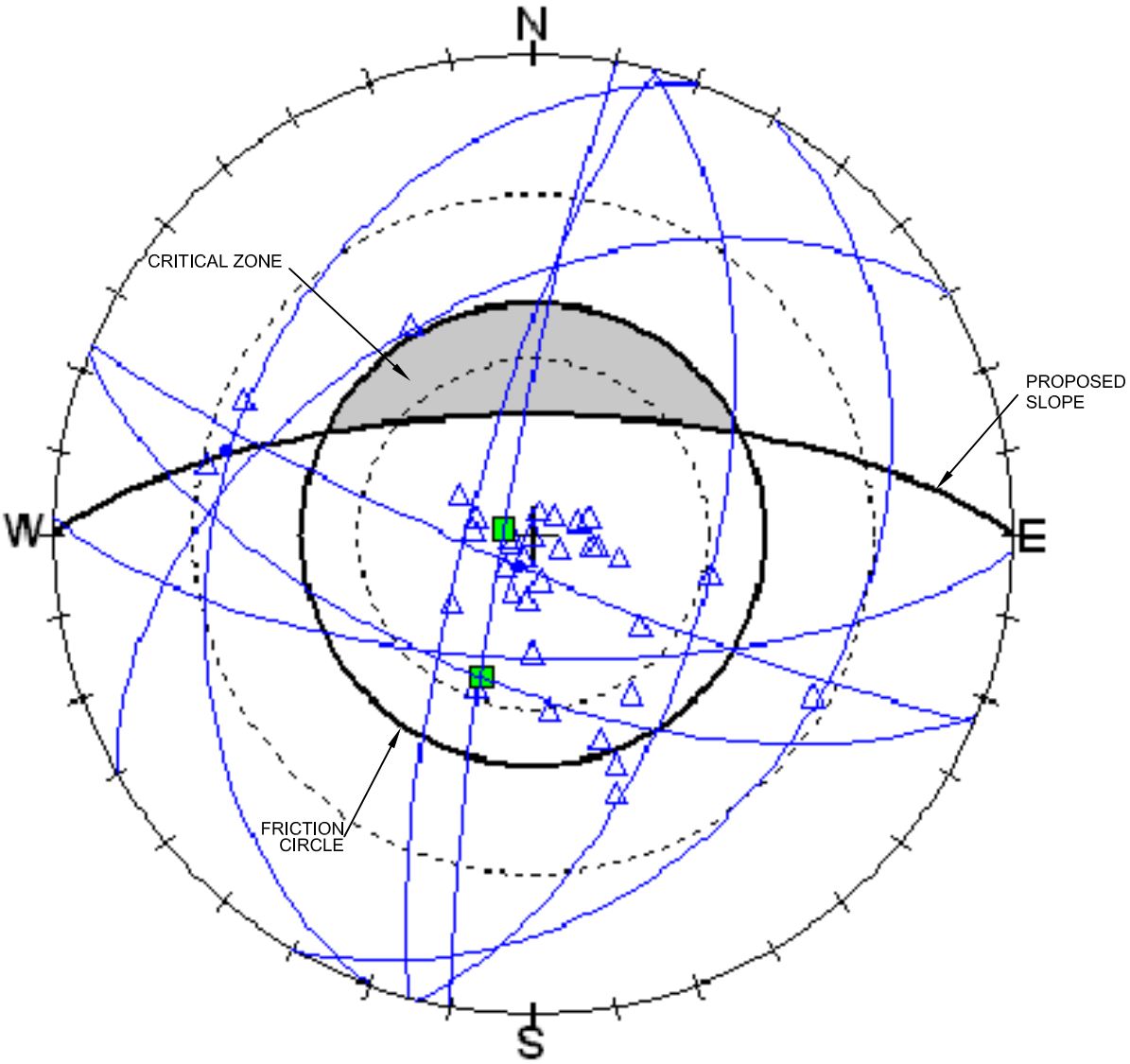
THERE IS CONTACT ON BOTH PLANES.

KEY:
- △ 1-Small Joints
- ■ 2- Faults
- ○ 3- Follations
- ● 4- Dikes

KINEMATIC ANALYSIS

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-5.0"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants



Note: potential failure modes not observed.

KEY:

- △ 1-Small Joints
- ■ 2- Faults
- ○ 3- Follations
- ● 4- Dikes

KINEMATIC ANALYSIS

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-6.0"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 59 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0.38 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 54.48 ft ²
(W) Weight of Slice = 56037.08 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 6.22 ft
(Z) Tension Crack Depth = 13.41 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 0.95

Rapid Wedge Failure Analysis Input Data

(GR) Density of Rock = 150 lb(f)/ft ³
(H) Height of Crest Above Intersection = 60 ft

Plane 1 : (D1) Dip Value = 66 °
(E1) Dip Direction = 130 °
Plane 2 : (D2) Dip Value = 59 °
(E2) Dip Direction = 103 °
Plane 3 : (D3) Dip Value = 1 °
(E3) Dip Direction = 65 °
Plane 4 : (D4) Dip Value = 70 °
(E4) Dip Direction = 65 °

Plane 1 : (C1) Cohesion = 800 lb(f)/ft ²
(P1) Friction Angle = 50 °
Plane 2 : (C2) Cohesion = 800 lb(f)/ft ²
(P2) Friction Angle = 50 °

Water Pressure : Cracks Completely Filled
(Free Draining)

(GW) Density of Water = 0 lb(f)/ft ³

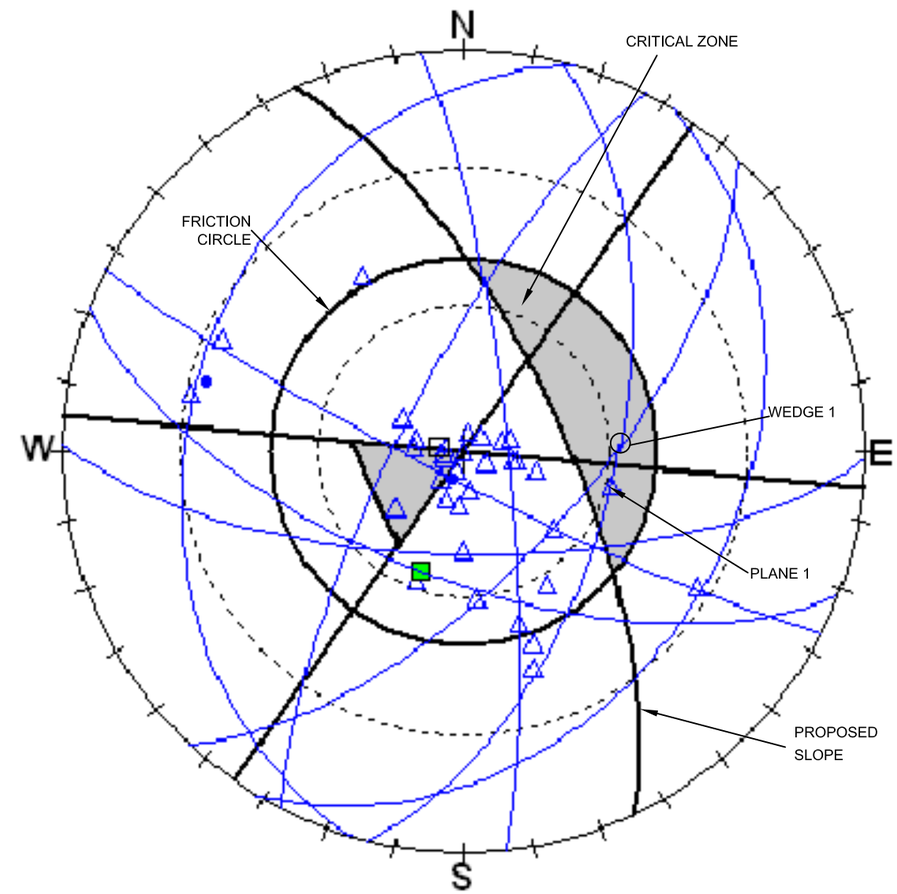
(HW) Overall Vertical Height of Wedge = 0 ft

The slope face DOES NOT hang over the
toe of the slope.

Rapid Wedge Failure Analysis Output Data

(F) Factor of Safety = 6.84
Water Pressure on both planes = 0 lb(f)/ft ²

THERE IS CONTACT ON BOTH PLANES.



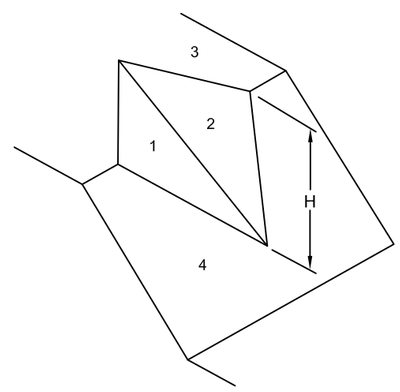
Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 59 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 54.48 ft ²
(W) Weight of Slice = 56037.08 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 6.22 ft
(Z) Tension Crack Depth = 13.41 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.62



KEY:
△ 1-Small Joints
■ 2- Faults
○ 3- Follations
● 4- Dikes

KINEMATIC ANALYSIS

FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-7.0"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 60 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0.38 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 55.01 ft ²
(W) Weight of Slice = 51038.68 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 5.67 ft
(Z) Tension Crack Depth = 12.46 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.01

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 58 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0.38 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 54 ft ²
(W) Weight of Slice = 61042.31 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 6.78 ft
(Z) Tension Crack Depth = 14.33 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 0.91

Rapid Wedge Failure Analysis Input Data

(GR) Density of Rock = 150 lb(f)/ft ³
(H) Height of Crest Above Intersection = 60 ft

Plane 1 : (D1) Dip Value = 58 °
(E1) Dip Direction = 148 °
Plane 2 : (D2) Dip Value = 59 °
(E2) Dip Direction = 103 °
Plane 3 : (D3) Dip Value = 1 °
(E3) Dip Direction = 160 °
Plane 4 : (D4) Dip Value = 70 °
(E4) Dip Direction = 160 °

Plane 1 : (C1) Cohesion = 800 lb(f)/ft ²
(P1) Friction Angle = 50 °
Plane 2 : (C2) Cohesion = 800 lb(f)/ft ²
(P2) Friction Angle = 50 °

Water Pressure : Cracks Completely Filled (Free Draining)

(GW) Density of Water = 62.4 lb(f)/ft ³

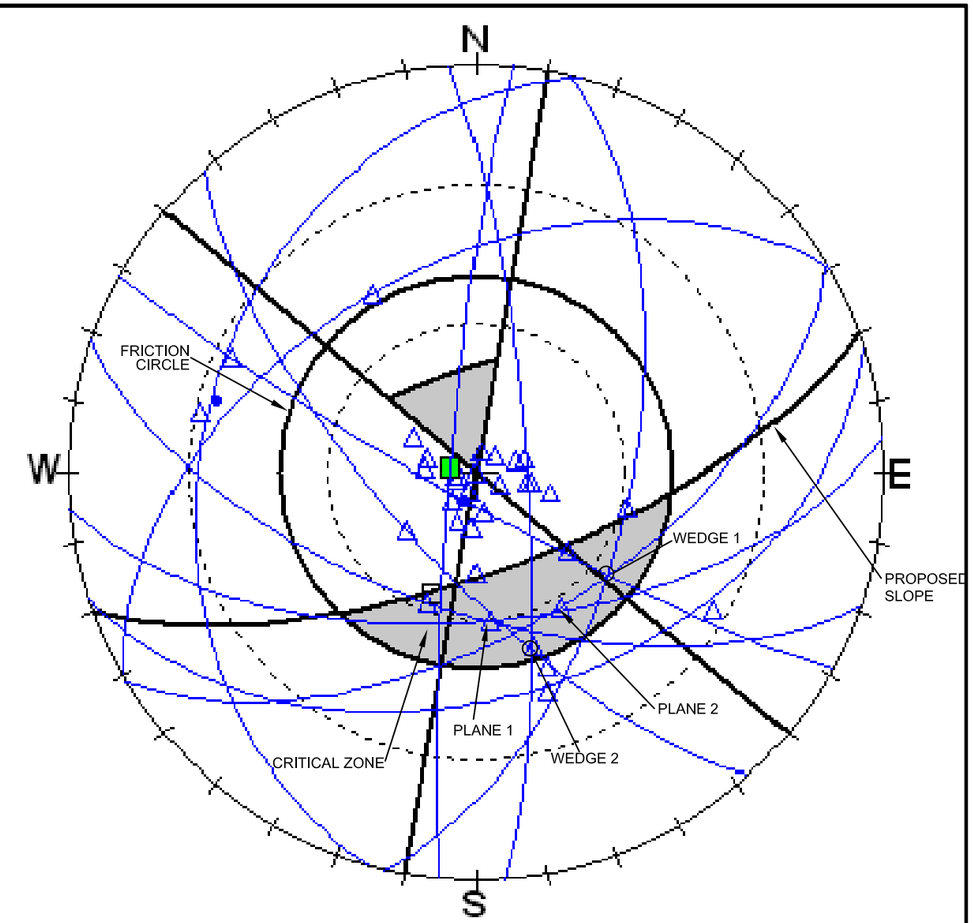
(HW) Overall Vertical Height of Wedge = 0 ft

The slope face DOES NOT hang over the toe of the slope.

Rapid Wedge Failure Analysis Output Data

(F) Factor of Safety = 2.94
Water Pressure on both planes = 0 lb(f)/ft ²

THERE IS CONTACT ON PLANE 1 ONLY.



Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 60 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 55.01 ft ²
(W) Weight of Slice = 51038.68 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 5.67 ft
(Z) Tension Crack Depth = 12.46 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.68

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 58 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 54 ft ²
(W) Weight of Slice = 61042.31 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 6.78 ft
(Z) Tension Crack Depth = 14.33 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.58

Rapid Wedge Failure Analysis Input Data

(GR) Density of Rock = 150 lb(f)/ft ³
(H) Height of Crest Above Intersection = 60 ft

Plane 1 : (D1) Dip Value = 72 °
(E1) Dip Direction = 230 °
Plane 2 : (D2) Dip Value = 79 °
(E2) Dip Direction = 100 °
Plane 3 : (D3) Dip Value = 1 °
(E3) Dip Direction = 160 °
Plane 4 : (D4) Dip Value = 70 °
(E4) Dip Direction = 160 °

Plane 1 : (C1) Cohesion = 800 lb(f)/ft ²
(P1) Friction Angle = 50 °
Plane 2 : (C2) Cohesion = 800 lb(f)/ft ²
(P2) Friction Angle = 50 °

Water Pressure : Cracks Completely Filled (Free Draining)

(GW) Density of Water = 62.4 lb(f)/ft ³

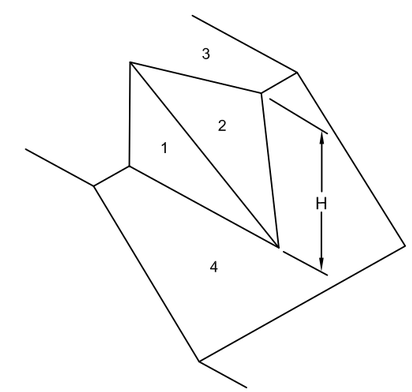
(HW) Overall Vertical Height of Wedge = 0 ft

The slope face DOES NOT hang over the toe of the slope.

Rapid Wedge Failure Analysis Output Data

(F) Factor of Safety = 4.69
Water Pressure on both planes = 0 lb(f)/ft ²

THERE IS CONTACT ON BOTH PLANES.



KEY:
- 1-Small Joints
- 2- Faults
- 3- Follations
- 4- Dikes

KINEMATIC ANALYSIS

FOR: OMYA CALIFORNIA
A DIVISION OF OMYA, INC.

DATE: JANUARY 2013

SLOPE STABILITY INVESTIGATION
PROPOSED AMENDED PLAN OF OPERATIONS
WHITE KNOB QUARRY MINING AND RECLAMATION PLAN
LUCERNE VALLEY, CALIFORNIA

ENCLOSURE "B-8.0"

JOB NUMBER 12715-8

CHJ Consultants

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 64 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0.38 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 57.67 ft ²
(W) Weight of Slice = 30990.53 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 3.44 ft
(Z) Tension Crack Depth = 8.23 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.51

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 60 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0.38 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 55.01 ft ²
(W) Weight of Slice = 51038.68 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 5.67 ft
(Z) Tension Crack Depth = 12.46 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.01

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 64 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 57.67 ft ²
(W) Weight of Slice = 30990.53 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 3.44 ft
(Z) Tension Crack Depth = 8.23 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 2.24

Plane Failure Analysis Input Data

(H) Height = 60 ft
(SF) Inclination of Slope Face = 70 °
(SS) Inclination of Upper Slope = 1 °
(SP) Inclination of Failure Plane = 60 °
(CO) Cohesive Strength of Failure Surface = 800 lb(f)
(PH) Friction Angle of Failure Surface = 50 °
(GR) Density of Rock = 150 lb(f)/ft ³
(GW) Density of Water = 62.4 lb(f)/ft ³
(AB) Starting Rock Bolt Angle = 0 °
(AR) Ending Rock Bolt Angle = 0 °
(AA) Bolt Angle Increment = 0 °
(T1) Starting Bolt Tension = 0 lb(f)
(T2) Ending Bolt Tension = 0 lb(f)
(T3) Bolt Tension Increment = 0 lb(f)
(AC) Horizontal Acceleration = 0 G
(TZ) Amount of Discontinuity = 0 decimal%
(VSUR) Vertical Surcharge = 0 lb(f)
(HSUR) Horizontal Surcharge = 0 lb(f)

Tension Crack Location Unknown: Dry Slope

Plane Failure Analysis Output Data

(A) Contact Area = 55.01 ft ²
(W) Weight of Slice = 51038.68 lb(f)
(U) Water Force Normal to Failure Plane = 0 lb(f)
(V) Horizontal Water Force on Tension Crack = 0 lb(f)
(B) Worst Location, Horizontal Distance = 5.67 ft
(Z) Tension Crack Depth = 12.46 ft
(ZW) Depth of Water in Crack = 0 ft
(TH) Bolt Angle = 0 °
(T) Tension = 0 lb(f)
(F) Factor of Safety = 1.68

Rapid Wedge Failure Analysis Input Data

(GR) Density of Rock = 150 lb(f)/ft ³
(H) Height of Crest Above Intersection = 60 ft

Plane 1 : (D1) Dip Value = 72 °
(E1) Dip Direction = 230 °
Plane 2 : (D2) Dip Value = 75 °
(E2) Dip Direction = 105 °
Plane 3 : (D3) Dip Value = 1 °
(E3) Dip Direction = 210 °
Plane 4 : (D4) Dip Value = 70 °
(E4) Dip Direction = 210 °

Plane 1 : (C1) Cohesion = 800 lb(f)/ft ²
(P1) Friction Angle = 50 °
Plane 2 : (C2) Cohesion = 800 lb(f)/ft ²
(P2) Friction Angle = 50 °

Water Pressure : Cracks Completely Filled (Free Draining)

(GW) Density of Water = 62.4 lb(f)/ft ³

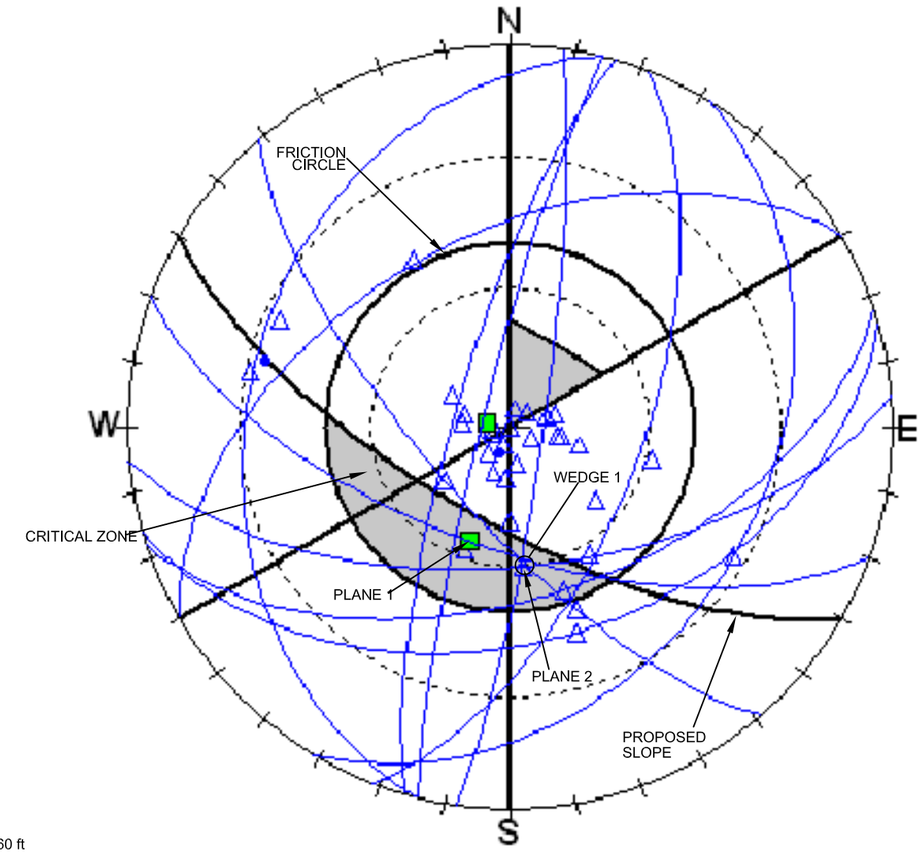
(HW) Overall Vertical Height of Wedge = 0 ft

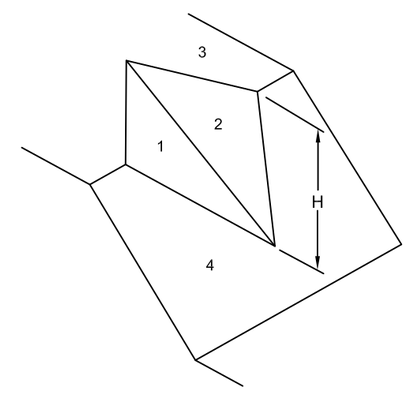
The slope face DOES NOT hang over the toe of the slope.

Rapid Wedge Failure Analysis Output Data

(F) Factor of Safety = 5.5
Water Pressure on both planes = 0 lb(f)/ft ²

THERE IS CONTACT ON BOTH PLANES.





KEY:
- 1-Small Joints
- 2- Faults
- 3- Follations
- 4- Dikes

KINEMATIC ANALYSIS

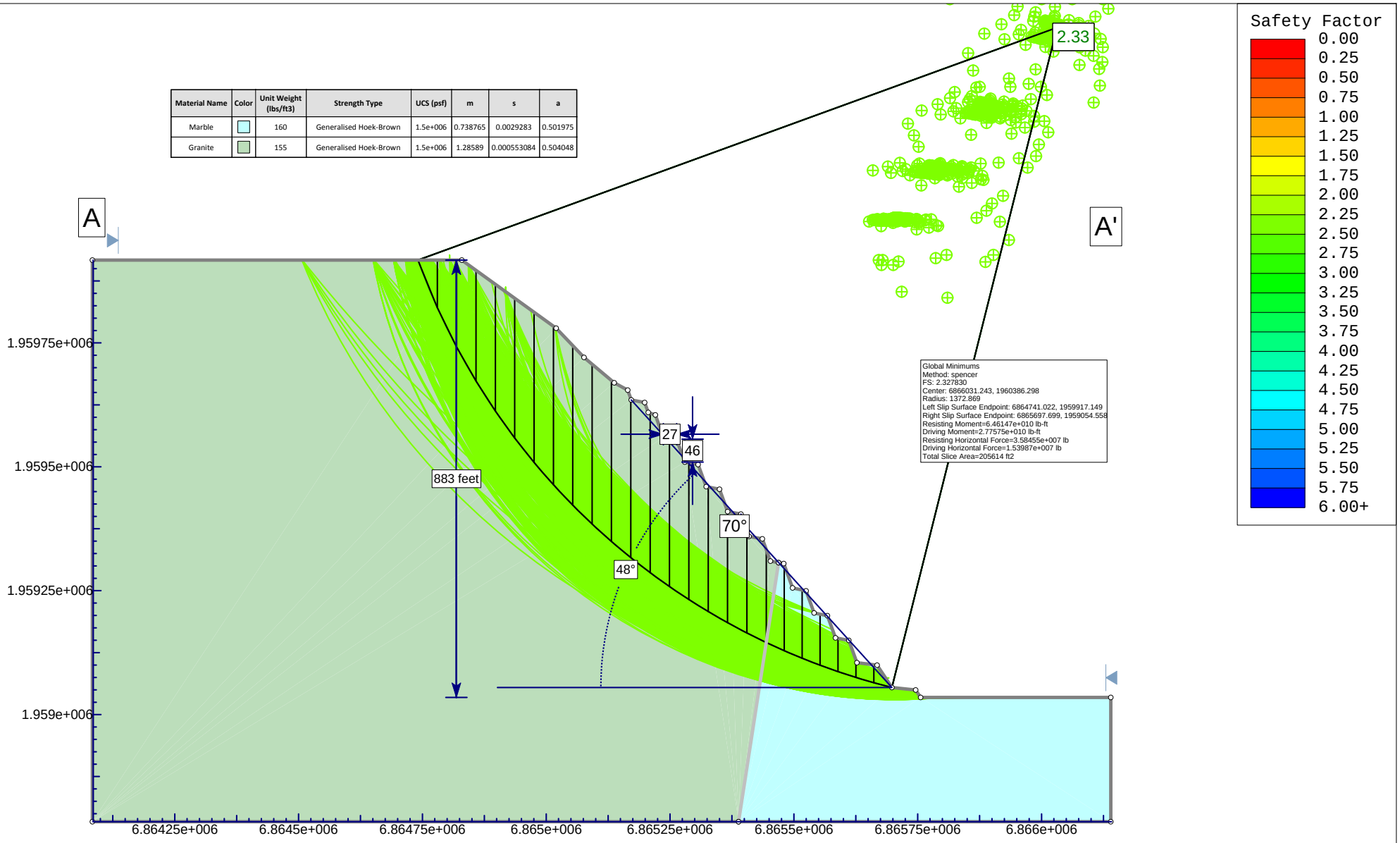
FOR: OMYA CALIFORNIA A DIVISION OF OMYA, INC.	SLOPE STABILITY INVESTIGATION PROPOSED AMENDED PLAN OF OPERATIONS WHITE KNOB QUARRY MINING AND RECLAMATION PLAN LUCERNE VALLEY, CALIFORNIA	ENCLOSURE "B-9.0"
DATE: JANUARY 2013		JOB NUMBER 12715-8

CHJ Consultants

APPENDIX "C"

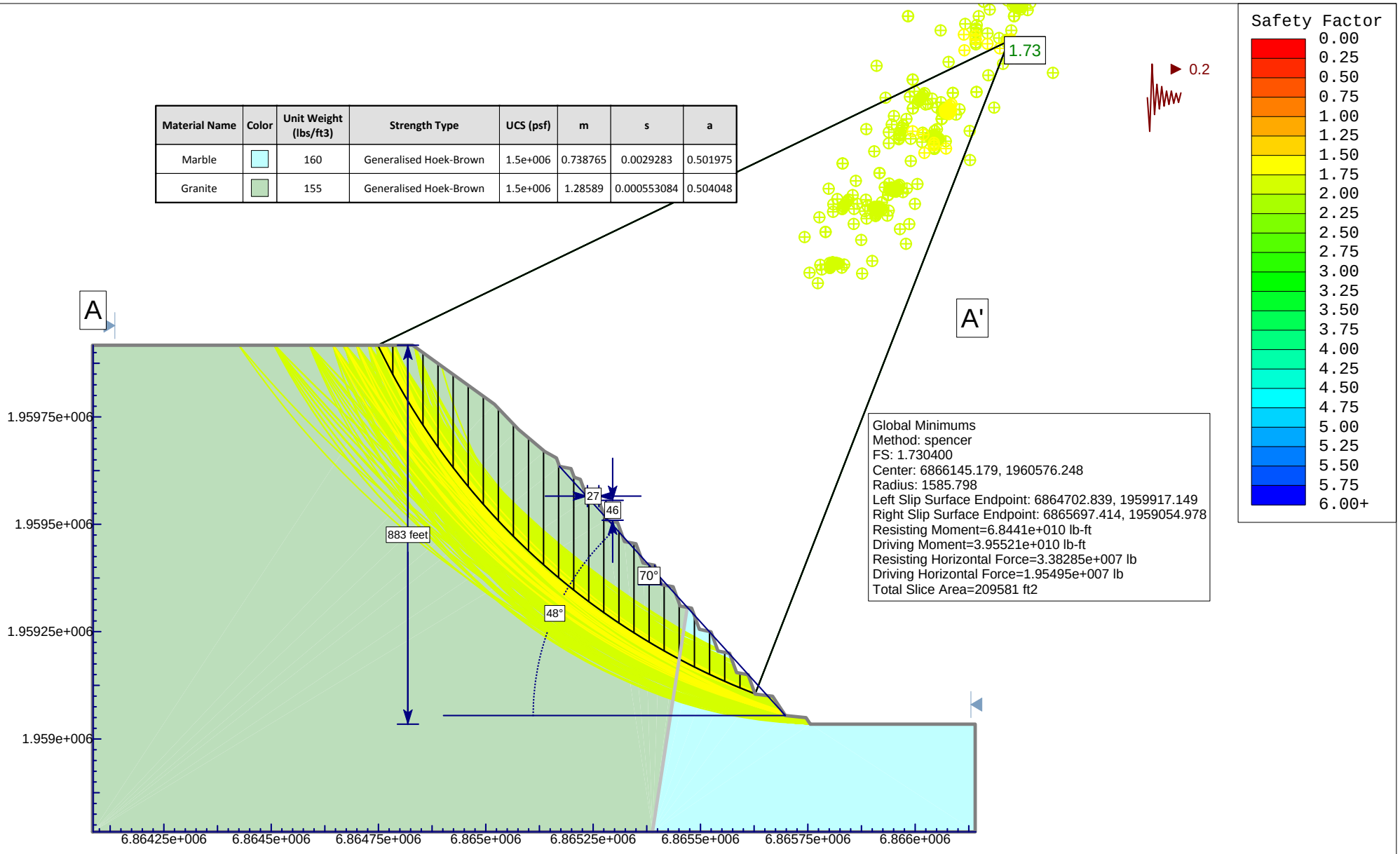
GLOBAL STABILITY CALCULATIONS

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	UCS (psf)	m	s	a
Marble		160	Generalised Hoek-Brown	1.5e+006	0.738765	0.0029283	0.501975
Granite		155	Generalised Hoek-Brown	1.5e+006	1.28589	0.000553084	0.504048



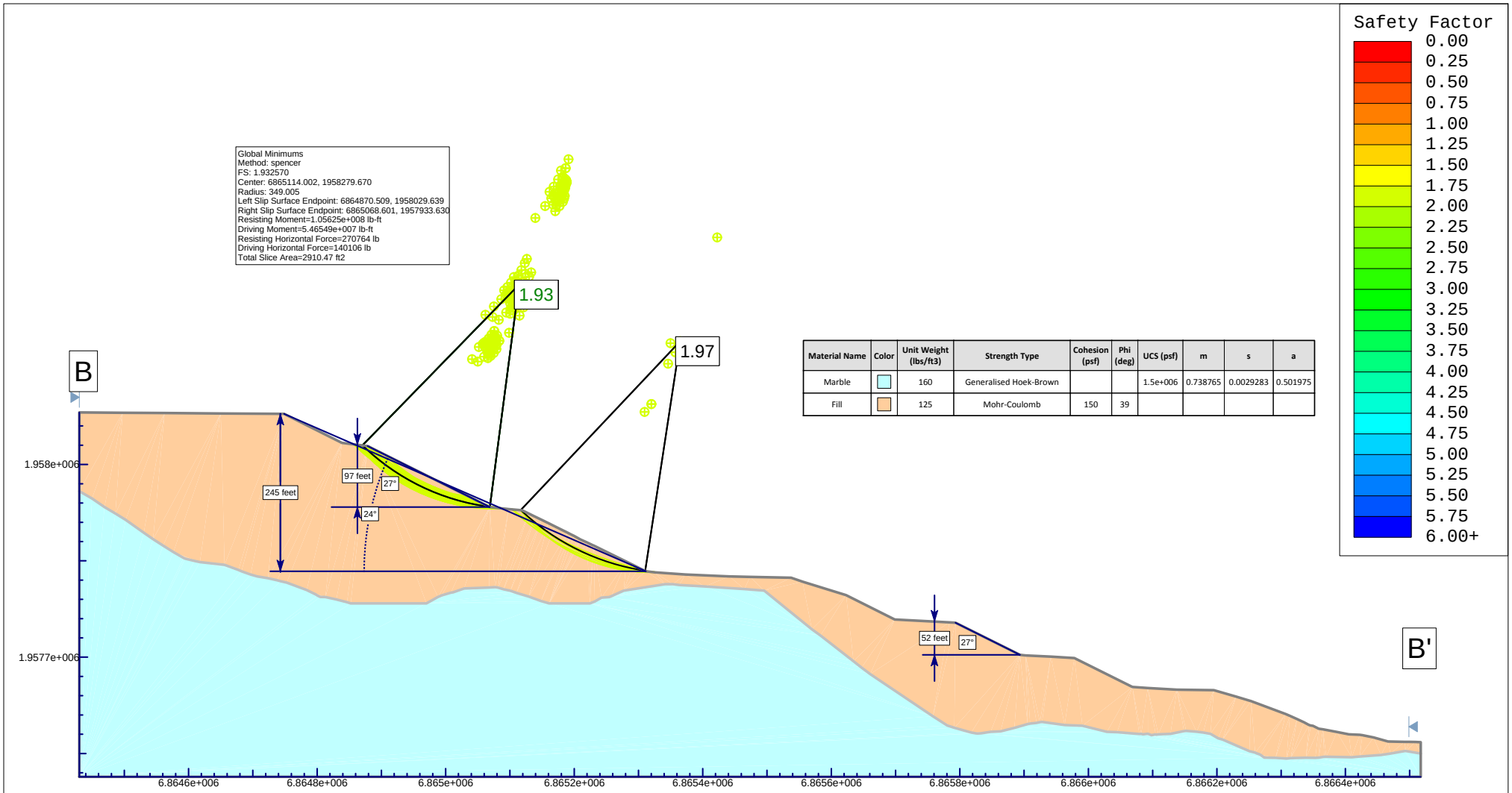
SLIDEINTERPRET 6.019	*Project* SLIDE - An Interactive Slope Stability Program		
	Analysis Description White Knob/Ridge Quarries		
	Drawn By CHJ Consultants	*Author* J. McKeown	*Scale* 1:3277
	File Name A stat.slim	*Date* 11/1/2012	*Enclosure* C-1

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	UCS (psf)	m	s	a
Marble		160	Generalised Hoek-Brown	1.5e+006	0.738765	0.0029283	0.501975
Granite		155	Generalised Hoek-Brown	1.5e+006	1.28589	0.000553084	0.504048



SLIDEINTERPRET 6.019

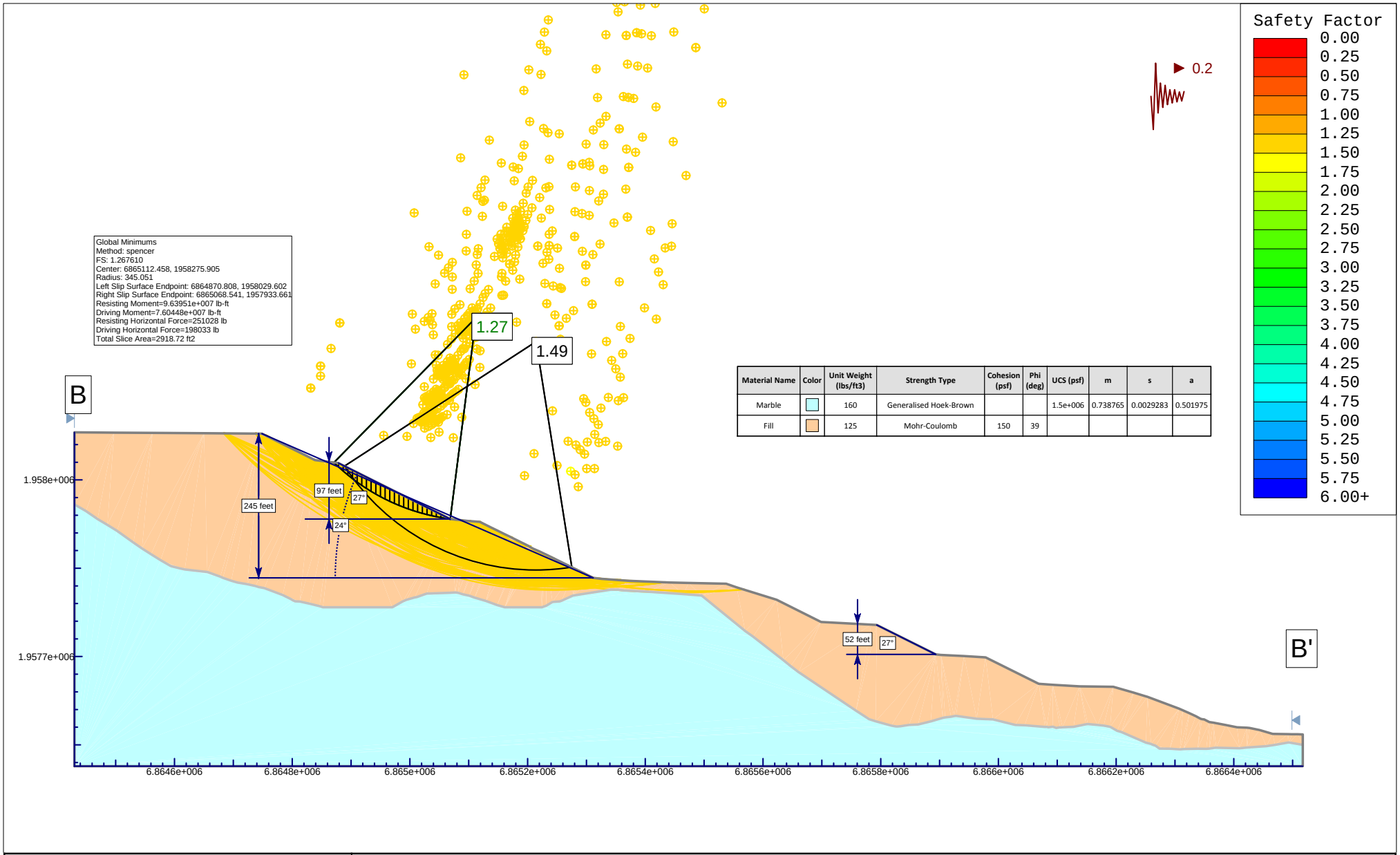
Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description	White Knob/Ridge Quarries		
Drawn By	CHJ Consultants	*Author* J. McKeown	*Scale* 1:3762
File Name	A seis.slim	*Date* 11/1/2012	*Enclosure* C-2



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
Marble		160	Generalised Hoek-Brown			1.5e+006	0.738765	0.0029283	0.501975
Fill		125	Mohr-Coulomb	150	39				

SLIDEINTERPRET 6.019

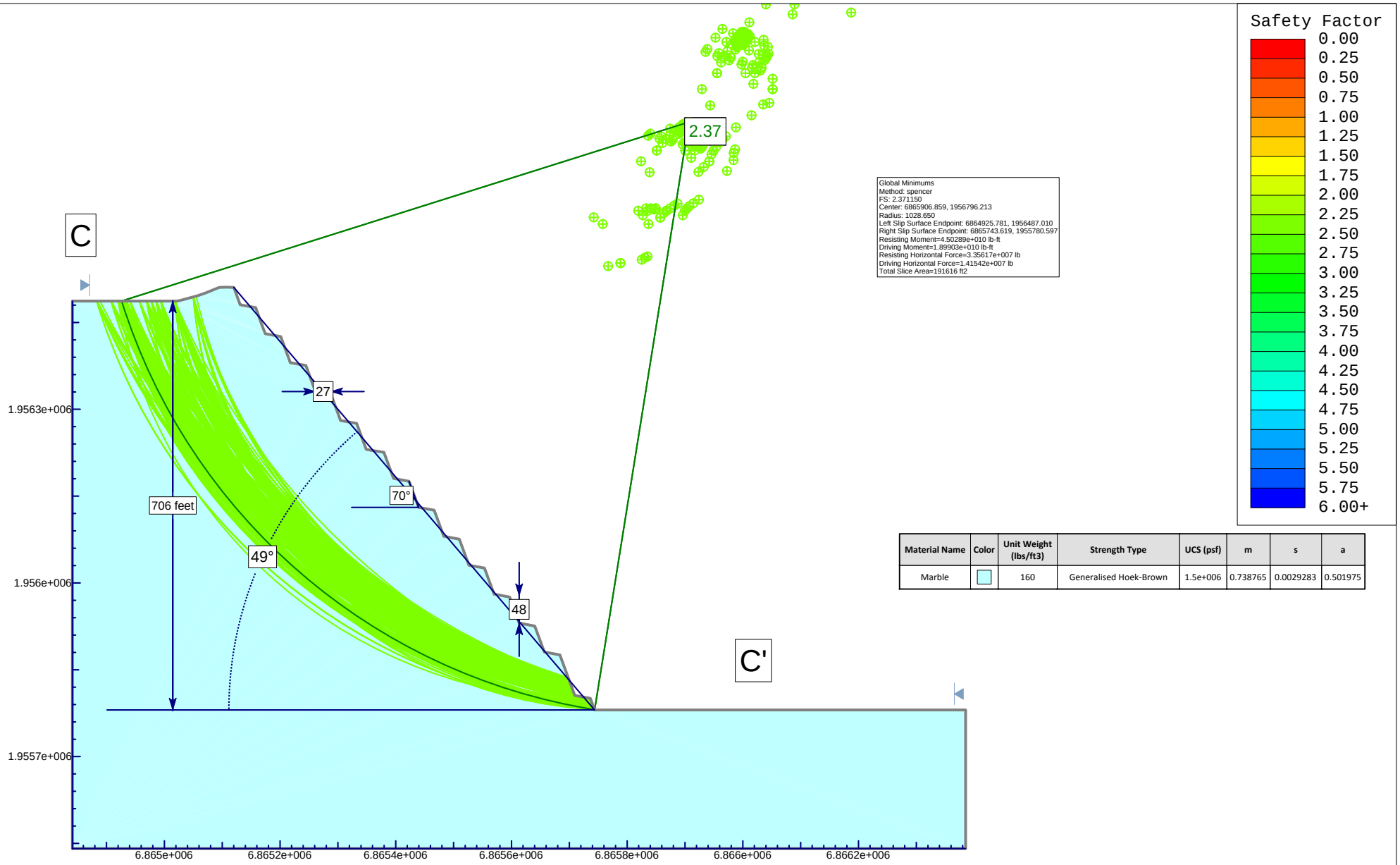
Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By	CHJ Consultants	*Author* J. McKeown	*Scale* 1:2675
File Name	B stat.slim	*Date* 10/31/2012	*Enclosure* C-3



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	UCS (psf)	m	s	a
Marble		160	Generalised Hoek-Brown			1.5e+006	0.738765	0.0029283	0.501975
Fill		125	Mohr-Coulomb	150	39				

SLIDEINTERPRET 6.019

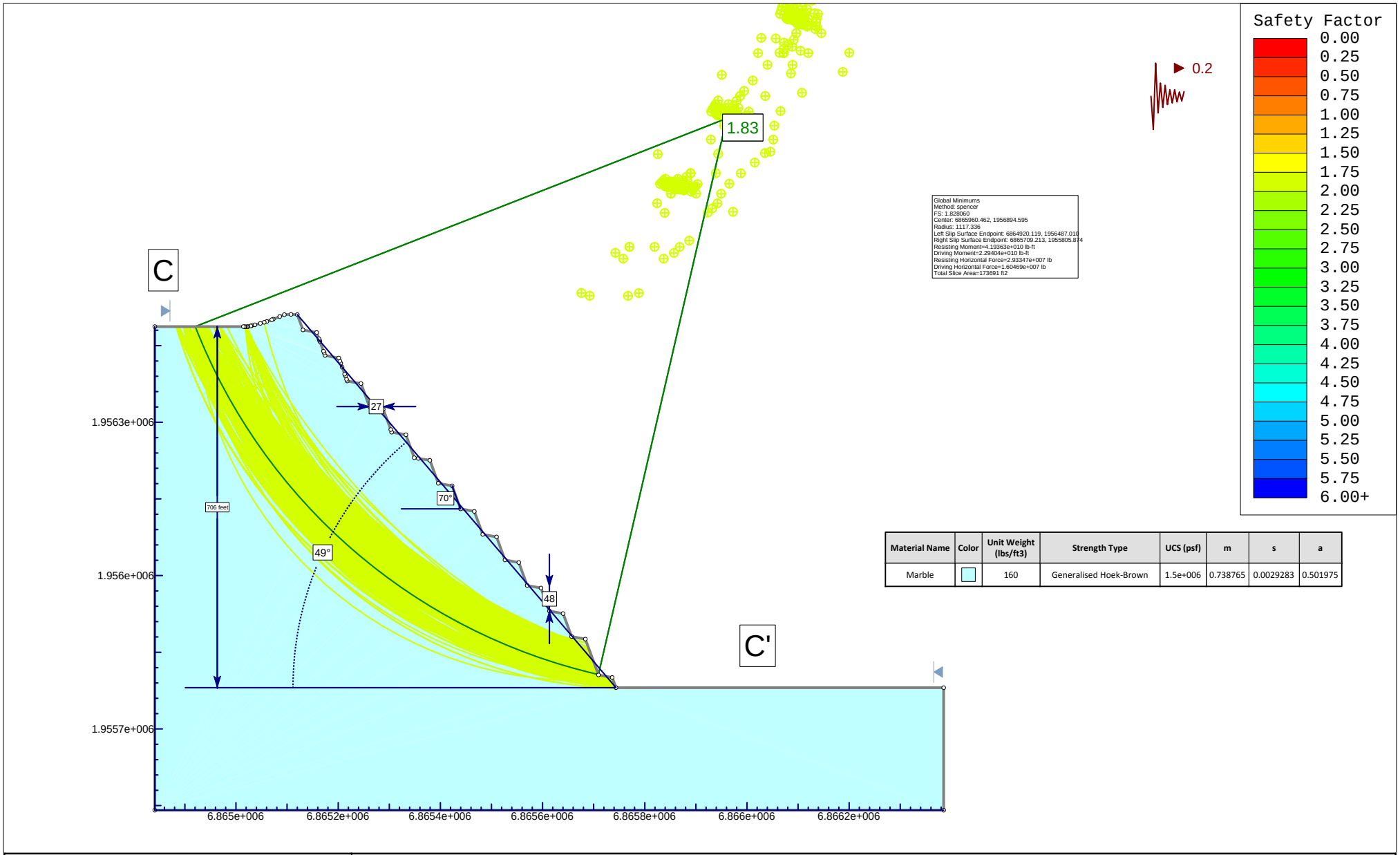
Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By	CHJ Consultants	*Author* J. McKeown	*Scale* 1:2705
File Name	B seis.slim	*Date* 10/31/2012	*Enclosure* C-4



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	UCS (psf)	m	s	a
Marble		160	Generalised Hoek-Brown	1.5e+006	0.738765	0.0029283	0.501975

SLIDEINTERPRET 6.019

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By	CHJ Consultants	*Author* J. McKeown	*Scale* 1:2806
File Name	C stat.slim	*Date* 11/1/2012	*Enclosure* C-5



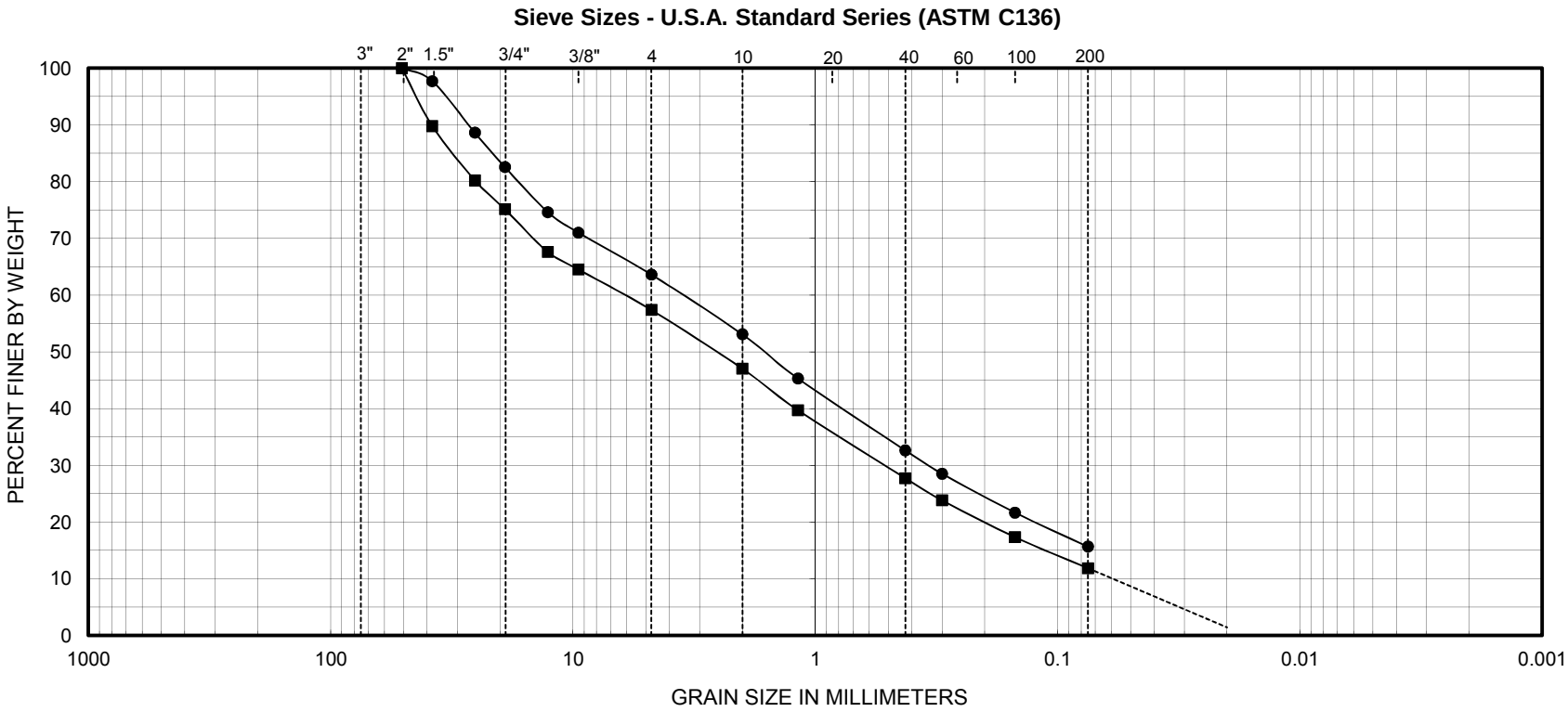
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	UCS (psf)	m	s	a
Marble		160	Generalised Hoek-Brown	1.5e+006	0.738765	0.0029283	0.501975

SLIDEINTERPRET 6.019

Project	SLIDE - An Interactive Slope Stability Program		
Analysis Description			
Drawn By	CHJ Consultants	*Author* J. McKeown	*Scale* 1:3116
File Name	C seis.slim	*Date* 11/1/2012	*Enclosure* C-6

APPENDIX "D"

BORING LOGS AND LABORATORY TEST DATA



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

Symbol	Boring No.	Depth (ft)	Classification	D_{10} (mm)	D_{30} (mm)	D_{50} (mm)	D_{60} (mm)	C_u	C_c	SE
●	1	0	(SM) Silty sand, fine to gravel to 2"		0.340	1.622	3.529			
■	2	0	(SP-SM) Sand with silt, fine to gravel to 2"	0.0592	0.516	2.563	6.123	103.492	0.735	

CHJ Consultants

GRAIN SIZE DISTRIBUTION			
Project:	Slope Stability Investigation - White Knob Quarry		
Location:	Lucerne Valley, San Bernardino County, California		
Job Number:	12715-3	Enclosure:	D-1

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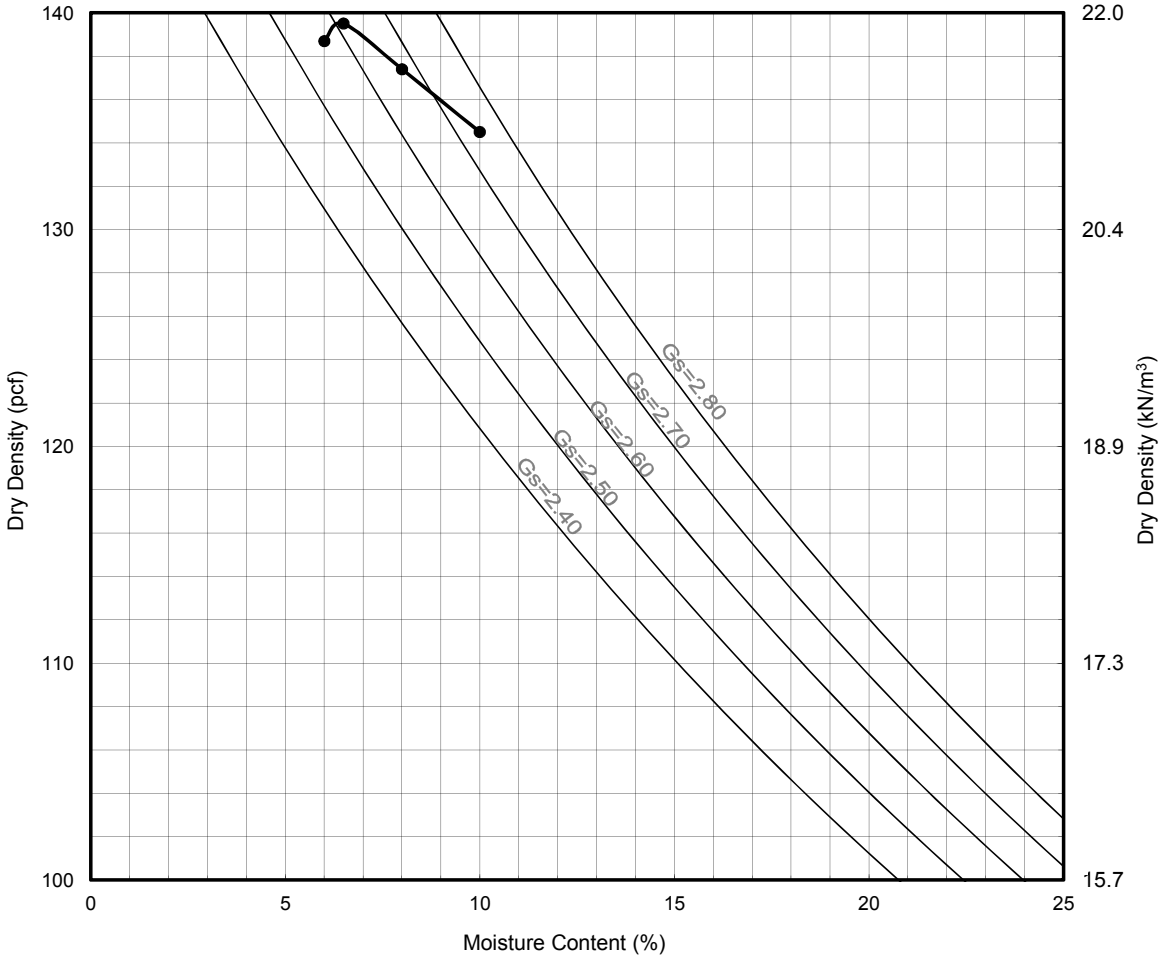
Optimum Moisture - Maximum Density Determination Test (ASTM D 1557)



Sample No.		Depth (ft)	Soil/Sample Type	γ_{max} (pcf)	w_{opt} (%)
●	1A+2A	0	(SM) Silty sand, fine to gravel	139.5	6.5

CHJ Consultants

MOISTURE-DENSITY RELATIONSHIP			
Project:	Slope Stability Investigation - White Knob Quarry		
Location:	Lucerne Valley, San Bernardino County, California		
Job No.:	12715-3	Enclosure:	D-2

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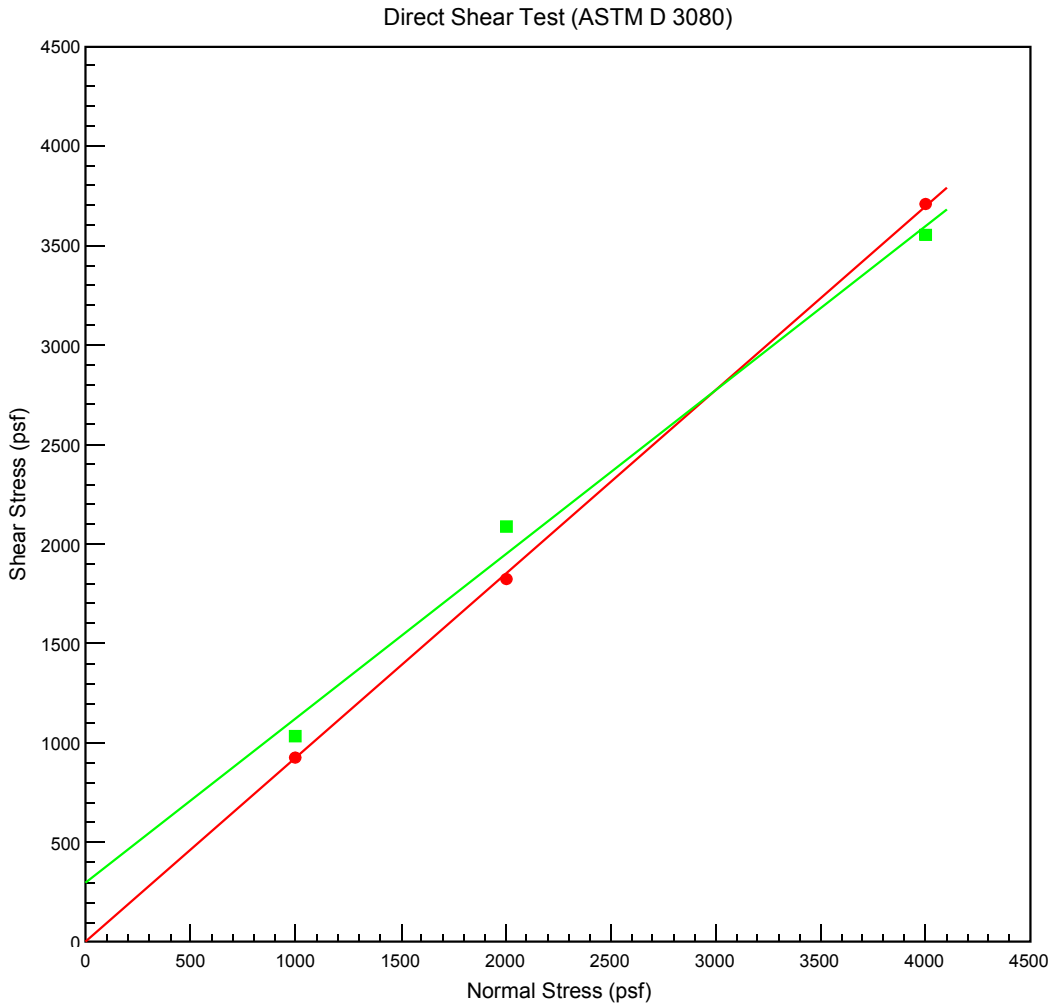

Boring No.		Depth (ft)	Soil/Sample Type	γ_d (pcf)	MC(%)	C (psf)	φ(°)
●	1	5	(SM) Silty sand, fine to gravel / 85% RC	118	7.5	0	42.7
■	2	5	(SP-SM) Sand with silt, fine to gravel / 85% RC	118	7.5	300	39.5

CHJ Consultants

DIRECT SHEAR TEST			
Project:	Slope Stability Investigation - White Knob Quarry		
Location:	Lucerne Valley, San Bernardino County, California		
Job No.:	12715-3	Enclosure:	D-3

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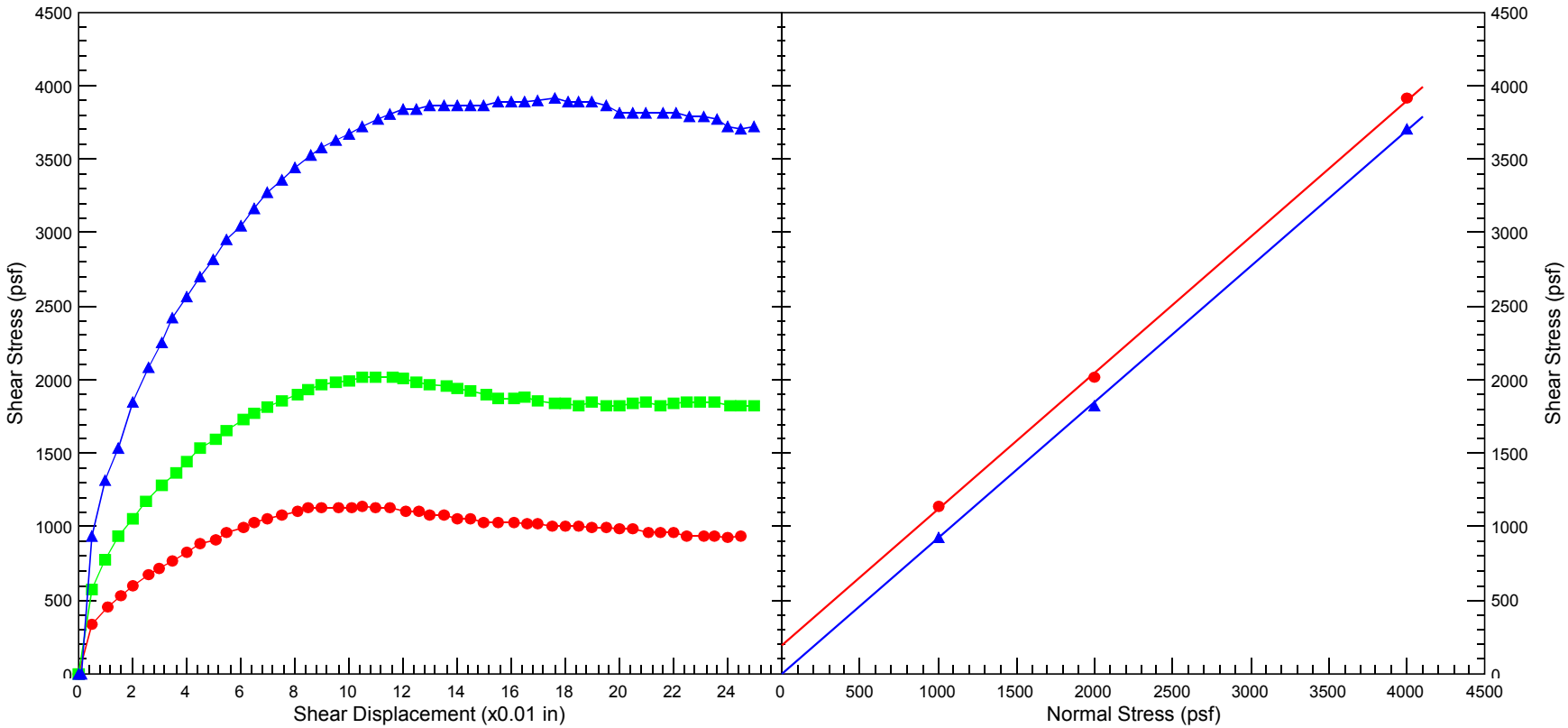

Boring No.		Depth (ft)	Soil/Sample Type	γ_d (pcf)	MC (%)	C_{peak} (psf)	φ_{peak} (°)	C_{res} (psf)	φ_{res} (°)
●	1	5	(SM) Silty sand, fine to gravel / 85% RC	118.2	7.5	192	42.8	0	42.7

CHJ Consultants

DIRECT SHEAR TEST			
Project:	Slope Stability Investigation - White Knob Quarry		
Location	Lucerne Valley, San Bernardino County, California		
Job Number	12715-3	Enclosure	D-4

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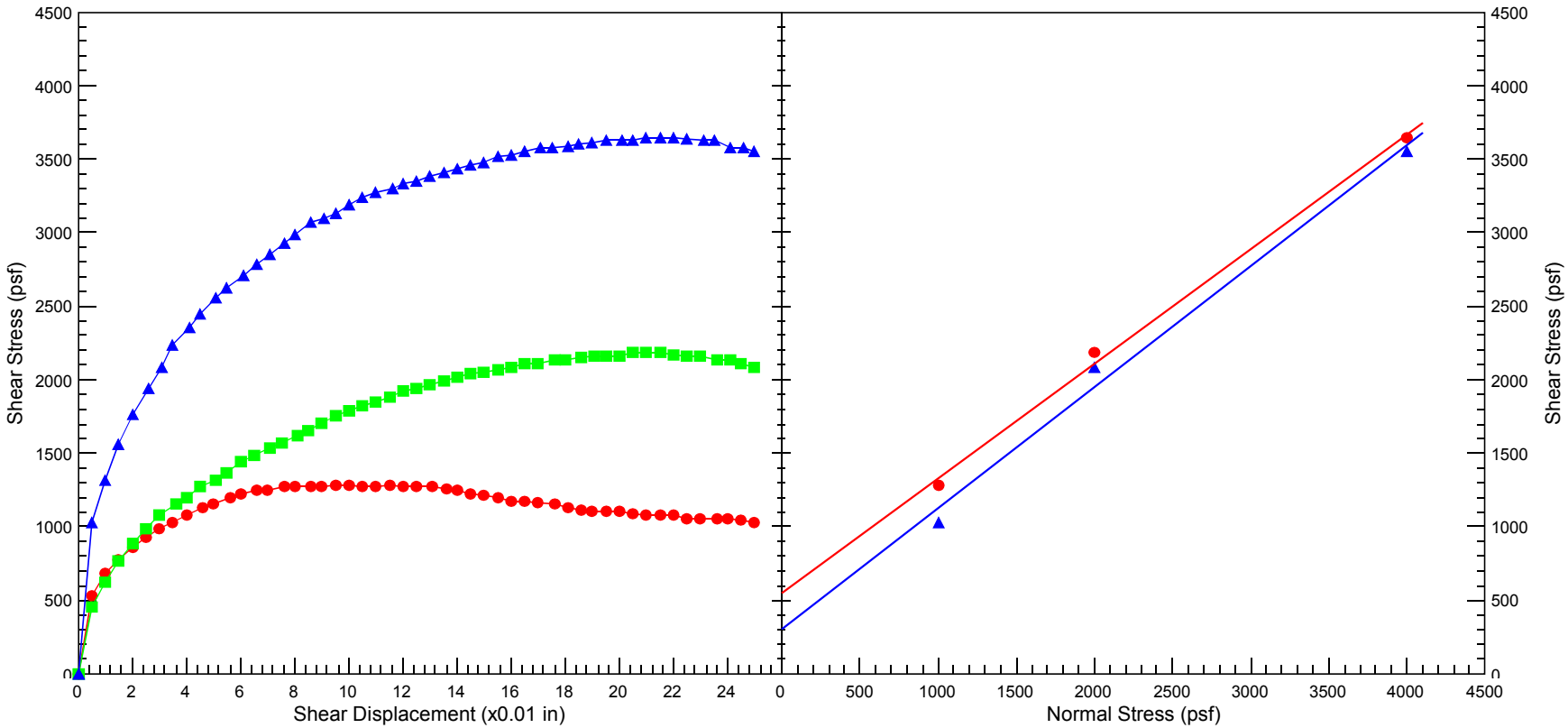

Boring No.		Depth (ft)	Soil/Sample Type	γ_d (pcf)	MC (%)	C_{peak} (psf)	φ_{peak} (°)	C_{res} (psf)	φ_{res} (°)
●	2	5	(SP-SM) Sand with silt, fine to gravel / 85% RC	118.2	7.5	552	38.0	300	39.5

CHJ Consultants

DIRECT SHEAR TEST			
Project:	Slope Stability Investigation - White Knob Quarry		
Location	Lucerne Valley, San Bernardino County, California		
Job Number	12715-3	Enclosure	D-5

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EXPLORATORY BORING NO. 1

Date Drilled: 7/13/07 | Client: Webber & Webber Mining Consultants, Inc.

Equipment: B61 Mobile Drill Rig | Driving Weight / Drop: 140 lbs./30 in.

Surface Elevation(ft): | Logged by: JMZ | Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine with medium to coarse, gravel and cobbles to 12", very light gray	Fill		▨		1.0		
5				X		15 18 40	2.6	126	Ring
10				X		7 10 13	2.1	130	Ring
15				X		4 16 12	N.R.	N.R.	Ring
20				X		11 7 10	2.6	117	Ring, DS
25				X		10 11 10	2.5	116	Ring
30				X		10 12 12	2.9	119	Ring

BORING LOG - NO EQUIV & BLOW PER 6 IN 07539-3.GPJ CHJ.GDT 8/15/07

C.H.J.

OMYA WHITE KNOB QUARRY
LUCERNE VALLEY, CALIFORNIA

Job No. 07539-8

Enclosure

EXPLORATORY BORING NO. 1

Date Drilled: 7/13/07 | Client: Webber & Webber Mining Consultants, Inc.

Equipment: B61 Mobile Drill Rig | Driving Weight / Drop: 140 lbs./30 in.

Surface Elevation(ft): | Logged by: JMZ | Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine with medium to coarse, gravel and cobbles to 4", light gray		X		10 11 16	2.9	113	Ring, DS
40				X		9 13 22	2.6	124	Ring
45				X		9 12 19	2.3	118	Ring
50				X		10 13 32	2.9	123	Ring
		END OF BORING NO BEDROCK, NO REFUSAL FILL TO 51.5', SLIGHT CAVING NO FREE GROUNDWATER							
55									
60									
65									

BORING LOG - NO EQUIV & BLOW PER 6 IN 07539-3.GPJ CHJ.GDT 8/15/07

C.H.J.

OMYA WHITE KNOB QUARRY
LUCERNE VALLEY, CALIFORNIA

Job No. 07539-8

Enclosure

EXPLORATORY BORING NO. 2

Date Drilled: 7/13/07 | Client: Webber & Webber Mining Consultants, Inc.

Equipment: B61 Mobile Drill Rig | Driving Weight / Drop: 140 lbs./30 in.

Surface Elevation(ft): | Logged by: JMZ | Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine with medium to coarse, gravel and cobbles to 4", light gray	Fill		▨		1.1		SA, MDC
5				☒		6 7 9	2.2	115	Ring
10				☒		7 5 6	2.4	Dist.	Ring
15				☒		3 4 8	1.9	114	Ring, DS
20				☒		6 10 25	1.7	128	Ring
25				☒		9 6 4	1.9	104	Ring, DS
30				☒		21 22 19	N.R.	N.R.	Ring

BORING LOG - NO EQUIV & BLOW PER 6 IN 07539-3.GPJ CHJ.GDT 8/15/07

EXPLORATORY BORING NO. 2

Date Drilled: 7/13/07 | Client: Webber & Webber Mining Consultants, Inc.

Equipment: B61 Mobile Drill Rig | Driving Weight / Drop: 140 lbs./30 in.

Surface Elevation(ft): | Logged by: JMZ | Measured Depth to Water(ft): N/A

DEPTH (ft)	GRAPHIC LOG	VISUAL CLASSIFICATION	REMARKS	SAMPLES DRIVE	SAMPLES BULK	BLOWS/6 IN.	FIELD MOISTURE (%)	DRY UNIT WT. (pcf)	LAB/FIELD TESTS
		(SM) Silty Sand, fine with medium to coarse, gravel and cobbles to 4", light gray		X		9 9 8	1.7	Dist.	Ring
40				X		8 8 28	0.8	121	Ring
45				X		10 12 38	2.9	114	Ring, DS
50				X		37 33 10	N.R.	N.R.	Ring
		END OF BORING NO BEDROCK, NO REFUSAL FILL TO 51.5', SLIGHT CAVING NO FREE GROUNDWATER							
55									
60									
65									

BORING LOG - NO EQUIV & BLOW PER 6 IN 07539-3.GPJ CHJ.GDT 8/15/07

C.H.J.

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Enclosure