

Appendix 23.A

Slope Stability Analysis



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September 21, 2011

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RE: Slope Stability Evaluation
Navajo Mine Area 4 Coal Haulage Road
Fruitland, New Mexico
GEOMAT Project No. 112-1388

As you requested, GEOMAT Inc. has completed geotechnical engineering analyses to evaluate the stability of selected cut and fill slopes of the proposed coal haulage road to be constructed in Area 4 at Navajo Mine. Our analyses were based on the following understandings:

- Cut and Fill slopes: generally 2:1 Horizontal:Vertical (H:V), except that the slopes of the shoulders of the haul road will be 4:1 H:V,
- Slope of the roadway: 2 % to the shoulders from the center of the roadway
- Roadway and existing grade elevations: based on the roadway profile drawings Sheets 11 and 12 titled West Haulroad dated July 07.
- As requested, the cut slope used in the analysis is at station 460+00, where the cut will be approximately 57 ft,
- As requested, the fill slope used in the analysis is at station 520+90, where the fill will be approximately 60 ft,
- Where coal exists in the cut slope, for fire control purposes, the coal will be removed for an approximate horizontal distance of 20 feet and replaced with compacted fill,
- Strength properties of the native soils and the compacted fill material were based on information from the geotechnical engineering reports by Converse (Soil and Foundation Investigation Report, Converse Project No. 07-53190-01 dated July 10, 2008) and GEOMAT (Preliminary Geotechnical Engineering Report-BHP Navajo Mine Extension Project, GEOMAT Project No. 72-0466 and dated May 18, 2007)
- Strengths of the coal were estimated based on properties of the coal indicated in the above-referenced geotechnical engineering reports,
- A pseudo static seismic force of 0.1g was used in the analyses,
- The embankments were not considered to retain water or to be submerged,
- The loaded weight of the haul trucks (Kress 200C) and dragline (Model 8750 Walking Dragline) were simulated by dividing the weight of the vehicle over the area of the base of the wheels/tracks.
- OSM regulations require a minimum static safety factor of 1.3 for primary road embankments.
- The properties shown in the attached diagrams for cohesion, unit weight, and internal angle of friction of the compacted fill portion of the embankments are based upon laboratory values in the aforementioned Converse report. The actual compacted fill material used for the embankments should be sampled and tested to verify it conforms at a minimum to these properties.

Selection, placement and compaction of the fill soils should be as recommended in the aforementioned Converse report.

Slope stability analyses were performed with Galena Slope Stability Analysis System software, v4.02 and v5.02. Properties of the soil and rock materials that are expected to exist in the cut and fill sections are noted on the slope stability analysis sheets that are attached to this report.

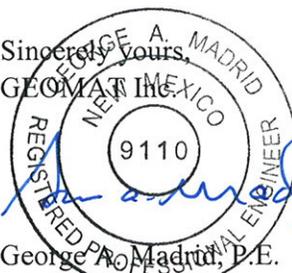
The results of the analyses are summarized in the following table. Individual sheets showing the details of the calculations and the configuration of the slope used in the calculations are attached.

Slope	Pseudo Static Earthquake (%g)	Calculated Factor of Safety
Fill Slope w/o vehicle load	0.1	1.5
Fill Slope w/ Kress haul truck	0.1	1.4
Fill Slope w/ dragline	0.1	1.5
Cut Slope w/o vehicle loading	0.1	1.4
Cut Slope w/ dragline @ toe	0.1	1.4

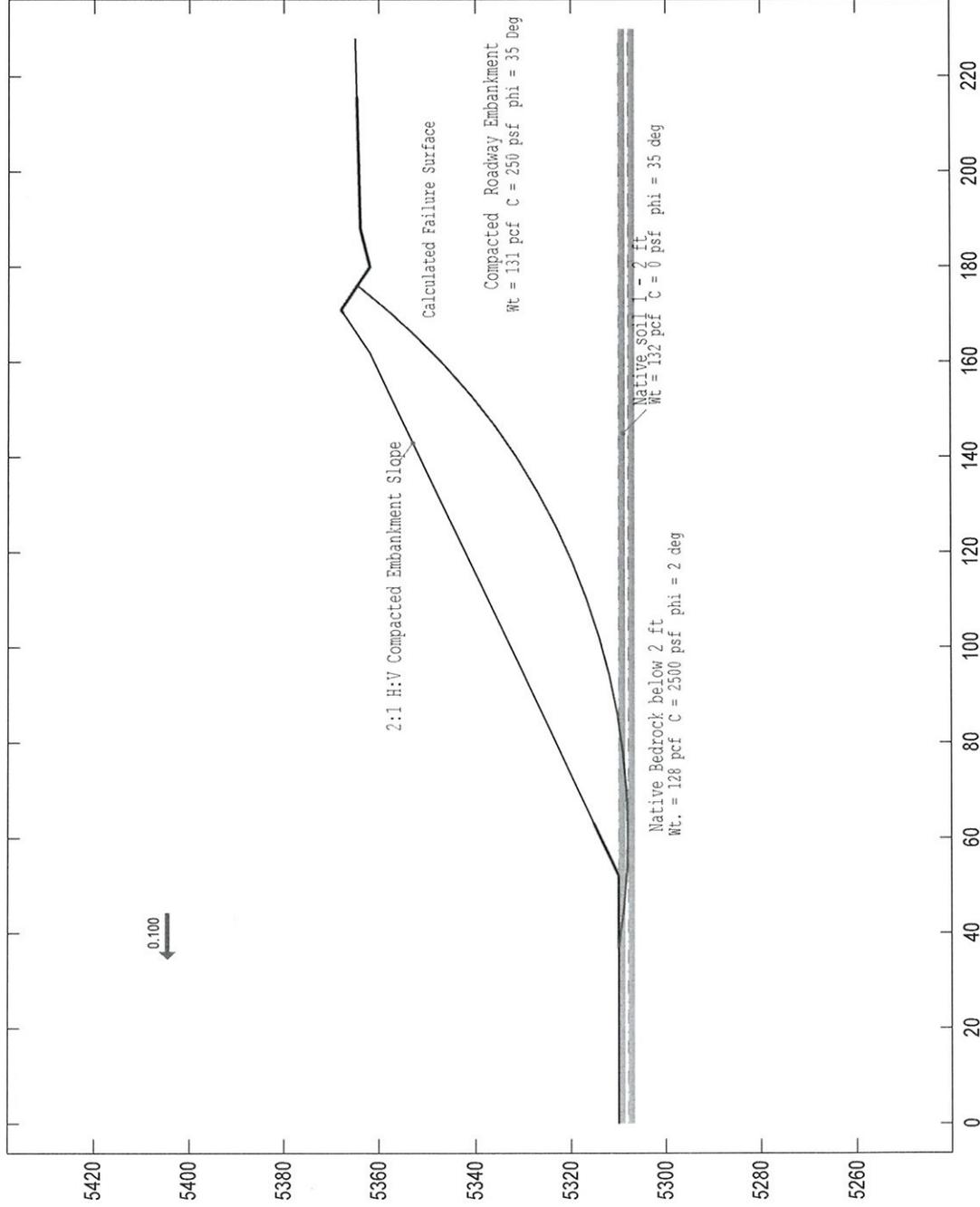
As shown in the table, the calculated factors of safety for both the cut and fill slopes are either 1.4 or 1.5. Based on the required factor of safety of 1.3, both the cut and fill slopes are considered to have adequate factors of safety for the conditions analyzed.

The nature and variation of materials may not become evident until construction. If variations then appear, it will be necessary to reevaluate the information in this report. Likewise, in the event that any changes in the nature, design, or location of the cut or fill slopes are made, the recommendations contained in this report shall not be considered valid unless the changes are reviewed and the recommendations of this report modified or verified in writing.

Thank you for the opportunity to work with you on this project. If you have any questions or need additional information, please let us know.

Sincerely yours,
GEOMAT Inc.

George A. Madrid, P.E.
President, Principal Engineer
9-21-11

Attachments



Analysis: 1

Multiple Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Critical (minimum)

Factor of Safety: 1.58

Edited: 21 Sep 2011 Processed: 21 Sep 2011

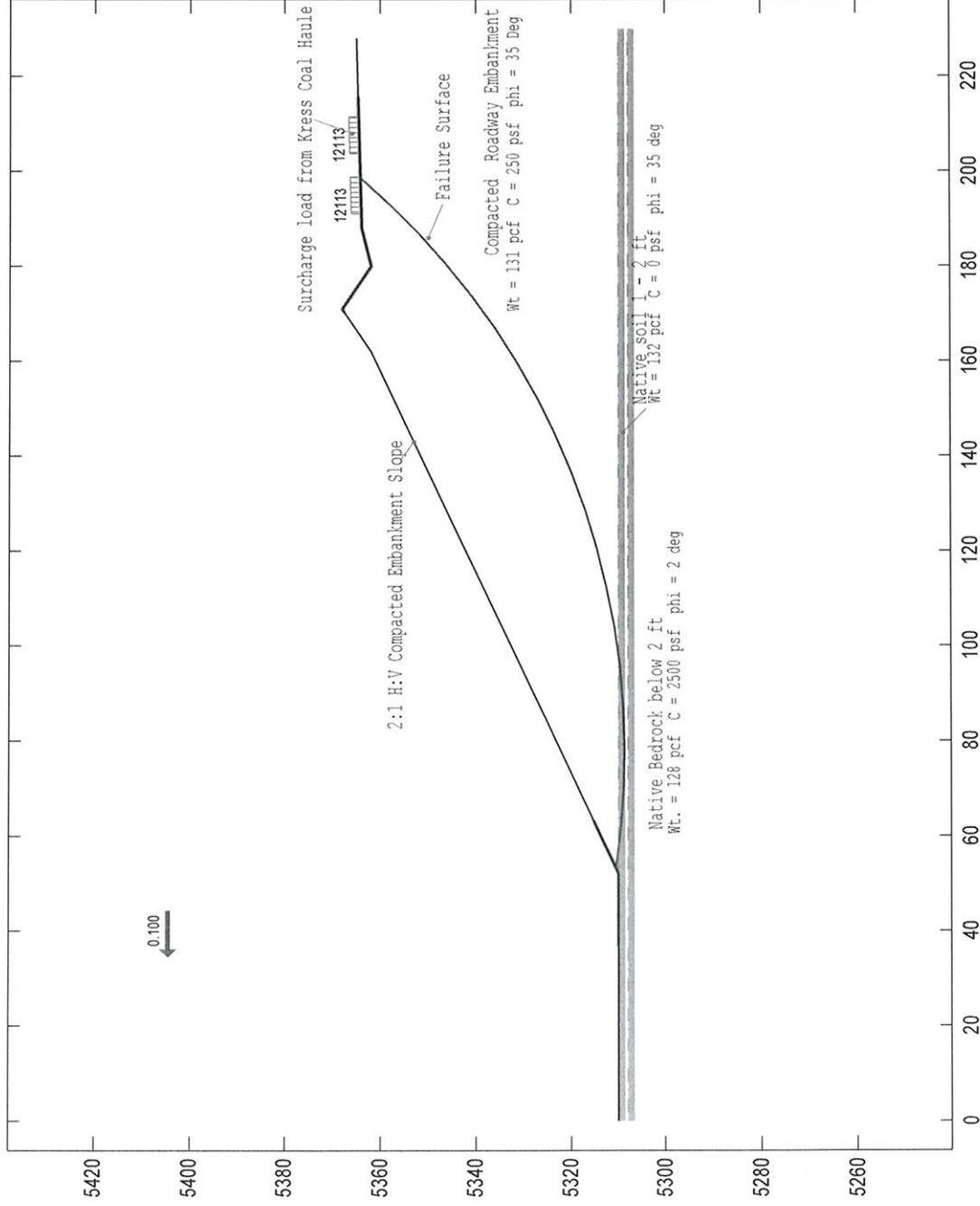


Project: BHP Haul Road

BHP Haul Road - Fill Slope w/o Vehicle Loads

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Analysis: 1

Multiple Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Critical (minimum)

Factor of Safety: 1.46

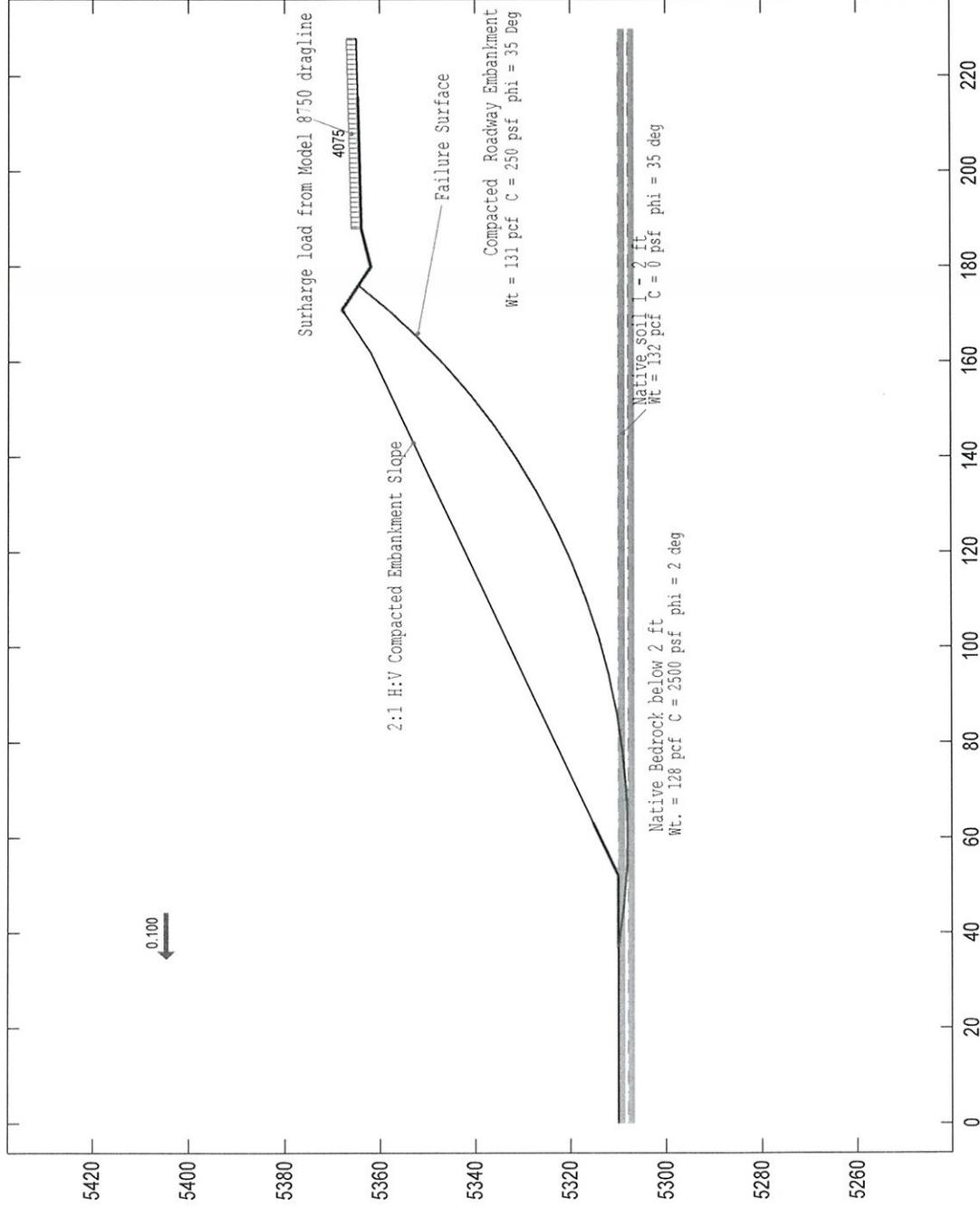
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Project: BHP Haul Road
BHP Haul Road - Fill Slope w/ Kress Truck

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Analysis: 1

Multiple Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Critical (minimum)

Factor of Safety: 1.58

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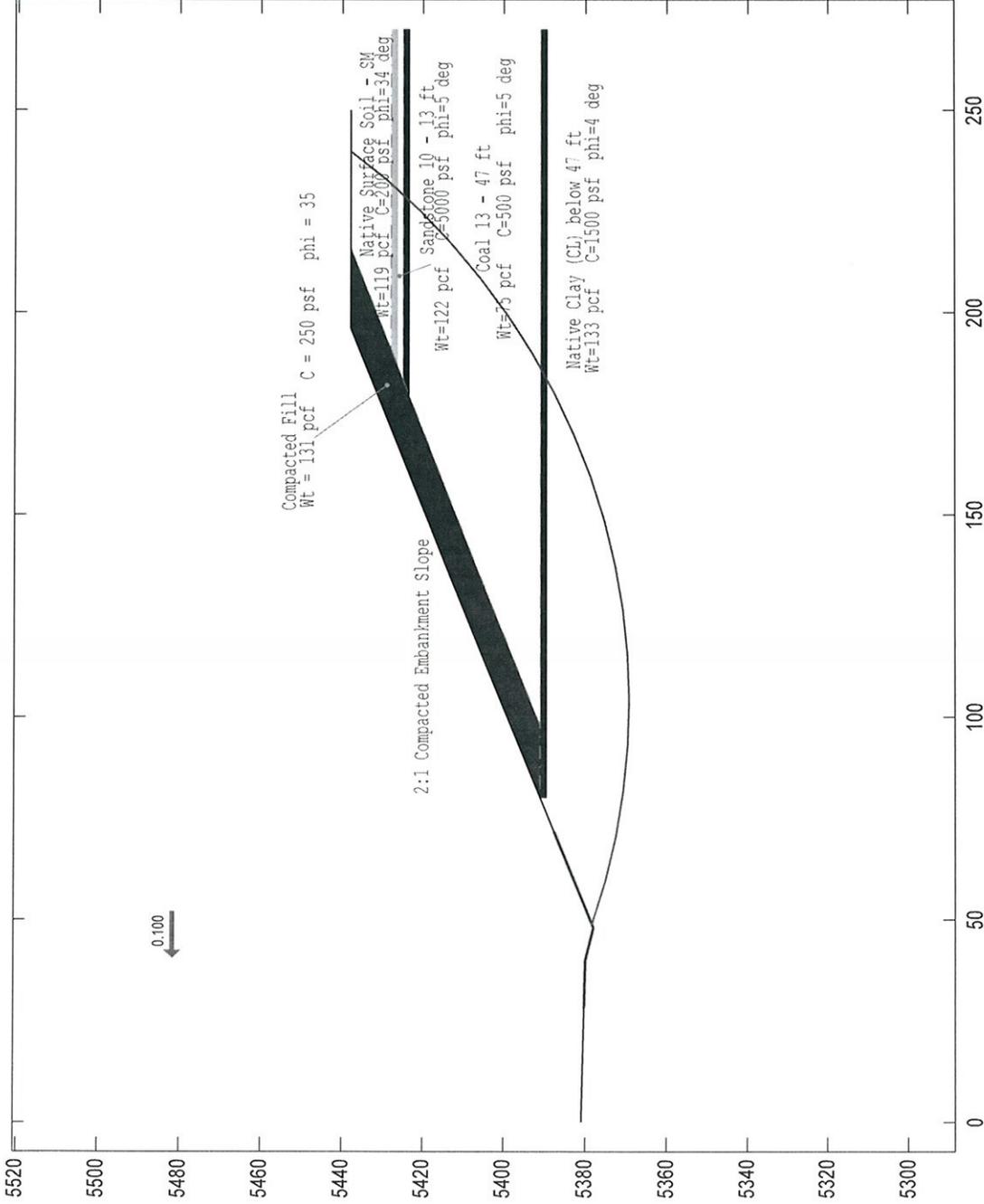


Project: BHP Haul Road

BHP Haul Road - Fill Slope w/ 8750 Dragline

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Analysis: 1

Multiple Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Critical (minimum)

Factor of Safety: 1.49

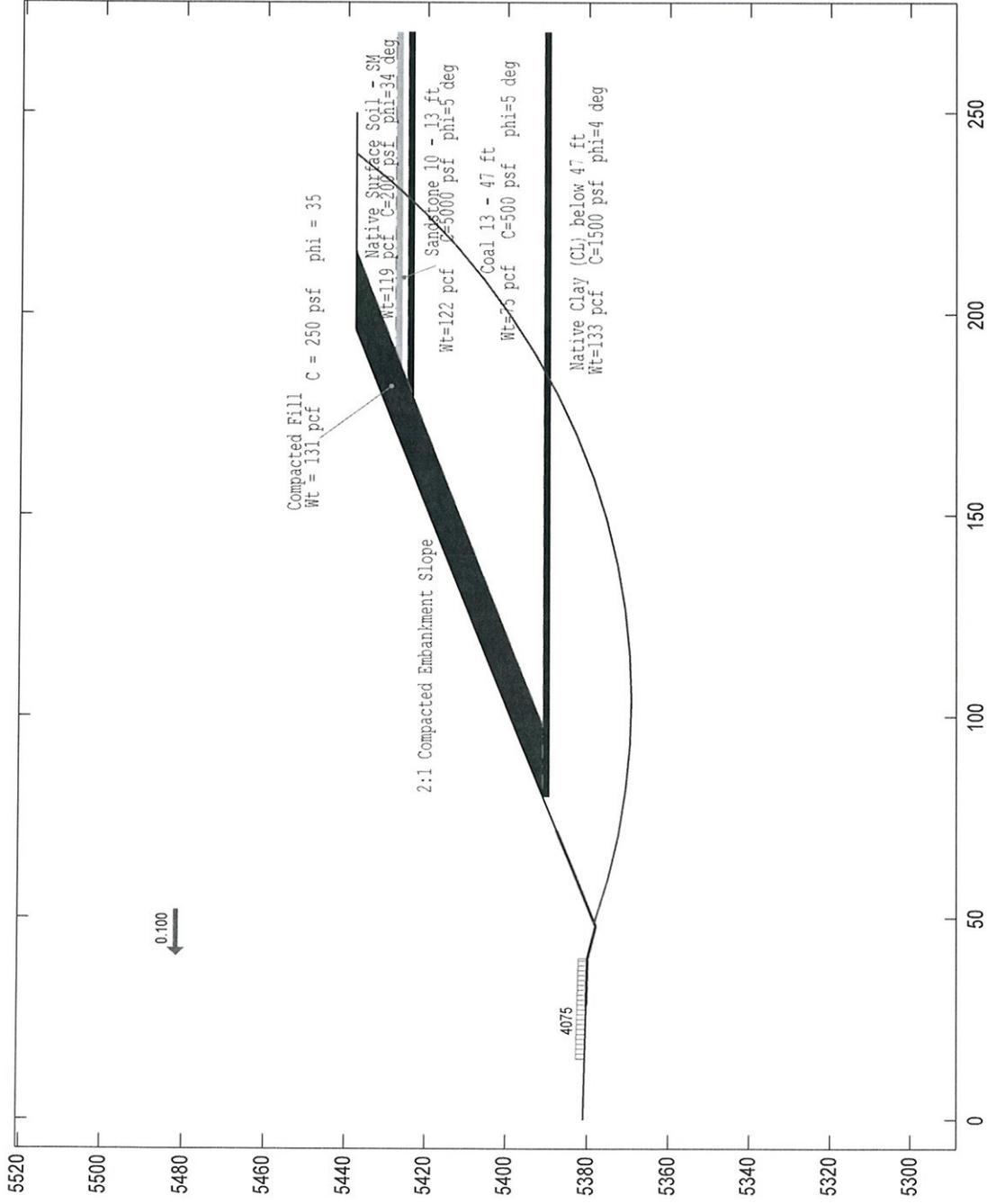
Edited: 21 Sep 2011 Processed: 21 Sep 2011



Project: BHP Haul Road Slope Analysis with Haul Truck Load
BHP Haul Road - Cut Slope w/o Vehicle Load

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Analysis: 1

Multiple Stability Analysis

Method: Bishop Simplified

Surface: Circular

Results

Critical (minimum)

Factor of Safety: 1.49

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Project: BHP Haul Road Slope Analysis with Haul Truck Load
BHP Haul Road - Cut Slope w/ Dragline at Toe

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