mcgehee engineering corp

December 19, 2013

Mr. J. Michael Harrison, PE
**ALABAMA SURFACE MINING COMMISSION**
P. O. Box 2390
Jasper, AL 35502-2390

RE: KODIAK MINING COMPANY, LLC
Coke Mine No. 1, P-3887, REVISION NO. 5

Dear Mr. Harrison:

I, Robert W. Usher, a qualified registered professional engineer, hereby certify that the information, cross-sections, data, maps, etc., contained in the design of Primary Road No. 2 is true and accurate to the best of my knowledge and belief. I also certify that this design is in accordance with current, prudent mining engineering practices, and meets or exceeds the applicable parts of 880-X-8I-.17, 880-X-10D-.65, and 880-X-10D-.66 pertaining to the construction, use, and/or maintenance of primary roads.

If you have any questions or need additional information, please do not hesitate to contact our office.

Sincerely,

**McGehee Engineering Corp.**

ALABAMA LICENSED PROFESSIONAL No. 15917 ENGINEER ROBERT W. USHER

Robert W. Usher, P.E.
AL Reg. No. 15917

Post Office Box 3431 • 450 19th Street West • Jasper, Alabama 35502-3431 • 205-221-0686 • Fax 205-221-7721 • staff@mcgehee.org

**KODIAK MINING COMPANY, LLC**

COKE MINE NO. 1 , P-3887

REVISION NO. 5

# DETAILED DESIGN FOR PRIMARY ROAD NO. 2

ATTACHMENT III-B-5 (a)

Prepared by:

**McGehee Engineering Corp.**
P. O. Box 3431
Jasper, Alabama 35502-3431
Telephone: (205) 221-0686
Fax: (205) 221-7721
Email: cw@mcgehee.org

# INTRODUCTION

Primary Road No. 2 is approximately 4330 feet in length. This roadway is to be constructed for the purpose of access from County Road 10 to the mine facility if County Road No. 270 is vacated and mined by an adjacent permit.

**TRAFFIC CONTROL SIGNS**

1. At the entrance of any primary road that accesses a public road, a stop sign shall be installed to stop traffic before exiting that primary road.
2. At the entrance of any primary road that accesses a public road, a speed limit sign, SPEED LIMIT 15 MPH, shall be installed.
3. At the exit of any primary road that tees into another road, a stop sign shall be installed to stop traffic before exiting that primary road.

**STABILITY ANALYSIS PROCEDURE**

Primary Road No. 2 has three areas where fill will exceed eight (8) feet. Slope stability of these areas was performed. See Stability Analysis at the end of this report for the results. All areas meet or exceed the requirements for road fills.

**DRAINAGE CONTROL STRUCTURES**

**DRAINAGE DITCHES**

Drainage ditches will be located as dictated by field conditions. All of the primary road drainage ditches have small drainage areas and anticipated peak runoffs of less than 3.0 C.F.S

One of the three (3) enclosed SEDCAD+ CHANNEL DESIGN TYPICAL ROAD DITCH will be more than adequate to safely pass the anticipated peak runoff from a 10-year, 6-hour precipitation event.

There are three options proposed for channel linings of the roadside ditches within these plans. See the three (3) SEDCAD+ CHANNEL DESIGN - TYPICAL ROAD DITCH cross-sections.

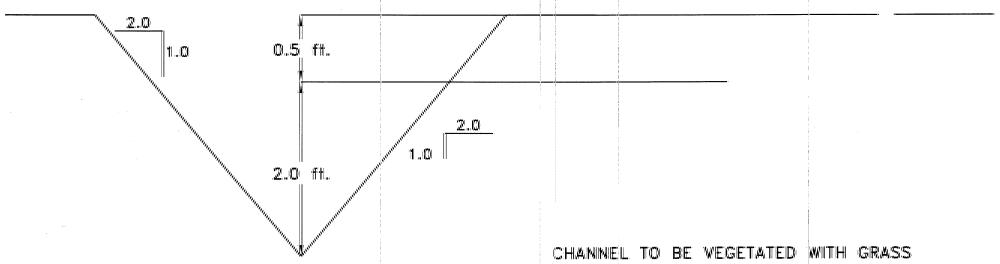
The following Channels (configuration and lining) may be used in areas where the grades are within the range specified below:

| **CHANNEL DESCRIPTION** | **CHANNEL GRADE** |
|---|---|
| Triangular - Grass lined | 0.5% - 10.0% |
| Triangular - Rip-rap lined | 10.0% - 15.0% |
| Trapezoidal - Grass lined | 10.0% - 15.0% |

When rip-rap channel lining is necessary, the rip-rap shall be Class II rip-rap.

All rip-rap will be limestone or sandstone material. When a riprap liner is necessary, the entire section of each ditch to be lined with riprap will be underlain with Mirafi 500X or equivalent filter blanket. The location of all drainage ditches with respect to the primary road will be as shown on the enclosed Typical Drainage Ditch X-Section.

# TYPICAL ROAD DITCH 0.5% -- 10.0%
# VEGETATED CHANNEL CROSS-SECTION




CHANNEL TO BE VEGETATED WITH GRASS MIXTURE, PREDOMINANTLY BERMUDA & FESCUE.

Design Discharge: 3.0 cfs
Limiting Velocity: 5.0 fps

| | 0.5 % Slope | | 10.0% Slope | |
|---|---|---|---|---|
| | STABILITY | CAPACITY | STABILITY | CAPACITY |
| Depth: | 1.22 ft. | 2.03 ft. | 0.65 ft. | 1.01 ft. |
| Depth w/ Freeboard: | 1.72 ft. | 2.53 ft. | 1.15ft. | 1.51 ft. |
| Top Width: | 4.89 ft. | 8.11 ft. | 2.59 ft | 4.03 ft. |
| Top Width w/Freeboard: | 6.89 ft. | 10.11 ft. | 4.59 ft. | 6.03 ft. |
| VELOCITY: | 1.00 fps | 0.36 fps | 3.57 fps | 1.48 fps |
| X-SECTION AREA: | 2.99 sq. ft. | 8.23 sq. ft. | 0.84 sq. ft. | 2.03 sq. ft. |
| HYDRAULIC RADIUS: | 0.546 | 0.907 | 0.29 | 0.451 |
| FROUDE NUMBER: | 0.23 | 0.06 | 1.11 | 0.37 |
| ROUGHNESS COEFFICIENT: | 0.0700 | 0.2706 | 0.0577 | 0.1873 |

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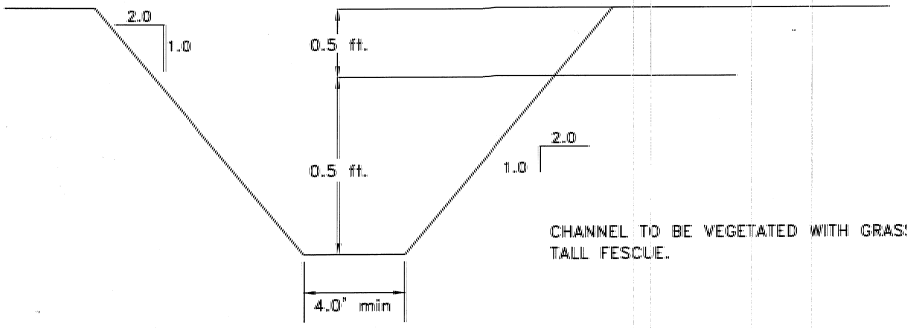
# TYPICAL ROAD DITCH 10.0% – 15.0%
# VEGETATED CHANNEL CROSS-SECTION




CHANNEL TO BE VEGETATED WITH GRASS TALL FESCUE.

Design Discharge: 3.0 cfs
Limiting Velocity: 5.0 fps

| | 10.0 % Slope | | 15.0% Slope | |
|---|---|---|---|---|
| | STABILITY | CAPACITY | STABILITY | CAPACITY |
| Depth: | 0.26 ft. | 0.51 ft. | 0.23 ft. | 0.45 ft. |
| Depth w/ Freeboard: | 0.76 ft. | 1.01 ft. | 0.73 ft. | 0.95 ft. |
| Top Width: | 5.04 ft. | 6.05 ft. | 4.92 ft | 5.80 ft. |
| Top Width w/Freeboard: | 7.04 ft. | 8.05 ft. | 6.92 ft. | 7.80 ft. |
| VELOCITY: | 2.54 fps | 1.16 fps | 2.92 fps | 1.36 fps |
| X-SECTION AREA: | 1.18 sq. ft. | 2.58 sq. ft. | 1.03 sq. ft. | 2.21 sq. ft. |
| HYDRAULIC RADIUS: | 0.228 | 0.410 | 0.204 | 0.367 |
| FROUDE NUMBER: | 0.93 | 0.31 | 1.13 | 0.39 |
| ROUGHNESS COEFFICIENT: | 0.0688 | 0.2233 | 0.0683 | 0.2180 |

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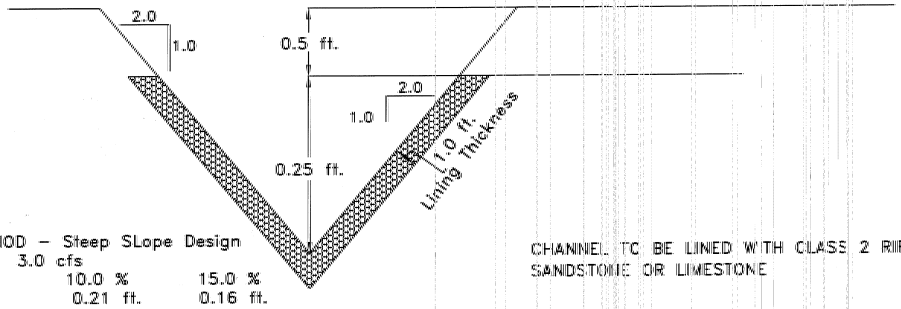
# TYPICAL ROAD DITCH 10.0% - 15.0%
# RIP-RAP CHANNEL CROSS-SECTION




SIMONS/OSM METHOD - Steep SLope Design
Design Discharge: 3.0 cfs

| | 10.0 % | 15.0 % |
|---|---|---|
| Depth: | 0.21 ft. | 0.16 ft. |
| Depth w/ Freeboard: | 0.71 ft. | 0.66 ft. |
| Top Width: | 0.82 ft. | 0.64 ft. |
| Top Width w/Freeboard: | 2.82 ft. | 10.11 ft. |
| VELOCITY: | ** | ** |
| X-SECTION AREA: | 0.08 sq. ft. | 0.05 sq. ft. |
| HYDRAULIC RADIUS: | 0.092 | 0.072 |
| FROUDE NUMBER: | ** | ** |
| MANNING'S N: | ** | ** |
| Dmin: | 4.00 in. | 4.00 in. |
| D50: | 12.00 in. | 12.00 in. |
| Dmax: | 15.00 in. | 15.00 in. |

Velocity and Manning's n calculations may not apply for this method.

CHANNEL TO BE LINED WITH CLASS 2 RIP-RAP SANDSTONE OR LIMESTONE

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## CULVERTS

There are five culverts proposed for Primary Road No. 2. The pertinent information for each culvert is listed in the drawings attached in this plan. Sections of the road will parallel an abandoned railroad grade. At 20+00 (culvert C-4) a 60 inch concrete pipe is currently located in the old railroad fill. Plans are to install a 60 inch CMP in the proposed fill of the road at this section. The railroad culvert and fill will govern the flow rate through the proposed pipe.

## POST MINING LAND USE

Primary Road No. 2 is proposed to be permanent and will be left for land owner access.

## INDEX OF DRAWINGS AND ATTACHMENTS


**Primary Road No. 2 Plan View**

**Primary Road No. 2 Profile View**

**Primary Road No. 2 Culvert Details**

**SedCad Runs for Culverts**

**Typical Primary Road**

# DESIGN, CONSTRUCTION, MAINTENANCE, AND RECLAMATION SPECIFICATIONS FOR PRIMARY ROADS

## 1. LOCATION

A) Primary roads will be located on ridges or high areas or on the most stable available slopes so as to control and prevent erosion, siltation, flooding, and adverse impacts to fish and wildlife, or their habitat and related environmental values, to the extent possible.

B) No part of any primary road will be located in the channel of an intermittent or perennial stream without written approval from the Regulatory Authority, in accordance with 880-X-10D-.12 through 880-X-10D-.14 and 880-X-10D-.26.

C) If at all possible, all primary roads will be located upstream of sediment basins to prevent, control and minimize additional contributions of suspended solids to stream flow or runoff outside the permit area, the violation of applicable State or Federal water quality standards, seriously altering the normal flow of water in stream-beds or drainage channels, and damage to all public or private property.

D) In instances where it is not possible to locate primary roads in the above manner, sediment control will be achieved by the use of silt fences, rock check dams, hay bale berms, etc.

## 2. DESIGN REQUIREMENTS

A) Primary roads will be designed by or under the direct supervision of a qualified registered Professional Engineer experienced in the design and construction of roads, in accordance with the ASMC rules and regulations, and current, prudent engineering practices. No Primary Road grade will be steeper than seventeen (17) percent.

B) All primary roadway embankments will be designed and constructed to be stable under normal construction and operating conditions, with a minimum static safety factor of 1.3.

C) All primary roads will be designed, constructed, reconstructed and maintained to have adequate drainage control structures to safely pass the peak runoff anticipated from a 10 year, 6 hour precipitation event.

## 3. CONSTRUCTION REQUIREMENTS

A) The foundation area of the roadbed will be cleared and grubbed of all organic material and the topsoil will be removed. The disturbed area will be kept to the minimum necessary to accommodate the roadbed and/or associated drainage ditch construction.

B) The road construction material will be suitable subgrade material, free of sod, roots, stumps, etc., and will not contain rocks which exceed twelve (12) inches in diameter. The road construction material will be placed in layers (12 inch maximum thickness) and compacted to ninety five (95%) percent of the standard proctor density, as set forth in ASTM.

C) The minimum top width of primary roads will under no circumstance be less than eighteen (18) feet and will be of maximum width necessary to facilitate the largest equipment using the road.

D) All slopes (cut and fill) will be no steeper than 2 horizontal to 1 vertical, unless specified otherwise in the detailed design.

E) Roadbeds will be cut into consolidated, non-erodible material or will be surfaced with durable, non-toxic, non-acid forming material. In most instances, durable sandstone overburden material from the mine site will be used for surfacing material. In instances where durable sandstone overburden material from the site is not available or suitable, then durable, non-toxic, non-acid forming material, such as chert, crushed limestone, redrock, and/or crushed sandstone will be hauled in from off site, placed and compacted on the roadbed surface a minimum depth of four (4) inches.

F) Primary roads will be constructed with grades as shown on the Detailed Primary Road Design Plans. No Primary Road grade will be steeper than seventeen (17) percent.

## 4. DRAINAGE AND SEDIMENT CONTROL REQUIREMENTS

A) Primary roads will be constructed, reconstructed, and maintained to have adequate drainage control, using structures such as, but not limited to bridges, culverts, drainage pipes, ditches, cross drains, and ditch relief drains designed to safely pass the peak runoff anticipated from a 10 year, 6 hour precipitation event. All drainage control structures will be designed and constructed in such a manner whereas, to allow a free and operating conditions to prevent, control, and minimize erosion at the inlets and outlets.

B) Culverts and drainage pipes will be designed and installed to provide adequate support for the load of the largest equipment using the road. For design purposes, "H-20" (live load + impact) was used. All culverts or drainage pipes with diameters of forty-eight (48) inches or less will be covered with a minimum of one (1) foot and the maximum cover will not exceed fifty-seven (57) feet of desirable compacted material. All culverts or

drainage pipes with diameters greater than forty- eight (48) inches will be covered with a minimum of two (2) feet and the maximum cover will not exceed forty-one (41) feet of desirable compacted material. See Detailed Primary Road Design Plans for actual depth of material proposed above each culvert or drainage pipe.

C) Culverts and drainage pipes will be designed and installed to allow adequate freeboard to prevent overtopping of the embankment.

D) Drainage ditches, cross drains, and ditch relief drains will be constructed and maintained to prevent uncontrolled surface drainage over the road surface and roadway embankment.

E) Drainage ditches will be constructed with no sustained grades greater than five (5%) percent, unless unavoidable. If ditches must be constructed with grades in excess of five (5%) percent, drainage ditches will be lined as shown on the Primary Road Detailed Design Plans.

F) Sediment control will be achieved by the use of silt fences, rock check dams, hay bale berms, etc. in strategic locations, to prevent excessive siltation to the receiving streams.

G) Upon completion of construction of all roads, the side slopes of the roadway cut and fill sections, including all borrow areas formed in the construction, areas used for disposal of excess material, ditches, etc. will be seeded with a mixture of perennial and annual grasses, fertilized and mulched to prevent erosion and ensure restabilization. Grass mixtures will include, but not be limited to, fescue, bermuda, rye grass, browntop millet, clover and sericea.

## 5. INSPECTION AND MAINTENANCE REQUIREMENTS

A) Routine inspections and maintenance (such as regrading, resurfacing, maintenance of sediment control structures, spot replanting, and dust control) will be conducted regularly during the life of each road to assure that each road continually meets design and performance standards.

B) Dust control will be achieved by the periodic application of water, chemical binders and/or other dust suppressants.

C) Any road damaged by a catastrophic event, such as a flood, or earthquake, will be repaired as soon as it is practicable after the damage has occurred.

## 6. CERTIFICATION REQUIREMENTS

A) Primary roads will be designed by or under the direct supervision of a qualified registered Professional Engineer experienced in the design and construction of roads, in accordance

with the ASMC rules and regulations, and current, prudent engineering practices. Each design will be certified by a registered Professional Engineer as being designed in accordance with the Regulations of the Alabama Surface Mining Commission, Chapter 880-X-10.

B) Upon the completion of the construction of each section of the primary road, as set forth in the detailed design plans, the construction will be certified by a registered Professional Engineer, to the Alabama Surface Mining Commission, as being constructed in accordance with the approved detailed design plans.

C) In the event that a primary road is mined through in the mining process and must be reconstructed, the newly constructed primary road will be reconstructed to the minimum design criteria within the detailed design plans and the construction will be certified by a registered Professional Engineer, to the Alabama Surface Mining Commission, as being constructed in accordance with the approved detailed design plans.

## 7. REMOVAL AND RECLAMATION REQUIREMENTS

A) All primary roads which are not mined through and remain after the completion of mining may be left as permanent roads for landowner access, if there is no opposition by said landowner.

B) All primary roads which are not mined through and remain after the completion of mining which are not to be retained as permanent for landowner access will be removed and reclaimed in accordance with the approved grading and reclamation plans as soon as practicable after it is no longer needed for mining and reclamation purposes. This removal and reclamation will include:

1. Closing the road to traffic;

2. Removing all bridges, culverts, drainage pipes, and other drainage control structures, unless otherwise approved as part of the post mining land use;

3. Removing and/or otherwise disposing of road surfacing materials, that are not compatible with the post mining land use and revegetation requirements, onsite or removed and stored for re-use;

4. Reshaping and regrading cut and fill slopes as necessary to be compatible with the post mining land use and to compliment the natural drainage pattern of the surrounding terrain;

5. Protecting the natural drainage patterns by installing dikes or cross drains as necessary to control surface runoff and erosion;

6. Scarifying or ripping the roadbed, replacing topsoil or substitute material, and revegetating the entire disturbed area in accordance with the approved reclamation plan.

## 8. TYPICAL ROADBED CONFIGURATION

A) See attached **typical primary road drawing**, cross-sections, etc., for an illustration of the typical roadbed configurations.

## STABILITY ANALYSIS

Stability analyses were performed at Stations 10+50, 20+00 and 31+50. Several samples of the onsite soil materials have been taken in association with design of the sediment basins in the area.

All of the material samples classified as either SC or SM-SC. The more conservative SC (coarse grained clayey sand) classification will be used for the embankment material in the stability analysis.

| SOIL CLASSIFICATION | COHESION(PSF) | PHI ANGLE (º) | UNIT WT.(PCF) |
|---|---|---|---|
| SC | 100 | 27.92 | 133.52 |

## STABILITY ANALYSIS RESULTS

| LOCATION | STATIC SAFETY FACTOR |
|---|---|
| **Primary Road No. 2 Fill @ Station 10+50** | **1.78** |
| **Primary Road No. 2 Fill @ Station 20+00** | **1.96** |
| **Primary Road No. 2 Fill @ Station 31+50** | **2.73** |

**REAME**
**(Rotational Equilibrium Analysis of Multilayered Embankments)**

REAME (ROTATIONAL EQUILIBRIUM ANALYSIS OF MULTILAYERED EMBANKMENTS)
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UNIVERSITY OF KENTUCKY, LEXINGTON, KY 40506

INPUT FILE NAME -fill1050

TITLE -Kodiak Mining P-3887 R-5 Primary Road 2 Fill 10+50

NO. OF STATIC AND SEISMIC CASES- 1

NO. OF NONCIRCULAR SLIP SURFACES= 0

CASE NO. 1 SEISMIC COEFFICIENT= 0

NO. OF BOUNDARY LINES= 3

NO. OF POINTS ON BOUNDARY LINE 1 = 2
1 X COORD.= 59 Y COORD.= 460
2 X COORD.= 190 Y COORD.= 452

NO. OF POINTS ON BOUNDARY LINE 2 = 2
1 X COORD.= 59 Y COORD.= 464
2 X COORD.= 153 Y COORD.= 458

NO. OF POINTS ON BOUNDARY LINE 3 = 5
1 X COORD.= 59 Y COORD.= 464
2 X COORD.= 80 Y COORD.= 474
3 X COORD.= 120 Y COORD.= 474
4 X COORD.= 153 Y COORD.= 458
5 X COORD.= 190 Y COORD.= 456

LINE NO. AND SLOPE OF EACH SEGMENT ARE:
1 -0.061
2 -0.064
3 +0.476 +0.000 -0.485 -0.054

MIN. DEPTH OF TALLEST SLICE= 0
NO. OF RADIUS CONTROL ZONES= 1

RADIUS DECREMENT FOR ZONE 1 = 0
NO. OF CIRCLES FOR ZONE 1 = 5
ID NO. FOR FIRST CIRCLE FOR ZONE 1 = 1
NO. OF BOTTOM LINES FOR ZONE 1 = 1

FOR ZONE 1 LINE SEQUENCE 1
LINE NO.= 1 BEG. NO.= 1 END NO.= 2
UNIT WEIGHT OF WATER= 62.4

| SOIL NO. | COHESION | FRIC. ANGLE | UNIT WEIGHT |
|---|---|---|---|
| 1 | 100 | 27.92 | 133.52 |
| 2 | 100 | 27.92 | 133.52 |

NO SEEPAGE
USE GRID
NO. OF SLICES= 10
NO. OF ADD. RADII= 3
ANALYSIS BY SIMPLIFIED BISHOP METHOD (MTHD=2)
NUMBER OF FORCES (NFO)= 0
SOFT SOIL NUMBER (SSN)= 0
INPUT COORD. OF GRID POINTS 1,2,AND 3

POINT 1 X COORD.= 140 Y COORD.= 505
POINT 2 X COORD.= 140 Y COORD.= 480
POINT 3 X COORD.= 160 Y COORD.= 480

X INCREMENT= 0 Y INCREMENT= 0
NO. OF DIVISIONS BETWEEN POINTS 1 AND 2= 5
NO. OF DIVISIONS BETWEEN POINTS 2 AND 3= 4
ONLY F. S. AT EACH CENTER WILL BE PRINTED

SLICES WILL BE SUBDIVIDED

FACTORS OF SAFETY BASED ON GRID

IN THE FOLLOWING TABLE WARNING INDICATES HOW MANY TIMES THE
MAXIMUM RADIUS IS LIMITED BY THE END POINTS OF GROUND LINES

| CENTER X COORDINATE | CENTER Y COORDINATE | NO. OF TOTAL | CIRCLE CRITIC. | LOWEST RADIUS | WARNING F.S. |
|---|---|---|---|---|---|
| 140 | 505 | 11 | 9 | 43.898 | 2.125 | 0 |
| 140 | 500 | 11 | 10 | 38.492 | 2.047 | 0 |
| 140 | 495 | 11 | 10 | 33.747 | 1.976 | 0 |
| 140 | 490 | 11 | 10 | 29.002 | 1.932 | 0 |
| 140 | 485 | 11 | 3 | 25.384 | 1.928 | 0 |
| 140 | 480 | 11 | 8 | 21.129 | 2.006 | 0 |
| 145 | 505 | 11 | 3 | 45.616 | 1.919 | 0 |
| 145 | 500 | 11 | 3 | 40.821 | 1.867 | 0 |
| 145 | 495 | 11 | 8 | 36.546 | 1.828 | 0 |
| 145 | 490 | 11 | 10 | 32.222 | 1.816 | 0 |
| 145 | 485 | 11 | 9 | 27.848 | 1.853 | 0 |
| 145 | 480 | 11 | 2 | 23.425 | 1.942 | 0 |
| 150 | 505 | 11 | 8 | 47.145 | 1.796 | 0 |
| 150 | 500 | 11 | 3 | 41.877 | 1.784 | 0 |
| 150 | 495 | 11 | 3 | 37.083 | 1.810 | 0 |
| 150 | 490 | 11 | 3 | 32.289 | 1.877 | 0 |
| 150 | 485 | 11 | 3 | 27.495 | 1.962 | 0 |
| 150 | 480 | 11 | 3 | 22.701 | 2.069 | 0 |
| 155 | 505 | 11 | 10 | 46.966 | 1.897 | 0 |
| 155 | 500 | 11 | 11 | 41.865 | 2.027 | 0 |
| 155 | 495 | 11 | 10 | 38.800 | 2.156 | 0 |
| 155 | 490 | 11 | 9 | 34.264 | 2.302 | 0 |
| 155 | 485 | 11 | 8 | 29.960 | 2.485 | 0 |
| 155 | 480 | 11 | 7 | 25.300 | 2.735 | 0 |
| 160 | 505 | 5 | 1 | 51.073 | 2.437 | 0 |
| 160 | 500 | 5 | 1 | 46.082 | 2.616 | 0 |
| 160 | 495 | 5 | 1 | 41.091 | 2.859 | 0 |
| 160 | 490 | 5 | 1 | 36.101 | 3.190 | 0 |
| 160 | 485 | 5 | 1 | 31.110 | 3.661 | 0 |
| 160 | 480 | 5 | 1 | 26.119 | 4.390 | 0 |

AT POINT ( 150 500 ) RADIUS 41.877

THE MINIMUM FACTOR OF SAFETY IS 1.784

SUMMARY OF SLICE INFORMATION FOR MOST CRITICAL SLIP SURFACE

| SL. NO. | SOIL NO. | SLICE WIDTH | SLICE HEIGHT | WATER HEIGHT | SLICE SINE | TOTAL WEIGHT | EFFEC. WEIGHT | RESIS. MOMENT | DRIVING MOMENT |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 2.828 | 1.692 | 0.000 | -.750 | 0.639E+03 | 0.639E+03 | 0.273E+05 | 0.201E+05 |
| 2 | 2 | 0.713 | 3.406 | 0.000 | -.708 | 0.324E+03 | 0.324E+03 | 0.931E+04 | 0.961E+04 |
| 3 | 2 | 3.541 | 4.363 | 0.000 | -.657 | 0.206E+04 | 0.206E+04 | 0.542E+05 | 0.568E+05 |
| 4 | 2 | 3.541 | 5.413 | 0.000 | -.573 | 0.256E+04 | 0.256E+04 | 0.647E+05 | 0.614E+05 |
| 5 | 2 | 3.541 | 5.915 | 0.000 | -.488 | 0.280E+04 | 0.280E+04 | 0.712E+05 | 0.571E+05 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6 | 2 | 3.541 | 5.964 | 0.000 | -.403 | 0.282E+04 | 0.282E+04 | 0.735E+05 | 0.476E+05 |
| 7 | 2 | 3.541 | 5.620 | 0.000 | -.319 | 0.266E+04 | 0.266E+04 | 0.715E+05 | 0.355E+05 |
| 8 | 2 | 3.541 | 4.923 | 0.000 | -.234 | 0.233E+04 | 0.233E+04 | 0.655E+05 | 0.228E+05 |
| 9 | 2 | 1.811 | 4.179 | 0.000 | -.170 | 0.101E+04 | 0.101E+04 | 0.298E+05 | 0.721E+04 |
| 10 | 1 | 1.730 | 3.588 | 0.000 | -.128 | 0.829E+03 | 0.829E+03 | 0.255E+05 | 0.445E+04 |
| 11 | 1 | 3.541 | 2.566 | 0.000 | -.065 | 0.121E+04 | 0.121E+04 | 0.417E+05 | 0.331E+04 |
| 12 | 1 | 1.874 | 1.342 | 0.000 | -.001 | 0.336E+03 | 0.336E+03 | 0.153E+05 | 0.753E+01 |
| 13 | 2 | 1.667 | 0.447 | 0.000 | 0.042 | 0.996E+02 | 0.996E+02 | 0.920E+04 | -.174E+03 |
| | | | | | SUM | 0.559E+06 | 0.326E+06 | | |

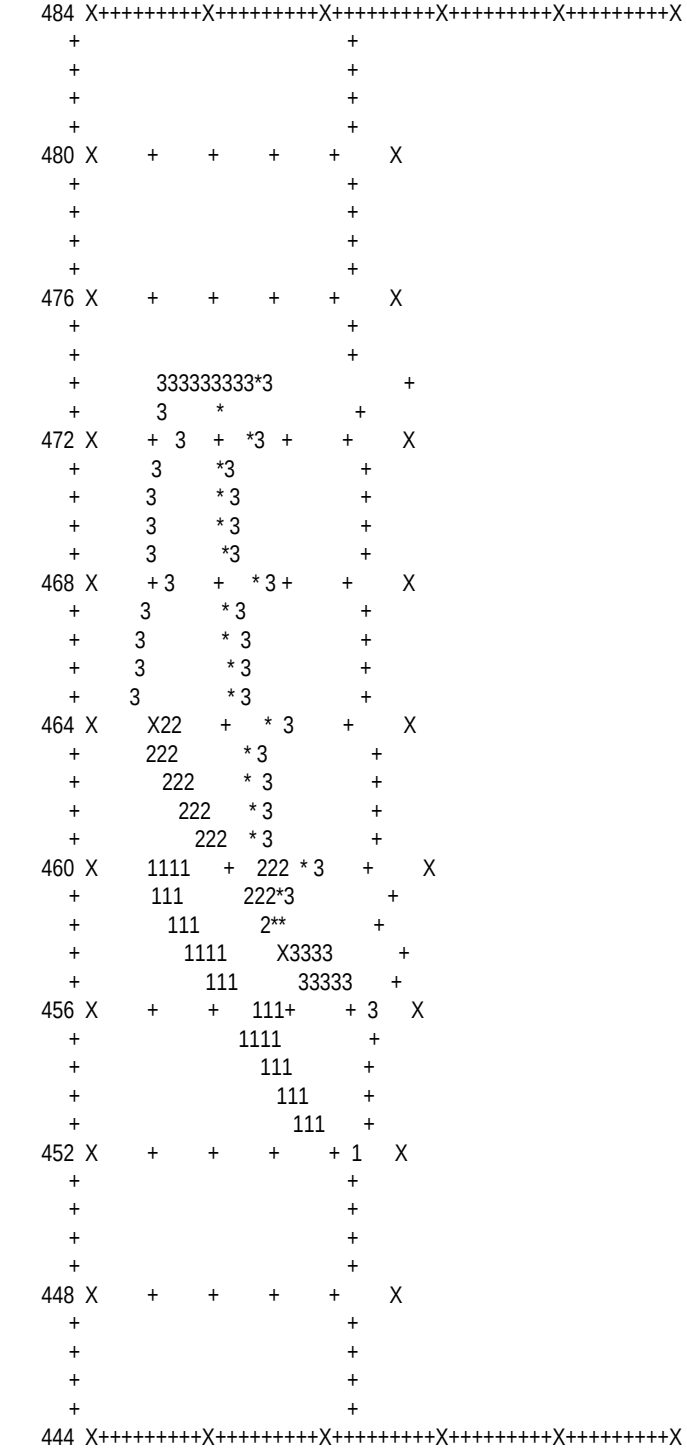
AT CENTER ( 150.000, 500.000) WITH RADIUS 41.877 AND SEISMIC COEFF. 0.00
FACTOR OF SAFETY BY NORMAL METHOD IS 1.715
FACTOR OF SAFETY BY SIMPLIFIED BISHOP METHOD IS 1.784

Kodiak Mining P-3887 R-5 Primary Road 2 Fill 10+50

CRITICAL FAILURE SURFACE IS INDICATED BY *********

CENTER AT POINT ( 150 500 ) WITH RADIUS OF 41.877

FACTOR OF SAFETY IS 1.784 BY SIMPLIFIED BISHOP METHOD



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UNIVERSITY OF KENTUCKY, LEXINGTON, KY 40506

INPUT FILE NAME -fill2000

TITLE -Kodiak Mining P-3887 R-5 Primary Road 2 Fill at 20+00

NO. OF STATIC AND SEISMIC CASES- 1

NO. OF NONCIRCULAR SLIP SURFACES= 0

CASE NO. 1 SEISMIC COEFFICIENT= 0

NO. OF BOUNDARY LINES= 3

NO. OF POINTS ON BOUNDARY LINE 1 = 5
1 X COORD.= 0 Y COORD.= 416
2 X COORD.= 32 Y COORD.= 416
3 X COORD.= 72 Y COORD.= 416
4 X COORD.= 156 Y COORD.= 421
5 X COORD.= 170 Y COORD.= 424

NO. OF POINTS ON BOUNDARY LINE 2 = 3
1 X COORD.= 32 Y COORD.= 420
2 X COORD.= 72 Y COORD.= 420
3 X COORD.= 156 Y COORD.= 425

NO. OF POINTS ON BOUNDARY LINE 3 = 6
1 X COORD.= 0 Y COORD.= 420
2 X COORD.= 32 Y COORD.= 420
3 X COORD.= 80 Y COORD.= 440
4 X COORD.= 120 Y COORD.= 440
5 X COORD.= 156 Y COORD.= 425
6 X COORD.= 170 Y COORD.= 428

LINE NO. AND SLOPE OF EACH SEGMENT ARE:
1 +0.000 +0.000 +0.060 +0.214
2 +0.000 +0.060
3 +0.000 +0.417 +0.000 -0.417 +0.214

MIN. DEPTH OF TALLEST SLICE= 0
NO. OF RADIUS CONTROL ZONES= 1

RADIUS DECREMENT FOR ZONE 1 = 0
NO. OF CIRCLES FOR ZONE 1 = 5
ID NO. FOR FIRST CIRCLE FOR ZONE 1 = 1
NO. OF BOTTOM LINES FOR ZONE 1 = 1

FOR ZONE 1 LINE SEQUENCE 1
LINE NO.= 1 BEG. NO.= 1 END NO.= 5
UNIT WEIGHT OF WATER= 62.4

SOIL NO. COHESION FRIC. ANGLE UNIT WEIGHT

| | | | |
|---|---|---|---|
| 1 | 100 | 27.92 | 133.52 |
| 2 | 100 | 27.92 | 133.52 |

NO SEEPAGE
USE GRID
NO. OF SLICES= 10
NO. OF ADD. RADII= 3
ANALYSIS BY SIMPLIFIED BISHOP METHOD (MTHD=2)
NUMBER OF FORCES (NFO)= 0
SOFT SOIL NUMBER (SSN)= 0
INPUT COORD. OF GRID POINTS 1,2,AND 3

POINT 1 X COORD.= 0 Y COORD.= 545
POINT 2 X COORD.= 0 Y COORD.= 420
POINT 3 X COORD.= 100 Y COORD.= 420

X INCREMENT= 12 Y INCREMENT= 12
NO. OF DIVISIONS BETWEEN POINTS 1 AND 2= 5
NO. OF DIVISIONS BETWEEN POINTS 2 AND 3= 4
ONLY F. S. AT EACH CENTER WILL BE PRINTED
SLICES WILL BE SUBDIVIDED

AUTOMATIC SEARCH WILL FOLLOW AFTER GRID

FACTORS OF SAFETY BASED ON GRID

IN THE FOLLOWING TABLE WARNING INDICATES HOW MANY TIMES THE
MAXIMUM RADIUS IS LIMITED BY THE END POINTS OF GROUND LINES

| CENTER X COORDINATE | CENTER Y COORDINATE | NO. OF TOTAL | CIRCLE CRITIC. | RADIUS | LOWEST F.S. | WARNING |
|---|---|---|---|---|---|---|
| 0 | 545 | 1 | 1 | 125.000 | 1000.000 | 1 |
| 0 | 520 | 1 | 1 | 100.000 | 1000.000 | 1 |
| 0 | 495 | 1 | 1 | 75.000 | 1000.000 | 1 |
| 0 | 470 | 1 | 1 | 50.000 | 1000.000 | 1 |
| 0 | 445 | 1 | 1 | 25.000 | 1000.000 | 1 |
| 0 | 420 | 1 | 1 | 0.000 | 1000.000 | 1 |
| 25 | 545 | 8 | 3 | 123.716 | 2.106 | 1 |
| 25 | 520 | 11 | 3 | 99.847 | 1.991 | 1 |
| 25 | 495 | 7 | 4 | 74.754 | 2.375 | 0 |
| 25 | 470 | 5 | 1 | 54.000 | 3.347 | 0 |
| 25 | 445 | 4 | 1 | 29.000 | 6.333 | 0 |
| 25 | 420 | 1 | 1 | 4.000 | 1000.000 | 0 |
| 50 | 545 | 11 | 2 | 125.040 | 2.795 | 0 |
| 50 | 520 | 11 | 8 | 97.504 | 2.538 | 0 |
| 50 | 495 | 11 | 10 | 70.654 | 2.245 | 0 |
| 50 | 470 | 11 | 10 | 46.615 | 2.009 | 0 |
| 50 | 445 | 11 | 3 | 23.862 | 2.231 | 0 |
| 50 | 420 | 1 | 0 | 4.000 | 1000.000 | 0 |
| 75 | 545 | 11 | 8 | 120.378 | 5.169 | 0 |
| 75 | 520 | 11 | 7 | 96.593 | 4.652 | 0 |
| 75 | 495 | 11 | 9 | 72.818 | 4.222 | 0 |
| 75 | 470 | 11 | 3 | 44.401 | 3.992 | 0 |
| 75 | 445 | 8 | 6 | 9.873 | 3.459 | 0 |
| 75 | 420 | 1 | 0 | 3.815 | 1000.000 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 100 | 545 | 1 | 1 | 127.108 | 1000.000 | 0 |
| 100 | 520 | 1 | 1 | 102.153 | 1000.000 | 0 |
| 100 | 495 | 1 | 1 | 77.197 | 1000.000 | 0 |
| 100 | 470 | 1 | 1 | 52.241 | 1000.000 | 0 |
| 100 | 445 | 1 | 1 | 27.285 | 1000.000 | 0 |
| 100 | 420 | 1 | 0 | 2.329 | 1000.000 | 0 |

AT POINT ( 25 520 ) RADIUS 99.847

THE MINIMUM FACTOR OF SAFETY IS 1.991

FACTORS OF SAFETY BASED ON SEARCH

IN THE FOLLOWING TABLE WARNING INDICATES HOW MANY TIMES THE
MAXIMUM RADIUS IS LIMITED BY THE END POINTS OF GROUND LINES

| CENTER X COORDINATE | CENTER Y COORDINATE | NO. OF CIRCLE TOTAL | CRITIC. | LOWEST RADIUS | WARNING F.S. |
|---|---|---|---|---|---|
| 25 | 520 | 11 | 3 | 99.847 | 1.991 | 1 |
| 37 | 520 | 11 | 7 | 99.915 | 2.099 | 0 |
| 13 | 520 | 1 | 1 | 100.841 | 1000.000 | 1 |
| 25 | 532 | 9 | 3 | 111.285 | 2.034 | 1 |
| 25 | 508 | 8 | 3 | 88.459 | 2.248 | 1 |
| 28 | 520 | 11 | 3 | 99.846 | 1.966 | 1 |
| 31 | 520 | 11 | 3 | 99.477 | 1.993 | 0 |
| 28 | 523 | 11 | 3 | 102.689 | 1.983 | 1 |
| 28 | 517 | 5 | 5 | 97.501 | 2.077 | 1 |

AT POINT ( 28 520 ) RADIUS 99.846

THE MINIMUM FACTOR OF SAFETY IS 1.966

SUMMARY OF SLICE INFORMATION FOR MOST CRITICAL SLIP SURFACE

| SL. NO. | SOIL NO. | SLICE WIDTH | SLICE HEIGHT | WATER HEIGHT | SLICE SINE | TOTAL WEIGHT | EFFEC. WEIGHT | RESIS. MOMENT | DRIVING MOMENT |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 5.512 | 0.982 | 0.000 | 0.074 | 0.723E+03 | 0.723E+03 | 0.933E+05 | 0.534E+04 |
| 2 | 2 | 5.512 | 2.716 | 0.000 | 0.129 | 0.200E+04 | 0.200E+04 | 0.160E+06 | 0.258E+05 |
| 3 | 2 | 5.512 | 4.137 | 0.000 | 0.184 | 0.304E+04 | 0.304E+04 | 0.214E+06 | 0.560E+05 |
| 4 | 2 | 5.512 | 5.238 | 0.000 | 0.240 | 0.385E+04 | 0.385E+04 | 0.255E+06 | 0.922E+05 |
| 5 | 2 | 5.512 | 6.006 | 0.000 | 0.295 | 0.442E+04 | 0.442E+04 | 0.281E+06 | 0.130E+06 |
| 6 | 2 | 5.512 | 6.425 | 0.000 | 0.350 | 0.473E+04 | 0.473E+04 | 0.293E+06 | 0.165E+06 |
| 7 | 2 | 5.512 | 6.473 | 0.000 | 0.405 | 0.476E+04 | 0.476E+04 | 0.291E+06 | 0.193E+06 |
| 8 | 2 | 5.512 | 6.122 | 0.000 | 0.460 | 0.451E+04 | 0.451E+04 | 0.274E+06 | 0.207E+06 |
| 9 | 2 | 3.280 | 5.532 | 0.000 | 0.504 | 0.242E+04 | 0.242E+04 | 0.149E+06 | 0.122E+06 |
| 10 | 2 | 2.231 | 4.546 | 0.000 | 0.532 | 0.135E+04 | 0.135E+04 | 0.870E+05 | 0.719E+05 |
| 11 | 2 | 5.512 | 1.986 | 0.000 | 0.571 | 0.146E+04 | 0.146E+04 | 0.131E+06 | 0.833E+05 |
| | | | | | SUM | 0.223E+07 | 0.115E+07 | | |

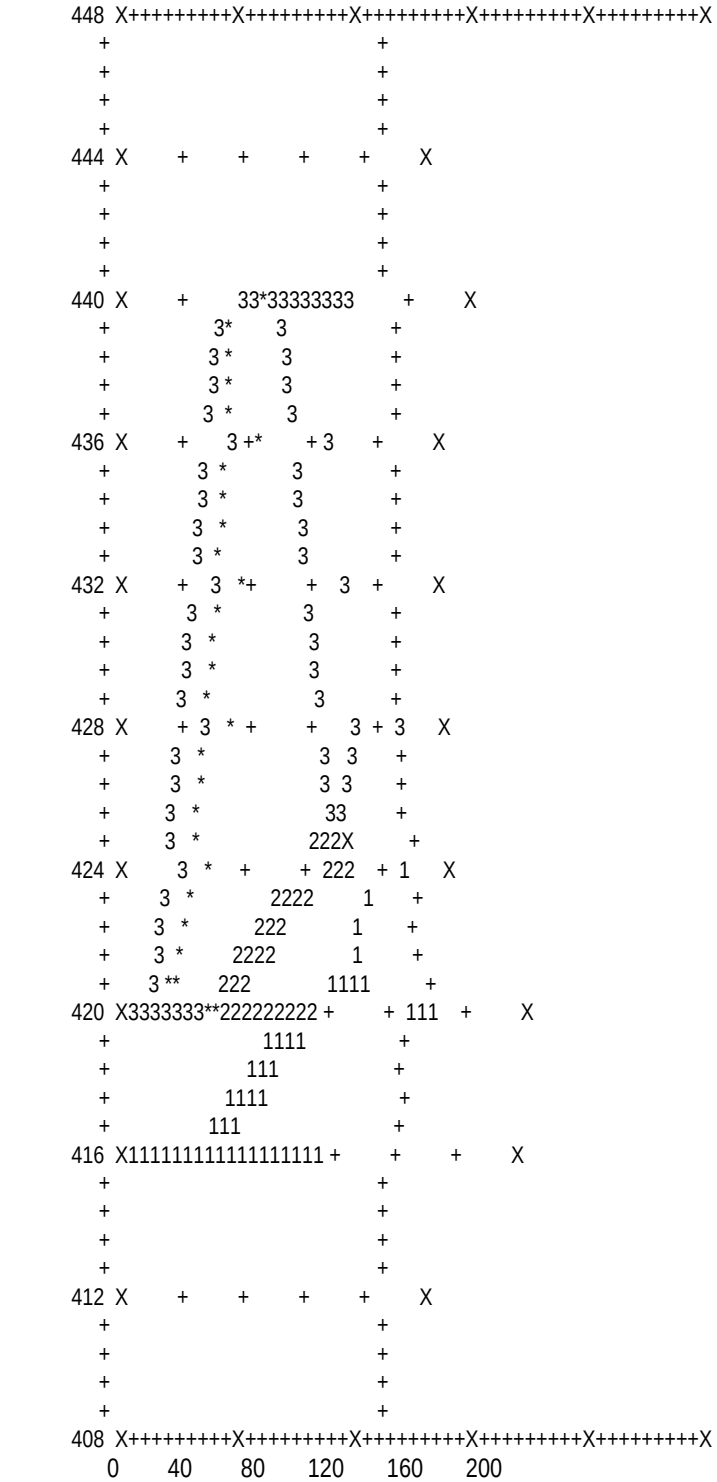
AT CENTER ( 28.000, 520.000) WITH RADIUS 99.846 AND SEISMIC COEFF. 0.00
FACTOR OF SAFETY BY NORMAL METHOD IS 1.934
FACTOR OF SAFETY BY SIMPLIFIED BISHOP METHOD IS 1.966

Kodiak Mining P-3887 R-5 Primary Road 2 Fill at 20+00

CRITICAL FAILURE SURFACE IS INDICATED BY *********

CENTER AT POINT ( 28 520 ) WITH RADIUS OF 99.846

FACTOR OF SAFETY IS 1.966 BY SIMPLIFIED BISHOP METHOD



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INPUT FILE NAME -fill3150

TITLE -Kodiak Mining P-3887 R-5 Primary Road 2 Fill at 31+50

NO. OF STATIC AND SEISMIC CASES- 1

NO. OF NONCIRCULAR SLIP SURFACES= 0

CASE NO. 1 SEISMIC COEFFICIENT= 0

NO. OF BOUNDARY LINES= 3

NO. OF POINTS ON BOUNDARY LINE 1 = 3
1 X COORD.= 0 Y COORD.= 416
2 X COORD.= 17 Y COORD.= 418
3 X COORD.= 99 Y COORD.= 419

NO. OF POINTS ON BOUNDARY LINE 2 = 2
1 X COORD.= 17 Y COORD.= 424
2 X COORD.= 99 Y COORD.= 423

NO. OF POINTS ON BOUNDARY LINE 3 = 5
1 X COORD.= 0 Y COORD.= 420
2 X COORD.= 17 Y COORD.= 424
3 X COORD.= 41 Y COORD.= 432
4 X COORD.= 81 Y COORD.= 432
5 X COORD.= 99 Y COORD.= 423

LINE NO. AND SLOPE OF EACH SEGMENT ARE:
1 +0.118 +0.012
2 -0.012
3 +0.235 +0.333 +0.000 -0.500

MIN. DEPTH OF TALLEST SLICE= 0
NO. OF RADIUS CONTROL ZONES= 1

RADIUS DECREMENT FOR ZONE 1 = 0
NO. OF CIRCLES FOR ZONE 1 = 5
ID NO. FOR FIRST CIRCLE FOR ZONE 1 = 1
NO. OF BOTTOM LINES FOR ZONE 1 = 1

FOR ZONE 1 LINE SEQUENCE 1
LINE NO.= 1 BEG. NO.= 1 END NO.= 3
UNIT WEIGHT OF WATER= 62.4

| SOIL NO. | COHESION | FRIC. ANGLE | UNIT WEIGHT |
|---|---|---|---|
| 1 | 100 | 27.92 | 133.52 |
| 2 | 100 | 27.92 | 133.52 |

NO SEEPAGE

USE GRID
NO. OF SLICES= 10
NO. OF ADD. RADII= 3
ANALYSIS BY SIMPLIFIED BISHOP METHOD (MTHD=2)
NUMBER OF FORCES (NFO)= 0
SOFT SOIL NUMBER (SSN)= 0
INPUT COORD. OF GRID POINTS 1,2,AND 3

POINT 1 X COORD.=-20 Y COORD.= 490
POINT 2 X COORD.=-20 Y COORD.= 440
POINT 3 X COORD.= 20 Y COORD.= 440

X INCREMENT= 4 Y INCREMENT= 4
NO. OF DIVISIONS BETWEEN POINTS 1 AND 2= 5
NO. OF DIVISIONS BETWEEN POINTS 2 AND 3= 4
ONLY F. S. AT EACH CENTER WILL BE PRINTED
SLICES WILL BE SUBDIVIDED

AUTOMATIC SEARCH WILL FOLLOW AFTER GRID

FACTORS OF SAFETY BASED ON GRID

IN THE FOLLOWING TABLE WARNING INDICATES HOW MANY TIMES THE
MAXIMUM RADIUS IS LIMITED BY THE END POINTS OF GROUND LINES

| CENTER X COORDINATE | CENTER Y COORDINATE | NO. OF TOTAL | CIRCLE CRITIC. | LOWEST RADIUS | WARNING F.S. |
|---|---|---|---|---|---|
| -20 | 490 | 1 | 1 | 72.801 | 1000.000 | 1 |
| -20 | 480 | 1 | 1 | 63.246 | 1000.000 | 1 |
| -20 | 470 | 1 | 1 | 53.852 | 1000.000 | 1 |
| -20 | 460 | 1 | 1 | 44.721 | 1000.000 | 1 |
| -20 | 450 | 1 | 1 | 36.056 | 1000.000 | 1 |
| -20 | 440 | 1 | 1 | 28.284 | 1000.000 | 1 |
| -10 | 490 | 4 | 1 | 70.711 | 19.679 | 1 |
| -10 | 480 | 2 | 1 | 60.828 | 39.240 | 1 |
| -10 | 470 | 1 | 1 | 50.990 | 1000.000 | 1 |
| -10 | 460 | 1 | 1 | 41.231 | 1000.000 | 1 |
| -10 | 450 | 1 | 1 | 31.623 | 1000.000 | 1 |
| -10 | 440 | 1 | 1 | 22.361 | 1000.000 | 1 |
| 0 | 490 | 5 | 1 | 70.000 | 3.830 | 1 |
| 0 | 480 | 5 | 1 | 60.000 | 4.529 | 1 |
| 0 | 470 | 5 | 1 | 50.000 | 5.650 | 1 |
| 0 | 460 | 5 | 1 | 40.000 | 7.085 | 1 |
| 0 | 450 | 5 | 1 | 30.000 | 8.557 | 1 |
| 0 | 440 | 5 | 1 | 20.000 | 11.685 | 1 |
| 10 | 490 | 5 | 1 | 70.711 | 2.862 | 1 |
| 10 | 480 | 5 | 1 | 60.828 | 2.790 | 1 |
| 10 | 470 | 5 | 1 | 50.990 | 2.777 | 1 |
| 10 | 460 | 5 | 1 | 41.231 | 2.893 | 1 |
| 10 | 450 | 5 | 1 | 31.623 | 3.102 | 1 |
| 10 | 440 | 5 | 1 | 22.361 | 3.439 | 1 |
| 20 | 490 | 11 | 7 | 68.870 | 3.269 | 0 |
| 20 | 480 | 11 | 8 | 58.535 | 3.094 | 0 |
| 20 | 470 | 11 | 3 | 48.252 | 2.926 | 0 |
| 20 | 460 | 11 | 3 | 38.458 | 2.792 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 20 | 450 | 11 | 10 | 29.488 | 2.757 | 0 |
| 20 | 440 | 11 | 2 | 20.415 | 2.991 | 0 |

AT POINT ( 20 450 ) RADIUS 29.488

THE MINIMUM FACTOR OF SAFETY IS 2.757

FACTORS OF SAFETY BASED ON SEARCH

IN THE FOLLOWING TABLE WARNING INDICATES HOW MANY TIMES THE
MAXIMUM RADIUS IS LIMITED BY THE END POINTS OF GROUND LINES

| CENTER X COORDINATE | CENTER Y COORDINATE | NO. OF CIRCLE TOTAL | CRITIC. | LOWEST RADIUS | WARNING F.S. |
|---|---|---|---|---|---|
| 20 | 450 | 11 | 10 | 29.488 | 2.757 | 0 |
| 24 | 450 | 11 | 9 | 27.655 | 2.817 | 0 |
| 16 | 450 | 5 | 1 | 32.016 | 2.803 | 0 |
| 20 | 454 | 11 | 8 | 33.004 | 2.747 | 0 |
| 20 | 458 | 11 | 3 | 36.499 | 2.774 | 0 |
| 24 | 454 | 11 | 9 | 31.563 | 2.861 | 0 |
| 16 | 454 | 5 | 1 | 36.014 | 2.761 | 0 |
| 21 | 454 | 11 | 3 | 32.447 | 2.762 | 0 |
| 19 | 454 | 11 | 10 | 33.529 | 2.738 | 0 |
| 18 | 454 | 11 | 9 | 34.025 | 2.741 | 0 |
| 19 | 455 | 11 | 10 | 34.514 | 2.738 | 0 |
| 19 | 453 | 11 | 10 | 32.545 | 2.741 | 0 |

AT POINT ( 19 454 ) RADIUS 33.529

THE MINIMUM FACTOR OF SAFETY IS 2.738

SUMMARY OF SLICE INFORMATION FOR MOST CRITICAL SLIP SURFACE

| SL. NO. | SOIL NO. | SLICE WIDTH | SLICE HEIGHT | WATER HEIGHT | SLICE SINE | TOTAL WEIGHT | EFFEC. WEIGHT | RESIS. MOMENT | DRIVING MOMENT |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 3.552 | 0.933 | 0.000 | -.252 | 0.442E+03 | 0.442E+03 | 0.199E+05 | -.374E+04 |
| 2 | 1 | 3.552 | 2.490 | 0.000 | -.146 | 0.118E+04 | 0.118E+04 | 0.328E+05 | -.578E+04 |
| 3 | 1 | 1.115 | 3.301 | 0.000 | -.076 | 0.491E+03 | 0.491E+03 | 0.125E+05 | -.126E+04 |
| 4 | 1 | 2.437 | 3.927 | 0.000 | -.023 | 0.128E+04 | 0.128E+04 | 0.309E+05 | -.998E+03 |
| 5 | 1 | 3.552 | 4.861 | 0.000 | 0.066 | 0.231E+04 | 0.231E+04 | 0.528E+05 | 0.510E+04 |
| 6 | 1 | 3.552 | 5.619 | 0.000 | 0.172 | 0.266E+04 | 0.266E+04 | 0.587E+05 | 0.154E+05 |
| 7 | 1 | 3.552 | 5.981 | 0.000 | 0.278 | 0.284E+04 | 0.284E+04 | 0.608E+05 | 0.264E+05 |
| 8 | 1 | 3.469 | 5.921 | 0.000 | 0.383 | 0.274E+04 | 0.274E+04 | 0.576E+05 | 0.352E+05 |
| 9 | 2 | 3.636 | 5.383 | 0.000 | 0.489 | 0.261E+04 | 0.261E+04 | 0.545E+05 | 0.428E+05 |
| 10 | 2 | 3.552 | 4.255 | 0.000 | 0.596 | 0.202E+04 | 0.202E+04 | 0.436E+05 | 0.403E+05 |
| 11 | 2 | 0.250 | 3.369 | 0.000 | 0.652 | 0.112E+03 | 0.112E+03 | 0.262E+04 | 0.246E+04 |
| 12 | 2 | 3.303 | 1.766 | 0.000 | 0.705 | 0.779E+03 | 0.779E+03 | 0.254E+05 | 0.184E+05 |
| | | | | | SUM | | | 0.452E+06 | 0.174E+06 |

AT CENTER ( 19.000, 454.000) WITH RADIUS 33.529 AND SEISMIC COEFF. 0.00
FACTOR OF SAFETY BY NORMAL METHOD IS 2.594
FACTOR OF SAFETY BY SIMPLIFIED BISHOP METHOD IS 2.738

Kodiak Mining P-3887 R-5 Primary Road 2 Fill at 31+50

CRITICAL FAILURE SURFACE IS INDICATED BY *********

CENTER AT POINT ( 19 454 ) WITH RADIUS OF 33.529

FACTOR OF SAFETY IS 2.738 BY SIMPLIFIED BISHOP METHOD