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UTAH DIVISION OIL, GAS AND MINING

**APPENDIX 5-21**

**Reclamation Fill Stability Analysis At The Crandall Canyon Mine**
**Emery County, Utah**

March 12, 1997

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DIVISION OF OIL, GAS AND MINING

# RECLAMATION FILL STABILITY ANALYSIS AT THE CRANDALL CANYON MINE EMERY COUNTY, UTAH

**Prepared for**

**GENWAL RESOURCES, INC.**
**195 NORTH 100 WEST**
**HUNTINGTON, UTAH 84528**

**Prepared by**

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March 12, 1997

I certify that the calculations contained in this report were prepared by me and are correct to the best of my knowledge.

COLORADO REGISTERED RICHARD H. FOX 26705 PROFESSIONAL ENGINEER

Richard H. Fox, P.E.

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# RECLAMATION SOIL SLOPE STABILITY ANALYSIS AT THE CRANDALL CANYON MINE EMERY COUNTY, UTAH

## INTRODUCTION

This report presents the results of a slope stability investigation for potential slide areas of reclaimed soils placed on previous disturbance areas. The disturbance areas are at the Crandall Canyon portals and facilities area for Genwal Resources mine that is located in Crandall Canyon, approximately 15 miles west of Huntington, Utah.

The purpose and scope of the study were discussed with Mr. Gary Gray, Reclamation Engineer for Genwal Resources, Inc. Several slope areas were to be investigated for potential failure of the reclamation material placed over slopes disturbed by mine related activities. The investigation included review of previous stability work for the initial portal and pad excavation, road expansion, storage pad expansion, revised sediment pond, sediment pond expansion, and plan and section maps of the proposed reclamation for the area.

## PROJECT DESCRIPTION

The project is in the south center portion of Section 5, T. 16 S., R. 7 W, Salt Lake Base and Meridian. Two portal pads, an access road to the pads, a coal stockpile pad, and a sediment pond are being reclaimed. One road will remain unreclaimed as access to US Forest Service land.

The reclamation will be done using existing borrow area materials and previously stockpiled topsoil excavated during site construction.

## SURFACE AND SUBSURFACE DESCRIPTION

The site is located close to the bottom of a prominent ridge, just above the Crandall Creek drainage. The slopes are generally steep, varying from 30 to 40 degrees to near vertical where cliff forming sandstones are exposed. The Blackhawk formation form the upper portion of the ridge with alternating cliff forming sandstone units and slope forming materials consisting of soft to hard and sand shale and several coal beds. The lower portion of the slopes is in the Star Point formation which consists of cliff forming sandstone separated by tongues of yellow to gray slope forming shale.

The reclamation soil will be placed over disturbance that is generally on subsoils that can be placed in 4 classifications:

1. Areas of exposed bedrock. This occurs on the upper access cut for the portals and portal pads.
2. Areas where bedrock is covered by 10 to 40 inches ± of silty sand with gravel and cobbles. Parts of the upper access road cut and portal pads are in this classification. The lower access road (U.S.F.S. access road) is also in this classification.
3. Areas where bedrock is covered by 15 feet ±of surficial deposits. The deposits generally consist of silt and fine gravel between 0 and 4 feet; dense silty sand with some gravel and cobbles between 4 and 12 feet; and boulders and silty sand to bedrock. The coal pad and sediment pond embankment were placed over this type of material.

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4. Areas over fill placed for pads and embankments. These areas are on the slopes of the coal storage pad and the sediment pond embankment.

## SLOPE STABILITY ANALYSIS

The computer program used to evaluate the stability of the reclamation slopes involving a slip circle failure is called REAME (Rotational Equilibrium Analysis of Multilayered Embankments) that is based on a simplified Bishop method of analysis. The program was developed by Dr. Y. H. Huang, Professor of Civil Engineering, University of Kentucky.

## SOIL PROPERTIES

A set of conservative soil properties was selected after reviewing data from a report by Earthfax Engineering, Inc., dated November 9, 1990. Sample FS-1 is uncompacted silty gravely sand that may have been a composite of road base and native fill material taken from the fill slope of the surface coal storage pad. Sample SS-1 is a silty gravely sand with calcium carbonate cementation that was taken along the north bank of Crandall Creek. Both samples were subjected to unsaturated and undrained direct shear tests to determine soil strength factors. Both of the samples were nonplastic and were in the the Unified Soil Class SM. The soil samples drained well and, although there was approximately 20 percent passing a #200 sieve, the material contained silt and not clay. The material from FS-1 and SS-1 represent the type of natural material that will be used for reclamation fill.

**SOIL MATERIAL PROPERTIES**

| SAMPLE | DENSITY (pcf) | INTERNAL FRICTION (Degrees) | COHESION (psf) |
|---|---|---|---|
| FS-1 | 123.5 | 55 | 1600 |
| SS-1 | 110 | 46 | 700 |
| Stability Study | 135 | 40 | 200 |

The 135 pcf used for density is for a saturated soil. The internal friction angle and cohesion were reduced to represent fill material that is not as highly compacted as an engineered fill such as the sediment pond embankment or the coal storage pad.

A 20 percent pore pressure ratio was used to account for potential saturation and concentration of water at the reclamation soil-bedrock contact. This type of condition would cause seeps at the toe of the reclamation soil slope.

## CRITICAL SLIP CIRCLES AND FACTORS OF SAFETY

| SECTION | STABILITY METHOD | HORIZONTAL DISTANCE | ELEVATION | CRITICAL RADIUS | FACTOR OF SAFETY |
|---|---|---|---|---|---|
| 6 North | Static | 481.57 | 8043.79 | 103.02 | 1.64 |
| 9 North | Static | 480.15 | 7929.55 | 45.69 | 2.21 |
| 9 South | Static | 252.55 | 7873.85 | 73.73 | 2.44 |
| 10 North | Static | 406.3 | 7922.5 | 109.11 | 1.57 |
| 11 North | Static | 385.85 | 7957.75 | 148.33 | 1.40 |

The static stability for all sections were above the minimum 1.3 static factor of safety . required by D.O.G.M. to meet reclamation standards in the MRP for the Crandall Canyon Mine

The data input, output of first and last stability circles and location of critical stability circle for each run are attached. Reduced plan and section maps showing the location of the sections and the critical circle for the sections reviewed are included.

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**SLOPE STABILITY - SECTION 6 - STATIC**
**NORTH SIDE OF CRANDALL CREEK**

ROTATIONAL EQUILIBRIUM ANALYSIS OF MULTILAYERED EMBANKMENTS
VERSION 1.21 LAST MODIFIED ON JAN-10-91

TODAY'S DATE = 03-05-1997 RUN TIME = 22:06:07

TITLE =GENWAL CRANDALL CANYON RECLAMATION SLOPE FOR SECTION 6+00 STATIC

FILE NAME =\basic\qb\reame\gen-6-1.SLP

READING FROM FILE

INCORPORATED
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NO. OF STATIC AND SEISMIC CASES = 1

CASE NO. 1 SEISMIC COEFFICIENT = 0

NO. OF BOUNDARY LINES = 2

NO. OF POINTS ON BOUNDARY LINE 1 = 13

BOUNDARY LINE - 1

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 287.00 | 7850.00 |
| 2 | 344.00 | 7850.00 |
| 3 | 359.00 | 7860.00 |
| 4 | 384.00 | 7870.00 |
| 5 | 405.00 | 7870.00 |
| 6 | 418.00 | 7880.00 |
| 7 | 428.00 | 7900.00 |
| 8 | 500.00 | 7942.00 |
| 9 | 531.00 | 7950.00 |
| 10 | 550.00 | 7960.00 |
| 11 | 563.00 | 7970.00 |
| 12 | 564.00 | 7982.00 |
| 13 | 571.00 | 7987.00 |

NO. OF POINTS ON BOUNDARY LINE 2 = 6

BOUNDARY LINE - 2

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 287.00 | 7850.00 |
| 2 | 332.00 | 7860.00 |
| 3 | 387.00 | 7880.00 |
| 4 | 428.00 | 7900.00 |
| 5 | 500.00 | 7942.00 |
| 6 | 571.00 | 7987.00 |

LINE NO. AND SLOPE OF EACH SEGMENT ARE:
1 0 .6666667 .4 0 .7692308 2 .5833333 .2580645 .5263158 .7692308 12 .7142857
2 .2222222 .3636364 .4878049 .5833333 .6338028

MIN. DEPTH OF TALLEST SLICE = 2
NO. OF RADIUS CONTROL ZONES = 1

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RADIUS DECREMENT FOR ZONE 1 = 0
NO. OF CIRCLES FOR ZONE 1 = 5
ID NO. OF 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.= 13

| SOIL NO. | COHESION | FRIC. ANGLE | UNIT WEIGHT |
|---|---|---|---|
| 1 | 200 | 40 | 135 |

USE PORE PRESSURE RATIO
USE GRID
NO. OF SLICES= 6 NO. OF ADD. RADII= 3

PORE PRESSURE RATIO= .2
COORDINATES OF GRID POINTS 1, 2, AND 3

POINT 1 X-COORD. = 170 Y-COORD. = 8050
POINT 2 X-COORD. = 272 Y-COORD. = 7848
POINT 3 X-COORD. = 580 Y-COORD. = 8000

X INCREMENT = 5 Y INCREMENT = 5
NO. OF DIVISIONS BETWEEN POINTS 1 AND 2= 36
NO. OF DIVISIONS BETWEEN POINTS 2 AND 3= 25

AT POINT ( 170 8050 ) THE RADIUS AND FACTOR OF SAFETY ARE:
231.7089 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 231.7089

AT POINT ( 172.8333 8044.389 ) THE RADIUS AND FACTOR OF SAFETY ARE:
225.4351 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 225.4351

## DATA REMOVED FOR REPORT SUMMARY

AT POINT ( 482.817 8042.541 ) THE RADIUS AND FACTOR OF SAFETY ARE:
101.2713 1.641088
99.84099 1.767204
98.41063 1.988624
96.98027 2.448517
95.54991 1000000
LOWEST FACTOR OF SAFETY = 1.641088 AND OCCURS AT RADIUS = 101.2713

AT POINT ( 480.317 8042.541 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 102.2699 | 1.664145 |
| 100.9075 | 1.798382 |
| 99.54509 | 2.032656 |
| 98.18269 | 2.517398 |
| 96.82028 | 1000000 |

LOWEST FACTOR OF SAFETY = 1.664145 AND OCCURS AT RADIUS = 102.2699

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JUL 30 1997
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AT POINT ( 481.567 8043.791 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 103.021 | 1.637418 |
| 101.5857 | 1.763284 |
| 100.1504 | 1.984129 |
| 98.71509 | 2.442613 |
| 97.27979 | 1000000 |

LOWEST FACTOR OF SAFETY = 1.637418 AND OCCURS AT RADIUS = 103.021

AT POINT ( 481.567 8045.041 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 103.7755 | 1.657748 |
| 102.4005 | 1.79066 |
| 101.0254 | 2.022748 |
| 99.6504 | 2.502934 |
| 98.27535 | 1000000 |

LOWEST FACTOR OF SAFETY = 1.657748 AND OCCURS AT RADIUS = 103.7755

AT POINT ( 482.817 8043.791 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 102.0235 | 1.661688 |
| 100.6539 | 1.795024 |
| 99.28426 | 2.027869 |
| 97.91463 | 2.509894 |
| 96.54499 | 1000000 |

LOWEST FACTOR OF SAFETY = 1.661688 AND OCCURS AT RADIUS = 102.0235

AT POINT ( 480.317 8043.791 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 103.4802 | 1.651432 |
| 102.0869 | 1.782166 |
| 100.6936 | 2.010725 |
| 99.30031 | 2.484257 |
| 97.907 | 1000000 |

LOWEST FACTOR OF SAFETY = 1.651432 AND OCCURS AT RADIUS = 103.4802

AT POINT ( 481.567 8043.791 )RADIUS 103.021

THE MINIMUM FACTOR OF SAFETY IS 1.637418

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**SLOPE STABILITY - SECTION 9 - STATIC**
**NORTH SIDE OF CRANDALL CREEK**

ROTATIONAL EQUILIBRIUM ANALYSIS OF MULTILAYERED EMBANKMENTS
VERSION 1.21 LAST MODIFIED ON JAN-10-91

TODAY'S DATE = 03-06-1997 RUN TIME = 21:57:24

TITLE =GENWAL CRANDALL CANYON RECLAMATION STABILITY FOR SECTION 9+00 STATIC

INCORPORATED
EFFECTIVE:
JUL 30 1997
97B
UTAH DIVISION OIL, GAS AND MINING

FILE NAME =\basic\qb\reame\gen-9nor.SLP

READING FROM FILE

NO. OF STATIC AND SEISMIC CASES = 1

CASE NO. 1 SEISMIC COEFFICIENT = 0

NO. OF BOUNDARY LINES = 2

NO. OF POINTS ON BOUNDARY LINE 1 = 10

BOUNDARY LINE - 1

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 393.00 | 7827.00 |
| 2 | 414.00 | 7830.00 |
| 3 | 426.00 | 7840.00 |
| 4 | 444.00 | 7857.00 |
| 5 | 470.00 | 7880.00 |
| 6 | 478.00 | 7882.00 |
| 7 | 491.00 | 7885.00 |
| 8 | 507.00 | 7885.00 |
| 9 | 515.00 | 7900.00 |
| 10 | 521.00 | 7906.00 |

NO. OF POINTS ON BOUNDARY LINE 2 = 6

BOUNDARY LINE - 2

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 393.00 | 7827.00 |
| 2 | 426.00 | 7840.00 |
| 3 | 444.00 | 7857.00 |
| 4 | 470.00 | 7880.00 |
| 5 | 478.00 | 7882.00 |
| 6 | 521.00 | 7906.00 |

LINE NO. AND SLOPE OF EACH SEGMENT ARE:
1 .1428571 .8333333 .9444444 .8846154 .25 .2307692 0 1.875 1
2 .3939394 .9444444 .8846154 .25 .5581396

MIN. DEPTH OF TALLEST SLICE = .5
NO. OF RADIUS CONTROL ZONES = 1

RADIUS DECREMENT FOR ZONE 1 = 0

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NO. OF CIRCLES FOR ZONE 1 = 5
ID NO. OF 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.= 10

| SOIL NO. | COHESION | FRIC. ANGLE | UNIT WEIGHT |
|---|---|---|---|
| 1 | 200 | 40 | 135 |

USE PORE PRESSURE RATIO
USE GRID
NO. OF SLICES= 10 NO. OF ADD. RADII= 3

PORE PRESSURE RATIO= .2
COORDINATES OF GRID POINTS 1, 2, AND 3

POINT 1 X-COORD. = 260 Y-COORD. = 7983
POINT 2 X-COORD. = 368 Y-COORD. = 7817
POINT 3 X-COORD. = 530 Y-COORD. = 7925

X INCREMENT = 5 Y INCREMENT = 5
NO. OF DIVISIONS BETWEEN POINTS 1 AND 2= 20
NO. OF DIVISIONS BETWEEN POINTS 2 AND 3= 20

AT POINT ( 260 7983 ) THE RADIUS AND FACTOR OF SAFETY ARE:
205 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 205

AT POINT ( 265.4 7974.7 ) THE RADIUS AND FACTOR OF SAFETY ARE:
195.1848 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 195.1848

AT POINT ( 270.8 7966.4 ) THE RADIUS AND FACTOR OF SAFETY ARE:
185.3788 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 185.3788

## DATA REMOVED FOR REPORT SUMMARY

AT POINT ( 486.4 7928.302 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 40.23618 | 2.488947 |
| 39.45625 | 2.755804 |
| 38.67633 | 3.21643 |
| 37.89641 | 4.162469 |
| 37.11649 | 7.047863 |

LOWEST FACTOR OF SAFETY = 2.488947 AND OCCURS AT RADIUS = 40.23618

AT POINT ( 478.9 7928.302 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 44.91358 | 2.256868 |
| 43.92922 | 2.459867 |
| 42.94487 | 2.816206 |
| 41.96051 | 3.556435 |
| 40.97615 | 5.834179 |

LOWEST FACTOR OF SAFETY = 2.256868 AND OCCURS AT RADIUS = 44.91358

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AT POINT ( 480.15 7929.552 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 45.69277 | 2.210005 |
| 44.64904 | 2.39872 |
| 43.6053 | 2.731908 |
| 42.56157 | 3.427411 |
| 41.51783 | 5.574027 |

LOWEST FACTOR OF SAFETY = 2.210005 AND OCCURS AT RADIUS = 45.69277

AT POINT ( 480.15 7930.802 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 46.51098 | 2.245097 |
| 45.5219 | 2.447822 |
| 44.53282 | 2.803027 |
| 43.54374 | 3.541034 |
| 42.55466 | 5.808965 |

LOWEST FACTOR OF SAFETY = 2.245097 AND OCCURS AT RADIUS = 46.51098

AT POINT ( 481.4 7929.552 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 44.7467 | 2.264048 |
| 43.77033 | 2.469091 |
| 42.79397 | 2.828791 |
| 41.8176 | 3.575498 |
| 40.84124 | 5.872989 |

LOWEST FACTOR OF SAFETY = 2.264048 AND OCCURS AT RADIUS = 44.7467

AT POINT ( 478.9 7929.552 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 46.13157 | 2.231561 |
| 45.12191 | 2.42886 |
| 44.11226 | 2.775535 |
| 43.1026 | 3.496699 |
| 42.09295 | 5.716574 |

LOWEST FACTOR OF SAFETY = 2.231561 AND OCCURS AT RADIUS = 46.13157

AT POINT ( 480.15 7929.552 )RADIUS 45.69277

THE MINIMUM FACTOR OF SAFETY IS 2.210005

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**SLOPE STABILITY - SECTION 9 - STATIC**
**SOUTH SIDE OF CRANDALL CREEK**

ROTATIONAL EQUILIBRIUM ANALYSIS OF MULTILAYERED EMBANKMENTS
VERSION 1.21 LAST MODIFIED ON JAN-10-91

TODAY'S DATE = 03-05-1997 RUN TIME = 22:31:19

TITLE =GENWAL CRANDALL CANYON RECLAMATION STABILITY FOR SECTION 9+00 STATIC

FILE NAME =\BASIC\QB\REAME\GEN-9SOU.SLP

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READING FROM FILE

NO. OF STATIC AND SEISMIC CASES = 1

CASE NO. 1 SEISMIC COEFFICIENT = 0

NO. OF BOUNDARY LINES = 2

NO. OF POINTS ON BOUNDARY LINE 1 = 3

BOUNDARY LINE - 1

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 190.00 | 7830.00 |
| 2 | 226.00 | 7800.00 |
| 3 | 262.00 | 7800.00 |

NO. OF POINTS ON BOUNDARY LINE 2 = 2

BOUNDARY LINE - 2

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 190.00 | 7830.00 |
| 2 | 262.00 | 7800.00 |

LINE NO. AND SLOPE OF EACH SEGMENT ARE:
1 -.8333333 0
2 -.4166667

MIN. DEPTH OF TALLEST SLICE = .5
NO. OF RADIUS CONTROL ZONES = 1

RADIUS DECREMENT FOR ZONE 1 = 0
NO. OF CIRCLES FOR ZONE 1 = 5
ID NO. OF 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

| SOIL NO. | COHESION | FRIC. ANGLE | UNIT WEIGHT |
|---|---|---|---|
| 1 | 200 | 40 | 135 |

USE PORE PRESSURE RATIO

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USE GRID
NO. OF SLICES= 10  NO. OF ADD. RADII= 3

PORE PRESSURE RATIO= .2
COORDINATES OF GRID POINTS 1, 2, AND 3

POINT 1 X-COORD. = 245  Y-COORD. = 7977
POINT 2 X-COORD. = 183  Y-COORD. = 7843
POINT 3 X-COORD. = 275  Y-COORD. = 7800

X INCREMENT = 5  Y INCREMENT = 5
NO. OF DIVISIONS BETWEEN POINTS 1 AND 2= 20
NO. OF DIVISIONS BETWEEN POINTS 2 AND 3= 20

AT POINT ( 245  7977 ) THE RADIUS AND FACTOR OF SAFETY ARE:
156.9522  1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 156.9522

AT POINT ( 241.9  7970.3 ) THE RADIUS AND FACTOR OF SAFETY ARE:
149.5916  1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 149.5916

AT POINT ( 238.8  7963.6 ) THE RADIUS AND FACTOR OF SAFETY ARE:
142.2332  1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 142.2332

## DATA REMOVED FOR SUMMARY REPORT

AT POINT ( 251.3  7875.099 ) THE RADIUS AND FACTOR OF SAFETY ARE:
73.8889  2.458972
72.15244  2.5884
70.41597  2.82747
68.6795  3.34189
66.94304  4.959418
LOWEST FACTOR OF SAFETY = 2.458972 AND OCCURS AT RADIUS = 73.8889

AT POINT ( 252.55  7876.349 ) THE RADIUS AND FACTOR OF SAFETY ARE:
75.64941  2.446155
73.88776  2.573485
72.12612  2.808969
70.36448  3.315836
68.60284  4.910172
LOWEST FACTOR OF SAFETY = 2.446155 AND OCCURS AT RADIUS = 75.64941

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AT POINT ( 252.55 7873.849 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 73.72885 | 2.435149 |
| 71.88978 | 2.553092 |
| 70.0507 | 2.774391 |
| 68.21163 | 3.255505 |
| 66.37256 | 4.778462 |

LOWEST FACTOR OF SAFETY = 2.435149 AND OCCURS AT RADIUS = 73.72885

AT POINT ( 252.55 7872.599 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 72.59863 | 2.438661 |
| 70.75484 | 2.55547 |
| 68.91104 | 2.775415 |
| 67.06725 | 3.254317 |
| 65.22345 | 4.772328 |

LOWEST FACTOR OF SAFETY = 2.438661 AND OCCURS AT RADIUS = 72.59863

AT POINT ( 253.8 7873.849 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 73.84863 | 2.451451 |
| 72.08176 | 2.577386 |
| 70.31488 | 2.810982 |
| 68.548 | 3.315103 |
| 66.78113 | 4.903771 |

LOWEST FACTOR OF SAFETY = 2.451451 AND OCCURS AT RADIUS = 73.84863

AT POINT ( 251.3 7873.849 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 72.92862 | 2.452916 |
| 71.15344 | 2.577445 |
| 69.37827 | 2.809133 |
| 67.60309 | 3.30995 |
| 65.82791 | 4.890348 |

LOWEST FACTOR OF SAFETY = 2.452916 AND OCCURS AT RADIUS = 72.92862

AT POINT ( 252.55 7873.849 )RADIUS 73.72885

THE MINIMUM FACTOR OF SAFETY IS 2.435149

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**SLOPE STABILITY - SECTION 10 - STATIC**
**NORTH SIDE OF CRANDALL CREEK**

ROTATIONAL EQUILIBRIUM ANALYSIS OF MULTILAYERED EMBANKMENTS
VERSION 1.21 LAST MODIFIED ON JAN-10-91

TODAY'S DATE = 03-05-1997 RUN TIME = 22:13:10

TITLE =GENWAL CRANDALL CANYON RECLAMATION STABILITY FOR SECTION 10+00 STATIC

FILE NAME =\BASIC\QB\REAME\GEN-10-1.SLP

INCORPORATED
EFFECTIVE:
JUL 3 0 1997
97B
UTAH DIVISION OIL, GAS AND MINING

READING FROM FILE

NO. OF STATIC AND SEISMIC CASES = 1

CASE NO. 1 SEISMIC COEFFICIENT = 0

NO. OF BOUNDARY LINES = 2

NO. OF POINTS ON BOUNDARY LINE 1 = 11

BOUNDARY LINE - 1

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 402.00 | 7812.00 |
| 2 | 466.00 | 7820.00 |
| 3 | 477.00 | 7830.00 |
| 4 | 480.00 | 7840.00 |
| 5 | 492.00 | 7850.00 |
| 6 | 498.00 | 7860.00 |
| 7 | 502.00 | 7870.00 |
| 8 | 511.00 | 7880.00 |
| 9 | 528.00 | 7890.00 |
| 10 | 567.00 | 7890.00 |
| 11 | 573.00 | 7910.00 |

NO. OF POINTS ON BOUNDARY LINE 2 = 5

BOUNDARY LINE - 2

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 402.00 | 7812.00 |
| 2 | 502.00 | 7870.00 |
| 3 | 511.00 | 7880.00 |
| 4 | 528.00 | 7890.00 |
| 5 | 573.00 | 7910.00 |

LINE NO. AND SLOPE OF EACH SEGMENT ARE:
1 .125 .9090909 3.333333 .8333333 1.666667 2.5 1.111111 .5882353 0 3.333333
2 .58 1.111111 .5882353 .4444444

MIN. DEPTH OF TALLEST SLICE = .5
NO. OF RADIUS CONTROL ZONES = 1

INCORPORATED
EFFECTIVE:
JUL 30 1997
97B
UTAH DIVISION OIL, GAS AND MINING

RADIUS DECREMENT FOR ZONE 1 = 0
NO. OF CIRCLES FOR ZONE 1 = 5
ID NO. OF 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.= 11

| SOIL NO. | COHESION | FRIC. ANGLE | UNIT WEIGHT |
|---|---|---|---|
| 1 | 200 | 40 | 135 |

USE PORE PRESSURE RATIO
USE GRID
NO. OF SLICES= 10 NO. OF ADD. RADII= 3

PORE PRESSURE RATIO= .2
COORDINATES OF GRID POINTS 1, 2, AND 3

POINT 1 X-COORD. = 190 Y-COORD. = 8150
POINT 2 X-COORD. = 375 Y-COORD. = 7810
POINT 3 X-COORD. = 588 Y-COORD. = 7930

X INCREMENT = 5 Y INCREMENT = 5
NO. OF DIVISIONS BETWEEN POINTS 1 AND 2= 20
NO. OF DIVISIONS BETWEEN POINTS 2 AND 3= 20

AT POINT ( 190 8150 ) THE RADIUS AND FACTOR OF SAFETY ARE:
398.9837 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 398.9837

AT POINT ( 199.25 8133 ) THE RADIUS AND FACTOR OF SAFETY ARE:
379.669 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 379.669

AT POINT ( 208.5 8116 ) THE RADIUS AND FACTOR OF SAFETY ARE:
360.3585 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 360.3585

## DATA REMOVED FOR SUMMARY REPORT

AT POINT ( 406.3 7922.5 ) THE RADIUS AND FACTOR OF SAFETY ARE:
109.1134 1.568819
105.9764 1.602489
102.8395 1.681782

| | |
|---|---|
| 99.70258 | 1.877028 |
| 96.56566 | 2.53976 |

LOWEST FACTOR OF SAFETY = 1.568819 AND OCCURS AT RADIUS = 109.1134

INCORPORATED
EFFECTIVE:
JUL 30 1997
97B
UTAH DIVISION OIL, GAS AND MINING

AT POINT ( 406.3 7923.75 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 109.7614 | 1.569471 |
| 106.7111 | 1.60635 |
| 103.6608 | 1.690252 |
| 100.6105 | 1.893496 |
| 97.56027 | 2.577722 |

LOWEST FACTOR OF SAFETY = 1.569471 AND OCCURS AT RADIUS = 109.7614

AT POINT ( 407.55 7922.5 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 108.0604 | 1.573135 |
| 105.0087 | 1.609432 |
| 101.9569 | 1.692682 |
| 98.90513 | 1.895195 |
| 95.85336 | 2.578268 |

LOWEST FACTOR OF SAFETY = 1.573135 AND OCCURS AT RADIUS = 108.0604

AT POINT ( 405.05 7922.5 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 109.2684 | 1.570748 |
| 106.2259 | 1.607752 |
| 103.1834 | 1.691897 |
| 100.1409 | 1.895677 |
| 97.09839 | 2.581679 |

LOWEST FACTOR OF SAFETY = 1.570748 AND OCCURS AT RADIUS = 109.2684

AT POINT ( 406.3 7922.5 )RADIUS 109.1134

THE MINIMUM FACTOR OF SAFETY IS 1.568819

INCORPORATED
EFFECTIVE:
JUL 3 0 1997
UTAH DIVISION OIL, GAS AND MINING

**SLOPE STABILITY - SECTION 11 - STATIC**
**NORTH SIDE OF CRANDALL CREEK**

ROTATIONAL EQUILIBRIUM ANALYSIS OF MULTILAYERED EMBANKMENTS
VERSION 1.21 LAST MODIFIED ON JAN-10-91

TODAY'S DATE = 03-05-1997 RUN TIME = 22:18:37

TITLE =GENWAL CRANDALL CANYON RECLAMATION STABILITY FOR SECTION 11+00 STATIC

FILE NAME =\BASIC\QB\REAME\GEN-11-1.SLP

INCORPORATED
EFFECTIVE:
JUL 30 1997
97B
UTAH DIVISION OIL, GAS AND MINING

READING FROM FILE

NO. OF STATIC AND SEISMIC CASES = 1

CASE NO. 1 SEISMIC COEFFICIENT = 0

NO. OF BOUNDARY LINES = 2

NO. OF POINTS ON BOUNDARY LINE 1 = 7

BOUNDARY LINE - 1

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 419.00 | 7813.00 |
| 2 | 450.00 | 7820.00 |
| 3 | 467.00 | 7830.00 |
| 4 | 519.00 | 7880.00 |
| 5 | 562.00 | 7890.00 |
| 6 | 568.00 | 7900.00 |
| 7 | 580.00 | 7918.00 |

NO. OF POINTS ON BOUNDARY LINE 2 = 3

BOUNDARY LINE - 2

| POINT | X-COORD | Y-COORD |
|---|---|---|
| 1 | 419.00 | 7813.00 |
| 2 | 519.00 | 7880.00 |
| 3 | 580.00 | 7918.00 |

LINE NO. AND SLOPE OF EACH SEGMENT ARE:
1 .2258064 .5882353 .9615384 .2325581 1.666667 1.5
2 .67 .6229508

MIN. DEPTH OF TALLEST SLICE = .5
NO. OF RADIUS CONTROL ZONES = 1

RADIUS DECREMENT FOR ZONE 1 = 0
NO. OF CIRCLES FOR ZONE 1 = 5
ID NO. OF 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.= 7

| SOIL NO. | COHESION | FRIC. ANGLE | UNIT WEIGHT |
|---|---|---|---|
| 1 | 200 | 40 | 135 |

INCORPORATED
EFFECTIVE:
JUL 30 1997
97B
UTAH DIVISION OIL, GAS AND MINING

USE PORE PRESSURE RATIO
USE GRID
NO. OF SLICES= 10 NO. OF ADD. RADII= 3

PORE PRESSURE RATIO= .2
COORDINATES OF GRID POINTS 1, 2, AND 3

POINT 1 X-COORD. = 282 Y-COORD. = 8000
POINT 2 X-COORD. = 400 Y-COORD. = 7813
POINT 3 X-COORD. = 590 Y-COORD. = 7936

X INCREMENT = 5 Y INCREMENT = 5
NO. OF DIVISIONS BETWEEN POINTS 1 AND 2= 20
NO. OF DIVISIONS BETWEEN POINTS 2 AND 3= 20

AT POINT ( 282 8000 ) THE RADIUS AND FACTOR OF SAFETY ARE:
231.8146 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 231.8146

AT POINT ( 287.9 7990.65 ) THE RADIUS AND FACTOR OF SAFETY ARE:
220.7865 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 220.7865

AT POINT ( 293.8 7981.3 ) THE RADIUS AND FACTOR OF SAFETY ARE:
209.7615 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 209.7615

AT POINT ( 299.7 7971.95 ) THE RADIUS AND FACTOR OF SAFETY ARE:
198.7398 1000000
LOWEST FACTOR OF SAFETY = 1000000 AND OCCURS AT RADIUS = 198.7398

**DATA REMOVED FOR SUMMARY REPORT**

AT POINT ( 382.0999 7957.749 ) THE RADIUS AND FACTOR OF SAFETY ARE:
149.3779 1.441406
147.6607 1.543221
145.9435 1.722038
144.2263 2.093626
142.509 3.236786
LOWEST FACTOR OF SAFETY = 1.441406 AND OCCURS AT RADIUS = 149.3779

AT POINT ( 388.3499 7957.749 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 146.5985 | 1.414483 |
| 144.7414 | 1.506162 |
| 142.8843 | 1.668985 |
| 141.0272 | 2.010027 |
| 139.1701 | 3.064745 |

LOWEST FACTOR OF SAFETY = 1.414483 AND OCCURS AT RADIUS = 146.5985

INCORPORATED
EFFECTIVE:
JUL 30 1997
97B
UTAH DIVISION OIL, GAS AND MINING

AT POINT ( 385.8499 7957.749 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 148.3313 | 1.401142 |
| 146.4059 | 1.488633 |
| 144.4806 | 1.644723 |
| 142.5553 | 1.972763 |
| 140.6299 | 2.988877 |

LOWEST FACTOR OF SAFETY = 1.401142 AND OCCURS AT RADIUS = 148.3313

AT POINT ( 384.5999 7957.749 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 148.78 | 1.40953 |
| 146.9041 | 1.5002 |
| 145.0282 | 1.661315 |
| 143.1522 | 1.998844 |
| 141.2763 | 3.042746 |

LOWEST FACTOR OF SAFETY = 1.40953 AND OCCURS AT RADIUS = 148.78

AT POINT ( 385.8499 7958.999 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 149.2323 | 1.405294 |
| 147.3345 | 1.494601 |
| 145.4366 | 1.653584 |
| 143.5387 | 1.986839 |
| 141.6409 | 3.018396 |

LOWEST FACTOR OF SAFETY = 1.405294 AND OCCURS AT RADIUS = 149.2323

AT POINT ( 385.8499 7956.499 ) THE RADIUS AND FACTOR OF SAFETY ARE:

| | |
|---|---|
| 147.2778 | 1.402374 |
| 145.3555 | 1.489947 |
| 143.4331 | 1.646249 |
| 141.5108 | 1.974739 |
| 139.5884 | 2.992398 |

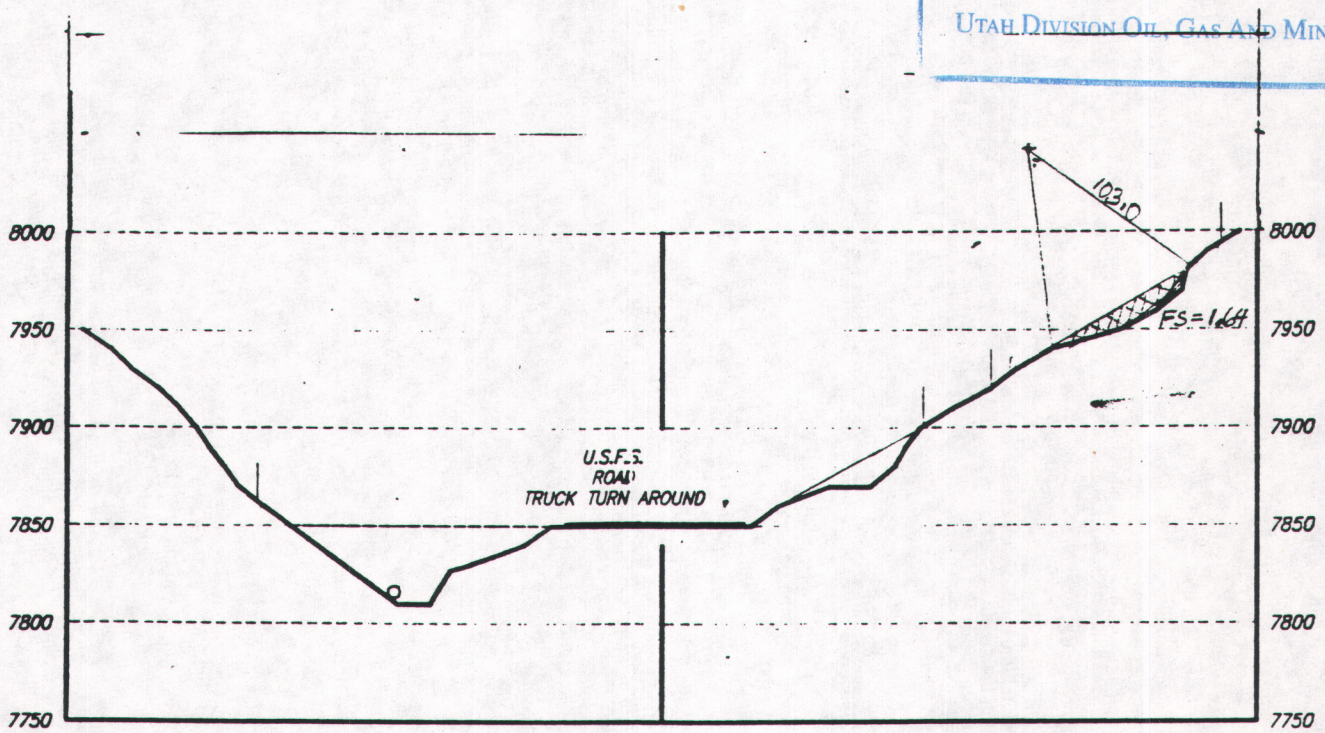
LOWEST FACTOR OF SAFETY = 1.402374 AND OCCURS AT RADIUS = 147.2778

AT POINT ( 385.8499 7957.749 )RADIUS 148.3313

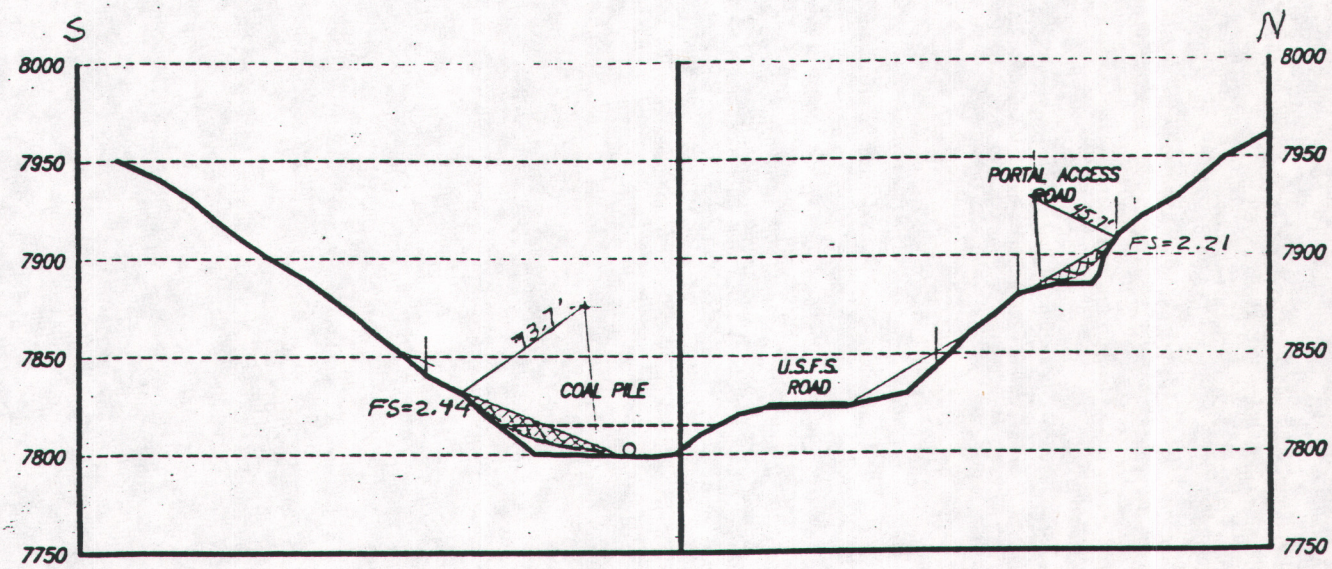
THE MINIMUM FACTOR OF SAFETY IS 1.401142

# CRANDALL CANYON MINE
# RECLAMATION STABILITY SECTIONS

INCORPORATED
EFFECTIVE:
JUL 30 1997
97B
UTAH DIVISION OIL, GAS AND MINING



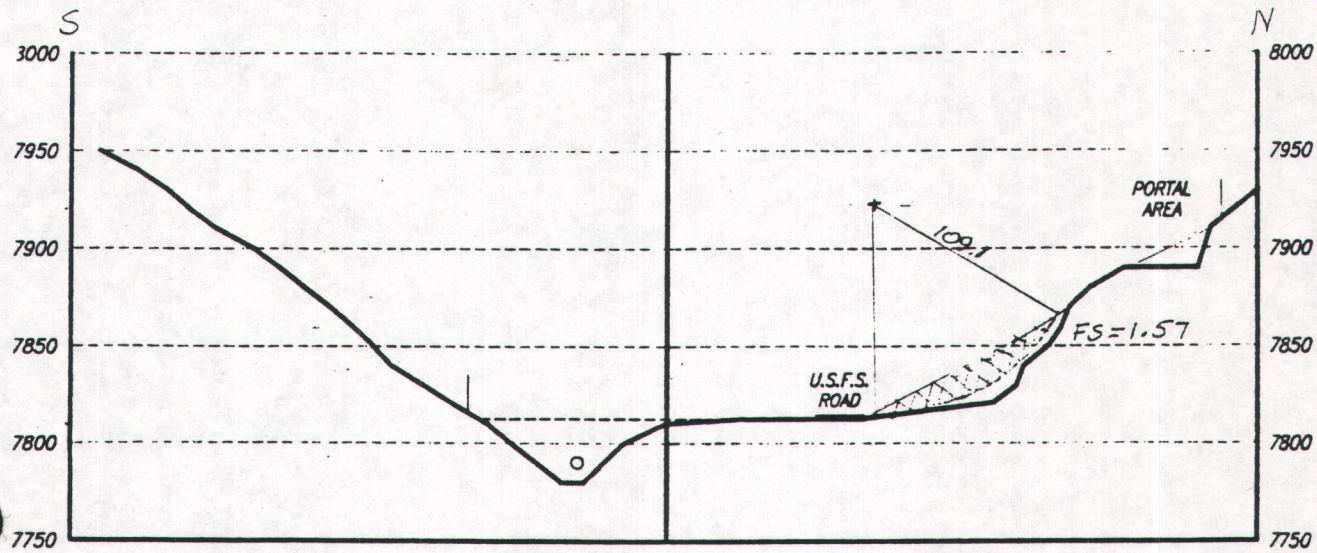

6+00



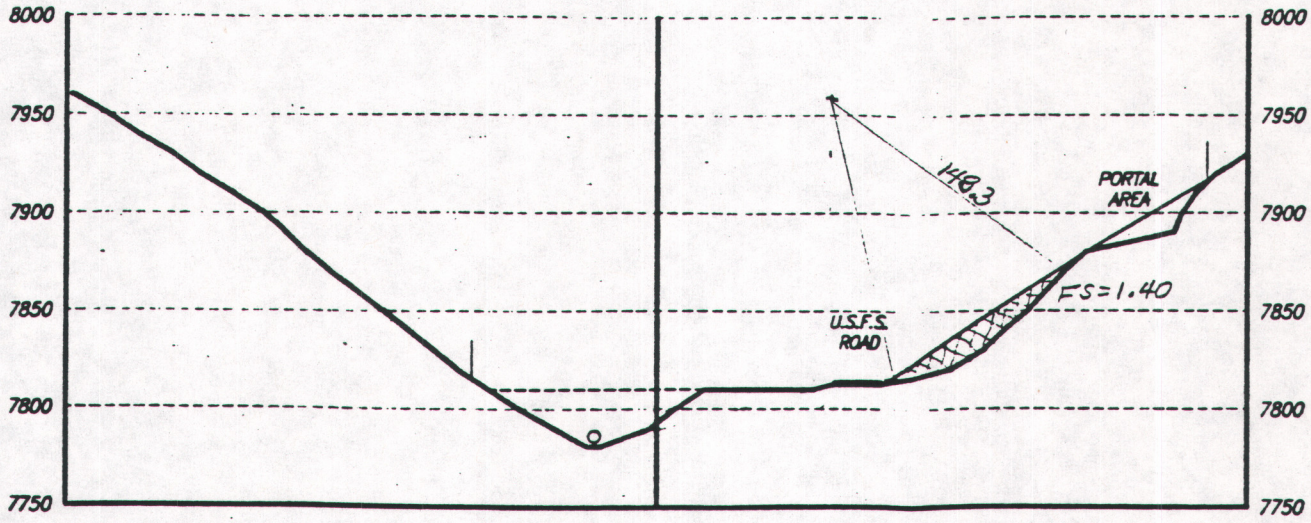

9+00

# CRANDALL CANYON MINE
# RECLAMATION STABILITY SECTIONS

INCORPORATED
EFFECTIVE:
JUL 30 1997
97B
UTAH DIVISION OIL, GAS AND MINING



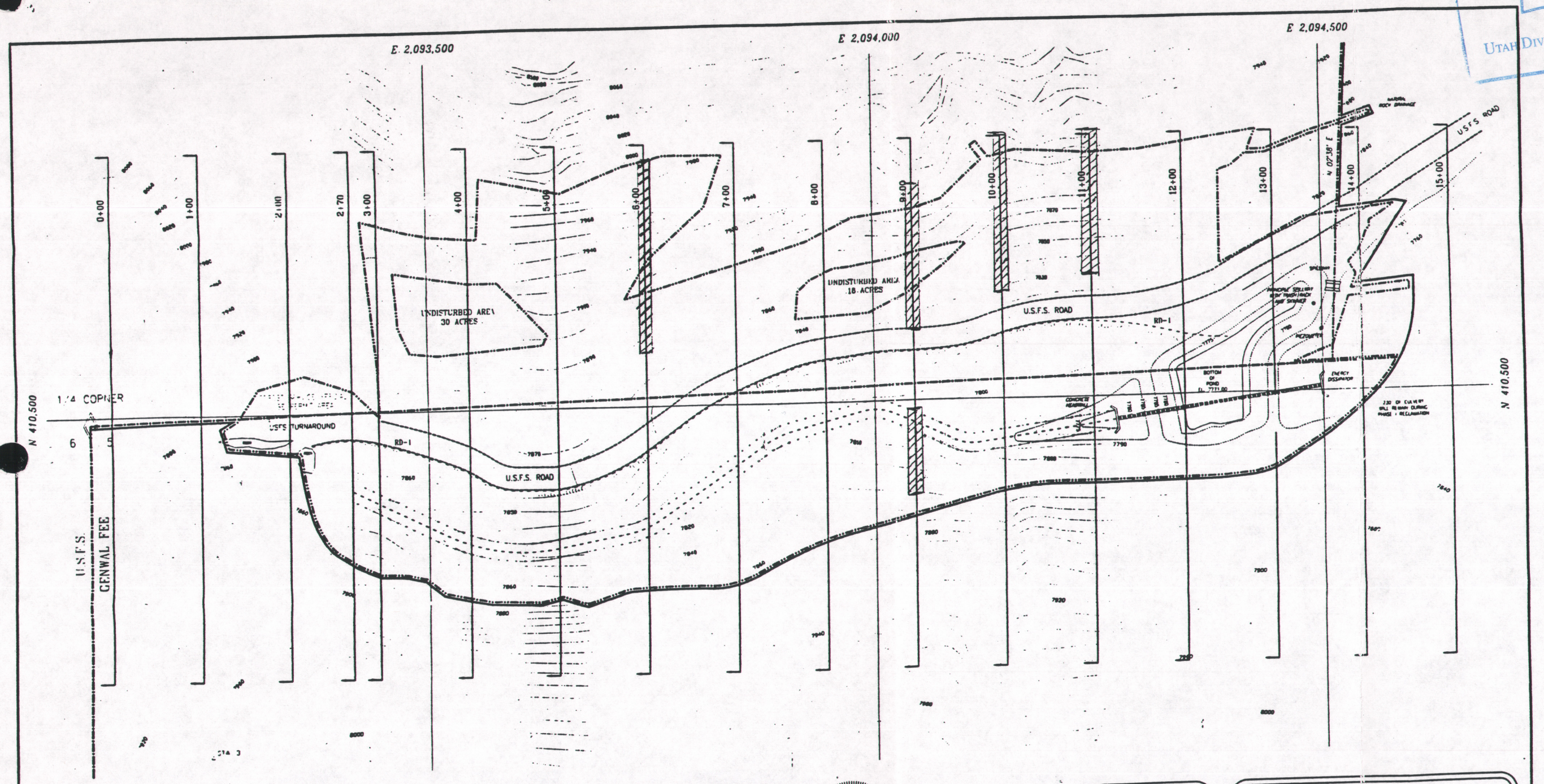

10+00




11+00

INCORPORATED
EFFECTIVE:
JUL 30 1997
97B
UTAH DIVISION OIL, GAS AND MINING

RECEIVED
APR 24 1997
DIV. OF OIL, GAS & MINING




LEGEND:

- DISTURBED AREA
- PERMIT AREA
- 10' CONTOUR
- CROSS-SECTION
- RECLAMATION DIVERSION DITCH — RD-1
- BERM
- ALTERNATE SEDIMENT CONTROL
- 6" Ø CULVERT

Slope Area Analyzed for Reclamation Material Failure

UTAH REGISTERED PROFESSIONAL ENGINEER 17933

N

25' 0' 50' 100'

CONTOUR INTERVAL = 10'
PHOTOGRAPHY DATE = OCTOBER 25, 1989

I hereby certify that the design and/or map contained herein was prepared by me or under my supervision and is true and correct to the best of my knowledge.

NOTE:

1) SEDIMENT POND WILL STAY IN PLACE DURING PHASE I RECLAMATION.

2) STREAM BED WILL BE RETURNED AS IT PRESENTLY EXISTS.

| <REVISIONS> | |
|---|---|
| 01/15/96 | D.B. |
| 12/11/96 | D.B. |
| | |
| | |
| | |
| | |
| | |
| | |

**GENWAL RESOURCES, INC.**

P.O. Box 1420 195 North 100 West Huntington, Utah
Telephone (801) 687-1813

CRANDALL CANYON MINE
RECLAMATION (PHASE I)

| | | | |
|---|---|---|---|
| DRAWN BY: | WOLF DRAFTING | ACAD REF: | PHASEI |
| DATE: | 01/01/96 | PLATE # | 5-16 |
| SCALE: | AS SHOWN | | |