APPENDIX 6

OFFICE OF SURFACE MINING
REPORT ON
SEEPAGE BARRIER STABILITY

BLANK PAGE

OFFICE OF SURFACE MINING (OSM)
REPORT ON
SEEPAGE BARRIER STABILITY

PREPARED IN RESPONSE TO THE OCTOBER 11, 2000,
IMPOUNDMENT BREAKTHROUGH
AT
MARTIN COUNTY COAL CORPORATION (MCCC)
BIG BRANCH SLURRY IMPOUNDMENT

This report was prepared by OSM as a part of its review of the MCCC 2000 breakthrough. This report addresses the stability of the seepage barrier at the 2000 breakthrough. The stability of the seepage barrier in the area of the 2000 breakthrough was analyzed using the Galena Slope Stability Analysis System software program.

Slope Configurations

Analyses were run for two separate seepage barrier slope configurations (Figures 1 and 2) under various fine refuse/water levels. A pool level 14 feet above the slurry was assumed for the initial configuration when the slurry was at 986 feet mean sea level (msl) elevation. A pool level of 15 feet above the slurry was assumed for all other configurations (slurry levels of 1,005, 1,025, and 1,045 feet msl elevation). One configuration was based on the designed seepage barrier as represented in the "Impoundment Sealing Plan" dated August 8, 1994. The second configuration was based on the actual constructed slope as represented on drawings contained in the annual certifications for the impoundment and original pre-impoundment surface slope in the area of the breakthrough as shown in the plans.

Material Parameters

Two separate analyses were run on each slope configuration; one each for consolidated and unconsolidated fine refuse material parameters (as shown below). The strength parameters (angle of internal friction and cohesion) for the seepage barrier and original surface materials were based on test results from samples collected as part of the Mine Safety and Health Administration investigation. Parameters for the fine refuse were based on data presented in the stability analysis contained in the permit revision that included the seepage barrier (permit revision 5, dated August 1994, Attachment 25.3.B).

Analysis Parameters – Consolidated Fine Refuse			
Material	**Unit Weight** (PCF)	**Angle of Internal Friction**	**Cohesion** (PSF)
Seepage Barrier	125	36.7	0
Fine Refuse	100	33	0
Original Surface	125	35.1	0

Analysis Parameters – Unconsolidated Fine Refuse			
Material	**Unit Weight** (PCF)	**Angle of Internal Friction**	**Cohesion** (PSF)
Seepage Barrier	125	36.7	0
Fine Refuse	70	22	0
Original Surface	125	35.1	0

Analysis Results

The results as indicated by factors of safety (FS) are shown in the tables below. In general, FS's are shown to increase as impoundment levels increase from the 1,000-foot elevation level to the 1,060-foot elevation level. The two exceptions to this trend are a slight decrease in FS from the 1,040-foot elevation level to the 1,060-foot elevation level for the designed configuration and from the 1,020-foot elevation level to the 1,040-foot elevation level for the constructed configuration.

Results of multiple failure surface analyses identifying the minimum FS for each scenario (shown in the tables under the "Minimum" columns) range from 1.3 to 1.5 for the designed barrier configuration and from 1.1 to 2.FS correspond to shallow failure surfaces on the face of the barrier. Failures under these conditions would result in what can be described as sloughing of the barrier face (see Figure 3 for an example). The three exceptions to the shallow failure scenarios occurred in analyses using unconsolidated refuse parameters: 1) 1.2 FS at the 1,000-foot pool elevation level of the constructed configuration (Figure 3); 2) 1.3 FS at the 1,000-foot pool elevation level of the designed configuration (Figure 4); and 3) 1.6 FS at the 1,020-foot pool elevation level of the constructed configuration (Figure 5). The "worst- case" failure surface shown in Figures 3 and 4 indicate a deep failure with the toe at/near the impoundment bank opposite the 2000 breakthrough and within the area of the seepage barrier constructed on that bank. (The portion of the seepage barrier installed on the opposite bank was not considered in the analysis.)

Designed Configuration

"Designed" Slope Stability Analysis Results (FS)								
Pool Elevation (feet)	Consolidated Fine Refuse				Unconsolidated Fine Refuse			
	Bishop		Spencer-Wright		Bishop		Spencer-Wright	
	Initial Surface (A)	Minimum (B)	Initial Surface (A)	Minimum (B)	Initial Surface (A)	Minimum (B)	Initial Surface (A)	Minimum (B)
1,060	1.8	1.5	1.8	1.5	1.8	1.5	1.8	1.5
1,040	1.9	1.5	1.9	1.5	1.9	1.5	1.9	1.5
1,020	1.8	1.5	1.8	1.5	1.8	1.5	1.8	1.5
1,000	1.7	1.3	1.7	1.5	1.7	1.3	1.7	1.3

A- Initial failure surface as represented by a circle through the top of barrier slope and toe of slope at the respective fine refuse level, with radius to approximate intersection with original ground surface.
B- Minimum FS using multiple failure surface analyses.

Constructed Configuration

"Constructed" Slope Stability Analysis Results (FS)								
Pool Elevation (feet)	Consolidated Fine Refuse				Unconsolidated Fine Refuse			
	Bishop		Spencer-Wright		Bishop		Spencer-Wright	
	Initial Surface (A)	Minimum (B)	Initial Surface (A)	Minimum (B)	Initial Surface (A)	Minimum (B)	Initial Surface (A)	Minimum (B)
1,060	2.8	1.8	2.8	1.8	2.8	1.8	2.8	1.8
1,040	2.4	1.8	2.4	1.8	2.4	1.8	2.4	1.8
1,020	2.2	2.0	2.2	2.0	2.2	1.6	2.2	1.6
1,000	2.1	1.4(C)	2.1	1.4(C)	2.1	1.2(C)	2.1	1.2(C)

A- Initial failure surface as represented by a circle through the top of barrier slope and toe of slope at the respective fine refuse level, with radius to approximate intersection with original ground surface.
B- Minimum FS using multiple failure surface analyses.
C-The indicated factor of safety represents the minimum that resulted in a significant deep failure surface. Actual minimum FS identified in the analysis was 1.1; however, this corresponded to a very shallow failure surface.

Conclusion

The analyses for the "Designed" slope configuration indicated minimum FS ranging from 1.3 to 1.5. The configuration for the 1,000-foot pool elevation resulted in a FS of 1.3. All configurations above this level resulted in a minimum safety factor of 1.5.

The analyses for the "Constructed" slope configuration resulted in minimum FS from 1.1 to 2.0. Configurations above the 1,000-foot pool elevation resulted in FS of 1.6 or greater indicating a stable barrier slope.

The 1.1 FS occurred at the 1,000-foot pool elevation level. The corresponding failure surface indicates sloughing of the barrier from just above the 1,000-foot water surface down to the slurry level (approximately 986 feet msl). This would have occurred before slurry was added to the impoundment. If a failure occurred that was so minor as not to be noticed (i.e., not reported by the company and/or noted in the annual certification), it would have been filled as the slurry level was increased. It is not likely that such a failure would have been significant enough to threaten the overall stability of the barrier fill or contribute to the 2000 breakthrough.

The next lowest FS at the 1,000-foot pool level was 1.2. Failure at this zone would have been fairly deep and would extend into the slurry foundation. This failure would be expected to produce a noticeable head-scarp at about 1,040 feet msl. The toe of the indicated failure surface would occur in the area of the seepage barrier that would have been constructed on the opposite impoundment bank. Although that portion of the barrier was not considered in the analysis, it would be expected to provide additional confining support that would result in an increased FS. If the failure had occurred during construction and prior to final dozer grading, the final grading would have covered the head scarp. However, neither the weekly inspections nor the annual certifications reported any slope failures. It is not likely that slope failure was a contributing factor to the breakthrough event.

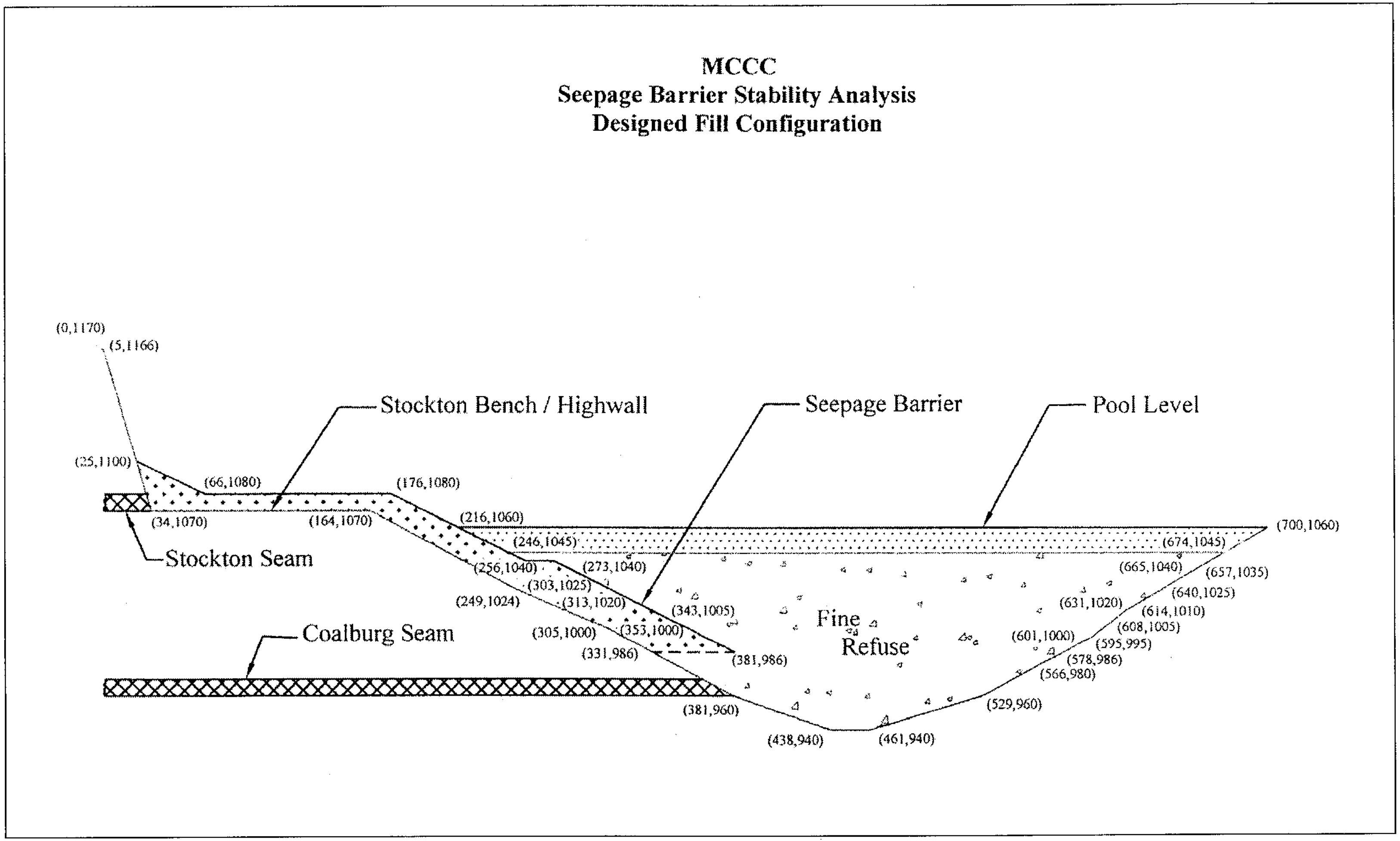
MCCC
Seepage Barrier Stability Analysis
Designed Fill Configuration
Stockton Bench / Highwall
Seepage Barrier
Pool Level
Stockton Seam
Coalburg Seam
Fine Refuse
(0,1170)
(5,1166)
(25,1100)
(66,1080)
(34,1070)
(164,1070)
(176,1080)
(216,1060)
(246,1045)
(256,1040)
(273,1040)
(303,1025)
(313,1020)
(249,1024)
(343,1005)
(353,1000)
(305,1000)
(331,986)
(381,986)
(381,960)
(438,940)
(461,940)
(529,960)
(566,980)
(578,986)
(595,995)
(601,1000)
(608,1005)
(614,1010)
(631,1020)
(640,1025)
(657,1035)
(665,1040)
(674,1045)
(700,1060)

Figure 1.

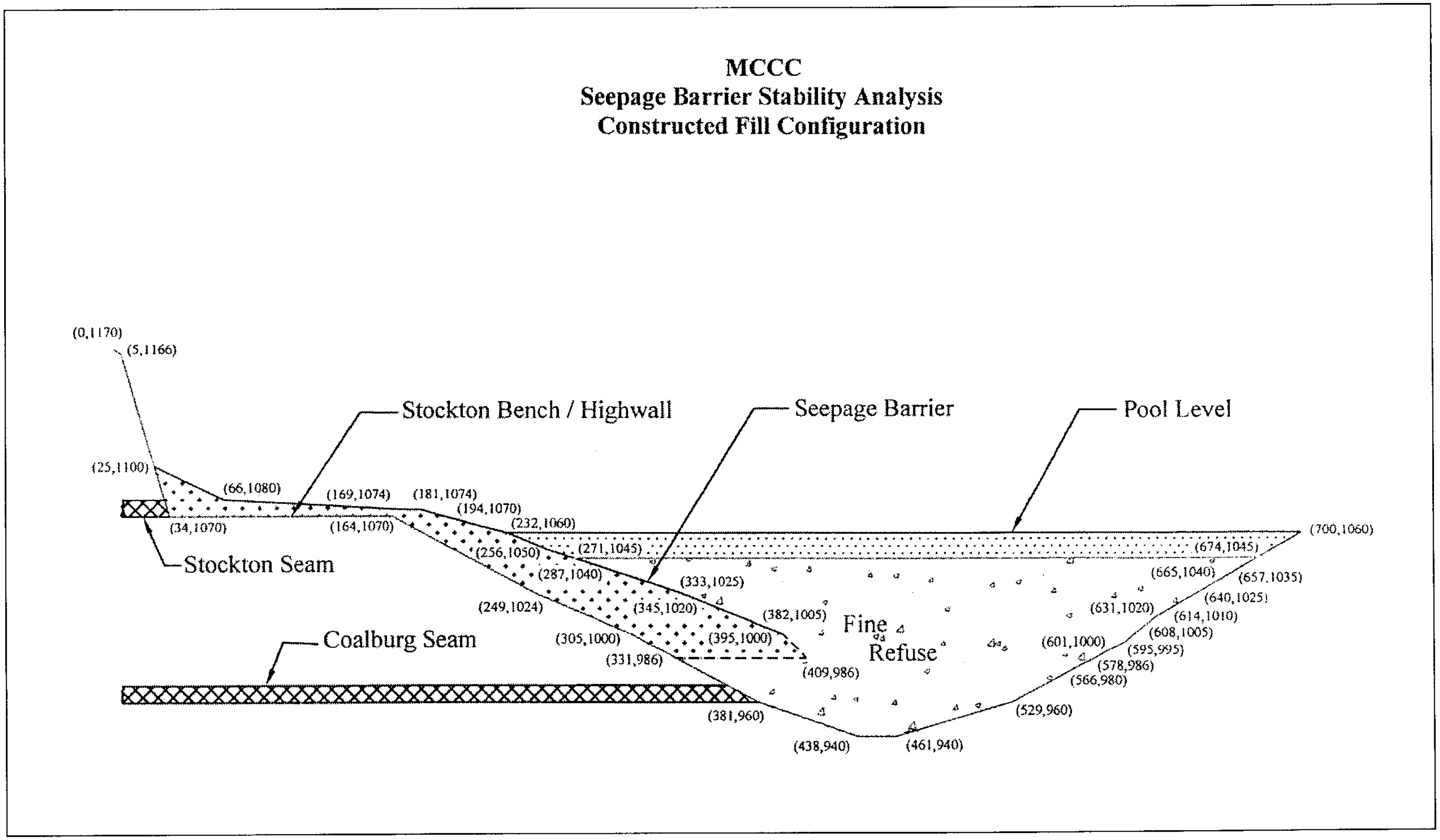
MCCC
Seepage Barrier Stability Analysis
Constructed Fill Configuration
Stockton Bench / Highwall
Seepage Barrier
Pool Level
Stockton Seam
Coalburg Seam
Fine
Refuse
(0,1170)
(5,1166)
(25,1100)
(66,1080)
(34,1070)
(169,1074)
(164,1070)
(181,1074)
(194,1070)
(232,1060)
(271,1045)
(256,1050)
(287,1040)
(249,1024)
(333,1025)
(345,1020)
(305,1000)
(331,986)
(382,1005)
(395,1000)
(409,986)
(381,960)
(438,940)
(461,940)
(529,960)
(566,980)
(578,986)
(595,995)
(601,1000)
(608,1005)
(614,1010)
(631,1020)
(640,1025)
(657,1035)
(665,1040)
(674,1045)
(700,1060)

Figure 2.

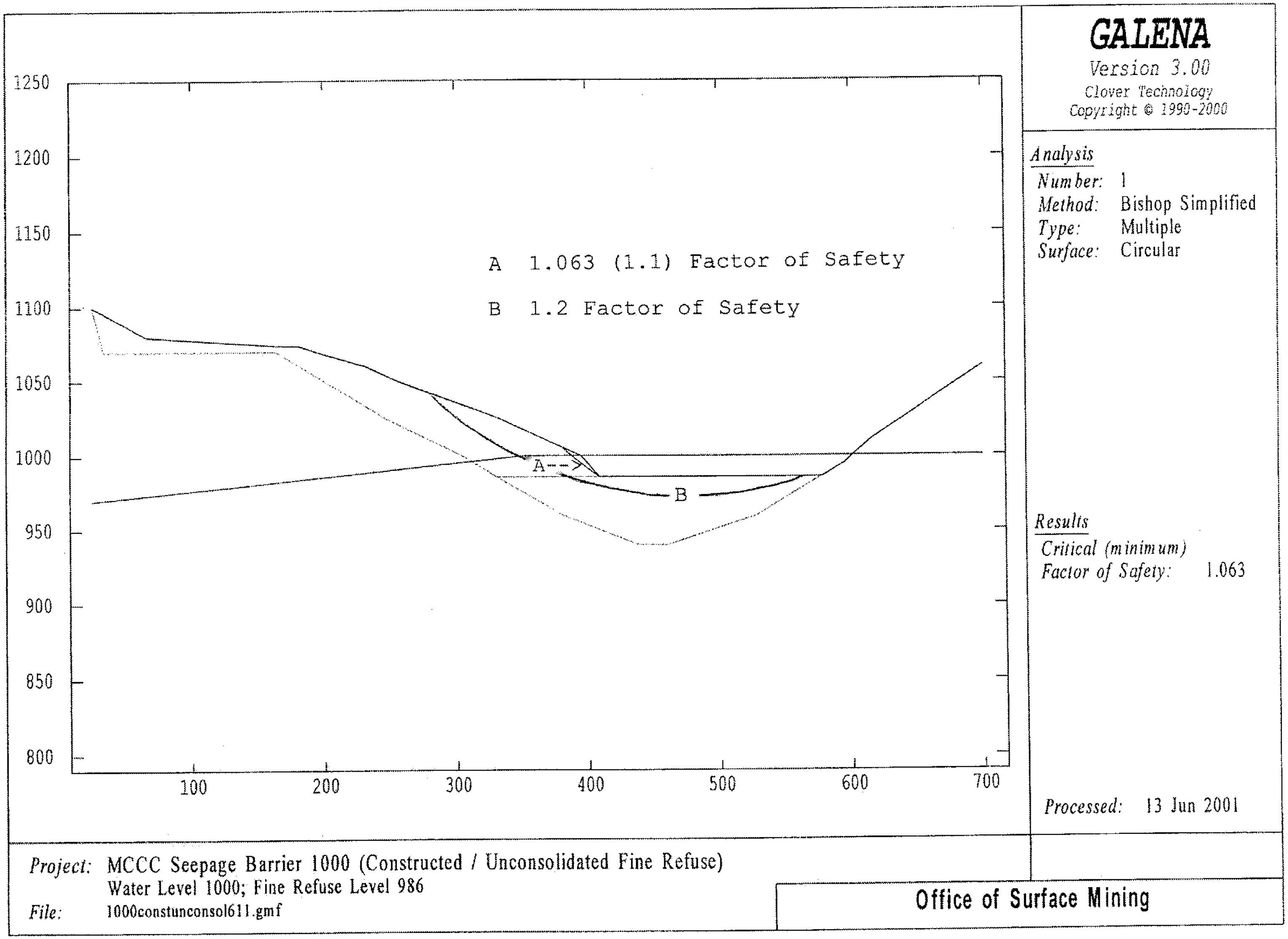
GALENA
Version 3.00
Clover Technology
Copyright © 1990-2000
Analysis
Number: 1
Method: Bishop Simplified
Type: Multiple
Surface: Circular
A 1.063 (1.1) Factor of Safety
B 1.2 Factor of Safety
A-->
B
1250
1200
1150
1100
1050
1000
950
900
850
800
100
200
300
400
500
600
700
Results
Critical (minimum)
Factor of Safety: 1.063
Processed: 13 Jun 2001
Project: MCCC Seepage Barrier 1000 (Constructed / Unconsolidated Fine Refuse)
Water Level 1000; Fine Refuse Level 986
File: 1000constunconsol611.gmf
Office of Surface Mining

Figure 3.

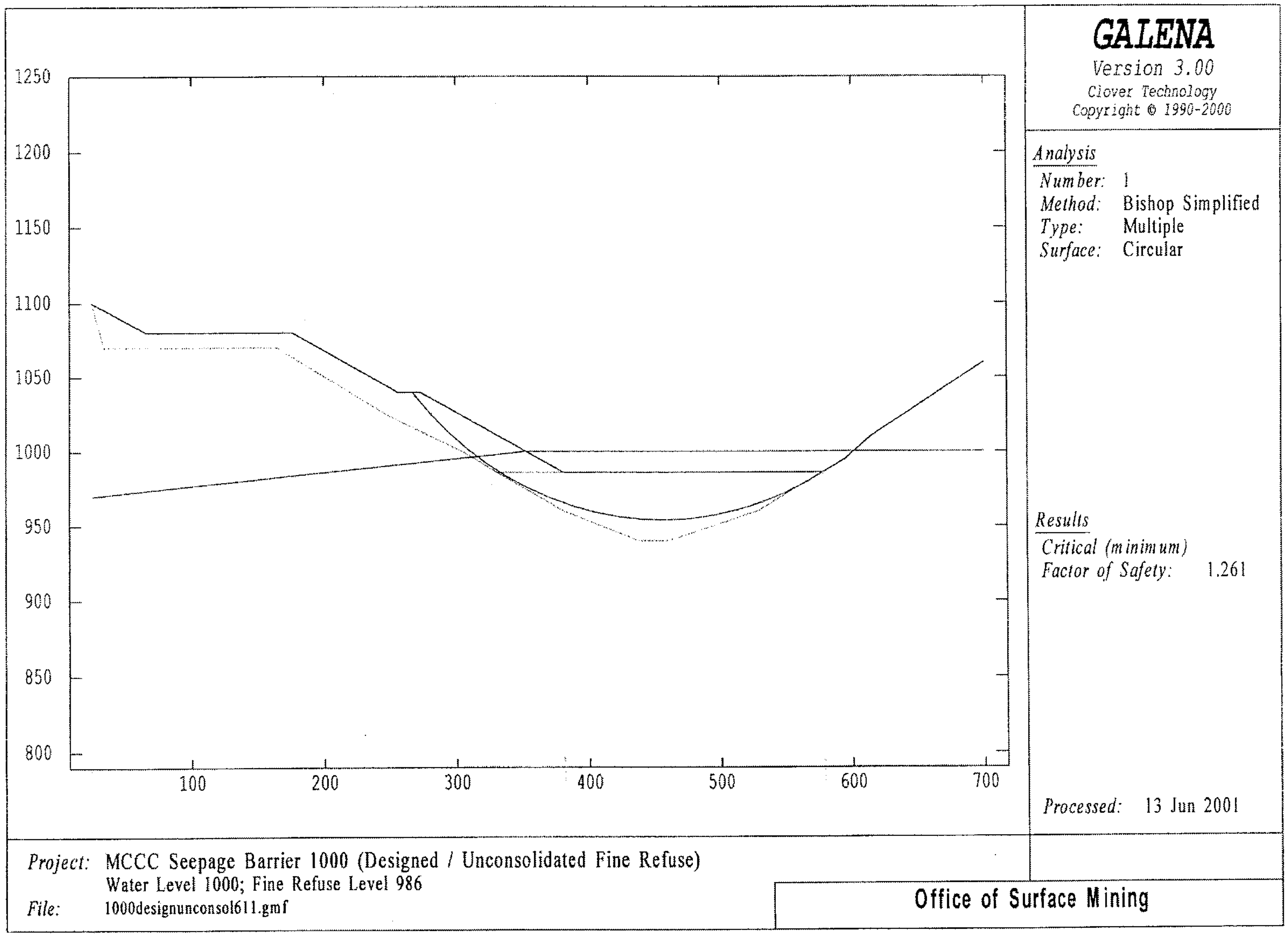
GALENA
Version 3.00
Clover Technology
Copyright © 1990-2000
Analysis
Number: 1
Method: Bishop Simplified
Type: Multiple
Surface: Circular
Results
Critical (minimum)
Factor of Safety: 1.261
Processed: 13 Jun 2001
1250
1200
1150
1100
1050
1000
950
900
850
800
100
200
300
400
500
600
700
Project: MCCC Seepage Barrier 1000 (Designed / Unconsolidated Fine Refuse)
Water Level 1000; Fine Refuse Level 986
File: 1000designunconsol611.gmf
Office of Surface Mining

Figure 4.

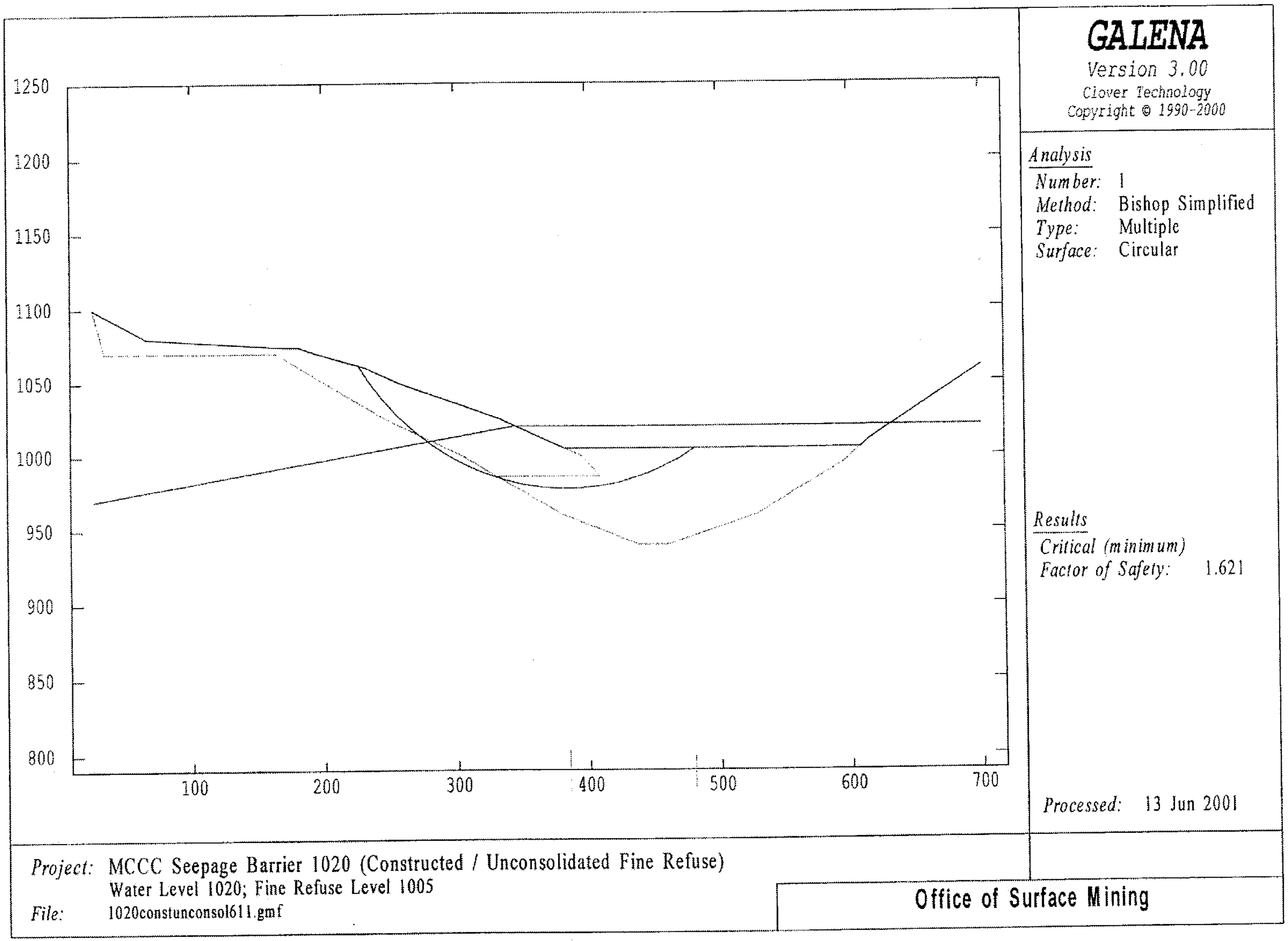
GALENA
Version 3.00
Clover Technology
Copyright © 1990-2000
Analysis
Number: 1
Method: Bishop Simplified
Type: Multiple
Surface: Circular
Results
Critical (minimum)
Factor of Safety: 1.621
Processed: 13 Jun 2001
1250
1200
1150
1100
1050
1000
950
900
850
800
100
200
300
400
500
600
700
Project: MCCC Seepage Barrier 1020 (Constructed / Unconsolidated Fine Refuse)
Water Level 1020; Fine Refuse Level 1005
File: 1020constunconsol611.gmf
Office of Surface Mining

Figure 5.

BLANK PAGE