



COLORADO
**Division of Reclamation,
Mining and Safety**
Department of Natural Resources
1313 Sherman Street, Room 215
Denver, CO 80203

MEMORANDUM

Date: May 26, 2020

To: Daniel Cunningham; Division of Reclamation, Mining & Safety

From: Peter Hays; Division of Reclamation, Mining & Safety

Re: **Austin & Betsy Clennin; Becker Pit; File No. M-2020-022**
Exhibit 6.5 - Geotechnical Stability Exhibit Review

The Division of Reclamation, Mining and Safety (Division/DRMS) reviewed the Geotechnical Stability Exhibit received from Environment, Inc. on May 13, 2020 for the Becker Pit 110c permit application, File No. M-2020-022.

The following list describes the information used by the Division as presented in the permit application to evaluate the slope stability for the proposed site:

- The Geotechnical Stability Exhibit was submitted to address the plan to mine within 200 feet of a dirt road owned by the Colorado State Land Board (SLB) located in the southeast corner of the permit area.
- The proposed setback from the SLB owned dirt road to the property line is 25 feet and the setback from the property line to top of slope (Dig Line) is 10 feet for a total setback of 35 feet.
- The perimeter slopes adjacent to the SLB road will be mined at the final 3.75H:1V slope.
- Geotechnical boring and sampling data is not available for the site.
- The soil strength parameters were determined based on typical values for the anticipated soil type.
- The site will be mined from 25 to 30 feet below grade. The pit depth was modeled at 30 feet below grade.
- No topsoil was modeled by the Applicant, however an average of 8 inches will be replaced during reclamation.
- Bedrock was modeled as sandstone by the Division.
- Groundwater will not be exposed by the mining excavation.



- A factor of safety of 3.44 for Section A and 3.38 for Section B were calculated by the Applicant.

In accordance with Table 1 - Recommended Factors of Safety for Slope Stability Analysis for Operations and Reclamation within Section 30.4 of the Policies of the Mined Land Reclamation Board (MLRB) effective May 16, 2018, the Division will require the Applicant to comply with the factor of safety (FOS) of 1.5 for critical structures in static conditions since the Applicant utilized generalized strength measurements in the analysis.

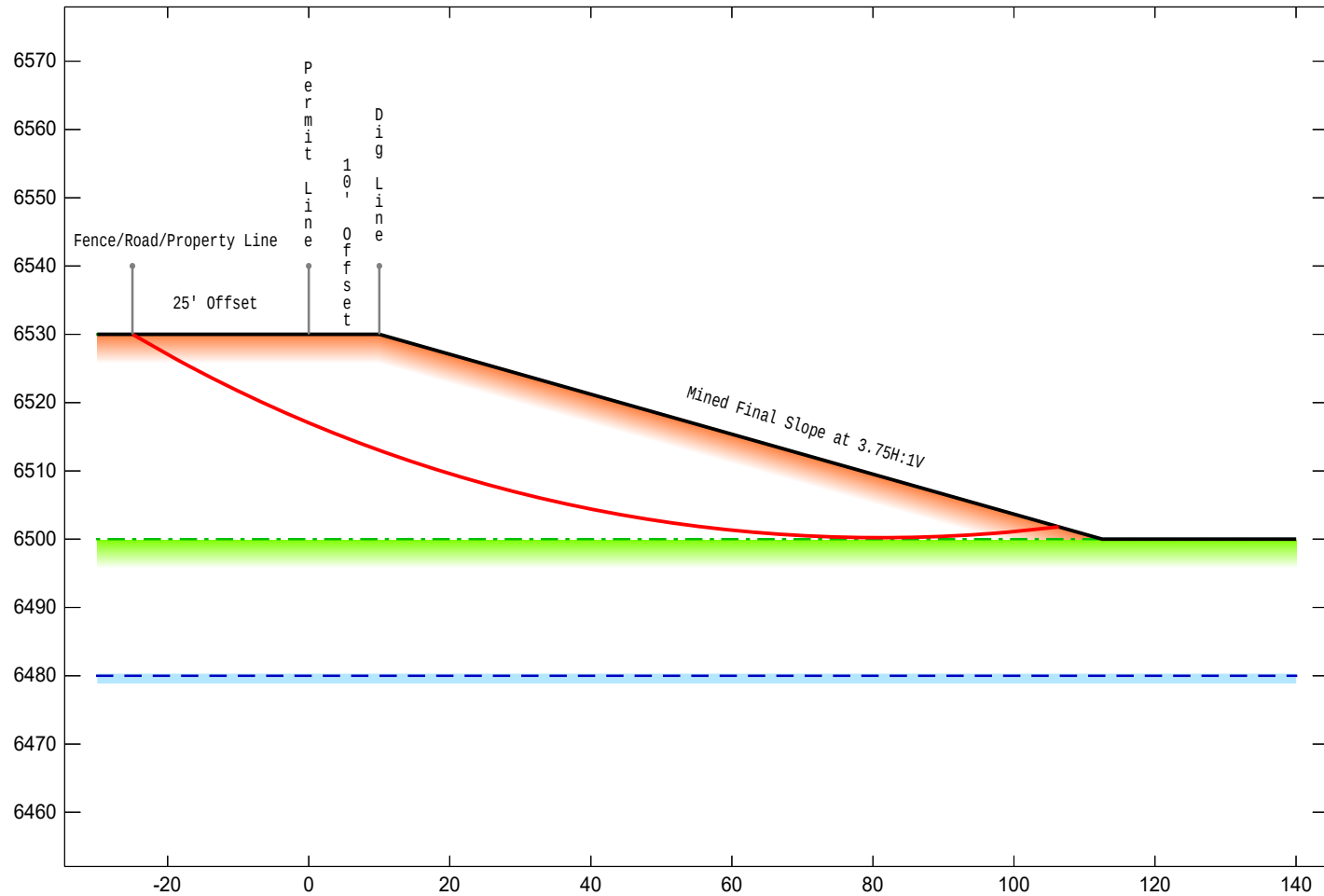
The Division replicated the Applicant's slope stability analysis using Clover Technologies Galena Slope Stability Analysis System, Version 7.2 with the X-Left coordinate maintained at the edge of the Fence/Road Property Line. A table of the Applicant's and the Division's analysis results are below:

Analysis Name	Applicant's FOS	DRMS FOS
Section A	3.44	3.18
Section B	3.38	3.93

The cross-sections were represented on Mining Plan Map - Exhibit E-2 (Revised 4/6/2020)

The Division accepts the proposed mining plan setback from the SLB owned road at the Becker Pit. If groundwater is intercepted and/or the soils differ from the expected profile, the Applicant must contact the Division immediately and reevaluate the stability analysis based on the updated information. Please note any transgression of the proposed setback and sloping will be considered a permit violation if the permit is approved and issued. The Division's stability analysis results are attached.

If you have any questions regarding these adequacy items, please contact me at peter.hays@state.co.us or (303) 866-3567, Ext. 8124.



GALENA Version 7.2

Material Keys

1: Rocky Sand & Gravel

2: Sandstone Bedrock

Analysis 1

Single Stability Analysis

Method: Spencer-Wright

Surface: Circular

Results

Factor of Safety: 3.18

Interslice Force (Final) Angle: 12.2°

Edited: 20 May 2020 Processed: 26 May 2020

Project Becker Pit / M-2020-022
Section A

File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\Becker Pit\Section A.gmf

Dept of the Interior - Office of Surface Mining

Project: Becker Pit / M-2020-022
 File: G:\My Drive\1 - My Projects Google\8 Galena - Stability Analysis Models\Becker Pit\Section B.gmf
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DATA: Analysis 1 - Section B

Material Properties (2 materials)

Material: 1 (Mohr-Coulomb Isotropic) - Rocky Sand & Gravel
 Cohesion Phi UnitWeight Ru
 0.00 35.0 130.00 Auto
 Material: 2 (Mohr-Coulomb Isotropic) - Sandstone Bedrock
 Cohesion Phi UnitWeight Ru
 500.00 35.0 140.00 Auto

Water Properties

Unit weight of water: 62.400 Unit weight of water/medium above ground: 0.000

Material Profiles (2 profiles)

Profile: 1 (2 points) Material beneath: 1 - Rocky Sand & Gravel
 -30.00 6530.00 140.00 6530.00
 Profile: 2 (2 points) Material beneath: 2 - Sandstone Bedrock
 -30.00 6500.00 140.00 6500.00

Slope Surface (4 points)

-30.00 6530.00 10.00 6530.00 119.30 6500.00 140.00 6500.00

Phreatic Surface (2 points)

-30.00 6480.00 140.00 6480.00

Failure Surface

Circular surface defined by: XL,XR,R

Intersects: XL: -26.00 YL: 6530.00 XR: 120.00 YR: 6500.00
 Centre: XC: 90.36 YC: 6726.02 Radius: R: 227.96

RESULTS: Analysis 1 - Section B

Spencer-Wright Method of Analysis - Circular Failure Surface

Factor of Safety: 3.93

Final Angle of Interslice Forces: 10.8 degrees

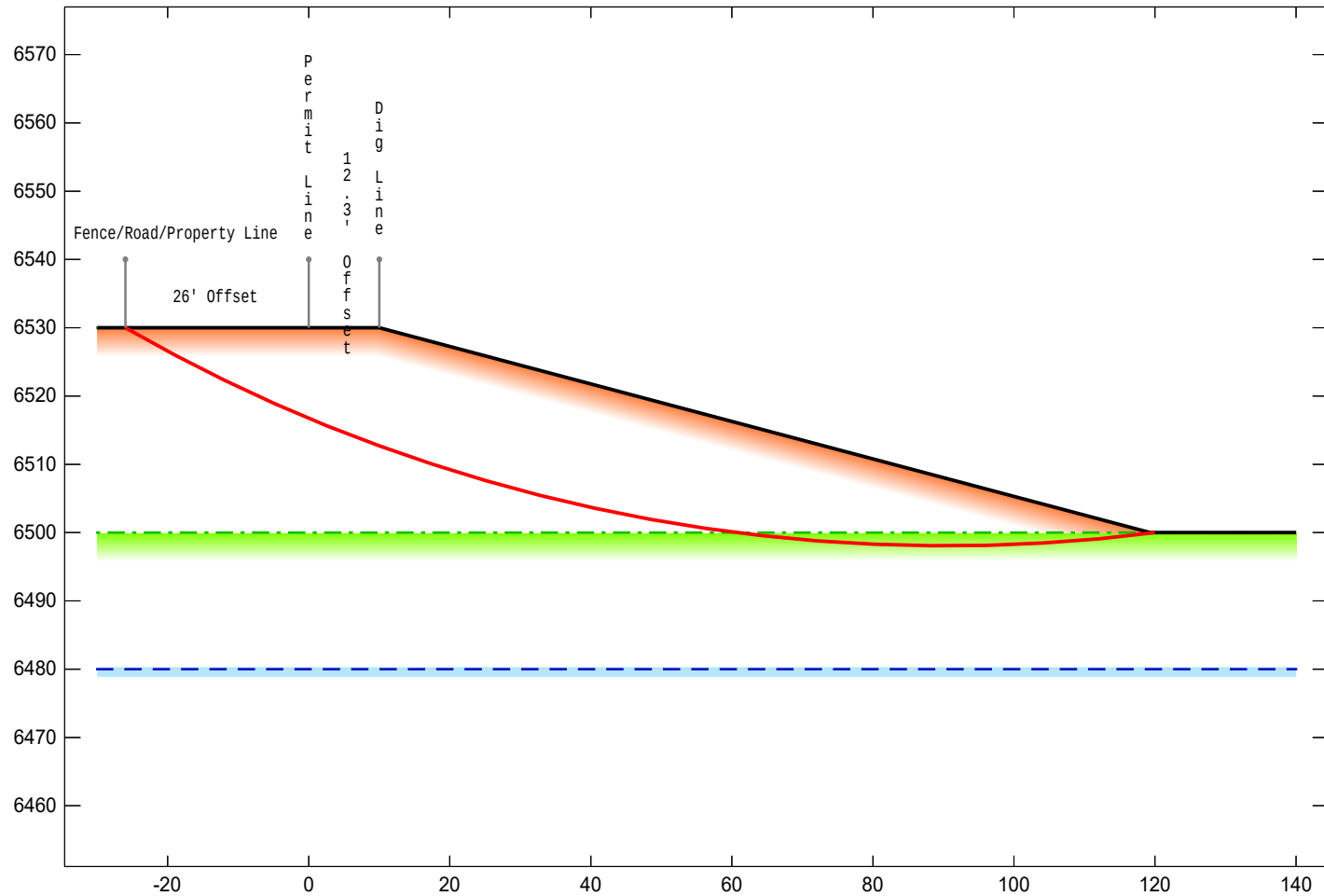
Negative interslice forces exist on one or more slices; examine slice data and consult the GALENA Help utility

Effective stress line-of-thrust is not within one or more slices; examine slice data and consult the GALENA Help utility

Slice Geometry and Properties (39 slices)

Slice	X-Left	X-S Area	Angle	Width	Base Length	Matl	Cohesion	Phi	Weight	Porewater Force	--- Left Hand Side --- Side Force	l/h	l'/h
1	-26.00	3.43	29.7	3.47	4.00	1	0.00	35.0	446.40	0.00	0.00	0.00	0.00
2	-22.53	10.30	29.7	3.47	4.00	1	0.00	35.0	1339.63	0.00	151.39	0.33	0.33
3	-19.06	17.29	27.7	3.54	4.00	1	0.00	35.0	2247.57	0.00	605.70	0.25	0.25
4	-15.52	23.86	27.7	3.54	4.00	1	0.00	35.0	3101.27	0.00	1289.27	0.23	0.23
5	-11.98	30.74	25.7	3.60	4.00	1	0.00	35.0	3996.28	0.00	2232.14	0.22	0.22
6	-8.38	36.97	25.7	3.60	4.00	1	0.00	35.0	4806.42	0.00	3308.26	0.21	0.21
7	-4.78	43.68	23.7	3.66	4.00	1	0.00	35.0	5677.77	0.00	4602.53	0.21	0.21
8	-1.12	49.55	23.7	3.66	4.00	1	0.00	35.0	6440.89	0.00	5935.53	0.21	0.21
9	2.54	55.99	21.7	3.71	4.00	1	0.00	35.0	7278.79	0.00	7446.98	0.20	0.20
10	6.25	61.46	21.7	3.71	4.00	1	0.00	35.0	7990.45	0.00	8904.81	0.20	0.20
11	9.97	65.68	19.6	3.76	4.00	1	0.00	35.0	8537.79	0.00	10504.28	0.19	0.19
12	13.73	66.84	19.7	3.76	4.00	1	0.00	35.0	8689.71	0.00	11919.69	0.20	0.20
13	17.49	68.55	17.6	3.81	4.00	1	0.00	35.0	8911.05	0.00	13361.26	0.21	0.21
14	21.30	69.17	17.6	3.81	4.00	1	0.00	35.0	8992.75	0.00	14531.01	0.22	0.22
15	25.11	70.26	15.6	3.85	4.00	1	0.00	35.0	9133.84	0.00	15711.48	0.22	0.22
16	28.96	70.34	15.6	3.85	4.00	1	0.00	35.0	9144.35	0.00	16595.07	0.23	0.23
17	32.81	70.78	13.6	3.88	4.00	1	0.00	35.0	9201.65	0.00	17479.67	0.24	0.24
18	36.69	70.30	13.6	3.88	4.00	1	0.00	35.0	9138.54	0.00	18047.54	0.24	0.24
19	40.57	70.08	11.6	3.91	4.00	1	0.00	35.0	9110.29	0.00	18612.60	0.25	0.25
20	44.49	69.02	11.6	3.91	4.00	1	0.00	35.0	8972.90	0.00	18855.37	0.25	0.25
21	48.40	68.13	9.6	3.94	4.00	1	0.00	35.0	8856.46	0.00	19095.56	0.25	0.25
22	52.34	66.50	9.6	3.94	4.00	1	0.00	35.0	8644.39	0.00	19016.39	0.25	0.25
23	56.28	76.83	7.6	4.70	4.74	1	0.00	35.0	9987.57	0.00	18939.12	0.26	0.26
24	60.98	50.80	7.6	3.22	3.25	2	500.00	35.0	6610.44	0.00	18489.60	0.26	0.26
25	64.20	60.45	5.6	3.98	4.00	2	500.00	35.0	7883.32	0.00	17773.93	0.26	0.26
26	68.18	57.66	5.6	3.98	4.00	2	500.00	35.0	7535.55	0.00	16610.16	0.27	0.27
27	72.15	54.73	3.6	3.99	4.00	2	500.00	35.0	7167.98	0.00	15474.83	0.27	0.27
28	76.14	51.36	3.6	3.99	4.00	2	500.00	35.0	6740.29	0.00	14096.95	0.28	0.28
29	80.13	47.78	1.6	3.99	4.00	2	500.00	35.0	6282.09	0.00	12769.97	0.29	0.29
30	84.12	43.84	1.6	3.99	4.00	2	500.00	35.0	5773.80	0.00	11249.98	0.29	0.29
31	88.12	39.63	-0.4	4.00	4.00	2	500.00	35.0	5228.36	0.00	9810.83	0.30	0.30

32	92.11	35.13	-0.4	4.00	4.00	2	500.00	35.0	4641.51	0.00	8246.26	0.31	0.31
33	96.11	30.32	-2.5	3.99	4.00	2	500.00	35.0	4012.32	0.00	6796.28	0.31	0.31
34	100.10	25.26	-2.5	3.99	4.00	2	500.00	35.0	3348.18	0.00	5300.39	0.32	0.32
35	104.09	19.89	-4.5	3.98	4.00	2	500.00	35.0	2640.15	0.00	3961.81	0.34	0.34
36	108.08	14.30	-4.5	3.98	4.00	2	500.00	35.0	1900.81	0.00	2672.71	0.35	0.35
37	112.06	7.91	-6.5	3.62	3.64	2	500.00	35.0	1053.49	0.00	1589.41	0.38	0.38
38	115.68	2.83	-6.5	3.62	3.64	2	500.00	35.0	377.98	0.00	736.80	0.43	0.43
39	119.30	0.03	-6.4	0.70	0.70	2	500.00	35.0	3.88	0.00	101.07	1.35	1.35
RHS	120.00	-----			-----				-----		-0.42	0.00	0.00
X-S Area:		1777.66	Path Length:		151.83	X-S Weight:		231846.88					



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Interslice Force (Final) Angle: 10.8 °

Edited: 20 May 2020 Processed: 26 May 2020

Project Becker Pit / M-2020-022
Section B

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Project: Becker Pit / M-2020-022
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	X-S Area:	1777.66		Path Length:	151.83			X-S Weight:	231846.88				
