DIVISION OF RECLAMATION, MINING AND SAFETY
Department of Natural Resources

1313 Sherman St., Room 215
Denver, Colorado 80203
Phone: (303) 866-3567
FAX: (303) 832-8106

John W. Hickenlooper
Governor

Mike King
Executive Director

Loretta Piñeda
Director

February 18, 2014

Glen Williams
Cotter Corporation
P.O. Box 700
Nucla, Colorado 81424

Re: Cotter Corporation, Mineral JD-6 Mine, File No. M-1977-310, Drainage Design Plan-AM01

Dear Mr. Williams:

Please see the Division's Engineer comments in an attached memo dated February 14, 2014

If you need additional information please contact me at the Division of Reclamation, Mining and Safety, Grand Junction Field Office, 101 S. 3rd St., Suite 301, Grand Junction, Colorado 81501, by telephone at 970.242.5025, or by e-mail at stephanie.mitchell@state.co.us.

Sincerely,

SMitchell

Stephanie Mitchell
Environmental Protection Specialist

Cc: Ed Cotter, DOE
Ec: Russ Means, DRMS

STATE OF COLORADO

DIVISION OF RECLAMATION, MINING AND SAFETY
Department of Natural Resources

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COLORADO DIVISION OF RECLAMATION MINING & SAFETY

MEMORANDUM

To: Stephanie Reigh

From: Tim Cazier, P.E. TC

Date: February 14, 2014

Re: **JD-6 Mine Drainage Design – Third Adequacy Review, Permit No. M-1977-310 / AM-01**

The Division of Reclamation, Mining and Safety (DRMS) engineering staff has reviewed the October 28, 2013 Drainage Design Plan for the JD-6 Mine prepared by Whetstone Associates, Inc. The following comments are posed to ensure adequate engineering analyses and design practices are implemented to eliminate or reduce to the extent practical the disturbance to the hydrologic balance expected by the mining operation with respect to water quality and quantity in accordance with Rules 3.1.6(1), 6.4.21(10) and 7.3.1. Please note, as this site is a designated mining operation (DMO), compliance with Rule 7.3.1 is applicable, thus requiring certified designs and specifications for engineered elements associated with the environmental protection plan (EPP). (*Note: the site specific technical and engineering content for this submittal is essentially the same as that submitted for the Mineral Joe Mine. The comments below are very similar, if not identical to comments on the Mineral Joe submittal, but are submitted separately as the two sites are separate permits*).

1. Hydrologic analyses corrections: The DRMS previously asked the Operator to correct subbasins N/C and N/D on Figure 1 to include the additional area contributing to the Upper Diversion Structure and the Middle Diversion Structure (Reference Figure 1, p. 13). This has not been corrected. Furthermore, these two diversions appear to terminate on the side of a hill, rather than in an existing drainage. Please provide the following:
   a. A discussion detailing why and how head cutting at the discharge point of the two diversion channels will not b a problem, and
   b. Revised subbasin map and hydrologic analyses to include the aforementioned additional contributing area for these tow diversion channels.
2. Existing channels: If the Operator intends to incorporate previously constructed channels, certified as-built drawings need to be provided along with a demonstration that the constructed channels still conform to the as-built condition and that the as-built condition can adequately convey the design peak flow under the aforementioned stability

and capacity constraints. If channels do not conform to the original design or were not designed for the required storm event they shall be reconstructed and/or redesigned as necessary. Based on photographs (e.g., Figures 6 & 10) and selected measured cross sections (e.g., Figure 5 & Attachment 3), the DRMS does not believe the geometry is consistent enough to successfully demonstrate adequate hydraulic performance. Furthermore, it appears an "average" cross-section is used for channel evaluation. This is unacceptable as it only takes one short reach with diminished conveyance to overtop ad breach the channel, leading to complete channel failure. The DRMS believes the existing channels should be reconstructed and/or redesigned as necessary.

3. Hydraulic stability: In the last paragraph on page 7 of the reviewed report, the author claims channels constructed in soil types C and D (per the Urban Drainage and Flood Control Manual) that stable conditions are met if the velocity is 7 ft/s **or** the Froude No. is 0.8. This is incorrect. The referenced manual requires the velocity $\leq$ 7 ft/s **and** Froude No. $\leq$ 0.8. The summary of results on pages 36-37, in Table 20 show all but two channel segments with Fr > 0.8 and most greater than 1.0. As previously stated by the DRMS, "earth-lined channels with a flow velocity greater than 5.0 feet per second (fps) will require revetment such as riprap to reduce the potential for scouring". Therefore, earth-lined channels with velocities > 5 ft/s must be redesigned to either lower the velocity or be designed with proper revetment. Note the existence of "cobble and boulder substrate" does not constitute proper revetment design. If the Operator wishes to pursue the "cobble and boulder substrate" material as stable, then analyses based on incipient motion, tractive force, and critical shear stress should be provided along with appropriate laboratory test showing channel substrate gradation. There are several published methods that can be used to evaluate this approach. The DRMS would require at least three of these methods demonstrate stable channels (for each reach with a different 100-year peak design flow and/or channel slope) and that a consistent channel geometry is, or will be present. Please provide the requisite designs and analyses.

4. Figure 15, p. 31: Three different symbols are shown, none of which are defined and all are different than those defined in Figure 14. Please provide an explanation of the symbols.

5. Table 17, p. 34: The submittal requires estimated runoff volumes resulting from the 10-year, 24-hour storm event and peak flows from the 100-year, 24-hour storm event. The DRMS could not find the requisite 10-year volumes and peak flows from three nonessential recurrence interval storms were provided. Please provide the requisite results and only the requisite results.

6. Conveyance capacity: The latest drainage design plan provides stage vs. flow tables to demonstrate compliance with freeboard requirements (e.g., Table 18, p. 35). These tables are presumably based on "average" channel sections (which are inadequate as stated above) and do not demonstrate the presence of adequate freeboard without tedious interpolation by the DRMS engineering staff. An example summary table of hydraulic evaluations for a hypothetical mine site is attached. Please make every effort to supply comparable information in the next response.

7. Plate 2: Plate 2 shows six check/drop structures (drop face) proposed for the Upper Diversion Channel. Please provide the following:

    a. Specifications or reference to specifications for the "D_{84} Grain Size of 16″",

b. Riprap or "D_{84} Grain Size of 16″" sizing analyses for the proposed revetment, and
c. An analysis demonstrating the hydraulic jump length is less than the proposed run out length of 11 feet.

8. Plate 6: Some explanation of the rock apron is required. Please provide the following:
   a. A discussion on why the rock apron terminates at the FL (presumed to be the flow line of an existing drainage).
   b. Why the asymmetrical shape of the rock apron is proposed,
   c. Dimensioned thickness of the rock apron and "D50 = 75″" material,
   d. Specifications or reference to specifications for the "D50 = 75″" material,
   e. Specifications or reference to specifications for the rock apron revetment, and
   f. How is the "D50 = 75″" material proposed for the spillway crest prevented from migrating into the presumably larger material in the rock apron.

In order to facilitate a faster review by the DRMS engineering staff of future response submittals, please include a response summary letter indicating how and where in the drainage design package each comment was addressed.

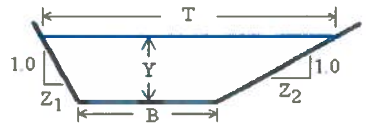
If either you or the applicants have any questions regarding the comments above, please call me at (303) 866-3567, extension 8169.

Enclosure

COLORADO DIVISION OF RECLAMATION MINING & SAFETY

Permittee: ACME Mining Company
Site Name: Vanadium Hill
Permit Number: M-1970-000

PRISMATIC CHANNEL DESIGN EVALUATION



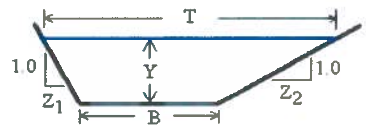
Date: 6/10/1971
Design by: AAA Consultants, Inc
Checked by: TC1

Absolute Minimum Freeboard, F_{min} (ft) = 0.5

Channel Information		Channel Design Geometry & Materials								Hydraulic Parameters			Hydraulic Calculations												Channel Evaluations		
Channel Segment ID	Design Peak Flow, Q (cfs)	Approx. Channel Length, L (ft)	Bed Slope, S (ft/ft)	Left Side Slope, Z_1 (H:1V)	Right Side Slope, Z_2 (H:1V)	Bottom Width, B (ft)	Min. Channel Design Depth, D (ft)	SELECT Roughness Code	Selected Channel Lining	SELECT Stability -OR- Capacity Parameters	Mannings 'n' for Stability (Velocity Calculation)	Mannings 'n' for Capacity (Depth Calculation)	Normal Flow Depth, Y (ft)	Flow Area, A (ft^2)	Flow Velocity, v (ft/sec)	Velocity Head, H_v (ft)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Top Width of Flow, T (ft)	Hydraulic Depth, d_h=A/T (ft)	Froude Number, Fr	Shear Force, τ_0 (lb/ft^2)	Available Freeboard, F (ft)	1/2 Velocity Head (ft)	Allowable Shear Stress Exceeded?	Sufficient Freeboard?	Allowable Velocity Exceeded?
Coll #1 (int) Seg 2	5.61	360	0.050	2.5	2.5	0.0	1.50	U1	Pre-mine Waste Rock	Stability	0.018		0.55	0.75	7.44	0.86	2.96	0.25	2.75	0.27	2.50	0.80	0.95	0.43	OK	OK	V > Vmax
										Capacity		*0.022*	**0.59**	*0.88*	*6.40*	*0.64*	*3.19*	*0.27*	*2.96*	*0.30*	*2.07*	*0.86*	*0.91*	*0.32*	*OK*	*OK*	*OK*
Coll #1 (int) Seg 3	5.61	100	0.075	2.5	2.5	0.0	1.25	U1	Pre-mine Waste Rock	Stability	0.018		0.51	0.65	8.66	1.17	2.74	0.24	2.51	0.25	3.03	1.11	0.74	0.58	OK	OK	V > Vmax
										Capacity		*0.022*	**0.55**	*0.75*	*7.45*	*0.86*	*2.95*	*0.25*	*2.74*	*0.27*	*2.51*	*1.19*	*0.70*	*0.43*	*OK*	*OK*	*OK*
Coll #1 (int) Seg 4	5.61	540	0.005	2.5	2.5	0.0	1.50	U2	Compacted Tailings	Stability	0.020		0.88	1.93	2.90	0.13	4.74	0.41	4.40	0.44	0.77	0.13	0.62	0.07	$\tau_o > \tau_{max}$	OK	OK
										Capacity		*0.025*	**0.96**	*2.29*	*2.45*	*0.09*	*5.15*	*0.44*	*4.78*	*0.48*	*0.63*	*0.14*	*0.54*	*0.05*	$\tau_o > \tau_{max}$	*OK*	*OK*
Coll #2 (int) Seg 1	5.61	780	0.030	2.5	2.5	0.0	1.25	U1	Pre-mine Waste Rock	Stability	0.018		0.60	0.91	6.14	0.59	3.25	0.28	3.02	0.30	1.97	0.53	0.65	0.29	OK	OK	V > Vmax
										Capacity		*0.022*	**0.65**	*1.06*	*5.29*	*0.43*	*3.51*	*0.30*	*3.26*	*0.33*	*1.63*	*0.57*	*0.60*	*0.22*	*OK*	*OK*	*OK*
Coll #2 (fin) Seg 1rec	8.02	150	0.303	1.5	1.5	2.0	1.75	RG	Grouted Riprap	Stability	0.028		0.29	0.72	11.15	1.93	3.06	0.23	2.88	0.25	3.93	4.44	1.46	0.97	OK	OK	OK
										Capacity		*0.040*	**0.36**	*0.92*	*8.73*	*1.18*	*3.30*	*0.28*	*3.08*	*0.30*	*2.82*	*5.26*	*1.39*	*0.59*	*OK*	*OK*	*OK*
Coll #2 (fin) Seg 2	8.02	120	0.077	2.5	2.5	0.0	1.75	U1	Pre-mine Waste Rock	Stability	0.018		0.58	0.84	9.57	1.42	3.12	0.27	2.90	0.29	3.13	1.29	1.17	0.71	OK	OK	V > Vmax
										Capacity		*0.022*	**0.62**	*0.97*	*8.23*	*1.05*	*3.36*	*0.29*	*3.12*	*0.31*	*2.60*	*1.39*	*1.13*	*0.53*	*OK*	*OK*	*OK*
Coll #3 Seg 1	1.57	160	0.165	2.5	2.5	0.0	1.50	U1	Pre-mine Waste Rock	Stability	0.018		0.27	0.19	8.47	1.11	1.47	0.13	1.36	0.14	4.04	1.30	1.23	0.56	OK	OK	V > Vmax
										Capacity		*0.022*	**0.29**	*0.22*	*7.29*	*0.82*	*1.58*	*0.14*	*1.47*	*0.15*	*3.35*	*1.40*	*1.21*	*0.41*	*OK*	*OK*	*OK*
Coll #3 Seg 2	4.06	620	0.036	2.5	2.5	0.0	1.25	RG	Grouted Riprap	Stability	0.028		0.61	0.93	4.36	0.29	3.29	0.28	3.05	0.31	1.39	0.64	0.64	0.15	OK	OK	OK
										Capacity		*0.040*	**0.70**	*1.22*	*3.33*	*0.17*	*3.76*	*0.32*	*3.49*	*0.35*	*0.99*	*0.73*	*0.55*	*0.09*	*OK*	*OK*	*OK*
Coll #3 Seg 3	9.58	470	0.005	2.5	2.5	0.0	1.75	U1	Pre-mine Waste Rock	Stability	0.018		1.03	2.67	3.59	0.20	5.57	0.48	5.17	0.52	0.88	0.15	0.72	0.10	OK	OK	OK
										Capacity		*0.022*	**1.11**	*3.10*	*3.09*	*0.15*	*6.00*	*0.52*	*5.57*	*0.56*	*0.73*	*0.16*	*0.64*	*0.07*	*OK*	*OK*	*OK*
Coll #4 Seg 1	4.79	300	0.015	2.5	2.5	0.0	1.25	U1	Pre-mine Waste Rock	Stability	0.018		0.65	1.05	4.55	0.32	3.49	0.30	3.24	0.32	1.41	0.28	0.60	0.16	OK	OK	OK
										Capacity		*0.022*	**0.70**	*1.22*	*3.92*	*0.24*	*3.77*	*0.32*	*3.50*	*0.35*	*1.17*	*0.30*	*0.55*	*0.12*	*OK*	*OK*	*OK*
Coll #5 Seg 1	2.41	630	0.022	2.5	2.5	0.0	1.25	U1	Pre-mine Waste Rock	Stability	0.018		0.47	0.54	4.43	0.30	2.51	0.22	2.33	0.23	1.62	0.30	0.78	0.15	OK	OK	OK
										Capacity		*0.022*	**0.50**	*0.63*	*3.81*	*0.23*	*2.71*	*0.23*	*2.52*	*0.25*	*1.34*	*0.32*	*0.75*	*0.11*	*OK*	*OK*	*OK*
Coll #5 Seg 2rec	2.41	20	0.840	1.5	1.5	2.0	1.25	RG	Grouted Riprap	Stability	0.028		0.11	0.23	10.34	1.66	2.39	0.10	2.32	0.10	5.75	5.12	1.14	0.83	OK	OK	OK
										Capacity		*0.040*	**0.13**	*0.29*	*8.22*	*1.05*	*2.48*	*0.12*	*2.40*	*0.12*	*4.15*	*6.19*	*1.12*	*0.52*	*OK*	*OK*	*OK*
Div #1 (int)	40.51	860	0.020	3.0	3.0	4.0	2.00	RM	Riprap - Medium (D50=12")	Stability	0.035		1.12	8.21	4.93	0.38	11.06	0.74	10.70	0.77	0.99	0.93	0.88	0.19	OK	OK	OK
										Capacity		*0.040*	**1.19**	*9.05*	*4.48*	*0.31*	*11.55*	*0.78*	*11.16*	*0.81*	*0.88*	*0.98*	*0.81*	*0.16*	*OK*	*OK*	*OK*
Div #1 (fin)	32.8	880	0.272	1.5	1.5	3.5	2.25	RG	Grouted Riprap	Stability	0.028		0.51	2.16	15.20	3.59	5.33	0.41	5.02	0.43	4.08	6.88	1.74	1.79	OK	F<Hv/2	OK
										Capacity		*0.040*	**0.62**	*2.75*	*11.91*	*2.20*	*5.74*	*0.48*	*5.36*	*0.51*	*2.93*	*8.14*	*1.63*	*1.10*	$\tau_o > \tau_{max}$	*OK*	*OK*
Div #1B (fin) Seg 1	10.6	150	0.050	2.5	2.5	0.0	2.00	U1	Pre-mine Waste Rock	Stability	0.018		0.70	1.21	8.72	1.18	3.75	0.32	3.49	0.35	2.60	1.01	1.30	0.59	OK	OK	V > Vmax
										Capacity		*0.022*	**0.75**	*1.41*	*7.51*	*0.87*	*4.05*	*0.35*	*3.76*	*0.38*	*2.16*	*1.09*	*1.25*	*0.44*	*OK*	*OK*	*OK*
Div #1B (fin) Seg 2	10.6	150	0.450	1.5	1.5	4.0	1.50	RG	Grouted Riprap	Stability	0.028		0.21	0.90	11.77	2.15	4.75	0.19	4.63	0.19	4.70	5.32	1.29	1.08	OK	OK	OK
										Capacity		*0.040*	**0.26**	*1.13*	*9.37*	*1.36*	*4.93*	*0.23*	*4.77*	*0.24*	*3.39*	*6.45*	*1.24*	*0.68*	*OK*	*OK*	*OK*
Div #1B (fin) Seg 3	10.6	290	0.050	2.5	2.5	0.0	2.00	U1	Pre-mine Waste Rock	Stability	0.018		0.70	1.21	8.72	1.18	3.75	0.32	3.49	0.35	2.60	1.01	1.30	0.59	OK	OK	V > Vmax
										Capacity		*0.022*	**0.75**	*1.41*	*7.51*	*0.87*	*4.05*	*0.35*	*3.76*	*0.38*	*2.16*	*1.09*	*1.25*	*0.44*	*OK*	*OK*	*OK*
Div #2	39.5	670	0.010	2.5	2.5	0.0	2.25	E	Earth-lined	Stability	0.022		1.66	6.93	5.70	0.51	8.96	0.77	8.32	0.83	1.10	0.48	0.59	0.25	OK	OK	V > Vmax
										Capacity		*0.025*	**1.75**	*7.62*	*5.18*	*0.42*	*9.40*	*0.81*	*8.73*	*0.87*	*0.98*	*0.51*	*0.50*	*0.21*	$\tau_o > \tau_{max}$	*OK*	*OK*

COLORADO DIVISION OF RECLAMATION MINING & SAFETY

PRISMATIC CHANNEL DESIGN EVALUATION



Permittee: ACME Mining Company
Site Name: Vanadium Hill
Permit Number: M-1970-000

Date: 6/10/1971
Design by: AAA Consultants, Inc
Checked by: TC1

Absolute Minimum Freeboard, F_{min} (ft) = 0.5

Channel Information		Channel Design Geometry & Materials								Hydraulic Parameters			Hydraulic Calculations												Channel Evaluations		
Channel Segment ID	Design Peak Flow, Q (cfs)	Approx. Channel Length, L (ft)	Bed Slope, S (ft/ft)	Left Side Slope, Z_1 (H:1V)	Right Side Slope, Z_2 (H:1V)	Bottom Width, B (ft)	Min. Channel Design Depth, D (ft)	SELECT Roughness Code	Selected Channel Lining	SELECT Stability -OR- Capacity Parameters	Mannings 'n' for Stability (Velocity Calculation)	Mannings 'n' for Capacity (Depth Calculation)	Normal Flow Depth, Y (ft)	Flow Area, A (ft^2)	Flow Velocity, v (ft/sec)	Velocity Head, H_v (ft)	Wetted Perimeter, P (ft)	Hydraulic Radius, R (ft)	Top Width of Flow, T (ft)	Hydraulic Depth, d_h=A/T (ft)	Froude Number, Fr	Shear Force, τ_o (lb/ft²)	Available Freeboard, F (ft)	1/2 Velocity Head (ft)	Allowable Shear Stress Exceeded?	Sufficient Freeboard?	Allowable Velocity Exceeded?
Div #3 Seg1rec	43.75	800	0.012	1.5	1.5	4.0	2.75	RG	Grouted Riprap	Stability	0.028		1.33	8.00	5.47	0.46	8.81	0.91	8.00	1.00	0.96	0.68	1.42	0.23	OK	OK	OK
										Capacity		*0.040*	1.61	*10.35*	*4.23*	*0.28*	*9.81*	*1.05*	*8.84*	*1.17*	*0.69*	*0.79*	*1.14*	*0.14*	*OK*	*OK*	*OK*
Div #3 Seg2rec	43.75	120	0.050	1.5	1.5	4.0	1.75	RG	Grouted Riprap	Stability	0.028		0.90	4.82	9.07	1.28	7.25	0.67	6.70	0.72	1.88	2.08	0.85	0.64	OK	OK	OK
										Capacity		*0.040*	1.10	*6.20*	*7.05*	*0.77*	*7.96*	*0.78*	*7.29*	*0.85*	*1.35*	*2.43*	*0.65*	*0.39*	*OK*	*OK*	*OK*
Div #3B	0.21	60	0.045	2.5	2.5	0.0	1.00	U1	Pre-mine Waste Rock	Stability	0.018		0.16	0.07	3.15	0.15	0.88	0.08	0.82	0.08	1.94	0.21	0.84	0.08	OK	OK	OK
										Capacity		*0.022*	0.18	*0.08*	*2.71*	*0.11*	*0.95*	*0.08*	*0.88*	*0.09*	*1.61*	*0.23*	*0.82*	*0.06*	*OK*	*OK*	*OK*
COLL A	4.36		0.010	3.0	10.0	0.0	1.00	U2	Compacted Tailings	Stability	0.020		0.48	1.52	2.86	0.13	6.40	0.24	6.29	0.24	1.03	0.15	0.52	0.06	τo > τmax	OK	OK
										Capacity		*0.025*	0.53	*1.80*	*2.42*	*0.09*	*6.95*	*0.26*	*6.84*	*0.26*	*0.83*	*0.16*	*0.47*	*0.05*	*τo > τmax*	*F < Fmin*	*OK*
COLL B	6.4		0.010	3.0	10.0	0.0	1.25	U2	Compacted Tailings	Stability	0.020		0.56	2.03	3.15	0.15	7.39	0.28	7.27	0.28	1.05	0.17	0.69	0.08	τo > τmax	OK	OK
										Capacity		*0.025*	0.61	*2.40*	*2.67*	*0.11*	*8.03*	*0.30*	*7.90*	*0.30*	*0.85*	*0.19*	*0.64*	*0.06*	*τo > τmax*	*OK*	*OK*

Manning's n Table (Mannings Velocity)

$v = 1.49/n\ Rh^{2/3}S^{1/2}$ Where: v = velocity (fps); n = roughness coeffient; Rh = Hydraulic Radius (ft); S = slope (ft/ft)

Lining Type	Mannings 'n' for Stability	Mannings 'n' for Capacity	Material	Maximum Velocity, Vmax (ft/s)	Maximum Shear Stress, τmax (lb/ft²)	Notes	Source
A	0.026	0.026	Articulated Concrete	25	6	limits depend on manufacturer	
C	0.011	0.015	Concrete	25	8		
Cl	0.020	0.023	Clay-lined	5	0.75		
E	0.022	0.025	Earth-lined	3	0.5		
G	0.030	0.035	Grass-lined	5	1.5		
I	0.013	0.017	Ductile Iron	50	10		
P	0.010	0.013	Plastic	25	10		
RG	**0.028**	**0.040**	Grouted Riprap	20	8	Use appropriate sizing methodology	ftp://ftp.odot.state.or.us/techserv/Geo-Environmental/Hydraulics/Hydraulics%20Manual/Chapter_08/Chapter_08_Appendix_A/Chapter_08_Appendix_A.p
RL	0.040	0.045	Riprap - Large (D50=24")	11	6	Use appropriate sizing methodology	
RM	0.035	0.040	Riprap - Medium	12	5	Use appropriate sizing methodology	
RS	0.032	0.036	Riprap - Small (D50=6")	10	4	Use appropriate sizing methodology	
T	0.025	0.035	Turf Reinf.	10	1.5	limits depend on manufacturer	
U1	**0.018**	**0.022**	Pre-mine Waste Rock	**6**	**2**	User defined	
U2	**0.020**	**0.025**	Compacted Tailings	5		User defined	
Z	0.005	0.080	Other	1	0.1	User defined	