

J&T Consulting, Inc.

June 10, 2024

Holcim Group | Holcim – WCR, Inc.
ATTN: Wyatt Webster
1687 Cole Blvd., Suite 300
Golden, CO 80401

RE: Irwin-Thomas Mine Pit Side Riprap Protection Sizing

Mr. Webster,

On June 4, 2024 J&T Consulting and Holcim met with Patrick Lennberg with the Colorado Division of Reclamation, Mining and Safety to discuss the requirements for river bank and/or pit side protection for the Irwin-Thomas mine in Longmont, Colorado. At this meeting a drawing reviewed with Mr. Lennberg that depicted the perimeter of Cell 2 of the mine relative to the river bank of St. Vrain Creek. It was agreed upon by all parties that pit side slope protection only would be acceptable for Cell 2 of the mine for the perimeter that will be within 400 feet of the river bank.

The perimeter length of Cell 2 that lies within 400 feet of the St. Vrain Creek bank is 103 feet. Using this length, we calculated the size of riprap required for the pit side protection using Version 4.03 of the Rock Chute design spreadsheet obtained from the Natural Resource Conservation Service. This spreadsheet is based on “Design of Rock Chutes” by Robinson, Rice, and Kadavy, ASAE Vol. 41(3), pp 621-626, 1998.

The spreadsheet calculated that a minimum D_{50} (mean rock size) riprap size of 12.7 inches is required for the pit side slope protection. We selected the closest Urban Drainage & Flood Control District (UDFCD) D_{50} riprap gradation larger than this size, 18 inches, as our basis in determining the thickness of the pit side slope protection riprap and underlying bedding. Per UDFCD guidelines the riprap thickness required is $2 \times D_{50}$, or 36 inches, with an underlying Type II (CDOT Class A) bedding thickness of 12 inches.

Attached are the Rock Chute design calculations, UDFCD “Technical Review Guidelines for Gravel mining & Water Storage Activities”, Figure 2.5 pit side slope protection detail, and UDFCD “Urban Storm Drainage Criteria Manual Volume 1”, Figure 8.3, including riprap gradation table, bedding gradation table, and bedding thickness table.

Please contact us if you have any questions or need any additional information.





J&T Consulting, Inc.

Regards,

J.C. York

J.C. York, P.E.
Principal/Owner



Attachments:

1. Rock Chute design spreadsheet output
2. UDFCD "Technical Review Guidelines for Gravel mining & Water Storage Activities", Figure 2.5
3. UDFCD "Urban Storm Drainage Criteria Manual Volume 1", Figure 8.3



Rock Chute Design Data

(Version 4.03 - 11/29/11, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Irwin-Thomas Mine

Designer: Todd Yee

Date: 06/07/24

County: Boulder

Checked by: J.C. York

Date: 06/07/24

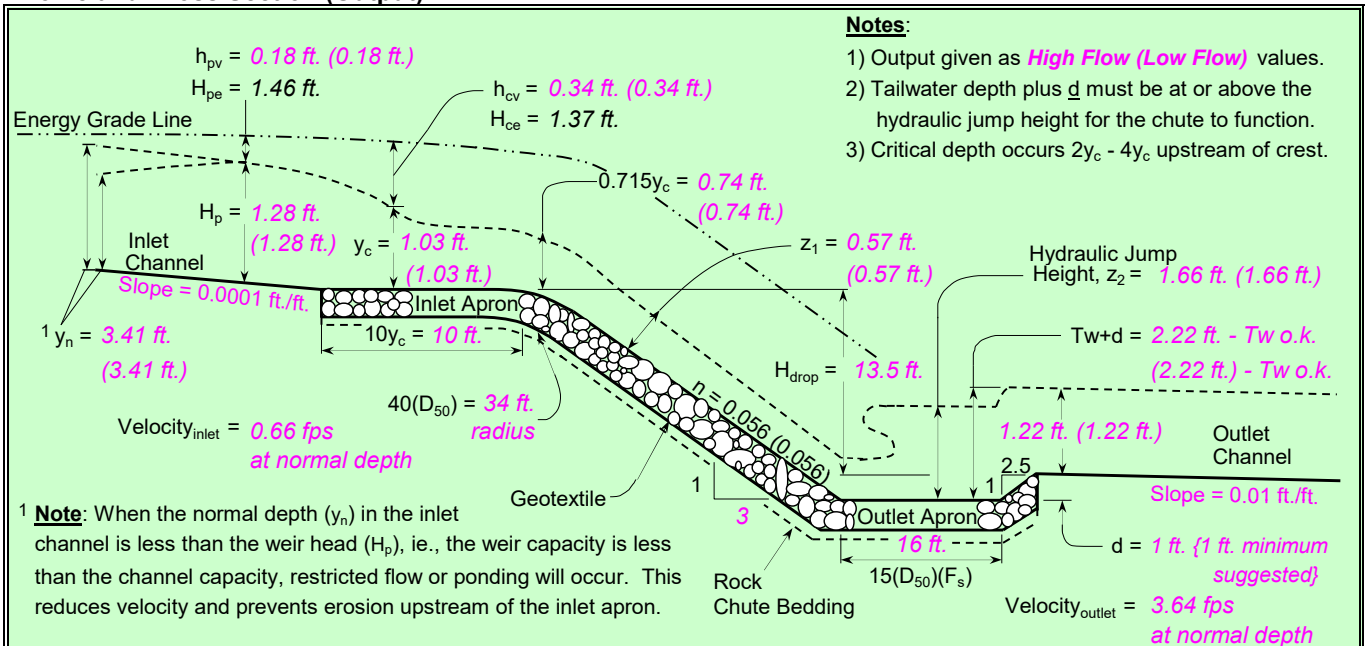
Input Channel Geometry

Inlet Channel	Chute	Outlet Channel
Bw = 103.0 ft.	Bw = 103.0 ft.	Bw = 103.0 ft.
Side slopes = 100.0 (m:1)	Factor of safety = 1.25 (F_s)	Side slopes = 100.0 (m:1)
n-value = 0.035	Side slopes = 100.0 (m:1) → 2.0:1 max.	n-value = 0.035
Bed slope = 0.0001 ft./ft.	Bed slope (3:1) = 0.330 ft./ft. → 2.5:1 max.	Bed slope = 0.0100 ft./ft.
Minimum Fill = 0.0 ft.	Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs
Freeboard = 0.0 ft.		

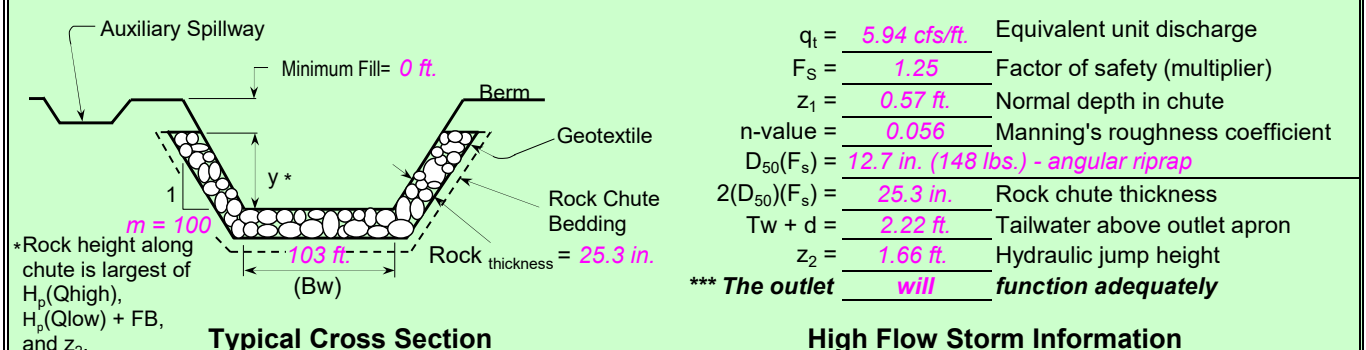
Design Storm Data (Table 2, NHCP, NRCS Grade Stabilization Structure No. 410)

Drainage area = _____ acres	Rainfall = ☐ 0 - 3 in. ☒ 3 - 5 in. ☐ 5+ in.	Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
Apron elev. --- Inlet = 4917.5 ft. --- Outlet = 4903.0 ft. --- ($H_{drop} = 13.5$ ft.)		Input tailwater (T_w):
Chute capacity = Q25-year	Minimum capacity (based on a 5-year, 24-hour storm with a 3 - 5 inch rainfall)	
Total capacity = Q100-year		
$Q_{high} = 1000.0$ cfs	High flow storm through chute	→ T_w (ft.) = Program 0.33
$Q_{low} = 1000.0$ cfs	Low flow storm through chute	→ T_w (ft.) = Program

Profile and Cross Section (Output)



Profile Along Centerline of Chute



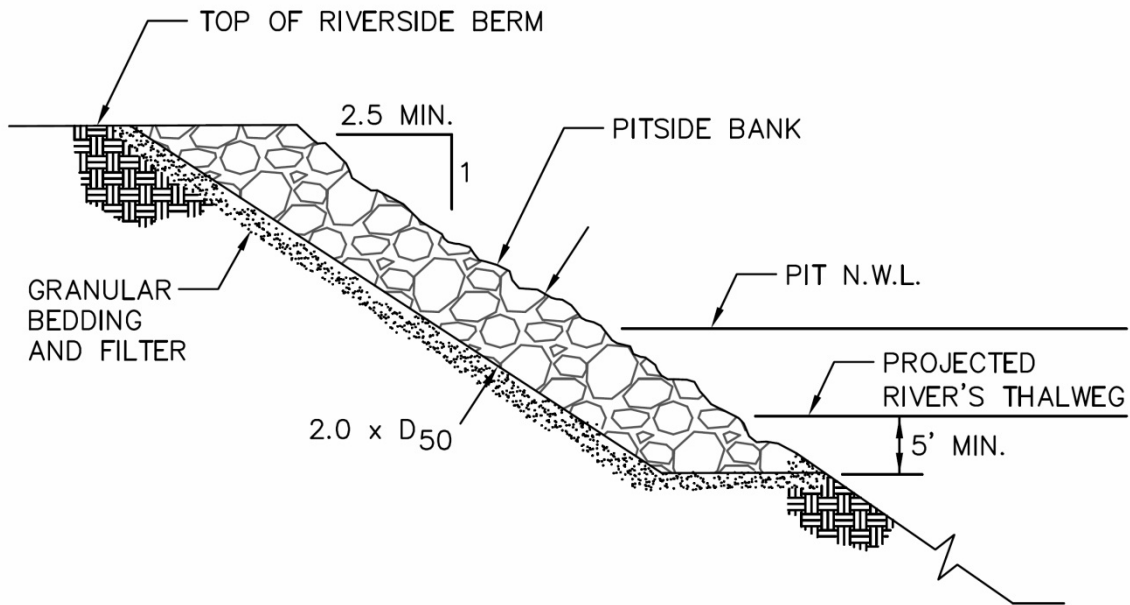


Figure 2.5
Typical Riprap Slope Protection (Pitside Slope)

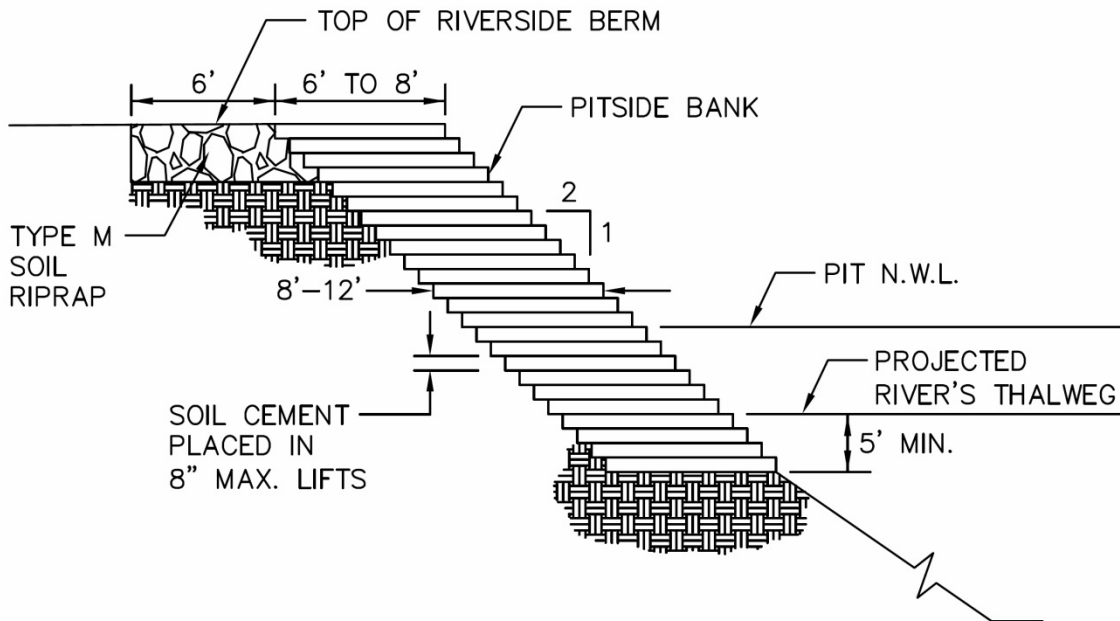
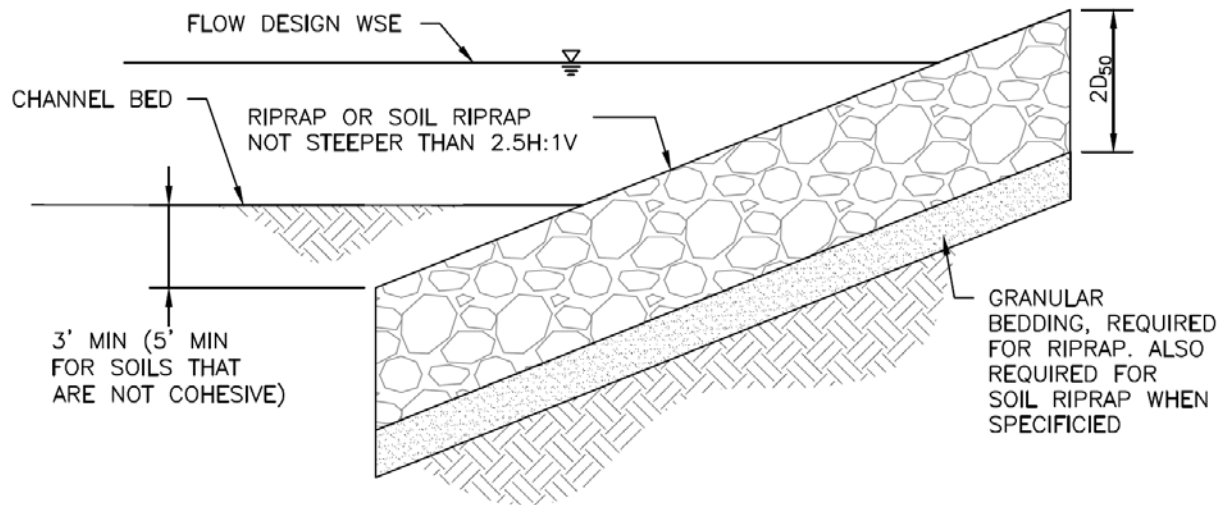


Figure 2.6
Typical Soil Cement Slope Protection (Pitside Slope)



RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	D ₅₀ * (INCHES)
TYPE VL	70 – 100 50 – 70 35 – 50 2 – 10	12 9 6 2	6
TYPE L	70 – 100 50 – 70 35 – 50 2 – 10	15 12 9 3	9
TYPE M	70 – 100 50 – 70 35 – 50 2 – 10	21 18 12 4	12
TYPE H	70 – 100 50 – 70 35 – 50 2 – 10	30 24 18 6	18
*D ₅₀ = MEAN ROCK SIZE			

Figure 8-34. Riprap and soil riprap placement and gradation (part 1 of 3)

SOIL RIPRAP NOTES:

1. ELEVATION TOLERANCES FOR THE SOIL RIPRAP SHALL BE 0.10 FEET. THICKNESS OF SOIL RIPRAP SHALL BE NO LESS THAN THICKNESS SHOWN AND NO MORE THAN 2-INCHES GREATER THAN THE THICKNESS SHOWN.
2. WHERE "SOIL RIPRAP" IS DESIGNATED ON THE CONTRACT DRAWINGS, RIPRAP VOIDS ARE TO BE FILLED WITH NATIVE SOIL. THE RIPRAP SHALL BE PRE-MIXED WITH THE NATIVE SOIL AT THE FOLLOWING PROPORTIONS BY VOLUME: 65 PERCENT RIPRAP AND 35 PERCENT SOIL. THE SOIL USED FOR MIXING SHALL BE NATIVE TOPSOIL AND SHALL HAVE A MINIMUM FINES CONTENT OF 15 PERCENT. THE SOIL RIPRAP SHALL BE INSTALLED IN A MANNER THAT RESULTS IN A DENSE, INTERLOCKED LAYER OF RIPRAP WITH RIPRAP VOIDS FILLED COMPLETELY WITH SOIL. SEGREGATION OF MATERIALS SHALL BE AVOIDED AND IN NO CASE SHALL THE COMBINED MATERIAL CONSIST PRIMARILY OF SOIL; THE DENSITY AND INTERLOCKING NATURE OF RIPRAP IN THE MIXED MATERIAL SHALL ESSENTIALLY BE THE SAME AS IF THE RIPRAP WAS PLACED WITHOUT SOIL.
3. WHERE SPECIFIED (TYPICALLY AS "BURIED SOIL RIPRAP"), A SURFACE LAYER OF TOPSOIL SHALL BE PLACED OVER THE SOIL RIPRAP ACCORDING TO THE THICKNESS SPECIFIED ON THE CONTRACT DRAWINGS. THE TOPSOIL SURFACE LAYER SHALL BE COMPACTED TO APPROXIMATELY 85% OF MAXIMUM DENSITY AND WITHIN TWO PERCENTAGE POINTS OF OPTIMUM MOISTURE IN ACCORDANCE WITH ASTM D698. TOPSOIL SHALL BE ADDED TO ANY AREAS THAT SETTLE.
4. ALL SOIL RIPRAP THAT IS BURIED WITH TOPSOIL SHALL BE REVIEWED AND APPROVED BY THE ENGINEER PRIOR TO ANY TOPSOIL PLACEMENT.

GRADATION FOR GRANULAR BEDDING		
U.S. STANDARD SIEVE SIZE	PERCENT PASSING BY WEIGHT	
	TYPE I CDOT SECT. 703.01	TYPE II CDOT SECT. 703.09 CLASS A
3 INCHES	—	90 — 100
1½ INCHES	—	—
¾ INCHES	—	20 — 90
⅜ INCHES	100	—
#4	95 — 100	0 — 20
#16	45 — 80	—
#50	10 — 30	—
#100	2 — 10	—
#200	0 — 2	0 — 3

RIPRAP BEDDING**Figure 8-34. Riprap and soil riprap placement and gradation (part 2 of 3)**

THICKNESS REQUIREMENTS FOR GRANULAR BEDDING			
RIPRAP DESIGNATION	MINIMUM BEDDING THICKNESS (INCHES)		
	FINE-GRAINED SOILS ¹		COARSE-GRAINED SOILS ²
	TYPE I (LOWER LAYER)	TYPE II (UPPER LAYER)	TYPE II
VL ($D_{50} = 6$ IN)	4	4	6
L ($D_{50} = 9$ IN)	4	4	6
M ($D_{50} = 12$ IN)	4	4	6
H ($D_{50} = 18$ IN)	4	6	8
VH ($D_{50} = 24$ IN)	4	6	8

NOTES:

1. MAY SUBSTITUTE ONE 12-INCH LAYER OF TYPE II BEDDING. THE SUBSTITUTION OF ONE LAYER OF TYPE II BEDDING SHALL NOT BE PERMITTED AT DROP STRUCTURES. THE USE OF A COMBINATION OF FILTER FABRIC AND TYPE II BEDDING AT DROP STRUCTURES IS ACCEPTABLE.
2. FIFTY PERCENT OR MORE BY WEIGHT RETAINED ON THE #40 SIEVE.

Figure 8-34. Riprap and soil riprap placement and gradation (part 3 of 3)