COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

Date: **November 15, 2024**

To: **Robin Reilley**

CC: **Jared Ebert**

From: **Ben Hammar**

RE: **Trapper Mine File No. C1981010**
Permit Revision No. 12. (PR12)

Robin,

As requested, myself and Zach Trujillo have reviewed the provided highwall engineering report, "Inwall HWM Sequence Analysis Proposed for N-Pit" (Report), conducted by Agapito Associates, Inc. on behalf of Trapper Mining Inc. regarding a proposed highwall mining operation located in the N-Pit of the Trapper Mine. The purpose of this memo is to summarize Agapito's report methodologies, analyses and recommendations in relation to the Rules and requirements of the Division. Questions and comments regarding the Report to ensure all Rules and requirements are satisfied will be summarized at the end of this memo.

Report Overview

As noted earlier, on July 31, 2024 DRMS received an engineering report detailing an analysis performed to generate a proposed highwall design planned to be located on the north and south highwalls of the N-Pit within the Trapper Mine. In the Report, the Mine is broken into a North and South highwall section, and the analysis is split further into web pillar and boundary pillar designs of both the M and Q coal seams.

Agapito's design approach was a two-step process, an initial empirical design based on assumed coal strengths, depths of cover, and mining heights, which was used to select a web and pillar design based on a standard factor of safety (FOS) of 1.6. The designed pillars were then subjected to a numerical modelling software tool to test for the possibility of a cascading failing as well as to confirm the design met the required FOS.

To summarize, DRMS found their design philosophy and assumptions made to be reasonable based upon previous similar highwall designs located in the Trapper Mine. Coal strengths were assumed to be 766 and 850 pounds-per-square inch (psi) for the M and Q seams, respectively. This was found to be consistent with previous designs performed by Agapito for these coal seams, as were the assumed seam height, and entry widths. During our review, we identified one point of uncertainty related to the provided design criteria. Agapito's highwall pillar design recommendations are dependent upon the depth of cover for the proposed highwall mining area. Rationale for the specific design depths of cover, 170 feet for the M seam pillar design, and 210 feet for the Q pillar, were not directly discussed in the Report or explicitly

1313 Sherman Street, Room 215, Denver, CO 80203 P 303.866.3567 F 303.832.8106 http://mining.state.co.us
Jared S. Polis, Governor | Dan Gibbs, Executive Director | Michael A. Cunningham, Director

cited as being drawn from a separate study. Per Trapper Mine's approved Appendix X – Summary of Geotechnical Design and Operations Considerations for Highwall Mining (2020), range of depths are 60 – 270 feet and 100 – 320 feet for the M and Q seam respectively within the N Pit. Although the chosen assumed depth of cover is not necessarily unreasonable, we request that the consultant state why they chose their design depths of cover. No other issues were found during the course of our review.

Empirical Pillar Design

As mentioned, Agapito's highwall design began with an empirical pillar design based on assumption drawn from similar highwall designs performed by Agapito for the Trapper Mine and a standard FOS of 1.6. Their empirical designs were created using the method laid out by the Analysis of Retreat Mining Pillar Stability-Highwall Mining (ARMPS-HWM) methodology, a method that is commonly accepted by MSHA as a reasonable design basis for highwall pillars. Using the required FOS and assumptions made from previous studies, Agapito back-calculated pillar dimensions. These parameters were later used to perform their numerical analysis of the designed web and barrier pillars to further test the integrity of their designs against slope failure and a cascading failure.

All pillar designs assumed a mining width of 11.5 ft and a total of 9 web pillars. As mentioned, coal strengths were assumed to be 850 psi and 766 psi and were taken from a previous highwall study performed by Agapito for Trapper. Seam heights, also referred to as mining height in the design tables in this section, were taken as 6 feet for the M seam and 11 feet for the Q seam. These values were also taken from a highwall analysis performed by Agapito and appear to be reliable assumptions based on known values for the Q and M seams.

Each pillar design also included an accompanying figure which shows pillar width as a function of design depth of cover, with different graphs plotted for each potential mining height. These figures are meant primarily as a visual representation of the methodology used to design each pillar from the design tables.

The consultant also included an analysis of expected recovery for each potential pillar. They used the same assumptions as for the structural pillar designs, however this analysis is not of particular interest to the Division related to the adequacy of this highwall study.

Numerical Modelling Analysis

In order to further analyze the stability of their empirical pillar designs, study the effects of multiple coal seams on design strength, check for the possibility of cascading failure, and identify any potential for a slope failure, two separate numerical analyses were performed by Agapito.

Both analyses used the dimensional parameters found through their empirical analysis for the Q and M seam pillars, with some conservative changed made to allow the software to run correctly. These changes were generally found to be minor or conservative enough to be considered unimpactful on the overall results by the Division.

The design depths of cover used, 170 ft and 210 feet for the M and Q seams, respectively, were the primary points of uncertainty found during the Division's review. The chosen design depths appear to be taken as an average value of previous cover ranges found for the M and Q seams by Agapito, however this information is not directly stated within the recent report. In addition, the Division would prefer the decision to utilize an average depth of cover be further supported by Agapito to ensure that their pillar designs are adequately conservative.

Agapito's analysis of general pillar stability and the effects of multi-seam interactions was performed using LaModel software. This software allows for stress analysis of their design pillars based on coal strength and the dimensions of the designed pillars. This software was also used to test for the possibility of a cascading failure.

To summarize their findings from the LaModel analysis, their web pillar design FOS' ranged from roughly 2.2 to 3.1, well above the required 1.6. Barrier pillar designs were also well above the required design FOS. Their cascading failure analysis demonstrated that given a total failure of a given web pillar a cascading failure is extremely unlikely to occur. Based on their analysis, even if a web pillar fails completely the surrounding pillars are still above an FOS of 1.0. This indicates that they would be unlikely to fail as a result of a neighboring pillar's failure.

Agapito utilized FLAC3D to study the displacement and stress values associated with their pillar designs. This was used to check to overall stability of the pillars, as well as identify the possibility of a slope failure under conditions found during a cascading failure. Their model included a 63 ft wide section of the southern highwall, and contained portions of the proposed mining activities of both the M and Q seams.

To summarize, Agapito again found their designs to be well within the required factor of safety. Little displacement was found to occur under their assumed material strength for each geological section of the highwall. These strengths were taken as a weighted average of values found in a previous report, and were also found to be reasonable. To further test their pillar's stability Agapito used a reduced strength value within the coal seams. This resulted in a total of 50% and 60% in material strength. Although these reductions did result in a pillar failure in the M seam, this indicates that the actual FOS of their design is somewhere in between 2.0 and 2.5, the range of strength reduction factors they used for their analysis. This implies their design is acceptable compared to the design FOS of 1.6.

That failure condition of a 2.5 strength reduction used in the previous model was also used to study the possibility of a slope failure following a cascading failure. Using those parameters, Agapito found that the likelihood of a sliding failure caused by web pillar failures is fairly low.

Recommendations

In general, the Division found the methods and assumptions made by Agapito and their findings to be reasonable based on their previous work in the Trapper Mine. Agapito concluded their analysis with a statement that they believe the proposed highwall design will be stable under the conditions provided in their report. They also recommended a catch bench be installed to avoid the risk of falling debris, a common safety practice.

Our primary concern is related to the design depths of cover used to perform the numerical analysis. These values, 170 ft for the M seam and 230 for the Q seam, are averages of the depths of cover present over these seams. We request that the consultant provide a justification for using an average value for their analysis, with a statement explaining why they believe these values to be conservative enough to be used in their design or a similar justification. Please incorporate the following comment within your adequacy letter:

1. It appears to the Division that an average depth value was used for both the M and Q seams within their highwall pillar design analysis. With the proposed highwall pillar design dependent on the depth of cover, please provide a justification for using the specific depth of cover for each seam with a statement explaining why they believe these values to be conservative enough to be used in their design.

This concludes my review of the provided highwall analysis report, "Inwall HWM Sequence Analysis Proposed for N-Pit" (Report), conducted by Agapito Associates, Inc. on behalf of Trapper Mining, Inc. regarding a proposed highwall mining operation located in the N-Pit of the Trapper Mine. If you have any questions feel free to contact me.

Sincerely,

Ben Hammar
Environmental Protection Specialist
(720) 793-2988
ben.hammar@state.co.us