



COLORADO

Division of Reclamation,
Mining and Safety

Department of Natural Resources

1313 Sherman St. Room 215
Denver, CO 80203

January 12, 2023

Neil Whitmer
Holcim-WCR, Inc
1687 Cole Blvd, STE 300
Golden CO 80401

RE: DRMS Permit M1973-021; Morrison Quarry; Technical Revision 9 (TR9) – Adequacy
Review Letter 3

Mr. Whitmer:

The Division of Reclamation, Mining and Safety received Technical Revision 9 (TR9) for the above listed permit on October 31, 2023. The decision date for this revision has been extended to January 31, 2024. DRMS has completed the initial adequacy review of TR9, and as with most revisions, there are several items that will require clarification of the existing information or submittal of additional information.

This attachment to this letter (in the form of an interoffice memo dated January 12, 2024 to Eric Scott) is intended to provide adequacy review comments for the “Geotechnical Stability Exhibit” provided as part of TR9.

Please be advised that if you are unable to satisfactorily address any adequacy concerns identified before the current decision date of January 31, 2024, it will be your responsibility to request an extension of the review period. If there are outstanding issues that have not been adequately addressed prior to the end of the review period, and no extension has been requested, the Division must deny this revision.

This letter shall not be construed to mean that there are no other technical issues in the submittal. Other issues may arise during the review process, or as additional information is supplied. If you have any questions, please contact me at (303) 229-9414.

Sincerely,

Eric Scott
Environmental Protection Specialist

CC: Kate Garufi, HDR Engineering, Inc. via email





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Division of Reclamation,
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Date: January 12, 2024

To: Eric Scott

CC: Amy Eschberger
Michael Cunningham

From: Zach Trujillo

RE: Holcim Morrison Quarry, DRMS File No. M-1973-021
Exhibit S – Geotechnical Stability Review

Eric,

As requested I have reviewed the provided Exhibit S, Engineering Evaluation of Highwall Design for the South Quarry of the Morrison Quarry (Report), conducted by HDR, Inc. (HDR) on behalf of Holcim – WCR, Inc. (Holcim) regarding the proposed Technical Revision No. 9 (TR-9) application for the Morrison Quarry (Mine). The purpose of this memo is to summarize HDR's Report methodologies and analyses 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.

Site Conditions

Site conditions are characterized in the Report based on site investigations performed by HDR, contractors under the supervision of HDR, as well as other parties throughout the historical time frame of the Mine. This includes previous and recent drill logs within the site, on-site investigation and reconnaissance, as well as site specific data from laboratory testing. The Mine site consists multiple rock types however are summarized as two general material profiles. The two profiles are designated as Talc-Gneiss and Granitic-Gneiss (defined as Competent Material in the provided modeling). Depths and relative locations of these profiles were determined by boring however mapped location the boreholes were not provided in the Report or in the application for the Division's review. Groundwater was not discussed in the Report or analyzed within the geotechnical model and so it is unclear if the presence of groundwater is to be expected at the Mine under the proposed mine plan.

In 2022, a total of five new exploratory boreholes were drilled. Of the five boreholes, one of the boreholes was designated for a future groundwater pump test. The method of drilling used for this borehole is destructive in nature which does not allow for subsurface geotechnical evaluation. Due to this, four of the five boreholes are used as part the geotechnical analysis. Each borehole was also evaluated using a downhole geophysical array to assist in the development of below surface geologic conditions encountered at the Mine. Summary of these borings are found in Table 1 of the Report and detailed logs are provided under the associated Appendix A – Subsurface Exploration Findings for the 2022 Geotechnical Boring Logs. In addition, results from previous drilling in the South Quarry was analyzed as part HDR's design and recommendations in the Report.

Morrison Quarry Review Memo

January 12, 2024



Core samples from the boring were evaluated for site specific material strength properties of the rock located at the Mine. A total of 35 (28 new and 7 historic) uniaxial compressive strength (UCS) tests were performed and analyzed along with 36 direct shear tests (14 new and 22 historic). In areas where UCS testing was not feasible due to low Rock Quality Designation (RQD), Point Load testing was performed. Summary of the compressive strength and shear testing results are found in Table 4, Table 5 and Table 6 of the Report. Material strength properties results from the testing were averaged and then assigned to the associated two rock types summarized at the Mine. Additional tests were also performed evaluate mineral assemblage and toughness. Results are found on Table 7 and 8 of the Report.

As noted early, on-site reconnaissance and investigation was performed at the Mine by HDR. The purpose of this was to determine Mine specific geological structures, discontinuities along with rock type and quality. Using the site conditions, exposed rock was assessed using the Geological Strength Index and Hoek-Brown rock mass classification system. Both methodologies are widely accepted and commonly used to estimate the strength of a rock mass. Selected parameters are shown in Table 9 with HDR's rationale discussed under Section 5.2 of the Report.

Kinematic and Stability Analyses

In order to determine the potential conditions of failure, HDR incorporated the discontinuity data collected from the reconnaissance and applied it to stereographic projections which maps orientations of planes, lines and the intersections of the Mine geology. Failure mode conditions of planar sliding, wedge sliding, planar sliding, flexural toppling and direct toppling were then analyzed. As circular failures within competent rock masses generally do not occur, these failure modes are most suitable for the site conditions. The resulting stereonet from the associated failure criteria were then analyzed to determine the likelihood of each failure mode. Based on the resulting stereonet, it was determined that wedge failure is the most probable failure mode along benches at the Mine given the site conditions. Summary of the stereonet failure mode results are summarized in Table 10 of the Report. Stereonet and kinematic results are found under Appendix C of the Report.

Based on the information determined from drill logs, on-site investigations, and laboratory testing, HDR assigned material strength properties to the material profiles. The material strength properties, as discussed earlier in this Memo, are based on site specific testing from the Mine. Per Section 30 of the Policies of the Mined Land Reclamation Board (Section 30), for strength measurements resulting from multiple tests for non-critical structures, the minimum recommended FOS is 1.25 for static conditions and 1.1 for seismic conditions. This review criteria is based off the previous reviews and approvals by the Division at the Mine along with the information proposed under TR-9.

In order to determine the stability of the current and proposed mined slopes and resulting factors of safety (FOS), HDR built two dimensional profiles of the Mine's conditions based on the results of the drill logs, site specific material strength properties, and critical sections within the slope stability programs SLIDE2 and FLAC/Slope. SLIDE2 was used to analyze the potential for global failure with FLAC/Slope being used to analyze the potential for localized inter-bench failures. A total of 25 scenarios were analyzed using SLIDE2 under multiple methods for determining FOS for static conditions. While all material strength parameters and profiles remain consistent with results from testing and site investigations in the slope stability models, it was observed that a circular failure plane was defined for each scenario. As noted earlier in this Memo, circular failures within competent rock masses generally do not occur and it was determined by HDR that wedge failure is the most probable failure mode at the Mine from the kinematic analysis.

Results and general descriptions of the analyses are outlined on Table 11 with modeling results provided under Appendix C within the Report. The resulting FOS from the stability analyses ranged from 1.288 to 4.566 for all existing and proposed scenarios. Results of the FLAC/Slope analysis are summarized under Table 12 and Appendix C as well. The resulting FOS range from 2.13 to 2.82. Overall, the results of each

stability analyses exceeded the minimum FOS requirements of 1.25 outlined in Section 30 for strength measurements resulting from multiple tests for non-critical structures, under static conditions. However, no seismic conditions were analyzed in HDR stability analysis.

Summary – Division Comments and/or Questions

The following is a summary of the Division's comments/questions discussed and observed during the previous sections of this Memo:

Site Conditions

- Please have Holcim provide a map detailing the name and location of each borehole that was discussed and used within HDR's Report for the Division's review.
- Please have HDR provide discussion regarding the potential of groundwater, or lack thereof, to ensure the impacts of groundwater are accurately taken into account within the slope stability analysis if necessary.

Stability Analyses

- Please have HDR provide rational for defining a circular failure plane for each scenario in the slope stability analyses when it was determined that wedge failure is the most probable failure mode at the Mine as a result from the kinematic analysis.
- Per Section 30 of the Policies of the Mined Land Reclamation Board, for strength measurements resulting from multiple tests for non-critical structures, the minimum recommended FOS is 1.25 for static conditions and 1.1 for seismic conditions. No seismic conditions were provided or evaluated by HDR in the Report. In order to ensure all requirements of Section 30 are satisfied, please have HDR provide stability analyses for the Mine under seismic conditions for all scenarios along with rational for the associated seismic load applied.

This concludes my review for the requested Exhibit S and geotechnical stability analysis conducted by HDR, Inc. on behalf of Holcim – WCR, Inc. regarding the proposed Technical Revision No. 9 for the application for the Morrison Quarry. If you have any questions or comments, feel free to reach out.

Sincerely,



Zach Trujillo
Environmental Protection Specialist
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Zach.Trujillo@state.co.us