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File 89241-6

Ms. Kimberly Finke-Morrison
Golder Associates, Inc.
44 Union Boulevard, Suite 300
Lakewood, Colorado 80228

Subject: Roadway Pavement Design Recommendations
Piñon Ridge Project
Montrose County, Colorado

Dear Ms. Morrison:

This report presents recommendations for roadway design at the Piñon Ridge Project located in Montrose County, Colorado. A site vicinity map is provided on Figure A-1 in Appendix A. Kleinfelder's work was performed as part of the Phase 2 Geotechnical Investigation and consisted of subsurface exploration, laboratory testing, design team meetings, engineering analyses, and preparation of this report.

PROJECT DESCRIPTION

This design report includes recommendations for the main access drive into the facility, which includes the haul road to the ore pad and access to the mill facility. The design also includes the administration building access drives and parking, employee parking at the mill, and secondary roads to monitoring stations and the project perimeter. The main roadways will be gravel surfaced while the secondary roads will be two-track dirt roads. The main roadways will be one-lane in each direction with a roadway width of 22 feet. In addition a 2-foot shoulder will be constructed on each edge. The deceleration lane off State Highway 90 into the site and the initial approximately 150 feet of the entry road to the project boundary will be asphalt surfaced and designed by a separate consultant.

American Association of State Highway and Transportation Officials (AASHTO) and United States Department of the Interior (DOI) design procedures were followed for roadway design. The Colorado Department of Transportation (CDOT) Design Manual was also consulted.

SUBGRADE MATERIAL

The subgrade materials were evaluated by reviewing data from the following sources:

- Geotechnical Design Recommendations, Mill and Infrastructure, Piñon Ridge Project, Montrose County, Colorado, report by Kleinfelder West, Inc., dated October 15, 2008.
- Phase 2 Geotechnical Field and Laboratory Program report by Golder Associates Inc., dated September 2008.
- Subsurface information obtained from Phase I Baseline Characterization Investigation, conducted by Kleinfelder West, Inc. as part of the permit application.

The borings and tests pits from the referenced data that were used in the roadway design are shown at the approximate locations indicated on the Borings and Test Pits Roadway Pavement Design (Figure A-2). The subgrade soils identified from these borings and test pits consisted mainly of wind blown loess comprised of silty and clayey sand to sandy clay and silt. Boring logs from the referenced investigations are attached in Appendix B.

Soil standard property testing performed on samples of the subgrade materials indicated an AASHTO classification of A-2-4, A-2-6, A-4 and A-6 with a group index of 0 to 3. The subgrade materials were classified primarily as A-4 and A-2-4 depending upon the amount of silt/clay fines. Test results not provided in the referenced reports are presented in Appendix C and Table C-1 at the front of the appendix summarizes test data from all borings used in the analysis. These soils are considered fair to good subgrade material by AASHTO. The distribution of AASHTO classification is presented in the following table.

AASHTO CLASSIFICATION	PERCENTAGE OF SUBGRADE
A-4	50
A-2-4	44
A-2-6	3
A-6	3

Hveem Stabilometer R-value testing performed on samples of the A-4 and A-6 subgrade soils measured R-values of 28 and 14, respectively, reference Figures C.1 and C.2. An R-value of 14 was used for roadway design. For design purposes, this R-value was converted to a California Bearing Ratio (CBR) of 2.7 by using correlation equations to a resilient modulus of 4,060 pounds per square inch (psi) calculated from the R-value.

CONCLUSIONS AND RECOMMENDATIONS

A roadway section is a layered system designed to distribute concentrated traffic loads to the subgrade. Performance of the roadway structure is directly related to the physical properties of the subgrade soils and traffic loadings. Soils are represented for design purposes by means of a soil support value, which is empirically related to strength.

Design Traffic:

Daily traffic for the mill site was provided by the client. Typical daily traffic is expected to consist of 42 haul trucks using the main haul road and ore pad roads, 2 chemical tanker trucks or large delivery trucks using the main haul road and access roadways to the mill, and 88 passenger cars and 4 light delivery trucks accessing both the administration building and mill area. Maximum weight for the haul trucks is expected to be around 40 tons. Trucks will be both end dump and side dump vehicles legal for state highways. A maximum wheel load of approximately 4,500 pounds was determined from the traffic data.

Ore will be hauled to the site and stockpiled during mill construction, but will consist of about 12 trucks per day. Approximately 30 construction vehicles are estimated per day during construction. Assuming construction vehicles will be similar in weight to the haul trucks, Kleinfelder believe traffic during construction will be similar to operational traffic.

Design Sections:

The DOI Design of Mine Haulage Roads - A Manual, 1977 was used to design the main access road and ore pad haulage roads. The DOI manual uses a maximum wheel load and CBR value to obtain aggregate roadway thickness. Using a CBR value of 2.7 for the subgrade soils and a maximum wheel load of 5,400 pounds (increased 20 percent per DOI procedures), a 17-inch aggregate roadway section was determined using Figure 18 from the DOI manual. The recommended aggregate section should consist of a 5-inch surface course of CDOT Class 6 aggregate base course over 12 inches of CDOT Class 1 aggregate base course. The DOI roadway thickness design chart and supporting calculations are attached in Appendix D.

AASHTO low-volume road design procedures were used for thickness design of mill roadway and drive areas that will by used by passenger cars and small trucks along with occasional chemical and delivery trucks, but will not be used by heavy mine haul trucks. Traffic loadings for these roadways were calculated using the above traffic mix and were converted to an 18-kip equivalent single axle load (ESAL) value of 40,000 using a 20-year design life. Pavement damage was computed using the AASHTO trial aggregate base thickness procedure and serviceability loss and rutting depth criteria of 2.5 and 2.0 inches, respectively.

Rutting controlled the design and an aggregate roadway total section of 14.5 inches was calculated. We recommend the design section consist of 5 inches CDOT Class 6 aggregate base course over 9.5 inches of CDOT Class 1 aggregate base course. Kleinfelder recommends the aggregate section for parking areas total 12 inches comprised of 4 inches of CDOT Class 6 base course over 8 inches of CDOT Class 1 base course. Calculations are presented in Appendix D. A summary of the recommended aggregate roadway design sections is presented in the following table.

AGGREGATE ROADWAY DESIGN SECTIONS

Roadway Type	CDOT Class 6 Aggregate Base Course (in.)	CDOT Class 1 Aggregate Base Course (in.)	Total Section Thickness (in.)
Main Access Road / Ore Pad Haulage Road	5.0	12.0	17.0
Mill Roadway / Administration Access Drive	5.0	9.5	14.5
Mill/Administration Parking Areas	4.0	8.0	12.0
Roadway Shoulders	5.0	-	5.0

Aggregate Materials:

Aggregate base course should conform to CDOT Standard Specifications for Road and Bridge Construction, latest edition. Class 6 and Class 1 aggregate base course should meet the requirements of Section 703.03 and design and construction should meet the requirements of Section 304. The gradation requirement for Class 6 should be modified for the percentage of material passing the No. 200 sieve to a range of 6 to 12 percent rather than the 3 to 12 percent passing specified by CDOT. This modification requires slightly more fines and provides more binder for a gravel-surfaced roadway.

Subgrade Preparation:

Prior to placing the pavement section, the subgrade should be scarified to a depth of 8 inches, adjusted to a moisture content within 2 percent of optimum moisture content and compacted to 95 percent of the maximum standard Proctor density as determined by ASTM Method D698.

The completed pavement subgrade should be proofrolled with a heavily loaded pneumatic-tired vehicle after preparation. Pavement design procedures assume a stable subgrade. Areas that deform under heavy wheel loads are not stable and should be removed and replaced to achieve a stable subgrade prior to paving.

Maintenance:

Periodic maintenance of aggregate roadways will extend roadway life. Blading of all roadways should be performed at least twice a year. As the roadway deteriorates over time fresh aggregate base course will have to be added to the surface. Estimated aggregate loss based on AASHTO procedures and the average daily traffic is approximately 2 inches per year.

LIMITATIONS

This report has been prepared in accordance with generally accepted geotechnical engineering principles and practices in this area at this time. Kleinfelder makes no warranty either express or implied. The conclusions and recommendations submitted in this report are based upon the data obtained from the borings drilled at the locations shown on Figure A-2 and Kleinfelder site observations.

This report has been prepared for the exclusive use of Golder Associates, Inc. and Energy Fuels Resources for pavement thickness design purposes. Kleinfelder is not responsible for technical interpretations by others of our exploratory information that has not been described or documented in this report. As the project evolves, Kleinfelder should be retained to provide continued consultation and field services to review and monitor the implementation of our recommendations and to verify that the recommendations have been appropriately interpreted. Observation and testing of pavement materials and construction should be in accordance with the project Technical Specifications.

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

Respectfully submitted,

KLEINFELDER WEST, INC.

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Enclosures: Appendix A – Vicinity Map, Location of Borings and Test Pits for Roadway Pavement Design
Appendix B – Logs of Pavement Borings and Pits
Appendix C – Laboratory Test Results
Appendix D – Roadway Thickness Calculations and Design Charts