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AGAPITO ASSOCIATES, INC.
Consulting Engineers

GRAND JUNCTION OFFICE

January 15, 2003

460-03

Ms. Pamela Grubaugh-Littig
Permit Supervisor
State of Utah, Department of Natural Resources
Division of Oil, Gas, and Mining
1594 W. Temple, Suite 1210
Salt Lake City, UT 84114-5801

RECEIVED
JAN 16 2003
DIV. OF OIL, GAS & MINING

c/007/041

RE: **Response to Technical Deficiencies, Division Order DO00A**
West Ridge Resources, Inc., West Ridge Mine

Dear Ms. Grubaugh-Littig:

1.0 INTRODUCTION

Agapito Associates, Inc., (AAI) has prepared this letter as requested by West Ridge Resources, Inc., (West Ridge) to document the proposed responses to the *Technical Analysis of the West Ridge Mine, Proposed Highwall Reclamation (Appendix 5-9)*, by the State of Utah, Division of Oil, Gas, and Mining (DOGM). Appendix 5-9 comprises the third revision to the "Stability Evaluation for the Proposed Reclaimed Slope at the Portal Excavation," which is the fourth design for the reclamation of the portal highwall that has been presented to DOGM. The response to Appendix 5-9 by DOGM, dated November 25, 2002, addressed several "deficiencies" found during the latest review.

2.0 SUMMARY OF PROPOSED APPROACH

The technical "deficiencies" cited in the latest DOGM review are focused on the following issues:

1. Definition of the source of backfill and topsoil for the highwall reclamation.

2. Shear strengths of existing and proposed slope materials.

3. Surficial stability of the reclaimed highwall.

4. Impacts of retaining the experimental *in situ* topsoil practice compared to decreasing the angle of the reclaimed highwall slope and abandoning the experimental practice.

To address these cited "deficiencies," West Ridge proposes the following actions:

- Regarding Item No. 1, West Ridge has committed to on-site sources of backfill and topsoil. Backfill material for the highwall will be excavated from the pad currently occupied by the warehouse and the pad at the elevation of the portals. Topsoil will be supplied from the topsoil stockpile.

- Regarding Item No. 2, West Ridge has sampled all soils that exist on the slope, or will be used to construct the reclaimed slope, and will have laboratory analyses performed on all of those soils to provide DOGM with complete and defensible shear strengths and material classifications. A complete list of geotechnical test parameters is provided in the following section. Soil chemistry testing is also being conducted for the backfill and topsoil. Soil chemistry analysis parameters were provided by Mt. Nebo Scientific (Mt. Nebo).

- Regarding shear strength of the bench at the base of the existing highwall, that bench is comprised of *in situ*, undisturbed rock, rather than compacted soil, as used by AAI in the previous analyses. The only fill areas on the bench are located directly above the three portals. Therefore, the bench will be assigned the shear strengths used in the previous analyses for "partially burned coal and interbedded sandstone and siltstone," because these geologic materials are present throughout the bench. During reclamation, the portal steel supports and lagging will be removed, along with the overlying geologic materals. The portal cuts will then be filled with the same compacted backfill material that will comprise the majority of the reclaimed slope. A 2-ft-thick drainage layer will be placed at the base of the fill, which will be comprised of clean, free-draining angular rockfill, which is consistent with the previous analysis.

- Standard Proctor compaction tests are being conducted on the backfill material to determine the optimum density and moisture content for placement. Direct shear tests are being conducted at 95% of Standard Proctor optimum conditions. West Ridge had previously agreed to conduct a test fill on the backfill material. This was agreed to in lieu of defining a source of backfill, to assure that the material could meet specifications used in the stability model. West Ridge proposes that defining the source of backfill, and conducting compaction testing on that backfill material, are sufficient assurance that the material will meet specifications. This approach is typical for earthworks. West Ridge also proposes committing to lift thicknesses no greater than 6 inches, to assure the compactive efforts reach the base of each lift. Therefore, West Ridge proposes that a test fill should no longer be required.

- The issue of stability of the surficial rooting zone layer is being addressed by committing to a geosynthetic reinforced slope face. Biaxial geogrid (Tensar BX1100 or equivalent) will be embedded in a lift, and then wrapped around the face of the slope and embedded in a higher lift. The distance between geogrid

"wraps" will be about 2 ft, and will be optimized in the design phase. The geogrid will have a permanent erosion blanket (Tensar TB1000 or equivalent) placed *behind* the geogrid to prevent loss of fines. Seed will be placed behind the erosion blanket prior to wrapping. Ledges and other features will be built to allow planting of containerized plants and trees, and to provide a non-uniform, natural appearance. The rooting zone will not receive any compactive effort.

- The technical "deficiencies" make mention of a 4-ft-thick rooting zone. However, throughout the DOGM publication, "The Practical Guide to Reclamation in Utah," a 2-ft-thick rooting zone is considered appropriate. West Ridge respectfully requests clarification regarding the reasoning behind a 4-ft-thick rooting zone for this particular application. West Ridge proposes to use a 2-ft-thick rooting zone, comprised of a 1-ft-thick base layer of non-compacted backfill material, overlain by a 1-ft-thick layer of topsoil, in accordance with the aforementioned DOGM document.

- West Ridge further proposes that the geogrid wrapped face will, by design, support the surficial rooting zone, such that determination of the angle of repose of surficial material, as requested by DOGM, will not be required. West Ridge will provide examples of geogrid supported slopes fully revegetated at slope angles much steeper than the 40-degree slope proposed for the highwall reclamation. Also, West Ridge could not find a defensible method for determination of angle of repose, based on a search of ASTM and contact with several soils laboratories.

- Regarding Item No. 4, West Ridge will conduct a comparative study to demonstrate the differences in environmental impacts between maintaining the experimental practice and abandoning the experimental practice to extend the toe of the reclaimed highwall slope. Maps and cross sections will be prepared illustrating each approach. An assessment of the environmental impacts of each scenario will be provided in an additional appendix.

A summary of the "deficiencies" is detailed in the following section, along with the response or action proposed by West Ridge.

3.0 SUMMARY OF "DEFICIENCIES" AND PROPOSED ACTION

R645-301-233, *The plan must clearly indicate the source of the substitute topsoil for the reclamation of the highwall.*

West Ridge has committed to a source of backfill and topsoil. The backfill material source comprises the fill that underlies the warehouse area. There are about 50,500 yd^3 of fill material available in the source area. The slope will require about 35,000 yd^3 of

backfill material. Therefore, an ample quantity of backfill material is available for the highwall reclamation.

The source of the substitute topsoil will be the topsoil stockpile located at the head of the filled area. The approximate volume of the topsoil stockpile is 2,650 yd^3. The approximate volume of topsoil required for the highwall reclamation is 2,000 yd^3. Therefore, there is ample topsoil in the topsoil stockpile to complete the highwall reclamation.

A 10-ft-thick layer of residual soil was included in the geotechnical model prepared by AAI. This layer represents the soil that overlies rock above the highwall. The residual soil layer is currently stable and was only added to the geotechnical model for the sake of completeness. However, because DOGM has raised concerns about the shear strength values of the residual soil that were used in the previous analyses, West Ridge has sampled the residual soil and is having laboratory strength determinations made on those samples.

The backfill material and the topsoil were sampled on December 31, 2002, by AAI. The residual soil was sampled on January 6, 2003. The samples have been sent to Advanced Terra Testing of Lakewood, Colorado, for geotechnical soil testing and Colorado Analytical Laboratories, Inc., of Brighton, Colorado, for soil chemistry testing. The geotechnical soil testing program for topsoil and residual soil is shown on Table 1. The geotechnical soil testing schedule for backfill material is shown on Table 2. The soil chemistry testing program for topsoil and backfill is shown on Table 3.

Table 1. Geotechnical Laboratory Tests – Topsoil and Residual Soil

Quantity	Test	ASTM No.	Instructions
1	Moisture Content	D 2216	Composite Sample
1	Grain Size Analysis	D 422	Composite Sample 3-inch to -200 sieve
1	Atterberg Limits	D 4318	Composite Sample 5-point test
1	USCS Soil Classification	D 2487	Composite Sample
1	Large Scale Direct Shear (12" × 12")	D 3080 (Modified)	Sieve to <2-inch Compact to 90 pcf 3 pts @ 10 psi, 25 psi, 50 psi

Table 2. Geotechnical Laboratory Tests – Backfill Material

Quantity	Test	ASTM No.	Instructions
1	Moisture Content	D 2216	Composite Sample
1	Soil pH Analysis	HACH Method	Composite Sample
1	Grain Size Analysis	D 422	Composite Sample 3-inch to -200 sieve
1	Atterberg Limits	D 4318	Composite Sample 5-point test
1	USCS Soil Classification	D 2487	Composite Sample
1	Standard Proctor	D 698	Composite Sample Method _____
1	Large Scale Direct Shear (12" × 12")	D 3080 (Modified)	Sieve to <2-inch Compact to 95% Standard Proctor at ± 2% Optimum water content 3 pts @ 25 psi, 50 psi, 75 psi

Table 3. Soil Chemistry Tests – Backfill and Topsoil (Colorado Analytical)

Lab Analyses and Method Recommended for the Topsoil/Backfill at the West Ridge Mine
January 8, 2003

MT. NEBO SCIENTIFIC, INC.
Springville, Utah

Parameter	Unit to Report	Methods
pH	saturated paste standard units	Soil Science Society of America. 1996. Series No. 5. Methods of Soil Analysis: Part 3 - Chemical Methods. Chapter 14, pp 420 and Chapter 16, pp 487.
Saturation Percent	percent	Soil Science Society of America. 1996. Series No. 5. Methods of Soil Analysis: Part 3 - Chemical Methods. Chapter 14, pp 420–422.
Electrical Conductivity	mmhos/cm	Soil Science Society of America. 1996. Series No. 5. Methods of Soil Analysis: Part 3 - Chemical Methods. Chapter 14, pp 420–422 and pp 427–431.
Sodium Adsorption Ratio	ratio	USDA Salinity Laboratory Staff. 1954.
Texture	percent salt, silt, clay	U.S. Department of Agriculture, Natural Resource Conservation Service. 1998. Field Book for Describing and Sampling Soils. Version 1.1, pp 2-28–2-31.
K-factor	calc. number	Agriculture Handbook 703. Chapter 3, p. 92. (To be calculated from % silt and very fine sand; % sand; % organic matter; soil structure and soil permeability). For methods also refer to http://www.statlab.iastate.edu/soils/nssh.
$CaCO_3$	percent	Western States Laboratory Proficiency Testing Program Soil and Plant Analytical Methods. 1998. Vol. 4.10, pp 99. (Soil Carbonates,

Lab Analyses and Method Recommended for the Topsoil/Backfill at the West Ridge Mine January 8, 2003 *MT. NEBO SCIENTIFIC, INC.* Springville, Utah		
		Gravimetric Determination after extraction with 3 M HCl.) Total Inorganic Carbon = %$CaCO_3$ × 0.12.
Total Organic Carbon	percent	Western States Laboratory Proficiency Testing Program Soil and Plant Analytical Methods. 1998. Vol. 4.10, pp 88. (Combustion Method)
Soluble Selenium	mg/kg	Soil Science Society of America. 1996. Series No. 5. Methods of Soil Analysis: Part 3 - Chemical Methods. Chapter 30, pp 805–811. (Hydride Generation Atomic Absorption-Spectrometry and Fluorimetry of water extractable selenium)
Available Boron	mg/kg	Soil Science Society of America. 1996. Series No. 5. Methods of Soil Analysis: Part 3 - Chemical Methods. Chapter 21, pp 611. (saturation extract)
Acid Potential	percent S	U.S. EPA. 1978. EPA 600/278-054. Method 3.2.6, pp 60.
Neutralization Potential	percent $CaCO_3$	U.S. EPA. 1978. EPA 600/278-054. Method 3.2.3, pp 47.

R645-301-233.100, ***The Permittee must identify the source of the backfill material which*** *will become the rooting zone as described on page 10 of the Agapito Associates, Inc. (AAI) and Mt. Nebo Scientific, entitled, "Stability Evaluation for the Proposed Reclaimed Slope at the Portal Excavation, West Ridge Mine, August 2002, Revision No. 3."*

West Ridge has identified the backfill source as the material on which the pad of the warehouse is located and the pad at the elevation of the portals. West Ridge has identified the topsoil stockpile as the source of topsoil for the highwall reclamation. Both of these materials are currently being tested for geotechnical properties and soil chemistry.

R645-301.120 and R645-301-242.120, *Appendix 5-9 should include: (1) a determination of the level of compaction at a depth of two and four feet in native ground on an adjacent, undisturbed, vegetated slope, and (2) an analysis of whether this existing level of compaction can be duplicated on the regarded slope at a depth of two and four feet while still maintaining stability.*

(1) West Ridge has proposed a mechanical stabilized surficial layer using geogrid and an erosion blanket, as discussed in Section 2.0. West Ridge assumes the request for determination of compaction in native ground was to determine the level of compaction necessary for stability in the surficial rooting zone. Therefore, West Ridge proposes that using a mechanically-stabilized surficial layer should negate the need for determination of *in situ* density of the native ground.

Aside from being unnecessary due to the proposed design changes, there are several factors that make determining the density of the native ground at West Ridge impractical. A nuclear density gage would be impractical because cobbles, boulders, and bedrock subcrops would create a high potential for rock substance near the nuclear gage probe to skew the density readings and give much higher densities than the actual density of the soil matrix. In addition, the currently frozen state of the native ground would yield an anomalously high density. An alternative method for *in situ* density determination is the sand cone method, which, however, would also be impractical on a steep, rocky slope in frozen ground. The soil penetration test (SPT), using a drilling rig with a split-spoon drive assembly, is an acceptable *in situ* density test for soils with cobbles and boulders, and is valid below the frost layer. However, the test is relatively expensive because a drilling rig, drill crew, and engineer are required on site. Also, rig access is not practical on steep slopes. Again, mechanical stabilization of the surficial rooting zone layer should render this request unnecessary.

(2) Duplicating the level of compaction of native ground should be unnecessary because West Ridge is proposing a mechanically-stabilized geogrid system for the surficial rooting zone. The mechanically-stabilized surficial layer will be stable by design. Note that mechanically stabilized soil slopes have been constructed and successfully revegetated at near vertical slope angles. The rooting zone depths of 2 and 4 ft are mentioned in this comment. Again, West Ridge is proposing that a 2-ft-thick rooting zone is adequate, as opposed to a 4-ft-thick rooting zone, and is in accordance with DOGM guidelines.

R645-301-521.190, *The Permittee must commit to observing and documenting the moisture condition on the highwall during the second and third quarters of every groundwater monitoring year over the life of the mine.*

West Ridge proposes establishing a few "photo stations" where the absence (or presence) of groundwater seepage from the highwall can be photo-documented during the second and third quarters of every groundwater monitoring year over the life of the mine. A photo station is a surveyed location from which photos are taken at fixed orientations. This allows a direct comparison of the photos over time.

R645-301-541.400, *(1) Machinery type and specifications required to achieve the compaction requirements must be included in the submittal. (2) The Permittee must commit to utilizing the expertise of a professionally certified engineer with geotechnical expertise during the construction process of the highwall area.*

Machine types and specifications will be included in the next submittal. A commitment to construction management by a registered professional engineer with expertise in steep slope construction will also be included in the next submittal.

R645-301-542.200 and R645-301-512.120, *(1) Although the designs in Appendix 5-9 have been certified by a registered professional engineer, Section 6.0 of Appendix 5-9 contains disclaimers*

relative to the ultimate performance of the design. The design engineer must evaluate as many factors as possible to develop a more credible design, including the geology of the existing slope, the properties of the existing fill, groundwater conditions, and state what assumptions were made in the design. (2) The professional engineer's stamp must be signed and dated.

West Ridge will limit the disclaimer statement to non-historic precipitation and seismic events. West Ridge will specifically omit a reference in the disclaimer to variability in the backfill. The engineer's stamp will be signed and dated.

R645-301-542.200, *(1) The Permittee must show that the backfill material can be compacted in six-inch to two-foot lifts to meet the soil properties that are recommended in Appendix 5-9. (2) The Permittee must commit to ensuring that the recommended lift thickness is verified and that adequate compaction is being met.*

(1) West Ridge proposes to compact the backfill material in 4-inch to 6-inch lifts. Compaction and moisture content specifications will be established by Standard Proctor compaction tests. Complete compaction through the vertical profile of each lift will be determined by density testing of the backfill during construction.

(2) West Ridge commits to assuring that the recommended lift thickness, compaction, and moisture content are being met during construction. *In situ* moisture/density testing will be conducted at several representative locations on each lift placed. Moisture/ density testing will be conducted under the supervision of a qualified professional engineer. Standard Proctor tests will be conducted in the field during construction, which will allow the moisture/density specification to change, if the character of the backfill changes. Any lift not meeting or exceeding compaction specifications will be scarified, moisture conditioned, and recompacted until specifications are met.

The foregoing discussion describes industry-standard practices for placing compacted fill and verifying moisture content and compaction specifications. Before a backfill source had been defined, West Ridge had proposed to conduct a test fill to verify that backfill material would meet specifications. West Ridge proposes that the commitment to a comprehensive laboratory testing program, coupled with defined backfill and topsoil sources, are adequate measures for assuring that compaction specifications will be met.

R645-301-542.200, *(1) The Permittee must clear up the confusion over what material was tested for shear strength parameters presented as backfill in Table 2 of Appendix 5-9. (2) The Permittee must state where the backfill material will come from. (3) The Permittee must provide the Division with the angle of repose of the backfill material. (4) The Permittee must provide the results of laboratory tests confirming the shear strength parameters described for the compacted fill and surficial residual soils.*

(1) West Ridge has defined the source of backfill, as discussed in Section 2.0, and laboratory shear strength testing is underway on this material. To address this issue of shear strength values, West Ridge has undertaken a comprehensive sampling and testing

program for all of the soils involved in the highwall reclamation, including backfill material, topsoil, and residual soil.

(2) The source areas for backfill and topsoil have been defined.

(3) The surficial layer will be comprised of 1 ft of backfill material and 1 ft of topsoil at the surface. This 2-ft-thick zone will not be compacted to allow for a rooting zone. However, the rooting zone will be mechanically stabilized using geogrid reinforcement. Migration of fines out of the slope will be controlled by an erosion blanket placed between the geogrid and the soil.

West Ridge has searched the ASTM standardized testing procedures and queried several soils laboratories concerning standard and defensible methods for determining the angle of repose of a geologic material, and has discovered no methods for this test. While such a test may appear intuitive (i.e., dump the material and measure the side slope angle), there are too many variables to consider without a standardized method. For example, what height would the sample be dumped from, would it be poured or dumped en mass, what moisture content would the sample be at, what size fractions would be allowed, would soil aggregates be acceptable, or would the material have to be screened? Although West Ridge deems determination of angle of repose unnecessary because of the commitment to mechanical stabilization of the surficial rooting zone, West Ridge would commit to angle of repose testing, if DOGM can supply defensible methods for this test.

(4) Previously, AAI modeled the existing bench at the base of the highwall as "compacted fill" and used Terracon (1997) shear strength data for this material. However, it has been determined that the material that comprises the bench at the base of the highwall is bedrock, except directly above the portals, where fill has been placed. Therefore, the values for shear strength of "partially burned coal and interbedded sandstone and siltstone" that was used in the previous model will be used for the bench. The slots that were cut in the bench to accommodate the portals represent a small percentage of the overall coverage of the bench and do not contribute to instability.

Regarding the shear strength of the surficial residual soil, the material is demonstrably stable and has no bearing on the design. Nonetheless, West Ridge has sampled the native residual soil and laboratory tests are currently being conducted to determine shear strength and physical properties of the residual soil.

4.0 OTHER COMMENTS

In addition to the foregoing items listed in the "Summary of Deficiencies," the issue of relative environmental impact of decreasing the slope angle of the highwall backfill and abandoning the experimental practice, or maintaining the experimental practice, was raised by DOGM. West Ridge proposes to conduct such an assessment. Maintaining the experimental practice involves restoring the drainage to the pre-mining alignment and constructing a

40-degree reclaimed slope at the portal highwall. Reducing the slope angle to the angle of the native ground above the highwall involves leaving the topsoil and geosynthetic liner buried below the valley fill, to accommodate the extended toe of the slope. The drainage would be pushed to the side of the valley. Maps and cross sections will be prepared for each scenario. Environmental benefits and liabilities for each scenario will be discussed in a new appendix.

DOGM also asked for a contingency plan, in the event that the assumptions made in the design cannot be met. West Ridge has defined the backfill and topsoil sources and undertaken a comprehensive sampling and laboratory testing program for all soils that will be involved in the reclaimed slope. West Ridge proposes that a contingency plan is not warranted because the level of uncertainty has been significantly reduced by these measures.

5.0 SUMMARY

In summary, West Ridge proposes the following actions to address the latest review of Appendix 5-9 by DOGM.

- Define on-site sources of backfill and topsoil.
- Conduct laboratory geotechnical and soil chemistry tests on the backfill material, topsoil, and residual soil.
- Design and construct a mechanically stabilized surficial rooting zone using geogrid and an erosion blanket.
- Conduct an environmental benefit/liability study comparing reducing the slope angle of the reclaimed highwall and abandoning the experimental practice, versus maintaining the experimental practice and the 40-degree reclaimed slope.
- Commit to construction management by a professional engineer with expertise in steep slope construction.
- Assure that the slope evaluation (Appendix 5-9) is signed and dated by a professional engineer.

Best regards,

Jim Cremeens
Senior Engineer

JC/pg
Cc: Gary Gray (West Ridge Resources, Inc.)