State of New Mexico
ENERGY, MINERALS and NATURAL RESOURCES DEPARTMENT
and the
ENVIRONMENT DEPARTMENT

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Electronic Transmission

November 12, 2019

Sherry Burt-Kested, Manager
Environmental Services
Freeport-McMoRan Chino Mines Company
P.O. Box 10
Bayard, NM 88023

Re: Joint Agency Comments on Hanover Mountain Test Plot Work Plan, MMD No. GR002RE and NMED DP-1403

Dear Ms. Burt-Kested,

The Energy, Minerals and Natural Resources Department, Mining and Minerals Division (MMD) and the New Mexico Environment Department (NMED) reviewed the Freeport-McMoRan Chino Mines Company (FMI Chino) – Hanover Mountain Test Plot Work Plan (Work Plan) dated August 29, 2019. The Work Plan was submitted pursuant to Condition 8.M.1.a of Mining Act Permit No. GR002RE and Conditions C109.A & C109.B of Discharge Permit 1403 (DP-1403). MMD and NMED approved two 90-day extensions of time for submittal of the Work Plan, which has been submitted prior to the August 30, 2019 extended deadline. MMD, NMED, and FMI Chino discussed concepts of the Work Plan in multiple teleconferences during the last few months in order to understand respective expectations for the test plot study. This letter provides written comments on the Work Plan.

General Comments

1) From the perspective of having an adequate closure/closeout plan and cost basis for reclamation cover material (RCM) at the Continental Mine, the agencies remain concerned about the third attempt of Colorado formation test plots (2006-2008 initial; 2014-2015 reseeded) and the Pearson Barnes reclaimed area. Table 1 summarizes previous test plot studies. Specifically, the agencies are concerned that the test plots constructed in accordance with this Work Plan may have a similar lack of success as observed on the previously constructed test plots using Colorado formation RCM. The treatments as proposed including

lime application, an alternate seed mix and a cover crop, do not include cover system treatments that may ultimately be necessary to achieve a self-sustaining ecosystem. An example of other treatments that may be necessary may include limiting the percentage of rock fragment (texture) and the application of organic soil amendments. If the test plots lack evidence of, or a trend towards successful establishment of vegetation based on plant density and percent cover after three growing seasons (fall of 2022) or later, the agencies will require additional test plots to evaluate modification of the Hanover Mountain RCM (HMRCM) textural characteristics and addition of organic amendments.

2) The Work Plan lacks a balance of treatment combinations and an explanation of why the selected treatment variables were chosen. Using the proposed treatment variables of lime, alternate seed mix, and a nurse crop, a balanced experimental design would require additional test plots to test all combinations of the independent and dependent variables. Instead, the Work Plan proposes an evaluation of the variables using only six test plots (4 flat and 2 sloped). A balanced experimental design would necessitate a total of sixteen test plots (8 flat and 8 sloped) to evaluate all combinations of the treatment variables including a combined treatment of lime and nurse crops for different seed mixes. Without a balanced experimental design, the results will be less useful and not statistically comparable. Table 2 represents the minimum number of test plots recommended by MMD and NMED.

3) The Work Plan needs to define terms relative to textural characteristics and consistently use these defined terms. Previously "rock fragment" and "rock content" has been defined to be material greater than 2 mm in size, whereas "fine earth fraction" is material less than 2 mm in size. "Oversize" material as used in the Work Plan appears to be referencing material greater than 3" in size. Comments below are using the terms as defined herein.

Specific Comments:

The following are specific comments on the Work Plan:

1. Section 1.0, page 1. Condition 8.M.1.a of GR002RE states that a comprehensive evaluation shall be performed in years three and five of the study. If the test plots are not on a trajectory towards meeting vegetation establishment including plant density and percent cover after year three, MMD and NMED may require installation of an additional test plot(s) that will evaluate application of an organic amendment (i.e., composted biosolids, biochar, composted mushrooms) and the use of a construction method that controls the rock fragment percentage. Composite or layered systems may be required for evaluation.

2. Section 2.1, page 2. Please add physical and textural characterization of cover material as an objective in this section.

3. Section 2.1, page 2; Section 3.1, page 3. Please clarify what the objectives of the test plot study are, why the three treatment variables were selected, and identify what are considered to be control plots for the study. In addition, the independent and dependent variables need to be defined for this study. Additional test plots incorporating lime application and a nurse crop are included in Table 2. Test plots should evaluate all of the parameters against each other so that the optimal combination of treatments may be determined.

4. Section 3.2, page 3. Please indicate if the HMRCM has been tested for pH and if so, what the measured pH values are. Surficial soil pH values are provided in Table 2 of the May 2015 Hanover Mountain Soils and Borrow Material Characterization. These pH values may be very different than the pH of the mined material.

5. Section 3.2.1, page 3. Golder indicates that the HMRCM generally has about 50 percent "rock fragment" by volume. Please clarify if this based on physical testing or visual estimates. Also please use appropriately defined terms. In this instance it is not clear if the phrase is intended to describe material greater then 2 mm in size or greater then 2" in size.

6. Section 3.2.1, page 3. Please provide a map of sampling locations and a discussion of how sampling bias will be avoided in the field.

7. Section 3.2.1, pages 3-4, Table 1. Please clarify how many field samples are proposed for the lime application study. The text appears to suggest that samples will be taken from four sample locations, but there is mention of additional samples that will be taken of each homogenized sample. In addition, please provide more detail on sample collection including depth of excavation, location(s) where samples will be taken in the sample pits, and the methodology of sample collection.

8. Section 3.2.1, pages 3-4, Table 1 and Section 3.4.2.1, pages 10-11, Table 5. Variability of properties of Colorado Formation material has been demonstrated in the Hanover Mountain Soils and Borrow Material Characterization report dated May 5, 2015. The agencies recommend collection of a minimum of 10 samples from the North Overburden Stockpile (NOBS), 10 samples from the OB-4 stockpile, and 10 samples from the active mining area in advance of test plot construction. Characterization of the NOBS, OB-4 and the active mining area shall follow what is shown in Table 1 and Table 5 in the Work Plan. These data will help identify variability in Colorado Formation RCM.

9. Section 3.2.1, page 4. Golder states that the sieved materials for a particular sample will be homogenized in the field prior to placing in the buckets. Please describe how the material will be "homogenized."

10. Section 3.2.1, page 4. Field weighing of particles greater than 2 mm in size is necessary to verify the uncertainty of the less reliable (NRCS Soil Survey Method) visual estimation of the coarse fraction. The agencies request comparison of the visual estimation method to actual field measurement by taking a minimum of one excavator shovel volume of cover material and weighing the greater than 2 mm size fraction in the field. The actual weight measurement of the greater than 2 mm size material can then be used to verify the visual estimates. This comment also applies to Section 3.4.1, page 10 under Field Methods.

11. Section 3.2.1, Table 1, page 4. Please add base saturation (% BS) and soil organic matter (SOM) as parameters to be measured for HMRCM (Table 1).

12. Section 3.2.1, Table 1, page 4. Please provide justification why the SMP buffer method was selected instead of the Adams-Evans buffer method. The SMP buffer method was developed for agricultural soils with high SOM, fine textures, and high amounts of 2:1 clays, as opposed to the Adams-Evans buffer method which was developed for coarse-textured, low SOM, and low 2:1 clay soils.

13. Section 3.2.2, page 4. Please explain why the chosen target pH range of the HMRCM is 6.5 -7. It is not clear if this pH range is based on a reference area with undisturbed soils, desired growth media pH range for a target plant species community, or some other factor.

14. Section 3.2.2., page 4. Please describe the difference between the lime application rates stated as the "highest rate as determined by the SMP buffer" and the "average lime requirement by SMP".

15. Section 3.2.2, page 5. It is unclear what "traditional lime rate estimation methods" are and how these can be compared to the SMP method. Please provide additional discussion.

16. Section 3.2.2, page 4-5. It is unclear how lime amendment rates will be scaled in the bench-scale tests, the greenhouse test and then in the field. The bench-scale test will use material <2 mm in size. The greenhouse study will use <2" material and the field test plots will be constructed with highly variable material greater than 2 mm in size. Please provide a description of how lime amendment rates will be adjusted/scaled from <2 mm sized material to material that may contain up to 70 percent large gravels and cobbles.

17. Section 3.2.3, page 5. Please correct the stated number of treatment combinations. The Work Plan proposes the following experimental design, with 3 replications. As proposed, this should result in 18 treatment combinations and 54 total individuals in the study, not 42.

    - Media (3 treatments): sand control, HMRCM (a), HMRCM (b)
    - Lime (3 treatments): none, average lime requirement (SMP buffer), high lime requirement (SMP buffer)

- Plant type (2 treatments): side-oats grama (grass), desert marigold (forb)

18. Section 3.2.3, pages 5-6. It is unclear why the three proposed growth mediums were chosen. Are the two HMRCM treatments considered replicates or is part of the goal of the study to determine which HMRCM sample is a superior growth medium? Additionally, what is the purpose of using a sand growth medium as a control in this study? Does using a sand control address any of the questions posed by this study? Please explain why the HMRCM is not used as the control.

19. Section 3.2.3, page 5. Please explain if the lime will be incorporated into the greenhouse study pots at the same depth as the field test plots (i.e., 6-inch depth).

20. Section 3.2.3, page 6. Please describe and propose a consistent photoperiod and watering regime to be used.

21. Section 3.2.3, page 7. Please discuss how a lime application rate will be chosen if there are no statistical differences in plant growth noted between different lime application rates in the greenhouse study.

22. Section 3.3.1, pages 7 and 8. The percent rock fragment influences the available water holding capacity of a material. The agencies are concerned that material hauled directly from the active mining area may have a significantly higher percent rock than the stockpile, which would lower the overall water holding capacity and may not meet the water holding capacity requirements as required in 20.6.7.33 NMAC. The test plots are not designed or intended to test or monitor the ability of the material to store water.

    In addition, a higher percent rock fragment may inhibit plant growth. The existing test plots are examples of how texture likely influences plant growth. The carbonate test plots have not shown successful plants growth and appear to have a high percent rock content. Based on the June 4, 2009, *As-Built Report, Cover, Erosion, and Revegetation Test Plots, Condition 77, DP-1403 (*As-Built Report*)*, the material greater than 2 mm in size in the cover material is 70% or less with upper bounds on the volume of cobbles (<30%) and stones (<10%). The same cover material specifications appear to be proposed in Table 4 of the Work Plan.

    Please describe how the Work Plan proposal differs from the test plot plan that was implemented and documented in the 2009 As-Built Report from a textural standpoint. Also, please define “suitable materials” and how they will be identified at the shovel face. In addition, the agencies understand that Golder will develop a relationship between WHC and materials greater than 2 mm in size using the NRCS method. The Agencies require a method that uses linear plots of WHC and percent material greater than 2 mm in size, using both the NRCS method and the linear regression of the laboratory data to determine the maximum and

minimum permissible percentage of material greater than 2 mm in size that will meet the required water holding capacity.

23. Section 3.3.3, page 9. Most plants have a rooting depth greater than six inches. Golder indicates that lime will be applied using a dozer ripper to a depth of approximately six inches. Please discuss how a lime amendment will be beneficial to plant growth if it is not distributed throughout the entire root zone. Also, please discuss the time frame for lime to effectively increase pH in the HMRCM after it is applied in the field. If this is a slow process that requires the lime amendment to dissolve and then geochemically raise the pH in the HMRCM, will seeds be able to germinate in this material following application? Please provide additional discussion.

24. Section 3.3.2, pages 8-9. The Material Handling Quality Control (MHQC) plan is inadequate because the previous test plots have not performed well with respect to vegetation establishment. The agencies require additional field measurements of the percentage of rock fragments greater than 2 mm in size rather than solely relying on visual estimates of rock fragment percentages.

25. Section 3.3, page 9. Please discuss how the lime application proposal in this study differs from the lime application performed in the Pearson-Barnes area. NMED and MMD understand that lime was used as a treatment to increase pH in the cover material used in the Pearson-Barnes area, but the results of the lime application were not conclusive. Lime was applied multiple times over a number of years. Plants eventually started growing in the cover material, and it is unclear how the combination of lime application and multiple seedings resulted in this vegetation growth. It is also noted that the predominant vegetation established was volunteer vegetation unrelated to the seed mixes applied.

26. Section 4.1, page 11. After the third growing season, an annual test plot report will be submitted. Based on the results of this annual report the agencies will determine if modification of the test plot study is required.

27. Section 3.4.1, page 10. The field methodology mentions excavating the test plot HMRCM cover to approximately 3 feet. Please indicate what depth(s) the HMRCM samples will be taken to test pH and other material properties.

28. Section 3.4.1, page 10. Please clarify why soil hydraulic samples are proposed to be taken from only 4 of 30 test pits. This does not cover the minimum number of treatment combinations described in this study. In addition to concerns about the number of treatment combinations, NMED and MMD expect there will be variability in material characteritics from the HMRCM sources.

29. Section 3.4, page 10. Please specify which laboratory is going to perform the soil hydraulic characterization.

30. Section 3.4.1, page 10. Please verify if a total of 30 test pits will be excavated (i.e., 5 test pits x 6 plots), and therefore, 30 composite samples will be taken to characterize the fine earth fraction. In addition, four large volume samples (5-gallons) will be taken from "selected" test pits for soil hydraulic characterization. Please describe the criteria that will be used to determine which test pits large volume samples will be taken from. In order to remain unbiased, NMED and MMD require that sample locations are chosen randomly.

31. Section 3.4.2.1, page 10. This Section references Table 1, when it's likely this should reference Table 5. Table 1 and Table 5 should have the same testing parameters for comparison to verify the variability or lack thereof for the HMRCM used in the lime application study and the field test plots.

32. Section 3.4.2.2, page 11. Field capacity at a matric potential of 100 cm for coarse textured soils may not be appropriate. Please provide a basis for why field capacity has been defined at a matric potential of 100 cm for coarse textured soils. Please provide a more detailed reference with the specific subsection in the NRCS National Soil Survey Handbook.

33. Section 3.4.2.2, page 11. Please indicate which method will be used to correct for the volumetric rock content. Also, the Agencies will require measurement by weight of the whole soil rock fragment in addition to visual estimates determined in the field. In addition, please explain why FMI is using a 3-inch (75 mm) cutoff of large rock fragments in the field.

34. Section 3.4.2.2, page 11. This section does not indicate if the WHC of the material will be compared to the Copper Rule WHC requirement. The As-Built Report must include a demonstration that the Copper Rule WHC as required in Section 20.6.7.33.F.2 NMAC has been met.

35. Section 5.0, Table 6, Page 13. Please add start dates for the lime application study, bench scale study, and greenhouse study. Characterization and field measurements of the coarse fragment percentage should be included.

36. Appendix A-1. The current proposed seeding rate for the triticale nurse crop is 25 pounds per acre (lbs/ac). The agencies recommend a seeding rate of no more than 15 lbs/ac for the test plot study given the semi-arid environment at the Continental Mine. Also, Granite Seed Company recommends a seeding rate of 8-15 lbs/ac for Quickguard Triticale.

37. Appendix A-1. The seeding rate for the alternative seed mix is above the NRCS recommendations of not more than 40 seeds per square foot (seeds/sq-ft) drilled or 60 seeds/sq-ft broadcast for native grasses in the semi-arid and arid Southwest.

Please provide a revised work plan implementation schedule and responses to the above agency comments within 60 days or no later than January 15, 2020.

Please contact respective MMD and NMED permit leads Kevin Myers at 505-476-3438 and Anne Maurer at 505-827-2906 with any questions regarding permitting issues for the Continental Mine.

Sincerely,

Anne Maurer
Mining Environmental Compliance Section
Ground Water Quality Bureau - NMED

Kevin Myers
Mining Act Reclamation Program
Mining and Minerals Division-EMNRD

cc: Kurt Vollbrecht, Program Manager – MECS (kurt.vollbrecht@state.nm.us)
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Table 1 Historical Test Plots and Pearson Barnes Reclamation using Colorado Formation and other cover materials at Continental Mine

Test Plot No.	Location	Acreage	Cover Material	Thickness (feet)	Slope (H to V) or Top Surface	Year of initial seeding	Year of reseeding (P = partial)	Other treatments (P= partial)	Comment
1	West WRF	1.08	Leach Cap	2	top surface	2008	2014, 2015	2012 shallow disk/rip/reseed (P)	2012 used 0.3 to 0.5 acre
2	West WRF	1.01	Leach Cap	3	top surface	2008	2014, 2015	2012 shallow disk/rip/reseed (P)	2012 used 0.3 to 0.5 acre
3	West WRF	1.21	Carbonate	3	top surface	2008	2014 (P)	2012 rip/reseed (P)	2012 used 0.3 to 0.5 acre
4	West WRF	1.01	Carbonate	2	top surface	2008	NA	2012 rip/blend/reseed (P)	2012 used 0.3 to 0.5 acre
5	West WRF	1.45	Leach Cap	3	3 to 1	2008	2014, 2015	2012 shallow disk/rip/reseed (P)	2012 used 0.3 to 0.5 acre
6	West WRF	1.31	Leach Cap	2	3 to 1	2008	2014, 2015		
7	West WRF	0.51	none	0	top surface	2008			control
8	East WRF	0.91	none	NA-in situ	top surface	2008			
9	East WRF	1.83	none	NA-in situ	3 to 1	2008	2015		
10	East WRF	1	none	NA-in situ	2.5 to 1	2008			
11	East WRF	0.52	none	NA-in situ	angle of rep.	2008			control
12	MTI	1.08	Leach Cap	2	top surface	2008	2014		
13	MTI	0.98	Leach Cap	1	top surface	2008	2014		
14	MTI	1.08	Carbonate	2	top surface	2008	2014		
15	MTI	0.97	Carbonate	1	top surface	2008	2014		
Reclaimed	Pearson Barnes	0.97	Leach Cap	3	3 to 1	2005	2011	2008 field adjust channels, pH	2011 correct rip rap channels

WRF = Waste Rock Facility MTI = Main Tailing Impoundment

Leach Cap is hermosa mountain area Colorado Formation cover material.

Carbonate is waste rock material

Table 2 Agency Recommended Hanover Test Plot Treatments

Plot No.	Location	H to V Sloped or top surface	Treatment	Seed Mix
H1	MTI	3 to 1	control	approved
H2	MTI	3 to 1	lime	approved
H3	MTI	top surface	control	approved
H4	MTI	top surface	lime	approved
H5	MTI	top surface	nurse crop	approved
H6	MTI	top surface	lime + nurse crop	approved
H7	MTI	top surface	control	proposed
H8	MTI	top surface	lime	proposed
H9	MTI	top surface	nurse crop	proposed
H10	MTI	top surface	lime + nurse crop	proposed

MTI = Main Tailing Impoundment