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TO: Minerals File

THRU: Tom Munson, Senior Reclamation Hydrologist

FROM: Paul Baker, Senior Reclamation Biologist

RE: Soil Test Results, Rancho Equipment Services, Topaz Valley Limestone, M/023/022, Juab County, Utah

The operator of the Topaz Valley Limestone Quarry has seeded the site three times, but almost no vegetation has become established. There have hardly even been any weeds.

One soil sample taken by Tom Munson was analyzed for sodium adsorption ratio (SAR), electrical conductivity (EC), pH, texture, organic matter, potassium, phosphorous, and nitrate-nitrogen. The analysis showed extremely high SAR and EC values, so he took four additional samples from different parts of the mine and one sample from an undisturbed area.

The results of the additional testing basically confirm the first test result but also offer additional insight into the problem. Neither sodium nor salinity is a problem in the offsite soils, so the question is, "From where did all the salt come in the reclaimed area?" There are at least three possibilities:

1. Sodic soil horizon at depth. The sample from the undisturbed area was taken from the surface, but there could be a sodic horizon at some depth below the surface. If the baseline soils information was inadequate, or if the plan was not developed or implemented properly, a sodic horizon might have been salvaged and later used for reclamation.

2. Over-fertilization. The nitrate-nitrogen levels in three of the four samples from the reclaimed area were found to be extremely high which is very rare for a desert soil. The average of the four samples from the reclaimed area was 60.93 ppm, but the sample from the undisturbed area showed 21.86 ppm. This indicates there was a large addition of nitrogen, possibly from fertilizer. In addition, the average

pH value in the undisturbed area was 7.57 compared to 8.15 in the undisturbed area. While this could be normal variability, the pH depression could also be explained by addition of a fertilizer like ammonium sulfate. This would also help explain the increased EC values. Interestingly, the one sample from the reclaimed area with a low nitrate-nitrogen level (18.81 ppm) also had a moderate EC level (4.20 dS/m), and this tends to confirm that over-fertilization may be at least part of the problem. Fertilization with a nitrogen fertilizer does not explain the elevated SAR levels.

3. Explosives. Ammonium nitrate with fuel oil (ANFO) is commonly used as an explosive, and depending on how the charge is set off, there may be varying amounts of residual ammonium nitrate. Although there was probably some nitrate added to the soil from explosives, according to Doug Jensen, it was probably not enough to make a significant difference in the soil nitrate level.

4. Combination of sodic soil and too much fertilizer. Adding too much fertilizer does not explain the elevated SAR levels, and use of a sodic soil horizon does not explain the increased nitrate-nitrogen levels. If both a sodic soil and excessive fertilizer were used, both the high SAR and the high nitrate-nitrogen could be explained.

No matter what the cause, there are few available options for establishing vegetation and only one that may be practical.

1. Natural leaching. With adequate precipitation, salts will leach from a soil over time, but this is not likely to happen at this site any time in the foreseeable future. The site is in a very arid environment where salts are more likely to rise and accumulate near the surface rather than be leached.

2. Irrigation/leaching. This is normally done with agricultural soils rather than rangelands. It requires large quantities of water, typically a foot if the site is sprinkler irrigated, and may also require subsurface drains. This is not likely to be practical.

3. Capillary barrier and borrow soil. The entire site could be covered with a three-inch layer of gravel followed by about two feet of soil from a borrow area. This would obviously be extremely expensive and would require identification, disturbance, and reclamation of a suitable borrow site. About 58,000 cubic yards of soil and 7300 cubic yards of gravel would be required. Although it is not known how large of an area would need to be disturbed to obtain the soil, there are very limited soils available in this area. It might be necessary to disturb a very

large area—perhaps four times as large as the mine disturbance—to obtain the borrow soil materials.

4. Seed with shadscale. There are a few plant species that will tolerate these high salinity levels, and the only one commonly available that might survive in this environment is shadscale. Although shadscale was included in the seed mix used most recently, it is possible the reason it did not become established is because of a combination of marginal soil conditions (marginal for this species but unacceptable for others) and poor weather. There could be other factors of which I am not aware that might have contributed to the seeding failure.

5. Wait and hope for delayed germination. The seed of shadscale has dormancy mechanisms that are not well understood, and it can remain dormant in the soil for a few years before germinating. Since the weather was relatively dry after the site was seeded, the shadscale seed may still be in the soil waiting for the right conditions before germinating. Indian ricegrass seed can also be very dormant, but it is doubtful whether it can tolerate the high soil salt levels. The other seeded species have little dormancy.

I recommend that the Division use the fifth option for 2004. I do not believe there are disadvantages to this option other than just having to wait. The site has had very few weeds, and there are no other particular environmental or public safety hazards. If there is no establishment after a year, I suggest that the site be drill seeded with shadscale. Drilling should be done on the contour, but no other site preparation should be needed.

jb
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