THE SAN LUIS MINE

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INTRODUCTION

The San Luis Mine is located on the western slope of the Sangre De Cristo Mountains adjacent to the San Luis Basin and about 3½ miles northeast of the town of San Luis. A permit to mine was approved by the Department of Natural Resources, Division of Minerals and Geology (DMG). Construction began in 1989 -1990.

Battle Mountain Resources, Inc. (BMRI) holds air, stormwater, water rights, waste, safety, explosive, and reclamation permits.

- BMRI's air permits state that fugitive dust must be controlled from the mine site. BMRI was required to monitor Particulate Matter less than 10 microns (PM10) every three days for 1 year at the mine site. BMRI monitored PM10 for 5 years with only one exceedance. This exceedance was discounted because of very high winds that day. BMRI continues to monitor wind direction, wind speed, temperature, and precipitation. BMRI is required to keep opacity (visible emissions) below set limits on the haul roads, at the top of the leach tanks, at any discharge pipes, at the crusher, etc. Two employees on site are tested every six months by the state on identifying opacity levels and are then certified to measure opacity. These two employees take opacity readings daily.
- BMRI's stormwater permit maintains best management practices for the control of sediment from entering area drainages. BMRI is required to maintain stormwater ditches, check dams, and sumps twice a year. In actuality, these areas are checked almost monthly.
- BMRI, through Colorado Water Court Case No. 89CW32, is required to augment water taken from a dewatering well, used to keep the pit dry for mining, back into the Rito Seco. The Water Court Case allowed BMRI to change point of diversion water use for existing water rights as well as requiring augmentation. This augmentation water comes from a farm ten miles away, purchased by BMRI. BMRI put in a pipeline from the farm to the mine site in order to supply water to the mine and for augmentation. Three to four irrigation fields are left dry and planted with dryland grasses in order to compensate for the water taken. In any one year, the mine site will use much less water than the farm. The water that is taken from the dewatering well must be sent directly to the tailings ponds. BMRI does not send this water directly back to Rito Seco because analysis of the water shows that it is periodically above drinking water standards for gross alpha radiological chemistry. Stream gauging of Rito Seco does not show that the dewatering well depletes the creek, yet BMRI is required to augment the dewatering well water due to the closeness and possible connection to the Rito Seco alluvial flows.

The San Luis Mine is a zero discharge facility and is located in a net evaporation environment; the Summitville Mine was located in a net precipitation environment.

- BMRI also holds a small quantity generator permit with the Environmental Protection Agency (EPA). This permit allows for the storage of only small quantities of hazardous waste for limited time periods.
- BMRI conducts all mining activities under the strict rules of the Mine Safety and Health Administration (MSHA). BMRI is routinely inspected by MSHA. BMRI holds an excellent safety record. This is attributable to the excellent workforce and safety training.
- BMRI holds a permit through the DMG to use explosives in order to break up the hard rock for mining.
- BMRI's reclamation permit was also issued by the DMG. This permit is the most extensive of all mine permits. This permit allows BMRI to mine and process the ore and mandates how the area will be reclaimed afterward.

RECLAMATION

BMRI chose to include concurrent reclamation in the mining schedule. Reclamation, by definition, is the treatment or manipulation of a disturbed site. The definition of reclamation can be interpreted as helping mother nature accelerate productivity.

Great advances have been made in reclamation technology in the past twenty years. Probably the most significant of these has been the "domestication" of many species—especially native species—for revegetation, and the development of commercially available sources of seed and nursery stock. With the emphasis on diversity as a desirable trait of reclaimed landscapes it is not uncommon to use seed mixtures for reclamation containing twenty or more species. Such mixes would not have been feasible in the West ten years ago.

Despite the progress that has been made in reclamation technology, reclaiming high elevation disturbances remains problematic. Problems include harsh climatic conditions, marginal or unsuitable soils, very short growing seasons, lack of adequate supply of water, and a short or non-existent supply of seed of adapted plant species. And good initial stands can die out altogether.

The first step to successful reclamation is a site characterization. This characterization includes baseline studies, determination of past and future uses of the land, and biological, ecological, geological, hydrological, climatological, and environmental studies. Baseline water quality sampling began at the San Luis Mine in November 1987 and water quality sampling has continued since then. Climatological studies and air sampling have been continuous since operations began. The biological, ecological, geological, hydrological, and environmental studies can all be found in the approved permit and ongoing environmental activities at the site.

Past land uses of the general area of the San Luis Mine have been principally rangeland for grazing of domestic livestock and as an open space for wildlife habitat. Grazing pressure currently ranges from low to moderate. Other present and past land uses are recreational fishing and picnicking along the Rito Seco, cutting of trees for firewood, and some previous mining and mineral exploration activities (i.e. a small mine and heap leach were developed in the project area in the 1970's, and exploration programs have continued since that time). Areas to the north, south, and east of the project were divided into large lot housing plots and an extensive road system has been constructed to access these plots. The area supports mostly sagebrush on the flats and lower slopes with piñon and juniper trees on the steeper upland slopes. The climate at this elevation in southern Colorado is warm and dry in the summer and cold with snow and rain in the fall, winter, and spring.

Following reclamation, the land should be able to support the same level of productive uses that existed prior to mining, including wildlife, agricultural, and recreation. Return of lands does not happen without effort, particularly in the arid west. Approved land uses after mining are to reclaim rangeland and to create an open space for wildlife habitat. At San Luis, BMRI intends to improve productive uses that existed prior to mining. Revegetation is planned to improve range conditions by planting a higher proportion of desirable forage grasses. Not only does this vegetative growth provide aesthetic qualities and erosion control, it also provides food and cover for wildlife. Because the area is currently dominated by sagebrush and supports sparse grass cover, both wildlife and range conditions will benefit from a diverse grassland community. Waste rock disposal areas and pits are recontoured to conform to the surrounding land or at least to an aesthetically pleasing form and integrated into the natural topography.

Our goal in revegetating is to establish a mature plant community on-site that is capable of reproducing itself year after year. In order to provide an environment that can produce the desired results, slope and growth medium stabilization is necessary. Extensive slope stability and reclamation studies conducted by the U.S. Forest Service in conjunction with mine operators in Central Idaho concluded that the optimum average outslope is 3:1. An average slope of 3:1 decreases the runoff velocity, allowing for runoff infiltration and minimizes growth medium erosion.

When construction is completed on each lift of a waste rock disposal area, the outslope is reclaimed. The building of subsequent benches proceeds concurrently with the reclamation of lower benches. The slopes are graded to allow 15 foot (dozer width) benches. These benches allow for sediment collection and erosion control. Vegetation of the lower slopes provides some filtration for sediment that might be present in runoff from upper unreclaimed slopes of the waste rock disposal areas. A small catch basin is left as each subsequent lift is graded and this bench provides a mechanism for slowing runoff from the slopes and allowing collection of sediment. As a result, all the active waste rock disposal areas have had their lower slopes reclaimed. This provides immediate stormwater management benefits through minimizing exposure of the waste rock and providing vegetative stabilization. Vegetative establishment reduces sediment generation and on the lower slopes it will provide some filtration for sediment that might be present in runoff from upper unreclaimed slopes of the waste rock disposal areas. Other stormwater management procedures implemented include controlling erosion and sedimentation by constructing drainage ditches, berms, settling basins, and small check dams.

Sediment runoff and soil erosion from exposed surfaces is minimized by diverting upslope runoff through diversion ditches into sumps where sediments are allowed to settle. These sumps and ditches are cleaned out periodically.

The heap leach area developed by Earth Sciences, Inc. (ESI), developed in the project area in the 1970's, had completely revegetated through natural invasion without growth medium replacement, fertilizer, or seeding. Several varieties of shrubs, trees, grasses, and wildflowers were observed flourishing in this rocky, soil deficient environment. This area blended quite well with the surrounding vegetation, suggesting that successful reclamation of disturbed areas, proposed as part of the San Luis Project, will be achieved. Testing of the area showed recoverable gold and additional testing by BMRI showed no cyanide. BMRI removed the spent ore, folded in and graded over the concrete pool and plastic pond liners, and covered the entire area with growth medium and reseeded.

The first pit to be mined by BMRI was the East Pit. This pit has been backfilled with approximately two million tons of waste rock from the West Pit. Benches of approximately 15 feet wide are maintained to aid in sediment and erosion control. The lowest bench was left to approximate the original contour. Backfill was placed in a style that blends with the surrounding topography. Following backfill placement, growth medium was distributed to a depth of 12 to 18 inches. The area was revegetated with the approved seed mixture and 2,500 seedlings of piñon and juniper have been planted. Piñon and juniper trees are drought resistant, native species. The piñon provide fatty seeds that are beneficial for mammals during wintertime. They adapt well on steep grade hillsides and their roots are horizontal spreaders that help in preventing erosion.

PERMIT MODIFICATION

In 1994, BMRI requested from the DMG, a modification to our permit. This modification addresses a change in waste rock disposal plans to include partial backfilling of the West Pit to a level that will allow the below surface area (southern portion) to have positive drainage. The improved plan results in eliminating one waste rock disposal area, reducing the size of another waste rock disposal area, and providing temporary waste rock storage at a third disposal area before eventual removal and placement in the pit. The approved permit boundary will not change as a result, but the size of certain waste rock disposal facilities will change. Overall net disturbance of land will decrease as a result of the modification. Partial West Pit backfilling also eliminates the long-term stability concerns associated with the south wall adjacent to Rito Seco, and the requirement for a partial backfill rock buttress.

The stockpiling of waste rock on Waste Rock Disposal Area B will temporarily increase the height of the waste pile until this material is removed for backfilling into the West Pit. Waste rock will be backfilled into the West Pit to an elevation of approximately 8,600 feet. The results of a recent hydrogeologic evaluation indicate that following closure the groundwater level within the pit area will rise to an elevation of approximately 8,570 feet, and the groundwater flow system will return to a regime similar to the pre-mining conditions.

A laboratory testing program to geochemically characterize the waste rock from the San Luis Mine was outlined in the approved permit. Additional geochemistry work has been performed in association with the backfill of the West Pit. The results from the testing program indicated that no acid production or leaching of degradational quantities of any metals or other constituents from the waste rock are expected to occur.

The backfill of the West Pit will be comprised of two geologic units, the Santa Fe Formation and Precambrian Pink Gneiss. The Santa Fe Formation is interbedded with silts, sands, and gravels of Tertiary age. Regionally, the Santa Fe Formation is known to include caliche layers that impart a significant acid neutralization potential. It is well known that in Santa Fe aquifers, high carbonate alkalinity is present. Three separate samples of Santa Fe material were further tested from the mine site. The samples were leached using EPA Method 1312. Results showed that the Santa Fe material does not leach metals.

Ten samples of Pink Gneiss underwent static acid-base accounting. This data shows that there is discernible acid neutralizing potential in the samples. The static leaching showed that the only cations leachable at levels above 1 ppm were calcium and potassium.

Humidity Cell Tests (HCT) are conducted quarterly on tailings samples. These tests support the inference that acidic leachates or leaching metals do not pose a risk to water resources from the San Luis Mine. The HCT samples produce excess carbonate alkalinity and do not produce acid. The alkalinity values are not high enough to indicate that there is residual lime in the tailings samples, which could bias the test. Tests are run until sulfates fall below detectable levels. Metals are essentially unleachable from the tailings material, even under the stressful geochemical conditions of the HCT.

Once the West Pit is backfilled and water returns to an elevation of 8570', there will no longer be the potential for point-source discharge of water from the waste rock into the surface-water flow system. Under the fully saturated condition and with the original groundwater flow system largely restored, the flux of oxygen to the inundated

materials will be greatly reduced compared to the current condition.

Sequential Batch Tests allow a rapid and relatively simple evaluation of changes that may occur over time. In order to conduct these tests, groundwater from the dewatering well was collected to ensure more accurate results. These tests show that the gneiss is not acid generating under fully saturated conditions, even when the groundwater reacting with the rock has discernible amounts of dissolved oxygen and has a positive redox potential. The only metal that appears to be leachable from the gneiss at values that are above the detection limit is manganese. This observation is expected and confirms the reliability of the testing procedures since baseline studies show manganese in the groundwater. Therefore, under fully saturated conditions, such as will be reestablished in the backfilled West Pit, the Pink Gneiss is not acid generating, does not leach significant concentrations of any metal save manganese (and that only at a maximum of about 1 ppm), and is not expected to adversely affect any beneficial use of groundwater or surface water near the Mine.

In the unlikely event that mining is terminated any time prior to completion of the full mine plan, an alternative reclamation plan will be implemented. To provide for the event of early closure, BMRI has increased the reclamation bond from $3,300,000 to $6,300,000 to cover additional costs associated with pit backfilling.

The following table is a list of permitted disturbance areas and their acreage, the table also shows acreage under reclamation.

Disturbance Area	Acres	Under Reclamation
East Pit	20	20
West Pit	110	34
Waste Rock Disposal area A	0	0
Waste Rock Disposal area B	18	8
Waste Rock Disposal area C	30	28
Waste Rock Disposal area D	42	42
South Waste Rock Disposal	50	15
Mill and Administrative Buildings	26	4
ESI Heap Leach	8	8
Test Heap	10	0
Borrow Area	11	0
Roads	30	0
Tailings Disposal Area	192	0
TOTAL AREA	547	159

Backfilling pits is a visual and safety issue that receives a large amount of public attention. Although pit backfilling may not be the most important issue of reclamation, the sheer magnitude of this commitment to land reclamation deserves recognition.

GROWTH MEDIUM

Careful management of growth medium is essential to allow productive plant growth. During mine development, construction activities, and before each additional area is disturbed, available suitable growth medium material is stripped and stockpiled. Growth medium stockpiles are located along roads and near disturbance areas to provide easy access for reclamation. The growth medium stockpiles are graded and stabilized with slopes no greater than 2:1. Growth medium stockpiles are planted with a cover crop of western wheatgrass for stabilization.

The topsoil at the San Luis Mine has been identified as the A soil horizon only, it is shallow and most of the nutrients have been translocated downward into the subsoils (B soil horizon). The A soil horizon has the lowest runoff potential, it includes deep sands with very little silt or clay, and deep, highly permeable gravel. The B soil horizon has a moderately low runoff potential, it is mostly sandy soils less deep and less aggregated than A, and has an above average infiltration after thorough wetting. These observations were based on soil profile inspections by soil and vegetation expert, Dr. Sam Bamberg. Dr. Sam Bamberg also cautioned BMRI early against the use of the predominantly sandy soils below the B soil horizon as a suitable subsoil material. These soils would likely provide less water holding capacity and would not enhance the revegetation efforts. Given these site specific conditions, mixing of the topsoil and the subsoil has provided a better and superior quality growth medium than segregating the two or salvaging topsoil only. Also the clay fines that are generated in the breakdown of the waste rock have provided better moisture and nutrient holding capacities than the predominantly sandy subsoils.

During final reclamation, growth medium is placed at a depth of 8 to 12 inches on waste rock disposal areas and 12 to 18 inches on the east and west pits. Since the amount of growth medium available is plentiful these numbers tend to be higher rather than lower in actuality. The average rooting depth of the grassland species is 12 to 15 inches, thus, the depth of growth medium is sufficient in allowing the development of these species. Haul trucks bring in and end-dump the growth medium. Each haul truck can hold approximately 75 tons of growth medium. Dozers are used to spread the growth medium. Growth medium is placed on roughened surfaces to ensure good contact and is lightly compacted to allow for water retention and to prevent erosion.

Diversion structures have been installed adjacent to and downhill from growth medium stockpiles to divert stormwater away. This minimizes the amount of

stormwater coming in contact with the growth medium and reduces the possibility of erosion. However, revegetating growth medium stockpiles is a more effective and less impactive method of controlling sediment runoff.

SEEDING

Seedbed preparation for areas to be revegetated takes place after grading, stabilization, and growth medium placement. Compacted surfaces are loosened and left in a rough condition. The prepared seedbeds are then seeded with the approved seed mixture and seeding rates are doubled when seeding is done by broadcasting.

Recommended seed mixtures and rates have been formulated based on known climatic and soil conditions of the project area. The average annual precipitation of about 15.25 inches is sufficient to support all present and proposed species. Grasses were chosen because it is believed that wildlife habitat can be improved by establishing a post mining community that is predominantly grassland. As evidenced by the ESI heap leach pad, the undisturbed areas are an excellent source of seeds and will result in the growth of sagebrush and piñon and juniper trees that are not included in the seed mixture.

The following species and rates are recommended for seeding on the site. This list has been checked with personnel at the U.S. Soil Conservation Service office in San Luis.

Plant Species	Rate (lbs/acre)
Western Wheatgrass	4
Mountain Brome	3
Blue Grama	2
Indian Ricegrass	2
Mountain Muhly	1
Cicer Milkvetch	1.5
Mountain Mahogany	0.5
Winterfat	0.5

Western wheatgrass is a cool season grass that is one of the most common and abundant wheatgrasses in the West. It is a long-lived and erect, sodformer. Western wheatgrass is a primary forage species on ranges of piñon woodlands. It produces forage early in the spring and it cures well on the ground providing good winter forage. Moderately palatable to livestock, bighorn sheep, deer, and elk and moderately drought resistant.

Mountain brome is also a cool season yet short-lived perennial bunchgrass native to the intermountain west, that requires plentiful amounts of water. It establishes quickly and easily on disturbed sites. Good palatability to livestock and elk especially when it is green. Performs well at high elevations.

Blue grama is a long-lived warm season grass. It is adapted to a broad spectrum of soils but thrives on medium textured, well-drained sites. It is the most drought resistant of major grasses and very resistant to grazing. It is highly palatable and nutritious all year long and is rated as the choice forage for livestock and wildlife.

Indian Ricegrass is a warm season grass and is highly palatable and nutritious for livestock and wildlife. It can be consumed all year long and supplies the most nutrition in the spring before other natives have begun much growing. It is one of the most drought resistant range grasses. The plants are short-lived and must produce seed if any quantity is to be maintained on-site. Excellent for rangeland improvement and land reclamation.

Mountain muhly is a warm season, perennial grass that grows in high elevations. It is a very important forage grass throughout ponderosa pine and piñon woodland areas.

Cicer milkvetch is a spreading, warm season, legume native to Eurasia but well adapted to the western United States. It can tolerate a wide range of soils. It is used for high elevation meadows, irrigated pastures, cover crop in orchards, windbreaks, and restoration of big game ranges. Useful for reclamation and erosion control. Slow to establish, but competitive over time, fair drought tolerance, and very resistant to cold weather.

Mountain mahogany is a bushy shrub/small tree and occurs on a wide range of either rocky or gravely sites. It is strongly drought tolerant and palatable for deer, bighorn sheep, elk, and livestock. It provides cover for small birds and animals. It is a good soil stabilizer and windbreaker.

Winterfat grows in such varied climates, for instance, Death Valley and high mountain ranges. It can grow from soils near alkaline to neutral calcareous and from clays to sandy loams. It is a very drought resistant shrub. Extremely palatable to livestock and wildlife.

CONCLUSION

At the San Luis Mine we are successfully and concurrently reclaiming. BMRI is committed to sound environmental practices and successful rehabilitation of disturbed areas. Our goal to reclaim the land to an improved wildlife habitat has already begun to be realized. During operations we have been visited by many herds of elk and deer, a bighorn sheep, a bear, and numerous small mammals. It is obvious that the elk and deer enjoy the grasses (planted as part of our reclamation plan) especially when winter forage becomes increasingly scarce.

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