CREATING DIVERSE WILDLIFE HABITAT AT LA PLATA MINE, NORTHWESTERN NEW MEXICO, A CASE STUDY: PART 2. SOILS AND VEGETATION[1]

by

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Abstract. Biodiversity has increasingly become an important issue in determining the success of reclaimed minelands. The post-mine land-use of La Plata Mine is wildlife habitat, primarily for ungulates and small mammals. A reclamation plan was developed to promote biodiversity of reclaimed lands through the use of variable soil substrates, landscape features, and targeted seed mixes. A GIS was used to delineate the post-mine final surface contour into eight slope classes and eight aspect classes. The class information was used to develop four reclamation land types: 1. Upland shrub – north aspects, 2. Upland shrub – south aspects, 3. Grassland, and 4. Drainage. These land types correspond to four reclamation vegetation types. Suitable spoil materials and coarse textured topsoil materials were targeted for use on strongly sloping areas to minimize soil loss. Finer textured topsoil materials were targeted for the grassland and drainage types. The replacement depth of topsoil and topsoil substitute materials was varied for the reclamation vegetation types. Pre-mine vegetation inventories were used to develop unique seed mixes specific to physical habitat conditions exhibited by each land-type. Research conducted at La Plata Mine found that topsoil replacement thickness less than 15 cm promotes shrub establishment and topsoil thickness greater than 30 cm promotes native grass species. Therefore, areas designated for shrub communities will receive an average of 10 cm of topsoil or topsoil substitute material and the areas designated for grassland and drainage type communities will receive a minimum of 40 cm of topsoil.

Additional Key Words: surface coal mining, reclamation design, reclamation planning.

Introduction

Federal and State coal mining regulations require that all lands affected by mining be reclaimed to a condition that supports the post-mining land-use. Special considerations must be given for the designated post-mine land-use as reclamation plans are developed. Wildlife habitat, for example, is a substantially different land-use from grazing or agricultural land-uses, and thus planning reclamation for this land-use is different. Often wildlife land-uses require greater emphasis on biodiversity rather than productivity. Developing a reclamation plan for wildlife habitat must consider the pre-mining wildlife species, their composition, habitat requirements, seasonal patterns of distribution, and relative abundance. Pre-mine vegetation inventories and pre-mine soils inventories are required. In general, the ecology of the natural pre-mine habitat must be well documented in order to develop an effective reclamation plan.

The types and seasonal abundance of wildlife species (e.g. big game) will largely affect the types of vegetation species that are used for revegetation. The baseline vegetation and soils inventories are important for understanding the proportion, distribution, and interrelationships of the vegetation communities. The natural communities are related to the physiochemical properties of soil types and to landscape components. Thus the biodiversity in habitats is dependant on the

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type of soils and landscapes that are recreated during reclamation.

This paper discusses a conceptual reclamation design that was developed for the BHP La Plata Mine (LPM). The design utilizes a number of plant mixes, soil substrates, and complex slopes to maximize biodiversity and habitat value of the reclaimed lands.

Setting

The BHP Minerals LPM is located in the San Juan Basin, Northwestern New Mexico. The general terrain in this region is characterized by rough broken topography consisting of cuestas, hills, and valleys.

Baseline soil inventories show a high level of diversity in physiochemical properties including salinity, sodicity, texture, and soil depth. Lithic torriorthents and rock outcrops dominate the uplands, ustollic Haplargids occupy transitional areas between uplands and valley positions, and ustic torrifluvents dominate the bottomlands. The unique properties of these soils and the landscapes they occupy have resulted in three discernable vegetation types.

Pre-mine vegetation inventories identified Piñon-Juniper woodlands in upland positions. This is the dominant vegetation type at LPM and is associated with shallow soils on hills and cuestas. Tree species provide nearly 80% of relative cover, shrub species about 13%, and grass and forbs about 7% of relative cover. The Sage-Grassland vegetation type is characterized by virtually pure stands of big sagebrush and occurs in transitional areas between the upland and bottomland landscape positions. The soils in these areas are deep and medium to heavy textured. Total relative cover of shrub species was nearly 81%, grasses was 7%, and forbs about 6.5%. The Greasewood-Sagebrush vegetation type occurs adjacent to and inclusive of drainages. These communities are found on flat and gently sloping areas that consist of very deep, medium and heavy textured soils. This vegetation type is predominately Greasewood and Sagebrush with minor proportions of grass and forb species.

Wildlife Habitats

Large mammals present in the vicinity of LPM are mule deer and elk. Mountain lion, bobcat, and coyote are the large mammalian predators in the area. Mule deer are the most common large mammal in the area. The LPM area and surrounding region serve primarily as winter range for migratory deer that spend the summer and fall in southwestern Colorado. Analysis of winter mule deer food habitats in the LPM area during 1982 indicated browse species accounted for over 96% of the estimated winter diet (Western Resources Development Corp. 1982).

A study of browse species utilization on a reclaimed plot at LPM was completed in 1989 (Wood, et al. 1992). The primary usage included curl-leaf mountain mahogany, four-wing saltbrush, rubber rabbitbrush, winterfat, shadscale, antelope bitterbrush, and big sagebrush. Grass and forb species contributed very little to the winter diet of mule deer. However, their value should not be underestimated because of their generally higher digestible energy values (Wallmo et al. 1977). Forage diversity to meet dietary winter deficiencies of mule deer is a critical component of habitat reclamation (Carpenter et al. 1979).

The most productive habitat for small mammals was the Sagebrush-Grassland. Structural and compositional complexities within this habitat provide a wide variety of food sources and foraging types for the small mammals. Reconstruction of this complexity must be included in habitat reclamation.

Habitat Reclamation Considerations

The Surface Mining Control Act of 1977 (SMCRA) requires that all lands affected by mining will establish: "a diverse, effective, and permanent vegetative cover" that is "capable of self-regeneration and plant succession at least equal in extent and cover to the natural vegetation of the area". This has been interpreted by some to mean that a number of native or introduced species, comprising a simple synthetic vegetation type is to be established (Call and Roundy 1991). Reclamation plans are often developed using a single seed mix, applied to a uniform thickness of cover soils on a uniform and gently rolling topography with only positive drainage over the entire mine site. In New Mexico, this type of reclamation has resulted in relatively uniform reclaimed mine lands, often dominated by a few species (Romig and Clark, 2000) that support production at the expense of cover and diversity.

Researchers have suggested several mechanisms for increasing biodiversity of reclaimed mined lands. These include complex landscapes, variable soil substrates, variable cover soil depths, and variable seed mixes. These components are being integrated into the reclamation plan for LPM. Wade and Tritton (1997) posed the question "Who is interested in biodiversity and why is it important?" In the case of LPM, stakeholders, which include New Mexico Mining and Minerals (MMD), Bureau of Land Management (BLM), Wildlife Federation, New Mexico Department of Game and Fish, and the mine operator consider the mine area an important ecological unit for winter habitat of mule deer. Also included in this unit are small mammals, birds, reptiles, and the complex array of other consumers and decomposers.

Mule deer habitat is comprised of three main components: thermal cover, hiding cover, and forage (Wallmo 1981, Leckenby et al. 1982), with forage being the most important component. Diversity will follow if re-establishing these components in reclaimed lands is effective.

Reclamation Plan

The reclamation plan for LPM was developed with the primary emphasis of creating biodiversity for wildlife on the reclaimed lands. The plan was developed in three phases: (1) landscape design (See Part I of this paper in these proceedings), (2) soil reconstruction, (3) and vegetation communities.

This reclamation plan integrates the post-mine landscape, variable soil reconstruction parameters, and vegetation seed mixes in an effort to re-establish pre-mine diversity. The post-mine landscape incorporates diversity enhancing elements such as steep slopes, aspect variability, water harvesting features (small depressions), talus slopes, and rock piles. A detailed description of the landscape design is presented in Part I of this paper.

The Final Surface Configuration (FSC) of the post-mine topography was used to develop slope and aspect layers with Arcview GIS ™ software. The topography was converted to a Triangulated Irregular Network (TIN) and Arcview's 3-D Analyst ™ extension was used to generate slope and aspect layers. Slopes were categorized into six classes: level (0-1%), nearly level (2-3%), gently sloping (4-5%), strongly sloping (6-20%), steep (21-33%), and very steep (34-50%). Aspects were divided into 8 classes: north, northeast, east, southeast, south, southwest, west, and northwest.

Maps were produced at a scale of 1:6000 showing slope and aspect with the AOC topography in the background. Buchanan Consultants, Ltd. (BCL) and LPM personnel visually delineated large (>0.50 ha) areas of slope and aspect values corresponding to the post-mine vegetation communities of grasslands, north and east facing shrublands, and south and west facing shrublands. Grasslands were primarily located on level to gently sloping areas without regard to aspect. Shrubland communities covered the steeper slopes and were divided into north and east facing or south and west facing based on the aspect map.

The hand-drawn polygons were digitized and the resulting layer was clipped with the maximum proposed disturbance line to create the post-mine vegetation communities layer. Drainage communities were identified by buffering the AOC drainages by 4.3 m. This created an 8.5 m wide drainage community along the drainage bottoms. The post-mine vegetation communities map is shown as Figure 1.

These delineations corresponded to four unique physical environments: (1) strongly sloping areas with northern and eastern exposures, (2) strongly sloping areas with southern and western exposures, (3) level to gently sloping area with all exposures, and (4) areas adjacent to drainages. Soil replacement depth and soil substrate will be varied for each of these areas.

A topsoil wedge study previously established at the mine was used to measure the influences of topsoil depth on species richness, cover, and production. Buchanan Consultants, Ltd. (1997) found topsoil depths of 0 to 15 cm favor the establishment of woody species. Topsoil depths of 15 to 35 cm resulted in a shrub/grassland type community with the greatest species richness and cover. Topsoil depths in excess of 35 cm resulted in a community composed predominately of cool-season grasses. Meikle et al. (2000) found deep topsoil application to benefit grass establishment and graded spoils provided a superior media for the establishment of mountain shrub communities. Similar results were observed at LPM.

These topsoil/plant establishment relationships were used in the design of the reclamation plan. Shallow applications (5 – 10 cm) of topsoil or coarse soil substitute will be applied to the strongly sloping areas. The coarse textured, rocky materials will simulate the shallow, skeletal pre-mine soils and will help to stabilize these more erosive landscape positions. Moderate applications (30 – 35 cm) of topsoil will be applied to near level areas with slopes <6%, and deep application of topsoil (>50 cm) will be replaced in areas adjacent to drainages. The physical conditions of these areas (slope, aspect, cover soil depth, and soil substrate) provide the physical conditions for the establishment of four separate revegetation communities: (1) Upland shrub, southern exposures, (2) Upland shrub, northern exposures, (3) Grassland, and (4) Drainage.

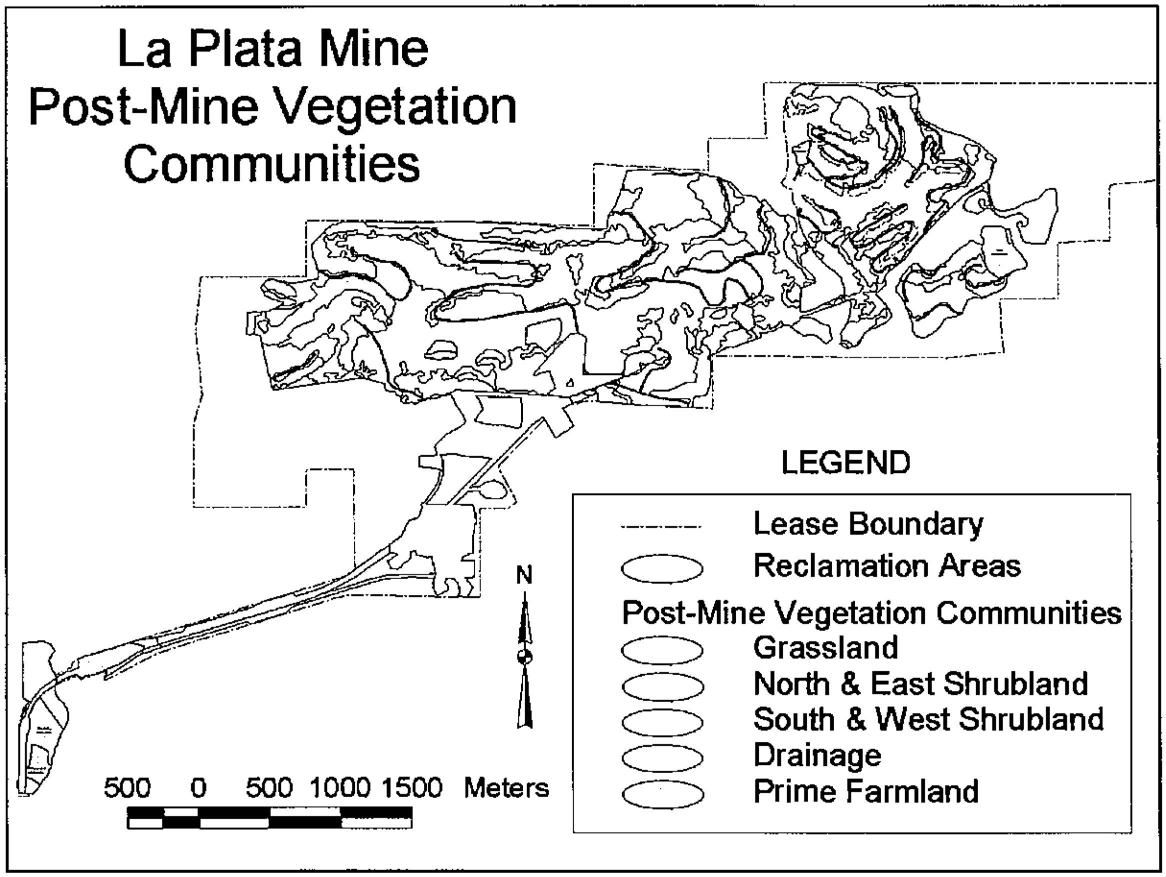

Figure 1. Post-Mine Vegetation Communities Map

Pre-mine vegetation inventories and plant species information from other sources were reviewed to develop a list of native species that will be suited to the physical conditions of each habitat type. Seed mixes were developed for each reclamation community (Table 1). This process initially was conducted by listing native species identified from pre-mine inventories. Characteristics such as wildlife habitat value, moisture requirements, physical adaptations, and seed costs were identified by species. These characteristics and concepts about the types and proportions of plants were used to narrow the list of potential species for each community. Information from reclamation studies conducted at LPM was important for determining the success of seeded species and their value for wildlife habitat. As with any seed mix, modifications as to rate and species will be adapted as data is collected from the revegetated areas.

A seed mix composition of 45% shrubs, 35% forbs, and 20% grasses will be used for the South Shrub Community. Species in this mix were selected based on adaptation to the arid conditions associated with the south exposure of these sites. North Shrub Community seed mix proportions will be similar with 40% shrubs, 40% forbs, and 20% grasses. However, species composition is somewhat dissimilar with plant types that are adapted to the cool, moist condition associated with these sites. Grassland community seed mix proportions will be 50% grasses, 30% forbs, and 20% shrubs. Composition differs from shrub communities with higher proportions of competitive cool-season grasses. Drainage community seed mix proportions will be 35% shrubs, 35% grasses, and 30% forbs. Composition in this mix was modified to include species that are adapted to deep soils and moist conditions associated with these sites.

Table 1 Seeding Rates by Species (Grasses, Shrubs, and Forbs) For the Grassland, Drainage, South Shrub, and North Shrub Vegetation Types at La Plata Mine.

GRASSLAND COMMUNITY

		PLS lbs/ac	PLS seeds/ft^2	% seeds/ft^2
Grasses				
Achnatherum hymenoides	Indian ricegrass	1.50	4.9	
Aristida purpurea	Purple three-awn	1.00	5.7	
Bouteloua curtipendula	Sideoats grama	1.00	4.4	
Elymus elymoides	Bottlebrush squirreltail	1.00	4.4	
Hilaria jamesii	Galleta grass	1.50	5.5	
Pascopyrum smithii	Western wheatgrass	2.00	5.0	
	Sub-Total	8.00	29.9	53
Shrubs				
Atriplex canescens	Fourwing saltbush	2.00	2.4	
Ceratoides lanata	Winterfat	2.00	2.6	
Chrysothamnus nauseosus	Rubber rabbitbrush	.50	2.3	
Purshia tridentata	Antelope bitterbrush	7.25	2.5	
	Sub-Total	11.75	9.8	17
Forbs				
Aster bigelovi	Plains aster	.10	3.5	
Eriogonum umbellatum	Sulfur flower	1.00	3.6	
Linum lewisii	Western blueflax	.50	3.4	
Penstemon strictus	Rocky Mtn. penstemon	.50	3.4	
Sphaeralcea coccinea	Scarlet globemallow	.30	3.4	
	Sub-Total	2.40	17.3	30
	Grassland Total	22.15	57	100

DRAINAGE COMMUNITY

		PLS lbs/ac	PLS seeds/ft^2	% seeds/ft^2
Grasses				
Aristida purpurea	Purple three-awn	.50	2.9	
Bouteloua gracilis	Blue grama	.25	4.7	
Elymus elymoides	Bottlebrush squirreltail	.50	2.2	
Elymus lanceolatus lan.	Thickspike wheatgrass	.75	2.6	
Elymus lanceolatus psa.	Streambank wheatgrass	.75	2.7	
Elymus trachycaulus tra.	Slender wheatgrass	.75	2.7	
Pascopyrum smithii	Western wheatgrass	1.00	2.5	
	Sub-Total	4.5	20.3	35
Shrubs				
Atriplex canescens	Fourwing saltbush	2.00	2.4	
Artemisia tridentata tri.	Basin big sagebrush	.15	8.6	
Ceanothus velutinus	Snowbrush	1.00	2.8	
Chrysothamnus nauseosus	Rubber rabbitbrush	.25	2.3	
Fallugia paradoxa	Apache plume	.25	2.4	
Ribes cereum	Wax currant	.25	2.0	
	Sub-Total	3.9	20.5	36
Forbs				
Aster tanacetifolius	Prairie aster	.25	2.8	
Echinacea purpurea	Purple coneflower	.50	1.3	
Linum lewisii	Western blueflax	.50	3.4	
Penstemon strictus	Rocky Mtn. penstemon	.25	3.4	

Table 1. Continued

DRAINAGE COMMUNITY				
Forbs				
Phlox drummondii	Drummond phlox	.50	2.7	
Sphaeralcea coccinea	Scarlet globemallow	.25	2.9	
	Sub-Total	2.25	16.5	29
	Drainage Total	10.65	57.3	100
SOUTH COMMUNITY				
Grasses		PLS lbs/ac	PLS seeds/ft^2	% seeds/ft^2
Achnatherum hymenoides	Indian ricegrass	.50	1.6	
Aristida purpurea	Purple three-awn	.25	1.4	
Elymus elymoides	Bottlebrush squirreltail	.25	1.1	
Hilaria jamesii	Galleta grass	.50	1.8	
Pascopyrum smithii	Western wheatgrass	.50	1.3	
Pseudoroegneria spicata	Bluebunch wheatgrass	.50	1.6	
Sporobolus airoides	Alkali sacaton	.05	2.0	
	Sub-Total	2.55	10.8	21
Shrubs				
Artemisia tridentata wyomingensis	Wyoming big sagebrush	.10	5.7	
Atriplex canescens	Fourwing saltbush	3.00	3.6	
Atriplex confertifolia	Shadscale	2.00	3.0	
Ceratoides lanata	Winterfat	3.00	3.9	
Chrysothamnus nauseosus	Rubber rabbitbrush	.50	4.6	
Purshia tridentata	Antelope bitterbrush	8.50	2.9	
	Sub-Total	17.10	23.7	45
Forbs				
Aster tanacetifolius	Prairie aster	.25	2.8	
Eriogonum umbellatum	Sulfur flower	.50	2.4	
Linum lewisii	Western blueflax	.50	3.4	
Penstemon strictus	Rocky Mtn. penstemon	.25	3.4	
Phlox drummondii	Drummond phlox	.50	2.7	
Sphaeralcea coccinea	Scarlet globemallow	.25	2.9	
	Sub-Total	2.25	17.6	34
	South Total	21.90	52.1	100
NORTH COMMUNITY				
Grasses		PLS lbs/ac	PLS seeds/ft^2	% seeds/ft^2
Hilaria jamesii	Galleta grass	.50	1.8	
Muhlenbergia wrightii	Spike muhly	.05	1.8	
Pascopyrum smithii	Western wheatgrass	1.00	2.5	
Poa fendleriana	Muttongrass	.10	2.0	
Pseudoroegneria spi. spi.	Bluebunch wheatgrass	.50	1.6	
	Sub-Total	2.15	9.7	19
Shrubs				
Artemisia tridentata wyo.	Wyoming sagebrush	.10	5.7	
Ceanothus velutinus	Snowbrush	1.00	2.8	
Cercocarpus montanus	True mountain mahogany	2.00	2.7	
Cowania mexicana	Cliffrose	2.00	3.0	

Table 1. Continued

NORTH COMMUNITY					
Shrubs					
Purshia tridentata	Antelope bitterbrush		8.50	2.9	
Rhus trilobata	Oakbrush sumac		6.00	2.8	
		Sub-Total	19.60	19.9	40
Forbs					
Aster tanacetifolius	Prairie aster		.25	2.8	
Eriogonum umbellatum	Sulfur flower		.50	2.4	
Linum lewisii	Western blueflax		.50	3.4	
Penstemon strictus	Rocky Mtn. penstemon		.25	3.4	
Phlox drummondii	Drummond phlox		.50	2.7	
Ratibida columnaris	Prairie coneflower		.10	2.8	
Sphaeralcea coccinea	Scarlet globemallow		.25	2.9	
		Sub-Total	2.35	20.4	41
	North Total		24.10	50.0	100

Discussion

Much of the reclamation conducted over the past 25 years in the southwestern United States has resulted in revegetated areas that appear relatively homogeneous. They are productive but lack diversity and in some cases sufficient cover to protect them from erosion. This in part, is because many of the variables that contribute to habitat diversity are homogenized in the mining and reclamation process (Prodgers and Keck, 1996) namely, uniform landscapes, topsoil depths, and single seed mixes. The initial reclamation plan for LPM was similar to previous attempts of reclamation, these were engineered landscapes covered with the uniform thickness of topsoil and seeded with the one mix. Implementation of traditional reclamation procedures will not produce high level of biodiversity desired by stakeholders. Uniformity is not warranted by the post-mining land-use, and without aggressive reclamation plans designed by operators and flexibility allowed by regulators, post-mine land-uses such as wildlife will ultimately fail. At LPM, pre-reclamation studies, a focused objective, and flexibility by regulators has provided the potential for meeting the needs of the post-mine land-use.

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