

SMCRA * BOND RELEASE- THE INITIAL STEPS AT SAN JUAN MINE

by

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Abstract San Juan Coal Company has submitted to the State of New Mexico's Mining and Minerals Division, the final phase III bond release application for the approval and release of 241 acres of permitted lands at its San Juan Mine located in San Juan County, New Mexico. The SMCRA* (Surface Mining Control and Reclamation Act) and New Mexico Surface Coal Mining Regulations mandate a minimum 10-year liability period following final reclamation, during which no additional treatments other than approved postmining land uses and approved interseedings may be applied to an area for which bond release is sought. Site-specific revegetation success standards must be met for two of the last four years of liability, beginning no sooner than year eight of the bonding period. Successful reclamation of the site was demonstrated by exceeding cover, production, shrub density, and diversity standards while supporting the primary postmining land use of livestock grazing.

Additional Key Words: Surface Mining Control and Reclamation Act, Bond Release Application, Revegetation Success, Livestock Carrying Capacity, Postmining Land Use.

Introduction

The Northwest Piñon (NW Piñon) area at San Juan Coal Company's (SJCC) San Juan Mine consists of 152 acres of reclaimed land and 85 acres of undisturbed land, all of which are bonded. The disturbed portion of the NW Piñon area was reclaimed in 1986, 1987, and 1988. The pasture was therefore eligible for full bond release consideration after 1998. Revegetation would be considered successful if the NW Piñon area met revegetation success criteria while sustaining the primary postmining land use of livestock grazing at a specified level. Site-specific revegetation success standards must be met for the last two consecutive years of liability, or for two of four years, beginning in year eight of the bonding period, as required under the New Mexico surface coal mine regulations (19 New Mexico Administrative Code [NMAC] 8.2). The information submitted in the Phase III Bond Release Application of the NW Pinon Area represented results

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of the 1998 (year-one) and 1999 (year-two) bond release studies.

Study Area and Methods

San Juan Mine Description

San Juan Mine is located in the San Juan Basin of the Colorado Plateau, north of the San Juan River in Northwestern New Mexico. The area has little local relief; elevations range between 1,597 m (5240 ft) and 1,699 m (5,573 ft). Low east-to west-trending ridges and mesas of the Kirtland formation dominate topography (Baars 1983:202). Surface relief ranges from nearly level, through rolling hills, to very steep slopes on escarpments and breaks.

An average of 178 mm (7 inches) of precipitation falls per year, most during thunderstorms in the late summer and early fall (Maker et al. 1973). Surface water is scarce; the closest reliable source of water is the San Juan River, 3.62 km (2.25 miles) south of the boundary of the permit area. Water also may be seasonally available in Shumway Arroyo, Westwater Arroyo, Stevens Arroyo, Hutch Canyon, and unnamed intermittent streams.

Ridge-top soils and talus slopes include the Badland-Rock Land association. Rockland soils are a complex of shallow-soils, sandstone outcrops, and exposures of other types of sedimentary rocks (Marker

et al. 1973). Soils of most of the permit area are classified into the Werlow-Fuitland-Turely association (Maker et al. 1973).

Sparse shrub vegetation dominates the area. Species include galleta [*Hilaria jamesii* (Torr.) Benth.], Indian ricegrass [*Oryzopsis hymenoides* (Roem. & Schult) Ricker ex Piper], sand dropseed [*Sporobolus cryptandrus* (Torr.) Gray], shadscale [*Atriplex confertifolia* (Torr. & Frem.) Wats.], snakeweed [*Gutierrezia sarothrae* (Pursh) Britt. & Rusby], four-wing saltbush [*Atriplex canescens* (Pursh) Nutt.], greasewood [*Sarcobatus vermiculatus* (Hook.) Torr. in Emory], Mormon tea [*Ephedra torreyana* Wats. and *E. viridis* Cov.], prickly pear [*Opuntia macrorhiza* Engelm. and *O. polyacantha* Haw.], and wolfberry [*Lycium pallidum* Miers] (Maker et al. 1973).

Since the late nineteenth century, the area has been utilized for farming, livestock grazing, oil and gas drilling and recreation. Developments in or adjacent to the permit area including the San Juan Mine are: coal burning power plant, gas and water pipelines, oil and gas wells, a gravel pit, small dams and reservoirs, three transmission power lines, three main dirt roads, the La Plata Mine Haul Road and other small dirt roads.

Mine Permit Status. The current mining area was originally permitted by Western Coal Company (WCC) under Permit to Mine #2, approved August 20, 1973 by the New Mexico Coal Surface Mining Commission (CSMC). In December 1980, Utah International acquired WCC leases and founded San Juan Coal Company (SJCC). Since then, the New Mexico Mining and Minerals Division (MMD) has approved 4 other permits for SJCC (current mine permit #99-01).

Bond Release Applications. Pursuant to 19 NMAC 8.2 Subpart 1412, San Juan Mine submitted to MMD, a Phase I Bond Release Application, on June 22, 1998, encompassing a total of 1563 acres. All lands within the requested bond release area had been graded to the designed post-mining topography consistent with approved mine plans. The final grading of the spoil and topsoil placement were completed from 1986 to 1988. Drainage control was in accordance with 19 NMAC 8.2 Subpart 2009.E.

On December 21, 2000, in accordance with 19 NMAC 8.2 Subpart 1412 (A), San Juan Mine submitted a Phase III Bond Release Application to MMD for 236.74 acres of the SJM called Northwest Piñon (NW Piñon) area, within the 1563 acres of the approved Phase I Bond Release area (Figure 1).

NW Piñon Area

Revegetation Success Criteria. The current revegetation success criteria for SJM permitted lands require reference area comparisons for perennial vegetative cover and production, and technical standards for woody species density, diversity and herbaceous species diversity (Table 1). Reference area values for cover and production are developed by sampling each of five vegetation types within SJM's reference area and calculating perennial cover and production weighted averages based on the acreage of each type within the lease area. Weighted average perennial species cover and production become the standards only for the year the vegetation is sampled. Technical standards for woody species density and species diversity are fixed throughout the life of mine but only need be met on one of the two years of bond release studies.

Livestock Grazing. NW Piñon's approved primary postmining land use is livestock grazing. Both the NW Piñon pasture (152-acre reclaim area plus 85 acres of undisturbed lands) and the reference area are located within the U.S. Bureau of Land Management's (BLM's)

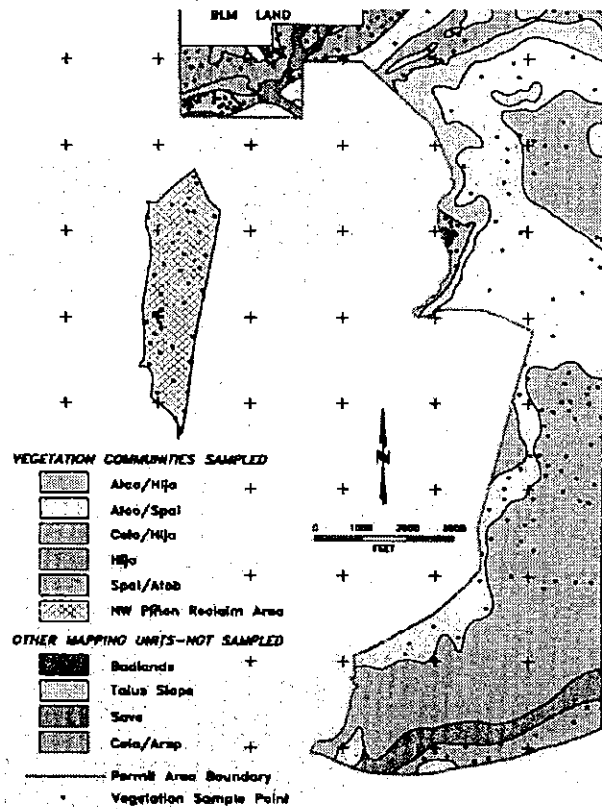


Figure 1. NW Piñon reclaim area and reference area (1998 vegetation sample points indicated).

Table 1. MMD-approved revegetation success standards (SJM 1997).

Vegetative Parameter	Revegetation Success Standard
Cover ^a	Yearly normalized mean ^b
Production ^a	Yearly normalized mean ^b
Woody Species	190 per acre
Diversity	Two grasses ^c and two woody species ^d

^a Cover and production values reflect only the current year's growth of perennial plant species.

^b Cover and production yearly normalized means are obtained by sampling five vegetation types within one reference area and weighting mean cover and production values by the proportion of each type within the lease area. These weighted values are the revegetation success standards for 1998 and 1999.

^c Two *perennial* grass species with relative *perennial* herbaceous cover values 5%, with no species comprising more than 70% relative *perennial* herbaceous cover. (Note: Words in italics have been added to clarify the standard per discussions with MMD, 1997.)

^d Two woody species with density values 10% of total woody species density, with no one species making up more than 85% of the total woody species density.

Shumway Arroyo Allotment. To obtain full bond release on the 237-acre pasture, SJM must demonstrate that the area meets revegetation success standards while sustaining the primary postmining land use of livestock grazing.

Two grazing programs have been implemented at SJM: grazing as a husbandry practice, and a grazing demonstration plan developed specifically for NW Piñon pasture bond release studies. Grazing as a husbandry practice was initiated in the NW Piñon pasture in 1996, when the pasture was grazed from January 1-31 at a rate of 0.33 animal unit month (AUM)/acre to remove the accumulated standing dead vegetation and to achieve an estimated 70% utilization.

The MMD-approved bond release grazing demonstration was conducted during two consecutive grazing seasons. The NW Piñon pasture was grazed at the optimal BLM-recommended stocking rate for one month during the winter season of December 1 through May 3, which is the historic grazing period on the Shumway Arroyo Allotment. In 1997/98, grazing occurred in December 1997; in 1998/99, during April 1999. Typically, BLM recommends a stocking rate of 0.05 AUM/acre. However, a rate of 0.12 AUM/acre is recommended by BLM for the allotment's better pastures, and SJM targeted this higher rate for the bond release grazing demonstration. During the 1997/1998 season, the reference area was grazed at a stocking rate of 0.09 AUM/acre. This stocking rate was slightly lower than the approved rate of 0.12 AUM/acre because the pasture includes 443.1 acres that were not part of the original proposed reference area. The oversight was

corrected in year two. In 1999, the NW Piñon pasture and reference area were grazed at stocking rates of 0.12 AUM/acre.

Livestock body condition was evaluated before and after the 1997/98 and 1998/99 grazing seasons on the NW Piñon pasture using New Mexico State University Body Conditioning Scoring (BCS) methods (Parker 1992). The BCS system is a visual rating of body condition ranging from emaciated (#1) to extremely fat (#9).

Study Design. Grazed vegetation on reclaimed areas within the NW Piñon pasture was compared with grazed vegetation in the reference area. Six types were sampled: N. W. Pinon and five vegetation types within the reference area. In 1998, we determined: vegetative cover by species and total ground cover; species diversity; perennial herbaceous production by species; shrub density; annual shrub production rates; and estimated stocking rates. Pursuant to MMD's Coal Mine Reclamation Program Vegetation Standards (MMD 1999), only cover and production were sampled in 1999.

Number of Samples Required. A minimum of 15 and a maximum of 40 randomly selected sample sites were located in each of the six types. Sample adequacies for cover, production, and shrub density were calculated after the minimum number of samples were obtained and then at intervals until sample adequacy or 40 samples were obtained.

Sampling Methods

Vegetative and Total Ground Cover. Vegetative and total ground cover were estimated using randomly located 50-m point intercept transects (Knight 1978; Barbour et al. 1980). Random locations were identified by randomly selecting x and y coordinates on a 50 x 50-ft grid overlain on the maps, and sample locations were determined in the field by pacing from recognizable landmarks. At each location, a random direction for the transect was determined. If the transect extended into a different vegetation type, it was angled back into the appropriate type in a new random direction. Cover was determined at 0.5-m intervals along a 50-m transect, for a total of 100 primary hits (defined as the first interception between a vertical projection down through the canopy and vegetation to litter, rock, or bare ground) per transect. Each transect was treated as one sample during analysis.

Species Diversity. Attainment of the diversity standard (Table 1) was evaluated by 1) computing perennial herbaceous vegetative cover by species and determining the number of species contributing between 5% and 70% relative herbaceous cover, and 2) computing subshrub/shrub species density by species and counting the number of species contributing between 10% and 85% relative woody species density. Diversity was not computed in 1999 because the diversity standard was met in 1998 and only one demonstration of adequate diversity is required by New Mexico regulations (MMD 1999).

Production. Vegetative production in 1998 and 1999 was estimated from clipped plots. In 1998, all of the current year's growth within the vertical projection of randomly located 1 x 1-m quadrats was clipped, segregated by species, dried to a constant weight, and weighed to the nearest 0.1 gram (Knight 1978; Bonham et al. 1980; SJM 1997). Current year's growth of shrubs included the year's annual growth of young stems and all leaves; hard, woody stems were not clipped because they are growth from previous years. Only perennial and biennial species were used in the analysis of revegetation success (MMD 1999).

Shrub Density. In 1998, shrub density was estimated in both the NW Piñon area and the reference area by counting the number of shrubs rooted within a 50 x 2-m belt transect located along cover transects (1 meter on either side of the transect) or, if cover was not sampled at a given location (because cover sample adequacy had already been met), along a randomly oriented transect adjacent to production plots. Shrub density was not sampled in 1999; only one demonstration of adequate

shrub stocking is required by New Mexico regulations (MMD 1999).

Stocking Rates. The current and proposed stocking rate for the NW Piñon reclaim area and the reference area is 0.12 AUM/acre. This stocking rate was validated using production data to compute stocking rates in AUMs/acre for each area sampled and the reference area combined.

Data Analysis. Data were entered into Microsoft® Excel spreadsheets and the desired parameters were calculated using standard formulas (Sokal and Rohlf, 1981). Reference area weighted averages were computed using the information presented in Table 2. Tests for assumptions of normality were performed with Minitab™ using the Ryan-Joiner test (Ryan and Joiner 1976). As suggested by MMD (1999) for data that are not normally distributed, the nonparametric sign test (Daniel 1990) was used to demonstrate that the NW Piñon reclaim area exceeded 90% of the approved revegetation success standards with 90% confidence.

Results and Discussion

Tests for Normality and Evaluation of Sampling Adequacy

Cover. In 1998, vegetative cover data were normally distributed in the NW Piñon reclaim area and in all types (except Hija, Table 3) in the reference area. While the Hija type was sampled to a 91.4% confidence level, the assumption of normality was not met. Sample adequacy was reached for vegetative cover with less than 40 samples in all six sampling areas (Tables 4 and 5).

In 1999, cover data were normally distributed in all types except the Atco/Spai and Hija types. Twenty-one Atco/Spai transects were sampled. Since the Hija cover data were not normally distributed in 1998, the MMD-required maximum of 40 cover samples (MMD 1997) was obtained in 1999.

Production. Vegetative production data in 1998 were not normally distributed except in the Cela/Hija type; however, the maximum of 40 samples per area was obtained in each type during production sampling. In 1999, none of the production data were normally distributed, but again, the maximum of 40 samples was obtained in each type.

Table 2. Acreage and proportion of each vegetation type within the Lease Area.

Vegetation Type	Acreage within Lease Area	Proportion of Lease Area
Atca/Hija	507	0.0791
Atco/Spai	2,393	0.3740
Cela/Hija	562	0.0877
Hija	1,507	0.2352
Spai/Atob	1,438	0.2244
Total	6,407	1.0000

Weighted average =

$$\text{AVG}(\text{Atca/Hija}) \times 0.0791 + \text{AVG}(\text{Atco/Spai}) \times 0.3740 + \text{AVG}(\text{Cela/Hija}) \times 0.0877 + \text{AVG}(\text{Hija}) \times 0.2352 + \text{AVG}(\text{Spai/Atob}) \times 0.2244$$

where AVG(Atca/Hija) is the average value of a given variable (e.g., cover, production) within the Atca/Hija vegetation type, etc.

Table 3. Probability values^a for tests for assumptions of normality.

Area	Cover		Productivity		Shrub/Subshrub Density
	1998	1999	1998	1999	1998
NW Piñon	>0.10	>0.10	<0.01	0.08	<0.01
Atca/Hija	>0.10	>0.10	<0.01	<0.01	<0.01
Atco/Spai	>0.10	0.04	<0.01	0.04	>0.10
Cela/Hija	>0.10	>0.10	>0.10	<0.01	>0.10
Hija	0.04	<0.01	<0.01	<0.01	<0.01
Spai/Atob	>0.10	>0.10	<0.01	<0.01	<0.01

^a Values of 0.1 or higher indicate that the data are likely normally distributed.

Shrub Density: Combined shrub/subshrub density data were normally distributed in the Atco/Spai and Cela/Hija types only. Again, the maximum of 40 shrub/subshrub density samples was obtained in each area.

Non-normality of the production and shrub density data and the Hija and Atco/Spai cover data violates the assumptions of a standard t test, so we used the nonparametric sign test to assess whether the reclaim area parameters were 90% of reference area parameters with 90% confidence.

Revegetation Success

The NW Piñon area met or exceeded all revegetation success standards) in 1998 and exceeded cover and production standards in 1999 (Table 6). Both perennial species cover and productivity by perennial species were higher in the NW Piñon area than in the

reference area; the standards were far exceeded. In 1998, the technical standard of 190 woody plants per acre on the reclaim area was exceeded by a factor of approximately three. The technical standard for herbaceous species diversity was met, with *Sporobolus airoides* and *Hilaria jamesii* providing 60.2% and 36.2%, respectively, of relative perennial herbaceous cover, and the woody species diversity standard was met, with *Atriplex canescens*, *Ceratoides lanata*, and *Gutierrezia sarothrae* providing 36.2%, 40.1%, and 13.9%, respectively, of the woody species relative density. Standards for shrub density and herbaceous and woody diversity were met in 1998 and further analysis was not required in 1999 (MMD 1999). The nonparametric sign test demonstrated that the NW Piñon reclaim area was greater than 90% of the revegetation success standards with 90% statistical confidence, as required by the Coal Mine Reclamation Program Vegetation Standards (MMD 1999).

Table 4. Evaluation of sampling adequacy, 1998.

Parameter	Area Sampled					
	NW Piñon	Atca/Hija	Atco/Spai	Cela/Hija	Hija	Spai/Atob
Vegetative Cover^a						
Mean (%)	31.07	32.40	32.67	34.96	20.94	34.70
Standard deviation	3.06	7.11	8.10	5.25	5.03	7.18
N	15	15	21	24	17	20
N _{MIN} ^b	3	15	19	7	18	13
Confidence level achieved	99.9	92.2	93.5	99.9	91.4	96.9
Production^a						
Mean (g/m ²) ^c	53.7	19.6	28.4	28.6	10.3	20.5
Standard deviation	50.4	20.5	22.5	18.5	15.0	39.2
N	40	40	40	40	40	40
N _{MIN}	250	308	178	118	602	1,031
Confidence level achieved	50.0	45.6	57.5	67.2	33.6	26.0
Shrub/Subshrub Density						
Mean (shrubs and subshrubs/acre)	640.4	1,718.9	2,531.3	4,252.2	745.6	712.2
Standard deviation	615.0	1,293.7	1,606.0	3,101.4	878.1	726.9
N	40	40	40	40	40	40
N _{MIN}	262	161	115	151	394	296
Confidence level achieved	49.1	59.9	68.3	61.6	41.4	46.5

^a Vegetative cover values used to compute sample adequacy include both annual and perennial species. Values presented in Table 8, the evaluation of revegetation success, include only perennial species. Production values used to compute sample adequacy and to evaluate revegetation success include perennial species only.

^b Multiply g/m² by 8.922 to obtain lbs/acre.

Table 5. Evaluation of sampling adequacy, 1999.

Parameter	Area Sampled					
	NW Piñon	Atca/Hija	Atco/Spai	Cela/Hija	Hija	Spai/Atob
Vegetative Cover^a						
Mean (%)	61.06	49.80	46.19	49.81	48.33	47.60
Standard deviation (%)	8.55	5.80	6.85	7.23	10.89	10.51
N	16	20	21	16	40	20
N _{MIN}	6	4	7	7	15	15
Confidence level achieved	99.8	99.9	99.8	99.5	99.5	95.8
Production						
Mean (g/m ²) ^b	43.6	27.2	34.7	51.6	13.0	31.2
Standard deviation (lbs/acre)	24.2	17.3	23.7	34.2	15.8	31.9
N	40	40	40	40	40	40
N _{MIN}	88	115	133	125	420	295
Confidence level achieved	74.6	67.8	64.8	65.8	39.7	46.5

^a Vegetative cover values used to compute sample adequacy include both annual and perennial species. Values presented in Table 7, the evaluation of revegetation success, include only perennial species. Production values used to compute sample adequacy and to evaluate revegetation success include perennial species only.

^b Multiply g/m² by 8.922 to obtain lbs/acre.

Table 6. Summary of data showing revegetation success, NW Piñon reclaim area.

Revegetation Parameters	Success	Area			
		NW Piñon Reclaim		Reference Area	
		1998	1999	1998	1999
Cover by perennial species		22.93%	41.13%	15.62%	27.11%
Production by perennial species		53.7 g/m ^b	43.6 g/m ^b	21.7 g/m ^b	29.7 g/m ^b
Woody species ^a stems per acre ^{b,c}		640.4	--	--	--
Perennial grass diversity ^{b,c}		<i>Hilaria jamesii</i> @ 36.2% of relative herbaceous perennial cover		--	--
		<i>Sporobolus airoides</i> @ 60.2% of relative herbaceous perennial cover			
Woody species ^a diversity ^{b,c}		<i>Atriplex canescens</i> @ 33.5% of woody species relative density		--	--
		<i>Ceratoides lanata</i> @ 37.6% of woody species relative density			
		<i>Gutierrezia sarothrae</i> @ 12.9% of woody species relative density			

^a Includes subshrubs, shrubs, and trees (i.e., *Tamarisk chinensis*). Excluding *Gutierrezia sarothrae*, there would be an average of 549.4 woody stems per acre.

^b These three parameters were evaluated using technical standards, so a reference area comparison is not required.

^c Demonstration of the woody species stems per acre and diversity standards were not required in 1999.

Table 7 shows that Hija perennial cover would have to exceed 100.00% before the weighted average reference area perennial cover would equal perennial cover in the NW Piñon. Therefore, additional cover data from the Hija type could not change the determination that the cover success standard has been met. In 1999, the maximum of 40 cover transects was sampled. Similarly, Table 7 indicates that 1999 perennial cover in the Atco/Spai type would have to exceed 71.74% before reference area perennial cover would exceed NW Piñon perennial cover.

Livestock Carrying Capacity

Prior to grazing in 1997/98, 54% of the cattle were in BCS #6 condition, 39% were in BCS #7 condition,

and 7% were in BCS #8 condition. After 30 days, 7% were in #5, 50% were in #6, and 43% were in #7 condition, a slight shift downward to #5 and #6. Prior to grazing in 1998/99, 57% were in #6 and 43% were in #7 condition. After a month, 36% were in #6 and 64% were in #7 condition, a slightly upward shift (the opposite of 1997/98).

Vegetation sampling results show that the NW Piñon pasture is capable of supporting livestock grazing at a level higher than is typical for the Shumway Allotment. After grazing in December 1997, the estimated perennial production for the NW Piñon reclaim area was 285.5 lbs/acre more than that of the reference area and after grazing in April 1999 it was 125.0 lbs/acre higher.

Table 7. 1998 vegetative cover sample size in the Hija type and 1999 cover sample size in the Atco/Spai type--No effect on determination of revegetation success.

Vegetation Type	Proportion of Lease Area	Measured Perennial Cover (%)	Hypothetical Perennial Cover (%)
1998			
Atca/Hija	0.0791	18.20	18.20
Atco/Spai	0.3740	19.10	19.10
Cela/Hija	0.0877	20.54	20.54
Hija	0.2352	9.35	100.00 ^a
Spai/Atob	0.2244	13.55	13.55
Weighted mean		11.96	22.59
NW Piñon perennial cover			22.93
1999			
Atca/Hija	0.0791	29.90	29.90
Atco/Spai	0.3740	34.24	71.74 ^b
Cela/Hija	0.0877	29.88	29.88
Hija	0.2352	17.43	17.43
Spai/Atob	0.2244	23.25	23.25
Weighted mean			41.13
NW Piñon perennial cover			41.13

^a Perennial herbaceous cover in the Hija vegetation type would have to exceed 100% before the reference area perennial herbaceous cover would equal that in the NW Piñon reclaim area.

^b Perennial herbaceous cover in the Atco/Spai type would have to exceed 71.74% before the reference area perennial cover would equal that in the NW Piñon reclaim area.

Table 8. Estimated carrying capacities based on perennial production measured in 1998 and 1999.

Parameter	NW Piñon	Atca/Hija	Atco/Spai	Cela/Hija	Hija	Spai/Atob
1998						
Production (lbs/acre)	479.1	174.9	253.4	255.2	91.9	182.9
Desired utilization	0.50	0.50	0.50	0.50	0.50	0.50
AUMs/acre ²	0.32	0.12	0.17	0.17	0.06	0.12
1999						
Production (lbs/acre)	389.0	242.7	310.6	460.4	116.0	278.4
Desired utilization	0.50	0.50	0.50	0.50	0.50	0.50
AUMs/acre ²	0.26	0.16	0.21	0.30	0.08	0.18

Note: Reference area weighted average AUM/acre = 0.13 (1998) and 0.18 (1999).

Based on perennial production data, the estimated carrying capacity for the NW Piñon reclaim area was 0.32 AUM/acre in 1998 and 0.26 AUM/acre in 1999 (Table 8). In 1998, computed reference area carrying capacities ranged from a low of 0.06 AUM/acre (Hija) to 0.17 AUM/acre (Cela/Hija); the weighted average was 0.13 AUM/acre. In 1999, reference area stocking rates ranged from 0.08 (Hija) to 0.30 (Cela/Hija); the weighted average was 0.14 AUM/acre. Thus, the NW Piñon area has a greater carrying capacity than the reference area and should easily support grazing at a rate of 0.12 AUM/acre for 30 days during the winter grazing season.

Summary

Vegetation in SJM's NW Piñon reclaim met or exceeded all revegetation success standards for two consecutive years at the end of a 10-year bonding period. The pasture was grazed in accordance with the MMD-approved grazing demonstration plan, and in both years, all cattle were in BCS #5, #6, and/or #7 after grazing the NW Piñon pasture for 30 days. This study, therefore, demonstrates that in 1998 and 1999, the NW Piñon reclaim area attained revegetation success while supporting the primary postmining land use of livestock grazing. In conclusion, the final reclamation should be considered successful because vegetative standards for the approved land uses have been met.

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