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VECETATION DATA REPORT
FOR
PRICE RIVER COAL'S MINE AREA
HELPER, UTAH

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VEGETATION DATA REPORT
FOR
PRICE RIVER COAL COMPANY'S MINE AREA
HELPER, UTAH

Prepared For

Price River Coal Company
Helper, Utah

By

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Laramie, Wyoming

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TABLE OF CONTENTS

1.0 INTRODUCTION 1

2.0 METHODS 4

2.1 MAPPING 5
2.2 SELECT REFERENCE AREAS 7
2.3 VEGETATION SPECIES COMPOSITION 8
2.4 SELECTION OF SAMPLE POINTS 8
2.5 VEGETATION COVER 9
2.6 SHRUB DENSITY AND HEIGHTS 10
2.7 TREE DENSITY AND BASAL AREA DATA 10
2.8 SOIL CONSERVATION SERVICE (SCS) PRODUCTIVITY ESTIMATES 11
2.9 PHOTOGRAPHS 11
2.10 PERSONS CONTACTED 11
2.11 DATA ANALYSIS AND REPORTING 11

3.0 RESULTS AND DISCUSSION 16

3.1 VEGETATION TYPES 16

3.1.1 Grass Sage 18
3.1.2 Mixed Brush 20
3.1.3 Pinyon-Juniper 22
3.1.4 Riparian Bottom 22
3.1.5 Conifer 24
3.1.6 Saltbush 26
3.1.7 Disturbed 26

3.2 THREATENED AND ENDANGERED SPECIES 26
3.3 VEGETATION ON REFERENCE AREAS AND POTENTIALLY AFFECTED VEGETATION TYPES 27

3.3.1 Sample Adequacy 27
3.3.2 Affected Areas and Corresponding Reference Areas 27
3.3.3 Data Presentation 31

3.3.3.1 Sowbelly grass-sage reference area 31
3.3.3.2 Willow Creek grass-sage reference area 36
3.3.3.3 Barn Canyon grass-sage reference area 36
3.3.3.4 Barn Canyon grass-sage affected 36
3.3.3.5 Sowbelly mixed brush reference area 37
3.3.3.6 Castle Gate mixed brush reference area 37
3.3.3.7 Barn Canyon mixed brush affected 38
3.3.3.8 Dry Canyon mixed brush reference area 38
3.3.3.9 Barn Canyon pinyon-juniper affected 39

Table of Contents (continued)

3.3.3.10 Crandall pinyon-juniper reference area 39
3.3.3.11 Castle Gate riparian reference area 40
3.3.3.12 Crandall riparian reference area 41
3.3.3.13 Barn Canyon conifer affected 41
3.3.3.14 Crandall conifer reference area 42

4.0 SUMMARY 43

5.0 LITERATURE CITED 44

LIST OF TABLES

Table 2.1	List of People Contacted for Information During the Vegetation Study on Price River Coal Company's Mine Plan Area, 1981	12
Table 2.2	Methods and Formulae Used for Vegetation Data Analysis	13
Table 3.1	Acreages of Disturbed and Potentially Disturbed Sites in the Mine Plan Area	17
Table 3.2	Statistical Adequacy of Vegetation Data for the Price River Coal Company's Mine Area, 1981	28
Table 3.3	List of Affected Areas and Corresponding Reference Areas, Price River Coal Company's Mine Plan Area, 1981	29
Table 3.4	Comparison of Vegetation Data from Affected Areas in Barn Canyon and Corresponding Reference Areas, 1981	30
Table 3.5	Summary Cover Data for Reference and Affected Areas on Price River Coal Company's Mine Plan Area, 1981	32
Table 3.6	Summary Shrub Density and Height Data for Reference and Affected Areas on Price River Coal Company's Mine Plan Area, 1981	33
Table 3.7	Summary Tree Density Data for Reference and Affected Areas on Price River Coal Company's Mine Plan Area, 1981	34
Table 3.8	Productivity Estimates for Reference and Affected Areas on Price River Coal Company's Mine Plan Area, 1981	35

LIST OF FIGURES

Figure 1.1 Location of Price River Coal Company's Mine Plan Area, Utah 2

LIST OF PLATES

Plate 3.1	Grass-sage vegetation on the Mine Plan Area	19
Plate 3.2	Mixed brush vegetation on the Mine Plan Area	21
Plate 3.3	Pinyon-juniper vegetation on the Mine Plan Area	23
Plate 3.4	Riparian Bottom vegetation on the Mine Plan Area	23
Plate 3.5	Conifer vegetation on the Mine Plan Area	25

LIST OF APPENDICES

Appendix A	Productivity Estimates from the Soil Conservation Service
Appendix B	Maps 1 - 5
Appendix C	Data and Vegetation Species List

1.0 INTRODUCTION

Mariah Associates conducted vegetation studies during the 1981 growing season on Price River Coal Company's Mine Plan Area around Helper, Carbon County, Utah (Figure 1.1). The mine plan area consisted of approximately 42 square miles in all or parts of Sections 35-36, T12S R8E; 25-36 T 12S R9E; 26-35 T12S R10E; 2 T13S R8E; 1-6, 8-12, 14, 16, 17, T13S R9E; 1-6, 8-12, 15-18, 20-22, 28-30, T13S R10E (Map 1, Appendix B).

Price River Coal Company (PRCC) has several facilities currently in operation or under construction within the mine plan area for which reference area were established. In addition, vegetation baseline studies for an area in Barn Canyon that may be disturbed by future activities were conducted. The objectives of the study were to:

- Establish reference areas for vegetation types that had been present prior to mining to serve as benchmarks for evaluating reclamation success.

- Measure selected parameters that would provide information on existing vegetation conditions on reference areas and the potentially affected area in Barn Canyon.

- Identify any threatened or endangered plant species protected by federal or state laws.

Vegetation parameters measured were species composition, cover, frequency, shrub density, shrub height, tree density, and basal area. Estimates of vegetation productivity were obtained from the Soil Conservation Service (Appendix A).

All methods used for the study area are described in this report. Results are summarized in tabular form and discussed in the text of the

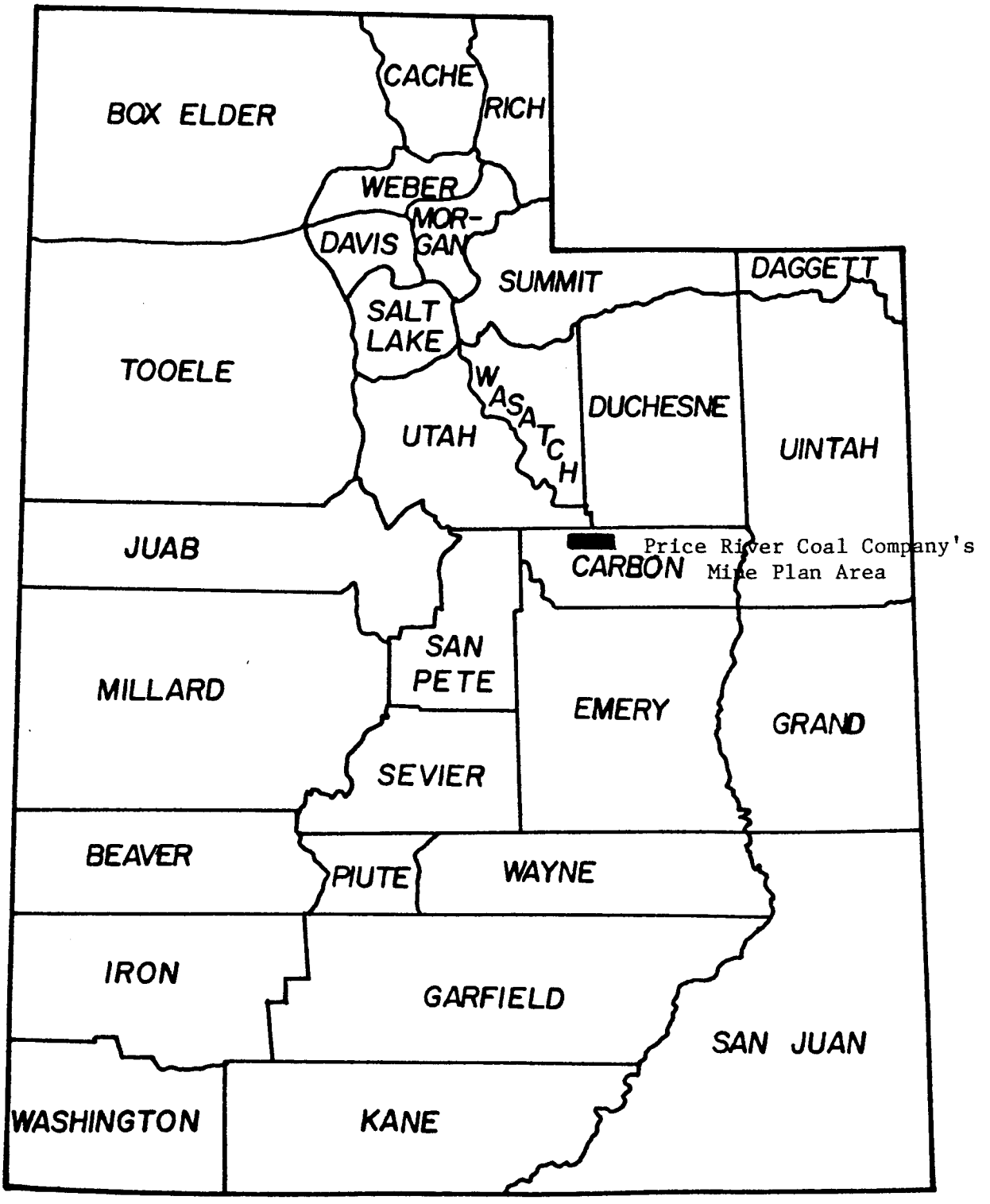

Figure 1.1 Mine Plan Area Location

report. Vegetation types, reference areas, and sample site locations are shown on Maps (Appendix B). Computer listings of all field and analyzed data are presented for each area sampled (Appendix C). Lists of vegetation species encountered on each of the vegetation types are also included (Appendix C).

2.0 METHODS

The study was patterned after Utah Divison of Oil, Gas, and Mining (UDOGM) Preliminary Guidelines for Vegetation Studies on Coal Mines (June 6, 1980 revision). Specific study requirements and techniques were defined during consultations with personnel from UDOGM (Mary Ann Wright, Reclamation Biologist and Administrator of Abandoned Mine Reclamation; Susan Linner, Reclamation Biologist; Lynn Kunzler, Reclamation Biologist), and Office of Surface Mining (OSM) (Larry Larson, Vegetation Specialist). Wyoming Department of Environmental Quality (WDEQ) Guideline #2 "Vegetation", January 1981, was used for supplemental information on data analysis techniques.

A field reconnaissance was performed in June 1981 to determine the boundaries of the mine plan areas, the number of vegetation types and identify potential reference areas. Disturbed areas associated with this underground mine include portals, loadout, waste disposal, and other surface facilities such as tanks, equipment, roads, and materials storage. Construction of a shaft and associated facilities is presently taking place in Crandall Canyon. Most disturbed areas are located in the bottoms of canyons. An area in Barn Canyon may be used for a waste disposal site in the future.

Vegetation studies necessary to meet regulatory requirements were preparation of a vegetation cover map for the mine plan area, selection of reference areas for vegetation types that existed in the disturbed areas prior to mining, selection of reference areas for vegetation types that occur in the affected area of Barn Canyon, and sampling of the affected area and the reference sites to describe vegetation species composition and cover. This reference area approach does not require sampling of vegetatin production until studies to ascertain success of reclamation are conducted. Estimates of vegetation production for the various reference areas as well as the affected area in Barn Canyon were obtained from the Soil Conservation Service (SCS) (Appendix A).

The folowing procedures were used to provide vegetation data for the project:

- Map and describe all major vegetation communities within the mine plan area
- Ascertain vegetation types that occurred in disturbed aras prior to mining activity and select reference areas to represent the various types
- Ascertain vegetation types that occur in the Barn Canyon affected area, select sampling points in the affected area, and select reference areas to represent the affected area vegetation types.
- Ascertain species composition and prepare voucher collection
- Estimate vegetation cover
- Estimate shrub density and shrub heights
- Estimate tree density and basal area
- Obtain estimates of productivity from the SCS
- Photograph all vegetation types

All procedures are explained below.

2.1 MAPPING

A thorough reconnaissance was conducted in June 1981 to identify plant communities within the permit area for a preliminary vegetation map. The distribution of vegetation types on the mine permit area was delineated on clear acetate sheets overlaying black and white aerial photographs. Type

delinations were then transferred to a topographic base map at a scale of 1 in = 1000 ft. Accurate transfer of type delineations was accomplished by aligning topographic and man-made features common to both the aerial photograph and the topographic base map with the aid of zoom transfer equipment. The vegetation map was ground-truthed at numerous points in and near the disturbed, affected, and reference areas. The final topographic base map with all vegetation type delineations was expanded to a scale of 1 in = 400 ft for all disturbed and affected areas and a 1 in = 100 ft map was prepared for the Crandall Canyon Leach Field (the scale of all maps was approved or specifically requested by UDOGM personnel, Lynn Kunzler, Reclamation, Biologist). Locations of each reference area on the mine permit area were plotted on the topographic maps. Sample site locations in the Barn Canyon affected area were also plotted on the vegetation map. Mapping units on the mine plan area were: grassland-sagebrush (grass-sage), pinyon-juniper, riparian bottom, mixed brush, conifer, saltbush, pre-1977 mining disturbances, post-1977 mining disturbances, (including areas disturbed by mining prior to 1977 that were subsequently used for mining activity) and other disturbances.

Total acreages of all disturbed areas within the mine plan area, the acreage of the vegetation to be disturbed in Crandall Canyon, and the acreage of potentially affected areas in Barn Canyon were estimated by standard polar planimeter techniques. Each measureable unit was planimetered until three independent measurements were within 10 percent of one another. These three measurements were then averaged to obtain an acreage estimate for the unit. The individual estimates for all units of a specific type were then summed to provide an estimate of the acreage within each type. Percent of each vegetation type in disturbed areas was estimated where the exact location of vegetation type boundaries prior to disturbance could not be determined. This estimate was based on relative distribution of vegetation types on nearby undisturbed areas with similar topography, similar slope, aspect, and soil characteristics.

2.2 SELECT REFERENCE AREAS

Vegetation types that occurred in the disturbed areas prior to mining activity were ascertained by examination of undisturbed areas immediately above, below, and surrounding the disturbed sites as well as other similar sites nearby that have not been disturbed. Aerial photos taken prior to disturbance were also used to help identify pre-disturbance vegetation types.

The primary goal of vegetation studies is to establish valid reference areas which must be utilized to meaure the success of revegetation for the purpose of bond release (UDOGM 1980). Reference areas, approximately 2 to 3 acres in size, were selected for each of the major vegetation types that have been disturbed as well as those types that occur in the potentially affected ara in Barn Canyon. Reference areas were selected on the basis of similarity of species composition, cover, productivity, geology, soils, slope, and aspect with representative vegetation types on the disturbed and affected areas. Reference sites were established in areas not to be disturbed by project activities. Location of the reference sites were marked by steel rods in the field and plotted on the vegetation maps (Appendix B).

On August 14, 1981, UDOGM personnel (Kunzler, Linner, and Wright) toured the proposed reference areas for the sites presently disturbed by mining, except for the grass-sage reference area near Barn Canyon, which was added later. Reference areas for the potentially affected types in Barn Canyon, which were not examined by UDOGM personnel because they were selected subsequent to the tour, were selected with an interative process on the basis of a t-test comparison of vegetative cover to demonstrate equality of the affected and reference areas. The t-test comparison is the least subjective method used to evaluate potential reference areas (Bonham et al. 1980:52). The reference area selection process involved comparison of vegetative cover data from each potentially affected type in Barn Canyon with data from corresponding reference areas for disturbed sites that had

been established for the type. If the t-test comparison indicated that vegetative cover on the affected area and proposed reference area were significantly different, another reference area was selected, sampled, and the data compared to the affected area vegetative cover data. This process was repeated for each type until no significant difference between the affected area and proposed reference area could be demonstrated. Such an approach assured that proposed reference areas would be equivalent for the potentially affected types in Barn Canyon.

2.3 VEGETATION SPECIES COMPOSITION

Reconnaissance-type surveys were conducted within each major vegetation type on the project site to obtain a complete listing of vegetation species for the study area. Specific species composition surveys were conducted by a plant taxonomist during two field trips scheduled to take advantage of different plenological periods in 1981. During the survey, the botanist listed all plants observed during a thorough reconnaissance of each vegetation type. A plant voucher collection was prepared for all plants identified during the study. For each plant collected, date, habitat, elevation, and associated species were recorded. Questionable plant species were taken to the Rocky Mountain Herbarium, Laramie, Wyoming for positive identification. Specific searches for threatened, endangered, noxious weeds, and selenium indicator plant species were conducted in appropriate habitats during the species composition study. Any additional species observed during the vegetation cover sampling were recorded and added to the species list of the appropriate vegetation type.

2.4 SELECTION OF SAMPLE POINTS

All sample points for vegetation cover, shrub, and tree data were randomly selected. On the reference areas, a table of random numbers was used to identify the starting point of each transect as follows: A random number indicated the number of paces across one side of the reference area and a second number indicated the number of paces perpendicular to that

side to the point within the reference area. A third random number was used to select transect direction. Sample points for the Barn Canyon affected area were selected by overlaying a grid (interval = 0.4 in) on the 1 in = 400 ft vegetation map and using a random numbers table to identify grid coordinates for each point. Each point was then located in the field by pacing from recognizable landmarks. Transect direction was randomly selected in the same manner as on the reference areas. These techniques ensured that position of each transect was unbiased.

2.5 VEGETATION COVER

Cover data were obtained at 50 points spaced at 1 m intervals along a transect at each randomly selected sample point. A linear point-frequency frame (Mueller-Dombois and Ellenbert 1974) was used to accurately measure vertical hits on vegetation, litter, and bare ground. Crown or shoot cover was measured by counting only the first interception of the pin with a plant part. Overhead canopy cover was determined by recording the plant species hit when the vertical line of the pin was protected upward above the frame. Where crowns overlap in layered vegetation, the uppermost layer was considered the primary vegetation hit and subsequent hits on lower vegetation were recorded separately.

Data derived by the technique described above provided an index for vegetative, litter-rock, and bare ground cover by identifying the frequency with which each of thse components of total cover was encountered along a given transect. Frequency of occurrence of plant species encountered along each transect was also determined by this technique to provide information regarding the relative distribution of all vegetative species encountered within each sample unit.

All cover data were collected during July 7-10, September 27, and October 7-10, 1981. Data were recorded on field forms developed for computer input. A minimum of 15 transects was sampled in each type or reference area prior to sample adequacy calculations. If necessary, additional cover

transects were sampled in each area until the desired level ($\pm$ 10% $\bar{x}$ @ 90% confidence) was achieved. The number of cover transects in each sampling area is shown in Table 3.1.

2.6 SHRUB DENSITY AND HEIGHTS

Shrub density and height were estimated along the same transects used for cover data. The height, number, and species of shrubs whose stems arose within 50 cm of either side of the 49 m long transect were recorded. Shrub heights were measured and recorded by the following classes: 1-10 cm, 11-30 cm, 31-50 cm, 51-100 cm, 1-2 m, 2-4 m, and over 4 m. On certain reference areas, it was more efficient to conduct an absolute count of the shrubs within the area of known size. The decision to use an absolute count or shrub density transects was based on the effects of distribution and density of the shrubs on efficiency of total counts relative to sampling. Desired confidence level for shrub density was $\pm$ 20% $\bar{x}$ @ 80%.

2.7 TREE DENSITY AND BASAL AREA DATA

The point-quarter technique (Smith 1974) was used to collect tree density and basal area data within tree covered types on the study area. At each sample point, imaginary grid lines were used to divide the area into four quarters. The tree nearest to the point in each quarter was recorded by species, circumference at breast height (in) for those larger than 1 in diameter, and distance from the point (ft) on a standard field data form. On certain areas, an absolute count or photo count of trees was conducted instead of point-quarter sampling for density estimates. Absolute counts involved recording the basal area and number of trees of each species within the reference area of known size. Density of trees on the pinyon-juniper areas was determined by counting individual trees within an area of known size on aerial photos with the aid of a magnifying stereoscope. The relative abundance of each species and figures for basal area calculations in the pinyon-juniper area were provided by the point-quarter samples.

2.8 SOIL CONSERVATION SERVICE (SCS) PRODUCTIVITY ESTIMATES

Productivity estimates for the various areas were obtained from the local SCS range conservationist (George Cook) who examined each site.

2.9 PHOTOGRAPHS

All vegetation types were photographed to provide visual documentation of characteristics.

2.10 PERSONS CONTACTED

A list of people contacted for information during the vegetation study is given in Table 2.1.

2.11 DATA ANALYSIS AND REPORTING

A comprehensive data base management and analysis system on a CYBER 730 computer was used to process vegetation data collected during this study. Data were input via keypunched cards that had been double punched and verified for accuracy. All field data were printed out on computer sheets in legible form and in the appropriate format. Cover data were analyzed first by transect, then all data were summarized to provide results by vegetation type. Data are reported for percent cover of vegetation, litter and rock, and bare ground. Vegetation cover data are reported by vegetative species and life form. Sample adequacy and species diversity calculations are shown for each vegetation type or sample area at the bottom of each print-out. This procedure ensures the careful, accurate documentation of every data analysis step from field collection and recording through summary data analysis thereby providing a logical, legible format of data with which any result and conclusion stated in this report can be easily verified. Formulas for all methods and calculations are given in Table 2.2.

Table 2.1 List of People Contacted for Information During the Vegetation Study on Price River Coal Company's Mine Plan Area, 1981

Mr. Thomas Behling
Carbon County Agriculture Extension Agent
Price, Utah

Mr. George Cook
Range Conservationist
Soil Conservation Service
Price, Utah

Mr. Lynn Kunzler
Reclamation Biologist
Utah Division of Oil, Gas, and Mining
Salt Lake City, Utah

Mr. Larry Larson
Vegetation Specialist
Office of Surface Mining
Denver, Colorado

Ms. Susan Linner
Reclamation Biologist
Utah Division of Oil, Gas, and Mining
Salt Lake City, Utah

Mr. Gary D. Moreau
District Conservationist
Soil Conservation Service
Price, Utah

Ms. Mary Ann Wright
Administrator of Abandoned Mine Reclamation
Utah Division of Oil, Gas, and Mining
Salt Lake City, Utah

Table 2.2 Methods and Formulae Used for Vegetation Data Analysis

---

$$\text{Percent Cover} = \frac{h}{pn} \times 100$$

where: h = number of times the species was hit
n = number of transects sampled
p = number of possible hits on each transect

$$\text{Percent Frequency} = \frac{T}{n} \times 100$$

where: T = number of transects containing the species
n = number of transects sampled

$$\text{Shrub Density/ha} = N \times (204.08)$$

where: N = the number of shrubs counted on the transect
204.08 = conversion factor for density per transect area (49 m^2) to density per hectare (10,000 m^2)

For reference areas on which all shrubs or trees were counted, the number of shrubs or trees was divided by the size of the area (determined by pacing in the field or measuring on aerial photos) to obtain the density estimate.

$$\text{Total Tree Density/ha} = \frac{43{,}560}{\left(\frac{\Sigma PT}{\Sigma D}\right)^2} \times (2.47)$$

where: 43,560 = ft^2/ac
2.47 = ac/ha
Σ PT = sum of the point to tree distances in ft
Σ D = total number of distances measured

Individual species densities are then calculated:

$$\text{Density for Species x} = \text{total density} \times \frac{\Sigma x}{T}$$

where: Σ x = number of trees of species x in sample
T = total number of trees of all species in the sample

Table 2.2 (continued)

Basal Area (cm^2) = $(CBH \times 0.404)^2$

where:
π = 3.1416
CBH = circumference at breast height in inches
.404 = conversion factor to calculate radius in cm from circumference.

$$\text{Mean } (\bar{x}) = \frac{\Sigma x}{n}$$

where: Σx = sum of values for variable under consideration
n = number of transects or observations sampled

$$\text{Standard Deviation } (s) = \sqrt{\frac{\Sigma \bar{x} - x_i}{n - 1}}$$

where: $\bar{x}$ = mean
x_i = value of variable for sample point i
n = number of sample points

Sample Size Adequacy (Wyoming Department of Environmental Quality Guideline #2):

$$N_{min} = \geq \frac{2\ (s\ z)^2}{(d\ \bar{x})^2}$$

where: N_{min} = minimum number of samples
s = sample standard deviation
z = z statistic (see table below)
d = amount of reduction to detect (see table below)
$\bar{x}$ = sample mean

z Statistic and d Table

	z	d
Cover	1.28	0.1
Productivity, grasslands	1.28	0.1
Productivity, shrublands	0.84	0.2
Tree and Shrub Density	0.84	0.2

Table 2.2 (continued)

Confidence Level Achieved: $z_i = \dfrac{\sqrt{\dfrac{n(d\ \bar{x})^2}{2}}}{s}$

where: n = number of sample points
z_i = calculated z value used in z table for identifying confidence level achieved (other variables defined in sample size adequacy).

Species Diversity Index (H) $= - \Sigma\ p_i \log_e p_i$

where: p_i = decimal fraction of total individuals belonging to the ith species.

Equality of Affected and Reference Areas: t-test Comparison

Ho: reference area j = affected area i
Ha: reference area j = affected area i

$$t_e = \frac{\bar{x}_j - \bar{x}_i}{\sqrt{s_p^2 \dfrac{n_j + n_i}{n_j n_i}}}$$

where: t_e = estimated t-value which is compared to tabular t-value
$\bar{x}$ = mean
s^2 = variance
n = sample size
i = affected area data
j = reference area data

$$sp^2 = \frac{m_j + m_i}{n_j + n_i - 2}$$

$$m = (n - 1)\ s^2$$

Similarity index: (Bonham et al. 1980:81):

$$s = \frac{2w}{a + b}$$

where: s = similarity between potential reference area and the inventory unit
a = number of species in area a
b = number of species in area b
w = number of species in common for a and b

References: Pielou (1966), Snedecor and Cochran (1967), Bonham et al. 1980, Larson (1980), Wyoming Department of Environmental Quality (1981).

3.0 RESULTS AND DISCUSSION

Coal mining has been conducted in the Mine Plan Area for over 100 years. Old abandoned mines and the associated refuse disposal, transportation facilities, villages, and houses for the work force are scattered throughout many of the canyons in and near the mine area. Major highways (U.S. 6 and Utah 33) and railroad routes pass through the area. There are also a Utah Power and Light Company Electric Generation Station and a municipal water treatment plant along the Price River in or near the Mine Plan Area. As a result of human activity, most of the land along the Price River and many of the canyon bottoms within the river area have been disturbed in the past or are presently in a disturbed condition. In addition to the native species usually found in the various vegetation types, numerous weeds and cultivated plants that have escaped or been abandoned are found in the Mine Plan Area. Land not presently devoted to uses such as mining and transportation, is used primarily for unmanaged livestock grazing. Mule deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) are the large native herbivores that occur in the area while smaller herbivores such as ground squirrels (*Spermophilus* spp.), chipmunks (*Eutamias* spp.) and rabbits (*Sylvilagus* and *Lepus* spp.) are abundant in several areas.

3.1 VEGETATION TYPES

Vegetation types on the entire Mine Plan Area are depicted on a 1 in = 1000 ft vegetation cover map presented in Appendix A (Map 1). Areas presently disturbed or which may be disturbed by future mining are also shown on the larger scale maps (Appendix A, Maps 2-5). Acreages of vegetation types, disturbed areas, and potential disturbance in the Mine Plan Area are shown in Table 3.1.

The five major vegetation types on the Mine Plan Area are grass-sage, mixed brush, conifer, pinyon-juniper, and riparian bottom (Plates 3.1-3.5, respectively). A very small area of saltbush type occurs on the southern

Table 3.1 Acreages of Disturbed and Potentially Disturbed Sites in the Mine Plan Area

Area		Acres
D1 - Disturbed by mining prior to 1977		190.8
D2 - Disturbed by mining after 1977		215.0
DS - Other disturbance		361.5
	Total Disturbed	767.3
Potential Disturbance in Barn Canyon:		
Conifer	49.4 (21)1/	
Grass-sage	39.7 (21)	
Mixed brush	27.8 (14)	
Pinyon-juniper	84.9 (44)	
Subtotal	192.8	
Potential Additional Disturbance Around Waste Disposal in Small Gulch South of Barn Canyon:		
Conifer	3.0 (11)1/	
Mixed brush	12.9 (48)	
Pinyon-juniper	11.0 (41)	
Subtotal	26.9	
	Total Potential Additional Disturbance	219.7
Crandall Canyon Area (already included in D2 above):		
Leach Field Area:		
Grass-sage	1.9 (37)	
Mixed brush	2.6 (51)	
Conifer	0.6 (12)	
Subtotal	5.1	
Shaft Site and Associated Facilities:		
Mixed brush	5.5 (48)	
Conifer	0.5 (4)	
Riparian bottom	5.5 (48)	
Subtotal	11.5	
	Total in Crandall Canyon	16.6

1/ Percent of type in the area

edge of the Mine Plan Area. Since not all disturbed areas were associated with mining and some of the mining disturbance was prior to the effective date of _____, disturbed sites on the Mine Plan Area were identified according to the following criteria: pre-1977 mining disturbance, post-1977 mining disturbance, (including areas disturbed by mining prior to 1977 that were used for subsequent mining activity) and other disturbance. A description of the major types is presented in this section. Quantitative data for specific reference and affected areas is presented in Section 3.3 and Appendix C.

3.1.1 Grass Sage

The grass-sage vegetation type (Plate 3.1) occurs on steep dry slopes as well as along some of the lower drainages in the Mine Plan Area. Relative cover provided by Artemisia spp. or the graminoid components varies depending on site characteristics. Artemisia is dominant in areas such as along the banks of Willow Creek and shares dominance on sites such as those found on the slopes of Sowbelly Canyon but grasses are often dominant on knolls or the tops of small ridges within the type. The area covered by the grass-sage type in the vicinity of the Castle Gate Preparation Plant appears to have been burned many years ago; a few weathered and charred pinyon or juniper stumps are scattered throughout slopes in that area. The upper end of the small grass-sage area in the vicinity of the proposed leach field in Crandall Canyon is covered with almost pure grass but sagebrush becomes more prevalent in the lower end.

The list of vegetative species occurring on the grass-sage type within the mine plan area is presented in Appendix C. No endangered or threatened plant species (Federal Register, December 15, 1980) was observed in this type. Two noxious weeds (Utah Noxious Weed Act 1958), (Cardaria chalepensis and Centaurea repens, and one selenium indicator, Stanleya pinnata, were found in this type. Twenty-four species listed as weeds by Holmgren and Andersen (1971) were found in this type. Neither of the noxious weeds was abundant or widespread enough to have been encountered along vegetation cover transects in the grass-sage type. Stanleya pinnata was encountered

Plate 3.1 Grass-sage vegetation on the Mine Plan Area

once in the Sowbelly grass-sage reference area; it accounted for 0.1 percent of the cover in the area. It was not encountered along transects on any of the other grass-sage areas that were sampled. Bromus tectorum, Chenopodium albium, and Salsola kali were the most widespread common weeds on the grass-sage areas.

3.1.2 Mixed Brush

The mixed brush type (Plate 3.2) generally occurs in relatively moist sites such as the bottoms of gulches and small depressions in the upland areas, however it is found on a wide range of slopes/aspect combinations throughout the study area. Composition of the mixed brush type is highly variable, ranging from dryer sites dominated by Artemisia tridentata, Pinus edulis, Juniperus osteosperma or Amelanchier utahensis, to moist sites dominated by Acer grandiditatum or even Populus tremuloides. The most common species throughout mixed brush type are Quercus gambelii, Symphoricarpos occidentalis, and Artemisia tridentata.

The list of vegetative species occurring within the mixed brush type is presented in Appendix C. No endangered or threatened plant species (Federal Register, December 15, 1980) was observed in this type. Three noxious weeds (Utah Noxious Weed Act 1958), Cardaria chalepensis, Cardeus nutans, and Convolvulus arvensis were found in this type; however, none was widespread or abundant enough to have been encountered on vegetation cover transects in the type. No selenium indicator species was found in the mixed brush type. Twenty-two species listed as weeds by Holmgren and Andersen (1971) were found in this type. Bromus tectorum was encountered on all mixed brush areas in which cover transects were run and Kochia scoparia was encountered on cover transects in the Sowbelly mixed brush reference area.

Plate 3.2 Mixed brush vegetation on the Mine Plan Area

3.1.3 Pinyon-Juniper

Pinyon-juniper vegetation (Plate 3.3) is found on slopes that are steep, rocky, and dry in the northern and central portions of the Mine Plan Area as well as on the more level but equally dry sites below the cliffs in the southern portions of the area. Dominant species in this open, wooded type are Pinus edulus and Juniperus osteosperma. Other common species are Cercocarpus ledifolius, Quercus gambelii, Artemisia tridentata, Chrysothamnus spp., and Agropyron spp. The steepness of the slopes on which this type occurs in much of the mine area precludes grazing by cattle.

The list of species in the pinyon-juniper type is presented in Appendix C. No endangered or threatened species (Federal Register, December 15, 1980) or noxious weed (Utah Noxious Weed Act 1958) was observed in this type. Two selenium indicators, Astragalus flavus and Stanleya pinnata, were found in the pinyon-juniper type; however, they were not widespread or abundant enough to have been encountered on the cover transects. Five species listed as weeds by Holmgren and Andersen (1971) were found in this type.

3.1.4 Riparian Bottom

The riparian bottom type (Plate 3.4) is limited to the streambanks along the Price River and a couple of sites in the bottom of Crandall Canyon. Distinguishing characteristics of this type are the presence of deciduous trees (primarily Populus angustifolia) or relatively open, grass-covered flats in canyon bottoms. Riparian bottoms have been disturbed in the past by overgrazing, human occupation, and periodic flooding and weedy species such as Cynoglossum officinale, Bromus tectorum, Salsola kali, and Convolvulus arvense are common. Senescent Populus angustifolia trees are numerous along Crandall Canyon and seedlings are abundant but there are relatively few saplings.

The list of species occurring in the riparian bottom type is found in Appendix C. No endangered or threatened species (Federal Register,

Plate 3.3 Pinyon-juniper vegetation on the Mine Plan Area

Plate 3.4 Riparian Bottom vegetation on the Mine Plan Area

December 15, 1980) or selenium indicator species was found on this type. Two noxious weeds (Utah Noxious Weed Act 1958), Cirsium arvense and Convolvulus arvensis, occur in the riparian type. Convolvulus arvensis was 3.3 percent of the cover on the Castle Gate riparian area. Cirsium sp. was 0.2 percent of the cover in the Crandall riparian area. Twenty-three species listed as weeds by Holmgren and Andersen (1971) were found in the type. Eight weed species were encountered on transects in the Castle Gate riparian area and four were encountered on transects in the Crandall riparian area.

3.1.5 Conifer

The conifer type (Plate 3.5) is found on the higher elevations, northerly facing slopes, and across some of the drainages in the Mine Plan Area. The type is often dominated by Pseudotsuga menziesii; however, Juniperus osteospermum, Pinus ponderosa, Abies concolor, or Abies lasiocarpa may be more abundant on certain sites. Composition of the understory is influenced by canopy coverage, therefore it varies as the density of trees in the conifer type varies throughout the study area. Relatively dense stands of conifer have relatively little understory of perennial grasses, forbs, and shrubs such as Symphoricarpos occidentalis and Berberis repens. Open stands have relatively more grasses as well as shrubs of the mixed brush type.

The list of vegetative species found in the conifer type is presented in Appendix C. No endangered or threatened species (Federal Register, Cecember 15, 1980) or selenium indicator species was found in this type. One noxious weed (Utah Noxious Weed Act 1958), Onopordum acanthium, was found in the type; however, it was not widespread or abundant enough to have been encountered on the vegetation cover transects. Eleven species listed as weeds by Holmgren and Andersen (1971) were found in this type. The most abundant weeds in the conifer type was Cerastium sp. which was 0.3 percent of the cover on the Crandall conifer area and Taraxacum officinale which was 0.1 percent of the cover in the Crandall area.

Plate 3.5 Conifer vegetation on the Mine Plan Area

3.1.6 Saltbush

An extremely small amount of the saltbush vegetation type (5 acres) occurs on the southern edge of the Mine Plan Area. This type occurs on a clay hillside which is sparsely vegetated by Atriplex cavesens and Sarcobatus vermiculatus as well as other species adopted to the harsh growing conditions. No affected sites or reference areas occur within this area so quantitative studies were not conducted in this minor type.

3.1.7 Disturbed

Sites for mine facilities and associated disturbance, highways, railroads, and other human disturbance are included in this type. Disturbed sites were identified according to whether they were pre-1977 mining disturbance, post-1977 mining disturbance (including areas disturbed by mining prior to 1977 that were subsequently used for mining activity), or disturbed by other activities. Most disturbed sites are in such condition that vegetation growth is limited, if it is allowed at all. Although isolated patches of species usually associated with the various natural vegetation types occur within and on the edges of adjacent disturbed areas, most species growing in those sites are primary succession species and are considered weeds: Salsola kali, Kochia scoporia, and Convolvulus arvense. Chrysothamnus nauseosus, a shrub species that invades disturbed sites, commonly grows on the edges of disturbed areas.

3.2 THREATENED AND ENDANGERED SPECIES

No threatened or endangered plant species (Federal Register, December 15, 1980) was found on the area.

No threatened or endangered plant species presently listed is known to occur in Carbon County; however, the occurrence of Eriogonum corymbosum var. davidsei and Eriogonum lancifolium, two species recommended for endangered listing, was reported by Welsh and Thone (1979). Eriogonum corymbosum var. davidsei occurs in a desert shrub community near Price. It occurs at approximately 5500 feet elevation in clay soil on a steep

hillside on the Mancos Shale Formation. Eriogonum lancifolium is also found on the Mancos Shale Formation and usually occurs in association with scattered juniper in salt desert shrub communities between 4900-5700 feet. It is found on gray clay soils. Neither of these species is known to occur on the Mine Plan Area.

3.3 VEGETATION ON REFERENCE AREAS AND POTENTIALLY AFFECTED VEGETATION TYPES

3.3.1 Sample Adequacy

Sample adequacy was calculated for all vegetative cover, shrub density, and tree density data gathered on the Mine Plan Area. All data met or exceeded the desired confidence level except for shrub density on the Barn Canyon pinyon-juniper affected area (Table 3.2). Desired confidence level for this data was 80 percent and the confidence level achieved was 79.4 percent (Table 3.2). One additional shrub transect would have been sufficient to exceed the desired confidence level; however, a snowstorm hit the Study Area on the last day of the field trip and, given the weather conditions, it was not practical to attempt additional sampling in the area.

3.3.2 Affected Areas and Corresponding Reference Areas

The list of affected areas and corresponding reference areas is given in Table 3.3. A comparison of vegetation data from the types in Barn Canyon that may be affected and the equivalent reference areas is provided in Table 3.4. Since the other affected areas were already disturbed, there are no baseline vegetation data for statistical comparison with reference area data. Although the reference area selection for the disturbed areas was more subjective than for the Barn Canyon types, the reference areas chosen are typical what would have been present in the disturbed sites due to the similarity of slope, aspect, and elevation as well as the proximity to areas they represent. Reference areas for the disturbed sites provide the basis for reclamation success standards; however, final reclamation success criteria will also have to take other factors, such as actual vegetation

Table 3.2 Statistical Adequacy of Vegetation Data for the Price River Coal Company's Mine Area, 1981

Sampling Area	Vegetation Cover			Shrub Density			Tree Density		
	N_{min}	n	CLA	N_{min}	n	CLA	N_{min}	n	CLA
REFERENCE AREAS:									
Sowbelly Grass Sage	11	15	92.8	2	15	99.6	NA.....		
Sowbelly Mixed Brush	14	15	91.0	2	15	98.8	NA.....		
Willow Creek Grass-Sage	7	15	97.4	5	15	93.7	NA.....		
Castle Gate Riparian	13	15	91.6	24	28	82.1	.....AC.....		
Castle Gate Mixed Brush	7	15	96.6	6	15	91.0	NA.....		
Crandall Riparian	23	24	90.3	.....AC.....			.....AC.....		
Crandall Conifer	6	15	97.4	3	15	96.5	22	28	83.1
Crandall Pinyon-Juniper	1	15	100.0	8	15	87.7	.....PC.....		
Barn Canyon Grass-Sage	4	15	99.5	8	15	88.1	NA.....		
Dry Canyon Mixed Brush	3	15	99.7	3	15	97.7	NA.....		
AFFECTED AREAS:									
Barn Canyon Pinyon-Juniper	7	15	97.2	16	15	79.4	.....PC.....		
Barn Canyon Mixed Brush	13	15	91.9	6	15	90.7	NA.....		
Barn Canyon Grass-Sage	5	15	98.7	4	15	95.5	NA.....		
Barn Canyon Conifer	3	15	99.7	12	15	82.1	11	15	83.4

N_{min} = minimum sample size to meet desired confidence levels
n = sample size collected
CLA = Confidence Level Achieved
AC = Absolute Count
NA = Not Applicable
PC = Photo Count

Table 3.3 List of Affected Areas and Corresponding Reference Areas, Price River Coal Company's Mine Plan Area, 1981.

Affected Area	Reference Area
Sowbelly and Hardscrabble Mines	Sowbelly Mixed Brush and Sowbelly Grass-Sage
Willow Creek Disturbed	Willow Creek Grass Sage
Castle Gate Prep Plant	Castle Gate Mixed Brush, Castle Gate Riparian Bottom, Barn Canyon Grass-Sage
Crandall Canyon Shaft Site	Castle Gate Mixed Brush, Crandall Conifer, Crandall Riparian Bottom
Crandall Canyon Leach Field	Barn Canyon Grass-Sage, Castle Gate Mixed Brush, Crandall Conifer
Barn Canyon Conifer[1/]	Crandall Conifer
Barn Canyon Pinyon-Juniper[1/]	Crandall Pinyon-Juniper
Barn Canyon Mixed Brush[1/]	Dry Canyon Mixed Brush
Barn Canyon Grass Sage[1/]	Barn Canyon Grass Sage

1/ Future refuse disposal area not presently affected.

Table 3.4 Comparison of Vegetation Data from Affected Areas in Barn Canyon and Corresponding Reference Areas, 1981

Vegetation Type	Vegetative Cover		Shrub Density	Tree Density	Species Similarity Index
	Percent	t[1]	#/ha	#/ha	Percent
Barn Canyon Grass-Sage Affected	54.4		6449.0	NA	
Barn Canyon Grass-Sage Reference	53.2	0.528	2421.8	NA	50
Barn Canyon Mixed Brush Affected	64.3		11,823.1	NA	
Dry Canyon Mixed Brush Reference	64.3	0.000	8054.4	NA	60
Barn Canyon Pinyon-Juniper Affected	56.9		2979.6	176.8	
Crandall Pinyon-Juniper Reference	53.1	1.651	2653.1	202.0	71
Barn Canyon Conifer Affected	72.9		4285.7	255.7	
Crandall Conifer Reference	74.4	0.455	12,952.4	961.6	54

1/ $t_{(95)} = 2.048$; therefore, there was no significant difference in vegetation cover on any of the four affected types and their respective reference areas.

cover prior to mining disturbance (e.g., there was previously a village on the site of the Castle Gate Preparation Plant) as well as dates of disturbance into consideration.

Vegetative cover on all reference areas was not significantly different (t=.05) from their corresponding affected area in Barn Canyon (Table 3.4). All vegetative species similarity indices were 50 percent or greater.

3.3.3 Data Presentation

Summarized cover data for all areas sampled on the Mine Plan Area are presented in Table 3.5, shrub density data are in Table 3.6, tree density data are in Table 3.7, and productivity estimates are in Table 3.8. A brief description of the location and a summary of vegetation data on each of the aeas sampled during the study are presented below. Complete vegetation data for each area is given in Appendix C.

3.3.3.1 Sowbelly grass-sage reference area. The sowbelly grass-sage reference area is located in Sowbelly Canyon in SW1/4 Section 4, T13S, R9E (Maps 1 and 2). To be comparable to the slope and aspect of the disturbed sites, this reference is comprised of two parts, one on a southwest aspect and the other on a northeast aspect. Vegetative cover on the sowbelly grass-sage reference area was 39 percent, litter-rock was 44 percent, and bare ground was 16 percent (Table 3.5). Forty-seven percent of the vegetation cover was *Agropyron* spp. and 28 percent was *Artemisia tridentata*, which were also species encountered with 100 percent frequency among the transects. Eleven species were encountered on the cover transects in the Sowbelly grass-sage reference area, which had a species diversity index of 1.373. *Artemisia tridentata* accounted for 96 percent of the 8816 mean shrubs per ha on this reference area (Table 3.6). Mean height of all shrubs was 19 cm. Production on the area was estimated to be 900 lbs per acre (Table 3.7).

Table 3.5 Summary Cover Data for Reference and Affected Areas on Price River Coal Company's Mine Plan Area, 1981

Sampling Area	Vegetative Cover (%)		Litter/Rock (%)		Vegetation,Litter/Rock(%)		Bare Ground		# of Species	Species Diversity Index
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s		
REFERENCE AREAS:										
Sowbelly Grass-Sage	38.9	7.3	44.5	8.2	83.5	9.1	16.5	9.1	11	1.373
Willow Creek Grass-Sage	39.6	5.6	33.5	10.5	73.1	6.7	26.9	6.7	17	1.578
Barn Canyon Grass-Sage	53.2	5.7	45.7	5.5	98.9	2.1	1.1	2.1	17	2.250
Sowbelly Mixed Brush	47.7	9.8	38.3	10.7	86.0	5.9	14.0	5.9	24	1.940
Castle Gate Mixed Brush	40.9	6.1	35.2	6.0	76.1	6.6	23.9	6.6	12	1.484
Dry Canyon Mixed Brush	64.3	6.3	32.7	5.6	96.9	4.7	3.1	4.7	22	1.642
Crandall Pinyon-Juniper	53.1	3.5	37.1	5.4	90.1	4.6	9.9	4.6	13	1.985
Castle Gate Riparian	56.4	11.3	20.3	8.3	76.7	12.4	23.3	12.4	41	2.958
Crandall Riparian	47.2	12.6	34.6	9.8	81.8	7.5	18.2	7.5	36	2.424
Crandall Conifer	74.4	10.4	20.4	9.5	94.8	5.2	5.2	5.5	23	1.379
AFFECTED AREAS:										
Barn Canyon Grass-Sage	54.4	6.7	34.9	9.0	89.3	6.6	10.7	6.6	17	1.846
Barn Canyon Mixed Brush	64.3	12.6	33.7	12.3	98.0	2.9	2.0	2.9	32	2.682
Barn Canyon Pinyon-Juniper	56.9	8.2	31.7	9.3	88.7	7.0	11.3	7.0	17	1.599
Barn Canyon Conifer	72.9	7.4	24.3	7.9	97.2	3.2	2.8	3.2	24	2.317

Table 3.6 Summary Shrub Density and Height Data for Reference and Affected Areas on Price River Coal Company's Mine Plan Area, 1981

Sampling Areas	Percent Frequency - Height Classes[1]							Height (cm)		Total Counted	Density (#/ha)	
	A	B	C	D	E	F	G	$\bar{x}$	s		$\bar{x}$	s
REFERENCE AREAS:												
Sowbelly Grass-Sage	26.3	67.4	3.7	1.7	0.6	0.3	0.0	19.4	21.7	648	8816.3	1832.2
Willow Creek Grass-Sage	5.4	30.1	38.3	24.9	1.2	0.0	0.0	42.2	25.2	1307	17,782.3	6351.8
Barn Canyon Grass-Sage	25.3	12.9	25.3	26.4	10.1	0.0	0.0	48.9	42.9	178	2421.8	1120.1
Sowbelly Mixed Brush	12.2	29.5	17.2	18.0	17.0	4.9	1.2	71.7	79.9	760	10,340.1	2528.7
Castle Gate Mixed Brush	13.5	23.0	27.4	28.0	5.7	2.4	0.0	53.1	52.6	453	6163.3	2539.9
Dry Canyon Mixed Brush	0.3	2.9	18.6	15.9	20.6	12.2	29.6	205.9	148.2	592	8054.4	2212.7
Crandall Pinyon-Juniper	0.0	18.5	16.4	19.5	13.8	6.7	25.1	166.4	152.9	195	2653.1	1253.3
Castle Gate Riparian	6.4	14.9	23.1	19.1	15.9	19.6	1.1	113.9	107.4	377	2747.8	2246.3
Crandall Riparian	8.2	31.7	26.5	20.7	8.2	4.0	0.6	59.6	67.7	328	404.9	---
Crandall Conifer	52.5	31.4	13.3	2.5	0.1	0.1	0.0	16.6	18.4	952	12,952.4	3914.9
AFFECTED AREAS:												
Barn Canyon Grass-Sage	12.9	19.0	38.4	21.7	8.0	0.0	0.0	48.1	37.5	474	6449.0	2085.2
Barn Canyon Mixed Brush	0.5	5.3	20.4	14.0	17.5	12.1	30.3	203.6	152.3	869	11,823.1	4907.3
Barn Canyon Pinyon-Juniper	5.5	11.0	14.6	17.4	20.1	12.3	19.2	165.4	143.0	219	2979.6	1990.3
Barn Canyon Conifer	8.6	1.9	13.0	35.6	28.3	4.8	7.9	121.2	104.8	315	4285.7	2544.3

1 Height classes:

Code	Range (cm)	Mid-Point (cm)
A	0-10	5
B	11-30	20
C	31-50	40
D	51-100	75
E	101-200	150
F	201-400	300
G	Over 400	-

Table 3.7 Summary Tree Density Data for Reference and Affected Areas on Price River Coal Company's Mine Plan Area, 1981

Vegetation Type	Density (#/ha)	Mean Basal Area (cm^2)
REFERENCE:		
Crandall Pinyon Juniper	42.0	1292.1
Castle Gate Riparian	147.0	969.9
Crandall Riparian	202.0	600.9
Crandall Conifer	961.6	369.0
AFFECTED:		
Barn Canyon Pinyon-Juniper	176.8	589.8
Barn Canyon Conifer	255.7	523.7

Table 3.8 Productivity Estimates for Reference and Affected Areas on Price River Coal Company's Mine Plan Area, 1981

Sampling Area	Productivity lbs/acre[1/]
REFERENCE:	
Sowbelly Grass-Sage	900
Willow Creek Grass-Sage	850 - 900
Barn Canyon Grass-Sage	
Sowbelly Mixed Brush	1200 - 1300
Castle Gate Mixed Brush	650 - 700
Dry Canyon Mixed Brush	
Crandall Pinyon-Juniper	
Castle Gate Riparian	2500 - 3000
Crandall Riparian	2500 - 3000
Crandall Conifer	200 - 300
AFFECTED:	
Barn Canyon Grass-Sage	
Barn Canyon Mixed Brush	
Barn Canyon Pinyon-Juniper	
Barn Canyon Conifer	

1/ Estimates provided by Soil Conservation Service, Price, Utah (Appendix A)

3.3.3.2 Willow Creek grass-sage reference area. The Willow Creek grass-sage reference area is located along Willow Creek in the SW1/4 Section 32, T12S, R10E, (Maps 1 and 3). Vegetative cover on this reference area was 40 percent, litter-rock was 34 percent, and bare ground was 27 percent (Table 3.5). Fifty-eight percent of the vegetation cover was Artemisia tridentata and 35 percent was grasses, primarily Agropyron smithii and Bromus tectorum. Artemisia tridentata occurred with 100 percent frequency while Agropyron smithii and Bromus tectorum both occurred with 73 percent frequency. Seventeen species were encountered along the transects in the Willow Creek grass-sage reference area. The species diversity index was 1.578. Artemisia tridentata accounted for 92 percent of the 17,782 mean shrubs per ha (Table 3.6). Mean height of all shrubs was 42 cm. Production on the area was estimated to be 850 to 900 lbs per acre (Table 3.7).

3.3.3.3 Barn Canyon grass-sage reference area. The Barn Canyon grass-sage reference is located in the NW1/4 Section 36, T12S, R9E (Maps 1 and 3). Vegetative cover was 53 percent, litter-rock was 46 percent, and bare ground was 1 percent (Table 3.5). Agropyron spp. provided 45 percent of the vegetation cover, Bromus tectorum provided 20 percent, Atriplex canescens provided 6 percent, and Artemisia tridentata provided 5 percent. Bromus tectorum was the species encountered with the highest frequency (93 percent) while Agropyron intermedium and other Agropyron spp. were the only other species that occurred with over 75 percent frequency. Seventeen species were encountered along the transects in the Barn Canyon grass-sage reference area, which had a species diversity index of 2.250. Sixty-two percent of the 2422 mean shrubs per ha were Artemisia tridentata and 23 percent were Atriplex canescens. Mean height of all shrubs was 48 cm (Table 3.6). Estimated Production on this area was was _____

3.3.3.4 Barn Canyon grass-sage affected. The grass-sage type covered 21 percent of the 193 acres of potential disturbance in Barn Canyon (Table 3.1) (Sections 25 and 36, T12S, R9E, Maps 1 and 3). Vegetation cover on the grass-sage affected area was 54 percent, litter-rock was 35 percent,

and bare ground was 11 percent (Table 3.5). Fifty-three percent of the vegetative cover was Agropyron intermedium and other Agropyron sp. while 17 percent was Artemisia tridentata. Agropyron intermedium was encountered with 100 percent frequency and Artemisia tridentata occurred with 87 percent frequency. Seventeen species were encountered on the transects in the grass-sage affected area. The species diversity index was 1.846. Artemisia tridentata accounted for 73 percent of the 6449 mean shrubs per ha and Atriplex canescens accounted for 12 percent (Table 3.6). Mean shrub height was 48 cm. Estimated production on the area was ___

3.3.3.5 Sowbelly mixed brush reference area. The Sowbelly mixed brush reference area is located in the bottom of Sowbelly Canyon in the SW1/4 Section 4, T13S, R9E (Maps 1 and 2). Vegetative cover was 48 percent, litter-rock was 38 percent, and bare ground was 14 percent (Table 3.5). Fifty-nine percent of the vegetation cover was Quercus gambelii, 11 percent was Artemisia tridentata, and 14 percent was Agropyron intermedium and other Agropyron species. Quercus gambelii occurred with 100 percent frequency and Artemisia tridentata occurred with 87 percent; all other species occurred with less than 50 percent frequency. Twenty-four species were encountered on the transect in the Sowbelly mixed brush reference area, which had a species diversity index of 1.940. Shrub density on this area was 10,340 per ha (Table 3.6). Forty-nine percent of the shrubs were Quercus gambelii, 30 percent were Artemisia tridentata, and 12 percent were Symphoricarpos occidentalis. Mean height of all shrubs was 72 cm. Estimated production on the Sowbelly mixed brush reference area was 1200 to 1300 lbs per acre (Table 3.7).

3.3.3.6 Castle Gate mixed brush reference area. The Castle Gate mixed brush reference area is located on a westerly-facing slope in the SW1/4 Section 36, T12S, R9E (Maps 1 and 3). Vegetation cover was 41 percent, litter-rock was 35 percent, and bare ground was 24 percent (Table 3.5). Fifty-one percent of the vegetation cover was Agropyron sp., 26 percent was Artemisia tridentata, and 9 percent was Amelanchier utahensis. Agropyron sp. occurred with 100 percent frequency, Artemisia tridentata occurred with

87 percent frequency, and all other species occurred with less than 50 percent frequency. Twelve species were encountered on the cover transects in the Castle Gate mixed brush reference area. Species diversity was 1.484. Seventy-six percent of the 6163 shrubs per ha (Table 3.6) were Artemisia tridentata and 10 percent were Atriplex canescens. Mean shrub height was 53 cm. Production on the Castle Gate mixed brush reference area was approximately 650-700 lbs per acre (Table 3.7).

3.3.3.7 Barn Canyon mixed brush affected. Approximately 14 percent of the 193 acres of potential disturbance in Barn Canyon (Table 3.1) (Sections 25 and 36, T12S, R9E) is classed as mixed brush (Maps 1 and 3). Vegetative cover on the mixed brush type in this area was 64 percent, litter-rock was 34 percent, and bare ground was 2 percent. Shrubs and trees were 70 percent of the vegetative cover with Acer grandidentatum and Quercus gambelii the most common (22 and 17 percent of vegetative cover, respectively). Bromus tectorum, which was the most common grass, was 8 percent of the vegetative cover. The most frequently occurring species were Acer grandidentatum (80 percent freuency), Quercus gambelii (73 percent), and Berberis repens (73 percent). Thirty-two species were encountered on the transects within the mixed brush affected area. Species diversity was 2.682. The most abundant shrubs were Symphoricarpos occidentalis, Acer grandidentatum, and Quercus gambelii which respectively accounted for 30, 30, and 24 percent of the 11,823 shrubs per ha on this type. Mean height of the shrub was 204 cm. Estimated production on the mixed brush affected area was _____

3.3.3.8 Dry Canyon mixed brush reference area. The Dry Canyon mixed brush reference area is located in the NE1/4 Section 32, T12S, R10E (Map 1). Vegetative cover was 64 percent, litter-rock was 33 percent, and bare ground was 3 percent (Table 3.5). Seventy-three percent of the vegetative cover were shrubs and trees with Quercus gambelii (56 percent) and Artemisia tridentata (12 percent) providing the most cover. Agropyron spicatum, Agropyron intermedium, and other Agropyron species provided approximately 20 percent of the vegetative cover. Quercus gambelii occurred with 100

percent frequency, Agropyron sp. occurred with 87 percent frequency, and Artemisia tridentata occurred with 80 percent frequency. The Dry Canyon mixed brush reference area had a species diversity index of 1.642. Twenty-two species were encountered on transects within this area. Sixty-eight percent of the 8054 shrubs per ha on this area were Quercus gambelii, and Artemisia tridentata accounted for 19 percent. Mean height of all shrubs was 206 cm. Production on the area was estimated to be ___

3.3.3.9 Barn Canyon pinyon-juniper affected. The pinyon-juniper type covered approximately 44 percent of the 193 acres of potential disturbance in Barn Canyon (Table 3.1) (Sections 25 and 36, T12S, R9E, Maps 1 and 3). Vegetative cover was 57 percent, litter-rock was 32 percent, and bare ground was 11 percent (Table 3.5). Fifty-six percent of the vegetative cover was Agropyron sp., 14 percent was Juniperus osteosperma, 13 percent was Pinus edulis, and 9 percent was Cercocarpus ledifolius. These same species also had the highest frequency of occurrence among the transects (100, 80, 80, and 67 percent, respectively). Seventeen species were encountered on the cover transects in the Barn Canyon pinyon-juniper type, which had a species diversity index of 1.599. Mean shrub density on this type was 2980 (Table 3.6) with Cercocarpus ledifolius, Artemisia tridentata, Quercus gambelii, and Pinus edulis the most abundant (27, 22, 20, and 11 percent, respectively). Mean height of all shrubs in the pinyon-juniper affected type was 165 cm. Estimated tree density in this type was 177 per ha and mean basal area for all trees was 590 cm^2 (Table 3.7). Fifty-one percent of the trees were Pinus edulis and 34 percent were Juniperus osteosperma. Estimated production on the pinyon-juniper affected type is approximately _____

3.3.3.10 Crandall pinyon-juniper reference area. The pinyon-juniper reference area is located in the NE1/4 Section 29, T12S, R9E in Crandall Canyon (Maps 2 and 4). Vegetative cover on this area was 53 percent, litter-rock was 37 percent, and bare ground was 10 percent (Table 3.5). Agropyron intermedium, Agropyron smithii, and other Agropyron sp. were 35 percent of the vegetative cover, Pinus edulis was 18 percent, Juniperus

osteosperma was 17 percent, and Cercocarpus ledifolius was 14 percent. Agropyron sp. occurred with 100 percent frequency, Cercocarpos ledifolius and Juniperus osteosperma each occurred with 67 percent frequency, and Pinus edulis occurred with 53 percent frequency. Thirteen species were encountered on the cover transects in the pinyon-juniper reference area. The species diversity index was 1.985. Cercocarpos ledifolius and Quercus gambelii were the most abundant (43 and 39 percent, respectively) of the 2653 mean shrubs per ha on the reference area (Table 3.6). Mean height of all shrubs was 166 cm. Tree density on the pinyon-juniper reference area was 202 trees per ha and mean basal area for all trees was 601 cm^2 (Table 3.7). Forty-seven percent of the trees were Juniperus osteosperma, 26 percent were Pinus edulis, and 22 percent were Cercocarpus ledifolius. Estimated production on the area was approximately ____

3.3.3.11 Castle Gate riparian reference area. The Castle Gate riparian reference area is located along the Price River in the SW1/4 Section 26, T12S, R9E (Maps 1 and 3). Vegetative cover was 56 percent, litter-rock was 20 percent, and bare ground was 23 percent (Table 3.5). Thirty-six percent of the vegetative cover was provided by 21 species of forbs, but the most cover of all species was provided by Bromus tectorum (18 percent) followed by Populus angustifolia (15 percent). Bromus tectorum occurred with 87 percent frequency, Clematis lingusticifolia occurred with 73 percent, Quercus gambelii occurred with 53 percent, and all of the other 38 species encountered on the cover transects occurred with less than 50 percent frequency. The Castle Gate riparian reference area had the highest species diversity of all areas sampled (2.958) (Table 3.5). Forty-six percent of the 2748 mean shrubs per ha on this type (Table 3.6) were Rosa sp., 19 percent were Quercus gambelii, and 11 percent were Rhus trilobata. Mean shrub height was 114 cm. Tree density in the Castle Gate riparian reference area was 42 per ha and mean basal area was 1292 cm^2 (Table 3.7). Populus angustifolia was the only tree species in the area. Production on the riparian area was 2500 to 3000 lbs per acre (Table 3.8).

3.3.3.12 Crandall riparian reference area. The Crandall riparian reference area is located in the bottom of Crandall Canyon in the NW1/4 Section 27, T12S, R9E (Maps 1 and 4). Vegetative cover on this area was 47 percent, litter-rock was 35 percent, and bare ground was 18 percent (Table 3.5). Thirty percent of the vegetative cover was Populus angustifolia, 13 percent was Poa sp., 11 percent was Bromus tectorum, and Cynoglossum officinale also provided 11 percent. Poa sp. occurred with 92 percent frequency, Populus angustifolia occurred with 83 percent, Aster sp. occurred with 75 percent, and Cynoglossum officinale occurred with 71 percent frequency among the cover transects in the area. Thirty-six species were encountered on the cover transects in the Crandall riparian reference area, which had a species diversity index of 2.424. Approximately 405 shrubs per ha occur within the area (Table 3.6). Forty-four percent of the shrubs were Symphoricarpos occidentalis, 11 percent were Quercus gambelii, and 10 percent were Ribes cereum. The mean height of shrubs was 60 cm. Tree density in the Crandall riparian reference area was 147 per ha and mean basal area was 970 cm^2 (Table 3.7). Trees in the type were Populus angustifolia, Acer grandidentatum, Juniperus osteosperma, Pseudotsuga menziesii, and Pinus ponderosa. Production on this riparian area was 2500-3000 lbs per acre (Table 3.8).

3.3.3.13 Barn Canyon conifer affected. The conifer type covered approximately 21 percent of the 193 acres of potential disturbance in Barn Canyon Table 3.1) (Sections 25 and 36, T12S, R9E, Maps 1 and 3). Vegetative cover was 73 percent, litter-rock was 24 percent, and bare ground was 3 percent (Table 3.5). Twenty-six percent of the vegetative cover was Agropyron sp., 16 percent was Juniperus osteosperma, 15 percent was Pseudotsuga menziesii, and 13 percent was Quercus gambelii. Species which occurred with the highest frequency among the transects were Agropyron sp. (100 percent), Juniperus osteosperma (100 percent), Pseudotsuga menziesii (87 percent), Quercus gambelii (60 percent), Abies lasiocarpa (53 percent), and Pinus edulis (53 percent). Twenty-four species were encountered along the cover transects in the conifer affected area. The species diversity index on this type was 2.317. Approximately 59 percent of the 4286 shrubs per ha on

this type (Table 3.6) were Quercus gambelii while Symphoricarpos occidentalis and Cercocarpos montanus each provided an additional 11 percent. Mean height of all shrubs was 121 cm. Tree density in the conifer affected type was 256 per ha and mean basal area was 524 cm^2 (Table 3.7). The most abundant trees were Juniperus osteosperma, Pseudotsuga menziesii, Pinus edulis, and Abies lasiocarpa. Estimated production in the conifer type in Barn Canyon was ___

3.3.3.14 Crandall conifer reference area. The conifer reference area is located in Crandall Canyon in the SW1/4 Section 289, T12S, R9E (Maps 1 and 4). Vegetative cover was 74 percent, litter-rock was 20 percent, and bare ground was 6 percent. Pseudotsuga menziesii provided 65 percent of the vegetative cover and Pinus ponderosa provided 14 percent. These two species occurred with 100 and 80 percent frequency, respectively; other frequently occurring species were Synmphoricarpos occidentalis (80 percent) and perennial grasses (60 percent). Twenty-three species were encountered along the cover transects in the conifer reference area. The species diversity index for this area was 1.379. Fifty-one percent of the 12,952 shrubs per ha on this area (Table 3.6) were Berberis repens, 35 percent were Symphoricarpos occidentalis, and 13 percent were Quercus gambelii. Mean shrub height was 17 cm. Tree density in the conifer reference area was 962 trees per ha and mean basal area was 359 cm^2 (Table 3.7). Pseudotsuga menziesii, Pinus ponderosa, and Juniperus osteosperma were the most abundant trees. Production in the conifer reference area was approximately 200 to 300 lbs per acre (Table 3.8).

4.0 SUMMARY

The vegetation baseline study for Price River Coal Company's Mine Plan Area near Helper, Utah was conducted during the 1981 growing season by Mariah Associates. Vegetation on the entire Mine Plan Area was mapped. Reference areas were selected and sampled for vegetation types that had occurred on sites that are presently occupied by surface facilities and other disturbance associated with the mine. Baseline vegetation studies were also conducted in an area in Barn Canyon that may be disturbed in the future.

The five major natural vegetation types in the Mine Plan Area were conifer, grassland-sagebrush, mixed brush, pinyon-juniper, and riparian bottom. Disturbance on the area was mapped and identified as either pre-1977 mining disturbance, post-1977 mining disturbance (including areas disturbed by mining prior to 1977 that were also subsequently used for mining activity), or other disturbance. Approximately ___ acres were identified as pre-1977 mining disturbance, ___ acres were post-1977 mining disturbance, and ___acres were identified as other disturbance. Vegetative cover on the 10 reference areas ranged from 39 percent to 74 percent, shrub density ranged from 405 per ha to 17,782 per ha, and species diversity ranged from 1.373 to 1.958. No threatened or endangered plants were encountered during the study.

5.0 LITERATURE CITED

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APPENDIX A

Productivity Estimates From the Soil Conservation Service

Rec. 11/12/81
TK
File # 148

United States Department of Agriculture
Soil Conservation Service
350 N. 400 E.
Price, UT 84501

November 4, 1981

Robert Wiley
Price River Coal Co.
P.O. Box 629
Helper, UT 84526

Dear Bob,

This letter confirms the findings of George Cook when he visited your Price Canyon operation on September 29, 1981. The rangeland productivity estimates by reference area are listed below:

Site #1 (above Castle Gate air vent) - Sagebrush-grass bottom community
850-900 lbs/acre air dry

Site #2 (water tank and sign) - Sagebrush-browse-grass community
650-700 lbs/acre air dry

Site #3 - Riparian community
2500-3000 lbs/acre

Site #4 (upper Crandall Canyon) - Woodland community
understory 200-300 lbs/acre
low production on conifers (ponderosa pine, whitefir, Douglas fir, western red juniper)

Site #5 (lower Crandall Canyon) - Riparian community
2500-3000 lbs/acre air dry

Site #6 (south aspect Sowbelly Canyon) - Salina Wildrye- black sagebrush community
900 lbs/acre

Site #7 (north aspect Sowbelly Canyon) - Gambel oak and grass community
1200-1300 lbs/acre

If we can be of further assistance please contact us in Price.

Sincerely,

Gary D. Moreau

Gary D. Moreau
District Conservationist
Price/Castle Dale Field Office

GM/lb

APPENDIX A

Additional Productivity Data from SCS

APPENDIX B

Maps 1 - 5