

**APPENDIX D8:
VEGETATION**

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EXHIBIT D8-2 Nichols Ranch Unit, Vegetation	Map Pocket

LIST OF ABBREVIATIONS AND ACRONYMS

GIS	Geographic information system
GPS	Global positioning system
ISR	In Situ Recovery
NRCS	Natural Resources Conservation Service
T&E	Threatened and endangered
TRC	TRC Environmental Corporation
USGS	U.S. Geological Survey
WDEQ/LQD	Wyoming Department of Environmental Quality, Land Quality Division

D8.1.0 INTRODUCTION

Baseline vegetation studies of the Nichols Ranch ISR Project area were conducted in June and July 2006 by TRC Environmental Corporation (TRC) in accordance with a vegetation study plan approved by the Wyoming Department of Environmental Quality, Land Quality Division (WDEQ/LQD) for noncoal project areas. The sampling design and methods used for the vegetation study followed Rule 1-V (revegetation performance standards): Noncoal Rules, Chapter 3 (WDEQ/LQD, amended April 25, 2006), WDEQ/LQD Guideline Number 2 (WDEQ/LQD 1997), and WDEQ/LQD Draft Guideline 2 Rewrite (WDEQ/LQD 2004).

The objectives of the vegetation study are: 1) to establish a detailed inventory of the premine vegetation characteristics within and adjacent to the project area; and 2) to provide baseline vegetation information for evaluating future reclamation success within the project area.

The information presented herein includes a description of the vegetation types and their distribution, species diversity, and composition; percent vegetative and percent total ground cover; and existing disturbances within the project area. Baseline data will be used to assess reclamation success during bond release.

The extended reference area concept was employed for this study.

D8.2.0 LOCATION

The Nichols Ranch ISR Project area is located in Campbell and Johnson Counties, Wyoming, and encompasses two production units--the Hank Unit and the Nichols Ranch Unit. The total project area encompasses approximately 3,370.53 acres in portions of Sections 7, 8, 17, 18, and 20, T43N, R76W (refer to Exhibit D8-1), and Sections 30 and 31, T44N, R75W, and Sections 5, 6, 7 and 8, T43N, R75W (refer to Exhibit D8-2). Access is by way of the Van Buggenum Road west from Wyoming Highway 50. The project area is within the 10- to 14-inch Northern Plains (10-14NP) zone of northeastern Wyoming (Natural Resources Conservation Service [NRCS] 1988). Topographic relief ranges from 5,055 to 5,209 ft above mean sea level in the Hank Unit and from 4,670 to 4,900 ft above mean sea level in the Nichols Ranch Unit. Annual precipitation varies from 10 to 14 inches, with approximately 35-41% falling during the normal growing season (NRCS 1988). Growth of native cool-season plants begins about April 1 and continues to about July 1. Growth of native warm-season plants begins about May 15 and continues to about August 15. According to Wyoming Gap data, two primary vegetation types occur in the project area--sagebrush shrubland and mixed grassland (Wyoming Gap Analysis 2000).

There are no perennial streams, ponds, or lakes in the project area. Cottonwood Creek, an ephemeral stream, is the main drainage in the Nichols Ranch Main Unit. Several springs with adjacent wetlands are located in the Cottonwood Creek drainage in the southeast corner of the Nichols Ranch Main Unit. Within the project area, Cottonwood Creek has been physically altered by local ranches, and a system of irrigation ditches has been constructed to supply water to the area for hay production; therefore, there is no defined bed/bank with a typical pool-riffle riverine system in the project area. Two ephemeral streams--Dry Willow Creek and Willow Creek--are the main drainages of the Hank Unit. Current land use in the project area is primarily livestock grazing, wildlife habitat, and coalbed methane and natural gas development.

D8.3.0 METHODS

Procedures used in conducting the vegetation studies followed Rule 1-V (revegetation performance standards): Noncoal Rules, Chapter 3 (WDEQ/LQD, amended April 25, 2006), WDEQ/LQD Guideline Number 2 (WDEQ/LQD 1997), and WDEQ/LQD Draft Guideline 2 Rewrite (WDEQ/LQD 2004).

Sampling included the collection of percent vegetative and total ground cover data. A plant species list was compiled (Addendum D8B), and searches were conducted within the project area for species of special concern, noxious weeds, and selenium indicator species. Premine sampling methods followed the requirements for using an extended reference area for postmine bond release studies.

D8.3.1 MAPPING

Vegetation communities, including wetlands (in accordance with U.S. Army Corps of Engineers 1987; Wetland Training Institute, Inc. 1995; refer to Appendix D10), were delineated in the field by TRC using U.S. Geological Survey (USGS) quadrangles and aerial photograph imagery and are presented on a 1 inch = 500 ft enlargement of the USGS 7.5' quadrangles (Dryfork Ranch, Rolling Pin Ranch, North Butte, and Fort Reno SE). Vegetation communities were based on dominant plant species (see Exhibits D8-1 and D8-2). Vegetation mapping included the project area and a 0.5-mi wide buffer adjacent to the project area. Photographs were taken of each vegetation community and are presented in Addendum D8A.

D8.3.2 SAMPLE SITE LOCATION

Sample sites were randomly selected using the ArcView 9.0 Hawth's tool in the geographic information system (GIS) for each vegetation community. The sample sites were downloaded into a handheld Trimble GeoExplorer global position system (GPS) unit and located in the field. Transect direction was determined by tossing a 12-inch spike in the air at each sample site. The

pointed end of the spike determined the transect direction. The locations of the randomly selected sample sites and the direction of each transect are presented on Exhibits D8-1 and D8-2.

D8.3.3 COVER

Vegetative cover by species for graminoides, grass-like species, forbs, subshrubs, shrubs, succulents, and other species (i.e., lichen) was determined along each of the 50-m long point-intercept transects within the sagebrush shrubland, mixed grassland, juniper outcrop, bottomland, and greasewood shrubland communities. Sampling was conducted July 18-25, 2006. Under the extended reference area concept, each vegetation community to be affected was sampled as one unit, with affected and unaffected areas combined according to the baseline sampling methodology outlined in WDEQ/LQD (1997, 2004, 2006). The point-intercept method was used to record primary and secondary hits (occurrences) of the current year's vegetative growth at 50 points spaced at 1-m intervals. Litter (previous years' growth or dead material), rock, and bare ground were also recorded along each transect. Sampling intensity and maximum sample size for each vegetation community was based on WDEQ/LQD Regulations (2004: Table D8-1). In accordance with the approved vegetation sampling plan, rock outcrop, wetlands, and disturbed lands were not sampled for cover. Each transect was analyzed as one sample (n), with primary hits used for total cover estimates (absolute) and for relative cover by species. Formulas used to calculate cover (absolute and relative) followed those presented in the WDEQ/LQD (1997) Guideline No. 2 and as revised in WDEQ/LQD Regulations (2004).

The following parameters were determined for each vegetation community:

- percent total vegetation cover (i.e., sum of all species),
- percent total ground cover (i.e., vegetation + litter + rock), and
- percent bare ground.

D8.3.4 STATISTICAL EVALUATIONS

Sample adequacy (i.e., Nmin) for vegetation cover was determined based on those tests outlined in WDEQ/LQD Guideline No. 2. The sample adequacy formula provided below was used to

determine the minimum number of sample points needed in the sage brush shrubland, mixed grassland, juniper outcrop, and bottomland. The number of sample points for the greasewood shrubland (15) was based on WDEQ/LQD (2004) Draft Guidelines and consultation with Stacy Page, WDEQ/LQD, in July 2006. A minimum of 20 cover transects were sampled prior to determining sample adequacy.

Sample Adequacy Formula:

$$N_{\min} = \frac{2(sz)^2}{(dx)^2}$$

where:

- Nmin = required size of the sample population
- s = sample standard deviation
- z = the z statistic (1.28)
- d = the acceptable amount of inherent variability between the sample mean and the true population (0.1)
- x = sample mean for cover

D8.3.5 SPECIES LIST

A plant species list was compiled during the vegetation mapping and sampling tasks. Plants are listed by scientific and common names and life form (i.e., annual grasses, perennial grasses, other grass-like species, annual and perennial forbs, succulents, subshrubs, full shrubs, and trees) for the project area. Plant species were identified and named using taxonomic keys including Dorn (1988), Beetle and Johnson (1996), Fertig et al. (1994), Hallsten et al. (1987), Stubbendieck et al. (1997), and Whitson et al. (1991). Plant species that could not be identified in the field were collected and taken to the Rocky Mountain Herbarium, University of Wyoming, for identification.

**D8.3.6 THREATENED AND ENDANGERED SPECIES, SPECIES OF CONCERN,
NOXIOUS WEEDS, AND SELENIUM INDICATOR SPECIES**

The vegetation study included a survey for plant species that are federally threatened and endangered (T&E), that are noxious weeds, and that are selenium indicators. The U.S. Fish and Wildlife Service was consulted concerning federal T&E species. In addition, a request was submitted to the Wyoming Natural Diversity Database, Laramie, Wyoming, for recorded occurrence of T&E species in and in the vicinity of the project area.

A list of prohibited, restricted, and declared weeds was obtained from the Wyoming Weed and Pest Council website at www.wyoweed.org. A list of selenium indicator plant species was obtained from WDEQ/LQD Guideline No. 2.

D8.4.0 RESULTS

Field mapping and sampling were conducted early summer 2006 and the results are included in this section. The types and acreages of each vegetation community/habitat type are presented in Table D8-1.

Construction of the two project production plants will occur in two vegetation communities--sagebrush shrubland and mixed grassland (see Exhibits D8-1 and D8-2). The other vegetation communities--juniper outcrop, bottomland, disturbed lands, and greasewood shrubland--and the one habitat type--rock outcrop--found in the project area may be disturbed by wells and pipelines and additional access roads. This assumes that the injection, recovery, and monitoring wells

Table D8-1 Vegetation/Habitat Types, Number of Acres, and Sampling Intensity, Nichols Ranch ISR Project, 2006.

Vegetation/ Habitat Type	Premine No. of Acres	Percent of Project Area	Estimated Affected Acres	Minimum Sample Size ¹	Adequate Sample Size (Nmin) ² for Vegetative Cover
Sagebrush shrubland	1,905.4	56.8	7	20	6.3
Mixed grassland	1,061.7	31.4	5	20	10.2
Juniper outcrop	148.3	4.4		20	28.2
Bottomland	125.1	3.7		20	16.5
Greasewood shrubland	64.4	1.9		15	12.2
Wetland	1.1	<0.1		Not sampled	--
Rock outcrop	17.5	0.5		Not sampled	--
Disturbed lands ³	42.3	1.2		Not sampled	--
Total	3,370.53	100	12 ⁴		

¹ Based on WDEQ/LQD (2004) and on approved sampling plan for the project submitted WDEQ/LQD prior to sampling.

² See Table D8-7.

³ Includes 8.3 acres of previously disturbed lands as evident by annual grasses and weeds and 8.8 mi (32.0 acres) of roads (30-ft wide disturbance).

⁴ Estimated disturbance from the two production plants. Disturbance from wells, pipelines, and additional access roads is unknown.

would be located over the uranium ore body and that the processing plants would be located as shown on Exhibits D8-1 and D8-2.

One additional vegetation community--wetlands--also occurs in the project area. Since this wetland community is located adjacent to a water of the U.S., it was determined to be jurisdictional and under the regulation of the U.S. Army Corp of Engineers. The wetland community was not sampled for cover; however, the boundary was delineated following the *Wetlands Delineation Manual* (U.S. Army Corps of Engineers 1987) so it could be avoided by project activities. A detailed description of the wetland community is presented in Appendix D10.

Photographs of each vegetation community within the project area are provided in Addendum D8A, the plant species list is provided in Addendum D-B, cover data for each transect are presented in Addendum D8C, and Addendum D8D presents correspondence with the USFWS and WNDD.

D8.4.1 MAPPING AND DESCRIPTION OF VEGETATION COMMUNITIES

Seven vegetation communities--sagebrush shrubland, mixed grassland, juniper outcrop, bottomland, greasewood shrubland, wetland, and disturbed lands--and one habitat type--rock outcrop--were identified within the project area (Exhibits D8-1 and D8-2). Approximately 40.3 acres (1.2%) of the 3,370.53-acre project area have been disturbed by coalbed methane and oil and gas development and existing access roads. The two production plants are expected to disturb a total of 12 acres primarily in the sagebrush shrubland and mixed grassland vegetation communities. The injection, recovery, and monitoring wells are expected to disturb unknown amounts of juniper outcrop, bottomland, greasewood shrubland, and rock outcrop areas. Wetlands will be avoided and will not be disturbed.

Tables D8-2 to D8-6 summarize the mean, absolute and relative cover by species, and life form for each vegetation community sampled. Tables D8C-1 to D8C-5 in Addendum D8C project

Table D8-2 Total Number of Hits, Mean, Percent Absolute Cover, and Percent Relative Vegetative Cover, Sagebrush Shrubland, Nichols Ranch ISR Project, 2006.

Vegetation Type/Species	Total No. of Primary Hits	Mean	Percent Absolute Cover	Percent Relative Vegetation Cover
Perennial Grass				
<i>Aristida purpurea longiseta</i>	2	0.10	0.2	0.4
<i>Bouteloua gracilis</i>	11	0.55	1.1	2.2
<i>Calamovilfa longifolia</i>	2	0.10	0.2	0.4
<i>Elymus spicatus</i>	9	0.45	0.9	1.8
<i>Elymus smithii</i>	6	0.30	0.6	1.2
<i>Koeleria macrantha</i>	14	0.70	1.4	2.8
<i>Poa secunda</i>	49	2.45	4.9	9.7
<i>Oryzopsis hymenoides</i>	2	0.10	0.2	0.4
<i>Stipa comata</i>	54	2.70	5.4	10.7
<i>Stipa viridula</i>	2	0.10	0.2	0.4
Subtotal	151	7.55	15.1	30.0
Annual Grasses				
<i>Festuca octoflora</i>	14	0.70	1.4	2.8
<i>Bromus japonicus</i>	24	1.20	2.4	4.8
<i>Bromus tectorum</i>	34	1.70	3.4	6.7
Subtotal	72	3.60	7.2	14.3
Other Grasslike Species				
<i>Carex filifolia</i>	65	3.25	6.5	12.9
Subtotal	65	3.25	6.5	12.9
Perennial Forb				
<i>Lygodesmia juncea</i>	2	0.10	0.2	0.4
<i>Psoralea tenuiflora</i>	1	0.05	0.1	0.2
Subtotal	3	0.15	0.3	0.6
Annual Forbs				
<i>Alyssum parvifolia</i>	21	1.05	2.1	4.2
<i>Lappula redowski</i>	1	0.05	0.1	0.2
<i>Plantago patagonia</i>	13	0.65	1.3	2.6
Subtotal	35	1.75	3.5	7.0

Table D8-2 (Continued)

Vegetation Type/Species	Total No. of Primary Hits	Mean	Percent Absolute Cover	Percent Relative Vegetation Cover
Subshrub				
<i>Artemisia frigida</i>	1	0.05	0.1	0.2
<i>Leptodactylon pungens</i>	2	0.10	0.2	0.4
<i>Gutierrezia sarothrae</i>	2	0.10	0.2	0.4
Subtotal	5	0.25	0.5	1.0
Succulent				
<i>Opuntia polyacantha</i>	6	0.30	0.6	1.2
Subtotal	6	0.30	0.6	1.2
Shrub				
<i>Artemisia cana</i>	1	0.05	0.1	0.2
<i>Artemisia tridentata wyomingensis</i>	164	8.20	16.4	32.5
<i>Cercocarpus montanus</i>	1	0.05	0.1	0.2
<i>Krascheninnikovia lanata</i>	2	0.10	0.2	0.4
Subtotal	168	8.40	16.8	33.3
Total No. of Vegetative Hits	505	25.25	50.5	100.3 ¹
% Vegetative Cover		50.50		
Litter	244	12.20	24.4	48.3
Rock	5	2.50	0.5	1.0
Subtotal	249	14.70	24.9	49.3
Total No. of Ground Cover Hits	754			
% Total Ground Cover		75.40		
Bare Ground No. of Hits	246	12.30		
% Bare Ground		24.60		

¹ May not total to 100 due to rounding.

Table D8-3 Total Number of Hits, Mean, Percent Absolute Cover, and Percent Relative Vegetative Cover, Mixed Grassland, Nichols Ranch ISR Project, 2006.

Vegetation Type/Species	Total No. of Primary Hits	Mean	Percent Absolute Cover	Percent Relative Vegetation Cover
Perennial Grass				
<i>Agropyron cristatum</i>	1	0.05	0.1	0.2
<i>Aristida purpurea longiseta</i>	1	0.05	0.1	0.2
<i>Bouteloua gracilis</i>	26	1.30	2.6	5.7
<i>Calamovilfa longifolia</i>	2	0.10	0.2	0.4
<i>Elymus spicatus</i>	9	0.45	0.9	2.0
<i>Elymus smithii</i>	15	0.75	1.5	3.3
<i>Koeleria macrantha</i>	13	0.65	1.3	2.8
<i>Poa secunda</i>	38	1.90	3.8	8.3
<i>Oryzopsis hymenoides</i>	2	0.10	0.2	0.4
<i>Stipa comata</i>	73	3.65	7.3	16.0
<i>Stipa viridula</i>	3	0.15	0.3	0.7
Subtotal	183	9.15	18.3	40.3
Annual Grasses				
<i>Festuca octoflora</i>	5	0.25	0.5	1.1
<i>Bromus japonicus</i>	8	0.40	0.8	1.8
<i>Bromus tectorum</i>	22	1.10	2.2	4.8
Subtotal	35	1.75	3.5	7.7
Other Grasslike Species				
<i>Carex filifolia</i>	162	8.10	16.2	35.4
Subtotal	162	8.10	16.2	35.7
Perennial Forb				
<i>Eriogonum</i> spp.	1	0.05	0.1	0.2
<i>Heterotheca villosa</i>	3	0.15	0.3	0.7
<i>Phlox hoodii</i>	1	0.05	0.1	0.2
<i>Psoralea tenuiflora</i>	4	0.20	0.4	0.9
<i>Sphaeralcea coccinea</i>	4	0.20	0.4	0.9
Unknown forb	1	0.05	0.1	0.2
<i>Yucca glauca</i>	1	0.05	0.1	0.2
Subtotal	15	0.75	1.5	3.3

Table D8-3 (Continued)

Vegetation Type/Species	Total No. of Primary Hits	Mean	Percent Absolute Cover	Percent Relative Vegetation Cover
Annual Forbs				
<i>Alyssum parvifolia</i>	7	0.35	0.7	1.5
<i>Plantago patagonia</i>	13	0.65	1.3	2.9
Unknown annual forb	1	0.05	0.1	0.2
Subtotal	21	1.05	2.1	4.6
Subshrub				
<i>Artemisia frigida</i>	2	0.10	0.2	0.4
<i>Leptodactylon pungens</i>	5	0.25	0.5	1.1
<i>Gutierrezia sarothrae</i>	2	0.10	0.2	0.4
Subtotal	9	0.45	0.9	1.9
Succulent				
<i>Opuntia polyacantha</i>	8	0.40	0.8	1.8
Subtotal	8	0.40	0.8	1.8
Shrub				
<i>Artemisia cana</i>	1	0.05	0.1	0.2
<i>Artemisia tridentata wyomingensis</i>	18	0.90	1.8	4.0
<i>Chrysothamnus viscidiflorus</i>	1	0.05	0.1	0.2
<i>Krascheninnikovia lanata</i>	1	0.05	0.1	0.2
Subtotal	21	1.05	2.1	4.6
Total No. of Vegetative Hits	454	22.7	45.4	99.9 ¹
% Vegetative Cover		45.40		
Litter	247	12.35	24.7	54.4
Rock	18	0.90	1.8	4.0
Subtotal	265	13.25	26.5	58.4
Total No. of Ground Cover Hits	719			
% Total Ground Cover		71.90		
Bare Ground No. of Hits	281	14.10		
% Bare Ground		28.10		

¹ May not total to 100 due to rounding.

Table D8-4 Total Number of Hits, Mean, Percent Absolute Cover, and Percent Relative Vegetative Cover, Juniper Outcrop, Nichols Ranch ISR Project, 2006.

Vegetation Type/Species	Total No. of Primary Hits	Mean	Percent Absolute Cover	Percent Relative Vegetation Cover
Perennial Grass				
<i>Bouteloua gracilis</i>	8	0.40	0.8	1.9
<i>Calamovilfa longifolia</i>	2	0.10	0.2	0.5
<i>Elymus cinereus</i>	12	0.60	1.2	2.9
<i>Elymus spicatus</i>	27	1.35	2.7	6.4
<i>Koeleria macrantha</i>	12	0.60	1.2	2.9
<i>Poa secunda</i>	4	0.20	0.4	1.0
<i>Poa</i> spp.	1	0.05	0.1	0.2
<i>Oryzopsis hymenoides</i>	8	0.40	0.8	1.9
<i>Stipa comata</i>	53	2.65	5.3	12.6
Unknown perennial grass	1	0.05	0.1	0.2
Subtotal	128	6.4	12.8	30.2
Annual Grasses				
<i>Bromus japonicus</i>	1	0.05	0.1	0.2
<i>Bromus tectorum</i>	33	1.65	3.3	7.8
Subtotal	34	1.70	3.4	8.0
Other Grasslike Species				
<i>Carex filifolia</i>	26	1.30	2.6	6.2
Subtotal	26	1.30	2.6	6.2
Perennial Forb				
<i>Achillea millefolium</i>	1	0.05	0.1	0.2
<i>Arenaria hookeri</i>	2	0.10	0.2	0.5
<i>Astragalus bisulcatus</i>	2	0.10	0.2	0.5
<i>Cirsium arvense</i>	2	0.10	0.2	0.5
<i>Chaenactis douglasii</i>	2	0.10	0.2	0.5
<i>Heterotheca villosa</i>	1	0.05	0.1	0.2
<i>Lupinus</i> spp.	1	0.05	0.1	0.2
<i>Phlox hoodsii</i>	1	0.05	0.1	0.2
<i>Psoralea tenuiflora</i>	9	0.45	0.9	2.1
<i>Sphaeralcea coccinea</i>	1	0.05	0.1	0.2
Unknown forb	1	0.05	0.1	0.2
Unknown aster	2	0.10	0.2	0.5
Subtotal	25	1.25	2.5	5.8

Table D8-4 (Continued)

Vegetation Type/Species	Total No. of Primary Hits	Mean	Percent Absolute Cover	Percent Relative Vegetation Cover
Annual Forbs				
<i>Alyssum parvifolia</i>	12	0.60	1.2	2.9
<i>Lappula redowski</i>	1	0.05	0.1	0.2
Subtotal	13	0.65	1.3	3.0
Subshrub				
<i>Artemisia frigida</i>	1	0.05	0.1	0.2
<i>Leptodactylon pungens</i>	2	0.10	0.2	0.5
<i>Gutierrezia sarothrae</i>	11	0.55	1.1	2.6
Subtotal	14	0.70	1.4	3.3
Succulent				
<i>Opuntia polyacantha</i>	2	0.10	0.2	0.5
Subtotal	2	0.10	0.2	0.5
Shrub				
<i>Artemisia tridentata</i> <i>wyomingensis</i>	100	5.00	10.0	23.8
<i>Chrysothamnus nauseosus</i>	1	0.05	0.1	0.2
<i>Chrysothamnus viscidiflorus</i>	1	0.05	0.1	0.2
<i>Krascheninnikovia lanata</i>	4	0.20	0.4	1.0
<i>Rhus trilobata</i>	1	0.05	0.1	0.2
<i>Symphoricarpos occidentalis</i>	3	0.15	0.3	0.7
Subtotal	110	5.50	11.0	25.9
Trees				
<i>Juniperus scopulorum</i>	67	3.35	6.7	15.9
<i>Pinus flexilis</i>	3	0.15	0.3	0.7
Subtotal	70	3.50	7.0	16.6
Total No. of Vegetative Hits	422	21.10	42.2	99.5 ¹
% Vegetative Cover		42.20		
Litter	131	6.55	13.1	31.1
Rock	147	7.35	14.7	34.9
Subtotal	278	13.90	27.8	65.8
Total No. of Ground Cover Hits	700			
% Total Ground Cover		70.00		
Bare Ground No. of Hits	300	15.00		
% Bare Ground		30.00		

¹ May not total to 100 due to rounding.

Table D8-5 Total Number of Hits, Mean, Percent Absolute Cover, and Percent Relative Vegetative Cover, Bottomland, Nichols Ranch ISR Project, 2006.

Vegetation Type/Species	Total No. of Primary Hits	Mean	Absolute Cover	Percent Relative Vegetation Cover
Perennial Grass				
<i>Bromus inermis</i>	38	1.90	3.8	7.0
<i>Distichlis stricta</i>	14	0.70	1.4	2.6
<i>Elymus intermedium</i>	8	0.40	0.8	1.5
<i>Elymus smithii</i>	217	10.85	21.7	40.2
<i>Hordeum jubatum</i>	25	1.25	2.5	4.6
<i>Koeleria macrantha</i>	2	0.10	0.2	0.4
<i>Poa secunda</i>	11	0.55	1.1	2.0
<i>Poa</i> spp.	6	0.30	0.6	1.1
<i>Sporobolus airoides</i>	1	0.05	0.1	0.2
Unknown perennial grass	3	0.15	0.3	0.6
Subtotal	325	16.25	32.2	60.2
Annual Grasses				
<i>Bromus tectorum</i>	86	4.30	8.6	15.9
Subtotal	86	4.30	8.6	15.9
Other Grasslike Species				
<i>Carex filifolia</i>	1	0.05	0.1	0.2
<i>Carex praegracilis</i>	4	0.20	0.4	0.7
<i>Equisetum</i> spp.	6	0.30	0.6	1.1
<i>Juncus balticus</i>	1	0.05	0.1	0.2
Subtotal	12	0.60	1.2	2.2
Perennial Forb				
<i>Achillea millefolium</i>	2	0.10	0.2	0.4
<i>Asclepias speciosus</i>	1	0.05	0.1	0.2
<i>Cirsium arvense</i>	10	0.50	1.0	1.9
<i>Grindellia squarosa</i>	2	0.10	0.2	0.4
<i>Melilotus officinalis</i>	1	0.05	0.1	0.2
Unknown forb	1	0.05	0.1	0.2
Unknown aster	6	0.30	0.6	1.1
Subtotal	23	1.15	2.3	4.4

Table D8-5 (Continued)

Vegetation Type/Species	Total No. of Primary Hits	Mean	Absolute Cover	Percent Relative Vegetation Cover
Annual Forbs				
<i>Alyssum parvifolia</i>	3	0.15	0.3	0.6
<i>Descurainia sophia</i>	8	0.40	0.8	1.5
<i>Kochia scoparia</i>	74	3.70	7.4	13.7
<i>Madia glomerata</i>	3	0.15	0.3	0.6
<i>Plantago patagonia</i>	1	0.05	0.1	0.2
Unknown annual forb	1	0.05	0.1	0.2
Subtotal	90	4.50	9.0	16.8
Subshrub				
<i>Artemisia frigida</i>	3	0.15	0.3	0.6
Subtotal	3	0.15	0.3	0.6
Shrub				
<i>Artemisia cana</i>	1	0.05	0.1	0.2
<i>Krascheninnikovia lanata</i>	0	0.00	0.0	0.0
Subtotal	1	0.05	0.1	0.2
Total No. of Vegetative Hits	540	27.00	54.0	100.3 ¹
% Vegetative Cover		54.00		
Litter	374	18.70	37.4	
Rock	0		0.0	
Subtotal	374	18.70	37.4	
Total No. of Ground Cover Hits	914			
% Total Ground Cover		91.40		
Bare Ground No. of Hits	86	4.30		
% Bare Ground		8.60		

¹ May not total to 100 due to rounding.

Table D8-6 Total Number of Hits, Mean, Percent Absolute Cover, and Percent Relative Vegetative Cover, Greasewood Shrubland, Nichols Ranch ISR Project, 2006.

Vegetation Type/Species	Total No. of Primary Hits	Mean	Percent Absolute Cover	Percent Relative Vegetation Cover
Perennial Grass				
<i>Bouteloua gracilis</i>	5	0.33	0.7	1.3
<i>Distichlis stricta</i>	1	0.07	0.1	0.2
<i>Elymus spicatus</i>	4	0.27	0.5	0.9
<i>Elymus smithii</i>	30	2.00	4.0	7.5
<i>Koeleria macrantha</i>	3	0.20	0.4	0.8
<i>Poa secunda</i>	22	1.47	2.9	5.5
<i>Oryzopsis hymenoides</i>	8	0.53	1.1	2.1
<i>Sporobolus airoides</i>	2	0.13	0.3	0.6
<i>Stipa comata</i>	18	1.20	2.4	4.5
Subtotal	93	6.2	12.4	23.4
Annual Grasses				
<i>Bromus japonicus</i>	3	0.20	0.4	0.8
<i>Bromus tectorum</i>	123	8.20	16.4	30.9
Subtotal	126	8.4	16.8	31.7
Other grasslike species				
<i>Carex filifolia</i>	30	2.00	4.0	7.5
Subtotal	30	2.00	4	7.5
Perennial Forb				
<i>Phlox hoodii</i>	2	0.13	0.3	0.6
<i>Sphaeralcea coccinea</i>	1	0.07	0.1	0.2
Unknown forb	3	0.20	0.4	0.8
Subtotal	6	0.40	0.8	1.6
Annual Forbs				
<i>Alyssum parvifolia</i>	26	1.73	3.5	6.6
<i>Kochia scoparia</i>	4	0.27	0.5	0.9
<i>Plantago patagonia</i>	13	0.87	1.7	3.2
Subtotal	43	2.87	5.7	10.7

Table D8-6 (Continued)

Vegetation Type/Species	Total No. of Primary Hits	Mean	Percent Absolute Cover	Percent Relative Vegetation Cover
Subshrub				
<i>Artemisia pedatifida</i>	14	0.93	1.9	3.6
Subtotal	14	0.93	1.9	3.6
Succulent				
<i>Opuntia polyacantha</i>	28	1.87	3.7	7.0
Subtotal	28	1.87	3.7	7.0
Shrub				
<i>Artemisia cana</i>	1	0.07	0.1	0.2
<i>Artemisia tridentata wyomingensis</i>	19	1.27	2.5	4.7
<i>Atriplex gardneri</i>	1	0.07	0.1	0.2
<i>Chrysothamnus viscidiflorus</i>	2	0.13	0.3	0.6
<i>Sarcobatus vermiculatus</i>	36	2.40	4.8	9.0
Subtotal	59	3.93	7.8	14.7
Total No. of Vegetative Hits	399	26.60	53.1	100.2 ¹
% Vegetative Cover		53.20		
Litter	166	11.07	22.1	41.6
Rock	0	0.00	0.0	0.0
Subtotal	166	11.10	22.1	41.6
Total No. of Ground Cover Hits	565			
% Total Ground Cover		75.33		
Bare Ground No. of Hits	185	12.33		
% Bare Ground		24.67		

¹ May not total to 100 due to rounding.

data by transect for each vegetation community sampled. The locations of trees are provided on Exhibits D8-1 and D8-2.

D8.4.1.1 Sagebrush Shrubland Community

The sagebrush shrubland community occurs on approximately 1,905.4 acres (56.8%) within the project area. This vegetation community generally occurs on loamy moderately deep soils on gently sloping uplands, upland ridges, shoulders, and hillslopes. Vegetation is dominated by Wyoming sagebrush (*Artemisia tridentata wyomingensis*) and perennial grasses--needle-and-thread (*Stipa comata*), Sandberg blue grass (*Poa secunda*), prairie junegrass (*Koeleria macrantha*), and blue grama (*Bouteloua gracilis*)--and annual grasses--six-weeks fescue (*Festuca octoflora*) and Japanese and downy brome (*Bromus japonicus* and *B. tectorum*). A grasslike species--threadleaf sedge (*Carex filifolia*)--is a dominate species in this community. Annual forbs such as alyssum (*Alyssum parvifolia*) and wooly plantain (*Plantago patagonia*) are more common in this community than any perennial forb. Several scattered cottonwood and juniper trees also occur in this community and are generally found growing along the drainages (see Exhibits D8-1 and D8-2).

D8.4.1.2 Mixed Grassland Community

The mixed grassland community occurs on approximately 1,061.7 acres (31.4%) within the project area. This vegetation community generally occurs on shallow sandy soils on upland ridges and gently sloping shoulders and hillslopes, as well as on nearly level uplands. Vegetation is mainly perennial grasses such as needle-and-thread, Sandberg bluegrass, blue grama, western wheatgrass (*Elymus smithii*), and bluebunch wheatgrass (*Elymus spicatus*) and grasslike species such as threadleaf sedge. Scurfpea (*Psoralea tenuiflora*), yucca (*Yucca glauca*), and globemallow (*Sphaeralcea coccinea*) are the common perennial forbs, and wooly plantain is the dominate annual forb in this community. Wyoming sagebrush and silver sagebrush (*Artemisia cana*) occur in scattered low-density stands throughout this community. Subshrubs such as fringed sage (*Artemisia fridiga*) and broom snakeweed (*Gutierrezia sarothrae*) occur throughout this community. No trees occur in this plant community.

D8.4.1.3 Juniper Outcrop Community

The juniper outcrop community occurs on approximately 148.3 acres (4.4%) within the project area. This community occurs on the side slope and top of North Middle Pumpkin Butte in the Hank Unit. Soils are generally shallow, with areas of deeper soils in swales. Areas of exposed bedrock, boulders, and gravel occur throughout this community. Rocky Mountain juniper (*Juniperus scopulorum*) and Wyoming sagebrush are the most visible species of this community and are scattered throughout the community. Perennial grasses include needle-and-thread, bluebunch wheatgrass, prairie junegrass, and Indian ricegrass (*Oryzopsis hymenoides*). Basin wildrye (*Elymus cinereus*) is common in the swales within this community. This community supports a wide diversity of perennial forb and shrub species (refer to Table D8-4) due to the numerous microhabitats created by the various soil depths and moisture and rock outcrop areas. Skunkbush (*Rhus trilobata*), snowberry (*Symphoricarpos occidentalis*), Rocky Mountain juniper, and limber pine (*Pinus flexilis*) occur only in this vegetation community.

D8.4.1.4 Bottomland Community

The bottomland community occurs on approximately 125.1 acres (3.7%) within the Nichols Ranch Unit of the project area adjacent Cottonwood Creek. Currently, this community is used for livestock grazing, but historically this community has been managed for hay production. In the project area, Cottonwood Creek has no defined channel. The drainage in the area has been modified by a system of irrigation canals that meander throughout this vegetation community. The vegetation is composed of grasses and forbs, with scattered mature or dead plains cottonwood (*Populus deltoides*) trees ranging from 20 to 60 ft tall. A significant portion of the bottomland community includes weedy annuals such as kochia (*Kochia scorparia*), flixweed tansymustard (*Descurainia sophia*), and Canada thistle (*Cirsium arvense*). Perennial grasses include western wheatgrass, smooth brome (*Bromus inermis*), inland saltgrass (*Distichlis stricta*), foxtail barley (*Hordeum jubatum*), Sandberg bluegrass, and several hybrid wheatgrass, fescue, and bluegrass species. Portions of the bottomland community in and adjacent irrigation canals generally support a higher percentage of sedges such as Baltic rush (*Juncus balticus*),

clustered field sedge (*Carex praegracilis*), and horsetails (*Equisetum* spp.). Scattered cottonwood trees occur in this community (see Exhibit D8-2).

D8.4.1.5 Greasewood Shrubland Community

The greasewood shrubland community occurs on approximately 64.4 acres (1.9%) within the Nichols Ranch Unit of the project area. Of the vegetation types delineated in the project area, greasewood (*Sarcobatus vermiculatus*), Gardner's saltbush (*Atriplex gardnerii*), and birdfoot sage (*Artemisia pedatifida*) occur exclusively in the greasewood shrubland community. Perennial grasses include Sandberg bluegrass, western wheatgrass, alkali sacaton (*Sporobolus airoides*), and needle-and-thread. Downy brome and prickly pear cactus (*Opuntia polyacantha*), both invasive species, are prevalent in this community.

D8.4.1.6 Wetland Community

The wetland community occurs on approximately 1.1 acres (<0.1%) within the Nichols Ranch Unit of the project area. A detailed description of this community is presented in Appendix D10. The wetland community was not sampled for cover.

D8.4.1.7 Rock Outcrop Habitat

The rock outcrop habitat occurs on approximately 17.5 acres (0.5%) within the project area. This habitat type is scattered throughout the project area as small inclusions generally occurring on the sides of exposed ridgetops, is composed of rocks, and is void of vegetation. Rock outcrop habitat was not sampled for cover.

D8.4.1.8 Disturbed Lands

Approximately 42.3 acres (1.2%) of the project area have been disturbed and reclaimed or are currently disturbed by coalbed methane development activities and existing access roads. This total includes 8.3 acres of previously disturbed lands, as evidenced by annual grasses and weeds

and 9.4 mi (32.0 acres) of roads (30-ft wide disturbance). Prior to disturbance, vegetation in these areas was probably similar to that of the vegetation communities immediately adjacent to the disturbed areas. Vegetated disturbed lands include monocultures of Japanese brome, downy brome, and crested wheatgrass (*Agropyron cristatum*). The disturbed lands community was not sampled for cover.

D8.4.2 COVER

Cover data were collected in accordance with the methods presented in Section D8.3.3, and the cover data results are summarized in Tables D8-2 to D8-6. Results of percent absolute and relative vegetative cover and total ground cover by life form and species for each transect are presented in Addendum D8C. Cover transect data was not collected from the wetland, rock outcrop, or disturbed land types.

D8.4.2.1 Sagebrush Shrubland Community

Absolute and relative cover by species and life form for the sagebrush shrubland is presented in Table D8-2. The mean vegetative cover in this community is 50.5%, and the mean total ground cover is 75.4%, with litter contributing an average 12.2% of the ground cover. Bare ground ranges from 12 to 32% and averaged 12.3%. The relative vegetative cover within this community averages approximately 30.0% perennial grasses, 14.3% annual grasses, 12.9% grasslike species (i.e., sedges), 0.6% perennial forbs, 7.0% annual forbs, 1.0% shrubs, 33.3% shrubs, and 1.2% succulents (refer to Table D8-2). Wyoming sagebrush is the dominant species of this vegetation community. Representative photographs of the sagebrush shrubland community are presented in Addendum D8A. The photograph locations are identified in Exhibits D8-1 and D8-2, and cover data for each transect are presented in Addendum D8C, Table D8C-1.

D8.4.2.2 Mixed Grassland Community

Absolute and relative cover by species and life form for the mixed grassland community is presented in Table D8-3. The mean vegetative cover in this community is 45.4%, and the mean total ground cover is 71.9%, with litter contributing an average 12.3% of the ground cover. Bare ground ranges from 6 to 42% and averaged 28.1%. Relative vegetative cover averages approximately 40.3% perennial grasses, 7.7% annual grasses, 35.7% grasslike species (i.e., sedges), 3.3% perennial forbs, 4.6% annual forbs, 1.9% subshrubs, 4.6% shrubs, and 1.8% succulents (refer to Table D8-3). Threadleaf sedge is the dominate species of this vegetation community. Representative photographs of the mixed grassland community are presented in Addendum D8A, and cover data for each transect are presented in Addendum D8C, Table D8C-2.

D8.4.2.3 Juniper Outcrop Community

Absolute and relative cover by species and life form for the juniper outcrop community is presented in Table D8-4. The mean vegetative cover in this community is 42.2%, and the mean total ground cover is 70.0%, with rock and litter contributing an average 13.9% of the ground cover. Bare ground ranged from 14 to 68% and averaged 30%. The relative vegetative cover averages approximately 30.2% perennial grasses, 8.0% annual grasses, 6.2% grasslike species (i.e., sedges), 5.8% perennial forbs, 3.0% annual forbs, 3.3% subshrubs, 25.9% shrubs, 16.6% trees, and 0.5% succulents (refer to Table D8-4). Rocky Mountain juniper, Wyoming sagebrush, and needle-and-thread are the dominant species. Representative photographs of the juniper outcrop community are presented in Addendum D8A, and cover data for each transect are presented in Addendum D8C, Table D8C-3.

D8.4.2.4 Bottomland Community

Absolute and relative cover by species and life form for the bottomland is presented in Table D8-5. The mean vegetative cover in this community is 54.0%, and the mean total ground cover is 91.4%, with litter contributing an average 18.7% of the ground cover. Bare ground

ranges from 0 to 22% and averages 8.6%. Relative vegetative cover within this community averages approximately 60.2% perennial grasses, 15.9% annual grasses, 2.2% grasslike species (i.e., sedges), 4.4% perennial forbs, 16.8% annual forbs, 0.6% subshrubs, and 0.2% shrubs (refer to Table D8-5). Although cottonwood trees are scattered throughout the bottomland community, none occurred in the cover transects. Representative photographs of the bottomland community are presented in Addendum D8A, and cover data for each transect are presented in Addendum D8C, Table D8C-4.

D8.4.2.5 Greasewood Shrubland Community

Absolute vegetative cover within the greasewood shrubland community averages 53.2% (refer to Table D8-6). Total ground cover averages 75.3%, with litter comprising 11.1% of the ground cover. Bare ground ranges from 0% to 58% and averages 24.7% (refer to Table D8-6). The relative vegetative cover within this community averages approximately 23.4% perennial grasses, 31.7% annual grasses, 7.5% grasslike species (i.e., sedges), 1.6% perennial forbs, 10.7% annual forbs, 3.6% subshrubs, 14.7% shrubs, and 7.0% succulents (refer to Table D8-6). Representative photographs of the greasewood shrubland community are presented in Addendum D8A, and cover data for each transect are presented in Addendum D8C, Table D8C-5.

D8.4.3 STATISTICAL EVALUATIONS

Sample adequacy for cover was achieved for four of the five sampled vegetation communities in accordance with the WDEQ/LQD Guideline No. 2. Sample adequacy was not achieved in the juniper outcrop community. Table D8-7 presents a summary of the statistical evaluation for the percent cover.

Table D8-7 Summary of Statistical Evaluation for Percent Cover for Five Vegetation Communities, Nichols Ranch ISR Project, 2006.

Transect	Sagebrush Shrubland		Mixed Grassland		Juniper Outcrop		Bottomland		Greasewood Shrubland	
	Vegetative Cover (%)	Total Cover (%)								
1	56	80	24	64	40	82	82	100	40	48
2	46	72	56	80	44	78	62	90	66	88
3	52	84	36	68	50	84	46	96	46	100
4	38	70	56	94	48	74	64	98	48	84
5	48	78	42	66	58	76	44	82	46	80
6	44	68	56	72	22	44	62	94	54	60
7	62	76	52	78	20	32	42	92	34	42
8	52	72	44	64	50	62	56	98	48	72
9	44	72	46	72	60	86	68	94	54	74
10	54	80	44	62	68	82	56	98	68	86
11	66	84	44	74	34	72	42	96	62	86
12	44	68	50	76	36	76	48	88	50	84
13	58	76	44	68	40	60	42	82	58	86
14	46	68	44	74	52	80	58	92	70	78
15	46	70	46	70	42	84	40	84	54	62
16	54	88	58	84	40	74	74	98		
17	50	70	40	60	24	74	56	86		
18	46	80	38	58	40	56	38	78		
19	58	78	46	62	42	64	52	90		
20	46	74	42	92	34	60	50	92		
Mean	50.5	75.4	45.4	71.9	42.2	70.0	54.1	91.4	53.2	75.3
St Dev	7.02	5.95	8.03	10.07	12.38	14.22	12.13	6.33	10.28	15.98
d	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
z	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
Nmin	6.3	2.0	10.2	6.4	28.2	15.8	16.5	1.4	12.2	14.7
n	20	20	20	20	20	20	20	20	15	15
CI	n/a	n/a	n/a	n/a	42.2±4.56	n/a	n/a	n/a	n/a	n/a

D8.4.4 SPECIES LIST

The list of plant species identified in the project area is presented in Addendum D8B. The number of species by life form and number of species greater than 2% relative cover for each vegetation community sampled is presented in Table D8-8.

D8.4.5 THREATENED AND ENDANGERED SPECIES, NOXIOUS WEEDS, AND SELENIUM INDICATOR SPECIES

No T&E plant species were observed, nor are any T&E plant species known to occur within the project area.

Based on the *Wyoming Weed and Pest Control Act* designated list (W.S.11-5-102 (a) (xi) and W.S.11-12-104), Canada thistle (*Cirsium arvense*) is the only prohibited and designated noxious weed species observed on the project area. Plants are concentrated around well pads and in the bottomland community where cattle tend to congregate. None of these areas are greater than 3 acres in size. No other declared weed species that are listed for Campbell or Johnson Counties (W.S.11-5-102 (a) (vii) and W.S.11-5-102(a)(viii)) occur in the project area.

One selenium indicator species, two-groove milkvetch (*Astragalus bisulcatus*), was observed within the project area. This species was observed primarily in small groups growing along the sides of several access roads. Species were verified at the Rocky Mountain Herbarium, University of Wyoming, Laramie.

Table D8-8 Species Composition and Species Diversity, Nichols Ranch ISR Project, 2006.

Lifeform	Sagebrush Shrubland			Mixed Grassland			Juniper Outcrop			Bottomland ¹			Greasewood Shrubland		
	Total No. Species	No. Species >2% Relative Cover	No. Species >2% Relative Cover	Total No. Species	No. Species >2% Relative Cover	No. Species >2% Relative Cover	Total No. Species	No. Species >2% Relative Cover	No. Species >2% Relative Cover	Total No. Species	No. Species >2% Relative Cover	No. Species >2% Relative Cover	Total No. Species	No. Species >2% Relative Cover	No. Species >2% Relative Cover
Perennial Grasses	10	4	4	11	6	6	10	4	4	10	5	5	9	4	4
Annual Grasses	3	3	1	3	1	1	2	1	1	1	1	1	2	1	1
Other Grass-like Species	1	1	1	1	1	1	1	1	1	4	0	0	1	1	1
Perennial Forbs	2	0	0	7	0	0	11	1	1	7	0	0	3	0	0
Annual Forbs	3	1	1	3	1	1	2	1	1	6	1	1	3	2	2
Subshrubs	3	0	0	3	0	0	3	1	1	1	0	0	1	1	1
Succulents	1	0	0	1	0	0	1	0	0	0	0	0	1	1	1
Shrubs	4	1	1	4	1	1	6	1	1	1	0	0	5	2	2
Trees	0	0	0	0	0	0	2	1	1	0	0	0	0	0	0

¹ Trees occur in bottomland; however, none of the randomly located sample point transects resulted in a hit.

D8.5.0 CONCLUSIONS

This vegetation study provides baseline data for a noncoal large or regular permit application, and was conducted in accordance with a study plan approved by WDEQ/LQD. This information will be used in the future by WDEQ/LQD to assess reclamation success. The methods used in this study comply with those outlined in WDEQ/LQD Guideline No. 2 for vegetation mapping, sampling, and statistical evaluation.

D8.6.0 LITERATURE CITED

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