APPLICATION FOR USNRC SOURCE MATERIAL LICENSE
MOORE RANCH URANIUM PROJECT
CAMPBELL COUNTY, WYOMING

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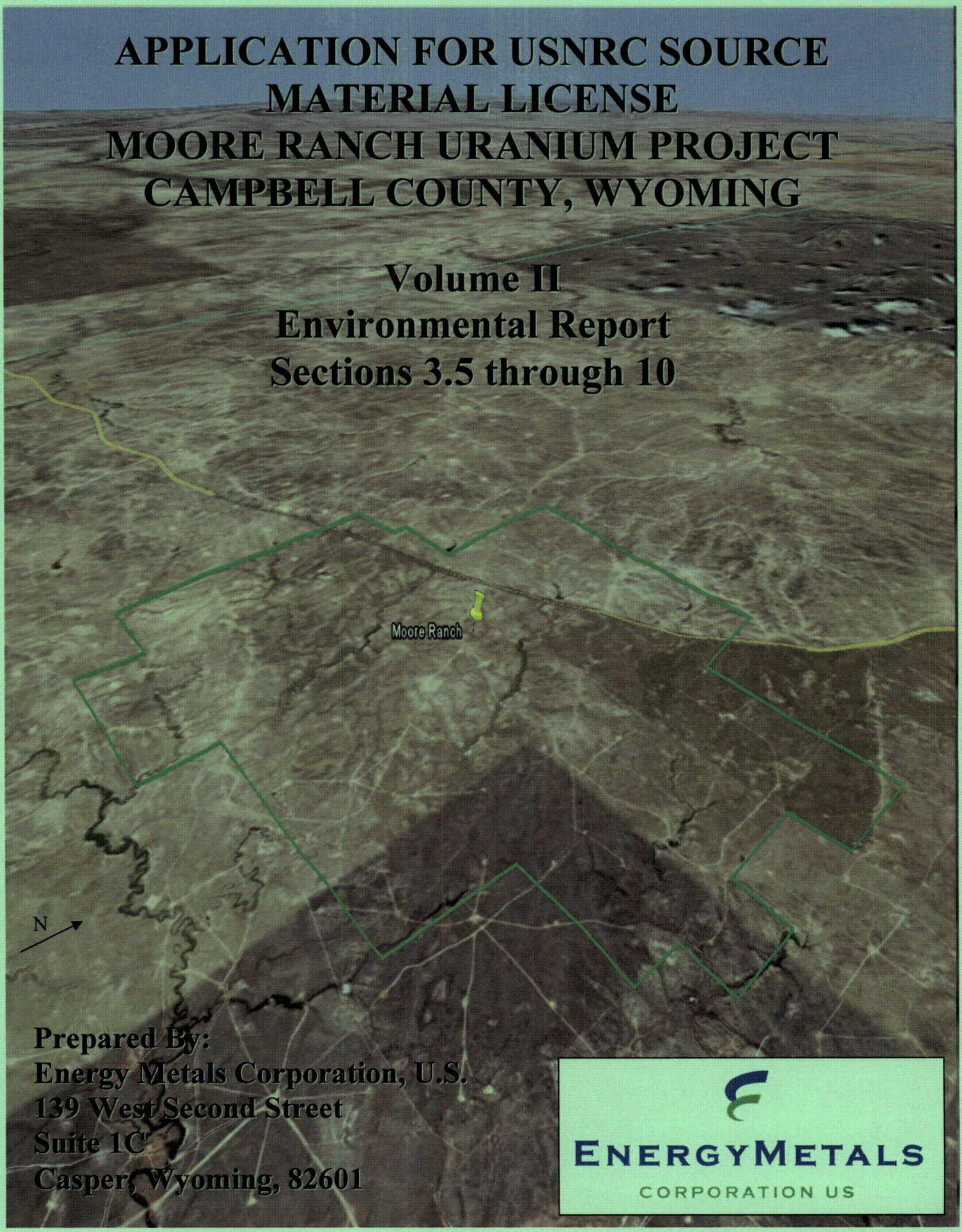
Sections 3.5 through 10



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3.5 ECOLOGICAL RESOURCES

3.5.1 Introduction

This section describes the existing ecological resources within the Moore Ranch Project area. The analysis consisted of a review of documents, databases, and reports in conjunction with field surveys.

All vegetation sampling procedures were designed according to the Wyoming Department of Environmental Quality – Land Quality Division (WDEQ-LQD) Rules and Regulations for Non-Coal Permitting, Guideline 2 (November 1997), and the methodology approved by the WDEQ-LQD.

The wetland surveys were conducted in accordance with the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region. All Other Waters of the United States (OWUS) (40 CFR –Part 404) were also assessed during the surveys. The routine wetland delineation approach with onsite inspection was utilized, and the survey was conducted by pedestrian reconnaissance and color infra-red (CIR) photography. Identification of potential wetlands was based on visual assessment of vegetation and hydrology indicators, as well as intrusive soil sampling to determine the presence of wetland criteria indicators. United States Army Corps of Engineers (USACE) Data Forms-Great Plains Region (Draft), were utilized for each observation point. Hydrology and soils were evaluated whenever a plant community type met hydrophytic vegetation parameters based on the Dominance Test and Prevalence Index (as defined by the USACE Great Plains Regional Supplement), or whenever indicators suggested the potential presence of a seasonal wetland area under normal circumstances.

Background information on wildlife in the vicinity of the Moore Ranch Project was obtained from several sources, including the South Powder River Basin Coal FEIS (BLM 2003a), records from the Wyoming Game and Fish Department (WGFD), Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS), and the U.S. Forest Service (USFS), and personal contact with biologists from those four agencies. Site-specific data for the Moore Ranch Project general analysis area were obtained from several sources, including WDEQ/LQD mine permit applications and annual wildlife monitoring reports for the various applicants and the neighboring Bates Creek, Cutthroat, and Rainbow CBM projects. Due to its proximity to existing mines, the proposed project area has also received extensive coverage during baseline and annual wildlife monitoring surveys for nearly 4 years. Both types of wildlife surveys encompass a large perimeter around mine permit areas. Consequently, all but the southeastern and extreme western sections have been included in multiple baseline studies and annual wildlife monitoring

efforts associated with the Bates Creek, Cutthroat, and Rainbow coal bed methane (CBM) activities.

3.5.2 Regional Setting

The Moore Ranch Project is within the mixed grass eco-region of the Northern Great Plains (EPA 1993). The elevation within the proposed Moore Ranch License Area (License area) ranges from approximately 5,220 to 5,391 feet above mean sea level (AMSL). Topography in that area is primarily level to gently rolling, though numerous prominent ephemeral drainages dissect the site. Similar terrain characterizes un-mined lands surrounding the License area.

The License area is comprised primarily of grassland with areas of sage in the southwest corner. Interspersed among those major communities are less abundant habitat types of seeded grasslands (improved pastures) and ephemeral draws.

No perennial streams or other permanent water bodies exist within the proposed License area. The majority of the area is drained to the south by Pine Tree Draw and Simons Draw tributaries of Ninemile Creek, which is a tributary of the perennial Antelope Creek. All natural flow in the region is categorized as intermittent or ephemeral. A few stock tanks and reservoirs were scattered throughout the area, though the reservoirs rarely contained water.

Trees were quite limited on the License area and consisted primarily of the plains cottonwood (*Populus deltoides*), peachleaf willow (*Salix amygdaloides*), and Russian-olive (*Elaeagnus angustifolia*). Most occurred alone or in small stands of fewer than five trees beside reservoirs or in drainage bottoms.

The License area is all private lands used for sheep grazing as the principal land use in the region for many years, although conventional oil and gas production has also had a long-term presence in the area. More recently, CBM activities, and their associated infrastructure, have become prominent across the landscape both within and surrounding the proposed License area.

3.5.3 Climate

The proposed Moore Ranch Project is located in a semi-arid or steppe climate. The region is characterized seasonally by cold harsh winters, hot dry summers, relatively warm moist springs and cool autumns. Temperature extremes range from roughly -25° F in the winter to 100° F in the summer. The "last freeze" occurs during late May and the "first freeze" mid-to-late September.

Yearly precipitation totals are typically near 10 inches. The region is prone to severe thunderstorm events throughout the spring and early summer months and much of the precipitation is attributed to these events. In a typical year, the area will see 4 or 5 severe thunderstorm events (as defined by the National Weather Service criteria) and 40 to 50 thunderstorm days. Autumn stratiform rain events also contribute to precipitation totals, but to a lesser degree than those before mentioned. Snow frequents the region throughout winter months (40-50 in / year), but provides much less moisture than rain events.

Windy conditions are fairly common to the area. Nearly 5% of the time hourly wind speed averages exceed 25 mph. The predominant wind direction is west/southwest with the wind blowing out of that direction 20% of the time. A north/northwest secondary mode is also present. Surface wind speeds are relatively high all year-round, with hourly averages 11 - 15 mph. Higher average wind speeds are encountered during the winter months while summer months experience lower average wind speeds.

3.5.4 Baseline Data

Ecological studies including baseline flora and fauna data were collected to fulfill the objectives specified in USNRC NUREG-1569, *Standard Review Plan for In situ Leach Uranium Extraction License Applications.* Ecological surveys were also conducted in accordance with applicable WDEQ-LQD, WGFD, and USFWS established guidelines. These agencies were consulted accordingly during development of survey plans to ensure adequate objectives, methodologies, and survey techniques were utilized.

Vegetation and wetland surveys were conducted by BKS Environmental Associates (BKS) of Gillette Wyoming during the spring/summer of 2007. Wildlife surveys were conducted by Thunderbird, Jones and Stokes of Gillette during the fall of 2006 through the summer of 2007.

The following sections were developed from the final survey reports completed by BKS and Thunderbird, Jones and Stokes.

3.5.5 Terrestrial Ecology

3.5.5.1 Vegetation

3.5.5.1.1 Survey Methodology

General

All sampling procedures were designed according to the WDEQ-LQD Rules and Regulations for Non-Coal Permitting, Guideline 2 (November 1997), and the methodology approved by the WDEQ.

Areas with sheep present were avoided by BKS during sampling by request of the land owner and, for this reason, numerical order of sampling points was not possible.

Mapping

Four different plant communities were identified for this area, i.e., Meadow Grassland, Upland Grassland, Agricultural Grassland, Big Sagebrush Shrubland, using 2001 CIR aerial photography, which was verified by field survey.

Transect Origin Selection

A computerized systematic grid (through ArcGIS) was used to randomly locate sample points within each vegetation community. These computer generated random numbers were then uploaded to a hand-held Garmin Global Positioning System (GPS) unit for actual location in the field.

Cover

A sample size of 20 50-meter point-intercept cover transects were sampled within the Meadow Grassland, Upland Grassland, and Big Sagebrush Shrubland and 22 50-meter point-intercept cover transects were sampled within the Agricultural Grassland for a total of 82 cover points in the License area.

In the vegetation communities, each 50-meter transect represented a single sample point. Percent cover measurements were taken from point-intercepts at 1-meter intervals along a 50-meter transect. Transects that exceeded the boundaries of the vegetation community being sampled were redirected back into its vegetation community at a 90 degree angle from the original transect direction at the point of intercept. In instances where a 90

degree angle of reflection did not place the transect within the sampled community, a 45 degree angle of reflection was used. Each point-intercept represents 2% towards cover measurements.

Percent cover measurements record "first-hit" point-intercepts by live foliar vegetation species, litter, rock, or bare ground. Multiple hits on vegetation were recorded, but used only for the purpose of constructing a plant species list for each plant community.

Species Composition

A list of plant species encountered during 2007 quantitative sampling is compiled in Addendum 3.5-A by vegetation community type for each of the three wellfield areas. The species list includes plant species sampled in cover transects as well as plant species observed along the belt transect. Plant names in the *Rocky Mountain Vascular Plants of Wyoming* (Dorn, 3rd Edition) were utilized.

Total Vegetation Cover

Vegetation cover data was recorded by species, using first hit data. All point intercepts of living vegetation and growth produced during the current growing season was counted toward total vegetation cover. Total vegetation cover measurements were expressed in absolute percentages for each sample point. Percent vegetation cover is the vertical projection of the general outline of plants to the ground surface. Cover summaries for each vegetation community are contained in Addendum 3.5-B.

Total Ground Cover

Total ground cover data was recorded by live vegetation, litter, rock, or bare ground. Litter includes all organic material that is dead including manure. Rock fragments were recorded when equal to or greater than 2 centimeters in size (i.e., sheet flow, minimum non-erodable particle size). Total ground cover measurements were expressed in absolute percentages for each sample point. Total ground cover equals the sum of cover values for percent vegetation, percent litter, and percent rock.

Shrub Density

Even though shrub density sampling is not required for non-coal sites, this data was taken at the time of cover sampling to ensure adequate use of field time. Summarization of that data can be found in Addendum 3.5-C. This area is not part of any wildlife critical winter range; thus, shrub density information is not necessary.

Extended Reference Area

The Extended Reference Area (EXREFA) is a native land unit used to evaluate revegetation success on portions of the same native plant community that was affected by the mining operation. For this study area, the mining operation will affect the four plant communities, Meadow Grassland, Upland Grassland, Agricultural Grassland, and Big Sagebrush Shrubland. All areas of these communities not affected by mining activities will serve as the EXREFA. The EXREFA will be as large as practical, at least 2 acres, considering land ownership patterns and land management history.

3.5.5.1.2 Vegetation Survey Results

Mapping

The total estimated acreage for the disturbed area is 7,104.1 acres. Of these acres, the Meadow Grassland community was 323.5 acres (4.55%), the Upland Grassland community was 5,008.9 acres (70.51%), the Agricultural Grassland community was 931.6 acres (13.11%), and the Big Sagebrush Shrubland was 707.78 acres (9.96%). Areas with disturbance were 132.3 acres, 1.86%. Refer to Table 3.5-1 below for acreage of each vegetation community by License area acreage, and ½ mile buffer acreage. Refer to Figure 3.5.5-1 (Addendum 3.5-D) showing vegetation community mapping units for the Moore Ranch Project Area.

Table 3.5-1. Acreage and Percent of Total Area for Each of the Mapping Units.

	License Area	% of Area	½ Mile Buffer Area	% of Area
Mapping Units				
Meadow Grassland	323.5	4.55	146.0	2.97
Upland Grassland	5,008.9	70.51	3,841.2	78.25
Agricultural Grassland	931.6	13.11	315.3	6.42
Big Sagebrush Shrubland	707.8	9.96	572.6	11.66
Disturbance	132.3	1.86	34.1	0.69
TOTAL	7,104.1		4,909.1	

General

The EXREFA will remain unaffected over the course of the mining operation and will be used to evaluate revegetation success. The EXREFA will include portions of the same

native plant community that was affected by the mining operation but located outside those disturbed areas and within the License boundary.

3.5.5.1.3 Meadow Grassland

Cover

The Meadow Grassland plant community comprised 323.5 of the 7,104.1 acres of the License area (4.55%). Twenty cover transects were sampled for this community. Absolute total vegetation cover was 80.90%. Absolute bare soil and litter/rock percentages were 5.20% and 13.90%, respectively. Absolute total ground cover was 94.80%. *Elymus smithii* (western wheatgrass), provided the highest relative vegetation cover at 23.73%, while *Bromus inermis* (smooth brome) provided the next highest relative vegetation cover at 9.64%. Refer to Table 3.5-2 below for the absolute cover values.

Table 3.5-2. 2007 Absolute Cover for the Meadow Grassland Plant Community.

Vegetation Parameter	Mean
Absolute Total Vegetation Cover (%)	80.90
Absolute Total Cover (%)	94.80

Sample Adequacy

There were 20 samples taken in the Meadow Grassland plant community. The sample adequacy formula outlined in WDEQ-LQD Guideline 2 was utilized to determine the minimum required size of the sample population. The Meadow Grassland met sample adequacy. Refer to Table 3.5-3 below for sample adequacy values.

Table 3.5-3. Summary of Sample Adequacy Calculations for % Vegetation Cover in the Meadow Grassland.

	Mean	Standard Deviation	Sample Adequacy	Actual Sample #	Z-Value	Confidence Level Achieved
Mapping Unit						
Meadow Grassland						
Total Vegetation Cover	80.90	6.37	4.06	20.00	4.02	99.99
Total Ground Cover	94.80	6.33	2.92	20.00	4.74	99.99

Species Composition

Species composition for the Meadow Grassland plant community was dominated by cool season perennial grasses with 58.84% relative cover, followed by perennial forbs with 16.19% relative cover. Annual grasses had 11.62% relative cover. Annual and biennial forbs had 11.74% and 0.25% relative cover, respectively. Full and sub-shrubs had a total of 1.01% relative cover. Succulents had 0.12% relative cover. The annual grasses for this area were mainly cheatgrass brome and *Bromus japonicus*, Japanese brome. The cool season perennial grasses were mainly western wheatgrass and smooth brome. Perennial forbs were dominated by *Achillea millefolium* (western yarrow), *Vicia americana* (American vetch), and *Taraxacum officinale* (common dandelion). Annual and biennial forbs included *Alyssum desertorum* (alyssum), *Lappula redowskii* (beggar's tick), and *Chenopodium berlandieri* (pitseed goosefoot). Present shrubs/subshrubs were *Artemisia ludoviciana* (Louisiana sagewort) and *Artemisia cana* (silver sagebrush). Also present were mushroom species and *Opuntia polyacantha* (plains prickly pear). Refer to Table 3.5-4 for relative Meadow Grassland cover summary and Addendum 3.5-B for a complete Meadow Grassland cover summary.

Table 3.5-4. Vegetation Cover Sampling Data Summary of Species by Lifeform for the Meadow Grassland Community. All values are means.

	Vegetation Cover	
	Absolute	**Relative (%)**
Annual Grasses		
Total	9.40	11.62
Cool Season Grasses		
Total	47.80	59.09
Annual/Biennial Forbs		
Total	9.50	11.74
Perennial Forbs		
Total	13.10	16.19
Perennial Shrubs		
Total	0.60	0.74
Perennial Sub-Shrubs		
Total	0.40	0.49
Succulents		
Total	0.10	0.12

3.5.5.1.4 Upland Grassland

Cover

The Upland Grassland plant community comprised 5,008.9 of the 7,104.1 acres of the License area (70.51%). Twenty cover transects were sampled for this community. Absolute total vegetation cover was 63.50%. Absolute bare soil and litter/rock percentages were 12.30% and 19.50%, respectively. Absolute total ground cover was 87.90%. Western wheatgrass provided the highest relative vegetation cover at 23.33%. *Carex filifolia*, threadleaf sedge, provided the next highest cover at 16.94%. Refer to Table 3.5-5 below, for the absolute cover values.

Table 3.5-5. 2007 Absolute Cover for the Upland Grassland Plant Community.

Vegetation Parameter	Mean
Absolute Vegetation Cover (%)	63.50
Absolute Total Cover (%)	87.90

Sample Adequacy

There were 20 samples taken in the Upland Grassland plant community. The sample adequacy formula outlined in WDEQ-LQD Guideline 2 was utilized to determine the minimum required size of the sample population. The Upland Grassland met sample adequacy. Refer to Table 3.5-6 below for sample adequacy values.

Table 3.5-6. Summary of Sample Adequacy Calculations for % Vegetation Cover in the Upland Grassland.

	Mean	Standard Deviation	Sample Adequacy	Actual Sample #	Z-Value	Confidence Level Achieved
Mapping Unit						
Upland Grassland						
Total Vegetation Cover	63.50	11.65	22.55	20.00	1.70	95.54
Total Ground Cover	87.90	6.15	3.21	20.00	4.52	99.99

Species Composition

Species composition for the Upland Grassland plant community was dominated by cool season perennial grasses with 54.01% relative cover, followed by annual forbs with 19.97% relative cover. Annual grasses and warm season perennial grasses had 12.95% and 3.68% relative cover, respectively. Shrubs and subshrubs had a total 2.56% relative cover. Succulents had 0.80% relative cover. The annual grasses for this area were mainly cheatgrass brome and Japanese brome. The cool season perennial grasses were mainly western wheatgrass, threadleaf sedge, and *Hesperostipa comata* (needleandthread). Warm season perennial grasses consisted of *Bouteloua gracilis*, blue grama, and *Buchloe dactyloides*, buffalo grass. Perennial forbs were dominated by *Phlox hoodii*, Hood's phlox, and American vetch. Annual forbs included alyssum and *Plantago patagonica*, Pursh's plantain. Shrubs and subshrubs included *Artemisia tridentata* (big sagebrush), silver sagebrush, *Artemisia frigida*, fringed sagewort, and *Artemisia pedatifida*, birdfoot

sagewort. Also present were lichens, mushroom species and plains prickly pear. Refer to Table 3.5-7 for relative Upland Grassland cover summary and Addendum 3.5-B for a complete Upland Grassland cover summary.

Table 3.5-7. Vegetation Cover Sampling Data Summary of Species by Lifeform for the Upland Grassland Community. All values are means.

	Vegetation Cover	
	Absolute	**Relative (%)**
Annual Grasses		
Total	8.10	12.90
Warm Season Grasses		
Total	2.30	3.66
Cool Season Grasses		
Total	33.70	53.66
Annual/Biennial Forbs		
Total	12.60	20.06
Perennial Forbs		
Total	4.00	6.37
Perennial Shrubs		
Total	0.90	1.43
Perennial Sub-Shrubs		
Total	0.70	1.11
Succulents		
Total	0.50	0.80

3.5.5.1.5 Agricultural Grassland

Cover

The Agricultural Grassland plant community comprised approximately 931.61 of the 7,104.1 acres of the License area (13.11%). Twenty-two cover transects were sampled for this community. Absolute total vegetation cover was 68.09%. Absolute bare soil and litter/rock percentages were 7.09 and 24.73, respectively. Absolute total ground cover was 93.00%. *Agropyron cristatum*, crested wheatgrass, provided the highest relative vegetation cover at 36.01%, while alyssum provided the next highest relative vegetation cover at 24.32%. Refer to Table 3.5-8 below for the absolute cover values.

Table 3.5-8. 2007 Absolute Cover for the Agricultural Grassland Plant Community.

Vegetation Parameter	Mean
Absolute Total Vegetation Cover (%)	68.09
Absolute Total Cover (%)	92.91

Sample Adequacy

There were 22 samples taken in the Agricultural Grassland plant community. The sample adequacy formula outlined in WDEQ-LQD Guideline 2 was utilized to determine the minimum required size of the sample population. The Agricultural Grassland met sample adequacy. Refer to Table 3.5-9 below for sample adequacy values.

Table 3.5-9. Summary of Sample Adequacy Calculations for % Vegetation Cover in the Agricultural Grassland.

	Mean	Standard Deviation	Sample Adequacy	Actual Sample #	Z-Value	Confidence Level Achieved
Mapping Unit						
Agricultural Grassland						
Total Vegetation Cover	68.09	7.84	8.69	22.00	3.58	99.80
Total Ground Cover	92.91	4.57	1.59	22.00	6.74	99.99

Species Composition

Species composition for the Agricultural Grassland plant community was dominated by cool season perennial grasses with 49.40% relative cover, followed by annual forbs with 28.62% relative cover. Annual grasses and warm season perennial grasses had 13.27% and 0.15% relative cover, respectively. Perennial forbs and biennial forbs had 6.90% and 0.26% relative cover, respectively. Succulents had 0.15% relative cover and subshrubs had 1.26% relative cover. The annual grasses for this area were mainly cheatgrass brome and Japanese brome. The cool season perennial grasses were mainly crested wheatgrass and western wheatgrass. Only one warm season perennial grass, blue grama, was noted. Perennial forbs were dominated by American vetch, *Sphaeralcea coccinea* (scarlet globemallow), and *Lygodesmia juncea* (skeletonweed). Annual and biennial forbs included alyssum, Pursh's plantain and *Melilotus officianalis*, yellow sweetclover. The only subshrub was *Atriplex gardneri*, Gardner's saltbush. Also present were mushroom species, and the succulents *Coryphantha vivipara*, purple ball cactus and plains prickly

pear. Refer to Table 3.5-10 below for relative Agricultural Grassland cover summary and Addendum 3.5-B for a complete Agricultural Grassland cover summary.

Table 3.5-10. Vegetation Cover Sampling Data Summary of Species by Lifeform for the Agricultural Grassland Community. All values are means.

	Vegetation Cover	
	Absolute	**Relative (%)**
Annual Grasses		
Total	9.09	13.35
Warm Season Grasses		
Total	0.09	0.13
Cool Season Grasses		
Total	33.82	49.67
Annual/Biennial Forbs		
Total	19.72	28.96
Perennial Forbs		
Total	4.73	6.95
Perennial Sub-Shrubs		
Total	0.55	0.81
Succulents		
Total	0.09	0.13

3.5.5.1.6 Big Sagebrush Shrubland

Cover

The Big Sagebrush Shrubland plant community comprised approximately 707.8 of the 7,104.1 acres of the License area (9.96%). Twenty cover transects were sampled for the Big Sagebrush Shrubland community. Absolute total vegetation cover was 67.30%. Absolute bare soil and litter/rock percentages were 8.90 and 20.10, respectively. Absolute total ground cover was 91.20%. Western wheatgrass provided the highest relative vegetation cover at 15.03%, while alyssum provided the next highest relative vegetation cover at 13.99%. Refer to Table 3.5-11 below for the absolute cover values.

Table 3.5-11. 2007 Absolute Cover for the Big Sagebrush Shrubland Plant Community.

Vegetation Parameter	Mean
Absolute Total Vegetation Cover (%)	67.30
Absolute Total Cover (%)	91.20

Sample Adequacy

There were 20 samples taken in the Big Sagebrush Shrubland plant community. The sample adequacy formula outlined in WDEQ-LQD Guideline 2 was utilized to determine the minimum required size of the sample population. The Big Sagebrush Shrubland met sample adequacy. Refer to Table 3.5-12 below for sample adequacy values.

Table 3.5-12. Summary of Sample Adequacy Calculations for % Vegetation Cover in the Big Sagebrush Shrubland.

	Mean	Standard Deviation	Sample Adequacy	Actual Sample #	Z-Value	Confidence Level Achieved
Mapping Unit						
Big Sagebrush Shrubland						
Total Vegetation Cover	67.30	9.85	14.04	20.00	2.16	98.46
Total Ground Cover	91.20	6.72	3.29	20.00	4.29	99.99

Species Composition

Species composition for the Big Sagebrush Shrubland plant community was dominated by cool season perennial grasses with 39.29% relative cover, followed by annual forbs with 22.02% relative cover. Annual grasses and warm season perennial grasses had 17.71% and 2.08% relative cover, respectively. Perennial forbs had 10.27% relative cover. Shrubs and subshrubs had a total 8.48% relative cover. Succulents had 0.15% relative cover. The annual grasses for this area were mainly cheatgrass brome and Japanese brome. The cool season perennial grasses were dominated by western wheatgrass and *Poa pratensis*, Kentucky bluegrass. Warm season perennial grasses consisted of blue grama and buffalo grass. Perennial forbs were dominated by American vetch and Hood's phlox. Annual forbs included alyssum and Pursh's plantain. Present shrubs and subshrubs were fringed sagewort, silver sagebrush, big sagebrush, *Atriplex*

canascens, four-wing saltbush, and *Hymenoxys richardsonii*, pingue rubberweed. Also present were lichens, mushroom species and plains prickly pear. Refer Table 3.5-13 below for relative Big Sagebrush Shrubland cover summary and to Addendum 3.5-B for a Big Sagebrush Shrubland complete cover summary.

Table 3.5-13. Vegetation Cover Sampling Data Summary of Species by Lifeform for the Big Sagebrush Shrubland Community. All values are means.

	Vegetation Cover	
	Absolute	**Relative (%)**
Annual Grasses		
Total	11.90	17.68
Warm Season Grasses		
Total	1.40	2.08
Cool Season Grasses		
Total	26.50	39.38
Annual/Biennial Forbs		
Total	14.80	21.99
Perennial Forbs		
Total	6.90	10.25
Perennial Shrubs		
Total	4.90	7.28
Perennial Sub-Shrubs		
Total	0.80	1.19
Succulents		
Total	0.10	0.15

3.5.5.1.7 Vegetation Survey Discussion

The proposed 7,104.1 acre License area consists of 4 vegetation communities: Meadow Grassland, Upland Grassland, Agricultural Grassland, and Big Sagebrush Shrubland. Each community was investigated for baseline vegetation information in support of an NRC Source Materials License and a Regular Mine Permit Application.

No threatened or endangered species were encountered within the License area. There was the presence of two state designated weeds, Canada thistle and field bindweed, in the License area.

3.5.5.2 Wetlands

The wetland delineation was conducted as part of the baseline assessment for the Moore Ranch Project. The wetland delineation will be utilized for reclamation planning and mining infrastructure location.

Figure 3.5.5-2 identifies the general area location on a color infrared (CIR) map and Figures 3.5.5-3 through 3.5.5-8 identify areas of wetland concentrations. All wetlands maps referenced in this section are presented in Addendum 3.5-E.

Construction, operation, or reclamation activities, which cause disturbance or impacts to jurisdictional wetlands on the proposed Moore Ranch Project, will be performed in accordance with appropriate Nationwide Permits (NWP), if applicable:

- NWP 44 non-coal mining activities, which requires Pre-construction Notification (PCN) for all activities;
- NWP 12 utility line activities, which requires a PCN for an area where a section 10 permit is required, discharges that result in the loss of >1/10 acre,
- NWP 14 linear transportation projects, which requires a PCN for ½ acre in non-tidal waters and 1/3 an acre in tidal waters.

NWP 44, NWP 12, and NWP 14 have an acreage limit of half an acre for Waters of the United States (WoUS). Impacts to Other Waters of the United States (OWUS) are not considered under the acreage limit. All of the wetlands presented in this study are recommended to be non-jurisdictional since the wetlands are all isolated and do not support interstate commerce. Final determination of jurisdictional decision lies with the United States Army Corps of Engineers (USACE).

3.5.5.2.1 Wetland Survey Methodology

The wetland surveys were conducted in accordance with the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region. All OWUS were also assessed during the surveys. The routine wetland delineation approach with onsite inspection was utilized, and the survey was conducted by pedestrian reconnaissance and CIR photography. Identification of potential wetlands was based on visual assessment of vegetation and hydrology indicators, as well as intrusive soil sampling to determine the presence of wetland criteria indicators. USACE Data Forms-Great Plains Region (Draft), were utilized for each observation point. Hydrology and soils were evaluated whenever a plant community type met hydrophytic vegetation parameters based on the Dominance Test and Prevalence Index (as defined by the

USACE Great Plains Regional Supplement), or whenever indicators suggested the potential presence of a seasonal wetland area under normal circumstances.

Natural Resources Conservation Service (NRCS) soils mapping for Campbell County, Wyoming, and BKS soil mapping of the project area were reviewed for general soils information.

Potential wetlands (WoUS) and OWUS were initially identified via review of area maps to include the following:

1) 1976 United States Fish and Wildlife Service hardcopy NWI mapping;
2) 2001 CIR imagery for the Pine Tree Quadrangle
3) 2001 CIR imagery for the Artesian Draw
4) 1954 Artesian Draw, Wyoming, Quadrangle Map
5) 1977 Pine Tree, Wyoming, Quadrangle Map

Wetland indicator categories were identified for each dominant plant species noted through use of the National List of Vascular Plant Species that Occur in Wetlands, 1996 National Summary. Region 4 (North Plains) indicator categories were utilized for the project area. Wetland species identified at the Moore Ranch Project site are listed in Addendum 3.5-F.

Field sample locations and resulting wetland boundaries were recorded with a hand-held Garmin GPSmap 60Cx Global Positioning System (GPS) unit and a Garmin III Plus GPS unit in NAD 1983 UTM Zone 13. BKS and Land Surveying Inc. (LSI) provided drafting services for the project.

3.5.5.2.2 Wetland Survey Results

The project area generally occurred on uplands, with inclusions of several drainages. Five of the main drainages were evaluated using pedestrian reconnaissance, while the remaining small drainages were evaluated based on CIR mapping and evaluated drainage results. The majority of the wetlands were found along existing drainage bottoms; however the wetlands were not continuous throughout the drainages. The wetland classifications along the drainages were primarily Palustrine Emergent (PEM) WoUS and Palustrine Unconsolidated Bottom (PUB) OWUS. The proposed project may affect a total of 35.29 acres of PEM stream channel, PUB stream channel, PEM isolated ponds, and PUB isolated ponds. See Table 3.5-14 (Addendum 3.5-E) for a summary of wetland areas within the proposed license area.

Several coal bed methane (CBM) outfalls, windmills and livestock watering tanks, were found within the project area. All were located along or within a drainage. Several of the outfalls, along with the watering tanks, were releasing water into the drainages that were being delineated.

Relatively abrupt upland/wetland transition areas occurred, and were a result of changes in topography occurring along drainage channels.

Soils information for the project area was obtained by NRCS Web Soil Survey for southern Campbell County, Wyoming, (2006) and by BKS soil mapping. Soils within the project area were mapped as the following:

There are six main drainage basins located in the project area; each of the drainages had differing soil types. Drainage basin 1 had 153-1 Haverdad clay loam, 0-6% slopes in the northern half of the drainage and 153-2 Kishona clay loam, 0-6% slopes in the southern half and on the southwest and northeast tributary. Drainage basin 2 had 116-1 Cambria loam, 0 to 6 percent slopes in the northern half and 153-2 Kishona clay loam, 0-6% slopes in the southern half. Drainage 3 had 153-1 Haverdad clay loam, 0-6% slopes. Drainage basin 2 had 116-2 Kishona loam, 0-6% slopes north of the Highway 387 and 235 Vonalee fine sandy loam, 0-10% slopes south of the highway. Drainage basin 5 and 6 also had 235 Vonalee fine sandy loam, 0-10% slopes. Refer to Section 2.6.2 for more information on site soils.

Soil map units 153-1, 153-2, 116-1, and 116-2 are found on the Wyoming Hydric Soils List for southern Campbell County. The map units in the 153 association are typically found on floodplains. The map units in the 116 complex are typically found in depressions and have poorly drained soils. Soil map unit 235 was not found on the Wyoming Hydric Soils List.

The project area was generally characterized by Upland Grass areas with pockets of Big Sagebrush Shrubland and an occasional Agricultural field. The drainage basins composed mainly of Meadow Grassland. Meadow Grassland comprised of 323.90 acres; the dominate vegetation were *Elymus smithii* (Western wheatgrass) and *Bromus inermis* (smooth brome). The wetland indicator status of these plants are UPL (upland) and FACU (facultative upland) respectively. Refer to Section 3.5.5.1 for more details regarding the vegetation communities and plants found within the project area.

Simmons Draw

Simmons Draw runs north to south and has several small tributaries and two large tributaries within the project area. Simmons Draw is located in T42N R75W Section 33 and T41N R75W is Section 2, 3, and 4. The first tributary to Simmons Draw intersects in T41N R75W in Section 3; the second tributary to Simmons Draw intersects in Section 2.

A PEM wetland is present at W10 in the southwest quarter of the southwest quarter of Section 33; this wetland was also mapped in 1976 by NWI mapping. The soils in the drainage are hydric from W7 to W9 to W11; however only at W10 was there water present and hydrophytic vegetation.

Moving southeast down the drainage the CIR map indicates red along the drainage however no water was present and the vegetation in the drainage had an indicator status of FACU primarily, with few to none obligate vegetation. Due to the presence of some *Populus deltoids* (plains cottonwood) and *Salix amygdaloides* (peachtree willow) trees in the drainage and saturated hydric soils the area between W5 and W15 were classified as a PUB wetland. At W5 there was a ponded area with surface water present (at a depth of about 12 inches) due to a man made berm. The ponded area had fringe and emergent vegetation that passed the dominance test and hydric clay loam soils with redox depressions and about 1 cm of muck present. The drainage channel south of the berm had no presence of hydric soils or hydrophytic vegetation, or water present.

The small unnamed tributaries off of Simmons Draw did not exhibit any wetland characteristics.

At W16 there is a small isolated PEM and POW stock pond wetland present. The stock pond had about four inches of water present with hydric silty clay soils with redox depressions, depleted matrix, and a loamy gleyed matrix. The stock pond is present due to a man made berm. The vegetation within the drainage bottom is primarily composed of vegetation that had UPL and FACU indicator status, *Poa pratensis* (Kentucky bluegrass), *Koelena macrantha* (Prairie junegrass), and *Hordeum jubatum* (foxtail barley). Another stock pond surrounded by upland vegetation is located at W10.

In the middle of Section 3 there are two small stock ponds that have the designation as POW and PEM wetland. The first wetland is found at W19; no surface water is present but had a water table at a depth of nine inches. The silty clay loam hydric soil had a depleted matrix and redox depressions. The dominate vegetation had an obligate indicator status, *Eleocharis acicularis* (slender spikerush). Upstream of this wetland was an upland swale and downstream was an old cattle water tank. The second wetland was

found further downstream of the first; both wetland ponds were isolated along the drainage.

The drainage between W20 and waypoint 23 was considered a PEM wetland based on the presences of hydrophytic vegetation and hydric soils. The hydrology present was based on secondary indicators of geomorphic position and oxidized rhizospheres in living root channels. Downstream of waypoint 23, upland vegetation is more dominant than the hydrophytic vegetation.

As Simmons Draw crosses over the project area, upland vegetation was dominant in the drainage and no wetlands existed in the area.

First Tributary to Simmons Draw

The first tributary to Simmons Draw is located on the western side of the project area in T42N R75W in Sections 28, 27, and 34, and in T41N R75W in Section 3.

The first tributary to Simmons Draw has no wetlands North of Highway 387. One previously identified PEM wetland just north of the road is no longer present; the wetland was previously mapped in 1976 by NWI.

South of the highway there is a windmill present, though the windmill is not active. A PEM wetland area is present within the drainage from W35 to W34, 0.125 acres. There is a berm that separates the two ponded areas but the wetland extends past the berm. There is no hydrology indicators present as the windmill is no longer active. This PEM wetland area is receding due to the lack of water present. South of W34 the hydrophytic vegetation begins to drop out and the uplands are more dominant in the drainage.

The channel between W34 and W33 is not a wetland since none of the wetland parameters are met. However from W33 to W31 the drainage is considered a wetland channel, 6.04 acres. The wetland characteristics at W32 are receding based on secondary hydrology indicators and vegetation did not pass the dominance or prevalence index, but the dominance test was fifty percent, and one of the dominant species was obligate, *Juncus balticus* (Baltic rush).

There is a CBM outfall area at W39. There is open water present at W27 but only secondary hydrology indicators present at W28. As the wetland channel begins to disappear at W31 there is still hydrophytic vegetation, however the hydric soil indicators are found within dead root channels and hydrology is present only by secondary indicators. It is likely that the wetland will recede to a point nearer to W27 in the future due to the lack of water presence downstream of W27.

Second Tributary to Simmons Draw

The second tributary to Simmons Draw is located on the eastern side of the project area in T42N R75W in Sections 2, 27, and 35. The drainage is split by highway 387. North of the highway there is a windmill that is generating water into a POW stock pond. There was no hydrophytic vegetation around the edge of the pond, so no intrusive soil samples were taken. This stock pond was originally mapped by NWI as a PEM wetland; however the hydrophytic vegetation is gone and now is a POW stock pond.

South of highway 387 there are three CBM outfalls. These outfalls are owned by Devon Energy Corporation. The first outfall is found at waypoint 71, just south of the outfall there is a PEM and POW ponded area. The pond is dominated by hydrophytic vegetation including *Typha latifolia* (cattails) and slender spikerush. Downstream of the pond to W38, hydric soils are present but the hydrophytic vegetation did not pass the dominance test or the prevalence index, thus this area had been a wetland in the past but the vegetation is receding as the water source is not present. At waypoint 70 there is another CBM outfall area with similar hydrophytic vegetation to waypoint 71, another pond sits below the outfall area. This pond is considered PEM wetland. Downstream of the outfall the drainage is considered a PEM wetland as hydrophytic vegetation is dominant and hydric soils are present with redox depressions. Water is not present in the drainage but due to the presence of the other two factors and that the CBM outfalls have water present, it can be concluded that water likely runs down the drainage sometime during the growing season. The wetland stops at waypoint 90 where the water ponds from another CBM outfall point.

South of the bermed pond area at W41 hydrophytic vegetation is no longer dominant and only hydric soils with redox depressions are present. The area was a wetland in the past due to the presence of hydric soils but the water source has left. Further south of W41, the CIR photo shows light areas of pink down to the junction of Simmons Draw, no wetlands were present along this section of the second tributary to Simmons Draw.

Pine Tree Draw

Pine Tree Draw is located on the eastern side of the project area in Township 42N Range 75W in part of Sections 25, 26, and 36. Pine Tree Draw runs north to south and has one main tributary to the northwest of the drainage that intersects the draw at W51. Along the main tributary at W48 there is a CBM outfall that is generating water into the drainage. Hydrophytic vegetation is dominant and the sandy clay loam soils are hydric with a depleted matrix, as well as 3-4 inches of surface water and saturation. This POW and PEM wetland extends down to W50 where upland vegetation is dominant and hydric

soils and water are not present. This tributary intersects with Pine Tree Draw at W51, there is not wetlands present at the intersection.

North of the tributary along Pine Tree Draw there are no wetlands present. South of the tributary along Pine Tree Draw there are wetlands present starting at W47 and ending at W53. Hydrophytic vegetation is dominant in this area as well as hydric soils and hydrology. The hydric soils in the northern portion of the wetland by W47 are silty clay loam with sandy redox and redox depressions; while the southern portion of the wetland by W53 were considered sandy clay loam with a sandy gleyed matrix, redox depressions, and a strong hydrogen sulfide odor. The drainage PEM wetland beginning at W47 had secondary hydrologic indicators present and continued down to W53. At W53, there was an unmarked pipe pumping water into a bermed pond.

The wetland channel continues south past the berm to W54 where hydrophytic vegetation is not dominant but passes the prevalence index. Upland vegetation is encroaching into the drainage bottom and secondary hydrology indicators were present, geomorphic position and oxidized rhizospheres in living root channels. The sandy loam soils are hydric with redox depressions and sandy redox features. Once the drainage crossed the CBM road, it was dominated by upland vegetation and the soils are no longer hydric.

Ninemile Creek

Ninemile Creek runs west to east in Township 41N Range 75W in Sections 3, 4, 9, and 10. Previous NWI mapping indicates that there were two PEM areas located on the western section of Ninemile creek in the northwest quarter of the northeast quarter of Section 9, however these wetlands were not found to be present during the 2007 wetland delineation. Another PEM wetland identified under the NWI mapping was confirmed near W24, the present PEM wetland is smaller than that identified by NWI. A PEM wetland drainage was present between W24 and W23, as hydrophytic vegetation and hydric soils were present at both locations. W24 had secondary hydrology indicators present including geomorphic position and oxidized rhizospheres on living root channels, while W23 only had geomorphic position. The clay loam hydric soils found by W24 had redox depressions and the silty clay soils by W23 also had redox depressions. Further east along Ninemile Creek, bare ground was present with no presence of hydrophytic vegetation, thus ending the wetland channel.

3.5.5.2.3 Wetland Survey Conclusions

Numerous CBM outfalls were located throughout the project area and occurred along drainages. Windmills and livestock watering tanks were also found within the project area. Some outfalls and watering tanks had no water present while others were releasing

water into the drainages where they were located. The release of water from the CBM outfalls and watering tanks has influenced the presence or absence of wetland parameters located within these drainages. In drainages where water is still being released the wetland characteristics are actively present. Where water has ceased being released, the wetland paramters are receding, particularlity wetland hydrology and hydrophytic vegetation causing upland vegetation encroachment.

The Moore Ranch Uranium Project area had 31.22 acres of wetland channel present and 4.07 acres of PEM and POW wetland ponds and stock ponds present. All of the wetlands presented in this study are recommended to be non-jurisdictional because the wetlands are all isolated and do not support interstate commerce. Final determination of jurisdictional decision lies within the USACE.

3.5.5.3 Wildlife

3.5.5.3.1 General Setting

This section discusses the affected environment and environmental consequences to wildlife (terrestrial vertebrates) in general. The subsequent sections address the potential impacts to specific groups of wildlife species. As no underground or open pit mining would occur as part of the Moore Ranch Project, the analysis was limited to the Proposed Action (in situ recovery or ISR) and No Action alternatives.

Baseline wildlife information for the Moore Ranch Project was available from data collected by biologists with Thunderbird Jones & Stokes Associates, Inc. (T/J&S) (formerly Thunderbird Wildlife Consulting) during previous inventory and monitoring efforts for the Bates Creek, Cutthroat, and Rainbow coal bed methane (CBM) plans-of-development (PODs). Those PODs collectively and coincidentally overlapped approximately 86% of the proposed Moore Ranch License area, 75% of the one-mile perimeter, and 52% of the two-mile perimeter. Generally, all but the extreme southeastern and western sections of the proposed License area and perimeters were included in previous studies. Surveys for one or more of those three PODs were conducted annually from 2003-2006, and included numerous wildlife species and habitat features of concern such as bald eagle (*Haliaeetus leucocephalus*) nesting and winter roost sites, grouse leks, and raptor nests, as well as surveys for other avian species of concern (e.g., mountain plover [*Charadrius montanus*], etc.).

Additional background information from wildlife surveys conducted near the Moore Ranch License area was obtained from several sources, including prior WDEQ/LQD mine permit applications and annual wildlife monitoring reports for nearby ISR

operations (Irigaray-Christensen Ranch [Cogema] and North Butte ISR [Pathfinder]: 1992-1999) and from similar documents generated from baseline and annual wildlife surveys conducted at local surface coal mines (1978-2007). Those data were further supplemented by Wyoming Game and Fish Department (WGFD), Bureau of Land Management (BLM), and U. S. Fish and Wildlife Service (USFWS) records from surveys conducted by their respective agency biologists in and near the vicinity of the Moore Ranch Project. Supporting data for impact analyses came from the Powder River Basin Oil and Gas Project FEIS (BLM 2003a), South Powder River Basin Coal FEIS (BLM 2003b), and Maysdorf Coal Lease Application FEIS (2007).

EMC commissioned T/J&S to conduct baseline wildlife investigations from October 2006 through June 2007 expressly for the Moore Ranch Project. Because much of the project area has been included in wildlife monitoring efforts annually since 2003, the WGFD reduced the study area for raptors and other migratory birds to the portions of the proposed Moore Ranch License area and one-mile perimeter not already encompassed by overlapping studies in recent years. Those locations within the License boundary included N and W ¼ Section 1 and W ½ Section 4, T41N, R75W; and SE ¼ Section 36, W ½ Section 33, and SE ¼ Section 28 T42N, R75W; the one-mile survey area for 2007 surrounded those locations. No reductions in the survey area were requested or implemented for sage-grouse, or Threatened and Endangered Species (T&E) inventories. As in previous years, wildlife surveys conducted specifically for the Moore Ranch Project targeted bald eagle winter roost sites, grouse leks, nesting raptors (including eagles), mountain plovers, and other avian species of concern. At the request of EMC, special attention was also paid to water bodies within the proposed Moore Ranch License area to gauge their use by waterfowl and shorebird species. In addition to these efforts, incidental observations of all other wildlife species seen within the proposed License area were recorded during each site visit.

3.5.5.3.2 Big Game

Pronghorn (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) are the only two big game species that regularly occur in the general analysis area for the Moore Ranch Project. No crucial big game habitat or migration corridors are recognized by the WGFD in this area. Crucial range is defined as any particular seasonal range or habitat component that has been documented as the determining factor in a population's ability to maintain and reproduce itself at a certain level.

Pronghorn are more abundant than mule deer in the Moore Ranch Project area, but neither species is prevalent. Upland grasslands dominate the project area and immediate perimeter. Although grassland habitats do provide adequate forage during much of the year, they are not considered as preferred by wintering pronghorn (Sundstrom et al.

1973). The home range for pronghorn can vary between 400 to 5,600 acres, depending on several factors including season, habitat quantity and quality, population characteristics, physical movement barriers, and local livestock occurrence. In northeast Wyoming, daily movement typically does not exceed 6.0 miles. Pronghorn may make seasonal migrations between summer and winter habitats, but migrations are often triggered by availability of specific plants and not local weather conditions (Fitzgerald et al. 1994).

The WGFD has classified the general analysis area as yearlong pronghorn range, which means that a population or a portion of a population of animals makes general use of this habitat on a year-round basis. The Moore Ranch Project spans two WGFD pronghorn Herd Units: the Pumpkin Buttes area to the north of Wyoming Highway 387, and the North Converse Unit south of the highway. The WGFD estimated the 2006 post-season pronghorn populations in those two hunt areas to be approximately 36,500 and 32,300, respectively; both considerably above objective (Pumpkin Buttes and North Converse Pronghorn JCR Reports, WGFD, 2006).

Mule deer use nearly all habitats, but prefer sagebrush-grassland, rough breaks, and riparian bottomland. Browse is an important component of the mule deer's diet throughout the year, comprising as much as 60 percent of total intake during autumn, while forbs and grasses typically make up the rest of their diet (Fitzgerald et al. 1994). Mule deer are not abundant in the general analysis area, with most individuals recorded in eroded draws and small tree windbreaks in that vicinity. In certain areas of the state, this species tends to be more migratory than white-tailed deer, traveling from higher elevations in the summer to winter ranges that provide more food and cover. However, monitoring indicates that mule deer are not very migratory in the vicinity of the Moore Ranch Project. The WGFD has classified the majority of the general analysis area as yearlong mule deer range, with a portion of the proposed License area south of the highway classified as "out". That range delineation is considered inadequate to support mule deer. As with pronghorn, the Moore Ranch Project spans the Pumpkin Buttes and North Converse mule deer Herd Units. The WGFD estimated the 2006 post-season pronghorn population to be approximately 12,350 and 9,700 animals, respectively whereas the herd objectives were 11,000 and 9,100, respectively (Pumpkin Buttes and North Converse Pronghorn JCR Reports, WGFD, 2006). No crucial or critical mule deer ranges or migration corridors occur on or within several miles of the Moore Ranch Project area.

3.5.5.3.3 Other Mammals

A variety of small and medium-sized mammal species occur in the vicinity of the general analysis area, although not all have been observed on the Moore Ranch tract itself. These

include predators and furbearers such as the coyote (*Canis latrans*), red fox (*Vulpes vulpes*), swift fox (*Vulpes velox*), bobcat (*Lynx rufus*), striped skunk (*Mephitis mephitis*), weasels (*Mustela* spp.), badger (*Taxidea taxus*), muskrat (*Ondatra zibethicus*), and raccoon (*Procyon lotor*). Prey species include various rodents (such as mice, rats, voles, gophers, ground squirrels, and chipmunks) and lagomorphs (jackrabbits [*Lepus* spp.] and cottontails [*Sylvilagus* spp.]). These prey species are cyclically common and widespread throughout the region, and are important for raptors and other predators. Porcupines (*Erethizon dorsatum*) and bats (such as hoary [*Lasiurus cinereus*], big brown [*Eptesicus fuscus*], and Townsend's big-eared [*Corynorhinus townsenii*[) have not been documented in the general analysis area, and have limited potential habitat in the vicinity. Repeated surveys in the Moore Ranch Project area and surrounding one-mile perimeter over the last few years have documented that no occupied black-tailed prairie dog (*Cynomys ludovicianus*) colonies are present there.

3.5.5.3.4 Raptors

The raptor species that could potentially occur in suitable habitats within the general analysis area for the Moore Ranch Project include the golden eagle (*Aquila chrysaetos*), ferruginous hawk, red-tailed hawk (*Buteo jamaicensis*), Swainson's hawk (*Buteo swainsoni*), northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), prairie falcon (*Falco mexicanus*), great horned owl (*Bubo virginianus*), burrowing owl (*Athene cunicularia*), and short-eared owl (*Asio flammeus*). Those species that are known to nest in the project area (proposed License and one-mile perimeter) are the ferruginous hawk, red-tailed hawk, and great horned owl. No nest sites have been documented in the general analysis area for any other raptor species since annual monitoring began there in 2003. Habitat is limited for those species that nest exclusively in trees or other uncommon habitat types, but several species are adapted to nesting on the ground, creek banks, buttes, or rock outcrops. Bald eagles and rough-legged hawks (*Buteo lagopus*) are primarily migrants and winter residents in northeast Wyoming. Bald eagles are not common nesters in eastern Wyoming due to the paucity of persistent fisheries and trees. Rough-legged hawks breed in the arctic regions.

Figure 3.5.5-9 shows the locations of 36 raptor nest sites that have been identified within the survey area (proposed License area and one-mile perimeter) for the Moore Ranch Project since 2003. Over time, natural forces have destroyed many nests. Nineteen nest sites were within the proposed Moore Ranch License area, and thus could potentially experience direct impacts from ISR operations in that area (Table 3.5-15); nests were present at 15 of the 19 sites during 2007. The remaining sites were within the surrounding perimeter. Information for each nest monitored over the last five years is presented in Table 3.5-15. As indicated, only those nest sites within one mile of portions of the License area never before surveyed were monitored during 2007. All three raptor species

known to historically nest within the Moore Ranch Project area actively nested (eggs laid) during 2007: the ferruginous hawk (three pairs), red-tailed hawk (three pairs), and great horned owl (three pairs). Seven of those nine active nest sites occurred within the proposed License area for the Moore Ranch Project.

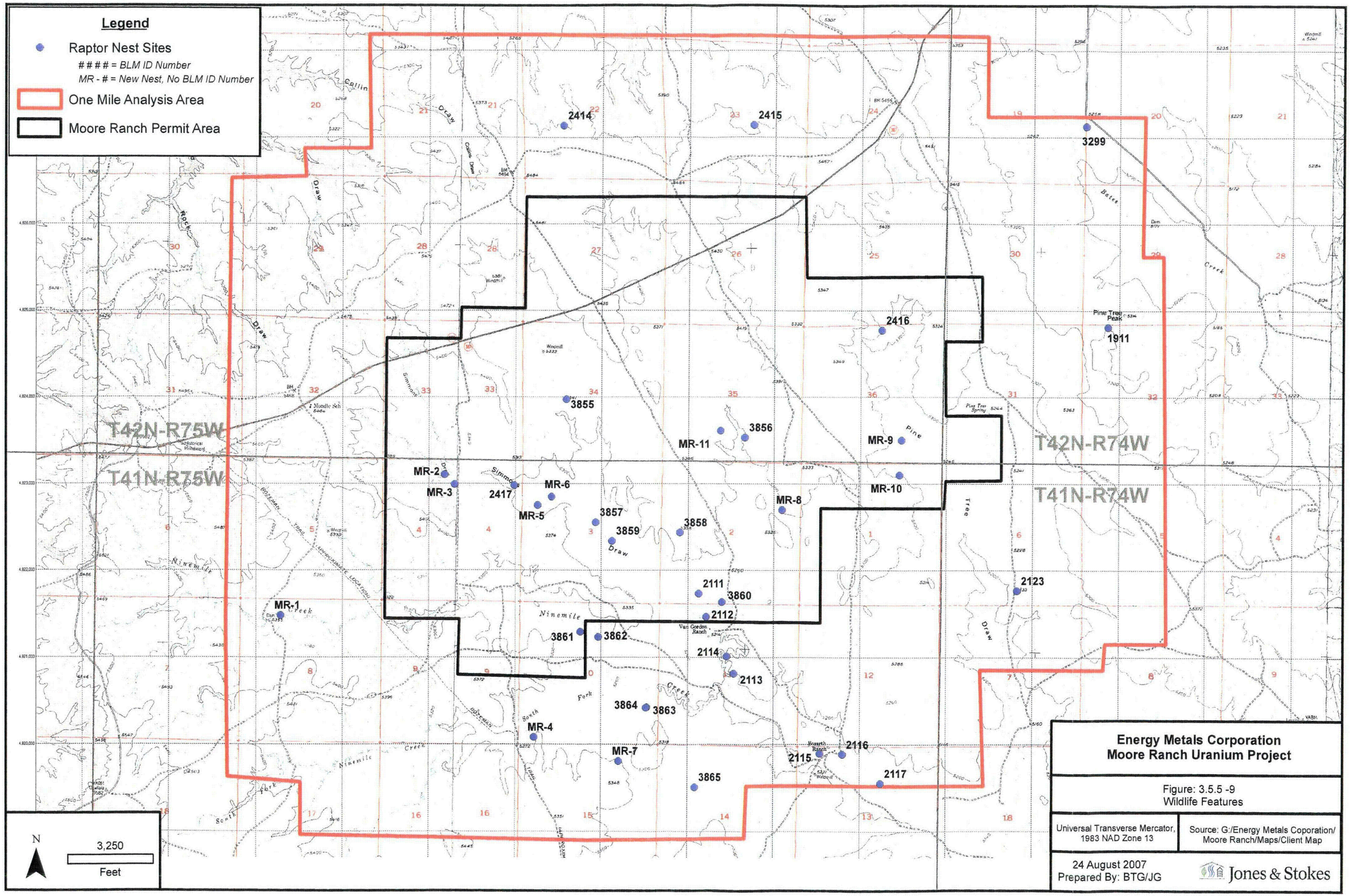
Legend
Raptor Nest Sites
= BLM ID Number
MR - # = New Nest, No BLM ID Number
One Mile Analysis Area
Moore Ranch Permit Area
T42N-R75W
T41N-R75W
T42N-R74W
T41N-R74W
2414
2415
3299
2416
1911
3855
3856
MR-11
MR-9
MR-2
MR-3
2417
MR-6
MR-5
3857
3859
3858
MR-8
MR-10
2111
3860
2112
2123
MR-1
3861
3862
2114
2113
3864
3863
MR-4
MR-7
3865
2115
2116
2117
N
3,250
Feet
Energy Metals Corporation
Moore Ranch Uranium Project
Figure: 3.5.5 -9
Wildlife Features
Universal Transverse Mercator, 1983 NAD Zone 13
Source: G:/Energy Metals Coporation/ Moore Ranch/Maps/Client Map
24 August 2007
Prepared By: BTG/JG
Jones & Stokes

Table 3.5-15. Raptor nest locations, status, and productivity at the Moore Ranch Uranium Project from 2003 through 2007.

BLM ID[1]	Species[2]	Subst-rate[3]	¼	¼	Sec	TWP	RNG	Nest Status & Productivity[4]				
								2003	2004	2005	2006	2007[5]
1911	FEHA	G	NW	NW	32	42N	74W	I	I	U	U	U
2111*	FEHA	G	SE	SW	2	41N	75W	--	A, ?, ?	I	A-T	A-T
2112*	GHOW	WIL	NE	NW	11	42N	75W	--	A	A, 1+, 1+	A,4?,4	A,2,2
2113	RTHA	WIL	SW	NE	11	41N	75W	--	A, ?, ?	A, 1+, 1	I	I
2114	BUTEO	WIL	SW	NW	11	42N	75W	--	I	I	I	D-N
2115	BUTEO	ELM	NW	NW	13	41N	75W	--	I	I	U	U
2116	BUTEO	ELM	NE	NW	13	41N	75W	--	I	I	U	U
2117	BUTEO	CW	NW	NE	13	41N	75W	--	CAGO	I	U	U
2123	FEHA	G	SW	SE	6	41N	74W	--	I	I	U	U
2414	FEHA	G	NE	SW	22	42N	75W	I	I	U	U	U
2415	FEHA	G	NW	SE	23	42N	75W	I	I	U	U	U
2416*	FEHA	G	NW	NE	36	42N	75W	I	I	D-N	--	--
2417*	RTHA	CW	NE	NE	4	42N	75W	I	I	D-N	--	--
3299	SWHA	PO	NW	SW	20	42N	74W	--	--	A-T	D-N	--
3855*	FEHA	G	NE	SW	34	42N	75W	--	--	U	I	I
3856*	FEHA	G	SW	SE	35	42N	75W	--	--	U	I	ALT

Table 3.5-15. Raptor nest locations, status, and productivity at the Moore Ranch Uranium Project from 2003 through 2007.

BLM ID[1]	Species[2]	Substrate[3]	¼	¼	Sec	TWP	RNG	Nest Status & Productivity[4]				
								2003	2004	2005	2006	2007[5]
3857*	GHOW	WIL	SW	NE	3	42N	75W	--	--	U	U	A, ?, ?
3858*	FEHA	G	SW	NW	2	41N	75W	--	--	U	I	I
3859*	FEHA	G	NW	SE	3	41N	75W	--	--	U	I	I
3860*	FEHA	CB	SE	SW	2	41N	75W	--	--	U	I	D-N
3861*	FEHA	G	NE	NW	10	41N	75W	--	--	U	I	I
3862	FEHA	G	NW	NE	10	41N	75W	--	--	U	I	I
3863	FEHA	G	NE	SE	10	41N	75W	--	--	U	I	U
3864	FEHA	G	NE	SE	10	41N	75W	--	--	U	I	U
3865	FEHA	G	SE	NW	14	41N	75W	--	--	U	I	U
MR-1	RTHA	CW	NW	NW	8	41N	75W	--	--	--	--	A, 1+, 1
MR-2*	GHOW	CW	SE	NW	4	42N	75W	--	--	--	U	A,1+,1+
MR-3*	RTHA	CW	SE	NW	4	42N	75W	--	--	--	U	A, 1+, ?
MR-4	RTHA	PO	SW	SW	10	41N	75W	--	--	--	A, ?, ?	A, 0, 0
MR-5*	FEHA	T	SW	NW	3	41N	75W	--	--	--	--	A, 0, 0
MR-6*	FEHA	T	SW	NW	3	41N	75W	--	--	--	U	D-N
MR-7	FEHA	G	NW	NE	15	41N	75W	--	--	--	A,0,0	I
MR-8*	FEHA	G	SE	NE	2	41N	75W	--	--	--	I	A, 1+, 1

Table 3.5-15. Raptor nest locations, status, and productivity at the Moore Ranch Uranium Project from 2003 through 2007.

BLM ID[1]	Species[2]	Subst-rate[3]	¼	¼	Sec	TWP	RNG	Nest Status & Productivity[4]				
								2003	2004	2005	2006	2007[5]
MR-9*	FEHA	G	SW	SE	36	42N	75W	--	--	--	--	A, 3+, 3
MR-10*	FEHA	G	NW	NE	1	41N	75W	--	--	--	--	I
MR=11*	FEHA	G	NE	SW	35	42N	75W	--	--	--	--	I

* Nest sites within the proposed Moore Ranch Project License area.

[1] BLM ID numbers obtained from the *September 2006 Raptors Database.* Nests without assigned BLM ID numbers were discovered during baseline studies for the Moore Ranch Project, and are numbered sequentially from west to east as MR-#.

[2] Species Codes
BUTEO = Unknown buteo
FEHA = Ferruginous hawk
GHOW = Great horned owl
RTHA = Red-tailed hawk
SWHA = Swainson's hawk
CAGO = Canada goose

[3] Nest Substrate Codes
CB = Creek bank
CW = Cottonwood
ELM = Elm tree
G = Ground
PO = Power pole
T = Tree species
WIL = Willow

[4] Nest Status Codes
X,#,# = Status, number of young hatched, number of young fledged.
# + = Minimum estimate
A = Active
ALT = Alternate nest
A-T = Active-tended, no eggs laid
U = Unknown
D-N = Destroyed, natural causes
I = Inactive
--- = Nonexistent or undiscovered
? = Final production undetermined

[5] Due to previous years' coverage, only locations within one mile of portions of the License area that had never been surveyed before (N and W ¼ Section 1 and W ½ Section 4, T41N, R75W; and SE ¼ Section 36, W ½ Section 33, and SE ¼ Section 28 T42N, R75W) were required by WGFD to be checked during 2007.

3.5.5.3.5 Upland Game Birds

The only upland game bird known to regularly occur in the vicinity of the Moore Ranch Project is the mourning dove (*Zenaida macroura*). This species is a relatively common breeder in Campbell County, and is the most prevalent upland game bird in the general analysis area. Doves are often seen in the area during migration, with fewer observations during the nesting season. Most sightings at the Moore Ranch Project occurred near sites with water sources or trees, though they were occasionally recorded in upland grassland habitats.

The greater sage-grouse is a species of concern throughout the west, and is considered a "landscape species" due to its use of wide expanses of sagebrush habitats. Sage-grouse are found in sagebrush shrubland habitats, and sagebrush is essential during all seasons and for every phase of their life cycle. Sage-grouse in Wyoming are regulated by the WGFD. However, since July 2002, the USFWS has received at least three petitions requesting that the greater sage-grouse be listed as threatened or endangered across its entire range. Following a 12-month status review of the best available scientific and commercial information on the species, the USFWS found that listing was not warranted at this time. However, the agency continues to have concerns regarding sage-grouse population status, trends and threats, as well as concerns for other sagebrush obligates (USFWS 2005). As part of its "not warranted" listing determination, the USFWS indicated the need for continued efforts to conserve sage-grouse and sagebrush habitat on a long-term basis, and encouraged continued development and implementation of conservation strategies throughout the species' range. In May 2002, the USFWS office in Cheyenne, Wyoming, released a list entitled *Coal Mine List of 40 Migratory Bird Species of Management Concern in Wyoming*, which replaced the previous *Migratory Birds of High Federal Interest List*. The greater sage-grouse is included on the updated list, giving further impetus to ongoing annual survey efforts.

Approximately 75% of the Moore Ranch Project area and one-mile perimeter were surveyed annually for sage-grouse leks as part of wildlife studies for adjacent and overlapping CBM projects from 2003 through 2006. The entire License area and one-mile perimeter were surveyed in spring 2007 as part of baseline studies specific for the Moore Ranch Project, with special emphasis on the limited sagebrush stands in that area.

Although the sage-grouse is a year-round resident throughout much of the Powder River Basin, it is rare in the vicinity of the Moore Ranch Project. Potential habitat for this species is limited to relatively small stands scattered throughout the general analysis area, with no large expanses of contiguous sagebrush within several miles of the tract. Consequently, few sage-grouse have ever been documented in the area, and no grouse

leks have ever been discovered on or near the Moore Ranch License area. The nearest known sage-grouse lek (Collins) is located approximately 3.0 miles to the northwest of the Moore Ranch License boundary in T42N, R76W, NW¼ SE¼ Section 13.

3.5.5.3.6 Other Birds

The USFWS uses a specific list entitled *Migratory Bird Species of Management Concern in Wyoming* (MBSMC) for reviews related to non-coal surface disturbance projects (USFWS 2002). This list was taken directly from the Wyoming Bird Conservation Plan (Cerovski et al. 2001). The MBSMC list includes 77 avian species of concern. Twenty-two species are considered to be Level I, defined as species in need of conservation action. The remaining 55 species are classified as Level II, for which continued careful monitoring is recommended. All 77 species are listed in Table 3.5-16, including their primary nesting habitats, historical occurrence in the general area, and whether or not they were observed on the Moore Ranch Project during the 2006-2007 baseline studies.

Surveys for avian species of concern, including mountain plovers, sage-grouse, and bald eagles, were conducted in the Moore Ranch Project area annually from 2003 through 2007, whether for the project itself or as part of surveys associated with overlapping CBM operations. Most surveys occurred primarily in the spring and summer to document migrating and breeding birds, with additional winter searches for bald eagle roost sites. The survey area included most of the proposed License area and one-half-mile perimeter (one-mile for bald eagles) through summer 2006, with the entire area surveyed from fall 2006 through early summer 2007.

Only 5 of the 77 avian species of management concern were documented in the Moore Ranch Project area during baseline surveys from October 2006 through June 2007 (Table 3.5-16): the ferruginous hawk, McCown's longspur (*Calcarius mccownii*), lark bunting (*Calamospiza melanocorys*), vesper sparrow (*Pooecetes gramineus*), and chestnut-collared longspur (*Calcarius ornatus*). The hawk and McCown's longspur are considered as Level I species (conservation action) and the other three are Level II (monitoring). The ferruginous hawk is the only species that has been recorded nesting in the area during surveys conducted in the project area since 2003. However, the remaining four species are presumed to also nest in the area based on their presence and behavior during the breeding season.

Given the habitat characteristics of the Moore Ranch Project area, nine additional avian species of concern could potentially occur there: the bald eagle (recently delisted), Swainson's hawk, long-billed curlew (*Numenius americanus*), short-eared owl, upland sandpiper (*Bartramia longicauda*) (all five as Level I species), grasshopper sparrow (*Ammodramus savannarum*), loggerhead shrike (*Lanius ludovicianus*), and lark sparrow

(*Chondestes grammacus*) (all Level II species). Burrowing owls (Level I) could occur in the project area, but the lack of occupied prairie dog colonies there would restrict those owls to nesting in existing badger (*Taxidea taxus*) burrows or canid dens. The remaining 63 species have either never been documented in the project area during species-specific surveys, would be limited to spring or fall migration periods, or are not likely to occur there at all due to habitat and/or range restrictions (e.g., no treed riparian corridors, coniferous forests, sage expanses, large permanent water bodies).

Table 3.5-16. Migratory Bird Species of Management Concern in Wyoming-Non-coal List.

Species	Primary Nesting Habitat(s)	Status/Occurrence in Project Region[1]	Occurrence Within Project Area[2]
LEVEL I SPECIES – CONSERVATION ACTION NEEDED			
Mountain plover *Charadrius montanus*	Short-grass prairie, shrub-steppe	Locally common breeder	No records
Trumpeter swan *Cygnus buccinator*	Wetlands	No records	No records
Greater sage-grouse *Centrocercus urophasianus*	Shrub-steppe	Year-round resident	No records
McCown's longspur *Calcarius mccownii*	Short-grass prairie, shrub-steppe	Breeder	Observed, presumed breeder
Baird's sparrow *Ammodramus bairdii*	Short-grass prairie	Uncommon, potential breeder	Low No records
Ferruginous hawk *Buteo regalis*	Shrub-steppe, grasslands	Breeder	Observed, breeder
Brewer's sparrow *Spizella breweri*	Shrub-steppe, montane shrublands	Breeder	No records
Wilson's phalarope *Phalaropus tricolor*	Wetlands	Breeder	Observed, potential breeder
Franklin's gull *Larus pipixcan*	Wetlands	Uncommon migrant	No records
Sage sparrow *Amphispiza belli*	Shrub-steppe, montane shrublands	Uncommon breeder	No records
Swainson's hawk *Buteo swainsoni*	Plains/Basin riparian, grasslands	Uncommon breeder	No records
Long-billed curlew *Numenius americanus*	Short-grass prairie	Uncommon migrant	No records
Short-eared owl *Asio flammeus*	Short-grass prairie, shrub-steppe	Irregular breeder	No records
Northern goshawk *Accipiter gentiles*	Conifer, aspen	Uncommon migrant	No records
Peregrine falcon *Falco peregrinus*	Cliffs	Rare migrant	No records
Burrowing owl *Athene cunicularia*	Grasslands, shrub-steppe	Uncommon breeder	No records
Forster's tern *Sterna forsteri*	Wetlands	Uncommon migrant	No records
Bald eagle *Haliaeetus leucocephalus*	Riparian	Common migrant, winter resident, potential breeder	No records
Upland sandpiper *Bartramia longicauda*	Short-grass prairie, shrub-steppe	Uncommon breeder	One record, potential breeder

Table 3.5-16. Migratory Bird Species of Management Concern in Wyoming-Non-coal List.

Species	Primary Nesting Habitat(s)	Status/Occurrence in Project Region[1]	Occurrence Within Project Area[2]
Black tern *Chlidonias niger*	Wetlands	Rare migrant	No records
Whooping crane *Grus Americana*	Wetlands	No records	No records
Piping plover *Charadrius melodus*	Wetlands, aquatic	No records	No records
LEVEL II SPECIES – CONTINUED MONITORING RECOMMENDED			
Calliope Humming Bird *Stellula calliope*	Mid-elevation conifers, montane riparian	No records	No records
Lewis Woodpecker *Melanerpes lewis*	Low elevation conifer, plains/basin riparian	Uncommon occurrence	No records
Cassin's Kingbird *Tyrannus vociferans*	Juniper Woodland Plain/basin riparian	No records	No records
Lark Bunting *Calamospiza melanocorys*	Shortgrass prairie, shrub steppe	Breeder	Observed, presumed breeder
American White Pelican *Pelecanus erythrorhynchos*	Aquatic-rivers, lakes, ponds	Uncommon occurrence	No records
William's Sapsucker *Sphyrapicus thyroideus*	Mid-elevation conifer	No records	No records
Black-backed Woodpecker *Picoides arcticus*	Mid-elevation conifer, High elevation conifer	Uncommon occurrence	No records
Gray Flycatcher *Empidonax wrightii*	Juniper woodland, mountain-foothills shrub	No records	No records
Juniper Titmouse *Baeolophus ridgwayi*	Juniper woodlands	No records	No records
Dickcissel *Spiza americana*	Shortgrass prairie	Rare occurrence	No records
Chestnut-collared Longspur *Calcarius ornatus*	Shortgrass prairie	Potential breeder	Observed, likely breeder
Harlequin Duck *Histrionicus histrionicus*	Montane riparian	No records	No records
Snowy Plover *Charadrius alexandrinus*	Wetlands	No records	No records
Black-chinned Hummingbird *Archilochus alexandri*	Plains/basin riparian, shrub-steppe	No records	No records
Rufous Hummingbird *Selasphorus rufus*	Mid-elevation conifer	Uncommon occurrence	No records

Table 3.5-16. Migratory Bird Species of Management Concern in Wyoming-Non-coal List.

Species	Primary Nesting Habitat(s)	Status/Occurrence in Project Region[1]	Occurrence Within Project Area[2]
Red-naped Sapsucker *Sphyrapicus nuchalis*	Aspen	No records	No records
American Three-toed Woodpecker *Picoides dorsalis*	Mid-elevation conifer, high elevation conifer	No records	No records
Willow Flycatcher *Empidonax traillii*	Montane riparian Plains/basin riparian	Breeder	No records
Hammond's Flycatcher *Epidonax hammondii*	Higher-elevation confer with aspen, montane riparian	No records	No records
Codilleran Flycatcher *Empidonax occidentalis*	Montane riparian, mid-elevation conifer	Uncommon occurrence	No records
Pygmy Nuthatch *Sitta pygmaea*	Low-elevation conifer	No records	No records
Marsh Wren *Cistothorus palustris*	Wetlands	No records	No records
American Dipper *Cinclus mexicanus*	Montane riparian	No records	No records
Plumbeouos Vireo *Vireo plumbeus*	Mid-elevation conifer, low-elevation conifer	No records	No records
Townsend's Warbler *Dendroica townsendii*	High-elevation conifer, mid-elevation conifer	No records	No records
Dusky Flycatcher *Empidonax oberholseri*	Low-elevation conifer, aspen, mountain-foothills shrub	No records	No records
Western Bluebird *Sialia Mexicana*	Juniper woodlands, low-elevation conifer	Breeder	No records
Sage Thrasher *Oreoscoptes montanus*	Shrub-steppe	Breeder	No records
Grasshopper Sparrow *Ammodramus savannarum*	Short-grass prairie, shrub-steppe	Breeder	No records
Bobolink *Dolichonyx oryzivorus*	Short-grass prairie, shrub-steppe	Uncommon occurrence	No records
Common Loon *Gavia immer*	Lakes, wetlands	Uncommon occurrence	No records
Black-billed Cuckoo *Coccyzus erythropthalmus*	Plains/basin riparian	No records	No records
Red-headed Woodpecker *Melanerpes erythrocephalus*	Plains/basin riparian, low-elevation conifer	Breeder	No records
Yellow-billed Cuckoo *Coccyzus americanus*	Plains/basin riparian	Uncommon occurrence	No records

Table 3.5-16. Migratory Bird Species of Management Concern in Wyoming-Non-coal List.

Species	Primary Nesting Habitat(s)	Status/Occurrence in Project Region[1]	Occurrence Within Project Area[2]
Eastern Screech Owl *Megascops asio*	Plains/basin riparian	No records	No records
Western Screech Owl *Megascops kennicottii*	Plains/basin riparian	No records	No records
Great Gray Owl *Strix nebulosa*	Mid-elevation conifer, High-elevation conifer	No records	No records
Boreal Owl *Aegolius funereus*	High elevation conifer	No records	No records
Broad-tailed Hummingbird *Selasphorus platycercus*	Montane riparian, Plains/basin riparian mid-elevation conifer	No records	No records
Western Scrub-Jay *Aphelocoma californica*	Juniper woodlands	No records	No records
Loggerhead shrike *Lanius ludovicianus*	Shrub-steppe	Breeder	No records
Vesper Sparrow *Pooecetes gramineus*	Shrub-steppe	Breeder	Observed, presumed breeder
Lark Sparrow *Chondestes grammacus*	Shrub-steppe	Breeder	No records
Golden-crowned Kinglet *Regulus satrapa*	High-elevation conifer	No records	No records
McGillivray's Warbler *Oporornis tolmiei*	Montane riparian, Plains/basin riparian	Uncommon occurrence	No records
Ash-throated Flycatcher *Myiarchus cinerascens*	Juniper woodlands	Uncommon occurrence	No records
Bushtit *Psaltriparus minimus*	Juniper woodlands	No records	No records
Brown Creeper *Certhia americana*	Mid-elevation conifer, high-elevation conifer	No records	No records
Merlin *Falco columbarius*	Low-elevation conifer	Breeder	No records
Sprague's Pipit *Anthus spragueii*	Grassland, Plains/Basin riparian, short-grass prairie	No records	No records
Barn Owl *Tyto alba*	Short-grass prairie, urban	Uncommon occurrence	No records
White-faced Ibis *Plegadis chihi*	Wetland, aquatic	Uncommon occurrence	No records

Table 3.5-16. Migratory Bird Species of Management Concern in Wyoming-Non-coal List.

Species	Primary Nesting Habitat(s)	Status/Occurrence in Project Region[1]	Occurrence Within Project Area[2]
American Bittern *Botaurus lentiginosus*	Wetland, aquatic	Uncommon occurrence	No records
Common Tern *Sterna hirundo*	Wetland, aquatic	Uncommon occurrence	No records
Purple Martin *Progne subis*	Wetland, aquatic/Basin riparian, montane riparian	No records	No records

[1] Wyoming latilong encompassing Moore Ranch Project (from Cerovski et al. 2004).
[2] Observed within proposed Moore Ranch Project permit area during wildlife surveys conducted from 2003-2007.

3.5.5.3.7 Waterfowl, Shorebirds

Wildlife surveys completed specifically for EMC and other energy projects in the area have documented numerous other wildlife species that inhabit the region, including various species of waterfowl and shorebirds. These species may or may not be locally common inhabitants of the area, depending on the quantity and quality of aquatic habitats present.

Under natural conditions, the proposed Moore Ranch License area provides extremely limited and marginal habitat for waterfowl and shorebirds. As described for other aquatics-related species, above, natural aquatic habitats are mainly present during spring migration. Many of those water features are reduced to small, isolated pools or are completely dry during summer. Recent CBM development in the Moore Ranch Project area has increased the number of water sources present in that area, though their flow and depth are still relatively minimal in nature and duration.

Several species of waterfowl and shorebird species were observed within the proposed License area during baseline studies conducted in 2006 and 2007. Those sightings consisted primarily of relatively low numbers of common species such as the mallard (*Anas platyrhynchos*) and killdeer (*Charadrius vociferus*), with other species recorded less often. Most observations occurred during spring migration in early 2007.

3.5.5.4 Threatened, Endangered, or Candidate Species

3.5.5.4.1 Bald Eagle (Haliaeetus leucocephalus)

The USFWS officially listed the bald eagle as an endangered species in 43 of the lower 48 states on July 4, 1976. The listing was due to a combination of several factors, including widespread habitat loss, negative effects of pesticide use on reproductive success, indiscriminant shooting, and others. The status of the bald eagle was upgraded to threatened throughout the lower 48 states in 1995. Bald eagle population trends began increasing throughout most of the species' range in the early 1990's, and it was proposed for de-listing in 1999. The USFWS removed (delisted) the bald eagle in the lower 48 states from the Federal List of Endangered and Threatened Wildlife in July 2007 (Federal Register 2007). However, the species will remain under the protection of the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Due to its status as a T&E species during field surveys for the Moore Ranch Project, and the recent occurrence of this delisting, the remaining discussion of bald eagles in this section is provided.

Bald eagles occur throughout North America, from Alaska and Canada south to Florida, the Gulf Coast, and northern Mexico. The northwest coast of North America serves as the stronghold for this species, with approximately one-half of the population inhabiting Alaska. The bald eagle is a relatively common winter resident and migrant in the Powder River Basin of northeast Wyoming, but only rarely nests in that region. In general, that area does not support consistent or concentrated sources of prey or carrion (e.g., fisheries, large groups of big game, waterfowl, or sheep, etc.) that would be expected to attract roosting or nesting bald eagles.

Biology and Habitat Requirements

Bald eagles typically nest in large trees within a stand of mature, similarly sized trees either along or in proximity (within 0.7 mile) to rivers, lakes, or reservoirs that harbor adequate fish populations. Those areas tend to be remote and experience little disturbance (Johnsgard 1990). Typically, the nest is placed in the crown of a large cottonwood or pine, but if the topography allows, eagles will nest on cliff edges or escarpments. Open-canopied trees and snags provide required perches in nesting and foraging areas.

All verified bald eagle nests in northeastern Wyoming (BLM Buffalo Field office GIS database) are located in significant, mature cottonwood stands along larger creeks or rivers (i.e., Tongue River, Powder River, Clear Creek, and Little Thunder Creek). Nesting attempts are rare elsewhere in the Powder River Basin (Beske 1994). Fish and waterfowl are the primary source of food for nesting bald eagles. Where available, large to mid-size carrion and large rodents (e.g., prairie dogs) can also be an important dietary component.

Bald eagles nest and winter throughout Wyoming, though typically are not locally abundant in the northeastern portion of the state. The species regularly migrates through and winters in Campbell County (Cerovski et al. 2004), and has often been documented during winter and early spring at local coal mines (see Annual Reports on file with the USFWS and LQD). Most eagles that migrate through or winter in Campbell County roost communally in stands of large ponderosa pine, along wooded cottonwood-riparian corridors, or in isolated stands of large trees. As water is scarce in the region, especially during winter, those birds likely forage widely for lagomorphs or carrion.

Existing Environment

No bald eagle nests or winter roosts have been documented within 1.0 mile of the Moore Ranch License area. The nearest documented winter roost is along the Powder River, approximately 10.0 miles to the northwest. Potential habitat for bald eagle nesting and roosting activities is quite limited within the project area (License and one-mile

perimeter). Only two small (10 trees or less) stands of mature cottonwoods are present on the Moore Ranch Project area itself, in the southwestern corner of the proposed License area. Other potential habitat is restricted to isolated or small (fewer than five trees) stands in the southern and southwestern portions of the one-mile perimeter. In general, the study area does not contain unique or sizeable, concentrated prey sources (e.g., fisheries, waterfowl wintering areas) that would be expected to attract bald eagles. No prairie dog colonies lie within the Moore Ranch study area boundary. Sheep and lambs are present in the spring, when bald eagles have typically left the region, though winter flocks are regularly pastured there. The area does not support a large big game herd, though some groups do winter in the area. No sightings of bald eagles occurred within the Moore Ranch survey area during winter roost surveys or other baseline surveys completed in that area from October 2006 through June 2007. No bald eagles were observed in or near the proposed License area during overlapping surveys in the area annually since 2003.

3.5.5.4.2 Black-footed Ferret (Mustela nigripes)

No occupied prairie dog colonies are present on or within one mile of the Moore Ranch Project area. Furthermore, that area is not within the boundaries of potential ferret reintroduction areas (USFS 2002, Grenier 2003). Consequently, the Proposed Action Alternative will have no direct, indirect, or cumulative effects on black-footed ferrets. The No Action Alternative also will have no effects on this species.

3.5.5.5 Aquatic Resources

3.5.5.5.1 Amphibians, Reptiles, and Aquatic Species

Wildlife surveys completed specifically for EMC and other energy projects in the area, as well as biological research projects in the eastern Powder River Basin, have documented numerous other wildlife species that inhabit the region, including various amphibians and reptiles. These species may or may not be locally common inhabitants of the area, depending on the quantity and quality of aquatic and other important habitats present.

Under natural conditions, aquatic habitat on and near the Moore Ranch Project area is limited by the ephemeral nature of surface waters in the general analysis area. The lack of deep-water habitat, and extensive and persistent water sources precludes the presence of fish, and limits the abundance and diversity of other aquatic species. As discussed above, water discharged from CBM wells has enhanced the water supply within some drainages in the general analysis area. However, those enhanced areas are still relatively

limited and/or isolated in nature, and no perennial drainages are present in the general analysis area.

Few reptiles and amphibians have been recorded during wildlife surveys conducted in the general analysis area over the years. The relatively low quantity and quality of aquatic habitat in the area reduces its potential to attract many of those species, particularly amphibians and turtles. Likewise, few rock outcrops or other habitats attractive to terrestrial reptiles are present in the project area.

The only herpetological species recorded within the proposed Moore Ranch Project License area during specific baseline studies in 2006 and 2007 was the common bullsnake (*Pituophis cantenifer sayi*), though others may have been present without being detected.

ADDENDUM 3.5-A

VEGETATION SPECIES SUMMARY

			Vegetation Community			
Code	Scientific Name	Common Name	Meadow Grassland	Upland Grassland	Agricultural Grassland	Big Sage Shrubland
Annual Grasses						
ALOCAR	*Alopecurus carolinianus*	Foxtail	X			
BROCOM	*Bromus commutatus*	Bromegrass	X			
BROJAP	*Bromus japonicus*	Japanese brome	X	X	X	X
BROTEC	*Bromus tectorum*	Cheatgrass	X	X	X	X
VULOCT	*Vulpia octoflora*	Sixweeks fescue	X	X	X	X
Perennial Grasses seasonality Unknown						
CARDOU	*Carex douglasii*	Douglas sedge	X			
Cool Season Grasses						
ACHHYM	*Achnatherum hymenoides*	Indian ricegrass			X	
AGRCRI	*Agropyron cristatum*	Crested wheatgrass	X	X	X	
AGRSTO	*Agrostis stolonifera*	Carpet bent	X			
BROINE	*Bromus inermis*	Smooth brome	X		X	
CARFIL	*Carex filifolia*	Threadleaf sedge	X	X	X	X
CARNEB	*Carex nebrascensis*	Nebraska sedge	X			
CARPRA	*Carex praegracilis*	Silver sedge	X			
CARSPP	*Carex* species	Sedge	X			
CARSTE	*Carex stenophylla*	Needleleaf sedge	X			
ELEACI	*Eleocharis acicularis*	Slender spikerush	X			
ELEPAL	*Eleocharis palustris*	Creeping spikerush	X			
ELYHIS	*Elymus hispidus*	Intermediate wheatgrass		X		
ELYLAN	*Elymus lanceolatus*	Thickspike wheatgrass	X	X	X	X
ELYSMI	*Elymus smithii*	Western wheatgrass	X	X	X	X
HESCOM	*Hesperostipa comata*	Needle-and-thread	X	X	X	X
JUNBAL	*Juncus balticus*	Baltic rush	X			
KOEMAC	*Koeleria macrantha*	Prairie junegrass	X	X	X	X
NASVIR	*Nassella viridula*	Green needlegrass	X	X	X	X
POABUL	*Poa bulbosa*	Bulbous bluegrass			X	
POACOM	*Poa compressa*	Canada bluegrass		X		
POAPRA	*Poa pratensis*	Kentucky bluegrass	X	X	X	X
POASEC	*Poa secunda*	Sandberg bluegrass	X	X	X	X
POASPP	*Poa* species	Bluegrass	X		X	
SCISPP	*Scirpus* species	Bulrush	X			
Warm Season Grasses						
BOUGRA	*Bouteloua gracilis*	Blue grama		X	X	X
BUCDAC	*Buchloe dactyloides*	Buffalo grass		X		X

			Vegetation Community			
Code	Scientific Name	Common Name	Meadow Grassland	Upland Grassland	Agricultural Grassland	Big Sage Shrubland
Annual Forbs						
ALYALY	*Alyssum alyssoides*	Pale alyssum	X	X		X
ALYDES	*Alyssum desertorum*	Desert alyssum	X	X	X	X
ALYSPP	*Alyssum* species	Alyssum		X		X
BASSIE	*Bassia sieversiana*	Fireweed summercypress			X	
CAMMIC	*Camelina microcarpa*	Littleseed falseflax	X	X	X	X
CHEBER	*Chenopodium berlandieri*	Pitseed goosefoot	X			
DESPIN	*Descurainia pinnata*	Tansy mustard	X		X	
DESSOP	*Descurainia sophia*	Flixweed tansy mustard	X	X	X	X
HALGLO	*Halogeton glomeratus*	Halogeton		X		X
LAPRED	*Lapulla redowskii*	Beggar's tick	X	X	X	X
PHALIN	*Phacelia linearis*	Phacelia				X
PLAPAT	*Plantago patagonica*	Pursh's plantain		X	X	X
SALTRA	*Salsola tragus*	Russian thistle			X	
THLARV	*Thlaspi arvense*	Field pennycress	X		X	
VERPER	*Veronica peregrina*	Purslane speedwell	X			
Biennial Forbs						
MELOFF	*Melilotus officianalis*	Yellow sweetclover	X		X	
TRADUB	*Tragopogon dubius*	Salsify	X	X	X	
Perennial Forbs						
ACHMIL	*Achillea millefolium*	Western yarrow	X	X	X	X
AGOGLA	*Agoseris glauca*	Pale agoseris	X	X		
ALLTEX	*Allium textile*	Textile onion	X	X		X
AMBPSI	*Ambrosia psilostachya*	Western ragweed		X		
ANTDIM	*Antennaria dimorpha*	Low pussytoes	X		X	
ANTMIC	*Antennaria microphylla*	Littleleaf pussytoes	X			X
ASTBIS	*Astragalus bisulcatus*	Two-grooved milkvetch	X	X		
ASTMIS	*Astragalus miser*	Weedy milkvetch	X	X	X	X
BESWYO	*Besseya wyomingensis*	Wyoming besseya	X			
CALNUT	*Calochortus nuttallii*	Sego lily	X			
CERARV	*Cerastium arvense*	Field mouse ear	X		X	X
CIRARV	*Cirsium arvense*	Canada thistle	X	X	X	X
CONARV	*Convolvulus arvensis*	Field bindweed			X	X
DELBIC	*Delphinium bicolor*	Little larkspur	X			
ECHANG	*Echinacea angustifolia*	Blacksamson echinacea	X			X
EQUARV	*Equisetum arvense*	Field horsetail	X			
EQULAE	*Equisetum laevigatum*	Smooth horsetail	X			
ERIOCH	*Erigeron ochroleucus*	Fleabane		X	X	X

		Vegetation Community				
Code	Scientific Name	Common Name	Meadow Grassland	Upland Grassland	Agricultural Grassland	Big Sage Shrubland
GAUCOC	*Gaura coccinea*	Scarlet gaura	X	X	X	X
GRISQU	*Grindelia squarrosa*	Gumweed			X	X
HETVIL	*Heterotheca villosa*	Golden aster	X			
LEWRED	*Lewisia rediviva*	Bitterroot	X	X		X
LINLEW	*Linum lewisii*	Blue flax	X			
LINPUN	*Linanthus pungens*	Granite prickly gilia	X			
LITINC	*Lithospermum incisum*	Pacoon	X			
LOMFOE	*Lomatium foeniculaceum*	Biscuitroot	X	X	X	X
LYGJUN	*Lygodesmia juncea*	Skeletonweed			X	
MACPIN	*Machaeranthera pinnatifida*	Ironplant goldenweed		X		
MEDLUP	*Medicago lupulina*	Black medic	X	X	X	
MEDSAT	*Medicago sativa*	Alfalfa medic	X			
MEDSPP	*Medicago* species	Medic	X		X	
MENARV	*Mentha arvensis*	Field mint	X			
MUSDIV	*Musineon divaricatum*	Wild parsley	X	X		
PEDARG	*Pediomelum argophyllum*	Silverleaf scurfpea	X		X	
PEDESC	*Pediomelum esculentum*	Breadroot scurfpea		X		X
PENALB	*Penstemon albidus*	White beardtounge		X		
PENERI	*Penstemon eriantherus*	Fuzzytounge penstemon			X	
PHLHOO	*Phlox hoodii*	Hoods phlox		X		X
PHLLON	*Phlox longifolia*	Longleaf phlox		X		X
POTSPP	*Potentilla* species	Cinquefoil	X			
RUMSPP	*Rumex* species	Dock	X			
SOLSPP	*Solidago* species	Goldenrod	X			
SPHCOC	*Sphaeralcea coccinea*	Scarlet globemallow	X	X	X	X
TAROFF	*Taraxacum officinale*	Common dandelion	X	X	X	X
TYPLAT	*Typha latifolia*	Common cattail	X			
VICAME	*Vicia americana*	American vetch	X	X	X	X
Perennial Half & Sub-Shrubs						
ARTFRI	*Artemisia frigida*	Fringed sagewort		X	X	X
ARTLUD	*Artemisia ludoviciana*	Louisiana sagewort	X	X		
ARTPED	*Artemisia pedatifida*	Birdfoot sagewort		X		X
ATRGAR	*Atriplex gardneri*	Gardner's saltbush			X	
GUTSAR	*Gutierrezia sarothrae*	Broom snakeweed			X	
HYMRIC	*Hymenoxys richardsonii*	Pingue rubberweed			X	X
Perennial Shrubs						
ARTCAN	*Artemisia cana*	Silver sagebrush	X	X		X
ARTTRI	*Artemisia tridentata*	Big sagebrush		X		X
ATRCAN	*Atriplex canascens*	Four-wing saltbush				X
Succulent						
CORVIV	*Coryphantha vivipara*	Purple ball cactus			X	
OPUPOL	*Opuntia polyacantha*	Plains prickly pear	X	X	X	X

			Vegetation Community			
Code	Scientific Name	Common Name	Meadow Grassland	Upland Grassland	Agricultural Grassland	Big Sage Shrubland
Fungi						
MUSSPP	*Mushroom* species	Mushroom	X	X	X	X
Lichen						
XANSPP	*Xanthoparmelia* species	Lichen		X		X

Species observed but not sampled.

ADDENDUM 3.5-B

VEGETATION COVER SUMMARIES

Energy Metals
Moore Ranch
Report: Cover Summary

Site Id: UG
Name: Upland grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/15/2007

*() Represents Second Hit Data

Sample Method: Point Intercept
Sample Size: 50 Meter Transect
Number of Samples: 20
Report Date: 8/13/2007

Species	Cover (%) Mean Absolute *	Cover (%) Relative	Std. Dev. n - 1	Frequency (%) Absolute	Frequency (%) Relative	I.V.	Rank
Annual & Biennial Forbs							
Alyssum desertorum	9.60(1.90)	14.04	6.38	85.00	8.90	22.94	3
Alyssum species	0.20	0.29	0.62	10.00	1.05	1.34	24
Halogeton glomeratus	0.20	0.29	0.62	10.00	1.05	1.34	25
Plantago patagonica	2.60(0.50)	3.80	3.95	55.00	5.76	9.56	7
Sub-Total	12.60	18.42					
Annual Grasses							
Bromus japonicus	2.40(0.20)	3.51	4.66	40.00	4.19	7.70	8
Bromus tectorum	4.00(0.40)	5.85	4.94	65.00	6.81	12.66	6
Vulpia octoflora	1.70(0.30)	2.49	3.39	30.00	3.14	5.63	11
Sub-Total	8.10	11.85					
Cacti & Succulents							
Opuntia polyacantha	0.50	0.73	1.10	20.00	2.09	2.82	16
Sub-Total	0.50	0.73					
Cool Season Perennial Grasses							
Carex filifolia	10.50(0.90)	15.35	9.86	90.00	9.42	24.77	2
Elymus lanceolatus	0.20(0.10)	0.29	0.89	5.00	0.52	0.81	28
Elymus smithii	14.60(2.10)	21.35	8.08	95.00	9.95	31.30	1
Hesperostipa comata	4.10(0.40)	5.99	4.56	65.00	6.81	12.80	5
Koeleria macrantha	0.30(0.10)	0.44	0.98	15.00	1.57	2.01	20
Poa secunda	1.40(0.10)	2.05	2.98	30.00	3.14	5.19	12
Sub-Total	31.10	45.47					
Full Shrubs							
Artemisia cana	0.20(0.10)	0.29	0.62	15.00	1.57	1.86	22
Artemisia tridentata	0.70	1.02	1.63	20.00	2.09	3.11	15
Sub-Total	0.90	1.31					
Introduced Perennial Grasses							
Elymus hispidus	0.50	0.73	2.24	5.00	0.52	1.25	27
Poa pratensis	2.10	3.07	4.13	30.00	3.14	6.21	10
Sub-Total	2.60	3.80					
Lower Plants							
Lichens	5.60(0.60)	8.19	4.97	90.00	9.42	17.61	4
Sub-Total	5.60	8.19					
Perennial Forbs							
Achillea millefolium	0.10	0.15	0.45	5.00	0.52	0.67	29
Allium textile	0.10	0.15	0.45	5.00	0.52	0.67	30
Ambrosia psilostachya	0.40	0.58	1.05	15.00	1.57	2.15	18
Lomatium foeniculaceum	0.20	0.29	0.62	10.00	1.05	1.34	26
Phlox hoodii	1.70	2.49	2.45	40.00	4.19	6.68	9
Phlox longifolia	0.40	0.58	1.23	10.00	1.05	1.63	23
Psoralea tenuiflora	0.10	0.15	0.45	5.00	0.52	0.67	32
Sphaeralcea coccinea	0.40	0.58	0.82	20.00	2.09	2.67	17
Vicia americana	0.60(0.30)	0.88	1.14	30.00	3.14	4.02	13
Sub-Total	4.00	5.85					
Sub-Shrubs & Half-Shrubs							
Artemisia frigida	0.10	0.15	0.45	5.00	0.52	0.67	31
Artemisia pedatifida	0.60	0.88	2.26	10.00	1.05	1.93	21

Energy Metals
Moore Ranch
Report: Cover Summary

Site Id: M
Name: Meadow grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/15/2007

*() Represents Second Hit Data

Sample Method: Point Intercept
Sample Size: 50 Meter Transect
Number of Samples: 20
Report Date: 8/13/2007

Species	Cover (%) Mean Absolute *	Relative	Std. Dev. n - 1	Frequency (%) Absolute	Relative	I.V.	Rank
Agoseris glauca	0.50	0.62	1.10	20.00	1.91	2.53	21
Antennaria dimorpha	0.20	0.25	0.89	5.00	0.48	0.73	38
Astragalus miser	0.10	0.12	0.45	5.00	0.48	0.60	42
Besseya wyomingensis	0.60	0.74	1.96	10.00	0.96	1.70	30
Cerastium arvense	0.70	0.87	1.63	20.00	1.91	2.78	15
Cirsium arvense	0.40	0.49	0.82	20.00	1.91	2.40	22
Delphinium bicolor	0.70	0.87	1.87	20.00	1.91	2.78	16
Echinacea angustifolia	0.70	0.87	1.87	20.00	1.91	2.78	17
Equisetum arvense	0.20	0.25	0.62	10.00	0.96	1.21	33
Equisetum laevigatum	0.20	0.25	0.62	10.00	0.96	1.21	34
Lithospermum incisum	0.10	0.12	0.45	5.00	0.48	0.60	50
Lomatium foeniculaceum	0.10	0.12	0.45	5.00	0.48	0.60	51
Medicago lupulina	0.30	0.37	0.98	10.00	0.96	1.33	32
Medicago sp.	0.40	0.49	1.39	10.00	0.96	1.45	31
Mentha arvensis	0.10(0.10)	0.12	0.45	5.00	0.48	0.60	52
Solidago sp.	0.40	0.49	1.05	15.00	1.44	1.93	27
Taraxacum officinale	1.50(0.20)	1.85	3.49	35.00	3.35	5.20	10
Trifolium species	0.10	0.12	0.45	5.00	0.48	0.60	55
Vicia americana	2.00(0.50)	2.47	3.37	50.00	4.78	7.25	8
Sub-Total	13.10	16.18					
Sub-Shrubs & Half-Shrubs							
Artemisia ludoviciana	0.30(0.10)	0.37	0.73	15.00	1.44	1.81	29
Linanthus pungens	0.10	0.12	0.45	5.00	0.48	0.60	49
Sub-Total	0.40	0.49					
Total Stratified Vegetation Cover	87.00	2.01	8.01				
Total Non-Stratified Vegetation Cover	80.90	2.01	6.37				
LITTER/ROCK	13.90		7.27				
Total Ground Cover	94.80		6.33				
BARE SOIL	5.20		6.37				
Total Cover	100.00		2.24				
Species Abundance (No. of Species/Sample)	56.00						

Energy Metals
Moore Ranch
Report: Cover Summary

Site Id: M
Name: Meadow grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/15/2007

*() Represents Second Hit Data

Sample Method: Point Intercept
Sample Size: 50 Meter Transect
Number of Samples: 20
Report Date: 8/13/2007

Species	Cover (%) Mean Absolute *	Cover (%) Relative	Std. Dev. n - 1	Frequency (%) Absolute	Frequency (%) Relative	I.V.	Rank
Annual & Biennial Forbs							
Alyssum alyssoides	1.10	1.36	3.52	10.00	0.96	2.32	23
Alyssum desertorum	7.00(0.70)	8.65	6.76	65.00	6.22	14.87	3
Camelina microcarpa	0.10	0.12	0.45	5.00	0.48	0.60	43
Chenopodium berlandieri	0.40	0.49	1.79	5.00	0.48	0.97	35
Descurainia pinnata	0.10	0.12	0.45	5.00	0.48	0.60	47
Descurainia sophia	0.10	0.12	0.45	5.00	0.48	0.60	48
Lappula redowskii	0.70	0.87	2.70	10.00	0.96	1.83	28
Sub-Total	9.50	11.73					
Annual Grasses							
Alopecurus carolinianus	0.10	0.12	0.45	5.00	0.48	0.60	41
Bromus commutatus	0.20	0.25	0.89	5.00	0.48	0.73	39
Bromus japonicus	2.40	2.97	5.30	25.00	2.39	5.36	9
Bromus tectorum	6.60(0.80)	8.16	6.90	70.00	6.70	14.86	4
Vulpia octoflora	0.10	0.12	0.45	5.00	0.48	0.60	56
Sub-Total	9.40	11.62					
Cacti & Succulents							
Opuntia polyacantha	0.10	0.12	0.45	5.00	0.48	0.60	54
Sub-Total	0.10	0.12					
Cool Season Perennial Grasses							
Agrostis stolonifera	0.10	0.12	0.45	5.00	0.48	0.60	40
Carex douglasii	0.10	0.12	0.45	5.00	0.48	0.60	44
Carex filifolia	0.90(0.20)	1.11	2.38	20.00	1.91	3.02	14
Carex nebrascensis	1.00	1.24	4.03	10.00	0.96	2.20	25
Carex praegracilis	1.00	1.24	2.94	15.00	1.44	2.68	18
Carex sp.	0.10	0.12	0.45	5.00	0.48	0.60	45
Carex stenophylla	0.10	0.12	0.45	5.00	0.48	0.60	46
Eleocharis acicularis	0.30(0.10)	0.37	1.34	5.00	0.48	0.85	37
Elymus lanceolatus	1.40	1.73	3.79	15.00	1.44	3.17	12
Elymus smithii	19.20(0.80)	23.73	17.80	80.00	7.66	31.39	1
Hesperostipa comata	0.90(0.10)	1.11	3.14	15.00	1.44	2.55	20
Juncus balticus	4.10(0.20)	5.07	12.52	30.00	2.87	7.94	7
Koeleria macrantha	0.40	0.49	1.05	15.00	1.44	1.93	26
Nassella viridula	0.10	0.12	0.45	5.00	0.48	0.60	53
Poa secunda	0.30(0.10)	0.37	0.73	20.00	1.91	2.28	24
Poa sp.	0.40	0.49	1.79	5.00	0.48	0.97	36
Scirpus spp	1.30(0.70)	1.61	3.45	15.00	1.44	3.05	13
Sub-Total	31.70	39.16					
Full Shrubs							
Artemisia cana	0.60	0.74	1.31	20.00	1.91	2.65	19
Sub-Total	0.60	0.74					
Introduced Perennial Grasses							
Agropyron cristatum	2.60	3.21	7.11	20.00	1.91	5.12	11
Bromus inermis	7.90(0.40)	9.77	14.79	50.00	4.78	14.55	5
Poa pratensis	5.60(0.50)	6.92	4.75	85.00	8.13	15.05	2
Sub-Total	16.10	19.90					
Perennial Forbs							
Achillea millefolium	3.80(0.60)	4.70	3.89	80.00	7.66	12.36	6

Energy Metals
Moore Ranch
Report: Cover Summary

Site Id: BS
Name: Big sagebrush shrubland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/13/2007

*() Represents Second Hit Data

Sample Method: Point Intercept
Sample Size: 50 Meter Transect
Number of Samples: 20
Report Date: 8/13/2007

Species	Cover (%) Mean Absolute *	Relative	Std. Dev. n - 1	Frequency (%) Absolute	Relative	I.V.	Rank
Sphaeralcea coccinea	0.90(0.10)	1.27	1.37	40.00	3.65	4.92	14
Taraxacum officinale	0.10	0.14	0.45	5.00	0.46	0.60	37
Vicia americana	3.00(0.40)	4.22	2.64	75.00	6.85	11.07	6
Sub-Total	6.90	9.71					
Sub-Shrubs & Half-Shrubs							
Artemisia frigida	0.40	0.56	1.79	5.00	0.46	1.02	26
Artemisia pedatifida	0.10	0.14	0.45	5.00	0.46	0.60	30
Hymenoxys richardsonii	0.30	0.42	0.98	10.00	0.91	1.33	23
Sub-Total	0.80	1.12					
Warm Season Perennial Grasses							
Bouteloua gracilis	0.50	0.70	2.24	5.00	0.46	1.16	25
Buchloe dactyloides	0.90	1.27	2.20	15.00	1.37	2.64	19
Sub-Total	1.40	1.97					
Total Stratified Vegetation Cover	71.80	2.34	12.78				
Total Non-Stratified Vegetation Cover	67.30	2.34	9.85				
LITTER/ROCK	23.70		12.60				
Total Ground Cover	94.80		6.72				
BARE SOIL	8.90		6.76				
Total Cover	100.00		0.45				
Species Abundance (No. of Species/Sample)	38.00						

Energy Metals
Moore Ranch
Report: Cover Summary

Page 1 of 2

Site Id: BS
Name: Big sagebrush shrubland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/13/2007

*() Represents Second Hit Data

Sample Method: Point Intercept
Sample Size: 50 Meter Transect
Number of Samples: 20
Report Date: 8/13/2007

Species	Cover (%) Mean Absolute *	Relative	Std. Dev. n - 1	Frequency (%) Absolute	Relative	I.V.	Rank
Annual & Biennial Forbs							
Alyssum alyssoides	0.30	0.42	1.34	5.00	0.46	0.88	27
Alyssum desertorum	9.40(1.20)	13.22	5.55	95.00	8.68	21.90	1
Halogeton glomeratus	1.00	1.41	2.10	25.00	2.28	3.69	17
Plantago patagonica	3.70(0.30)	5.20	3.91	65.00	5.94	11.14	5
Sub-Total	14.40	20.25					
Annual Forbs							
Phacelia linearis	0.40	0.56	1.39	10.00	0.91	1.47	22
Sub-Total	0.40	0.56					
Annual Grasses							
Bromus japonicus	4.10	5.77	5.82	40.00	3.65	9.42	11
Bromus tectorum	6.20(1.00)	8.72	8.63	65.00	5.94	14.66	4
Vulpia octoflora	1.60(0.10)	2.25	2.39	35.00	3.20	5.45	13
Sub-Total	11.90	16.74					
Cacti & Succulents							
Opuntia polyacantha	0.10	0.14	0.45	5.00	0.46	0.60	35
Sub-Total	0.10	0.14					
Cool Season Perennial Grasses							
Carex filifolia	3.50(0.10)	4.92	5.31	55.00	5.02	9.94	10
Elymus lanceolatus	0.90	1.27	2.38	20.00	1.83	3.10	18
Elymus smithii	10.20(0.70)	14.35	9.45	75.00	6.85	21.20	2
Hesperostipa comata	3.30	4.64	3.96	60.00	5.48	10.12	9
Koeleria macrantha	1.20(0.20)	1.69	1.36	50.00	4.57	6.26	12
Nassella viridula	0.30	0.42	0.98	10.00	0.91	1.33	24
Poa secunda	0.20(0.10)	0.28	0.62	15.00	1.37	1.65	20
Sub-Total	19.60	27.57					
Full Shrubs							
Artemisia cana	0.40	0.56	1.39	10.00	0.91	1.47	21
Artemisia tridentata	4.40	6.19	6.31	50.00	4.57	10.76	7
Atriplex canescens	0.10	0.14	0.45	5.00	0.46	0.60	31
Sub-Total	4.90	6.89					
Introduced Perennial Grasses							
Poa pratensis	6.90	9.70	5.82	80.00	7.31	17.01	3
Sub-Total	6.90	9.70					
Lower Plants							
Lichens	3.80(0.10)	5.34	5.15	55.00	5.02	10.36	8
Sub-Total	3.80	5.34					
Perennial Forbs							
Achillea millefolium	1.00	1.41	1.65	35.00	3.20	4.61	16
Antennaria microphylla	0.10	0.14	0.45	5.00	0.46	0.60	29
Cerastium arvense	0.10	0.14	0.45	5.00	0.46	0.60	32
Convolvulus arvensis	0.10	0.14	0.45	5.00	0.46	0.60	33
Echinacea angustifolia	0.10	0.14	0.45	5.00	0.46	0.60	34
Oenothera sp.	0.00(0.10)	0.00	0.00	5.00	0.46	0.46	38
Pediomelum argophyllum	0.10	0.14	0.45	5.00	0.46	0.60	36
Phlox hoodii	1.20(0.20)	1.69	2.28	35.00	3.20	4.89	15
Phlox longifolia	0.20	0.28	0.89	5.00	0.46	0.74	28

Energy Metals
Moore Ranch
Report: Cover Summary

Site Id: AG
Name: Agricultural grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/13/2007

*() Represents Second Hit Data

Sample Method: Point Intercept
Sample Size: 50 Meter Transect
Number of Samples: 22
Report Date: 8/13/2007

Species	Cover (%) Mean Absolute *	Relative	Std. Dev. n - 1	Frequency (%) Absolute	Relative	I.V.	Rank
Bouteloua gracilis	0.09	0.13	0.43	4.55	0.60	0.73	25
Sub-Total	0.09	0.13					
Total Stratified Vegetation Cover	68.72	4.89	7.80				
Total Non-Stratified Vegetation Cover	68.09	4.89	7.84				
LITTER/ROCK	24.73		6.00				
Total Ground Cover	92.91		4.57				
BARE SOIL	7.09		4.57				
Total Cover	100.00		0.00				
Species Abundance (No. of Species/Sample)	31.00						

Energy Metals
Moore Ranch
Report: Cover Summary

Site Id: AG
Name: Agricultural grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/13/2007

*() Represents Second Hit Data

Sample Method: Point Intercept
Sample Size: 50 Meter Transect
Number of Samples: 22
Report Date: 8/13/2007

Species	Cover (%) Mean Absolute *	Relative	Std. Dev. n - 1	Frequency (%) Absolute	Relative	I.V.	Rank
Annual & Biennial Forbs							
Alyssum desertorum	16.64	24.40	7.23	100.00	13.17	37.57	2
Bassia sieveriana	0.09	0.13	0.43	4.55	0.60	0.73	24
Descurainia pinnata	0.09	0.13	0.43	4.55	0.60	0.73	28
Lappula redowskii	0.36	0.53	1.00	13.64	1.80	2.33	15
Melilotus officinalis	0.18	0.27	0.59	9.09	1.20	1.47	21
Plantago patagonica	2.27	3.33	3.56	45.45	5.99	9.32	5
Thlaspi arvense	0.09	0.13	0.43	4.55	0.60	0.73	30
Sub-Total	19.72	28.92					
Annual Grasses							
Bromus japonicus	0.55	0.80	1.10	22.73	2.99	3.79	11
Bromus tectorum	8.18	12.00	9.68	59.09	7.78	19.78	3
Vulpia octoflora	0.36	0.53	1.18	9.09	1.20	1.73	19
Sub-Total	9.09	13.33					
Cacti & Succulents							
Coryphantha vivipara	0.09	0.13	0.43	4.55	0.60	0.73	27
Sub-Total	0.09	0.13					
Cool Season Perennial Grasses							
Carex filifolia	0.09	0.13	0.43	4.55	0.60	0.73	26
Elymus lanceolatus	1.73	2.53	2.64	40.91	5.39	7.92	6
Elymus smithii	2.18	3.20	3.65	31.82	4.19	7.39	7
Nassella viridula	0.36	0.53	1.00	13.64	1.80	2.33	17
Poa secunda	1.27(0.18)	1.87	1.80	40.91	5.39	7.26	9
Poa sp.	0.18	0.27	0.59	9.09	1.20	1.47	22
Sub-Total	5.81	8.53					
Fungi							
Mushroom sp.	0.09	0.13	0.43	4.55	0.60	0.73	29
Sub-Total	0.09	0.13					
Introduced Perennial Grasses							
Agropyron cristatum	24.64	36.13	11.24	100.00	13.17	49.30	1
Bromus inermis	0.91	1.33	1.72	27.27	3.59	4.92	10
Poa bulbosa	1.73(0.18)	2.53	2.98	36.36	4.79	7.32	8
Poa pratensis	0.73	1.07	1.58	18.18	2.40	3.47	13
Sub-Total	28.01	41.06					
Perennial Forbs							
Achillea millefolium	0.09	0.13	0.43	4.55	0.60	0.73	23
Convolvulus arvensis	0.27	0.40	0.94	9.09	1.20	1.60	20
Lygodesmia juncea	0.55	0.80	1.10	22.73	2.99	3.79	12
Medicago lupulina	0.00(0.18)	0.00	0.00	4.55	0.60	0.60	31
Medicago sp.	0.36	0.53	1.00	13.64	1.80	2.33	16
Sphaeralcea coccinea	0.55	0.80	1.26	18.18	2.40	3.20	14
Vicia americana	2.91(0.09)	4.27	5.08	68.18	8.98	13.25	4
Sub-Total	4.73	6.93					
Sub-Shrubs & Half-Shrubs							
Atriplex gardneri	0.55	0.80	1.87	9.09	1.20	2.00	18
Sub-Total	0.55	0.80					
Warm Season Perennial Grasses							

Energy Metals
Moore Ranch
Report: Cover Summary

Site Id: UG
Name: Upland grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/15/2007

*() Represents Second Hit Data

Sample Method: Point Intercept
Sample Size: 50 Meter Transect
Number of Samples: 20
Report Date: 8/13/2007

Species	Cover (%) Mean Absolute *	Cover (%) Relative	Std. Dev. n - 1	Frequency (%) Absolute	Frequency (%) Relative	I.V.	Rank
Sub-Total	0.70	1.03					
Warm Season Perennial Grasses							
Bouteloua gracilis	1.60	2.34	4.52	15.00	1.57	3.91	14
Buchloe dactyloides	0.70	1.02	2.36	10.00	1.05	2.07	19
Sub-Total	2.30	3.36					
Total Stratified Vegetation Cover	70.20	1.30	14.62				
Total Non-Stratified Vegetation Cover	62.80	1.14	11.65				
LITTER/ROCK	19.50		7.94				
Total Ground Cover	87.90		6.15				
BARE SOIL	12.30		6.17				
Total Cover	95.00		0.89				
Species Abundance (No. of Species/Sample)	32.00						

ADDENDUM 3.5-C

VEGETATION DENSITY SUMMARIES

Energy Metals
Moore Ranch
Report: Density Summary

Site Id: AG
Name: Agricultural grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/11/2007

Sample Method: Transect
Sample Size: 50 sq. m.
Number of Samples: 22
Report Date: 8/13/2007

	Mean (Number/Plot)	Relative Density	Std. Dev. n - 1 (Number/Plot)	Mean (Number/sq.m.)	Mean (Number/Acre)
Full Shrubs					
Artemisia cana	6.45	77.17	14.64	0.13	522.64
Artemisia tridentata	1.41	16.85	6.61	0.03	114.10
Atriplex canescens	0.32	3.80	1.29	0.01	25.76
Sub-Total	8.18	97.83	22.54	0.16	662.50
Sub-Shrubs & Half-Shrubs					
Artemisia frigida	0.18	2.17	0.50	0.00	14.72
Sub-Total	0.18	2.17	0.50	0.00	14.72
Total	8.36	100.00	17.05	0.17	677.22

Energy Metals
Moore Ranch
Report: Density Summary

Site Id: BS
Name: Big sagebrush shrubland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/14/2007

Sample Method: Transect
Sample Size: 50 sq. m.
Number of Samples: 20
Report Date: 8/13/2007

	Mean (Number/Plot)	Relative Density	Std. Dev. n - 1 (Number/Plot)	Mean (Number/sq.m.)	Mean (Number/Acre)
Full Shrubs					
Artemisia cana	12.20	17.38	18.86	0.24	987.85
Artemisia tridentata	34.70	49.43	37.46	0.69	2,809.72
Atriplex canescens	3.80	5.41	13.38	0.08	307.69
Sub-Total	50.70	72.22	69.69	1.01	4,105.26
Sub-Shrubs & Half-Shrubs					
Artemisia frigida	16.70	23.79	58.01	0.33	1,352.23
Artemisia pedatifida	2.80	3.99	12.52	0.06	226.72
Sub-Total	19.50	27.78	70.53	0.39	1,578.95
Total	70.20	100.00	60.34	1.40	5,684.21

Energy Metals
Moore Ranch
Report: Density Summary

Site Id: M
Name: Meadow grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/15/2007

Sample Method: Transect
Sample Size: 50 sq. m.
Number of Samples: 20
Report Date: 8/13/2007

	Mean (Number/Plot)	Relative Density	Std. Dev. n - 1 (Number/Plot)	Mean (Number/sq.m.)	Mean (Number/Acre)
Full Shrubs					
Artemisia cana	3.15	87.50	7.34	0.06	255.06
Atriplex canescens	0.10	2.78	0.45	0.00	8.10
Sub-Total	3.25	90.28	7.79	0.07	263.16
Sub-Shrubs & Half-Shrubs					
Artemisia frigida	0.30	8.33	1.13	0.01	24.29
Krascheninnikovia lanata	0.05	1.39	0.22	0.00	4.05
Sub-Total	0.35	9.72	1.35	0.01	28.34
Total	3.60	100.00	8.34	0.07	291.50

Energy Metals
Moore Ranch
Report: Density Summary

Site Id: UG
Name: Upland grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/15/2007

Sample Method: Transect
Sample Size: 50 sq. m.
Number of Samples: 20
Report Date: 8/13/2007

	Mean (Number/Plot)	Relative Density	Std. Dev. n - 1 (Number/Plot)	Mean (Number/sq.m.)	Mean (Number/Acre)
Full Shrubs					
Artemisia cana	4.60	20.00	7.26	0.09	372.47
Artemisia tridentata	7.40	32.17	12.56	0.15	599.19
Atriplex canescens	0.05	0.22	0.22	0.00	4.05
Sub-Total	12.05	52.39	20.04	0.24	975.71
Sub-Shrubs & Half-Shrubs					
Artemisia frigida	2.95	12.83	5.93	0.06	238.87
Artemisia pedatifida	8.00	34.78	28.33	0.16	647.77
Sub-Total	10.95	47.61	34.26	0.22	886.64
Total	23.00	100.00	29.35	0.46	1,862.35

Energy Metals
Moore Ranch
Report: Density Summary

Site Id: UG
Name: Upland grassland
Comm. Type/Form: Vegetation Baseline
Sample Date: 6/15/2007

Sample Method: Transect
Sample Size: 50 sq. m.
Number of Samples: 20
Report Date: 8/13/2007

	Mean (Number/Plot)	Relative Density	Std. Dev. n - 1 (Number/Plot)	Mean (Number/sq.m.)	Mean (Number/Acre)

ADDENDUM 3.5-D

MOORE RANCH VEGETATION MAP

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

DRAWING NO.: FIGURE 3.5.5-1, "MOORE RANCH URANIUM PROJECT VEGETATION MAPPING"

WITHIN THIS PACKAGE... OR, BY SEARCHING USING THE DOCUMENT/REPORT DRAWING NO. FIGURE 3.5.5-1

D-01

ADDENDUM 3.5-E

WETLAND LOCATION SUMMARY AND MAPS

Table 3.5-14: Summary of Wetlands within the Project Area

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Simmons Draw	W1	Sec. 4 T41N R75W	Roll 1 P4 & P5	Non-Wetland	--	--	Foot slope	Upland vegetation	--
Simmons Draw	W3	Sec. 4 T41N R75W	Roll 1 P6 & P7	Non-Wetland	--	--	Depression area	Depression area caused by berm	--
Simmons Draw	Wpt 4	Sec. 4 T41N R75W	Roll 1 P11 & P12	Non-wetland	--	--	Tributary to main drainage	Upland grass in tributary	--
Simmons Draw	W5	Sec. 4 T41N R75W	Roll 1 P17 & P18	Wetland	POW		Pond due to man made berm	--	Non-jurisdictional
Simmons Draw	W6	Sec. 33 T42N R75W	Roll 1 P19 & P20	Non-wetland	--	--	Drainage bottom	Upland vegetation	--
Simmons Draw	W7	Sec. 33 T42N R75W	Roll 1 P22 & P23	Non-wetland	--	--	Drainage bottom	Upland vegetation	--
Simmons Draw	W8	Sec. 33 T42N R75W	Roll 1 P24-P26	Non-wetland	--	--	Depression in drainage	Upland vegetation dominant	--
Simmons Draw	*W9*	Sec. 33 T42N R75W	No Photo	Non-wetland	--	--	Drainage bottom	Primarily upland vegetation	--
Simmons Draw	*W10*	Sec. 33 T42N R75W	Roll 1 P27 &	Wetland	PEM		Depression located in an	PEM identified	Non-jurisdictional

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
			P28				upland area	with NWI mapping	
Simmons Draw	W11	Sec. 33 T42N R75W	Roll 1 P29 & P30	Non-wetland	--	--	Drainage bottom	Primarily upland vegetation	--
Simmons Draw	W12	Sec. 33 T42N R75W	Roll 1 P31	Wetland	PEM		Drainage	--	Non-jurisdictional
Simmons Draw	*W13*	Sec. 4 T41N R75W	Roll 1 P32-P34	--	--	--	--	--	--
Simmons Draw	W14	Sec. 4 T41N R75W	No Photo	Non-wetland	--	--	Tributary of main drainage	Vegetation and hydrology is out	--
Simmons Draw	W15	Sec. 4 T41N R75W	Roll 1 P35 & P36	Non-wetland	--	--	Tributary of main drainage	Silver sage in bottom of drainage	--
Simmons Draw	W16	Sec. 4 T41N R75W	Roll 2 P1-P3	Stock Pond	PEM & POW		Stock pond	Vegetation in drainage is dominated by FACU & UPL plants	Non-jurisdictional
Simmons Draw	Wpt. 5	Sec. 4 T41N R75W	Roll 2 P4 & P5	Pond	PEM		--	Pond bermed on all sides	Non-jurisdictional

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Simmons Draw	W17	Sec. 4 T41N R75W	Roll 2 P6 & P7	Non-wetland	--	--	Drainage bottom	Upland vegetation is same throughout	--
Simmons Draw	Wpt. 9	Sec. 4 T41N R75W	Roll 2 P8	Non-wetland	--	--	Stock pond area dammed	Vegetation dominated by upland	--
Simmons Draw	W18	Sec. 3 T41N R75W	Roll 2 P9 & P10	Non-wetland	--	--	Drainage bottom	--	--
Simmons Draw	W19	Sec. 3 T41N R75W	Roll 2 P11-P13	Wetland	PUB		Stock pond	--	Non-jurisdictional
Simmons Draw	Wpt. 16	Sec. 3 T41N R75W	Roll 2 P14 & P15	Wetland	PEM		Stock pond	Soils similar to W19	Non-jurisdictional
Simmons Draw	W20	Sec. 3 T41N R75W	Roll 2 P16 & P17	Wetland	PUB		Drainage bottom	--	Non-jurisdictional
Simmons Draw	W21	Sec. 3 T41N R75W	Roll 2 P18 & P19	Non-wetland	--	--	Drainage bottom	--	--
Simmons Draw	Wpt. 23	Sec. 3 T41N R75W	Roll 2 P20 & P21	Non-wetland	--	--	Drainage bottom	Dominated by UPL and FACU	--

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
								vegetation	
Simmons Draw	W22	Sec. 3 T41N R75W	Roll 2 P22 & P23	Non-wetland	--	--	Drainage bottom	--	--
Simmons Draw	Wpt. 24	Sec. 2 T41N R75W	Roll 2 P24 & P25	Non-wetland	--	--	Drainage bottom	Upland vegetation found in drainage bottom	--
Ninemile Creek	W23	Sec. 10 T41N R75W	Roll 2 P26 & P27	Wetland	PUB		Drainage bottom	--	Non-jurisdictional
Ninemile Creek	Wpt. 25	Sec. 10 T41N R75W	Roll 2 P28-P30	Wetland	PUB		--	End wetland channel, CBM outfall	Non-jurisdictional
Ninemile Creek	W24	Sec. 9 T41N R75W	Roll 2 P31 & R32	Wetland	PUB		Pond area	Secondary Indicator is water	Non-jurisdictional
Ninemile Creek	Wpt. 33	Sec. 9 T41N R75W	Roll 2 P33 & P34	Wetland	PUB		Pond and drainage bottom	Drainage vegetation same as W24	Non-jurisdictional
Ninemile Creek	W25	Sec. 4 T41N R75W	Roll 2 P35 & P36	Non-wetland	--	--	Drainage bottom	--	--

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Ninemile Creek	Wpt. 34	Sec. 9 T41N R75W	Roll 2 P37 & P38	Non-wetland	--	--	Drainage bottom	Vegetation is dominated by UPL and FACU	--
Tributary to Simmons Draw	W26	Sec. 3 T41N R75W	Roll 2 P39	Non-wetland	--	--	Drainage bottom	--	--
Tributary to Simmons Draw	W27	Sec. 34 T42N R75W	Roll 2 P40 & P41	Wetland	PEM & POW		Edge of drainage	CBM Well	Non-jurisdictional
Tributary to Simmons Draw	W28	Sec. 34 T42N R75W	Roll 2 P42 & P43	Wetland	PUB		Drainage bottom	--	Non-jurisdictional
Tributary to Simmons Draw	Wpt. 36	Sec. 34 T42N R75W	Roll 2 P44 & P45	Wetland	PEM & POW		Drainage bottom	--	Non-jurisdictional
Tributary to Simmons Draw	W29	Sect. 34 T42N R75W	Roll 2 P46 & P47	Wetland	PUB		Floodplain	--	Non-jurisdictional
Tributary to	Wpt. 38	Sec. 34 T42N R75W	Roll 2 P48-P50	Wetland	PEM		Drainage by outfall	CBM Outfall	Non-jurisdictional

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Simmons Draw									
Tributary to Simmons Draw	W30	Sec. 3 T41N R75W	Roll 3 P1 & P2	Non-wetland	--	--	Drainage bottom	--	--
Tributary to Simmons Draw	W31	Sec. 34 T42N R75W	Roll 3 P3 & P4	Wetland	PUB		Drainage bottom	Second hydrology indicators redox concentrations found in dead roots	Non-jurisdictional
Tributary to Simmons Draw	Wpt. 40	Sec. 34 T42N R75W	Roll 3 P5& P6	Wetland	PEM & POW		Pond	OBL vegetation present	Non-jurisdictional
Tributary to Simmons Draw	W32	Sec. 34 T42N R75W	Roll 3 P7-P9	Non-wetland	--	--	Outfall	--	--
Tributary to Simmons Draw	W33	Sec. 34 T42N R75W	Roll 3 P10 & P11	Non-wetland	--	--	Drainage bottom	End of wetland characteristics are dropping out	--

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Tributary to Simmons Draw	W34	Sec. 34 T42N R75W	Roll 3 P12-P14	Wetland	PEM			Near windmill	Non-jurisdictional
Tributary to Simmons Draw	W35	Sec. 35 T42N R75W	Roll 3 P15-P17	Non-wetland	--	--	Drainage	Wetland boundary	--
Second Tributary to Simmons Draw	W36	Sec. 35 T42N R75W	Roll 3 P20 & P21	Wetland	POW		Stock pond	--	Non-jurisdictional
Second Tributary to Simmons Draw	W37	Sec. 35 T42N R75W	Roll 3 P24 & P25	Wetland	PUB		Drainage bottom	--	Non-jurisdictional
Second Tributary to Simmons Draw	W38	Sec. 35 T42N R75W	Roll 3 P26 & P27	Non-wetland	--	--	Drainage bottom	Swale in downstream photo (roll 3, photo 27)	--
Second Tributary to Simmons Draw	Wpt. 57	Sec. 34 T42N R75W	Roll 3 P28 & P29	Wetland	PEM		CBM outfall area	CBM outfall area and bermed area	Non-jurisdictional

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Second Tributary to Simmons Draw	Wpt. 71	Sec. 35 T42N R75W	Roll 3 P30 & P31	Wetland	PEM & POW		CBM	OBL vegetation dominant in area, water from outfall present	Non-jurisdictional
Second Tributary to Simmons Draw	W39	Sec. 35 T42N R75W	Roll 3 P32-P35	Non-wetland	--	--	Flat floodplain	Near outfall area	--
Second Tributary to Simmons Draw	W40	Sec. 35 T42N R75W	Roll 3 P38-P41	Wetland	PEM		Drainage bottom	Open water in channel below	Non-jurisdictional
Second Tributary to Simmons Draw	Wpt. 72	Sec. 35 T42N R75W	Roll 3 P36 & P37	Non-wetland	--	--	Drainage bottom	Silver sage in drainage	--
Second Tributary to Simmons Draw	W41	Sec. 2 T41N R75W	Roll 3 P45 & P46	Non-wetland	--	--	Drainage bottom	Dead root channels	--

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Second Tributary to Simmons Draw	Wpt. 77	Sec. 2 T41N R75W	Roll 3 P42-P44	Non-wetland	--	--	Culvert and berm	South side of vegetation similar to W39, berm area	--
Second Tributary to Simmons Draw	W42	Sec. 35 T42N R75W	Roll 3 P52 & P53	Wetland	PUB		--	--	Non-jurisdictional
Second Tributary to Simmons Draw	Wpt. 78	Sec. 35 T42N R75W	Roll 3 P47-P51	Wetland	POW		Pond near outfall	OBL vegetation present on fringe	Non-jurisdictional
Second Tributary to Simmons Draw	Wpt. 92	Sec. 35 T42N R75W	Roll 4 P4-P6	Wetland	PEM at Outfall		CBM outfall	--	Non-jurisdictional
Second Tributary to Simmons Draw	Wpt. 93	Sec. 36 T42N R75W	Roll 4 P7 & P8	Wetland	PEM		Drainage bottom	Drainage below outfall	Non-jurisdictional
Pine Tree	Wpt. 95	Sec. 36	Roll 4	Non-	--	--	Pond	Outfall	--

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Draw		T42N R75W	P11	wetland				and surrounding pond are dry	
Pine Tree Draw	Wpt. 98	Sec. 26 T42N 75W	Roll 4 P23 & P24	Wetland	PEM		Wellhead and drainage	Water from well head, PEM from Wpt. 98-W48	Non-jurisdictional
Pine Tree Draw	Wpt. 102	Sec. 25 T42N R75W	No Photo	Non-wetland	--	--	CBM outfall	No water	--
Pine Tree Draw	Wpt. 103-104	Sec. 25 T42N R75W	Roll 4 P32-P35	Wetland	PEM		Drainage bottom	Upland encroaching on bottom of drainage to the west	--
Pine Tree Draw	Wpt. 115	Sec. 36 T42N R7W	Roll 4 P39 & P40	Wetland	PEM		Drainage bottom	Near culvert Upland area in middle	--
Pine Tree	Wpt. 117	Sec. 36	Roll 4	Non-wetland	--	--	CBM Outfall	--	--

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Draw		T42N R75W	P46-P48						
Pine Tree Draw	Wpt. 119	Sec. 1 T41N R75W	--	--	--	--	--	--	--
Pine Tree Draw	Wpt. 128	Sec. 1 T41N R75W	Roll 4 P59 & P60	Wetland	PEM & POW		Stock pond	Similar characteristics to other large ponds	--
Second Tributary to Simmons Draw	Wpt. 129 (move point to the west to SC27)	Sec. 27 T42N R75W	Roll 4 P61-P63	Wetland	POW		Stock pond	Similar characteristics to other large ponds	--
Second Tributary to Simmons Draw	W43	Sec. 35 T42N R75W	Roll 3 P54 & P55	Wetland	PEM		Drainage bottom	Soils same as W42 No water source	Non-jurisdictional
Second Tributary to Simmons Draw	W44	Sec. 35 T42N R75W	Roll 4 P1-P3	Wetland	PEM		Drainage bottom	--	Non-jurisdictional

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Pine Tree Draw	W45	Sec. 36 T42N R75W	Roll 4 P9 & P10	Non-Wetland	--	--	Drainage bottom	Edge of wetland boundary More upland vegetation and slight topological change	--
Pine Tree Draw	W46	Sec. 36 T42N R75W	Roll 4 P12-P14	Non-Wetland	--	--	Drainage bottom	Hydrophytic vegetation to east (W47) that abuts drainage	--
Pine Tree Draw	W47	Sec. 36 T42N R75W	Roll 4 P16-P18	Wetland	PEM		Swale that abuts drainage bottom	Upper portion of drainage east of W46	Non-jurisdictional
Pine Tree Draw	W48	Sec. 26 T42N R75W	Roll 4 P19-P21	Wetland	PEM and POW		Drainage bottom	Channel approx. 20-25 ft Water coming from outfall; more	Non-jurisdictional

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
								redox concentrations lower in depth	
Pine Tree Draw	W50	Sec. 25 T42N R75W	Roll 4 P24-P26	Non-wetland	--	--	Hillslope drainage	Wet boundary where tank water begins	--
Pine Tree Draw	W51	Sec. 25 T42N R75W	Roll 4 P27 & P28	Non-wetland	--	--	Drainage bottom	Oxidation in pore lining and matrix below 5 inches and above 5-8 inches	--
Pine Tree Draw	W52	Sec. 25 T42N R75W	Roll 4 P30 & P31	Non-wetland	--	--	Drainage bottom	Cattail remnants 15' upstream from point	--
Pine Tree Draw	W53	Sec. 36 T42N R75W	Roll 4 P36-P38	Wetland	POW		Pond	WPT 109 pipe with water running out	Non-jurisdictional

Drainage	Map and Plot ID (no Data Form 1 if italicized)	Legal Description	Photo #	2007 Delineation Designation	Cowardin Classification	Acreage of Cowardin Classification	Geomorphic Setting	Comments	Jurisdictional Recommendation
Pine Tree Draw	W54	Sec. 36 T42N R75W	Roll 4 P41-P43	Wetland	PUB		Drainage bottom	--	Non-jurisdictional
Pine Tree Draw	W55	Sec. 36 T42N R75W	Roll 4 P44 & P45	Non-wetland	--	--	Drainage bottom	Possible soil effects from CBM water; redox features from 3-7 inches; dead root channels	--

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DRAWING NO.: FIGURE 3.5.5-2, "MOORE RANCH WETLAND MAPPING"

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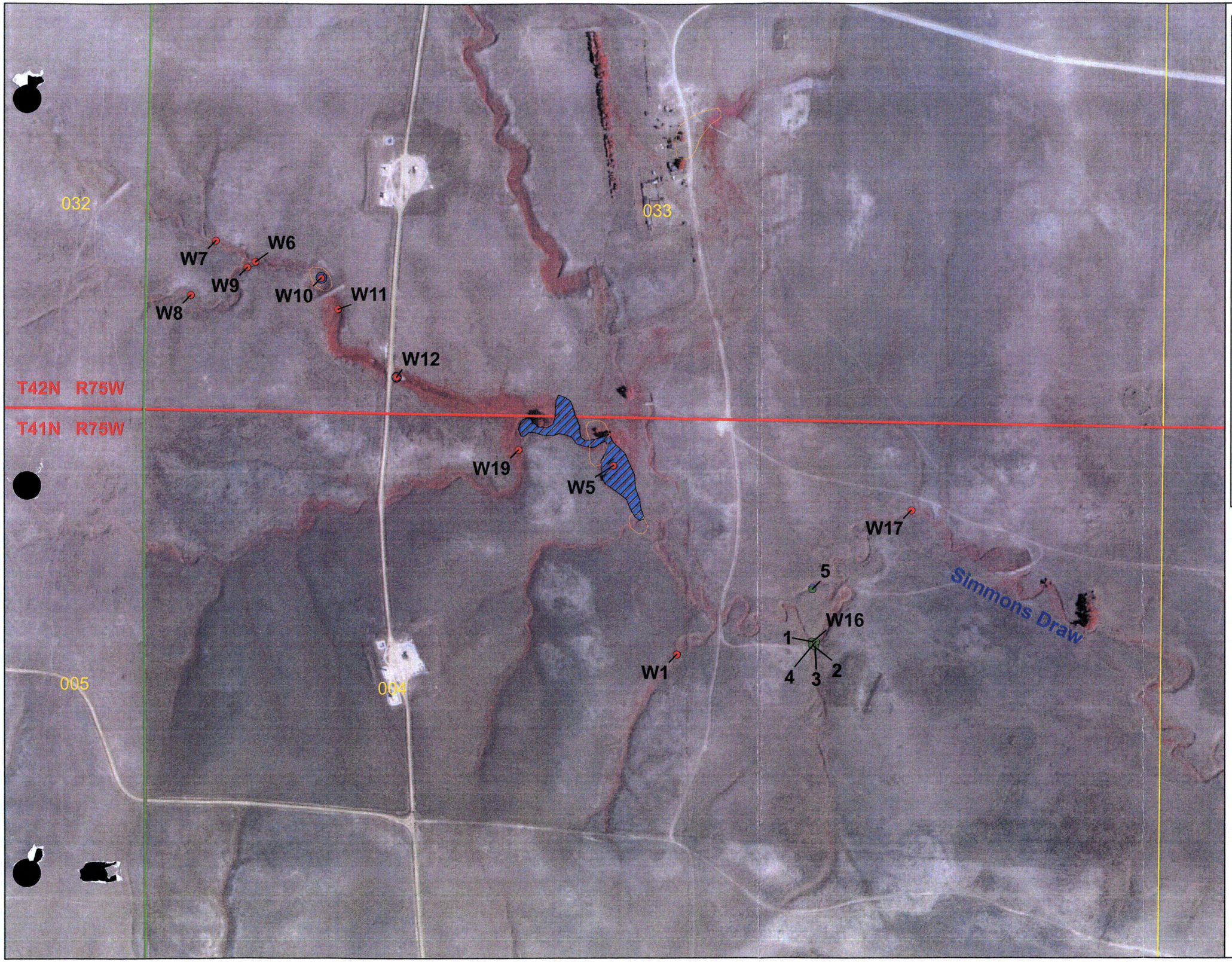
D-02



ENERGYMETALS
CORPORATION US

Figure 3.5.5-3

Moore Ranch Wetland Map (Simmons Draw)

Designed by: K. Halvorson
Drawn by: C. Robinson/LSI
Checked by: K. Halvorson
Date Drawn: 6/29/2007
Date Modified: 9/4/2007

Scale: 1"= 500'
Projection: NAD 1983, UTM Zone 13
Year of CIR photo: 2001
Sheet 1 of 1
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Legals

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Sections 26-27, 33-36
T42N R74 W
SW1/4 of Sec. 31
SW1/2, SW1/4 of Sec. 30

T41N R75W
Sections 2, 3, 4
N/12, N12 of Sec. 1
W1/2, W1/2 of Sec. 1
NE1/4 of Sec. 9
NW1/4 of Sec. 10

Legend

- BKS Points
- D10a Points
- Windmill
- 1976 NWI Mapping (PEM)
- Wetland Channel
- Pond
- Berm
- Permit Boundary
- Central Plant Facility and Compressor Station
- Wellfield Areas
- Township/Range Line
- Section Line

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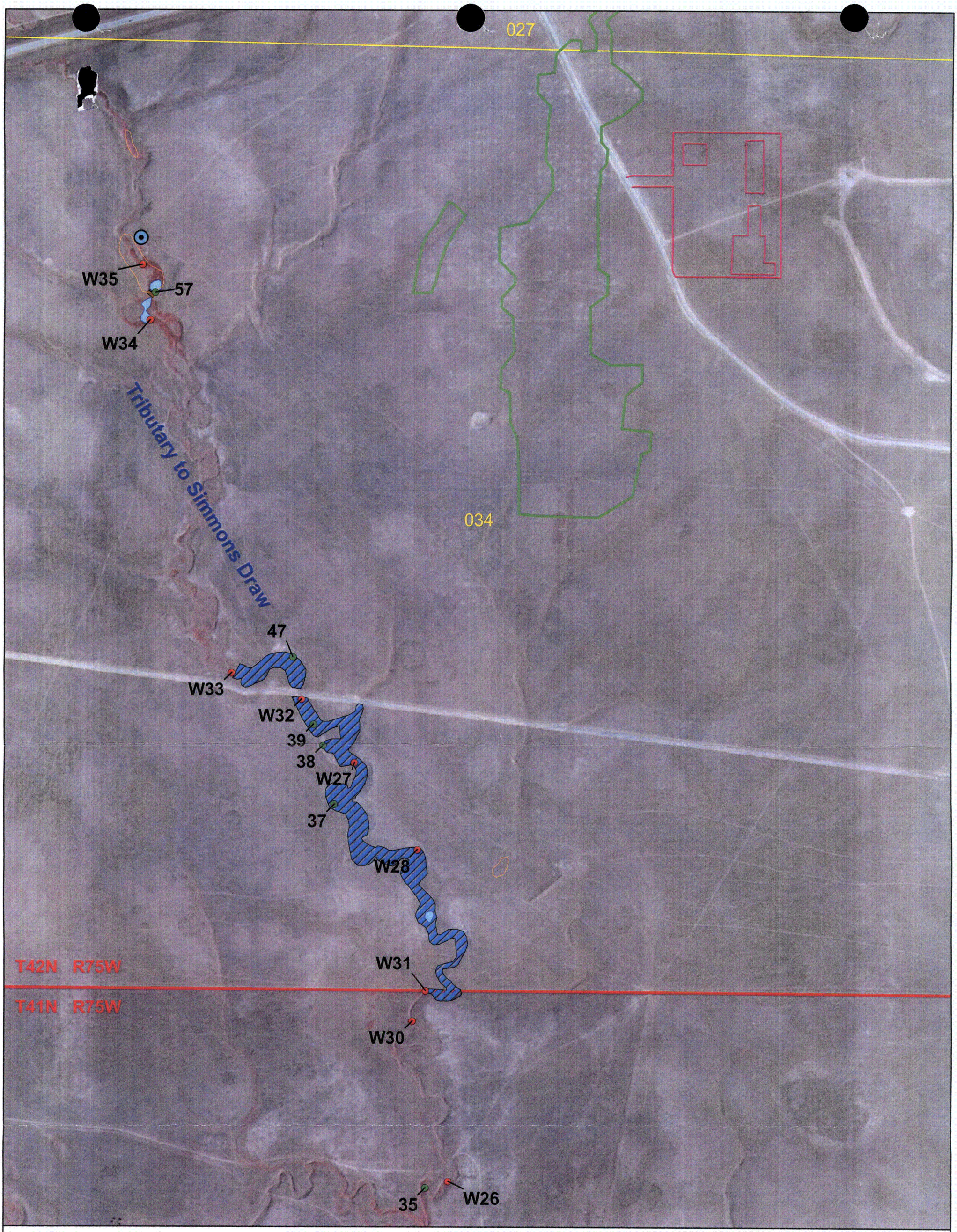

Legals

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SW1/4 of Sec. 31	W1/2, W1/2 of Sec. 1
SW1/2, SW1/4 of Sec. 30	NE1/4 of Sec. 9
	NW1/4 of Sec. 10

Designed by: K. Halvorson
Drawn by: C. Robinson/LSI
Checked by: K. Halvorson
Date Drawn: 6/29/2007
Date Modified: 9/4/2007

Scale: 1"= 500'
Projection: NAD 1983, UTM Zone 13
Year of CIR photo: 2001
Sheet 1 of 1
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ENERGYMETALS
CORPORATION US

Figure 3.5.5-4

Moore Ranch Wetland Map (Tributary to Simmons Draw)

Legend

- BKS Points
- D10a Points
- Windmill
- 1976 NWI Mapping (PEM)
- Wetland Channel
- Pond
- Berm
- Permit Boundary
- Central Plant Facility and Compressor Station
- Wellfield Areas
- Township/Range Line
- Section Line

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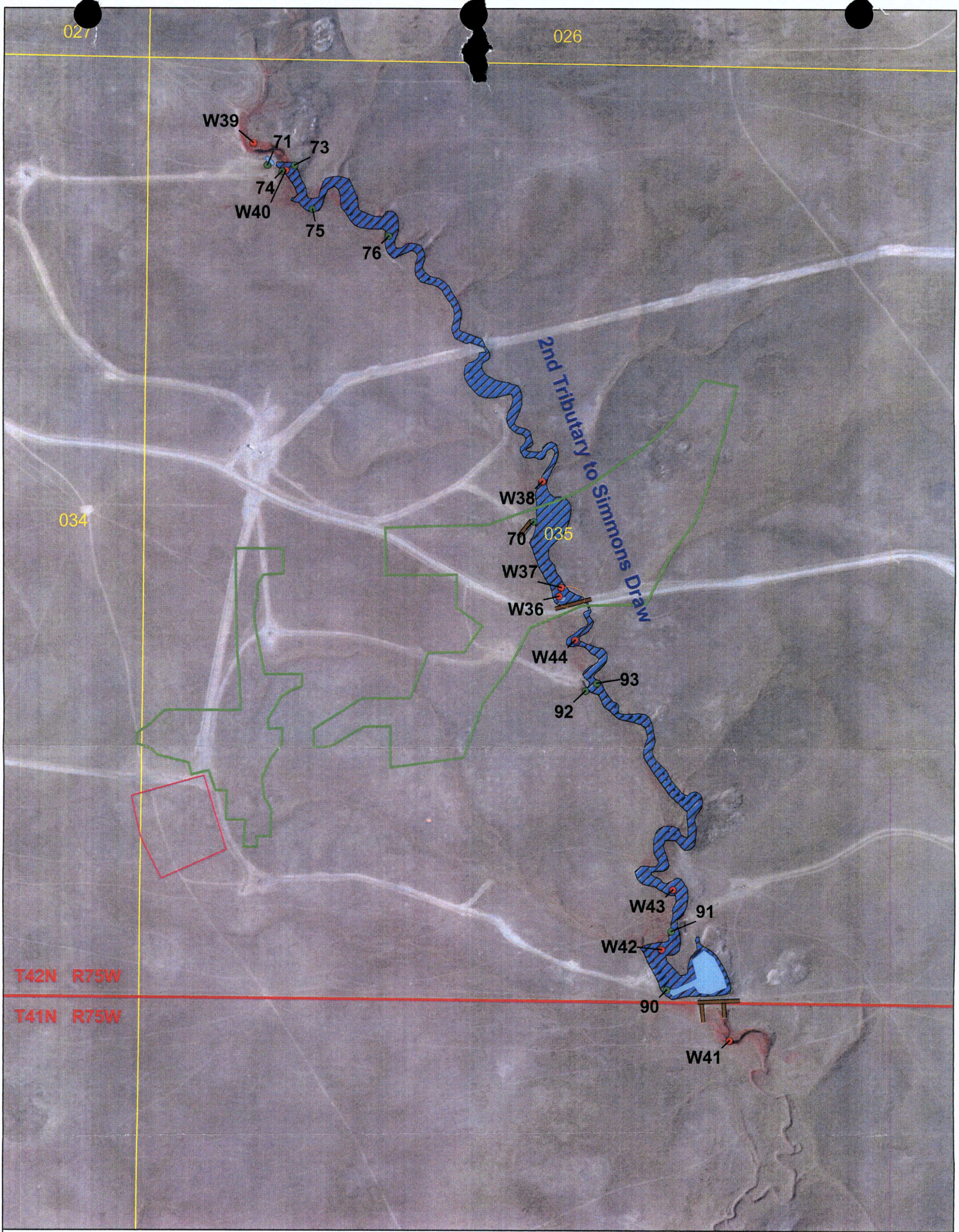

Legals

T42N R75W	T41N R75W
Sections 26-27, 33-36	Sections 2, 3, 4
T42N R74 W	N/12, N12 of Sec. 1
SW1/4 of Sec. 31	W1/2, W1/2 of Sec. 1
SW1/2, SW1/4 of Sec. 30	NE1/4 of Sec. 9
	NW1/4 of Sec. 10

Designed by: K. Halvorson
Drawn by: C. Robinson/LSI
Checked by: K. Halvorson
Date Drawn: 6/29/2007
Date Modified: 9/4/2007

Scale: 1"= 500'
Projection: NAD 1983, UTM Zone 13
Year of CIR photo: 2001
Sheet 1 of 1
File:C:\DATA\ArcGIS \BKS Environmental\07251\MAP\ Moore_Ranch_Tributary_SD2.mxd

ENERGYMETALS
CORPORATION US

Figure 3.5.5-5

Moore Ranch Wetland Map (Second Tributary to Simmons Draw)

Legend

- BKS Points
- D10a Points
- Windmill
- 1976 NWI Mapping (PEM)
- Wetland Channel
- Pond
- Berm
- Permit Boundary
- Central Plant Facility and Compressor Station
- Wellfield Areas
- Township/Range Line
- Section Line

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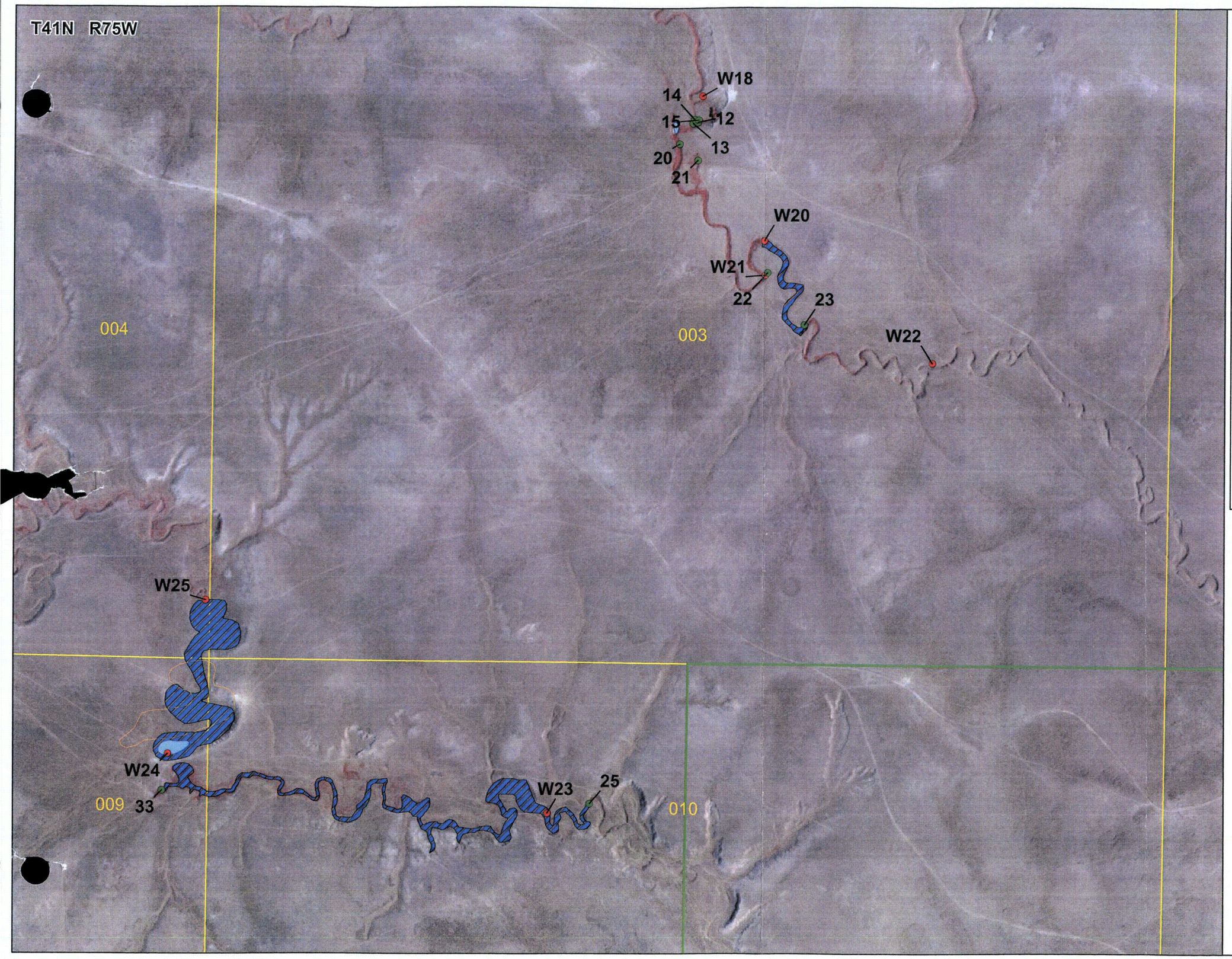

ENERGYMETALS
CORPORATION US

Figure 3.5.5-6

Moore Ranch Wetland Map (Nine Mile Creek)

Designed by: K. Halvorson
Drawn by: C. Robinson/LSI
Checked by: K. Halvorson
Date Drawn: 6/29/2007
Date Modified: 9/4/2007

Scale: 1"= 500'
Projection: NAD 1983, UTM Zone 13
Year of CIR photo: 2001
Sheet 1 of 1
File:C:\DATA\ArcGIS \BKS Environmental\07251\MAP\ Moore_Ranch_NineMileCreek.mxd

Legals

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Sections 26-27, 33-36
T42N R74 W
SW1/4 of Sec. 31
SW1/2, SW1/4 of Sec. 30

T41N R75W
Sections 2, 3, 4
N/12, N12 of Sec. 1
W1/2, W1/2 of Sec. 1
NE1/4 of Sec. 9
NW1/4 of Sec. 10

Legend

- BKS Points
- D10a Points
- Windmill
- 1976 NWI Mapping (PEM)
- Wetland Channel
- Pond
- Berm
- Permit Boundary
- Central Plant Facility and Compressor Station
- Wellfield Areas
- Township/Range Line
- Section Line

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W51
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W52
W45
W46
95
W47
Pine Tree Draw
94
W53
109
105
W54
116
W55
117
118
T42N R75W
T41N R75W

Legals

T42N R75W	T41N R75W
Sections 26-27, 33-36	Sections 2, 3, 4
T42N R74 W	N/12, N12 of Sec. 1
SW1/4 of Sec. 31	W1/2, W1/2 of Sec. 1
SW1/2, SW1/4 of Sec. 30	NE1/4 of Sec. 9
	NW1/4 of Sec. 10

Designed by: K. Halvorson
Drawn by: C. Robinson/LSI
Checked by: K. Halvorson
Date Drawn: 6/29/2007
Date Modified: 9/4/2007

Scale: 1"= 600'
Projection: NAD 1983, UTM Zone 13
Year of CIR photo: 2001
Sheet 1 of 1
File:C:\DATA\ArcGIS \BKS Environmental\07251\MAP\ PineTreeDraw.mxd

ENERGYMETALS
CORPORATION US

Figure 3.5.5-7

Moore Ranch Wetland Map (Pine Tree Draw)

Legend

- BKS Points
- D10a Points
- Windmill
- 1976 NWI Mapping (PEM)
- Wetland Channel
- Pond
- Berm
- Permit Boundary
- Central Plant Facility and Compressor Station
- Wellfield Areas
- Township/Range Line
- Section Line

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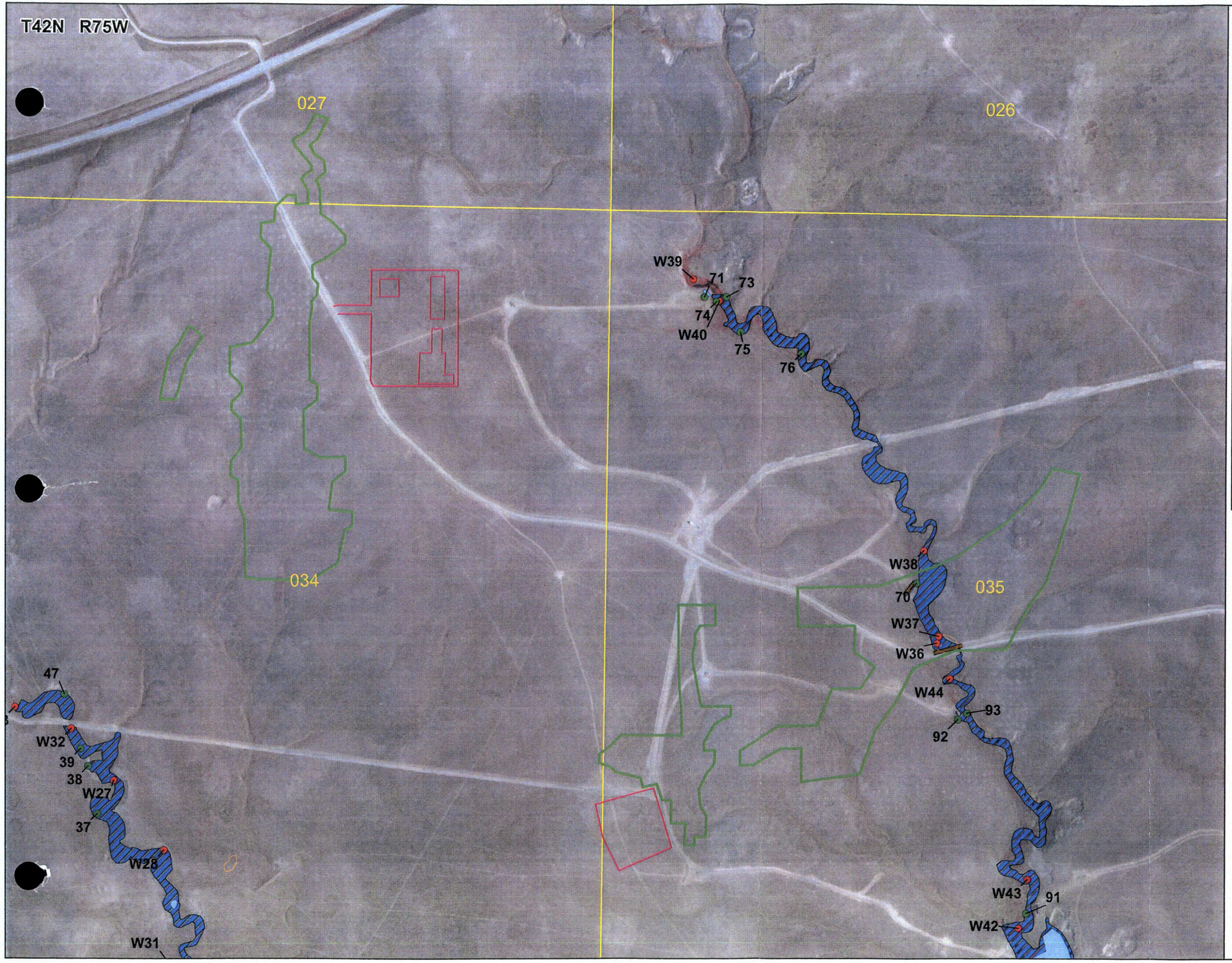

ENERGYMETALS
CORPORATION US

Figure 3.5.5-8

Moore Ranch Wetland Map (Wellfield Areas)

Designed by: K. Halvorson
Drawn by: C. Robinson/LSI
Checked by: K. Halvorson
Date Drawn: 6/29/2007
Date Modified: 9/4/2007

Scale: 1"= 625'
Projection: NAD 1983, UTM Zone 13
Year of CIR photo: 2001
Sheet 1 of 1
File:C:\DATA\ArcGIS \BKS Environmental\07251\MAP\ Moore_Ranch_Wellfields.mxd

Legals

T42N R75W
Sections 26-27, 33-36
T42N R74 W
SW1/4 of Sec. 31
SW1/2, SW1/4 of Sec. 30

T41N R75W
Sections 2, 3, 4
N/12, N12 of Sec. 1
W1/2, W1/2 of Sec. 1
NE1/4 of Sec. 9
NW1/4 of Sec. 10

Legend

- BKS Points
- D10a Points
- Windmill
- 1976 NWI Mapping (PEM)
- Wetland Channel
- Pond
- Berm
- Permit Boundary
- Central Plant Facility and Compressor Station
- Wellfield Areas
- Township/Range Line
- Section Line

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ADDENDUM 3.5-F

WETLAND SPECIES LIST

Scientific Name	Common Name	Indicator Status
Achillea millefolium	Common yarrow	FACU
Achnatherum hymendoides	Indian ricegrass	UPL
Agropyron cristatum	Crested wheatgrass	UPL
Alyssum alyssoides	Pale alyssum	UPL
Alyssum desertorum	Desert alyssum	UPL
Ambrosia tomentosa	Skeletonleaf bursage	UPL
Antennaria species	Pussytoes	UPL
Artemisia cana	Silver sagebrush	FACU
Astragulus miser	Timber milkvetch	UPL
Bromus inermis	Smooth brome	FACU
Bromus japiconus	Japanese brome	FACU
Bromus tectorum	Cheatgrass brome	UPL
Carex brevior	Sedge	FACU
Carex nebrascensis	Nebraska sedge	OBL
Carex praegracilis	Fieldclustered sedge	FACW
Carex species	Sedge	UPL
Cerastium arvense	Field cerastium	FACU
Cerastium vulgatum	Big chickweed	FACU
Cirsium arvense	Canada thistle	FACU
Danthonia species	Oatgrass	UPL
Descurainia sophia	Herb sophia	UPL
Eleocharis acicularis	Slender spikerush	OBL
Eleocharis palustris	Creeping spikerush	OBL
Elymus hispidus	Intermediate wheatgrass	UPL
Elymus smithii	Western wheatgrass	UPL
Equisetum arvense	Field horsetail	FAC
Helianthus species	Sunflower	UPL
Hordeum jubatum	Foxtail barley	FACW
Juncus balticus	Baltic rush	OBL
Juncus bufonius	Toad rush	OBL
Juncus gerardii	Saltmeadow rush	FAC
Koeleria macrantha	Prairie junegrass	UPL
Lappula redowski	Beggars tick	UPL
Medicago lupulina	Black medic	FACU
Medicago sativa	Alfalfa medic	NI
Microsteris gracilis	Slender phlox	UPL
Nassella viridula	Green needlegrass	UPL
Navarretia intertexta	Needleleaf navarretia	NI

Scientific Name	Common Name	Indicator Status
Phleum pratense	Common timothy	FACU
Poa pratensis	Kentucky bluegrass	FACU
Polygonum species	Knotweed	UPL
Polygonum aviculare	Prostrat knotweed	FACU
Potentilla species	Cinquefoil	UPL
Ratibida columnifera	Upright prairieconeflower	UPL
Rosa species	Rose	UPL
Rumex salicifolius	Willowleaf dock	NI
Rumex species	Dock	UPL
Ruppia cirrhosa	Spiral ditchgrass	OBL
Schoenoplectus pungens	Leafy bulrush	UPL
Sisyrinchium montanum	Strict blued-eyed grass	FAC
Solidago mollis	Velvety goldenrod	UPL
Solidago species	Goldenrod	UPL
Taraxacum officinale	Common dandelion	FACU
Thlaspi arvense	Field pennycress	FACU
Tragopogon dubius	Yellow salsify	UPL
Typha latifolia	Common cattail	OBL
Verbena bracteata	Bigbract verbena	FACU
Verbena hastate	Swamp verbena	UPL
Veronica anagallis-aquatica	Water speedwell	OBL
Veronica peregrina	Purslane speedwell	FACW
Vicia americana	American vetch	FAC
Polygonum aviculare	Devil's shoestring	FACU

3.6 METEOROLOGY

3.6.1 Introduction

The proposed Moore Ranch Project is located in a semi-arid or steppe climate. The region is characterized seasonally by cold harsh winters, hot dry summers, relatively warm moist springs and cool autumns. Temperature extremes range from roughly -25° F in the winter to 100° F in the summer. The "last freeze" occurs during late May and the "first freeze" mid-to-late September.

Yearly precipitation totals are typically near 10 inches. The region is prone to severe thunderstorm events throughout the spring and early summer months and much of the precipitation is attributed to these events. In a typical year, the area will see 4 or 5 severe thunderstorm events (as defined by the National Weather Service criteria) and 40 to 50 thunderstorm days. Autumn stratiform rain events also contribute to precipitation totals, but to a lesser degree than those before mentioned. Snow frequents the region throughout winter months (40-50 in / year), but provides much less moisture than rain events.

Windy conditions are fairly common to the area. Nearly 5% of the time hourly wind speed averages exceed 25 mph. The predominant wind direction is west/southwest with the wind blowing out of that direction 20% of the time. A north/northwest secondary mode is also present. Surface wind speeds are relatively high all year-round, with hourly averages 11 - 15 mph. Higher average wind speeds are encountered during the winter months while summer months experience lower average wind speeds.

Meteorological data has been compiled for ten sites surrounding the Moore Ranch project. Data has been acquired through the Western Regional Climate Center (WRCC, 2007) for eight COOP and ASOS stations operated by the National Weather Service (NWS) including Casper AP, Douglas, Dull Center 1SE, Glenrock 5 ESE, Kaycee, Lance Creek 3 WNW, Midwest, and Reno. In addition, Glenrock Coal Company (GCC) and Antelope Coal Company (ACC) meteorological data have been obtained through Inter-Mountain Laboratories (IML) located in Sheridan Wyoming. The latter two mentioned sites are operated in compliance with regulations set forth by the Wyoming Air Quality Division (AQD) for air quality monitoring. IML has maintained the sites and archived the data for nearly 20 years. Baseline meteorological information for the Moore Ranch Project was collected by IML and subsequently reported to EMC and is described in this Section. Table 3.6-1 provides the station identification, coordinates, and period of operation for each site.

The Antelope Coal (ACC) and Glenrock Coal (GCC) mines were both analyzed in the site specific analysis due to their proximity to the permitted region and to provide perspective from both a ridge top and drainage. The GCC site is located on the western

slope just below the peak of a ridge and ACC is situated on the eastern slope of a small drainage. ACC data is chosen over GCC as most representative of the proposed project area, for several reasons. The ACC site, like the proposed project area, extends from the eastern slope of a ridge downward into a drainage. GCC lies slightly higher in elevation and is on the opposite facing slope. GCC's location leads to slightly higher wind speeds since ACC is slightly sheltered from the predominant winds. ACC experiences greater temperature extremes than GCC, which may also be related to terrain. Lastly, ACC is approximately 10 miles closer to the project area than GCC.

Table 3.6-1 Meteorological Stations Included in Climate Analysis.

Name	Agency	X	Y	Z(ft)	Years_Operation
Antelope Coal Company	IML	474179	4816180	4675	1986-2006
Glenrock Coal Company	IML	431649	4767610	4910	1996-2006
Casper AP (112)	NWS	380229	4750539	5338	1948-2005
Douglas (118)	NWS	468655	4732910	4820	1909-2005
Dull Center 1SE (71)	NWS	503239	4806131	4420	1926-2005
Glenrock 5 ESE (117)	NWS	436247	4742017	4950	1941-2005
Kaycee (58)	NWS	368677	4840739	4660	1900-2005
Lance Creek 3 WNW (77)	NWS	528436	4782869	4340	1962-1984
Midwest (59)	NWS	396362	4806926	4820	1939-2005
Reno (68)	NWS	458891	4836243	5080	1963-1983

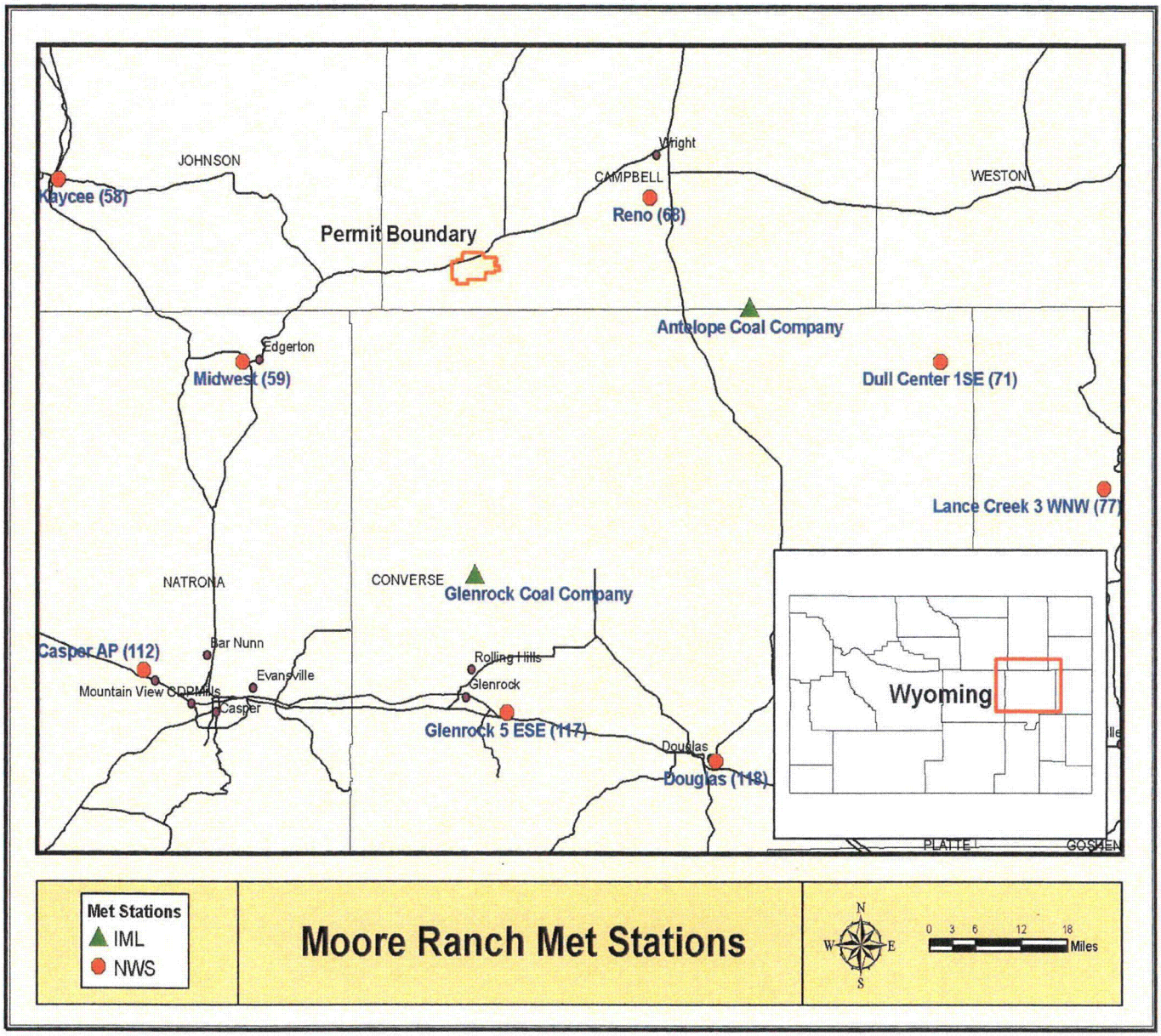
The ten sites collectively have been analyzed to provide a regional climatic temperature and precipitation analysis of the proposed project area. Only the Casper AP, GCC, and ACC sites will be analyzed for the regional wind summaries. The eight NWS sites will be incorporated into the snowfall discussion as neither mine site records snowfall data. No on-site data is available for the proposed area and the combination of the ACC and GCC sites will be substituted as the nearest representative available data sets for the site specific analysis. GCC and ACC lie in similar terrain as that seen in the proposed project area. Figure 3.6-1 shows the ten sites in relation to the project permit boundary. As can be seen in the figure, ACC and GCC are the closest available sites with wind data. The closest NWS operated station which continuously records all weather parameters is the Casper AP site which lies some 55-60 miles to the southwest.

A regional overview will be presented first. The section will include a discussion of the maximum and minimum temperature, relative humidity, annual precipitation including snowfall estimates, and a short wind speed and direction summary. ACC, GCC and the Casper AP provide the only wind data for the region. Casper AP will be incorporated into the regional overview and ACC and GCC will be analyzed for the site specific analysis. The last portion of the regional analysis will include a general climate data summary from Casper.

The site specific analysis will follow with much of the data based on the ACC, and GCC meteorological data with many of the same parameters listed previously. An in-depth wind analysis will be comprised of summaries including wind speed and direction averages, joint frequency distributions to characterize the wind data for the site by stability class, and wind speed distributions to provide insight into the wind speed relative frequencies. A seasonal data discussion is included for the temperature and wind parameters. The seasonal classification does not follow the general calendar dates. The seasons are classified in three month intervals as follows; January – March for winter, April-June for spring, July – September for summer, and October – December for fall. No site specific general climate data will be included as the regional evaluation is deemed adequate.

The ACC and GCC meteorological stations were also proposed to the NRC for use in baseline data collection for the Allemand-Ross Project by High Plains Uranium, Inc. (HPU) in August of 2006. Since that time, HPU was acquired by Energy Metals Corporation. In a letter from the NRC to HPU dated September 14, 2006, the NRC states that the meteorological stations at the Antelope and Glenrock mines meet the standards identified in NRC Regulatory Guide 3.63, *Onsite Meteorological Measurement Program for Uranium Recovery Programs- Data Acquisition and Reporting,* and can be recognized as "standard installations" per NUREG-1569. Therefore, data from these stations may be used in place of NWS Station Data. As described above, the ACC and GCC stations are closer to the Moore Ranch Project than the nearest NWS station and lie in very similar terrain. As a result, EMC believes that data from the ACC and GCC stations is representative of expected long term conditions at the Moore Ranch site.

Figure 3.6-1 NWS and Coal Mine Meteorological Stations.



3.6.2 Regional Overview

3.6.2.1 Temperature

The annual average temperature for the region is 46° F. The graph (Figure 3.6-2) shows monthly average temperatures for the two mine sites and the Casper AP. As illustrated, there is very little difference exhibited between the three sites. July shows the highest average monthly temperatures followed by August. January and December record the lowest average temperatures for the year. Table 3.6-2 below compares the monthly average temperatures for the three sites. The slight differences in average temperatures could be attributed to the small change in elevation between the stations. ACC has the highest average temperature of the three and the lowest elevation while Casper has the lowest average temperature and is the highest in elevation.

The proposed project region has annual average maximum temperatures of 58.5° F and average minimum temperatures of 33.6° F. July has the highest maximum temperatures with averages near 90° F while the lowest minimum temperatures are observed in January with averages near 10° F. Annual average minimum and maximum temperatures are shown in Figures 3.6-3 and 3.6-4, respectively.

Large diurnal temperature variations are found in the region due in large part to its altitude and low humidity. Figure 3.6-5 depicts the seasonal diurnal temperature variations for the two mine sites. The site specific monthly values are shown in Table 3.6-2 spring and summer daily variations of 15° - 25° F are common with maximum temperature variations of 30 - 40° F observed during extremely dry periods. Less daily variation is observed during the cooler portions of the year as fall and winter have variations of 10° - 15° F.

The lesser variation in daily temperature can be attributed to the more stable environment the region is exposed to during the fall and winter months. Stable periods have much lower mixing heights and accompanying lapse rates allowing for less temperature variation. The graphs also show ACC having larger diurnal variations than GCC. This may be attributed to the major soil type/surface each site is exposed too. ACC is an active coal mine with much bare soil (coal) exposed and little vegetation in the areas surrounding the meteorological station. GCC, on the other hand, has been in reclaim for an extended period with the meteorological station located in the middle of rolling prairie with native grasses and scattered scrub brush present. The vegetated region will "hold" more moisture and moderate temperatures to a greater extent as more energy is applied to latent heating rather than to sensible heating.

Table 3.6-2 Annual and Monthly Average Temperatures for ACC, GCC, and Casper AP

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Casper	23.4	27.1	33.6	42.8	52.7	62.9	70.9	69.2	58.5	46.6	33.2	25.3	45.5
Glenrock	26.1	26.7	32.5	41.7	51.1	60.7	70.8	68.1	57.9	45.7	33.7	26.1	46.1
Antelope	26.0	27.2	34.4	43.7	53.4	63.9	71.5	69.9	58.7	45.4	33.5	26.1	47.8

Figure 3.6-2 Average Monthly Temperatures for ACC, GCC, and Casper AP

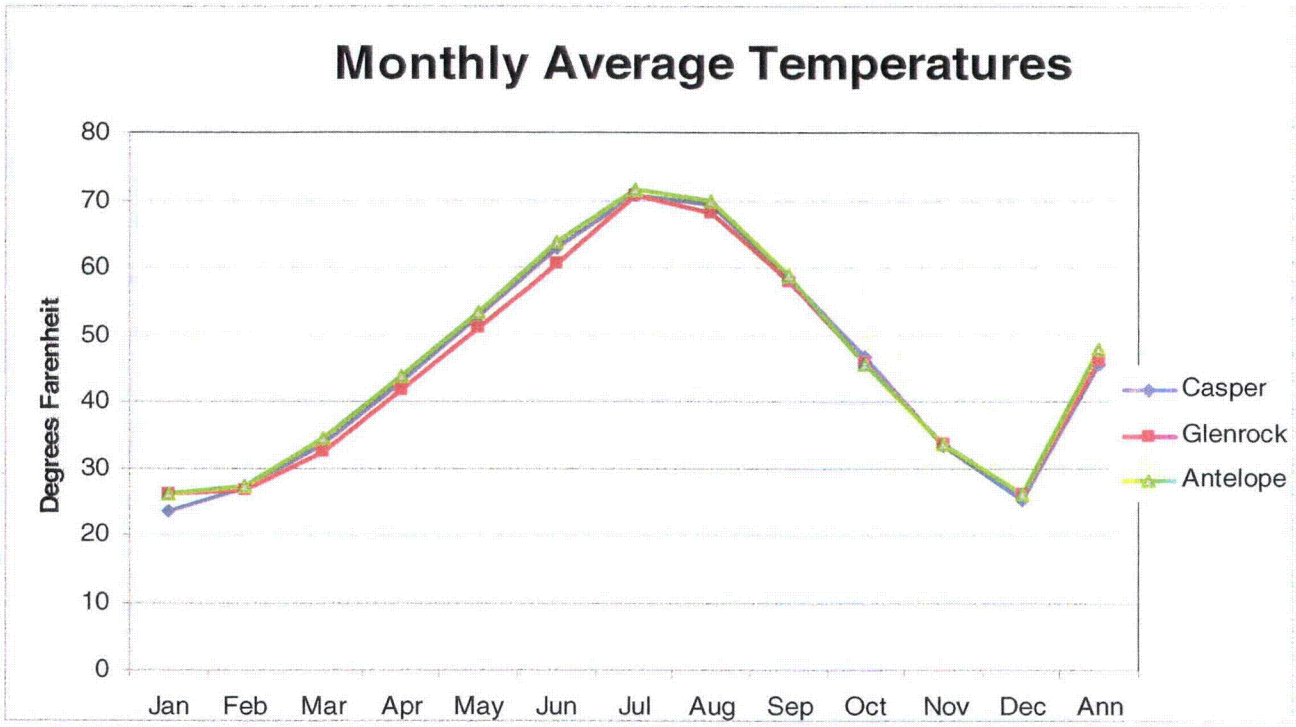


Figure 3.6-3 Regional Annual Average Minimum Temperatures.

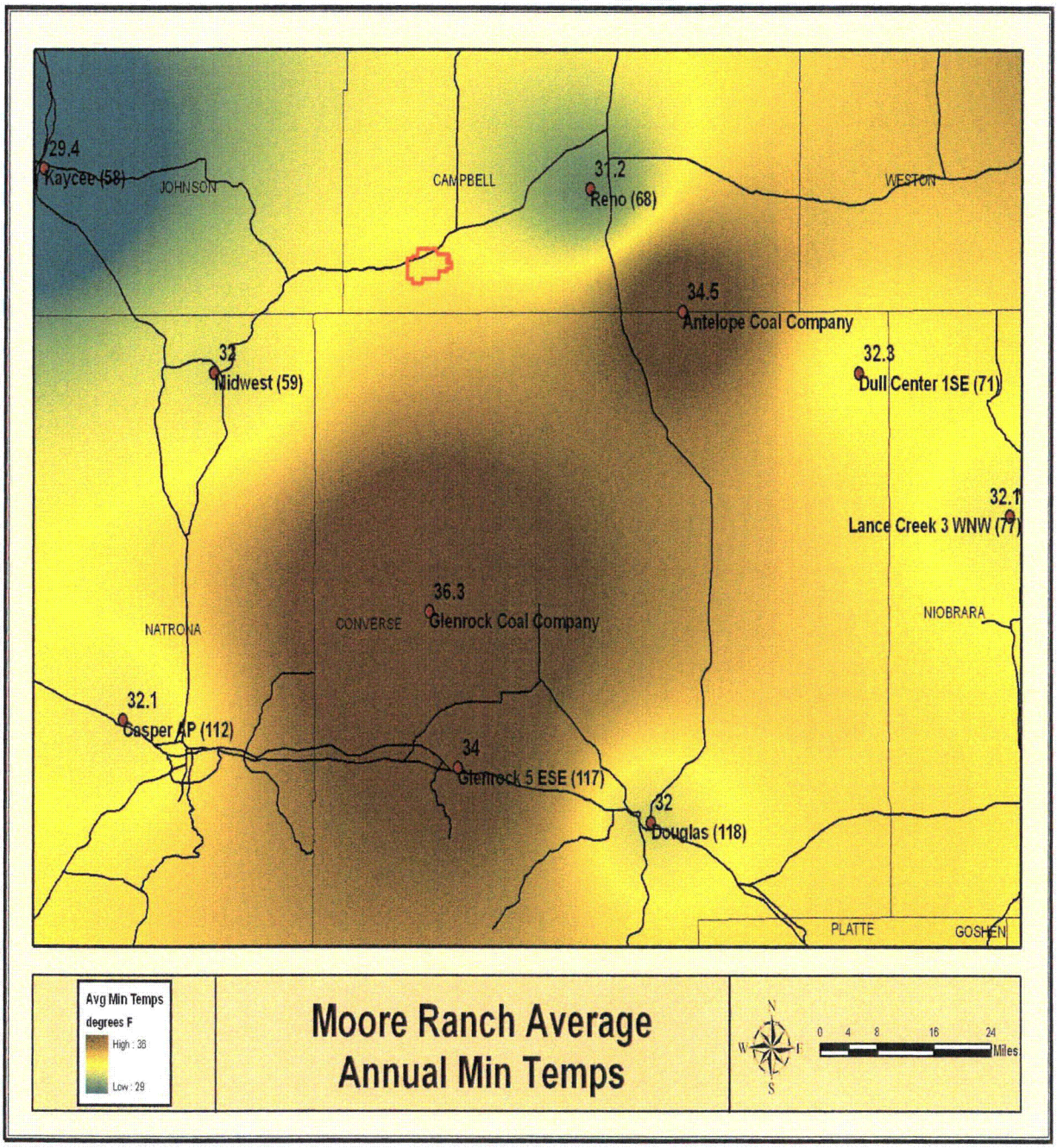


Figure 3.6-4 Regional Annual Average Maximum Temperatures.

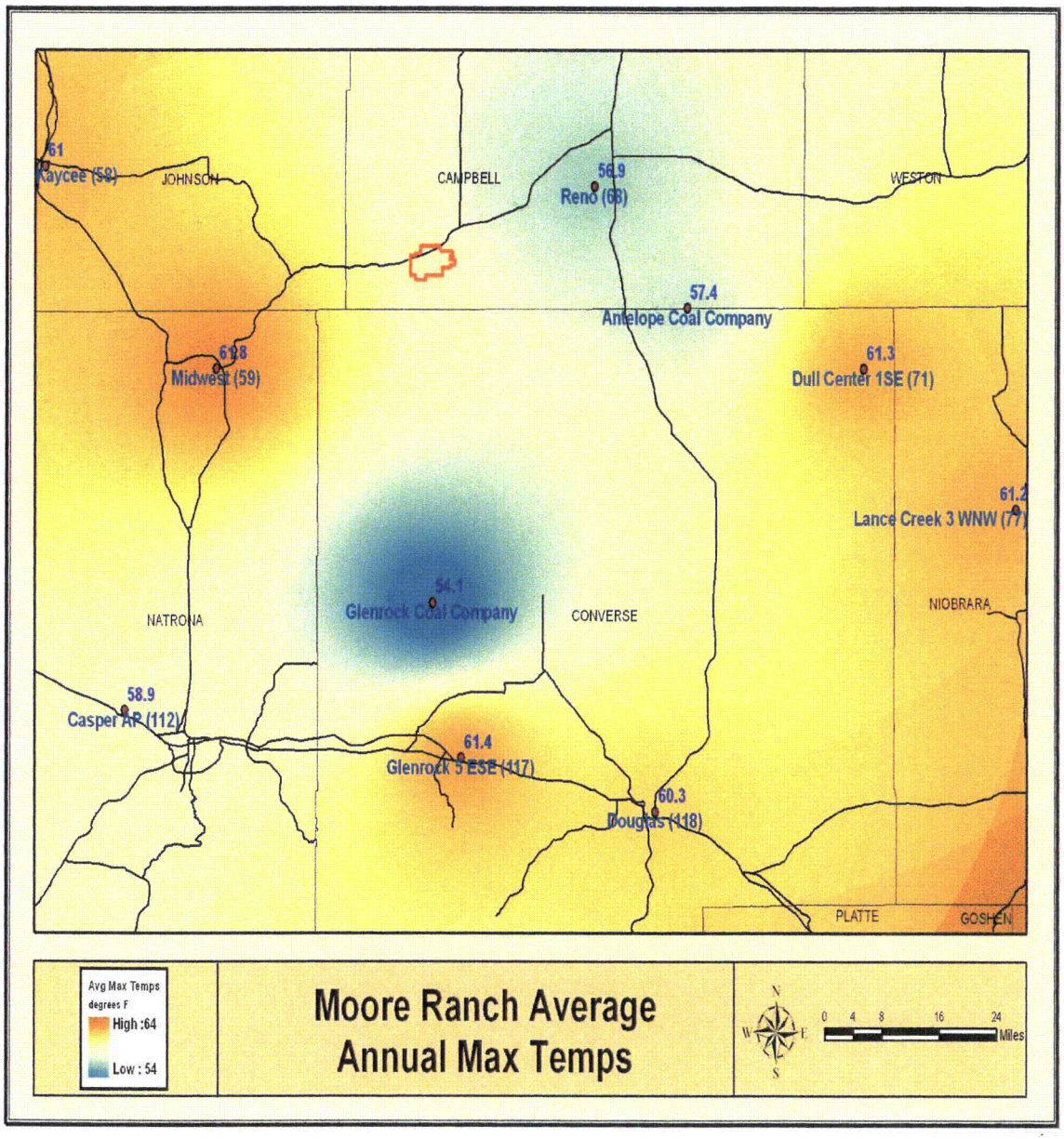
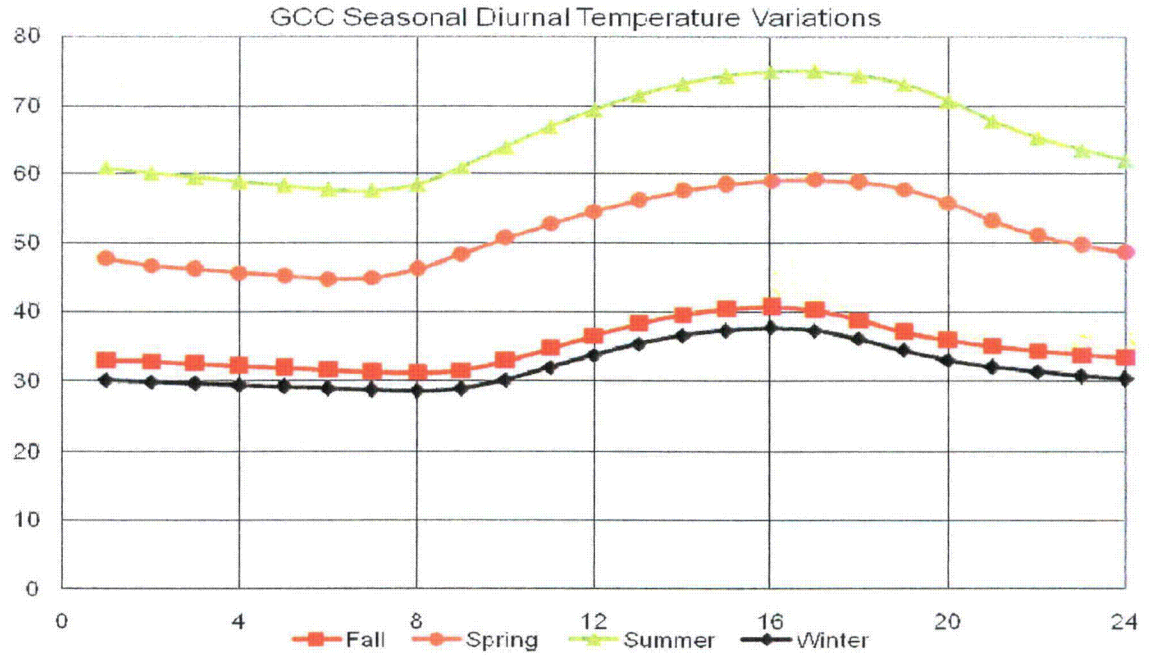
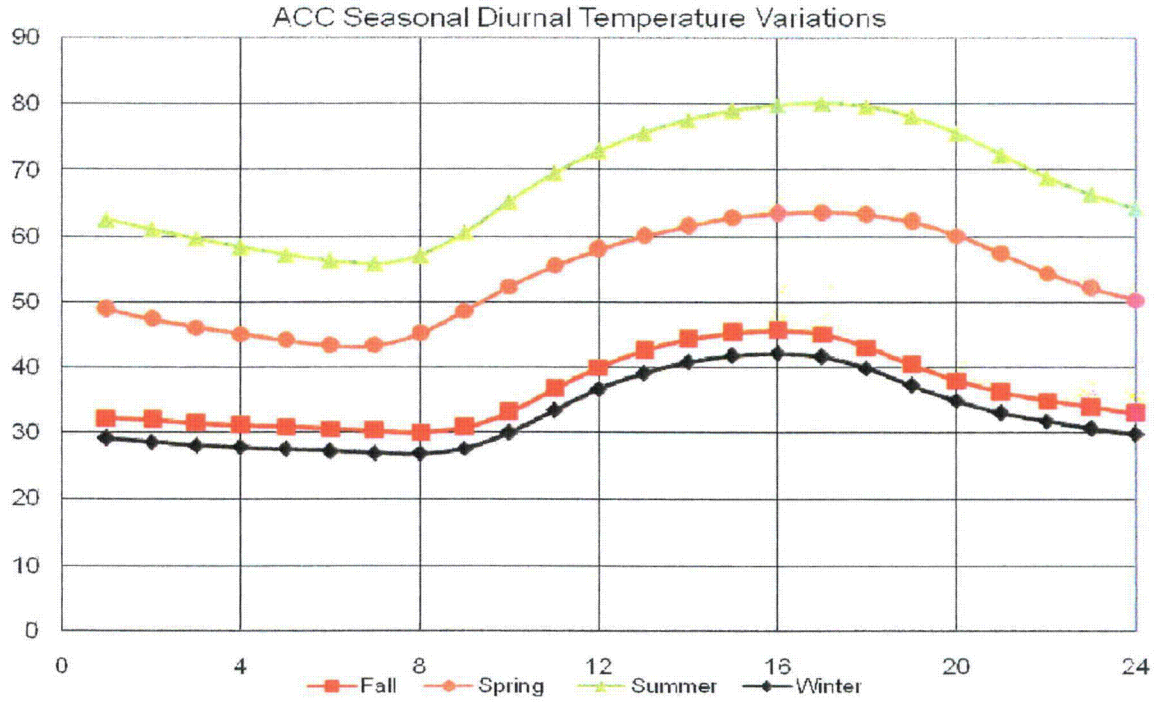


Figure 3.6-5 GCC (top) and ACC (bottom) Seasonal Diurnal Temperature Variations

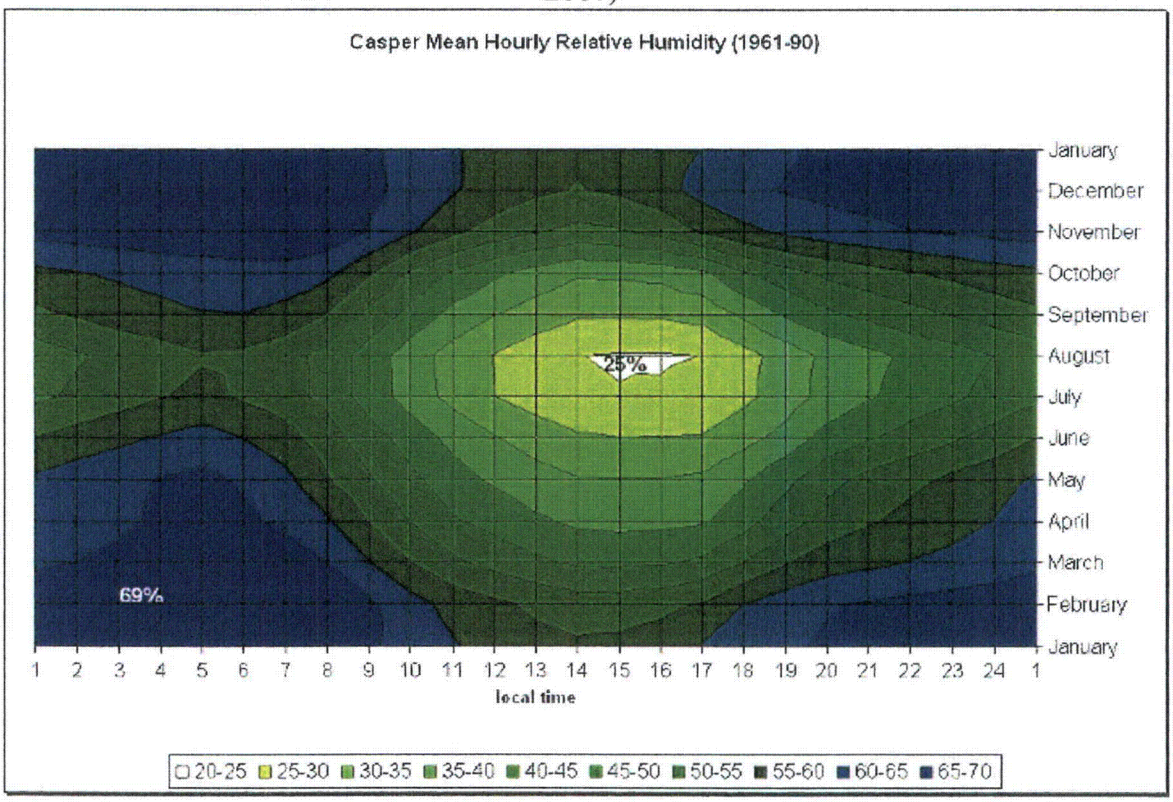




3.6.2.2 Relative Humidity

The Casper AP is the only site included in the analysis that records relative humidity (dew point) data. The graph shown in Figure 3.6-6 presents data taken from the Wyoming Climate Atlas (WRDS, 2007). The graph shows the mean hourly relative humidity (%) by time of day and month. It can be seen here that July is the "driest" month of the year followed by August and June. It also shows the winter months of December and January are the "wettest" portions of the year. The extreme values are stenciled on the graph where 25% is the lowest mean hourly value while 69% is the highest mean hourly value.

Figure 3.6-6 Mean Monthly and Hourly Relative Humidity for Casper AP (WRDS, 2007)



Relative humidity maximums occur more frequently in mornings (5:00 am) while minimums typically occur during the afternoon (5:00 pm). The average annual readings are 70% and 43% for mornings and afternoons, respectively. Mean monthly afternoon values range from 24% in August to 62% in December while morning mean values range from 66% in August to 77% in May. There is a much greater variation in the afternoon values which coincides with the greater temperature variations which occur during that time. Relative humidity is a temperature based calculation which shows the fraction of moisture present versus the amount of moisture for saturated air at that temperature.

3.6.2.3 Precipitation

The region is characterized by extremely dry conditions. On average, the region experiences only 40-60 days with measurable (>0.01 in) precipitation (WRCC, 2007). The proposed project region has an annual average in the 11 – 11.5 inch category based on the interpolated values (Figure 3.6-7). Annual averages across the region range from 9 – 13 inches. Spring and early summer (May-July) thunderstorms produce the majority of the precipitation, 45%. May is typically the wettest month of the year; all stations have monthly averages greater than 2 inches for that time as can be seen in Figure 3.6-8 below. January, on the contrary, is the driest month of the year as values are generally one half inch or less. The winter months (Dec-Feb) typically account for only 10% of the yearly totals. A secondary minimum is also evident during August as warm conditions have persisted over the course of the summer months. This promotes extremely stable conditions and light precipitation amounts as convective activity is limited.

Severe weather does arise throughout the region, but is limited to 4-5 severe events per year. These severe events are generally split between hail and damaging wind events. Tornadoes can occur but on rare occasions, with less than one tornado per county per year (Martner, 1986).

Major snowstorms (more than 6 in/day) also frequent the region. The region surrounding Casper experiences one to two snowstorms per year. Casper AP has the highest annual snowfall of all the sites with an average of nearly 80 inches. This value is sharply contrasted by three sites having annual averages of 20 – 25 inches. The great disparity between the sites can attributed to Casper's proximity to Casper Mountain. The site is located at the base of the northern slopes of the mountains and is influenced by snow events which occur as a result of orographic lifting. The interpolated values (Figure 3.6-9) show the project region having averages near 40 inches. This value agrees well with the Wyoming Climate Atlas (Martner, 1986) which lists averages for southwestern Campbell County at 40-50 inches. Substantial monthly averages (more than 3 in/month) occur for half the year and "measurable" averages (>1 in/month) for 2/3 of the year (Figure 3.6-10).

Figure 3.6-7 Regional Annual Average Precipitation

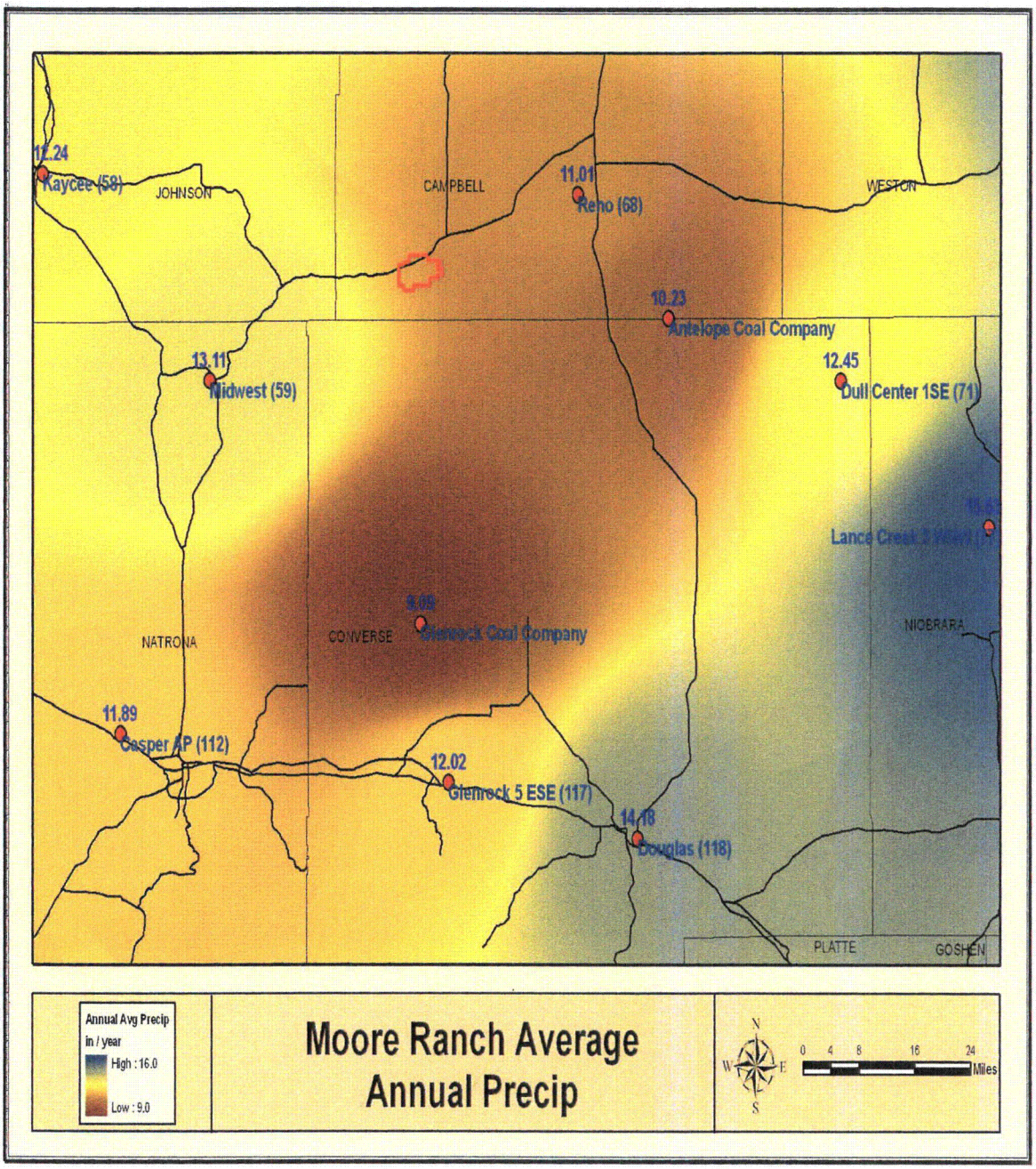


Figure 3.6-8 NWS Station Monthly Precipitation Averages (NCDC, 2007)

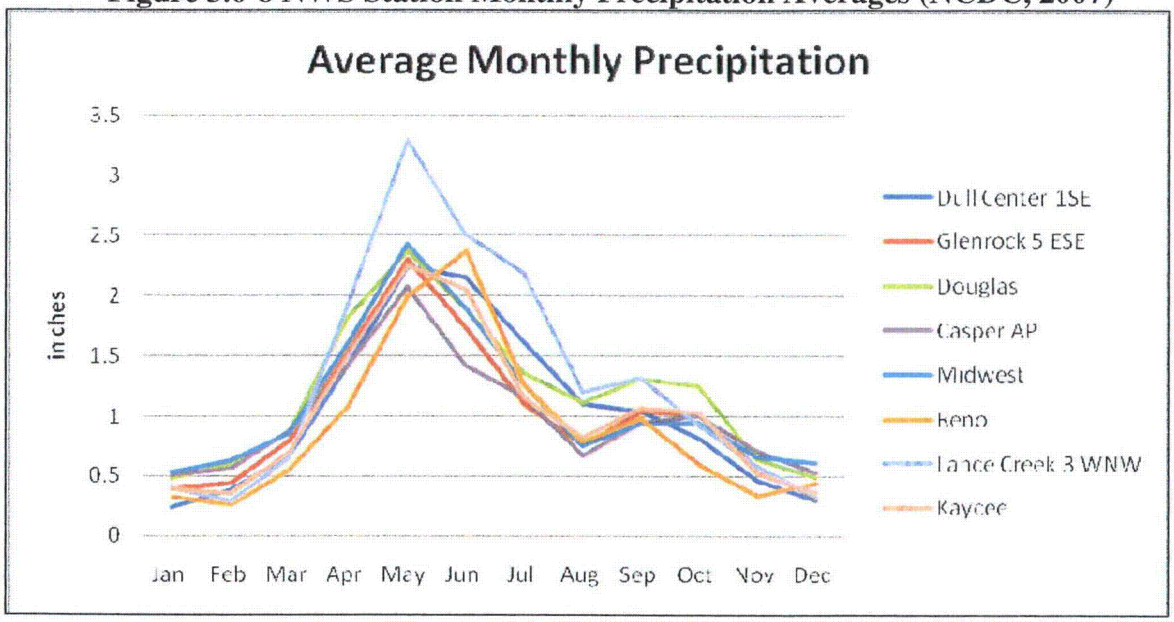


Figure 3.6-9 Regional Annual Average Snowfall

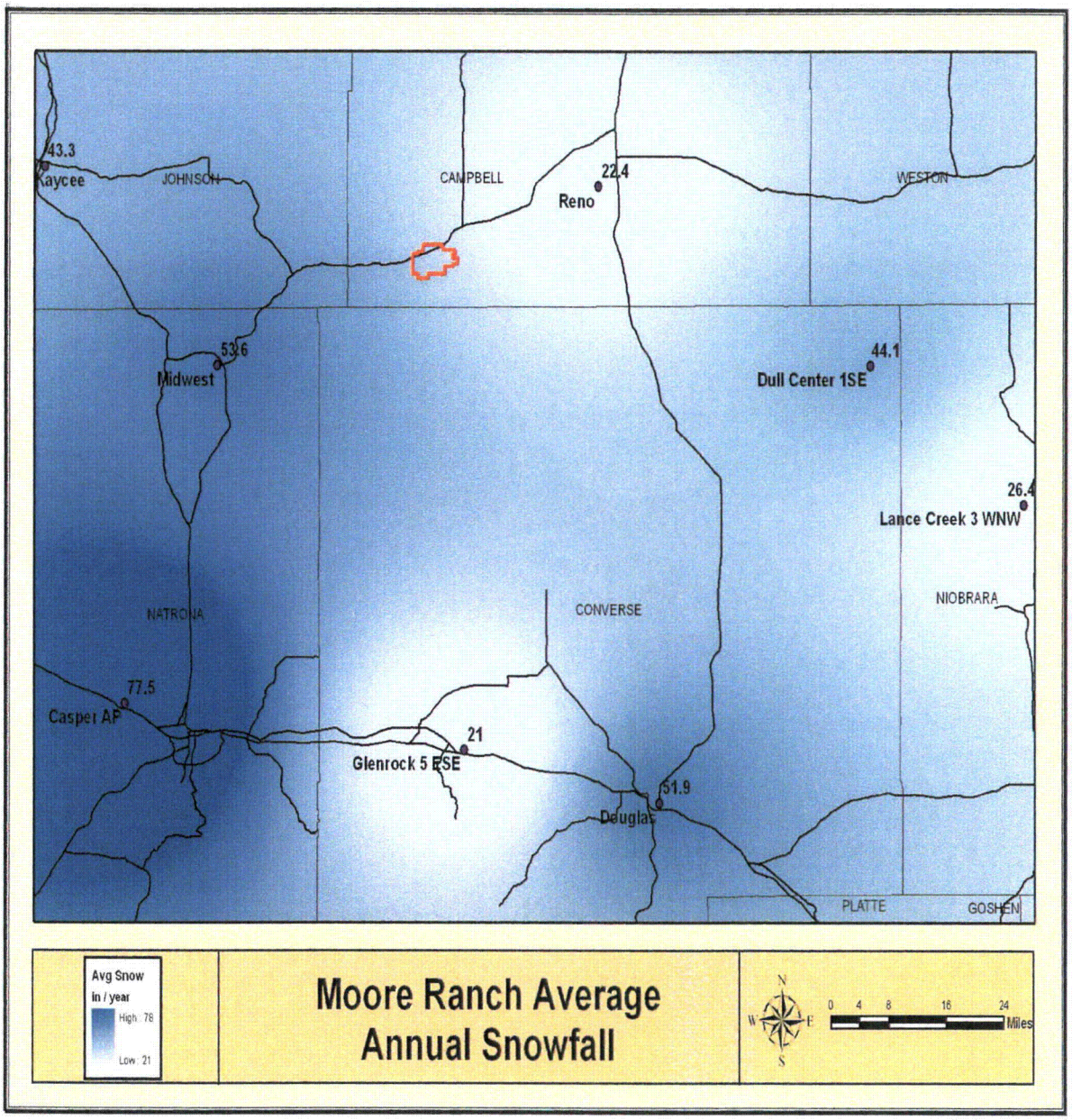
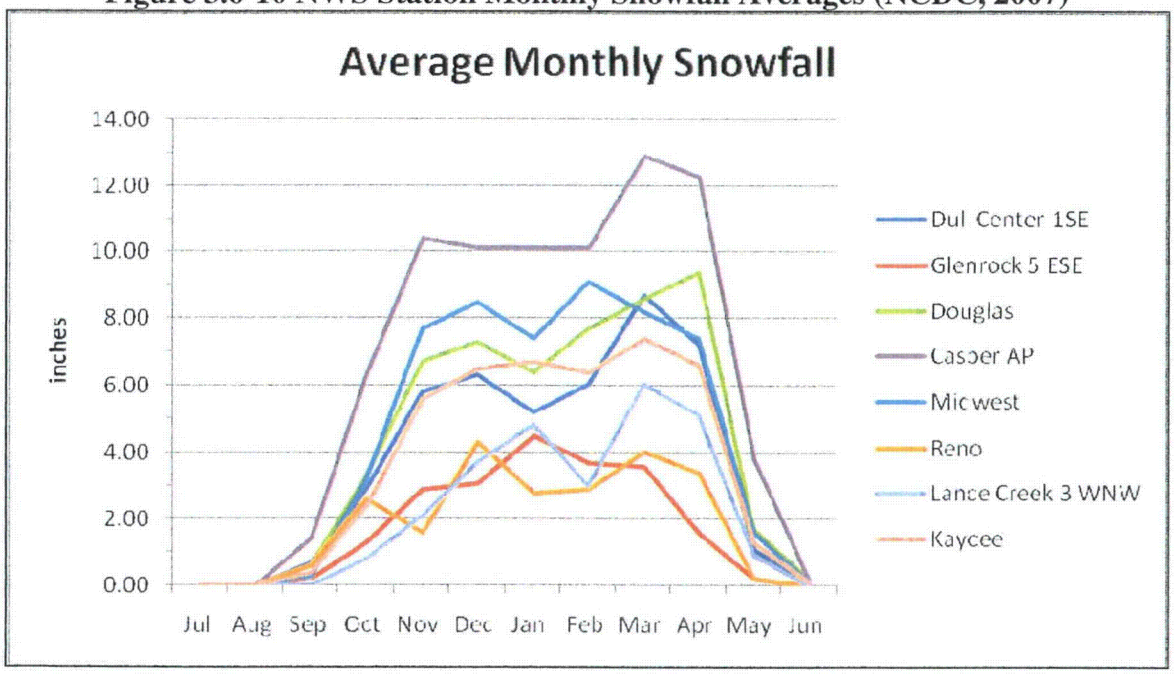


Figure 3.6-10 NWS Station Monthly Snowfall Averages (NCDC, 2007)



3.6.2.4 Wind Patterns

The Casper AP site averaged 12.8 mph for the 50+ years included in its climate database. The wind patterns throughout the region show very little variability. Strong west/southwesterly winds frequent the region. More than 40% of the time the wind direction is from the southwest to west sectors and accompanying wind speeds are generally fairly high with averages greater than 12 mph nearly 75% of the time. Mean monthly values from the Casper AP show July having the lowest value of 10.1 mph and January the highest at 16.3 mph. (Table 3.6-3) shows the monthly wind speed and direction averages along with monthly gust values. NWS direction data are summarized to the nearest 10 degrees. High wind events are a regular event as gust data from the Casper AP shows every month recording wind gusts greater than 60 mph. Little change is evident in the predominant seasonal wind directions. Spring and summer show west/southwest as the predominant direction, with southwest winds dominating fall and winter.

Table 3.6-3 Casper AP Monthly Wind Parameters Summary (WRCC, 2007)

	Wind Speed	Wind Direction	Wind Gust
JAN	16.3	SW	67
FEB	15.0	SW	64
MAR	13.8	SW	63
APR	12.6	WSW	60
MAY	12.6	WSW	64
JUN	11.0	WSW	64
JUL	10.1	WSW	60
AUG	10.3	SW	62
SEP	10.9	WSW	63
OCT	12.0	SW	62
NOV	14.4	SW	60
DEC	16.0	SW	66
ANN	**12.8**	**SW**	**67**

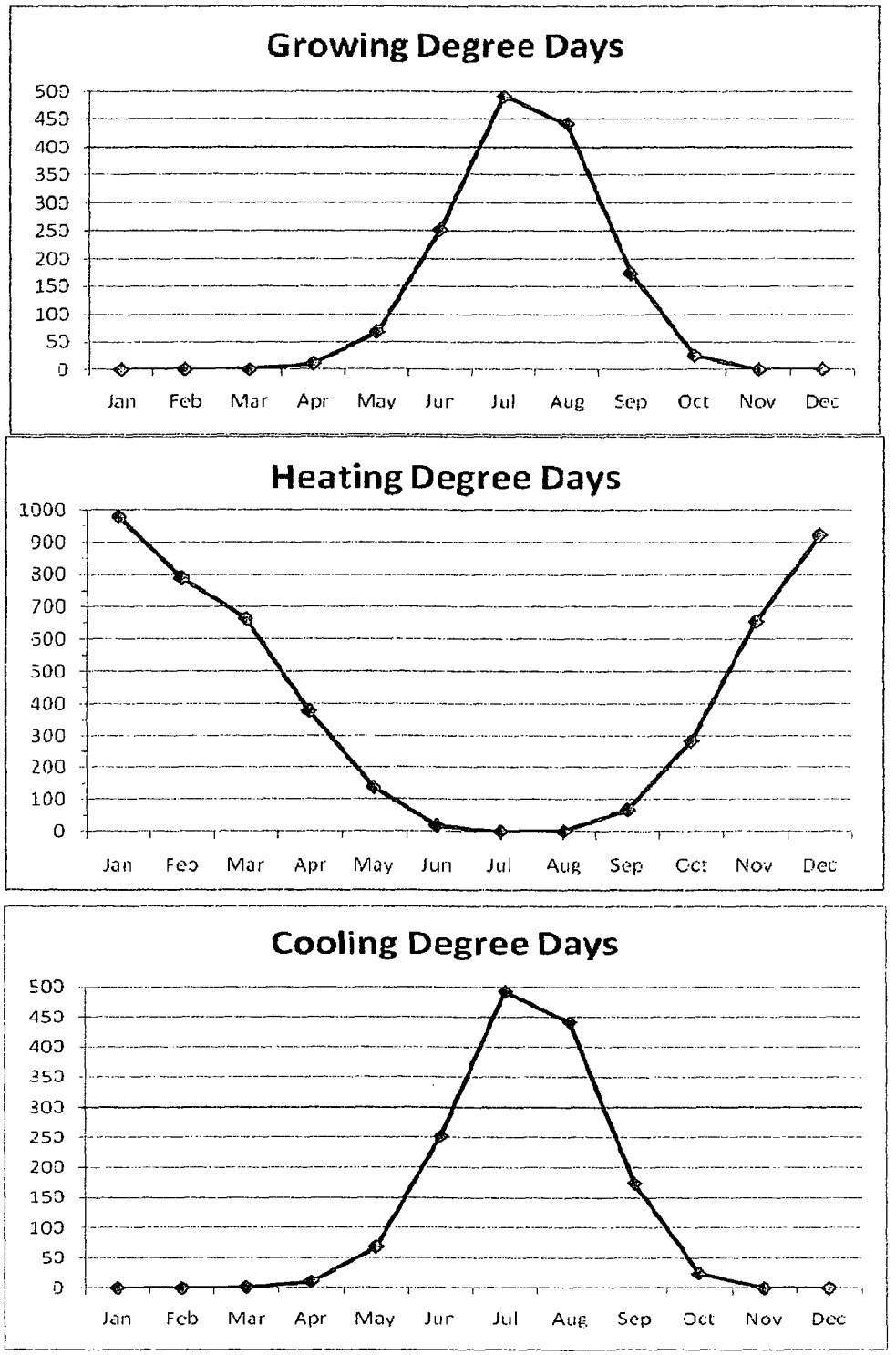
3.6.2.5 Cooling, Heating, and Growing Degree Days

The graphs shown on the next page (Figure 3.6-11) summarize the cooling, heating, and growing degree days for Casper. The data are assumed to be indicative of the region as the other meteorological parameters for the various sites track very closely.

The heating and cooling degree days are included to show deviation of the average daily temperature from a predefined base temperature. In this case, 55° F has been selected as the base temperature. The number of heating degree days is computed by taking the average of the high and low temperature occurring that day and subtracting it from the base temperature. The calculation for computing growing and cooling degree days is the same. The number of days is computed in the opposite fashion as the base temperature is subtracted from the average of the high and low temperature for the day. Negative values are disregarded for both calculations.

As expected, the heating degree days and cooling degree days are inversely proportional and the number of growing and cooling degree days are identical when the same base temperature is chosen. The maximum number of heating degree days occurs in January, 980 degree days, which coincides with January having the lowest minimum average temperature. Conversely, July registers the most cooling/growing degree days with 492, which also corresponds to July having the highest maximum average temperature.

Figure 3.6-11 Casper AP Cooling, Heating, and Growing Degree Days (WRCC, 2007).



3.6.3 Site Specific Analysis

The site specific discussion will be limited to the meteorological data from the two mine sites, Glenrock Coal (GCC) and Antelope Coal (ACC). These two sites were chosen as surrogate sites based on their proximity and similar topographic features to the permitted region. The region is characterized by high plains, rolling hills and minor ridges. Both sites are included to provide a depiction of the differences experienced between the ridge tops and lower drainages. The vegetation types are mainly confined to native grasses with some sage brush and very sparse woody coverage. Each mine's meteorological station is surrounded by rolling hills covered with native grasses.

3.6.3.1 Temperature

The annual average site temperature is 46.5 °F with temperatures for each site experiencing a maximum exceeding 98° F and minimum falling below -25° F. Figure 3.6-12 shows the seasonal average temperatures for both sites, which are nearly identical. The accompanying Table 3.6-4 provides the maximum, minimum and average seasonal temperatures for both mine sites. Average temperatures range from 30° F in the winter to 65° in the summer.

Tables 3.6-5 and 3.6-6 provide meteorological summaries for the two surrogate sites. The averages, maximums, and minimums are specified for each parameter recorded at the site along with the recovery rate for each. The recovery rates are greater than 90% for all parameters at both sites with the exception of sigma theta at GCC which had a recovery rate of 89%.

Table 3.6-4 ACC and GCC Max, Min, and Average Seasonal Temps (°F)

	ACC			GCC		
	Avg	**Max**	**Min**	**Avg**	**Max**	**Min**
Winter	29.2	76.2	-35.7	28.5	70	-25
Spring	53.4	98.5	3.6	51.6	92.7	0
Summer	66.7	102.1	21.7	65.7	97.4	21.7
Fall	34.9	84.4	-39.9	35.3	78.7	-18.9

Figure 3.6-12. ACC and GCC Seasonal Average Temperatures °F

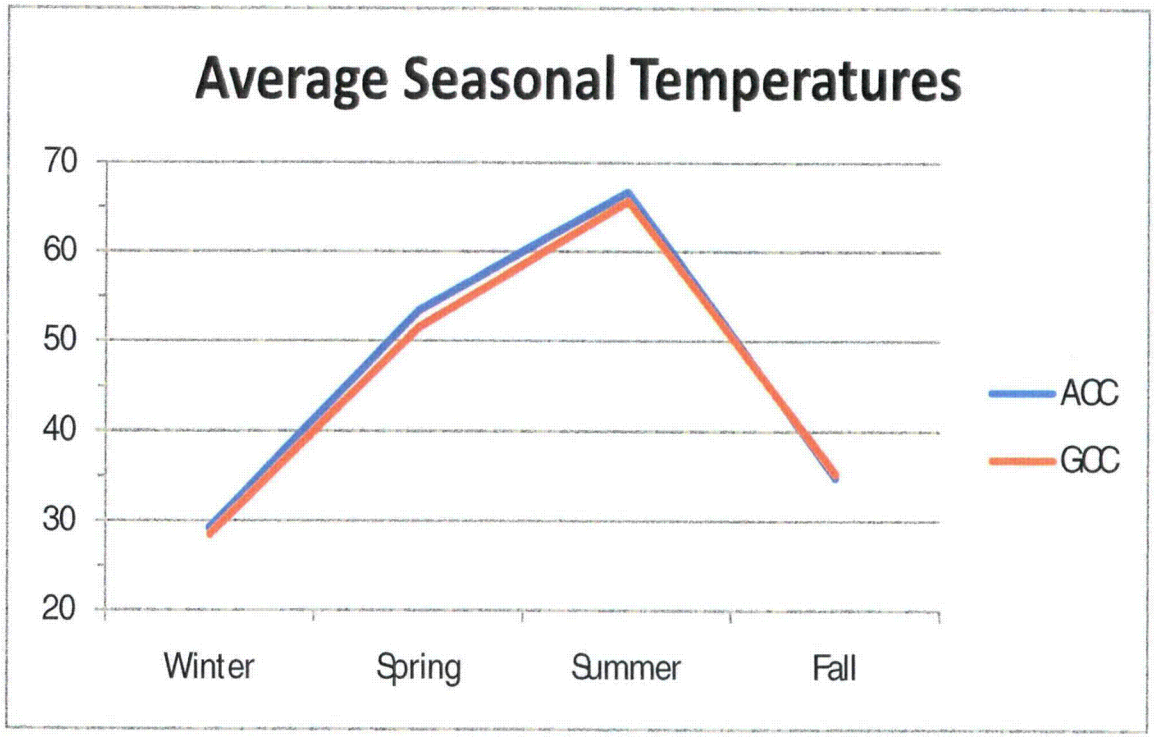


Table 3.6-5 ACC Meteorological Summary for January 1997-December 2006

Hourly Data

	Average/Total	Max	Min
Wind Speed (mph)	11.2	50.6	0.0
Sigma-Theta (°)	16.3	82.0	0.4
Temperature (F)	47.5	102.1	-33.8
Precipitation (in)	102.34	1.48	

Predominant wind direction was from the W sector, accounting for 15.2% of the possible winds

Data Recovery

Parameter	Possible (hours)	Reported (hours)	Recovery
Wind Speed	87648	81938	93.49%
Wind Direction	87648	81951	93.50%
Sigma-Theta	87648	81951	93.50%
Temperature	87648	83702	95.50%
Precipitation	87648	83705	95.50%

Table 3.6-6 GCC Meteorological Summary for January 1997-December 2006

Hourly Data

	Average/Total	Max	Min
Wind Speed (mph)	14.8	57.6	0.0
Sigma-Theta (°)	11.0	79.3	0.0
Temperature (F)	46.1	97.4	-25.0
Precipitation (in)	89.92	1.56	

Predominant wind direction was from the W/SW sector, accounting for 20.0% of the possible winds

Data Recovery

Parameter	Possible (hours)	Reported (hours)	Recovery
Wind Speed	87648	81406	92.88%
Wind Direction	87648	81406	92.88%
Sigma-Theta	87648	78171	89.19%
Temperature	87648	81376	92.84%
Precipitation	87648	82827	94.50%

3.6.3.2 Wind Patterns

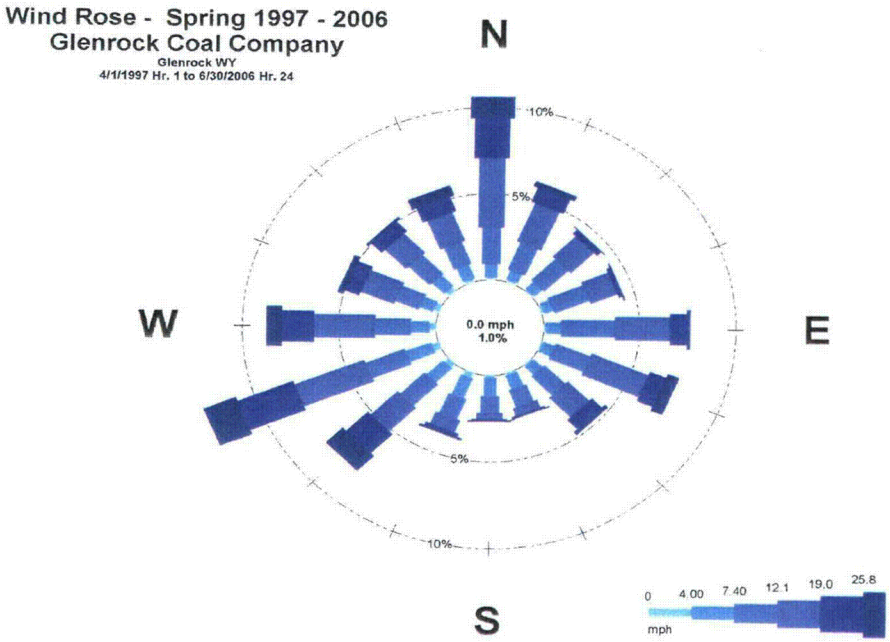
Figure 3.6-13 and Figure 3.6-14 show the seasonal wind roses for GCC and ACC, respectively. The GCC predominant wind direction is west/southwest and the ACC predominant wind direction is west with a secondary maximum of west/southwest. High pressure located over the southwestern United States is the culprit for the strong west/southwesterly winds which frequent the region. Spring experiences the greatest variability in wind direction with secondary modes from the southeast/east and northerly directions. The modes are a result of the synoptic scale transition period that occurs during this time. Low pressure regions develop on the lee side of the Rockies bringing southeast/easterly winds during development. As the low pressure systems form and move off with the general atmospheric flow, winds switch to a northerly direction.

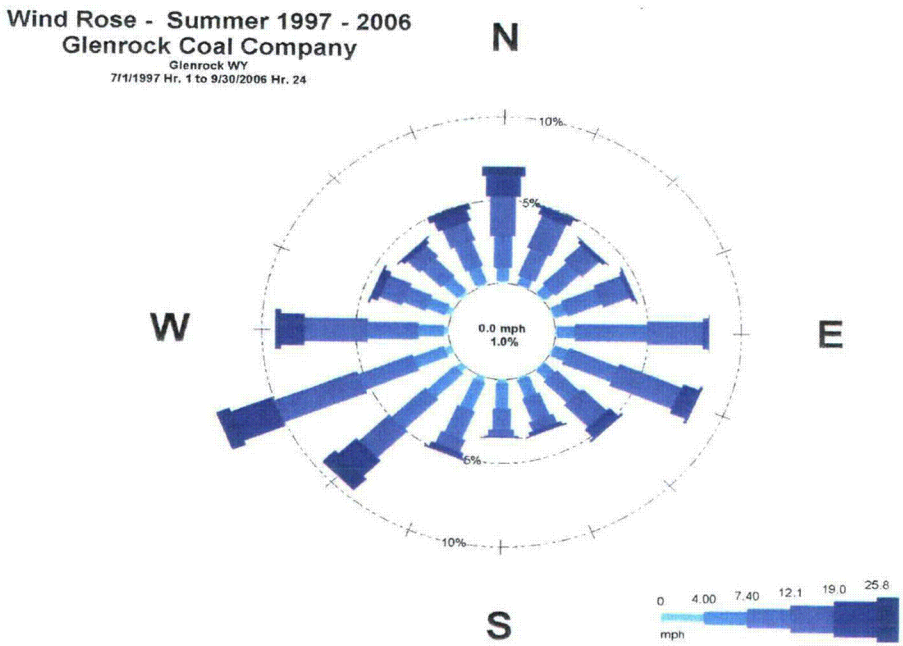
The monthly and seasonal wind speeds are summarized in Figures 3.6-15 and 3.6-16. The graphs show a pronounced difference between the winter and summer averages. GCC experiences higher wind speeds, but the seasonal changes seem to mirror each other. Late fall and winter time averages are in the upper teens while summer time averages dip into the upper single digits to low teens. Overall, sites see differences of 3-4 mph from summer to winter months.

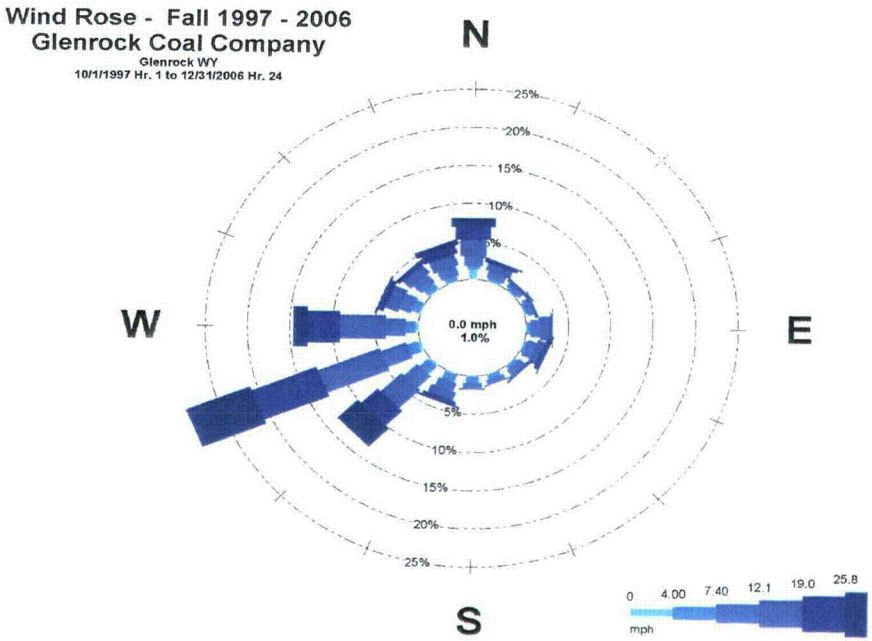
The site average for GCC is 14.8 mph for the entire ten year period analyzed and 11.1 mph for ACC. A closer look at the wind speed, summarized in the ACC and GCC wind summaries (Table 3.6-7 and Table 3.6-8), shows the west/southwesterly component average wind speed is 19.4 mph for GCC and 15.8 mph for ACC. The values suggest that the predominant wind direction is comprised of high, sustained wind speeds. Maximum hourly averages of greater 50 mph have been recorded at both mine sites. Figure 3.6-17 shows the cumulative frequency wind speed distributions for ACC and GCC. It is clearly evident from the graphs that light wind speeds are a rare occurrence.

The Joint Frequency Distributions are included for GCC (Table 3.6-9) and ACC (Table 3.6-10). The distributions show the frequencies of average wind speed for each direction based on stability class. Seventy percent of all winds at GCC and better than 56% at ACC fall into stability class D which represents near neutral to slightly unstable conditions. The light winds which accompany stable environments can be seen by the stability class F summaries (stable) as neither site has wind speed averages greater than 6 knots (6.9 mph).

Figure 3.6-13. GC[illegible]easonal Wind Roses







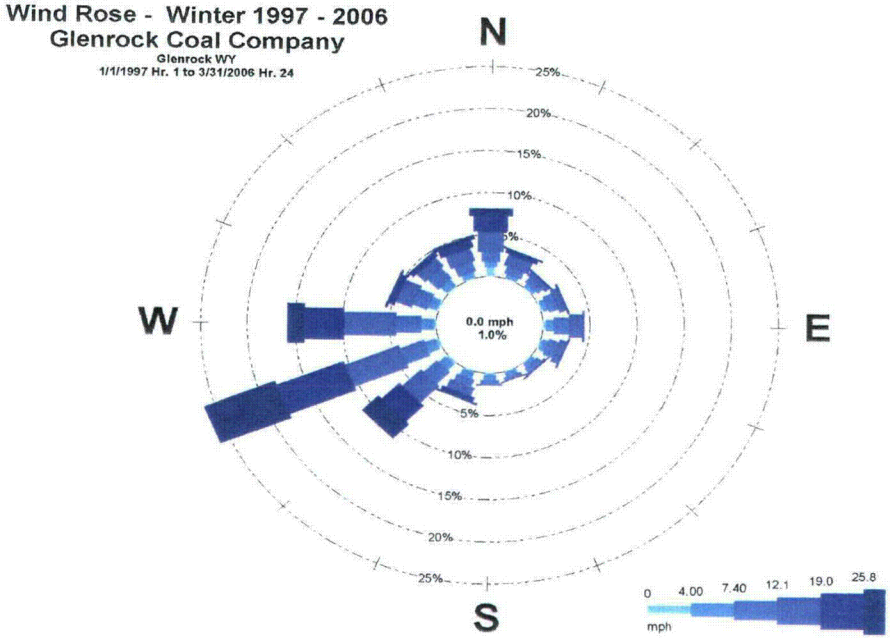
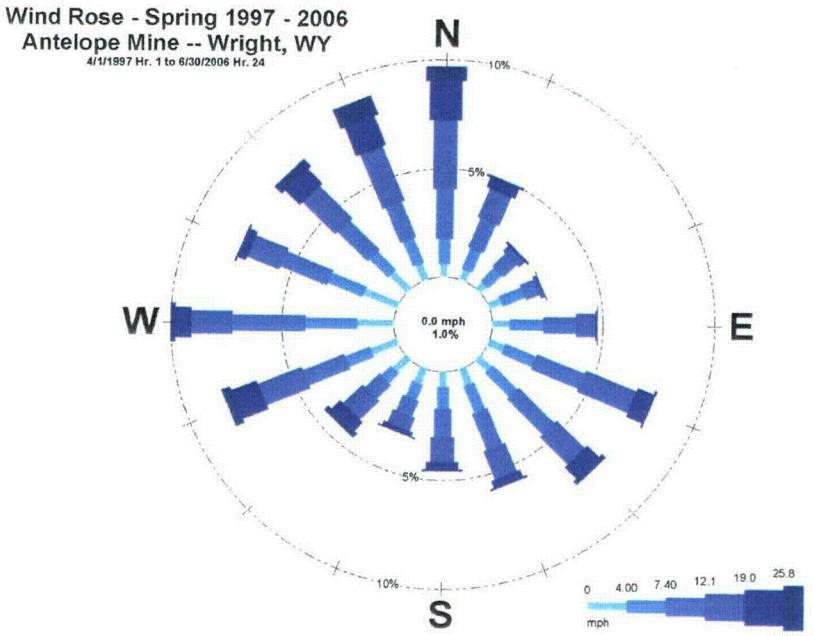
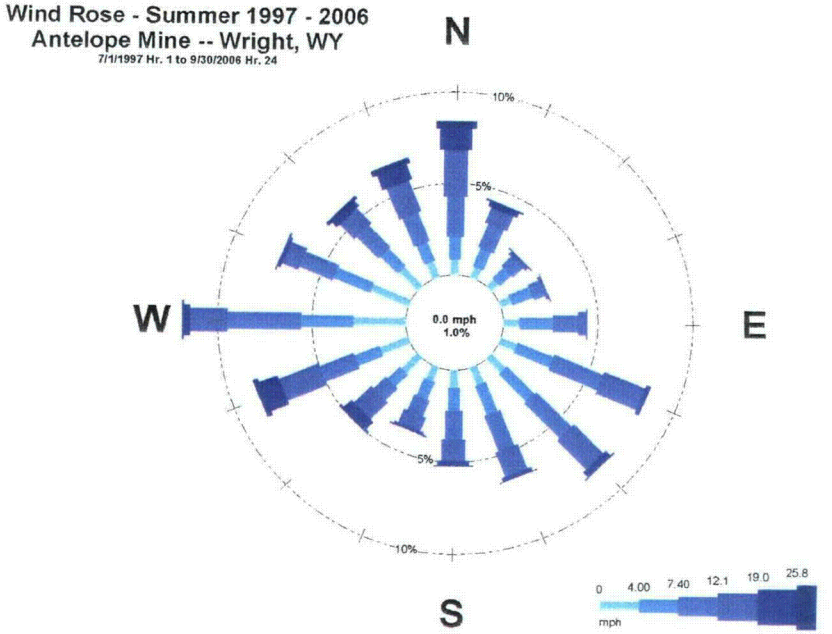
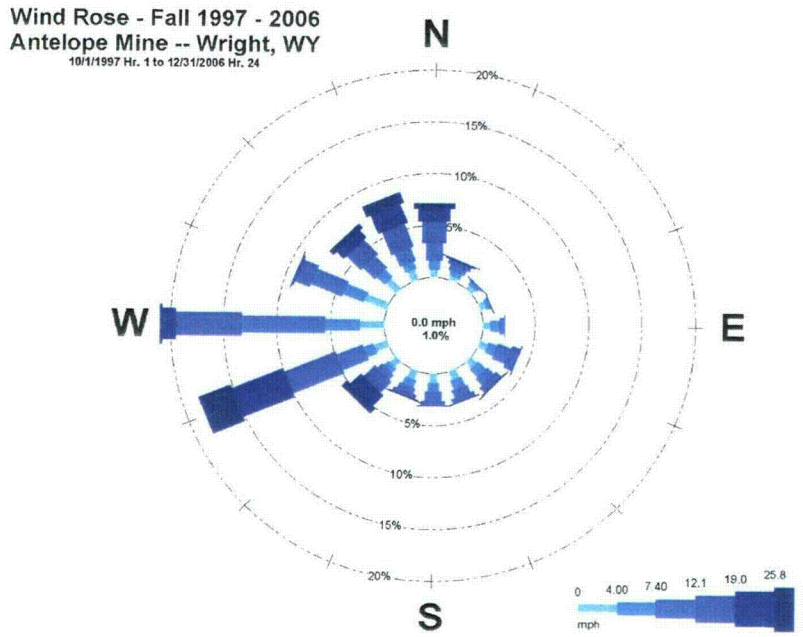


Figure 3.6-14. ACC Seasonal Wind Roses







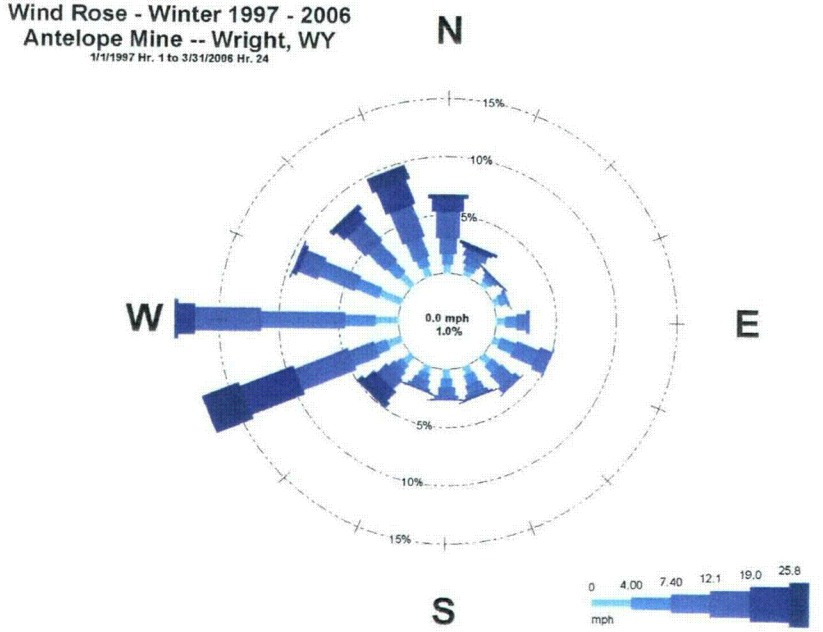


Figure 3.6-15 Monthly Wind Speed Averages for ACC and GCC.

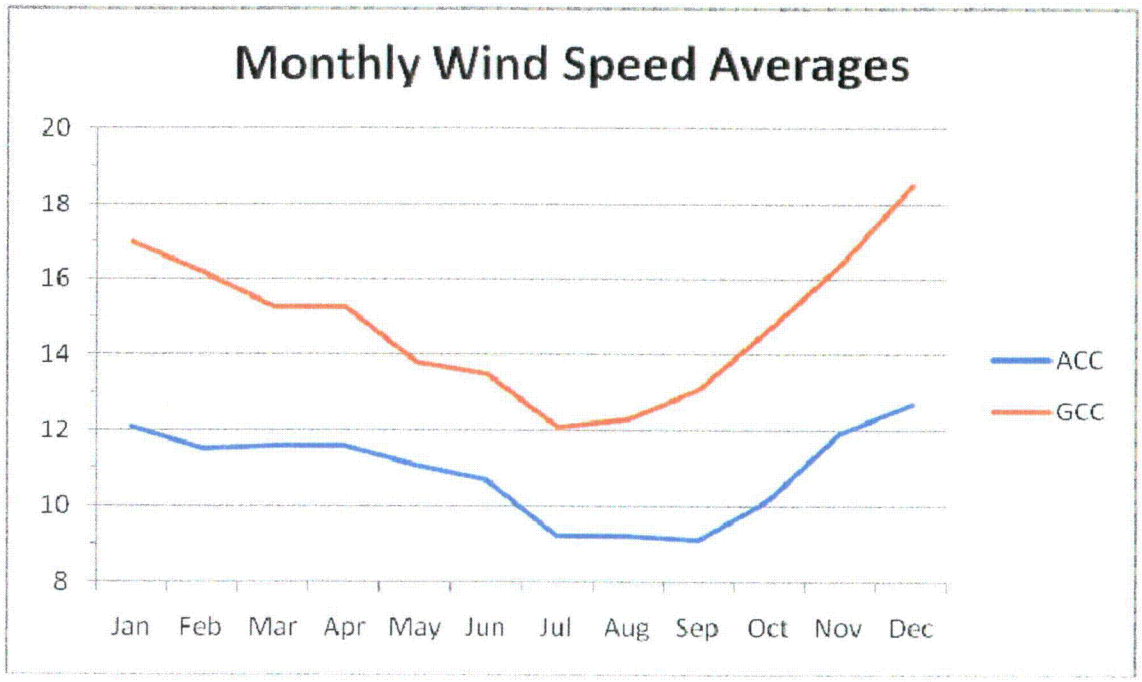


Figure 3.6-16 Seasonal Wind Speed Averages for ACC and GCC

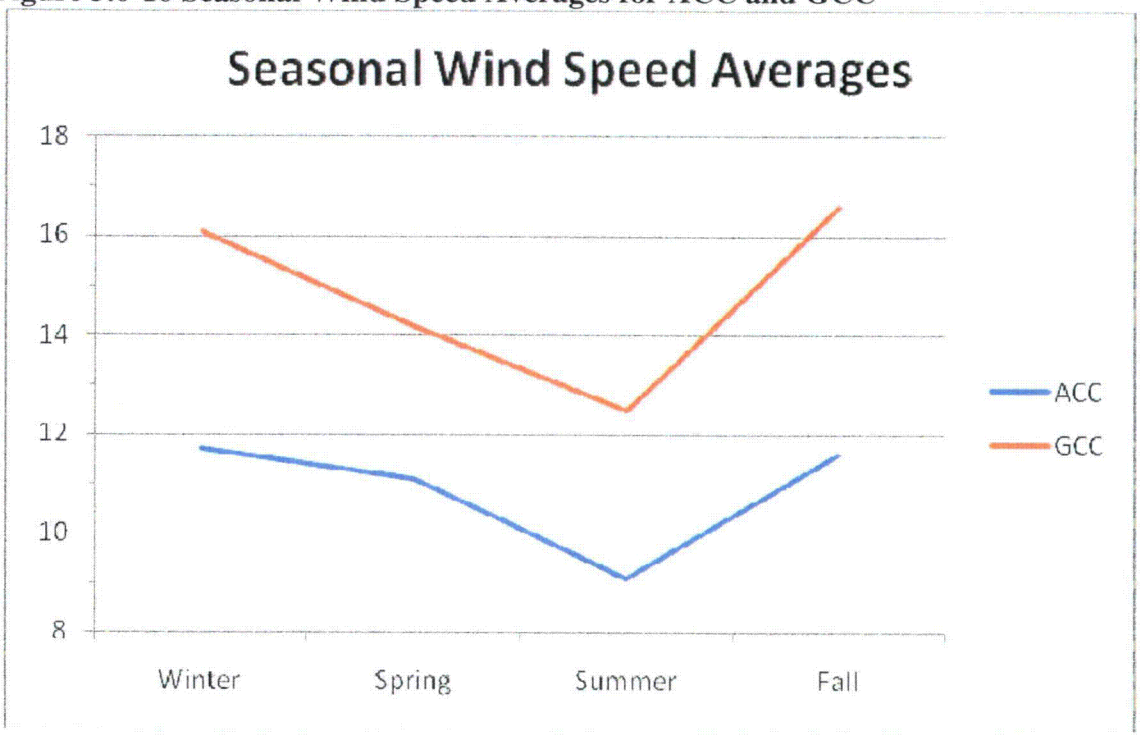


Table 3.6-7 ACC Wind Summary

Antelope Mine

Wind Data Summary

1/1/1997 - 12/31/2006

Hourly Data

	Average	Max	Min
Wind Speed (mph)	11.14	50.60	-
Sigma Theta (°)	16.15	78.50	0.35
Wind Direction			
N	13.26	47.32	0.30
NNE	10.55	39.25	0.58
NE	7.38	37.61	0.38
ENE	6.09	27.41	0.60
E	7.34	28.30	0.56
ESE	9.94	33.86	0.50
SE	9.78	35.52	0.50
SSE	8.98	33.57	0.40
S	8.89	32.30	0.69
SSW	8.33	36.90	0.57
SW	12.64	41.99	-
WSW	15.79	50.60	0.09
W	10.27	37.90	0.30
WNW	8.39	37.40	0.30
NW	11.48	45.10	0.30
NNW	14.49	43.50	-

Predominant wind direction was from the W sector, accounting for 15.7% of the winds, the average wind direction was 217°.

Data Recovery

	Possible (hours)	Reported (hours)	Recovery
Wind Speed	87648	79756	91.00%
Sigma Theta	87648	39657	45.25%
Wind Direction	87648	39657	45.25%

Table 3.6-8 GCC Wind Summary

Glenrock Coal Company

Wind Data Summary

1/1/1997 - 12/31/2006

Hourly Data

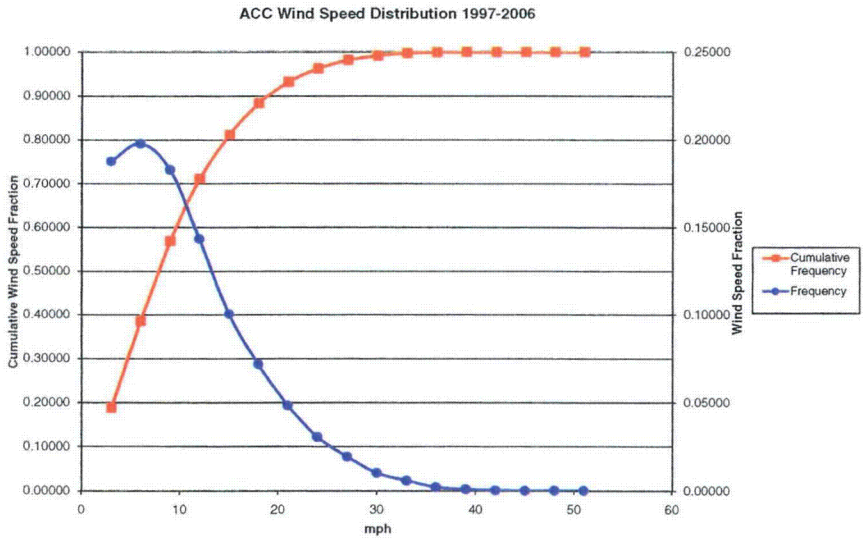
	Average	Max	Min
Wind Speed (mph)	14.82	57.60	-
Sigma Theta (°)	10.96	79.30	-
Wind Direction			
N	15.36	46.29	-
NNE	13.52	38.22	-
NE	11.32	30.90	-
ENE	11.14	29.80	-
E	11.92	37.15	0.10
ESE	13.52	38.80	-
SE	12.37	39.44	-
SSE	9.05	33.30	0.10
S	8.16	34.50	-
SSW	10.99	37.46	-
SW	17.09	55.58	-
WSW	19.36	57.60	-
W	15.89	48.21	-
WNW	12.69	39.44	0.10
NW	11.88	38.49	0.30
NNW	14.64	44.07	-

Predominant wind direction was from the WSW sector, accounting for 20% of the winds, the average wind direction was 205°.

Data Recovery

	Possible (hours)	Reported (hours)	Recovery
Wind Speed	87648	81406	92.88%
Sigma Theta	87648	78171	89.19%
Wind Direction	87648	81406	92.88%

Figure 3.6-17 ACC and GCC Wind Speed Frequency Distributions



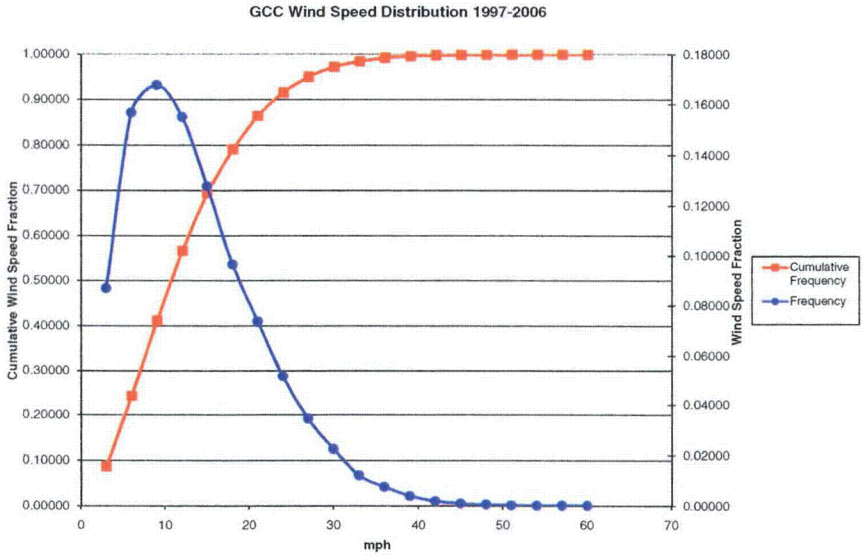


Table 3.6-9 GCC Joint Frequency Distribution for 1997 -2006

Glenrock Coal Company
Rolling Hills, Wyoming
Calm Readings 334

Frequency Distribution
Hourly Average Wind Speed, Wind Direction and Sigma
Total Readings 78171 Possible Readings 87648
From 1/1/1997 To 12/31/2006

IML Air Science
Sheridan, WY
Data Capture 89.2%

Stability Class A

Direction	Wind Speed (Knots) 0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00023	0.00148	0.00127	0.00006	0.00001		0.00306
ENE	0.00030	0.00117	0.00069	0.00008	0.00001		0.00225
ESE	0.00031	0.00122	0.00101	0.00014			0.00269
N	0.00026	0.00166	0.00159	0.00017	0.00001		0.00369
NE	0.00026	0.00136	0.00109	0.00001		0.00001	0.00274
NNE	0.00015	0.00116	0.00128	0.00015			0.00275
NNW	0.00037	0.00222	0.00127	0.00017	0.00003	0.00001	0.00407
NW	0.00046	0.00216	0.00189	0.00040	0.00001	0.00001	0.00493
S	0.00026	0.00167	0.00089	0.00022	0.00003		0.00306
SE	0.00024	0.00105	0.00093	0.00014			0.00236
SSE	0.00027	0.00143	0.00110	0.00010			0.00290
SSW	0.00048	0.00207	0.00112	0.00024			0.00391
SW	0.00045	0.00230	0.00204	0.00045	0.00001		0.00525
W	0.00045	0.00170	0.00247	0.00069	0.00009	0.00003	0.00542
WNW	0.00055	0.00170	0.00182	0.00030	0.00001	0.00001	0.00439

WSW	0.00048	0.00216	0.00227	0.00060	0.00006		0.00558
Sum	0.00551	0.02649	0.02275	0.00393	0.00028	0.00008	0.05905

Table 3.6-9 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class B — **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00008	0.00026	0.00049	0.00024			0.00107
ENE	0.00005	0.00018	0.00057	0.00009			0.00089
ESE	0.00009	0.00018	0.00084	0.00024			0.00135
N	0.00003	0.00024	0.00095	0.00039	0.00003	0.00008	0.00171
NE	0.00006	0.00012	0.00049	0.00009			0.00076
NNE	0.00003	0.00026	0.00085	0.00019			0.00132
NNW	0.00004	0.00027	0.00110	0.00060	0.00005		0.00207
NW	0.00012	0.00044	0.00094	0.00072	0.00004		0.00225
S	0.00010	0.00037	0.00031	0.00021	0.00001	0.00001	0.00101
SE	0.00006	0.00026	0.00075	0.00030		0.00001	0.00137
SSE	0.00004	0.00039	0.00041	0.00023	0.00001		0.00108
SSW	0.00012	0.00048	0.00066	0.00058	0.00004		0.00186
SW	0.00023	0.00059	0.00116	0.00119	0.00019	0.00005	0.00342
W	0.00017	0.00054	0.00168	0.00177	0.00019	0.00008	0.00443
WNW	0.00014	0.00037	0.00096	0.00100	0.00010		0.00258
WSW	0.00022	0.00051	0.00130	0.00167	0.00021	0.00005	0.00396
Sum	0.00157	0.00545	0.01344	0.00952	0.00087	0.00028	0.03113

Table 3.6-9 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class C — **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00008	0.00044	0.00087	0.00081			0.00220
ENE	0.00008	0.00028	0.00062	0.00040		0.00001	0.00139
ESE	0.00003	0.00045	0.00094	0.00132	0.00003		0.00276
N	0.00009	0.00032	0.00154	0.00297	0.00135	0.00099	0.00726
NE	0.00003	0.00015	0.00089	0.00044			0.00150
NNE	0.00003	0.00030	0.00099	0.00118	0.00001		0.00251
NNW	0.00006	0.00058	0.00140	0.00161	0.00037	0.00013	0.00415
NW	0.00013	0.00048	0.00131	0.00209	0.00049	0.00009	0.00459
S	0.00010	0.00066	0.00051	0.00042	0.00010	0.00001	0.00181
SE	0.00008	0.00054	0.00117	0.00131	0.00006	0.00001	0.00317
SSE	0.00009	0.00045	0.00062	0.00045	0.00003	0.00001	0.00164
SSW	0.00013	0.00075	0.00104	0.00091	0.00037	0.00006	0.00326
SW	0.00026	0.00091	0.00189	0.00297	0.00143	0.00027	0.00772
W	0.00022	0.00080	0.00164	0.00441	0.00159	0.00035	0.00901
WNW	0.00012	0.00050	0.00121	0.00276	0.00067	0.00015	0.00541
WSW	0.00026	0.00089	0.00247	0.00511	0.00226	0.00059	0.01158
Sum	0.00176	0.00848	0.01910	0.02916	0.00876	0.00269	0.06995

Table 3.6-9 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class D **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00033	0.00190	0.00957	0.02189	0.00403	0.00075	0.03848
ENE	0.00033	0.00112	0.00550	0.01107	0.00141	0.00026	0.01970
ESE	0.00027	0.00202	0.00903	0.02149	0.00591	0.00281	0.04154
N	0.00032	0.00258	0.00951	0.02536	0.01484	0.01046	0.06307
NE	0.00014	0.00119	0.00497	0.01015	0.00161	0.00026	0.01832
NNE	0.00013	0.00134	0.00545	0.01611	0.00495	0.00203	0.03000
NNW	0.00040	0.00247	0.00641	0.01381	0.00714	0.00641	0.03664
NW	0.00067	0.00375	0.00723	0.01043	0.00365	0.00175	0.02748
S	0.00040	0.00335	0.00325	0.00166	0.00039	0.00008	0.00912
SE	0.00008	0.00238	0.00567	0.00879	0.00384	0.00119	0.02194
SSE	0.00035	0.00258	0.00353	0.00245	0.00076	0.00022	0.00989
SSW	0.00075	0.00445	0.00579	0.00523	0.00132	0.00078	0.01832
SW	0.00082	0.00561	0.00949	0.01742	0.01382	0.02167	0.06885
W	0.00068	0.00567	0.01377	0.03848	0.02288	0.01382	0.09530
WNW	0.00053	0.00412	0.00763	0.01314	0.00501	0.00244	0.03288
WSW	0.00107	0.00624	0.01566	0.05036	0.04394	0.05395	0.17122
Sum	0.00726	0.05077	0.12247	0.26785	0.13550	0.11888	0.70274

Table 3.6-9 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class E — **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00049	0.00257	0.01188				0.01494
ENE	0.00019	0.00164	0.00686				0.00870
ESE	0.00037	0.00159	0.00609				0.00806
N	0.00030	0.00143	0.00313				0.00486
NE	0.00019	0.00153	0.00443				0.00615
NNE	0.00014	0.00141	0.00446				0.00601
NNW	0.00031	0.00184	0.00356				0.00570
NW	0.00028	0.00218	0.00373				0.00619
S	0.00055	0.00425	0.00376				0.00857
SE	0.00026	0.00140	0.00376				0.00542
SSE	0.00039	0.00283	0.00352				0.00673
SSW	0.00082	0.00433	0.00380				0.00895
SW	0.00072	0.00398	0.00420				0.00890
W	0.00060	0.00224	0.00424				0.00708
WNW	0.00046	0.00199	0.00265				0.00510
WSW	0.00089	0.00298	0.00403				0.00790
Sum	0.00696	0.03820	0.07412				0.11927

Table 3.6-9 GCC Joint Frequency Distribution for 1997 -2006 (Continued)

Stability Class F **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00045	0.00077					0.00122
ENE	0.00050	0.00067					0.00117
ESE	0.00039	0.00054					0.00093
N	0.00033	0.00040					0.00073
NE	0.00036	0.00046					0.00082
NNE	0.00027	0.00050					0.00077
NNW	0.00031	0.00059					0.00090
NW	0.00051	0.00068					0.00119
S	0.00041	0.00067					0.00108
SE	0.00040	0.00053					0.00093
SSE	0.00042	0.00046					0.00089
SSW	0.00039	0.00054					0.00093
SW	0.00068	0.00060					0.00128
W	0.00072	0.00103					0.00175
WNW	0.00077	0.00077					0.00154
WSW	0.00071	0.00103					0.00173
Sum	0.00762	0.01024					0.01786

Table 3.6-10 ACC Joint Frequency Distribution for 1997-2006

Antelope Coal Company
Wright, Wyoming
Calm Readings 28

Frequency Distribution
Hourly Average Wind Speed, Wind Direction and Sigma
Total Readings 81938 Possible Readings 87648
From 1/1/1997 To 12/31/2006

IML Air Science
Sheridan, WY
Data Capture 93.5%

Stability Class A

Direction	Wind Speed (Knots) 0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00226	0.00203	0.00076	0.00001			0.00505
ENE	0.00193	0.00214	0.00039	0.00006			0.00452
ESE	0.00192	0.00212	0.00088	0.00016			0.00508
N	0.00259	0.00260	0.00193	0.00013	0.00005		0.00730
NE	0.00175	0.00204	0.00070	0.00009			0.00457
NNE	0.00183	0.00264	0.00098	0.00005	0.00002		0.00552
NNW	0.00261	0.00278	0.00173	0.00021	0.00001		0.00735
NW	0.00316	0.00316	0.00217	0.00028			0.00878
S	0.00164	0.00273	0.00125	0.00016			0.00577
SE	0.00175	0.00295	0.00133	0.00009	0.00001		0.00613
SSE	0.00165	0.00289	0.00138	0.00012			0.00604
SSW	0.00134	0.00236	0.00111	0.00006	0.00002		0.00490
SW	0.00172	0.00205	0.00131	0.00031	0.00010	0.00011	0.00559
W	0.00271	0.00333	0.00206	0.00032	0.00002	0.00002	0.00847
WNW	0.00342	0.00360	0.00225	0.00032	0.00001		0.00960
WSW	0.00190	0.00282	0.00193	0.00031	0.00010	0.00001	0.00707

Sum	0.03417	0.04225	0.02215	0.00266	0.00035	0.00015	0.10173

Table 3.6-10 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class B — **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00042	0.00048	0.00049	0.00004			0.00142
ENE	0.00027	0.00024	0.00038	0.00004			0.00093
ESE	0.00026	0.00039	0.00095	0.00018			0.00178
N	0.00023	0.00055	0.00164	0.00063	0.00002	0.00001	0.00309
NE	0.00021	0.00024	0.00055	0.00006			0.00106
NNE	0.00015	0.00049	0.00088	0.00017	0.00001		0.00170
NNW	0.00024	0.00057	0.00139	0.00077	0.00002	0.00004	0.00304
NW	0.00061	0.00070	0.00154	0.00082	0.00002	0.00002	0.00371
S	0.00024	0.00055	0.00089	0.00028	0.00002		0.00199
SE	0.00033	0.00079	0.00134	0.00033			0.00280
SSE	0.00023	0.00078	0.00120	0.00032	0.00001		0.00254
SSW	0.00020	0.00031	0.00059	0.00021	0.00001		0.00131
SW	0.00016	0.00039	0.00054	0.00048	0.00009	0.00005	0.00170
W	0.00066	0.00110	0.00183	0.00096	0.00004		0.00459
WNW	0.00087	0.00090	0.00166	0.00101	0.00006	0.00002	0.00453
WSW	0.00039	0.00054	0.00128	0.00127	0.00015	0.00010	0.00372
Sum	0.00546	0.00902	0.01714	0.00757	0.00046	0.00024	0.03990

Table 3.6-10 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class C — **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00026	0.00063	0.00052	0.00043			0.00184
ENE	0.00017	0.00043	0.00037	0.00016			0.00112
ESE	0.00023	0.00093	0.00137	0.00096	0.00002		0.00352
N	0.00016	0.00051	0.00266	0.00454	0.00147	0.00084	0.01018
NE	0.00010	0.00042	0.00043	0.00022	0.00001		0.00117
NNE	0.00005	0.00054	0.00125	0.00096	0.00006	0.00002	0.00288
NNW	0.00012	0.00066	0.00226	0.00418	0.00101	0.00035	0.00858
NW	0.00037	0.00096	0.00226	0.00294	0.00060	0.00013	0.00726
S	0.00010	0.00073	0.00137	0.00099	0.00009	0.00001	0.00328
SE	0.00021	0.00089	0.00251	0.00198	0.00009		0.00568
SSE	0.00015	0.00100	0.00214	0.00183	0.00011		0.00523
SSW	0.00013	0.00034	0.00085	0.00085	0.00011		0.00230
SW	0.00017	0.00029	0.00076	0.00160	0.00054	0.00050	0.00386
W	0.00057	0.00232	0.00309	0.00396	0.00068	0.00016	0.01078
WNW	0.00052	0.00165	0.00236	0.00286	0.00048	0.00007	0.00794
WSW	0.00012	0.00073	0.00136	0.00365	0.00151	0.00077	0.00814
Sum	0.00343	0.01304	0.02554	0.03211	0.00678	0.00287	0.08376

Table 3.6-10 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class D **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00074	0.00620	0.00678	0.00411	0.00032	0.00004	0.01819
ENE	0.00059	0.00354	0.00265	0.00087	0.00005	0.00001	0.00770
ESE	0.00077	0.00685	0.01279	0.01637	0.00275	0.00032	0.03985
N	0.00034	0.00421	0.01107	0.01977	0.01002	0.00448	0.04990
NE	0.00015	0.00227	0.00321	0.00171	0.00037	0.00011	0.00781
NNE	0.00022	0.00289	0.00608	0.00751	0.00241	0.00116	0.02027
NNW	0.00052	0.00380	0.00941	0.01935	0.01261	0.00955	0.05524
NW	0.00046	0.00438	0.01044	0.01425	0.00632	0.00420	0.04006
S	0.00052	0.00270	0.00504	0.00645	0.00170	0.00039	0.01680
SE	0.00063	0.00531	0.00905	0.01156	0.00287	0.00084	0.03026
SSE	0.00079	0.00352	0.00614	0.00752	0.00186	0.00033	0.02016
SSW	0.00052	0.00182	0.00364	0.00413	0.00109	0.00037	0.01156
SW	0.00043	0.00139	0.00424	0.01034	0.00708	0.00414	0.02762
W	0.00128	0.01170	0.03427	0.03327	0.00778	0.00226	0.09055
WNW	0.00096	0.00802	0.01688	0.01012	0.00215	0.00048	0.03862
WSW	0.00048	0.00360	0.01284	0.03002	0.02392	0.02084	0.09170
Sum	0.00942	0.07220	0.15454	0.19734	0.08327	0.04951	0.56628

Table 3.6-10 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class E — **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00096	0.00250	0.00167				0.00514
ENE	0.00055	0.00142	0.00044				0.00241
ESE	0.00105	0.00328	0.00534				0.00967
N	0.00052	0.00162	0.00122				0.00337
NE	0.00042	0.00078	0.00027				0.00147
NNE	0.00042	0.00088	0.00118				0.00248
NNW	0.00088	0.00117	0.00112				0.00317
NW	0.00101	0.00149	0.00148				0.00398
S	0.00103	0.00167	0.00237				0.00507
SE	0.00121	0.00289	0.00370				0.00780
SSE	0.00100	0.00271	0.00276				0.00647
SSW	0.00077	0.00150	0.00133				0.00360
SW	0.00105	0.00095	0.00094				0.00294
W	0.00267	0.00523	0.01179				0.01969
WNW	0.00233	0.00315	0.00286				0.00834
WSW	0.00129	0.00206	0.00359				0.00695
Sum	0.01717	0.03332	0.04206				0.09254

Table 3.6-10 ACC Joint Frequency Distribution for 1997-2006 (Continued)

Stability Class F **Wind Speed (Knots)**

Direction	0.6 - 3.0	4 - 6	7 - 10	11-16	17 - 21	> 21	Row Total
E	0.00363	0.00131					0.00493
ENE	0.00244	0.00081					0.00325
ESE	0.00372	0.00151					0.00524
N	0.00346	0.00110					0.00455
NE	0.00220	0.00071					0.00291
NNE	0.00250	0.00079					0.00330
NNW	0.00446	0.00125					0.00570
NW	0.00750	0.00138					0.00888
S	0.00509	0.00156					0.00665
SE	0.00458	0.00162					0.00620
SSE	0.00481	0.00151					0.00632
SSW	0.00479	0.00153					0.00631
SW	0.00581	0.00190					0.00772
W	0.01356	0.00380					0.01736
WNW	0.01183	0.00272					0.01455
WSW	0.00939	0.00253					0.01192
Sum	0.08976	0.02603					0.11579

3.6.4 Air Quality

The primary new emission source of non-radiological pollutants will be particulate matter with a diameter less than ten micrometers (PM_{10}) resulting from vehicle traffic within the Moore Ranch Project Area. EMC estimated fugitive dust emissions from operation of the Moore Ranch Uranium Project based on projected activity levels and emission factors supplied by the WDEQ. Projected activities impacting dust emissions included ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Based on these activities, the projected total PM_{10} emissions is 18.5 tons per year. This level of emissions is small relative to surface mines and other industrial operations that generate dust from vehicles and disturbed areas. The larger surface mines in the Powder River Basin show PM_{10} emissions inventories in the thousands of tons per year. Sections of unpaved county roads can also exceed this 15 tons per year emission rate by an order of magnitude or more. Viewed another way, atmospheric dispersion modeling generally shows that fugitive PM_{10} emissions on the order of 15 tons per year result in insignificant impacts to ambient air beyond a distance of a few hundred yards from the sources. Significant impact for PM_{10} is defined as 1.0 μg/m3 or more. For reference purposes, the National Ambient Air Quality Standard (NAAQS) for annual average PM_{10} is 50 μg/m3. All area within the 80 km radius or the project are in attainment of NAAQS.

It is important to note that no control factors were assumed for the emission calculations. Periodic watering or chemical treatment of the unpaved roads will reduce emission factors by half or more.

3.7 NOISE

Open rangeland is the primary land use within and in the surrounding 2.0-mile area. Other land uses include oil and gas and CBM production facilities, as well as pastureland located to the west of the Project area. The existing ambient noise in the vicinity of the Moore Ranch Project area is dominated by the traffic noise from State Highway 387, surrounding oil and gas operations, and on-site CBM operations.

There are no occupied housing units in the vicinity of the proposed Moore Ranch Uranium Project. The nearest resident is approximately 4.3 miles to the east of the license area. As a result of the remote location of the Project and the low population density of the surrounding area, impact to noise or congestion above ambient background noise within the Project area or in the surrounding 2.0-mile area are not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Campbell or other neighboring counties.

3.8 HISTORIC AND CULTURAL RESOURCES

3.8.1 Historic, Archeological, and Cultural Resources

Beginning in September of 2006 through July 20, 2007, Mr. James A Brunette, dba Frontier Archaeology, conducted a Class III Cultural Resource Inventory of the Moore Ranch Project License area including record searches from the Wyoming State Historic Preservation Office (WSHPO) and field surveys of areas that have not been previously inventoried. Standard pedestrian transects were used to conduct the Class III inventory.

Subsurface tests were not conducted in association with this project. Fieldwork conditions were favorable, with no snow cover, sunny to partly cloudy skies, temperatures ranging from the 40's to the upper 90's, and variable winds. Field notes and other data are on file at the Frontier Archaeology office at 3630 West 46th Street, Casper, Wyoming.

The Class II Cultural Resource Inventory investigations found seven sites, 48CA6691-48CA6697, and 25 Isolate Resources/Artifacts, including artifacts from the Paleo-Indian, Middle Archaic, Late Archaic and Historic periods. Two sites, 48CA6694 and 48CA6696, are considered eligible for nomination to the National Register of Historic Places (NRHP). All sites and artifacts are described in detail in the Class III Inventory Report in Appendix B. Six previously recorded sites were also revisited during this investigation. None of the previously recorded sites have been affected by CBM development or exploratory drilling activities associated with uranium development. Only two sites, 48CA965 and 48CA966, which are listed as not eligible for nomination to the NRHP, are at or near any current development areas (near the monitor well ring). No sites are located within planned wellfield areas (see report in Appendix B).

None of the sites eligible for nomination are located within areas currently planned for in situ development, and in fact, are located well over a mile away from any planned development. If exploration and development plans are subsequently expanded near those areas, then all associated ground-disturbing activities will avoid impacting sites 48CA6694 and 48CA6696. If avoidance is not feasible, then a testing/data recovery plan will need to be implemented and completed prior to commencement of any ground disturbing activities to mitigate the adverse affects to the eligible sites.

As concluded in the Class III Cultural Resource Inventory Report in Appendix B, the currently proposed Moore Ranch Project will not affect any known significant cultural resources and additional archaeological work is not considered necessary.

The Class III Cultural Resource Inventory in Appendix B contains information that falls under the confidentiality requirement for archeological resources under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w-3(a)). The report, including Wyoming Cultural Resource Forms, has also been submitted to WSHPO for concurrence and the WDEQ-LQD under a separate cover from Frontier Archaeology. The Wyoming Cultural Resource Forms are not included in Appendix B since these forms were not provided to the client due to disclosure restrictions in the NHPA Section 304. Accordingly, disclosure is specifically exempted by statute as specified in 10 CFR §2.390(a)(3). Therefore, EMC requests that all applicable portions of Appendix B remain "CONFIDENTIAL" for the purpose of Public Disclosure of this application. Each page of the protected cultural resource information has been marked as follows:

Confidential Information Submitted under 10 CFR 2.390

The cover page for Appendix B has been marked with a more detailed statement, as follows:

Confidential Information Submitted under 10 CFR 2.390
Disclosure is Limited Under the National Historic Preservation Act, Section 304 (16 U.S.C. 470w-3(a)).

3.9 VISUAL AND SCENIC RESOURCES

The Moore Ranch License Area is on private land and therefore is not managed by any public agency to protect scenic quality. However, it is located in prairie landscape of the Powder River Basin in the vicinity of public lands that are administered by the Buffalo Field Office of the Bureau of Land Management (BLM). The BLM has inventoried the visual resources of all lands within the boundaries of the Buffalo Field Office, including private lands, with the Visual Resource Management (VRM) system.

The VRM system is the basic tool used by the BLM to inventory and manage visual resources on public lands. The VRM inventory process involves rating the visual appeal of a tract of land, measuring public concern for scenic quality, and determining whether the tract of land is visible from travel routes or observation points.

3.9.1 Visual Resource Management Classes

The elements used to determine the visual resource inventory class are the scenic quality, sensitivity levels, variety classes, and distance zones. Each of the elements used to identify the VRM Class is defined below:

Scenic Quality - Scenic quality is a measure of the visual appeal of a tract of land. In the visual resource inventory process, public lands are assigned an A, B, or C rating based on the apparent scenic quality, which is determined using seven key factors: landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modifications. During the rating process, each of these factors is ranked comparatively against similar features within the physiographic province.

Sensitivity Level – A degree or measure of viewer interest in the scenic qualities of the landscape. Factors to consider include 1) type of users; 2) amount of use; 3) public interest; 4) adjacent land uses; and 5) special areas. Three levels of sensitivity have been defined:

- Sensitivity Level 1 – The highest sensitivity level, referring to areas seen from travel routes and use areas with moderate to high use.
- Sensitivity Level 2 – An average sensitivity level, referring to areas seen from travel routes and use areas with low to moderate use.
- Sensitivity Level 3 – The lowest sensitivity level, referring to areas seen from travel routes and use areas with low use.

Distance Zones – Areas of landscapes denoted by specified distances from the observer, particularly on roads, trails, concentrated-use areas, rivers, etc. The three categories are foreground-middleground, background, and seldom seen.

- Foreground-Middleground – The area visible from a travel route, use area, or other observer position to a distance of 3 to 5 miles. The outer boundary of this zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape and vegetation is apparent only in pattern or outline.

- Background - The viewing area of a distance zone that lies beyond the foreground and middleground. This area usually measures from a minimum of 3 to 5 miles to a maximum of about 15 miles from a travel route, use area, or other observer position. Atmospheric conditions in some areas may limit the maximum to about 8 miles or increase it beyond 15 miles.

- Seldom Seen – The area is screened from view by landforms, buildings, other landscape elements, or distance.

The visual resource inventory classes are used to develop visual resource management classes, which are generally assigned by the BLM through the resource management plan process. VRM objectives are developed to protect scenic public lands, especially those lands that receive the greatest amount of public viewing. The following VRM classes are objectives that outline the amount of disturbance an area can tolerate before it no longer meets the visual quality of that class.

- Class I Objective: To preserve the existing character of the landscape. The level of change to the characteristic landscape should be very low and must not attract attention.

- Class II Objective: To retain the existing character of the landscape. The level of change to the characteristic landscape should be low.

- Class III Objective: To partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate.

- Class IV Objective: To provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

The Scenic Quality, Sensitivity Level, and Distance Zone inventory levels are combined to assign the VRM Class to inventoried lands as shown in the following matrix:

Determining BLM Visual Resource Inventory Classes								
Visual Sensitivity		High			Medium			Low
Special Areas		I	I	I	I	I	I	I
Scenic Quality	A	II	II	II	II	II	II	II
	B	II	III	III/IV	III	IV	IV	IV
	C	III	IV	IV	IV	IV	IV	IV
Distance Zones		f/m	b	ss	f/m	b	ss	ss

f/m = foreground-middleground
b = background
ss – seldom seen

3.9.2 Moore Ranch Visual Resource Management Rating

The BLM has inventoried the landscape within the Moore Ranch License Area and the surrounding 2-mile area and rated the areas as VRM Class IV. The management objective of VRM Class IV is to provide for management activities which require major modification of the existing character of the landscape. The level of change to the characteristic landscape can be high.

The scenic quality inventory was based on methods provided in BLM Manual 8410 – Visual Resource Inventory as well as a review of the factors that contribute to the existing VRM Class IV inventory for the License Area. The key factors of landform, vegetation, water, color, influence of adjacent scenery, scarcity and cultural modifications were evaluated and scored according to the rating criteria. The criteria for each key factor ranged from high to moderate to low quality based on the variety of line, form, color, texture and scale of the factor within the landscape. A score was associated with each rating criteria, with a higher score applied to greater complexity and variety for each factor in the landscape. The results of the inventory and the associated score for each key factor are summarized in Table 3.9-1. According to NUREG-1569, if the visual resource evaluation rating is 19 or less, no further evaluation is required. Based on field reconnaissance conducted in May 2007, the total score of the scenic quality inventory for the Moore Ranch License Area is 4; therefore, no further evaluation of existing scenic resources and any changes to scenic resources from proposed project facilities is required.

Table 3.9-1 Scenic Quality Inventory and Evaluation for the Moore Ranch Permit Area

Key Factor	Rating Criteria	Score
Landform	Flat to rolling terrain with no interesting landscape features	1
Vegetation	Very little variety in vegetation, which consists of grazed grassland with sage and other shrubs.	1
Water	Water is present, but not evident as viewed from residences and roads	0
Color	Vegetation and soil colors are tan (various midtones) throughout most of the year.	1
Influence of adjacent scenery	Adjacent scenery is very similar to Permit Area, and provides no variety in line, form, color, and texture.	0
Scarcity	Landscape is common for the region	1
Cultural modifications	Existing modifications consist of numerous oil and gas production facilities and infrastructure, and grazing activities.	0
	Total Score	**4**

3.10 SOCIOECONOMICS

Information presented in this section concerns those demographic and social characteristics of the counties and communities that may be affected by the proposed development of a uranium in-situ recovery facility at the Moore Ranch Project in Campbell County, Wyoming. Data were obtained through the 1980, 1990, and 2000 U.S. Census of Population, the 2005 and 2006 Census Population Estimates program, and various State of Wyoming government agencies.

3.10.1 Demography

3.10.1.1 Regional Population

The area within an 80-kilometer (km) (50-mile) radius of the Moore Ranch License Area (License Area) includes portions of six counties in northeastern Wyoming (Campbell, Converse, Johnson, Natrona, Weston Counties and a small portion of Niobrara County), as shown on Figure 3.10-1 (all Tables and Figures are included at end of this Section). The proposed Moore Ranch Project is located in southwest Campbell County. The nearest communities are Wright, a small Campbell County incorporated town located northeast on State Highway 387, and the Towns of Edgerton and Midwest, which are located in Natrona County southwest of the Moore Ranch Project on State Highway 387.

Historical and current population trends in counties and communities within an 80 km distance of the Project are shown in Table 3.10-1, which summarize past growth trends in the counties relative to state population trends between 1980 and 2006. The largest growth rates in the six-county region since 2000 occurred in Johnson, Natrona, and Campbell Counties, primarily because of ongoing mineral resource development in the Powder River Basin. Population growth in Campbell, Johnson, and Converse Counties has outpaced state population growth for most years since 1980, with the largest average annual growth rate of 13.7 percent occurring in Converse County during the 1980s. The state population declined during this period, primarily because of declines in historic agricultural economic sectors, while the high growth rates in Campbell, Johnson, and Converse Counties indicated boom years in oil, coal, and gas development. The population in Campbell County grew at a slower rate between 2000 and 2006 than in previous decades, so that growth rates are more in line with the state growth rates. The overall county and state economies are more diverse in the current decade than they were during the 1980s.

3.10.1.2 Population Characteristics

2005 population by age and sex for counties within 80 km of the License Area is shown in Table 3.10-2. Overall, the 40- to 64-year age group (which includes the 'baby boom' cohort) is the largest age group in each of the counties. According to the Wyoming Economic and Demographic Forecast: 2005 to 2014 (Wyoming Economic Analysis Division 2005), the early baby boom population in Wyoming is one of the highest in the nation as a result of the in-migration of workers during the oil boom years in the late 1970s and early 1980s. In contrast, the population in the 27- to 42-year age group is relatively low because there was a high net out-migration (outflow greater than inflow) in this age group between 1995 and 2000 as young adults left the state during a declining economy. The aging population is expected to affect the economy through changes in the labor supply as retiring baby boomers reach retirement age and are replaced by fewer new workers. The older population would also require different types of goods and services, requiring a shift in local economic sectors to accommodate the changing demographics.

In 2005, 96.9 percent of the six-county population was classified as white. Native American and persons of Hispanic origin comprised 1.1 percent and 4.4 percent, respectively, of the total six-county population of 136,541. The populations in all other racial categories account for less than 1 percent of the total population. The racial characteristics of each county were similar to the racial characteristics of the state.

3.10.1.3 Population Projections

The projected populations for selected years by county within the 80 km radius of the proposed License Area are shown in Table 3.10-3. The population projections between 2000 and 2020 anticipate that the relatively stable population trends evident between 2000 and 2006 will continue for the county and the state. The projected population growth in Campbell and Johnson Counties will continue to outpace population growth in the state, in response to ongoing and potential new mineral development projects located in these counties. The populations of Niobrara and Weston Counties will experience very slow growth or declines in population, indicating that these counties are not anticipated to see in-migrations of new residents seeking employment in the mineral development of nearby counties. It is not expected that there will be the large in-migrations of population that were typical of the 1980s.

3.10.1.4 Seasonal Population and Visitors

The proposed License Area consists of private lands in southwest Campbell County. The surrounding area within an 80 km (50-mile) radius contains mostly private lands, but also federal and state lands, which provide open space for a variety of dispersed

outdoor recreation opportunities. No developed recreation opportunities are provided on federal and state lands within the 80 km radius. Recreation opportunities offered by the private sector consist of community facilities in urban areas and the infrastructure of tourist services and facilities.

The closest recreational facility that would be a destination for tourists to the License Area is the Bozeman Trail, which crosses State Highway 387 about 1 mile west of the License Area. Visitation statistics are not compiled for the trail. Approximately 41,500 people visited the Edness Kimball Wilkins State Park (55 miles SSW of the License Area and 5 miles east of Casper) in 2005, which was a decrease of 50 percent from the 84,109 people who visited the park in 2001. Visits to the park were the lowest in 2005 for the years 1998 through 2005 (WDAI EAD 2005). Comparison of the park visitor fluctuations over this period with other parks and facilities in northeast Wyoming did not reveal a trend or pattern that would account for the annual fluctuations.

The Thunder Basin National Grassland is 14 miles east of the east boundary of the License Area. The most popular recreation use category is motorized travel/viewing scenery. Hunting and camping are also popular. Recreation use accounted for an average of 64,100 Recreation Visitor Days annually between 1992 and 1996. There are no developed recreation facilities on the Thunder Basin National Grassland.

A primary source of seasonal population in the six-county area is short-term labor for mineral resource development, construction, and service industries engaged in tourism/recreation. A review of reports prepared by the Wyoming Economic Analysis Division indicates that these workers are most likely to relocate temporarily from neighboring counties and states including Montana, Nebraska, Colorado, and South Dakota. The seasonal labor force for these economic sectors is not included in any available population or labor force data for the counties.

3.10.1.5 Schools

The License Area is located within Campbell County School District 1, which serves all of Campbell County. The nearest Campbell County community that provides education services to residents in the vicinity of the License Area is Wright, which is located 22 miles northeast of the License Area on State Highway 387. Two schools are located in Wright. The Cottonwood Elementary School serves kindergarten through grade 6. Total enrollment in these two schools for the 2005-2006 school year was 228 in the elementary school and 228 in the junior – senior high school (Wyoming Department of Education 2007). Enrollment in the elementary school has increased by 30 students since the 2001-2002 school year enrollment of 198 in the elementary school. Enrollment in the high school has decreased by 39 from the 2001-2002 enrollment of 267. The elementary school currently has a student to teacher ratio of 12.5 to 1 while the high school has a ratio of 9.7 to 1.

In Natrona County, the Midwest School provides classes for students from preschool through grade 12. Enrollment for the 2005-2006 school year was 229. The school has a student to teacher ratio of 9.4 to 1.

Families moving into the Natrona and Campbell County school districts as a result of the proposed Moore Ranch License Area operations would not stress the current school system because it is presently under capacity.

3.10.1.6 Sectorial Population

Existing population within the 80 km radius centered on the License Area was estimated for 16 compass sectors, by concentric circles of 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70 and 80 km from the center of the proposed License Area, for a total of 208 sectors. Sectorial population was estimated with data from the U.S. Census Bureau's Population Estimates Program. Subtotals by sector and compass points, as well as the total population, are shown in Table 3.10-4.

The most recent available population data were acquired from Geographic Data Technology, Inc., a division of the Environmental Systems Research Institute (ESRI). The data were created using U.S. Census 2000 boundary and demographic information for block groups within the United States, and intercensal population estimates for 2004 from the Population Estimates Program.

ArcInfo Geographic Information System (GIS) was used to extract data from U.S. Census 2004 population estimates for Census Tract Block Groups located wholly or partially within the 80 km radius from the approximate center of the License Area. Urban areas within each county were generally assigned their own block groups. To assign a population to each sector, a percentage area of each sector within one or more block groups was calculated for all of the block groups. The total 2004 population within the 80 km radius from the center of the License Area estimated by this method was 28,092.

The sectorial populations calculated using the percentage areas were modified for the sectors within a 20-mile distance because the GIS calculations are averages that do not accurately reflect the distribution of urban and rural populations within the 20-mile (32 km) radius. In addition, some sectors throughout the 80 km radius contain mostly Bureau of Land Management (BLM)-administered federal lands and do not contain any residents. These sectors were assigned a zero population. Most of the area within the 80 km radius is rural, with the majority of the population residing in the small communities near the License Area or in larger urban areas in the sectors farthest from the License Area center. Urban areas include the towns of Wright, located 22.0 miles (35.4 km) to the northeast of the License Area; Edgerton, located 23.6 miles (38.0 km) to the west-southwest; and Midwest, located 25.0 miles (40.2 km) west-southwest. The City of Glenrock is located in the 70 to 80 km sector south of the License Area.

The Census Designated Places of Antelope Hill and Homa Hills are located to the southwest along I-25, between 60 to 80 km (37.3 to 50 miles). The south part of the City of Gillette that is within the 80 km radius area consists of Census Tract 2, Block Group 2.

The population within 2 miles of the License Area boundary was estimated by locating occupied residences within 2 miles using 2006 aerial photos and field reconnaissance. The U.S. Census 2000 blocks (blocks are subdivisions of block groups) included in this area were reviewed for the total number of people residing within housing units within the blocks. There are no individual block data available for the intercensal years of the U.S. Census Population Estimates Program.

The total population within the 80 km radius was estimated to be 27,987 once individual sectors were modified to better represent the distribution of urban and rural populations within the area (Table 3.10-4). This total varied less than 1 percent (105 people) from the total population of 28,092 people that was calculated using GIS percentage calculations in the unmodified table.

3.10.2 Local Socioeconomic Characteristics

3.10.2.1 Major Economic Sectors

The Moore Ranch License Area is located in Campbell County; however, social and economic characteristics are described for Natrona in addition to Campbell County because communities in Natrona County, primarily the City of Casper, provide a relatively large resident labor force for mineral extraction and construction industries in northeast Wyoming. A substantial portion of the project labor force is likely to be based in Natrona County, primarily residing in the City of Casper. Table 3.10-5 summarizes unemployment rates and employment in Campbell and Natrona Counties.

The economies of Campbell County and Natrona County depend on the energy sector, primarily those that are mineral-based. The largest employment sector in Campbell County is mining, which includes coal mining, oil and gas extraction, crude, petroleum-natural gas, oil and gas field service, and nonmetallic minerals as defined by the U.S. Bureau of Labor Statistics.

A report prepared by the Wyoming Department of Employment, Research and Planning analyzes labor supply in Wyoming by place of residence. The analysis concluded that a portion of the available labor pool in Wyoming consists of non-residents. According to the report, the construction sector is one of the industries most dependent upon seasonal and short-term workers. Of all persons working in heavy construction in 2000, 38.4 percent did not work in Wyoming in 1999.

Table 3.10-5 also shows the labor force characteristics in Campbell and Natrona Counties in 2005. In general, unemployment rates were highest in the early 1990s and have decreased overall by 2005 because of renewed energy development in northeastern Wyoming. Annual fluctuations in unemployment rates are driven primarily by short-term changes in production due to changing prices for coal, oil, and coal bed methane gas.

Per capita personal income is the income that is received by persons from all sources, including wages and other income over the course of 1 year. In 2005, personal income in Campbell County was $37,318, which was 109 percent of the state average of $34,371. The county ranks sixth in per capita annual income out of 23 counties in the state (BEA 2004). Natrona County had a higher per capita income of $41,462, which was 120 percent of the state average and ranked third in the state. Most of the Wyoming counties with the highest per capita personal incomes have strong mineral development economic sectors.

3.10.2.2 Housing

The nearest permanent housing is located in the communities of Wright in Campbell County, and Midwest and Edgerton in Natrona County. According to the U.S. Census 2000 (the most recent year for which housing data were available for communities), there were 544 housing units in Wright. Of these units, the average occupancy rate was 87.3 percent, including 114 renter-occupied housing units. The vacancy rate for all types of housing units was 12.7 percent.

In Natrona County, there were 119 housing units in Edgerton, of which 74 units were occupied. The number of occupied rental units was 17. The vacancy rate was 37.8 percent. In nearby Midwest, 149 of the total 228 housing units were occupied. There were 32 renter-occupied and 79 vacant housing units.

It is likely that current vacancy rates in Wright, Edgerton, and Midwest will decrease as a result of insufficient housing stock and increasing in-migration of workers for employment in ongoing mineral resource development. A rental vacancy survey summarized in the Wyoming Community Development Authority report (2007) shows that rental vacancy rates in Natrona County decreased to 1.67 percent (Table 3.10-6) from a post-U.S. Census 2000 high of 4.49 percent in 2002. A similar decrease in rental vacancy rates occurred in the same time period in Converse County, from a high of 3.66 percent in 2002 to the 2006 rate of 0.42 percent. The influx of population in these counties as a result of economic growth stimulated by coal bed methane gas and coal production has outstripped the available housing supply.

Urban areas within Campbell and Natrona Counties are generally within a 1- to 2-hour commuting distance from the proposed License Area. Rural areas in the counties are sparsely populated, so that most of the housing units characterized in Table 3.10-6 are

located within the communities of Gillette (Campbell County), Casper (Natrona County), and other smaller communities located along the I-25 corridor through Natrona County. Table 3.10-6 also includes the total number of housing units in the counties, but focuses on rental characteristics because most of the labor force that would originate from outside of Campbell and Natrona Counties would likely reside in rental units and other temporary lodging.

The household forecast (a household is defined as all the persons who occupy a housing unit) project an increase of 18,171 households in Campbell County from 12,207 in 2000 to 30,378 in 2030. The number of renters in Campbell County is projected to increase from 3,218 in 2000 to 7,271 in 2030. In Natrona County, the number of households is projected to increase by 19,650, from 26,819 in 2000 to 46,469 by 2030. The number of renters is expected to increase from 8,079 in 2000 to 11,831 in 2030.

3.10.2.3 Temporary Housing

Temporary housing options in the vicinity of the License Area include hotels, motels, and campgrounds. Vacancy rates are not currently available for temporary accommodations in Campbell and Natrona Counties. Available local motels/hotels/cabin establishments in the region generally have low vacancy rates during hunting seasons. There is also a high level of occupancy by the coal bed methane gas industry workers. Many motels and recreational vehicle (RV) campgrounds in the region provide accommodation for long-term visits by the week or month.

The temporary lodgings closest to the License Area are in Wright and Edgerton. Accommodations in Wright include a mobile home park, a hotel, an RV park, and one apartment complex (Town of Wright 2007). One motor lodge is located in Edgerton.

Casper and Glenrock, both on the I-25 corridor south of the License Area, provide numerous temporary lodging options (Casper Chamber of Commerce 2007). There are 28 motel/hotels in Casper and nine RV parks/campgrounds in the vicinity of Casper. Glenrock provides lodging in two motels and one RV park.

There are 18 hotels in Gillette, with a total capacity of 1,420 rooms. In addition, the two campgrounds in the Gillette area provide RV hookups and tent sites. The Cam-Plex is funded by Gillette and Campbell County, and may not compete with private enterprise (Barks 2005). The additional 1,821 RV sites at the Cam-Plex are available only for special events and not for the general public.

Temporary lodging is also available in the Town of Kaycee (located approximately 40 miles west of the License Area) in Johnson County and Sundance (located 60 miles

east of Gillette) in Crook County. Temporary lodging facilities include two motels and two RV parks, which also provide tent sites and cabin rentals.

Table 3.10-1 1980-2006 Historical and Current Population Change for Counties and Communities within the 80 km Radius of the Moore Ranch License Area

	Year						Average Annual Percent Change				
State/County/City	**1980**	**1990**	**2000**	**2002**	**2004**	**2006**	**1980/ 1990**	**1990/ 2000**	**2000/ 2002**	**2002/ 2004**	**2004/ 2006**
State of Wyoming	469,557	453,588	493,782	498,973	505,534	515,004	4.1%	-0.3%	0.9%	0.5%	0.7%
Campbell County	24,367	29,370	33,698	36,142	36,629	38,934	8.8%	2.1%	1.5%	3.6%	0.7%
Gillette city	12,134	17,635	19,646	21,819	22,174	-	6.9%	4.5%	1.1%	5.5%	-
Wright town	-	1,236	1,347	1,426	1,408	-	-	-	0.9%	2.9%	-
Converse County	14,069	11,128	12,052	12,352	12,501	12,866	13.7%	-2.1%	0.8%	1.2%	0.6%
Glenrock town	2,736	2,153	2,231	2,290	2,302	-	8.1%	-2.1%	0.4%	1.3%	-
Rolling Hills town	-	330	449	460	461	-	-	-	3.6%	1.2%	-
Johnson County	6,700	6,145	7,075	7,412	7,609	8,014	2.0%	-0.8%	1.5%	2.4%	1.3%
Kaycee town	271	256	249	261	269	-	0.0%	-0.6%	-0.3%	2.4%	-
Natrona County	71,856	61,226	66,533	67,509	68,989	70,401	4.0%	-1.5%	0.9%	0.7%	1.1%
Bar Nunn town	-	835	936	955	1,139	-	-	-	1.2%	1.0%	-
Edgerton town	510	247	169	170	172	-	4.6%	-5.2%	-3.2%	0.3%	-
Midwest town	638	495	408	411	427	-	-	-2.2%	-1.8%	0.4%	-
Niobrara County	2,924	2,499	2,407	2,266	2,283	2,253	0.0%	-1.5%	-0.4%	-2.9%	0.4%
Weston County	7,106	6,518	6,644	6,616	6,675	6,762	1.3%	-0.8%	0.2%	-0.2%	0.4%

Table 3.10-2 2005 Population by Age and Sex for Wyoming and the Counties within the 80 km Radius of the Moore Ranch License Area

AREA	AGE	MALE	FEMALE	TOTAL	TOTAL % BREAKDOWN
State of Wyoming	Under 5	16,247	14,818	31,065	6.1%
	5 - 19	51,074	48,270	99,344	19.5%
	20 - 39	53,964	49,387	103,351	20.3%
	40 - 64	107,479	106,018	213,497	41.9%
	65+	27,962	34,075	62,037	12.2%
	Total	256,726	252,568	509,294	100.0%
Campbell County	Under 5	1,399	1,184	2,583	6.9%
	5 - 19	4,173	3,849	8,022	21.4%
	20 - 39	4,307	4,006	8,313	22.2%
	40 - 64	8,468	7,932	16,400	43.8%
	65+	953	1,134	2,087	5.6%
	Total	19,300	18,105	37,405	100.0%
Converse County	Under 5	340	323	663	5.2%
	5 - 19	1,351	1,222	2,573	20.2%
	20 - 39	1,072	1,157	2,229	17.5%
	40 - 64	2,880	2,861	5,741	45.0%
	65+	717	843	1,560	12.2%
	Total	6,360	6,406	12,766	100.0%
Johnson County	Under 5	159	155	314	4.1%
	5 - 19	699	675	1,374	17.8%
	20 - 39	692	630	1,322	17.1%
	40 - 64	1,634	1,729	3,363	43.6%
	65+	622	726	1,348	17.5%
	Total	3,806	3,915	7,721	100.0%
Natrona County	Under 5	2,350	2,208	4,558	6.5%
	5 - 19	7,002	6,680	13,682	19.6%
	20 - 39	7,115	6,992	14,107	20.2%
	40 - 64	14,255	14,333	28,588	41.0%
	65+	3,828	5,036	8,864	12.7%
	Total	34,550	35,249	69,799	100.0%
Niobrara County	Under 5	44	49	93	4.1%
	5 - 19	209	178	387	16.9%
	20 - 39	145	189	334	14.6%
	40 - 64	515	524	1,039	45.5%
	65+	200	233	433	18.9%
	Total	1,113	1,173	2,286	100.0%
Weston County	Under 5	156	155	311	4.7%
	5 - 19	571	548	1,119	16.8%
	20 - 39	638	549	1,187	17.8%
	40 - 64	1,546	1,392	2,938	44.0%
	65+	501	615	1,116	16.7%
	Total	3,412	3,259	6,671	100.0%

Source: U.S. Bureau of the Census 2007

Table 3.10-3 2005-2025 Population Projections for Wyoming and the Counties within the 80 km Radius of the Moore Ranch License Area

Area	Census 2000	Projected 2005	Projected 2010	Projected 2015	Projected 2020
State of Wyoming	494,078	506,184	519,595	529,352	533,534
Campbell County	33,981	37,075	39,701	42,414	44,595
Converse County	12,104	12,433	12,882	13,226	13,392
Johnson County	7,108	7,725	8,268	8,789	9,198
Natrona County	66,550	68,965	70,529	71,685	72,151
Niobrara County	2,390	2,185	2,102	1,996	1,892
Weston County	6,642	6,645	6,669	6,627	6,509

Note: Population projections for the years after 2020 are not available.
Source: Wyoming Department of Administration and Information, Economic Analysis Division 2007.

Table 3.10-4 2000 Population within the 80 km Radius of the Moore Ranch License Area

	Radius in km													
Sector	**0-1**	**1-2**	**2-3**	**3-4**	**4-5**	**5-10**	**10-20**	**20-30**	**30-40**	**40-50**	**50-60**	**60-70**	**70-80**	**Total**
N	0	0	0	0	0	0	8	33	88	112	137	161	3,682	4,221
NNE	0	0	0	0	0	0	11	5	88	112	147	205	1,901	2,469
NE	0	0	0	0	0	0	3	3	1,408	109	116	624	679	2,942
ENE	0	0	0	0	0	0	0	3	503	113	132	224	3,139	4,114
E	0	0	0	0	0	5	0	0	1,007	113	587	435	1,207	3,354
ESE	0	0	0	0	0	0	3	0	69	91	117	131	107	518
SE	0	0	0	0	0	3	3	5	68	146	263	303	153	944
SSE	0	0	0	0	0	0	0	0	125	242	273	194	1,701	2,535
S	0	0	0	0	0	0	5	5	136	190	188	164	2,763	3,451
SSW	0	0	0	0	0	0	3	0	30	38	67	115	133	386
SW	0	0	0	0	0	0	0	0	29	38	46	177	341	631
WSW	0	0	0	0	0	2	3	0	599	38	53	83	98	876
W	0	0	0	0	0	9	8	3	29	0	33	39	49	170
WNW	0	0	0	0	0	0	0	3	29	38	38	269	37	414
NW	0	0	0	0	0	0	0	0	30	71	110	113	78	402
NNW	0	0	0	0	0	0	0	0	0	112	136	148	164	560
Total	0	0	0	0	0	19	47	60	4,238	1,563	2,443	3,385	16,232	27,987

Notes: Current population living between 10 and 80 km of the mine site were estimated using 2004 census block data. Field reconnaissance was conducted in 2007 to verify data collected within 2 miles (3.22 km). The population between 3 and 30 km was estimated with the average household size in 2000 and aerial photos to count the number of housing units in each sector. See Section 3.10.1. for a detailed description of the methodology.

Table 3.10-5 2005 Annual Average Labor Force Characteristics and Employment in Economic Sectors for State of Wyoming for Campbell and Natrona Counties

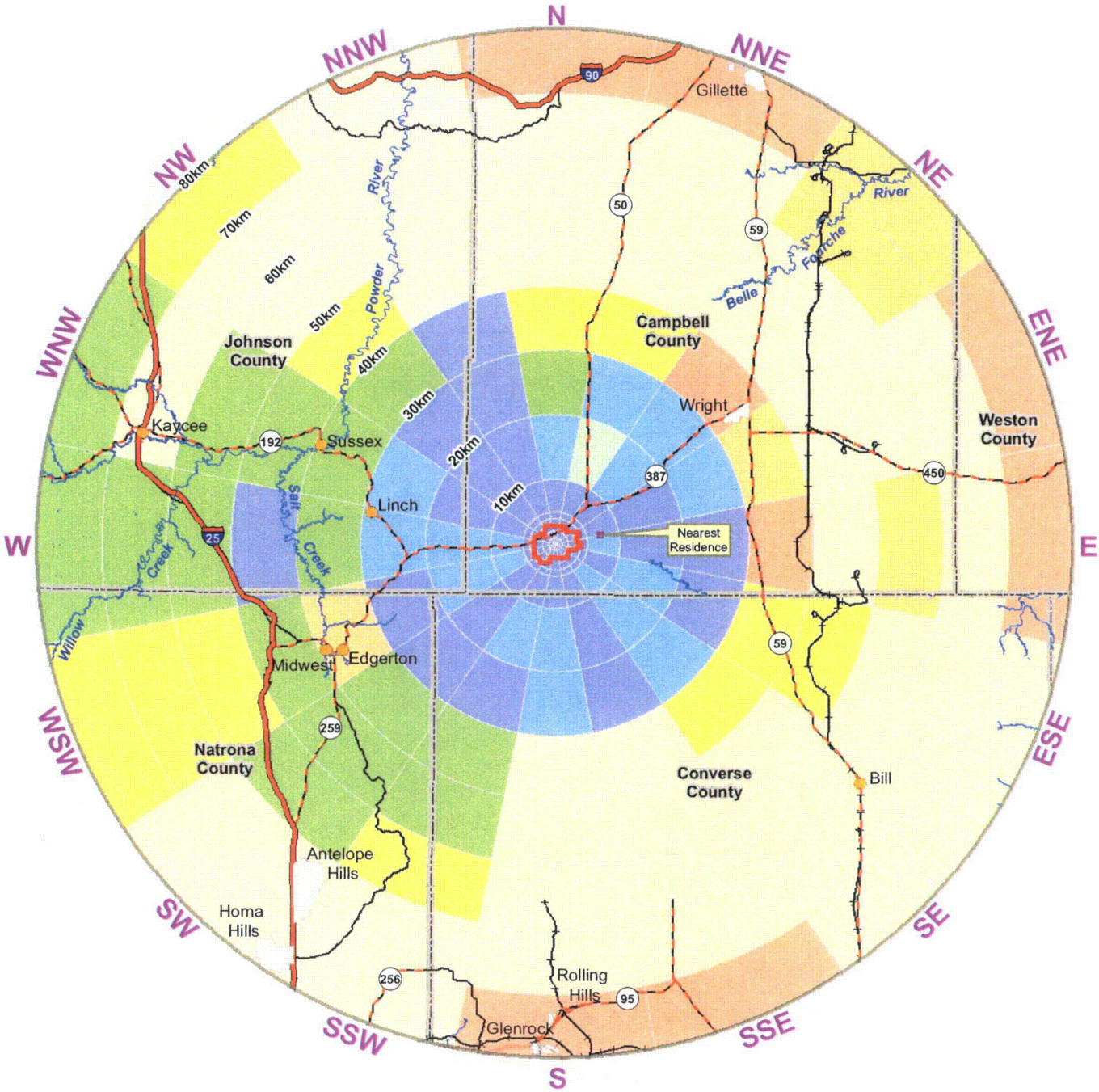
	State of Wyoming		Campbell County		Natrona County	
Labor Force	284,538	-	23,679	-	40,164	-
Employment	274,362	-	23,062	-	38,797	-
Unemployment	10,176	-	617	-	1,367	-
Unemployment Rate	**3.6**	**-**	**2.6**	**-**	**3.4**	**-**
Total employment	360,558	100.0%	27,714	100.0%	50,149	100.0%
Farm employment	12,096	3.4%	611	2.2%	433	0.9%
Non-farm employment	348,462	96.6%	27,103	97.8%	49,716	99.1%
Forestry, fishing, related activities, and other 3/	2,780	0.8%	(D)	-	(D)	-
Mining	25,578	7.1%	7,340	26.5%	4,656	9.3%
Utilities	2,422	0.7%	190	0.7%	(D)	
Construction	29,356	8.1%	2,735	9.9%	3,533	7.0%
Manufacturing	11,352	3.1%	632	3.10%	1,979	3.9%
Wholesale trade	8,784	2.4%	1,281	4.6%	2,700	5.4%
Retail trade	40,188	11.1%	2,442	8.8%	6,307	12.6%
Transportation and warehousing	12,842	3.6%	1,209	4.4%	(D)	-
Information	5,088	1.4%	228	0.8%	676	1.3%
Finance and insurance	11,247	3.1%	453	1.6%	1,794	3.6%
Real estate and rental and leasing	13,837	3.8%	441	1.6%	2,267	4.5%
Professional and technical services	16,000	4.4%	939	3.4%	2,383	4.8%
Management of companies and enterprises	970	0.3%	179	0.6%	96	0.2%
Administrative and waste services	11,871	3.3%	853	3.1%	2,343	4.7%
Educational services	2,985	0.8%	60	0.2%	373	0.7%
Health care and social assistance	26,555	7.4%	978	3.5%	5,688	11.3%
Arts, entertainment, and recreation	6,612	1.8%	169	0.6%	919	1.8%
Accommodation and food services	31,964	8.9%	1,748	6.3%	3,480	6.9%
Other services, except public administration	19,524	5.4%	(D)	-	3,013	6.0%
Government and government enterprises	68,507	19.0%	3,911	14.1%	5,797	11.6%
Federal, civilian	7,491	2.1%	86	0.3%	695	1.4%
Military	6,138	1.7%	213	0.8%	396	0.8%
State and local	54,878	15.2%	3,612	13.0%	4,706	9.4%
State government	14,942	4.1%	170	0.6%	736	1.5%
Local government	39,936	11.1%	3,442	12.4%	3,970	7.9%

(D) = Not shown to avoid disclosure of confidential information, but the estimates for this item are included in the totals.
- = Not Available

Table 3.10-6 2006 Housing Characteristics for Campbell and Natrona Counties

	Campbell County	Natrona County
Type of Unit	Number of Units	Number of Units
Housing Unit Estimate[1]	14,085	30,668
Rental Housing Costs[2]		
Apartments	$649	$508
House	$867	$767
Mobile Home	$786	$581
Rental Vacancy[3]		
Total Units	1,467	3,226
Vacant Units	6	54
Vacancy Rate	0.4%	1.67%

1 – Intercensal estimate for July 2005
2 – Second quarter 2006
3 – Rental vacancy survey conducted in December 2006
Source: Wyoming Community Development Authority 2007



Legend

Population

0	51 - 100
1 - 10	101 - 500
11 - 20	501 - 1000
21 - 50	Greater than 1,000

Moore Ranch Project Area

0 5 10 20

ARCADIS

ENERGY METALS CORP.

FIGURE 3.10-1
MOORE RANCH PROJECT
SIGNIFICANT POPULATION CENTERS
WITHIN 80 KILOMETERS

Project Number: CO001252.0001.0002

3.11 PUBLIC AND OCCUPATIONAL HEALTH

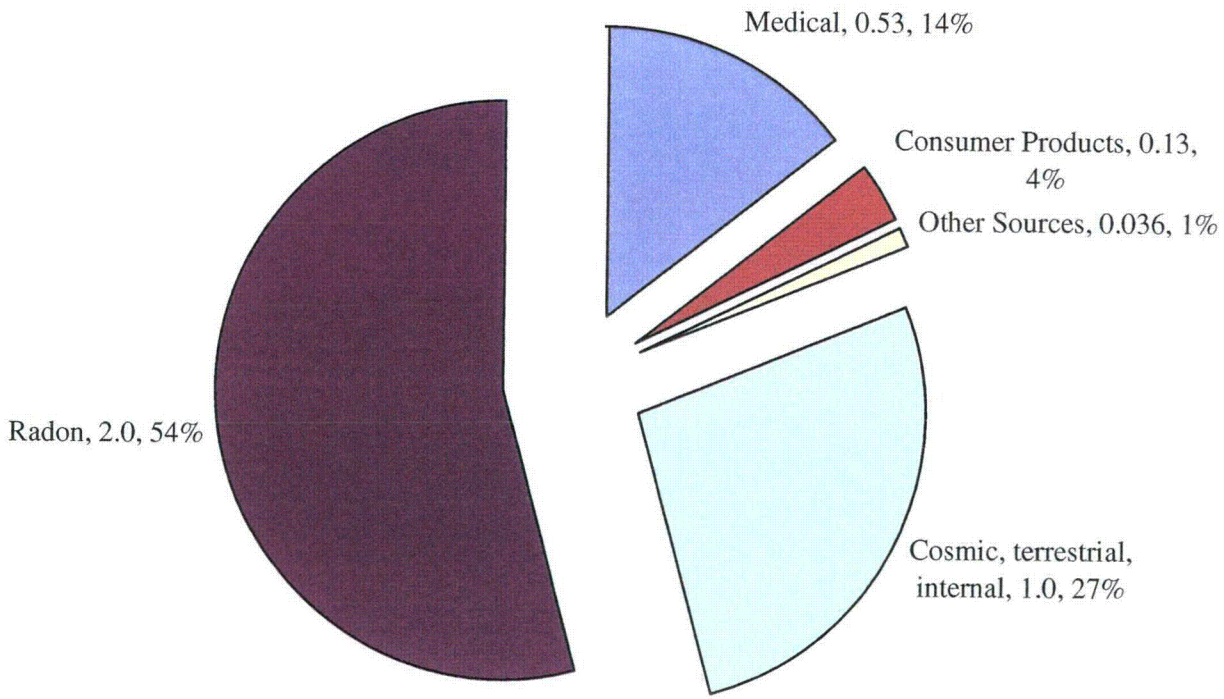
3.11.1 Background Exposure to Ionizing Radiation

Everyone is exposed to a certain level of background radiation from naturally occurring radioactive substances in the ground (terrestrial radiation), radiation from outer space (cosmic radiation), and from naturally occurring radiation in our bodies. This is commonly referred to as background radiation. The combined annual dose from these sources is thought to range from 1 to 2 millisievert [mSv]. In addition, the same level of radiation is received annually from radon gas.

Levels of natural or background radiation can vary greatly from one location to the next. People residing in Wyoming are exposed to more natural background radiation because of higher levels of cosmic radiation at higher altitudes and more terrestrial radiation from soils enriched in naturally occurring uranium. This naturally occurring uranium in the soil also results in a higher exposure to radon gas.

Shown in the Figure 3.11-1 are the average annual radiation doses received per capita in the United States from naturally occurring and manmade sources of radioactivity. The total yearly dose is approximately 0.0036 Sv (i.e., 3.6 mSv or 360 mrem).

Figure 3.11-1, Annual Background Radiation Doses in the United States (Source, mSv per year, Percent of Total)



As discussed in Section 4.12.2, the maximum total effective dose equivalent (TEDE) calculated by MILDOS-AREA for the Moore Ranch project is 0.8 mrem/yr. This dose is located at the northwest property boundary and is a 0.2 percent increase over the annual average dose to the general public. The closest resident to the Moore Ranch facility showed an estimated TEDE of 0.7 mrem/yr, which is 0.7 percent of the regulatory dose limit to the general public from NRC-licensed operations of 100 mrem/yr.

Expressed another way, the maximum radiological effect of the Moore Ranch operation would be to increase the TEDE of continental population by 0.000045 percent.

3.11.2 Occupational Health and Safety

Addendum 3.11A contains the incident rates of nonfatal occupational injuries and illnesses by industry and case type in the State of Wyoming for 2005. The incident rate is calculated using the following formula:

$$\left(N/_{EH}\right) \times 200{,}000$$

Where:

N	=	number of injuries and illnesses
EH	=	total hours worked by all employees during a calendar year
200,000	=	base for 100 equivalent full-time workers

The incident rates for mining are contained under NAICS code 21 and include oil and gas extraction, mining, and support activities for mining. ISR uranium mining would be included in metal/nonmetal mining.

3.12 WASTE MANAGEMENT

There are no current waste generation activities since this is a proposed action for a new facility. Waste management impacts for the proposed action are discussed in Section 4.12.

4 ENVIRONMENTAL IMPACTS

4.1 LAND USE IMPACTS

As discussed in Section 3.1 of this Environmental Report (ER), rangeland is the primary land use within the Moore Ranch License Area and the surrounding 2.0-mile review area. Oil and gas production facilities and infrastructure are also located on rangeland throughout the review area. The review area also contains pastureland to the west. Based on a site reconnaissance conducted in May 2007 and a 2006 aerial photo, there are no occupied housing units in the License Area. Figure 3.1-1 depicts land use in the review area.

Construction of the Moore Ranch Central Plant and associated structures will encompass approximately 11 acres. Operation of the Moore Ranch Project will ultimately encompass approximately 150 acres. Use of the land as rangeland will be excluded from this area during the life of the project. Oil and gas production facilities will not be affected. Considering the relatively small size of the area impacted by construction and operation, the exclusion of grazing from this area over the course of the Moore Ranch project will have an insignificant impact on local livestock production.

These impacts to land use are considered temporary and reversible by returning the land to its former grazing use through post-mining surface reclamation. There will be no long-term impacts or institutional controls following decommissioning of the site.

Mitigation measures for the loss of agricultural production over the course of the project are discussed in Section 5.1.

4.2 TRANSPORTATION IMPACTS

4.2.1 Access Road Construction Impacts

State Highway 387 passes through the northern end of the proposed License Area. Delivery of construction materials will access the site on this highway. An existing gravel road accesses the general location selected for construction of the central plant. This existing road may require minor improvements and completion of a short spur road to accommodate access by trucks and heavy equipment during construction and operation. The environmental impacts of these minor improvements will be insignificant. Access road construction activities will primarily have minor air quality impacts, which are discussed in detail in Section 4.6.

4.2.2 Traffic Impacts

The most heavily used public road segment would be State Highway 387 between I-25 to the west and State Highway 59 to the east. Access to the License Area from Gillette would be from State Highway 59, and from Casper would be from I-25. Construction traffic, the construction workforce, and the operations workforce would converge on the License Area on State Highway 387 from the east and the west. The existing traffic levels on the highway are low. The highest levels of project-related traffic would be from the operations workforce, and assuming there would be an average of one employee per vehicle, per one-way vehicle trip, there could be an increase of 5.4 percent in daily traffic along the highway. This 5.4 percent (10.8 percent for two trips per day) increase is well below the 25 percent threshold generally used for predicting significant effects to a transportation system.

Equipment needed for construction and installation of the proposed facility would include heavy equipment (cranes, bulldozers, graders, track hoes, trenchers, and front-end loaders), and heavy- and light-duty trucks.

4.2.3 Transportation Accident Impacts

Transportation of hazardous materials to and from the Moore Ranch Project can be classified as follows:

- Shipments of uranium-laden resin from the Moore Ranch plant to a licensed facility for toll "milling" and return shipments of barren, eluted resin. Resin will be transported in tank trucks to a nearby licensed facility for elution, precipitation, and drying.

- Shipments of dried yellowcake. Yellowcake will be transported in 208-L (55-gal.) drums to a distant conversion facility for refining and conversion. Conversion facilities are currently located in Metropolis, Illinois and Port Hope, Ontario, Canada.

- Shipments of process chemicals or fuel from suppliers to the site.

- Shipment of radioactive waste from the site to a licensed disposal facility.

Accident risks involving potential transportation occurrences are discussed in the following sections. Mitigation and control measures to eliminate or minimize transportation accident environmental impacts are discussed in Section 5.2.

4.2.3.1 Accidents Involving Ion Exchange Resin Shipments

A potential transportation risk associated with operation of the Moore Ranch Project as a uranium extraction plant using toll "milling" at another licensed processing facility is the transfer of the ion exchange resin to and from the central plant. Loaded ion exchange resin would be transported from the Moore Ranch Project in a 4,000 gallon capacity tanker trailer. It is currently anticipated that up to four loads of uranium-laden resin may be transported for elution and up to four loads of barren eluted resin may be returned on a daily basis. The transfer of resin will occur on a combination of private, county and state roads. For shipments of ion exchange resin to a central plant, NRC determined that the probability of an accident involving such a truck was 0.009 in any year.

The worst case accident scenario involving resin transfer transportation would be an accident involving the transport truck and tanker trailer when carrying uranium-laden resin where all of the tanker contents were spilled. Because the uranium is ionically-bonded to the resin and the resin is in a wet condition during shipment, the radiological and environmental impacts of such a spill are minimal. The radiological and environmental impact of a similar accident with barren, eluted resin would be less significant. The primary environmental impact associated with either accident would be the salvage of soils impacted by the spill area and the subsequent damage to the topsoil and vegetation structure. Areas impacted by the removal of soil would be revegetated.

4.2.3.2 Accidents Involving Yellowcake Shipments

NUREG-0706 concluded that the probability of a truck accident involving shipments of yellowcake in any year is 11 percent for each uranium extraction facility. This calculation used average accident probabilities (4.0×10^{-7}/km for rural interstate, 1.4×10^{-6}/km for rural two-lane road, and 1.4×10^{-6}/km for urban interstate) that NUREG/CR-6733 determined were conservative.

The worst case accident scenario involving yellowcake transportation would be an accident involving the transport truck where the integrity of one or more drums containing yellowcake was breached, resulting in a release to the environment.

4.2.3.3 Accidents Involving Shipments of Process Chemicals and Fuel

It is estimated that approximately 4 bulk chemical, fuel, and supply deliveries will be made per working day throughout the operational life of the project. Types of deliveries will include carbon dioxide, oxygen, salt, soda ash, hydrogen peroxide, anhydrous ammonia, sulfuric acid, and fuel. All shipment will be made in accordance with the applicable DOT hazardous materials shipping provisions.

4.2.3.4 Accidents Involving Radioactive Wastes

Low level radioactive 11e.(2) by-product material or unusable contaminated equipment generated during operations will be transported to a licensed disposal site. Because of the low levels of radioactive concentration involved, these shipments are considered to have minimal potential environmental impact in the event of an accident. Shipments are generally made bulk in sealed roll off containers in accordance with the applicable DOT hazardous materials shipping provisions.

4.3 GEOLOGY AND SOILS IMPACTS

4.3.1 Geologic Impacts

Geological impacts from operations are expected to be minimal, if any. No significant matrix compression or ground subsidence is expected, as the net withdrawal of fluid from the target sandstone will be on the order of 1 percent or less. Further, once mining and restoration operations are completed, groundwater levels will return to near original conditions under a natural gradient.

It is more likely that geologic factors could have an impact on the project. As discussed in Section 3.3, current earthquake probability maps that are used in the newest building codes (2500 year maps) suggest a scenario that would result in moderate damage to buildings and their contents. The probability-based worst-case scenario could result in an Intensity VII earthquake in the area of the Moore Ranch Project. In intensity VII earthquakes, damage is negligible in buildings of good design and construction, slight-to-moderate in well-built ordinary structures, considerable in poorly built or badly designed structures such as unreinforced masonry buildings. Some chimneys will be broken.

Mitigation measures to minimize seismic impacts on the project are discussed in Section 5.3.1.

4.3.2 Soil Impacts

Based on the soil mapping unit descriptions in Section 3.3, the hazard for water erosion within the Moore Ranch Project varies from slight to severe and the hazard from wind erosion varies from moderate to severe. The potential for wind and water erosion is mainly a factor of surface characteristics of the soil, including texture and organic matter content. Given the fine-loamy and sandy texture of the surface horizons throughout the majority of the Moore Ranch Project and the semi-arid climate, the soils are more susceptible to erosion from wind than water. See Table 4.3-1 for a summary of wind and water erosion hazards within the Moore Ranch Project.

The 11 acre fenced controlled area is underlain by soils with a slight potential for water erosion and a severe potential for wind erosion. The soils underlying the proposed wellfields are at a moderate to severe risk of erosion from both wind and water. Though no topsoil will be stripped from the wellfields, construction may result in an increase in the erosion hazard from both wind and water due to the removal of vegetation and the physical disturbance from heavy equipment.

Mitigation measures for soil impacts are described in Section 5.3.2.

Table 4.3-1 Summary of Wind and Water Erosion Hazards[1] Within the Moore Ranch Unit

Map Symbol	Map Unit Description	Water Erosion Hazard	Wind Erosion Hazard
110	Bidman loam, loamy substratum, 0 to 6 percent slopes	Slight	Moderate
144	Forkwood loam, 0 to 6 percent slopes	Slight	Moderate
156	Hiland fine sandy loam, 0 to 6 percent slopes	Slight	Severe
226	Ulm loam, 0 to 6 percent slopes	Slight	Moderate
227	Ulm clay loam, 0 to 6 percent slopes	Slight	Moderate
235	Vonalee fine sandy loam, 0 to 10 percent slopes	Moderate	Severe
111-1	Bidman loam, 0 to 6 percent slopes	Slight	Moderate
111-2	Parmleed loam, 0 to 6 percent slopes	Slight	Moderate
112-1	Bidman loam, 6 to 15 percent slopes	Slight	Moderate
112-2	Parmleed loam, 6 to 15 percent slopes	Slight	Moderate
116-1	Cambria loam, 0 to 6 percent slopes	Slight	Moderate
116-2	Kishona loam, 0 to 6 percent slopes	Slight	Moderate
116-3	Zigweid loam, 0 to 6 percent slopes	Slight	Moderate
117-1	Cambria loam, 6 to 15 percent slopes	Slight	Moderate
117-2	Kishona loam, 6 to 20 percent slopes	Severe	Moderate
122-1	Cushman loam, 6 to 15 percent slopes	Severe	Moderate
124-2	Shingle loam, 3 to 30 percent slopes	Severe	Moderate
127-2	Theedle loam, 0 to 30 percent slopes	Severe	Moderate
140-1	Embry sandy loam, 3 to 20 percent slopes	Moderate	Severe
146-2	Cushman loam, 0 to 6 percent slopes	Severe	Moderate
147-1	Forkwood loam, 6 to 15 percent slopes	Slight	Moderate
153-1	Haverdad clay loam, 0 to 6 percent slopes	Slight	Moderate
153-2	Kishona clay loam, 0 to 6 percent slopes	Slight	Moderate
157-2	Bowbac fine sandy loam, 0 to 6 percent slopes	Slight	Severe
158-1	Hiland fine sandy loam, 6 to 15 percent slopes	Slight	Severe
158-2	Bowbac fine sandy loam, 6 to 15 percent slopes	Slight	Severe
170-2	Tullock loamy sand, 6 to 30 percent slopes	Slight	Severe
171-1	Keeline, dry complex, 3 to 30 percent slopes	Moderate	Severe
194-1	Pugsley sandy loams, 6 to 15 percent slopes	Severe	Severe
194-2	Decolney sandy loams, 6 to 15 percent slopes	Severe	Severe
205-1	Samday clay loam, 3 to 15 percent slopes	Severe	Moderate
213-1	Terro sandy loam, 6 to 30 percent slopes	Severe	Severe
216-2	Kishona loam, 6 to 30 percent slopes	Severe	Severe
221-1	Turnercrest fine sandy loam, 6 to 30 percent slopes	Severe	Severe
221-3	Taluce fine sandy loam, 6 to 30 percent slopes	Severe	Severe
228-2	Renohill clay loam, 0 to 6 percent slopes	Moderate	Moderate
236-2	Terro fine sandy loam, 2 to 10 percent slopes	Moderate	Severe

[1]Based on soil mapping unit descriptions.

4.4 WATER RESOURCES IMPACTS

4.4.1 Surface Water Impacts

4.4.1.1 Impacts on Surface Waters and Wetlands

EMC plans to construct three wellfields and a central plant facility for the Moore Ranch Project. No wetlands will be impacted due to the construction of the central plant and the two western wellfield sites (Wellfields #1 and #3). Wetlands or surface water channels may be impacted in the easternmost wellfield site (Wellfield #2), which is located in Section 35. The second tributary to Simmons Draw runs north to south in the northern half of the eastern wellfield site. The section of the tributary is between waypoint W70 (a CBM outfall location) and W37. There is a small POW stock pond (0.02 acres) at W36. The tributary in the eastern wellfield area is considered PUB on the drainage bottom and is approximately 1.66 acres. As previously noted in Section 3.5, wetlands located within the Moore Ranch boundaries are recommended as non-jurisdictional.

No drainages or bodies of water will be significantly modified or altered within the Moore Ranch Project area during project construction or operations. If significant changes or alterations were to occur, the impact to the second tributary to Simmons Draw wetlands would be minimal as the disturbance is short-term and the draw is ephemeral. The potential for erosion is present due to the construction of the wells near the drainage; however, disturbance is short-term and disturbed areas will be reseeded soon after the wellfields are constructed.

4.4.1.2 Surface Water Impacts from Sedimentation

Normal construction activities within the wellfields, process plant, and along the pipeline courses and roads have the potential to increase the sediment yield of the disturbed areas. However, the relative size of these disturbances is small when compared to the size of the overall areas and to the size of the watersheds, and also have a short term impact. Since well field decommissioning and reclamation activities will be on-going throughout the life of the project, the area to be reclaimed at the conclusion of operations will be reduced, although a slight increase in sediment yields and total runoff can still be expected. Since all natural flow within the project boundaries is ephemeral with no intermittent or perennial streams, potential impacts to surface water from construction and decommissioning activities are also limited to uncommon precipitation or runoff events.

The physical presence of the surface facilities including wellfields and associated structures, access roads, office buildings, pipelines, facilities and other structures associated with ISR mining and processing of uranium are not expected to significantly change peak surface water flows because of the relatively flat topography of the drainages at the site, the low regional precipitation, the absorptive capacity of the soils, and the small area of disturbance relative to the large drainage within and adjacent to the proposed License Area.

Mitigation and control measures to eliminate or reduce surface water impacts from sedimentation are discussed in Section 5.4.2.3.

4.4.1.3 Potential Surface Water Impacts from Accidents

Surface water quality could potentially be impacted by accidents such as excessive rainwater or runoff in impacted soil areas or failure or an uncontrolled release of process liquids due to a wellfield leak. Section 5.4.2 discusses measures to prevent and control wellfield spills. Process buildings and chemical storage areas will be constructed with sumps or secondary containments, and a regular program of inspections and preventive maintenance will be implemented.

4.4.2 Groundwater Impacts

The potential groundwater impacts of ISR mining are related to the consumption of groundwater and short-and long-term changes to groundwater quality. Perhaps the most significant environmental impact that can occur as a result of ISR mining is the degradation of water quality in the ore-bearing aquifer.

4.4.2.1 Groundwater Consumption

Based on a bleed of 0.5% to 1.5% which has been successfully applied at other ISR operations, the potential impact from consumptive use of groundwater is expected to be minimal. In this regard, the vast majority (e.g., on the order of 99%) of groundwater used in the mining process will be treated and re-injected. Potential impacts on groundwater due to consumptive use outside the proposed License Area are expected to be negligible.

To generally quantify the potential impact of drawdown due to mining and restoration operations, the following assumptions were used:

Mining/restoration and plant life:	12.5 years
Average net consumptive use:	105 gpm

Location of pumping centroid:	NE ¼ of Section 34
Observation radius:	Variable based on water use 5,000 feet (nearest stock well) 6,500 feet (nearest permit boundary) 16,000 feet (nearest water supply well)
Formation transmissivity	586 ft^2/d (preliminary pump test results)
Formation thickness	80 feet
Formation hydraulic conductivity	7.3 ft/d
Formation storativity	4.0×10^{-3} (pump test results)

The data were used to predict drawdown over time with a Theis semi-steady state analytical solution, which includes the following assumptions:

- The aquifer is confined and has apparent infinite extent;
- The aquifer is homogeneous and isotropic, and of uniform effective thickness over the area influenced by pumping;
- The piezometric surface is horizontal prior to pumping;
- The well is pumped at a constant rate;
- No recharge to the aquifer occurs;
- The pumping well is fully penetrating; and,
- Well diameter is small, so well storage is negligible.

Based on these assumptions and results from the Moore Ranch Pump Test, drawdown after 12.5 years of operation at various distances from the centroid of pumping (e.g., the center of the NE ¼ of Section 34) were estimated to be 11.3, 9.8 and 5.1 feet, respectively. This amount of drawdown is approximately 10 to 15 percent of the available drawdown (approximately 70 feet, depending on location) in the 70 Sand.

As shown in Figure 3.4-1, few water wells are present in the vicinity of Moore Ranch. There is little use of shallow ground water in the immediate vicinity of Moore Ranch. The closest industrial well is approximately 2,900 feet from the centroid of pumping (NE ¼ of Section 34). The closest stock well is approximately 5,000 feet from the centroid of pumping; the closest domestic well is approximately 16,000 feet. The limited drawdown that likely will be induced from mining, groundwater restoration and plant operations will have little if any impact on local water users.

Mitigation measures associated with groundwater consumption are discussed in Section 5.4.2.1.

4.4.2.2 Impacts on Ore Zone Groundwater Quality

During ISR mining operations, water quality impacts are usually of greater concern than water consumption impacts because water consumption during mining is relatively small. Contamination of groundwater from the proposed lixiviant is caused by (1) the addition of sodium bicarbonate and oxygen to the groundwater, (2) the addition of chloride to the groundwater by the processing plant, and (3) the interaction of these chemicals with the mineral and chemical constituents of the aquifer being mined. The result is that during mining, the concentration of most of the naturally occurring dissolved constituents in the mining zone will be appreciably higher than their concentrations in the original groundwater.

EMC has estimated the post-mining water quality based on the experience of COGEMA Mining, Inc. in Production Units 1 through 9 at the Irigaray ISR project located in the Powder River Basin near the proposed Moore Ranch Uranium Project. The Irigaray data was selected because of the proximity and similar geologic conditions to Moore Ranch. Cogema employed ammonium bicarbonate with hydrogen peroxide as the oxidant during early mining operations. In May 1980, the lixiviant system for the entire site was converted to sodium bicarbonate chemistry with gaseous oxygen as the oxidant. The water quality database is extensive because it represents nine production units located in a 30 acre site.

The water quality of the Irigaray ore zone after mining was established by sampling each of the designated restoration wells. The post-mining mean of the analytical results from Production Units 1 through 9 is presented in Table 4.4-1. The chemical alteration of the ore zone aquifer can be observed through comparison of the post-mining mean concentrations with the baseline concentrations.

Table 4.4-1 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Aluminum (mg/l)	<0.05 – 4.25	<1.037
Ammonia Nitrogen as N (mg/l)*	<0.05 – 1.88	23
Dissolved Arsenic (mg/l)	<0.001 – 0.105	<0.601
Dissolved Barium (mg/l)	<0.01 – 0.12	<1.067
Boron (mg/l)	<0.01 – 0.225	<0.442

Table 4.4-1 Irigaray Post-Mining Water Quality

Parameter (units)	Irigaray Baseline Range	Irigaray Post-Mining Mean
Dissolved Cadmium (mg/l)	<0.002 – 0.013	<0.979
Dissolved Chloride (mg/l)*	5.3 – 15.1	277
Dissolved Chromium (mg/l)	<0.002 – 0.063	<1.018
Dissolved Copper (mg/l)	<0.002 – 0.04	<0.828
Fluoride (mg/l)	0.11 – 0.66	<1
Total and Dissolved Iron (mg/l)	0.02 – 11.8	<1.098
Dissolved Mercury (mg/l)	<0.0002 - <0.001	<0.971
Dissolved Magnesium (mg/l)	0.02 – 9.0	45.7
Total Manganese (mg/l)	<0.005 – 0.190	1.249
Dissolved Molybdenum (mg/l)	<0.02 - <0.1	<1.067
Dissolved Nickel (mg/l)	<0.01 - <0.2	<1.018
Nitrate + Nitrite as N (mg/l)	<0.2 – 1.0	<3
Dissolved Lead (mg/l)	<0.002 - <0.050	<1.018
Radium-226 (pCi/L)	0 – 247.7	200.5
Dissolved Selenium (mg/l)	<0.001 – 0.416	0.247
Dissolved Sodium (mg/l)	95 - 280	827
Sulfate (mg/l)	136 - 824	639
Uranium (mg/l)	<0.0003 – 18.8	7.411
Vanadium (mg/l)	<0.05 – 0.55	<1.067
Dissolved Zinc (mg/l)	<0.01 – 0.200	<0.065
Dissolved Calcium (mg/l)*	1.6 – 33.5	199.2
Bicarbonate (mg/l)*	5 - 144	1343
Carbonate (mg/l)	0 - 96	<2
Dissolved Potassium (mg/l)	0.4 – 17.5	9
Total Dissolved Solids (TDS) @ 180°F (mg/l)	308 - 1054	2451

* Parameters with RTV other than baseline

In general, these post-mining concentrations are within the range of those projected by NRC for ISR operations at the Crownpoint Uranium Project. EMC expects similar baseline and post-mining water quality at the Moore Ranch site.

Mitigation measures for impacts on groundwater quality are discussed in Section 5.4.2.2.

4.4.2.3 Potential Groundwater Quality Impacts from Accidents

4.4.2.3.1 Lixiviant Excursions

Water quality impacts in adjacent aquifers from ISR mining activities are related to the identification, control, and clean-up of excursions. During production, injection of the lixiviant into the wellfield results in a temporary degradation of water quality compared to pre-mining conditions. Movement of this water out of the wellfield results in an excursion. Excursions of contaminated groundwater in a wellfield can result from an improper balance between injection and recovery rates, undetected high permeability strata or geologic faults, improperly abandoned exploration drill holes, discontinuity and unsuitability of the confining units which allow movement of the lixiviant out of the ore zone, poor well integrity, or hydrofracturing of the ore zone or surrounding units. Past experience from other commercial scale in-situ recovery projects in the Powder River Basin has shown that when proper steps are taken in monitoring and operating a wellfield, excursions, if they do occur, can be controlled and recovered and that serious impacts on the groundwater are prevented.

Excursions of lixiviant at ISR facilities have the potential to contaminate adjacent aquifers with radioactive and trace elements that have been mobilized by the mining process. These excursions are typically classified as horizontal or vertical. A horizontal excursion is a lateral movement of mining solutions outside the mining zone of the ore-body aquifer. A vertical excursion is a movement of solutions into overlying or underlying aquifers.

The historical experience at other ISR uranium operations indicates that the selected excursion indicator parameters and UCLs allow detection of horizontal excursions early enough that corrective action can be taken before water quality outside the exempted aquifer boundary is significantly degraded. As noted in NUREG/CR-6733, significant risk from a horizontal excursion would occur only if it persisted for a long period without being detected.

Vertical excursions can be caused by improperly cemented well casings, well casing failures, improperly abandoned exploration wells, or leaky or discontinuous confining layers.

Mitigation measures to prevent excursions are described in Section 5.4.2.3.

4.4.2.3.2 Wellfield Spills

Potential impacts to groundwater and surface water may occur during operations as a result of an uncontrolled release of process liquids due to a wellfield leak. Should an uncontrolled wellfield release occur, there would be a potential for contamination of the shallow aquifer as well as surrounding soil. With a slow leak that remains undiscovered or a catastrophic failure, a shallow excursion is one potential impact.

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the plant, would result in a release of injection or production solution which would contaminate the ground in the area of the break.

Occasionally, small leaks at pipe joints and fittings in the headerhouses or at the wellheads may occur. Until remedied, these leaks may drip process solutions onto the underlying soil. These leaks seldom result in soil contamination.

Mitigation measures to prevent wellfield spills are described in Section 5.4.2.3.

4.5 ECOLOGICAL RESOURCES IMPACTS

4.5.1 Vegetation

Wellfield and production facilities will be constructed within upland grassland vegetation communities. Direct impacts include the short-term loss of vegetation (modification of structure, species composition, and areal extent of cover types). Indirect impacts would include the short-term and long-term increased potential for non-native species invasion, establishment, and expansion; exposure of soils to accelerated erosion; shifts in species composition or changes in vegetative density; reduction of wildlife habitat; reduction in livestock forage; and changes in visual aesthetics. An estimated 150 acres of upland grassland would be affected by construction disturbance under current development plans.

Construction activities, increased soil disturbance, and higher traffic volumes could stimulate the introduction and spread of undesirable and invasive, non-native species

within the project area. Non-native species invasion and establishment has become an increasingly important result of previous and current disturbance in Wyoming. These species often out-compete desirable species, including special-status species, rendering an area less productive as a source of forage for livestock and wildlife. Additionally, sites dominated by invasive, non-native species often have a different visual character that may negatively contrast with surrounding undisturbed vegetation. The presence of two State-designated weeds, Canada thistle and field bindweed, was observed in the Moore Ranch Project area during the baseline surveys along with other undesired annual grass species such as cheat grass brome.

No threatened or endangered vegetation species were observed within the Moore Ranch Project area; therefore, no impacts are anticipated.

Mitigation measures to lessen impacts on native vegetation and control State-designated weeds are discussed in Section 5.5.1.

4.5.2 Wildlife and Fisheries

ISR uranium mining differs from conventional surface mining by using less intrusive extraction methods that are more efficient and, thus, have less impact on the surrounding area. In situ operation use a series of injection and production wells that extract the uranium from the ore body without physically removing the ore or overburden from the ground. The mine area consists of a series of wells within a systematic pattern with a single processing facility to remove the uranium from the lixiviant.

ISR uranium mining can have direct and indirect impacts on local wildlife populations. These impacts are both short-term (lasting until successful reclamation is achieved) and long-term (persisting beyond successful completion of reclamation). However, long term impacts are not expected to be substantial due to the relatively limited habitat disturbance associated with this mining method. The direct impacts of ISR mining on wildlife include injuries and mortalities caused by collisions with project-related traffic or habitat removal actions such as topsoil stripping, particularly for smaller species with limited mobility such as some rodents and herptiles, and restrictions on wildlife movement due to construction of fences. The likelihood for the impacts resulting in injury or mortality is greatest during the construction phase due to increased levels of traffic and physical disturbance during that period. Traffic will persist during production, but should occur at a reduced, and possibly more predictable level.

Because ISR mining has a much smaller impact footprint than conventional surface mining, topsoil stripping and habitat destruction are restricted to relatively small areas needed for the processing facility and access roads. Surface disturbance associated with

the Moore Ranch Project is expected to consist of approximately 150 acres of disturbed area including an 11-acre central plant facility, approximately 1.0 mile of new access road, and a permanent working staff of approximately 60 individuals. Total surface disturbance from this new infrastructure would be approximately 150 non-contiguous acres. As indicated, most of that habitat disturbance will consist of scattered, confined drill sites for wells that will not result in large expanses of habitat being dramatically transformed from its original character as in other surface mining operations. Therefore, most indirect impacts would relate to the displacement of wildlife due to increased noise, traffic, or other disturbances associated with the development and operation of the Moore Ranch Project, as well as from small reductions in existing or potential cover and forage due to habitat alteration, fragmentation, or loss. Indirect impacts typically persist longer than direct impacts. However, the nature of ISR mining decreases the occurrence of large-scale habitat alterations and, thus, the need for reclamation efforts that can result in dramatic differences between pre-construction and post-construction vegetative communities.

Repeated surveys over multiple, consecutive years in the project area have documented that three wildlife species of particular concern do not occur in the Moore Ranch Project area: the bald eagle, greater sage-grouse (Centrocercus urophasianus), and mountain plover. Suitable habitat for all three species (trees, sagebrush, and sparse, low-growth vegetation, respectively) is extremely limited, further minimizing the potential for both direct and indirect impacts for those species, and others that require similar habitats. Other wildlife species of concern, such as ferruginous hawks (Buteo regalis), that do occur in the area may experience indirect impacts from increased travel and noise in the area during project construction and operation. However, the combination of documented nesting despite existing CBM facilities, the presence of potential alternate nesting and foraging habitat in the immediate vicinity, and the mobility of this species reduces impacts to ferruginous hawks and other such species.

Some vegetative communities currently present in the project area can be difficult to reestablish through artificial plantings, and natural seeding of those species would likely take many years. Consequently, wildlife species associated with specific habitats such as blue grama (Bouteloua gracilis) grasslands, birdsfoot sagebrush (Artemisia pedatifida), and big sagebrush (Artemisia tridentata) could be reduced in number or replaced by generalist species with broader habitat requirements until natural reseeding of certain vegetation occurs or reclamation matures to its target mix. Again, because the proposed Moore Ranch Project area is dominated by mid-grass species, the species using these three habitat types do not occur in the project area, and because the actual surface disturbance will be relatively limited (approximately 150 non-contiguous acres), negative impacts to these wildlife species are expected to be minimal.

Mitigation measure to control impacts on wildlife are discussed in Section 5.5.2.

4.5.3 Medium-Sized and Small Mammals

Medium-sized mammals (such as lagomorphs, coyotes, and foxes) may be temporarily displaced to other habitats during the initial uranium mining activities. Direct losses of some small mammal species (e.g., voles, ground squirrels, mice) may be higher than for other wildlife due to their more limited mobility and likelihood that they would retreat into burrows when disturbed, and thus be impacted by topsoil scraping or staging activities. However, given the limited area expected to be disturbed (approximately 150 non-contiguous acres) by the Moore Ranch Project, such impacts would not be expected to result in major changes or reductions in mammalian populations for small or medium-sized animals. The species known to be, or potentially, present in the project area have shown an ability to adapt to human disturbance in varying degrees, as evidenced by their presence in CBM developments and residential areas of similar, or greater, disturbance. Additionally, small mammal species in the area have a high reproductive potential and tend to re-occupy and adapt to altered and/or reclaimed areas quickly.

4.5.4 Big Game Mammals

Beginning in 2000, the Wyoming Game and Fish Department (WGFD) and WDEQ/LQD no longer required surface mining operations in Wyoming to conduct surveys for big game.

Under the proposed action, big game could be displaced from portions of the Moore Ranch Project to adjacent areas, particularly during construction of the wellfield and facilities, when disturbance activities would be greatest. Disturbance levels would decrease during actual production and restoration operations and would consist primarily of vehicular traffic on improved and unimproved (two-track) roads throughout the project area. Similar disturbance is already present in the area due to existing CBM operations. Pronghorn would be most affected, as they are more prevalent in the area. However, no areas classified as crucial pronghorn habitat occur on or within several miles of the Moore Ranch Project area and this species is not as common in the general analysis area as elsewhere within the region due to the limited presence of sagebrush in the area. Mule deer would not be substantially impacted given their infrequent use of these lands, the paucity of winter forage and security cover, and the availability of suitable habitat in adjacent areas. The WGFD does not consider the general area to be within the "use range" of any other big game species. Sightings of those species in that vicinity are rare, if they occur at all.

4.5.5 Upland Game Birds

ISR uranium mining in the Moore Ranch Project area would affect approximately 150 non-contiguous acres of potential foraging and nesting habitat for mourning doves, though such disturbance is not expected to have any marked impacts on doves. While woody corridors are not abundant in the general area, they also are not unique to the Moore Ranch Project area. Similar habitat is present immediately south of the area, where mining is not projected to occur in the near future. Additionally, doves are not restricted to treed habitats, nor are they subject to any special mitigation measures for habitat loss.

Annual monitoring studies conducted by private and agency biologists in the Moore Ranch Project area since at least 2003 have repeatedly demonstrated that sage-grouse do not inhabit that locale. As described previously in Section 3.5, those surveys encompassed most of the proposed License Area and its one-mile perimeter through 2006, and the entire area in 2007. The nearest known sage-grouse lek is approximately 3.0 miles northwest of the Moore Ranch Project area (WGFD records obtained from D. Thiele, Regional Biologist, WGFD, Buffalo, WY). Given the lack of sage-grouse observations in the area, and the minimal quantity and marginal quality of potential sage-grouse habitat, implementation of the proposed action is not likely to negatively impact any existing or potential sage-grouse leks, or important sagebrush habitats.

4.5.6 Other Birds

The Moore Ranch Project could impact 14 avian species of concern (8 Level I and 6 Level II) known to occur or potentially present as seasonal or year-round residents. Direct impacts could include injury or mortality due to encounters with vehicles or heavy equipment during construction or maintenance operations. Indirect impacts could include habitat loss or fragmentation and increased noise and activity that may deter use of the area by some species. Surface disturbance would be relatively minimal (total of approximately 150 non-contiguous acres) and would be greatest during construction.

4.5.7 Raptors

ISR uranium mining in the Moore Ranch Project area would not impact regional raptor populations, though individual birds or pairs may be affected. Mining activity could cause raptors to abandon nests proximate to disturbance, particularly if mining encroaches on active nests during a given breeding season. The Wyoming Ecological Services Office of the US Fish and Wildlife Service (FWS) recommends a one-mile buffer around all ferruginous hawk nests. Nests of most other raptor species (including all

of the others present in the project area) are typically buffered by a one-quarter- or one-half-mile radius. Thirteen intact ferruginous hawk nests were known to be present within the portions of the Moore Ranch Project area monitored during 2007. Eleven were located within the proposed license boundary and two were located within a one-mile radius. Three documented great horned owl nest sites (one-quarter mile buffer or less) are located within the license area. Only one of four intact red-tailed hawk nest sites (one-half mile buffer) occurred within that boundary in 2007. Other potential direct impacts to these species are limited to injury or mortality due to collisions with mine-related vehicular traffic.

Typically, approval from the leading regulatory agency is required before disturbance activities can occur within buffer zones for active raptor nests. All three species represented on the Moore Ranch Project have successfully nested near active surface coal mining and other energy development areas throughout the Powder River Basin for many years as documented in Annual Reports from various coal mines submitted to the WDEQ/LQD. Efforts to maintain viable raptor territories and protect nest productivity have succeeded due to a combination of the raptors becoming acclimated to the gradual encroachment of mine operations and the successful execution of state-of-the-art mitigation techniques.

Construction activities associated with the Moore Ranch Project that occur within or near active raptor territories would temporarily impact the availability of foraging habitat for nesting birds. However, equipment yards associated with mining provide additional habitat for prey species such as cottontails and raptors have been documented voluntarily nesting quite near those areas. As at other surface mines throughout the region, including nearby uranium projects, nesting raptors at the Moore Ranch project have likely been influenced primarily by natural factors such as prey abundance and availability of nesting substrates. Due to the paucity of woody vegetation and river cliffs, raptors that nest in trees or on high cliffs are not as abundant as those that either nest on the ground or are adaptable to nesting on mine facilities or other man-made structures (platform nests, etc.). During active mining, new nesting habitat can be created through enhancement efforts (nest platforms, nest boxes, and tree plantings) to mitigate any negative impacts associated with the project.

Mitigation measures for impacts on raptors are discussed in Section 5.5.4.

4.5.8 Fish and Macroinvertebrates

No aquatic habitat exists on the Moore Ranch Project that will support fish or macroinvertebrates. Therefore, no impacts from construction or operations to fish or macroinvertebrates can occur.

4.5.9 Threatened and Endangered Species

4.5.9.1 Bald Eagle (Federal Threatened)

ISR mining at the Moore Ranch Project may affect, but is not likely to adversely affect, bald eagles. As bald eagle nests and winter roost sites are absent in the study area, potential hazards for this species would be limited to foraging individuals during winter.

Direct impacts to bald eagles would include the potential for injury or mortality to individual birds foraging in the project area due to collisions with mine-related equipment during construction or operation of the Moore Ranch Project. The increased human presence and noise associated with construction activities, if conducted while eagles are wintering within the area, could displace individual eagles from using the area during that period. As bald eagles have not been documented in the project area, impacts of the proposed action would be limited to occasional foraging individuals rather than a large segment of the population. If necessary, the majority of direct impacts could be mitigated if construction activities were conducted outside the winter and early spring months, or outside the daily roosting period, should eagles be present during construction. Any bald eagles that might roost or nest in the area once the mine is operational would be doing so in spite of continuous and on-going human disturbance, indicating a tolerance for such activities.

Indirect impacts such as area avoidance could result from increased noise and human presence associated with mining related operations. Potential winter foraging habitat could be further fragmented by linear disturbances such as fences and new roads associated with the project. Given the size of the proposed project, those disturbances would occur within narrow corridors over relatively short distances.

Due to the lack of potential nesting or roosting sites and the lack of concentrated sources of prey, both the direct and indirect effects of the proposed action to bald eagles are expected to be minimal.

4.5.9.2 Reptiles, Amphibians, and Fish

Potential habitat for reptiles, amphibians, and aquatic species is quite limited within the proposed license area and occurs primarily as ephemeral or intermittent habitat associated with small, scattered stock ponds or drainages in the area. Portions of Pine Tree Draw, Simons Draw, and Ninemile Creek, and their ephemeral tributaries, occur within the proposed License Area, but do not represent reliable water sources.

Activities associated with the Moore Ranch Project are not expected to disturb existing surface water or alter the topography in the area. Furthermore, under natural conditions, such habitat is limited in the project area and few observations of aquatic species have been recorded there over time. Impacts to surface water flow and channels are expected to be minimal, as no significant alterations to these features would result from construction and operations. Additionally, any primary channels and surface water flow affected during mining would be restored during reclamation.

4.5.10 Waterfowl and Shorebirds

Construction and operation of the Moore Ranch Project would have a negligible effect on migrating and breeding waterfowl and shorebirds. Little existing habitat is present in the area, so it does not currently support large groups or populations of these species. Ponding of water from fluid releases during operations will be immediately removed, minimizing any contact of released fluids with waterfowl or shorebirds. Any new treated water sources would enhance current habitat conditions for these species, though such effects may be ephemeral and temporary in nature.

4.6 AIR QUALITY IMPACTS

The only gaseous effluent from the Moore Ranch Project is radon-222 gas. The impacts from this effluent are discussed in detail in Section 4.12.2.

Construction activities at the Moore Ranch Project will cause minimal short term effects on local air quality. Increased suspended particulates from vehicular traffic on unpaved roads, fugitive dust caused by wind erosion of areas cleared of vegetation, and diesel emissions from construction equipment would be the primary air quality impacts. Diesel emissions from construction equipment are expected to be short term only, ceasing once the operational phase begins.

EMC estimated fugitive dust emissions from operation of the Moore Ranch Project based on projected activity levels and emission factors supplied by the WDEQ. Projected activities impacting dust emissions included ongoing wellfield construction activities, routine site traffic related to operations and maintenance, heavy truck traffic delivering chemicals and material and shipping product, and employee traffic to and from the site. Based on these activities, the projected total PM_{10} emissions is 15.5 tons per year. This level of emissions is small relative to surface mines and other industrial operations that generate dust from vehicles and disturbed areas. The larger surface mines in the Powder River Basin show PM_{10} emissions inventories in the thousands of tons per year. Sections of unpaved county roads can also exceed this 15 tons per year emission rate by an order

of magnitude or more. Viewed another way, atmospheric dispersion modeling generally shows that fugitive PM_{10} emissions on the order of 15 tons per year result in insignificant impacts to ambient air beyond a distance of a few hundred yards from the sources. Significant impact for PM_{10} is defined as 1.0 μg/m3 or more. For reference purposes, the national ambient standard for annual average PM_{10} is 50 μg/m3.

It is important to note that no control factors were assumed for the emission calculations. Periodic watering or chemical treatment of the unpaved roads will reduce emission factors by half or more.

Mitigation measures for air quality impacts from dust are discussed in Section 5.6.

4.7 NOISE IMPACTS

There are no occupied housing units in the vicinity of the proposed Moore Ranch Project. Open rangeland is the primary land use within and in the surrounding 2.0-mile area. Other land uses include oil and gas and coal bed methane production facilities, as well as pastureland located to the west of the project area. As a result of the remote location of the project and the low population density of the surrounding area, impact to noise or congestion within the project area or in the surrounding 2.0-mile area are not anticipated. Additionally, given the maximum increase in population due to migrant workers is insignificant, noise and congestion impacts are not anticipated in Campbell or other neighboring counties.

Mitigation measures to control impacts from noise are discussed in Section 5.7.

4.9 VISUAL/SCENIC RESOURCES IMPACTS

The visible surface structures proposed for the Moore Ranch Project include wellhead covers, headerhouses, electrical distribution lines, and the central plant facility. The project will use existing and new roads to access each headerhouse and the central plant.

Each wellhead cover typically consists of a weatherproof structure placed over the well. These covers are approximately 3 feet high and 2 feet in diameter. Each headerhouse is a small metal building. The central plant building will be approximately 400 feet by 100 feet in size for the initial phase. In addition, maintenance, warehouse, and office structures are planned. A disturbance area around each headerhouse is necessary to provide an adequate area for operations and maintenance vehicles to turn around. Electric distribution lines would connect headerhouses to existing electric distribution lines. The distribution poles are approximately 20 feet high and are wooden so that their natural color harmonizes with the landscape.

Temporary and short-term visual effects during the construction period in each wellfield would result from headerhouse construction, well drilling, and construction of access roads and electric distribution lines. Following completion of wellfield installation, temporarily disturbed areas will be reclaimed. Only long-term effects associated with operations and maintenance will remain following post-construction reclamation.

Long-term effects will result from the addition of structures to the landscape, such as the central plant and associated structures, headerhouses, wellhead covers, access roads, and electric distribution lines. Effects from long-term activities will occur over the life of the project.

Project development is planned for an area where extensive CBM development has already occurred and where additional development is planned. CBM installations are similar in visual impact to those associated with ISR uranium mining. CBM wells are installed in a network of approximately eight wells per square mile. These wells are

connected by underground pipelines to collection and pumping structures that appear similar to ISR wellhouses. Overhead power lines are installed to each well.

As noted in Section 3.9, the total score of the scenic quality inventory for the Moore Ranch License Area is 4. According to NUREG-1569, if the visual resource evaluation rating is 19 or less, no further evaluation is required. Therefore, no further evaluation of changes to scenic resources from the proposed Moore Ranch Project is required.

Despite the existing visual impacts from CBM development and the low scenic quality rating for the proposed project site, EMC intends to implement measures to lessen the visual impact from the project. Mitigative measures for visual and scenic resource impacts are discussed in section 5.9.

4.10 SOCIOECONOMIC IMPACTS

The construction and operating work force for the Moore Ranch project is anticipated to come from the region surrounding the License Area, primarily Campbell and Natrona Counties in northeastern Wyoming. At least 50 percent of the work force would likely be located in Gillette, which provides labor for a number of large-scale energy related projects in the region. The proposed project is located in Campbell County, which would be most likely to experience effects to housing, public and other community services, recreation, county and municipal finances, crime, and the local transportation network. The adjacent Natrona County would also experience effects to housing and community services, as some of the project workforce would likely reside in Natrona County communities.

It is anticipated that the overall effect of the proposed facility operations on the local and regional economy would be beneficial. Purchases of goods and services by the mine and mine employees would contribute directly to the economy. Local, state, and the federal governments would benefit from taxes paid by the mine and its employees. Indirect impacts, resulting from the circulation and recirculation of direct payments through the economy, would also be beneficial. These economic effects would further stimulate the economy, resulting in the creation of additional jobs. Beneficial impacts to the local and regional economy provided by the proposed Moore Ranch operation would continue for the life of the facility, estimated to be 10 years for the well field operation and 25 years for the central plant operations as of June 2007. Economic impacts of the proposed operation are discussed in detail in Section 7.

4.10.1 Construction

The construction phase would cause a moderate impact to the local economy, resulting from the purchases of goods and services directly related to construction activities. Impacts to community services in rural Campbell County or the nearby towns of Midwest and Edgerton in Natrona County, and Wright in Campbell County, such as roads, housing, schools, and energy costs would be minor or non-existent and temporary.

An estimated 50 percent (25 workers) of the construction work force would be based in Campbell County, which contains the project site. The workforce hired outside of the County would likely be based in Casper, located in the neighboring Natrona County, as Casper is a regional economic hub that provides a variety of construction services and labor for projects located throughout Wyoming.

Most construction work available to the local construction labor pool consists of temporary contract work that varies in duration, depending on the scope of each construction project. Further, the number of unemployed construction workers does not represent the number of workers that would be available to the proposed project from the local construction labor pool. The number is an annual average that does not take into account monthly variations in the available construction labor pool from construction start-ups and completions. Contractors for projects located throughout northeastern Wyoming typically hire the local construction labor pool. The actual number of construction workers available for the proposed project would potentially draw from the entire construction labor pool of 6,268 (2005 estimate; the construction labor pool as of 2007 is likely to be larger), as construction activities from some active projects would conclude so that workers would be available for future projects.

4.10.2 Operations Workforce

An estimated 40 to 60 people would be required for the operation of the proposed Moore Ranch Project. It is not known how many of the required operations workforce would be hired from outside of Campbell and Natrona Counties. In the event that the entire operations workforce and their families relocated to the counties, the population increase would be a maximum of 150, based on the 2005 average household size of 2.52 in Wyoming. This increase would account for 0.1 percent of the population of Campbell and Natrona Counties, and is smaller than the projected annual growth rate. Therefore, there would be little to no effect to the vacancy rates of any type of housing in Gillette area or Campbell County.

4.10.3 Effects to Housing

The License Area lies within commuting distance of Gillette and Wright, in Campbell County, and Casper in Natrona County, so that workers from these counties would likely commute from their homes. There would be no impact to temporary housing located within commuting distance (an estimated 1 to 2 hours) of the License Area.

In the event that workers from other states are hired for construction of the project, temporary housing such as motel/hotel rooms and RV sites located within commuting distance would be required, as no on-site housing (man camp) is planned. The available stock of motel/hotel rooms would accommodate relocating workers.

It is recognized, however, that the coal bed methane gas and mineral industries are presently a dominating factor for temporary housing availability in the area, and the workforce employed in these industries occupy much of the temporary housing that becomes available.

It is anticipated that few of the construction work force during any phase of the proposed project would purchase or rent housing of any type. Therefore, there would be no effects on the costs of any type of housing in the counties. Because rental housing usually require a long-term lease (generally a minimum of 6 months), only operations employees would likely enter into this type of lease agreement. Under a hiring scenario that assumes all of the proposed operations workforce would need to relocate to the area, 40 to 60 housing units would be required over the life of the project. In 2006, there were a total of 60 vacant housing units in Campbell and Natrona Counties, which would not meet the future demand for housing in the counties from anticipated population growth. Therefore, there would be little to no effect to the rental rates of any type of housing in Gillette or Campbell County.

Household projections estimate an increase in households from 2000 to 2030 as 140 percent in Campbell County and 73 percent in Natrona County. The existing housing stock would not accommodate the projected households. Local communities in general are aware of the pressing need for the new residential development.

4.10.4 Effects to Services

It is likely that both the construction and operating work force would be from Campbell and Natrona Counties, or other nearby counties in northeast Wyoming, and would not require permanent or temporary housing. In the event that up to 50 percent of the construction and operating workforce are non-local workers, it is anticipated that there would be a less than one percent increase in the population of Campbell and Natrona

Counties from the permanent relocation of the workers and their families. Most non-local workers would utilize temporary housing. Because existing mobile home and RV parks will be used for a majority of the temporary housing, the project will not require new water, sewer, electrical lines, or other infrastructure. There will be no additional demands of increases in service levels for local infrastructure, such as police, fire, water, or utilities. In addition, there would be little measurable increase in non-basic employment, as these jobs are generated from ongoing employment of the existing base of construction workers, and would be maintained through the continued employment of local construction workers. Therefore, construction and operation of the project would not significantly affect the various public and non-public facilities and services described above from the in-migration of workers for non-basic employment opportunities.

Families moving into the Natrona and Campbell County school districts as a result of the proposed Moore Ranch License Area operations would not stress the current school system because it is presently under capacity.

4.10.5 Economic Impact Summary

Economic impacts are discussed in detail in the benefit-cost analysis in Section 7.

4.11 ENVIRONMENTAL JUSTICE

The U.S Census 2000 Decennial Population program provides race and poverty characteristics for Census Tracts and Block Groups, which are subdivisions of Census Tracts. The Moore Ranch License Area and the surrounding 2-mile buffer are contained within five Census Tracts and one additional Block Group that encompass portions of Campbell, Converse, Johnson, and Natrona Counties.

As summarized in Table 4.11-1, the combined population of the surrounding Census Tracts was 4,799. Minority populations accounted for a small percentage of the total population, with percentages of minorities generally similar to or smaller than those of the state as a whole.

The State of Wyoming was selected to be the geographic area to compare the demographic data for the population in the affected Census Tracts. This determination was based on the need for a larger geographic area encompassing affected area Census Tracts in which equivalent quantitative resource information is provided. The population characteristics of the affected Census Tracts are compared with Wyoming population characteristics to determine whether there are concentrations of minority or low-income populations in the Census Tracts relative to the state.

The data in Table 4.11-1 show that minority populations in the affected Tracts account for an overall smaller proportion of the population than the proportion of minority populations at the state level. No concentrations of minority populations were identified as residing near the proposed project facilities, as residents nearest to the License Area are rural populations, while most of the minority population lives in Gillette and communities along the I-25 corridor to the south. There would be no disproportionate impact to minority population from the construction and operation of the Moore Ranch Project.

With the exception of Census Tracts 9551 in Johnson County and 14.01 in Natrona County, the populations within the Tracts exhibit lower rates of people living below the poverty level than the state. Census Tracts 9551 and 14.01 contain rural populations; therefore, there is no concentration of people living below the poverty level in these Tracts. No disproportionate adverse environmental impacts would occur in populations living below the poverty level within the Census Tracts from proposed project activities.

Table 4.11-1 Race and Poverty Level Characteristics of the Population in the Moore Ranch License Area Census Tracts

	State of Wyoming	Percent of Total State Population	Census Tract 1, Campbell County	Percent of Census Tract 1	Census Tract 9566, Converse County	Percent of Census Tract 9566	Block Group 1, Census Tract 9566, Converse County	Percent of Block Group 1, Census Tract 9566	Census Tract 9551, Johnson County	Percent of Census Tract 9551	Census Tract 14.01, Natrona County	Percent of Census Tract 14.01	Census Tract 18, Natrona County	Percent of Census Tract 18	Total
Total	493,782	100.0	4,779	100.0	2,944	100.0	1,412	100.0	1,918	100.0	3,478	100.0	3,285	100.0	**17,816**
Urban:	322,073	65.2	418	8.7	0	0.0	0	0.0	0	0.0	0	0.0	9	0.3	**427**
Inside urbanized areas	125,706	25.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	9	0.3	**9**
Inside urban clusters	196,367	39.8	418	8.7	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	**418**
Rural	171,709	34.8	5,615	117.5	2,944	100.0	1,412	100.0	1,918	100.0	3,478	100.0	3,276	99.7	**18,643**
White alone	454,095	92.0	4,671	97.7	2,805	95.3	1,331	94.3	1,877	97.9	3,284	94.4	3,150	95.9	**17,118**
Black or African American alone	3,126	0.6	1	0.0	6	0.2	3	0.2	1	0.1	11	0.3	8	0.2	**30**
American Indian and Alaska Native alone	11,363	2.3	22	0.5	18	0.6	13	0.9	8	0.4	41	1.2	45	1.4	**147**
Asian alone	2,972	0.6	4	0.1	12	0.4	5	0.4	3	0.2	8	0.2	6	0.2	**38**
Native Hawaiian and Other Pacific Islander alone	232	0.0	2	0.0	1	0.0	1	0.1	0	0.0	8	0.2	2	0.1	**14**
Some other race alone	12,595	2.6	24	0.5	60	2.0	46	3.3	11	0.6	47	1.4	28	0.9	**216**
Two or more races	9,399	1.9	55	1.2	42	1.4	13	0.9	18	0.9	79	2.3	46	1.4	**253**
People who are Hispanic or Latino	31,384	6.4	88	1.8	113	3.8	73	5.2	52	2.7	106	3.0	78	2.4	**510**
Median household income in 1999	37,892	-	55,233	-	47,250	-	44,821	-	40,053	-	38,629	-	45,481	-	na
Per capita income in 1999	19,134	-	21,886	-	22,673	-	19,598	-	20,595	-	15,601	-	21,084	-	na
Population with income in 1999 below poverty level:	54,777	-	398	-	157	-	85	-	241	-	571	-	191	-	**1,643**
Percent below poverty level	11.1%	-	8.3%	-	5.3%	-	6.0%	-	12.6%	-	16.4%	-	5.8%	-	**9.2%**

4.12 PUBLIC AND OCCUPATIONAL HEALTH IMPACTS

4.12.1 Nonradiological Impacts

4.12.1.1 Public Health Impacts

The area within an 80-kilometer (km) (50-mile) radius of the License Area includes portions of six counties in northeastern Wyoming (Campbell, Converse, Johnson, Natrona, Weston Counties and a small portion of Niobrara County). The proposed Moore Ranch Project is located in southwest Campbell County. The nearest communities are Wright, a small Campbell County incorporated town located northeast on State Highway 387, and the Towns of Edgerton and Midwest, which are located in Natrona County southwest of the Moore Ranch Project on State Highway 387.

Section 3.10 discussed the population distribution for the 80 km radius around the Moore Ranch Project. Figure 3.10-1 provides the sectorial population for the 16 compass sectors in concentric rings of 1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 70 and 80 km from the center of the proposed project. The population within 2 miles of the License Area boundary was estimated by locating occupied residences within 2 miles using 2006 aerial photos and field reconnaissance in 2007. The nearest resident is approximately 4.5 km from the proposed central plant location. The nearest sensitive receptors (e.g., schools) are in the Town of Wright, located approximately 32.2 km from the central plant location.

NUREG-1569 requires that applicants provide estimates of concentrations of nonradioactive constituents in effluents at the points of discharge and provide a comparison with natural ambient concentrations and applicable discharge standards. There are two effluents expected from the Moore Ranch Project.

- A gaseous and airborne effluent will consist of air ventilated from the plant building ventilation system and vented from process vessels and tanks. This gaseous effluent will contain radon gas as discussed below in Section 4.12.2. The gaseous and airborne effluent will not contain any non-radiological effluents. Nonradioactive airborne effluents at the Moore Ranch Project will be limited to fugitive dust from access roads and wellfield activities. Fugitive dust emissions will be minimal and dust suppressants will be used if conditions warrant their use. Air quality impacts of construction and operation of the Moore Ranch Project were discussed in detail in Section 4.6.

- The liquid effluent will be managed in the deep disposal wells. The deep disposal wells will permanently dispose of liquid wastes and will be permitted under a Class I UIC Permit issued by the WDEQ. No routine liquid environmental discharges, other than waste disposal via deep well injection, are planned and as such, no definable water related pathways for routine operations exist. There are no non-radiological impacts to public health expected due to the liquid effluents from the Moore Ranch Project.

4.12.1.2 Occupational Health Impacts

Accidents involving human safety associated with the ISR uranium mining technology typically have far less severe consequences that accidents associated with underground and open pit mining methods. In-situ mining provides a higher level of safety for employees and neighboring communities when compared to conventional mining methods or other energy related industries. Accidents that may occur would generally be considered minor when compared to other industries. Radiological accidents that might occur would typically manifest themselves slowly and are therefore easily detected and mitigated. The remote location of the Moore Ranch facility and the low level of radioactivity associated with the process combine to decrease the potential hazard of an accident to the general public.

NRC has previously evaluated the effects of accidents at conventional uranium milling facilities in NUREG–0706 and specifically at ISR uranium facilities in NUREG/CR-6733. These analyses demonstrate that, for most credible potential accidents, consequences are minor so long as effective emergency procedures and properly trained personnel are used. The proposed Moore Ranch facilities are consistent with the operating assumptions, site features, and designs examined in the NRC analyses in NUREG/CR-6733.

NUREG-0706 considered the environmental effects of accidents at single and multiple uranium milling facilities. Analyses were performed on incidents involving radioactivity and classified these incidents as trivial, small, and large. NUREG-0706 also considered transportation accidents. Some of the analyses in NUREG-0706 are applicable to ISR facilities, such as transportation accidents. NUREG/CR-6733 specifically addressed risks at ISR facilities and identified the "risk insights" that are discussed in the following sections.

4.12.1.2.1 Chemical Risk

NUREG/CR-6733 noted that the scope of the NRC mission includes hazardous chemicals to the extent that mishaps with these chemicals could affect releases of radioactive materials. Industrial safety aspects associated with the use of hazardous chemicals at Moore Ranch is regulated by the Wyoming State Mine Inspector.

Sulfuric Acid

Sulfuric acid is used to split the uranyl carbonate complex from rich eluate into carbon dioxide gas and uranyl ions in preparation for precipitation using hydrogen peroxide. The sulfuric acid will be stored in a tank located outdoors and piped to the central plant for use in the precipitation circuit. The concentration of sulfuric acid fumes that are immediately dangerous to life and health (IDLH) is 15 mg/m^3. In the risk analysis from NUREG/CR-6733, a spill of 93 percent sulfuric acid was not deemed a significant inhalation hazard to workers as long as normal air dilution is available from the facility ventilation system. NUREG/CR-6733 also noted that sulfuric acid reacts vigorously with ammonia, sodium carbonate, and water, all of which will be present at Moore Ranch. To minimize the potential for chemical reactions in the unlikely event of simultaneous tank leaks, the sulfuric acid storage tank will be located away from other process tanks.

The use of sulfuric acid is subject to Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 1,000 pounds. As discussed in Section 3, the Moore Ranch design includes a sulfuric acid tank with a capacity of 6,000 gallons Based on the design capacity, EMC will be subject to the Emergency Response Plan requirements.

Anhydrous Ammonia

Anhydrous ammonia is used for pH adjustment during the precipitation process. The ammonia will be stored in a tank located outdoors and piped to the central plant for use in the precipitation circuit. Ammonia in the liquid form is not the primary hazard. The liquid will evaporate to a gaseous state. The IDLH concentration of ammonia is 300 parts per million (ppm). NUREG/CR-6733 identified an ammonia leak as a significant risk factor within a plant structure because ventilation rates adequate to dilute ammonia fumes in a localized area to maintain concentrations below the IDLH in the event of a leak would not be feasible. An additional hazard associated with ammonia is that it reacts vigorously with sulfuric acid, which will also be present in the precipitation circuit.

To minimize the probability and consequence of an ammonia accident, the EMC system design and operating procedures will be consistent with American National Standards Institute (ANSI) recommendations. These recommendations include 1) providing an excess flow valve located as close to the storage tank as possible that automatically closes if the flow rate exceeds a specific value; 2) the use of appropriate ANSI and American Society of Material Evaluation (ASME) standard codes for norrefrigerated pressure piping; and 3) provision of positive pressure, self-contained, full face respirators in the immediate vicinity of the ammonia piping and process operations. The ammonia piping will be placed so as to minimize the potential for impact from vehicles or other objects that might cause ruptures.

The use of anhydrous ammonia is subject to various regulatory programs including the following:

- Risk Management Planning (RMP) required in 40 CFR Part 68 for threshold quantities (TQs) in excess of 10,000 pounds;
- Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 500 pounds; and
- Reportable Quantities (RQs) for spills from the Comprehensive Environmental, Response, Compensation and Liability Act (CERCLA) in 40 CFR § 302.4 for spills in excess of 100 pounds.

As discussed in Section 2, the Moore Ranch design includes an anhydrous ammonia tank with a capacity of 90,000 pounds. Based on this design capacity, EMC will be subject to all of the aforementioned regulatory programs.

In addition to the listed regulatory programs, the Process Safety Management (PSM) of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119 applies to anhydrous ammonia for TQs in excess of 10,000 pounds. In the State of Wyoming, industrial safety at ISR mines is regulated by the Wyoming State Mine Inspector and OSHA's PSM standard does not apply. However, EMC will consider the PSM standard during the development of the ammonia system design and operating procedures.

Hydrogen Peroxide

Hydrogen peroxide will be used in the precipitation phase at Moore Ranch. A 50-percent solution of hydrogen peroxide will be added to the acidified uranium-rich eluant to form an insoluble uranyl peroxide compound. Hydrogen peroxide is a strong oxidizer and is a reactive, easily decomposable compound. Its hazardous decomposition products include oxygen and hydrogen gas, heat, and steam. Decomposition can be caused by mechanical shock, incompatible materials including alkalies, light, ignition sources, excess heat, combustible materials, strong oxidants, rust, dust, and a pH above 4.0. When sealed in strong containers, the decomposition of hydrogen peroxide can cause excessive pressure to build up which may then cause the container to burst explosively.

As noted in NUREG/CR-6733, a hydrogen peroxide piping system leak in a process building has the potential to result in localized vapor concentrations in excess of the IDLH value of 75 ppm within several minutes. A leak in a confined space has the potential to generate lethal concentrations of vapor at an even faster rate. EMC will incorporate recommendations concerning materials of construction for tanks and piping systems and the use of local ventilation with explosion-proof fans to control vapors in the event of a leak of hydrogen peroxide.

The use of hydrogen peroxide at concentrations greater than 52 percent is subject to the following regulatory programs:

- Process Safety Management of Highly Hazardous Chemicals standard contained in 29 CFR §1910.119 for TQs in excess of 7,500 pounds; and
- Threshold Planning Quantities (TPQs) contained in 40 CFR Part 355, Emergency Response Plans for threshold quantities (TQs) in excess of 1,000 pounds.

As discussed in Section 2, the Moore Ranch design includes the use of hydrogen peroxide at a concentration of 50 percent contained in a hydrogen peroxide tank with a capacity of 6,000 gallons. With the design hydrogen peroxide concentration and capacity, EMC will not be subject to the aforementioned regulatory programs.

Oxygen

Oxygen presents a substantial fire and explosion hazard. The design and installation of the oxygen storage facility is typically performed by the oxygen supplier and meets applicable industry standards. The oxygen will be delivered to Moore Ranch by truck and stored on site under pressure in a cryogenic tank in liquid form. The oxygen will be allowed to evaporate and will be added to the barren lixiviant upstream of the injection manifold. The design and installation of underground and above-ground gaseous oxygen piping at Moore Ranch including material specifications, velocity restrictions, location and specifications for valves, and design specifications for metering stations and filters will be in accordance with industry standards contained in CGA G-4.4. Header houses will be equipped with an exhaust ventilation system.

Combustibles such as oil and grease will burn in oxygen if ignited. EMC will ensure that all oxygen service components are cleaned to remove all oil, grease, and other combustible material before putting them into service. Acceptable cleaning methods are described in CGA G-4.1.

EMC will develop procedures that implement emergency response instructions for a spill or fire involving oxygen systems.

Carbon Dioxide

The primary hazard associated with the use of carbon dioxide is concentration in confined spaces, presenting an asphyxiation hazard. Bulk carbon dioxide facilities are typically located outdoors and are subject to industry design standards. Floor level ventilation and carbon dioxide monitoring at low points will be performed to protect workers from undetected leaks of carbon dioxide within the central plant.

Sodium Carbonate and Sodium Chloride

Sodium carbonate and sodium chloride are primarily inhalation hazards. Soda ash and carbon dioxide will be used to prepare sodium carbonate for injection in the wellfield. Sodium carbonate and sodium chloride are also used for regeneration of ion exchange resin. Dry storage and handling systems will be designed to industry standards to control the discharge of dry material.

Sodium Sulfide

Sodium sulfide may be used as a reductant during groundwater restoration. Sodium sulfide is corrosive and will cause severe eye and skin burns. Routes of entry into the body include inhalation, ingestion, and contact with the skin. Under low pH conditions, sodium sulfide can react with water to liberate hydrogen sulfide gas. Sodium sulfide can be flammable and contact with heat, flame, or other sources of ignition will be avoided. Sodium sulfide will be stored separately from hydrogen peroxide and sulfuric acid.

4.12.2 Radiological Impacts

EMC is proposing to develop a uranium in-situ recovery facility with a production and restoration flow of approximately 3000 and 500 gallons per minute (gpm) respectively. An assessment of the radiological effects of the Moore Ranch Project must consider the types of emissions, the potential pathways present, and an evaluation of potential consequences of radiological emissions.

The project will use fixed bed pressurized down flow ion exchange columns to separate uranium from the pregnant production fluid and to treat restoration solutions. The uranium contained in the eluant from the production ion exchange columns will be precipitated and subsequently vacuum dried.

In addition to ion exchange treatment, the groundwater restoration process will also use reverse osmosis to remove the dissolved solids. Liquid waste disposal will be via direct deep well injection. No evaporation ponds are planned at this time.

The facility could receive uranium-loaded ion exchange resin from various satellite facilities around the region in the future. An average of 6 resin transfers per day from these satellite facilities is anticipated.

Since the drying and packaging operation is conducted under vacuum, the only expected routine emission at the facility will be radon-222 gas. Radon-222, a decay product of radium-

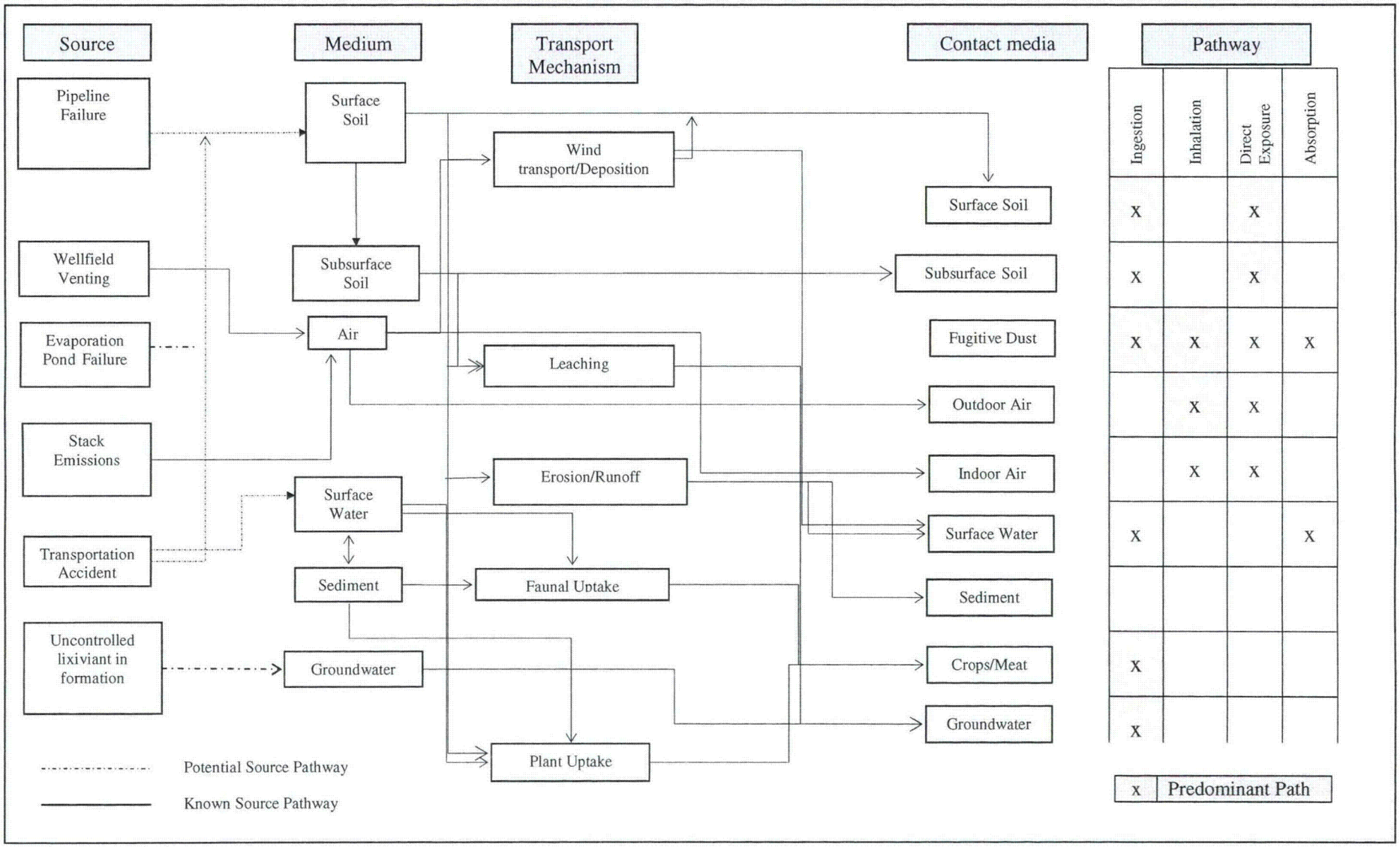
226, is dissolved in the lixiviant as it travels through the ore to a production well where it is brought to the surface. The concentration of radon-222 in the production solution and estimated releases are calculated using the methods found in USNRC Regulatory Guide 3.59. The details of and assumptions used in these calculations are found in Section 4.12.2.3.

MILDOS-AREA is used to model radiological impacts on human and environmental receptors (e.g. air and soil) using site specific radon-222 release estimates, meteorological and population data, and other parameters. The estimated radiological impacts resulting from routine site activities will be compared to applicable public dose limits as well as naturally occurring background levels.

4.12.2.1 Exposure Pathways

Figure 4.12-1 presents exposure pathways from all potential sources at the Moore Ranch facility. The predominant pathways for planned and unplanned releases are identified. As mentioned earlier, atmospheric radon-222 is expected to be the predominant pathway for impacts on human and environmental media. Impacts of radon-222 releases can be expected in all quadrants surrounding the facility, the magnitude of which is driven predominantly by wind direction and atmospheric stability. As a noble gas, radon-222 itself has very little radiological impact on human health or the environment. Radon-222 has a relatively short half-life (3.2 days) and its decay products are short lived, alpha emitting, nongaseous radionuclides. These decay products have the potential for radiological impacts to human health and the environment. As Figure 4.12-1 shows, all exposure pathways, with the possible exception of absorption, can be important depending on the environmental media impacted. All of the pathways related to air emissions of radon-222 are evaluated by MILDOS-AREA. Output from MILDOS-AREA simulations is provided in Appendix C.

Figure 4.12-1 Human Exposure Pathways for Known and Potential Sources from the Moore Ranch Area



4.12.2.2 Exposures from Water Pathways

The mining solutions in the ore zone will be controlled and adequately monitored to ensure that migration does not occur. The overlying aquifers will also be monitored.

The primary method of waste disposal at the facility will be by deep well injection. The deep well(s) will be completed at a depth greater than 6,000 feet and will be isolated geologically from underground sources of drinking water. The well(s) will be constructed under a permit from the Wyoming Department of Environment Quality (WDEQ) and all requirements of the Underground Injection Control (UIC) program for Class I wells will be met.

The uranium ion exchange, precipitation, drying and packaging facilities will be located on curbed concrete pads to prevent any liquids from entering the environment. Solutions used to wash down equipment drain to a sump and are either pumped back into the processing circuit or to the disposal well. The pads will be of sufficient size to contain the contents of the largest tank in the event of a rupture.

No routine liquid environmental discharges, other than waste disposal via deep well injection, are planned and as such, no definable water related pathways for routine operations exist.

4.12.2.3 Exposures from Air Pathways

The only source of radionuclide emissions is radon-222 released into the atmosphere through a vent system in the main plant area or from the wellfields. As shown in Figure 4.12-1, atmospheric releases of radon-222 can result in radiation exposure via three pathways; inhalation, ingestion, and direct exposure. The Total Effective Dose Equivalent (TEDE) to nearby residents in the region around the facility was estimated using MILDOS-AREA.

4.12.2.3.1 Source Term Estimates

The source terms used to estimate radon-222 releases from the facility include three well fields in production, one restoration well field, new well field development, operation of the central process plant, and resin transfers from neighboring satellite processing facilities. The parameters used to characterize and estimate releases are provided in Table 4.12-1.

Table 4.12-1 Parameters used to estimate and characterized source terms at the Moore Ranch In-Situ Recovery facility.

Parameter	Value	Unit	Source
Average Ore Grade	0.1	%	Application
Ore radium-226 Concentration	282	pCi g^{-1}	Reg. Guide 3.59
Mined Area	3.12E+05	m^2 y^{-1}	Application
Average Lixiviant Flow	1.14E+04	L m^{-1}	Application
Average Restoration Flow	1.89E+03	L m^{-1}	Application
Operating days per year	365	days	
Ore formation thickness	6.1	meters	Application
Ore formation porosity	0.2	NA	Application
Ore formation rock density	2.65	g cm^{-3}	Application
Average residence time for lixiviant	7	days	Application
Average residence time for restoration solutions	35	days	Application
Average mass of ore material in mud pit	1.02E+07	g	Estimate based on planned activities
Number of mud pits generated per year	300	NA	Estimate based on planned activities
Storage time in mud pits	14	days	Estimate based on planned activities
Radon-222 emanating power	0.2	NA	Reg. Guide 3.59
Radon-222 release rates	0.1	y^{-1}	Estimate based on process
Resin Porosity	0.4	NA	NUREG 1569
Ion Exchange Column Volume	1.42E+04	L	Estimate based on planned activities
Number of Resin Transfers per day	6	NA	Estimate based on planned activities
Stack Height	16	m	Application
Stack Diameter	0.3	m	Application
Stack Velocity	11	m s^{-1}	Application

Production Releases

Currently EMC plans to have up to three wellfield areas at Moore Ranch that could potentially be mined concurrently. The potential radon-222 releases from the production well fields were estimated using methods described in Regulatory Guide 3.59 as follows:

Radon released (equilibrium condition) to production fluid from leaching is calculated using Equation 1:

$$G = R\rho E \frac{(1-p)}{p} x10^{-6} \qquad \text{(Equation 1)}$$

Where:

G	=	radon released (Ci/m^3)
R	=	radium content of ore (pCi/g)
E	=	emanating power
ρ	=	rock density ($g\ cm^{-3}$)
p	=	formation porosity

The yearly radon released to the production fluid is calculated using Equation 2:

$$Y = 1.44GMD(1 - e^{-\lambda t}) \qquad \text{(Equation 2)}$$

Where:

Y	=	yearly radon released to production fluid ($Ci\ yr\text{-}^{1}$)
G	=	radon released at equilibrium ($Ci\ m^{-3}$)
M	=	lixiviant flow rate ($L\ min^{-1}$)
D	=	production days per year (d)
λ	=	radon-222 decay constant (d^{-1})
t	=	lixiviant residence time
1.44	=	unit conversion factor

Using Equations 1 and 2 and the parameters in Table 4.12-1, the yearly radon released to production fluid is 2563 $Ci\ yr^{-1}$. Regulatory Guide 3.56 assumes all the radon-222 that is released to the production fluid is ultimately released to the atmosphere, which is the case for ion exchange columns operating at atmospheric pressure in an open system and is an appropriate conservative assumption for this type of ion exchange system. In cases where pressurized downflow ion exchange columns are used and wellfields are operated under pressure, the majority of radon released to the production fluid stays in solution and is not released. The radon which is released is from occasional well field venting for sampling events, small unavoidable leaks in well field and ion exchange equipment, and

maintenance of well field and ion change equipment. For this reason, an estimated annual release of 10% of the radon-222 in the production fluid from the wellfields and an additional 10% in the ion exchange circuit was assumed. Given this assumption, the annual radon-222 released from production in the wellfield and at the central plant facility is 256 and 230 Ci yr^{-1}, respectively. For purposes of MILDOS-AREA model simulations, the wellfield release of 256 Ci yr^{-1} was distributed equally among the three proposed well fields at the site.

Restoration Releases

Radon-222 releases resulting from wellfield restoration activities were estimated in the same manner as the production activities above (i.e., using Equation 2) but modified for the lower restoration flow rate and the longer restoration fluid residence time, both of which are listed in Table 4.12-1. The estimate of a 10% release in the well field and treatment facility results in releases of 59 and 53 Ci yr^{-1} respectively. For purposes of the MILDOS-AREA model simulations, the wellfield release of 59 Ci yr^{-1} was distributed equally among the three proposed well fields at the site.

New Well Field Releases

Radon-222 releases resulting from new wellfield development activities were estimated using methods described in NUREG-1569 as follows:

$$Rn_{nw} = EL[Ra]TmNx10^{-12} \qquad \text{(Equation 3)}$$

Where:

Rn_{nw}	=	Radon-222 release rate from new well field (Ci yr^{-1})
E	=	emanating power
[Ra]	=	concentration of radium-226 in ore (pCi g^{-1})
L	=	decay constant of radon-222
T	=	storage time in mud pit (d)
m	=	average mass of ore material in the pit (g)
N	=	number of mud pits generated per year
10^{-12}	=	unit conversion factor (Ci pCi^{-1})

Using Equation 3 and the parameters in Table 4.12-1, the yearly radon released from new wellfield development is 0.43 Ci yr^{-1}. For purposes of the MILDOS-AREA model simulations, the new wellfield release was assumed to occur at the central plant location.

Resin Transfer Releases

Radon-222 releases resulting from resin transfers from neighboring satellite facilities were estimated using methods described in NUREG-1569 as follows:

$$Rn_x = 3.65x10^{-10} F_i C_{Rn} \qquad \text{(Equation 4)}$$

Where:

Rn_x	=	Radon release rate from resin transfers (Ci yr^{-1})
F_i	=	water discharge rate from resin unloading (L d^{-1})
C_{Rn}	=	Steady state radon-222 concentration in process water (pCi L^{-1})
$3.65x10^{-12}$	=	unit conversion factor (Ci pCi^{-1})(d yr^{-1})

The steady state radon-222 concentration in process water (C_{Rn}) can be estimated from the following expression:

$$C_{Rn} = \frac{Y * 1.9E6}{M} \qquad \text{(Equation 5)}$$

Where:

C_{Rn}	=	Steady state radon-222 concentration in process water (pCi L^{-1})
Y	=	yearly radon released to production fluid (Ci yr-^{1})
M	=	lixiviant flow rate (L min^{-1})
1.9E6	=	unit conversion factor (pCi Ci^{-1})(yr min^{1})

The water discharge rate from resin unloading (Fi) can be estimated from the following expression:

$$F_i = N_i * V_i * P_i$$

(Equation 6)

Where:

F_i	=	water discharge rate from resin unloading (L d^{-1})
N_i	=	Number of resin transfers per day
V_i	=	volume of resin in transfer (L)
P_i	=	porosity of resin

Using Equations 4-6 and the parameters in Table 4.12-1, the yearly radon released from resin transfers from satellite facilities development is 5.3 Ci yr^{-1}. This estimate assumes the ore grade mined at the satellite facilities would yield the same radon concentration in production fluid as the Moore Ranch facility. For purposes of the MILDOS-AREA model simulations, the resin transfer release was assumed to occur at the central plant location.

Radon-222 Release Summary

A summary of estimated radon-222 releases from the Moore Ranch Facility is presented in Table 4.12-2. The source coordinates in Table 4.12-2 are relative to the main plant area.

Table 4.12-2 Estimated Radon-222 Releases (Ci yr^{-1}) from the Moore Ranch Facility

Location	X (km)	Y (km)	Production	Restoration	Drilling	Resin Transfer	Total
Well Field 1	-0.42	0.07	85.3	20	0	0	105.3
Well Field 2	0.89	-0.53	85.3	20	0	0	105.3
Well Field 3	0.47	-0.64	85.3	20	0	0	105.3
Main Plant Stack	0	0	230	53	0	5.3	288.3
New Well Field	0	0	0	0	0.43	0	0.43
Total			486	113	0.43	5.3	604.7

4.12.2.3.2 Receptors

The receptors used in the MILDOS-AREA simulations are presented in Table 4.12-3 and include the property boundary in 16 compass directions, 2 residences, and the town of Wright.

Table 4.12-3 Moore Ranch Receptor Names and Locations

Location	X (km)	Y (km)	Distance (km)
1. Property Boundary- N	0.00	2.60	2.60
2. Property Boundary- NNE	1.09	2.63	2.85
3. Property Boundary- NE	1.96	1.96	2.77
4. Property Boundary- ENE	3.64	1.50	3.94
5. Property Boundary- E	6.71	0.00	6.71
6. Property Boundary- ESE	4.27	-1.96	5.11
7. Property Boundary- SE	2.31	-2.31	3.27
8. Property Boundary- SSE	1.19	-2.87	3.11
9. Property Boundary- S	0.00	-2.85	2.85
10. Property Boundary- SSW	-1.51	-3.64	3.94
11. Property Boundary- SW	-2.85	-2.85	4.03
12. Property Boundary- WSW	-3.02	-1.25	3.27
13. Property Boundary- W	-2.77	0.00	2.77
14. Property Boundary- WNW	-2.17	0.90	2.35
15. Property Boundary-NW	-1.42	1.42	2.01
16. Property Boundary- NNW	-1.09	2.63	2.85
17. Nearest Resident East	4.50	0.00	4.50
18. Nearest Resident South	0.00	-13.4	13.4
19. Wright	26.1	18.9	32.2

4.12.2.3.3 Miscellaneous Parameters

The metrological data used in the MILDOS-AREA model is from the Joint Frequency Distribution data presented in Section 3.6 of this Environmental Report.

The population distribution used in the MILDOS-AREA model to estimate population doses is from the demographic information presented in Section 3.10 of this Environmental Report.

4.12.2.3.4 Total Effective Dose Equivalent (TEDE) to Individual Receptors

In order to show compliance with the annual dose limit found in 10 CFR §20.1301, EMC has demonstrated by calculation that the TEDE to the individual most likely to receive the highest dose from the Moore Ranch uranium in-situ recovery operation is less than 100 mrem per year. The results of the MILDOS-AREA simulation for each receptor in Table 4.12-3 are presented in Table 4.12-4.

An evaluation of the TEDE follows:

1) The maximum TEDE of 0.8 mrem/yr, located at the northwest property boundary, is 0.8 percent of the public dose limit of 100 mrem.

2) Receptor #17 is the closest resident to the Moore Ranch facility. The estimated TEDE at this location is 0.7 mrem/yr, which is 0.7 percent of the regulatory limit.

3) The effect of the Moore Ranch operation on any potential resident is less that 1 mrem/yr.

4) Since radon-222 is the only radionuclide emitted, public dose requirements in 40 CFR part 190 and the 10 mrem/y constraint rule in 10 CFR §20.1101 do not apply.

5) Even if 100% of the radon-222 contained in restoration and production fluids were released to the atmosphere (i.e. 100% released instead of 10%), the impacts to potential residents surrounding the facility would be less than the 100 mrem public dose limit.

Table 4.12-4 Estimated Total Effective Dose Equivalent (TEDE) to Receptors near the Moore Ranch Processing Facility

Receptor	Distance from Main Plant (km)	TEDE (mrem/y)
1. Property Boundary- N	2.60	0.43
2. Property Boundary- NNE	2.85	0.32
3. Property Boundary- NE	2.77	0.34
4. Property Boundary- ENE	3.94	0.41
5. Property Boundary- E	6.71	0.45
6. Property Boundary- ESE	5.11	0.45
7. Property Boundary- SE	3.27	0.54
8. Property Boundary- SSE	3.11	0.50
9. Property Boundary- S	2.85	0.48
10. Property Boundary- SSW	3.94	0.22
11. Property Boundary- SW	4.03	0.15
12. Property Boundary- WSW	3.27	0.22
13. Property Boundary- W	2.77	0.41
14. Property Boundary- WNW	2.35	0.74
15. Property Boundary-NW	2.01	0.80
16. Property Boundary- NNW	2.85	0.46
17. Nearest Resident East	4.50	0.69
18. Nearest Resident South	13.4	0.08
19. Wright	32.2	0.03

4.12.2.3.5 Population Dose

The annual population dose commitment to the population in the region within 80 km of the Moore Ranch facility is also predicted by the MILDOS-AREA code. The results are contained in Table 4.12-5 where TEDE is expressed in terms of person-rems. For comparison, the dose to the population within 80 km of the facility due to background radiation has been included in the table. Background radiation doses are based on a North American population of 346 million and an average TEDE of 360 mrem.

The atmospheric release of radon also results in a dose to the population on the North American continent. This continental dose is calculated by comparison with a previous calculation based on a 1 kilocurie release near Casper, Wyoming, during the year 1978. The results of these calculations are included in Table 4.12-5 and also combined with

dose to the region within 80 km (50 mi) of the facility to arrive at the total radiological effects of one year of operation at the Moore Ranch project.

The maximum radiological effect of the Moore Ranch operation would be to increase the TEDE of continental population by 0.000045 percent.

Table 4.12-5 Total Effective Dose Equivalent to the Population from One Year's Operation at the Moore Ranch Facility

Criteria	TEDE (person rem/yr)
Dose received by population within 80 km of the facility	0.09
Dose received by population beyond 80 km of the facility	5.3
Total Continental Dose	5.4
Background North American Dose	1.2 E8
Fractional increase to background dose	4.5 E-8

4.12.2.3.6 Exposure to Flora and Fauna

To estimate potential radiological impacts to flora and fauna, the most important pathway for exposure should be identified. Since the only planned emissions from the facility is radon-222 to the atmosphere, the most important pathway for exposure to flora and fauna is deposition of radon-222 decay products on surface water, surface soils, and vegetation. MILDOS-AREA estimates surface deposition rate as a function of distance from the source for the radon-222 decay products and calculates surface concentrations. Table 4.12-6 presents the highest surface concentrations of radon-222 decay products predicted by MILDOS-AREA over a 100 year period. Soil concentrations were calculated based on a conservative assumption of 1.5 g cm^{-3} bulk soil density.

Table 4.12-6 Highest Surface Concentrations of Radon-222 Decay Products Resulting from Moore Ranch ISR Operations

Radionuclide	Distance from site (km)	Direction	Surface Concentration (pCi/m^2)	Soil Concentration in upper 0.5 cm (pCi/g)
Polonium-218	1.5	E	25	$3\ E^{-3}$
Lead-214	1.5	E	25	$3\ E^{-3}$
Bismuth-214	1.5	E	25	$3\ E^{-3}$
Lead-210	35	E	50	$6\ E^{-3}$

Lead-210 represents the radionuclide with the highest concentration ($6\ E^{-3}$ pCi/g) which is at least an order of magnitude below most analytical laboratories detection limits. Recent site specific surface soil (0-5 cm) data (discussed in Section 6.1) show that lead-210 ranges from 1.1 to 4.6 with a mean of 2.8 ± 1.6 pCi/g. The increase in soil radioactivity projected by MILDOS over a 100-year period is insignificant compared to site specific background concentrations.

It is likely that soil re-suspension from background soils would be the predominant source of lead-210 concentration in vegetation surrounding the site since lead-210 concentrations in vegetation would be similar to that of soil.

From this evaluation, the radiological impact of operations at the Moore Ranch Project would be minimal and indistinguishable from current baseline conditions. Mitigation measures to minimize radiological impacts that were considered in the design of the Moore Ranch Project are discussed in Section 5.12.2.

4.12.2.4 Potential Radiological Accidents

The following sections discuss potential accident scenarios that could have radiological impacts. Mitigation measures to reduce or eliminate these impacts are discussed in Section 5.12.2.

4.12.2.4.1 Tank Failure

A spill of the materials contained in the process tanks at the Moore Ranch Project will present a minimal radiological risk. Process fluids will be contained in vessels and piping circuits within the central plant. The tanks at Moore Ranch will contain injection and

production solutions, ion exchange resin, pregnant eluant, yellowcake, and liquid waste. All tanks will be constructed of fiberglass or steel with the exception of the hydrogen peroxide storage tank, which will typically be constructed of aluminum. Instantaneous failure of a tank is unlikely. Tank failure would more likely occur as a small leak in the tank. In this case, the tank would be emptied to at least a level below the leaking area and repairs or replacement made as necessary.

NUREG/CR-6733 analyzed the potential impacts of a failure of a yellowcake thickener resulting in a release of 20% of the contents outside the plant structure. This postulated accident scenario was based on an event at the Irigaray ISR facility in 1994. The event in question was caused by the failure of an inadequate concrete pad supporting the thickener. The subsequent release from the building was a result of the proximity of the thickener to the plant wall. NUREG/CR-6733 concluded that, based on conservative calculations of this unlikely event, the dose to the public would be below the limits in 10 CFR Part 20. The calculations resulted in a dose to an unprotected worker in excess of the exposure limits from 10 CFR Part 20 (i.e., 5 rem). However, this dose estimate was based on a number of unlikely, conservative assumptions. The scenario made the unrealistic assumption that no efforts would be made to clean up the spill, allowing the yellowcake to dry and become transportable. The dose was based on lung clearance class Y uranium, which produces the highest dose estimates. No allowance in the dose calculation was made for the use of protective equipment, including protection factors from the use of respiratory protection equipment.

NUREG/CR-6733 also assessed the potential dose from a catastrophic spill from an ion exchange column resulting in the release of the entire contents of the vessel and the resultant release of radon gas. Based on a number of assumptions, the predicted dose was 1.3 rem in a 30-minute period to a worker in the area. Any change to the Rn-222 concentration or exposure time has a linear affect on dose. For example, if the room size is doubled or the exposure time is halved, then the dose will be halved. NUREG/CR-6733 recommended that the use of ventilation or atmosphere-supplying respirators designed to protect against gases would be sufficient to mitigate doses, that unprotected personnel should evacuate spill areas near ion-exchange columns, and that ISR facilities maintain proper equipment, training, and procedures to respond to large lixiviant spills or ion-exchange column failure.

4.12.2.4.2 Plant Pipe Failure

The rupture of a pipe within the central plant will be easily detected by operating staff and can be quickly controlled. Spilled solution will be contained and managed in the same fashion as for a tank failure.

4.12.2.4.3 Wellfield Spill

The rupture of an injection or recovery line in a wellfield, or a trunkline between a wellfield and the plant, would result in a release of injection or production solution which would contaminate the ground in the area of the break.

Occasionally, small leaks at pipe joints and fittings in the wellhouses or at the wellheads may occur. Small leaks in wellfield piping typically occur in the injection system due to the higher system pressures. Until remedied, these leaks may drip process solutions onto the underlying soil. These leaks seldom result in soil contamination. Following repair of a leak, EMC will require that the affected soil be surveyed for contamination and the area of the spill documented. If contamination is detected, the soil is sampled and analyzed for the appropriate radionuclides. Contamination may be removed as appropriate.

4.13 WASTE MANAGEMENT IMPACTS

4.13.1 Gaseous and Airborne Particulates

The primary radioactive airborne effluent at the Moore Ranch Facility will be radon-222 gas. Radon-222 is found in the pregnant lixiviant that comes from the wellfield into the facility for separation of uranium. The uranium will be separated from the groundwater by passing the solution through fixed bed ion exchange (IX) units operated in a pressurized downflow mode. Vessel vents from the individual IX vessels will be directed to a manifold that is exhausted to atmosphere outside the building via an induced draft fan. Venting any released radon-222 gas to atmosphere outside the plant minimizes employee exposure. Small amounts of radon-222 may be released via solution spills, filter changes, IX resin transfer, reverse osmosis (RO) system operation during groundwater restoration, and maintenance activities. These are minimal radon gas releases on an infrequent basis. The exhaust system in the plant will further reduce employee exposure. The air in the central plant and other structures will be sampled for radon daughters to assure that concentration levels of radon and radon daughters are maintained as low as reasonably achievable (ALARA).

4.13.2 Liquid Waste

As a result of in-situ recovery mining, there are several sources of liquid waste that are collected. The potential waste water sources that exist at the Moore Ranch Facility will include the following.

4.13.2.1 Liquid Process Waste

The operation of the ion exchange process generates production bleed, the primary source of liquid waste as previously discussed in Section 2.0. This bleed is routed to the deep disposal well(s) for disposal. Other liquid waste streams from the central plant include plant wash down water and bleed stream from the elution and precipitation circuits. However, these other liquid waste streams make up a very small portion of the total liquid waste stream.

4.13.2.2 Aquifer Restoration

Following mining operations, restoration of the affected aquifer commences which results in the production of wastewater. The current groundwater restoration plan consists of four activities:

1. Groundwater Transfer,
2. Groundwater Sweep,
3. Groundwater Treatment, and
4. Wellfield Circulation.

Only the groundwater sweep and groundwater treatment activities will generate wastewater.

During groundwater sweep, water is extracted from the mining zone without injection, causing an influx of baseline quality water to sweep the affected mining area. The extracted water must be sent to the wastewater disposal system during this activity.

Groundwater treatment activities involve the use of process equipment to lower the ion concentration of the groundwater in the affected mining area. A reverse osmosis (RO) unit will be used to reduce the total dissolved solids of the groundwater. The RO unit produces clean water (permeate) and brine. The permeate is injected back into the formation and the brine is sent to the wastewater disposal system. Chemical reducing agents such as sodium sulfide or biological reducing agents may also be employed during the groundwater treatment phase.

4.13.2.3 Water Collected from Wellfield Releases

This water is injection lixiviant or recovery fluids recovered from areas where a liquid release has occurred from a well or pipeline. The water will be placed into the wastewater disposal system for deep well injection.

4.13.2.4 Stormwater Runoff

A final source of water is storm runoff. Stormwater management is controlled under NPDES permits issued by the WDEQ-WQD. Facility drainage will be designed to route storm runoff water away or around the plant, ancillary building and parking areas, and chemical storage. The design of the Moore Ranch facilities and procedural and engineering controls contained in a Best Management Practices (BMP) Plan will be implemented such that runoff is not considered to be a potential source of pollution.

4.13.2.5 Liquid Waste Disposal

EMC expects that the liquid waste stream generated at the Moore Ranch Facility will be chemically and radiologically similar to the waste disposed in the current disposal wells in operation at existing ISR sites in the Powder River Basin. It is anticipated that the maximum volume of liquid waste stream for disposal will be approximately 45 gpm during normal operations and approximately 100 gpm during restoration. The average net consumptive use during the operational and restoration phases of the Moore Ranch Project was estimated at 105 gpm as discussed in Section 4.4.2.1. This waste stream will require effective disposal.

4.13.2.6 Domestic Liquid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the State of Wyoming. These systems are in common use throughout the United States and the effect of the system on the environment is known to be minimal.

4.13.3 Solid Waste

4.13.3.1 Uncontaminated Solid Waste

Waste which is not contaminated with radioactive material or which can be decontaminated and re-classified as uncontaminated waste includes solid waste, piping, valves, instrumentation, equipment and any other items that are not contaminated or which may be successfully decontaminated. If decontamination of waste material is possible, surveys for residual surface contamination will be made before releasing the material. Decontaminated materials must have activity levels lower than those specified in NRC guidance. Methods for decontamination and release of contaminated equipment are discussed in further detail in Section 5 of the Technical Report.

EMC estimates that the proposed Moore Ranch Project will produce approximately 2,000 cubic yards (yd^3) of uncontaminated solid waste per year. Uncontaminated solid waste will be collected on the site on a regular basis and disposed of in the nearest sanitary landfill.

4.13.3.2 Byproduct Material

All contaminated items that cannot be decontaminated to meet release criteria will be properly packaged, transported, and disposed at a disposal site licensed to accept 11e.(2) byproduct material. Solid wastes generated by this project that may become contaminated with radioactive materials consist of items such as rags, trash, packing material, worn or replaced parts from equipment, piping, filters, protective clothing, and solids removed from process pumps and vessels. Radioactive solid waste that has a contamination level requiring controlled disposal will be isolated in drums or other suitable containers. EMC estimates that the proposed Moore Ranch Project will produce approximately 100 yd^3 of 11e.(2) byproduct material per year. These materials will be stored on site inside the restricted area until such time that a full shipment can be shipped to a licensed waste disposal site or mill tailings facility.

4.13.3.3 Septic System Solid Waste

Domestic liquid wastes from the restrooms and lunchrooms will be disposed of in an approved septic system that meets the requirements of the WDEQ for Class V UIC wells. Disposal of solid materials collected in septic systems must be performed in accordance with WDEQ Solid Waste Management rules and regulations.

4.13.3.4 Hazardous Waste

The potential exists for any industrial facility to generate hazardous waste as defined by the Resource Conservation and Recovery Act (RCRA). In the State of Wyoming, hazardous waste is governed by WDEQ Hazardous Waste Rules and Regulations. Based on preliminary waste determinations conducted by EMC in consideration of the processes and materials that will be used on the project, EMC will likely be classified as a Conditionally Exempt Small Quantity Generator (CESQG), defined as a generator that generates less than 100 kg of hazardous waste in a calendar month and that complies with all applicable hazardous waste program requirements. EMC expects that only used waste oil and universal hazardous wastes such as spent batteries will be generated at Moore Ranch.

4.14 CUMULATIVE IMPACTS

4.14.1 Cumulative Impacts of Coal Bed Methane Development Projects

The Powder River Basin has been developed since the mid-1980's for the recovery of coal bed methane (CBM). With advancements in technology, development and production of CBM has been increasing substantially since the mid-1990s. Development has been centered in all or parts of Campbell, Converse, Johnson, and Sheridan counties. The target coal zones are contained in the Fort Union formation.

The following discussion of CBM recovery methods (Section 4.14.1.1) and environmental impacts (Section 4.14.1.2) is based on a Final Environmental Impact Statement (FEIS) prepared by the Bureau of Land Management (BLM) for the Powder River Basin. The proposed Moore Ranch License Area includes existing CBM recovery facilities which are discussed in Section 4.14.1.3. Cumulative environmental impacts of existing CBM development and the Moore Ranch Project are discussed in Section 4.14.1.4.

4.14.1.1 Coal Bed Methane Recovery Method

Recovery of CBM involves installation of facilities including access roads, pipelines for gathering gas and produced water, electrical utilities, facilities for measuring and compressing recovered gas, facilities for treating, discharging, disposing of, containing, or injecting produced water, and pipelines to transport gas to high-pressure transmission pipelines. Several coal beds may occur together. Standard practice in these areas is to drill a separate well to develop each coal bed. Where possible, wells are collocated on the same well pad. Wells and well pads are generally installed on an 80-acre spacing pattern (eight pads per square mile).

Typically, the CBM operators use a truck-mounted water well type of drilling rig to drill CBM wells. A well is drilled to a depth of 350 feet to 1,500 feet or deeper to the top of a coal zone. When the target coal is reached, the well production casing is placed and cemented. Placement of production casing includes insertion of a steel pipe into the drill hole from the bottom of the hole to the surface. Casing is set into the hole one joint at a time and is threaded at one end with a collar located at the other end to connect each joint. The casing is then cemented into place by pumping a slurry of dry cement and water into the casing head, down through the casing string to the bottom, and then up through the annulus between the casing and the well. A plug and water flush is then pumped to the bottom of the well to remove any residual cement from the inside walls of the casing. Sufficient cement is pumped into the annulus to fill the space, where it is

allowed to harden. If indications of inadequate primary cementing exist such as lost returns, cement channeling, or mechanical failure of equipment, the operator evaluates the adequacy of the cementing by pressure testing the casing shoe, running a cement bond log, cement evaluation tool log, or a combination.

Cementing the annulus around the casing pipe restores the original isolation of formations by creating a barrier to the vertical migration of fluids and gas between rock formations within the borehole. It also protects the well by preventing pressure in the formation from damaging the casing and retards corrosion by minimizing contact between the casing and corrosive formation waters.

After the coal zone is drilled, the open hole is flushed with clean chlorinated water to remove the coal fines from the hole. Steel tubing is then inserted inside the casing and in the open hole. A submersible electric pump is attached to the bottom end of the tubing to pump water from the coal. The size and capacity of the submersible pump depends on the coal's thickness and the rate of production expected from the well. Most pumps are rated at 10 to 20 gallons per minute. The pump is necessary because water pressure in the coal zone must be reduced before gas (methane) will flow to the open hole. The water is pumped up the tubing to the surface where, generally, it is gathered in a pipeline for disposal. When the gas is released from the coal, it flows up the space between the tubing and the steel casing to the gas-gathering system and compressors at the surface.

After well productivity is established, a small area of about 5 to 6 feet square is leveled and a weatherproof covering or box is placed over the wellhead. Enclosures for wellheads and metering facilities are vented. Usually, a metal fence or rail is installed immediately around the box and electrical panel to protect them from livestock. Meters to measure pressure and rates of water production may be placed in the box. Injection facilities, including some treatment facilities, may be collocated at CBM wells. The power lines for the submersible water pumps are laid in trenches, usually with water pipelines, to minimize surface disturbance and the visual impact of operations.

Three types of pipelines are generally constructed. These pipelines gather gas and produced water and deliver gas at high pressure. The gathering pipelines convey gas from the wells to compressor facilities and the produced water to discharge or disposal points. The high-pressure gas pipelines connect compressor facilities to transmission pipelines. The pipelines to gather gas and produced water are constructed of high density polyethylene (HDPE) pipe with an outside diameter of 2 to 12 inches. The high-pressure pipelines are constructed of steel pipe with an outside diameter of 12 to 16 inches. Rights-of-way for the pipelines vary from 20 to 50 feet for HDPE pipeline and 100 feet for steel pipelines. All pipelines are generally installed along access roads to minimize disturbance.

Produced water is brought to a point of discharge into a natural drainage or into containment for disposal. The average rate of water production per well is about 10 gpm. This rate for an individual well may rise as deeper, thicker coals are produced. Historically, the rate of water production drops to one-half its initial level after the first year of production in a new area where the water pressure is being reduced before gas production begins.

The method of handling produced water varies as the water quality, water volumes, and desires of the surface owner change. Typical water handling methods include direct surface discharge, passive or active treatment of produced water followed by direct surface discharge, infiltration or containment impoundments for produced water, land application using irrigation equipment, and injection of produced water through disposal wells. Presently, the primary method of disposal is to convey the water in an underground pipe to a surface discharge location mutually selected by the operator and the surface owner or lessee. WDEQ permits these surface discharges through the State NPDES program.

Gas-gathering pipelines for an average of 10 wells are tied together in a central measuring facility (CMF). At the CMF, gas is commingled into the gas-gathering system, which transports it to a compressor station. Two types of compressor stations are constructed: central reciprocating and booster stations. Produced natural gas under pressure from the wellhead moves through the low-pressure gas-gathering system to a booster compressor station. Typical pressure in the gathering line is less than 50 psi. At booster stations, low horsepower (350 HP) natural gas or electric-powered boosters or blowers enhance the flow of gas through the pipelines. Gas from the booster compressor stations then flows through medium-pressure pipelines (50 to 125 psi) to a central reciprocating compressor station. High horsepower (1,650 HP) compressors at these stations increase the pressure of natural gas to an estimated 700 to 1,450 psi to facilitate transmission of the natural gas to high-pressure transmission pipelines.

As production areas deplete, surface facilities are removed. Depleted production holes are plugged and abandoned in accordance with Onshore Oil and Gas Order No. 2 and Wyoming Oil and Gas Conservation Commission (WOGCC) rules. Once the well is conditioned as a static column, the well is decommissioned by pouring redundant plugs, a slurry of cement and water at strategic locations in the well bore. These locations are based on each well's configuration to prevent migration of fluids or gas up the well bore or any uncemented paths. A mixture of bentonite and water is placed between the cement plugs. Well pads are recontoured, plowed, and seeded. Wells may also be assigned to the landowner consistent with the terms of the surface use agreement. When the well is assigned, all rights and responsibilities, including reclamation, pass to the landowner, unless otherwise specified. The underground pipelines are cleaned, disconnected, and then abandoned in place to avoid any unnecessary surface disturbance. Underground

electric lines are disconnected and are also abandoned in place to avoid any unnecessary surface disturbance. Aboveground lines are disconnected and the power poles are removed from the sites.

The productive life of each well is expected to be about 7 years. Final reclamation of these wells occurs during the 2 to 3 years after production ends, resulting in an overall average life of 10 years.

4.14.1.2 Environmental Impacts of CBM Recovery in the Powder River Basin

In 2003, the BLM issued a Final Environmental Impact Statement (FEIS) and a Record of Decision (ROD) for a proposed expansion of CBM production in the Powder River Basin. The following sections describe the environmental impacts of the alternative approved by the BLM in the ROD. This review is limited to CBM impacts that may contribute to a cumulative impact when considered with the environmental impacts of the Moore Ranch Project as discussed in this Section of the ER. It should be noted that the environmental impacts associated with CBM development discussed in this section were associated with a large project (51,000 total CBM wells) located in a large area within the Powder River Basin (approximately 8 million acres). The cumulative impacts of development in the Moore Ranch Project area will be based on the actual and planned CBM development within that area and are discussed in detail in Section 4.14.1.4.

4.14.1.2.1 Groundwater Impacts

CBM recovery requires the removal of large volumes of groundwater from the coal zone in order to depressurize the zone and release the gas. The BLM estimated that development of CBM in the Powder River Basin through 2018 would remove about 3 million acre-feet, less than 0.3 percent of the total recoverable groundwater (nearly 1.4 billion acre-feet) in the Wasatch and Fort Union Formations within the Powder River Basin. An estimated 15 to 33 percent of the groundwater removed will infiltrate the surface and recharge the shallow aquifers above the coals. Redistribution of pressure within the coals after water production ends would allow the hydraulic pressure head to recover within approximately 50 feet or less of pre-project levels within 25 years after the project end. Complete recovery of water levels likely would take tens to hundreds of years, depending on the location.

BLM models indicated that Wasatch aquifers that overlie the coals also would be affected by development. As the coal is de-pressurized by water removal during mining or development of CBM, water contained in deep Wasatch sands would leak into the coals. Water levels in the deep Wasatch sands would be lowered, but BLM estimated that the

drawdown likely would be less than 10 percent of the level that would occur in the coal. Conversely, in some areas BLM estimated that water levels in very shallow Wasatch sands likely would rise initially, up to 50 feet in the immediate vicinity of infiltration impoundments and up to 10 feet at distances of several hundred feet from impoundments or surface drainages that receive CBM discharge. This rise would occur through enhanced recharge from infiltration of CBM produced water.

BLM projected that the infiltration of produced water would not noticeably affect groundwater quality.

Wells completed in developed coals that are located within the areal extent of the 100-foot drawdown contour created by a CBM well could experience drops in water level and possibly methane occurrence. Flowing artesian wells and springs that emanate from coals in these areas would likely experience a decrease in flow rate. BLM estimated that recovery of artesian conditions likely would not occur unless recovery of the last five percent or so of hydraulic head occurs.

4.14.1.2.2 Surface Water Impacts

An estimated 9 to 52 percent of CBM produced water would contribute to surface flows. Perennial flows would be likely to develop in formerly ephemeral channels. The preferred alternative included management of surface water discharges of produced water by sub-watersheds and the emphasized use of infiltration for produced water management. The Moore Ranch Project is located in the BLM Upper Belle Fourche River watershed. Under modeled conditions, the amount of produced water assumed to reach the main stem of the Upper Belle Fourche River sub-watershed during the peak year of CBM water production (2006) was about 61 cfs (44,168 acre-feet/year).

BLM expects noticeable changes in water quality of main stems during periods of low flow. The key water quality parameters of concern due to their impacts on water use for irrigation are sodicity (as measured by the sodium absorption ratio or SAR) and salinity (as measured by conductivity). NPDES permit conditions provide enforceable assurance that water quality standards and designated uses would not be degraded from discharges of CBM produced water. Under modeled conditions, the BLM estimated that the resultant water quality in the Upper Belle Fourche River sub-watershed at Moorcroft, Wyoming, during all months of the year would be adequate to meet the Most Restrictive Proposed Limit (MRPL) for both conductivity and SAR that the WDEQ has adopted in its NPDES permitting process to be protective of downstream irrigation. Under some flow conditions, the modeled SAR values and concentrations of sodium may inhibit the use of irrigation on some tributaries in the Upper Belle Fourche River sub-watershed. However, BLM noted that samples collected since the onset of CBM production in the Upper Belle

Fourche River sub-watershed had not detected changes in ambient stream water quality which were predicted by the mass balance model.

BLM projected that concentrations of suspended sediment in surface waters would be likely to rise above baseline levels as a result of increased flows and runoff from disturbed areas. BLM requires site-specific Water Management Plans (WMPs) as an integral part of mitigation planning to control and monitor the potential effects from increased flows in surface drainages.

As a positive impact of CBM development, the discharge of produced water would result in the increased availability of surface water for irrigation and other downstream beneficial uses. Numerous impoundments are constructed to temporarily store CBM produced water for beneficial use. BLM estimated that between 8 to 25 percent of CBM produced water would be held in storage.

4.14.1.2.3 Air Quality Impacts

Fugitive dust and exhaust from construction activities, along with air pollutants emitted during operation (i.e., well operations, injection well and pipeline compressor engines, etc.), are potential causes of decreases in air quality related to CBM development and production. BLM performed air pollutant dispersion modeling to quantify potential PM_{10} and SO_2 impacts during construction based on the individual pollutant's period of maximum potential emissions. Construction emissions would occur during potential road and well pad construction, well drilling, and well completion testing. During well completion testing, natural gas may be flared and exhausted. Maximum air pollutant emissions from each well would be temporary (i.e., occurring during a short construction period) and would occur in isolation. Air quality impacts would occur during production including non-CBM well production equipment and booster and pipeline compression engine exhausts. The amount of air pollutant emissions during construction is controlled by watering disturbed soils, and by air pollutant emission limitations imposed by the WDEQ. Before actual development can occur, the WDEQ must review the specific air pollutant emissions pre-construction permit application that examines the source-specific air quality impacts. As part of these permits (depending on source size), the WDEQ may require additional air quality impacts analyses or mitigation measures.

4.14.1.3 CBM Development at Moore Ranch

Two companies (Barrett Resources Corporation and Devon Energy Corporation) have CBM claims located within the proposed Moore Ranch License Area. EMC has met with representatives of both companies to discuss current and planned CBM operations within

he proposed license area and coordination with EMC activities. Currently existing CBM facilities operated by Devon located within the proposed Moore Ranch License Area are shown in Figure 4.14-1. Barrett has plans for future development within the license area. The producing interval is the Anderson/Big George coal at depths of between 1,000 and 1,200 feet below ground surface.

Existing Devon installations were installed approximately seven years ago and will be nearing the end of their operational life at the time EMC expects to begin construction. Reclamation activities for these Devon wells and facilities will likely occur during the operational phase of the Moore Ranch Project.

Barrett plans to install new facilities within the next several years in Sections 2, 3, 4, 33 and the NW ¼ of Section 34. These planned facilities are located outside EMC wellfields.

Based on discussions with both CBM operators and experience with concurrent CBM and uranium recovery development in other locations in the Powder River Basin, EMC believes that these activities can be coordinated to maintain health, safety, and environmental controls.

THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

DRAWING NO.: FIGURE 4.14-1, "MOORE RANCH URANIUM PROJECT EXISTING AND PROPOSED SITE FEATURES"

WITHIN THIS PACKAGE... OR, BY SEARCHING USING THE DOCUMENT/REPORT DRAWING NO. FIGURE 4.14-1

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4.14.1.4 Cumulative Environmental Impacts of the Moore Ranch Project and CBM Development

The only potential cumulative environmental impact of CBM and ISR operation would be hydrologic. As previously mentioned, the producing interval for CBM is the Anderson/Big George coal at depths of between 1,000 and 1,200 feet below ground surface. The Anderson/Big George Coal is within the Fort Union Formation and is separated from the uranium-producing 70 Sand in the Wasatch Formation by over 700 feet of interbedded clays, siltstone, and discontinuous sands. As a result, no hydrologic impacts from coal bed methane production are expected on sandstone and clay aquitards relevant to in situ mining at Moore Ranch.

4.14.1.5 Accident Risk Associated with Coal Bed Methane Development

The presence of CBM development on the Moore Ranch Project site presents accident risks that are not commonly associated with ISR mining. These additional accident risks, the control methods that the CBM operators currently have in place, additional control measures proposed by EMC, and the potential effect of accidents on the health and safety of EMC employees and the public and the security of licensed material are discussed in the following sections. The potential accident scenarios that could impact EMC operations are based on those analyzed by the BLM in the 2003 FEIS for the Powder River Basin.

4.14.1.5.1 Methane Migration and Seepage

CBM development includes potentially increased risks of methane seepage, fires, or explosions. Methane is not biologically toxic, but high concentrations in confined spaces can displace oxygen and present a danger of fire or explosion.

Methane gas can reach the surface by naturally occurring seepage along fault lines, fractures, or sandstone layers in areas where coal beds are shallow. Gas migration could also be enhanced during CBM development in areas along a coal outcrop, which are not present on the Moore Ranch site. Non-CBM wells that penetrate the coal seam may provide pathways for migration of methane if the casings or plugs are inadequate or faulty or lack isolation through the coal horizons.

The potential for migration of methane in CBM wells is minimized or prevented by the use of the current CBM industry standards for cementing and casing wells that isolate or protect all zones from gas or fluid migration. Well construction methods for CBM wells were discussed in detail in this section.

Risks from methane associated with oil and gas wells, including CBM wells, are controlled through the BLM-mandated conditions of approval for the Application for Permit to Drill (APD) that address well conditions, casing, ventilation, and plugging procedures appropriate to site-specific CBM development plans. In addition, CBM operators must have emergency plans and employee training programs that address fire prevention and control measures.

BLM reported in the 2003 FEIS that experience in the Powder River Basin has shown that few cases of methane seeps that involve potentially explosive concentrations of gas have occurred.

4.14.1.5.2 Pipeline Ruptures

CBM development involves the potential for leaks or ruptures of gas flowlines or pipelines. Most ruptures occur when heavy equipment accidentally strikes the pipeline while operating in close proximity. These ruptures may result in a fire or explosion if a spark or open flame ignites the escaping gas.

Materials used in the pipelines are designed and selected in accordance with applicable standards to minimize the potential for a leak or rupture. Pipeline markers are posted at frequent intervals along the pipelines to warn excavators and to reduce the risk of accidental rupture from excavating equipment. EMC will work with CBM operators located on the proposed license area to ensure that all gas collection and transmission lines within proposed development areas are adequately marked to prevent accidental rupture by EMC activities.

The CBM operators monitor the pipeline flows by either remote sensors or daily inspections of the flow meters. Routine monitoring reduces the probability of effects to health and safety from ruptures by facilitating the prompt detection of leaks. If pressure losses are detected, the wells are shut in until the problem is isolated and addressed.

The projected development area of the Moore Ranch Project includes approximately 2,100 feet of gas pipeline. Based on a statistical average of one significant safety incident per year per 4,154 miles of total pipeline, 0.0001 additional pipeline safety incidents (including ruptures) may occur within the license area per year over the life of the project.

Based on the low incident rate, location of existing and planned pipelines, and the preventative measures planned for the Moore Ranch Project, there is an insignificant

increase in risks to human health and safety and control of licensed material associated with potential pipeline ruptures from CBM-related facilities.

4.14.2 Cumulative Impacts of Other Uranium Development Projects

The Powder River Basin has been historically developed for the recovery of uranium using ISR and conventional (underground and pit) mining. The only existing licensed uranium projects currently located in the Powder River Basin are the Smith Ranch/Highland Uranium Project (operated by Power Resources, Inc.) and the Irigaray/Christensen Ranch Project (operated by Cogema Mining, Inc). These ISR projects are located approximately 59 km south southeast and 30 km north northwest of the Moore Ranch Project, respectively. Considering the distance between the existing projects and the proposed Moore Ranch Project, cumulative environmental impacts are not expected.

EMC is aware that several companies are actively investigating the potential for ISR mining in areas near the Moore Ranch Project. These projects are in various stages of development. Licensing and permitting applications have not been submitted to the regulatory agencies at the time of this application. As such, it is not possible for EMC to accurately predict the cumulative environmental impacts should these uranium projects seek and ultimately gain regulatory approval and be developed.