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3.7 Meteorology, Climatology and Air Quality

This section describes meteorology, climatology, and air quality in the region where the Permit Area is located. Both regional (long-term) and site-specific (one-year) data are discussed to characterize climatological conditions at the Permit Area. Where site-specific data are not available, data from the closest representative location are presented.

3.7.1 Meteorology and Climatology

The Permit Area is located in the intermountain semi-desert ecoregion (Wyoming State Climate Office, 2005), which has cold winters and short, hot summers (Bailey, 1995). The average annual temperatures range from 40 to 52 degrees Fahrenheit (°F) in this ecoregion. The average annual precipitation ranges from five to 14 inches (Bailey, 1995). Meteorological stations within 50 miles of the Permit Area are shown in **Figure 3.7-1**. The National Weather Service (NWS) meteorological station, closest to the Permit Area, with a long period of record is Muddy Gap, Wyoming (High Plains Regional Climate Center [HPRCC], 2007a). This station is 28 miles northeast of the Permit Area, and temperature, precipitation, snowfall and snow depth data have been collected since 1949.

A meteorological station (Lost Soldier [LS] Station) was installed at a location near Bairoil in April 2006. The LS meteorological station is about 12 miles northeast from the Permit Area (**Figure 3.7-1**). Another meteorological station (Lost Creek [LC] Station) was installed within the Permit Area in May 2007 to collect on-site data (**Figure 3.7-1**).

Information collected from the LS station will be used to describe on-site conditions. All data were measured at a height of 6.6 feet (two meters), with a recovery rate of over 90 percent. The Muddy Gap station is in the same Climate Division as the Permit Area, Climate Division 10 (CLIMAS, 2005), which means that these locations have similar climatic characteristics. At the date of this document, only data through 2005 were available for the Muddy Gap station.

3.7.1.1 Temperature

Based on the Muddy Gap data, July is the warmest month; the average maximum daily temperature is approximately 85°F, and the average minimum daily temperature is approximately 55°F. January is the coldest month; the average daily maximum temperatures are 30 to 35°F, and the average minimum daily temperatures are approximately 10 to 15°F. The maximum temperature on record is 100°F in July, while the minimum temperature on record is -40°F in December. The average monthly temperatures at the LS station, collected in 2006 and 2007, were generally within range of the long-term averages at Muddy Gap. Temperatures from these stations are compared in **Table 3.7-1**.

Dew point temperatures were calculated for the months of April to December; temperatures between January and March showed negative temperatures. The averages ranged from 22.4 to 35.1°F. The highest average dew point temperature occurred in July, while the lowest average dew point temperature occurred in May. The maximum dew point temperatures range from 32.6 to 53.2°F; the minimum dew point temperatures range from -10.2 to 19.7°F. The lowest minimum dew point temperatures occurred in May and November, while the highest maximum dew point temperatures occurred in July and August. **Table 3.7-2** presents the dew point temperature data.

3.7.1.2 Precipitation

The Permit Area is drier than many areas in the State of Wyoming. **Figure 3.7-2** shows the total monthly precipitation in the Project region.

The mean annual precipitation at the Muddy Gap station from 1949 through 2005 was 10.0 inches. Precipitation is distributed throughout the year; the mean monthly precipitation exceeds one inch only in April, May, and June. May is the wettest month, with 1.9 inches of mean precipitation. The actual annual moisture may be somewhat higher, since precipitation gages capture only a small proportion of snowfall under windy conditions.

The precipitation at the LS station from May 2006 to April 2007 showed that precipitation for this period was much lower than normal. Regional data showed the area received 50 to 70 percent less rainfall than average (HPRCC, 2007b). The nearest bodies of water within 50 miles are the Pathfinder and Seminoe Reservoirs (see **Figure 3.7-1**).

3.7.1.3 Humidity

The average relative humidity at the Permit Area is low in the summer, with the lowest average occurring in June (30.2 percent). The relative humidity is elevated during the winter, where the highest average occurred in February (75.6 percent). The monthly maximum and minimum humidity measured at the LS meteorological station is provided in **Table 3.7-3**.

3.7.1.4 Wind

The annual average wind speed at a height of ten meters, measured between May 2006 and April 2007, was 23 feet per second (ft/s) (7.0 meters per second [m/s]) at the LS station. The wind speed is highest in February and November (29.9 and 29.2 ft/s or 9.1 and 8.9 m/s, respectively). The lowest wind speeds occur in July and August (16.4 and 16.7 ft/s or 5.0 and 5.1 m/s, respectively). The wind speed and wind direction from May 2006 to April 2007 is shown in **Figures 3.7-3a to m**. The prevailing monthly wind direction is from the west-northwest and west for most of the year, with some variability occurring in the spring.

3.7.1.5 Evaporation

Evaporation from a Class A pan was measured from March to November at the Pathfinder Dam, 56 miles from the Permit Area. This location is in the same climatic zone as the Permit Area (Wyoming State Climate Office, 2007), so potential evaporation would be similar in both locations. Evaporation pan data were not collected during the winter months. Evaporation occurs at a slower rate in lakes than in pans, so empirical equations are generally used to estimate actual lake evaporation. The Kohler-Nordenson-Fox equation uses temperature, wind, humidity, and radiation to predict monthly and annual evaporation, and has been shown to produce reliable results in Wyoming (Pochop et al., 2007). This paper reported the annual estimated lake evaporation at the Pathfinder Dam is 42.5 inches (**Table 3.7-4**). The highest estimated evaporation rates occurred during the summer months, with a peak of 7.5 inches in July. The period of maximum evaporation is consistent with the pan evaporation measurements from the Pathfinder Dam. Evaporation rates were low in the winter, with less than one inch of evaporation predicted for December and January.

3.7.1.6 Severe Weather

Tornadoes are more prevalent in eastern Wyoming than in western Wyoming, because mountain ranges in western Wyoming are barriers to the flow of warm, moist air that causes tornadoes. In Sweetwater County, 19 tornados, none of which caused any injury or death, were reported in a 55-year period. An individual tornado would affect only a portion of Sweetwater County; therefore, the chances are small that the Permit Area would experience a tornado. The Fujita Scale is used to rate the intensity of a tornado by examining the damage caused to man-made structures (The Tornado Project, 2003). The most destructive tornado recorded in Sweetwater County from 1950 to 2004 was an F-1 "moderate" tornado, which would be unlikely to cause extensive damage to the Project.

Figure 3.7-4 presents tornado data collected by the Storm Prediction Center from 1950 to 2004 (Storm Prediction Center, 2005).

July has the highest number of thunderstorm days, as measured over many years at select stations in Wyoming. Wind gusts during thunderstorms are often over 49 mph. The Permit Area is located in an area that has statistically shown a lower density of lightning strikes. The probability of hail is also low, with six occurrences recorded in a 24-year period (Curtis and Grimes, 2007).

3.7.1.7 Local Air Flow Patterns and Characteristics

Atmospheric stability was categorized into six classes according to Pasquill. Calculations were made using wind speed and solar radiation data collected at the Permit Area, and the results are presented in **Table 3.7-5**. The data show that low stability conditions, which contribute to good dispersion conditions, occur 91 percent of the time, making atmospheric inversion conditions unlikely.

3.7.2 Air Quality

National Ambient Air Quality Standards (NAAQS) exist for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), lead, and particulate matter small enough to move easily into the lower respiratory tract (particles less than ten micrometers in aerodynamic diameter, designated Particulate Matter [PM_{10}]). The NAAQS are expressed as pollutant concentrations that are not to be exceeded in the ambient air, that is, in the outdoor air to which the general public has access (40 CFR Part 50.1(e)). Primary NAAQS are designated to protect human health; secondary NAAQS are designated to protect human welfare by safeguarding environmental resources (such as soils, water, plants, and animals) and manufactured materials. Primary and secondary NAAQS are presented in **Table 3.7-6**.

The air quality in the Project region is good. The area is sparsely populated and is not heavily developed with industrial sources of air pollution. The closest monitoring station to the Permit Area is in Rawlins, and shows that regional air quality is in compliance with the NAAQS and Wyoming Ambient Air Quality Standards (WAAQS) (BLM, 2004c).

In addition to ambient air quality standards, which represent an upper bound on allowable pollutant concentrations, there are national standards for the Prevention of Significant Deterioration (PSD) of air quality (40 CFR § 51.166). The PSD standards differ from the NAAQS in that the NAAQS provide maximum allowable concentrations of pollutants, while PSD requirements provide maximum allowable increases in concentrations of pollutants for areas already in compliance with the NAAQS. PSD standards are, therefore, expressed as allowable increments in the atmospheric concentrations of specific pollutants. Allowable PSD increments currently exist for three pollutants: NO_2, SO_2, and PM_{10}. Increments are particularly relevant when a major proposed action (involving either a new source or a major modification to an existing source) may degrade air quality without exceeding the NAAQS, as would be the case, for example, in an area where the ambient air is very clean. One set of allowable increments exists for Class II areas, which cover most of the US; a much more stringent set of allowable increments exists for Class I areas, which are designated areas where the degradation of ambient air quality is severely restricted. Class I areas include certain national parks and monuments, wilderness areas, and other areas as described in 40 CFR § 51.166(e) and 40 CFR Part 81:400-437. Maximum allowable PSD increments for Class I and Class II areas are given in **Table 3.7-7**. Class I areas, as designated in the Rawlins RMP, include the Savage Run Wilderness and Rocky Mountain National Park. PSD Class I areas receive the highest degree of protection from air pollution; only small amounts of particulate, SO_2, and NO_2 air pollutants are allowed in these areas (BLM, 2004c).

Emission air quality data in the EPA database consist of the amount of selected air quality parameters that are released into a particular airshed. Criteria Air Pollutant parameters reported include CO, NO_X (a group of highly reactive gases that contain nitrogen and oxygen in varying amounts), SO_2, volatile organic compounds (VOCs), $PM_{2.5}$, PM_{10} and ammonia (NH_3). Near the Permit Area, reported sources of emissions include that from the Amoco CO_2 Bairoil station, the Northern Gas Bunker Hill compression station and the Sinclair Oil Bairoil station (**Table 3.7-8**). Hazardous Air Pollutants consist of 188 parameters and are also reported in the EPA database; the reported total emissions from the facilities near the Permit Area are presented in **Table 3.7-9**.

Air particulate matter in the Permit Area was sampled using two Mini-Volumetric (MiniVol) samplers with ten micron (PM_{10}) filters. Dust trapped by these filters is the size considered most detrimental to human health. Two samplers were used as a pair, with samples collected concurrently upwind and downwind of the Permit Area, at three locations: Northern (LCAIR9&10), Central (LCAIR13&14), and Southern (LCAIR11&12). The sampling duration was approximately 24 hours; the results were time-adjusted for a 24-hour period. **Figure 3.7-5** shows the sampling locations, and the results are presented in **Table 3.7-10**.

The average PM_{10} concentration in June 2006, including both upwind and downwind sampling locations, was 8.5 micrograms per cubic meter ($\mu g/m^3$). The maximum value was 10.5 $\mu g/m^3$, and the minimum value was 5.4 $\mu g/m^3$. For comparison, the average PM_{10} in Casper Wyoming was 18.8 $\mu g/m^3$ from 1990 through 1994 (Natural Resources Defense Council, 2007). At the northern sampling location, the PM_{10} concentration in the upwind sample was more than 70 percent higher than the downwind sample. At the central and southern sampling locations, the upwind and downwind samples differed by 15 percent or less. The sample collection runs lasted between 21.5 to 28 hours. In February 2007, the PM_{10} concentration at the central sampling location was about one-half of the concentration in June 2006, possibly due to slightly damper soil conditions.

The NAAQS criteria for PM_{10} sets a limit of 150 $\mu g/m^3$ for a 24-hour period, not to be exceeded more than once per year on an average over three years. The data show that for both upwind and downwind locations, this standard was not exceeded. More information on dust and emissions from Project activities are covered in **Section 4.7** of this report.

Passive radon and gamma air sampling for the Project was initiated in November 2006. Sampling locations were established at the closest full-time residence, which is in Bairoil, (URPA1 [Ur-Energy Passive Air 1]), at the western site boundary (URPA7), at the southeastern site boundary (URPA8), at the northeastern site boundary (URPA10), and at the center of the site (URPA9). An additional sampling site was added (URPA13) after the first quarter, to reflect changes to the Permit Area. **Figure 3.7-6** shows passive radiological sampling locations, which represent conditions both upwind (west) and downwind (east) of the Permit Area.

The samplers were retrieved quarterly, and the results are presented in **Table 3.7-11**. The elevated radon measurement at URPA9 during the first quarter may be due to radon retention by snow cover. When retrieved, the sensor was buried in a snow drift; thereafter, the sampler was relocated five feet away. The gamma sensor at URPA10 was missing at the end of the second quarter, but was replaced.