## 4.0 MID-FIELD AND FAR-FIELD ANALYSES

The purpose of the mid-field and far-field analyses were to quantify potential air quality impacts on Class I and Class II areas from air pollutant emissions of $NO_x$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ expected to result from the development of the Project. The analyses were performed using the EPA CALMET/CALPUFF modeling system to predict air quality impacts from Project and regional sources at far-field PSD Class I and sensitive Class II areas and at several mid-field PSD Class II areas. The PSD Class I areas and sensitive Class II areas analyzed are shown on Map 1.2 and include:

- the Bridger Wilderness Area (Class I);
- the Fitzpatrick Wilderness Area (Class I);
- the Popo Agie Wilderness Area (Class II);
- the Wind River Roadless Area (Class II)
- Grand Teton National Park (Class I);
- the Teton Wilderness Area (Class I);
- Yellowstone National Park (Class I); and
- the Washakie Wilderness Area (Class I).

Modeled pollutant concentrations at these sensitive areas were compared to applicable WAAQS, NAAQS, and PSD Class I and Class II increments, and were used to assess potential impacts to AQRVs (i.e., visibility [regional haze] and acid deposition). Note that visibility is protected in Class I areas; Class II areas are included here to further define impacts in potentially sensitive areas. In addition, analyses were performed for seven lakes designated as acid sensitive located within the sensitive PSD Class I and Class II wilderness areas to assess potential lake acidification from acid deposition impacts (see Map 1.2). These lakes include:

- Deep Lake in the Bridger Wilderness Area;
- Black Joe Lake in the Bridger Wilderness Area;
- Hobbs Lake in the Bridger Wilderness Area;
- Upper Frozen Lake in the Bridger Wilderness Area;

- Lazy Boy Lake in the Bridger Wilderness Area;
- Ross Lake in the Fitzpatrick Wilderness Area; and
- Lower Saddlebag Lake in the Popo Agie Wilderness Area.

The mid-field analysis assessed direct project and regional source impacts at in-field locations within the JIDPA and other mid-field locations defined as Class II areas (regional communities) (see Map 1.2), which include the Wyoming communities of:

- Big Piney;
- Big Sandy;
- Boulder;
- Bronx;
- Cora;
- Daniel;
- Farson;
- La Barge;
- Merna; and
- Pinedale.

Predicted pollutant impacts at in-field locations were compared to applicable ambient air quality standards, and mid-field Wyoming community locations impacts to visibility (regional haze) were assessed.

## 4.1 MODELING METHODOLOGY

The EPA-approved CALMET/CALPUFF modeling system (CALMET Version 5.53, Level 030709, and CALPUFF Version 5.711, Level 030625) was used for the mid-field and far-field modeling analyses. The CALMET meteorological model was used to develop wind fields for a year of meteorological data (1995) and the CALPUFF dispersion model combined these wind fields with Project-specific and regional emissions inventories of $SO_2$, $NO_x$, $PM_{10}$, and $PM_{2.5}$ to estimate ambient concentrations and AQRV impacts at mid-field and far-field receptor locations. The study area is shown in Map 1.2.

The CALMET and CALPUFF models were utilized in this analysis generally following the methods described in the Protocol (Appendix A) and the following guidance sources:

- *Guideline on Air Quality Models*, 40 *Code of Federal Regulations* (C.F.R.), Part 51, Appendix W (EPA 2003a);
- *Interagency Work Group on Air Quality Modeling (IWAQM) Phase 2 Summary Report and Recommendations for Modeling Long Range Transport Impacts*, EPA-454/R-98-019, Office of Air Quality Planning and Standards, December 1998 (IWAQM 1998); and
- *Federal Land Managers - Air Quality Related Values Workgroup (FLAG), Phase I Report*, December 2000 (FLAG 2000).

The CALMET wind fields developed for this analysis follow the CALMET methodologies established as part of the Southwest Wyoming Technical Air Forum (SWWYTAF) for southwest Wyoming, and were further enhanced through the use of additional meteorological datasets and revised CALMET model code.

## 4.2 PROJECT ALTERNATIVE MODELING SCENARIOS

Modeling scenarios were developed for a range of proposed project development including the Proposed Action, Alternative A, Alternative B, Alternative C, and Alternative F. WDRs of 250 wells/year, 150 wells/year, and 75 wells/year were analyzed. The Proposed Action, and Alternatives A, B, and F are proposals for 3,100 new wells; Alternative C proposes 1,250 new wells. As discussed in Section 1.2, modeling analyses were not performed for every NEPA alternative analyzed because there is considerable similarity of modeled air quality components within many proposed alternatives, and due to the additional time and resources required for performing all of the potential analyses. A summary of the modeled Project Alternatives is provided in Table 4.1 that indicates the expected impact ranges for the alternatives that were not modeled.

Maximum field-wide emissions scenarios were determined for each analyzed alternative and reflect the last year of field development, at the maximum WDR, combined with nearly full-field production. An additional field-wide emissions scenario was developed for the Proposed Action assuming only full-field development (i.e., maximum field-wide productions emissions).

Table 4.1 Summary of Modeled Project Alternatives, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

| Alternative | Number of Wells and Type | Modeled (Y/N) | Well Development Rates Modeled (wells/year) | Comments |
|---|---|---|---|---|
| Proposed Action | 395 directional, 2,705 straight[1] | Yes | 0, 250 | Alternative A WDR250 used to approximate the Proposed Action WDR250 scenario |
| Alternative A | 3,100 straight | Yes | 250, 150, 75 | |
| Alternative B | 3,100 directional | Yes | 250, 150, 75 | |
| Alternative C | 1,250 straight | Yes | 250, 150, 75 | |
| Alternative D | 2,200 straight wells | No | -- | Alternative D impacts are expected to fall between Alternative A and Alternative C |
| Alternative E | 2,834 directional, 266 straight[2] | No | -- | Alternative E impacts are expected to fall between Alternative B and Alternative F |
| Alternative F | 2,072 directional, 1,028 straight | Yes | 250, 150, 75 | |
| Alternative G and Preferred Alternative | 547 directional, 2,553 straight | No | - | Alternative G impacts are expected to fall between Alternative A and Alternative F |

1 Modeled as all straight (3,100 wells).
2 Modeled as 50% straight and 50% directional (1,550 straight wells and 1,550 directional wells).

The maximum emissions scenarios conservatively assume that both production emissions (producing wellsites and operational ancillary equipment including compressor stations) and construction emissions (drilling rigs and pit flaring operations) occur simultaneously throughout the year. Anticipated future compression expansions for the Bird Canyon, Falcon, Jonah, and Luman compressor stations were included in the field-wide emissions scenarios. Future compression in the field was assumed to operate at 90% of fully permitted capacity, which Operators indicated was a reasonable assumption based on field operation expectations. The WDR250 case assumed 20 drilling rigs and 3 pit flares operating continuously throughout the year, WDR150 assumed 12 drilling rigs and 2 pit flares, and WDR75 assumed 6 drilling rigs and 1 pit flare.

Development rates considered both straight and directional drilling operations generally consistent with the proposed project alternatives. The Proposed Action, Alternative A, and Alternative C scenarios assume all straight drilling. The Alternative B scenario assumes all directional drilling, and the Alternative F scenarios assume 50% straight drilling and 50% directional drilling. The scenario developed for Alternative A, with WDR250, approximates the Proposed Action.

The maximum field-wide emissions scenarios are summarized in Table 4.2 for the Proposed Action and Alternatives A, B, C, and F. The emissions used to develop these field-wide scenarios are described in Chapter 2.0.

## 4.3 METEOROLOGICAL MODEL INPUT AND OPTIONS

CALMET was used to develop wind fields for the study area shown in Map 1.2. Model domain extent was selected based on available refined mesoscale meteorological model (MM5) data from the SWWYTAF study and the locations of the PSD Class I and sensitive Class II Wilderness areas that were selected for air quality analyses.

Table 4.2 Summary of Maximum Modeled Field-Wide Emissions (tpy), Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.

| Emissions | Maximum Production[8] | Alternative A 3,100 Wells - Straight Drilling | | | Alternative B 3,100 Wells - Directional Drilling | | | Alternative C 1,250 Wells - Straight Drilling | | | Alternative F 3,100 Wells - 50% Straight and 50% Directional Drilling | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WDR250 | WDR250[1] | WDR150 | WDR75 | WDR250 | WDR150 | WDR75 | WDR250 | WDR150 | WDR75 | WDR250 | WDR150 | WDR75 |
| **Production Emissions** | | | | | | | | | | | | | |
| **Wells[2]** | | | | | | | | | | | | | |
| $NO_x$ | 140.6 | 129.2 | 133.8 | 137.2 | 129.2 | 133.8 | 137.2 | 45.3 | 49.9 | 53.3 | 129.2 | 133.8 | 137.2 |
| $SO_2$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $PM_{10}$ | 26.9 | 24.7 | 25.6 | 26.3 | 24.7 | 25.6 | 26.3 | 8.7 | 9.5 | 10.2 | 24.7 | 25.6 | 26.3 |
| $PM_{2.5}$ | 26.9 | 24.7 | 25.6 | 26.3 | 24.7 | 25.6 | 26.3 | 8.7 | 9.5 | 10.2 | 24.7 | 25.6 | 26.3 |
| **Traffic[3]** | | | | | | | | | | | | | |
| $NO_x$ | 26.0 | 23.9 | 24.7 | 25.4 | 23.9 | 24.7 | 25.4 | 8.4 | 9.2 | 9.9 | 23.9 | 24.7 | 25.4 |
| $SO_2$ | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.2 | 0.3 | 0.3 | 0.7 | 0.7 | 0.7 |
| $PM_{10}$ | 709.2 | 652.0 | 674.9 | 692.0 | 652.0 | 674.9 | 692.0 | 228.8 | 251.7 | 268.8 | 652.0 | 674.9 | 692.0 |
| $PM_{2.5}$ | 107.8 | 99.1 | 102.6 | 105.2 | 99.1 | 102.6 | 105.2 | 34.8 | 38.3 | 40.9 | 99.1 | 102.6 | 105.2 |
| **Compression[4]** | | | | | | | | | | | | | |
| $NO_x$ | 211.0 | 211.0 | 211.0 | 211.0 | 211.0 | 211.0 | 211.0 | 211.0 | 211.0 | 211.0 | 211.0 | 211.0 | 211.0 |
| $SO_2$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $PM_{10}$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $PM_{2.5}$ | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Construction Emissions** | | | | | | | | | | | | | |
| **Well Drilling[5]** | | | | | | | | | | | | | |
| $NO_x$ | -- | 843.2 | 505.9 | 252.9 | 1,043.8 | 626.3 | 313.1 | 843.2 | 505.9 | 252.9 | 943.5 | 566.1 | 287.0 |
| $SO_2$ | -- | 27.2 | 16.3 | 8.1 | 33.3 | 20.0 | 10.0 | 27.2 | 16.3 | 8.1 | 30.2 | 18.1 | 9.1 |
| $PM_{10}$ | -- | 47.3 | 28.4 | 14.2 | 58.7 | 35.2 | 17.6 | 47.3 | 28.4 | 14.2 | 53.0 | 31.8 | 16.2 |
| $PM_{2.5}$ | -- | 47.3 | 28.4 | 14.2 | 58.7 | 35.2 | 17.6 | 47.3 | 28.4 | 14.2 | 53.0 | 31.8 | 16.2 |

Table 4.2 (Continued)

| Emissions | Maximum Production[8] | Alternative A 3,100 Wells - Straight Drilling | | | Alternative B 3,100 Wells - Directional Drilling | | | Alternative C 1,250 Wells - Straight Drilling | | | Alternative F 3,100 Wells - 50% Straight and 50% Directional Drilling | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WDR250 | WDR250[1] | WDR150 | WDR75 | WDR250 | WDR150 | WDR75 | WDR250 | WDR150 | WDR75 | WDR250 | WDR150 | WDR75 |
| **Traffic[6]** | | | | | | | | | | | | | |
| $NO_x$ | -- | 13.5 | 8.1 | 4.1 | 13.5 | 8.1 | 4.1 | 13.5 | 8.1 | 4.1 | 13.5 | 8.1 | 4.1 |
| $SO_2$ | -- | 0.4 | 0.2 | 0.1 | 0.4 | 0.2 | 0.1 | 0.4 | 0.2 | 0.1 | 0.4 | 0.2 | 0.1 |
| $PM_{10}$ | -- | 225.1 | 135.1 | 67.5 | 225.1 | 135.1 | 67.5 | 225.1 | 135.1 | 67.5 | 225.1 | 135.1 | 67.5 |
| $PM_{2.5}$ | -- | 34.5 | 20.7 | 10.3 | 34.5 | 20.7 | 10.3 | 34.5 | 20.7 | 10.3 | 34.5 | 20.7 | 10.3 |
| **Flaring[7]** | | | | | | | | | | | | | |
| $NO_x$ | -- | 406.9 | 271.3 | 135.6 | 406.9 | 271.3 | 135.6 | 406.9 | 271.3 | 135.6 | 406.9 | 271.3 | 135.6 |
| $SO_2$ | -- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $PM_{10}$ | -- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| $PM_{2.5}$ | -- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total Emissions** | | | | | | | | | | | | | |
| $NO_x$ | 377.6 | 1,627.7 | 1,154.8 | 766.2 | 1,828.3 | 1,275.2 | 826.4 | 1,528.3 | 1,055.4 | 666.8 | 1,728.0 | 1,214.9 | 800.3 |
| $SO_2$ | 0.7 | 28.3 | 17.2 | 9.0 | 34.4 | 20.9 | 10.8 | 27.8 | 16.8 | 8.5 | 31.3 | 19.1 | 9.9 |
| $PM_{10}$ | 736.1 | 949.1 | 864.0 | 800.0 | 960.5 | 870.8 | 803.4 | 509.9 | 424.7 | 360.7 | 954.8 | 867.4 | 802.0 |
| $PM_{2.5}$ | 134.1 | 205.6 | 177.3 | 156.0 | 217.0 | 184.1 | 159.4 | 125.3 | 96.9 | 75.6 | 211.4 | 180.7 | 158.0 |

1 This scenario approximates the Proposed Action.
2 Includes emissions from indirect heater, separator heater, and dehydrator heater.
3 Includes emissions from all traffic associated with full field production. Emissions calculations assume 20 wells can be visited per day.
4 Includes emissions from the following compressor stations: Bird Canyon, Luman, Falcon, and Jonah, and the Jonah water disposal well engine.
5 Includes emissions from drilling rigs operating continuously during the year. The 20-drilling rig cases (WDR250) assume 10 with Tier 1 emissions levels, and 10 with Tier 2 emissions levels; the 12-rig cases (WDR150) assume 6 each, with Tier 1 and Tier 2 emissions levels; and the 6-rig cases (WDR75) assume 3 each, with Tier 1 and Tier 2 levels. Further, under Alternative F, the 20-drilling rig 50% straight/50% directional cases assume 5 directional Tier 1, 5 directional Tier 2, 5 straight Tier 1, and 5 straight Tier 2; the 12-drilling rig cases assume 3 directional Tier 1, 3 directional Tier 2, 3 straight Tier 1, and 3 straight Tier 2; and the 6-drilling rig cases assume 2 directional Tier 1, 2 directional Tier 2, 1 straight Tier 1, and 1 straight Tier 2.
6 Includes emissions from all traffic associated with 20, 12, and 6 simultaneous drilling operations.
7 Includes emissions from 3, 2, and 1 "completion/testing" flares operating continuously during the year.
8 Includes production emissions only.

The modeling domain was processed to a uniform horizontal grid using 4-km resolution, based on a Lambert Conformal Projection defined with a central longitude/latitude at (-108.55°/42.55°) and first and second latitude parallels at 30° and 60°. The modeling grid consisted of 116 x 112 4-km grid cells that cover the Project area and all analyzed Class I and sensitive Class II areas. The total area of the modeling domain is 288 x 278 mi (464 x 448 km). Ten vertical layers were used, with heights of 20, 40, 100, 140, 320, 580, 1,020, 1,480, 2,220, and 2,980 m.

The CALMET analysis utilized the MM5 data, (which was processed at a 20-km horizontal grid spacing), data from 55 surface meteorological stations and 155 precipitation stations, and four upper air meteorological stations to supplement MM5 upper air estimates. USGS 1:250,000-Scale Land Use and Land Cover (LULC) data, and USGS 1º DEM data were used for land use and terrain data in the development of the CALMET wind fields. Listings of the surface and upper air meteorological stations, and the precipitation stations that were used in this analysis are provided in Appendix E. The CALMET model was run following control switch settings that were developed as part of SWWYTAF to develop the one-year (1995) wind field data set.

The modeling domain extended as far north as possible given the available refined MM5 data. The IWAQM guidance for CALMET/CALPUFF recommends that the horizontal domain of the model grid extend 50 to 80 km beyond the receptors and sources being modeled, for modeling potential recirculation wind flow effects. Because the area of Yellowstone National Park included in the modeling is along the boundary of the modeling domain, and the northern portions of Grand Teton National Park, and the Teton and Washakie Wilderness Areas are less than 50 km from the modeling grid boundary, the recirculation wind patterns may not be completely resolved by CALMET in those areas. However, because the direct wind flow patterns that could transport potential Project and regional source emissions to these areas are fully characterized in the modeling domain, any potential impacts from Project sources in these areas would be fully captured.

## 4.4 DISPERSION MODEL INPUT AND OPTIONS

The CALPUFF model was used to model Project-specific and regional emissions of $NO_x$, $SO_2$, $PM_{10}$, and $PM_{2.5}$. CALPUFF was run using the IWAQM-recommended default control file switch settings for all parameters. Chemical transformations were modeled based on the MESOPUFF II chemistry mechanism for conversion of $SO_2$ to sulfate ($SO_4$) and $NO_x$ to nitric acid ($HNO_3$) and nitrate ($NO_3$). Each of these pollutant species was included in the CALPUFF model runs. $NO_x$, $HNO_3$, and $SO_2$ were modeled with gaseous deposition, and $SO_4$, $NO_3$, $PM_{10}$, and $PM_{2.5}$ were modeled using particle deposition. The $PM_{10}$ emissions input to CALPUFF included only the $PM_{10}$ emissions greater than the $PM_{2.5}$ (i.e., modeled $PM_{10}$ = $PM_{10}$ emission rate – $PM_{2.5}$ emission rate). Total $PM_{10}$ impacts were determined in the post-processing of modeled impacts, as discussed in Section 4.5.

### 4.4.1 Chemical Species

The CALPUFF chemistry algorithms require hourly estimates of background $O_3$ and ammonia ($NH_3$) concentrations for the conversion of $SO_2$ and NO/$NO_2$ to sulfates and nitrates, respectively. Background $O_3$ data, for the meteorology 1995 modeling year, were available for six stations within the modeling domain:

- Pinedale, Wyoming,
- Centennial, Wyoming,
- Yellowstone National Park, Wyoming,
- Craters of the Moon National Park, Idaho,
- Highland, Utah, and
- Mount Zirkel Visibility Study, Hayden, Colorado.

Hourly $O_3$ data from these stations was used in the CALPUFF modeling, with a default value of 44.7 parts per billion (ppb) (7 a.m.-7 p.m. mean) used for missing hours. A background $NH_3$ concentration of 1.0 ppb was used as suggested in the IWAQM guidance for arid lands.

### 4.4.2 Model Receptors

Input to CALPUFF were model receptors at which the concentration, deposition, and AQRV impacts were calculated. Receptors were placed along the boundaries of all Class I and other sensitive areas at 2-km spacing, and within the boundaries of these areas on a 4-km Cartesian grid. Discrete receptors were placed on a Cartesian grid at 1-km spacing within the JIDPA. Individual receptor points were determined for each of the seven acid-sensitive lakes. Grids of at least 3 x 3 1-km spaced receptors were used for modeling each of the mid-field Wyoming communities. Receptor elevations for all sensitive Class I and Class II areas were determined from 1:250,000 scale USGS DEM data. Elevations for the sensitive lake receptors were derived from 7.5-minute USGS topographical maps. All model receptors utilized in the mid-field and far-field analyses are shown in Figures 4.1 and 4.2.

### 4.4.3 Source Parameters

CALPUFF source parameters were determined for all Project and regional source emissions of $NO_x$, $SO_2$, $PM_{10}$, and $PM_{2.5}$. Project sources were input to CALPUFF using point sources to idealize compressor stations, drilling rigs, pit flares, and water disposal well engines. Additionally, 148 1-$km^2$ area sources at 1-km spacing were placed throughout the JIDPA to idealize well site heater, vehicle traffic, and wind erosion emissions. Locations of Jonah Field compressor stations with anticipated future expansions are shown in Figure 4.3. Compressor station emissions and modeled parameters are provided in Appendix D. Parameters used in modeling the drilling rigs, pit flares, water disposal well, and wind erosion are given in Appendix B and illustrated in Figure 4.4. Field-wide emissions from well heaters and traffic for each analyzed Project alternative are summarized in Section 4.2. Monthly emissions scalars were used to adjust the heater emissions for seasonal variations.

Non-project regional emissions were input to CALPUFF using area sources to idealize non-compression RFD sources and county-wide well sites, and point sources to idealize state-permitted sources, RFD compression sources, and RFFA. The source parameters used in

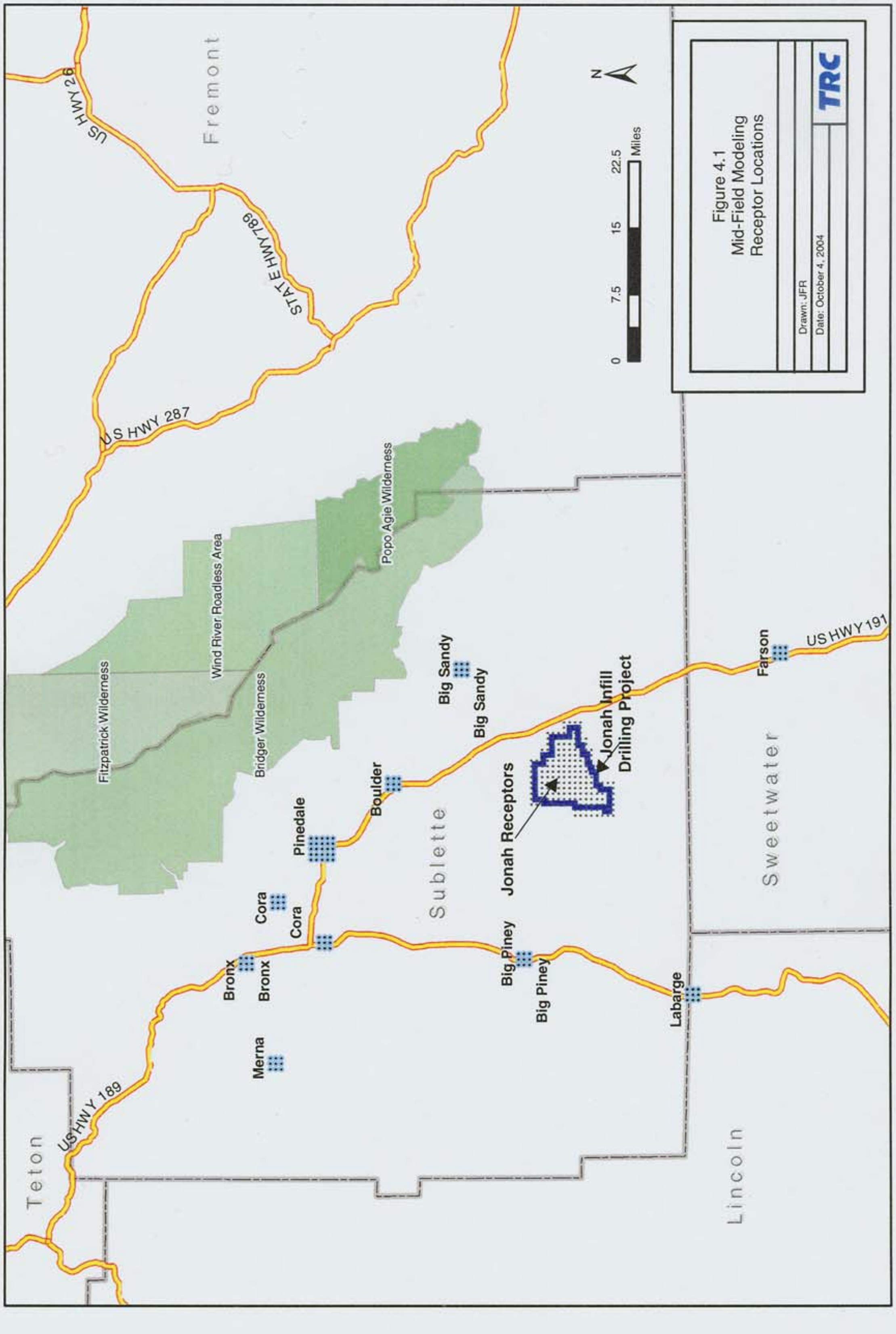


Figure 4.1 Mid-field Modeling Receptor Locations.

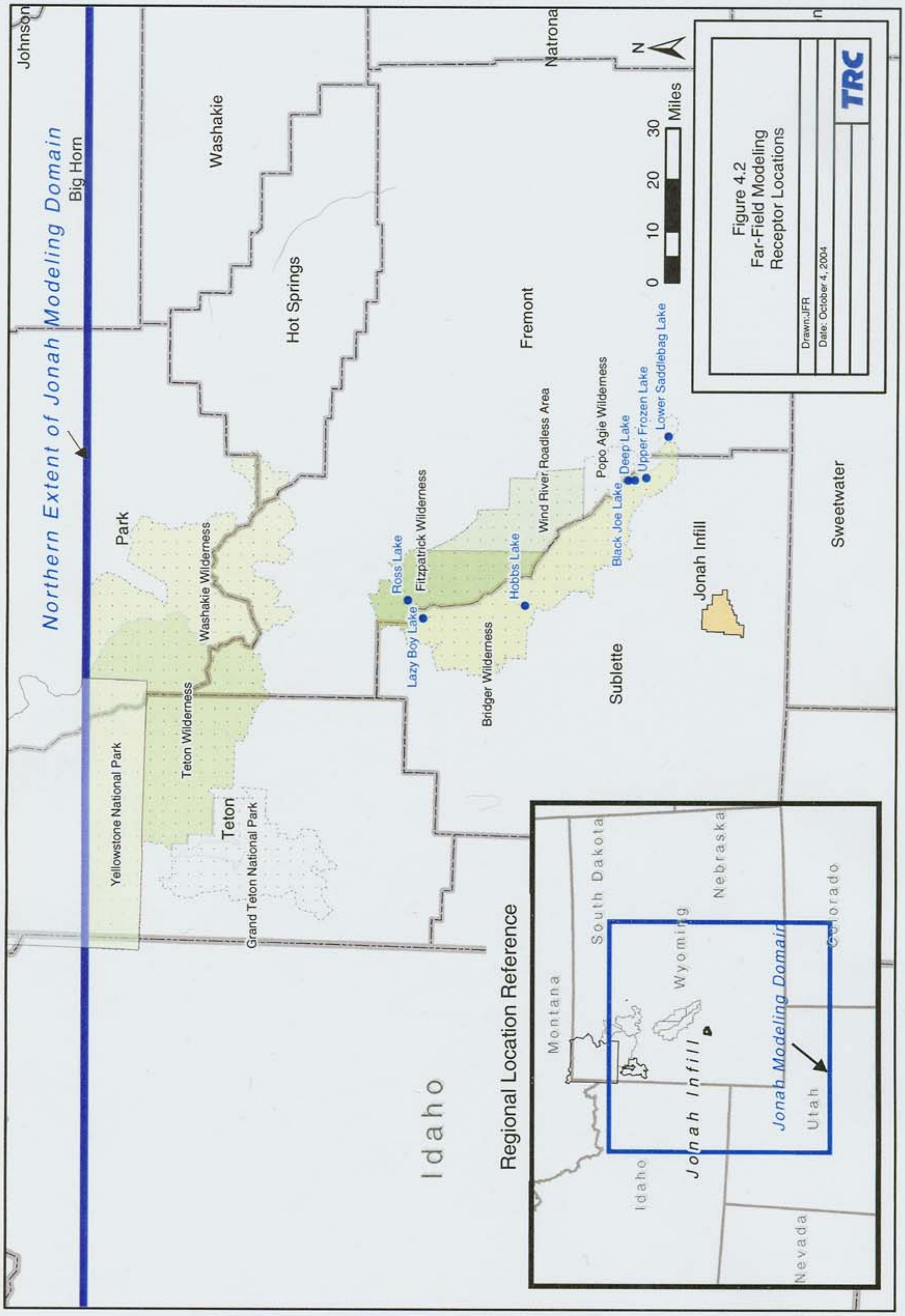


Figure 4.2 Far-field Modeling Receptor Locations.

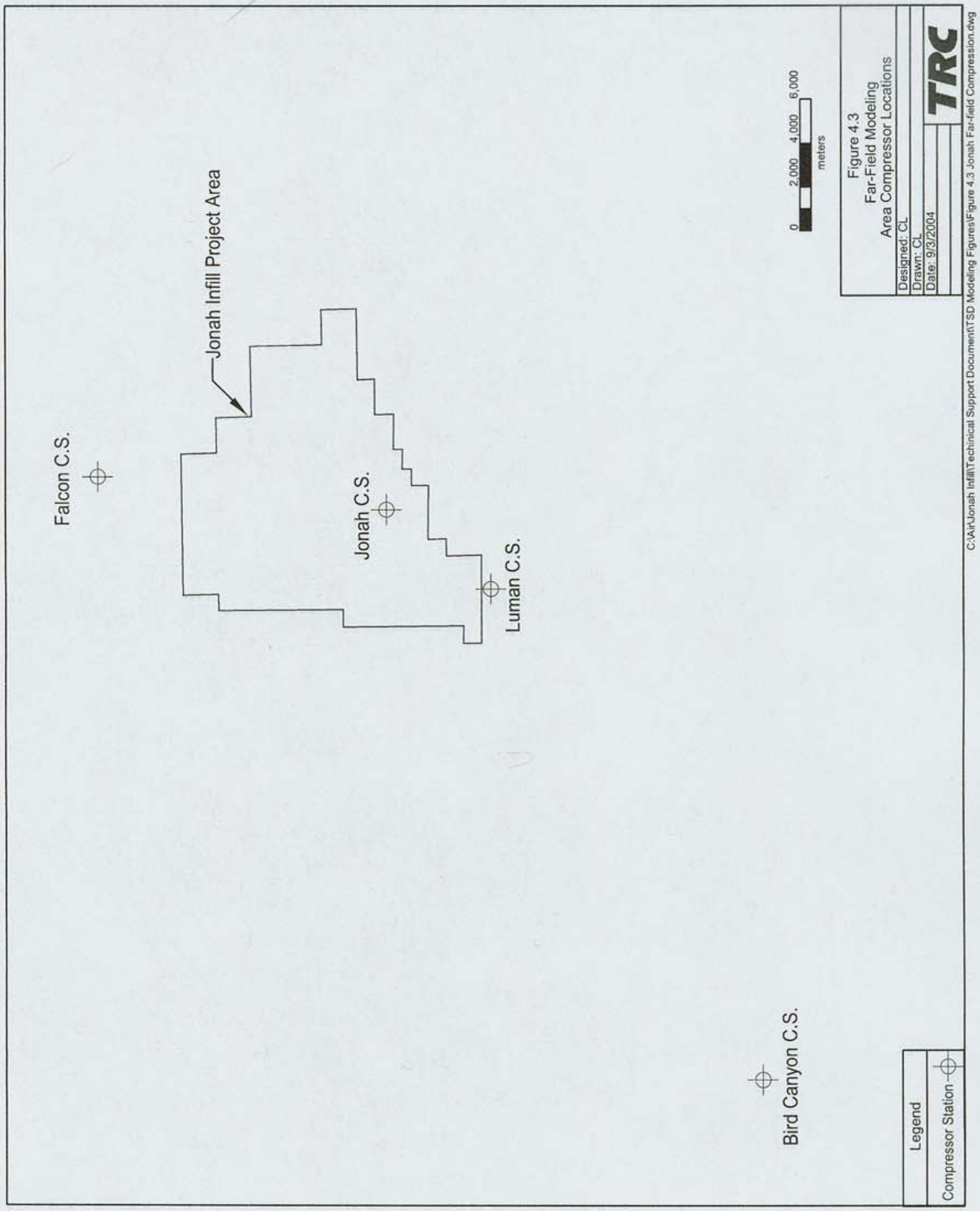


Figure 4.3 Far-field Modeling Area Compressor Locations.

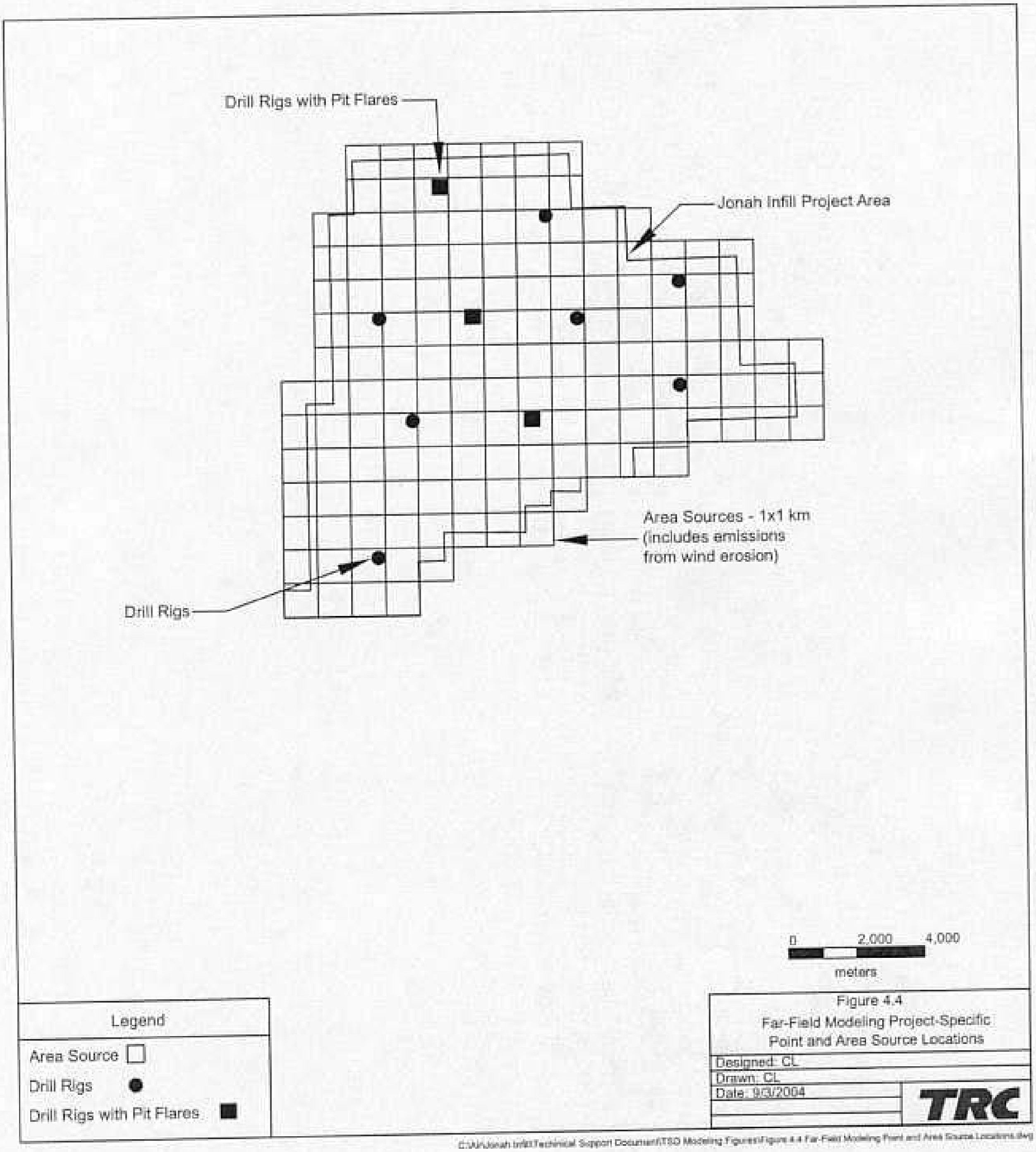


Figure 4.4 Far-field Modeling Project-Specific Point and Area Source Locations.

modeling all state-permitted and RFFA sources are provided in Appendix C. Non-compression RFD emissions were modeled using area sources developed for each proposed field development as a "best fit" to the respective project area. The area sources developed for each RFD project are shown in Figure 4.5. County-wide well emissions were modeled using area sources developed as a best fit to the respective county area. The area sources used to model county-wide well site emissions are shown in Figure 4.6. Seasonal emission-rate adjustment factors were applied to emissions from well site heaters to account for seasonal variations in heater use. Source elevations for all RFD and county-wide area sources were determined from 1:250,000 scale USGS DEM data.

## 4.5 BACKGROUND DATA

### 4.5.1 Criteria Pollutants

Ambient air concentration data collected at monitoring sites in the region provide a measure of the background conditions during the most recent available time period. Regional monitoring-based background values for criteria pollutants ($PM_{10}$, $PM_{2.5}$, $NO_2$, and $SO_2$) were collected at monitoring sites in Wyoming and northwestern Colorado, and are summarized in Table 4.3. Although $O_3$ is also a criteria pollutant, it is not utilized in the far-field modeling as a background concentration and is therefore excluded from this table. These ambient air background concentrations were added to modeled pollutant concentrations (expressed in $\mu g/m^3$) to arrive at total ambient air quality impacts for comparison to NAAQS and WAAQS.

### 4.5.2 Visibility

Background visibility data representative of the study area were collected from IMPROVE monitoring sites located at Yellowstone National Park and the Bridger Wilderness Area (Table 4.4). Background visibility data were used in combination with modeled pollutant impacts to estimate change in visibility conditions (measured as change in light extinction). The IMPROVE background visibility data are provided as reconstructed aerosol total extinction data,

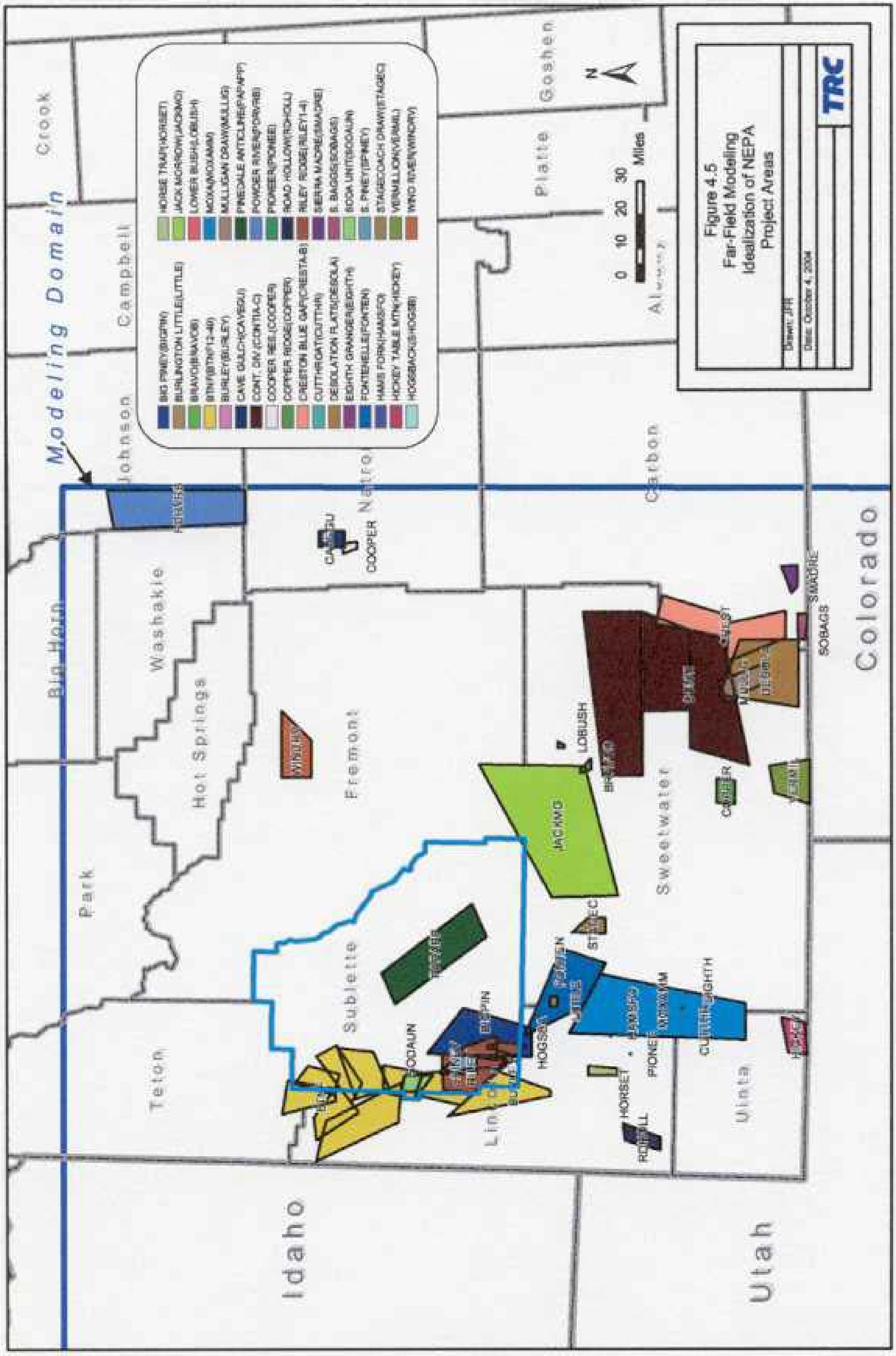


Figure 4.5 Far-field Modeling Idealization of NEPA Project Areas.

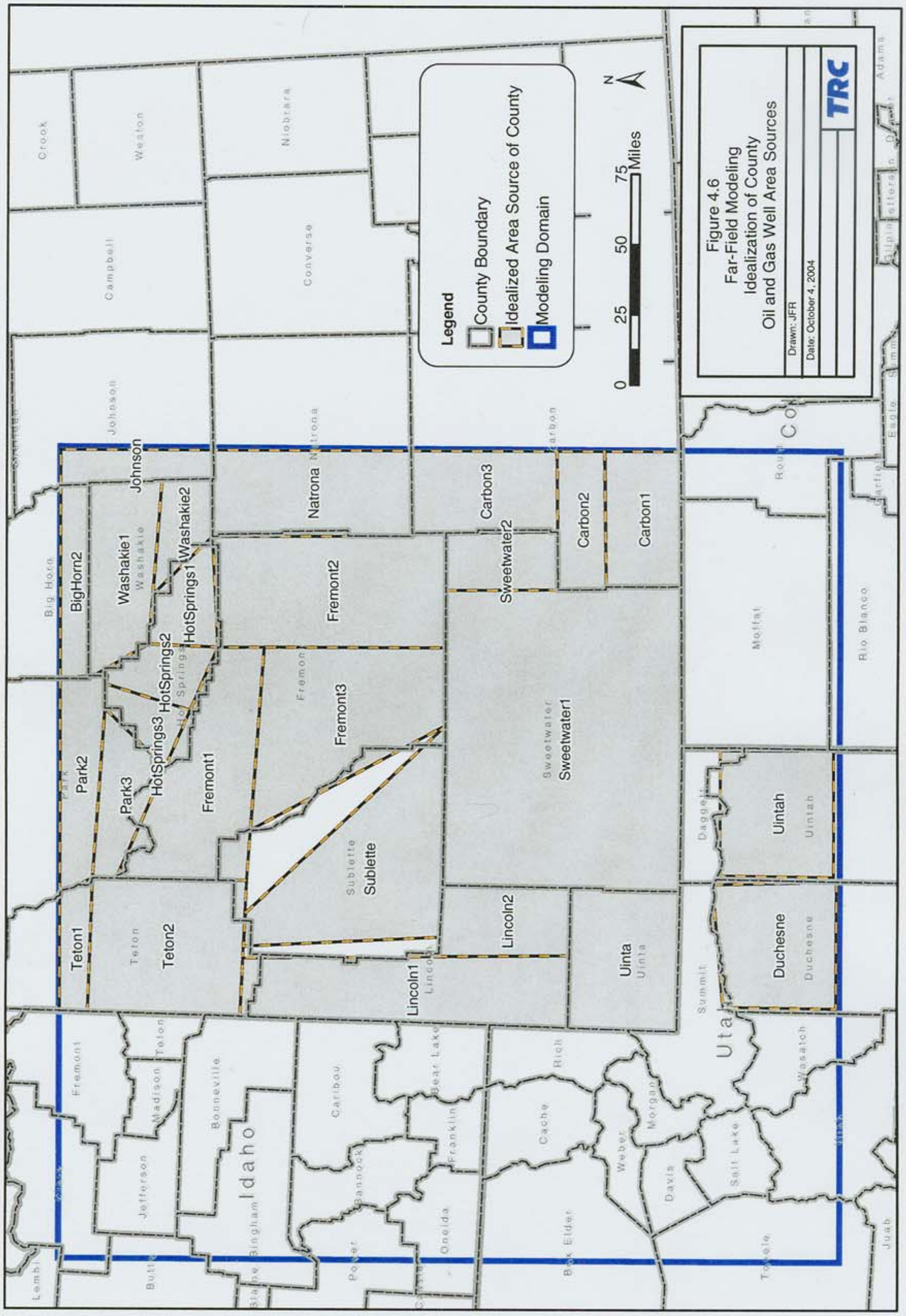


Figure 4.6 Far-field Modeling Idealization of County Oil and Gas Well Area Sources.

Table 4.3 Far-field Analysis Background of Ambient Air Quality Concentrations (μg/m$^3$).

| Pollutant | Averaging Period | Measured Background Concentration |
|---|---|---|
| $NO_2$[1] | Annual | 3.4 |
| $PM_{10}$[2] | 24-hour | 33 |
| | Annual | 16 |
| $PM_{2.5}$[2] | 24-hour | 13 |
| | Annual | 5 |
| $SO_2$[3] | 3-hour | 132 |
| | 24-hour | 43 |
| | Annual | 9 |

1 Data collected at Green River Basin Visibility Study site, Green River, Wyoming during period January-December 2001 (ARS 2002).
2 Data collected by WDEQ-AQD at Emerson Building, Cheyenne, Wyoming, Year 2001.
3 Data collected at LaBarge Study Area at the Northwest Pipeline Craven Creek Site 1982-1983.

Table 4.4 IMPROVE Background Aerosol Extinction Values.[1]

| IMPROVE Site | Quarter | Hygroscopic ($Mm^{-1}$)[2] | Non-hygroscopic ($Mm^{-1}$)[2] | Monitoring Period |
|---|---|---|---|---|
| Bridger Wilderness Area | 1 | 0.845 | 1.666 | 1989-2002 |
| | 2 | 1.730 | 3.800 | 1988-2002 |
| | 3 | 1.902 | 5.637 | 1988-2002 |
| | 4 | 0.915 | 2.035 | 1988-2002 |
| Yellowstone National Park | 1 | 1.126 | 2.973 | 1988-2002 |
| | 2 | 1.502 | 4.531 | 1988-2002 |
| | 3 | 1.811 | 7.330 | 1988-2002 |
| | 4 | 1.033 | 2.990 | 1988-2002 |

1 Cooperative Institute for Research in the Atmosphere (2003).
2 $Mm^{-1}$ = inverse megameters.

based on the quarterly mean of the 20% cleanest days measured at the Bridger Wilderness Area and Yellowstone National Park IMPROVE sites for the historical monitoring period of record through December 2002.

### 4.5.3 Lake Chemistry

The most recent lake chemistry background acid neutralizing capacity (ANC) data were obtained for each sensitive lake included in the analysis. The 10th percentile lowest ANC values were calculated for each lake following procedures provided by the USDA Forest Service. These ANC values and the number of samples used in the calculation of the 10$^{th}$ percentile lowest ANC values are provided in Table 4.5.

## 4.6 IMPACT ASSESSMENT

CALPUFF modeling was performed to compute direct Project impacts for each of the analyzed alternatives and for estimating cumulative impacts from potential Project and regional sources. The analyzed alternatives, as described in Section 4.2, included the Proposed Action, and Alternatives A, B, C, and F. Maximum emissions scenarios for each alternative included the last

Table 4.5 Background ANC Values for Acid Sensitive Lakes.

| Wilderness Area | Lake | Latitude (Deg-Min-Sec) | Longitude (Deg-Min-Sec) | 10th Percentile Lowest ANC Value (μeq/l) | Number of Samples | Monitoring Period |
|---|---|---|---|---|---|---|
| Bridger | Black Joe | 42º44'22" | 109º10'16" | 67.0 | 61 | 1984-2003 |
| Bridger | Deep | 42º43'10" | 109º10'15" | 59.9 | 58 | 1984-2003 |
| Bridger | Hobbs | 43º02'08" | 109º40'20" | 69.9 | 65 | 1984-2003 |
| Bridger | Lazy Boy | 43º19'57" | 109º43'47" | 18.8 | 1 | 1997 |
| Bridger | Upper Frozen | 42º41'13" | 109º09'39" | 5.0 | 6 | 1997-2003 |
| Fitzpatrick | Ross | 43º22'41" | 109º39'30" | 53.5 | 44 | 1988-2003 |
| Popo Agie | Lower Saddlebag | 42º37'24" | 108º59'38" | 55.5 | 43 | 1989-2003 |

year of field development, at the maximum annual construction activity rate, combined with nearly full-field production. Three well development rates (WDR250, WDR150, and WDR75), were analyzed. An additional full-field development emissions scenario was developed for the Proposed Action assuming maximum production emissions. Regional emissions inventories of existing state-permitted RFD and RFFA sources, as described in Chapter 2.0, were modeled alone to estimate cumulative impacts for the No Action Alternative. These regional inventories were modeled in combination with Project alternatives to provide cumulative impact estimates for each alternative. A total of 27 modeling scenarios were evaluated in this analysis. A list of these scenarios is summarized in Table 4.6.

For each far-field sensitive area, CALPUFF-modeled concentration impacts were post-processed with POSTUTIL and CALPOST to derive: 1) concentrations for comparison to ambient air quality standards (WAAQS and NAAQS), PSD Class I significance thresholds, and PSD Class I and II Increments; 2) deposition rates for comparison to sulfur (S) and nitrogen (N) deposition levels of concern and to calculate changes to ANC at sensitive lakes; and 3) light extinction changes for comparison to visibility impact thresholds. For the mid-field analyses, CALPOST concentrations were post-processed to estimate light extinction changes at regional communities for comparison to the visibility impact thresholds. For in-field locations, CALPUFF concentrations were post-processed to compute maximum concentration impacts for comparison to WAAQS and NAAQS.

### 4.6.1 Concentration

The CALPOST and POSTUTIL post-processors were used to summarize concentration impacts of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ at PSD Class I and sensitive PSD Class II areas, and at in-field locations. Predicted impacts are compared to applicable ambient air quality standards, PSD Class I and Class II increments, and significance levels as shown in Table 4.7.

Table 4.6 Modeling Scenarios Analyzed for Project Alternative and Regional Emissions, Jonah Infill Drilling Project, Sublette County, Wyoming, 2004.[1]

| Modeling Scenario | Source Impacts Evaluated | Project Alternative | Number of New Wells in Production | Number of Wells under Construction | Well Drilling Rig Type |
|---|---|---|---|---|---|
| 1 | Direct Project | Proposed Action | 3,100 | 0 | -- |
| 2 | Direct Project | Proposed Action and Alternative A | 2,850 | 250/year | Straight |
| 3 | Direct Project | Alternative A | 2,950 | 150/year | Straight |
| 4 | Direct Project | Alternative A | 3,025 | 75/year | Straight |
| 5 | Direct Project | Alternative B | 2,850 | 250/year | Directional |
| 6 | Direct Project | Alternative B | 2,950 | 150/year | Directional |
| 7 | Direct Project | Alternative B | 3,025 | 75/year | Directional |
| 8 | Direct Project | Alternative C | 1,000 | 250/year | Straight |
| 9 | Direct Project | Alternative C | 1,100 | 150/year | Straight |
| 10 | Direct Project | Alternative C | 1,175 | 75/year | Straight |
| 11 | Direct Project | Alternative F | 2,850 | 250/year | 50% Straight/ 50% Directional |
| 12 | Direct Project | Alternative F | 2,950 | 150/year | 50% Straight/ 50% Directional |
| 13 | Direct Project | Alternative F | 3,025 | 75/year | 50% Straight/ 50% Directional |
| 14 | Cumulative | No Action[1] | 0 | 0 | -- |
| 15 | Cumulative | Proposed Action | 3,100 | 0 | -- |
| 16 | Cumulative | Proposed Action and Alternative A | 2,850 | 250/year | Straight |
| 17 | Cumulative | Alternative A | 2,950 | 150/year | Straight |
| 18 | Cumulative | Alternative A | 3,025 | 75/year | Straight |
| 19 | Cumulative | Alternative B | 2,850 | 250/year | Directional |
| 20 | Cumulative | Alternative B | 2,950 | 150/year | Directional |
| 21 | Cumulative | Alternative B | 3,025 | 75/year | Directional |
| 22 | Cumulative | Alternative C | 1,000 | 250/year | Straight |
| 23 | Cumulative | Alternative C | 1,100 | 150/year | Straight |
| 24 | Cumulative | Alternative C | 1,175 | 75/year | Straight |
| 25 | Cumulative | Alternative F | 2,850 | 250/year | 50% Straight/ 50% Directional |
| 26 | Cumulative | Alternative F | 2,950 | 150/year | 50% Straight/ 50% Directional |
| 27 | Cumulative | Alternative F | 3,025 | 75/year | 50% Straight/ 50% Directional |

[1] Includes 198 wells in Jonah Field which began production after 2001 as RFD.

Table 4.7 NAAQS, WAAQS, PSD Class I and Class II Increments, and PSD Class I and Class II Significance Levels for Comparison to Far-field Analysis Results (μg/m$^3$).

| Pollutant/Averaging Time | NAAQS | WAAQS | PSD Class I Increment | PSD Class II Increment | PSD Class I Significance Level[1] | PSD Class II Significance Level |
|---|---|---|---|---|---|---|
| **$NO_2$** | | | | | | |
| Annual[2] | 100 | 100 | 2.5 | 25 | 0.1 | 1.0 |
| **$SO_2$** | | | | | | |
| 3-hour[3] | 1,300 | 1,300 | 25 | 512 | 1.0 | 25.0 |
| 24-hour[3] | 365 | 260 | 5 | 91 | 0.2 | 5.0 |
| Annual[2] | 80 | 60 | 2 | 20 | 0.1 | 1.0 |
| **$PM_{10}$** | | | | | | |
| 24-hour[3] | 150 | 150 | 8 | 30 | 0.3 | 5.0 |
| Annual[2] | 50 | 50 | 4 | 17 | 0.2 | 1.0 |
| **$PM_{2.5}$** | | | | | | |
| 24-hour[4] | 65 | 65 | -- | -- | -- | -- |
| Annual [4] | 15 | 15 | -- | -- | -- | -- |

1 Proposed Class I significance levels from 61 *Federal Register* 142, pg. 38292, July 23, 1996.
2 Annual arithmetic mean.
3 No more than one exceedance per year is allowed.
4 Standard not yet enforced in Wyoming; -- = no current or proposed value.

$PM_{10}$ concentrations were computed by adding predicted CALPUFF concentrations of $PM_{10}$ (fraction of PM greater than $PM_{2.5}$), $PM_{2.5}$, $SO_4$, and $NO_3$. $PM_{2.5}$ concentrations were calculated as the sum of modeled $PM_{2.5}$, $SO_4$, and $NO_3$ concentrations. In post-processing the $PM_{10}$ impacts at all far-field receptor locations, Project alternative traffic emissions of $PM_{10}$ (production and construction) were not included in the total estimated impacts, only the $PM_{2.5}$ impacts were considered. This assumption was based on supporting documentation from the Western Regional Air Partnership (WRAP) analyses of mechanically generated fugitive dust emissions that suggest that particles larger than $PM_{2.5}$ tend to deposit out rapidly near the emissions source and do not transport over long distances (Countess et al. 2001). This phenomenon is not modeled adequately in CALPUFF; therefore, to avoid overestimates of $PM_{10}$ impacts at far-field locations, these sources were not considered in the total modeled impacts. However, the total $PM_{10}$ impacts from traffic emissions were included in all in-field concentration estimates.

Far-field Results

The maximum predicted concentrations of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ at each of the analyzed PSD Class I and sensitive Class II areas, for each of the 27 modeled direct Project alternatives and cumulative source scenarios, are provided in Appendix F. Predicted direct impacts are compared to applicable PSD Class I and Class II increments and significance levels, then added to representative background pollutant concentrations (see Table 4.3), the total concentration is compared to applicable NAAQS and WAAQS. Cumulative impacts from all analyzed alternatives are compared directly to applicable PSD Class I and Class II increments, and to the NAAQS and WAAQS when background pollutant concentrations are added. Tables F.1.1-F.1.27 provide the maximum modeled $NO_2$ concentrations at each of the sensitive areas. The maximum modeled $SO_2$ concentrations are provided in Tables F.2.1-F.2.27, and the maximum modeled $PM_{10}$ and $PM_{2.5}$ impacts are provided in Tables F.3.1-F.3.27, and Tables F.4.1-F.4.27, respectively. Summaries of results by alternative for $NO_x$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ are provided in Tables F.10.1-F10.2, F.10.3-F.10.4, F.10.5-F.10.6, and F.10.7-F.10.8, respectively.

The modeling results indicate that neither direct Project impacts nor cumulative source impacts would exceed any ambient air quality standards (WAAQS and NAAQS) or PSD Increment (see Tables F.1.1-F.4.27). Direct Project $NO_2$ impacts at the Bridger Class I Wilderness Area are above the proposed PSD Class I significance level of 0.1 $\mu g/m^3$ for $NO_2$. A direct Project maximum $NO_2$ concentration of 0.15 $\mu g/m^3$ is predicted under Alternative B (see Table F.1.5). In addition, direct Project impacts of 24-hour $PM_{10}$, concentrations are above the proposed Class I significance level of 0.3 $\mu g/m^3$ under each alternative, with a maximum of 1.70 $\mu g/m^3$ predicted under Alternative B WDR250 (see Table F.3.5).

In-Field Results

The maximum predicted concentrations of $NO_2$, $SO_2$, $PM_{10}$, and $PM_{2.5}$ within and nearby the JIDPA, for each of the 27 modeled direct Project and cumulative scenarios are provided in Appendix F, Tables F.5.1 - F.5.27. A summary of results by alternative is provided in Tables F.10.9 - F.10.10. Predicted direct Project and cumulative impacts are added to representative background pollutant concentrations and are compared to applicable NAAQS and WAAQS. As shown in Tables F.5.1 - F.5.27, there would be no exceedances of the NAAQS or WAAQS within and nearby the JIDPA from field-wide Project sources or cumulative sources. This analysis further supports the compliance demonstrations shown in Section 3.4 for maximum near-field impacts.

### 4.6.2 Deposition

Maximum predicted S and N deposition impacts were estimated for each analyzed Project alternative and cumulative source scenario. The POSTUTIL utility was used to estimate total S and N fluxes from CALPUFF predicted wet and dry fluxes of $SO_2$, $SO_4$, $NO_x$, $NO_3$, and $HNO_3$. CALPOST was then used to summarize the annual S and N deposition values from the POSTUTIL program. Predicted direct Project impacts were compared to the NPS deposition analysis thresholds (DATs) for total N and S deposition in the western U.S., which are defined as 0.005 kilograms per hectare per year (kg/ha-year) for both N and S. Cumulative deposition impacts from Project alternative and regional sources were compared to USDA Forest Service levels of concern, defined as 5 kg/ha-yr for S and 3 kg/ha-yr for N (Fox et al. 1989) below which no adverse impacts from acid deposition are likely.

The maximum predicted N and S deposition impacts for each of the analyzed alternatives are provided in Appendix F, Tables F.6.1 – F.6.4. A summary of results by alternative is provided in Tables F.10.11 - F.10.14. Modeling results for Project sources under each Alternative indicate that there would be no direct project S deposition impacts above the DAT, and that all cumulative N and S deposition impacts would be well below the cumulative analysis levels of concern. Modeling results do indicate that there could be direct project N deposition impacts at the Bridger and Fitzpatrick Class I Wilderness Areas, and at the Wind River Roadless

Area that are above the DAT under each Project alternative (see Table F.6.1). The maximum predicted nitrogen deposition impacts occurred under Alternative B and are 0.04, 0.02, and 0.01 kg/ha-yr, at Bridger and Fitzpatrick Wilderness Areas, and at the Wind River Roadless Area, respectively (see Table F.6.1).

### 4.6.3 Sensitive Lakes

The CALPUFF-predicted annual deposition fluxes of S and N at sensitive lake receptors listed in Section 4.2.3 were used to estimate the change in ANC. The change in ANC was calculated following the January 2000, USDA Forest Service Rocky Mountain Region's *Screening Methodology for Calculating ANC Change to High Elevation Lakes, User's Guide* (USDA Forest Service 2000). The predicted changes in ANC are compared with the USDA Forest Service's Level of Acceptable Change (LAC) thresholds of 10% for lakes with ANC values greater than 25 microequivalents per liter (ìeq/l) and 1 ìeq/l for lakes with background ANC values of 25 ìeq/l or less. Of the seven lakes listed in Table 4.5 and identified by the USDA Forest Service as acid sensitive, Upper Frozen and Lazy Boy lakes are considered extremely acid sensitive.

ANC calculations were performed for each of the analyzed Project alternative and cumulative source scenarios, with the results presented in Appendix F, Tables F.7.1 – F.7.27. A summary of results by alternative is provided in Tables F.10.15 - F.10.16. The modeling results indicate that deposition impacts from direct Project and cumulative emissions would not exceed the LAC threshold for ANC at any of the sensitive lakes.

### 4.6.4 Visibility

The CALPUFF model-predicted concentration impacts at far-field PSD Class I and sensitive Class II areas and at mid-field regional community locations were post-processed with CALPOST to estimate potential impacts to visibility (regional haze) for each analyzed alternative and cumulative source scenario for comparison to visibility impact thresholds. CALPOST estimated visibility impacts from predicted concentrations of $PM_{10}$, $PM_{2.5}$, $SO_4$, and $NO_3$.

$PM_{10}$ emissions from Project traffic emissions were not included in the total estimated impacts (see Section 4.6.1), only the impacts to visibility from $PM_{2.5}$ were considered.

Visibility impairment calculations were performed using estimated natural background visibility conditions obtained from FLAG (2000) (FLAG method) and measured background visibility conditions from the Bridger Wilderness Area and Yellowstone National Park IMPROVE sites (IMPROVE method). IMPROVE-method data are based on the quarterly mean of the 20% cleanest days as shown in Table 4.4. The IMPROVE background visibility data are provided as reconstructed aerosol total extinction data, based on the quarterly mean of the 20% cleanest days measured at the Bridger Wilderness Area and Yellowstone National Park IMPROVE sites for the historical monitoring period of record through December 2002.

For the FLAG method, estimated natural background visibility values as provided in Appendix 2.B of FLAG (2000), and monthly relative humidity factors as provided in the *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule* (EPA 2003b) were used. The natural background visibility data used with the FLAG visibility analysis for each area analyzed are shown in Table 4.8.

The IMPROVE method used the measured background conditions at the Bridger Wilderness Area and at the Yellowstone National Park site, and the monthly relative humidity factors as provided in EPA (2003b). Visibility data from the Bridger Wilderness Area IMPROVE site were used for the Bridger, Fitzpatrick, and Popo Agie Wilderness Areas and for the Wind River Roadless Area, and visibility data from the Yellowstone National Park IMPROVE site were used for the Teton and Washakie Wilderness Areas and for Grand Teton and Yellowstone National Parks.

Background visibility data monitored at the Bridger Class I Wilderness Area IMPROVE site, an area more pristine than populated residential areas, were used to estimate potential visibility impairment at the regional community locations.

Table 4.8 FLAG Report Background Extinction Values.[1]

| Site | Season | Hygroscopic $(Mm^{-1})^2$ | Non-hygroscopic $(Mm^{-1})^2$ |
|---|---|---|---|
| Bridger Wilderness Area[3] | Winter | 0.6 | 4.5 |
| | Spring | 0.6 | 4.5 |
| | Summer | 0.6 | 4.5 |
| | Fall | 0.6 | 4.5 |
| Fitzpatrick Wilderness Area | Winter | 0.6 | 4.5 |
| | Spring | 0.6 | 4.5 |
| | Summer | 0.6 | 4.5 |
| | Fall | 0.6 | 4.5 |
| Teton Wilderness Area | Winter | 0.6 | 4.5 |
| | Spring | 0.6 | 4.5 |
| | Summer | 0.6 | 4.5 |
| | Fall | 0.6 | 4.5 |
| Washakie Wilderness Area | Winter | 0.6 | 4.5 |
| | Spring | 0.6 | 4.5 |
| | Summer | 0.6 | 4.5 |
| | Fall | 0.6 | 4.5 |
| Grand Teton National Park | Winter | 0.6 | 4.5 |
| | Spring | 0.6 | 4.5 |
| | Summer | 0.6 | 4.5 |
| | Fall | 0.6 | 4.5 |
| Yellowstone National Park | Winter | 0.6 | 4.5 |
| | Spring | 0.6 | 4.5 |
| | Summer | 0.6 | 4.5 |
| | Fall | 0.6 | 4.5 |

1 FLAG (2000).
2 $Mm^{-1}$ = inverse megameters
3 Also used for Popo Agie Wilderness, Wind River Roadless Area, and regional communities.

As recommended in EPA (2003b), monthly relative humidity factors determined from the Bridger IMPROVE site were used for the Bridger and Fitzpatrick Wilderness Areas; Yellowstone IMPROVE data were used for Yellowstone and Grand Teton National Parks and for the Teton Wilderness Area; and North Absaroka IMPROVE data were used for the Washakie Wilderness Area. Relative humidity data for the Bridger site were also used for the Popo Agie Wilderness Area and for the Wind River Roadless Area. Table 4.9 provides the relative humidity factors (f[RH]) that were used in the analyses.

Change in atmospheric light extinction relative to background conditions is used to measure regional haze. Analysis thresholds for atmospheric light extinction are set forth in FLAG (2000), with the results reported in percent change in light extinction and change in deciview (dv). The thresholds are defined as 5% and 10% of the reference background visibility or 0.5 and 1.0 dv for Project sources alone and cumulative source impacts, respectively. The BLM considers a 1.0 dv

Table 4.9 Monthly f(RH) Factors from Regional Haze Rule Guidance.

| IMPROVE Site | Quarter | Months | f(RH) Values |
|---|---|---|---|
| Bridger Wilderness Area[1] | 1 | Jan, Feb, Mar | 2.5, 2.3, 2.3 |
| | 2 | Apr, May, Jun | 2.1, 2.1, 1.8 |
| | 3 | Jul, Aug, Sep | 1.5, 1.5, 1.8 |
| | 4 | Oct, Nov, Dec | 2.0, 2.5, 2.4 |
| North Absaroka Wilderness Area[2] | 1 | Jan, Feb, Mar | 2.4, 2.2, 2.2 |
| | 2 | Apr, May, Jun | 2.1, 2.1, 1.9 |
| | 3 | Jul, Aug, Sep | 1.6, 1.5, 1.8 |
| | 4 | Oct, Nov, Dec | 2.0, 2.3, 2.4 |
| Yellowstone National Park[3] | 1 | Jan, Feb, Mar | 2.5, 2.3, 2.2 |
| | 2 | Apr, May, Jun | 2.1, 2.1, 1.9 |
| | 3 | Jul, Aug, Sep | 1.7, 1.6, 1.8 |
| | 4 | Oct, Nov, Dec | 2.1, 2.4, 2.5 |

1 Also used for Fitzpatrick and Popo Agie Wilderness Areas, Wind River Roadless Area, and regional communities.
2 Also used for Washakie Wilderness Area.
3 Also used for Teton Wilderness Area and Grand Teton National Park.

change as a significant adverse impact; however, there are no applicable local, state, tribal, or federal regulatory visibility standards. It is the responsibility of the Federal Land Manager (FLM) or Tribal government responsible for that land to determine when adverse impacts are significant or not, and these may differ from BLM levels for significant adverse impacts (e.g., the USFS considers a 0.5-dv change as a threshold in order to protect visibility in sensitive areas).

**Far-Field Results**

The maximum predicted far-field visibility impacts for each of the analyzed Project alternatives are provided in Appendix F, Tables F.8.1 – F.8.27. A summary of results by alternative is provided in Tables F.10.17 - F.10.20. Predicted impacts are shown using both the FLAG and IMPROVE background visibility data. For each Class I and sensitive Class II area the maximum predicted change in dv and the estimated number of days per year that could potentially exceed 0.5 and 1.0 dv thresholds are provided. Note that visibility is protected in Class I areas; Class II areas are included here to further define impacts in potentially sensitive areas.

Direct visibility impacts from the Project sources were predicted to be above the 0.5-dv threshold at the Bridger, Fitzpatrick and Popo Agie Wilderness Areas, and at the Wind River Roadless Area (for proposed 3,100 well Alternatives only) using both the FLAG and IMPROVE background visibility data, and above the 1.0-dv threshold at the Bridger Wilderness area using both sets of background data. The highest frequency of predicted visibility impacts occurred at the Bridger Wilderness under Alternative B (WDR250) where there were 30 days per year (FLAG) and 33 days per year (IMPROVE) when visibility impacts were predicted to be above the 0.5-dv threshold, and 11 days per year (FLAG and IMPROVE) above the 1.0-dv threshold (see Table F.8.5). The maximum dv change was estimated as 3.3 dv (FLAG) and 3.7 dv (IMPROVE) (see Table F.8.5).

Cumulative visibility impacts from the Project and regional sources were predicted to be above the 1.0-dv threshold at the Bridger and Popo Agie Wilderness Areas, and at the Wind River Roadless Area. The highest frequency of predicted cumulative visibility impacts occurred at the

Bridger Wilderness under Alternative B (WDR250) where there were 15 days per year (FLAG) and 19 days per year (IMPROVE) when visibility impacts were predicted to be above the 1.0-dv (see Table F.8.19) threshold. The maximum dv change at the Bridger Wilderness Area was estimated as 3.8 dv (FLAG) and 4.2 dv (IMPROVE) (see Table F.8.19).

Tables are also provided in Appendix F (Tables F.8.28 – F.8.35), for each Class I and sensitive Class II area where the maximum predicted change in dv is estimated to potentially exceed 0.5 and 1.0 dv thresholds, that present all predicted impacts above the thresholds and lists the days when the impacts were predict to occur.

**Mid-Field Results**

The maximum predicted mid-field visibility impacts for each of the analyzed Project Alternative scenarios are provided in Appendix F, Tables F.9.1 – F.9.27. A summary of results by alternative is provided in Tables F.10.21 - F.10.24. Predicted impacts are shown using both the FLAG and IMPROVE background visibility data. The maximum predicted visibility impacts (change in dv) at regional communities and the estimated number of days per year that could potentially exceed the 1.0 dv threshold are provided for each community location using both the FLAG and IMPROVE background visibility data.

Modeling results for direct Project alternative scenarios indicate impacts above the 1.0-dv threshold at all regional community locations, with the exception of Merna, where there are no predicted impacts above the 1.0-dv threshold under any of the alternatives. The highest frequency of predicted visibility impacts occurred at Big Sandy under Alternative B (WDR250) where there were 24 days per year (FLAG) and 26 days per year (IMPROVE) when visibility impacts were predicted to be above the 1.0-dv threshold (Table F.9.5). The maximum dv change, 4.3 dv (FLAG), and 4.9 dv (IMPROVE) was predicted to occur at Pinedale (see Table F.9.5). Modeling analyses using the Proposed Action maximum production emissions indicate that there would be only 1 day above the 1.0-dv threshold (IMPROVE), occurring at Pinedale, with a maximum impact of 1.1 dv (Table F.9.1).

Cumulative impacts from Project and regional sources indicate impacts above the 1.0-dv threshold at all regional community locations (all WDR250 and most WDR150 scenarios). The highest frequency of predicted cumulative visibility impacts is estimated for Big Sandy under Alternative B where there were 36 days per year (FLAG) and 34 days per year (IMPROVE) when the visibility impacts were predicted to be above the 1.0-dv threshold (see Table F.9.19). The maximum dv change, 4.4 dv (FLAG), and 5.0 dv (IMPROVE) was predicted to occur at Pinedale (see Table F.9.19).

Tables are also provided in Appendix F (Tables F.9.28 – F.9.47), for each regional community location, that present all predicted impacts above the thresholds and lists the days when the impacts were predict to occur.

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