DRAFT AIR QUALITY TECHNICAL SUPPORT DOCUMENT FOR THE JONAH INFILL DRILLING PROJECT ENVIRONMENTAL IMPACT STATEMENT

Prepared for

Bureau of Land Management
Wyoming State Office
Cheyenne, Wyoming

Pinedale Field Office
Pinedale, Wyoming

and

Jonah Infill Drilling Project Operators

Prepared by

TRC Environmental Corporation
Laramie, Wyoming

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MAI Project 35982

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EXECUTIVE SUMMARY

To be completed upon receipt of agency comments.

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LIST OF ACRONYMS AND ABBREVIATIONS

µeq/l	Microequivalents per liter
$\mu g/m^3$	Micrograms per cubic meter
ANC	Acid neutralizing capacity
AQD	Air Quality Division
AQRV	Air Quality Related Value
AQTSD	Air Quality Technical Support Document
ARS	Air Resource Specialists
BACT	Best available control technology
BLM	Bureau of Land Management
BP	BP America Production Company
BTEX	Benzene, toluene, ethylbenzene, and xylene
BTNF-MA	Bridger-Teton National Forest Management Area
C.F.R.	*Code of Federal Regulations*
CDPHE/APCD	Colorado Department of Public Health and Environment/Air Pollution Control Division
CD/WII	Continental Divide/Wamsutter II
CO	Carbon monoxide
COGCC	Colorado Oil and Gas Conservation Commission
DAT	Deposition analysis thresholds
DEM	Digitized elevation map
dv	Deciview
EIS	Environmental impact statement
EnCana	EnCana Oil & Gas (USA) Inc.
EPA	Environmental Protection Agency
FLAG	Federal Land Managers' Air Quality Related Values Workgroup
FLM	Federal Land Managers
f(RH)	Relative humidity factor
GRI	Gas Research Institute
HAP	Hazardous air pollutant
HNO_3	Nitric acid
hp	Horsepower
hp-hr	Horsepower-hour
IDEQ	Idaho Division of Environment Quality

IDLH	Immediately dangerous to life or health
IOGCC	Idaho Oil and Gas Conservation Commission
IWAQM	Interagency Workgroup on Air Quality Modeling
JIDPA	Jonah Infill Drilling Project Area
kg/ha-yr	Kilograms per hectare per year
LAC	Level of Acceptable Change
LOP	Life of Project
LULC	Land use and land cover
MEI	Maximum exposed individual
MLE	Most likely exposure
MM5	Mesoscale meteorological model
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
NEPA	*National Environmental Policy Act*
NH_3	Ammonia
NIOSH	National Institute for Occupational Safety and Health
NO_2	Nitrogen dioxide
NO_3	Nitrate
NOI	Notice of Installation
NO_x	Nitrogen oxides
NPS	National Park Service
NSR	New Source Review
NWS	National Weather Service
O_3	Ozone
Operators	EnCana Oil and Gas (USA) Inc., BP America Production Company, and other oil and gas companies
PAPA	Pinedale Anticline Project Area
P-BACT	Presumptive BACT
PFO	Pinedale Field Office
PM_{10}	Particulate matter less than or equal to 10 microns in size
$PM_{2.5}$	Particulate matter less than or equal to 2.5 microns in size
ppb	Parts per billion
ppm	Parts per million
Project	Jonah Infill Drilling Project
Protocol	Air Quality Impact Assessment Protocol

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

PSD	Prevention of Significant Deterioration
QA/QC	Quality Assurance/Quality Control
REL	Reference exposure level
RfC	Reference Concentrations for Chronic Inhalation
RFD	Reasonably foreseeable development
RFFA	Reasonably foreseeable future action
RMP	Resource Management Plan
ROD	Record of Decision
RT	Round trip
S	Sulfur
SO_2	Sulfur dioxide
SO_4	Sulfate
SWWYTAF	Southwest Wyoming Technical Air Forum
tpy	Tons per year
TRC	TRC Environmental Corporation
TSP	Total suspended particulates
UDEQ-AQD	Utah Department of Environmental Quality-Air Quality Division
UDNR-DOGM	Utah Department of Natural Resources-Division of Oil, Gas, and Mining
URF	Unit risk factor
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VOC	Volatile organic compound
VMT	Vehicle miles traveled
WAAQS	Wyoming Ambient Air Quality Standards
WAQSR	Wyoming Air Quality Standards and Regulations
WDEQ	Wyoming Department of Environmental Quality
WDR	Well development rate
WOGCC	Wyoming Oil and Gas Conservation Commission
WRAP	Western Regional Air Partnership
WYDOT	Wyoming Department of Transportation

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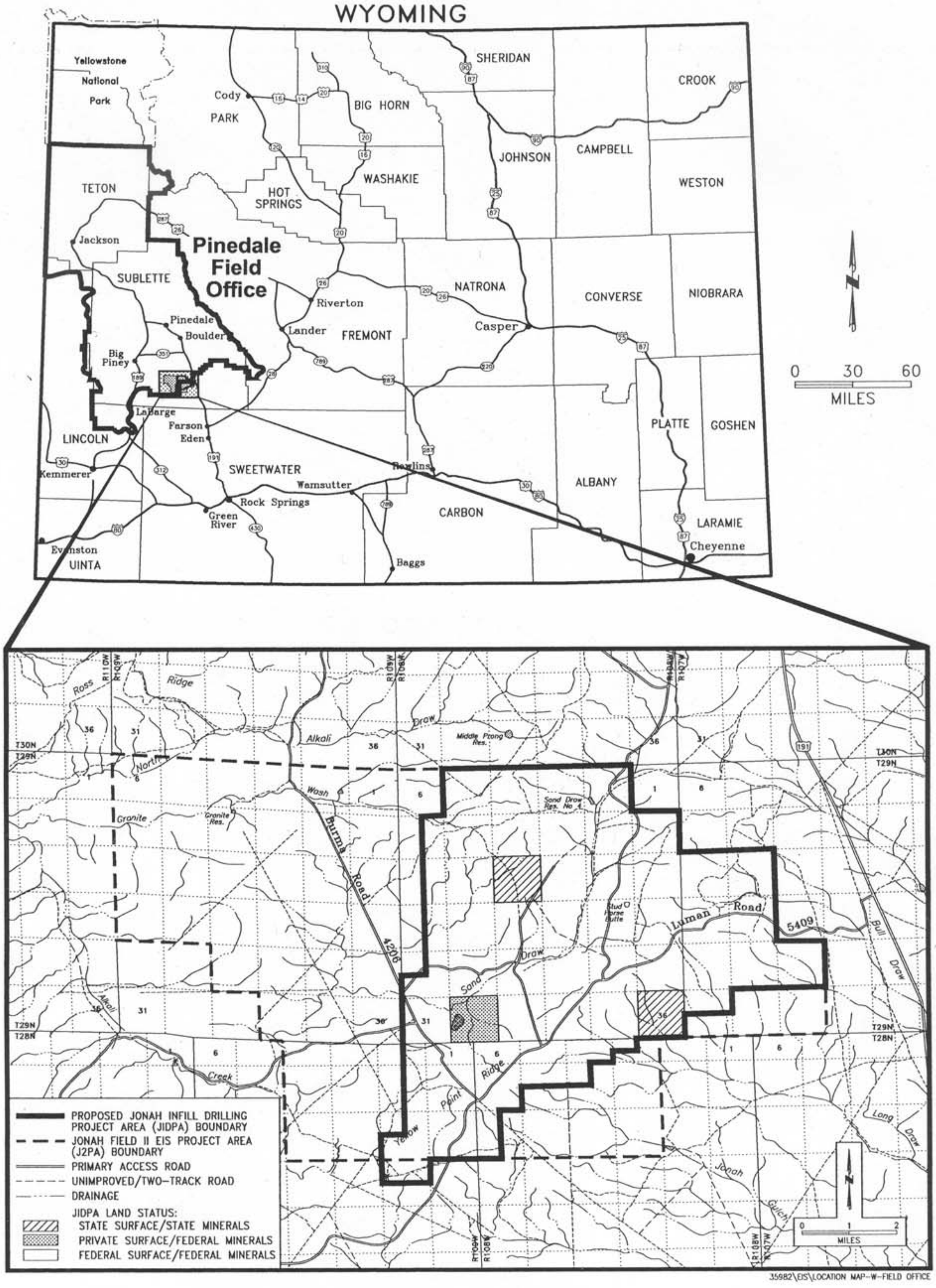
1.0 INTRODUCTION

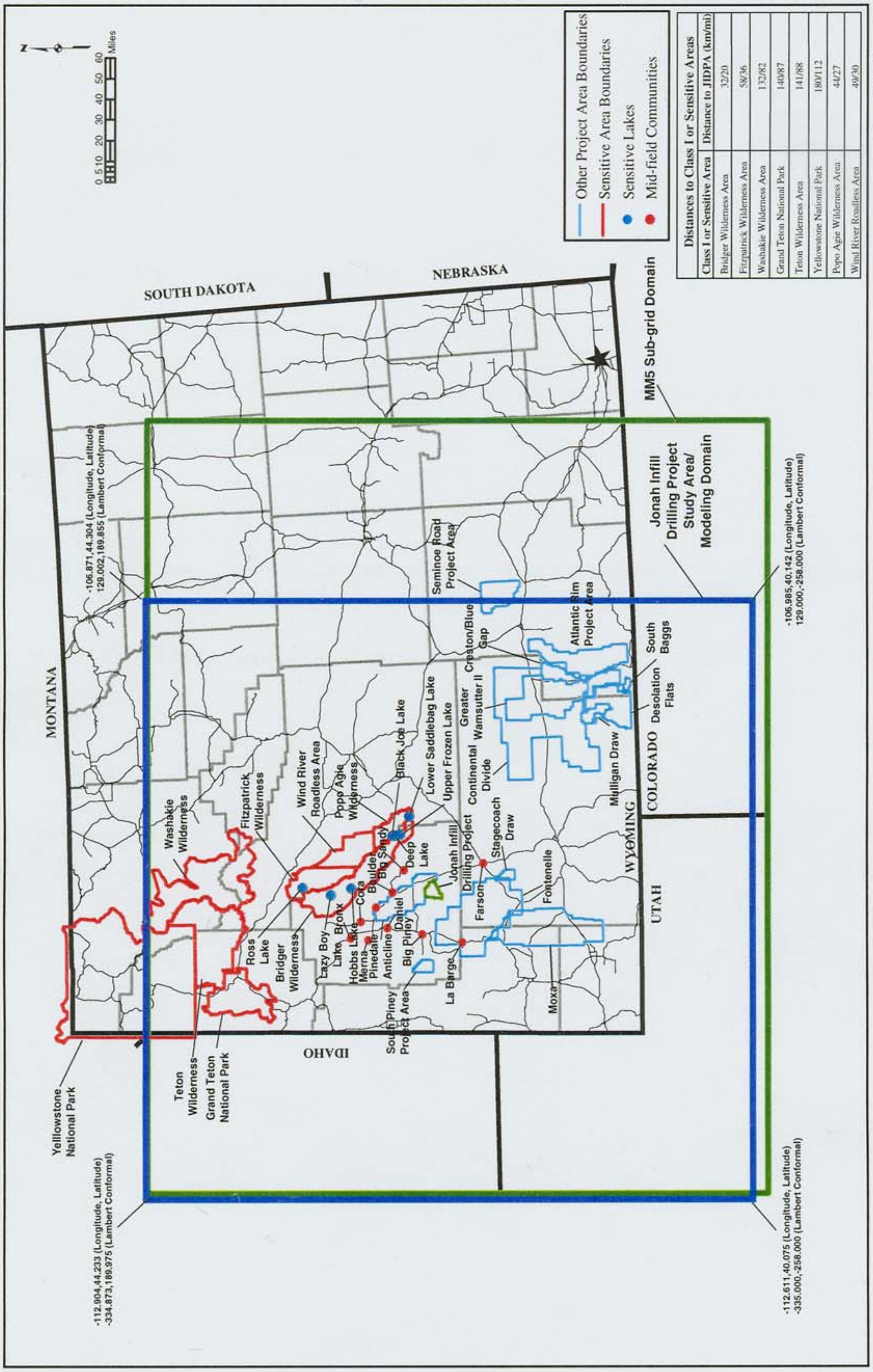
This Air Quality Technical Support Document (AQTSD) was prepared to summarize analyses performed to quantify potential air quality impacts from the proposed Jonah Infill Drilling Project (Project). The methodologies utilized in the analysis were originally defined in an air quality impact assessment protocol (Protocol) prepared by TRC Environmental Corporation (TRC) (2003) with input from the lead agency, U.S. Department of Interior Bureau of Land Management (BLM), and project stakeholders including the U.S. Environmental Protection Agency (EPA), National Park Service (NPS), U.S. Department of Agriculture Forest Service (USDA Forest Service), and Wyoming Department of Environmental Quality Air Quality Division (WDEQ-AQD). The AQTSD discusses those methodologies as necessary and summarizes the findings of the air emissions inventories and subsequent dispersion modeling analyses.

The Project's location in west-central Wyoming required the examination of Project and cumulative source impacts in Wyoming, northwestern Colorado, northeastern Utah, and southeastern Idaho within a defined study area (modeling domain) (Maps 1.1 and 1.2). The analysis area includes the area surrounding the proposed Project area (JIDPA) and all or a portion of the Bridger, Fitzpatrick, Popo Agie, Teton, and Washakie Wilderness Areas; the Wind River Roadless Area; and Grand Teton and Yellowstone National Parks.

Impacts analyzed include those on air quality and air quality related values (AQRVs) resulting from air emissions from: 1) project sources within the JIDPA, 2) non-project state-permitted and reasonably foreseeable future action (RFFA) sources within the modeling domain, and 3) non-project reasonably foreseeable development (RFD) within the modeling domain. The Project source emissions inventory was performed in accordance with the Protocol and following WDEQ-AQD oil and gas inventory guidance (WDEQ-AQD 2001). Portions of the inventory were submitted to WDEQ-AQD for review prior to inventory finalization. Non-project sources were inventoried as part of a cooperative effort between the BLM Wyoming State Office, the



Map 1.1 Jonah Infill Drilling Project Location, Sublette County, Wyoming.



Map 1.2 Air Quality Study Area/Modeling Domain.

Project proponents, and the Atlantic Rim Natural Gas Development Project proponents. These data were obtained for use in the Rawlins and Pinedale Resource Management Plan (RMP) revisions, the Project environmental impact statement (EIS) air quality analysis, and the Atlantic Rim Natural Gas Development Project EIS air quality analysis. Chapter 2.0 specifically presents an overview of the emissions inventories.

The remainder of this AQTSD describes the Project in further detail, provides a description of the alternatives proposed and evaluated, and presents a list of tasks performed for the study. Descriptions of the near-field air quality impact assessment methodology and impacts are provided in Chapter 3.0, and Chapter 4.0 describes the CALPUFF analyses performed for assessment of in-field cumulative, mid-field cumulative, and far-field Project direct and cumulative impacts.

1.1 PROJECT DESCRIPTION

EnCana Oil & Gas (USA) Inc. (EnCana), BP America Production Company (BP), and other oil and gas companies (collectively referred to as the Operators) have notified the BLM, Pinedale Field Office (PFO), that they propose to continue development of natural gas resources located within the JIDPA (see Map 1.1). The JIDPA is generally located in Townships 28 and 29 North, Ranges 107 through 109 West, Sublette County, Wyoming. The JIDPA encompasses approximately 30,500 acres, of which 28,580 acres are federal surface/federal mineral estate, 1,280 acres are State of Wyoming surface/mineral estate, and 640 acres are private surface/federal mineral estate.

The Operator Proposed Action for this Project involves the development of up to 3,100 new natural gas wells on up to 16,200 acres of new surface disturbance. However, additional alternatives involving alternate well pad densities, alternate well numbers, and variable mitigations are also analyzed. The maximum number of wells would be 3,100, assuming an approximately 5- to 10-acre down-hole well spacing throughout the JIDPA. Depending upon the authorized rate of development (75, 150, or 250 wells per year), development operations are expected to last from approximately 5 to 42 years, with a total life-of-field (LOF) of approximately 43 to 85 years. The JIDPA is currently accessed by existing developed roads.

Approximately 63-87 days would be required to develop each well (four days to construct the well pad and access road, from one to four days for rig-up, generally from 18 to 36 days for drilling [an average of 23 days is used in this air quality analysis], 35 days over a 60-day period for completion and testing, from one to four days for rig-down, and four days for pipeline construction). The estimated size of each single-well drill pad is 3.8 acres, of which approximately 2.9 acres would be reclaimed after the well is completed and the gas gathering pipeline is installed. A reserve pit would be constructed at each drill site location to hold drilling fluids and cuttings. Non-productive and non-economical wells would be reclaimed as soon as practical to appropriate federal, state, or private landowner specifications.

The gas produced within the JIDPA would be transported by existing pipelines from the field. To facilitate a complete cumulative impact assessment and since gas compression needs for the Project cannot reasonably be separated from those necessary for the adjacent Pinedale Anticline Project Area (PAPA), future compression requirements for the PAPA are also considered in this air quality analysis. Projections of future compression requirements supporting both the JIDPA and the PAPA were obtained from pipeline companies currently transporting gas from these areas. This total regional compression estimate was analyzed as part of both the Proposed Action and alternatives.

1.2 ALTERNATIVES EVALUATED

Nine project alternatives are currently being analyzed in the *National Environmental Policy Act* (NEPA) EIS for this Project. These alternatives are summarized below:

- the No Action Alternative - no further development includes 533 wells from 497 well pads; LOF is approximately 43 years;

- the Proposed Action - up to 3,100 new wells (2,705 straight, 395 directional) on up to 16,200 acres of new surface disturbance, a well development rate (WDR) of 250 wells/year (WDR250), and an LOF of 56 years;
- Alternative A - up to 3,100 new wells (all straight) from approximately 3,100 new well pads, WDRs of 75, 150, and 250, and an LOF from 56 to 85 years;
- Alternative B - up to 3,100 new wells (all directional) from the existing 497 well pads, WDRs of 75, 150, and 250, and an LOF from 56 to 85 years;
- Alternative C - up to 1,250 new wells (all straight) from a maximum of 1,250 new well pads, WDRs of 75, 150, and 250, and an LOF from 48 to 60 years;
- Alternative D - up to 2,200 new wells (all straight) from a maximum of 2,200 new well pads, WDRs of 75, 150, and 250, and an LOF from 52 to 73 years;
- Alternative E - up to 3,100 new wells (266 straight, 2,834 directional) on up to 266 new well pads (16 total pads/section), WDRs of 75, 150, and 250, and an LOF from 56 to 85 years;
- Alternative F - up to 3,100 new wells (1,028 straight, 2,072 directional) on up to 1,028 new pads (32 total pads/section), WDRs of 75, 150, and 250, and an LOF from 56 to 85 years;
- Alternative G - up to 3,100 new wells (2,553 straight, 547 directional) on up to 2,553 new well pads (64 total pads/section), WDRs of 75, 150, and 250, and an LOF from 56 to 85 years; and
- Preferred Alternative - up to 3,100 new wells (2,553 straight, 547 directional), WDRs of 75, 150, and 250, and an LOF from 56 to 85 years..

Modeling analyses were performed to quantify near-field pollutant concentrations within and nearby the JIDPA from project-related emissions sources for the range of alternatives to assure that the maximum near-field impacts were estimated. Impacts from scenarios considering 1,250 and 3,100 wells in production, at various well-spacing densities of 5, 10, 20, and 40 acres were modeled. Emissions from directional and straight drilling and construction of alternate well pads sizes of 3.8, 7.0, and 10.0 acres were evaluated. Near-field impacts are described in detail in Chapter 3.0.

Direct project and cumulative mid-field and far-field modeling analyses were not performed for every NEPA alternative analyzed, since 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. Modeling scenarios were developed to approximate a range of project development alternatives including: No Action, Proposed Action, Alternative A, Alternative B, Alternative C, and Alternative F. These modeling scenarios assumed the maximum field emissions which could potentially occur concurrently (i.e., the final year of construction representing the maximum annual construction activity rate combined with nearly full-field production). Three WDRs were analyzed--250 wells/year (WDR250), 150 wells/year (WDR150), and 75 wells/year (WDR75). Development rates considered both straight and directional drilling operations and are generally consistent with the proposed Project alternatives.

Mid-field and far-field impacts and their applicability to each alternative are described in greater detail in Chapter 4.0.

1.3 STUDY TASKS

The following eight tasks were performed for air quality and AQRVs impact assessment:

1. **Project Air Emissions Inventory.** Development of an air pollutant emissions inventory for the Project.

2. **Regional Air Emissions Inventory.** Development of an air pollutant emissions inventory for other regional sources not represented by background air quality measurements, including state-permitted sources, RFFA, and RFD.

3. **Project Near-Field Analysis.** Assessment of near-field air quality concentration impacts resulting from activities proposed within the JIDPA.

4. **Regional Near-Field Analysis.** Assessment of near-field air quality concentration impacts resulting from activities proposed within the JIDPA in combination with other existing and proposed regional compressor stations.

5. **In-Field Cumulative Analysis.** Assessment of concentration impacts within the JIDPA resulting from the project and other regional sources inventoried under item 2 above.

6. **Mid-Field Cumulative Analysis.** Assessment of mid-field visibility impacts to regional communities resulting from the Project and other regional sources.

7. **Far-Field Direct Project Impact Analysis.** Assessment of far-field air quality concentration and AQRV impacts resulting from proposed Project activities.

8. **Far-Field Cumulative Impact Analysis.** Assessment of far-field air quality concentration and AQRV impacts resulting from activities proposed within the JIDPA combined with other regional sources inventoried under item 2 above.

2.0 EMISSIONS INVENTORY

2.1 PROJECT EMISSIONS

The Proposed Action includes the development of up to 3,100 natural gas wells. Wells may be developed on single well pads, on multiple well pads, or on a combination thereof.

Criteria pollutant and hazardous air pollutant (HAP) emissions were inventoried for construction activities, production activities, and ancillary facilities. Criteria pollutants included nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), volatile organic compounds (VOCs), particulate matter less than 10 microns in diameter (PM_{10}), and particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). HAPs consisted of n-hexane; benzene, toluene, ethylbenzene, and xylene (BTEX); and formaldehyde. All emission calculations were completed in accordance with WDEQ-AQD oil and gas guidance (WDEQ-AQD 2001) in effect at the time the inventory was conducted, stack test data, EPA's AP-42, or other accepted engineering methods (see Appendix A, Protocol). Additions to WDEQ-AQD *Oil and Gas Production Facility Emission Control and Permitting Requirements for the Jonah and Pinedale Anticline Gas Fields* were approved by the Air Quality Advisory Board on July 28, 2004. The additional guidance became effective upon approval and applies to all wells reported to WOGCC after the approval date of July 28, 2004. The additional guidance revised emission control requirements and permitting process currently utilized under WDEQ-AQD Notice of Intent (NOI)/Presumptive Best Available Control Technology (P-BACT) permitting processes. Because the Project air emissions inventory and dispersion modeling analysis was complete prior to the adoption of the guidance referenced above, the revised guidance is not reflected in this analysis.

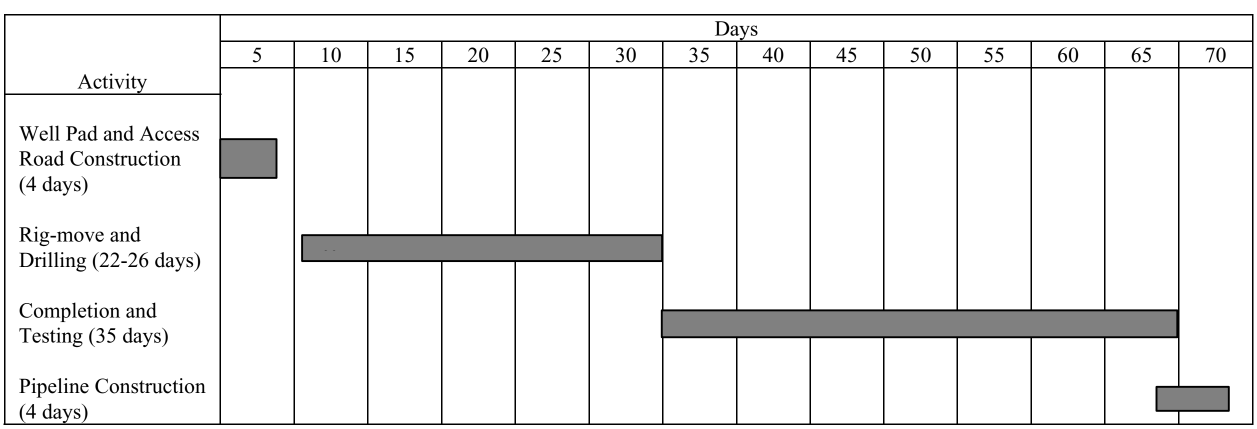
2.1.1 Construction Emissions

Construction activities are a source of primarily criteria pollutants. Emissions would occur from well pad and resource road construction and traffic, rig-move/drilling and associated traffic, completion/testing and associated traffic, pipeline installation and associated traffic, and wind erosion during construction activities. A timeline illustrating the duration of construction activities for a single well is provided in Figure 2.1. Up to 3,100 natural gas wells may be developed; however, a lesser number of developed wells are considered under two alternatives. Regardless of total wells developed, three separate WDRs were examined in this emissions inventory: 75, 150, and 250 wells developed per year.

Well pad and resource road emissions would include fugitive PM_{10} and $PM_{2.5}$ emissions from 1) construction activities and 2) traffic to and from the construction site. Other criteria pollutant emissions would occur from diesel combustion in haul trucks and heavy construction equipment. On resource roads, water would be used for fugitive dust control, effecting a control efficiency of 50%. On collector roads (e.g., Luman Road) magnesium chloride would be used for dust control, effecting a control efficiency of 85%.

After the pad is prepared, rig-move/drilling would begin. Emissions would include fugitives from unpaved road travel to and from the drilling site and emissions from diesel drilling engines (three total engines). At directionally drilled wells the amount of traffic would increase by 20%, and one additional drilling engine (a total of four engines) would be utilized. Emissions from well completion and testing would include fugitive PM_{10} and $PM_{2.5}$ emissions from traffic and

Figure 2.1 Approximate Single-Well Development Timeline.



emissions from diesel haul truck tailpipes. During the completion phase, gas and condensate are both vented to the atmosphere and combusted (flared). Emissions from the venting of natural gas include HAPs and VOCs. Flaring emissions from the combustion of natural gas and condensate include NO_x, CO, VOCs, and HAPs.

Pollutant emissions would also occur from pipeline installation activities, including general construction activities, travel to and from the pipeline construction site, and diesel combustion from on-site construction equipment.

Fugitive dust (PM_{10} and $PM_{2.5}$) would occur during well pad, road, and pipeline construction due to wind erosion on disturbed areas.

A summary of single-well construction emissions for both straight and directionally drilled wells are shown in Table 2.1. Construction emission calculations are provided in detail, showing all emission factors, input parameters, and assumptions, in Appendix B (Project Emissions Inventory).

2.1.2 Production Emissions

Field production equipment and operations would be a source of criteria pollutants and HAPs including BTEX, n-hexane, and formaldehyde. Pollutant emission sources during field production would include:

- combustion engine emissions and dust from road travel to and from well sites;
- diesel combustion emissions from haul trucks;
- combustion emissions from well site heaters;
- fugitive HAP/VOC emissions from well site equipment leaks;
- condensate storage tank flashing and flashing control;
- glycol dehydrator still vent flashing;
- wind erosion from well pad disturbed areas; and
- natural gas-fired reciprocating internal combustion compressor engines.

Table 2.1 Single-well Construction Emissions Summary for Both Straight and Directionally Drilled Wells.

	Well Pad and Access Road Construction		Rig Move and Drilling		Completion and Testing		Pipeline Construction		Totals	
Pollutant	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)	(lb/hr)	(tons/well)
Emissions for one straight well										
NO_x	12.23	0.23	9.78[2]	2.24	0.35	0.10	7.81	0.067	30.17	2.6362
CO	3.76	0.071	3.76[2]	1.47	0.45	0.13	3.03	0.024	11.00	1.6938
SO_2	1.46	0.028	0.31[2]	0.071	0.0096	0.00	0.74	0.74	0.0067	0.8400
PM_{10}	10.76[1]	0.21	3.11[2]	0.80	6.56	1.95	4.88[3]	0.073	25.30	3.0388
$PM_{2.5}$	3.52[1]	0.069	0.93[2]	0.23	1.00	0.30	1.52[3]	0.019	6.97	0.6136
VOC	0.90	0.017	1.97[2]	0.45	0.17	57.62	0.76	0.76	0.0066	58.8545
Emissions for one directional well										
NO_x	12.23[4]	0.23	12.09[5]	3.34	0.35[6]	0.10	7.81[6]	0.067	32.48	3.7420
CO	3.76[4]	0.071	7.89[5]	2.19	0.45[6]	0.13	3.03[6]	0.024	15.13	2.4130
SO_2	1.46[4]	0.028	0.38[5]	0.106	0.0096[5]	0.00	0.74[6]	0.74	2.60	0.8751
PM_{10}	10.76[4]	0.21	3.28[5]	1.00	6.56[5]	1.95	4.88[3,6]	0.073	25.47	3.2358
$PM_{2.5}$	3.52[4]	0.069	1.07[5]	0.31	1.00[5]	0.30	1.52[3,6]	0.019	7.11	0.6958
VOC	0.90[4]	0.017	2.43[5]	0.67	0.17[5]	57.62	0.76[6]	0.76	4.26	59.0756

1 Sum of well pad construction, road construction, well pad and road construction traffic, and construction heavy equipment tailpipe emissions.
2 Sum of straight drilling traffic, straight drilling engines, and straight drilling heavy equipment tailpipe emissions.
3 Sum of pipeline construction, pipeline construction traffic, and pipeline heavy equipment tailpipe emissions.
4 Well pad and access road construction emissions for one directionally drilled well are equal to emissions for one straight drilled well.
5 Sum of directional drilling traffic, directional drilling engines, and directional drilling heavy equipment tailpipe emissions.
6 Completion and testing emissions and pipeline construction emissions are the same for straight and directional wells.

Fugitive PM_{10} and $PM_{2.5}$ emissions would occur from road travel and wind erosion from well pad disturbances. Criteria pollutant emissions would occur from diesel combustion in haul trucks traveling in the field during production.

Heaters required at each well site include an indirect heater, a dehydrator reboiler heater, and a separator heater. Stack testing was performed for NO_x and CO on these heaters by Operators in 2003 to obtain an accurate estimate of these emissions from these sources. These stack test emissions were used throughout this air quality analysis. Heater emissions for all other pollutants were calculated using AP-42.

HAPs and VOC emissions would occur from fugitive equipment leaks (i.e., valves, flanges, connections, pump seals, and opened lines). Condensate storage tank flashing and glycol dehydrator still vent flashing emissions also would include VOC/HAP emissions. Emissions from these sources were provided by Operators.

Total production emissions of criteria pollutants and HAPs occurring from a single well are presented in Table 2.2. Production emission calculations are provided in detail, in Appendix B, showing all emission factors, input parameters, and assumptions.

Table 2.2 Single-Well Production Emissions Summary.

Pollutant	Traffic Emissions [1] (tpy)	Production Emissions [2] (tpy)	Total Emissions (tpy)
NO_x	0.0084	0.045	0.054
CO	0.011	0.43	0.45
SO_2	0.00024	0.00	0.0024
PM_{10}	0.23	0.0087	0.24
$PM_{2.5}$	0.035	0.0087	0.043
VOC	0.0042	18.59	18.59
Benzene	--	1.22	1.22
Toluene	--	2.47	2.47
Ethylbenzene	--	0.13	0.13
Xylene	--	1.33	1.33
n-hexane	--	0.50	0.50

1 Includes emissions from all traffic associated with full-field production. PM_{10} and $PM_{2.5}$ emissions calculations assume 20 wells can be visited per day. Light trucks/pickups emissions on primary access roads (see Table B.2.1) are adjusted to assume 20 wells can be visited per day.

2 Includes emissions from indirect heater, separator heater, dehydrator heater, and dehydrator flashing, and fugitive HAP/VOC. Assumes 25% of the dehydrators have BTEX control, and the remaining 75% have a pump limit.

2.1.3 Total Field Emissions

Annual emissions in the JIDPA under the Proposed Action and each alternative at WDRs of 75, 150, and 250 are shown in Table 2.3. Emissions assume construction and production occurring simultaneously in the field and include one year of maximum construction emissions plus one year of production at maximum emission rates.

Construction emissions were based on well construction, drilling, drilling traffic, completion traffic, and completion flaring. Well construction emissions were based on the number of wells constructed per year and the type of well constructed. Drilling, drilling traffic, completion traffic, and completion flaring were based on the number of wells developed per year. Completion flaring operations were assumed to occur at 20% of the wells under construction. For alternatives with both directional and straight wells, a proportional split between straight and directional wells was used to determine the number of straight and directional drilling rigs.

Production emissions were calculated based on the total number of producing wells in the field. Total producing wells were equal to the difference in number of wells proposed and the number of wells constructed per year.

2.2 REGIONAL EMISSIONS INVENTORY

An emissions inventory of industrial sources within the JIDPA cumulative modeling domain was prepared for use in the cumulative air quality analysis. The modeling domain included portions of Wyoming, Colorado, Utah, and Idaho (see Map 1.2). Industrial sources and oil and gas wells permitted within a defined time frame (January 1, 2001 through June 30, 2003) through state air quality regulatory agencies and state oil and gas permitting agencies were first researched. The subset of these sources which had begun operation as of the inventory end-date was classified as

Table 2.3 Estimated Jonah Infill Drilling Project Maximum Annual In-field Emissions Summary - Construction and Production.

Alternative	Annual Development Rate	Pollutant	Annual Construction Emissions[1] (tpy)	Total Proposed Wells	Total Producing Wells	Annual Production Emissions[2] (tpy)	Total Annual Emissions (tpy)
Proposed Action (Maximum Recovery) (395 directional, 2,705 straight)	250	NO_x	744.5	3,100	2,850	360.6	1,105.1
		CO	803.9			1,412.9	2,216.8
		SO_2	25.9			0.7	26.6
		PM_{10}	976.7			676.1	1,652.8
		$PM_{2.5}$	190.1			123.8	313.9
		VOC	3,154.0			53,069.9	56,223.9
		HAPs	243.6			16,118.2	16,361.8
Alternative A (100% straight)	250	NO_x	716.5	3,100	2,850	360.6	1,077.1
		CO	783.2			1,412.9	2,196.1
		SO_2	25.6			0.7	26.3
		PM_{10}	985.7			676.7	1,662.5
		$PM_{2.5}$	191.7			123.9	315.6
		VOC	3,147.4			53,069.9	56,217.3
		HAPs	243.6			16,118.2	16,361.8
	150	NO_x	429.9	3,100	2,950	366.0	795.9
		CO	469.9			1,457.4	1,927.3
		SO_2	15.4			0.7	16.1
		PM_{10}	591.4			700.5	1,291.9
		$PM_{2.5}$	115.0			128.2	243.3
		VOC	1,888.5			54,929.0	56,817.4
		HAPs	146.2			16,683.3	16,829.4
	75	NO_x	212.7	3,100	3,025	370.0	582.8
		CO	233.5			1,490.8	1,724.3
		SO_2	7.6			0.7	8.3
		PM_{10}	295.6			718.3	1,013.9
		$PM_{2.5}$	57.4			131.5	188.9
		VOC	943.8			56,323.2	57,267.0
		HAPs	73.1			17,107.0	17,180.1

Table 2.3 (Continued)

Alternative	Annual Development Rate	Pollutant	Annual Construction Emissions[1] (tpy)	Total Proposed Wells	Total Producing Wells	Annual Production Emissions[2] (tpy)	Total Annual Emissions (tpy)
Alternative B[4] (all directional, no new pads)	250	NO_x	935.3	3,100	2,850	360.6	1,295.9
		CO	945.0			1,412.9	2,357.9
		SO_2	27.5			0.7	28.2
		PM_{10}	914.6			671.6	1,586.2
		$PM_{2.5}$	179.0			123.1	302.1
		VOC	3,198.5			53,069.9	56,268.4
		HAPs	243.6			16,118.2	16,361.8
	150	NO_x	561.2	3,100	2,950	366.0	927.1
		CO	567.0			1,457.4	2,024.4
		SO_2	16.5			0.7	17.2
		PM_{10}	548.7			695.2	1,243.9
		$PM_{2.5}$	107.4			127.4	234.9
		VOC	1,919.1			54,929.0	56,848.1
		HAPs	146.2			16,683.3	16,829.4
	75	NO_x	277.3	3,100	3,025	370.0	647.3
		CO	281.4			1,490.8	1,772.2
		SO_2	8.1			0.7	8.9
		PM_{10}	274.2			712.9	987.1
		$PM_{2.5}$	53.5			130.7	184.2
		VOC	958.9			56,323.2	57,282.2
		HAPs	73.1			17,107.0	17,180.1
Alternative C (100% straight)	250	NO_x	716.5	1,250	1,000	261.2	977.7
		CO	783.2			589.5	1,372.7
		SO_2	25.6			0.2	25.9
		PM_{10}	985.7			237.5	1,223.2
		$PM_{2.5}$	191.7			43.5	235.2
		VOC	3,147.4			18,677.3	21,824.7
		HAPs	243.6			5,664.9	5,908.5

Table 2.3 (Continued)

Alternative	Annual Development Rate	Pollutant	Annual Construction Emissions[1] (tpy)	Total Proposed Wells	Total Producing Wells	Annual Production Emissions[2] (tpy)	Total Annual Emissions (tpy)
Alternative C (cont.)	150	NO_x	429.9	1,250	1,100	266.6	696.5
		CO	469.9			634.0	1,103.9
		SO_2	15.4			0.3	15.6
		PM_{10}	591.4			261.2	852.6
		$PM_{2.5}$	115.0			47.8	162.8
		VOC	1,888.5			20,536.3	22,424.8
		HAPs	146.2			6,229.9	6,376.1
	75	NO_x	212.7	1,250	1,175	270.6	483.3
		CO	233.5			667.4	900.9
		SO_2	7.6			0.3	7.9
		PM_{10}	295.6			279.0	574.6
		$PM_{2.5}$	57.4			51.1	108.5
		VOC	943.8			21,930.6	22,874.4
		HAPs	73.1			6,653.7	6,726.8
Alternative D (100% straight)	250	NO_x	716.5	2,200	1,950	312.2	1,028.7
		CO	783.2			1,012.3	1,795.5
		SO_2	25.6			0.5	26.1
		PM_{10}	985.7			463.0	1,448.8
		$PM_{2.5}$	191.7			84.8	276.5
		VOC	3,147.4			36,338.3	39,485.8
		HAPs	243.6			11,032.8	11,276.4
	150	NO_x	429.9	2,200	2,050	317.6	747.5
		CO	469.9			1,056.8	1,526.8
		SO_2	15.4			0.5	15.9
		PM_{10}	591.4			486.8	1,078.2
		$PM_{2.5}$	115.0			89.1	204.1
		VOC	1,888.5			38,197.4	40,085.9
		HAPs	146.2			11,597.9	11,744.0

Table 2.3 (Continued)

Alternative	Annual Development Rate	Pollutant	Annual Construction Emissions[1] (tpy)	Total Proposed Wells	Total Producing Wells	Annual Production Emissions[2] (tpy)	Total Annual Emissions (tpy)
Alternative D (cont.)	75	NO_x	212.7	2,200	2,125	321.7	534.4
		CO	233.5			1,090.2	1,323.8
		SO_2	7.6			0.5	8.1
		PM_{10}	295.6			504.6	800.2
		$PM_{2.5}$	57.4			92.4	149.8
		VOC	943.8			39,591.7	40,535.5
		HAPs	73.1			12,021.6	12,094.7
Alternative E[4] (2,834 directional, 266 straight, 266 new pads)	250	NO_x	917.0	3,100	2,850	360.6	1,277.6
		CO	931.5			1,412.9	2,344.3
		SO_2	27.4			0.7	28.0
		PM_{10}	920.7			672.1	1,592.8
		$PM_{2.5}$	180.1			123.2	303.3
		VOC	3,194.2			16,190.4	19,384.7
		HAPs	243.6			16,118.2	16,361.8
	150	NO_x	549.7	3,100	2,950	366.0	915.7
		CO	558.6			1,457.4	2,016.0
		SO_2	16.4			0.7	17.1
		PM_{10}	552.4			695.7	1,248.0
		$PM_{2.5}$	108.0			127.5	235.6
		VOC	1,916.5			54,929.0	56,845.4
		HAPs	146.2			16,683.3	16,829.4
	75	NO_x	275.4	3,100	3,025	370.0	645.4
		CO	279.7			1,490.8	1,770.4
		SO_2	8.2			0.7	8.9
		PM_{10}	276.3			713.4	989.6
		$PM_{2.5}$	54.1			130.8	184.8
		VOC	958.3			56,323.2	57,281.6
		HAPs	73.1			17,107.0	17,180.1

Table 2.3 (Continued)

Alternative	Annual Development Rate	Pollutant	Annual Construction Emissions[1] (tpy)	Total Proposed Wells	Total Producing Wells	Annual Production Emissions[2] (tpy)	Total Annual Emissions (tpy)
Alternative F[4] (2,072 directional, 1,028 straight, 1,028 new pads)	250	NO_x	862.6	3,100	2,850	360.6	1,223.2
		CO	891.3			1,412.9	2,304.2
		SO_2	26.9			0.7	27.6
		PM_{10}	938.1			673.3	1,611.5
		$PM_{2.5}$	183.2			123.4	306.6
		VOC	3,181.6			53,069.9	56,251.5
		HAPs	243.6			16,118.2	16,361.8
	150	NO_x	517.3	3,100	2,950	366.0	883.3
		CO	534.6			1,457.4	1,992.0
		SO_2	16.1			0.7	16.8
		PM_{10}	562.8			697.0	1,259.8
		$PM_{2.5}$	109.9			127.7	237.6
		VOC	1,908.9			54,929.0	56,837.8
		HAPs	146.2			16,683.3	16,829.4
	75	NO_x	258.7	3,100	3,025	370.0	628.7
		CO	267.3			1,490.8	1,758.1
		SO_2	8.1			0.7	8.8
		PM_{10}	281.4			714.7	996.1
		$PM_{2.5}$	55.0			131.0	185.9
		VOC	954.4			56,323.2	57,277.7
		HAPs	73.1			17,107.0	17,180.1
Alternative G[4] (547 directional, 2,553 straight, 2,553 new pads)	250	NO_x	754.9	3,100	2,850	360.6	1,115.5
		CO	811.7			1,412.9	2,224.6
		SO_2	26.0			0.7	26.6
		PM_{10}	973.1			673.3	1,646.5
		$PM_{2.5}$	189.5			123.4	312.8
		VOC	3,156.4			53,069.9	56,226.3
		HAPs	243.6			16,118.2	16,361.8

Table 2.3 (Continued)

Alternative	Annual Development Rate	Pollutant	Annual Construction Emissions[1] (tpy)	Total Proposed Wells	Total Producing Wells	Annual Production Emissions[2] (tpy)	Total Annual Emissions (tpy)
Alternative G (cont.)	150	NO_x	452.5	3,100	2,950	366.0	818.5
		CO	486.7			1,457.4	1,944.1
		SO_2	15.6			0.7	16.3
		PM_{10}	583.8			699.6	1,283.4
		$PM_{2.5}$	113.6			128.1	241.7
		VOC	1,893.8			54,929.0	56,822.7
		HAPs	146.2			16,683.3	16,829.4
	75	NO_x	226.3	3,100	3,025	370.0	596.3
		CO	243.4			1,490.8	1,734.1
		SO_2	7.8			0.7	8.5
		PM_{10}	291.9			717.3	1,009.2
		$PM_{2.5}$	56.8			131.4	188.2
		VOC	946.9			56,323.2	57,270.1
		HAPs	73.1			17,107.0	17,180.1
Preferred Alternative (547 directional, 2,553 straight, 2,553 new pads)	250	NO_x	754.9	3,100	2,850	360.6	1,115.5
		CO	811.7			1,412.9	2,224.6
		SO_2	26.0			0.7	26.6
		PM_{10}	973.1			673.3	1,646.5
		$PM_{2.5}$	189.5			123.4	312.8
		VOC	3,156.4			53,069.9	56,226.3
		HAPs	243.6			16,118.2	16,361.8
	150	NO_x	452.5	3,100	2,950	366.0	818.5
		CO	486.7			1,457.4	1,944.1
		SO_2	15.6			0.7	16.3
		PM_{10}	583.8			699.6	1,283.4
		$PM_{2.5}$	113.6			128.1	241.7
		VOC	1,893.8			54,929.0	56,822.7
		HAPs	146.2			16,683.3	16,829.4

Table 2.3 (Continued)

Alternative	Annual Development Rate	Pollutant	Annual Construction Emissions[1] (tpy)	Total Proposed Wells	Total Producing Wells	Annual Production Emissions[2] (tpy)	Total Annual Emissions (tpy)
Preferred Alternative (cont.)	75	NO_x	226.3	3,100	3,025	370.0	596.3
		CO	243.4			1,490.8	1,734.1
		SO_2	7.8			0.7	8.5
		PM_{10}	291.9			717.3	1,009.2
		$PM_{2.5}$	56.8			131.4	188.2
		VOC	946.9			56,323.2	57,270.1
		HAPs	73.1			17,107.0	17,180.1

1 Includes emissions from well pad and access road construction and associated traffic (see Tables B.1.1, B.1.2, B.1.3, and B.1.4), rig moving and drilling and associated traffic (see Tables B.1.10, B.1.11, and B.1.12).

2 Includes emissions from indirect heater (see Table B.2.3), separator heater (see Table B.2.4), dehydrator heater (see Table B.2.4), dehydrator flashing (see table B.2.6), fugitive HAP/VOC (see Table B.2.7), and traffic associated with full-field production (see Tables B.2.1 and B.2.2). Assumes 50% of condensate storage tanks are controlled and 50% are uncontrolled, and 25% of the dehydrators have BTEX control, and the remaining 75% have a pump limit.

3 At WDR of 250, assumes emissions include 250 drilling operations occurring during the year including 125 rigs with Tier 1 emission levels (see Table B.1.8) and 125 rigs with Tier 2 emission levels (see Table B.1.9). Emissions also include 50 completion flares (see Table B.1.12) operating during the year.

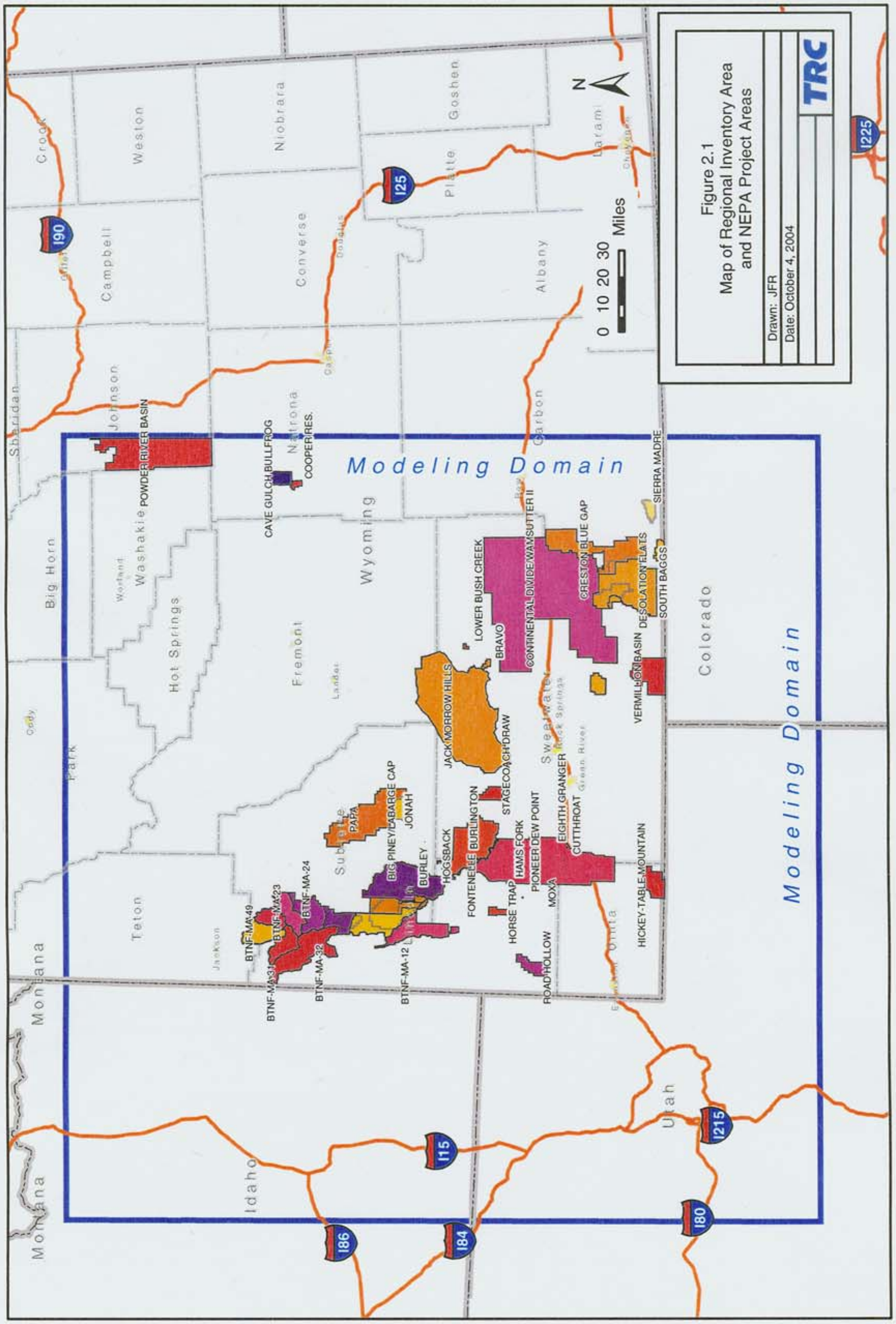
4 At WDR of 150, assumes emissions include 150 drilling operations occurring during the year including 75 rigs with Tier 1 emission levels (see Table B.1.8) and 75 rigs with Tier 2 emission levels (see Table B.1.9). Emissions also include 30 completion flares (see Table B.1.12) operating during the year.

5 At WDR of 75, assumes emissions include 75 drilling operations occurring during the year including 37 rigs with Tier 1 emission levels (see Table B.1.8) and 37 rigs with Tier 2 emission levels (see Table B.1.9). Emissions also include 15 completion flares (see Table B.1.12) operating during the year.

state-permitted sources, and those not yet in operation were classified as RFFA. Also included in the regional inventory were industrial sources proposed under NEPA in the State of Wyoming. The developed portions of these projects were assumed to be either included in monitored ambient background or included in the state-permitted source inventory. The undeveloped portions of projects proposed under NEPA were classified as RFD. In accordance with definitions agreed upon by BLM, EPA, WDEQ-AQD, and USDA Forest Service for use in EIS projects, RFD was defined as 1) the NEPA-authorized but not yet developed portions of Wyoming NEPA projects, and 2) not yet authorized NEPA projects for which air quality analyses were in progress and for which emissions had been quantified.

Map 2.1 shows the regional inventory area with NEPA project areas, and a summary of the regional inventory is shown in Table 2.4. Values presented in Table 2.4 represent the change in emissions between the inventory start-date (January 1, 2001) and the inventory end-date (June 30, 2003).

The regional inventory including methodologies used to compile the regional source emissions are provided in Appendix C and include a description of the data collected, the period of record for the data collected, inclusion and exclusion methodology, stack parameter processing methods, and the state-specific methodologies required due to significant differences in the content and completeness of data obtained from each state.



Map 2.1 Regional Inventory Area and Included NEPA Project Areas.

Table 2.4 Regional Inventory Summary of Emissions Changes from January 1, 2001 to June 30, 2003.

			Emission			
State	Source Category	Quantity of Sources	NO_x (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
Colorado	State-permitted[1]	17	177.1	2.7	64.8	22.6
	RFFA	0	--	--	--	--
	RFD	0	--	--	--	--
	Excluded	203	--	--	--	--
Idaho	State-permitted[2]	17	568.4	(112.2)	61.6	61.6
	RFFA	0	--	--	--	--
	RFD	0	--	--	--	--
	Excluded	37	--	--	--	--
Utah	State-permitted[3]	126	2,619.9	47.1	424.5	424.1
	RFD	0	--	--	--	--
	RFFA	0	--	--	--	--
	Excluded	202	--	--	--	--
Wyoming	State-permitted[4]	34	733.5	1.0	8.3	8.3
	RFFA[5]	47	486.3	(1,407.0)	(1,282.8)	(586.6)
	RFD[6]	42	3,166.5	56.1	84.0	81.9
	Excluded	693	--	--	--	--
Total	State Permitted[7]	194	4,098.9	(61.4)	559.2	516.6
	RFFA	47	486.3	(1,407.0)	(1,282.8)	(586.6)
	RFD	42	3,166.5	56.1	84.0	81.9
	Excluded	1,135	--	--	--	--
Total Change		--	7,751.7	(1,412.3)	(639.6)	11.9

1 See Appendix C, Table C.1
2 See Appendix C, Table C.3.
3 Includes state-permitted oil and gas well emissions. See Appendix C, Tables C.5 and C.9.
4 Includes state-permitted oil and gas well emissions. See Appendix C, Tables C.7 and C.9.
5 See Appendix C, Table C.11.
6 See Appendix C, Table C.12.
7 Includes state-permitted oil and gas well emissions.

3.0 NEAR-FIELD MODELING ANALYSES

3.1 MODELING METHODOLOGY

A near-field ambient air quality impact analysis was performed to quantify the maximum criteria pollutants (PM_{10}, $PM_{2.5}$, CO, NO_2, SO_2, and ozone [O_3]) and HAPs (BTEX, n-hexane, and formaldehyde) impacts that could occur within and near the JIDPA. These impacts would result from emissions associated with Project construction and production activities, and are compared to applicable ambient air quality standards, and significance thresholds. All modeling analyses were generally performed in accordance with the Protocol presented in Appendix A with input from the BLM and members of the air quality stake holders' group, including the EPA, USDA Forest Service, and WDEQ-AQD.

The EPA's proposed guideline dispersion model, AERMOD (version 02222), was used to assess near-field impacts of criteria pollutants PM_{10}, $PM_{2.5}$, CO, NO_2 and SO_2, and to estimate short-term and long-term HAP impacts. This version of AERMOD utilizes the PRIME building downwash algorithms which are the most recent "state of science" algorithms for modeling applications where aerodynamic building downwash is a concern. One year of JIDPA meteorology data was used with the AERMOD dispersion model to estimate these pollutant impacts. O_3 impacts were estimated from a screening methodology developed by Scheffe (1988) that utilizes NO_x and VOC emissions ratios to calculate O_3 concentrations. Various construction and production activities were modeled to provide for a complete range of alternatives and activities. For each pollutant, the magnitude and duration of emissions from each Project phase (i.e., construction or production) emissions activity were examined to determine the maximum emissions scenario for modeling.

3.2 METEOROLOGY DATA

One year of surface meteorological data, collected in the JIDPA from January 1999 through January 2000, was used in the analysis. A wind rose for these data is presented in Figure 3.1.

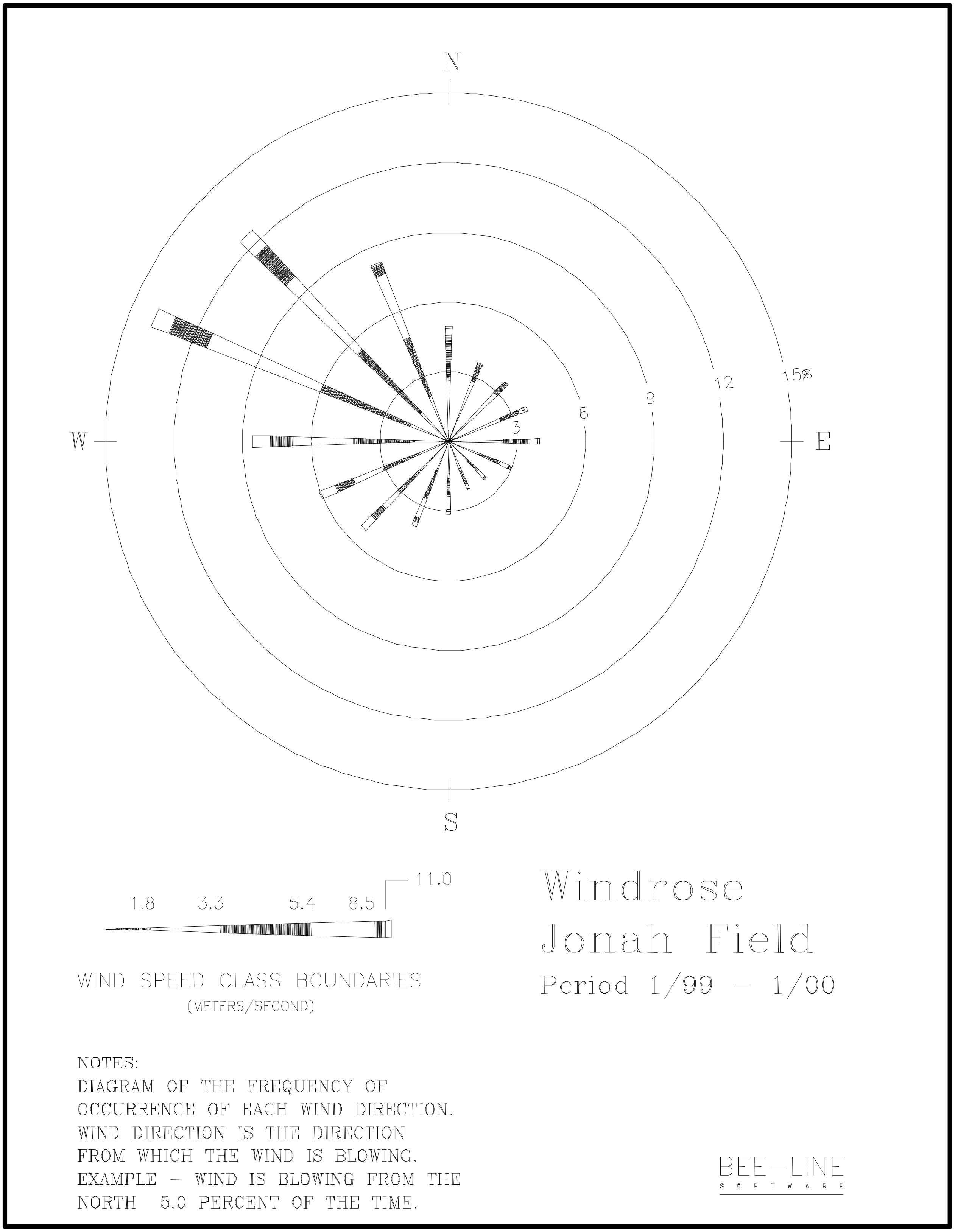


Figure 3.1 Wind Rose, Jonah Field, 1999.

The JIDPA meteorology data included hourly surface measurements of wind speed, wind direction, standard deviation of wind direction [sigma theta], and temperature. These data were processed using the AERMET preprocessor to produce a dataset compatible with the AERMOD dispersion model. AERMET was used to combine the JIDPA surface measurements with twice daily sounding data from Riverton, Wyoming, cloud cover data collected at Big Piney, Wyoming, and solar radiation measurements collected at Pinedale, Wyoming.

3.3 BACKGROUND POLLUTANT CONCENTRATIONS

Background concentration data collected for criteria pollutants at regional monitoring sites were added to concentrations modeled in the near-field analysis to establish total pollutant concentrations for comparison to ambient air quality standards. The most representative monitored regional background concentrations available for criteria pollutants are shown in Table 3.1.

Table 3.1 Near-Field Analysis Background Ambient Air Quality Concentrations (Micrograms per Cubic Meter [$\mu g/m^3$]).

Pollutant	Averaging Period	Measured Background Concentration
CO[1]	1-hour	3,336
	8-hour	1,381
NO_2[2]	Annual	3.4
O_3[3]	1-hour	169
	8-hour	147
PM_{10}[4]	24-hour	33
	Annual	16
$PM_{2.5}$[4]	24-hour	13
	Annual	5
SO_2[5]	3-hour	132
	24-hour	43
	Annual	9

1 Data collected by Amoco at Ryckman Creek for an 8-month period during 1978-1979, summarized in the Riley Ridge EIS (BLM 1983).
2 Data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period January-December 2001 (Air Resource Specialists [ARS] 2002).
3 Data collected at Green River Basin Visibility Study site, Green River, Wyoming, during period June 10, 1998, through December 31, 2001 (ARS 2002).
4 Data collected by WDEQ-AQD at Emerson Building, Cheyenne, Wyoming, Year 2001, second highest 24-hour concentrations. These data were determined by WDEQ-AQD to be the most representative co-located PM_{10} and $PM_{2.5}$ data available.
5 Data collected at LaBarge Study Area, Northwest Pipeline Craven Creek Site 1982-1983.

3.4 CRITERIA POLLUTANT IMPACT ASSESSMENT

The near-field criteria pollutant impact assessment was performed to estimate maximum potential impacts of PM_{10}, $PM_{2.5}$, NO_2, SO_2, CO, and O_3 from project emissions sources including well site and compressor station emissions. Maximum predicted concentrations in the vicinity of project emissions sources were compared with the Wyoming Ambient Air Quality Standards (WAAQS), National Ambient Air Quality Standards (NAAQS), and applicable Prevention of Significant Deterioration (PSD) Class II increments shown in Table 3.2. This NEPA analysis compared potential air quality impacts from Project alternatives to applicable ambient air quality standards and PSD increments. The comparisons to the PSD Class I and II increments are intended to evaluate a threshold of concern for potential impacts, and does not represent a regulatory PSD increment comparison. Such a regulatory analysis is the responsibility of the state air quality agency (under EPA oversight) and would be conducted during the permitting process.

Table 3.2 Ambient Air Quality Standards and Class II PSD Increments for Comparison to Near-Field Analysis Results (μg/m^3).

Pollutant/Averaging Time	NAAQS	WAAQS	PSD Class II Increment
CO			
1-hour[1]	40,000	40,000	--[2]
8-hour[1]	10,000	10,000	--
NO_2			
Annual[3]	100	100	25
O_3			
1-hour[1]	235	235	--
8-hour[4]	157	157	--
PM_{10}			
24-hour[1]	150	150	30
Annual[3]	50	50	17
$PM_{2.5}$			
24-hour[1]	65	65[5]	--
Annual[3]	15	15[5]	--
SO_2			
3-hour[1]	1,300	1,300	512
24-hour[1]	365	260	91
Annual[3]	80	60	20

1 No more than one exceedance per year.
2 -- = No PSD Class II Increment has been established for this pollutant.
3 Annual arithmetic mean.
4 Average of annual fourth-highest daily maximum 8-hour average.
5 Standard not yet enforced in Wyoming.

The EPA's proposed guideline dispersion model, AERMOD, was used to model the near-field concentrations of PM_{10}, $PM_{2.5}$, CO, NO_2, and SO_2. AERMOD was run using one year of AERMET preprocessed JIDPA meteorology data following all regulatory default switch settings. Since PM_{10}/$PM_{2.5}$ emissions would be greatest during the resource road/well pad construction phase of field development, construction emissions sources were modeled to determine compliance with the PM_{10}/$PM_{2.5}$ WAAQS and NAAQS. Similarly, SO_2 emissions would be greatest from well drilling operations during construction. CO and NO_x emissions primarily from compressor stations would be greatest during well production.

O_3 impacts were estimated using the screening methodology developed by Scheffe (1988) which utilizes NO_x and VOC emissions ratios to calculate O_3 concentrations. NO_x and VOC emissions would be greatest during production activities, and these emissions were used to estimate O_3 impacts.

3.4.1 PM_{10}/$PM_{2.5}$

Maximum localized PM_{10}/$PM_{2.5}$ impacts would result from well pad and road construction activities and from wind erosion. Three different approximate well pad sizes are proposed within the range of Project alternatives; 3.8 acres, 7.0 acres, and 10.0 acres. Modeling scenarios were developed for each of these well pad sizes, with each scenario consisting of a well pad and a 2.5-mi resource road using the emissions estimates provided in Section 2.1. Model receptors were placed at 100-m intervals beginning 200 m from the edge of the well pad and road. Flat terrain was assumed for each modeling scenario. Figure 3.2 presents the configurations used to model each well pad and resource road scenario. Volume sources were used to represent emissions from well pads and roads. Hourly emission rate adjustment factors were applied to limit construction emissions to daytime hours. AERMOD was used to model each scenario 36 times, once at each of 36 10º rotations, to ensure that impacts from all directional layout configurations and meteorological conditions were assessed. Wind erosion emissions were modeled for all hours where the wind speed exceeded a threshold velocity defined by emissions calculations performed using AP-42 Section 13.2.5, Industrial Wind Erosion (EPA 2004).

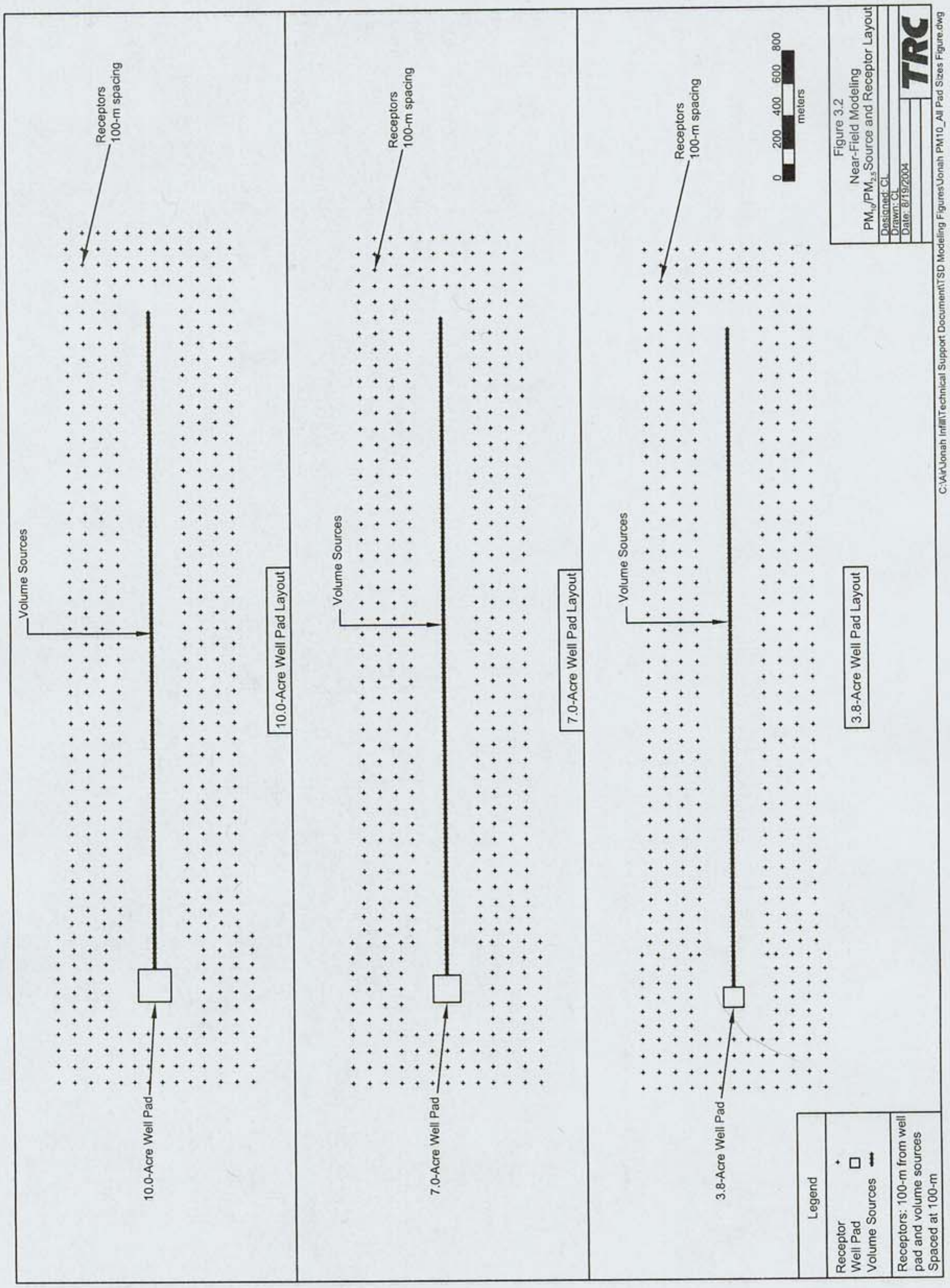


Figure 3.2 Near-field Modeling $PM_{10}/PM_{2.5}$ Source and Receptor Layout.

Table 3.3 presents the maximum modeled $PM_{10}/PM_{2.5}$ concentrations, for each well pad scenario. When the maximum modeled concentration was added to representative background concentrations, it was demonstrated that PM_{10} and $PM_{2.5}$ concentrations for all scenarios comply with the WAAQS and NAAQS for PM_{10} and proposed standards for $PM_{2.5}$.

Emissions associated with temporary construction activities do not consume PSD Increment; therefore, temporary PM_{10} emissions from well pad and road construction are excluded from increment consumption analyses.

Table 3.3 Maximum Modeled $PM_{10}/PM_{2.5}$ Concentrations, Jonah Infill Drilling Project.

Scenario	Pollutant	Averaging Time	Direct Modeled ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted ($\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
3.8-acre pad	PM_{10}	24-Hour	74.1	33	107.1	150	150
		Annual	3.4	16	19.4	50	50
	$PM_{2.5}$	24-Hour	27.0	13	40.0	65	65
		Annual	1.3	5	6.3	15	15
7-acre pad	PM_{10}	24-Hour	94.0	33	127.0	150	150
		Annual	4.7	16	20.7	50	50
	$PM_{2.5}$	24-Hour	31.0	13	44.0	65	65
		Annual	1.6	5	6.6	15	15
10-acre pad	PM_{10}	24-Hour	102.1	33	135.1	150	150
		Annual	5.6	16	21.6	50	50
	$PM_{2.5}$	24-Hour	32.2	13	45.2	65	65
		Annual	1.8	5	6.8	15	15

3.4.2 SO_2

Emissions from construction drilling operations would result in maximum SO_2 concentrations of all other project phases. Both straight well drilling and directional well drilling are proposed as part of the Project. Therefore, modeling scenarios were developed that included a drilling rig at the center of a pad, with model receptors placed along 100-m intervals, 100 m from the drilling engines, for both straight and directional drilling operations. Drilling rigs were modeled as point sources, with aerodynamic building downwash from the rig structure. Figure 3.3 illustrates the modeling configuration used for drilling rig SO_2 emissions.

AERMOD was used to model drilling rig SO_2 emissions for both straight and directional drilling operations. The maximum predicted concentrations are provided in Table 3.4. The modeled SO_2 impacts, when added to representative background concentrations, are below the applicable standards and, as with PM_{10} construction emissions, emissions from drilling rigs are temporary and do not consume SO_2 PSD Increment.

3.4.3 NO_2

Emissions from production activities (well site and compression) would result in the maximum near-field NO_2 concentrations. Analyses were performed to quantify the maximum NO_2 impacts that could occur within and nearby the JIDPA using the emissions from existing in-field compressor station and well emissions, anticipated future compression expansions, and proposed Project alternatives. Proposed well emissions include those from well site heaters, truck traffic, and from a water disposal well engine. Although no increases to compression are proposed as part of the Project, anticipated future compression expansions were obtained from the gas transmission companies that operate within the region and were considered in the modeling analyses. Anticipated future compression expansions were provided for the Bird Canyon, Falcon, Gobblers Knob, Jonah, Luman, and Paradise compressor stations. Bird Canyon, Falcon, Luman, and Jonah are primarily associated with the Jonah Field, whereas Gobblers Knob and Paradise are considered part of the Pinedale Anticline Project.

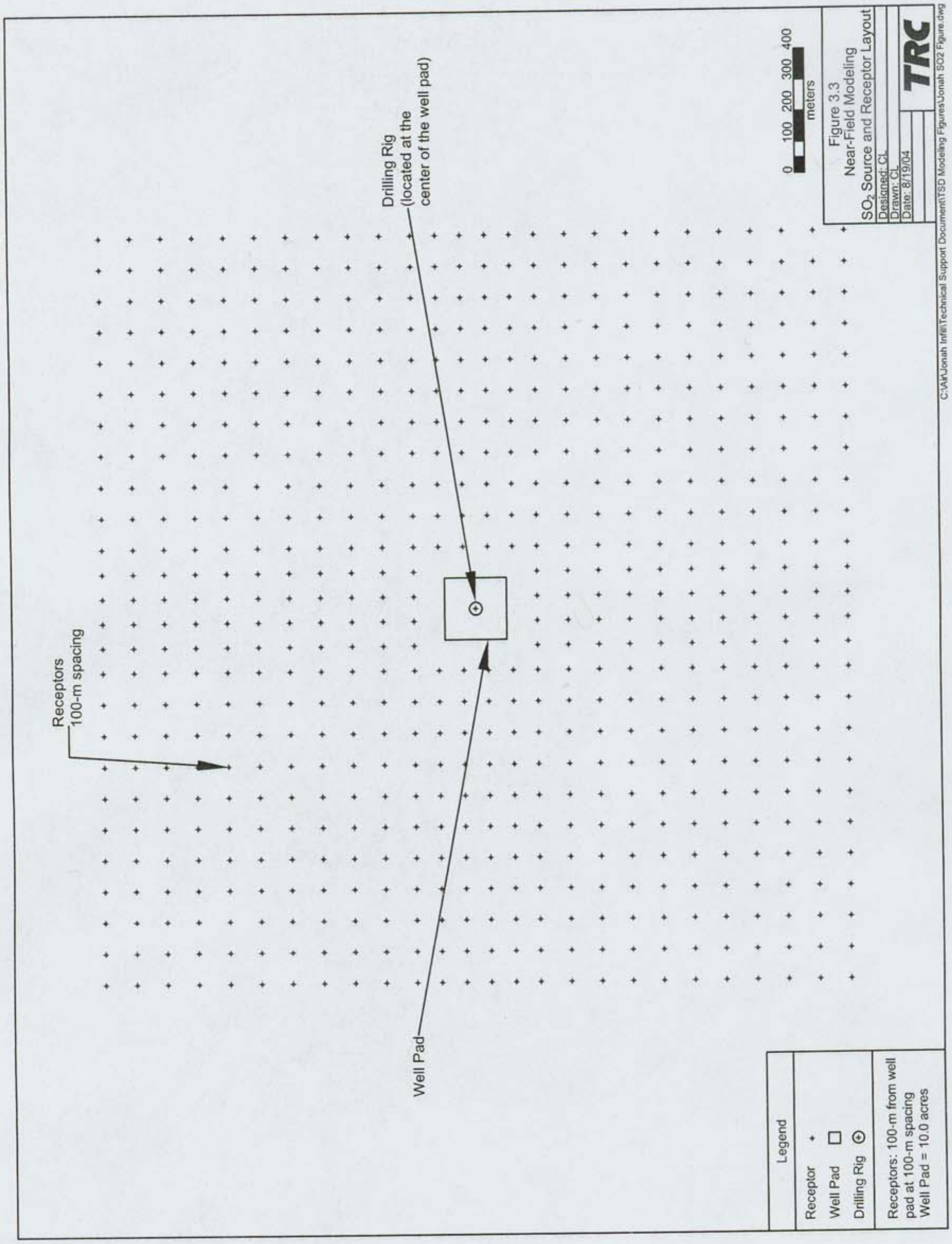


Figure 3.3 Near-field Modeling SO_2 Source and Receptor Layout.

Table 3.4 Maximum Modeled SO_2 Concentrations, Jonah Infill Drilling Project.

Scenario	Pollutant	Averaging Time	Direct Modeled ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted ($\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
Straight Drilling	SO_2	3-Hour	103.8	132	235.8	1,300	1,300
		24-Hour	36.7	43	79.7	260	365
		Annual	5.2	9	14.2	60	80
Directional Drilling	SO_2	3-Hour	128.3	132	260.3	1,300	1,300
		24-Hour	45.3	43	88.3	260	365
		Annual	6.4	9	15.4	60	80

Two modeling analyses were performed to estimate near-field NO_2 concentrations. Scenario 1 utilized compressor emissions from the proposed compressor station expansions within the Jonah Field in combination with well emissions from the Proposed Action and alternative expansions of either 3,100 or 1,250 wells (the maximum range of well development for all Project alternatives). Scenario 2 utilized the projected compression expansions proposed within the Jonah and Pinedale Anticline fields, well site heater emissions from 198 wells developed in the JIDPA since January 2002, well site emissions from either 3,100 or 1,250 proposed wells and an inventory of existing regional compressor station emissions provided by the WDEQ-AQD. A WDEQ-AQD regional compressor station inventory has historically been required for use in ambient air quality compliance demonstrations performed under WDEQ-AQD guidance. The modeled impacts from the first analysis are reported as the maximum predicted direct impacts from the Proposed Action and alternatives, and results of the second analysis are representative of near-field cumulative impacts, since they include contributions from additional regional emissions. This near-field cumulative analysis is presented to further demonstrate regional compliance with ambient air quality standards and PSD increments.

Figure 3.4 illustrates all components of modeled Scenarios 1 and 2, above. NO_x emissions provided in Section 2.1.2 for well site heaters and truck tail pipe emissions were modeled

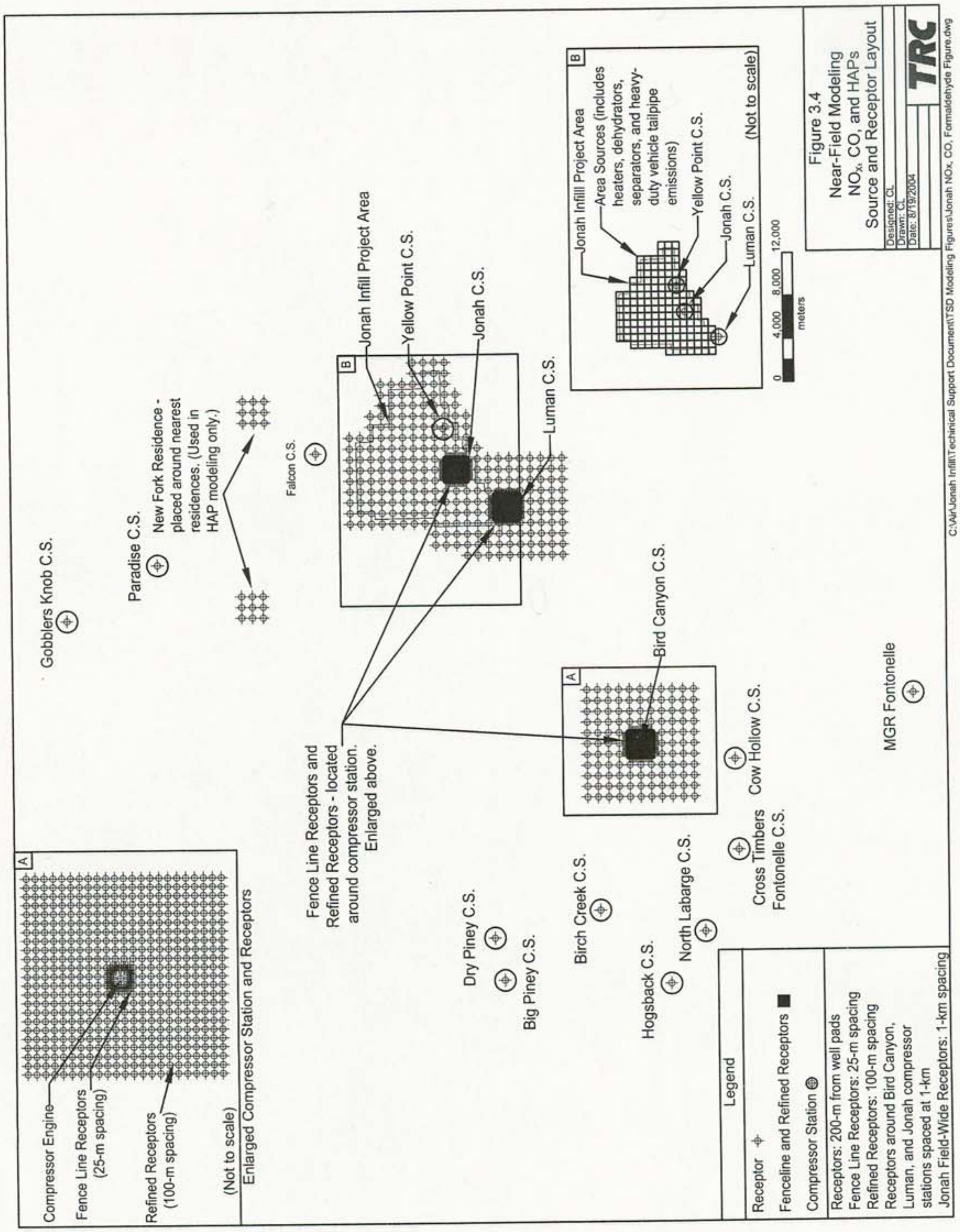


Figure 3.4 Near-field Modeling NO_x, CO, and HAPs Source and Receptor Layout.

using 1-km-spaced area sources placed throughout the JIDPA. Emissions scalars were used to adjust the heater emissions for seasonal variations. Point sources were used for modeling all compressor station emissions and water disposal well emissions. The compressor station emissions and modeling parameters utilized in near-field NO_x modeling Scenarios 1 and 2 are provided in Appendix D.

Refined receptor grids were placed around the Bird Canyon, Jonah, and Luman compressor stations, which are the largest compressor stations associated with the Jonah Field operations. Model receptors were placed at 25-m intervals along the fence lines of these compressor stations and at 100-m intervals from the fence lines out to 2 km, and at 1-km intervals between 2 km and 5 km from the fence lines of the Bird Canyon and Luman compressor stations, and at 1-km intervals throughout the JIDPA. AERMAP was used to determine receptor height parameters from digitized elevation map (DEM) data. Aerodynamic building downwash parameters were considered for each compressor station.

The AERMOD model was used to predict maximum NO_x impacts for modeled Scenario 1 (direct project impacts) and modeled Scenario 2 (cumulative impacts). The maximum modeled concentrations occurred near the Luman compressor station, near the southwest end of the JIDPA. Maximum modeled NO_2 concentrations were determined by multiplying maximum predicted NO_x concentrations by 0.75, in accordance with EPA's Tier 2 NO_x to NO_2 conversion method (EPA 2003a). Maximum predicted NO_2 concentrations are given in Table 3.5.

As shown in Table 3.5, direct modeled NO_2 concentrations from both project sources and from cumulative sources are below the PSD Class II Increment for NO_2. In addition, when these NO_2 impacts are combined with representative background NO_2 concentrations, they are below the applicable WAAQS and NAAQS.

Table 3.5 Maximum Modeled Annual NO_2 Concentrations, Jonah Infill Drilling Project.

Scenario	Pollutant	Direct Modeled ($\mu g/m^3$)	PSD Class II Increment ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted ($\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
Scenario 1, Project Alone, 3,100 Wells	NO_2	6.8	25	3.4	10.2	100	100
Scenario 1, Project Alone, 1,250 Wells	NO_2	6.5	25	3.4	9.9	100	100
Scenario 2, Cumulative Sources, 3,100 Wells	NO_2	18.9	25	3.4	22.3	100	100
Scenario 2, Cumulative Sources, 1,250 Wells	NO_2	18.6	25	3.4	22.0	100	100

3.4.4 CO

Maximum CO emissions would occur from the same production activities (well site and compression) that result in maximum NO_2 impacts. The modeling scenarios used to model NO_2 impacts were also used to determine maximum CO direct Project and cumulative impacts (see Figure 3.4).

AERMOD was used to predict maximum CO impacts for model Scenario 1 (direct Project impacts) and model Scenario 2 (cumulative impacts). Maximum predicted CO concentrations are shown in Table 3.6. As indicated in Table 3.6, maximum modeled CO concentrations, when combined with representative background CO concentrations, are below the applicable WAAQS and NAAQS.

Table 3.6 Maximum Modeled CO Concentrations, Jonah Infill Drilling Project.

Scenario	Pollutant	Averaging Time	Direct Modeled ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Predicted $\mu g/m^3$)	WAAQS ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)
Scenario 1, Project Alone, 3,100 Wells	CO	1-Hour	425.3	3,336	3,761.3	40,000	40,000
		8-Hour	113.5	1,381	1,494.5	10,000	10,000
Scenario 1, Project Alone 1,250 Wells	CO	1-Hour	171.5	3,336	3,507.5	40,000	40,000
		8-Hour	45.8	1,381	1,426.8	10,000	10,000
Scenario 2, Cumulative Sources, 3,100 Wells	CO	1-Hour	459.1	3,336	3,795.1	40,000	40,000
		8-Hour	266.0	1,381	1,647.0	10,000	10,000
Scenario 2, Cumulative Sources, 1,250 Wells	CO	1-Hour	439.0	3,336	3,775.0	40,000	40,000
		8-Hour	262.1	1,381	1,643.1	10,000	10,000

3.4.4 O_3

O_3 is formed in the atmosphere as a result of photochemical reactions involving ambient concentrations of NO_2 and VOCs. Because of the complex photochemical reactions necessary to form O_3, compliance with ambient air quality standards cannot be determined with conventional dispersion models. Instead, a nomograph developed from the Reactive Plume Model (Scheffe 1988) was used to predict maximum ozone impacts. This screening methodology, utilizes NO_x and VOC emissions ratios to estimate ozone concentrations.

NO_x and VOC emissions are greatest during production activities and these emissions were used to estimate O_3 impacts. Emissions from a 1-mi^2 "patch" of 128 wells, which is the maximum proposed Project well density (128 wells per mi^2; 5-acre spacing) and the emissions from the Luman compressor station were used. This scenario was selected since the Luman station is the largest compressor station and the largest NO_x source within or adjacent to the JIDPA. The emissions assumed for the Luman station were 171.6 and 124.7 tons per year (tpy) of NO_x and

VOC, respectively, and these emissions include anticipated future compression expansion. The emissions used for the 128 well section were 5.8 tpy (NO_x) and 3,703.5 tpy (VOC), and assume that all wells have no VOC control. The ratio of total VOC emissions to total NO_x emissions is 3,828.2:177.3 or 21.6. At this ratio, the estimated maximum potential 1-hour O_3 concentration is 0.057 parts per million (ppm) or 111.8 micrograms/cubic meter ($\mu g/m^3$). Using EPA's recommended screening conversion factor of 0.7 to convert 1-hour concentrations to 8-hour values (EPA 1977), the predicted 8-hour O_3 concentration is 78.3 $\mu g/m^3$. Predicted maximum O_3 impacts are summarized in Table 3.7.

The maximum O_3 impacts shown in Table 3.7 represent the amount of O_3 that could potentially form within and nearby the JIDPA as a result of the ratio of direct project emissions of NO_x and VOC. Direct modeled concentrations shown in Table 3.7 were added to average hourly background O_3 conditions monitored as part of the Green River Basin Visibility Study (ARS 2002) during the period June 10, 1998, through December 31, 2001. This value 75.2 $\mu g/m^3$ is slightly higher than the background O_3 concentration of 62.6 $\mu g/m^3$ used in the RPM modeling to derive the Scheffe nomograph. The highest, second highest O_3 concentrations measured over the monitoring period of record, shown in Table 3.1, were not added concentrations estimated with the Scheffe method since it is overly conservative to add a maximum concentration to a screening level estimated concentration. O_3 formation is a complex atmospheric chemistry process that varies greatly due to meteorological conditions and the presence of ambient atmospheric concentrations of many chemical species. Adding NO_x and VOC emissions to the ambient air, where some amount of O_3 has already formed, is not necessarily an indication that the potential for ozone formation has increased. In fact, it could decrease, since the ambient background conditions that caused O_3 formation have changed, and the new mixture of chemical species in the atmosphere may not be conducive to O_3 formation. In addition, the concentrations shown in Table 3.7 are likely overestimates of the actual O_3 impacts that would occur, since the Reactive Plume Model nomograph used to derive these estimates was developed using meteorological conditions (high temperatures and stagnant conditions) more conducive to forming O_3 than the conditions found in southwestern Wyoming.

Table 3.7 Maximum Modeled O_3 Concentrations, Jonah Infill Drilling Project.

Pollutant	Averaging Time	Direct Modeled (μg/m^3)	GRBVS Average 1-hour Background (μg/m^3)	Total Predicted (μg/m^3)	WAAQS (μg/m^3)	NAAQS (μg/m^3)
O_3	1-Hour	111.8	75.2	187.0	235	235
	8-Hour	78.3	75.2	153.5	157	157

3.5 HAP IMPACT ASSESSMENT

AERMOD was used to determine HAP impacts in the immediate vicinity of the JIDPA emission sources for short-term (acute) exposure assessment and at the nearest residences to the JIDPA for calculation of long-term risk. Sources of HAPs include well-site fugitive emissions (BTEX and n-hexane), completion flaring and venting (BTEX and n-hexane), and compressor station combustion emissions (formaldehyde). Because maximum field-wide annual emissions of HAPs occur during the production phase, only HAP emissions from production were analyzed for long-term risk assessment. Short-term exposure assessments were performed for production HAP emissions using various well densities, and for an individual well construction completion (venting and flaring) event.

Four modeling scenarios were developed for modeling short-term (1-hour) HAPs (BTEX, and n-hexane) from well-site fugitive emissions. These scenarios were developed to represent the complete range of well densities proposed for the Proposed Action and alternatives. The scenarios include one-section areas (1 mi^2), with wells at 5-, 10-, 20-, and 40-acre surface spacing. These modeling scenarios represent well densities of 128, 64, 32, and 16 wells per section, respectively. The purpose of modeling this range of well density was to determine the maximum HAP short-term (1-hour) impacts that could occur within and near the JIDPA. Volume sources were used for modeling the well-site fugitive HAP emissions. The HAP emissions for wells with uncontrolled VOC emissions were used. Flat terrain receptors were spaced evenly and at a maximum distance of 100 m from a well, throughout each section. The source and receptor layouts utilized for the short-term HAP modeling are presented in Figure 3.5.

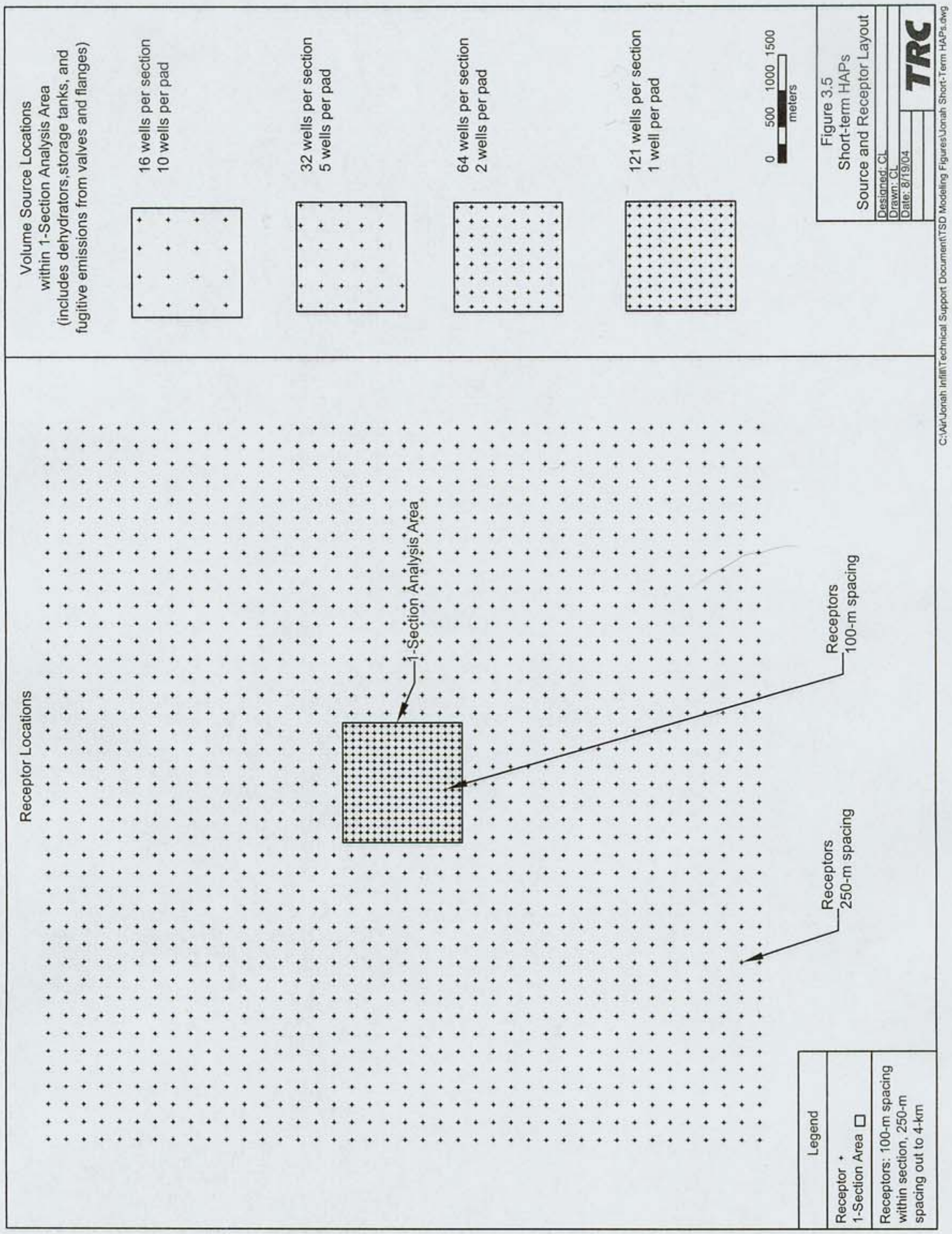


Figure 3.5 Short-term HAPs Source and Receptor Layout.

A single scenario was developed for modeling long-term (annual) fugitive HAP emissions. This scenario utilized the same 1-km spaced area sources placed throughout the JIDPA that were used for modeling NO_x emissions from well site heaters (see Section 3.4.3 and Figure 3.4). Fugitive HAP model runs were performed for both 3,100 and 1,250 wells in production. Field-wide emissions scenarios were developed using the individual well emissions provided in Section 2.2, assuming 50% of condensate storage tanks are equipped with a control device and 25% of dehydrators are equipped with a control device. Receptor grids (3 x 3) using 1-km spacing were placed at the nearest residential locations along the New Fork River north of the JIDPA (see Figure 3.4). Receptor elevations were determined from U.S. Geological Survey (USGS) DEM data using AERMAP.

For modeling formaldehyde emissions from compressor station sources, an analysis similar to that performed for NO_2 and CO (see Sections 3.4.3 and 3.4.4) was used. Formaldehyde emissions from anticipated future compression expansions at the Bird Canyon, Falcon, Gobblers Knob, Jonah, Luman, and Paradise compressor stations were modeled in combination with emissions from the WDEQ-AQD inventory of existing regional compressor stations. These emissions are provided in Appendix D. Modeled Scenarios 1 and 2 were analyzed as described in Section 3.4. The modeling parameters and receptor grids developed for the NO_x and CO impacts analyses and the receptor grids at the nearest residential locations along the New Fork River were utilized for modeling formaldehyde impacts. Long-term impacts are reported for the residential receptor locations. The source and receptor layout for modeling formaldehyde impacts is presented in Figure 3.4.

Reference Exposure Levels (RELs) are defined as concentrations at or below which no adverse health effects are expected. Since no RELs are available for ethylbenzene and n-hexane, the available Immediately Dangerous to Life or Health (IDLH) values were used. These REL and IDLH values are determined by the National Institute for Occupational Safety and Health (NIOSH) and were obtained from EPA's Air Toxics Database (EPA 2002). Modeled short-term HAP concentrations are compared to REL and IDLH values in Table 3.8. As shown in Table 3.8

Table 3.8 Maximum Modeled 1-Hour HAP Concentrations, Jonah Infill Drilling Project.

	Direct Modeled Concentration by Modeling Scenario (µg/m^3)				REL or IDLH[1] (µg/m^3)
HAP	5-Acre Spacing	10-Acre Spacing	20-Acre Spacing	40-Acre Spacing	
Benzene	996	566	590	309	1,300
Toluene	1,994	1,132	1,181	619	37,000
Ethylbenzene	109	62	64	34	35,000
Xylene	1,085	616	643	337	22,000
n-Hexane	536	304	317	166	39,000
	Project Alone	Cumulative Sources			
Formaldehyde	22.1	31.9	--	--	94

1 EPA (2002).

the maximum predicted short-term HAP impacts within and near the JIDPA would be below the REL or IDLH values under all Project alternatives.

Additional modeling analyses with AERMOD were performed to quantify the maximum short term HAP (BTEX and n-hexane) concentrations that could potential occur from well site completion venting and flaring. For wells that require these activities, it is estimated that venting operations could last up to 4 hours and flaring could last up to 80 hours. A single volume source was used for modeling completion venting and a single point source was used for modeling flaring. 100-m spaced receptors beginning at a distance of 100 m from each source were used. The results of these modeling analyses indicated that from flaring operations short-term HAP concentration would be below the REL or IDLH values. From venting operations short-term benzene concentrations could potentially exceed the thresholds within 500 meters of a completion venting operation, however, all other HAP concentrations would be below the REL or IDLH.

Long-term (annual) modeled HAP concentrations at the nearest residence are compared to Reference Concentrations for Chronic Inhalation (RfCs). A RfC is defined by EPA as the daily inhalation concentration at which no long-term adverse health effects are expected. RfCs exist for both non-carcinogenic and carcinogenic effects on human health (EPA 2002). The maximum predicted annual HAP concentrations at the nearest residential area are compared to the corresponding non-carcinogenic RfC in Table 3.9.

As shown in Table 3.9 the maximum predicted long-term (annual) HAP impacts at the nearest residence locations along the New Fork River would be below the RfCs for all analyzed alternatives. In addition, formaldehyde impacts at the nearest residence are shown to be below the RfC thresholds when Project source impacts are combined with regional source impacts.

Long-term exposures to emissions of suspected carcinogens (benzene and formaldehyde) were evaluated based on estimates of the increased latent cancer risk over a 70-year lifetime. This analysis presents the potential incremental risk from these pollutants, and does not represent a total risk analysis. The cancer risks were calculated using the maximum predicted annual concentrations and EPA's chronic inhalation unit risk factors (URF) for carcinogenic constituents

Table 3.9 Maximum Modeled Long-term (Annual) HAP Concentrations, Jonah Infill Drilling Project.

	Direct Modeled Concentration at Nearest Residence by Modeling Scenario (μg/m^3)		
HAP	3,100 Wells	1,250 Wells	Non-carcinogenic RfC[1] (μg/m^3)
Benzene	0.85	0.35	30
Toluene	1.73	0.71	400
Ethylbenzene	0.09	0.04	1,000
Xylene	0.93	0.38	430
n-Hexane	0.35	0.14	200
	Project Alone	Cumulative Sources	
Formaldehyde	0.003	0.02	9.8

1 EPA (2002).

(EPA 2002). Estimated cancer risks were evaluated based on the Superfund National Oil and Hazardous Substances Pollution Contingency Plan (EPA 1993), where a cancer risk range of 1 x 10^{-6} to 1 x 10^{-4} is generally acceptable. Two estimates of cancer risk are presented: 1) a most likely exposure (MLE) scenario; and 2) a maximum exposed individual (MEI) scenario. The estimated cancer risks are adjusted to account for duration of exposure and time spent at home.

The adjustment for the MLE scenario is assumed to be 9 years, which corresponds to the mean duration that a family remains at a residence (EPA 1993). This duration corresponds to an adjustment factor of 9/70 = 0.13. The duration of exposure for the MEI scenario is assumed to be 50 years (i.e., the LOF), corresponding to an adjustment factor of 50/70 = 0.71. A second adjustment is made for time spent at home versus time spent elsewhere. For the MLE scenario, the at-home time fraction is 0.64 (EPA 1993), and it is assumed that during the rest of the day the individual would remain in an area where annual HAP concentrations would be one quarter as large as the maximum annual average concentration. Therefore, the final MLE adjustment factor is (0.13) x [(0.64 x 1.0) + (0.36 x 0.25)] = 0.0949. The MEI scenario assumes that the individual is at home 100% of the time, for a final MEI adjustment factor of (0.71 x 1.0) = 0.71.

For each constituent, the cancer risk is computed by multiplying the maximum predicted annual concentration by the URF and by the overall exposure adjustment factor. The cancer risks for both constituents are then summed to provide an estimate of the total inhalation cancer risk.

The modeled long-term risk from benzene and formaldehyde are shown in Table 3.10 for both the 3,100-well and 1,250-well scenarios. For each scenario, the maximum predicted formaldehyde concentration representative of cumulative impacts was used. Under the MLE scenario, the estimated cancer risk associated with long-term exposure to benzene and formaldehyde is below 1 x 10^{-6} for both 3,100-well and 1,250-well cases. Under the MEI analyses, for each modeling scenario, the incremental risk for formaldehyde is less than 1 x 10^{-6}, and both the incremental risk for benzene and the combined incremental risk fall on the lower end of the cancer risk range of 1 x 10^{-6} to 1 x 10^{-4}.

Table 3.10 Long-term Modeled MLE and MEI Cancer Risk Analyses, Jonah Infill Drilling Project.

Modeling Scenario	Analysis	HAP Constituent	Modeled Concentration (μg/m^3)	Unit Risk Factor 1/(μg/m^3)	Exposure Adjustment Factor	Cancer Risk
3,100 Wells	MLE	Benzene	0.85	7.8×10^{-6}	0.0949	0.63×10^{-6}
		Formaldehyde	0.02	1.3×10^{-5}	0.0949	0.02×10^{-6}
Total Combined						0.6×10^{-6}
3,100 Wells	MEI	Benzene	0.85	7.8×10^{-6}	0.71	4.73×10^{-6}
		Formaldehyde	0.02	1.3×10^{-5}	0.71	0.18×10^{-6}
Total Combined						4.9×10^{-6}
1,250 Wells	MLE	Benzene	0.35	7.8×10^{-6}	0.0949	0.26×10^{-6}
		Formaldehyde	0.02	1.3×10^{-5}	0.0949	0.02×10^{-6}
Total Combined						0.3×10^{-6}
1,250 Wells	MEI	Benzene	0.35	7.8×10^{-6}	0.71	1.94×10^{-6}
		Formaldehyde	0.02	1.3×10^{-5}	0.71	0.18×10^{-6}
Total Combined[1]						2.1×10^{-6}

[1] Total risk is calculated here; however, the additive effects of multiple chemicals are not fully understood and this should be taken into account when viewing these results.

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.

	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		
Emissions	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

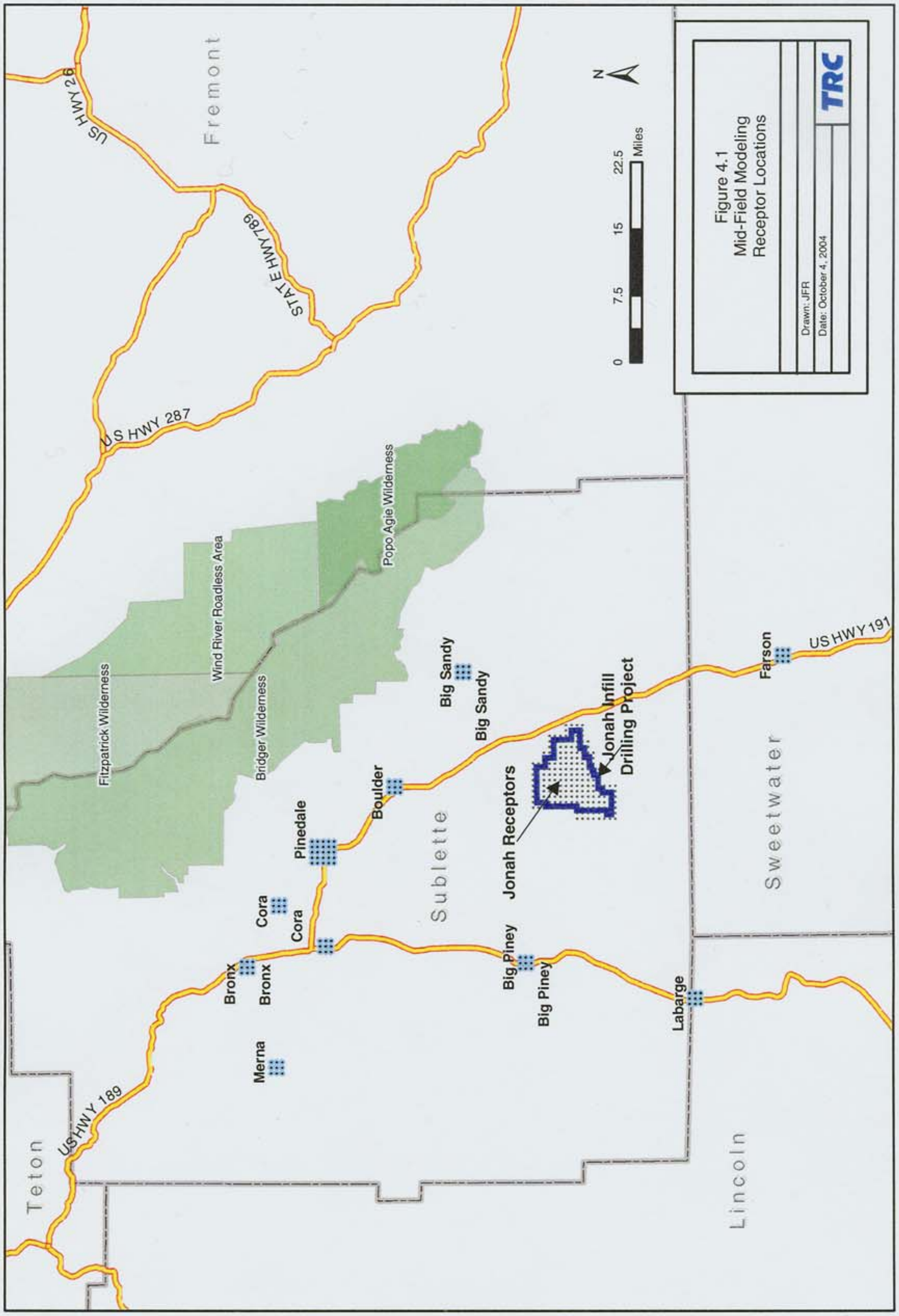


Figure 4.1 Mid-field Modeling Receptor Locations.

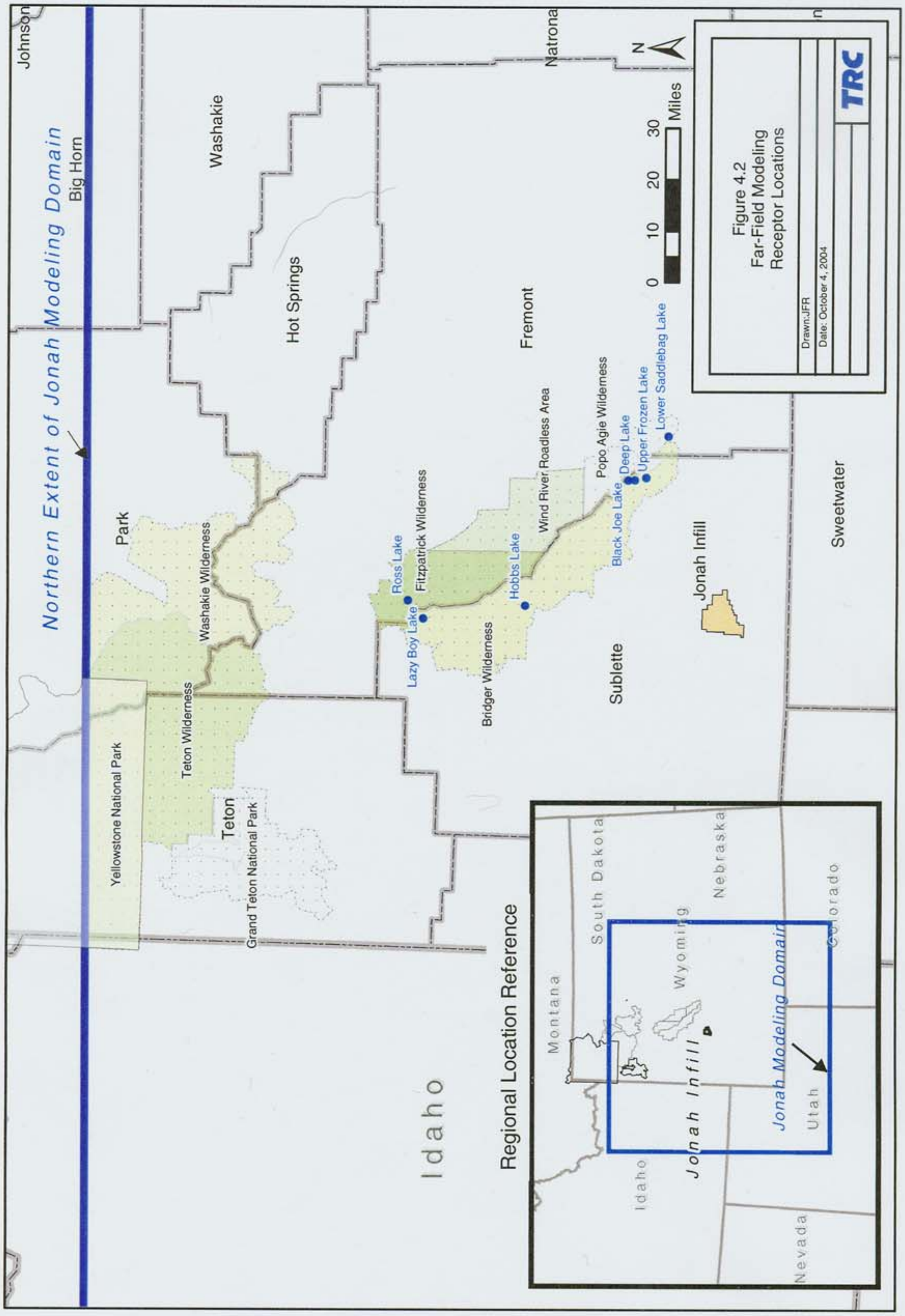


Figure 4.2 Far-field Modeling Receptor Locations.

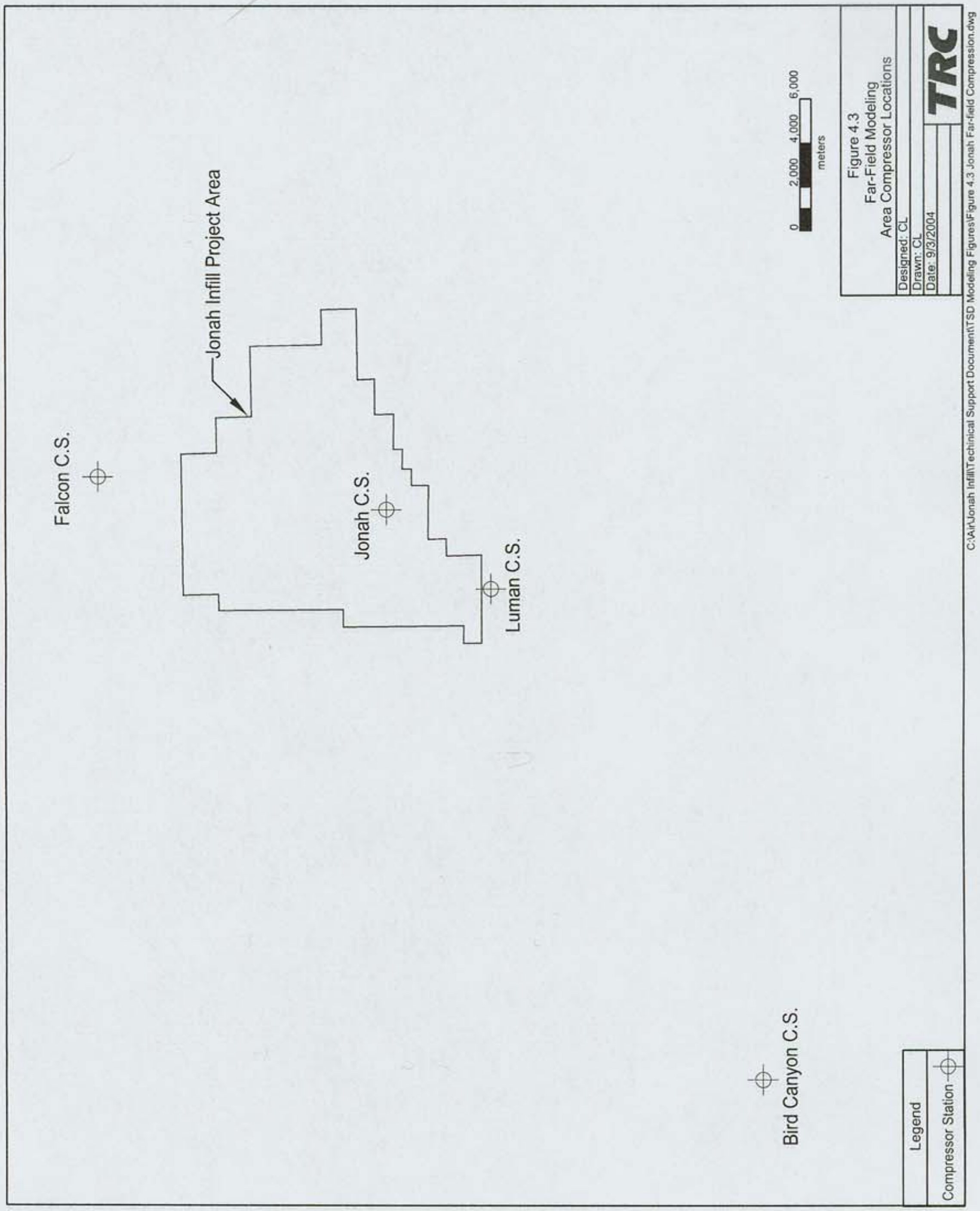


Figure 4.3 Far-field Modeling Area Compressor Locations.

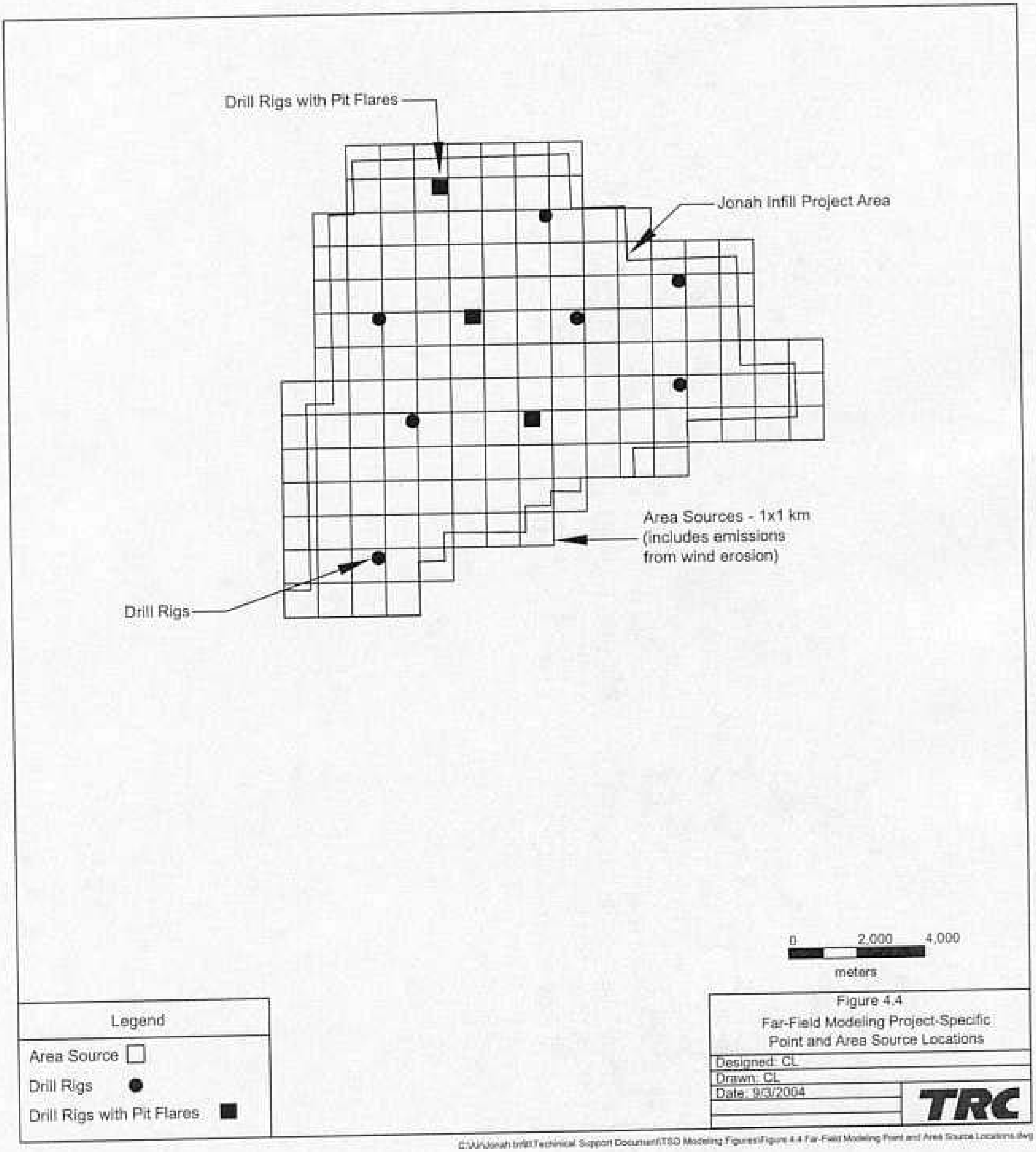


Figure 4.4 Far-field Modeling Project-Specific Point and Area Source Locations.

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,

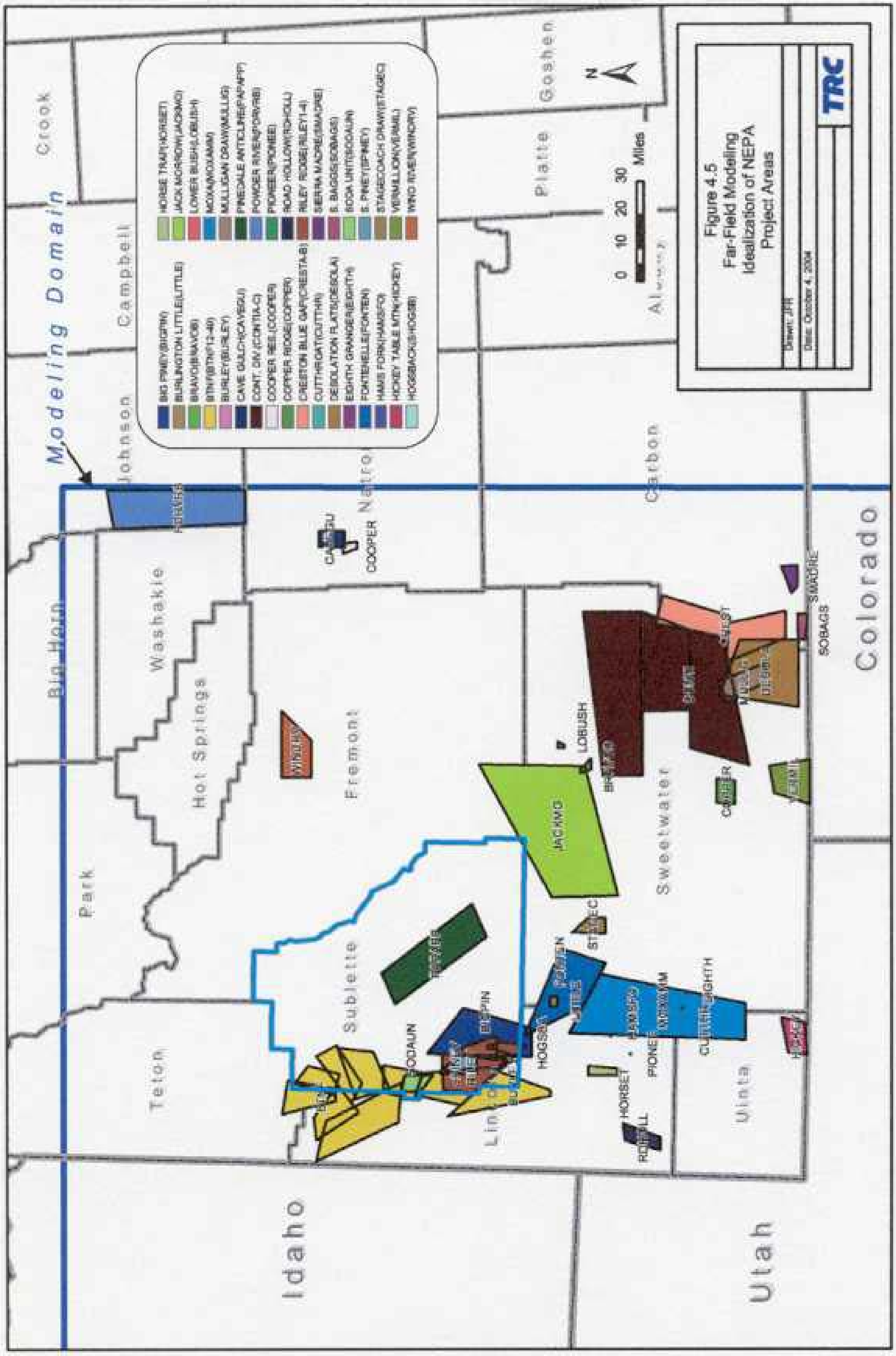


Figure 4.5 Far-field Modeling Idealization of NEPA Project Areas.

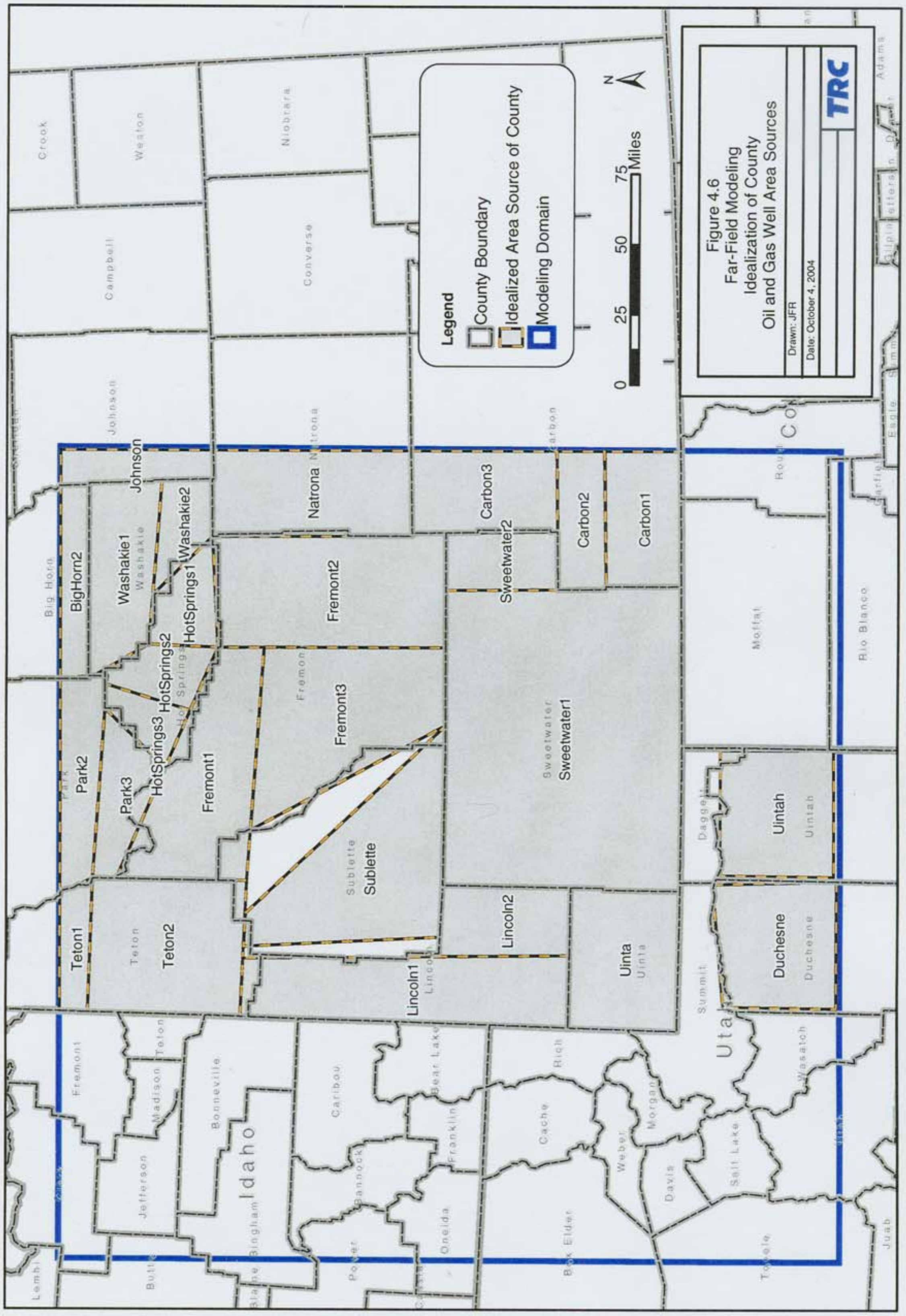


Figure 4.6 Far-field Modeling Idealization of County Oil and Gas Well Area Sources.

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 10th 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.

<u>4.6.1 Concentration</u>

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 ($\mu g/m^3$).

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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