Air Quality Impact Analysis TSD Report

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List of Acronyms and Abbreviations

µeq/l	Microequivalents per liter
µg/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
BTEX	Benzene, toluene, ethylbenzene, and xylene
C.F.R.	*Code of Federal Regulations*
CDPHE/APCD	Colorado Department of Public Health and Environment/Air Pollution Control Division
CO	Carbon monoxide
COGCC	Colorado Oil and Gas Conservation Commission
DAT	Deposition analysis thresholds
DEM	Digital elevation model
dv	Deciview
EIS	Environmental impact statement
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
JIDP	Jonah Infill Drilling Project
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
PAPA	Pinedale Anticline Project Area
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
Protocol	Air Quality Impact Assessment Protocol
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
S	Sulfur
SO_2	Sulfur dioxide
SO_4	Sulfate
tpy	Tons per year
TRC	TRC Environmental Corporation
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
WAAQS	Wyoming Ambient Air Quality Standards
WAQSR	Wyoming Air Quality Standards and Regulations
WDEQ	Wyoming Department of Environmental Quality
WOGCC	Wyoming Oil and Gas Conservation Commission
WRAP	Western Regional Air Partnership
WYDOT	Wyoming Department of Transportation

1.0 INTRODUCTION

This Air Quality Impact Analysis Technical Support Document (Air Quality TSD) was prepared to summarize analyses performed to quantify impacts from the proposed project in the Pinedale Anticline Project Area (PAPA) to ambient air quality and Air Quality Related Values (AQRVs) from: 1) air emissions resulting from development and production activities within the PAPA during 2005; 2) potential air emissions from development and production within the PAPA after 2005 that could occur under the Proposed Action and Alternative C; 3) potential air emissions after 2005 resulting from continued development and production activities under the No Action Alternative; and 4) air emissions from other documented regional emissions sources within the study area.

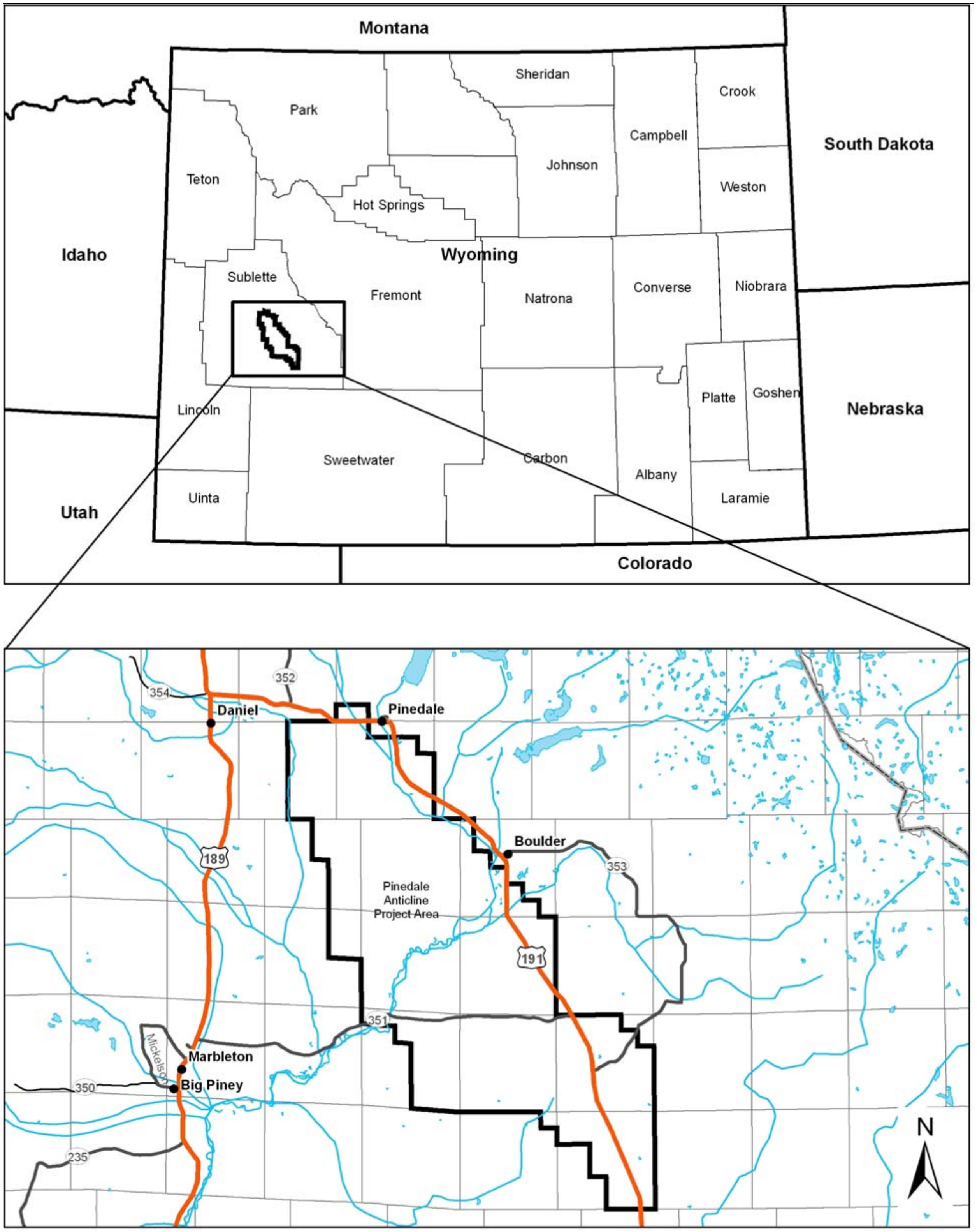
Ambient air quality impacts were quantified and compared to applicable state and federal standards. AQRV impacts (visibility [regional haze], acid deposition, and potential increases in acidification to acid sensitive lakes) were quantified and compared to applicable thresholds as defined in the Federal Land Managers' (FLMs') Air Quality Related Values Workgroup (FLAG), IWAQM guidance documents (FLAG, 2000 and IWAQM, 1998), and other state and federal agency guidance.

The methodologies utilized in the analysis were originally defined in an air quality impact assessment protocol (Protocol) prepared by TRC Environmental Corporation 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-FS), and Wyoming Department of Environmental Quality - Air Quality Division (WDEQ-AQD). The protocol is included in Appendix A.

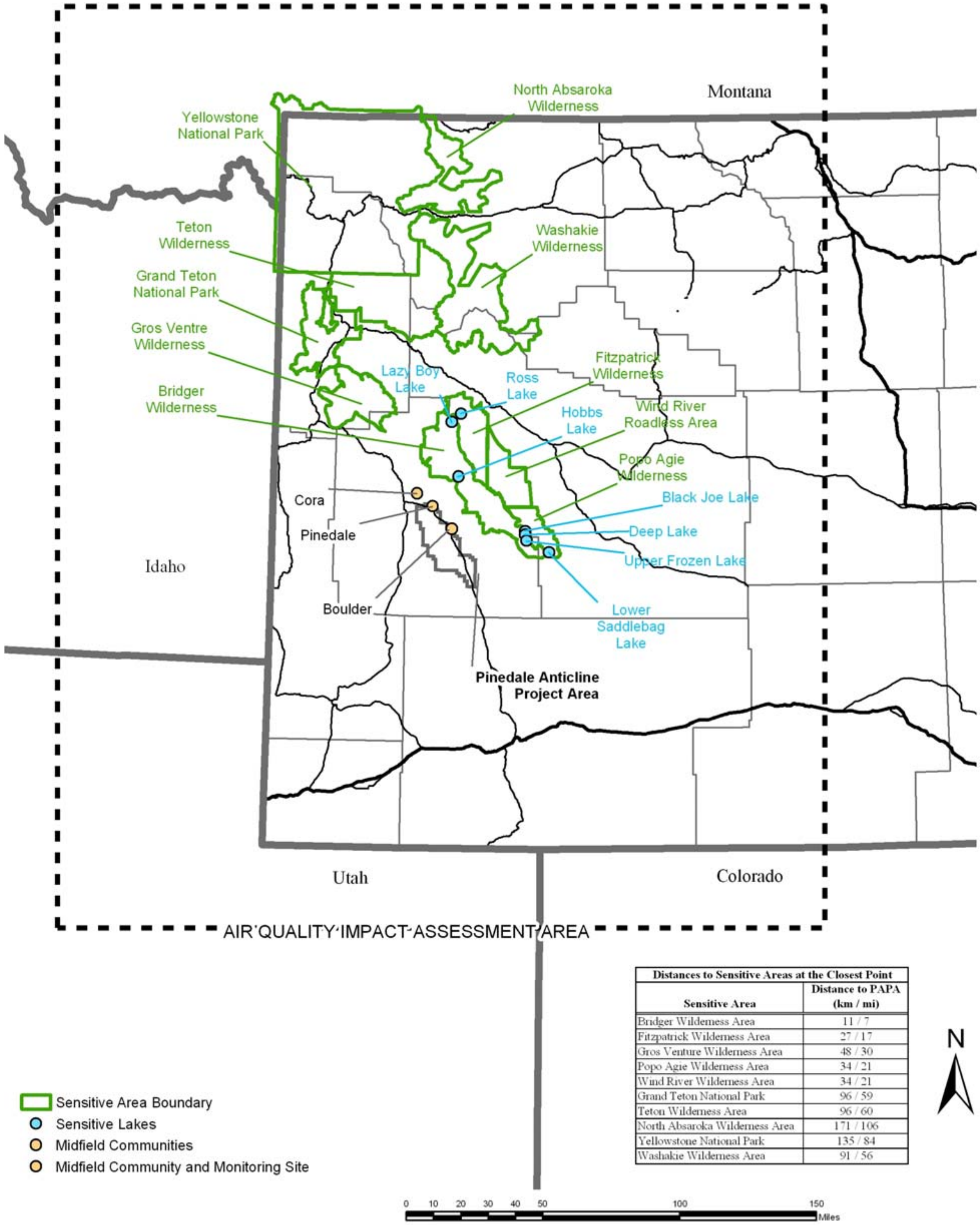
The project's location in west-central Wyoming required the examination of project and cumulative source impacts in Wyoming, northwestern Colorado, northeastern Utah, and southeastern Idaho within a defined study area (modeling domain) (Maps 1.1 and 1.2). The analysis area includes the area surrounding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

The remainder of this Air Quality TSD describes the project in further detail, provides a description of the alternatives 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 near-field and far-field (includes in-field and mid-field) direct and cumulative impacts.

Map 1.1
Pinedale Anticline Project Location, Sublette County Wyoming



Map 1.2
Air Quality Impact Assessment Area



Distances to Sensitive Areas at the Closest Point	
Sensitive Area	**Distance to PAPA (km / mi)**
Bridger Wilderness Area	11 / 7
Fitzpatrick Wilderness Area	27 / 17
Gros Venture Wilderness Area	48 / 30
Popo Agie Wilderness Area	34 / 21
Wind River Wilderness Area	34 / 21
Grand Teton National Park	96 / 59
Teton Wilderness Area	96 / 60
North Absaroka Wilderness Area	171 / 106
Yellowstone National Park	135 / 84
Washakie Wilderness Area	91 / 56

Analyses of potential ozone formation from project alternative sources and regional sources were performed using the Comprehensive Air Quality Model with extensions (CAMx) photochemical grid model.

The Air Quality TSD contains eight appendices; Appendix A (Air Quality Impact Analysis Protocol); Appendices B, C, and D, which provide supplemental air quality model parameter information; Appendix E (model results summary tables); Appendix F (PAPA emissions inventory); Appendix G (regional emissions inventories); and Appendix H (Regional Ozone Assessment of the Pinedale Anticline Project and other New Source in the Region).

1.1 PROJECT DESCRIPTION

Jointly referred to as the Operators, Ultra Resources, Inc. (Ultra), Shell Exploration & Production Company (Shell), Questar Market Resources including Wexpro Company (Questar), BP America Production Company, Stone Energy Corporation, Yates Petroleum Corporation, and others who agree to participate, have notified the BLM Pinedale Field Office (PFO) that they propose a new long-term development plan that includes limited year-round drilling and completions of natural gas wells within their leaseholds in the PAPA.

As of December 31, 2005, there were approximately 322 producing well pads and 457 producing wells in the PAPA. An additional 26 pads and 205 producing wells are proposed by the Operators in 2006. The Proposed Action consists of drilling approximately 4,400 new wells (in addition to the 662 wells drilled through 2006) within the PAPA, beginning in 2007. As part of the Proposed Action, there would be up to 48 drilling rigs operating in the PAPA after 2007. The Operators propose to install emissions controls to achieve Tier 2 equivalent emissions on approximately 60 percent of the drilling rig engines by 2009. Questar has previously committed (BLM, 2005a) to install Tier 2 equivalent emission controls on all year-round drilling rigs by 2008. In 2005, a liquids (condensate and produced water) gathering system was installed in the northern leaseholds in the PAPA, reducing overall emissions through reduction in truck traffic. As part of the Proposed Action, the Operators propose to install a liquids gathering system in the central and southern portions of the PAPA. Operation of the liquids gathering system would require installation of central gathering facilities within the PAPA which would have associated emissions. Condensate would be gathered within the PAPA and the crude petroleum would be transported via pipeline to processing facilities in southwestern Wyoming. Produced water would be gathered and trucked from a central location within the PAPA. Operators are currently investigating options for produced water disposal both within and outside of the PAPA. Questar Gas Management (QGM) is proposing to install an additional 7,440 horsepower (hp) of compression at the Pinedale/Gobblers Knob Compressor Station within the PAPA in 2006. QGM also intends to install an additional compression of 31,000 hp in 2009 and 15,500 hp in 2015 at the Pinedale/Gobblers Knob Compressor Station. Jonah Gas Gathering Company (JGGC) is proposing to install an additional 184,000 hp of compression at the Paradise Compressor Station, an additional 37,366 hp at the Falcon Compressor Station and 14,672 hp at the Bird Canyon Compressor Station (outside of the PAPA) all in 2011 as part of the Proposed Action. One 30-inch gas sales pipeline (the Rendezvous Phase 6 – R6) is proposed by Rendezvous Gas Services (RGS) to transport natural gas from the PAPA to the Granger and Blacks Fork processing plants in southwestern Wyoming. JGGC is proposing the 36-inch (Paradise to Bird Canyon or PBC Pipeline) and a connecting 45.5-mile long, 30-inch pipeline (Opal Loop III Pipeline) which would transport gas from the PAPA to the Opal and Pioneer gas processing plants. In conjunction with the proposed R6 Pipeline Project, RGS proposes to expand the existing 33.6-acre Granger Gas Processing Plant by 86.4 acres, for a total of 120 acres on BLM-administered federal lands in Section 16, T. 18 N., R. 111 W. The purpose of the proposed expansion is to construct and operate additional natural gas processing facilities to sufficiently increase processing capacity for an anticipated increased input of 600 million standard cubic feet per day (MMSCF/D) of natural gas and crude petroleum. The current Granger Gas Processing Plant capacity is 600 MMSCF/D. The expansion would represent a 100 percent increase in treatment capacity.

BLM is also analyzing the No Action Alternative (Alternative A) in addition to the Proposed Action Alternative (Alternative B) and a third alternative (Alternative C). The No Action Alternative is defined as continued development of the PAPA under current BLM management practices. The Operators have provided estimates of new pads, expansion pads, and proposed number of wells that would be drilled under the No Action Alternative with continued management practices under the PAPA ROD (BLM, 2000b). However, at some point, the limits of the PAPA Record of Decision (BLM, 2000b) would be reached for maximum allowed well pads within specific Management Areas and further NEPA (National Environmental Policy Act) analysis would be required for continued development. The liquids gathering systems in the southern and central portions of the PAPA would not be installed under the No Action Alternative. The R6, PBC, and Opal Loop III pipelines would be constructed under the No Action Alternative.

Alternative C includes provisions for concentrating development activities to allow for maintenance of wildlife habitat, seasonal wildlife stipulations, as well as additional mitigation for air quality impacts. All components included in the Proposed Action Alternative are also a part of Alternative C, and therefore, emissions and associated impacts for the two alternatives would be similar, except that Alternative C includes additional mitigation.

1.2 RELATIONSHIP TO EXISTING PLANS AND DOCUMENTS

Potential impacts to air quality resulting from exploration and development of natural gas within the PAPA was previously analyzed in the Pinedale Anticline Oil and Gas Exploration and Development Environmental Impact Statement (PAPA EIS) (BLM, 2000a).

In 2004, Questar submitted a proposal to BLM for limited year-round drilling within their lease holdings in the PAPA. As part of their proposal for mitigation, Questar would install a gathering system to remove condensate and water from the PAPA (reducing truck traffic) and utilize Tier 2 compliant engines or alternate fuels on all drilling rig engines by 2007. In November 2004, BLM issued a Decision Record (BLM, 2004) approving Questar’s limited year-round drilling proposal. Although potential emissions from the proposal were disclosed, a complete air quality impact analysis was not conducted because the operator-committed mitigation would cause the impacts to be reduced. In 2005, BLM issued a Decision Record (BLM, 2005a) which allowed for modification of the proposed condensate (crude petroleum) pipeline route and extended the requirement for the drilling rig engines to become Tier 2 compliant to 2008. Again, potential emissions were disclosed but a complete air quality impact analysis was not conducted.

Also in 2005, Anschutz, Shell and Ultra (ASU) submitted a proposal to BLM for a year-round demonstration project within the PAPA. In September, 2005, BLM issued a Decision Record (BLM, 2005b) that allowed each operator to have two drilling rigs on one pad each within crucial winter range during the winter of 2005-2006. For mitigation of the air quality impacts, the operators committed to reduce emissions by testing selective catalytic reduction on two of the drilling rigs and testing bi-fuel technology on the other four drilling rigs. Because the proposal represented an overall reduction in emissions (the rigs would have operated in the PAPA outside of crucial winter range if the proposal were not approved), potential emissions were disclosed but a complete air quality impact analysis was not conducted.

In November of 2005, BLM issued a Decision Record (BLM, 2005c) that allowed Questar to have one additional winter drill rig. Four winter completions and one drill rig move were also approved.

Since the PAPA ROD (BLM, 2000b) was issued in July 2000, natural gas development within the PAPA has occurred at a pace greater than was analyzed in the PAPA DEIS (BLM, 1999) as disclosed in the subsequent NEPA documents. The PAPA ROD authorized the development of 700 producing wells and/or well pads, however, the ROD was ambiguous at to whether the limit was wells or well pads. The air quality impact analysis for the PAPA DEIS assumed 700 producing wells and up to eight drilling rigs operating in the PAPA at any one time. As of December 2005, there were approximately 457 producing wells in the PAPA with an additional 205 wells projected for 2006. Twenty-nine of the existing wells were drilled prior to the PAPA ROD, therefore, there would be potentially 633 producing wells by the end of 2006. The PAPA ROD also set an analysis threshold of 376.59 tpy NO_x emissions from compression and 693.5 tpy of NO_x emissions from all sources in the field. The PAPA ROD stated that additional environmental analysis would be conducted if the analysis thresholds were exceeded. Even though the limit of 700 producing wells and/or well pads has not been exceeded, the NO_x emissions from all sources in the PAPA currently exceeds the 693.5 tpy analysis limit specified in the PAPA ROD. For this reason, and to analyze the current proposal, BLM has determined that it is necessary to prepare a Supplemental Environmental Impact Statement (SEIS) which includes a complete and accurate air quality impact analysis.

The BLM Pinedale Resource Management Plan (RMP) (BLM, 1988) issued in 1988, amended in 2000, and currently under revision, directs the management of BLM administered lands within the PAPA. Management of oil and gas resources, as stated in the RMP, provides for leasing, exploration, and development of oil and gas while protecting other resource values. According to the RMP, all public lands in the PAPA are suitable for oil and gas leasing and development, subject to certain stipulations.

The most recent EIS completed in Sublette County is the Final EIS, Jonah Infill Drilling Project (JIDP), Sublette County, Wyoming (BLM, 2006). This Protocol represents a new and separate analyses from that performed for the JIDP EIS. With the exception of shared methodologies common to many regional modeling analyses, no portions of the JIDP air quality analysis were utilized in this study.

The BLM is currently developing a state-wide cumulative air quality analysis deemed the BLM State of the Atmosphere air quality analysis. That study is in the early development stages, and will utilize a 1-year 2002 Western Regional Air Partnership (WRAP) meteorological dataset and a separate inventory that is not yet available. No portions of the BLM State of the Atmosphere air quality analysis were utilized in this analysis.

Analyses of potential ozone formation from project alternative sources and regional sources were performed for the Pinedale Anticline Project Draft SEIS using the CALGRID model. Results from the CALGRID modeling analysis were published as a supplement (BLM, 2007) to the *Draft Supplemental Pinedale Anticline Oil and Gas Exploration and Development Environmental Impact Statement, Air Quality Impact Analysis Technical Support Document* (BLM, 2006). This Air Quality TSD includes a more refined modeling analysis for ozone using the CAMx modeling system.

1.3 STUDY TASKS

The assessment of impacts will include the completion of the following tasks:

1. **Direct Project Air Emissions Inventory.** Development of air pollutant emissions inventories for the project.
2. **Regional Source Air Emissions Inventory.** Development of an air pollutant emissions inventory for other regional sources not represented by background air quality measurements, including sources from the following:
    - state-permitted sources
    - reasonably foreseeable future actions (RFFA, and
    - reasonably foreseeable development (RFD).
3. **Direct Project Near-Field Analysis.** Assessment of near-field air quality concentration impacts resulting from activities proposed within the PAPA.
4. **Direct Project Far-Field Impact Analysis.** Assessment of far-field air quality concentration and AQRV impacts resulting from proposed project activities.
5. **Direct Project In-Field Analysis.** Assessment of concentration impacts within the PAPA resulting from the project.
6. **Direct Project Mid-Field Analysis.** Assessment of mid-field visibility impacts to regional communities resulting from the project.
7. **Cumulative Far-Field Impact Analysis.** Assessment of far-field air quality concentration and AQRV impacts resulting from proposed project activities and other regional sources.
8. **Cumulative In-Field Analysis.** Assessment of concentration impacts within the PAPA resulting from the project and other regional sources.
9. **Cumulative Mid-Field Impact Analysis.** Assessment of mid-field air quality concentration and AQRV impacts resulting from activities proposed within the PAPA and other regional sources.
10. **Ozone Analysis.** Assessment of ozone from the PAPA and other new sources in the region.

2.0 EMISSIONS INVENTORY

2.1 PROJECT EMISSIONS

The direct project emissions inventory for the PAPA is divided into four sections in Appendix:

- 2005 Actual Emissions Inventory (Section.1),
- 2005 Potential Emissions Inventory (Section 2),
- Proposed Action Emissions Inventory (Section 3), and
- No Action Emissions Inventory (Section 4).

Calculation methods are similar for each emissions inventory except as noted in the following sections. Specific details for each inventory are provided in the respective sections of Appendix F.

Criteria pollutant and hazardous air pollutant (HAP) emissions were inventoried for construction activities, production activities, and ancillary facilities. Criteria pollutants included nitrogen dioxide (NO_2), 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 consist 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), WDEQ-AQD additional guidance for the Jonah and Pinedale Anticline Gas Fields (WDEQ-AQD 2004), stack test data, EPA's AP-42, or other accepted engineering methods (see Appendix F, Section1). Actual 2005 emissions were obtained from emissions inventories submitted by PAPA Operators to WDEQ-AQD, when available. Emissions not quantified in these inventories were conservatively assumed to be equal to those calculated for the 2005 potential emissions inventory.

2.1.1 Construction Emissions

Construction activities are a source of primarily criteria pollutants. Emissions would occur from construction (well pads, roads, gathering pipelines, and ancillary facilities), drilling, completion/testing, traffic, and wind erosion. Well development rates were provided by the Operators based on their future projections for both the Proposed Action Alternative and the No Action Alternative. These well development rates vary by alternative. Detailed well development rates per year can be found in the tables of Appendix F.

Emissions from construction of well pads and roads and traffic include fugitive PM_{10} and $PM_{2.5}$. Other criteria pollutant emissions would occur from diesel combustion in haul trucks and heavy construction equipment. On well pads and resource roads, water would be used for fugitive dust control, with a control efficiency of 50%. On local roads, magnesium chloride would be used for dust control, with a control efficiency of 85%.

After the well pad is constructed, rig-move/drilling would begin. Emissions would include fugitives from unpaved road travel to and from the drilling site. There would be emissions from diesel drilling engines and from boilers in the winter months. Emissions from well completion and testing would include fugitive PM_{10} and $PM_{2.5}$ from traffic. It would also include combustion emissions from diesel fracturing engines and haul truck tailpipes. All completions would be “green completions” with no flaring other than for upset/emergency conditions.

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

Construction emission calculations are provided in detail, showing all emission factors, input parameters, and assumptions, in Appendix F.

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

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 production facilities include separator/indirect line heaters and dehydrator reboiler heaters. These heaters are sources of mainly NO_x and CO as well as small amounts of VOCs. Emissions from these sources were calculated on run-time percentages for both the summer and winter seasons based on data provided by Operators.

VOC and HAP 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. VOC and HAP emissions would decrease over the life of an individual well due to declines in condensate and gas production. Emissions from these sources were based on information provided by Operators.

Production emission calculations are provided in detail, showing all emission factors, input parameters, and assumptions, in Appendix F.

2.1.3 Total Field Emissions

Estimates of maximum potential annual emissions in the PAPA under the No Action and Proposed Action alternatives, and for year 2005 are shown in Table 2.1. Maximum potential annual emissions assume construction and production occurring simultaneously in the field for the maximum emissions year for each project alternative.

Table 2.1 Estimated Potential Emissions by Alternative (tpy), Pinedale Anticline Project.

Source	Pollutant	Year 2005	Alternative A (No Action) 2007	Alternative B (Proposed Action) 2009
Construction Emissions				
Drill Rigs	NO_x	2590.9	4066.5	3232.6
	CO	2031.6	2445.2	2307.0
	SO_2	221.0	48.5	55.7
	PM_{10}	133.5	160.4	130.3
	$PM_{2.5}$	133.5	160.4	130.3
	VOC	244.5	292.9	271.3
Fugitives	NO_x	427.4	641.8	559.4
(Pad/Road Construction, Traffic, Completions, etc...)	CO	305.3	493.5	428.1
	SO_2	10.6	15.6	14.4
	PM_{10}	682.2	712.6	415.9
	$PM_{2.5}$	144.8	143.7	82.7
	VOC	192.9	66.1	57.0
Production Emissions				
Compression:	NO_x	421.9	472.2	532.1
	CO	157.7	175.7	235.5
	SO_2	0.0	0.0`	0.0
	PM_{10}	0.0	0.0	0.0
	$PM_{2.5}$	0.0	0.0	0.0
	VOC	320.5	353..5	357.1
Granger Gas Plant	NO_x	301.7	301.7	301.7
(Expansion)	CO	322.8	322.8	322.8
	SO_2	0.0	0.0	0.0
	PM_{10}	0.0	0.0	0.0
	$PM_{2.5}$	0.0	0.0	0.0
	VOC	140.2	140.2	140.2
Wind Erosion	PM_{10}	254.8	357.2	440.8
	$PM_{2.5}$	101.9	142.9	176.3
Fugitives	NO_x	72.2	119.8	108.8
(Heaters, dehys, tanks, traffic, other production equipment, etc…)	CO	251.1	318.7	54.8
	SO_2	0.2	0.5	0.6
	PM_{10}	128.5	311.7	73.7
	$PM_{2.5}$	21.2	51.3	17.8
	VOC	1736.5	1396.2	1150.7
Total	NO_x	3512.4	5602.0	4734.6
	CO	2745.7	3755.9	2978.3
	SO_2	231.8	64.6	70.7
	PM_{10}	1199.0	1541.9	1060.7
	$PM_{2.5}$	401.4	498.3	407.1
	VOC	2494.4	2248.9	1976.3

Well pad construction emissions were based on the number of pads proposed per year and their estimated size and scale. Drilling, drilling traffic, completions, and completion traffic were based on the number of wells developed per year.

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. A production decline factor was applied to all wells in production based on actual data from current wells provided by the Operators. This allows estimation of emissions from these sources as production volumes decrease over time. Annual emissions estimates for each project alternative for each year of field development are provided in Appendix F.

2.2 REGIONAL EMISSIONS INVENTORY

An emissions inventory of industrial sources within the PAPA 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, 2005 through February 1, 2006) through state air quality regulatory agencies and state oil and gas permitting agencies were researched. The subset of these sources which had begun operation as of the inventory end-date was classified as 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 FS 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.

A summary of the regional inventory is shown in Table 2.2. Values presented in Table 2.2 represent the change in emissions between the inventory start-date (January 1, 2005) and the inventory end-date (February 1, 2006).

The regional inventory, including methodologies used to compile the regional source emissions, are provided in Appendix G and includes 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.

Table 2.2 Regional Inventory Summary of Emissions Changes from January 1, 2005 to February 1, 2006.

State	Source Category	Quantity of Sources	Emissions NO_x (tpy)	SO_2 (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)
Colorado	State-permitted[1]	5	97.8	1.4	2.0	2.0
	RFD	0	--	--	--	--
	Excluded	82	--	--	--	--
Idaho	State-permitted[2]	4	18.9	4.0	45.9	45.9
	RFD	0	--	--	--	--
	Excluded	9	--	--	--	--
Utah	State-permitted[3]	34	13.7	(40.4)	10.0	10.0
	RFD	0	--	--	--	--
	Excluded	1	--	--	--	--
Wyoming	State-permitted[4]	150	(2,705.0)	145.7	418.6	418.6
	RFD[5]	46	6,427.8	406.1	2923.9	802.8
	Excluded	1452	--	--	--	--
Total	State Permitted	193	(2,574.6)	110.7	476.4	476.4
	RFD	46	6,465.3	406.1	2923.9	802.8
	Excluded	1,544	--	--	--	--
Total Change		--	3,853.2	516.8	3,400.4	1,279.3

1 See Appendix G, Tables G.1 and G.9.
2 See Appendix G, Table G.3.
3 See Appendix G, Tables G.5 and G.9.
4 See Appendix G, Tables G.7 and G.9.
5 See Appendix G, Table G.10.

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}, $PM_{2.5}$, SO_2, NO_2, and CO) and HAPs (BTEX, n-hexane, and formaldehyde) impacts that could occur within and near the PAPA. 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 performed in general accordance with the Protocol presented in Appendix A with input from the BLM and members of the Air Quality Stakeholders Group, including the EPA, USDA-FS, NPS, and WDEQ-AQD.

Ozone may develop from NO_x, VOC, and CO emissions. Analyses of potential ozone formation from project alternative sources and regional sources were performed using the CAMx photochemical grid model. Detailed information regarding the modeling methodologies used in the CAMx ozone analyses is provided in Appendix H.

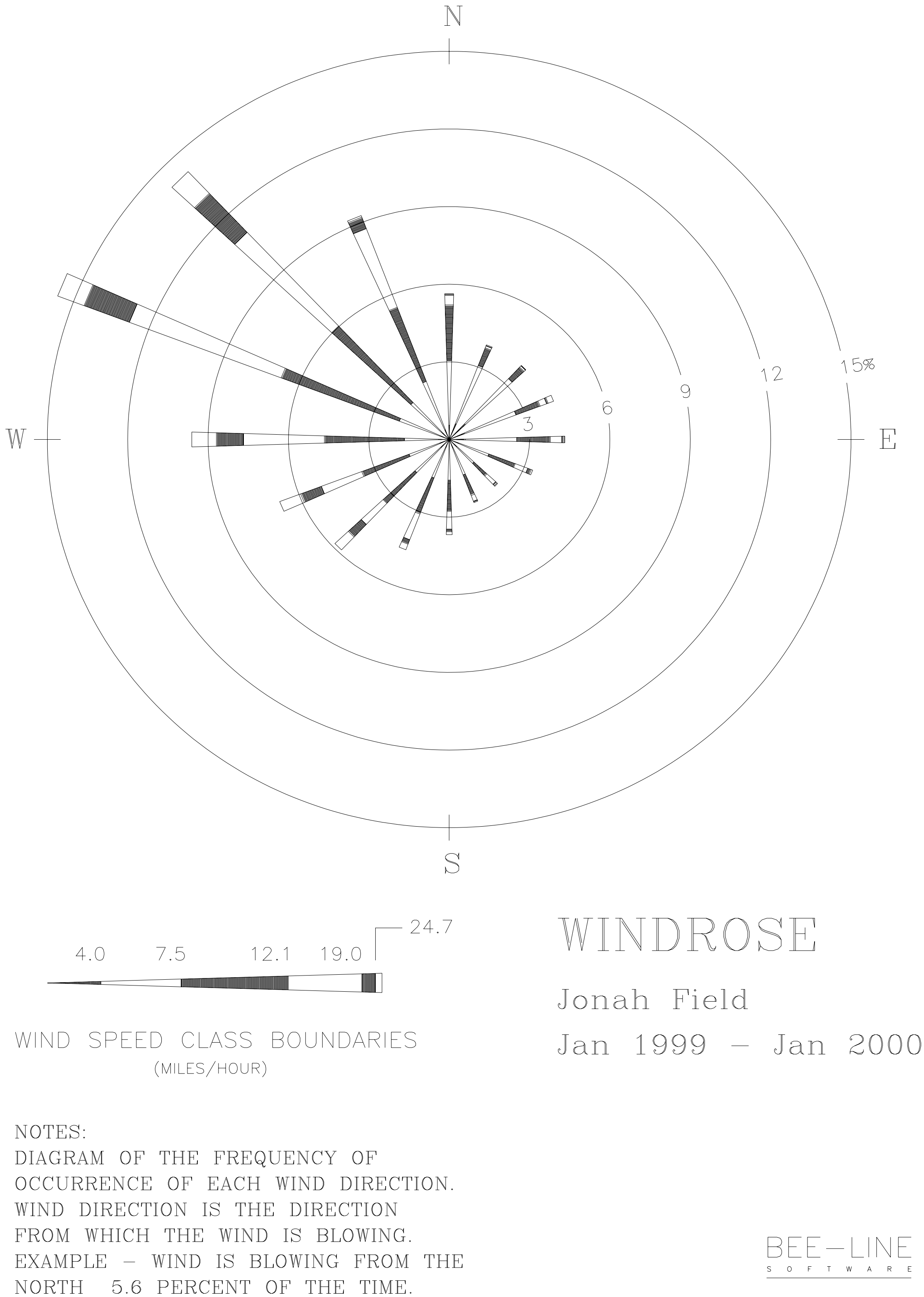
The EPA's guideline dispersion model, AERMOD (version 04300), was used to assess near-field impacts of criteria pollutants PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO, and to estimate short-term and long-term HAP impacts. One year of meteorology data collected in the Jonah Field was used with the AERMOD dispersion model to estimate these pollutant impacts. Various construction and production activities were modeled to provide analyses 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.

Modeling analyses were performed to quantify near-field pollutant concentrations within and nearby the PAPA from project-related emissions sources for a range of scenarios to assure that the maximum near-field impacts were estimated. Impacts from scenarios including the construction of well pads, well drilling activities, and field compression were modeled. Drill rig with emissions at EPA Tier 0 (AP-42 levels), Tier 1, and Tier 2 levels were evaluated.

3.2 METEOROLOGY DATA

One year of surface meteorological data, collected in Jonah Field from January 1999 through January 2000, was used in the analysis. A wind rose for these data is presented in Figure 3.1. The Jonah Field 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 Jonah Field 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. Seasonal values for albedo, Bowen ratio and surface roughness length, for land use type “desert shrubland”, were selected from tables in the AERMET user’s guide and used in processing the meteorological data.

Figure 3.1 Jonah Field Meteorological Data Windrose



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 as identified by WDEQ-AQD are shown in Table 3.1.

Table 3.1 Near-Field Analysis Background Ambient Air Quality Concentrations (Micrograms per Cubic Meter [µg/m^3])

Pollutant	Averaging Period	Measured Background Concentration
CO[1]	1-hour	1,979
	8-hour	931
NO_2[2]	Annual	8
O_3[3]	8-hour	148
PM_{10}[2]	24-hour	32
	Annual	9
$PM_{2.5}$[4]	24-hour	15
	Annual	6
SO_2[5]	3-hour	132
	24-hour	43
	Annual	9

1 Background data collected during 2005 in Yellowstone National Park, Wyoming, monitoring site near “Old Faithful.”
2 Background data collected approximately 5 miles south-west of Boulder, Wyoming during the period April 2005 – March 2006.
3 Background data collected approximately 5 miles south-west of Boulder, Wyoming during 2005 and 2006.
4 Background data collected by WDEQ-AQD in Pinedale, Wyoming during the period July 2005 – June 2006.
5 Data collected at LaBarge Study Area, Wyoming at the 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}, $PM_{2.5}$, SO_2, NO_2, and CO 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).

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[1]
CO			
1-hour[2]	40,000	40,000	--[3]
8-hour[2]	10,000	10,000	--[3]
NO_2			
Annual[4]	100	100	25
PM_{10}			
24-hour[2]	150	150	30
Annual[4]	--[5]	50	17
$PM_{2.5}$			
24-hour	35[6]	65[7]	--[3]
Annual[4]	15	15	--[3]
SO_2			
3-hour[2]	1,300	1,300	512
24-hour[2]	365	260	91
Annual[4]	80	60	20

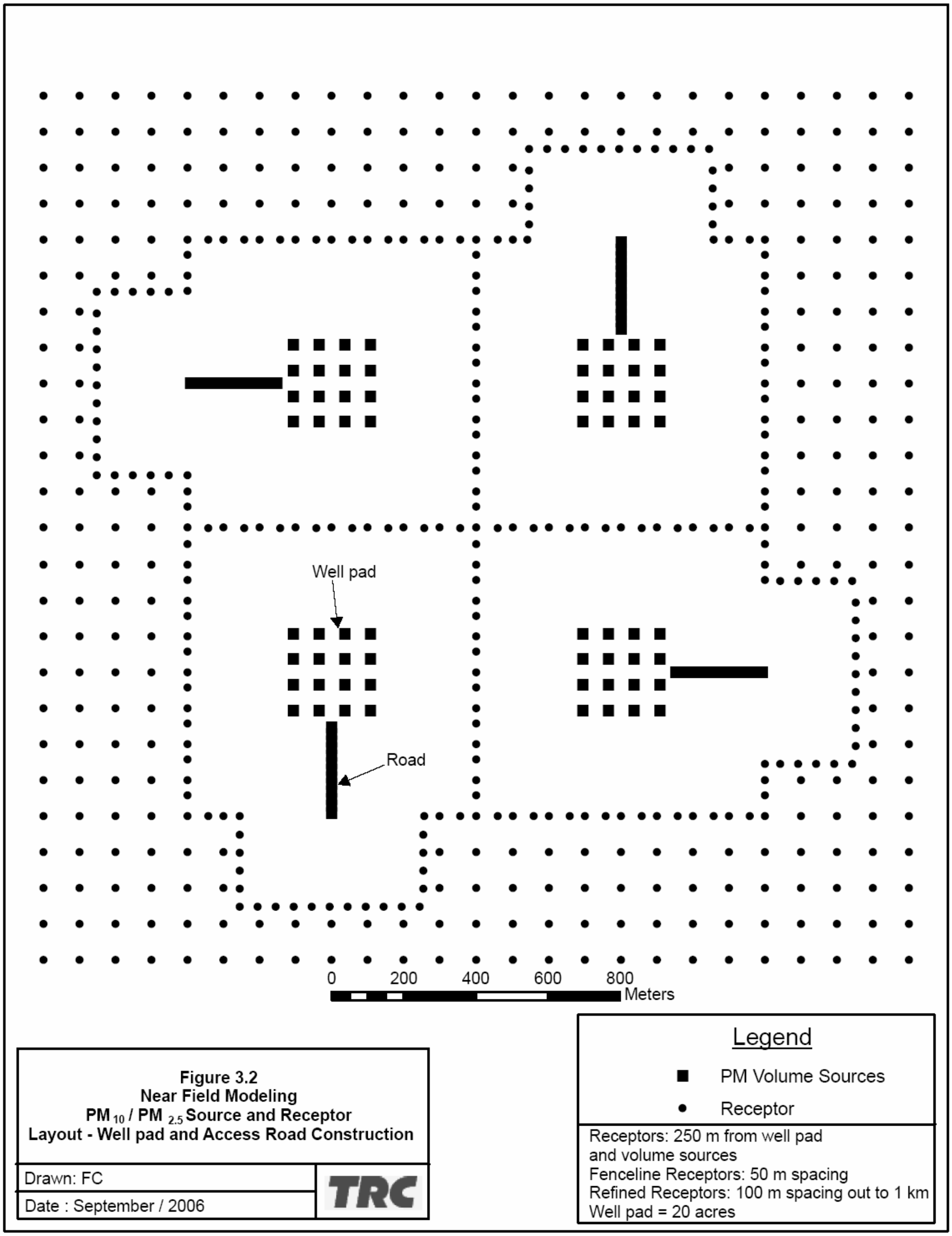
1 The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
2 No more than one exceedance per year.
3 No PSD Class II increment has been established for this pollutant.
4 Annual arithmetic mean.
5 Annual NAAQS for PM_{10} was revoked by EPA effective December 18, 2006.
6 Revised NAAQS effective December 18, 2006. An area is in compliance with the standard if the 98th percentile of 24-hour $PM_{2.5}$ concentrations in a year, averaged over three years, is less than or equal to the level of the standard.
7 EPA has revised the NAAQS effective December 18, 2006. The State of Wyoming will enter rulemaking to revise the WAAQS.

The AERMOD model was used to estimate the near-field concentrations of PM_{10}, $PM_{2.5}$, SO_2, NO_2, and. CO. AERMOD was run using 1 year of AERMET preprocessed Jonah Field meteorology data following all regulatory default switch settings. Short-term (24-hour) PM_{10}/$PM_{2.5}$ emissions would be greatest during the resource road/well pad construction phase of field development, and were modeled to determine compliance with the 24-hour PM_{10}/$PM_{2.5}$ WAAQS and NAAQS. For determining compliance with the annual PM_{10}/$PM_{2.5}$ WAAQS and annual $PM_{2.5}$ NAAQS well drilling operations were modeled. Similarly, SO_2 emissions would be greatest from well drilling operations and were modeled for WAAQS and NAAQS compliance. Impact analyses of CO emissions from field compression and NO_x emissions from both field compression and drilling activities were evaluated.

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. These emissions would be temporary in nature, and the impacts would be greatest at and immediately adjacent to their source and would decrease rapidly with distance. A modeling scenario to evaluate well pad and road construction activities for short-term (24-hour) PM_{10}/$PM_{2.5}$ impacts was developed assuming a one-section land area (1 square mile (mi^2)) and placing well pad and access road construction activities in each of four quarter sections. Twenty-acre well pads with 3/16 mile resource roads were used. Model receptors were placed, beginning 250 meters from the well pads and resources roads, at 50 meter spacing for a single row, then at 100 meter intervals out to 1 km. Flat terrain was assumed for this modeling scenario. Figure 3.2 presents the configuration used to model the well pad and resource road scenario. Volume sources were used to represent emissions from

Figure 3.2 Near Field Modeling PM_{10}/$PM_{2.5}$ Source and Receptor Layout – Well pad and Access Road Construction



well pads and roads. The emissions used for modeling the well pad and resource road construction are provided in Appendix B and are further detailed in Appendix F. Hourly emission rate adjustment factors were applied to limit construction emissions to daytime hours. 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 2004a).

Two modeling scenarios to evaluate well drilling activities for long-term (annual) $PM_{10}/PM_{2.5}$ impacts were also developed using a one-section land area and placing well drilling activities in each of four quarter sections. One scenario considered single drill rigs in each of four quarter sections (one per well pad), and the other scenario had two pairs of drill rigs placed in two of the four quarter sections, with the drill rigs in each pair spaced 1/8 mile apart (2 drill rigs per well pad). Model receptors were placed, beginning 250 meters from the drill rigs, at 50 meter spacing for a single row, then at 100 meter intervals out to 1 km and 250 meter spacing out to 10 km. Flat terrain was assumed for these modeling scenarios. Figures 3.3 and 3.4 illustrate the configurations used to model the drill rigs. Drilling rigs were modeled as point sources, with aerodynamic building downwash from the rig structures. For each of these scenarios drill rig emissions at EPA Tier 1 and Tier 2 levels were modeled. An additional model run was performed with drill rig emissions at Tier 0 (AP-42 levels) assuming two drill rigs on a single well pad spaced 1/8 mile apart. The emissions used for modeling the drill rigs are provided in Appendix B and are further detailed in Appendix F.

Table 3.3 presents the maximum modeled $PM_{10}/PM_{2.5}$ concentrations, for each modeling 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 $PM_{2.5}$.

Emissions associated with temporary construction activities do not consume PSD increment; therefore, the PM_{10} emissions are excluded from increment consumption comparison.

Figure 3.3 Near Field Modeling PM_{10}/$PM_{2.5}$ NO_x and SO_2 Source and Receptor Layout – 2 Drill rigs per well pad, 4 Drill rigs per section

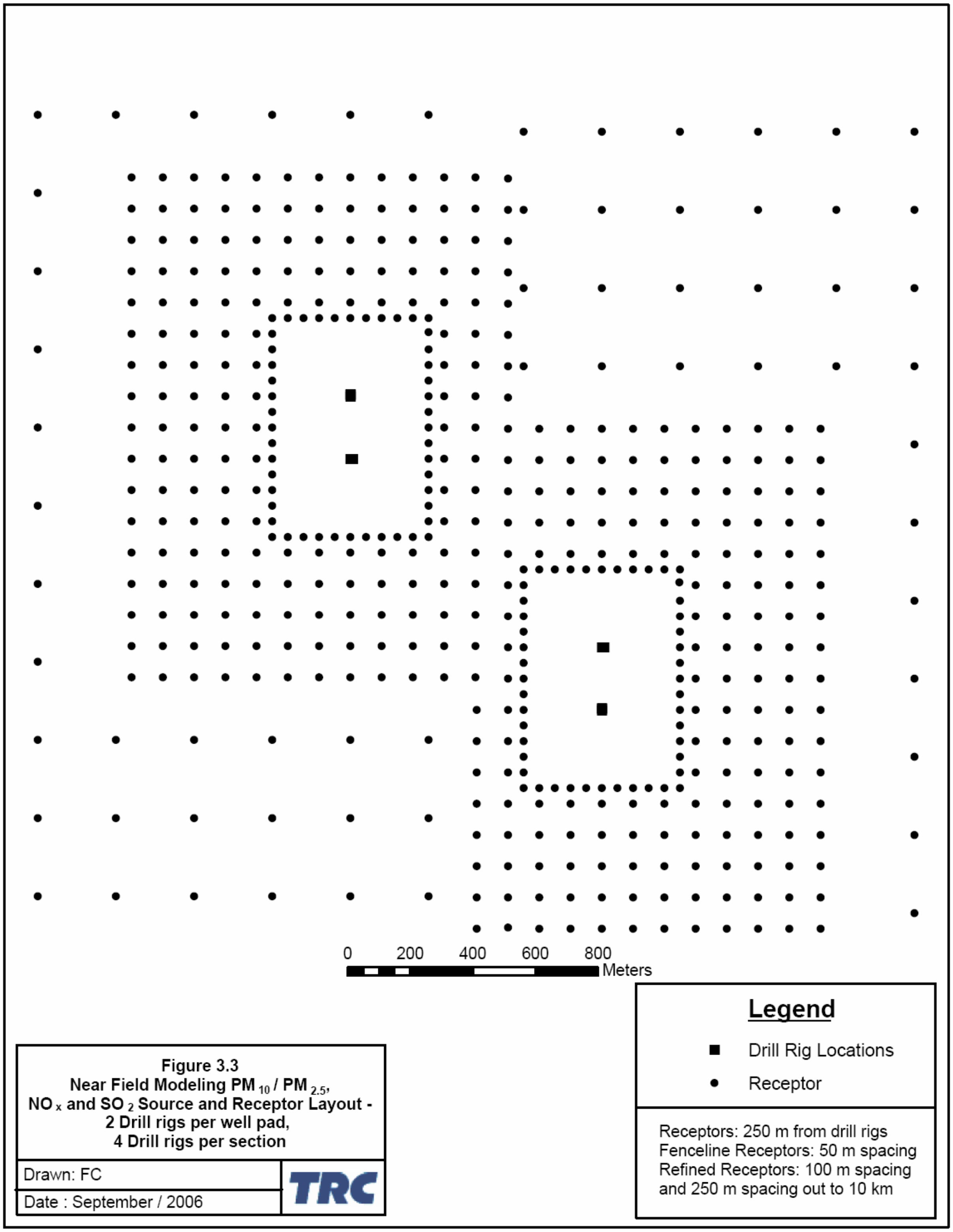


Figure 3.4 Near Field Modeling for PM_{10}/$PM_{2.5}$ NO_x and SO_2 Source and Receptor Layout – 1 Drill rig per well pad, 4 Drill rigs per section

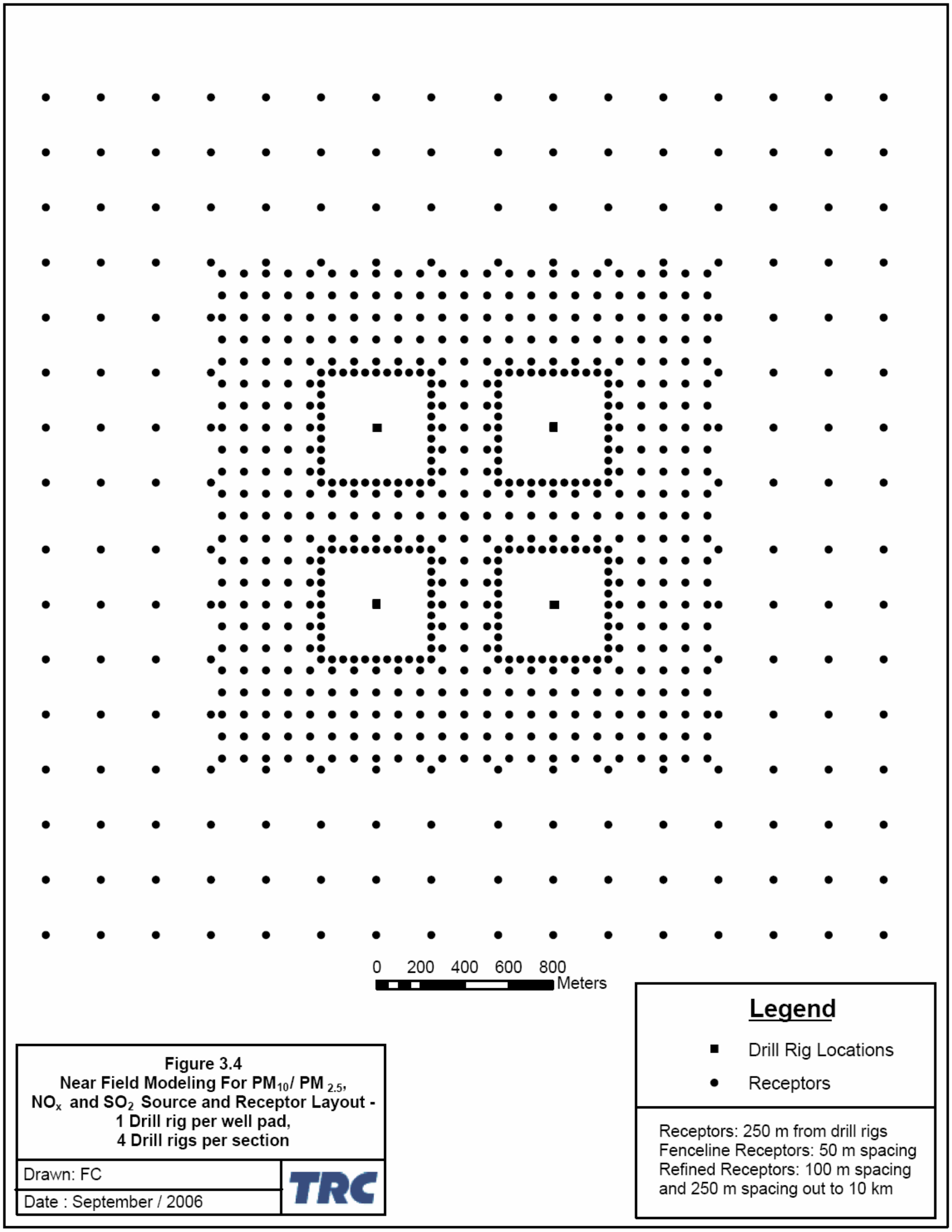


Table 3.3 Maximum Modeled PM_{10}/$PM_{2.5}$ Concentrations, Pinedale Anticline Project.

Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m³)	Background (µg/m³)	Total Predicted (µg/m³)	WAAQS (µg/m³)	NAAQS (µg/m³)
20-acre well pad, 4 well pads per section	PM_{10}	24-Hour	74.2	32	106.2	150	150
	$PM_{2.5}$	24-Hour	14.3	15	29.3	65[1]	35[2]
2 drill rigs per well pad Tier 0 emissions	PM_{10}	24-Hour	7.3	32	39.3	150	150
		Annual	1.6	9	10.6	50	--[3]
	$PM_{2.5}$	24-Hour	4.9	15	19.9	65[1]	35[2]
		Annual	1.6	5	6.6	15	15
2 drill rigs per well pad/ 4 drill rigs Per section Tier 1 emissions	PM_{10}	24-Hour	9.8	32	41.8	150	150
		Annual	2.1	9	11.1	50	--[3]
	$PM_{2.5}$	24-Hour	6.3	15	21.3	65[1]	35[2]
		Annual	2.1	5	7.1	15	15
2 drill rigs per well pad/ 4 drill rigs Per section Tier 2 emissions	PM_{10}	24-Hour	3.7	32	35.7	150	150
		Annual	0.8	9	9.8	50	--[3]
	$PM_{2.5}$	24-Hour	2.4	15	17.4	65[1]	35[2]
		Annual	0.8	5	5.8	15	15
1 drill rig per well pad/ 4 drill rigs per section Tier 1 Emissions	PM_{10}	24-Hour	8.1	32	40.1	150	150
		Annual	1.7	9	9.7	50	--[3]
	$PM_{2.5}$	24-Hour	5.5	15	20.5	65[1]	35[2]
		Annual	1.7	5	6.7	15	15
1 drill rig per well pad/ 4 drill rigs per section Tier 2 emissions	PM_{10}	24-Hour	6.0	32	38.0	150	150
		Annual	1.1	9	10.1	50	--[3]
	$PM_{2.5}$	24-Hour	4.1	15	19.1	65[1]	35[2]
		Annual	1.1	5	6.1	15	15

1 EPA has revised the NAAQS effective December 18, 2006. The State of Wyoming will enter rulemaking to revise the WAAQS.
2 Revised NAAQS effective December 18, 2006.
3 Annual NAAQS for PM_{10} was revoked by EPA effective December 18, 2006.

3.4.2 SO_2

Well drilling activities were modeled using AERMOD to determine maximum SO_2 concentration impacts. The model scenarios and source parameters used to evaluate long-term PM_{10}/$PM_{2.5}$ impacts were also to estimate maximum SO_2 concentrations (see Figures 3.2 and 3.4). Drill rig emissions at Tier 0 (AP-42 levels), EPA Tier 1 and Tier 2 levels were modeled. The SO_2 emissions used for modeling the drill rigs are provided in Appendix B and are further detailed in Appendix F.

The Maximum modeled SO_2 concentrations for each modeling scenario are shown in Table 3.4. When the maximum modeled concentration was added to representative background concentrations, it was demonstrated that SO_2 concentrations for all scenarios comply with the WAAQS and NAAQS.

As with PM_{10} construction emissions, emissions from drilling rigs are temporary and do not consume SO_2 PSD increment and as a result are excluded from increment consumption comparison.

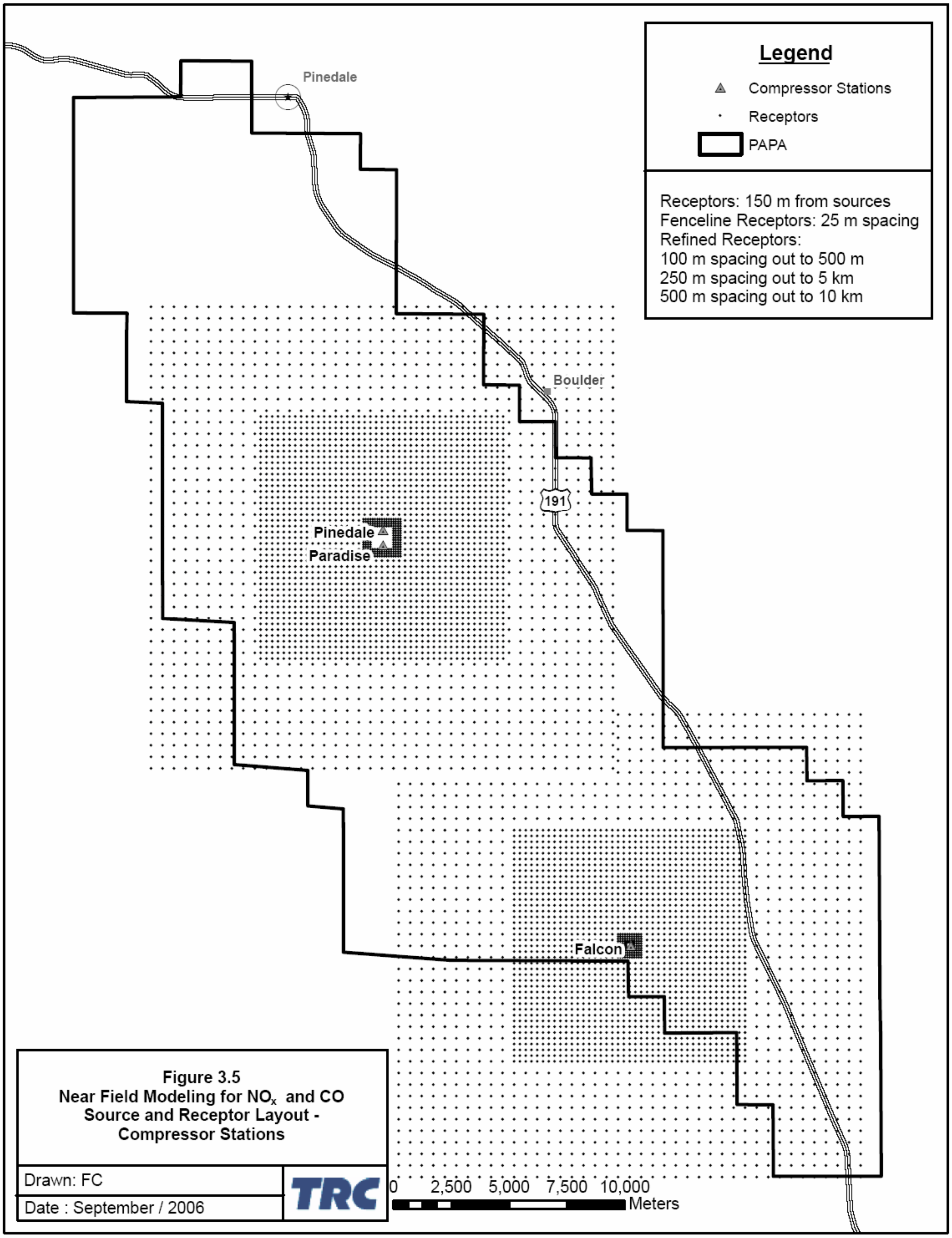
Table 3.4 Maximum Modeled SO_2 Concentrations, Pinedale Anticline Project.

Scenario	Pollutant	Averaging Time	Direct Modeled (μg/m^3)	Background (μg/m^3)	Total Predicted (μg/m^3)	WAAQS (μg/m^3)	NAAQS (μg/m^3)
2 drill rigs per well pad Tier 0 emissions	SO_2	3-Hour	13.5	132	145.5	1,300	1,300
		24-Hour	2.9	43	45.9	260	365
		Annual	0.6	9	9.6	60	80
2 drill rigs per well pad/ 4 drill rigs per section Tier 1 emissions	SO_2	3-Hour	13.5	132	145.5	1,300	1,300
		24-Hour	3.2	43	46.2	260	365
		Annual	0.7	9	9.7	60	80
2 drill rigs per well pad/ 4 drill rigs per section Tier 2 emissions	SO_2	3-Hour	13.5	132	145.5	1,300	1,300
		24-Hour	3.2	43	46.2	260	365
		Annual	0.7	9	9.7	60	80
1 drill rig per well pad/ 4 drill rigs per section Tier 1 emissions	SO_2	3-Hour	10.8	132	142.8	1,300	1,300
		24-Hour	2.6	43	45.6	260	365
		Annual	0.6	9	9.6	60	80
1 drill rig per well pad/ 4 drill rigs per section Tier 2 emissions	SO_2	3-Hour	10.8	132	142.8	1,300	1,300
		24-Hour	2.6	43	45.6	260	365
		Annual	0.6	9	9.6	60	80

3.4.3 NO_2

Analyses were performed using AERMOD to quantify the maximum NO_2 impacts that could occur within and nearby the PAPA with the emissions from existing in-field and nearby compressor stations and proposed compression expansions. The compressor stations analyzed include the in-field Pinedale/Gobblers Knob, Paradise and Falcon stations, and the nearby Bird Canyon facility. The compressor stations were modeled as point sources, using aerodynamic building downwash parameters. Model receptors were placed using 25 meter spacing along assumed fencelines placed 150 meters from the compressor stations, at 100 meter intervals out to 500 meters, then at 250 meter intervals out to 5 km, and 500 meter intervals out to 10 km. AERMAP was used to determine receptor height parameters from digital elevation model (DEM) data. Figure 3.5 illustrates the compressor station model configuration.

Figure 3.5 Near Field Modeling for NO_x and CO Source and Receptor Layout – Compressor Stations



Well drilling activities were also modeled using AERMOD to determine maximum NO_x concentration impacts. The model scenarios and source parameters used to evaluate long-term $PM_{10}/PM_{2.5}$ impacts and SO_2 concentrations were used (see Figures 3.2 and 3.4). Drill rig emissions at EPA Tier 0 (AP-42 levels), EPA Tier 1 and Tier 2 levels were modeled.

The NO_x emissions and parameters used for modeling the compressor stations and the drill rigs are provided in Appendix B and are further detailed in Appendix F.

The AERMOD model was used to predict maximum NO_x impacts for each modeling scenario. 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, when the maximum modeled NO_2 concentrations are combined with representative background NO_2 concentrations, the predicted impacts for all scenarios are below the applicable WAAQS and NAAQS. Predicted direct project NO_2 impacts from the compressor station modeling scenario are above the PSD Class II increment; however, all NEPA PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis, which may be completed as necessary by the WDEQ-AQD. In addition, because the emissions from drilling rigs are temporary and do not consume PSD increment, and as a result, are excluded from increment consumption comparison.

Table 3.5 Maximum Modeled Annual NO_2 Concentrations, Pinedale Anticline Project.

Scenario	Pollutant	Direct Modeled (μg/m³)	PSD Class II Increment[1,2] (μg/m³)	Background (μg/m³)	Total Predicted (μg/m³)	WAAQS (μg/m³)	NAAQS (μg/m³)
Compressor stations	NO_2	34.5	25	8	42.5	100	100
2 drill rigs per well pad - Tier 0 emissions	NO_2	39.9	--[3]	8	47.9	100	100
2 drill rigs per well pad/ 4 drill rigs per section -Tier 1 emissions	NO_2	27.6	--[3]	8	35.6	100	100
2 drill rigs per well pad/ 4 drill rigs per section -Tier 2 emissions	NO_2	18.0	--[3]	8	26.0	100	100
1 drill rig per well pad/ 4 drill rigs per section -Tier 1 emissions	NO_2	22.5	--[3]	8	30.5	100	100
1 drill rig per well pad/ 4 drill rigs per section -Tier 2 emissions	NO_2	14.6	--[3]	8	22.6	100	100

1 The PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis.
2 Background concentrations are not added to modeled concentrations for comparison to the PSD increment.
3 Drilling rigs are temporary and do not consume NO_2 PSD increment and are excluded from increment consumption comparison.

3.4.4 CO

Maximum CO emissions were determined using the same compressor station model scenario that was developed and used for modeling NO_2 (see Figure 3.5). AERMOD was used to predict the maximum CO impacts at receptor location within and nearby the PAPA. 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, Pinedale Anticline Project.

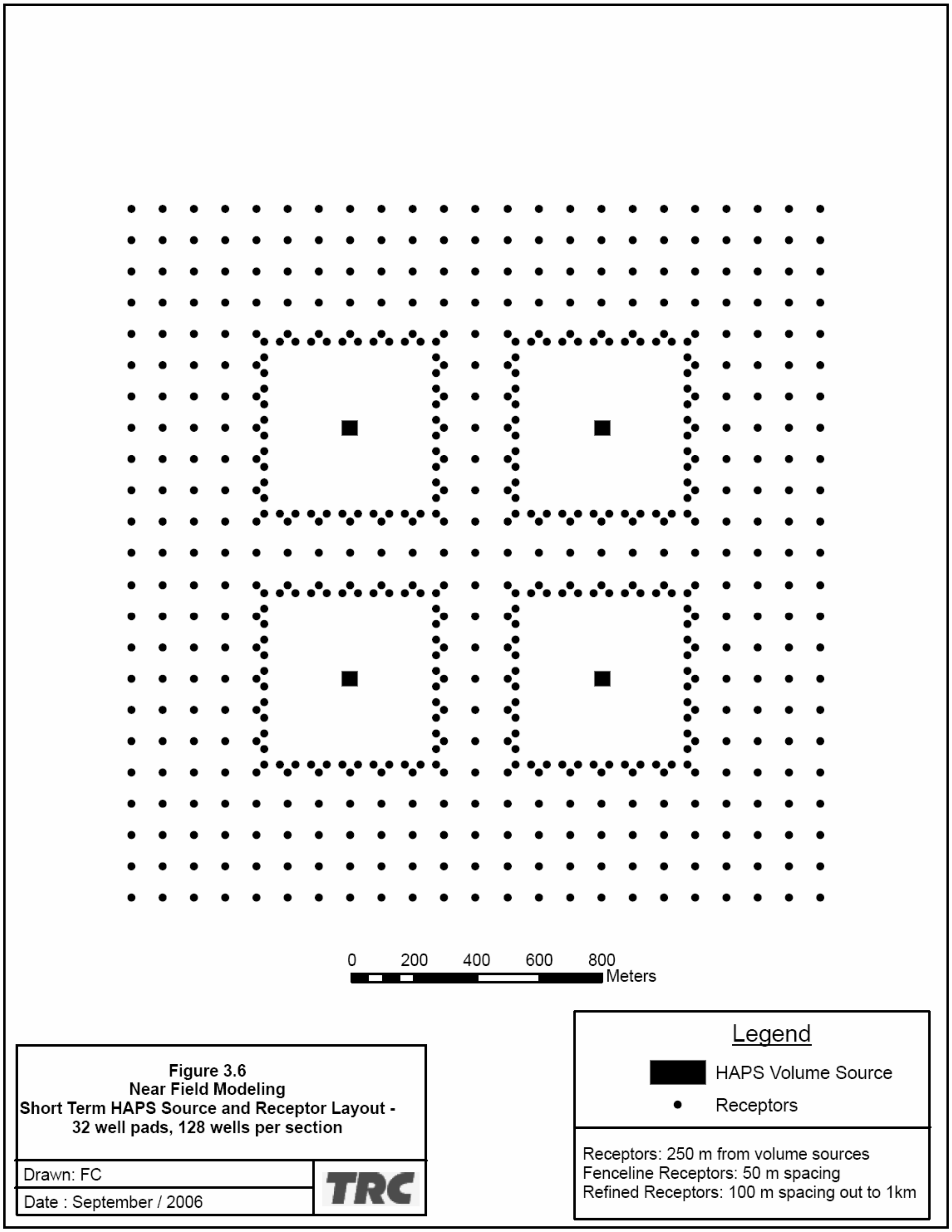
Scenario	Pollutant	Averaging Time	Direct Modeled (µg/m^3)	Background (µg/m^3)	Total Predicted (µg/m^3)	WAAQS (µg/m^3)	NAAQS (µg/m^3)
Compressor stations	CO	1-Hour	328.5	1,979	2,307.5	40,000	40,000
		8-Hour	231.7	931	1,162.7	10,000	10,000

3.5 HAP IMPACT ASSESSMENT

AERMOD was used to determine HAP impacts in the immediate vicinity of the PAPA emission sources for short-term (acute) exposure assessment and at residence locations that are within the PAPA for calculation of long-term risk. Sources of HAPs include well-site fugitive emissions (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. For long-term risk assessment, estimated field development scenarios were developed for the No Action and Proposed Action project alternatives. Short-term exposure assessments were performed for production HAP emissions using a maximum emissions scenario that included four, multi-well pads, placed in the center of each quarter section of a one-section area (similar to drill rig modeling analyses).

HAPs (BTEX, and n-hexane) from well-site fugitive emissions were modeled with AERMOD to determine the maximum HAP short-term (1-hour) impacts that could occur within and near the PAPA. Volume sources were used for modeling the well-site fugitive HAP emissions. Flat terrain receptors were spaced at 50 m intervals at a minimum distance of 250 m from a well-site in each quarter section, and at 100 m intervals out to 1 km from the well-sites. The source and receptor layouts utilized for the short-term fugitive source HAP modeling are presented in Figure 3.6. For modeling short-term 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. The compressor stations analyzed include the in-field Pinedale/Gobblers Knob, Paradise and Falcon stations. The HAP emissions are summarized in Appendix B and further detailed in Appendix F.

Figure 3.6 Near Field Modeling Short Term HAPS Source and Receptor Layout – 32 well pads, 128 wells per section



Long-term (annual) HAPs were analyzed at residential locations within the PAPA. Maximum projected formaldehyde emissions from compressor station sources including Pinedale/Gobblers Knob, Paradise, and Falcon stations were modeled at each residence location. Compressor stations were modeled as point source emissions. The formaldehyde emissions are provided in Appendix B. Receptor elevations at residence locations were determined from USGS DEM data using AERMAP.

Model scenarios for the No Action and Proposed Action alternatives were developed for modeling long-term fugitive HAP emissions. Estimated project field development areas for year 2007 (No Action) and year 2019 (Proposed Action) were used to estimate fugitive HAP source locations. These years were selected for modeling because the maximum HAP emissions are expected to occur during these years under each project alternative. The emissions for the long-term HAPs analyses are provided in Appendix F. Area sources dimensioned using 1-mile sections were used for modeling the fugitive HAPs. Figures 3.7 (No Action) and 3.8 (Proposed Action) illustrate the modeling scenarios used for the long-term HAPs analyses. These figures indicate the projected development areas for the project, the compressor stations, and the residence locations.

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, divided by 10, 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 2007a). Modeled short-term HAP concentrations are compared to REL and IDLH values in Table 3.7. As shown in Table 3.7 the maximum predicted short-term HAP impacts within and near the PAPA would be below the REL or IDLH values under all project alternatives.

Table 3.7 Maximum Modeled 1-Hour HAP Concentrations, Pinedale Anticline Project.

	Direct Modeled Concentration by Modeling Scenario (μg/m³)		REL or IDLH[1] (μg/m³)
HAP	**No Action**	**Proposed Action**	
Benzene	128.5	128.5	1,300[2]
Toluene	248.9	248.9	37,000[2]
Ethylbenzene	15.4	15.4	350,000[3]
Xylene	189.7	189.7	22,000[2]
n-Hexane	82.2	82.2	390,000[3]
Formaldehyde	79.3	79.3	94[2]

[1] EPA (2007a).
[2] Reference Exposure Level
[3] Immediately Dangerous to Life or Health value divided by 10.

Figure 3.7 Near Field Modeling for Long Term HAPS Source and Receptor Layout – No Action

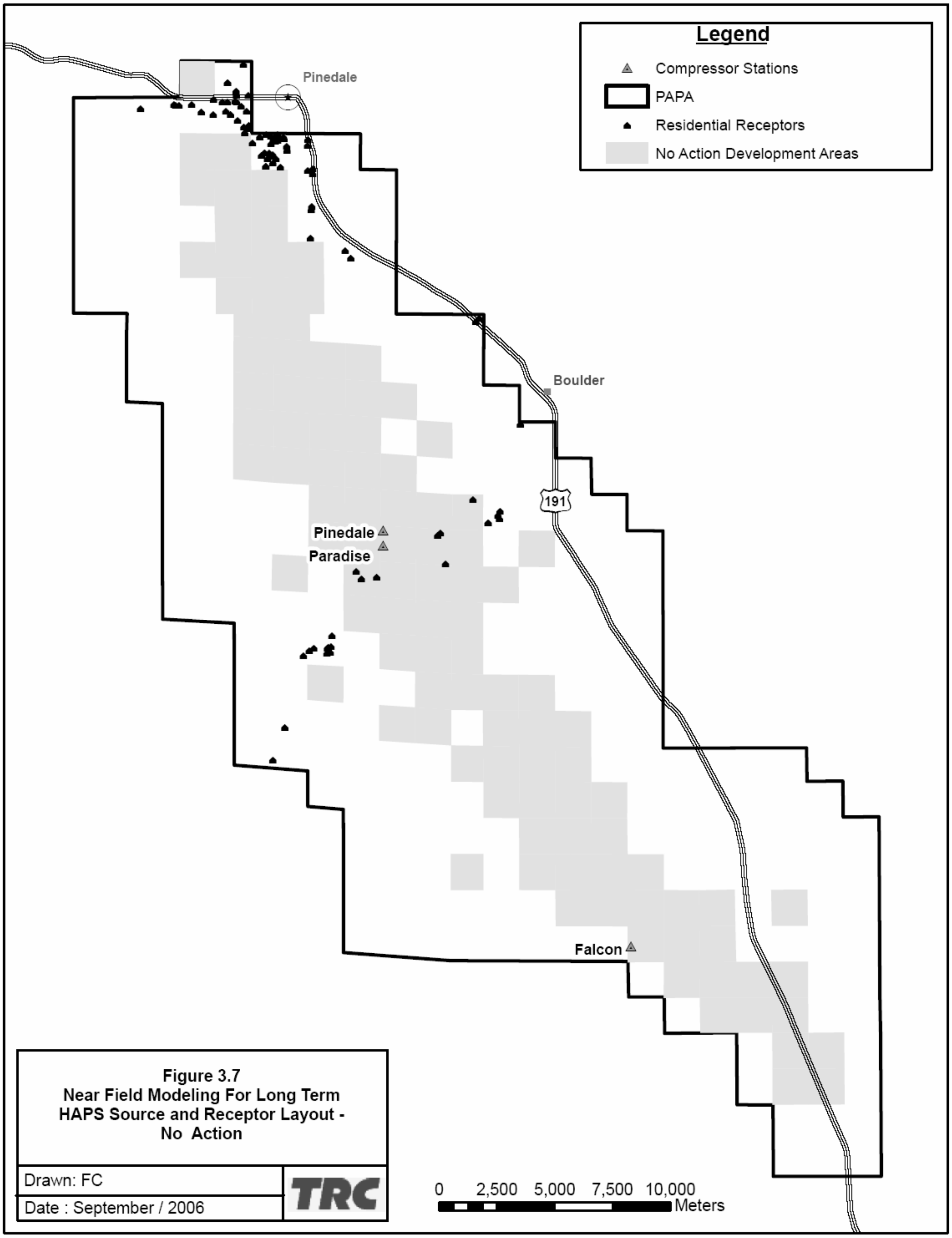
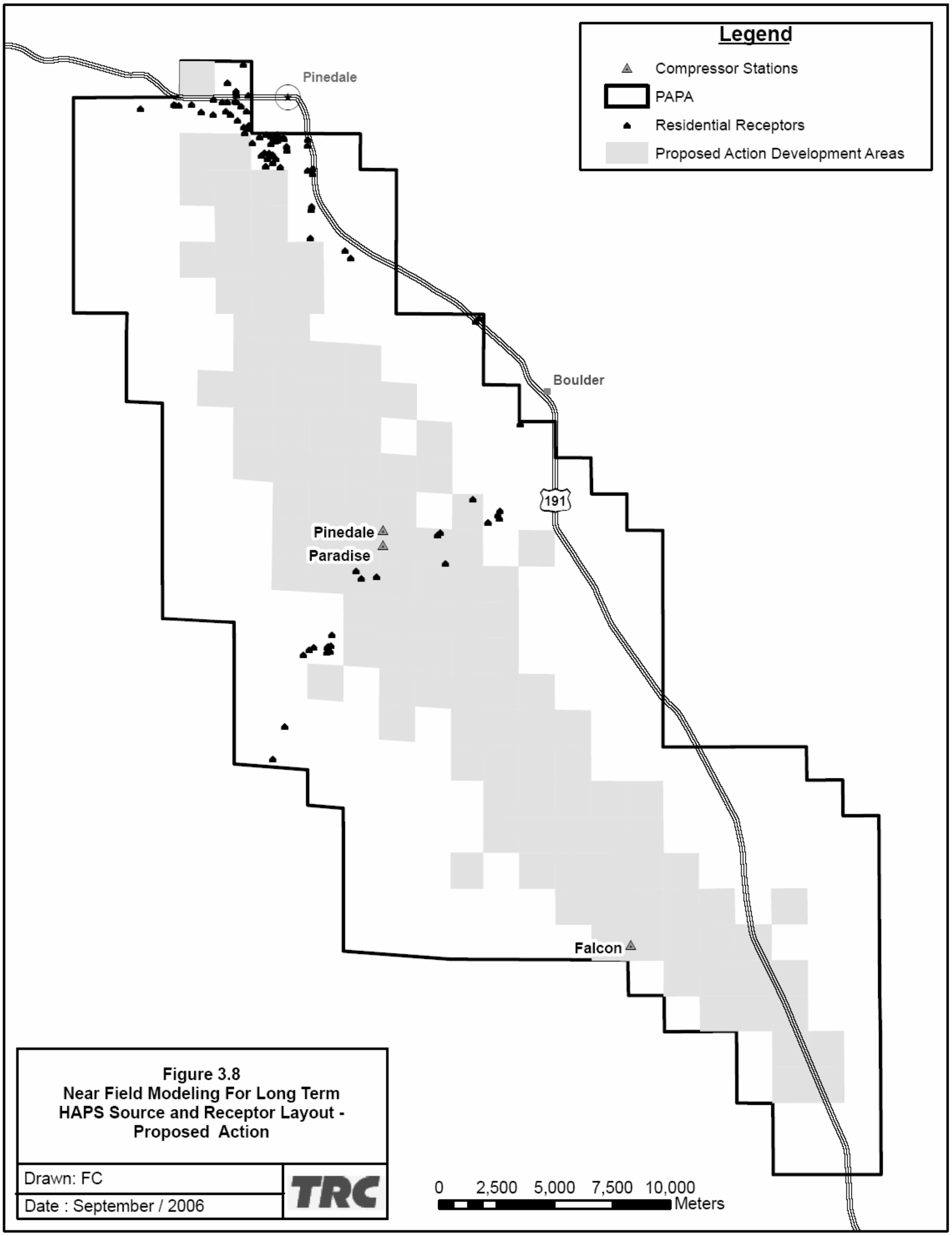


Figure 3.8 Near Field Modeling for Long Term HAPS Source and Receptor Layout – Proposed Action



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 2007b). The maximum predicted annual HAP concentrations at the nearest residential area are compared to the corresponding non-carcinogenic RfC in Table 3.8.

As shown in Table 3.8 the maximum predicted long-term (annual) HAP impacts at the nearest residence locations within the PAPA would be below the RfCs for all alternatives.

Table 3.8 Maximum Modeled Long-term (Annual) HAP Concentrations, Pinedale Anticline Project.

HAP	Direct Modeled Concentration by Modeling Scenario ($\mu g/m^3$)		Non-carcinogenic RfC[1] ($\mu g/m^3$)
	No Action	Proposed Action	
Benzene	0.2	0.5	30
Toluene	0.6	1.2	5,000
Ethylbenzene	0.03	0.06	1,000
Xylene	0.4	1.0	100
n-Hexane	0.1	0.1	700
Formaldehyde	0.2	0.2	9.8

1 EPA (2007b).

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 (EPA 2007a). Estimated cancer risks were evaluated based on the Superfund National Oil and Hazardous Substances Pollution Contingency Plan (EPA 1990a), where a cancer risk range of 1 to 100 x 10^{-6} 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 60 years (i.e., the LOP), corresponding to an adjustment factor of 60/70 = 0.86. 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 (0.86 x 1.0) = 0.86.

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 3.9. 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}. Under the MEI analyses, 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 at the lower end of the presumptively acceptable cancer risk range of 1 to 100 x 10^{-6} as stated by EPA (EPA 1990a).

Table 3.9 Long-term Modeled MLE and MEI Cancer Risk Analyses, Pinedale Anticline Project.

Modeling Scenario	Analysis	HAP Constituent	Modeled Concentration (μg/m³)	Unit Risk Factor 1/(μg/m³)	Exposure Adjustment Factor	Cancer Risk
No Action	MLE	Benzene	0.24	7.8 x 10^{-6}	0.0949	0.18 x 10^{-6}
		Formaldehyde	0.18	1.3 x 10^{-5}	0.0949	0.22 x 10^{-6}
Total Combined[1]						0.4 x 10^{-6}
No Action	MEI	Benzene	0.24	7.8 x 10^{-6}	0.86	1.6 x 10^{-6}
		Formaldehyde	0.18	1.3 x 10^{-5}	0.86	2.0 x 10^{-6}
Total Combined[1]						3.6 x 10^{-6}
Proposed Action	MLE	Benzene	0.45	7.8 x 10^{-6}	0.0949	0.33 x 10^{-6}
		Formaldehyde	0.18	1.3 x 10^{-5}	0.0949	0.22 x 10^{-6}
Total Combined[1]						0.55 x 10^{-6}
Proposed Action	MEI	Benzene	0.45	7.8 x 10^{-6}	0.86	3.0 x 10^{-6}
		Formaldehyde	0.18	1.3 x 10^{-5}	0.86	2.0 x 10^{-6}
Total Combined[1]						5.0 x 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 FAR-FIELD ANALYSES

The purpose of the far-field analysis is to quantify potential air quality impacts on PSD Class I and sensitive PSD 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 PSD Class II areas and at several mid-field PSD Class II areas. The PSD Class I areas and sensitive PSD Class II areas analyzed are shown on Map 1.2 and include:

- Bridger Wilderness Area (Class I);
- Fitzpatrick Wilderness Area (Class I);
- Gros Ventre Wilderness Area (Class II);
- Popo Agie Wilderness Area (Class II);
- Wind River Roadless Area (Class II)
- Grand Teton National Park (Class I);
- Teton Wilderness Area (Class I);
- North Absaroka Wilderness Area (Class I);
- Yellowstone National Park (Class I); and
- 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 atmospheric deposition). Note that visibility is protected in Class I areas only; Class II areas have no visibility protection and are included here only 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 atmospheric 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 far-field analysis also includes in-field analysis. Impacts were assessed for direct project and regional source impacts at in-field locations within the PAPA. It also includes mid-field analysis in which impacts were assessed at mid-field locations (regional communities) (see Map 1.2), which include the Wyoming communities of:

- Boulder;
- Cora; and
- Pinedale.

Predicted pollutant impacts at in-field locations were compared to applicable ambient air quality standards. At mid-field Wyoming community locations impacts to visibility (regional haze) were assessed, although these communities are classified as PSD Class II areas where no visibility protection exits under local, state, or federal law.

4.1 MODELING METHODOLOGY

The EPA-approved CALMET/CALPUFF modeling system (CALMET Version 5.53b and CALPUFF Version 5.711b dated December 16, 2005) was used for the mid-field and far-field modeling analyses. The CALMET meteorological model was used to develop windfields for 3 years of meteorological data (2001, 2002, and 2003) and the CALPUFF dispersion model combined these wind fields with project-specific and regional emissions inventories of NO_x, SO_2, NO_x, PM_{10}, and $PM_{2.5}$ to estimate ambient concentrations and AQRV impacts at in-field, 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 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).

4.2 PROJECT ALTERNATIVE MODELING SCENARIOS

Modeling scenarios were developed for the proposed project development scenarios including the No Action (Alternative A) Proposed Action (Alternative B), and Alternative C and for the level of project development that occurred during year 2005. Project alternative modeling scenarios were based on the maximum emissions year determined for each alternative. Emissions calculations were performed for each project alternative for each year over the LOP (see Appendix F). The project year under each alternative that is expected to have to overall largest pounds per hour emissions of pollutants NO_x, SO_2, and PM_{10}/$PM_{2.5}$ was selected for modeling to assure that the maximum impacts under each alternative were quantified. For the No Action Alternative, year 2007 was selected, and for the Proposed Action, year 2009. Alternative C is similar to the Proposed Action (Alternative B), however it includes mitigation options. For Alternative C, two mitigation options were modeled, Phase 1 and Phase 2. Phase 1 is Alternative B with emissions levels mitigated to year 2005 levels, and under Phase 2 the emissions levels mitigated to year 2005 levels are further reduced by mitigating the drill rig emissions an additional 80 percent.

The PAPA field activities in year 2005 and both the No Action and Proposed Action maximum emissions years include both field development (construction) and field operation (production) emissions. An additional modeling scenario was developed for the Proposed Action when the field is in full production, which is expected to occur in 2026. The modeled emissions for year 2005 project activities and the analyzed project alternatives are shown in Table 4.1.

Note that the modeled emissions for these scenarios assume continuous operation of drill rigs and other PAPA sources that operate intermittently throughout the year and therefore are not comparable to annual field-wide emissions estimates provided in Table 2.1. The field-wide emissions provided in Table 2.1 include source emissions duration in the annual emissions total. The Project Alternative emissions modeled and shown in Table 4.1 represent conservative estimates of the annual emission that could potentially occur under each alternative. These modeling analyses are used to quantify the maximum short-term impacts (24-hour) that could occur under project alternatives because visibility impairment has been identified as a major concern and visibility impairment calculations are performed on a 24-hour average basis.

Table 4.1 Summary of Maximum Modeled Field-Wide Emissions (tpy), Pinedale Anticline Project.

Emissions	PAP 2005	Alternative A 2007	Alternative B 2009	Alternative C (Phase 1)	Alternative C (Phase 2)	Alternative B 2026
Field Compression						
NO_x	379.7	425.0	478.9	379.7	379.7	1537.7
SO_2	0.0	0.0	0.0	0.0	0.0	0.0
PM_{10}	0.0	0.0	0.01	0.0	0.0	0.04
$PM_{2.5}$	0.0	0.0	0.01	0.0	0.0	0.04
Granger Gas Plant						
NO_x	0.0	301.7	301.7	301.7	301.7	301.7
SO_2	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
$PM_{2.5}$	0.0	0.0	0.0	0.0	0.0	0.0
Drill Rigs						
NO_x	2632.2	4748.2	4390.0	2632.2	526.4	0.0
SO_2	222.9	54.8	64.2	222.9	44.6	0.0
PM_{10}	141.6	184.9	185.7	141.6	28.3	0.0
$PM_{2.5}$	141.6	184.9	185.7	141.6	28.3	0.0
Fugitives						
NO_x	495.7	731.1	661.3	495.7	495.7	414.7
SO_2	10.8	16	15.1	10.8	10.8	2.5
PM_{10}	730.9	1024.9	531.8	730.9	730.9	384.9
$PM_{2.5}$	154.1	193.2	107.0	154.1	154.1	85.7
Wind Erosion						
PM_{10}	254.8	357.2	440.8	440.8	440.8	764.2
$PM_{2.5}$	101.9	142.9	176.3	176.3	176.3	305.7
Total						
NO_x	3507.6	6206.0	5831.9	3809.3	1703.5	2254.1
SO_2	233.7	70.8	79.3	233.7	55.4	2.5
PM_{10}	1127.3	1567.0	1158.3	872.5	759.2	1149.2
$PM_{2.5}$	397.6	521.0	469.0	295.7	182.4	391.4

4.3 METEOROLOGICAL MODEL INPUT AND OPTIONS

The CALMET model was used to develop windfields for the study area shown in Map 1.2. The modeling domain covers the PAPA and PSD Class I and other sensitive PSD Class II areas within 200-km of the PAPA with a sufficient buffer zone to allow for potential recirculation or flow reversal effects to be evaluated. The modeling domain follows IWAQM guidance that 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.

Three years of CALMET windfield data were developed and used for the modeling analysis. The years 2001, 2002, and 2003, were selected based on the availability of representative MM5 mesoscale model data for the analysis. The 2001, 2002 and 2003 MM5 data were developed for EPA or for a Regional Planning Organization (RPO), have undergone significant QA/QC verification and peer review, and are the most recent available consecutive 3 years of prognostic data that are available. The MM5 data sets that were used for the analysis include year 2001 data processed at 36-km spacing for EPA (Alpine Geophysics, LLC, 2003), year 2002 data processed at 36-km spacing for WRAP (ENVIRON, 2005) and year 2003 data processed at 36-km spacing for the Midwest RPO (Baker, 2005).

Surface meteorology data for sites throughout the modeling domain obtained from National Climatic Data Center (NCDC) integrated surface observation data sets, Clean Air Status and Trends Network (CASTNET) sites, and from onsite data collected by BP America Production Company in the Jonah Field were incorporated into the windfields. In addition, upper air rawinsonde meteorology data, and precipitation data for applicable observation sites throughout the modeling domain were obtained from NCDC and included in the analysis. Listings of the surface and upper air meteorological stations that were used in this analysis are provided in Appendix C.

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 (-109.80°/43.05°) and first and second latitude parallels at 30° and 60°. The modeling grid consisted of 116 x 138 4-km grid cells that cover the project area and all analyzed PSD Class I and sensitive PSD Class II areas. Ten vertical layers were used, with heights of 20, 40, 100, 160, 320, 560, 1,000, 1,500, 2,250, and 3,200 meters.

The CALMET analysis utilized the MM5 data, surface meteorological data, precipitation data, and 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. All CALMET model control switch settings follow IWAQM guidance.

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 hourly O_3 data, for monitoring stations within the modeling domain were used in the CALPUFF modeling for each of the three modeling years. A list of the O_3 monitoring stations is provided in Appendix C. Monthly averaged O_3 data from these stations for each year were used as default values 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

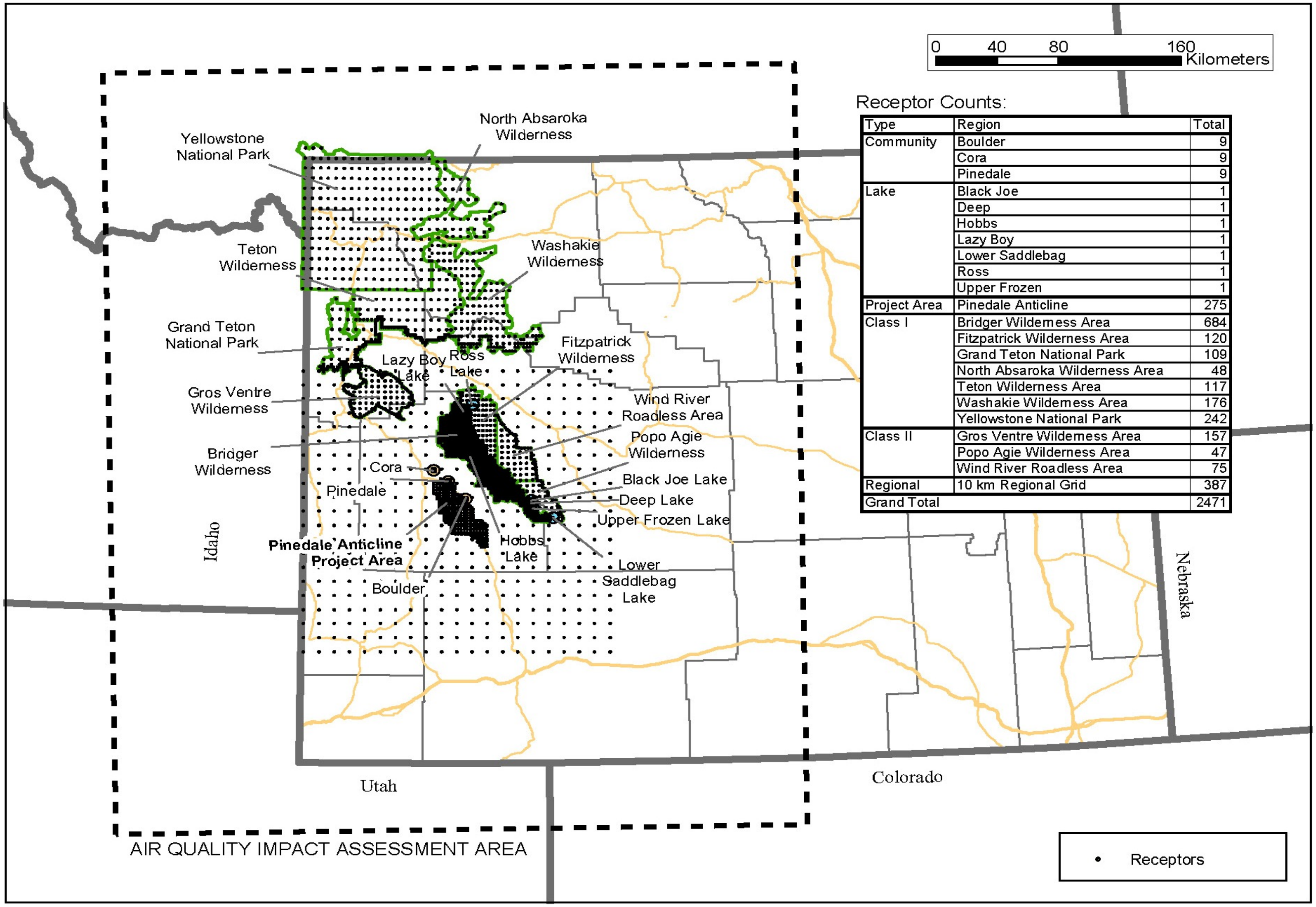
Receptor sets available from the NPS for PSD Class I areas were used as a basis for determining modeling receptors for all PSD Class I and sensitive PSD Class II areas. The complete NPS receptor set was used for modeling the nearby Bridger Wilderness Area, however the receptor grid densities were thinned at the more distant PSD Class I areas, while maintaining adequate area coverage, for consideration of model run times. For the three sensitive PSD Class II areas located within the modeling domain (Gros Ventre and Popo Agie Wilderness Areas, and Wind River Roadless Area), receptor sets were developed using 2-km spacing along the wilderness area boundaries and at 4-km spacing within each area. Receptors were placed within the PAPA using 2-km spacing, and out to 100 km from the PAPA using 10-km spacing. For the regional communities of Boulder, Pinedale and Cora receptors 3 x 3, 1-km grids were used. Receptor elevations for the sensitive PSD Class II area receptors, the regional communities, the receptors within the PAPA and extending outward 100 km were determined from 1:250,000 scale USGS DEM data. Discrete receptors were placed at the seven lakes identified as sensitive to acid deposition. Elevations for the sensitive lake receptors were derived from 7.5-minute USGS maps.

All model receptors utilized in the CALPUFF modeling are shown in Figure 4.1.

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 the Granger Gas Plant expansion, compressor stations and drilling rig engines. Additionally, 1-mi^2 area sources were placed throughout the PAPA to idealize fugitive emissions from well-site heaters, vehicle traffic, well completion activities and wind erosion. Source locations for each modeled scenario were estimated from the current PAPA development and future projected expansion. The source locations used for each modeled scenario are provided in Appendix C, in Tables C.4 through C.11. Compressor station, gas plant, and drill rig emissions are provided in Appendix F. Parameters used for modeling the gas plant, compressor stations and drill rigs are in Appendix C. Monthly emissions scalars were used to adjust the heater and drill rig emissions for seasonal variations.

Figure 4.1 CALPUFF Model Receptors



Type	Region	Total
Community	Boulder	9
	Cora	9
	Pinedale	9
Lake	Black Joe	1
	Deep	1
	Hobbs	1
	Lazy Boy	1
	Lower Saddlebag	1
	Ross	1
	Upper Frozen	1
Project Area	Pinedale Anticline	275
Class I	Bridger Wilderness Area	684
	Fitzpatrick Wilderness Area	120
	Grand Teton National Park	109
	North Absaroka Wilderness Area	48
	Teton Wilderness Area	117
	Washakie Wilderness Area	176
	Yellowstone National Park	242
Class II	Gros Ventre Wilderness Area	157
	Popo Agie Wilderness Area	47
	Wind River Roadless Area	75
Regional	10 km Regional Grid	387
Grand Total		2471

Non-project regional emissions were input to CALPUFF using area sources to idealize non-compression RFD sources, county-wide well emissions, and point sources to idealize state-permitted sources, RFD compression sources, and RFFA. The source parameters used in modeling all state-permitted and RFFA sources are provided in Appendix G. 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 source parameters used for modeling the compression sources for each RFD project are provided in Appendix G. County-wide well emissions were modeled using area sources developed as a “best fit” to the respective county area. 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. The most representative regional monitoring-based background values for criteria pollutants (NO_2, PM_{10}, $PM_{2.5}$, and SO_2), as identified by WDEQ-AQD, collected at monitoring sites in Wyoming, are summarized in Table 4.2. The ambient air background concentrations provided in Table 4.2 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.

Table 4.2 Far-field Analysis Background of Ambient Air Quality Concentrations ($\mu g/m^3$).

Pollutant	Averaging Period	Measured Background Concentration
NO_2[1]	Annual	8
PM_{10}[1]	24-hour	32
	Annual	9
$PM_{2.5}$[2]	24-hour	15
	Annual	6
SO_2[3]	3-hour	132
	24-hour	43
	Annual	9

[1] Background data collected by WDEQ-AQD approximately 5 miles south-west of Boulder, Wyoming during the period April 2005 - March 2006.
[2] Background data collected by WDEQ-AQD in Pinedale, Wyoming during the period July 2005 - June 2006.
[3] Data collected at LaBarge Study Area, Wyoming at the Northwest Pipeline Craven Creek Site 1982-1983.

4.5.2 Visibility

Background visibility data representative of the study area were collected from IMPROVE monitoring sites located at the Bridger Wilderness Area, North Absaroka Wilderness Area and at Yellowstone National Park (Table 4.3). These background visibility data are used in combination with modeled pollutant impacts to estimate change in visibility conditions (measured as change in light extinction) at PSD Class I and sensitive PSD Class II areas. 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 a 5 year period, years 2000 through 2004.

Table 4.3 IMPROVE Background Aerosol Extinction Values.[1]

IMPROVE Site	Quarter	Hygroscopic (Mm^{-1})[2]	Non-hygroscopic (Mm^{-1})[2]
Bridger	1	0.775	1.233
	2	1.565	3.283
	3	1.791	4.965
	4	0.704	1.192
North Absaroka	1	0.774	1.565
	2	1.326	2.249
	3	1.360	4.931
	4	0.600	1.368
Yellowstone	1	1.104	1.588
	2	1.453	2.983
	3	1.550	5.414
	4	0.738	1.544

[1] Cooperative Institute for Research in the Atmosphere (2006).
[2] Mm^{-1} = inverse megameters.

Background visibility data were also collected at a nephelometer monitoring site near Boulder beginning in late January 2005. Quarterly averages of the cleanest 20th percent days were determined from daily averaged extinction measurements and from transmissometer extinction data and IMPROVE aerosol data collected at the Bridger Wilderness Area (ARS, 2006) for the 1 year period, March 1, 2005 through February 28, 2006. These data are shown in Table 4.4. These background visibility data were used in combination with modeled pollutant impacts to estimate change in visibility conditions for the Wyoming regional community locations (Boulder, Cora, and Pinedale).

Table 4.4 Boulder Background Extinction Data.

Quarter	20th Cleanest Days (Mm-1)
1	14.0
2	14.7
3	19.0
4	14.3

4.5.3 Deposition

Background total sulfur (S) and nitrogen (N) deposition data (expressed in kilograms per hectare per year [kg/ha-yr]) collected at National Acid Deposition Program (NADP) National Trends Network (NTN) and Clean Air Status and Trends Network (CASTNET) station monitoring locations near Pinedale, Wyoming, and Yellowstone National Park are provided in Table 4.5. These background S and N deposition data are added to modeled cumulative (project alternative and regional sources) deposition impacts to estimate total S and N deposition impacts.

Table 4.5 Background N and S Deposition Values (kg/ha-yr).

Site Location	Nitrogen Deposition	Sulfur Deposition	Year of Monitoring
Pinedale	1.4	0.74	2004
Yellowstone National Park	1.3	0.70	2003

4.5.4 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 4.6.

Table 4.6 Background ANC Values for Acid Sensitive Lakes.[1]

Wilderness Area	Lake	Latitude (Deg-Min-Sec)	Longitude (Deg-Min-Sec)	10th Percentile Lowest ANC Value (μeq/l)[2]	Number of Samples	Monitoring Period
Bridger	Black Joe	42º44'22"	109º10'16"	67.1	67	1984-2005
Bridger	Deep	42º43'10"	109º10'15"	59.7	64	1984-2005
Bridger	Hobbs	43º02'08"	109º40'20"	69.9	71	1984-2005
Bridger	Lazy Boy	43º19'57"	109º43'47"	10.8	3	1997-2004
Bridger	Upper Frozen	42º41'13"	109º09'39"	6.0	8	1997-2005
Fitzpatrick	Ross	43º22'41"	109º39'30"	53.7	49	1988-2005
Popo Agie	Lower Saddlebag	42º37'24"	108º59'38"	55.2	48	1989-2005

[1] From USFS (2006).
[2] 10th Percentile Lowest ANC Values reported.

4.6 IMPACT ASSESSMENT

CALPUFF modeling was performed to compute direct project impacts from direct project emissions for year 2005, direct project impacts for each of the alternatives, and for estimating cumulative impacts from potential project alternative emissions and regional sources. The alternatives, as described in Section 4.2, include Alternative A (No Action), Alternative B (Proposed Action), and Alternative C (Proposed Action mitigation to year 2005 emissions levels – Phase 1), and Alterative C (Proposed Action mitigation to year 2005 emissions levels with an additional 80 percent mitigation on drill rig emissions – Phase 2). Maximum emissions scenarios for each alternative were analyzed which included year 2007 emissions for the No Action Alternative and year 2009 emissions for the Proposed Action Alternative. An additional full-field development emissions scenario was developed for the Proposed Action assuming that PAPA field development is complete and the project is operating at maximum production (Year 2026). Regional emissions inventories of existing state-permitted RFD and RFFA sources, as described in Chapter 2.0, were modeled in combination with project alternatives to provide cumulative impact estimates for each alternative. A total of 11 modeling scenarios were evaluated in this analysis. A list of these scenarios is summarized in Table 4.7.

Table 4.7 Modeling Scenarios Analyzed for the Pinedale Anticline Project.

Modeling Scenario	Source Impacts Evaluated	Project Alternative
1	Direct Project	PAPA Year 2005 actual emissions from field activities
2	Direct Project	No Action Alternative (Alternative A) – Year 2007
3	Direct Project	Proposed Action Alternative (Alternative B) – Year 2009
4	Direct Project	Alternative C – Phase 1 (Proposed Action mitigated to 2005 levels)
5	Direct Project	Alternative C – Phase 2 (Proposed Action mitigated to 2005 levels, additional 80 % control on drill rig emissions)
6	Direct Project	Proposed Action Alternative (Alternative B) – Year 2026
7	Cumulative	No Action Alternative (Alternative A) – Year 2007 and regional sources
8	Cumulative	Proposed Action Alternative (Alternative B) – Year 2009 and regional sources
9	Cumulative	Alternative C – Phase 1 (Proposed Action mitigated to 2005 levels) and regional sources
10	Cumulative	Alternative C – Phase 2 (Proposed Action mitigated to 2005 levels, additional 80 % control on drill rig emissions) and regional sources
11	Cumulative	Proposed Action Alternative (Alternative B) – Year 2026 and regional sources

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 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.

An additional modeling analysis was performing using CALPUFF to test whether sources located in particular areas or zones within the PAPA may have a larger influence on impacts at the Bridger Wilderness Area. This test was performed due to the close proximity and physical alignment of the PAPA to the Bridger Wilderness Area. The results of the sensitivity modeling are provided in Appendix D.

4.6.1 Concentration

The CALPOST and POSTUTIL post-processors were used to summarize concentration impacts of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ at PSD Class I and sensitive PSD Class II areas, and at in-field locations. Predicted impacts are compared to applicable ambient air quality standards and PSD Class I and Class II increments as shown in Table 4.8. All NEPA PSD demonstrations serve information purposes only and do not constitute a regulatory PSD increment consumption analysis, which may be completed as necessary by the WDEQ-AQD.

Table 4.8 NAAQS, WAAQS, and PSD Class I and Class II Increments for Comparison to Far-field Analysis Results (μg/m³).

Pollutant/Averaging Time	NAAQS	WAAQS	PSD Class I Increment	PSD Class II Increment
NO_2				
Annual[1]	100	100	2.5	25
SO_2				
3-hour[2]	1,300	1,300	25	512
24-hour[2]	365	260	5	91
Annual[1]	80	60	2	20
PM_{10}				
24-hour[2]	150	150	8	30
Annual[1]	--[3]	50	4	17
$PM_{2.5}$				
24-hour[3]	35[4]	65[5]	--	--
Annual[3]	15	15	--	--

1 Annual arithmetic mean.
2 No more than one exceedance per year is allowed.
3 Annual NAAQS for PM_{10} was revoked by EPA effective December 18, 2006.
4 Revised NAAQS effective December 18, 2006.
5 EPA has revised the NAAQS effective December 18, 2006. The State of Wyoming will enter rulemaking to revise the WAAQS.

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.

<u>Far-field Results</u>

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 year 2005 PAPA sources and each of the modeled direct project alternatives and cumulative source modeling scenarios, are provided in Appendix E. Predicted direct impacts are compared to applicable PSD Class I and Class II increments, and when added to representative background pollutant concentrations (see Table 4.2), the total concentration is compared to applicable NAAQS and WAAQS. Cumulative impacts from all 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 E.1.1 through E.1.11 provide the maximum modeled NO_2 concentrations at each of the sensitive areas. The maximum modeled SO_2 concentrations are provided in Tables E.2.1 through E.2.11, and the maximum modeled PM_{10} and $PM_{2.5}$ impacts are provided in Tables E.3.1 through E.3.11, and Tables E.4.1 through E.4.11, respectively.

As shown in these tables there were no predicted exceedances of the NAAQS, WAAQS, or the applicable PSD increments at any of the analyzed PSD Class I and sensitive PSD Class II areas resulting from year 2005 project source emissions. The modeling results also indicate that neither direct project impacts nor cumulative source impacts would exceed any ambient air quality standards (WAAQS and NAAQS) or be above PSD increment.

In-Field Results

The maximum predicted concentrations of NO_2, SO_2, PM_{10}, and $PM_{2.5}$ within and nearby the PAPA, for each of the modeled direct project and cumulative scenarios are provided in Appendix E, Tables E.5.1 through E.5.11, Tables E.6.1 through E.6.11, Tables E.7.1 through E.7.11, and Tables E.8.1 through E.8.11, for NO_2, SO_2, PM_{10}, and $PM_{2.5}$, respectively. Direct project and cumulative impacts are compared to applicable PSD increments. Predicted direct project and cumulative impacts are added to representative background pollutant concentrations and are compared to applicable NAAQS and WAAQS. As shown in these tables there were no exceedances of the NAAQS or WAAQS within and nearby the PAPA resulting from year 2005 project source emissions. In addition there would be no exceedances of the NAAQS or WAAQS within and nearby the PAPA from project alternative field-wide project sources or cumulative sources. This analysis further supports the compliance demonstrations shown in Section 3.4 for maximum near-field impacts.

Predicted impacts resulting from year 2005 emissions are above the annual NO_2 PSD Class II increment and both the 24-hour and annual PM_{10} Class II increments. Predicted direct project and cumulative impacts resulting from project alternative emissions are above the annual NO_2 PSD Class II increment under the Alternative A (No Action), Alternative B (Proposed Action) and Alternative C (Phase 1 - mitigation to 2005 emissions levels) and below the NO_2 increment for all other analyzed alternatives. Predicted direct project and cumulative impacts resulting from Alternative A (No Action) project alternative emissions are above the annual and 24-hour PM_{10} PSD Class II increments, and predicted cumulative impacts under the Alternative C (Phase 1 - mitigation to 2005 emissions levels) are above the 24-hour PM_{10} PSD Class II increment. Predicted direct project and cumulative impacts are below the applicable PM_{10} increments for all other analyzed alternatives. Modeled direct project and cumulative impacts from all analyzed alternatives are below the applicable SO_2 increments. All NEPA analysis comparisons to the PSD increments are intended to evaluate a threshold of concern and do not represent a regulatory PSD Increment Consumption Analysis.

4.6.2 Deposition

Maximum predicted S and N deposition impacts were estimated for year 2005 PAPA impacts, project alternatives, 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-FS 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 atmospheric deposition are likely.

The maximum predicted N and S deposition impacts for each of the modeled scenarios are provided in Appendix E, Tables E.9.1 through E.9.11 (N deposition) and Tables E.10.1 through E.10.11 (S deposition). Model results for project year 2005 sources indicate N deposition impacts above the DAT at the Bridger, Fitzpatrick, Gros Ventre, Popo Agie Wilderness Areas and at Yellowstone National Park, and S deposition impacts above the DAT at the Bridger Wilderness Area. 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, including background N and S deposition values, would be well below the cumulative analysis levels of concern. Modeling results do indicate that for Alternative A (No Action) direct project N deposition impacts are above the DAT at the Bridger, Fitzpatrick, Gros Ventre, Popo Agie, Teton, and Washakie Wilderness Areas and at Grand Teton National Park and the Wind River Roadless Area. For Alternative B (Proposed Action) direct project N deposition impacts are above the DAT at the Bridger, Fitzpatrick, Gros Ventre, and Popo Agie Wilderness Areas and at Grand Teton National Park and the Wind River Roadless Area. Under Alternative C direct project N deposition impacts are above the DAT at the Bridger, Fitzpatrick, Gros Ventre, and Popo Agie Wilderness Areas and at the Wind River Roadless Area, and for Alternative C (Phase 2 - 80 percent drill rig mitigation) direct project N deposition impacts are above the DAT at the Bridger, and Popo Agie Wilderness Areas and at the Wind River Roadless Area.

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-FS 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 (µeq/l) and 1 µeq/l for lakes with background ANC values of 25 µeq/l or less. Of the seven lakes listed in Table 4.5 and identified by the USDA-FS as acid sensitive, Upper Frozen and Lazy Boy lakes are considered extremely acid sensitive.

ANC calculations were performed for each of modeled source scenarios, with the results presented in Appendix E, Tables E.11.1 through E.11.11. The modeling results indicate that deposition impacts from year 2005 direct project sources, alternative sources, and cumulative sources 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 PSD Class II areas and at mid-field regional community locations were post-processed with CALPOST to estimate potential impacts to visibility (regional haze) for year 2005 PAPA source impacts and for each 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.

At the request of the BLM, WDEQ, and USDA-FS visibility impairment calculations for the PSD Class I and sensitive PSD Class II areas were performed using three separate methods using FLAG and IMPROVE background visibility data. Two methods which follow recent CALPUFF modeling guidance for Best Available Retrofit Technology (BART) analyses developed for the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) RPO were also performed (VISTAS, 2006) for the PSD Class I and sensitive PSD Class II areas. For the mid-field, regional community locations visibility impairment was calculated with a method that used background visibility data determined from nephelometer data measured at Boulder (Table 4.4).

The BLM visibility calculation method uses CALPOST visibility method 6 (CALPOST model switch setting “MVISBK” set to 6) for computing light extinction change in combination with FLAG background data. The WDEQ visibility calculation method uses CALPOST visibility method 6 (MVISBK=6) in combination with IMPROVE background data. The two BART screening calculation procedures use CALPOST method 6 combined with background visibility conditions as provided in the *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule* (EPA, 2003b). Method 6 uses monthly averaged humidity factors, and it is not sensitive to synoptic weather events that lead to high extinction events and subsequent explanation as to why certain events should be discounted. The USFS visibility calculation method uses the FLAG background data in combination with hourly relative humidity data from the CALMET windfields (MVISBK=2).

For the FLAG method 6, estimated natural background visibility values as provided in Appendix .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. FLAG method 2 uses the natural background visibility conditions and hourly relative humidity data from surface observations in the CALMET wind field data. The natural background visibility data used with the FLAG visibility analysis for each area analyzed are shown in Table 4.9. Table 4.10 provides the relative humidity factors (f[RH]) that were used for the FLAG method 6 tests.

The IMPROVE method uses the measured background conditions at the Bridger Wilderness Area, North Absaroka Wilderness Area and at the Yellowstone National Park site (see Table 4.3), and the monthly relative humidity factors as provided in EPA (2003b) (Table 4.10). Visibility data from the Bridger Wilderness Area IMPROVE site were used for the Bridger, Fitzpatrick, Gros Ventre, and Popo Agie Wilderness Areas and for the Wind River Roadless Area. Visibility data from the Yellowstone National Park IMPROVE site were used for the Teton Wilderness Area and for Grand Teton and Yellowstone National Parks. Data from the North Absaroka site were used for the North Absaroka and Washakie Wilderness Areas.

Table 4.9 FLAG Report Background Extinction Values.[1]

Site	Season	Hygroscopic (Mm^{-1})[2]	Non-hygroscopic (Mm^{-1})[2]
Bridger Wilderness Area (Will also be used for Popo Agie Wilderness Area and Wind River Roadless Area)	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
North Absaroka 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 (will also be used for Gros Ventre Wilderness Area)	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

Table 4.10 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
Fitzpatrick Wilderness Area	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
Grand Teton National Park	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
North Absaroka Wilderness Area	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
Teton Wilderness Area	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
Waskakie Wilderness Area	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	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 Gros Ventre, and Popo Agie Wilderness Areas, Wind River Roadless Area, and regional communities.

The two BART screening methods use the background visibility data provided in Appendix B of the *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule.* These methods use CALPOST visibility method 6. The first test uses the "best days" background visibility condition and the second test uses the annual average background. These background data given in deciview (dv) units are shown in Table 4.11. The BART methods also utilize monthly relative humidity factors as provided in the *Guidance for Estimating Natural Visibility Conditions Under the Regional Haze Rule* (Table 4.10).

Table 4.11 Default Natural Conditions.[1]

Site	Annual Average (dv)	Best Days (dv)
Bridger Wilderness[2]	4.52	1.96
Fitzpatrick Wilderness	4.53	1.97
North Absaroka Wilderness	4.53	1.97
Teton Wilderness	4.53	1.97
Washakie Wilderness	4.53	1.97
Grand Teton National Park	4.53	1.97
Yellowstone National Park	4.56	2.00

1 Default natural conditions from Appendix B (EPA, 2003b).
2 Also used for Gros Ventre and Popo Agie Wilderness Areas, and Wind River Roadless Area

For the Wyoming regional community locations (Boulder, Cora, and Pinedale) adjusted nephelometer data collected at Boulder (see Table 4.4) were used to estimate visibility impairment. This visibility test uses CALPOST method 6 with quarterly averaged background visibility data and monthly averaged relative humidity factors to estimate the change in light extinction from CALPUFF modeled impacts. Relative humidity data factors for the Bridger Wilderness Area (EPA, 2003b) were used.

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 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. FLAG (2000) also identifies a goal that any specific project combined with cumulative new source growth will have 0 days of visibility impairment at or above 1.0 dv in any PSD Class I area. The BLM considers a 1.0 dv change as a perceptible significance threshold; however, there are no applicable local, state, tribal, or federal regulatory visibility standards. It is the responsibility of the Federal Land Manager 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 USDA-FS considers a 0.5 dv change as a threshold in order to protect visibility in sensitive areas). The BLM recognizes that other federal agencies may use alternative methods to calculate visibility impairment.

Visibility impact assessments following FLAG guidance are typically based on the maximum predicted daily (24-hour) visibility impacts on an annual basis. The maximum number of days above threshold values and the maximum predicted impacts are reported. Visibility impact assessments following EPA's regional haze rule guidance (EPA, 2005) use the annual 98th percentile maximum predicted daily values (8th highest daily value) for assessing visibility impacts.

Far-Field Results

The maximum predicted far-field visibility impacts for each of the modeled scenarios are provided in Appendix E, Tables E.12.1 through E.12.11 (FLAG Method 6 test), Tables E.13.1 through E.13.11 (IMPROVE data test), Tables E.14.1 through E.14.11 (FLAG Method 2 test), Tables E.15.1 through E.15.11 (BART Regional Haze Rule Best Days test), and Tables E.16.1 through E.16.11 (BART Regional Haze Rule Average Days test). For each PSD Class I and sensitive PSD Class II area the 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. For the FLAG and IMPROVE visibility tests the maximum visibility impact and the maximum number of days per year that could potentially exceed the 0.5 and 1.0 dv thresholds are reported. For the two BART visibility tests, the impacts reported are the 98^{th} percentile values. The maximum predicted change in dv represents the 8^{th} highest value in any of the modeling years, and the number of days per year reported that could potentially exceed the 0.5 and 1.0 dv thresholds exclude 7 events, i.e., these values represent the additional number of days above the 8^{th} highest values that are above the thresholds.. The largest number of days of visibility impairment from both direct project sources and from cumulative sources were predicted to occur at Bridger Wilderness Area, under the Proposed Action Alternative (Alternative B).

Mid-Field Results

The maximum predicted mid-field visibility impacts for each of the modeled scenarios are provided in Appendix E, Tables E.17.1 through F.17.11. 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. The highest frequency of predicted visibility impacts from direct project and cumulative sources occurred at Boulder under the Proposed Action Alternative (Alternative B) where there were 138 days per year (direct project) and 153 days per year (cumulative) predicted to be above the 1.0 dv threshold (Table E.17.3).

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