Technical Support Document

Air Quality Impact Assessment for the Montana Final Statewide Oil and Gas EIS and Proposed Amendment of the Powder River and Billings Resource Management Plans and the Wyoming Final EIS and Planning Amendment for the Powder River Basin Oil and Gas Development Project

Prepared for

U.S. Department of the Interior
Bureau of Land Management
Montana and Wyoming State Offices

Prepared by

Environmental Assessment Division
Argonne National Laboratory
Argonne, Illinois 60439

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The following is a list of the acronyms, initialisms, and abbreviations (including units of measure) used in this document.

ACRONYMS, INITIALISMS, AND ABBREVIATIONS

AACL	acceptable ambient concentration level
AB	Absaroka-Beartooth WA
AF	Agate Fossil Beds NM
ANC	acid neutralizing capacity
ANL	Argonne National Laboratory
APD	application for permit to drill
AQRV	air-quality-related value
AWDN	Automated Weather Data Network
BACT	best available control technology
BC	Bighorn Canyon NRA
BE	Black Elk WA
b_{ext}	total extinction
BG	Bridger WA
BL	Badlands WA
BLM	Bureau of Land Management
CBM	coal-bed methane
CI	Crow IR
CO	carbon monoxide
CP	Cloud Peak WA
DEQ	Department of Environmental Quality
DM&E	Dakota, Minnesota, and Eastern Railway Corporation
DOI	U.S. Department of the Interior
DT	Devils Tower NM
EC	elemental carbon
EIC	ENVIRON International Corporation
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
FB	Fort Belknap IR
FL	Fort Laramie NHS
FLAG	Federal Land Managers' Air-Quality-Related Values Workgroup
FLM	Federal Land Manager
FP	Fort Peck IR

FS	Forest Service
FWS	U.S. Fish and Wildlife Service
FZ	Fitzpatrick WA
GM	Gates of the Mountains WA
GT	Grand Teton NP
HAP	hazardous air pollutant
HNO_3	nitric acid
IMPROVE	Interagency Monitoring of Protected Visual Environments
IR	Indian Reservation
IWAQM	Interagency Workgroup on Air Quality Modeling
JC	Jewel Cave NM
LAC	limit of acceptable change
LCP	Lambert Conformal Projection
MAAQS	Montana Ambient Air Quality Standards
MDEQ	Montana Department of Environmental Quality
MEI	maximally exposed individual
MLE	most likely exposure
MM4	mesoscale meteorological model version 4
MM5	mesoscale meteorological model version 5
MR	Mount Rushmore National Memorial
MT	Montana
NA	North Absaroka WA
NAAQS	National Ambient Air Quality Standards
NC	Northern Cheyenne IR
NCAR	National Center for Atmospheric Research
NEPA	National Environmental Policy Act
NHS	National Historic Site
NH_4NO_3	ammonium nitrate
$(NH_4)_2SO_4$	ammonium sulfate
NM	National Monument
NO_2	nitrogen dioxide
NO_3^-	nitrate ion
NO_x	nitrogen oxides
NP	National Park
NPS	National Park Service
NRA	National Recreational Area
NWS	National Weather Service

O&G	oil and gas
O_3	ozone
OC	organic carbon
PA	Popo Agie WA
Pb	lead
PM	particulate matter
$PM_{2.5}$	particulate matter with an aerodynamic diameter equal to or less than 2.5 μm; fine particulate matter
PM_{10}	particulate matter with an aerodynamic diameter equal to or less than 10 μm; inhalable particulate matter
PRB	Powder River Basin
PSD	Prevention of Significant Deterioration
RAWS	Remote Automated Weather Station
RFD	reasonably foreseeable development
RFFA	reasonably foreseeable future action
RR	Red Rock Lakes WA
SAAQS	State Ambient Air Quality Standards
SC	Soldier Creek WA
SG	Scapegoat WA
SO_2	sulfur dioxide
$SO_4^=$	sulfate ion
TN	Theodore Roosevelt NP-North
TS	Theodore Roosevelt NP-South
TT	Teton WA
UB	UL Bend WA
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UTM	universal transverse Mercator
VOC	volatile organic compound
WA	Wilderness Area
WAAQS	Wyoming Ambient Air Quality Standards
WAQS&R	Wyoming Air Quality Standards and Regulations
WC	Wind Cave NP
WDEQ	Wyoming Department of Environmental Quality
WK	Washakie WA
WY	Wyoming
YS	Yellowstone NP

UNITS OF MEASURE

bhp	brake horsepower
Btu	British thermal unit
d	day(s)
dv	deciview(s)
ft	foot (feet)
ft^3	cubic foot (feet)
g	gram(s)
h	hour(s)
ha	hectare(s)
hp	horsepower
in.	inch(es)
kg	kilogram(s)
km	kilometer(s)
kW	kilowatt(s)
L	liter(s)
m	meter(s)
m^3	cubic meter(s)
mi	mile(s)
mi^2	square mile(s)
Mm^{-1}	inverse megameter(s)
MMCFD	million cubic feet per day
MMTPY	million tons per year
ppb	part(s) per billion
s	second(s)
TPY	tons per year
μeq	microequivalent
μg	microgram(s)
yr	year(s)

1 INTRODUCTION

Development of coal-bed methane (CBM) in the Powder River Basin (PRB) in Wyoming and Montana has been occurring over the last few years, and is expected to accelerate and continue in the next 10 to 20 years. Two Bureau of Land Management (BLM) offices, that is, the Wyoming State Office (Wyoming BLM) and the Miles Field Office in Montana (Montana BLM) separately identified the need to prepare an environmental impact statement (EIS) for future CBM and conventional oil and gas (O&G) development activities in the portions of the PRB within the respective states of Wyoming and Montana.

In July 2000, the Wyoming BLM requested that Argonne National Laboratory (ANL) conduct an assessment of potential impacts on ambient air quality and air-quality-related values (AQRVs) associated with CBM and conventional O&G development in the Wyoming portion of the PRB by using the CALPUFF modeling system (Scire et al. 1999a) (Wyoming Project Study). The modeling domain selected for the assessment included northeastern Wyoming and portions of adjacent Montana, South Dakota, and Nebraska. In the Wyoming Project Study, emissions from potential CBM and conventional O&G development in the Montana portion of the PRB were not considered. The Wyoming BLM used the results of the Wyoming Project Study completed in November 2001 (ANL 2002) as input to the Draft Environmental Impact Statement and Draft Planning Amendment for the Powder River Basin Oil and Gas Project (BLM 2002).

In April 2001, the Montana BLM requested that Argonne conduct an assessment of potential impacts on ambient air quality and AQRVs associated with the CBM and conventional O&G development in the Montana portion of the PRB by using the CALPUFF modeling system (Montana Project Study). For this assessment, a larger modeling domain was selected that included most of Wyoming and Montana and portions of adjacent North Dakota, South Dakota, and Nebraska (Figure 1.1); also, more recent and detailed meteorological data over the new modeling domain were developed and used. In the Montana Project Study, emissions from the Wyoming Project were considered. The air quality and AQRV impact assessments for the Montana Project were completed in April 2002, and the results were submitted to the Montana BLM in tabular form.

In July 2002, the Montana BLM and the Wyoming BLM jointly requested that ANL conduct an assessment of potential impacts on ambient air quality and AQRVs, that simultaneously considers both the Montana and Wyoming Projects (Combined Montana/Wyoming Project Study). Additional requirements for this combined study included the following: (1) conduct CALPUFF modeling for the Wyoming Project by using the modeling domain and meteorological data developed for the Montana Project Study; (2) update the emissions inventories for the new and reasonably foreseeable future actions (RFFAs) or reasonably foreseeable development (RFD) sources within the modeling domain; and (3) consider various combinations of alternatives considered for each of the Montana and Wyoming Projects for evaluation of a range of potential cumulative impacts. The air quality and AQRV impact assessment for the Montana and Wyoming Projects was completed in

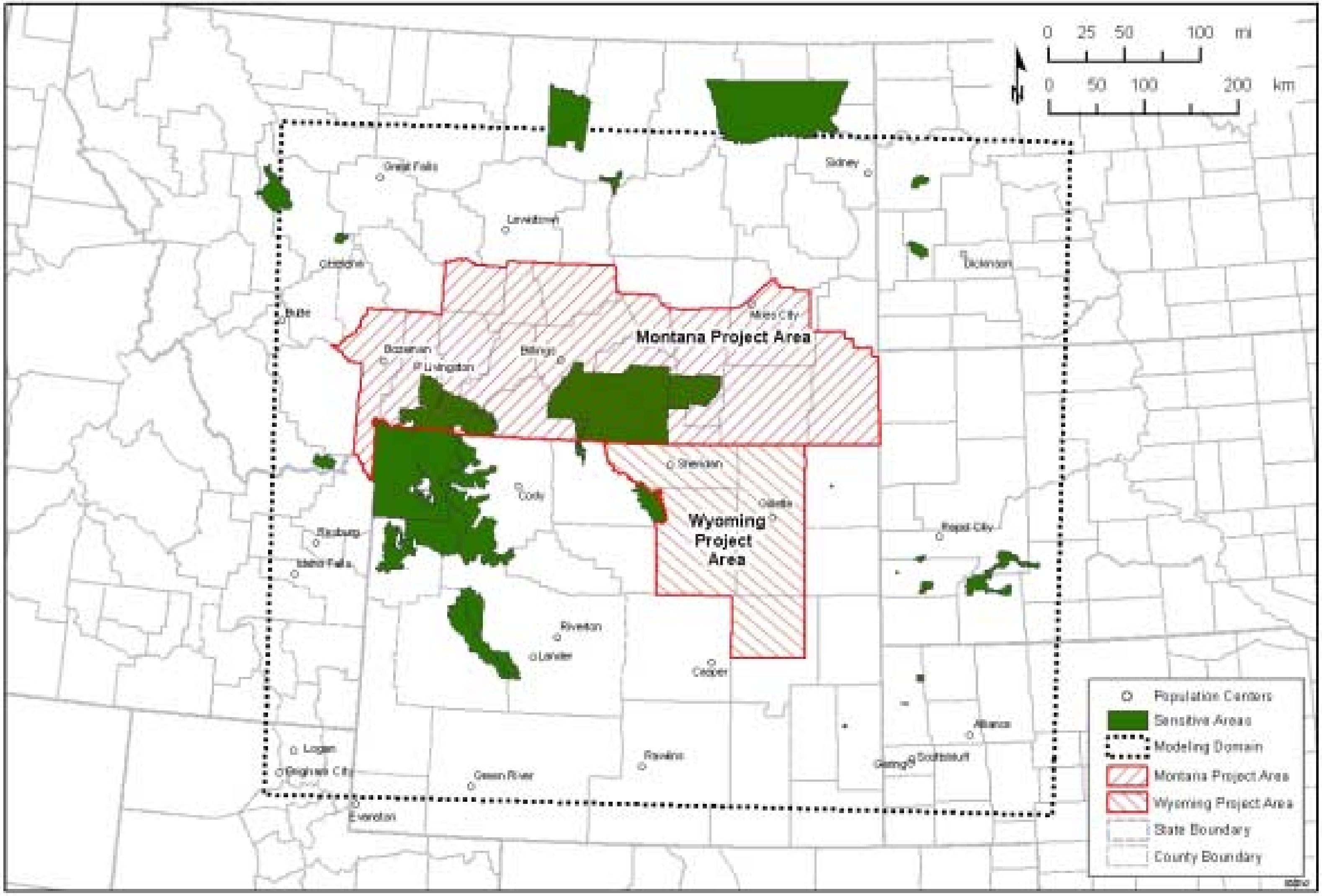

FIGURE 1.1 Modeling Domain, Project Areas, Population Centers, and Sensitive Receptors for the Montana and Wyoming Projects

September 2002, and the results were submitted to the Montana BLM and the Wyoming BLM in tabular form.

In October 2002, the Montana BLM requested that ANL conduct separate assessments of the potential impacts on ambient air quality and AQRVs associated with the potential emissions from CBM and conventional O&G development and operational activities forecast in (1) the Crow Indian Reservation (IR); (2) Northern Cheyenne IR; (3) Custer Forest Service (FS) land; and (4) Montana and Wyoming Project Areas, including the emissions from the Crow IR, Northern Cheyenne IR, and Custer FS lands as RFFAs (i.e., part of the non-project emission sources). The air quality and AQRV impact assessments for these cases were completed in November 2002, and the results were submitted to the Montana BLM and the Wyoming BLM in tabular form.

This document describes the methodologies used in assessing potential impacts on air quality and AQRVs due to the emissions from the Montana and Wyoming Projects; other new and RFFA sources in the surrounding area (non-project sources), and cumulative sources (Montana and Wyoming Project sources and other new and RFFA sources combined); and the results of that assessment. The methodologies used in the assessment are based primarily on the air quality modeling guidelines of the U.S. Environmental Protection Agency (EPA); guidelines of the U.S. Department of the Interior (DOI), National Park Service (NPS), the U.S. Fish and Wildlife Service (FWS); and the U.S. Department of Agriculture (USDA), Forest Service (FS); and guidance documents of the Wyoming Department of Environmental Quality (WDEQ) and the Montana Department of Environmental Quality (MDEQ).

Before ANL initiated the Wyoming and Montana Project Studies, Air Quality Assessment Protocol documents that describe Argonne's plans for conducting the studies were prepared with input from stakeholders (ANL 2001a,b). The stakeholders include the BLM; Federal Land Managers (FLMs) of affected areas; the EPA; Departments of Environmental Quality (DEQs) of affected states; industries proposing new development; and environmental groups, including the Wyoming Outdoor Council; and the Crow Tribal Council and the Northern Cheyenne Tribal Council.

In work conducted for several recent EISs for various development projects within the modeling domain, detailed emission inventories for new and RFFA projects were developed. The air quality modeling conducted for the Dakota, Minnesota, and Eastern Railway Corporation (DM&E) New Railway Retrofit Project EIS, one of the most recent of these EISs, used the CALPUFF modeling system for both near-field and far-field impact analyses (EIC 2000). ANL evaluated appropriate data from these efforts and used them in the Montana and Wyoming Project Studies to achieve consistency and to minimize duplication of efforts. In addition, detailed meteorological data for the Montana Project modeling domain were prepared by using the MM5 and CALMET (Scire et al. 1999b) meteorological models.

The remainder of this document describes the Montana and Wyoming Projects in further detail and provides a list of tasks performed for the combined study. Section 2 presents an overview of the assessment approach. Descriptions of the air quality modeling system and modeling domain used in the study are provided in Section 3. Section 4 describes model input data, including meteorological, receptor, baseline ambient air quality, AQRV, and emissions inventory data. Section 5 describes how air quality modeling and postprocessing of model output data were performed. Section 6 presents the criteria used in the assessments of estimated air quality and AQRV impacts. Section 7 presents the results of CALPUFF modeling and provides assessments of potential impacts on ambient air quality and AQRVs on the basis of the modeling results.

1.1 PROJECT DESCRIPTION

1.1.1 Montana Project

The proposed Montana Project would include the potential development of CBM wells, conventional O&G wells, and ancillary facilities within the Montana Project Area, which encompasses all of Big Horn, Carbon, Gallatin, Golden Valley, Musselshell, Park, Powder River, Stillwater, Sweet Grass, Treasure, Wheatland, and Yellowstone Counties and portions of Carter, Custer, and Rosebud Counties (Figure 1.1). New CBM and oil well locations are proposed for development on the basis of an 80-acre spacing per coal seam and a 40-acre well spacing (minimum acres per well) pattern, respectively. The exact well locations would be determined at a later date during the environmental assessment to be conducted for each well's Application for Permit to Drill (APD), which would be reviewed and approved on a case-by-case basis. The APD process allows Conditions of Approval to be developed for each well on the basis of site-specific monitoring requirements and environmental constraints. In addition to well sites, other facilities, such as access roads, tanks and/or pipelines for gas gathering and water transport, electric utilities, and compressors and other associated facilities/equipment, would be developed or installed to facilitate O&G production and transportation.

The proposed Montana Project Area totals approximately 39,000 mi^2 (25,000,000 acres). Well density, combined with a preferred approach to locating wells, tends to result in groupings of wells into "pods," depending on the structure of the coal seam and oil-bearing strata. Developed areas may have up to 24 CBM wells per square mile based on 80-acre spacing and 3 coal seams, and 16 oil wells per square mile based on 40-acre spacing within productive portions of the project area. The projected number of oil wells in the project area are based on historical drilling activity in the area. The remaining less productive portions of the project area may never have any activity. As a result, if the total number of anticipated wells were drilled, the average density of new wells would be approximately 1 CBM well and 1 oil well per square mile.

The forecast wells are projected to be drilled over the next 20-year period. The rate of development would depend on the productivity of the wells and the ability to transport and market the products. The Montana Project would include well development and production on private, state, and federal lands. However, well development would likely continue on private, state, and IR mineral estates, even if development were not to occur on federal lands.

The Montana Project facilities would be designed to use appropriate control technologies on emissions sources such as compressor engines. The specific systems would be determined through a New Source Review analysis conducted as a part of the Montana permitting process (*Administrative Rules of Montana*, Title 17, Chapter 8, Sub-Chapter 7).

1.1.2 Wyoming Project

The proposed Wyoming Project would include the development of CBM wells, conventional O&G wells, and ancillary facilities within the Wyoming Project Area, which encompasses all of Campbell, Johnson, and Sheridan Counties and a major portion of northern Converse County (Figure 1.1). New CBM and oil well locations are proposed for development on the basis of an 80-acre and 40-acre well spacing pattern, respectively. The exact well locations would be determined at a later date during the environmental assessment to be conducted for each well's APD, which would be reviewed and approved on a case-by-case basis. The APD process allows Conditions of Approval to be developed for each well on the basis of site-specific monitoring requirements and environmental constraints. In addition to well sites, other facilities, such as access roads, tanks and/or pipelines for gas gathering and water transport, electric utilities, and compressors and other associated facilities/equipment, would be developed or installed to facilitate O&G production and transportation.

The proposed Wyoming Project Area totals approximately 13,500 mi^2 (8,636,000 acres). Well density, combined with a preferred approach to locating wells, tends to result in groupings of wells into "pods," depending on the structure of the coal seam and oil-bearing strata. Developed areas may have up to 8 CBM wells per square mile based on 80-acre spacing, and 16 oil wells per square mile based on 40-acre spacing within productive portions of the project area. The remaining less productive portions of the project area may never have any activity. As a result, if the total number of anticipated wells were drilled, the average density of new wells would be approximately 3.3 CBM wells and 0.4 oil well per square mile.

A group of O&G companies is planning to drill these wells over the next 10-year period. The rate of development would depend on the productivity of the wells and the ability to transport and market the products. The Wyoming Project would include well development and production from private, state, and federal O&G properties. However, CBM and oil well development would likely continue on private and state mineral estates, even if the BLM denies development of federal mineral estates.

The Wyoming Project facilities would be designed to use appropriate control technologies on emissions sources such as compressor engines. The specific systems would be determined through a New Source Review analysis conducted as a part of the Wyoming permitting process (*Wyoming Air Quality Standards and Regulations* [WAQS&R], Chapter 6, Section 2). Preliminary information indicates that the emissions control systems for compressor engines might include the use of lean-burn natural gas reciprocating engines with catalytic control and/or catalytic-controlled rich-burn engines with an air-fuel ratio controller to limit emissions of nitrogen oxides (NO_x), carbon monoxide (CO), and formaldehyde.

1.2 ALTERNATIVES EVALUATED

1.2.1 Montana EIS

Five alternatives were considered in the Montana EIS:

1. Alternative A: no action (existing management);

2. Alternative B: emphasize soil, water, air, vegetation, wildlife, and cultural resources;

3. Alternative C: emphasize CBM development;

4. Alternative D: encourage exploration and development while maintaining existing land uses; and

5. Alternative E: preferred alternative.

Under Alternative A (No Action), about 250 new CBM wells would be drilled and tested. Ninety percent of CBM wells on State land would go into production, but no CBM wells on BLM land would go into production. Well pads and roads would be constructed for all wells drilled, and other ancillary facilities, such as pipelines, power lines, and compressors would be installed for production wells. During the period of well completion, testing, and initial operation prior to installation of a commercial power line, temporary field generators would be operated for the purpose of lighting and water pumping. For CBM production, about 10 field (booster) compressors and a single sales (reciprocating) compressor would be installed, all of which would be gas-fired. The number of wells connected to each compressor would depend on the operator's circumstances. During construction, compressors and generators could be powered by diesel, electric, or gas-fired engines. About 600 to 2,000 conventional O&G wells would also be drilled under this alternative. Thirty percent of conventional O&G wells on both State and BLM lands would go into production.

Under Alternative B (Gas-fired Engines), the numbers of CBM wells drilled would range between 9,000 and 18,265. Well pads and roads would be constructed for all wells drilled, and other ancillary facilities, such as pipelines, power lines, and compressors would be installed for production wells. During the period of well completion, testing, and initial operation prior to installation of a commercial power line, temporary field generators would be operated for the purpose of lighting and water pumping. Ninety percent of CBM wells on both State and BLM lands would go into production. The number of wells connected to each compressor would be maximized, with the number of field (booster) compressors ranging between 350 to 1,000, and the number of sales (reciprocating) compressors ranging between 50 to 100. All generators and field (booster) and sales (reciprocating) compressors would be gas-fired. The number of conventional O&G wells would be identical to that of Alternative A.

Alternative C (Diesel Generator) is identical to Alternative B, except that there would be no minimum number of CBM wells connected to a field (booster) compressor, nor would the number of compressors be limited, and operators could use diesel generators with best available control technology (BACT) emission devices.

Alternative D (Electric Field Compressors) is identical to Alternative B, except that all field (booster) compressor engines would be required to be powered by electricity.

Alternative E (Preferred Alternative) is also identical to Alternative B, except that the installation of electrical field (booster) compressor engines may be required in areas with sensitive resources, including people, where noise is an issue.

Alternative A (No Action) is distinctly different from all other alternatives because of its smaller number of CBM wells (250 versus 9,000 to 18,265). Alternative D (Electric Field Compressors) is also quite different from the others because all of its field compressor engines would be powered by electricity. However, Alternatives B (Gas-Fired Engines), C (Gas-Fired Engines with Diesel Generator Option), and E (Preferred Alternative - Gas-Fired Engines with the Possibility of Some Electrical Field Compressors) are quite similar to one another with only minor differences. Potential air quality and AQRV impacts of Alternatives B and E would be only slightly smaller than those of Alternative C. Therefore, only Alternatives A, D, and E (also representing B and C) were selected for air quality and AQRV impact analysis.

For Alternatives D and E, another set of air quality and AQRV impact analyses was conducted that included potential impacts of well development on the Crow and Northern Cheyenne IR and Custer National Forest (FS) lands. (These two cases are designated as Alternatives Da and Ea, respectively.) The number of CBM wells forecast on the IR and FS lands are 4,000, 4,000, and 200, respectively, representing approximately 22, 22, and 1%, respectively, of the CBM wells forecast under Alternative D or E. The number of conventional O&G wells forecast on the IR and FS lands is 55, representing approximately 3% of the conventional O&G wells forecast under Alternative D or E.

Table 1.1 provides information on the new wells and ancillary facilities (well pads, roads, pipelines, power lines, compressors, and temporary field generators) to be developed/installed during the 20-year period under the three Montana Project Alternatives. Similar information is also provided for Alternatives Da and Ea (i.e., Alternatives D and E plus well development on the IR and FS lands). The year-by-year development plan for CBM wells and compressors and projected annual gas production volumes under various alternatives are presented in Table 1.2.

For each of the three Montana Project Alternatives and two additional cases of Da and Ea (Alternatives D and E plus well development on the IR and FS lands), the high- and low-emissions Wyoming alternatives, that is, Alternative 1 (Proposed Action) and Alternative 3 (No Action) of the Wyoming Project, respectively, were considered to evaluate a range of cumulative impacts. This resulted in six Montana-Wyoming Alternative combinations and four Montana Alternative plus well development on IR &FS lands-Wyoming Alternative combinations for impact assessment (Table 1.3).

TABLE 1.1 New CBM Wells and Ancillary Facilities under Various Montana EIS Alternatives[a]

Wells/Facilities		Unit	Alternative[b] A	D (Da)	E[c] (Ea[c])
CBM wells		each	897[d]	18,266 (26,466)	18,266 (26,466)
Well pads		each	299	6,089 (8,822)	6,089 (8,822)
Roads[e]		mi	75	1,522 (2,206)	1,522 (2,206)
Poly pipeline	2–3 in.	mi	598	12,177 (17,644)	12,177 (17,644)
	12 in.	mi	40	1,482 (2,098)	1,482 (2,098)
Steel pipeline	12 in.	mi	11	434 (600)	434 (600)
Electric line	Overhead	mi	60	1,218 (1,764)	1,218 (1,764)
Compressors[f]	Field (booster)	each	20	741 (1,049)	741 (1,049)
	Sales (reciprocating)	each	2	76 (105)	76 (105)
Field generators[g]		each	112	2,278 (3,308)	2,278 (3,308)

[a] Data for Blaine County are not included because it is located outside the modeling domain.

[b] Data for Alternatives Da and Ea, respectively, represent those for Alternatives D and E plus the data for development on IR and FS lands.

[c] Assumed to represent Alternatives B and C. Diesel generators with BACT would be allowed under Alternative C.

[d] Of the 897 wells drilled, only 515 would be operated as producing wells. All others would be shut down after testing.

[e] For both improved and two-track roads.

[f] Field compressors (400 hp each) and sales compressors (1,731 hp each) would be gas-fired under all alternatives, except that field compressors would be operated by electricity under Alternatives D and Da.

[g] Field generators (125 kW each) for lighting and water pumping purposes are temporary units assumed to operate for an average of 120 days during the period of well completion, testing, and initial operation prior to installation of a commercial power line. Each field generator is assumed to serve an average of eight wells.

TABLE 1.2 Development Plan for CBM Wells and Compressors and Projected Annual Gas Production under Various Montana EIS Alternatives

				Compressors								
	CBM Wells[a]			Field			Sales			Annual Gas Volume (MMCFD)[b]		
Year	Alt. A	Alt. D	Alt. E[c]	Alt. A	Alt. D	Alt. E[c]	Alt. A	Alt. D	Alt. E[c]	Alt. A	Alt. D	Alt. E[c]
1	67	710	710	2	37	37	1	8	8	8	142	142
2	102	1,058	1,058	2	38	38	0	11	11	19	354	354
3	124	1,408	1,408	3	49	49	0	11	11	33	635	635
4	160	1,731	1,731	3	61	61	1	8	8	52	981	981
5	110	1,374	1,374	7	94	94	0	3	3	64	1,256	1,256
6	94	1,237	1,237	1	49	49	0	2	2	75	1,504	1,504
7	59	1,291	1,291	1	51	51	0	4	4	82	1,762	1,762
8	26	1,231	1,231	1	49	49	0	2	2	85	2,008	2,008
9	25	1,230	1,230	0	32	32	0	2	2	88	2,254	2,254
10	27	998	998	0	14	14	0	2	2	91	2,454	2,454
11	17	801	801	0	7	7	0	3	3	93	2,614	2,614
12	16	831	831	0	39	39	0	4	4	95	2,780	2,780
13	18	812	812	0	30	30	0	3	3	97	2,942	2,942
14	14	798	798	0	28	28	0	3	3	99	3,102	3,102
15	12	744	744	0	42	42	0	5	5	100	3,251	3,251
16	10	615	615	0	28	28	0	2	2	101	3,374	3,374
17	6	514	514	0	31	31	0	1	1	102	3,477	3,477
18	4	431	431	0	25	25	0	0	0	102	3,563	3,563
19	4	302	302	0	23	23	0	0	0	103	3,623	3,623
20	2	150	150	0	16	16	0	0	0	103	3,653	3,653
Total	897	18,266	18,266	20	741	741	2	76	76	1,593	45,728	45,728

[a] It is assumed that three wells would be drilled at one well pad.

[b] MMCFD = million cubic feet per day.

[c] Also represents Alternatives B and C.

TABLE 1.3 Alternative Combinations Evaluated for Air Quality and AQRV Impacts

	Alternative Combination[a]	Montana Project Alternative	Wyoming Project Alternative
Montana EIS	1	Alt. E	Proposed Action (Alt. 1)
	2	(Preferred Alternative)	No Action (Alt. 3)
	3	Alt. E	Proposed Action (Alt. 1)
	4	with Development on IR and FS Lands (Ea)	No Action (Alt. 3)
	5	Alt. D	Proposed Action (Alt. 1)
	6	(with Electric Field Compressors)	No Action (Alt. 3)
	7	Alt. D	Proposed Action (Alt. 1)
	8	with Development on IR and FS Lands (Da)	No Action (Alt. 3)
	9	Alt. A	Proposed Action (Alt. 1)
	10	(No Action)	No Action (Alt. 3)

	Alternative Combination[a]	Wyoming Project Alternative	Montana Project Alternative
Wyoming EIS	11	Alt. 1	Preferred Alternative (Alt. E)
	12	(Proposed Action)	No Action (Alt. A)
	13	Alt. 2a	Preferred Alternative (Alt. E)
	14	(50% Electric Booster Compressors)	No Action (Alt. A)
	15	Alt. 2b	Preferred Alternative (Alt. E)
	16	(100% Electric Booster Compressors)	No Action (Alt. A)
	17	Alt. 3	Preferred Alternative (Alt. E)
	18	(No Action)	No Action (Alt. A)

[a] Cumulative impacts for the following alternative combinations are identical: 1 and 11, 2 and 17, 9 and 12, and 10 and 18.

1.2.2 Wyoming EIS

Four alternatives were considered in the Wyoming EIS:

1. Alternative 1: proposed action,

2. Alternative 2a: 50% electric field (booster) compressors,

3. Alternative 2b: 100% electric field (booster) compressors, and

4. Alternative 3: no action.

Under Alternative 1 (Proposed Action), companies would drill/construct, complete, and operate about 39,367 new CBM wells, about 3,200 conventional O&G wells, and ancillary facilities such as roads, pipelines, power lines, compressors, and temporary field generators. Under this alternative, about 1,060 booster (field) compressors and about 298 reciprocating (sales) compressors would be installed and operated, all of which would be gas-fired.

Alternative 2 (Electric Booster Compressors) would include two cases for compression of the CBM, with no other differences from Alternative 1. These cases would involve operation of booster compressors by electricity rather than gas. Reciprocating compressors would remain the same. Half of the new 1,060 booster compressors would be electrically powered under the first option (Alternative 2a), while all of the new booster compressors would be electrified under the second option (Alternative 2b). The power for the electrical units would be brought to the compressor stations via the same power lines included in the Proposed Action.

Under Alternative 3 (No Action), development of CBM and conventional O&G wells would occur on nonfederal lands within the Wyoming Project Area, but there would be no additional development of CBM and conventional O&G wells on federal leases. As a result, the number of new CBM and conventional O&G wells to be drilled would be reduced by about 60% (to about 15,458) and about 56% (to about 1,409), respectively. Construction of ancillary facilities would also be reduced accordingly.

Table 1.4 provides information on the new wells and ancillary facilities (well pads, roads, pipelines, power lines, compressors, and temporary filed generators) to be developed/installed during the 10-year period under these four alternatives. The year-by-year development plans for CBM wells and compressors and projected annual gas production volume under various alternatives are presented in Table 1.5.

For each of the four Wyoming Project Alternatives, the high- and low-emissions Montana Alternatives, that is, Alternative E (Preferred Alternative) and Alternative A (No Action) of the Montana Project, respectively, were considered to evaluate a range of cumulative impacts. This resulted in eight Wyoming Alternative-Montana Alternative combinations for impact assessment (Table 1.3).

TABLE 1.4 New CBM Wells and Ancillary Facilities under Various Wyoming EIS Alternatives

Wells/Facilities		Unit	Alternative 1, 2a, 2b[a]	Alternative 3
CBM wells		each	39,367	15,458
Well pads		each	25,997	10,542
Roads	Improved	mi	6,657	2,170
	Two-track	mi	10,619	4,337
Poly pipeline	2–3 in.	mi	14,127	5,769
	12 in.	mi	5,311	2,170
Steel pipeline	12 in.	mi	1,036	396
Electric line	Overhead	mi	5,311	2,170
Compressors	Booster	each	1,060	350
		hp	371,000	122,500
	Reciprocating	each	298	97
		hp	491,700	160,050
Field generators[b]		each	4,921	1,932

[a] Half of the booster compressors would be operated by electricity under Alternative 2a, and all of the booster compressors would be operated by electricity under Alternative 2b.

[b] Field generators (125 kW each) for lighting and water pumping purposes are temporary units assumed to operate for an average of 120 days during the period of well completion, testing, and initial operation prior to installation of a commercial power line. Each field generator is assumed to serve an average of eight wells.

TABLE 1.5 Development Plan for CBM Wells and Compressors and Projected Annual Gas Production under Various Wyoming EIS Alternatives

	CBM Wells		Well Pads		Compressors: Booster		Compressors: Reciprocating		Annual Gas Volume (MMCFD)[a]	
Year	Alt. 1, 2a, 2b	Alt. 3	Alt. 1, 2a, 2b	Alt. 3	Alt. 1, 2a, 2b	Alt. 3	Alt. 1, 2a, 2b	Alt. 3	Alt. 1, 2a, 2b	Alt. 3
1	4,960	1,994	3,590	1,486	304	127	84	24	1,713	1,254
2	5,037	1,952	3,637	1,454	373	101	106	31	2,654	1,615
3	5,038	1,899	3,317	1,339	212	60	56	20	3,177	1,795
4	4,890	1,899	3,205	1,248	133	43	39	16	3,517	1,951
5	4,907	1,830	3,294	1,229	31	13	8	4	3,588	1,938
6	4,899	1,905	3,151	1,244	4	4	1	0	3,578	1,977
7	4,296	1,566	2,649	1,067	3	2	4	2	3,495	1,882
8	1,853	841	1,107	511	0	0	0	0	3,086	1,925
9	1,774	792	1,141	496	0	0	0	0	2,296	1,554
10	1,713	830	906	468	0	0	0	0	1,620	1,279
Total	39,367	15,458	25,997	10,542	1,060	350	298	97	28,724	17,170

[a] MMCFD = million cubic feet per day.

1.3 STUDY TASKS

The following eight tasks were performed for air quality and AQRV impact assessment of the combined Montana/Wyoming Projects:

1. Development of air pollutant emissions inventories for the Montana and Wyoming Projects, including the proposed action, alternatives, and other new and RFFA activities not represented by the background air quality measurements.

2. Updating of the emissions inventory database used in the DM&E Expansion Project air quality modeling study by (a) adding data for additional new and RFFA sources within the modeling domain identified or proposed since the cutoff date for the DM&E emissions inventory database and (b) revising the database as needed.

3. Assessment of the reasonable but conservative near-field air quality impacts and cancer risks due to emissions from various activities of the Montana and Wyoming Projects.

4. Assessment of the reasonably foreseeable near-field cumulative air quality impacts due to emissions from the Montana and Wyoming Projects and other new and RFFA sources.

5. Assessment of the far-field air quality impacts due to emissions from the Montana and Wyoming Projects at Class I areas and specified Class II areas of concern within the modeling domain.

6. Assessment of the far-field cumulative air quality impacts due to emissions from the Montana and Wyoming Projects and other new and RFFA sources.

7. Assessment of the impacts due to emissions from the Montana and Wyoming Projects on visibility and acid deposition at the Class I areas and specified Class II areas of concern.

8. Assessment of the cumulative impacts due to emissions from the Montana and Wyoming Projects and other new and RFFA sources on visibility and acid deposition at the Class I areas and specified Class II areas of concern.

2 OVERVIEW OF ASSESSMENT APPROACH

As requested by the Montana BLM and the Wyoming BLM, Argonne estimated and assessed the potential impacts of air pollutant emissions from the Montana Project and Wyoming Project (current project) sources, other new and RFFA sources in the surrounding area, and cumulative sources (Montana Project and Wyoming Project sources and other new and RFFA sources combined) under the 18 alternative combinations of the two projects. Potential impacts assessed included near-field impacts on criteria and hazardous air pollutants and far-field impacts on criteria air pollutants and AQRVs (visibility and acid deposition).

Argonne used the latest version of the CALPUFF modeling system (Version 5) to predict potential impacts on air quality and AQRVs. For the CALPUFF modeling domain for the combined Montana/Wyoming Project Study (current study), ANL defined a modeling domain that includes most of Montana and Wyoming, and portions of adjacent North Dakota, South Dakota, and Nebraska (Figure 1.1). Near-field receptor locations were arranged to identify the maximum concentrations due to the emissions under various alternative combinations. Receptors were located along the boundaries and within each of the Class I areas and specified Class II areas of concern within the modeling domain (e.g., National Parks [NPs] and National Monuments [NMs], Wilderness Areas [WAs], and IRs).

The DM&E CALPUFF cumulative emissions inventory database was updated and used in air quality modeling for the current study with a few exceptions, including (1) emissions data for the proposed sources of the current project; (2) emissions data for additional new sources since the DM&E emission inventory database cutoff date, identified by the state DEQs; and (3) selected DM&E emission inventory database revisions, reviewed by the state DEQs, revised by Argonne, and approved by the BLM, as needed.

The meteorological database used in the CALPUFF modeling for the current study was the output from the CALMET modeling based on the 1996 MM5 prognostic meteorological model output and the 1996 surface wind and precipitation data from selected National Weather Service (NWS) and other meteorological stations located in the area slightly larger than the modeling domain.

The outputs from the air quality modeling were used to assess potential impacts on near-field and far-field air quality and far-field AQRVs. Air quality impact assessments were conducted (1) by comparing potential air quality impacts predicted to result from the project emissions under each of the various alternatives alone, all other new and RFFA sources emissions alone, and all sources emissions combined (cumulative) with the applicable Prevention of Significant Deterioration (PSD) increments (Class I or Class II depending on receptor location); and (2) by comparing the potential total concentrations (direct cumulative air quality impacts plus the existing background concentration) with the applicable National Ambient Air Quality Standards (NAAQS) and applicable State Ambient Air Quality Standards (SAAQS).

Near-field impacts of emissions from construction sites, including fugitive dust emissions and operational emissions from compressor stations, were assessed by comparing them with

NAAQS and SAAQS. Near-field impacts of hazardous air pollutants (HAPs) from compressor stations were evaluated by comparing them with acceptable ambient concentration levels (AACLs) identified by states and by calculating the distances from the source beyond which potential cancer risks for a maximally exposed individual (MEI) and most likely exposure (MLE) condition would decrease to the levels of 1×10^{-4} and 1×10^{-6}.

AQRVs evaluated included visibility and acid deposition. Potential visibility impacts were assessed at the far-field receptors located in sensitive receptor areas by using the screening procedure drafted by the FLMs' Air-Quality-Related Values Workgroup (FLAG). This procedure uses an assumed natural background visibility reference level and visibility degradation parameter equations recommended by FLAG. Estimated potential visibility degradations were compared with the limit of acceptable change (LAC) thresholds. Assessments of potential visibility impairment were also made on the basis of background reference levels (visibility conditions) provided by the State of Wyoming. For those receptors for which the potential visibility impairment predicted by using the FLAG screening procedure was equal to or exceeded the LAC thresholds, a refined assessment of daily visibility impairment was made on the basis of available hourly optical visibility data in order to determine the magnitude, frequency, and duration of such a potential impairment. The locations of sensitive receptors for which potential visibility impairment was assessed are shown in Figure 2.1.

Acid deposition impacts were assessed by comparing predicted annual total acid deposition fluxes (wet and dry) with existing deposition LACs (Fox et al. 1989), as well as with sensitive lakes in terms of their acid neutralizing capacity (ANC) and the LAC threshold established on the basis of FS-recommended prediction methods (FS Rocky Mountain Region 2000). These include Black Joe, Deep, Hobbs, and Upper Frozen Lakes in the Class I Bridger WA, Ross Lake in the Class I Fitzpatrick WA, Stepping Stone and Twin Island Lakes in the Class II Absaroka-Beartooth WA, Emerald Lake and Florence Lake in the Class II Cloud Peak WA, and Lower Saddlebag Lake in the Class II Popo Agie WA.

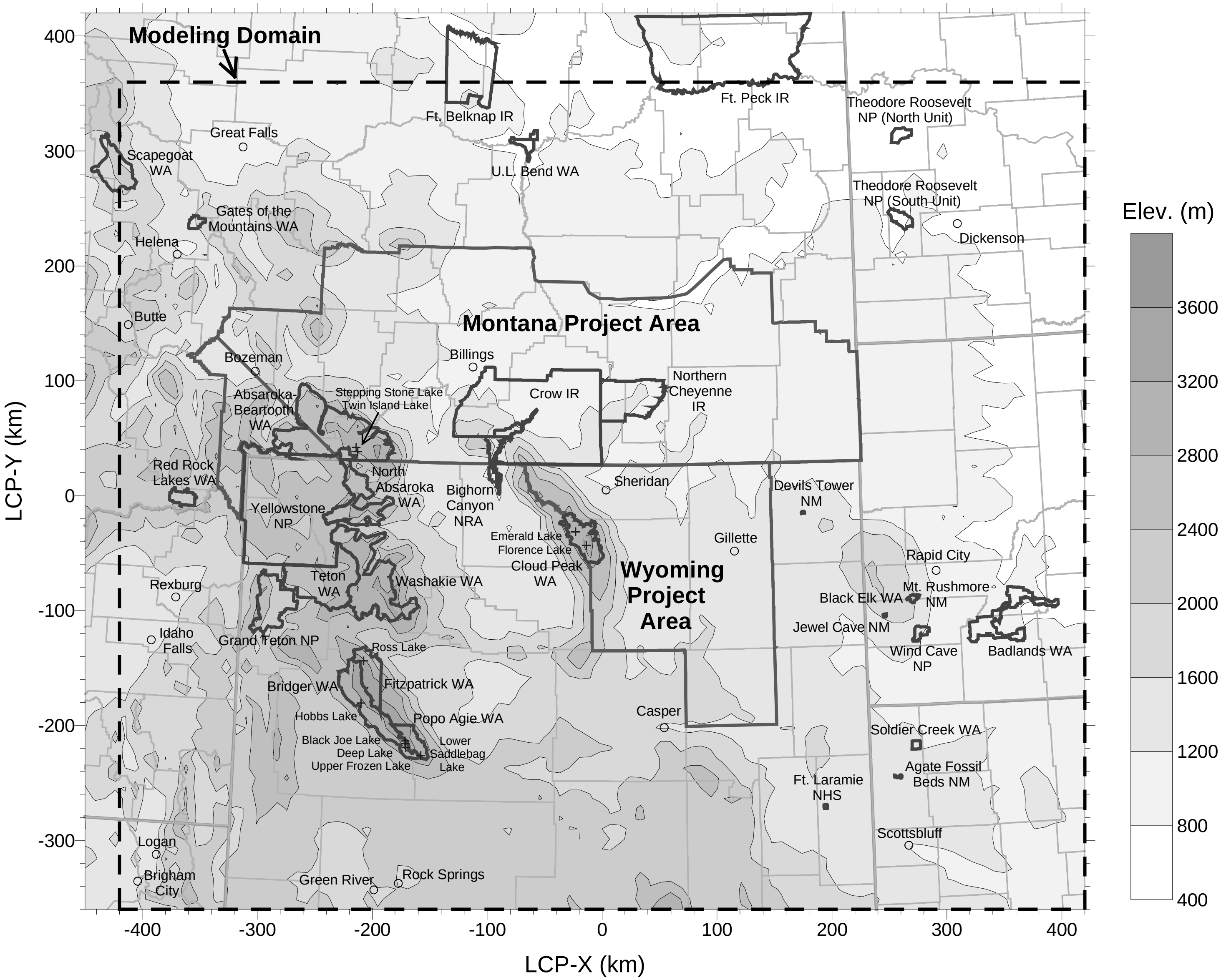

FIGURE 2.1 Topography of the Modeling Domain, Population Centers, and Sensitive Receptors

3 AIR QUALITY MODELING SYSTEM AND MODELING DOMAIN

An air quality modeling analysis was conducted for the Montana and Wyoming Projects (current study) to assess potential impacts on ambient air quality and AQRVs due to the Montana and Wyoming Projects and other new and RFFA sources in the modeling domain. The CALPUFF modeling system (Scire et al. 1999a) recommended by the Interagency Workgroup on Air Quality Modeling (IWAQM) was used as the basis of the modeling analysis for both near- and far-field impact assessments. The CALPUFF modeling system is recommended for a refined modeling analysis (as opposed to a screening-type analysis) to address the air quality impacts of pollutants transported over relatively long distances (EPA 1998).

The CALPUFF modeling system has three main components: CALMET (a diagnostic three-dimensional meteorological model), CALPUFF (the transport and dispersion model), and CALPOST (a postprocessing analysis package). The CALPUFF modeling system is designed to (1) treat time-varying point and area sources, (2) model domains from tens of meters to hundreds of kilometers from a source, (3) predict averaging times ranging from one hour to one year, (4) be applied to inert pollutants and those subject to linear removal and chemical conversion mechanisms, and (5) be applied to rough or complex terrain situations. CALPUFF is a Lagrangian puff model with the capability to simulate regional-scale, long-range dispersion as well as local-scale, short-range dispersion (Scire et al. 1999a).

The CALPUFF model not only enables the prediction of direct concentrations that may result from new and RFFA sources but also the prediction of total cumulative ambient concentrations by summing up the observed background concentrations (due to existing sources) and the direct impact due to new and RFFA sources.

To be able to easily evaluate impacts due to a specific source category or categories, the air quality modeling program for the current project was designed so that impact contributions from various source category(ies) could be readily separated from overall impacts due to all source categories. Source categories were defined at two hierarchical levels. At the first level, emission sources were divided into three groups: (1) emission sources for the proposed actions (or alternatives); (2) sources with permits to construct or operate; and (3) all other potential new sources, reasonably foreseeable but without permits to construct. At the second level, each first-level source category was classified into subgroups by industry category (power plant, surface coal mine, locomotive, gas/oil production site, compressor station, petroleum refinery, petroleum storage tank, gas processing plant, etc.). The program was also designed to allow emission inventory information for specific emission sources to be easily added or removed, so that additional model runs could be performed with minimal effort.

The modeling domain proposed for the current study includes most of Wyoming and Montana and portions of adjacent North Dakota, South Dakota, and Nebraska (Figure 1.1). The modeling domain is defined in the Lambert Conformal Projection (LCP) grid system as follows:

- Central reference LCP point (longitude, latitude) = (-107.0°, 44.75°),
- Standard latitude parallels at 30° and 60°, and
- Grid origin offset from central reference point = (-420 km, -360 km).

For the near-field impact assessment, the air quality modeling was limited to an area extending approximately 30 km in all directions beyond the locations of stationary emissions sources of the Montana and Wyoming Projects that are closest to the boundaries of the respective project area.

4 MODEL INPUT DATA

4.1 METEOROLOGICAL DATA

Hourly three-dimensional meteorological data fields for 1996 were developed for the modeling domain selected for the current study by ENVIRON International Corporation (EIC) by using Version 5.2 of the CALMET meteorological model (Scire et al. 1999b), a diagnostic meteorological model (EIC 2001). The meteorological database with local wind variations at a 4-km by 4-km resolution was used as input to the CALPUFF model for the current study.

CALMET, one of the three main components of the CALPUFF modeling system, includes a diagnostic wind model that combines surface and upper-air meteorological data with diagnostic effects of terrain and other factors in order to generate three-dimensional wind fields (Scire et al. 1999b). It also includes other interpolation algorithms that generate three-dimensional temperature, pressure, and other meteorological variables, and two-dimensional precipitation fields. For areas with complex terrain and sparse wind observations, a diagnostic wind model cannot accurately depict the complex flow fields by using surface observation data alone. In those situations, CALMET defines the synoptic-scale flow features by using the output from a coarse grid (e.g., 36 km) resolution simulation of a prognostic meteorological model (e.g., Pennsylvania State University/National Center for Atmospheric Research [NCAR] mesoscale meteorological model [MM5]) and then better characterizes the local wind variations at a finer scale (e.g., 4 km) by using its diagnostic wind algorithms and local surface observations. The MM5 simulation was performed by using four-dimensional data assimilation of analysis fields generated by interpolation of the standard NWS upper-air meteorological data. Thus, the three-dimensional MM5 meteorological fields implicitly contain the effects of the NWS upper-air meteorological observations.

The detailed meteorological database for the project domain was developed by using surface meteorological data from a total of 240 surface stations from the following networks within areas somewhat larger than the modeling domain (Figure 4.1):

- NWS sites (64),
- Automated Weather Data Network (AWDN) (40),
- Remote Automated Weather Stations (RAWSs) (118),
- North Dakota Sulfur Dioxide (SO_2) Monitoring Sites (3),
- CASTNET sites (3), and
- Powder River Basin (PRB) Industrial sites (12).

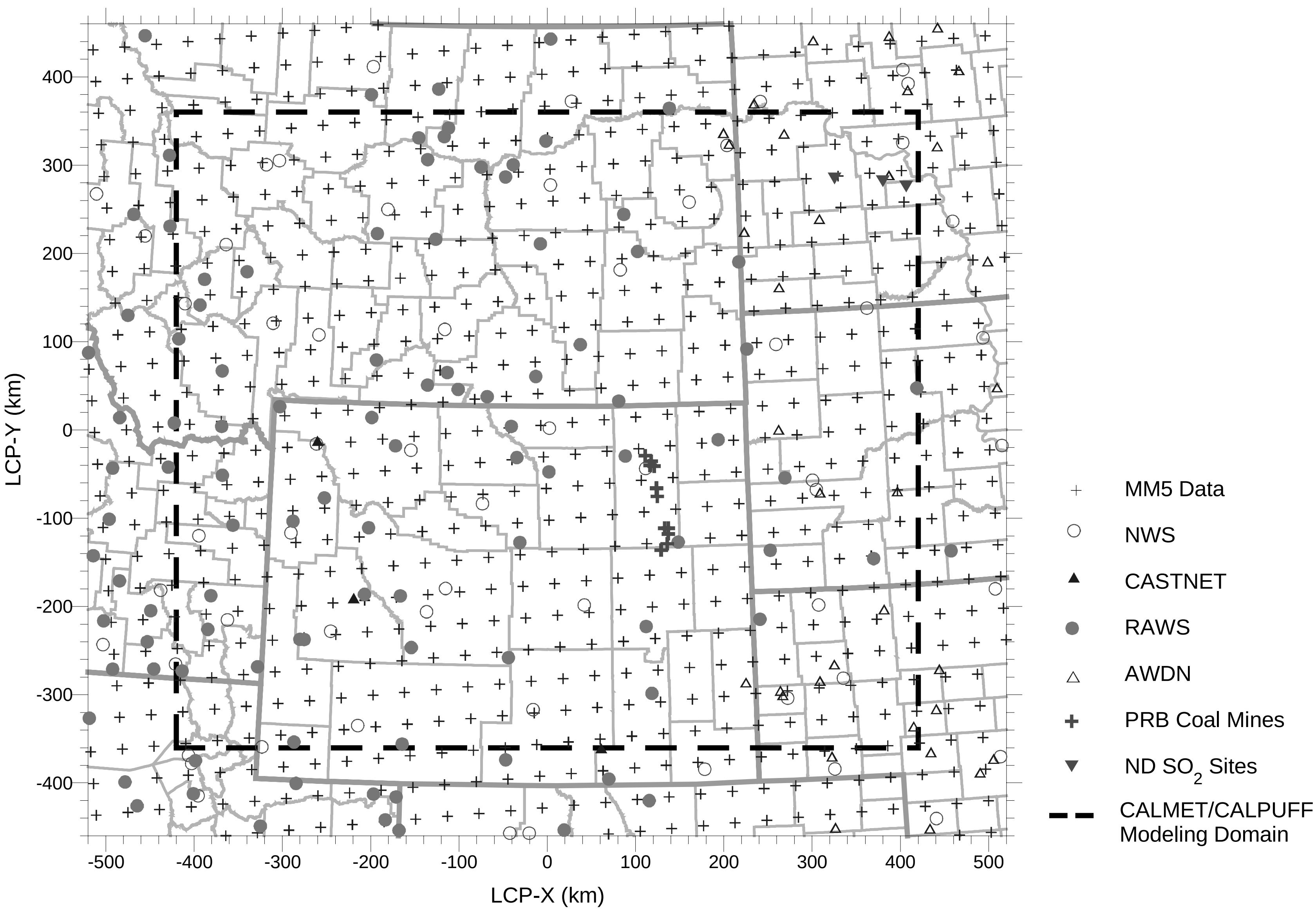

FIGURE 4.1 Weather Stations with Surface Data

For the CALMET modeling performed for the current study, precipitation data from 249 Cooperative Weather Sites (COOPs) were acquired from the Western Regional Climate Center (WRCC) and used in CALMET modeling for the current study (Figure 4.2). Terrain and land use data from the U.S. Geological Survey (USGS 2000a,b) were processed to obtain average terrain elevation and predominant land use type for each of the 210 by 180 grid cells (4-km by 4-km) in the modeling domain. The topography of the modeling domain on the basis of average terrain elevation data is displayed in Figure 2.1.

Annual wind roses at a 10-m level based on the hourly CALMET 5.2 output described above are presented in Figure 4.3 for Helena, Billings, and Miles City in Montana; Sheridan, Lander, and Casper in Wyoming; Rapid City in South Dakota; and Scottsbluff in Nebraska.

4.2 RECEPTOR DATA

Near-field receptor locations were arranged to obtain the maximum estimated concentrations that would result from the proposed new sources identified in the Montana and Wyoming Projects. Subsequent near-field modeling with smaller receptor grid intervals was conducted in an area (45 km by 20 km) located in the south central part of the Montana Project Area, and in an area (30 km by 30 km) located in the north-central part of the Wyoming Project Area. These areas were selected because high impacts were predicted during the initial modeling, and the stationary emissions sources are most densely concentrated in these areas. The receptor grid interval for these areas was reduced to 1 km, except for the area near the boundary of the areas, where the receptor grid was set at 2-km intervals (Figure 4.4).

Near-field impacts of particulate matter emitted from construction activities of the current projects were evaluated by modeling emissions from the construction site for a sales or reciprocating compressor engine (6 to 7 acres) and a service road (40 ft wide and 1,575 ft long). Receptors for the near-field fugitive dust impact modeling were located at 100-m intervals within an area extending from 400 to 600 m from the center of the compressor station construction site and from 200 to 600 m from the center of the service road. Operational emissions of criteria pollutants and HAPs from the current projects were also evaluated for near-field impacts by modeling emissions from the largest compressor station (assuming six units of reciprocating compressor engines). Receptors for these near-field impact modeling were located at 100-m intervals within an area extending to approximately 1 km from the center of the compressor station.

For far-field impact assessment, receptors were located along the boundaries and within each of the Class I areas and specified Class II areas of concern within the modeling domain. Figure 2.1 shows the locations of these Class I and Class II areas of concern and other sensitive areas (sensitive lakes), and Figure 4.4 shows the receptor locations at these sensitive areas within the modeling domain. The receptors were defined with the density necessary to ensure that maximum potential air quality and AQRV impacts were evaluated (i.e., at 4- to 5-km intervals in the interior and along the boundaries of the Class I and specified Class II areas of concern, and at specific sensitive lakes).

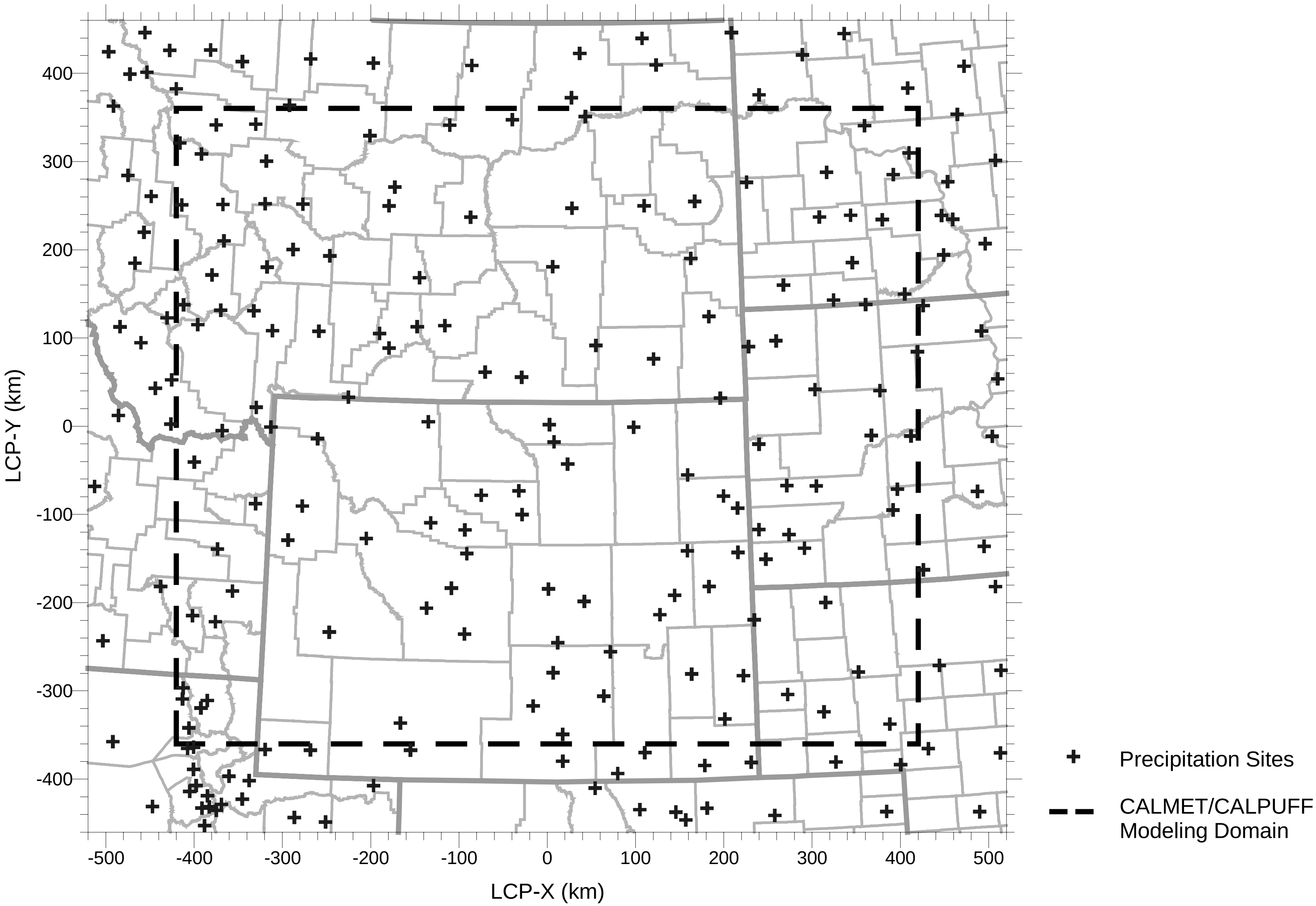

FIGURE 4.2 Weather Stations with Precipitation Data

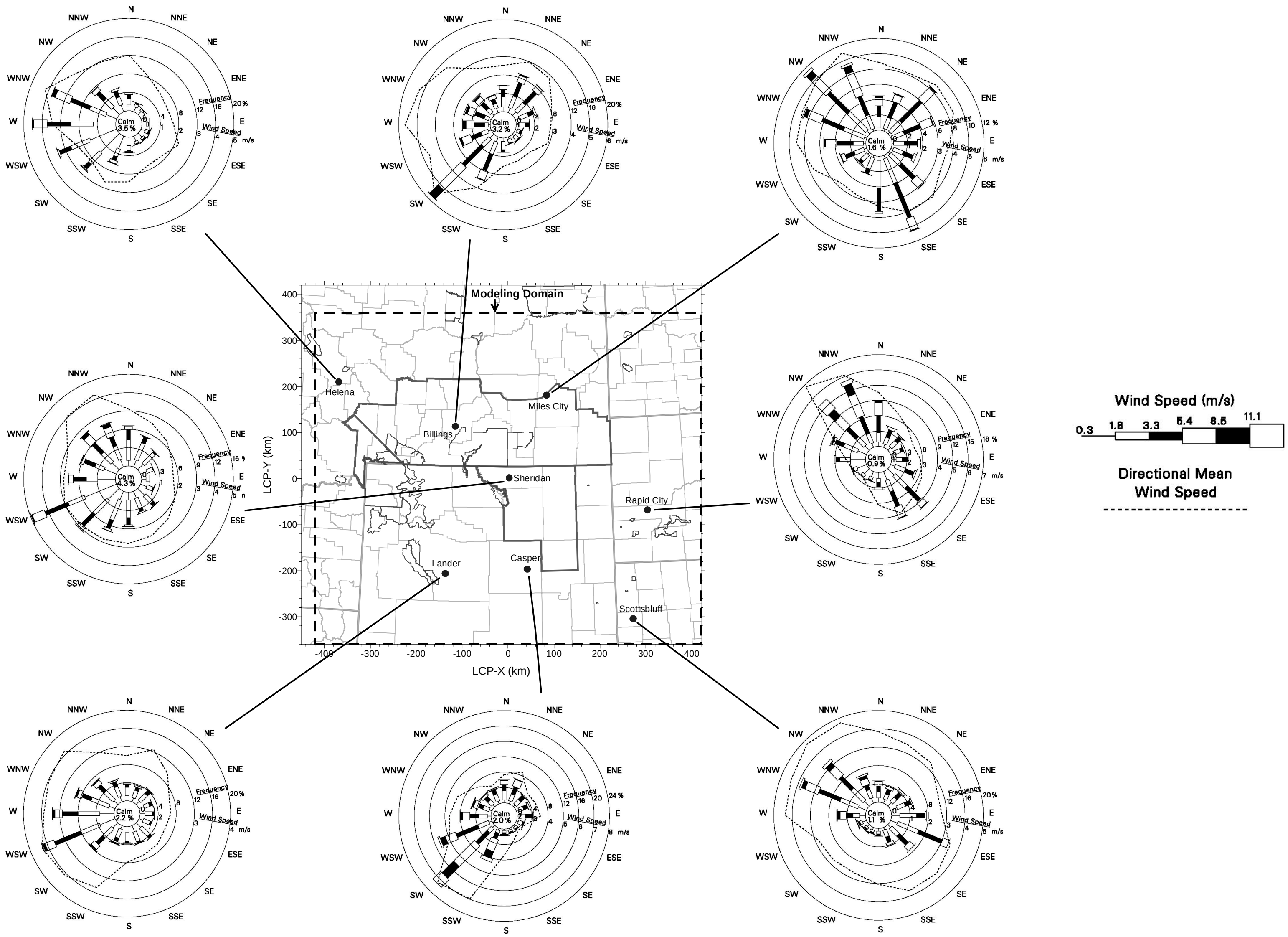

FIGURE 4.3 Annual Wind Roses at the 10-m Level in 1996 at Selected Locations within the Modeling Domain Based on CALMET Output Data

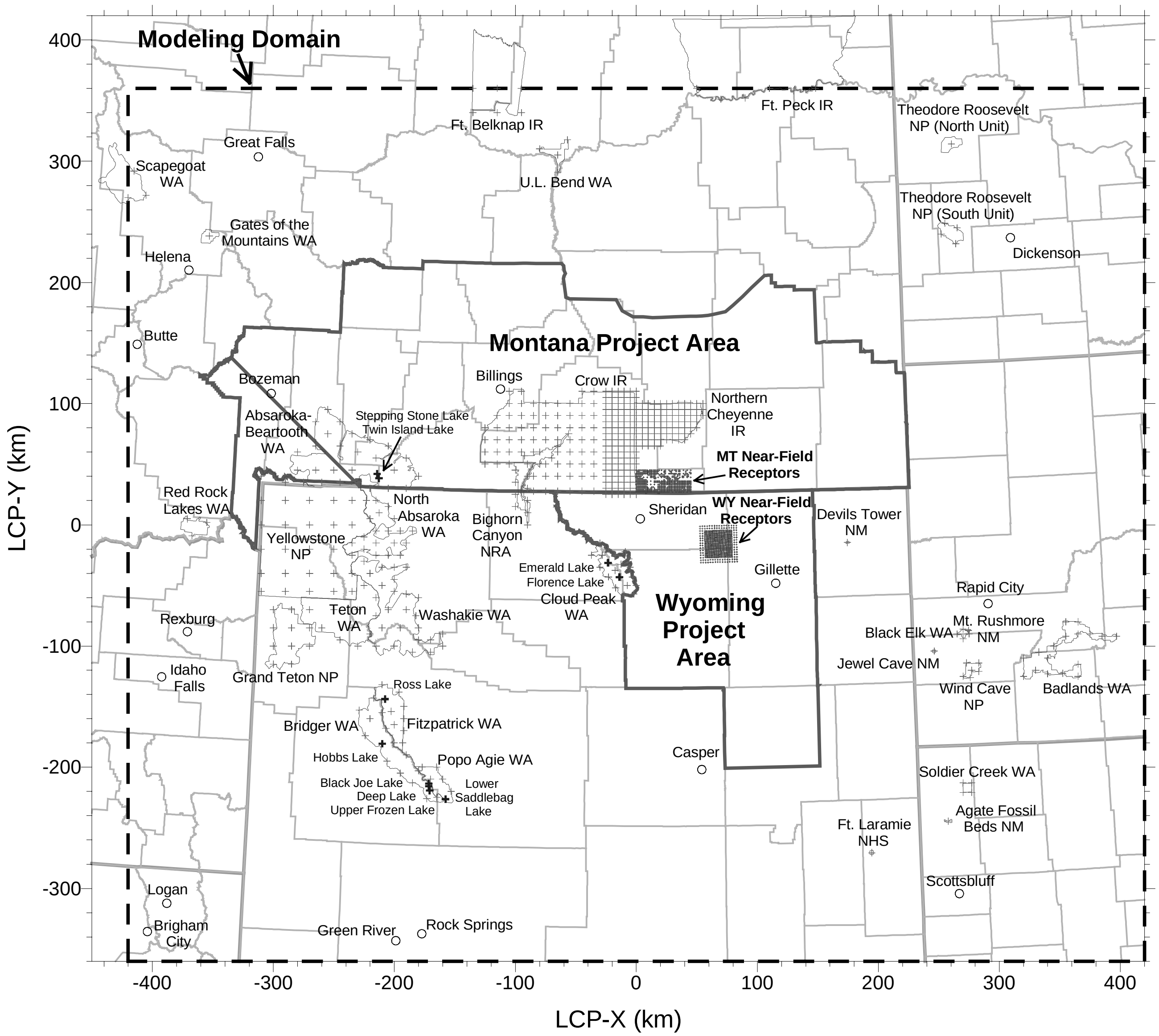

FIGURE 4.4 Near-Field and Far-Field Receptor Locations Selected for CALPUFF Modeling

The elevation of each receptor was obtained by using Digital Elevation Model data for the 1:250,000 quads with 30-m horizontal resolution (USGS 2000a).

4.3 AMBIENT AIR QUALITY AND AQRV DATA

The existing ambient air quality levels, visibility, and lake chemistry parameters in and around the project areas are described in several recently published EISs for proposed activities in the modeling domain (e.g., BLM 1999a; EIC 2000). These background data were used in the current study as follows:

- Data on background concentrations for criteria pollutants based on the most recent representative maximum concentrations measured in the region were combined with the data on predicted maximum cumulative impacts for comparison with ambient standards,
- Data on background ozone (O_3) concentrations were used as input to the CALPUFF model,
- Data on background concentrations of particulate chemical species were combined with data on ambient and CALPUFF-predicted chemical species concentrations for performing the sulfate/nitrate/ammonia equilibrium calculation needed to predict the secondary particulate concentration, and
- Data on background levels of visibility and acid deposition were used to assess the significance of predicted changes in visibility and acid deposition.

The background data selected for use in the impact assessment of the Montana and Wyoming Projects are described in the following sections. Additional data on ambient air quality, visibility, acid deposition, and ANC that have become available since the preparation of the recently published EISs were obtained and evaluated. Valid new data were included in defining the background ambient air quality and AQRV levels for this analysis.

4.3.1 Criteria Pollutants

Ambient concentrations of criteria pollutants monitored within the modeling domain that were used to define regional background air quality levels for the Montana and Wyoming Project Areas are listed in Tables 4.1 and 4.2, respectively. The ranges of values recorded during the three-year period (1998–2000) are presented for all monitoring stations located within the Montana Project Area (Table 4.1). Particulate matter (PM) data (PM_{10} and $PM_{2.5}$) for the Wyoming Project Area are presented for two locations: Sheridan and Gillette, Wyoming. Sheridan data were used to represent the background concentrations for the population center receptors in the community of Sheridan. Gillette data were used to represent the background concentrations for the rest of the Wyoming Project Area. Because of Gillette's environmental

TABLE 4.1 Regional Ambient Air Quality Levels for the Montana Project Area

Pollutant	Averaging Time	NAAQS (μg/m³)	Montana AAQS (μg/m³)	Ambient Air Quality Level (μg/m³)	Ambient Air Quality Data Source[a]
NO_2	Annual	100	100	11.3	Rosebud County, Montana (1998–2000)[c]
	1-hour	-[b]	566	117	
SO_2	Annual	80	60	15.7	Billings, Montana (1998–2000)[d]
	24-hour	365	260	73	
	3-hour	1,300	-	291	
	1-hour	-	1,300	666	
PM_{10}	Annual	50	50	29.9	Rosebud County, Montana (1998–2000)[e]
	24-hour	150	150	105	
$PM_{2.5}$	Annual	15	-	8.1	Rosebud County, Montana (2000)[f]
	24-hour	65	-	20	
CO	8-hour	10,000	10,000	6,600	Billings, Montana (1998–2000)[g]
	1-hour	40,000	26,000	15,000	
O_3	8-hour	157	-	100	Flathead County, Montana (1998–2000)[h]
	1-hour	235	196	108	

[a] Data source is EPA (2001a), unless otherwise noted.

[b] A hyphen indicates no standard exists.

[c] Highest among six monitors in the county.

[d] Highest among seven monitors in the city. Three-hour and 24-hour average data represent the highest and annual second-highest concentrations for a 3-year period.

[e] Highest among 12 monitors in the county. Twenty four-hour average data represent the annual 99th percentile concentration. All concentration values are 3-year averages.

[f] Higher of two monitors. Twenty four-hour average data represent the annual 98th percentile concentration.

[g] Higher of two monitors. Eight-hour and one-hour average data represent second-highest concentrations.

[h] Annual fourth-highest daily maximum 8-hour and 1-hour average concentrations, averaged over a 3-year period. The monitor is located just outside of the modeling domain.

TABLE 4.2 Regional Ambient Air Quality Levels for the Wyoming Project Area

Pollutant	Averaging Time	NAAQS ($\mu g/m^3$)	Wyoming AAQS ($\mu g/m^3$)	Ambient Air Quality Level ($\mu g/m^3$)	Ambient Air Quality Data Source
NO_2	Annual	100	100	16.5	Gillette, Wyoming (1996-1997)[a]
SO_2	Annual	80	60	3	Devils Tower, Wyoming (1983)[b]
	24-hour	365	260	8	
	3-hour	1,300	1,300	8	
PM_{10}	Annual	50	50	17	Gillette, Wyoming (1999)[c]
	24-hour	150	150	42	
	Annual	50	50	33	Sheridan, Wyoming (1999)[c]
	24-hour	150	150	105	
$PM_{2.5}$	Annual	15	15	7.6	Gillette, Wyoming (1999)[d]
	24-hour	65	65	19	
	Annual	15	15	9.5	Sheridan, Wyoming (1999)[c]
	24-hour	65	65	33	
CO	8-hour	10,000	10,000	1,500	Riley Ridge EIS[e]
	1-hour	40,000	40,000	3,500	
O_3	8-hour	157	157	130[f]	Pinedale, Wyoming
	1-hour	235	235	82[g]	

[a] NO_2 concentration data collected at Gillette, Wyoming, from March 27, 1996, to April 28, 1997 (EIC 2000).

[b] SO_2 data collected at Devils Tower during 1983 (EIC 2000).

[c] Twenty four-hour average data represent the 99th percentile (second highest) concentration (WDEQ 2000a).

[d] Sheridan annual $PM_{2.5}/PM_{10}$ ratio for 1999 (0.45) applied to Gillette PM_{10} values.

[e] Taken from representative data collected by WDEQ and commercial operators (BLM 1983).

[f] Fourth-highest maximum daily 8-hour concentration, averaged over a 3-year period (1992–1994).

[g] Data collected in 2000.

setting and its smaller population, Gillette data are considered more representative of the rest of the Wyoming Project Area than the data collected in Sheridan. As shown in these tables, all regional background air quality levels are in compliance with the NAAQS and SAAQS.

4.3.2 Chemical Species

The regional background ozone concentration value is needed as input to the CALPUFF model for use in its empirical chemical transformation algorithm. Because of the lack of available data, this study used the same constant values as those used in modeling for other recent EIS projects: the values are in the region of 40 ppb (e.g., EIC 2000).

Chemical species data for ambient aerosols were determined by analyzing PM samples collected twice a week at two Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring sites located near the Badlands and Bridger WAs. PM mass concentration data reconstructed from the speciated PM data at the two monitoring sites were processed to generate monthly average PM speciation profiles (EIC 2000). The Badlands and Bridger IMPROVE data were used to define the background concentrations of particulate sulfate, nitrate, and ammonium for those sensitive receptor areas located, respectively, east and west of the eastern boundary of the project areas (Figure 4.4).

In addition to the chemical species data for airborne PM, background concentration data for gaseous free ammonia and nitric acid (HNO_3) are also required. Because there are no measurements of gaseous ammonia or HNO_3 in the region, values of 5 and 0.5 ppb, respectively, were used in the current analysis, since they were used in the previous CALPUFF modeling analyses (EIC 2000), to provide conservatively high estimates.

4.3.3 Visibility

FLAG has established a recommended screening procedure for identifying and evaluating potential visibility impairment primarily in mandatory federal PSD Class I areas (FLAG 2000). (See Appendix A for details.) According to the FLAG procedure, predicted changes in visibility in terms of percent change in extinction (or change in deciview [*dv*]; a 10% change in extinction corresponds to 1.0 *dv* change) because of emissions from proposed sources would be computed and compared with estimated seasonal natural background reference visibility levels, and the resulting percent change in extinction (or change in *dv*) would be compared with FLAG-prescribed threshold levels for impact assessment. Table 4.3 lists the PSD Class I areas and specified PSD Class II areas of concern within the modeling domain. Estimated seasonal natural background visibility reference levels and associated parameter values, including site-specific, seasonal relative humidity adjustment factors as recommended by FLAG, are provided in Table 4.4 for the PSD Class I and PSD Class II areas of concern (FLAG 2000) located within the modeling domain. The analysis using the FLAG-prescribed threshold levels is called the FLAG screening procedure in this study.

TABLE 4.3 PSD Class I Areas and PSD Class II Areas of Concern within the Modeling Domain of the Montana and Wyoming Projects

PSD Class I Area or PSD Class II Area of Concern	PSD Class	Responsible Agency	Location with Respect to Montana Project[a]		Location with Respect to Wyoming Project[a]	
			Distance (km)	Direction	Distance (km)	Direction
Badlands WA[b]	I	NPS	339	ESE	280	E
Wind Cave NP	I	NPS	282	SE	209	ESE
Grand Teton NP	I	NPS	368	WSW	368	W
Yellowstone NP	I	NPS	323	W	348	W
Theodore Roosevelt NP - South	I	NPS	283	NE	346	NNE
- North	I	NPS	337	NE	411	NNE
Bridger WA	I	FS	344	SW	306	WSW
Fitzpatrick WA	I	FS	323	SW	294	WSW
Washakie WA	I	FS	273	WSW	272	W
North Absaroka WA	I	FS	265	WSW	290	W
Teton WA	I	FS	314	WSW	315	W
Gates of the Mountains WA	I	FS	447	WNW	521	NW
Scapegoat WA	I	FS	518	WNW	593	NW
UL Bend WA	I	FWS	283	NNW	388	NNW
Red Rock Lakes WA	I	FWS	419	W	446	W
Fort Peck IR	I	FPTEB[c]	311	N	411	N
Northern Cheyenne IR	I	NCTC[d]	45	NW	149	NNW
Crow IR	II	CTC[e]	92	WNW	169	NW
Fort Belknap IR	II	FBCC[f]	344	NNW	448	NNW
Devils Tower NM	II	NPS	139	ESE	104	ENE
Mount Rushmore National Memorial	II	NPS	261	ESE	199	E
Jewel Cave NM	II	NPS	248	SE	175	ESE
Agate Fossil Beds NM	II	NPS	359	SE	262	SE
Fort Laramie NHS[g]	II	NPS	351	SSE	246	SSE
Absaroka-Beartooth WA	II	FS	284	W	330	WNW
Black Elk WA	II	FS	259	ESE	195	E
Popo Agie WA	II	FS	338	SW	289	WSW
Soldier Creek WA	II	FS	347	SE	254	SE
Cloud Peak WA	II	FS	109	SW	96	W
Bighorn Canyon NRA[h]	II	NPS	139	W	189	WNW

[a] Distance and direction from the center of the major project emission area to the center of the receptor area.

[b] The Wilderness Area portion of Badlands NP is designated as a mandatory federal PSD Class I area. The remainder of Badlands NP is a PSD Class II area.

[c] Fort Peck Tribal Executive Board.

[d] Northern Cheyenne Tribal Council.

[e] Crow Tribal Council.

[f] Fort Belknap Community Council.

[g] NHS = National Historic Site.

[h] NRA = National Recreational Area.

TABLE 4.4 Estimated Seasonal Natural Background Visibility Reference Levels

Mandatory Federal Class I Area	Season[a]	Hygroscopic (Mm^{-1})	Non-hygroscopic (Mm^{-1})	Rayleigh (Mm^{-1})	f(RH)[b]	Particle b_{ext} with f(RH) (Mm^{-1})	Reference Level (Mm^{-1})[c]
Badlands WA	Winter	0.6	4.5	10.0	3.1	6.4	16.4
	Spring	0.6	4.5	10.0	2.6	6.1	16.1
	Summer	0.6	4.5	10.0	2.2	5.8	15.8
	Fall	0.6	4.5	10.0	2.8	6.2	16.2
Bridger WA[d]	Winter	0.6	4.5	10.0	2.9	6.2	16.2
	Spring	0.6	4.5	10.0	1.9	5.6	15.6
	Summer	0.6	4.5	10.0	1.5	5.4	15.4
	Fall	0.6	4.5	10.0	2.4	5.9	15.9
Fitzpatrick WA	Winter	0.6	4.5	10.0	2.9	6.2	16.2
	Spring	0.6	4.5	10.0	1.9	5.7	15.7
	Summer	0.6	4.5	10.0	1.5	5.4	15.4
	Fall	0.6	4.5	10.0	2.4	6.0	16.0
Fort Peck IR[e]	Winter	0.6	4.5	10.0	3.2	6.4	16.4
	Spring	0.6	4.5	10.0	2.4	5.9	15.9
	Summer	0.6	4.5	10.0	2.2	5.8	15.8
	Fall	0.6	4.5	10.0	3.5	6.6	16.6
Gates of the Mountains WA	Winter	0.6	4.5	10.0	3.1	6.4	16.4
	Spring	0.6	4.5	10.0	2.3	5.9	15.9
	Summer	0.6	4.5	10.0	1.8	5.6	15.6
	Fall	0.6	4.5	10.0	2.8	6.2	16.2
Grand Teton NP	Winter	0.6	4.5	10.0	3.0	6.3	16.3
	Spring	0.6	4.5	10.0	2.0	5.7	15.7
	Summer	0.6	4.5	10.0	1.6	5.5	15.5
	Fall	0.6	4.5	10.0	2.5	6.0	16.0
North Absaroka WA[f]	Winter	0.6	4.5	10.0	2.9	6.2	16.2
	Spring	0.6	4.5	10.0	2.1	5.8	15.8
	Summer	0.6	4.5	10.0	1.7	5.5	15.5
	Fall	0.6	4.5	10.0	2.5	6.0	16.0
Red Rock Lakes WA	Winter	0.6	4.5	10.0	3.2	6.4	16.4
	Spring	0.6	4.5	10.0	2.1	5.8	15.8
	Summer	0.6	4.5	10.0	1.7	5.5	15.5
	Fall	0.6	4.5	10.0	2.7	6.1	16.1
Scapegoat WA	Winter	0.6	4.5	10.0	3.5	6.6	16.6
	Spring	0.6	4.5	10.0	2.4	5.9	15.9
	Summer	0.6	4.5	10.0	1.9	5.6	15.6
	Fall	0.6	4.5	10.0	3.1	6.3	16.3

TABLE 4.4 (Cont.)

Mandatory Federal Class I Area	Season[a]	Hygroscopic (Mm^{-1})	Non-hygroscopic (Mm^{-1})	Rayleigh (Mm^{-1})	f(RH)[b]	Particle b_{ext} with f(RH) (Mm^{-1})	Reference Level (Mm^{-1})[c]
Teton WA	Winter	0.6	4.5	10.0	2.9	6.2	16.2
	Spring	0.6	4.5	10.0	2.0	5.7	15.7
	Summer	0.6	4.5	10.0	1.6	5.5	15.5
	Fall	0.6	4.5	10.0	2.5	6.0	16.0
Theodore Roosevelt NP	Winter	0.6	4.5	10.0	3.7	6.7	16.7
	Spring	0.6	4.5	10.0	2.5	6.0	16.0
	Summer	0.6	4.5	10.0	2.1	5.8	15.8
	Fall	0.6	4.5	10.0	3.2	6.4	16.4
UL Bend WA[g]	Winter	0.6	4.5	10.0	3.3	6.5	16.5
	Spring	0.6	4.5	10.0	2.3	5.9	15.9
	Summer	0.6	4.5	10.0	1.8	5.6	15.6
	Fall	0.6	4.5	10.0	2.8	6.2	16.2
Washakie WA	Winter	0.6	4.5	10.0	2.8	6.2	16.2
	Spring	0.6	4.5	10.0	2.0	5.7	15.7
	Summer	0.6	4.5	10.0	1.6	5.5	15.5
	Fall	0.6	4.5	10.0	2.5	6.0	16.0
Wind Cave NP[h]	Winter	0.6	4.5	10.0	2.9	6.2	16.2
	Spring	0.6	4.5	10.0	2.5	6.0	16.0
	Summer	0.6	4.5	10.0	2.1	5.7	15.7
	Fall	0.6	4.5	10.0	2.6	6.1	16.1
Yellowstone NP[i]	Winter	0.6	4.5	10.0	3.0	6.3	16.3
	Spring	0.6	4.5	10.0	2.1	5.8	15.8
	Summer	0.6	4.5	10.0	1.7	5.5	15.5
	Fall	0.6	4.5	10.0	2.5	6.0	16.0

[a] Winter = December, January, and February; Spring = March, April, and May; Summer = June, July, and August; Fall = September, October, and November.

[b] Site-specific, seasonal relative humidity adjustment factor for hygroscopic aerosols.

[c] Calculated values based on procedures summarized in Appendix A.

[d] Values also assumed to be representative of the PSD Class II Popo Agie WA.

[e] Values for the Medicine Lake WA.

[f] Values also assumed to be representative of the redesignated PSD Class I Northern Cheyenne IR, the PSD Class II Bighorn Canyon NRA, the PSD Class II Cloud Peak WA, and the PSD Class II Crow IR.

[g] Values also assumed to be representative of the PSD Class II Fort Belknap IR.

[h] Values also assumed to be representative of the PSD Class II Agate Fossil Beds, Devils Tower, and Jewel Cave NMs; the PSD Class II Black Elk and Soldier Creek WAs; the PSD Class II Fort Laramie NHS; and the PSD Class II Mount Rushmore National Memorial.

[i] Values also assumed to be representative of the PSD Class II Absaroka-Beartooth WA.

Source: FLAG (2000).

In addition, the State of Wyoming DEQ has provided a set of reference levels (visibility conditions) for mandatory federal PSD Class I areas within the original Wyoming Project Study modeling domain, on the basis of the mean of the cleanest 20% from the period winter 1987 to summer 1997. A separate visibility analysis was performed; it used the same procedures as those described in Appendix A but was based on the following reference levels (in Mm^{-1}) provided by the State of Wyoming: (1) for Badlands WA and Wind Cave NP (winter 23.04, spring 26.13, summer 27.35, and fall 23.13); and (2) for Bridger, Fitzpatrick, North Absaroka, and Washakie WA (winter 14.41, spring 17.56, summer 19.05, and fall 16.37). Except for the winter season at the Bridger, Fitzpatrick, North Absaroka, and Washakie WAs, all the reference levels provided by the WDEQ are higher than the FLAG-estimated seasonal natural background reference levels listed in Table 4.4. The analysis using the WDEQ-provided reference levels is called the WDEQ screening procedure in this study.

In the refined visibility impact assessment conducted in this study (refined procedure), potential daily visibility degradation was calculated on the basis of direct total optical monitoring (transmissometer) data collected at the Badland WA (BL) during a 12-year period (1988–1999) and at Bridger WA (BG) during an 11-year period (1989–1999). The BL data were also used for Agate Fossil Beds NM (AF), Black Elk WA (BE), Devils Tower NM (DT), Fort Laramie National Historic Site (NHS) (FL), Jewel Cave NM (JC), Mount Rushmore National Memorial (MR), Soldier Creek WA (SC), Theodore Roosevelt NP-North (TN), Theodore Roosevelt NP-South (TS), and Wind Cave NP (WC). The BG data also were used for Absaroka-Beartooth WA (AB), Bighorn Canyon NRA (BC), Cloud Peak WA (CP), Crow IR (CI), Fitzpatrick WA (FZ), Fort Belknap IR (FB), Fort Peck IR (FP), Gates of the Mountains WA (GM), Grand Teton NP (GT), North Absaroka WA (NA), Northern Cheyenne IR (NC), Popo Agie WA (PA), Red Rock Lakes WA (RR), Scapegoat WA (SG), Teton WA (TT), UL Bend WA (UB), Washakie WA (WK), and Yellowstone NP (YS). The potential number of days with visibility degradation equal to or greater than 1.0 *dv* was calculated for each year, and an annual average number of days with such visibility degradation was reported.

4.3.4 Acid Deposition

Acid deposition impacts were assessed by comparing (1) predicted annual total acid deposition fluxes (wet and dry) with existing deposition LACs for terrestrial ecosystems in sensitive receptors within the modeling domain (Fox et al. 1989), and (2) predicted changes in ANC of sensitive lakes based on FS-recommended prediction methods (FS Rocky Mountain Region 2000) with the LAC thresholds for ANC changes. The sensitive lakes located in the modeling domain include Black Joe, Deep, Hobbs, and Upper Frozen Lakes in the Class I Bridger WA, Ross Lake in the Class I Fitzpatrick WA, Stepping Stone and Twin Island Lakes in the Class II Absaroka-Beartooth WA, Emerald Lake and Florence Lake in the Class II Cloud Peak WA, and Lower Saddlebag Lake in the Class II Popo Agie WA. Information on location, size of watershed area, and monitored ANC for these sensitive lakes is presented in Table 4.5.

TABLE 4.5 Acid Neutralizing Capacities of Sensitive Lakes within the Modeling Domain of the Montana and Wyoming Projects

		Location with Respect to Montana Project[a]		Location with Respect to Wyoming Project[b]			
Sensitive Lake	Wilderness Area Where Lake Is Located	Distance (km)	Direction	Distance (km)	Direction	Water-shed Area (ha)	10% Most Sensitive ANC (µeq/L)
Black Joe	Bridger	345	SW	296	WSW	890	69.0
Deep	Bridger	347	SW	298	WSW	205	61.0
Hobbs	Bridger	348	SW	315	WSW	293	68.0
Upper Frozen	Bridger	349	SW	299	WSW	64.8	5.8[c]
Ross	Fitzpatrick	324	SW	300	WSW	4,455	61.4
Stepping Stone	Absaroka-Beartooth	266	W	308	WNW	26.4	27.0
Twin Island	Absaroka-Beartooth	265	W	305	WNW	44.9	36.0
Emerald	Cloud Peak	110	SW	104	WNW	293	55.3
Florence	Cloud Peak	114	SW	93	W	417	32.7
Lower Saddlebag	Popo Agie	347	SW	292	SW	155	55.5

[a] Distance and direction from the center of the major emission area of the Montana Project to the center of the receptor area.

[b] Distance and direction from the center of the major emission area of the Wyoming Project to the center of the receptor area.

[c] The background ANC value is based on only six samples taken between 1997 and 2001.

4.4 EMISSIONS INVENTORY DATA

The projected emissions from the Montana and Wyoming Projects were estimated by using appropriate equipment manufacturer's specifications, testing information, and/or EPA emission factors, equations, and data for anticipated levels of construction and operational activities.

The emissions inventory database for the current study was developed by combining the data for the following five categories of sources:

- Construction and operation-related emissions from the Montana and Wyoming Projects,
- Coal mine emissions,
- DM&E railroad and related emissions,
- Other new source emissions,
- RFFA source emissions.

The emission inventory data developed for the Wyoming Project Study were submitted to interested stakeholders, including state DEQs, for their review. Stakeholders' comments were reflected as appropriate in the final emissions inventory database, including the data on emissions associated with the Wyoming Project and other new and RFFA sources within the modeling domain.

A map depicting the distribution of the Montana and Wyoming Project-related emissions sources is provided in Figure 4.5. Figure 4.6 shows the locations of other emission sources not related directly to the Montana and Wyoming Projects.

4.4.1 Non-Project Emission Sources

This section describes the emissions from the sources that would not directly occur under the Montana and Wyoming Projects, including coal mine sources, DM&E railroad and related sources, and other new and RFFA sources. (RFFA sources include several coal-burning power plants forecast within the modeling domain and potential CBM and conventional O&G wells on the IR and FS lands.) Emissions from these sources are common to all alternatives considered for the Montana and Wyoming Project impact assessments, except potential indirect sources on IR and FS lands, which would not occur under Montana Alternative A (No Action). (See Figure 4.6 for the locations of non-project emission sources.)

4.4.1.1 Coal Mine Sources

Currently, approximately 20 coal mines (14 in Wyoming and 6 in Montana) are operating within the modeling domain of the current study. At a given mine, the annual coal production, and, consequently, the activities associated with mining, vary from year to year depending on demand. Coal mining locations change gradually as coal mining progresses. Therefore, potential emissions from coal mining activities at each mine within the modeling domain were estimated for 2006, the projected peak emission year for the Montana and Wyoming Projects. The estimates were derived on the basis of the projected 2006 annual coal production (Doelger 2001; Giovanini 2001) and the reported emission rates per unit coal production at each mine (WDEQ 2000b; Montana Department of Environmental Quality [MDEQ] 2001). The projected locations of the mines anticipated to operate in 2006 were also obtained from the BLM (Doelger 2001; Giovanini 2001). Estimated 2006 emissions of criteria pollutants and volatile organic compounds (VOCs) from coal mines in the modeling domain are provided in Table 4.6. Projected emissions increases of NO_x, SO_2, PM_{10}, CO, and VOCs from coal mines within the modeling domain from 2000 to 2006 are estimated to be 2,744; 301; 2,229; 4,772; and 252 tons per year, respectively.

4.4.1.2 Other New and RFFA Sources

Emissions from new and RFFA sources within the modeling domain are based on the emissions database used in the DM&E expansion project modeling analysis (EIC 2000), which

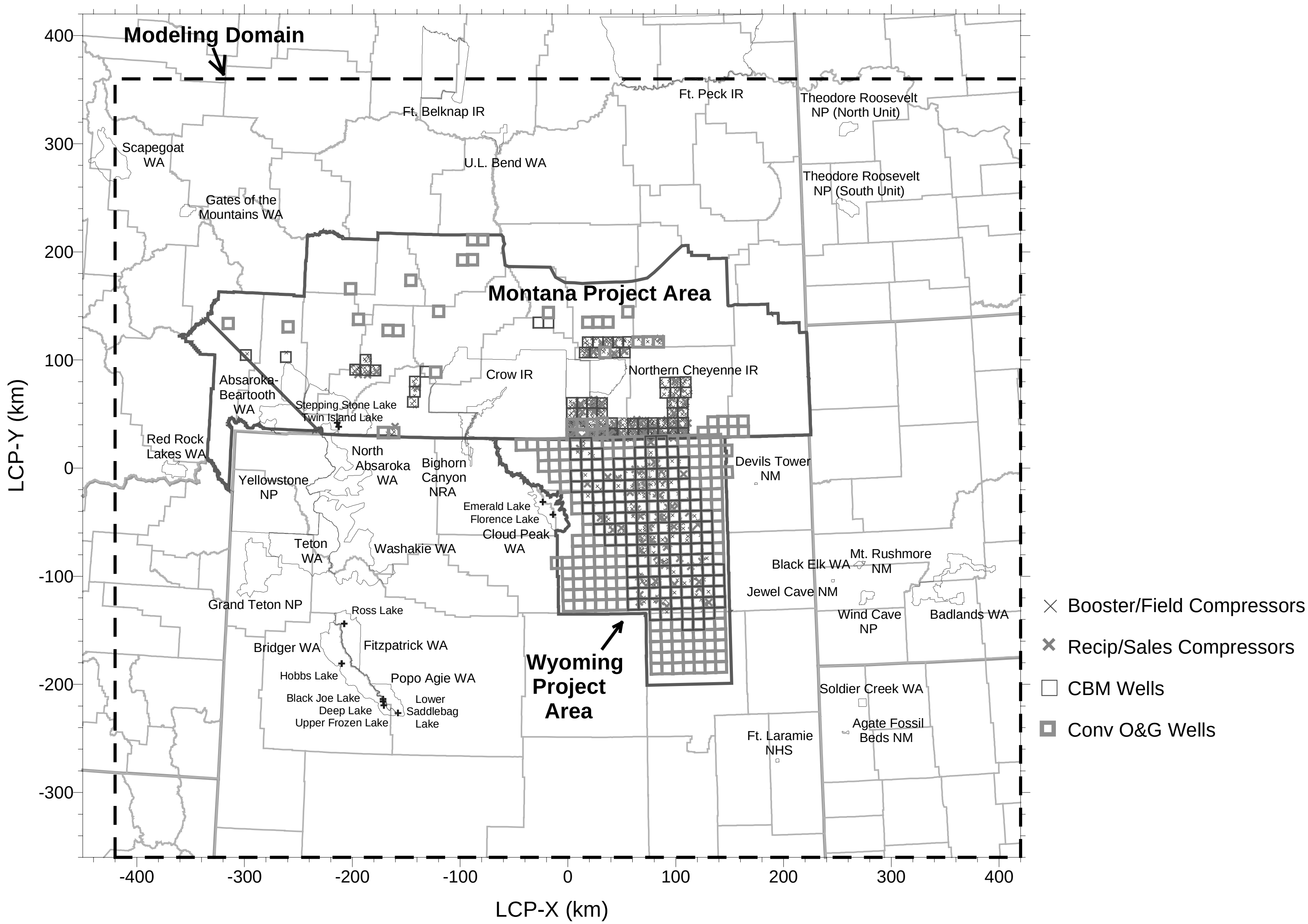

FIGURE 4.5 Montana and Wyoming Project Emission Sources under Proposed Actions

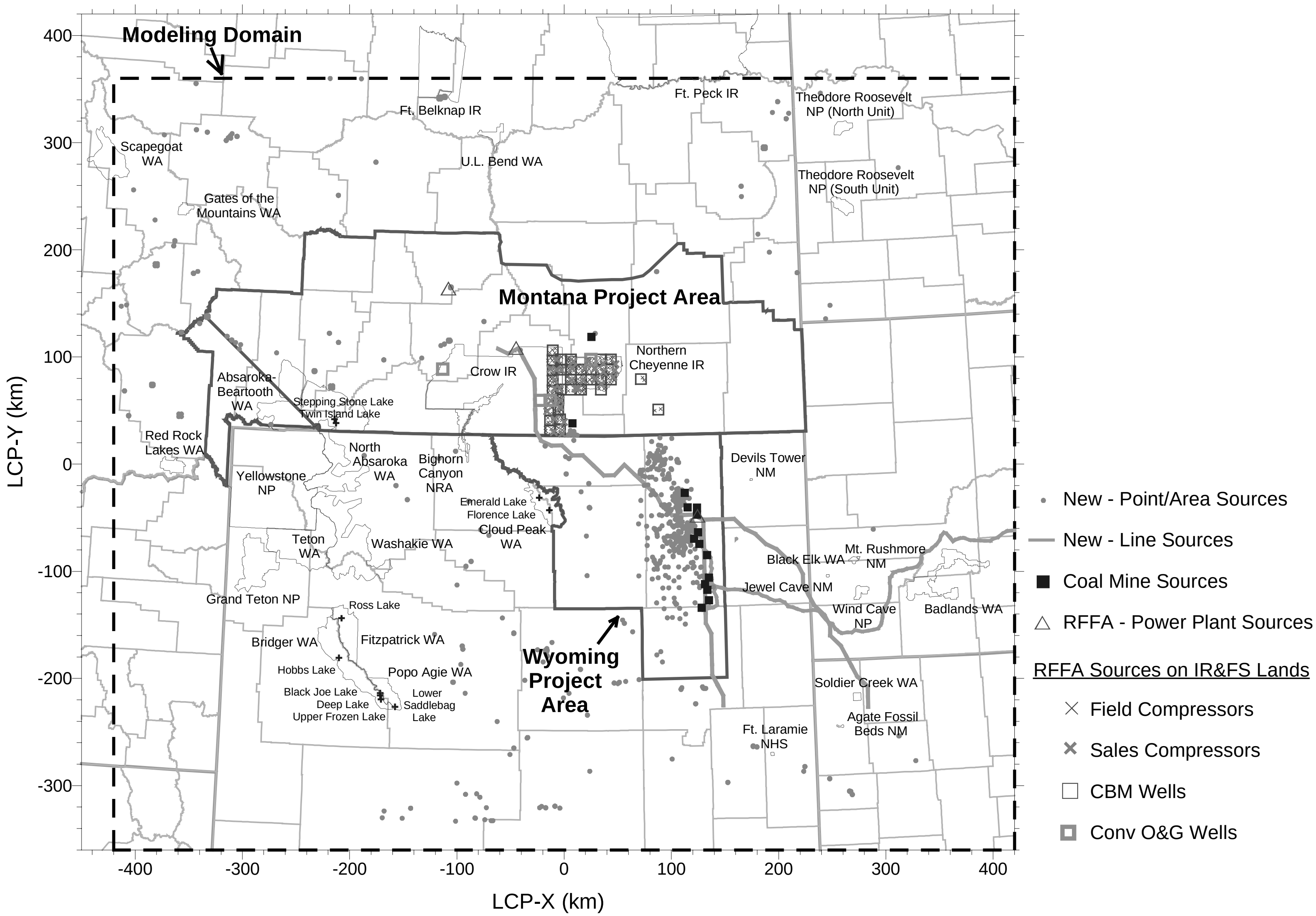

FIGURE 4.6 Non-Project Emission Sources

TABLE 4.6 Criteria Pollutant and VOC Emissions from Coal Mines within the Modeling Domain[a]

		Project Mine Location in 2006				Annual Coal Production (MMTP)				Emission Changes between 2000[b] and 2006 (TPY)[c]				
River Basin	Mine	Pit Area	Section	Town-ship	Range	Actual Production in 2000	2000 Air Quality Permit	2006 Market Share	Increase from 2000 to 2006	NO_x	PM_{10}	SO_2	CO	VOCs
SPRB South Group	Antelope	North	23, 25, 26, 27	41	71	23.0	35.0	28.3	5.3	154.3	73.1	16.4	319.6	16.8
		West	34	41	71									
		South	3, 10, 15	40	71									
	Black Thunder	South	30, 31	43	70	60.1	100.0	74.0	13.9	372.5	274.7	45.5	838.1	43.9
		Center	7, 18, 19, 30	43	70									
		Thunder Cloud	1,5,6	43	70,71									
	Jacobs Ranch	Main	33, 34	44	70	28.3	50.0	34.8	6.5	3.0	165.9	15.0	391.9	20.6
	North Antelope-Rochelle	West	17, 18, 19, 20	41	70	70.7	105.0	87.0	16.3	436.2	430.6	45.8	982.9	51.5
		Middle	32, 33, 34, 35	42	70									
		East	1, 6, 7, 36	41, 42	69, 70									
	North Rochelle	West	5, 32	42, 43	70	24.8	35.0	30.5	5.7	51.8	178.0	6.4	343.7	18.0
		Middle	9	42	70									
	South Pod Total					206.9	325.0	254.6	47.7	1,137.7	1,122.3	129.1	2,876.2	150.8
SPRB Middle Group	Belle Ayr	Main	31	48	71	15.0	45.0	18.5	3.5	268.2	138.1	29.8	211.0	11.1
	Caballo-North, Caballo	Main	9, 10, 15, 16	48	71	25.7	40.0	31.6	5.9	299.9	208.2	31.6	355.8	18.7
	Coal Creek	Main	19, 20, 21, 22, 27, 28, 29	46	70	4.2	18.0	5.2	1.0	55.9	39.6	6.2	60.3	3.2
	Cordero Rojo	South	2, 3	46	71	38.6	65.0	47.5	8.9	392.9	325.1	44.6	536.6	28.1
		South Center	27, 34	47	1									
		North Center	15, 22	47	71									
		North	2, 11	47	71									
		West	8, 9, 10, 16	47	71									
		East	11, 12	47	71									
	Middle Pod Total					83.5	168.0	102.8	19.3	1,016.9	710.9	112.1	1,1637	61.0

TABLE 4.6 (Cont.)

River Basin	Mine	Pit Area	Section	Town-ship	Range	Annual Coal Production (MMTPY): Actual Production in 2000	2000 Air Quality Permit	2006 Market Share	Increase from 2000 to 2006	Emission Changes between 2000[b] and 2006 (TPY)[c]: NO_x	PM_{10}	SO_2	CO	VOCs
		Project Mine Location in 2006												
SPRB North Group	Buckskin	Main	16, 17	52	72	15.8	22.0	19.5	3.7	161.6	67.9	16.8	223.1	11.7
	Dry Fork	South East	31 36	51 51	71 71	2.2	15.0	2.7	0.5	21.8	11.3	2.3	30.2	1.6
	Eagle Butte	Main	27, 34	51	72	18.6	35.0	22.9	4.3	226.9	95.8	23.6	259.3	13.6
	Wyodak	Main	21, 22	50	71	3.0	10.0	3.7	0.7	30.6	13.7	3.2	42.2	2.2
	Clovis Point	NA	NA	NA	NA	-[d]	4.0	-	-	-	-	-	-	-
	Rawhide	Main	8, 9	51	72	-	24.0	-	-	-	-	-	-	-
	Fort Union/ Kennecott	NA	NA	NA	NA	-	9.4	-	-	-	-	-	-	-
	North Pod Total					39.6	119.4	48.8	9.2	440.9	188.8	45.8	554.7	29.1
Wyoming Total						330.0	612.4	406.2	76.2	2,595.6	2,022.0	286.9	4,594.7	240.9
NPRB	Savage	NA	21	20	57	0.3	0.5	0.3	0.1	2.1	3.0	0.2	3.0	0.2
	Absaloka	NA	32	1	38	7.0	11.0	4.0						
	Big Sky	NA	24	1	40	4.3	6.5	1.5						
	Rosebud	NA	8	1	41	8.9	20.5	10.0	1.1	44.1	87.3	4.8	71.9	3.5
	Decker	NA	17	9	40	11.9	16.0	9.5						
	Spring Creek	NA	25	8	39	8.3	15.0	11.0	2.7	102.1	116.5	9.0	101.9	7.4
Montana Total						40.7	69.5	36.3	3.8	148.3	206.8	14.0	176.8	11.1
Wyoming and Montana Total						370.7	681.9	442.5	80	2,743.9	2,228.8	300.9	4,771.5	252.0

TABLE 4.6 (Cont.)

[a] Data for Wyoming and Montana are provided from Doelger (2001) and Giovanini (2001), respectively. Abbreviations: MMTPY = million tons per year, TPY = tons per year, SPRB = South Powder River Basin, NPRB = North Powder River Basin, and NA = not applicable.

[b] Actual production for 1997 was used for Montana mines.

[c] For Wyoming, emissions increases above the 1997/2000 emissions levels are provided for 2006, the year when the NO_x emissions from the Wyoming Project activities are projected to be the highest; emissions changes for Montana coal mines are based on 1997 – 2006 data.

[d] A hyphen indicates no data available.

was an enhancement of the Horse Creek EIS modeling analysis (McVehil-Monnett Associates, Inc. 1999). The DM&E database was updated by (1) adding data for any known and quantifiable new (permitted) and RFFA sources that were not included in the DM&E database (RFFA sources include several coal-burning power plants forecast within the modeling domain. Potential CBM and conventional O&G wells on the IR and FS lands are also included in RFFA sources under all Montana Project alternatives except Alternative A [No Action].); (2) updating data for any known and quantifiable changes in operating levels of existing sources that affect emissions, including facility shutdowns; (3) deleting data for any new (permitted) sources whose permits have been cancelled; and (4) revising data in the DM&E database where necessary. The DM&E database includes data on emissions from surface coal mining and train operations in addition to emissions related to CBM production.

An updated emissions inventory database for the new (permitted) and RFFA sources that are not represented by the background air quality measurements was prepared. Electronic files of emission inventory data for criteria pollutants and HAPs that were used in the recent EIS projects in the modeling domain were obtained through the BLM (e.g., EIC 2000). Emission inventory data for additional new sources and RFFA sources were obtained from state DEQs and the industries proposing such sources. Argonne reviewed these data sets and reorganized them into an appropriate format. The review was conducted with care to ensure that no source was counted more than once. For example, emission sources that were identified as RFFA sources in the emissions inventories for the previous modeling studies but for which permits have been obtained to construct since that time, were included in the new source category (with permits to construct or operate) but eliminated from the previous RFFA source category. Emissions inventory data were revised on the basis of information available in the permits issued.

Any revision or updating of data in the existing emissions inventory databases that became necessary because of changes in design or operation (including facility shutdowns), permit cancellation, or because more appropriate emissions factors became available, were performed following the guidance provided by the BLM and state DEQs.

Emissions from CBM sources that were aggregated into one large source in the previous air quality modeling studies were disaggregated as necessary to the extent possible.

The new NO_x emission sources whose impacts are not reflected in the background ambient concentrations identified for the Wyoming Project Area were included in the updated emissions inventory database. The impacts of new sources that received permits to construct from state DEQs from September 1, 1994, through May 31, 2002, would not have been reflected in background ambient concentrations measured between March 1996 and April 1997, provided that the construction period for new sources is assumed to be approximately 18 months. This monitoring period (March 1996 through April 1997) was selected for the updated emissions inventory database because it is the period when the most recent background nitrogen dioxide (NO_2) data monitored within the State of Wyoming were available for this analysis (at Gillette, Wyoming [see Table 4.2]). The permit cutoff date for new sources to be included in the updated emissions inventory database (August 31, 2000) was selected at the Wyoming Project stakeholders meeting held in Buffalo, Wyoming, on August 3, 2000. Similarly, the RFFA projects are those clearly defined as of August 31, 2000, as the sources reasonably expected to be in operation within the next 10 years. The cutoff dates for the permits and for defining RFFA sources were later extended to May 31, 2002, and emissions data for these additional sources were collected and incorporated into the updated emissions inventory database.

Although available data on ambient background concentrations are more recent for other criteria pollutants than the NO_2 data (March 1996 through April 1997) identified for the Wyoming Project Area, the updated emissions inventory database was used in CALPUFF modeling without further modification so that conservatively high impact estimates would be obtained for those criteria pollutants. For example, PM_{10} ambient concentration data within the Wyoming Project Area are available for the period from January 1, 1999, through December 31, 1999 (at Gillette and Sheridan, Wyoming [see Table 4.2]). In this case, the new sources with a construction permit receipt date from September 1, 1994, until July 1, 1997 (18 months before January 1, 1999), were assumed to not be reflected in the ambient concentration monitored during the period from January 1, 1999, through December 31, 1999.

The new and RFFA source emissions inventories are presented in Appendix B.1 and summarized in Table 4.7.

4.4.2 Project Emission Sources

Activities associated with the first year of the Montana and Wyoming Projects that would result in air pollutant emissions would include construction/installation, operation, and/or maintenance of wells, well pads, compressor engines, roads, pipelines, electric power lines, and other ancillary facilities. These activities would increase in their spatial extent as more wells were drilled and ancillary facilities were developed or installed. Then, as some of the wells drilled early in the project period reached the end of their productive periods, reclamation activities for these wells and associated facilities would be initiated. Consequently, air pollutant emissions would gradually increase to their peak, followed by a gradual decrease as fewer new wells were drilled and more wells reached the end of their productive periods. The locations of the Montana and Wyoming Project emission sources are shown in Figure 4.5.

Air pollutant emissions from each of these activities were first estimated for the entire project period (20 year for the Montana Project or 10 years for the Wyoming Project), allocated to each year of the project period according to the development plans presented in Tables 1.2 and 1.5, and then the year of peak emissions for each pollutant was identified. To minimize the air quality impact assessment effort, CALPUFF modeling was performed once for each alternative combination, using composite peak emissions data, that is, the combination of peak-year emissions data for each pollutant. Thus the air quality impacts estimated in this study are conservatively high estimates, because the peak-year emissions for all pollutants do not occur in any of the 20-year project periods.

Construction-related emissions estimates focused on emissions of PM_{10} and $PM_{2.5}$. However, other criteria pollutant and VOC emissions released from construction equipment and vehicles, as well as temporary field generators, were also estimated. Fugitive PM emissions from

TABLE 4.7 Annual Criteria Pollutant and VOC Emissions from New and RFFA Sources within the Modeling Domain

	Source Category	Annual Emissions (tons/yr)					
		NO_x	SO_2	PM_{10}	$PM_{2.5}$	CO	VOCs
New Sources	DM&E project sources	4,177	502	191	191	799	294
	DM&E permitted new sources	10,214	3,153	531	72	-[a]	-
	CDWII[b] permitted new sources	1,269	563	257	-	-	-
	Wyoming permitted new sources	7,250	1,773	2,691	1,028	13,505	2,795
	Montana permitted new sources	3,169	950	2,279	1,003	2,576	880
	Nebraska permitted new sources	603	17	84	30	122	80
	North Dakota permitted new sources	511	9	18	18	327	52
	South Dakota sources	289	35	53	53	175	71
	Subtotal	27,481	7,001	6,104	2,396	17,504	4,172
RFFA Sources	Montana sources[c]	2,844	4,796	127	71	6,171	20
	CBM and conventional O&G well-related sources on IR and FS lands[d]	2,633	49	308	135	2,687	1,387
	Wyoming sources	1,578	3,381	298	155	3,381	-
	Subtotal	7,054	8,226	733	361	12,238	1,406
Total		34,536	15,227	6,837	2,757	29,742	5,579

[a] A hyphen indicates that no data are available.

[b] Continental Divide/Wamsutter II and South Baggs Natural Gas Development Projects (BLM 1999b).

[c] Excluding CBM and conventional O&G well-related sources on IR and FS lands.

[d] Peak-year emissions.

the construction of wells, associated facilities, and roads were computed on the basis of an EPA emission factor for construction activity (EPA 2000a). Emissions of road dust generated from construction vehicles were estimated by using the EPA unpaved road emission factor equation (EPA 2000a) and the anticipated volume of project traffic. Exhaust emissions from construction equipment and vehicles were computed by using applicable EPA emissions factors (EPA 2000b) and estimated usage levels of construction equipment and vehicles. Exhaust emissions from temporary field generators were also computed by using applicable EPA emissions factors and estimated usage level and duration. Construction site emissions were treated as area sources. Exhaust and road dust emissions were also treated similarly because the exact locations of the roads to be built are not known.

For the operational phase, emissions of criteria pollutants (NO_x, SO_2, CO, PM_{10}, and $PM_{2.5}$) and VOCs were estimated for compressor engines (including booster [field] compressors and sales [reciprocating] compressors), other equipment, road traffic, and road maintenance activities. HAP emissions were estimated for benzene, n-hexane, toluene, ethyl benzene, xylene, and formaldehyde. The emissions factors and stack parameters were obtained from equipment manufacturers with state DEQ review.

Emission rates were computed on the basis of the emissions factors and anticipated level of operational activities (e.g., load factors and hours of operation per year). The reasonably foreseeable emissions for compressor engines and dehydrators at compressor stations were estimated by using conservatively high estimates of compressor engine hp requirements to move a unit volume of produced CBM (160 hp/10^6 ft^3/d for booster compressors and 183 hp/10^6 ft^3/d for reciprocating compressors) and the dehydrator heat input rate to process a unit volume of produced CBM (250×10^6 Btu/h) (Keanini 2001). For impact analysis modeling, similar emissions from individual stacks at a given facility were aggregated into emissions from a single stack.

Road dust emissions from vehicles traveling on access roads were estimated by using the EPA unpaved road emission factor equation (EPA 2000a) and the anticipated volume of project traffic. Fugitive dust emissions from access road maintenance activities were estimated on the basis of the EPA emissions for construction activity (EPA 2000a) and the anticipated level of road maintenance activity.

4.4.2.1 Montana Project Sources

4.4.2.1.1 Alternative B, C, and E Sources. The estimated total emissions of criteria pollutants and VOCs from various project activities throughout the entire 20-year project period under Alternative E (Preferred Alternative) are summarized in Tables 4.8 through 4.10. Estimated emissions for the CBM project activities are provided in Table 4.8, and those for the conventional O&G project activities are provided in Table 4.9. Estimated combined total emissions for the two types of project activities are presented in Table 4.10.

Table 4.11 presents the estimated year-by-year emissions of criteria pollutants and VOCs from various project activities under Alternative E. (See also Figures 4.7 and 4.8.) The 18th year is estimated to be the year with the highest level of total project-related emissions of all pollutants for the Montana Project. The peak-emissions year is different for each pollutant. For example, the peak-emissions year is the 18th year for NO_x (7,361 tons per year), and the 4th year for PM_{10} (956 tons per year). The projected peak-year emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, CO, and VOCs from the Montana CBM and conventional O&G project activities under Alternative E are estimated to be 7,361; 293; 956; 382; 6,692; and 3,454 tons per year, respectively. With well development on the IR and FS lands (Alternative Ea), the projected peak-year emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, CO, and VOCs from the Montana CBM and

TABLE 4.8 Estimated Total Criteria Pollutant and VOC Emissions from CBM-Related Activities of the Montana Project under the Preferred Alternative during the 20-Year Project Period

	Project Activity	Emission Source	Total Project Emissions (tons)						Total
			NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOCs	(tons)
Construction	Construction sites (roads, wells, pads, pods, pipelines, compressor stations, field generators)	Heavy equipment							
		Fugitive dust	0	280	42	0	0	0	280
		Exhaust	17,325	1,235	1,235	1,153	3,974	1,441	25,128
		Commuting vehicles							
		Road dust	0	4,963	725	0	0	0	4,963
		Exhaust	52	12	11	10	153	31	257
	Subtotal		17,376	6,490	2,013	1,163	4,127	1,473	30,629
Operation	Compressor stations	Compressors							
		Sales	27,183	898	898	36	21,086	18,122	67,325
		Field	52,082	2,293	2,293	69	60,762	26,041	141,247
		Dehydrators	491	37	37	3	412	27	971
		Inspection visits							
		Road dust	0	113	16	0	0	0	113
		Exhaust	<0.5	<0.5	<0.5	<0.5	3	<0.5	3
	Wells	Workover							
		Road dust	0	942	138	0	0	0	942
		Exhaust							
		On-site	1,132	80	80	75	244	93	1,625
		On-road	8	2	2	2	17	5	34
	Wells and pipelines	Inspection visits							
		Road dust	0	881	129	0	0	0	881
		Exhaust	2	<0.5	<0.5	<0.5	22	1	26
	Subtotal		80,899	5,246	3,593	185	82,547	44,290	213,166

TABLE 4.8 (Cont.)

Project Activity		Emission Source	Total Project Emissions (tons)						Total (tons)
			NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOCs	
Maintenance	Roads	Heavy equipment							
		Fugitive dust	0	477	43	0	0	0	477
		Exhaust	265	23	23	32	57	13	391
		Commuting vehicles							
		Road dust	0	128	19	0	0	0	128
		Exhaust	<0.5	<0.5	<0.5	<0.5	3	<0.5	4
	Compressor stations	Maintenance visits							
		Road dust	0	207	30	0	0	0	207
		Exhaust	<0.5	<0.5	<0.5	<0.5	5	<0.5	6
	Subtotal		266	835	115	33	65	14	1,213
Total			98,541	12,571	5,722	1,381	86,739	45,776	245,007

TABLE 4.9 Estimated Total Criteria Pollutant and VOC Emissions from Conventional Oil- and Gas-Related Activities of the Montana Project under the Preferred Alternative during the 20-Year Project Period

			Total Project Emissions (tons)						
	Project Activity	Emission Source	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	Total (tons)
Construction	Construction sites (roads, wells, pads, pods, pipelines, compressor stations, field generators)	Heavy equipment							
		Fugitive dust	0	29	4	0	0	0	29
		Exhaust	21,639	788	788	2,668	5,053	801	30,949
		Commuting vehicles							
		Road dust	0	1,084	158	0	0	0	1,084
		Exhaust	11	3	2	2	28	6	50
	Subtotal		21,649	1,904	953	2,670	5,081	807	32,112
Operation	Wells	Workover							
		Road dust	0	16	2	0	0	0	16
		Exhaust							
		On-site	518	37	37	34	112	42	742
		On-road	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Wells and pipelines	Inspection visits							
		Road dust	0	259	38	0	0	0	259
		Exhaust	1	<0.5	<0.5	<0.5	6	<0.5	8
	Subtotal		518	312	77	34	118	43	1,025
Maintenance	Roads	Heavy equipment							
		Fugitive dust	0	128	12	0	0	0	128
		Exhaust	71	6	6	9	15	4	105
		Commuting vehicles							
		Road dust	0	34	5	0	0	0	34
		Exhaust	<0.5	<0.5	<0.5	<0.5	1	<0.5	1
	Subtotal		71	169	23	9	16	4	269
Total			22,239	2,385	1,053	2,713	5,215	854	33,406

TABLE 4.10 Estimated Total Criteria Pollutant and VOC Emissions from the Montana CBM- and Conventional Oil- and Gas-Related Activities under the Preferred Alternative during the 20-Year Project Period

	Project Activity	Emission Source	Total Project Emissions (tons)						Total (tons)
			NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	
Construction	Construction sites (roads, wells, pads, pods, pipelines, compressor stations, field generators)	Heavy equipment							
		Fugitive dust	0	309	46	0	0	0	309
		Exhaust	38,963	2,023	2,023	3,821	9,027	2,242	56,077
		Commuting vehicles							
		Road dust	0	6,047	884	0	0	0	6,047
		Exhaust	62	14	13	12	181	38	307
	Subtotal		39,026	8,394	2,967	3,833	9,207	2,280	62,740
Operation	Compressor stations	Compressors							
		Sales	27,183	898	898	36	21,086	18,122	67,325
		Field	52,082	2,293	2,293	69	60,762	26,041	141,247
		Dehydrators	491	37	37	3	412	27	971
		Inspection visits							
		Road dust	0	113	16	0	0	0	113
		Exhaust	<0.5	<0.5	<0.5	<0.5	3	<0.5	3
	Wells	Workover							
		Road dust	0	958	140	0	0	0	958
		Exhaust							
		On-site	1,650	117	117	109	356	135	2,367
		On-road	8	2	2	2	17	5	34
	Wells and pipelines	Inspection visits							
		Road dust	0	1,140	167	0	0	0	1,140
		Exhaust	2	<0.5	<0.5	<0.5	28	2	33
	Subtotal		81,417	5,557	3,670	220	82,665	44,333	214,192

TABLE 4.10 (Cont.)

	Project Activity	Emission Source	Total Project Emissions (tons)						Total (tons)
			NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	
Maintenance	Roads	Heavy equipment							
		Fugitive dust	0	605	55	0	0	0	605
		Exhaust	336	29	29	41	73	17	496
		Commuting vehicles							
		Road dust	0	163	24	0	0	0	163
		Exhaust	<0.5	<0.5	<0.5	<0.5	4	<0.5	5
	Compressor stations	Maintenance visits							
		Road dust	0	207	30	0	0	0	207
		Exhaust	<0.5	<0.5	<0.5	<0.5	5	<0.5	6
	Subtotal		337	1,004	138	41	82	18	1,482
Total			120,780	14,956	6,775	4,094	91,954	46,630	278,414

TABLE 4.11 Estimated Annual Criteria Pollutant and VOC Emissions from the Montana CBM- and Conventional Oil- and Gas-Related Activities under the Preferred Alternative during the 20-Year Project Period

		Annual Emissions (tons/yr)																				Total Emissions (tons)
Project	Pollutant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
CBM Project	NO_x	1,147	1,985	2,891	3,789	4,060	4,257	4,717	4,996	5,236	5,140	5,061	5,427	5,663	5,891	6,216	6,300	6,406	6,471	6,476	6,412	98,541
	PM_{10}	336	484	656	824	788	682	734	733	722	627	559	647	640	647	678	620	604	575	537	479	12,571
	$PM_{2.5}$	107	166	231	295	291	279	304	313	319	296	277	304	310	319	333	324	323	319	311	296	5,722
	SO_2	49	73	98	121	98	89	93	90	90	75	62	65	64	63	60	52	45	40	32	21	1,381
	CO	584	1,129	1,751	2,408	3,027	3,364	3,806	4,165	4,424	4,509	4,570	4,925	5,185	5,433	5,810	6,007	6,215	6,368	6,495	6,564	86,739
	VOCs	308	624	972	1,318	1,613	1,778	2,001	2,172	2,301	2,358	2,413	2,599	2,737	2,869	3,075	3,180	3,279	3,345	3,402	3,433	45,776
	Total	2,425	4,295	6,368	8,459	9,586	10,170	11,352	12,156	12,773	12,708	12,665	13,663	14,289	14,903	15,840	16,159	16,549	16,799	16,941	16,910	245,007
Conventional Oil and Gas Project	NO_x	741	992	1,124	1,411	1,567	1,520	1,544	1,329	1,330	1,246	1,127	1,104	1,212	1,104	913	938	854	890	747	544	22,239
	PM_{10}	67	91	104	132	148	147	151	135	137	132	123	123	134	127	111	115	109	114	102	85	2,385
	$PM_{2.5}$	33	45	51	64	72	70	71	62	62	59	54	53	58	53	45	46	43	45	38	29	1,053
	SO_2	90	121	137	172	191	185	188	162	162	152	138	135	148	135	111	114	104	109	91	66	2,713
	CO	174	232	263	331	367	356	362	312	312	292	264	259	284	259	214	220	201	209	176	128	5,215
	VOCs	28	38	43	54	60	58	59	51	51	48	43	42	47	42	35	36	33	34	29	21	854
	Total	1,100	1,474	1,672	2,100	2,334	2,266	2,305	1,989	1,992	1,870	1,695	1,662	1,824	1,667	1,386	1,423	1,301	1,356	1,145	845	33,406
CBM Project and Conventional Oil and Gas Project	NO_x	1,888	2,977	4,015	5,200	5,627	5,777	6,261	6,325	6,566	6,387	6,188	6,531	6,874	6,995	7,130	7,238	7,260	7,361	7,223	6,956	120,780
	PM_{10}	403	574	760	956	936	829	885	867	859	758	682	769	774	774	790	735	713	688	639	564	14,956
	$PM_{2.5}$	141	211	282	360	363	349	375	374	382	355	331	357	368	372	378	371	366	364	349	326	6,775
	SO_2	139	194	235	293	289	274	282	252	253	227	199	199	212	198	172	166	150	149	123	88	4,094
	CO	758	1,362	2,014	2,739	3,394	3,720	4,168	4,477	4,736	4,801	4,834	5,184	5,470	5,692	6,024	6,228	6,416	6,577	6,671	6,692	91,954
	VOCs	337	662	1,015	1,372	1,673	1,836	2,060	2,223	2,352	2,406	2,456	2,642	2,784	2,912	3,110	3,216	3,311	3,379	3,430	3,454	46,630
	Total	3,525	5,770	8,039	10,559	11,919	12,436	13,656	14,144	14,765	14,578	14,360	15,325	16,113	16,570	17,225	17,582	17,850	18,155	18,086	17,754	278,414

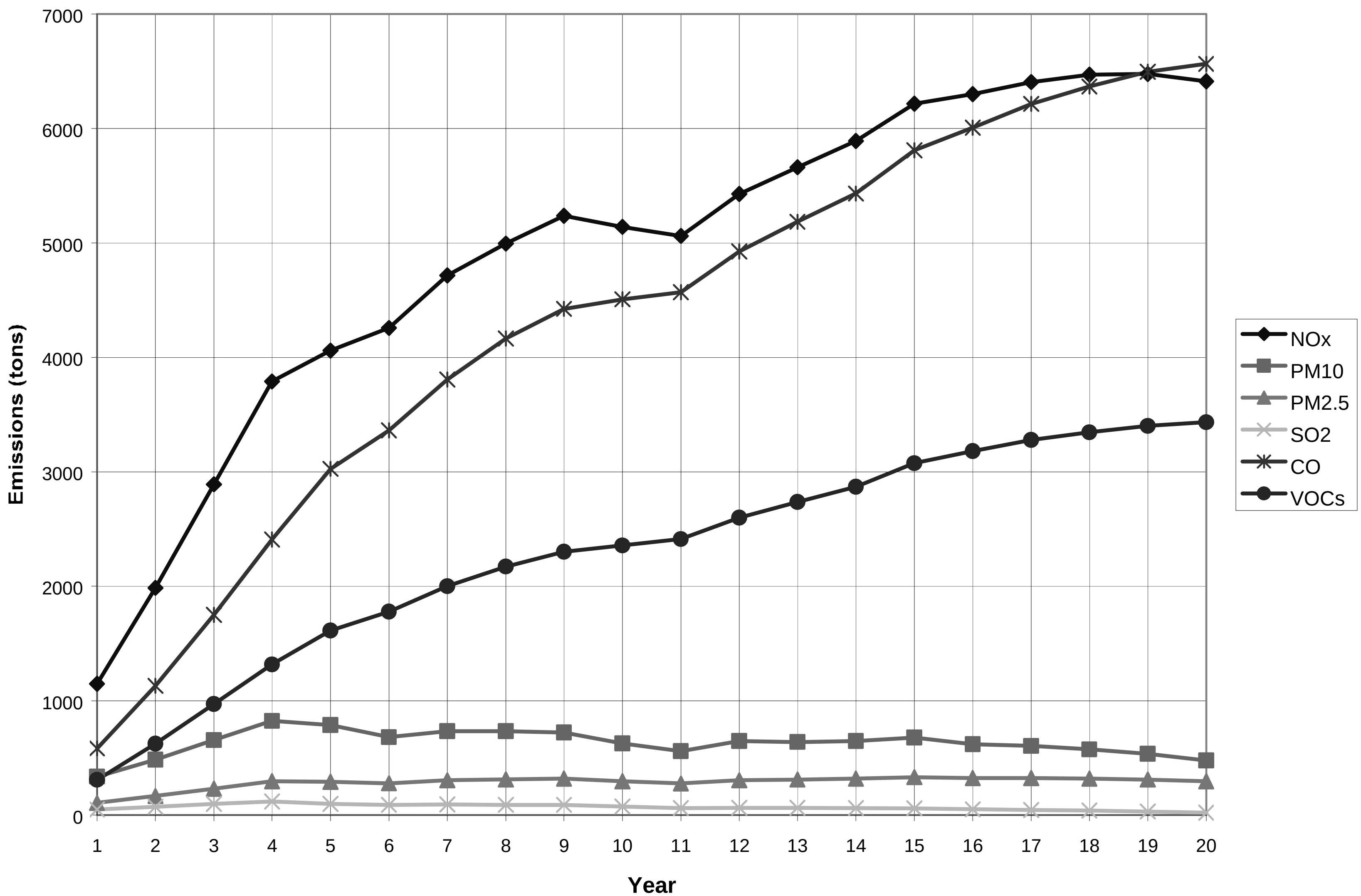

FIGURE 4.7 Estimated Annual Criteria Pollutant and VOC Emissions from Montana CBM-Related Activities under the Preferred Alternative during the 20-Year Project Period

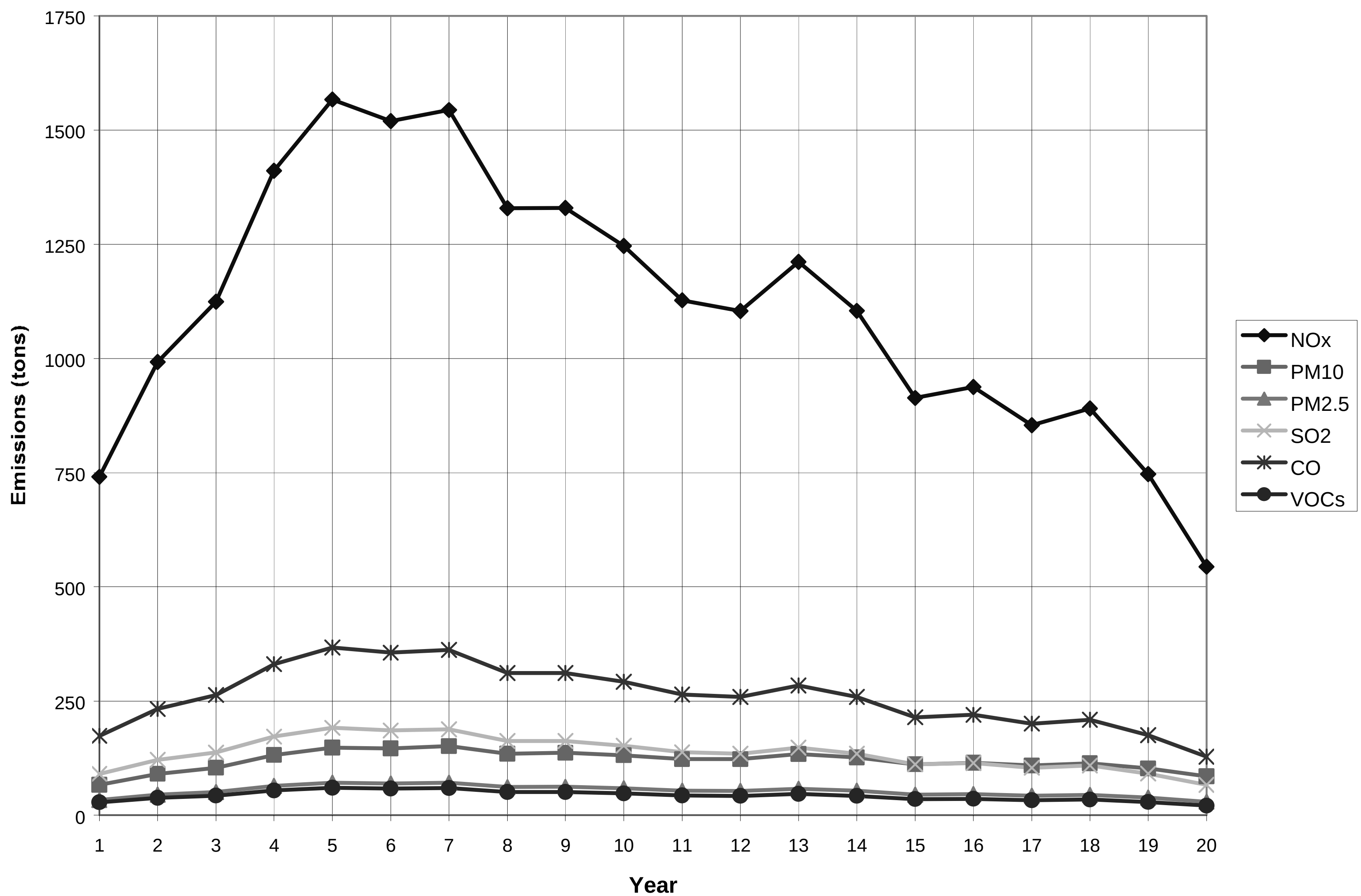

FIGURE 4.8 Estimated Annual Criteria Pollutants and VOC Emissions from Montana Conventional Oil- and Gas-Related Activities under the Preferred Action during the 20-Year Project Period

conventional O&G project activities are estimated to be 9,959; 339; 1,230; 514; 9,378; and 4,841 tons per year, respectively. These values are larger than those under Alternative E by approximately 35, 16, 29, 35, 40, and 40%, respectively.

Details of the total estimated emissions and the basic data used in emissions calculations for the Montana CBM project activities under Alternative E are provided in Appendix B.2.1. Those for the Montana conventional O&G project activities, which are common to all Montana Project alternatives, are provided in Appendix B.2.2.

4.4.2.1.2 Alternative D Sources. The only difference between Alternative D and E (Preferred Alternative) is that field (booster) compressors would be operated by electricity under Alternative D, while they would be fired by gas under Alternative E. Thus, emissions under Alternative D would be the emissions under Alternative E, minus the emissions from field (booster) compressor engines. Emissions would be released in generating electricity used to operate the compressor engines, which would be provided by the generating stations or power plants considered in this study as a part of RFFA sources in the non-project emissions inventory. Potential emissions from generating additional electricity that may be required from generating stations at remote locations outside the modeling domain were not considered in the current study. The projected peak-year emissions for NO_x, SO_2, PM_{10}, $PM_{2.5}$, CO, and VOCs under Alternative D are estimated to be 4,135; 292; 909; 313; 1,863; and 1,351 tons per year, respectively. These values represent 56, 100, 95, 82, 28, and 39% of those under Alternative E, respectively. With well development on the IR and FS lands, the projected peak-year emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, CO, and VOCs under Alternative Da are estimated to be 4,805; 336; 1,155; 389; 2,512; and 1,860 tons per year, respectively. These values are equivalent to about 48, 99, 94, 76, 27, and 38% of those under Alternative Ea (Preferred Alternative, including well development on the IR and FS lands), respectively.

4.4.2.1.3 Alternative A Sources. As listed in Table 1.1, the total number of CBM wells to be drilled under Montana Project Alternative A (No Action) is very small (897), which is only about 5% of the total number of CBM wells to be drilled under Alternative E (18,266). The peak-year emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, CO, and VOCs under Alternative A (No Action) are 1,828; 199; 206; 92; 548; and 153 tons per year, respectively. These values are about 25, 68, 22, 24, 8, and 4% of those under Alternative E, respectively.

4.4.2.2 Wyoming Project Sources

4.4.2.2.1 Alternative 1 Sources. The estimated total criteria pollutant and VOC emissions from various project activities throughout the entire 10-year project period under Wyoming Project Alternative 1 (Proposed Action) are summarized in Tables 4.12 through 4.14. Estimated emissions for the CBM project activities are provided in Table 4.12, and those for the conventional O&G project activities are provided in Table 4.13. Estimated combined total emissions for the two types of project activities are presented in Table 4.14.

TABLE 4.12 Estimated Total Criteria Pollutant and VOC Emissions from CBM-Related Activities of the Wyoming Project under the Proposed Action during the 10-Year Project Period

			Total Project Emissions (tons)						
	Project Activity	Emission Source	NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	Total (tons)
Construction	Construction sites (roads, wells, pads, pods, pipelines, compressor stations, field generators)	Heavy equipment							
		Fugitive dust	0	647	97	0	0	0	647
		Exhaust	37,333	2,660	2,660	2,490	8,167	3,035	53,684
		Commuting vehicles							
		Road dust	0	9,737	1,423	0	0	0	9,737
		Exhaust	111	26	24	22	290	67	515
	Subtotal		37,443	13,069	4,204	2,511	8,457	3,102	64,582
Operation	Compressor stations	Compressors							
		Reciprocating	35,529	1,692	1,692	68	40,604	33,837	111,729
		Booster	29,584	1,954	1,954	59	51,772	22,188	105,557
		Dehydrators	206	16	16	1	173	11	406
		Inspection visits							
		Road dust	0	226	33	0	0	0	226
		Exhaust	1	<0.5	<0.5	<0.5	8	1	10
	Wells	Workover							
		Road dust	0	1,378	201	0	0	0	1,378
		Exhaust							
		On-site	2,441	173	173	161	526	200	3,502
		On-road	18	4	4	4	37	10	73
	Wells and pipelines	Inspection visits							
		Road dust	0	579	85	0	0	0	579
		Exhaust	2	<0.5	<0.5	<0.5	21	1	25
	Subtotal		67,779	6,022	4,158	293	93,142	56,249	223,485

TABLE 4.12 (Cont.)

	Project Activity	Emission Source	Total Project Emissions (tons)						Total (tons)
			NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	
Maintenance	Roads	Heavy equipment							
		Fugitive dust	0	804	73	0	0	0	804
		Exhaust	446	39	39	55	96	23	659
		Commuting vehicles							
		Road dust	0	147	21	0	0	0	147
		Exhaust	<0.5	<0.5	<0.5	<0.5	5	<0.5	6
	Compressor stations	Maintenance visits							
		Road dust	0	89	13	0	0	0	89
		Exhaust	<0.5	<0.5	<0.5	<0.5	3	<0.5	4
	Subtotal		447	1,079	146	55	105	23	1,709
Reclamation	Roads	Heavy equipment							
		Fugitive dust	0	18	2	0	0	0	18
		Exhaust	6	1	1	1	1	<0.5	9
		Commuting vehicles							
		Road dust	0	3	0	0	0	0	3
		Exhaust	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Wells	Heavy equipment							
		Fugitive dust	0	173	16	0	0	0	173
		Exhaust	71	6	6	9	15	4	105
		Commuting vehicles							
		Road dust	0	31	5	0	0	0	31
		Exhaust	<0.5	<0.5	<0.5	<0.5	1	<0.5	1
	Subtotal		77	232	29	9	18	4	340
Total			105,747	20,402	8,537	2,869	101,721	59,377	290,116

TABLE 4.13 Estimated Total Criteria Pollutant and VOC Emissions from Conventional Oil- and Gas-Related Activities of the Wyoming Project under the Proposed Action during the 10-Year Project Period

	Project Activity	Emission Source	Total Project Emissions (tons)						Total
			NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	(tons)
Construction	Construction sites (roads, wells, pads, pods, pipelines, compressor stations, field generators)	Heavy equipment							
		Fugitive dust	0	280	42	0	0	0	280
		Exhaust	37,421	1,370	1,370	4,604	9,224	1,468	54,087
		Commuting vehicles							
		Road dust	0	1,965	287	0	0	0	1,965
		Exhaust	20	5	4	4	50	12	90
	Subtotal		37,441	3,620	1,703	4,607	9,274	1,480	56,422
Operation	Wells	Workover							
		Road dust	0	19	3	0	0	0	19
		Exhaust							
		On-site	893	63	63	59	192	73	1,281
		On-road	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	1
	Wells and pipelines	Inspection visits							
		Road dust	0	147	22	0	0	0	147
		Exhaust	<0.5	<0.5	<0.5	<0.5	5	<0.5	6
	Subtotal		893	230	88	59	198	74	1,454
Maintenance	Roads	Heavy equipment							
		Fugitive dust	0	108	10	0	0	0	108
		Exhaust	60	5	5	7	13	3	88
		Commuting vehicles							
		Road dust	0	20	3	0	0	0	20
		Exhaust	<0.5	<0.5	<0.5	<0.5	1	<0.5	1
	Subtotal		60	133	18	7	14	3	217
Total			38,394	3,982	1,809	4,674	9,486	1,557	58,093

TABLE 4.14 Estimated Total Criteria Pollutant and VOC Emissions from Wyoming CBM- and Conventional Oil- and Gas-Related Activities under the Proposed Action during the 10-Year Project Period

	Project Activity	Emission Source	Total Project Emissions (tons)						Total (tons)
			NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	
Construction	Construction sites (roads, wells, pads, pods, pipelines, compressor stations, field generators)	Heavy equipment							
		Fugitive dust	0	927	139	0	0	0	927
		Exhaust	74,754	4,030	4,030	7,093	17,391	4,503	107,771
		Commuting vehicles							
		Road dust	0	11,701	1,710	0	0	0	11,701
		Exhaust	130	30	28	25	340	78	605
	Subtotal		74,884	16,689	5,907	7,119	17,731	4,581	121,004
Operation	Compressor stations	Compressors							
		Reciprocating	35,529	1,692	1,692	68	40,604	33,837	111,729
		Booster	29,584	1,954	1,954	59	51,772	22,188	105,557
		Dehydrators	206	16	16	1	173	11	406
		Inspection visits							
		Road dust	0	226	33	0	0	0	226
		Exhaust	1	<0.5	<0.5	<0.5	8	1	10
	Wells	Workover							
		Road dust	0	1,397	204	0	0	0	1,397
		Exhaust							
		On-site	3,334	237	237	220	718	274	4,782
		On-road	18	4	4	4	38	11	74
	Wells and pipelines	Inspection visits							
		Road dust	0	726	106	0	0	0	726
		Exhaust	2	<0.5	<0.5	<0.5	27	2	31
	Subtotal		68,673	6,251	4,245	352	93,340	56,323	224,939

TABLE 4.14 (Cont.)

Project Activity		Emission Source	Total Project Emissions (tons)						Total (tons)
			NO_x	PM_{10}	$PM_{2.5}$	SO_2	CO	VOC	
Maintenance	Roads	Heavy equipment							
		Fugitive dust	0	911	83	0	0	0	911
		Exhaust	506	44	44	62	109	26	747
		Commuting vehicles							
		Road dust	0	166	24	0	0	0	166
		Exhaust	1	<0.5	<0.5	<0.5	6	<0.5	7
	Compressor stations	Maintenance visits							
		Road dust	0	89	13	0	0	0	89
		Exhaust	<0.5	<0.5	<0.5	<0.5	3	<0.5	4
	Subtotal		507	1,211	164	62	119	26	1,925
Reclamation	Roads	Heavy equipment							
		Fugitive dust	0	18	2	0	0	0	18
		Exhaust	6	1	1	1	1	<0.5	9
		Commuting vehicles							
		Road dust	0	3	0	0	0	0	3
		Exhaust	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
	Wells	Heavy equipment							
		Fugitive dust	0	173	16	0	0	0	173
		Exhaust	71	6	6	9	15	4	105
		Commuting vehicles							
		Road dust	0	31	5	0	0	0	31
		Exhaust	<0.5	<0.5	<0.5	<0.5	1	<0.5	1
	Subtotal		77	232	29	9	18	4	340
Total			144,141	24,384	10,346	7,543	111,207	60,934	348,209

Table 4.15 presents the estimated year-by-year criteria pollutant and VOC emissions from various project activities under Alternative 1 (Proposed Action). (See also Figures 4.9 and 4.10.) The 5th year is estimated to be the year with the highest level of total project-related emissions of all pollutants for the Wyoming Project. The peak-emissions year is different for each pollutant. For example, the peak-emissions year is the 5th year for NO_x (17,834 tons per year), and the 6th year for PM_{10} (2,918 tons per year). The projected peak-year emissions for NO_x, SO_2, PM_{10}, $PM_{2.5}$, CO, and VOCs from the Wyoming CBM and conventional O&G project activities are estimated to be 17,834; 829; 2,918; 1,280; 14,799; and 8,268 tons per year, respectively.

Details of the total estimated emissions and the basic data used in emission calculations for the Wyoming CBM project activities under Alternative 1 (Proposed Action) are provided in Appendix B.3.1. Those for the Wyoming conventional O&G project activities under Alternative 1 (Proposed Action) are provided in Appendix B.3.2.

4.4.2.2.2 Alternative 2 Sources. The only difference between Alternatives 2a and 2b from Alternative 1 (Proposed Action) is that 50% and 100% of the booster (field) compressors would be operated by electricity under Alternative 2a and 2b, respectively. Under Alternative 1 (Proposed Action), the booster compressor engines would be fired by gas. Thus, the emissions under Alternative 2a would be the emissions under Alternative 1, minus 50% of the emissions from booster (field) compressor engines, and the emissions under Alternative 2b would be the emissions under Alternative 1 minus 100% of the emissions from booster (field) compressors.

Emissions would be released in generating electricity used to operate the compressor engines, which would be provided by the generating stations or power plants considered in this study as a part of RFFA sources in the non-project emissions inventory. Potential emissions from generating additional electricity that may be required from generating stations at remote locations outside the modeling domain were not considered in the current study.

The estimated peak-year emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, CO, and VOCs under Alternative 2a are 15,802; 825; 2,784; 1,146; 11,243; and 6,744 tons per year, respectively. These values represent approximately 89, 100, 95, 90, 76, and 82% of those under Alternative 1 (Proposed Action), respectively. The estimated peak-year emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, CO, and VOCs under Alternative 2b are 13,770; 822; 2,651; 1,012; 7,688; and 5,220 tons per year, respectively. These values are equivalent to about 77, 99, 91, 79, 52, and 63% of those under Alternative 1 (Proposed Action), respectively.

4.4.2.2.3 Alternative 3 Sources. As listed in Table 1.4, the total number of CBM wells to be drilled under Wyoming Project Alternative 3 (No Action) is 15,458, which is about 39% of the total number of CBM wells to be drilled under Alternative 1 (Proposed Action) (39,367). The peak-year emissions of NO_x, SO_2, PM_{10}, $PM_{2.5}$, CO, and VOCs under Alternative 3 (No Action) are 6,940; 323; 1,134; 498; 5,743; and 3,206 tons per year, respectively. These values are about 39% of those under Alternative 1 (Proposed Action) for all pollutants.

TABLE 4.15 Estimated Annual Criteria Pollutant and VOC Emissions from CBM- and Conventional Oil- and Gas-Related Activities under the Proposed Action during the 10-Year Project Period

		Annual Emissions (tons/yr)										Total Emissions (tons)
Project	Pollutant	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	
CBM Project	NO_x	7,632	10,925	12,716	13,723	13,995	13,962	13,071	9,220	6,440	4,063	105,747
	PM_{10}	2,114	2,392	2,468	2,479	2,508	2,517	2,305	1,400	1,206	1,014	20,402
	$PM_{2.5}$	741	940	1,036	1,083	1,099	1,098	1,016	664	502	359	8,537
	SO_2	345	358	361	354	357	357	317	151	139	129	2,869
	CO	4,803	9,364	11,900	13,497	13,851	13,807	13,265	10,732	6,892	3,611	101,721
	VOCs	2,633	5,389	6,925	7,900	8,113	8,086	7,791	6,388	4,067	2,086	59,377
	Total	17,527	28,428	34,370	37,953	38,823	38,729	36,748	27,891	18,743	10,903	290,116
Conventional Oil and Gas Project	NO_x	3,834	3,836	3,837	3,838	3,839	3,840	3,841	3,842	3,843	3,844	38,394
	PM_{10}	375	380	385	391	396	401	406	411	416	421	3,982
	$PM_{2.5}$	178	178	179	180	181	181	182	183	183	184	1,809
	SO_2	467	467	467	467	467	467	468	468	468	468	4,674
	CO	947	947	948	948	948	949	949	949	950	950	9,486
	VOCs	155	155	156	156	156	156	156	156	156	156	1,557
	Total	5,779	5,786	5,792	5,799	5,806	5,813	5,819	5,826	5,833	5,840	58,093
CBM Project and Conventional Oil and Gas Project	NO_x	11,467	14,761	16,553	17,560	17,834	17,802	16,912	13,063	10,283	7,907	144,141
	PM_{10}	2,489	2,773	2,853	2,869	2,904	2,918	2,711	1,811	1,622	1,435	24,384
	$PM_{2.5}$	919	1,118	1,215	1,262	1,280	1,279	1,198	846	685	543	10,346
	SO_2	812	825	829	822	825	825	784	618	607	597	7,543
	CO	5,750	10,311	12,847	14,445	14,799	14,756	14,215	11,682	7,841	4,562	111,207
	VOCs	2,789	5,544	7,081	8,056	8,268	8,242	7,946	6,544	4,223	2,242	60,934
	Total	23,306	34,214	40,162	43,752	44,629	44,542	42,568	33,717	24,576	16,743	348,209

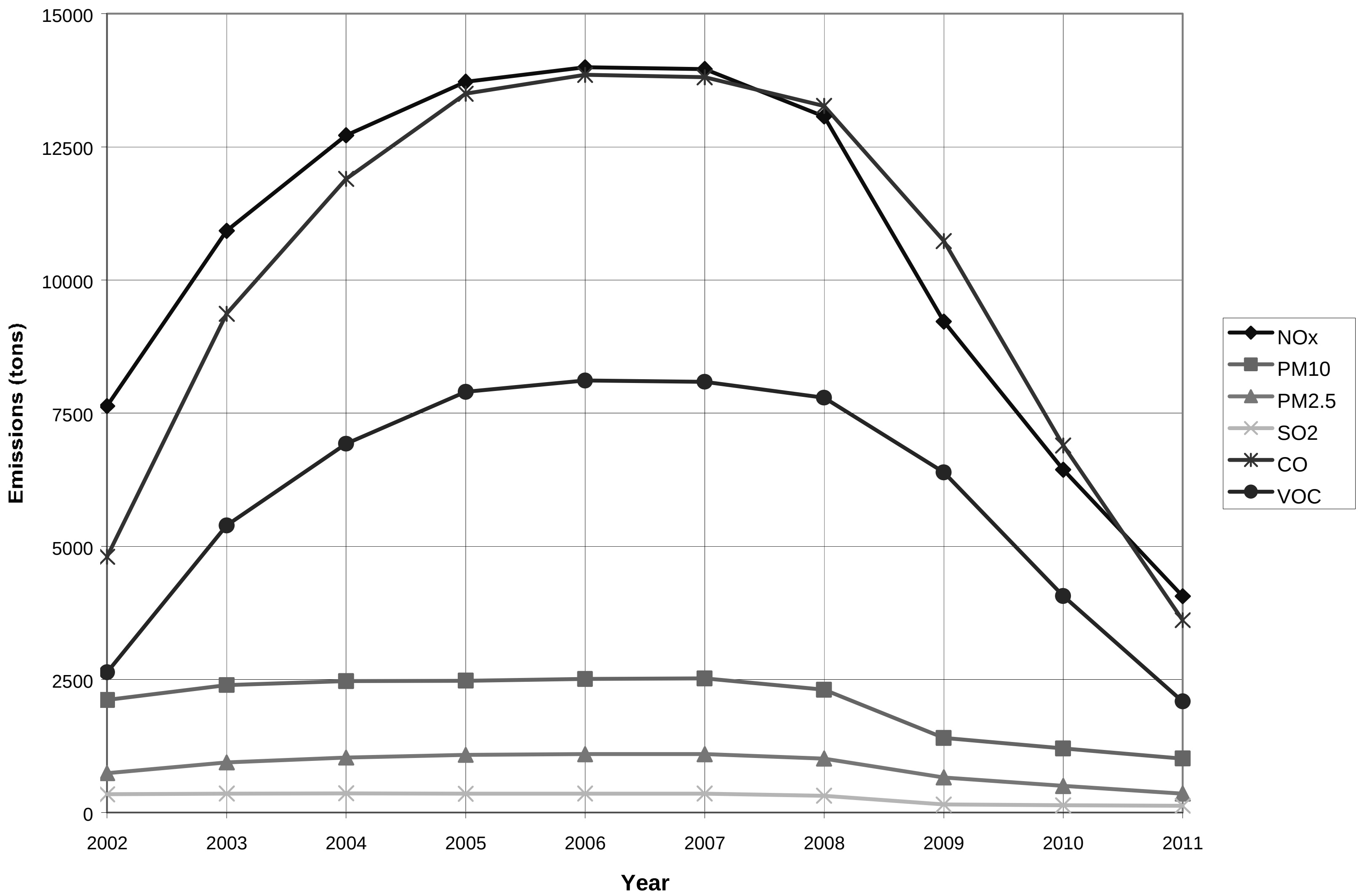

FIGURE 4.9 Estimated Annual Criteria Pollutant and VOC Emissions from Wyoming CBM-Related Activities under the Proposed Action during the 10-Year Project Period

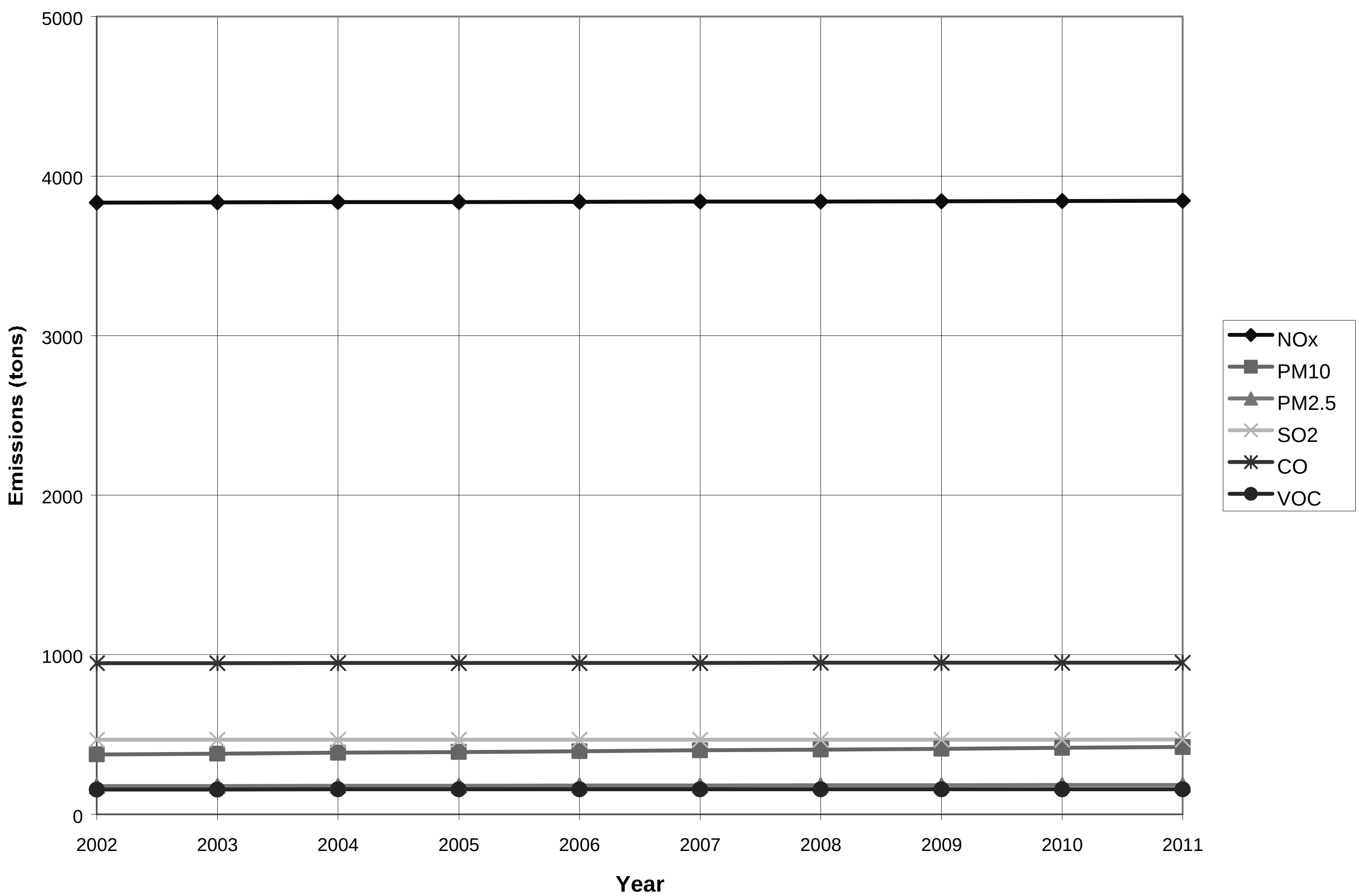

FIGURE 4.10 Estimated Annual Criteria Pollutant and VOC Emissions from Wyoming Conventional Oil- and Gas-Related Activities under the Proposed Action during the 10-Year Project Period

5 AIR QUALITY MODELING AND POSTPROCESSING

The air quality modeling analysis for the current study was conducted by using the CALPUFF (Scire et al. 1999a) modeling system described in Section 3, with model input data described in Section 4 to assess potential direct impacts on ambient air quality and AQRVs (visibility and acid deposition) that would result from the proposed new sources of each of the Montana and Wyoming Project Alternatives. Additional model runs were also made to assess the potential impacts of other new and RFFA sources in the region alone, as well as to assess cumulative impacts from the combined Montana and Wyoming Projects and other new and RFFA sources.

The air quality modeling analysis used the daily maximum emission rates for the Montana and Wyoming Project sources and long-term (seasonal maximum) emission estimates for the other new and RFFA sources (as defined in the DM&E Expansion Project EIS emission inventory database). The IWAQM-recommended default settings were used when they were consistent with the current version of CALPUFF. Thus, the default dry and wet deposition algorithms were used. In addition, the following CALPUFF options were selected:

- Turbulence-based dispersion (based on similarity theory);
- Transitional plume rise;
- Stack tip downwash;
- Transition of horizontal dispersion to time-dependent (Heffter) growth rates; and
- Chemical transformation based on the RIVAD/ARM3 scheme, which treats the NO and NO_2 conversion processes in addition to the NO_2 to total NO_3 and SO_2 to SO_4 conversions, with equilibrium between gaseous HNO_3 and ammonium nitrate aerosol.

Other CALPUFF model options and assumptions about background concentrations of chemical species used in the current study were based on those used in the DM&E Expansion Project modeling study (EIC 2000).

Potential increases in concentrations of NO_2, SO_2, PM_{10}, $PM_{2.5}$, and CO, and in sulfur and nitrogen deposition, as well as in visibility impairment (light extinction), were predicted at selected receptor locations, as described in Section 4. Concentration increases in PM_{10} and $PM_{2.5}$ due to construction activities were also predicted for locations close to a selected construction site, as described in Section 4. Concentrations of HAPs (e.g., formaldehyde) due to emissions from the proposed new sources of the Montana and Wyoming Projects were predicted at near-field receptors, as described in Section 4.

Nitrogen oxides would be a major component of the emissions from the Montana and Wyoming Projects and other new sources in the region. CALPUFF simulates the oxidation of NO_X to nitrate and calculates the equilibrium between sulfate, nitrate, and ammonia to determine how much of the converted NO_X is particulate nitrate and how much is gaseous HNO_3. The latest version of CALPUFF allows the background concentrations of pollutants, such as sulfate and nitrate (representing contributions due to existing sources), to be input; thus, the contributions of background concentrations of these species to the overall cumulative impacts would be included.

All air quality outputs from the modeling program are hourly values of direct concentration increases, which were processed to compute 3-, 8-, and 24-hour, and annual average direct concentration increases. Another category of predicted outputs is total ambient concentration values (direct concentration increases plus the background concentrations). Visibility and deposition estimates are daily values, and the annual number of days with a given level of visibility degradation and annual total sulfur and nitrogen deposition flux increments was derived from the daily values.

6 CRITERIA USED IN ASSESSING POTENTIAL AIR QUALITY AND AQRV IMPACTS

To evaluate the significance of predicted air quality and AQRV impacts, the results of air quality modeling and postprocessing are compared with applicable standards and criteria, as described in the following sections.

6.1 SIGNIFICANT DETERIORATION OF AIR QUALITY

The potential air quality concentration increases predicted at the Class I and Class II areas that result from the contributions from the Montana Project sources alone, Wyoming Project sources alone, other new and RFFA sources, and cumulative sources (Montana Project, Wyoming Project, and other new and RFFA sources), respectively, are compared with the allowable increments under the PSD air quality regulations. (This comparison with the PSD Class I and II increments within the context of the National Environmental Policy Act [NEPA] is intended to provide a general idea of how much of the increments are consumed by a particular project and does not represent a regulatory PSD increment consumption analysis.) The allowable PSD increments for Class I and Class II areas are given in Table 6.1.

TABLE 6.1 Maximum Allowable PSD Increments for PSD Class I and Class II Areas

		Allowable Concentration Increment ($\mu g/m^3$)		
PSD Class	Pollutant	Annual Arithmetic Mean	24-hour Maximum	3-hour Maximum
Class I	NO_2	2.5	-[a]	-
	SO_2	2	5	25
	PM_{10}	4	8	-
Class II	NO_2	25	-	-
	SO_2	20	91	512
	PM_{10}	17	30	-

[a] A hyphen indicates no increment exists.

6.2 AMBIENT AIR QUALITY

6.2.1 Criteria Pollutants

The potential total concentrations (cumulative concentration contributions due to the emissions from the proposed new sources of the Montana Project Study, the Wyoming Project, other new sources and RFFA sources, plus the background concentrations) of criteria pollutants estimated at near-field receptors are compared with applicable health- and welfare-related NAAQS and SAAQS.

The NAAQS and SAAQS for the states, parts of which are located within the modeling domain (Wyoming, Montana, North Dakota, South Dakota, and Nebraska), are established for NO_2, SO_2, PM_{10}, $PM_{2.5}$, O_3, CO, and lead (Pb). Given the insignificant levels of potential Pb emissions, the Pb standard is not addressed in this analysis. The O_3 standard is also not addressed in this analysis because an appropriate algorithm to estimate O_3 concentrations over the modeling domain is not available in the CALPUFF modeling system. Table 6.2 gives the NAAQS and SAAQS addressed in this study.

6.2.2 Hazardous Air Pollutants

Because ambient HAP standards have not been established by the EPA or the States of Montana and Wyoming, the maximum estimated concentration increases (8-hour average) of HAPs due to the proposed new sources of the Montana and Wyoming Projects are compared with a range of state AACLs (EPA 1997) (Table 6.3). The distances from a compressor station with the highest HAP emission rates where the potential cancer risks from long-term (70-year) exposures to HAPs would be less than the threshold range of 1×10^{-6} to 1×10^{-4} were estimated under two cases: an MEI and an MLE condition. These potential cancer risks were estimated by using the EPA unit risk factors (EPA 2001b). For each case (MEI or MLE), an adjustment factor was used to account for the duration of exposure to HAPs. If exposure of an MEI is based on 100% of the time for the lifetime of a CBM compressor (i.e., 20 years), the adjustment factor would be 0.29 ($20/70 \times 1$). If it is assumed that an MLE condition consists of 64% of the time at a receptor location (at the maximum predicted concentration) and 36% of the time at a more distant location (i.e., at 1/4 the maximum predicted concentration) for a total period of 20 years, then the adjustment factor would be 0.21 (i.e., $20/70 \times [0.64 \times 1 + 0.36 \times 0.25]$). Since there are no regulatory requirements, the above assessments are provided for information purposes only.

TABLE 6.2 Applicable Ambient Air Quality Standards

Pollutant	Averaging Time	Concentration (µg/m^3)		
		NAAQS	Montana AAQS	Wyoming AAQS
NO_2	Annual[a]	100	100	100
	1-hour[b]	-[c]	566	-
SO_2	Annual[a]	80	60	60
	24-hour[b]	365	260	260
	3-hour[b]	1,300	-	1,300
	1-hour[b]	-	1,300	-
PM_{10}	Annual[d]	50	50	50
	24-hour[e]	150	150	150
$PM_{2.5}$	Annual[d]	15	-	15
	24-hour[f]	65	-	65
CO	8-hour[b]	10,000	10,000	10,000
	1-hour[b]	40,000	26,000	40,000
Lead	Quarterly	1.5	1.5	1.5
O_3	8-hour	157	-	157
	1-hour	235	196	235

[a] Annual arithmetic mean not to be exceeded, unless otherwise noted.

[b] Not to be exceeded more than once per year, unless otherwise noted.

[c] A hyphen indicates no standard exists.

[d] Expected annual arithmetic mean averaged over a 3-year period.

[e] Annual 99th percentile concentration averaged over a 3-year period.

[f] Annual 98th percentile concentration averaged over a 3-year period.

TABLE 6.3 Range of State AACLs for Selected Hazardous Air Pollutants

HAP Species	Range of 8-hour State AACL (μg/m^3)
n-Hexane	1,800[a] – 36,000[b]
Benzene	30[c] – 714[d]
Toluene	1,870[e] – 8,930[d]
Ethyl benzene	4,340[f] – 43,500[g]
Xylene	2,170[h] – 10,400[d]
Formaldehyde	4.5[a] – 71[c]

[a] Florida, Pinellas County Air Pollution Control Board.

[b] Connecticut Department of Environmental Protection, Air Compliance Unit.

[c] Florida, Broward County Department of Natural Resources.

[d] Nevada Division of Environmental Protection, Air Quality Control.

[e] Indiana, Indianapolis Air Pollution Control Division.

[f] North Dakota Department of Health, Division of Environmental Engineering.

[g] Vermont Department of Environmental Conservation, Air Pollution Control Division.

[h] Indiana Department of Environmental Management.

6.3 AIR-QUALITY-RELATED VALUES

6.3.1 Visibility

Estimated potential maximum visibility degradations at the Class I areas and specified Class II areas of concern due to the contributions from Montana Project sources alone, Wyoming Project sources alone, other new sources and RFFA sources, and cumulative sources, respectively, were processed to obtain potential visibility impairment in terms of delta *dv*. Although the U.S. Congress has established the National Visibility Goal of no man-made visibility impairment within mandatory federal PSD Class I areas, there are no applicable local, state, tribal, or federal visibility standards. In the absence of applicable standards, these predicted visibility impairments were then compared with the LAC thresholds (5% and 10% of the reference background visibility, or 0.5 and 1.0 *dv*, respectively, for the impairment attributable to the Montana Project sources alone, Wyoming Project sources alone, and cumulative sources [including both the Montana and Wyoming Project sources and other new sources and RFFA sources]).

Initially, potential visibility impacts were predicted (screened) by using the assumed natural background visibility data presented in Table 4.4 and the reference levels provided by the State of Wyoming. For those locations where predicted visibility impairment would equal or exceed 10% extinction or 1.0 *dv*, a refined assessment of potential daily optical visibility impairment was made by using measured optical conditions in order to determine the magnitude, frequency, and duration of such impairment. (See Appendix A for the procedures to be used to predict visibility impairment.)

6.3.2 Acid Deposition

There are no applicable local, state, tribal or federal standards with respect to acid deposition. In the absence of applicable standards, predicted increases in acid deposition fluxes and changes in ANC were compared with LAC thresholds recommended by the USDA Forest Service.

Estimated annual wet, dry, and total (wet plus dry) deposition fluxes of total sulfur and nitrogen due to the contributions from the Montana Project sources alone, Wyoming Project sources alone, other new and RFFA sources, and cumulative sources combined, respectively, were compared with LAC thresholds for terrestrial ecosystems (Fox et al. 1989). The LAC threshold values used for terrestrial ecosystems in sensitive areas throughout the modeling domain were 5 and 3 kg/ha/yr for total sulfur and nitrogen deposition fluxes, respectively (Fox et al. 1989). The LAC thresholds for ANC changes were 10% for lakes with background ANC values greater than 25 μeq/L, and no more than a 1 μeq/L change in ANC for lakes with background ANC values equal to or less than 25 μeq/L (FS Rocky Mountain Region 2000).

7 ASSESSMENT OF POTENTIAL AIR QUALITY AND AQRV IMPACTS

This section presents the modeling results of potential air quality and AQRV impacts of the emissions from:

1. Montana Project sources, non-Montana Project sources (Wyoming Project sources and other new and RFFA sources in the modeling domain), and cumulative sources (Montana and Wyoming Project sources, other new and RFFA sources combined) under the 10 alternative combinations considered for the Montana Project EIS (Table 1.3); and

2. Wyoming Project sources, non-Wyoming Project sources (Montana Project sources and other new and RFFA sources in the modeling domain), and cumulative sources (Wyoming and Montana Project sources, other new and RFFA sources combined) under eight alternative combinations considered for the Wyoming Project EIS (Table 1.3).

Estimated potential maximum near-field and far-field air quality impacts were compared with applicable PSD increments and ambient air quality standards, and potential near-field HAP impacts were compared with a range of AACLs established by states. Estimated potential maximum far-field AQRV (visibility and acid deposition) impacts were compared with relevant LAC thresholds (Section 6).

For the most part, the estimated potential maximum near-field and far-field air quality impacts and acid deposition impacts were much lower than the applicable standards or LAC thresholds. However, potential maximum far-field visibility impacts estimated by the screening procedures exceeded LAC thresholds at most visibility-sensitive receptors for the case of Montana Project emissions under Alternative A (No Action) and Wyoming Project emissions under Alternative 3 (No Action). Thus, potential maximum far-field visibility impacts were further estimated by the refined procedure, and the magnitude, frequency, and duration of potential daily visibility impairment are presented.

7.1 NON-PROJECT SOURCES

Estimated potential near- and far-field impacts on air quality and AQRV due to non-project sources (new and RFFA sources) are described in Sections 7.2 and 7.3 where appropriate.

7.2 MONTANA PROJECT SOURCES

7.2.1 Near-Field Impacts

7.2.1.1 Criteria Pollutants

7.2.1.1.1 Emissions from Montana Project, Non-Montana Project, and Cumulative Sources. The estimated potential near-field air quality impacts due to the emissions from each category of emission sources under each of the five Montana-Wyoming Alternative combinations evaluated (Montana Alternatives E, Ea, D, Da, and A, combined with Wyoming Alternative 1) are presented in Appendix C.1.1 for the Montana Project sources, non-Montana Project sources (Wyoming Project sources under Alternative 1 and other new and RFFA sources, excluding those on the IR and FS lands), and cumulative sources. Table 7.1 summarizes the estimated potential maximum near-field impacts of criteria air pollutants due to the emissions from these source categories under five Montana-Wyoming alternative combinations (Montana Alternatives E, Ea, D, Da, and A, all with Wyoming Project Alternative 1; simply designated as Alternatives E, Ea, D, Da, and A, hereafter). The potential increases in maximum near-field concentrations of criteria pollutants due to the emissions from the Montana Project sources alone under all five alternative combinations are estimated to be equal or less than about 9 $\mu g/m^3$ and 102 $\mu g/m^3$ for annual and 1-hour average NO_2, respectively; about 1, 2, 4, and 5 $\mu g/m^3$ for annual, 24-hour, 3-hour, and 1-hour average SO_2, respectively; equal to or less than about 4 $\mu g/m^3$ and 13 $\mu g/m^3$ for annual and 24-hour average PM_{10}, respectively; equal to or less than about 1 $\mu g/m^3$ and 7 $\mu g/m^3$ for annual and 24-hour average $PM_{2.5}$, respectively; and equal to or less than about 77 $\mu g/m^3$ and 113 $\mu g/m^3$ for 8-hour and 1-hour average CO, respectively.

Among the five alternative combinations, potential near-field air quality impacts due to the emissions from the Montana Project sources are highest under Alternative Ea (Preferred Alternative plus well development on the IR and FS lands). Potential maximum near-field criteria pollutant concentration increases due to the emissions from Montana Project source emissions are lower than those due to non-Montana source emissions for all SO_2, PM_{10}, $PM_{2.5}$, and CO, but are higher for NO_2. Under all alternatives, these concentration increases due to the emissions from the Montana Project sources are less than the maximum allowable PSD increments for Class II areas and represent percentages equal or less than about 36, 5, and 43% of the maximum allowable Class II PSD increments for NO_2, SO_2, and PM_{10}, respectively.

Potential maximum near-field criteria pollutant concentration increases for NO_2, SO_2, and annual PM_{10} that are due to the emissions from non-Montana Project sources (Wyoming Project sources under Alternative 1 and other new and RFFA sources, excluding RFFA sources on the IR and FS lands) are less than the maximum allowable PSD increments for Class II areas and represent percentages equal to or less than about 20, 11, and 76% of the maximum allowable Class II PSD increments for NO_2, SO_2, and annual PM_{10}, respectively. The potential maximum

TABLE 7.1 Estimated Potential Maximum Near-Field Air Quality Impacts Due to Emissions from Montana Project Sources, Non-Montana Project Sources, and Cumulative Sources under Various Alternative Combinations[a]

		Maximum Concentration Increase (μg/m³)									
		Non-Montana Project Sources	Montana Project Sources					Cumulative Sources			PSD Increment for Class II Area (μg/m³)
Criteria Pollutant	Averaging Time	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A	
NO_2	Annual	5	9	9	6	7	2	11	8	6	25
		(20)[b]	(36)	(36)	(24)	(28)	(8)	(44)	(32)	(24)	
	1-hour	181	100	102	50	50	21	207	195	187	-[c]
SO_2	Annual	1	0.7	0.7	0.7	0.7	0.3	1	1	1	20
		(5)	(4)	(5)	(4)	(4)	(2)	(5)	(5)	(5)	
	24-hour	10	2	2	2	2	1	11	10	10	91
		(11)	(2)	(2)	(2)	(2)	(1)	(12)	(11)	(11)	
	3-hour	23	4	4	4	4	2	24	24	23	512
		(4)	(1)	(1)	(1)	(1)	(<1)	(5)	(5)	(4)	
	1-hour	27	5	5	5	5	2	28	28	28	-
PM_{10}	Annual	13	4	4	3	3	1	14	14	13	17
		(76)	(24)	(24)	(18)	(18)	(6)	(82)	(82)	(76)	
	24-hour[d]	104	12	13	11	11	2	107	106	105	30
		(346)	(40)	(43)	(37)	(37)	(7)	(357)	(353)	(350)	
$PM_{2.5}$	Annual	6	1	1	1	1	<1	6	6	6	-
	24-hour[d]	44	6	7	4	5	1	46	45	44	-
CO	8-hour	311	74	77	29	30	30	337	320	314	-
	1-hour	540	109	113	48	48	49	548	541	540	-

[a] Non-Montana Project sources include Wyoming Project sources under Alternative 1 and other new and RFFA sources, excluding RFFA sources on the IR and FS lands. Cumulative sources include Montana Project sources, Wyoming Project sources under Alternative 1, and other new and RFFA sources, including RFFA sources on the IR and FS lands.

[b] Values in parentheses are the predicted maximum concentration increases as a percent of the maximum allowable PSD increments for a Class II area.

[c] A hyphen indicates no increment exists.

[d] Concentration increases for 24-hour PM_{10} and $PM_{2.5}$ are the second-highest values.

near-field 24-hour PM_{10} concentration increase due to the emissions from non-Montana Project sources is estimated to be about 346% of the maximum allowable Class II PSD increment for the 24-hour PM_{10} concentration, which is primarily due to the emissions from coal mine sources. Excluding emissions from coal mine sources (e.g., Spring Creek Mine), the potential maximum near-field 24-hour PM_{10} concentration increase due to the emissions from non-Montana Project sources is estimated to be about 45% of the maximum allowable Class II PSD increment for the 24-hour PM_{10} concentration. Again, comparisons with PSD increments are made as a general comparison; since emissions sources included in this analysis may or may not legally consume PSD increments, this comparison does not represent a regulatory PSD increment consumption analysis.

The potential increases in maximum near-field concentrations of criteria pollutants due to the emissions from cumulative sources (Montana Project sources, Wyoming Project sources under Alternative 1, and other new and RFFA sources, including RFFA sources on the IR and FS lands) under all five alternative combinations (cumulative sources under Alternative Ea are identical to those under Alternative E, and cumulative sources under Alternative Da are identical to those under Alternative D) are estimated to be equal or less than about 11 $\mu g/m^3$ and 207 $\mu g/m^3$ for annual and 1-hour NO_2, respectively; equal to or less than 1, 11, 24, and 25 $\mu g/m^3$ for annual, 24-hour, 3-hour, and 1-hour average SO_2, respectively; equal to or less than 14 $\mu g/m^3$ and 107 $\mu g/m^3$ for annual and 24-hour average PM_{10}, respectively; equal to or less than 6 $\mu g/m^3$ and 46 $\mu g/m^3$ for annual and 24-hour average $PM_{2.5}$, respectively; and equal to or less than 337 $\mu g/m^3$ and 548 $\mu g/m^3$ for 8-hour and 1-hour average CO, respectively.

Among the five alternative combinations, potential near-field air quality impacts due to the emissions from cumulative sources are highest under Alternative E (or Ea). Potential maximum near-field criteria concentration increases for NO_2, SO_2, and annual PM_{10} that are due to emissions from cumulative sources are less than the maximum allowable Class II PSD increments and represent percentages equal to or less than about 44, 28, and 82% of the maximum allowable Class II PSD increments for NO_2, SO_2, and annual PM_{10}, respectively. The potential maximum near-field 24-hour PM_{10} concentration increase due to the emissions from cumulative sources is estimated to be about 357% of the maximum allowable Class II PSD increment for 24-hour PM_{10}, which is primarily due to the emissions from coal mine sources. Excluding the emissions from coal mine sources, the potential maximum near-field 24-hour PM_{10} concentration increase due to the emissions from cumulative sources is estimated to be about 85% of the maximum allowable Class II PSD increment for 24-hour PM_{10}.

The estimated potential maximum near-field total concentrations (concentration increases due to cumulative source emissions plus background concentrations) of criteria pollutants are compared with applicable ambient air quality standards (Montana SAAQS [MAAQS] and NAAQS) in Table 7.2. The potential maximum total concentrations are less than applicable MAAQS or NAAQS under all alternative combinations, representing percentages equal or less than about 57, 53, 88, 93, and 69% of applicable standards for NO_2, SO_2, annual PM_{10}, annual $PM_{2.5}$ and CO, respectively. Potential maximum near-field total concentrations of 24-hour PM_{10} and $PM_{2.5}$ are estimated to be equal to or less than about 141 and 101% of the applicable MAAQS or NAAQS. Excluding emissions from coal mine sources (e.g., Spring Creek Mine),

TABLE 7.2 Estimated Potential Maximum Near-Field Total Air Quality Concentrations, Including Contributions from Montana Project Sources and Non-Montana Project Sources under Various Alternative Combinations

		Maximum Concentration (μg/m³)								
			Increase Due to Cumulative Sources			Total Concentration				
Criteria Pollutant	Averaging Time	Montana Background	Alt. E	Alt. D	Alt. A	Alt. E	Alt. D	Alt. A	MAAQS (μg/m³)	NAAQS (μg/m³)
NO_2	Annual	11	11	8	6	22 (22)[a]	19 (19)	17 (17)	100	100
	1-hour	117	207	195	187	324 (57)	312 (55)	304 (54)	566	-[b]
SO_2	Annual	16	0.7	0.7	0.3	17 (28)	17 (28)	17 (28)	60	80
	24-hour	73	11	10	10	84 (32)	83 (32)	83 (32)	260	365
	3-hour	291	24	24	23	315 (24)	315 (24)	314 (24)	-	1,300
	1-hour	666	28	28	28	694 (53)	694 (53)	694 (53)	1,300	-
PM_{10}	Annual	30	14	14	13	44 (88)	44 (88)	43 (88)	50	50
	24-hour[c]	105	107	106	105	212 (141)	211 (141)	210 (140)	150	150
$PM_{2.5}$	Annual	8	6	6	6	14 (93)	14 (93)	14 (93)	15	15
	24-hour[c]	20	46	45	44	66 (101)	65 (100)	64 (98)	65	65
CO	8-hour	6,600	337	320	314	6,937 (69)	6,920 (69)	6,914 (69)	10,000	10,000
	1-hour	15,000	548	541	540	15,548 (60)	15,541 (60)	15,540 (60)	26,000	40,000

[a] Values in parentheses are the predicted maximum total concentrations as a percent of MAAQS. Where MAAQS do not exist, NAAQS were used.

[b] A hyphen indicates no standard exists.

[c] Concentration increases for 24-hour PM_{10} and $PM_{2.5}$ are the second-highest values.

the potential maximum near-field total concentrations of 24-hour PM_{10} and $PM_{2.5}$ are estimated to be equal to or less than about 87 and 61% of the applicable MAAQS or NAAQS.

7.2.1.1.2 Fugitive Dust Emissions from Construction Sites. The potential maximum 24-hour average PM_{10} concentration impact due to fugitive dust emissions from the largest construction site of the Montana Project (6-acre sales compressor station site with a two-track road 480 m long and 12 m wide) was estimated to be about 57 $\mu g/m^3$ and to occur about 400 m away from the center of the construction site and about 200 m from the road. The total PM_{10} concentration, including the contributions from the largest construction site of the Montana Project, was estimated and compared with applicable MAAQS and NAAQS. Adding the estimated potential maximum 24-hour average PM_{10} concentration increase of 57 $\mu g/m^3$ to the background concentration of 105 $\mu g/m^3$ would amount to a total concentration of about 162 $\mu g/m^3$, which is about 108% of MAAQS or NAAQS. Construction activities are not normally subject to PSD increment consumption regulations. Because all other construction sites of the Montana Project would be smaller in size than the 6-acre sales compressor station construction site, potential PM_{10} concentration impacts at these sites would be less.

7.2.1.1.3 Operational Emissions from Compressor Stations. Table 7.3 gives the estimated potential maximum near-field impacts of criteria pollutants due to emissions from 6-unit field or sales compressor stations, with compressor engines using various combustion technologies. Among the five combinations of compressor type and combustion technology, the near-field impacts of NO_2, SO_2, and 24-hour average PM_{10} and $PM_{2.5}$ are the highest for the sales compressor station with the lean-burn Caterpillar G3516LE model engines; near-field impacts of annual average PM_{10} and $PM_{2.5}$ are the highest for the field compressor station with rich-burn compressor engines; and near-field impacts of CO are highest for the sales compressor station with rich-burn compressor engines.

The estimated maximum near-field criteria concentration increases for NO_2, SO_2, and PM_{10} that are due to emissions from 6-unit field or sales compressor stations are less than the maximum allowable Class II PSD increments and represent percentages equal to or less than about 32, 0.1, and 16% of the maximum allowable Class II PSD increments for NO_2, SO_2, and PM_{10}, respectively.

The estimated potential maximum near-field total concentrations (concentration increases due to compressor station emissions plus background concentrations) of criteria pollutants are compared with applicable ambient air quality standards (MAAQS and NAAQS) in Table 7.3. The potential total concentrations are less than applicable MAAQS or NAAQS for all five compressor type and combustion technology combinations, representing percentages equal or less than about 63, 51, 73, 56, and 68% of MAAQS or NAAQS for NO_2, SO_2, PM_{10}, $PM_{2.5}$ and CO, respectively.

TABLE 7.3 Estimated Potential Maximum Near-Field Air Quality Impacts Due to Emissions from the 6-Unit Field and Sales Compressor Station

		Maximum Concentration Increase ($\mu g/m^3$)[a]						Maximum Concentration ($\mu g/m^3$)			
		Field Compressor		Sales Compressor							
Criteria Pollutant	Averaging Time	Rich Burn	Lean Burn	Rich Burn	Lean Burn 1[b]	Lean Burn 2[c]	PSD Increment for Class II Area	Montana Background	Total[d]	MAAQS	NAAQS
NO_2	Annual	6.7 (27)[e]	6.6 (26)	4.1 (16)	7.9 (32)	3.6 (14)	25	11	19 (19)	100	100
	1-hour	131	122	171	237	164	-[f]	117	354 (63)	566	-
SO_2	Annual	< 0.1 (< 0.1)	< 0.1 (< 0.1)	< 0.1 (<0.1)	< 0.1 (< 0.1)	< 0.1 (< 0.1)	20	16	16 (27)	60	80
	24-hour	0.1 (0.1)	.1 (0.1)	0.1 (0.1)	0.3 (0.1)	0.1 (0.1)	91	73	73 (28)	260	365
	3-hour	0.2 (< 0.1)	0.2 (< 0.1)	0.2 (<0.1)	0.3 (0.1)	0.2 (<0.1)	512	291	291 (22)	-	1,300
	1-hour	0.2	0.2	0.3	0.4	0.3	-	666	666 (51)	1,300	-
PM_{10}	Annual	0.4 (2)	0.4 (2)	0.2 (1)	0.2 (1)	0.1 (1)	17	30	30 (61)	50	50
	24-hour	3.6 (12)	3.8 (13)	4.5 (15)	4.9 (16)	1.5 (5)	30	105	110 (73)	150	150
$PM_{2.5}$	Annual	0.4	0.4	0.2	0.2	0.1	-	8	8 (56)	15	15
	24-hour	3.6	3.8	4.5	4.9	1.5	-	20	25 (38)	65	65
CO	8-hour	152	124	210	85	28	-	6,600	6,810 (68)	10,000	10,000
	1-hour	233	163	304	106	44	-	15,000	15,304 (59)	26,000	40,000

[a] Estimated concentration increases are for a 6-unit compressor station with a total capacity of 2,100 hp and 9,900 hp for field (booster) and sales (reciprocating) compressor stations, respectively.

[b] Lean-burn Caterpillar G3516LE model.

[c] Lean-burn Caterpillar G3608 model.

[d] Values in parentheses are the predicted maximum total concentrations as a percent of MAAQS. Where MAAQS do not exist, NAAOS were used.

[e] Values in parentheses are the predicted maximum concentration increases as a percent of the maximum allowable PSD increments for a Class II Area.

[f] A hyphen indicates no increment or standard exists.

7.2.1.2 Hazardous Air Pollutants

Table 7.4 lists the emission factors, emission rates, estimated potential maximum 8-hour average ground-level concentrations, state-established AACL ranges, and estimated cancer-risk-related data for various HAPs emitted from a 6-unit sales or reciprocating compressor station. The HAP emission rates of the 6-unit sales compressor station are the highest among all compressor stations proposed for the Montana Project. As shown in the table, the estimated potential maximum 8-hour average ground-level concentrations of benzene, ethyl benzene, *n*-hexane, toluene, and xylene represent very small fractions of the state-established AACL ranges. Only the estimated potential maximum 8-hour average ground-level concentration of formaldehyde (11.9 $\mu g/m^3$) lies within the range of state-established AACLs (4.5 to 71 $\mu g/m^3$).

Among the HAPs listed in Table 7.4, the inhalation cancer unit risk factors from the EPA's IRIS database are available only for benzene and formaldehyde (EPA 2001b). The estimated potential maximum long-term concentrations of these HAPs due to emissions from the 6-unit sales compressor station are so low that there are no receptors in the vicinity of the station with potential cancer risk from the long-term (70-year) exposure of 1×10^{-6} and 1×10^{-4} for benzene and formaldehyde, respectively. The estimated distance from the 6-unit sales compressor station beyond which the potential maximum cancer risk from the long-term (70-year) exposure to formaldehyde would be less than the threshold of 1×10^{-6}, is 0.5 km and less than 0.3 km from the compressor station for the MEI and MLE cases, respectively.

7.2.2 Far-Field Impacts

7.2.2.1 Criteria Pollutants

The estimated potential far-field air quality impacts at each of the Class I and II sensitive receptors (Table 4.3) due to the emissions from each category of emission sources under each of the five alternative combinations evaluated (Montana Alternatives E, Ea, D, Da, and A, combined with Wyoming Alternative 1) are presented in Appendix C.1.2 for the Montana Project sources, non-Montana Project sources (Wyoming Project sources under Alternative 1 and other new and RFFA sources, excluding those on the IR and FS lands), and cumulative sources. Table 7.5 summarizes the estimated potential maximum far-field impacts of criteria air pollutants at Class I sensitive receptors identified in the modeling domain that are due to the emissions from the Montana Project sources, non-Montana Project sources, and cumulative sources under various alternative combinations. Among the five Montana alternatives, estimated potential maximum air quality impacts due to the Montana Project emissions are highest under Alternative Ea (Preferred Alternative with well development on the IR and FS lands) for all criteria pollutants. All of the estimated potential maximum far-field impacts of criteria air pollutants at the Class I sensitive receptors that are due to the Montana Project source emissions occur at the Northern Cheyenne IR (NC), the closest to the Montana Project Area among all of the Class I sensitive receptors listed in Table 4.3. Significant portions of the high impacts at NC (except for CO and 1-hour NO_2 concentrations) under Alternatives Ea and Da are due to potential emissions from well development within the NC land.

TABLE 7.4 Estimated Potential Maximum Near-Field HAP Impacts Due to Emissions from the 6-Unit Sales Compressor Station

	Hazardous Air Pollutant Species					
Parameter	Benzene	Formaldehyde	Ethyl Benzene	*n*-Hexane	Toluene	Xylene
Emission factor (10^{-3} g/bhp-h)[a]	4.3[b]	70[c]	0.3[b]	3.2[c]	27[b]	1.3[c]
Emission rate (10^{-3}g/s)[d]	12	193	0.9	8.9	74	3.5
Maximum 8-hour ground-level concentration (μg/m^3)[e]	0.7	11.9	0.1	0.5	4.6	0.2
Range of 8-hour state AACL (μg/m^3)[f]	30 – 714	4.5 – 71	4,340 – 43,500	1,800 – 36,000	1,870 – 8,930	2,170 – 10,400
Inhalation cancer unit risk (10^{-6}/μg/m^3)[g]	7.8	13	NA[h]	NA	NA	NA
Concentration (μg/m^3) to be at risk of:						
10^{-4}	13	7.7	NA	NA	NA	NA
10^{-6}	0.1	0.08	NA	NA	NA	NA
Maximum distance from the station (km) for an MEI to be at risk of:						
10^{-4}	-[i]	-	NA	NA	NA	NA
10^{-6}	-	0.50	NA	NA	NA	NA
Maximum distance from the station (km) for a MLE to be at risk of:						
10^{-4}	-	-	NA	NA	NA	NA
10^{-6}	-	0.30	NA	NA	NA	NA

[a] For a sales (reciprocating) compressor with a four-stroke, lean-burn engine; bhp = brake horsepower.

[b] GRI-HAPCalc 3.0 (Gas Research Institute [GRI] 1999).

[c] Bailey (2001).

[d] For a 6-unit sales (reciprocating) compressor station with a total capacity of 9,900 hp operating at full load.

[e] Estimated by using the CALPUFF model with 1996 MM5 meteorological data and flat terrain.

[f] See Table 6.3.

[g] IRIS database (EPA 2001b).

[h] NA = data not available.

[i] A hyphen indicates that there are no locations where predicted concentrations would exceed the listed value.

TABLE 7.5 Estimated Potential Maximum Far-Field Air Quality Impacts at Class I Areas Due to Emissions from Montana Project Sources, Non-Montana Project Sources, and Cumulative Sources under Various Alternative Combinations[a]

Criteria Pollutant	Averaging Time	Maximum Concentration Increase ($\mu g/m^3$)									PSD Increment for Class I Area ($\mu g/m^3$)
		Non-Montana Project Sources	Montana Project Sources					Cumulative Sources			
		All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A	
NO_2	Annual	0.5 (20)[b]	1.9 (77)	3.7 (148)	1.1 (43)	2.0 (79)	0.2 (7)	4.2 (167)	2.5 (98)	0.7 (27)	2.5
	1-hour	26	53	55	24	25	6.7	68	38	29	-[c]
SO_2	Annual	0.1 (7; WC)	0.1 (4)	0.1 (7)	0.1 (4)	0.1 (7)	0.02 (1)	0.3 (13)	0.2 (12)	0.1 (7;WC)	2
	24-hour	1.2 (24; FZ)	0.4 (8)	0.5 (11)	0.4 (8)	0.5 (10)	0.1 (3)	1.2 (24; FZ)	1.2 (24; FZ)	1.2 (24; FZ)	5
	3-hour	5.1 (20)	1.0 (4)	1.2 (5)	1.0 (4)	1.2 (5)	0.4 (2)	5.1 (20)	5.1 (20)	5.1 (20)	25
	1-hour	5.6	1.5	1.7	1.5	1.6	0.6	5.6	5.6	5.6	-
PM_{10}	Annual	0.5 (12)	0.7 (18)	1.2 (31)	0.6 (16)	1.0 (26)	0.1 (2)	1.7 (42)	1.5 (37)	0.5 (13)	4
	24-hour	8.4 (105)	4.2 (53)	5.9 (73)	3.3 (42)	4.4 (55)	0.5 (7)	13 (161)	11 (139)	8.7 (108)	8
$PM_{2.5}$	Annual	0.4	0.4	0.6	0.3	0.4	0.03	1.0	0.8	0.4	-
	24-hour	7.6	3.1	4.0	1.7	2.5	0.3	11	9.3	7.8	-
CO	8-hour	29	56	58	15	16	4.7	78	36	29	-
	1-hour	43	68	69	19	25	6.7	96	51	44	-

[a] Non-Montana Project sources include Wyoming Project sources under Alternative 1 and other new and RFFA sources, excluding RFFA sources on the IR and FS lands. Cumulative sources include Montana Project sources, Wyoming Project sources under Alternative 1, and other new and RFFA sources, including RFFA sources on the IR and FS lands.

[b] Values in parentheses are the predicted maximum concentration increases as a percent of the maximum allowable PSD increments for a Class I area. Abbreviations in parentheses indicate the locations where the potential maximum concentration increases were predicted to occur; FZ = Fitzpatrick WA; and WC = Wind Cave NP. All other concentration increases for which no location is indicated were predicted to occur at the Northern Cheyenne IR.

[c] A hyphen indicates no increment exists.

The estimated potential maximum far-field criteria pollutant concentration increases due to the emissions from the Montana Project are generally lower than those due to non-Montana Project source emissions for SO_2 and 24-hour PM_{10} and $PM_{2.5}$. These concentration increases due to the Montana Project source emissions are less than the maximum allowable Class I PSD increments for all alternatives, except for annual NO_2 under Alternative Ea. Except for the annual NO_2 under Alternative Ea, these concentration increases represent percentages equal to or less than about 79, 11, and 73% of the maximum allowable Class I PSD increments for NO_2, SO_2, and PM_{10}, respectively. The percentage of the annual NO_2 concentration increase under Alternative Ea (Preferred Alternative with well development on the IR and FS lands) with respect to the maximum allowable Class I PSD increment for NO_2 is 148%, while the increase under Alternative E (Preferred Alternative) is reduced to 77% of the maximum allowable increment.

The potential increases in maximum far-field concentrations of criteria pollutants due to the emissions from cumulative sources (Montana Project sources, Wyoming Project sources under Alternative 1, and other new and RFFA sources, including RFFA sources on the IR and FS lands) under all five alternative combinations (cumulative sources under Alternative Ea are identical to those under Alternative E, and cumulative sources under Alternative Da are identical to those under Alternative D) are estimated to be equal or less than about 4.2 $\mu g/m^3$ and 68 $\mu g/m^3$ for annual and 1-hour NO_2 concentration, respectively; equal to or less than 0.3, 1.2, 5.1 and 5.6 $\mu g/m^3$ for annual, 24-hour, 3-hour, and 1-hour average SO_2, respectively; equal to or less than 1.7 $\mu g/m^3$ and 13 $\mu g/m^3$ for annual and 24-hour average PM_{10}, respectively; equal to or less than 1 $\mu g/m^3$ and 11 $\mu g/m^3$ for annual and 24-hour average $PM_{2.5}$, respectively; and equal to or less than 78 $\mu g/m^3$ and 96 $\mu g/m^3$ for 8-hour and 1-hour average CO, respectively.

Among the five alternative combinations, potential far-field air quality impacts due to the emissions from cumulative sources are highest under Alternative E (or Ea). Potential maximum far-field SO_2 concentration increases due to emissions from cumulative sources are less than the maximum allowable Class I PSD increments for SO_2 and represent percentages equal to or less than about 24% of the maximum allowable Class I PSD increments for SO_2. Potential maximum far-field annual PM_{10} concentration increases due to the emissions from cumulative sources are also estimated to be less than the maximum allowable Class I PSD increment for the annual PM_{10} concentration (42% or less). The potential maximum far-field annual NO_2 concentration increase due to the emissions from cumulative sources is estimated to be about 167% of the maximum allowable Class I PSD increment for annual NO_2 at NC, which is primarily due to the emissions from Alternative Ea (Preferred Alternative with development on IR and FS lands). These emissions account for about 88% of the maximum allowable Class I PSD increment for annual NO_2. The potential maximum far-field 24-hour PM_{10} concentration increase due to the emissions from cumulative sources is estimated to be about 161% of the maximum allowable Class I PSD increment for 24-hour PM_{10} at NC, which is primarily due to the emissions from Montana and Wyoming Project sources. The potential maximum far-field 24-hour PM_{10} concentration increase due to these sources is estimated to be about two-thirds of the maximum allowable Class I PSD increment for 24-hour PM_{10}.

The estimated potential maximum far-field impacts of criteria air pollutants at the Class II sensitive receptors identified in the modeling domain that are due to the emissions from the Montana Project sources, non-Montana Project sources, and cumulative sources are summarized in Table 7.6 for various alternative combinations. Among the five alternatives, the estimated potential maximum air quality impacts due to Montana Project emissions are highest under Alternative Ea (Preferred Alternative with well development on the IR and FS lands) for all criteria pollutants. The estimated potential maximum far-field impacts of criteria air pollutants at the Class II sensitive receptors that are due to the Montana Project source emissions occur at the Crow IR (CR), the closest to the Montana Project Area among all of the Class II sensitive receptors listed in Table 4.3.

The estimated potential maximum far-field criteria pollutant concentration increases due to Montana Project emissions are lower than those due to non-Montana Project source emissions for all criteria pollutants, except for the annual NO_2 (under Alternatives E, Ea, D, and Da), 1-hour NO_2 (under Alternatives E and Ea) and 8-hour CO (under Alternative Ea). These concentration increases due to Montana Project emissions are only small fractions of the maximum allowable PSD increments for Class II under all alternatives, representing percentages equal to or less than about 19, 2, and 27% of the maximum allowable Class II PSD increments for NO_2, SO_2, and PM_{10}, respectively.

Potential maximum far-field criteria concentration increases for NO_2, SO_2, and PM_{10} that are due to emissions from cumulative sources are less than the maximum allowable Class II PSD increments and represent percentages equal to or less than about 22, 6, and 99% of the maximum allowable Class II PSD increments for NO_2, SO_2, and PM_{10}, respectively.

The estimated potential maximum far-field total concentrations (concentration increases due to cumulative source emissions plus baseline concentrations) of criteria pollutants are compared with applicable ambient air quality standards (MAAQS and NAAQS) in Table 7.7. The estimated potential maximum total concentrations are less than the applicable MAAQS or NAAQS under all alternative combinations, representing percentages equal to or less than about 34, 54, 90, 62, and 67% of the applicable ambient standards for NO_2, SO_2, PM_{10}, $PM_{2.5}$ and CO, respectively.

7.2.2.2 Visibility

The potential far-field visibility impacts due to the emissions from the following emissions source categories were estimated by the screening and refined procedures (Appendix A) at each of the Class I and Class II sensitive receptors (Table 4.3) for each of the 10 alternative combinations (Montana Alternatives E, Ea, D, Da, and A, combined with Wyoming Alternative 1 or 3):

- Non-project sources (new and RFFA sources, excluding the RFFA sources on the IR and FS lands),

TABLE 7.6 Estimated Potential Maximum Far-Field Air Quality Impacts at Class II Areas Due to Emissions from Montana Project Sources, Non-Montana Project Sources, and Cumulative Sources under Various Alternative Combinations[a]

Criteria Pollutant	Averaging Time	Maximum Concentration Increase ($\mu g/m^3$)									PSD Increment for Class II Area ($\mu g/m^3$)
		Non-Montana Project Sources	Montana Project Sources					Cumulative Sources			
		All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A	
NO_2	Annual	1.4 (6; FB)[b]	3.9 (16)	4.7 (19)	2.4 (10)	2.8 (11)	1.2 (5)	5.4 (22)	3.5 (14)	2.0 (8)	25
	1-hour	36 (AB)	58	60	33	33	13	73	44	36	-[c]
SO_2	Annual	0.4 (2)	0.3 (1)	0.3 (2)	0.3 (1)	0.3 (2)	0.2 (1)	0.4 (2)	0.4 (2)	0.4 (2)	20
	24-hour	5.3 (6)	1.0 (1)	1.1 (1)	1.0 (1)	1.1 (1)	0.6 (1)	5.3 (6)	5.3 (6)	5.3 (6)	91
	3-hour	17 (3)	1.7 (0.3)	1.8 (0.4)	1.7 (0.3)	1.8 (0.3)	1.0 (0.2)	17 (3)	17 (3)	17 (3)	512
	1-hour	30	2.2	2.2	2.2	2.2	1.2	30	30	30	-
PM_{10}	Annual	2.7 (16; FB)	1.5 (9)	1.7 (10)	1.3 (8)	1.5 (9)	0.3 (2)	2.7 (16; FB)	2.7 (16; FB)	2.7 (16; FB)	17
	24-hour	30 (99; FB)	7.1 (24)	8.0 (27)	5.5 (18)	6.1 (20)	1.3 (4)	30 (99; FB)	30 (99; FB)	30 (99; FB)	30
$PM_{2.5}$	Annual	1.2 (FB)	0.7	0.8	0.5	0.6	0.2	1.2	1.2 (FB)	1.2 (FB)	-
	24-hour	13 (FB)	4.2	5.1	2.6	2.9	0.7	15	13	13	-
CO	8-hour	52 (AB)	51	54	13	13	6.2	65	52 (AB)	52 (AB)	-
	1-hour	100 (AB)	64	67	21	25	14	100 (AB)	100 (AB)	100 (AB)	-

TABLE 7.6 (Cont.)

[a] Non-Montana Project sources include Wyoming Project sources under Alternative 1 and other new and RFFA sources, excluding RFFA sources on the IR and FS lands. Cumulative sources include Montana Project sources, Wyoming Project sources under Alternative 1, and other new and RFFA sources, including RFFA sources on the IR and FS lands.

[b] Values in parentheses are the predicted maximum concentration increases as a percent of the maximum allowable PSD increments for a Class II area. Abbreviations in parentheses indicate the locations where the potential maximum concentration increases were predicted to occur; AB = Absaroka-Beartooth WA; and FB = Fort Belknap IR. All other concentration increases for which no locations are indicated were predicted to occur at the Crow IR.

[c] A hyphen indicates no increment exists.

TABLE 7.7 Estimated Potential Maximum Far-Field Total Air Quality Concentrations, Including Contributions from Montana Project Sources, Non-Montana Project Sources, and Cumulative Sources under Various Alternative Combinations

			Maximum Concentration (μg/m³)							
			Increase due to Cumulative Sources			Total Concentration				
Criteria Pollutant	Averaging Time	Montana Background	Alt. E	Alt. D	Alt. A	Alt. E	Alt. D	Alt. A	MAAQS (μg/m³)	NAAQS (μg/m³)
NO_2	Annual	11	5.4 (5)[a]	3.5 (4)	2.0 (2)	18 (18; DT)	18 (18; DT)	18 (18; DT)	100	100
	1-hour	117	73 (13)	44 (8)	36 (6; AB)	190 (34)	160 (28)	150 (27)	566	-[b]
SO_2	Annual	16	0.4 (1)	0.4 (1)	0.4 (1)	16 (27)	16 (27)	16 (27)	60	80
	24-hour	73	5.3 (2)	5.3 (2)	5.3 (2)	78 (30)	78 (30)	78 (30)	260	365
	3-hour	291	17 (1)	17 (1)	17 (1)	310 (24)	310 (24)	310 (24)	-	1,300
	1-hour	666	30 (2)	30 (2)	30 (2)	700 (54)	700 (54)	700 (54)	1,300	-
PM_{10}	Annual	30	2.7 (5; FB)	2.7 (5; FB)	2.7 (5; FB)	33 (65; FB)	33 (65; FB)	33 (65; FB)	50	50
	24-hour	105	30 (20; FB)	30 (20; FB)	30 (20; FB)	130 (90; FB)	130 (90; FB)	130 (90; FB)	150	150
$PM_{2.5}$	Annual	8	1.2 (8)	1.2 (8; FB)	1.2 (8; FB)	9.2 (62)	9.2 (61; FB)	9.2 (61; FB)	15	15
	24-hour	20	15 (23)	13 (20)	13 (20; FB)	35 (53)	33 (50)	33 (50; FB)	65	65
CO	8-hour	6,600	78 (1; NC)	52 (1; AB)	52 (1; AB)	6,700 (67; NC)	6,700 (67; AB)	6,700 (67; AB)	10,000	10,000
	1-hour	15,000	100 (0.4; AB)	100 (0.4; AB)	100 (0.4; AB)	15,000 (58; AB)	15,000 (58; AB)	15,000 (58; AB)	26,000	40,000

TABLE 7.7 (Cont.)

[a] Values in parentheses are the predicted maximum concentrations as a percent of the AAQS of the state where the receptor is located. Abbreviations in parentheses indicate the locations where the potential maximum concentration increases were predicted to occur; AB = Absaroka-Beartooth WA; DT = Devils Tower NM; FB = Fort Belknap IR; and NC = Northern Cheyenne IR. All other concentration increases for which no locations are indicated were predicted to occur at the Crow IR.

[b] A hyphen indicates no standard exists.

- Non-Montana Project sources (Wyoming Project sources and other new and RFFA sources, excluding the RFFA sources on the IR and FS lands),

- Montana Project sources, and

- Cumulative sources (Montana Project sources, Wyoming Project sources and other new and RFFA sources).

The results estimated by the screening procedures are presented in Appendix D.1 and those estimated by the refined procedure are provided in Appendix E.1.

7.2.2.2.1 Screening Analysis. Tables 7.8 and 7.9 summarize the potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* and 1.0 *dv*, respectively, estimated by the WDEQ and FLAG screening procedures at the visibility-sensitive receptors.

The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* due to emissions from the Montana Project sources estimated by the WDEQ screening procedure ranges from less than 1 day at Badland WA, Bridger WA, Fitzpatrick WA, North Absaroka WA, Washakie WA, and Wind Cave NP under Alternative A, to 30 days at North Absaroka WA under Alternative Ea (Preferred Alternative plus well development on the IR and FS lands). The annual number of days equal to or greater than 1.0 *dv* due to emissions from the Montana Project sources ranges from less than 1 at BL, BG, FZ, NA, WK, and WC under Alternative A, to 16 days at NA and WK under Alternative Ea.

The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* and 1.0 *dv* due to emissions from each of the source categories estimated by the FLAG screening procedure is substantially larger than the number estimated by the WDEQ screening procedure. The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* due to emissions from the Montana Project sources estimated by the FLAG screening procedure ranges from less than 1 day at BL, BG, FZ, FP, GM, GT, RR, SG, TT, TS, UB, WC, YS, AF, BE, DT, JC, MR, and SC under Alternative A, to 364 days at NC and CI under Alternative Ea. The estimated potential annual number of days with a visibility degradation equal to or greater than 1.0 *dv* due to emissions from the Montana Project sources ranges from less than 1 day at all visibility-sensitive receptors except at NC, BC, and CI under Alternative A, to 362 days at NC and 364 days at CI under Alternative Ea.

Potential visibility impacts due to the Montana Project emissions are highest under Alternative Ea. According to WDEQ screening procedure estimates, potential maximum visibility impacts at the PSD Class I sensitive receptors occur at NA, the PSD Class I area closest to the Montana Project Area among all of the PSD Class I areas evaluated using the WDEQ screening procedure. According to the FLAG screening procedure estimates, potential maximum visibility impacts at the PSD Class I and II sensitive receptors occur at CI, the receptor closest to the Montana Project Area among all PSD Class I and II visibility-sensitive receptors evaluated.

TABLE 7.8 Estimated Potential Visibility Impairment ($\Delta dv \geq 0.5$) Due to Emissions from Montana Project Sources, Non-Montana Project Sources, and Cumulative Sources Predicted by Screening Procedures under Various Alternative Combinations[a]

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 0.5$[b]									
			Location[c]		Non-Project Sources	Non-MT Project Sources	MT Project Sources					Cumulative Sources		
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
WDEQ	Badlands WA	I	339	ESE	108	146[d] 129	12	15	2	7	0	158[d] 145	155 133	147 131
	Bridger WA	I	344	SW	42	53 48	15	21	9	9	0	59 54	56 52	53 50
	Fitzpatrick WA	I	323	SW	42	50 46	14	18	6	8	0	57 55	55 51	50 47
	N. Absaroka WA	I	265	WSW	50	52 51	22	30	7	17	0	65 64	61 61	60 57
	Washakie WA	I	273	WSW	56	61 58	18	29	10	16	0	68 68	66 66	63 59
	Wind Cave NP	I	282	SE	134	170 154	12	23	1	7	0	182 165	174 158	170 156
FLAG	Badlands WA	I	339	ESE	191	228 208	33	53	13	18	0	240 231	238 224	229 210
	Bridger WA	I	344	SW	51	58 57	16	23	9	13	0	66 63	66 61	62 58
	Fitzpatrick WA	I	323	SW	51	56 53	17	21	8	12	0	63 61	62 57	59 54
	Fort Peck IR	I	311	N	39	54 46	14	20	8	13	0	71 67	66 57	59 52
	Gates of the Mountains WA	I	447	WNW	144	146 146	3	6	2	3	0	149 148	148 148	147 147

TABLE 7.8 (Cont.)

	Visibility-Sensitive Receptor				Number of Days with Δdv ≥ 0.5[b]									
			Location[c]		Non-Project Sources	Non-MT Project Sources	MT Project Sources					Cumulative Sources		
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
FLAG (Cont.)	Grand Teton NP	I	368	WSW	24	32[d] 26	10	13	4	8	0	35[d] 32	34 31	32 27
	N. Absaroka WA	I	265	WSW	68	73 68	28	39	18	26	2	89 88	84 81	78 75
	N. Cheyenne IR	I	45	NW	332	333 332	363	364	362	364	95	364 364	364 364	338 337
	Red Rock Lakes WA	I	419	W	30	36 31	1	5	0	0	0	38 37	38 36	37 36
	Scapegoat WA	I	518	WNW	51	52 51	4	4	2	2	0	56 56	55 54	53 52
	Teton WA	I	314	WSW	46	49[d] 47	15	20	9	12	0	58 57	55 54	50 47
	T. Roosevelt NP-North	I	337	NE	44	62 52	21	27	8	14	1	83 68	75 65	67 56
	T. Roosevelt NP-South	I	283	NE	82	100 90	32	43	21	29	0	117 110	113 105	106 92
	UL Bend WA	I	283	NNW	81	90 82	22	24	7	20	0	103 101	101 96	94 86
	Washakie WA	I	273	WSW	68	74 72	24	38	18	21	3	83 82	80 79	77 74
	Wind Cave NP	I	282	SE	235	253 241	32	44	14	21	0	265 255	262 250	254 245
	Yellowstone NP	I	323	W	72	75 73	23	28	11	17	0	83 82	83 82	81 79

TABLE 7.8 (Cont.)

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 0.5$[b]									
			Location[c]		Non-Project Sources	Non-MT Project Sources	MT Project Sources					Cumulative Sources		
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
FLAG (Cont.)	Absaroka-Beartooth WA	II	284	W	175	175[d] 175	44	47	28	30	3	178[d] 178	178 178	177 177
	Agate Fossil Beds NM	II	359	SE	193	213 202	24	32	5	10	0	221 211	216 209	215 203
	Bighorn Canyon NRA	II	139	W	249	253 251	69	94	52	69	11	269 269	266 266	259 259
	Black Elk WA	II	259	ESE	229	259 243	33	43	15	18	0	268 260	266 255	261 248
	Cloud Peak WA	II	109	SW	115	144 130	78	97	62	71	4	158 152	155 150	148 137
	Crow IR	II	92	WNW	356	356 356	364	364	364	364	362	364 364	364 364	364 364
	Devils Tower NM	II	139	ESE	240	281 266	84	100	49	65	0	302 291	293 285	286 270
	Fort Belknap IR	II	344	NNW	354	356 355	11	18	5	10	1	356 356	356 356	356 356
	Fort Laramie NHS	II	351	SSE	195	216 204	24	33	9	14	1	228 212	220 210	218 205
	Jewel Cave NM	II	248	SE	238	256 249	29	41	13	22	0	268 263	264 255	258 249
	Mt. Rushmore National Memorial	II	261	ESE	213	240 227	31	43	14	17	0	253 245	251 240	242 229

TABLE 7.8 (Cont.)

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 0.5$[b]									
			Location[c]		Non-Project Sources	Non-MT Project Sources	MT Project Sources					Cumulative Sources		
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
FLAG (Cont.)	Popo Agie WA	II	338	SW	54	62[d] 56	15	26	8	10	1	64[d] 62	63 62	63 59
	Soldier Creek WA	II	347	SE	207	234 223	24	38	6	11	0	243 232	238 228	235 224

[a] Non-project sources include other new and RFFA sources, excluding those on IR and FS lands. Non-Montana Project sources include Wyoming Project sources and other new and RFFA sources, excluding RFFA sources on the IR and FS lands. Cumulative sources include Montana Project sources, Wyoming Project sources, and other new and RFFA sources, including RFFA sources on the IR and FS lands.

[b] The number of days is a rounded value.

[c] Distance and direction are from the center point of the project area to the center point of the receptor area.

[d] Values in the first row are with Wyoming Project emissions under Alt. 1 (high emissions case), and values in the second row are with Wyoming Project emissions under Alt. 3 (low emissions case).

TABLE 7.9 Estimated Potential Visibility Impairment ($\Delta dv \geq 1.0$) Due to Emissions from Montana Project Sources, Non-Montana Project Sources, and Cumulative Sources Predicted by Screening Procedures under Various Alternative Combinations[a]

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
			Location[c]		Non-Project Sources	Non-MT Project Sources	MT Project Sources					Cumulative Sources		
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
WDEQ	Badlands WA	I	339	ESE	56	79[d] 63	2	7	0	0	0	88[d] 76	83 69	80 65
	Bridger WA	I	344	SW	21	30 25	9	10	3	4	0	41 35	36 29	31 26
	Fitzpatrick WA	I	323	SW	19	26 20	7	8	3	3	0	36 33	29 25	27 21
	N. Absaroka WA	I	265	WSW	26	33 28	7	16	4	4	0	43 42	40 39	38 35
	Washakie WA	I	273	WSW	33	43 41	11	16	4	8	0	53 51	50 47	46 45
	Wind Cave NP	I	282	SE	67	91 75	1	8	0	0	0	103 86	99 79	95 77
FLAG	Badlands WA	I	339	ESE	112	154 130	10	15	1	5	0	167 153	163 143	154 133
	Bridger WA	I	344	SW	25	35 29	9	11	4	6	0	48 42	45 37	38 29
	Fitzpatrick WA	I	323	SW	23	33 27	8	14	3	6	0	46 41	42 35	38 31
	Fort Peck IR	I	311	N	13	26 16	6	10	0	4	0	39 34	33 27	27 17

TABLE 7.9 (Cont.)

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
			Location[c]		Non-Project Sources	Non-MT Project Sources	MT Project Sources					Cumulative Sources		
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
FLAG (Cont.)	Gates of the Mountains WA	I	447	WNW	57	59[d] 58	2	3	0	1	0	60[d] 60	59 59	59 58
	Grand Teton NP	I	368	WSW	15	17 17	4	7	0	0	0	20 18	18 17	17 17
	N. Absaroka WA	I	265	WSW	42	47 46	14	21	5	10	0	57 56	55 53	53 51
	N. Cheyenne IR	I	45	NW	254	263 259	333	362	329	362	27	363 363	362 362	271 266
	Red Rock Lakes WA	I	419	W	13	17 16	0	0	0	0	0	19 17	17 17	17 16
	Scapegoat WA	I	518	WNW	26	27 26	2	2	0	0	0	30 28	29 27	28 27
	Teton WA	I	314	WSW	22	28 24	9	13	3	5	0	40 37	35 30	32 27
	T. Roosevelt NP-North	I	337	NE	18	32 26	5	11	1	2	0	44 39	37 32	32 28
	T. Roosevelt NP-South	I	283	NE	31	53 44	11	25	4	7	0	77 66	71 59	59 49
	UL Bend WA	I	283	NNW	34	40 38	5	12	1	3	0	49 49	49 46	43 41
	Washakie WA	I	273	WSW	46	53 49	15	20	6	11	0	61 59	59 55	54 51

TABLE 7.9 (Cont.)

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
			Location[c]		Non-Project Sources	Non-MT Project Sources	MT Project Sources					Cumulative Sources		
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
FLAG (Cont.)	Wind Cave NP	I	282	SE	154	196[d] 172	12	16	2	4	0	202[d] 190	201 185	198 175
	Yellowstone NP	I	323	W	35	39 39	9	17	3	7	0	46 44	41 41	41 41
	Absaroka-Beartooth WA	II	284	W	129	132 129	19	26	8	12	0	136 135	134 134	133 133
	Agate Fossil Beds NM	II	359	SE	102	128 110	5	9	1	2	0	140 126	137 123	131 113
	Bighorn Canyon NRA	II	139	W	166	175 170	46	63	32	46	2	194 193	190 187	182 179
	Black Elk WA	II	259	ESE	146	192 162	12	16	2	6	0	209 184	201 175	195 163
	Cloud Peak WA	II	109	SW	69	111 91	52	68	29	42	0	128 118	120 111	114 100
	Crow IR	II	92	WNW	306	308 306	364	364	364	364	259	364 364	364 364	348 348
	Devils Tower NM	II	139	ESE	170	234 204	37	52	15	25	0	255 238	250 230	237 208
	Fort Belknap IR	II	344	NNW	326	326 326	2	7	1	1	0	327 327	327 327	327 326
	Fort Laramie NHS	II	351	SSE	108	137 117	8	15	1	3	0	145 130	141 124	137 118
	Jewel Cave NM	II	248	SE	167	207 181	13	21	1	5	0	220 204	214 198	210 187

TABLE 7.9 (Cont.)

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
			Location[c]		Non-Project Sources	Non-MT Project Sources	MT Project Sources					Cumulative Sources		
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
FLAG (Cont.)	Mt. Rushmore National Memorial	II	261	ESE	133	168[d] 144	12	16	2	6	0	186[d] 162	180 156	173 146
	Popo Agie WA	II	338	SW	30	44 34	8	10	5	6	0	47 46	46 41	45 39
	Soldier Creek WA	II	347	SE	125	156 139	5	9	1	2	0	166 154	165 147	157 140

[a] Non-project sources include other new and RFFA sources, excluding those on IR and FS lands. Non-Montana Project sources include Wyoming Project sources and other new and RFFA sources, excluding RFFA sources on the IR and FS lands. Cumulative sources include Montana Project sources, Wyoming Project sources, and other new and RFFA sources, including RFFA sources on the IR and FS lands.

[b] The number of days is a rounded value.

[c] Distance and direction are from the center point of the project area to the center point of the receptor area.

[d] Values in the first row are with Wyoming Project emissions under Alt. 1 (high emissions case), and values in the second row are with Wyoming Project emissions under Alt. 3 (low emissions case).

In general, estimated potential visibility impacts decrease as the distance between the Montana Project Area and the receptor area increases, and as the direction from the Montana Project Area to the receptor area changes from downwind to upwind of the prevailing winds.

The potential visibility impacts due to the Montana Project source emissions estimated by the screening procedures are lower than those due to the non-project source emissions at all visibility-sensitive receptors except NC and CI, under all Montana alternatives evaluated. As expected, the potential visibility impacts due to non-project source emissions estimated by the screening procedures are similar to or lower than those due to the non-Montana Project source emissions at all visibility-sensitive receptors under all alternative combinations evaluated.

The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* due to emissions from cumulative sources estimated by the WDEQ screening procedure ranges from about 47 days at FZ under Montana Alternative A and Wyoming Alternative 3, to 182 days at WC under Montana Alternative E and Wyoming Alternative 1. The estimated potential annual number of days with visibility degradation equal to or greater than 1.0 *dv* due to emissions from cumulative sources estimated by the WDEQ screening procedure ranges from about 21 days at FZ under Montana Alternative A and Wyoming Alternative 3, to 103 days at WC under Montana Alternative E and Wyoming Alternative 1.

The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* due to emissions from cumulative sources estimated by the FLAG screening procedure ranges from about 27 days at GT under Montana Alternative A and Wyoming Alternative 3, to 364 days at CI under all of Montana Alternatives E and Wyoming Alternative 1 or 3. The estimated potential annual number of days with visibility degradation equal to or greater than 1.0 *dv* due to emissions from cumulative sources ranges from about 16 days at RR under Montana Alternative A and Wyoming Alternative 3, to 364 days at CI under any combination of Montana Alternative D or E and Wyoming Alternative 1 or 3.

7.2.2.2.2 Refined Analysis. The potential far-field daily visibility impacts due to the emissions from each source category were also estimated by the refined procedure at each of the Class I and II sensitive receptors (Table 4.3) for each of the 10 alternative combinations (Montana Alternatives E, Ea, D, Da, and A, combined with Wyoming Alternative 1 or 3). The results are presented in Appendix E.1 for the non-project sources, non-Montana Project sources, Montana Project sources, and cumulative sources.

Table 7.10 summarizes the potential annual number of days with visibility degradation equal to or greater than 1.0 *dv*. Visibility degradation trends indicated in the result of the visibility impact analysis conducted by using the refined procedure are similar to those of the analysis conducted by using the screening procedures described in Section 7.2.2.2.1, with respect to the following parameters: (1) relative significance of the Montana Project sources, non-Montana Project sources, and non-project sources; (2) effect of the distance between the Montana Project Area and receptor area; and (3) direction from the Montana Project Area to the receptor area relative to the prevailing wind direction.

TABLE 7.10 Estimated Potential Visibility Impairment ($\Delta dv \geq 1.0$) Due to Emissions from Montana Project Sources, Non-Montana Project Sources, and Cumulative Sources Predicted by Refined Procedures under Various Alternative Combinations[a]

Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
		Location[c]		Non-Project Sources	Non-Montana Project Sources	Montana Project Sources					Cumulative Sources		
Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
Badlands WA	I	339	ESE	13	25[d] 17	0	0	0	0	0	28[d] 21	26 20	25 18
Bridger WA	I	344	SW	6	10 8	2	3	0	1	0	12 10	11 9	10 8
Fitzpatrick WA	I	323	SW	6	9 7	2	3	0	0	0	12 10	10 8	10 8
Fort Peck IR	I	311	N	1	2 1	0	1	0	0	0	5 4	3 2	2 2
Gates of the Mountains WA	I	447	WNW	3	4 3	0	0	0	0	0	4 4	4 3	4 3
Grand Teton NP	I	368	WSW	3	6 4	0	0	0	0	0	8 6	7 5	6 4
N. Absaroka WA	I	265	WSW	9	12 10	2	4	0	1	0	15 13	14 12	12 11
N. Cheyenne IR	I	45	NW	24	38 30	33	60	17	38	0	92 87	76 70	42 33
Red Rock Lakes WA	I	419	W	0	1 0	0	0	0	0	0	3 2	2 1	1 0
Scapegoat WA	I	518	WNW	2	2 2	0	0	0	0	0	3 3	3 2	3 2

TABLE 7.10 (Cont.)

Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]										
		Location[c]		Non-Project Sources	Non-Montana Project Sources	Montana Project Sources					Cumulative Sources		
Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
Teton WA	I	314	WSW	6	9[d] 7	1	3	0	0	0	11[d] 10	10 9	10 7
T. Roosevelt NP-North	I	337	NE	0	2 1	0	0	0	0	0	3 2	2 1	2 1
T. Roosevelt NP-South	I	283	NE	1	4 2	0	1	0	0	0	7 4	5 3	4 2
UL Bend WA	I	283	NNW	4	5 5	1	1	0	0	0	8 6	6 5	6 5
Washakie WA	I	273	WSW	9	14 11	3	5	1	1	0	18 16	16 14	15 12
Wind Cave NP	I	282	SE	17	27 21	0	0	0	0	0	32 25	29 23	28 22
Yellowstone NP	I	323	W	7	11 9	1	3	0	0	0	13 12	12 11	11 9
Absaroka-Beartooth WA	II	284	W	27	29 28	2	4	0	1	0	33 32	31 30	30 28
Agate Fossil Beds NM	II	359	SE	7	15 10	0	0	0	0	0	19 14	17 12	15 10
Bighorn Canyon NRA	II	139	W	16	21 19	9	17	3	7	0	34 32	28 25	23 19
Black Elk WA	II	259	ESE	16	26 20	0	1	0	0	0	31 24	28 22	26 20

TABLE 7.10 (Cont.)

Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
		Location[c]		Non-Project Sources	Non-Montana Project Sources	Montana Project Sources					Cumulative Sources		
Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
Cloud Peak WA	II	109	SW	16	28[d] 21	6	10	1	2	0	39[d] 35	35 28	30 23
Crow IR	II	92	WNW	47	61 56	61	75	42	56	2	116 113	105 102	69 65
Devils Tower NM	II	139	ESE	16	38 24	1	3	0	0	0	47 34	42 29	39 26
Fort Belknap IR	II	344	NNW	60	61 60	1	1	0	0	0	62 61	61 61	61 61
Fort Laramie NHS	II	351	SSE	10	17 13	0	1	0	0	0	20 16	18 15	17 13
Jewel Cave NM	II	248	SE	18	31 24	0	0	0	0	0	36 28	34 26	33 24
Mt. Rushmore National Memorial	II	261	ESE	13	22 17	0	0	0	0	0	26 20	23 18	22 17
Popo Agie WA	II	338	SW	6	10 8	2	3	0	1	0	13 11	11 9	10 8
Soldier Creek WA	II	347	SE	9	18 13	0	0	0	0	0	21 16	20 14	18 13

TABLE 7.10 (Cont.)

[a] Non-project sources include other new and RFFA sources, excluding those on IR and FS lands. Non-Montana Project sources include Wyoming Project sources and other new and RFFA sources, excluding RFFA sources on the IR and FS lands. Cumulative sources include Montana Project sources, Wyoming Project sources, and other new and RFFA sources, including RFFA sources on the IR and FS lands.

[b] The number of days is a rounded value.

[c] Distance and direction are from the center point of the project area to the center point of the receptor area.

[d] Values in the first row are with Wyoming Project emissions under Alt. 1 (high emissions case), and values in the second row are with Wyoming Project emissions under Alt. 3 (low emissions case).

The potential annual number of days with visibility degradation equal to or greater than 1.0 *dv* due to emissions from the Montana Project sources as estimated by the refined procedure ranges from less than 1 day at all visibility-sensitive receptors evaluated except CI under one or more alternatives, to about 75 days at CI under Alternative Ea.

The potential visibility impacts due to the Montana Project source emissions estimated by the refined procedure are lower than those due to the non-project source emissions at all visibility-sensitive receptors except NC and CI, under all Montana Project alternatives evaluated. The potential visibility impacts due to non-project source emissions estimated by the refined procedure are similar to or lower than those due to the non-Montana Project source emissions at all visibility-sensitive receptors under all alternatives evaluated.

The potential annual number of days with visibility degradation equal to or greater than 1.0 *dv* due to emissions from cumulative sources estimated by the refined procedure ranges from less than 1 day at RR under Montana Alternative A and Wyoming Alternative 3, to 116 days at CI under Montana Alternative E and Wyoming Alternative 1.

7.2.2.3 Acid Deposition

The potential far-field acid deposition impacts due to the emissions from each of the following source categories were estimated at each of the Class I and II sensitive receptors (Table 4.3) and sensitive lakes (Table 4.5) for each of the 10 alternative combinations (Montana Alternatives E, Ea, D, Da, and A, combined with Wyoming Alternative 1 or 3):

- Non-project sources (new and RFFA sources, excluding the RFFA sources on the IR and FS lands),
- Non-Montana Project sources (Wyoming Project sources and other new and RFFA sources, excluding the RFFA sources on the IR and FS lands),
- Montana Project sources, and
- Cumulative sources (Montana Project sources, Wyoming Project sources and other new and RFFA sources).

The results are presented in Appendix F.1.

The predicted maximum acid deposition fluxes at the Class I and II sensitive receptors listed in Table 4.3 due to the emissions from cumulative sources under Montana Alternative E and Wyoming Alternative 1 occur at the Fort Belknap IR for sulfur (0.12 kg/ha/yr) and the Northern Cheyenne IR for nitrogen (0.97 kg/ha/yr). These annual deposition fluxes are approximately 2 and 32% of the LAC thresholds of 5 and 3 kg/ha/yr for total sulfur and nitrogen deposition fluxes, respectively. Adding these predicted maximum increases in acid deposition fluxes to the current highest background total deposition fluxes (0.90 and 1.62 kg/ha/yr for sulfur and nitrogen, respectively) monitored in the modeling domain (ESE 2001) results in predicted maximum total acid deposition fluxes of 1.02 and 2.59 kg/ha/yr for sulfur and nitrogen, respectively. These predicted maximum total acid deposition fluxes represent about 20 and 86% of the LAC thresholds of 5 and 3 kg/ha/yr for total sulfur and nitrogen deposition fluxes, respectively.

Table 7.11 presents the potential changes in ANC at the sensitive lakes listed in Table 4.5 estimated for emissions from non-project sources, non-Montana Project sources, Montana Project sources, and cumulative sources under various alternative combinations. Except for the Upper Frozen Lake and Florence Lake, the estimated potential changes in ANC due to emissions from non-project sources, non-Montana Project sources, Montana Project sources, and cumulative sources under all alternative combinations evaluated are less than 10%, the LAC threshold for lakes with background ANC values greater than 25 μeq/L (see Table 7.11 for the 10% most sensitive ANC values of the sensitive lakes evaluated).

At Florence Lake, the estimated potential change in ANC due to emissions from cumulative sources under Montana Alternative E and Wyoming Alternative 1 is 10.4%, slightly above the LAC threshold for lakes with background ANC values greater than 25 μeq/L (10%).

For the Upper Frozen Lake (with the 10% most sensitive ANC value of 5.8 μeq/L), the estimated potential change in ANC due to emissions from Montana Project Sources are all less than 1 μeq/L, the LAC threshold for lakes with background ANC values equal to or less than 25 μeq/L. However, the estimated potential changes in ANC due to emissions from cumulative sources range from 1.3 to 1.8 μeq/L under all alternative combinations evaluated. These changes are mainly due to the contributions from non-Montana Project sources (1.2 to 1.6 μeq/L).

7.3 WYOMING PROJECT SOURCES

7.3.1 Near-Field Impacts

7.3.1.1 Criteria Pollutants

7.3.1.1.1 Emissions from Wyoming Project, Non-Wyoming Project, and Cumulative Sources. Table 7.12 summarizes the estimated potential maximum near-field impacts of criteria air pollutants due to the emissions from the Wyoming Project sources under Wyoming Alternatives 1, 2a, 2b, and 3, non-Wyoming Project sources (Montana Project sources under Alternative E and other new and RFFA sources), and cumulative sources under four Wyoming-Montana alternative combinations. The potential increases in maximum near-field concentrations of criteria pollutants due to the emissions from the Wyoming Project sources under all four alternatives are estimated to be equal to or less than about 8 $\mu g/m^3$ for annual average NO_2; <1, 2, and 3 $\mu g/m^3$ for annual, 24-hour, and 3-hour average SO_2, respectively; 3 and 20 $\mu g/m^3$

TABLE 7.11 Estimated Potential Changes in ANC at Sensitive Lakes Due to Emissions from the Montana Project Sources, Non-Montana Project Sources, and Cumulative Sources under Various Alternative Combinations[a]

Sensitive Lake					Potential ANC Change (%)									
	Location[b]			10% Most Sensitive ANC (µeq/L)	Non-Project Sources	Non-MT Project Sources	MT Project Sources					Cumulative Sources		
Name	WA	Distance (km)	Direction		All Alt.	All Alt.	Alt. E	Alt. Ea	Alt. D	Alt. Da	Alt. A	Alt. E	Alt. D	Alt. A
Black Joe	Bridger	345	SW	69.0	1.5	2.2[c] 1.8	0.3	0.4	0.2	0.2	0.1	2.6[c] 2.1	2.4 2.0	2.3 1.8
Deep	Bridger	347	SW	61.0	1.7	2.5 2.0	0.3	0.4	0.2	0.2	0.1	2.9 2.4	2.7 2.2	2.6 2.1
Hobbs	Bridger	348	SW	68.0	0.8	1.2 1.0	0.2	0.3	0.1	0.2	0.04	1.5 1.3	1.4 1.1	1.3 1.0
Upper[d] Frozen	Bridger	349	SW	5.8[e]	1.1	1.6 1.2	0.19	0.25	0.10	0.13	0.04	1.8 1.5	1.7 1.4	1.6 1.3
Ross	Fitzpatrick	324	SW	61.4	1.2	1.7 1.3	0.3	0.4	0.2	0.2	0.1	2.1 1.7	1.9 1.6	1.7 1.4
Stepping Stone	Absaroka-Beartooth	266	W	27.0	1.7	2.0 1.8	0.4	0.6	0.3	0.3	0.1	2.5 2.4	2.3 2.1	2.1 1.9
Twin Island	Absaroka-Beartooth	265	W	36.0	1.2	1.4 1.3	0.3	0.4	0.2	0.2	0.1	1.8 1.7	1.6 1.5	1.5 1.4
Emerald	Cloud Peak	101	SW	55.3	2.8	4.4 3.5	1.1	1.4	0.6	0.7	0.2	5.9 4.9	5.2 4.2	4.6 3.7
Florence	Cloud Peak	114	SW	32.7	5.0	8.1 6.3	1.7	2.3	0.9	1.1	0.3	10.4 8.5	9.2 7.4	8.4 6.5
Lower Saddlebag	Popo Agie	347	SW	55.5	2.2	3.2 2.5	0.4	0.5	0.2	0.2	0.1	3.6 3.0	3.4 2.8	3.2 2.6

TABLE 7.11 (Cont.)

[a] Non-project sources include other new and RFFA sources, excluding those on IR and FS lands. Non-Montana Project sources include Wyoming Project sources and other new and RFFA sources, excluding RFFA sources on the IR and FS lands. Cumulative sources include Montana Project sources, Wyoming Project sources, and other new and RFFA sources, including RFFA sources on the IR and FS lands.

[b] Direction and distance are from the center of the Montana Project area to the center of each sensitive lake.

[c] Values in the first row are with Wyoming Project emissions under Alt. 1 (high emissions case), and values in the second row are with Wyoming Project emissions under Alt. 3 (low emissions case).

[d] ANC values for the Upper Frozen Lake are in μeq/L.

[e] The background ANC value is based on only six samples taken on four days between 1997 and 2001.

TABLE 7.12 Estimated Potential Maximum Near-Field Air Quality Impacts Due to Emissions from Wyoming Project Sources, Non-Wyoming Project Sources, and Cumulative Sources under Various Alternative Combinations[a]

		Maximum Concentration Increase (μg/m³)									
		Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources				PSD Increment for Class II Area (μg/m³)
Criteria Pollutant	Averaging Time	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	
NO_2	Annual	3 (12)[b]	8 (32)	7 (28)	6 (24)	3 (12)	10 (40)	10 (40)	9 (36)	6 (24)	25
SO_2	Annual	0.2 (1)	0.5 (3)	0.5 (3)	0.5 (3)	0.2 (1)	0.6 (3)	0.6 (3)	0.6 (3)	0.3 (2)	20
	24-hour	2 (2)	2 (2)	2 (2)	2 (2)	0.6 (1)	3 (3)	3 (3)	3 (3)	2 (2)	91
	3-hour	5 (1)	3 (1)	3 (1)	3 (1)	1 (<1)	5 (1)	5 (1)	5 (1)	5 (1)	512
PM_{10}	Annual	0.9 (5)	3 (18)	3 (18)	3 (18)	1 (6)	4 (24)	4 (24)	4 (24)	2 (12)	17
	24-hour[c]	9 (30)	20 (67)	17 (57)	15 (50)	7 (23)	31 (103)	28 (93)	25 (83)	16 (53)	30
$PM_{2.5}$	Annual	0.7	2	1	1	0.7	2	2	2	1	-[d]
	24-hour[c]	9	16	13	11	6	24	21	19	13	-
CO	8-hour	124	156	93	77	183	156	132	124	183	-
	1-hour	142	223	157	157	261	223	197	169	261	-

[a] Non-Wyoming Project sources include Montana Project sources under Alternative E, and other new and RFFA sources. Cumulative sources include Wyoming Project sources, Montana Project sources under Alternative E, and other new and RFFA sources.

[b] Values in parentheses are the predicted maximum concentration increases as a percent of the maximum allowable PSD increments for a Class II area.

[c] Concentration increases for 24-hour PM_{10} and $PM_{2.5}$ are the second-highest values.

[d] A hyphen indicates no increment exists.

for annual and 24-hour average PM_{10}, respectively; 2 and 16 μg/m^3 for annual and 24-hour average $PM_{2.5}$, respectively; and 183 and 261 μg/m^3 for 8-hour and 1-hour average CO, respectively.

Among the four Wyoming alternatives, potential air quality impacts due to the emissions from Wyoming Project sources are the highest under Alternative 1 (Proposed Action), except for the potential concentration increases in 8-hour and 1-hour average CO under Alternative 3 (No-Action Alternative). The predicted increase in CO impacts under the "No Action" Alternative is a result of different CO emission source densities than under Alternatives 1, 2a, and 2b. Potential maximum near-field criteria pollutant concentration increases due to the emissions from Wyoming Project sources under Alternative 1 (Proposed Action) are lower than those due to non-Wyoming Project source emissions for 3-hour SO_2, but are higher for NO_2, annual and 24-hour SO_2, PM_{10}, $PM_{2.5}$, and CO. Under all alternatives, these concentration increases due to the emissions from the Wyoming Project sources are less than the maximum allowable PSD increments for Class II areas, representing percentages equal to or less than about 32, 3, and 67% of the maximum allowable Class II PSD increments for NO_2, SO_2, and PM_{10}, respectively. Again, comparisons with PSD increments are made as a general comparison; since emission sources included in this analysis may or may not legally consume PSD increments, this comparison does not represent a regulatory PSD increment consumption analysis.

Potential increases in maximum near-field concentrations of criteria pollutants due to the emissions from non-Wyoming Project sources (Montana Project sources under Alternative E and other new and RFFA sources, including RFFA sources on the IR and FS lands) are estimated to be less than the maximum allowable PSD increments for Class II areas and represent percentages equal to or less than about 12, 2, and 30% of the maximum allowable Class II PSD increments for NO_2, SO_2, and PM_{10}, respectively.

The potential increases in maximum near-field concentrations of criteria pollutants due to the emissions from cumulative sources (Wyoming Project sources, Montana Project sources under Alternative E, and other new and RFFA sources, including RFFA sources on the IR and FS lands) under all four alternative combinations are estimated to be equal to or less than about 10 μg/m^3 for annual average NO_2; equal to or less than 0.6, 3, and 5 μg/m^3 for annual, 24-hour, and 3-hour average SO_2, respectively; equal to or less than 4 μg/m^3 and 31 μg/m^3 for annual and 24-hour average PM_{10}, respectively; equal to or less than 2 μg/m^3 and 24 μg/m^3 for annual and 24-hour average $PM_{2.5}$, respectively; and equal to or less than 183 μg/m^3 and 261 μg/m^3 for 8-hour and 1-hour average CO, respectively.

Among the four alternative combinations, potential near-field air quality impacts due to the emissions from cumulative sources are highest under Alternative 1. Potential maximum near-field criteria concentration increases for NO_2, SO_2, and annual PM_{10} that are due to emissions from cumulative sources are less than the maximum allowable Class II PSD increments and represent percentages equal to or less than about 40, 3, and 24% of the maximum allowable Class II PSD increments for NO_2, SO_2, and annual PM_{10}, respectively. The potential maximum near-field 24-hour PM_{10} concentration increase due to the emissions from cumulative sources is estimated to be about 103% of the maximum allowable Class II PSD increment for 24-hour PM_{10} concentration, which is primarily due to the emissions from Wyoming Project sources.

The potential maximum near-field 24-hour PM_{10} concentration increase from Wyoming Project sources is estimated to be about two-thirds of the maximum allowable Class II PSD increment for 24-hour PM_{10}.

The estimated potential maximum near-field total concentrations (concentration increases due to cumulative source emissions plus background concentrations) of criteria pollutants are compared with applicable ambient air quality standards (Wyoming SAAQS [WAAQS] and NAAQS) in Table 7.13. The potential maximum total concentrations are less than applicable WAAQS or NAAQS under all alternative combinations, representing percentages equal or less than about 27, 7, 49, 67, and 17% of WAAQS for NO_2, SO_2, PM_{10}, $PM_{2.5}$ and CO, respectively.

7.3.1.1.2 Fugitive Dust Emissions from Construction Sites. The potential maximum 24-hour average PM_{10} concentration impact due to fugitive dust emissions from the largest construction site of the Wyoming Project (7-acre reciprocating compressor station with a two-track road 480 m long and 12 m wide) was estimated to be about 55 $\mu g/m^3$ and occur about 240 m away from the compressor station site and about 200 m from the road. The total PM_{10} concentration, including the contributions from the largest construction site of the Wyoming Project, was estimated and compared with applicable WAAQS and NAAQS. Construction activities are not normally subject to PSD increment consumption regulations. Adding the estimated potential maximum 24-hour average PM_{10} concentration increase of 55 $\mu g/m^3$ to the background concentration of 42 $\mu g/m^3$ would amount to a total concentration of about 97 $\mu g/m^3$, which is about 65% of WAAQS. Because all other construction sites of the Wyoming Project would be smaller in size than the 7-acre reciprocating compressor station site, potential PM_{10} concentration impacts at these sites would be less.

7.3.1.1.3 Operational Emissions from Compressor Stations. Table 7.14 presents the estimated potential maximum near-field impacts of criteria pollutants due to emissions from 6-unit booster or reciprocating compressor stations with compressor engines using various combustion technologies. Among the five combinations of compressor engine type and combustion technology, the near-field impacts of NO_2, SO_2, and 24-hour average PM_{10} and $PM_{2.5}$ are the highest for the reciprocating compressor station with the lean-burn Caterpillar G3516LE model engines; near-field impacts of annual average PM_{10} and $PM_{2.5}$ are the highest for the booster compressor station with rich-burn compressor engines; and near-field impacts of CO are highest for the reciprocating compressor station with rich-burn compressor engines.

The estimated maximum near-field criteria concentration increases for NO_2, SO_2, and PM_{10} that are due to emissions from 6-unit booster or reciprocating compressor stations are less than the maximum allowable Class II PSD increments and represent percentages equal to or less than about 30, 0.1, and 18% of the maximum allowable Class II PSD increments for NO_2, SO_2, and PM_{10}, respectively.

The estimated potential maximum near-field total concentrations (concentration increases due to compressor station emissions plus background concentrations) of criteria pollutants are

TABLE 7.13 Estimated Potential Maximum Near-Field Total Air Quality Concentrations, Including Contributions from Wyoming Project Sources and Non-Wyoming Project Sources under Various Alternative Combinations

		Maximum Concentration (µg/m^3)										
			Increase Due to Cumulative Sources				Total Concentration					
Criteria Pollutant	Averaging Time	Wyoming Back-ground	Alt. 1	Alt. 2a	Alt. 2b	Alt. C	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	WAAQS (µg/m^3)	NAAQS (µg/m^3)
NO_2	Annual	17	10	10	9	6	27 (27)[a]	27 (27)	26 (26)	23 (23)	100	100
SO_2	Annual	3	0.6	0.6	0.6	0.3	4 (7)	4 (7)	4 (7)	3 (5)	60	80
	24-hour	8	3	3	3	2	11 (4)	11 (4)	11 (4)	10 (4)	260	365
	3-hour	8	5	5	5	5	13 (1)	13 (1)	13 (1)	13 (1)	1,300	1,300
PM_{10}	Annual	17 [33][b]	4	4	4	2	21 (42)	21 (42)	21 (42)	19 (38)	50	50
	24-hour[c]	42 [105]	31	28	25	16	73 (49)	70 (47)	67 (45)	58 (39)	150	150
$PM_{2.5}$	Annual	8 [10]	2	2	2	1	10 (67)	10 (67)	10 (67)	9 (60)	15	15
	24-hour[c]	19 [33]	24	21	19	13	43 (66)	40 (62)	38 (58)	32 (49)	65	65
CO	8-hour	1,500	156	132	124	183	1,656 (17)	1,632 (16)	1,624 (16)	1,683 (17)	10,000	10,000
	1-hour	3,500	223	197	169	261	3,723 (9)	3,697 (9)	3,669 (9)	3,761 (9)	40,000	40,000

TABLE 7.13 (Cont.)

[a] Values in parentheses are the predicted maximum total concentrations as a percent of WAAQS.

[b] Values in brackets are the background concentrations at Sheridan, Wyoming.

[c] Concentration increases for 24-hour PM_{10} and $PM_{2.5}$ are the second-highest values.

TABLE 7.14 Estimated Potential Maximum Near-Field Air Quality Impacts Due to Emissions from the 6-Unit Booster and Reciprocating Compressor Station

		Maximum Concentration Increase ($\mu g/m^3$)[a]						Maximum Concentration ($\mu g/m^3$)			
		Booster Compressor		Reciprocating Compressor							
Criteria Pollutant	Averaging Time	Rich Burn	Lean Burn	Rich Burn	Lean Burn 1[b]	Lean Burn 2[c]	PSD Increment for Class II Area	Wyoming Back-ground	Total[d]	WAAQS	NAAQS
NO_2	Annual	4.1 (16)[e]	4.0 (16)	3.1 (12)	7.5 (30)	1.9 (8)	25	16.5	24 (24)	100	100
SO_2	Annual	< 0.1 (< 0.1)	< 0.1 (< 0.1)	< 0.1 (< 0.1)	< 0.1 (< 0.1)	< 0.1 (< 0.1)	20	3	3 (5)	60	80
	24-hour	0.1 (0.1)	.1 (0.1)	0.1 (0.1)	0.3 (0.1)	0.1 (0.1)	91	8	8 (3)	260	365
	3-hour	0.2 (< 0.1)	0.2 (< 0.1)	0.3 (0.1)	0.4 (0.1)	0.3 (0.1)	512	8	8 (1)	1,300	1,300
PM_{10}	Annual	0.4 (2)	0.4 (2)	0.3 (2)	0.2 (1)	0.1 (1)	17	17	17 (34)	50	50
	24-hour	3.7 (12)	3.8 (13)	3.8 (13)	5.3 (18)	1.5 (5)	30	42	47 (31)	150	150
$PM_{2.5}$	Annual	0.4	0.4	0.3	0.2	0.1	-[f]	7.6	8 (53)	15	15
	24-hour	3.7	3.8	3.8	5.3	1.5	-	19	24 (37)	65	65
CO	8-hour	170	130	240	82	33	-	1,500	1,700 (17)	10,000	10,000
	1-hour	230	160	400	140	60	-	3,500	3,900 (10)	40,000	40,000

TABLE 7.14 (Cont.)

[a] Estimated concentration increases are for a 6-unit compressor station with a total capacity of 2,100 hp and 9,900 hp for booster and reciprocating compressor stations, respectively.

[b] Lean-burn Caterpillar G3516LE model.

[c] Lean-burn Caterpillar G3608 model.

[d] Values in parentheses are the predicted maximum total concentrations as a percent of WAAQS.

[e] Values in parentheses are the predicted maximum concentration increases as a percent of the maximum allowable PSD increments for a Class II Area.

[f] A hyphen indicates no increment exists.

compared with applicable ambient air quality standards (WAAQS and NAAQS) in Table 7.14. The potential total concentrations are less than applicable WAAQS or NAAQS for all five compressor type and combustion technology combinations, representing percentages equal or less than about 24, 5, 34, 53, and 17% of WAAQS for NO_2, SO_2, PM_{10}, $PM_{2.5}$ and CO, respectively.

7.3.1.2 Hazardous Air Pollutants

Table 7.15 lists the emission factors, emission rates, estimated potential maximum 8-hour average ground-level concentrations, state-established AACL ranges, and estimated cancer-risk-related data for various HAPs emitted from a 6-unit reciprocating compressor station. The HAP emission rates of the 6-unit reciprocating compressor station are the highest among all compressor stations proposed for the Wyoming Project. As shown in the table, the estimated potential maximum 8-hour average ground-level concentrations of benzene, ethyl benzene, *n*-hexane, toluene, and xylene represent very small fractions of the state-established AACL ranges. Only the estimated potential maximum 8-hour average ground-level concentration of formaldehyde (11.5 $\mu g/m^3$) lies within the range of state-established AACLs (4.5 to 71 $\mu g/m^3$).

Among the HAPs listed in Table 7.15, the inhalation cancer unit risk factors from the EPA's IRIS database are available only for benzene and formaldehyde (EPA 2001b). The estimated potential maximum long-term concentrations of these HAPs due to emissions from the 6-unit reciprocating compressor station are so low that there are no receptors in the vicinity of the station with potential cancer risk from the long-term (70-year) exposure of 1×10^{-6} and 1×10^{-4} for benzene and formaldehyde, respectively. The estimated distance from the 6-unit reciprocating compressor station beyond which the potential maximum cancer risk from the long-term (70-year) exposure to formaldehyde would be less than the threshold of 1×10^{-6} is 0.4 km and less than 0.4 km from the compressor station for the MEI and MLE cases, respectively.

7.3.2 Far-Field Impacts

7.3.2.1 Criteria Pollutants

The estimated potential far-field air quality impacts at each of the PSD Class I and II sensitive receptors (Table 4.3) due to the emissions from each category of emission sources under each of four alternative combinations evaluated (Wyoming Alternatives 1, 2a, 2b, and 3, combined with Montana Alternative E) are presented in Appendix C.2.2 for the Wyoming Project sources, non-Wyoming Project sources (Montana Project sources under Alternative E and other new and RFFA sources), and cumulative sources. Table 7.16 summarizes the estimated potential maximum far-field impacts of criteria air pollutants at Class I sensitive receptors identified in the modeling domain that are due to the emissions from the Wyoming Project

TABLE 7.15 Estimated Potential Maximum Near-Field HAP Impacts Due to Emissions from the 6-Unit Reciprocating Compressor Station

	Hazardous Air Pollutant Species					
Parameter	Benzene	Formaldehyde	Ethyl Benzene	n-Hexane	Toluene	Xylene
Emission factor (10^{-3} g/bhp-h)[a]	4.3[b]	70[c]	0.3[b]	3.2[c]	27[b]	1.3[c]
Emission rate (10^{-3} g/s)[d]	12	193	0.9	8.9	74	3.5
Max. 8-h ground-level concentration (μg/m^3)[e]	0.7	11.5	0.1	0.5	4.4	0.2
Range of 8-h state AACL (μg/m^3)[f]	30 – 714	4.5 – 71	4,340 – 43,500	1,800 – 36,000	1,870 – 8,930	2,170 – 10,400
Inhalation cancer unit risk (10^{-6}/μg/m^3)[g]	7.8	13	NA[h]	NA	NA	NA
Concentration (μg/m^3) to be at risk of:						
10^{-4}	13	7.7	NA	NA	NA	NA
10^{-6}	0.1	0.08	NA	NA	NA	NA
Maximum distance from the station (km) for an MEI to be at risk of:						
10^{-4}	-[i]	-	NA	NA	NA	NA
10^{-6}	-	0.40	NA	NA	NA	NA
Maximum distance from the station (km) for an MLE to be at risk of:						
10^{-4}	-	-	NA	NA	NA	NA
10^{-6}	-	0.35	NA	NA	NA	NA

[a] For a reciprocating compressor with a four-stroke, lean-burn engine; bhp = brake horsepower.

[b] GRI-HAPCalc 3.0 (GRI 1999).

[c] Bailey (2001).

[d] For a 6-unit reciprocating compressor station with a total capacity of 9,900 hp operating at full load.

[e] Estimated by using the CALPUFF model with 1990 MM4 meteorological data and flat terrain.

[f] See Table 6.3.

[g] IRIS database (EPA 2001b).

[h] NA = data not available.

[i] A hyphen indicates that there are no locations where predicted concentrations would exceed the listed value.

TABLE 7.16 Estimated Potential Maximum Far-Field Air Quality Impacts at Class I Areas Due to Emissions from Wyoming Project Sources, Non-Wyoming Project Sources, and Cumulative Sources under Various Alternative Combinations[a]

		Maximum Concentration Increase ($\mu g/m^3$)										PSD Increment for Class I Area ($\mu g/m^3$)
		Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources					
Criteria Pollutant	Averaging Time	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3		
NO_2	Annual	3.9 (157)[b]	0.3 (10)	0.2 (9)	0.2 (8)	0.1 (5)	4.2 (167)	4.1 (166)	4.1 (164)	4.1 (162)		2.5
	1-hour	60	21	20	20	10	68	67	66	65		-[c]
SO_2	Annual	0.2 (12)	0.01 (1)	0.01 (1)	0.01 (1)	0.01 (1)	0.3 (13)	0.3 (13)	0.3 (13)	0.2 (12)		2
	24-hour	1.1 (23; FZ)	0.2 (4)	0.2 (4)	0.2 (4)	0.1 (2)	1.2 (24; FZ)	1.2 (24; FZ)	1.2 (24; FZ)	1.2 (23; FZ)		5
	3-hour	5.1 (20)	0.6 (3)	0.6 (3)	0.6 (3)	0.3 (1)	5.1 (20)	5.1 (20)	5.1 (20)	5.1 (20)		25
	1-hour	5.6	1.5	1.5	1.5	0.7	5.6	5.6	5.6	5.6		-
PM_{10}	Annual	1.5 (37)	0.2 (5)	0.2 (4)	0.2 (4)	0.1 (2)	1.7 (42)	1.7 (42)	1.6 (41)	1.6 (39)		4
	24-hour	9.4 (118)	3.9 (48)	3.4 (43)	3.0 (37)	1.5 (19)	13 (161)	12 (155)	12 (151)	11 (134)		8
$PM_{2.5}$	Annual	0.8	0.1	0.1	0.1	0.1	1.0	1.0	0.9	0.9		-
	24-hour	7.6	3.5	3.1	2.6	1.4	11	11	10	8.9		-
CO	8-hour	70	19	14	9	8	78	76	74	75		-
	1-hour	85	27	21	14	12	96	94	91	93		-

[a] Non-Wyoming Project sources include Montana Project sources under Alternative E, and other new and RFFA sources. Cumulative sources include Wyoming Project sources, Montana Project sources under Alternative E, and other new and RFFA sources.

[b] Values in parentheses are the predicted maximum concentration increases as a percent of the maximum allowable PSD increments for a Class I area. Abbreviations in parentheses indicate the locations where the potential maximum concentration increases were predicted to occur; FZ = Fitzpatrick WA. All other concentration increases for which no location is indicated were predicted to occur at Northern Cheyenne IR.

[c] A hyphen indicates no increment exists.

sources, non-Wyoming Project sources, and cumulative sources under various alternative combinations. Among the four Wyoming alternatives, estimated potential maximum air quality impacts due to the Wyoming Project emissions are highest under Alternative 1 (Proposed Action) for all criteria pollutants. With a few exceptions, the estimated potential maximum far-field impacts of criteria air pollutants at the Class I sensitive receptors that are due to the Wyoming Project source emissions occur at the Northern Cheyenne IR, the closest to the Wyoming Project Area among all of the Class I sensitive receptors listed in Table 4.3. A significant portion of the high annual NO_2 impacts at NC are due to potential well development within NC lands.

The estimated potential maximum far-field criteria pollutant concentration increases due to the emissions from Wyoming Project sources are lower than those due to non-Wyoming Project source emissions for all criteria pollutants. These concentration increases due to the Wyoming Project emissions are considerably less than the maximum allowable PSD increments for Class I areas under all alternatives, representing percentages equal to or less than about 10, 4, and 48% of the maximum allowable Class I PSD increments for NO_2, SO_2, and PM_{10}, respectively.

The potential increases in maximum far-field concentrations of criteria pollutants due to the emissions from cumulative sources (Wyoming Project sources, Montana Project sources under Alternative E, and other new and RFFA sources, including RFFA sources on the IR and FS lands) under all four alternative combinations are estimated to be equal to or less than about 4.2 $\mu g/m^3$ and 68 $\mu g/m^3$ for annual and 1-hour NO_2, respectively; equal to or less than 0.3, 1.2, 5.1, and 5.6 $\mu g/m^3$ for annual, 24-hour, 3-hour, and 1-hour average SO_2, respectively; equal to or less than 1.7 $\mu g/m^3$ and 13 $\mu g/m^3$ for annual and 24-hour average PM_{10}, respectively; equal to or less than 1 $\mu g/m^3$ and 11 $\mu g/m^3$ for annual and 24-hour average $PM_{2.5}$, respectively; and equal to or less than 78 $\mu g/m^3$ and 96 $\mu g/m^3$ for 8-hour and 1-hour average CO, respectively.

Among the four alternative combinations, potential far-field air quality impacts due to the emissions from cumulative sources are highest under Alternative 1. Potential maximum far-field SO_2 concentration increases due to emissions from cumulative sources are less than the maximum allowable Class I PSD increments for SO_2 and represent percentages equal to or less than about 24% of the maximum allowable Class I PSD increments for SO_2. Potential maximum far-field annual PM_{10} concentration increases due to the emissions from cumulative sources are also estimated to be less than the maximum allowable Class I PSD increment for annual PM_{10} (42% or less). The potential maximum far-field annual NO_2 concentration increase due to the emissions from cumulative sources is estimated to be about 167% of the maximum allowable Class I PSD increment for annual NO_2 at NC, which is primarily due to the emissions from Alternative Ea (Preferred Alternative with development on IR and FS lands). These emissions account for about 88% of the maximum allowable Class I PSD increment for annual NO_2. The potential maximum far-field 24-hour PM_{10} concentration increase due to the emissions from cumulative sources is estimated to be about 161% of the maximum allowable Class I PSD increment for 24-hour PM_{10} at NC, which is primarily due to the emissions from Montana and Wyoming Project sources. The potential maximum far-field 24-hour PM_{10} concentration increase due to the emissions from these sources is estimated to be about two-thirds of the maximum allowable Class I PSD increment for 24-hour PM_{10}.

The estimated potential maximum far-field impacts of criteria air pollutants at the Class II sensitive receptors identified in the modeling domain that are due to the emissions from the Wyoming Project sources, non-Wyoming Project sources, and cumulative sources are summarized in Table 7.17 for various alternative combinations. Among the four alternative combinations, the estimated potential maximum air quality impacts due to Wyoming Project emissions are highest under Alternative 1 (Proposed Action) for all criteria pollutants. The estimated potential maximum far-field impacts of criteria air pollutants at the Class II sensitive receptors occur at the Crow IR (the closest to the Wyoming Project Area among all of the Class II sensitive receptors listed in Table 4.3) or Devils Tower NM (the closest to the Wyoming Project Area downwind of the prevailing winds among all of the Class II sensitive receptors listed in Table 4.3).

The estimated potential maximum far-field criteria pollutant concentration increases due to Wyoming Project source emissions are lower than those due to non-Wyoming Project source emissions for all criteria pollutants. These concentration increases due to Wyoming Project emissions are only small fractions of the maximum allowable PSD increments for Class II areas under all alternatives, representing percentages equal to or less than about 2, 0.3, and 18% of the maximum allowable PSD increments for Class II areas for NO_2, SO_2, and PM_{10}, respectively.

Potential maximum far-field criteria concentration increases for NO_2, SO_2, and PM_{10} that are due to emissions from cumulative sources are less than the maximum allowable Class II PSD increments and represent percentages equal to or less than about 22, 6, and 99% of the maximum allowable Class II PSD increments for NO_2, SO_2, and PM_{10}, respectively.

The estimated potential maximum far-field total concentrations (concentration increases due to cumulative source emissions plus baseline concentrations) of criteria pollutants are compared with applicable ambient air quality standards (WAAQS and NAAQS) in Table 7.18. The estimated potential maximum total concentrations are less than the applicable WAAQS or NAAQS under all alternative combinations, representing percentages equal to or less than about 34, 54, 90, 62, and 67% of WAAQS for NO_2, SO_2, PM_{10}, $PM_{2.5}$ and CO, respectively.

7.3.2.2 Visibility

The potential far-field visibility impacts due to the emissions from the following emissions source categories were estimated by the screening and refined procedures (Appendix A) at each of the Class I and II sensitive receptors (Table 4.3) for each of the eight alternative combinations (Wyoming Alternatives 1, 2a, 2b, and 3, combined with Montana Alternative E or A):

- Non-project sources (new and RFFA sources, excluding the RFFA sources on the IR and FS lands),

TABLE 7.17 Estimated Potential Maximum Far-Field Air Quality Impacts at Class II Areas Due to Emissions from Wyoming Project Sources, Non-Wyoming Project Sources, and Cumulative Sources under Various Alternative Combinations[a]

		Maximum Concentration Increase (μg/m³)									
		Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources				PSD Increment for Class II Area (μg/m³)
Criteria Pollutant	Averaging Time	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	
NO_2	Annual	5.1 (20)[b]	0.6 (2; DT)	0.5 (2; DT)	0.5 (2; DT)	0.3 (1)	5.4 (22)	5.4 (21)	5.3 (21)	5.3 (21)	25
	1-hour	69	17	15	14	9.8	73	73	72	73	-[c]
SO_2	Annual	0.4 (2)	0.04 (0.2; DT)	0.04 (0.2; DT)	0.04 (0.2; DT)	0.01 (0.0; DT)	0.4 (2)	0.4 (2)	0.4 (2)	0.4 (2)	20
	24-hour	5.3 (6)	0.3 (0.3)	0.3 (0.3)	0.3 (0.3)	0.1 (0.2)	5.3 (6)	5.3 (6)	5.3 (6)	5.3 (6)	91
	3-hour	17 (3)	0.7 (0.1)	0.7 (0.1)	0.7 (0.1)	0.3 (0.1)	17 (3)	17 (3)	17 (3)	17 (3)	512
	1-hour	30	1.0	1.0	1.0	0.5	30	30	30	30	-
PM_{10}	Annual	2.7 (16; FB)	0.3 (2; DT)	0.3 (2; DT)	0.2 (1; DT)	0.2 (1; DT)	2.7 (16; FB)	2.7 (16; FB)	2.7 (16; FB)	2.7 (16; FB)	17
	24-hour	30 (99; FB)	5.5 (18)	4.8 (16)	4.1 (14)	2.1 (7)	30 (99; FB)	30 (99; FB)	30 (99; FB)	30 (99; FB)	30
$PM_{2.5}$	Annual	1.2 (FB)	0.2 (DT)	0.2 (DT)	0.2 (DT)	0.1	1.2	1.2	1.2	1.2 (FB)	-
	24-hour	13 (FB)	5.1	4.5	3.8	2.0	15	14	13	13 (FB)	-
CO	8-hour	62	18	14	9.6	9.0	65	65	64	64	-
	1-hour	100 (AB)	25 (DT)	19 (DT)	13 (DT)	11	100 (AB)	100 (AB)	100 (AB)	100 (AB)	-

TABLE 7.17 (Cont.)

[a] Non-Wyoming Project sources include Montana Project sources under Alternative E, and other new and RFFA sources. Cumulative sources include Wyoming Project sources, Montana Project sources under Alternative E, and other new and RFFA sources.

[b] Values in parentheses are the predicted maximum concentration increases as a percent of the maximum allowable PSD increments for a Class II area. Abbreviations in parentheses indicate the locations where the potential maximum concentration increases were predicted to occur; AB = Absaroka-Beartooth WA; DT = Devils Tower NM; and FB = Fort Belknap IR. All other concentration increases for which no locations are indicated were predicted to occur at Crow IR.

[c] A hyphen indicates no increment exists.

TABLE 7.18 Estimated Potential Maximum Far-Field Total Air Quality Concentrations, Including Contributions from Wyoming Project Sources, Non-Wyoming Project Sources, and Cumulative Sources under Various Alternative Combinations

		Maximum Concentration (μg/m^3)										
			Increase due to Cumulative Sources				Total Concentration					
Criteria Pollutant	Averaging Time	Wyoming Background	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	WAAQS (μg/m^3)	NAAQS (μg/m^3)
NO_2	Annual	16.5	5.4 (5)[a]	5.4 (5)	5.3 (5)	5.3 (5)	18 (18; DT)	18 (18; DT)	18 (18; DT)	17 (17; DT)	100	100
	1-hour	-	73 (13)	73 (13)	72 (13)	73 (13)	190 (34)	190 (34)	190 (33)	190 (34)	-[b]	-
SO_2	Annual	3	0.4 (1)	0.4 (1)	0.4 (1)	0.4 (1)	16 (27)	16 (27)	16 (27)	16 (27)	60	80
	24-hour	8	5.3 (2)	5.3 (2)	5.3 (2)	5.3 (2)	78 (30)	78 (30)	78 (30)	78 (30)	260	365
	3-hour	8	17 (1)	17 (1)	17 (1)	17 (1)	310 (24)	310 (24)	310 (24)	310 (24)	1,300	1,300
	1-hour	-	30 (2)	30 (2)	30 (2)	30 (2)	700 (54)	700 (54)	700 (54)	700 (54)	-	-
PM_{10}	Annual	17 [33][c]	2.7 (5; FB)	2.7 (5; FB)	2.7 (5; FB)	2.7 (5; FB)	33 (65; FB)	33 (65; FB)	33 (65; FB)	33 (65; FB)	50	50
	24-hour	42 [105]	30 (20; FB)	30 (20; FB)	30 (20; FB)	30 (20; FB)	130 (90; FB)	130 (90; FB)	130 (90; FB)	130 (90; FB)	150	150
$PM_{2.5}$	Annual	7.6 [9.5]	1.2 (8)	1.2 (8)	1.2 (8)	1.2 (8; FB)	9.2 (62)	9.2 (62)	9.2 (61)	9.2 (61; FB)	15	15
	24-hour	19 [33]	15 (23)	14 (22)	13 (21)	13 (20; FB)	35 (53)	34 (52)	33 (51)	33 (50; FB)	65	65
CO	8-hour	1,500	78 (1)	76 (1)	74 (1)	75 (1)	6,700 (67)	6,700 (67)	6,700 (67)	6,700 (67)	10,000	10,000
	1-hour	3,500	100 (0.4; AB)	100 (0.4; AB)	100 (0.4; AB)	100 (0.4; AB)	15,000 (58; AB)	15,000 (58; AB)	15,000 (58; AB)	15,000 (58; AB)	40,000	40,000

TABLE 7.18 (Cont.)

[a] Values in parentheses are the predicted maximum concentrations as a percent of the AAQS of the state where the receptor is located. Abbreviations in parentheses indicate the locations where the potential maximum concentration increases were predicted to occur; AB = Absaroka-Beartooth WA; DT = Devils Tower NM; FB = Fort Belknap IR; and NC = Northern Cheyenne IR. All other concentration increases for which no locations are indicated were predicted to occur at the Crow IR.

[b] A hyphen indicates no standard exists.

[c] Values in brackets are the background concentrations at Sheridan, Wyoming.

- Non-Wyoming Project sources (Montana Project sources and other new and RFFA sources),

- Wyoming Project sources, and

- Cumulative sources (Wyoming Project sources, Montana Project sources, and other new and RFFA sources).

The results estimated by the screening procedures are presented in Appendix D.2 and those estimated by the refined procedure are provided in Appendix E.2.

7.3.2.2.1 Screening Analysis. Tables 7.19 and 7.20 summarize the potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* and 1.0 *dv*, respectively, estimated by the WDEQ and FLAG screening procedures at the visibility-sensitive receptors.

The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* due to emissions from the Wyoming Project sources estimated by the WDEQ screening procedure ranges from 6 days at FZ under Alternative 3, to 55 days at BL under Alternative 1. The annual number of days equal to or greater than 1.0 *dv* due to emissions from the Wyoming Project sources estimated by the WDEQ screening procedure ranges from 2 days at BL and WC under Alternative 3, to 28 days at WC under Alternative 1.

The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 and 1.0 *dv* due to emissions from each of the source categories estimated by the FLAG screening procedure is larger than the number estimated by the WDEQ screening procedure. The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* due to emissions from the Wyoming Project sources estimated by the FLAG screening procedure ranges from less than 1 day at RR under Alternative 3, to 215 days at DT under Alternative 1. The estimated potential annual number of days with a visibility degradation equal to or greater than 1.0 *dv* due to emissions from the Wyoming Project sources estimated by the FLAG screening procedure ranges from less than 1 day at GM, RR, and SG under Alternative 3, to 144 days at DT under Alternative 1.

Potential visibility impacts due to the Wyoming Project emissions are highest under Alternative 1. According to the WDEQ screening procedure estimates, potential maximum visibility impacts at the PSD Class I sensitive receptors occur at BL and WC, the PSD Class I areas located closest to the downwind direction of prevailing winds from the Wyoming Project Area among all of the PSD Class I areas evaluated using the WDEQ screening procedure. According to the FLAG screening procedure estimates, potential maximum visibility impacts at the Class I and II sensitive receptors occur at DT, the receptor closest to the Wyoming Project Area in the downwind direction of prevailing winds among all Class I and II visibility-sensitive receptors evaluated. In general, estimated potential visibility impacts decrease as the distance between the Wyoming Project Area and the receptor area increases and as the direction from the

TABLE 7.19 Estimated Potential Visibility Impairment ($\Delta dv \geq 0.5$) Due to Emissions from Wyoming Project Sources, Non-Wyoming Project Sources, and Cumulative Sources Predicted by Screening Procedures under Various Alternative Combinations[a]

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 0.5$[b]									
			Location[c]		Non- Project Sources	Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources			
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3
WDEQ	Badlands WA	I	280	E	108	129[d] 111	55	44	40	21	158[d] 147	154 144	153 141	145 131
	Bridger WA	I	306	WSW	42	54 45	21	20	15	8	59 53	59 53	58 52	54 50
	Fitzpatrick WA	I	294	WSW	42	52 46	20	18	14	6	57 50	57 50	57 50	55 47
	N. Absaroka WA	I	290	W	50	63 53	19	18	14	8	65 60	65 60	65 58	64 57
	Washakie WA	I	272	W	56	67 56	24	22	22	12	68 63	68 63	68 63	68 59
	Wind Cave NP	I	209	ESE	134	149 139	54	47	38	20	182 170	177 168	174 166	165 156
FLAG	Badlands WA	I	280	E	191	215 196	102	91	86	44	240 229	240 229	239 228	231 210
	Bridger WA	I	306	WSW	51	60 53	26	24	23	12	66 62	66 61	66 61	63 58
	Fitzpatrick WA	I	294	WSW	51	58 52	22	21	21	10	63 59	63 58	63 57	61 54
	Fort Peck IR	I	411	N	39	61 42	14	12	12	3	71 59	71 57	71 56	67 52
	Gates of the Mountains WA	I	521	NW	144	148 145	5	5	4	2	149 147	149 147	149 147	148 147

TABLE 7.19 (Cont.)

Screening Procedure	Visibility-Sensitive Receptor: Name	PSD Class	Location[c]: Distance (km)	Location[c]: Direction	Number of Days with $\Delta dv \geq 0.5$[b]: Non-Project Sources: All Alt.	Non-Wyoming Project Sources: All Alt.	Wyoming Project Sources: Alt. 1	Wyoming Project Sources: Alt. 2a	Wyoming Project Sources: Alt. 2b	Wyoming Project Sources: Alt. 3	Cumulative Sources: Alt. 1	Cumulative Sources: Alt. 2a	Cumulative Sources: Alt. 2b	Cumulative Sources: Alt. 3
FLAG (Cont.)	Grand Teton NP	I	368	W	24	32[d] 25	14	11	11	6	35[d] 32	35 32	35 32	32 27
	N. Absaroka WA	I	290	W	68	87 72	21	21	19	10	89 78	89 78	89 78	88 75
	N. Cheyenne IR	I	149	NNW	332	364 337	124	121	117	90	364 338	364 338	364 338	364 337
	Red Rock Lakes WA	I	446	W	30	36 32	6	5	4	0	38 37	38 37	38 37	37 36
	Scapegoat WA	I	593	NW	51	55 52	3	3	3	2	56 53	56 53	56 52	56 52
	Teton WA	I	315	W	46	56 46	18	18	16	9	58 50	58 50	57 49	57 47
	T. Roosevelt NP-North	I	411	NNE	44	64 49	24	20	19	8	83 67	82 65	80 64	68 56
	T. Roosevelt NP-South	I	346	NNE	82	104 85	44	40	36	19	117 106	117 105	114 103	110 92
	UL Bend WA	I	388	NNW	81	101 82	17	15	14	6	103 94	103 93	103 93	101 86
	Washakie WA	I	272	W	68	81 71	29	27	26	15	83 77	83 77	83 77	82 74
	Wind Cave NP	I	209	ESE	235	249 235	124	109	102	43	265 264	264 254	263 254	255 245
	Yellowstone NP	I	348	W	72	82 78	20	19	16	10	83 81	83 80	83 80	82 79

TABLE 7.19 (Cont.)

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 0.5$[b]									
			Location[c]		Non-Project Sources	Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources			
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3
FLAG (Cont.)	Absaroka-Beartooth WA	II	330	WNW	175	178[d] 177	20	19	18	12	178[d] 177	178 177	178 177	178 177
	Agate Fossil Beds NM	II	262	SE	193	204 194	85	78	67	25	221 215	220 213	218 211	211 203
	Bighorn Canyon NRA	II	189	WNW	249	269 257	54	50	48	33	269 259	269 259	269 259	269 259
	Black Elk WA	II	195	E	229	250 231	117	107	96	38	268 261	268 259	268 258	260 248
	Cloud Peak WA	II	96	W	115	142 121	105	100	97	62	158 148	158 147	157 147	152 137
	Crow IR	II	169	NW	356	364 364	166	164	162	140	364 364	364 364	364 364	364 364
	Devils Tower NM	II	104	ENE	240	284 253	215	211	203	120	302 286	301 285	299 285	291 270
	Fort Belknap IR	II	411	N	354	356 355	13	10	8	4	356 356	356 356	356 356	356 356
	Fort Laramie NHS	II	246	SSE	195	207 195	62	56	53	27	228 218	224 216	222 215	212 205
	Jewel Cave NM	II	175	ESE	238	257 240	138	127	119	52	268 258	268 257	268 257	263 249
	Mt. Rushmore National Memorial	II	199	E	213	235 217	110	100	85	37	253 242	251 239	251 239	245 229
	Popo Agie WA	II	289	WSW	54	60 56	26	26	25	12	64 63	64 62	64 62	62 59

TABLE 7.19 (Cont.)

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 0.5$[b]									
			Location[c]		Non-Project Sources	Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources			
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3
FLAG (Cont.)	Soldier Creek WA	II	254	SE	207	223[d] 210	94	88	85	26	243[d] 235	242 235	239 234	232 224

[a] Non-project sources include other new and RFFA sources, excluding those on the IR and FS lands. Non-Wyoming Project sources include Montana Project sources, and other new and RFFA sources. Cumulative sources include Wyoming Project sources, Montana Project sources, and other new and RFFA sources.

[b] The number of days is a rounded value.

[c] Distance and direction are from the center point of the project area to the center point of the receptor area.

[d] Values in the first row are with Montana Project emissions under Alt. E (high emissions case), and values in the second row are with Montana Project emissions under Alt. A (low emissions case).

TABLE 7.20 Estimated Potential Visibility Impairment ($\Delta dv \geq 1.0$) Due to Emissions from Wyoming Project Sources, Non-Wyoming Project Sources, and Cumulative Sources Predicted by Screening Procedures under Various Alternative Combinations[a]

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
			Location[c]		Non-Project Sources	Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources			
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3
WDEQ	Badlands WA	I	280	E	56	69[d] 57	27	23	20	2	88[d] 80	86 76	85 75	76 65
	Bridger WA	I	306	WSW	21	29 21	12	11	8	4	41 31	40 29	37 29	35 26
	Fitzpatrick WA	I	294	WSW	19	27 19	9	8	8	4	36 27	36 27	35 26	33 21
	N. Absaroka WA	I	290	W	26	42 32	10	9	9	4	43 38	43 37	43 37	42 35
	Washakie WA	I	272	W	33	49 38	14	12	12	4	53 46	53 46	53 46	51 45
	Wind Cave NP	I	209	ESE	67	78 70	28	23	19	2	103 95	98 88	95 85	86 77
FLAG	Badlands WA	I	280	E	112	134 117	57	50	44	20	167 154	163 152	162 155	153 133
	Bridger WA	I	306	WSW	25	40 25	14	13	12	6	48 38	48 36	48 35	42 29
	Fitzpatrick WA	I	294	WSW	23	37 26	12	11	9	6	46 38	46 36	45 34	41 31
	Fort Peck IR	I	411	N	13	28 13	5	3	3	1	39 27	38 27	37 26	34 17
	Gates of the Mountains WA	I	521	NW	57	60 58	2	2	2	0	60 59	60 59	60 59	60 58
	Grand Teton NP	I	368	W	15	18 15	8	6	6	1	20 17	19 17	19 17	18 17

TABLE 7.20 (Cont.)

Screening Procedure	Name	PSD Class	Location[c] Distance (km)	Location[c] Direction	Non-Project Sources All Alt.	Non-Wyoming Project Sources All Alt.	Wyoming Project Sources Alt. 1	Wyoming Project Sources Alt. 2a	Wyoming Project Sources Alt. 2b	Wyoming Project Sources Alt. 3	Cumulative Sources Alt. 1	Cumulative Sources Alt. 2a	Cumulative Sources Alt. 2b	Cumulative Sources Alt. 3
					Number of Days with $\Delta dv \geq 1.0$[b]									
FLAG (Cont.)	N. Absaroka WA	I	290	W	42	54[d] 48	14	12	10	5	57[d] 53	57 52	57 51	56 51
	N. Cheyenne IR	I	149	NNW	254	363 263	92	87	85	46	363 271	363 270	363 269	363 266
	Red Rock Lakes WA	I	446	W	13	17 14	0	0	0	0	19 17	18 17	18 17	17 16
	Scapegoat WA	I	593	NW	26	27 27	3	2	2	0	30 28	30 28	30 27	28 27
	Teton WA	I	315	W	22	35 25	11	9	9	5	40 32	40 32	39 32	37 27
	T. Roosevelt NP-North	I	411	NNE	18	36 20	13	13	9	2	44 32	44 31	43 30	39 28
	T. Roosevelt NP-South	I	346	NNE	31	61 36	27	24	20	5	77 59	75 57	73 56	66 49
	UL Bend WA	I	388	NNW	34	47 39	7	7	6	1	49 43	49 42	49 42	49 41
	Washakie WA	I	272	W	46	58 48	19	17	15	7	61 54	61 54	61 53	59 51
	Wind Cave NP	I	209	ESE	154	172 156	62	54	45	21	202 198	201 197	201 194	190 175
	Yellowstone NP	I	348	W	35	43 40	13	10	10	5	46 41	45 41	45 41	44 41
	Absaroka-Beartooth WA	II	330	WNW	129	135 130	15	13	12	6	136 133	136 133	136 133	135 133
	Agate Fossil Beds NM	II	262	SE	102	116 103	34	28	26	5	140 131	139 127	135 124	126 113

TABLE 7.20 (Cont.)

	Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
			Location[c]		Non-Project Sources	Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources			
Screening Procedure	Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3
FLAG (Cont.)	Bighorn Canyon NRA	II	189	WNW	166	191[d] 177	36	32	29	17	194[d] 182	194 182	193 182	193 179
	Black Elk WA	II	195	E	146	165 148	58	49	40	18	209 195	207 190	200 185	184 163
	Cloud Peak WA	II	96	W	69	110 76	65	60	56	31	128 114	125 112	124 111	118 100
	Crow IR	II	169	NW	306	364 348	123	116	113	87	364 348	364 348	364 348	364 348
	Devils Tower NM	II	104	ENE	170	213 176	144	130	124	54	255 237	253 234	251 233	238 208
	Fort Belknap IR	II	411	N	326	327 326	5	4	4	1	327 327	327 327	327 327	327 326
	Fort Laramie NHS	II	246	SSE	108	122 112	39	33	26	10	145 137	143 135	140 133	130 118
	Jewel Cave NM	II	175	ESE	167	189 169	71	64	53	23	220 210	215 205	214 202	204 187
	Mt. Rushmore National Memorial	II	199	E	133	153 137	53	43	38	18	186 173	182 167	177 164	162 146
	Popo Agie WA	II	289	WSW	30	41 31	15	14	13	5	47 45	47 44	47 44	46 39
	Soldier Creek WA	II	254	SE	125	141 127	35	32	29	6	166 157	165 156	164 154	154 140

TABLE 7.20 (Cont.)

[a] Non-project sources include other new and RFFA sources, excluding those on the IR and FS lands. Non-Wyoming Project sources include Montana Project sources, and other new and RFFA sources. Cumulative sources include Wyoming Project sources, Montana Project sources, and other new and RFFA sources.

[b] The number of days is a rounded value.

[c] Distance and direction are from the center point of the project area to the center point of the receptor area.

[d] Values in the first row are with Montana Project emissions under Alt. E (high emissions case), and values in the second row are with Montana Project emissions under Alt. A (low emissions case).

Wyoming Project Area to the receptor area changes from downwind to upwind of the prevailing winds.

The potential visibility impacts due to the Wyoming Project source emissions estimated by the screening procedures are lower than those due to the non-project source emissions at all visibility-sensitive receptors, under all Wyoming alternatives evaluated. As expected, the potential visibility impacts due to non-project source emissions estimated by the screening procedures are similar to or lower than those due to the non-Wyoming Project source emissions at all visibility-sensitive receptors under all alternative combinations evaluated.

The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* due to emissions from cumulative sources estimated by the WDEQ screening procedure ranges from about 47 days at FZ under Wyoming Alternative 1 and Montana Alternative A, to 182 days at WC under Wyoming Alternative 1 and Montana Alternative E. The estimated potential annual number of days with visibility degradation equal to or greater than 1.0 *dv* due to emissions from cumulative sources estimated by the WDEQ screening procedure ranges from about 21 days at FZ under Wyoming Alternative 3 and Montana Alternative A, to 103 days at WC under Wyoming Alternative 1 and Montana Alternative E.

The estimated potential annual number of days with visibility degradation equal to or greater than 0.5 *dv* due to emissions from cumulative sources estimated by the FLAG screening procedure ranges from about 27 days at GT under Wyoming Alternative 3 and Montana Alternative A, to 364 days at NC under all Wyoming Alternatives with Montana Alternative E, and at CI under all eight alternative combinations. The estimated potential annual number of days with visibility degradation equal to or greater than 1.0 *dv* due to emissions from cumulative sources estimated by the FLAG screening procedure ranges from about 16 days at RR under Wyoming Alternative 3 and Montana Alternative A, to 364 days at CI under all Wyoming alternatives with Montana Alternative E.

7.3.2.2.2 Refined Analysis. The potential far-field daily visibility impacts due to the emissions from each source category were also estimated by the refined procedure at each of the Class I and II sensitive receptors (Table 4.3) for each of the eight alternative combinations (Wyoming Alternatives 1, 2a, 2b, and 3, combined with Montana Alternative E or A). The results are presented in Appendix E.2 for the non-project sources, non-Wyoming Project sources, Wyoming Project sources, and cumulative sources.

Table 7.21 summarizes the potential annual number of days with visibility degradation equal to or greater than 1.0 *dv*. Visibility degradation trends indicated in the results of the visibility impact analysis conducted by using the refined procedure are similar to those of the analysis conducted by using the screening procedures described in Section 7.3.2.2.1, with respect to the following parameters: (1) relative significance of the Wyoming Project sources, non-Wyoming Project sources, and non-project sources; (2) effect of the distance between the Wyoming Project Area and receptor area; and (3) direction from the Wyoming Project Area to the receptor area relative to the prevailing wind direction.

TABLE 7.21 Estimated Potential Visibility Impairment ($\Delta dv \geq 1.0$) Due to Emissions from Wyoming Project Sources, Non-Wyoming Project Sources, and Cumulative Sources Predicted by Refined Procedures under Various Alternative Combinations[a]

Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
		Location[c]		Non-Project Sources	Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources			
Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3
Badlands WA	I	280	E	13	17[d] 13	3	3	1	0	28[d] 25	27 24	26 22	21 18
Bridger WA	I	306	WSW	6	9 7	4	4	3	1	12 10	12 10	11 9	10 8
Fitzpatrick WA	I	294	WSW	6	9 6	4	3	3	1	12 10	12 9	11 9	10 8
Fort Peck IR	I	411	N	1	3 1	0	0	0	0	5 2	5 2	4 2	4 2
Gates of the Mountains WA	I	521	NW	3	4 3	0	0	0	0	4 4	4 4	4 4	4 3
Grand Teton NP	I	368	W	3	5 3	1	1	0	0	8 6	7 6	7 5	6 4
N. Absaroka WA	I	290	W	9	13 9	4	3	2	0	15 12	14 12	14 12	13 11
N. Cheyenne IR	I	149	NNW	24	82 27	17	16	14	7	92 42	91 39	90 38	87 33
Red Rock Lakes WA	I	446	W	0	1 0	0	0	0	0	3 1	3 1	2 1	2 0
Scapegoat WA	I	593	NW	2	2 2	0	0	0	0	3 3	3 2	3 2	3 2
Teton WA	I	315	W	6	9 6	3	3	2	0	11 10	11 9	11 9	10 7
T. Roosevelt NP-North	I	411	NNE	0	1 0	0	0	0	0	3 2	3 2	3 1	2 1

TABLE 7.21 (Cont.)

Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
		Location[c]		Non-Project Sources	Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources			
Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3
T. Roosevelt NP-South	I	346	NNE	1	3[d] 1	1	0	0	0	7[d] 4	6 4	6 3	4 2
UL Bend WA	I	388	NNW	4	5 4	1	1	1	0	8 6	8 5	7 5	6 5
Washakie WA	I	272	W	9	14 10	5	4	4	1	18 15	18 14	17 14	16 12
Wind Cave NP	I	209	ESE	17	21 17	4	3	2	0	32 28	30 27	28 25	25 22
Yellowstone NP	I	348	W	7	11 8	3	2	1	0	13 11	13 11	13 11	12 9
Absaroka-Beartooth WA	II	330	WNW	27	32 28	4	3	3	0	33 30	33 29	33 29	32 28
Agate Fossil Beds NM	II	262	SE	7	11 8	2	1	0	0	19 15	17 14	16 13	14 10
Bighorn Canyon NRA	II	189	WNW	16	30 17	9	8	7	3	34 23	34 22	33 21	32 19
Black Elk WA	II	195	E	16	20 17	4	3	2	0	31 26	29 25	28 24	24 20
Cloud Peak WA	II	96	W	16	30 17	13	12	9	3	39 30	38 28	37 27	35 23
Crow IR	II	169	NW	47	108 59	20	16	14	10	116 69	115 69	115 68	113 65
Devils Tower NM	II	104	ENE	16	25 17	9	6	5	1	47 39	44 36	42 34	34 26
Fort Belknap IR	II	411	N	60	61 60	1	1	1	0	62 61	61 61	61 61	61 61

TABLE 7.21 (Cont.)

Visibility-Sensitive Receptor				Number of Days with $\Delta dv \geq 1.0$[b]									
		Location[c]		Non-Project Sources	Non-Wyoming Project Sources	Wyoming Project Sources				Cumulative Sources			
Name	PSD Class	Distance (km)	Direction	All Alt.	All Alt.	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3	Alt. 1	Alt. 2a	Alt. 2b	Alt. 3
Fort Laramie NHS	II	246	SSE	10	14[d]	2	2	1	0	20[d]	19	19	16
					10					17	17	16	13
Jewel Cave NM	II	175	ESE	18	23	4	3	2	0	36	35	33	28
					19					32	30	29	24
Mt. Rushmore National Memorial	II	199	E	13	17	3	2	1	0	26	25	24	20
					13					22	21	21	17
Popo Agie WA	II	289	WSW	6	9	4	3	3	1	13	12	12	11
					7					10	10	10	8
Soldier Creek WA	II	254	SE	9	13	2	1	1	0	21	21	20	16
					10					18	17	16	13

[a] Non-project sources include other new and RFFA sources, excluding those on the IR and FS lands. Non-Wyoming Project sources include Montana Project sources, and other new and RFFA sources. Cumulative sources include Wyoming Project sources, Montana Project sources, and other new and RFFA sources.

[b] The number of days is a rounded value.

[c] Distance and direction are from the center point of the project area to the center point of the receptor area.

[d] Values in the first row are with Montana Project emissions under Alt. E (high emissions case), and values in the second row are with Montana Project emissions under Alt. A (low emissions case).

The potential annual number of days with visibility degradation equal to or greater than 1.0 *dv* due to emissions from the Wyoming Project sources as estimated by the refined procedure is less than 1 day at the majority of the visibility-sensitive receptors evaluated under one or more Wyoming Alternatives. The highest estimated potential annual number of days with visibility degradation equal to or greater than 1.0 *dv* due to emissions from the Wyoming Project sources as estimated by the refined procedure is 20 days at CI under the Wyoming Alternative 1.

The potential visibility impacts due to the Wyoming Project source emissions estimated by the refined procedure are lower than those due to the non-project source emissions at all visibility-sensitive receptors under all Wyoming Project alternatives evaluated. As expected, the potential visibility impacts due to non-project source emissions estimated by the refined procedure are similar to or lower than those due to the non-Wyoming Project source emissions at all visibility-sensitive receptors under all alternative combinations evaluated.

The potential annual number of days with visibility degradation equal to or greater than 1.0 *dv* due to emissions from cumulative sources estimated by the refined procedure ranges from less than 1 day at RR under Wyoming Alternative 3 and Montana Alternative A, to 116 days at CI under Wyoming Alternative 1 and Montana Alternative E.

7.3.2.3 Acid Deposition

The potential far-field acid deposition impacts due to the emissions from each of the following source categories were estimated at each of the Class I and II sensitive receptors (Table 4.3) and sensitive lakes (Table 4.5) for each of the eight alternative combinations (Wyoming Alternatives 1, 2a, 2b, and 3, combined with Montana Alternative E or A):

- Non-project sources (new and RFFA sources, excluding the RFFA sources on the IR and FS lands),
- Non-Wyoming Project sources (Montana Project sources and other new and RFFA sources),
- Wyoming Project sources, and
- Cumulative sources (Wyoming Project sources, Montana Project sources, and other new and RFFA sources).

The results are presented in Appendix F.2.

The predicted maximum acid deposition fluxes at the Class I and II sensitive receptors listed in Table 4.3 due to the emissions from cumulative sources under Wyoming Alternative 1 and Montana Alternative E occur at the Fort Belknap IR for sulfur (0.12 kg/ha/yr) and at the Northern Cheyenne IR for nitrogen (0.97 kg/ha/yr). These annual deposition fluxes are approximately 2 and 32% of the LAC thresholds of 5 and 3 kg/ha/yr for total sulfur and nitrogen deposition fluxes, respectively. Adding these predicted maximum increases in acid deposition fluxes to the current highest background total deposition fluxes (0.90 and 1.62 kg/ha/yr for sulfur and nitrogen, respectively) monitored in the modeling domain (ESE 2001) results in predicted maximum total acid deposition fluxes of 1.02 and 2.59 kg/ha/yr for sulfur and nitrogen, respectively. These predicted maximum total acid deposition fluxes represent about 20 and 86% of the LAC thresholds of 5 and 3 kg/ha/yr for total sulfur and nitrogen deposition fluxes, respectively.

Table 7.22 gives the potential changes in ANC at the sensitive lakes listed in Table 4.5 estimated for emissions from non-project sources, non-Wyoming Project sources, Wyoming Project sources, and cumulative sources under various alternative combinations. Except for the Upper Frozen Lake and Florence Lake, the estimated potential changes in ANC due to emissions from non-project sources, non-Wyoming Project sources, Wyoming Project sources, and cumulative sources under all alternative combinations evaluated are less than 10%, the LAC threshold for lakes with background ANC values is greater than 25 μeq/L (see Table 7.22 for the 10% most sensitive ANC values of the sensitive lakes evaluated).

At Florence Lake, the estimated potential change in ANC due to emissions from cumulative sources under Wyoming Alternative 1 and Montana Alternative E is 10.4%, slightly above the LAC threshold for lakes with background ANC values greater than 25 μeq/L (10%).

For the Upper Frozen Lake (with the 10% most sensitive ANC value of 5.8 μeq/L), the estimated potential change in ANC due to emissions from Wyoming Project Sources are all less than 1 μeq/L, the LAC threshold for lakes with background ANC values equal to or less than 25 μeq/L. However, the estimated potential changes in ANC due to emissions from cumulative sources range from 1.3 to 1.8 μeq/L under all alternative combinations evaluated. These changes are mainly due to the contributions from non-Wyoming Project sources (1.1 to 1.3 μeq/L).

TABLE 7.22 Estimated Potential Changes in ANC at Sensitive Lakes Due to Emissions from the Wyoming Project Sources, Non-Wyoming Project Sources, and Cumulative Sources under Various Alternative Combinations[a]

Sensitive Lake					Potential ANC Change (%)									
	Location[b]			10% Most Sensitive ANC (μeq/L)	Non-Project Sources All Alt.	Non-WY Project Sources All Alt.	Wyoming Project Sources				Cumulative Sources			
Name	WA	Distance (km)	Direction				Alt. 1	Alt.2a	Alt. 2b	Alt. 3	Alt. 1	Alt.2a	Alt. 2b	Alt. 3
Black Joe	Bridger	296	WSW	69.0	1.5	1.9[c]	0.7	0.6	0.6	0.3	2.6[c]	2.5	2.4	2.1
						1.6					2.3	2.2	2.1	1.8
Deep	Bridger	298	WSW	61.0	1.7	2.1	0.8	0.7	0.6	0.3	2.9	2.8	2.7	2.4
						1.8					2.6	2.5	2.4	2.1
Hobbs	Bridger	315	WSW	68.0	0.8	1.1	0.4	0.3	0.3	0.2	1.5	1.5	1.4	1.3
						0.9					1.3	1.2	1.2	1.0
Upper Frozen[d]	Bridger	299	WSW	5.8[e]	1.1	1.3	0.51	0.45	0.39	0.19	1.81	1.75	1.69	1.49
						1.1					1.59	1.53	1.47	1.27
Ross	Fitzpatrick	300	WSW	61.4	1.2	1.6	0.5	0.5	0.4	0.2	2.1	2.0	2.0	1.7
						1.2					1.7	1.7	1.6	1.4
Stepping Stone	Absaroka-	308	WNW	27.0	1.7	2.2	0.3	0.3	0.2	0.1	2.5	2.5	2.5	2.4
	Beartooth					1.8					2.1	2.1	2.1	1.9
Twin Island	Absaroka-	305	WNW	36.0	1.2	1.6	0.2	0.2	0.2	0.1	1.8	1.8	1.8	1.7
	Beartooth					1.3					1.5	1.5	1.5	1.4
Emerald	Cloud Peak	104	WNW	55.3	2.8	4.2	1.7	1.5	1.3	0.7	5.9	5.7	5.5	4.9
						3.0					4.6	4.4	4.3	3.7
Florence	Cloud Peak	93	W	32.7	5.0	7.2	3.1	2.8	2.5	1.3	10.4	10.0	9.7	8.5
						5.2					8.4	8.0	7.7	6.5
Lower	Popo Agie	292	SW	55.5	2.2	2.6	1.0	0.9	0.8	0.4	3.6	3.5	3.4	3.0
Saddlebag						2.2					3.2	3.1	3.0	2.6

[a] Non-project sources include other new and RFFA sources, excluding those on the IR and FS lands. Non-Wyoming Project sources include Montana Project sources, and other new and RFFA sources. Cumulative sources include Wyoming Project sources, Montana Project sources, and other new and RFFA sources.

[b] Direction and distance are from the center of the Wyoming Project Area to the center of each sensitive lake.

[c] Values in the first row are with Montana Project emissions under Alt. E (high emissions case), and values in the second row are with Montana Project emissions under Alt. A (low emissions case).

[d] ANC values for the Upper Frozen Lake are in μeq/L.

[e] The background ANC is based on only six samples taken on four days between 1997 and 2001.

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APPENDIX A:

PROCEDURES FOR PREDICTING MAXIMUM AND DAILY VISIBILITY IMPAIRMENT

APPENDIX A:

PROCEDURES FOR PREDICTING MAXIMUM AND DAILY VISIBILITY IMPAIRMENT

The Federal Land Managers' Air-Quality-Related Values Workgroup (FLAG), consisting of the Forest Service (FS) in the U.S. Department of Agriculture (USDA), and the National Park Service (NPS) and U.S. Fish and Wildlife Service (FWS) in the Department of the Interior (DOI), has established recommended procedures for identifying and evaluating potential visibility impacts primarily in mandatory federal Prevention of Significant Deterioration (PSD) Class I areas (FLAG 2000). The procedures are designed to help FLAG agencies when they review New Source Review permit applications to focus on the potential contribution of anthropogenic pollutant emissions to visibility degradation. Although the seasonal FLAG screening visibility analysis approach applies conservative assumptions (tending to overestimate potential impacts), it does represent an appropriate screening level analysis (e.g., if potential impacts do not exceed the conservative screening thresholds, then further refined analysis is not necessary).

FLAG has developed a generalized seasonal screening analysis approach on the basis of the following:

1. Estimation of the potential concentration of visibility-impairing pollutants (mainly primary fine and coarse particulate matter [PM], secondary ammonium nitrate [NH_4NO_3], and secondary ammonium sulfate [$NH_4]_2SO_4$);

2. Application of bulk-averaged visibility extinction efficiencies, including a representative relative humidity adjustment factor;

3. Computation of the predicted percent change (increase) of predicted extinction above an assumed "natural background" reference level; and

4. Comparison of the predicted change with FLAG-prescribed threshold levels.

Representative site-specific, seasonal relative humidity adjustment factors and estimated "natural background" reference visibility levels are presented in Table 4.4 and in Appendix 2.B (Estimate of Natural Conditions) of the FLAG Report (2000). In addition, the State of Wyoming Department of Environmental Quality has established different "natural background" reference visibility levels for selected mandatory federal PSD Class I areas within Wyoming.

Specifically, the maximum 24-hour concentrations of primary fine particulate matter ($PM_{2.5}$) and primary coarse particulate matter ([PM_{10}] – [$PM_{2.5}$]), as well as nitrate ion (NO_3^-) and sulfate ion ($SO_4^=$), are predicted at each of the Class I and Class II areas of concern located in the modeling domain. The mass concentrations of secondary NH_4NO_3 and $[NH_4]_2SO_4$ are calculated by assuming the presence of excess ambient ammonia (by using adjustment factors of 1.290 and 1.375, respectively). Separate "dry" extinction coefficients are applied for each pollutant species (e.g., 1.0 for primary fine particulate matter, 0.6 for primary coarse particulate matter, 3.0 for NH_4NO_3, and 3.0 for $[NH_4]_2SO_4$). A relative humidity adjustment factor representative of each specific modeled location is also applied to account for greater extinction due to hygroscopic aerosol growth as the humidity level increases.

In summary, the total modeled extinction (b_{ext}) due to pollutant scattering (extinction due to absorption is assumed to be negligible) is:

$$b_{ext}\ (\text{modeled}) = b_{ext}\ (PM_{2.5}) + b_{ext}\ ([PM_{10}] - [PM_{2.5}]) + b_{ext}\ (NH_4NO_3) + b_{ext}\ ([NH_4]_2SO_4)$$

where

$b_{ext}\ (PM_{2.5}) = 1.0 \times [PM_{2.5}]$,

$b_{ext}\ ([PM_{10}] - [PM_{2.5}]) = 0.6 \times ([PM_{10}] - [PM_{2.5}])$,

$b_{ext}\ (NH_4NO_3) = 3.0 \times 1.290 \times [NO_3^-] \times f(RH)$,

$b_{ext}\ ([NH_4]_2SO_4) = 3.0 \times 1.375 \times [SO_4^=] \times f(RH)$, and

$[PM_{2.5}]$ = maximum 24-hour primary fine particulate matter concentration,

$[PM_{10}]$ = maximum 24-hour primary inhalable particulate matter concentration,

$[NO_3^-]$ = maximum 24-hour nitrate ion concentration,

$[SO_4^=]$ = maximum 24-hour sulfate ion concentration, and

f(RH) = site-specific, relative humidity adjustment factor.

Other factors that may degrade visibility, but that are not included in the seasonal FLAG screening analysis, include:

$b_{ext}\ (EC) = 10.0 \times [EC]$,

$b_{ext}\ (OC) = 4.0 \times [OC]$, and

$b_{ext}\ (NO_2) = 0.17 \times [NO_2]$

where

[EC] = maximum 24-hour elemental carbon concentration,

[OC] = maximum 24-hour organic carbon concentration, and

$[NO_2]$ = maximum 24-hour nitrogen dioxide concentration.

Using the seasonal FLAG screening analysis, the site-specific total modeled extinction is compared with each site-specific assumed "natural background" reference level to determine the potential percent (and corresponding deciview [*dv*]) change. A 10% change in extinction corresponds to 1.0 *dv*. Finally, the predicted potential change in visibility is compared with the FLAG-prescribed threshold levels of 5 and 10% change in extinction (0.5 and 1.0 *dv* change) as their limits of acceptable change (LACs). If the predicted visibility impairment is less than 5% (0.5 *dv*), then "the FLM [Federal Land Manager] would not likely object to the proposed action." Where a cumulative analysis has been performed and the predicted visibility impairment is greater than, or equal to, 10% (1.0 *dv*), then "the FLM will consider the magnitude, frequency, duration, and other factors to assess the impact, but is likely to object to the issuance of the permit." Where a cumulative analysis has been performed and the predicted visibility impairment is greater than or equal to 5% (0.5 *dv*) but less 10% (1.0 *dv*), then "the FLM is not likely to object to the proposed action."

For example, if the maximum 24-hour primary fine particulate matter, primary coarse particulate matter, nitrate ion, and sulfate ion concentrations at Badlands Wilderness Area (WA) were predicted to be 0.01, 0.03, 0.10, and 0.06 $\mu g/m^3$ on August 31, respectively, the f(RH) is assumed to be 2.2, and the "natural background" reference level is assumed to be 15.8 Mm^{-1} (FLAG 2000). Then the predicted extinction due to pollutant scattering would be 1.42 Mm^{-1}, resulting in predicted visibility impairment of about 9% (0.9 *dv*). However, if the same pollutant concentrations were predicted to occur on the next day (September 1), when the f(RH) is assumed to be 2.8 and the "natural background" reference level is assumed to be 16.2 Mm^{-1}, then the predicted extinction due to pollutant scattering would be 1.80 Mm^{-1}, resulting in predicted visibility impairment of about 11.0% (1.1 *dv*). Since this is a cumulative impact analysis, in the first case, the predicted visibility impairment would be less than 10% (1.0 *dv*), and "the FLM is not likely to object." However, in the second case, the predicted visibility impairment would be more than 10% (1.0 *dv*), and "the FLM is likely to object."

In the current study for the Montana and Wyoming Project Environmental Impact Statement (EIS), the total modeled extinction level (on the basis of predicted site-specific maximum 24-hour primary fine particulate matter, primary coarse particulate matter, nitrate ion, and sulfate ion concentrations and the assumed site-specific relative humidity adjustment factor) was compared with the seasonal FLAG screening "natural background" reference level at each Class I area and each Class II area of concern. Where the predicted maximum visibility impairment was equal to or exceeded 10% (1.0 *dv*), an assessment of potential daily visibility impairment using the daily FLAG refined methodology was made in order to determine the magnitude, frequency, and duration of such impairment.

The refined daily visibility impairment analysis calculates total modeled extinction on the basis of predicted maximum 24-hour primary fine particulate matter, primary coarse particulate matter, nitrate ion, and sulfate ion concentrations, as described above, but it uses site-specific daily relative humidity adjustment factors based on hourly site-specific relative humidity values measured concurrently with the hourly optical extinction values. A maximum relative humidity of 90% is used because direct optical monitoring devices are not reliable above this level.

Potential daily visibility impairment is calculated on the basis of direct total optical monitoring (transmissometer) data collected at Badlands WA (also used for Agate Fossil Beds National Monument [NM], Black Elk WA, Devils Tower NM, Fort Laramie National Historic Site [NHS], Jewel Cave NM, Mount Rushmore National Memorial, Soldier Creek WA, Theodore Roosevelt National Park [NP]-north, Theodore Roosevelt NP-south, and Wind Cave NP) and at Bridger WA (also used for Absaroka-Beartooth WA, Bighorn Canyon National Recreational Area [NRA], Cloud Peak WA, Crow Indian Reservation [IR], Fitzpatrick WA, Fort Belknap IR, Fort Peck IR, Gates of the Mountains WA, Grand Teton NP, North Absaroka WA, Northern Cheyenne IR, Popo Agie WA, Red Rock Lakes WA, Scapegoat WA, Teton WA, UL Bend WA, Washakie WA, and Yellowstone NP).

For example, if on April 1, 1990, the daily average transmissometer value was measured to be 32.16 Mm^{-1}; the maximum 24-hour primary fine particulate matter, primary coarse particulate matter, nitrate ion, and sulfate ion concentrations at Badlands WA were predicted to be 0.03, 0.04, 0.07, and 0.16 $\mu g/m^3$, respectively; and the daily average f(RH) was calculated to be 1.8, then the predicted extinction due to pollutant scattering would be 1.73 Mm^{-1}, resulting in predicted visibility impairment of about 5% (0.5 *dv*). By reporting the entire range of potential visibility impairment throughout the optical monitoring period, the magnitude, frequency, and duration of such impairment will be evident.

REFERENCE

Federal Land Managers, 2000, *Federal Land Managers' Air Quality Related Values Workgroup (FLAG) Phase I Report*, Dec.

Appendix B: Emission Inventories

B.3.2 Wyoming Conventional Oil and Gas Project Activities under the Proposed Action (Alt. 1)

B.3.2.1 Construction Activities

B.3.2.2 Operational Activities

B.3.2.3 Maintenance Activities

Appendix C: Estimated Impacts on Criteria Air Pollutants

C.1 Criteria Pollutant Impacts for Montana EIS

C.1.1 Near-Field Impacts of Montana Project, Non-Project, and Cumulative Sources
- C.1.1.1 Montana Project Alt. E (and Ea) and Wyoming Project Alt. 1
- C.1.1.2 Montana Project Alt. D (and Da) and Wyoming Project Alt. 1
- C.1.1.3 Montana Project Alt. A and Wyoming Project Alt. 1

C.1.2 Far-Field Impacts of Montana Project, Non-Project, and Cumulative Sources
- C.1.2.1 Montana Project Alt. E (and Ea) and Wyoming Project Alt. 1
- C.1.2.2 Montana Project Alt. D (and Da) and Wyoming Project Alt. 1
- C.1.2.3 Montana Project Alt. A and Wyoming Project Alt. 1

C.2 Criteria Pollutant Impacts for Wyoming EIS

C.2.1 Near-Field Impacts of Wyoming Project, Non-Project, and Cumulative Sources
- C.2.1.1 Wyoming Project Alt. 1 and Montana Project Alt. E
- C.2.1.2 Wyoming Project Alt. 2a and Montana Project Alt. E
- C.2.1.3 Wyoming Project Alt. 2b and Montana Project Alt. E
- C.2.1.4 Wyoming Project Alt. 3 and Montana Project Alt. E

C.2.2 Far-Field Impacts of Wyoming Project, Non-Project, and Cumulative Sources
- C.2.2.1 Wyoming Project Alt. 1 and Montana Project Alt. E
- C.2.2.2 Wyoming Project Alt. 2a and Montana Project Alt. E
- C.2.2.3 Wyoming Project Alt. 2b and Montana Project Alt. E
- C.2.2.4 Wyoming Project Alt. 3 and Montana Project Alt. E

APPENDIX D: ESTIMATED VISIBILITY IMPACTS AT SENSITIVE RECEPTORS - FLAG AND WYOMING SCREENING ANALYSIS

APPENDIX E: ESTIMATED VISIBILITY IMPACTS AT SENSITIVE RECEPTORS - REFINED ANALYSIS

APPENDIX F: ESTIMATED ACID DEPOSITION IMPACTS AT SENSITIVE LAKES