Developing Air Emissions Inventories for 2 Rural Indian Reservations in Montana

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ABSTRACT

Portage Environmental, Inc. (Portage) is a Native American owned, 8(a) / small disadvantaged business. Portage has a prime contract with the U.S. Environmental Protection Agency (EPA) to assist them and federally recognized tribes with the implementation of the Clean Air Act (CAA) in Indian Country.

In 2004, Portage conducted two level 1 baseline air emissions inventories (EI), one for the Rocky Boy's Indian Reservation and one for the Crow Reservation both located in Montana. The reservations in Montana are relatively remote and undeveloped by most urban standards. As a result, there is relatively little data available from traditional sources. Consequently, estimates were used where data was not available. The EI's were completed to establish emissions baselines for air quality management and planning, modeling, and for tracking the effects of future development. Criteria emissions were quantified for calendar year 2002 and included emissions from both stationary (point and area) and mobile sources.

Stationary sources are comprised primarily of combustion sources and biogenic sources. Mobile sources include privately owned vehicles, as well as service trucks, buses, and automobiles that visit the reservations. In addition, agricultural activities, timber harvest activities, and residential wood smoke were also considered. Emission estimates were used when actual data was not available. Emissions were calculated for criteria pollutants using varying methodologies.

This paper discusses the methodologies used to estimate emissions from the various source categories, presents an analysis of the emissions baseline, and their implications for future development and air quality planning. It also describes the unique attributes of collecting data on reservations and the areas surrounding them, and describes source categories identified in the inventories. Finally, this paper contains some useful tips and recommendations for building initial baseline inventories.

INTRODUCTION

In 2004, Region 8 of the EPA funded Portage Environmental to complete two level 1 baseline emissions inventories. The primary objective of the studies was to gather baseline emissions data for the Crow Indian Reservation in Southwest Montana and the Rocky Boy Indian Reservation in North-central Montana. Both inventories address stationary (point and area) and mobile sources (cars, trucks, and trains). EPA's MOBILE6 emissions estimating program was used to quantify mobile source emissions, EPA's landfill Gas Emissions Model, Version 2.0 for calculating landfill emissions, and the emissions factors established in EPA's AP-42 were used for point source calculations. State and Federal emissions databases were utilized where appropriate and the inventories were complied to be compatible for data upload into the National Emissions Inventory (NEI).

The purpose of establishing a baseline emissions inventory on these reservations was to begin tracking increases in atmospheric emissions from energy development and other growth; and to provide tribes with an understanding of what source categories impact air quality for management purposes on the reservations. Renewed interest in exploration and development of energy resources in central and eastern Montana has been prevalent in recent years. Emissions inventory data collected by the State of Montana is generally not available within the exterior boundaries of reservations, creating an air emissions data gap in Indian Country. The baseline emissions data is also useful to the individual tribes for making informed air quality choices and for prioritizing limited air quality management funds.

The results of the baseline air emissions inventories show that on-road mobile emissions account for the majority of emissions within the reservations. The majority of particulate emissions were attributed to area sources within both reservations with unpaved road and fire being the greatest contributors. Industrial point sources are present with 50 miles of each reservation boundary, but none are present within the Rocky Boy's Reservation and only one is present within the Crow Indian Reservation.

BODY

Until these two studies were completed, no emissions data had been collected from the two reservations. The Congress through the 1990 Clean Air Act (CAA) authorized Federally Recognized Indian Tribes to operate federally approved air pollution control and management programs. The EPA may also delegate its authority to the tribe for implementation of certain sections of the CAA. In the event that the tribe does not or will not implement a federally approved program, the EPA is obligated to implement a federal program for them; the states generally lack authority to implement the CAA in Indian Country.

In 2002 neither the Crow nor the Rocky Boy had air pollution programs and the State of Montana does not have regulatory authority over the air pollution sources on the reservations. As a first step in filling this regulatory gap, EPA initiated a program of establishing a baseline emissions inventory of sources within the reservations and industrial point sources within 50 miles of the reservation.

THE RESERVATIONS

Rocky Boy's Reservation

The Rocky Boy's Reservation is the home of the Chippewa-Cree Tribe. The 130,000-acre reservation is located in north-central Montana on parts of Hill and Choteau Counties. The reservation lies 50 miles south of the Canadian border near the boundary separating the provinces of Alberta and Saskatchewan and its northern boarder is approximately 15 miles south of Havre, Montana. U.S. Highway 87, which runs southwesterly from Havre for 115 miles to Great Falls, Montana, passes through the Western part of the reservation. The Burlington Northern Santa Fe Railroad runs adjacent to this highway.

There is no town site on the reservation and the *Rocky Boy* community, where most of the tribal institutions are located, is considered a rural area. The institutions include a high school, elementary school, head start, college, firehouse, forestry, and tribal office facilities. The nearest town to the Rocky Boy community is Havre, 26 miles to the north. The nearest urban center is Great Falls, which has a population of 57,000, and is located 100 miles to the southwest of the reservation. The population on the reservation is approximately 5,000.

About 12 percent of the Rocky Boy's Reservation is cropland; 16 percent is used for commercial timber harvest; and the remaining 72 percent is rangeland, pastureland, and commercial woodland. Grazing is the primary agricultural use of the reservation land. None of the land on the Reservation is allotted and all the land and resources, with the exception of recent tribal land acquisitions, are held in trust for the Chippewa Cree Tribe and is protected by the U.S. Government against alienation.

The Little Bear and Poplar Bands of Cree came to Montana to escape prosecution in Canada due to their support of the Louis Riel rebellion. These Cree refugees eventually scattered throughout the area after loosing employment on the Fort Assiniboine Military Reservation. Attempts were made to resettle the Cree back into Canada. In 1896, protesting the cutting of Tribal rolls by a corrupt Indian agent that resulted in dividing families and clans; Rocky Boy's Band of Chippewa departed the Turtle Mountain Reservation in North Dakota. Rocky Boy's Band made their way to north central Montana.

In 1916, congress passed a bill to set aside approximately 56,035 acres of the abandoned Fort Assiniboine Military Reservation to establish a reservation for "Rocky Boy's Band of Chippewa and such other homeless Indians in Montana." Little Bear's Band found a home with the Rocky Boy's Band on the "Rocky Boy's Reservation". The reservation obtained its present size through land purchases and

Congressional addition of land from public domain in 1935, 1939, and 1947. Figure 1 shows the location of the Rocky Boy's Indian Reservation in Montana.

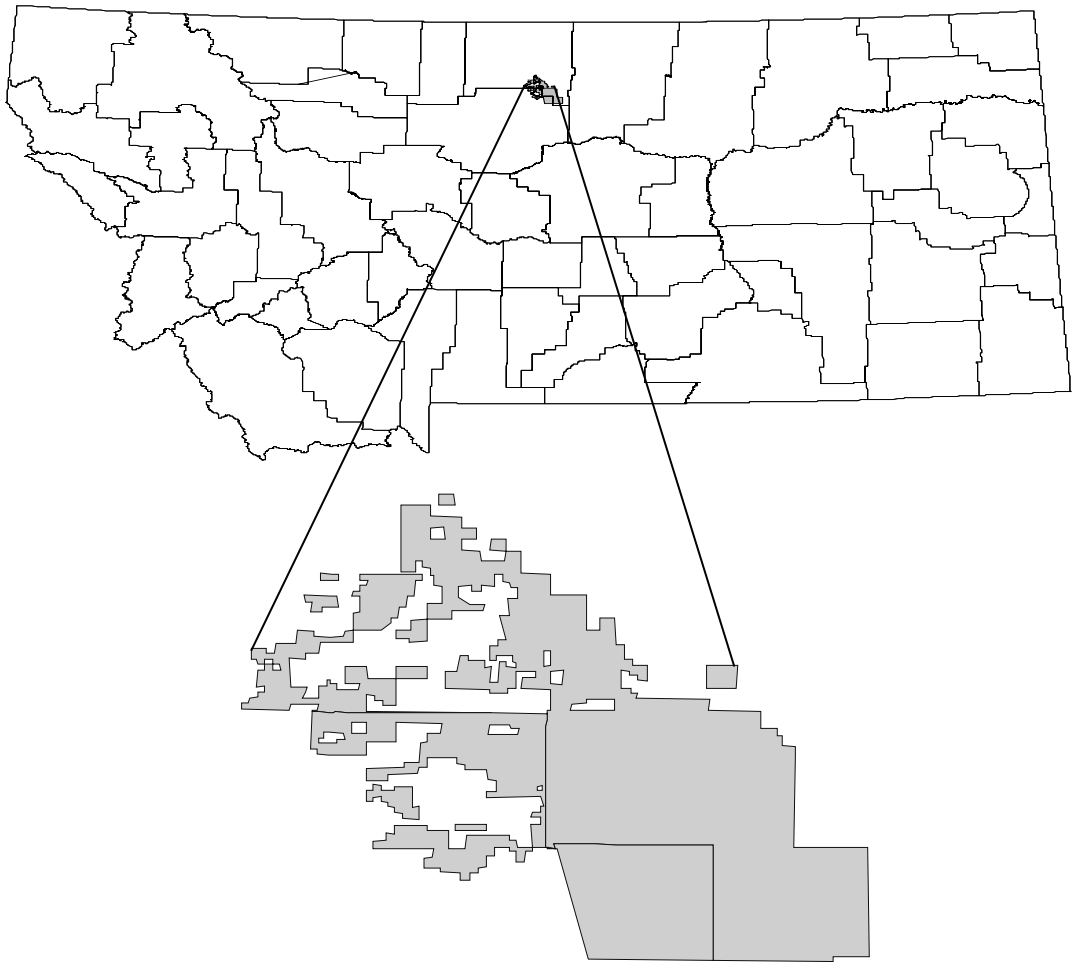


Figure 1. Rocky Boy's Indian Reservation Location Map

Mapping Courtesy of State of Montana Natural Resources Information System (NRIS).

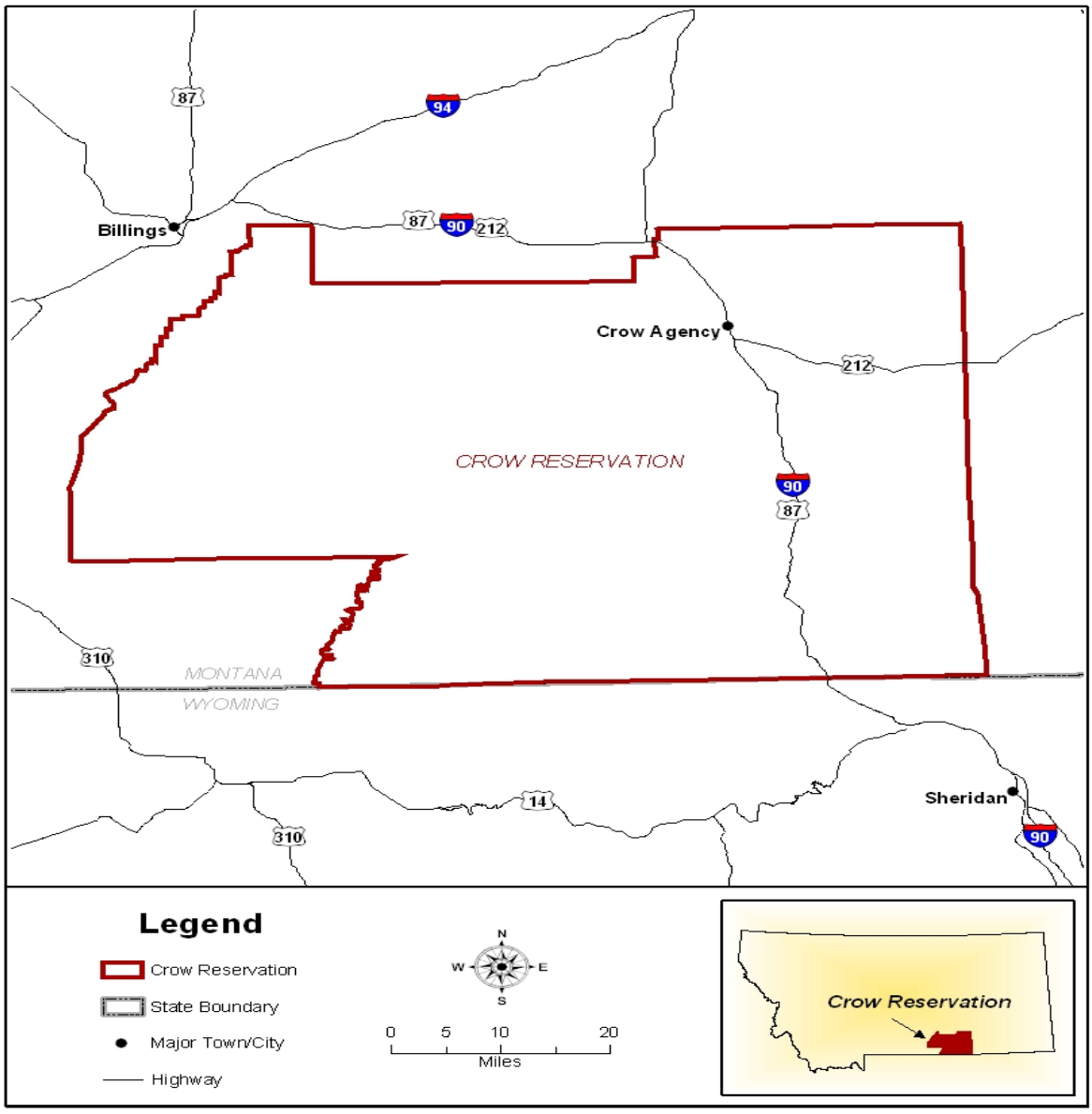
Crow Indian Reservation

The Crow Indian Reservation is approximately 60 miles wide and 40 miles in length and is the largest of Montana's seven reservations. The reservation encompasses nearly 2.3 million acres of land in south-central Montana and is located in Bighorn and Yellowstone Counties. The reservation is bordered by Wyoming on the south and the Northern Cheyenne Reservation on the east with its northwestern boundary approximately 10 miles from Billings, Montana. The Reservation is entirely rural with the largest settlement being *Crow Agency*, which contains the Tribal Government, Bureau of Indian Affairs (BIA), and the Little Big Horn College.

Major Highways though the reservation include Interstate 90 (I-90) which extends North to east nearly 45 miles from the reservation boundary near Hardin, Montana to the Wyoming border. U.S. Highway 85 and Burlington Northern Santa Fe Rail Road parallels the interstate. To the east U.S. Highway 212 connects Crow Agency with the Northern Cheyenne Indian Reservation.

The Crow Tribe owns 18 percent of the reservation with individual tribal members owning 50 percent through individual allotments. Non-Indians own 32 percent of the land within the reservation boundaries. Land uses include livestock grazing, irrigated and dry land crop production, forestland, and developed areas for communities and natural resource production. Approximately 68 percent of the reservation is grazing rangeland, 12 percent is dry cropland, 3 percent is irrigated cropland, 15 percent is forested, 1 percent is wild land, and 1 percent is developed areas. Figure 2 shows the location of the Crow Indian Reservation in Montana.

Figure 2. Crow Indian Reservation Location Map



EMISSIONS FROM ROCKY BOY'S

Emissions sources on the Rocky Boy's Reservation were categorized as *Area*, *Mobile*, and *Biogenic* sources. Each category was then further broken down to the individual emissions sources. The following discussion describes the methodology used to estimate emissions from these individual sources. A table of criteria pollutant emissions from the reservation will then follow at the end of the section. A search and evaluation of emissions sources revealed the following:

- External Combustion Sources
  - Liquid Petroleum Gas
  - Residential Wood Stoves
- Food and Agriculture Industries
  - Harvesting Operations
  - Pesticide Application
  - Tilling Operations
- Petroleum Industry
  - Transportation and Marketing of Petroleum Liquids
- Miscellaneous Sources
  - Wildfires and Prescribed Burning
  - Particulate Emissions From Paved Roads
  - Particulate Emissions From Unpaved Roads
- Biogenic Sources
- Mobile Sources

Table 1 shows the estimated emissions by source category for the Rocky Boy's Indian Reservation.

Table 1. Rocky Boy's Reservation Emissions by Source

Tons in 2002

Source	NOx	SO_2	$PM_{2.5}$	PM_{10}	Lead	CO	VOC	NH3
Residential wood stove combustion	0.49	0.07	5.05	5.32	-	40.11	5.21	-
LPG combustion	3.06	1.57	0.09	0.09	-	0.42	0.07	-
Wheat Harvesting operations	-	-	negligible	negligible	-	-	-	-
Tilling operations	-	-	11.16	14.11	-	-	-	-
Pesticide application	-	-	-	-	-	-	13.33	-
PM emissions from paved roads	-	-	0.07	0.29	-	-	-	-
PM emissions from un-paved roads	-	-	2.34	16.02	-	-	-	-
Transportation and marketing of petroleum liquids	-	-	-	-	-	-	1.27	-
On-road Mobile sources	86.69	2.57	2.41	16.31	-	1,797.97	133.37	2.45
Wild fires	65.64	-	241.81	241.81	-	2297.41	393.84	-
Prescribed burning	-	-	166.10	267.78	-	1714.16	-	-
Biogenic sources	66.60	-	-	-	-	213.70	965.20	-
Total	**222.48**	**4.21**	**429.03**	**561.73**	**-**	**6,063.77**	**1,512.29**	**2.45**

Rocky Boy's Reservation External Combustion Sources

External combustion sources on Rocky Boy's Reservation include the residential and commercial combustion of Liquid Petroleum Gas (LPG) and wood.

Two LPG venders supplied propane to both residential and commercial users on the Rocky Boy's Reservation. Once these sales quantities were received, AP-42 emissions factors were used to calculate emissions.

The Chippewa Cree Housing Authority reported the number of homes on the reservation that use wood stoves as a secondary heating source. The results of a wood burning study in a nearby municipality was used as the basis for estimating the quantity and type of wood that is likely burned in reservation homes. The AP-42 emissions factors were then used to calculate the emissions due to wood combustion in residential wood stoves.

Rocky Boy's Reservation Food and Agriculture Industry

Emissions from the food and agricultural industries on Rocky Boy's Reservation originate from harvesting operations, pesticide application, and tilling of fields.

Much of the reservation lands are agricultural with grazing the predominate land use. Emissions from cropland operations were calculated. Field crops, chemical application, and fallow fields data where obtained through the Montana Agriculture Statistics Service (MASS) agricultural records for the county in which the reservation is located, personal communications with the reservation's liaison to the Natural Resource Conservation Service (NRCS), and personal communications with the Montana

NRCS. AP-42 emission factors were used to calculate volatile organic carbon (VOC) emissions from pesticides and particulate (PM) emissions from harvesting operations. The NEI procedures document provided the methodology for estimating PM emissions from tilling operations.

Rocky Boy's Reservation Petroleum Industry Sources

The Methodology used to calculate emissions from the transportation and marketing of petroleum products on the Rocky Boy's Reservation was similar to that used for the Crow Indian Reservation. Gasoline and diesel sales on Rocky Boy's Reservation were obtained from the Montana Department of Transportation (MDT) and VOC emissions due to the transportation and marketing of these fuels were calculated using the AP-42 emissions factors.

Rocky Boy's Reservation Mobile sources

Emissions form mobile sources on the Rocky Boy's Reservation were calculated for on-road mobile sources. There are no known significant non-road mobile sources (i.e. railroads) located on the reservation. The methodology used to calculate emissions from on-road mobile sources are similar to those used on the Crow Indian Reservation.

Motor vehicles are the most abundant mobile sources on the reservation. Characterization data of vehicles, roads, and traffic patterns needed to be obtained before estimates could be made for on-road mobile source emissions. The MDT and the Bureau of Indian Affairs (BIA) division of transportation provided road characterization and vehicle traffic patterns including Average Daily Traffic (ADT) counts. Weights and classes of vehicles were estimated using nearby MDT continuous count station data. The reservation roads were then separated into segments depending on their characteristics. The MOBILE6 model was used to create emissions factors appropriate for estimated vehicle speeds. The road characteristics were used to estimate speed and further define the fleet for the model. Once the emissions factors were generated they were multiplied by the Vehicle Miles Traveled (VMT), which is the ADT multiplied by the length in miles of that road segment. This process generated the emissions per road segment.

Rocky Boy's Reservation Miscellaneous sources

Miscellaneous sources on Rocky Boy's Reservation include particulate emissions from paved roads, particulate emissions from unpaved roads, and emissions from wildfires and prescribed burning.

Particulate matter (PM) emissions on the reservation due to vehicle traffic over paved roads were calculated using AP-42 emissions factors. Fleet characteristics were estimated using the mobile source techniques discussed previously. The formula for paved-roads given in AP-42 generated PM emissions factors for each road segment in units of grams/VMT. Multiplying these emissions factors by the VMT of each road segment provided the emissions estimate per road segment. PM emissions due to vehicle traffic over non-paved roads where calculated using the formula for non-paved roads given in AP-42. The generated PM emissions factors where applied to the appropriate road segment in the same manner as that for paved-roads.

The Chippewa Cree Tribe's Natural Resource Department provided acreages consumed by wildfires on the reservation for the base year. Fuel loading judgments were made and applied to AP-42 emissions factors. The Natural Resource Department also provided acreage for prescribed burning with estimates of percent grassland and percent pine. Fuel loading judgments were made and the appropriate AP-42 emissions factors were used to calculate emissions due to prescribed burning operation on the reservation.

Rocky Boy's Reservation Biogenic Sources

The EPA has prepared county-level biogenic emissions estimates that may be used by states as a default estimate. The states may also submit new or revised estimates. By proportioning the county estimates for those counties sharing land with the reservation, the reservation estimates were generated for the Rocky Boy's Reservation.

EMISSIONS FROM CROW

Emissions sources on the Crow Indian Reservation were categorized as *Area, Mobile*, and *Biogenic* sources. Each category was then further broken down to the individual emissions sources. The following will describe the methodology used to estimate emissions from these individual sources. A table of criteria pollutant emissions from the reservation will then follow at the end of this section. A search and evaluation of sources of emissions revealed the following:

- External Combustion Sources
  - Liquid Petroleum Gas
  - Natural Gas
  - Coal
  - Residential Wood Stoves
- Food and Agriculture Industries
  - Harvesting Operations
  - Pesticide Application
  - Tilling Operations
- Biogenic Sources
- Petroleum Industry
  - Transportation and Marketing of Petroleum Liquids
- Solid Waste Disposal
  - Landfill Gas
- Mobile Sources
  - On-Road Sources
  - Non-Road Sources
- Miscellaneous sources
  - Particulate Emissions From Paved Roads
  - Particulate Emissions From Unpaved Roads
  - Wildfires and Prescribed Burning

Table 2 shows the estimated emissions of criteria pollutants by source category for the Crow Indian Reservation.

Table 2. Crow Indian Reservation Emissions by Source

Tons in 2002

Source	NOx	SO_2	$PM_{2.5}$	PM_{10}	Lead	CO	VOC	NH3
Natural gas combustion	4.16	0.03	0.33	0.33	-	2.66	0.24	-
Coal combustion	5.54	10.36	4.15	8.31	0.01	3.15	-	-
Residential wood stove combustion	1.88	0.05	3.54	4.12	-	31.05	4.04	-
LPG combustion	8.61	4.43	0.25	0.25	-	1.17	0.18	-
Fuel oil combustion	0.67	0.24	0.03	0.04	-	0.17	-	-
Wheat Harvesting operations	-	-	negligible	0.01	-	-	-	-
Tilling operations	-	-	30.30	94.55	-	-	-	-
Pesticide application	-	-	-	-	-	-	5.23	-
PM emissions from paved roads	-	-	0.61	2.64	-	-	-	-
PM emissions from un-paved roads	-	-	4.75	32.48	-	-	-	-
Transportation and marketing of petroleum liquids	-	-	-	-	-	-	18.35	-
On-road Mobile sources	3,355.36	8.19	5.35	35.12	-	7,501.94	354.21	4.38
Non-road mobile sources	527.18	30.02	11.77	13.08	-	51.93	19.62	-
Wild fires	1,040.93	-	3,204.44	3,465.45	-	36,432.66	6,245.60	-
Prescribed burning	-	-	18.10	21.12	-	618.59	-	-
Landfill gas	-	-	-	-	-	-	2.09	-
Biogenic sources	1,125.53	-	-	-	-	4,361.17	37,739.99	-
Point Source	202.04	0.03	-	0.52	-	-	6.50	-
Total	**6,271.91**	**53.35**	**3,278.26**	**3,642.89**	**0.01**	**49,004.49**	**44,393.95**	**4.38**

Crow Reservation External Combustion Sources

External combustion sources on the Crow Indian Reservation include the residential and commercial combustion of LPG, natural gas, coal, and wood. There is one point source located on the reservation is engaged in the compression of natural gas.

Without performing an intensive search, reliable information could not be obtained for residential sales, related to home heating by means of coal, fuel oil, and LPG. A utility company supplied natural gas sales for the reservation. Additionally this utility categorized the sales into residential and commercial use. The number of homes using natural gas was obtained from the reservation census. Natural gas used per home could now be easily calculated. The heat equivalent of the natural gas used per home became the basis for the other fuels used in the other non-natural gas

homes (the number of coal, fuel oil, wood, and LPG-heated homes are also in the census). Coal and natural gas used commercially was obtained from vendors. The AP-42 emissions factors where then used to calculate emissions from combustion of natural gas, coal, fuel oil, and LPG.

Crow Reservation Food and Agricultural Industry

Emissions from the food and agricultural industries on the Crow Indian Reservation are from harvesting operations, pesticide application, and tilling of fields.

Field crops, chemical application, and fallow fields data were obtained through the MASS agricultural records for Big Horn County (Big Horn County makes-up most of the reservation and provides good representation of its agricultural practices), personal communications with the reservations natural resource department, and personal communications with the Montana NRCS. The AP-42 emission factors were used to calculate VOC emissions from pesticides and PM emissions from harvesting operations. The NEI procedures document provided the methodology for estimating PM emissions from tilling operations.

Crow Reservation Biogenic Sources

The EPA has prepared estimated 2002 county-level biogenic emissions defaults to be used by the states. Alternately, the states may submit new or revised estimates. By proportioning these county estimates, the reservation estimates were generated.

Crow Reservation Petroleum Industry Sources

Emissions from the petroleum industry were limited to the transportation and marketing of petroleum liquids. Gasoline and diesel sales on the Crow Indian Reservation were obtained from the MDT. VOC emissions due to the transportation and marketing of these fuels were calculated using the AP-42 emissions factors.

Crow Reservation Solid Waste Disposal

The Crow Indian Reservation operates a Class II municipal landfill. The Montana Department of Environmental Quality (DEQ) provided the landfill's capacity and waste stream flow from conception through 2002. VOC emissions from landfill gas were calculated using EPA's landfill Gas Emissions Model, Version 2.0.

Crow Reservation Mobile Sources

Emissions form mobile sources on the Crow Indian Reservation were from on-road and non-road mobile sources.

The reservation's non-road mobile sources are from the 63 miles of the Burlington Northern / Santa Fe Railroad running through it. The NEI reported emissions of this source for counties within the reservation. The emissions for the reservation were estimated by applying the appropriate ratio to the NEI report of the county of concern (Bighorn County).

Mobile sources most abundant on the reservation are motor vehicles. Characterization of vehicles, roads, and traffic patterns needed to be obtained before estimates could be made for on-road mobile source emissions.

The MDT and the BIA division of transportation provided road characterization and vehicle traffic patterns including ADT traffic counts. Weights and classes of vehicles were estimated using nearby MDT continuous count station data. The reservation roads were separated into segments depending on their characteristics and EPA's model, MOBILE6, was used to create emissions factors per vehicle speed conditions. Road characteristics were used to estimate speed and further define the fleet for the model. Once the emissions factor was generated it was multiplied by the VMT, which is the ADT multiplied by the length in miles of that road segment. This process generated the emissions per road segment.

Crow Reservation Miscellaneous sources

Miscellaneous sources on the Crow Indian Reservation include particulate emissions from paved roads, particulate emissions from unpaved roads, and emissions from wildfires and prescribed burning.

Particulate emissions on the reservation due to vehicle traffic over paved roads were calculated using the AP-42 emissions factors. Fleet characteristics were estimated using the procedure for mobile sources detailed above. The formula for paved-roads given in AP-42 generated PM emissions factors for each road segment in units of grams/VMT. Multiplying these emissions factors by the VMT of each road segment provided the emissions per road segment. Particulate emissions due to vehicle traffic over non-paved roads where calculated using the formula for non-paved roads given in the AP-42. The calculated PM emissions factors where then applied to the appropriate road segment in the same manner as that for paved-roads.

The National Interagency Fire Center (NIFC) in Boise, ID provided acreages, both non-forested and forested, consumed by wildfires on the Crow Indian Reservation for the base year. Fuel loading judgments were made and applied to AP-42 emission factors. The NIFC also provided acreage for prescribed burning on the reservation during the base year. The appropriate AP-42 emissions factors were used to calculate emissions due to prescribed burning on the reservation.

SUMMARY OF RESULTS

The emissions estimate for Rocky Boy's indicates that on-road mobile sources contribute significant amounts of criteria pollutants and including the most nitrogen oxides (NOx) as a source category. Emissions from non-road mobile sources were not collected for the Rocky Boy's Reservation because data was not available to define these sources. Non-road sources include recreational vehicles, farm equipment, lawn mowers and other miscellaneous equipment. For VOC emissions, the data indicates that biogenic emission sources are the largest contributor. Area sources yield the highest particulate emissions as a source category and the most carbon monoxide (CO).

Table 3 shows the total estimated emissions by source category and pollutant for the Rocky Boy's Reservation. The table also shows the total pollutants emitted by point sources located within 50 miles of the reservation boundary. All of the point sources identified near the reservation boundary with the exception of one crematorium are engaged in the processing and transmission of natural gas or LPG.

Table 3. Rocky Boy's Emissions by Source Category and Pollutant (Tons)

Source Category	NO_X	SO_2	$PM_{2.5}$	PM_{10}	Pb	CO	VOC	NH_3
Area	69.19	1.64	426.62	545.42	N/A	4052.10	413.72	N/A
On-road Mobile*	86.69	2.57	2.41	16.31	N/A	1,797.97	133.37	2.45
Biogenic	66.60	N/A	N/A	N/A	N/A	213.70	965.20	N/A
Total	**222.48**	**4.21**	**429.03**	**561.73**	**N/A**	**6,063.77**	**1,512.29**	**2.45**
Total Near Reservation Point Source	**1,327.87**	**1.11**	**3.29**	**3.38**	**N/A**	**353.58**	**169.43**	**N/A**

*Insufficient data was available to characterize non-road mobile sources on the Rocky Boy's Reservation.

The emissions estimates for the Crow Reservation indicate that area sources contribute the most criteria pollutants as a source category including emissions of $PM_{2.5}$, PM_{10} and CO. The proportionally large amount of CO emitted by area sources is attributed to wildfire and prescribed burning during the inventory year. Over 8,000 acres of forested wildlands were consumed by fire in 2002. Biogenic sources contributed the highest quantity of VOC's as a source category and mobile sources contribute the most NOx as a source category. Table 4 shows the total estimated emissions by source category and criteria pollutant for the Crow Indian Reservation. The table also shows the total pollutants emitted by Montana point sources located within 50 miles of the reservation boundary.

Several point sources located in Wyoming were identified within 50 miles of the reservation boundary, but Wyoming point source emissions data was not readily available for inclusion in the estimate. The point sources identified near the reservation boundary are engaged in a variety of industrial activities including the processing and transmission of natural gas or LPG, petroleum products refining, smelting, coal mining, electric power generation, and grain processing.

Table 4. Crow Emissions by Source Category and Pollutant (Tons)

Source Category (tons/year)	NO_X	SO_2	$PM_{2.5}$	PM_{10}	Pb	CO	VOC	NH_3
Area	1,061.80	15.11	3,266.49	3,594.17	0.01	37,089.45	6,273.63	N/A
Mobile*	3,882.54	38.21	11.77	48.2	N/A	7,553.87	373.83	4.38
Point	202.04	0.03	N/A	0.52	N/A	N/A	6.50	N/A
Biogenic	1,125.53	N/A	N/A	N/A	N/A	4,361.17	37,739.99	N/A
Total	**6,271.91**	**53.35**	**3,278.26**	**3,642.89**	**0.01**	**49,004.49**	**44,393.95**	**4.38**
Total Near Reservation Point Source	**39,197.55**	**32,283.65**	**99.99**	**3,238.46**	**2.96**	**7,032.03**	**3,729.32**	**1.19**

*Includes PM emissions from unpaved roads and railroad (non-road) mobile emissions.

RECOMENDATIONS

Residential Wood Stoves

The EI data indicates that residential wood stoves may be a significant contributor on both the Rocky Boy's and Crow Indian reservations. Emissions estimates are based on AP-42 emissions factors and tribal estimates of the use of wood burning as a secondary heat source. More accurate data regarding the number of wood stoves, amount of wood burned per year, and age and condition of wood stoves would improve the quality of this estimate. This data can be collected by conducting a survey similar to the *Residential Wood Burning Survey in Great Falls, Montana* (Ganesan 1997) and verified by census data.

Paved and Unpaved Roads

Area emissions from paved and unpaved roads are a significant source of PM emissions on the reservations and mobile sources are significant NOx and CO emitters. Improving ADT estimates will lead to more accurate prediction of paved road emissions, the unpaved road emissions, and the mobile source emissions. The ADT is the most significant emissions factor in these categories and therefore vital in the estimation of emissions. In many cases reservation ADT data is several years old and scaled for population growth. Two methods are recommended to significantly improve ADT estimates for roads on the reservations.

First, increasing the number of stations that have traffic counts by adding traffic counts on many of the secondary roads throughout the reservation would improve the estimates. Because of the largely rural setting of the reservations, there is a significant amount of traffic on un-paved roads that is often not quantified by traffic counting. Area PM emissions from unpaved roads are significant and conducting traffic counts on these roads would improve EI quality. Including a breakdown of vehicle types into the eight categories that are listed in EPA's emission estimating programs such as MOBILE6 during the traffic counts would also significantly improve EI quality.

In coming years, the BIA Roads department will be placing more vehicle counters and gathering more precise information that will greatly improve accuracy of their road inventory. The ability to apply a grid to the on-road mobile sources will greatly improve due to the BIA, Roads Department plan for digitizing all the roads using satellite receiver navigation equipment (Walker 2004).

Prescribed Burning and Wildfire

Prescribed burning is often used as a natural resource management tool on the reservations and can be a significant component of air pollutant emissions and local air quality impacts. Emissions due to fire vary widely according to type of fuel, weather conditions, ignition techniques, and amount of fuel consumed. In many cases, the percent of woody material versus grassland or riparian acreage and other basic data is not available. Fuel inventories which would provide fuel composition data are generally not available on the reservations. More specific information regarding these fire parameters should be recorded through management tools (fuels inventories) and during the actual controlled burn or wildfire (weather conditions). This data would improve the quality and applicability of emissions estimates.

Non-Road Mobile Sources

Emission estimates for non-road mobile sources were not provided in these inventories with the exception of a rail segment located on the Crow Reservation because sufficient data was lacking to make even a conservative estimate of emissions. Due to the rural environment and demographics of the reservations, studies performed in other locations would correlate poorly with reservation conditions. Further study of reservation household and farm equipment (agricultural, lawn, garden, and recreational) is recommended so that estimates of emissions may be performed for this source category. The model, manufacturer, fuel, engine type and run-time each year are examples of data that would be useful in calculating emissions from non-road mobile sources.

CONCLUSIONS

In conclusion, the Rocky Boy's and Crow Indian Reservation emissions inventories show results consistent with the rural non-industrialized environment present. Emissions from mobile sources account for the majority of priority pollutant emissions at Rocky Boy's while area source emissions are the greatest contributor at Crow. Extensive agricultural development accounts for the area source emissions on the Crow Reservation. Biogenic emissions of VOC's, CO and NOx are significant on both reservations. Neighboring point source emissions are significant and in some cases (NOx and SO_2) exceed the reservation-generated emissions.

Estimate improvements may be realized by further study and surveys for specific source categories. Conducting a survey to verify the cord wood quantity, cord wood composition, wood stove age, and wood stove condition would improve the quality of residential wood heating emissions estimates. Additional and more current ADT data for paved and unpaved roads would improve the quality of area emissions calculations from these sources. Wildfire and controlled burn emissions have been significant in recent years, but on-reservation fuels inventories are generally lacking. Fuels inventories would provide important fuel type and distribution information for improving the quality of emissions estimates. Non-road mobile emissions data is lacking because of the lack of data for the reservations. Household and agricultural surveys would provide important data for improving these emissions estimates.

REFERENCES

Ganesan, K., Montana Tech of the University of Montana, Butte, MT. July 1997. *Residential Wood Burning In Great Falls, Montana*.

Montana Natural Resources Conservation Service. *Montana Soil Data* [Data base available online]. Data downloaded February 2004, http://nris.state.mt.us/nrcs/soils.

U.S. Environmental Protection Agency, Air and Radiation, Office of Mobile Sources. June 1998. *Update of Fleet Characterization Data for Use in MOBILE6 – Final Report.*

U.S. Environmental Protection Agency, Assessment and Standards Division, Office of Transportation and Air Quality. August 2003. *MOBILE6.2 Vehicle Emission Modeling Software.*

U.S. Environmental Protection Agency, Assessment and Standards Division, Office of Transportation and Air Quality. January 2002. Technical Guidance on the Use of MOBILE6 for Emissions Inventory Preparation.

U.S. Environmental Protection Agency, Assessment and Standards Division, Office of Transportation and Air Quality. October 2002. *User's Guide to MOBILE6.1 and MOBILE6.2: Mobile Source Emission Factor*.

U.S. Environmental Protection Agency, EPA 454/C-03-001 Version 10 [Public software containing AP-42]. January 2003. *Air Chief Emissions Factor and Inventory Group EMAD/OAQPS.*

U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emissions, Monitoring and Analysis Division, Emissions Factor and Inventory Group (D205-01). Prepared by: E.H. Pechan & Associates, Inc. March 2004. *DOCUMENTATION FOR THE 2002 NONPOINT SOURCE NATIONAL EMISSION INVENTORY FOR CRITERIA AND HAZARDOUS AIR POLLUTANTS (JANUARY 2004 VERSION).*

KEYWORDS
Average Daily Traffic Count (ADT)
Bureau of Indian Affairs (BIA)
Carbon Monoxide (CO)
Clean Air Act (CAA)
Indian Country
Emissions Inventory (EI)
Environmental Protection Agency (EPA)
Liquid Petroleum Gas (LPG)
Montana Agriculture Statistics Service (MASS)
Montana Department of Environmental Quality (MDEQ)
Montana Department of Transportation (MDT)
Montana Natural Resources Information System (NRIS)
National Emissions Inventory (NEI)
National Interagency Fire Center (NIFC)
Natural Resource Conservation Service (NRCS)
Nitrogen Oxides (NOx)
Particulate Matter (PM)
Reservations
Sulfur Dioxide (SO_2)
Tribes
Vehicle Miles Traveled (VMT)
Volatile Organic Carbon (VOC)