DRAFT
AIR QUALITY MODELING REPORT
SNOWMOBILE AND SNOWCOACH EMISSIONS

WINTER USE PLAN
Supplemental Environmental Impact Statement

YELLOWSTONE NATIONAL PARK

Prepared for

NATIONAL PARK SERVICE
12795 West Alameda Parkway
Lakewood, Colorado 80225-0287

Prepared by

AIR RESOURCE SPECIALISTS, INC.
1901 Sharp Point Drive, Suite E
Fort Collins, Colorado 80525

June 28, 2012

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

TABLE OF CONTENTS (CONTINUED)

LIST OF FIGURES

Air Quality Modeling Report
Winter Use Plan Supplemental Environmental Impact Statement
Yellowstone National Park

1.0 Introduction and Background

In support of the Winter Use Plan Supplemental Environmental Impact Statement (SEIS) for Yellowstone National Park (Yellowstone), Air Resource Specialists, Inc. (ARS) completed an analysis of potential air quality impacts from snowmobile and snowcoach operations. This report analyzes potential air quality impacts for several alternatives utilizing air dispersion modeling and other accepted methods and models. Motorized over-snow vehicle (OSV) vehicle entry limits and other details for each of the alternatives were provided by NPS to ARS and are discussed in Section 3.0 and Appendix A. This air quality study is part of the National Park Service's (NPS) efforts to complete a long-term analysis of the environmental impacts of winter use in the parks.

Within Yellowstone, all snowmobiles must also meet Best Available Technology (BAT) requirements. The assessment of alternatives analyzed in this study is based on implementation of the associated entry limits and BAT requirements under consideration in the PDEIS, and beginning during the winter season of 2011-2012, which determines emissions factors.

For this air quality study of OSV emissions in Yellowstone, maximum predicted ambient concentrations of carbon monoxide (CO), nitrogen dioxide (NO_2), and particulate matter (PM_{10} and $PM_{2.5}$) were calculated using U.S. Environmental Protection Agency (EPA) approved air quality models. Impacts for each alternative were assessed with respect to the National Ambient Air Quality Standards (NAAQS). Modeling results were also compared to Prevention of Significant Deterioration (PSD) increments for particulate matter, and potential visibility impacts for each alternative were assessed. Winter-season emission estimates for criteria pollutants (CO, PM, and nitrogen oxides (NO_x)), hydrocarbons (HC), and hazardous air pollutants (HAPs) (benzene, 1,3 butadiene, formaldehyde, and acetaldehyde) were calculated. The methodology employed for this study is discussed in the following sections.

2.0 Regulatory Overview

Yellowstone is classified as a Class I area under the Federal Clean Air Act. This air quality classification is to provide protection against air quality degradation in national parks and wilderness areas. The Clean Air Act defines mandatory Class I areas as national parks over 6,000 acres, wilderness areas over 5,000 acres, and national memorial parks over 5,000 acres designated as of the date of the Act.

For this study, dispersion modeling was utilized to predict concentrations of CO, nitrogen dioxide (NO_2), and particulates (PM_{10} and $PM_{2.5}$) for a short-term localized basis at specific locations in the parks. These predicted concentrations were assessed with respect to the NAAQS, which are discussed below, to determine the potential for air quality impacts. In addition, an emission inventory was completed for the four (4) pollutants discussed below to assess regional OSV emissions during the winter season. Also, as a Class I area, an analysis of potential visibility impacts resulting from OSV emissions was conducted for four (4) areas. The methodology and results of this visibility analysis are presented in Section 8.0.

In 2002, EPA adopted new standards for new non-road engines, including snowmobiles, which were previously unregulated. As a significant source of air pollution, newly manufactured non-road engines will need to meet exhaust emission standards. For snowmobiles, the new HC and CO standards began to take effect for the 2006 model year, with a 50 percent phase-in requirement. Further details on these standards are provided below in Section 4.0.

2.1 Pollutants

Carbon monoxide (CO), a colorless, odorless, and poisonous gas, is produced in locations with motor vehicles, primarily by the incomplete combustion of gasoline and other fossil fuels. Health effects include impairment of the central nervous system, particularly on people with heart disease. CO also interferes with the transport of oxygen in the blood. In the vicinity of roadways, the majority, if not all, CO emissions are from motor vehicles. CO concentrations can vary greatly over relatively short distances. Elevated concentrations are usually limited to locations near crowded intersections, typically along heavily traveled and congested roadways.

Consequently, CO concentrations must be predicted on a localized or microscale basis. Elevated traffic volumes of snowmobiles and snowcoaches on certain park roadways could result in localized increases in CO levels. Therefore, the mobile source analysis evaluated CO concentrations from snowmobiles and snowcoaches at several modeling locations within the park.

Particulate matter (PM_{10} and $PM_{2.5}$) is emitted into the atmosphere from a variety of sources: industrial facilities, power plants, construction activity, etc. Gasoline powered vehicles typically do not produce any significant quantities of particulate emissions. Although less relevant to this study, diesel-powered vehicles, especially heavy trucks and buses, also emit particulates, and particulate concentrations may be locally elevated near roadways with high volumes of heavy diesel-powered vehicles. The mobile source analysis evaluated particulate (PM_{10} and $PM_{2.5}$) concentrations from snowmobiles, snowcoaches, and diesel buses (for one alternative) at several modeling locations within the park.

Hydrocarbon (HC) emissions from motor vehicles can result from partially-burned fuel emitted through the tailpipe and from fuel evaporations from the crankcase, carburetor and gas tank. Hydrocarbons are also released from gasoline fuel vapor when vehicles are re-fueled at gas stations and when bulk storage tanks are refilled. When exposed to sunlight, hydrocarbons or volatile organic compounds (VOCs) contribute to formation of harmful ground level ozone, also known as smog. For the purposes of this study, hydrocarbons may also be expressed as VOCs, which include air toxins or hazardous air pollutants (HAPs). Within the park, these pollutants are of primary concern due to their potential serious health effects on NPS workers and visitors.

Air toxins or HAPs associated with motor vehicles also result from fuel evaporation and the fuel-burning process. These pollutants include a variety of chemicals known to cause cancer, poisoning and other ailments. The emission inventory completed for this study included hydrocarbon emissions as well as the following HAPs: benzene; 1,3 butadiene; formaldehyde; and acetaldehyde.

Nitrogen oxides (NO_x), are typically of principal concern because of their role as precursors in the formation of photochemical oxidants, such as ozone. Ozone is formed through a series of reactions that take place in the atmosphere in the presence of sunlight. However, ozone is not an issue in the parks in the winter, although NO_x also contributes to atmospheric particles, and can cause respiratory problems and visibility impairment. NO_x emissions from mobile sources and the pollutants formed from NO_x can be transported over long distances, so they are generally examined on a regional basis and are assessed in the emission inventory component of this study. However, on a localized basis, the mobile source analysis evaluated NO_2 concentrations from snowmobiles and snowcoaches at several modeling locations within the park, for comparison to the 1-hour NAAQS.

2.2 Air Quality Standards

As required by the Clean Air Act and its amendments, the Environmental Protection Agency has established primary and secondary National Ambient Air Quality Standards (NAAQS) for six major air pollutants: CO, NO_2, ozone, particulate matter (PM_{10} and $PM_{2.5}$), SO_2, and lead. The NAAQS of primary concern for this analysis (CO, NO_2, PM_{10} and $PM_{2.5}$) are shown in Table 2-1.

The primary standards protect public health, and represent levels at which there are no known significant effects on human health. The secondary standards are intended to protect the nation's welfare, and account for air pollutant effects on soil, water, visibility, materials, vegetation, and other aspects of the environment. For CO, NO_2, PM_{10} and $PM_{2.5}$, the primary and secondary standards are the same.

Impacts for each alternative were assessed with respect to the NAAQS and relative to current and historical conditions. For Wyoming, Montana, and Idaho, the applicable state standards for CO, NO_2, and particulates are the same as the federal standards, with the exception of the 1-hour CO standard in Montana, which is 23 ppm.

Since Yellowstone is classified as Federal Class I area, PM_{10} increment comparison under PSD was also assessed. PSD increments are the maximum permitted increases in pollutant concentrations over baseline levels. For Class I areas, the PM_{10} PSD increments are 4 and 8 micrograms per cubic meter, for the annual and 24-hour

Table 2-1
National Ambient Air Quality Standards

Pollutant	Primary		Secondary	
	PPM	Micrograms Per Cubic Meter	PPM	Micrograms Per Cubic Meter
Carbon Monoxide (CO)			None	
Maximum 8-Hour Concentration[1]	9			
Maximum 1-Hour Concentration[1]	35			
Nitrogen Dioxide (NO_2)				
Annual Arithmetic Mean	0.053		Same as Primary	
Maximum 1-Hour Concentration[2]	0.100			
Respirable Particulates (PM_{10})				
Maximum 24-Hour Concentration[3]		150	Same as Primary	
Respirable Particulates ($PM_{2.5}$)				
Annual Arithmetic Mean[4]		15	Same as Primary	
Maximum 24-Hour Concentration[5]		35		

Notes:
1 Not to be exceeded more than once per year.
2 To attain this standard, the 3-year average of the 98th percentile of the daily maximum 1-hour average at each monitor within an area must not exceed 100 ppb (effective January 22, 2010).
3 Not to be exceeded more than once per year on average over 3 years.
4 To attain this standard, the 3-year average of the weighted annual mean $PM_{2.5}$ concentrations from single or multiple community-oriented monitors must not exceed 15.0 ug/m^3.
5 To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 ug/m^3.
PPM = parts per million

Source: 40 CFR Part 50—National Primary and Secondary Ambient Air Quality Standards

averaging periods, respectively. Winter OSV emissions were considered increment consuming or contributing sources for this analysis. This study only assessed PSD increments for the 24-hour averaging period, since the sources of concern are only present during the winter season and an applicable annual average cannot be prepared. This assessment is a screening level approach and may indicate that a detailed analysis is required if concentrations are near the PM_{10} PSD increments. Furthermore, as the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis.

2.3 Air Quality Monitoring

In recent years, ARS has been contracted by NPS to conduct winter air quality monitoring in Yellowstone near the Old Faithful geyser. Meteorological, gaseous, and particulate variables were monitored continuously.

The most recent monitored CO and $PM_{2.5}$ concentrations at these locations can be found in the *Data Transmittal Report for the Yellowstone National Park Winter Use Air*

Quality Study December 15, 2009 - March 15, 2010, Air Resource Specialists, July 2010. The highest CO 1- and 8-hour averages were 2.5 and 0.8 ppm, respectively, at the Old Faithful monitor for 2009-2010. These were well below the respective 1- and 8-hour CO NAAQS (35 and 9 ppm), Montana and Wyoming air quality standards. Similarly, the highest $PM_{2.5}$ 24-hour average in 2009-2010 was 5.1 micrograms per cubic meter at the Old Faithful monitor, which was well below the $PM_{2.5}$ NAAQS of 35 micrograms per cubic meter for the 24-hour averaging period.

Since monitoring began in 1998 for CO and in 2002 for $PM_{2.5}$ at Yellowstone, measured pollutant concentrations have steadily decreased, consistent with the decrease in number of snowmobile visits and the recent snowmobile technology emission requirements under the temporary plan. As documented in the *Winter Air Quality Study 2004-2005*, John D. Ray, Ph.D., NPS Air Resources Division, December 2005, at the West Entrance, the highest measured 8-hour average CO concentrations have gone from a near NAAQS exceedance of 8.9 ppm in the 1998-1999 winter season to 1.0 ppm in 2004-2005. At Old Faithful, the highest measured 8-hour average CO concentrations have declined from 1.2 ppm in the 2002-2003 winter season to 0.8 ppm in 2009-2010.

Similarly, the highest measured 24-hour average $PM_{2.5}$ concentrations at Old Faithful have declined from 32.1 micrograms per cubic meter in the 2002-2003 winter season to 5.1 micrograms per cubic meter in 2009-2010. These monitored maximum values demonstrate a distinct trend of improvement in winter pollutant concentrations in Yellowstone.

3.0 Alternatives

OSV entry limits and other details of the alternatives required as inputs for the air quality modeling and emission inventory were provided by the National Park Service (NPS). Descriptions of the alternatives are provided in the SEIS. In addition, distribution factors spreadsheets are included as Appendix A of this report. A summary of the development of modeling scenarios analyzed in this study follows.

The development of a model to distribute use within the park, based on the entrance limits specified under each alternative, is necessary in order to understand the impacts of the alternatives on park resources and values. These models, called travel factors, were developed in the past for the Temporary Winter Use EA and the 2007 Plan/EIS. The scenarios attempt to predict the total amount of daily winter recreational (motorized) traffic on each road segment within Yellowstone, by vehicle type.

The scenarios provide both a sense of how much snowmobile or snowcoach traffic one can expect in a day on each road segment within the parks and a comparison of the relative differences among the alternatives. This approach facilitates an understanding of the magnitude of differences of the environmental consequences of each alternative. The alternatives also provide fundamental air quality inputs to the modeling analyses.

4.0 Mobile Source Modeling

Estimates of maximum concentrations for pollutant averaging periods were prepared to compare with the national ambient air quality standards (which are based on 1- and 8-hour averages for CO concentrations, 1-hour averages for NO_2 concentrations, and 24-hour averages for particulate concentrations). The prediction of CO, NO_2, PM_{10} and $PM_{2.5}$ concentrations generated by over-snow vehicles takes into account emissions data, meteorological phenomena, vehicle traffic/travel conditions, and physical configurations (of roadways and staging areas). The mathematical formulations that comprise the dispersion and emission models attempt to simulate the extremely complex physical phenomenon as closely as possible. Although most dispersion models are typically conservative, especially under adverse meteorological conditions, the results of the modeling below compared with monitored concentrations show predicted concentrations within the reasonable in range of possibility, considering that all models must employ approximations of actual conditions.

The analysis employs a modeling approach widely used for evaluating air quality impacts throughout the country. This approach was coupled with a series of conservative assumptions for meteorology, traffic conditions, background concentration levels, etc. This combination results in conservative, yet realistic, estimates of expected pollutant concentrations and resulting potential impacts to air quality from the winter use vehicle emissions.

4.1 Dispersion Modeling

Air dispersion modeling analyses were conducted for emissions of CO, NO_2, PM_{10}, and $PM_{2.5}$ employing EPA's CAL3QHCR and AERMOD models. The models and modeling inputs, parameters, and assumptions, along with emission factors are discussed in detail below.

4.1.1 CAL3QHCR

At the entrance stations and roadways selected for study, analysis was performed using EPA's CAL3QHCR model (*Addendum to the User's Guide to CAL3QHC, A Modeling Methodology for Predicting Pollutant Concentrations Near Roadway Intersections*, Office of Air Quality, Planning Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina). The CAL3QHCR model is an enhanced, but separate, version of CAL3QHC, which is based on the CALINE-3 line source dispersion model, with an additional algorithm for estimating vehicle queue lengths at signalized intersections. It is a Gaussian model utilized for predicting CO and PM concentrations along roadway segments and assumes the dispersion of pollutants downwind of a pollution source along a Gaussian (or normal) distribution. The pollution source is the emissions from motorized vehicles operating under free flow conditions. CAL3QHCR processes up to a year of meteorological data, vehicle emissions and traffic data using algorithms from CAL3QHC.

For this analysis, CAL3QHCR was run using the Tier II approach, with detailed data reflecting traffic conditions for each hour of the day and week. In addition to maximum hourly averages, CAL3QHCR is able to calculate running 8-hour averaged CO or 24-hour averaged PM concentrations. Similar to CAL3QHC, CAL3QHCR also provides the refinement of including the contribution of emissions from idling vehicles in the overall concentration. The model's queuing algorithm requires additional input for local traffic parameters, such as signal timing, and performs delay calculations to estimate the number of idling vehicles. In this study, locations with snowmobiles and snowcoaches stopping and idling were simulated with the characteristics of a signalized intersection for CAL3QHCR modeling.

4.1.2 AERMOD

Air pollutant concentrations from emissions at the snowmobile staging areas were evaluated with the AERMOD, developed by EPA. All modeling was performed using BEE-Line Software's BEEST suite, which integrates AERMOD (Version 12060), ISC, and related programs (AERMET, AERMAP, BPIP, etc.) into a graphical user interface. Since vehicles in the staging area are clustered (in the parking lots), the AERMOD model was selected, utilizing its area source dispersion modeling capabilities. All AERMOD technical options selected followed the *regulatory default option*.

Model inputs also specified rural conditions for dispersion coefficients and other variables. Terrain data for the park was obtained from United States Geological Survey (USGS) using The National Map Seamless Server website. Coordinates for the modeled area were input into a coordinate search in the National Map, in order to zoom into the site and 1-Arc Second National Elevation Dataset (NED) terrain files were downloaded as a Tagged Image File Format (TIFF) file for an area big enough to encompass the area to be modeled area.

4.2 Modeling Locations

Four (4) locations in the park were selected for air quality modeling because they were expected to generate the most elevated ambient air quality impacts associated with snowmobile and snowcoach operations, due to expected vehicle traffic levels. These locations (shown on Figure 4-1) are: Site 1, The West Entrance; Site 2, West Entrance to Madison Junction; Site 3, Canyon to Fishing Bridge; and Site 4, Old Faithful Staging Area. At the roadway modeling locations, multiple ground-level receptors (computer simulations of roadside locations) were modeled for CAL3QHCR along the approach and departure links at spaced intervals, outside of the mixing zone, the area of uniform emissions and turbulence. The receptor with the highest predicted concentration was used to represent each modeling site for each alternative.

Figure 4-1


Greater Yellowstone Area
Gardiner, MT
Cooke City, MT
North Entrance
Mammoth
Yellowstone
National Park
Norris
West
Yellowstone, MT
1
2
Canyon
Village
3
West Entrance
Madison
Lake
Village
Fishing
Bridge
East Entrance
To Cody, WY
West
Thumb
4
Old Faithful
Grant
Village
Cave
Falls
South
Entrance
Flagg Ranch
John D. Rockefeller, Jr.
Memorial Parkway
Jackson Lake
Grand
Teton
Nat'l Park
Moran Junction
Spatial Analysis Center
Yellowstone National Park
(307) 344-2246
February 18, 2003
N
Miles
0 5 10 15 20
Jackson, WY

Site 1: West Entrance

The West Entrance is a unique location for modeling as snowmobiles and snowcoaches approach the entrance station and then stop for a short time while entrance permits are checked. Vehicles experience delay and queuing traffic conditions. In addition, this location is in close proximity to West Yellowstone, MT. Modeling was performed based on an average "low speed" approach and departure and an average engine idle time of 30 seconds at each kiosk. The approach and departure paths of the vehicles were simulated by line sources or "links", up to 1,000 feet in each direction from the West Entrance. CAL3QHCR modeling was performed for this intersection-type location.

At the West Entrance modeling location, receptors were spaced oppositely in each direction out from a central receptor placed at the origin of the queuing links, with receptors placed in pairs on each side of the links. Receptors were placed 3 feet both east and west (lengthwise) of the central receptor; the next pair of receptors were placed 25 feet from the central receptor. The remaining receptors were placed at intervals of 25 feet out to a distance of 500 feet along the link.

Site 2: West Entrance to Madison

For many of the alternatives, this modeling location is expected to have the highest traffic volumes compared to other roadway segments in Yellowstone. This is expected to result in elevated emissions and associated impacts from snowmobile and snowcoach traffic. CAL3QHCR modeling was performed for the free-flow roadway segments of this location, employing emissions data for OSVs traveling at "cruise" speeds (see discussion of modes below). In winter, the speed limit for this road segment is 35 mph, whereas the limit is 45 mph for most of the park. As discussed above, vehicle traffic levels were based on the proposed entry limits in the winter use plan for each alternative.

For the West Entrance to Madison location, receptors were spaced along 2000 feet of the straight portions of the links. For the middle section of this modeling location, a gradual curve in the roadway geometry could result in potential overlapping emission contributions from roadway link segments at some modeling wind directions. Therefore, along these links, receptors were placed in pairs at intervals of 5, 25, 25, 50, 200, 200, 1500, and 1500 feet in both directions from the central receptors at the apex of the curve. As at the West Entrance, receptors were placed in pairs on each side of the links.

Site 3: Canyon to Fishing Bridge

This modeling location is expected to have moderate traffic volumes compared to other roadway segments in Yellowstone and is expected to result in lower emissions and associated impacts. CAL3QHCR modeling was performed for the free-flow roadway segments of this location, employing emissions data for snowmobiles and snowcoaches traveling at "cruise" speeds. As discussed above, vehicle traffic levels were based on the proposed entry limits for each alternative. For this location, receptors were placed in pairs on each side of the modeling roadway at intervals of 100 feet in both directions.

Site 4: Old Faithful Staging Area

The Old Faithful staging area was selected for modeling because of the concentration of emissions from snowmobiles and snowcoaches bringing visitors to the Old Faithful Geyser Basin and parking area. The primary contributor of emissions is the idling of engines after visitors enter and also prior to leaving these staging areas.

At the staging areas, emissions are clustered in distinct areas (the parking lots). Therefore, the AERMOD model was selected for area source modeling. Emissions at the staging area were calculated only for engine idling, which is assumed to be a total of five minutes on average for each vehicle, including during arrival and before departure. Engine emission calculations for the staging area did not explicitly include ingress and egress emissions from the vehicles, as these were included in the roadway segment emissions. It was conservatively assumed that all vehicles traveling from Madison and West Thumb to Old Faithful would enter the Old Faithful staging area, to maximize the number of vehicles included in the modeling for this site.

The Old Faithful staging area, including the three (3) main parking areas, was modeled as a 630 meter by 1037 meter rectangular area source for AERMOD modeling, aligned north-south. These dimensions were confirmed by Yellowstone staff.

At the staging areas, a grid network of receptors was modeled for AERMOD along the perimeters of the area sources representing idling vehicles. Receptors were arranged in rectangular grids surrounding the Old Faithful staging area. At Old Faithful, receptors were placed at 100 meter intervals around the perimeter of the staging area out to approximately 1.5 kilometers in both the east and west directions, and out to approximately 2.0 kilometers in both the north and south directions.

4.3 Vehicle Emissions Data

To predict ambient concentrations of pollutants generated by vehicular traffic, emissions from vehicle exhaust systems must be estimated accurately. This analysis focuses primarily on emissions associated with visitor use of OSVs within the park, however, administrative vehicles are also included in the modeling.

Emissions data and vehicle usage data (discussed below) were used for atmospheric dispersion modeling analyses to calculate the ambient levels of CO, NO_2, PM_{10} and $PM_{2.5}$ at four (4) locations within the park, for the alternatives. Emissions data will also be utilized to predict the total winter-season emissions of CO, PM, NO_x, HC, and HAPs from the operation of OSVs in the park. The data to be employed for this analysis were obtained from past air quality and emissions testing, and research studies. Snowmobile laboratory test data utilized may not reflect actual operating conditions in Yellowstone, as high altitude and low winter temperatures in the parks are likely to decrease overall snowmobile engine performance and increase relative emissions. However, this data may be the best available.

For all alternatives, the analysis assumed that all snowmobiles are 4-stroke engines meeting NPS Best Available Technology (BAT) requirements. Current BAT for snowmobiles operating in Yellowstone has been established for CO and HC emissions, at less than 120 and 15 grams per kilowatt hour, respectively. BAT requirements are shown in Table 4-1.

Table 4-1
Snowmobile BAT Requirements and EPA Standards

	Emission Requirement or Standard		**Phase-in***
	Hydrocarbons (HC) (g/KW-hr)	**Carbon Monoxide (CO) (g/KW-hr)**	
NPS BAT	15	120	-
EPA Emission Standards			
Model Year			
2006	100	275	50%
2007-2009	100	275	100%
2010	75	275	100%
2012	75	200	100%

Note:
* Percent of newly manufactured sleds for the model year that must meet the applicable requirement.

In addition, EPA adopted new standards for new non-road engines in 2002. For snowmobiles, the new standards will begin to take effect for the 2006 model year, with a 50 percent phase-in requirement. These standards and the corresponding implementation years are also provided in Table 4-1.

Composite emission factors for each alternative were calculated by weighting the snowmobile and snowcoach emission factors appropriate for each particular alternative according to usage levels of each vehicle type. These composite emission factors (weighted averages) were inputted to the CAL3QHCR modeling.

4.3.1 4-Stroke Snowmobile Emission Factors

4-stroke snowmobile emission factors for CO, NO_x and HC used this analysis were calculated based on testing performed in the NPS's *Yellowstone Over-snow Vehicle Emission Tests – 2012: Preliminary Report*, John D. Ray, Gary A. Bishop, Brent Schuchmann, Chris Frey, Gurdas Sandu, Brandon Graver, June 2012. This study collected in-use measurements of emissions from two snowmobiles (2011 Arctic Cat TZ1 and a 2012 Ski Doo Bombardier) operating in Yellowstone during March 2012.

Particulate emission factors for 4-stroke snowmobiles were not measured in the above study, and were determined from manufacturers' EPA certification modal emission testing and engine performance results, following standard EPA test procedures, for the BAT-approved snowmobile engines of two different manufacturers (Arctic Cat T660 Touring and Polaris Frontier), in SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002. Based on these data, the average 4-stroke snowmobile emission factors representative of the current snowmobile fleet are shown in Table 4-2.

Table 4-2
Snowmobile Emission Factors

	PM			CO			HC			NO_X		
	Idle (g/hr)	Low Speed mph (g/mi)	Cruise Speed mph (g/mi)	Idle (g/hr)	Low Speed mph (g/mi)	Cruise Speed mph (g/mi)	Idle (g/hr)	Low Speed mph (g/mi)	Cruise Speed mph (g/mi)	Idle (g/hr)	Low Speed mph (g/mi)	Cruise Speed mph (g/mi)
BAT 4- Stroke snowmobiles	0.49	0.065	0.031	416.2	653.0	34.2	16.2	28.8	1.3	1.3	4.0	9.7

4.3.2 Snowcoach Emission Factors

Snowcoach emission factors for this analysis were also obtained from the NPS's *Yellowstone Over-snow Vehicle Emission Tests – 2012: Preliminary Report*, referenced in the section above. This study measured emissions from five (5) snowcoaches operating in Yellowstone during March 2012. The study, along with others, show that the vehicle operating conditions (altitude, temperature, terrain, vehicle operator, etc.) can greatly affect snowcoach emission factors.

A summary of the idle and traveling (low speeds of less than 15 mph and cruise speeds of 15 to 35 mph) emissions is shown in Table 4-3, representing gas and diesel "current fleet" (non-BAT) and BAT emissions, for modeling purposes.

The future snowcoach BAT requirements are likely to be based on a functional definition of BAT, rather than meeting actual emission standards, as snowcoaches operate in conditions very different from on-road counterparts.

For modeling purposes, the alternatives assume a 80/20 split of gas to diesel snowcoaches for modeling the "current fleet", and an 70/30 split of gas snowcoaches to diesel snowcoaches for future BAT.

4.4 Traffic Activity Data

Traffic data for the air quality analysis were derived from snowmobile and snowcoach entry limits and other information for each alternative provided to ARS by NPS (Appendices A and H). Refined microscale, or localized, dispersion modeling analysis was conducted for the each hour of the day, at each of the four modeling locations, to most accurately assess the potential for significant air quality impacts.

To determine hourly vehicle inputs for the modeling locations, hourly distribution data of OSVs collected by the park was used together with the travel factor spreadsheets previously discussed in Section 3.0 to determine hourly traffic activity and emission factors for each alternative. The modeling assumed two lanes open in the morning, with

Table 4-3
Snowcoach Emission Factors for Modeling

	PM			CO			HC			NO_X		
	Idle (g/hr)	Low Speed mph (g/mi)	Cruise Speed mph (g/mi)	Idle (g/hr)	Low Speed mph (g/mi)	Cruise Speed mph (g/mi)	Idle (g/hr)	Low Speed mph (g/mi)	Cruise Speed mph (g/mi)	Idle (g/hr)	Low Speed mph (g/mi)	Cruise Speed mph (g/mi)
Current Fleet Gas Snowcoaches*	0.063	0.025	0.025	289.7	110.5	184.6	17.2	3.3	6.8	1.38	8.9	10.74
Current Fleet Diesel Snowcoaches	0.108	0.140	0.105	12.9	8.7	3.3	0.3	0.1	2.9	31.9	30.5	24.3
BAT Gas Snowcoaches*	0.062	0.025	0.025	30.5	24.6	110.2	7.4	1.2	1.0	1.3	4.82	7.14
BAT Diesel Snowcoaches	0.04	0.02	0.01	6.7	1.0	0.7	0.54	0.20	0.10	13.32	14.7	10.05

Note:
*Gas snowcoach PM emissions from MOBILE6.

Source: *Yellowstone Over-snow Vehicle Emission Tests – 2012: Preliminary Report*, Ray, Bishop, Schuchmann, Frey, Sandu, Graver .

about two thirds of daily entries going to the southernmost booth and third going to the middle (north) booth; the northernmost booth is currently unused in winter.

4.5 Meteorological Conditions

Following EPA methodology and guidance from NPS, on-site meteorological data from Yellowstone's Water Tank site IMPROVE monitoring site, along with concurrent upper air data from Riverton, Wyoming Airport, were processed with AERMET for use in the AERMOD modeling. In addition, the same data were processed with the Meteorological Processor for Regulatory Models (MPRM) for use in CAL3QHCR modeling. The meteorological data sets employed for the modeling include five (5) individual full years of data for 2003 to 2007. However, both AERMOD and CAL3QHCR modeling were completed selecting only the January 1st thru March 31st and December 15th thru December 31st periods of each modeling year, as meteorological conditions for these periods would most closely represent the park's winter use season.

4.6 Background Concentrations

Background concentrations are those pollutant concentrations not directly accounted for by the modeling analysis. Background concentrations must be added to modeling results to obtain total pollutant concentrations at prediction sites. Background concentrations can typically be attributed to local sources, long-range transport and natural sources. For this analysis, background levels include smoke (from wood-burning stoves and fireplaces) and other emissions from West Yellowstone. Background concentrations for this analysis were estimated considering the guidelines provided in

Guideline on Air Quality Models, Appendix W to 40 CFR part 51, Federal Register, November 9, 2005.

Recent data collected at West Yellowstone and Old Faithful monitors provided background concentration estimates of a 1-hour average CO background of 0.17 ppm, and an 8-hour average CO background of 0.15 ppm, based on overnight monitoring data (John D. Ray, Atmospheric Chemist, NPS Air Resources Division, Denver, Colorado, July 2006 personal communication), so that emissions from the daytime OSVs modeled in this analysis would not be "double-counted".

The 24-hour average PM_{10} background concentration was determined from the IMPROVE network aerosol data (gravimetric mass average of 2002-04 annual mean values) and is 4.2 micrograms per cubic meter. The 24-hour average $PM_{2.5}$ background concentration was determined from *$PM_{2.5}$ Winter Air Quality in Yellowstone National Park*, John D. Ray, Ph.D., National Park Service, and is 1.4 micrograms per cubic meter. Consistent with EPA guidance, IMPROVE data provide representative background particulate levels that are not directly affected by winter OSVs emissions, as the monitoring station is located near Lake Village. All background concentrations used in this analysis are shown in Table 4-4.

Table 4-4
Background Concentrations

CO (ppm)	
1-hour	**8-hour**
0.17	0.15
24-hour Particulates (ug/m^3)	
PM_{10}	**$PM_{2.5}$**
4.2	1.4
Note: CO backgrounds estimated from average overnight values from John D. Ray (Atmospheric Chemist, NPS Air Resources Division, Denver Colorado), July 2006, personal communication. Particulate backgrounds based on IMPROVE network aerosol data.	

5.0 Dispersion Modeling Results

As noted previously, receptors were placed at multiple locations at each of four modeling locations. The receptor with the highest predicted concentration was used to represent each modeling site for each of the alternatives. CO, NO_2, and PM concentrations were calculated for each location, for each alternative.

For all modeling results, the values shown are the highest predicted concentrations for each receptor location and include background levels. CO concentrations under each alternative were determined using the methodology previously described.

Tables 5-1 and 5-2 show the maximum predicted 1- and 8-hour average CO concentrations for each of the alternatives and fleet assumptions at the analysis sites. The modeling results indicate that winter use vehicle emissions would not result in any exceedances of the CO NAAQS, or the Montana or Wyoming ambient air quality standards, under any of the alternatives.

Table 5-3 shows the maximum predicted 1-hour average NO_2 concentrations for each of the alternatives and fleet assumptions at the analysis sites. Based on guidance in the *Guideline on Air Quality Models, Appendix W to 40 CFR part 51*, and discussion with NPS, a ratio of 0.78 was used to determine the NO_2 fraction of NO_x. The modeling results indicate that winter use vehicle emissions would not result in any exceedances of the NO_2 NAAQS, or the Montana or Wyoming ambient air quality standards, under any of the alternatives.

Table 5-4 shows the maximum predicted 24-hour $PM_{2.5}$ concentrations for each of the alternatives and fleet assumptions at the analysis sites. The modeling results indicate that no winter use vehicle emissions from any of the alternatives would result in exceedances of the 24-hour $PM_{2.5}$ NAAQS, or the Montana or Wyoming ambient air quality standards. In addition, it should be noted that all predicted $PM_{2.5}$ concentrations for this analysis are conservative, as most available emission factors utilized for vehicles assumed total particulates, or PM_{10} as all $PM_{2.5}$. However, the modeling results indicate there would not be any exceedances of the 24-hour PM_{10} NAAQS, or the Montana or Wyoming ambient air quality standards, under any of the alternatives.

Since Yellowstone is a Class I area, PM_{10} increment consumption under PSD was also assessed. For Class I areas, the PM_{10} PSD increment is 8 micrograms per cubic meter, for the 24-hour averaging period, which EPA has determined is the small "allowable" incremental increase for PM_{10} in these areas. This increment is evaluated in reference to the previously established (by Montana and Wyoming) baseline date of 1979 for Yellowstone (*Air Quality Concerns Related to Snowmobile Usage in National Parks*, National Park Service Air Resources Division, February 2000), which was used to determine baseline concentrations. This study employed only a screening level approach in comparing predicted PM_{10} increments (no background contribution) with estimated 1979 baseline concentrations to determine the increment for the alternatives.

Although snowmobile (and snowcoach) traffic in the parks has increased since 1979, it was expected that the 4-stroke BAT snowmobiles required by the alternatives would generally result in a net decrease in 24-hour PM_{10} levels compared to the established baseline date. The 1979 baseline levels were estimated from adjusting 1999 Historical Conditions Scenario modeled PM_{10} levels (from the 2007 Plan/EIS) based on the maximum daily snowmobile levels (from Yellowstone entry records) of the two years. As the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis. Typically, detailed analysis would be required if concentrations are near or "consume" allowable Class I PM_{10} PSD increment. Calculations for estimating baseline levels are included as Appendix G.

Table 5-1
Maximum Predicted 1-hour CO Concentrations
(parts per million)

Scenario	Description	Fleet Assumption	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Canyon to Fishing Bridge	Site 4: Old Faithful Staging Area
			1-hour (ppm)	1-hour (ppm)	1-hour (ppm)	1-hour (ppm)
Existing Conditions	Average Use	Current Fleet	8.3	0.4	0.3	0.4
Alternative 1	No Action	Current Fleet	3.4	0.2	0.2	0.2
Alternative 2	Interim Use Levels	Current Fleet	9.3	0.4	0.4	0.4
		BAT Snowcoaches	8.6	0.4	0.3	0.4
Alternative 3	Transition to BAT Snowcoaches Only	BAT Snowcoaches	7.2	0.4	0.3	0.3
Alternative 4a	Transportation Event Mgmt. (480 snowmobiles/60 snowcoaches)	Current Fleet	13.0	0.4	0.4	0.5
		BAT Snowcoaches	13.0	0.4	0.4	0.5
Alternative 4b	Transportation Event Mgmt. SC only (0 snowmobiles/110 snowcoaches)	Current Fleet	6.4	0.4	0.3	0.3
		BAT Snowcoaches	6.4	0.3	0.2	0.3
Alternative 4c	Trans. Event Mgmt., Adaptive (480 sm/ 120 sc)	BAT Snowcoaches	14.2	0.5	0.4	0.5
Alternative 4d	Trans Event Mgmt. Adaptive (0 sm/220 sc)	BAT Snowcoaches	7.2	0.4	0.3	0.3

Note:
NAAQS for CO are 35 and 9 parts per million (ppm), for the 1-hour and 8-hour averaging periods, respectively.

Table 5-2
Maximum Predicted 8-hour CO Concentrations
(parts per million)

Scenario	Description	Fleet Assumption	Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Canyon to Fishing Bridge	Site 4: Old Faithful Staging Area
			8-hour (ppm)	8-hour (ppm)	8-hour (ppm)	8-hour (ppm)
Existing Conditions	Average Use	Current Fleet	1.4	0.3	0.2	0.2
Alternative 1	No Action	Current Fleet	1.0	0.2	0.2	0.2
Alternative 2	Interim Use Levels	Current Fleet	3.4	0.3	0.2	0.2
		BAT Snowcoaches	3.2	0.3	0.2	0.2
Alternative 3	Transition to BAT Snowcoaches Only	BAT Snowcoaches	2.3	0.2	0.2	0.2
Alternative 4a	Transportation Event Mgmt. (480 snowmobiles/60 snowcoaches)	Current Fleet	4.5	0.3	0.2	0.3
		BAT Snowcoaches	4.5	0.3	0.2	0.3
Alternative 4b	Transportation Event Mgmt. SC only (0 snowmobiles/110 snowcoaches)	Current Fleet	2.3	0.3	0.2	0.2
		BAT Snowcoaches	2.3	0.2	0.2	0.2
Alternative 4c	Trans. Event Mgmt., Adaptive (480 sm/ 120 sc)	BAT Snowcoaches	5.2	0.3	0.2	0.3
Alternative 4d	Trans Event Mgmt. Adaptive (0 sm/220 sc)	BAT Snowcoaches	3.2	0.2	0.2	0.2

Note:
NAAQS for CO are 35 and 9 parts per million (ppm), for the 1-hour and 8-hour averaging periods, respectively.

Table 5-3
Maximum Predicted 1-hour NO_2 Concentrations
(parts per billion)

Scenario	Description	Fleet Assumption	Site 1: West Entrance 1-hour (ppb)	Site 2: West Entrance to Madison 1-hour (ppb)	Site 3: Canyon to Fishing Bridge 1-hour (ppb)	Site 4: Old Faithful Staging Area 1-hour (ppb)
Existing Conditions	Average Use	Current Fleet	29	55	22	1
Alternative 1	No Action	Current Fleet	5	7	2	0
Alternative 2	Interim Use Levels	Current Fleet	37	53	32	1
		BAT Snowcoaches	30	48	30	1
Alternative 3	Transition to BAT Snowcoaches Only	BAT Snowcoaches	16	25	12	1
Alternative 4a	Transportation Event Mgmt. (480 snowmobiles/60 snowcoaches)	Current Fleet	47	70	40	1
		BAT Snowcoaches	41	64	39	1
Alternative 4b	Transportation Event Mgmt. SC only (0 snowmobiles/110 snowcoaches)	Current Fleet	22	39	13	1
		BAT Snowcoaches	14	25	12	1
Alternative 4c	Trans. Event Mgmt., Adaptive (480 sm / 120 sc)	BAT Snowcoaches	53	72	45	1
Alternative 4d	Trans Event Mgmt. Adaptive (0 sm /220 sc)	BAT Snowcoaches	29	44	22	1

Note:
NAAQS for NO_2 is 100 parts per billion (ppb), for the 1-hour averaging period.

Table 5-4
Maximum Predicted 24-hour $PM_{2.5}$ Concentrations
(micrograms per cubic meter)

Scenario	Description	Fleet Assumption	Site 1: West Entrance 24-hour (ug/m^3)	Site 2: West Entrance to Madison 24-hour (ug/m^3)	Site 3: Canyon to Fishing Bridge 24-hour (ug/m^3)	Site 4: Old Faithful Staging Area 24-hour (ug/m^3)
Existing Conditions	Average Use	Current Fleet	1.6	1.4	1.4	1.4
Alternative 1	No Action	Current Fleet	1.4	1.4	1.4	1.4
Alternative 2	Interim Use Levels	Current Fleet	1.7	1.4	1.4	1.5
		BAT Snowcoaches	1.7	1.4	1.4	1.5
Alternative 3	Transition to BAT Snowcoaches Only	BAT Snowcoaches	1.4	1.4	1.4	1.4
Alternative 4a	Transportation Event Mgmt. (480 snowmobiles/60 snowcoaches)	Current Fleet	2.1	1.4	1.4	1.5
		BAT Snowcoaches	2.1	1.4	1.4	1.5
Alternative 4b	Transportation Event Mgmt. SC only (0 snowmobiles/110 snowcoaches)	Current Fleet	1.4	1.4	1.4	1.4
		BAT Snowcoaches	1.4	1.4	1.4	1.4
Alternative 4c	Trans. Event Mgmt., Adaptive (480 sm / 120 sc)	BAT Snowcoaches	2.1	1.5	1.4	1.5
Alternative 4d	Trans Event Mgmt. Adaptive (0 sm /220 sc)	BAT Snowcoaches	1.4	1.4	1.4	1.4

Note:
NAAQS for PM_{10} is 150 µg/m^3 and for $PM_{2.5}$ is 35 µg/m3, for the 24-hour averaging period.

The predicted 24-hour PM_{10} increment consumption values based on the previously described particulate modeling are shown in Table 5-5 for each of the alternatives and fleet assumptions. There is no 24-hour PM_{10} increment consumption for any of the modeling locations compared to the baseline date.

Table 5-5
24-hour PM_{10} PSD Increment Consumption

Scenario	Description	Fleet Assumption	Site 1: West Entrance 24-hour (ug/m^3)	Site 2: West Entrance to Madison 24-hour (ug/m^3)	Site 3: Canyon to Fishing Bridge 24-hour (ug/m^3)	Site 4: Old Faithful Staging Area 24-hour (ug/m^3)
Existing Conditions	Average Use	Current Fleet	0.2	0.0	0.0	0.0
Alternative 1	No Action	Current Fleet	0.0	0.0	0.0	0.0
Alternative 2	Interim Use Levels	Current Fleet	0.3	0.0	0.0	0.1
		BAT Snowcoaches	0.3	0.0	0.0	0.1
Alternative 3	Transition to BAT Snowcoaches Only	BAT Snowcoaches	0.0	0.0	0.0	0.0
Alternative 4a	Transportation Event Mgmt. (480 snowmobiles/60 snowcoaches)	Current Fleet	0.7	0.0	0.0	0.1
		BAT Snowcoaches	0.7	0.0	0.0	0.1
Alternative 4b	Transportation Event Mgmt. SC only (0 snowmobiles/110 snowcoaches)	Current Fleet	0.0	0.0	0.0	0.0
		BAT Snowcoaches	0.0	0.0	0.0	0.0
Alternative 4c	Trans. Event Mgmt., Adaptive (480 sm/ 120 sc)	BAT Snowcoaches	0.7	0.1	0.0	0.1
Alternative 4d	Trans Event Mgmt. Adaptive (0 sm/220 sc)	BAT Snowcoaches	0.0	0.0	0.0	0.0
1999 Historical	Historical Unregulated Scenario		191.5	40.2	5.9	3.8
PSD Baseline Year	1979 Historical Conditions		42.5	8.9	1.1	0.7

Note:
Baseline Year concentrations are based on the ratio of 1979 to 1999 snowmobile levels at the modeling locations.
Class I PSD Increment for 24-hour average PM_{10} is 8 $\mu g/m^3$

As the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis.

6.0 Emissions Inventory

In addition to the dispersion modeling analysis for determining potential short-term CO and particulate concentrations, an emissions inventory of snowmobiles and snowcoaches operating in Yellowstone in tons per winter season was completed for each alternative and fleet assumption, based on vehicle entry limits and other information provided (Appendix A).

Emissions were calculated using travel estimates of OSV and on-road vehicles used on Yellowstone roadways, the roadway lengths, and modes of operation of the vehicles. Emission factor data previously discussed in Section 4.3 were combined with daily vehicle traffic levels for each roadway segment, for each alternative, to determine total park-wide emissions for each pollutant. The winter season was defined as a 90-day period that typically runs from about mid-December to early March.

Estimates were prepared for criteria pollutants (CO, PM, and NO_x) and HC. The total maximum potential winter season emissions due to operations of snowmobiles and snowcoaches in the parks in tons per winter season are shown for each of the alternatives and fleet assumptions in Table 6-1. Detailed emission inventory calculations are included as Appendix H. An emissions inventory for HAPs was also completed for each alternative and is discussed in the next section. Table 6-2 shows the contribution by vehicle type by percentage of the total season emissions for the alternatives and fleet assumptions.

7.0 Hazardous Air Pollutant (HAP) Emissions

Emissions of HAPs (benzene, 1,3 butadiene, formaldehyde, and acetaldehyde) occur in OSVs emissions and are associated with incomplete fuel combustion. An emission inventory for these HAPs was completed based on HC speciation estimates and the total winter season HC emissions previously determined. For snowmobiles, HAPs emissions were estimated as a fraction of measured HC emissions from 4-stroke snowmobiles based on data reported in SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002. HAPs classified as air toxics are presented in Table 7-1 as a percentage of the total HC mass, for snowmobiles.

HAPs emissions from snowcoaches were calculated using the percentages of the total HC mass derived from MOBILE6, based on the on-road vehicle types that are converted to snowcoaches. The snowcoach vehicle mix was approximated by the following MOBILE6 vehicle mix fractions: 50 percent light-duty trucks (LDT4), 17 percent CLASS 2b heavy-duty vehicles (HDV), 17 percent CLASS 3 HDV, and 16 percent CLASS 4 HDV. HAP emissions as a percentage of total HC mass, for snowcoaches and on-road vehicles are presented in Table 7-2. Using the methodology described, total winter season mobile source emissions of HAPs were estimated and are summarized in Table 7-3.

Table 6-1
Park-wide Total Winter Season Mobile Source Emissions (Pounds per Day / Tons per Year)

Scenario	Description	Fleet Assumption	CO		HC		NOx		PM	
			lb/day	tpy	lb/day	tpy	lb/day	tpy	lb/day	tpy
Existing Conditions	Average Use	Current Fleet	3,072	138	120	5.4	611	28	2	0.1
Alternative 2	Interim Use Levels	Current Fleet	4,969	224	195	8.8	934	42	3	0.1
		BAT Snowcoaches	3,874	174	114	5.1	850	38	3	0.1
Alternative 3	Transition to BAT Snowcoaches Only	BAT Snowcoaches	2,306	104	38	1.7	335	15	1	0.0
Alternative 4a	Transportation Event Mgmt. (480 snowmobiles/60 snowcoaches)	Current Fleet	5,594	252	213	9.6	1,184	53	4	0.2
		BAT Snowcoaches	4,719	212	153	6.9	1,117	50	4	0.2
Alternative 4b	Transportation Event Mgmt. SC only (0 snowmobiles/110 snowcoaches)	Current Fleet	3,663	165	147	6.6	435	20	1	0.1
		BAT Snowcoaches	2,173	98	37	1.6	322	14	1	0.0
Alternative 4c	Trans. Event Mgmt., Adaptive (480 sm / 120 sc)	BAT Snowcoaches	5,519	248	161	7.2	1,200	54	4	0.2
Alternative 4d	Trans Event Mgmt. Adaptive (0 sm/220 sc)	BAT Snowcoaches	3,645	164	51	2.3	474	21	1	0.1

Note:
All Alternatives assume snowmobile BAT.

Table 6-2
Percent Contribution by Vehicle Type to Total Scenario Emissions

Scenario	Description	Fleet Assumption	CO		HC		NOx		PM	
			Snowmobile	Snowcoach	Snowmobile	Snowcoach	Snowmobile	Snowcoach	Snowmobile	Snowcoach
Alternative 2	Interim Use Levels	Current Fleet	54%	46%	53%	47%	78%	22%	79%	21%
		BAT Snowcoaches	69%	31%	90%	10%	86%	14%	88%	12%
Alternative 3	Transition to BAT Snowcoaches Only	BAT Snowcoaches	24%	76%	56%	44%	46%	54%	52%	48%
Alternative 4a	Transportation Event Mgmt.	Current Fleet	67%	33%	68%	32%	86%	14%	87%	13%
	(480 snowmobiles/60 snowcoaches)	BAT Snowcoaches	80%	20%	94%	6%	91%	9%	93%	7%
Alternative 4b	Transportation Event Mgmt. SC only	Current Fleet	15%	85%	14%	86%	35%	65%	37%	63%
	(0 snowmobiles/110 snowcoaches)	BAT Snowcoaches	26%	74%	58%	42%	48%	52%	54%	46%
Alternative 4c	Trans. Event Mgmt., Adaptive (480 sm / 120 sc)	BAT Snowcoaches	68%	32%	90%	10%	85%	15%	88%	12%
Alternative 4d	Trans Event Mgmt. Adaptive (0 sm/220 sc)	BAT Snowcoaches	15%	85%	42%	58%	32%	68%	38%	62%

Table 7-1
Snowmobile HC Speciation Data

	4-stroke Snowmobiles (percent of HC)
Benzene	2.60 %
1-3 Butadiene	0.00 %
Formaldehyde	2.81 %
Acetaldehyde	1.08 %

Table 7-2
Snowcoach HC Speciation

	Current Fleet (percent of HC)	BAT Snowcoach (percent of HC)
Benzene	3.78 %	3.68 %
1-3 Butadiene	0.61 %	0.56 %
Formaldehyde	1.61 %	1.82 %
Acetaldehyde	0.55 %	0.65 %

Table 7-3
Park-wide Total Winter Season Mobile Sources HAPs Emissions
(Tons per Year)

Scenario	Description	Fleet Assumption	Benzene (tpy)	1-3 Butadiene (tpy)	Formaldehyde (tpy)	Acetaldehyde (tpy)
Existing Conditions	Average Use	Current Fleet	0.17	0.01	0.13	0.05
Alternative 2	Interim Use Levels	Current Fleet	0.28	0.03	0.20	0.07
		BAT Snowcoaches	0.14	0.00	0.14	0.05
Alternative 3	Transition to BAT Snowcoaches Only	BAT Snowcoaches	0.05	0.00	0.04	0.02
Alternative 4a	Transportation Event Mgmt. (480 snowmobiles/60 snowcoaches)	Current Fleet	0.29	0.02	0.23	0.09
		BAT Snowcoaches	0.18	0.00	0.19	0.07
Alternative 4b	Transportation Event Mgmt. SC only (0 snowmobiles/110 snowcoaches)	Current Fleet	0.24	0.03	0.12	0.04
		BAT Snowcoaches	0.05	0.00	0.04	0.01
Alternative 4c	Trans. Event Mgmt., Adaptive (480 sm/ 120 sc)	BAT Snowcoaches	0.20	0.00	0.20	0.07
Alternative 4d	Trans Event Mgmt. Adaptive (0 sm/220 sc)	BAT Snowcoaches	0.07	0.01	0.05	0.02

Note:
4-stroke snowmobile HAPs estimated as a fraction of measured HC emissions based on data reported in SwRI's *Laboratory Testing of Snowmobile Emissions*, Lela and White, July 2002.
Snowcoach HAPs estimated as a fraction of HC emissions based on MOBILE6 modeling of HC and air toxics emission factors for light- and heavy-duty vehicles.

8.0 Visibility

Yellowstone and Grand Teton are classified as Class I areas under the Federal Clean Air Act. As required by the visibility protection provision of the Clean Air Act, additional procedural requirements apply when a proposed source has the potential to impair visibility in a Class I area (40 CFR 52.27 (d)). Therefore, an analysis of anticipated visibility impacts resulting from on-snow vehicle emissions was conducted following procedures in the *Workbook for Plume Visual Impact Screening and Analysis*, EPA-450/4-88-015, 1992. The EPA model VISCREEN incorporates the methodology and was used to conduct a Level 1 screening analysis of potential visibility impacts. Virtual point source methods were applied to adapt procedures originally designed for assessing plume impacts resulting from industrial stacks to the line and area sources modeled at the four locations in this study.

For the visibility analysis, a winter Yellowstone value of 240 kilometers was assumed for the background visual range. This was converted from the reference level light-extinction coefficient for Yellowstone (winter) provided in Appendix 2.B of the *Federal Land Managers' Air Quality Related Values Workgroup (FLAG), Phase I Report*, U.S Forest Service, NPS, and U.S. Fish and Wildlife Service (December 2000) using conversion equation 1 in Appendix 2.A of the report.

The results of the VISCREEN modeling are shown in Table 8-1. There were no potential localized, perceptible, visibility impairments predicted for any of the alternatives at the screening locations. Visibility modeling parameters and modeling input and output files are included as Appendix I.

Table 8-1
Visibility Impairment

Scenario	Description	Fleet Assumption	Screening Criteria Exceedance			
			Site 1: West Entrance	Site 2: West Entrance to Madison	Site 3: Canyon to Fishing Bridge	Site 4: Old Faithful Staging Area
Existing Conditions	Average Use	Current Fleet	No	No	No	No
Alternative 1	No Action	Current Fleet	No	No	No	No
Alternative 2	Interim Use Levels	Current Fleet	No	No	No	No
		BAT Snowcoaches	No	No	No	No
Alternative 3	Transition to BAT Snowcoaches Only	BAT Snowcoaches	No	No	No	No
Alternative 4a	Transportation Event Mgmt. (480 snowmobiles/60 snowcoaches)	Current Fleet	No	No	No	No
		BAT Snowcoaches	No	No	No	No
Alternative 4b	Transportation Event Mgmt. SC only (0 snowmobiles/110 snowcoaches)	Current Fleet	No	No	No	No
		BAT Snowcoaches	No	No	No	No
Alternative 4c	Trans. Event Mgmt., Adaptive (480 sm/ 120 sc)	BAT Snowcoaches	No	No	No	No
Alternative 4d	Trans Event Mgmt. Adaptive (0 sm/220 sc)	BAT Snowcoaches	No	No	No	No

9.0 Summary and Conclusions

In support of the Winter Use Plan SEIS for Yellowstone, this report analyzed potential air quality impacts from snowmobile and snowcoach operations for several alternatives and fleet assumptions, utilizing air dispersion modeling and other accepted methods and models. For all alternatives, snowmobiles entering Yellowstone must be BAT machines. In addition, all alternatives consider the implementation of a snowcoach BAT.

For each alternative and fleet assumption, maximum predicted ambient concentrations of CO, NO_2 and $PM_{2.5}$ were calculated using dispersion modeling and impacts were assessed with respect to the NAAQS. Modeling results were also compared to PSD increments for particulate matter. Winter-season emission estimates in tons per year were calculated for CO, PM, NO_x, HC, and HAPs, and potential visibility impacts for each alternative were also assessed.

The results of the air quality modeling revealed that none of the alternatives would be likely to exceed the CO, NO_2, and $PM_{2.5}$ NAAQS, or the Montana or Wyoming ambient air quality standards.

In addition, the results of the Class I PSD assessment shows that 24-hour PM_{10} increment consumption for each of the alternatives and fleet assumptions at all modeling locations would be lower than the PSD increment of 8 micrograms per cubic meter. However, as the methodology employed in this study is a screening-level analysis, it is not intended for regulatory purposes and does not constitute a regulatory PSD increment consumption analysis