FINAL

# 2001 AIR EMISSIONS INVENTORY

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# LAKE MEREDITH NATIONAL RECREATION AREA
# TEXAS

## U.S. NATIONAL PARK SERVICE

OCTOBER 2003

FINAL

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# LAKE MEREDITH NATIONAL RECREATION AREA
# TEXAS

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*Cover Photo by NPS*

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# 1. INTRODUCTION

## 1.1 BACKGROUND

In August of 1999, the National Park Service (NPS) embarked on the Natural Resource Challenge, a major effort to substantially improve how the NPS manages the natural resources under its care. As part of Natural Resource Challenge, the NPS Air Resources Division (ARD) was tasked with the responsibility of expanding efforts to monitor and understand air quality and related values in the parks. In addition, the NPS Environmental Leadership policy directs the NPS to manage the parks in a manner "that demonstrates sound environmental stewardship by implementing sustainable practices in all aspects of NPS management...." In order to achieve both of these objectives, it is necessary to gain an understanding of air pollution emissions that result from activities within the park. In this regard, development of an in-park air emissions inventory for Lake Meredith National Recreation Area (NRA) serves three functions. First, it provides an understanding of the sources and magnitude of in-park emissions and a basis for contrasting them with emissions from the surrounding area. Second, it identifies existing and potential strategies to mitigate in-park air emissions. Finally, it evaluates and ensures the compliance status of the park relative to state and federal air pollution regulations.

## 1.2 TYPICAL AIR EMISSION SOURCES

Typical air emission sources within NPS units include stationary, area, and mobile sources. Stationary sources can include fossil fuel-fired space and water heating equipment, generators, fuel storage tanks, and wastewater treatment plants. Area sources may include woodstoves, fireplaces, campfires, and prescribed burning. Mobile sources may include vehicles operated by visitors, tour operators, and NPS and concessioner employees, and nonroad vehicles and equipment.

The air pollutants that are addressed in this report are summarized in the table below. Of the pollutants noted, ozone is not produced and emitted directly from stationary, area, or mobile sources, but rather it is formed as a result a chemical reaction of NOx and VOC emissions in the presence of sunlight. Carbon dioxide historically has not been considered a pollutant. However, in recent years, there has been much interest in its contribution to global climate warming since it is considered a greenhouse gas.

**AlR PO[.Z.U'1'ANTS AND THEIR CHARACTERl4T1CS**

| Pollutant | Characteristics |
|---|---|
| Partioulatcb (PM ↑„) | • **Mixture of solid particles** and **liquid droplets; fine particles (less than** 23 micrometers) produced by fuel combustion, power plants, **and** diesel buses and trucks<br>• Can aggravate astiuua, praducc acute respiratory symptoms, including aggravated coughing and difficult **or painful** breathing, and chronic bronchitis<br>• Impairs visibility |
| ulft]r Dioxide (SO2) | • Can cause temporary breathing difficulties for people with asthma<br>Reacts with other chemicals to form sulfate particles that are major cause of reduced visibility in many parts of the country<br>• Main contributor to acid rain |
| | + **High** temperature fuel combustion exhaust product<br>+ Can be an irritant to Itumans and participates in the formation of ozone<br>+ Reacts with other poi lutarkrs to farm nitrite pm-ticks that are a significant contributor to visihiliryreductton **in many parrs** of the **country**<br>r Contributor xo formation of **acid** rain |
| | |
| | |
| • | r r |
| Carbon Dioxide (C'O· | |

## 1 3 INVENTORY METHODOLOGY

The methodology to accomplish the air emissions inventory was outlined in a protocol that was prepared at **the initiation** of the project (EA Engineering 2001). '1 asks consisted of a site survey **in** February 2002, interviews with Lake Meredith NR A[1] personnel, rcview of applicable park records, emission calculations. review of applicable suite and local air quality regulations, an assessment of mitigation measures and potential emission reduction initiatives, and report preparation, The data were used in conjunction with a number of manual and computer software

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computational tools to calculate emissions. Computational tools included U.S. Environmental Protection Agency (USEPA) emission factors such as the Factor Information Retrieval System (FIRE) database, USEPA *TANKS 4.0* model, U.S. Forest Service *First Order Fire Effects Model (FOFEM) 4.0* model, and USEPA *MOBILE6.2* mobile source emissions model. The year 2001 was selected as the basis for the air emission inventory since data for that year were the most recent available at the park. It should be noted that emissions are expected to vary from year to year due to fluctuations in visitation, prescribed and wildland fires, and other activities. Additional information on emission estimation methodology, including emission factors, is provided in Appendices A and **B.**

## 1.4 PARK DESCRIPTION

Lake Meredith NRA is near Fritch, Texas, in the center of the Texas Panhandle, about 40 miles north of Amarillo, Texas (Figure 1). Lake Meredith was formed in the 1960s when the U.S. Bureau of Reclamation constructed Sanford Dam on the Canadian River. The dam was built to supply water to 11 communities in the Panhandle by means of 322 miles of pipeline. The Bureau administers the surface estate on approximately 760 acres around the dam, and operation of the dam and delivery of water is administered by the Canadian River Municipal Water Authority. The NRA consists of about 45,000 acres, and the reservoir covers about 10,000 acres (Figure 2).

Lake Meredith is a major site of water-based recreation in the Panhandle, averaging more than 1.5 million visits per year from 1992 to 2000. There are no comparable large bodies of water or land that provide such recreational diversity in the Texas Panhandle area. The waters of Lake Meredith NRA support a major sport fishery, and facilities for camping, picnicking, and boating also are provided. Lake Meredith NRA is the only public land in a radius of approximately 50 miles that permits the hunting of deer, quail, ducks, and other migratory birds.

Park headquarters and visitor center are located in a leased building in the community of Fritch east of the park. Developed areas within the park boundaries are noted in Table 1. There are also 11 campsites and seven boat launch ramps. Lake Meredith also manages the 1,370 acre Alibates Flint Quarries National Monument that is located adjacent to the NRA; however, there are no developments within the Monument.

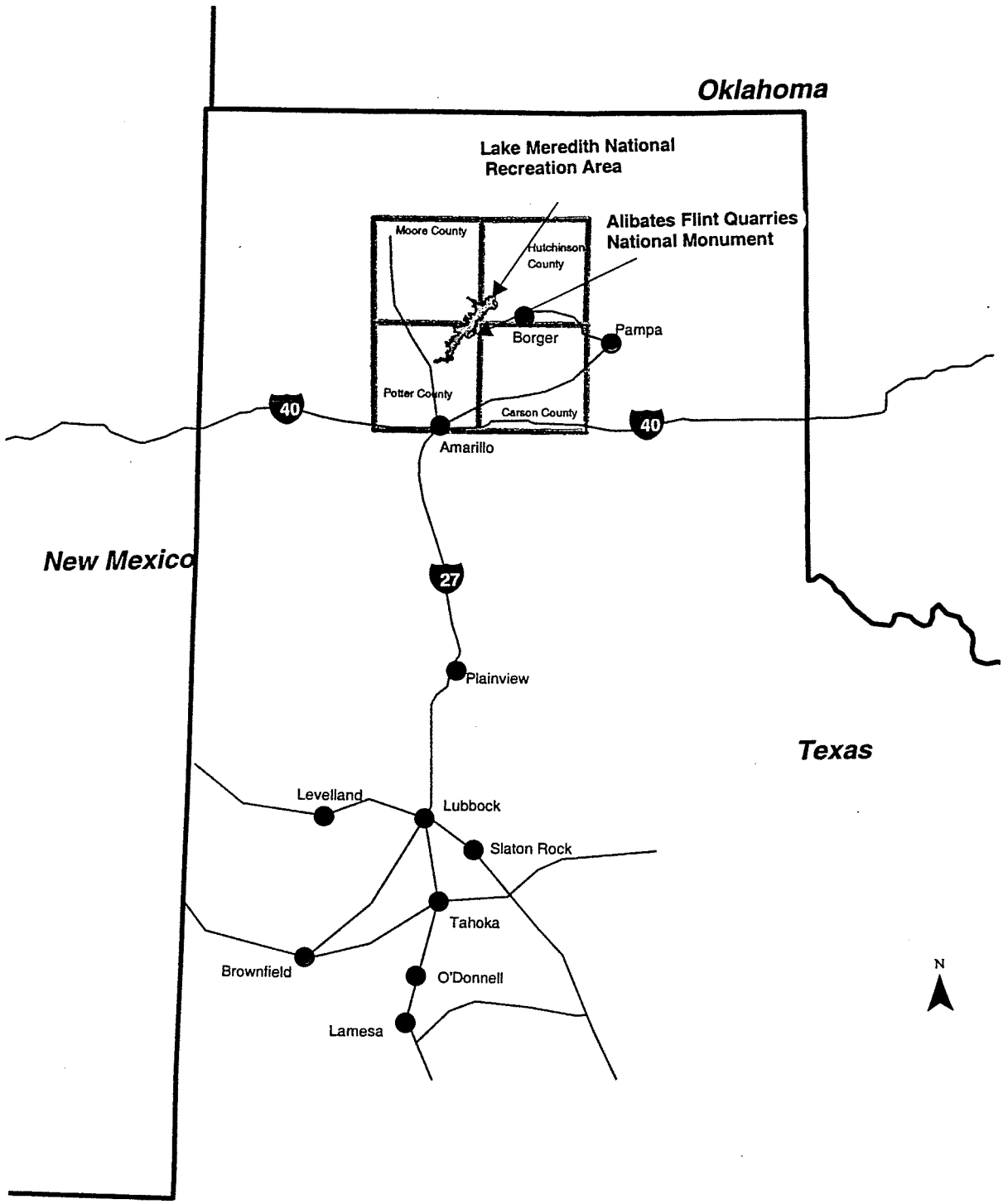


Figure 1. Lake Meredith NRA Region/Vicinity

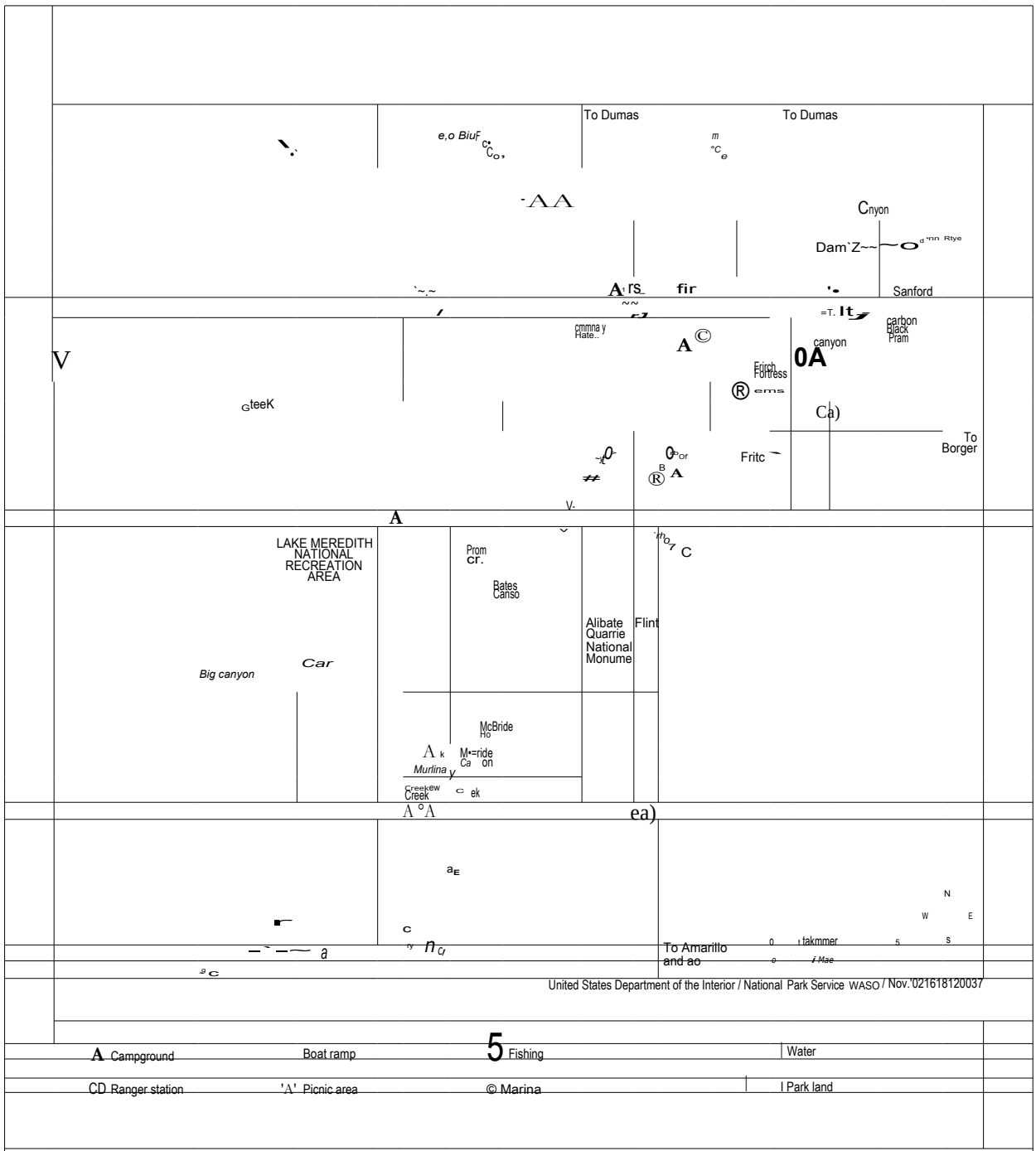


Figure 2. Lake Meredith National Recreation Area

TABLE 1: LAKE MEREDITH **NRA DEVELOPED** AREAS

| Name/Location | Function/Facilities |
|---|---|
| Fritch Headquarters | Headquarters, Visitor Center |
| Sanford | Maintenance Building, Fire Cache, Ranger Station |
| Sanford Yake Marina | Public Marina |
| Canadian River Municipal Water Authority | CRMWA Headquarters, Maintenance Shop, Sanford Dam |
| Fritch Fortress Amphitheater | Performing Arts Amphitheater |

There are also 170 active oil and gas operations within the two parks. When the parks were created, the federal government acquired surface ownership within the two areas, but either private entities or the state retained subsurface mineral interests. Thus, the federal government does not own any of the subsurface oil and gas rights in the parks. In addition, there are transpark oil and gas pipelines and activities in their associated rights-of-way.

## 1.5 AIR QUALITY STATUS

Lake Meredith NRA is located in Hutchinson, Potter, and Moore Counties. There are no air monitoring stations within the park, and the nearest monitoring station is in Amarillo, TX where $PM_{2.5}$ is monitored. Data from this site have shown no exceedances, and the Texas Commission on Environmental Quality has recommended to EPA that the site be closed since air quality has been consistently below standards. The region is in attainment with all National Ambient Air Quality Standards (NAAQS), and the park is a Class II area for purposes of air quality.

There are numerous industrial facilities and operations surrounding the park that impact air quality, including thousands of oil and gas wells, the largest inland petroleum refinery in the country, a chemical plant, and several carbon black plants. Monitoring data from outside the park may indicate that ozone originating southeast of the park in industrial regions of Texas, such as Dallas/Fort Worth, may be causing slight elevations in ozone levels (NPS 2003).

# 2. STATIONARY AND AREA SOURCE EMISSIONS

This section summarizes emissions from sources at Lake Meredith NRA for the year 2000. The discussion is divided into sections covering emissions from combustion sources, fuel storage sources, and area sources. The following emissions were calculated for each source: particulate matter ($PM_{10}$), sulfur dioxide ($SO_2$), nitrogen oxides ($NO_X$), carbon monoxide (CO), carbon dioxide ($C0_2$), and volatile organic compounds (VOCs). Emission factors used in the calculations are provided in Appendices A and B.

## 2.1 STATIONARY **SOURCES**

### 2.1.1 Space And Water Heating Equipment

While the majority of space and water heating equipment is electric at Lake Meredith NRA, there are several propane space heating units. Criteria air emissions were calculated using the appropriate residential unit emission factors. For example, NOx emissions from a propane heating unit at the Sanford Ranger Station are calculated as follows:

$$740\ gal/yr \times \frac{14\ lb\ NOx}{1{,}000\ gal} = 10\ lb\ NOx/yr$$

Actual criteria pollutant emissions from space and water heating equipment are summarized in Table 2. Although the park provided propane and natural gas consumption data for the year 2001, similar data were not available from the Canadian River Municipal Water Authority, which operates facilities at Sanford Dam. However, information on their heating equipment, including size ratings, were available. Therefore, their energy consumption was estimated as a proportion of the park's energy consumption relative to the size of equipment. Potential emissions also were calculated by assuming that the heating units were operated continuously during the year or 8,760 hours per year, and these emissions are summarized in Table 3.

TABLE **2: 2001** ACTUAL **CRITERIA EMISSIONS FROM HEATING EQUIPMENT AT LAKE MEREDITH NRA**

| Location | Consumption (gal/yr) | $PM_{10}$ (Ibs/yr) | $SO_2$ (Ibs/yr) | NOx (Ibs/yr) | CO (Ibs/yr) | VOC (lbslyr) | $CO_2$ (Ibs/yr) |
|---|---|---|---|---|---|---|---|
| **National Park Service - Propane** | | | | | | | |
| Sanford Ranger Station | 740 | 0 | 0 | 10 | 1 | 0 | 9,254 |
| Sanford Ranger Station | 278 | 0 | 0 | 4 | 1 | 0 | 3,470 |
| Sanford Maintenance | 833 | 0 | 0 | 12 | 2 | 0 | 10,410 |
| Sanford Maintenance | 278 | 0 | 0 | 4 | 1 | 0 | 3,470 |
| Sanford Sign Shop | 740 | 0 | 0 | 10 | 1 | 0 | 9,254 |
| Sanford Adm Building | 1,110 | 0 | 0 | 16 | 2 | 0 | 13,881 |
| Sanford Adm Building | 555 | 0 | 0 | 8 | 1 | 0 | 6,940 |
| Fire Cache | 1,666 | 1 | 0 | 23 | 3 | 0 | 20,821 |
| **National Park Service - Natural Gas** | | | | | | | |
| Headquarters | 700,000 cu ftlyr | 5 | 0 | 66 | 28 | 4 | 84,000 |
| | Total | 8 | 0 | 153 | 40 | 6 | 161,500 |
| **Canadian River Water Authority - Propane** | | | | | | | |
| Laboratory | 1,360 | 1 | 0 | 19 | 0 | 0 | 17,002 |
| Laboratory | 315 | 0 | 0 | 4 | 0 | 0 | 3,932 |
| Meter Shop | 1,157 | 0 | 0 | 16 | 0 | 0 | 14,458 |
| Meter Shop | 250 | 0 | 0 | 3 | 0 | 0 | 3,123 |
| Equipment Shop | 694 | 0 | 0 | 10 | 0 | 0 | 8,675 |
| Equipment Shop | 1,666 | 1 | 0 | 23 | 0 | 0 | 20,819 |
| Equipment Shop | 333 | 0 | 0 | 5 | 0 | 0 | 4,164 |
| Headquarters | 1,388 | 1 | 0 | 19 | 0 | 0 | 17,349 |
| Headquarters | 1,666 | 1 | 0 | 23 | 0 | 0 | 20,819 |
| Headquarters | 1,628 | 1 | 0 | 23 | 0 | 0 | 20,356 |
| Headquarters | 910 | 0 | 0 | 13 | 0 | 0 | 11,369 |
| Resource Office | 1,360 | 1 | 0 | 19 | 0 | 0 | 17,002 |
| Resource Office | 315 | 0 | 0 | 4 | 0 | 0 | 3,932 |
| Total | 13,040 | 5 | 0 | 183 | 4 | 4 | 163,000 |
| | | | | | | | |
| | Park Totals | 13 | 1 | 335 | 66 | 10 | 324,000 |

TABLE **3: 2001** POTENTIAL CRITERIA EMISSIONS FROM HEATING EQUIPMENT AT LAKE MEREDITH NRA

| **Location** | **Consumption (gal/yr)** | **$PM_{10}$ (Ibs/yr)** | $SO_2$ **(lbs/yr)** | **$NO_X$ (Ibs/yr)** | **CO (Ibs/yr)** | **VOC (Ibs/yr)** | **$CO_2$ (Ibs/yr)** |
|---|---|---|---|---|---|---|---|
| **National Park Service - Propane** | | | | | | | |
| Sanford Ranger Station | 7,701 | 3 | 0 | 108 | 15 | 2 | 96,264 |
| Sanford Ranger Station | 2,888 | 1 | 0 | 40 | 6 | 1 | 36,099 |
| Sanford Maintenance | 8,664 | 3 | 0 | 121 | 17 | 3 | 108,297 |
| Sanford Maintenance | 2,888 | 1 | 0 | 40 | 6 | 1 | 36,099 |
| Sanford Sign Shop | 7,701 | 3 | 0 | 108 | 15 | 2 | 96,264 |
| Sanford Adm Building | 11,552 | 5 | 0 | 162 | 23 | 3 | 144,396 |
| Sanford Adm Building | 5,776 | 2 | 0 | 81 | 12 | 2 | 72,198 |
| Fire Cache | 17,327 | 7 | 0 | 243 | 35 | 5 | 216,593 |
| **National Park Service - Natural Gas** | | | | | | | |
| Headquarters | 1,288,235 cu ft/yr | 10 | 1 | 121 | 52 | 7 | 154,588 |
| | Total | 36 | 1 | 1,024 | 181 | 26 | 960,797 |
| **Canadian** River **Municipal Water Authority - Propane** | | | | | | | |
| Laboratory | 14,151 | 6 | 0 | 198 | 28 | 4 | 176,885 |
| Laboratory | 3,273 | 1 | 0 | 46 | 7 | 1 | 40,912 |
| Meter Shop | 12,033 | 5 | 0 | 168 | 24 | 4 | 150,412 |
| Meter Shop | 2,599 | 1 | 0 | 36 | 5 | 1 | 32,489 |
| Equipment Shop | 7,220 | 3 | 0 | 101 | 14 | 2 | 90,247 |
| Equipment Shop | 17,327 | 7 | 0 | 243 | 35 | 5 | 216,593 |
| Equipment Shop | 3,465 | 1 | 0 | 49 | 7 | 1 | 43,319 |
| Headquarters | 14,440 | 6 | 0 | 202 | 29 | 4 | 180,495 |
| Headquarters | 17,327 | 7 | 0 | 243 | 35 | 5 | 216,593 |
| Headquarters | 16,942 | 7 | 0 | 237 | 34 | 5 | 211,780 |
| Headquarters | 9,463 | 4 | 0 | 132 | 19 | 3 | 118,284 |
| Resource Office | 14,151 | 6 | 0 | 198 | 28 | 4 | 176,885 |
| Resource Office | 3,273 | 1 | 0 | 46 | 7 | 1 | 40,912 |
| Total | 135,664 | 54 | 1 | 1,899 | 271 | 41 | 1,695,806 |
| | | | | | | | |
| | Park Totals | 90 | 2 | 2,923 | 452 | 67 | 2,656,603 |

### 2.1.2 Generators

There are no stationary generators at Lake Meredith NRA.

### 2.1.3 Fuel Storage Tanks

There are two gasoline aboveground gasoline storage tanks at the Sanford Yake Marina in Lake Meredith NRA that serves the boating public. The park has no gasoline tanks for its vehicles since park-operated vehicles are refueled at off-site commercial gas stations. Emissions from fuel storage tanks were calculated using the EPA *TANKS 4.0* model. The gasoline tanks are equipped with Phase I vapor emission controls that capture vapors displaced from the vapor space in the tank when it is refilled. Emissions associated with gasoline dispensing are accounted for in the mobile source model.

There are two basic types of VOC emissions from storage tanks: working losses and standing losses. Working losses are composed of both withdrawal and refilling loss emissions. Withdrawal loss emissions result from the vaporization of liquid fuel residue on the inner surface of tank walls as the liquid levels in the tank are decreased and air is drawn into the tank. Refilling losses refer to fuel vapor releases to the air during the process of refilling the tank as the liquid level in the tank increases and pressurizes the vapor space. Standing losses describe those tank emissions from the vaporization of the liquid fuel in storage due to changes in ambient temperatures. VOC losses are also a direct function of the annual product throughput or turnovers. VOC emissions from gasoline storage tanks are summarized in Table 4.

**TABLE 4: LAKE MEREDITH NRA GASOLINE STORAGE TANK EMISSIONS**

| **Location** | Number | **Type** | **Volume (gal)** | **Throughput** (gal/yr) | **VOC (lbs/yr)** |
|---|---|---|---|---|---|
| Sanford Yake Marina | 1 | AST | 5,000 | 10,500 | 750 |
| | 1 | AST | 2,500 | 5,250 | 425 |
| Totals | 2 | | | 15,750 | 1,175 |

### 2.1.4 Wastewater Treatment Plants

Wastewater is treated in leach fields at Lake Meredith NRA. Since these are passive systems rather than mechanical processes such as primary wastewater treatment plants, few VOC emissions are generated.

## 2.2 AREA SOURCES

### 2.2.1 Woodstoves/Fireplaces

There are no woodstoves or fireplaces in Lake Meredith NRA.

### 2.2.2 Campfires

There are ten campgrounds throughout Lake Meredith NRA that accommodate tent and recreation vehicles (RVs). Park personnel provided estimates of the total number of campers at both NPS and concessionaire operated sites. It was estimated that only 25 percent of these were tent campers, with the remainder being RV campers. There were an estimated 2.5 campers per campsite and approximately 50 percent had an evening or morning campfire at each campsite. Assuming that each campfire site consumes approximately 10 lbs of wood, air emissions from campsites in 2001 were calculated and are summarized in Table 5.

**TABLE 5: 2001 LAKE MEREDITH NRA CAMPFIRE EMISSIONS**

| **Tent Campers** | **Campfires** | **Fuel** (tons/yr) | **$PM_{10}$ (lbs/yr)** | $SO_2$ (lbs/yr) | **NOx (lbs/yr)** | **CO** (Ibs/yr) | **VOC (lbs/yr)** |
|---|---|---|---|---|---|---|---|
| 16,130_ | 6,450 | 16 | 558 | 6 | 42 | 4,075 | 3,694 |
| | | | tons/yr | | | | |
| | | | 0.28 | <0.01 | 0.02 | 2.04 | 1.85 |

### 2.2.3 Wildfires and Prescribed Fires

Wildland fire consists of both wildfires and prescribed fires. Wildfires are ignited naturally, usually by lightening, are typically unwanted, and therefore suppressed. On the other hand, prescribed burning is a land treatment process to accomplish natural resource management objectives, including reducing the potential for destructive wildfires, eliminating excessive fuel buildup, controlling insects and disease, improving wildlife habitat and forage production, maintaining natural succession of plant communities, and

restoring natural processes. Prescribed burning can be for either ecological restoration or ecological maintenance. By policy, only prescribed burning for ecological restoration is considered an anthropogenic source of emissions; however, for the purposes of this emissions inventory, all prescribed burning has been treated as an anthropogenic source.

Park data indicated that an average of 1,120 acres a year had been consumed by prescribed burning over the 1998-2002 timeframe and another 1,380 acres a year by wildfires. The vegetation was a mixture of blue grama buffalo grass and bluestem grama grassland.

The First Order Fire Effects Model (FOFEM) was used to estimate emissions from prescribed fires. FOFEM is a computer program developed by the Intermountain Fire Sciences Lab, U.S. Forest Service to predict the effects of prescribed fire and wildfire in forests and rangelands throughout the U.S. In particular, it quantifies emissions of $PM_{10}$, $PM_{2.5}$, CO, $C0_2$, and VOCs ($CH_4$) which are summarized in Table 6 for prescribed burning and wildfires. Emission factors produced by the FOFEM model and emission calculations are provided in Appendix B.

**TABLE 6: AIR EMISSIONS FROM PRESCRIBED BURNING AND WILDFIRES IN 2001 IN LAKE MEREDITH NRA**

| Fuel Type | Acres | PM10 (Ibs/yr) | $PM_{2,5}$ (Ibs/yr) | VOC[1] (lbs/yr) | CO (lbs/yr) | $CO_2$ (Ibs/yr) |
|---|---|---|---|---|---|---|
| **Prescribed Burning** | | | | | | |
| Blue Grama-Buffalo Grass | 560 | 1,680 | 1,680 | 560 | 3,920 | 1,129,520 |
| Bluestem-Grama Prairie | 560 | 3,360 | 2,800 | 560 | 6,720 | 1,864,240 |
| Totals | 1,120 | 5,040 | 4,480 | 1,120 | 10,640 | 2,993,760 |
| **Wildfires** | | | | | | |
| Blue Grama-Buffalo Grass | 690 | 2,070 | 2,070 | 690 | 4,830 | 1,391,730 |
| Bluestem-Grama Prairie | 690 | 4,140 | 3,450 | 690 | 8,280 | 2,297,010 |
| Totals | 1,380 | 6,210 | 5,520 | 1,380 | 13,110 | 3,688,740 |

As methane ($CH_4$)

### 2.2.4 Oil and Gas Operations

The park is near the center of Carson, Moore, Hutchinson, and Potter Counties where petroleum, petrochemical, and related industries are important components to the local and regional economies. There are approximately 9,200 producing wells in these four counties and about 170 in the park itself When the park was created, the federal government acquired surface ownership within the two areas, but either private entities or the state retained subsurface mineral interests. Thus, the federal government does not own any of the subsurface oil and gas rights in the parks. In addition, there are transpark oil and gas pipelines and activities in their associated rights-of-way. Based on average well production rates in the four counties, production from

wells inside the park is estimated to be about 7,000 barrels of oil and condensate and 8 billion cubic feet of gas per year, which represents about 0.3 percent and 6 percent of the oil and gas production, respectively, in the four county area (NPS 2002).

Park officials estimate that there are about 40 gas compressors rated at about 400 cubic inches that are on park property. Emissions from these gas compressors were calculated based on the assumption that the compressors operate on a full-time basis, and these are provided in Table 7. In addition to the compressors, the exploration and production of oil and gas in the park has the potential to impact air quality from other miscellaneous sources, including (NPS 2002):

- air-drilling
- construction of access roads, wellpads, production facilities, flowlines, gathering lines, compressors, and pipelines
- site reclamation activities
- oil storage tanks
- vehicle traffic on paved and unpaved roads
- accidental oil product spills
- flaring of gas during well testing and production operations.

### 2.2.5 **Miscellaneous Area Sources**

Miscellaneous area sources include food preparation, degreasers, paints and other surface coatings, lighter fluid consumption, consumer solvents, propane use by visitors in recreational vehicles, and highway maintenance, such as paving materials. However, few data on these activities and products were available, and their emissions are negligible.

## 2.3 **SUMMARY** OF STATIONARY AND AREA **SOURCE EMISSIONS**

Table 7 summarizes the stationary and area source emissions calculated above in a format that allows comparison between the various sources as well as providing totals for each pollutant or pollutant category under consideration.

TABLE 7: SUMMARY OF **2001** STATIONARY AND AREA SOURCE EMISSIONS AT **LAKE MEREDITH NRA**

| Activity | Particulates ($PM_{10}$) | | Sulfur Dioxide | | Nitrogen Oxides | | Carbon Monoxide | | Carbon Dioxide | | VOCs | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr |
| | | | | Stationary **Sources** | | | | | | | | |
| Heating Equipment | 13 | <0.01 | 1 | <.01 | 335 | 0.17 | 66 | 0.03 | 324,000 | 162 | 10 | <0.01 |
| Gasoline Storage Tanks | | | | | | | | | | | 1,175 | 0.59 |
| Stationary Sources Subtotal | 13 | <0.01 | 1 | <.01 | 335 | 0.17 | 66 | 0.03 | 324,000 | 162 | 1,185 | 0.60 |
| | | | | Area **Sources** | | | | | | | | |
| Campfires | 558 | 0.28 | 6 | <0.01 | 42 | 0.02 | 4,075 | 2.04 | -- | -- | 3,694 | 1.85 |
| Prescribed Burning | 5,040 | 2.52 | -- | -- | -- | -- | 10,640 | 5.32 | 2,993,760 | 1,497 | 1,120 | 0.56 |
| Wildfires | 6,210 | 3.11 | -- | -- | -- | -- | 13,110 | 6.56 | 3,688,740 | 1,844 | 1,380 | 0.69 |
| Oil and Gas Well Compressors | 12,912 | 6.46 | 14,673 | 7.34 | 105,646 | 52.82 | 44,020 | 22.01 | 4,531,022 | 2,266 | 31,048 | 15.52 |
| Area Sources Total | 24,720 | 12.36 | 14,680 | 7.34 | 105,688 | 52.84 | 71,845 | 35.92 | 11,213,522 | 5,607 | 37,242 | 18.62 |
| | | | | **Totals** | | | | | | | | |
| | Particulates (PM,o) | | Sulfur Dioxide | | Nitrogen Oxides | | Carbon Monoxide | | Carbon Dioxide | | VOCs | |
| | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr |
| Totals without Prescribed Burning, Wildfires, and Oil and Gas Compressors | 571 | 0.29 | 7 | <0.01 | 377 | 0.19 | 4,141 | 2.07 | 324,000 | 162 | 4,879 | 2.44 |
| Totals with Prescribed Burning | 5,611 | 2.81 | 7 | <0.01 | 377 | 0.19 | 14,781 | 7.39 | 3,317,760 | 1,659 | 6,000 | 3.00 |
| Totals with Prescribed Burning and Oil and Gas Compressors | 18,523 | 9.26 | 14,687 | 7.34 | 106,023 | 53.01 | 58,800 | 29.40 | 7,848,782 | 3,924 | 37,048 | 18.52 |

As methane

# 3. MOBILE SOURCE EMISSIONS

This section summarizes emissions from mobile sources at Lake Meredith NRA for 2001. Mobile emission sources include highway and nonroad vehicles, including marine vessels.

## 3.1 HIGHWAY VEHICLES

### 3.1.1 Visitor Vehicles

Visitors travel only a relatively short distance on park property to reach one of the16 day and overnight visitor use areas in the park. In 2001, 1,248,700 visitors were estimated to have visited the use areas. Assuming a visitor per vehicle ratio of approximately 2.5 and a roundtrip distance on park property of two miles, an estimated 500,000 visitor vehicles traveled one million vehicle miles on park property in 2001.

The majority of mobile source emissions can be categorized as either exhaust or evaporative emissions. Exhaust emissions are related to the combustion of fuel in the engine and include VOC, NOx, CO, and $PM_{10}$. Exhaust emissions are dependent on a number of factors, including engine load, engine design and age, combustion efficiency, emissions equipment such as catalytic converters, and other factors. Evaporative emissions, which can occur while the vehicle is running or at rest, are related to the volatilization of fuel from vapor expansion, leaks and seepage, and fuel tank vapor displacement. Evaporative emissions are primarily dependent on daily temperature cycles and fuel volatility. In addition to vehicle exhaust, $PM_{10}$ emissions also result from brake and tire wear, as well as the re-entrainment of dust from paved and unpaved roads (referred to as fugitive dust).

Emission factors produced by the USEPA MOBILE6.2 model were used in conjunction with VMT data in order to estimate mobile source emissions for VOC (both exhaust and evaporative), NOx, CO, and $PM_{10}$ (exhaust, brake, and tire) for visitor vehicles. MOBILE6.2 produces exhaust and evaporative emission factors for light duty gasoline vehicles, light duty gasoline trucks, heavy duty gasoline vehicles, light duty diesel vehicles, light duty diesel trucks, heavy duty diesel vehicles, and motorcycles. It also produces a composite emission factor for all vehicles based on the vehicle VMT mix supplied to the model. Inputs to the model include average vehicle speed, vehicle VMT mix, inspection and maintenance (UM) program information, fuel information, ambient temperature data, elevation, and others. Fugitive $PM_{10}$ emissions resulting from tire-roadway interaction were based on EPA's road dust emission factors.

The MOBILE6.2 model are typically used to support planning and modeling efforts in urban or regional areas and include default inputs suited for these applications. Therefore, it is suitable for applications over large, regional transportation networks. Application of the MOBILE5b model required the utilization of unique inputs that were representative of mobile source activity within the park. In particular, it was necessary to utilize unique inputs for the visitor vehicle VMT mix and the vehicle age distribution. The Center for Environmental Research and Technology within the College of Engineering at the University of California's Riverside Campus (CE-CERT) established park-specific vehicle fleet characterizations in developing air emission inventories for Zion National Park (CE-CERT, 2001). CE-CERT found that the distribution of vehicle ages in the park reflected a larger fraction of newer vehicles compared to the general vehicle population. The park-specific mix vehicle types and vehicle age distribution developed by CE-CERT have been applied in the mobile modeling for Lake Meredith NRA.

In addition to park-specific age distribution, CE-CERT also developed park-specific modeling inputs for driving patterns that differ significantly from the default driving patterns typically used in mobile modeling, such as the Federal Test Procedure (FTP). In particular, they found that the FTP reflects both higher speeds and a wider range of speeds than observed in national parks. However, since the MOBILE6.2 model is not designed to readily incorporate unique driving pattern data, the default driving cycle remains the basis for the mobile source emission estimates provided here.

Other important mobile modeling inputs that can significantly affect mobile emission factors are the average speed, fuel characteristics, and UM program parameters. The average speed input to the mobile model was 35 mph, and fuel volatility was assumed to be Reid vapor pressure (RVP) of 8.0 (summer) and 11.8 (winter)[1]. Finally, UM program inputs were not included since there are no I/M programs in the areas near the park.

In order to account for seasonal differences in mobile emissions, separate MOBILE6.2 runs were performed to produce emission factors for winter and summer. A composite emission factor for each season, reflecting a park specific VMT mix adapted from CE-CERT, served as the basis for mobile source emission estimates. Additional particulate emissions (or entrained road dust) from vehicles operating on paved roads in Lake Meredith NRA also were calculated based on VMT. A summary of visitor vehicle emissions is provided in Table 11 at the end of this section.

[1] Office of Transportation and Air Quality, U.S. Environmental Protection Agency, EPA420-R-02-011, February 2002

### 3.1.2 NPS/GSA Highway Vehicles

Lake Meredith NRA operates a fleet of highway vehicles that are owned by the Depal tinent of the Interior (DOI) or leased from the General Services Administration (GSA). Emission factors by vehicle class were used to estimate emissions from the NPS and GSA vehicles. A summary of NPS and GSA vehicles and their estimated annual mileage is provided in Table 8, and emissions are summarized in Table 11 at the end of this section. A tenant, the Canadian River Municipal Water Authority (CEMWA) also operates a fleet of vehicles; however, it is estimated that approximately one percent of their mileage is accumulated on park proper for a total of less than 5,000 miles.

**TABLE 8: NPS AND GSA ROAD VEHICLES AT LAKE MEREDITH NRA**

| Vehicle Type | Number | Annual Usage (mi/yr) |
|---|---|---|
| **DOIJNPS Vehicles** | | |
| Light Duty Gasoline Vehicles | 0 | 0 |
| Light Duty Gasoline Trucks | 11 | 121,000 |
| Light Duty Diesel Trucks | 1 | 11,000 |
| Heavy Duty Diesel Trucks | 14 | 154,000 |
| Totals | 26 | 286,000 |
| **GSA Vehicles** | | |
| Light Duty Gasoline Vehicles | 3 | 33,000 |
| Light Duty Gasoline Trucks | 18 | 198,000 |
| Heavy Duty Gasoline Vehicles | 0 | 0 |
| Heavy Duty Diesel Trucks | 2 | 13,900 |
| Totals | 23 | 244,900 |

N.A. - Not Available

## 3.2 NPS NONROAD VEHICLES

The NPS also owns and operates nonroad motorized equipment that is used to maintain roads and grounds and for other purposes. There are records of the Lake Meredith NRA equipment inventory, while operating hours data were taken from those thought to be representation of a park this size. These data are noted in Table 9. Emission factors from the USEPA nonroad emission database were used to calculate annual emissions that are provided in Table 11.

**TABLE 9: NPS NONROAD VEHICLES AT LAKE MEREDITH NRA**

| Vehicle Type | Number | Annual Usage (hrs/yr) |
|---|---|---|
| Tractors | 2 | 500 |
| Grader | 1 | 100 |
| Backhoe | 1 | 100 |
| Mowers | 7 | 700 |
| Sweepers | 2 | 200 |
| Forklifts | 2 | 200 |
| Front End Loader | 1 | 100 |
| ATVs | 4 | 500 |

## 3.3 MARINE VESSELS

Water-based activities are principal recreation activities in the park. Data on public marine vessels and personal watercraft emissions were obtained from a recent Personal Watercraft Use Environmental Assessment (NPS 2003) and are presented in Table 11 and Appendix B. It should be noted that personal watercraft were temporarily banned from the park beginning in November 2002. The ban remains in effect until a special regulation is finalized. Data for NPS owned and operated marine vessels were provided by park personnel, and emissions were estimated using EPA nonroad emission factors for 2-stroke and 4-stroke engines. A summary of these data are provided in Table 10, and emission factors for the various types of marine vessels are provided in Appendix B.

**TABLE 10: LAKE MEREDITH NRA NPS MARINE VESSEL EMISSIONS**

| Marine Vessel Type | Rated Engine Power (hp)[3] | Hours of Operation | $PM_{10}$ (lb/yr) | $NO_x$ (lb/yr) | CO (lb/yr) | HC (lb/yr) |
|---|---|---|---|---|---|---|
| Twin-engine, Two-stroke Outboard[1] | 150 | 100 | 107 | 17 | 3,208 | 1,614 |
| Twin-engine, Two-stroke Outboard[1] | 225 | 100 | 160 | 25 | 4,811 | 2,421 |
| Single-engine, Four-stroke Inboard/Outboard[1] | 120 | 30 | 13 | 2 | 385 | 194 |
| Twin-engine, Four-stroke Outboard[1] | 130 | 100 | 1 | 90 | 4,077 | 179 |
| Single-engine, Two-stroke Outboard[2] | 115 | 50 | 20 | 3 | 615 | 309 |
| | | Totals | 301 | 136 | 13,096 | 4,718 |

[1] NPS boat [2] CRMWA boat [3] An average load factor of 0.21 was applied to all rated hp

## 3.4 SUMMARY OF MOBILE SOURCE EMISSIONS

Table 11 summarizes the mobile source emissions calculated above in a format that allows comparison between the various sources as well as providing totals for each pollutant or pollutant category under consideration.

**TABLE 11: SUMMARY OF 2001 MOBILE SOURCE EMISSIONS AT LAKE MEREDITH NRA**

| Activity | Particulates (PM, 0) | | Sulfur Dioxide | | Nitrogen Oxides | | Carbon Monoxide | | VOCs | |
|---|---|---|---|---|---|---|---|---|---|---|
| | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr |
| **Road Vehicles** | | | | | | | | | | |
| Visitor Vehicles | 1,923 | 0.96 | -- | -- | 2,962 | 1.48 | 47,983 | 1.17 | 2,339 | 1.17 |
| DOI/NPS Road Vehicles | 640 | 0.32 | -- | -- | 6,062 | 3.03 | 8,943 | 4.47 | 500 | 0.25 |
| GSA Road Vehicles | 477 | 0.24 | -- | -- | 1,185 | 0.59 | 12,660 | 6.33 | 606 | 0.30 |
| Road Vehicle Emission Subtotal | 20,348 | 10.17 | -- | -- | 10,209 | 5.11 | 69,586 | 34.79 | 3,445_ | 1.72 |
| **Nonroad Vehicles** | | | | | | | | | | |
| NPS Nonroad Vehicles | 447 | 0.22 | -- | -- | 3,060 | 1.53 | 1,770 | 0.88 | 536 | 0.27 |
| Public Motorized Boats | 10,200 | 5.10 | -- | -- | 7,600 | 3.80 | 491,000 | 245.50 | 116,400 | 58.20 |
| Public/Rental Personal Watercraft | 4,200 | 2.10 | -- | -- | 600 | 0.30 | 185,000 | 92.50 | 85,600 | 42.80 |
| NPS Marine Vessels | 300 | 0.15 | -- | -- | 136 | 0.07 | 13,096 | 6.55 | 4,718 | 2.36 |
| Nonroad Vehicle Emission Subtotal | 15,147 | 7.58 | -- | -- | 11,396 | 5.70 | 690,866 | 345.43 | 207,254 | 103.63 |
| **Totals** | | | | | | | | | | |
| | Particulates (PM,o) | | Sulfur Dioxide | | Nitrogen Oxides | | Carbon Monoxide | | VOCs | |
| | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr | lbs/yr | tons/yr |
| Totals | 35,495 | 17.75 | -- | -- | 21,605 | 10.80 | 760,450 | 380.23 | 210,700 | 105.35 |

Includes exhaust PM ;o and road dust

# 4. LAKE MEREDITH NRA AND REGIONALEMISSION SUMMARY

## 4.1 LAKE MEREDITH NRA SUMMARY

A summary of Lake Meredith NRA emissions is provided in Table 12.

**TABLE 12: ESTIMATED ANNUAL EMISSIONS FROM LAKE MEREDITH NRA**

| Source | $PM_{10}$ (tons) | $SO_2$ (tons) | NO,~ (tons) | CO (tons) | VOCs (tons) |
|---|---|---|---|---|---|
| **Point Sources** | | | | | |
| Space and Water Heaters | <0.01 | <0.01 | 0.17 | 0.03 | <0.01 |
| Gasoline Storage Tanks | -- | -- | -- | -- | 0.59 |
| Subtotal | <0.01 | <0.01 | 0.17 | 0.03 | 0.60 |
| **Area Sources** | | | | | |
| Campfires | 0.28 | <0.01 | 0.02 | 2.04 | 1.85 |
| Prescribed Burning | 2.52 | -- | -- | 5.32 | 0.56 |
| Wildfires | 3.11 | -- | -- | 6.56 | 0.69 |
| Oil and Gas Well Operations | 6.46 | 7.34 | 52.82 | 22.01 | 15.52 |
| Subtotal | 12.36 | 7.34 | 52.84 | 35.92 | 18.62 |
| **Mobile Sources** | | | | | |
| Road Vehicles | 10.17 | -- | 5.11 | 34.79 | 1.72 |
| Nonroad Vehicles | 0.22 | -- | 1.53 | 0.88 | 0.27 |
| Marine Vessels | 7.35 | -- | 4.17 | 344.55 | 103.36 |
| Subtotal | 17.75 | -- | 10.80 | 380.23 | 105.35 |
| Totals | | | | | |
| Totals | 30.11 | 7.34 | 63.81 | 416.18 | 124.57 |

## 4.2 Regional Air Emissions

Emission estimates for Hutchinson, Moore, and Potter Counties and the State of Texas were obtained from the 1999 National Emission Inventory (NEI) maintained by USEPA. It is important to note that differences may exist between the methodologies used to generate the park emission inventory and those used to generate the NEI. For example, here gasoline storage tanks have been included as stationary sources, while the NEI treats them as area sources. Table 13 provides a comparison of Lake Meredith NRA emissions with those from the surrounding counties and the state. For all pollutants, Lake Meredith NRA emissions account for less than 1 percent of the surrounding county point and mobile source emissions.

**TABLE 13: ESTIMATED ANNUAL EMISSIONS FROM LAKE MEREDITH NRA, SURROUNDING COUNTIES, AND THE STATE OF TEXAS**

| Area | $PM_{10}$ (tons/yr) | $SO_2$ (tons/yr) | NOx (tons/yr) | CO (tons/yr) | VOC (tons/yr) |
|---|---|---|---|---|---|
| | **Point Sources** | | | | |
| Lake Meredith NRA Total | <0.01 | <0.01 | 0.17 | 0.03 | 0.60 |
| | | | | | |
| Hutchinson County, TX | 539 | 19,540 | 7,206 | 17,510 | 7,842 |
| Moore County, TX | 264 | 10,804 | 12,556 | 6,529 | 2,061 |
| Potter County, TX | 519 | 29,095 | 16,578 | 4,213 | 542 |
| Surrounding Counties | 1,322 | 59,439 | 36,340 | 28,252 | 10,445 |
| | | | | | |
| Texas | 54,700 | 977,386 | 920,494 | 463,370 | 251,840 |
| | **Area Sources** | | | | |
| Lake Meredith NRA Total | 12.36 | 7.34 | 52.84 | 35.92 | 18.62 |
| | | | | | |
| Hutchinson County, TX | 1,964 | 25 | 35 | 101 | 2,122 |
| Moore County, TX | 2,562 | 14 | 23 | 61 | 2,436 |
| Potter County, TX | 2,435 | 68 | 114 | 331 | 4,073 |
| Surrounding Counties | 6,961 | 107 | 172 | 493 | 8,631 |
| | | | | | |
| Texas | 797,800 | 8,361 | 40,542 | 532,560 | 545,340 |
| | **Mobile Sources** | | | | |
| Lake Meredith NRA Total | 17.75 | -- | 10.80 | 380.23 | 105.35 |
| | | | | | |
| Hutchinson County, TX | 5,174 | 110 | 1,561 | 6,774 | 787 |
| Moore County, TX | 2,672 | 139 | 1,395 | 5,085 | 594 |
| Potter County, TX | 4,537 | 410 | 6,059 | 32,910 | 3,582 |
| Surrounding Counties | 12,383 | 659 | 9,015 | 44,769 | 4,963 |
| | | | | | |
| Texas | 1,873,475 | 113,121 | 1,274,494 | 5,161,011 | 600,335 |

# 5. COMPLIANCE AND RECOMMENDATIONS

## 5.1 COMPLIANCE

The Texas Commission on Environmental Quality (formerly, the Texas Natural Resources Conservation Commission) administers the state's air pollution program. Park personnel should coordinate with the agency on permit issues relating to stationary sources, as well as prescribed burning activities (see Appendix D for selected air quality regulations). Prior to replacing or adding relatively large heating units, generators, and fuel storage tanks, the Texas Administrative Code (TAC) should be consulted regarding the need to obtain a permit to construct or a permit to operate such sources. According to the TAC Chapter 106, current general exemptions to these permits include:

- Natural gas or propane fuel burning equipment of less than 40 million Btu per hour heat input
- Stationary internal combustion engines rated less than 240 hp.

According to TAC Chapter 111, Subchapter B, outdoor burning, under certain conditions, is allowed for:

- Fires used solely for recreational or ceremonial purposes (§111.207)
- Prescribed burning (§111.211)
- Firefighting training (§ 111.205).

The park Fire and Resources Management Division personnel noted that they cooperate with the Texas Commission on Environmental Quality in preparation for prescribed burns.

In addition to the 170 gas and oil wells operating on park property, there are numerous industrial facilities and operations surrounding the park that impact air quality. These include thousands of oil and gas wells, the largest inland petroleum refinery in the country, a chemical plant, and several carbon black plants.

NPS regulations governing nonfederal oil and gas operations are published at Title 36 of the Code of Federal Regulations, Part 9, Subpart B (36 CFR Part 9B). Under these regulations, each operator requiring access on, across, or through NPS lands or water may conduct activities only under a Plan of Operations approved by the NPS. Once a Plan of Operations is approved, it serves as the operator's permit to operate in the park. Through the plan, the operator must show that the "...operations will be conducted in a manner that utilizes technologically feasible

methods least damaging to the federally owned or controlled lands, water, and resources of the unit..." These requirements are discussed in greater detail in the recently completed Oil and Gas Management Plan EIS (NPS 2002).

Based on the results of this study, the park is in compliance with state air quality regulations.

## 5.2 RECOMMENDATIONS

**Energy Recordkeeping** Although Lake Meredith NRA had a 2001 Annual Energy Management Data Report, it is incomplete. For example, units of natural gas consumption were not clearly stated, there were no data for gasoline consumption, and no consumption or cost data for diesel fuel. Although NPS gasoline vehicles are refueled off-site at commercial facilities, it would be of interest to track total gasoline usage over time to ascertain increasing or decreasing gasoline consumption trends.

**Oil and Gas** Wells-There are approximately 170 active oil and gas wells on park property that are owned and operated by private interests. These wells produce the overwhelming majority of total emissions from point and area sources within the park. The park recently completely an *Oil and Gas Management Plan, Environmental Impact Statement* for the combined Lake Meredith NRA and Alibates Flint Quarries National Monument (NPS 2002). The purpose of the plan was to clearly define a direction for long-term management of existing and anticipated oil and gas operations associated with the exercise of nonfederal oil and gas interests underlying the parks, while protecting park resources, visitor use and experience, and human health and safety, and preventing impairment to park resources and values.

**Sustainable Development** Actions to promote sustainable development in the design, retrofit, and construction of park facilities have associated air quality benefits. These include actions that reduce or replace consumption of conventional fossil fuels and/or reduce the consumption of other resources. Reductions in potable and non-potable water consumption also achieve concurrent reductions in energy consumption and associated air emissions. Acquisition of energy efficient appliances whenever possible also is an incremental energy saving measure that has associated air quality benefits.

The park has undertaken several actions that reduce emissions and the use of energy and water. These include:

- Photovoltaic-powered parking lights at the boat ramps at Blue West, Harbor Way, and Fritch Fortress.
- Two wind-powered warning lights
- The Alibates Flint Quarries National Monument comfort station is an enclosed vault toilet system that requires pumping at least semi-annually. A retrofit project installed a patented vault system that converts 75 percent or more of waste material to water vapor. Since the retrofit was accomplished, pumping the vaults has almost been eliminated, resulting in reduced pump truck diesel fuel consumption and emissions.
- The park has 16 solar photovoltaic powered comfort stations in back country areas, and ten more will be installed in 2004.
- Solar heating panels provide partial heating in the Roads and Trails Shop and Buildings and Utilities Shop.

**Marine**Vessels-Marine engines are estimated to produce over 80 percent of both CO and VOC emissions that are generated by stationary, area, and mobile sources within the park. Emissions from marine vessels operated by the public on Lake Meredith NRA far exceed emissions from visitor road vehicles. However, over time these levels will decrease as new marine gasoline engines that meet new EPA standards are phased in. Table 14 compares estimated emissions from personal watercraft and motor boats operating at Lake Meredith NRA in 2002 to a proposed scenario wherein personal watercraft are regulated under an NPS strategy that reduces user conflicts in certain lake areas by the year 2012 (NPS 2003).

**TABLE 14: PERSONAL WATERCRAFT AND MOTOR BOAT EMISSIONS AT LAKE MEREDITH NRA UNDER SPECIAL NPS REGULATION**

| **$PM_{10}$ (tons/yr)** | $NO_x$ (tons/yr) | **CO (tons/yr)** | **VOC** (tons/yr) |
|---|---|---|---|
| **2002** | | | |
| 6.7 | 3.8 | 313.7_ | 95.8 |
| **2012** | | | |
| 5.0 | 4.3 | 256.7 | 47.7 |
| **Percent Change** | | | |
| -25 | +13 | -18 | -50 |

Two of the four marine vessels operated by the NPS are equipped with 2-stroke engines. As these engines and vessels are replaced, models with 4-stroke engines should be procured. Four-stroke engines produce significantly lower $PM_{10}$ and VOC emissions compared to 2-stroke models. However, NOx and CO emissions would increase.

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# APPENDIX A

# FUEL DATA AND EMISSION FACTORS

## FUEL DATA

| Fuel | Heating Value | Sulfur Content |
|---|---|---|
| No. 2 Distillate Fuel Oil/Diesel | 140,000 Btu/gal | 0.05% by weight |
| Natural Gas | 1,050 Btu/$ft^3$ | 2,000 grains/$10^6$ $ft^3$ |
| Propane | 91,500 Btu/gal | 0.18 grains/100 $ft^3$ |

## STATIONARY SOURCE EMISSION FACTORS - BOILERS/HEATING UNITS

| DISTILLATE OIL (DF-2) - CRITERIA POLLUTANTS | | | | | |
|---|---|---|---|---|---|
| Combustor Type | Emission Factor (lb/1.000 gal fuel burned) | | | | |
| | PM [a] | S02 [b] | $NO_X$ [c] | CO | VOC [a] |
| Residential Furnace) | 0.4 | 142S | 18 | 5 | 0.713 |
| Boilers < 100 Million Btu/hr (Commercial/Institutional Combust. [r]) | 2 | 142S | 20 | 5 | 0.34 |
| Boilers < 100 Million Btu/hr (Industrial Boilers [s]) | 2 | 142S | 20 | 5 | 0.2 |
| Boilers > 1 00 Million Btu/hr (Utility Boilers [h]) | 2 | 157S | 24 | 5 | -- |
| Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Tables 1.3-1 and 1.3-3. | | | | | |

| NATURAL GAS - CRITERIA POLLUTANTS | | | | | |
|---|---|---|---|---|---|
| Combustor Type (MMBtu/hr Heat Input) | Emission Factor (lb/$10^6$ $ft^3$ fuel burned) | | | | |
| | PM [j] | $SO_2$ | NO, [v] | CO | VOC |
| Residential Furnaces (<0.3) | | | | | |
| -Uncontrolled | 7.6 | 0.6 | 94 | 40 | 5.5 |
| Tangential-Fired Boilers (All Sizes) | | | | | |
| -Uncontrolled | 7.6 | 0.6 | 170 | 24 | 5.5 |
| -Controlled-Flue gas recirculation | 7.6 | 0.6 | 76 | 98 | 5.5 |
| Small Boilers (<100) | | | | | |
| -Uncontrolled | 7.6 | 0.6 | 100 | 84 | 5.5 |
| -Controlled-Low NO, burners | 7.6 | 0.6 | 50 | 84 | 5.5 |
| -Controlled-Low NO, burners/Flue gas recirculation | 7.6 | 0.6 | 32 | 84 | 5.5 |
| Large Wall-Fired Boilers (>100) | | | | | |
| -Uncontrolled (Pre-NSPS) [k] | 7.6 | 0.6 | 280 | 84 | 5.5 |
| -Uncontrolled (Post-NSPS) [k] | 7.6 | 0.6 | 190 | 84 | 5.5 |
| -Controlled-Low $NO_x$ burners | 7.6 | 0.6 | 140 | 84 | 5.5 |
| -Controlled-Flue gas recirculation | 7.6 | 0.6 | 100 | 84 | 5.5 |
| Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Tables 1.4-1 and 1.4-2. | | | | | |

## STATIONARY SOURCE EMISSION FACTORS - BOILERS/HEATING UNITS (Continued)

| PROPANE (LPG) - CRITERIA POLLUTANTS | | | | | |
|---|---|---|---|---|---|
| Combustor Type | Emission Factor (lb/1,000 'al fuel burned) | | | | |
| | PM[a] | SOP[b] | $NO_X$[c] | CO | VOC[d] |
| Commercial Boilers[t0] | 0.4 | 0.105 | 14 | 1.9 | 0.3 |
| Industrial Boilers[(~~] | 0.6 | 0.10S | 19 | 3.2 | 0.3 |
| Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 1.5-1. | | | | | |

## STATIONARY SOURCE EMISSION FACTORS - GENERATORS

For generators rated at less than or equal to 448 kW (600 hp):

| Fuel Type | | Emission Factor (lb/hp-hr) | | | |
|---|---|---|---|---|---|
| | PM | $SO_X$ | $NO_X$ | CO | VOC |
| DF-2 | 2.20 E-03 | 2.05 E-03 | 0.031 | 6.68 E-03 | 2.51 E-03 |
| Gasoline | 7.21 E-04 | 5.91 E-04 | 0.011 | 0.439 | 0.022 |
| Natural Gas/Propane | 1.54 E-04 | 7.52 E-03(S) | 3.53 E-03 | 8.6 E-04 | 1.92 E-04 |
| Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 3.3-1 and 3.1-1 | | | | | |

For generators rated at greater than 448 kW (600 hp):

| Fuel Type | Emission Factor (lb/hp-hr) | | | | |
|---|---|---|---|---|---|
| | PM | $SO_x$[b] | NO,, | CO | VOC |
| DF-2 | 0.0007 | (8.09 E-03)S | 0.024 | 5.5 E-03 | 6.4 E-04 |
| Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 3.4-1. | | | | | |

## FIREPLACE EMISSION FACTORS

| Fuel Type | | Emission Factor (lb/ton) | | | |
|---|---|---|---|---|---|
| | PM[a] | $SO_X$ | $NO_X$[c] | CO | VOC |
| Wood | 34.6 | 0.4 | 2.6 | 252.6 | 229.0 |
| Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 1.9-1. | | | | | |

## WOODSTOVE EMISSION FACTORS

| Stove Type | Emission Factor (lb/ton) | | | | |
|---|---|---|---|---|---|
| | PM[0)] | | NO,[(')] | CO | VOC |
| Conventional | 30.6 | 0.4 | 2.8 | 230.8 | 53 |
| Noncatalytic | 19.6 | 0.4 | -- | 140.8 | 12 |
| Catalytic | 20.4 | 0.4 | 2.0 | 104.4 | 15 |
| Source: AP-42, 5th Edition, Supplements A, B, C, D, and E, Table 1.10-1. | | | | | |

## STATIONARY SOURCE EMISSION FACTORS - SURFACE COATING OPERATIONS

| Surface Coating Type | VOC Emission Factor (lb/gal) |
|---|---|
| Paint: Solvent Base | 5.6 |
| Paint: Water Base | 1.3 |
| Enamel: General | 3.5 |
| Lacquer: General | 6.1 |
| Primer: General | 6.6 |
| Varnish/Shellac: General | 3.3 |
| Thinner: General | 7.36 |
| Adhesive: General | 4.4 |
| Source: *Calculation Methods for Criteria Air Pollutant Emission Inventories,* AL/OE-TR-1994-0049, July 1994. Armstrong Laboratory. | |

(a) PM = Filterable Particulate Matter.
(b) These factors must be multiplied by the fuel sulfur content (for example, if the sulfur content is 0.05%, then S equals 0.05).
(c) Expressed as $NO_2$.
(d) Emission factors given in AP-42 are actually for non-methane total organic compounds (NMTOC) which includes all VOCs and all exempted organic compounds (such as ethane, toxics and HAPs, aldehydes and semivolatile compounds) as measured by EPA reference methods.
(e) Unit Rating <300,000 Btu/hr.
(f) Unit Rating 3300,000 Btulhr, but <10,000,000 Btu/hr.
(g) Unit Rating 310,000,000 Btu/hr, but <100,000,000 Btulhr.
(h) Unit Rating 3100,000,000 Btu/hr.
(i) POM = Particulate POM only.
(j) PM = Filterable Particulate Matter + Condensible Particulate Matter.
(k) NSPS = New Source Performance Standard as defined in 40 CFR 60 Subparts D and Db. Post-NSPS units are boilers with greater than 250 MMBtu/hr of heat input that commenced construction, modification, or reconstruction after August 17, 1971, and units with heat input capacities between 100 and 250 MMBtu/hr that commenced construction, modification, or reconstruction after June 19, 1984.
(1) Emission factors are given on a fuel input basis (lb/MMBtu). To convert to a power output basis (lb/hp-hr), use an average brake-specific fuel consumption (BSFC) of 7,000 Btu/hp-hr.

# APPENDIX **B**

# EMISSION CALCULATIONS

## 2001 ACTUAL CRITERIA EMISSIONS FROM HEATING UNITS AT LAKE MEREDITH NRA

| Emission Source | Facilities | Fuel | Number of Sources | Capacity (Btu/hr) | | Consumption (gal/yr) | PM (Ibs/yr | $SO_2$ (Ibs/yr) | NOx (Ibs/yr) | CO (Ibs/yr) | $CO_2$ (Ibs/yr) | VOC (Ibs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **National Park Service** | | | | | | | | |
| Heater | Sanford Ranger Station | Propane | 1 | 80,000 | 80,000 | 740 | 0 | 0 | 10 | 1 | 9,254 | 0 |
| Water Heater | Sanford Ranger Station | Propane | 1 | 30,000 | 30,000 | 278 | 0 | 0 | 4 | 1 | 3,470 | 0 |
| 1-Heater | Sanford Maintenance | Propane | 1 | 90,000 | 90,000 | 833 | 0 | 0 | 12 | 2 | 10,410 | 0 |
| Water Heater | Sanford Maintenance | Propane | 1 | 30,000 | 30,000 | 278 | 0 | 0 | 4 | 1 | 3,470 | 0 |
| Heater | Sanford Sign Shop | Propane | 2 | 40,000 | 80,000 | 740 | 0 | 0 | 10 | 1 | 9,254 | 0 |
| Heater | Sanford Administration Building | Propane | 3 | 40,000 | 120,000 | 1,110 | 0 | 0 | 16 | 2 | 13,881 | 0 |
| Heater | Sanford Administration Building | Propane | 1 | 60,000 | 60,000 | 555 | 0 | 0 | 8 | 1 | 6,940 | 0 |
| Heater | Fire Cache | Propane | 2 | 90,000 | 180,000 | 1,666 | 1 | 0 | 23 | 3 | 20,821 | 0 |
| | | Subtotal | 12 | | 670,000 | 6,200 | 2 | 0 | 87 | 12 | 77,500 | 2 |
| | | | | | | Cu Ft/Yr | | | | | | |
| Furnaces | Headquarters | Natural Gas | | | | 700,000 | 5 | 0 | 66 | 28 | 84,000 | 4 |
| | | Totals | | | | | 8 | 1 | 153 | 40 | 161,500 | 6 |
| Emission Factors from AP-42, Tables 1.5-1 for commercial boilers, S = 0.18 grains/100 Cu fl | | | | | | | 0.4 | 0.1 *S | 14.00 | 1.90 | 12,500 | 0.30 |
| Propaane Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal) | | | | | | | | | | | | |
| Natural Gas Formula = Consumption (Cu ft/yr) * Emission Factor (lb/1,000,000 Cu fl) | | | | | | | 7.60 | 0.60 | 94.00 | 40.00 | 120,000 | 5.50 |

| Emission Source | Facilities | Fuel | Number of Sources | Capacity (Btu/hr) | | Consumption (gal/yr) | PM (Ibs/yr) | $SO_2$ (Ibs/yr) | NOx (Ibs/yr) | CO (Ibs/yr) | $CO_2$ (Ibs/yr) | VOC (Ibs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **Canadian River Municipal: Water Authority** | | | | | | | | |
| Heater | Laboratory | Propane | 1 | 147,000 | 147,000 | 1,360 | 1 | 0 | 19 | 3 | 17,002 | 0 |
| Water Heater | Laboratory | Propane | 1 | 34,000 | 34,000 | 315 | 0 | 0 | 4 | 1 | 3,932 | 0 |
| Heater | Meter Shop | Propane | 1 | 125,000 | 125,000 | 1,157 | 0 | 0 | 16 | 2 | 14,458 | 0 |
| Water Heater | Meter Shop | Propane | 1 | 27,000 | 27,000 | 250 | 0 | 0 | 3 | 0 | 3,123 | 0 |
| Heater | Equipment Shop | Propane | 1 | 75,000 | 75,000 | 694 | 0 | 0 | 10 | 1 | 8,675 | 0 |
| Heater | Equipment Shop | Propane | 3 | 60,000 | 180,000 | 1,666 | 1 | 0 | 23 | 3 | 20,819 | 0 |
| Water Heater | Equipment Shop | Propane | 1 | 36,000 | 36,000 | 333 | 0 | 0 | 5 | 1 | 4,164 | 0 |
| Heater | Headquarters | Propane | 2 | 75,000 | 150,000 | 1,388 | 1 | 0 | 19 | 3 | 17,349 | 0 |
| Heater | Headquarters | Propane | 3 | 60,000 | 180,000 | 1,666 | 1 | 0 | 23 | 3 | 20,819 | 0 |
| Heater | Headquarters | Propane | 2 | 88,000 | 176,000 | 1,628 | 1 | 0 | 23 | 3 | 20,356 | 0 |
| Heater | Headquarters | Propane | 1 | 98,300 | 98,300 | 910 | 0 | 0 | 13 | 2 | 11,369 | 0 |
| Heater | Resource Office | Propane | 1 | 147,000 | 147,000 | 1,360 | 1 | 0 | 19 | 3 | 17,002 | 0 |
| Water Heater | Resource Office | Propane | 1 | 34,000 | 34,000 | 315 | 0 | 0 | 4 | 1 | 3,932 | 0 |
| | | Total | 19 | | 1,409,300 | 13,040 | 5 | 0 | 183 | 26 | 163,000 | 4 |
| Emission Factors from AP-42, Tables 1.5-1 for commercial boilers, S = 0.18 grains/100 cu ft | | | | | | | 0.4 | 0.1 *S | 14.00 | 1.90 | 12,500 | 0.30 |
| Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal) | | | | | | | | | | | | |
| | | Park Totals | 31 | | | Ibs/yr | 13 | 1 | 335 | 66 | 324,500 | 10 |
| | | | | | | tons/yr | 0.01 | 0.00 | 0.17 | 0.03 | 162 | 0.00 |

## 2001 POTENTIAL CRITERIA EMISSIONS FROM HEATING UNITS AT LAKE MEREDITH NRA

| Emission Source | Facilities | Fuel | Number of Sources | Capacity (Btu/hr) | | Consumption (gal/yr) | PM (Ibs/yr) | $SO_2$ (lbs/yr) | NOx (Ibs/yr) | CO (Ibs/yr) | $CO_2$ (Ibslvr) | VOC (Ibs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | National Park Service | | | | | | | | |
| Heater | Sanford Ranger Station | Propane | I | 80,000 | 80,000 | 7,701 | 3 | 0 | 108 | 15 | 96,264 | 2 |
| Water Heat( | Sanford Ranger Station | Propane | I | 30,000 | 30,000 | 2,888 | 1 | 0 | 40 | 6 | 36,099 | 1 |
| Heater | Sanford Maintenance | Propane | 1 | 90,000 | 90,000 | 8,664 | 3 | 0 | 121 | 17 | 108,297 | 3 |
| Waterl-leat( | Sanford Maintenance | Propane | I | 30,000 | 30,000 | 2,888 | 1 | 0 | 40 | 6 | 36,099 | 1 |
| Beater | Sanford Sign Shop | Propane | 2 | 40,000 | 80,000 | 7,701 | 3 | 0 | 108 | 15 | 96,264 | 2 |
| Heater | Sanford Administration Building | Propane | 3 | 40,000 | 120,000 | 11,552 | 5 | 0 | 162 | 23 | 144,396 | 3 |
| Heater | Sanford Administration Building | Propane | 1 | 60,000 | 60,000 | 5,776 | 2 | 0 | 81 | 12 | 72,198 | 2 |
| Heater | Fire Cache | Propane | 2 | 90,000 | 180,000 | 17,327 | 7 | 0 | 243 | 35 | 216,593 | 5 |
| | | Subtotal | 12 | | 670,000 | 64,497 | 26 | 1 | 903 | 129 | 806,209 | 19 |
| | | | | | | Cu Ft/Yr | | | | | | |
| Furnaces | Headquarters | Natural Gas | 1 | 150,000 | 150,000 | 1,288,235 | 10 | 1 | 121 | 52 | 154,588 | 7 |
| | | Totals | | | | | 36 | 2 | 1,024 | 181 | 960,797 | 26 |
| Emission Factors from AP-42, Tables 1.5-1 for commercial boilers, S = 0.18 grains/100 cu it | | | | | | | 0.4 | 0.1 *S | 14.00 | 1.90 | 12,500 | 0.30 |
| Propaane Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal) | | | | | | | | | | | | |
| Natural Gas Formula = Consumption (cu ft/yr) * Emission Factor (lb/1,000,000 cu ft) | | | | | | | 7.60 | 0.60 | 94.00 | 40.00 | 120,000 | 5.50 |

| Emission Source | Facilities | Fuel | Number of Sources | Capacity (Btu/hr) | | Consumption (pal/yr) | PM (Ibs/yr) | $SO_2$ (Ibs/yr) | NOx (Ibs/yr) | CO Ohs/yr) | $CO_2$ (Ibs/yr) | VOC (Ibs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Canadian River **Municipal** Water Authority | | | | | | | | |
| Heater | Laboratory | Propane | 1 | 147,000 | 147,000 | 14,151 | 6 | 0 | 198 | 28 | 176,885 | 4 |
| Water Heat( | Laboratory | Propane | 1 | 34,000 | 34,000 | 3,273 | 1 | 0 | 46 | 7 | 40,912 | |
| Heater | Meter Shop | Propane | 1 | 125,000 | 125,000 | 12,033 | 5 | 0 | 168 | 24 | 150,412 | 4 |
| Water Heat( | Meter Shop | Propane | 1 | 27,000 | 27,000 | 2,599 | 1 | 0 | 36 | 5 | 32,489 | |
| Heater | Equipment Shop | Propane | 1 | 75,000 | 75,000 | 7,220 | 3 | 0 | 101 | 14 | 90,247 | 2 |
| Heater | Equipment Shop | Propane | 3 | 60,000 | 180,000 | 17,327 | 7 | 0 | 243 | 35 | 216,593 | 5 |
| Water Heat( | Equipment Shop | Propane | I | 36,000 | 36,000 | 3,465 | 1 | 0 | 49 | 7 | 43,319 | |
| Heater | Headquarters | Propane | 2 | 75,000 | 150,000 | 14,440 | 6 | 0 | 202 | 29 | 180,495 | 4 |
| Ileater | Headquarters | Propane | 3 | 60,000 | 180,000 | 17,327 | 7 | 0 | 243 | 35 | 216,593 | 5 |
| Heater | Headquarters | Propane | 2 | 88,000 | 176,000 | 16,942 | 7 | 0 | 237 | 34 | 211,780 | 5 |
| Heater | Headquarters | Propane | 1 | 98,300 | 98,300 | 9,463 | 4 | 0 | 132 | 19 | 118,284 | 3 |
| Heater | Resource Office | Propane | 1 | 147,000 | 147,000 | 14,151 | 6 | 0 | 198 | 28 | 176,885 | 4 |
| Water Heat( | Resource Office | Propane | 1 | 34,000 | 34,000 | 3,273 | 1 | 0 | 46 | 7 | 40,912 | |
| | | Total | 19 | | 1,409,300 | 135,664 | 54 | 2 | 1,899 | 271 | 1,695,806 | 41 |
| Emission Factors from AP-42, Tables 1.5-I for commercial boilers, S = 0.18 grains/100 cu ft | | | | | | | 0.4 | 0.1 *S | 14.00 | 1.90 | 12,500 | 0.30 |
| Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal) | | | | | | | | | | | | |
| | | Park Totals | 31 | | | lbs/yr | 90 | 4 | 2,923 | 452 | 2,656,603 | 67 |
| | | | | | | tons/yr | 0.04 | 0.00 | 1.46 | 0.23 | 1,328 | 0.03 |

# TANKS 4.0
# Emissions Report - Summary Format
# Tank Identification and Physical Characteristics

**Identification**

| | |
|---|---|
| User Identification: | MERE |
| City: | Amarillo |
| State: | Texas |
| Company: | NPS |
| Type of Tank: | Horizontal Tank |
| Description: | 5000 gallon AST |

**Tank Dimensions**

| | |
|---|---|
| Shell Length (ft): | 13.25 |
| Diameter (ft): | 8.00 |
| Volume (gallons): | 5,000.00 |
| Turnovers: | 0.00 |
| Net Throughput (gal/yr): | 10,500.00 |
| Is Tank Heated (yin): | N |
| Is Tank Underground (y/n): | N |

**Paint Characteristics**

| | |
|---|---|
| Shell Color/Shade: | White/White |
| Shell Condition: | Good |

**Breather Vent Settings**

| | |
|---|---|
| Vacuum Settings (psig): | -0.03 |
| Pressure Settings (psig): | 0.03 |

Meteorological Data used in Emissions Calculations: Amarillo, Texas (Avg Atmospheric Pressure = 12.92 psia)

# TANKS 4.0
# Emissions Report - Summary Format
# Tank Identification and Physical Characteristics

**Identification**

| | |
|---|---|
| User Identification: | MERE 1 |
| City: | Amarillo |
| State: | Texas |
| Company: | NPS |
| Type of Tank: | Horizontal Tank |
| Description: | 2500 gasoline AST |

**Tank Dimensions**

| | |
|---|---|
| Shell Length (ft): | 15.00 |
| Diameter (ft): | 5.25 |
| Volume (gallons): | 2,500.00 |
| Turnovers: | 0.00 |
| Net Throughput (gal/yr): | 5,250.00 |
| Is Tank Heated (yin): | N |
| Is Tank Underground (y/n): | N |

**Paint Characteristics**

| | |
|---|---|
| Shell Color/Shade: | White/White |
| Shell Condition: | Good |

**Breather Vent Settings**

| | |
|---|---|
| Vacuum Settings (psig): | -0.03 |
| Pressure Settings (psig): | 0.03 |

Meteorological Data used in Emissions Calculations: Amarillo, Texas (Avg Atmospheric Pressure = 12.92 psia)

# TANKS 4.0
## Emissions Report - Summary Format
## Liquid Contents of Storage Tank

| Mixture/Component | Month | Daily Liquid Surf. Temperatures (deg F) Avg. | Min. | Max. | Liquid Bulk Temp. (deg F) | Vapor Pressures (psia) Avg. | Min. | Max. | Vapor Mol. Weight | Liquid Mass Fract. | Vapor Mass Fract. | Mot. Weight | Basis for Vapor Pressure Calculations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline (RVP 8) | All | 59.09 | 52.30 | 65.88 | 56.96 | 3.9708 | 3.4582 | 4.5430 | 68.0000 | | | 92.00 | Option 4: RVP=8, ASTM Slope=3 |

# TANKS 4M
# Emissions Report - Summary Format
# Individual Tank Emission Totals

## Annual Emissions Report

| | Losses(lbs) | | |
|---|---|---|---|
| Components | Working Loss | Breathing Loss | Total Emissions |
| Gasoline (RVP 8) | 33.75 | 393.66 | 427.42 |

## 2001 ACTUAL EMISSIONS FROM CAMPFIRES AT LAKE MEREDITH NRA

| Location | Total Campers | Tent Campers | Camps[1] | Fires/Yr[2] | Tons/Yr[3] | PM (lbs/yr) | $SO_2$ (Ibs/yr) | $NO_x$ (lbs/yr) | CO (lbs/yr) | VOC (Ibs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| NPS Campgrounds | 64,523 | 16,131 | 6,452 | 3,226 | 16 | 558 | 6 | 42 | 4,075 | 3,694 |
| | | | | | | tons/yr | tons/yr | tons/yr | tons/yr | tons/yr |
| | | | | | | 0.28 | 0.00 | 0.02 | 2.04 | 1.85 |

Assumptions:

[1] There were an estimated 2.5 campers per campsite

[2] Fifty percent of camp sites have either an evening or morning campfire

[3] Assumes 10 lbs wood per fire

| | | | | | |
|---|---|---|---|---|---|
| Emission Factor (Ibs/ton) | 34.60 | 0.40 | 2.60 | 252.60 | 229.00 |

TITLE: Results of FOFEM model execution on date: 6/13/2003

**FUEL** CONSUMPTION CALCULATIONS

Region: Interior West
Cover Type: SAF/SRM - SRM 611 - Blue Grama - Buffalograss
Fuel Type: Natural
Fuel Reference: FOFEM 271

FUEL CONSUMPTION TABLE

| Fuel Component Name | Preburn Load (t/acre) | Consumed Load (t/acre) | Postburn Load (t/acre) | Percent Reduced (%) | Equation Reference Number | Moisture |
|---|---|---|---|---|---|---|
| Litter | 0.00 | 0.00 | 0.00 | 0.0 | 999 | |
| Wood (0-1/4 inch) | 0.00 | 0.00 | 0.00 | 0.0 | 999 | |
| Wood (1/4-1 inch) | 0.00 | 0.00 | 0.00 | 0.0 | 999 | 25.0 |
| Wood (1-3 inch) | 0.00 | 0.00 | 0.00 | 0.0 | 999 | |
| Wood (3+ inch) Sound | 0.00 | 0.00 | 0.00 | 0.0 | 999 | 20.0 |
| 3->6 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 6->9 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 9->20 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 20-> | 0.00 | 0.00 | 0.00 | 0.0 | | |
| Wood (3+ inch) Rotten | 0.00 | 0.00 | 0.00 | 0.0 | 999 | 20.0 |
| 3->6 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 6->9 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 9->20 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 20-> | 0.00 | 0.00 | 0.00 | 0.0 | | |
| Duff | 0.00 | 0.00 | 0.00 | 0.0 | 2 | 100.0 |
| Herbaceous | 0.63 | 0.57 | 0.06 | 90.0 | 221 | |
| Shrubs | 0.00 | 0.00 | 0.00 | 0.0 | 23 | |
| Crown foliage | 0.00 | 0.00 | 0.00 | 0.0 | 37 | |
| Crown branchwood | 0.00 | 0.00 | 0.00 | 0.0 | 38 | |
| Total Fuels | 0.63 | 0.57 | 0.06 | 90.0 | | |

FIRE EFFECTS ON FOREST FLOOR COMPONENTS

| Forest Floor Component | Preburn Condition | Amount Consumed | Postburn Condition | Percent Reduced | Equation Number |
|---|---|---|---|---|---|
| Duff Depth (in) | 0.0 | 0.0 | 0.0 | 0.0 | 6 |
| Min Soil Exp (%) | .0 | 21.9 | 21.9 | 21.9 | 10 |

| | Emissions -- lbs/acre flaming | smoldering | total |
|---|---|---|---|
| PM 10 | 3 | 0 | 3 |
| PM 2.5 | 3 | 0 | 3 |
| CH 4 | 1 | 0 | 1 |
| CO | 7 | 0 | 7 |
| CO 2 | 2017 | 0 | 2017 |

| | Consumption tons/acre | Duration hour:min:sec |
|---|---|---|
| Flaming: | 0.57 | 00:01:00 |
| Smoldering: | 0.00 | 00:00:00 |
| Total: | 0.57 | |

TITLE: Results of FOFEM model execution on date: 6/13/2003

## FUEL CONSUMPTION CALCULATIONS

Region: Interior West
Cover Type: SAF/SRM - SRM 604 - Bluestem - Grama Prairie
Fuel Type: Natural
Fuel Reference: SMFDB 438

FUEL CONSUMPTION TABLE

| Fuel Component Name | Preburn Load (t/acre) | Consumed Load (t/acre) | Postburn Load (t/acre) | Percent Reduced (%) | Equation Reference Number | Moisture |
|---|---|---|---|---|---|---|
| Litter | 0.00 | 0.00 | 0.00 | 0.0 | 999 | |
| Wood (0-1/4 inch) | 0.00 | 0.00 | 0.00 | 0.0 | 999 | |
| Wood (1/4-1 inch) | 0.00 | 0.00 | 0.00 | 0.0 | 999 | 25.0 |
| Wood (1-3 inch) | 0.00 | 0.00 | 0.00 | 0.0 | 999 | |
| Wood (3+ inch) Sound | 0.00 | 0.00 | 0.00 | 0.0 | 999 | 20.0 |
| 3->6 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 6->9 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 9->20 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 20-> | 0.00 | 0.00 | 0.00 | 0.0 | | |
| Wood (3+ inch) Rotten | 0.00 | 0.00 | 0.00 | 0.0 | 999 | 20.0 |
| 3->6 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 6->9 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 9->20 | 0.00 | 0.00 | 0.00 | 0.0 | | |
| 20-> | 0.00 | 0.00 | 0.00 | 0.0 | | |
| Duff | 0.00 | 0.00 | 0.00 | 0.0 | 2 | 100.0 |
| Herbaceous | 1.04 | 0.94 | 0.10 | 90.0 | 221 | |
| Shrubs | 0.00 | 0.00 | 0.00 | 0.0 | 23 | |
| Crown foliage | 0.00 | 0.00 | 0.00 | 0.0 | 37 | |
| Crown branchwood | 0.00 | 0.00 | 0.00 | 0.0 | 38 | |
| Total Fuels | 1.04 | 0.94 | 0.10 | 90.0 | | |

FIRE EFFECTS ON FOREST FLOOR COMPONENTS

| Forest Floor Component | Preburn Condition | Amount Consumed | Postburn Condition | Percent Reduced | Equation Number |
|---|---|---|---|---|---|
| Duff Depth (in) | 0.0 | 0.0 | 0.0 | 0.0 | 6 |
| Min Soil Exp (%) | .0 | 21.9 | 21.9 | 21.9 | 10 |

| | Emissions -- lbs/acre flaming | smoldering | total |
|---|---|---|---|
| PM 10 | 6 | 0 | 6 |
| PM 2.5 | 5 | 0 | 5 |
| CH 4 | 1 | 0 | 1 |
| CO | 12 | 0 | 12 |
| CO 2 | 3329 | 0 | 3329 |

| | Consumption tons/acre | Duration hour:min:sec |
|---|---|---|
| Flaming: | 0.94 | 00:01:00 |
| Smoldering: | 0.00 | 00:00:00 |
| Total: | 0.94 | |

## 2001 WILDFIRE EMISSIONS AT LAKE MEREDITH NRA

| Fuel Type | Acres | $PM_{10}$ (lbs/yr) | $PM_{2.5}$ (lbs/yr) | $CH_4$ (lbs/yr) | CO (lbs/yr) | $CO_2$ (lbs/yr) | $PM_{10}$ (tons/yr) | $PM_{2.5}$ (tons/yr) | $CH_4$ (tons/yr) | CO (tons/yr) | $CO_2$ (tons/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Blue Grama-Buffalo Grass | 690 | 2,070 | 2,070 | 690 | 4,830 | 1,391,730 | 1.04 | 1.04 | 0.35 | 2.42 | 695.87 |
| Bluestem-Grama Prairie | 690 | 4,140 | 3,450 | 690 | 8,280 | 2,297,010 | 2.07 | 1.73 | 0.35 | 4.14 | 1,148.51 |
| Totals | 1,380 | 6,210 | 5,520 | 1,380 | 13,110 | 3,688,740 | 3.11 | 2.76 | 0.69 | 6.56 | 1,844.37 |

| Emission Factors (lbs/acre) | | | | | |
|---|---|---|---|---|---|
| Blue Grama-Buffalo Grass | 3 | 3 | 1 | 7 | 2017 |
| Bluestem-Grama Prairie | 6 | 5 | 1 | 12 | 3,329 |

## PRESCRIBED BURNING EMISSIONS AT LAKE MEREDITH NRA

| Fuel Type | Acres | $PM_{10}$ (lbs/yr) | $PM_{2.5}$ (lbs/yr) | $CH_4$ (lbs/yr) | CO (lbs/yr) | $CO_2$ (lbs/yr) | $PM_{10}$ (tons/yr) | $PM_{2.5}$ (tons/yr) | $CH_4$ (tons/yr) | CO (tons/yr) | $CO_2$ (tons/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Blue Grama-Buffalo Grass | 560 | 1,680 | 1,680 | 560 | 3,920 | 1,129,520 | 0.84 | 0.84 | 0.28 | 1.96 | 564.76 |
| Bluestem-Grama Prairie | 560 | 3,360 | 2,800 | 560 | 6,720 | 1,864,240 | 1.68 | 1.40 | 0.28 | 3.36 | 932.12 |
| | 1,120 | 5,040 | 4,480 | 1,120 | 10,640 | 2,993,760 | 2.52 | 2.24 | 0.56 | 5.32 | 1,496.88 |

| Emission Factors (lbs/acre) | | | | | |
|---|---|---|---|---|---|
| Blue Grama-Buffalo Grass | 3 | 3 | 1 | 7 | 2017 |
| Bluestem-Grama Prairie | 6 | 5 | 1 | 12 | 3,329 |

## **2001** ACTUAL CRITERIA EMISSIONS FROM OIL AND GAS WELL **COMPRESSORS** AT **LAKE MEREDITH NRA**

| Emission Source | Location | Fuel | Number of Sources | Rating (kW) | Run Time (hrs/yr) | Output (kW-hr/yr) | PM (lbs/yr) | $SO_2$ (lbs/yr) | $NO_x$ (lbs/yr) | CO (lbs/yr) | $CO_2$ (lbs/yr) | VOC (lbs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Compressor | Oil and Gas Wells | Natural Gas | 40 | 13 | 8,760 | 4,380,000 | 12,912 | 14,673 | 105,646 | 44,019 | 4,531,022 | 31,048 |
| | | | | | | | 2.20E-03 | 0.05*S | 1.80E-02 | 7.50E-03 | 7.72E-01 | 5.29E-03 |

Emission Factors from AP-42, Chapter 3.4-I for gas generators rated less than 448 kW, S =0.05
Formula = Output (kW-hr/yr) * 1.34 (hp/kW) * Emission Factor (lb/hp-hr)

| PM (tons/yr) | $SO_2$ (tons/yr) | $NO_x$ (tons/yr) | CO (tons/yr) | $CO_2$ (tons/yr) | VOC (tons/yr) |
|---|---|---|---|---|---|
| 6.46 | 7.34 | 52.82 | 22.01 | 2,265.51 | 15.52 |

```
  # # # # # # # # # # # # # # # # # # # #    # # #
' Lake Meredith NRA Winter Conditions.
' File 1, Run 1, Scenario 17.
 # # # # # # # # # # # # # # # # # # # # # # # #
 M584 Warning:
           The user supplied area wide average speed of 35.0
           will be used for all hours of the day. 100°% of VMT
           has been assigned to a fixed combination of freeways,
           freeway ramps, arterial/collector and local roadways
           for all hours of the day and all vehicle types.

 Reading PM Gas Carbon ZML Levels
' from the external data file PMGZML.CSV

 Reading PM Gas Carbon DR1 Levels
 from the external data file PMGDR1.CSV

 Reading PM Gas Carbon DR2 Levels
 from the external data file PMGDR2.CSV

 Reading PM Diesel Zero Mile Levels
 from the external data file PMDZML.CSV

 Reading the First PM Deterioration Rates
 from the external data file PMDDR1.CSV

 Reading the Second PM Deterioration Rates
' from the external data file PMDDR2.CSV

        User supplied gasoline sulfur content = 300.0 ppm.

 M616 Comment:
              User has supplied post-1999 sulfur levels.
 M 48 Warning:
            there are no sales for vehicle class HDGV8b

                  Calendar Year:   2001
                          Month:   Jan.
                       Altitude:   High
            Minimum Temperature:    0.0  (F)
```

Maximum Temperature: 10.0 (F)
Absolute Humidity: 75. grains/lb
Nominal Fuel RVP: 11.8 psi
Weathered RVP: 11.8 psi
Fuel Sulfur Content: 299. ppm

Exhaust I/M Program: No
Evap I/M Program: No
ATP Program: No
Reformulated Gas: No

| Vehicle Type: | LDGV | LDGT12 | LDGT34 | LDGT | HDGV | LDDV | LDDT | HDDV | MC | All Veh |
|---|---|---|---|---|---|---|---|---|---|---|
| GVWR: | | <6000 | >6000 | (All) | | | | | | |
| VMT Distribution: | 0.7002 | 0.1410 | 0.1044 | | 0.0060 | 0.0008 | 0.0016 | 0.0180 | 0.0280 | 1.0000 |
| Composite Emission Factors (g/mi): | | | | | | | | | | |
| Composite VOC : | 1.044 | 1.479 | 1.307 | 1.406 | 1.072 | 0.433 | 0.439 | 0.509 | 2.84 | 1.172 |
| Composite CO | 26.95 | 35.74 | 31.91 | 34.11 | 32.08 | 1.308 | 0.931 | 6.582 | 31.55 | 28.433 |
| Composite NOX : | 1.006 | 1.484 | 1.725 | 1.587 | 4.092 | 1.267 | 1.212 | 16.834 | 1.41 | 1.464 |

| Veh. Type: | LDGT1 | LDGT2 | LDGT3 | LDGT4 | LDDT12 | LDDT34 |
|---|---|---|---|---|---|---|
| VMT Mix: | 0.0330 | 0.1080 | 0.0719 | 0.0325 | 0.0000 | 0.0016 |
| Composite Emission Factors (g/mi): | | | | | | |
| Composite VOC : | 1.383 | 1.508 | 1.269 | 1.389 | 2.424 | 0.391 |
| Composite CO | 34.89 | 36.00 | 31.75 | 32.24 | 6.522 | 0.795 |
| Composite NOX : | 1.168 | 1.580 | 1.558 | 2.095 | 2.555 | 1.180 |

| Veh. Type: | HDGV2B | HDGV3 | HDGV4 | HDGV5 | HDGV6 | HDGV7 | HDGVBA • | HDGV8B |
|---|---|---|---|---|---|---|---|---|
| VMT Mix: | 0.0060 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Composite Emission Factors (g/mi): | | | | | | | | |
| Composite VOC : | 1.072 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Composite CO | 32.08 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Composite NOX : | 4.092 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

| Veh. Type: | HDDV2B | HDDV3 | HDDV4 | HDDV5 | HDDV6 | HDDV7 | HDDV8A | HDDV8E |
|---|---|---|---|---|---|---|---|---|

```
            VMT Mix:     0.0020     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000     0.0000
-----------------------------------------------------------------------------------------------------------------
Composite Emission Factors (g/mi):
    Composite VOC :      0.378      0.000      0.000      0.000      0.000      0.000      0.000      0.000
    Composite CO         1.942      0.000      0.000      0.000      0.000      0.000      0.000      0.000
    Composite NOX :      4.150      0.000      0.000      0.000      0.000      0.000      0.000      0.000


 # # # # # # It # # # # # # # # # # # # # # # # # # # #
 Lake Meredith NRA Summer Conditions.
 File 1, Run 1, Scenario 18.
 # # # # # # # # # # # # # # # # # # # # # # # # # # # #
 M584 Warning:
           The user supplied area wide average speed of 35.0
           will be used for all hours of the day. 100% of VMT
           has been assigned to a fixed combination of freeways,
           freeway ramps, arterial/collector and local roadways
           for all hours of the day and all vehicle types.

' Reading PM Gas Carbon ZML Levels
' from the external data file PMGZML.CSV

 Reading PM Gas Carbon DR1 Levels
 from the external data file PMGDR1.CSV

' Reading PM Gas Carbon DR2 Levels
' from the external data file PMGDR2.CSV

 Reading PM Diesel Zero Mile Levels
 from the external data file PMDZML.CSV

 Reading the First PM Deterioration Rates
 from the external data file PMDDR1.CSV

 Reading the Second PM Deterioration Rates
 from the external data file PMDDR2.CSV

         User supplied gasoline sulfur content = 300.0 ppm.

 M616 Comment:
              User has supplied post-1999 sulfur levels.
```

M 48 Warning:
there are no sales for vehicle class HDGV8b

| | |
|---|---|
| Calendar Year: | 2001 |
| Month: | July |
| Altitude: | High |
| Minimum Temperature: | 95.0 (F) |
| Maximum Temperature: | 105.0 (F) |
| Absolute Humidity: | 75_ grains/lb |
| Nominal Fuel RVP: | 8.0 psi |
| weathered RVF: | 7.1 psi |
| Fuel Sulfur Content: | 299, ppm |
| Exhaust I/MI Program: | No |
| Evap Y/M Program: | No |
| ATP Program: | No |
| Reformulated Gas: | No |

| Vehicle Type: | LDCV | LDCT12 | LDGT34 | LDGT | HDGV | LDDV | LDDT | HDDV | TIC | All Veh |
|---|---|---|---|---|---|---|---|---|---|---|
| GVWR: | | <6000 | >6000 | (All) | | | | | | |
| VMT Distribution; | 0.7002 | 0.1410 | 0.1044 | | 0.0060 | 0.0008 | 0.0016 | 0.0180 | 0,0280 | 1.0000 |
| Composite Omission Factors (g/mi): | | | | | | | | | | |
| Composite VOC : | 0.861 | 0.998 | 0.975 | 0.989 | 0.942 | 0.405 | 0.461 | 0.490 | 3.31 | 0.954 |
| Composite CO | 14,10 | 16.37 | 16.12 | 16.26 | 23,39 | 1.277 | 0.945 | 6.500 | 37.99 | 15.188 |
| Composite NOX : | 0.841 | 1,078 | 1.370 | 1.202 | 3.688 | 1.170 | 1.239 | 16.556 | 0.75 | 1,229 |

| Veh. Type: | LDGT1 | LWGT2 | LDGT3 | LDGT4 | LDDT12 | LDDT34 |
|---|---|---|---|---|---|---|
| VMT Mix: | 0.0330 | 0.1080 | 0.0719 | 0.0325 | 0.0000 | 0.0016 |
| Composite Emission Factors (g/mi): | | | | | | |
| Composite VOC : | 0.961 | 1,010 | 0.958 | 1.013 | 2.512 | 0.418 |
| Composite CO | 16.09 | 16.45 | 16.04 | 16.31 | 6.775 | 0.824 |
| Composite NOX : | 0.856 | 1.146 | 1.237 | 1.666 | 2.574 | 1.212 |

| Veh Type : | MDGV2B | HDGV 3 | IIDGV4 | HDGVS | HE)CV6 | HDGV7 | HCGV$A | HL;GV8B |
|---|---|---|---|---|---|---|---|---|
| VMT Mix: | 0.0060 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Composite Emission Factors (g/mi):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Composite VOC : | 0.942 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Composite CO | 23.39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Composite NOX : | 3.688 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

| Veh. Type: | HDDV2B | HDDV3 | HDDV4 | HDDV5 | HDDV6 | HDDV7 | HDDV8A | HDDV8B |
|---|---|---|---|---|---|---|---|---|
| VMT Mix: | 0.0020 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Composite Emission Factors (g/mi):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Composite VOC : | 0.374 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Composite CO | 1.957 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Composite NOX : | 4.078 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

```
##################################
Lake Meredith NRA Winter Conditions.
File 1,  Run 1,  Scenario 17.
# # # # if if # # # # # # # # # # # # # # #  # # # #

                          Calendar Year:   2001
                                  Month:   Jan.
            Gasoline Fuel Sulfur Content:   299.  ppm
              Diesel Fuel Sulfur Content:   500.  ppm
                    Particle Size Cutoff:   10.00 Microns
                        Reformulated Gas:   No

     Vehicle Type:       LDGV    LDGT12    LDGT34      LDGT      HDGV      LDDV      LDDT      HDDV        MC   All Veh
            GVWR:                 <6000     >6000      (All)
                       - - - - - - - - - - - -      ------    ------    ------    ------    ------    ------    ------
  VMT Distribution:     0.7002    0.1410    0.1044               0.0060    0.0008    0.0016    0.0180    0.0280    1.0000
-------------------------------------------------------------------------------------------------------------------------
Composite Emission Factors  (g/mi):
              Lead:     0.0000    0.0000    0.0000    0.0000    0.0000    ------    ------    ------    0.0000    0.0000
             GASPM:     0.0042    0.0047    0.0044    0.0046    0.0523    ------    ------    ------    0.0205    0.0050
           ECARBON:     ------    ------    ------    ------    ------    0.1244    0.0488    0.1250    ------    0.0024
           OCARBON:     ------    ------    ------    ------    ------    0.0351    0.0703    0.0997    ------    0.0019
               SO4:     0.0028    0.0049    0.0047    0.0048    0.0118    0.0049    0.0106    0.0540    0.0010    0.0043
  Total Exhaust PM:     0.0071    0.0096    0.0091    0.0094    0.0640    0.1644    0.1297    0.2786    0.0215    0.0136
             Brake:     0.0125    0.0125    0.0125    0.0125    0.0125    0.0125    0.0125    0.0125    0.0125    0.0125
              Tire:     0.0080    0.0080    0.0080    0.0080    0.0080    0.0080    0.0080    0.0115    0.0040    0.0080
          Total PM:     0.0276    0.0302    0.0297    0.0300    0.0846    0.1849    0.1503    0.3027    0.0380    0.0341
               SO2:     0.0684    0.0804    0.1134    0.0944    0.1603    0.0939    0.2028    0.7715    0.0328    0.0872
               NH3:     0.1016    0.1005    0.1015    0.1009    0.0451    0.0068    0.0068    0.0270    0.0113    0.0970
Idle Emissions  (g/hr)
           PM Idle:     ------    ------    ------    ------    ------    ------    ------    1.0557    ------    0.0190
-------------------------------------------------------------------------------------------------------------------------
         Veh. Type:      LDGT1     LDGT2     LDGT3     LDGT4    LDDT12    LDDT34
                                 - - - - - - - - - - - - - - - - - - - - - -
           VMT Mix:     0.0330    0.1080    0.0719    0.0325    0.0000    0.0016
-------------------------------------------------------------------------------------------------------------------------
Composite Emission Factors  (g/mi):
              Lead:     0.0000    0.0000    0.0000    0.0000    ------    ------
             GASPM:     0.0047    0.0047    0.0044    0.0044    ------    ------
           ECARBON:     ------    ------    ------    ------    0.1498    0.0464
           OCARBON:     ------    ------    ------    ------    0.2156    0.0668
```

| | | | | | | |
|---|---|---|---|---|---|---|
| S04: | 0.0049 | 0.0049 | 0.0047 | 0.0047 | 0.0062 | 0.0107 |
| Total Exhaust PM: | 0.0096 | 0.0096 | 0.0091 | 0.0091 | 0.3717 | 0.1238 |
| Brake: | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 |
| Tire: | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0080 |
| Total PM: | 0.0302 | 0.0302 | 0.0297 | 0.0297 | 0.3922 | 0.1444 |
| S02: | 0.0804 | 0.0804 | 0.1134 | 0.1134 | 0.1196 | 0.2049 |
| NH3: | 0.1005 | 0.1005 | 0.1015 | 0.1015 | 0.0068 | 0.0068 |
| Idle Emissions (g/hr) | | | | | | |
| PM Idle: | ------ | ------ | ------ | ------ | ------ | ------ |

| Veh. Type: | HDGV2B | HDGV3 | HDGV4 | HDGVS | HDGV6 | HDGV7 | HDGV8A | HDGV8B |
|---|---|---|---|---|---|---|---|---|
| VMT Mix: | 0.0060 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Composite Emission Factors (g/mi):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lead: | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| GASPM: | 0.0523 | 0.0523 | 0.0503 | 0.0504 | 0.0503 | 0.0503 | 0.0503 | 0.0000 |
| ECARBON: | ------ | ------ | ------ | ------ | ------ | ------ | ------ | |
| OCARBON: | ------ | ------ | ------ | ------ | ------ | ------ | ------ | |
| S04: | 0.0118 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Total Exhaust PM: | 0.0640 | 0.0523 | 0.0503 | 0.0504 | 0.0503 | 0.0503 | 0.0503 | 0.0000 |
| Brake: | 0.0125 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tire: | 0.0080 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Total PM: | 0.0846 | 0.0523 | 0.0503 | 0.0504 | 0.0503 | 0.0503 | 0.0503 | 0.0000 |
| S02: | 0.1603 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| NH3: | 0.0451 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Idle Emissions (g/hr) | | | | | | | | |
| PM Idle: | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |

| Veh. Type: | HDDV2B | HDDV3 | HDDV4 | HDDV5 | HDDV6 | HDDV7 | HDDV8A | HDDV8B |
|---|---|---|---|---|---|---|---|---|
| VMT Mix: | 0.0020 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

Composite Emission Factors (g/mi):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Lead: | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| GASPM: | ------ | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| ECARBON: | 0.0514 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| OCARBON: | 0.0535 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| S04: | 0.0172 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Total Exhaust PM: | 0.1221 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Brake: | 0.0125 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tire: | 0.0080 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Total PM: | 0.1426 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| SO2: | 0.2452 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| NH3: | 0.0270 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Idle Emissions (g/hr) | | | | | | | | |
| PM Idle: | 1.0617 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

\# # # # # # # # # # # # # # # # # # # # # #
Lake Meredith NRA Summer Conditions.
File 1, Run 1, Scenario 18.
\# # # # # # # # # # # # # # # # # # # # # #

Calendar Year: 2001
Month: July
Gasoline Fuel Sulfur Content: 299. ppm
Diesel Fuel Sulfur Content: 500. ppm
Particle Size Cutoff: 10.00 Microns
Reformulated Gas: No

| Vehicle Type: | LDGV | LDGT12 | LDGT34 | LDGT | HDGV | LDDV | LDDT | HDDV | MC | All Veh |
|---|---|---|---|---|---|---|---|---|---|---|
| GVWR: | | <6000 | >6000 | (All) | | | | | | |
| VMT Distribution: | 0.7002 | 0.1410 | 0.1044 | | 0.0060 | 0.0008 | 0.0016 | 0.0180 | 0.0280 | 1.0000 |
| Composite Emission Factors (g/mi): | | | | | | | | | | |
| Lead: | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | ------ | ------ | ------ | 0.0000 | 0.0000 |
| GASPM: | 0.0042 | 0.0046 | 0.0044 | 0.0045 | 0.0523 | ------ | ------ | ------ | 0.0205 | 0.0050 |
| ECARBON: | ------ | ------ | ------ | ------ | ------ | 0.1192 | 0.0485 | 0.1160 | ------ | 0.0023 |
| OCARBON: | ------ | ------ | ------ | ------ | ------ | 0.0336 | 0.0698 | 0.0926 | ------ | 0.0018 |
| SO4: | 0.0028 | 0.0049 | 0.0047 | 0.0048 | 0.0120 | 0.0049 | 0.0106 | 0.0540 | 0.0010 | 0.0042 |
| Total Exhaust PM: | 0.0070 | 0.0095 | 0.0091 | 0.0093 | 0.0643 | 0.1576 | 0.1289 | 0.2626 | 0.0215 | 0.0133 |
| Brake: | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 |
| Tire: | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0116 | 0.0040 | 0.0080 |
| Total PM: | 0.0276 | 0.0300 | 0.0297 | 0.0299 | 0.0848 | 0.1782 | 0.1494 | 0.2867 | 0.0380 | 0.0338 |
| SO2: | 0.0684 | 0.0804 | 0.1134 | 0.0944 | 0.1601 | 0.0929 | 0.2031 | 0.7714 | 0.0328 | 0.0872 |
| NH3: | 0.1016 | 0.1007 | 0.1015 | 0.1010 | 0.0451 | 0.0068 | 0.0068 | 0.0270 | 0.0113 | 0.0970 |
| Idle Emissions (g/hr) | | | | | | | | | | |
| PM Idle: | ------ | ------ | ------ | ------ | ------ | ------ | ------ | 1.0472 | ------ | 0.0189 |

| Veh. Type: | LDGT1 | LDGT2 | LDGT3 | LDGT4 | LDDT12 | LDDT34 |
|---|---|---|---|---|---|---|
| VMT Mix: | 0.0330 | 0.1080 | 0.0719 | 0.0325 | 0.0000 | 0.0016 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Composite Emission Factors (g/mi): | | | | | | |
| Lead: | 0.0000 | 0.0000 | 0.0000 | 0.0000 | ------ | ------ |
| GASPM: | 0.0046 | 0.0046 | 0.0044 | 0.0044 | ------ | ------ |
| ECARBON: | ------ | ------ | ------ | ------ | 0.1498 | 0.0464 |
| OCARBON: | ------ | ------ | ------ | ------ | 0.2156 | 0.0668 |
| SO4: | 0.0049 | 0.0049 | 0.0047 | 0.0047 | 0.0062 | 0.0107 |
| Total Exhaust PM: | 0.0095 | 0.0095 | 0.0091 | 0.0091 | 0.3717 | 0.1238 |
| Brake: | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 | 0.0125 |
| Tire: | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0080 | 0.0080 |
| Total PM: | 0.0300 | 0.0300 | 0.0297 | 0.0297 | 0.3922 | 0.1444 |
| SO2: | 0.0804 | 0.0804 | 0.1134 | 0.1134 | 0.1196 | 0.2049 |
| NH3: | 0.1007 | 0.1007 | 0.1015 | 0.1015 | 0.0068 | 0.0068 |
| Idle Emissions (g/hr) | | | | | | |
| PM Idle: | ------ | ------ | ------ | ------ | ------ | ------ |

| Veh. Type: | HDGV2B | HDGV3 | HDGV4 | HDGV5 | HDGV6 | HDGV7 | HDGV8A | HDGV8B |
|---|---|---|---|---|---|---|---|---|
| VMT Mix: | 0.0060 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Composite Emission Factors (g/mi): | | | | | | | | |
| Lead: | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| GASPM: | 0.0523 | 0.0523 | 0.0506 | 0.0506 | 0.0506 | 0.0506 | 0.0505 | 0.0000 |
| ECARBON: | ------ | ------ | ------ | ------ | ---- - | ------ | ------ | ------ |
| OCARBON: | ------ | ------ | ---- - | ------ | ------ | ------ | ------ | ------ |
| SO4: | 0.0120 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Total Exhaust PM: | 0.0643 | 0.0523 | 0.0506 | 0.0506 | 0.0506 | 0.0506 | 0.0505 | 0.0000 |
| Brake: | 0.0125 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tire: | 0.0080 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Total PM: | 0.0848 | 0.0523 | 0.0506 | 0.0506 | 0.0506 | 0.0506 | 0.0505 | 0.0000 |
| SO2: | 0.1601 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| NH3: | 0.0451 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Idle Emissions (g/hr) | | | | | | | | |
| PM Idle: | ------ | ------ | ------ | ------ | ------ | ------ | | |

| Veh. Type: | HDDV2B | HDDV3 | HDDV4 | HDDV5 | HDDV6 | HDDV7 | HDDV8A | HDDV8B |
|---|---|---|---|---|---|---|---|---|
| VMT Mix: | 0.0020 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Composite Emission Factors (g/mi): | | | | | | | | |
| Lead: | - - - - - - - - - - | ------ | ------ | ------ | ------ | ------ | ------ | ------ |
| GASPM: | - - - - - - - - - - | ------ | ----- - | ------ | ------ | ------ | ------ | ------ |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ECARBON: | 0.0503 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| OCARBON: | 0.0523 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| SO4: | 0.0171 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Total Exhaust PM: | 0.1198 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Brake: | 0.0125 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Tire: | 0.0080 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Total PM: | 0.1403 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| SO2: | 0.2450 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| NH3: | 0.0270 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| Idle Emissions (g/hr) | | | | | | | | |
| PM Idle: | 1.0504 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

---

## 2001 LAKE MEREDITH NRA VISITOR VEHICLE EMISSIONS

| Paved Road Annual VMT |
|---|
| 1,000,000 |

**Emission Factors (g/mi) - All Vehicles**

| | | | | Phi I() (Paved) | | |
|---|---|---|---|---|---|---|
| | NOx | CO | VOC | Exhaust, Brake, and Tire | Fugitive | Total |
| Summer | 1.229 | 15.188 | 0.954 | 0.0338 | 0.84 | 0.8738 |
| Winter | 1.464 | 28.433 | 1.172 | 0.0341 | 0.84 | 0.8741 |
| Average | 1.347 | 21.811 | 1.063 | | | 0.874 |

Emissions (tons/yr) - All Vehicles

| NOx | CO | VOC | Paved $PM_{10}$ |
|---|---|---|---|
| 1.48 | 23.99 | 1.17 | 0.96 |

**Emissions (lbs/yr) -AllVehicles**

| NOx | CO | VOC | Paved $PM_{10}$ |
|---|---|---|---|
| 2,962 | 47,983 | 2,339 | 1,923 |

LAKE MEREDITH NRA DO1 VEHICLES

| | LDGV | LDGT | LDDT | HDDV | Total |
|---|---|---|---|---|---|
| Total Miles | 0 | 121,000 | 11,000 | 154,000 | 286,000 |

**Emission Factors (g/mi) - LDGV**

| | | | | | $PM_{10}$ | |
|---|---|---|---|---|---|---|
| | NOx | CO | VOC | **Exhaust, Brake,** and Tire | **Fugitive** | Total |
| Summer | 0.8410 | 14.1000 | 0.8610 | 0.0276 | 0.8400 | 0.8676 |
| Winter | 1.0060 | 26.9500 | 1.0440 | 0.0276 | 0.8400 | 0.8676 |
| Average | 0.9235 | 20.5250 | 0.9525 | | | 0.8676 |

Emissions (tonslyr) - LDGV

| NOx | CO | **VOC** | $PM_{10}$ |
|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 |

Emission Factors (g/mi) - LDGT

| | | | | | $PM_{10}$ | |
|---|---|---|---|---|---|---|
| | NOx | CO | VOC | **Exhaust, Brake,** and Tire | Fugitive | Total |
| Summer | 1.202 | 16.260 | 0.989 | 0.030 | 0.840 | 0.870 |
| Winter | 1.587 | 34.110 | 1.406 | 0.030 | 0.840 | 0.870 |
| Average | 1.395 | 25.185 | 1.198 | | | 0.870 |

Emissions (tonslyr) - LDGT

| NOx | CO | VOC | $PM_{10}$ |
|---|---|---|---|
| 0.19 | 3.35 | 0.16 | 0.12 |

Emission Factors (glmi) - LDDT

| | | | | | $PM_{10}$ | |
|---|---|---|---|---|---|---|
| | NOx | CO | VOC | Exhaust, **Brake,** and Tire | Fugitive | Total |
| Summer | 1.239 | 0.945 | 0.461 | 0.149 | 0.840 | 0.989 |
| Winter | 1.212 | 0.931 | 0.439 | 0.150 | 0.840 | 0.990 |
| Average | 1.226 | 0.938 | 0.450 | | | 0.990 |

Emissions (tonslyr) - HDGV

| NOx | CO | VOC | PM. |
|---|---|---|---|
| 0.01 | 0.01 | 0.01 | 0.01 |

Emission Factors (glmi) - HDDV

| | | | | | $PM_{10}$ | |
|---|---|---|---|---|---|---|
| | NOx | CO | VOC | Exhaust, Brake, and Tire | Fugitive | Total |
| Summer | 16.586 | 6.500 | 0.490 | 0.287 | 0.840 | 1.127 |
| Winter | 16.834 | 6.582 | 0.509 | 0.303 | 0.840 | 1.143 |
| Average | 16.710 | 6.541 | 0.500 | | | 1.135 |

Emissions (tonslyr) - HDDV

| NOx | CO | VOC | $PM_{10}$ |
|---|---|---|---|
| 2.83 | 1.11 | 0.08 | 0.19 |

Emissions (tons/yr) - Total

| NOx | CO | VOC | $PM_{10}$ |
|---|---|---|---|
| 3.03 | 4.47 | 0.25 | 0.32 |

Emissions (Ibslyr) - Total

| NOx | CO | VOC | $PM_{10}$ |
|---|---|---|---|
| 6,062 | 8,943 | 499 | 640 |

LAKE MEREDITH NRA **GSA** VEHICLES

| | LDGV | LDGT | LDDT | HDDV | Total |
|---|---|---|---|---|---|
| Total Miles | 33,000 | 198,000 | 0 | 13,900 | 244,900 |

**Emission Factors (glmi) LDGV**

| | NOx | CO | VOC | $PM_{10}$ Exhaust, Brake, and Tire | $PM_{10}$ Fugitive | $PM_{10}$ Total |
|---|---|---|---|---|---|---|
| Summer | 0.8410 | 14.1000 | 0.8610 | 0.0276 | 0.8400 | 0.8676 |
| Winter | 1.0060 | 26.9500 | 1.0440 | 0.0276 | 0.8400 | 0.8676 |
| Average | 0.9235 | 20.5250 | 0.9525 | | | 0.8676 |

Emissions (tonslyr) LDGV

| NOx | CO | **VOC** | $PM_{10}$ |
|---|---|---|---|
| 0.03 | 0.75 | 0.03 | 0.03 |

Emission Factors (glmi) - LDGT

| | NOx | CO | VOC | $PM_{10}$ Exhaust, **Brake,** and Tire | $PM_{10}$ Fugitive | $PM_{10}$ Total |
|---|---|---|---|---|---|---|
| Summer | 1.202 | 16.260 | 0.989 | 0.030 | 0.840 | 0.870 |
| Winter | 1.587 | 34.110 | 1.406 | 0.030 | 0.840 | 0.870 |
| Average | 1.395 | 25.185 | 1.198 | | | 0.870 |

Emissions (tonslyr) - LDGT

| NOx | CO | VOC | $PM_{10}$ |
|---|---|---|---|
| 0.30 | 5.49 | 0.26 | 0.19 |

Emission Factors (glmi) - LDDT

| | NOx | CO | VOC | $PM_{10}$ Exhaust, Brake, and Tire | $PM_{10}$ Fugitive | $PM_{10}$ Total |
|---|---|---|---|---|---|---|
| Summer | 1.239 | 0.945 | 0.461 | 0.149 | 0.840 | 0.989 |
| Winter | 1.212 | 0.931 | 0.439 | 0.150 | 0.840 | 0.990 |
| Average | 1.226 | 0.938 | 0.450 | | | 0.990 |

Emissions (tons/yr) - HDGV

| NOx | CO | VOC | $PM_{10}$ |
|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 |

Emission Factors (glmi) - HDDV

| | NOx | CO | VOC | $PM_{10}$ Exhaust, Brake, and Tire | $PM_{10}$ Fugitive | $PM_{10}$ Total |
|---|---|---|---|---|---|---|
| Summer | 16.586 | 6.500 | 0.490 | 0.287 | 0.840 | 1.127 |
| Winter | 16.834 | 6.582 | 0.509 | 0.303 | 0.840 | 1.143 |
| Average | 16.710 | 6.541 | 0.500 | | | 1.135 |

Emissions (tonslyr) - HDDV

| NOx | CO | VOC | $PM_{10}$ |
|---|---|---|---|
| 0.26 | 0.10 | 0.01 | 0.02 |

Emissions (tonslyr) - Total

| NOx | CO | VOC | $PM_{10}$ |
|---|---|---|---|
| 0.59 | 6.33 | 0.30 | 0.24 |

Emissions (lbs/yr) - Total

| NOx | CO | VOC | $PM_{10}$ |
|---|---|---|---|
| 1,185 | 12,661 | 606 | 477 |

**2001 LAKE MEREDITH NRA NONROAD VEHICLE EMISSIONS**

| | | Emission Factors (gm/hp-hr) | | | | | | | Emissions (lbs/yr) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle | No. | PM | Nox | CO | VOC | hp | load | hrs/yr | PM | Nox | CO | VOC |
| Tractors | 5 | 2.04 | 1.03 | 2.31 | 2.19 | 42.35 | 0.68 | 500 | 65 | 330 | 730 | 69 |
| Backhoe | 1 | 2.04 | 1.03 | 2.31 | 2.19 | 77 | 0.55 | 100 | 19 | 10 | 22 | 20 |
| Riding Mower | 7 | 1.11 | 10.3 | 4.8 | 1.3 | 15 | 0.55 | 700 | 14 | 131 | 61 | 17 |
| Grader | 1 | 1.06 | 9.6 | 3.8 | 1.43 | 172 | 0.61 | 100 | 24 | 222 | 88 | 33 |
| Sweeper | 2 | 1.7 | 14 | 6.06 | 1.46 | 30 | 0.68 | 200 | 15 | 126 | 54 | 13 |
| Forklift | 2 | 1.06 | 9.6 | 3.8 | 1.43 | 172 | 0.61 | 200 | 49 | 443 | 175 | 66 |
| Front End Loader | 1 | 1.11 | 10.3 | 4.8 | 1.3 | 77 | 0.55 | 100 | 10 | 96 | 45 | 12 |
| ATVs | 4 | 1 | 8 | 5 | 1.22 | 350 | 0.65 | 500 | 250 | 2,002 | 1,251 | 305 |
| | | | | | | | Totals: | (lbs/yr) | 447 | 3,061 | 1,769 | 536 |
| | | | | | | | | (tons/yr) | 0.22 | 1.53 | 0.88 | 0.27 |

## LAKE MEREDITH NRA NPS MARINE VESSEL EMISSIONS

Diesel **Engine Emission Factors**[1]

| Units | HC | CO | $NO_x$ | PM | $SO_2$ |
|---|---|---|---|---|---|
| (g/hp-hr) | 1.26 | 1.91 | 8.92 | 0.563 | 0.352 |
| (lb/hp-hr) | 0.003 | 0.004 | 0.020 | 0.001 | 0.001 |

1 g = 0.002202
BSFC = 0.367

[1] Source: Exhaust Emission Factors for Nonroad Engine Modeling - Compression-Ignition EPA Report No., NR-009A; Table 1

**2-Stroke Gasoline Engine Emission Factors**[3]

| Units | HC | CO | $NO_x$ | PM | $SO_2$ |
|---|---|---|---|---|---|
| (g/hp-hr) | 116.38 | 231.26 | 1.19 | 7.7 | 0.000 |
| (lb/hp-hr) | 0.256 | 0.509 | 0.003 | 0.017 | 0.000 |

**4-Stroke Gasoline Engine Emission Factors**[3]

| Units | HC | CO | $NO_x$ | PM | $SO_2$ |
|---|---|---|---|---|---|
| (g/hp-hr) | 14.92 | 339.18 | 7.46 | 0.06 | 0.000 |
| (lb/hp-hr) | 0.033 | 0.747 | 0.016 | 0.000 | 0.000 |

[3] Source: Nonroad Emission Inventory Model, Draft, June 17, 1998

**Criteria Pollutant Emissions**[3]

| Vessel Type | | No. of Engines | Engine Power (hp) | Hours of Operation | Load Factor | HC (lb/yr) | CO (lb/yr) | $NO_x$ (lb/yr) | PM (lb/yr) | $SO_2$ (lb/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| 150 HP Outboard[1] | NPS | 2 | 150 | 100 | 0.21 | 1,614 | 3,208 | 17 | 107 | 0 |
| 225 HP Outboard[1] | NPS | 2 | 225 | 100 | 0.21 | 2,421 | 4,811 | 25 | 160 | 0 |
| Inboard/Outboard[2] | NPS | 1 | 120 | 30 | 0.21 | 194 | 385 | 2 | 13 | 0 |
| 4-Stroke Outboard[2] | NPS | 2 | 130 | 100 | 0.21 | 179 | 4,077 | 90 | 1 | 0 |
| Outboard[1] | CRMWA[3] | 1 | 115 | 50 | 0.21 | 309 | 615 | 3 | 20 | 0 |
| | | | | | | 4,718 | 13,096 | 136 | 301 | 0 |
| | | | | | | tons/year | | | | |
| | | | | | | 2.36 | 6.55 | 0.07 | 0.15 | 0.00 |

[1] Assumes 2-stroke engine
[2] Assumes 4-stroke engine
[3] Canadian River Municipal Water Authority
Emissions = Emission Factor * No. of Engines * Engine Power * Hours of Operation *Load Factor

## 2002 Boating Activity at Lake Meredith National Recreation Area

Source: *Lake Meredith National Recreation Area Personal Watercraft Use Environmental Assessment,* February 2003

### 2002 Public Personal Watercraft and Motor Boats

| | Annual Visits |
|---|---|
| **Motor Boats** | 16,300 |
| **PWCs** | 4,075 |
| **Totals** | 20,375 |

| | HC (lb/yr) | CO (lb/yr) | NO,, (lb/yr) | $PM_{10}$ (lb/yr) |
|---|---|---|---|---|
| **Motor Boats** | 116,400 | 491,000 | 7,600 | 10,200 |
| **PWCs** | 85,600 | 185,000 | 600 | 4,200 |
| **Totals** | 202,000 | 676,000 | 8,200 | 14,400 |

| | (tons/yr) | (tons/yr) | (tons/yr) | (tons/yr) |
|---|---|---|---|---|
| **Motor Boats** | 58.20 | 245.50 | 3.80 | 5.10 |
| **PWCs** | 42.80 | 92.50 | 0.30 | 2.10 |
| **Totals** | 101.00 | 338.00 | 4.10 | 7.20 |

### Public and NPS Total Boating Emissions

| | HC (lb/yr) | CO (lb/yr) | NO. (lb/yr) | $PM_{10}$ (lb/yr) |
|---|---|---|---|---|
| **Public** | 202,000 | 676,000 | 8,200 | 14,400 |
| **NPS** | 4,718 | 13,096 | 136 | 301 |
| Totals | 206,718 | 689,096 | 8,336 | 14,701 |
| Totals (tons/yr) | 103.36 | 344.55 | 4.17 | 7.35 |

# APPENDIX C

# PUBLIC USE DATA

# Monthly Public Use Report

Printed on 01 /20/2003

| LAKE MEREDITH NRA | | | 12/2001 | 7540 |
|---|---|---|---|---|
| | December 2001 | | | |
| | Recreational | Non-Recreational | Total | Calendar Year-To-Date |
| Visits | 51,326 | 0 | 51,326 | 1,248,702 |
| Visitor Hours | 157,755 | 0 | 157,755 | 3,807,403 |
| | | | | Fiscal YTD |
| 'Total Fiscal YTD Visitor Days | | | | 59,819 |

| Recreation O/N stays | Current Month | Year-To-Date | | |
|---|---|---|---|---|
| Concessioner Lodging | 0 | 0 | NPS Campgrounds | |
| Concessioner Campgrounds | 0 | 0 | Tents | 364 |
| NPS Campgrounds | 1,957 | 64,523 | RN's . | 1,593 |
| | | | Total | 1,957 |
| NPS Backcountry | 890 | 4,957 | | |
| NPS Miscellaneous | 0 | 478 | | |
| Non Recreation O/N stays | 0 | 0 | | |
| Total Overnight stays | 2,847 | 69,958 | | |

| | This Month | Same Month Last Year | Percent Change |
|---|---|---|---|
| Total Rec | 51,326 | 39,744 | 29.14 % |
| Total NonRec | 0 | 0 | 0.00 % |
| Total Visits | 51,326 | 39,744 | 29.14 % |
| Total YTD | 1,248,702 | 1,634,876 | -23.62 % |

| Special Use Data | This Month | Year-To-Date |
|---|---|---|
| GROUP CAMPERS | 0 | 200 |
| MOTORCYCLES/DUNEBUG | 4,851 | 47,842 |
| HUNTERS | 1,555 | 4,510 |
| BOAT OVERNIGHTS | 0 | 278 |

# LAKE MEREDITH NRA

## Report Date: December 2001

| | Non-Reporting Vehicles | This Month | Same Month Last Year | % Change | This Year YTD | Last Year YTD | % Change YTD |
|---|---|---|---|---|---|---|---|
| Sanford-Yake | 601 | 8,274 | 3,843 | 115.31 | 176,096 | 251,293 | -29.9 |
| Cedar Canyon | 60 | 5,8491 | 2,867 | 104.01 | 194,3551 | 285,236 | -31.9 |
| Spring Canyon | 01 | 0 | 1,673 | -100.0 | 71,323 | 102,5991 | -30.5 |
| Fritch Fortress | 301 | 3,595 | 3,388 | 6.1 | 153,2861 | 199,7521 | -23.3 |
| Harbor Bay | 601 | 6,619 | 431 | 1437.41 | 203,774 | 283,808 | -28.2 |
| Alibates/McBride | 6011 | 4,624 | *23,293* | -80.2 | 79,9161 | 130,351 | -38.7 |
| 'P1um Creek | 601 | 1,176 | 1,621 | -27.41 | 30,923 | 27,5731 | 12.1 |
| Blue West | 30 | 2,786 | 98 | 2742.91 | 123,865 | 78,14111 | 58.5 |
| Big Blue | 90 | 1,6141 | 812 | 98.7 | 57,734 | 91,0841 | -36.61 |
| Bugbee Canyon | 60 | 1,0081 | 728 | 38.51 | 37,1841 | 42,991 | -13.5 |
| North Canyon | | 908 | 455 | 99.61 | 16,907 | 19,6461 | -13.9 |
| Rosita | 60 | 14,875 | 537 | 2668.71 | 103,341 | 122,4041 | -15.6 |
| **Total Recreation Visits** | | 51,326 | 39,744 | 29.1 | 1,248,702 | 1,634,876 | -23.6 |
| **Overnight Stays** | | | | | | | |
| Tent | | 3641 | 84 | 333.31 | 15,6171 | 12,7231 | 22.8 |
| Recreation Vehicles | | 1,593 | 347 | 359.6 | 48,906 | 65,877 | -25.8 |
| Backcountry | | 890 | 797 | 11.7 | 4,957 | 5,787 | -14.3 |
| Group | | 0 | 0 | 0 | 200 | 1,9631 | -89.8 |

# APPENDIX D

# SELECTED TEXAS
# AIR QUALITY REGULATIONS

**SUBCHAPTER G: COMBUSTION**
**§§106.181 - 106.183**
**Effective November 1, 2001**

**§106.181. Used-Oil Combustion Units.**

Small boilers and heaters burning used oil that has not been mixed with hazardous waste are permitted by rule provided that all of the following conditions are met:

(1) the combustion unit or combination of combustion units at the same account have a maximum capacity of 1.0 million Btu per hour (MMBtu/hr) and each individual combustion unit is not greater than 0.5 MMBtu/hr;

(2) the combustion gases from the combustion unit(s) are vented to the ambient air in accordance with the following requirements:

(A) through an unobstructed vent; or

(B) through a vertical vent with a cap; and

(i) a flat roof, through a minimum of a three-foot stack; or

(ii) a sloped roof, through a stack that is at least three feet higher than the highest point on the roof or three feet higher than a point extending ten feet horizontally from the roof; and

(3) the combustion unit(s) burns only used oil the owner or operator generates on-site or used oil received from household do-it-yourself used oil generators.

Adopted October 10, 2001 Effective November 1, 2001

**§106.182. Ceramic Kilns.**

Kilns used for firing ceramic ware, heated exclusively by natural gas, liquid petroleum gas, electricity, or any combination thereof are permitted by rule where the conditions of this section are met:

(1) the total heat input is ten million British thermal units per hour or less; and

(2) there are no emissions of lead, beryllium, or fluorides, and emissions of sulfur dioxide and particulate matter from both the material being fired and fuel burned do not exceed 25 tons per year of either air contaminant.

Adopted August 9, 2000 Effective September 4, 2000

**§106.183. Boilers, Heaters, and Other Combustion Devices.**

Boilers, heaters, drying or curing ovens, furnaces, or other combustion units, but not including stationary internal combustion engines or turbines are permitted by rule, provided that the following conditions are met.

(1) The only emissions shall be products of combustion of the fuel.

(2) The maximum heat input shall be 40 million British thermal unit (Btu) per hour with the fuel being:

(A) sweet natural gas;

(B) liquid petroleum gas;

(C) fuel gas containing no more than 0.1 grain of total sulfur compounds, calculated as sulfur, per dry standard cubic foot; or

(D) combinations of the fuels in subparagraphs (A) - (C) of this paragraph.

(3) Distillate fuel oil shall be fired as a backup fuel only. Firing shall be limited to 720 hours per year. The fuel oil shall contain less than 0.3% sulfur by weight and shall not be blended with waste oils or solvents.

(4) All gas fired heaters and boilers with a heat input greater than ten million Btu per hour (higher heating value) shall be designed such that the emissions of nitrogen oxides shall not exceed 0.1 pounds per million Btu heat input.

(5) Records of hours of fuel oil firing and fuel oil purchases shall be maintained on-site on a two-year rolling retention period and made available upon request to the commission or any local air pollution control agency having jurisdiction.

Adopted August 9, 2000 Effective September 4, 2000

**SUBCHAPTER W: TURBINES AND ENGINES**
**§106.511, §106.512**
**Effective June 13, 2001**

**§106.511. Portable and Emergency Engines and Turbines.**

Internal combustion engine and gas turbine driven compressors, electric generator sets, and water pumps, used only for portable, emergency, and/or standby services are permitted by rule, provided that the maximum annual operating hours shall not exceed 10% of the normal annual operating schedule of the primary equipment; and all electric motors. For purposes of this section, "standby" means to be used as a "substitute for" and not "in addition to" other equipment.

Adopted August 9, 2000 Effective September 4, 2000

**§106.512. Stationary Engines and Turbines.**

Gas or liquid fuel-fired stationary internal combustion reciprocating engines or gas turbines that operate in compliance with the following conditions of this section are permitted by rule.

(1) The facility shall be registered by submitting the commission's Form PI-7, Table 29 for each proposed reciprocating engine, and Table 31 for each proposed gas turbine to the commission's Office of Permitting, Remediation, and Registration in Austin within ten days after construction begins. Engines and turbines rated less than 240 horsepower (hp) need not be registered, but must meet paragraphs (5) and (6) of this section, relating to fuel and protection of air quality. Engine hp rating shall be based on the engine manufacturer's maximum continuous load rating at the lesser of the engine or driven equipment's maximum published continuous speed. A rich-bum engine is a gas-fired spark-ignited engine that is operated with an exhaust oxygen content less than 4.0% by volume. A lean-bum engine is a gas-fired spark-ignited engine that is operated with an exhaust oxygen content of 4.0% by volume, or greater.

(2) For any engine rated 500 hp or greater, subparagraphs (A) - (C) of this paragraph shall apply.

(A) The emissions of nitrogen oxides ($NO_x$) shall not exceed the following limits:

(i) 2.0 grams per horsepower-hour (g/hp-hr) under all operating conditions for any gas-fired rich-bum engine;

(ii) 2.0 g/hp-hr at manufacturer's rated full load and speed, and other operating conditions, except 5.0 g/hp-hr under reduced speed, 80-100% of full torque conditions, for any spark-ignited, gas-fired lean-burn engine, or any compression-ignited dual fuel-fired engine manufactured new after June 18, 1992;

**SUBCHAPTER B**
**OUTDOOR BURNING**
**§§111.201, 111.203, 111.205, 111.207, 111.209, 111.211, 111.213, 111.215, 111.219, 111.221**
**Effective June 12, 2002**

## §111.201. General Prohibition.

No person may cause, suffer, allow, or permit any outdoor burning within the State of Texas, except as provided by this subchapter or by orders or permits of the commission. Outdoor disposal or deposition of any material capable of igniting spontaneously, with the exception of the storage of solid fossil fuels, shall not be allowed without written permission of the executive director. The term "executive director," as defined in Chapter 3 of this title (relating to Definitions), includes authorized staff representatives.

Adopted August 21, 1996 Effective September 16, 1996

## §111.203. Definitions.

Unless specifically defined in the Texas Clean Air Act (TCAA) or in the rules of the Texas Natural Resource Conservation Commission (commission), the terms used by the commission have the meanings commonly ascribed to them in the field of air pollution control. In addition to the terms which are defined by the TCAA, the following terms, when used in this chapter, shall have the following meanings, unless the context clearly indicates otherwise.

**(1) Extinguished -** The absence of any visible flames, glowing coals, or smoke.

**(2) Landclearing operation -** The uprooting, cutting, or clearing of vegetation in connection with conversion for the construction of buildings, rights-of-way, residential, commercial, or industrial development, or the clearing of vegetation to enhance property value, access or production. It does not include the maintenance burning of on-site property wastes such as fallen limbs, branches, or leaves, or other wastes from routine property clean-up activities, nor does it include burning following clearing for ecological restoration.

**(3) Practical alternative -** An economically, technologically, ecologically and logistically viable option.

**(4) Prescribed burn -** The controlled application of fire to naturally-occurring vegetative fuels under specified environmental conditions and confined to a predetermined area, following appropriate planning and precautionary measures.

**(5) Structure containing sensitive receptor(s) -** A man-made structure utilized for human residence or business, the containment of livestock, or the housing of sensitive live vegetation. The term "man-made structure" does not include such things as range fences, roads, bridges, hunting blinds or facilities used solely for the storage of hay or other livestock feeds. The term "sensitive live vegetation" is defined as vegetation which has potential to be damaged by smoke and heat, examples of which include, but are not limited to: nursery production, mushroom cultivation, pharmaceutical plant production, or laboratory experiments involving plants.

**(6) Sunrise/Sunset -** Official sunrise/sunset as set forth in the United States Naval Observatory tables available from National Weather Service offices.

**(7) Wildland -** Uncultivated land other than fallow, land minimally influenced by human activity, and land maintained for biodiversity, wildlife forage production, protective plant cover, or wildlife habitat.

Adopted August 21, 1996 Effective September 16, 1996

**§111.205. Exception for Fire Training.**

(a) Outdoor burning shall be authorized for training fire-fighting personnel when requested in writing and when authorized either verbally or in writing by the local air pollution control agency. In the absence of such local entities, the appropriate commission regional office shall be notified. The burning shall be authorized if notice of denial from the local air pollution control agency, or commission regional office is not received within 10 working days after the date of postmark or the date of personal delivery of the request.

(b) Facilities dedicated solely for fire-fighting training, at which training routinely will be conducted on a frequency of at least once per week, shall submit an annual written notification of intent to continue such training to the appropriate commission regional office and any local air pollution control agency.

(c) Facilities dedicated solely for fire-fighting training, at which training is conducted less than weekly, shall provide an annual written notification of intent, with a telephone or electronic facsimile notice 24 hours in advance of any scheduled training session. No more than one such notification is required for multiple training sessions scheduled within any one-week period, provided the initial telephone/facsimile notice includes all such sessions. Both the written and telephone notifications shall be submitted to the appropriate commission regional office and any local air pollution control agency.

(d) Authorization to conduct outdoor burning under this provision may be revoked by the executive director if the authorization is used to circumvent other prohibitions of this subchapter.

Adopted August 21, 1996 Effective September 16, 1996

**§111.207. Exception for Fires Used for Recreation, Ceremony, Cooking, and Warmth.**

Outdoor burning shall be authorized for fires used solely for recreational or ceremonial purposes, or in the noncommercial preparation of food, or used exclusively for the purpose of supplying warmth during cold weather. Such burning shall be subject to the requirements of §111.219(7) of this title (relating to General Requirements for Allowable Outdoor Burning).

Adopted August 21, 1996 Effective September 16, 1996

**§111.209. Exception for Disposal Fires.**

Outdoor burning shall be authorized for:

(1) Domestic waste burning at a property designed for and used exclusively as a private residence, housing not more than three families, when collection of domestic waste is not provided or authorized by the local governmental entity having jurisdiction, and when the waste is generated only from that property. Provision of waste collection refers to collection at the premises where the waste is generated. The term "domestic waste" is defined in §101.1 of this title (relating to Definitions). Wastes normally resulting from the function of life within a residence that can be burned include such things as kitchen garbage, untreated lumber, cardboard boxes, packaging (including plastics and rubber), clothing, grass, leaves, and branch trimmings. Examples of wastes not considered domestic waste which cannot be burned, include such things as tires, non-wood construction debris, furniture, carpet, electrical wire, and appliances.

(2) Diseased animal carcass burning when burning is the most effective means of controlling the spread of disease.

(3) Animal remains burning by a veterinarian if the burning is conducted on property owned by the veterinarian; the property is in a county with a population of less than 10,000; and the veterinarian does not charge for the burning. Animal remains refer to an animal that dies in the care of the veterinarian and does not include any other type of medical waste.

(4) On-site burning of trees, brush, and other plant growth for right-of-way maintenance, landclearing operations, and maintenance along water canals when no practical alternative to burning exists and when the materials are generated only from that property. Structures containing sensitive receptors must not be negatively affected by the burn. Such burning shall be subject to the requirements of §111.219 of this title (relating to General Requirements for Allowable Outdoor Burning). When possible, notification of intent to burn should be made to the appropriate commission regional office prior to the proposed bum. For a single project entailing multiple days of burning, an initial notice delineating

the scope of the burn is sufficient if the scope does not constitute circumvention of the rule for a continual burning situation. Commission notification or approval is not required.

(5) Crop residue burning for agricultural management purposes when no practical alternative exists. Such burning shall be subject to the requirements of §111.219 of this title, and structures containing sensitive receptors must not be negatively affected by the burn. When possible, notification of intent to burn should be made to the appropriate commission regional office prior to the proposed burn. Commission notification or approval is not required. This section is not applicable to crop residue burning covered by an administrative order.

(6) Brush, trees, and other plant growth causing a detrimental public health and safety condition may be burned by a county or municipal government at a site it owns upon receiving site and burn approval from the executive director. Such a bum can only be authorized when there is no practical alternative, and it may be done no more frequently than once every two months. Such bums cannot be conducted at municipal solid waste landfills unless authorized under §111.215 of this title (relating to Executive Director Approval of Otherwise Prohibited Outdoor Burning), and shall be subject to the requirements of §111.219 of this title.

Adopted May 22, 2002 Effective June 12, 2002

**§111.211. Exception for Prescribed Burn.**

Outdoor burning shall be authorized for:

(1) Prescribed burning for forest, range and wildland/wildlife management purposes, with the exception of coastal salt-marsh management burning. Such burning shall be subject to the requirements of §111.219 of this title (relating to General Requirements for Allowable Outdoor Burning), and structures containing sensitive receptors must not be negatively affected by the burn. When possible, notification of intent to bum should be made to the appropriate commission regional office prior to the proposed burn. Commission notification or approval is not required.

(2) Coastal salt-marsh management burning conducted in Aransas, Brazoria, Calhoun, Chambers, Galveston, Harris, Jackson, Jefferson, Kleberg, Matagorda, Nueces, Orange, Refugio, and San Patricio Counties. Coastal salt-marsh burning in these counties shall be subject to the following requirements:

(A) All land on which burning is to be conducted shall be registered with the appropriate commission regional office using a United States Geological Survey map or equivalent upon which are identified significant points such as roads, canals, lakes, and streams, and the method by which access is made to the site. For large acreage, the map should be divided into manageable blocks with

identification for each defined block. The information must be received for review at least 15 working days before the burning takes place.

(B) Prior to any burning, notification, either verbal or written, must be made to, and authorization must be received from the appropriate commission regional office. Notification must identify the specific area and/or block to be burned, approximate start and end time, and a responsible party who can be contacted during the bum period.

(C) Such burning shall be subject to the requirements of §111.219 of this title.

Adopted August 21, 1996 Effective September 16, 1996

**§111.213. Exception for Hydrocarbon Burning.**

Outdoor burning shall be authorized for hydrocarbon burning from pipeline breaks and oil spills only upon proper notification as set forth in §101.6 of this title (relating to Notification Requirements for Major Upset), and if the executive director has determined that the burning is necessary to protect the public welfare. Sampling and monitoring may be required to determine and evaluate environmental impacts.

Adopted August 21, 1996 Effective September 16, 1996

**§111.215. Executive Director Approval of Otherwise Prohibited Outdoor Burning.**

If not otherwise authorized by this chapter, outdoor burning may be authorized by written permission from the executive director if there is no practical alternative and if the burning will not cause or contribute to a nuisance, traffic hazard or to a violation of any federal or state primary or secondary ambient air standard. The executive director may specify procedures or methods to control or abate emissions from outdoor burning authorized pursuant to this rule. Authorization to burn may be revoked by the executive director at any time if the burning causes nuisance conditions, is not conducted in accordance with the specified conditions, violates any provision of an applicable permit, or causes a violation of any air quality standard.

Adopted August 21, 1996 Effective September 16, 1996

**§111.219. General Requirements for Allowable Outdoor Burning.**

Outdoor burning which is otherwise authorized shall also be subject to the following requirements when specified in any section of this subchapter.

(1) Prior to prescribed or controlled burning for forest management purposes, the Texas Forest Service shall be notified.

(2) Burning must be outside the corporate limits of a city or town except where the incorporated city or town has enacted ordinances which permit burning consistent with the Texas Clean Air Act, Subchapter E, Authority of Local Governments.

(3) Burning shall be commenced and conducted only when wind direction and other meteorological conditions are such that smoke and other pollutants will not cause adverse effects to any public road, landing strip, navigable water, or off-site structure containing sensitive receptor(s).

(4) If at any time the burning causes or may tend to cause smoke to blow onto or across a road or highway, it is the responsibility of the person initiating the burn to post flag-persons on affected roads.

(5) Burning must be conducted downwind of or at least 300 feet (90 meters) from any structure containing sensitive receptors located on adjacent properties unless prior written approval is obtained from the adjacent occupant with possessory control.

(6) Burning shall be conducted in compliance with the following meteorological and timing considerations:

(A) The initiation of burning shall commence no earlier than one hour after sunrise. Burning shall be completed on the same day not later than one hour before sunset, and shall be attended by a responsible party at all times during the active burn phase when the fire is progressing. In cases where residual fires and/or smoldering objects continue to emit smoke after this time, such areas shall be extinguished if the smoke from these areas has the potential to create a nuisance or traffic hazard condition. In no case shall the extent of the burn area be allowed to increase after this time.

(B) Burning shall not be commenced when surface wind speed is predicted to be less than six miles per hour (mph) (five knots) or greater than 23 mph (20 knots) during the burn period.

(C) Burning shall not be conducted during periods of actual or predicted persistent low-level atmospheric temperature inversions.

(7) Electrical insulation, treated lumber, plastics, non-wood construction/demolition materials, heavy oils, asphaltic materials, potentially explosive materials, chemical wastes, and items containing natural or synthetic rubber must not be burned.

**§111.221. Responsibility for Consequences of Outdoor Burning.**

The authority to conduct outdoor burning under this regulation does not exempt or excuse any person responsible from the consequences, damages, or injuries resulting from the burning and does not exempt or excuse anyone from complying with all other applicable laws or ordinances, regulations, and orders of governmental entities having jurisdiction, even though the burning is otherwise conducted in compliance with this regulation.

Adopted August 21, 1996 Effective September 16, 1996