FINAL

# 2000 AIR EMISSIONS INVENTORY

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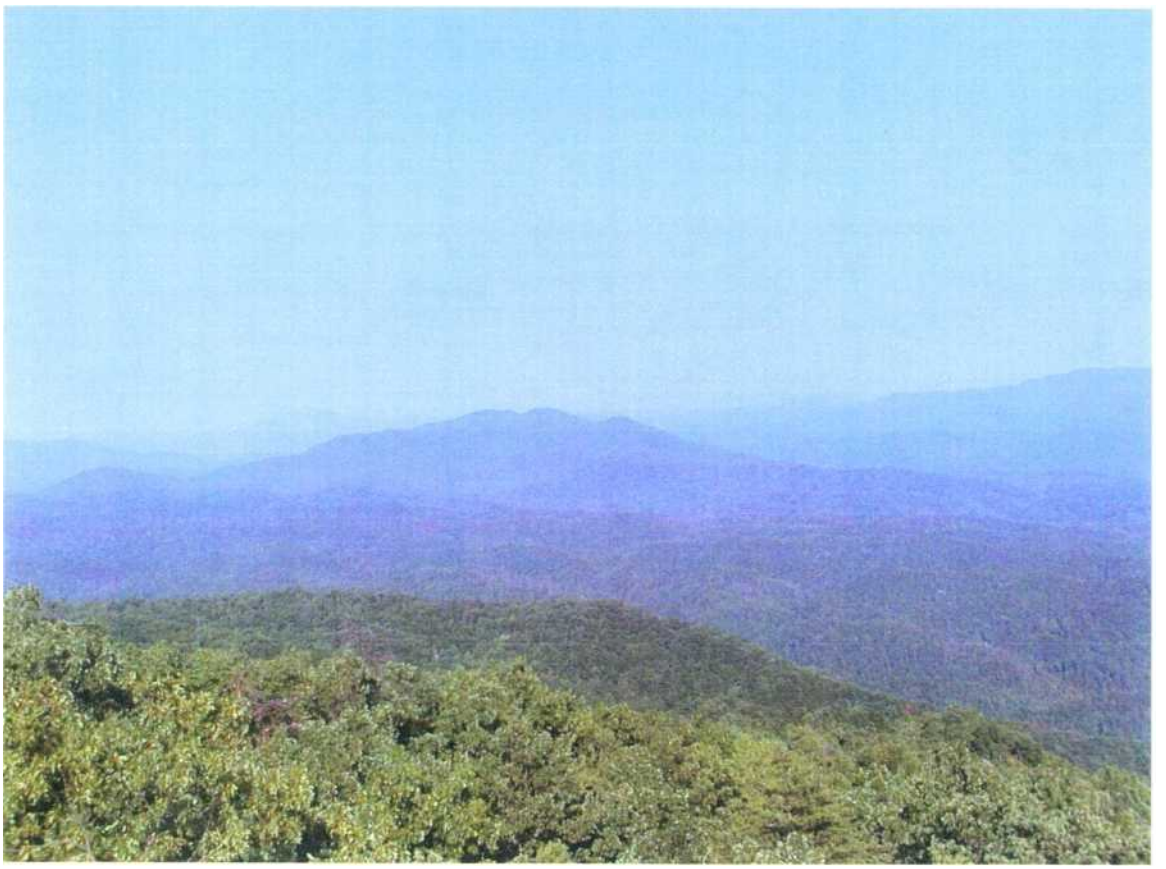
## GREAT SMOKY MOUNTAINS NATIONAL PARK
## TENNESSEE/NORTH CAROLINA



**U.S. NATIONAL PARK SERVICE**

**OCTOBER 2002**

FINAL

# **2000** AIR EMISSIONS INVENTORY

## GREAT **SMOKY** MOUNTAINS NATIONAL PARK
## **TENNESSEE/NORTH** CAROLINA

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*Cover Photo: View from Look Rock by NPS Web Cam*

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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. Development of an in-park air emissions inventory for Great Smoky Mountains National Park (NP) serves three functions in this regard. First, it provides a baseline and 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, and fuel storage tanks. Area sources may include prescribed burning, woodstoves and fireplaces, campfires, and miscellaneous visitor activities. Mobile sources may include vehicles operated by visitors, tour operators, and NPS and concessionaire employees, and nonroard vehicles and equipment.

## 1.3 INVENTORY METHODOLOGY

The methodology to accomplish the air emissions inventory consisted of a site survey in March 2002, interviews with Great Smoky Mountains NP[1] and concessionaire personnel, review of applicable park records, emission calculations, and report preparation. The data were used in conjunction with a number of manual and computer software 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

[1] Jim Renfro, Great Smoky Mountains NP, Air Resource Specialist (865) 436-1708

*TANKS 4.0* model, U.S. Forest Service *First Order Fire Effects Model (FOFEM) 4.0* model, and USEPA *MOBILE5band PARTS* mobile source emissions model. 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, are provided in Appendix A.

## 1.4 PARK DESCRIPTION

Great Smoky Mountains National Park, in the states of North Carolina and Tennessee (Figure 1), encompasses over 800 square miles or 521,490 acres of which 95 percent are forested. World renowned for the diversity of its plant and animal resources, the beauty of its ancient mountains, the quality of its remnants of Southern Appalachian mountain culture, and the depth and integrity of the wilderness sanctuary within its boundaries, it is one of the largest protected areas in the east. It was established as a National Park in 1934 and was designated an International Biosphere Reserve in 1976 and a World Heritage Site 1983. A map of the park is depicted in Figure 2.

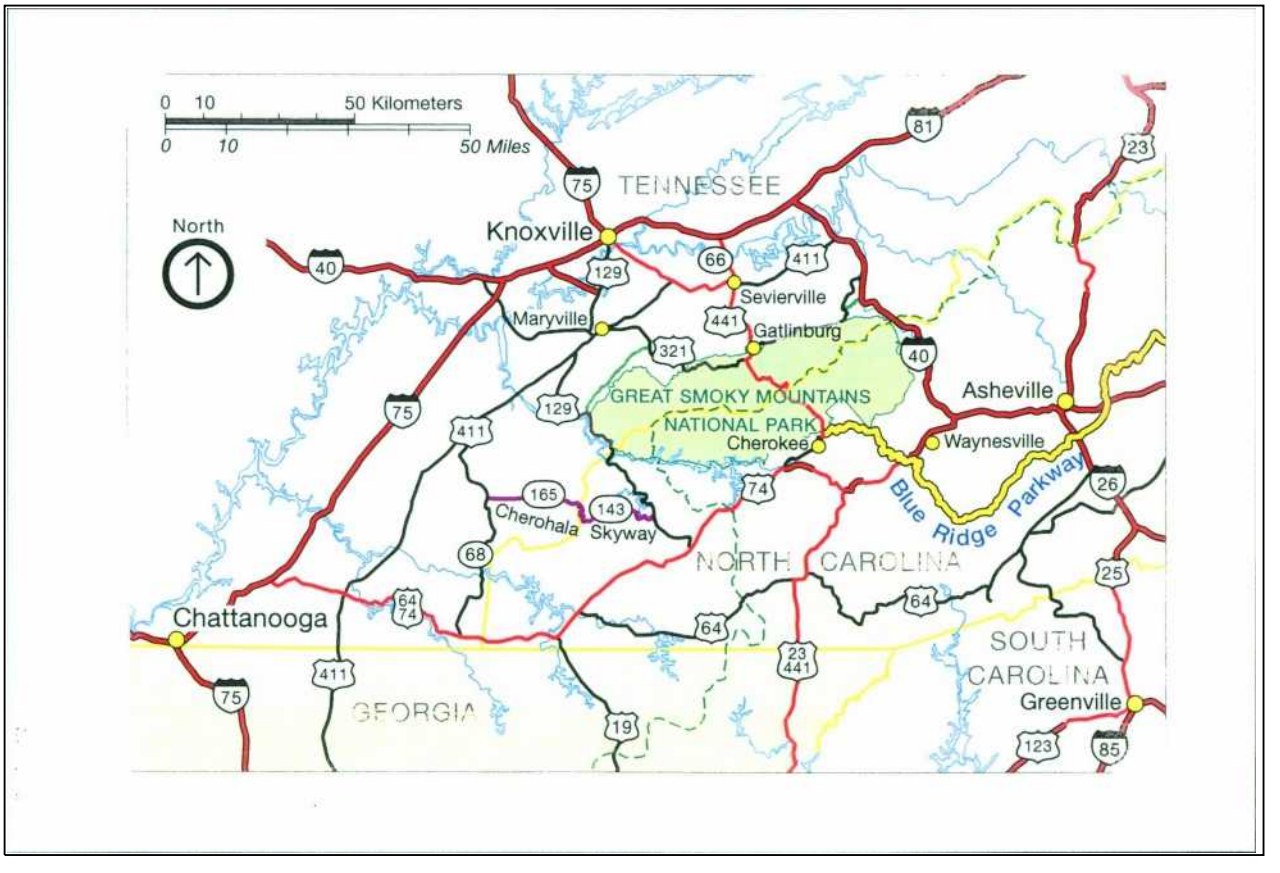


**FIGURE** 1. GREAT **SMOKY** MOUNTAINS NATIONAL **PARK** LOCATION

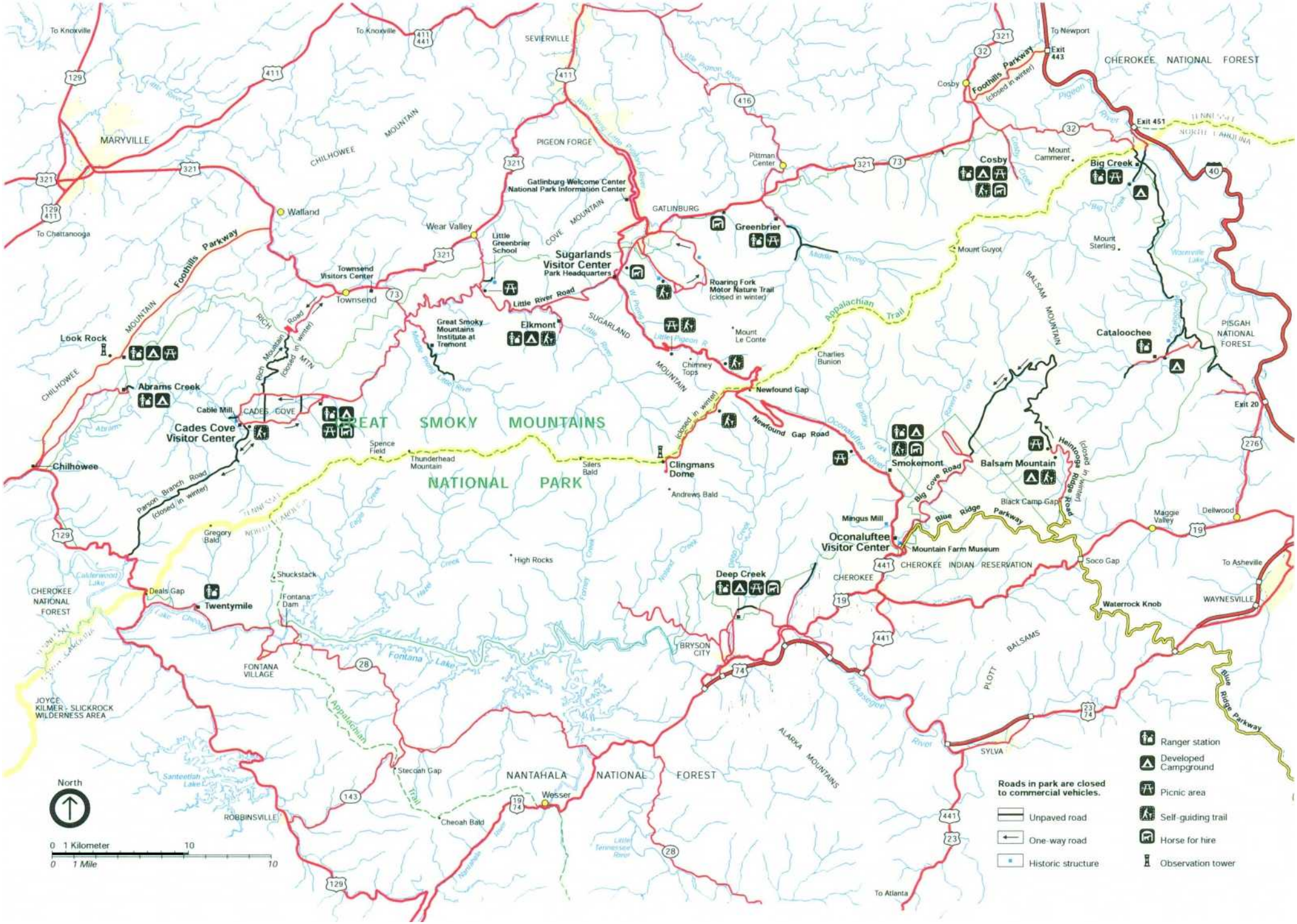


FIGURE 2. GREAT SMOKY MOUNTAINS NATIONAL PARK

Information on developed areas in the park is summarized in Table 1, and site maps of many of these developed areas are provided in Appendix B. The only lodging in the park are rustic cabins and lodge on top of Mount LeConte that can be reached only by hiking trails.

**TABLE 1: GREAT SMOKY MOUNTAINS NP DEVELOPED AREAS**

| Name/Location | Function/Facilities |
|---|---|
| Sugarlands | Visitor Center, Park Headquarters, Maintenance Shops, Employee Housing |
| Twin Creeks | Natural Resources Center, Resource Management & Science Division |
| Cades Cove/Cable Mill | Visitor Center, Ranger Station, Maintenance Shop, Water Plant, Employee Housing |
| LeConte Lodge | Cabins and Lodge |
| Deep Creek | Seasonal Quarters, Ranger Station, Maintenance Shop |
| Look Rock | Maintenance Yard, Campgrounds, Picnic Area, Air Quality Station |
| Cataloochee | Ranger Station, Maintenance Yard |
| Oconaluftee | Visitor Center, Maintenance Yard, Employee Housing |
| Cosby | Campground, Ranger Station, Maintenance Yard |
| Oconaluftee Job Corps | Administrative Office, Dormitories, Dining Hall, Training Facility, Laundry, Dispensary, Gymnasium |
| Institute at Tremont | Administrative Offices, Dormitory, Dining Hall, Seasonal Apartments, Director's House |
| Campgrounds | See Section 2, Table 8 |

## 1.5 AIR QUALITY STATUS

Great Smoky Mountains NP is located in Blount, Sevier, and Cocke Counties, TN and Swain and Haywood Counties, NC. The Tennessee Department of Environment and Conservation and North Carolina Department of Environment and Natural Resources are the governing authorities for regulating air pollution. All the counties currently are classified as attainment for all the National Ambient Air Quality Standards (NAAQS); however, with the exception of Cocke County, TN, it has been recommended by the governors of Tennessee and North Carolina that the park be designated as nonattainment for the 8-hour ozone standard. Data from five ozone monitoring stations throughout the park indicate that the 8-hour ozone standard was exceeded for a peak of 52 days in 1999, which declined to 31 and 14 days in 2000 and 2001 days, respectively. However, data for 2002 indicate 43 exceedences up to October 2002. Information on the air quality monitoring sites, equipment, and data are provided in Appendix C.

Great Smoky Mountains NP is one of 49 NPS units that are designated as Class I areas by the Clean Air Act and its Amendments. A Class I area is one that receives the most stringent degree of air quality protection within and around its borders. For example, potential new or modified sources of significant pollution that plan to locate near a Class I area must obtain a permit from the applicable air quality regulatory agency. The NPS has significant input to the permitting process to ensure that potential air emissions do not pose a threat to visibility or other park air quality related values.

# 2. STATIONARY AND AREA SOURCE EMISSIONS

This section summarizes emissions from sources at Great Smoky Mountains NP 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), and volatile organic compounds (VOCs). Emission factors used in the calculations are provided in Appendix A.

## 2.1 STATIONARY SOURCES

### 2.1.1 Space And Water Heating Equipment

Stationary combustion sources at Great Smoky Mountains NP include No. 2 fuel oil and propane space and water heating units, and Table 2 provides an inventory of these heating units. Criteria air emissions were calculated using the appropriate residential and commercial unit emission factors. For example, PM emissions from a No. 2 fuel oil boiler at the Sugarlands Visitor Center are calculated as follows:

$$4{,}922\ gal/yr\ x\ \frac{2.0\ lb\ PM}{1{,}000\ gal} = 10\ lb\ PM/yr$$

Actual criteria pollutant emissions from space and water heating equipment are summarized in Table 3. 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 4.

**TABLE 2: HEATING EQUIPMENT AT GREAT SMOKY MOUNTAINS NP**

| Location | Capacity (Btu/hr) | Number | Fuel Type |
|---|---|---|---|
| **National Park Service** | | | |
| Sugarlands Visitor Center | 85,000 | 5 | No. 2 fuel oil |
| Park Headquarters | 1,000,000 | 1 | No. 2 fuel oil |
| Twin Creeks Area | 250,000 | 1 | No. 2 fuel oil |
| Cades Cove Ranger Station | 80,000 | 1 | Propane |
| Cades Cove Maintenance Building | 100,000 | 1 | Propane |
| Cades Cove Maintenance Building | 200,000 | 2 | Propane |
| Cable Mill Visitor Center | 80,000 | 1 | Propane |
| Cable Mill Visitor Center | 28,000 | 1 | Propane |
| Cable Mill Comfort Station | 100,000 | 1 | Propane |
| Cable Mill Comfort Station | 60,000 | 1 | Propane |
| Cable Mill Sewer Building | 28,000 | 1 | Propane |
| Cable Mill Water Plant | 28,000 | 1 | Propane |
| **Tremont Institute** | | | |
| Dorm | 120,000 | 4 | Propane |
| Dorm | 200,000 | 1 | Propane |
| Kitchen | 100,000 | 2 | Propane |
| Kitchen | 120,000 | 1 | Propane |
| Office/Maintenance | 125,000 | 1 | Propane |
| Staff Quarters | 60,000 | 1 | Propane |
| Directors House | 90,000 | 1 | Propane |

TABLE 3: **2000** ACTUAL **CRITERIA EMISSIONS FROM HEATING EQUIPMENT AT GREAT SMOKY MOUNTAINS NP**

| Location | Fuel Type | Consumption (gallyr) | $PM_{10}$ (lbs/yr) | $SO_2$ (lbs/yr) | NOa (lbs/yr) | CO (lbs/yr) | VOC (lbs/yr) |
|---|---|---|---|---|---|---|---|
| **National Park Service** | | | | | | | |
| Sugarlands Visitor Center | No. 2 oil | 4,922 | 10 | 349 | 98 | 25 | 2 |
| Park Headquarters | No. 2 oil | 11,582 | 23 | 822 | 232 | 58 | 4 |
| Twin Creeks Area | No. 2 oil | 2,896 | 1 | 206 | 52 | 14 | 2 |
| No. 2 Oil Subtotal | | 19,400 | 34 | 1,377 | 382 | 97 | 8 |
| Cades Cove Ranger Station | Propane | 1,027 | 0 | 0 | 14 | 2 | 0 |
| Cades Cove Maintenance Building | Propane | 1,283 | 1 | 0 | 18 | 3 | 0 |
| Cades Cove Maintenance Building | Propane | 5,133 | 2 | 0 | 72 | 10 | 2 |
| Cable Mill Visitor Center | Propane | 1,027 | 0 | 0 | 14 | 2 | 0 |
| Cable Mill Visitor Center | Propane | 359 | 0 | 0 | 5 | 1 | 0 |
| Cable Mill Comfort Station | Propane | 1,283 | 1 | 0 | 18 | 3 | 0 |
| Cable Mill Comfort Station | Propane | 770 | 0 | 0 | 11 | 2 | 0 |
| Cable Mill Sewer Building | Propane | 359 | 0 | 0 | 5 | 1 | 0 |
| Cable Mill Water Plant | Propane | 359 | 0 | 0 | 5 | 1 | 0 |
| Propane Subtotals | | 11,600 | 4 | 0 | 162 | 25 | 2 |
| National Park Service Subtotals | | | 38 | 138 | 544 | 122 | 10 |
| **Tremont Institute** | | | | | | | |
| Dorm | Propane | 6,162 | 2 | 0 | 86 | 12 | 2 |
| Dorm | Propane | 2,568 | 1 | 0 | 36 | 5 | 1 |
| Kitchen | Propane | 2,568 | 1 | 0 | 36 | 5 | 1 |
| Kitchen | Propane | 1,541 | 1 | 0 | 22 | 3 | 0 |
| Office/Maintenance | Propane | 1,605 | 1 | 0 | 22 | 3 | 0 |
| Staff Quarters | Propane | 770 | 0 | 0 | 11 | 2 | 0 |
| Directors House | Propane | 1,155 | 0 | 0 | 16 | 2 | 0 |
| Tremont Institute Subtotals | | 16,369 | 7 | 0 | 229 | 33 | 5 |
| | | | | | | | |
| | | Totals | 45 | 1,378 | 774 | 153 | 16 |

**TABLE 4: 2000 POTENTIAL CRITERIA EMISSIONS FROM HEATING EQUIPMENT AT GREAT SMOKY MOUNTAINS NP**

| Location | Fuel Type | Consumption (gallyr) | $PM_{10}$ (lbs/yr) | $SO_2$ (lbs/yr) | NOx (Ibs/yr) | CO (lbs/yr) | VOC (lbs/yr) |
|---|---|---|---|---|---|---|---|
| **National Park Service** | | | | | | | |
| Sugarlands Visitor Center | No. 2 oil | 26,593 | 53 | 1,888 | 532 | 133 | 9 |
| Park Headquarters | No. 2 oil | 62,571 | 125 | 4,443 | 1,251 | 313 | 21 |
| Twin Creeks Area | No. 2 oil | 15,643 | 6 | 1,111 | 282 | 78 | 11 |
| No. 2 Oil Subtotal | | 104,807 | 184 | 7,441 | 2,065 | 524 | 41 |
| Cades Cove Ranger Station | Propane | 7,659 | 3 | 0 | 107 | 15 | 2 |
| Cades Cove Maintenance Building | propane | 9,574 | 4 | 0 | 134 | 19 | 3 |
| Cades Cove Maintenance Building | Propane | 38,295 | 15 | 0 | 536 | 77 | 11 |
| Cable Mill Visitor Center | Propane | 7,659 | 3 | 0 | 107 | 15 | 2 |
| Cable Mill Visitor Center | Propane | 2,681 | 1 | 0 | 38 | 5 | 1 |
| Cable Mill Comfort Station | Propane | 9,574 | 4 | 0 | 134 | 19 | 3 |
| Cable Mill Comfort Station | Propane | 5,744 | 2 | 0 | 80 | 11 | 2 |
| Cable Mill Sewer Building | Propane | 2,681 | 1 | 0 | 38 | 5 | 1 |
| Cable Mill Water Plant | Propane | 2,681 | 1 | 0 | 38 | 5 | 1 |
| Propane Subtotal | | 86,547 | 35 | 2 | 1,212 | 173 | 26 |
| National Park Service Subtotals | | | 218 | 7,443 | 3,277 | 695 | 67 |
| **Tremont Institute** | | | | | | | |
| Dorm | Propane | 45,954 | 18 | 1 | 643 | 92 | 14 |
| Dorm | Propane | 19,148 | 8 | 0 | 268 | 38 | 6 |
| Kitchen | Propane | 19,148 | 8 | 0 | 268 | 38 | 6 |
| Kitchen | Propane | 11,489 | 5 | 0 | 161 | 23 | 3 |
| Office/Maintenance | Propane | 11,967 | 5 | 0 | 168 | 24 | 4 |
| Staff Quarters | Propane | 5,744 | 2 | 0 | 80 | 11 | 2 |
| Directors House | Propane | 8,616 | 3 | 0 | 121 | 17 | 3 |
| Tremont Institute Subtotals | | 122,066 | 49 | 2 | 1,709 | 244 | 37 |
| | | | | | | | |
| | | Totals | 268 | 7,445 | 4985 | 941 | 104 |

### 2.1.2 Generators

#### 2.1.2.1 Generator Emissions - Actual

Emissions were calculated by multiplying the unit rating (kW) of the generators by an estimated annual run time (hr/yr) to get the kW-hr/yr, and the appropriate emission factors were then applied. For example, PM emissions from the two 45 kW generators at the Water Plant are calculated as:

$$45\ kW \times 2\ units \quad \frac{3{,}650\ hours}{year} \quad x \quad \frac{1.34\ hp}{kW} \quad x \quad \frac{0.00220\ lb\ PM}{hp\text{-}hr} = 68 lb\ PM/yr$$

Actual generator criteria emissions are summarized in Table 5.

#### 2.1.2.2 **Generator Emissions - Potential**

Potential emissions were also calculated for the generators, and the same emission factors that were used to calculate the actual emissions were used to calculate these potential emissions. Potential criteria generator emissions also are summarized in Table 6.

### 2.1.3 Fuel Storage Tanks

Great Smoky Mountains NP has eight aboveground gasoline storage tanks, and information on these tanks is provided in Tables 7. 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 Tables 7.

**TABLE 7: GREAT SMOKY MOUNTAINS NP GASOLINE STORAGE TANK EMISSIONS**

| Location | Number | Type | Volume (gal) | Throughput (gal/yr) | VOC (lbs/yr) |
|---|---|---|---|---|---|
| **National Park Service North District** | | | | | |
| Park Headquarters | 2 | AST | 2,000 | 27,623 | 752 |
| Park Headquarters | 1 | AST | 1,000 | 13,811 | 416 |
| Cosby Maintenance | 1 | AST | 1,000 | 13,811 | 416 |
| **Cades Cove Maintenance** | | | | | |
| Tank #1 | 1 | AST | 1,000 | 7,620 | 313 |
| Tank #2 | 1 | AST | 1,000 | 2,825 | 278 |
| Tank #3 | 1 | AST | 1,000 | 5,647 | 299 |
| **Look Rock Maintenance** | | | | | |
| Tank #1 | 1 | AST | 1,000 | 2,450 | 276 |
| Oconaluftee **Maintenance** | | | | | |
| Tank #1 | 1 | AST | 2,000 | 30,613 | 682 |
| | | | Totals | 104,400 | 3,432 |

TABLE **5: 2000** ACTUAL GREAT SMOKY MOUNTAINS **NP** GENERATOR CRITERIA EMISSIONS

| Facility | **Fuel** | **Number** | **Rating (kW)** | **Run Time (hrs/yr)** | **Output (kW-hr/yr)** | **$PM_{10}$ (Ibs/yr)** | **$SO_2$** (lbs/yr) | **NOx (lbs/yr)** | **CO (Ibs/yr)** | **VOC** (lbs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| Water Plant | Propane | 2 | 45 | 3,650 | 328,500 | 68 | 596 | 1,554 | 379 | 85 |

TABLE **6: 2000** POTENTIAL GREAT SMOKY MOUNTAINS **NP** GENERATOR CRITERIA EMISSIONS

| **Facility** | **Fuel** | **Number** | **Rating (kW)** | **Run Time (hrs/yr)** | **Output (kW-hr/yr)** | $PM_{10}$ (lbs/yr) | $SO_2$ (lbs/yr) | **NOx (lbs/yr)** | **CO (Ibs/yr)** | **VOC** (lbs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| Water Plant | Propane | 2 | 45 | 8,760 | 788,400 | 163 | 1,430 | 3,730 | 909 | 203 |

### 2.1.4 Wastewater Treatment Plants

There were no data available on wastewater treatment plants at Great Smoky Mountains NP.

## 2.2 AREA SOURCES

### 2.2.1 Woodstoves/Fireplaces

There are no woodstoves or fireplaces in Great Smoky Mountains NP.

### 2.2.2 Campfires

There are ten frontcountry campgrounds with about 900 campsites and about 100 in the backcountry in Great Smoky Mountains NP. These sites were occupied between 150 to 365 days a year, and it was estimated that approximately 50 percent had an evening or morning campfire at each site. Assuming that each campfire site consumes approximately 10 lbs of wood, air emissions from campsites in 2000 were calculated and are summarized in Table 8.

**TABLE 8: 2000 GREAT SMOKY MOUNTAINS NP CAMPFIRE EMISSIONS**

| Location | Campfires | Fuel (tons/yr) | $PM_{10}$ (lbs/yr) | $SO_2$ (lbs/yr) | $NO_X$ (lbs/yr) | CO (lbs/yr) | VOC (lbs/yr) |
|---|---|---|---|---|---|---|---|
| Abrams Creek | 1,688 | 8 | 292 | 3 | 22 | 2,131 | 1,932 |
| Balsam Mountain | 3,450 | 17 | 597 | 7 | 45 | 4,357 | 3,950 |
| Big Creek | 1,350 | 7 | 234 | 3 | 18 | 1,705 | 1,546 |
| Cades Cove | 29,383 | 147 | 5,083 | 59 | 382 | 37,110 | 33,643 |
| Calaloochee | 3,038 | 15 | 525 | 6 | 39 | 3,836 | 3,478 |
| Cosby | 18,563 | 93 | 3,211 | 37 | 241 | 23,444 | 21,254 |
| Deep Creek | 9,660 | 48 | 1,671 | 19 | 126 | 12,201 | 11,061 |
| Elkmont | 28,050 | 140 | 4,853 | 56 | 365 | 35,427 | 32,117 |
| Look Rock | 2,310 | 12 | 400 | 5 | 30 | 2,918 | 2,645 |
| Smokemont | 25,915 | 130 | 4,483 | 52 | 337 | 32,731 | 29,673 |
| Total | 123,405 | 617 | 21,349 | 247 | 1,604 | 155,861 | 141,299 |
| | | | tons/yr | | | | |
| | | | 10.67 | 0.12 | 0.80 | 77.93 | 70.65 |

### 2.2.3 Prescribed and Wildland Fires

Wildland fires are ignited naturally, usually by lightning and are typically suppressed, while prescribed fires are ignited intentionally in order to achieve fire management objectives. 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. Only prescribed burning emissions are considered as anthropogenic emissions; however, to the extent that prescribed burning is conducted to achieve ecological benefit, the emissions could be considered natural.

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 $PM_{10}$, $PM_{2.5}$, $CH_4$, and CO, which are summarized in Table 9 for prescribed fires only.

**TABLE 9: AIR EMISSIONS FROM PRESCRIBED FIRES IN 2000**
**IN** GREAT SMOKY MOUNTAINS **NP** IN **2000**

| Fire Name | Acres | $PM_{10}$ (Ibs/yr) | $PM_{2.5}$ (Ibs/yr) | VOC' (ibs/yr) | CO (lbs/yr) |
|---|---|---|---|---|---|
| Cades Cove Fields | 664 | 5,976 | 4,648 | 1,328 | 11,952 |
| Ski Mtn Pile | 4 | 436 | 371 | 212 | 4,496 |
| Total | 668 | 6,412 | 5,019 | 1,540 | 16,448 |

As methane ($CH_4$)

It should be noted that annual variations in emissions from prescribed burning are dependent on the number of acres burned in a given year, and to a lesser extent on meteorological conditions.

### 2.2.4 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.

## 2.3 SUMMARY OF STATIONARY AND AREA SOURCE EMISSIONS

Table 10 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 10: SUMMARY OF 2000 STATIONARY AND AREA SOURCE EMISSIONS AT GREAT SMOKY MOUNTAINS NP**

| Activity | Particulates | | 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 |
| Stationary Combustion Sources | | | | | | | | | | |
| Space and Water Heating Units | 45 | 0.02 | 1,378 | 0.69 | 774 | 0.39 | 153 | 0,08 | 16 | <0.01 |
| Generators | 68 | 0.03 | 596 | 0.30 | 1,554 | 0.78 | 379 | 0.19 | 85 | 0.04 |
| Gasoline Storage Tanks | | | | | | | | | 3,432 | 1.72 |
| Stationary Sources Subtotal | 113 | 0.06 | 1,974 | 0.99 | 2,328 | 1.16 | 532 | 0.27 | 3,533 | 1.77 |
| Area Sources | | | | | | | | | | |
| Campfires | 21,349 | 10.67 | 247 | 0.12 | 1,604 | 0.80 | 155,861 | 77.93 | 141,299 | 70.65 |
| Prescribed Fires | 6,412 | 3.21 | -- | -- | -- | -- | 16,448 | 8.22 | 1,540[1] | 0.77[1] |
| Area Sources Subtotal | 27,761 | 11.01 | 247 | 0.12 | 1,604 | 0.80 | 172,309 | 86.15 | 142,840 | 71.42 |
| Totals | | | | | | | | | | |
| | Particulates | | 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 without Prescribed Burning | 21,462 | 10.73 | 2,221 | 1.11 | 3,932 | 1.97 | 156,393 | 78.20 | 144,832 | 72.42 |
| Totals with Prescribed Burning | 27,874 | 13.94 | 2,221 | 1.11 | 3,932 | 1.97 | 172,841 | 86.42 | 146,372 | 73.19 |

[1] As methane

# 3. MOBILE SOURCE EMISSIONS

This section summarizes emissions from mobile sources at Great Smoky Mountains NP for 2000. Mobile emission sources include highway and nonroad vehicles.

## 3.1 HIGHWAY VEHICLES

### 3.1.1 Visitor Vehicles

The park maintains statistics on the number of vehicles entering the park from the three principal entrances at Gatlinburg, Cherokee, and Townsend, as well as eleven outlying entrances. **In** order to calculate visitor vehicle miles traveled (VMT) for this analysis, a number of broad assumptions were made. For example, visitor studies indicate that approximately 50 percent of visitors travel to the Cades Cove area (University of Idaho, 1997). For this analysis, it was assumed that 50 percent of visitor vehicles entering from the three principal entrances traveled to Cades Cove and exited from the same entrance. The remaining 50 percent traveled through the park and exited from another principal entrance. The vehicles entering from the outlying areas were assumed to exit from the same outlying entrance. Vehicles operating on the East and West Foothills Parkway were assumed to travel its length one-way. These assumptions are summarized in Table 11.

**TABLE 11: ESTIMATED VISITOR VEHICLE TRAVEL IN GREAT SMOKY MOUNTAINS NP**

| Entrance | Exit | Vehicles | | Miles |
|---|---|---|---|---|
| | | Summer | Winter | |
| Gatlinburg | Gatlinburg via Cades Cove | 617,098 | 78,130 | 65 |
| | Cherokee | 617,098 | 78,130 | 34 |
| Townsend | Townsend via Cades Cove | 283,909 | 37,039 | 30 |
| | Cherokee | 283,909 | 37,039 | 52 |
| Cherokee | Cherokee via Cades Cove | 419,970 | 54,329 | 125 |
| | Gatlinburg | 419,970 | 54,329 | 34 |
| Abrams Creek | Abrams Creek | 48,835 | 6,738 | 2 |
| Big Creek | Big Creek | 37,398 | 5,160 | 2 |
| Cataloochee | Cataloochee | 39,980 | 5,516 | 10 |
| Cherokee Orchard | Cherokee Orchard | 43,799 | 6,043 | 2 |
| Foothills Parkway East | Foothills Parkway East | 230,866 | 31,855 | 15 |
| Cosby | Cosby | 26,220 | 3,618 | 5 |
| Twentymile | Twentymile | 1,981 | 273 | 1 |
| Foothills Parkway West | Foothills Parkway West | 144,683 | 19,963 | 5 |
| Greenbrier | Greenbrier | 92,030 | 12,698 | 6 |
| Deep Creek | Deep Creek | 106,743 | 14,728 | 2 |
| Bryson City | Bryson City | 23,866 | 47,663 | 2 |
| | Total | 3,438,355 | 493,251 | |

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 MOBILE5b model were used in conjunction with VMT data in order to estimate mobile source emissions for VOC (both exhaust and evaporative NOx, and CO for visitor vehicles. Similarly, emission factors produced by the PARTS model were used in conjunction with VMT data to estimate $PM_{10}$ emissions. MOBILE5b produces exhaust and evaporative emission factors for the following classes of vehicles: Light Duty Gasoline Vehicles (LDGV), Light Duty Gasoline Trucks 1 (LDGT1), Light Duty Gasoline Trucks 2 (LDGT2), Heavy Duty Gasoline Vehicles (HDGV), Light Duty Diesel Vehicles (LDDV), Light Duty Diesel Trucks (LDDT), Heavy Duty Diesel Vehicles (HDDV), 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, annual mileage accumulation rates and registration distributions by age, inspection and maintenance (I/M) program information, fuel information, ambient temperature data, and others.

Both the MOBILE5b and PARTS models 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 Great Smoky Mountains NP.

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 (FI'P). 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 MOBILE5b 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 I/M program parameters. The average speed input to the mobile model was 35 mph, fuel volatility was assumed to be Reid vapor pressure (RVP) 9, and reformulated gasoline (RFG) was not assumed to be present. Finally, I/M 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 MOBILE5b 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 Great Smoky Mountains NP also were calculated based on VMT.

A summary of visitor vehicle emissions is provided in Table 14 at the end of this section.

### 3.1.2 NPS Highway Vehicles

Great Smoky Mountains NP operates a fleet of highway vehicles that are owned by the NPS, but no vehicles are leased from the General services Administration (GSA), which is a common practice among many NPS units. There were some data on the annual VMT for light-duty and heavy-duty trucks, and these data were extrapolated to the other vehicle categories for purpose of this analysis. A summary of NPS and concessionaire vehicles and their estimated annual mileage is provided in Table 12, and emissions are summarized in Table 14 at the end of this section.

**TABLE 12: NPS ROAD VEHICLES AT GREAT SMOKY MOUNTAINS NP**

| Vehicle Type | Number | Annual Usage (mi/yr) |
|---|---|---|
| Light-Duty Gasoline Vehicles | 29 | 145,000 |
| Light-Duty Gasoline Trucks | 165 | 495,000 |
| Medium Duty Diesel Trucks | 25 | 75,000 |
| Heavy Duty Gasoline Vehicles | 15 | 32,600 |

## 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 Great Smoky Mountains NP equipment inventory, and the larger pieces of equipment for which there are usage data are noted in Table 13. Emission factors from the USEPA nonroad emission database were used to calculate annual emissions, and it was assumed that each piece of equipment was operated approximately 100 hours per year. Estimated emissions are provided in Table 14.

**TABLE 13: NPS NONROAD VEHICLES AT GREAT SMOKY MOUNTAINS NP**

| Vehicle Type | Number | Annual Usage (hrs/yr) |
|---|---|---|
| Tractors | 13 | 1,300 |
| Backhoe | 9 | 900 |
| Grader | 4 | 400 |
| Sweeper | 4 | 400 |
| Forklift | 3 | 100 |
| Roller/Compactor | 1 | 100 |
| Utility Vehicle | 11 | 1,100 |
| Riding Mower | 7 | 700 |
| Bobcat | 1 | 100 |
| Dozer | 1 | 100 |
| Chipper | 3 | 100 |

## 3.3 SUMMARY OF MOBILE SOURCE EMISSIONS

Table 14 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 14: SUMMARY **OF 2000 MOBILE SOURCE EMISSIONS AT GREAT SMOKY MOUNTAINS NP**

| Activity | Particulates[1] | | 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 | 354,834 | 157.10 | -- | -- | 368,436 | 184.22 | 3,468,631 | 1,734.32 | 372,217 | 186.11 |
| NPS Road Vehicles | 1,497 | 0.75 | -- | -- | 1,738 | 0.87 | 14,649 | 7.32 | 1,512 | 0.76 |
| Road Vehicle Emissions Subtotal | 356,331 | 178.17 | -- | -- | 370,174 | 185.09 | 3,483,280 | 1,741.64 | 373,729 | 186.86 |
| | | | Nonroad Vehicles | | | | | | | |
| NPS Nonroad Vehicles | 628 | 0.31 | -- | -- | 2.140 | n7 | 1,248 | 6~ | 714 | 0.36 |
| | | | Totals | | | | | | | |
| Totals | Particulates[1] | | 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 |
| | 356,959 | 178.48 | -- | -- | 372,314 | 186.16 | 3,484,520 | 1,742.26 | 374,443 | 187.22 |

[1] Includes exhaust $PM_{10}$ and road dust

# 4. GREAT SMOKY MOUNTAINS NP AND REGIONAL EMISSIONS

## 4.1 GREAT SMOKY MOUNTAINS NP SUMMARY

A summary of Great Smoky Mountains NP emissions is provided in Table 15.

TABLE 15: ESTIMATED ANNUAL EMISSIONS FROM GREAT SMOKY MOUNTAINS NP

| Source | $PM_{10}$ (tons/yr) | $SO_2$ (tons/yr) | $NO_X$ (tons/yr) | CO (tons/yr) | VOCs (tons/yr) |
|---|---|---|---|---|---|
| | | Point Sources | | | |
| Space and Water Heaters | 0.02 | 0.69 | 0.39 | 0,08 | <0.01 |
| Generators | 0.03 | 0.30 | 0.78 | 0.19 | 0.04 |
| Gasoline Storage Tanks | -- | -- | -- | -- | 1.72 |
| Subtotal | 0.06 | 0.99 | 1.16 | 0.27 | 1.77 |
| | | Area Sources | | | |
| Campfires | 10.67 | 0.12 | 0.80 | 77.93 | 70.65 |
| Prescribed Burning | 3.21 | -- | -- | 8.22 | 0.77' |
| Subtotal | 11.01 | 0.12 | 0.80 | 86.15 | 71.42 |
| | | Mobile Sources | | | |
| Road Vehicles | 178.17 | -- | 185.09 | 1,741.64 | 186.86 |
| Nonroad Vehicles | 0.31 | -- | 1.07 | 0.62 | 0.36 |
| Subtotal | 178.48 | -- | 186.16 | 1,742.26 | 187.22 |
| | | | | | |
| Totals | 189.55 | 1.11 | 188.12 | 1,828.68 | 260.41 |

[1] As methane

## 4.2 REGIONAL AIR EMISSIONS

Emission estimates for Blount, Cocke, and Sevier Counties, TN, Haywood and Swain Counties, NC, and the states of Tennessee and North Carolina 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 NET. For example, here gasoline storage tanks have been included as stationary sources, while the NEI treats them as area sources. Table 16 provides a comparison of Great Smoky Mountains NP emissions with those from the surrounding counties and the two states. For all pollutants, Great Smoky Mountains NP emissions account for less than 1 percent of the surrounding county point and area source emissions.

**TABLE *16:* ESTIMATED ANNUAL EMISSIONS FROM GREAT SMOKY MOUNTAINS *NP*, SURROUNDING COUNTIES, AND THE STATES OF TENNESSEE AND NORTH CAROLINA**

| Area | $PM_{10}$ (tons/yr) | $SO_2$ (tons/yr) | NOx (tons/yr) | CO (tons/yr) | VOC (tons/yr) |
|---|---|---|---|---|---|
| **Point Sources** | | | | | |
| Great Smoky Mountains NP Total | 0.06 | 0.99 | 1.16 | 0.27 | 1.77 |
| | | | | | |
| Blount County, TN | 1,931 | 2,840 | 2,529 | 5,270 | 470 |
| Cocke County, TN | 86 | 203 | 188 | 28 | 10 |
| Sevier County, TN | 18 | 84 | 39 | 5 | 2 |
| Haywood County, NC | 164 | 7,550 | 3,791 | 2,236 | 75 |
| Swain County, NC | -- | 15 | 2 | <1 | <1 |
| Surrounding County Total | 2,200 | 10,695 | 6,550 | 7,540 | 558 |
| | | | | | |
| Tennessee | 26,966 | 609,058 | 284,711 | 106,151 | 120,220 |
| North Carolina | 27,473 | 544,445 | 271,630 | 80,879 | 68,306 |
| Tennessee/North Carolina Total | 54,439 | 1,153,503 | 556,341 | 187,030 | 188,526 |
| **Area Sources** | | | | | |
| Great Smoky Mountains NP Total | 11 | <1 | <1 | 86 | 71 |
| | | | | | |
| Blount County, TN | 593 | 85 | 100 | 4,170 | 2,473 |
| Cocke County, TN | 349 | 34 | 46 | 2,342 | 1,161 |
| Sevier County, TN | 585 | 76 | 85 | 4,100 | 1,735 |
| Haywood County, NC | 650 | 90 | 59 | 4,391 | 1,979 |
| Swain County, NC | 228 | 19 | 22 | 1,561 | 540 |
| Surrounding County Total | 2,405 | 304 | 312 | 16,564 | 7,888 |
| | | | | | |
| Tennessee | 272,941 | 40,504 | 49,156 | 318,682 | 226,223 |
| North Carolina | 340,059 | 31,162 | 30,971 | 867,428 | 318,707 |
| Tennessee/North Carolina Total | 613,000 | 71,666 | 80,127 | 1,186,110 | 544,930 |
| **Mobile Sources** | | | | | |
| Great Smoky Mountains NP Total | 178 | -- | 186 | 1,742 | 187 |
| | | | | | |
| Blount County, TN | 234 | 342 | 4,987 | 31,488 | 3,338 |
| Cocke County, TN | 115 | 140 | 2,603 | 13,291 | 1,566 |
| Sevier County, TN | 131 | 213 | 3,044 | 16,482 | 1,693 |
| Haywood County, NC | 171 | 234 | 4,150 | 17,956 | 1,950 |
| Swain County, NC | 32 | 48 | 568 | 2,931 | 351 |
| Surrounding County Total | 683 | 977 | 15,352 | 82,148 | 8,898 |
| | | | | | |
| Tennessee | 111,674 | 36,420 | 406,655 | 1,879,125 | 202,336 |
| North Carolina | 171,063 | 32,259 | 373,528 | 2,208,120 | 248,798 |
| Tennessee/North Carolina Total | 282,737 | 68,679 | 780,183 | 4,087,245 | 451,134 |

Finally, estimated emissions from the eight states that constitute Region 4 and those from the United States are summarized in Table 17.

**TABLE 17: ESTIMATED 1999 EMISSIONS FROM REGION 4 AND THE** U.S.

| Area | $PM_{10}$ (tons/yr) | $SO_2$ (tons/yr) | NOa (tons/yr) | CO (tons/yr) | VOC (tons/yr) |
|---|---|---|---|---|---|
| **Point Sources** | | | | | |
| Tennessee | 26,966 | 609,058 | 284,711 | 106,151 | 120,220 |
| North Carolina | 27,473 | 544,445 | 271,630 | 80,879 | 68,306 |
| South Carolina | 9,570 | 272,578 | 136,304 | 66,773 | 49,525 |
| Kentucky | 26,148 | 698,840 | 344,319 | 75,615 | 63,760 |
| Georgia | 39,711 | 594,918 | 242,933 | 178,368 | 36,050 |
| Mississippi | 10,226 | 164,064 | 158,352 | 90,578 | 43,430 |
| Alabama | 46,634 | 665,668 | 285,896 | 207,527 | 96,960 |
| Florida | 23,225 | 820,475 | 373,354 | 74,422 | 27,154 |
| Region 4 Totals | 209,953 | 4,370,046 | 2,097,499 | 880,313 | 505,405 |
| | | | | | |
| United States | 1,111,756 | 16,296,167 | 9,037,572 | 5,307,982 | 2,061,167 |
| Area **Sources** | | | | | |
| Tennessee | 272,941 | 40,504 | 49,156 | 318,682 | 226,223 |
| North Carolina | 340,059 | 31,162 | 30,971 | 867,428 | 318,707 |
| South Carolina | *93,467* | 13,868 | 136,304 | 66,773 | 49,525 |
| Kentucky | 146,687 | 54,855 | 70,723 | 169,936 | 129,203 |
| Georgia | 307,592 | 5,681 | 64,864 | 1,316,334 | 248,555 |
| Mississippi | 180,140 | 71,135 | 52,021 | 442,300 | 142,759 |
| Alabama | 158,799 | 43,682 | 63,506 | 628,610 | 151,317 |
| Florida | 204,469 | 38,115 | 61,110 | 979,936 | 376,167 |
| Region 4 Totals | 1,704,154 | 299,002 | 528,655 | 4,789,999 | 1,642,456 |
| | | | | | |
| United States | 9,734,269 | 1,289,884 | 2,251,929 | 16,972,636 | 7,574,071 |
| **Mobile Sources** | | | | | |
| Tennessee | 111,674 | 36,420 | 406,655 | 1,879,125 | 202,336 |
| North Carolina | 171,063 | 32,259 | 373,528 | 2,208,120 | 248,798 |
| South Carolina | 201,778 | 16,156 | 218,302 | 1,360,805 | 152,338 |
| Kentucky | 122,815 | 31,733 | 280,317 | 1,262,003 | 137,257 |
| Georgia | 520,615 | 35,260 | 453,921 | 2,810,844 | 288,475 |
| Mississippi | 219,254 | 14,662 | 194,181 | 1,013,591 | 127,336 |
| Alabama | 320,076 | 20,540 | 285,785 | 1,733,273 | 197,263 |
| Florida | 341,205 | 65,103 | 678,983 | 4,808,725 | 543,028 |
| Region 4 Totals | 2,008,480 | 252,133 | 2,891,672 | 17,076,486 | 1,896,831 |
| | | | | | |
| United States | 12,831,958 | 1,299,342 | 14,105,483 | 75,151,535 | 8,536,092 |

# 5. **COMPLIANCE** AND RECOMMENDATIONS

## 5.1 COMPLIANCE

The Tennessee Department of Environment and Conservation (TNDEC) and North Carolina Department of Environment and Natural Resources (NCDENR) are the governing authorities for regulating air pollution. Park personnel should continue to coordinate with the agency on permit issues relating to stationary sources, as well as prescribed burning activities. Prior to replacing or adding relatively large heating units, generators, and fuel storage tanks, the appropriate agency should be consulted regarding the need to obtain a permit to construct or a permit to operate such sources. For example, North Carolina Air Quality Rule 15A NCAC 2Q.102 (c) exempts the following from permit requirements:

- liquid or gas fueled space heaters used solely for comfort heat
- residential woodstoves, heaters, or fireplaces
- hot water heaters used for domestic purposes only.

Both states also have exemptions to open burning regulations that apply to visitor activities in the park. The Rules of Tennessee DEC Chapter 1200-3-4-04 exempts "fires used for cooking of food or for ceremonial, recreational, or comfort-heating purposes, including barbecues, campfires, and outdoor fireplaces." North Carolina Air Quality Rule 15A NCAC 2D.1903(a)(3) exempts "campfires and fires used solely for outdoor cooking and other recreational purposes or for ceremonial occasions or for human warmth and comfort and which do not create a nuisance and do not use synthetic materials or refuse or salvageable materials for fuel."

With respect to visible emissions, Tennessee DEC Chapter 1200-3-5.01 limits visible emissions from any contaminant source to an opacity of 20 percent or less. NC Rule 15A NCAC 2D.D521 limits 01 limits visible emissions from sources manufactured after 1971 to an opacity of 20 percent or less, and 40 percent for sources manufactured after 1971. Measures to prevent the creation of fugitive dust also must be taken. For example, Tennessee DEC Chapter 1200-3-8-.01 requires that persons handling, transporting, or storing materials take reasonable precautions to prevent particulate matter from becoming airborne.

## 5.2 RECOMMENDATIONS

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.

Opportunities to reduce NOx and VOC emissions, which are the precursors for ozone formation, in Great Smoky Mountains NP are related to the reduction or replacement of conventional fossil fuels. The park has several photovoltaic power units in operation. These include four radio repeaters on Webb, Shuckstack, and Spur Mountains and Clingmans Dome and a unit to power air quality monitoring equipment,op Clingmans Dome. The park, in conjunction with the Tennessee Valley Authority, also has a solar hot water heater at the Sugarlands Visitor Center.

Vehicle emissions are the largest source of emissions in the park. One current investigation is directed at reducing visitor vehicle congestion and associated emissions. The park is participating with the Knoxville Regional Transportation Planning Organization to undertake a Development Concept and Transportation Management Plan for Cades Cove. The Plan will result in a range of alternatives that provide for a comprehensive, long-range approach for managing the natural and cultural resources and improving the quality of visitor experience by providing for greater visitor mobility through a variety of transportation initiatives.

The park has undertaken a project to demonstrate the feasibility of electric vehicles in the Cades Cove and other areas. These vehicles include three John Deere Electric Gators, and Electric tractor "Ox", three Global Electric Motor Cars, four Club Car Carryalls, and three ZAPWorld Electric Bikes (EPRI, 2002). The project will run until March 2003 and will gather baseline fuel use and emission information, identify applicable and feasible electric vehicles, perform an energy efficiency study, and assess supporting infrastructure.

The park is also investigating the use of low sulfur gasoline and diesel fuels and biodiesel fuel for use in its vehicles. An analysis of the emission reductions possible with these fuels are summarized in Table 17. Although these reductions would be minor if such fuels were used by park vehicles only, significant reductions may be possible if these fuels were widely available in the surrounding communities for use by the general public.

TABLE 18: ESTIMATED EMISSIONS WITH LOW **SULFUR/BIODIESEL VEHICLE FUELS**

| **Fuel** | | **Percent Reduction** | | | |
|---|---|---|---|---|---|
| | **$PM_{10}$** | **$SO_2$** | **NOx** | **CO** | **VOC** |
| Low Sulfur Gasoline[1] | -13 | -88 | -11 | -15 | -16 |
| Low Sulfur Diesel[2] | -9 | -97 | 0 | 0 | 0 |
| Biodiesel (20% biomass based oil) | -18 | -100 | +1 | -12.5 | -11 |
| | | | | | |
| | **Emissions (tons/yr)** | | | | |
| Regular Gasoline/Regular Diesel | 0.03 | 0.055 | 1.51 | 5.30 | 0.32 |
| Low Sulfur Gasoline[1]/Low Sulfur Diesel[2] | 0.03 | <0.01 | 1.47 | 4.52 | 0.27 |
| Low Sulfur Gasoline[1]/Biodiesel | 0.03 | <0.03 | 1.49 | 4.50 | 0.27 |

[1] 30 ppmw (Tier 2 gasoline rule) versus 300 ppmw

[2] 15 ppmw (proposed diesel sulfur rule) versus 500 ppmw

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# APPENDIX A

# FUEL DATA, EMISSION FACTORS, AND EMISSION CALCULATIONS

## 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] | $SO_Z$[Cb] | $NO_x$[c] | CO | VOC[d] |
| Residential Furnace[e] | 0.4 | 142S | 18 | 5 | 0.713 |
| Boilers < 100 Million Btu/hr (Commercial/Institutional Combust.[°]) | 2 | 142S | 20 | 5 | 0.34 |
| Boilers < 100 Million Btu/hr (Industrial Boilers[g]) | 2 | 142S | 20 | 5 | 0.2 |
| Boilers > 100 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[0] | $SO_2$ | $NO_x$[e] | 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 $NO_x$ burners | 7.6 | 0.6 | 50 | 84 | 5.5 |
| -Controlled-Low $NO_x$ 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.

| PROPANE (LPG) - CRITERIA POLLUTANTS | | | | | |
|---|---|---|---|---|---|
| Combustor Type | Emission Factor (lb/1,000 gal fuel burned) | | | | |
| | PM[a] | $SO_2$[b] | $NO_x$[c] | CO | VOC[d] |
| Commercial Boilers[e] | 0.4 | 0.10S | 14 | 1.9 | 0.3 |
| Industrial Boilers[g] | 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/h -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] | $NO_x$ | 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. | | | | | |

## F REPLACE EMISSION FACTORS

| Fuel Type | Emission Factor (lb/ton) | | | | |
|---|---|---|---|---|---|
| | PM[0)] | SO, | $NO_x$[cc] | 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)] | $SO_x$ | $NO_x$[(c)] | 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 Btu/hr, but <10,000,000 Btu/hr.
(g) Unit Rating 310,000,000 Btu/hr, but <100,000,000 Btu/hr.
(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.
(l) 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.

**2000 ACTUAL CRITERIA EMISSIONS FROM HEATING UNITS AT GREAT SMOKY MOUNTAINS NP**

| Emission Source | Location | Fuel | Number of Sources | Capacity (Btu/hr) | | Consumption (gal/yr) | $PM_{10}$ (lbs/yr) | $SO_2$ (lbs/yr) | $NO_X$ (lbs/yr) | CO (lbs/yr) | CO, (lbs/yr) | VOC (lbs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | National Park Service | | | | | | | | |
| Furnace | Sugarlands Visitor Center | No. 2 Fuel Oil | 5 | 85,000 | 425,000 | 4,922 | 10 | 349 | 98 | 25 | 105,831 | 2 |
| Boiler | Sugarlands Park Headquarters | No. 2 Fuel Oil | 1 | 1,000,000 | 1,000,000 | 11,582 | 23 | 822 | 232 | 58 | 249,015 | 4 |
| Boiler | Twin Creeks Administration | No. 2 Fuel Oil | 1 | 250,000 | 250,000 | 2,896 | 1 | 206 | 52 | 14 | 62,254 | 2 |
| | | Totals | 7 | 1,335,000 | 1,675,000 | 19,400 | 34 | 1,377 | 382 | 97 | 417,100 | 8 |
| Emission Factors from AP-42, Tables 1.3-1 and 1.3-3 for residential furnaces (<300,000 Btu/hr) S = 0.5 percent | | | | | | | 0.4 | I42S | 18.0 | 5.0 | 21,500 | 0.7 |
| Emission Factors from AP-42, Tables 1.3-1 and 1.3-3 for boilers (>300,000 Btu/hr) S = 0.5 percent | | | | | | | 2.0 | 142S | 20.0 | 5.0 | 21,500 | 0.3 |
| Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal) | | | | | | | | | | | | |
| Heater | Cades Cove Ranger Station | Propane | 1 | 80,000 | 80,000 | 1,027 | 0 | 0 | 14 | 2 | 12,832 | 0 |
| Heater | Cades Cove Maintenance Building | Propane | 1 | 100,000 | 100,000 | 1,283 | 1 | 0 | 18 | 3 | 16,040 | 0 |
| Ceiling Heater | Cades Cove Maintenance Building | Propane | 2 | 200,000 | 400,000 | 5,133 | 2 | 0 | 72 | 10 | 64,159 | 2 |
| Fireplace | Cable Mill Visitor Center | Propane | 1 | 80,000 | 80,000 | 1,027 | 0 | 0 | 14 | 2 | 12,832 | 0 |
| Wall Heater | Cable Mill Visitor Center | Propane | 1 | 28,000 | 28,000 | 359 | 0 | 0 | 5 | 1 | 4,491 | 0 |
| Water Heater | Cable Mill Comfort Station | Propane | 1 | 100,000 | 100,000 | 1,283 | 1 | 0 | 18 | 3 | 16,040 | 0 |
| Heater | Cable Mill Comfort Station | Propane | 1 | 60,000 | 60,000 | 770 | 0 | 0 | 11 | 2 | 9,624 | 0 |
| Heater | Cable Mill Sewer Building | Propane | 1 | 28,000 | 28,000 | 359 | 0 | 0 | 5 | 1 | 4,491 | 0 |
| Wall Heater | Cable Mill Water Plant | Propane | 1 | 28,000 | 28,000 | 359 | 0 | 0 | 5 | 1 | 4,491 | 0 |
| | | Totals | 10 | | 904.000 | 11.600 | 5 | 0 | 162 | 23 | 145.000 | 3 |
| | | | | Tremont Institute | | | | | | | | |
| Heating Unit | Dorm | Propane | 4 | 120,000 | 480,000 | 6,162 | 2 | 0 | 86 | 12 | 77,025 | 2 |
| Water Heater | Dorm | Propane | 1 | 200,000 | 200,000 | 2,568 | 1 | 0 | 36 | 5 | 32,094 | 1 |
| Heating Unit | Kitchen | Propane | 2 | 100,000 | 200,000 | 2,568 | 1 | 0 | 36 | 5 | 32,094 | 1 |
| Heating Unit | Kitchen | Propane | 1 | 120,000 | 120,000 | 1,541 | 1 | 0 | 22 | 3 | 19,256 | 0 |
| Heating Unit | Office/Maintenance | Propane | 1 | 125,000 | 125,000 | 1,605 | 1 | 0 | 22 | 3 | 20,059 | 0 |
| Heating Unit | Staff Quarters | Propane | 1 | 60,000 | 60,000 | 770 | 0 | 0 | 11 | 2 | 9,628 | 0 |
| Water Heater | Directors House | Propane | 1 | 90,000 | 90,000 | 1,155 | 0 | 0 | 16 | 2 | 14,442 | 0 |
| | | Totals | 11 | | 1,275,000 | 16,368 | 7 | 0 | 229 | 33 | 204,598 | 5 |
| 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) | | | | | | | | | | | | |
| | | Total Heating Units | 28 | | | | 45 | 1,378 | 774 | 153 | 766,698 | 16 |

**2000 POTENTIAL CRITERIA EMISSIONS FROM HEATING UNITS AT GREAT SMOKY MOUNTAINS NP**

| Emission Source | Location | Fuel | Number o: Sources | Capacity (Btu/hr) | | Consumption (gal/yr) | $PM_{10}$ (Ibs/yr) | $SO_2$ (Ibs/yr) | NOx (lbs/yr) | CO (lbs/yr) | CO, (lbs/yr) | VOC (lbs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| National Park Service | | | | | | | | | | | | |
| Furnace | Sugarlands Visitor Center | No. 2 Fuel Oil | 5 | 85,000 | 425,000 | 26,593 | 53 | 1,888 | 532 | 133 | 571,746 | 9 |
| Boiler | Sugarlands Park Headquarters | No. 2 Fuel Oil | 1 | 1,000,000 | 1,000,000 | 62,571 | 125 | 4,443 | 1,251 | 313 | 1,345,286 | 21 |
| Boiler | Twin Creeks Administration | No. 2 Fuel Oil | 1 | 250,000 | 250,000 | 15,643 | 6 | 1,111 | 282 | 78 | 336,321 | 11 |
| | | Totals | 7 | 1,335,000 | 1,675,000 | 104,807 | 185 | 7,441 | 2,065 | 524 | 2,253,354 | 41 |
| Emission Factors from AP-42, Tables 1.3-1 and 1.3-3 for residential furnaces (<300,000 Btu/hr) S = 0.5 percent | | | | | | | 0.4 | 142S | 18.0 | 5.0 | 21,500 | 0.7 |
| Emission Factors from AP-42, Tables 1.3-I and 1.3-3 for boilers (>300,000 Btu/hr) S = 0.5 percent | | | | | | | 2.0 | 142S | 20.0 | 5.0 | 21,500 | 0.3 |
| Formula = Consumption (gal/yr) * Emission Factor (lb/1,000 gal) | | | | | | | | | | | | |
| Heater | Cades Cove Ranger Station | Propane | 1 | 80,000 | 80,000 | 7,659 | 3 | 0 | 107 | 15 | 95,738 | 2 |
| Heater | Cades Cove Maintenance Building | Propane | 1 | 100,000 | 100,000 | 9,574 | 4 | 0 | 134 | 19 | 119,672 | 3 |
| Ceiling Heater | Cades Cove Maintenance Building | Propane | 2 | 200,000 | 400,000 | 38,295 | 15 | 1 | 536 | 77 | 478,689 | 11 |
| Fireplace | Cable Mill Visitor Center | Propane | 1 | 80,000 | 80,000 | 7,659 | 3 | 0 | 107 | 15 | 95,738 | 2 |
| Wall Heater | Cable Mill Visitor Center | Propane | 1 | 28,000 | 28,000 | 2,681 | 1 | 0 | 38 | 5 | 33,508 | 1 |
| Water Heater | Cable Mill Comfort Station | Propane | 1 | 100,000 | 100,000 | 9,574 | 4 | 0 | 134 | 19 | 119,672 | 3 |
| Heater | Cable Mill Comfort Station | Propane | 1 | 60,000 | 60,000 | 5,744 | 2 | 0 | 80 | 11 | 71,803 | 2 |
| Heater | Cable Mill Sewer Building | Propane | 1 | 28,000 | 28,000 | 2,681 | 1 | 0 | 38 | 5 | 33,508 | 1 |
| Wall Heater | Cable Mill Water Plant | Propane | 1 | 28,000 | 28,000 | 2,681 | 1 | 0 | 38 | 5 | 33,508 | 1 |
| | | Totals | 10 | | 904,000 | 86,547 | 35 | 2 | 1,212 | 173 | 1,081,836 | 26 |
| Tremont Institute | | | | | | | | | | | | |
| Heating Unit | Dorm | Propane | 4 | 120,000 | 480,000 | 45,954 | 18 | 1 | 643 | 92 | 574,426 | 14 |
| Water Heater | Dorm | Propane | 1 | 200,000 | 200,000 | 19,148 | 8 | 0 | 268 | 38 | 239,344 | 6 |
| Heating Unit | Kitchen | Propane | 2 | 100,000 | 200,000 | 19,148 | 8 | 0 | 268 | 38 | 239,344 | 6 |
| Heating Unit | Kitchen | Propane | 1 | 120,000 | 120,000 | 11,489 | 5 | 0 | 161 | 23 | 143,607 | 3 |
| Heating Unit | Office/Maintenance | Propane | 1 | 125,000 | 125,000 | 11,967 | 5 | 0 | 168 | 24 | 149,590 | 4 |
| Heating Unit | Staff Quarters | Propane | 1 | 60,000 | 60,000 | 5,744 | 2 | 0 | 80 | 11 | 71,803 | 2 |
| Water Heater | Directors House | Propane | 1 | 90,000 | 90,000 | 8,616 | 3 | 0 | 121 | 17 | 107,705 | 3 |
| | | Totals | 11 | | 1,275,000 | 122,066 | 49 | 2 | 1,709 | 244 | 1,525,820 | 37 |
| 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) | | | | | | | | | | | | |
| | | Total Heating Units | 18 | | | | 268 | 7,445 | 4,985 | 941 | 1,082,604 | 104 |

## 2000 ACTUAL CRITERIA EMISSIONS FROM GENERATORS AT GREAT SMOKY MOUNTAINS NP

| Emission Source | Location | Fuel | Number of Sources | Rating (kW) | Run Time (hrs/yr) | Output (kW-hr/yr) | $PM_{10}$ (Ibs/yr) | $SO_2$ (lbs/yr) | NO, (Ibs/yr) | CO (lbs/yr) | VOC (Ibs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **National Park** Service | | | | | | | | | | | |
| Generator | Water Plant | Propane | 2 | 45 | 3,650 | 328,500 | 68 | 596 | 1,554 | 379 | 85 |
| | Propane Generator Totals | | 2 | 45 | 3,650 | 328,500 | 68 | 596 | 1,554 | 379 | 85 |
| Emission Factors from AP-42, Chapter 3.1-1 for natural gas turbines (lb/hp-hr), S = 0.18 grains/100 cu ft<br>Formula = Emission Factor (lb/hp-hr) * 608 (g/kW-hr / lb/hp-hr) * Output (kW-hr/yr) / 453.6 (glib) | | | | | | | 1.54E-04 | 7.52E-03*S | 3.53E-03 | 8.60E-04 | 1.92E-04 |
| | | | | | | Park Totals (tons/yr) | 0.03 | 0.30 | 0.78 | 0.19 | 0.04 |

## 2000 POTENTIAL CRITERIA EMISSIONS FROM GENERATORS AT GREAT SMOKY MOUNTAINS NP

| Emission Source | Location | Fuel | Number of Sources | Rating (kW) | Run Time (hrs/yr) | Output (kW-hr/yr) | $PM_{10}$ (Ibs/yr) | $SO_2$ (Ibs/yr) | $NO_x$ (Ibs/yr) | CO clbs/rr) | VOC (lbs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| National Park Service | | | | | | | | | | | |
| Generator | Medical Clinic | Propane | 2 | 45 | 8,760 | 788,400 | 163 | 1,430 | 3,730 | 909 | 203 |
| | Propane Generator Totals | | 2 | 45 | 8,760 | 788,400 | 163 | 1,430 | 3,730 | 909 | 203 |
| Emission Factors from AP-42, Chapter 3.1-1 for natural gas turbines (lb/hp-hr), S = 0.18 grains/100 cu ft<br>Formula = Emission Factor (lb/hp-hr) * 608 (g/kW-hr / lb/hp-hr) * Output (kW-hr/yr) / 453.6 (glib) | | | | | | | 1.54E-04 | 7.52E-03*S | 3.53E-03 | 8.60E-04 | 1.92E-04 |
| | | | | | Park Totals (tons/yr) | | 0.08 | 0.72 | 1.87 | 0.45 | 0.10 |

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

**Identification**

| | |
|---|---|
| User Identification: | GRSM Headquaters |
| City: | Knoxville |
| State: | Tennessee |
| Company: | NPS |
| Type of Tank: | Horizontal Tank |
| Description: | Tank #1 |

**Tank Dimensions**

| | |
|---|---|
| Shell Length (ft): | 12.00 |
| Diameter (ft): | 5.25 |
| Volume (gallons): | 2,000.00 |
| Turnovers: | 0.00 |
| Net Throughput (gal/yr): | 27,623.00 |
| Is Tank Heated (y/n): | N |
| Is Tank Underground (y/n): | N |

**Paint Characteristics**

| | |
|---|---|
| Shell Color/Shade: | Gray/Medium |
| Shell Condition: | Good |

**Breather Vent Settings**

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

Meteorological Data used in Emissions Calculations: Knoxville, Tennessee (Avg Atmospheric Pressure = 14.25 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. | Mol. Weight | Basis for Vapor Pressure Calculations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline (RVP 8) | All | 66.48 | 56.03 | 76.93 | 60.63 | 4.5963 | 3.7327 | 5.6139 | 68.0000 | | | 92.00 | Option 4: RVP=8, ASTM Slope=3 |

# TANKS 4.0
# Emissions Report - Summary Format
# Individual Tank Emission Totals

**Annual Emissions Report**

| | Losses(lbs) | | |
|---|---|---|---|
| Components | Working Loss | Breathing Loss | Total Emissions |
| Gasoline (RVP 8) | 205.56 | 546.61 | 752.17 |

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

**Identification**

| | |
|---|---|
| User Identification: | GRSM Headquarters |
| City: | Knoxville |
| State: | Tennessee |
| Company: | NPS |
| Type of Tank: | Horizontal Tank |
| Description: | Tank #2 |

**Tank Dimensions**

| | |
|---|---|
| Shell Length (ft): | 10.75 |
| Diameter (ft): | 4.00 |
| Volume (gallons): | 1,000.00 |
| Turnovers: | 0.00 |
| Net Throughput (gal/yr): | 13,811.00 |
| Is Tank Heated (y/n): | N |
| Is Tank Underground (yin): | N |

**Paint Characteristics**

| | |
|---|---|
| Shell Color/Shade: | Gray/Medium |
| Shell Condition: | Good |

**Breather Vent Settings**

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

Meteorological Data used in Emissions Calculations: Knoxville, Tennessee (Avg Atmospheric Pressure = 14.25 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. | Mol. Weight | Basis for Vapor Pressure Calculations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline (RVP 8) | All | 66.48 | 56.03 | 76.93 | 60.63 | 4.5963 | 3.7327 | 5.6139 | 68.0000 | | | 92.00 | Option 4: RVP=8, ASTM Slope=3 |

# TANKS 4.0
# Emissions Report - Summary Format
# Individual Tank Emission Totals

**Annual Emissions Report**

| | Losses(lbs) | | |
|---|---|---|---|
| Components | Working Loss | Breathing Loss | Total Emissions |
| Gasoline (RVP 8) | 102.78 | 313.35 | 416.13 |

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

**Identification**

| | |
|---|---|
| User Identification: | Cades Cove Maintenance |
| City: | Knoxville |
| State: | Tennessee |
| Company: | NPS |
| Type of Tank: | Horizontal Tank |
| Description: | Tank #1 |

**Tank Dimensions**

| | |
|---|---|
| Shell Length (ft): | 10.75 |
| Diameter (ft): | 4.00 |
| Volume (gallons): | 1,000.00 |
| Turnovers: | 0.00 |
| Net Throughput (gal/yr): | 7,620.00 |
| Is Tank Heated (y\|n): | N |
| Is Tank Underground (y/n): | N |

**Paint Characteristics**

| | |
|---|---|
| Shell Color/Shade: | Gray/Light |
| Shell Condition: | Good |

**Breather Vent Settings**

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

Meteorological Data used in Emissions Calculations: Knoxville, Tennessee (Avg Atmospheric Pressure = 14.25 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 Mal. Weight | Liquid Mass Fract. | Vapor Mass Fract. | Mot. Weight | Basis for Vapor Pressure Calculations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline (RVP 8) | All | 64.53 | 55.39 | 73.67 | 59.79 | 4.4237 | 3.6845 | 5.2780 | 68.0000 | | | 92.00 | Option 4: RVP=8, ASTM Slope=3 |

# TANKS 4.0
# Emissions Report - Summary Format
# Individual Tank Emission Totals

**Annual Emissions Report**

| | Losses(lbs) | | |
|---|---|---|---|
| Components | Working Loss | Breathing Loss | Total Emissions |
| Gasoline (RVP 8) | 54.58 | 258.11 | 312.68 |

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

**Identification**

| | |
|---|---|
| User Identification: | Cades Cove Maintenancel |
| City: | Knoxville |
| State: | Tennessee |
| Company: | NPS |
| Type of Tank: | Horizontal Tank |
| Description: | Tank #2 |

**Tank Dimensions**

| | |
|---|---|
| Shell Length (ft): | 10.75 |
| Diameter (ft): | 4.00 |
| Volume (gallons): | 1,000.00 |
| Turnovers: | 0.00 |
| Net Throughput (gal/yr): | 2,825.00 |
| Is Tank Heated (y/n): | N |
| Is Tank Underground (y/n): | N |

**Paint Characteristics**

| | |
|---|---|
| Shell Color/Shade: | Gray/Light |
| Shell Condition: | Good |

**Breather Vent Settings**

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

Meteorological Data used in Emissions Calculations: Knoxville, Tennessee (Avg Atmospheric Pressure = 14.25 psia)

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

| Mixture/Component | Month | Daily Liquid Surf. Temperatures (deg F) Avg. | | Max. | Liquid Bulk Temp. (deq F) | Vapor Pressures (psia) Avg. | Min. | Max. | Vapor Mol. Weight | Liquid Mass Fract. | Vapor Mass Fract. | Mol. Weight | Basis for Vapor Pressure Calculations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline (RVP 8) | All | 64.53 | 55.39 | 73.67 | 59.79 | 4.4237 | 3.6845 | 5.2780 | 68.0000 | | | 92.00 | Option 4: RVP=B, ASTM Slope=3 |

# TANKS 4.0
# Emissions Report - Summary Format
# Individual Tank Emission Totals

**Annual Emissions Report**

| | Losses(lbs) | | |
|---|---|---|---|
| Components | Working Loss | Breathing Loss | Total Emissions |
| Gasoline (RVP 8) | 20.23 | 258.11 | 278.34 |

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

**Identification**

| | |
|---|---|
| User Identification: | Cades Cove2 |
| City: | Knoxville |
| State: | Tennessee |
| Company: | NPS |
| Type of Tank: | Horizontal Tank |
| Description: | Tank #3 |

**Tank Dimensions**

| | |
|---|---|
| Shell Length (ft): | 10.75 |
| Diameter (ft): | 4.00 |
| Volume (gallons): | 1,000.00 |
| Turnovers: | 0.00 |
| Net Throughput (gal/yr): | 5,647.00 |
| Is Tank Heated (y/n): | N |
| Is Tank Underground (y/n): | N |

**Paint Characteristics**

| | |
|---|---|
| Shell Color/Shade: | Gray/Light |
| Shell Condition: | Good |

**Breather Vent Settings**

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

Meteorological Data used in Emissions Calculations: Knoxville, Tennessee (Avg Atmospheric Pressure = 14.25 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. | Mol. Weight | Basis for Vapor Pressure Calculations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline (RVP 8) | All | 64.53 | 55.39 | 73.67 | 59.79 | 4.4237 | 3.6845 | 5.2780 | 68.0000 | | | 92.00 | Option 4: RVP=8, ASTM Slope=3 |

# TANKS 4.0
# Emissions Report - Summary Format
# Individual Tank Emission Totals

**Annual Emissions Report**

| | Losses(lbs) | | |
|---|---|---|---|
| Components | Working Loss | Breathing Loss | Total Emissions |
| Gasoline (RVP 8) | 40.44 | 258.11 | 298.55 |

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

**Identification**

| | |
|---|---|
| User Identification: | Look Rock Maintenance |
| City: | Knoxville |
| State: | Tennessee |
| Company: | N PS |
| Type of Tank: | Horizontal Tank |
| Description: | Tank #1 |

**Tank Dimensions**

| | |
|---|---|
| Shell Length (ft): | 10.75 |
| Diameter (it): | 4.00 |
| Volume (gallons): | 1,000.00 |
| Turnovers: | 0.00 |
| Net Throughput (gallyr): | 2,450.00 |
| Is Tank Heated (y/n): | N |
| Is Tank Underground (yin): | N |

**Paint Characteristics**

| | |
|---|---|
| Shell Color/Shade: | Gray/Light |
| Shell Condition: | Good |

**Breather Vent Settings**

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

Meteorological Data used in Emissions Calculations: Knoxville, Tennessee (Avg Atmospheric Pressure = 14.25 psia)

# TANKS 4M
# 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. | Mol. Weight | Basis for Vapor Pressure Calculations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline (RVP 8) | All | 64.53 | 55.39 | 73.67 | 59.79 | 4.4237 | 3.6845 | 5.2780 | 68.0000 | | | 92.00 | Option 4: RVP=8, ASTM Slope=3 |

# TANKS 4.0
# Emissions Report - Summary Format
# Individual Tank Emission Totals

**Annual Emissions Report**

| | Losses(lbs) | | |
|---|---|---|---|
| Components | Working Loss | Breathing Loss | Total Emissions |
| Gasoline (RVP 8) | 17.55 | 258.11 | 275.65 |

# TANKS 4M
# Emissions Report - Summary Format
# Tank Identification and Physical Characteristics

**Identification**

| | |
|---|---|
| User Identification: | GRSM Oconaluftee |
| City: | Knoxville |
| State: | Tennessee |
| Company: | NPS |
| Type of Tank: | Horizontal Tank |
| Description: | AST |

**Tank Dimensions**

| | |
|---|---|
| Shell Length (ft): | 12.00 |
| Diameter (ft): | 5.33 |
| Volume (gallons): | 2,000.00 |
| Turnovers: | 0.00 |
| Net Throughput (gal/yr): | 30,613.00 |
| Is Tank Heated (y/n): | N |
| Is Tank Underground (y/n): | N |

**Paint Characteristics**

| | |
|---|---|
| Shell Color/Shade: | Gray/Light |
| Shell Condition: | Good |

**Breather Vent Settings**

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

Meteorological Data used in Emissions Calculations: Knoxville, Tennessee (Avg Atmospheric Pressure = 14.25 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. | Mol. Weight | Basis for Vapor Pressure Calculations |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gasoline (RVP 8) | All | 64.53 | 55.39 | 73.67 | 59.79 | 4.4237 | 3.6845 | 5.2780 | 68.0000 | | | 92.00 | Option 4: RVP=8, ASTM Slope=3 |

# TANKS 4.0
# Emissions Report - Summary Format
# Individual Tank Emission Totals

**Annual Emissions Report**

| | Losses(lbs) | | |
|---|---|---|---|
| Components | Working Loss | Breathing Loss | Total Emissions |
| Gasoline (RVP 8) | 219.26 | 462.48 | 681.74 |

**2000 ACTUAL EMISSIONS FROM CAMPFIRES AT GREAT SMOKY MOUNTAINS NATIONAL PARK**

| Location | Campsites | Open Days/Yr | Camps | Fires/Yr | Tons/Yr | PM (lbs/yr) | $SO_2$ (lbs/yr) | NO, (lbs/yr) | CO (lbs/yr) | VOC (lbs/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| Abrams Creek | 15 | 225 | 3,375 | 1,688 | 8 | 292 | 3 | 22 | 2,131 | 1,932 |
| Balsam Mountain | 46 | 150 | 6,900 | 3,450 | 17 | 597 | 7 | 45 | 4,357 | 3,950 |
| Big Creek | 12 | 225 | 2,700 | 1,350 | 7 | 234 | 3 | 18 | 1,705 | 1,546 |
| Cades Cove | 161 | 365 | 58,765 | 29,383 | 147 | 5,083 | 59 | 382 | 37,110 | 33,643 |
| Calaloochee | 27 | 225 | 6,075 | 3,038 | 15 | 525 | 6 | 39 | 3,836 | 3,478 |
| Cosby | 165 | 225 | 37,125 | 18,563 | 93 | 3,211 | 37 | 241 | 23,444 | 21,254 |
| Deep Creek | 92 | 210 | 19,320 | 9,660 | 48 | 1,671 | 19 | 126 | 12,201 | 11,061 |
| Elkmont | 220 | 255 | 56,100 | 28,050 | 140 | 4,853 | 56 | 365 | 35,427 | 32,117 |
| Look Rock | 28 | 165 | 4,620 | 2,310 | 12 | 400 | 5 | 30 | 2,918 | 2,645 |
| Smokemont | 142 | 365 | 51,830 | 25,915 | 130 | 4,483 | 52 | 337 | 32,731 | 29,673 |
| | 908 | | 246,810 | 123,405 | 617 | 21,349 | 247 | 1,604 | 155,861 | 141,299 |
| | | | | | Tons/Yr | 10.67 | 0.12 | 0.80 | 77.93 | 70.65 |

Assumption: Fifty percent of camp sites have either an evening or morning campfire

| | Emission Factors (lbs/ton) | | | | |
|---|---|---|---|---|---|
| | 34.6 | 0.4 | 2.6 | 252.6 | 229 |

TITLE: Results of FOFEM model execution on date: 7/20/2002

FUEL CONSUMPTION CALCULATIONS

egion: Interior_West
:over Type: SAF/SRM - SRM 613 - Fescue Grassland
Fuel Type: Natural
Fuel Reference: SMFDB 335

FUEL CONSUMPTION TABLE

| Fuel Component Tame | 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 | |
| Toad (1/4-1 inch) | 0.00 | 0.00 | 0.00 | 0.0 | 999 | 25.0 |
| food (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 | | |
| uff | 0.00 | 0.00 | 0.00 | 0.0 | 2 | 100.0 |
| erbaceous | 1.56 | 1.40 | 0.16 | 90.0 | 221 | |
| shrubs | 0.00 | 0.00 | 0.00 | 0.0 | 23 | |
| Crown foliage | 0.00 | 0.00 | 0.00 | 0.0 | 37 | |
| rown branchwood | 0.00 | 0.00 | 0.00 | 0.0 | 38 | |
| Dotal Fuels | 1.56 | 1.40 | 0.16 | 90.0 | | |

', IRE EFFECTS ON FOREST FLOOR COMPONENTS

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

| | Emissions flaming | -- lbs/acre smoldering | total |
|---|---|---|---|
| "M 10 | 9 | 0 | 9 |
| 'A 2.5 | 7 | 0 | 7 |
| 4 | 2 | 0 | 2 |
| CO | 18 | 0 | 18 |
| r O 2 | 4994 | 0 | 4994 |

| | Consumption tons/acre | Duration hour:min:sec |
|---|---|---|
| Flaming: | 1.40 | 00:01:00 |
| Smoldering: | 0.00 | 00:00:00 |
| Total: | 1.40 | |

CITLE: Results of FOFEM model execution on date: 7/20/2002

FUEL CONSUMPTION CALCULATIONS

legion: South_East
over Type: SAF/SRM - SAF 059 - Yellow Poplar - White Oak - Northern Red Oak
?uel Type: Natural
?uel Reference: FOFEM 231

FUEL CONSUMPTION TABLE

| Fuel 2omponent \Tame | Preburn Load (t/acre) | Consumed Load (t/acre) | Postburn Load (t/acre) | Percent Reduced (%) | Equation Reference Number | Moisture |
|---|---|---|---|---|---|---|
| Litter | 2.00 | 2.00 | 0.00 | 100.0 | 999 | |
| ood (0-1/4 inch) | 0.05 | 0.05 | 0.00 | 100.0 | 999 | |
| good (1/4-1 inch) | 0.45 | 0.45 | 0.00 | 99.9 | 999 | 25.0 |
| Mood (1-3 inch) | 0.00 | 0.00 | 0.00 | 0.0 | 999 | |
| good (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 | 4.00 | 0.25 | 3.75 | 6.4 | 16 | 100.0 |
| Herbaceous | 0.05 | 0.05 | 0.00 | 100.0 | 22 | |
| Shrubs | 0.10 | 0.00 | 0.10 | 0.0 | 234 | |
| Crown foliage | 0.00 | 0.00 | 0.00 | 0.0 | 37 | |
| Crown branchwood | 0.00 | 0.00 | 0.00 | 0.0 | 38 | |
| Total Fuels | 6.65 | 2.80 | 3.85 | 42.2 | | |

FIRE EFFECTS ON FOREST FLOOR COMPONENTS

| Forest Floor Component | Preburn Condition | Amount Consumed | Postburn Condition | Percent Reduced | Equation Number |
|---|---|---|---|---|---|
| Duff Depth (in) | 0.8 | 0.1 | 0.7 | 6.4 | 16 |
| Min Soil Exp (%) | .0 | 0.0 | 0.0 | 0.0 | 14 |

| | Emissions -- lbs/acre flaming | smoldering | total |
|---|---|---|---|
| PM 10 | 13 | 108 | 121 |
| PM 2.5 | 11 | 92 | 103 |
| CH 4 | 3 | 56 | 59 |
| CO | 28 | 1221 | 1249 |
| CO 2 | 7722 | 4969 | 12691 |

| | Consumption tons/acre | Duration hour:min:sec |
|---|---|---|
| Flaming: | 2.17 | 00:13:00 |
| Smoldering: | 2.02 | 00:13:00 |
| Total: | 4.19 | |

**2000 PRESCRIBED FIRE EMISSIONS AT GRAND CANYON NATIONAL PARK**

| Name | Acres | PM10 (lbs/yr) | PM2.5 (lbs/yr) | CH4 (lbs/yr) | CO (lbs/yr) | PM10 (lbs/acre) | PM2.5 (lbs/acre) | CH4 (lbs/acre) | CO (lbs/acre) |
|---|---|---|---|---|---|---|---|---|---|
| Cades Cove Fields | 664 | 5,976 | 4,648 | 1,328 | 11,952 | 9 | 7 | 2 | 18 |
| Ski Mtn Pile | 4 | 436 | 371 | 212 | 4,496 | 121 | 103 | 59 | 1,249 |
| Totals | 668 | 6,412 | 5,019 | 1,540 | 16,448 | | | | |
| | | tons/yr | | | | | | | |
| | | 3.21 | 2.51 | 0.77 | 8.22 | | | | |

**TOTAL GREAT SMOKY MOUNTAINS NP VISITOR VEHICLES**

| | Gatlinburg | Townsend | Cherokee | Abrams Creek | Big Creek | Cataloochee | Cherokee Orchard | Foothills Parkway E | Cosby | Foothills Twentymile | Parkway W | Greenbrier | Deep Creek | Bryson City Fontana Rd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 53,722 | 19,606 | 29,122 | 1,890 | 1,448 | 1,548 | 1,695 | 8,936 | 1,015 | 77 | 5,600 | 3,562 | 4,132 | 924 |
| Feb | 57,841 | 23,326 | 39,541 | 2,544 | 1,948 | 2,082 | 2,281 | 12,025 | 1,366 | 103 | 7,536 | 4,794 | 5,560 | 1,243 |
| Mar | 77,847 | 34,243 | 53,440 | 2,677 | 2,050 | 2,192 | 2,401 | 12,656 | 1,437 | 109 | 7,931 | 5,045 | 5,851 | 1,308 |
| Apr | 121,567 | 51,838 | 76,632 | 3,964 | 3,035 | 3,245 | 3,555 | 18,738 | 2,128 | 161 | 11,743 | 7,470 | 8,664 | 1,937 |
| May | 124,915 | 55,451 | 80,051 | 4,706 | 3,604 | 3,853 | 4,221 | 22,248 | 2,527 | 191 | 13,943 | 8,869 | 10,286 | 2,300 |
| Jun | 161,039 | 72,659 | 105,457 | 5,764 | 4,414 | 4,719 | 5,169 | 27,248 | 3,095 | 234 | 17,076 | 10,862 | 12,598 | 2,817 |
| Jul | 207,710 | 92,450 | 136,148 | 6,883 | 5,271 | 5,635 | 6,173 | 32,541 | 3,696 | 279 | 20,393 | 12,972 | 15,045 | 3,364 |
| Aug | 153,740 | 64,782 | 102,277 | 7,768 | 5,949 | 6,360 | 6,967 | 36,724 | 4,171 | 315 | 23,015 | 14,639 | 16,980 | 3,796 |
| Sep | 139,927 | 62,351 | 94,131 | 6,031 | 4,619 | 4,938 | 5,409 | 28,512 | 3,238 | 245 | 17,868 | 11,366 | 13,183 | 2,947 |
| Oct | 154,123 | 90,425 | 125,846 | 7,230 | 5,537 | 5,919 | 6,485 | 34,182 | 3,882 | 293 | 21,422 | 13,626 | 15,804 | 3,534 |
| Nov | 93,328 | 43,619 | 65,958 | 3,811 | 2,919 | 3,120 | 3,418 | 18,017 | 2,046 | 155 | 11,291 | 7,182 | 8,330 | 1,863 |
| Dec | 44,697 | 31,146 | 39,995 | 2,304 | 1,765 | 1,886 | 2,067 | 10,893 | 1,237 | 93 | 6,826 | 4,342 | 5,036 | 1,126 |
| | 1,390,456 | 641,896 | 948,598 | 55,573 | 42,558 | 45,496 | 49,842 | 262,720 | 29,837 | 2,254 | 164,646 | 104,728 | 121,471 | 27,159 |

**Great Smoky Mountains NP Winter Visitor Vehicles**

| | Gatlinburg | Townsend | Cherokee | Abrams Creek | Big Creek | Cataloochee | Cherokee Orchard | Foothills Parkway E | Cosby | Foothills Twentymile | Parkway W | Greenbrier | Deep Creek | Bryson City Fontana Rd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 53,722 | 19,606 | 29,122 | 1,890 | 1,448 | 1,548 | 1,695 | 8,936 | 1,015 | 77 | 5,600 | 3,562 | 4,132 | 924 |
| Feb | 57,841 | 23,326 | 39,541 | 2,544 | 1,948 | 2,082 | 2,281 | 12,025 | 1,366 | 103 | 7,536 | 4,794 | 5,560 | 1,243 |
| Dec | 44,697 | 31,146 | 39,995 | 2,304 | 1,765 | 1,886 | 2,067 | 10,893 | 1,237 | 93 | 6,826 | 4,342 | 5,036 | 1,126 |
| | 156,260 | 74,078 | 108,658 | 6,738 | 5,160 | 5,516 | 6,043 | 31,855 | 3,618 | 273 | 19,963 | 12,698 | 14,728 | 3,293 |

**Great Smoky Mountains NP Summer Visitor Vehicles**

| | Gatlinburg | Townsend | Cherokee | Abrams Creek | Big Creek | Cataloochee | Cherokee Orchard | Foothills Parkway E | Cosby | Foothills Twentymile | Parkway W | Greenbrier | Deep Creek | Bryson City Fontana Rd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mar | 77,847 | 34,243 | 53,440 | 2,677 | 2,050 | 2,192 | 2,401 | 12,656 | 1,437 | 109 | 7,931 | 5,045 | 5,851 | 1,308 |
| Apr | 121,567 | 51,838 | 76,632 | 3,964 | 3,035 | 3,245 | 3,555 | 18,738 | 2,128 | 161 | 11,743 | 7,470 | 8,664 | 1,937 |
| May | 124,915 | 55,451 | 80,051 | 4,706 | 3,604 | 3,853 | 4,221 | 22,248 | 2,527 | 191 | 13,943 | 8,869 | 10,286 | 2,300 |
| Jun | 161,039 | 72,659 | 105,457 | 5,764 | 4,414 | 4,719 | 5,169 | 27,248 | 3,095 | 234 | 17,076 | 10,862 | 12,598 | 2,817 |
| Jul | 207,710 | 92,450 | 136,148 | 6,883 | 5,271 | 5,635 | 6,173 | 32,541 | 3,696 | 279 | 20,393 | 12,972 | 15,045 | 3,364 |
| Aug | 153,740 | 64,782 | 102,277 | 7,768 | 5,949 | 6,360 | 6,967 | 36,724 | 4,171 | 315 | 23,015 | 14,639 | 16,980 | 3,796 |
| Sep | 139,927 | 62,351 | 94,131 | 6,031 | 4,619 | 4,938 | 5,409 | 28,512 | 3,238 | 245 | 17,868 | 11,366 | 13,183 | 2,947 |
| Oct | 154,123 | 90,425 | 125,846 | 7,230 | 5,537 | 5,919 | 6,485 | 34,182 | 3,882 | 293 | 21,422 | 13,626 | 15,804 | 3,534 |
| Nov | 93,328 | 43,619 | 65,958 | 3,811 | 2,919 | 3,120 | 3,418 | 18,017 | 2,046 | **155** | 11,291 | 7,182 | 8,330 | 1,863 |
| | 1,234,196 | 567,818 | 839,940 | 48,835 | 37,398 | 39,980 | 43,799 | 230,866 | 26,220 | 1,981 | 144,683 | 92,030 | 106,743 | 23,866 |

**GREAT SMOKY MOUNTAINS NP SUMMER VISITOR VMT**

| Entrance | Exit | Vehicles | Percent | Vehicles | Length | Annual VMT |
|---|---|---|---|---|---|---|
| Gatlinburg | Gatlinburg via Cades Cove | 1,234,196 | 50 | 617,098 | 65 | 40,111,370 |
| | Cherokee | 1,234,196 | 50 | 617,098 | 34 | 20,981,332 |
| Townsend | Townsend via Cades Cove | 567,818 | 50 | 283,909 | 30 | 8,517,270 |
| | Cherokee | 567,818 | 50 | 283,909 | 52 | 14,763,268 |
| Cherokee | Cherokee via Cades Cove | 839,940 | 50 | 419,970 | 125 | 52,496,250 |
| | Gatlinburg | 839,940 | 50 | 419,970 | 34 | 14,278,980 |
| Abrams Creek | Abrams Creek | 48,835 | 100 | 48,835 | 2 | 97,670 |
| Big Creek | Big Creek | 37,398 | 100 | 37,398 | 2 | 74,796 |
| Cataloochee | Cataloochee | 39,980 | 100 | 39,980 | 10 | 399,799 |
| Cherokee Orchard | Cherokee Orchard | 43,799 | 100 | 43,799 | 2 | 87,597 |
| Foothills Parkway East | Foothills Parkway East | 230,866 | 100 | 230,866 | 15 | 3,462,988 |
| Cosby | Cosby | 26,220 | 100 | 26,220 | 5 | 131,098 |
| Twentymile | Twentymile | 1,981 | 100 | 1,981 | 1 | 1,981 |
| Foothills Parkway West | Foothills Parkway West | 144,683 | 100 | 144,683 | 5 | 723,415 |
| Greenbrier | Greenbrier | 92,030 | 100 | 92,030 | 6 | 552,181 |
| Deep Creek | Deep Creek | 106,743 | 100 | 106,743 | 2 | 213,485 |
| Bryson City | Bryson City | 23,866 | 100 | 23,866 | 2 | 47,732 |
| | | | | | | 156,941,211 |

**GREAT SMOKY MOUNTAINS NP WINTER VISITOR VMT**

| Entrance | Exit | Vehicles | Percent | Vehicles | Length | Annual VMT |
|---|---|---|---|---|---|---|
| Gatlinburg | Gatlinburg via Cades Cove | 156,260 | 50 | 78,130 | 65 | 5,078,450 |
| | Cherokee | 156,260 | 50 | 78,130 | 34 | 2,656,420 |
| Townsend | Townsend via Cades Cove | 74,078 | 50 | 37,039 | 30 | 1,111,170 |
| | Cherokee | 74,078 | 50 | 37,039 | 52 | 1,926,028 |
| Cherokee | Cherokee via Cades Cove | 108,658 | 50 | 54,329 | 125 | 6,791,125 |
| | Gatlinburg | 108,658 | 50 | 54,329 | 34 | 1,847,186 |
| Abrams Creek | Abrams Creek | 6,738 | 100 | 6,738 | 2 | 13,476 |
| Big Creek | Big Creek | 5,160 | 100 | 5,160 | 2 | 10,320 |
| Cataloochee | Cataloochee | 5,516 | 100 | 5,516 | 10 | 55,164 |
| Cherokee Orchard | Cherokee Orchard | 6,043 | 100 | 6,043 | 2 | 12,087 |
| Foothills Parkway East | Foothills Parkway East | 31,855 | 100 | 31,855 | 15 | 477,818 |
| Cosby | Cosby | 3,618 | 100 | 3,618 | 5 | 18,089 |
| Twentymile | Twentymile | 273 | 100 | 273 | 1 | 273 |
| Foothills Parkway West | Foothills Parkway West | 19,963 | 100 | 19,963 | 5 | 99,816 |
| Greenbrier | Greenbrier | 12,698 | 100 | 12,698 | 6 | 76,189 |
| Deep Creek | Deep Creek | 14,728 | 100 | 14,728 | 2 | 29,456 |
| Bryson City | Bryson City | 47,663 | 100 | 47,663 | 2 | 95,326 |
| | | | | | | 20,298,393 |

## GREAT SMOKY MOUNTAINS NP VISITOR VEHICLE EMISSIONS

| Summer VMT | Winter VMT |
|---|---|
| 156,941,211 | 20,298,393 |

| | Emission Factors (g/mi) | | | | Emissions (tons/yr) | | | |
|---|---|---|---|---|---|---|---|---|
| | **NOx** | **CO** | **VOC** | **PM10** | **NOx** | **CO** | **VOC** | **PM10** |
| Summer | 0.93 | 8.41 | 0.95 | 0.91 | 160.55 | 1,451.86 | 164.00 | 157.10 |
| Winter | 1.06 | 12.65 | 0.99 | 0.91 | 23.67 | 282.45 | 22.10 | 20.32 |
| | | | | Total | 184.22 | 1,734.32 | 186.11 | 177.42 |
| | | | | | **Emissions (lbs/yr)** | | | |
| | | | | | 368,438 | 3,468,631 | 372,217 | 354,834 |

**GREAT SMOKY MOUNTAINS NP-OWNED VEHICLE EMISSIONS**

| | LDGV | LDGT | LDGT2 | LDDT | HDGV |
|---|---|---|---|---|---|
| Vehicles | 29 | 157 | 8 | 25 | 15 |
| VMT | 145,000 | 471,000 | 24,000 | 75,000 | 32,600 |

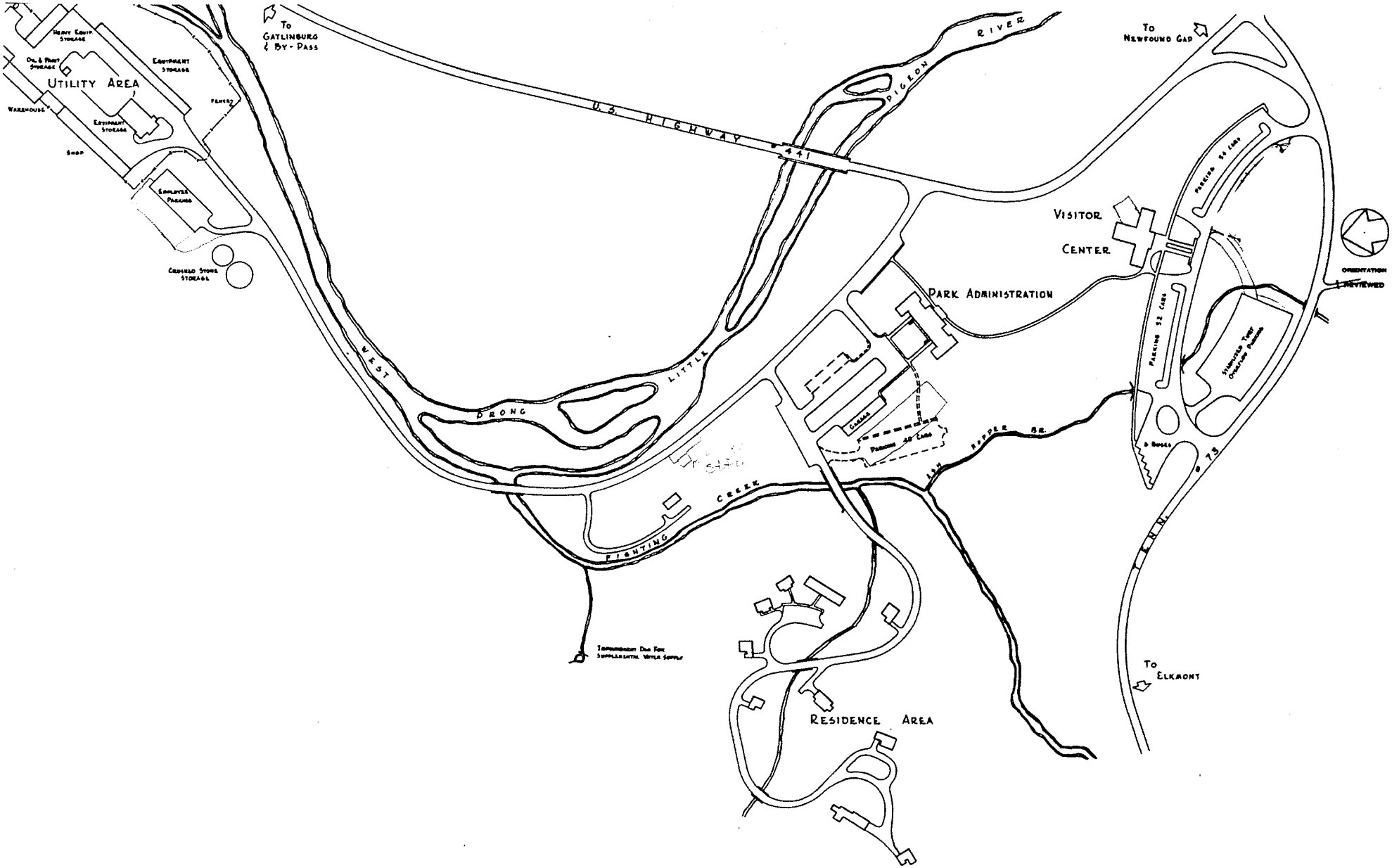
| | Emission Factors (g/mi) | | | | Emissions (tons/yr) | | | |
|---|---|---|---|---|---|---|---|---|
| | NOx | CO | VOC | PM10 | NOx | CO | VOC | PM10 |
| LDGV | 0.73 | 7.65 | 0.83 | 0.91 | 233 | 2,440 | 265 | 290 |
| LDGT | 0.93 | 10.52 | 1.00 | 0.91 | 964 | 10,901 | 1,036 | 943 |
| LDGT2 | 1.00 | 10.52 | 0.97 | 0.91 | 53 | 555 | 51 | 48 |
| LDDT | 1.13 | 0.88 | 0.44 | 0.91 | 186 | 145 | 73 | 150 |
| HDGV | 4.21 | 8.46 | 1.21 | 0.91 | 302 | 607 | 87 | 65 |
| | | | | Total | 1,738 | 14,649 | 1,512 | 1,497 |
| | | | | tons/yr | 0.87 | 7.32 | 0.76 | 0.75 |

**2000 GREAT SMOKY MOUNTAINS NP NONROAD VEHICLE EMISSIONS**

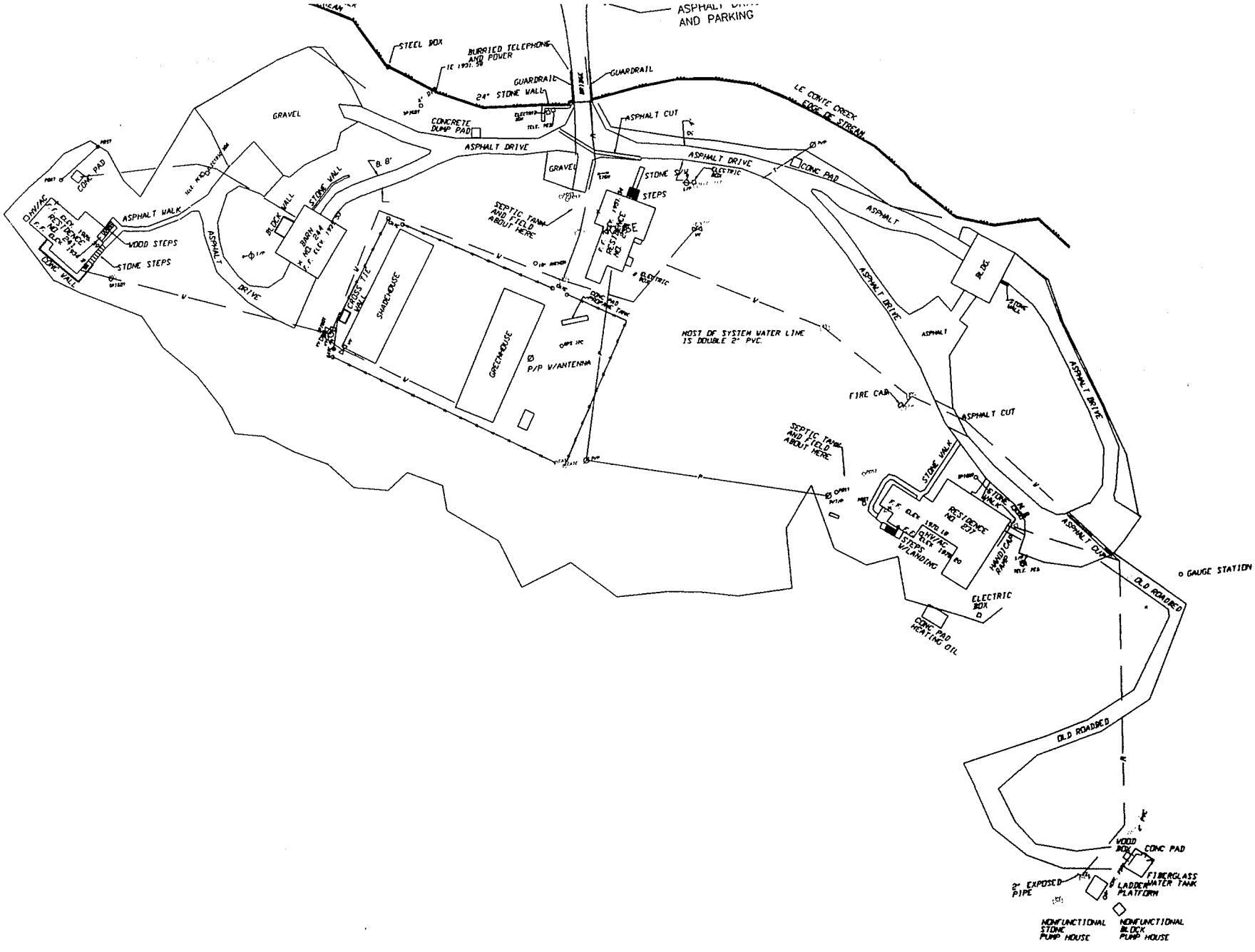
| | | Emission Factors (gm/hp-hr) | | | | | | | Emissions (lbs/yr) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vehicle | No. | PM | Nox | CO | VOC | hp | load | hrs/yr | PM | Nox | CO | VOC |
| Utility Vehicle | 11 | 2.04 | 1.03 | 2.31 | 2.19 | 15 | 0.55 | 1100 | 40.7 | 20.6 | 46.1 | 43.7 |
| Tractors | 13 | 2.04 | 1.03 | 2.31 | 2.19 | 42.35 | 0.68 | 1300 | 168.0 | 84.8 | 190.3 | 180.4 |
| Backhoe | 9 | 2.04 | 1.03 | 2.31 | 2.19 | 77 | 0.55 | 900 | 171.1 | 0.0<br>86.4 | 0.0<br>193.7 | 183.6 |
| Riding Mower | 7 | 1.11 | 10.3 | 4.8 | 1.3 | 15 | 0.55 | 700 | 14.1 | 130.9 | 61.0 | 16.5 |
| Bobcat | 1 | 2.04 | 1.03 | 2.31 | 2.19 | 15 | 0.55 | 100 | 3.7 | 1.9 | 4.2 | 4.0 |
| Dozer | 1 | 2.04 | 1.03 | 2.31 | 2.19 | 77 | 0.55 | 100 | 19.0 | 9.6 | 21.5 | 20.4 |
| Grader | 4 | 1.06 | 9.6 | 3.8 | 1.43 | 172 | 0.61 | 400 | 97.9 | 886.4 | 350.9 | 132.0 |
| Sweeper | 4 | 1.7 | 14 | 6.06 | 1.46 | 30 | 0.68 | 400 | 30.5 | 251.3 | 108.8 | 26.2 |
| Forklift | 3 | 1.06 | 9.6 | 3.8 | 1.43 | 172 | 0.61 | 300 | 73.4 | 664.8 | 263.1 | 99.0 |
| Front End Loader | 0 | 1.11 | 10.3 | 4.8 | 1.3 | 77 | 0.55 | 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| Roller/Compactor | 1 | 2.04 | 1.03 | 2.31 | 2.19 | 30 | 0.55 | 100 | 7.4 | 3.7 | 8.4 | 7.9 |
| Chipper | 3 | 3.99 | 0.9 | 1372 | 495 | 30 | 0.55 | 0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | | | | Totals: | (lbs/yr) | 626 | 2,140 | 1,248 | 714 |
| | | | | | | | | (tons/yr) | 0.31 | 1.07 | 0.62 | 0.36 |

# APPENDIX **B**

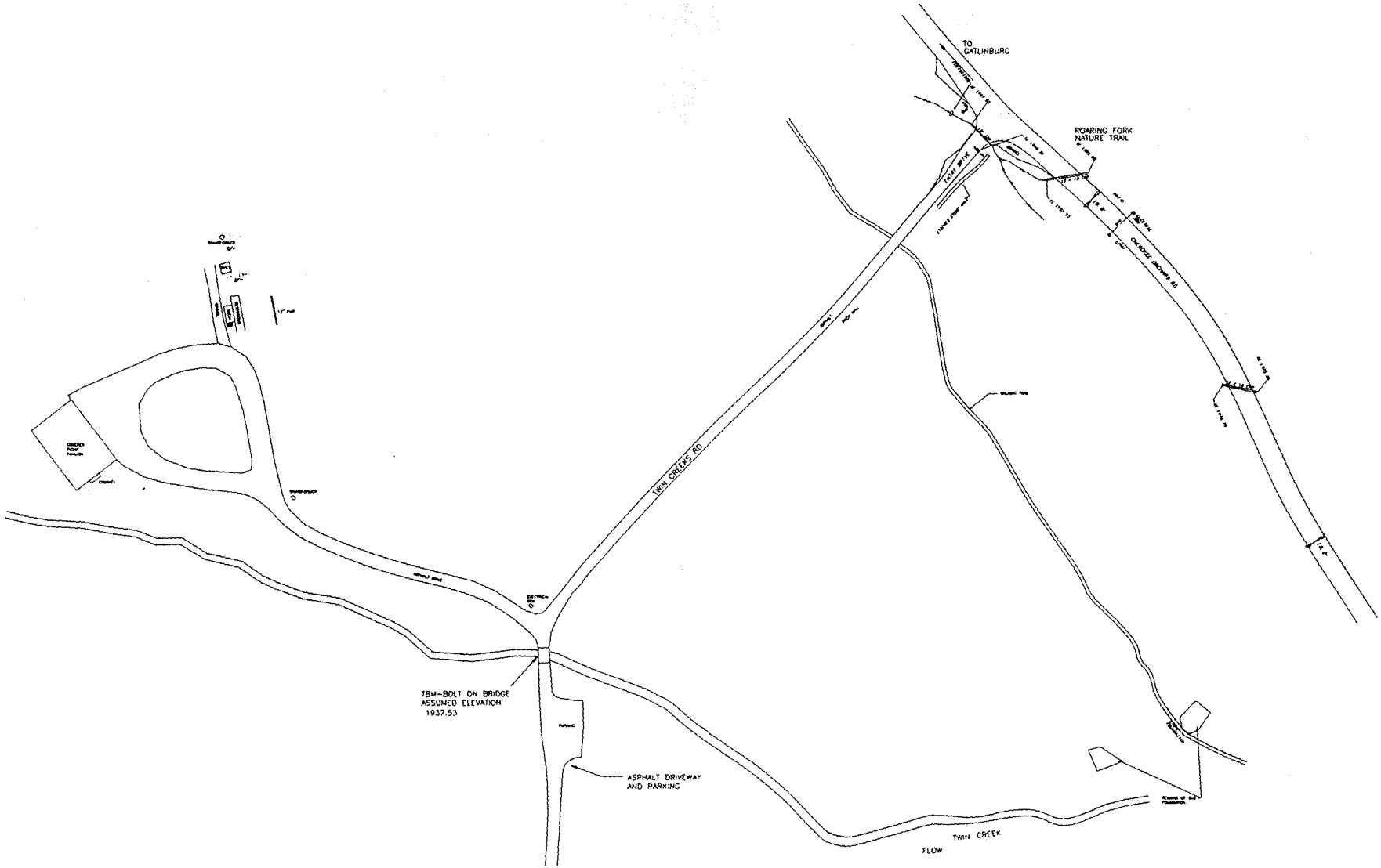
## DEVELOPED AREAS IN GREAT SMOKY MOUNTAINS NATIONAL PARK




SUGARLANDS VISITOR CENTER, PARK HEADQUARTERS, RESIDENTIAL AREA, AND UTILITY AREA

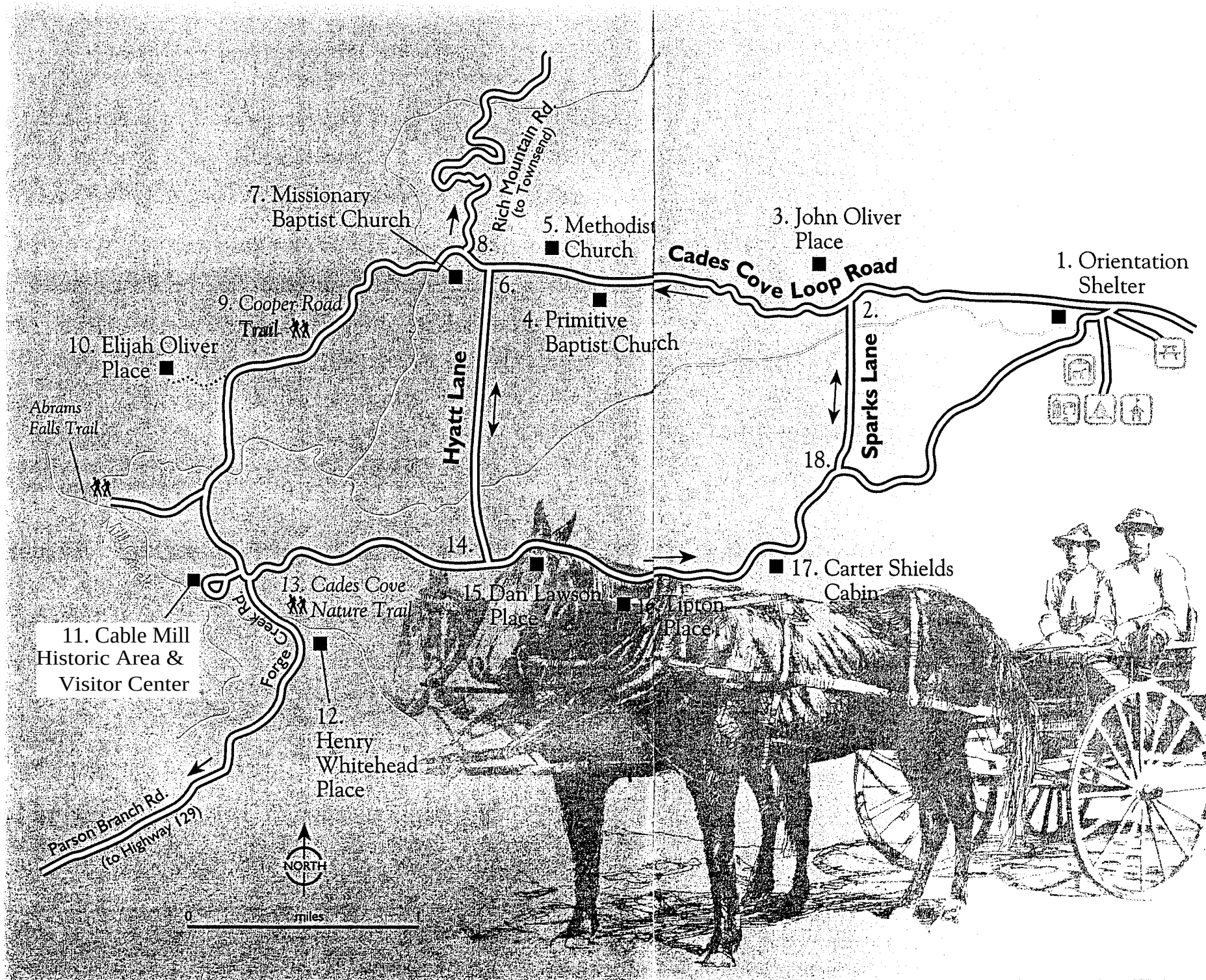


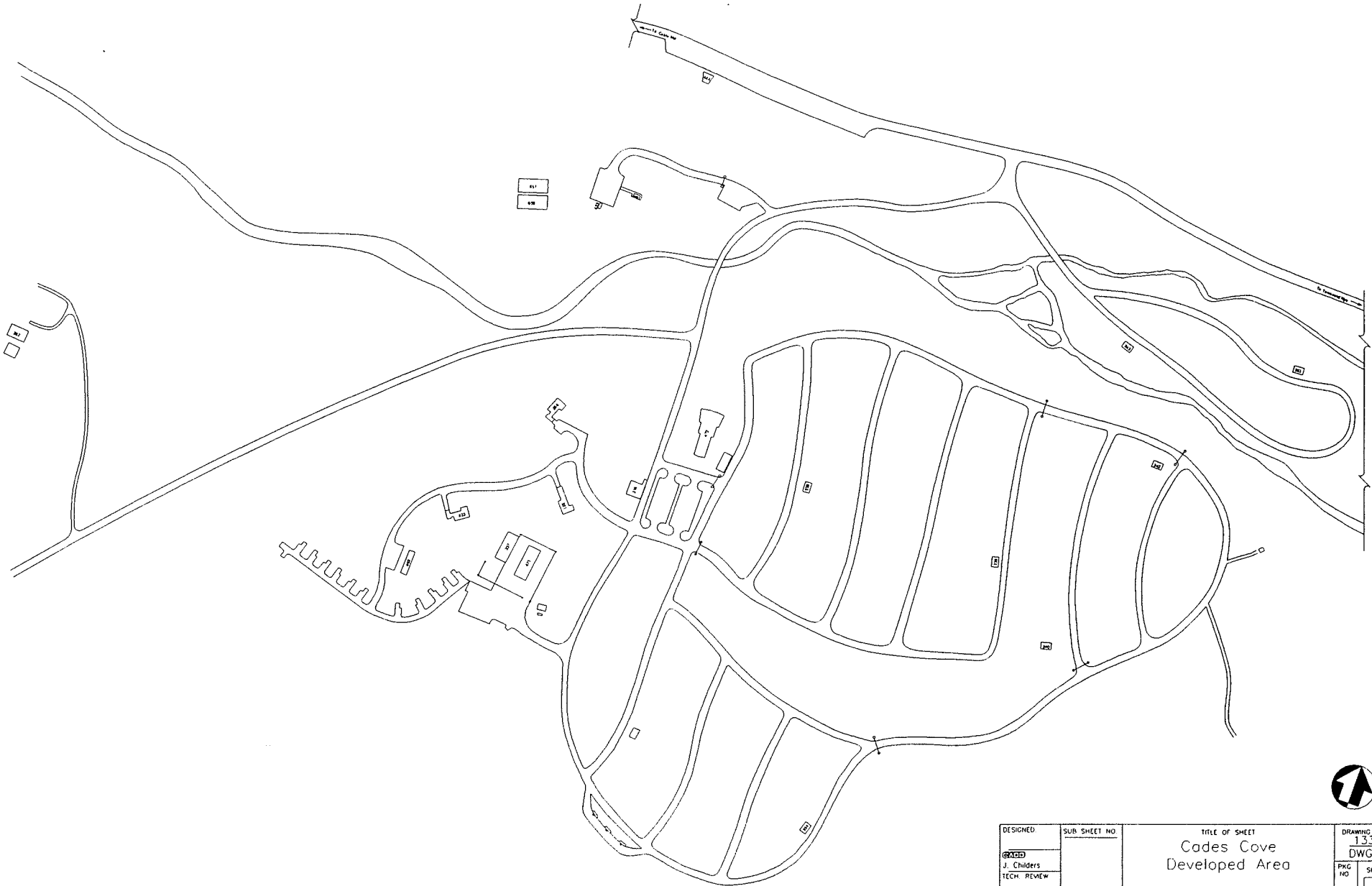

TWIN CREEKS ADMINISTRATION AREA



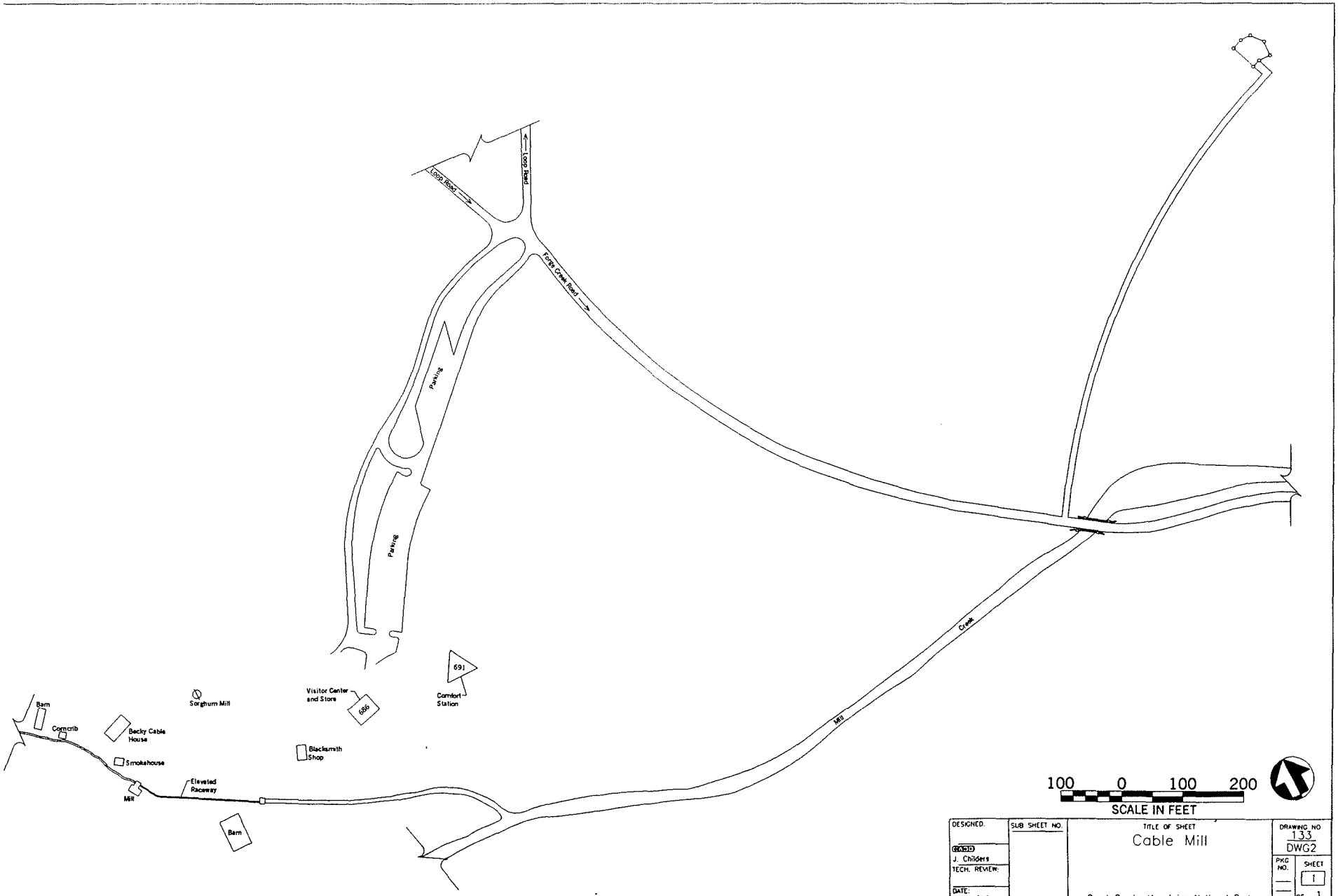

TWIN *CREEKS* PICNIC AREA

# Cades Cove Map

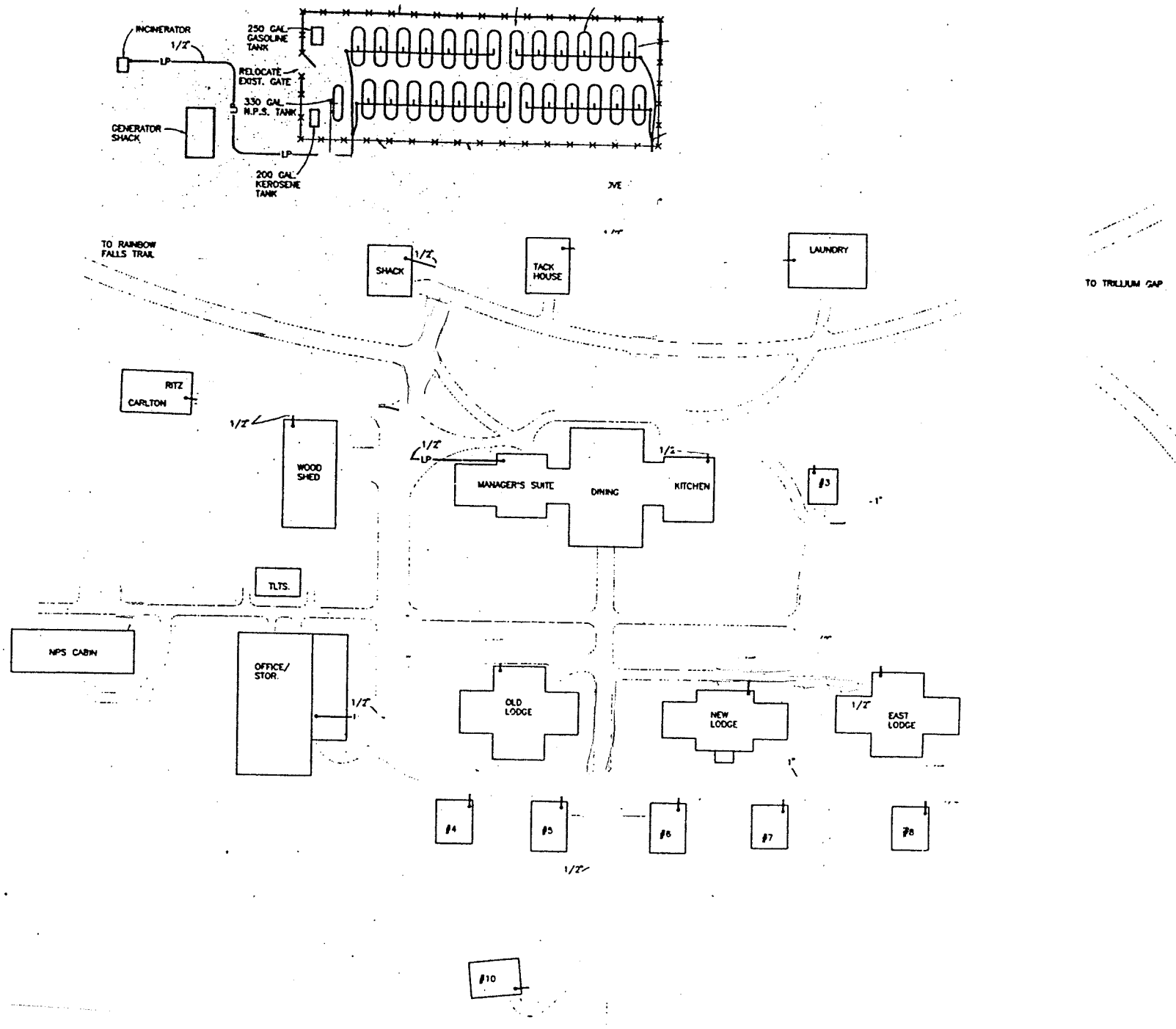




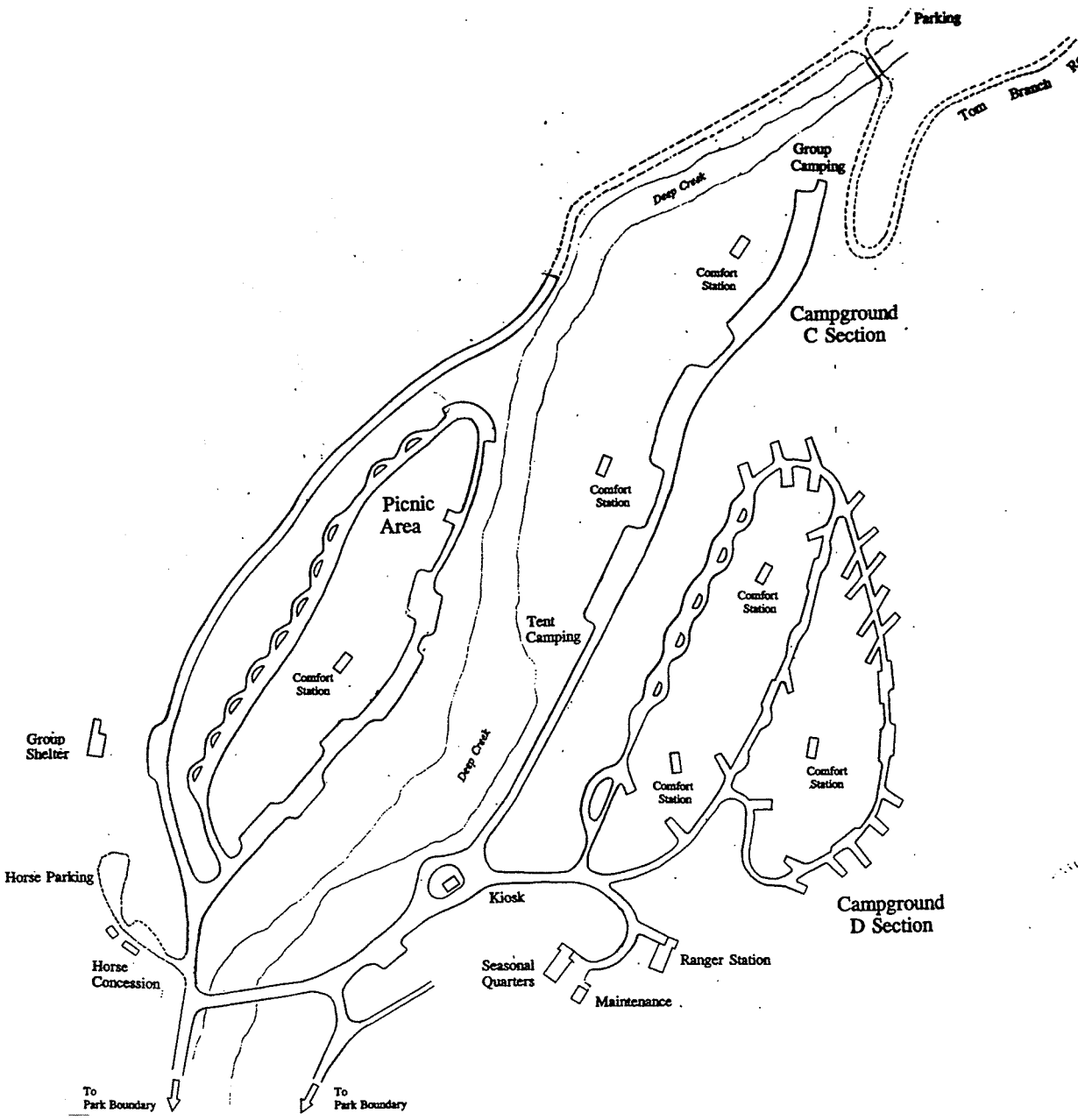
| | | | |
|---|---|---|---|
| DESIGNED: CADD J. Childers<br>TECH. REVIEW<br>DATE 3/02 | SUB SHEET NO. | TITLE OF SHEET<br>Cades Cove<br>Developed Area<br>Great Smoky Mountains National Park | DRAWING NO 133 DWG2<br>PKG NO. ——<br>SHEET 1 OF 1 |



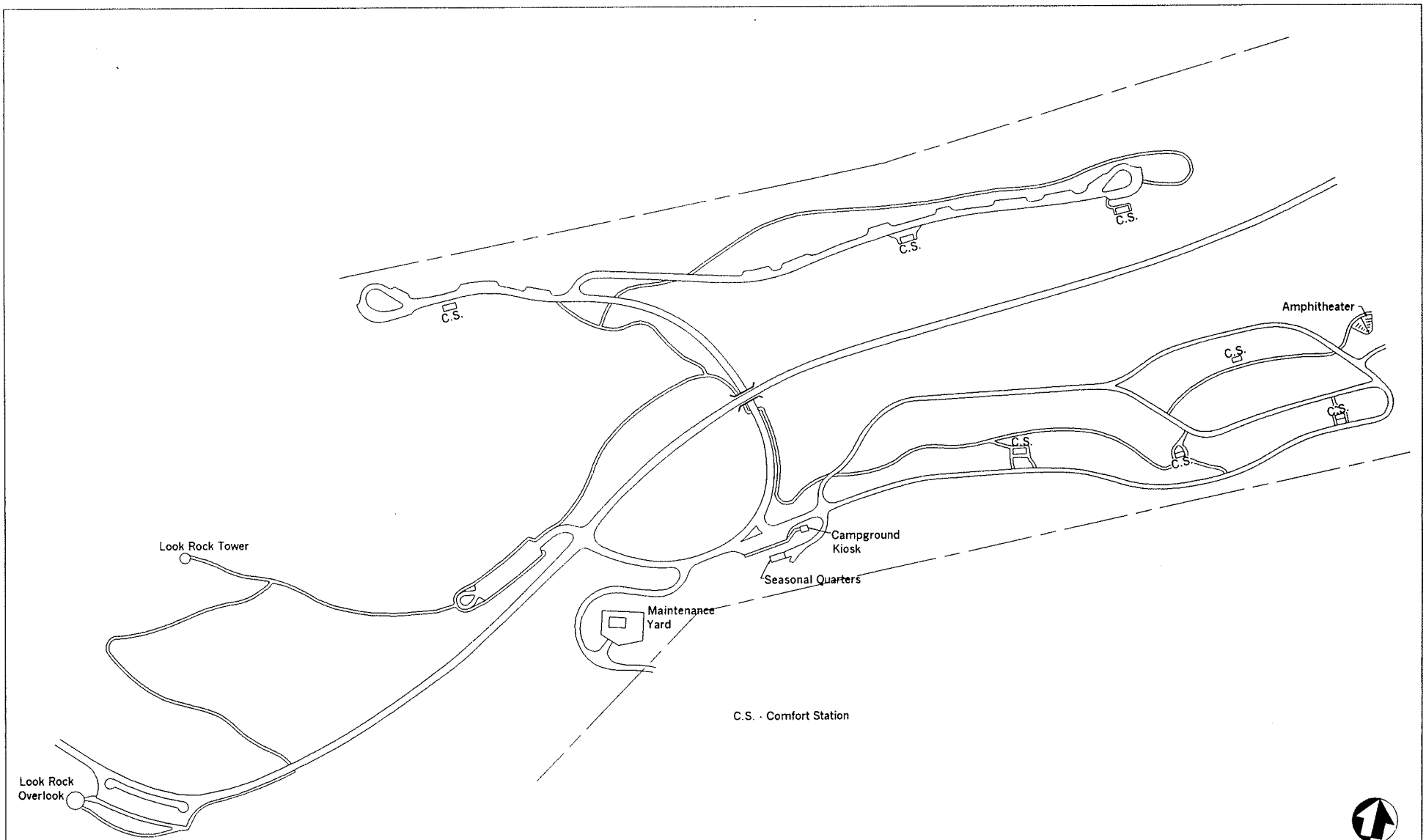

| | | | |
|---|---|---|---|
| DESIGNED: | SUB SHEET NO. | TITLE OF SHEET | DRAWING NO |
| DRAWN: J. Childers | | Cable Mill | 133 DWG2 |
| TECH. REVIEW: | | | PKG NO. — — SHEET 1 OF 1 |
| DATE: 1/02 | | Great Smoky Mountains National Park | |



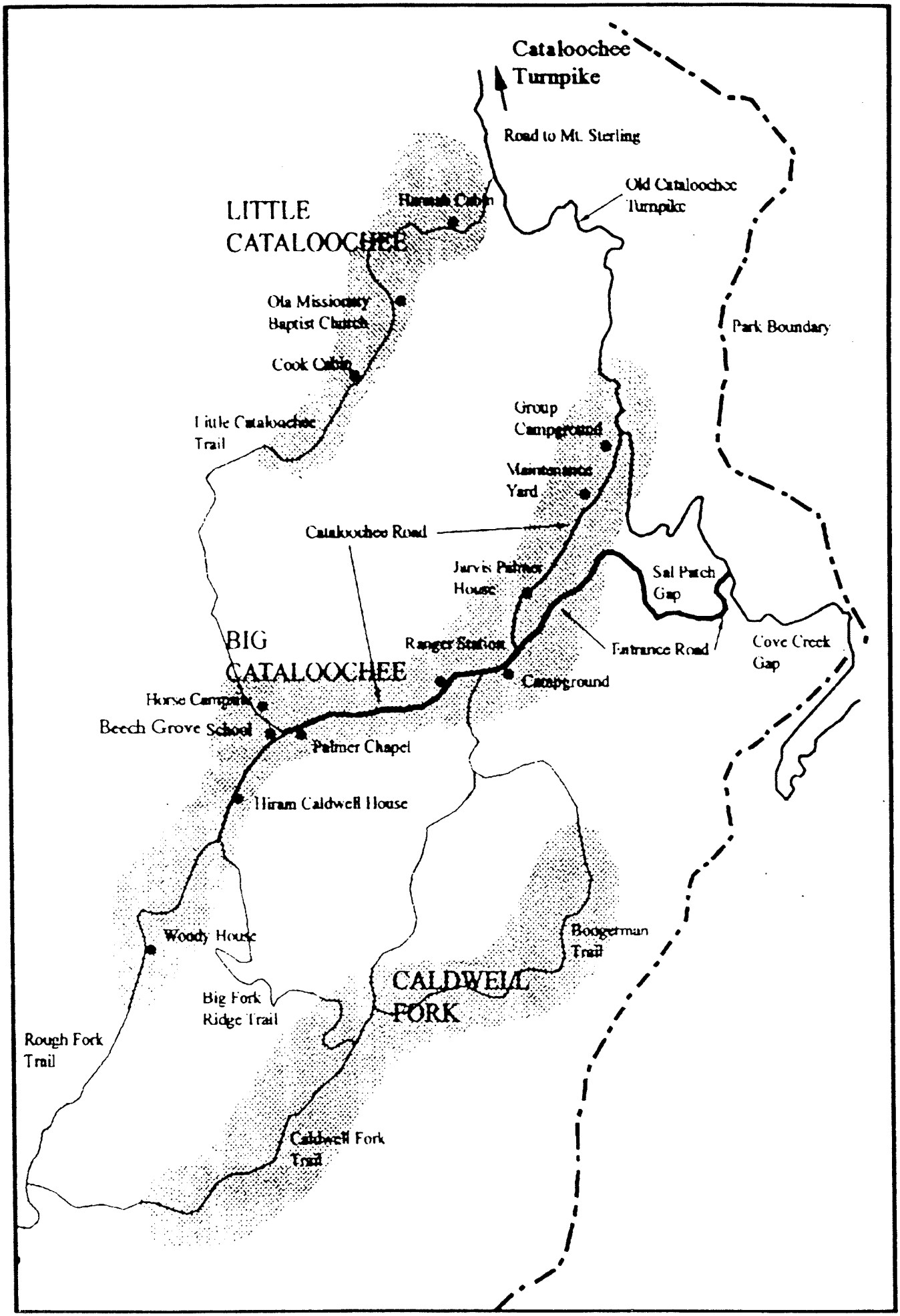

**LeConte Lodge**


Parking
Toms Branch
Group Camping
Deep Creek
Comfort Station
Campground C Section
Picnic Area
Comfort Station
Tent Camping
Comfort Station
Comfort Station
Group Shelter
Comfort Station
Deep Creek
Comfort Station
Comfort Station
Horse Parking
Kiosk
Campground D Section
Horse Concession
Seasonal Quarters
Ranger Station
Maintenance
To Park Boundary
To Park Boundary

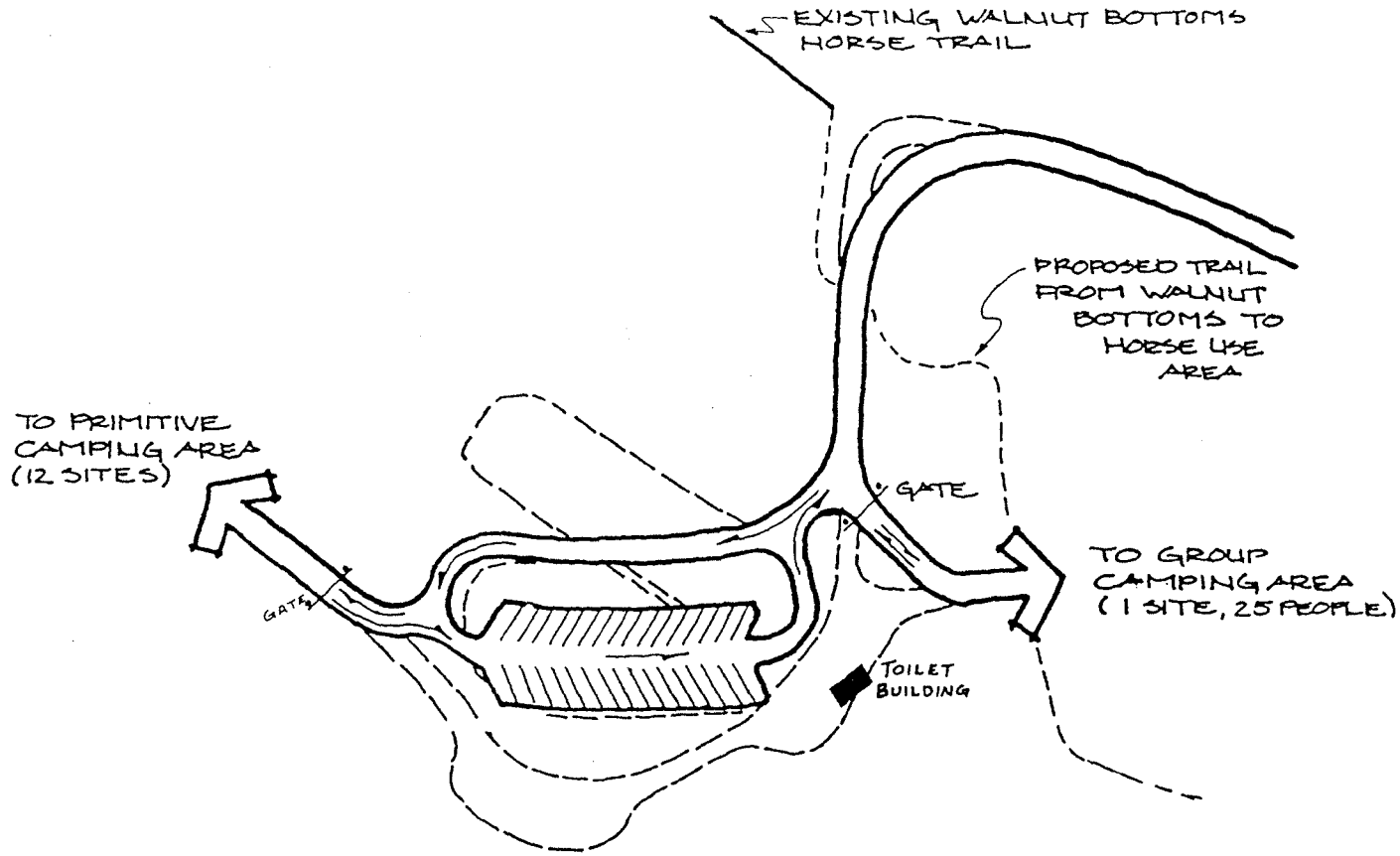
DEEP CREEK



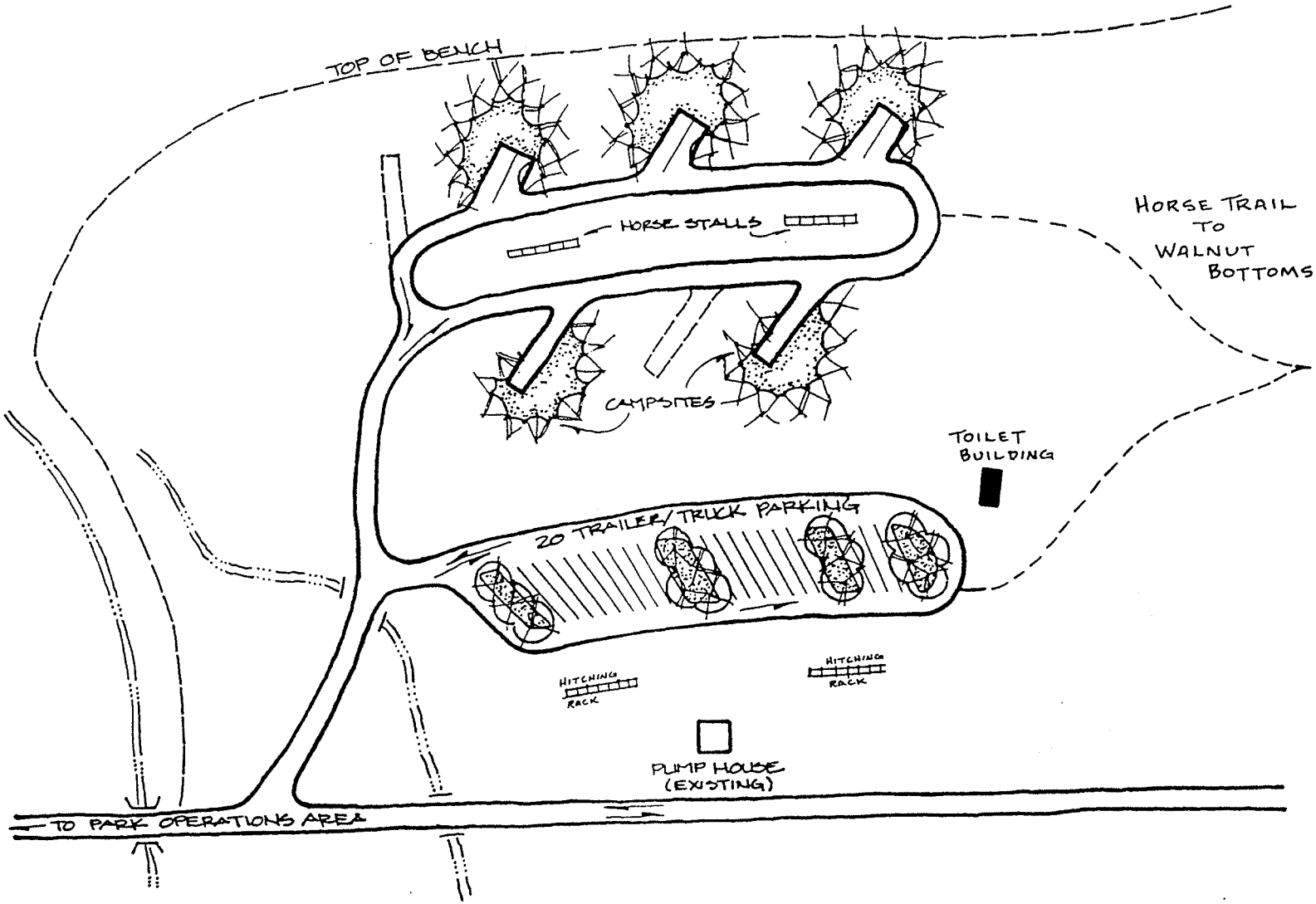

| | | | |
|---|---|---|---|
| DESIGNED: RADD J. Childers; TECH REVIEW; DATE 3/02 | SUB SHEET NO. | TITLE OF SHEET: Look Rock Area — Great Smoky Mountains National Park | DRAWING NO 133 DWG2; PKG NO —; SHEET 1 OF 1 |




**Cataloochee Map**




**BIG CREEK DAY USE AREA**

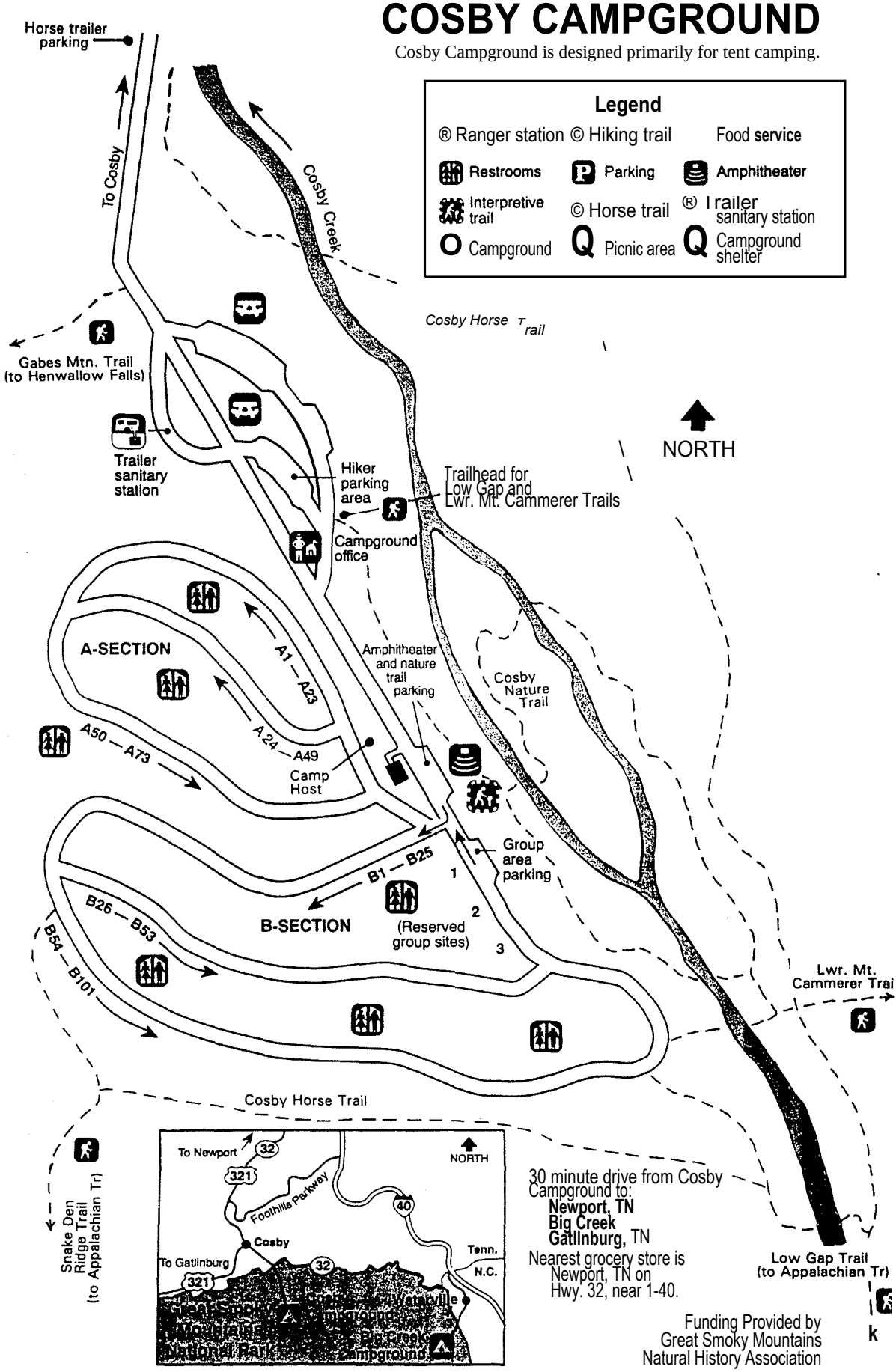



**BIG CREEK HORSE USE AREA**


OCONALUFTEE VISITOR CENTER, MAINTENANCE YARD, AND RESIDENTIAL AREA

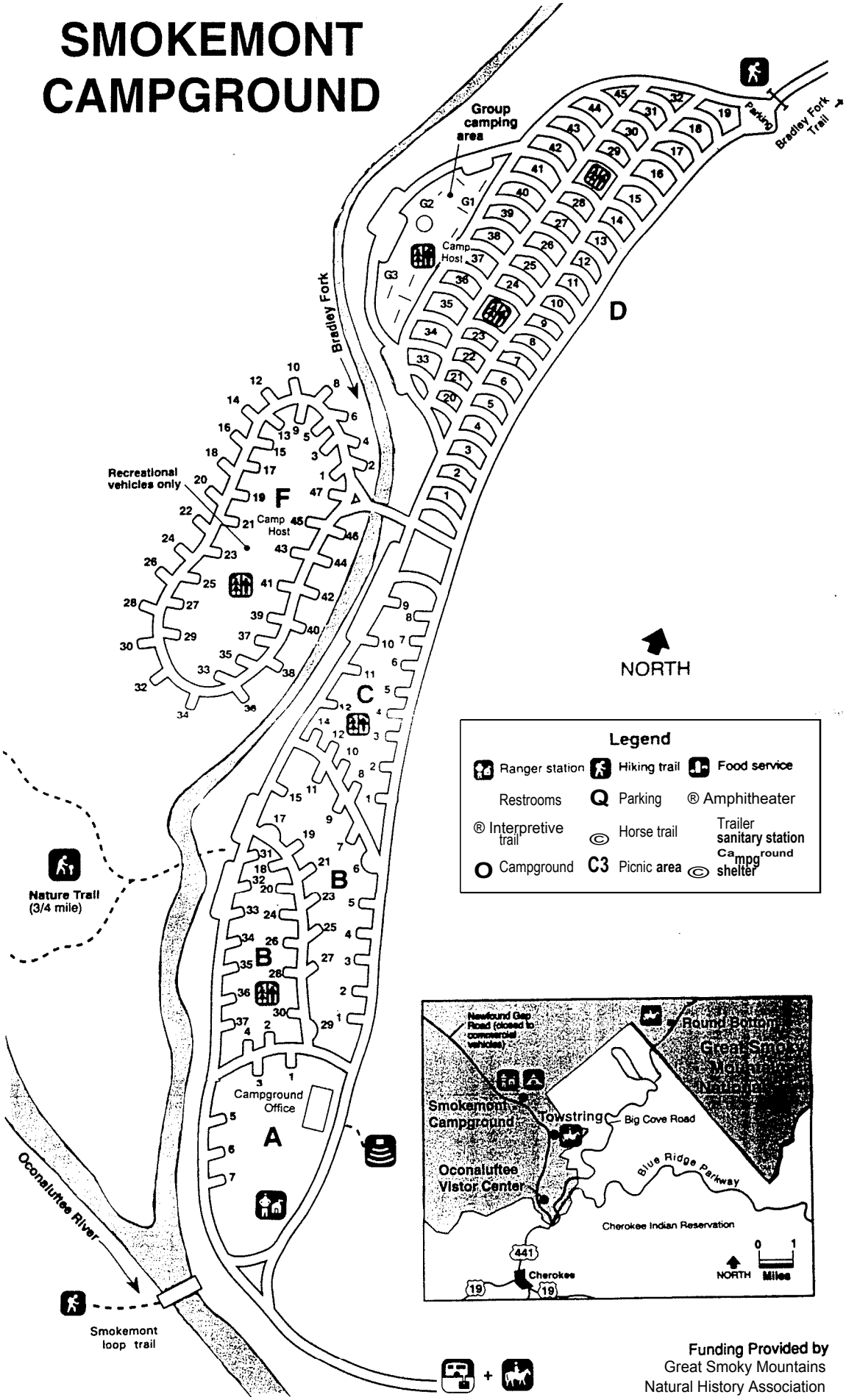
# COSBY CAMPGROUND

Cosby Campground is designed primarily for tent camping.



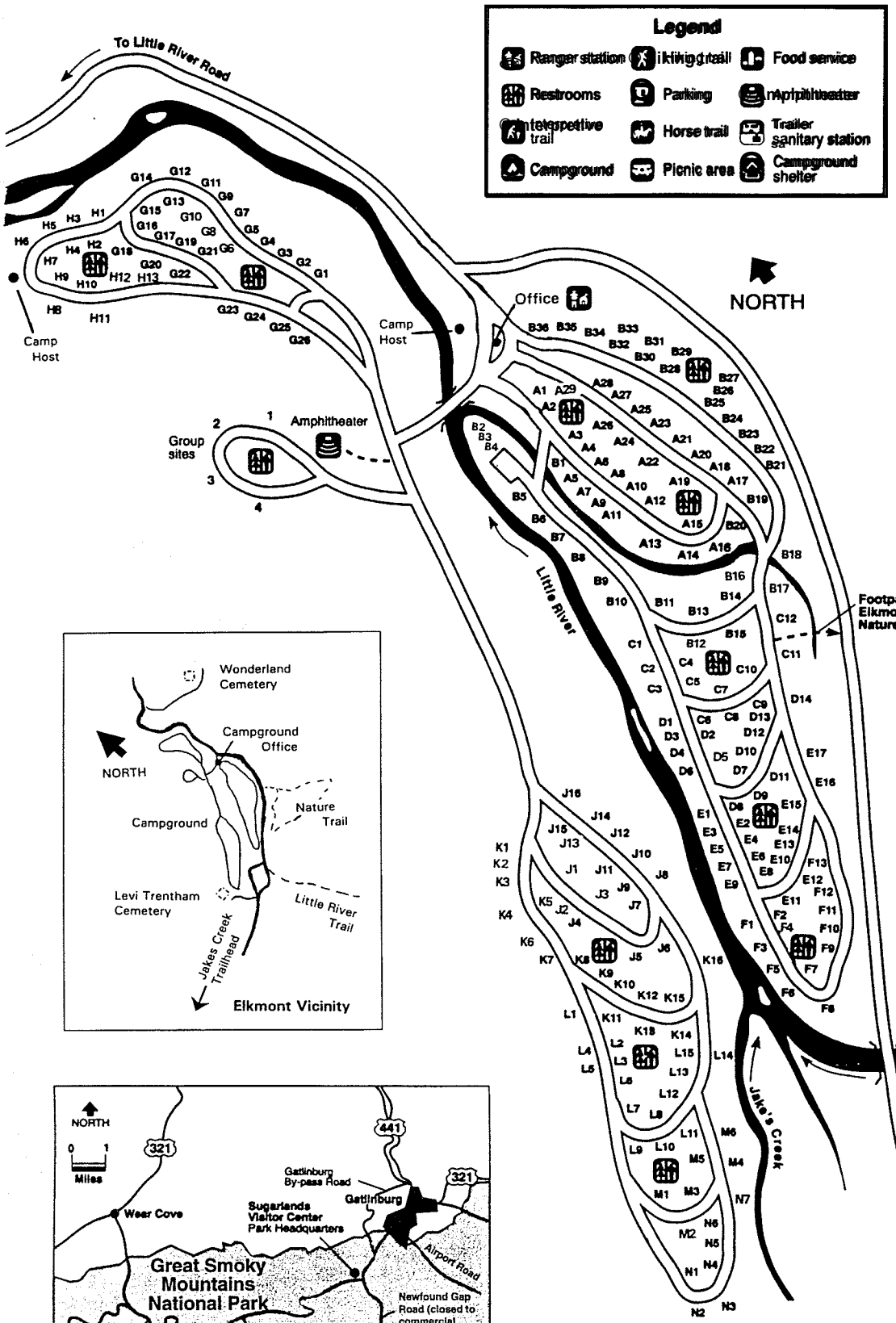

Funding Provided by
Great Smoky Mountains
Natural History Association

# SMOKEMONT CAMPGROUND




**Funding Provided by**
Great Smoky Mountains
Natural History Association

# ELKMONT CAMPGROUND

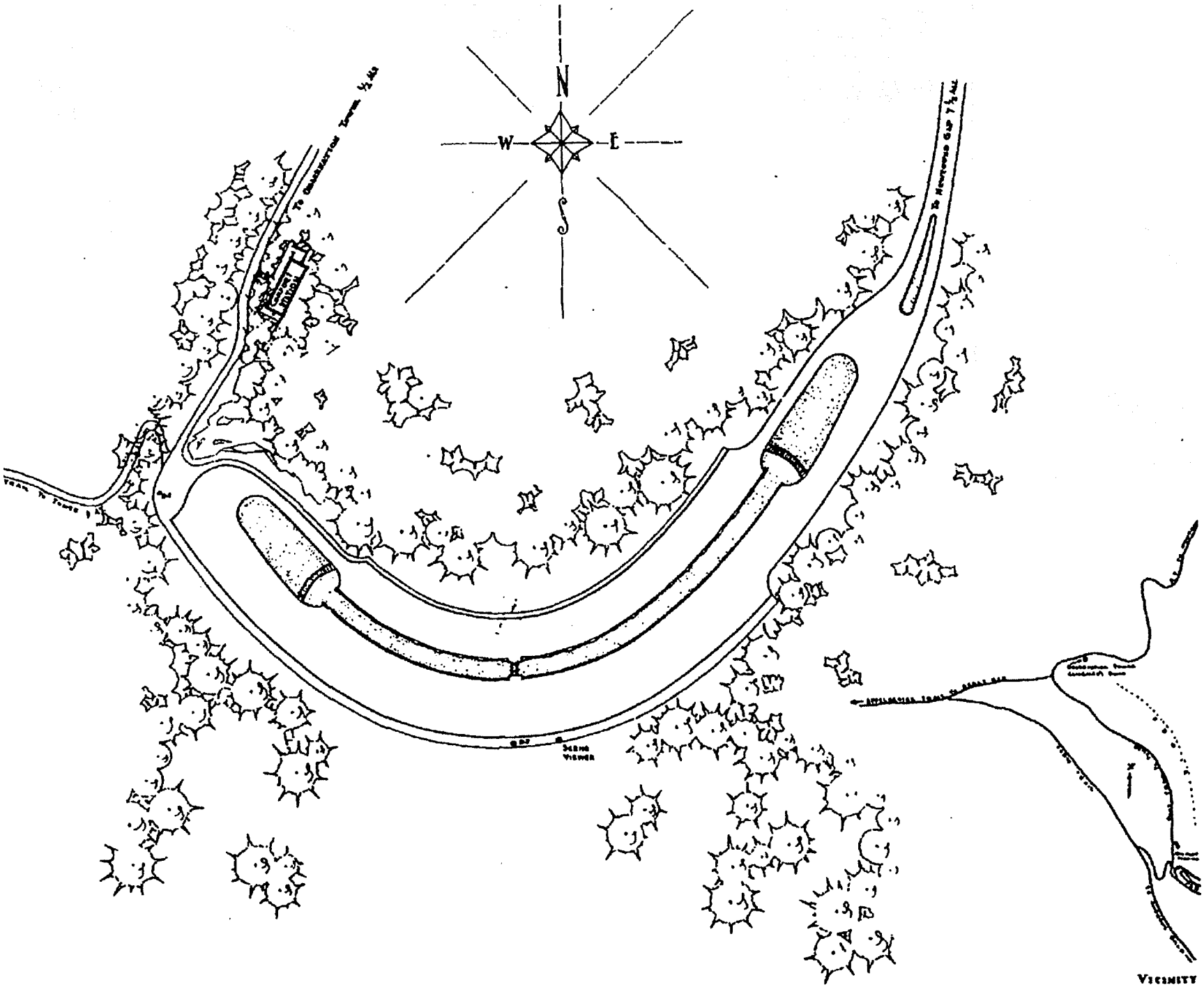


# BALSAM MOUNTAIN CAMPGROUND

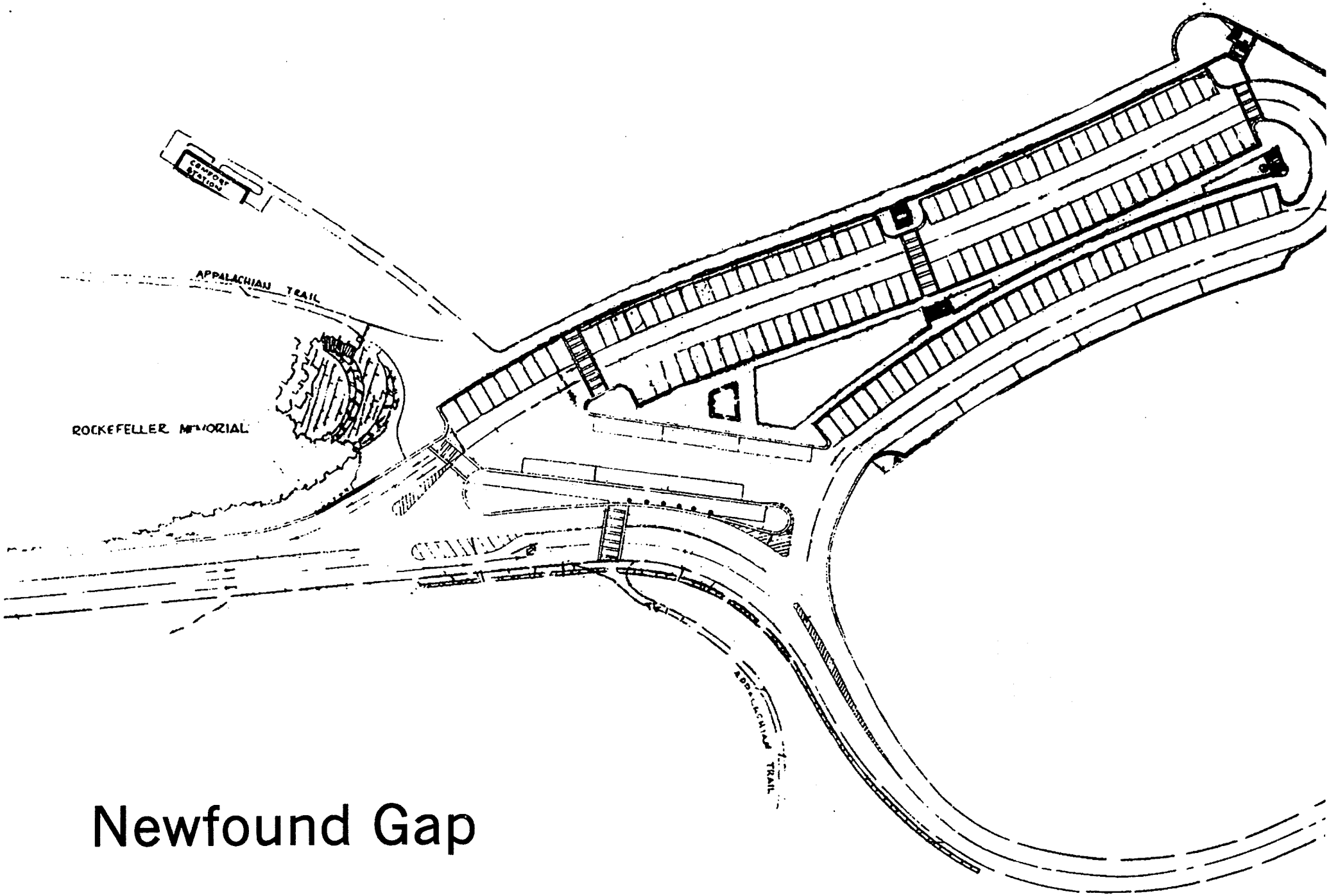
**Legend**

| | | |
|---|---|---|
| ® Ranger station | © Hiking trail | Food service |
| Restrooms | O Parking | ® Amphitheater |
| Interpretive trail | ® Horse trail | ® Trailer sanitary station |
| O Campground | D Picnic area | @ C9t~ppoground shelter |

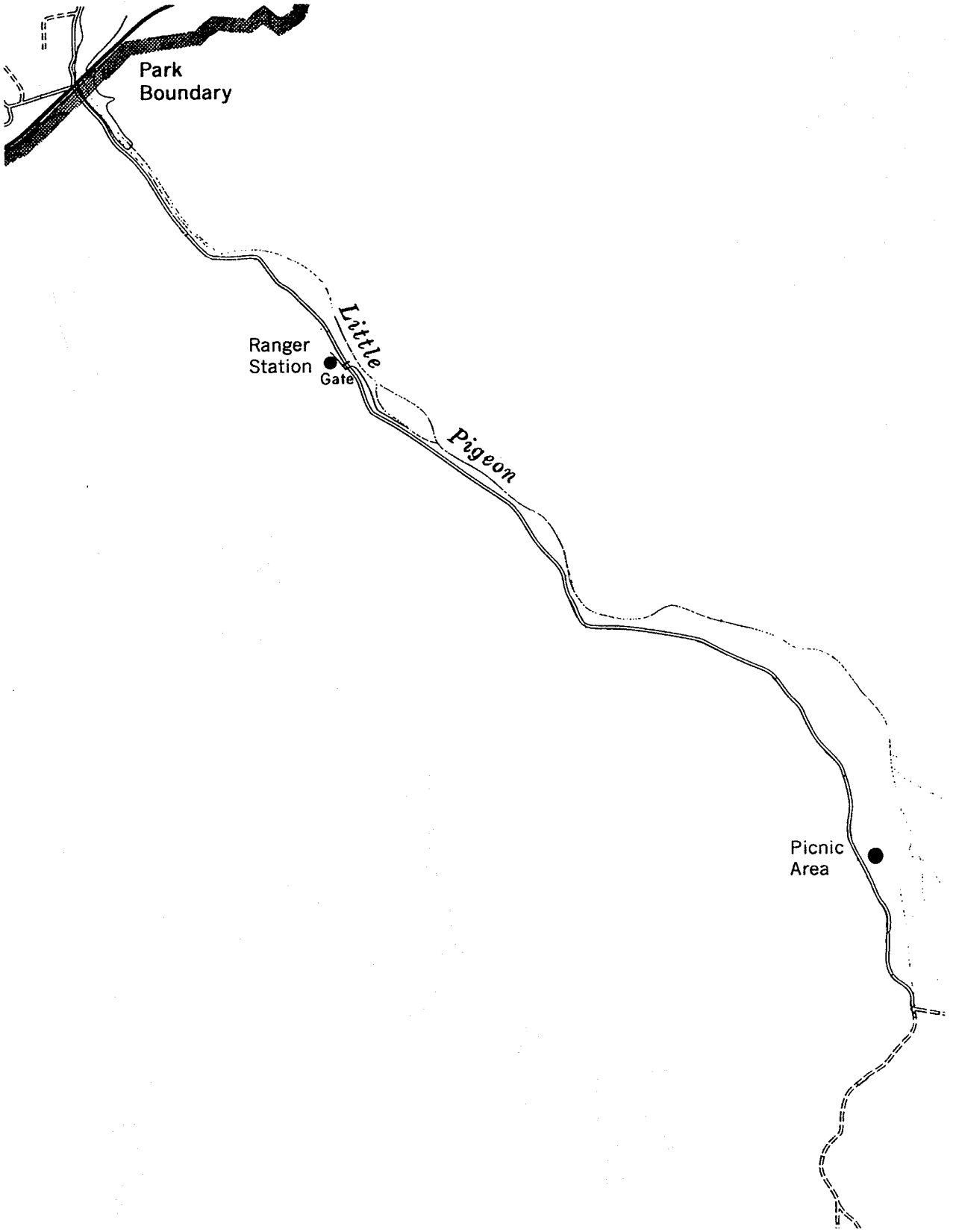
**Funding Provided by**
**Great Smoky Mountains**
**Natural History Association**



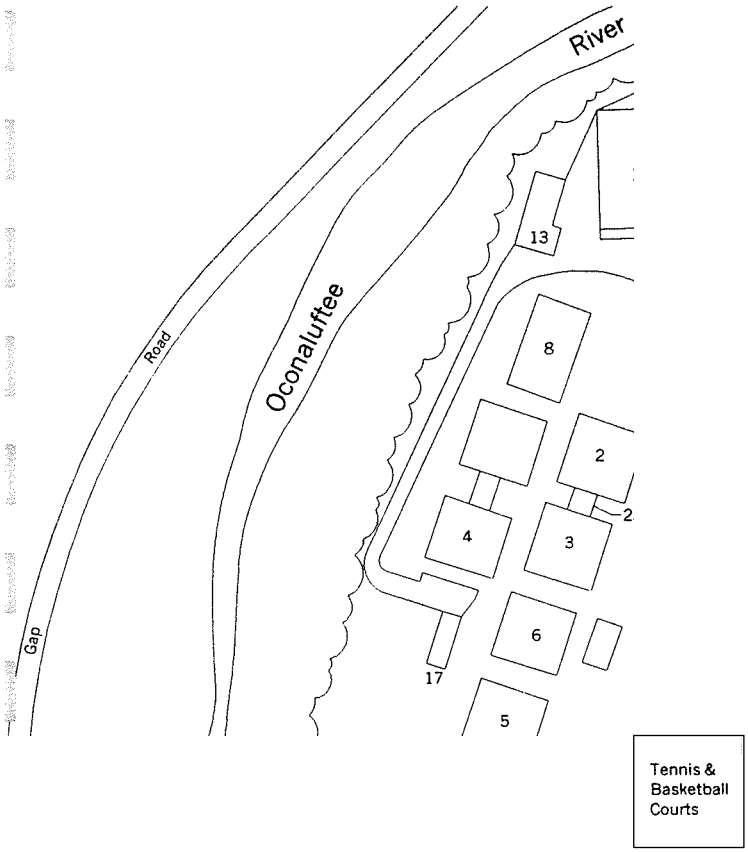

FORNEY BRIDGE




# Newfound Gap




Greenbrier Area
No Scale



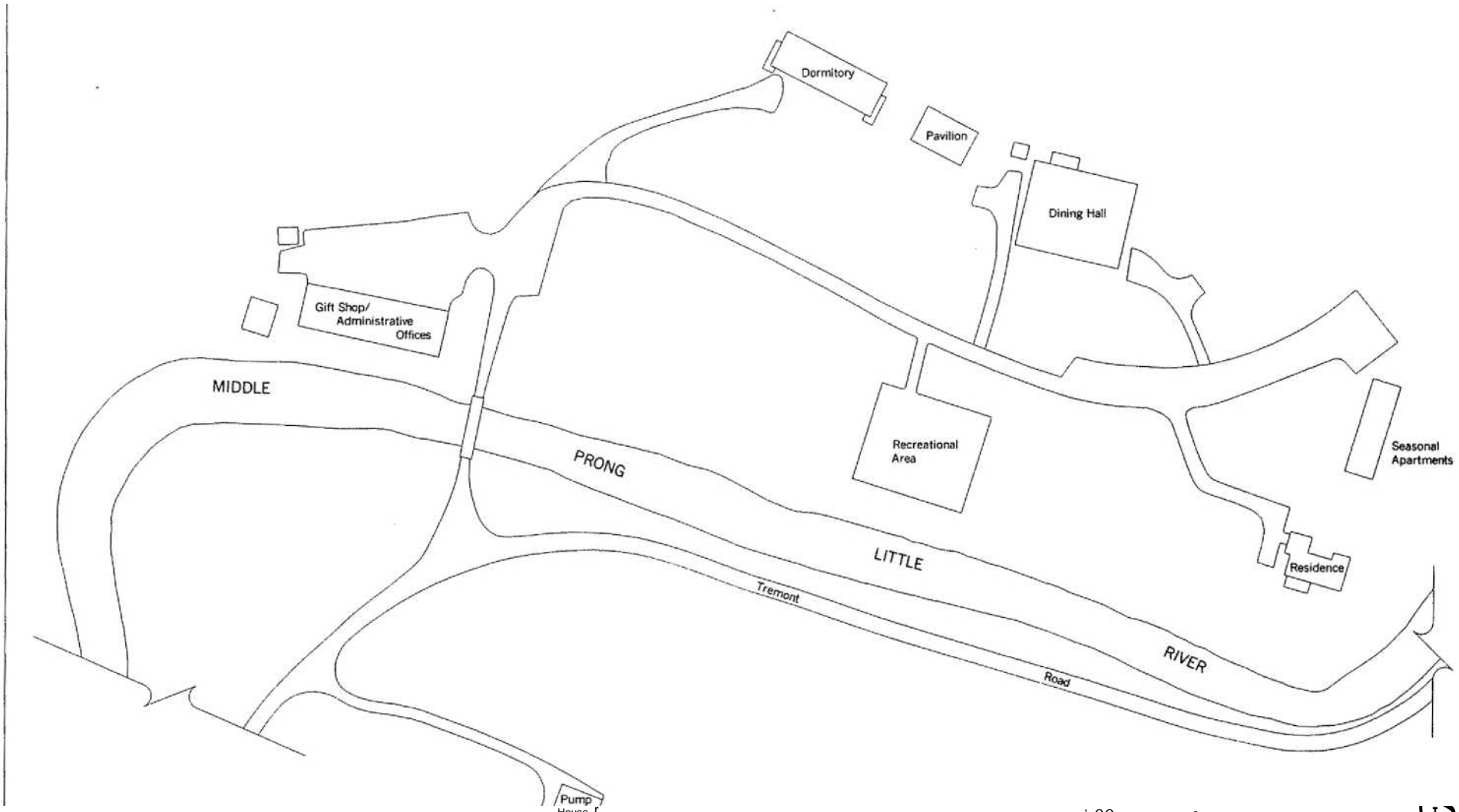

BUILDING LEGEND

| NO. | USAGE |
|---|---|
| 1 | Administration |
| 2 | Dormitory A |
| 2A | Night Staff Office |
| 3 | Dormitory B |
| 4 | Dormitory C |
| 5 | Dormitory D |
| 6 | Dormitory E |
| 7 | Education |
| 8 | Counseling/Orientation |
| 9 | Dining Hall |
| 10 | Works |
| 11 | Vocational Training |
| 12 | Laundry/Paint Storage |
| 13 | Training Kitchen |
| 14 | Supply |
| 15 | Dispensary |
| 16 | Gymnasium |
| 17 | Recreational Storage |
| 18 | Vocational & Storage |
| 19 | Flammable Storage |

cc c c tee cccc

100 0 100 200

SCALE IN FEET



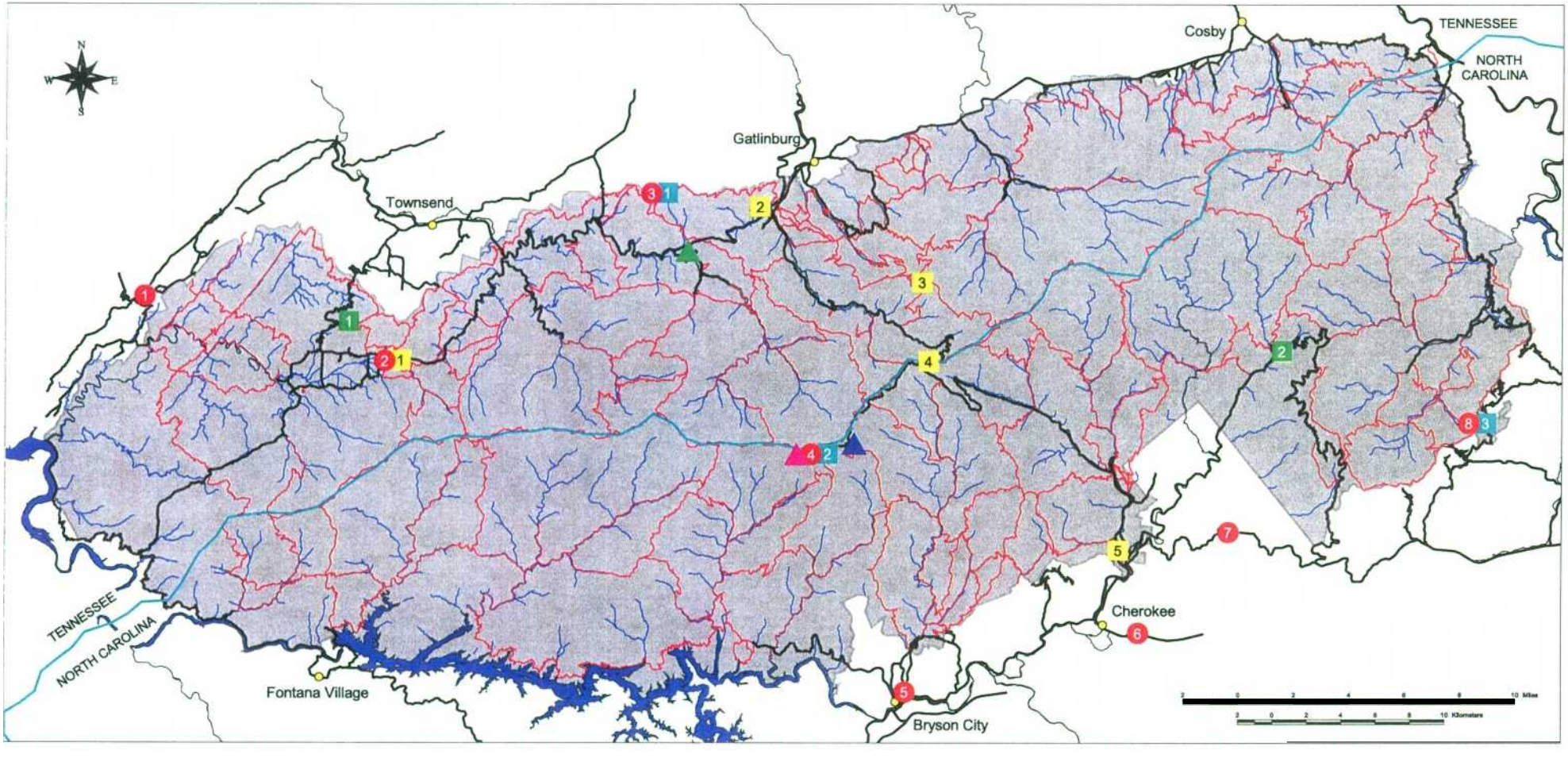

SCALE OF FEET

Great Smoky Mountains
Institute at Tremont

# APPENDIX C

# AIR QUALITY MONITORING SITES AND DATA IN GREAT SMOKY MOUNTAINS NATIONAL PARK

# Air Quality Monitoring Sites In and Near Great Smoky Mountains National Park




NATIONAL ATMOSPHERIC DEPOSITION PROGRAM AT ELKMONT (2,100') - precipitation chemistry

NOLAND DIVIDE WATERSHED (5,700') - precipitation chemistry, meteorology

EPA MOUNTAIN ACID DEPOSITION PROGRAM AT CLINGMANS DOME (6,660') - NDDN and cloud chemistry/deposition

GASEOUS POLLUTANT MONITORING STATION (NPS, TVA, TN, NC and NOAA)

1. Look Rock (2,700') - $0_3$, $SO_2$, CO, NO-NOx, $PM_{25}$, visibility (camera, nephelometer, IMPROVE), NDDN, meteorology
2. Cades Cove (1,850') - $0_3$, UV-B, meteorology
3. Cove Mountain (4,150') - $0_3$, $0_3$ Flux, $SO_2$, CO, NO-NOy, $PM_{25}$, hydrocarbons, IMPROVE, meteorology
4. Clingmans Dome (6,670') - $0_3$, meteorology
5. Bryson City (1,900') - $0_3$, $SO_2$, $PM_{2.5}$
6. Cherokee (2,100') - CO, $PM_{25}$
7. Barnett Knob (4,700') - 03, visibility (camera), meteorology
8. The Purchase (4,900') - $0_3$, meteorology

NOAA WEATHER STATION - meteorology

1. Cove Mountain (4,150')
2. Clingmans Dome (6,670')
3. The Purchase (4,900')

REMOTE AREA WEATHER SYSTEM (RAWS) - meteorology

1. Indian Grave (2,600')
2. Cherokee (3,380')

PARK WEATHER STATION - temperature, precipitation

1. Cades Cove (1,850')
2. Park Headquarters (1,500')
3. Mt. LeConte (6,500')
4. Newfound Gap (5,040')
5. Oconaluftee (2,100')

Great Smoky Mountains National Park

Large Lakes, Rivers

Streams

Roads

Trails

Cities, Towns

State Boundary

2002 Air Quality Monitoring **Program at Great Smoky Mountains National Park, Tennessee/North Carolina**

| Site Name/Location/Cooperators/Start Year | Parameter(s) | Sampling Frequency/Duration |
|---|---|---|
| *LOOK ROCK-2700'* (Blount Co, TN, Ridge) NPS (1984) | 03, meteorology[1] | Hourly |
| NPS (1984) | $PM_{2.5}$/PM,o | 24-hour speciated PM (every day) |
| NPS, EPA, TN (2002) | $PM_{2.5}$ (mass only)[3] | Hourly (TEOM) planned for 2002 |
| NPS (1993) | Nephelometer ($Bs_{at}$)[2] | Hourly, 15-minute |
| NPS (1998) | Dry deposition[4] | Weekly average (Tue-Tue) |
| TVA | Speciated M2.5[5] | Hourly (real-time PM speciation) |
| ***CARES*** COVE-1850' (Blount Co, TN, Valley) NPS, NWS(1994) | $O_3$, meteorology[6] | Hourly[1], min/max temp, precip.[b] |
| NPS, EPA (1996) | UV-B[7] | Hourly |
| ***COVE MTN*** -4150' (Sevier Co, TN, Ridge) NPS, NOAA (1986) | 03, meteorology[1,14] | Hourly |
| NPS, TVA (1994) | $O_3$, $SO_2$, CO, NO-$NO_y$[1] | Hourly, 5-minute |
| NPS, TVA (2000) | PM25, $B_{at}$[8] | Seasonal (daily PM; Hourly $Bs_{ca}$, |
| CLINGMANSDOME-6610'(Sevier Co, TN, Ridge) NPS (1993) | $O_3$, meteorology[1] | Hourly |
| NPS, EPA, TVA (1998) | Dry deposition | Weekly average (Tue-Tue) |
| NPS, EPA, TVA (1994) | Cloud deposition | Daily bulk |
| TVA, NPS (2002) | Mercury deposition[10] | Weekly bulk (Tue-Tue) |
| UT, W. Carolina U., Emory U. (2002) | $PM_{2.5}$' (mass only) | Hourly (portable continuous) |
| *ELKMONT* - 1850' (Sevier Co, TN, Valley) NPS (1980) | Wet deposition[12] | Weekly bulk (Tue-Tue) |
| NPS, TVA (2002) | Mercury deposition[10] | Weekly bulk (Tue-Tue) |
| ***HEADQUARTERS*** - 1500' (Sevier Co, TN, Valley) NWS, NPS | Meteorology[&] | Min/max temp, daily precipitation |
| *MT. LECONTE - 6300'* (Sevier Co, TN, Ridge) NWS, NPS | Meteorology[&] | Min/max temp, daily precipitation |
| *OCONALUFTEE*- 2000' (Swain CO, NC, Valley) NWS, NPS | Meteorology[&] | Min/max temp, daily precipitation |
| ***PURCHASE KNOB*** - 4900'(Haywood Co, NC, Ridge) NC, NOAA (1995) | 03[13], met" | Hourly |
| *BARNETT KNOB* - 4700' (Jackson Co, NC, Ridge) NC (1998) | $O_3$, meteorology[13,15] | Hourly |
| *BRYSON CITY* - 1900' (Swain Co, NC, Valley) NC (1995) | 03[13] | Hourly |
| NC (1998) | $PM_{2.5}/PM_{10}$[13] | 24-hour speciated PM (3'1 day) |
| *NOLAND DIVIDE-5700'(Swain* Co, NC, Ridge) NPS/UT(1991) | Wet/total deosition[1] | Weekly bulk (Tue-Tue) |
| NPS, UT (2000) | Meteorology | Hourly |
| *NEWFOUND GAP* - 5020' (Swain Co, NC, Ridge) UT (2002) | $O_3$, meteorology[1] | Hourly (portable), partial day |
| UT, W. Carolina U., Emory U. (2002) | PM2.5 (mass only) | Hourly (portable), partial day |
| NWS, NPS | Meteorology[&] | Min/max temp, daily precipitation |

1 *Part of the NPS/GRSMAir Quality Monitoring Network*
*Meteorological measurements include wind speed/direction, relative humidity, temperature, solar radiation, and precipitation*

2 *Part of the Interagency Monitoring of Protected Visual Environments (IMPROVE)*
*Speciated particle measurements include filter-based $SO_4$, $NO_3$, $NH_4$, organics, elemental carbon, soil, ions, PM10*

3 *Planned TEOM with NPS, EPA, TN*

4 *Part of the National Dry Deposition Network (NDDN)*
*Measurements include filter-based $SO_2$, $SO_4$, $NO_3$, $NH_4$, $HNO_3$*

5 *Possibly planned with WA, Southern Company, DOE, EPRI, and NPS*

6 *Part of the National Weather Service (Remote Area Weather Stations)*

7 *Part of the Park's Research and Intensive Monitoring of Ecosystems Network (PRIMENet)*

8 *Part of the NPS and WA Enhanced Gaseous Pollutant Monitoring*

9 *Part of the NPS, EPA, TVA Cloud-water Monitoring Program/ Clean Air Status and Trends Network (CASTNet)*
*Measurements include $SO_4$, $NO_3$, $NH_4$, it, Ca, Mg, K, Cl, cloud frequency, liquid water content, particle size*

10 *Part of the Mercury Deposition Network (MDN)*

11 *University of Tennessee, Western Carolina University, and Emory University Adult Day-Hiker Health Study*

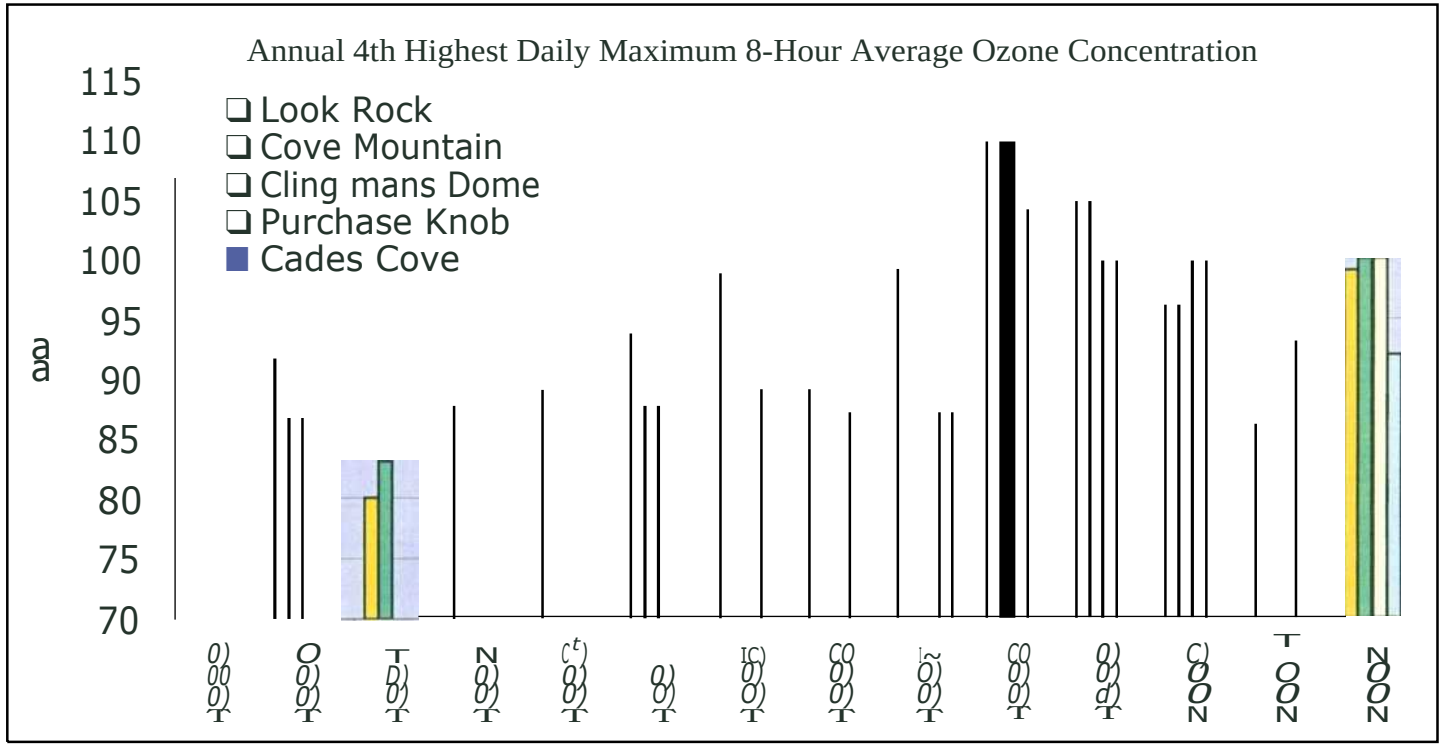
12 *Part of the National Atmospheric Deposition Program (NADP)*
*Measurements include $SO_4$, $NO_3$, $NH_4$, $II^+$, inorganic N, pH, conductivity, major cations (Ca, Mg, K), precipitation volume*

13 *Part of the State of North Carolina Air Quality Monitoring Program (available in AIRS)*

14 *Part of National Oceanic and Atmospheric Administration (NOAA) East Tennessee Met Network*

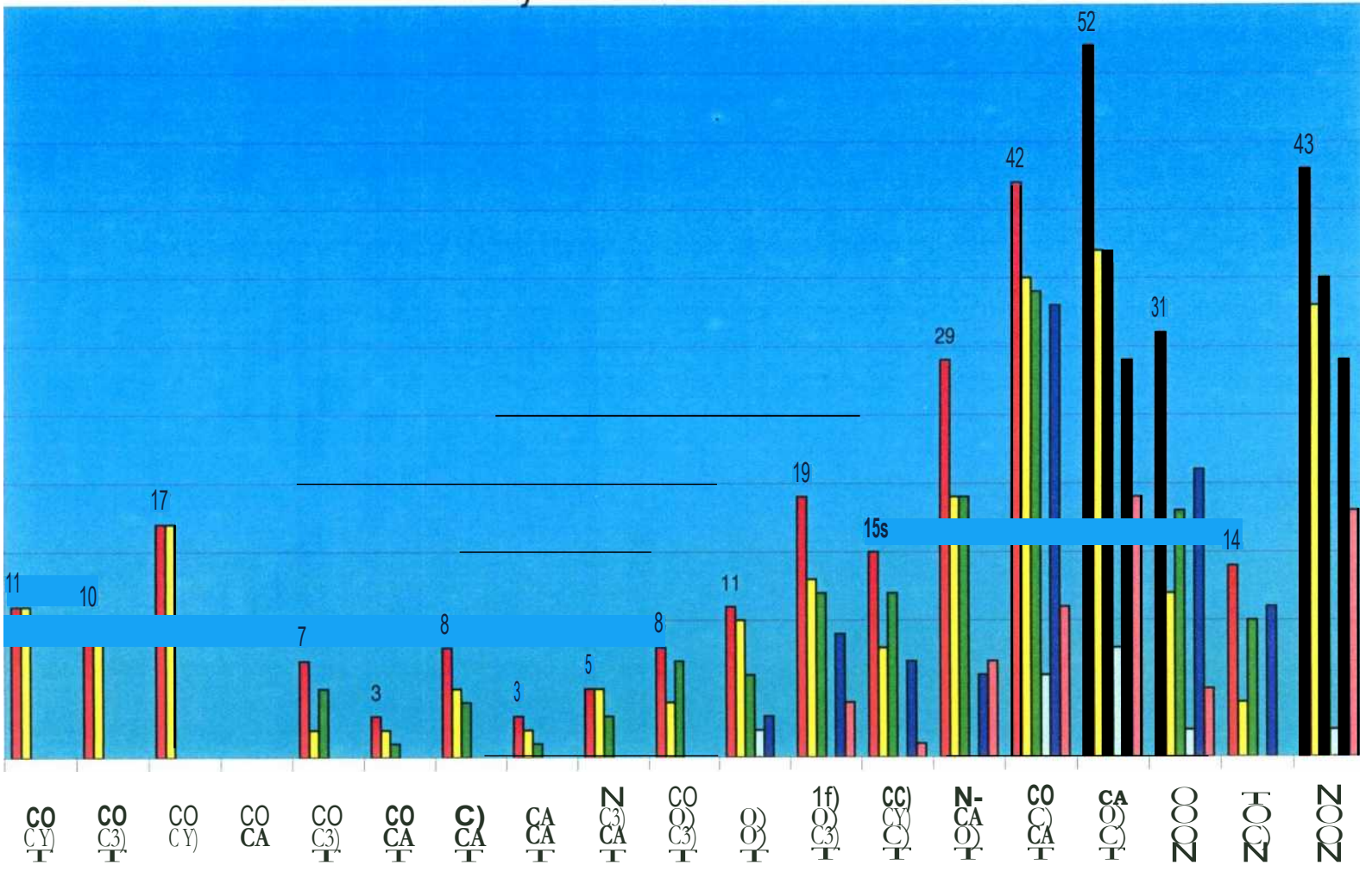
15 *Part of the Cherokee Tribal Utilities Air Quality Monitoring Program*

**Prepared by Jim Renfro, Air Resource Specialist, National Park Service, Great Smoky Mountains National Park 1314 Cherokee Orchard Rd., Gatlinburg, Tennessee 37738, phone: 865/436-1708, fax: 865/430-4753, email: Jim renfro@nps.gov [Monitoring Info2.doc]**


Annual 4th Highest Daily Maximum 8-Hour Average Ozone Concentration
115
110
105
100
95
90
85
80
75
70
Look Rock
Cove Mountain
Cling mans Dome
Purchase Knob
Cades Cove

# Number of Days Exceeding 8-hour Ozone Standard

at Great Smok Mountains National Park



# Trends in the 8-Hour Ozone NAAQS

## (3-Year Average of the 4th Highest 8-Hour Average)