Report No. NPS D-321

Annual Data Summary

MOUNT RAINIER NATIONAL PARK

1996

National Park Service
Gaseous Air Pollutant Monitoring Network

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ACKNOWLEDGEMENTS

The National Park Service Air Resources Division (ARD) recognizes the level of effort required by individual park units, site operators, auditors, cooperating state and local agencies, and ARD contractors. ARD sincerely appreciates the contributions of all participants in assisting with the collection, validation, and reporting of these air quality and meteorological data.

At Mount Rainier National Park the ARD specifically recognizes Dave Larson and Dawn Adams for performing the technical and administrative skills required to help provide the data presented within this report.

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1.0 INTRODUCTION

1.1 THE NATIONAL PARK SERVICE GASEOUS POLLUTANT MONITORING NETWORK

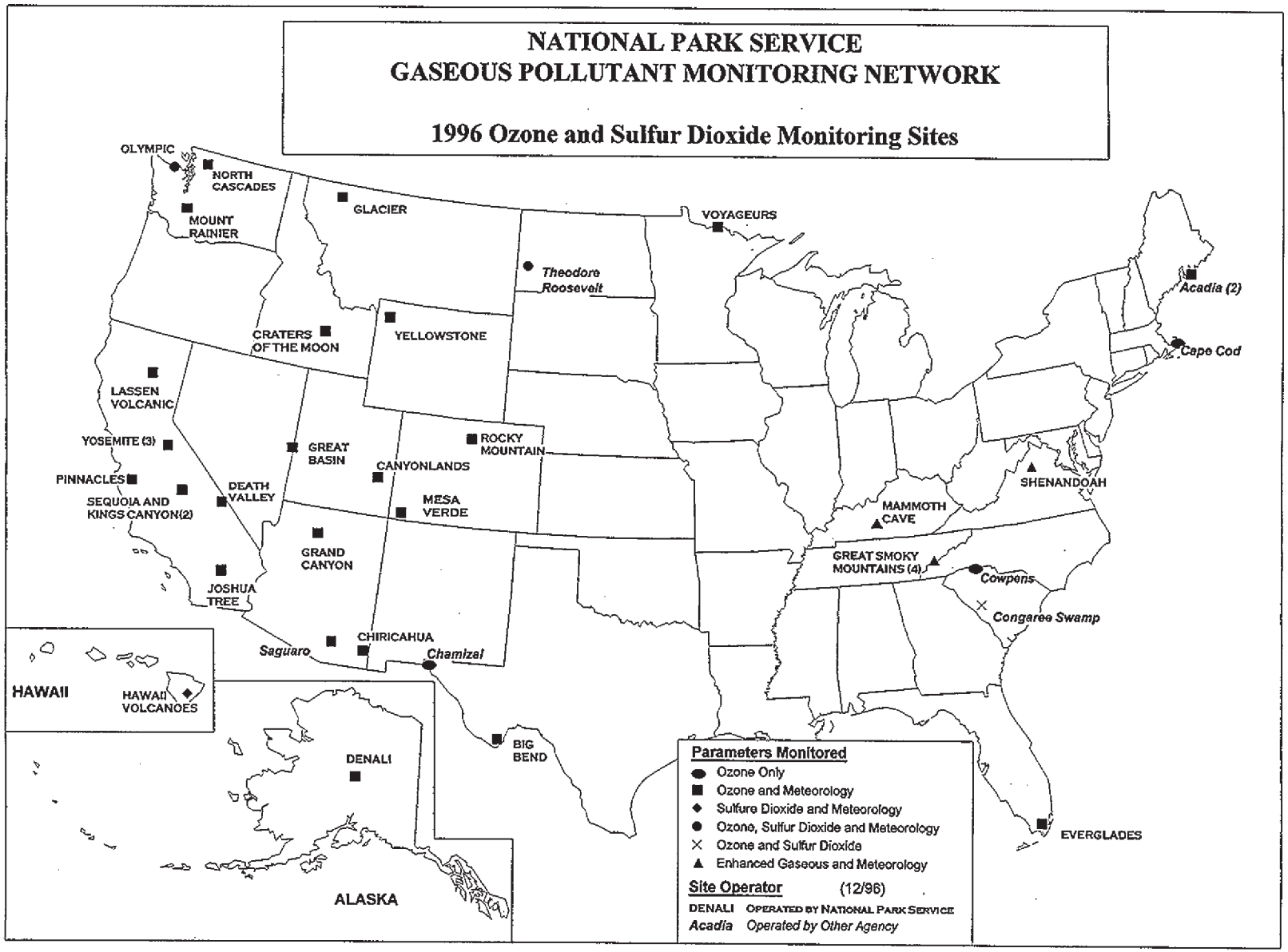
Gaseous air pollutants, including ozone and sulfur dioxide, are of concern to the National Park Service (NPS). Pollutants like these can affect park unit biological resources as well as the health of park unit residents and visitors. The NPS established a gaseous pollutant monitoring program for several pollutants linked to effects on NPS resources. This program was designed to meet certain resource management objectives.

The primary objective of this monitoring program is to establish the status and trends of park unit air quality conditions and to determine if a park unit is exceeding the National Ambient Air Quality Standards established by the U.S. Environmental Protection Agency (EPA) to protect public health and welfare. In addition, such monitoring is designed to detect changes or trends in pollution levels over time. A monitoring station may also be established if there is documented biological injury due to air pollution in a park unit. Information on ambient air pollution levels is an important part of research on effects of air pollutants on NPS resources, and can help confirm suspected causes of observed effects.

Other monitoring objectives call for the collection of data to support the National Park Service's required involvement in both the development of state air quality control plans, and the evaluation of permit applications for new or expanding air pollution sources wishing to locate near park units. The Clean Air Act gives federal land managers and superintendents an affirmative responsibility to protect air quality related values in Class I areas and to assess whether new sources will have an adverse impact on park unit resources and values. Information on air quality levels in NPS units can also be used to evaluate the performance of atmospheric models that simulate how pollutants are transported into park units and predict impacts on the park unit caused by air pollution sources.

The National Park Service Gaseous Pollutant Monitoring Network site locations and measured parameters collected in this reporting year are shown on the map on the following page. During this reporting period, 42 monitoring sites in 33 units of the National Park System had some combination of ozone, sulfur dioxide, meteorological, and CASTNet dry deposition monitoring. Monitoring methods and quality assurance procedures used in the national park network meet the applicable 40 CFR Part 58 EPA requirements. This allows for the direct comparison of NPS collected data with that collected by the EPA, and state and local air pollution control agencies. Data collected by this network are incorporated in the EPA Aerometric Information Retrieval System (AIRS) database which is a national database of all air quality data collected throughout the country. These data are also stored in the NPS Air Resources Division's Information Management Center (IMC) that allows for easy access and analysis of data.

This report includes a variety of data summaries for data collected at an individual monitoring site at a national park unit during this reporting period. These summaries highlight the average range and frequency of the data collected during the year. A PC-compatible diskette containing a digital copy of all data collected during the year and data summary products included in this report is available. Individual reports are generated for each site where monitoring was conducted in the national park network.


NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK
1996 Ozone and Sulfur Dioxide Monitoring Sites
OLYMPIC
NORTH CASCADES
MOUNT RAINIER
GLACIER
VOYAGEURS
Theodore Roosevelt
Acadia (2)
Cape Cod
CRATERS OF THE MOON
YELLOWSTONE
LASSEN VOLCANIC
YOSEMITE (3)
GREAT BASIN
ROCKY MOUNTAIN
CANYONLANDS
PINNACLES
DEATH VALLEY
SEQUOIA AND KINGS CANYON(2)
MESA VERDE
SHENANDOAH
MAMMOTH CAVE
GRAND CANYON
GREAT SMOKY MOUNTAINS (4)
Cowpens
JOSHUA TREE
Congaree Swamp
CHIRICAHUA
Saguaro
Chamizal
HAWAII
HAWAII VOLCANOES
BIG BEND
DENALI
EVERGLADES
ALASKA
Parameters Monitored
Ozone Only
Ozone and Meteorology
Sulfure Dioxide and Meteorology
Ozone, Sulfur Dioxide and Meteorology
Ozone and Sulfur Dioxide
Enhanced Gaseous and Meteorology
Site Operator (12/96)
DENALI Operated by National Park Service
Acadia Operated by Other Agency

1.2 MOUNT RAINIER NATIONAL PARK

Mount Rainier National Park, a Class I area, is located in Washington about 40 kilometers southeast of Seattle. Its location and site specifications are presented on the following page.

The purpose of Mount Rainier National Park is to protect, preserve and interpret the natural, scenic and historical resources. Mount Rainier is a classic example of a dormant composite volcano, with the largest single-peak glacial system in the contiguous United States. The park also contains outstanding examples of the native flora and fauna of the Cascade Mountains.

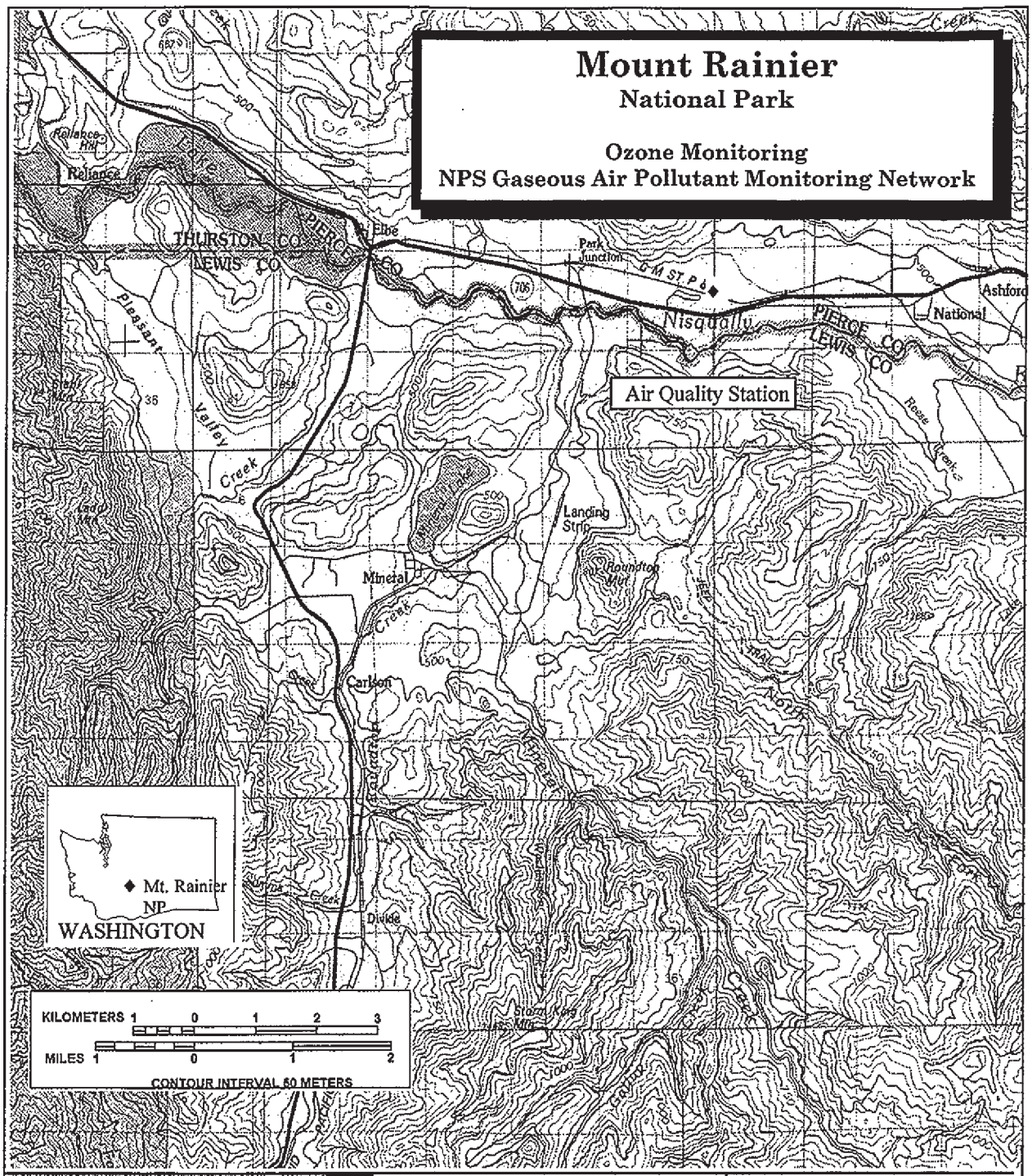
The topography of the park is rugged and precipitous, consisting mainly of peaks and valleys. The Cascade Range of the east, the Tatoosh Range on the south, and mountains on all sides tower from 2,000 to 4,000 feet above the valleys. These mountains are dwarfed by the mass of Mount Rainier. The spectacular glacier-covered volcanic peak of Mount Rainier is the park's prime attraction. It rises to 14,410 feet above sea level and almost 10,000 feet in a single peak above surrounding peaks and valleys of the Cascade Range.

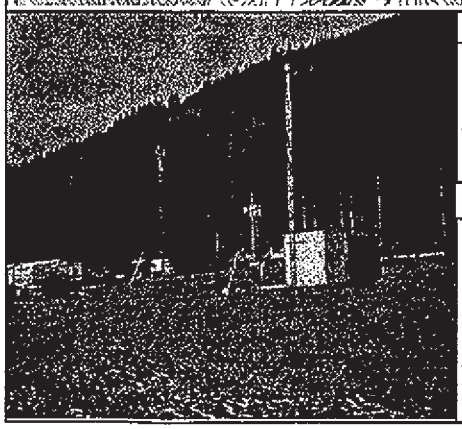
Over 700 species of vascular plants are found in the park, including spectacular virgin forests containing nearly 40 percent of the species of trees native to the region. Forests of Douglas fir, western red cedar and western hemlock occur primarily in the western hemlock zone, while Pacific silver fir, Alaska cedar, noble fir and western white pine appear in the silver fir zone. Spectacular subalpine flower fields laced by stands of mountain hemlock and subalpine fir dominate the mountain hemlock zone. The harsh alpine zone supports hardy alpine plants, including mosses and lichens, in areas free from ice and snow.

Wildlife includes at least 126 species of birds, 54 species of mammals, and 17 species of reptiles and amphibians. Examples are: white-tailed ptarmigan, blue and ruffed grouse, varied thrush, grey jay, raven, mountain goat, deer, black bear, elk, coyote, bobcat, marmot, redlegged frog, tailed frog, Pacific giant salamander and Pacific garter snake.

Mount Rainier
National Park

Ozone Monitoring
NPS Gaseous Air Pollutant Monitoring Network





SITE IDENTIFICATION	
Site Abbreviation:	MORA
AIRS ID NO.:	53-053-1010

INSTRUMENTATION	
O_3 Analyzer	Delta Temperature
Calibrator	Temperature
Wind Speed	Solar Radiation
Wind Direction	Precipitation
Relative Humidity	

MAP INFORMATION	
Mean Elevation:	421 m
Longitude:	122° 07' 18"W
Latitude:	46° 45' 41"N
UTM Zone:	10
Easting:	567074 m
Northing:	5178805 m
Map Reference:	Centralia
	46122-E1
	1:100,000

2.0 DATA SUMMARY

2.1 OVERVIEW

Based on the site specifications during this annual reporting period, data summaries and statistics are provided in this section.

Data Collection Statistics
Mount Rainier National Park

Final Data

01/01/96 - 12/31/96

Parameter	Par Code	Data Recovery			Valid Data	
		No. Possible	No. Collected	% Collected	No. Valid	% Valid
Ozone Analyzer	O3	8784	8218	93.6	7895	89.9
Scalar Wind Speed	SWS	8784	8537	97.2	8537	97.2
Vector Wind Speed	VWS	8784	8168	93.0	8168	93.0
Vector Wind Direction	VWD	8784	8334	94.9	8334	94.9
Standard Deviation for Wind Direction	SDWD	8784	8252	93.9	8252	93.9
Ambient Temperature (aspirated)	TMP	8784	8703	99.1	8703	99.1
Delta Temperature	DTP	8784	8702	99.1	8242	93.8
Relative Humidity	RH	8784	8702	99.1	8460	96.3
Precipitation	RNF	8784	8665	98.6	8665	98.6
Wetness Sensor	WET	8784	8709	99.1	8709	99.1
Solar Radiation	SOL	8784	8622	98.2	8622	98.2

Notes: All statistics are for hourly averages.

The number collected does not include normal maintenance or events beyond the control of the network.

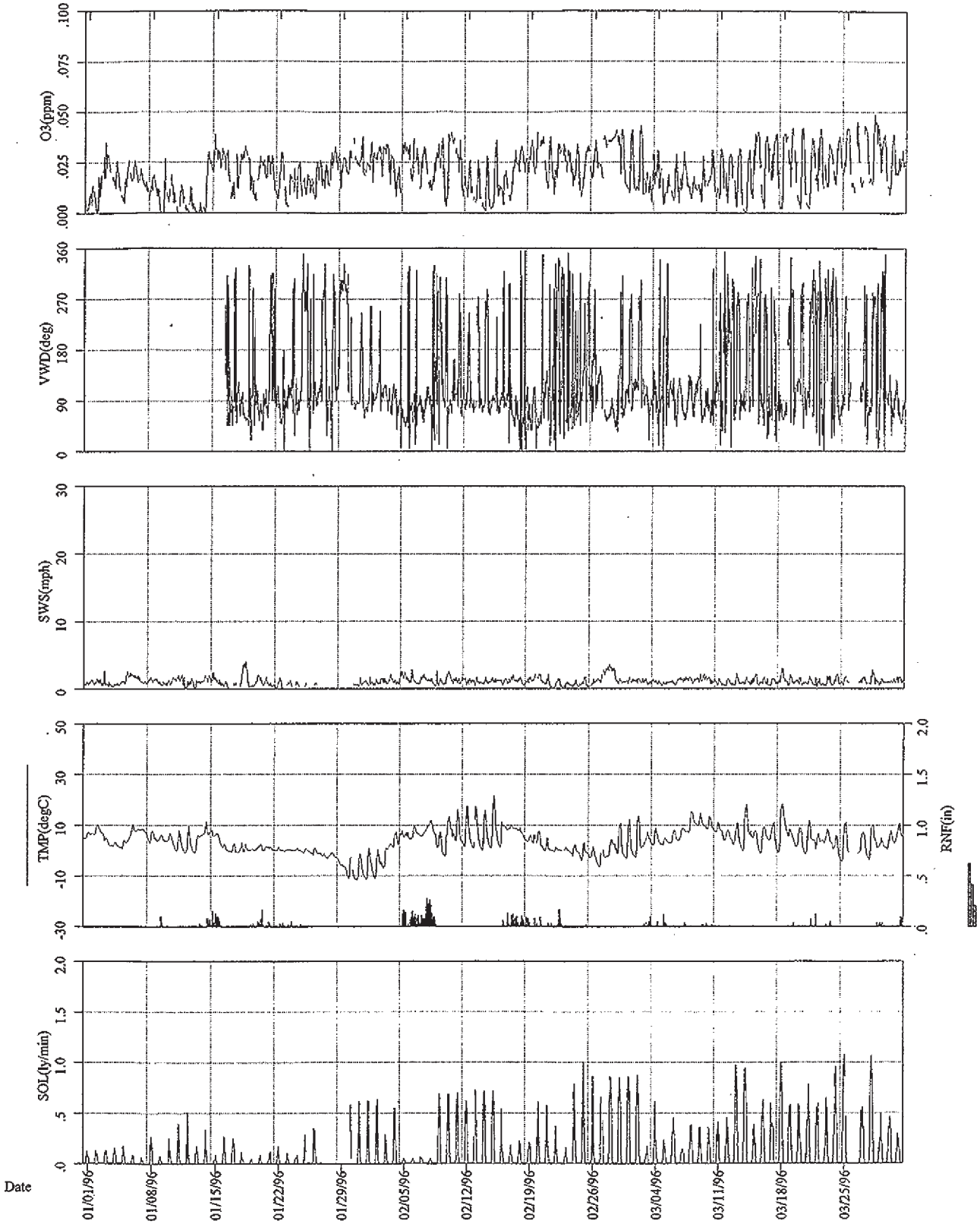
The percent valid is calculated against the number possible.

Automatic zeros and spans are performed daily on most ambient gas analyzers, therefore, no ambient data can be collected during this time. As a result, the maximum percent valid for ambient gas data typically can not be greater than 95.8.

NPS Performance Goals:

Quarterly Criteria:	Monthly Criteria:
100% of sites, >= 85% valid data capture	100% of sites, >= 60% valid data capture
90% of sites, >= 90% valid data capture	90% of sites, >= 75% valid data capture
80% of sites, >= 95% valid data capture	80% of sites, >= 85% valid data capture

Mount Rainier National Park

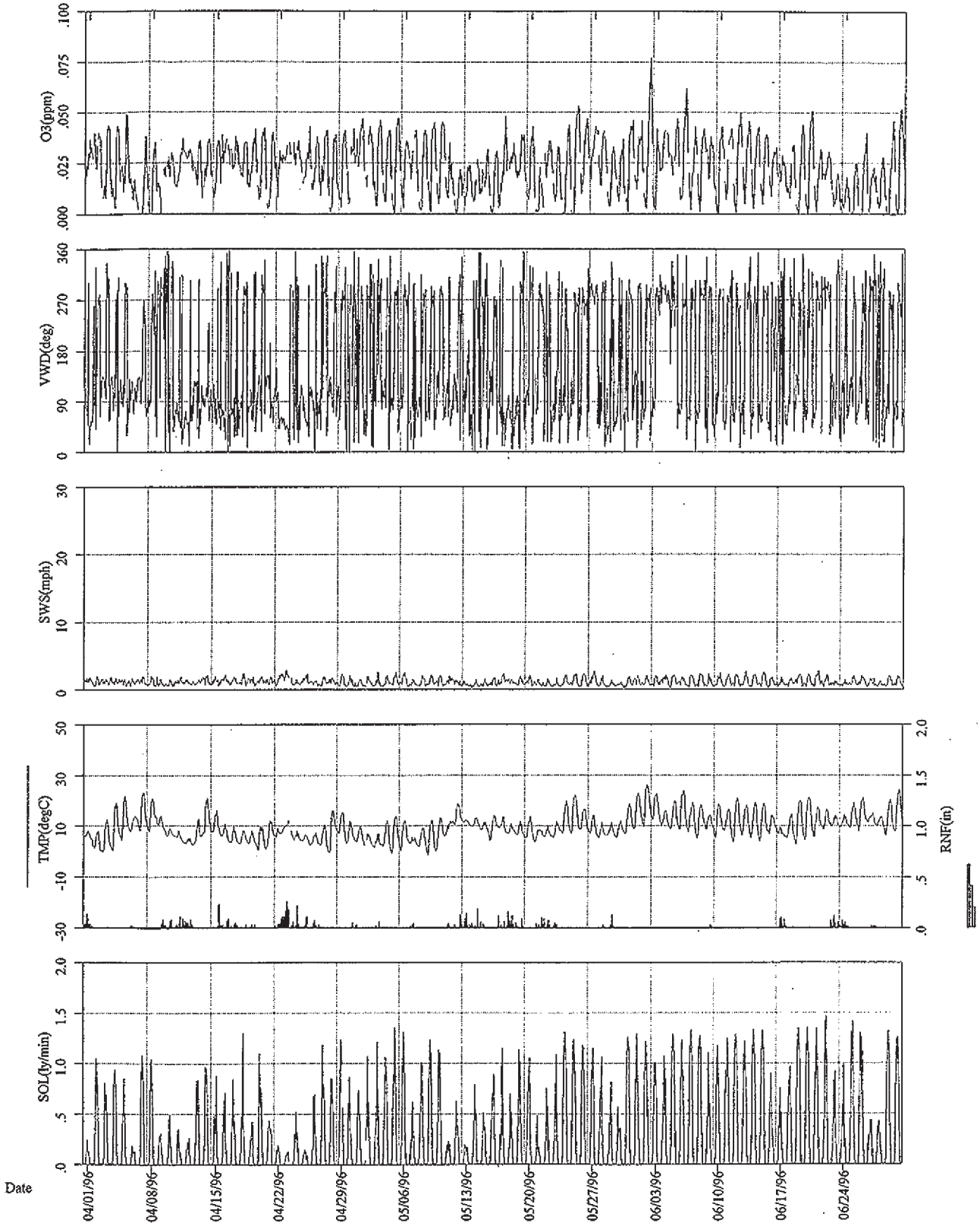


Final Validation

First Quarter 1996

mora96.stk - mora96.dat 04-16-1998

Mount Rainier National Park



Final Validation

Second Quarter 1996

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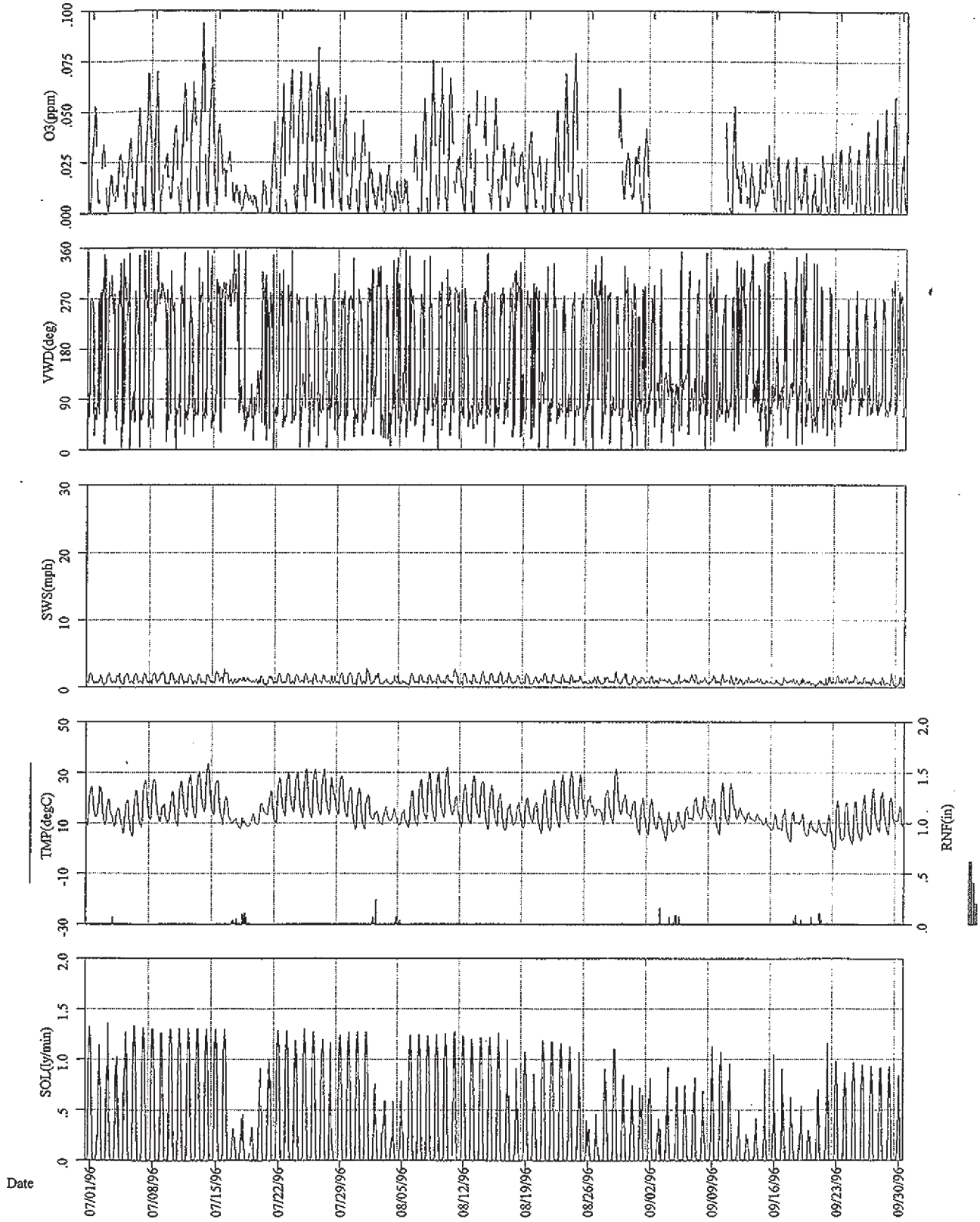
Mount Rainier National Park



Final Validation

Third Quarter 1996

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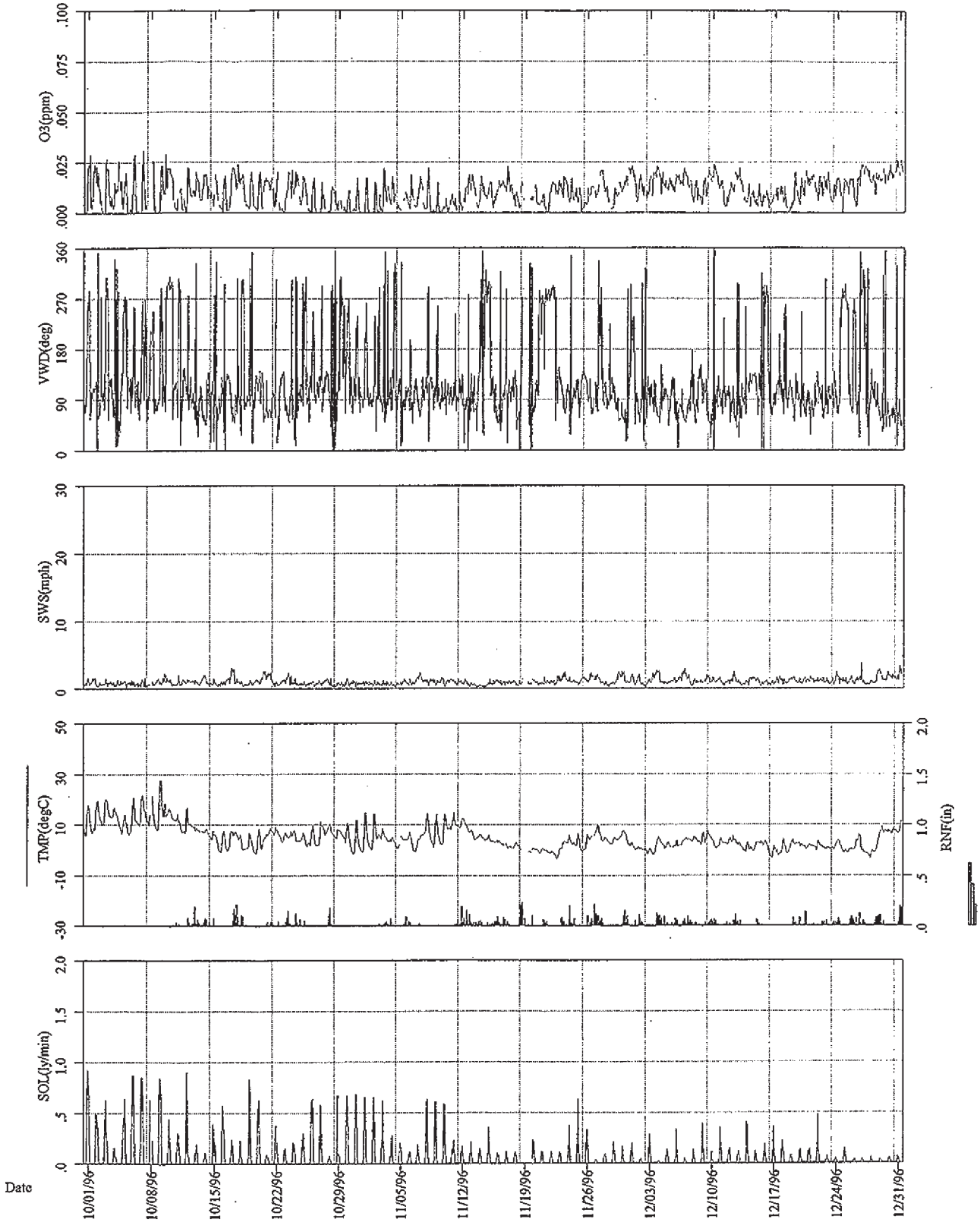
Mount Rainier National Park



Final Validation

Fourth Quarter 1996

mora96.stk - mora96.dat 04-16-1998

2.2 OZONE DATA SUMMARY

Ozone Quick Look Annual Summary Statistics
Mount Rainier National Park

01/01/96 - 12/31/96

STATISTIC*	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MAY-SEP	ANNUAL
DAILY 1-HR MAXIMUM	41	41	49	49	53	77	94	79	58	31	23	28	94	94
NO. OF DAYS	(31)	(29)	(31)	(30)	(31)	(30)	(31)	(28)	(23)	(31)	(30)	(31)	(143)	(356)
AVERAGE DAILY MAXIMUM	26	34	36	37	39	40	49	43	33	21	16	19	41	33
NO. OF DAYS	(31)	(29)	(31)	(30)	(31)	(30)	(31)	(28)	(23)	(31)	(30)	(31)	(143)	(356)
MAXIMUM DAILY MEAN	29	37	32	31	34	35	42	35	20	17	14	23	42	42
NO. OF DAYS	(30)	(29)	(31)	(29)	(31)	(30)	(31)	(23)	(21)	(30)	(29)	(31)	(136)	(345)
AVERAGE DAILY MEAN	16	24	21	23	23	23	24	20	13	9	8	13	21	18
NO. OF DAYS	(30)	(29)	(31)	(29)	(31)	(30)	(31)	(23)	(21)	(30)	(29)	(31)	(136)	(345)
MAX PEAK:MIN RATIO	14.000	28.000	21.000	39.000	46.000	50.000	94.000	79.000	34.000	22.000	16.000	13.000	94.000	94.000
NO. OF DAYS	(24)	(29)	(30)	(25)	(27)	(22)	(19)	(13)	(5)	(16)	(20)	(28)	(86)	(258)
AVERAGE PEAK:MIN RATIO	3.723	4.726	6.535	6.755	12.856	14.190	26.803	23.508	14.720	9.636	6.314	3.554	17.997	9.764
NO. OF DAYS	(24)	(29)	(30)	(25)	(27)	(22)	(19)	(13)	(5)	(16)	(20)	(28)	(86)	(258)
MAX 9AM-4PM AVERAGE	31	38	43	41	46	52	66	62	41	21	18	23	66	66
NO. OF DAYS	(28)	(28)	(31)	(28)	(31)	(29)	(31)	(24)	(22)	(27)	(29)	(30)	(87)	(338)
MONTHLY 9AM-4PM AVERAGE	19	28	30	33	34	33	37	33	26	14	11	15	33	26
NO. OF DAYS	(28)	(28)	(31)	(28)	(31)	(29)	(31)	(24)	(22)	(27)	(29)	(30)	(87)	(338)
MAX 7AM-7PM AVERAGE	30	37	38	36	42	51	58	52	32	20	15	22	58	58
NO. OF DAYS	(30)	(29)	(31)	(29)	(31)	(30)	(31)	(24)	(22)	(30)	(29)	(31)	(88)	(347)
MONTHLY 7AM-7PM AVERAGE	18	26	27	29	31	31	34	29	20	12	9	14	30	23
NO. OF DAYS	(30)	(29)	(31)	(29)	(31)	(30)	(31)	(24)	(22)	(30)	(29)	(31)	(88)	(347)
MONTHLY MEAN	17	23	21	24	23	23	24	20	13	9	8	13	21	18
NO. OF HOURS	(687)	(653)	(698)	(667)	(701)	(678)	(698)	(583)	(492)	(683)	(658)	(697)	(3152)	(7895)
SUM0 EXPOSURE INDEX	11421	15344	14898	15694	16053	15266	16808	11928	6440	6038	5411	9296	66495	144597
NO. OF HOURS	(687)	(653)	(698)	(667)	(701)	(678)	(698)	(583)	(492)	(683)	(658)	(697)	(3152)	(7895)
SUM60 EXPOSURE INDEX	-	-	-	-	-	541	3326	1682	-	-	-	-	5549	5549
NO. OF HOURS	(0)	(0)	(0)	(0)	(0)	(8)	(49)	(25)	(0)	(0)	(0)	(0)	(82)	(82)
SUM80 EXPOSURE INDEX	-	-	-	-	-	-	510	-	-	-	-	-	510	510
NO. OF HOURS	(0)	(0)	(0)	(0)	(0)	(0)	(6)	(0)	(0)	(0)	(0)	(0)	(6)	(6)
W126 EXPOSURE INDEX	58	162	209	212	351	650	2578	1303	128	12	6	18	5011	5689
NO. OF HOURS	(687)	(653)	(698)	(667)	(701)	(678)	(698)	(583)	(492)	(683)	(658)	(697)	(3152)	(7895)

Concentrations in parts per billion (ppb)
Exposures in parts per billion-hours (ppb-hr)

* Statistics defined in the Quick Look subsection of the Glossary

Final Validation

5/8/1998

Frequency Distribution
Ozone Analyzer

Mount Rainier National Park

Monitoring Season: 04/01/96 - 10/31/96[1]

Averaging Period	% Obs.[3]	# Obs.[2]	Min. Obs.[4]	Percentile[5] 10	30	50	70	90	95	99	Max. Obs.	2nd Max.	Arith. Mean	Geo. Mean	Geo. Stdv.
1-Hour	92	4502	0.009	0.019	0.029	0.037	0.043	0.062	0.070	0.082	0.094	0.082	0.0380	0.0347	1.55

Concentrations in parts per million (ppm)

[1] Records for this report are selected in accordance with the AIRS Geo-Common file criteria. This criteria is based on the state-specific Monitoring Season defined in AIRS.

[2] The number of observations (# Obs.) includes all valid observations recorded within the Monitoring Season.

[3] The percent of valid observations (% Obs.) is the percentage of valid days to the number of possible monitoring days during the Monitoring Season. A valid day is defined as a day with 9 or more valid observations between 9:00 a.m. and 9:00 p.m..

[4] The minimum observation value (Min. Obs.) is the minimum daily maximum recorded during the Monitoring Season.

[5] The percentiles and other statistics are derived from the daily maximums.

Ozone Standards Report and Daily Maximum 1-Hour Concentrations (ppm)

Mount Rainier National Park

01/01/96 - 12/31/96

Day	Jan-96		Feb-96		Mar-96		Apr-96		May-96		Jun-96		Jul-96		Aug-96		Sep-96		Oct-96		Nov-96		Dec-96	
1	.014	M	.035	T	.041	F	.037	M	.047	W	.046	S	.053	M	.030	T	.042	S	.029	T	.017	F	.023	S
2	.020	T	.033	F	.043	S	.040	T	.043	T	.077	S	.034	T	.020	F		M	.024	W	.015	S	.019	M
3	.035	W	.034	S	.029	S	.044	W	.046	F	.042	M	.019	W	.024	S		T	.027	T	.022	S	.020	T
4	.026	T	.027	S	.031	M	.043	T	.041	S	.041	T	.029	T	.016	S		W	.026	F	.018	M	.023	W
5	.026	F	.035	M	.019	T	.049	F	.047	S	.047	W	.037	F	.017	M		T	.020	S		T	.017	T
6	.026	S	.037	T	.029	W	.018	S	.036	M	.062	T	.052	S	.039	T		F	.029	S	.019	W	.019	F
7	.022	S	.033	W	.030	T	.038	S	.041	T	.043	F	.069	S	.057	W		S	.031	M	.018	T	.022	S
8	.019	M	.030	T	.018	F	.035	M	.041	W	.042	S	.070	M	.076	T		S		T	.022	F	.016	S
9	.027	T	.037	F	.028	S		T	.045	T	.038	S	.029	T	.072	F		M	.023	W	.015	S	.017	M
10	.019	W	.040	S	.031	S	.030	W	.045	F	.043	M	.043	W	.067	S	.045	T	.029	T	.007	S	.024	T
11	.014	T	.036	S	.032	M	.037	T	.035	S	.042	T	.064	T	.028	S	.053	W	.012	F	.009	M	.016	W
12	.013	F	.026	M	.029	T	.032	F	.022	S	.050	W	.065	F	.049	M	.026	T	.022	S	.013	T	.019	T
13	.005	S	.026	T	.032	W	.036	S	.024	M	.046	T	.094	S		T	.025	F	.020	S	.019	W	.022	F
14	.030	S	.028	W	.031	T	.037	S	.027	T	.043	F	.082	S	.058	W	.024	S	.019	M	.018	T	.014	S
15	.039	M	.036	T	.040	F	.039	M	.032	W	.039	S	.044	M	.057	T	.034	S	.019	T	.015	F	.014	S
16	.032	T	.021	F	.038	S	.037	T	.031	T	.033	S	.030	T	.034	F	.028	M	.018	W	.016	S	.011	M
17	.041	W	.031	S	.039	S	.038	W	.048	F	.029	M	.014	W	.035	S	.027	T	.022	T	.023	S	.012	T
18	.033	T	.033	S	.039	M	.035	T	.035	S	.034	T	.014	T	.030	S	.028	W	.024	F	.010	M	.013	W
19	.026	F	.036	M	.042	T	.042	F	.039	S	.044	W	.009	F	.040	M	.024	T	.020	S		T	.020	T
20	.028	S	.040	T	.042	W	.042	S	.043	M	.051	T	.016	S	.028	T	.020	F	.020	S	.014	W	.018	F
21	.028	S	.038	W	.037	T	.040	S	.029	T	.032	F	.045	S		W	.029	S	.017	M	.009	T	.021	S
22	.030	M	.034	T	.042	F	.031	M	.036	W	.031	S	.064	M	.051	T	.030	S	.020	T	.015	F	.018	S
23	.019	T	.034	F	.034	S		T	.033	T	.020	S	.071	T	.069	F	.032	M	.020	W	.018	S	.020	M
24	.025	W	.034	S	.038	S	.036	W	.044	F	.018	M	.070	W	.079	S	.034	T	.021	T	.017	S	.017	T
25	.019	T	.033	S	.042	M	.043	T	.053	S	.025	T	.069	T		S	.032	W	.018	F	.012	M	.017	W
26	.026	F	.036	M	.045	T	.038	F	.047	S	.040	W	.082	F		M	.041	T	.017	S	.013	T	.018	T
27	.024	S	.038	T	.043	W	.041	S	.043	M	.023	T	.062	S		T	.047	F	.015	S	.021	W	.024	F
28	.033	S	.041	W	.049	T	.039	S	.041	T	.028	F	.057	S		W	.052	S	.013	M	.021	T	.021	S
29	.027	M	.041	T	.039	F	.041	M	.033	W	.046	S	.058	M	.062	T	.058	S	.011	T	.014	F	.022	S
30		T			.039	S	.042	T	.037	T	.052	S	.040	T	.030	F	.029	M	.011	W	.022	S	.024	M
31	.038	W			.031	S			.046	F			.046	W	.033	S			.017	T			.028	T
Valid Days	30		29		31		28		31		30		31		25		22		30		28		31	
Maximum	.041		.041		.049		.049		.053		.077		.094		.079		.058		.031		.023		.028	
Violations	0		0		0		0		0		0		0		0		0		0		0		0	

7895 Total Samples	0 Daily-maxima exceeding the standard of .12 ppm (starred[*])
89.9 % Possible	8 Missing days assumed to be less than the standard
346 Valid daily maxima	0 Daily maximas exceed the alert level of .200 ppm

Concentrations in parts per million (ppm)

Final Validation

5/8/98

Mount Rainier NP

1996 Attainment Status With U.S. Environmental Protection Agency (EPA)
PRIMARY Ozone National Ambient Air Quality Standard

Ozone Season: April Through October

The primary National Ambient Air Quality Standard for ozone is designed to protect human health. The level of the primary ozone standard promulgated by the EPA on July 18, 1997 is 0.08 parts per million (ppm) [80 parts per billion, (ppb)], daily maximum 8-hour average. The primary ozone standard is met at an ambient monitoring site when the 3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentration is less than or equal to 0.08 ppm. This standard is not met when the 3-year average is greater than 0.08 ppm. Using the EPA's rounding convention, a computed 3-year average ozone concentration of 0.085 ppm (85 ppb) is the smallest value that is greater than the level of the 0.08 ppm standard.

The primary standard requires 90 percent data completeness, on average, during the 3-year period, with no single year within the period having less than 75 percent data completeness. This data completeness requirement would have to be satisfied in order to determine that the standard has been met at a monitoring site. However, calendar years with less than 75 percent data completeness are included in the computation if the annual fourth-highest daily maximum 8-hour concentration is greater than the level of the standard. A site could be found not to have met the standard with less than complete data. The percent data completeness is the percent of valid ozone monitoring days. A day is valid if valid 8-hour averages are available for at least 75 percent of possible hours in the day (i.e., at least 18 of the 24 averages). An 8-hour average is considered valid if at least 75 percent (or 6) of the hourly averages for the 8-hour period are available.

The table below lists the 3-year average fourth-highest daily maximum 8-hour ozone concentration based on data collected in 1996 and the two previous years. This is the number to compare to the level of the new primary standard. The 3-year average data completeness percent and the 1996 highest five daily maximum 8-hour averages are also tabulated. A * in the Data Comp % Met? column indicates EPA data completeness requirement was not met for the three-year period.

Year	3-Year Avg 4th High Daily Max 8-hr Ozone (ppb)	3-Year Avg Data Comp %	Data Comp % Met?	Annual 1st High Daily Max 8-hr Ozone (ppb)	Annual 2nd High Daily Max 8-hr Ozone (ppb)	Annual 3rd High Daily Max 8-hr Ozone (ppb)	Annual 4th High Daily Max 8-hr Ozone (ppb)	Annual 5th High Daily Max 8-hr Ozone (ppb)
1996	66	90		75	68	67	66	66

Ozone
Ten Highest Daily 1-Hour Average Maximum Concentrations
Mount Rainier National Park

Final Data
01/01/96 - 12/31/96

Rank	Date	Hour	Concentration (ppm)
1	07/13/96	17	0.094*
2	07/14/96	17	0.082*
3	07/26/96	15	0.082*
4	08/24/96	16	0.079*
5	06/02/96	17	0.077*
6	08/08/96	14	0.076*
7	08/09/96	15	0.072
8	07/23/96	15	0.071*
9	07/08/96	15	0.070
10	07/24/96	15	0.070

* Other high value(s) were also recorded during one or more hours in the day.

Note: The primary and secondary ambient air standard for ozone is 0.12 ppm averaged over a one hour period not to be exceeded more than once per year. (A value greater than .12 ppm, 124 ppb, or 235 ug/m^3 exceeds the standard.) (40 CFR 50.9 with reference to Appendix D and H.)

Episodes with 1-Hour Ozone Concentrations
≥ 100 ppb and > 124 ppb
Mount Rainier National Park

Final Data
01/01/96 - 12/31/96

Date	Beginning Hour	No. Hours ≥ 100 ppb	No. Hours >124 ppb	Max (ppb)
No values exceeded 100 ppb during this period				
Total		0	0	

Note: The primary and secondary national ambient air standard for ozone that applied in 1996 is 0.12 ppm over a one hour period not to be exceeded more than once per year. (A value greater than .12 ppm, 124 ppb, or 235 ug/m^3 exceeds the standard.) (40 CFR 50.9 with reference to Appendix D and H.)

Episodes with 8-Hour Average Ozone Concentrations > 84 ppb
Mount Rainier National Park

Final Data
01/01/96 - 12/31/96

Date	Start and End Time of Daily Maximum 8-Hour Average > 84 ppb (hr)	Daily Maximum 8-Hour Average (ppb)	Number of 8-Hour Averages > 84 ppb During the Day
No values exceeded 84 ppb during this period			
0	Days with 8-hour average concentrations > 84 ppb		

Note: This table presents episodes of high ozone based on running 8-hour averages. In 1997, the EPA published new primary and secondary national ambient air quality standards for ozone based on 8-hour average ozone concentrations. Attainment of the new primary standard is reached if the annual fourth highest daily maximum 8-hour ozone concentration, averaged over three years, does not exceed 0.08 ppm (84 ppb or 157 ug/m).

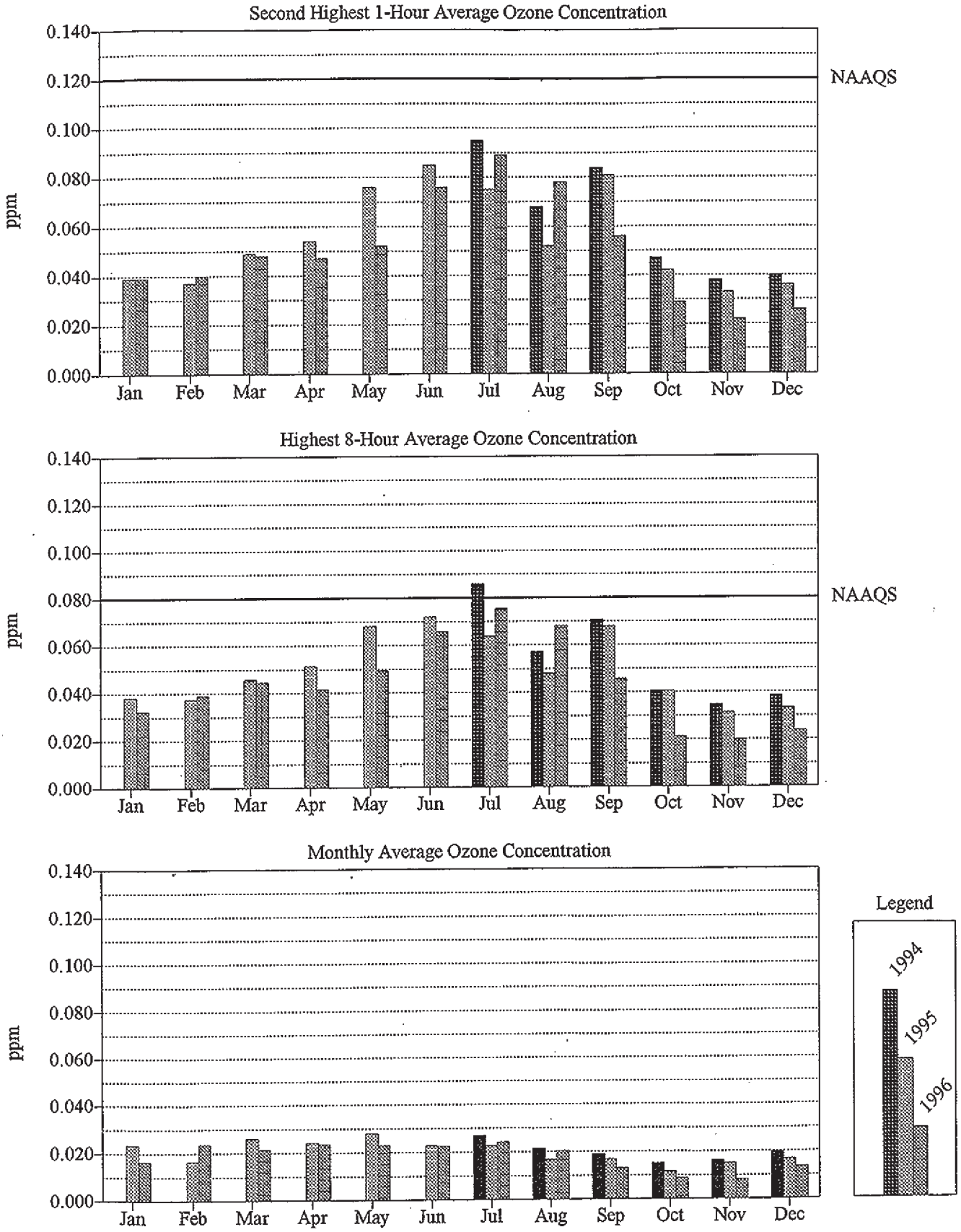
Ozone Rank Listings of Second Highest 1-Hour Average Concentrations, 4th Highest 8-Hour Average Concentrations, and Annual SUM60 Exposure Index for All NPS Monitoring Sites

01/01/96 - 12/31/96

Second Highest 1-Hour Average Concentration		
Site	Rank	Concentration (ppb)
JOTR-YV	1	139
CHAM-XX	2	135
CACO-XX	3	127
SEKI-LK	4	122
PINN-ES	5	118
SEKI-AM	6	117
GRSM-CM	7	108
MACA-OC	8	107
YOSE-TD	9	106
COWP-XX	10	102
GRSM-CD	11	102
GRSM-LR	12	102
COSW-XX	13	101
YOSE-WV	14	101
ACAD-ST	15	100
ACAD-CM	16	96
SHEN-BM	17	96
DEVA-PV	18	94
LAVO-ML	19	92
ROMO-LP	20	91
YOSE-CM	21	91
SAGU-PC	22	90
CRMO-VC	23	89
GRSM-CC	24	89
MORA-TW	25	89
BIBE-KB	26	84
EVER-BC	27	84
GRCA-AS	28	83
CANY-IS	29	81
GRBA-MY	30	80
CHIR-ES	31	79
MEVE-MY	32	76
VOYA-SB	33	74
YELL-WT	34	74
VOYA-BB	35	73
NOCA-MM	36	67
GLAC-WG	37	64
YELL-LY	38	64
THRO-NO	39	63
DENA-HQ	40	62
OLYM-VC	41	56

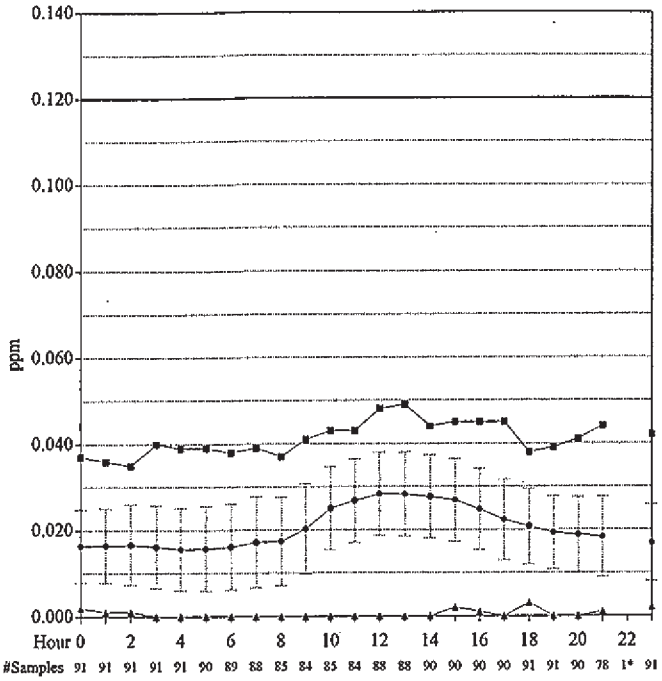
4th Highest 8-hour Average Concentration		
Site	Rank	Concentration (ppb)
JOTR-YV	1	109
SEKI-LK	2	105
SEKI-AM	3	101
CACO-XX	4	97
PINN-ES	5	95
GRSM-CM	6	92
YOSE-TD	7	90
GRSM-LR	8	89
GRSM-CD	9	87
ACAD-CM	10	82
MACA-OC	11	82
SHEN-BM	12	82
YOSE-WV	13	82
COWP-XX	14	81
YOSE-CM	15	79
CHAM-XX	16	78
DEVA-PV	17	78
GRSM-CC	18	76
SAGU-PC	19	76
ACAD-ST	20	74
CANY-IS	21	74
COSW-XX	22	74
GRBA-MY	23	74
BIBE-KB	24	73
GRCA-AS	25	73
LAVO-ML	26	73
MEVE-MY	27	73
ROMO-LP	28	73
CHIR-ES	29	72
MORA-TW	30	66
VOYA-BB	31	65
CRMO-VC	32	64
EVER-BC	33	63
VOYA-SB	34	63
YELL-WT	35	62
YELL-LY	36	60
THRO-NO	37	59
GLAC-WG	38	58
DENA-HQ	39	53
NOCA-MM	40	50
OLYM-VC	41	47

Annual Sum60 Exposure Index			
Site	Rank	Sum60	Count
JOTR-YV	1	179079	2377
SEKI-LK	2	152521	2011
GRSM-CM	3	142000	2044
SEKI-AM	4	131221	1722
YOSE-TD	5	113904	1617
GRSM-LR	6	106846	1539
GRSM-CD	7	101985	1489
SHEN-BM	8	88363	1306
CANY-IS	9	66059	1023
PINN-ES	10	64788	896
DEVA-PV	11	54552	820
GRCA-AS	12	50827	786
YOSE-WV	13	49470	698
MACA-OC	14	46419	669
COWP-XX	15	45805	662
CHIR-ES	16	42596	662
ROMO-LP	17	37452	575
GRBA-MY	18	37370	578
CACO-XX	19	36861	510
YOSE-CM	20	34437	511
GRSM-CC	21	32322	484
LAVO-ML	22	31993	483
SAGU-PC	23	30164	452
ACAD-CM	24	28315	408
MEVE-MY	25	22976	355
BIBE-KB	26	15715	235
COSW-XX	27	15620	225
CRMO-VC	28	14039	223
CHAM-XX	29	13085	176
ACAD-ST	30	11340	167
MORA-TW	31	5549	82
YELL-WT	32	4162	66
VOYA-BB	33	3771	58
VOYA-SB	34	3550	55
EVER-BC	35	2496	37
YELL-LY	36	2330	38
GLAC-WG	37	1850	30
THRO-NO	38	1834	30
NOCA-MM	39	1012	16
DENA-HQ	40	125	2
OLYM-VC	41	0	0


Second Highest 1-Hour Average Ozone Concentration
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
ppm
NAAQS
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Highest 8-Hour Average Ozone Concentration
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
ppm
NAAQS
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Monthly Average Ozone Concentration
0.140
0.120
0.100
0.080
0.060
0.040
0.020
0.000
ppm
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Legend
1994
1995
1996

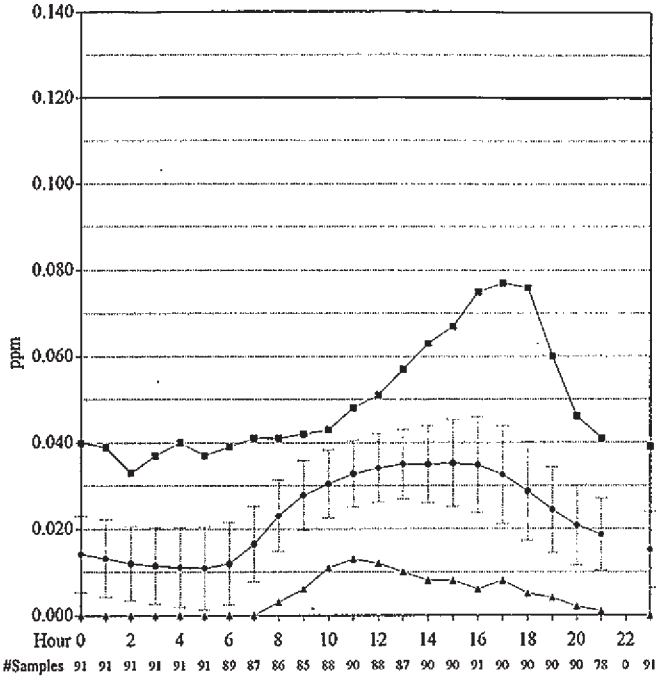

NATIONAL PARK SERVICE
GASEOUS POLLUTANT MONITORING NETWORK
1996 Second Highest 1-Hour Ozone Concentrations (ppb)
OLYMPIC 56
NORTH CASCADES 67
MOUNT RAINIER 89
GLACIER 64
VOYAGEURS 74
THEODORE ROOSEVELT 63
ACADIA 100
CRATERS OF THE MOON 89
YELLOWSTONE 74
CAPE COD 127
LASSEN VOLCANIC 92
YOSEMITE 106
PINNACLES 118
DEATH VALLEY 122
SEQUOIA AND KINGS CANYON 94
GREAT BASIN 80
CANYONLANDS 81
ROCKY MOUNTAIN 91
MESA VERDE 76
JOSHUA TREE 139
GRAND CANYON 83
MAMMOTH CAVE 107
SHENENDOAH 96
COWPENS 108
GREAT SMOKY MOUNTAINS 102
CONGAREE SWAMP 101
SAGUARO 90
CHIRICAHUA 79
CHAMIZAL 135
BIG BEND 84
DENALI 62
EVERGLADES 84
ALASKA

FIRST QUARTER (JAN-MAR)

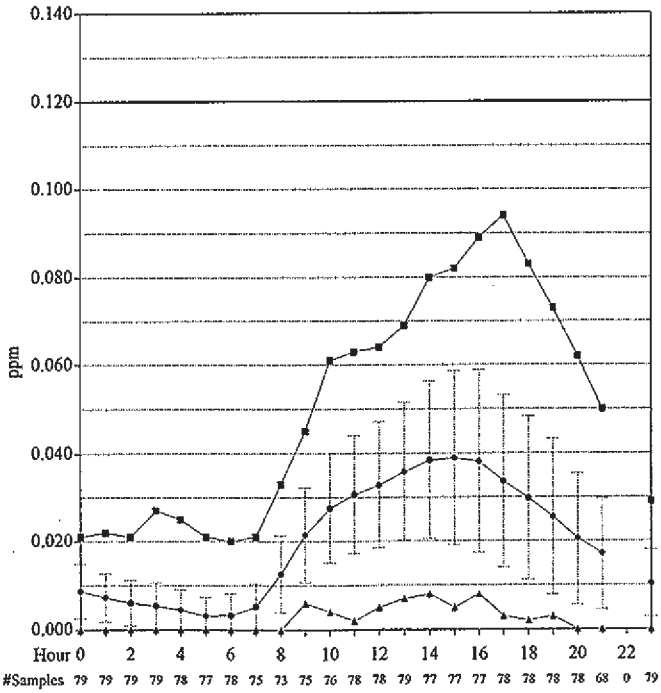


* Number of samples < 20% of maximum available hours during period

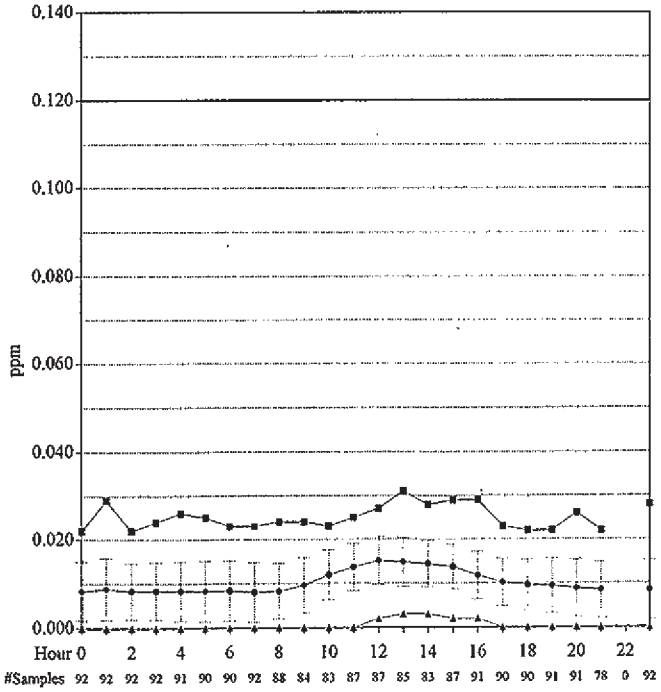
SECOND QUARTER (APR-JUN)



THIRD QUARTER (JUL-SEP)



FOURTH QUARTER (OCT-DEC)



NAAQS (0.12 ppm)

Average of Valid O3 in ppm
(Bar is equal to +/- one standard deviation)

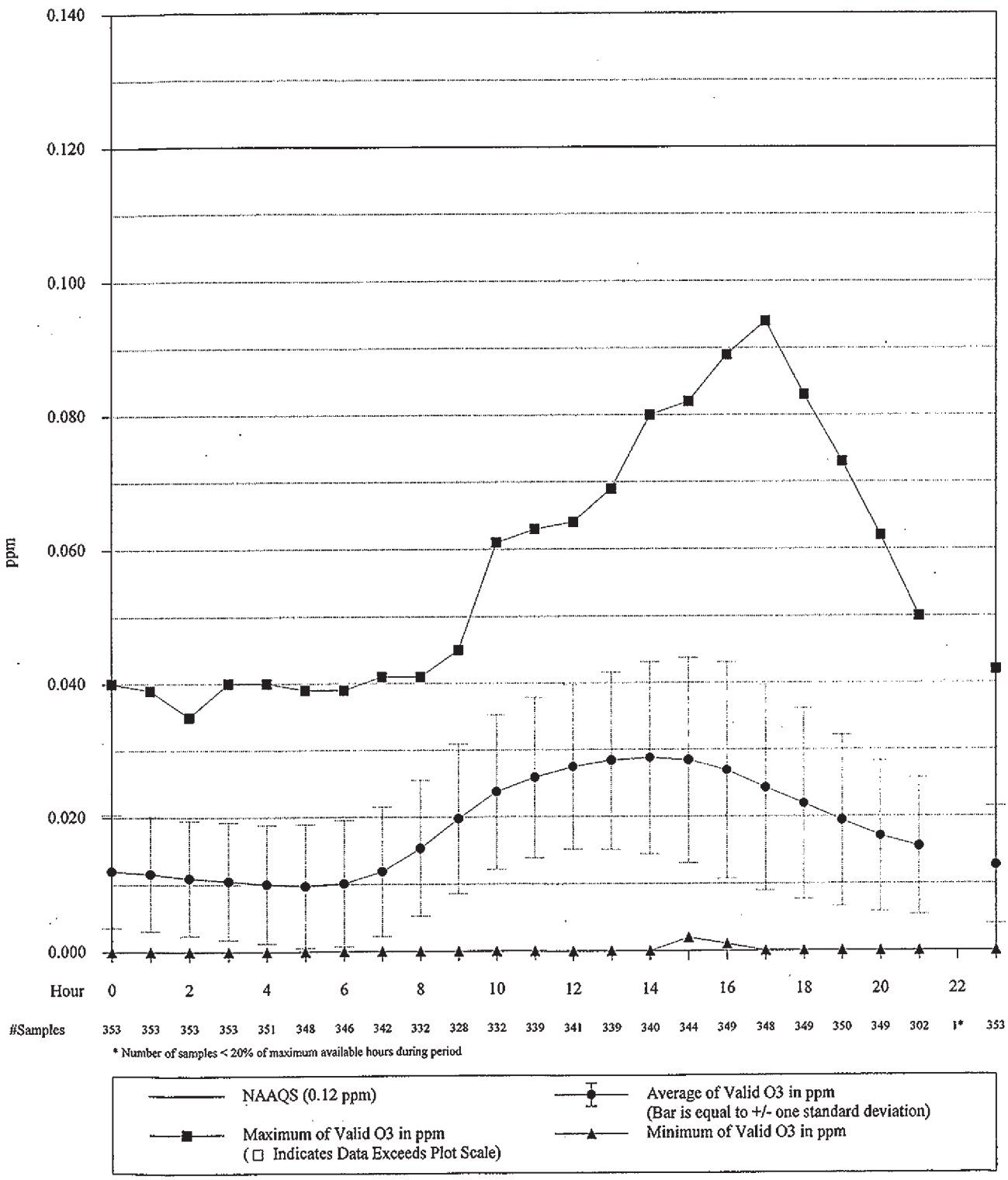
Maximum of Valid O3 in ppm
(o Indicates Data Exceeds Plot Scale)

Minimum of Valid O3 in ppm

Mount Rainier
National Park

Annual Diurnal
Ozone Plot

1996



Final Validation

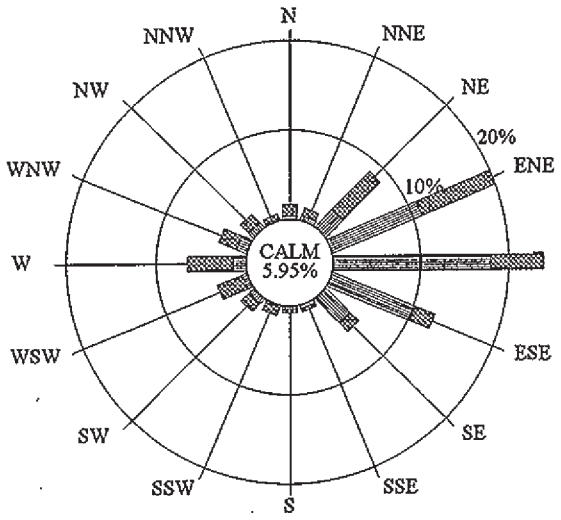
05-06-1998

Mount Rainier
National Park

Quarterly Ozone
Pollutant Rose

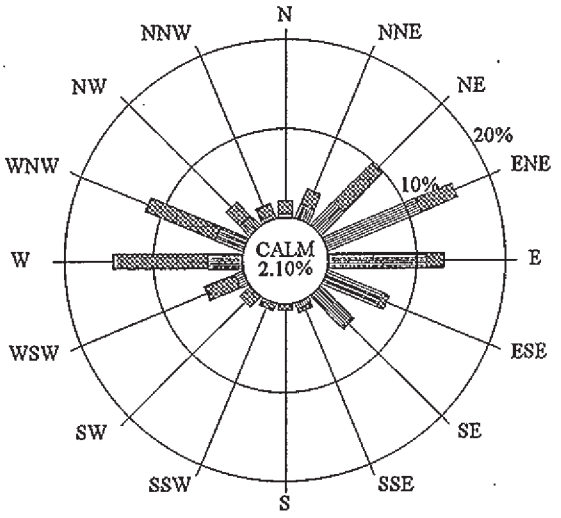
1996

FIRST QUARTER (JAN-MAR)



76.2% Collected 69.3% Valid
2184 Possible /1665 Collected /1513 Valid

SECOND QUARTER (APR-JUN)

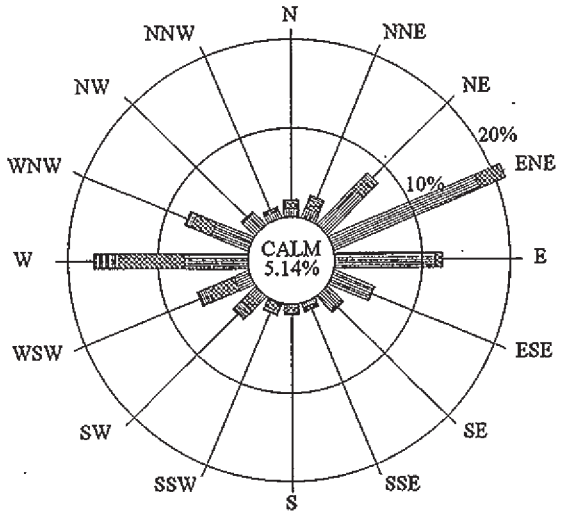


93.7% Collected 93.7% Valid
2184 Possible /2046 Collected /2046 Valid

Ozone (ppm)

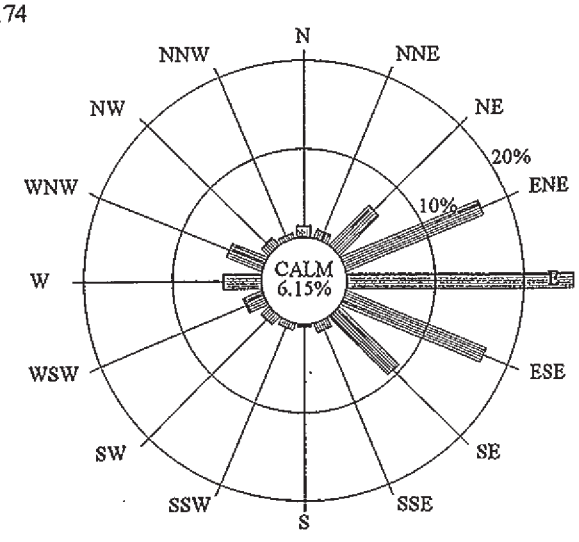
0.000-0.024
0.025-0.049
0.050-0.074
0.075-0.099
0.100-0.124
0.125-0.149
0.150-0.174
0.175+

THIRD QUARTER (JUL-SEP)



94.9% Collected 80.3% Valid
2208 Possible /2095 Collected /1772 Valid

FOURTH QUARTER (OCT-DEC)



92.1% Collected 92.1% Valid
2208 Possible /2034 Collected /2034 Valid

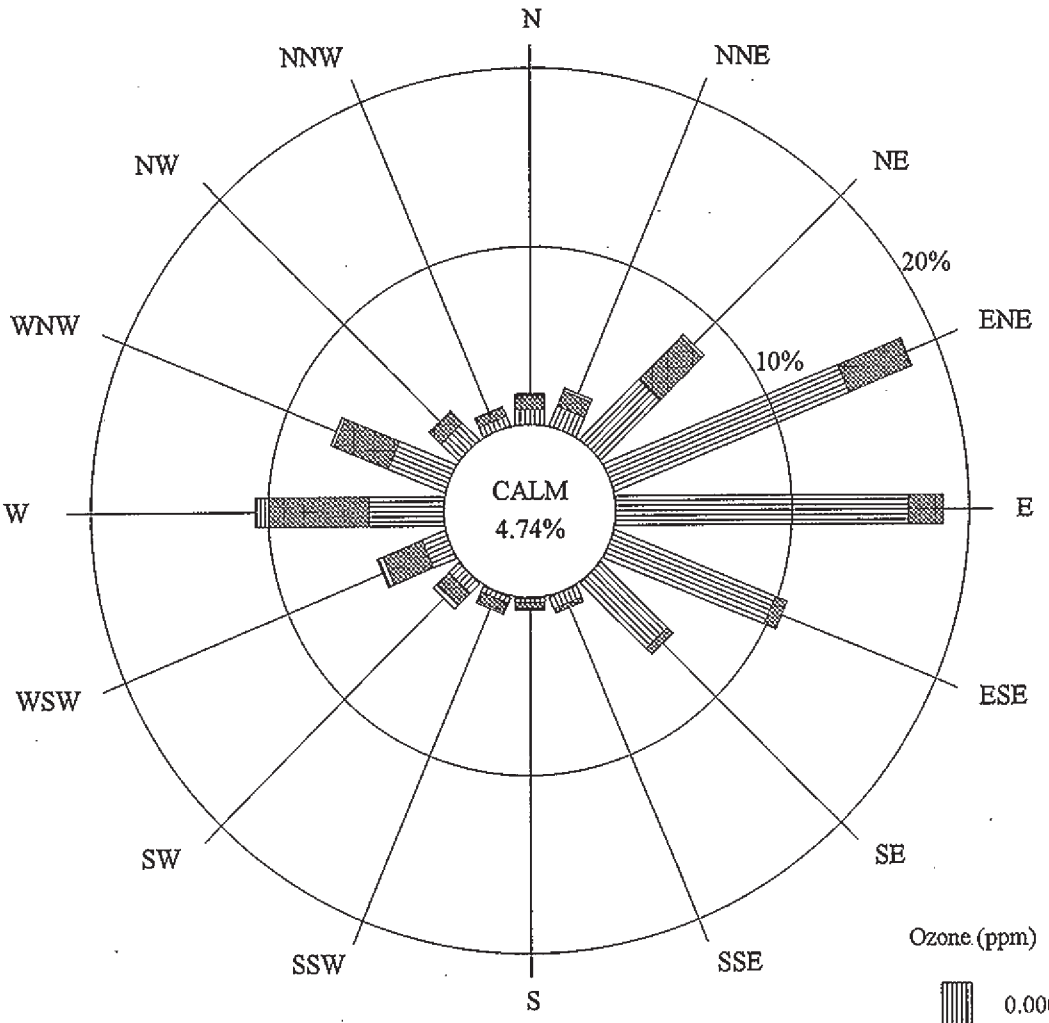
Final Validation

05-06-1998

Mount Rainier
National Park

Annual Ozone
Pollutant Rose

1996



89.3% Collected 83.8% Valid
8784 Possible /7840 Collected /7365 Valid

Final Validation

05-06-1998

Ozone Precision Check Summary
Mount Rainier National Park

Precision checks are required by the Environmental Protection Agency (EPA) of all monitoring instruments collecting data which are to be submitted to the EPA Aerometric Information Retrieval System (AIRS). A precision check is performed by challenging the pollutant analyzer with a known concentration of gas (between 0.08 and 0.10 ppm for ozone and sulfur dioxide) from the pollutant transfer standard. This precision check must be performed at least every 14 days of monitoring operation. The percent difference between the analyzer and the transfer standard is then calculated.[1] According to NPS Standard Operating Procedures, the pollutant analyzer must respond within 10% of the transfer standard. The table below gives the number of precision checks performed during each quarter, the average[2] of all the individual precision check percent differences for the quarter, and the upper and lower 95% probability limits[3] for precision checks. The probability limits represent the interval having a 95% chance of containing the true average percent difference. The quarterly average percent difference and probability limits should ideally be within +/- 10%.

Final Data 01/01/96 - 12/31/96				
Calendar Quarter	Number of Precision Checks	Average Percent Difference[1,2]	Lower 95% Probability Limit[3]	Upper 95% Probability Limit[3]
1	13	-3.18	-19.25	12.90
2	4	-1.98	-2.95	-1.01
3	13	-2.34	-9.32	4.64
4	11	1.72	-19.49	22.92

[1] Percent Difference= $\frac{\text{analyzer - transfer std}}{\text{transfer std}}$ X 100.

[2] Average Percent Difference is the mean of all individual precision check percent differences during the quarter.

[3] Upper/Lower 95% Probability Limits=(Average Percent Difference) +/- (1.96)(Standard Deviation of precision check percent differences in the quarter.)

2.3 METEOROLOGICAL DATA SUMMARY

Summary of Selected Meteorological Data

Mount Rainier National Park

Final Data

01/01/96 - 12/31/96

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	1.1	m/s	8537	0.5
Maximum	4.0	m/s		
Percent calm = 4.86				
AMBIENT TEMPERATURE				
Average	8.2	degC	8703	6.9
Maximum	33.4	degC		
Minimum	-11.8	degC		
RELATIVE HUMIDITY				
Average	81	percent	8460	19
Maximum	100	percent		
Minimum	10	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	.04	in/hr	1450	.04
Maximum non-zero rate	.27	in/hr		
Minimum non-zero rate	.01	in/hr		
Accumulated during period	60.69	in		
SOLAR RADIATION				
Average Daily Total	266.607	ly/day	366	210.397
Maximum Daily Total	714.840	ly/day		
Minimum Daily Total	8.160	ly/day		

Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

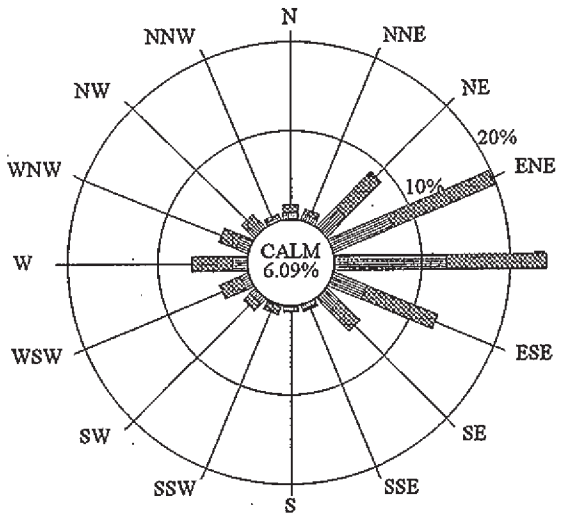
NA indicates instrument not available.

Mount Rainier
National Park

Quarterly Wind Rose

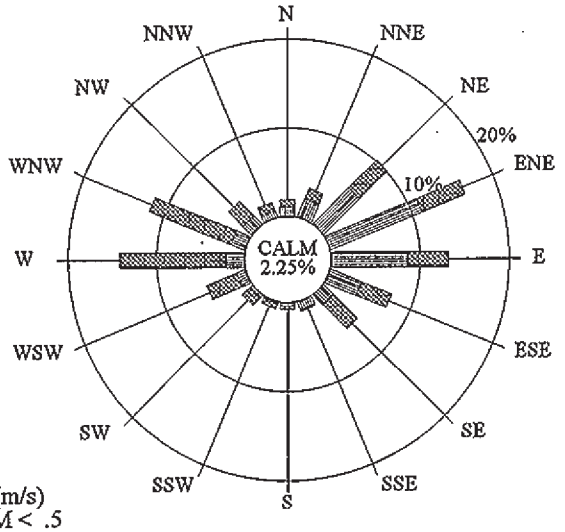
1996

FIRST QUARTER (JAN-MAR)



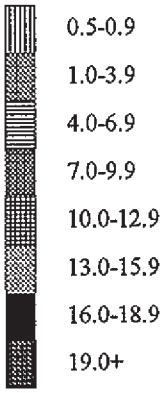
73.6% Collected 73.6% Valid
2184 Possible /1608 Collected /1608 Valid

SECOND QUARTER (APR-JUN)

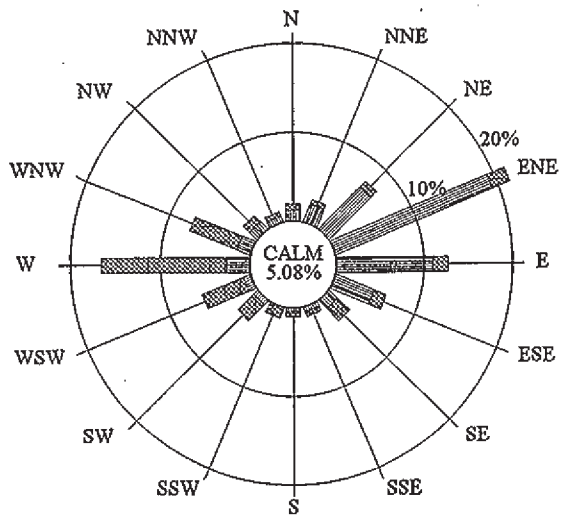


99.7% Collected 99.7% Valid
2184 Possible /2177 Collected /2177 Valid

Scalar Wind Speed (m/s)
CALM < .5

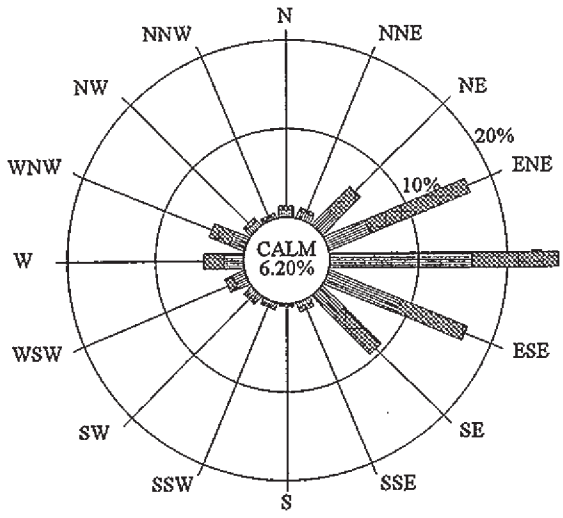


THIRD QUARTER (JUL-SEP)



99.9% Collected 99.9% Valid
2208 Possible /2205 Collected /2205 Valid

FOURTH QUARTER (OCT-DEC)



98.6% Collected 98.6% Valid
2208 Possible /2178 Collected /2178 Valid

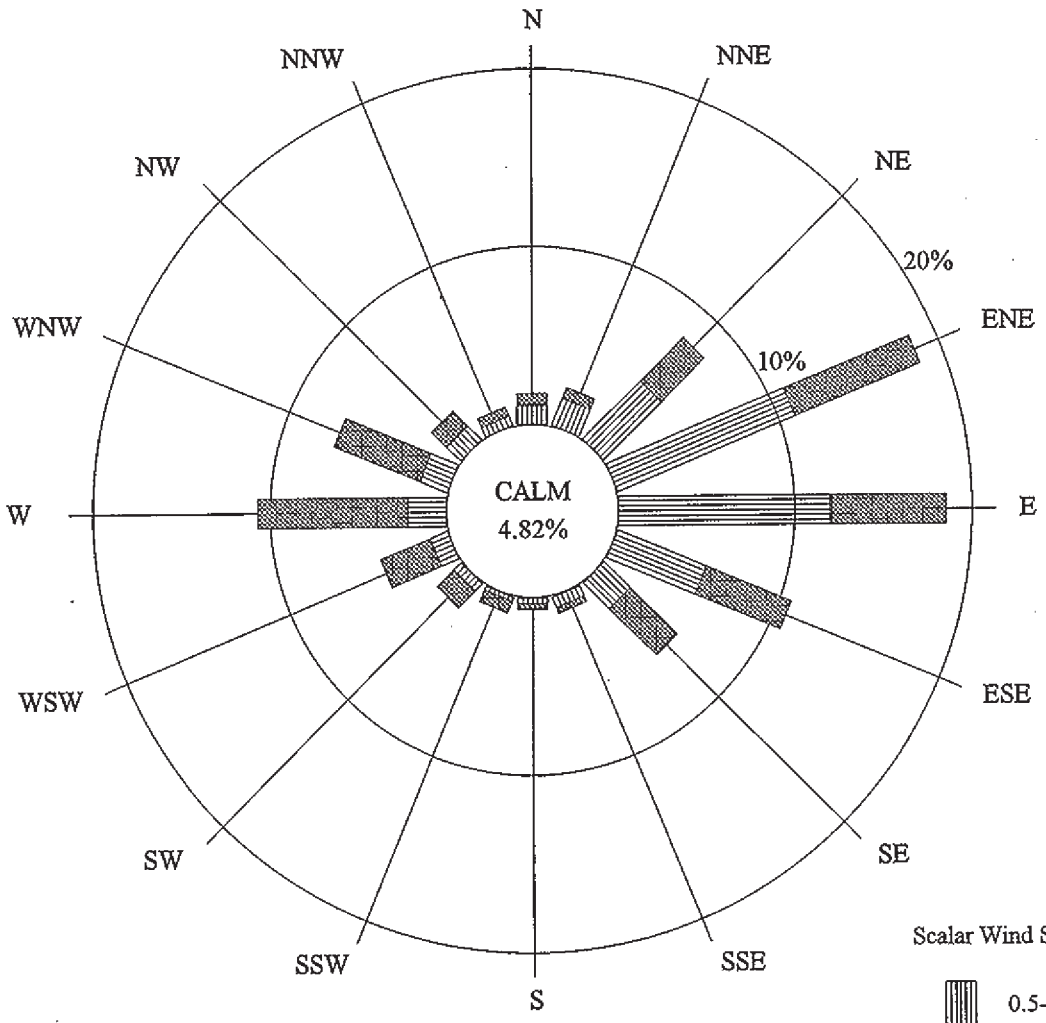
Final Validation

05-07-1998

Mount Rainier
National Park

Annual Wind Rose

1996



Scalar Wind Speed (m/s)
CALM < .5

- 0.5-0.9
- 1.0-3.9
- 4.0-6.9
- 7.0-9.9
- 10.0-12.9
- 13.0-15.9
- 16.0-18.9
- 19.0+

93.0% Collected 93.0% Valid
8784 Possible /8168 Collected /8168 Valid

Final Validation

05-07-1998

2.4 DRY DEPOSITION DATA SUMMARY

Clean Air Status and Trends Network (CASTNet)
Dry Deposition Monitoring

In 1995, the National Park Service (NPS) and the Environmental Protection Agency (EPA) entered a partnership to jointly measure dry deposition in park units, mostly in the West. A portion of the 1996 data collected from this partnership is presented in this section.

Atmospheric deposition of acidic species takes two pathways: wet deposition and dry deposition. Wet deposition is the result of precipitation events (rain, snow, or fog) that remove particles and gases from the atmosphere. Dry deposition is less event driven, but still involves the transfer of particles and gases from the atmosphere to surfaces and plants. Wet deposition has been well documented for many years. In the national parks, the National Acidic Deposition Program (NADP) measures and reports wet deposition (see the web site at http://nadp.sws.uiuc.edu for further information). Dry deposition is much harder to measure and a smaller network of monitoring stations are involved. The method used to measure dry deposition is sometimes called the "inferential method" because air quality concentration data is combined with meteorological measurements and land use functions to compute deposition velocities. The CASTNet program provides long-term estimates of total acidic deposition by adding dry deposition values to wet deposition values.

This annual summary report presents the air quality concentration portion of the dry deposition inferential method, which is the only currently available data set. These data were compiled from the analyses of filters collected by CASTNet deposition filter pack systems in the parks. The filter pack analyses yielded weekly average concentrations of particulate sulfate (SO_4^{2-}), particulate nitrate (NO_3^-), particulate ammonium (NH_4^+), sulfur dioxide (SO_2), and nitric acid (HNO_3). In some cases, the positive ions Na^+, K^+, Ca^{2+}, and Mg^{2+} were also measured from the filter samples. These concentration data for the individual ionic species are presented as weekly bar charts and summarized by quarter and by year in this report. Concentration data can be used to compare sites and to indicate the amount of acidic species available for deposition. As with the continuous analyzer data, the filter pack concentration data are included on a computer diskette that accompanies this report.

Estimated dry deposition values derived from EPA modeling will be reported at a later time to complete the inferential analyses. When available, these modeling results will be posted on the NPS Air Resources Division Internet web site at http://www.aqd.nps.gov/ard1 or on the EPA CASTNet site (http://www.epa.gov/ardpublc/acidrain/castnet/about.html). Initial CASTNet results have shown that dry deposition can be a significant portion of total acidic deposition.

CASTNet Dry Deposition Monitoring
Quarterly and Annual Average Concentrations
Mount Rainier National Park
1/1/96 - 12/31/96

Quarter	No.Valid Samples	p-NO_3 (ug/m^3)	HNO_3 (ug/m^3)	Total NO_3 (ug/m^3)	NH_4 (ug/m^3)	p-SO_4 (ug/m^3)	SO_2 (ug/m^3)	SO_4/SO_2 Ratio
1	9	0.158	0.148	0.304	0.106	0.430	0.370	1.161
2	13	0.234	0.413	0.640	0.244	0.935	1.352	0.692
3	13	0.218	1.066	1.267	0.404	1.358	1.644	0.826
4	7	0.105	0.337	0.437	0.204	0.618	0.357	1.730
Annual Average		0.191	0.546	0.728	0.254	0.905	1.066	0.849
Standard Deviation		0.147	0.601	0.641	0.181	0.563	1.092	

Data Recovery Table			
Total No. Filters	No. Invalidated	Data Capture	No. Valid Hours
50	8	84.0%	7099.0

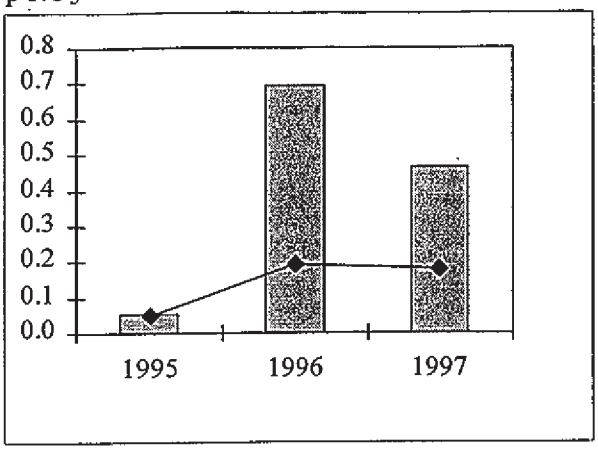
CASTNet Dry Deposition Monitoring Weekly Concentrations Report
Mount Rainier National Park
1/1/96 - 12/31/96

On Date	Off Date	p-NO_3 (ug/m^3)	HNO_3 (ug/m^3)	Total NO_3 (ug/m^3)	NH_4 (ug/m^3)	p-SO_4 (ug/m^3)	SO_2 (ug/m^3)	SO_4/SO_2 Ratio
12/12/95	01/09/96							
01/09/96	01/23/96	0.059	0.047	0.105	0.050	0.193	0.097	1.982
01/30/96	02/06/96	0.029	0.107	0.134	0.062	0.181	0.148	1.223
02/06/96	02/13/96	0.128	0.066	0.193	0.055	0.218	0.562	0.388
02/13/96	02/20/96	0.061	0.149	0.208	0.072	0.254	0.157	1.617
02/20/96	02/27/96	0.106	0.100	0.204	0.118	0.380	0.131	2.900
02/27/96	03/05/96	0.099	0.216	0.312	0.144	0.392	0.250	1.570
03/05/96	03/12/96	0.109	0.148	0.255	0.087	0.215	0.246	0.874
03/12/96	03/19/96	0.339	0.336	0.670	0.112	1.150	1.117	1.029
03/19/96	03/26/96	0.495	0.165	0.657	0.254	0.885	0.623	1.421
03/26/96	04/02/96	0.134	0.196	0.327	0.187	0.803	0.965	0.832
04/02/96	04/09/96	0.190	0.279	0.465	0.241	1.050	1.654	0.635
04/09/96	04/16/96	0.170	0.166	0.333	0.181	0.359	0.478	0.751
04/16/96	04/23/96	0.081	0.038	0.118	0.066	0.207	0.069	3.014
04/23/96	04/30/96	0.257	0.105	0.360	0.151	0.597	1.619	0.369
04/30/96	05/07/96	0.240	0.343	0.578	0.348	1.270	1.988	0.639
05/07/96	05/14/96	0.186	0.241	0.423	0.369	1.330	1.826	0.728
05/14/96	05/21/96	0.110	0.099	0.207	0.181	0.584	0.146	3.989
05/21/96	05/28/96	0.329	0.645	0.964	0.229	1.040	0.362	2.872
05/28/96	06/04/96	0.260	0.476	0.728	0.292	1.010	0.364	2.774
06/04/96	06/11/96	0.156	0.874	1.016	0.321	1.450	3.385	0.428
06/11/96	06/18/96	0.525	1.090	1.598	0.281	1.150	1.689	0.681
06/18/96	06/25/96	0.406	0.813	1.206	0.319	1.310	3.032	0.432
06/25/96	07/02/96	0.053	0.343	0.391	0.173	0.438	0.346	1.266
07/02/96	07/09/96	0.176	1.100	1.259	0.354	1.340	3.368	0.398
07/09/96	07/16/96	0.251	2.300	2.514	0.543	1.860	1.579	1.178
07/16/96	07/23/96	0.384	0.397	0.775		1.240	1.271	0.976
07/23/96	07/30/96	0.100	2.260	2.324	0.591	2.030	2.649	0.766
07/30/96	08/06/96	0.097	0.928	1.010	0.469	1.770	3.397	0.521
08/06/96	08/13/96	0.117	1.810	1.898	0.376	1.560	0.958	1.629
08/13/96	08/20/96	0.416	1.320	1.715	0.703	1.900	4.157	0.457
08/20/96	08/27/96	0.147	1.590	1.712	0.525	1.450	1.201	1.207
08/27/96	09/03/96	0.691	0.872	1.549	0.466	1.490	1.044	1.428
09/03/96	09/10/96	0.243	0.400	0.637	0.198	0.840	0.569	1.476
09/10/96	09/17/96	0.049	0.364	0.407	0.285	1.040	0.569	1.827
09/17/96	09/24/96	0.106	0.176	0.279	0.169	0.698	0.270	2.584
09/24/96	10/01/96	0.147	1.360	1.485	0.709	1.700	0.517	3.286
10/01/96	10/08/96	0.159	0.290	0.444	0.319	1.030	0.794	1.298
10/08/96	10/15/96	0.099	0.297	0.391	0.172	0.630	0.303	2.079
10/15/96	10/22/96	0.112	0.065	0.176	0.075	0.403	0.507	0.795
10/22/96	10/29/96							
10/29/96	11/05/96							
11/05/96	11/12/96							
11/12/96	11/20/96	0.040	0.089	0.128	0.052	0.205	0.147	1.397
11/20/96	11/26/96	0.111	0.195	0.303	0.077	0.232	0.124	1.871
11/26/96	12/03/96							
12/03/96	12/10/96							
12/10/96	12/17/96							
12/17/96	12/24/96	0.067	0.063	0.129	0.026	0.125	0.108	1.157
12/24/96	12/31/96							

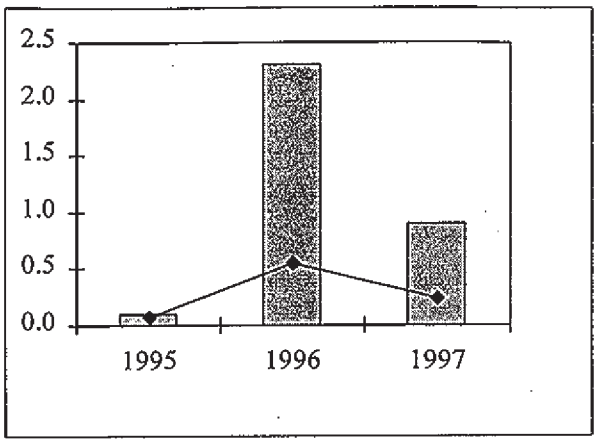
Mount Rainier National Park

CASTNet Dry Deposition Monitoring
Three Year Comparison of Maximum and Average Concentrations

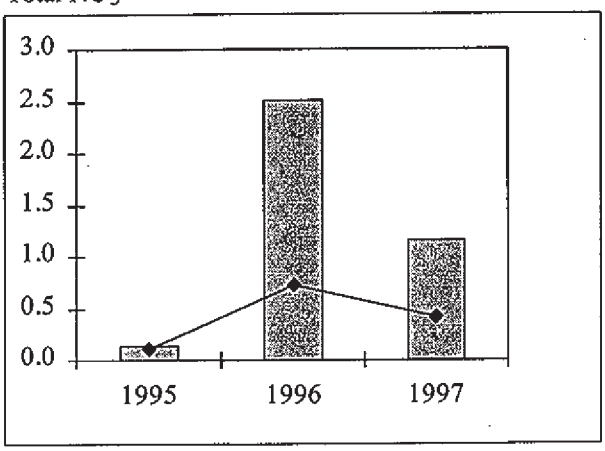
p-NO_3



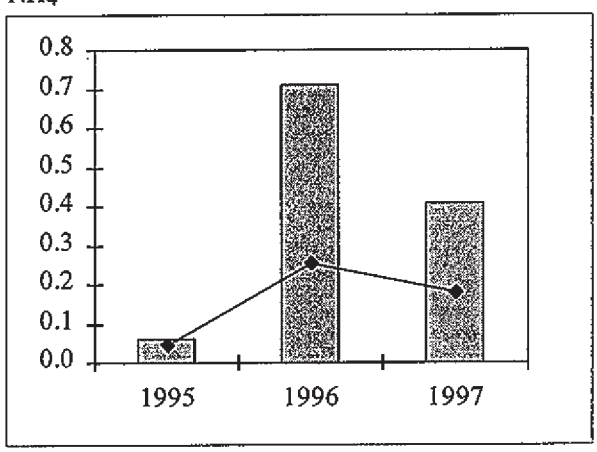
HNO_3



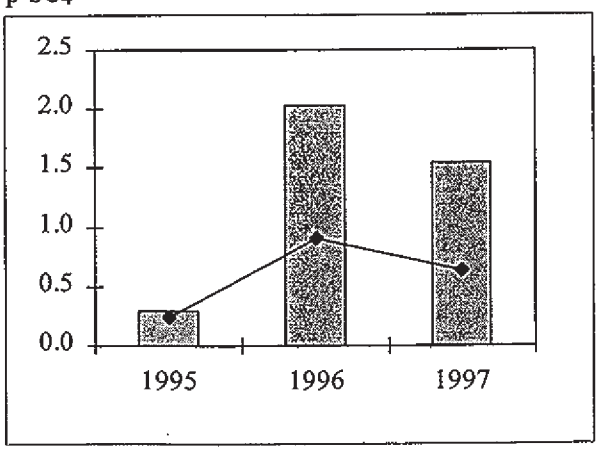
Total NO_3



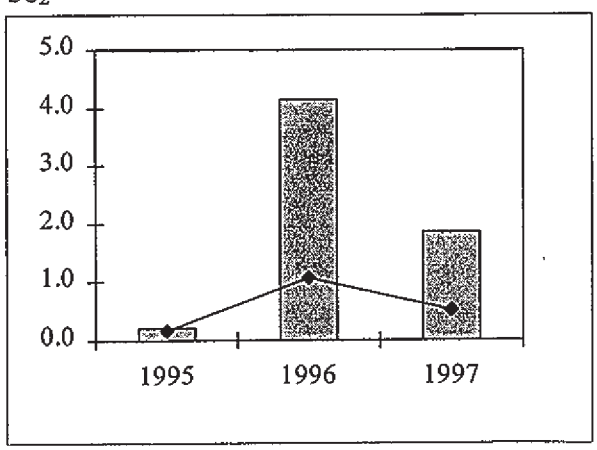
NH_4



p-SO_4

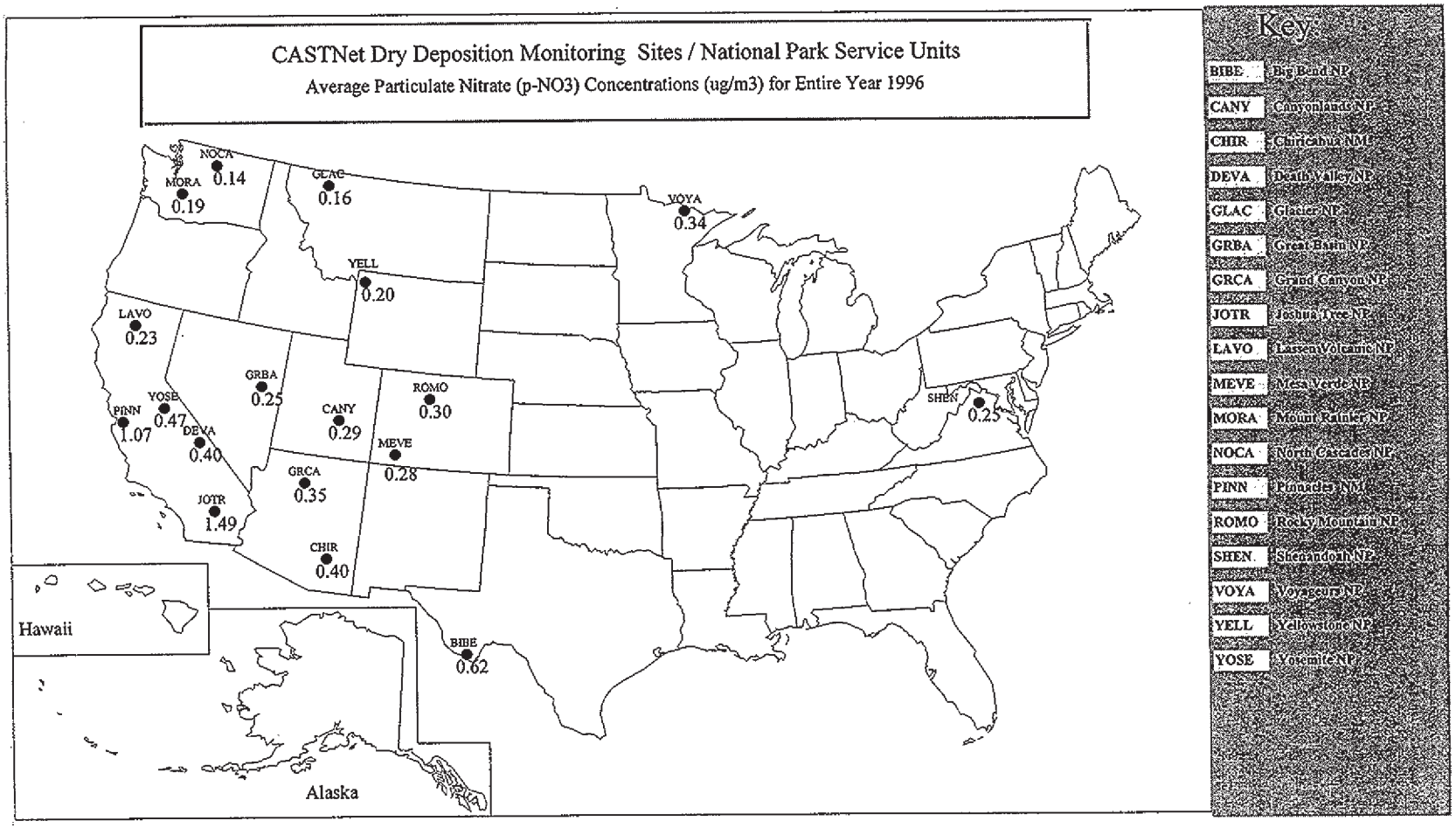


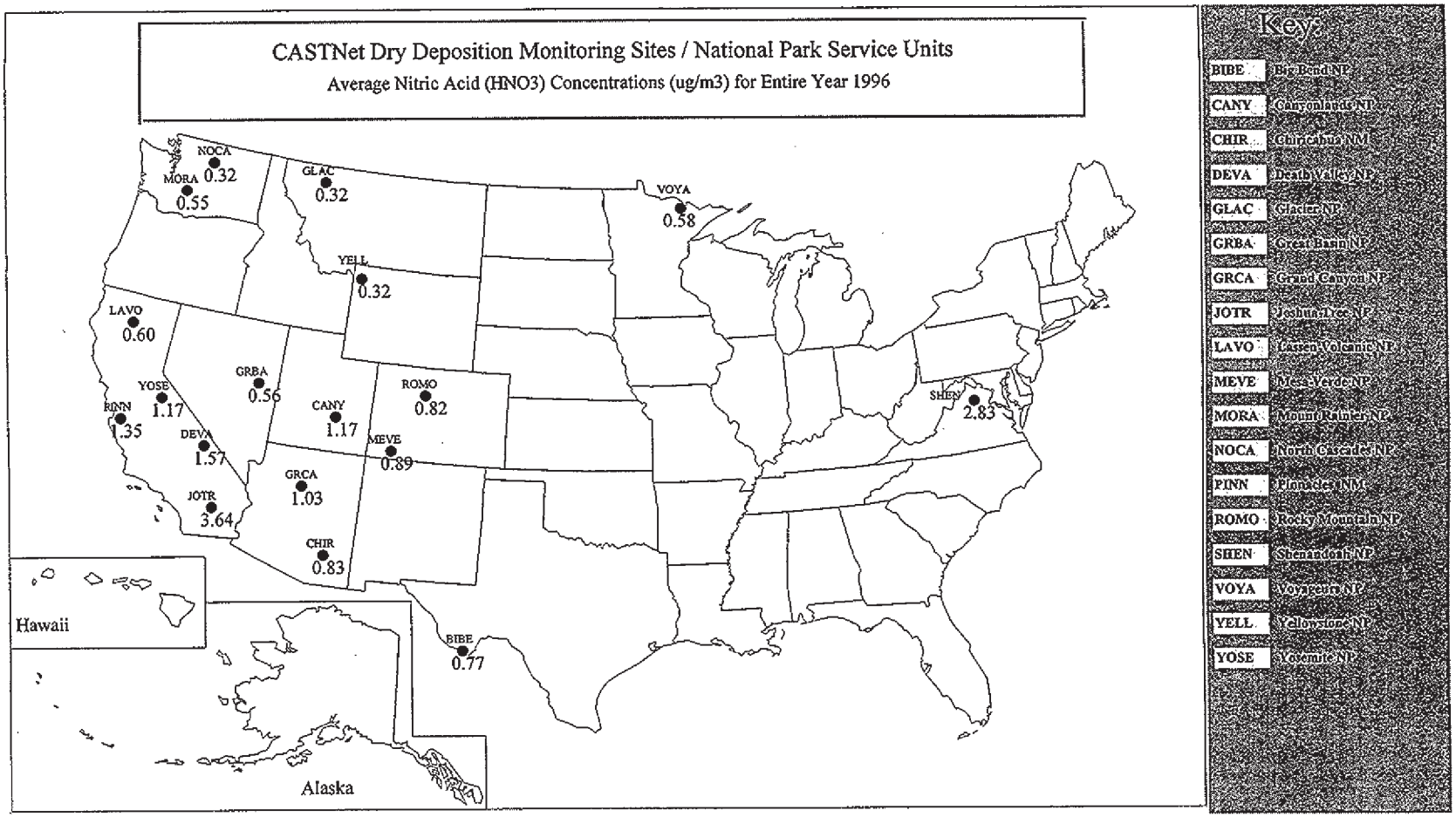
SO_2

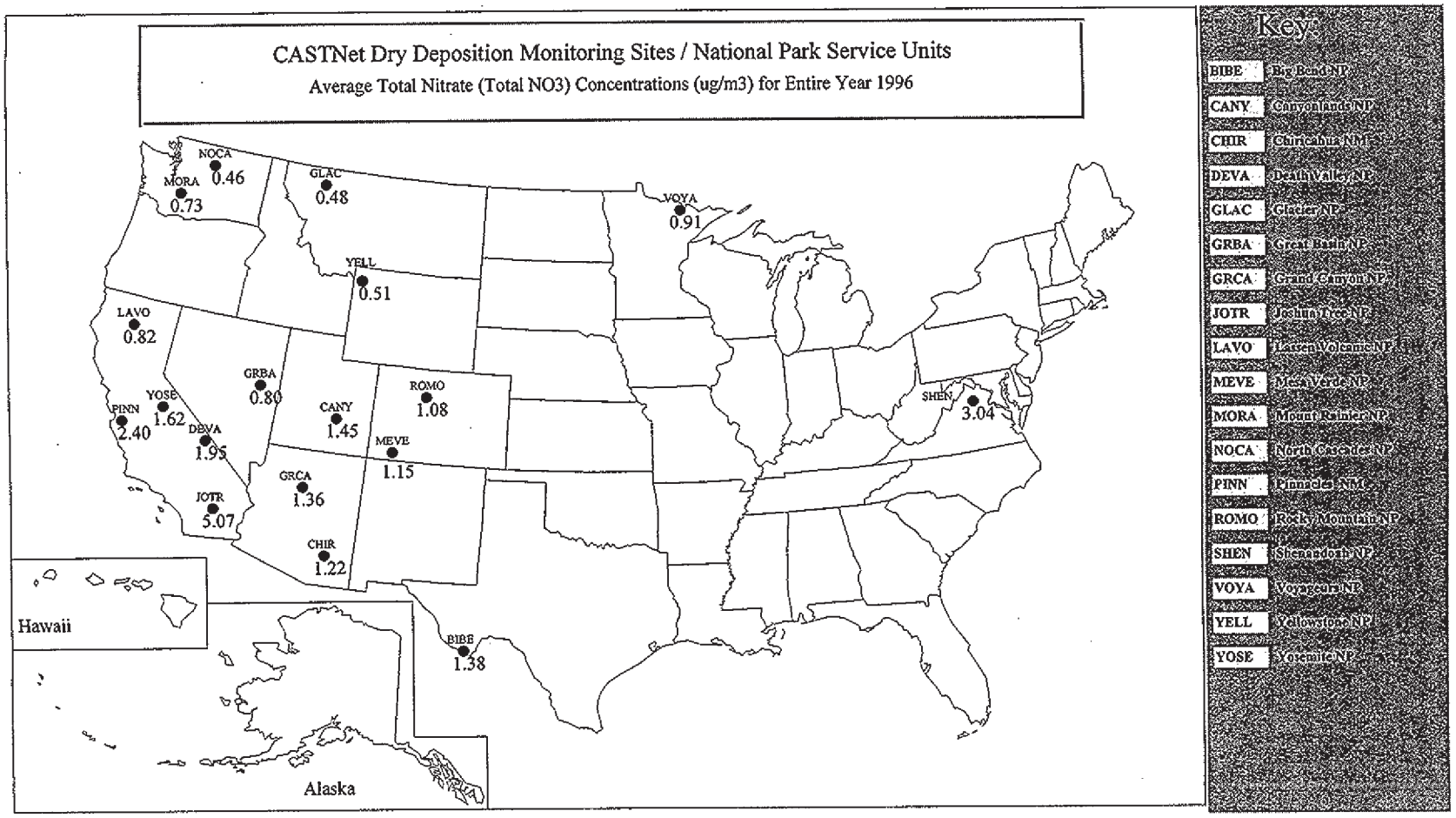


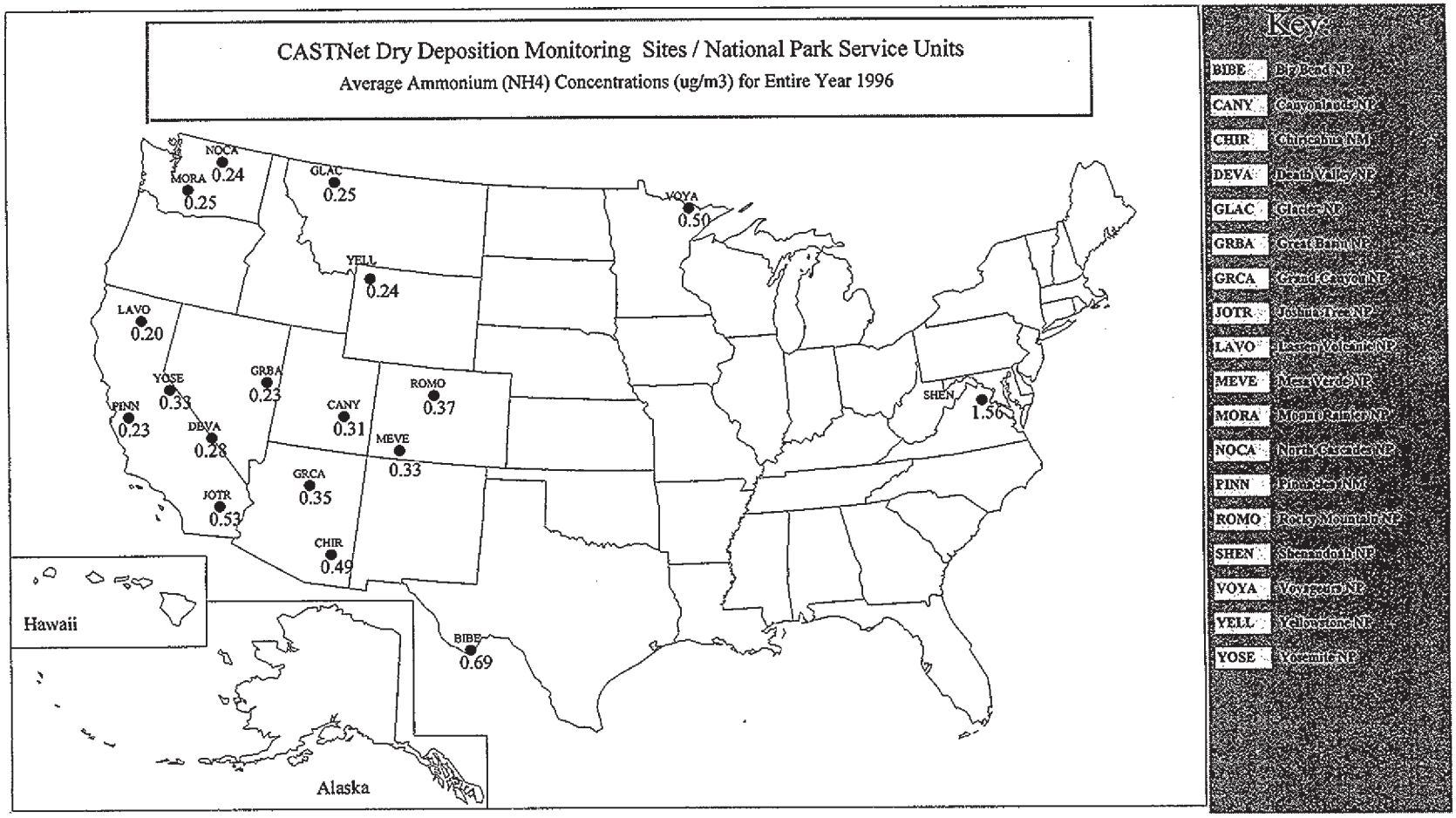
Maximum Concentration (ug/m³) — Average Concentration (ug/m³)

7/16/98


CASTNet Dry Deposition Monitoring Sites / National Park Service Units
Average Particulate Nitrate (p-NO3) Concentrations (ug/m3) for Entire Year 1996
NOCA 0.14
MORA 0.19
GLAC 0.16
VOYA 0.34
YELL 0.20
LAVO 0.23
GRBA 0.25
ROMO 0.30
YOSE 0.47
PINN 1.07
CANY 0.29
DEVA 0.40
MEVE 0.28
SHEN 0.25
GRCA 0.35
JOTR 1.49
CHIR 0.40
BIBE 0.62
Hawaii
Alaska
Key:
BIBE Big Bend NP
CANY Canyonlands NP
CHIR Chiricahua NM
DEVA Death Valley NP
GLAC Glacier NP
GRBA Great Basin NP
GRCA Grand Canyon NP
JOTR Joshua Tree NP
LAVO Lassen Volcanic NP
MEVE Mesa Verde NP
MORA Mount Rainier NP
NOCA North Cascades NP
PINN Pinnacles NM
ROMO Rocky Mountain NP
SHEN Shenandoah NP
VOYA Voyageurs NP
YELL Yellowstone NP
YOSE Yosemite NP


CASTNet Dry Deposition Monitoring Sites / National Park Service Units
Average Nitric Acid (HNO3) Concentrations (ug/m3) for Entire Year 1996
NOCA 0.32
MORA 0.55
GLAC 0.32
VOYA 0.58
YELL 0.32
LAVO 0.60
GRBA 0.56
YOSE 1.17
PINN 1.35
CANY 1.17
ROMO 0.82
DEVA 1.57
MEVE 0.89
SHEN 2.83
GRCA 1.03
JOTR 3.64
CHIR 0.83
BIBE 0.77
Hawaii
Alaska
Keys
BIBE Big Bend NP
CANY Canyonlands NP
CHIR Chiricahua NM
DEVA Death Valley NP
GLAC Glacier NP
GRBA Great Basin NP
GRCA Grand Canyon NP
JOTR Joshua Tree NP
LAVO Lassen Volcanic NP
MEVE Mesa Verde NP
MORA Mount Rainier NP
NOCA North Cascades NP
PINN Pinnacles NM
ROMO Rocky Mountain NP
SHEN Shenandoah NP
VOYA Voyageurs NP
YELL Yellowstone NP
YOSE Yosemite NP


CASTNet Dry Deposition Monitoring Sites / National Park Service Units
Average Total Nitrate (Total NO3) Concentrations (ug/m3) for Entire Year 1996
NOCA 0.46
MORA 0.73
GLAC 0.48
VOYA 0.91
YELL 0.51
LAVO 0.82
GRBA 0.80
YOSE 1.62
PINN 2.40
DEVA 1.95
CANY 1.45
ROMO 1.08
MEVE 1.15
SHEN 3.04
GRCA 1.36
JOTR 5.07
CHIR 1.22
BIBE 1.38
Hawaii
Alaska
Key
BIBE Big Bend NP
CANY Canyonlands NP
CHIR Chiricahua NM
DEVA Death Valley NP
GLAC Glacier NP
GRBA Great Basin NP
GRCA Grand Canyon NP
JOTR Joshua Tree NP
LAVO Lassen Volcanic NP
MEVE Mesa Verde NP
MORA Mount Rainier NP
NOCA North Cascades NP
PINN Pinnacles NM
ROMO Rocky Mountain NP
SHEN Shenandoah NP
VOYA Voyageurs NP
YELL Yellowstone NP
YOSE Yosemite NP


CASTNet Dry Deposition Monitoring Sites / National Park Service Units
Average Ammonium (NH4) Concentrations (ug/m3) for Entire Year 1996
NOCA 0.24
MORA 0.25
GLAC 0.25
VOYA 0.50
YELL 0.24
LAVO 0.20
YOSE 0.33
GRBA 0.23
PINN 0.23
CANY 0.31
ROMO 0.37
DEVA 0.28
MEVE 0.33
SHEN 1.56
GRCA 0.35
JOTR 0.53
CHIR 0.49
BIBE 0.69
Hawaii
Alaska
Key:
BIBE Big Bend NP
CANY Canyonlands NP
CHIR Chiricahua NM
DEVA Death Valley NP
GLAC Glacier NP
GRBA Great Basin NP
GRCA Grand Canyon NP
JOTR Joshua Tree NP
LAVO Lassen Volcanic NP
MEVE Mesa Verde NP
MORA Mount Rainier NP
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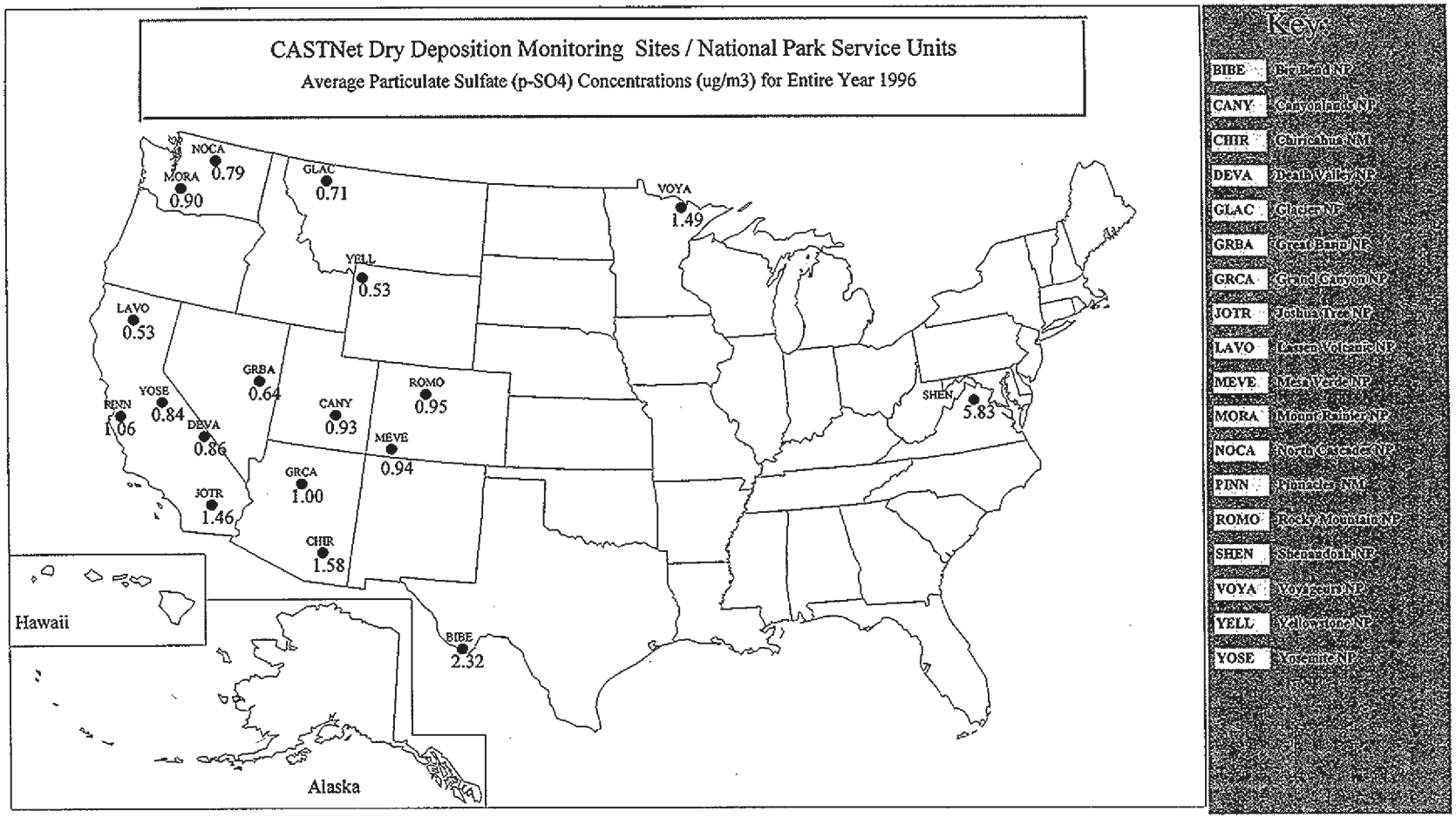
SHEN Shenandoah NP
VOYA Voyageurs NP
YELL Yellowstone NP
YOSE Yosemite NP


CASTNet Dry Deposition Monitoring Sites / National Park Service Units
Average Particulate Sulfate (p-SO4) Concentrations (ug/m3) for Entire Year 1996
NOCA 0.79
MORA 0.90
GLAC 0.71
VOYA 1.49
YELL 0.53
LAVO 0.53
GRBA 0.64
YOSE 0.84
PINN 1.06
CANY 0.93
ROMO 0.95
DEVA 0.86
MEVE 0.94
SHEN 5.83
GRCA 1.00
JOTR 1.46
CHIR 1.58
BIBE 2.32
Hawaii
Alaska
Key:
BIBE Big Bend NP
CANY Canyonlands NP
CHIR Chiricahua NM
DEVA Death Valley NP
GLAC Glacier NP
GRBA Great Basin NP
GRCA Grand Canyon NP
JOTR Joshua Tree NP
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MORA Mount Rainier NP
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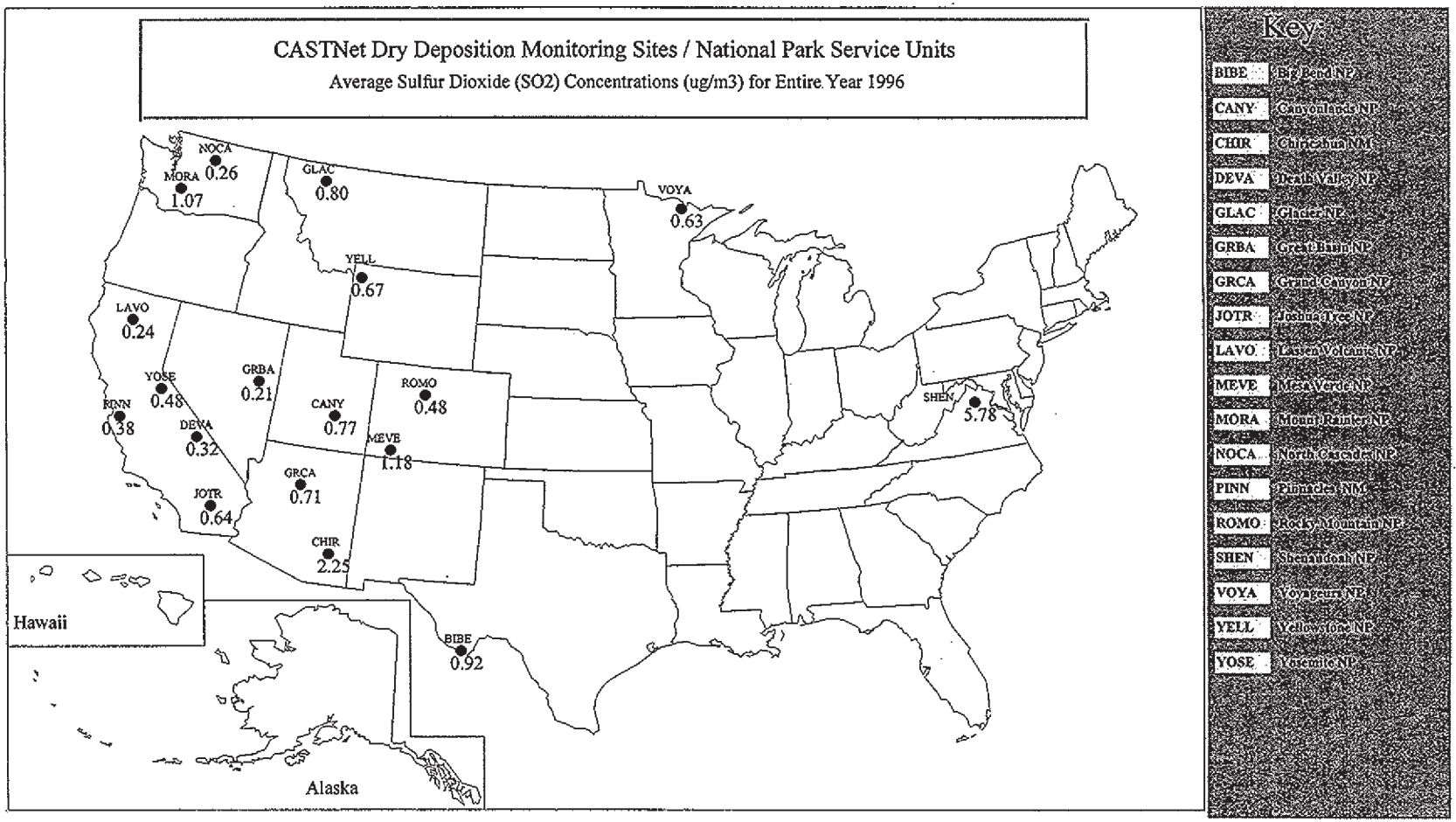
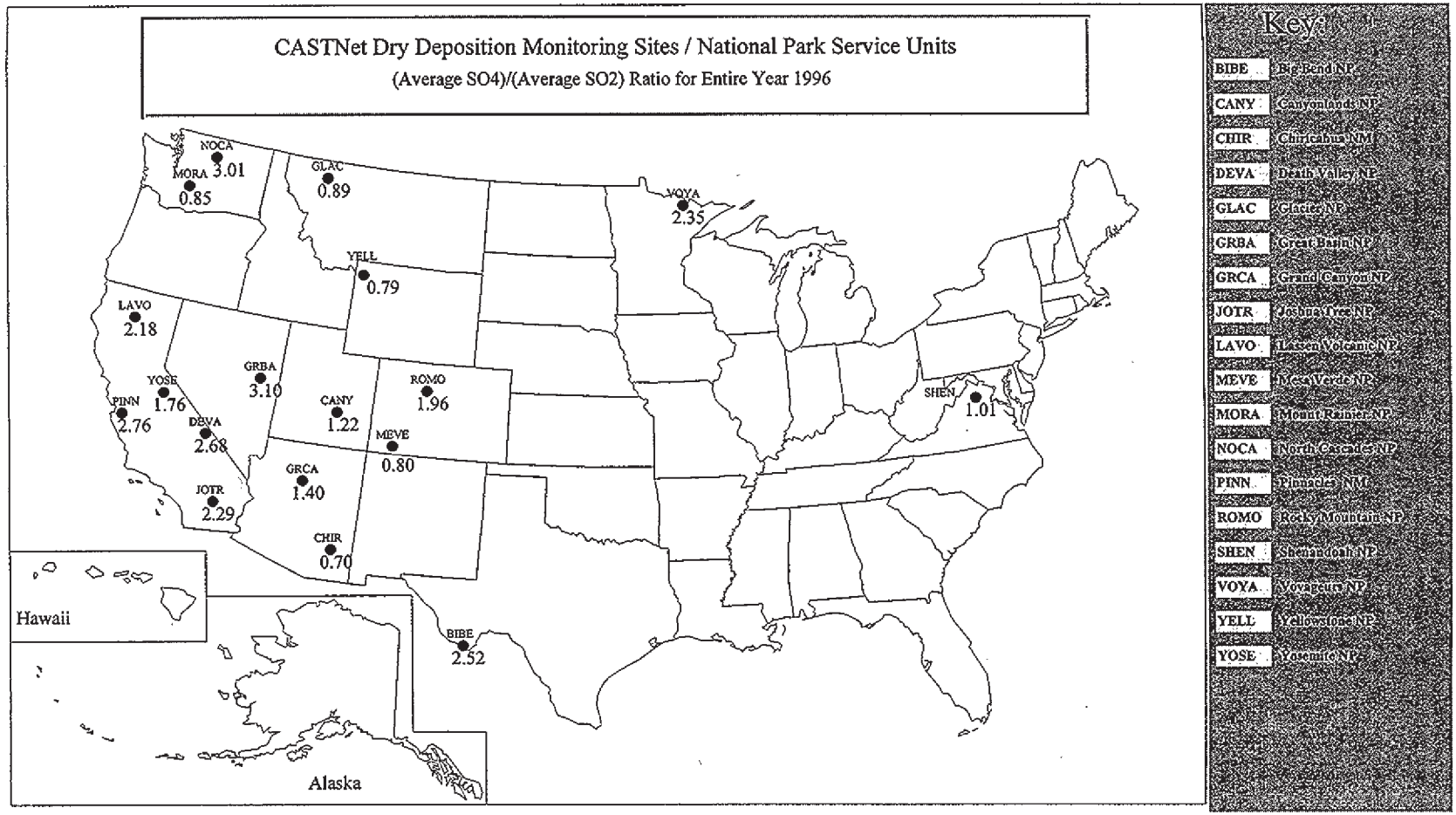
PINN Pinnacles NM
ROMO Rocky Mountain NP
SHEN Shenandoah NP
VOYA Voyageurs NP
YELL Yellowstone NP
YOSE Yosemite NP


CASTNet Dry Deposition Monitoring Sites / National Park Service Units
Average Sulfur Dioxide (SO2) Concentrations (ug/m3) for Entire Year 1996
NOCA 0.26
MORA 1.07
GLAC 0.80
VOYA 0.63
YELL 0.67
LAVO 0.24
YOSE 0.48
GRBA 0.21
PINN 0.38
DEVA 0.32
CANY 0.77
ROMO 0.48
MEVE 1.18
GRCA 0.71
JOTR 0.64
CHIR 2.25
SHEN 5.78
BIBE 0.92
Hawaii
Alaska
Key
BIBE Big Bend NP
CANY Canyonlands NP
CHIR Chiricahua NM
DEVA Death Valley NP
GLAC Glacier NP
GRBA Great Basin NP
GRCA Grand Canyon NP
JOTR Joshua Tree NP
LAVO Lassen Volcanic NP
MEVE Mesa Verde NP
MORA Mount Rainier NP
NOCA North Cascades NP
PINN Pinnacles NM
ROMO Rocky Mountain NP
SHEN Shenandoah NP
VOYA Voyageurs NP
YELL Yellowstone NP
YOSE Yosemite NP


CASTNet Dry Deposition Monitoring Sites / National Park Service Units
(Average SO4)/(Average SO2) Ratio for Entire Year 1996
NOCA 3.01
MORA 0.85
GLAC 0.89
VOYA 2.35
YELL 0.79
LAVO 2.18
GRBA 3.10
YOSE 1.76
PINN 2.76
DEVA 2.68
CANY 1.22
ROMO 1.96
MEVE 0.80
SHEN 1.01
GRCA 1.40
JOTR 2.29
CHIR 0.70
BIBE 2.52
Hawaii
Alaska
Key:
BIBE Big Bend NP
CANY Canyonlands NP
CHIR Chiricahua NM
DEVA Death Valley NP
GLAC Glacier NP
GRBA Great Basin NP
GRCA Grand Canyon NP
JOTR Joshua Tree NP
LAVO Lassen Volcanic NP
MEVE Mesa Verde NP
MORA Mount Rainier NP
NOCA North Cascades NP
PINN Pinnacles NM
ROMO Rocky Mountain NP
SHEN Shenandoah NP
VOYA Voyageurs NP
YELL Yellowstone NP
YOSE Yosemite NP

3.0 NATIONAL PARK SERVICE AIR RESOURCES DIVISION DATA SOURCES

3.1 GUIDE TO ATTACHED DATA DISKS

Data disks containing ASCII files of the validated hourly data, as shown in the following table are available. Please return the enclosed postcard or contact the address below. These data may be imported into other programs to perform additional data processing and analysis. The data format of each file is included within each file. The second table describes the validation codes used in the data tables to indicate why data are missing or invalid. Wind and pollutant frequency distribution tables in ASCII format are also included on the diskette if available for this site.

Data users should acknowledge the National Park Service Air Resources Division whenever using these data or any portion of this report.

3.2 OTHER SOURCES FOR RETRIEVING NATIONAL PARK SERVICE GASEOUS POLLUTANT DATA

The data contained in this report may also be obtained from the following sources:

- National Park Service AIRWeb (http://www.aqd.nps.gov/natnet/ard) - available after last quarter 1997
- EPA AIRS database
- Data requests directed to:

NPS Air Resources Division
Information Management Center
c/o Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, Colorado 80525
Telephone: (970) 484-7941
Fax: (970) 484-3423
E-Mail: AIR-IMC@AIR-RESOURCE.COM

Data Disk Contents Summary	
File Name (s)	Description
ssssyy.DAT	All Validated Air Quality Data
ssssyymm.ppp	Monthly Data Summary Tables
ssssAN95.Rpp	Annual Wind and Pollutant Frequency Distribution
ssssQ195.Rpp	Quarter 1 Wind and Pollutant Frequency Distribution
ssssQ295.Rpp	Quarter 2 Wind and Pollutant Frequency Distribution
ssssQ395.Rpp	Quarter 3 Wind and Pollutant Frequency Distribution
ssssQ495.Rpp	Quarter 4 Wind and Pollutant Frequency Distribution
Where: ssss = site code yy = year mm = month ppp = air quality data parameter code AN = Annual Qn = Quarter 1-4 R = Wind Frequency distribution table	
CASTNet Weekly Species Summary Data	
File Name	Description
ssssCNyr.ASC	Weekly averages
Where: ssss = site code CN = CASTNet yr = year asc = ascii file	

NPS IMC and AIRS Invalid Data Codes			
NPS IMC VAL CODE	REASON	AIRS CODE	AIRS REASON
TO	Sample time out of limits	9973	Sample time out of limits
IW	Instrument warmup	9978	Voided by operator
OE	Operator error	9978	
BM	Begin monitoring	9979	Miscellaneous void
TL	Station temp low	9979	
OS	Off scale	9979	
EM	End monitoring	9979	
LI	Local interference	9979	
TH	Station temp high	9979	
IM	Instrument malfunction	9980	Machine malfunction
IN	Interference	9981	Bad weather
RF	Recording system failure	9983	Collection error
NA	No data	9987	Monitoring waived
PF	Power failure	9988	Power Failure
PC	Precision check	9990	Precision Check
ZS	Instrument zero/span check	9991	QC Control Points (Zero/Span)
SA	System audit	9992	QC Audit
PA	Performance audit	9992	
MT	Maintenance	9993	Maintenance/Routine Repairs
OR	Out for repair	9993	
CA	Calibration	9995	Multipoint calibration
SC	Station check	9998	Precision/zero/span

4.0 GLOSSARY

4.1 DEFINITIONS AND COMPUTATIONAL PROCEDURES FOR NATIONAL PARK SERVICE QUICK LOOK ANNUAL SUMMARY STATISTICS REPORT

The National Park Service Quick Look Annual Summary Statistics Table (Page 2-8) provides ozone summary statistics for various indices computed on a monthly basis for an entire year. Growing season (generically defined to be May 1 - September 30) and annual statistics are also presented under the "MAY-SEP" and "ANNUAL" columns, respectively. All concentrations are expressed in the units of parts per billion (PPB) and exposures in parts per billion-hours (PPB-HR). The definitions for each of the statistics appearing on the Quick Look Annual Summary Table are given below.

(1) **Daily 1-Hr Maximum**. The maximum 1-hour average concentration recorded during each month, the growing season or the year regardless of the number of valid hourly observations recorded during a given day. The number in parentheses below this statistic, (N), indicates the number of days in the month, growing season, or year with valid data.

(2) **Average Daily Maximum**. The average of all Daily 1-Hr Maxima during the month regardless of the number of Daily 1-Hr Maxima recorded during the month. For the "MAY-SEP" column the average of all the Daily Maxima recorded during the growing season is given. For the "ANNUAL" column the average of all the Daily Maxima is given. N is as in (1) above.

(3) **Maximum Daily Mean**. The maximum of the valid daily means computed for each month, the growing season ("MAY-SEP" column), and the year ("ANNUAL" column). A valid daily mean is one for which 75% of the observations are available for each day, i.e., 18 hours. N is the number of days during each month, growing season, and year with at least 18 observations.

(4) **Average Daily Mean**. The average of all valid daily means for the month, the growing season ("MAY-SEP" column), and the year ("ANNUAL" column). N is as in (3) above.

(5) **Max Peak:Min Ratio**. The ratio of the Daily 1-Hr Maximum to the Daily 1-Hr Minimum. A ratio is computed only if a valid Daily Mean is computed and if the Daily 1-Hr Minimum is not equal to zero. N is the number of days with a valid Peak:Min ratio.

(6) **Average Peak:Min Ratio**. The average of all Peak:Min ratios for the month, growing season, or year. N is as in (5) above.

(7) **Max 9AM-4PM Average**. The maximum of all valid 9AM-4PM Averages computed for the month, growing season, or year. A valid 9AM-4PM Average is one which has 75% of the observations available during that time period (i.e., 6 hours. N is the number of days with valid averages.)

(8) **Monthly 9AM-4PM Average.** The average of all valid 9AM-4PM Averages for the month, growing season, or year. N is as in (7) above.

(9) **Max 7AM-7PM Average.** The maximum of all valid 7AM-7PM Averages computed for the month, growing season, or year. A valid 7AM-7PM Average is one which has 75% of the observations available during that time period, i.e., 9 hours. N is the number of days with valid averages.

(10) **Monthly 7AM-7PM Average.** The average of all valid 7AM-7PM averages for the month, growing season, or year. N is as in (9) above.

(11) **Monthly Mean.** The average of all 1-Hr ozone concentrations recorded during the month, growing season, or year. A mean is computed regardless of the number of hours with valid data. N is the number of hours with valid observations.

(12) **SUM0 Exposure Index.** The monthly sum of all hourly ozone concentrations. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. N is the number of hours with valid observations and is the same N as in (11) above.

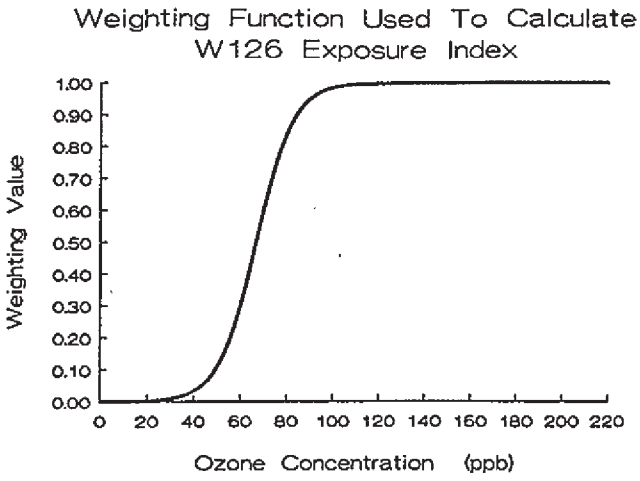
(13) **SUM60 Exposure Index.** The monthly sum of all hourly ozone concentrations equaling or exceeding 60 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. N is the number of hours equaling or exceeding 60 PPB during the month, growing season, or year.

(14) **SUM80 Exposure Index.** The monthly sum of all hourly ozone concentrations equaling or exceeding 80 PPB. Units are PPB-HR. The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. N is the number of hours equaling or exceeding 80 PPB during the month, growing season, or year.

(15) **W126 Exposure Index.** The monthly sum of all hourly ozone concentrations where each concentration is weighted by a function that gives greater emphasis to the higher hourly concentrations while still including the lower ones. This weighting function provides a weighting value that is unique for each hourly ozone concentration. The weighting function, as described by Lefohn, Laurence, and Kohut[1] is:

$$w_i = \frac{1}{1 + 4403 \exp(-.126 c_i)}$$

where



w_i = weighting value for hourly concentration *i*, and
c_i = hourly concentration *i* in PPB.

The graph of weighting value versus ozone concentration, in the figure to the left, illustrates the greater weights given to higher hourly ozone concentrations.

Each hour's weighting value is multiplied by its corresponding hourly concentration. This product is summed over all the valid hours in each month to calculate the monthly W126 exposure.

Thus, the monthly W126 exposure is:

$$W126 = \sum_{i=1}^{n} w_i c_i$$

where

W126 = monthly W126 exposure index,
w_i = weighting value for hourly concentration *i*,
c_i = hourly concentration *i* in PPB, and
n = number of hours in the month with valid ozone concentrations.

The "MAY-SEP" column sums across the months of May through September to give the cumulative exposure for the growing season. The "ANNUAL" column sums across every month to give the cumulative exposure for the year. The exposure units are PPB-HR.

Because each hour contributes to this exposure index, N is the number of hours with valid observations and is the same N as in (11) and (12) above.

The U.S. Environmental Protection Agency usually considers air quality statistics, such as a mean, to be "valid" (i.e., representative of the parameter being estimated for the time interval in question) only if 75% or more of the total possible observations have been measured during that time interval. Therefore, one should exercise caution when comparing these statistics between months and sites, particularly those that are not averages (e.g., maxima and exposures) whenever the number of valid observations is less than 75% of the total possible.

References

1. Lefohn, A.S., J. A. Laurence, and R. J. Kohut. 1988. A Comparison of Indices That Describe the Relationship Between Exposure to Ozone and Reduction in the Yield of Agricultural Crops. *Atmospheric Environment* 22, 1229-1240.

4.2 AIR QUALITY GLOSSARY

Acid Deposition: Air pollution produced when acid chemicals are incorporated into rain, snow, fog, or mist.

Aerometric Information Retrieval System (AIRS): A computer-based database of U.S. air pollution information administered by the EPA Office of Air Quality Planning and Standards (U.S. Environmental Protection Agency).

AIRWeb: Air Resources Web, an air quality information retrieval system for U.S. parks and wildlife refuges developed by the Air Resources Division of the National Park Service and the Air Quality Branch of the Fish and Wildlife Service.

Air Pollutant: An unwanted chemical or other material found in the air.

Air Pollution: Degradation of air quality resulting from unwanted chemicals or other materials occurring in the air.

Air Quality: The properties and degree of purity of air to which people and natural and heritage resources are exposed (in the context of national parks).

Air Pollution Control Permitting Process: Process by which facilities are permitted to emit specified types and quantities of air pollutants.

Air Quality Related Values (AQRVs): Values including visibility, flora, fauna, cultural and historical resources, odor, soil, water, and virtually all resources that are dependent upon and affected by air quality. "These values include visibility and those scenic, cultural, biological, and recreation resources of an area that are affected by air quality." *(43 Fed. Reg. 15016)*

Ambient Air: Air that is accessible to the public.

Class I: Areas of the country set aside under the Clean Air Act to receive the most stringent degree of air quality protection.

Class II: Areas of the country protected under the Clean Air Act but identified for somewhat less stringent protection from air pollution damage than Class I, except in specified cases.

Clean Air Act: Originally passed in 1963, our current national air pollution control program is based on the 1970 version of the law. Substantial revisions were made by the 1990 Clean Air Act Amendments.

Continuous Sampling Device: An air analyzer that measures air quality components continuously.

Criteria: Information on health and/or environmental effects of pollution (in the context of criteria air pollutants).

Criteria Air Pollutant: A group of very common air pollutants regulated by EPA on the basis of criteria and for which a National Ambient Air Quality Standard is established (SO_2, NO_2, PM_{10}, Pb, CO, O_3).

Emissions: Release of pollutants into the air from a source.

Environmental Protection Agency (EPA): The federal agency responsible for regulating air quality.

Monitoring: Measurement of air pollution.

National Ambient Air Quality Standards (NAAQS): Permissible levels of criteria air pollutant established to protect public health and welfare.

Ozone (O_3): A criteria air pollutant that is a strong oxidizing agent, reactive with many other compounds and surfaces, and a health hazard in high concentrations. Ozone is formed by nitrogen oxides and organic compounds reacting in sunlight.

Source: Any place or object from which air pollutants are released. Sources that are fixed in space are stationary sources; sources that move are mobile sources.

Sulfur Dioxide (SO_2): A criteria air pollutant that is a gas produced by burning coal and some industrial processes.

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* Recent updates to this glossary may be found on the NPSARD AIRWeb - http://www.aqd.nps.gov/natnet/ard/glossary.htm.

4.3 GLOSSARY OF AIR QUALITY UNITS

Units Conversion Table			
Parameter Type	Multiply	By	To Obtain
Pollutant	ppm	1000	ppb
	ppm	1960	$\mu g/m^3$ Ozone (at 25°C)
	ppm	2615	$\mu g/m^3$ Sulfur Dioxide (at 25°C)
	ppb	0.001	ppm
	ppb	1.960	$\mu g/m^3$ Ozone (at 25°C)
	ppb	2.615	$\mu g/m^3$ Sulfur Dioxide (at 25°C)
	$\mu g/m^3$ Ozone (25°C)	0.0005102	ppm
	$\mu g/m^3$ Ozone (25°C)	0.5102	ppb
	$\mu g/m^3$ Sulfur Dioxide (25°C)	0.0003824	ppm
	$\mu g/m^3$ Sulfur Dioxide (25°C)	0.3824	ppb
Wind Speed	m/s	2.05	mph
	mph	0.489	m/s
Solar Radiation	ly/min	697	w/m^2
	w/m^2	0.00143	ly/min
Precipitation	mm/hr	0.0394	in/hr
	in/hr	25.4	mm/hr
Temperature	°C + 17.78	1.8	°F
	°F - 32	5/9	°C

Where:
ppm = parts per million
ppb = parts per billion
$\mu g/m^3$ = micrograms per cubic meter (at 25°C)
m/s = meters per second
mps = miles per hour
ly/min = langleys per minute
w/m^2 = watts per square meter
mm/hr = millimeters per hour
in/hr = inches per hour
°C = degrees centigrade
°F = degrees fahrenheit