

**QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES**

**TITLE                    OPTICAL MONITORING DATA REPORTING**  
  
**TYPE                    STANDARD OPERATING PROCEDURE**  
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## TABLE OF CONTENTS

<b><u>Section</u></b>	<b><u>Page</u></b>
1.0 PURPOSE AND APPLICABILITY	1
2.0 RESPONSIBILITIES	2
2.1 Project Manager	2
2.2 Data Analyst	2
2.3 Field Specialist	2
2.4 Secretary	2
3.0 REQUIRED EQUIPMENT AND MATERIALS	2
4.0 METHODS	3
4.1 Seasonal Data Reporting	3
4.2 Annual Data Reporting	4
4.3 Other Reporting	5
4.4 Distribution	5
5.0 REFERENCES	5

## 1.0 PURPOSE AND APPLICABILITY

This standard operating procedures (SOP) is a guide to the written reporting of optical visibility monitoring data from sites operating according to IMPROVE Protocol. Optical monitoring sites include those equipped with an Optec LPV transmissometer and/or Optec NGN nephelometer.

IMPROVE Program goals include timely reporting of collected data in presentation formats that further the understanding of the visual resource and support effective management decisions. The program encompasses:

- Establishing baseline conditions and long-term trends of visual air quality in Class I wilderness areas, and monitoring progress toward the national visibility goals.
- Obtaining high quality visibility data that can be used in planning, permit review, and policy decision processes by using instrumentation capable of measuring quantities that can be directly related to those perceived by the human eye.
- Establishing a database that will assist in the scientific investigation of visibility and validation of computer models designed to predict visibility impairment.
- Determining the existing sources of visibility impairment, detecting new problems and developments early, and determining the sensitivity of individual vistas and Class I areas to varying concentrations of pollutants.

The program has partitioned visibility-related characteristics and measurements into three groups: optical, scene, and aerosol. This SOP pertains to the optical group and encompasses the following:

- Reporting the measurement of basic electro-optical properties of the atmosphere, independent of specific vista characteristics.
- Reporting data in various comprehensive graphics forms.
- Reporting optical extinction measurements made with transmissometers (represented in a variety of units including haziness in  $dv$ , extinction in  $km^{-1}$ , and standard visual range in km).
- Reporting optical scattering measurements made with nephelometers (represented as scattering in  $km^{-1}$ ).

Data reports are prepared in a format that generally conforms to the *Guidelines for Preparing Reports for the NPS Air Quality Division* (AH Technical Services, 1987). The following technical instructions (TIs) provide detailed information regarding reporting data collected by optical instruments:

- TI 4500-5000      Nephelometer Data Reporting (IMPROVE Protocol)
- TI 4500-5100      Transmissometer Data Reporting (IMPROVE Protocol)

## **2.0 RESPONSIBILITIES**

### **2.1 PROJECT MANAGER**

The project manager shall:

- Determine the COTR's (Contracting Officer's Technical Representative) project-specific reporting and distribution requirements).
- Review draft and final data reports for completeness and accuracy.
- Verify that completed reports are properly distributed.

### **2.2 DATA ANALYST**

The data analyst shall:

- Prepare all final data plots for inclusion in the reports.
- Compile data statistics and compose text for draft reports.
- Coordinate with the secretary for report preparation.
- Review final reports for completeness and accuracy before distribution.

### **2.3 FIELD SPECIALIST**

The field specialist shall provide current and accurate site specifications to the data analyst.

### **2.4 SECRETARY**

The secretary shall:

- Word process draft and final reports.
- Coordinate with the data analyst for complete report information, format, and statistics.
- Prepare final, approved reports for photocopying and distribution.
- Distribute final reports in accordance with project-specific distribution requirements.

## **3.0 REQUIRED EQUIPMENT AND MATERIALS**

All data reports are prepared on IBM-PC compatible systems. A word processing package capable of creating large documents with figures and tables is used (such as WordPerfect), with a letter-quality laserjet printer. Other materials include photocopy and binding machines (with required materials) or a photocopy and binding service.

## 4.0 METHODS

Data for each optical monitoring instrument type (nephelometer or transmissometer) are released in separate data reports. Data reports are prepared in a format that conforms to the *Guidelines for Preparing Reports for the NPS Air Quality Division* (AH Technical Services, 1987). Reporting consists of various text discussions and graphics presentations concerning the instrumentation and collected data. Specific contents of the seasonal and/or annual report are defined by the contracting agency COTR. This section includes four (4) subsections:

- 4.1 Seasonal Data Reporting
- 4.2 Annual Data Reporting
- 4.3 Other Reporting
- 4.4 Distribution

### 4.1 SEASONAL DATA REPORTING

Seasonal reporting is completed within three months after the end of a monitoring season. Standard meteorological monitoring seasons are defined as:

Winter	(December, January, and February)
Spring	(March, April, and May)
Summer	(June, July, and August)
Fall	(September, October, and November)

Optical data are presented in the following formats for each reporting season:

- Overview of monitoring program goals and objectives, and a description of the monitoring networks.
- Comprehensive discussion of data collection, reduction, and processing procedures.
- Brief overview of site configuration(s) and description of instrumentation.
- Map of all site locations and site abbreviations.
- Table of monitoring instrumentation history at each site.
- Table of site specifications and operating period for each site during the reporting season.
- Seasonal data summary plot for each site. The plots contain five data presentations: 1) a graph of the four-hour average variation in visual air quality, 2) a relative humidity graph, 3) a frequency of occurrence graph and table based on hourly data, 4) a visibility metric table, and 5) data recovery statistics.
- Detailed explanation of data presentations included in the summary plots.
- Discussion of events and circumstances influencing data recovery, specific for each site.

- Data recovery and cumulative frequency distribution table, including data recovery statistics and 10%, 50%, and 90% cumulative frequency values for each site. The table includes  $dv$ ,  $b_{ext}$ , and SVR values for transmissometers and  $b_{scat}$  (filtered data and unfiltered data) values for nephelometers.

Refer to TI 4500-5000, *Nephelometer Data Reporting (IMPROVE Protocol)* and TI 4500-5100, *Transmissometer Data Reporting (IMPROVE Protocol)* for detailed discussions on each type of data presentation.

## 4.2 ANNUAL DATA REPORTING

Annual reporting is completed within three months after the end of the last season to be reported. Optical data are presented in the following formats for each annual reporting period:

- Overview of monitoring program goals and objectives, and a history of the program.
- Comprehensive discussion of data collection, reduction, and processing procedures.
- Brief overview of site configuration(s) and description of instrumentation.
- Map of all site locations and site abbreviations.
- Table of site specifications and operating period for each site and season during the annual reporting period.
- Seasonal data summary plots for each season and site. The plots contain five data presentations: 1) a graph of the four-hour average variation in visual air quality, 2) a relative humidity graph, 3) a frequency of occurrence graph and table based on hourly data, 4) a visibility metric table, and 5) data recovery statistics.
- Annual data summary plots for each site. The plots contain three data presentations: 1) a bar graph depicting the monthly median air quality values, 2) a monthly cumulative frequency summary table including data recovery statistics. The table displays  $dv$  and  $b_{ext}$  for transmissometers and  $b_{scat}$  (for filtered data and all data) values for nephelometers, and 3) an annual frequency of occurrence graph based on hourly data.
- Detailed explanation of data presentations included in the seasonal and annual data summary plots.
- Data recovery and cumulative frequency distribution tables for each season of the reporting period. The tables include data recovery statistics and 10%, 50%, and 90% cumulative frequency values for each site. The tables include  $dv$ ,  $b_{ext}$ , and SVR values for transmissometers and  $b_{scat}$  (unfiltered data and filtered data) values for nephelometers.

Refer to TI 4500-5000, *Nephelometer Data Reporting (IMPROVE Protocol)* and TI 4500-5100, *Transmissometer Data Reporting (IMPROVE Protocol)* for detailed discussions on each type of data presentation.

### **4.3 OTHER REPORTING**

Contracting agencies will periodically request additional data reports. Cases or events of special scientific, legal, or political importance to the NPS or other cooperating agencies may occur during the term of the project. New techniques, hardware, software, or other technical advances may also occur that will be applicable to the visibility monitoring program. Additional data reporting or analyses may be required to address these special circumstances and will be executed according to project-specific direction.

### **4.4 DISTRIBUTION**

Reports are reviewed and approved by the project manager prior to preparation for distribution. When ready, ARS contacts the local project-specific COTR office for distribution requirements and provides the deliverable products as directed. The amount or type of deliverable product may vary with each report.

### **5.0 REFERENCES**

AH Technical Services, 1987, Guidelines for Preparing Reports for the NPS Air Quality Division, September.

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QA MANAGER	Gloria S. Mercer	
OTHER		

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## TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1.0 PURPOSE AND APPLICABILITY	1
2.0 RESPONSIBILITIES	1
2.1 Project Manager	1
2.2 Data Analyst	1
2.3 Field Specialist	1
2.4 Secretary	1
3.0 REQUIRED EQUIPMENT AND MATERIALS	2
4.0 METHODS	2
4.1 Seasonal Data Reporting	2
4.1.1 Introduction	2
4.1.2 Data Collection and Reduction	3
4.1.2.1 Site Configuration	3
4.1.2.2 Data Reduction	3
4.1.3 Nephelometer Data Summaries	3
4.1.3.1 Data Summary Description	3
4.1.3.2 Events and Circumstances Influencing Data Recovery	9
4.1.4 References	9
4.1.5 Appendix A - Nephelometer Data Collection and Reduction Procedures	9
4.1.5.1 On-Site Data Logging and Transmission	9
4.1.5.2 Daily and Weekly Processing Procedures	10
4.1.5.3 Seasonal Data Processing Procedures	10
4.2 Annual Data Reporting	10
4.2.1 Introduction	10
4.2.2 Data Collection and Reduction Procedures	10
4.2.3 Site Configuration	12
4.2.4 Data Summary Description	12
4.2.5 Nephelometer Data Summaries	12
4.2.6 Summary	14
4.2.7 References	14
4.3 Report Distribution	14
5.0 REFERENCES	14

## LIST OF FIGURES

<b><u>Figure</u></b>	<b><u>Page</u></b>
4-1 Example Visibility Network Location Map	4
4-2 Example Seasonal Nephelometer Data Summary	7
4-3 Nephelometer Data Processing Flow Chart	11
4-4 Example Annual Nephelometer Data Summary	13

## LIST OF TABLES

<b><u>Table</u></b>	<b><u>Page</u></b>
4-1 Example Monitoring History Summary Table	5
4-2 Example Nephelometer Site Specifications Summary Table	6
4-3 Example Analysis Summary Table	9

## **1.0 PURPOSE AND APPLICABILITY**

This technical instruction (TI) describes the procedures and methods for preparing written reports of Optec NGN-2 nephelometer data collected according to IMPROVE Protocol. This TI is referenced from SOP 4500, *Optical Monitoring Data Reporting*, and specifically describes:

- Reporting frequency and contents of seasonal nephelometer reports.
- Reporting contents of annual nephelometer reports.
- Report distribution requirements.

## **2.0 RESPONSIBILITIES**

### **2.1 PROJECT MANAGER**

The project manager shall:

- Determine the COTR's (Contracting Officer's Technical Representative) project-specific reporting and distribution requirements.
- Review draft and final data reports for completeness and accuracy.
- Verify that completed reports are properly distributed.

### **2.2 DATA ANALYST**

The data analyst shall:

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The field specialist shall provide current and accurate site specifications to the data analyst.

### **2.4 SECRETARY**

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- Coordinate with the data analyst for complete report information, format, and statistics.

- Prepare final, approved reports for photocopying and distribution.
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### **3.0 REQUIRED EQUIPMENT AND MATERIALS**

All data reports are prepared on IBM-PC compatible systems. A word processing package capable of creating large documents with figures and tables is used (such as WordPerfect), with a letter-quality laserjet printer. Other materials include photocopy and binding machines (with required materials) or a photocopy and binding service.

### **4.0 METHODS**

Data reports are prepared in a format that generally conforms to the *Guidelines for Preparing Reports for the NPS Air Quality Division* (AH Technical Services, 1987). A separate data report is prepared for each instrument type; nephelometer data reports contain only nephelometer data. Reporting consists of various text discussions and graphics presentations concerning the instrumentation and collected data. Specific contents of the reports are defined by the contracting agency COTR. This section includes the following three (3) main subsections:

- 4.1 Seasonal Data Reporting
- 4.2 Annual Data Reporting
- 4.3 Report Distribution

#### **4.1 SEASONAL DATA REPORTING**

Seasonal nephelometer reporting is completed within three months after the end of a monitoring season. Standard meteorological monitoring seasons are defined as:

Winter	(December, January, and February)
Spring	(March, April, and May)
Summer	(June, July, and August)
Fall	(September, October, and November)

Seasonal reports contain the five (5) major sections listed below:

- 1.0 Introduction
- 2.0 Data Collection and Reduction
- 3.0 Nephelometer Data Summaries
- 4.0 References
- A.0 Appendix A - Nephelometer Data Collection and Processing Procedures

The information and data presentation formats included in each section of the seasonal report are summarized in the following subsections.

##### **4.1.1 Introduction**

The introduction contains a conceptual overview of the purpose of the monitoring program and a description of the monitoring networks.

#### **4.1.2 Data Collection and Reduction**

Data collection and reduction is presented in two subsections, Site Configuration and Data Reduction.

##### **4.1.2.1 Site Configuration**

Nephelometer system components and basic system operation are briefly discussed in each seasonal report. Measurement principles and data collection specifications are also described. Detailed descriptions of system components and operation are presented in TI 4070-3001, *Site Documentation for Optec NGN-2 Nephelometer Systems*.

Figures and tables in this section include:

- Map of the United States depicting the location of all IMPROVE and IMPROVE Protocol monitoring network sites. An example map is presented as Figure 4-1.
- Monitoring History Summary Table - The table lists for each monitoring site the name, type of instrumentation, and period of operation for each instrument type (see Table 4-1).
- Site Specifications Summary Table - The table lists for each monitoring site the site name, abbreviation, latitude, longitude, and elevation of the nephelometer, the number of readings taken each day, and the operating period during the season (see Table 4-2).

##### **4.1.2.2 Data Reduction**

Each seasonal report contains a brief discussion of daily and seasonal data collection, reduction, and processing procedures. The discussion includes daily data review, file format, and daily and seasonal analytical processing and reduction procedures. Reduced data are presented as the scattering component of the atmospheric extinction coefficient ( $b_{\text{scat}}$ ) in  $\text{km}^{-1}$ . More detailed discussions of collection and reduction procedures and assumptions (including discussion of levels of validation, calculation of uncertainties, and identification of meteorological and optical interferences) are presented in an appendix to each report (see Section 4.1.5). Refer to SOP 4300, *Collection of Optical Data (IMPROVE Protocol)*, and TI 4400-5010, *Nephelometer Data Reduction and Validation (IMPROVE Protocol)*, for a complete discussion of procedures.

#### **4.1.3 Nephelometer Data Summaries**

Data are presented in various forms in seasonal reports. Each mode of presentation is accompanied by an explanation of the presentation; the following two (2) subsections are included in each seasonal report and detail each data presentation.

##### **4.1.3.1 Data Summary Description**

A Seasonal Nephelometer Data Summary plot is prepared for each site that operated during the reporting season. An example Seasonal Nephelometer Data Summary is presented as Figure 4-2. The following is a detailed explanation of the contents of the data summaries and accompanies the summaries in each report. Nephelometer Data Summaries include the following five data presentations:

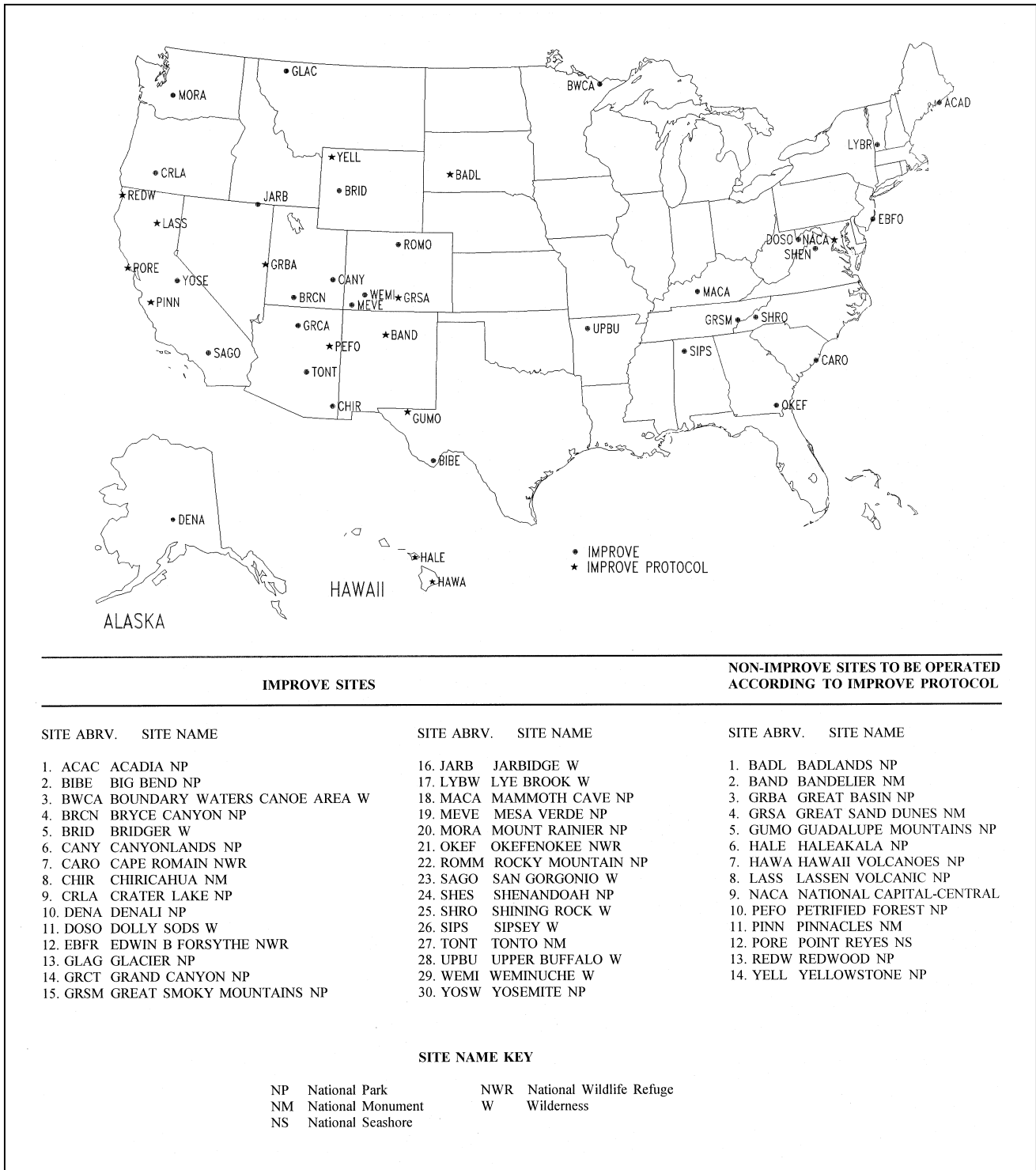


Figure 4-1. Example Visibility Network Location Map.

Table 4-1

Example Monitoring History Summary Table

NETWORK	SITE NAME	TELERRADIOMETER		CAMERA		TRANSMISSOMETER		NEPHELOMETER	
		MANUAL Start End	AUTO Start End	MANUAL Start End	AUTO Start End	Start	End	Start	End
IMPROVE	Acadia NP		10/79 02/86	01/80 10/84	04/85	11/87	06/93	06/93	
IMP Pro.	Badlands NP				08/87	01/88			
IMPROVE	Bandelier NM	07/78 09/84		06/79 02/85	07/87	10/88			
IMPROVE	Big Bend NP	08/78 02/86		09/81 06/86	06/86	12/88			
IMPROVE	Boundary Waters Canoe Area W				10/85			05/93	
IMPROVE	Bridger W				09/86	07/88			
IMPROVE	Bryce Canyon NP	06/78 11/83	12/83 02/86	01/79 11/83	04/84				
IMPROVE	Canyonlands NP	09/78 02/86		07/82 01/87	01/87	12/86			
IMPROVE	Cape Romain NWR								
IMPROVE	Chiricahua NM	06/81 02/86		06/81 06/86	06/86	02/89			
IMPROVE	Crater Lake NP	07/82 09/82		08/82 09/82	06/85	09/88	09/91		
IMPROVE	Denali NP				06/88				
IMPROVE	Dolly Sods W				09/85			05/93	
IMPROVE	Edwin B. Forsythe NWR				05/92			04/93	04/94
IMPROVE	Glacier NP	06/83 05/85	06/85 11/85	07/82 06/85	06/85	02/88			
IMPROVE	Grand Canyon NP (South Rim)	07/78 10/83	12/83 02/86	10/79 11/83	11/83	12/86			
IMPROVE	Grand Canyon NP (In-Canyon)					12/89			
IMP Pro.	Great Basin NP	06/82 02/86		06/82 06/86	06/86	08/92			
IMP Pro.	Great Sand Dunes NM				07/87				
IMPROVE	Great Smoky Mountains NP		12/83 02/85		01/84			03/90	
IMP Pro.	Guadalupe Mountains NP		02/82 02/86	06/83 05/84	06/84	11/88			
IMP Pro.	Haleakala NM				07/87				
IMP Pro.	Hawaii Volcanoes NP				10/86				
IMPROVE	Jarbridge W				09/86			04/93	
IMP Pro.	Lassen Volcanic NP	07/82 11/83		08/82 10/83	06/87				
IMPROVE	Lye Brook W				05/87			08/93	04/94
IMPROVE	Mammoth Cave NP				03/92			03/93	
IMPROVE	Mesa Verde NP	07/78 02/86		09/79 06/86	06/86	09/88	06/93		
IMPROVE	Mount Rainier NP				06/85			06/90	
IMP Pro.	National Capital-Central				12/88				
IMPROVE	Okefenokee NWR				04/92 11/92			02/93	
IMP Pro.	Petrified Forest NP				07/86	04/87			
IMP Pro.	Pinnacles NM				08/86	03/88	06/93		
IMP Pro.	Point Reyes NS				06/87				
IMP Pro.	Redwood NP				06/87				
IMPROVE	Rocky Mountain NP	06/80 05/85		07/85 09/85	07/85	11/87			
IMPROVE	San Geronio W				08/86	04/88			
IMPROVE	Shenandoah NP	05/80 10/85		05/80 10/86	10/86	12/88			
IMPROVE	Shining Rock W								
IMPROVE	Sipsey W				11/88				
IMPROVE	Tonto NM				04/89	04/89	09/91		
IMPROVE	Upper Buffalo W				11/88			02/93	
IMPROVE	Weminuche W				08/86 08/93				
IMP Pro.	Yellowstone NP	06/81 06/82		09/81 06/82	09/86	07/89	06/93		
IMPROVE	Yosemite NP	09/82 07/83	01/84 10/85	09/82 09/83	09/84	08/88			

**NETWORK KEY**

IMPROVE - IMPROVE site  
IMP Pro. - Non-IMPROVE site to be operated  
according to IMPROVE Protocol

**SITE NAME KEY**

NP - National Park  
NM - National Monument  
NS - National Seashore  
NWR - National Wildlife Refuge  
W - Wilderness

Table 4-2

Example Nephelometer Site Specifications Summary Table

SITE NAME	SITE ABRV	INSTRUMENT LOCATION			OBS. PER DAY	OPERATING PERIOD DURING FALL 1994
		LAT (°N)	LONG (°W)	ELEV (M)		
ACADIA NATIONAL PARK	ACAD	44°22'27"	68°15'39"	122	288	09/01/94 - 11/30/94
BOUNDARY WATERS CANOE AREA WILDERNESS	BOWA	47°56'42"	91°29'47"	524	288	11/01/94 - 11/30/94
DOLLY SODS WILDERNESS	DOSO	39°06'17"	79°25'33"	1175	288	10/14/94 - 11/30/94
GREAT SMOKY MOUNTAINS NATIONAL PARK	GRSM	35°37'56"	83°56'32"	808	288	09/01/94 - 11/30/94
JARBIDGE WILDERNESS	JARB	41°53'33"	115°25'31"	1856	288	09/01/94 - 11/30/94
MAMMOTH CAVE NATIONAL PARK	MACA	37°13'04"	86°04'25"	225	288	09/01/94 - 11/30/94
MOUNT RAINIER NATIONAL PARK	MORA	46°45'28"	122°07'17"	420	288	09/01/94 - 11/30/94
OKEFENOKEE NATIONAL WILDLIFE REFUGE	OKEF	39°44'19"	82°07'00"	15	288	09/14/94 - 11/30/94
UPPER BUFFALO WILDERNESS	UPBU	35°49'32"	93°12'51"	696	288	09/01/94 - 11/30/94



JARBIDGE WILDERNESS, NEVADA  
IMPROVE Nephelometer Data Summary  
Fall Season: September 1, 1994 - November 30, 1994

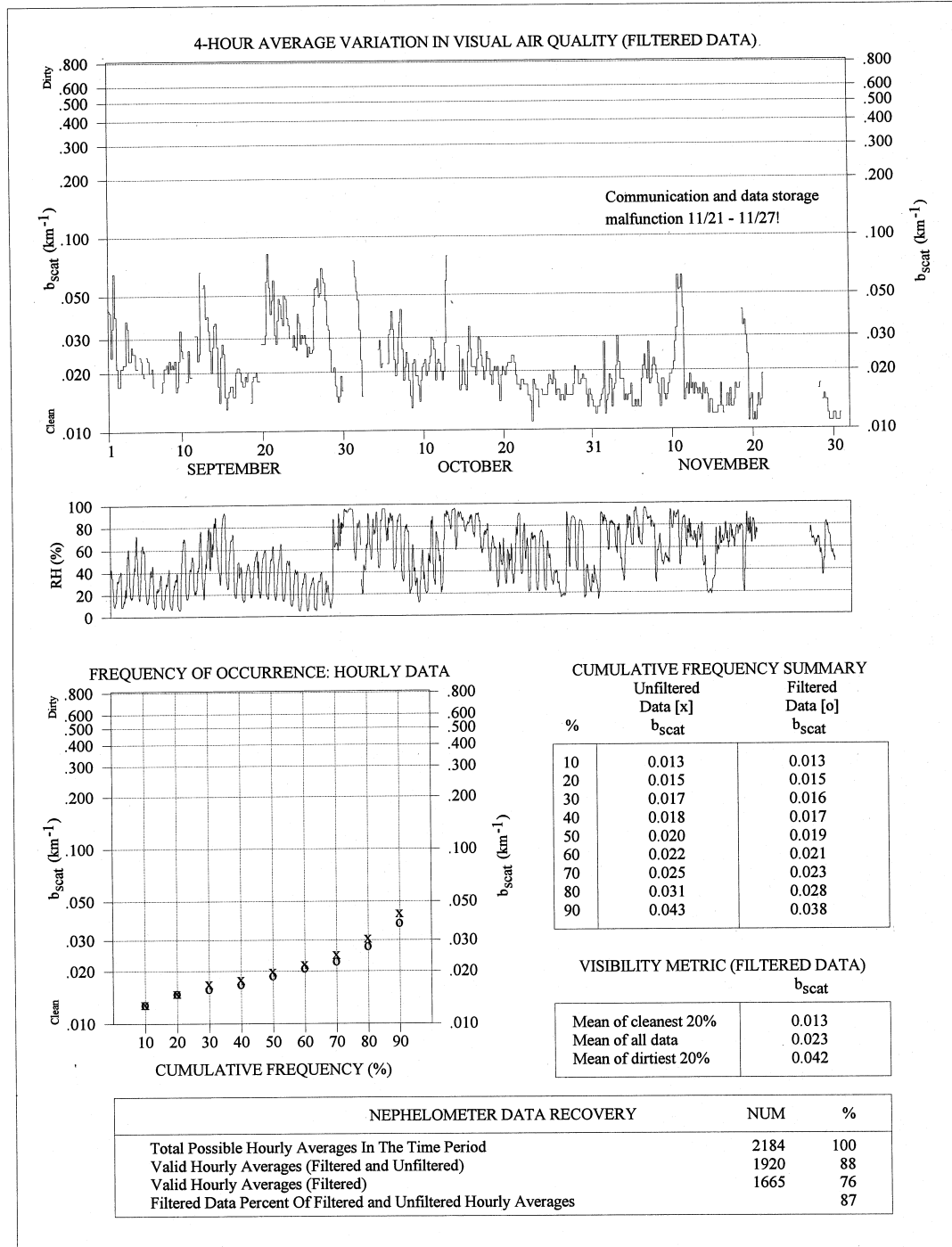


Figure 4-2. Example Seasonal Nephelometer Data Summary.

- **4-Hour Average Variation in Visual Air Quality (Filtered Data)** - Plot of four-hour averaged  $b_{scat}$  values (without interference-influenced observations) for each day of the reporting season. Gaps in the plot indicate that data were missing, interference-influenced, or failed validation procedures.
- **Relative Humidity** - Timeline of hourly average relative humidity measurements. This allows for a comparison of the effect of increasing relative humidity on measured  $b_{scat}$ .
- **Frequency of Occurrence: Hourly Data** - This plot is a frequency distribution of hourly average  $b_{scat}$  values, both unfiltered and filtered for meteorological interference. The 10% to 90% values are plotted in 10% increments and are summarized in the table to the right of the plot.

For  $b_{scat}$ , the 10%, 50%, and 90% values can be interpreted as:

<u>Value</u>	<u>Interpretation</u>
10%	10% of the time the $b_{scat}$ was less than or equal to the 10% value;
50%	Median value; 50% of the $b_{scat}$ observations are less than the 50% value and 50% of the observations are greater than the 50% value; and
90%	90% of the time the $b_{scat}$ was less than or equal to the 90% value (10% of the time it was greater than or equal to the 90% value).

- **Visibility Metric (Filtered Data)** - This table presents mean values of filtered  $b_{scat}$  data affected by meteorological interference. The best, worst, and average conditions using the arithmetic means of the 20th percentile least impaired visibility, the 20th percentile most impaired visibility, and for all data for the season are presented.
- **Data Recovery Statistics**

**Total Possible Hourly Averages in the Time Period** - The total possible category is calculated by subtracting the number of hourly averages included in periods when the instrument was removed due to conditions unrelated to system performance (installation, construction, site relocation, etc.) from the theoretical maximum number of hourly average periods possible during a season.

**Valid Hourly Averages (Filtered and Unfiltered)** - The number of valid hourly averages collected during a season. The percentage data recovery represents the number of valid hourly averages compared to the total possible hourly averages.

**Valid Hourly Averages (Filtered)** - The number of valid hourly averages (excluding any data indicating meteorological interference) collected during a season. The percentage represents the number of valid hourly averages compared to the total possible hourly averages.

**Filtered Data Percent of Filtered and Unfiltered Hourly Averages** - This percentage collection efficiency represents the number of filtered hourly averages compared to the number of all valid hourly averages.

**4.1.3.2 Events and Circumstances Influencing Data Recovery**

Each seasonal report contains a brief discussion of events and circumstances that influence data recovery. An analysis summary table is also prepared (for all data and for all data excluding meteorological-influenced data) based on actual monitoring periods. The table lists for each site, site name and abbreviation, the number of seasonal hourly averages possible, the number and percentage of valid hourly averages for all data and for filtered data only, and the cumulative frequency distribution (10%, 50%, and 90%  $b_{scat}$  values) for all data and filtered data only. An example Analysis Summary Table is presented as Table 4-3.

Table 4-3  
Example Analysis Summary Table

SITE	SITE ABRV	DATA RECOVERY			CUMULATIVE FREQUENCY DISTRIBUTION					
		POSSIBLE HOURLY AVERAGES	VALID HOURLY AVERAGES (ALL DATA)	VALID HOURLY AVERAGES (FILTERED)	$b_{scat}$ (km <sup>-1</sup> ) UNFILTERED DATA			$b_{scat}$ (km <sup>-1</sup> ) FILTERED DATA		
					10%	50%	90%	10%	50%	90%
ACADIA NP	ACAD	2184	2027 (93%)	1736 (79%)	.016	.028	.092	.016	.025	.066
BOUNDARY WATERS CANOE AREA W	BOWA	1186	709 (60%)	608 (51%)	.018	.029	.110	.017	.027	.071
DOLLY SODS W	DOSO	1143	1090 (95%)	737 (64%)	.018	.037	.286	.016	.029	.066
GREAT SMOKY MOUNTAINS NP	GRSM	2184	2072 (95%)	1619 (74%)	.021	.052	.221	.019	.041	.144
JARBIDGE W	JARB	2184	1920 (88%)	1665 (76%)	.013	.020	.043	.013	.019	.038
MAMMOTH CAVE NP	MACA	2184	2087 (96%)	1260 (58%)	.024	.073	.370	.022	.045	.409
MOUNT RAINIER NP	MORA	2184	2150 (98%)	1460 (67%)	.023	.050	.132	.022	.044	.109
OKEFENOKEE W	OKEF	1860	1267 (68%)	797 (43%)	.033	.079	.263	.030	.057	.136
UPPER BUFFALO W	UPBU	2184	1906 (87%)	1474 (67%)	.021	.076	4.160	.020	.054	.170

**4.1.4 References**

References are presented in two subsections: 1) Technical References, and 2) Related Reports and Publications. Technical references are those documents that are cited in the seasonal report. Related reports and publications include all prior reports pertaining to the monitoring program, produced by Air Resource Specialists, Inc. (ARS).

**4.1.5 Appendix A - Nephelometer Data Collection and Processing Procedures**

Each seasonal report contains an appendix that fully details nephelometer data collection and processing procedures. The following subsections, which are presented in the appendix, discuss these procedures.

**4.1.5.1 On-Site Data Logging and Transmission**

Nephelometer data transmittal from the site to ARS facilities is discussed. The data are transferred either by telephone modem directly from the site or through data collection platforms (DCPs) to the GOES satellite, to ARS via telephone modem. A full description of data collection procedures is included in SOP 4300, *Collection of Optical Monitoring Data (IMPROVE Protocol)*.

#### **4.1.5.2 Daily and Weekly Processing Procedures**

Detailed data collection and daily and weekly processing procedures performed at ARS facilities are described. This discussion includes the steps involved in reviewing data files for extraneous information, searching for problems that require corrective action, verifying the date and time of the transmitted data, and applying preliminary validity codes. Refer to TI 4400-5010, *Nephelometer Data Reduction and Validation (IMPROVE Protocol)*, for a complete discussion of data reduction procedures.

#### **4.1.5.3 Seasonal Data Processing Procedures**

Detailed discussions of the various processing and validation levels performed during each season are presented. Discussion includes file formats, validity codes applied during the various stages of processing (validation levels), theoretical concepts of uncertainty measurements, and identification of meteorological and optical interferences that affect the calculation of  $b_{\text{scat}}$  from nephelometer measurements. Figure 4-3 presents the nephelometer data processing flow chart.

### **4.2 ANNUAL DATA REPORTING**

Annual reports contain seven (7) major sections:

- 1.0 Introduction
- 2.0 Data Collection and Reduction
- 3.0 Site Configuration
- 4.0 Data Summary Description
- 5.0 Nephelometer Data Summaries
- 6.0 Summary
- 7.0 References

The information and data presentation formats included in each section are summarized in the following subsections.

#### **4.2.1 Introduction**

The introduction section contains a conceptual overview of the purpose of the monitoring program and a description of the monitoring networks. It also includes a map of the United States, depicting locations of all nephelometer monitoring sites (see Figure 4-1).

#### **4.2.2 Data Collection and Reduction Procedures**

Each annual report contains detailed nephelometer data collection and processing procedures, identical to the appendix included in seasonal reports (refer to Section 4.1.5). Discussion includes data collection methods, data file review, data validation, application of validity codes, processing through various validation levels, and discussion of file formats, theoretical concepts of uncertainty measurements, and identification of meteorological and optical interferences that affect the calculation of  $b_{\text{scat}}$  from nephelometer measurements.

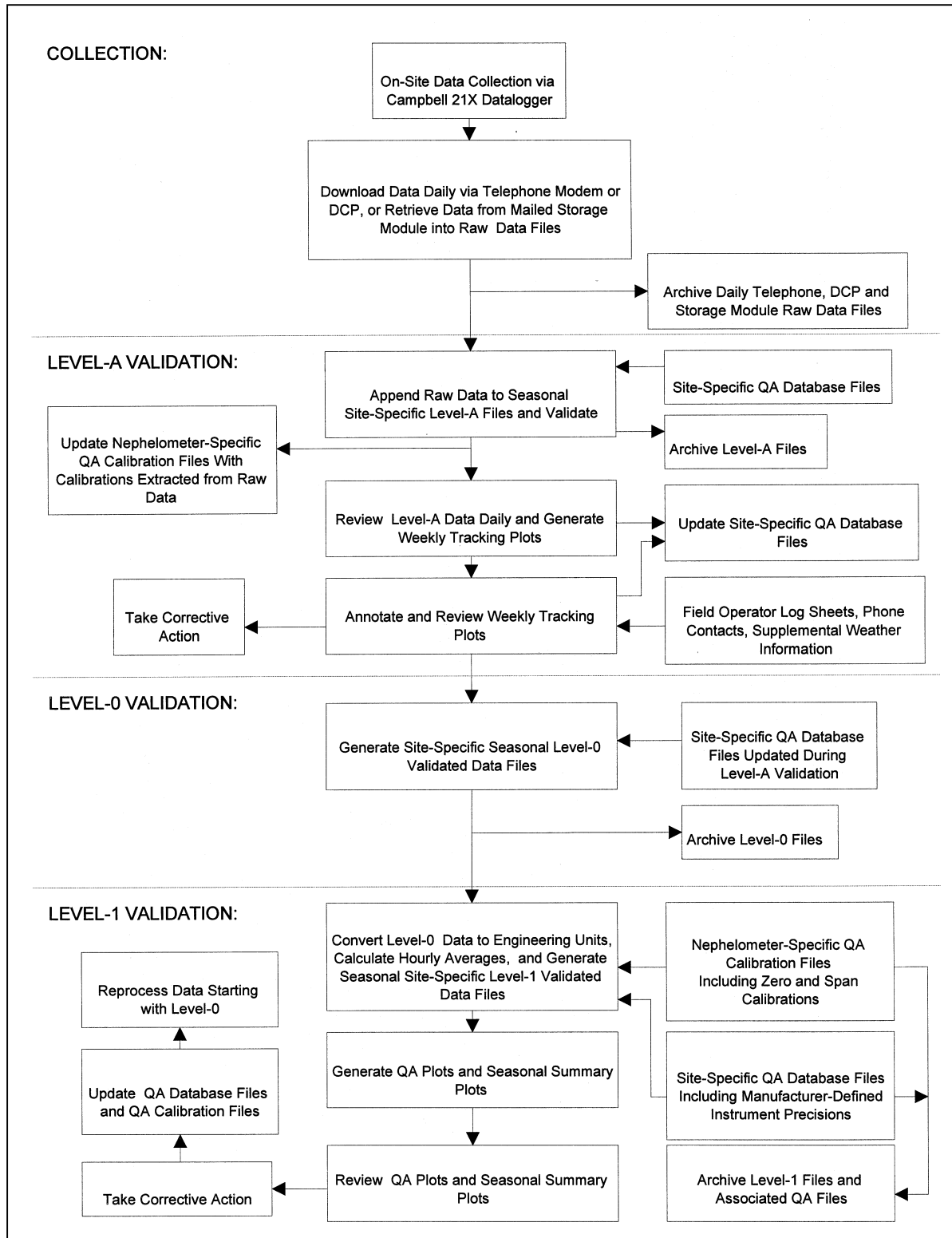


Figure 4-3. Nephelometer Data Processing Flow Chart.

### **4.2.3 Site Configuration**

The site configuration section contains a brief discussion of instrumentation at each nephelometer site and basic principles of operation. A site specifications summary table is presented (see Table 4-2).

### **4.2.4 Data Summary Description**

Each annual report contains a data summary description section describing seasonal and annual data summaries. Refer to Section 4.1.3 for a detailed discussion of seasonal summaries. Annual data summaries are prepared for each site that operated during the reporting period, and are based on a calendar year instead of season. An example Annual Nephelometer Data Summary is presented as Figure 4-4. The following is a detailed explanation of the contents of the data summaries and accompanies the summaries in each report. Annual Nephelometer Data Summaries include three data presentations:

- **Monthly Median Visual Air Quality** - Plot of median monthly  $b_{\text{scat}}$  for all data and for filtered data only. As the visual air quality improves,  $b_{\text{scat}}$  values decrease. A Rayleigh atmosphere is defined by a  $b_{\text{scat}}$  of approximately  $0.01 \text{ km}^{-1}$ .
- **Monthly Cumulative Frequency Summaries** - Table of cumulative frequency distribution average  $b_{\text{scat}}$  values for all data and for filtered data only. The 10%, 50%, and 90% values are presented. Also included are data recovery statistics (total possible readings, number and percent of collected readings, and number and percent of valid readings (both all data and filtered data only)).
- **Annual Frequency of Occurrence: Hourly Data** - This plot is a frequency distribution of hourly average  $b_{\text{scat}}$  values for all data and for filtered data only. The 10% to 90% values are plotted in 10% increments. Numerical values are presented in the adjacent cumulative frequency summary table.

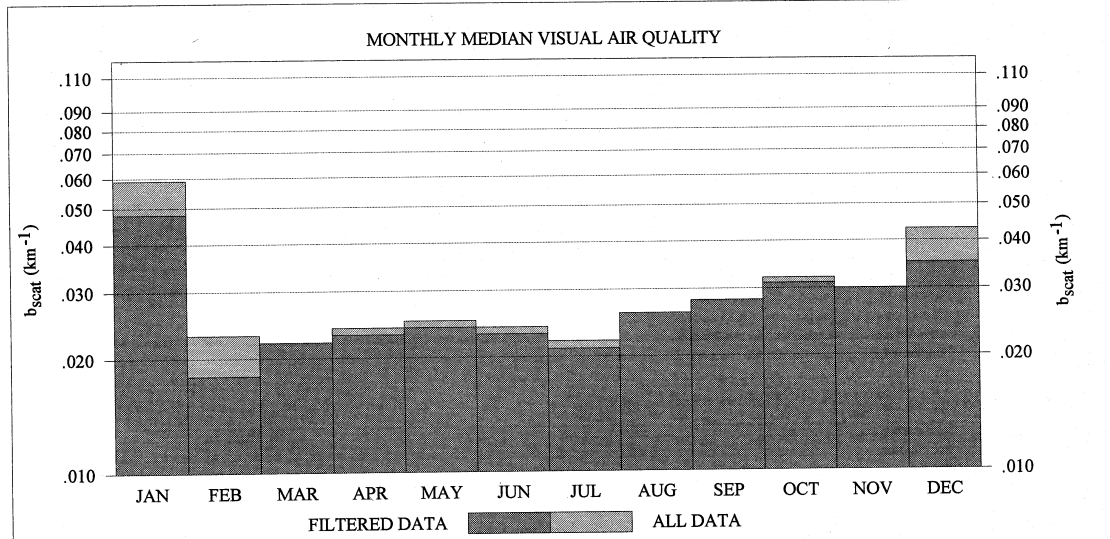
For  $b_{\text{scat}}$ , the 10%, 50%, and 90% values can be interpreted as:

<u>Value</u>	<u>Interpretation</u>
10%	10% of the time the $b_{\text{scat}}$ was less than or equal to the 10% value;
50%	Median value; 50% of the $b_{\text{scat}}$ observations are less than the 50% value and 50% of the observations are greater than the 50% value; and
90%	90% of the time the $b_{\text{scat}}$ was less than or equal to the 90% value (10% of the time it was greater than or equal to the 90% value).

### **4.2.5 Nephelometer Data Summaries**

The data summary section presents first the seasonal summary plots, then the annual summary plots. Data recovery and cumulative frequency distribution tables follow, containing a summary of values for each season (see Table 4-3).

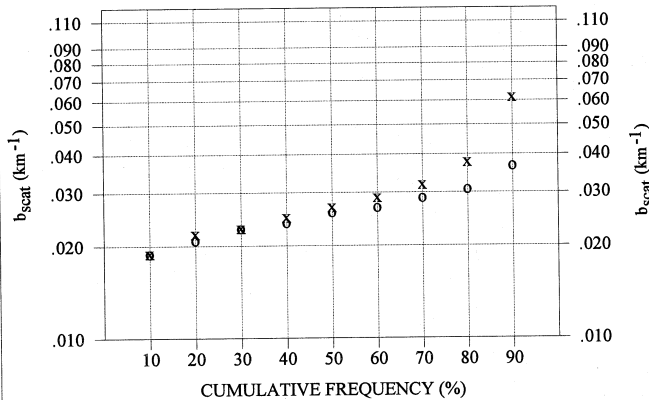
MOUNT RAINIER NATIONAL PARK, WASHINGTON  
Annual Nephelometer Data Summary  
All Data: January 1, 1992 - December 31, 1992



MONTHLY CUMULATIVE FREQUENCY SUMMARIES

MONTH	YEAR	FILTERED DATA			ALL DATA			DATA RECOVERY STATISTICS						
		10% bscat	50% bscat	90% bscat	10% bscat	50% bscat	90% bscat	POSS. NUM	COLLECTED NUM	%	ALL NUM	%	FILTERED NUM	%
JAN	1992	0.027	0.048	0.069	0.029	0.059	0.608	744	741	100	739	99	135	18
FEB	1992	0.015	0.018	0.031	0.015	0.023	0.076	696	693	100	692	99	371	53
MAR	1992	0.017	0.022	0.027	0.017	0.022	0.031	744	741	100	740	99	555	75
APR	1992	0.019	0.023	0.029	0.019	0.024	0.030	720	720	100	720	100	655	91
MAY	1992	0.019	0.024	0.030	0.020	0.025	0.033	744	744	100	744	100	554	74
JUN	1992	0.019	0.023	0.029	0.019	0.024	0.033	720	719	100	718	100	595	83
JUL	1992	0.017	0.021	0.028	0.017	0.022	0.030	744	742	100	741	100	654	88
AUG	1992	0.021	0.026	0.033	0.022	0.026	0.037	744	738	99	720	97	674	91
SEP	1992	0.025	0.028	0.035	0.025	0.028	0.036	720	708	98	707	98	685	95
OCT	1992	0.025	0.031	0.039	0.025	0.032	0.041	744	735	99	735	99	683	92
NOV	1992	0.024	0.030	0.038	0.024	0.030	0.044	720	717	100	717	100	623	87
DEC	1992	0.022	0.035	0.059	0.023	0.043	0.169	744	738	99	735	99	506	68
ALL DATA		0.019	0.026	0.037	0.019	0.027	0.062	8784	8736	99	8708	99	6690	76

ANNUAL FREQUENCY OF OCCURRENCE: HOURLY DATA



ANNUAL CUMULATIVE FREQUENCY SUMMARY

%	Filtered Data [o] bscat	All Data [x] bscat
10	.019	.019
20	.021	.022
30	.023	.023
40	.024	.025
50	.026	.027
60	.027	.029
70	.029	.032
80	.031	.038
90	.037	.062

D:01/20/94 1:48 p P:03/20/95

V1.01:3/20/95

Figure 4-4. Example Annual Nephelometer Data Summary.

#### **4.2.6 Summary**

The summary section provides a synopsis of the nephelometer network, including changes in operational techniques, and a general conclusion of the monitoring year in review.

#### **4.2.7 References**

Identical to the seasonal reports, references are presented in two subsections: 1) Technical References, and 2) Related Reports and Publications. Technical references are those documents that are cited in the annual report. Related reports and publications include all prior reports pertaining to the monitoring program, produced by ARS.

### **4.3 REPORT DISTRIBUTION**

Reports are reviewed and approved by the project manager prior to preparation for distribution. When ready, ARS contacts the local project-specific COTR office for distribution requirements and provides the deliverable products as directed. The amount or type of deliverable product may vary with each report; for example, 15 seasonal reports and 5 annual reports are delivered to the NPS.

### **5.0 REFERENCES**

AH Technical Services, 1987, Guidelines for Preparing Reports for the NPS Air Quality Division, September.