AIR QUALITY SURVEILLANCE SYSTEM

By

H. V. Geary
H. E. Cramer
R. M. Bradway

Prepared by

GCA CORPORATION
GCA TECHNOLOGY DIVISION
Bedford, Massachusetts 01730

Contract No. 68-02-0041

November 1971

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OFFICE OF AIR PROGRAMS
ENVIRONMENTAL PROTECTION AGENCY

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TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

SECTION 1
INTRODUCTION

1.1 OBJECTIVES

The overall objective of the work is to provide technical assistance to the State of Oregon in formulating the segments of the Implementation Plan for achieving National Ambient Air Quality Standards that treat the design and operation of an air quality surveillance system. Detailed work objectives are defined below. Under Task 1, first priority is assigned to Items e, f, g and h.

1. Describe the existing and planned air quality surveillance system and if change or additions are recommended, design and describe an adequate system which is a modification of the existing or planned system. Each description shall include:

    a. The basis for the design of the system, selection of samplers, and sampling sites.

    b. Designation of responsibilities of state and each regional agency in operation of a single coordinated system of sampling, analysis and data management.

    c. Locations of samplers by UTM grid coordinates or equivalent.

    d. Sampling schedules.

    e. Methods of sampling and analysis, including specifications of alternative commercially available instruments.

    f. Method of data acquisition, data handling and analysis procedures, including specifications of alternative commercially available instrumentation.

g. Timetable for the installation of any additional equipment needed to complete the system.

h. Detailed estimation of costs for implementation of the system.

i. Other

2. Design a provision for monitoring during any air pollution episode stage.

1.2 APPROACH AND REPORT ORGANIZATION

The first step in this study was to describe in detail the present air quality surveillance system in Oregon with particular attention focused on system functions and organization; air quality and meteorological monitoring networks; measurement and laboratory assay techniques; and on the procedures followed in the handling and analysis of air quality data. The second step in the study consisted of a detailed analysis of the requirements for air quality surveillance in Oregon arising from both the Federal Priority Classifications of major pollutants in each of the five air quality control regions in Oregon and from air quality programs currently being implemented by the State. As part of this step, the Federal specifications for air quality measurement procedures were compared with the corresponding procedures currently employed by Oregon in air quality surveillance. The third step in the study was the development of the concepts for a new surveillance system in Oregon, starting with a review of current emissions and air quality data, as well as the air pollution climatology and meteorology of Oregon. Detailed specifications were then developed for the air quality networks needed in routine air quality surveillance and air pollution episodes; for the corresponding data handling, laboratory assay, and data analysis procedures; and for the organizational and operational responsibilities of the five air quality control regions in the new system. The final step in the study was the development of plans for implementing the new air quality surveillance system.

The organization of the material in this report follows the steps in the approach outlined above, with a major section of the main body of the report devoted to each step. Background material and other auxiliary information important to a proper understanding and interpretation of the contents of the main body of the report have been placed in five appendices.

SECTION 2

DESCRIPTION OF THE PRESENT SURVEILLANCE SYSTEM

2.1 SYSTEM FUNCTIONS AND ORGANIZATION

The existing air quality surveillance system in Oregon is made up of several monitoring networks operated by separate air pollution control agencies, with the Department of Environmental Quality of the State of Oregon operating the major network which covers most of the State. Three Regional Air Pollution Authorities—Columbia-Willamette Air Pollution Authority (CWAPA), Mid-Willamette Valley Air Pollution Authority (MWVAPA), and Lane Regional Air Pollution Authority (LRAPA)—operate surveillance systems within their respective jurisdictional areas. Figure 2-1 shows the areas of jurisdiction for the three Regional Air Pollution Authorities and the five Federal Air Quality Control Regions. The existing surveillance networks were designed to provide the information necessary to establish the general levels and trends of suspended particulate matter, sulfur dioxide, and particle fallout for the major cities and communities of the State. In addition, special source monitoring stations are operated by the Department of Environmental Quality and the Regional Air Pollution Authorities.

The Department of Environmental Quality operates and maintains a continuous air monitoring system (CAM) at 718 West Burnside Street, Portland, Oregon. Pollutant measurements made at this site include:

- Carbon monoxide
- Sulfur dioxide
- Nitrogen dioxide
- Ozone
- Total hydrocarbons

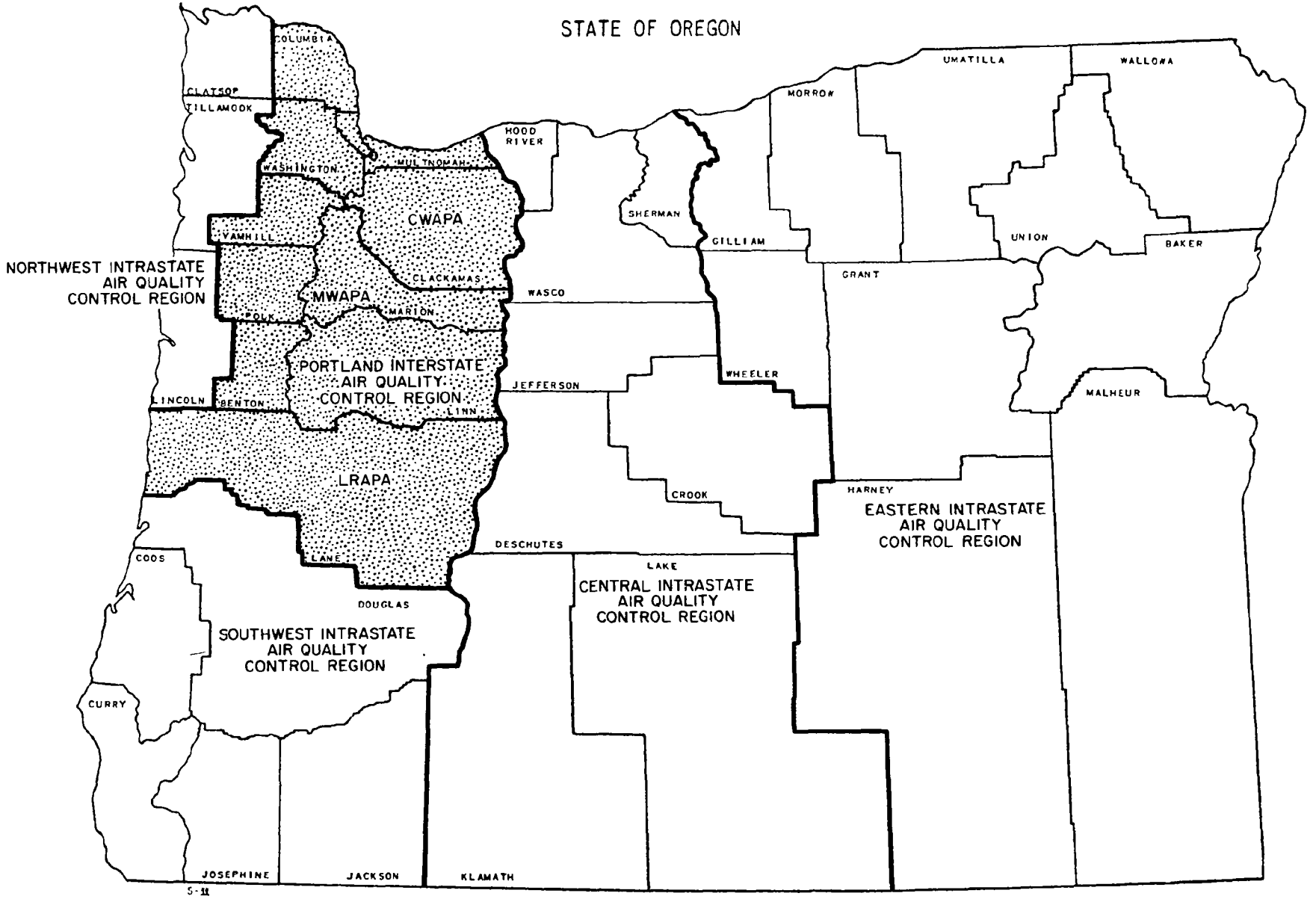

FIGURE 2-1. Political jurisdictions of the Regional Air Pollution Authorities and Federal Air Quality Control Regions.

- Nitric oxide
- Total oxidants
- Soiling Index

The Department of Environmental Quality (DEQ) also operates the Oregon State Air Sampling Network (OSASN) which comprises 25 stations in each of 23 cities in the State having a population of 10,000 or more. Measurements made at each station include suspended particulates, particle fallout, and sulfur-containing gases. Periodic gas sampling has been conducted in the major cities of Oregon to establish the concentration levels for sulfur dioxide, oxides of nitrogen, carbon monoxide and total oxidants.

The Columbia-Willamette Air Pollution Authority operates a continuous gas monitoring station at 1010 N.E. Couch Street in Portland for nitrogen dioxide, carbon monoxide, ozone, soiling index, and suspended particulates. Lane Regional Air Pollution Authority operates a continuous gas monitoring station at 11th and Willamette Streets in Eugene for carbon monoxide, total hydrocarbons, suspended particulates and soiling index. Mid-Willamette Valley Air Pollution Authority operates a continuous suspended particulate monitoring station at 2585 State Street in Salem.

The inventory of sampling equipment that is currently available for use in air quality monitoring programs within the State is given in Table 2-1.

2.2 AIR QUALITY AND METEOROLOGICAL NETWORKS

2.2.1 Current Surveillance Network for Suspended Particulates

Suspended particulate measurements are being made on a routine basis using hi-vol samplers at approximately 64 locations, AISI tape samplers at 5

TABLE 2-1

SAMPLING EQUIPMENT INVENTORY

Agency	Manufacturer	Model No.	Number
HI-VOL SAMPLERS			
DEQ	General Metals	2000	75
CWAPA	General Metals	2000	12
	Electro-Neuclonics	620	20
MWVAPA	General Metals	2000	12
	UNICO	550	12
LRAPA	General Metals	2000	11
		Total	142
AISI TAPE SAMPLERS			
DEQ	RAC	E1, E2, F2	10
CWAPA	UNICO	80TS	8
	RAC	E2, F2	3
MWVAPA	Gelman	23000	2
	UNICO	40TS	4
LRAPA	RAC	F2	2
		Total	29
LEAD PEROXIDE CANDLES			
DEQ	RAC		50
MWVAPA	RAC		8
		Total	58
SEQUENTIAL SAMPLERS (IMPINGERS)			
DEQ	Gelman	(24)	1
LRAPA	RAC	(8)	1
	CENCO	(8)	1
		Total	3
DEQ	Impingers		15
	Impingers - Midget		60
		Total	75

TABLE 2-1 (Continued)

Agency	Manufacturer	Model No.	Number
OZONE			
DEQ	Mast Development Corporation	724-2	1
CWAPA	Mast Development Corporation	724-2	1
			Total 2
TOTAL OXIDANTS			
DEQ	Beckman	K1005	1
NITROGEN DIOXIDE			
DEQ	Beckman	K1008	2
CWAPA	Technicon	4	1
			Total 3
CARBON MONOXIDE			
DEQ	MSA	LIRA200	2
CWAPA	MSA	LIRA200	2
LRAPA	Beckman	315AL	1
			Total 5
SULFUR DIOXIDE			
DEQ	Beckman	K1006	2
	L&N	64251-A1	1
CWAPA	Beckman	K1006	2
			Total 5

TABLE 2-1 (Continued)

Agency	Manufacturer	Model No.	Number
TOTAL HYDROCARBONS			
DEQ	Beckman	109A	1
CWAPA	Beckman	109A	1
LRAPA	Beckman	400	1
			Total 3
NEPHELOMETER			
CWAPA	MRI	1550	1
LRAPA	MRI	1550	1
MWVAPA	MRI	1550	1
			Total 3
PARTICULATE FALLOUT			
DEQ	(Custom Built to Oregon Specifications)		275
CWAPA	(Custom Built to Oregon Specifications)		100
LRAPA	(Custom Built to Oregon Specifications)		75
MWVAPA	(Custom Built to Oregon Specifications)		50
			Total 500

locations, and MRI nephelometers at 3 locations. The locations of the sampling stations, the sampling schedule, the land use, and the UTM coordinates for each station are presented in Table 2-2.

2.2.2 Current Surveillance Network for Particle Fallout

The current particle-fallout surveillance network includes approximately 93 sampling stations operated on a routine monthly basis. A particle fallout jar is maintained at each of the 64 suspended particulate hi-vol stations listed in Table 2-2 and at 21 other locations listed in Table 2-3. In addition, the Department of Environmental Quality operates approximately 10 non-permanent particle-fallout stations in the vicinity of specific sources.

2.2.3 Current Network for Sulfur Dioxide

There is currently one continuous SO_2 monitoring station operated by the Department of Environmental Quality at the CAM Station at 718 West Burnside Street in Portland. The SO_2 measurements are obtained with a Leeds and Northrup autometer model 64251-A1 using the conductimetric detection method.

In the past, periodic gas sampling of SO_2 concentration has been conducted using a midget impinger and the West-Gaeke analytical method of detection. The sampling schedule was based upon one 10-minute sample per hour for 12 hours per day, for three to five consecutive days. Periodic gas samples of SO_2 concentration were taken at the following locations:

- Salem, Tallman Piano, County Courthouse
- Eugene, State Office Building, City Hall and Armory

TABLE 2-2

SUSPENDED PARTICULATE NETWORK

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates	
				x	y
REGION 190 - Central Air Quality Control Region					
DEPARTMENT OF ENVIRONMENTAL QUALITY					
Hi-Vol					
090405	Bend Deschutes County Courthouse	Every 4th day	Commercial/ Residential	636,200	4,880,200
181014	Klamath Falls Broad & Wall Sts.	Every 4th day	Commercial/ Residential	604,200	4,672,800
181015	Klamath Falls Oregon Technical Institute	Every 4th day	Rural		
331716	The Dalles 400 E. 5th Sts.	Every 4th day	Commercial/ Residential	641,600	5,050,600
REGION 191 - Eastern Air Quality Control Region					
DEPARTMENT OF ENVIRONMENTAL QUALITY					
Hi-Vol					
311612	LaGrande EOC Science Bldg.	Every 4th day	Residential	414,800	5,018,900
302018	Pendleton Umatilla County Courthouse	Every 4th day	Commercial/ Residential	360,600	5,058,800
010404	Baker 1925 Washington St.	Every 4th day	Commercial/ Residential	434,000	4,957,900

TABLE 2-2 (Continued)

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates x	UTM Coordinates y
REGION 192 - Northwest Air Quality Control Region					
DEPARTMENT OF ENVIRONMENTAL QUALITY					
Hi-Vol					
040205	Astoria 857 Commercial St.	Every 4th day	Commercial/ Residential	435,500	5,115,200
REGION 193 - Portland Interstate Air Quality Control Region					
DEPARTMENT OF ENVIRONMENTAL QUALITY					
OSASN Hi-Vol					
220214	Albany 4th & Broadalbin	Every 4th day	Commercial/ Residential	491,593	4,942,235
341001	Beaverton 450 SW Hall St.	Every 4th day	Commercial/ Residential	515,420	5,036,684
020406	Corvallis 124 NW 7th St.	Every 4th day	Commercial/ Residential	479,226	4,934,535
201835	Eugene 11th & Pearl Sts.	Every 4th day	Commercial/ Residential	482,850	4,884,450
343403	Hillsboro 150 NE 3rd Ave.	Every 4th day	Commercial/ Residential	500,977	5,040,398
034001	Lake Oswego 368 S. State St.	Every 4th day	Commercial/ Residential	517,200	5,028,417
361703	McMinnville 5th & Evans Sts.	Every 4th day	Commercial/ Residential	484,914	5,006,321
034311	Milwaukie 1550 23rd St.	Every 4th day	Residential	528,405	5,031,852
261477	Portland 3119 SE Holgate	Every 4th day	Residential	528,785	5,037,251

TABLE 2-2 (Continued)

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates x	UTM Coordinates y
REGION 193 (Continued)					
DEPARTMENT OF ENVIRONMENTAL QUALITY (Continued)					
OSASN Hi-Vol					
243826	Salem Willamette Univ. Univ. Center Bldg.	Every 4th day	Commercial/ Residential	497,180	4,976,580
203311	Springfield 3rd and B Sts.	Every 4th day	Commercial/ Residential	487,800	4,875,300
261476	Portland 718 W Burnside St.	Every 4th day	Commercial	525,259	5,040,865
AISI Tape Samplers					
261476	Portland 718 W Burnside St.	Continuous	Commercial	525,259	5,040,865
COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY					
Hi-Vol					
261403	Portland 1830 SE Schiller	Every 4th day	Industrial	527,846	5,037,069
261407	Portland 6941 N. Central	Every 4th day	Residential	520,488	5,048,243
261408	Portland 55 SW Ash	Every 4th day	Commercial	525,872	5,040,743
261410	Portland 10623 SW 35th	Every 4th day	Residential	522,327	5,032,661

TABLE 2-2 (Continued)

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates	
				x	y
REGION 193 (Continued)					
COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY (Continued)					
Hi-Vol					
261412	Portland 1845 NE Couch	Every 4th day	Commercial	527,789	5,040,909
261415	Portland 333 SW Skyline	Every 4th day	Residential	520,761	5,040,819
261416	Portland 3200 NW Yeon	Every 4th day	Industrial	523,046	5,043,414
261423	Portland 340 NE 122	Every 4th day	Commercial	536,188	5,041,367
261435	Portland 11212 NW St. Helens	Every 4th day	Industrial	516,570	5,049,737
261436	Portland 11717 NE Shaver	Every 4th day	Residential	535,761	5,044,326
261437	Portland 500 N. Willamette	Every 4th day	Residential	527,459	5,046,599
261452	Portland Rivergate Ind. Park	Every 4th day	Industrial	517,215	5,052,531
260801	Gresham 1300 N. Main	Every 4th day	Residential	547,356	5,039,046
261701	Troutdale	Every 4th day	Non-Urban	547,706	5,044,483
035201	Oak Grove Oak Grove School	Every 4th day	Residential	528,152	5,029,121

TABLE 2-2 (Continued)

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates	
				x	y
REGION 193 (Continued)					
COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY (Continued)					
Hi-Vol					
035501	Oregon City 8th and Main	Every 4th day	Commercial	530,826	5,022,559
035504	Oregon City 4th and Central	Every 4th day	Residential	530,805	5,022,123
036401	Sandy Fire Station	Every 4th day	Commercial	557,828	5,027,054
052501	Rainier C Street	Every 4th day	Commercial	505,182	5,103,552
052801	St. Helens Condon Grade School	Every 4th	Residential	514,823	5,078,582
052802	St. Helens 2256 Old Ptld. Rd.	Every 4th day	Suburban	513,897	5,076,496
053101	Scappoose NW Beacon-Airport	Every 4th	Suburban	510,921	5,068,826
343402	Hillsboro Airport	Every 4th day	Suburban	503,976	5,041,969
AISI Tape Samplers					
261426	Portland 1010 NE Couch St.	Continuous	Commercial	527,062	5,040,911
Nephelometer					
261426	Portland 1010 NE Couch St.	Continuous	Commercial	527,062	5,040,911

TABLE 2-2 (Continued)

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates	
				x	y
REGION 193 (Continued)					
MID-WILLAMETTE VALLEY AIR POLLUTION AUTHORITY					
Hi-Vol					
020001	Mary's Peak	26 per year Summer Only	Rural	456,138	4,927,996
220001	Hoodoo Ski Bowl	Every 4th day	Rural	589,964	4,918,110
222909	Sweet Home Jr. High School	Every 4th day	Commercial	521,935	4,915,768
221401	Lebanon Main & Maple	26 per year	Commercial	506,749	4,951,391
243821	Salem 2585 State St.	Every 4th day	Commercial	499,364	4,975,269
244403	Silverton 115 N. 1st St.	26 per year	Commercial	517,279	4,983,498
243824	Salem 100 Chemeketa	26 per year	Commercial	496,704	4,976,505
244702	Stayton	26 per year	Industrial	515,606	4,960,720
245603	Woodburn West Building	26 per year	Commercial	513,790	4,999,700
270402	Dallas County Courthouse	26 per year	Commercial	475,205	4,974,041
271601	Perrydale Perrydale Grade School	26 per year	Residential	477,741	4,985,390

TABLE 2-2 (Continued)

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates x	UTM Coordinates y
REGION 193 (Continued)					
MID-WILLAMETTE VALLEY AIR POLLUTION AUTHORITY (Continued)					
AISI Tape Samplers					
243821	Salem 2585 State St.	Continuous	Commercial	499,364	4,975,269
Nephelometer					
243821	Salem 2585 State St.	Continuous	Commercial	499,364	4,975,269
LANE REGIONAL AIR POLLUTION AUTHORITY					
Hi-Vol					
201832	Eugene City Hall	Every 4th day	Commercial	492,950	4,877,550
201833	Eugene Airport	Every 4th day	Rural	482,850	4,884,450
203337	Springfield City Library	Every 4th day	Commercial/ Residential	498,250	4,876,950
203335	Springfield City Shops	Every 4th day	Industrial	500,180	4,876,620
202404	Junction City City Library	Every 4th day	Commercial/ Residential	483,850	4,895,930

TABLE 2-2 (Continued)

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates x	UTM Coordinates y
REGION 193 (Continued)					
LANE REGIONAL AIR POLLUTION AUTHORITY (Continued)					
AISI Tape Samplers					
201852	Eugene 11th & Willamette	Continuous	Commercial	492,660	4,875,900
203351	Springfield 5th & Main Sts.	Continuous	Commercial		
Nephelometer					
201852	Eugene 11th & Willamette	Continuous	Commercial	492,660	4,875,900
REGION 194 - Southwest Air Quality Control Region					
DEPARTMENT OF ENVIRONMENTAL QUALITY					
Hi-Vol					
150205	Ashland City Hall	Every 4th day	Commercial/ Residential	523,400	4,671,500
060701	Coos Bay 4th & Central Ave.	Every 4th day	Commercial/ Residential	401,300	4,802,000
170705	Grants Pass NW 6th & C Sts.	Every 4th day	Commercial/ Residential	473,200	4,697,200
152017	Medford Main & Oakdale	Every 4th day	Commercial/ Residential	510,000	4,685,300
102717	Roseburg 1154 SE Douglas	Every 4th day	Commercial/ Residential	473,200	4,784,700

TABLE 2-3

PARTICLE FALLOUT NETWORK STATIONS NOT INCLUDED IN HI-VOL SUSPENDED PARTICULATE SAMPLING NETWORK

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates	
				x	y
REGION 193 - Portland Interstate Air Quality Control Region					
	COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY				
261442	Portland 10105 N. Lombard	Monthly	Industrial	518,586	5,049,538
261455	Portland Rivergate	Monthly	Industrial	518,210	5,050,915
	MID-WILLAMETTE VALLEY AIR POLLUTION AUTHORITY				
245602	Woodburn Front & Cleveland	Monthly		511,379	4,999,298
362001	Newberg Post Office	Monthly		502,065	5,016,058
362301	Sheridan Railroad & Bridge	Monthly		469,192	4,993,701
	LANE REGIONAL AIR POLLUTION AUTHORITY				
201829	Eugene 6th & Garfield St.	Monthly	Urban		
201831	Eugene 50 N. Danebo St.	Monthly	Urban		
201835	Eugene Willamette High School	Monthly	Urban		

TABLE 2-3 (Continued)

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates	
				x	y
REGION 193 (Continued)					
	LANE REGIONAL AIR POLLUTION AUTHORITY (Continued)				
200034	Eugene Lane BPA Substation	Monthly	Rural		
203336	Springfield Water Treatment Plt.	Monthly	Urban		
203332	Springfield 3400 N. Street	Monthly	Urban		
203315	Springfield Yolando School	Monthly	Urban		
203320	Springfield 47th & Main Sts.	Monthly	Urban		
200007	Springfield Thurston Walter- ville Fire Station	Monthly	Rural		
200021	Springfield Mohawk School	Monthly	Rural		
200916	Cottage Grove 1133 E. Main St.	Monthly	Commercial/ Residential		
200901	Cottage Grove City Hall	Monthly	Commercial/ Residential		
203001	Oakridge Fire Station	Monthly	Commercial/ Residential		
202701	Lowell PNB Building	Monthly	Residential		

TABLE 2-3 (Continued)

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates x	UTM Coordinates y
REGION 193 (Continued)					
LANE REGIONAL AIR POLLUTION AUTHORITY (Continued)					
203601	Veneta Western Lane Fire Protection Assoc.	Monthly	Rural		
202113	Florence City Shops	Monthly	Residential		
REGION 192 - Northwest Air Quality Control Region					
NONE					
REGION 194 - Southwest Air Quality Control Region					
NONE					
REGION 190 - Central Air Quality Control Region					
NONE					
REGION 191 - Eastern Air Quality Control Region					
NONE					

- Medford, Medical Center Building and old City Hall
- Portland, State Office Building
- Grants Pass, Josephine County Courthouse

2.2.4 Supplementary Sulfur Dioxide Monitoring Program - Lead Peroxide Candles

The current surveillance network includes 27 lead peroxide candle stations located throughout the State. Twenty-three of these stations are operated by the Department of Environmental Quality as part of the OSASN system. Mid-Willamette Valley Air Pollution Authority operates four stations at the following locations:

- Lebanon, Main and Maple Streets
- Salem, Court and High Streets
- Salem, 100 Chemeketa Street
- Newberg, Publishers Paper Holding Pond

An additional 5 lead peroxide candles are operated by the Department of Environmental Quality in special source monitoring studies.

2.2.5 Current Surveillance Network for Nitrogen Oxides

Currently, NO and NO_2 concentrations are being measured continuously at the Department of Environmental Quality's CAM Station at 718 West Burnside Street in Portland with a Beckman model K1008 acralyzer, using the modified Saltzman detection method. Continuous NO_2 concentrations are also being measured by the Columbia-Willamette Air Pollution Authority at 1010 Couch Street

in Portland with a Technicon Air Monitor IV, using the modified Saltzman method of detection.

Periodic gas sampling has been conducted in the past using fritted bubblers and the Saltzman analytical detection method for NO and NO_2. The sampling schedule was based upon one 10-minute sample per hour for 12 hours for three to five consecutive days. Measurements of NO and NO_2 concentrations were obtained at the following locations:

- Salem, Tallman Piano, County Courthouse
- Eugene, State Office Building, City Hall and Armory
- Medford, Medical Center Building and old City Hall
- Grants Pass, Josephine County Courthouse

Additional NO_2 samples were taken at:

- Portland, State Office Building

2.2.6 Current Surveillance Network for Oxidants

Currently, total oxidants O_x and ozone O_3 are being measured continuously at the Department of Environmental Quality's CAM Station at 718 West Burnside Street in Portland. Ozone concentrations are also being measured on a continuous basis at the Columbia-Willamette Air Pollution Authority's office at 1010 N. E. Couch Street in Portland. Both monitoring sites operate a Mast Development Corporation model 724-2 using the Coulometric potassium-iodide detection method.

Periodic gas sampling was conducted using midget impingers and the neutral buffered potassium iodide analytical detection method for O_x. The sampling schedule was based upon one 10-minute sample per hour for 12 hours per day, for three to five consecutive days. Periodic gas samples of O_x concentration were taken at the following locations:

- Salem, Tallman Piano, County Courthouse
- Eugene, State Office Building, City Hall and Armory
- Medford, Medical Center Building and old City Hall
- Grants Pass, Josephine County Courthouse
- Portland, State Office Building

2.2.7 Current Surveillance Network for Carbon Monoxide

Currently, CO concentrations are being monitored continuously by the Department of Environmental Quality, Lane Regional Air Pollution Authority, and Columbia-Willamette Air Pollution Authority at the following locations:

- Portland, 718 West Burnside Street
- Eugene, 11th and Willamette Street
- Portland, Pioneer Post Office

The Columbia-Willamette Air Pollution Authority also operates one continuous CO sampler in taking spot measurements within their five county region. All of the continuous CO measurements are obtained with Beckman model 315AL or MSA model LIRA200 nondispersive infrared instruments.

Periodic gas sampling for CO was conducted by the Department of Environmental Quality using the length of stain detector tube method at the following locations:

- Salem, Tallman Piano, County Courthouse
- Eugene, State Office Building, City Hall and Armory
- Medford, Medical Center Building and old City Hall
- Grants Pass, Josephine County Courthouse
- Portland, State Office Building

The sampling schedule was based upon one 30-minute sample per hour for 12 hours per day, for three to five consecutive days.

2.2.8 Current Surveillance Network for Hydrocarbons

Currently, total hydrocarbons are being measured and continuously recorded at the Department of Environmental Quality's CAM Station at 718 West Burnside Street in Portland, Columbia-Willamette Air Pollution Authority's site at 1010 N.E. Couch Street in Portland, and at Lane Regional Air Pollution Authority's site at 11th and Willamette Streets in Eugene. Measurements at all three sites are made with Beckman models 109A and 400 total hydrocarbon analyzers utilizing a flame ionization detection method.

2.2.9 Current Surveillance Network for Meteorology

Currently, the only meteorological networks operated in conjunction with air quality surveillance activities are two automated systems (one Berkeley and one Litton 512) located in the Portland Interstate Air Quality Control Region and

operated by the Columbia-Willamette Air Pollution Authority. These systems automatically acquire the following meteorological data from one central site located at 1010 Couch Street and eight remote sites:

- Wind Speed
- Wind Direction
- Air Temperature

The meteorological data from the remote sites are presented in the form of mean values for specified, but variable, time periods. The mean wind speeds and directions are not true arithmetic averages; instead, they are obtained from the vectorial combination of mean values of the orthogonal u- and v-wind velocity components. The locations of the remote stations of the two automated systems are presented in Table 2-4. Both of these systems are capable of acquiring air quality data and the implementation of this capability has been started with CO measurements at one station (see Table 2-4).

Meteorological information is obtained by the Department of Environmental Quality via the agricultural (Ag) teletype circuit from the National Weather Service, U. S. Forest Service and other participating agencies. Currently, local and regional meteorological information, air pollution advisories and area weather forecasts are the primary types of information supplied by this teletype circuit that are used in DEQ air pollution control activities. Arrangements can be made to have other pertinent meteorological information transmitted over this circuit. This teletype circuit thus supplies almost all the meteorological information needed by DEQ and is inexpensive.

TABLE 2-4

LOCATIONS OF REMOTE METEOROLOGICAL STATIONS IN THE CWAPA AUTOMATED NETWORK

Site Number	Location	System	Measurements
261701	Troutdale Troutdale Airport	Litton 512	Wind speed, wind direction, air temperature
35504	Oregon City 4th and Central	Litton 512	Wind speed, wind direction, air temperature
053101	Scappoose NW Beacon Airport	Litton 512	Wind speed, wind direction, air temperature
343402	Hillsboro Airport FAA Tower	Litton 512	Wind speed, wind direction, air temperature
261446	Portland KPTV Tower	Litton 512	Wind speed, wind direction (2 levels), air temperature (3 levels)
261447	Portland 104 5th	Litton 512	Wind speed, wind direction, air temperature
261453	Portland River Gate	Litton 512	Wind speed, wind direction, air temperature
245604	Woodburn McLaren School	Litton 512	Wind speed, wind direction, air temperature
261426	Portland 1010 NE Couch	Berkeley	Wind speed, wind direction
261453	Portland Pioneer Post Office 520 SW Morrison	Berkeley	Wind speed, wind direction*

*Currently, this station is being used to measure CO concentrations instead of wind speed and wind direction.

2.3 PARTICULATE MEASUREMENT AND ASSAY TECHNIQUES

Laboratory analysis of the particle fallout jars and the hi-vol suspended-particulate filters is carried out by the Department of Environmental Quality and the three Regional Authorities in accordance with the Oregon Administrative Rules, Chapter 340. The approved measurement techniques, laboratory techniques, and analysis methods are described in Exhibits A and B of the Rules which are reproduced in Appendix A. At the laboratory facilities maintained by the Department of Environmental Quality, suspended particulate samples are routinely analyzed for:

- Total weight
- Benzene solubles
- Copper
- Iron
- Lead
- Manganese
- Nickel
- Zinc

The laboratories maintained by the Regional Authorities perform the routine total weight analysis and some material extractions. Regional Authorities rely upon the Department of Environmental Quality for completing the analysis of the extractions and for performing the rest of the analysis.

In addition to the suspended particulate analyses described above, the National Air Sampling Network samples have in the past been analyzes for the following materials:

- Nitrates
- Cadmium
- Molybdenum
- Tin
- Titanium
- Vanadium
- Antimony
- Bismuth
- Cobalt

2.4 DATA-HANDLING AND ANALYSIS PROCEDURES

The data handling procedures used by each of the air pollution agencies are shown by data flow diagrams. The flow diagram for the Department of Environmental Quality is presented in Figure 2-2. Figures 2-3, 2-4 and 2-5 are samples of the hard-copy data forms currently being used by DEQ. Figure 2-6 is a sample form of the statistical summaries being produced using automatic data processing.

Data flow diagrams for the Mid-Willamette Valley Air Pollution Authority and Lane Regional Air Pollution Authority are presented in Figures 2-7 and 2-8 respectively. Mid-Willamette Valley Air Pollution Authority uses the facilities of the Columbia-Willamette Air Pollution Authority to produce the statistical summaries for their reports and in-house studies.

Data flow for the Columbia-Willamette Air Pollution Authority is presented in two diagrams. The first, Figure 2-9, shows the current data flow. The present

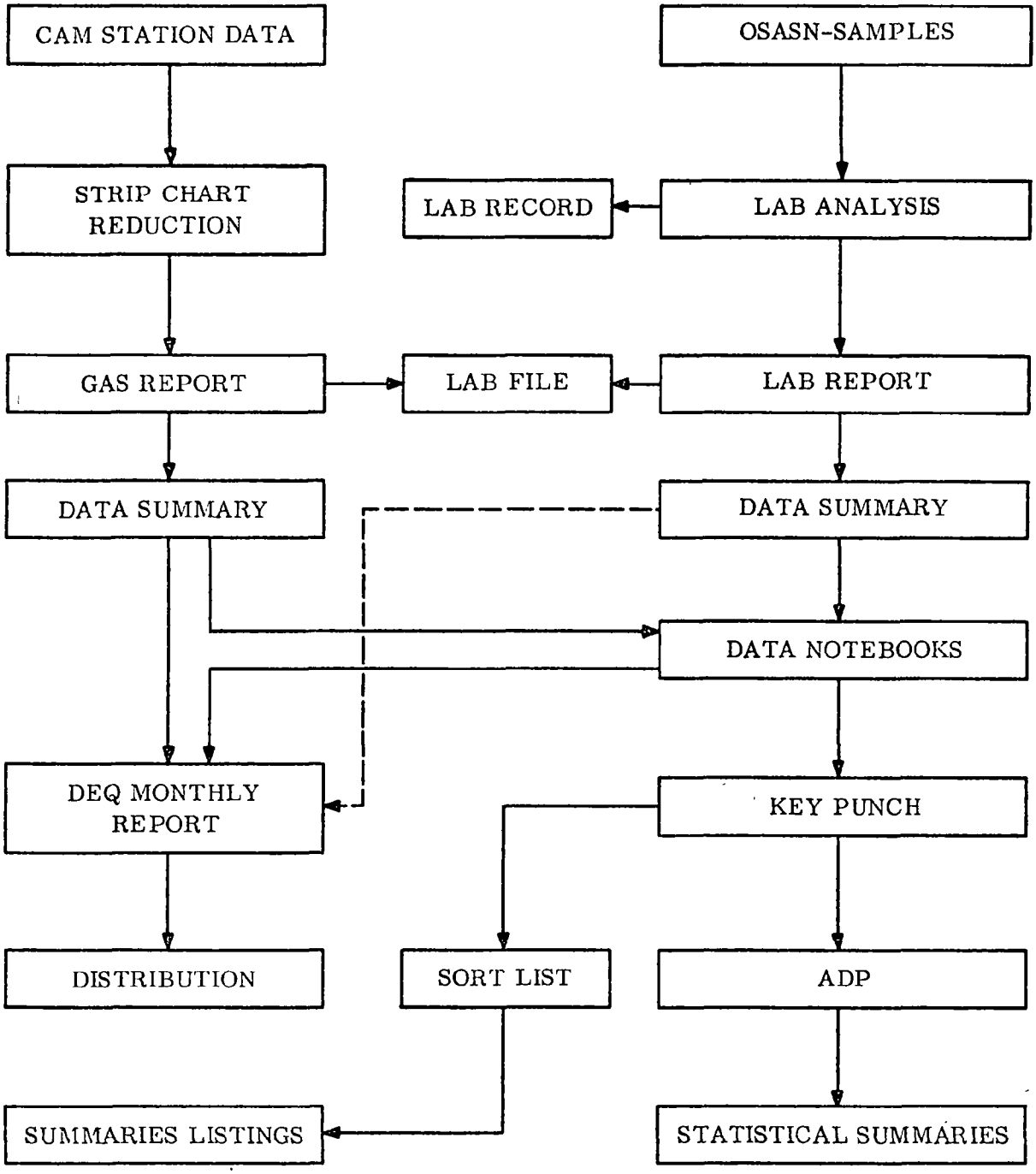

FIGURE 2-2. Oregon DEQ air quality data flow diagram.

OREGON STATE DEPARTMENT OF ENVIRONMENTAL QUALITY

AIR QUALITY CONTROL LABORATORY REPORT WORK SHEET

Suspended Particulate Data

All Values in Micrograms per Cubic M

AQC LAB NUMBER	SAMPLE TYPE	STATION NUMBER	SAMPLE DATES	SAMPLE TIME	TOTAL PARTIC-ULATE	ORGANIC FRACTION BENZENE SOL.	CaO	Fe	Pb	Mn	Ni	Cu
—	HV.	EUG35	3-4-71	0000 2400	—	Void	Machine malfunction					
33220	"	"	3-8-71	"	30			0.2	0.09	0.01	0	0.04
33236	"	"	3-11-71	"	68			0.3	0.1	0.02	0	0.1
33257	"	"	3-16-71	"	113			2.1	0.4	0.05	0.03	0.07
—	"	"	3-15-71	"	—	VOID	No Stop Flow					
33350	"	"	3-31-71	"	100			1.7	0.2	0.07	0.03	0.1

Suspended Particulate Station: Eugene - 35 Month: March Year: 19

FIGURE 2-3. DEQ work sheet for suspended particulates.

DEPARTMENT OF ENVIRONMENTAL QUALITY

AIR QUALITY CONTROL DIVISION

Location_____

Date_____

Time	CO	THC	NO	NO_2	TO	OZ	SOIL.	SO_2	T	WS	WD	H	V.
0000-0100													
0100-0200													
0200-0300													
0300-0400													
0400-0500													
0500-0600													
0600-0700													
0700-0800													
0800-0900													
0900-1000													
1000-1100													
1100-1200													
1200-1300													
1300-1400													
1400-1500													
1500-1600													
1600-1700													
1700-1800													
1800-1900													
1900-2000													
2000-2100													
2100-2200													
2200-2300													
2300-2400													

FIGURE 2-4. CAM station hourly data summary and telephone reporting form.

OREGON STATE DEPARTMENT OF ENVIRONMENTAL QUALITY

AIR QUALITY CONTROL LABORATORY REPORT WORK SHEET

Particle Fallout — All Values Grams per square meter per month

AQC LAB NUMBER	SAMPLE TYPE	STATION NUMBER	SAMPLE DATES	SAMPLE TIME	TOTAL PARTIC-ULATE	TOTAL ASH	CA^{++} as CaO	Cl^{-}	F-	NA^{+}	SO_4		
29324	FO	Albio	1-12-70 2-4-70		0.7	0.25	0.01	0.1		0.09	0.2	✓	
29564	"	"	2-4-70 3-4-70		1.6	0.6	0.05	0.1		0.06	0.4	✓	
	"	"	3-4-70 to										
30093	"	"	5-13-70		1.8	1.1	0.02	0.056		0.06	0.46	✓	
30449	"	"	5-13-70 6-1-70		4.3	0.95	0.03	0.07		0.07	0.08	—	
31020	"	"	6-1-70 7-1-70		1.2	0.7	0.03	0.01		0.06	0.08	—	
31166	"	"	7-1-70 8-7-70		1.0	0.6	0.02	0.01		0.05	0.05	—	
31235	"	"	8-7-70 9-10-70		1.6	0.1	0.03	0.02		0.01	0.1	—	
31287	"	"	9-10-70 10-7-70		0.6	0.2	0.06	0.01		0.01	0	—	
31397	"	"	10-7-70 11-4-70		2.3	0.6	0.04	0.00		0.09	0.5	✓	
31443	"	"	11-4-70 11-30-70		1.1	0.9	0.02	0.08		0.10	0.4	✓	
31553	"	"	11-30-70 1-20-71		0.5	0.2	0.02	0.3		0.15	1.1	✓	

Particle Fallout — Station: Albany – 10 — Year: 1970

FIGURE 2-5. DEQ work sheet for particle fallout.

JANUARY 1970 CARBON MONOXIDE PAGE 1

DEPT OF ENVIRONMENTAL QUALITY AIR QUALITY CONTROL CONTINUOUS AIR MONITORING DATA

718 W. BURNSIDE ST PORTLAND, OREGON UNITS = PPM 1-HOUR AVERAGES

DATE		01	02	03	04	05	06	07	08	09	10	11	12	MAXIMUMS 1-HR	MAXIMUMS 8-HR	AVE 24-HR
1	AM	6.00	3.00	2.00	2.00	3.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00			
	PM	2.00	2.00	1.00	4.00	4.00	4.00	5.00	4.00	4.00	4.00	4.00	4.00	6.0	4.1	2.7
2	AM	3.00	2.00	1.00	1.00	1.00	1.00	3.00	4.00	7.00	5.00	3.00	3.00			
	PM	4.00	4.00	5.00	7.00	8.00	15.00	13.00	10.00	12.00	14.00	11.00	9.00	15.0	11.5	6.0
3	AM	6.00	5.00	4.00	3.00	2.00	2.00	4.00	4.00	4.00	5.00	7.00	7.00			
	PM	8.00	9.00	8.00	7.00	8.00	6.00	3.00	3.00	5.00	4.00	5.00	6.00	9.0	7.5	5.2
4	AM	6.00	6.00	4.00	3.00	2.00	2.00	3.00	2.00	2.00	2.00	2.00	3.00			
	PM	4.00	3.00	4.00	4.00	6.00	5.00	5.00	4.00	4.00	4.00	4.00	3.00	6.0	4.5	3.6
5	AM	2.00	1.00	1.00	1.00	1.00	1.00	2.00	5.00	6.00	4.00	5.00	5.00			
	PM	6.00	5.00	6.00	8.00	11.00	16.00	6.00	3.00	4.00	3.00	3.00	2.00	16.0	7.8	4.4
6	AM	2.00	1.00	1.00	1.00	1.00	1.00	2.00	5.00	5.00	4.00	4.00	3.00			
	PM	5.00	6.00	5.00	6.00	9.00	12.00	4.00	2.00	2.00	3.00	2.00	2.00	12.0	6.2	3.6
7	AM	2.00	1.00	1.00	1.00	1.00	1.00	1.00	4.00	4.00	3.00	4.00	6.00			
	PM	4.00	5.00	5.00	6.00	10.00	12.00	3.00	2.00	2.00	2.00	2.00	2.00	12.0	6.5	3.5
8	AM	1.00	1.00	1.00	1.00	1.00	1.00	2.00	4.00	5.00	4.00	3.00	4.00			
	PM	4.00	5.00	6.00	8.00	10.00	13.00	6.00	4.00	3.00	3.00	5.00	4.00	13.0	7.0	4.1
9	AM	4.00	**********	**********	**********	**********	**********	**********	**********	**********	**********	5.00	5.00			
	PM	8.00	6.00	6.00	8.00	9.00	10.00	5.00	4.00	5.00	4.00	5.00	5.00	10.0	7.1******	
10	AM	13.00	8.00	7.00	5.00	6.00	4.00	5.00	8.00	7.00	2.00	3.00	4.00			
	PM	5.00	8.00	14.00	12.00	16.00	12.00	10.00	12.00	10.00	8.00	8.00	7.00	16.0	11.7	8.0
11	AM	8.00	5.00	3.00	2.00	3.00	2.00	2.00	2.00	2.00	4.00	4.00	2.00			
	PM	2.00	3.00	4.00	3.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	8.0	3.8	3.4
12	AM	5.00	5.00	4.00	3.00	2.00	2.00	5.00	12.00******		8.00	16.00	20.00			
	PM	12.00	11.00	10.00	10.00	16.00	15.00	10.00	11.00	6.00	5.00	4.00	4.00	20.0	13.7	8.5
13	AM	5.00	4.00	2.00	2.00	2.00	2.00	7.00	13.00	18.00	13.00	14.00	11.00			
	PM	15.00	20.00	12.00	11.00	16.00	20.00	8.00	5.00	4.00	5.00	4.00	3.00	20.0	14.8	9.0
14	AM	3.00	2.00	2.00	2.00	2.00	2.00	3.00	10.00	11.00	10.00	8.00	9.00			
	PM	9.00	11.00	10.00	10.00	11.00	6.00	2.00	2.00	2.00	2.00	2.00	2.00	11.0	9.7	5.5
15	AM	2.00	2.00	1.00	1.00	1.00	2.00	3.00	4.00	3.00	4.00	3.00	4.00			
	PM	4.00	5.00	6.00	5.00	7.00	6.00	3.00	4.00	4.00	3.00	4.00	4.00	7.0	5.0	3.5
16	AM	4.00	3.00	2.00	1.00	1.00	1.00	3.00	7.00	9.00	7.00	9.00	10.00			
	PM	10.00	11.00	10.00	14.00	17.00	18.00	8.00	6.00	6.00	6.00	6.00	6.00	18.0	12.3	7.2
17	AM	5.00	4.00	3.00	2.00	2.00	1.00	1.00	3.00	3.00	4.00	3.00	5.00			
	PM	5.00	7.00	5.00	8.00	6.00	6.00	12.00	10.00	11.00	10.00	6.00	4.00	12.0	8.6	5.2

FIGURE 2-6. Sample of DEQ Statistical Summaries.

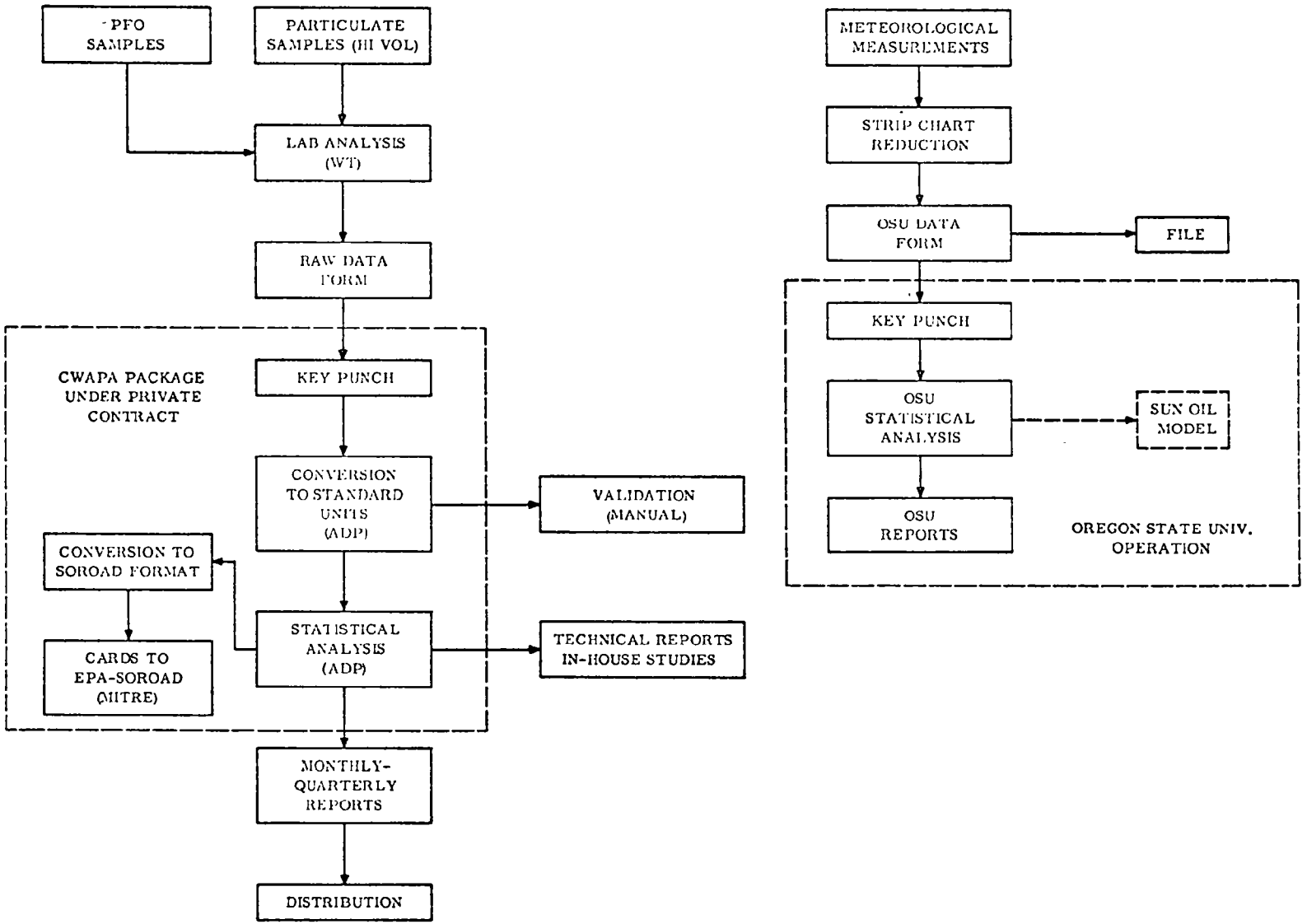

FIGURE 2-7. Data flow - Mid-Willamette Air Pollution Authority.

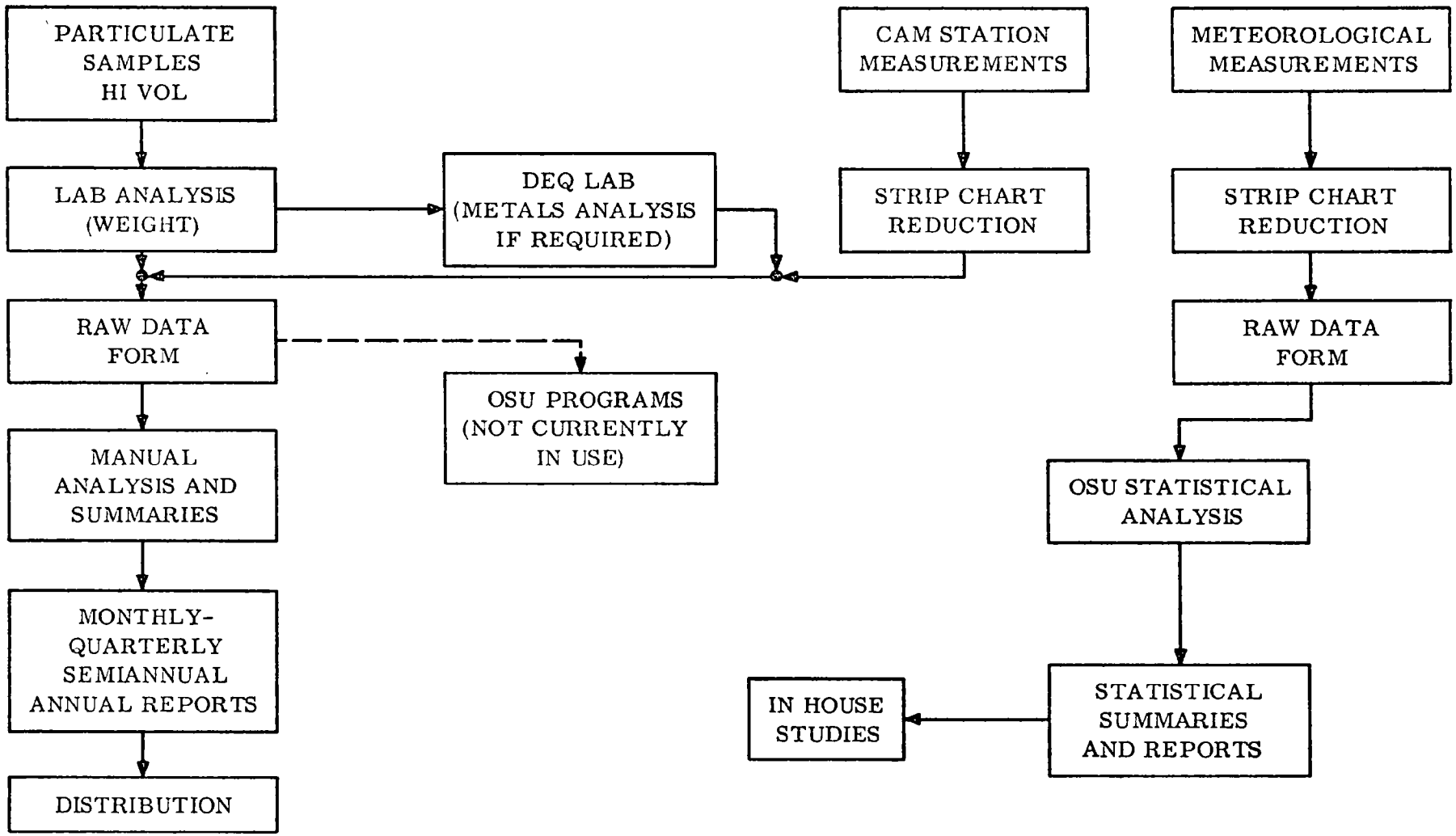

FIGURE 2-8. Data flow - Lane Regional Air Pollution Authority.

system is currently being expanded to include automatic data processing of the data obtained from the automated acquisition systems. Data flow reflecting the planned expansion of the system is shown in Figure 2-10. Samples of the data forms being employed by the above Regional Authorities are presented in Figures 2-11 through 2-13.

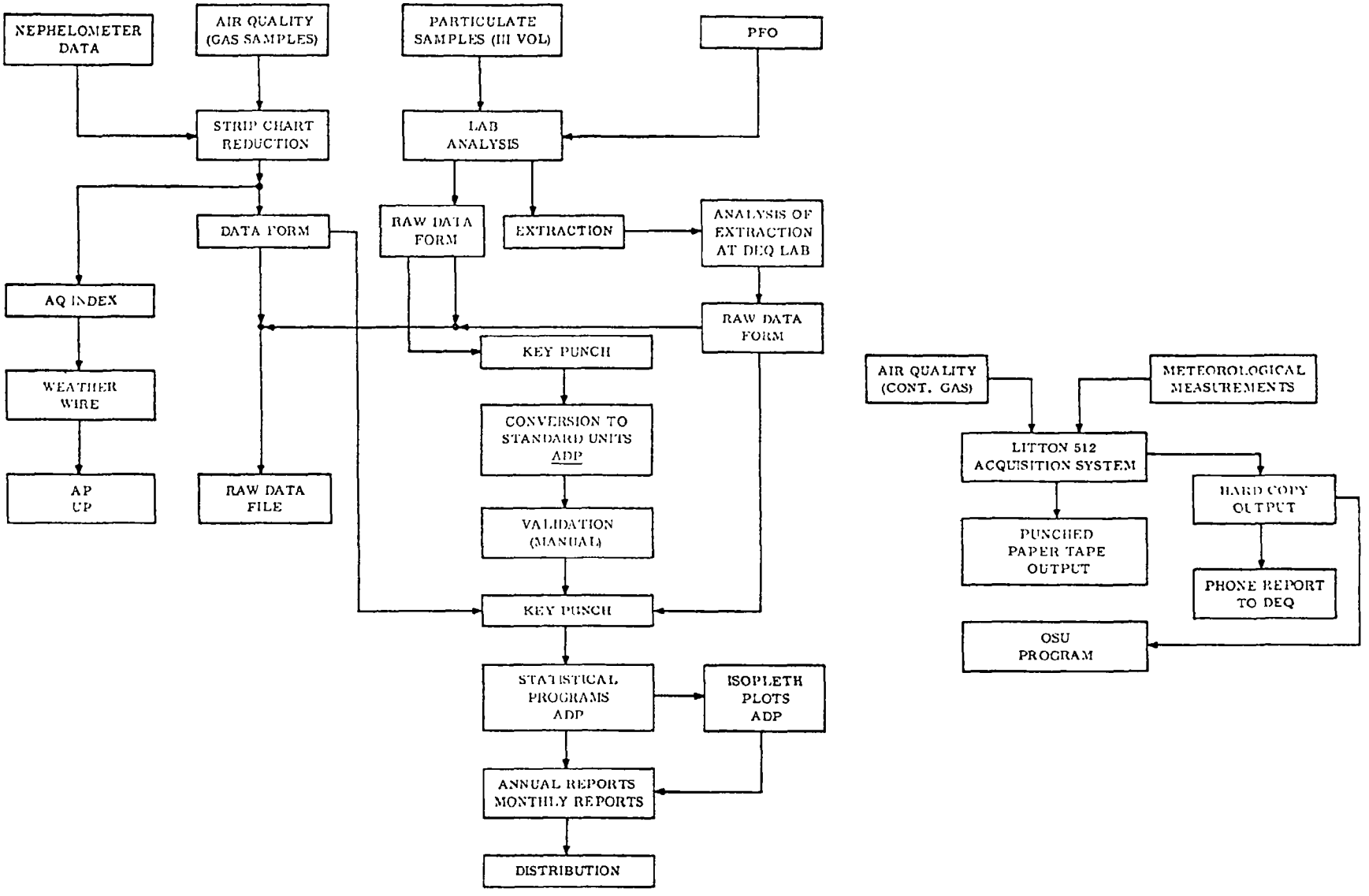

FIGURE 2-9. Current data flow - Columbia-Willamette Air Pollution Authority.

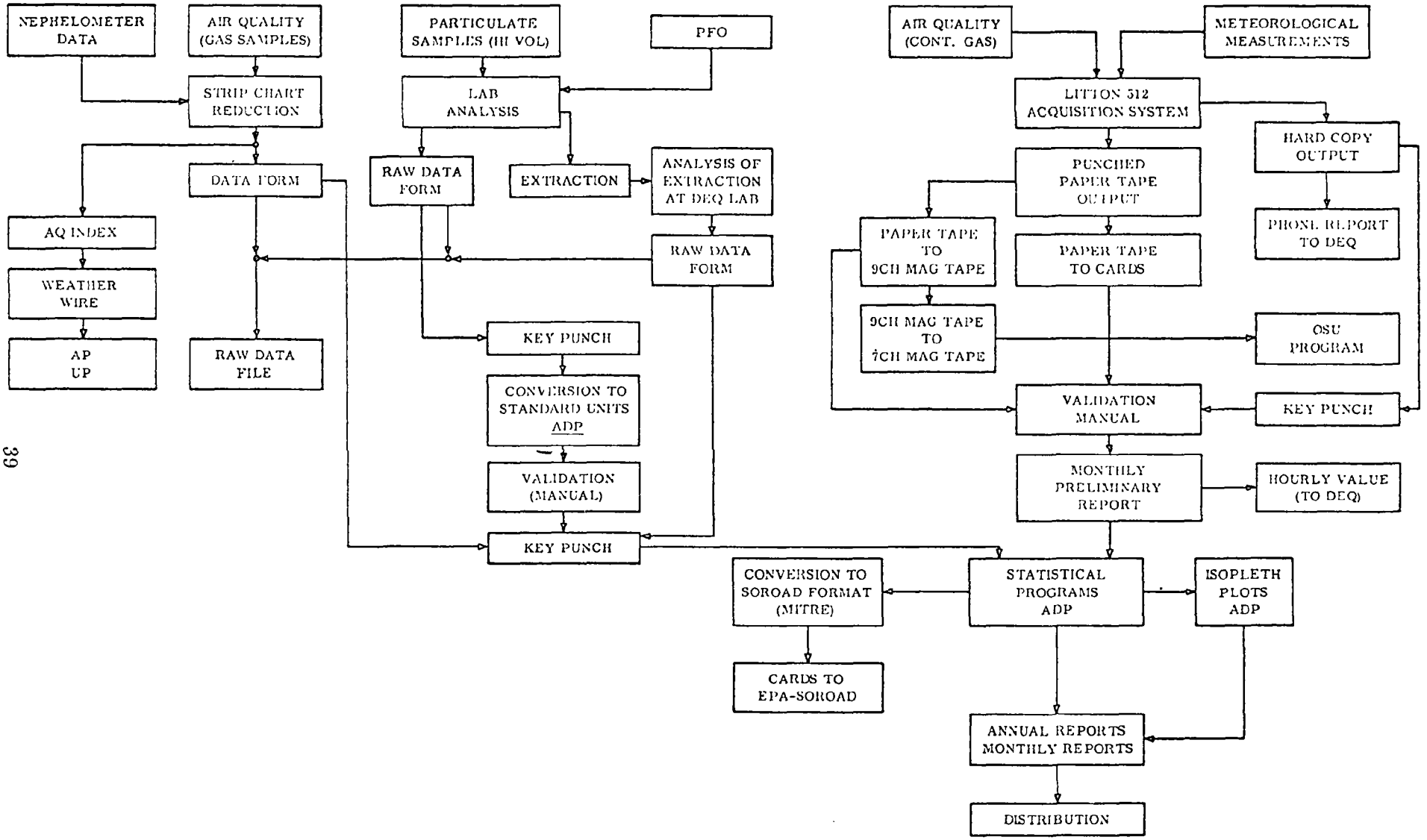

FIGURE 2-10. Planned data flow for the Columbia-Willamette Air Pollution Authority.

COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY

SITE FORM

(1) State

(3) County

(5) City

(7) Site Address and Number

(9) SUB STATION NO.

(10) TYPE OF AREA

Industrial = 1
Residential = 2
Commercial = 3
Suburban = 4
Non urban = 5
Mixed = 6

(11) STATION TYPE

Special routine = 01
Special random = 02
PAMS routine = 11
PAMS random = 12
PGLMS routine = 21
PGLMS random = 22

(13) OPERATING AGENCY

State = 1 Lane Regional = 3
CWAPA = 2 MWVAPA = 2

ELEVATION:

(14) Ground (MSL) (feet)

(18) Sampler above Ground level (feet)

COORDINATES:

STATE PLANE SYSTEM

(22) X - Coord

(29) Y - Coord

Longitude

(37)

Latitude

(45)

UTM. SYSTEM

(52) Zone

(54) X - Coord

(60) Y - Coord

FIGURE 2-11. Columbia-Willamette Air Pollution Authority site data form.

COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY

Raw Sampling and Lab Data
(Coding form)

Suspended Particulate

Filter # _____

Time
Start 0 0 0 0
Stop 2 4 0 0
HV# _____

Format (1)	Cnty (2)	City (4)	Site (6)	Yr (8)	Mon (10)	Dy (12)	Hr (14)	Time (16)	Type (17)	Agency (19)	Time Run (20)	Flow Start (24)	Flow Stop
A							0 0	6		2	2 4 0 0		

Pollutant	Method	Total Vol.	Aliquot	Sample Wt.	DP	Blank	% Filter	
1 1 1 0 1	9 1				4	0 0 0	1 0 0	(28-52)
								(53-77)

CD No (1)	Pollutant (28)	Method	Total Vol.	Aliquot	Sample Wt.	DP	Blank	%Filter	
2									(28-52)
									(53-77)
(1) 3	(28)								(28-52)
									(53-77)
(1) 4	(28)								(28-52)
									(53-77)
(1) 5	(28)								(28-52)
									(53-77)
(1) 6	(28)								(28-52)
									(53-77)

Remarks

Final Wt.
Tare Wt. _____ _____ _____ _____
Sample Wt.

FIGURE 2-12. Columbia-Willamette Air Pollution Authority raw data form.

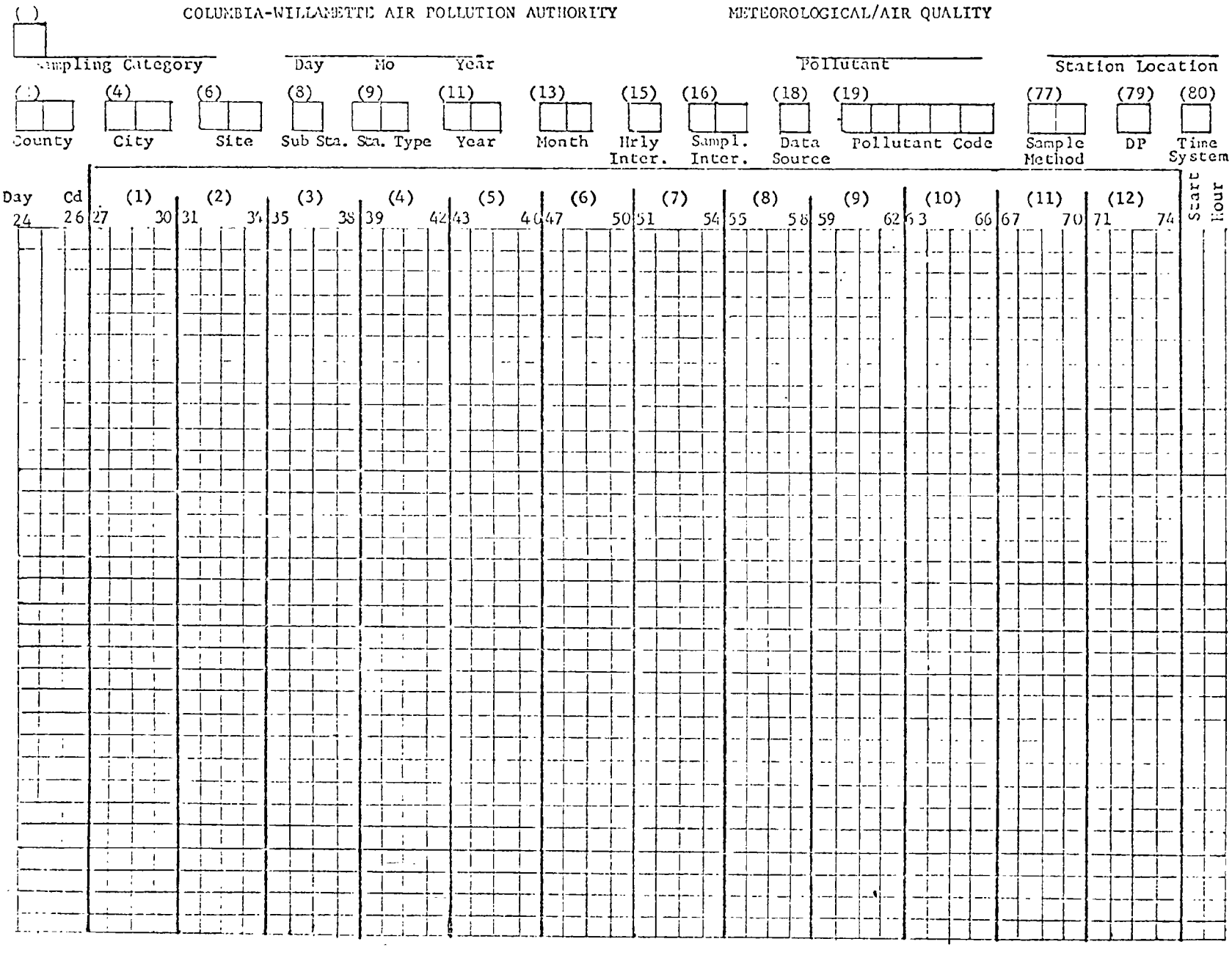

FIGURE 2-13. Columbia-Willamette Air Pollution Authority meteorological/air quality data form.

SECTION 3

REQUIREMENTS FOR AIR QUALITY SURVEILLANCE

3.1 REQUIREMENTS IMPOSED BY FEDERAL PRIORITY CLASSIFICATION

The Federal priority classification is based upon historical air quality measurements or population of the region being classified. The suggested Federal priority classifications for the Oregon air quality regions and the minimum surveillance network required by the classification are given in Table 3-1.

3.2 STATE OF OREGON REQUIREMENTS

The State of Oregon requirements for air quality surveillance are identified with the following activities:

- Measurements of air quality levels at particular locations not included in the Federal priority classification network
- Estimation of the effects of adding new pollutant sources or eliminating existing sources on ambient air quality within Oregon
- Measurements of pollutant transport into Oregon from bordering states and between air quality regions within Oregon
- Control of agricultural field-burning and forest slash-burning programs

TABLE 3-1

SUGGESTED FEDERAL PRIORITIES AND SAMPLING REQUIREMENTS

Region/Pollutant	Priority	Population	Required Samplers	Required Sample Schedule
Portland Interstate		1,727,358		
Suspended Particulates			12 Hi-Vol (Total)*	1-24 hours every 6 days
		Oregon	10 Hi-Vol (Oregon)	
		1,475,384	7 AISI Tape (Total)	Continuous 2-hour samples
		Wash.	6 AISI Tape (Oregon)	
		251,974		
SO_2	1A		3 Pararosaniline or equivalent	1-24 hours every 6 days
			1	Continuous
CO	I		4 Nondispersive IR or equivalent (Total)	Continuous
			3 Nondispersive IR or equivalent (Oregon)	Continuous
NO_2	I		10 Jacobs-Hochheiser (Total)	1-24 hours every 14 days
			9 Jacobs-Hochheiser (Oregon)	
O_x	I		4 Chemiluminescence or equivalent (Total)	Continuous
			3 Chemiluminescence or equivalent (Oregon)	Continuous
Northwest Intrastate		72,158		
Suspended Particulates	III		1 Hi-Vol	1-24 hours every 6 days
SO_2	III		1 Pararosaniline or equivalent	1-24 hours every 6 days
CO, NO_2, O_x	III			

*Total includes the State of Washington requirements.

TABLE 3-1 (Continued)

Region/Pollutant	Priority	Population	Required Samplers	Required Sample Schedule
Southwest Intrastate		271,543		
Suspended Particulates	II		3 Hi Vol 1 AISI Tape	1-24 hours every 6 days Continuous 2-hour samples
SO_2	III		1 Pararosaniline or equivalent	1-24 hours every 6 days
CO, NO_2, O_x	III			
Central Intrastate		140,798		
Suspended Particulates	II		3 Hi Vol 1 AISI Tape	1-24 hours every 6 days Continuous 2-hour samples
SO_2	III		1 Pararosaniline or equivalent	1-24 hours every 6 days
CO, NO_2, O_x	III			
Eastern Intrastate		131,502		
Suspended Particulates	II		3 Hi Vol 1 AISI Tape	1-24 hours every 6 days Continuous 2-hour samples
SO_2	III		1 Pararosaniline or equivalent	1-24 hours every 6 days
CO, NO_2, O_x	III			

3.3 ADEQUACY OF THE PRESENT SURVEILLANCE SYSTEM

3.3.1 Laboratory Assay Procedures for Particulates

The laboratory procedures currently used by the Department of Environmental Quality and the three Regional Authorities are outlined in the Oregon Administrative Rules, Chapter 340, Exhibits A and B. These procedures, which are reproduced in Appendix A, meet the Federal specifications for particulate assay and are judged to be adequate for the Oregon air quality surveillance system.

3.3.2 Air Quality Instrumentation

The air quality instrumentation currently contained in the Oregon sampling equipment inventory is evaluated below with respect to the requirements of the Environmental Protection Agency. These requirements are listed in the Code of Federal Regulations, Title 42, Chapter IV, Part 420—Requirements for the Preparation, Adoption, and Submittal of Implementation Plans.

Suspended Particulates

General Metals Model 2000
UNICO Model 550

The above General Metals and UNICO high-volume samplers meet all the Federal requirements.

Sulfur Dioxide

(1) Leeds and Northrup Thomas Autometer, Model 64251-A1.

Sulfur dioxide measurements made with the Thomas autometer can be used for establishing existing air quality and the priority classification of a

region according to the statement made in 420.13(q) of the Code of Federal Regulations: "Sulfur dioxide measurement based on use of the continuous conductimetric method also are acceptable for this purpose." The use of this instrument for future air quality surveillance, however, is doubtful. It does not conform to the reference method or any of the specified equivalent methods, which means it must meet the 12 performance specifications listed in paragraph 420.17 of the Code. Specific data are difficult to find on the Thomas autometer because it is an antique as far as air pollution instrumentation goes. Shikiya and MacPhee (1969) indicate the rise time may be too slow to meet the Federal specifications, but more information is required before an evaluation can be made.

(2) Beckman K-1005 and K-1006

These Beckman instruments can be used to define existing SO_2 air quality for regional priority classification. They do not, however, meet the Federal requirements for future monitoring. There is some discrepancy in reporting performance, but even the most favorable data show the specifications to be below those required by the Environmental Protection Agency. Data are available on the K-70 series of Beckman acralyzers (American Conference of Government Industrial Hygienists, 1966) and Mr. Mike Johnson of the Applications Engineering Department of Beckman confirmed that the performance specifications of the K-1000 series are the same as those of the K-70 series. The K-70 series are rack mounted, non-portable units and the K-1000 series are three component "portable" systems with identical internal mechanics. Accordingly, the available data on the K-70 series were extrapolated to the K-1000 series.

Rodes, et al. (1969) also provide detailed performance specifications on both the K-70 and K-1000 series. These data, along with the required performance, are presented in Table 3-2. As can be seen, the Beckman acralyzers do not meet the required rise time in any of the reported data. Furthermore, one

TABLE 3-2

REQUIRED AND REPORTED PERFORMANCE SPECIFICATIONS
OF BECKMAN ACRALYZERS

Specifications Required		Reported*	Reported** K-70 Series	K-1000 Series
Range	0-1 ppm		0-2.0 ppm	0-2.0 ppm
Minimum Detectable Sensitivity	0-0.01 ppm		0.01 ppm	0.01 ppm
Rise Time, 90 percent	5 min.	5-10 min	11.0 min	19.0 min
Fall Time, 90 percent	5 min			
Zero Drift	± 1% 24 hours ± 2% 72 hours	± 2%	0.0%	0.0%
Span Drift	± 1% 24 hours ± 2% 72 hours	± 2%	0.4%	0.4%
Precision	± 2%	± 4%		
Operation Period	3 Days			
Noise	± 0.5% full scale		0.4%	0.5%
Interference Equivalent	0.01 ppm			
Operating Temperature Fluctuation	± 5°C			
Linearity	2% full scale			

*American Conference of Governmental Industrial Hygienists (1969).
**Rodes, et al. (1969).

report shows the Beckman instrument to be deficient in zero drift, span drift and precision.

Photochemical Oxidants

(1) Mast Development Company 724-2

The technique employed by the Mast instrument is not defined by the reference method nor any of the specified equivalent methods given in the Code. However, Mr. Chuck Shanklin of Mast Development Company confirmed verbally on 17 September 1971 that their equipment meets all of the performance specifications required by the Environmental Protection Agency. Mast has performed their own evaluation showing compliance with the requirements and will supply their data on request.

(2) Beckman K-1005

The Beckman K-1005 acralyzer uses the potassium iodide colorimetric technique for oxidant measurement and this has been specified as an equivalent technique, provided that corrections are made for SO_2 and NO_2. It appears, therefore, that the continued use of this instrument is justified as long as the corrections are made.

Nitrogen Dioxide

Beckman K-1008 and Technicon Air Monitor IV

The only approved method for measuring nitrogen dioxide is the Jacobs-Hochheiser technique. The Beckman instrument uses the Saltzman method and the Technicon instrument uses the modified Saltzman method. Neither instrument meets the requirements of the Code.

Carbon Monoxide

MSA Lira 200 and Beckman 315-AL

The MSA Lira 200 instrument meets the requirements for carbon monoxide monitoring, as does the Beckman 315-AL nondispersive infrared instrument.

Hydrocarbons

Beckman 109A and 400

The Beckman 109A and 400 instruments employ the require flame-ionization detection method, but these instruments do not have the required capability for correcting for methane. Although Federal specifications require this correction, it would seem that measurements made without the correction would be conservative (that is, the measured values are too high). However, the Beckman 109A and 400 do not strictly meet the specifications in the Code.

Summary

The inventories of air sampling equipment used in Oregon and the results of the evaluation are shown in Table 3-3. The table indicates whether the existing data may be used for priority classification of regions and whether the instrumentation can be included in future surveillance networks. The evaluation was accomplished by referring to the measurement method, equivalent methods, and performance specifications detailed in Part 420 of the Code. However, paragraph 420.2(c) states: "Nothing in this part shall be construed in any manner to preclude a State from employing techniques other than those specified in this part for purposes of estimating air quality or demonstrating the adequacy of a control strategy, provided that such other techniques are shown to be adequate and approximate

TABLE 3-3

ADEQUACY OF CURRENT INSTRUMENTATION FOR DETERMINING AIR QUALITY

Pollutant	Sample Manufacturer	Model No.	Existing Data	Future Use
Oregon State Department of Environmental Quality Air Quality Control Division				
Suspended Particulates	General Metals	2000	Yes	Yes
Sulfur Dioxide	Leeds & Northrup	64251-A1	Yes	?
Sulfur Dioxide	Beckman	K-1006	Yes	No
Nitrogen Dioxide	Beckman	K-1008	No	No
Photochemical Oxidants	Mast	724-2	Yes*	Yes*
Photochemical Oxidants	Beckman	K-1005	Yes*	Yes*
Hydrocarbons	Beckman	109A	Yes	No
Columbia-Willamette Air Pollution Authority Portland, Oregon				
Suspended Particulates	General Metals	2000	Yes	Yes
Suspended Particulates	Electro-Nucleonics	620	?	?
Sulfur Dioxide	Beckman	K-1005	Yes	No
Nitrogen Dioxide	Technicon	Air Monitor IV	No	No
Carbon Monoxide	MSA	Lira 200	Yes	Yes
Photochemical Oxidants	Mast	724-2	Yes*	Yes*
Hydrocarbons	Beckman	109A	Yes	No

*Provided corrections are made for SO_2 and NO_2.

TABLE 3-3 (Continued)

Pollutant	Sample Manufacturer	Model No.	Existing Data	Future Use
Mid-Willamette Valley Air Pollution Authority Salem, Oregon				
Suspended Particulates	UNICO	550	Yes	Yes
Suspended Particulates	General Metals	2000	Yes	Yes
Lane Regional Air Pollution Authority Eugene, Oregon				
Suspended Particulates	General Metals	2000	Yes	Yes
Carbon Monoxide	Beckman	315 AL	Yes	Yes
Hydrocarbons	Beckman	400	Yes	No

for such purposes." An interpretation of this statement, particularly of "adequate and appropriate", by EPA would be desirable.

3.3.3 Air Quality Monitoring Sites and Station Locations

The current surveillance networks monitoring sites were reviewed with respect to the State and Federal requirements for surveillance networks. Presently, there is at least one monitoring site in each population center of 10,000 people or more. The major cities and industrial centers have multiple monitoring sites. The majority of the monitoring sites are hi-vol sampling locations with only a relatively few sites utilized in monitoring other pollutants. This review showed that the current suspended particulate surveillance network contained more monitoring sites than required to meet all stated requirements. Although it was not possible to visit individual site locations, it appeared that the existing locations were adequate and proper.

Current sites at which SO_2, NO_2, CO and photochemical oxidants are being monitored on a routine basis are too few in number to satisfy the State and Federal requirements. Routine monitoring of these pollutants is currently conducted only at the CAM Station, operated by the Department of Environmental Quality, and at the three continuous monitoring sites operated by the Regional Authorities. There is a supplementary SO_2 network measuring the sulfation rate using lead peroxide candles. However, this method does not meet the Federal requirement for monitoring SO_2.

The surveillance networks for SO_2, NO_2, CO and photochemical oxidants could be revised to meet the State and Federal requirements by installing the equipment needed to monitor these pollutants at selected stations in the existing hi-vol sampling network.

3.3.4 Meteorological Network

There are no Federal requirements for air quality surveillance networks that specify the need for the monitoring of meteorological parameters by the State. Meteorological information currently available at the Department of Environmental Quality from the Ag teletype circuit, and from the National Weather Service and other agencies, appears to be adequate for most of the DEQ air pollution activities. In the discussion of Oregon's meteorological data requirements in Section 4.2.3, two recommendations are made for increased meteorological support of the field-burning and slash-burning programs. The first recommendation is for the establishment of a new surface wind station in the Willamette Valley near Coburg and for the timely reporting of the station observations to DEQ. The second recommendation is for the addition of teletype Circuit A to the existing Ag circuit at DEQ to ensure the timely availability of the meteorological information required in the field-burning and slash-burning programs as well as during air pollution episodes.

The two automated meteorological data systems currently operated by the Columbia-Willamette Air Pollution Authority were designed to be used, in conjunction with continuous air quality monitoring equipment, to gather the information required to develop and implement a real-time computer model for predicting the atmospheric transport and diffusion of pollutants in the Willamette and Columbia Valleys. Only limited progress has been made toward the systems' objective. Also, it appears that the mean wind speeds and directions calculated by the Litton 512 system at CWAPA, as explained in Section 2.2.9, are not in a form that can readily be used by the State in its air pollution activities requiring historical meteorological data. Reformatting these data so that they correspond to arithmetic means rather than vector means would appear to require extensive reprogramming and possibly some hardware additions to the Litton 512.

SECTION 4

DEVELOPMENT OF SYSTEM CONCEPTS

4.1 REVIEW OF AIR QUALITY MEASUREMENTS AND EMISSIONS INVENTORY DATA

A review of existing air quality measurements and of current emissions inventory data for Oregon is an essential step in the development of an air quality surveillance system because these data are important in determining the requirements for:

- Number of air quality sampling stations
- Station locations
- Pollutant measurements at each location

4.1.1 Summary of Air Quality Data for Oregon

A summary of air quality measurements made during 1969 and 1970 in Oregon is presented in Table 4-1. The data in the table are arranged by air quality control region and show for each region the station locations by city name and UTM coordinates; length of the sampling interval and the number of samples obtained at each location; and pertinent statistics for each pollutant measured.

In the Portland Interstate AQCR, the entries in Table 4-1 for suspended particulates show that the Federal primary standard for the maximum 24-hour concentration was exceeded at three stations in Portland during 1969 and 1970 and at single stations located in Lake Oswego and Beaverton during 1970. The Federal secondary standard for the maximum 24-hour concentration was exceeded at 24 stations during 1969 and 1970 in the Portland Interstate AQCR. During 1969,

TABLE 4-1

AIR QUALITY DATA SUMMARY (POLLUTANT CONCENTRATIONS ARE IN MICROGRAMS PER CUBIC METER)

Pollutant	Location	UTM Coordinates		Sampling Interval	Start	End	Number of	Max	Max 3 hrs	Max	Max	Annual Arith.	Std.	Annual Geo.	Geom. Std.
	City	x	y	(Months)	Date	Date	Samples	1 hr	6-9 a.m.	8 hrs	24 hrs	Mean	Dev.	Mean	Dev.
Portland Interstate AQCR															
Suspended Particulate	Rainier	505,182	5,103,552	12	1-70	12-70	91	--	--	--	134	36.5	27.7	27.9	2.1
	St. Helens	514,823	5,078,582	12	1-69	12-69	79	--	--	--	129	48.0	25.1	41.1	1.8
	St. Helens	514,823	5,078,582	12	1.70	12.70	91	--	--	--	119	39.5	23.0	34.1	1.7
	St. Helens	513,897	5,076,482	12	1-70	12-70	91	--	--	--	164	41.3	24.9	36.3	1.6
	Scappoose	509,666	5,066,943	9	1-70	10-70	67	--	--	--	103	40.4	21.7	33.9	1.9
	Portland	527,846	5,037,069	12	1-69	12-69	89	--	--	--	303	89.5	49.9	75.7	1.8
	Portland	527,846	5,037,069	12	1-70	12-70	90	--	--	--	197	48.2	43.6	65.3	1.9
	Portland	520,488	5,048,243	12	1-69	12-69	87	--	--	--	160	59.9	32.1	50.9	1.8
	Portland	520,488	5,048,243	12	1-70	12-70	91	--	--	--	132	45.4	25.8	39.2	1.7
	Portland	525,872	5,040,743	12	1-69	12-69	61	--	--	--	374	100.4	66.9	82.1	1.9
	Portland	525,872	5,040,743	12	1-70	12-70	90	--	--	--	214	83.6	50.7	68.1	1.9
	Portland	522,327	5,032,660	12	1-69	12-69	86	--	--	--	103	38.2	23.1	30.3	2.1
	Portland	522,327	5,032,662	12	1-70	12-70	90	--	--	--	313	36.2	28.3	27.5	2.2
	Portland	527,696	5,040,906	12	1-69	12-69	88	--	--	--	157	65.3	33.2	56.7	1.7
	Portland	527,696	5,040,906	12	1-70	12-70	90	--	--	--	138	58.6	30.6	51.1	1.7
	Portland	526,663	5,044,730	12	1-69	12-69	85	--	--	--	148	62.1	31.3	54.0	1.7
	Portland	520,760	5,040,819	12	1-69	12-69	89	--	--	--	153	35.2	24.3	27.5	2.1
	Portland	520,760	5,040,819	12	1-70	12-70	91	--	--	--	103	29.9	21.2	22.8	2.1
	Portland	523,046	5,043,414	12	1-69	12-69	88	--	--	--	215	90.3	50.2	75.1	1.9
	Portland	523,046	5,043,414	12	1-70	12-70	91	--	--	--	233	90.4	54.9	71.6	2.1
	Portland	536,188	5,041,367	12	1-69	12-69	82	--	--	--	147	55.2	26.7	48.7	1.7
	Portland	536,188	5,041,367	12	1-70	12-70	86	--	--	--	177	50.8	32.9	39.3	2.2
	Portland	516,570	5,049,737	12	1-70	12-70	91	--	--	--	167	59.8	38.7	49.2	1.8
	Portland	535,761	5,044,326	12	1-70	12-70	88	--	--	--	186	49.9	33.4	41.0	1.9
	Portland	527,459	5,046,599	12	1-70	12-70	86	--	--	--	186	56.8	34.9	47.7	1.8
	Portland	538,785	5,037,251	12	1-70	12-70	89	--	--	--	147	53.3	30.2	45.1	1.8
	Gresham	547,356	5,039,046	12	1-70	12-70	87	--	--	--	116	38.9	25.0	30.1	2.1
	Troutdale	547,706	5,044,483	11	2-70	12-70	79	--	--	--	153	37.8	24.9	29.4	2.2
	Lake Oswego	517,200	5,038,417	12	1-70	12-70	101	--	--	--	338	84.0	57.8	67.4	2.0
	Oregon City	530,826	5,022,559	12	1-69	12-69	84	--	--	--	194	65.4	34.7	56.3	1.7
	Oregon City	530,826	5,022,559	12	1-70	12-70	88	--	--	--	176	56.3	34.5	46.7	1.9
	Sandy	557,828	5,027,054	10	2-70	12-70	78	--	--	--	258	45.0	33.0	36.3	1.9
	Beaverton	315,420	5,036,684	12	1-70	12-70	107	--	--	--	418	53.1	46.8	43.1	1.8
	Hillsboro	500,977	5,040,398	12	1-70	12-70	103	--	--	--	159	43.4	23.3	38.3	1.7
	McMinnville	484,914	5,006,321	12	1-70	12-70	92	--	--	--	99	35.8	18.5	31.8	1.6
	Woodburn	513,791	4,999,701	8	5-70	12-70	35	--	--	--	114	46.2	26.4	37.9	2.0

TABLE 4-1 (Continued)

Pollutant	Location	UTM Coordinates		Sampling Interval	Start	End	Number of	Max	Max 3 hrs	Max	Max	Annual Arith.	Std.	Annual Geo.	Geom. Std.
	City	x	y	(Months)	Date	Date	Samples	1 hr	6-9 a.m.	8 hrs	24 hrs	Mean	Dev.	Mean	Dev.
Portland Interstate AQCR (Continued)															
Suspended Particulates	Silverton	517,280	4,983,499	12	1-70	12-70	45	--	--	--	95	45.8	20.7	40.6	1.7
	Salem	499,365	4,975,269	9	3-69	12-69	65	--	--	--	161	68.4	33.2	60.3	1.7
	Salem	499,365	4,975,269	12	1-70	12-70	100	--	--	--	148	52.1	26.5	45.7	1.7
	Salem	497,021	4,975,144	12	1-70	12-70	82	--	--	--	170	43.4	31.3	35.2	1.9
	Stayton	515,607	4,960,720	12	1-70	12-70	60	--	--	--	162	58.4	36.5	46.4	2.1
	Dallas	475,201	4,974,041	9	3-69	12-69	80	--	--	--	160	41.3	24.4	36.7	1.6
	Dallas	475,201	4,974,041	12	1-70	12-70	63	--	--	--	94	33.1	16.7	29.8	1.6
	Corvallis	479,226	4,934,535	12	1-69	12-69	74	--	--	--	142	49.4	25.5	42.3	1.9
	Corvallis	479,226	4,934,535	9	1-70	9-70	52	--	--	--	140	50.1	25.6	43.8	1.7
	Corvallis	478,995	4,934,620	12	1-70	12-70	60	--	--	--	121	40.9	23.1	35.7	1.7
	Albany	491,593	4,942,235	12	1-70	12-70	88	--	--	--	171	51.4	30.4	44.0	1.8
	Lebanon	506,750	4,951,392	9	3-69	12-69	50	--	--	--	115	46.3	24.1	40.0	1.8
	Eugene	482,850	4,884,450	9	4-69	12-69	79	--	--	--	187	53.0	--	--	--
	Eugene	492,950	4,877,550	9	4-70	12-70	90	--	--	--	214	82	--	--	--
	Eugene	483,200	4,875,200	12	1-70	12-70	42	--	--	--	171	68	41	56	2.0
	Springfield	487,800	4,875,300	12	1-70	12-70	63	--	--	--	226	75	46	63	1.8
Sulfur Dioxide	Portland	525,100	5,410,000	12	1-69	12-69	Cont.	602	--	--	113	29	0	18	2.52
	Portland	525,100	5,410,000	12	1-70	12-70	Cont.	340	--	--	191	34	29	21	2.67
	Salem			3	11-70	1-71	Cont.	419	--	--	105	--	--		--
Nitrogen Dioxide	Portland	525,100	5,410,000	12	1-69	12-69	Cont.	413	--	--	169	53	21	49	1.52
	Portland	525,100	5,410,000	12	1-70	12-70	Cont.	451	--	--	173	53	17	49	1.41
Photochemical Oxidants	Portland	525,100	5,410,000	12	1-69	12-69	Cont.	216	--	--	--	20	14	14	2.29
	Portland	525,100	5,410,000	12	1-70	12-70	Cont.	275	--	--	--	18	14	12	2.57
Ozone (Mast)	Portland	525,100	5,410,000	12	1-69	12-69	Cont.	196	--	--	--	4	6	2	2.22
	Portland	525,100	5,410,000	12	1-70	12-70	Cont.	176	--	--	--	--	--	--	--
Carbon Monoxide	Portland	525,100	5,410,000	12	1-69	12-69	Cont.	48,000	--	33,000	--	5,750	2,970	4,950	1.78
	Portland	525,100	5,410,000	12	1-70	12-70	Cont.	50,000	--	25,000	--	4,580	2,540	3,870	1.84
	Portland	523,347	5,010,524	1.0	12-68	1-69	Cont.	44,000	--	31,000	--	--	--	--	--
	Portland	525,785	5,041,299	1.5	4-69	6-69	Cont.	21,000	--	13,000	--	--	--	--	--

TABLE 4-1 (Continued)

Pollutant	Location	UTM Coordinates		Sampling Interval	Start	End	Number of	Max	Max 3 hrs	Max	Max	Annual Arith.	Std.	Annual Geo.	Geom. Std.
	City	x	y	(Months)	Date	Date	Samples	1 hr	6-9 a.m.	8 hrs	24 hrs	Mean	Dev.	Mean	Dev.
Portland Interstate AQCR (Continued)															
Carbon Monoxide	Portland	532,800	5,039,500	1.0	9-69	10-69	Cont.	28,000	--	23,000	--	--	--	--	--
	Portland	525,100	5,040,000	1.0	10-69	11-69	Cont.	37,000	--	27,000	--	--	--	--	--
Total Hydrocarbons	Portland	525,100	5,410,000	12	1-69	12-69	Cont.	7,190	5,229	--	--	1,294	405	1,235	889
	Portland	525,100	5,410,000	12	1-70	12-70	Cont.	6,209	3,987	--	--	1,288	438	1,216	922
Northwest Oregon Intrastate AQCR															
Suspended Particulates	Astoria	435,500	5,115,200	12	1-70	12-70	80	--	--	--	137	40.5	22.7	35.6	1.7
Southwest Oregon Intrastate AQCR															
Suspended Particulates	Roseburg	473,200	4,784,700	12	1-70	12-70	106	--	--	--	231	59.0	38.0	50.6	1.7
	Coos Bay	401,300	4,802,000	12	1-70	12-70	89	--	--	--	152	58.7	30.3	51.7	1.7
	Grants Pass	473,200	4,697,200	12	1-70	12-70	103	--	--	--	249	68.2	43.8	56.0	1.8
	Medford	510,000	4,685,300	12	1-70	12-70	108	--	--	--	298	88.8	44.8	78.0	1.7
	Ashland	523,400	4,671,500	12	1-70	12-70	107	--	--	--	118	52.2	21.7	47.2	1.6
Central Oregon Intrastate AQCR															
Suspended Particulates	The Dalles	641,600	5,050,600	12	1-70	12-70	103	--	--	--	240	65.6	39.9	56.5	1.7
	Bend	636,200	4,880,200	12	1-70	12-70	102	--	--	--	155	59.1	44.3	50.6	1.7
	Klamath Falls	604,200	4,672,800	12	1-70	12-70	85	--	--	--	195	78.3	40.3	68.8	1.7
Eastern Oregon Intrastate AQCR															
Suspended Particulates	Pendleton	360,600	5,058,800	12	1-70	12-70	71	--	--	--	282	83.5	41.5	75.7	1.5
	LaGrande	414,800	5,018,900	12	1-70	12-70	62	--	--	--	180	58.8	38.8	48.2	1.9
	Baker	434,000	4,957,900	12	1-70	12-70	75	--	--	--	286	77.8	52.1	65.4	1.8

the Federal primary standard for the annual geometric mean concentration of suspended particulates was expected at three stations, all of which are in Portland. The corresponding annual Federal secondary standard was exceeded at the same three stations in Portland during 1970, at Lake Oswego and Springfield in 1970, and at one of the three stations in Salem in 1969. Measured concentrations of sulfur dioxide in Portland and Salem and of nitrogen dioxide in Portland are well below the Federal standards. However, the method of determining the nitrogen dioxide concentrations, the modified Saltzman method, is not approved by EPA and preliminary samples taken using the approved Jacobs-Hochheiser method indicate that the nitrogen dioxide concentrations are significantly higher than the past measurements indicate. Carbon monoxide concentrations measured in Portland exceeded the Federal maximum 1-hour standard at two of the five locations for which data are available; the Federal maximum 8-hour standard was exceeded at all five locations. Concentration of photochemical oxidants as given by ozone measurements made at the CAM Station exceeded the Federal maximum 1-hour standard during both 1969 and 1970. Measurements of total hydrocarbons made at the CAM Station have not been adjusted for methane and therefore cannot be compared directly with the Federal 3-hour maximum standard.

Only suspended particulate concentration data are provided in Table 4-1 for the four intrastate air quality control regions. The Federal primary standard for the maximum 24-hour concentration was exceeded at Medford, Pendleton and Baker. The corresponding Federal secondary standard was exceeded at Roseburg, Coos Bay, Grants Pass, The Dalles, Bend, Klamath Falls and LaGrande. The value of 155 micrograms per cubic meter given in the table for the maximum 24-hour suspended particulate concentration at Bend, in the Central Oregon Intrastate AQCR, is the second highest value reported for 1970. The highest reported value of 400 micrograms per cubic meter was judged to be in error and not representative; 400 micrograms per cubic meter is more than twice larger than any other 24-hour suspended particulate measurement ever obtained at Bend.

4.1.2 Summary of Emissions Inventory Data by County and UTM-Coordinate Grids

The emissions inventory data for each air quality control region by county are presented in Table 4-2. The Washington portion of the Portland Interstate Air Quality Control Region has been omitted from the table. Emissions density maps for each pollutant by county are presented in Figures 4-1 through 4-5.

The emissions inventory for the Oregon portion of the Portland Interstate AQCR was used to prepare an emissions density map by UTM-coordinate grids. The UTM 10,000-meter northing and easting points were used to form a grid over the area. The emissions from each point source were assigned to the grid in which the source was located, and the total point-source emissions were accumulated by grids. The county area sources were apportioned to the grids which fell within the county boundaries on the following basis:

- Automobile Vehicle Emissions - The percentage of the total county vehicle miles in the cities of Portland, Salem and Eugene was used to apportion the total county emissions to the grid areas enclosing these cities; the remainder of the total county vehicle emissions was apportioned over the remaining grid areas in each county

- Field-Burning Emissions - The county field burning emissions were apportioned over the grid areas within the county in which the mean elevation above sea level was 500 feet or less

TABLE 4-2

EMISSIONS IN TONS PER YEAR FOR 1970 BY AIR QUALITY REGION AND COUNTY

Region and County	Particulates		Sulfur Oxides (SO_x)	Total Hydrocarbons (R_x)	Carbon Monoxide (CO)	Nitrogen Oxides (NO_x)
	Fine <10μ	Total				
Northwest Intrastate						
Clatsop	1,150	1,400	1,198	3,915	8,831	2,586
Lincoln	3,056	3,327	630	5,242	15,122	2,122
Tillamook	1,009	2,002	664	3,811	13,084	1,840
Portland Interstate (Oregon)						
Columbia-Willamette						
Clackamas	3,461	4,275	1,992	22,372	95,867	6,396
Columbia	2,841	3,314	759	7,419	15,239	2,029
Multnomah	7,457	10,597	1,197	71,192	287,351	19,812
Washington	1,677	2,592	816	18,647	77,318	4,285
Mid-Willamette Valley						
Benton	1,640	3,130	422	7,382	32,922	5,303
Linn	9,676	15,853	1,380	20,666	100,336	8,810
Marion	2,591	4,372	4,634	25,554	111,360	7,471
Polk	1,580	3,854	186	6,747	30,822	2,677
Yamhill	1,614	2,423	1,406	6,624	28,155	2,306
Lane						
Lane	11,920	37,327	2,753	38,441	165,658	16,478

TABLE 4-2 (Continued)

Region and County	Particulates		Sulfur Oxides (SO_x)	Total Hydrocarbons (R_x)	Carbon Monoxide (CO)	Nitrogen Oxides (NO_x)
	Fine	Total				
Southwest Intrastate						
Coos	2,339	5,472	2,810	8,385	20,223	4,517
Curry	1,334	3,239	148	2,941	12,734	1,464
Douglas	22,540	29,804	3,429	21,250	69,904	10,522
Jackson	4,103	12,187	1,037	14,474	41,538	7,056
Josephine	1,529	4,110	403	6,621	21,311	3,126
Central Intrastate						
Crook	387	690	91	1,490	4,166	919
Deschutes	940	2,678	284	4,379	11,843	2,114
Hood River	586	910	264	2,788	8,479	1,360
Jefferson	305	338	180	1,830	5,789	1,156
Klamath	2,367	5,670	964	8,091	22,613	5,742
Lake	1,078	1,582	210	2,469	10,919	934
Sherman	55	60	113	923	2,568	574
Wasco	1,559	1,835	846	4,098	12,937	1,870
Eastern Intrastate						
Baker	552	898	314	3,125	8,799	1,673
Grant	787	1,230	115	2,134	8,489	901
Harney	571	997	114	1,850	5,101	1,306
Malheur	185	215	290	3,439	8,845	1,893
Morrow	168	228	160	1,269	3,645	889
Umatilla	913	1,352	708	6,588	18,651	3,261
Union	1,195	13,375	256	3,212	10,143	1,871
Wallowa	382	465	59	1,181	4,333	483
Wheeler	236	371	20	547	1,921	388
Gilliam	121	138	240	1,123	3,090	777

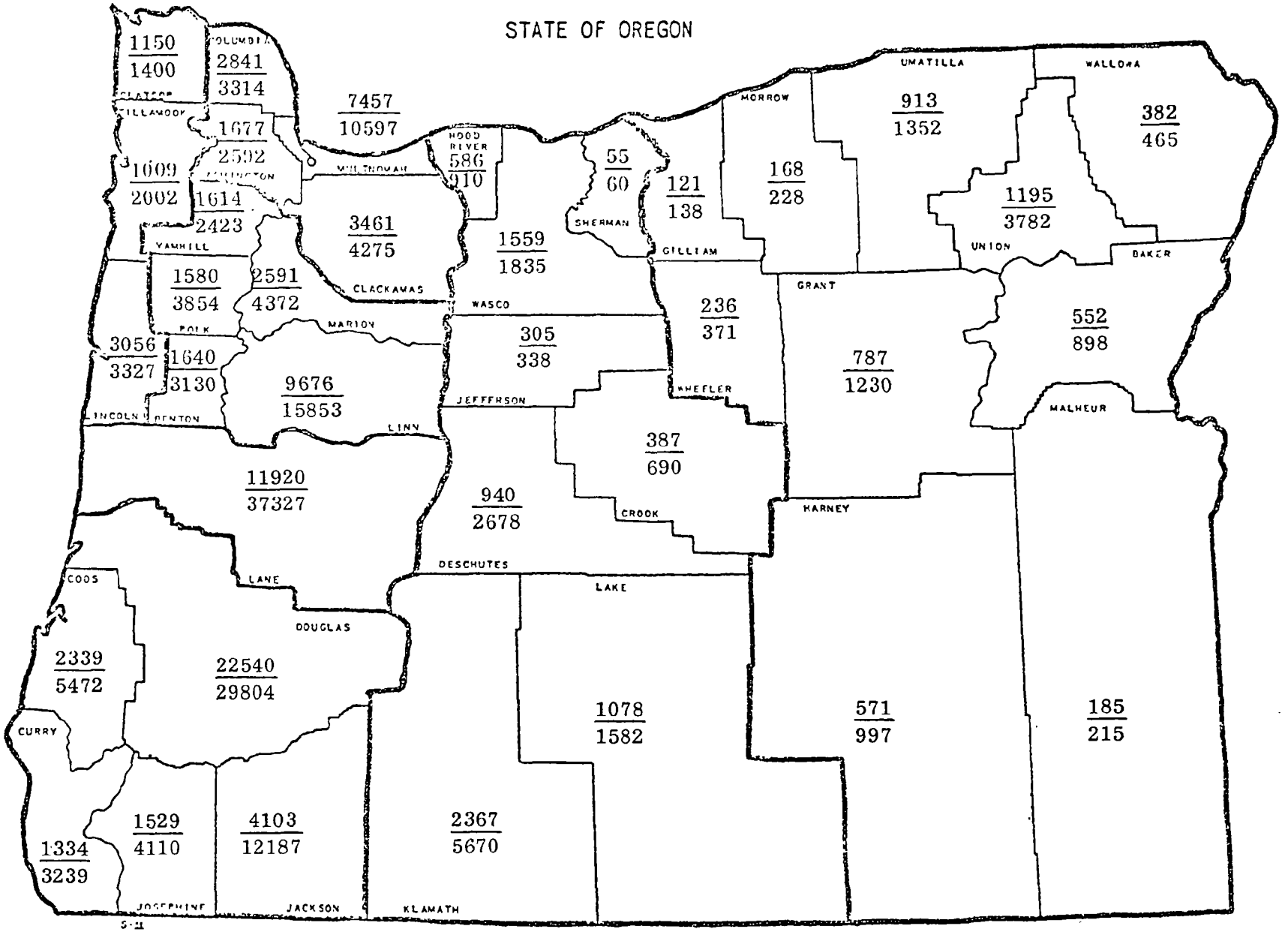

FIGURE 4-1. Existing (1970) emissions of fine particulates (upper number) and total particulates (lower number) in tons per year for each County.

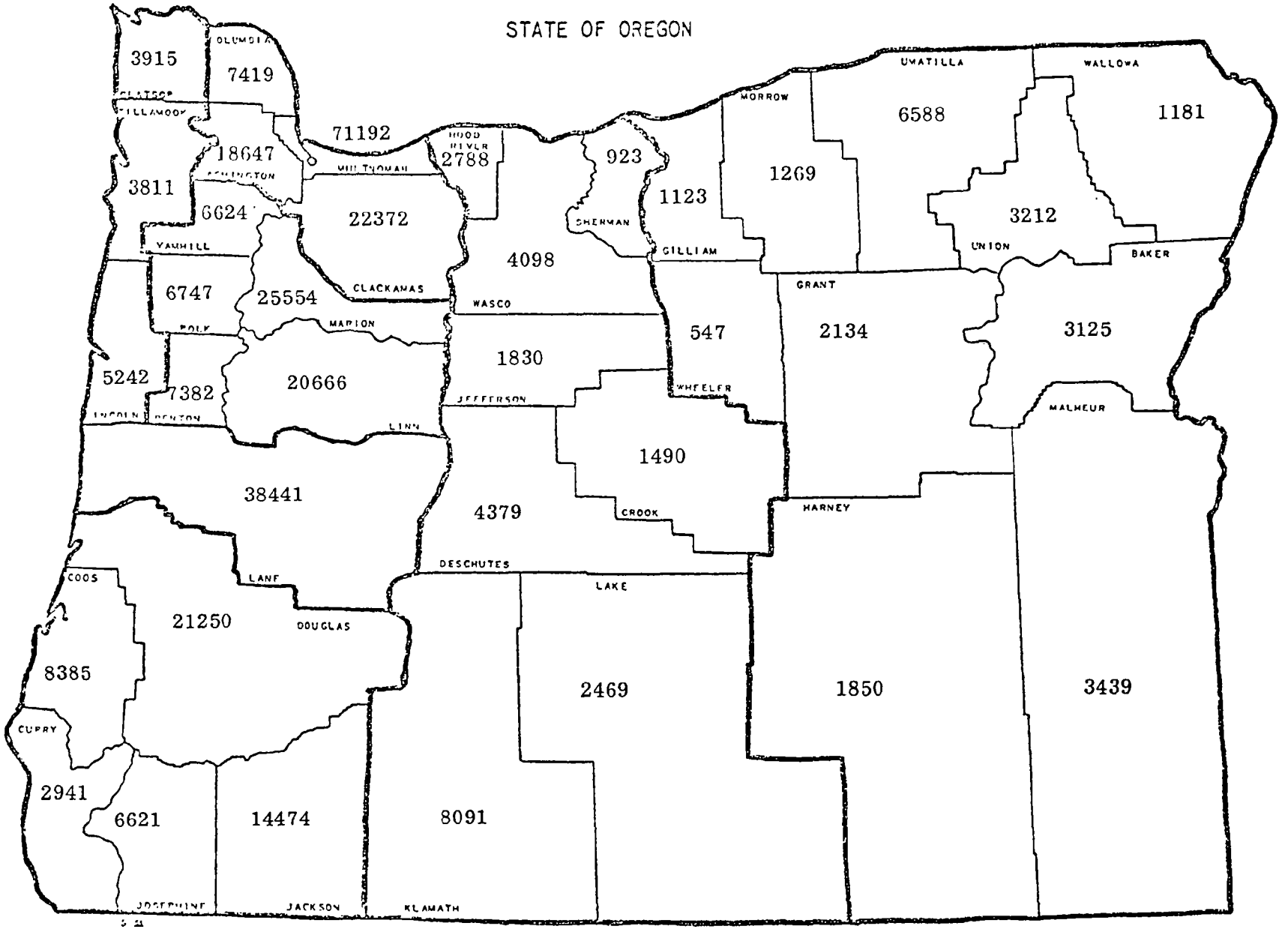

FIGURE 4-2. Existing (1970) emissions of total hydrocarbons in tons per year for each County.

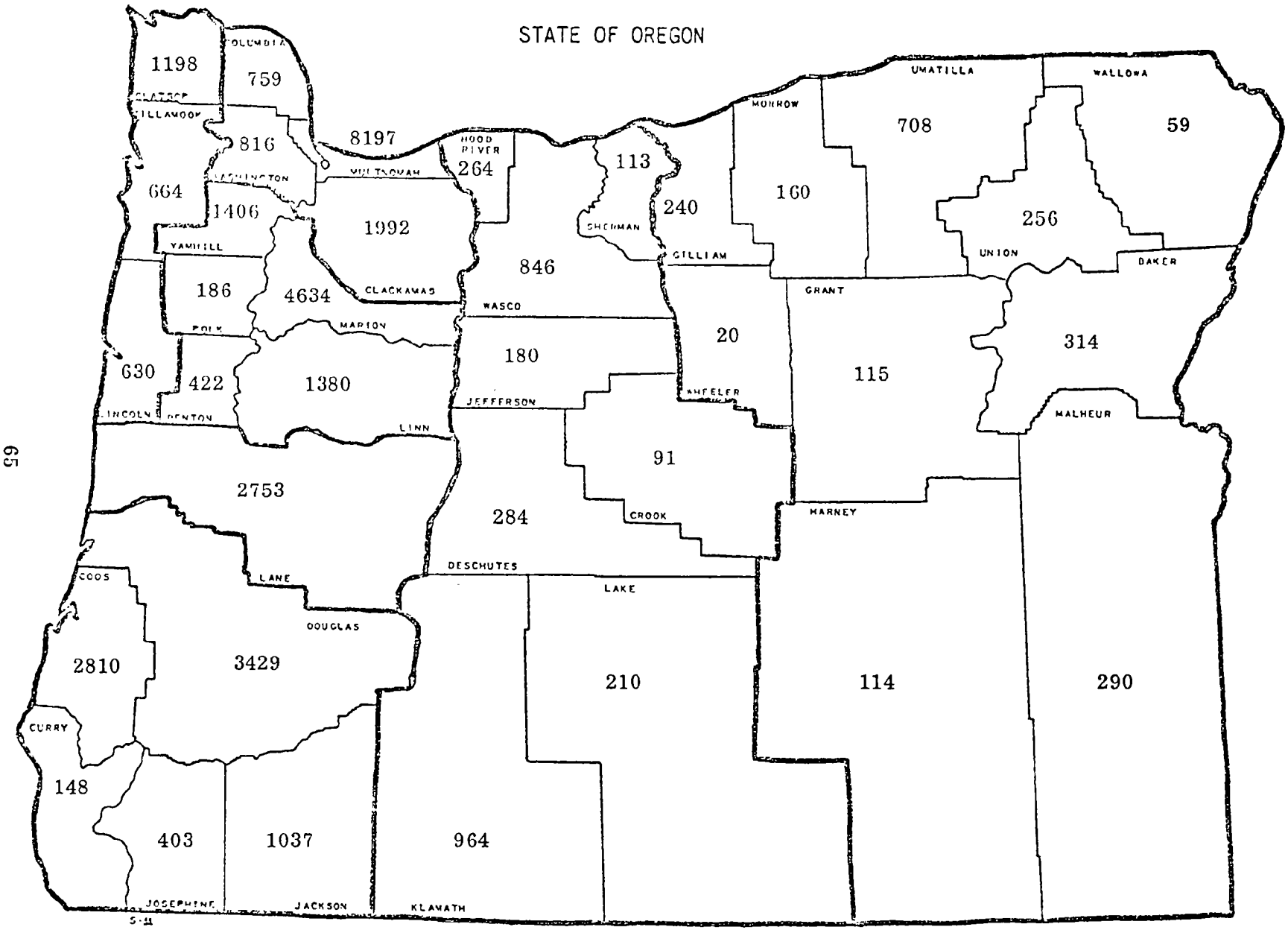

FIGURE 4-3. Existing (1970) emissions of sulfur oxides (SO_x) in tons per year for each County.

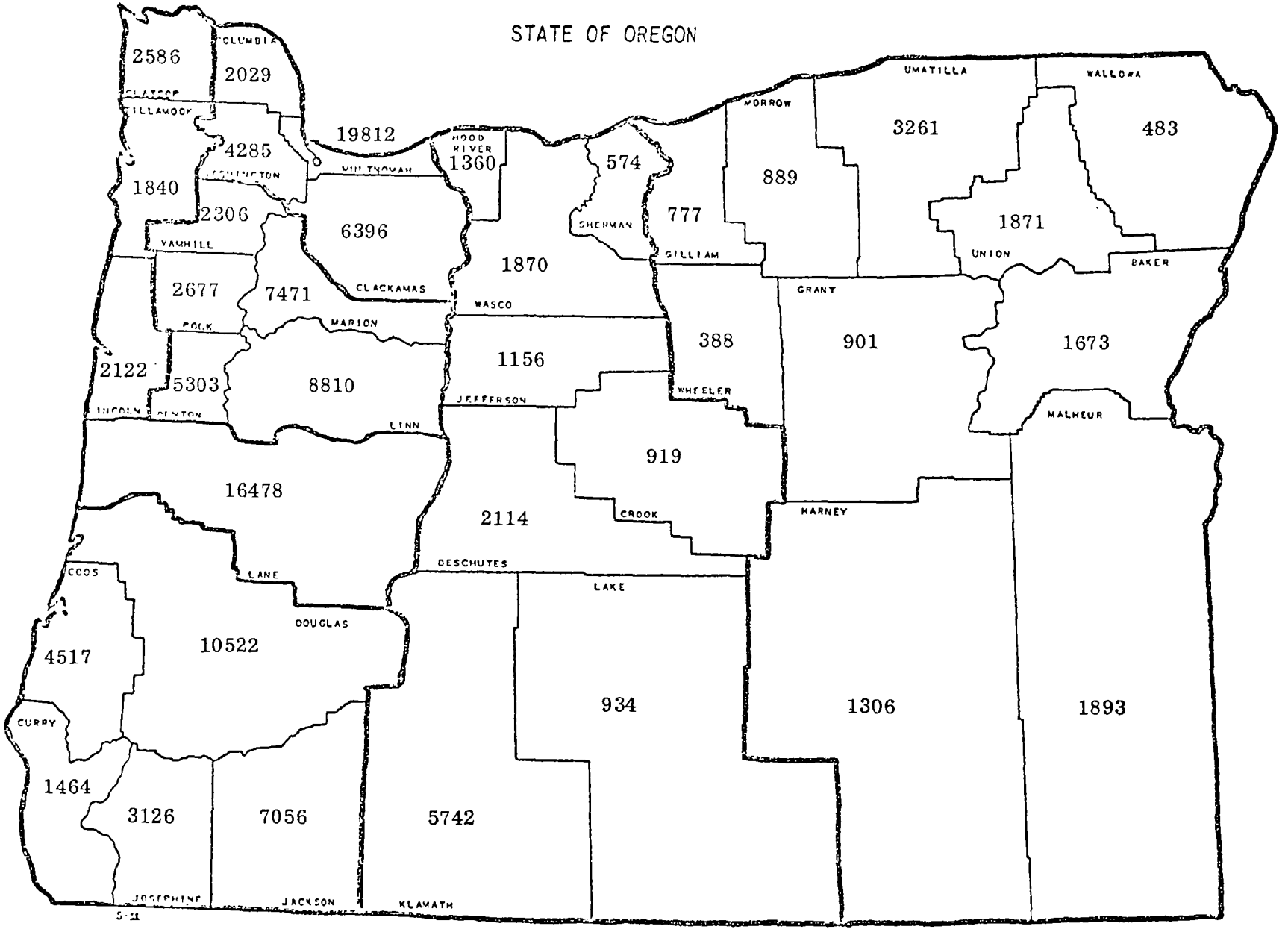

FIGURE 4-4. Existing (1970) emissions of nitrogen oxides (NO_x) in tons per year for each County.

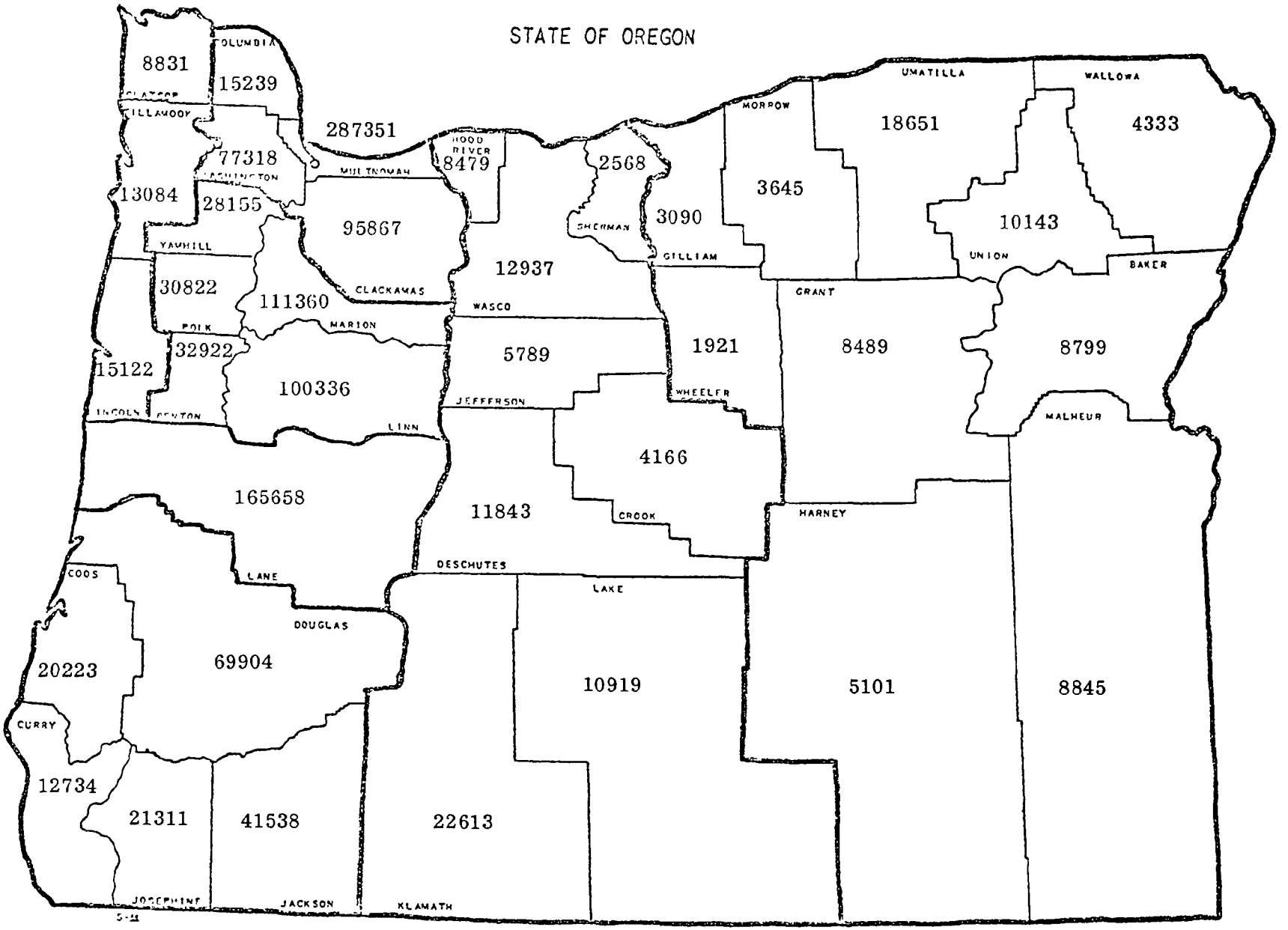

FIGURE 4-5. Existing (1970) emissions of carbon monoxide (CO) in tons per year for each County.

- Slash-Burning Emissions - For the Cascade Mountain area, the county slash-burning emissions were apportioned over the grid areas within each county in which the mean elevation above sea level was over 2000 feet; in the Coast Range area, the county slash-burning emissions were apportioned to grid areas in which the mean elevation above sea level was over 1000 feet

- Other Emissions - All remaining county emissions were apportioned equally over the grid areas within the county

A computer program was written to apportion the Oregon emissions inventory data, which is available on magnetic tape, to 100 square kilometer grids as explained above and to sum the area-source and point-source emissions within each grid. Computer calculations of emissions density for the Oregon portion of the Portland Interstate AQCR were performed on the UNIVAC 1108 machine at the University of Utah Computer Center. The results of the calculations, which are presented in tabular form in Appendix B, are arranged by county. Within each county, the UTM coordinates and the total annual emissions in tons per year of five pollutants are listed for each grid area. The five pollutants are:

- Total Hydrocarbons
- Total Suspended Particulates
- Nitrogen Oxides
- Sulfur Oxides
- Carbon Monoxide

To aid in the interpretation of the computer calculations, maps of emissions density were constructed for the Oregon portion of the Portland Interstate AQCR showing the total annual emissions in tons per year of each pollutant by grid area. One interesting result shown by the maps is that all pollutant emissions in the grid for the Springfield area of Lane County are generally higher than those in the adjacent grid area containing Eugene. On the basis of population above, emissions in the Eugene grid area would be expected to be about three times larger than in the Springfield grid area.

4.1.3 Summary of Motor Vehicle Emissions Data for the Downtown Portland Core Area

The air quality data summary in Table 4-1 indicates that 1-hour maximum and 8-hour maximum concentrations of carbon monoxide, measured in downtown Portland at the CAM Station, far exceed the applicable Federal air quality standards. Levels of photochemical oxidants, ozone and total hydrocarbons measured at the CAM Station also appear to be somewhat higher than the applicable Federal air quality standards. Because motor vehicle emissions are the likely primary source for all of these pollutants, the question arises whether there are other areas in the overall downtown Portland core area, similar to the area surrounding the CAM Station, in which motor vehicle emissions approach or exceed those in the CAM Station area.

To answer this question, a density map of carbon monoxide emissions from motor vehicles was constructed from data previously prepared by the Columbia-Willamette Air Pollution Authority. This map is shown in Figure 4-6. The numbers in the figure represent tons of carbon monoxide per year produced by motor vehicle emissions within each grid area. These annual estimates of carbon monoxide emissions were developed from estimates of the total vehicle miles driven in each grid during 1970. Total vehicle miles were in turn estimated from average

FIGURE 4-6. Emissions density map of CO emissions in the downtown Portland core area.

daily traffic volume data for 1969 obtained from the City of Portland Bureau of Traffic Engineering. Because these data represented the average 24-hour vehicle traffic during a typical 5-day week, they were reduced by 8 percent to yield 7-day week figures. Within each grid area, non-freeway and freeway vehicle miles were tabulated separately. Emission factors used to convert 1970 vehicle miles to carbon monoxide emissions were obtained from an EPA publication by McGraw and Duprey, "Compilation of Air Pollution Emission Factors," dated April 1971. An average non-freeway speed of 10 miles per hour and an average freeway speed of 45 miles per hour were assumed in the emission calculations.

The largest grid shown in Figure 4-6 has an approximate area of 0.136 square miles. The areas covered by the intermediate- and small-size grids are respectively one-quarter and one-sixteenth as large. The northwest-southeast lengths of the intermediate-size grids along the Willamette River are not drawn to scale and are too short. In Figure 4-6, the intermediate-size grid containing the CAM Station (Area A) has a total annual emission of 293 tons of carbon monoxide. In Areas B and C, which are adjacent to the CAM Station area and of the same size, the estimated emissions are 366 and 528 tons per year. The highest emission of 600 tons per year for an intermediate-size grid occur in Area D. Because Area D is close to the Willamette River, the ventilation rate is likely to be higher than in Areas A, B, and C. Air quality levels in Area D relative to those in three other areas may thus not be directly related to total emissions. Spot sampling of motor vehicle pollutants should be conducted in Areas B, C, D and other similar areas of high indicated carbon monoxide emissions to establish air quality levels.

4.2 METEOROLOGICAL DATA REQUIREMENTS

The Federal requirements for state air quality surveillance systems do not include meteorological measurements. Requirements for meteorological data, however, are implicit in many of the requisite state activities under the Implementation Plan. These activities include the calculation of air quality levels from emissions data; assessment of the representativeness of air quality measurements; evaluation of the impact of new sources or the elimination of existing sources on air quality; location of air quality sampling stations; and the development of emergency-episode and other control strategies. This section begins with a description of the air pollution climatology and meteorology of the Willamette Valley and other climatic regions of Oregon. This background material is followed by a discussion of the specific requirements of the State of Oregon for meteorological data and measurements.

4.2.1 Air Pollution Climatology and Meteorology of the Willamette Valley

Because the principal population centers of the State of Oregon are located in the Willamette Valley, the air quality in this area is of major concern. Air quality in the Willamette Valley and elsewhere depends not only on the total quantities of pollutants that are injected into the atmosphere, but is also significantly affected by the atmospheric dispersal and transport of these pollutants. These latter processes are largely controlled by topographical features and by meteorological factors such as wind speed, wind direction, and the height of the surface mixing layer.

Topographical Features

The major topographical features controlling climatology and meteorology of the Willamette Valley are:

- The Pacific Ocean which forms the western border of the State
- The Coast Range and the Cascade Mountains
- The Columbia and Willamette Rivers

As shown in Figure 4-7, the Willamette Valley lies between the Coast Range and the Cascade Mountains. The Coast Range extends the entire length of the western edge of the State. The height of the Range varies from 2000 to 3500 feet above sea level and the crests are located approximately 20 to 30 miles inland from the coast. The Cascade Mountains are found approximately 75 miles east of the Coast Range and are oriented north-south, approximately parallel to the Coast Range, until the two mountain systems merge north of the California border to form the Siskiyou Mountains. The average height of the Cascades is about 5000 feet above sea level with a few high peaks extending above 10,000 feet. The width of the Willamette Valley floor, as defined by the 500-foot contour, is approximately 40 miles at Portland and Salem and about 25 miles near Eugene (see Figure 4-7).

The gorge of the Columbia River, which forms most of the northern border of the State, cuts through both the Coast Range and the Cascade Mountains. The Columbia River Valley thus provides a natural passageway for the eastward transport of marine air from the Pacific Ocean and for the westward transport of continental air masses from western Oregon, western Washington, and Idaho. The Willamette River Valley opens into the Columbia River Valley at Portland and extends southward approximately 100 miles to Eugene in the lowlands between the Coast Range and the Northern Cascades. It thus provides a natural passageway for the southward movement of both continental and Pacific-marine air from the Columbia River Valley to Salem and Eugene, and for the northward flow of air masses in the Willamette Valley into the Columbia River Valley. The Cascades form a solid airflow barrier on the eastern side of the Willamette Valley. The

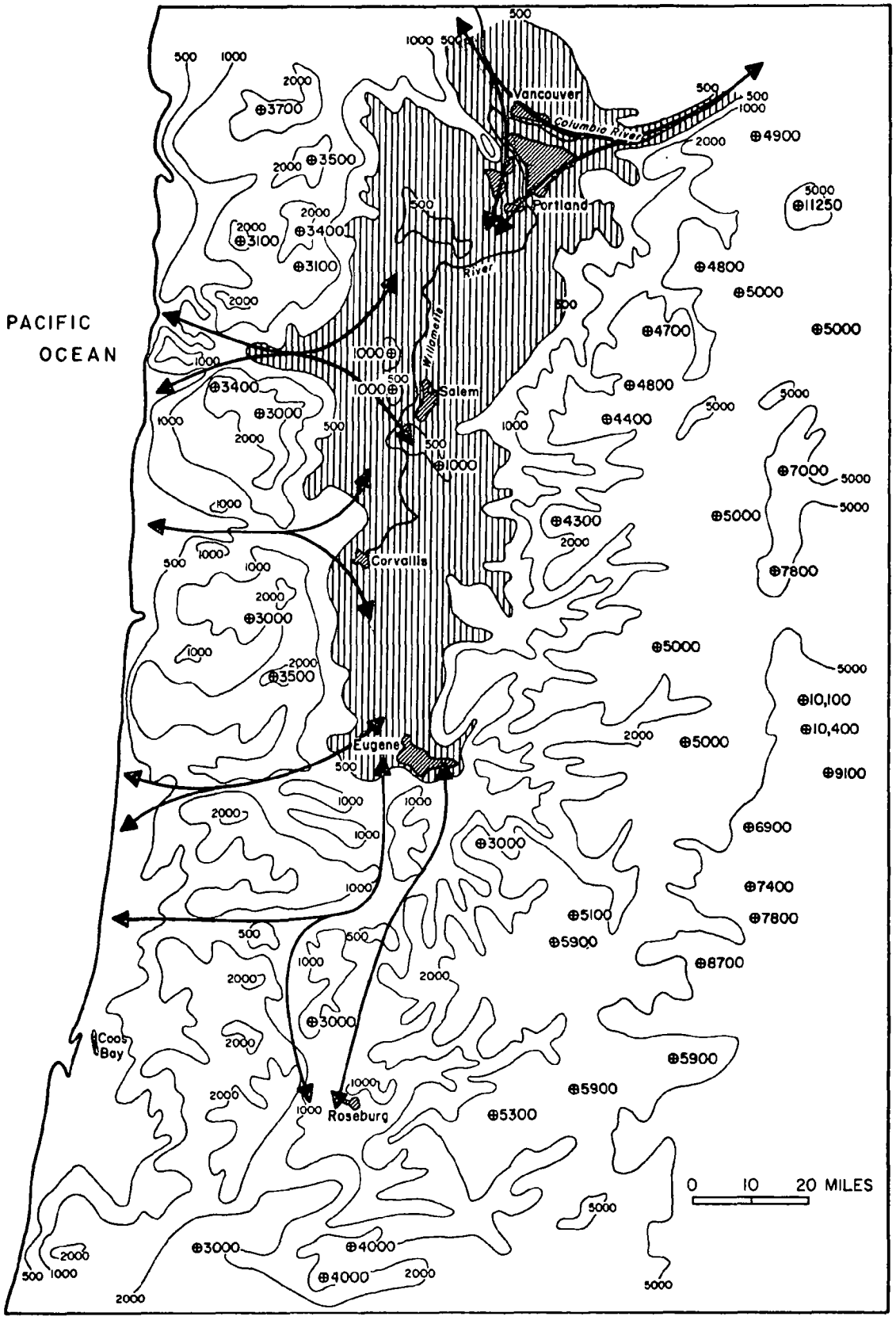

FIGURE 4-7. Topographical map of northwest Oregon. Elevations are in feet above mean sea level. The Willamette and Columbia River Valleys are indicated by the vertical striping. Heavy curved lines show the major natural air passageways leading in and out of the Willamette Valley.

Coast Range on the western side of the Valley forms only a partial airflow barrier because of the lower crest elevations and because of several low points (especially those west of Salem, Corvallis and Eugene) through which Pacific marine air can enter the Willamette Valley.

Major Meteorological Regimes

There are three large-scale meteorological regimes that account for important seasonal variations in the wind circulations and general weather patterns of the Willamette Valley:

- A winter regime characterized by the frequent passage of cyclonic storms from the Pacific Ocean with attendant low barometric pressure off the Oregon coast and high pressure inland to the east
- A summer regime characterized by high barometric pressure centered off the coast with a weak anticyclonic circulation and generally fair weather conditions inland
- A transitional regime in both spring and fall incorporating the major features of both the winter and summer regimes

The winter meteorological regime features strong southerly winds in advance of the Pacific storm systems, as well as extensive cloudiness and precipitation. The summer regime features westerly or northwesterly winds during the day in the Columbia and Willamette River Valleys; at night, the winds become very light and the direction

of the airflow tends to be the reverse of the daytime flow. The Pacific maritime air that flows up the Columbia River and enters the Willamette Valley at Portland, or comes from the west through low passes in the Coast Range, has a high moisture content and may contain stratiform low clouds similar to those found along the coast. In general, the anticyclonic fair weather conditions that prevail in summer over the entire region east of the Coast Range lead to a dissipation of the stratiform clouds as the Pacific marine air travels inland and away from a supply of moisture.

Cloudiness and Precipitation

Clouds reduce the amount of solar radiation reaching the surface. A reduction in solar radiation precludes photochemical reactions and thus prohibits smog formation. A reduction in solar radiation also inhibits the development of convective air circulations which decrease pollutant concentrations by mixing pollutants through deep air layers. Precipitation removes pollutants from the air and deposits them on the underlying surface.

Most of the cloudiness and precipitation in the Willamette Valley occur during the winter season and in the late fall and early spring. According to Mathew's (1971) study of Salem climatological records, over 70 percent of the frontal system and cyclone passages produce precipitation during the months from November through April. As shown in Table 4-3, approximately half the total annual precipitation occurs during the three winter months of December, January and February. Only about six percent of the total annual precipitation occurs in summer with the remainder about equally divided between the spring and fall seasons. Most of the precipitation that occurs in the Willamette Valley is in the form of light rain showers and drizzle. Thunderstorms occur on the average only on four or five days each year as compared with 150 to 180 days per year on which measurable precipitation occurs.

TABLE 4-3

MEAN TOTAL HOURS OF SUNSHINE, DAILY SOLAR RADIATION, DAILY SKY COVER, AND TOTAL PRECIPITATION BY MONTHS FOR THE WILLAMETTE VALLEY (W. V.) AND THE LOS ANGELES BASIN (L. A. B.) (ESSA CLIMATIC ATLAS OF THE U.S., 1968)

Month	Sunshine (Total Hours)		Solar Radiation (Langleys)		Sky Cover (Tenths)		Precipitation (Inches)	
	W. V.	L. A. B.	W. V.	L. A. B.	W. V.	L. A. B.	W. V.	L. A. B.
December	65	230	80	240	8.6	4.5	8.6	3.6
January	70	200	90	240	7.9	4.6	7.7	3.4
February	100	210	140	330	7.9	4.8	6.2	3.4
March	150	270	290	450	8.0	4.8	5.6	3.0
April	200	260	400	500	7.4	5.3	3.3	1.4
May	240	280	520	565	7.1	4.8	2.7	0.3
June	260	310	550	600	6.9	4.1	2.0	0.1
July	330	330	650	650	4.6	2.8	0.5	0.1
August	270	330	550	580	5.4	2.7	0.7	0.2
September	210	300	390	500	5.1	2.8	1.8	0.2
October	130	270	230	370	7.0	3.9	4.9	0.6
November	90	240	140	280	8.2	3.4	7.6	1.6
Annual Total or (Average)	2,115	2,320	(336)	(442)	(7.0)	(4.0)	51.8	17.8

Table 4-3 also presents the mean total hours of sunshine, average daily solar radiation, average daily sky cover, and total precipitation for each month of the year for both the Willamette Valley and the Los Angeles Basin. During the winter months, the Los Angeles Basin has approximately two and one-half times more hours of sunshine and receives about two and one-half times more solar radiation than the Willamette Valley. The average sky cover in the Willamette Valley in winter exceeds eight-tenths as compared with less than five-tenths sky cover for the Los Angeles area. During the summer months, the total hours of sunshine and the average daily solar radiation for the Los Angeles area are about 10 percent larger than those for the Willamette Valley. The average sky cover in the Willamette Valley in summer is about five-tenths as compared with an average sky cover of about three-tenths for Los Angeles. During the spring and fall seasons, the total hours of sunshine and the total solar radiation in the Los Angeles Basin are about one and a half times larger than in the Willamette Valley. The average sky cover in spring is about 7.5 tenths in the Willamette Valley and about five-tenths in the Los Angeles Basin; the corresponding values for the average sky cover during the fall season are about seven-tenths and three-tenths, respectively.

Air Circulations in the Willamette Valley

It follows from the previous discussions of topographical features and major meteorological regimes that the airflow in the Willamette Valley proper is generally from the north or south, depending on the season of the year. Because of the low crest elevations and the various openings in the Coast Range, there is also a good possibility of westerly winds. Easterly winds, on the other hand, are expected to occur infrequently south of Portland because of the massive airflow barrier formed by the Cascade Mountains. Most of the easterly winds are probably produced by nighttime drainage of cold air into the Valley from the higher elevations in the Cascades. At Portland, the low-level air circulations are channeled

by the Columbia and Willamette River Valleys and the predominant wind directions are from the northwest, south, and southeast.

Figure 4-8 shows surface wind roses for the Portland Airport, Salem Airport, Eugene Airport and for Corvallis. The data used to construct these wind roses were taken from Volume III, Part A of the Climatological Handbook Columbia Basin States (1968). The length of the observational record at Corvallis is only one year, 1943-1944, and mean wind speeds have not been estimated for the various wind direction sectors. Also, the percentage calms at Corvallis include all wind speeds from 0 to 4 miles per hour while, at the three other locations, calms include only wind speeds below 1 mile per hour. The wind data for Portland and Salem are based on 10 years (1949-1958) of hourly observations taken over 24-hour periods; the data for Eugene are based on 11 years (1948-1958) of hourly observations, but the observations that do not cover a full 24-hour period were omitted.

The seasonal variations in wind direction at the four stations, as expected, show the combined effects of the large-scale pressure gradient and the channeling of the wind by prominent topographical features. In winter, the prevailing winds are southerly from Eugene to Salem. At Portland, southeast winds occur most frequently because of the channeling by the Columbia River Valley. There is not much difference in the mean wind speeds at Salem and Eugene. Portland shows lighter and less frequent northerly winds than Salem or Eugene because of the topography. Calms at Eugene comprise about 15 percent of all observations, while calm conditions occur about 10 percent of the time at both Salem and Portland.

In summer, the surface wind-direction patterns at Portland and Eugene are almost the reverse of the winter patterns, with prevailing northwest winds at Portland and northerly winds at Eugene. The summer wind rose at Salem shows a wide spread in wind directions from north-northeast through west to south-southeast. This probably reflects the mid-valley location of Salem and the deep

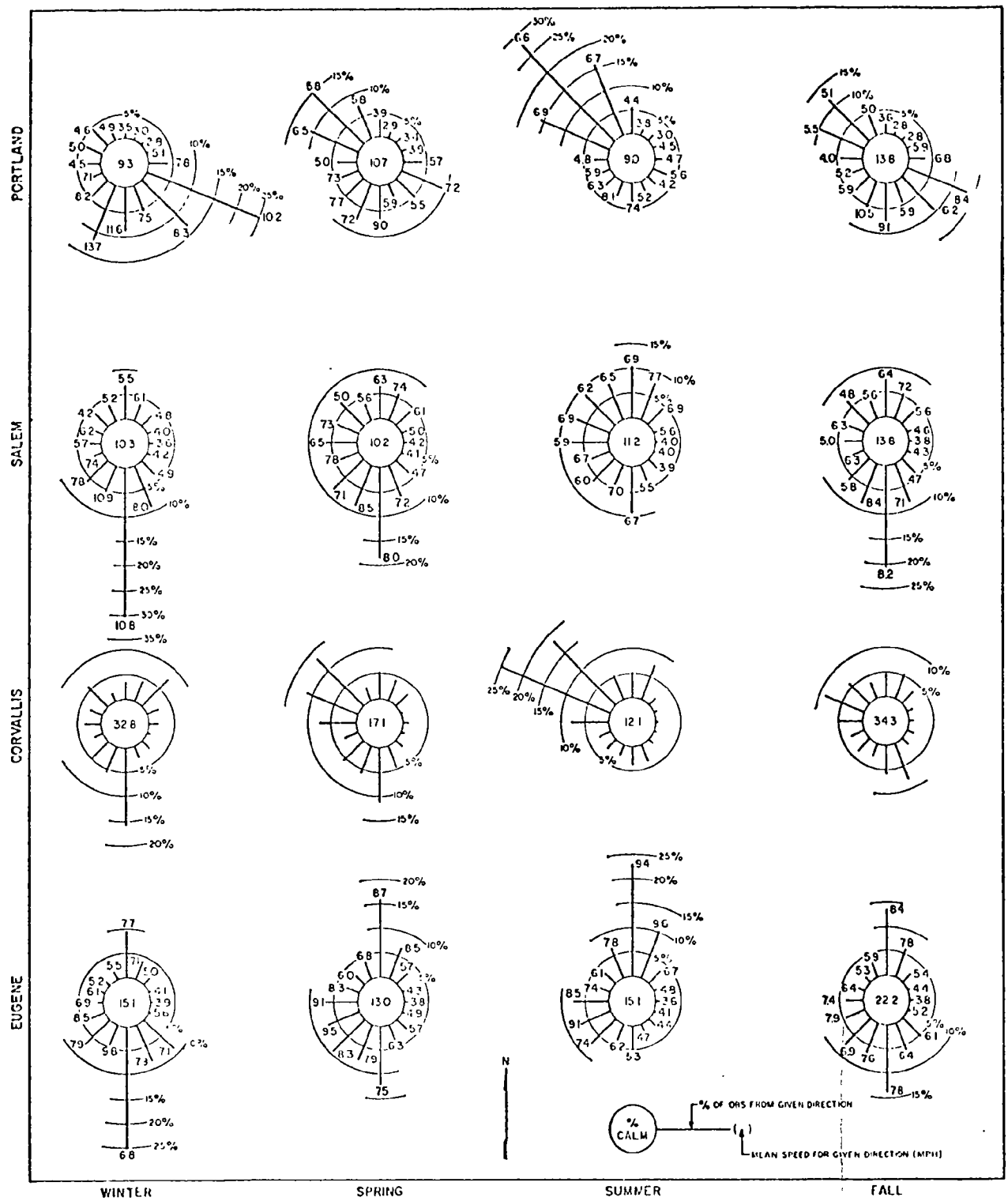

FIGURE 4-8. Seasonal wind roses for Portland, Salem, Corvallis, and Eugene (data are from Volume III, Part A of the Climatological Handbook, Columbia Basin States, 1968).

indentations in the Coast Range to the west-northwest and southwest of Salem. The northwest winds at Corvallis in summer are also explained by a break in the Coast Range that allows Pacific air to enter the Willamette Valley. Wind speeds in summer and percentages of calms are approximately equal at both Portland and Salem. Eugene has a higher percentage of calm conditions and slightly higher mean wind speeds than either Salem or Portland. For the most part, the spring and fall wind regimes at all four stations are composites of the winter and summer patterns. An important feature of the fall wind distributions at Portland, Salem and Eugene is the higher percentage of calm conditions in fall compared to the three other stations (about 14 percent calms at Portland and Salem for fall versus about 10 percent for the other three stations; at Eugene, the corresponding percentages are 22 for fall and 15 for the other seasons).

Wind roses for upper-level winds over Salem and Eugene presented by Olsson and Tuft (1970) show that the surface wind-direction distributions for these stations described above are representative of the first 500 to 1000 meters, depending on the season of the year.

Mixing Layer Heights, Ventilation Rates, and Air Pollution Potential

Holzworth (1971) presents average values of mixing layer heights and wind speeds in the mixing layer calculated from rawinsonde data for Medford, Salem and 60 other stations in the contiguous United States. Estimates of these parameters were made for the early morning and afternoon periods for each day over a five-year period. Holzworth has also estimated the air pollution potential at three stations for hypothetical city sizes of 10 and 100 kilometers. The air pollution potential is directly proportional to city size and inversely proportional to the product of the layer wind speed and mixing layer height. The Holzworth (1971) and the 7 April 1971 Federal Register urban diffusion models used to estimate air pollution potential are described in Appendix D.

Mean mixing layer heights H and layer wind speeds U, by season and annually, for the early morning and afternoon periods given by Holzworth are reproduced in Table 4-4 for four stations (Medford, Salem, Boise and Seattle). As shown in the table, morning values of H and U at Medford are consistently lower than those for Salem. In the afternoon, however, the H values at Medford are larger than at Salem or Seattle and are approximately equal to those at Boise.

Cumulative frequency distributions of the air pollution potential $\bar{\chi}/\bar{Q}$, where $\bar{\chi}$ is the mean city-wide concentration and $\bar{Q}$ is the city-wide source strength, were also calculated by Holzworth for hypothetical city sizes of 10 and 100 kilometers. Median values of these cumulative distributions are reproduced in Table 4-5 for Medford, Salem, Boise and Seattle. For the morning period, the air pollution potential at Medford is consistently higher than at the other three locations. For the afternoon period, however, the pollution potentials at all four locations are approximately equal.

Holzworth also estimated the number of episodes and the total number of episode days for several combinations of NOP mixing layer depths and layer wind speeds. NOP values for H and U are used in the calculations because no precipitation is assumed to occur during an episode. Table 4-6 presents Holzworth's results for episodes lasting at least two days and for $H \leq 500$, 1000 and 1500 meters. Medford has by far the largest number of episodes and episode days for the lowest wind speed category. Figure 4-9 presents median values, by season, of the early morning mixing height H and layer wind speed U for Salem and Medford obtained from tabulations prepared by the National Weather Records Center (1968). This figure shows that both H and U are significantly lower at Medford than at Salem in all seasons of the year. Median values of the average surface wind speeds, for the period from 0200 through 0600 LST, for Portland, Salem, Eugene, and Medford are shown in Figure 4-10. These values were calculated from 10 years' observations summarized in the Climatological Handbook Columbia Basin States

TABLE 4-4

MEAN SEASONAL AND ANNUAL MIXING LAYER HEIGHTS H (METERS) AND LAYER WIND SPEEDS U (METERS PER SECOND) FOR MORNING AND AFTERNOON; NOP MEANS NO PRECIPITATION
(FROM HOLZWORTH, 1971)

Station		Winter					Spring					Summer					Autumn					Annual				
		H		%	U		H		%	U		H		%	U		H		%	U		H		%	U	
		NOP	ALL	NOP	NOP	ALL	NOP	ALL	NOP	NOP	ALL	NOP	ALL	NOP	NOP	ALL	NOP	ALL	NOP	NOP	ALL	NOP	ALL	NOP	NOP	ALL
Medford, Oregon	AM	289	387	60.6	1.5	1.9	392	535	68.0	1.8	2.2	259	285	93.7	1.2	1.3	220	293	75.0	1.1	1.3	290	375	74.3	1.4	1.7
	PM	747	933	65.0	2.2	2.8	2004	2079	67.6	4.5	4.8	2332	2349	92.0	4.6	4.6	1481	1594	77.6	3.2	3.5	1641	1738	75.5	3.6	3.9
Salem, Oregon	AM	325	431	56.2	3.0	3.8	432	627	55.4	2.3	2.9	379	424	89.1	2.0	2.2	292	404	68.1	2.2	2.8	357	471	67.2	2.4	2.9
	PM	622	787	50.4	3.7	4.5	1614	1733	56.3	4.3	4.8	1655	1632	86.1	4.4	4.5	1115	1212	67.9	4.2	4.6	1251	1354	65.1	4.1	4.6
Boise, Idaho	AM	327	407	68.1	3.6	4.2	342	424	76.7	4.5	5.0	185	193	90.4	3.3	3.4	224	279	79.8	3.8	4.2	269	326	78.7	3.8	4.2
	PM	631	754	67.9	4.3	4.9	2244	2329	78.0	6.4	6.7	2511	2540	92.2	5.8	5.9	1320	1409	81.5	5.0	5.3	1676	1758	79.9	5.4	5.7
Seattle, Washington	AM	626	824	49.8	5.1	6.2	681	838	55.1	4.6	5.5	532	576	85.1	4.0	4.2	476	585	61.5	4.3	5.0	578	705	62.8	4.5	5.2
	PM	585	718	45.8	4.7	5.4	1490	1577	56.5	5.7	6.2	1398	1419	89.5	4.8	4.9	898	987	66.3	4.6	5.0	1092	1175	64.5	4.9	5.4

TABLE 4-5

MEDIAN AIR POLLUTION POTENTIAL $\overline{\chi}/\overline{Q}$ (sec m^{-1}) FOR A 10-km CITY
(FROM HOLZWORTH, 1971)

City		Season				
		Winter	Spring	Summer	Fall	Annual
Medford, Oregon	AM	29	24	62	47	39
	PM	11	10	10	10	10
Salem, Oregon	AM	13	12	24	19	17
	PM	10	10	9	10	10
Boise, Idaho	AM	14	14	19	19	17
	PM	11	9	10	10	10
Seattle, Washington	AM	10	10	11	11	10
	PM	10	10	10	10	10

TABLE 4-6

NUMBER OF EPISODES AND EPISODE DAYS OF HIGH METEOROLOGICAL POTENTIAL OVER A 5-YEAR PERIOD; THE SPECIFIED METEOROLOGICAL CONDITIONS MUST EXIST FOR AT LEAST TWO DAYS IN SUCCESSION WITH NO PRECIPITATION (FROM HOLZWORTH, 1971)

Site	Layer Speed	≤ 2m/sec		≤ 4m/sec		≤ 6m/sec	
	H ≤	Number of Episodes	Episode Days	Number of Episodes	Episode Days	Number of Episodes	Episode Days
Medford, Oregon	500	15	52	15	55	15	55
	1000	33	124	39	152	40	156
	1500	37	144	55	214	61	235
Salem, Oregon	500	1	2	12	38	16	52
	1000	5	13	32	98	51	163
	1500	5	13	59	172	96	318
Boise, Idaho	500	2	6	17	57	24	81
	1000	2	7	28	111	46	181
	1500	2	7	36	144	60	245
Seattle, Washington	500	0	0	7	15	13	37
	1000	0	0	18	44	52	138
	1500	0	0	27	66	94	259

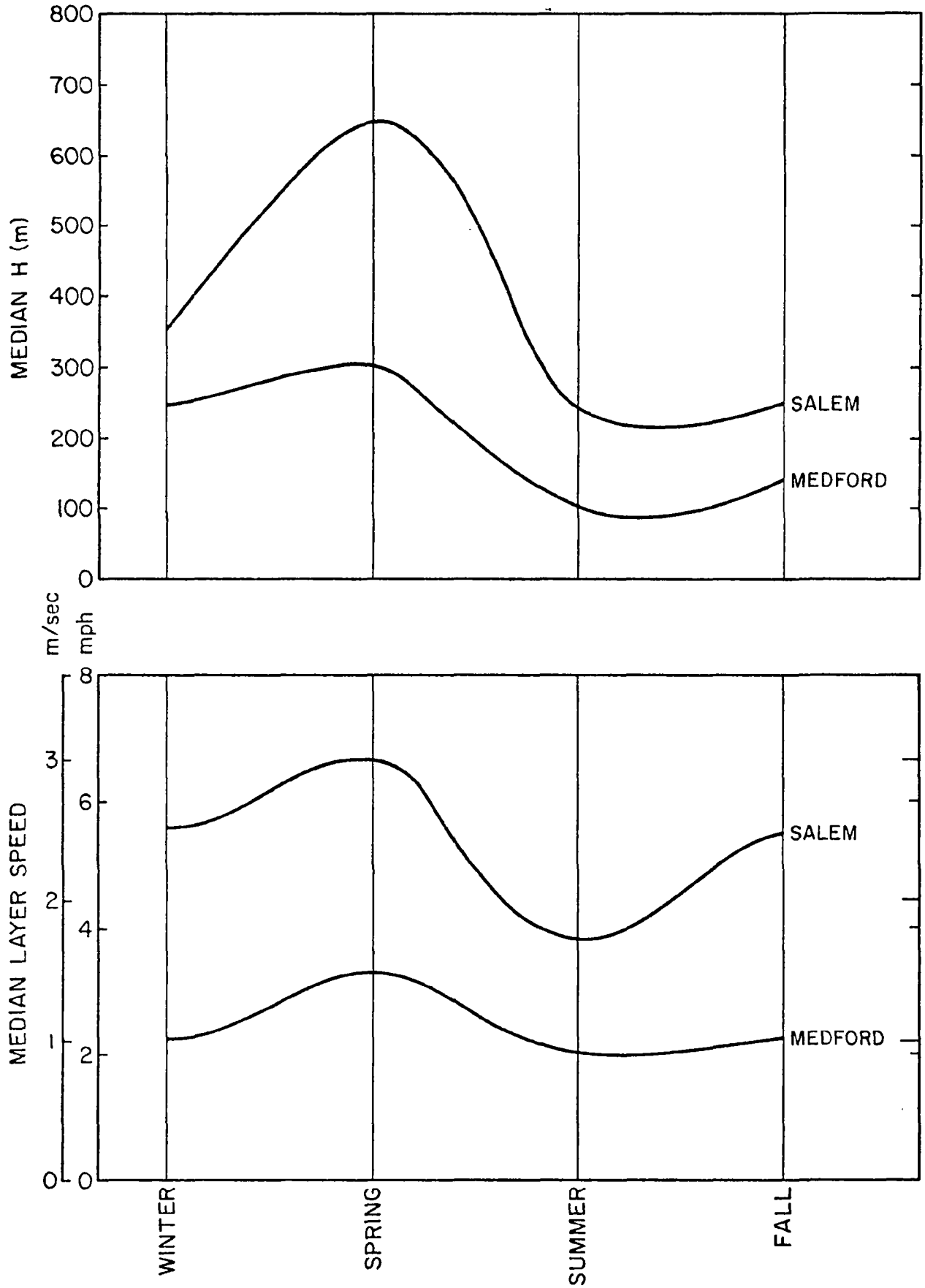

FIGURE 4-9. Median early morning mixing layer heights and wind speeds by season for Salem and Medford (from Tabulation 3, NWRC Job 6234).

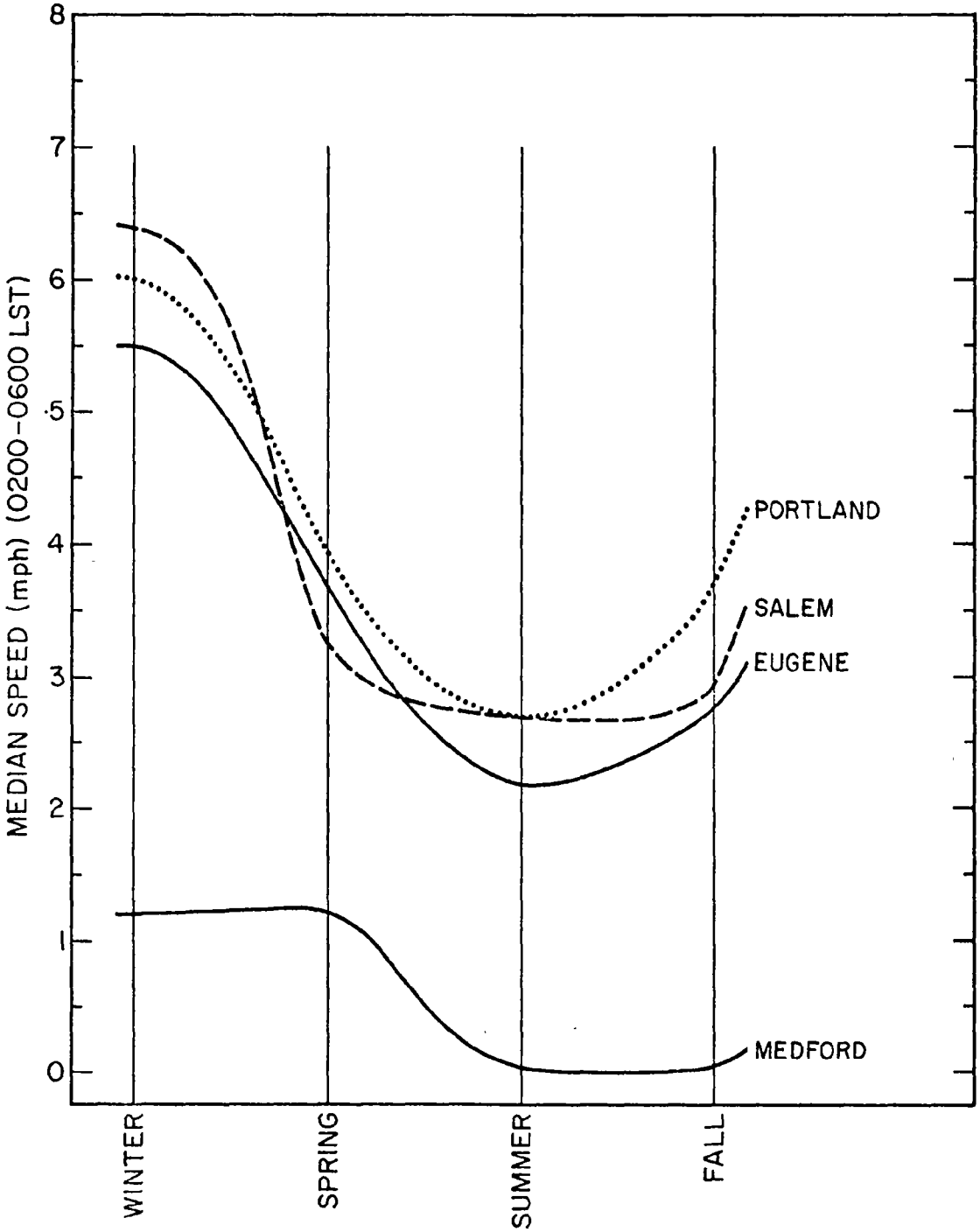

FIGURE 4-10. Median surface wind speeds averaged from 0200 through 0600 LST by season for Portland, Salem, Eugene and Medford.

(1968). The 0200-0600 LST period is used by Holzworth in calculating the surface speeds that go into the mean layer speeds; because of the low morning values of H at Medford, the surface speed is often equivalent to the mean layer speed. The results in the figure show that the three sites in the Willamette Valley all have similar median early morning wind speeds and that these are very much higher than the corresponding median speeds at Medford.

It is concluded from the above discussion that Salem meteorological data are representative of the air pollution potential of the entire Willamette Valley, while Medford meteorological data are definitely not representative of the Willamette Valley. Holzworth's (1971) statements about the very high air pollution potential in Oregon therefore apply strictly to Medford and do not apply to the Willamette Valley or to the Portland area.

4.2.2 Regional Air Pollution Climatology and Meteorology

The climatic regions of Oregon are shown in Figure 4-11. The boundaries of the various regions were determined from watershed rather than airshed considerations. Major topographical features of Oregon, in addition to those described in Section 4.2.1 above, include:

- The Columbia and Snake River Basins forming, respectively, the northern boundary of the North Central Region and the eastern boundaries of the Northeast and Southeast Regions

- The Wallowa Mountains in the extreme northeast corner of the State with an average elevation of 5000 to 6000 feet above mean sea level

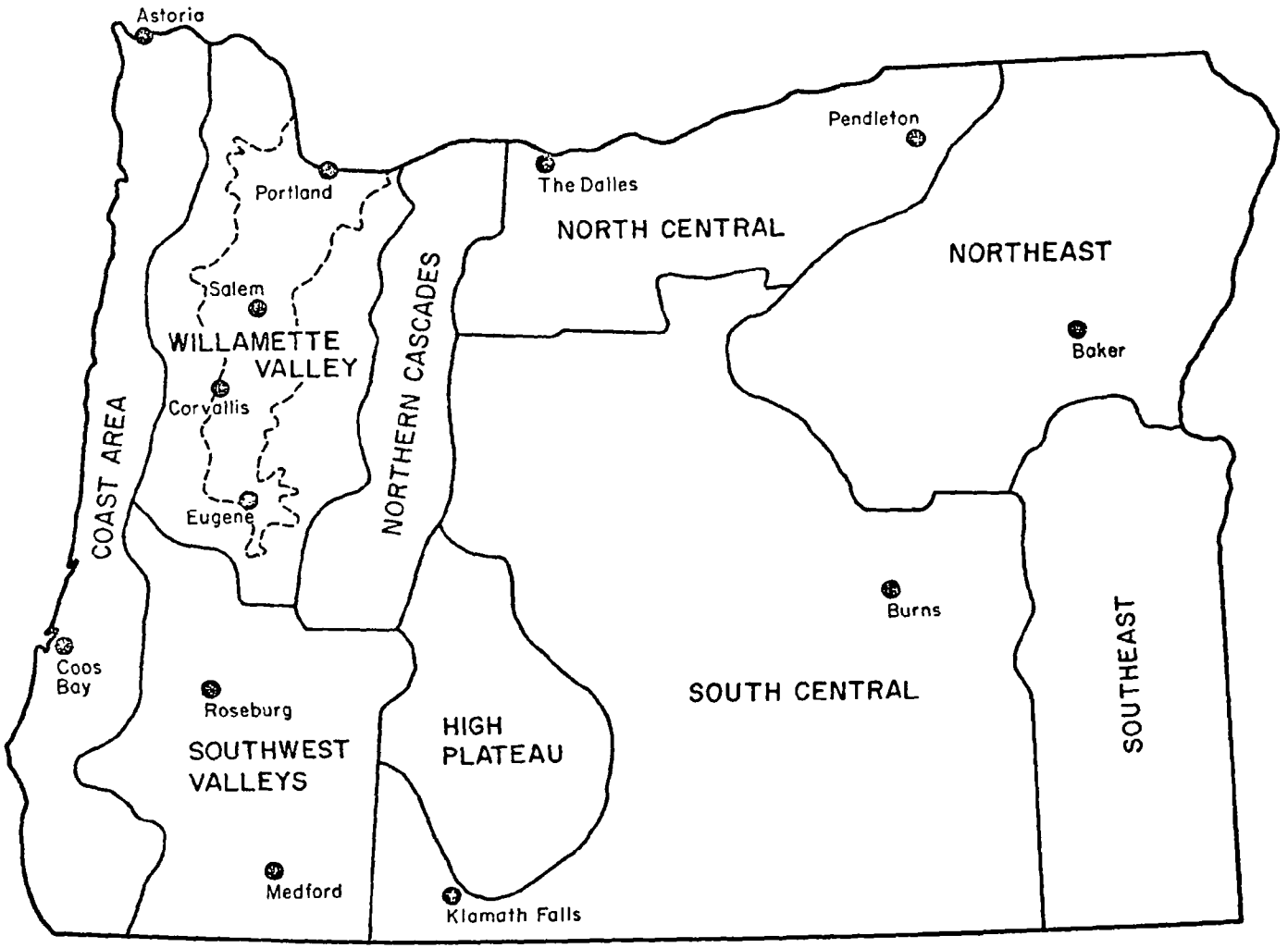

FIGURE 4-11. Climatic Regions in Oregon from the Climatic Atlas of the United States (ESSA, 1965).

- An interior plateau, covering approximately one-third of the total area of the State, that includes the South Central and High Plateau Regions; the elevation of the plateau region varies from 4000 to 6000 feet above mean sea level

The major meteorological regimes are the same as those outlined in Section 4.2.1 above. Cloudiness and precipitation patterns are largely determined by distance from the Pacific Ocean and elevation above mean sea level. The heaviest precipitation occurs in the Coast area where the average annual amount is approximately 75 inches. The Northern Cascades receive approximately 65 inches total annual precipitation. The Cascades are followed, in descending order, by the Willamette Valley (52 inches per year) and by the Southwest Valleys and High Plateau Regions, each of which receives about 30 inches of precipitation each year. In the other climatic regions, the total annual precipitation varies from about 10 to 20 inches, with the largest amounts occurring in the North Central Region and in the Wallowa Mountains of the Northeast Region. Cloudiness is apportioned similarly to total annual precipitation. The average annual sky cover in the western one-third of the State is about seven-tenths as against five-tenths for the remaining two-thirds of the State.

Because of the aridity of the central and eastern portions of the State, there is a wide diurnal range in air temperature produced by greater solar heating during the day and greater radiational cooling at night than occurs elsewhere. The Southwest Valleys also tend to follow this diurnal pattern because of their high elevation and because the forced lifting of Pacific air by the Coast Range and the Siskiyou Mountains removes much of the moisture content before the Pacific air reaches the Southwest Valleys. This wide diurnal temperature range is associated with low morning mixing heights and large afternoon mixing heights.

As might be expected, air circulations near the surface are quite complex in all the climatic regions because of the influence of topographical factors and local heat sources and sinks. Because of the light anticyclonic pressure gradient typically present over the entire State in summer, the summer wind circulations show strong upvalley daytime winds and light nighttime downvalley flows. Surface wind observations for many stations in Oregon are summarized in the Climatological Handbook Columbia Basin States (1968). Upper-level wind data are available only for the Salem, Eugene and Medford stations in Oregon. Similar data are also available for Seattle, Spokane and Boise.

As a rough guide to the air pollution meteorology of the various climatic regions, Table 4-7 lists average seasonal morning and afternoon mixing heights and mean wind speeds in the mixing layer for each of the regions. The entries in the table are gross estimates read from isopleth maps contained in Holzworth (1971). Cumulative frequency distributions of morning and afternoon mixing layer depths for Salem, Medford, and Boise, as well as seasonal curves of median morning mixing layer depths at Salem, are presented in Appendix E.

4.2.3 Meteorological Data Requirements for Oregon

Except for the agricultural field-burning and the forest slash-burning programs, meteorological information requirements for the routine operation of the air quality surveillance system are adequately satisfied by air pollution advisories and forecasts issued by the National Weather Service. Agricultural field burning in Oregon is under the direct control of the Oregon State Department of Environmental Quality. With respect to the forest slash-burning program, the Oregon State Forester consults with the Department of Environmental Quality on the issuance of burning permits and the management of slash burning. Forecasts of wind and stability conditions and decisions regarding the types of burning to be permitted in both of these programs are made by DEQ's meteorologist. The forecasts

TABLE 4-7

MEAN SEASONAL MORNING AM AND AFTERNOON PM MIXING HEIGHTS H (METERS) AND LAYER WIND SPEEDS U (METERS PER SECOND) FOR THE CLIMATIC REGIONS OF OREGON (AFTER HOLZWORTH, 1971)

Climatic Region \ Season	Winter				Spring				Summer				Fall			
	A. M.		P. M.		A. M.		P. M.		A. M.		P. M.		A. M.		P. M.	
	H	U	H	U	H	U	H	U	H	U	H	U	H	U	H	U
Coast Area	600	5	700	5.5	800	4	1300	6	600	3.5	1300	6	550	3.5	900	5
Willamette Valley	500	4	800	5	750	3.5	1700	5	500	3	1600	5	450	3	1200	5
Southwest Valleys	400	3	900	4	600	3	1800	5	400	2	1700	5	400	2	1200	4
Northern Cascades	400	3	800	4	600	3	1800	5	400	2	1800	5	350	2	1300	4
High Plateau	350	2	900	3	500	3	2100	5	250	2	2200	4.5	300	2	1600	4
North Central	400	4	700	4	450	4	1800	6	250	2.5	1900	5	350	3	1200	4.5
South Central	350	2.5	900	4	400	3.5	2200	6	200	2	2500	5	250	3	1600	4.5
Northeast	400	4	700	4.5	350	5	2000	6.5	200	3.5	2400	5	250	3.5	1300	5
Southeast	350	3	900	4.5	400	4	2300	6.5	100	3	2800	5.5	250	3.5	1600	5

are based principally on an analysis of area weather advisories prepared by the National Weather Service; upper-level wind information from Eugene and upper-level wind and temperature information from the Salem radiosonde; surface wind and visibility data from airport stations and other meteorological stations operated by Government agencies and private industry.

DEQ's requirement for meteorological information can therefore be satisfied, with one exception noted below, by the data outlined above, provided that this information is available at DEQ in a convenient form and on a timely basis. The one exception is the need for surface wind data from the area north of Eugene, where there are presently no reporting stations. A surface wind station located near Coburg would satisfy this requirement. Use of the data from this station in preparing the field-burning and slash-burning forecasts requires that satisfactory arrangements be made to transmit the wind information on a timely basis to DEQ.

By far the largest amount of meteorological information is required in the interpretation of air quality measurements and in the estimation of air quality levels from emissions data. These activities, which are of central importance in determining the achievement of air quality standards, require historical rather than real-time data. The following types of historical data are required for this purpose:

Surface Wind Measurements

(1) Hourly values of wind speed and wind direction are required at the major natural air passageways leading into the Columbia and Willamette River Valleys. These data are needed to estimate the flux of pollutants from the Columbia River Valley into the Portland area and the Willamette Valley, as well as the flux of pollutants into the Willamette Valley from the south.

(2) Hourly values of wind speed and wind direction are also needed at selected points within the Portland area and within the Willamette Valley. Recommended station locations are:

- Along the Willamette River in downtown Portland, preferably on a bridge crossing the river
- Along the Columbia River, possibly at the Portland International Airport
- On top of a high downtown office building
- In or near Salem and Eugene (airport stations are probably adequate)

(3) There also must be a spot surface wind-measurement capability to document air circulations at selected sites of interest.

Upper-Air Wind and Temperature Measurements

(1) Measurements are required of the diurnal variations in the height of the surface mixing layer and in the mean wind speeds and directions in this layer that are representative of the entire Willamette Valley. The Salem rawinsonde data and the Eugene pibal data, supplemented by spot sampling data from an MSU unit, would satisfy this requirement.

Arrangements should be made to acquire the types of data described above from the various Government agencies and private sources. No meteorological measurement activities are required of DEQ, except possibly in connection with the operation of the recommended new station at Coburg and a few surface stations in the greater Portland area. The timely availability of meteorological data for use in the field-burning and slash-burning programs, and in pollution episodes, can be ensured by adding Circuit A to the Ag teletype circuit already available at DEQ.

4.3 MEASUREMENT NETWORKS FOR ROUTINE AIR QUALITY SURVEILLANCE

The minimum measurement requirements, within each of the five Oregon air quality control regions, for air quality surveillance networks are defined by the Federal Priority Classifications. These requirements are summarized in Table 3-1. State of Oregon requirements for air quality surveillance are listed in Section 3.2. The details of the proposed measurement networks for routine air quality surveillance given below satisfy the measurement requirements and sampling schedules listed in Table 3-1. In some instances, measurements have been added to those given in Table 3-1 and changes have been made in the sampling schedules shown in Table 3-1, either to satisfy the State of Oregon requirements or to simplify network operations.

4.3.1 Suspended Particulate Network

The surveillance network for suspended particulates is designed principally to measure air quality in the highly populated areas of Oregon. We have adopted the population criterion used previously in the design of the Oregon State Air Sampling Network (OSASN) that at least one suspended particulate monitoring site be located in population centers of 10,000 or more. This procedure results in the addition of five monitoring sites to the minimum number of 20 suspended particulate sites specified in Table 3-1 that are required to meet the Federal Priority Classification requirements. Two of the additional sites are in the Southwest Air Quality Control Region, two are in the Portland Interstate Air Quality Control Region, and one is in the Central Air Quality Control Region. We have also added two other suspended particulate monitoring sites in the Portland Interstate Air Quality Control Region along the Columbia River Valley for the purpose of measuring the transport or flux of suspended particulates into the metropolitan Portland area.

Measurements of suspended particulates are to be made with the following two types of sensors:

- Hi-vol samplers that meet the specifications given in the 30 April 1971 Federal Register (Volume 36, Number 84, Appendix B, Section 5, page 8189)
- AISI Tape Samplers

The laboratory assay of the hi-vol filter samples follows the procedures described in Exhibit A of the Oregon Administrative Rules, Chapter 340 (see Appendix A) and in Appendix B, Section 9 of the 30 April 1971 Federal Register referenced above.

The details of the suspended-particulate surveillance network including station locations, sampling schedules and the types of sensors are given in Table 4-8. The proposed network contains 27 suspended-particulate monitoring sites. Hi-vol samplers are installed at all 27 sites and, in addition, AISI tape samplers are installed at six of the 27 sites. The locations of 25 of the 27 proposed stations are the same as the permanent air quality monitoring stations in the Oregon State Air Sampling Network (OSASN), which has been in operation since January 1970. The 25 OSASN stations were located on a population basis, with at least one station assigned to each population center of 10,000 or more. The sampling stations within the largest cities of each air quality region have also been designated as the tape sampling locations. The two remaining sites in the proposed surveillance network were selected to obtain measurements of the transport of suspended particulates along the Columbia River Valley into the metropolitan Portland area. These sites are located at the Troutdale Airport and at the airport northeast of Scappoose and are included in the air quality surveillance network operated by the Columbia-Willamette Air Pollution Authority.

TABLE 4-8

SUSPENDED PARTICULATE NETWORK

Site No.	Location	Sampler	Sampling Schedule	Land Use	UTM Coordinates	
					x	y
REGION 190 - Central Intrastate Air Quality Control Region						
090405	Bend Deschutes County Courthouse	Hi-Vol	Every 6th day	Commercial/ Residential	636,200	4,880,200
181014	Klamath Falls Broad & Wall Sts.	Hi-Vol	Every 6th day	Commercial/ Residential	604,200	4,672,800
		Tape Sampler	Continuous 2-Hour Samples			
181015	Klamath Falls Oregon Technical Institute	Hi-Vol	Every 6th day	Rural		
331716	The Dalles 400 E. 5th St.	Hi-Vol	Every 6th day	Commercial/ Residential	641,600	5,050,600
REGION 191 - Eastern Intrastate Air Quality Control Region						
311612	LaGrande EOC Science Bldg.	Hi-Vol	Every 6th day	Residential	414,800	5,018,900
302018	Pendleton Umatilla County Courthouse	Hi-Vol	Every 6th day	Commercial/ Residential	360,600	5,058,800
		Tape Sampler	Continuous 2-Hour Samples			

TABLE 4-8 (Continued)

Site No.	Location	Sampler	Sampling Schedule	Land Use	UTM Coordinates	
					x	y
REGION 191 (Continued)						
010404	Baker 1925 Washington St.	Hi-Vol	Every 6th day	Commercial/ Residential	434,000	4,957,900
REGION 192 - Northwest Intrastate Air Quality Control Region						
040205	Astoria 857 Commercial St.	Hi-Vol	Every 6th day	Commercial/ Residential	435,500	5,115,200
REGION 193 - Portland Interstate Air Quality Control Region						
220214	Albany 4th & Broadalbin	Hi-Vol	Every 6th day	Commercial/ Residential	491,593	4,942,235
341001	Beaverton 450 SW Hall St.	Hi-Vol	Every 6th day	Commercial/ Residential	515,420	5,036,684
		Tape Sampler	Continuous 2-Hour Samples			
020406	Corvallis 124 NW 7th St.	Hi-Vol	Every 6th day	Commercial/ Residential	479,226	4,934,535
		Tape Sampler	Continuous 2-Hour Samples			

TABLE 4-8 (Continued)

Site No.	Location	Sampler	Sampling Schedule	Land Use	UTM Coordinates	
					x	y
REGION 193 (Continued)						
201852	Eugene 11th & Willamette	Hi-Vol Tape Sampler	Every 6th day Continuous 2-Hour Samples	Commercial	492,660	4,875,900
343401	Hillsboro 150 NE 3rd Ave.	Hi-Vol	Every 6th day	Commercial/ Residential	500,977	5,040,398
034001	Lake Oswego 368 S. State St.	Hi-Vol	Every 6th day	Commercial/ Residential	517,200	5,028,417
361703	McMinnville 5th & Evans Sts.	Hi-Vol	Every 6th day	Commercial/ Residential	484,914	5,006,321
034311	Milwaukie 1550 23rd St.	Hi-Vol	Every 6th day	Residential	528,405	5,031,852
261476	Portland 718 W Burnside St.	Hi-Vol Tape Sampler	Every 6th day Continuous 2-Hour Samples	Commercial	525,259	5,040,865
261477	Portland 3119 SE Holgate	Hi-Vol	Every 6th day	Residential	528,785	5,037,251

TABLE 4-8 (Continued)

Site No.	Location	Sampler	Sampling Schedule	Land Use	UTM Coordinates	
					x	y
REGION 193 (Continued)						
261701	Troutdale* Airport	Hi-Vol	Every 6th day	Non-Urban	547,706	5,044,483
243826	Salem Willamette Univ. Univ. Center Bldg.	Hi-Vol Tape Sampler	Every 6th day Continuous 2-Hour Samples	Commercial/ Residential	497,180	4,976,580
053101	Scappoose* NW Beacon-Airport	Hi-Vol	Every 6th day	Suburban	510,921	5,068,826
203311	Springfield 3rd and B Sts.	Hi-Vol Tape Sampler	Every 6th day Continuous 2-Hour Samples	Commercial	487,800	4,875,300
REGION 194 - Southwest Intrastate Air Quality Control Region						
150205	Ashland City Hall	Hi-Vol	Every 6th day	Commercial/ Residential	523,400	4,671,500
060701	Coos Bay 4th & Central Ave.	Hi-Vol	Every 6th day	Commercial/ Residential	401,300	4,802,000
170705	Grants Pass NW 6th & C Sts.	Hi-Vol	Every 6th day	Commercial/ Residential	473,200	4,697,200

*Flux Estimating Sampling Stations

TABLE 4-8 (Continued)

Site No.	Location	Sampler	Sampling Schedule	Land Use	UTM Coordinates	
					x	y
REGION 194 (Continued)						
152017	Medford Main & Oakdale	Hi-Vol Tape Sampler	Every 6th day Continuous 2-Hour Samples	Commercial/ Residential	510,000	4,685,300
102717	Roseburg 1154 SE Douglas	Hi-Vol	Every 6th day	Commercial/ Residential	473,200	4,784,700

4.3.2 Sulfur Dioxide Network

In determining the locations of sampling sites for the proposed sulfur dioxide network, both emissions inventory data and population figures were considered. Emissions inventory data for Oregon show that the bulk of the SO_2 emissions in Oregon are produced by area sources. The one notable exception is in the Washington portion of the Portland Interstate AQCR at Centralia, Washington where the Pacific Power and Light Company is constructing a new plant. Of the two units at the Centralia plant, one was placed in operation on 1 September 1971 and the other unit is scheduled to go into operation during the fall of 1972. When the Centralia plant is fully operational, it will increase the total SO_2 emissions in the Portland Interstate AQCR by more than 300 percent. Estimates of the impact of SO_2 emissions from the new plant on air quality in the Portland Interstate AQCR are given in Appendix C. These estimates show that the emissions from this new source will result in average seasonal ground-level SO_2 concentrations of about 1 part per billion in the Oregon portions of the Portland Interstate AQCR. For these reasons, the sulfur dioxide monitoring sites were selected on a population basis.

The details of the proposed sulfur dioxide network are summarized in Table 4-9. As shown in Table 3-1, the Federal Priority Classification for the Portland Interstate AQCR requires three stations equipped with bubbler type SO_2 samplers and the station at which continuous SO_2 measurements are made. In each of the four intrastate regions, the Federal Priority Classification requires one station equipped with a bubbler type SO_2 sampler. The sampling schedules shown in Table 4-9 are the same as those in Table 3-1.

We recommend that the State of Oregon continue to operate the continuous sulfur dioxide instrument at the CAM Station at 718 West Burnside Street in Portland. This instrumentation does not meet the current Federal specifications for continuous monitoring of sulfur dioxide. However, it is necessary to

TABLE 4-9

SULFUR DIOXIDE SURVEILLANCE NETWORK

Site No.	Location	Sampler	Sampling Schedule	Land Use	UTM Coordinates	
					x	y
REGION 190 - Central Air Quality Control Region						
181014	Klamath Falls Broad & Wall Sts.	Impinger	Every 6th day	Commercial/ Residential	604,200	4,672,800
REGION 191 - Eastern Air Quality Control Region						
302018	Pendleton Umatilla County Courthouse	Impinger	Every 6th day	Commercial/ Residential	360,600	5,058,800
REGION 192 - Northwest Air Quality Control Region						
040205	Astoria 857 Commercial St.	Impinger	Every 6th day	Commercial/ Residential	435,500	5,115,200
REGION 193 - Portland Interstate Air Quality Control Region (Oregon Portion)						
020406	Corvallis 124 NW 7th St.	Impinger	Every 6th day	Commercial/ Residential	479,226	4,934,535
201852	Eugene 11th & Willamette St.	Impinger	Every 6th day	Commercial	492,660	4,875,900

TABLE 4-9 (Continued)

Site No.	Location	Sampler	Sampling Schedule	Land Use	UTM Coordinates	
					x	y
REGION 193 (Continued)						
261476	Portland 718 W. Burnside		Continuous	Commercial	525,259	5,040,865
243826	Salem Willamette Univ.	Impinger	Every 6th day	Commercial/ Residential	497,180	4,976,580
REGION 194 - Southwest Air Quality Control Region						
152017	Medford Main & Oakdale Sts.	Impinger	Every 6th day	Commercial/ Residential	510,000	4,685,300

continue the operation of this equipment until instrumentation that meets the Federal specifications can be procured, installed and put into operation. After the equipment becomes operational, operation of the old instrumentation should still be continued until satisfactory procedures have been developed for relating the measurements previously obtained with the older instrumentation to the measurements outlined with the new instrumentation.

4.3.3 Nitrogen Dioxide Network

According to the Federal Priority Classification requirements in Table 3-1, surveillance of nitrogen dioxide concentrations is required only in the Portland Interstate AQCR. The Federal requirements also state that the Jacobs-Hochheiser method for measuring nitrogen dioxide must be used and that, on a population basis, ten sampling sites must be included in the Portland Interstate AQCR network. On a population basis, nine of these sites must be located in Oregon. Selection of the nine required sampling sites in Oregon was made from a consideration of total emissions and population. Motor vehicles are the primary source of nitrogen dioxide emissions in the Oregon portion of the Region. Therefore, the sampling sites were located in the cities with large traffic volumes and large populations. Portland, the largest city, was assigned three sites and one site was assigned to each of the next six largest cities by population in the Portland Interstate AQCR.

The locations of the nitrogen dioxide sites and other network details are given in Table 4-10. The sampling schedule of 12 days was chosen because it is exactly half the frequency of the sulfur dioxide sampling schedule. Since both pollutants are measured at four common sites in Portland, Salem, Corvallis and Eugene, the 12-day schedule for nitrogen dioxide simplifies network operations.

TABLE 4-10

NO_2 SURVEILLANCE NETWORK

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates	
				x	y
220214	Albany 4th & Broadalbin Sts.	Every 12 days	Commercial/ Residential	491,593	4,942,235
341001	Beaverton 450 SW Hall St.	Every 12 days	Commercial/ Residential	515,420	5,036,684
020406	Corvallis 124 NW 7th St.	Every 12 days	Commercial/ Residential	479,226	4,934,535
201852	Eugene 11th & Willamette St.	Every 12 days	Commercial	492,660	4,875,900
261476	Portland 718 W Burnside	Every 12 days	Commercial	525,259	5,040,865
261426	Portland 1010 NE Couch St.	Every 12 days	Commercial/ Residential	527,062	5,040,911
261427	Portland State Office Bldg.	Every 12	Commercial	525,150	5,040,150
243826	Salem Willamette Univ.	Every 12 days	Commercial/ Residential	497,180	4,976,580
203311	Springfield 3rd and B Sts.	Every 12 days	Commercial/ Residential	487,800	4,875,300

4.3.4 Hydrocarbons Network

There are no Federal requirements for the routine surveillance of total hydrocarbons. There are, however, Federal air quality standards for total hydrocarbons and approved measurement techniques. At the present time, total hydrocarbons are measured at the CAM Stations in Portland and Eugene. The measurement technique employed at these two sites do not meet the Federal measurement specifications because the measurements include methane which is to be excluded under the Federal measurement specifications. The Columbia-Willamette Air Pollution Authority has similar instrumentation for measuring total hydrocarbons.

Auxiliary equipment for excluding methane is not available at present for the particular instrumentation at the two CAM Stations and at the Columbia-Willamette Air Pollution Authority. Replacement instrumentation for measuring hydrocarbons that meets the Federal specifications is very expensive. The present instrumentation provides background measurements of the concentrations of total hydrocarbons in the Portland Interstate AQCR. Until instrumentation that is capable of meeting the approved measurement standard becomes available to the State, we recommend that the State continue to monitor total hydrocarbons at the two CAM Stations in Portland and Eugene with the existing equipment and that a third instrument of this type be put in operation in Salem. The details of this network are shown in Table 4-11.

4.3.5 Carbon Monoxide Network

According to the Federal Priority Classifications in Table 3-1, the surveillance of carbon monoxide concentrations is required only in the Portland Interstate AQCR. Because motor vehicle emissions are the primary source of carbon monoxide in Oregon, the core areas of the three largest cities (Portland, Salem, and Eugene) were selected as the general areas in which carbon monoxide

TABLE 4-11

SURVEILLANCE NETWORK FOR HYDROCARBONS, CARBON MONOXIDE AND PHOTOCHEMICAL OXIDANTS

Site No.	Location	Sampling Schedule	Land Use	UTM Coordinates	
				x	y
201852	Eugene 11th & Willamette St.	Continuous	Commercial	492,660	4,875,900
261476	Portland 718 W Burnside St.	Continuous	Commercial	525,259	5,040,865
243826	Salem Willamette Univ.	Continuous	Commercial/ Residential	497,180	4,976,580

monitoring sites should be located. In addition, one carbon monoxide analyzer is reserved for use in making spot measurements of air quality levels in areas of suspected or potential high concentration such as Areas B, C and D in Figure 4-6. The station locations, sampling schedule and other details of the proposed carbon monoxide network are given in Table 4-11.

4.3.6 Photochemical Oxidants

The Federal Priority Classification in Table 3-1 requires the surveillance of photochemical oxidants only in the Portland Interstate AQCR. The primary purpose of measuring concentrations of photochemical oxidants is to provide information to be used in conjunction with measurements of total hydrocarbons to indicate the formation of photochemical smog. Because the hydrocarbons in Oregon are produced principally by motor vehicle emissions, the sites for measuring photochemical oxidants were placed in the core areas of the three largest cities as the same locations as those selected for the hydrocarbon measurements. These site locations and the sampling schedule for photochemical oxidants are shown in Table 4-11.

4.3.7 Meteorological Network

As pointed out in Section 3.3.4, there are no Federal requirements for monitoring meteorological parameters as part of the air quality surveillance networks in Oregon. Meteorological information currently available at the Department of Environmental Quality from the Ag teletype circuit, and from the National Weather Service and other agencies, appears to be adequate for most of the DEQ air pollution activities. In the discussion of Oregon's meteorological data requirements in Section 4.2.3, two recommendations are made for increased meteorological support of the field-burning and slash-burning programs. The

first recommendation is for the establishment of a new surface wind station in the Willamette Valley near Coburg and for the timely reporting of the station observations to DEQ. The second recommendation is for the addition of teletype Circuit A to the existing Ag circuit at DEQ to ensure the timely availability of other meteorological information required in the field-burning and slash-burning programs as well as during air pollution episodes.

In the discussion in Section 4.2.3 of Oregon's requirements for historical surface wind data, it is pointed out that hourly wind speed and wind direction measurements from stations in the Columbia and Willamette River Valleys are needed to aid in estimating the flux of pollutants into the metropolitan Portland area and into the Willamette Valley. We recommend that arrangements be made to acquire the requisite historical surface wind data from the following two stations in the Columbia River Valley:

- Troutdale Airport
- Scappoose (Columbia County Airport)

We understand that the Columbia-Willamette Air Pollution Authority has installed wind sensors and has collected wind data at these stations. Because of the data formatting procedures used by CWAPA, which are discussed in Section 3.3.4, these data are likely to be unsuitable for DEQ's requirements. If further investigation shows this to be true, other arrangements should be made to acquire the requisite data from these two station locations.

The availability of a National Weather Service Environmental Meteorological Support Unit (EMSU) in the Willamette Valley would provide a much needed capability of making spot checks of mixing heights, mean wind speeds in the surface mixing layer, and other significant features of local wind circulations. One very important task that requires EMSU capability is the establishment of the representativeness of the Salem rawinsonde data for determining mixing heights and ventilation rates in the Willamette Valley.

4.4 SYSTEM OPERATIONAL RESPONSIBILITIES

In the above descriptions of the monitoring networks and data-handling and processing procedures of the proposed air quality surveillance system for Oregon, it has been stressed that the operation of the system must be under the direct control of a single agency. This is both a technical requirement, based on first principles of systems engineering, and, in Oregon, a legal requirement as well. The Department of Environmental Quality is charged by Oregon State law with the responsibility of providing for a coordinated state-wide program of air quality control. As explained in Section 2.1, the existing air quality surveillance system in Oregon consists of several monitoring networks operated by the Department of Environmental Quality and the three Regional Authorities in the Willamette Valley. Of the three Regional Authorities, the Columbia-Willamette Air Pollution Authority has by far the largest monitoring network. In the proposed Oregon surveillance system networks described in Section 4.3, the existing monitoring networks, laboratory facilities, and staffs of the Regional Authorities are utilized to the fullest extent consistent with the basic technical requirement that the system operation be under the direct control of a single agency (DEQ). Details are given below of the operational responsibilities of the three Regional Authorities with respect to the following major activities of the proposed Oregon surveillance system:

- Air quality measurements
- Laboratory assay of air quality samples
- Processing and analysis of air quality measurements

4.4.1 Air Quality Measurements

The three Regional Authorities have been assigned the responsibility for operating the air quality monitoring stations and equipment listed in Table

4-12, in accordance with procedures specified by the Department of Environmental Quality and the Environmental Protection Agency. Station locations are given in Tables 4-8 through 4-11.

There are no local air pollution authorities in the Northwest, Southwest, Central and Eastern Intrastate Air Quality Regions. In these Regions, the Department of Environmental Quality is directly responsible for the operation of air quality monitoring equipment. The current Oregon State Air Sampling Network uses volunteer operators to conduct the routine monitoring of particulates. Volunteer operators may also be used to operate the monitoring sites in the proposed surveillance network at which only hi-vol measurements are made. However, in each of these air quality control regions, there is at least one complex monitoring site where SO_2 impinger samples and continuous AISI tape samplers are operated in addition to the hi-vol samplers. The use of volunteers to operate the complex monitoring stations is not acceptable because of the limited technical training of the volunteers and the necessity for strict adherence to sampling schedules. Therefore, employees in the Department of Environmental Quality, other State agencies, local county or city governments must be trained and assigned as operators at the complex monitoring stations located in the following cities:

- Astoria
- Medford
- Klamath Falls
- Pendleton

4.4.2 Laboratory Assay of Air Quality Samples

Successful operation of a single, coordinated state-wide air quality surveillance system requires that samples from the system monitoring network be assayed in an accurate, well-documented, uniform and timely manner. The

TABLE 4-12

RESPONSIBILITIES OF THE REGIONAL AUTHORITIES FOR AIR QUALITY MEASUREMENTS IN THE PROPOSED SURVEILLANCE SYSTEM FOR OREGON

COLUMBIA-WILLAMETTE AIR POLLUTION AUTHORITY
Hi-Vol Suspended Particulate Measurements Continue operation of 5 stations currently being operated for DEQ and operate the Troutdale and Scappoose stations currently in the CWAPA network. Tape Stain Measurements Operate tape-stain monitoring at the Beaverton station. Nitrogen Dioxide Measurements Operate impinger samplers at the Beaverton station and the CWAPA station at 1010 N. E. Couch Street.
MID-WILLAMETTE AIR POLLUTION AUTHORITY
Hi-Vol Suspended Particulate Measurements Continue operation of the Salem station currently being operated for DEQ and operate 3 additional stations currently operated by OSASN volunteers at Albany, Corvallis, and McMinnville. Tape Stain Measurements Operate tape-stain samplers at the Salem and Corvallis stations. Nitrogen Dioxide Measurements Operate impinger samplers at the Albany, Corvallis and Salem stations. Sulfur Dioxide Measurements Operate impinger samplers at the Corvallis and Salem stations.

TABLE 4-12 (Continued)

MID-WILLAMETTE AIR POLLUTION AUTHORITY (Continued)
Photochemical Oxidants, Hydrocarbons, and Carbon Monoxide Measurements Operate continuous monitoring equipment for these three pollutants at the Salem station.
LANE REGIONAL AIR POLLUTION AUTHORITY
Hi-Vol Suspended Particulate Measurements Continue operation of the Lane station currently being operated for DEQ and operate the Springfield station currently in the OSASN volunteer network. Tape Stain Measurements Operate tape-stain samplers at the Eugene and Springfield stations. Nitrogen Dioxide Measurements Operate impinger samplers at the Eugene and Springfield stations. Sulfur Dioxide Measurements Operate impinger samplers at the Eugene station. Photochemical Oxidants, Hydrocarbons and Carbon Monoxide Measurements Operate continuous monitoring equipment for these three pollutants at the Eugene station.

Air Quality Control Laboratory of the Department of Environmental Quality is adequately equipped to perform all of the assaying of the air quality samples. The maximum numbers of air quality samples that must be assayed each month in the Laboratory when the proposed surveillance network for Oregon becomes fully operational are as follows:

162 hi-vol suspended particulates
30 Jacobs-Hochheiser NO_2 samples
42 Pararosaniline SO_2 samples

The routine use of both lead peroxide candles for monitoring sulfation rate and of particle fallout jars has been eliminated from the proposed surveillance network. Also, the total number of assays of hi-vol filter samples has been reduced from the present network total of about 200 per month to 162 per month. For these reasons, the assaying requirements for the proposed surveillance system should not require an increase in Laboratory personnel in the Department of Environmental Quality. However, some changes in the duties of Laboratory personnel may be required.

The requirements for uniform assaying procedures, documentation and timely reporting of the assays are most easily met if the assaying is conducted by a single agency. The advantages gained by having the Department of Environmental Quality's Air Quality Control Laboratory perform all of the assaying required by the State's air quality surveillance network are sufficient to warrant any small added work load that might be required. The air quality laboratories operated by the local air pollution authorities will continue to provide the assaying capabilities for their special source surveillance studies and other monitoring activities.

4.4.3 Data Handling and Analysis

The primary objective of the surveillance system is to obtain information that can be used to determine the air quality of the State and the progress being made toward meeting the Federal standards for ambient air quality. Achievement of this objective requires the establishment and implementation of a carefully-planned data-handling and analysis program. This program must conform to the Federal requirements for air quality surveillance outlined by the Federal Priority Classifications in Table 3-1 for each air quality control region in Oregon. Because the Department of Environmental Quality is the State agency charged with the responsibility for meeting the Federal ambient air quality standards, it must therefore have at its disposal the facilities needed to process and analyze the air quality data from the surveillance system. We recommend that the Department of Environmental Quality conduct all data handling and analysis operations, except for the reduction of some strip-chart records by Regional Authorities as described below; and that the Regional Authorities and other local agencies, operating monitoring sites for DEQ, provide DEQ with detailed information pertaining to individual air quality samples and measurements. In addition, the Regional Authorities and local agencies are jointly responsible with DEQ for the validation of data that originated from air quality monitoring sites operated for DEQ within their respective jurisdictions.

The strip-chart records from the continuous monitoring equipment currently operated by Regional Authorities are, in most instances, being reduced by the Authorities for use in their respective air quality programs. We recommend that the Regional Authorities be assigned the responsibility for reducing, on a regularly scheduled basis, the strip-chart records from all monitoring equipment operated by them for DEQ in the proposed surveillance system. It is also recommended that the Regional Authorities be required to supply DEQ with the reduced hourly mean pollutant concentrations entered on appropriate data forms. A sample data form is shown in Figure 4-12.

Less than 24-hour sampling interval

1 _____ Agency

_____ City Name

_____ Site Address

_____ Project

ENVIRONMENTAL PROTECTION AGENCY
National Aerometric Data Bank
Research Triangle Park, N. C. 27711

SAROAD Hourly Data Form

_____ Parameter observed

_____ Time-interval of obs.

_____ Method

_____ Units of obs.

State Area Site
2 3 4 5 6 7 8 9 10

Agency Project Time Year Month
11 12 13 14 15 16 17 18

Parameter code Method Units DP
23 24 25 26 27 28 29 30 31 32

Day	St	Hr	Rdg 1	Rdg 2	Rdg 3	Rdg 4	Rdg 5	Rdg 6	Rdg 7	Rdg 8	Rdg 9	Rdg 10	Rdg 11	Rdg 12
19 20	21 22		33 34 35 36	37 38 39 40	41 42 43 44	45 46 47 48	49 50 51 52	53 54 55 56	57 58 59 60	61 62 63 64	65 66 67 68	69 70 71 72	73 74 75 76	77 78 79 80

OMB No. 158-R0012
Approval Expires 6 '30 76

FIGURE 4-12. Sample standardized data reporting form.

4.4.4 Summary

The operational responsibilities described above for the proposed air quality surveillance system do not appear to produce any appreciable net increase in the current work load of the four air pollution agencies involved (DEQ, CWAPA, MWAPA, and LRAPA). The level of effort currently expended in operating the OSASN and CAM stations is approximately equivalent to the level of effort required to operate the proposed system. The reduced sampling frequency for hi-vol stations and the elimination of particle fallout and sulfation rate sampling from the routine surveillance network provides the time and manpower required to operate the new gas sampling and expanded continuous air-monitoring networks. It is anticipated that no additional personnel will be required by the Regional Authorities to carry out their operational responsibilities under the new system. The Department of Environmental Quality has the responsibility of providing additional personnel, either through the Department or through other State or local government agencies, to operate the four complex stations located outside of the Willamette Valley.

4.5 DATA-HANDLING AND ANALYSIS PROCEDURES

The Department of Environmental Quality is responsible for supplying the detailed specifications for the processing and analysis of surveillance system data. Both the large amount of data that will be acquired from the various air quality surveillance networks and the limited staff that the State has available for routine data handling and analysis dictate that maximum use should be made of existing automatic data-processing facilities.

We propose that the handling and analysis of air quality data be accomplished in two phases. In Phase I, which is devoted to preprocessing, the raw data from the air quality surveillance networks are transcribed, converted to standard forms and validated. In Phase II, the statistical analysis is performed and data summaries and archiving records are generated. Details of the data-handling and analysis procedures in these two phases are given below.

4.5.1 Phase I - Preprocessing Procedures

As shown in Figure 4-13, data from the surveillance networks are obtained in two forms:

- Strip-chart records from continuous monitoring equipment
- Physical samples from the air quality sampling networks

Physical samples must be assayed in the laboratory before the raw pollutant-concentration data are available for processing. Also, the raw data from most laboratory assaying is not in a form that directly relates to air quality. For

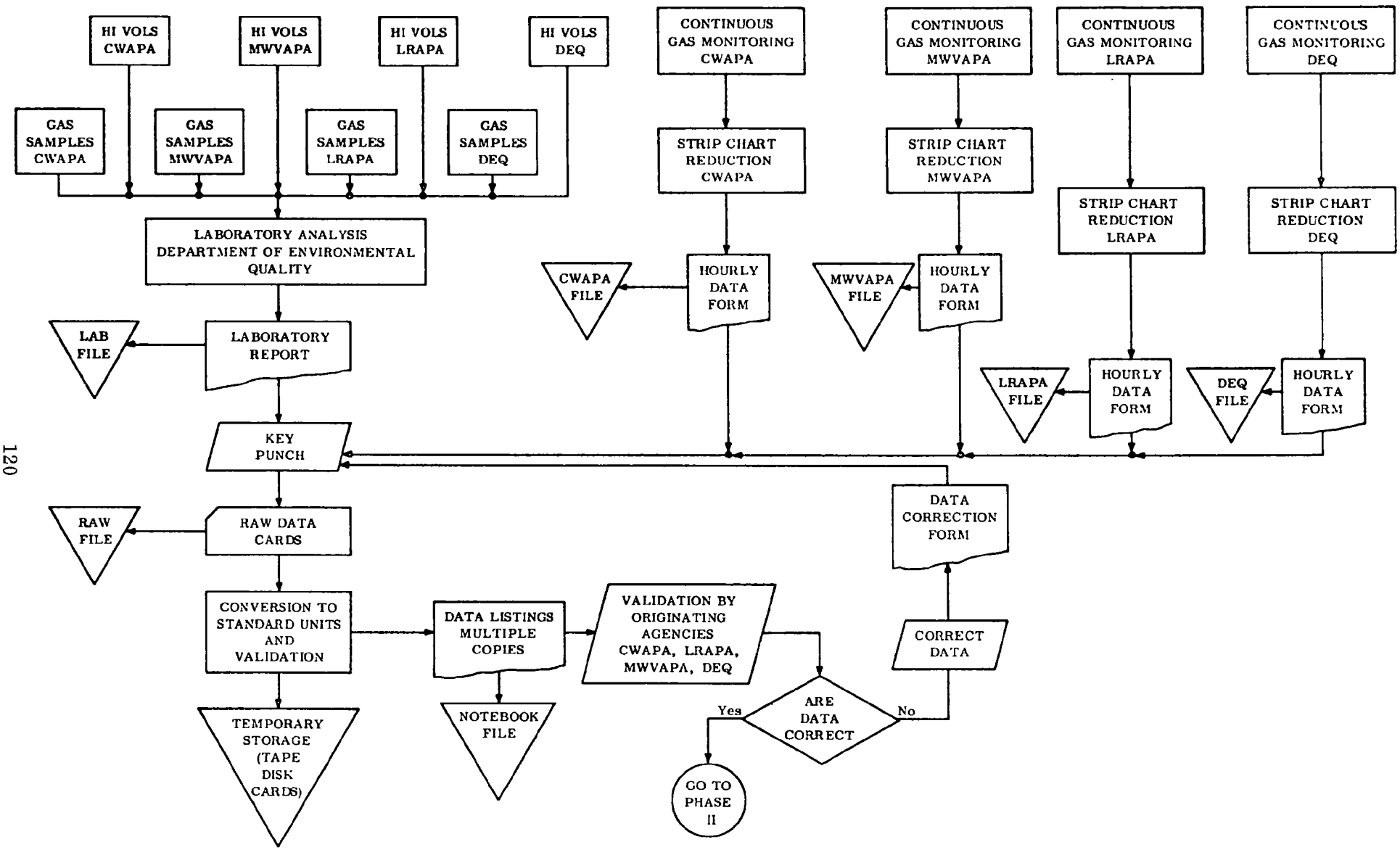

FIGURE 4-13. Phase I - Preprocessing procedures.

example, the raw data available from the laboratory assay of a hi-vol filter sample is in the form of total weight of the filter and the suspended particulates captured by the filter. Blank sample weights, flow rates and the exposure time of the filter must be combined with the total weight of the sample to obtain the desired air quality parameter, which is the weight of suspended particulates expressed in micrograms per cubic meter of air. Strip-chart data must also undergo a manual reduction procedure in which the chart data are converted to a time series of discrete data points, each point representing the average value of the measured parameter over a fixed-time interval.

The raw data from the strip-chart reduction and the laboratory assaying procedures are recorded, along with other pertinent information, on raw data forms in preparation for key punching. As shown by the Phase I data-flow diagram in Figure 4-13, the conversion of the raw data to standard units and preliminary validation of the data are accomplished through the use of automatic data-processing techniques. These automatic techniques produce data listings that are used in performing the detailed manual validation of the data and also provide a convenient means for temporary data storage prior to further processing.

The detailed manual validation of the data is a very important and critical step in the overall data processing system because it is the only satisfactory method for maintaining high standards of data quality. This validation should be performed by the personnel most familiar with the measurements, the measurement techniques, raw data extraction procedures, and various features of the sampling locations at which the physical samples were obtained. These personnel are required to use their technical judgment to verify, reject, or correct processed data that appears questionable. If this step is eliminated or compromised, good practice is violated and data errors that might have been eliminated are allowed to enter the data-analysis phase and they eventually become part of the permanent records stored in the State's technical data base.

A diagram illustrating the steps in the automatic preprocessing of hi-vol raw data cards is shown in Figure 4-14. The hi-vol raw data cards are punched from the entries on raw data forms made after the results of the laboratory sample assay have been completed. Figure 4-15 contains a sample raw data form for listing laboratory assay values of hi-vol filter samples. After the raw assay values and other pertinent information are punched on cards, the cards are read into the storage areas of the data-processing facility. The data associated with each hi-vol sample are first used to calculate the volume of air that was sampled and then to calculate the concentration of suspended particulates represented by the sample. The calculated suspended particulate concentration is then checked against the reported value if it is available. This optional step in the data flow program may be used to keep a running check on the automated process by submitting hand-calculated concentrations at regular intervals for comparison with the machine-calculated values. If the hand-calculated concentration is not reported, the option is ignored and the process continues to the next step. If the machine calculation does not compare with the hand calculation within the preset limits, ± 1 percent in this example, the machine automatically flags or identifies the data point with a symbol and continues to the next step. During the next step, the calculated concentration is checked to see if it falls within preset limits. The preset limits are generally set in the extreme maximum and minimum values that might be expected for a particular pollutant. If the calculated concentration value falls outside these preset limits, the data point is flagged with a specific symbol. At this point, the automated process is repeated until all the hi-vol samples have been processed.

At the completion of the conversion and automatic validation of all samples, a listing is printed of all the processed hi-vol samples. This listing includes the sampling site locations, dates, filter numbers, suspended particulate concentrations, and validation flags. These data are also placed in temporary storage for future processing in Phase II. The listed data must be manually verified by the cognizant technical personnel before the Phase II activities described below are initialized.

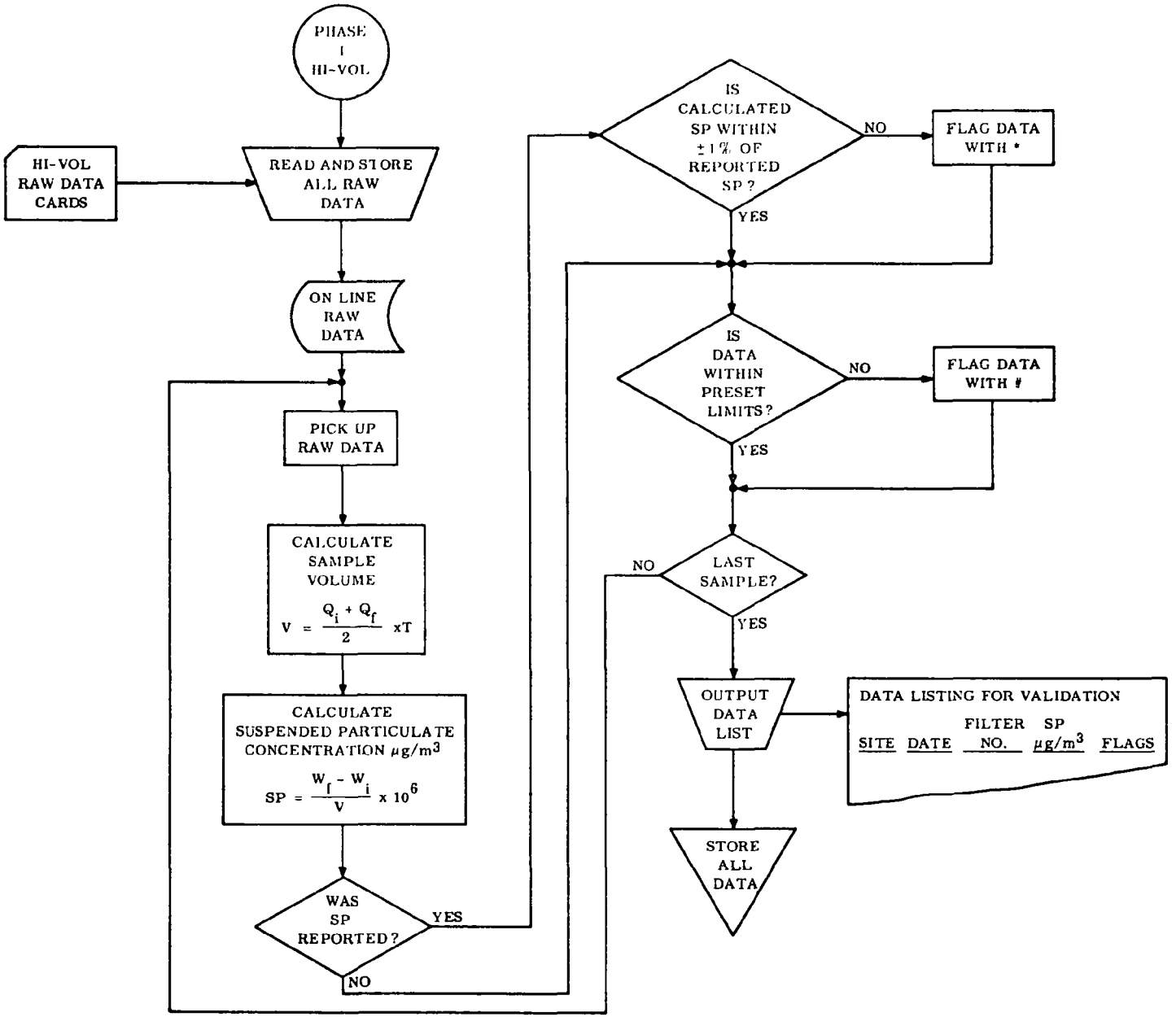

FIGURE 4-14. Steps in the automatic preprocessing of hi-vol raw data cards.

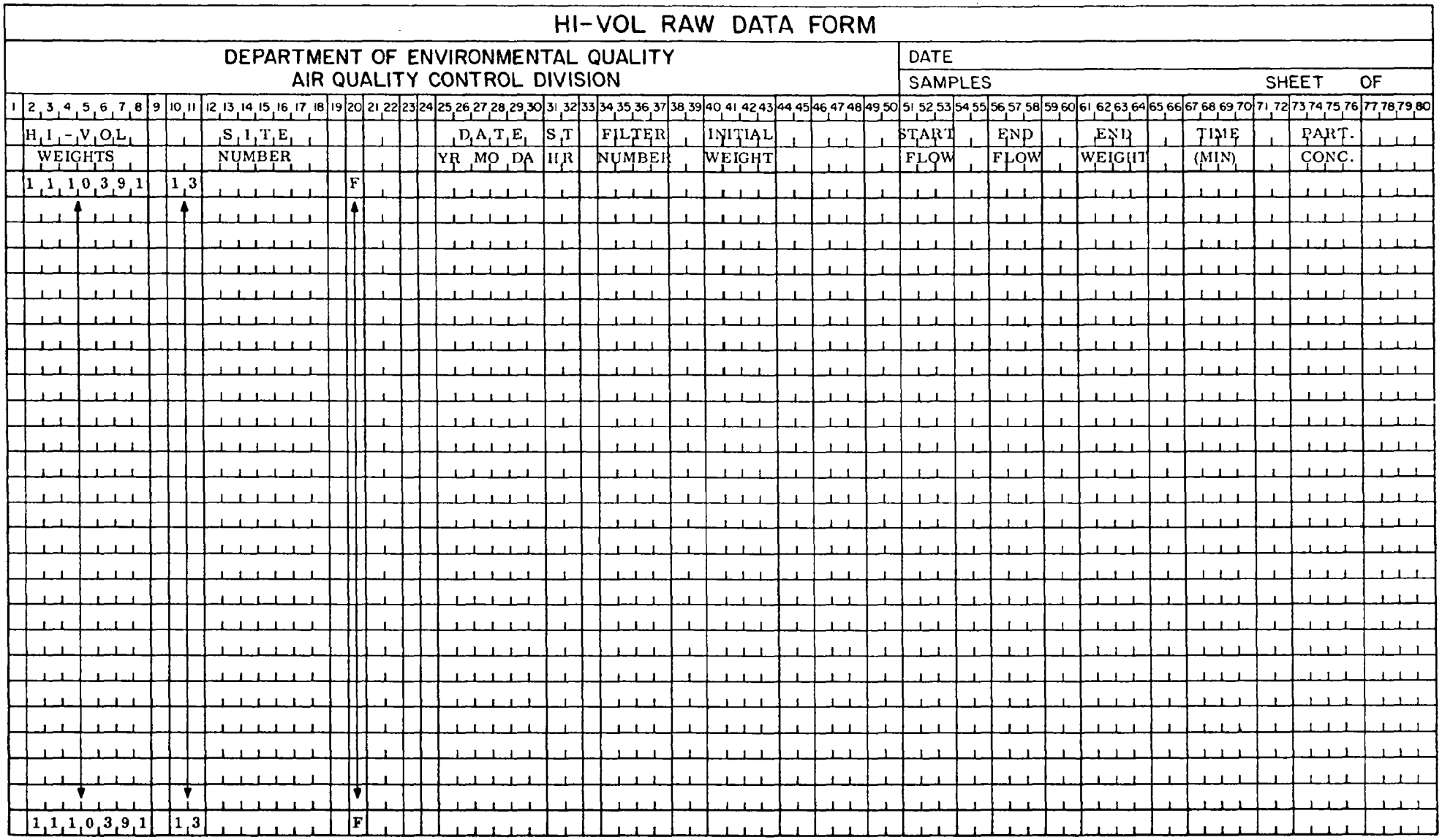

FIGURE 4-15. Sample form for listing raw laboratory assay values of hi-vol filter samples.

4.5.2 Phase II - Analysis and Archiving Procedures

Phase II is initiated after the Phase I manual validation has been completed. The statistical analysis, data summarization and data archiving are accomplished during Phase II as shown in Figure 4-16. The data archiving task is the first operation in Phase II. The important information pertaining to each sample, such as site number, type of sample, data, and concentration is extracted from the temporary storage and converted to a SAROAD format. Specific information pertaining to the individual formats and the required data is found in the SAROAD Users Manual APTD-0663 and SAROAD Parameter Coding Manual APTD-0633. The information in SAROAD format is transferred to punched cards for storage in the State's technical data base. Duplicates of the punched cards are sent to the National Aerometric Data Bank operated by the Environmental Protection Agency. The SAROAD formatted data are also available at this point in the main storage facilities of the computer.

Standard statistical programs are used to summarize the data for report requirements and for analysis by technical personnel. The actual programs used will depend upon the type of data to be analyzed and the purpose of the analysis. The Phase II data-processing programs and procedures are set up to accept their input from the temporary storage facility used at the end of Phase I or from the punched cards that are generated in the first step of Phase II. This procedure provides for the analysis of any set of data or data sets contained in the State's technical data base at any time in the future.

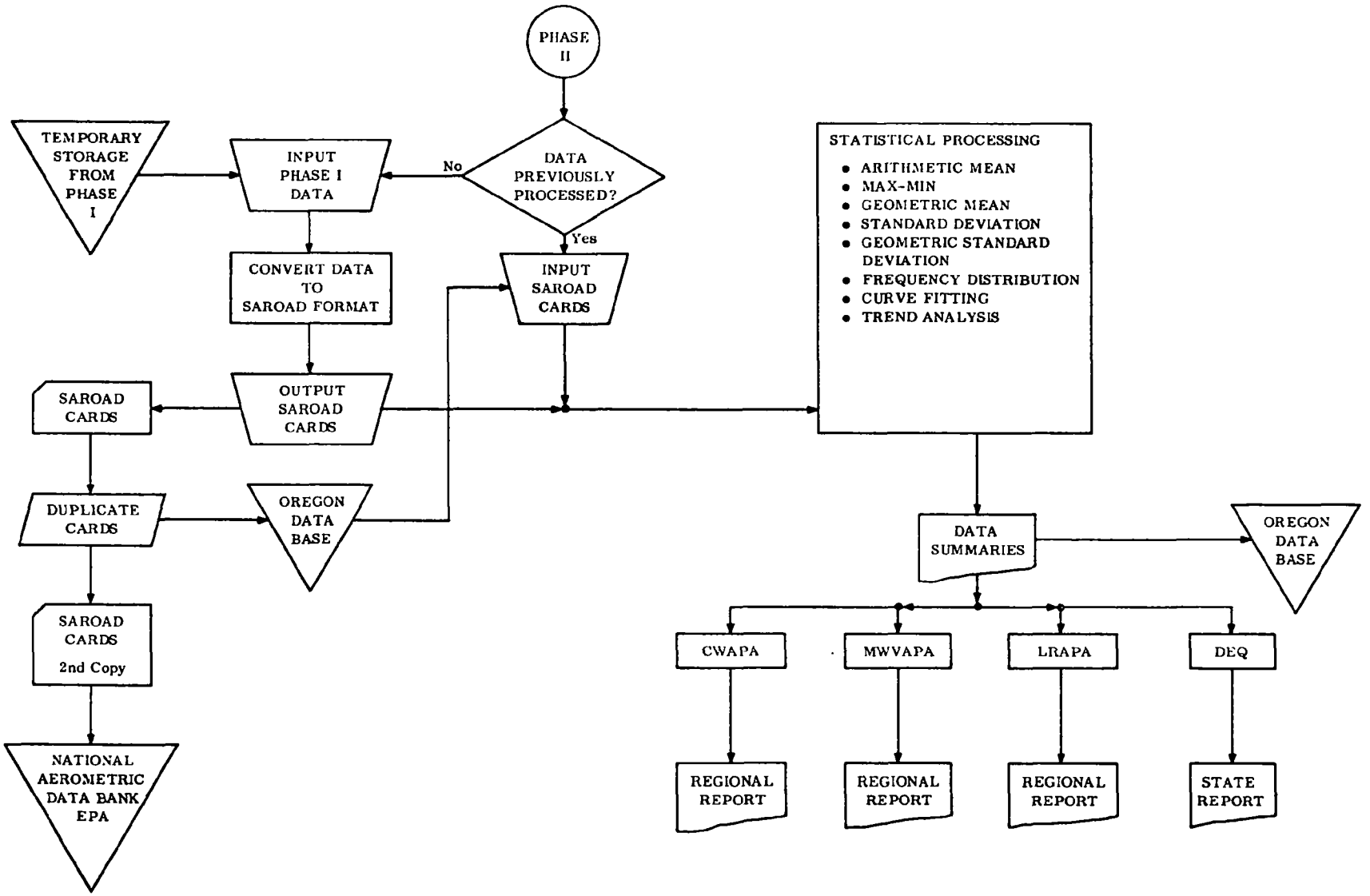

FIGURE 4-16. Phase II - Analysis and archiving procedures.

4.6 EPISODE MONITORING

4.6.1 Air Quality Measurements

The requirements for air quality surveillance during episodes differ principally from the requirements for routine air quality surveillance in that the timeliness and availability of the air quality measurements become very critical. During episodes, the surveillance system should operate as nearly as possible on a real-time basis. In general, data are not needed more frequently than from hour to hour and data lags greater than 24 hours are unacceptable. The air quality monitoring requirements during episodes are best satisfied through the use of the continuous monitoring equipment located at the CAM Stations in Portland, Salem and Eugene. Because the CAM Stations are located in the areas where the highest pollutant concentrations are expected, no changes in monitoring sites are required during episodes.

The use of auxiliary measurement and sampling equipment to supplement the information acquired from the routine surveillance network is highly recommended. The current operation of three MRI nephelometers, in Portland, Salem and Eugene, should be continued in an effort to relate visibility to suspended particulate concentrations. A method of estimating suspended particulate concentrations from the visibility measurements on a near real-time basis would be extremely helpful during episodes involving high particulate concentration levels. In addition, it is recommended that the Department of Environmental Quality conduct a study program to determine how accurately the suspended particulate concentrations can be determined using hi-vol samplers for a reduced sampling period of 6 hours, and a reduced equilibrate time of 1 to 2 hours prior to determining the weight of the sample. The use of hi-vol samplers to establish a quantitative measurement of the suspended particulate concentrations on a timely basis would be very useful in determining the effects of control and abatement strategies.

4.6.2 Episode Network Description

The network used for monitoring air quality during episodes is a portion of the network that is used for routine surveillance of air quality. Those stations of the regular network at which continuous air quality monitoring instrumentation is located are the episode monitoring stations. The frequency of reporting of the measurements from these stations is increased and the methods used in communicating these reports are upgraded. The stations and the associated instrumentation that make up the episode monitoring network are given in Table 4-13.

The requirement for air quality measurements that are both meaningful and timely during air pollution episodes leads to the necessity for a reliable communications system and a method of summarizing network air quality measurements into a meaningful and useful form. A sample of the required communications network is shown in Figure 4-17. The actual line of communication may take any reasonable form, from a simple messenger who hand carries information to a very complex high-grade telemetering system. A common type of communication system that is almost always available and easily used is the public telephone system. This system is generally reliable and is available in a wide range of type of service from the common public exchange to dedicated leased lines.

The methods used in summarizing and presenting the information in its most useful form also can vary widely. At one extreme, there are hand calculations using pad and paper; at the other extreme, there is a large computer facility with many displays and peripheral equipment. The system that will be used to monitor and report air quality information during air pollution episodes, and the degree of automation that can be achieved, will depend a great deal upon the assets in both equipment and manpower that are available to the State.

TABLE 4-13

EPISODE MONITORING NETWORK

Pollutant	Region	Site	Measurement Method	Schedule
Suspended Particulates	190	Klamath Falls Broad & Wall Sts.	AISI Tape Sampler Hi-Vol Sampler	Hourly Every 6 hours
	191	Pendleton	AISI Tape Sampler Hi-Vol Sampler	Hourly Every 6 hours
	192	Astoria 857 Commercial St.	Hi-Vol Sampler	Every 6 hours
	193	Portland 718 W. Burnside	AISI Tape Sampler Hi-Vol Sampler Nephelometer	Hourly Every 6 hours Continuous
		Salem Willamette Univ.	AISI Tape Sampler Hi-Vol Sampler Nephelometer	Hourly Every 6 hours Continuous
		Eugene 11th and Willamette Sts.	AISI Tape Sampler Hi-Vol Sampler Nephelometer	Hourly Every 6 hours Continuous
	194	Medford Main & Oakdale St.	AISI Tape Sampler Hi-Vol Sampler	Hourly Every 6 hours
Sulfur Dioxide	193	Portland 718 W. Burnside	Conductometric	Continuous
Carbon Monoxide	193	Portland 718 W. Burnside	Nondispersive Infrared	Continuous
		Salem Willamette Univ.	Nondispersive Infrared	Continuous
		Eugene 11th and Willamette Sts.	Nondispersive Infrared	Continuous

TABLE 4-13 (Continued)

Pollutant	Region	Site	Measurement Method	Schedule
Nitrogen Dioxide	193	Portland 718 W. Burnside	Modified Saltzman	Continuous
Photochemical Oxidants	193	Portland 718 W. Burnside	Coulometric Potassium Iodide	Continuous
		Salem Willamette Univ.	Coulometric Potassium Iodide	Continuous
		Eugene 11th and Willamette Sts.	Coulometric Potassium Iodide	Continuous
Hydrocarbons	193	Portland 718 W. Burnside	Flame Ionization	Continuous
		Salem Willamette Univ.	Flame Ionization	Continuous
		Eugene 11th and Willamette Sts.	Flame Ionization	Continuous

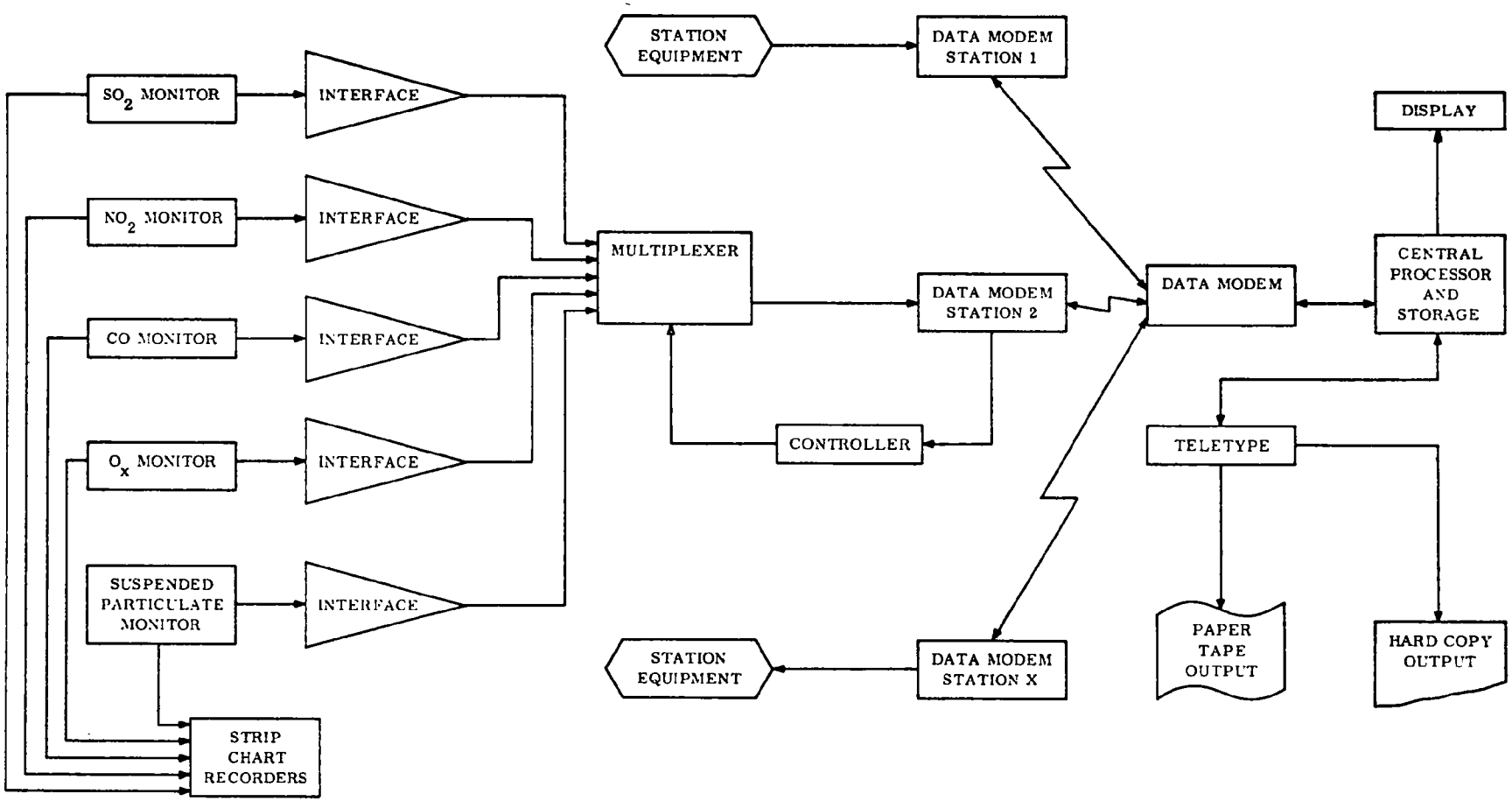

FIGURE 4-17. Automated episode monitoring network.

We recommend that the initial episode monitoring network for the State be a manual system in which all of the monitoring sites are physically manned with personnel from the Department of Environmental Quality or the local regional air pollution authorities. These operating personnel are responsible for obtaining the air quality measurements, preparing useful summaries of the measurements and reporting the results to the State's Emergency Action Center. In addition, they may be required to report the results to the local air pollution authorities' emergency action centers. The initial system uses commercial telephone circuits for voice communications between the monitoring sites and the Emergency Action Centers.

Plans for an automated emergency episode monitoring network have not been finalized. However, it is recommended that the first objective in automation of the system be the addition of facilities to prepare data summaries automatically. Once these facilities have been obtained, the addition of an automatic data link and acquisition equipment can be undertaken to achieve a fully automated system. The acquisition and installation of an automated communications link and acquisition equipment, prior to the procurement of an automatic processing facility, are not advisable because of the excessive work load that would be placed on EAC personnel in the recording, summarizing, and interpretation of the raw data.

The current continuous air quality monitoring equipment at the CAM Stations produces electrical output signals that are analogous to the parameters being monitored and are easily interfaced with automatic data acquisition equipment. A typical automated system for monitoring air quality during episodes is shown in Figure 4-18. The system operates under the control of a programmable central processor. The processor performs the calculations necessary to represent the measured air quality in terms that can be directly related to the Federal ambient air standards. The processor also controls the display devices and the operation of the equipment at the remote sites. The data modems serve to link the central processor with the remote

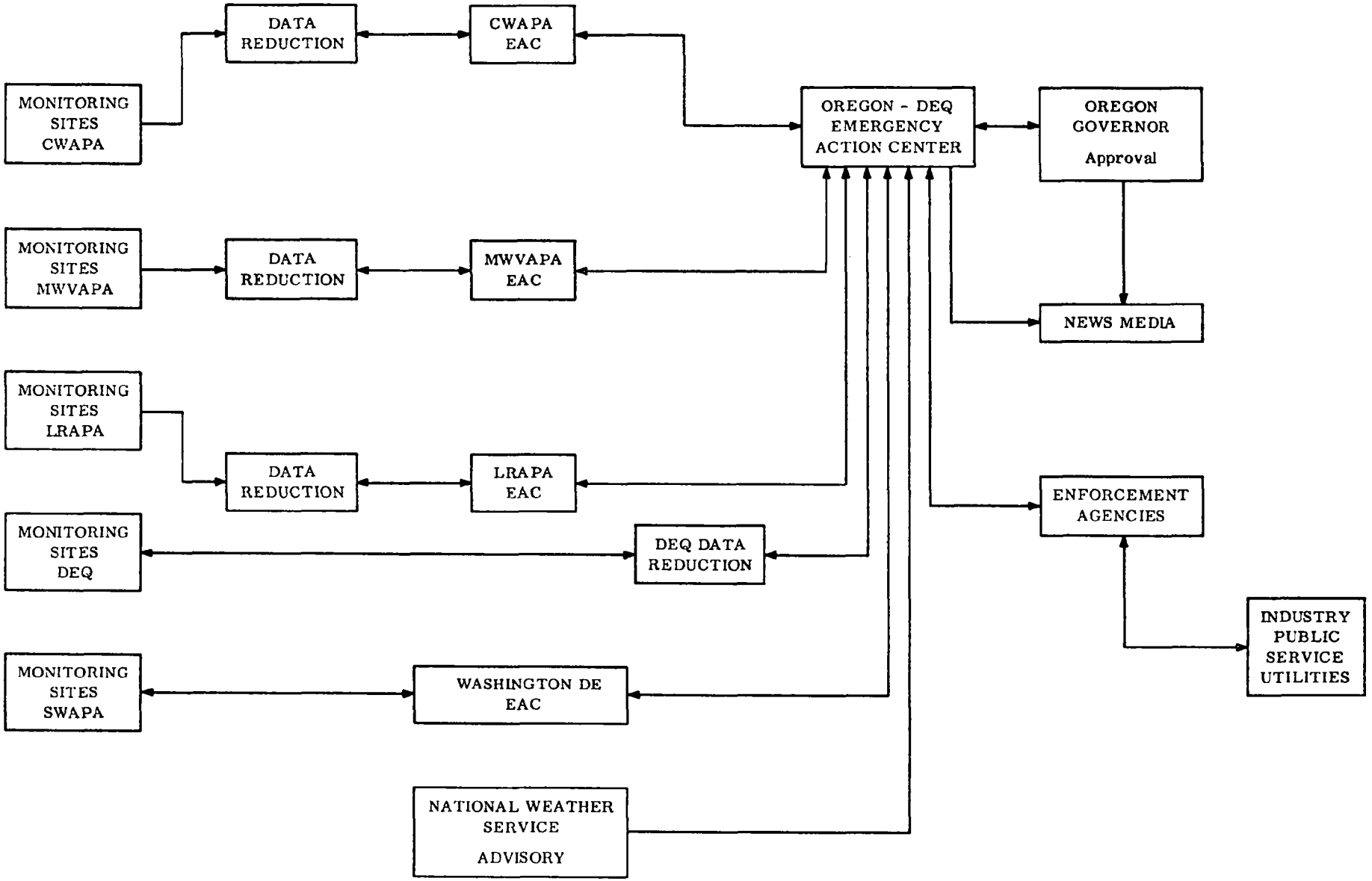

FIGURE 4-18. Sample communications for surveillance during episodes.

station equipment via some form of duplex communication network. The exact type of communications link is not specified; r f telemetering, dedicated phone line and normal voice grade commercial telephone exchange service are all adequate for the data rates encountered in air quality monitoring. The remote station multiplexer and controller operate on command from the central processor to sequence through the outputs of the air quality monitoring equipment and to present the data to the remote station modems for transmission to the central processor. Each air quality monitoring instrument is linked to the multiplexer through an interface unit. The interface unit provides the impedance matching, scaling and filtering of the instrument output necessary to properly link the monitors with the data acquistion equipment. Filtering of the instrument outputs is one of the important steps that is often overlooked in measurement acquisition by automatic systems. The filters serve to remove unwanted transients and provide a simple integration of the sensor output which eliminates some of the disadvantages of instantaneous samples. Typical filters or integrators for the interfacing of air quality data should provide approximately a one- or two-minute integration time.

The system should operate so that at least 30 samples are acquired each hour from each continuous air quality instrument. The central processor should be capable of storing all of the information and, at predetermined periods or upon demand, have the capability of calculating the statistical summaries that relate the measured air quality to the Federal and State ambient air quality standards, as well as those quantities used in determining control and abatement strategies.

The type of system described above can generally be assembled from off-the-shelf standard manufactured items. In some cases, the interface units will require special construction. However, this equipment is neither complex nor expensive. The control of the central processor is generally accomplished through the use of a stored sequence of instructions that operates in conjunction with a timer

or clock. The advent of the small-scale data processors and computers has basically solved the problem associated with developing this type of equipment. The development of the stored program or software for controlling the operation of this type of system is generally specified by the system user and requires custom development.

SECTION 5

IMPLEMENTATION OF SYSTEM CONCEPTS

5.1 INSTRUMENTATION

5.1.1 Measurements of Suspended Particulates and Bubbler Concentrations

The proposed air quality surveillance network is comprised of twenty-seven monitoring stations. All of these stations, with the possible exception (Scappoose), are currently being operated by DEQ or the Regional Authorities. The types of measurements that are to be made at some of these sites have been changed. Use of impingers to sample nitrogen dioxide and sulfur dioxide on a routine basis is a new function to be conducted at nine of these stations. Similarly, the routine operation of AISI tape samplers at six stations represents an expanded function of the current network. The continuous monitoring of air quality at the CAM Stations in Salem and Eugene has been expanded to include measurements of all pollutants for which Federal air quality standards have been established.

The implementation of the proposed network for suspended particulates does not present any special problems. The approved hi-vol samplers and other station equipment already installed and operating at the proposed stations. The State's inventory of AISI tape samplers is more than sufficient to supply the requirements of the proposed network.

Implementation of the network for measuring the concentrations of nitrogen dioxide requires a procurement of approximately 50 impingers and the sampling equipment for nine sampling sites, as specified in the Federal Register, dated 30 April 1971. In addition, operators must be trained in the techniques used in performing this sampling.

Implementation of the network for impinger sampling of sulfur dioxide concentrations does not require additional equipment. Sufficient midget impingers are currently included in the DEQ equipment inventory and the sampling station equipment obtained for the NO_2 concentration measurements described above can be utilized in obtaining the sulfur dioxide concentration measurements. Station operators must be trained in the techniques used to acquire the sulfur dioxide samples which are described in the 30 April 1971 Federal Register.

5.1.2 Continuous Air Quality Monitoring

The implementation of the proposed continuous air quality monitoring stations presents many problems. As explained in Section 3.3.2, the current inventory of continuous air quality monitoring equipment does not meet the Federal requirements for the methods to be employed in determining concentrations of sulfur dioxide, nitrogen dioxide and hydrocarbons. We recommend that the State use the current equipment to determine air quality during the immediate future. Instrument manufacturers are currently in the process of evaluating the most recent Federal specifications for approved instrumentation and have not reached a decision. The State should continue to correspond with the manufacturers with regard to instrumentation that meets the Federal specifications.

Plans for the future procurement of approved instrumentation or for suitable modification of current equipment should be made by the Department of Environmental Quality.

5.1.3 Laboratory Facilities

The implementation of the proposed air quality surveillance network does not require any basic changes in the current DEQ Air Quality Control Laboratory facilities. The transportation of blank and exposed impinger samples

requires that DEQ investigate available containers and methods that are suitable for this purpose.

5.1.4 Meteorological Measurements

The requirements for the implementation of the proposed meteorological networks are discussed in detail in Sections 4.3.2 and 4.3.7.

5.2 DATA HANDLING, PROCESSING AND ANALYSIS

The implementation of the proposed data-handling, processing and analysis procedures can be achieved with facilities that are currently available to DEQ. Implementation of the following automatic data-handling and processing procedures should be initiated without delay:

- Standardized reporting
- Data validation procedures
- Archiving systems for SAROAD and the Oregon technical data base
- Statistical analysis procedures
- Report requirements

The Department of Environmental Quality should acquire the part-time services of a data-processing systems' analyst during the development of the above procedures. This type of service can be obtained from private contractors; suitable arrangements may also be made for these services with a State agency.

As indicated in Section 4.6, the next step in system automation is a very large one and logically begins with the automation of air quality calculations during pollution episodes. Once this is accomplished, automation of air quality data acquisition from the surveillance system is the final step required for a completely automated system. The capacity of the fully-automated episode surveillance system is more than adequate to handle the data from the continuous air monitoring stations in the routine air quality surveillance system. Also, it should be noted that hardware components of the Litton 512 System currently in use at the Columbia-Willamette Air Pollution Authority can probably be adapted to satisfy the major hardware requirements of the fully automated system described above.

5.3 TIME SCHEDULE AND COST ESTIMATES

The time schedule for implementing the proposed air quality surveillance system is shown in Figure 5-1.

Cost estimates for procuring Federally-approved instrumentation are incomplete because the manufacturers of certain types of instrumentation have not as yet made the modifications needed to meet the Federal specifications. Table 5-1 presents a list of instruments that, according to the manufacturer, meet the Federal specifications. Additionally, we have included only those instruments that in our opinion will perform satisfactorily.

Approximately $5000 is estimated as the total cost of procuring the additional impingers and the associated auxiliary equipment required to complete the instrumentation inventory for the gas sampling networks.

The total estimated cost of the hardware items required to automate the episode monitoring network is $50,000. An additional $20,000 would be required to procure the necessary system software for operating both the episode network and the routine surveillance network. If the CWAPA Litton 512 System were to be utilized for this purpose, we estimate that $7000 would be required to purchase the additional required memory and instrument-interface equipment. Software procurement costs are estimated to be $15,000.

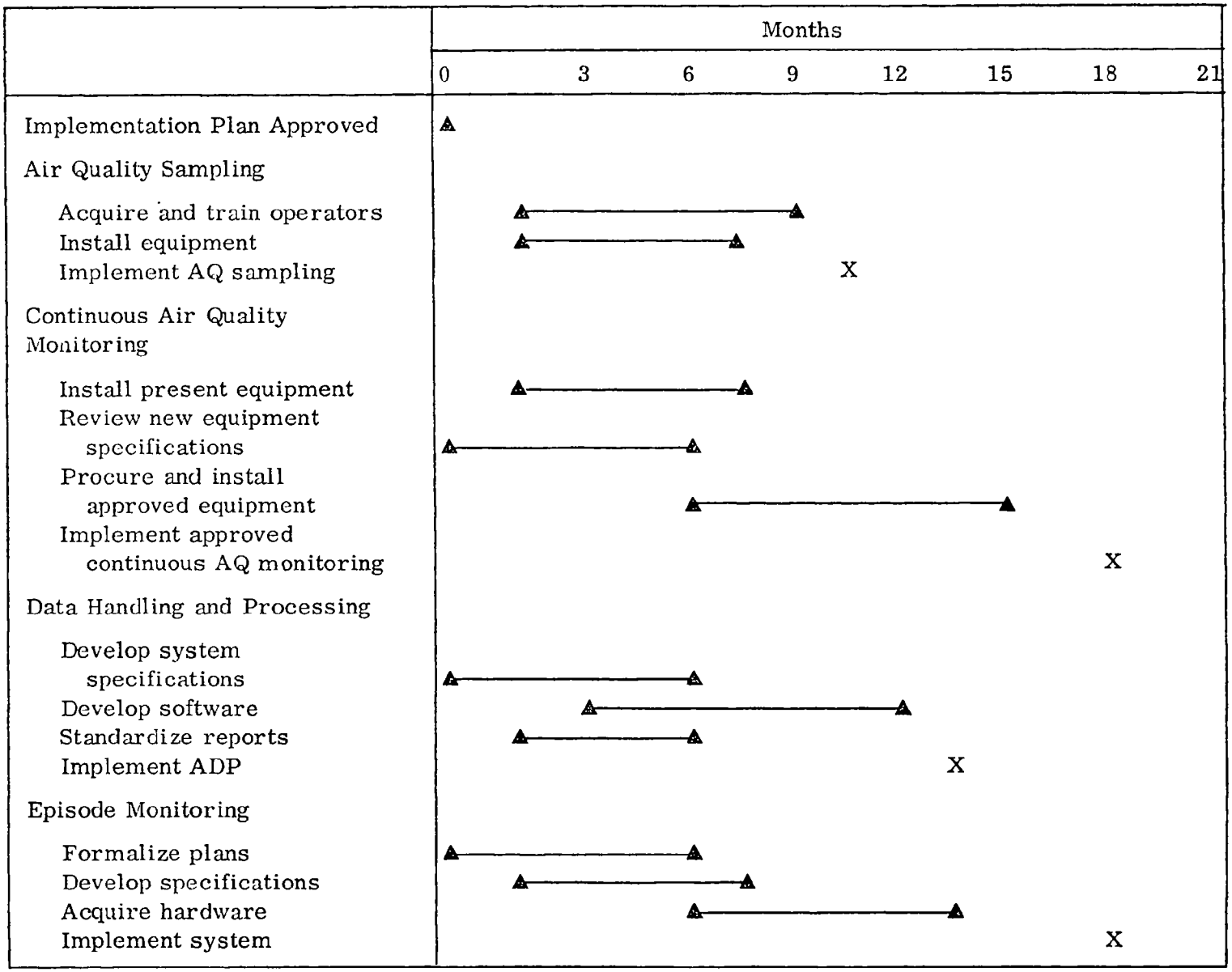

FIGURE 5-1. Time schedule for implementation.

TABLE 5-1

APPROVED INSTRUMENTATION FOR CONTINUOUS MONITORING

Pollutant	Manufacturer	Model	Method	Cost
Ozone	Bendix	8002	Chemiluminescence	3950
	Meloy Laboratories			
	McMillen Elect. Inc.			
Hydrocarbons	Beckman	6800	Chromatograph	7350
	MSA	650	Chromatograph	10900
	Bendix	8200	Chromatograph	7000
Sulfur Dioxide	Meloy Laboratories	SA160	Flame Photometer	4750
	Bendix	Total Sulfur Monitor		3950
	Tracor	250H		5275

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APPENDIX A

EXHIBITS A AND B FROM CHAPTER 340 OF THE STATE OF OREGON ADMINISTRATIVE RULES

EXHIBIT A - Suspended Particulate, Method of Determination and Reporting

EXHIBIT B - Collection and Analysis of Particle Fallout

EXHIBIT "A"

SUSPENDED PARTICULATE
METHOD OF DETERMINATION AND REPORTING

GENERAL:

Samples of air-borne particulates are collected on 8" x 10" tared sheets of flash-fired glass fiber filter web for 24 ± 2 hours, using a high volume air sampler, and weighed to determine total air particulate collected on the filter.

APPARATUS:

1. High Volume air sampler, with frame adapter for 8" x 10" sheets of filter web. (2, 3, 4)

2. Housing which allows for vertical positioning of the air sampler and provides a minimum of 65 square inches and a maximum of 100 square inches in area to permit a uniform flow of ambient air into space above the filter. (2, 3, 4)

3. Flowmeter calibrated in cubic feet per minute. A constant flow regulator or continuous flow recorder is recommended if flow rate during sampling period decreases more than 10% due to particulate loading. (2, 4, 5)

4. Timer switch, 7 day.

5. Elapsed time indicators (recommended).

6. Analytical balance, capable of weighing to 1.0 mg, and a weighing chamber large enough to accommodate an open full-sized 8" x 10" filter web. If the balance is to be used as a multipurpose balance, it is recommended it be capable of weighing to 0.1 mg and have a capacity of 160 to 200 grams. (1, 4, 7)

7. Large desiccating and/or humidifying chamber, such as a converted oven, refrigerator or incubator with trays for holding desiccant and racks for holding filters. (1, 4, 7)

8. A constant temperature (20-24°C) and humidity (less than 50% r.h.) balance room for equilibrating and weighing samples. If a balance room is not available, it is recommended that a humidity chamber be placed immediately adjacent to the balance in a room held at constant temperature (20-24°C). Saturated solutions of sodium nitrite ($NaNO_2$) (50% r.h. @ 21°C) or calcium nitrate ($Ca(NO_3)_2$) (46% r.h. @ 23°C) may be used to provide constant relative humidity in the chamber. (2, 4, 6, 7)

9. Flash-fired glass fiber filter web, 8" x 10". (2, 4, 6)
10. A 6-wheel numbering device.
11. Paper supplies:
    a. Manila tag cards, 9½" x 11".
    b. Envelopes, 5" x 11½".
    c. File folder, 9" x 12".

PRELIMINARY FILTER PREPARATION:

1. Each filter will be screened over a light table for "pin holes" and other visible defects. The filter will be discarded if defects are found.

2. The last filter sheet from each group of 25 of a specific manufacturer's lot will be analyzed as blanks. (2, 4)

3. Number the filter web on two diagonally opposite corners, one on front and one on reverse, and outside the area to be exposed, using the numbering device with gentle prossure. A series of filters assigned at one time to one location should be numbered consecutively, weighed and placed on top of one another in a folder with manila tag cards separating them. (1, 4)

4. Weigh the 8" x 10" filter, full size, to the nearest milligram after a minimum 16 hr. equilibration in an air conditioned room or chamber at a temperature of 20-24°C and a relative humidity below 50%. (2, 4, 6, 7)

SAMPLING PROCEDURE: (For General Metals Sampler; procedure with minor modifications is applicable to other acceptable sampling devices. (Care should be taken while handling filter to prevent damage or contamination)

1. Secure the high volume air sampler in a vertical position in a shelter at the sampling site. The sampler should be allowed to run to seat the brushes and insure a representative flow rate. It is helpful to position the shelter so that the lid provides a windbreak during installation of the filter.

2. Set the time switch for the desired sampling period.

3. Remove the frame from the filter holder and position the pre-numbered and weighed filter with rough side out, making certain the filter is centered on its holder. (1, 2, 4)

4. Turn the sampler on and then replace the filter holder. Secure the wing nuts diagonally and finger tight so the frame holder is not put in a bind which may cause air leaks. Close the roof of the shelter. (2, 4)

5. Allow the sampler to run for several minutes, then connect the calibrated flowmeter to the sampler and take a flow reading with the flowmeter in a vertical position. Read the top of the flowmeter ball estimating to the nearest whole number. Make a record of the time the time switch will start and the flowmeter reading. (2, 4)

6. Turn the sampler off, remove the flowmeter and make sure the clock and time switch are operational.

7. After a 24-hour sample has been obtained, measure the air flow as in Step 5 above. Turn the sampler on for several minutes before taking the reading. Record the stop time and the final flowmeter reading.

8. Stop the motor, remove the filter, fold once lengthwise with the dirty side in, place in a folded manila tag card and finally into an envelope. Return the packaged filter to the laboratory.

ANALYSIS:

1. Equilibrate the sample at 20-24°C and 50%, or less, relative humidity in an air conditioned room or humidity chamber for a minimum of 16 hours. If it is necessary to remove excess moisture from the filter, dry it in a desiccating chamber at room temperature for 24 hours prior to equilibration. Weigh the filter sample to the nearest milligram. (1, 2, 4, 6, 7)

2. For further analysis, aliquot the filter sample across the 8" dimension using a plastic template designed for the purpose. (2, 3)

   a. Organic materials; half the sample is used for extraction.
   b. Non-metals; a ¼" wide strip representing 8% of the sample is used for water extraction, nitrate, and sulfate determinations.
   c. Metals; a 2" wide strip representing 22% of the sample is used.

3. Water soluble constituents are extracted by placing the 8% aliquot filter strip in a 125 ml boiling flash containing 50 ml of distilled water. The filter is refluxed for a minimum of 90 minutes, cooled and filtered through Whatman #1, or equivalent, paper. Repeat the extraction with 10-15 ml of water for a few minutes without a condensor. Pass the additional extract through the same Whatman filter. Wash the boiling flask and sample filter to insure good quantitative transfer. (2, 3, 4, 10)
   a. Sulfates are determined by the Sulfa Ver Turbidimetric or Turbidimetric Barium Sulfate Method.
   b. Nitrates are determined by the 2, 4 Xylenol Method. (2, 3, 4, 10)
4. Organic constituents are extracted with benzene. (2, 3, 4, 10)
   a. Fold the sample into a small bundle such that the particulate matter is entirely enclosed within the filter. Tie the bundle with copper wire and place in a 125 ml soxhlet extraction apparatus.
   b. Add about 80 ml of redistilled reagent grade benzene and extract for a minimum of 6 hours. Concentrate the extract to approximately 5 ml. and quantitatively transfer through a medium porosity fritted disc funnel into a pre-weighed vial. Rinse the extraction flask 3 times, using about 5 ml of benzene in each rinse. Transfer the wash through the funnel and into the vial.
   c. Evaporate the benzene in an explosion proof, ventilated oven at 62°C.
   d. Transfer the vial to a constant humidity chamber, equilibrate over night and weigh to the nearest milligram.

CALCULATIONS - TOTAL WEIGHT:

1. Correct field flowmeter readings to true air flow from calibration curve.
2. Calculate the average air flow (cfm): $\frac{\text{start flow} + \text{stop flow}}{2}$
3. Calculate the total hours of sampling time: stop time - start time.

4. Calculate the total air flow: Average air flow (cfm) x total hours sample time (to nearest tenth of one hour) x 1.7 = total air volume (to the nearest whole number in cubic meters (m^3).

5. Report as micrograms per cubic meter (ug/m^3) to the nearest microgram.

$$\frac{\text{grams of collected material, (nearest 1.0 mg)} \times 10^6}{\text{air volume } (M^3)} = ug/m^3 \quad (1,4)$$

SAMPLER LOCATION:

1. The sampler may be located at a Primary Air Mass Station or at a Primary Ground Level Monitoring Station adhering to the requirements of these locations.

2. Other stations, designated as Special Stations, shall be evaluated to be representative of the pollution information desired. The placement of the sampling unit shall minimize biased results from eddy currents, etc., to the fullest extent possible. The filter should be approximately 3 to 4 feet above mounting level. (2, 9)

3. A sampling site report form shall be completed for each site.

SAMPLING SCHEDULE:

1. All samples shall be taken on a midnight to midnight schedule. (4)

2. It has been shown that:

   a. A 100-day random sampling schedule is considered sufficient with 95% assurance to estimate within $\pm$ 20% of the seasonal means, but not monthly means. (Ref. 11, 13, 14)

   b. Approximately 250 to 300 days on a random schedule per year would be required to produce accurate estimates of monthly means (i.e.$\pm$ 20%).

   c. Twenty-six bi-weekly random samples are sufficient to determine a site's annual mean ($\pm$ 20% of the true mean). (Ref. 11, 13, 14)

3. Determination of seasonal and monthly estimates of means is best accomplished by sampling on a systematic basis; example, every fourth day. Any bias introduced into the selection of the starting date may be removed by selecting the starting date for the first week of sampling from a table of random numbers. (11)

4. Sampling schedules on file with the Washington State Air Pollution Control Board and Department of Environmental Quality require a nimimum number of samples and allow make-up sampling as follows: A minimum of 85 samples shall be collected in a calendar year and a minimum of seven samples shall

be taken each calendar month. A maximum of 2 make-up samples may be taken each month. It is desireable, but not mandatory, that make-up samples be taken the same day of the week as the missed samples.

5. For a community sampling program all high volume sampler should operate during the same time period to provide for comparison of the suspended particulate pollution within the area. (11)

DATE RECORDING:

The type of data form utilized shall be compatible with the type of data processing used.

Weather observations shall be recorded with each sample if not available elsewhere. Record any unusual happenings which may affect sampling results.

DATA REPORTING:

1. All suspended particulate data obtained with the high-volume air sampler shall be reported in micrograms per cubic meter. (2, 3, 4)

2. Data reporting should relate to the effects that are caused by the contaminant and should reflect how the data relates to standards. (11, 1[illegible]

3. Total suspended particulate data shall be reported to the nearest whole number and shall include:

   a. All sample results including dates of sampling and types of stations.

   b. Minimum, maximum and median values, including number of samples exceeding 60 ug/m^3.

   c. Number of samples $\geq$ 100 ug/m^3 (PAMS, PGLMS ONLY).

CALIBRATION PROCEDURE:

GENERAL:

High volume samplers operated with regular use should be calibrated every six months and after each motor change. Calibration can be performed either in the field or laboratory using a National Air Sampling Network (NASN) type orifice calibration assembly.

EQUIPMENT:

1. National Air Sampling Network (NASN) type calibration orifice and calibration curve.

2. Manometer, fittings and tubing.
3. Flowmeter and small wrenches for adjustment.
4. Variable voltage transformer.
5. Graph paper.

PRE-CALIBRATION CHECKS:

1. Replace flowmeter tubing if dirty.
2. Clean or replace flowmeter. A soft pipe cleaner and Stoddard solvent is good for cleaning.
3. Check the system for leaks. (See leak test procedure under post calibration checks)
4. If new brushes have been installed, run the sampler for 30 minutes to seat the brushes. (Leak check can be done at this time.)

CALIBRATION:

1. Remove filter head from sampler and install the calibration orifice. Make sure the joint is air tight.
2. Set up the manometer and attach the tubing from manometer to the pressure tap on the side of the calibration orifice.
3. Plug sampler into output plug of the variable voltage transformer.
4. Adjust the scaler on the manometer to zero.
5. Check all connections (electrical and tubing) and plug the variac into 120 VAC power line.
6. Adjust variable voltage transformer such that the manometer read the inches of water equivalent to 50 cfm as shown on the orifice calibration curve. Adjust the flowmeter to read 50 cfm by turning the orifice screw at the top of the flowmeter. If a constant flow regulator is to be used in the sampler, the manometer and flow meter should be set at 35 cfm.
7. Tighten the locknut and put a drop of sealant, ie. Duco cement, to assure the setting is not changed. Recheck to assure a 50 cfm flow at the proper manometer setting. (35 cfm for constant flow regulator use)

8. Run a standard calibration from 15 to 65 cfm in intervals of 5 cfm, recording the inches of water at each interval.
9. Using the orifice calibration data draw a flow curve so that a best fit line is drawn through the points. On the ordinate of the graph, plot the true air flow as taken from the orifice data and on the abscissa, plot the flowmeter readings. The curve should approximate a 45° angle from 40 to 60 cfm (30 - 40 cfm for constant flow regulator). If not, all connections should be checked and another calibration run.

POST CALIBRATION CHECKS:

1. Remove calibration orifice and return equipment to operational configuration.
2. Place an 8" x 10" piece of tag board into the filter holder and tighten the wing nuts.
3. Start the motor to check for leaks. If the flowmeter does not stay on zero a leak exists. Tighten the holder adaptor connection and retest. CAUTION! Do not leave the motor running with the tag board on the filter holder as they will damage the motor.
4. Remove tag board and replace with a clean filter.
5. Start the sampler, record the air flow through the clean filter (should not be greater than 65 cfm).
6. Information should be recorded on the calibration curve to include the following:

   Sampler Number
   Date
   Date of Previous Calibration
   Clean Air Filter Flow
   Flowmeter Set -- cfm
   Calibrated by_____
   Remarks
   Pressure Regulator Number (if used)

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EXHIBIT B

COLLECTION AND ANALYSIS

of

PARTICLE FALLOUT

GENERAL: Collection of particle fallout in the Pacific Northwest must be adapted to fulfill the requirements of the local region. Particle sizes exceed those found in other parts of the country. The predominance of wigwam waste burners and other lumber operations within the two states necessitates procedures for detection of large cinders and fly ash particulates. The screening method recommended by ASTM, APCA and USPHS therefore cannot be utilized in this analysis.

The use of a wet collection method was selected due to regional climatic conditions where collection of dry samples is virtually impossible except during the summer months. The following recommendations incorporate specific variations in the accepted standards of particle fallout collection and analyses methods for the needs of the area.

SAMPLING EQUIPMENT:

A. Collector jar:

1. Jar should be made of polyethylene. Glass, stainless steel, or other non-reactive material may be used. For convenience in shipping and storage, jar should be equipped with a watertight cover.

2. Top opening of not less than six inches in diameter.

3. Height between two to three times diameter of top opening.

4. The recommended design for the collector is shown in Figure 1.

When necessary an algaecide may be added to the distilled water placed in the collector. Dowcide B is recommended - five milliliters of 0.2% solution per sampler is sufficient. Use of any type of antifreeze should be discouraged unless absolutely necessary.

B. Sampler Support:

Suitable unrestricted holder with a bird ring or other attachments, when necessary to preserve sampling purity.

SAMPLING STATION CRITERIA:

A. Location:

Station be freely exposed and not subject to interference from local sources or adjacent buildings and high objects. The top of

any building, structure or natural growth should not be on a line exceeding 30° angle above the sampling position from the horjzontal. Concur with other conditions as stated under PAMS and PGLMS criteria.

B. Height:

Not less than10 feet or over 150 feet above ground level following the criteria of PAMS, PGLMS and special stations. When mounting on roof tops the minimum height of the jar opening shall be 5 feet above the roof level.

SAMPLING PROCEDURE:

A. Add distilled water to the jar. The amount of water can vary to meet existing climatic conditions.

B. Remove lid from the collecting jar and mount the jar in the support assembly.

C. The sampling duration time of PRIMARY stations shall be 1 calendar-month ± 2 days. Special sampling time duration shall be as needed to document the problem.

LABORATORY EQUIPMENT:

1. Analytical Balance - 160-gram capacity, sensitivity 0.1 milligram.

2. Steam bath.

3. Drying oven - Temperature regulation of ± 2° C at 105° C.

4. Evaporating dish - Coors capable of holding 150-200 milliliters of sample.

5. Electric stirrer.

6. Rubber policeman broad tip.

7. Desiccator.

8. Laboratory furnace with temperature at 800° C.

9. Waring Blender - 1-gallon capacity. (Optional method)

LABORATORY ANALYSIS:

1. Selectively remove all insects, leaves, and other substances that are not considered fallout material.

2. Scrub down the inside of the jar and quantitatively transfer to a suitable beaker.

3. Adjust the volume of the sample by evaporation, or the addition of distilled water to exactly 500 ml.

4. Using a stirrer, remove 100 mls of sample for the chemical analysis, 100 mls for soluble-insoluble analysis (if desired). The remainder is used for the determination of total particulate, ash and volatile. If chemical and soluble-insoluble analyses are not desired, the whole sample should be used to determine the total particulate, etc.

5. To determine total particulate, ash and volatile, transfer to a pre-weighed evaporating dish and evaporate at 105° C to dryness. Desiccate and weigh to determine the total particulate weight.

6. Place the evaporating dish in a muffle furnace at 800° C for twenty minutes, desiccate and weigh to determine the total ash weight. Calculate volatile portion (%).

OPTIONAL METHOD (From Step 2 above):

3a. Adjust the volume of the sample to less than 500 ml by evaporation, or by the addition of distilled water.

4a. Quantitatively transfer to a Waring blender for mixing. Blend and transfer to a 500 ml graduate using the blender wash water to adjust the volume to 500.0 ml. Mix thoroughly.

5a. Pipet 200 ml from the graduate and transfer to a pre-weighed evaporating dish. Evaporate at 105° C to dryness, desiccate and weigh to determine the total weight.

6a. Place the evaporating dish in a muffle furnace at 800° C for twenty minutes, desiccate and weigh to determine the total ash weight and calculate volatile portion (%).

7a. Transfer the remaining 300 ml from Step 4 into a beaker, heat and vacuum filter through a Buechner funnel. Adjust the volume of the filtrate to exactly 300 ml.

8a. Transfer 100 ml of the filtrate to a storage bottle for later chemical analysis.

(OPTIONAL METHOD, Continued)

9a. Transfer the remaining 200 ml from Step seven to a pre-weighed evaporating dish, evaporate to dryness at 105° C. Desiccate and weigh to determine the total soluble weight.

10a. Place the soluble weight evaporating dish from step 9a in a muffle furnace at 800° C for twenty minutes, desiccate and weigh to determine the soluble ash weight.

CALCULATIONS:

Total particulates and chemical analyses shall be expressed in gram, per square meter per month. Other units may be used to suit individual needs. Total particulate will be reported to the nearest 0.1 grams per square meter per month for values under 10. For values of 10 or above, the data will be reported to the nearest whole number.

Volatile fractions will be reported as a percent of the total weight to the nearest 1%.

Chemical analyses, solubles and insoluble fractions will be reported to the nearest hundredth of a gram per square meter per month.

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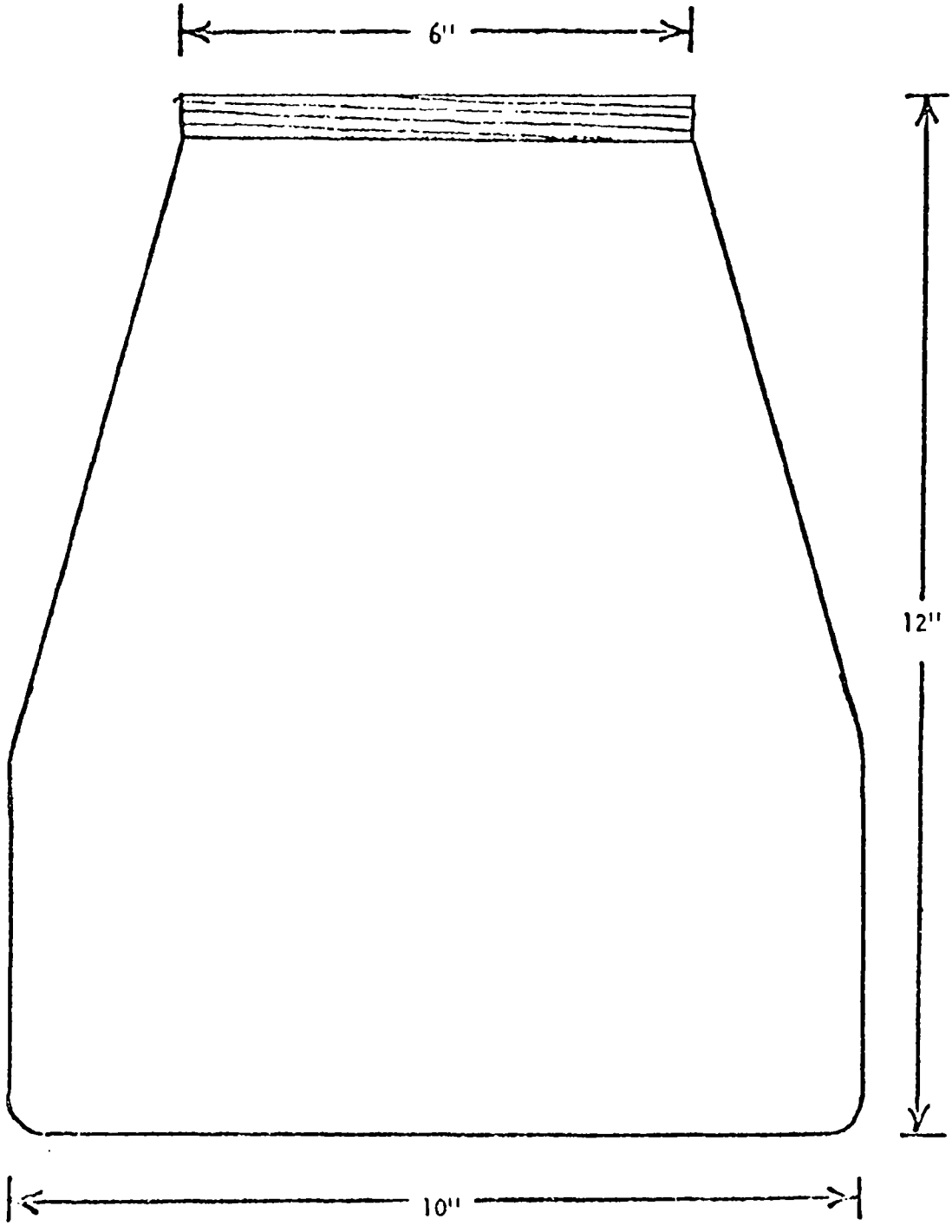
RECOMMENDED DESIGN
for
PARTICLE FALLOUT COLLECTION



With Plastic Screw Cap
Should Be Leak-Proof

Oregon-Washington
Air Quality Committee
Dec. , 1969

Figure 1

APPENDIX B

TABULAR SUMMARY OF EMISSIONS DENSITY FOR 10 x 10 KILOMETER GRIDS IN THE OREGON PORTION OF THE PORTLAND INTERSTATE AIR QUALITY CONTROL REGION

UTM grid areas are identified in the tables by the 5-digit number. The first three digits correspond to the 10-kilometer Northing Lines and the last two digits correspond to the 10-kilometer Easting Lines. Total emissions are presented in tons per year.

COUNTY NAME IS BENTON, CODE = 2

UTM AREA	HC	PART	NOX	SOX	CO
49044	.343273+03	.212483+02	.922008+02	.123127+02	.142552+04
49045	.343273+03	.212483+02	.922008+02	.123127+02	.142552+04
49046	.334473+03	.146483+02	.907317+02	.123127+02	.137858+04
49047	.480362+03	.196739+03	.115126+03	.152192+02	.251679+04
49144	.343273+03	.212483+02	.922008+02	.123127+02	.142552+04
49145	.343273+03	.121248+03	.922008+02	.123127+02	.142552+04
49146	.402813+03	.315088+03	.147501+03	.131077+02	.218199+04
49147	.467956+03	.193892+03	.112984+03	.123220+02	.249991+04
49245	.343273+03	.212483+02	.922008+02	.123127+02	.142552+04
49246	.334473+03	.146483+02	.907317+02	.123127+02	.137858+04
49247	.469318+03	.235333+03	.114278+03	.123172+02	.269964+04
49345	.343348+03	.212883+02	.922158+02	.123152+02	.142573+04
49346	.558718+03	.107623+03	.961758+02	.147122+02	.166327+04
49347	.859117+03	.113794+04	.514044+03	.188910+03	.324643+04
49445	.343273+03	.212483+02	.922008+02	.123127+02	.142552+04
49446	.343273+03	.121248+03	.922008+02	.123127+02	.142552+04
49447	.343273+03	.212483+02	.922008+02	.123127+02	.142552+04
49448	.478754+03	.203713+03	.115374+03	.156637+02	.252056+04

COUNTY NAME IS CLKAMS, CODE = 3

UTM AREA	HC	PART	NOX	SOX	CO
49754	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49755	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49756	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49757	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49758	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49759	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49853	.477884+03	.316970+02	.124657+03	.184382+02	.197101+04
49854	.477884+03	.316970+02	.124657+03	.184382+02	.197101+04
49855	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49856	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49857	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49858	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49859	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49952	.495974+03	.559300+02	.130417+03	.184432+02	.212234+04
49953	.528654+03	.208437+03	.133119+03	.189844+02	.263564+04
49954	.477884+03	.316970+02	.124657+03	.184382+02	.197101+04
49955	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49956	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49957	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49958	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
49959	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
50052	.495884+03	.723100+02	.127657+03	.184382+02	.212234+04
50053	.517474+03	.156274+03	.132162+03	.187992+02	.246034+04
50054	.477884+03	.316970+02	.124657+03	.184382+02	.197101+04
50055	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
50056	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
50057	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
50058	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
50059	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
50151	.495884+03	.559970+02	.127657+03	.184382+02	.212234+04
50152	.508184+03	.115007+03	.131487+03	.191412+02	.231339+04
50153	.477884+03	.316970+02	.124657+03	.184382+02	.197101+04
50154	.477884+03	.316970+02	.124657+03	.184382+02	.197101+04
50155	.487244+03	.915970+02	.126217+03	.185942+02	.211801+04
50156	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
50157	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
50252	.521364+03	.279486+03	.516657+03	.184382+02	.213655+04
50253	.557775+03	.885112+03	.424798+03	.118740+04	.229992+04
50254	.507764+03	.121097+03	.129637+03	.186362+02	.230834+04
50255	.523724+03	.245997+03	.132307+03	.192032+02	.269001+04
50256	.484814+03	.640170+02	.125812+03	.185537+02	.207912+04
50257	.515368+03	.626455+02	.130896+03	.184502+02	.217861+04
50258	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04
50259	.514668+03	.592855+02	.130776+03	.184382+02	.216731+04

COUNTY NAME IS CLMBIA, CODE = 5

UTM AREA	HC	PART	NOX	SOX	CO
50650	.184441+03	.220867+02	.764201+02	.137714+02	.748438+03
50651	.182706+03	.172581+02	.750362+02	.137704+02	.739693+03
50747	.182706+03	.172581+02	.750362+02	.137704+02	.739693+03
50748	.184505+03	.193267+02	.753401+02	.137734+02	.751256+03
50749	.184405+03	.184867+02	.753101+02	.137704+02	.748436+03
50750	.182706+03	.172581+02	.750362+02	.137704+02	.739693+03
50751	.318006+03	.349697+04	.583506+03	.502223+03	.848956+03
50847	.182706+03	.172581+02	.750362+02	.137704+02	.739693+03
50848	.182706+03	.172581+02	.750362+02	.137704+02	.739693+03
50849	.184405+03	.184867+02	.753101+02	.137704+02	.748436+03
50850	.182706+03	.172581+02	.750362+02	.137704+02	.739693+03
50851	.378727+04	.955161+02	.949362+02	.138244+02	.739729+03
50947	.182706+03	.172581+02	.750362+02	.137704+02	.739693+03
50948	.184505+03	.193267+02	.753401+02	.137734+02	.751256+03
50949	.184405+03	.184867+02	.753101+02	.137704+02	.748436+03
50950	.182706+03	.189581+02	.750362+02	.137704+02	.739693+03
51047	.184405+03	.184867+02	.753101+02	.137704+02	.748436+03
51048	.200316+03	.991581+02	.779562+02	.140624+02	.101469+04
51049	.182706+03	.172581+02	.750362+02	.137704+02	.739693+03
51050	.182706+03	.172581+02	.750362+02	.137704+02	.739693+03

COUNTY NAME IS LANE , CODE =20

UTM AREA	HC	PART	NOX	SOX	CO
48152	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48153	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48154	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48155	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48156	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48249	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48250	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48251	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48252	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48253	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48254	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48255	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48256	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48349	.226322+03	.380426+02	.710584+02	.194398+02	.935861+03
48350	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48351	.278652+03	.565334+03	.247640+03	.195698+02	.109503+04
48352	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48353	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48354	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48355	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48356	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48357	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48449	.270084+03	.392750+04	.236019+03	.194418+02	.107336+04
48450	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48451	.226358+03	.380716+02	.710784+02	.194398+02	.936014+03
48452	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48453	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48454	.355208+03	.237406+04	.576127+03	.194978+02	.104973+04
48455	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48456	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48457	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48458	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48546	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48547	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48548	.333550+03	.117176+03	.125309+03	.194398+02	.176055+04
48549	.233660+03	.107706+04	.886102+02	.194433+02	.109018+04
48550	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48551	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48552	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48553	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48554	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48555	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48556	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48557	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48641	.241694+03	.153548+03	.756114+02	.253518+02	.116935+04
48642	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48643	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48644	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48645	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48646	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03

48650	.291010+03	.143594+04	.330975+03	.194398+02	.109209+04
48651	.191395+03	.117898+02	.652060+02	.194398+02	.749163+03
48652	.191395+03	.117898+02	.652060+02	.194398+02	.749163+03
48653	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48654	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48655	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48656	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48657	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48741	.236220+03	.761556+02	.753444+02	.302363+02	.106482+04
48742	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48743	.330500+03	.117099+04	.266144+03	.203523+02	.183055+04
48744	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48745	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48746	.374070+03	.167044+04	.593119+03	.196998+02	.128345+04
48747	.226010+03	.579436+02	.709752+02	.194398+02	.104009+04
48748	.294494+04	.219941+04	.103422+04	.117300+03	.139398+05
48749	.313965+04	.254295+04	.158733+04	.837484+02	.139724+05
48750	.802635+03	.119244+05	.196370+04	.181956+03	.169305+04
48751	.191395+03	.117898+02	.652060+02	.194398+02	.749163+03
48752	.191395+03	.117898+02	.652060+02	.194398+02	.749163+03
48753	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48754	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48755	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48756	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48757	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48758	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48841	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48842	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48843	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48844	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48845	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48846	.191395+03	.117898+02	.652060+02	.194398+02	.749163+03
48847	.191395+03	.117898+02	.652060+02	.194398+02	.749163+03
48848	.281407+04	.136302+04	.890562+03	.980024+02	.138997+05
48849	.226010+03	.799436+02	.709752+02	.194398+02	.104009+04
48850	.275944+04	.153765+03	.836932+03	.738867+02	.135626+05
48851	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48852	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48853	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48854	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48855	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48856	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48857	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48858	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48859	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48941	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48942	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48943	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48944	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48945	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48946	.235600+03	.182286+03	.722394+02	.195618+02	.105055+04
48947	.226010+03	.579436+02	.709752+02	.194398+02	.104009+04
48948	.257154+03	.631312+03	.180490+03	.243548+02	.106059+04

48953	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48954	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48955	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48956	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48957	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48958	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03
48959	.226250+03	.379856+02	.710194+02	.194398+02	.935555+03

COUNTY NAME IS LINN , CODE =22

UTM AREA	HC	PART	NOX	SOX	CO
49048	.635287+03	.340916+03	.127096+03	.114638+02	.278311+04
49049	.446107+03	.280186+03	.126236+03	.987377+01	.277247+04
49050	.252007+03	.101856+02	.924859+02	.987377+01	.106697+04
49051	.276607+03	.277656+02	.990859+02	.109738+02	.116047+04
49052	.243607+03	.101856+02	.924859+02	.987377+01	.106697+04
49053	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49054	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49055	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49056	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49057	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49058	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49148	.448994+03	.116252+04	.158696+03	.118375+03	.277355+04
49149	.447097+03	.515386+03	.126236+03	.987377+01	.277346+04
49150	.453152+03	.395402+03	.151771+03	.116323+02	.277980+04
49151	.244067+03	.106636+02	.950629+02	.149233+02	.106779+04
49152	.505064+03	.132881+04	.777570+03	.257116+02	.204901+04
49153	.243607+03	.101856+02	.924859+02	.987377+01	.106697+04
49154	.272708+03	.330238+02	.974693+02	.101618+02	.122213+04
49155	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49156	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49157	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49158	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49248	.446152+03	.280210+03	.126245+03	.987527+01	.277260+04
49249	.446107+03	.280186+03	.126236+03	.987377+01	.277247+04
49250	.484312+03	.161453+04	.558093+03	.155124+02	.114873+04
49251	.476661+03	.445852+03	.160651+03	.107003+02	.308521+04
49252	.243607+03	.101856+02	.924859+02	.987377+01	.106697+04
49253	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49254	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49255	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49256	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49257	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49258	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49346	.449257+03	.286006+03	.127236+03	.987577+01	.277248+04
49349	.463795+03	.303172+03	.163650+03	.997529+01	.302350+04
49350	.688457+03	.147820+04	.573153+03	.289719+03	.356521+04
49351	.244462+03	.136256+02	.929009+02	.987627+01	.107719+04
49352	.252442+03	.509206+02	.939539+02	.100323+02	.120315+04
49353	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49354	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49355	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49356	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49357	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49358	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49359	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49449	.982002+03	.474621+04	.824478+03	.362906+03	.290029+04
49450	.449457+03	.280353+03	.126295+03	.988477+01	.277330+04
49451	.446665+03	.281638+03	.127235+03	.116903+02	.277388+04
49452	.243607+03	.101856+02	.924859+02	.987377+01	.106697+04
49453	.243607+03	.101856+02	.924859+02	.987377+01	.106697+04

49457	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49458	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49459	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49551	.446416+03	.280520+03	.127274+03	.118618+02	.277316+04
49552	.446107+03	.280186+03	.126236+03	.987377+01	.277247+04
49553	.278614+03	.488252+02	.105690+03	.992937+01	.125264+04
49554	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04
49555	.272698+03	.320038+02	.973253+02	.987377+01	.122213+04

COUNTY NAME IS MARION, CODE =24

UTM AREA	HC	PART	NOX	SOX	CO
49549	.593033+03	.105777+03	.153335+03	.142329+02	.260512+04
49550	.592505+03	.991714+02	.151642+03	.109774+02	.260462+04
49556	.574986+03	.588746+02	.148531+03	.110394+02	.234758+04
49557	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49558	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49559	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49649	.594540+03	.991134+02	.151629+03	.109669+02	.260398+04
49650	.620056+03	.151488+03	.307883+03	.297567+02	.263189+04
49651	.629696+03	.119978+03	.184224+03	.251206+02	.260789+04
49652	.540935+03	.272414+02	.143177+03	.110994+02	.214830+04
49653	.536805+03	.250414+02	.142352+03	.109624+02	.213660+04
49654	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49655	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49656	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49657	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49658	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49659	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49749	.477201+04	.474791+03	.160575+04	.403584+04	.204046+05
49750	.411983+04	.208567+03	.117415+04	.159515+03	.198138+05
49751	.605505+03	.405491+03	.302064+03	.170979+02	.304130+04
49752	.536925+03	.251054+02	.142376+03	.109664+02	.213694+04
49753	.571896+03	.513596+02	.148197+03	.109624+02	.232323+04
49849	.616835+03	.226676+03	.157521+03	.240697+02	.260646+04
49850	.614903+03	.116883+03	.185744+03	.368202+02	.260905+04
49851	.609771+03	.256687+03	.153328+03	.145359+02	.262004+04
49852	.592600+03	.993054+02	.151681+03	.109889+02	.260615+04
49950	.630745+03	.992044+02	.151665+03	.109854+02	.260517+04
49951	.625245+03	.131456+03	.173250+03	.297269+02	.261648+04
50050	.592680+03	.105493+03	.151769+03	.110169+02	.260603+04
50051	.595893+03	.152488+03	.171801+03	.326291+02	.260891+04

COUNTY NAME IS MLTNMA, CODE =26

UTM AREA	HC	PART	NOX	SOX	CO
50352	.122050+05	.125957+04	.330013+04	.769118+03	.560098+05
50353	.120761+05	.113948+04	.330772+04	.409559+03	.560867+05
50354	.181437+04	.161293+03	.527385+03	.299644+03	.520977+04
50355	.181437+04	.140573+03	.527385+03	.299644+03	.520977+04
50356	.183525+04	.156243+03	.530865+03	.299644+03	.532113+04
50357	.183525+04	.156243+03	.530865+03	.299644+03	.532113+04
50358	.183525+04	.156243+03	.530865+03	.299644+03	.532113+04
50452	.123910+05	.375463+04	.350121+04	.175633+04	.579210+05
50453	.119320+05	.960333+03	.331782+04	.677837+03	.573309+05
50454	.182691+04	.178947+04	.615130+03	.104379+04	.560885+04
50455	.181437+04	.140573+03	.527385+03	.299644+03	.520977+04
50456	.181437+04	.140573+03	.527385+03	.299644+03	.520977+04
50457	.183525+04	.156243+03	.530865+03	.299644+03	.532113+04
50458	.183525+04	.156243+03	.530865+03	.299644+03	.532113+04
50551	.192148+04	.440172+04	.961413+03	.391910+03	.663075+04

COUNTY NAME IS POLK , CODE =27

UTM AREA	HC	PART	NOX	SOX	CO
49544	.296894+03	.200705+02	.881680+02	.596096+01	.128150+04
49545	.296894+03	.200705+02	.881680+02	.596096+01	.128150+04
49546	.287974+03	.133805+02	.866850+02	.596096+01	.123390+04
49547	.287974+03	.133805+02	.866850+02	.596096+01	.123390+04
49548	.360974+03	.111164+03	.988517+02	.596096+01	.184857+04
49644	.296894+03	.204505+02	.881680+02	.596096+01	.128150+04
49645	.296894+03	.200705+02	.881680+02	.596096+01	.128150+04
49646	.302797+03	.225695+02	.899350+02	.790496+01	.129380+04
49647	.376774+03	.606605+02	.104425+03	.892096+01	.148490+04
49648	.444290+03	.970474+03	.160135+03	.607398+02	.264417+04
49744	.296894+03	.200705+02	.881680+02	.596096+01	.128150+04
49745	.296894+03	.200705+02	.881680+02	.596096+01	.128150+04
49746	.296894+03	.462705+02	.867680+02	.796096+01	.128150+04
49747	.566058+03	.176983+04	.806997+03	.823146+01	.202526+04
49748	.382619+03	.112509+03	.988577+02	.596546+01	.184863+04
49844	.345004+03	.247764+03	.126088+03	.866096+01	.201957+04
49845	.296894+03	.205205+02	.881680+02	.596096+01	.128150+04
49846	.287974+03	.133805+02	.866850+02	.596096+01	.123390+04
49847	.360974+03	.111164+03	.988517+02	.596096+01	.184857+04
49848	.360974+03	.111164+03	.988517+02	.596096+01	.184857+04

COUNTY NAME IS WSHGTN, CODE =34

UTM AREA	HC	PART	NOX	SOX	CO
50250	.927560+03	.665347+02	.211051+03	.434707+02	.382418+04
50251	.956478+03	.156585+03	.226427+03	.590438+02	.388860+04
50346	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04
50347	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04
50348	.969944+03	.206440+03	.275597+03	.397407+02	.390135+04
50349	.937433+03	.916405+02	.219901+03	.404834+02	.389368+04
50350	.934995+03	.139698+03	.210867+03	.397423+02	.388841+04
50351	.935857+03	.125724+03	.210673+03	.399907+02	.388835+04
50447	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04
50448	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04
50449	.936998+03	.866895+02	.211297+03	.411011+02	.388837+04
50450	.934944+03	.782005+02	.210597+03	.397407+02	.388835+04
50451	.934944+03	.782005+02	.210597+03	.397407+02	.388835+04
50547	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04
50548	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04
50549	.927069+03	.677005+02	.209285+03	.397407+02	.382200+04
50550	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04
50647	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04
50648	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04
50649	.927467+03	.679987+02	.209351+03	.397407+02	.382413+04

COUNTY NAME IS YAMHILL CODE =36

UTM AREA	HC	PART	NOX	SOX	CO
49944	.273017+03	.144758+02	.831062+02	.669657+01	.115171+04
49945	.273054+03	.145678+02	.837262+02	.777657+01	.115171+04
49946	.393973+03	.252440+03	.183000+03	.176523+02	.171597+04
49947	.303392+03	.554258+02	.882487+02	.669657+01	.140746+04
49948	.307124+03	.957058+02	.896377+02	.937007+01	.140827+04
49949	.303452+03	.550078+02	.882607+02	.669857+01	.140763+04
50044	.292394+03	.289758+02	.864040+02	.669657+01	.125472+04
50045	.292394+03	.289758+02	.864040+02	.669657+01	.125472+04
50046	.292394+03	.289758+02	.864040+02	.669657+01	.125472+04
50047	.292394+03	.289758+02	.864040+02	.669657+01	.125472+04
50048	.516910+03	.100230+04	.284301+03	.508678+02	.166141+04
50049	.307639+03	.101038+03	.984857+02	.298621+02	.140792+04
50146	.292394+03	.289758+02	.864040+02	.669657+01	.125472+04
50147	.292394+03	.289758+02	.864040+02	.669657+01	.125472+04
50148	.305348+03	.724023+02	.890977+02	.831732+01	.140818+04
50149	.311675+03	.158173+03	.910452+02	.141195+02	.140822+04
50150	.415563+03	.738082+03	.259186+03	.117216+04	.151129+04
50246	.292394+03	.289758+02	.864040+02	.669657+01	.125472+04
50247	.292394+03	.289758+02	.864040+02	.669657+01	.125472+04
50248	.280041+03	.341248+02	.875132+02	.112721+02	.120355+04
50249	.292394+03	.289758+02	.864040+02	.669657+01	.125472+04

NORMAL EXIT. EXECUTION TIME: 54599 MILLISECONDS.

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APPENDIX C

IMPACT OF SO_2 EMISSIONS FROM THE CENTRALIA, WASHINGTON PLANT OF THE PACIFIC POWER AND LIGHT COMPANY ON AMBIENT AIR QUALITY IN THE PORTLAND INTERSTATE AIR QUALITY REGION

SECTION 1
INTRODUCTION

The Centralia Plant of the Pacific Power and Light Company is located about 5 miles northeast of Centralia, Washington along the extreme northern border of the Portland Interstate Air Quality Region (PIAQR). The first unit of the Plant began operation about the first of September 1971, and the second unit of the Plant is scheduled to begin operation in the fall of 1972. To aid in the design of the air quality surveillance system for the State of Oregon, it is important to know the probable impact of SO_2 emissions from this Plant on ambient air quality in the PIAQR.

Preliminary quantitative estimates of average seasonal and annual SO_2 concentrations due to emissions from the first unit of the Centralia Plant were made for the area within a 175 kilometer radius of the Plant, by means of a computerized atmospheric diffusion model. The atmospheric diffusion model used to make these calculations is a modified form of the Air Quality Display Model used by the Environmental Protection Agency (1969). Surface observations of wind direction and speed used in the computations were obtained from the Climatological Handbook Columbia Basin States (Meteorology Committee of the Pacific Northwest River Basins Committee, 1968) for Chehalis during the eight-year period 1930 to 1938. No adjustments were made in the joint frequency distribution of wind direction and speed measured at Chehalis for the effect of terrain in channeling wind flow. However, qualitative comparison of the wind distribution at Chehalis with wind distributions at Kelso, Washington and other stations in the area revealed that the Chehalis data were probably adequate for a preliminary assessment of the impact of the Centralia Plant on regional air quality. Surface mixing layer depths required by the diffusion model were obtained from an analysis of mixing layer depths at Salem, Oregon prepared by the National Climatic Center under the direction of G. C. Holzworth (Environmental Data Service, 1968) and the maps of mean afternoon and early morning mixing depths prepared by Holzworth (1971).

The diffusion model and the mathematical formula used in the calculation of concentration and plume rise are described in Section 2. Meteorological and source parameters used in the calculations are given in Section 3. In Section 4, the computational procedures followed in obtaining the concentration estimates are outlined. Finally, the results of the calculations are summarized in Section 5.

SECTION 2

DESCRIPTION OF THE ATMOSPHERIC DIFFUSION MODELS AND PLUME RISE MODEL

2.1 AVERAGE SEASONAL AND ANNUAL CONCENTRATION MODEL

The atmospheric dispersion model used to calculate annual and seasonal ground-level concentration patterns is a modified version of the conventional sector model and similar in form to the Air Quality Display Model used by the Environmental Protection Agency (1969) to predict annual and seasonal concentrations. In the sector model, the area surrounding a continuous source of pollutants is divided into sectors of equal angular widths corresponding to the class intervals of the seasonal frequency distributions of wind direction. The total emission during a season or year is then partitioned by sector according to the relative wind direction frequencies. In the version of the sector model used in this study, the plume is initially assumed to have a Gaussian vertical concentration distribution centered about the effective height obtained from a plume rise model. As the plume is transported downwind and mixes, the model transforms the vertical concentration distribution into a rectangular distribution with boundaries at ground level and the mixing layer depth. Thus, the mean seasonal concentration at a point (x, y) downwind from a continuous source is given by the expression

$$\chi_{\ell}\{x,y\} = \sum_{i,j,k}\left[\left\{\frac{2\,K\,T_{\ell}\,Q\,f_{i,k,\ell}\,\{\phi\}\,f_{j,\ell}}{x\,\Delta\theta'\,\sqrt{2\pi}\,\sigma_{z;i,j,\ell}\,\bar{u}_i}\right\}\left\{S_k\right\}\right.$$

$$\left\{\exp\left(-\frac{1}{2}\left[\frac{H_{i,j,\ell}}{\sigma_{z;i,j,\ell}}\right]^2\right)+\sum_{n=1}\left\{\exp\left(-\frac{1}{2}\left[\frac{2n\,H_{m;j,\ell}-H_{i,j,\ell}}{\sigma_{z;i,j,\ell}}\right]^2\right)\right.\right. \quad (2\text{-}1)$$

$$\left.\left.\left.+\exp\left(-\frac{1}{2}\left[\frac{2n\,H_{m;j,\ell}+H_{i,j,\ell}}{\sigma_{z;i,j,\ell}}\right]^2\right)\right\}\right\}\right]$$

where

K = scaling coefficient used to convert input parameters into dimensionally consistent units

T_ℓ = ambient air temperature in absolute degrees for the ℓ^{th} season (used in conversion to parts per billion SO_2)

Q = source emission rate in tons per hour

$f_{i,k,\ell}\{\phi\}$ = frequency of the seasonal azimuth wind direction for the i^{th} wind speed category, k^{th} wind direction sector, and ℓ^{th} season of the year

$f_{j,\ell}$ = frequency of j^{th} time of day during the ℓ^{th} season

x = downwind distance from the source to the point $\{x, y\}$ in meters

$\sigma_{z;i,j,\ell}$ = standard deviation of the vertical concentration distribution at the point $\{x, y\}$ for the i, j, ℓ^{th} condition

$$= \sigma_{E;i,j,\ell} \left(\frac{\pi}{180}\right) x \qquad (2\text{-}2)$$

$\sigma_{E;i,j,\ell}$ = standard deviation of the wind elevation angle at height $H_{i,j,\ell}$ in degrees for the i, j, ℓ^{th} condition

$\bar{u}_i$ = mean transport wind speed in miles per hour for the i^{th} condition

$H_{i,j,\ell}$ = effective source height in meters for the i, j, ℓ^{th} condition

$H_{m;j,\ell}$ = depth of the surface mixing layer in meters for the j, ℓ^{th} condition

$$= \begin{cases} 0 & ; \quad \tan(\Delta\theta') - |y_k| \leq 0 \\ \dfrac{x \tan(\Delta\theta') - |y_k|}{x \tan(\Delta\theta')} & ; \quad \tan(\Delta\theta') - |y_k| > 0 \end{cases} \qquad (2\text{-}3)$$

S_k = smoothing function

$\Delta\theta'$ = wind direction sector width in radians

y_k = lateral distance from the centerline of the k^{th} wind direction sector to the point $\{x, y\}$

According to Equation (2-1), the rectangular lateral concentration distribution within a given angular sector is modified by the linear smoothing function S given by Equation (2-3). The function S acts to smooth "square-wave" discontinuities in concentration at the boundaries of two adjacent sectors. The centerline concentration in each sector is unaffected by contributions from adjacent sectors. At points on either side of the sector centerline, the concentration is a linearly weighted function of the concentration at the centerline of the sector in which the calculation is being made and the concentration at the centerline of the nearest adjoining sector. The two exponential terms following the second summation sign in Equation (2-1) act to transform the concentration distribution into a rectangular distribution bounded by ground-level and H_m at larger downwind distances. At each point (x, y), the two terms must be summed n times until the additional contribution from the sum of the two terms in the n^{th} pass is insignificant. The computer program incorporating Equation (2-1) automatically ceases to sum the terms when the exponent of the first term equals negative ten. The computer program is also designed to calculate concentration fields resulting from emissions of multiple point, area, and line sources. The resultant concentration field is found by summing the concentration fields from individual sources on a reference grid system.

The average annual concentration at the point (x, y) is obtained from the seasonal calculations using the expression

$$\chi_a\{x, y\} = \frac{1}{4} \sum_{\ell} \chi_{\ell}\{x, y\} \qquad (2\text{-}4)$$

2.2 PLUME RISE MODEL

The effective source height H appearing in Equation (2-1) is the sum of the actual stack height and the rise of the plume due to buoyant forces generated by

the emission process. Thus, effective source heights for use in Equation (2-1) were calculated from the expression, due to Briggs (1970), given by

$$H_{i,j,\ell} = h + \left(\frac{6\, F_\ell}{\gamma^2\, \bar{u}_i\, s_{i,j,\ell}} \right)^{1/3} \tag{2-5}$$

where

h = actual stack height in meters

F_ℓ = buoyant flux

$$= g\, w\, r^2 \left(1 - \frac{T_\ell}{T_s} \right) \tag{2-6}$$

g = acceleration of gravity in meters per second per second

w = stack exit velocity in meters per second

r = stack exit radius in meters

T_s = stack gas exit temperature in degrees Absolute

γ = entrainment parameter

$s_{i,j,\ell}$ = stability parameter

$$= \frac{g}{T_\ell} \frac{\partial \Theta}{\partial z} \{i,j,\ell\} \tag{2-7}$$

$\frac{\partial \Theta}{\partial z}\{i,j,\ell\}$ = lapse rate of potential temperature in degrees Absolute per meter

The entrainment parameter γ appearing in Equation (2-5) is a measure of the rate at which air at ambient temperature is entrained in the plume as it rises and acts, in conjunction with the stability parameter s, to reduce cloud rise from buoyancy due to heat generated in the emission process. In the development of Equation (2-5), Briggs has assumed that γ is proportional to the increase in plume radius as it rises to height $H_{i,j,\ell}$. It should be noted that when the effective height $H_{i,j,\ell}$ exceeds the depth of the mixing layer H_m, there is no contribution to the ground-level concentration distribution from the plume.

SECTION 3

MODEL INPUT PARAMETERS

3.1 METEOROLOGICAL INPUT PARAMETERS

The meteorological inputs required for the concentration and plume rise models described in Section 2 above are listed in Table 3-1. The first step in specifying meteorological inputs for use in the calculation of average seasonal and annual concentration patterns is to assign a discrete set of indices to the major meteorological regimes that occur over a season or a year. The set of indices used in the calculations is indicated in the model equations above and is also listed in Table 3-2.

As mentioned in Section 1 above, joint frequency distributions of wind speed and wind direction for the Chehalis Airport were available from the Climatological Handbook Columbia Basin States for the years 1930 to 1938. These data were modified by assigning the percentage of calms to the 16 major wind direction sectors in our 0 to 3 miles-per-hour category according to the occurrence frequencies in the lowest speed category listed in the Climatological Handbook. The adjusted wind distributions for the seasonal and annual periods are presented in Table 3-3.

The surface wind speed and direction data in Table 3-3 were separated by time of day in the Climatological Handbook Columbia Basin States. Because the values of H_m and σ_E appearing in the concentration model are strongly dependent on time of day, the joint-frequency distributions of wind speed and direction in Table 3-3 are multiplied by a factor $f_{j,\ell}$ in Equation (2-1) to generate wind distributions for use with nighttime and daytime values of H_m and σ_E. The values of $f_{j,\ell}$ used with the Chehalis wind distribution are given in Table 3-4.

TABLE 3-1

METEOROLOGICAL MODEL INPUTS

Parameter	Definition
$\bar{u}$	Mean wind speed
H_m	Depth of the surface mixing layer
σ_E	Standard deviation of the wind elevation angle in degrees
T	Ambient air temperature
$\frac{\partial \Theta}{\partial z}$	Vertical gradient of potential temperature

TABLE 3-2

INDICES FOR AVERAGE SEASONAL AND ANNUAL CONCENTRATION CALCULATIONS

Surface Wind Speed Category	-	i = 1 (0-3 mph), 2 (4-15 mph), 3 (16-31 mph)
Time of Day	-	j = 1 (night), 3 (morning), 3 (afternoon), 4 (evening)
Wind Direction Sector	-	k = 1,2,$\cdots$,16
Season of the Year	-	ℓ = 1 (winter), 2 (spring), 3 (summer), 4 (fall)

TABLE 3-3

CHEHALIS SURFACE WIND DISTRIBUTIONS

Season	mph	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
Winter	0-3	1.9	0.7	0.9	0	0.1	0.1	4.4	6.5	4.2	1.5	1.6	0.4	0.3	0.2	0.4	0.5	23.7
	4-15	5.4	2.0	2.5	0.1	0.3	0.2	12.2	18.1	11.7	4.2	4.5	1.0	0.8	0.5	1.1	1.5	66.1
	16-31	0.1	0.4	0.2	--	--	--	1.3	6.0	1.5	0.2	0.2	0.1	--	--	0.1	--	10.1
Total		7.4	3.1	3.6	0.1	0.4	0.3	17.9	30.6	17.4	5.9	6.3	1.5	1.1	0.7	0.6	2.0	99.9
Spring	0-3	2.7	1.1	1.3	0	0.1	0.1	2.9	3.5	3.7	1.9	3.6	1.6	1.0	0.6	1.4	1.4	26.9
	4-15	6.9	2.8	3.3	0.1	0.3	0.2	7.2	8.9	9.4	4.9	9.0	4.0	2.6	1.6	3.4	3.4	68.0
	16-31	0.3	0.3	0.2	0	0	0	0.4	1.8	0.8	0.2	0.3	0.2	0.2	0.1	0.1	0.1	5.0
Total		9.9	4.2	4.8	0.1	0.4	0.3	10.5	14.2	13.9	7.0	12.9	5.8	3.8	2.3	4.9	4.9	99.9
Summer	0-3	4.2	1.7	1.7	0.1	0.2	0.1	1.5	1.8	3.2	1.9	4.6	2.3	1.6	1.0	3.3	3.1	32.3
	4-15	8.6	3.4	3.4	0.3	0.4	0.2	3.1	3.6	6.4	3.9	9.3	4.6	3.3	2.1	6.7	6.2	65.5
	16-31	0.5	0.4	0.1	0	0	0	0	0.3	0.1	0.1	0.2	0.1	0.1	0	0.1	0.1	2.1
Total		13.3	5.5	5.2	0.4	0.6	0.3	4.6	5.7	9.7	5.9	14.1	7.0	5.0	3.1	10.1	9.4	99.9
Fall	0-3	4.5	1.4	1.9	0.1	0.2	0	4.3	5.3	4.5	2.0	3.0	0.7	0.7	0.4	1.5	2.0	32.5
	4-15	8.8	2.8	3.7	0.2	0.3	0.1	8.3	10.2	8.8	3.8	5.8	1.4	1.4	0.8	3.0	3.8	63.2
	16-31	0.3	0.2	0.1	--	--	--	0.7	2.2	0.5	0.1	--	--	0.1	--	--	0.1	4.3
Total		13.6	4.4	5.7	0.3	0.5	0.1	13.3	17.7	13.8	5.9	8.8	2.1	2.2	1.2	4.5	5.9	100.0
Annual	0-3	3.3	1.2	1.4	0	0.2	0.1	3.3	4.3	3.9	1.8	3.2	1.2	0.9	0.6	1.6	1.8	28.8
	4-15	7.4	2.8	3.2	0.2	0.3	0.2	7.7	10.2	9.1	4.2	7.1	2.8	2.0	1.2	3.6	3.7	65.7
	16-31	0.3	0.3	0.2	0	0	0	0.6	2.6	0.7	0.2	0.2	0.1	0.1	0	0.1	0.1	5.5
Total		11.0	4.3	4.8	0.2	0.5	0.3	11.6	17.1	13.7	6.2	10.5	4.1	3.0	1.8	5.3	5.6	100.0

TABLE 3-4

FREQUENCY OF TIME OF DAY ($f_{j,\ell}$)

Time of Day	Season			
	Winter	Spring	Summer	Fall
Night	0.58	0.54	0.42	0.54
Morning	0.21	0.17	0.17	0.17
Afternoon	0.12	0.21	0.29	0.17
Evening	0.09	0.08	0.12	0.12

Each combination of time of day and season must be assigned a value of surface mixing layer depth H_m for use in Equation (2-1). The Environmental Data Service, under the direction of G. C. Holzworth, has prepared tabulations of the early morning and afternoon mixing depths at Medford and Salem, Oregon and at Seattle, Washington. Inspection of isopleths of mean seasonal and annual afternoon and early morning mixing layer depths, presented by Holzworth (1971) for the United States, shows that the isopleths are nearly parallel to the coasts of Oregon and Washington. For this reason, and because the Seattle mixing depths are strongly influenced by over-water trajectories, we chose the Salem, Oregon median mixing layer depths for use in the concentration calculations. We also assumed that the early morning median mixing layer depths are representative of nighttime conditions and afternoon median mixing layer depths are representative of afternoon conditions. Median mixing layer depths for the morning and evening time periods were obtained by averaging the values assigned to the nighttime and afternoon periods. Values of mixing layer depths used in the concentration calculations are given in Table 3-5.

Table 3-6 gives values of the standard deviations of wind elevation angle σ_E used in Equation (2-2). These estimates, and estimates of the vertical gradient of potential temperature $\partial\Theta/\partial z$ given in Table 3-7, were specified from a knowledge of turbulence and temperature-profile measurements made under terrain and meteorological conditions similar to those found near the Centralia Plant.

Mean seasonal temperatures for use in the concentration and plume rise calculations given in Table 3-8 were obtained by averaging the mean daily temperatures for monthly periods given in the Climatic Atlas of the United States (ESSA, 1968) for Portland, Oregon.

3.2 SOURCE INPUT PARAMETERS

The source input parameters required by the concentration and plume rise models described in Section 2 are listed in Table 3-9. The scaling coefficient K

TABLE 3-5

VALUES OF SURFACE MIXING LAYER DEPTH H_m IN METERS

Time of Day	Season			
	Winter	Spring	Summer	Fall
Night	400	600	150	200
Morning	425	975	875	550
Afternoon	450	1350	1600	900
Evening	425	975	875	550

TABLE 3-6

VALUES OF THE STANDARD DEVIATION OF WIND ELEVATION ANGLE σ_E IN DEGREES

Time of Day	Wind Speed Category (mph)	Season			
		Winter	Spring	Summer	Fall
Night	0-3	1.0	1.0	1.0	1.0
	4-15	2.0	2.0	2.0	2.0
	16-31	2.5	2.5	2.5	2.5
Morning	0-3	1.5	1.5	1.5	1.5
	4-15	3.0	3.0	3.0	3.0
	16-31	3.5	3.5	3.5	3.5
Afternoon	0-3	5.0	7.5	10.0	7.5
	4-15	5.0	5.0	7.5	5.0
	16-31	5.0	5.0	5.0	5.0
Evening	0-3	3.0	3.0	5.0	3.0
	4-15	2.5	3.0	5.0	3.0
	16-31	2.5	3.0	5.0	3.0

TABLE 3-7

POTENTIAL TEMPERATURE LAPSE RATES $\partial\Theta/\partial z$ IN DEGREES ABSOLUTE PER METER IN THE BUOYANT PLUME RISE

Time of Day	Wind Speed Category (mph)	Season			
		Winter	Spring	Summer	Fall
Night	0-3	.010	.005	.030	.030
	4-15	.005	.004	.020	.020
	16-31	.005	.003	.010	.010
Morning	0-3	.005	.003	.003	.005
	4-15	.004	.003	.003	.004
	16-31	.003	.003	.003	.003
Afternoon	0-3	.001	.001	.001	.001
	4-15	.002	.002	.002	.002
	16-31	.003	.003	.003	.003
Evening	0-3	.005	.003	.003	.005
	4-15	.004	.003	.003	.004
	16-31	.003	.003	.003	.003

TABLE 3-8

MEAN SEASONAL AMBIENT AIR TEMPERATURE T
IN ABSOLUTE DEGREES

Season			
Winter	Spring	Summer	Fall
277.4	284.1	291.3	285.2

TABLE 3-9

SOURCE MODEL INPUTS

Parameter	Definition
Q	Pollutant emission rate
h	Stack height
r	Stack radius
w	Stack exit velocity
T_s	Stack exit temperature
γ	Entrainment parameter
K	Scaling coefficient

shown in the table, although not strictly a source parameter, is used to convert input parameters into dimensionally consistent units. In these calculations, the desired units are parts per billion SO_2. Thus, when Q is in units of tons SO_2 per hour, x is in meters, $\bar{u}$ is in miles per hour, and T is in degrees Absolute, K is given by

$$K = 7.22767 \times 10^5$$

Values of the source inputs for stack height h, stack radius r, stack exit velocity w, and stack exit temperature T_s, used in the calculations of plume rise, are given in Table 3-10. These data were supplied by the State of Oregon Department of Environmental Quality and are for the first unit of the Centralia Plant. The entrainment parameter γ in Table 3-10 is a measure of the rate ambient air is entrained in the plume as the plume rises to the effective height H given by Equation (2-5). In the calculations, γ was set equal to 0.5 in all cases as recommended by Briggs (1970, p. 8).

TABLE 3-10

SOURCE INPUT PARAMETERS

Q	=	6.5 tons SO_2 per hour
h	=	143.3 meters
r	=	1.68 meters
w	=	27.4 meters per second
T_S	=	416.3 degrees absolute
γ	=	0.5
K	=	7.228×10^5

SECTION 4
CALCULATION PROCEDURES

The meteorological and source inputs described above were combined in a computer program with the diffusion model equations given in Section 2. The program was run on the UNIVAC 1108 System at the University of Utah Computer Center to generate seasonal and annual SO_2 concentration patterns for an area within a 175-kilometer radius of the Centralia Plant. The basic structure and operation of the program closely follows the description of automated procedures for calculating annual and seasonal concentration patterns given by Cramer and Dumbauld (1969).

The operation of the computer program is indicated schematically in Figure 4-1. The calculation of the modified wind-frequency distribution and specification of meteorological and source parameters is described in detail in Section 3 above. These data were punched on cards for input to the computer program. The reference grid system consisted of points along 23 radial arcs at intervals of 5.625 degrees, yielding a total of 1,472 grid points.

The computer program accepts the three decks of punched card information and calculates the effective cloud height and the average seasonal and annual concentrations at the grid coordinates, using the model formulas described in Section 2. The program generates a listed output of the concentrations and a magnetic tape used by the Gerber 622 drafting system at the University of Utah for the automatic plotting of specified concentration isopleths. This activity resulted in four seasonal and one annual plot of average SO_2 concentration isopleths.

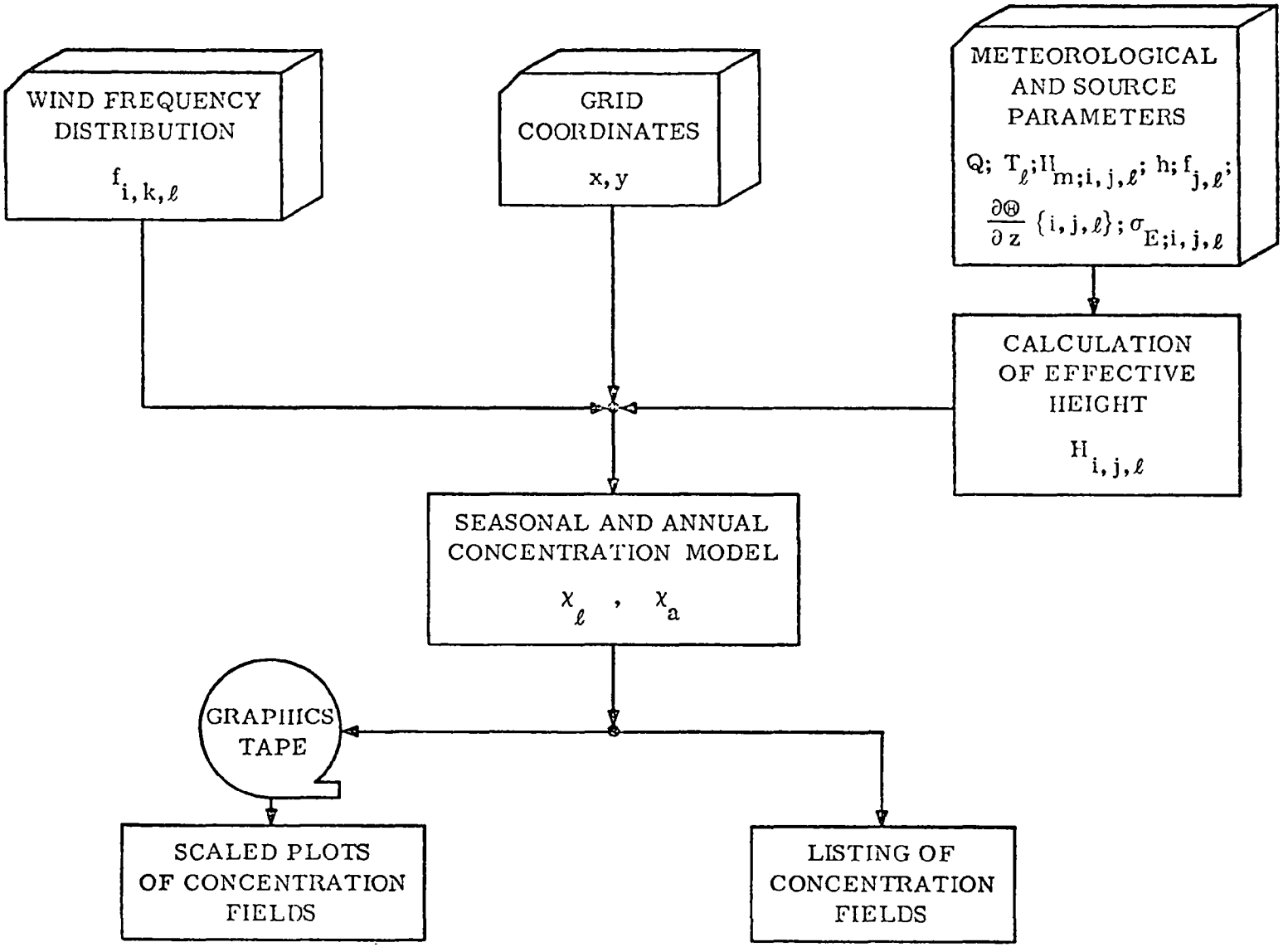

FIGURE 4-1. Schematic diagram showing procedures used in the calculation of seasonal and annual concentration fields.

SECTION 5

RESULTS OF THE CONCENTRATION CALCULATIONS

Maps of annual and seasonal SO_2 concentration isopleths are shown in Figures 5-1 through 5-5. The general form of the concentration-isopleth patterns closely resembles the form of the wind frequency distribution used in the calculations (see Table 3-3). As noted in Section 1, these preliminary estimates of the impact of emissions from the first unit at the Centralia Plant were made without modification of the wind frequency distribution for possible terrain effects. The Chehalis wind distribution does, however, reflect the blocking effect of the Cascade Range on the transport of SO_2 toward the east.

The blocking effect of the Cascade Range is evident from inspection of the average annual SO_2 isopleth patterns shown in Figure 5-1. In the figure, the major axis of the isopleth patterns is oriented north-south in agreement with the expected flow patterns for the area. Figure 5-1 shows concentrations of 0.3 to 0.5 parts per billion in the Portland, Oregon area resulting from operations of the first unit of the Centralia Plant. These levels are not very dependent on the shape of the isopleth pattern in the area between Kelso and Portland.

Figure 5-1 also shows areas of high concentration northwest and northeast of the Centralia Plant. Inspection of wind direction frequency distributions for the Tacoma and Seattle areas indicate that prevailing low-level wind flow in the Puget Sound area is north-south. For this reason, the isopleth patterns indicated in Figure 5-1 over the Olympic Peninsula should probably be shifted toward the north and east. Annual average SO_2 concentrations in the Seattle area due to operations of the first unit of the Centralia Plant are estimated to be from 0.3 to 0.8 parts per billion.

Figures 5-2 through 5-5 show average seasonal SO_2 concentrations. Concentration levels in the Portland area attributable to operations at the Centralia

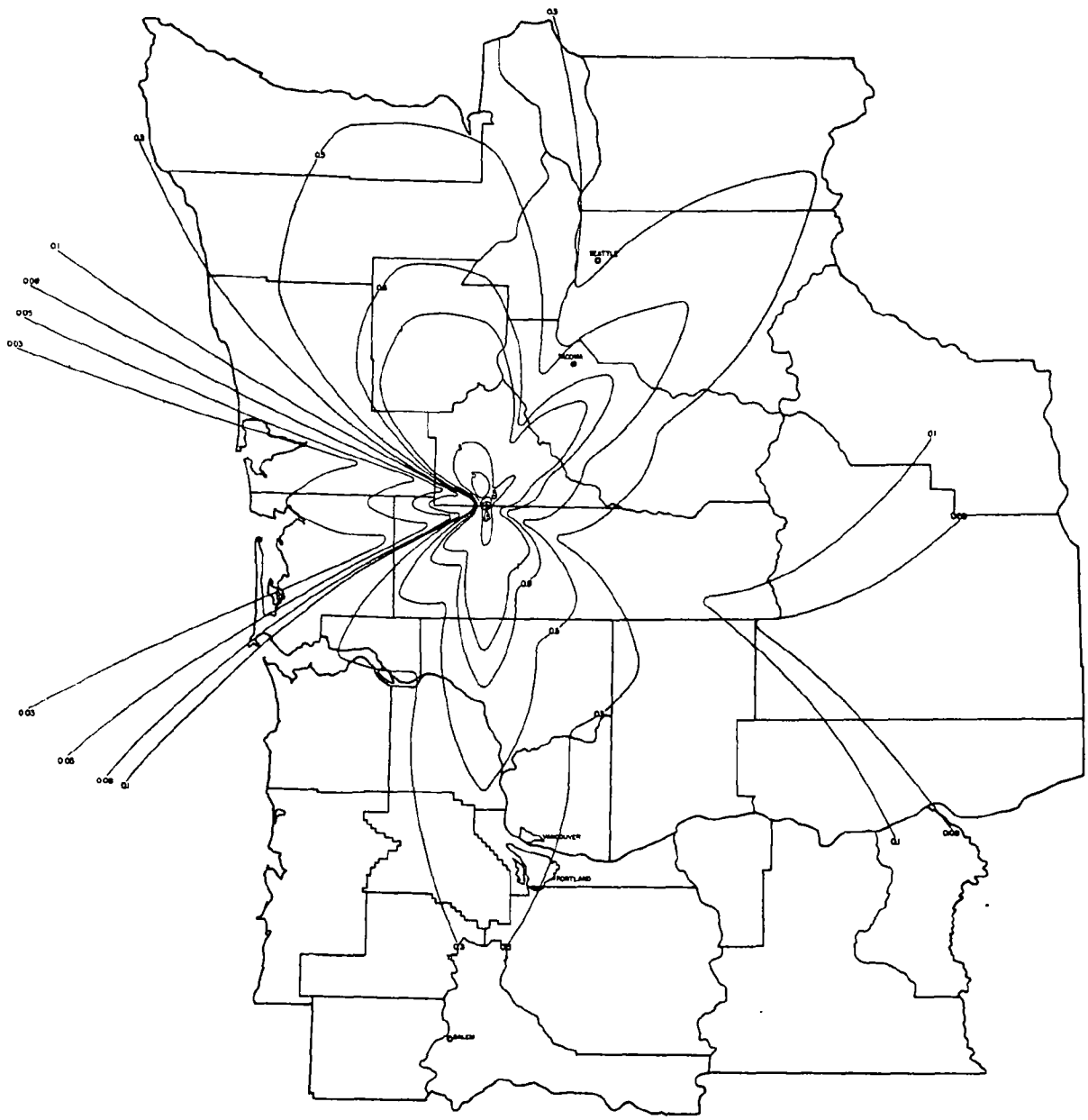

FIGURE 5-1. Average annual SO_2 concentration isopleths in parts per billion attributable to operations of a single unit of the Centralia Plant of the Pacific Power and Light Company.

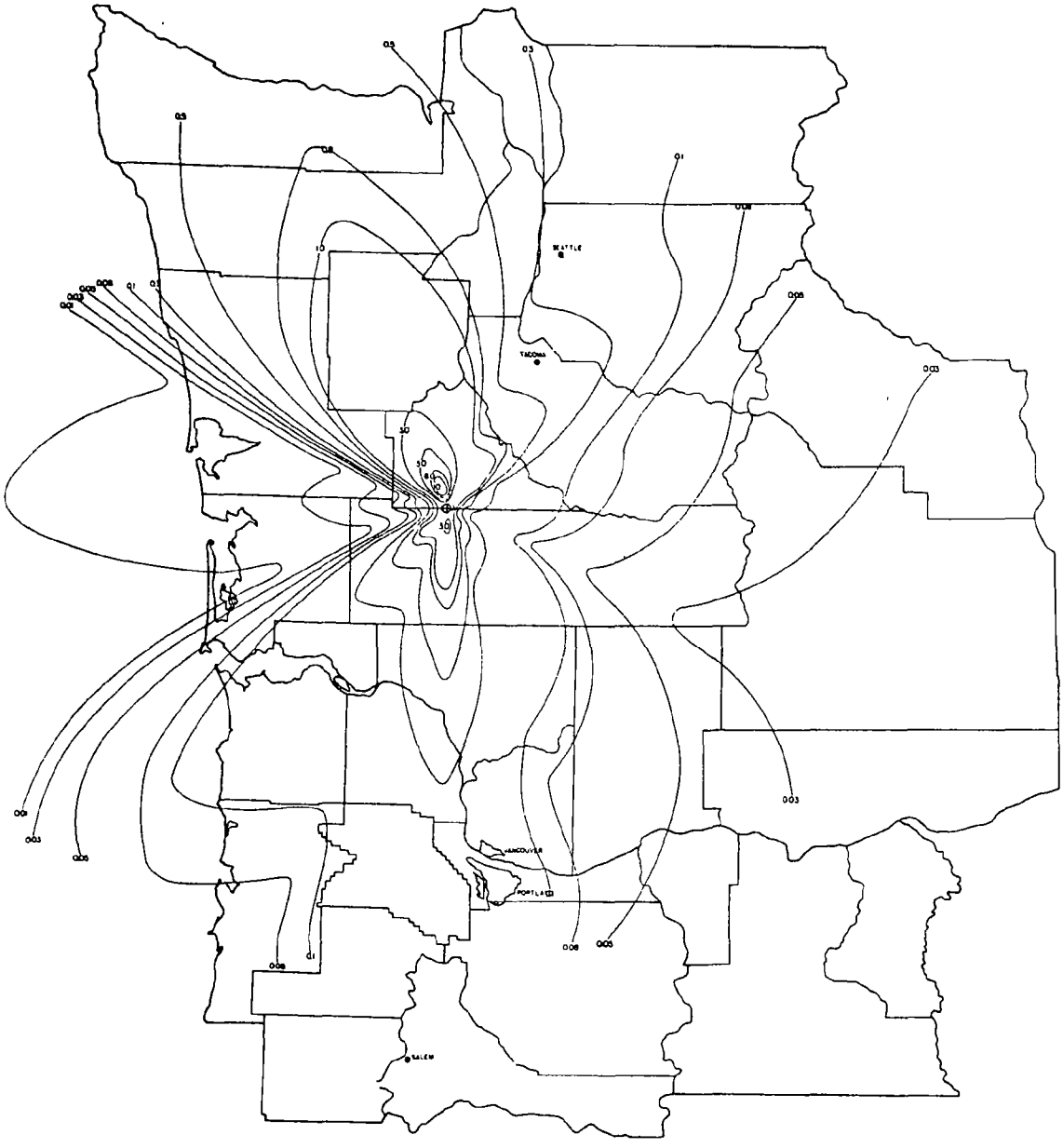

FIGURE 5-2. Average winter season SO_2 concentration isopleths in parts per billion attributable to operations of a single unit of the Centralia Plant of the Pacific Power and Light Company.

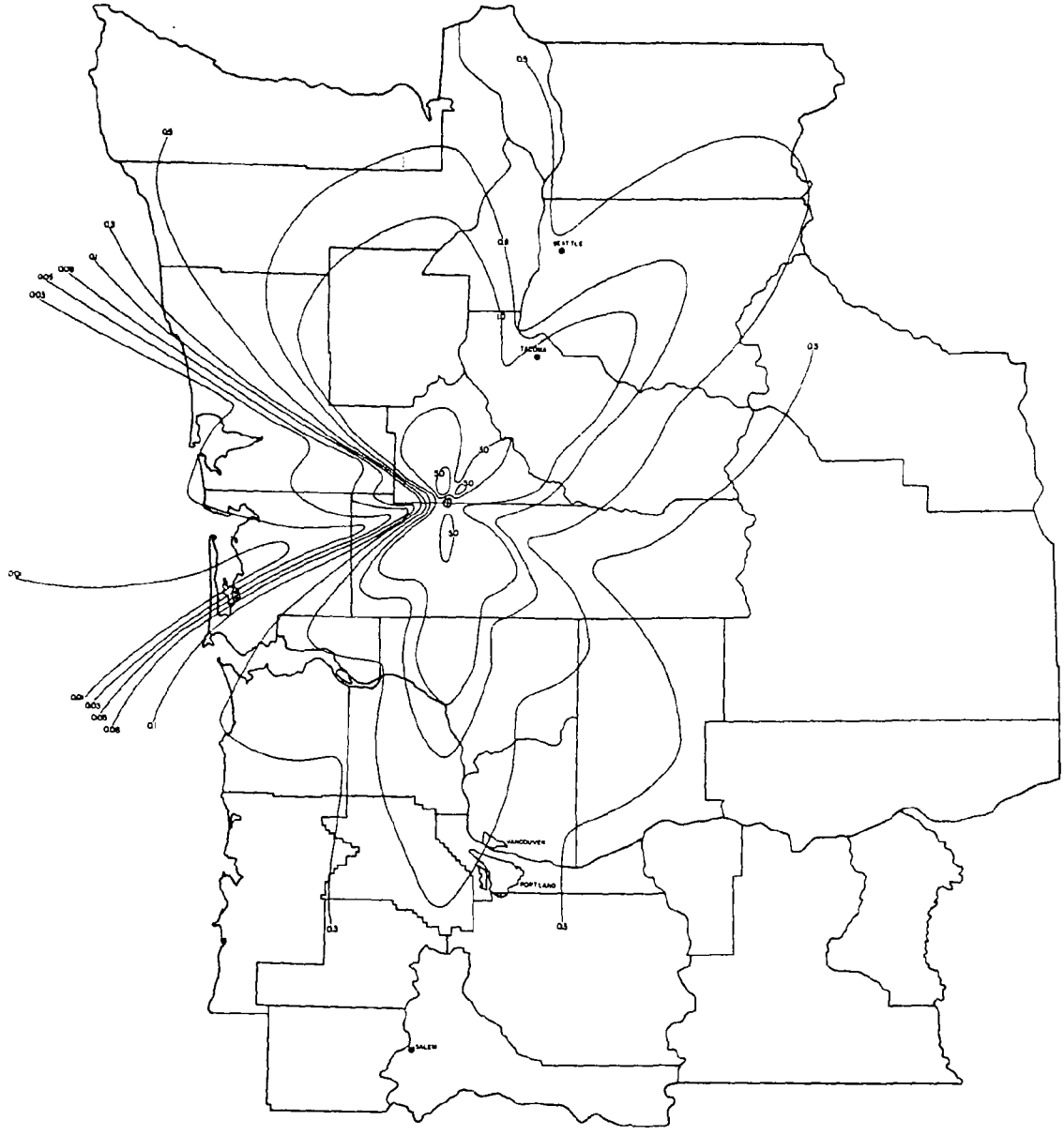

FIGURE 5-3. Average spring season SO_2 concentration isopleths in parts per billion attributable to operations of a single unit of the Centralia Plant of the Pacific Power and Light Company.

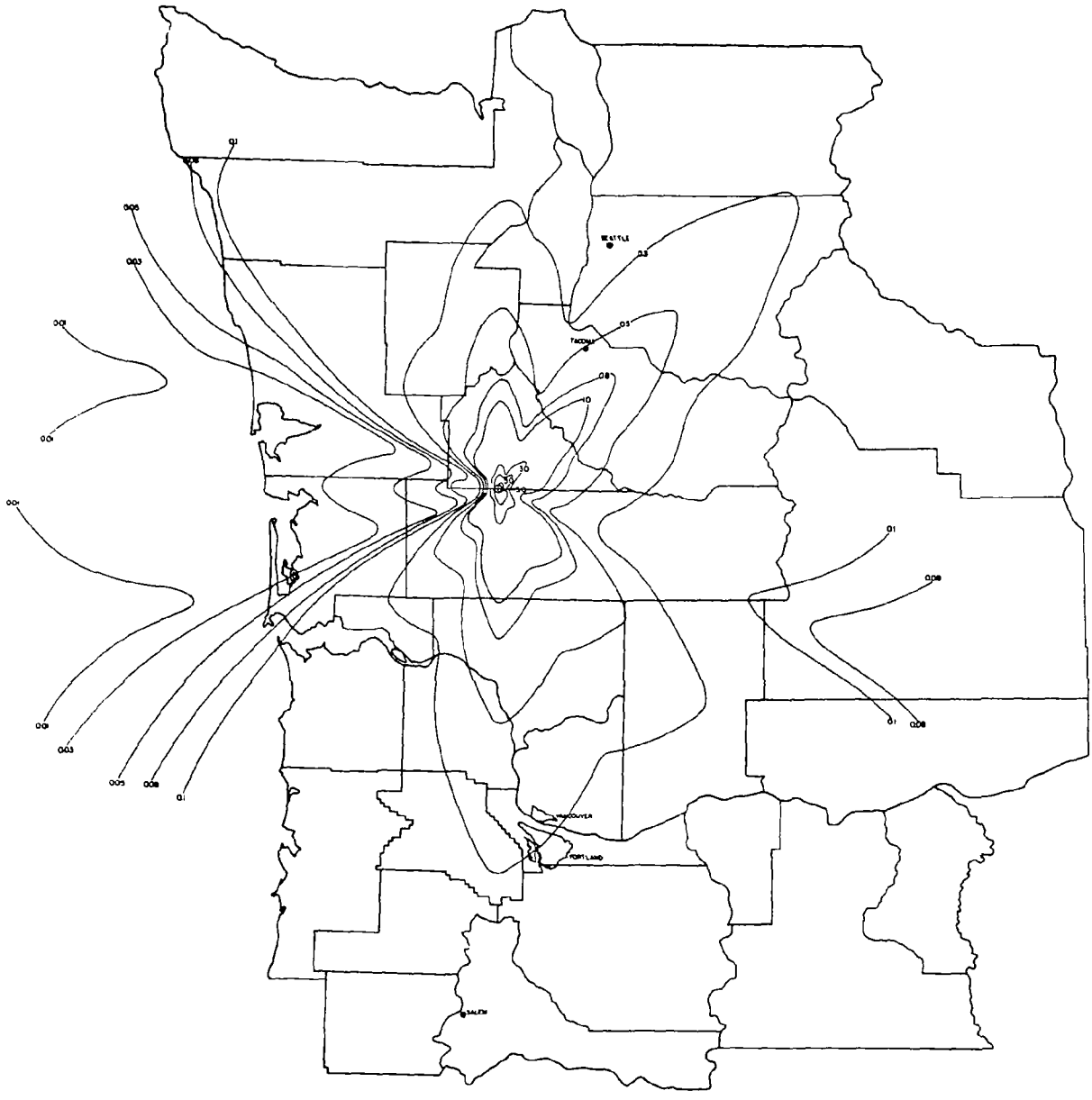

FIGURE 5-4. Average summer season SO_2 concentration isopleths in parts per billion attributable to operations of a single unit of the Centralia Plant of the Pacific Power and Light Company.

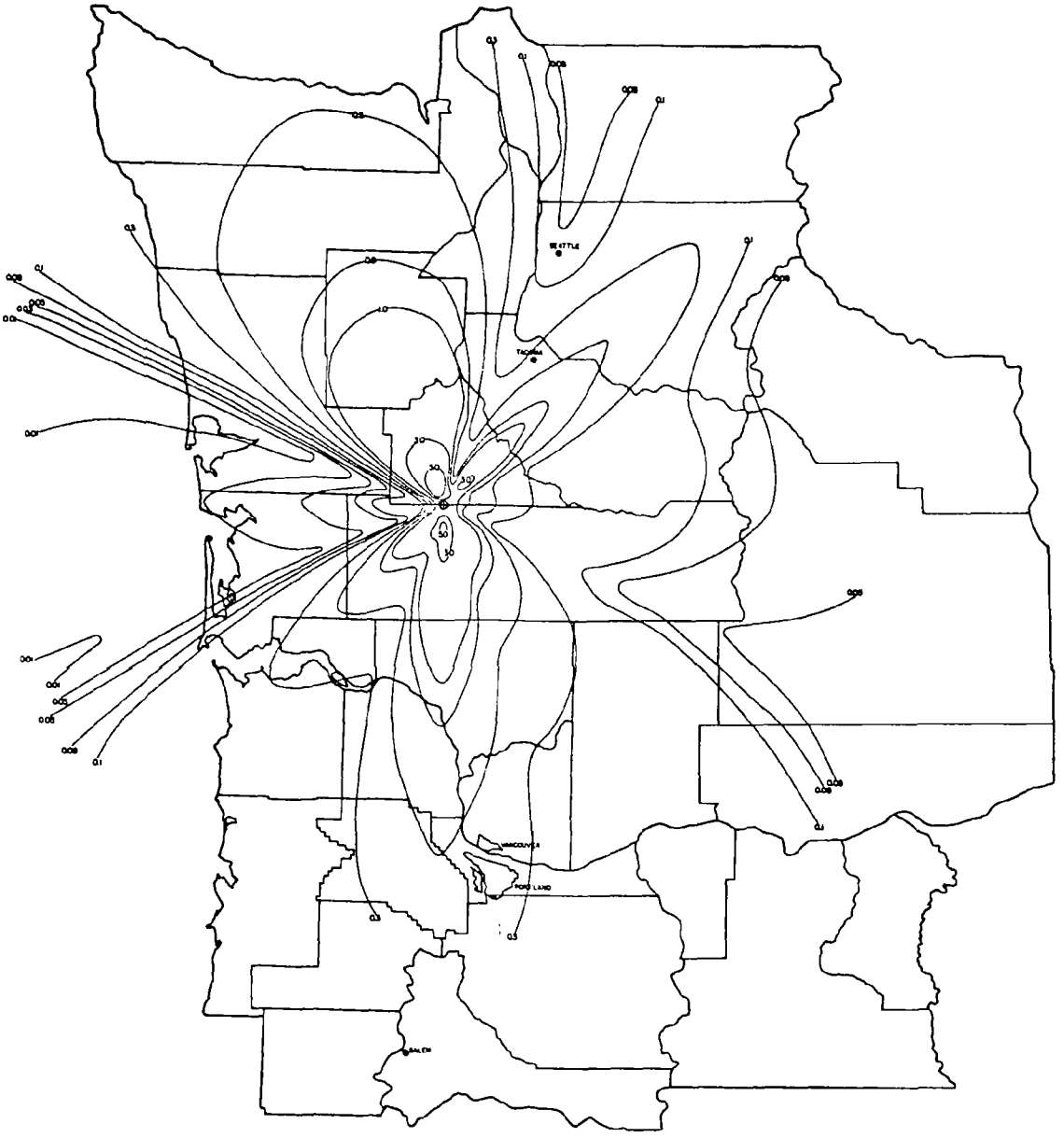

FIGURE 5-5. Average fall season SO_2 concentration isopleths in parts per billion attributable to operations of a single unit of the Centralia Plant of the Pacific Power and Light Company.

Plant are higher during the spring season than any other period of the year. Figure 5-3 shows that average SO_2 concentrations in the Portland area in spring are about 0.5 parts per billion. Average SO_2 concentrations for the fall season in the Portland area are about 0.3 to 0.5 parts per billion. The concentration level in the Portland area due to the Centralia Plant is about 0.1 parts per billion in winter.

Average seasonal SO_2 concentrations in the Puget Sound area due to Centralia Plant operations are also highest during the spring season, averaging about 1 part per billion in the vicinity of Tacoma and about 0.8 parts per billion in the Seattle area. Predicted SO_2 concentrations in the Puget Sound area during the winter, summer, and fall seasons are about 0.5 parts per billion in the vicinity of Tacoma and 0.3 parts per billion in the Seattle area.

When the second unit goes into operation at the Centralia Plant, the estimates of annual and seasonal concentrations given above should be doubled. Assuming the source information used in the calculations to be approximately correct, we feel that the predicted annual and seasonal SO_2 concentrations are certainly of the correct order of magnitude. Because no allowance was made for losses of SO_2 by decay or other processes, the estimates are probably too high. This positive bias in the estimates is possibly offset by uncertainties in the meteorological inputs used in the calculations.

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APPENDIX D

COMPARISON OF THE URBAN DIFFUSION MODEL IN APPENDIX A OF THE 7 APRIL 1971 FEDERAL REGISTER WITH THE HOLZWORTH (1971) MODEL

SECTION 1
INTRODUCTION

Two atmospheric diffusion models, each intended for use in obtaining gross estimates of average annual pollutant concentration levels for large urban areas, have appeared in recent EPA literature. One of these models is briefly described on page 6686 in Appendix A of the 7 April 1971 Federal Register. This model, which we will identify as the Federal Register model, is based on previous work by Miller and Holzworth (1967) and by Fensterstock, et al. (1969). The second urban model is described by Holzworth (1971) in a Preliminary EPA Document. Although both of these models yield estimates of normalized concentration for various city sizes and both are associated, at least in part, with Holzworth, there are important differences in the methods used to calculate pollutant concentrations. Also, the description of the Federal Register model given in the 7 April 1971 edition does not give any of the details of the construction of the model. The purpose of this note is to describe each of the two models in detail, to point out the limitations of each model, and to compare the estimates of air quality obtained from both models for similar inputs.

SECTION 2

DESCRIPTION OF THE FEDERAL REGISTER MODEL

The simple urban diffusion model described in Appendix A of the 7 April 1971 Federal Register is based on the following assumptions with respect to source and meteorological inputs:

- Emissions of pollutants occur from continuous ground-level sources which are uniformly distributed over the entire urban area; a single average annual emission rate in grams per second per square meter is calculated for the entire urban area
- The urban area is square in shape and the mean wind is always directed parallel to a side of the urban area
- Meteorological input data are limited to the mean annual wind speeds in the surface mixing layers as calculated by the National Climatic Center in Asheville, North Carolina
- Neutral stability (Pasquill D Category) prevails throughout the year
- Lateral diffusion, mixing depths and topographical factors can be neglected

The starting point for the Federal Register model is the integral form of the concentration equation for an infinite crosswind line source located at ground level given by

$$\frac{\chi_c \bar{u}}{\bar{Q}} = \int_0^{x_c} \frac{2}{\sqrt{2\pi}\ \sigma_z}\ dx \qquad (2\text{-}1)$$

where

χ_c = concentration at the center of the urban area

$\bar{Q}$ = mean annual emission rate (g m^{-2} sec^{-1})

$\bar{u}$ = annual m an wind speed (m sec^{-1}) in the surface mixing layer

x_c = distance (m) from the upwind side of the urban area to the center of the urban area

σ_z = standard deviation (m) of the concentration distribution along the vertical, assumed to be Gaussian

For the Pasquill D Stability Category assumed to prevail throughout the year, σ_z is defined by the power-law expression

$$\sigma_z = a\, x_c^{\,b} \qquad (2\text{-}2)$$

where the constants a and b were determined over five consecutive ranges of x_c by fitting Equation (2-2) to Turner's (1969, Figure 3-3) curve for the Pasquill D Stability Category. When Equation (2-2) with the five sets of constants is substituted for σ_z in Equation (2-1) and the integration is performed, the resulting set of normalized concentration expressions is

$$\frac{\chi_c \bar{u}}{\bar{Q}} = \begin{cases} -98.528 + 62.432\, x_c^{\,0.142} & ;\ 100 < x_c \leq 500 \text{ m} \\ -40.854 + 22.046\, x_c^{\,0.232} & ;\ 500 < x_c \leq 1000 \text{ m} \\ +0.942 + 5.327\, x_c^{\,0.368} & ;\ 1000 < x_c \leq 10{,}000 \text{ m} \\ +23.045 + 2.541\, x_c^{\,0.432} & ;\ 10{,}000 < x_c \leq 30{,}000 \text{ m} \\ +57.796 + 0.966\, x_c^{\,0.509} & ;\ 30{,}000 < x_c \leq 100{,}000 \text{ m} \end{cases} \qquad (2\text{-}3)$$

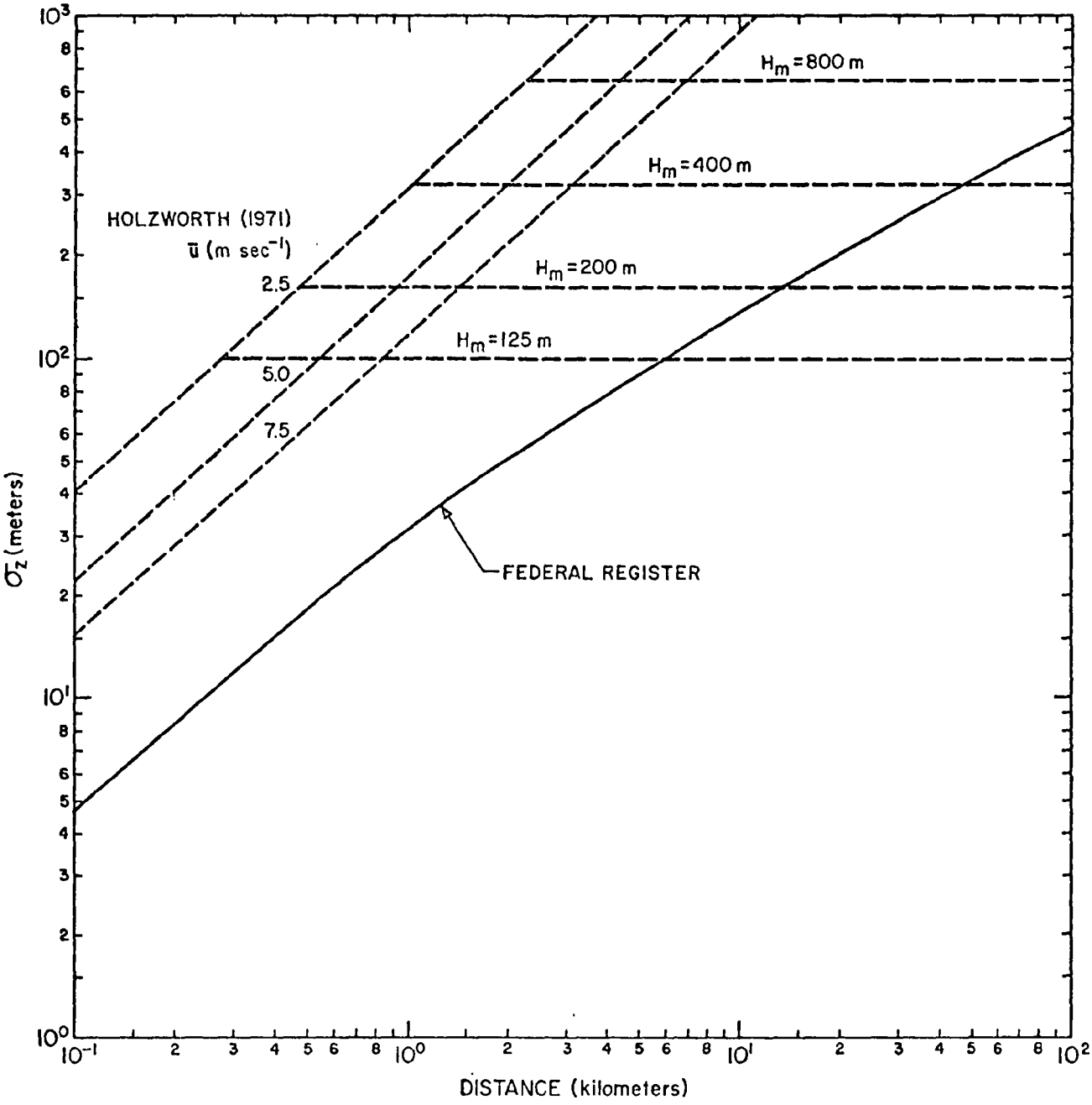

FIGURE 2-1. Federal Register model curve for σ_z (solid line) and Holzworth (1971) σ_z curves (dashed lines) for selected wind speeds and mixing depths.

The solid line in Figure 2-2 is a plot of Equation (2-3) against city size x_c which corresponds to the normalized concentration curve reproduced in Figure 1 on page 6686 of the 7 April 1971 Federal Register.

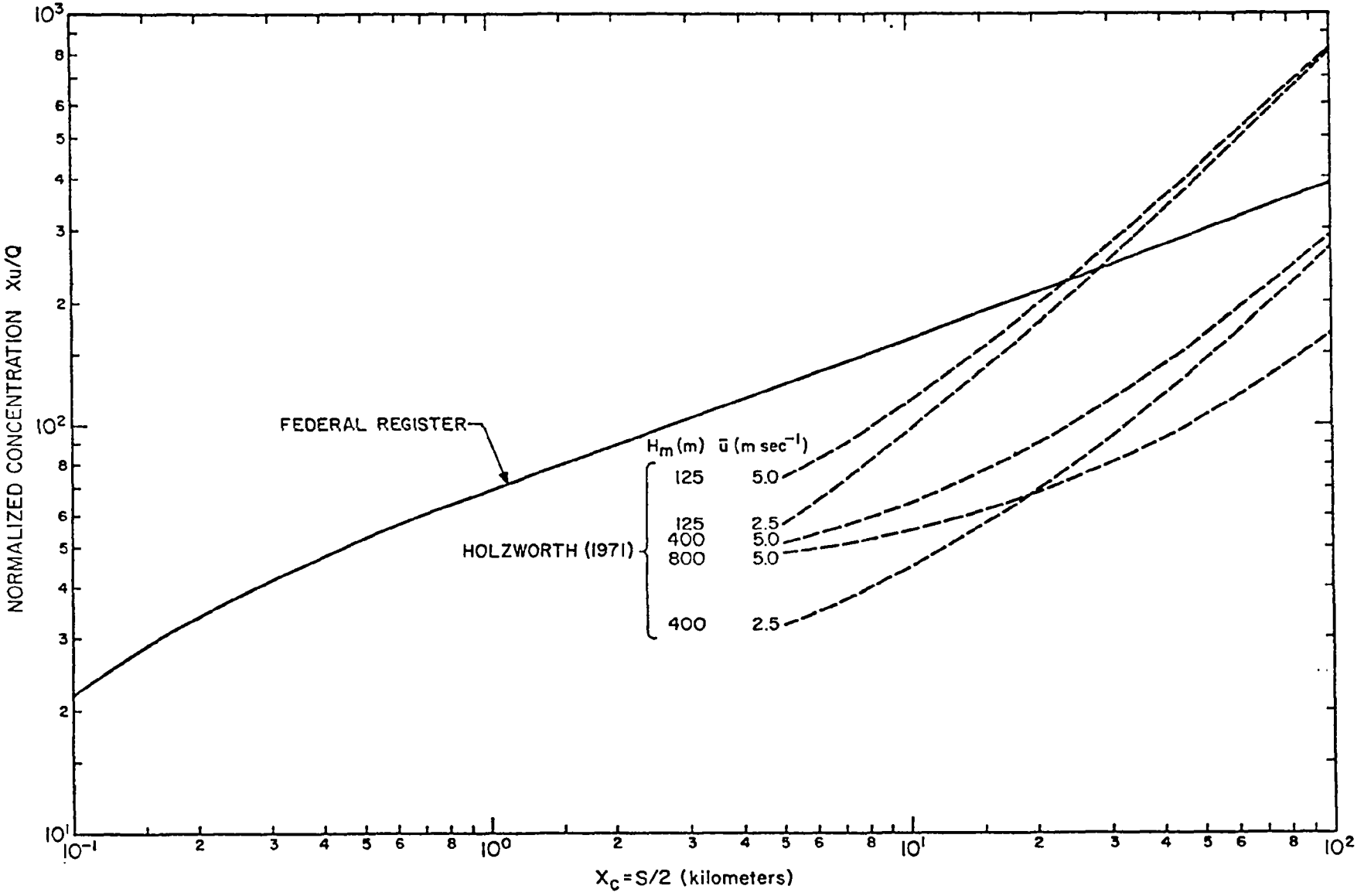

FIGURE 2-2. Normalized concentration versus city size.

SECTION 3

THE HOLZWORTH (1971) URBAN MODEL

The urban model described by Holzworth (1971) is based on the same assumption as the Federal Register model with respect to the uniform distribution of ground-level pollutant sources over an entire urban area and uses the same source term $\bar{Q}$ for the average annual emission rate. Although Holzworth does not explicitly specify the shape of the urban area, a square shape is implied by the use of the distance S across the urban area as the index of city size. Holzworth also states that the model is more appropriate for larger cities where $S \geq 10$ kilometers. Lateral diffusion is neglected as in the Federal Register model. Unlike the Federal Register model, however, vertical diffusion in the Holzworth model occurs in unstable rather than neutral stability conditions and the vertical concentration distribution is Gaussian only out to a defined travel time which is a function of the mixing depth; for longer travel times, vertical dispersion is restricted to the surface mixing layer and the vertical distribution of pollutants is uniform.

The starting point for the Holzworth model is a modified integral form of the infinite crosswind line source formula given by Equation (2-1), the starting point for the Federal Register model,

$$\chi/\bar{Q} = \int_0^t \frac{2}{\sqrt{2\pi}\,\sigma_z\{\tau\}}\, d\tau \qquad (3\text{-}1)$$

where the integration is over the travel time t instead of the travel distance from the upwind edge of the city. The expression for σ_z as a function of time τ required for Equation (3-1) was obtained by converting the average of Singer and Smith's (1966) curves of $\sigma_z\{x\}$ for Brookhaven gustiness classes B_2 and B_1 (very unstable and unstable stability conditions) to $\sigma_z\{\tau\}$, using an average of the mean wind speeds for these classes. The resulting expression obtained by Holzworth is

$$\sigma_z\{\tau\} = 1.558\,\tau^{0.885} \tag{3-2}$$

For purposes of comparing the above expression for σ_z with the σ_z curve of the Federal Register model, Equation (3-2) has been plotted in Figure 2-1 versus distance for mean wind speeds of 2.5, 5, and 7.5 meters per second.

Equation (3-2) is valid for travel times $t \leq t_{H_m}$ where

$$t_{H_m} = 0.471\,H_m^{1.130} \tag{3-3}$$

When $t = t_{H_m}$, the ground-level concentration, assuming a Gaussian vertical distribution, is equal to the ground-level concentration resulting from a uniform vertical distribution within the surface mixing layer H_m. For $t \geq t_{H_m}$, the expression for $\sigma_z\{\tau\}$ is

$$\sigma_z\{\tau\} = \frac{2H_m}{\sqrt{2\pi}} \approx 0.8\,H_m \tag{3-4}$$

The effects of Equation (3-4) on vertical expansion are indicated by the dashed horizontal lines in Figure 2-1.

The highest pollutant concentration will occur at the downwind edge of the city or urban area or for a travel time $t = S/\bar{u} = T$, where S is the alongwind length of the urban area. To obtain the average concentration $\bar{\chi}$ over the entire urban area, Equation (3-1) is integrated again with respect to T. In brief,

$$\frac{\bar{\chi}}{Q} = \frac{1}{T}\int_0^T\int_0^t \frac{2}{\sqrt{2\pi}\,\sigma_z\{\tau\}}\,d\tau\,dt \tag{3-5}$$

using Equations (3-2) and (3-4) to define $\sigma_z\{\tau\}$. Holzworth thus obtains the following set of equations for the normalized city-wide average pollutant concentration:

$$\frac{\bar{\chi}}{\bar{Q}} = \left\{ \begin{array}{ll} 3.994\ T^{0.115} & ;\quad T \leq t_{H_m} \\ \frac{1}{T}\ 3.994\ t_{H_m}^{1.115} + 4.453\ t_{H_m}^{0.115}\left(T - t_{H_m}\right) & \\ \quad + \dfrac{\left(T - t_{H_m}\right)^2}{2H_m} & ;\quad T \geq t_{H_m} \end{array} \right\} \qquad (3\text{-}6)$$

Holzworth has used Equation (3-6) to generate values of $\bar{\chi}/\bar{Q}$ for S = 10 and 100 kilometers and for various combinations of H_m and $\bar{u}$ at locations for which the National Climatic Center has prepared tabulations of mixing depth and wind speed.

For purposes of comparing Holzworth's model with the Federal Register model, Equation (3-6) has been multiplied by the mean wind speed and the results plotted as dashed lines in Figure (2-2) for selected values of the mixing depth and the mean wind speed.

SECTION 4
DISCUSSION

The principal differences between the Federal Register model and the Holzworth (1971) urban model are:

- The Federal Register model yields the pollutant concentration at the center of the urban area, whereas the Holzworth model calculates the average concentration over the entire urban area

- The Federal Register model uses a $\sigma_z\{x\}$ curve fitted to Turner's $\sigma_z\{x\}$ curve for Pasquill Type D neutral stability conditions; Holzworth uses a $\sigma_z\{\tau\}$ curve obtained by converting Singer and Smith's $\sigma_z\{x\}$ curves for very unstable and unstable (Brookhaven B_2 and B_1 gustiness classes) and by limiting the vertical dispersal of pollutants to the surface mixing layer

Both models should probably be used only for urban areas that are of the order of 10 to 100 kilometers in length. With this restriction in mind, the curves shown in Figure 3-2 may be summarized as follows:

- Normalized concentrations obtained from the Federal Register model will generally be two to three times larger than the corresponding concentrations calculated by the Holzworth model

- For low wind speeds and large mixing depths, the Holzworth model concentrations may be one order of

magnitude smaller than those given by the Federal Register model; there is a serious question as to the validity of the Holzworth $\sigma_z\{\tau\}$ transformation at wind speeds less than about 2.5 meters per second

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APPENDIX E

CUMULATIVE FREQUENCY DISTRIBUTIONS OF MORNING AND AFTERNOON MIXING LAYER DEPTHS, BY SEASON, FOR MEDFORD, SALEM, AND BOISE

This appendix contains cumulative seasonal frequency distributions of morning and afternoon mixing layer depths for Medford, Salem and Boise. In addition, median morning mixing layer depths at Salem during each season of the year are shown as a function of surface wind speed. These figures were constructed from tabulations prepared by the National Climatic Center (NWRC Tabulation I, Job 6234, 1968).

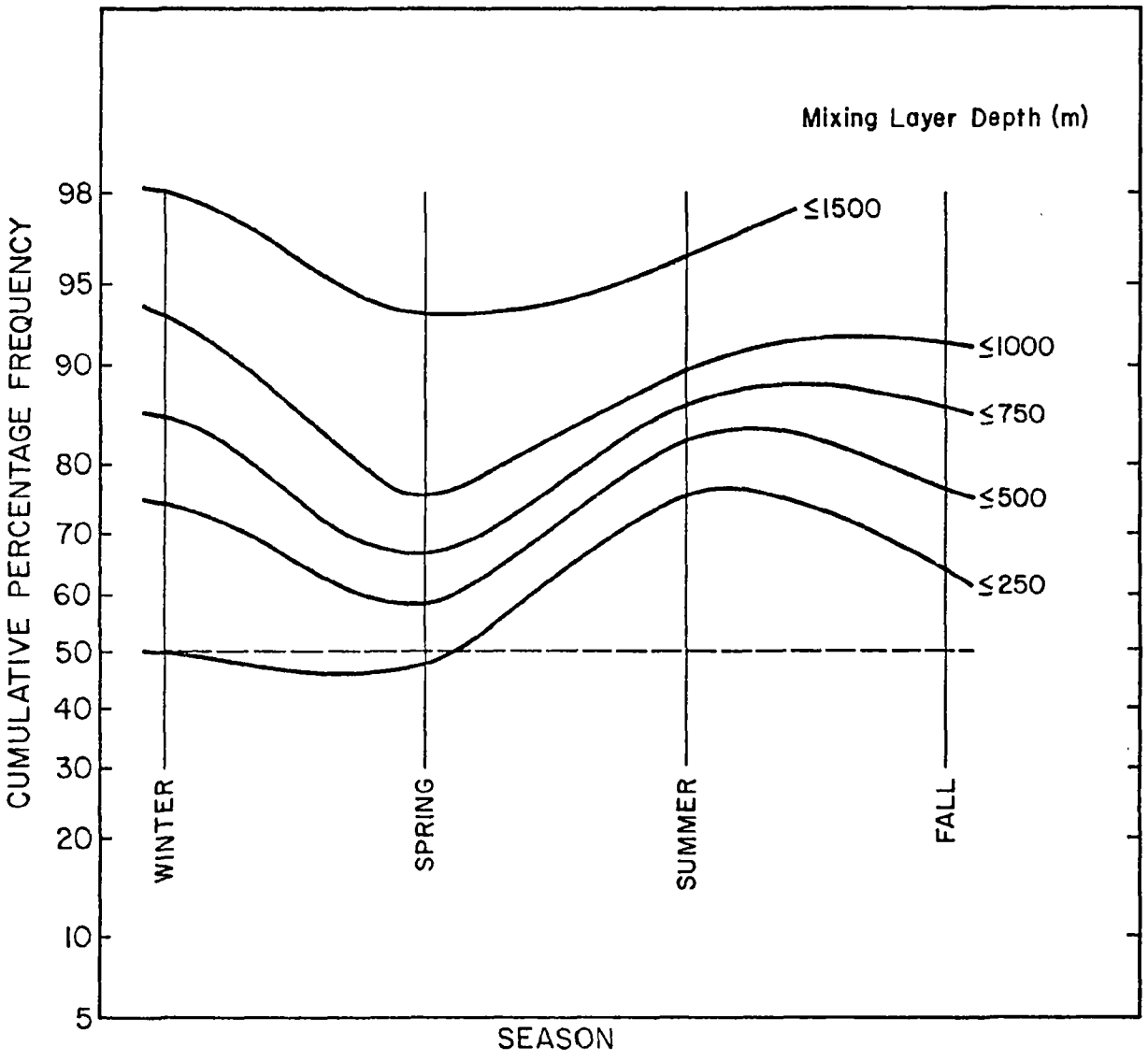

FIGURE 1. Early morning mixing layer depths by season at Medford, Oregon.

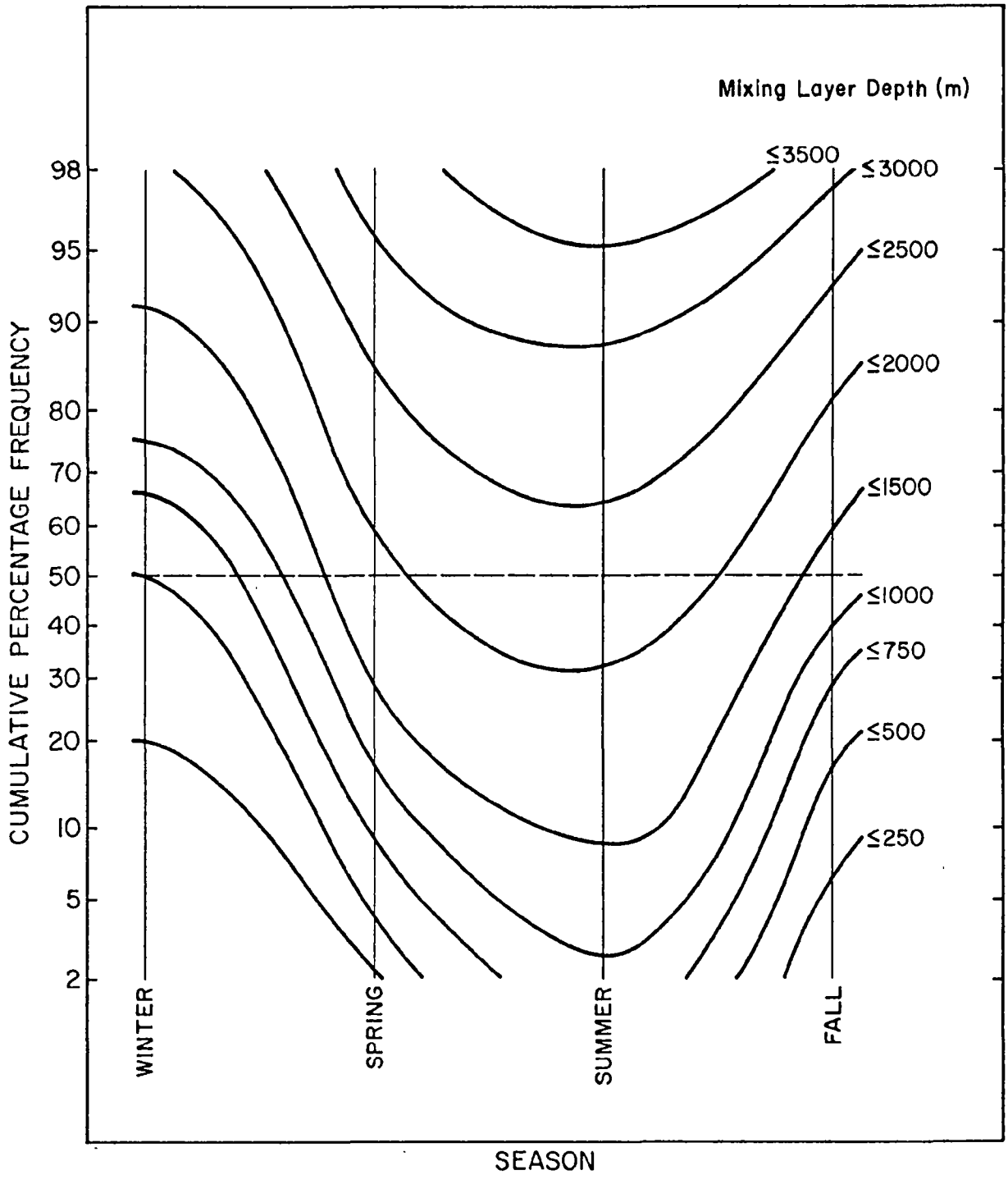

FIGURE 2. Afternoon mixing layer depths by season at Medford, Oregon.

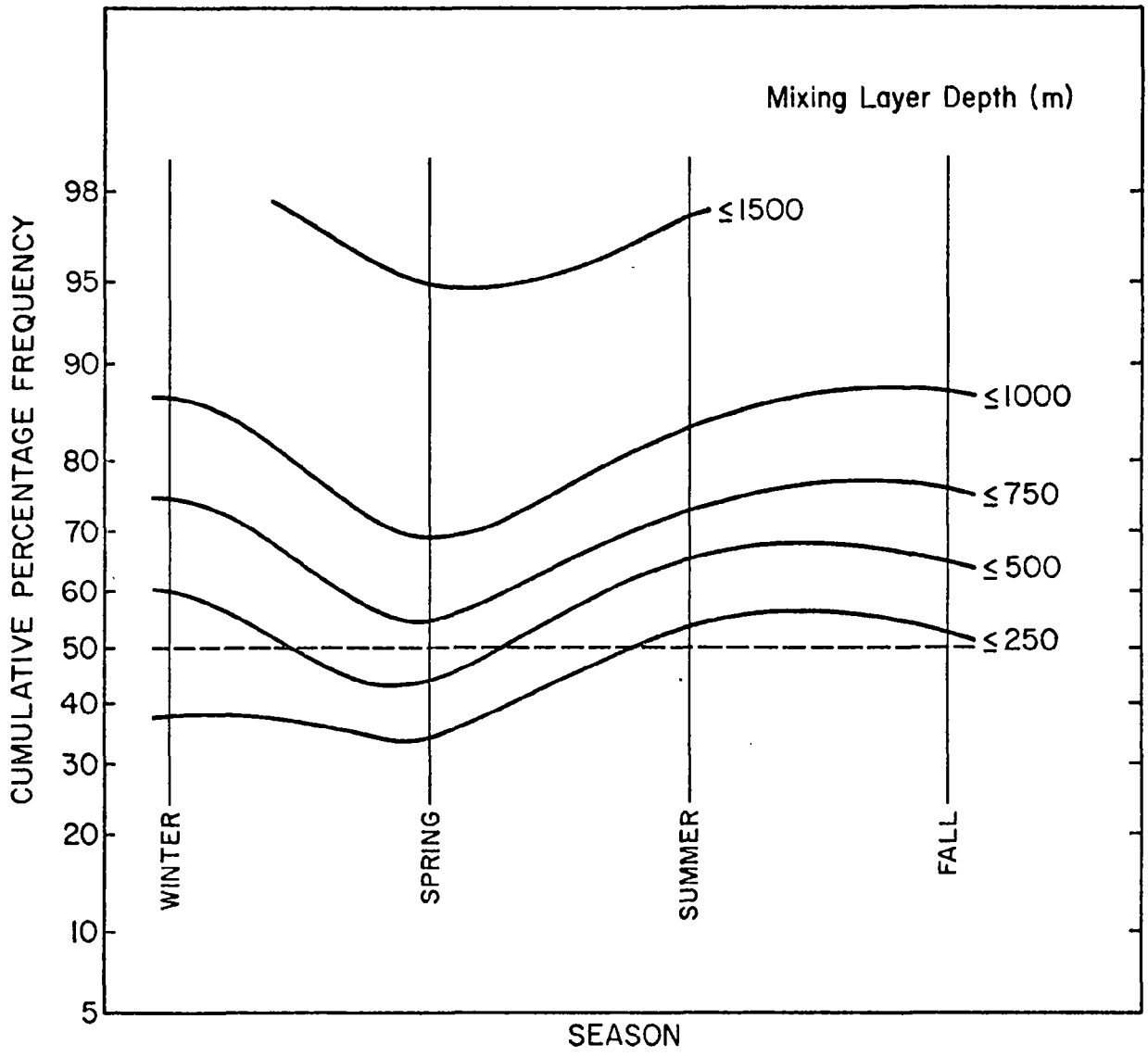

FIGURE 3. Early morning mixing layer depths by season at Salem, Oregon.

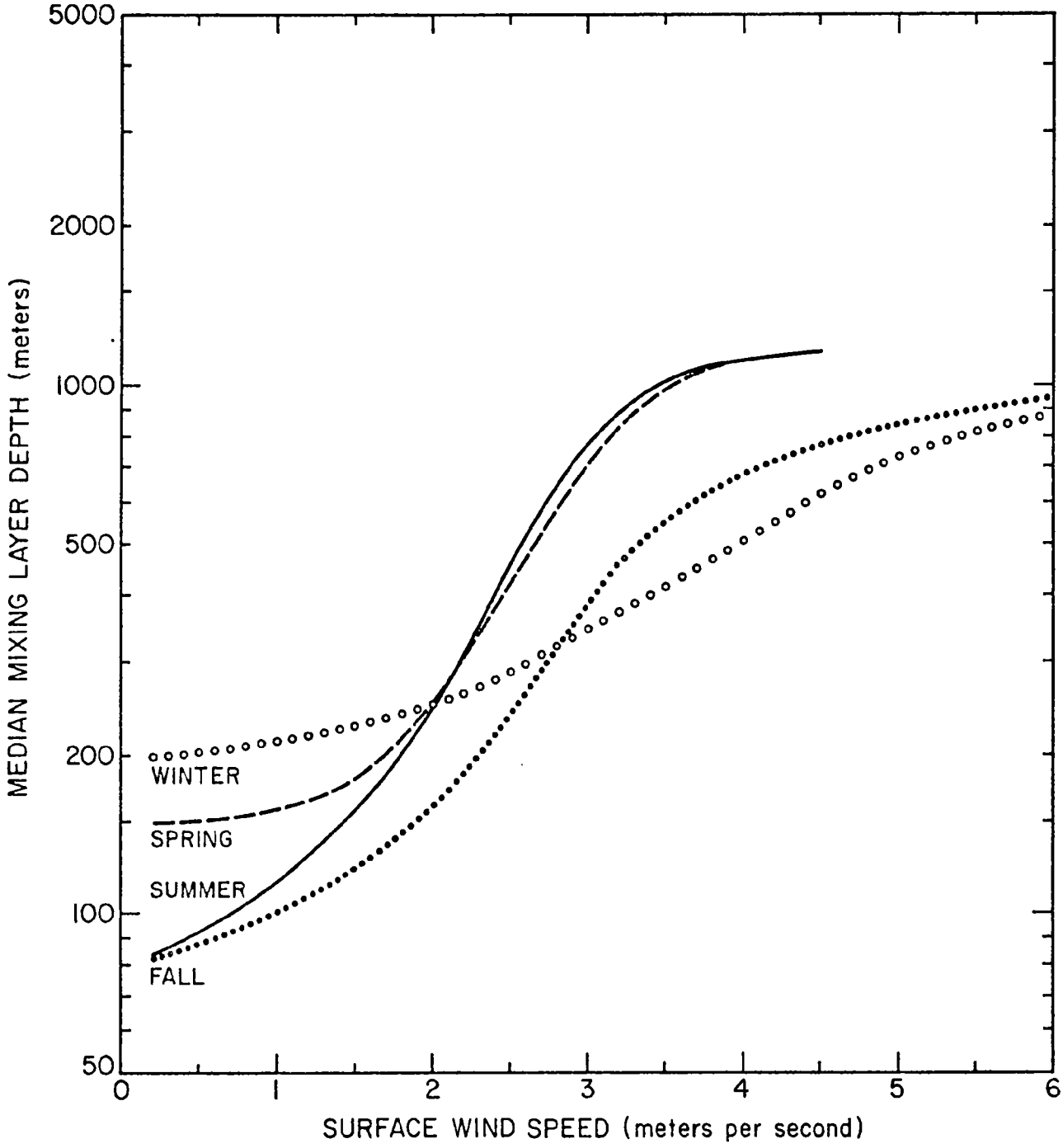

FIGURE 4. Early morning mixing layer depths by season at Salem, Oregon as a function of the surface wind speed.

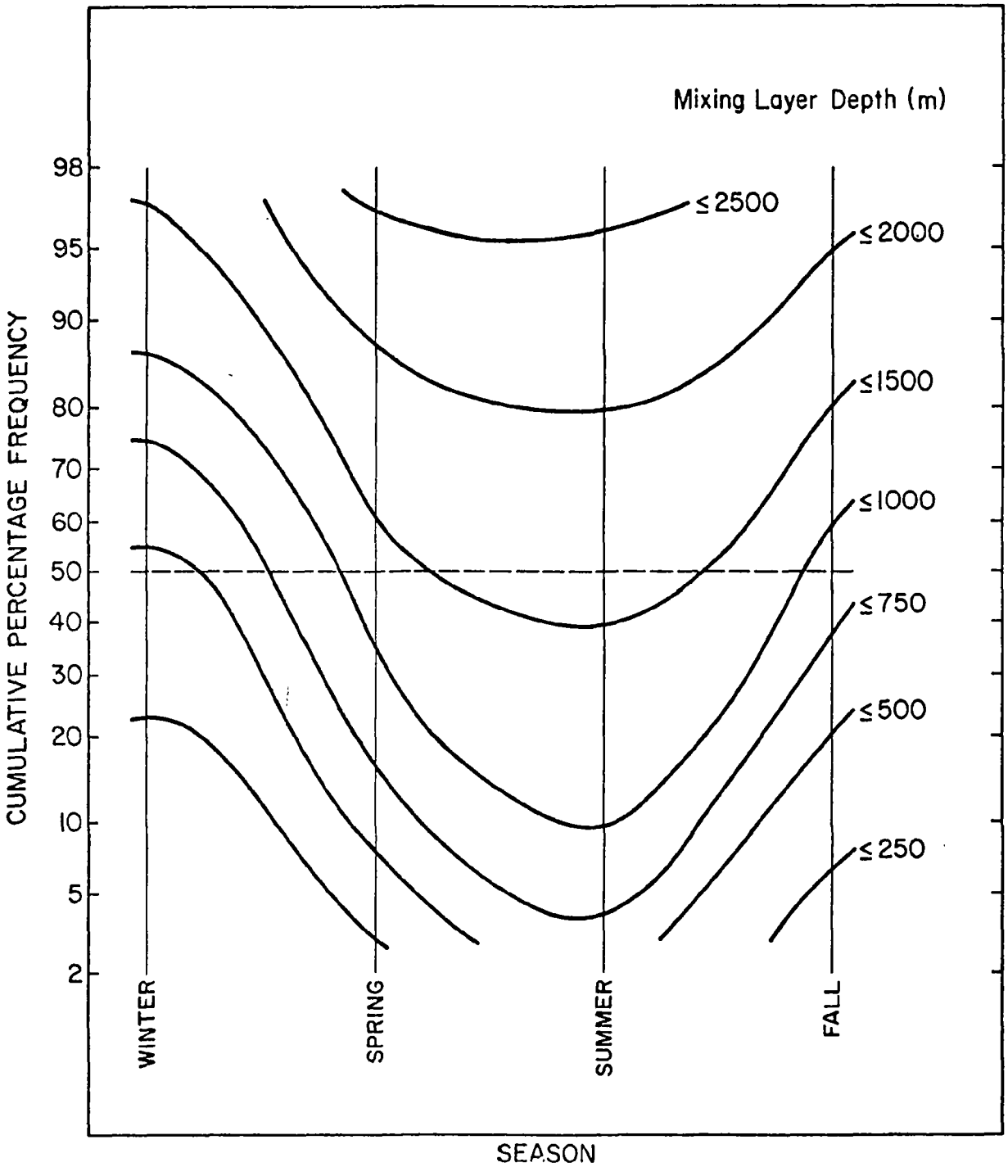

FIGURE 5. Afternoon mixing layer depths by season at Salem, Oregon.

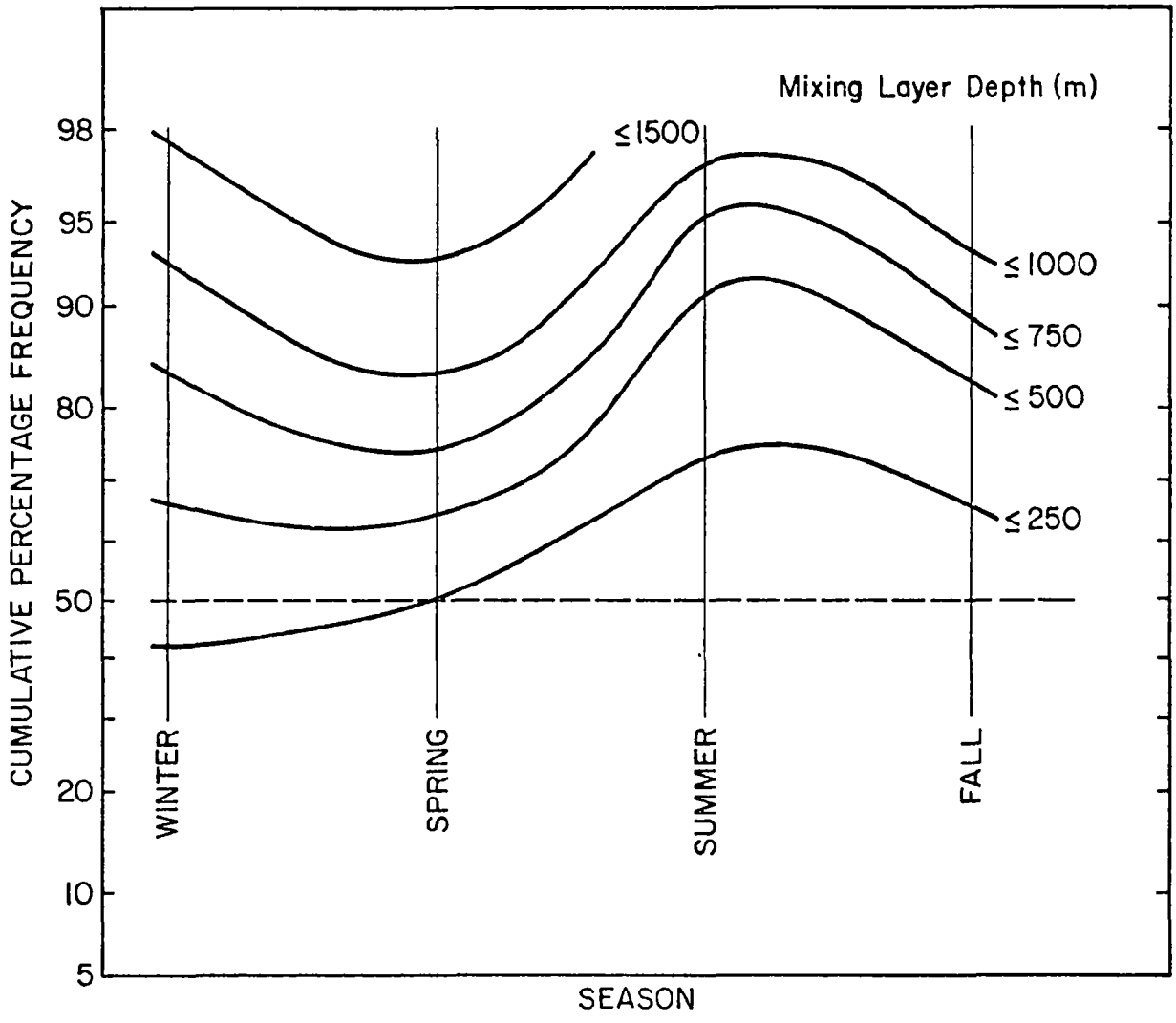

FIGURE 6. Early morning mixing layer depths by season at Boise.

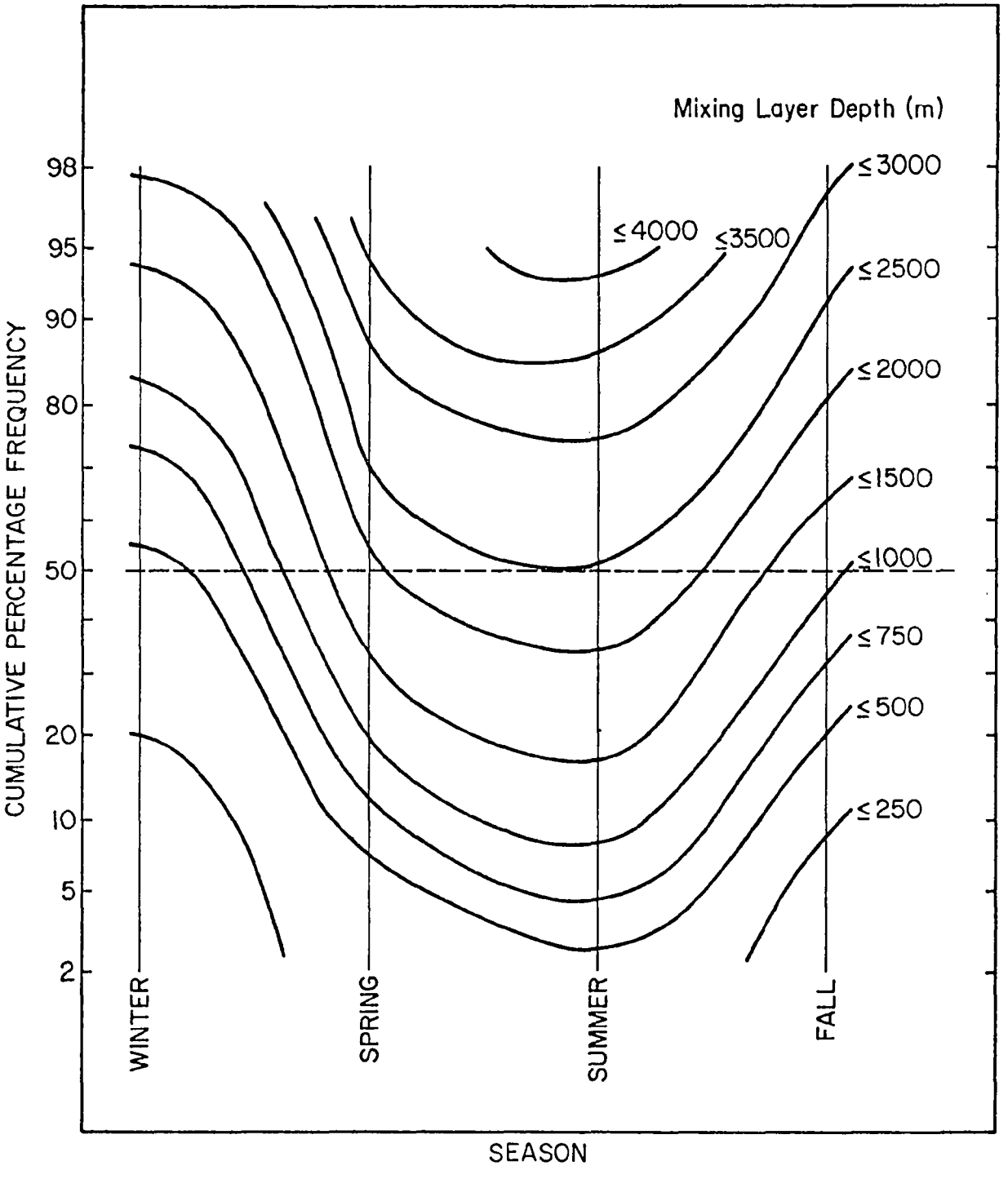

FIGURE 7. Afternoon mixing layer depths by season at Boise.