A STUDY OF AIR POLLUTION POTENTIALITY IN THE WILLAMETTE VALLEY

by

JAMES VANNER RAMSDELL, JR.

A THESIS

submitted to

OREGON STATE UNIVERSITY

in partial fulfillment of
the requirements for the
degree of

MASTER OF SCIENCE

June 1962

APPROVED:

Redacted for Privacy

Assistant Professor of Forest Meteorology

In Charge of Major

Redacted for Privacy

Chairman of Department of Meteorology

Redacted for Privacy

Chairman of School Graduate Committee

Redacted for Privacy

Dean of Graduate School

Date thesis is presented 18 May 1962

Typed by Carol E. Berglund

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

A STUDY OF AIR POLLUTION POTENTIALITY IN THE WILLAMETTE VALLEY

CHAPTER I

INTRODUCTION

This is an exploratory study of the air pollution potentiality in the Willamette Valley and, as such, it is intended to indicate promising directions for future research as well as to report the results of several attempts to clarify the relationships between factors having to do with this potentiality.

In order to evaluate the air pollution potentiality of a region, it would appear necessary for one to know the meteorological and topographical factors related to air pollution and the nature of these relationships. Assuming a source of pollutants and a constant emission rate, the level of contamination is related to the volume of air in which the pollutants are confined and to their dispersion within that volume. Those meteorological and topographical factors which affect movement or dispersion of pollutants, either horizontally or vertically, are critical to air pollution.

Meteorological Factors

The horizontal movement and dispersion of pollutants

is affected by wind velocity (4, p.4). In general, their concentration is inversely proportional to the wind speed and may be independent of the wind direction (5, p.46). However, the use of the vector quantity, wind velocity, is necessary for a study of horizontal dispersion in areas which experience frequent or diurnal changes in wind direction. Such changes are usually due to land-sea breezes, mountain-valley winds, or other locally induced winds (5, p.38). In these cases, the daily average wind speed may be relatively high but the magnitude of the resultant daily wind vector may reveal a relatively low removal of pollutants. The concept of wind velocity as representing a combination of magnitude and direction seems to have been disregarded in several air pollution studies (8, p.12-13; 2, p.5).

Vertical dispersion of pollutants is directly affected by the thermal structure of the lower atmosphere (7, p.5-13). The temperature lapse rate of a layer of air is an indication of its stability. Stability is inversely proportional to the steepness of the lapse rate, thus a temperature inversion indicates a highly stable layer of air. An unstable layer of air will aid the vertical dispersion of pollutants, while a stable layer will hinder it. Other meteorological parameters such as humidity and precipitation may have some affect on the concentration of

pollutants (1, vol.1, p.21-32).

Topographical Factors

The topographical factors which affect air pollution may do so in several ways. Mountain ranges may provide barriers which limit horizontal dispersion (14, p.5). Valleys may channel air flow, thereby concentrating pollutants (10, p.34). Both of these interrelated topographical effects involve the physical restrictions of pollutants.

Topography and geography may affect the horizontal dispersion of pollutants through locally induced winds. As noted above, in those areas affected by local winds, the wind diurnal cycle frequently reduces the net distance that pollutants are carried during a given period of time.

An additional effect of topography on air pollution is that related to the vertical dispersion of pollutants. The drainage of cool air into valleys may result in a "lake" of cold air and a thermal belt above the lake. This is one of the ways in which the thermal stratification most conducive to the accumulation of pollutants, i.e. temperature inversions, occurs (6, p.195-210).

The role of the atmosphere and topography in air pollution may be summarized in the following manner. In order for a high level of pollution to occur, there must be a pollutant source. With a source, either low

horizontal dispersion because of low average wind velocity, or reduced vertical dispersion because of atmospheric stability could cause an increase in the concentration of pollutants.

Topography of the Willamette Valley

The Willamette Valley, which extends into the State of Oregon in a southerly direction from the Columbia River, covers an area of approximately 7,200 square miles. It is bordered on the west by the Oregon Coast Range, whose ridge crests average about 3,000 feet. On the east it is bordered by the Cascade Range, whose crests average about 5,000 feet. To the south, the Willamette Valley gradually rises to the Siskiyou Mountains, but for the purposes of this study the southern end of the Valley will be considered to be the Calapooya Mountains, a group of hills extending across the Valley just south of Eugene. Because in the north the Valley experiences complex wind flow patterns associated with the Columbia River Gorge, the Portland area is excluded from this study. From this physical description, it may be seen that the Willamette Valley has major topographical restrictions on the horizontal dispersion of pollutants in three directions.

Present Status of Air Pollution in the Willamette Valley

The Willamette Valley does not have frequent occurrences of the eye-irritating, corrosive smog so often associated with the Los Angeles Basin. There have been individual occurrences of this, yet they seem to be the exception rather than the rule (3). For the most part, the only evidences of pollution in the Valley as a whole are occasional visibility reductions because of smoke. These occurrences become quite frequent during the fall.

CHAPTER II

DATA SOURCES AND AVAILABLE DATA

The data sources for an air pollution study may be divided into two groups: those which provide direct measurements of air pollutants, and those which provide measurement of meteorological parameters. Of these two groups of data, the latter is much more accessible. As will be shown, there is a need for additional measurement of pollutants in the Willamette Valley.

Pollutant Measurements

The National Air Sampling Network, operated under the direction of the staff of the Robert A. Taft Sanitary Engineering Center of the U. S. Department of Health, Education and Welfare, has been a source of air pollution measurements made on a random basis at various locations throughout the country for several years (1, vol.1, p.1). At present, the measurements are of suspended particulate matter made by means of high volume air samplers (1, vol.1, p.1). Pollutant concentrations are expressed in micrograms of particulates per cubic meter of air (21). These data are available from the Taft Center for 70 urban stations on a biennial basis (22). Additional particulate data may be obtained through local or state health or air

pollution authorities.

The direct measurements of pollution used in this study consist of 11 NASN observations made in Eugene at the Lane County Court House on a random basis between February 4, and June 20, 1961, (21), and 19 observations made by the Oregon State Sanitary Authority in Salem at the Marion County Court House between September 13, and November 2, 1961, in conjunction with one of their sampling programs (15). The Salem data are not random. There are some additional data , available from the Oregon State Sanitary Authority, which were taken near suspected pollutant sources. The inclusion of these data was judged to be of little value for two reasons: 1) the number of days on which particulate observations were made would not have been increased, and 2) it was felt that the data would not be representative of the Willamette Valley.

That particulate matter is not the only type of pollutant is recognized by the writer, as is the problem of attempting to combine two different data sources into one sample.

Meteorological Data

The Weather Bureau maintains a large number of surface observation stations which take hourly observations throughout the country. These records are readily

available at the stations. Use of the station records, as a rule, requires that the individual travel to the station and extract the desired information himself. As an alternative to this, the Weather Bureau compiles and publishes climatological data on a monthly basis for many stations (20, p.11). Among the various meteorological parameters, visibility or the nature of obstructions to visibility may provide a substitute for the direct measurement of particulate matter.

In the Willamette Valley, local climatological data are available for both Salem and Eugene. In this study, the Weather Bureau station records for Salem and Eugene (27; 28) were used in addition to the published data (23; 24; 25).

Salem is one of the Weather Bureau stations taking rawinsonde observations. From these observations, the thermal structure of the air above the surface may be estimated. In addition, information about the moisture distribution and wind velocity at various levels above the surface may be obtained. These data are published in Part II of the Daily Series of the Synoptic Weather Maps (26).

CHAPTER III

RESULTS

In order to examine the air pollution potentiality of the Willamette Valley, it appears desirable to determine the relationships of various meteorological parameters to the levels of pollution at the time of this study. A tabulation of the available particulate air pollution data and several meteorological parameters is found in Table 1.

Meteorological Parameters and Particulate Data

The first relationship to be examined is that between wind and particulate pollutants. This relationship is shown in Figure 1, where average wind speed, in miles per hour, is the abscissa and average particulate count, expressed in micrograms of particulates per cubic meter of air, is the ordinate. The data from Salem are represented in this figure, as in the remainder of the figures using particulate data, by dots. Eugene data are represented by x's. Each particulate observation was taken between noon one day (to be called the "first day") and noon the next day (to be called the "second day"), and is listed under the date of the "second day". The average wind speed used is the average for the two days covered by

Table 1. Average particulate pollutant count and assorted meteorological variables for 11 days at Eugene and 19 days at Salem in 1961.

	Date	TR[1]	S[2]	V[3]	PC[4]	K[5]
Eugene						
	2- 4	18	8.6	40	73	no
	2-19	11	16.8	35	35	no
	3- 2	12	8.1	40	51	no
	3-16	14	8.1	45	61	no
	3-27	16	10.4	35	43	no
	4-14	27	5.8	29	136	yes
	4-30	18	8.5	30	55	no
	5-11	15	7.4	45	40	no
	5-27	28	9.6	40	102	no
	6- 8	21	9.8	40	69	no
	6-20	30	10.1	27	120	no
Salem						
	9-14	40	5.5	87	142	no
	9-15	14	4.5	12	112	yes
	9-19	27	4.7	30	83	yes
	9-20	34	6.2	45	114	no
	9-21	25	5.6	50	71	no
	9-22	34	3.7	20	112	yes
	9-26	42	4.3	48	85	no
	9-27	34	4.4	37	152	no
	9-28	32	7.1	30	101	no
	9-29	24	7.0	32	92	no
	9-30	28	3.7	55	73	no
	10- 1	21	4.2	20	81	yes
	10- 2	39	4.7	65	75	no
	10- 3	41	4.0	47	131	no
	10- 4	43	3.8	14	130	yes
	10- 5	42	4.2	13	124	yes
	10-31	30	4.0	16	165	yes
	11- 1	14	6.1	16	118	yes
	11- 2	19	8.9	60	84	no

1. Temperature range in degrees Fahrenheit.
2. Average wind speed in miles per hour.
3. The sum of 1600 PST and 0800 PST visibility in miles.
4. Average particulate count in micrograms per cubic meter.
5. Occurrence of smoke reducing visibility to less than seven miles.

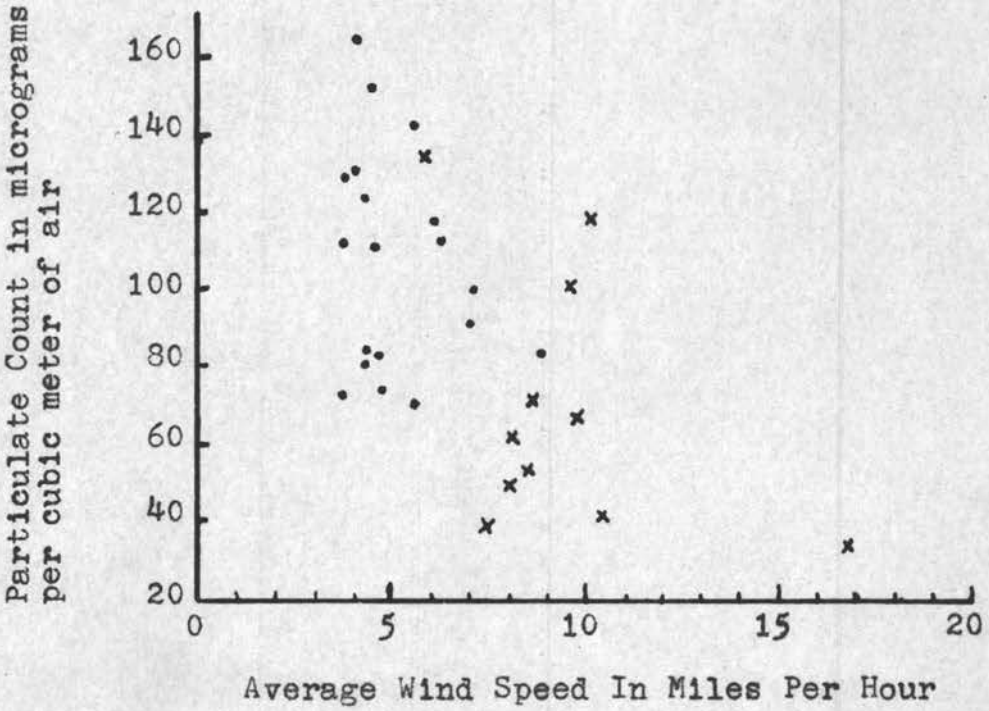

Figure 1. Relationship between particulate count and average wind speed in the Willamette Valley, as indicated by observations from Eugene (x's) and from Salem (dots) on selected days in 1961.

each observation. The loss of precision in the use of such averages, as well as the problems inherent in the use of wind speed, are recognized by the writer as noted in Chapter I. There appears to be an inverse curvilinear relationship. Markee obtained a similar relationship between optical density, used as an expression of particulate concentration, and wind speed (13, p.51). No further consideration will be given to this relationship at this point for reasons which will become clear in the section on the seasonal variation of pollution.

The relationship between temperature range and particulate count is the next to be examined. This relationship is shown in Figure 2. Temperature range in degrees Fahrenheit is represented along the abscissa; particulate count is, again, represented along the ordinate. The temperature range for each observation is the range during the time of the observation: the range between the maximum temperature on the afternoon of the "first day" and the minimum temperature on the morning of the "second day". There appears to be a direct relationship between temperature range and particulate count.

Relationships between other meteorological parameters and particulate count did not produce as promising results as those above. This is not to say that these relationships should be disregarded in future studies, for air

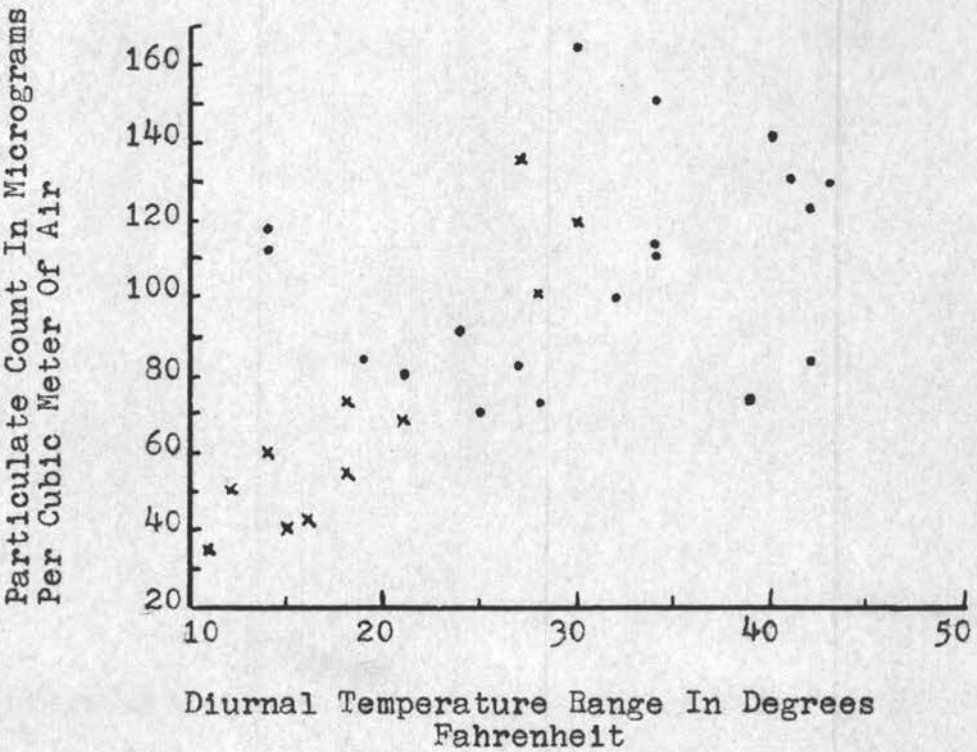

Figure 2. Relationship between diurnal temperature range and particulate count in the Willamette Valley, as indicated by observations from Eugene (x's) and from Salem (dots) on selected days in 1961.

pollution data yet to be gathered may produce better results than were found in these comparisons. Among the parameter-pollution relationships which should be pursued further are wind velocity (combined speed and direction) and pollutants, and precipitation (both quantity and periods of occurrence) and pollutants.

Meteorological Parameters as Substitutes for Particulate Data

The relationships between meteorological visibility, visibility obstruction by smoke and particulate count were examined in order to determine if either might be used in place of particulate data.

In Figure 3, the sum of the visibility at 1600 PST on the "first day" and at 0800 PST on the "second day" is plotted on the abscissa, and the particulate count on the ordinate. There is a wide scatter of the points in this scattergram, although there is a suggestion of the inverse relationship which would be expected. The scatter is doubtless increased by a number of types of error. For example, the visibility values used in this study are visual estimates made by many Weather Bureau observers. Thus, the difference between a visibility of 15 and 25 miles may often be only a difference between observers. In addition, meteorological parameters such as fog and precipitation reduce visibility.

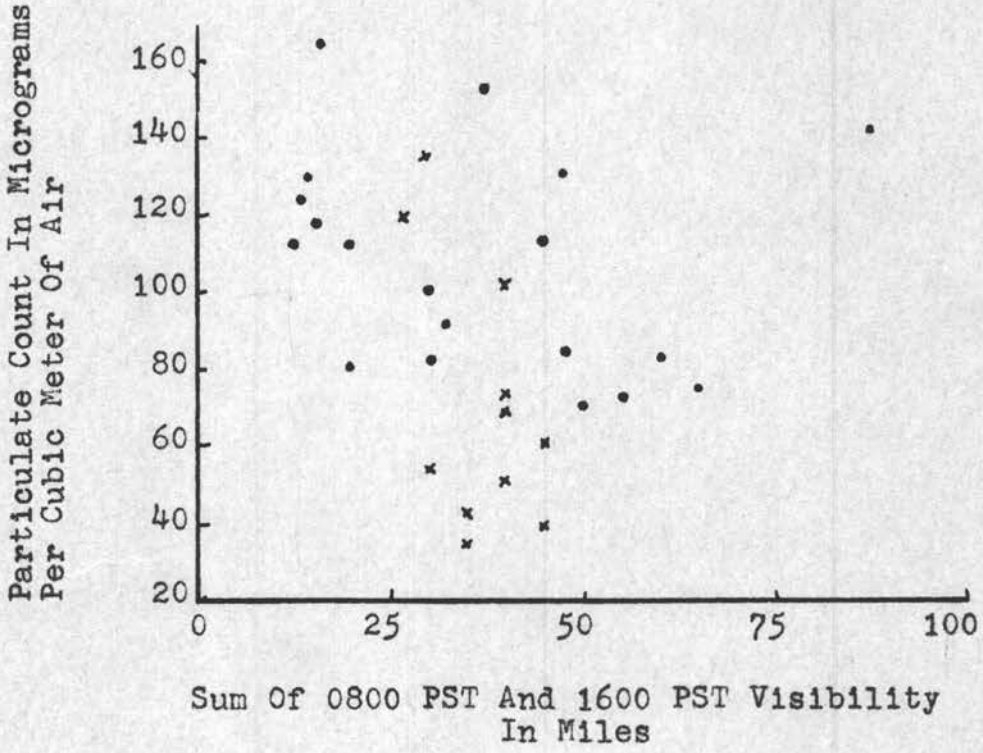

Figure 3. Relationship between the sum of 0800 PST and 1600 PST visibility and particulate count in the Willamette Valley, as indicated by observations from Eugene (x's) and from Salem (dots) on selected days in 1961.

Arrangement of the 30 particulate samples in order of ascending particulate count (Table 2) shows an increased tendency for smoke occurrence as the particulate count increases. According to the Weather Bureau Manual of Surface Observations (Circular N), when visibility is reduced to less than 7 miles, the obscuring phenomena must be recorded (12, p.33B). Thus, smoke which reduces visibility to less than 7 miles is the occurrence specified in Table 2. As smoke is a visual determination, it is subject to being affected by other meteorological parameters. Smoke may be listed as an obstruction to visibility in conjunction with for or precipitation when the same amount of smoke alone would not be sufficient to reduce the visibility to less than 7 miles.

Even with the difficulties mentioned, the writer feels that the occurrence of smoke is a useful guide by which to distinguish days having pollution above some minimum level. This minimum level, in the Willamette Valley, appears to be somewhere above 80 micrograms of particulate matter per cubic meter of air. It is not necessary, however, to establish the exact level for the purposes of this study. Although smoke is doubtless not the only air pollutant present, and may not even be a major pollutant in terms of harmful effects, days with smoke will hereafter be considered to be days with "high

Table 2. Average particulate count arranged in ascending numerical order with associated occurrences of smoke and values of an index of inversion persistence.

Particulate Count	Smoke	Inversion Persistence
35	no	0
40	no	1
43	no	2
51	no	0
55	no	3
61	no	12
69	no	15
71	no	10
73	no	0
73	no	15
75	no	--
81	yes	--
83	yes	11
84	no	--
85	no	15
92	no	15
101	no	15
102	no	3
112	yes	15
112	yes	13
114	no	5
118	yes	--
120	no	21
124	yes	--
130	yes	--
131	no	--
136	yes	9
142	no	15
152	no	21
165	yes	--

pollution".

Thermal Structure and Particulate Data

Having examined the relationships between air pollution and various meteorological parameters available from surface observations, and having arrived at the conclusion that smoke is a satisfactory and readily obtainable indicator of "high pollution", the relationship between the occurrence of smoke and the thermal structure of the atmosphere will now be examined. In examination of the thermal structure, an arbitrary decision was made to consider only the atmosphere below 850 millibars. The choice of 850 millibars was made because it is approximately the height of the ridge crests of the Cascades, and, also, because it is a mandatory level for rawinsonde observations. The days in the 5 year period from July, 1956, to June, 1961, were divided into two groups: those having a temperature inversion based below 850 millibars, and those not having such an inversion (26). The criterion for the existence of an inversion is a lapse rate less than isothermal.

Binomial Relationship of Smoke and Inversions

In Appendices 1 through 4 appear tabulations of the 5 years of morning inversion occurrences at Salem and 5

years of smoke occurrences at both Salem and Eugene. The assumption has been made that the one rawinsonde observation at Salem will be representative of conditions throughout the Willamette Valley.

The correlation of smoke occurrences at Salem and inversions, as established by use of a chi square test (11, p.390-446), is found in Table 3. The similarly established correlation between the occurrence of smoke in Eugene and inversions is found in Table 4. These tables show that there is a connection between the occurrence of inversions and smoke which is statistically significant in both cities. The large number of occurrences of inversions without smoke, in both cases, indicates the probability of complicating factors. Normally, a binomial distribution with this degree of correlation has high relative frequencies in diagonal quarters. The nature of the complicating factors will be discussed in the section on the seasonal variation of pollution.

In the remainder of this thesis, the statistical test cited above has been used in establishing correlations between various pairs of variables.

Relationship of Pollution and Inversion Persistence

Having established the above correlations, the writer decided to explore this relationship further. In order to

Table 3. The relationship between the occurrence of smoke and the occurrence of inversions at Salem. July 1956 - June 1961

SMOKE	INVERSION		
	Yes	No	Total
Yes	273	18	291
No	1053	480	1533
Total	1326	498	1824

Chi Square: 104.6

(Needed for significance at 0.5 o/o level with 1 degree of freedom: 7.88)

Table 4. The relationship between the occurrence of smoke and the occurrence of inversions at Eugene. July 1956 - June 1961

SMOKE	INVERSION		
	Yes	No	Total
Yes	539	72	611
No	787	426	1213
Total	1326	498	1824

Chi Square: 109.4

(Needed for significance at 0.5 o/o level with 1 degree of freedom: 7.88)

change the simple binomial variable, inversion ("yes" or "no"), into a "continuous" variable, a weighting system was arbitrarily adopted assuming that the longer the duration of an inversion, the higher the level of pollution. The weighting system is as follows: 8 points were given for an inversion on the morning of the "second day" of the observation, 6 points for one on the afternoon of the "first day", 4 points for one on the morning of the "first day", 2 points for an inversion the morning before the beginning of the observation, and 1 point for an inversion on the morning two days before the beginning of the observation. In this portion of the study, particulate count was again used to represent pollution.

As no inversion data are available to the writer after September, 1961, only 22 of the 30 observations in Table 2 were used. The variation of particulate count with the arbitrary index of inversion persistence is presented in Figure 4. Pollution seems to be directly proportional to inversion persistence.

Inversion Index and Smoke

Thus far, only the presence and persistence of an inversion have been considered in characterizing thermal structure. There are a number of other characteristics of inversions which might have an affect upon the

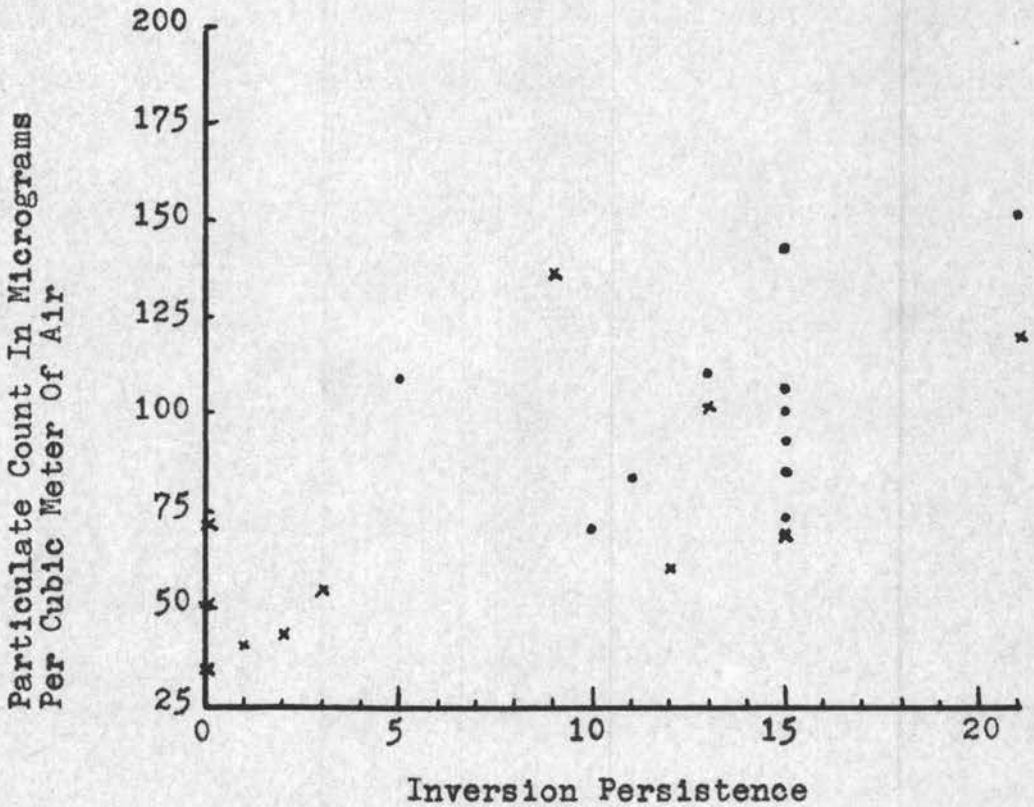

Figure 4. Relationship between inversion persistence and particulate count in the Willamette Valley, as indicated by observations from Eugene (x's) and from Salem (dots) on selected days in 1961.

concentration of pollutants. Among these are: the height of the base of the inversion, the temperature difference between the top and the bottom of the inversion, and the lapse rate through the inversion. Stanford Research Institute developed an expression combining these characteristics for use in studies at Los Angeles (18, p.247). The expression, called the Inversion Index, is:

$$I = \frac{\Delta\theta^2}{3 + Z_B \Delta Z}$$

where I is the Inversion Index, $\Delta\theta$ is the difference in potential temperature between the top and the bottom of the inversion in degrees Kelvin, ΔZ is the thickness of the inversion in hundreds of meters, and Z_B is the height of the base of the inversion in hundreds of meters. The 3 is added to the denominator as a "leakage factor" to account for possible dispersion of pollutants through the inversion. Inversions which had bases less than 150 meters were assigned an arbitrary base of 150 meters to keep the Inversion Index from becoming extremely large (19, p.27-33). The criterion for inversion remains the same as above. Days having no inversion were arbitrarily assigned an Inversion Index of 0.

Using this empirical device, the Inversion Indices for Salem morning rawinsonde observations from July, 1960, through June, 1961, were calculated. This year was chosen

because plotted soundings were readily available at the Atmospheric Science Branch of the Science Research Institute, Oregon State University. The results of these calculations are tabulated in Appendix 4.

Using the Inversion Indices and the occurrence of smoke at Salem and Eugene, the correlation between the three was examined. The results of this examination are presented in Tables 5 and 6. For both cities there is a statistically significant relationship between Inversion Indices and the frequency of smoke occurrences.

The validity of using an Inversion Index designed for the Los Angeles Basin in the Willamette Valley is open to some question. It was doubted by the writer at the outset of this study, but it is at present accepted on the basis of the above results as being useful and, at least, partially valid.

On a chance that the occurrence of smoke might be related to the height of the base of the inversion alone, correlations between smoke at Salem, smoke at Eugene and the height of the inversion base were made. The heights of the bases of inversions were arbitrarily divided into 3 groups: surface to 950 millibars, 949 to 900 millibars, and 899 to 850 millibars. The results of this comparison are found in Tables 7 and 8. Only at Eugene is there a significant relationship between smoke and the height of

Table 5. The relationship between Inversion Index and the occurrence of smoke restricting visibility to less than seven miles at Salem. July 1960 - June 1961

INVERSION INDEX	SMOKE		
	Yes	No	Total
0	2	109	111
≤ 2.0	23	92	115
2.1 to 4.0	17	36	53
4.1 to 6.0	9	17	26
6.1 to 8.0	5	13	18
8.1 to 10.0	4	10	14
Above 10.0	7	20	27
Total	67	297	364

Chi Square: 34.9

(Needed for significance at 0.5 o/o level with 6 degrees of freedom: 18.55)

Table 6. The relationship between Inversion Index and the occurrence of smoke restricting visibility to less than seven miles at Eugene. July 1960 - June 1961

INVERSION INDEX	SMOKE		
	Yes	No	Total
0	17	94	111
≤ 2.0	41	74	115
2.1 to 4.0	23	30	53
4.1 to 6.0	12	14	26
6.1 to 8.0	12	6	18
8.1 to 10.0	10	4	14
Above 10.0	16	11	27
Total	131	233	364

Chi Square: 46.0

(Needed for significance at 0.5 o/o level with 6 degrees of freedom: 18.55)

Table 7. The relationship between the height of the inversion base and the occurrence of smoke at Salem. July 1960 - June 1961

INVERSION BASE	SMOKE		
	Yes	No	Total
Surface to 950	60	171	231
949 to 900	3	15	18
899 to 850	3	3	6
Total	66	189	255

Chi Square: 1.86

(Needed for significance at 5 o/o level with 2 degrees of freedom: 5.99)

Table 8. The relationship between the height of the inversion base and the occurrence of smoke at Eugene. July 1960 - June 1961

INVERSION BASE	SMOKE		
	Yes	No	Total
Surface to 950	107	124	231
949 to 900	3	15	18
899 to 850	3	3	6
Total	113	142	255

Chi Square: 6.06

(Needed for significance at 5 o/o level with 2 degrees of freedom: 5.99)

the base of an inversion. Even then, the significance of the relationship is at a much lower level than the relationship between smoke and Inversion Index. These results would tend to indicate that the intensity of the inversion must be considered in addition to the height of its base.

Seasonal Variation of Pollution

When compiling the data for this study, the writer gained the impression that pollution in the Willamette Valley is highly seasonal in nature. This seasonal variation may be due to a difference in particulate emission rates, to a difference in meteorological conditions, or to both. In order to determine which of these alternatives is most likely, the already established correlation between smoke and inversions may be used to reduce the effect of changing meteorological conditions by considering only days having inversions. In Figure 5, the frequency of inversion days having smoke occurrences during a month is plotted by months. The data used in this figure are from the 5 year period, July, 1956, to June, 1961, and are found in Appendices 1 through 4. The variations among the monthly frequencies of smoke occurrences in Figure 5 may be assumed largely due to changing particulate emission rates. In no month, on the average, does the percentage of inversion days having smoke occurrences

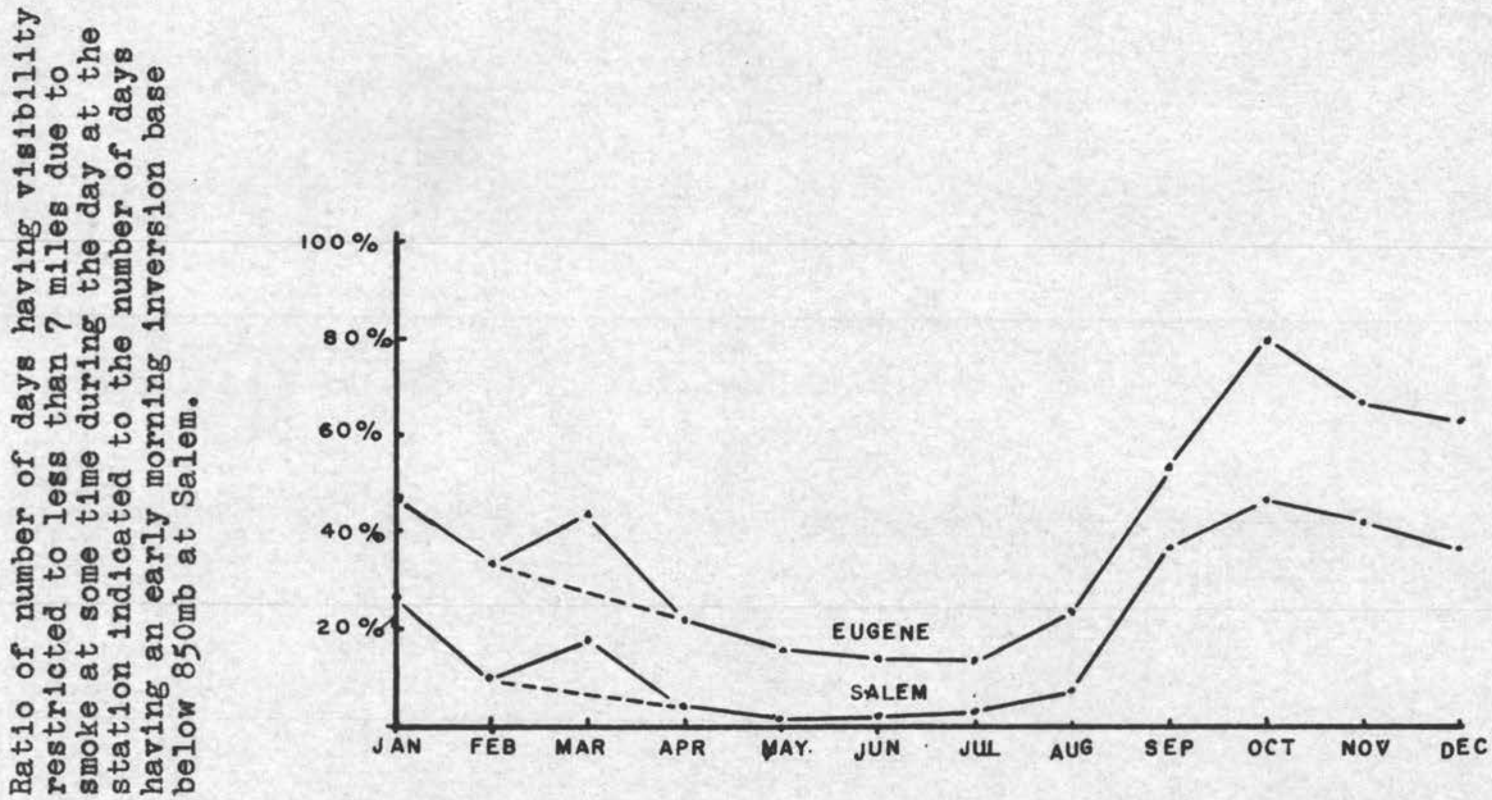

Figure 5. Annual variation of the number of days with smoke restricting visibility relative to the number of days with a morning inversion in the Willamette Valley. July, 1956 - June, 1961.

reach 100 percent; thus, a lack of inversions does not seem to be the limiting factor in months having a low smoke frequency.

A clear picture of the seasonal trend in smoke may also be seen in Figure 5. There seem to be two quite distinct seasons: one a smoky season, September through January; and an "off" season, February through August. March was treated as anomalous for two reasons: 1) only 5 years of data are represented, and 2) March, 1960, had a disproportionate number of smoke occurrences. Recognition of this anomaly is denoted in Figure 5 by the dotted portions of the trend line.

Figure 5 does not distinguish between those months having a high frequency of inversion occurrence and those having a low frequency of inversion occurrence. To show the effect of variations in the frequency of inversion occurrence, Figure 6 is presented. In Figure 6, the percentage frequency of inversions for each month is shown along with the percentage frequency of smoke occurrences for each month. The month having the highest frequency of inversions, July, has one of the lowest frequencies of smoke occurrence. On the other hand, October, having a lower frequency of inversions, has the highest frequency of smoke occurrences. This indicates that the seasonal variation of pollution may, to a large degree, be

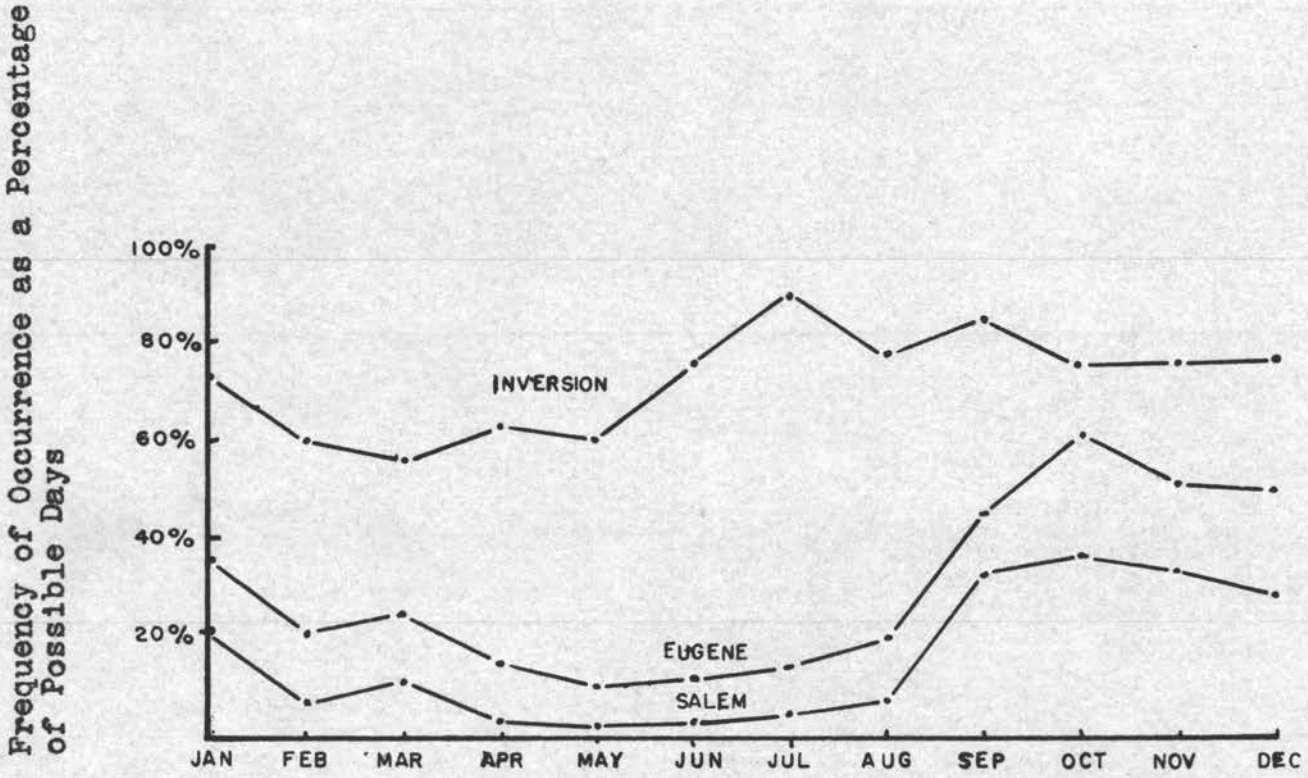

Figure 6. Annual variation of relative frequencies of occurrences of morning inversions at Salem, restricted visibility due to smoke at Eugene, and restricted visibility due to smoke at Salem. July 1956 - June 1961.

accounted for by seasonal changes in the particulate emission rate in the Willamette Valley.

If a significant portion of the seasonal variation of pollution is due to the variation of emission rates, then, given the pollution sources existing at the time of the study, the meteorological conditions which cause occurrences of restricted visibility due to smoke during the "off" season will necessarily be more restrictive than those required during the smoky season. For this reason, it does not seem to the writer that the data from the two seasons should be mixed. Therefore, each of the contingency tables presented thus far is repeated, with due regard taken for the seasonal variation of emission rates.

The binomial distribution of smoke and inversions for Salem, originally presented in Table 3, is repeated for the "off" season in Table 9, and for the smoky season in Table 10. It will be noted that there is a large difference in the value of chi square between the seasons although the relationship is significant in both seasons at the 0.5 percent level. This difference is probably caused by a low number of smoke days, due to a lower pollutant emission rate, during the "off" season.

The same data for Eugene, originally found in Table 4, are treated by seasons in Tables 11 and 12.

The relationship between Inversion Index and the

Table 9. The relationship between the occurrence of smoke and the occurrence of inversions at Salem during the "off" season.
July 1956 - June 1961

SMOKE	INVERSION		
	Yes	No	Total
Yes	45	6	51
No	688	320	1008
Total	733	326	1059

Chi Square: 9.6

(Needed for significance at 0.5 o/o level with 1 degree of freedom: 7.88)

Table 10. The relationship between the occurrence of smoke and the occurrence of inversions at Salem during the smoky season.
July 1956 - June 1961

SMOKE	INVERSION		
	Yes	No	Total
Yes	228	12	240
No	365	160	525
Total	593	172	765

Chi Square: 61.4

(Needed for significance at 0.5 o/o level with 1 degree of freedom: 7.88)

Table 11. The relationship between the occurrence of smoke and the occurrence of inversions at Eugene during the "off" season.
July 1956 - June 1961

SMOKE	INVERSION		
	Yes	No	Total
Yes	168	38	206
No	565	288	853
Total	733	326	1059

Chi Square: 19.1

(Needed for significance at 0.5 o/o level with 1 degree of freedom: 7.88)

Table 12. The relationship between the occurrence of smoke and the occurrence of inversions at Eugene during the smoky season.
July 1956 - June 1961

SMOKE	INVERSION		
	Yes	No	Total
Yes	371	34	405
No	222	138	360
Total	593	172	765

Chi Square: 92.6

(Needed for significance at 0.5 o/o level with 1 degree of freedom: 7.88)

occurrence of smoke at Salem, Table 5, is treated again in Tables 13 and 14. It is felt that the lack of significance in Table 13 is caused by a low particulate emission rate during the "off" season. Salem, as compared with Eugene, has very little smoke during the "off" season. The relationship between Inversion Index and smoke at Eugene, Table 6, is treated by seasons in Tables 15 and 16.

When the relationship of smoke to height of inversion base, Tables 7 and 8, is treated by seasons, all distributions are found insignificant, as shown in Tables 17 through 20.

It may be seen in Table 1 that the particulate data from Eugene were gathered during the "off" season while that from Salem came from the smoky season. Thus, if the data are considered by site, they are also considered by season. In Figures 7 and 8, the distribution of particulate matter with relation to temperature range is shown for Salem and Eugene, respectively. In Figures 9 and 10, the distribution of particulate matter with respect to average wind speed is similarly shown.

Smoke as a Function of Temperature Range and Inversion Index

Considering the scattergrams in Figures 7 through 10, the highest degree of correlation seems to be between

Table 13. The relationship between Inversion Index and the occurrence of smoke restricting visibility to less than seven miles at Salem during the "off" season. July 1960 - June 1961

INVERSION INDEX	SMOKE		
	Yes	No	Total
0	1	75	76
≤ 2.0	1	67	68
2.1 to 4.0	2	24	26
4.1 to 6.0	2	13	15
6.1 to 8.0	0	7	7
8.1 to 10.0	0	6	6
Above 10.0	1	12	13
Total	7	204	211

Chi Square: 8.3

(Needed for significance at 5 o/o level with 6 degrees of freedom: 12.59)

Table 14. The relationship between Inversion Index and the occurrence of smoke restricting visibility to less than seven miles at Salem during the smoky season. July 1960 - June 1961

INVERSION INDEX	SMOKE		
	Yes	No	Total
0	1	34	35
≤ 2.0	22	25	47
2.1 to 4.0	15	12	27
4.1 to 6.0	7	4	11
6.1 to 8.0	5	6	11
8.1 to 10.0	4	4	8
Above 10.0	6	8	14
Total	60	93	153

Chi Square: 28.8

(Needed for significance at 0.5 o/o level with 6 degrees of freedom: 18.55)

Table 15. The relationship between Inversion Index and the occurrence of smoke restricting visibility to less than seven miles at Eugene during the "off" season. July 1960 - June 1961

INVERSION INDEX	SMOKE		
	Yes	No	Total
0	10	66	76
≤ 2.0	16	52	68
2.1 to 4.0	4	22	26
4.1 to 6.0	2	13	15
6.1 to 8.0	4	3	7
8.1 to 10.0	3	3	6
Above 10.0	3	10	13
Total	42	169	211

Chi Square: 12.6

(Needed for significance at 5 o/o level with 6 degrees of freedom: 12.59)

Table 16. The relationship between Inversion Index and the occurrence of smoke restricting visibility to less than seven miles at Eugene during the smoky season. July 1960 - June 1961

INVERSION INDEX	SMOKE		
	Yes	No	Total
0	7	28	35
≤ 2.0	25	22	47
2.1 to 4.0	19	8	27
4.1 to 6.0	10	1	11
6.1 to 8.0	8	3	11
8.1 to 10.0	7	1	8
Above 10.0	13	1	14
Total	89	64	153

Chi Square: 39.0

(Needed for significance at 0.5 o/o level with 6 degrees of freedom: 18.55)

Table 17. The relationship between the height of the inversion base and the occurrence of smoke at Salem during the "off" season.
July 1960 - June 1961

INVERSION BASE	SMOKE		
	Yes	No	Total
Surface to 950	5	117	122
949 to 900	1	11	12
899 to 850	0	1	1
Total	6	129	135

Chi Square: 0

(Needed for significance at 5 o/o level with 2 degrees of freedom: 5.99)

Table 18. The relationship between the height of the inversion base and the occurrence of smoke at Salem during the smoky season.
July 1960 - June 1961

INVERSION BASE	SMOKE		
	Yes	No	Total
Surface to 950	55	54	109
949 to 900	2	4	6
899 to 850	3	2	5
Total	60	60	120

Chi Square: 1.02

(Needed for significance at 5 o/o level with 2 degrees of freedom: 5.99)

Table 19. The relationship between the height of the inversion base and the occurrence of smoke at Eugene during the "off" season.
July 1960 - June 1961

INVERSION BASE	SMOKE		
	Yes	No	Total
Surface to 950	31	91	122
949 to 900	0	12	12
899 to 850	0	1	1
Total	31	104	135

Chi Square: 4.42

(Needed for significance at 5 o/o level with 2 degrees of freedom: 5.99)

Table 20. The relationship between the height of the inversion base and the occurrence of smoke at Eugene during the smoky season.
July 1960 - June 1961

INVERSION BASE	SMOKE		
	Yes	No	Total
Surface to 950	76	33	109
949 to 900	3	3	6
899 to 850	3	2	5
Total	82	38	120

Chi Square: 1.05

(Needed for significance at 5 o/o level with 2 degrees of freedom: 5.99)

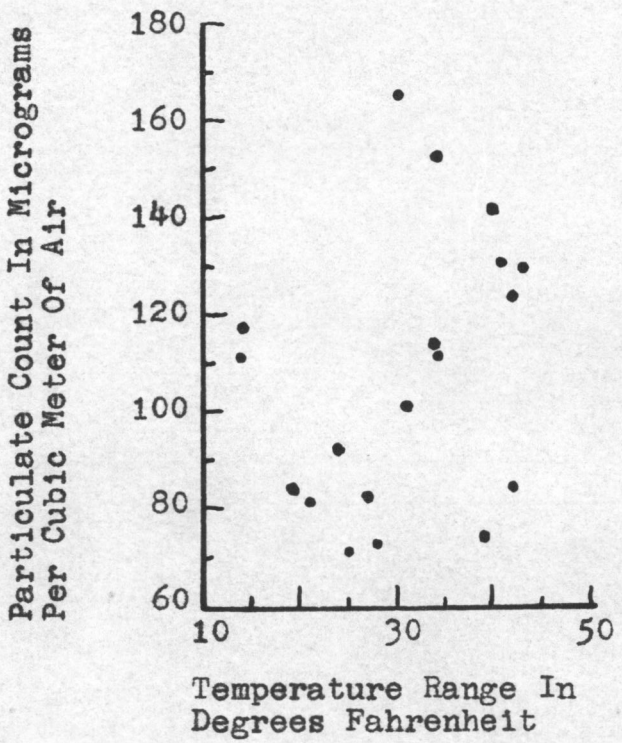

Figure 7. Relationship between temperature range and particulate count at Salem on selected days, September - November 1961.

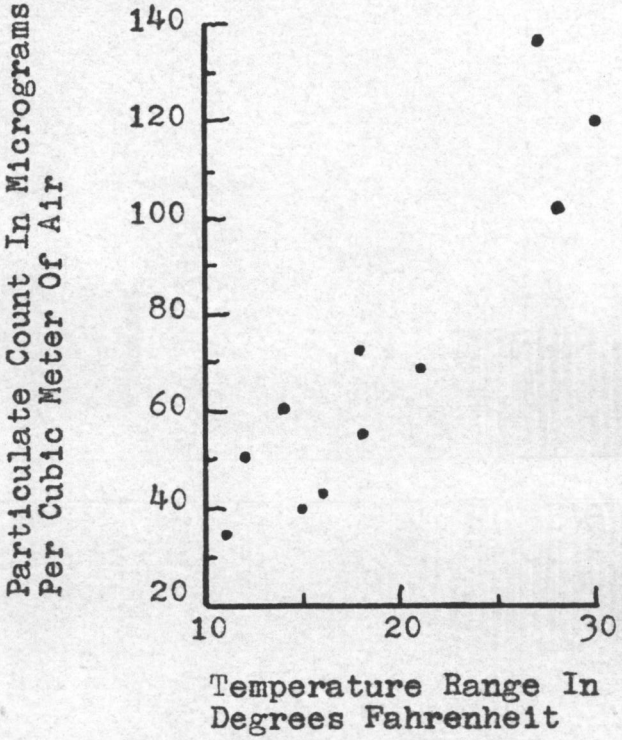

Figure 8. Relationship between temperature range and particulate count at Eugene on selected days, February - June 1961.

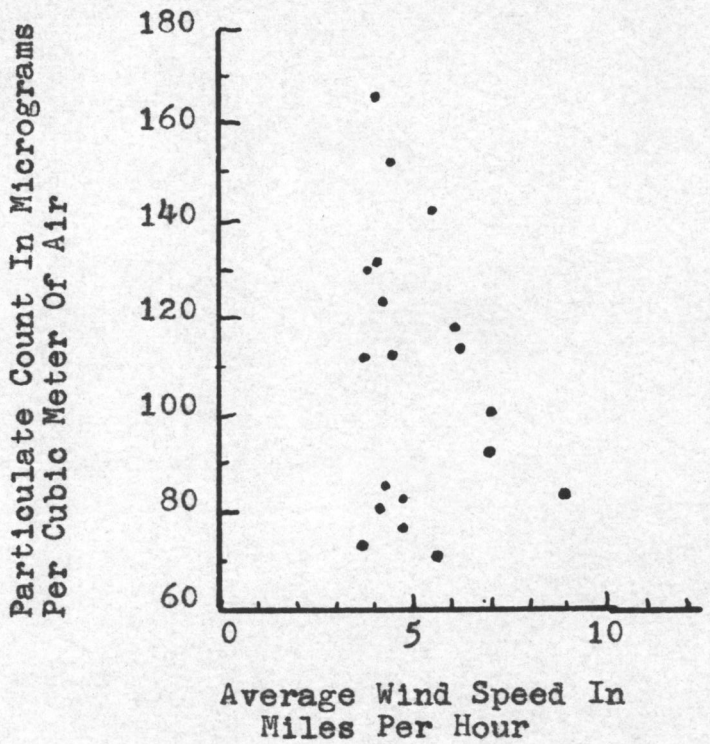

Figure 9. Relationship between wind speed and particulate count at Salem on selected days, September - November 1961.

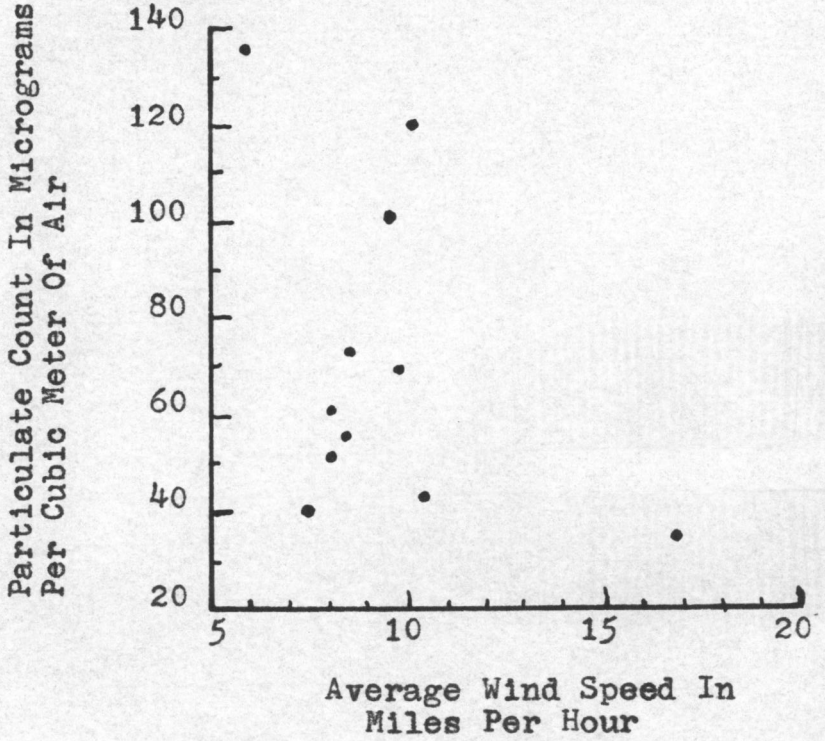

Figure 10. Relationship between wind speed and particulate count at Eugene on selected days, February - June 1961.

temperature range and particulate count at Eugene during the "off" season, Figure 8. Thus, in view of Tables 13 through 16, it was thought by the writer that an objective aid for the determination of days having high pollution might be developed using temperature range and Inversion Index. As a basis for a test of this possibility, random samples of days were drawn from the 5 years, July, 1956, to June, 1961, in such a way that 20 were selected randomly from the 155 January days, 20 from the 141 February days, and so on. These samples are tabulated in Appendix 5. For each day, the temperature range was obtained from the published climatological data (23; 24), and the Inversion Index was calculated using the published soundings at Salem (26). A tabulation of these data may also be found in Appendix 5.

The results of this attempt to relate smoke, and thus pollution, and a combination of these two meteorological variables are presented in Figures 11 through 14. In each of these figures, days having an occurrence of limited visibility due to smoke are denoted by x's; days without such conditions are represented by dots. Discouragingly, these figures do not seem to provide any reliable basis for differentiating between days having high pollution and those with low pollution. Furthermore, the writer feels that it is very likely that no other similar treatment of

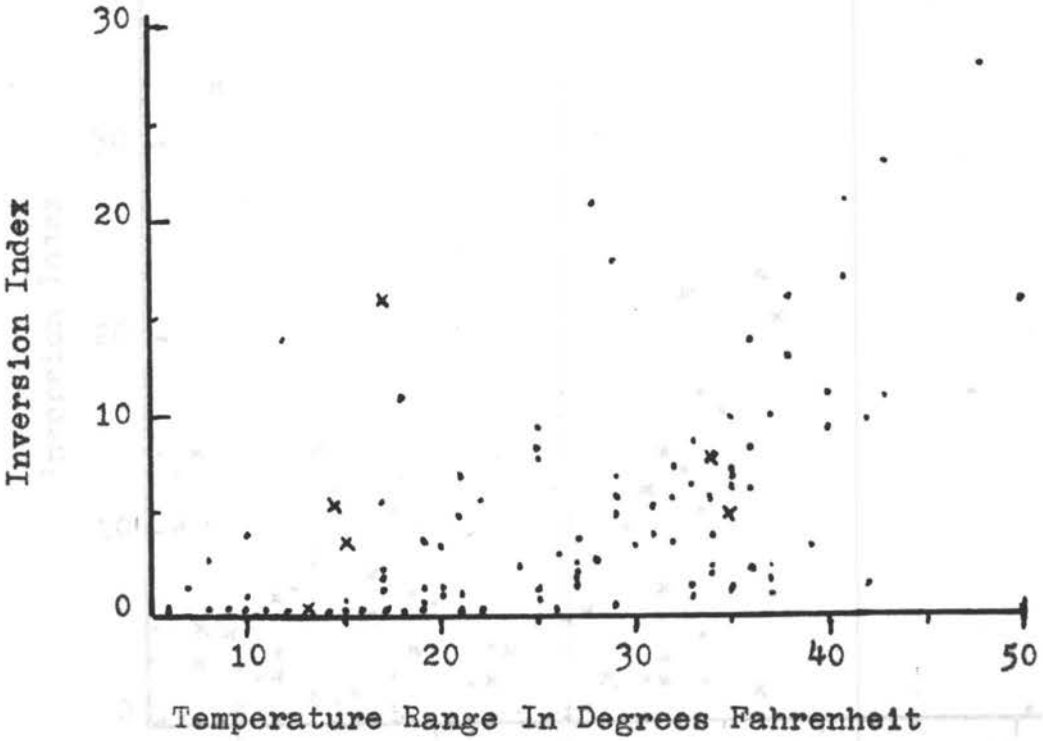

Figure 11. Relationship of occurrence of smoke restricting visibility to less than 7 miles (x's) at Salem to Inversion Index and diurnal temperature range during the months, February - August. Dots represent days without visibility restriction due to smoke.

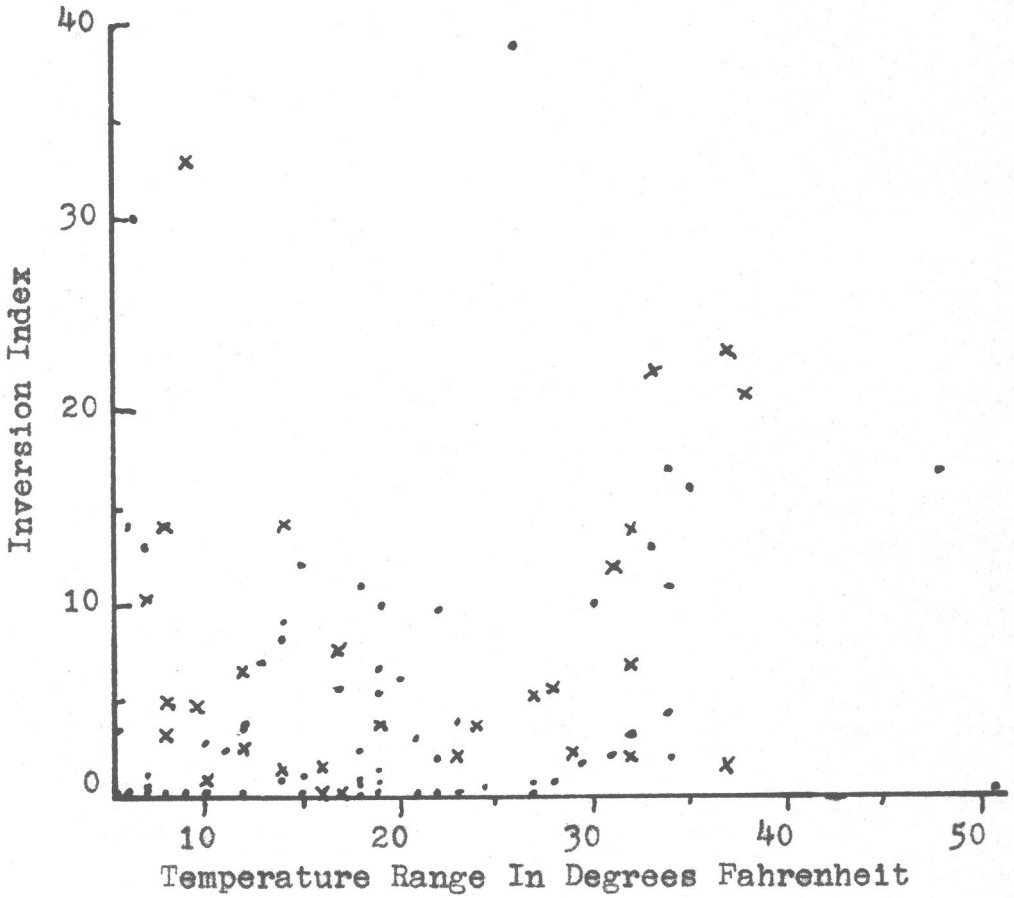

Figure 12. Relationship of occurrence of smoke restricting visibility to less than 7 miles (x's) at Salem to Inversion Index and diurnal temperature range during the months, September-January. Dots represent days without visibility restriction due to smoke.

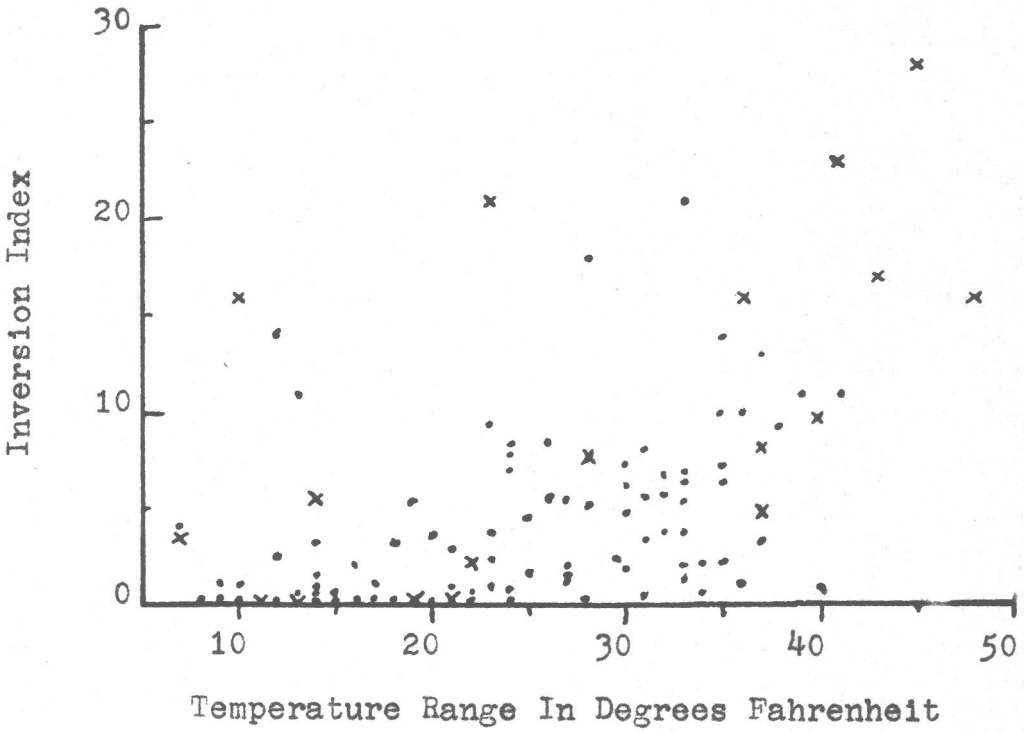

Figure 13. Relationship of occurrence of smoke restricting visibility to less than 7 miles (x's) at Eugene to Inversion Index and diurnal temperature range during the months, February - August. Dots represent days without visibility restriction due to smoke.

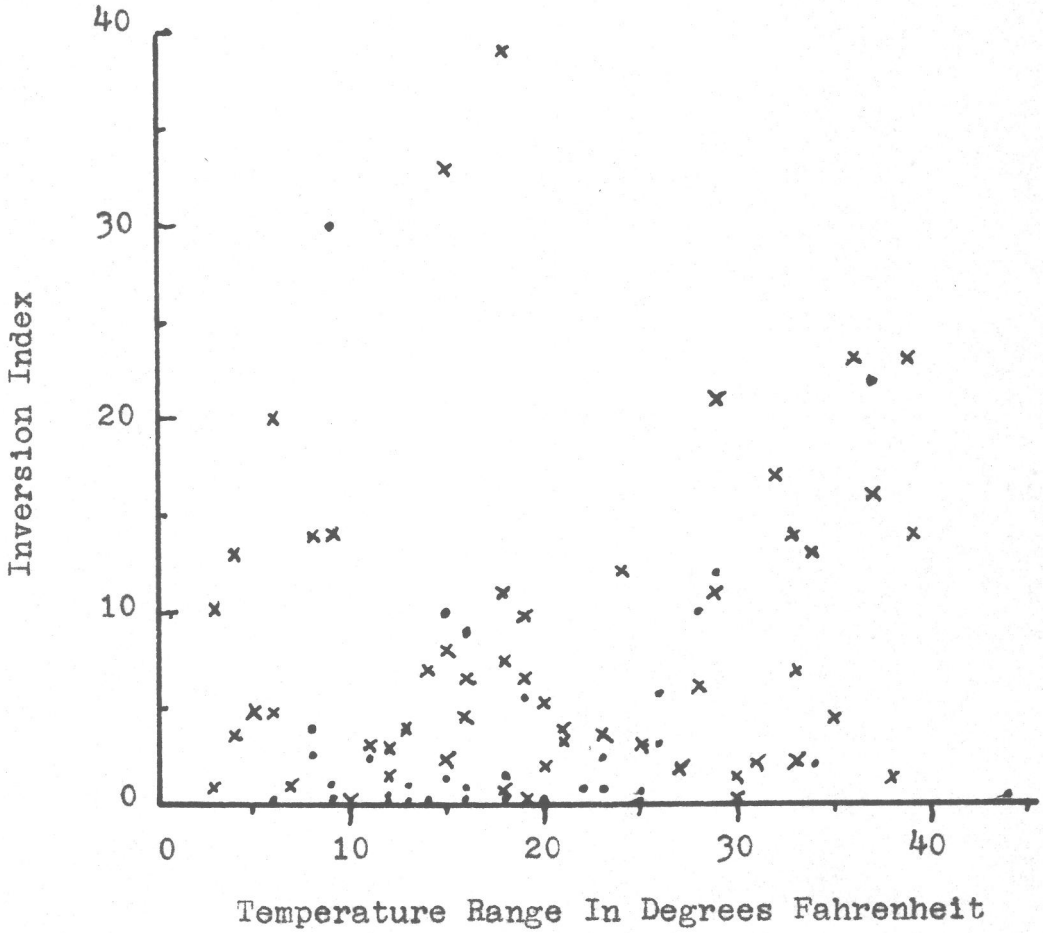

Figure 14. Relationship of occurrence of smoke restricting visibility to less than 7 miles (x's) at Eugene to Inversion Index and diurnal temperature range during the months, September-January. Dots represent days without visibility restriction due to smoke.

comparable complexity and involving different variables would provide a reliable basis for such a division.

CHAPTER IV

DISCUSSION

Air Pollution Potentiality

Judging from the results of Tables 9 through 12, the occurrence of smoke at either Salem or Eugene is nearly always accompanied by an inversion with a base below 850 millibars. From this, it has been inferred that a day with such an inversion condition is potentially a day with high pollution. Whether the potentiality is realized or not depends upon the particulate emission rate. Those days with high potentiality which also fall in a period with a high emission rate are likely to experience a high level of pollution. The curve of average monthly inversion frequencies shown in Figure 6 may, then, be taken to be the approximate monthly variation in the air pollution potentiality of the Willamette Valley. The potentiality is lowest in March and highest in July. Only in the months of February through May is the potentiality lower than 70 percent. In these months the potentiality is approximately 60 percent.

Using the reduction of visibility to less than 7 miles due to smoke as the criterion for a day having a high level of pollution, the frequency of inversion days having no smoke occurrences may be considered to be a measure of unrealized pollution potentiality. This unrealized

potentiality is the difference between 100 percent and the smoke frequency in Figure 5. It is greatest during the months of May, June and July and is least during October.

Climatology of Present Air Pollution in the Willamette Valley

One aspect of the climatology of the present air pollution in the Willamette Valley has already been introduced in the section on seasonal variation in Chapter III. It will be recalled that, on the basis of Figures 5 and 6, air pollution in the Willamette Valley has been divided into two seasons. It will also be recalled that there is a statistically significant correlation between the Inversion Index and the occurrence of smoke on a given day (Tables 13 through 16).

With the above in mind, Figures 15 and 16 were drawn. These figures are graphical displays of the data contained in Tables 13 through 16. In both of these figures, the percentage of days falling within a given Inversion Index range and having smoke occurrences is plotted against the mid-point of the Inversion Index range. Using the curves in these figures, the probability of smoke on a given day may readily be estimated if the Inversion Index for the morning sounding and the time of year are known. Looking at Figure 16, for example, it will be seen that on a day

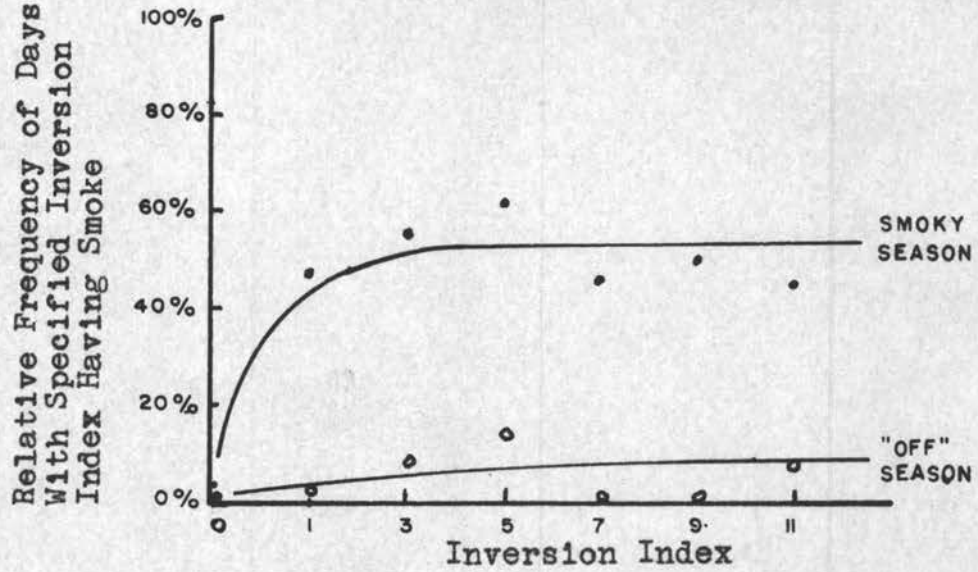

Figure 15. Likelihood of restricted visibility due to smoke as a function of Inversion Index and time of year at Salem.

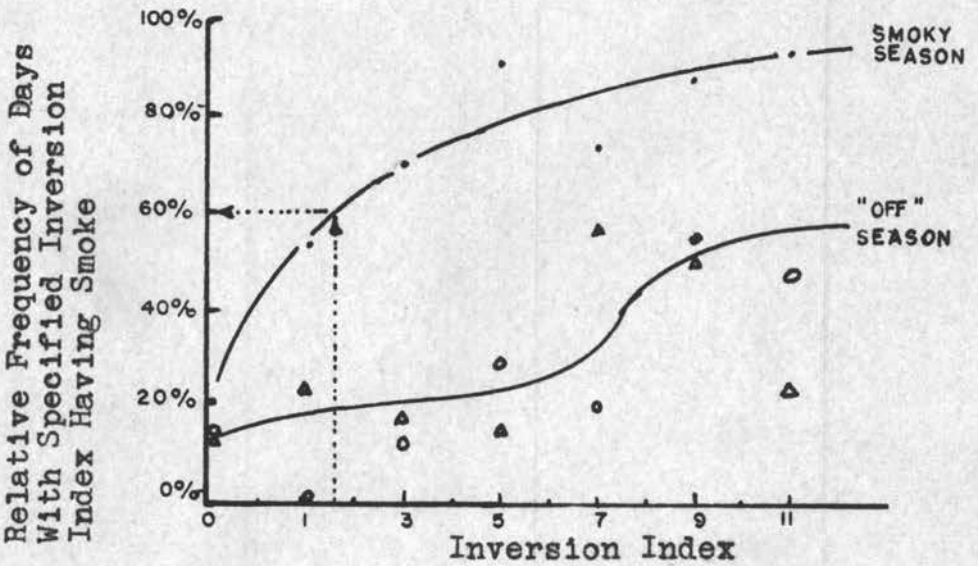

Figure 16. Likelihood of restricted visibility due to smoke as a function of Inversion Index and time of year at Eugene.

during the smoky season for which an Inversion Index of 1.6 is calculated at Salem, there would be about a 60 percent probability of a smoke occurrence in Eugene. This process is indicated by the dotted line in Figure 16.

In Salem during the smoky season, the probability of smoke occurrences rises from near 0 with no inversion to near 40 percent with an Inversion Index of 1 and levels off just above 50 percent with Inversion Indices above 3. This indicates that on days with Inversion Indices of 3 or above, the emission rate of particulate pollutants dominates the role of the thermal structure of the atmosphere. That is, only a substantial increase in emission rate would be likely to produce a marked increase in the probability of a smoke occurrence.

During the "off" season at Salem, the emission rate seems to be such that there is little likelihood of smoke occurrences at any time. During the "off" season at Eugene, the probability of smoke occurrences begins to rise abruptly when the Inversion Index becomes greater than 6. Above this point, the structure of inversions becomes sufficiently restrictive to increase the probability of smoke. The shape of the "off" season curve in Figure 16 was drawn by eye to conform to the data from the original 1 year sample, indicated by triangles, and data from the 5 year random sample, indicated by open

circles.

The writer feels that the stages in the realization of pollution potentiality are shown in these two figures. The "off" season curve for Salem shows a relatively pollution-free condition. As the emission rate of pollutants increases, the shape of the curve becomes like that for the "off" season at Eugene. As the increase in emission rate continues, the rising portion of the curve moves to the left and the top of the curve becomes higher. Thus, the "off" season at Eugene progresses to the smoky season at Salem, which, in turn, progresses to the smoky season at Eugene. An increase in particulate emission rates should move any of these curves up and to the left.

Having shown the relationship between the occurrence of smoke and Inversion Index (Figures 15 and 16), the writer feels that a frequency distribution of Inversion Indices would be of interest. In Figure 17, the frequency of Inversion Indices for the period from July, 1960, through June, 1961, is presented without regard to season. Similar relationships for the two seasons described could be derived from Appendix 4.

Together with Figures 5 and 6, Figures 15, 16, and 17 may be considered to be a rudimentary climatology of present air pollution in the Willamette Valley.

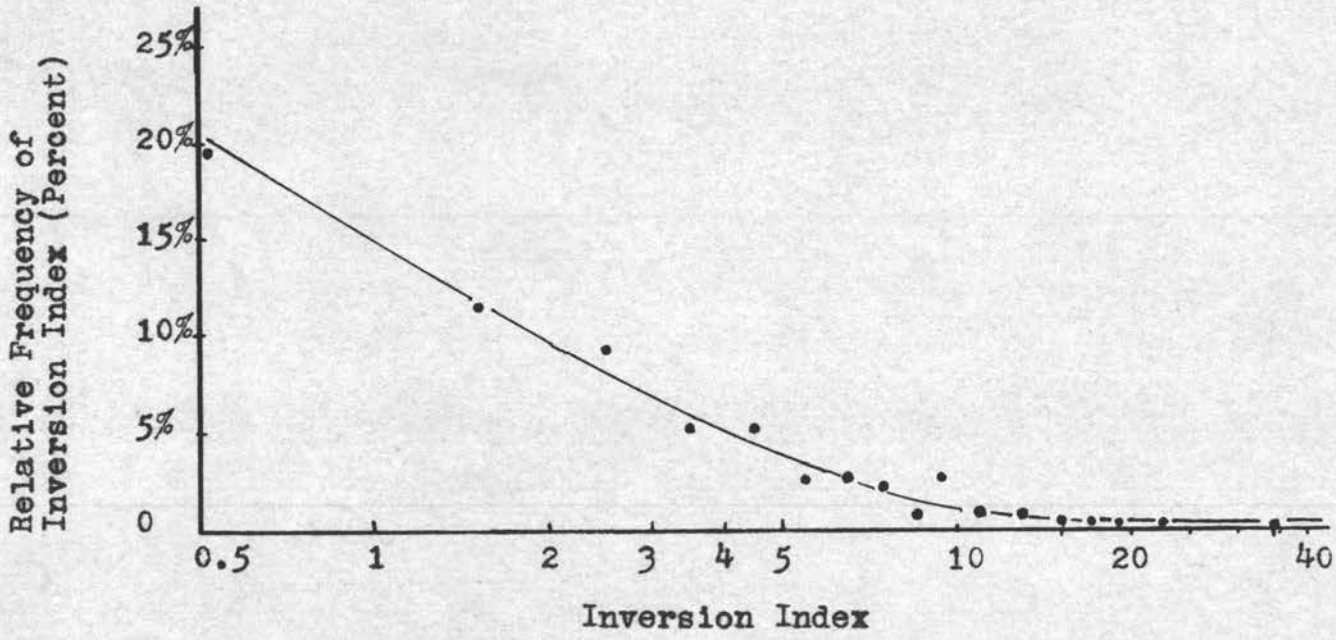

Figure 17. Frequency distribution of Inversion Index at Salem, Oregon, during the period July, 1960, through June, 1961.

Log-Normal Distribution of Particulate Count

Bryan and Hilst reported that the particulate count sampled randomly at a single location follows a log-normal distribution (1, vol.2, p.3-4). As a matter of interest, to the writer, the particulate data used in this study were plotted on log-normal coordinates (Figure 18) to see if they followed the reported distribution. The results show an approximate log-normal distribution even though the Salem data were not gathered on a random basis.

The Level of Air Pollution in the Willamette Valley in 1961

Throughout the thesis, reference has been made to high levels of pollution, smoke, as opposed to low levels of pollution. These, of course, are only relative degrees of pollution. The highest particulate count dealt with here, 165 micrograms per cubic meter, is below the 200 micrograms per cubic meter considered to be the threshold of a high level of pollution by the U.S. Public Health Service (9). Thus, in 1961, it may be concluded, conditions of pollutant emission and atmospheric stagnation are such as to produce periods of pollution at or near levels designated by responsible agencies as potentially harmful and serious enough to warrant corrective actions being taken.

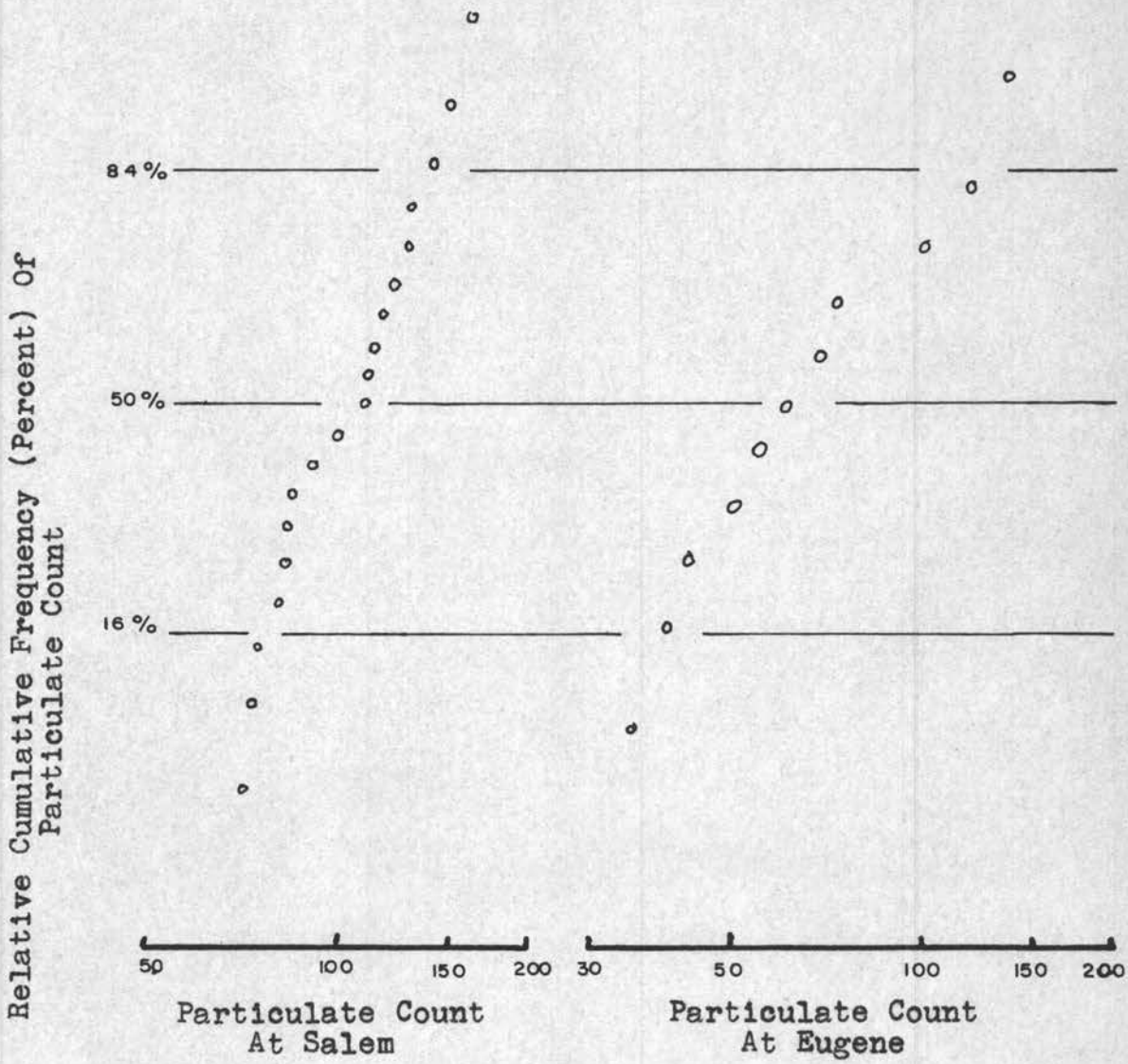

Figure 18. Relative cumulative frequency of observations of particulate count at Salem and at Eugene during selected periods of 1961.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

As a result of this study, the writer feels the following conclusions are tenable:

1. There is a definite potentiality for air pollution in the Willamette Valley.

2. There is a highly significant positive correlation between the occurrence of temperature inversions with bases below 850 millibars and the concentration of pollutants as represented by the occurrence of smoke which reduces the visibility to less than 7 miles.

3. The Inversion Index developed for the Los Angeles Basin may be used to advantage in the Willamette Valley as a single parameter combining the height of the base of an inversion and the intensity of the inversion in air pollution studies.

4. At the present time, there is a marked seasonal variation of air pollution as indicated by the occurrence of smoke. This is due, in large part, to a seasonal variation in the emission rate of particulate pollutants in the Willamette Valley.

5. At the present time, the level of pollution at Eugene is generally higher than the level of pollution at Salem.

6. It is unlikely that any simple combination of meteorological variables will provide a reliable basis for distinguishing between days having high levels of pollution and days having low levels of pollution.

As a result of this study, the following recommendations are offered by the writer to anyone who may be interested in undertaking further research in this area:

1. Additional research is needed to determine the effect of wind velocity and precipitation on air pollution in the Willamette Valley.

2. It would be desirable to use shorter sampling periods than the 24 hour periods used in this study in taking future pollutant measurements.

3. The major pollutant sources in the Willamette Valley should be inventoried, and their relative emission rates should be determined during representative periods of the year.

BIBLIOGRAPHY

1. Bryan, Joseph G. and Glenn R. Hilst. Preliminary meteorological analysis of national air sampling network data, final report. Hartford, Travelers Research Center, 1962. 2 vols.

2. California. Dept. of Public Health. Fresno air pollution study. Berkeley, 1960. 20p.

3. Council sets air pollution hearing. Capitol Journal (Salem, Oregon) p. 1, col. 6. Nov. 12, 1958.

4. Cramer, H. E. A brief survey of the meteorological aspects of atmospheric pollution. Cambridge, Massachusetts Institute of Technology, n.d. 15p.

5. Faith, W. L. Air pollution control. New York, Wiley, 1959. 259p.

6. Geiger, Rudolf. The climate near the ground. Rev. 2d ed. Tr. by Milroy N. Stewart, et al. Cambridge, Harvard University, 1959. 494p.

7. Gosline, Carl A., Jr., L. L. Falk and E. N. Helmers. Evaluation of weather effects. In: Air pollution handbook. New York, McGraw-Hill, 1956. p. 5-1 - 5-66.

8. Harding, Charles I., Samuel B. McKee and J. J. Schueneman. A report on Florida's air resources. Jacksonville, Florida State Board of Health, 1961. 66p.

9. Hatchard, Richard E., Chief, Air Pollution Control Section, Oregon Air Pollution Authority, Personal communication, January, 1962.

10. Kentucky. Louisville and Jefferson Co. Air Pollution Control Board. The air over Louisville: Summary of a joint report. 1956-57. Louisville, 1958. 57p.

11. Li, Jerome C. R. Introduction to statistical inference. Ann Arbor, Edwards Bros., 1957. 553p.

12. Manual of surface observations. 7th ed. Washington, U. S. Government printing office, 1961. 160p. (Circular N)

13. Markee, E. H., Jr. Relationships of an air quality measurement to meteorological parameters. American Industrial Hygene Association Journal 20:50-55. Feb., 1959.

14. Neiburger, Morris and James G. Edinger. Summary report on meteorology of the Los Angeles Basin with particular respect to the "smog" problem. Los Angeles, Air Pollution Foundation, 1954. 98p. (Report no. 1.)

15. Oregon. State Board of Health - Air Pollution Control. Record of high volume filter analyses, Salem. Portland, Oregon, Oregon State Sanitary Authority, 1961. 5 unnumb. leaves.

16. Oregon. State Sanitary Authority. A report on air pollution conditions in and around Roseburg. Portland, 1960. 44p. (A February, 1960 report on air pollution in and around Roseburg)

17. Oregon. State Sanitary Authority. The air pollution problem in Medford, Oregon. Portland, 1960. 57p. (A February, 1960 report on air pollution in and around Medford)

18. Robinson, Elmer. Some air pollution aspects of the Los Angeles temperature inversion. Bulletin of the American Meteorological Society 33:247-250. 1952.

19. Stanford Research Institute. The uses of meteorological data in large scale air pollution surveys. 1958. 110p. (State of California. Dept. of Public Health, Bureau of Air Sanitation, Berkeley)

20. U. S. Government Printing Office. Price list 48. Weather, astronomy, and meteorology. 47th ed. 1959. 19p.

21. U. S. Public Health Service. Air quality data. Table 1 - Suspended particulates and record of high volume filter analysis, Eugene. Cincinnati, Ohio, Robert A. Taft Sanitary Engineering Center, 1961. 1 unnumb. leaf.

22. U. S. Public Health Service. 1961 national air sampling network. Cincinnati, Ohio, Robert A. Taft Sanitary Engineering Center, 1961. 3 unnumb. leaves.

23. U. S. Weather Bureau. Local climatological data, Eugene, Oregon. Washington, July, 1956 - Sept., 1961. (Eugene Airport)

24. U. S. Weather Bureau. Local climatological data, Salem, Oregon. Washington, July, 1956 - Sept., 1961. (Salem Airport)

25. U. S. Weather Bureau. Local climatological data. Supplement. Washington, 1961. (Salem Airport)

26. U. S. Weather Bureau. Northern hemisphere data tabulations. Daily series synoptic weather maps. Part II. Washington, July, 1956 - June, 1961 and Sept., 1961. (Daily bulletin)

27. U. S. Weather Bureau. Surface weather observations. Eugene, July, 1956 - June, 1961. (WBAN 10)

28. U. S. Weather Bureau. Surface weather observations. Salem, July, 1956 - June, 1961. (WBAN 10)

APPENDIX

APPENDIX 1

Occurrences of Morning Inversions With
Bases Below 850 Millibars at Salem
July 1956 - June 1960

July	1956	1957	1958	1959
1	yes	yes	yes	yes
2	yes	yes	yes	no
3	no	yes	yes	yes
4	yes	yes	yes	yes
5	no	yes	yes	no
6	yes	no	yes	yes
7	yes	yes	yes	no
8	yes	yes	yes	yes
9	yes	no	yes	yes
10		yes	yes	yes
11	yes	no	yes	yes
12	yes	yes	yes	yes
13	yes	yes	yes	yes
14	yes	no	yes	yes
15	yes	no	yes	yes
16	yes	yes	yes	yes
17	yes	yes	yes	yes
18	yes	yes	yes	yes
19	yes	yes	yes	yes
20	yes	yes	yes	yes
21	yes	yes	yes	yes
22	yes	yes	yes	yes
23	yes	yes	yes	yes
24	yes	yes	yes	yes
25	yes	yes	yes	yes
26	yes	no	yes	yes
27	yes	yes	yes	yes
28	yes	yes	yes	yes
29	yes	yes	yes	yes
30	yes	no	yes	yes
31	yes	no	yes	yes

APPENDIX 1 (continued)

August	1956	1957	1958	1958
1	no	yes	yes	yes
2	no	yes	yes	yes
3	no	yes	yes	yes
4	no	no	yes	yes
5	yes	yes	yes	yes
6	yes	no	yes	yes
7	yes	no	no	yes
8	yes	no	yes	yes
9	yes	yes	yes	yes
10	yes	no	yes	yes
11	yes	yes	yes	yes
12	yes	yes	yes	no
13	yes	yes	yes	yes
14	yes	yes	yes	yes
15	yes	yes	yes	yes
16	yes	yes	yes	yes
17	yes	yes	yes	no
18	yes	yes	yes	no
19		no	yes	yes
20	yes	yes	yes	yes
21	yes	yes	yes	yes
22	yes	yes	yes	no
23	yes	yes	yes	yes
24	no	yes	yes	yes
25	no	yes	yes	yes
26	yes	yes	yes	no
27	no	yes	yes	yes
28	yes	yes	yes	yes
29	yes	yes	no	yes
30	yes	yes	no	yes
31	yes	yes	yes	yes

APPENDIX 1 (continued)

September	1956	1957	1958	1959
1	yes	yes	yes	yes
2	yes	yes	yes	yes
3	yes	yes	yes	yes
4	yes	yes	yes	no
5	yes	yes	yes	no
6	yes	yes	yes	no
7	yes	yes	yes	no
8	yes	yes	no	yes
9	no	yes	no	yes
10	no	yes	yes	yes
11	yes	yes	yes	yes
12	yes	yes	yes	yes
13	yes	yes	no	yes
14	yes	yes	no	yes
15	yes	yes	yes	yes
16	yes	no	yes	yes
17	yes	yes	yes	yes
18	yes	yes	yes	yes
19	yes	yes	no	no
20	no	yes	yes	no
21	yes	yes	no	no
22	yes	yes	yes	no
23	yes	yes	yes	yes
24	yes	yes	yes	yes
25	yes	yes	no	no
26	yes	yes	yes	no
27	yes	yes	yes	yes
28	yes	yes	yes	yes
29	yes	yes	yes	yes
30	yes	yes	yes	yes

APPENDIX 1 (continued)

October	1956	1957	1958	1959
1	yes	yes	yes	yes
2	yes	no	yes	yes
3	yes	no	yes	yes
4	yes	no	yes	yes
5	yes	no	yes	yes
6	yes	no	yes	no
7	yes	no	yes	yes
8	yes	yes	no	no
9	yes	yes	yes	yes
10	no	yes	yes	yes
11	yes	yes	yes	no
12	no	yes	yes	yes
13	yes	no	yes	yes
14	yes	no	yes	yes
15	yes	yes	yes	no
16	yes	yes	yes	yes
17	no	yes	yes	yes
18	no	yes	yes	yes
19	yes	yes	no	yes
20	no	yes	yes	yes
21	no	yes	yes	yes
22	yes	no	yes	no
23	no	yes	yes	no
24	no	yes	yes	no
25	yes	yes	yes	yes
26	no	yes	yes	yes
27	no	yes	yes	yes
28	yes	yes	yes	yes
29	no	yes	yes	yes
30	yes	no	yes	yes
31	yes	yes	yes	yes

APPENDIX 1 (continued)

November	1956	1957	1958	1959
1	no	yes	yes	yes
2	yes	yes	no	yes
3	yes	yes	no	yes
4	yes	yes	no	yes
5	yes	yes	no	yes
6	no	yes	no	yes
7	yes	yes	yes	yes
8	yes	yes	no	yes
9	yes	yes	yes	yes
10	yes	yes	yes	yes
11	yes	yes	yes	yes
12	yes	yes	no	yes
13	no	no	yes	yes
14	yes	no	yes	yes
15	yes	no	no	yes
16	yes	yes	yes	yes
17	no	yes	yes	yes
18	yes	yes	yes	no
19	yes	yes	no	no
20	yes	yes	no	no
21	yes	yes	yes	no
22	yes	yes	yes	yes
23	yes	yes	yes	yes
24	yes	yes	yes	yes
25	yes	yes	yes	no
26	yes	yes	yes	yes
27	yes	yes	yes	yes
28	yes	yes	yes	no
29	yes	yes	yes	yes
30	yes	yes	yes	yes

APPENDIX 1 (continued)

December	1956	1957	1958	1959
1	yes	no	yes	yes
2	yes	no	yes	yes
3	yes	yes	no	yes
4	no	yes	yes	yes
5	no	yes	yes	yes
6	yes	no	yes	yes
7	no	no	yes	yes
8	yes	yes	yes	yes
9	yes	yes	yes	yes
10	yes	yes	yes	yes
11	yes	yes	no	no
12	no	yes	yes	no
13	yes	yes	yes	yes
14	yes	no	yes	yes
15	yes	yes	yes	yes
16	no	yes	yes	yes
17	yes	no	yes	yes
18	no	yes	yes	yes
19	yes	yes	yes	yes
20	yes	no	yes	yes
21	yes	no	no	yes
22	yes	no	yes	yes
23	yes	no	yes	yes
24	yes	no	yes	no
25	yes	no	no	yes
26	yes	yes	yes	yes
27	yes	yes	no	yes
28	yes	yes	no	yes
29	yes	no	yes	yes
30	yes	no	no	yes
31	yes	yes	yes	no

APPENDIX 1 (continued)

January	1957	1958	1959	1960
1	yes	yes	no	yes
2	yes	yes	no	yes
3	no	yes	yes	yes
4	yes	yes	yes	yes
5	yes	yes	yes	yes
6	yes	yes	yes	yes
7	no	yes	yes	yes
8	yes	yes	yes	no
9	yes	yes	no	yes
10	no	yes	no	yes
11	yes	no	no	yes
12	yes	no	no	yes
13	yes	yes	yes	yes
14	yes	no	yes	yes
15	yes	no	yes	yes
16	yes	yes	no	no
17	yes	yes	yes	yes
18	yes	yes	yes	yes
19	yes	yes	no	yes
20	yes	yes	no	yes
21	yes	yes	no	yes
22	yes	yes	no	yes
23	yes	yes	yes	yes
24	yes	yes	no	yes
25	yes	no	yes	yes
26	yes	yes	no	no
27	yes	no	no	yes
28	yes	no	no	yes
29	yes	no	no	yes
30	yes	no	no	yes
31	yes	no	no	yes

APPENDIX 1 (continued)

February	1957	1958	1959	1960
1	yes	yes	yes	yes
2	yes	yes	yes	no
3	yes	yes	no	yes
4	no	yes	yes	no
5	no	yes	yes	no
6	yes	yes	no	yes
7	yes	yes	no	yes
8	no	yes	no	no
9	no	no	no	no
10	yes	no	no	yes
11	yes	yes	no	yes
12	yes	yes	yes	yes
13	yes	yes	yes	yes
14	yes	no	no	no
15	yes	no	no	no
16	yes	yes	yes	yes
17	yes	yes	yes	yes
18	yes	yes	yes	no
19	no	yes	no	yes
20	yes	yes	yes	yes
21	yes	yes	no	no
22	yes	yes	no	yes
23	yes	yes	no	yes
24	no	yes	yes	yes
25	yes	no	no	no
26	no	no	yes	yes
27	no	no	no	yes
28	yes	yes	yes	yes
29				yes

APPENDIX 1 (continued)

March	1957	1958	1959	1960
1	yes	yes	no	yes
2	no	yes	yes	yes
3	yes	yes	yes	yes
4	no	yes	yes	yes
5	no	no	yes	yes
6	no	yes	yes	yes
7	no	yes	yes	yes
8	yes	no	yes	no
9	no	no	no	no
10	yes	yes	yes	yes
11	no	yes	yes	yes
12	no	yes	no	yes
13	no	no	no	no
14	no	yes	yes	yes
15	no	yes	yes	no
16	no	yes	yes	no
17	yes	no	yes	yes
18	yes	no	no	yes
19	yes	yes	yes	yes
20	no	yes	yes	yes
21	no	yes	no	yes
22	no	yes	yes	yes
23	yes	no	no	yes
24	no	yes	no	yes
25	yes	no	yes	yes
26	yes	yes	no	yes
27	yes	yes	yes	no
28	yes	yes	no	no
29	no	yes	no	no
30	no	yes	no	no
31	yes	no	no	no

APPENDIX 1 (continued)

April	1957	1958	1959	1960
1	no	yes	no	no
2	yes	no	yes	yes
3	yes	yes	yes	yes
4	no	yes	yes	yes
5	no	yes	yes	yes
6	no	yes	yes	yes
7	yes	no	yes	yes
8	yes	no	yes	yes
9	yes	yes	yes	yes
10	no	no	no	yes
11	yes	yes	yes	no
12	no	yes	yes	yes
13	yes	yes	no	no
14	no	yes	no	yes
15	no	no	yes	yes
16	yes	no	yes	yes
17	yes	no	no	no
18	no	yes	yes	yes
19	no	no	yes	yes
20	yes	no	yes	no
21	no	no	yes	no
22	yes	no	yes	yes
23	no	no	yes	no
24	no	no	yes	yes
25	yes	yes	no	yes
26	yes	yes	no	no
27	yes	yes	no	yes
28	yes	yes	no	yes
29	yes	yes	yes	yes
30	yes	yes	no	yes

APPENDIX 1 (continued)

May	1957	1958	1959	1960
1	no	yes	yes	no
2	no	yes	no	yes
3	yes	no	yes	yes
4	yes	yes	yes	no
5	yes	no	no	yes
6	yes	no	yes	no
7	yes	yes	yes	no
8	no	no	yes	yes
9	no	yes	no	yes
10	no	yes	no	yes
11	no	no	yes	no
12	no	yes	yes	no
13	no	yes	yes	no
14	no	no	no	yes
15	no	yes	no	yes
16	no	yes	yes	yes
17	no	yes	no	no
18	no	yes	no	yes
19	no	yes	yes	yes
20	no	yes	yes	no
21	yes	yes	no	no
22	yes	yes	yes	yes
23	no	yes	yes	yes
24	no	yes	yes	yes
25	yes	yes	no	yes
26	yes	yes	no	no
27	yes	yes	yes	yes
28	yes	yes	yes	yes
29	yes	no	yes	yes
30	yes	no	yes	yes
31	yes	no	yes	no

APPENDIX 1 (continued)

June	1957	1958	1959	1960
1	yes	yes	yes	yes
2	yes	yes	yes	yes
3	yes	no	no	yes
4	yes	yes	yes	yes
5	yes	yes	no	yes
6	no	yes	yes	yes
7	yes	no	no	yes
8	no	yes	no	yes
9	yes	yes	no	yes
10	yes	no	no	yes
11	yes	no	no	yes
12	yes	no	no	yes
13	yes	no	yes	yes
14	no	yes	no	yes
15	no	yes	yes	no
16	yes	yes	yes	yes
17	yes	yes	no	yes
18	yes	yes	yes	yes
19	no	yes	yes	no
20	no	yes	yes	yes
21	yes	yes	yes	yes
22	yes	yes	yes	yes
23	yes	yes	yes	yes
24	yes	no	no	yes
25	yes	yes	yes	yes
26	yes	yes	no	yes
27	yes	yes	no	yes
28	yes	yes	yes	yes
29	yes	no	yes	yes
30	no	no	yes	no

APPENDIX 2

Occurrences of Smoke Which Reduce Visibility to Less Than Seven Miles at Salem July 1956 - June 1960

July	1956	1957	1958	1959
1	no	no	no	no
2	no	no	no	no
3	no	no	yes	no
4	no	no	no	no
5	no	no	no	no
6	no	no	no	no
7	no	no	no	no
8	no	no	no	no
9	no	no	no	no
10	no	no	yes	no
11	no	no	no	no
12	yes	no	no	no
13	no	no	no	no
14	no	no	no	no
15	no	no	no	no
16	no	no	no	no
17	no	no	no	no
18	no	no	no	no
19	no	no	no	no
20	no	no	no	no
21	no	no	no	no
22	no	yes	no	no
23	no	no	no	no
24	no	no	no	no
25	no	no	no	no
26	no	no	no	no
27	no	no	no	no
28	no	no	no	no
29	no	no	no	no
30	no	no	no	no
31	no	no	no	no

APPENDIX 2 (continued)

August	1956	1957	1958	1959
1	no	no	no	no
2	no	no	no	no
3	no	no	no	no
4	no	no	no	no
5	no	no	no	no
6	no	no	no	no
7	no	no	no	no
8	no	no	no	no
9	no	no	no	no
10	no	no	no	no
11	no	no	no	no
12	yes	no	yes	no
13	no	no	no	no
14	yes	yes	no	no
15	no	yes	no	no
16	no	no	no	no
17	no	no	no	no
18	no	no	no	no
19	no	no	no	no
20	no	no	no	yes
21	no	no	no	no
22	no	no	no	yes
23	no	no	no	no
24	no	yes	no	no
25	yes	no	no	no
26	no	no	no	no
27	no	no	no	no
28	no	no	no	no
29	no	no	no	no
30	no	no	no	no
31	no	no	no	no

APPENDIX 2 (continued)

September	1956	1957	1958	1959
1	no	no	no	no
2	no	no	no	no
3	no	no	yes	no
4	no	no	yes	no
5	no	no	no	no
6	no	no	no	no
7	no	no	no	no
8	no	no	no	no
9	no	no	no	no
10	no	no	no	yes
11	no	no	yes	no
12	yes	yes	no	yes
13	no	yes	no	yes
14	yes	no	no	no
15	yes	no	no	no
16	yes	no	no	yes
17	yes	no	no	yes
18	yes	no	no	yes
19	yes	no	no	no
20	no	no	no	no
21	no	yes	no	no
22	no	no	no	no
23	yes	yes	no	yes
24	no	yes	no	yes
25	no	yes	no	no
26	no	yes	no	no
27	no	no	no	no
28	no	no	no	no
29	yes	no	yes	no
30	no	no	yes	yes

APPENDIX 2 (continued)

October	1956	1957	1958	1959
1	yes	no	yes	yes
2	no	no	yes	no
3	yes	no	yes	no
4	yes	no	yes	yes
5	yes	no	yes	yes
6	no	no	no	yes
7	no	no	no	no
8	yes	no	no	no
9	yes	no	no	no
10	no	no	no	no
11	yes	no	no	no
12	no	no	no	no
13	no	no	no	yes
14	no	no	yes	yes
15	no	no	yes	no
16	yes	no	yes	yes
17	yes	no	yes	yes
18	no	no	no	yes
19	no	yes	no	no
20	no	yes	no	no
21	no	yes	no	no
22	no	no	no	no
23	no	yes	no	yes
24	no	no	no	yes
25	no	no	no	no
26	no	yes	yes	no
27	no	yes	yes	no
28	no	yes	yes	no
29	no	no	yes	no
30	no	no	yes	no
31	no	yes	yes	yes

APPENDIX 2 (continued)

November	1956	1957	1958	1959
1	no	yes	yes	yes
2	yes	no	yes	yes
3	no	no	no	yes
4	no	yes	no	no
5	no	yes	no	no
6	no	yes	no	yes
7	yes	yes	no	yes
8	yes	yes	yes	no
9	yes	yes	no	yes
10	yes	yes	no	yes
11	yes	no	no	yes
12	yes	no	no	yes
13	no	no	no	no
14	no	no	no	no
15	no	no	no	no
16	no	no	no	no
17	no	yes	no	yes
18	no	no	no	no
19	no	yes	no	no
20	yes	yes	no	no
21	yes	no	no	no
22	yes	yes	no	no
23	no	yes	no	no
24	no	yes	no	yes
25	no	yes	no	no
26	yes	no	no	no
27	no	no	no	no
28	no	no	no	no
29	no	no	yes	no
30	yes	yes	yes	yes

APPENDIX 2 (continued)

December	1956	1957	1958	1959
1	yes	no	yes	yes
2	yes	no	no	yes
3	yes	no	no	yes
4	no	no	no	no
5	no	no	yes	yes
6	no	no	no	yes
7	no	no	no	no
8	no	no	yes	yes
9	no	no	yes	yes
10	no	no	yes	yes
11	no	yes	no	no
12	no	no	no	no
13	no	yes	no	no
14	no	no	no	no
15	no	no	yes	no
16	no	no	no	no
17	no	no	yes	yes
18	no	no	no	no
19	no	no	yes	yes
20	no	no	yes	yes
21	no	no	no	yes
22	no	no	yes	no
23	no	no	yes	yes
24	no	no	no	no
25	no	no	no	no
26	no	no	no	no
27	no	no	no	yes
28	no	no	no	no
29	no	no	no	no
30	yes	yes	no	no
31	no	no	yes	yes

APPENDIX 2 (continued)

January	1957	1958	1959	1960
1	no	no	no	no
2	no	yes	no	yes
3	no	yes	no	yes
4	no	yes	no	yes
5	no	yes	no	yes
6	no	yes	no	no
7	no	yes	no	yes
8	no	yes	no	yes
9	no	yes	no	no
10	no	no	no	no
11	no	no	yes	no
12	no	no	no	no
13	no	no	no	no
14	no	no	yes	no
15	no	no	yes	no
16	no	no	no	no
17	no	no	no	no
18	no	no	no	no
19	yes	no	no	no
20	yes	no	no	no
21	yes	no	no	no
22	no	no	no	no
23	no	no	no	no
24	no	no	no	yes
25	no	no	no	yes
26	no	no	no	no
27	no	no	no	no
28	no	no	no	yes
29	no	no	no	no
30	no	no	no	yes
31	no	no	yes	yes

APPENDIX 2 (continued)

February	1957	1958	1959	1960
1	no	no	no	no
2	no	no	no	no
3	no	no	yes	no
4	no	no	no	no
5	no	no	no	no
6	no	no	no	no
7	yes	no	no	no
8	yes	no	no	no
9	no	no	no	no
10	no	no	no	no
11	no	no	no	no
12	no	no	yes	no
13	yes	no	no	no
14	yes	no	no	no
15	no	no	no	no
16	no	no	no	no
17	no	no	no	no
18	no	yes	no	no
19	no	no	no	yes
20	no	yes	no	no
21	no	yes	no	no
22	no	no	no	no
23	no	no	no	no
24	no	no	no	no
25	no	no	no	no
26	no	no	no	no
27	no	yes	no	no
28	no	yes	no	no
29				no

APPENDIX 2 (continued)

March	1957	1958	1959	1960
1	no	yes	no	yes
2	no	no	no	no
3	no	no	no	no
4	no	no	no	no
5	no	no	no	no
6	no	yes	no	no
7	no	no	no	no
8	no	no	no	no
9	no	no	no	no
10	no	no	no	no
11	no	no	no	no
12	no	no	no	no
13	no	no	no	no
14	no	no	no	no
15	no	no	no	no
16	no	yes	yes	no
17	no	no	no	no
18	yes	no	no	no
19	no	no	no	yes
20	no	no	no	no
21	no	no	no	yes
22	no	no	no	yes
23	no	no	no	yes
24	no	no	no	no
25	no	no	no	yes
26	no	no	no	no
27	no	no	no	no
28	no	no	no	no
29	no	yes	no	no
30	no	no	no	no
31	no	no	no	no

APPENDIX 2 (continued)

April	1957	1958	1959	1960
1	no	no	no	no
2	no	no	no	no
3	no	no	yes	no
4	no	no	no	no
5	no	no	no	no
6	no	no	no	no
7	no	no	no	no
8	no	no	no	no
9	no	no	no	no
10	no	no	no	no
11	no	yes	no	no
12	no	no	no	no
13	no	no	no	no
14	no	no	no	no
15	no	no	no	no
16	no	no	no	yes
17	no	no	no	no
18	no	no	no	no
19	no	no	no	no
20	no	no	no	no
21	no	no	no	no
22	no	no	no	no
23	no	no	no	no
24	no	no	no	no
25	no	no	no	no
26	no	no	no	no
27	no	no	no	no
28	no	no	no	no
29	no	no	no	no
30	no	no	no	yes

APPENDIX 2 (continued)

May	1957	1958	1959	1960
1	no	no	no	no
2	no	no	no	no
3	no	no	no	no
4	no	no	no	no
5	no	no	no	no
6	no	no	no	no
7	no	no	no	no
8	no	no	no	no
9	no	no	no	no
10	no	no	no	no
11	no	no	no	no
12	no	no	no	no
13	no	no	no	no
14	no	no	no	no
15	no	no	no	no
16	no	no	no	no
17	no	no	no	no
18	no	no	no	no
19	no	no	no	no
20	no	no	no	no
21	no	no	no	no
22	no	no	no	no
23	no	no	no	no
24	no	no	no	no
25	no	no	no	no
26	no	no	no	no
27	no	no	no	no
28	no	no	no	no
29	no	no	no	no
30	yes	no	no	no
31	no	no	no	no

APPENDIX 2 (continued)

June	1957	1958	1959	1960
1	no	no	no	no
2	no	no	no	no
3	no	no	no	no
4	no	no	no	no
5	no	no	no	no
6	no	no	no	no
7	no	no	no	no
8	no	no	no	no
9	no	no	no	no
10	no	no	no	no
11	no	no	no	no
12	no	no	no	no
13	no	no	no	no
14	no	no	no	no
15	no	no	no	no
16	no	no	no	no
17	no	no	no	no
18	no	no	no	no
19	no	no	no	no
20	no	no	no	no
21	no	no	no	no
22	no	no	no	no
23	no	no	no	no
24	no	no	no	no
25	no	no	no	no
26	no	no	no	no
27	no	no	no	no
28	no	no	no	no
29	no	no	no	no
30	no	no	no	no

APPENDIX 3

Occurrences of Smoke Which Reduce Visibility to Less Than Seven Miles at Eugene July 1956 - June 1960

July	1956	1957	1958	1959
1	no	no	yes	yes
2	no	no	no	no
3	no	no	no	no
4	no	no	no	no
5	no	no	no	no
6	no	no	no	no
7	no	no	no	no
8	no	no	yes	no
9	no	no	no	no
10	no	no	yes	no
11	no	no	yes	no
12	no	no	no	no
13	no	no	yes	no
14	no	no	no	no
15	no	no	yes	no
16	yes	no	no	no
17	yes	no	no	no
18	yes	no	no	yes
19	yes	yes	yes	yes
20	no	no	no	no
21	no	no	no	no
22	no	yes	no	no
23	no	no	no	no
24	no	no	no	no
25	no	no	no	no
26	no	no	no	no
27	no	no	no	no
28	no	no	no	no
29	no	no	no	no
30	no	no	no	yes
31	no	no	no	no

APPENDIX 3 (continued)

August	1956	1957	1958	1959
1	no	no	no	no
2	no	no	no	no
3	no	no	no	no
4	yes	no	no	no
5	no	no	no	no
6	no	no	no	no
7	yes	no	yes	no
8	no	no	no	no
9	no	no	no	no
10	no	no	no	no
11	yes	no	no	no
12	yes	no	yes	no
13	no	no	no	no
14	yes	yes	yes	no
15	no	yes	no	yes
16	no	yes	no	no
17	yes	yes	no	no
18	yes	yes	no	no
19	no	no	no	yes
20	no	yes	no	no
21	yes	yes	no	no
22	no	yes	no	yes
23	no	no	no	no
24	no	no	yes	no
25	no	no	no	yes
26	no	no	no	no
27	no	yes	no	no
28	no	no	no	no
29	yes	no	yes	no
30	no	no	no	no
31	yes	no	no	no

APPENDIX 3 (continued)

September	1956	1957	1958	1959
1	no	no	no	yes
2	no	no	no	yes
3	no	no	yes	no
4	no	no	yes	no
5	no	no	yes	no
6	yes	no	yes	no
7	yes	no	no	no
8	no	no	no	no
9	no	no	yes	yes
10	no	no	yes	no
11	no	no	no	no
12	yes	yes	no	yes
13	yes	yes	no	no
14	no	yes	no	no
15	yes	no	no	no
16	yes	yes	no	yes
17	yes	no	no	yes
18	yes	no	yes	no
19	yes	no	no	no
20	no	no	yes	no
21	yes	yes	yes	no
22	yes	no	no	no
23	yes	no	no	yes
24	yes	yes	yes	yes
25	yes	yes	yes	yes
26	no	yes	yes	no
27	no	no	yes	no
28	no	no	yes	yes
29	no	yes	yes	yes
30	no	yes	yes	yes

APPENDIX 3 (continued)

October	1956	1957	1958	1959
1	no	no	yes	no
2	yes	no	yes	yes
3	yes	no	yes	yes
4	yes	no	yes	yes
5	no	no	yes	yes
6	yes	no	no	no
7	yes	no	no	no
8	yes	yes	no	no
9	yes	no	no	no
10	no	yes	yes	yes
11	no	yes	yes	no
12	no	yes	yes	no
13	yes	no	yes	yes
14	yes	no	yes	yes
15	yes	yes	yes	no
16	yes	yes	yes	yes
17	yes	yes	yes	yes
18	yes	yes	yes	yes
19	yes	yes	no	yes
20	no	no	yes	no
21	no	yes	yes	yes
22	yes	yes	yes	no
23	no	yes	yes	yes
24	no	yes	yes	yes
25	yes	yes	yes	no
26	no	yes	yes	no
27	no	yes	yes	no
28	no	yes	yes	yes
29	no	yes	yes	yes
30	no	yes	yes	yes
31	no	yes	yes	yes

APPENDIX 3 (continued)

November	1956	1957	1958	1959
1	no	yes	yes	yes
2	no	no	yes	yes
3	yes	no	no	yes
4	yes	yes	yes	yes
5	yes	yes	no	no
6	yes	yes	no	yes
7	yes	yes	no	yes
8	yes	yes	no	yes
9	yes	yes	no	yes
10	yes	yes	no	yes
11	yes	no	no	yes
12	yes	no	no	yes
13	no	no	no	no
14	yes	no	no	yes
15	yes	no	no	yes
16	yes	yes	yes	no
17	no	yes	no	yes
18	yes	no	no	yes
19	no	yes	no	yes
20	yes	yes	no	no
21	yes	yes	yes	no
22	yes	yes	no	no
23	yes	no	yes	no
24	yes	yes	yes	yes
25	yes	yes	no	yes
26	yes	yes	no	no
27	yes	yes	yes	yes
28	yes	yes	yes	yes
29	yes	yes	yes	yes
30	yes	no	no	yes

APPENDIX 3 (continued)

December	1956	1957	1958	1959
1	yes	no	no	yes
2	yes	yes	no	yes
3	yes	yes	no	yes
4	no	yes	yes	yes
5	no	yes	yes	yes
6	no	no	yes	no
7	no	no	no	yes
8	no	no	yes	yes
9	no	no	yes	yes
10	yes	no	yes	yes
11	no	yes	no	no
12	no	yes	no	no
13	no	yes	yes	no
14	yes	no	no	no
15	yes	yes	yes	yes
16	no	yes	yes	yes
17	no	no	yes	yes
18	no	no	yes	yes
19	no	no	yes	yes
20	yes	no	yes	yes
21	no	no	no	yes
22	no	no	yes	yes
23	no	no	yes	yes
24	yes	no	yes	yes
25	no	no	no	no
26	yes	no	no	yes
27	no	no	no	yes
28	no	no	no	yes
29	no	no	no	yes
30	yes	no	yes	no
31	yes	yes	yes	no

APPENDIX 3 (continued)

January	1957	1958	1959	1960
1	yes	yes	no	yes
2	yes	yes	no	no
3	yes	no	no	yes
4	yes	yes	yes	yes
5	no	no	yes	yes
6	yes	yes	no	yes
7	no	yes	no	yes
8	no	yes	no	yes
9	no	yes	no	yes
10	yes	yes	no	yes
11	no	no	no	no
12	yes	no	no	no
13	no	no	no	no
14	no	no	yes	no
15	yes	no	yes	no
16	no	no	yes	no
17	no	no	yes	yes
18	yes	yes	no	no
19	yes	yes	no	yes
20	no	no	no	no
21	no	no	no	no
22	no	no	no	no
23	no	no	no	yes
24	no	no	no	yes
25	no	no	no	yes
26	no	yes	no	yes
27	no	no	no	yes
28	no	no	no	no
29	yes	no	yes	no
30	yes	no	no	no
31	no	no	no	no

APPENDIX 3 (continued)

February	1957	1958	1959	1960
1	no	no	no	no
2	no	no	no	no
3	no	no	yes	no
4	no	no	no	yes
5	no	no	no	no
6	no	no	no	no
7	yes	no	no	yes
8	yes	no	no	no
9	yes	no	no	no
10	yes	no	no	yes
11	no	yes	yes	yes
12	yes	no	no	no
13	yes	no	no	no
14	yes	no	no	no
15	yes	no	no	no
16	yes	no	no	yes
17	yes	yes	no	yes
18	yes	no	no	yes
19	no	no	no	yes
20	no	no	yes	yes
21	no	yes	no	no
22	yes	no	no	no
23	yes	no	no	yes
24	no	no	no	yes
25	no	no	no	no
26	no	no	yes	no
27	no	yes	no	no
28	yes	yes	no	no
29				no

APPENDIX 3 (continued)

March	1957	1958	1959	1960
1	yes	yes	no	yes
2	no	no	yes	no
3	no	no	no	no
4	no	no	yes	yes
5	no	no	yes	no
6	yes	yes	yes	yes
7	no	no	no	yes
8	yes	no	no	no
9	no	no	no	no
10	no	yes	no	yes
11	no	no	yes	yes
12	no	no	no	yes
13	no	no	no	yes
14	no	yes	no	no
15	no	no	no	no
16	no	yes	yes	yes
17	no	no	no	yes
18	yes	no	no	yes
19	no	no	no	yes
20	no	yes	yes	no
21	no	no	no	yes
22	no	no	no	yes
23	no	no	no	yes
24	yes	no	no	yes
25	no	no	no	no
26	no	no	no	no
27	yes	no	no	no
28	no	no	no	no
29	no	no	no	no
30	no	no	no	no
31	no	no	no	no

APPENDIX 3 (continued)

April	1957	1958	1959	1960
1	no	no	yes	no
2	no	no	no	no
3	no	no	no	yes
4	no	no	no	yes
5	no	no	no	no
6	no	no	no	yes
7	no	no	no	no
8	no	no	no	no
9	no	no	no	no
10	no	no	no	no
11	no	yes	no	no
12	no	no	no	no
13	no	no	no	no
14	no	no	yes	no
15	no	no	yes	no
16	no	yes	yes	no
17	no	no	no	no
18	no	no	no	no
19	no	no	no	yes
20	no	no	yes	no
21	no	no	no	no
22	no	no	no	yes
23	no	no	no	yes
24	no	no	no	no
25	no	yes	no	no
26	yes	no	no	no
27	yes	no	no	no
28	yes	no	no	no
29	no	no	no	no
30	no	no	no	yes

APPENDIX 3 (continued)

May	1957	1958	1959	1960
1	no	no	no	no
2	no	no	no	no
3	yes	no	no	no
4	yes	no	no	yes
5	no	no	yes	yes
6	no	no	no	yes
7	no	yes	no	no
8	no	yes	no	no
9	no	no	no	no
10	no	no	no	no
11	no	no	no	no
12	no	no	no	no
13	no	yes	no	no
14	no	yes	no	no
15	yes	no	no	yes
16	no	yes	no	no
17	no	no	no	no
18	no	no	no	no
19	no	no	yes	no
20	no	no	yes	no
21	no	no	no	no
22	no	no	no	no
23	no	no	no	no
24	no	no	no	no
25	no	no	no	yes
26	no	no	no	yes
27	no	no	no	no
28	no	no	no	yes
29	yes	no	no	no
30	no	no	no	no
31	no	no	yes	no

APPENDIX 3 (continued)

June	1957	1958	1959	1960
1	no	no	no	yes
2	no	no	no	no
3	no	no	no	no
4	no	no	no	no
5	no	yes	no	no
6	no	no	no	no
7	no	yes	no	no
8	no	no	no	no
9	no	no	no	no
10	no	no	no	yes
11	no	no	no	yes
12	no	no	no	no
13	no	no	no	no
14	no	no	no	no
15	no	no	no	no
16	no	no	no	no
17	no	yes	no	no
18	no	no	yes	no
19	no	no	no	no
20	no	no	no	no
21	no	yes	no	no
22	no	yes	no	no
23	no	no	no	yes
24	no	no	no	no
25	no	no	no	no
26	yes	no	yes	no
27	no	no	no	no
28	no	no	no	no
29	no	no	no	no
30	no	no	no	no

APPENDIX 4

Continuation of Data From Appendices 1 Through 3 With Accompanying Inversion Indices July 1960 - June 1961

July	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	no	no	no	0
2	no	no	yes	4.8
3	no	no	yes	.54
4	no	no	yes	4.9
5	no	no	yes	4.0
6	no	no	yes	1.4
7	no	no	yes	.32
8	no	no	yes	1.8
9	no	no	yes	2.2
10	no	no	yes	1.2
11	no	no	yes	9.1
12	no	no	yes	2.7
13	no	no	no	0
14	no	no	yes	1.1
15	yes	no	yes	12
16	no	no	yes	16
17	no	no	yes	13
18	no	no	yes	2.4
19	no	no	yes	2.8
20	no	no	yes	18
21	no	no	yes	1.9
22	no	no	yes	5.8
23	no	no	yes	2.0
24	no	no	yes	1.7
25	no	no	yes	6.7
26	yes	no	yes	9.0
27	no	no	yes	5.3
28	no	no	yes	4.3
29	yes	no	yes	8.0
30	no	no	yes	11
31	no	no	yes	1.8

APPENDIX 4 (continued)

August	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	no	no	yes	2.0
2	no	no	yes	1.1
3	no	no	yes	1.0
4	no	no	yes	1.3
5	no	no	yes	1.2
6	yes	no	yes	.72
7	no	no	yes	2.3
8	no	no	yes	7.4
9	no	no	yes	4.5
10	no	no	yes	4.9
11	yes	no	yes	2.5
12	no	no	yes	3.9
13	no	no	yes	1.9
14	no	no	yes	.19
15	no	no	no	0
16	no	no	no	0
17	yes	no	no	0
18	no	yes	yes	2.1
19	yes	no	yes	.21
20	yes	no	yes	1.9
21	no	no	no	0
22	no	no	no	0
23	no	no	no	0
24	no	no	no	0
25	yes	no	no	0
26	no	no	no	0
27	yes	no	no	0
28	no	no	yes	.96
29	yes	no	no	0
30	yes	no	yes	21
31	yes	yes	no	0

APPENDIX 4 (continued)

September	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	no	no	yes	.57
2	yes	yes	yes	.30
3	yes	yes	yes	3.2
4	no	no	no	0
5	no	no	no	0
6	no	no	yes	2.2
7	yes	no	yes	1.7
8	no	no	yes	.35
9	yes	no	yes	.44
10	yes	no	yes	2.3
11	no	no	yes	6.6
12	yes	yes	yes	3.6
13	yes	yes	yes	3.7
14	yes	yes	yes	5.4
15	yes	yes	yes	1.1
16	yes	yes	yes	1.8
17	yes	yes	yes	1.5
18	yes	yes	yes	7.1
19	yes	yes	yes	2.1
20	no	no	yes	.38
21	yes	yes	yes	1.6
22	yes	no	yes	2.4
23	yes	no	yes	.49
24	yes	yes	yes	9.1
25	yes	yes	yes	1.1
26	yes	yes	yes	3.7
27	yes	yes	yes	4.4
28	yes	yes	yes	11
29	yes	yes	yes	6.7
30	yes	yes	yes	2.8

APPENDIX 4 (continued)

October	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	yes	yes	yes	.49
2	no	no	yes	mm
3	no	yes	yes	.94
4	yes	yes	yes	3.3
5	yes	yes	yes	13.7
6	yes	no	no	0
7	no	no	no	0
8	no	no	no	0
9	yes	no	yes	3.7
10	yes	yes	yes	6.9
11	yes	no	yes	7.9
12	yes	no	yes	1.6
13	yes	yes	yes	small
14	yes	yes	yes	1.6
15	yes	yes	yes	6.0
16	yes	no	yes	small
17	yes	no	yes	9.0
18	yes	yes	yes	6.4
19	yes	yes	yes	5.6
20	yes	yes	yes	1.1
21	yes	yes	yes	.90
22	yes	yes	yes	.52
23	yes	yes	yes	4.4
24	no	no	no	0
25	yes	no	yes	7.4
26	no	no	no	0
27	no	no	no	0
28	no	no	yes	.68
29	yes	yes	yes	.56
30	yes	yes	yes	9.3
31	no	no	no	0

APPENDIX 4 (continued)

November	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	no	no	yes	small
2	yes	yes	yes	1.5
3	no	yes	yes	3.0
4	no	no	yes	.84
5	no	no	yes	1.5
6	no	no	yes	3.3
7	no	no	no	0
8	yes	yes	yes	2.4
9	yes	yes	yes	.98
10	yes	yes	no	0
11	no	no	no	0
12	yes	no	no	0
13	yes	no	no	0
14	no	no	no	0
15	no	no	yes	.19
16	no	no	no	0
17	no	no	no	0
18	no	no	no	0
19	no	no	no	0
20	no	no	yes	small
21	no	no	no	0
22	no	no	yes	2.9
23	no	no	no	0
24	no	no	no	0
25	no	no	yes	1.3
26	yes	yes	yes	small
27	no	no	yes	.97
28	no	yes	yes	9.5
29	yes	no	yes	17
30	yes	no	yes	9.4

APPENDIX 4 (continued)

December	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	yes	no	no	0
2	no	no	yes	1.5
3	no	no	yes	1.1
4	no	no	yes	6.7
5	no	no	yes	.44
6	yes	no	yes	5.6
7	yes	no	yes	22
8	yes	no	yes	9.6
9	yes	no	yes	12
10	yes	yes	yes	4.0
11	yes	yes	yes	2.8
12	no	no	no	0
13	yes	yes	yes	20
14	yes	no	no	0
15	no	no	yes	.82
16	no	no	yes	4.8
17	yes	no	yes	8.8
18	no	no	no	0
19	no	yes	yes	.61
20	yes	yes	yes	4.5
21	yes	yes	yes	10
22	yes	yes	yes	14
23	yes	yes	yes	43
24	yes	yes	yes	33
25	yes	yes	yes	.73
26	no	no	yes	small
27	yes	yes	yes	2.2
28	yes	no	yes	6.9
29	yes	no	yes	23
30	yes	yes	yes	1.8
31	no	no	yes	2.3

APPENDIX 4 (continued)

January	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	yes	yes	yes	.88
2	yes	yes	yes	1.8
3	yes	no	yes	3.3
4	yes	yes	yes	2.2
5	no	no	no	0
6	no	no	no	0
7	yes	no	yes	5.4
8	no	no	no	0
9	no	no	yes	6.1
10	no	no	yes	small
11	yes	no	yes	2.8
12	no	no	yes	small
13	no	no	no	0
14	no	no	yes	.76
15	no	no	no	0
16	no	no	no	0
17	no	no	yes	small
18	yes	yes	yes	3.0
19	yes	no	yes	18
20	no	no	yes	14
21	yes	no	yes	28
22	yes	no	yes	12
23	yes	yes	yes	4.1
24	yes	yes	yes	4.8
25	yes	no	yes	4.0
26	no	no	yes	2.1
27	no	no	yes	2.9
28	yes	yes	yes	6.1
29	no	yes	yes	2.6
30	yes	no	no	0
31	no	no	no	0

APPENDIX 4 (continued)

February	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	no	no	yes	3.8
2	yes	no	yes	small
3	no	no	no	0
4	no	no	no	0
5	no	no	yes	1.4
6	no	no	no	0
7	no	no	no	0
8	yes	no	no	0
9	no	no	yes	2.1
10	yes	no	no	0
11	no	no	no	0
12	no	no	no	0
13	no	no	no	0
14	no	no	no	0
15	no	no	yes	small
16	no	no	yes	small
17	no	no	no	0
18	yes	no	yes	3.5
19	no	no	no	0
20	no	no	no	0
21	no	no	no	0
22	no	no	no	0
23	no	no	yes	2.7
24	no	no	yes	3.4
25	no	no	no	0
26	no	no	yes	3.2
27	no	no	yes	1.9
28	no	no	yes	.33

APPENDIX 4 (continued)

March	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	no	no	no	0
2	no	no	no	0
3	no	no	no	0
4	yes	no	no	0
5	no	no	no	0
6	no	no	no	0
7	no	no	yes	small
8	yes	no	yes	8.4
9	no	no	no	0
10	no	no	no	0
11	no	no	no	0
12	no	no	no	0
13	no	no	no	0
14	no	no	yes	2.0
15	no	no	yes	2.4
16	no	no	no	0
17	yes	no	yes	3.6
18	yes	yes	yes	5.3
19	no	yes	yes	12
20	no	no	no	0
21	yes	yes	yes	2.6
22	no	no	yes	3.2
23	no	no	no	0
24	no	no	no	0
25	no	no	yes	1.1
26	no	no	no	0
27	no	no	no	0
28	yes	no	yes	10
29	yes	no	yes	.58
30	yes	no	yes	7.3
31	no	no	no	0

APPENDIX 4 (continued)

April	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	no	no	yes	1.5
2	no	no	no	0
3	no	no	yes	small
4	no	no	yes	.64
5	no	no	yes	.64
6	no	no	yes	.86
7	yes	no	yes	.72
8	no	no	yes	1.3
9	no	no	yes	small
10	yes	no	yes	small
11	yes	no	yes	.64
12	no	no	no	0
13	no	no	no	0
14	yes	no	yes	small
15	no	no	yes	1.7
16	no	no	yes	4.2
17	no	no	no	0
18	no	no	no	0
19	no	no	no	0
20	no	no	no	0
21	no	no	no	0
22	yes	no	no	0
23	yes	no	no	0
24	no	no	no	0
25	yes	no	yes	small
26	yes	no	yes	.63
27	yes	no	yes	.64
28	no	no	yes	small
29	no	no	yes	2.6
30	no	no	no	0

APPENDIX 4 (continued)

May	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	no	no	yes	small
2	no	no	no	0
3	no	no	no	0
4	no	no	yes	2.9
5	no	no	no	0
6	no	no	no	0
7	no	no	yes	small
8	no	no	no	0
9	no	no	no	0
10	no	no	no	0
11	no	no	no	0
12	no	no	yes	11
13	no	no	yes	.45
14	no	no	no	0
15	no	no	yes	small
16	yes	no	yes	7.2
17	no	no	yes	5.3
18	no	no	yes	7.9
19	no	no	yes	20
20	no	no	yes	2.4
21	no	no	yes	.70
22	no	no	no	0
23	no	no	yes	.72
24	no	no	yes	4.1
25	no	no	yes	.98
26	no	no	no	0
27	no	no	no	0
28	yes	no	yes	4.5
29	no	no	yes	.33
30	no	no	yes	small
31	no	no	no	0

APPENDIX 4 (continued)

June	Smoke at Eugene	Smoke at Salem	Inversion Below 850mb	Inversion Index
1	yes	no	yes	7.7
2	no	no	yes	4.4
3	no	no	yes	5.8
4	no	no	yes	9.0
5	no	no	yes	2.7
6	yes	no	yes	1.3
7	yes	no	yes	1.6
8	no	no	yes	1.1
9	no	no	no	0
10	yes	yes	yes	small
11	no	no	no	0
12	no	no	no	0
13	yes	no	yes	9.8
14	no	no	yes	3.9
15	no	no	yes	21
16	no	no	yes	23
17	no	yes	yes	4.1
18	no	no	yes	10
19	no	no	yes	2.1
20	no	no	yes	1.4
21	no	no	yes	3.6
22	no	no	yes	11
23	no	no	yes	1.3
24	no	no	yes	1.0
25	no	no	yes	small
26	no	no	yes	.73
27	no	no	yes	small
28	no	no	no	0
29	no	no	yes	small
30	yes	no	yes	1.5

APPENDIX 5

Five year random sample of occurrences of inversions below 850 millibars with Inversion Indices at Salem, and associated temperature ranges and smoke occurrences at Salem and Eugene.
July 1956 - June 1961

JULY	INV.[1]	IND.[2]	TR_E[3]	K_E[4]	TR_S[5]	K_S[6]
5-56	no	0	17	no	17	no
18-56	yes	16	48	yes	50	no
26-56	yes	3.3	37	no	39	no
3-57	yes	7.2	35	no	35	no
7-57	yes	6.9	33	no	35	no
21-57	yes	1.6	27	no	27	no
24-57	yes	6.4	35	no	35	no
17-58	yes	2.9	21	no	26	no
18-58	yes	2.4	23	no	27	no
15-58	yes	28	45	yes	48	no
7-59	no	0	22	no	21	no
11-59	yes	13	37	no	38	no
12-59	yes	3.8	33	no	31	no
23-59	yes	18	28	no	29	no
27-59	yes	5.2	28	no	31	no
3-60	yes	.54	34	no	37	no
9-60	yes	2.2	35	no	37	no
10-60	yes	1.2	36	no	33	no
13-60	no	0	24	no	26	no
23-60	yes	2.0	34	no	36	no

1. Inversion occurrence below 850 millibars at Salem.
2. Inversion Index.
3. Temperature range at Eugene in degrees Fahrenheit.
4. Reduction of visibility to less than 7 miles by smoke at Eugene.
5. Temperature range at Salem in degrees Fahrenheit.
6. Reduction of visibility to less than 7 miles by smoke at Salem.

APPENDIX 5 (continued)

	INV.[1]	IND.[2]	TR_E[3]	K_E[4]	TR_S[5]	K_S[6]
AUG.						
1-56	no	0	20	no	19	no
5-56	yes	2.2	27	no	34	no
20-56	yes	10	36	no	37	no
22-56	yes	5.4	33	no	31	no
1-57	yes	6.4	34	no	33	no
14-57	yes	4.9	37	yes	35	yes
22-57	yes	17	43	yes	41	no
25-57	yes	7.4	30	no	32	no
26-57	yes	1.0	36	no	35	no
15-58	yes	11	39	no	40	no
17-58	yes	3.4	31	no	32	no
24-58	yes	23	41	yes	43	no
2-59	yes	2.5	29	no	28	no
8-59	yes	9.3	38	no	40	no
9-59	yes	11	41	no	43	no
15-59	yes	8.2	37	yes	36	no
10-60	yes	4.9	30	no	29	no
13-60	yes	1.9	30	no	34	no
24-60	no	0	21	no	18	no
26-60	no	0	22	no	19	no
SEPT.						
14-56	yes	12	29	no	31	yes
17-56	yes	14	33	yes	32	yes
20-56	no	0	25	no	21	no
3-57	yes	2.0	34	no	34	no
22-57	yes	17	51	no	48	no
29-57	yes	11	29	yes	34	no
8-58	no	0	14	no	23	no
11-58	yes	5.7	26	no	28	yes
15-58	yes	.58	25	no	24	no
23-58	yes	10	28	no	30	no
25-58	no	0	30	yes	23	no
26-58	yes	4.4	35	yes	34	no
16-59	yes	5.1	20	yes	27	yes
23-59	yes	2.1	33	yes	32	yes
24-59	yes	7.5	18	yes	17	yes
6-60	yes	1.7	30	yes	29	no
8-60	yes	.35	44	no	51	no
10-60	yes	2.3	31	yes	31	no
13-60	yes	3.7	21	yes	19	yes
21-60	yes	1.6	38	yes	37	yes

APPENDIX 5 (continued)

	INV.[1]	IND.[2]	TR_E[3]	K_E[4]	TR_S[5]	K_S[6]
OCT.						
1-56	yes	22	37	no	33	yes
7-56	yes	1.9	27	yes	37	no
14-56	yes	6.1	28	yes	20	no
10-57	yes	9.8	19	yes	22	no
17-57	yes	3.1	25	yes	21	no
25-57	yes	2.5	23	yes	18	no
5-58	yes	23	39	yes	37	yes
21-58	yes	13	34	yes	33	no
24-58	yes	17	32	yes	34	no
3-59	yes	16	37	yes	35	no
12-59	yes	.74	22	no	27	no
15-59	no	0	20	no	27	no
16-59	yes	21	29	yes	38	yes
17-59	yes	23	36	yes	37	yes
20-59	yes	5.3	20	no	19	no
22-59	no	0	13	no	8	no
24-59	no	0	19	yes	17	yes
8-60	no	0	18	no	18	no
10-60	yes	6.9	33	yes	32	yes
26-60	no	0	16	no	21	no
NOV.						
8-56	yes	14	8	yes	8	yes
14-56	yes	.53	18	yes	18	no
19-56	yes	1.5	15	no	19	no
25-56	yes	39	18	yes	26	no
7-57	yes	3.6	23	yes	24	yes
20-57	yes	2.3	15	yes	23	yes
26-57	yes	3.8	21	yes	24	no
3-58	no	0	16	no	12	no
9-58	yes	2.5	11	no	11	no
10-58	yes	.91	18	no	14	no
25-58	yes	9.9	15	no	19	no
27-58	yes	6.6	19	yes	19	no
30-58	yes	1.4	18	no	14	yes
5-59	yes	3.2	26	no	32	no
15-59	yes	2.0	20	yes	22	no
17-59	yes	14	39	yes	14	yes
2-60	yes	1.5	12	yes	16	yes
4-60	yes	.84	23	no	28	no
7-60	no	0	16	no	19	no
12-60	no	0	10	yes	12	no

APPENDIX 5 (continued)

	INV.[1]	IND.[2]	TR_E[3]	K_E[4]	TR_S[5]	K_S[6]
DEC.						
4-56	no	0	10	no	9	no
10-56	yes	1.1	7	yes	7	no
12-56	no	0	10	no	9	no
26-56	yes	20	6	yes	5	no
31-56	yes	4.6	16	yes	8	no
4-57	yes	14	9	yes	6	no
9-57	yes	30	9	no	6	no
12-57	yes	3.4	4	yes	5	no
14-57	no	0	10	no	15	no
16-57	yes	11	18	yes	18	no
20-57	no	0	9	no	10	no
23-57	no	0	9	no	6	no
8-58	yes	4.9	5	yes	8	yes
9-58	yes	3.1	11	yes	8	yes
13-58	yes	4.0	13	yes	23	no
31-59	no	0	12	no	16	yes
12-60	no	0	25	no	22	no
21-60	yes	10	3	yes	7	yes
24-60	yes	33	15	yes	9	yes
28-60	yes	6.9	14	yes	13	no
JAN.						
7-57	no	0	10	no	7	no
15-58	no	0	16	no	21	no
16-58	yes	8.9	16	no	14	no
19-58	yes	1.1	9	yes	15	no
28-58	no	0	6	no	10	no
3-59	yes	3.9	8	no	12	no
5-59	yes	13	4	yes	7	no
7-59	yes	5.6	19	no	17	no
13-59	yes	.74	16	no	18	no
14-59	yes	4.8	6	yes	9	yes
17-59	yes	8.0	15	yes	14	no
23-59	yes	.44	12	no	7	no
29-59	no	0	10	yes	12	no
12-60	yes	.91	13	no	19	no
24-60	yes	6.5	16	yes	12	yes
30-60	yes	2.4	23	no	29	yes
1-61	yes	.88	3	yes	10	yes
11-61	yes	2.8	12	yes	10	no
22-61	yes	12	24	yes	15	no
29-61	yes	2.6	8	no	12	yes

APPENDIX 5 (continued)

	INV.[1]	IND.[2]	TR_E[3]	K_E[4]	TR_S[5]	K_S[6]
FEB.						
4-57	no	0	9	no	6	no
7-57	yes	16	10	yes	17	yes
8-57	no	0	13	yes	13	yes
12-57	yes	21	23	yes	28	no
13-57	yes	5.3	14	yes	14	yes
14-57	yes	3.5	7	yes	10	yes
25-57	yes	1.2	9	no	7	no
25-58	no	0	8	no	11	no
1-59	yes	1.6	14	no	17	no
11-59	no	0	13	yes	12	no
14-59	no	0	10	no	11	no
15-59	no	0	9	no	11	no
17-59	yes	5.5	19	no	17	no
24-59	yes	6.9	24	no	21	no
25-59	no	0	15	no	18	no
1-60	yes	14	12	no	12	no
25-60	no	0	15	no	16	no
7-61	no	0	16	no	14	no
8-61	no	0	13	yes	10	no
27-61	yes	1.9	16	no	17	no
MAR.						
3-57	yes	.95	10	no	20	no
7-57	no	0	10	no	12	no
16-57	no	0	16	no	22	no
24-57	no	0	11	yes	11	no
30-57	no	0	8	no	10	no
31-57	yes	.35	15	no	19	no
11-58	yes	3.8	23	no	27	no
27-58	yes	3.8	32	no	34	no
1-59	no	0	19	no	19	no
5-59	yes	7.9	24	yes	25	no
6-59	yes	9.3	23	yes	25	no
12-59	no	0	15	no	12	no
23-59	no	0	14	no	16	no
30-59	no	0	8	no	9	no
10-60	yes	4.7	25	yes	21	no
2-61	no	0	12	no	12	no
5-61	no	0	8	no	9	no
7-61	yes	1.0	21	no	21	no
20-61	no	0	14	no	17	no
25-61	yes	1.1	17	no	19	no

APPENDIX 5 (continued)

	INV.[1]	IND.[2]	TR_E[3]	K_E[4]	TR_S[5]	K_S[6]
APRIL						
9-57	yes	6.3	30	no	36	no
30-57	yes	3.3	14	no	30	no
7-58	no	0	16	no	15	no
11-58	yes	7.7	28	yes	34	yes
22-58	no	0	13	no	15	no
25-58	yes	8.3	24	yes	25	no
22-59	yes	5.7	31	no	34	no
23-59	yes	8.5	26	no	33	no
25-59	no	0	15	no	15	no
26-59	no	0	13	no	13	no
27-59	no	0	8	no	8	no
30-59	no	0	18	no	21	no
15-60	yes	3.3	18	no	20	no
22-60	yes	2.2	22	yes	24	no
24-60	yes	3.6	20	no	19	no
2-61	no	0	24	no	16	no
13-61	no	0	17	no	16	no
15-61	yes	1.7	25	no	27	no
22-61	no	0	21	yes	10	no
29-61	yes	2.6	12	no	8	no
MAY						
2-57	no	0	17	no	19	no
6-57	yes	2.0	33	no	34	no
7-57	yes	4.0	7	no	10	no
11-57	no	0	16	no	10	no
13-57	no	0	14	no	18	no
15-57	no	0	19	yes	29	no
20-57	no	0	19	no	19	no
4-58	yes	.55	31	no	33	no
11-58	no	0	16	no	19	no
2-59	no	0	18	no	21	no
7-59	yes	1.5	33	no	37	no
8-59	yes	11	13	no	18	no
17-59	no	0	15	no	19	no
1-60	no	0	18	no	18	no
26-60	no	0	19	yes	15	no
30-60	yes	6.8	32	no	29	no
8-61	no	0	16	no	10	no
13-61	yes	.45	13	no	15	no
15-61	yes	1.0	23	no	25	no
30-61	yes	1.0	14	no	17	no

APPENDIX 5 (continued)

JUNE	INV.[1]	IND.[2]	TR_E[3]	K_E[4]	TR_S[5]	K_S[6]
30-57	no	0	28	no	31	no
6-58	yes	.60	14	no	10	no
17-58	yes	16	36	yes	38	no
29-58	no	0	17	no	14	no
6-59	yes	.70	24	no	21	no
7-59	no	0	24	no	22	no
20-59	yes	5.7	32	no	32	no
5-60	yes	14	35	no	36	no
6-60	yes	5.6	26	no	22	no
8-60	yes	8.2	31	no	36	no
13-60	yes	10	35	no	35	no
15-60	no	0	17	no	18	no
20-60	yes	1.3	27	no	27	no
24-60	yes	5.7	27	no	29	no
8-61	yes	1.1	21	no	20	no
11-61	no	0	11	no	18	no
13-61	yes	9.8	40	yes	42	no
15-61	yes	21	33	no	41	no
24-61	yes	1.0	40	no	42	no
29-61	yes	small	22	no	25	no