THE AIR QUALITY DISPLAY MODEL ANALYSIS FOR SUSPENDED PARTICULATES IN KEOKUK, IOWA

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Abstract

The Iowa Department of Environmental Quality (DEQ) is currently examining possible revisions of the State Implementation Plan. These air pollution control srategy revisions are being evaluated so that the National Ambient Air Quality Standards can eventually be attained and maintained in all parts of Iowa as required by the Clean Air Act Amendments of 1977. To accomplish this, it is necessary to analyze current air quality attainment problems.

To examine these current air quality attainment problems, a dispersion model is used. The dispersion model is a computer program that predicts what the ambient air quality will be at a certain point within an air basin. The Air Quality Display Model (AQDM) is the major tool DEQ used to model each air basin. AQDM is a computer model that combines point source emissions (industrial plants), area source emissions (residential heating, fugitive dust, solid waste disposal, transportation, etc.) and meteorological factors (wind speed, wind direction, average temperature, pressure, and mixing height) over a specified area to predict the annual distribution of pollutants for that area. From the results obtained by using AQDM, a reliable estimation of source contribution is found.

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Introduction

Total suspended particulate (TSP) is one of the six pollutants for which the federal EPA has declared national air quality standards for the protection of human health and welfare. A set of strategies to control TSP emissions, and thereby reduce ambient concentrations of this pollutant to acceptable levels, was developed by the Iowa Air Pollution Control Commission in 1971 and 1972. These strategies became part of a federally approved State Implementation Plan on May 31, 1972 (40 CFR, Part 52). Since that time most air pollution sources have reached compliance with State particulate emission standards, yet air monitoring has shown portions of Iowa are still plagued with unacceptably high TSP concentrations. The Clean Air Act Amendments of 1977 required each state to identify those areas with unacceptably high TSP concentrations and devise a control strategy to reduce these high concentrations.

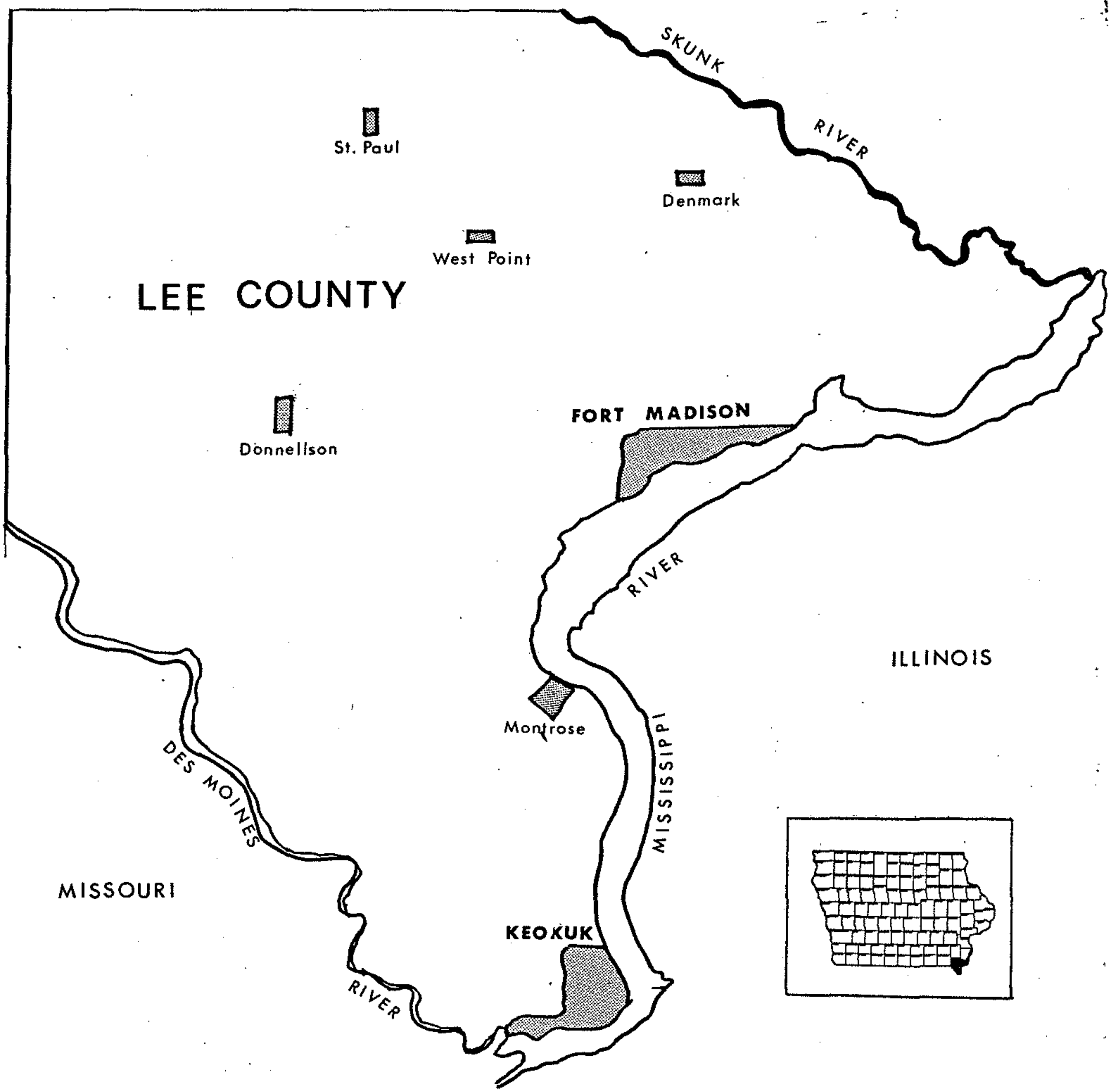
The purpose of this analysis is to explore the causes of these high TSP concentrations to aid in the future development of necessary control strategies which will lead to reducing TSP to an acceptable level.

County Statistics

Lee County is located at the southeast tip of Iowa between the Des Moines and Mississippi Rivers. The eastern section of Lee County is part of a long bluff line rising over one hundred and fifty feet above the Mississippi River, while the remainder of the county has a gently rolling terrain. Two major cities border the Mississippi River, Keokuk, on the southern tip of the county, and Fort Madison, near the northeastern edge of the county. The 1970 populations for Fort Madison was 13,996 and for Keokuk was 14,631; the 1970 population for Lee County was 42,996. Major industrial processes in Lee County consist of secondary metals manufacturing, wood processing, grain processing and mineral

Figure 1

Illustration of Lee County
and Location in Iowa



product manufacturing. Major sources of fugitive dust and fugitive emissions include grain transferring, mineral product storage and transferring, construction, agricultural tilling, and roads (both paved and unpaved).

Lee County is situated in a temperate climate in the middle of a large land mass. The area is largely influenced by pressure systems moving in a general west-east direction. The winds are dominant from the northwest and the south to southeast, except for the area east of the bluffs, which tends to channel winds parallel to the bluffs. The mean annual temperature is 52 degrees Fahrenheit, the mean annual precipitation is 34 inches. Neutral atmospheric stability is dominant for this area with slightly unstable and stable conditions occurring less frequently.

Background

Because of large-scale natural suspended particulate emissions (such as volcanoes and dust storms) and large-scale man-made suspended particulate sources (such as agricultural activities) which cannot be accurately modeled, a natural background estimate must be developed for Iowa to include in any modeling.

To develop a numerical value for background, extensive monitoring of an isolated rural area must be conducted. The background of suspended particulates in Iowa was estimated from monitoring conducted from 1959 to 1965 at Backbone State Park in northeast Iowa. This site appears to be the most isolated area monitored in the State and is located away from any localized agricultural and urban sources. However, because of the large amount of agricultural activity in the State, an additional contribution from soil erosion, tilling, and travel on unpaved surfaces is inevitable and thus a true background measurement not influenced by any man-made sources is unlikely. Therefore the background recorded at Backbone

State Park is expected to include not only a natural worldwide background but a local and statewide background. To estimate the contribution of all sources to the background site, a study of rural sources was conducted.

The background figure monitored at Backbone State Park averaged 44 micrograms per cubic meter annual arithmetic mean. An estimated breakdown of sources accounting for this monitored value is shown in Table 1 below.

TABLE 1

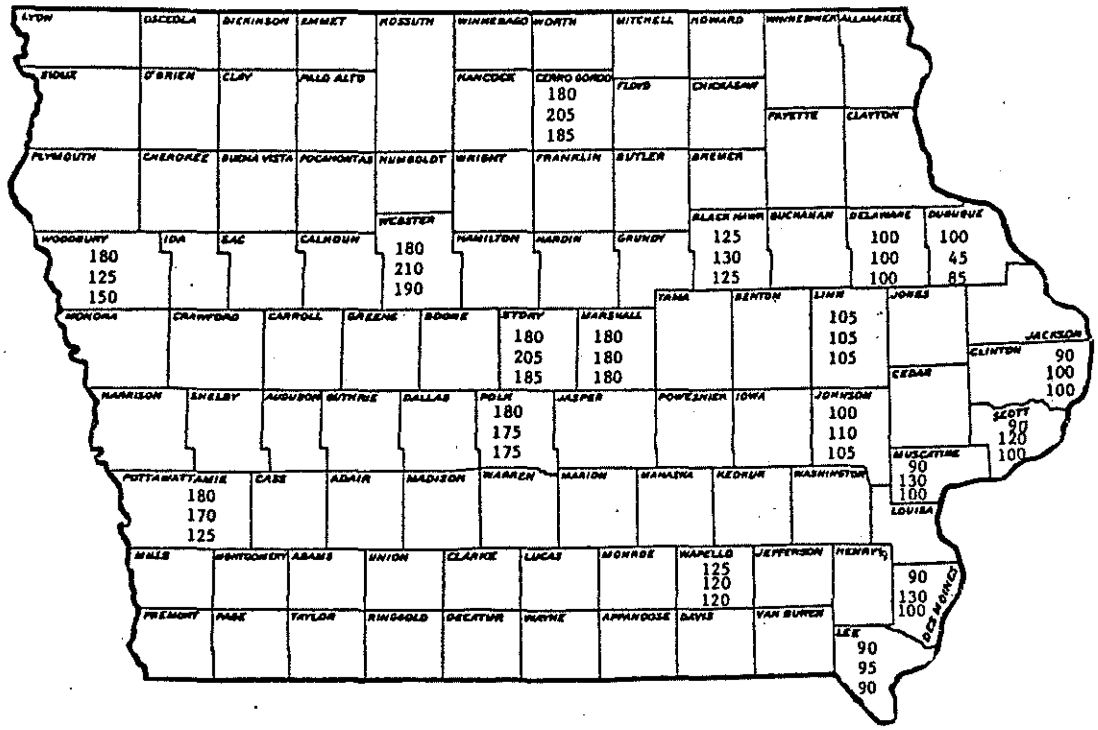
Source Contributions to the Recorded
Background level at Backbone State Park
(Values shown are in micrograms per cubic meter [ug/m^3])

Worldwide Concentration	15 ug/m^3
Continental Concentration	10 ug/m^3
Unpaved Roads	6 ug/m^3
Agriculture (soil erosion)	13 ug/m^3
Total Background	44 ug/m^3

The worldwide and continental values were obtained from studies conducted by GCA Corporation for DEQ[1]. This natural background that is not influenced by man is approximately 25 ug/m^3. The unpaved road estimate of 6 ug/m^3 was established by computer modeling of all rural unpaved roads in a five county area. The remaining 13 ug/m^3 was assumed to be from agricultural processes such as tilling and soil erosion.

Since the contribution from agricultural processes could easily be larger or smaller in other areas of the state depending on the farming practices, an investigation of these farming practices throughout the state was conducted. By comparing climatic factors, soil types, crops planted, and tilling frequencies in other areas of the state with the area around Backbone State Park, an index of soil erodibility was developed as shown in Figure 2. Using this index to increase or decrease the contribution of agricultural sources, an estimation of background throughout the State has been developed as shown in Figure 3.

Figure 2
Agricultural Index For Selected
Counties in Iowa



100 The first number represents the climatic factor for the county using the Federal Soil Conservation's climatic factors for Iowa. Deleware County is the reference county and has been given a value of 100. Numbers greater than 100 represent drier conditions while numbers less than 100 represent wetter conditions.

100 The second number represents the proportion of tilled land in soybeans or row crops. Deleware County is the reference county and has been given a value of 100. A county registering 200 would have twice the amount of land in soybeans or row crops.

100 The third number represents the agricultural index for the county. Deleware County is the reference county and has been given a value of 100. This index was based on the climatic factor, proportion of tilled land, and county size. Numbers greater than 100 represent areas of more severe wind erosion than Deleware County while numbers less than 100 represent areas of less severe soil erosion.

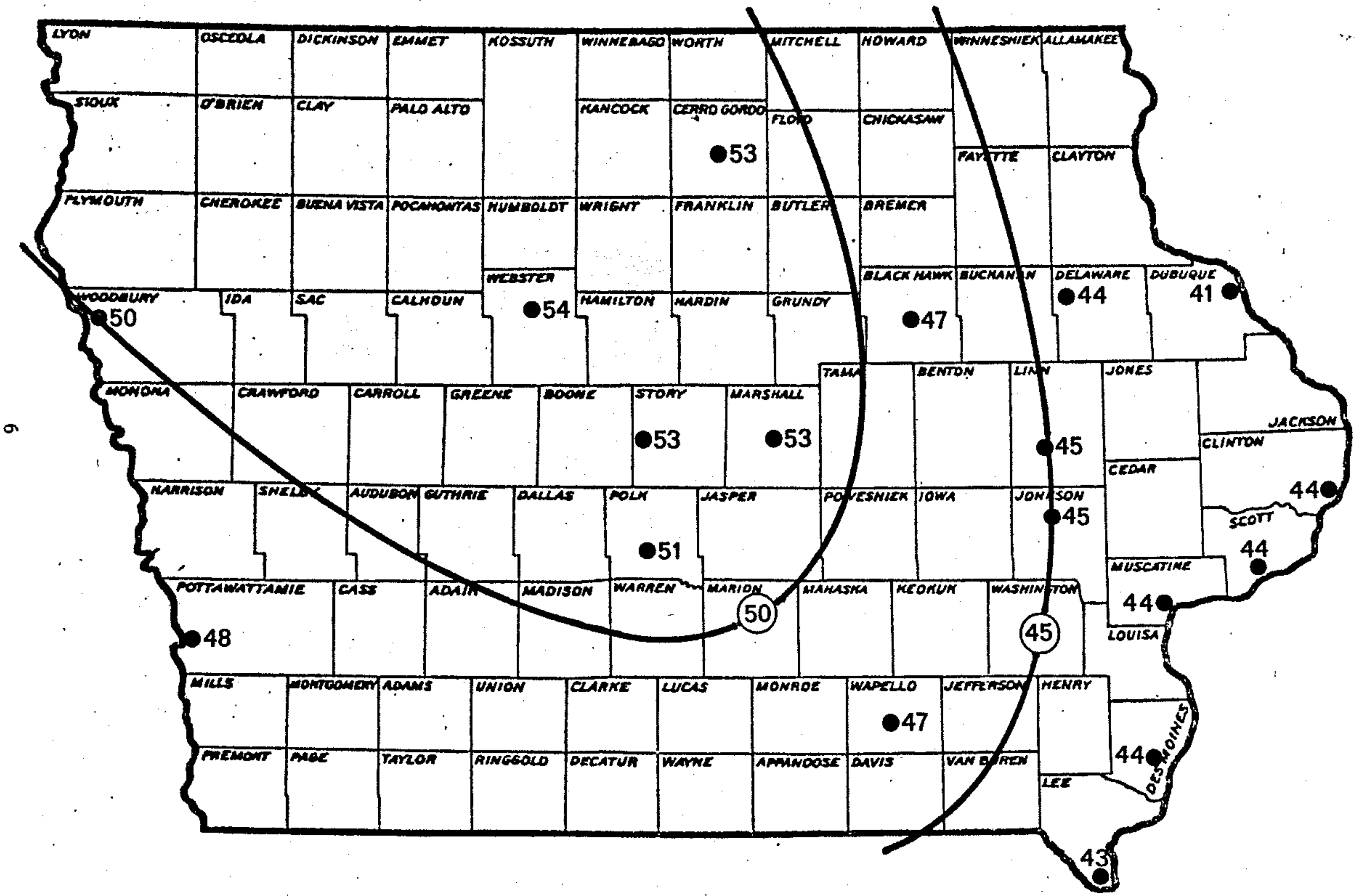


Figure 3
Estimations of Rural Background levels in Iowa
(Values shown are arithmetic means in micrograms per cubic meter)

Air Monitoring

The most accurate measurement of suspended particulate levels in an area is obtained by monitoring the air. Air quality data for suspended particulate are obtained using the high volume sampler. The sampler draws a known quantity of ambient air through a preweighed glass fiber filter for a twenty-four-hour period once every six days. After each twenty-four-hour period the sample filter is sent to the laboratory where it is weighed again. The weight difference measured in micrograms is the amount of particulate. Combined with the volume of air that passed through the filter during the twenty-four-hour period, the sampling results are calculated and recorded as the average micrograms of particulate matter per cubic meter of air for a twenty-four-hour period. Three State owned high volume samplers are currently located in Keokuk. These monitors are located at (1) Water Pollution Control Plant, 1000 Mississippi Dr.; (2) Fire Station, 13th & Johnson St.; (3) High School, Washington & Middle Road. (See Figure 4) Table 2 shows the monitored values at these sites. An asterik after the year indicates insufficient data for that year to calculate a valid annual mean.

The National Ambient Air Quality Standards were developed in 1971 to determine air quality problems throughout the United States. The standards for suspended particulates were developed for a twenty-four-hour and annual time periods. These time periods were also divided into two categories: primary, to protect the public's health; and secondary to protect the public's welfare. The national twenty-four-hour primary standard, not to be exceeded more than once per year, is 260 micrograms per cubic meter; the secondary standard is 150 micrograms per cubic meter. The primary annual standard is 75 micrograms per cubic meter as an annual gemetric mean; the secondary standard is 60 micrograms per cubic meter as an annual geometric mean.

Figure 4

Location of Suspended Particulate Air Monitoring Equipment in Lee County

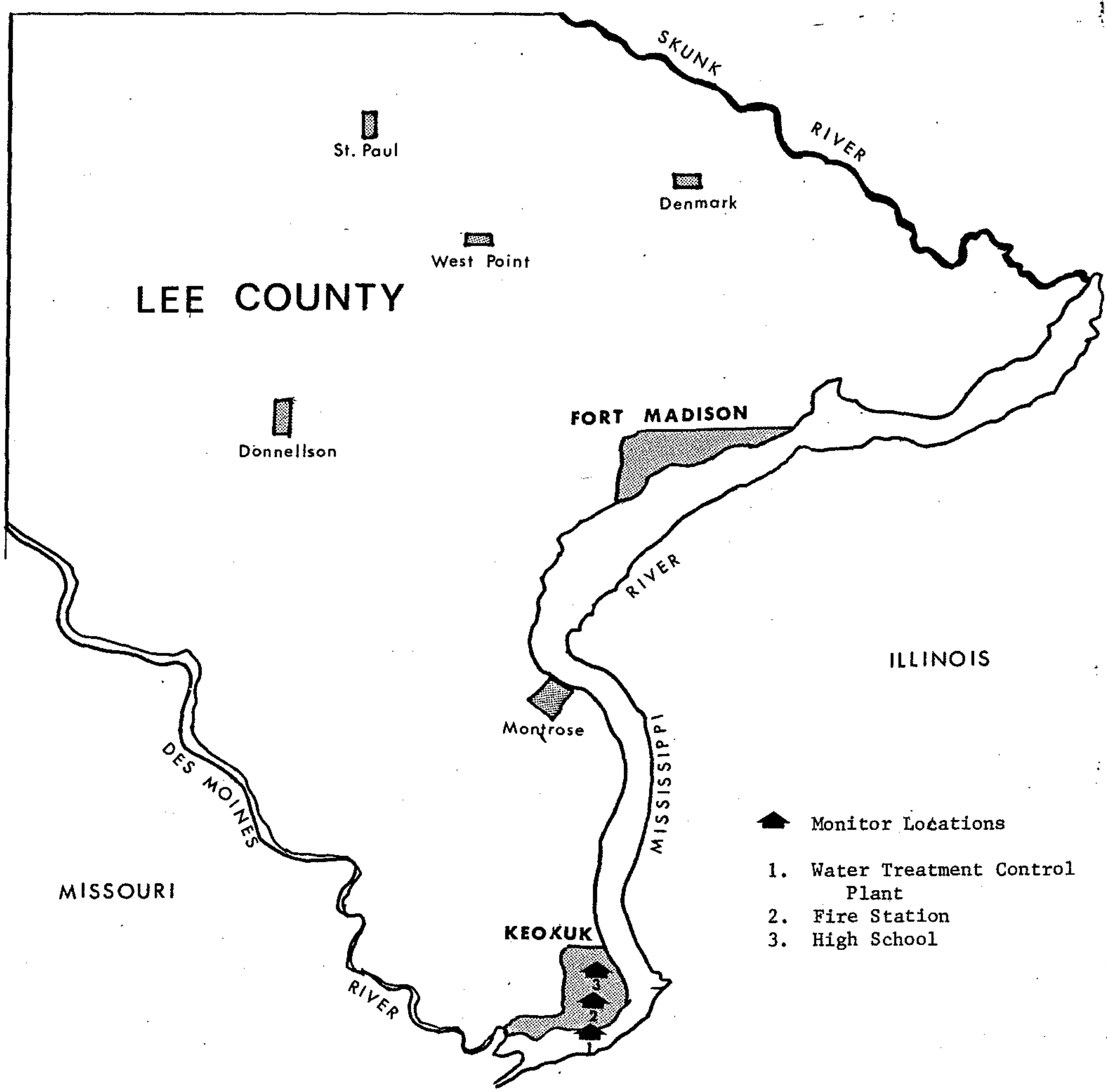


TABLE 2

Air monitoring data for Keokuk

Location	Year	Number of Samples	Maximum 24-Hour Value	2nd Max. 24-Hour Value	Arithmetic Mean	Geometric Mean	Standard Geometric Deviation
1. Water Pollution Control Plant	1970*	7	327.0	262.0	174	159	1.56
	1971*	17	840.0	559.0	145	86	2.00
	1972	38	667.0	655.0	166	118	2.27
	1973	40	648.5	351.0	156	119	1.93
	1974	54	458.0	377.0	133	97	2.17
	1975	54	387.0	377.0	143	118	1.90
	1976	54	906.0	510.0	206	171	1.86
	1977*	38	335.9	319.1	124	104	1.85
2. Fire Station	1976*	42	296.0	155.0	88	80	1.52
	1977	50	174.0	155.1	78	70	1.65
3. High School	1976*	32	229.0	144.0	70	64	1.48
	1977	53	175.8	119.3	59	53	1.59

* These years do not have a sufficient number of samples to calculate a valid annual mean.

The air monitoring data are an essential tool in calibrating the computer model. The annual means that are predicted by the model are correlated with the monitoring data to estimate the accuracy of the projections. Large variances between the monitored values and the projections indicates poor correlation and revisions to the model inputs must be made. Small variances indicate good correlation and correct model inputs.

The Model (Annual Average Estimation)

A dispersion model is a compter program that predicts what the ambient air quality will be at a certain point within an air basin. The Air Quality Display Model (AQDM)[2] is the model DEQ used in each air basin. AQDM is a computer model that combines point source emissions (industrial plants), area source emissions (residential heating, fugitive dust, solid waste disposal, transportation, etc.) and meteorological factors (wind speed, wind direction, average temperature, pressure, and mixing height) over a specified area to predict the annual distribution of pollutants for that area. The annual particulate concentrations predicted by the model for each year are plotted as isopleths over the air basin. Five designated receptors are also broken down into specific source contribution percentages.

The computer algorithm and the program inputs reflect several assumptions. Assumptions used in the computer algorithm are:

(a) Total reflection of the pollutant plume takes place at the earth's surface.

(b) Conditions describing the plume are averaged over a time period of several minutes.

(c) All effluent gases and particulates have diameters less than 20 microns and have neutral buoyancy in the atmosphere. Zero fallout is assumed.

(d) The plume exhibits a Gaussian concentration distribution and the spread in both directions is considered to be a function of downwind distance and atmospheric stability only.

(e) The plume is a steady-state phenomenon resulting from a constant, continuous emission.

Assumptions used in the program input are:

(a) Point source data from plant emission inventory forms, from stack tests, and from permit information are accurate and complete.

(b) Sources not reporting stack parameters were given parameters of similar sources (this was true in interstate air basins where other states occasionally were not able to provide stack parameters).

(c) Area source data from the National Emissions Data System (NEDS) are accurate and complete.

(d) Population distribution and area source emissions are directly related.

(e) Fugitive emissions from paved and unpaved roads are accurately calculated.

Source of Suspended Particulates (Point)

All Keokuk point sources were acquired from DEQ's current emission inventory. Stack emissions, diameters, emission velocities and temperatures were taken from values supplied by the plant operators on emission inventory forms, permit applications, or stack tests performed at the plant. Emissions for the modeled year were taken from the 1975 emission inventory and updated by permit applications, compliance schedules, or stack tests. All plant emission controls were assumed to be working the entire year unless breakdown or maintenance reports were submitted to the Department. The emissions during periods of emission control device breakdown or maintenance were added to the plant totals. All industrial point source estimates calculated were verified by the appropriate plant officials. Fugitive dust point sources were given plume heights of 6.0 meters. All source emissions were calculated in tons per year and divided by 365 days to obtain the necessary model input of tons per day. No consideration was given to seasonal operation or weekend shutdowns.

Sources of Suspended Particulates (Area)

Residential Emissions

Total residential emissions for fuel use in Lee County were taken from the National Emissions Data System (NEDS) estimates of area source emissions supplied by EPA. Solid waste emissions were calculated using an estimated tonage of solid waste and an appropriate emission factor. The emissions were distributed by housing population calculated from the census population for

1970 and updated from projections from the Iowa Office of Planning and Programming.[3] The 1977 Keokuk population growth was estimated at 1.060 times the 1970 census figure.

The Lee County census population was broken down into designated area sources in the model region as shown in Figure 5. Area housing populations were divided by the total county housing population and multiplied by the county emission totals to obtain area emissions for residential fuel use and solid waste.

All housing emissions were assumed to be uniform for the county. Total particulate emissions for the modeled year obtained from NEDS were:

	1977
Residential Fuel	46 tons per year
Residential Solid Waste	351 tons per year

Commercial-Institutional Emissions

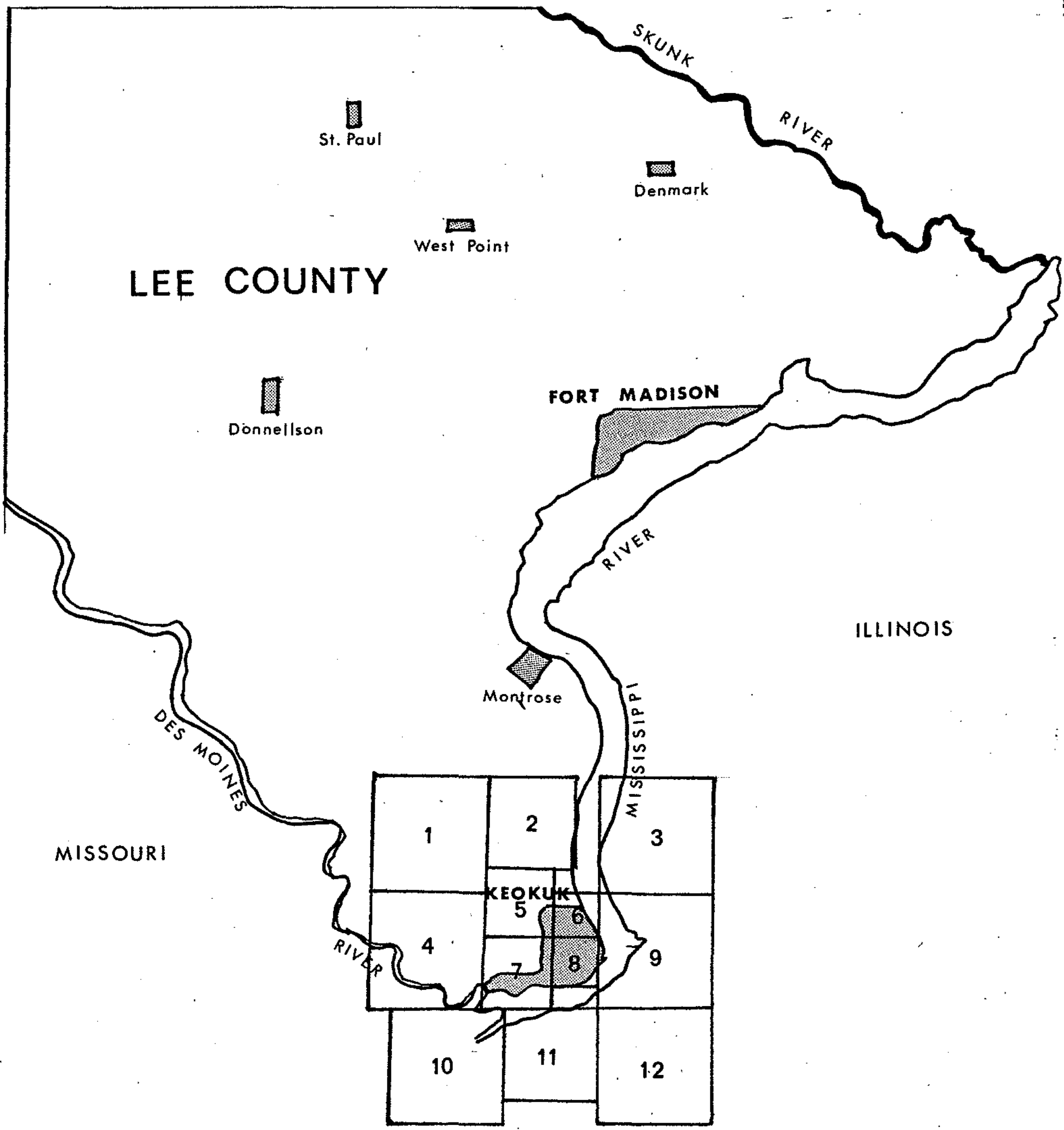
Total commercial-institutional emissions for fuel use and solid waste disposal in Lee County were taken from the NEDS data supplied by EPA. Forty-six percent of the county emissions was assumed to be in Keokuk, while fifty-four percent was assumed to be in Fort Madison and the smaller cities.

All commercial-institutional building emissions were assumed to be uniform for the county. Total particulate emissions for the modeled year were:

	1977
Commercial-Institutional Fuel	55 tons per year
Commercial-Institutional Solid Waste	37 tons per year

Figure 5

Area Source Grid Pattern for Lee County



Transportation-Motor Vehicle

Total emissions from transportation sources, excluding fugitive emissions, were taken from the NEDS data supplied by EPA. Emissions from major highway line sources and rural paved and unpaved roads were individually calculated.

Major access street and highway line source emissions were calculated by multiplying the emission factor for vehicles (0.66 grams per vehicle mile)[4] by the product of the length of the road segment and the traffic flow count. Each line source emission was assigned to the appropriate designated area and was assumed to disperse equally over the area. All car and truck emissions were assumed to be approximately the same. After all major access highway emissions were calculated, the total line source emissions assigned to each area was subtracted from the NEDS county total and distributed by the population proportion in each area.

Fugitive dust from vehicle travel on paved and unpaved roads was calculated from emission factors found in two recent reports.[5,6] Fugitive dust from unpaved roads was calculated by multiplying the emission factor (1179 grams per vehicle mile) by the product of the length of the road segment and the traffic flow count. Thirty percent of these emissions was assumed to actually become suspended. Paved road emissions were also calculated by multiplying the emission factor (11 grams per vehicle mile) by the product of the length of the road segment and the traffic flow count. These emission factors were derived from an emission formula that combines conditions of the road, vehicle speeds, and climatological factors to obtain grams of particulate per vehicle mile. Emissions from each road segment are assumed to disperse equally over the designated areas.

Total estimated particulate emissions for the modeled year were:

	1977
Vehicles	181 tons per year
Fugitive (paved roads)	2865 tons per year
Fugitive (unpaved roads)	16256 tons per year

Transportation - Railroads

Total railroad fuel use emissions for railroads in Lee County were taken from the NEDS data supplied by EPA. Approximate track mileage was estimated for each designated area. Emissons were distributed by the portion of track miles in each area.

Transportation - Off Highway

Off highway transportation was considered to be any fuel burning machine not operated on a road (i.e., farm tractor, lawnmowers, motorized boats, etc.). Because of the difficulty in estimating the concentration of off-highway transportation, it was assumed that the NEDS emissions were distributed equally over the entire county.

Transportation - Aircraft

The Keokuk Airport was not located within the model area, therefore no aircraft emissions were used.

Area Source Totals

A listing of area sources and total emissions used in the model is given in Appendix A.

Model Meteorology Parameters

To accurately model the suspended particulate emission sources, detailed meterological parameters are necessary.

Meteorological wind data consists of five stability classes and sixteen wind directions for Burlington Airport, since no acceptable data were available for Keokuk.

Other necessary meteorological parameters that were obtained for Cedar Rapids are shown below:

Average daily mixing depth:	1200 meters
Average ambient temperature	284 degrees Kelvin (11 degrees Celsius)
Average ambient pressure	995 millibars

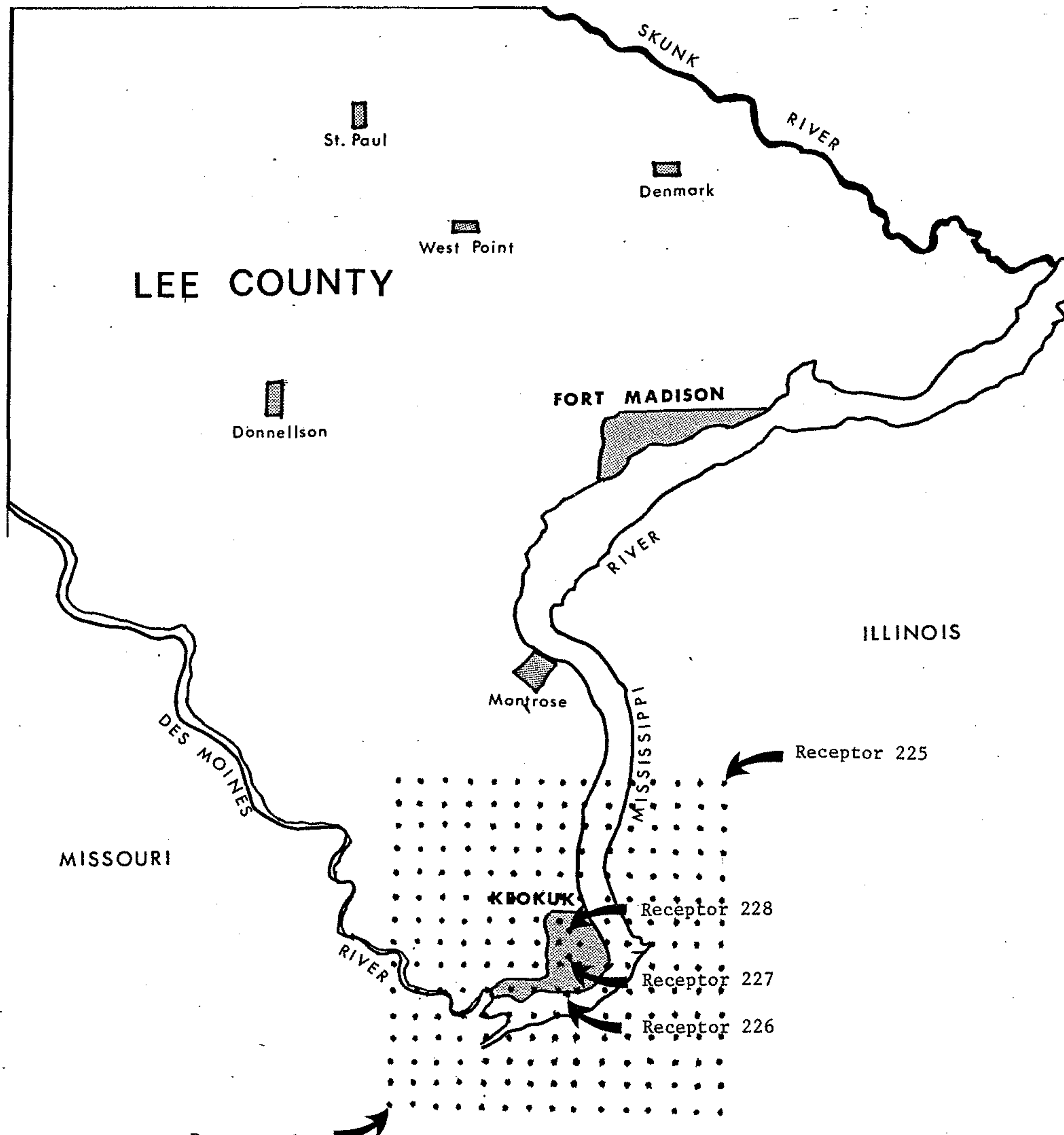
Results

A grid area of 15 kilometers by 15 kilometers was set up around Keokuk with receptors placed at one kilometer intervals as shown in Figure 6. Twelve additional receptors located throughout the county were also included in the total receptor count.

Expected concentrations at each receptor are given in Appendix B. Graphical displays of these results are illustrated in Figure 7 for Lee County and Figure 8 for Keokuk. Each line represents an isopleth of suspended particulate concentration as an annual arithmetic mean. The highest concentration expected was 181 micrograms per cubic meter at receptor 111. Figure 9 illustrates these results as annual geometric means which can be compared to the national standards described on page 7 of this report.

Figure 6

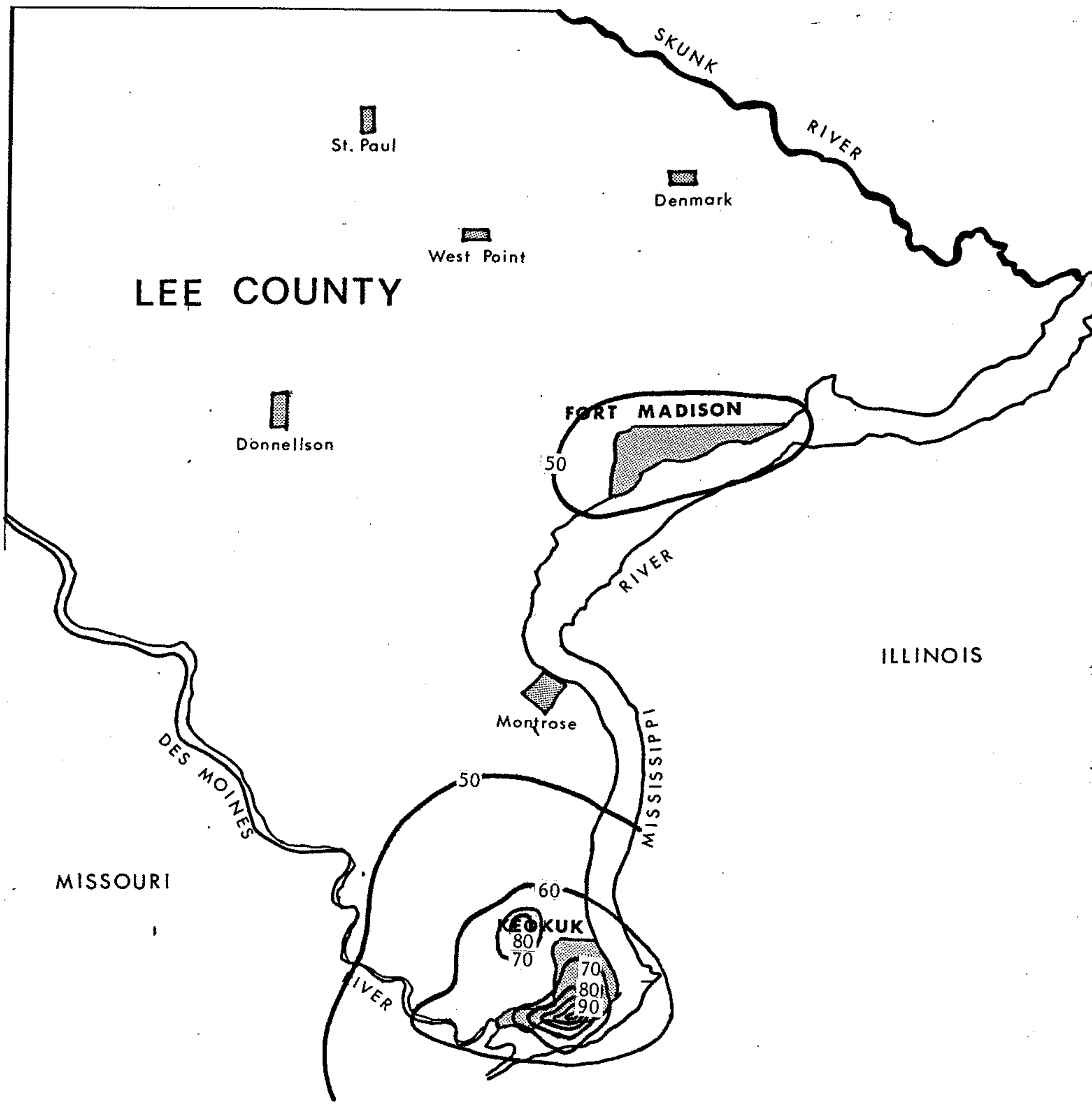
Receptor Locations for the Keokuk AQDM Model



NOTE: Except for Receptors 226-237, grid numbering runs bottom to top and left to right.

Figure 7

Lee County
1977 Suspended Particulate Isopleth Map
(values shown are arithmetic means in micrograms per cubic meter)



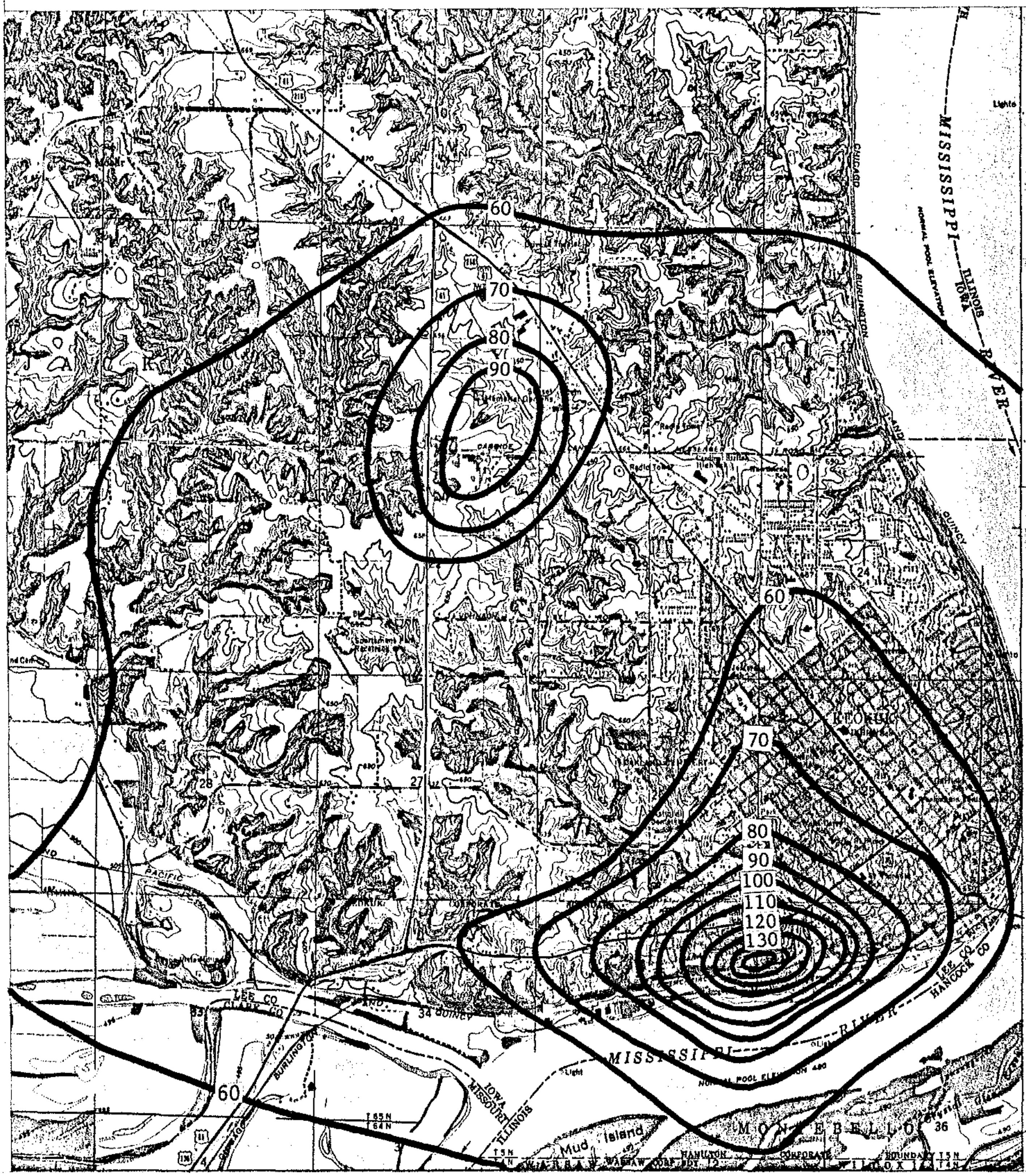


Figure 8

Suspended Particulate Isopleth Map for Keokuk
(values shown are arithmetic means in micrograms per cubic meter)

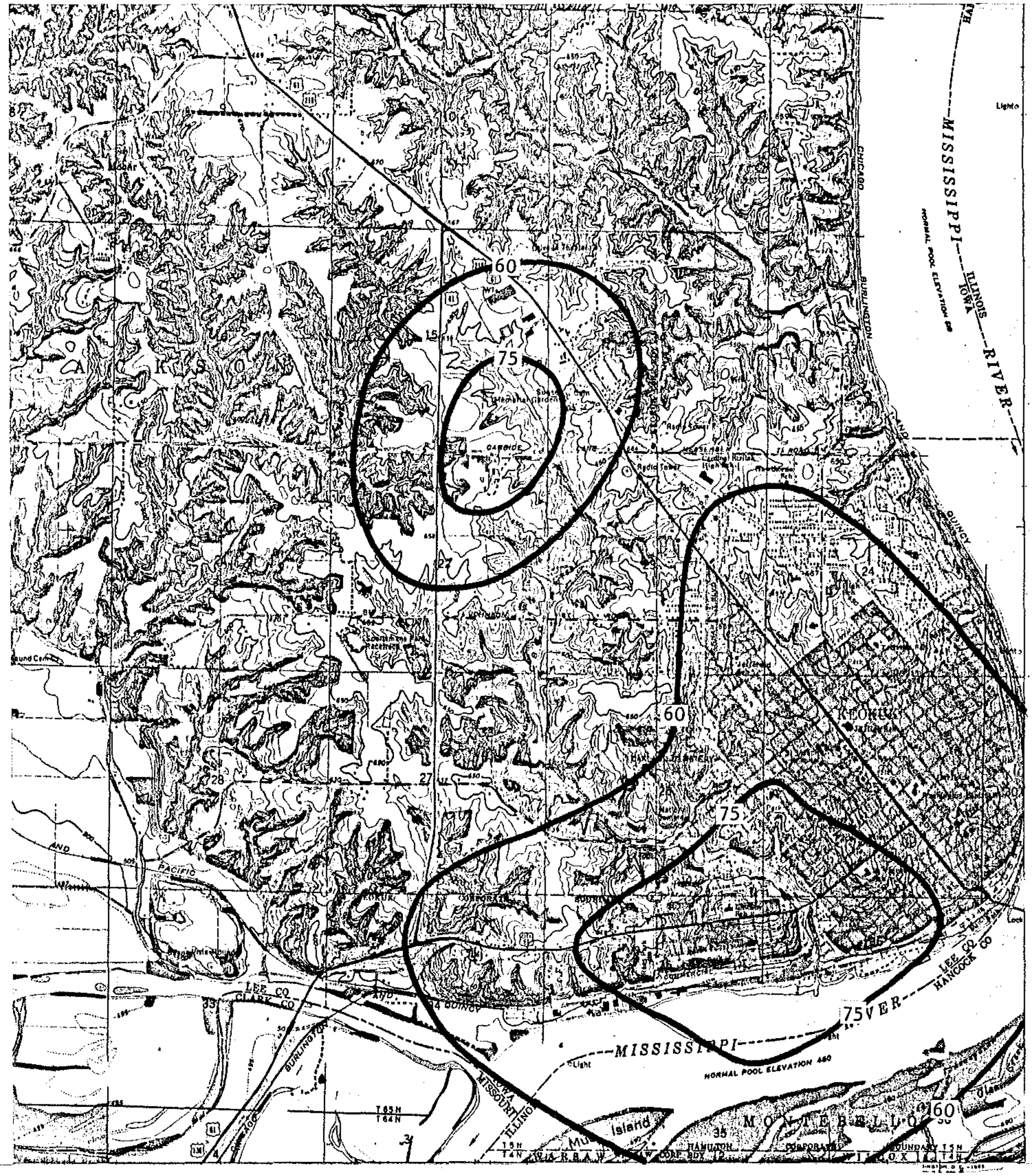


Figure 9

Suspended Particulate Isopleth Map for Keokuk
(values shown are geometric means in micrograms per cubic meter)

To estimate the impact of each source on a receptor, a special audit was requested for receptors 226, 227, 228, and 230. Results for each source are given in Appendix B and a summary is shown in Table 3.

The Hubinger Corporation is expected to have the greatest industrial impact on Keokuk, contributing over thirty-five micrograms per cubic meter of particulate to the area surrounding the plant. The contribution from Hubinger is expected to be quite large at Receptor 227 and 230. However, these values may be calculated incorrectly because of the unknown effect of the bluff that is located between the plant and the receptor location. Since the AQDM assumes a somewhat flat terrain, the accuracy of modeling sources along the river next to the bluff may be improperly represented. The isopleth pattern near the river is probably extended too far north by the model because of this topographic assumption.

The area of high particulate potential in northern Keokuk is expected to be caused by Midwest Carbide. Although the exact contribution was not generated by the model, receptors near this area indicate a source contribution of twenty to twenty-five percent from Midwest Carbide. Other particulate sources in this area also contribute to the total projected concentration, but they are not as great as Midwest Carbide.

Area sources are also shown to be large contributor to suspended particulate levels in Keokuk. The large amount of particulate from area eight, which is located in the central business and residential area, illustrates the impact that urban areas have on the ambient air quality.

Table 4 shows a breakdown of suspended particulates by source types with a detailed breakdown of area sources. A graphical display of the estimated contributions by various suspended particulate source types is shown in Figure

TABLE 3
Source Contributions to Four
Selected Receptors
(values shown are in micrograms per cubic meter)

Source	Receptor 226 Water Treatment Control Plant	Receptor 227 Fire Station	Receptor 228 High School	Receptor 230 St. Vincents School
Point Sources				
Kast Metal Corporation	0.00	0.02	0.01	0.00
Griffen Wheel	0.15	0.22	0.54	0.19
Midwest Carbide	0.84	1.36	3.25	0.96
General Mills	0.95	1.04	0.48	2.75
Foote Mineral	0.08	1.10	1.02	0.52
Hubinger Corporation	38.20	10.82	5.35	17.47
Area Sources				
Area Eight	21.13	8.24	4.23	18.11
Other Areas	7.48	11.00	12.87	7.51
Background	43.00	43.00	43.00	43.00
Total Concentration	111.62	76.48	69.89	90.29

TABLE 4

Breakdown of Annual Suspended Particulate Concentration for Three Selected Sites in Lee County

Sources of Particulate	Expected Concentrations (ug/m^3) Water Pollution Control Plant	Fire Station	High School
Point Sources	40.22	14.56	10.68
Area Sources			
Fuel use (Residential and Commercial)	0.63	0.42	0.37
Solid Waste Disposal (Open Burning)	2.42	1.62	1.43
Transportation			
Exhaust, Tire Wear	1.33	0.86	0.71
Fugitive Dust from Paved Roads	22.17	14.30	12.32
Fugitive Dust from Unpaved Roads	1.90	1.98	2.20
Miscellaneous (structural fire, construction)	0.16	0.05	0.07
Background	43.00	43.00	43.00
TOTAL	111.62	76.48	69.89

9. The largest sources of particulate shown in Table 4, excluding background are from industrial sources and from transportation sources. The industrial sources account for fifteen to thirty-five percent of the total projected concentration in most of the city.

The area source contribution from fugitive dust generated by travel on paved roads accounts for fifteen to twenty percent of the total projected concentration. These fugitive emissions appear to be unusually high presumably because no factor was used to estimate fallout of heavier particulate.

To estimate the accuracy of the modeling results, a comparison of expected concentrations and monitoring data is necessary. This comparison is shown in Table 4. The discrepancies appear to be caused by improper area source input data. The Water Treatment Control Plant probably records higher concentrations than calculated by the model because nearby fugitive dust sources from grain handling, traffic, and construction are underestimated. On the other hand, the Keokuk High School site appears to be calculated too high because of an overestimation of area sources and fugitive dust sources. Although the calculated concentrations are not exactly the same as the actual monitored values, the projected concentrations represent averages that do not reflect changing weather conditions and unusual topography. Therefore, these projections should be used more as a guideline for locating high concentration areas than as exact calculation of suspended particulate levels at each receptor.

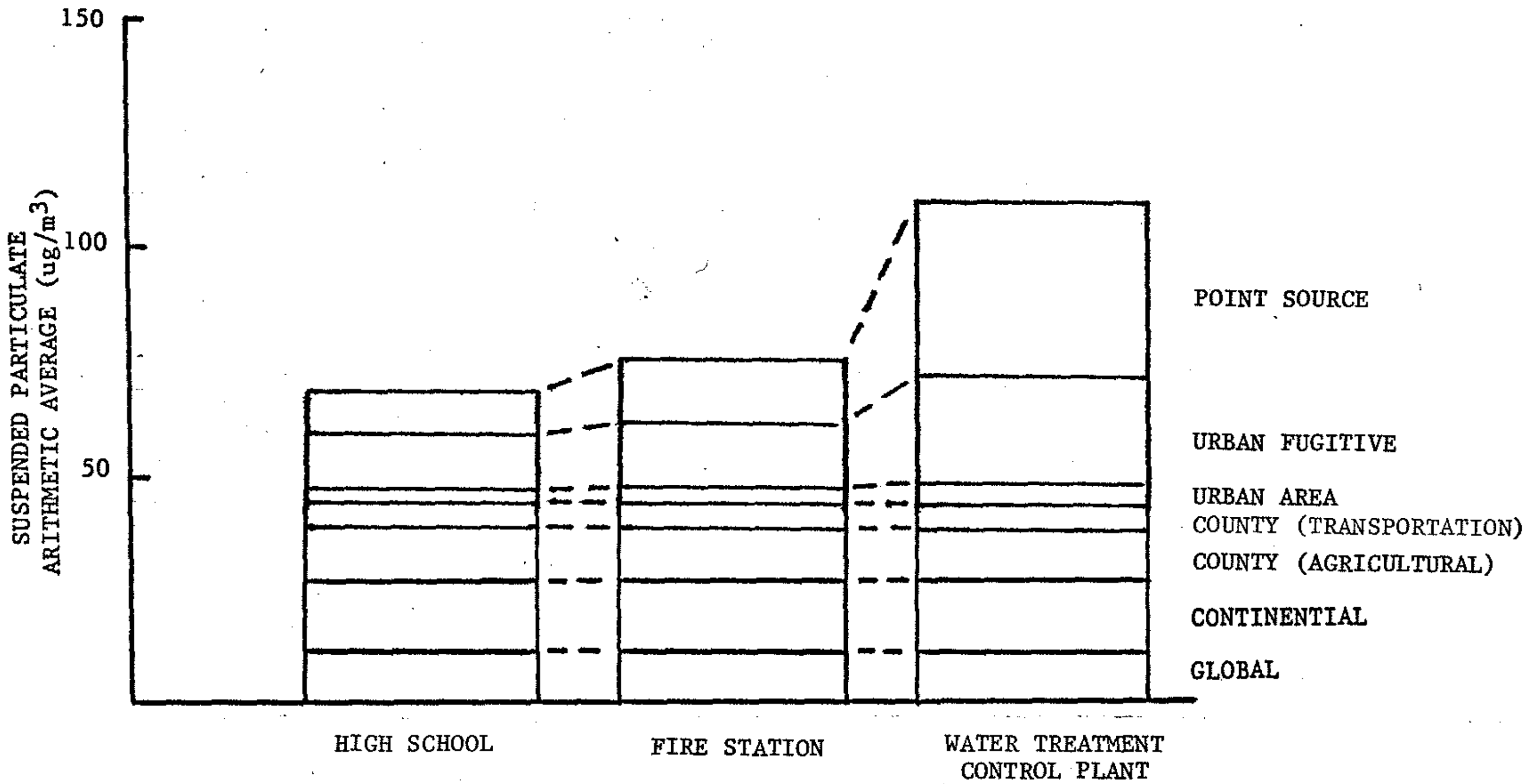


Figure 10. Estimated contributions of various suspended particulate source types

TABLE 4

Comparison of Air Monitoring Data with Projected Concentrations

Monitor Location	1977 Arithmetic Mean	Projected Concentration
1. Water Pollution Control Plant	124*	112
2. Fire Station	78	76
3. High School	59	70

* This year does not have a sufficient number of samples to calculate a valid annual mean.

Summary

Using the AQDM results, a portion of Keokuk is projected to exceed the annual primary ambient air quality standard unless additional emission reduction is implemented. An area of southwestern Keokuk and a small area in northwest Keokuk are projected to have annual geometric means in excess of 75 micrograms per cubic meter.

The Hubinger plant in southern Keokuk is calculated to be the largest contributor to the annual concentration, aside from background. A large percentage of the emissions from this plant is fugitive, however, and currently does not require stringent control. The Hubinger plant is expected to contribute from ten to thirty-five percent of the annual particulate concentration recorded in Keokuk at receptors around the plant site. All other industries are expected to account for two to ten percent of the annual particulate concentration, except for Midwest Carbide, which may contribute up to twenty-five percent of the annual particulate concentration at receptors in northern Keokuk.

Transportation sources are calculated to be the largest area source contributor to the annual concentration in Keokuk. Fugitive dust from unpaved roads contributes the largest percentage of particulates from transportation sources. These values appear to be overcalculated because no large particulate fallout factor was used.

The monitoring values for 1977 in Lee County support the general particulate isopleth pattern of annual concentrations shown by the model. The two monitoring sites that do not compare closely with the projected particulate concentrations appear to be in error because of inaccurate fugitive dust and fugitive emissions modeling.

References

1. GCA/Technology Division, "Assessment of Particulate Attainment and Maintenance Problem", Volume 1 and 4, DEQ Contract No. 76-2000-06, September, 1976.

2. Air Quality Display Model prepared for Department of Health Education and Welfare Public Health Service by TRW Systems Group, November 1969, Contract No. PH-22-68-60.

3. "Official Iowa Population Projections, 1975-2020", Iowa Office of Planning and Programming, Series I-76, No. 1, July, 1976.

4. AP-42, "Compilation of Air Pollutant Emission Factors, Second Edition", U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, February 1976.

5. Amick, R. S., Axetell, K., and Wells, D. M., "Fugitive Dust Emissions Inventory Techniques", Presented at the 67th Annual APCA meeting, #74-58, Page 7.

6. Cowherd, C. Jr., and Mann, C. O., "Quantification of Dust Entrainment from Paved Roads", Presented at the 69th Annual APCA meeting, #76-5.4, Page 13.

APPENDIX A

Keokuk Sources and
Corresponding Source Numbers Used
in the AQDM Model

Source Number	
1-4	Kast Metals Corporation
5-13	Griffin Wheel Company
14-26	Midwest Carbide Company
27-35	General Mills Chemicals
36-38	Foote Mineral Company
39-63	Hubiner Corporation
64-75	Area Sources

KEOKUK, IOWA 1977 PARTICULATE CONCENTRATIONS AUGUST 1979

SOURCE DATA

SOURCE NUMBER	SOURCE LOCATION (KILOMETERS) HORIZONTAL	VERTICAL	SOURCE AREA SQUARE KILOMETERS	ANNUAL SOURCE EMISSION RATE (TONS/DAY) SO2	PART	STACK DATA HT (M)	DIAM (M)	VEL (M/SEC)	TEMP (DEG.K)
1	633.7	4476.7	0.0	0.0	0.008	3.0	1.0	2.8	321.
2	633.7	4476.7	0.0	0.0	0.011	11.0	1.0	16.1	321.
3	633.7	4476.7	0.0	0.0	0.002	11.0	1.0	3.3	305.
4	633.7	4476.7	0.0	0.0	0.003	22.8	1.0	0.2	305.
5	633.8	4475.8	0.0	0.0	0.076	13.1	2.4	15.2	319.
6	633.8	4475.8	0.0	0.0	0.110	13.1	2.0	5.0	300.
7	633.8	4475.8	0.0	0.0	0.008	15.2	0.7	7.6	295.
8	633.8	4475.8	0.0	0.0	0.042	11.9	0.7	8.9	305.
9	633.8	4475.8	0.0	0.0	0.040	15.2	0.5	6.0	310.
10	633.8	4475.8	0.0	0.0	0.009	8.1	0.3	1.0	305.
11	633.8	4475.8	0.0	0.0	0.006	8.1	0.3	0.8	305.
12	633.8	4475.8	0.0	0.0	0.020	11.9	0.7	5.3	352.
13	633.8	4475.8	0.0	0.0	0.013	7.3	0.4	2.4	305.
14	633.9	4475.5	0.0	0.0	0.014	12.8	0.7	19.8	377.
15	633.9	4475.5	0.0	0.0	0.002	11.6	0.6	14.8	294.
16	633.9	4475.5	0.0	0.0	0.005	16.5	0.6	20.1	294.
17	633.9	4475.5	0.0	0.0	0.726	11.9	1.1	25.9	394.
18	633.9	4475.5	0.0	0.0	0.012	17.1	0.4	5.2	1227.
19	633.9	4475.5	0.0	0.0	0.012	17.1	0.3	11.9	1227.
20	633.9	4475.5	0.0	0.0	0.055	17.1	0.4	5.2	1227.
21	633.9	4475.5	0.0	0.0	0.021	17.1	0.3	7.0	1227.
22	633.9	4475.5	0.0	0.0	0.050	17.1	0.4	5.2	1227.
23	633.9	4475.5	0.0	0.0	0.002	23.8	0.2	18.5	311.
24	633.9	4475.5	0.0	0.0	0.004	21.3	0.2	8.2	308.
25	633.9	4475.5	0.0	0.0	0.070	20.0	1.0	10.0	294.
26	633.9	4475.5	0.0	0.0	0.348	6.0	0.0	6.0	294.
27	637.1	4472.6	0.0	0.0	0.011	24.4	0.9	15.2	339.
28	637.1	4472.6	0.0	0.0	0.014	16.7	0.9	3.9	338.
29	637.1	4472.6	0.0	0.0	0.038	13.7	0.9	3.9	338.
30	637.1	4472.6	0.0	0.0	0.003	10.7	0.3	15.2	322.
31	637.1	4472.6	0.0	0.0	0.010	24.4	0.9	15.2	339.
32	637.1	4472.6	0.0	0.0	0.010	7.6	0.2	15.2	338.
33	637.1	4472.6	0.0	0.0	0.006	7.2	0.7	15.2	339.
34	637.1	4472.6	0.0	0.0	0.011	19.8	0.6	8.1	322.
35	637.1	4472.6	0.0	0.0	0.011	19.8	0.6	9.5	322.
36	634.2	4471.4	0.0	0.0	0.006	38.5	0.4	10.4	329.
37	634.5	4471.4	0.0	0.0	0.009	35.5	0.4	15.4	338.
38	634.5	4471.4	0.0	0.0	0.160	15.3	1.8	16.2	294.
39	636.4	4471.9	0.0	0.0	0.690	22.6	1.7	15.5	470.
40	636.4	4471.9	0.0	0.0	0.848	31.7	1.7	13.1	481.
41	636.1	4471.9	0.0	0.0	0.051	22.4	0.8	18.8	394.
42	636.1	4471.9	0.0	0.0	0.214	23.8	1.3	27.2	400.
43	636.1	4471.9	0.0	0.0	0.214	23.8	1.3	27.2	400.
44	636.1	4471.9	0.0	0.0	0.253	23.8	1.6	12.8	371.
45	636.1	4471.9	0.0	0.0	0.112	27.7	0.9	16.8	296.
46	636.1	4471.9	0.0	0.0	0.112	33.1	0.9	21.3	294.
47	636.1	4471.9	0.0	0.0	0.052	27.7	0.8	11.3	311.
48	635.0	4471.8	0.0	0.0	0.112	10.0	5.0	1.0	300.
49	636.3	4471.8	0.0	0.0	0.093	18.3	0.8	11.9	313.
50	636.3	4471.8	0.0	0.0	0.051	18.3	0.8	8.2	316.
51	636.3	4471.8	0.0	0.0	0.012	20.7	0.9	5.5	340.
52	636.3	4471.8	0.0	0.0	0.013	20.7	0.9	2.1	310.
53	636.3	4471.8	0.0	0.0	0.043	18.6	1.1	7.3	337.
54	636.3	4471.8	0.0	0.0	0.042	18.3	0.9	8.2	320.
55	636.3	4471.8	0.0	0.0	0.127	25.0	0.9	31.1	341.
56	636.3	4471.8	0.0	0.0	0.059	25.0	0.9	31.1	341.
57	636.4	4471.8	0.0	0.0	0.021	25.3	1.3	14.6	316.
58	636.4	4471.8	0.0	0.0	0.006	25.0	1.0	23.5	371.
59	636.4	4471.8	0.0	0.0	0.021	16.5	0.6	16.5	352.
60	636.4	4471.8	0.0	0.0	0.042	14.0	0.5	16.1	357.
61	636.0	4471.8	0.0	0.0	0.143	6.0	0.0	0.0	294.
62	636.2	4471.9	0.0	0.0	0.205	6.0	0.0	0.0	294.
63	635.4	4471.5	0.0	0.0	0.338	6.0	0.0	0.0	294.
64	628.0	4470.0	25.00	0.0	0.647	0.0	0.0	0.0	0.
65	633.0	4477.0	16.00	0.0	0.668	0.0	0.0	0.0	0.
66	638.0	4470.0	25.00	0.0	1.059	0.0	0.0	0.0	0.
67	628.0	4471.0	25.00	0.0	1.928	0.0	0.0	0.0	0.
68	633.0	4474.0	9.00	0.0	0.809	0.0	0.0	0.0	0.
69	628.0	4474.0	4.00	0.0	2.660	0.0	0.0	0.0	0.
70	633.0	4471.0	9.00	0.0	0.566	0.0	0.0	0.0	0.
71	636.0	4472.0	4.00	0.0	2.337	0.0	0.0	0.0	0.
72	638.0	4471.0	25.00	0.0	1.040	0.0	0.0	0.0	0.
73	629.0	4466.0	25.00	0.0	0.649	0.0	0.0	0.0	0.
74	634.0	4467.0	16.00	0.0	0.649	0.0	0.0	0.0	0.
75	638.0	4466.0	25.00	0.0	0.649	0.0	0.0	0.0	0.

APPENDIX B

RECEPTOR CONCENTRATION DATA

RECEPTOR NUMBER	RECEPTOR LOCATION (KILOMETERS) HORIZ	VERT	EXPECTED ARITHMETIC MEAN (MICROGRAMS/CU. METER) SO2	PARTICULATES
1	629.0	4467.0	0.	50.
2	629.0	4468.0	0.	51.
3	629.0	4469.0	0.	52.
4	629.0	4470.0	0.	55.
5	629.0	4471.0	0.	57.
6	629.0	4472.0	0.	59.
7	629.0	4473.0	0.	59.
8	629.0	4474.0	0.	57.
9	629.0	4475.0	0.	55.
10	629.0	4476.0	0.	56.
11	629.0	4477.0	0.	54.
12	629.0	4478.0	0.	52.
13	629.0	4479.0	0.	51.
14	629.0	4480.0	0.	50.
15	629.0	4481.0	0.	49.
16	630.0	4467.0	0.	50.
17	630.0	4468.0	0.	51.
18	630.0	4469.0	0.	52.
19	630.0	4470.0	0.	56.
20	630.0	4471.0	0.	59.
21	630.0	4472.0	0.	60.
22	630.0	4473.0	0.	59.
23	630.0	4474.0	0.	57.
24	630.0	4475.0	0.	53.
25	630.0	4476.0	0.	57.
26	630.0	4477.0	0.	54.
27	630.0	4478.0	0.	53.
28	630.0	4479.0	0.	51.
29	630.0	4480.0	0.	50.
30	630.0	4481.0	0.	50.
31	631.0	4467.0	0.	50.
32	631.0	4468.0	0.	51.
33	631.0	4469.0	0.	52.
34	631.0	4470.0	0.	55.
35	631.0	4471.0	0.	59.
36	631.0	4472.0	0.	60.
37	631.0	4473.0	0.	58.
38	631.0	4474.0	0.	58.
39	631.0	4475.0	0.	59.
40	631.0	4476.0	0.	58.
41	631.0	4477.0	0.	55.
42	631.0	4478.0	0.	53.
43	631.0	4479.0	0.	52.
44	631.0	4480.0	0.	51.
45	631.0	4481.0	0.	50.
46	632.0	4467.0	0.	50.
47	632.0	4468.0	0.	51.
48	632.0	4469.0	0.	52.
49	632.0	4470.0	0.	56.
50	632.0	4471.0	0.	60.
51	632.0	4472.0	0.	62.
52	632.0	4473.0	0.	61.
53	632.0	4474.0	0.	61.
54	632.0	4475.0	0.	62.
55	632.0	4476.0	0.	61.
56	632.0	4477.0	0.	57.
57	632.0	4478.0	0.	54.
58	632.0	4479.0	0.	52.
59	632.0	4480.0	0.	51.
60	632.0	4481.0	0.	50.
61	633.0	4467.0	0.	51.
62	633.0	4468.0	0.	52.
63	633.0	4469.0	0.	53.
64	633.0	4470.0	0.	57.
65	633.0	4471.0	0.	63.
66	633.0	4472.0	0.	[illegible]
67	633.0	4473.0	0.	63.
68	633.0	4474.0	0.	62.
69	633.0	4475.0	0.	66.
70	633.0	4476.0	0.	67.
71	633.0	4477.0	0.	59.
72	633.0	4478.0	0.	55.
73	633.0	4479.0	0.	54.
74	633.0	4480.0	0.	52.
75	633.0	4481.0	0.	52.
76	634.0	4467.0	0.	52.
77	634.0	4468.0	0.	52.
78	634.0	4469.0	0.	53.
79	634.0	4470.0	0.	57.
80	634.0	4471.0	0.	64.

RECEPTOR CONCENTRATION DATA

RECEPTOR NUMBER	RECEPTOR LOCATION (KILOMETERS) HORIZ	VERT	EXPECTED ARITHMETIC MEAN (MICROGRAMS/CU. METER) SO2	PARTICULATES
81	634.0	4472.0	0.	71.
82	634.0	4473.0	0.	66.
83	634.0	4474.0	0.	65.
84	634.0	4475.0	0.	72.
85	634.0	4476.0	0.	90.
86	634.0	4477.0	0.	65.
87	634.0	4478.0	0.	59.
88	634.0	4479.0	0.	55.
89	634.0	4480.0	0.	54.
90	634.0	4481.0	0.	53.
91	635.0	4467.0	0.	53.
92	635.0	4468.0	0.	52.
93	635.0	4469.0	0.	53.
94	635.0	4470.0	0.	56.
95	635.0	4471.0	0.	66.
96	635.0	4472.0	0.	94.
97	635.0	4473.0	0.	65.
98	635.0	4474.0	0.	66.
99	635.0	4475.0	0.	65.
100	635.0	4476.0	0.	65.
101	635.0	4477.0	0.	61.
102	635.0	4478.0	0.	57.
103	635.0	4479.0	0.	55.
104	635.0	4480.0	0.	54.
105	635.0	4481.0	0.	53.
106	636.0	4467.0	0.	52.
107	636.0	4468.0	0.	53.
108	636.0	4469.0	0.	55.
109	636.0	4470.0	0.	58.
110	636.0	4471.0	0.	77.
111	636.0	4472.0	0.	181.
112	636.0	4473.0	0.	85.
113	636.0	4474.0	0.	73.
114	636.0	4475.0	0.	69.
115	636.0	4476.0	0.	65.
116	636.0	4477.0	0.	62.
117	636.0	4478.0	0.	58.
118	636.0	4479.0	0.	56.
119	636.0	4480.0	0.	54.
120	636.0	4481.0	0.	53.
121	637.0	4467.0	0.	51.
122	637.0	4468.0	0.	52.
123	637.0	4469.0	0.	54.
124	637.0	4470.0	0.	57.
125	637.0	4471.0	0.	64.
126	637.0	4472.0	0.	52.
127	637.0	4473.0	0.	73.
128	637.0	4474.0	0.	69.
129	637.0	4475.0	0.	64.
130	637.0	4476.0	0.	63.
131	637.0	4477.0	0.	60.
132	637.0	4478.0	0.	59.
133	637.0	4479.0	0.	55.
134	637.0	4480.0	0.	54.
135	637.0	4481.0	0.	53.
136	638.0	4467.0	0.	51.
137	638.0	4468.0	0.	51.
138	638.0	4469.0	0.	53.
139	638.0	4470.0	0.	56.
140	638.0	4471.0	0.	62.
141	638.0	4472.0	0.	63.
142	638.0	4473.0	0.	59.
143	638.0	4474.0	0.	64.
144	638.0	4475.0	0.	62.
145	638.0	4476.0	0.	60.
146	638.0	4477.0	0.	59.
147	638.0	4478.0	0.	57.
148	638.0	4479.0	0.	55.
149	638.0	4480.0	0.	53.
150	638.0	4481.0	0.	52.
151	639.0	4467.0	0.	50.
152	639.0	4468.0	0.	51.
153	639.0	4469.0	0.	53.
154	639.0	4470.0	0.	56.
155	639.0	4471.0	0.	60.
156	639.0	4472.0	0.	64.
157	639.0	4473.0	0.	63.
158	639.0	4474.0	0.	67.
159	639.0	4475.0	0.	60.
160	639.0	4476.0	0.	55.

KEOKUK, IOWA 1977 PARTICULATE CONCENTRATIONS AUGUST 1978

RECEPTOR CONCENTRATION DATA

RECEPTOR NUMBER	RECEPTOR LOCATION (KILOMETERS)		EXPECTED ARITHMETIC MEAN (MICROGRAMS/CU. METER)	
	HORIZ	VERT	SO2	PARTICULATES
161	639.0	4477.0	0.	58.
162	639.0	4478.0	0.	55.
163	639.0	4479.0	0.	54.
164	639.0	4480.0	0.	53.
165	639.0	4481.0	0.	52.
166	640.0	4467.0	0.	50.
167	640.0	4468.0	0.	51.
168	640.0	4469.0	0.	52.
169	640.0	4470.0	0.	55.
170	640.0	4471.0	0.	58.
171	640.0	4472.0	0.	60.
172	640.0	4473.0	0.	60.
173	640.0	4474.0	0.	60.
174	640.0	4475.0	0.	59.
175	640.0	4476.0	0.	58.
176	640.0	4477.0	0.	57.
177	640.0	4478.0	0.	55.
178	640.0	4479.0	0.	53.
179	640.0	4480.0	0.	52.
180	640.0	4481.0	0.	51.
181	641.0	4467.0	0.	50.
182	641.0	4468.0	0.	50.
183	641.0	4469.0	0.	52.
184	641.0	4470.0	0.	54.
185	641.0	4471.0	0.	56.
186	641.0	4472.0	0.	58.
187	641.0	4473.0	0.	59.
188	641.0	4474.0	0.	59.
189	641.0	4475.0	0.	58.
190	641.0	4476.0	0.	57.
191	641.0	4477.0	0.	55.
192	641.0	4478.0	0.	54.
193	641.0	4479.0	0.	53.
194	641.0	4480.0	0.	52.
195	641.0	4481.0	0.	51.
196	642.0	4467.0	0.	49.
197	642.0	4468.0	0.	50.
198	642.0	4469.0	0.	52.
199	642.0	4470.0	0.	53.
200	642.0	4471.0	0.	55.
201	642.0	4472.0	0.	55.
202	642.0	4473.0	0.	57.
203	642.0	4474.0	0.	57.
204	642.0	4475.0	0.	56.
205	642.0	4476.0	0.	56.
206	642.0	4477.0	0.	55.
207	642.0	4478.0	0.	54.
208	642.0	4479.0	0.	53.
209	642.0	4480.0	0.	52.
210	642.0	4481.0	0.	51.
211	643.0	4467.0	0.	49.
212	643.0	4468.0	0.	50.
213	643.0	4469.0	0.	51.
214	643.0	4470.0	0.	53.
215	643.0	4471.0	0.	54.
216	643.0	4472.0	0.	55.
217	643.0	4473.0	0.	55.
218	643.0	4474.0	0.	56.
219	643.0	4475.0	0.	56.
220	643.0	4476.0	0.	55.
221	643.0	4477.0	0.	54.
222	643.0	4478.0	0.	53.
223	643.0	4479.0	0.	53.
224	643.0	4480.0	0.	52.
225	643.0	4481.0	0.	51.
226	635.4	4471.7	0.	112.
227	636.5	4473.2	0.	75.
228	636.5	4474.6	0.	70.
229	635.7	4472.3	0.	95.
230	636.6	4472.5	0.	99.
231	635.5	4472.0	0.	124.
232	636.5	4472.0	0.	135.
233	636.0	4471.5	0.	111.
234	635.5	4471.0	0.	77.
235	636.5	4471.0	0.	70.
236	636.0	4770.5	0.	43.
237	633.5	4475.5	0.	61.

Keokuk Sources and
Corresponding Source Numbers Used
in the AQDM Model

Source Number	
1-4	Kast Metals Corporation
5-13	Griffin Wheel Company
14-26	Midwest Carbide Company
27-35	General Mills Chemicals
36-38	Foote Mineral Company
39-63	Hubiner Corporation
64-75	Area Sources

KECKUK, IOWA 1977 PARTICULATE CONCENTRATIONS AUGUST 1978

SOURCE CONTRIBUTIONS TO FIVE SELECTED RECEPTORS

ANNUAL PARTICULATES

MICROGRAMS PER CUBIC METER

SOURCE	RECEPTOR 226	RECEPTOR 227	RECEPTOR 228	RECEPTOR 230	RECEPTOR 232
1	0.00 %	0.01 %	0.01 %	0.00 %	0.08 %
	0.0036	0.0051	0.0092	0.0042	0.0476
2	0.00 %	0.01 %	0.01 %	0.00 %	0.06 %
	0.0032	0.0047	0.0087	0.0029	0.0352
3	0.00 %	0.00 %	0.00 %	0.00 %	0.02 %
	0.0009	0.0013	0.0023	0.0015	0.0112
4	0.00 %	0.00 %	0.00 %	0.00 %	0.03 %
	0.0013	0.0019	0.0034	0.0016	0.0163
5	0.02 %	0.04 %	0.10 %	0.03 %	0.02 %
	0.0197	0.0297	0.0694	0.0224	0.0098
6	0.05 %	0.11 %	0.29 %	0.08 %	1.45 %
	0.0537	0.0867	0.2002	0.0709	0.8830
7	0.00 %	0.01 %	0.02 %	0.01 %	0.24 %
	0.0044	0.0066	0.0154	0.0057	0.1462
8	0.02 %	0.04 %	0.12 %	0.03 %	1.28 %
	0.0230	0.0335	0.0806	0.0272	0.7827
9	0.02 %	0.04 %	0.11 %	0.03 %	1.22 %
	0.0213	0.0320	0.0771	0.0259	0.7441
10	0.00 %	0.01 %	0.03 %	0.01 %	0.69 %
	0.0050	0.0072	0.0177	0.0058	0.4188
11	0.00 %	0.01 %	0.02 %	0.00 %	0.45 %
	0.0032	0.0046	0.0119	0.0039	0.2907
12	0.01 %	0.02 %	0.05 %	0.01 %	0.49 %
	0.0132	0.0155	0.0376	0.0129	0.2992
13	0.01 %	0.01 %	0.04 %	0.01 %	0.96 %
	0.0072	0.0104	0.0256	0.0086	0.5830
14	0.01 %	0.01 %	0.03 %	0.01 %	0.0 %
	0.0036	0.0053	0.0222	0.0046	0.0
15	0.00 %	0.01 %	0.03 %	0.01 %	0.0 %
	0.0034	0.0039	0.0225	0.0043	0.0
16	0.00 %	0.01 %	0.02 %	0.00 %	0.0 %
	0.0030	0.0049	0.0122	0.0035	0.0
17	0.24 %	0.57 %	1.33 %	0.35 %	0.0 %
	0.2617	0.4369	0.9280	0.3155	0.0
18	0.01 %	0.02 %	0.04 %	0.01 %	0.0 %
	0.0071	0.0116	0.0279	0.0084	0.0
19	0.01 %	0.02 %	0.04 %	0.01 %	0.0 %
	0.0071	0.0117	0.0289	0.0084	0.0
20	0.03 %	0.07 %	0.18 %	0.04 %	0.0 %
	0.0326	0.0534	0.1278	0.0383	0.0
21	0.01 %	0.03 %	0.07 %	0.02 %	0.0 %
	0.0125	0.0204	0.0495	0.0147	0.0
22	0.03 %	0.06 %	0.17 %	0.04 %	0.0 %
	0.0297	0.0485	0.1162	0.0348	0.0
23	0.00 %	0.00 %	0.01 %	0.00 %	0.0 %
	0.0012	0.0020	0.0049	0.0014	0.0
24	0.00 %	0.01 %	0.01 %	0.00 %	0.0 %
	0.0024	0.0039	0.0099	0.0028	0.0
25	0.04 %	0.09 %	0.24 %	0.05 %	0.0 %
	0.0416	0.0681	0.1669	0.0489	0.0
26	0.19 %	0.45 %	1.28 %	0.27 %	0.0 %
	0.2093	0.3444	0.8928	0.2460	0.0
27	0.02 %	0.03 %	0.03 %	0.02 %	0.01 %
	0.0174	0.0266	0.0184	0.0174	0.0051
28	0.04 %	0.12 %	0.06 %	0.23 %	0.02 %
	0.0431	0.0922	0.0399	0.2093	0.0149
29	0.11 %	0.36 %	0.16 %	0.88 %	0.07 %
	0.1257	0.2778	0.1112	0.7961	0.0404
30	0.01 %	0.05 %	0.01 %	0.17 %	0.01 %
	0.0126	0.0394	0.0092	0.1493	0.0037
31	0.01 %	0.03 %	0.02 %	0.02 %	0.01 %
	0.0128	0.0243	0.0167	0.0158	0.0047
32	0.04 %	0.18 %	0.05 %	0.88 %	0.02 %
	0.0458	0.1345	0.0327	0.7925	0.0107
33	0.01 %	0.04 %	0.02 %	0.15 %	0.01 %
	0.0127	0.0341	0.0154	0.1317	0.0064
34	0.03 %	0.10 %	0.05 %	0.16 %	0.02 %
	0.0350	0.0799	0.0321	0.1428	0.0117
35	0.03 %	0.10 %	0.05 %	0.15 %	0.02 %
	0.0337	0.0730	0.0315	0.1310	0.0117
36	0.03 %	0.02 %	0.01 %	0.03 %	0.03 %
	0.0311	0.0171	0.0035	0.0231	0.0092
37	0.04 %	0.03 %	0.02 %	0.04 %	0.02 %
	0.0453	0.0253	0.0142	0.0340	0.0129
38	0.48 %	0.30 %	0.20 %	0.34 %	0.26 %
	[illegible]	0.2311	0.1317	0.3067	0.1607
39	0.00 %	0.61 %	0.61 %	0.20 %	0.16 %
	[illegible]	0.4463	0.4264	0.1850	0.0962
40	0.00 %	0.65 %	0.72 %	0.21 %	0.19 %
	[illegible]	0.5002	0.5025	0.1833	0.1162
41	0.07 %	0.19 %	0.13 %	0.17 %	0.04 %
	0.0775	0.1456	0.0925	0.1493	0.0265
42	0.01 %	0.25 %	0.31 %	0.14 %	0.10 %
	0.0093	0.1902	0.2149	0.1224	0.0597

KEOKUK, IOWA 1977 PARTICULATE CONCENTRATIONS AUGUST 1978

SOURCE CONTRIBUTIONS TO FIVE SELECTED RECEPTORS

ANNUAL PARTICULATES

MICROGRAMS PER CUBIC METER

SOURCE	RECEPTOR 226	RECEPTOR 227	RECEPTOR 228	RECEPTOR 230	RECEPTOR 237
43	0.01 %	0.25 %	0.31 %	0.14 %	0.10 %
	0.0023	0.1902	0.2169	0.1224	0.0592
44	0.10 %	0.66 %	0.57 %	0.46 %	0.19 %
	0.1099	0.5020	0.3984	0.4170	0.1160
45	0.56 %	0.78 %	0.46 %	1.02 %	0.17 %
	0.6212	0.5976	0.3228	0.9246	0.1047
46	0.24 %	0.62 %	0.43 %	0.66 %	0.17 %
	0.2629	0.4711	0.3030	0.5935	0.1034
47	0.20 %	0.32 %	0.21 %	0.36 %	0.09 %
	0.2163	0.2422	0.1444	0.3279	0.0482
48	2.15 %	0.60 %	0.41 %	0.78 %	0.16 %
	2.3961	0.4582	0.2871	0.7078	0.1003
49	0.12 %	0.77 %	0.39 %	0.85 %	0.14 %
	0.1342	0.5911	0.2745	0.7714	0.0863
50	0.09 %	0.46 %	0.22 %	0.53 %	0.09 %
	0.1009	0.3491	0.1539	0.4797	0.0542
51	0.01 %	0.14 %	0.08 %	0.15 %	0.03 %
	0.0152	0.1085	0.0525	0.1356	0.0163
52	0.04 %	0.14 %	0.06 %	0.19 %	0.02 %
	0.0325	0.1042	0.0407	0.1732	0.0118
53	0.02 %	0.30 %	0.17 %	0.30 %	0.06 %
	0.0234	0.2262	0.1185	0.2750	0.0357
54	0.06 %	0.40 %	0.21 %	0.44 %	0.07 %
	0.0620	0.3064	0.1462	0.3963	0.0444
55	0.00 %	0.75 %	0.49 %	0.52 %	0.14 %
	0.0025	0.5744	0.3424	0.4664	0.0886
56	0.00 %	0.30 %	0.25 %	0.26 %	0.07 %
	0.0002	0.2281	0.1722	0.2344	0.0444
57	0.00 %	0.37 %	0.19 %	0.29 %	0.05 %
	0.0021	0.2823	0.1357	0.2623	0.0322
58	0.00 %	0.30 %	0.21 %	0.18 %	0.05 %
	0.0020	0.2264	0.1464	0.1616	0.0274
59	0.01 %	0.17 %	0.09 %	0.18 %	0.03 %
	0.0064	0.1269	0.0613	0.1602	0.0192
60	0.03 %	0.34 %	0.17 %	0.30 %	0.06 %
	0.0313	0.2612	0.1234	0.2622	0.0390
61	10.59 %	1.23 %	0.60 %	2.66 %	0.21 %
	11.7235	0.9403	0.4176	2.3980	0.1320
62	12.69 %	2.63 %	0.99 %	5.46 %	0.32 %
	14.0527	2.0092	0.6947	4.9277	0.1961
63	7.09 %	2.29 %	0.83 %	3.40 %	0.47 %
	7.7141	1.7429	0.5800	3.0672	0.2944
64	0.24 %	0.44 %	0.35 %	0.34 %	0.81 %
	0.2676	0.3350	0.3213	0.3055	0.4966
65	0.22 %	0.47 %	0.72 %	0.34 %	2.16 %
	0.2497	0.3573	0.5002	0.3102	1.3192
66	0.33 %	0.60 %	2.20 %	0.73 %	1.37 %
	0.2727	0.4619	1.5344	0.7942	0.8369
67	1.22 %	1.78 %	2.00 %	1.48 %	2.29 %
	1.3530	1.3615	1.3976	1.3340	1.3974
68	0.83 %	1.33 %	1.72 %	2.94 %	2.77 %
	0.9232	1.0194	1.2045	2.6525	1.6884
69	0.63 %	5.85 %	7.63 %	0.99 %	2.01 %
	0.7075	4.4742	5.2235	0.8273	1.2205
70	0.77 %	1.02 %	0.96 %	0.91 %	0.91 %
	0.8545	0.7822	0.6687	0.8217	0.5537
71	16.93 %	10.78 %	6.06 %	20.06 %	4.05 %
	21.1253	8.2437	4.2215	18.1117	2.4755
72	1.47 %	1.36 %	0.92 %	1.70 %	1.06 %
	1.6445	1.0428	0.6425	1.5344	0.6467
73	0.37 %	0.48 %	0.47 %	0.42 %	0.51 %
	0.4076	0.3702	0.3292	0.3825	0.3140
74	0.49 %	0.62 %	0.56 %	0.56 %	0.61 %
	0.5512	0.4751	0.3917	0.5069	0.3734
75	0.34 %	0.43 %	0.42 %	0.40 %	0.41 %
	0.3813	0.3273	0.2900	0.3612	0.2500
BACK-GROUND	36.53 %	56.85 %	61.54 %	47.63 %	75.17 %
[illegible]	42.	42.	43.	43.	43.
TOTAL	100.0 %	100.0 %	100.0 %	100.0 %	100.0 %
	111.4102	76.4834	69.8766	90.2332	61.2729