REPORT FOR CONSULTATION ON THE METROPOLITAN DETROIT - PORT HURON INTRASTATE AIR QUALITY CONTROL REGION

AIR POLLUTION & AIR QUALITY

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service

REPORT FOR CONSULTATION ON THE

METROPOLITAN DETROIT - PORT HURON INTRASTATE

AIR QUALITY CONTROL REGION

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration
October 1969

CONTENTS

Page

PREFACE

INTRODUCTION 1

EVALUATION OF URBAN FACTORS 10

EVALUATION OF ENGINEERING FACTORS 24

THE PROPOSED REGION 38

DISCUSSION OF PROPOSAL 38

APPENDIX A 46

REFERENCES 50

PREFACE

The Secretary, Department of Health, Education, and Welfare is directed by the Clean Air Act, as amended, to designate "air quality control regions" as an initial step toward the establishment of regional air quality standards and implementation of air quality control programs. In addition to listing the major factors to be considered in the designation of region boundaries, the Act stipulates that the designation of a region shall be preceded by consultation with appropriate State and local authorities.

The National Air Pollution Control Administration, DHEW, has conducted a study of the Metropolitan Detroit - Port Huron area, the results of which are presented in this report. The boundaries of the Region,* as proposed in this report, reflect consideration of available and pertinent data; however, the boundaries remain subject to revision suggested by consultation with State and local authorities. Formal designation will be withheld pending the outcome of that consultation.

The Administration is appreciative of assistance received during the course of this study and during previous activities in the Metropolitan Detroit - Port Huron area from official air pollution control agencies, the Michigan Bureau of Planning and Program Development, the Detroit Regional Transportation and Land Use Study, and local county planning commissions.

---

*For the purposes of this report, the word "region," when capitalized, will refer to the Metropolitan Detroit - Port Huron Intrastate Air Quality Control Region. When not capitalized, unless otherwise noted, it will refer to air quality control regions in general.

INTRODUCTION

> "For the purpose of establishing ambient air quality standards pursuant to section 108, and for administrative and other purposes, the Secretary, after consultation with appropriate State and local authorities shall, to the extent feasible, within 18 months after the date of enactment of the Air Quality Act of 1967 designate air quality control regions based on jurisdictional boundaries, urban-industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards. The Secretary may from time to time thereafter, as he determines necessary to protect the public health and welfare and after consultation with appropriate State and local authorities, revise the designation of such regions and designate additional air quality control regions. The Secretary shall immediately notify the Governor or Governors of the affected State or States of such designation."
>
> Section 107(a)(2), Clean Air Act, as amended

THE REGIONAL APPROACH

Air pollution in most of the Nation's urban areas is a regional problem, often extending across a number of State and local governmental jurisdictions. The problem demands a regional solution consisting of coordinated planning, data gathering, standard setting, and enforcement. Yet, with few exceptions, such coordinated efforts are notably absent among the Nation's urban complexes.

Beginning with the Section quoted above, in which the Secretary is required to designate air quality control regions, the Clean Air Act presents a regional approach to air pollution control involving coordinated efforts by Federal, State, and

local governments. Figure 1 illustrates this approach which is initiated when the Federal Government has designated regions and published air quality criteria and information on available control techniques. Following the completion of these steps, the Governor(s) of the State(s) involved in a region designation file a letter of intent with the Secretary within 90 days indicating that the State(s) will adopt within 180 days ambient air quality standards for the pollutants covered by the published criteria and control technology documents and adopt within an additional 180 days plans for the implementation, maintenance, and enforcement of those standards in the designated air quality control region.

The new Federal legislation provides for a regional attack on air pollution and, at the same time, allows latitude in the form which regional efforts may take. While the Secretary retains approval authority, the State(s) involved in a designated region assumes the responsibility for developing standards and an implementation plan which includes administrative procedures for abatement and control. Informal cooperative arrangements with proper safeguards may be adequate in some regions. In others, more formal arrangements, such as interstate compacts, may be selected. The objective in each instance will be to provide effective mechanisms for control on a regional basis.

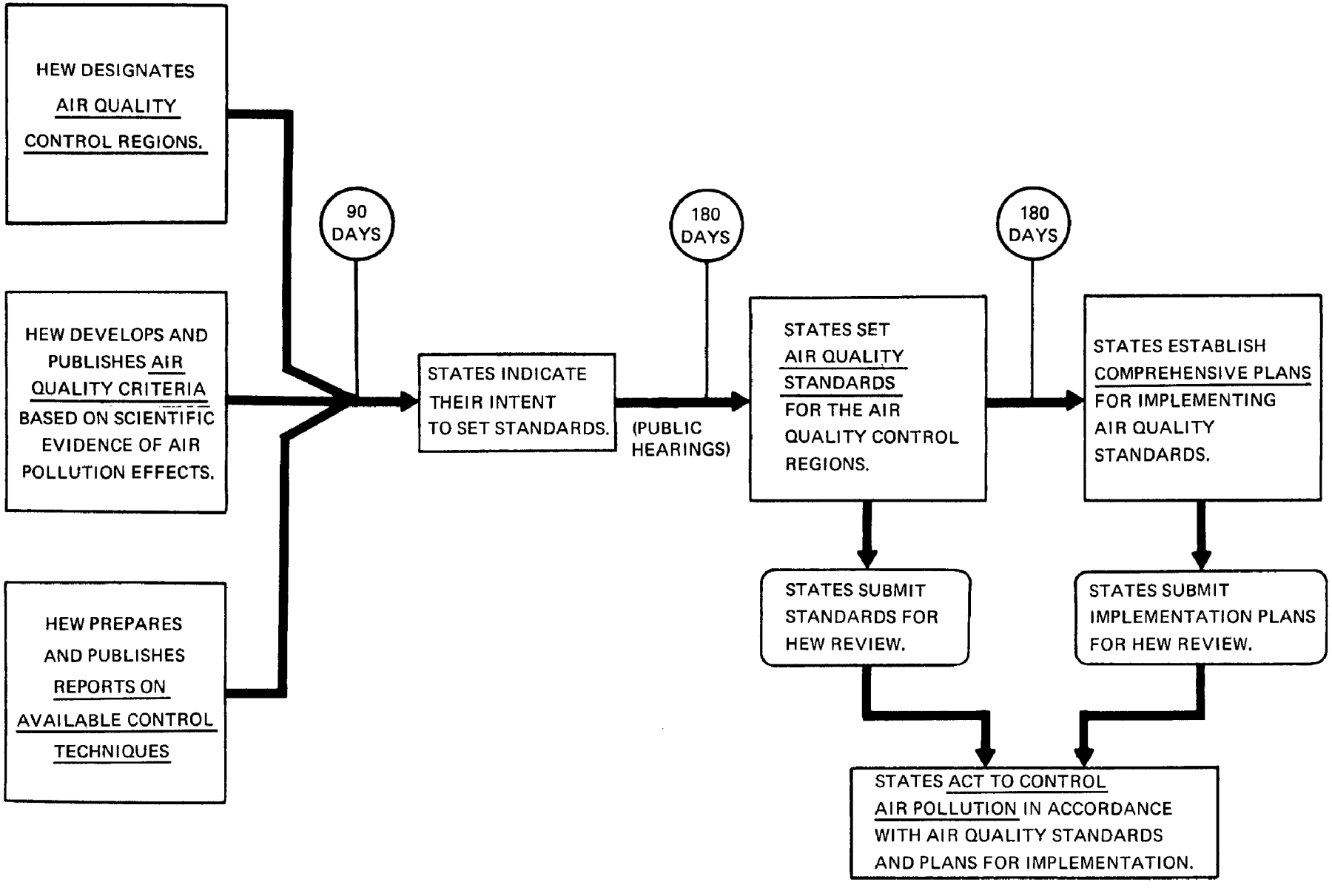


Figure 1. FLOW DIAGRAM FOR ACTION TO CONTROL AIR POLLUTION ON A REGIONAL BASIS.

THE SIZE OF A REGION

Several objectives are important in determining how large an air quality control region should be. Basically, these objectives can be divided into three separate categories. First, a region should be self-contained with respect to air pollution sources and receptors. In other words, a region should include most of the important sources in the area as well as most of the people and property affected by those sources. In this way, all the major elements of the regional problem will lie within one unified administrative jurisdiction. Unfortunately, since air pollutants can travel long distances, it is impractical if not impossible to delineate regions which are completely self-contained. The air over a region will usually have at least trace amounts of pollutants from external sources. During episodic conditions, such contributions from external sources may even reach significant levels. Conversely, air pollution generated within a region and transported out of it can affect external receptors to some degree. It would be impractical and inefficient to make all air quality control regions large enough to encompass these low-level effects. The geographic extent of trace effects overestimates the true problem area which should be the focus of air pollution control efforts. Thus, the first objective, that a region be self-contained, becomes a question of relative magnitude and frequency. The dividing line between "important influence" and "trace effect"

will be a matter of judgment. The judgment should be based on estimates of the impact a source has upon a region, and the level of pollution to which receptors are subjected. In this respect, annual and seasonal data on pollutant emissions and ambient air concentrations are a better measure of relative influence than short-term data on episodic conditions.

The second general objective requires that region boundaries be designed to meet not only present conditions but also future conditions. In other words, the region should include areas where industrial and residential expansion are likely to create air pollution problems in the foreseeable future, and provide a way of maintaining areas now favored by clean air. This objective requires careful consideration of existing metropolitan development plans, expected population growth, and projected industrial expansion. Such considerations should result in the designation of regions which will contain the sources and receptors of regional air pollution for a number of years to come. Of course, region boundaries need not be permanently fixed, once designated. Boundaries should be reviewed periodically and altered when changing conditions warrant readjustment.

The third objective is that region boundaries should be compatible with and even foster unified and cooperative governmental administration of the air resource throughout the region. Air pollution is a regional problem which often extends across several municipal, county, and even state boundaries. Clearly,

the collaboration of several governmental jurisdictions is prerequisite to the solution of the problem. Therefore, the region should be delineated in a way which encourages regional cooperation among the various governmental bodies involved in air pollution control. The existing pattern of governmental cooperation on the whole range of urban problems may become an important consideration. The pattern of cooperation among existing air pollution control programs is a relevant factor. In general, administrative considerations dictate that governmental jurisdictions should not be divided. Although it would be impractical to preserve State jurisdictions undivided, usually it is possible to preserve the unity of county governments by including or excluding them in their entirety. Occasionally, even this is impractical due to a county's large size, wide variation in level of development, or striking topographical features.

To the extent that any two of the above three objectives lead to incompatible conclusions concerning region boundaries, the region must represent a reasonable compromise. A region should represent the best way of satisfying the three objectives simultaneously.

PROCEDURE FOR DESIGNATION OF REGIONS

Figure 2 illustrates the procedures used by the National Air Pollution Control Administration for designating air quality control regions. A preliminary delineation of the region is

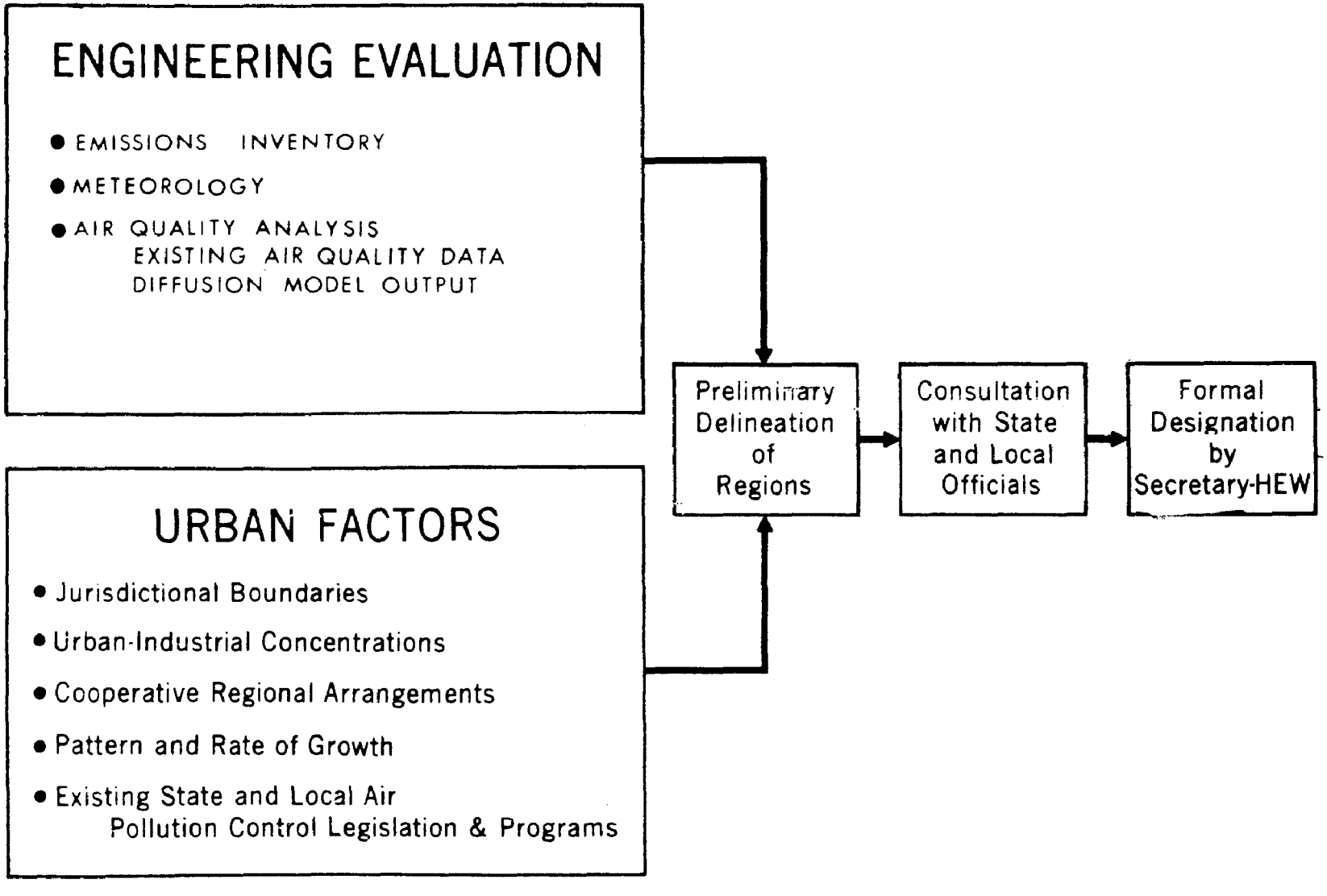


Figure 2. Flow diagram for the designation of air quality control regions.

developed by bringing together two essentially separate studies--the "Evaluation of Urban Factors," and the "Evaluation of Engineering Factors."

The "Evaluation of Urban Factors" encompasses considerations of a non-engineering nature. This evaluation consists of a review of existing governmental jurisdictions, current air pollution control programs, demographic data, current urbanization, and projected patterns of urbanization. The study of urban factors also attempts to determine the size of the region that is necessary to include areas where projected urbanization will create increasing air pollution problems in the future.

The "Evaluation of Engineering Factors" considers pollutant source locations, emissions, and the geographic extent of air pollutant concentrations in the ambient air.

The findings of the urban-factors evaluation are combined with the results of the engineering-factors evaluation, and an initial proposal for the air quality control region is made. As indicated in Figure 2, the proposal is submitted for consultation with State and local officials. After reviewing the official transcript of the consultation proceedings which provides the viewpoints of State and local officials toward the proposal, the Secretary formally designates the region. Formal designation includes a notice in the Federal Register and a notification to the Governor(s) of the State(s) affected by the designation.

The body of this report contains a proposal for the boundaries of the Metropolitan Detroit - Port Huron Intrastate Air Quality Control Region and the urban and engineering factors evaluations supporting the proposal. The report itself is intended to serve as a background document for the formal consultation with appropriate State and local authorities.

EVALUATION OF URBAN FACTORS

INTRODUCTION

A number of urban factors are relevant to defining air quality control region boundaries. Since human activity is the primary cause of air pollution, and humans are the ultimate victims, the location of population is an important consideration. The projected population growth pattern is another important consideration, since an air quality control region should be designed not only for the present but also for the future. For similar reasons, the location of industrial activity and the industrial growth pattern are relevant considerations. Political and jurisdictional considerations are important since the Clean Air Act envisions regional air pollution programs based on cooperative efforts among many political jurisdictions. The following discussion of urban factors will present these considerations as they apply to the Detroit - Port Huron area.

REGIONAL SETTING

The seven counties considered for inclusion in the Metropolitan Detroit - Port Huron Intrastate Air Quality Control Region are Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne. These counties are members of Region I of Michigan's Planning and Development Regions and are included in the Detroit Area Transportation and Land Use Study (TALUS). This group of counties is referred to throughout this section

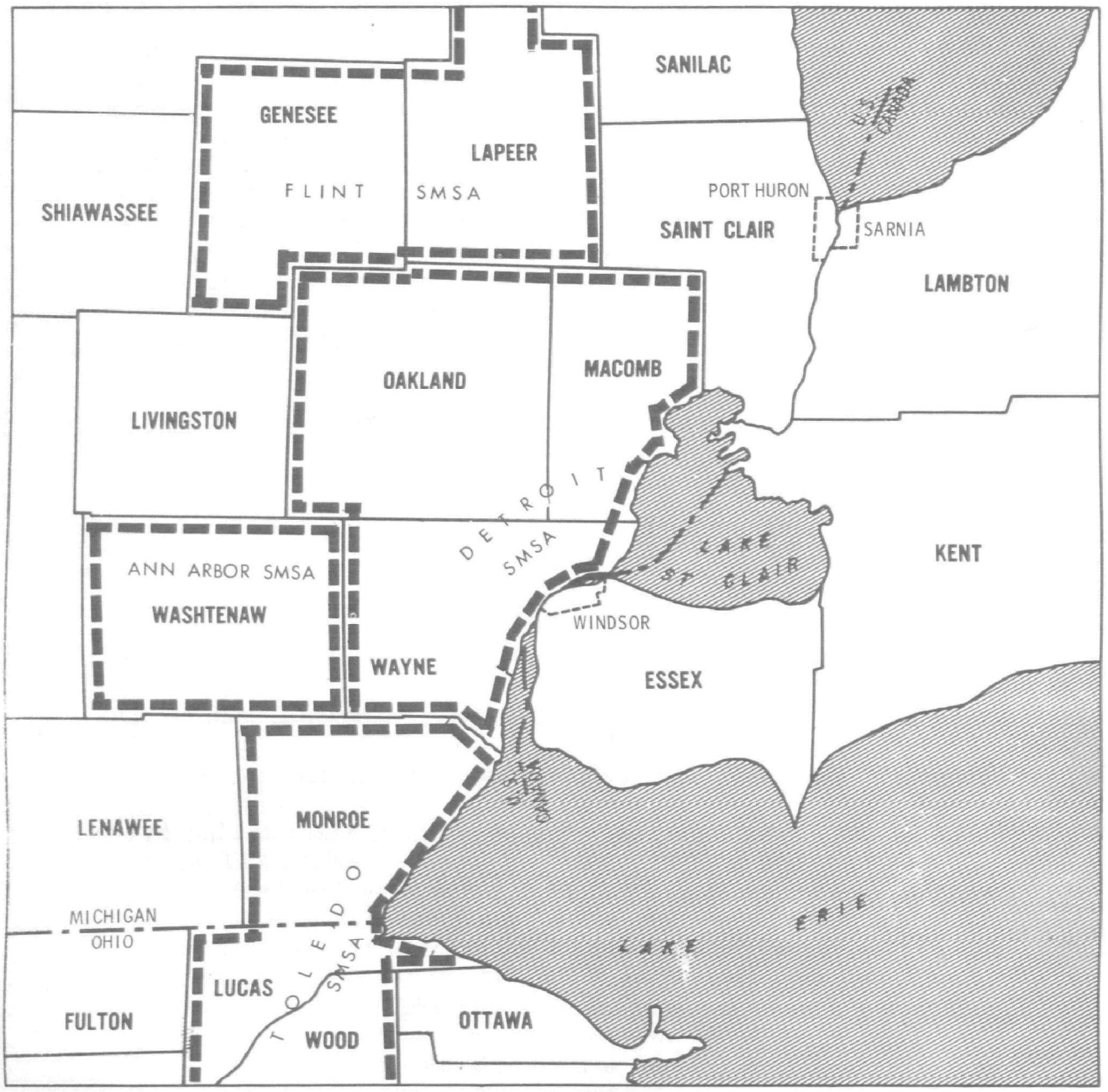
as the "study area." The study area lies in the southeast corner of Michigan with Ohio on its southern boundary and the Canadian cities of Sarnia and Windsor on its eastern boundary. The three counties of Oakland, Macomb, and Wayne comprise the Detroit Standard Metropolitan Statistical Area (SMSA).* Monroe County is a part of the Toledo, Ohio, SMSA. The Ann Arbor SMSA is formed by a single county, Washtenaw. The Flint SMSA abuts the study area to the northwest. St. Clair and Livingston Counties are not part of SMSA's. Figure 3 outlines the four Standard Metropolitan Statistical Areas.

Population

Figure 4 and Table 1 display present population and population densities in the Detroit area.[1,2] Wayne County contains over 2,700,000 people and represents 58% of the 7-county study area population. Another 31% live in Oakland and Macomb Counties. Thus, 89% of the study area population is located in three of the seven counties. The population distribution by county is shown in Figure 4. Figure 5,[3] a generalized land-use map, illustrates the 1965 urbanized area in the study area, portraying a continuous urban area centered in Wayne County and extending into Oakland and Macomb Counties.

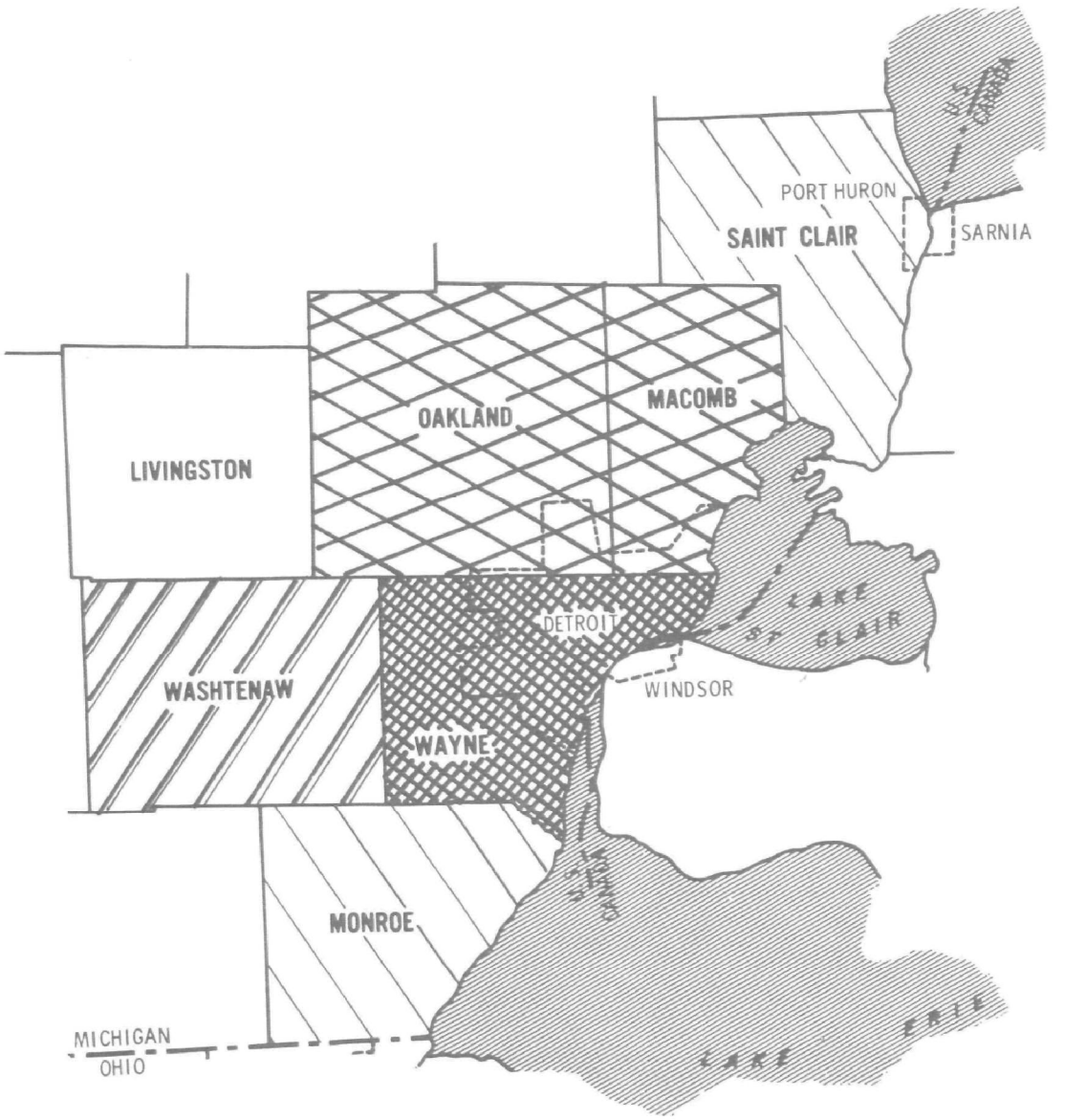
Projected population growth[1] from 1965 to 2000 is shown in Table 1 and in Figure 6. Macomb County is expected to show the greatest growth in population density with 2,215 additional residents per square mile. Wayne and Oakland Counties are

*SMSA's are defined by the Bureau of the Census and other Federal agencies for use in publishing census data and a variety of other government statistics.



SMSA Boundary

Figure 3. Map of Standard Metropolitan Statistical Areas (SMSA's).



Residents per square mile

- >4000
- 1000---4000
- 300---1000
- 100----300
- < 100

Figure 4. 1969 Population Density[2]

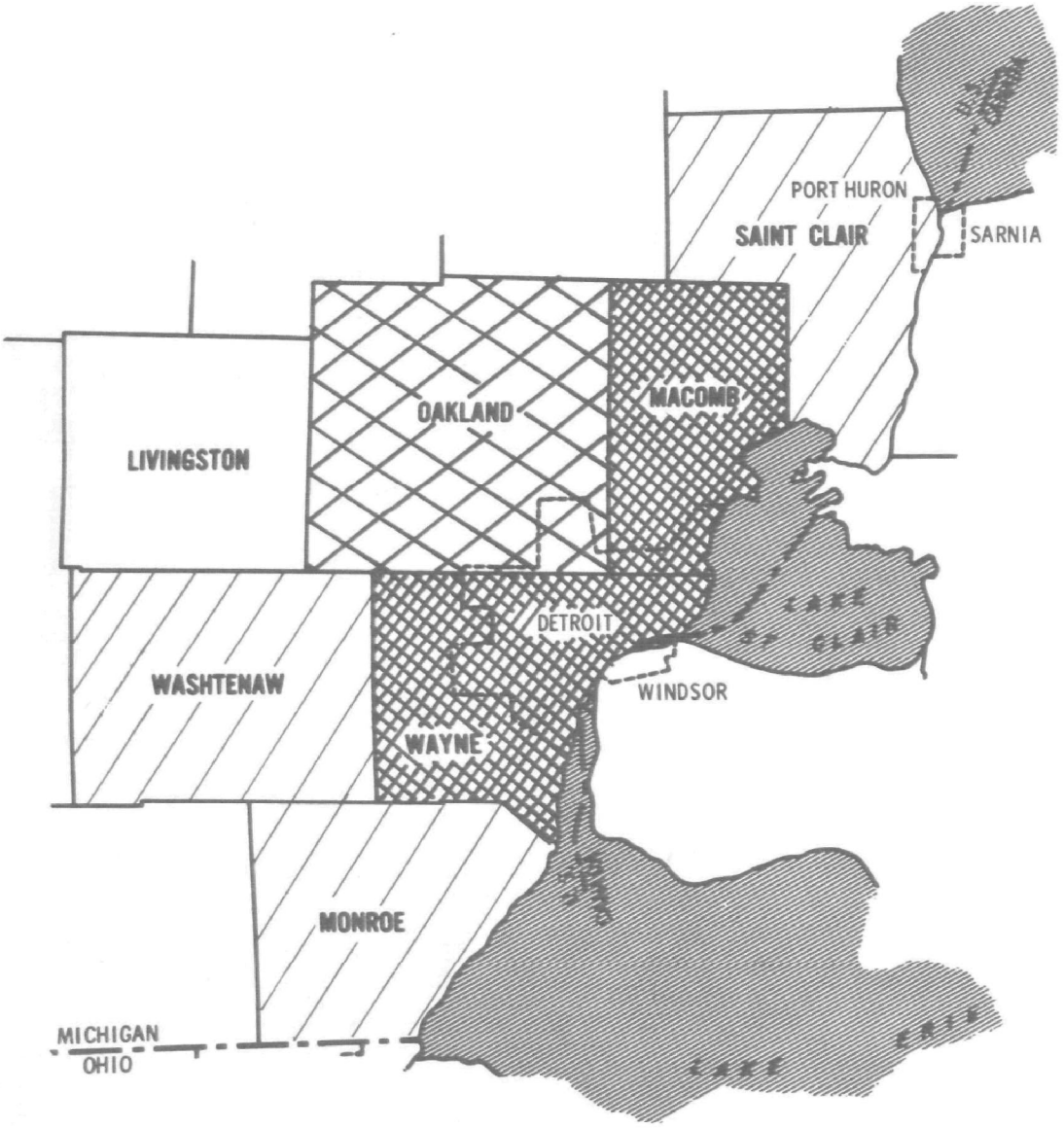
TABLE I. POPULATION AND EMPLOYMENT DATA FOR DETROIT STUDY AREA

Area $mi.^2$	County	Pop. 1965[a]	Pop. Den Res./mi. 1965	Pop. 1969[a]	Pop. Den. Res./mi. 1969	Pop.* 2000	Pop. Den. Res./$mi.^2$ 2000	Add. Res. per $mi.^2$ 1965-2000	Percent Increase 1965 -2000	Mfg. Empl. 1963a	Den. of Mfg. Empl. Empl./mi^2 1963
572	Livingston	41,327	72	48,000	84	108,114	190	118	162%	2,303	4
480	Macomb	521,000	1085	595,000	1,240	1,586,998	3,300	2,215	205%	69,722	145
557	Monroe	107,421	193	117,000	210	342,067	615	422	218%	6,837	12
867	Oakland	771,000	890	885,000	1,020	1,690,180	1,950	1,060	119%	66,528	77
734	St. Clair	107,985	147	117,000	159	253,624	346	199	135%	9,741	13
711	Washtenaw	191,223	268	233,000	328	419,999	590	322	119%	25,827	36
605	Wayne	2,679,000	4420	2,740,000	4,540	3,836,000	6,345	1,925	43%	357,663	592

*"Population Study", Detroit Regional Transportation and Land Use Study, TATUS, June, 1967.

a Commercial Atlas and Manufacturing Guide, 100th Edition, 1969, Rand-McNally and Company.

Figure 5. Generalized land use maps of the TALUS study area (1965) and Region I of Michigan's Planning and Development Regions (Adapted from Detroit Regional Transportation and Land Use Study).



Additional Residents per square mile

- >1500
- 500---1500
- 150----500
- < 150

Figure 6. Population Growth, 1965-2000, Expressed in Absolute Terms.

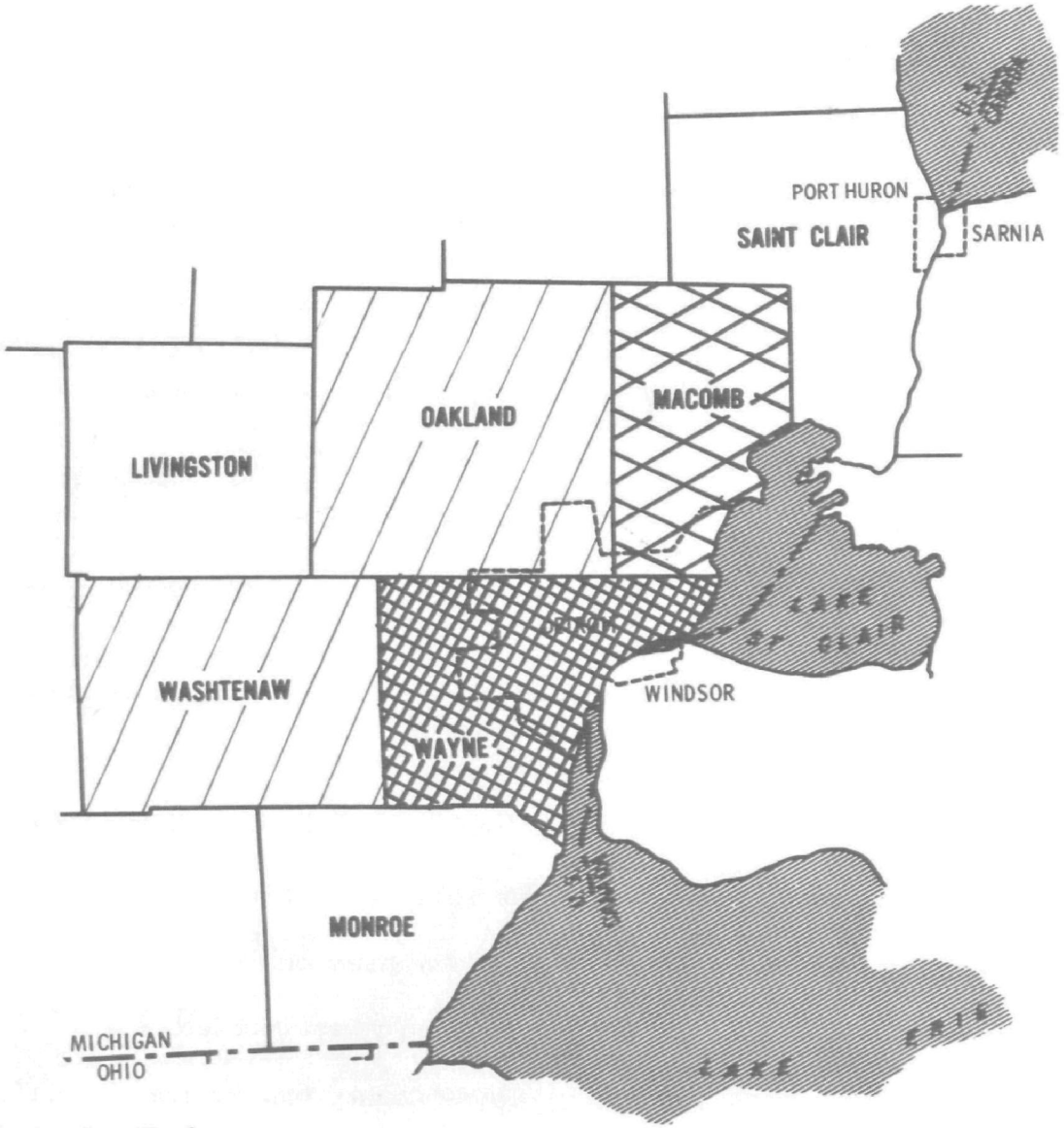
expected to follow with increases of 1,925 and 1,060 additional residents per square mile, respectively. The remaining four counties are projected to show increases of from 100 to 500 additional residents per square mile. By percent rate of population growth, Macomb and Monroe Counties are expected to show the greatest growth with rates of over 200% in the thirty-five year period.

In summary, present population statistics indicate that the core of the study area is the City of Detroit (Wayne County) whose metropolitan area extends into Macomb and Oakland Counties. Projected growth patterns indicate that most of the growth will occur in locations north and northeast of Detroit, especially in Macomb County.

Industry

Two techniques are used to illustrate the location of industrial activity. The first method is based on the density by county of people employed in manufacturing activities. According to 1963 data,[2] Figure 7, Wayne County had by far the greatest density of manufacturing employees with 592 per square mile. Macomb County followed with 145 employees per square mile. The remaining counties in the study area had less than 100 manufacturing employees per square mile.

The second method shows the location of industrial areas by the land use map[3] (see page 15). Figure 5 shows that all



Manufacturing Employees per square mile

- > 500
- 100---500
- 20---100
- < 20

Figure 7. Manufacturing Employment Density, 1963.[2]

counties in the study area except Livingston have industrial areas which are large enough to appear on the map. The greatest concentration of industrial land-use is found in Wayne County. Industrial land use is prevalent along the Detroit River and along a corridor extending from northeast Wayne County into southwestern Macomb County.

AIR POLLUTION CONTROL PROGRAMS

In 1966 the Governments of Canada and the United States requested the International Joint Commission to investigate the sources and extent of transboundary flow of air pollution in the vicinity of Port Huron (St. Clair County)--Sarnia, Ontario, and Detroit (Wayne County)--Windsor, Ontario. This industrialized area along the St. Clair and Detroit Rivers includes Wayne, Oakland, Macomb, and St. Clair Counties. The study within the United States is being conducted on a cooperative basis by the personnel and material resources of appropriate Federal, State, county, and municipal agencies. The study within Canada has been conducted under the technical administration and coordination of the Canadian Department of National Health and Welfare (DNHW) and the Ontario Department of Health. If transboundary flows of air pollution are demonstrated, there will be recommendations of preventive or remedial measures. In Canada, the Province of Ontario, and in the United States, the Detroit-Port Huron Air Quality Control Region would provide the proper mechanisms to deal effectively with the transboundary air pollution problems.

The Air Pollution Control Section of the Michigan Department of Public Health administers a comprehensive air pollution control program on a state-wide basis. Local units of government, such as the Wayne County Department of Health, Division of Air Pollution Control, may administer their own air pollution control program if the rules and regulations of the State are suspended by the State's Air Pollution Control Commission. The Michigan Air Pollution Control Commission may suspend its rules and regulations in a local jurisdiction which enacts regulations at least as stringent as those of the State.

One significant aspect of the State program is its monitoring of air quality in the major metropolitan areas. Additional activities include the development of a comprehensive state-wide emission inventory and a schedule for emission control, and technical support to local community programs.

The Wayne County Department of Health, Division of Air Pollution Control, was formed by the recent merger of the Wayne County Department of Health, Air Pollution Control Section, with the Detroit Air Pollution Control Program.

One purpose of the merger was to promote the control of air pollution on a uniform county-wide basis. The merger combined the staff and equipment of both departments. The new program has plans to have 32 new staff members during the first year, in accordance with a projected expansion to 113 staff members at the end of three years. The new program will include field evaluation

of emission sources, county-wide monitoring of ambient air quality, an expanded emission inventory program, development of emission and air quality standards, a meteorological and air quality processing program, and permits and inspection activities.

Regional Planning

The Office of Planning Coordination (Bureau of Planning and Program Development), State of Michigan, has divided the State into fourteen planning and development regions. Region I, with Detroit as the regional center, is comprised of seven counties--Livingston, Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne. Several factors were used to delineate the regional boundaries including inter-county commuting, State Economic Areas, and newspaper circulation.

The Detroit Regional Transportation and Land Use Study (TALUS) grew out of recommendations by a Special Mayor's Committee on Transportation in 1963. The four-year investigation of the study area began in July 1965, as a special project of the Detroit Metropolitan Area Regional Planning Commission, now called the Planning Division of the Southeast Michigan Council of Governments--SEMCOG. SEMCOG consists of governmental units of six counties--Macomb, Monroe, Oakland, St. Clair, Washtenaw, and Wayne. Besides the Planning Division, SEMCOG has divisions of public works, public safety, health, education, and governmental services.

The six counties included in SEMCOG are also included in the Southeastern Michigan Transportation Authority (SEMTA). The Authority may consolidate, improve, and coordinate public transportation within its jurisdiction.

In 1965, the Detroit Edison Company, working with Doxiadis Associates (Athens, Greece) and Wayne State University, undertook a 5-year comprehensive study to analyze growth patterns in the Detroit and Great Lakes area. The results of the first two phases of the study are published in two volumes, Emergence and Growth of an Urban Region--THE DEVELOPING URBAN DETROIT AREA.[5] The third phase will be completed in 1970 and will provide a broad basis for planning for future growth in the Urban Detroit Area (25 counties in Michigan, 9 counties in Ohio, and 3 counties in Ontario, Canada).

In THE DEVELOPING URBAN DETROIT AREA, Volume II,[5] various alternatives to the present urbanization trends are explored and evaluated. Each alternative solution falls into one of five broad families which vary as to location of the major center of the region: "A" and "B"--Detroit as a single center; "C"--twin centers of Detroit and Port Huron area; "D"--twin centers of Detroit and an area south of Toledo; and "E"--twin centers of Detroit and the Flint area. Within each family, other parameters and planned variables are introduced such as transportation networks, future population, maximum travel times, location of ports, airports, and schools, and employment

distribution. In short, after use of the Isolation of Dimensions and Elimination of Alternatives method (IDEA), Alternative 120 is ranked as the one superior to all others. Alternative 120 is based on a twin urban center for Detroit in the Port Huron area. This alternative solution to the future urbanization pattern of the Detroit area awaits critical review by experts and the community.

EVALUATION OF ENGINEERING FACTORS

The engineering evaluation for the Detroit-Port Huron area was based on a study of topography, air pollutant emissions, meteorology, estimated air quality levels, and available ambient air quality data. The emission inventory indicated the location of point and area sources and estimated the quantity of pollutants emitted from these sources. This information was combined with average meteorological data and used in a diffusion model[5] to estimate air quality levels. The estimated air quality information was supplemented by measured air quality data whenever available.

EMISSION INVENTORY

The emissions inventory for the Metropolitan Detroit-Port Huron area was conducted by the National Air Pollution Control Administration, Division of Abatement. The four counties included in the emissions inventory study area were Wayne, Macomb, Oakland and St. Clair County. This inventory was based on fuel-usage data for 1967. The National Air Pollution Control Administration was also responsible for developing a final emissions report for the International Joint Commission (IJC) composed of representatives of the United States and Canadian Federal Governments. The data from the IJC emission

inventory will be used as part of the final IJC report in 1970, which covers the same four-county area in Michigan, plus the western portions of the Province of Ontario, Canada.

For the purposes of this report, only total particulates, sulfur oxides, and carbon monoxide emissions estimates are considered. These three pollutants best represent the spectrum of air pollution sources. Particulate emissions indicate primarily the extent of industrial, heating, power and incineration emissions. Carbon monoxide emissions show the impact of motor vehicle emissions, since over 91 percent of all carbon monoxide emitted in the Detroit-Port Huron area comes from motor vehicles. Emissions of sulfur oxides illustrate the distribution of fuel burning activities at private, commercial, industrial, and governmental establishments including power plants.

The emissions inventory study area (Wayne, Oakland, Macomb, and St. Clair Counties) was divided into 65 grids based on the Universal Transverse Mercator (UTM) System. Grid squares --5, 10 and 20 kilometers on a side--enclose a total area of 6,200 square kilometers. The study area includes some of the most densely populated and heavily industrialized areas in the United States.

Emission densities in tons/km^2/day were determined for each of the three pollutants by relating the estimated quantity of pollutants emitted in each of the zones to the land area of each zone. The resulting emission densities for particulates, CO,

and SO_X are presented in Figures 8, 9, and 10. Figure 8 shows high particulate emission densities in the vicinity of Zug Island along the Detroit River. The sulfur oxides emission density map, Figure 9, shows high emission densities in Detroit and in southern Port Huron. The highest densities extend along the Detroit River near the River Rouge-Zug Island area. Carbon monoxide emission densities, shown in Figure 10, are more evenly distributed throughout the urbanized portions of the four-county study area. Highest densities are found in downtown Detroit where traffic density is greatest.

Major industrial, institutional and municipal point sources located in the area include 90 separate plants. Industrial establishments cover a wide variety of processes, including the following: food processing; paper manufacturing; crude oil refining; chemical manufacturing; minerals processing; iron, steel, and non-ferrous metals manufacturing; metal fabricating; and automotive manufacturing. Figures 11 and 12 show the locations of major point sources of particulates and sulfur oxides emissions, respectively. There are 17 power plants and heating plants among the 90 point sources. It should be noted that the maps of estimated emission densities and point source locations do not include emission sources for the Province of Ontario, Canada.

AIR QUALITY ANALYSIS

A study of air quality levels, measured and estimated, is useful in determining which areas are affected by pollution sources. Such

Figure 8. Density of Particulate Emissions

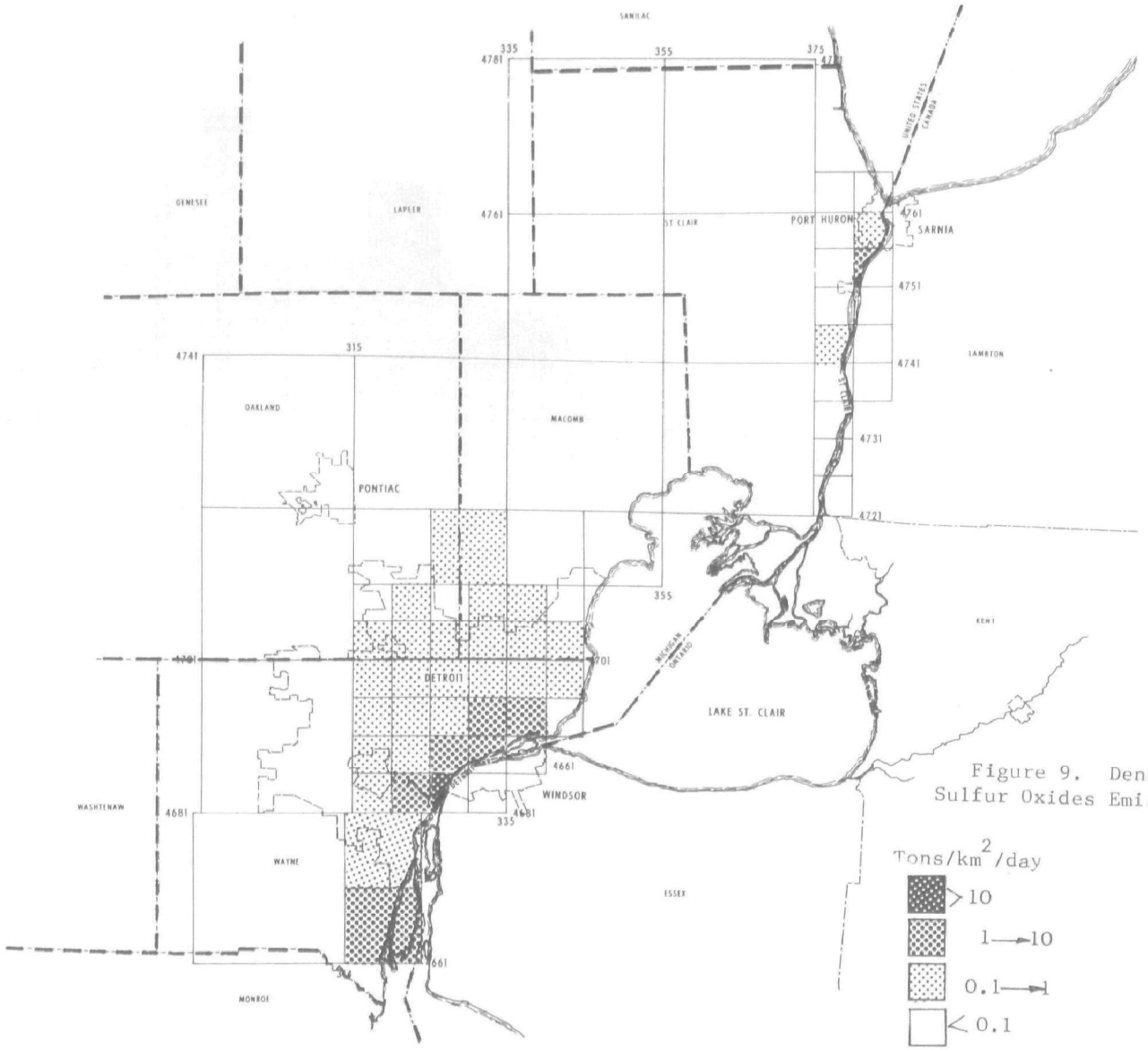


Figure 9. Density of Sulfur Oxides Emissions

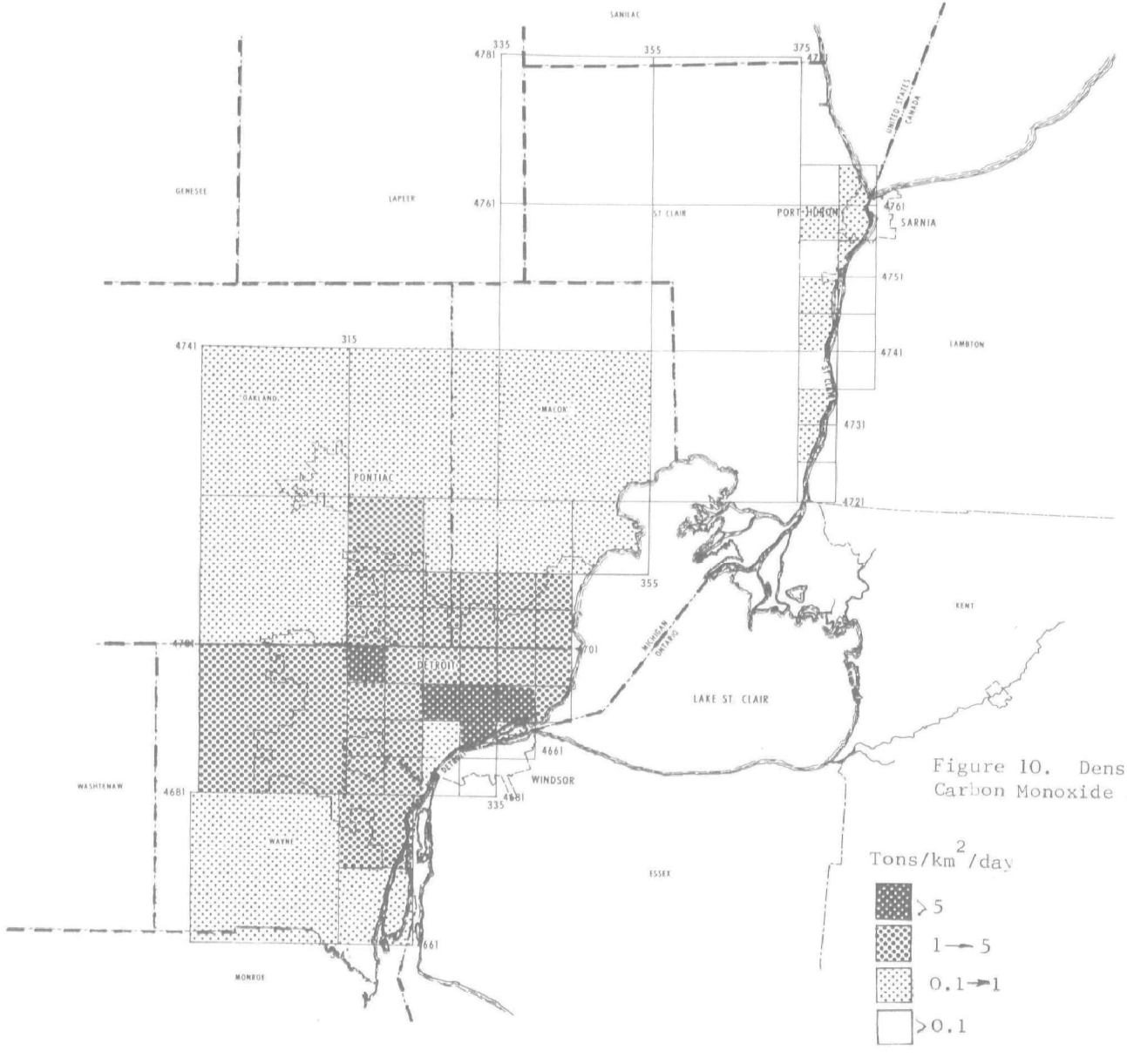


Figure 10. Density of Carbon Monoxide Emissions

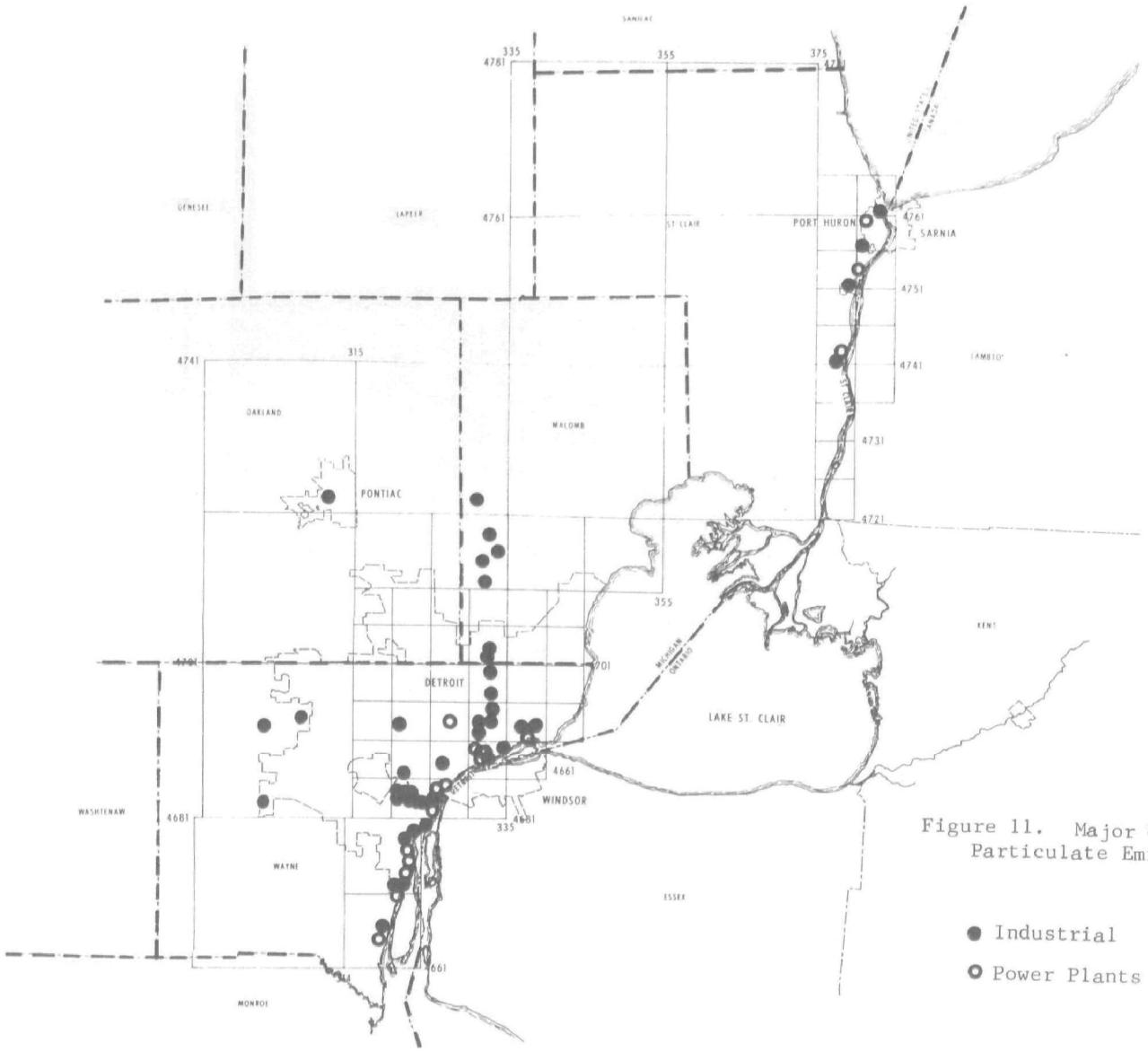


Figure 11. Major Sources of Particulate Emissions

● Industrial

○ Power Plants

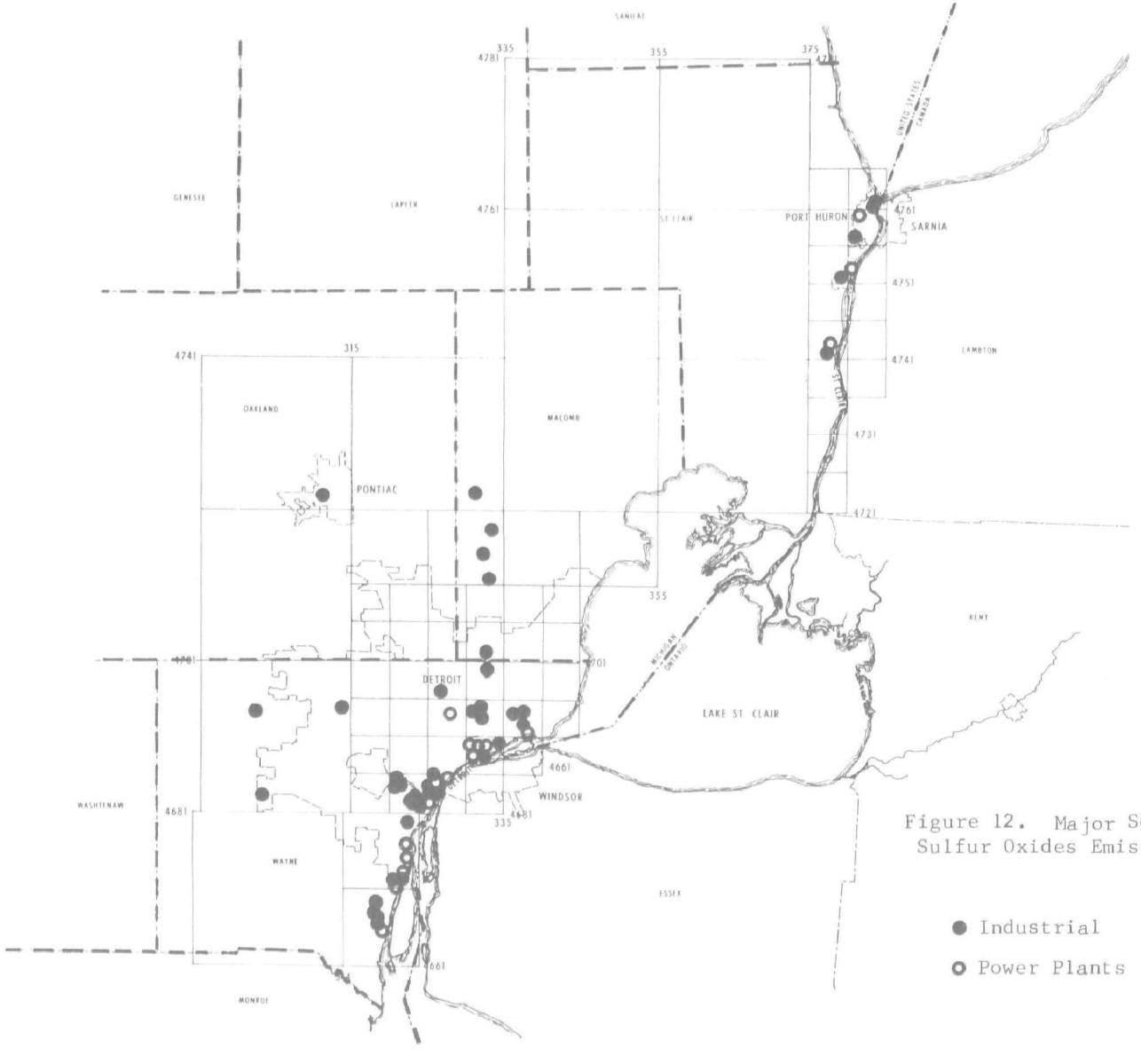


Figure 12. Major Sources of Sulfur Oxides Emissions

● Industrial

○ Power Plants

analysis can be based directly on air quality sampling data in those instances where the sampling program for particulates, CO, and SO_X covers a sufficiently large area. Air quality data, measured over a time period long enough to provide a reliable pattern, rarely exists. It becomes necessary in this situation to estimate prevailing air quality through use of a diffusion model.[5]

A description of the diffusion model used in this study, and the meteorological data input are shown in detail in Appendix A. The diffusion model results for the Detroit area are discussed below.

By estimating the patterns of dispersion of three major pollutants: particulates, carbon monoxide, and SO_X, the diffusion model technique has provided a guide to the Region boundaries but does not dictate the exact boundary location. By way of example, if significant concentrations of one or more of the three pollutants are found in a county contiguous to the Detroit urbanized area, the county should be considered for inclusion in the Air Quality Control Region. The final decision on the boundaries of the Region, however, should be based on joint consideration of non-engineering as well as engineering factors.

Suspended Particulates

Figure 13 shows adjusted theoretical suspended particulate contours as predicted by the diffusion model based on estimated annual emissions and meteorological conditions. A comparison with

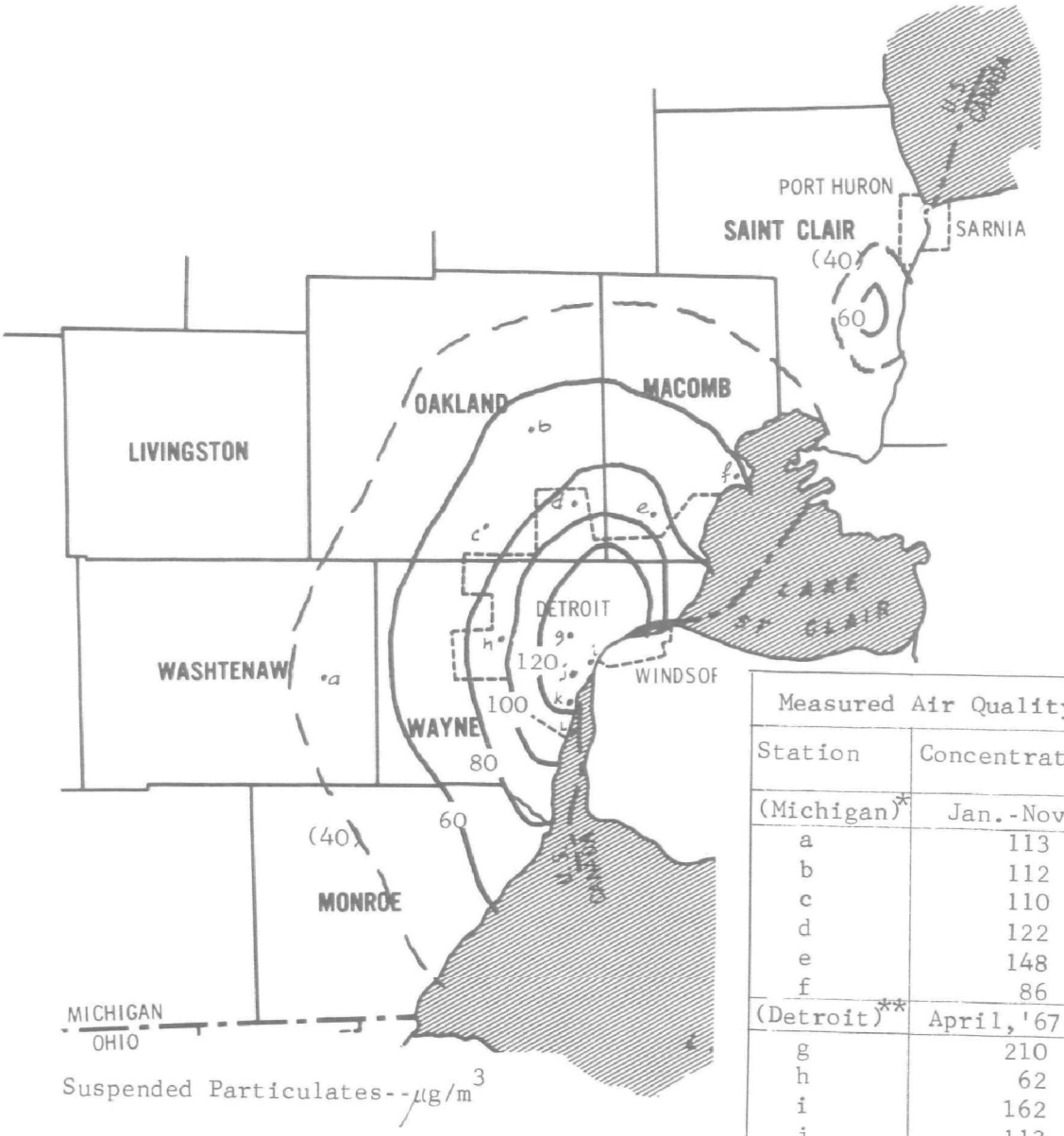


Figure 13. Theoretical annual suspended particulate levels. Levels adjusted to include estimated background level.

Measured Air Quality Data	
Station	Concentration, μg/m³
(Michigan)*	Jan.-Nov., 1967
a	113
b	112
c	110
d	122
e	148
f	86
(Detroit)**	April,'67-Jan.,'68
g	210
h	62
i	162
j	113
k	124
l	161

*Data supplied by the Michigan Department of Public Health.
**Data supplied by the Wayne County Health Department.

measured air quality data from the National Air Surveillance Network, the Wayne County Health Department and the Michigan Department of Public Health, showed that the theoretical contour values tended to underestimate the measured levels by a factor of about two in the Detroit area. The lower theoretical values may be explained by one or both of the following: the theoretical estimates do not take into account background concentrations of suspended particulates (approximately 40 $\mu g/m^3$); and emissions from the surrounding counties in Michigan, Ohio, and Canada were not programmed into the diffusion model. If the assumed background level of 40 $\mu g/m^3$ is added to each of the theoretical contour values, the levels predicted tend to more nearly approximate the measured air quality levels. Adjusted values are given in Figure 13. Figure 13 shows that large parts of Macomb, Oakland, and Wayne Counties and parts of Washtenaw and Monroe Counties have annual suspended particulate concentrations which are above background levels. Another center of particulate pollution is found in St. Clair County, just southwest of Port Huron.

Carbon Monoxide

Figure 14 shows diffusion model contours based on CO emissions in the four-county area. These contours are presented as relative rather than absolute. Highest relative carbon monoxide levels are found in Detroit where traffic density is greatest.

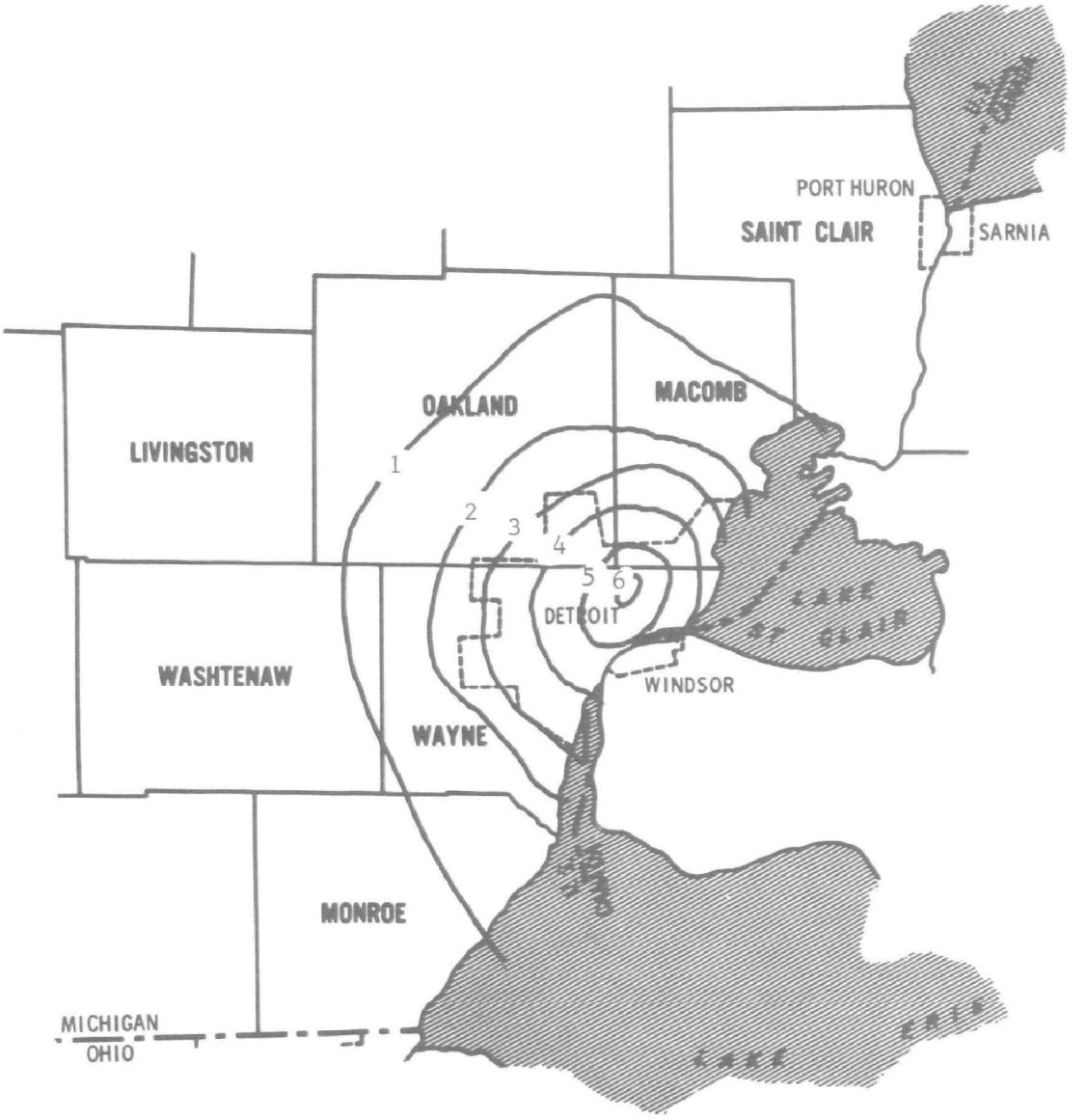
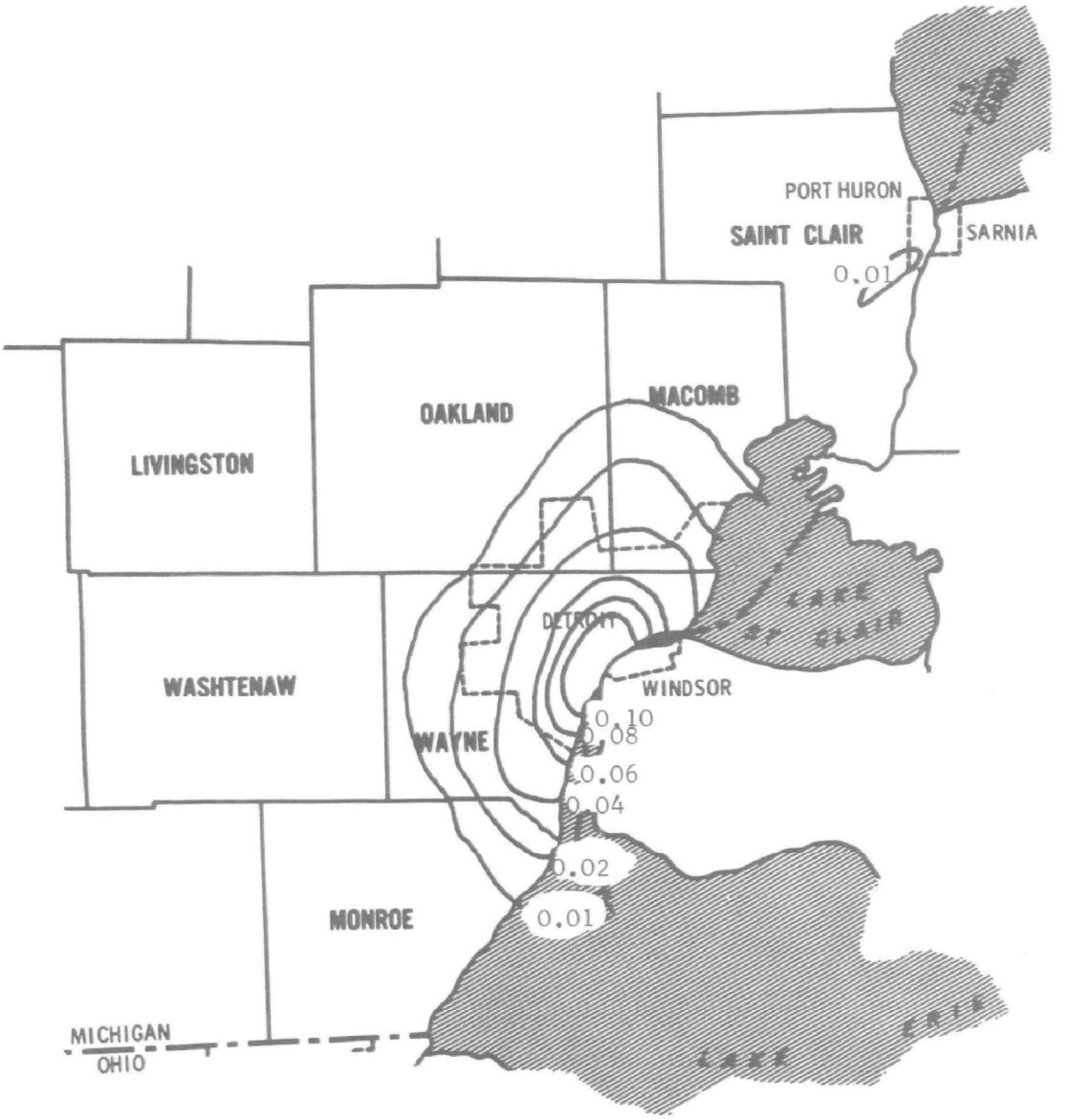


Figure 14. Relative levels of Carbon Monoxide.

Sulfur Oxides

Figure 15 shows theoretical annual sulfur oxide levels as predicted by the diffusion model. The isopleths are based on estimated annual emissions and meteorology in the four counties of St. Clair, Macomb, Oakland, and Wayne. Despite a 3-hour half-life factor applied to the model to allow for decay of sulfur oxide in the air, the model results seem to be slightly overestimated.

The theoretical 0.01 ppm (approx. 28 $\mu g/m^3$) contour as predicted by the model has been used in past air quality control region studies as a guide to show that area which is significantly affected by sulfur oxides emissions from an urban complex. The area enclosed by this isopleth should therefore be considered for inclusion in the Air Quality Control Region. Encompassed by the 0.01 ppm contour are parts of Wayne, Macomb, Oakland and Monroe. A separate 0.01 ppm contour is found in St. Clair County in the vicinity of Port Huron.



Sulfur oxides--ppm

Figure 15. Theoretical concentration of sulfur oxides pollution, annual average.

THE PROPOSED REGION

Subject to the scheduled consultation, the Secretary, Department of Health, Education, and Welfare, proposes to designate an air quality control region for the Metropolitan Detroit - Port Huron area, consisting of the following jurisdictions in the State of Michigan:

Macomb County
Oakland County
St. Clair County
Wayne County

As so proposed, the Metropolitan Detroit - Port Huron Intrastate Air Quality Control Region would consist of the territorial area encompassed by the outermost boundaries of the above jurisdictions and the territorial area of all municipalities located therein and as defined in Section 302(f) of the Clean Air Act, 42 U.S.C. 1857h(f). Figure 16 shows the boundaries of the proposed Region while Figure 17 indicates the geographic relationship of the Region to the surrounding area.

DISCUSSION OF PROPOSAL

To be successful, an air quality control region should meet three basic conditions. First, its boundaries should encompass most of the pollution sources as well as most of the people and property affected by those sources. Second, the boundaries should encompass those locations where industrial and residential development will create significant air pollution problems in the future. Third,

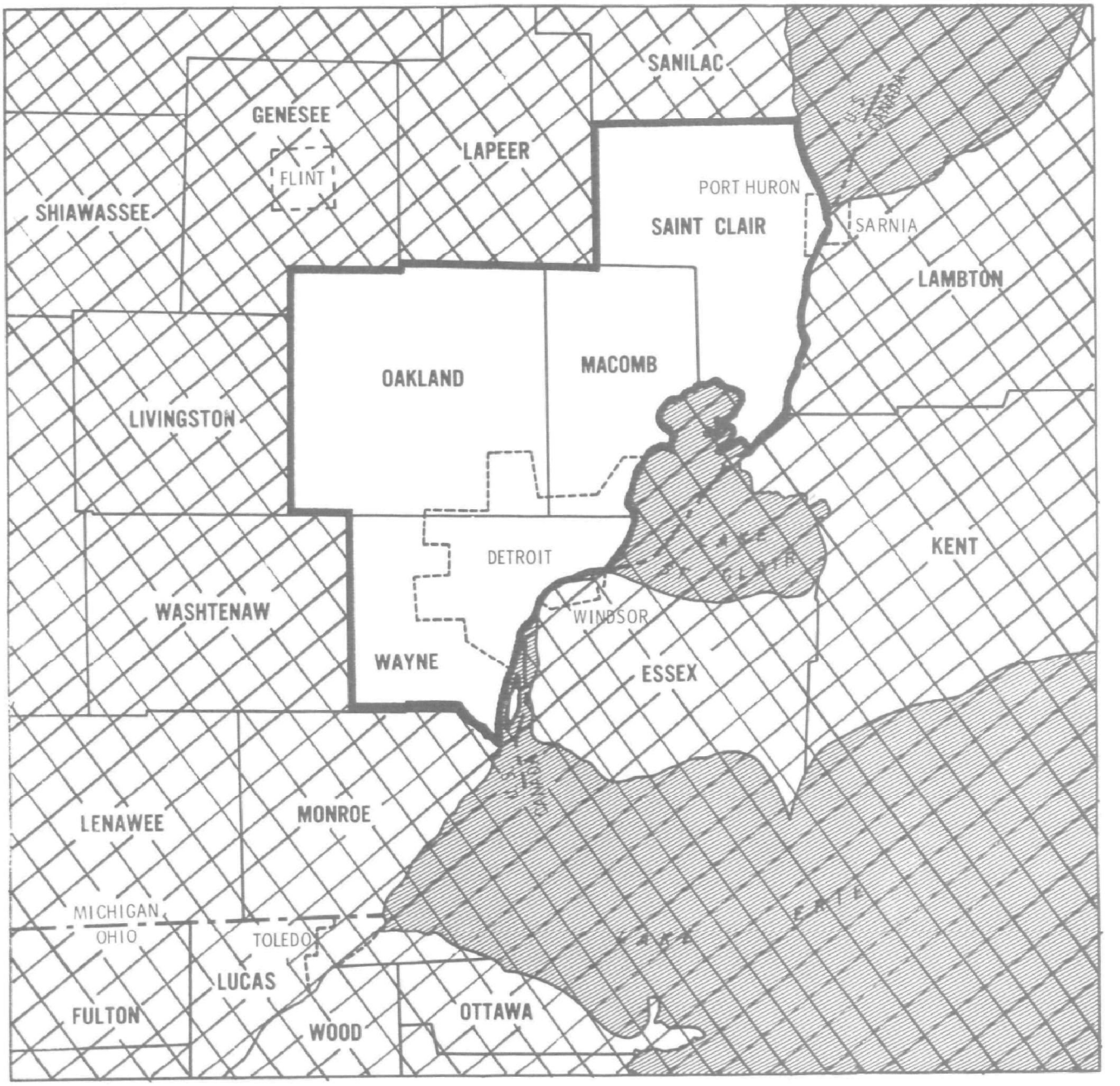


Figure 16. Proposed Metropolitan Detroit-Port Huron Intrastate Air Quality Control Region.

Figure 17. Relationship of Proposed Metropolitan Detroit-Port Huron Air Quality Control Region to surrounding areas.

the boundaries should be chosen in a way which is compatible with and even fosters unified and cooperative governmental administration of the air resources throughout the region. The "Evaluation of Engineering Factors" (discussion beginning with page 24) discussed the first of these conditions, and the "Evaluation of Urban Factors" (page 10), the second and third. The determination of regional boundaries requires that both urban and engineering factors be considered. The boundaries chosen should create a cohesive combination of jurisdictions suitable for region-wide administration of an air resource management program.

The first consideration--that most air pollution sources and receptors be within the Region boundaries--is satisfied by the proposed Region. Most major point sources of sulfur oxides and particulates are found in Wayne County. However, St. Clair and Macomb Counties also have several major industrial point sources and power plants. The emission density maps (Figures 8, 9, and 10) point out the area of high emissions of particulates, sulfur oxides, and carbon monoxide. Wayne County is the primary source of particulates and sulfur oxides. Highest emission densities of particulates are found in Detroit and of sulfur oxides in Detroit and south Port Huron. Carbon monoxide emission densities are more evenly distributed over the four-county area, and they tend to reflect the urbanization pattern, since the motor vehicle is the main emittor. Highest densities are found in Detroit where the

traffic density is greatest.

Air pollution concentrations were predicted by a mathematical diffusion model. Theoretical concentrations of suspended particulates were adjusted by adding an assumed background-level concentration. Parts of six counties have areas which are enclosed by the 40 $\mu g/m^3$ isopleth (annual average)--St. Clair near Port Huron, southeastern Oakland, eastern Washtenaw, northeastern Monroe, most of Macomb and all of Wayne. Highest relative levels of carbon monoxide are found in Detroit. The area within 0.01 ppm (approx. 28 $\mu g/m$) sulfur oxides contour is less extensive than that within 40 $\mu g/m^3$ suspended particulate isopleth. Five of the same six counties, however are affected according to the diffusion model; Washtenaw does not appear to be significantly affected by emissions from the proposed 4-county Region.

The second consideration is directed towards population and industrial growth potential in the area. Over 4,300,000 people live in the area proposed as the Detroit - Port Huron Region, which represents over 49% of the population of the State, and over 90% of the population in the 7-county southeast Michigan area. Out of the seven counties in the area, Macomb County is expected to show the greatest absolute growth in population density from 1965 to 2000 with an increase of over 2,200 residents per square mile. Wayne and Oakland are projected to show increases of 1,925 and 1,060 additional residents per square mile, respectively. Thus, the main thrust of

population growth is projected to occur north and northeastward from the City of Detroit.

Though St. Clair County is not projected to grow as rapidly as Macomb, Oakland, and Wayne Counties, potential for urban growth certainly exists. In THE DEVELOPING URBAN DETROIT AREA, Volume I,[4] it is pointed out that Port Huron presently lies on one of the lines forming the "six-radial pattern of Detroit urban growth." In Volume II[4] of the same study, various alternatives to the present urbanization trends were explored and evaluated. Alternative 120, based on a twin urban center for Detroit in the Port Huron area, was ranked as the one superior to all others. This alternative solution to the future urbanization pattern of the Detroit area awaits critical review by experts and the community. It does point out, however, that Port Huron and therefore St. Clair County does have the potential for future urbanization and industrial growth.

The third objective relates to governmental administration in the area. The four counties proposed for the Air Quality Control Region are members of SEMCOG--Southeastern Michigan Council of Governments--along with Monroe and Washtenaw Counties. They are also part of the Region I of the Office of Planning Coordination, State of Michigan. The counties are included in the Michigan Economic Region I and the Southeastern Michigan Transportation Authority (SEMTA). The National Air Pollution Control Administration attempts when feasible, to propose regions which correspond to, or are at least compatible

with State or locally defined planning regions and councils of government. Though the whole of SEMCOG or Region I of the State's Office of Planning Coordination is not included in this proposal, the proposed Air Quality Control Region boundaries do not cross other existing regional boundaries. The importance of this action will be more fully realized subsequent to the designation of the Air Quality Control Region when air quality standards must be set and an implementation plan devised to achieve these standards. The regional planning groups may be capable of providing assistance in the development of air quality standards and implementation plans which recognize the close relationship between air quality management and transportation, land-use patterns, solid waste disposal and other urban activities.

In summary, based on the technical data on air pollution emissions and theoretical ambient air concentrations, four counties should be included in the Region. Monroe County, though affected by emissions of SO_X and particulates from Wayne County, is, at the same time, closely tied to Toledo, Ohio (Monroe is part of the Toledo SMSA). It is anticipated that Monroe will be proposed as part of the Toledo Air Quality Control Region later this year. Washtenaw County does not appear to be significantly affected by air pollution eminating from the Detroit core area. The county is, however, part of SEMCOG and the proposed Region I of the Office of Planning Coordination, State of Michigan, and has considerable growth potential. Therefore,

it should be observed carefully and added to the Region if future conditions warrant. Livingston County, likewise, is not part of the regional air pollution problem and is at present almost entirely rural, but it is included in area-wide planning efforts now in effect. It is expected that Livingston will become part of SEMCOG in the near future. Like Washtenaw it may be considered for inclusion in the Air Quality Control Region at a later date if conditions warrant.

The Region proposed is considered on the whole to be the most cohesive and yet inclusive area within which an effective regional effort can be mounted to prevent and control air pollution in the Detroit - Port Huron area.

APPENDIX A. DIFFUSION MODEL

Section 107(a)(2) of the Clean Air Act, as amended, calls for the designation of air quality control regions based on a number of factors including "atmospheric areas," interpreted to mean that the boundaries of air quality control regions should reflect the technical aspects of air pollution and its dispersion. Within this guideline, however, the position has been taken that region boundaries cannot be based on an extreme set of circumstances which might have a theoretical chance of occurrence. Hence, the analysis of a region's atmospheric dilution potential is largely based on mean annual, summer and winter conditions.

With the realization that the meteorological analysis would help define tentative boundaries only and the final boundaries would be developed subsequently to reflect local government aspects, it was decided that the meteorological assessment should be as unpretentious as possible. Accordingly, the modified long-term Gaussian diffusion equation described by Pasquill[6] and Turner[7] has been applied. The basic equation assumes that the concentration of a pollutant within a plume has a Gaussian distribution about the plume centerline in the vertical and horizontal directions, with the standard deviations in the two directions being a function of distance from the source and certain characteristics of mixing layer, collectively referred to as "stability class." In summary,

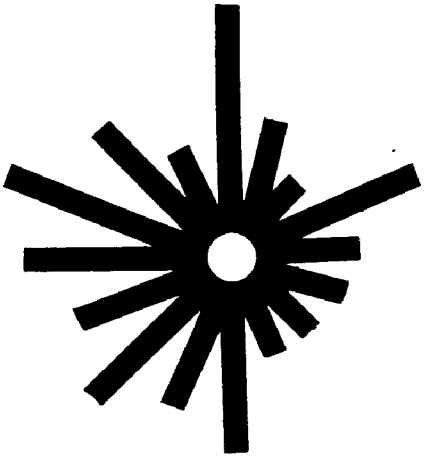
the diffusion equation is utilized to provide a theoretical estimate of the geographical distribution of long-period man ground-level concentrations. This model has the necessary flexibility to utilize information on emissions from both point and area-wide sources.

To maintain simplicity, sulfur oxide and particulate point sources were assumed to emit pollutants from a 75 meter level, and area sources from ground level. A three hour half-life for SO_X was arbitrarily selected.

METEOROLOGICAL DATA INPUT

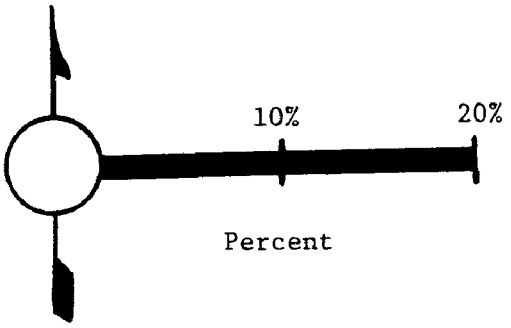
Appropriate surface wind rose data are selected from U.S. Weather Bureau records; if necessary, special wind data tabulations are obtained from the National Weather Records Center (NWRC). The mean mixing depth for each region, for each respective time period (seasonal and average), is determined on the basis of computed mixing depths documented by Holzworth[8,9] and recent tabulations furnished the Meteorology Program by the National Weather Records Center (ESSA).

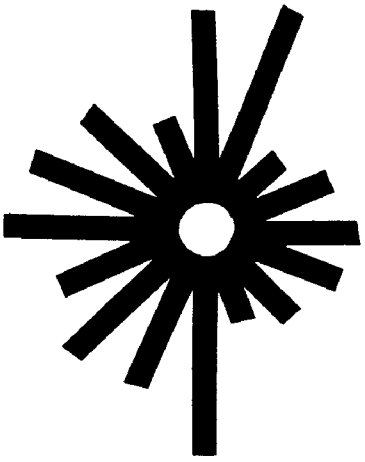
The diffusion model was applied for each of the three pollutants for the three different time periods--annual, winter and summer. Table A-1 and Figure A-1 show the meteorological data required to apply the model for each of the three time periods. Figure A-1 shows the percent frequency of occurrence of wind direction from 1951 through 1960 at the Detroit City Airport for summer, winter,



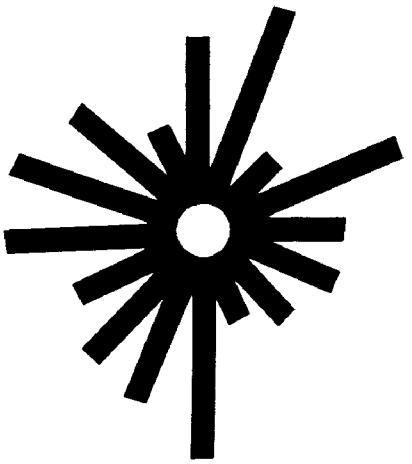
Annual

Figure A-1. Percent frequency of wind direction for various averaging times based on data from the Detroit City Airport.





Winter



Summer

and annual conditions. The wind data from the Detroit City Airport was selected as adequately representing prevailing wind patterns throughout the area.

The mixing depths for each season and the year are shown in Table A-1.

Table A-1

AVERAGE MIXING DEPTHS FOR THE DETROIT-PORT HURON AREA*
BY SEASON IN METERS

Season	Mixing Depths, Meters		
	Morning	Afternoon	Average Morning and Afternoon
Summer	280	1,697	989
Autumn	400	1,213	807
Winter	518	762	640
Spring	429	1,496	963
Annual (Four Seasons)	407	1,292	850

*Flint, Michigan (1960-1964)

REFERENCES

1. "Population Study," Detroit Regional Transportation and Land Use Study, TALUS, June, 1967.

2. Commercial Atlas and Manufacturing Guide, 100th Edition, 1969, Rand-McNally and Company.

3. "Generalized Land-Use, 1965," Detroit Regional Transportation and Land-Use Study, June, 1968.

4. Doxiadis, Constantinos A., Emergence and Growth of an Urban Region, The Developing Urban Detroit Area, Volumes 1 and 2, Detroit, Michigan, Detroit Edison Company, 1966, 1967.

5. "General Atmospheric Diffusion Model for Estimating the Effects on Air Quality of One or More Sources," Martin D. and Tikvart, J., Paper No. 68-148, 61st Annual Meeting, APCA, St. Paul, Minnesota, June, 1968.

6. Pasquill, F., "The Estimation of the Dispersion of Windborn Material," Meteorology Magazine, 90, 1963, pp.33-49.

7. Turner, D. B., "Workbook of Atmospheric Dispersion Estimates," U.S. DHEW, Cincinnati, Ohio, 1967, revised 1969.

8. Holzworth, G. C., "Mixing Depths, Wind Speeds and Air Pollution Potential for Selected Locations in the United States," J. Appl. Meteor., No. 6, December 1967, pp. 1039-1044.

9. Holzworth, G. C., "Estimates of Mean Maximum Mixing Depths in the Contiguous United States," Mon. Weather Rev. 92, No. 5, May, 1964, pp. 235-242.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1969—395-977/21