REPORT FOR CONSULTATION ON THE METROPOLITAN SAN ANTONIO INTRASTATE AIR QUALITY CONTROL REGION (TEXAS)

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

REPORT FOR CONSULTATION ON THE

SAN ANTONIO

INTRASTATE AIR QUALITY CONTROL REGION

(TEXAS)

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

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

SECTION I

THE REGIONAL APPROACH TO AIR QUALITY CONTROL AND A FEDERAL PROPOSAL FOR THE SAN ANTONIO REGION

PREFACE

The Secretary, Department of Health, Education, and Welfare, is directed by the Clean Air Act, as amended, to designate "air quality control regions" prior to the adoption by the State(s) of air quality standards and plans for the implementation of the standards. In addition to listing the major factors to be considered in the development 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 (NAPCA) recently established a new policy by which States may propose to the Federal Government boundaries for air quality control regions. The Texas Air Control Board is the first state agency to initiate proposals for region boundaries under the new policy. The Air Control Board, with assistance from NAPCA, has conducted a study of the San Antonio metropolitan area, the results of which are presented in the body of this report. The Region boundaries proposed in the report reflect consideration of available and pertinent data; however, the boundaries remain subject to revision suggested by consultation between Federal, State, and local authorities. Formal designation will be withheld pending the outcome of the meeting. This report is intended to serve as the starting point for the consultation.

THE REGIONAL APPROACH

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 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), Air Quality Act of 1967

Air pollution, because of its direct relationship to people and their activities, is an urban problem. Urban sprawls often cover thousands of square miles; they quite often include parts of more than one state and almost always are made up of several counties and an even greater number of cities. Air pollution, therefore, also becomes a regional problem, and the collaboration of several governmental jurisdictions is prerequisite to the solution of the problem in any given area. Air quality control regions called for in the above-quoted section of the Air Quality Act of 1967 are meant to define the geographical extent of air pollution problems in different urban areas and the combination of jurisdictions that must contribute to the solution in each.

The regional approach set up by the Air Quality Act is illustrated in Figure 1. The approach involves a series of steps to be taken by Federal, State, and local governments, beginning with the designation of regions, the publication of air quality criteria, and the publication of information on available control techniques by the Federal Government. Following the completion of these three steps, the Governors of the States affected by a region must file with the Secretary within 90 days a letter of intent, indicating that the States will adopt within 180 days ambient air quality standards for the pollutants covered by the published criteria and control technology documents and adopt within another 180 days plans for the implementation, maintenance, and enforcement of those standards in the designated air quality control regions.

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 reserves approval authority, the States involved in a designated region assume the responsibility for developing standards and an implementation plan which includes administrative procedures for abatement and control.

Criteria for Determining Region Size

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 as well as most of the people and property affected by those sources.

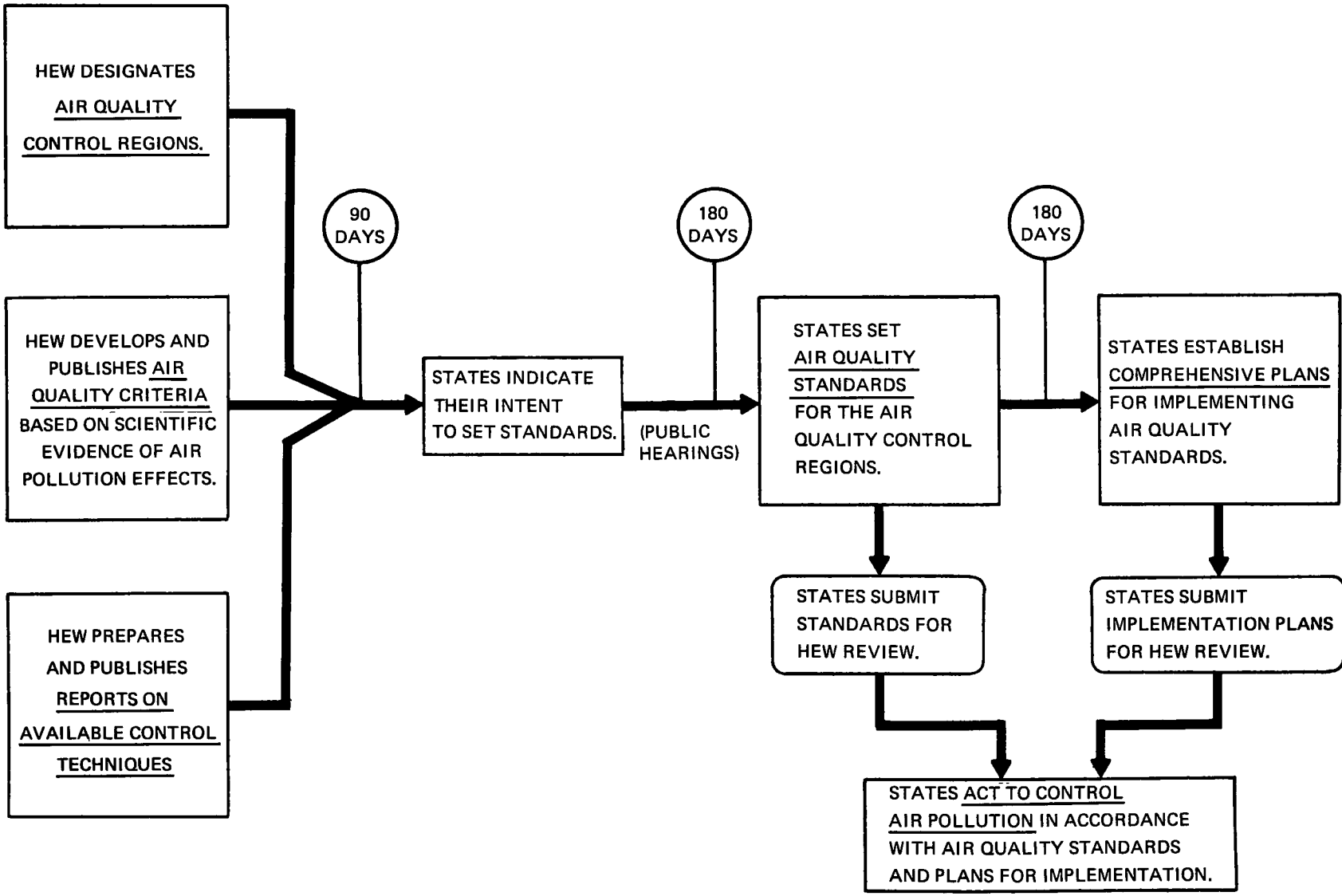


Figure 1 FLOW DIAGRAM FOR ACTION TO CONTROL AIR POLLUTION ON A REGIONAL BASIS, UNDER THE AIR QUALITY ACT.

In this way, all the major elements of the regional problem will be 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 better measures 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 pattern of cooperation among existing air pollution control programs is a relevant factor. The existing boundaries of regional planning agencies or councils of government may also become an important consideration. 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.

Procedures for Designating Region Boundaries

Figure 2 summarizes the procedure used by the National Air Pollution Control Administration for designating air quality control regions whose boundaries are proposed by the State.

A preliminary delineation of the region is developed by bringing together two essentially separate studies--the "Evaluation of Engineering Factors" and the "Evaluation of Urban Factors."

The study of "Engineering Factors" indicates the location of pollution sources and the geographic extent of serious pollutant concentrations in the ambient air. Pollution sources are located by an inventory of emissions from automobiles, industrial activities, space heating, waste disposal, and other pollution generators. Pollution concentrations in the ambient air are estimated from air quality sampling data and from a theoretical diffusion model. When it exists, air quality sampling data is more reliable than the theoretical diffusion model results since the data is directly recorded by pollution measuring instruments. Unfortunately, in many cases extensive air quality sampling data is unavailable in the rural areas surrounding an urban complex.

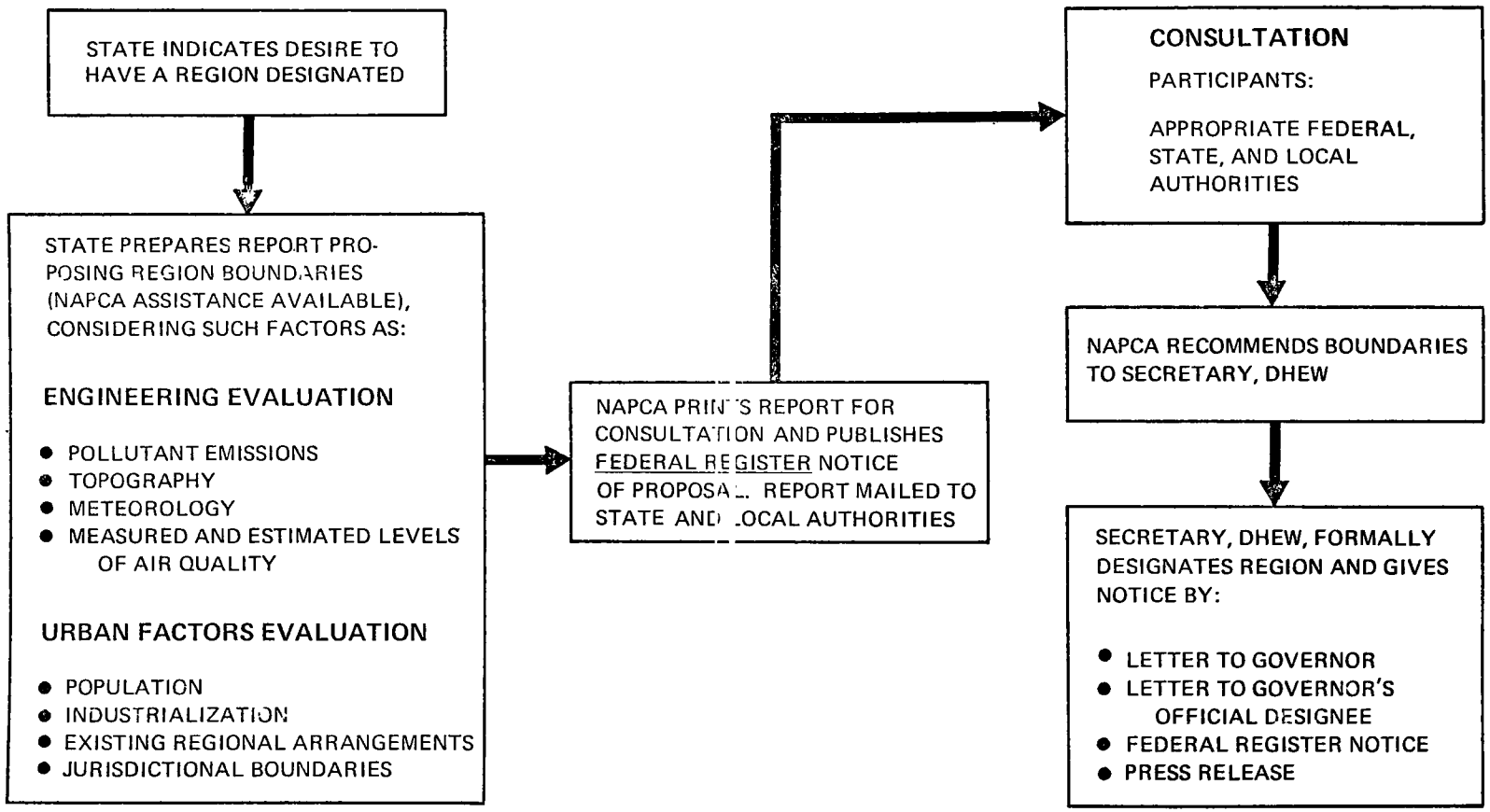


Figure 2. FLOW DIAGRAM FOR STATE-INITIATED AIR QUALITY CONTROL REGIONS.

The study of "Urban Factors" encompasses non-engineering considerations. It reviews existing governmental jurisdictions, current air pollution control programs, present concentrations of population and industry, and expected patterns of urban growth. Other non-engineering factors are discussed when they are relevant. As a whole, the study of urban factors indicates how large an air quality control region must be in order to encompass expected growth of pollution sources in the future. It also considers which group of governmental jurisdictions will most effectively administer a strong regional air quality control program.

The conclusions of the engineering study are combined with the results of the urban factors study to form the basis of an initial proposal for an air quality control region. As shown in Figure 2, the proposal is then submitted to NAPCA for review and printing.

The report is mailed to State and local authorities in preparation for the consultation between appropriate Federal, State, and local officials. After reviewing the suggestions raised during the consultation, the Secretary formally designates the region with a notice in the Federal Register and notifies the Governor(s) of the State(s) affected by the designation.

Section II of this report and the proposal therein were prepared by the Texas Air Control Board. The report itself is intended to serve as the background document for the formal consultation.

THE FEDERAL PROPOSAL

The National Air Pollution Control Administration has reviewed the proposal and supportive dissusion prepared by the Texas Air Control Board. NAPCA concurs with the findings of the Board and proposes to include Bexar, Comal, and Guadalupe Counties in the Metropolitan San Antonio Intrastate Air Quality Control Region.

The proposed Region satifies the three conditions discussed in "Criteria for Determining Region Size". Most air pollution sources and receptors in the eight-county study area are located in Bexar, Comal, and Guadelupe Counties. The remaining five counties are primarily rural. The three counties in the proposed Region are expected to register the greatest population growth of the study area counties in the next few decades.

The National Air Pollution Control Administration encourages the establishment of air quality control regions which correspond to, or are compatible with, existing State or locally defined planning regions. Such designation can be realized when the air pollution problem area lies wholly within the boundaries of the planning agency. In the San Antonio area, the regional air pollution ploblem was found to extend over three counties, one of which (Guadalupe County) is not a member of the five-county Alamo Area Council of Governments. Establishing an air quality control region which is coterminous with the jurisdictional boundaries of the Council of Governments, therefore, becomes impractical. The Texas Air Control Board is encouraged, however, to periodically review the

boundaries of the Region and to add areas which, through population growth and industrial expansion, become part of the regional air pollution problem in the future.

The Region proposed is considered to be the best combination of counties to adequately abate air pollution in the metropolitan San Antonio area.

SECTION II

ANALYSIS AND PROPOSAL FOR THE METROPOLITAN SAN ANTONIO INTRASTATE AIR QUALITY CONTROL REGION BY THE TEXAS AIR CONTROL BOARD

EVALUATION OF ENGINEERING FACTORS

INTRODUCTION

The engineering evaluation for the San Antonio area was based on a study of topography, air pollutant emissions, meteorology, estimated air quality levels, and available air quality data. The emission inventory indicated the location of point and area sources and the quantity of pollutants emitted from these sources. Emission densities were calculated from the emission quantities and grid areas. Emissions and average meteorological data were used in a diffusion model to estimate air quality levels. Figure 1 shows the San Antonio Metropolitan Area in relation to other metropolitan areas. Figure 2 is a more detailed map of the eight-county study area.

TOPOGRAPHY[1]

The San Antonio Study Area is located in the south-central portion of Texas. The central and southeastern region of Bexar County lies on the edge of the Gulf Coastal Plain. In this part of Bexar County as well as most all of Guadalupe and Wilson counties the land is level to gently rolling. The Balcones Fault escarpment enters the northeastern part of Bexar County and swings westward passing just north of the city of San Antonio. This section is characterized by rocky, hilly country along the northern edge of Bexar County with rugged hills and low mountains extending into Kendall County and rolling land throughout Comal County. The upper one third of Medina County and the upper one fifth of Bexar County along with the majority of Bandera and Kendall County form the southeastern tip of the Edwards Plateau. This plateau has a characteristically

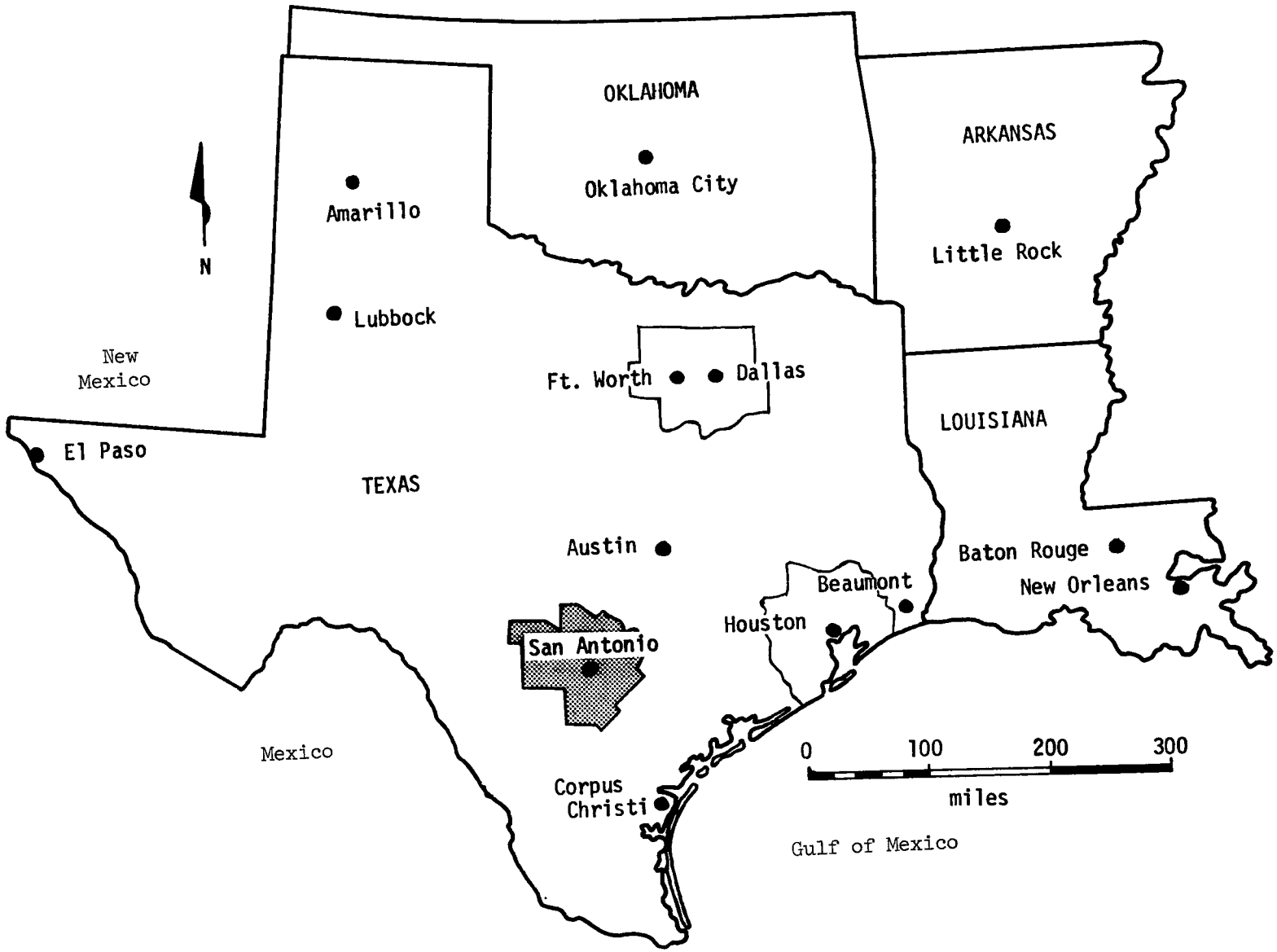


Figure 1. Location of the San Antonio Study Area Within the State of Texas

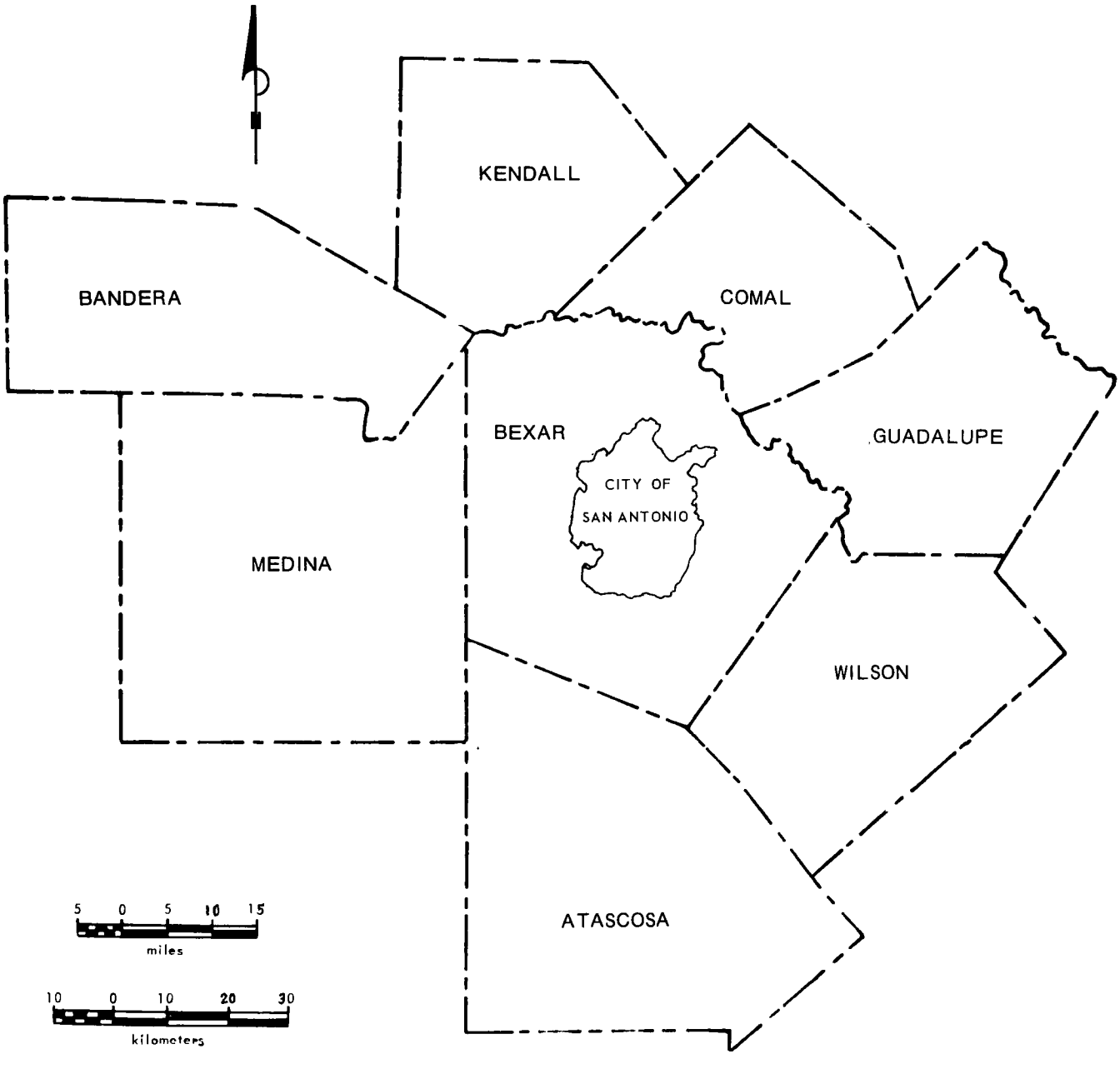


Figure 2. Detailed map of the San Antonio study area.

rough topography. The lower two-thirds of Medina County, the southwestern tip of Bexar County and all of Atascosa County are located in the Rio Grande Plain in which the land is generally level to rolling prairie. Figure 3 shows the geographic regions of the study area.

The eight-county area historically has been agriculturally oriented with large stock ranches and farms located throughout the area. Elevations within the eight counties vary from 300 feet to 1500 feet.

METEOROLOGY[4]

The degree to which pollutants accumulate is greatly influenced by the weather. In the San Antonio area the normal state of the atmosphere favors both vertical and horizontal mixing. Stagnating anticyclones highly favorable for prolonged air pollution concentrations are almost non-existent in the San Antonio area.

San Antonio has a modified subtropical climate predominantly continental during the winter months and marine during the summer months. Normal temperatures range from the low 50's to the mid 80's. Extreme high or low temperatures are rare. The growing season averages 282 days a year. Average annual rainfall is 29 inches. The prevailing winds are southeasterly averaging 9.3 mph.

Annual and seasonal wind roses for the San Antonio area are shown in Figure 4. Average mixing depths in meters for the San Antonio area are shown in Table I.

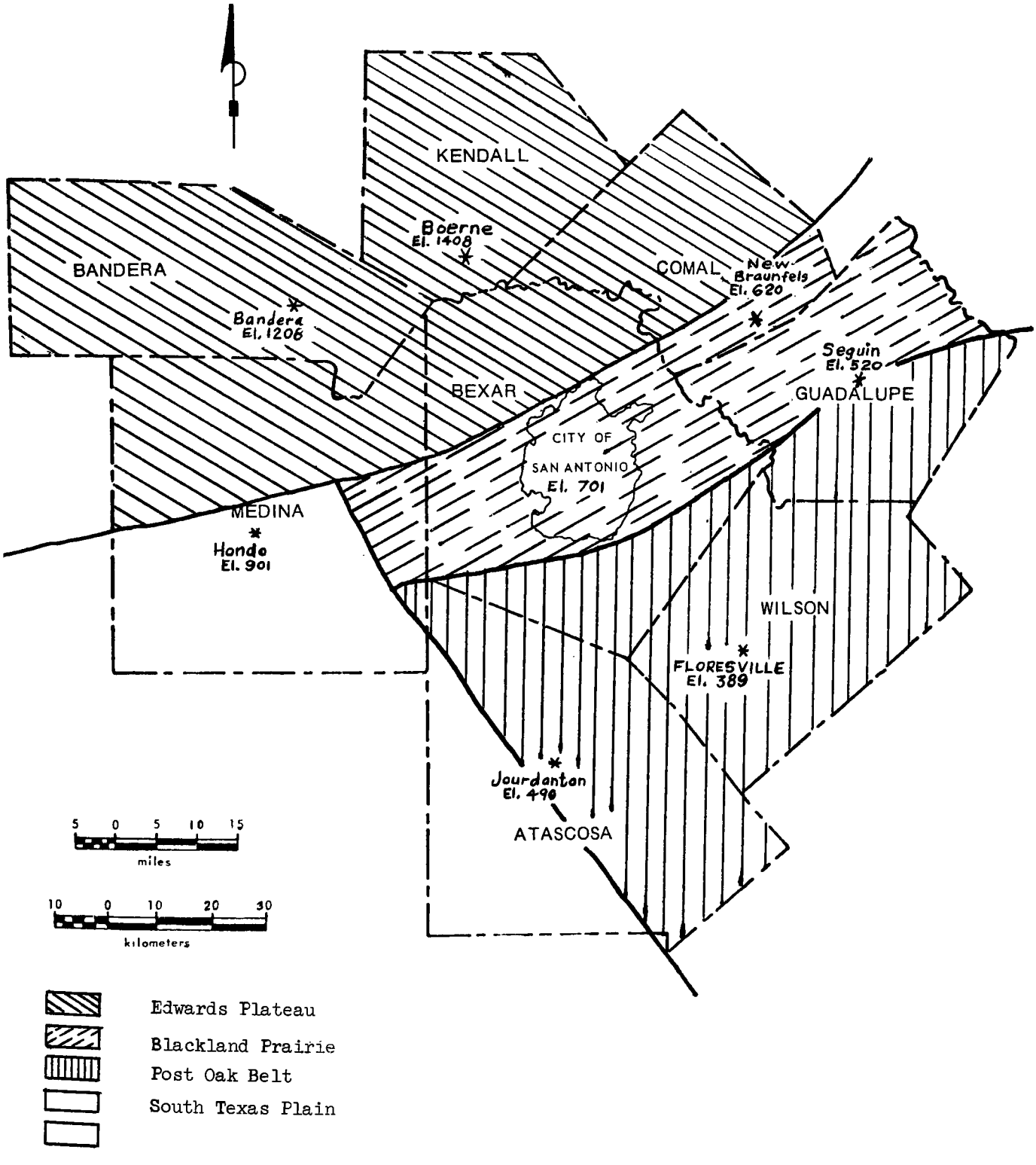
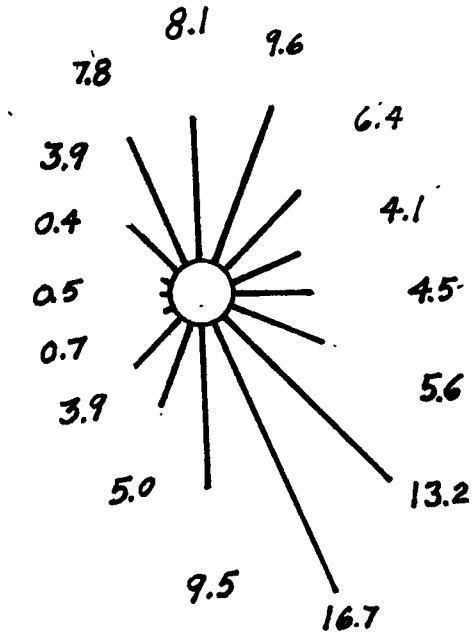
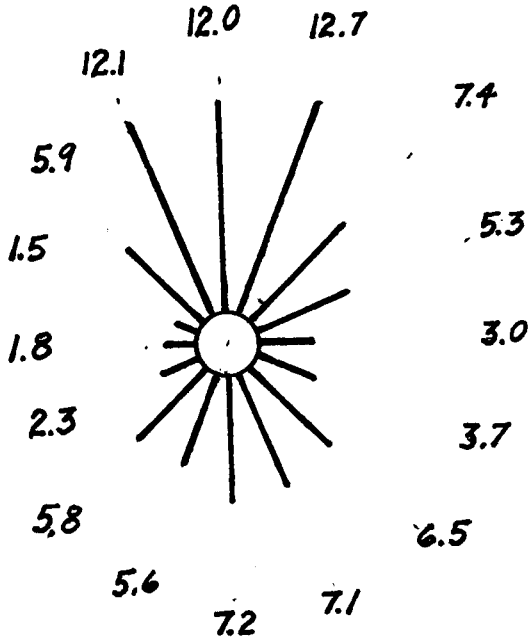


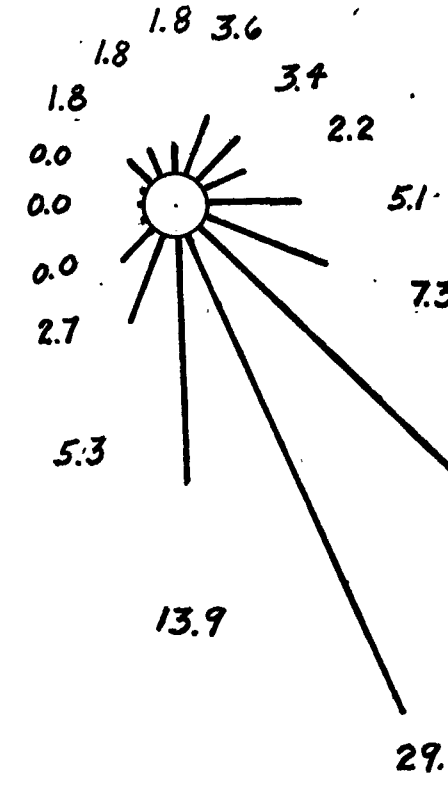
Figure 3. Geographic Regions of San Antonio Study Area



ANNUAL



WINTER



SUMMER

Scale : 1" = 10%

Figure 4. Wind Roses for eight county study area (numbers indicate % of time)

Table I

	Winter	Spring	Summer	Autumn	Average
Morning	370	678	897	1595	1098
Afternoon	1065	1529	2108	2108	

The wind rose data and mixing depth information were utilized in the simulation model for the eight-county study area.

EMISSION INVENTORY

The National Air Pollution Control Administration, in cooperation with the State and local control programs, conducted an inventory of air pollutant emissions for the eight-county San Antonio study area. The method employed was the Rapid Survey Technique for Estimating Community Air Pollutant Emissions.[5] This technique provided estimates of the total emissions for the following five pollutants: sulfur oxides; nitrogen oxides; hydrocarbons; carbon monoxide; and particulate matter. Sulfur oxides, total particulates and carbon monoxide are considered in this report since they provide an indication of the geographic extent of the air pollution problem.

Sulfur oxide levels and total particulate emissions illustrate the impact of industrial processing activities from stationary sources. Levels of carbon monoxide provide the best indication of the impact of gasoline powered motor vehicles.

The eight county study area was divided into grid zones which served as the basis for locating sources and reporting emissions.

Figure 5 shows the grid coordinate system for the San Antonio study area. Major point source locations are shown in Figure 6. Most of the major point sources are located in Bexar County.

Figure 7 illustrates sulfur oxide emission densities for the eight county study area. Sulfur emissions are shown for Bexar County. Figure 8 shows the particulate emission density for the study area. Again, Bexar County shows relatively high emissions of particulates. Carbon monoxide emission densities are shown in Figure 9. Portions of Bexar, Bandera, Kendall, Comal, Guadalupe, Medina, Atascosa, and Wilson counties show carbon monoxide emissions.

A summary of the emissions by source category is shown in Figure 10.

AIR QUALITY ANALYSIS

The geographical distribution of pollutant sources illustrates the core of the problem area. However, this does not elucidate the extent of the influence of the pollution sources on the people and the property located outside of the highly urbanized portions of the San Antonio area. A study of air quality levels known to occur is useful in determining the area affected by the pollution sources and thus subject to inclusion in the Air Quality Control Region. Such an analysis can be based directly on air sampling data in those instances where the monitoring program covers a large enough area and has been in existence long enough to provide a reliable pattern of air quality throughout the region under study. Since such comprehensive air quality data rarely exists, it becomes necessary to develop estimates of prevailing air quality. Diffusion modeling is a technique by which such estimates can be made based on the location and quantity of the pollutant emissions and on meteorological conditions. Topography

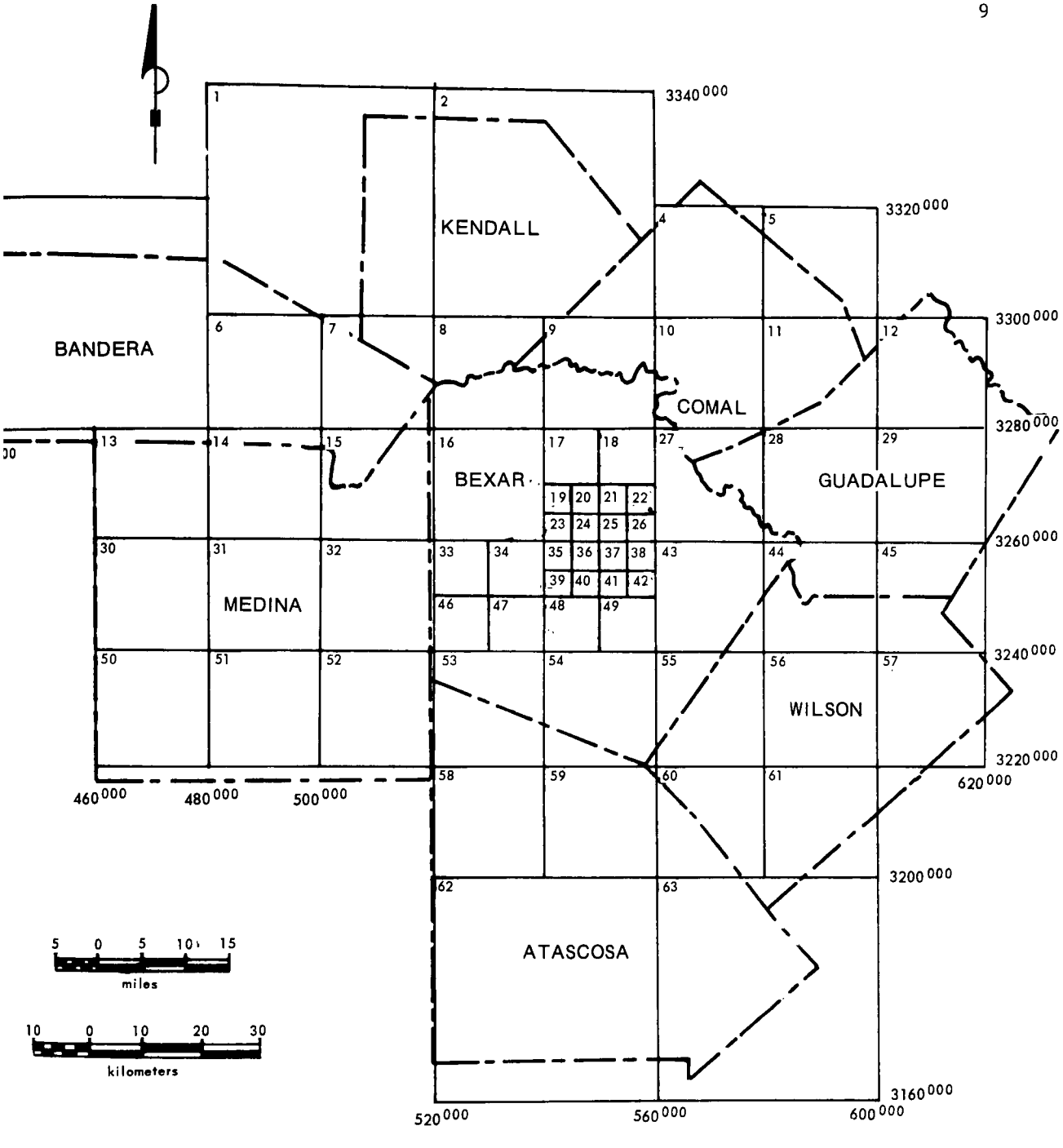


Figure 5. Grid Coordinate System For San Antonio Study Area.

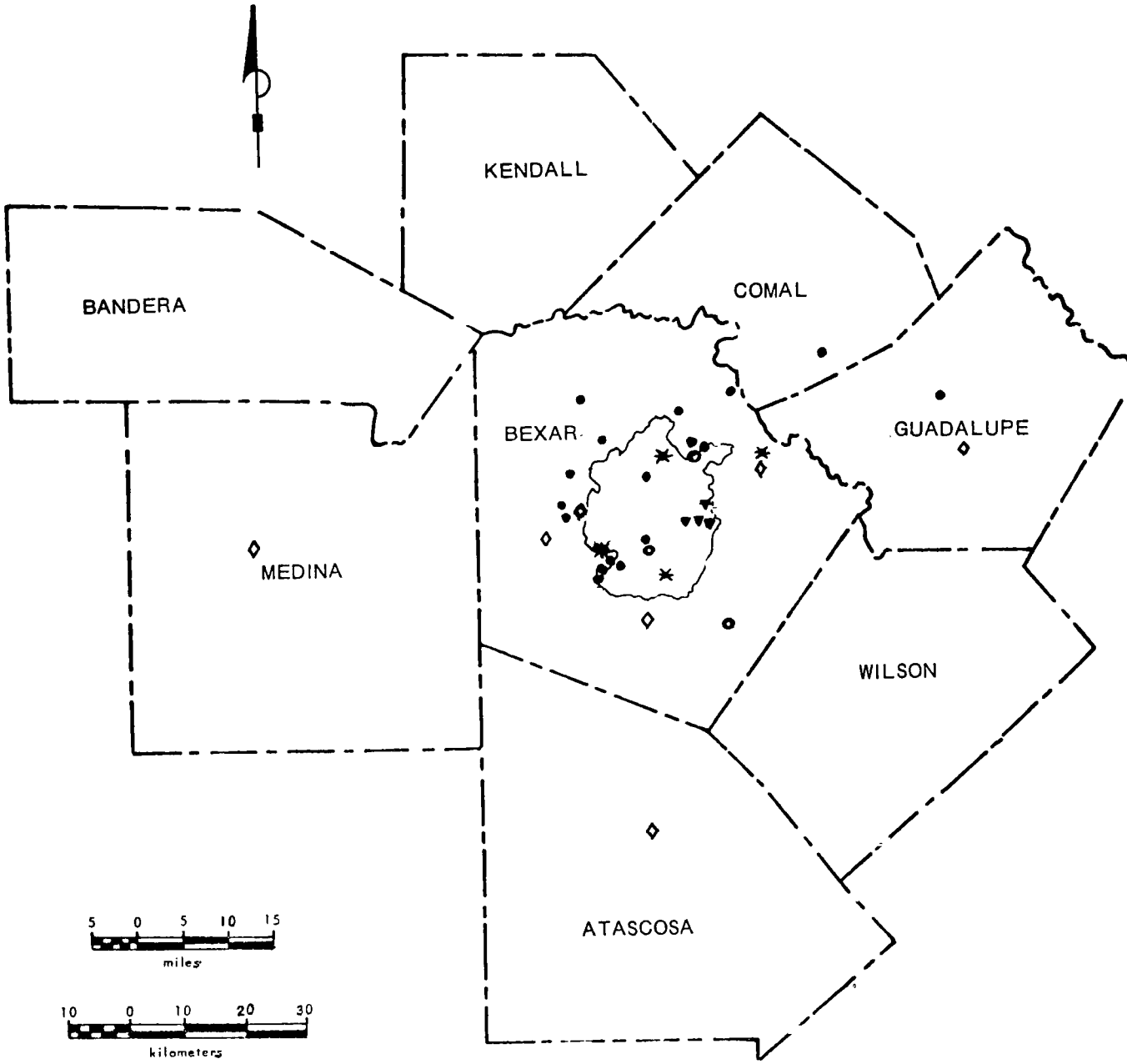


FIGURE 6. POINT SOURCE LOCATIONS WITHIN SAN ANTONIO STUDY AREA

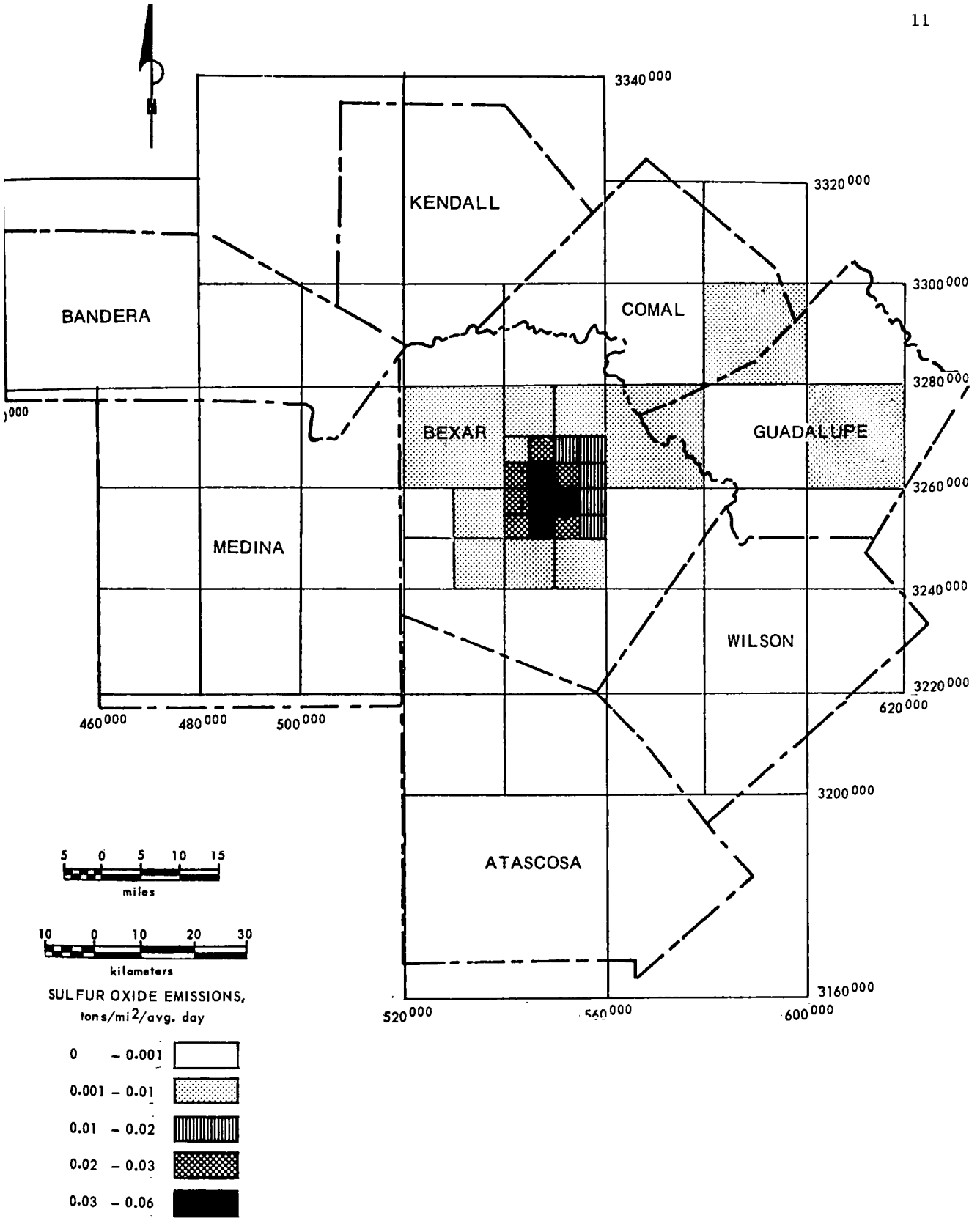


Figure 7 Sulfur oxide emission density map for all sources in San Antonio study area, 1968.

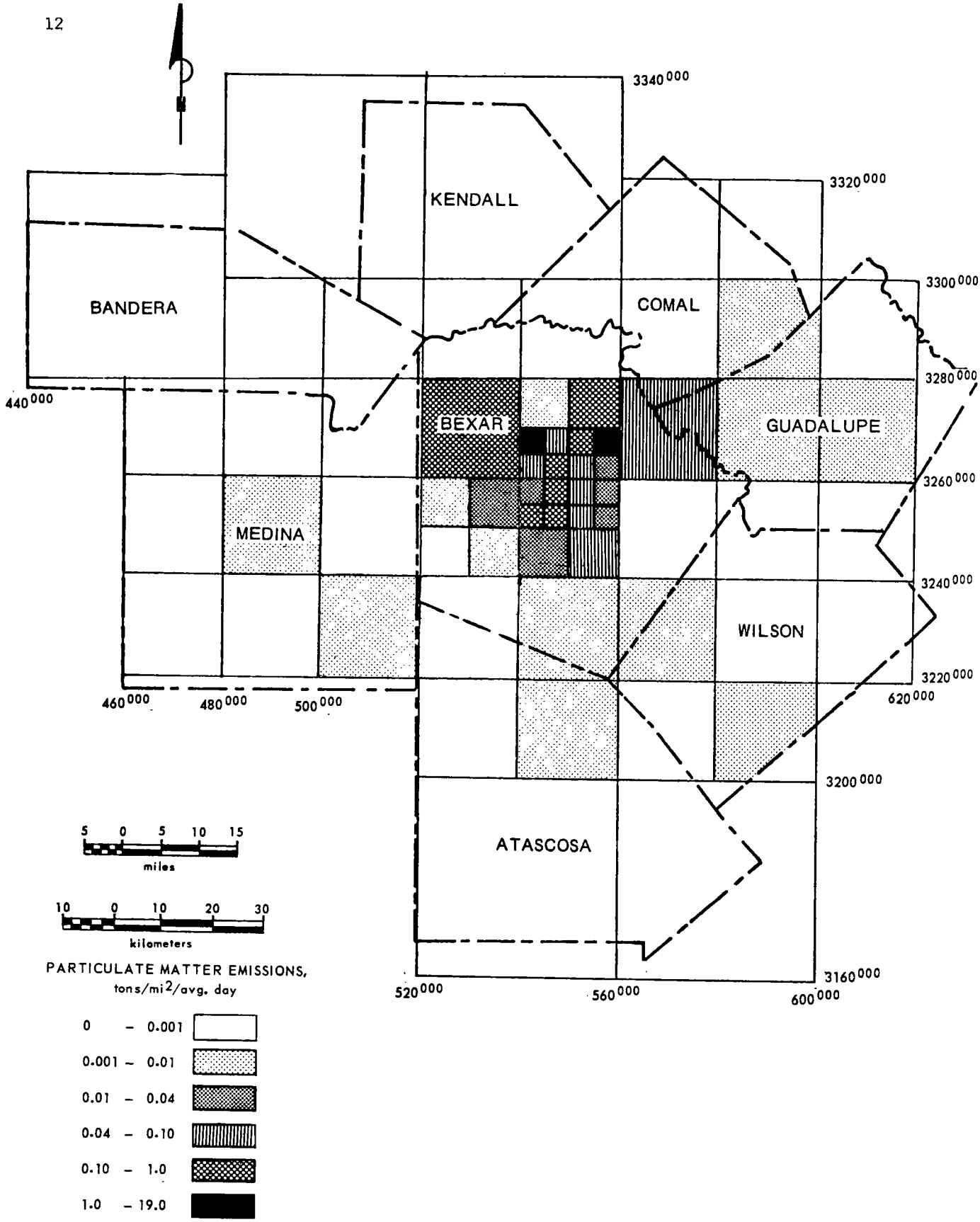


Figure 8. Particulate matter emission density map for all sources in San Antonio study area, 1968.

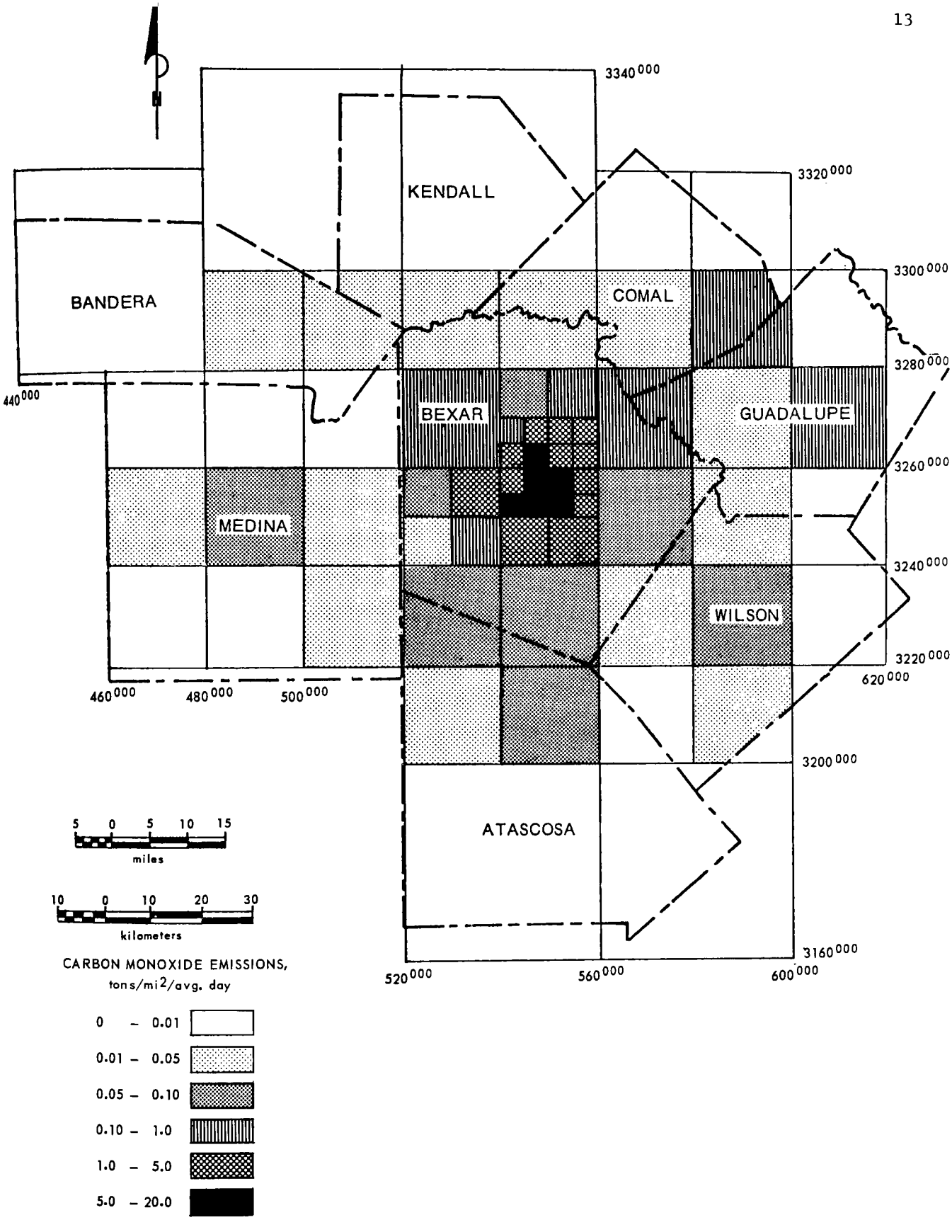


Figure 9. Carbon monoxide emission density map for all sources in San Antonio study area, 1968.

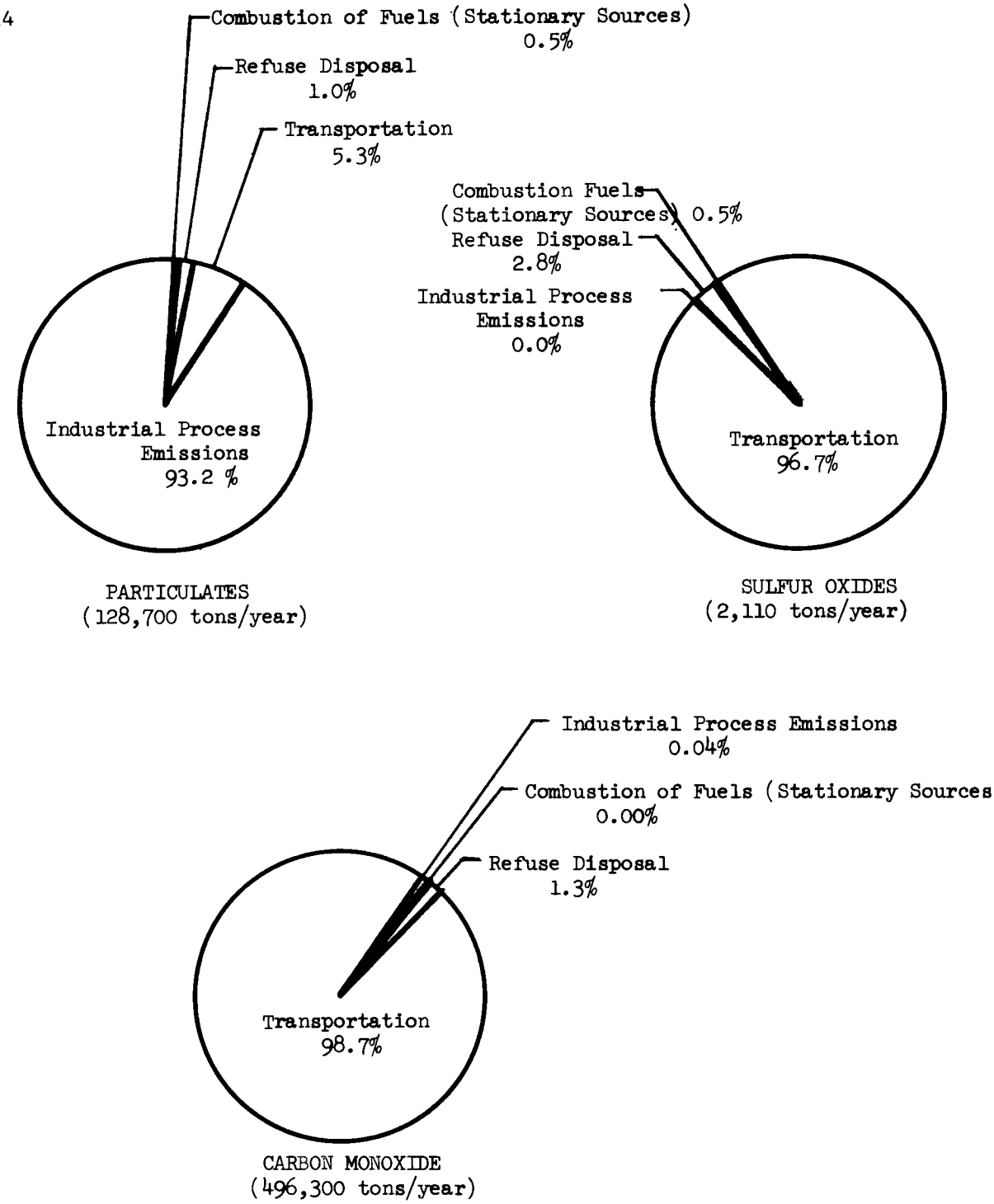


Figure 10. Summary of Air Pollutant Emissions - 1968
Eight County Study Area

NOTE: This information represents data on specific air pollutant emissions gathered during the rapid survey for the major point sources shown in Figure 6 and the area sources. It should not be interpreted as representative of air pollutant emissions for any specific location within the study area.

is reflected in the results of the model, but only to the extent that it influences general meteorological conditions.

The diffusion model was applied for each of the three pollutants for an average summer day, winter day and annual day. Since the Martin-Tikvart[6] model used in this study attempts to show long-term rather than episodic air quality conditions, only average emissions and long-term meteorology are considered. The results of the diffusion model are theoretical in nature and are not meant to show exact concentrations. The relative magnitudes and general shape of the contours, however, should be valid. The outputs from the computer model have been adjusted to reflect measured air quality data. Figures 11 and 12 show these adjusted values for particulates and carbon monoxide, respectively.

SUSPENDED PARTICULATE AIR LEVELS

The levels predicted by the diffusion model were generally lower than the actual measured air quality data. The theoretical levels aid in delineating the affected area. Figure 11 shows the annual average distribution of particulate pollution. Portions of Bexar, Comal, and Guadalupe counties are shown to be experiencing levels above background.

SULFUR OXIDE LEVELS

The absence of high sulfur content fuels and major processes involving sulfur products eliminates the area-wide sulfur oxide problems encountered in many other metropolitan areas. Figure 7 indicates that

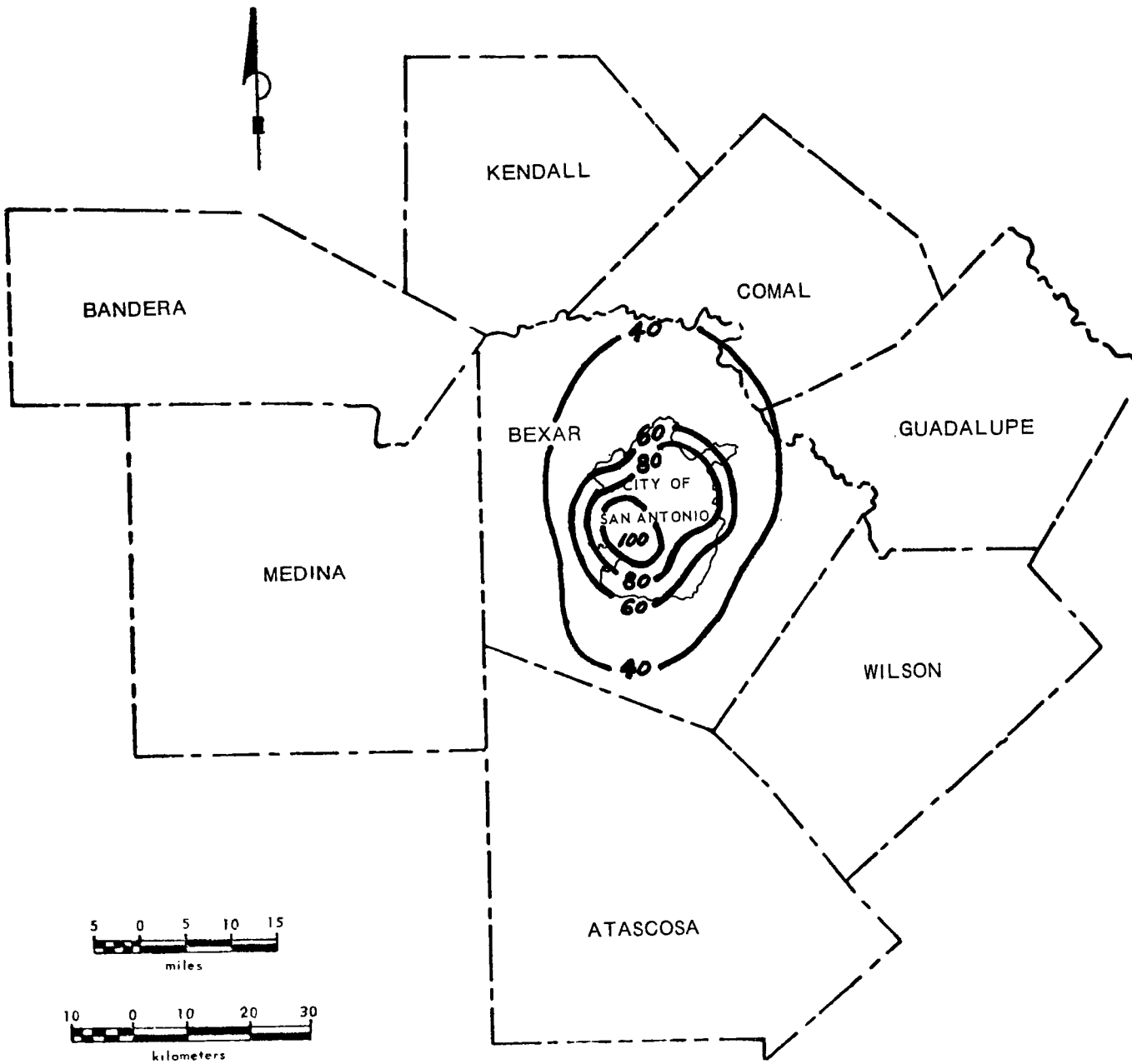


Figure 11. Annual Particulate Concentrations $\left(\frac{\mu g}{m^3}\right)$

the maximum sulfur oxide emission density for the San Antonio area is less than 0.06 tons/square mile/day. All ambient air monitoring for sulfur oxides has shown levels of less than 0.005 ppm, even on short-term averages. Annual average concentrations of sulfur oxides are considered negligible for the eight-county study area.

CARBON MONOXIDE LEVELS

Since the primary source of carbon monoxide is the internal combustion engine, the distribution of this pollutant tends to correlate with major traffic patterns. The influences of the interstate freeway system are shown. Bexar County is shown in Figure 12 to be experiencing the major portion of the carbon monoxide pollution.

SUMMARY

The engineering evaluation of the eight county study area shows that at the present time the major point sources are located in Bexar, Comal, and Guadalupe counties. Receptors in these counties are also shown to be experiencing the major air pollution problems.

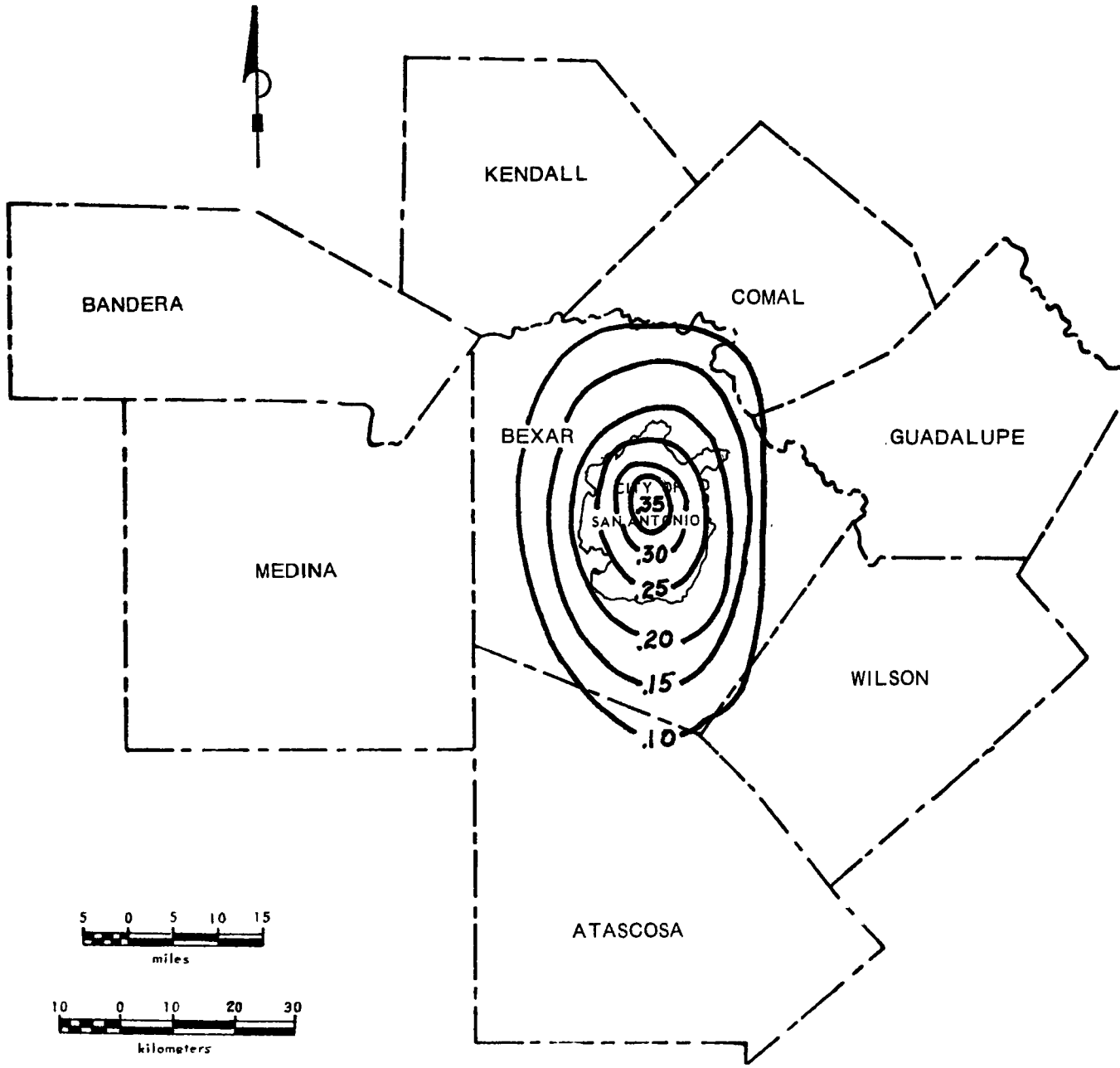


Figure 12. Annual Carbon Monoxide Concentrations (ppm)

EVALUATION OF URBAN FACTORS

INTRODUCTION

A number of urban factors are relevant to the problems of defining the boundaries of air quality control regions. These factors include the location of population and industry, the population density, projected growth of both population and industry, and jurisdictional considerations such as control agencies and Regional Planning Commission. These are all important considerations since human activity is the initial cause of most air pollution. Humans are also the receptors affected by the pollution. The projected growth patterns are most important for future planning purposes.

POPULATION

Table II shows the population growth for the study area from 1960 to 1968 with an overall growth of 23%. Projections of population to the year 2000 show that there will be almost two million people in the eight-county area.[2] Currently more than 93% of the population for the study area resides in Bexar, Comal, and Guadalupe counties. The remaining 7% is spread among the other five counties which are primarily rural. Figure 13 shows the population density. Bexar and Guadalupe counties comprise the San Antonio Standard Metropolitan Statistical Area.

INDUSTRY

The eight-county study area is generally void of heavy industry. Bexar, Comal, and Guadalupe counties contain the majority of the industry in the study area. Production and processing of cement, stone, clay, petroleum and metal products are the major industrial operations in the

TABLE II [7]

AREA AND POPULATION CHARACTERISTICS FOR SAN ANTONIO STUDY AREA

Political Jurisdiction	Land Area (sq. mi.)	Population 1960	Population 1968	Population Density (1968)
Atascosa County	1,206	18,800	21,200	17
Bandera County	763	3,900	4,400	6
Bexar County	1,246	687,500	861,000	691
Comal County	567	19,800	23,000	40
Gaudalupe County	714	29,000	29,100	41
Kendall County	670	5,600	7,500	11
Medina County	1,352	18,900	21,000	16
Wilson County	802	13,300	14,400	18
Total Study Area	7,320	796,800	981,600	134

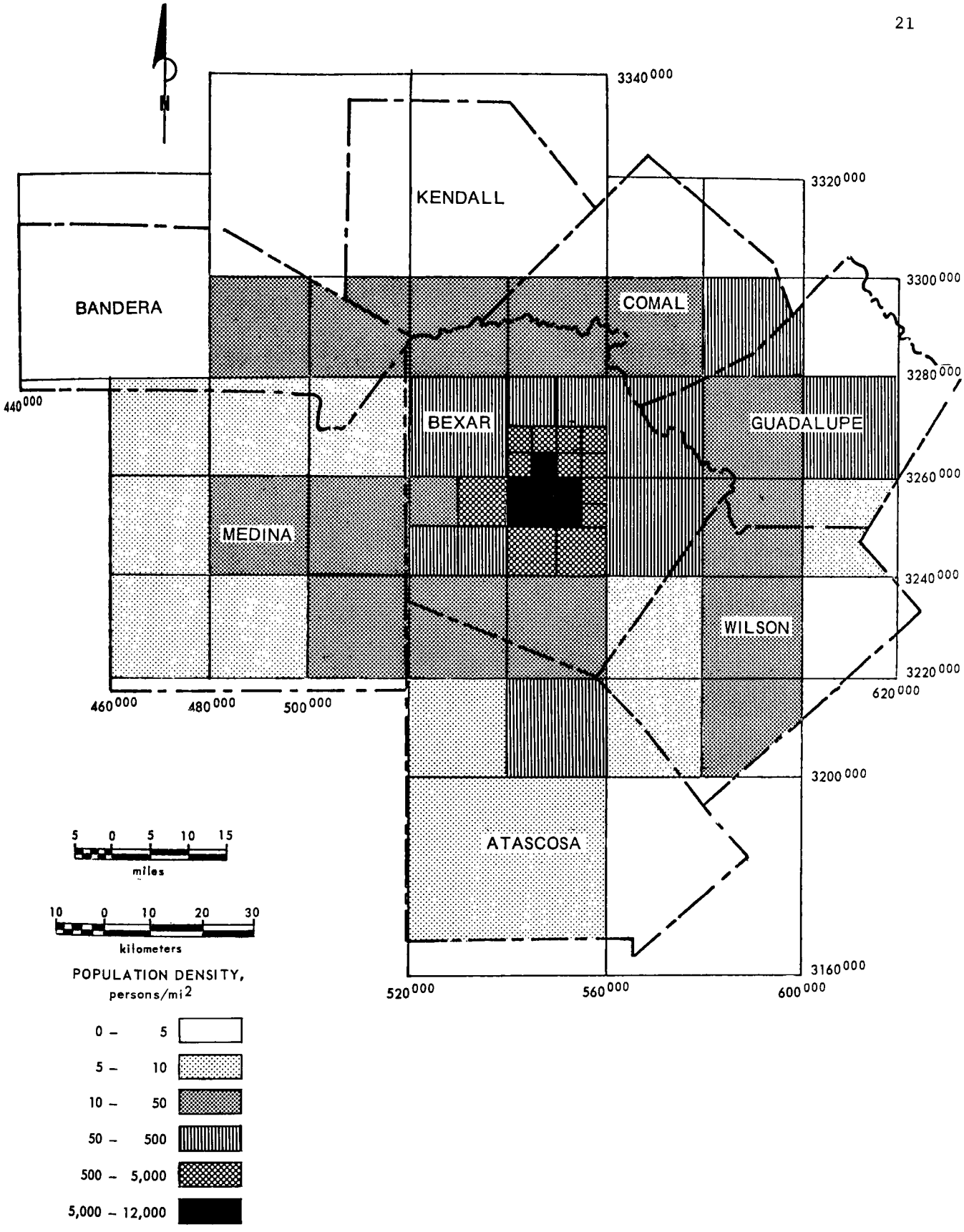


Figure 13. Population density for San Antonio metropolitan area, 1968.

San Antonio Metropolitan Area. Table III shows selected manufacturing establishments in the eight-county area.

REGIONAL PLANNING

The Alamo Area Council of Governments is the regional planning agency for the area. Five of the eight counties of the Alamo area, including 20 cities and 10 school districts, make up the council which was formed in 1966. Guadalupe, Kendall and Medina counties are not members of the Council. Projects relating to urban and social planning as well as regional water and sewer planning are in progress.

AIR POLLUTION CONTROL AGENCIES

The Texas Air Control Board is the State agency responsible for air pollution control activities. The Texas Clean Air Act provides for equal enforcement of State Rules and Regulations by local governments (cities, counties, and health districts). The State Board has adopted regulations relating to smoke and suspended particulate matter, outdoor burning, sulfur compounds and toxic materials. Enforcement provisions allow both injunctive relief and civil and criminal penalty of up to $1000 per day. One local air pollution control program is organized in the eight-county area with jurisdiction in San Antonio and Bexar County.

TABLE III[8]

SELECTED MANUFACTURING ESTABLISHMENTS IN

SAN ANTONIO STUDY AREA 1963

Establishments by Jurisdiction	TYPE ESTABLISHMENT						
	Food & Kindred Products	Textile Products	Paper & Printing	Chemicals & Petroleum Products	Stone, Clay & Glass	Metal Products	Total
Atascosa	--	--	--	--	--	--	--
Bandera	--	1	--	--	--	--	1
Bexar	62	25	24	10	16	15	152
Comal	1	3	--	--	2	--	6
Guadalupe	4	1	--	--	1	1	7
Kendall	--	--	--	--	--	--	--
Medina	--	--	--	--	2	--	2
Wilson	--	--	--	--	1	--	1
Total Study Area	67	30	24	10	22	16	169

THE PROPOSED REGION

Subject to the scheduled consultation, The Texas Air Control Board recommends that the Secretary, Department of Health, Education and Welfare, designate an air quality control region for the San Antonio Metropolitan Area, consisting of the following jurisdictions in Texas:

Bexar County
Comal County
Guadalupe County

As so proposed, the San Antonio Air Quality Control Region would consist of the territorial area encompassed by the outermost boundaries of the proposed jurisdictions. The proposed Region is shown in Figure 14.

DISCUSSION OF PROPOSAL

To be successful, an air quality control region should meet three basic conditions. First, its boundaries should encompass most pollution sources as well as most 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, 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 1) discussed the first of these conditions, and the "Evaluation of Urban Factors" (page 19), the second and third.

The first consideration--that most air pollution sources and receptors be within the Region boundaries--is satisfied by the proposed Region. Major point sources are located in Bexar, Comal and Guadalupe counties. Emission

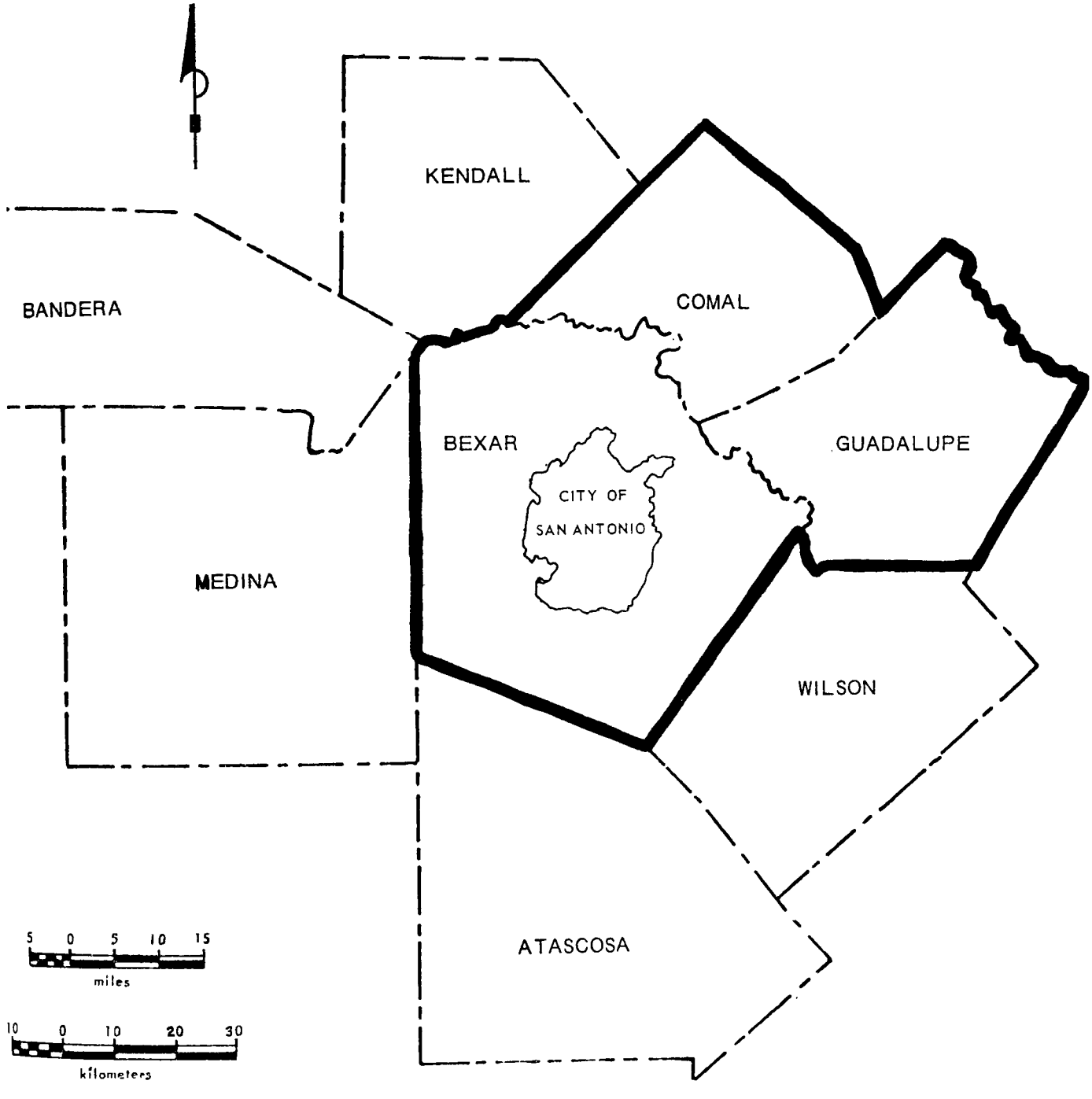


Figure 14. Proposed Metropolitan San Antonio Intrastate Air Quality Control Region.

densities of particulates, carbon monoxide, and sulfur oxides are greatest in Bexar County.

The second consideration is directed towards future population and industrial expansion. Approximately 1,000,000 people live in the proposed Region, which represents about 10% of the population of the State. Estimates for the year 2000 show approximately 2,000,000 people in the eight-county area. Of the eight counties, Bexar, Comal, and Guadalupe will receive most of the growth during the next 15 to 30 years.

The third objective relates to governmental administration in the area. Regional planning is coordinated by the Alamo Area Council of Governments which includes five of the eight counties of the study area. However, considering air quality control from a regional standpoint, it does not seem justifiable to include all eight counties in the region at the present time. It does seem reasonable to assume that perhaps in the future the air quality region will need to encompass all of the eight counties. Therefore, for the present the counties of Bexar, Comal, and Guadalupe seem to define the best region from an administrative viewpoint.

Based on the technical data presented on air pollutant emissions and the resultant ambient air concentrations, only Bexar, Comal, and Guadalupe need be a part of the region. Jurisdictional considerations also indicate that for the present these three counties will form the most cohesive region in the San Antonio Metropolitan Area.

REFERENCES

1. "San Antonio Metropolitan Air Pollutant Emission Inventory", U.S.D.H.E.W., P.H.S., C.P.E.H.S., N.A.P.C.A., June, 1969.

2. "Texas Market Trends and Potential", #15, by Texas Industrial Commission.

3. " U.S. Weather Bureau, Normal Surface Wind Data for the United States", Washington, D.C., 1942.

4. "An Evaluation of the Meteorological Potential for Air Pollution at San Antonio, Texas", by Robert Orton, Weather Bureau State Climatologist, Environmental Science Service Administration, Austin, Texas.

5. "Rapid Survey Technique for Estimating Community Air Pollution Emissions", PHS Publication No. 999-AP-29, Environmental Health Series, USDHEW, NCAPC, Cincinnati, Ohio, October 1966.

6. "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.

7. "Population Estimates", San Antonio Area Council of Governments, 1968.

8. "County and City Data Book", 1967, United States Department of Commerce, April, 1967.

☆ U. S. GOVERNMENT PRINTING OFFICE : 1969—395-976/17