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HACKENSACK MEADOWLANDS AIR POLLUTION STUDY - EMISSION PROJECTION METHODOLOGY

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

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HACKENSACK MEADOWLANDS AIR POLLUTION STUDY - EMISSION PROJECTION METHODOLOGY

by

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Prepared for

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PREFACE

Increasing recognition is being placed on the importance of land use planning as a means of improving future air quality. As a part of this recognition the New Jersey Department of Environmental Protection and the U.S. Environmental Protection Agency jointly sponsored a study to develop methods to assess the air pollution impact of land use plans, and to apply these methods to the evaluation of alternative land use plans for the New Jersey Hackensack Meadowlands as a case study.

Environmental Research & Technology, Inc. (ERT) of Lexington, Mass. was selected to undertake the study. In response to the study objectives, ERT designed a computer-oriented tool, called the AQUIP (Air Quality for Urban & Industrial Planning) System, which is intended for use by planners to incorporate air pollution considerations more directly into the planning process.

The specific study objectives included the development and application of techniques for projecting to the year 1990 the total air pollutant emissions from an urbanized area. This methodology for computing emissions based on planning data inputs is one of the basic features of the AQUIP System. Since AQUIP permits direct input of land use and transportation planning data, it can be used by urban planners to compute ambient air quality related to specific land use activities.

The Hackensack Meadowlands Air Pollution Study final report consists of a summary report, 5 task reports, and 3 appendices, each bound separately. This report is the first of the 5 task reports. It describes the emission projection methodology that was developed and its application to the

Hackensack Meadowlands Development Plans. The report is divided into three major parts:

PART I - Emission Projection Methodology

PART II - Discussion of the Emission Inventories

The Appendices - Data Sets and Emission Inventories

Part I covers the procedures developed, requirements of the methodology, and the major clarifying assumptions and constraints. Figures are numbered I-1, I-2, etc. It is divided into sections as follows:

1. Background, including the form of planning activity data.
2. Those requirements of the AQUIP system and the dispersion model that influence the structure of the emission inventories.
3. The role of regulations and control technology in the study.
4. The actual development of the methodology.
5. The assumptions and constraints, including a discussion of the decisions concerning activity data, activity indices, fuel use, and emission factors.

Part II describes the actual emission inventories as developed, particularly for the Meadowlands plans. Figures are numbered II-1, II-2, etc. It is divided into sections covering:

1. The emissions catalog specifications.
2. The current emission inventory.
3. The background emission inventory.
4. The inventories for the 1990 land use plans.

The emissions inventory was prepared before Nation Emission Data System (NEDS) forms were available from the U. S. Environmental Protection Agency (EPA). Readers are cautioned that emissions inventories now prepared in conjunction with any EPA requirement must be in compliance with NEDS forms and procedures. The Appendix material includes:

Appendix A - Plan Data Sets and Conversion Factors Catalog

Appendix B - Current and Background Emission Inventories (Confidential Material)

It is intended as a supplement to the software descriptions of the Task 5 Report and as a user manual for those interested in using the data and techniques for further study; several test cases are included.

ACKNOWLEDGEMENTS

The work upon which this report is based was performed pursuant to Contract No. EHSD-71-39 with the Environmental Protection Agency, and Contract No. 1P-290 with the New Jersey Department of Environmental Protection.

The comments and assistance of Mr. George D. Cascino, Engineer, Hackensack Meadowlands Development Commission and other members of the staff are gratefully acknowledged as are the efforts of numerous individuals in the U.S. Environmental Protection Agency (EPA) and the New Jersey Department of Environmental Protection (NJDEP). The significant contribution of our subcontractor, Burns and Roe, Inc., of Oradell, N.J., particularly of Mr. William Foy of their staff, is gratefully acknowledged. Mr. David Berghoffer of the ERT staff was responsible for the majority of the software development for Task 1.

SUMMARY OF FINDINGS

Application of the emissions projection methodology to the Meadowlands plans showed that we could achieve our basic objectives. In addition, the five step procedure developed to transform activity levels into emission strengths was workable and, in fact, quite adaptable to the land use considerations which were encountered. In particular, the development of the conversion factors catalog demonstrated that the planner need input only planning-related data.

However, it was found that the planner must specify data he does not normally deal with, including the size of a development as it relates to heating demand and the types of manufacturing operations anticipated. Furthermore, the level of detail obtainable from the data was unsatisfactory for discerning between related activities, particularly for calculating default parameters such as the propensity to use different fuels and the amount of separate process emissions. Consequently, the greatest need for further work involves the empirical derivation of activity indices and default parameters. The availability of current region wide emissions data for model validation and determination of projective indices was inadequate as well.

The methodology as developed and applied allows for meaningful comparison between the alternative land use plans and provides a useful tool for use by others in determining the effect of incremental changes in a plan or in the testing of additional plans. This methodology is combined with the other aspects of the AQUIP system, namely:

1. A model for computing air quality based on emission and meteorological data

2. Methods for evaluating the air pollution impact associated with a given plan and ranking alternative land use plans based on air quality criteria, this methodology for computing emissions should permit planners to incorporate air pollution considerations more directly into the planning process

TERMINOLOGY

Because the terminologies of several different professions are used in this report, often in unfamiliar ways, this brief discussion of terminology is presented to show the context within which different terms were used in our study. Specific definitions of these and other terms are listed in the Glossary.

The basic land use and transportation planning units of intensity of use - vehicles per day on a highway, acres of residential land use, square feet of industrial plant space - are called the activities or the activity level. The parameters which translate the activity levels into demand for fuel for heating purposes are called activity indices; for instance, BTU's (British thermal units of heat demand) per square foot for industrial plant space.

We distinguish between fuel related and non-fuel related activities or sources of emissions. The fuel related sources use fuel for:

1. heating area, such as heating a school in the winter; the amount of heat required and the fuel consumed is a function of the temperature or the number of degree-days (the sum of negative departures of average daily temperature from 65°F). We have termed this fuel use as that required for heating, or space heating.
2. raising a product to a certain temperature during an industrial process, or for cooking (with gas) in the home; the amount of fuel consumed is a function of the activity and is generally not related to outside temperature. We have termed this fuel use as that required for process heating, or non-space heating.

The area to be heated for space heating purposes and the amount of the year it will be heated (a function of the schedule, such as 250 days per year for an industrial plant) help determine the heating requirements for an activity. If the activity requires process heat as well, the total heating requirements will be the sum of the space heating requirements and the non-space heating requirements. The percent of the total allocated to either type is called the percent space heat, or, conversely, percent process heat.

The total heat requirement determines the demand for fuel; different activities are more apt to use one fuel than another. The propensity to use a particular fuel or fuels (the fuel use propensity) determines the actual fuel used to satisfy the heat requirement.

Different types of activities may have varying activity indices or percent space heat or fuel use propensities; for instance, each industrial category in the U.S. census 4-digit SIC classification may have a unique value. However, we may know information only by broad industrial groups (1 or 2 digit SIC). The value applying to the larger or broader group being used for the smaller or more detailed group when the unique value is not known has been termed a default parameter in our study.

There are two types of non-fuel related activities or sources of emissions. Transportation sources - motor vehicles, vessels, and airplanes - that do not burn fuel primarily for heating purposes have been termed non-fuel burning sources. The emissions are a function of:

1. activity level, times
2. emission factors, yields
3. emissions

whereas, for what we term fuel burning sources the emissions are a function of:

1. activity levels, times
2. activity indices, yields
3. fuel demand; fuel use, times
4. emission factors, yields
5. emissions

The other type of non-fuel related activity is composed of emissions from sources, often industrial, that do not come from the burning of fuel; for example, evaporation from a refinery storage tank. Refuse burning and incineration fall into this category. These are termed separate process emissions or process emissions in our study. Note the distinction between process heating related emissions and separate process emissions. Separate process emissions are a function of:

1. activity level, times
2. emission factors, yields
3. emissions

There are several distinctions made geographically or spatially, or in terms of different portions of the study area. Our main effort in determining emissions is concentrated on the Meadowlands planning area and emissions resulting from activities presented in the plans. All other sources of emissions are considered to be background sources and are discussed as a part of the background inventory for the year 1990. On the other hand all background sources for 1969 and all sources presently within the Meadowlands are treated equally and discussed as a part of the current inventory. In brief, there are three emissions inventories and all sources are discussed relative to these:

1. current inventory - all sources for 1969
2. background inventory - all sources for 1990 not directly related to the Meadowlands plans.
3. plans inventories - all sources for 1990 related to the Meadowlands plans.

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PART I

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PART I: EMISSION PROJECTION METHODOLOGY

1. BACKGROUND

1.1 General Applicability

One of the major purposes of the study was to develop a general tool to aid planners in determining emissions directly from activity data, and to apply this tool to a case study for the Hackensack Meadowlands. As the study developed compromises had to be made when the requirements of the Meadowlands analysis were in conflict with the general methodology. In all cases the premise was made that the procedures should be transferable to other regions and that no procedure should be used if it were specific to the Meadowlands. Wherever possible particular approaches or applications which reflect unique characteristics of the Meadowlands and their translation to a general case have been pointed out.

1.2 Pollutants Investigated

EPA and the New Jersey Department of Environmental Protection were originally interested in six pollutants: total suspended particulates (herein referred to as particulates or TSP), sulfur dioxide (SO_2), carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NO_X), and oxidants. It was recognized from the outset that oxidants could not be modeled directly and would have to be examined by a secondary analysis. Furthermore, there was no way to validate our estimates for oxidants. Therefore, it was agreed upon early in the analysis that oxidants would not be considered in the study.

Although much of the existing emissions information is confined to sulfur dioxides and particulates all of the analyses were carried out for all five pollutants equally. In many cases this meant a great deal of extra effort, as in the determination of separate process emissions for carbon monoxide, hydrocarbons, and oxides of nitrogen, but it was essential for maintaining a consistent analysis of each pollutant so that the final determination of impact for Meadowlands plans could involve comparison between pollutants as well as the combined effect of all pollutants.

As a result of these efforts the first comprehensive detailed inventory for certain pollutants for this region has been developed. However, the scope of the task did not include improvement, updating or verification of current emission inventories for the New York region and therefore these data should not be used for purposes beyond those intended.

1.3 Confidentiality

The development of emissions inventories depends to a very large extent on the cooperation of individual emitters. Because of the nature of the data and the competitiveness of many of the industries, it is extremely important that the confidentiality of the information for individual sources be maintained. Accordingly, as a part of this study, all point sources are referred to only by number and industrial category. No mention is made or is intended for individual sources by name. In addition, only data from Federal and state air pollution agencies provided specifically for this study was used. In turn it is these same agencies who will be reviewing the results; therefore, there is no net transfer of confidential information on point sources from one interested party to another.

1.4 Planning Activity Data

As a part of this study air pollution emissions have been characterized as a function of land use and transportation planning data, referred to as "activities". Such planning information may consist of specific data on the development of parcels of land, zoning regulations, tables of statistics such as employment projections, vehicular travel assignments, capital improvement programs, and information specific to an activity such as the extension of utility lines. In general this study was concerned only with planning data for activities which would contribute to air pollutant emissions. Furthermore, it was necessary that the planning data be spatially located so that emissions could likewise be spatially assigned. This makes it difficult to use a great deal of information, such as general tables of statistics or capital improvement program material, that do not locate specific projects and give their magnitude.

Air pollutant emission patterns are a function of the intensity of land use as well as the type and location of the land use. In most cases neither regional nor local plans give an adequate indication of the intensity of development so that emissions can be accurately assessed. The information provided by the Hackensack Meadowlands Commission was very detailed due in part to the fact that it was designed for this study. Information existed from zoning ordinances on the intensity of development by detailed categories of activity.

However, investigation of the Tri-State Transportation data and the New York City Planning Commission data as representative of what might be available showed that estimates are forthcoming, in general, for only such parameters as population, total employment, square foot usage by various categories, and vehicular travel. Therefore, the extension of the procedures to other regions must take into account the less detailed information that characterizes most planning data. The procedures that were formulated for the background area, using Tri-State Transportation data, may be more representative of certain general situations. On the other hand the air quality determined from such data can only be assessed on a regional basis. Furthermore, the development of the procedures for the background area was of secondary priority in this study and, therefore, the applicability was not adequately tested.

1.5 Meadowlands Case Study

The proposed development of the Hackensack Meadowlands area is quite unique in many aspects. It involves very intensive development in a highly industrialized and densely populated area. It is, therefore, not characteristic of many proposed new town projects. Secondly, because it does involve new development in an area where little current development exists, it cannot be characterized as representative of urban redevelopment programs. These differences should be kept in mind when attempts are made to translate the methodologies to other planning situations.

Furthermore the Meadowlands area represents the possibility of highly controlled development with many single projects built at a much larger scale than normally found. For this reason the concept of large scale central heating systems is much more heavily emphasized for the Meadowlands plans than would generally be true. In addition, because of the high density development anticipated, the concepts of low, medium, and high density housing takes on a different meaning here. A density of ten housing units or dwelling units* per acre would generally be considered fairly high; however, this is the low density category specified for the Meadowlands, whereas high density is 50 to 80 dwelling units per acre.

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* The term "dwelling unit" is used in this report since it was contained in the Hackensack Meadowlands Development Commissions land use plans and supporting data.

The reliance on large-scale planned projects with integrated commercial and institutional facilities greatly lessens the need for the automobile for local travel. Therefore most vehicular travel is assigned to major highways. This, too, would not be representative of many other planning situations.

These unique characteristics of the Meadowlands in no way invalidate the procedures developed. However, their existence means that caution should be exercised in translating the exact indices used for the Meadowlands to other situations. For instance, the analysis of low density housing for the Meadowlands should not be transferred intact to 2 and 3 acre zoning, nor should the negligible amount of local motor vehicle emissions.

2. REQUIREMENTS OF THE AQUIP SYSTEM

2.1 Role of Emissions in the System

The development and the use of the emissions inventories are only one set of steps in the AQUIP system. Figure I-1 shows the general flow of information in the AQUIP system from the specification of land use plans through to plan evaluation and ranking. Only the first three boxes relate to emissions inventories. In a general sense the information on land use plans is translated directly into emissions by the use of the conversion factors catalog. This catalog contains all necessary information on heating requirements, fuel use, process emissions and the manner in which specific activities produce air pollutant emissions.

It is intended as the black box for the planner to use: he can input his land use planning information and obtain a profile of the air pollution emissions that would result. The content and form of the land use plan is determined by the specific interests of the planner. On the other hand, the content and form of the emissions inventories is mainly a function of modeling requirements. Finally, the conversion factors catalog is directly a function of the information needed to translate the land use plans into the required emissions inventories.

Figure I-2 shows the relationship of the background emission inventories to this process and to the initial step of model validation using current air quality data. As noted in the glossary of terms the background inventories include all sources not directly related to the Meadowlands plans.

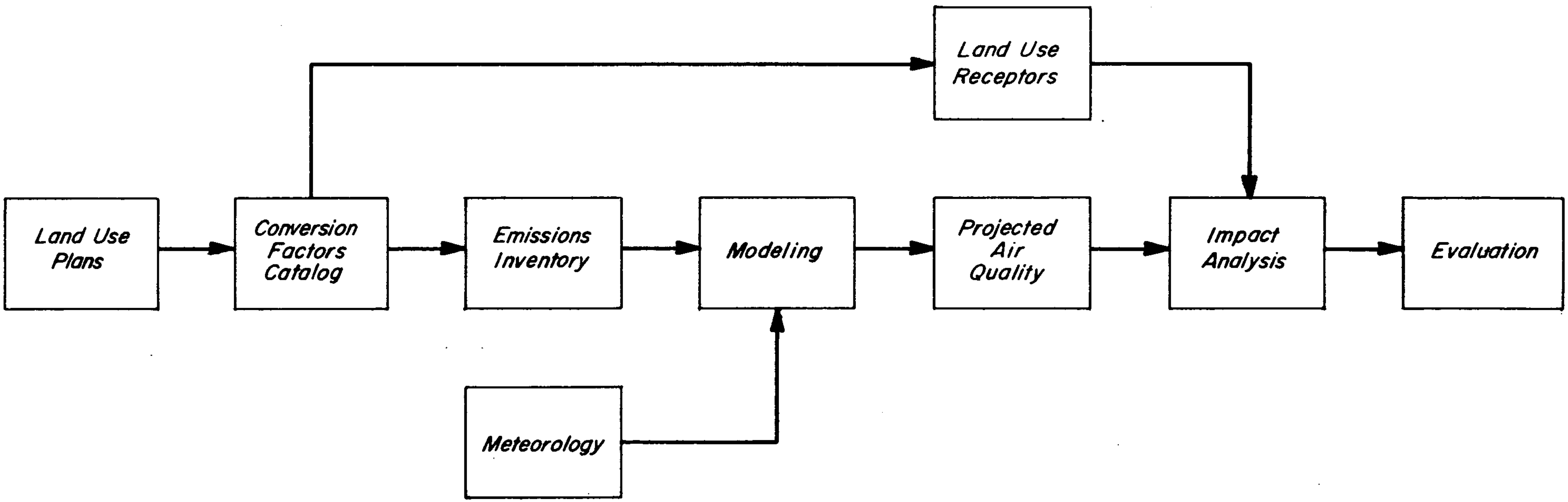

Figure I-1 AQUIP System Information Flow

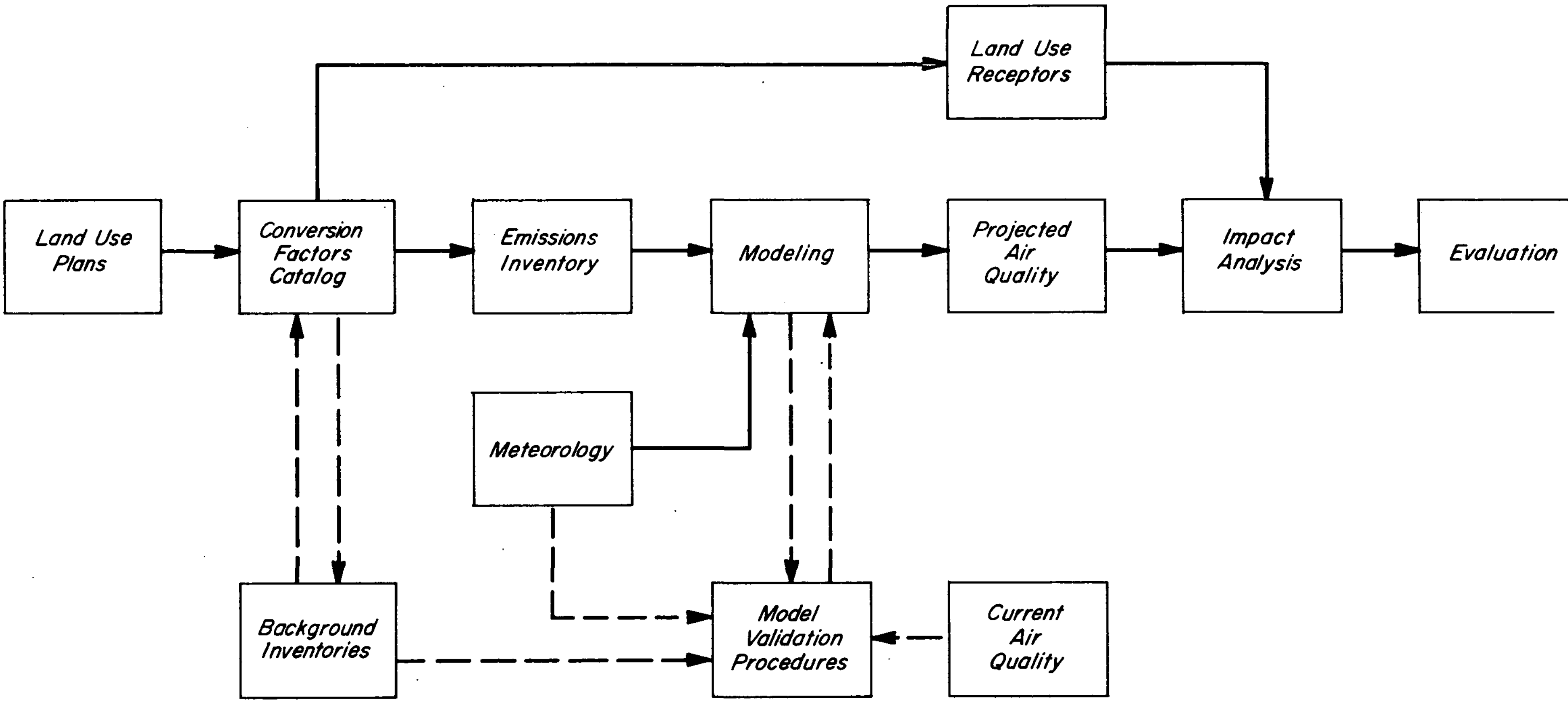

Figure I-2 AQUIP System Information Flow: Background Emission Inventories

2.2 Requirements Due To Modeling

The diffusion model (MARTIK)[1,2] used in this study accepts data on emission rates for discrete point, line and area sources. Point sources can be defined as major single emitters termed significant by the particular criteria of the study. Line sources represent mobile emissions characterized by highway or other transportation line segments that are similarly of significance according to the criteria of the study. All other individual sources of emission and mobile sources, together with general area-wide sources (such as home heating) are aggregated into area grid cells. The emission rate for any one grid cell is assumed to be uniform over its area and is the sum of all contributing sources contained within that cell.

The criteria for deciding what sources should be point, line, or area specific were determined in conjunction with the modeling requirements for this study. This approach greatly determined the form and content of the emissions inventories developed. Furthermore, the area-wide sources assigned to grid cells are, by definition, the residual of total emissions minus the specific point and line sources. It should be stressed that the emissions inventories used were in response to the specific study objectives and constraints and were not designed to improve our knowledge of total emissions in the New York area or for any other purposes outside the scope of the study.

2.2.1 Scale of Analysis

The scale of analysis to be undertaken is a function of both the model requirements and the availability of information. Stated simply, if the model could distinguish among all sources of emissions and if every source could be identified uniquely, both the data and the corresponding results would be more accurate. However, a point of diminishing returns is rapidly reached in terms of the amount of information that the model can accurately reflect on a small scale basis and the cost of obtaining and using that information. It was hoped that at least two different scales of analysis could be identified in the existing emissions inventories so as to test out the question of accuracy in emissions estimation. One scale was to have consisted of the EPA 1965-1966 Regional Abatement Inventory[3,4] while the other was to have been a more detailed assessment of current emissions prepared as a part of the study. The availability of information was such that no reasonable comparative analysis could be made relative to present air quality; therefore, it was necessary to make the assessment based upon an incomplete current inventory and its comparison to the current air quality.

2.2.2 Criteria For Grid Size Selection

The selection of a grid size for area source modeling depends upon many factors including accuracy of the diffusion model, emissions inventory data, and the meteorological, topographical and climatological features of the region under study. It was felt that a grid size much below 2,000 ft. on a side would tend to overpower the model while not yielding more accurate results. Further, grid sizes much smaller than the zone sizes of the original land use and planning data can lead to misleading conclusions in terms of data accuracy.

The 1 km grid system established by the Meadowlands Commission served as a base for all future grid cell decisions. Grid cells used for the area source inventories were always multiples of this system. Improved data for the area sources for the region surrounding the Meadowlands would have allowed investigation of a grid system for that area in more detail; however, it is not possible to conclude how much this would have increased the accuracy of the analysis.

One aspect of the validation analysis was to define the region of influence for the Meadowlands area. Based upon the availability of information, the 17 county New York Abatement Region[3,4] was defined as the initial area for analysis with the assumption that some influence from the Philadelphia area might be required. The data available from the 17 county region was not accurate enough in practice to warrant selecting a subsection of the 17 county area for use in 1990. Therefore, the entire 17 county region was used as the influence region for both the current and 1990 analysis.

Sensitivity tests showed that the influence of the Philadelphia area would not be significant. Furthermore, the degree to which this influence could be specified would not have significantly increased the accuracy of the analysis. Figure I-3 shows the 17 county influence region while Figure I-4 shows the area source grid cell system to which the influence region data were assigned.

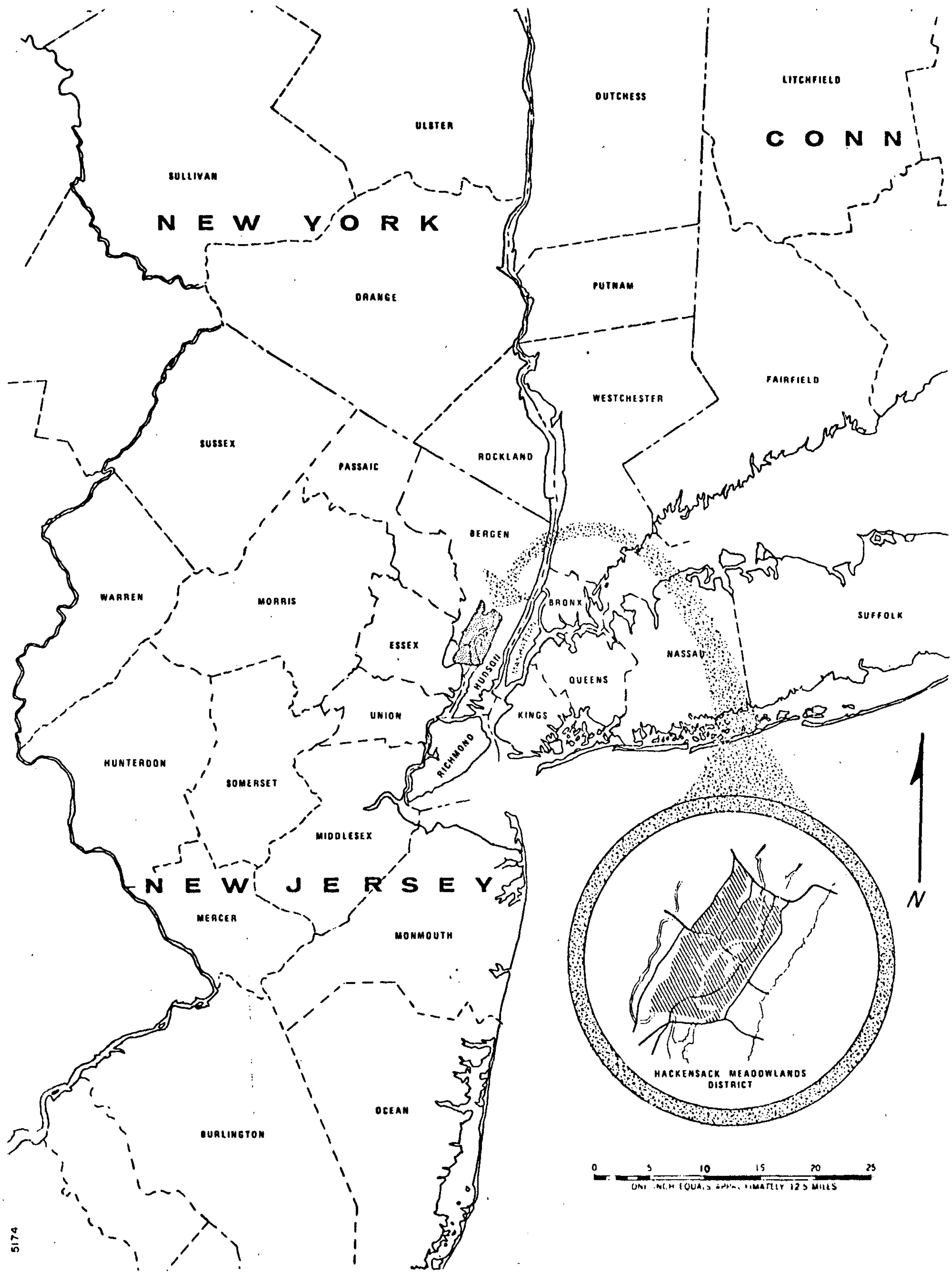

Figure I-3 Seventeen County Influence Region

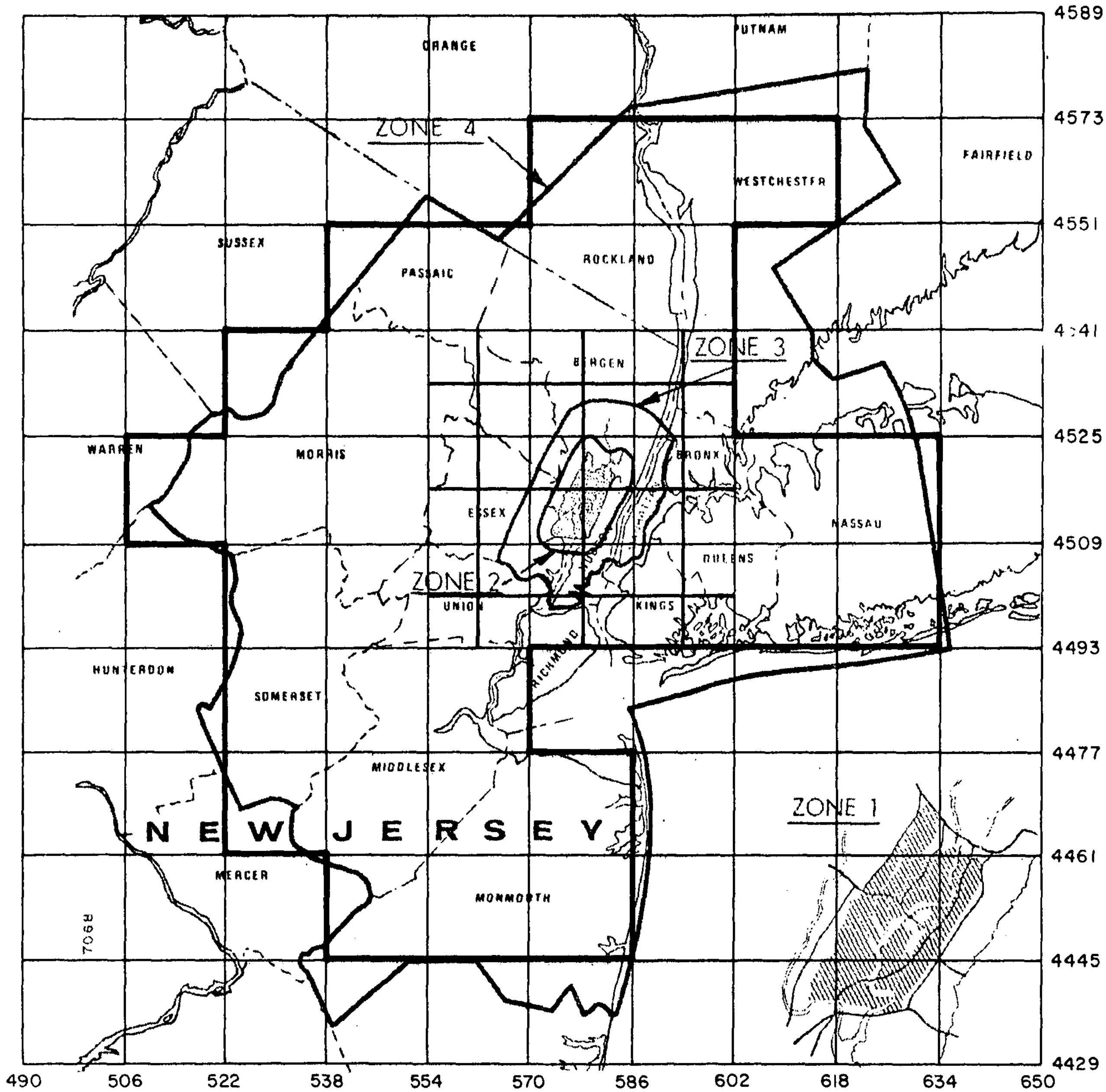

Figure I-4 Area Source Grid System

3. REGULATIONS AND CONTROL TECHNOLOGY

3.1 Role of Control Technology

One of the important peripheral aspects of this study was the examination of control technology as it would influence emissions for 1990. Because of the enormous scope of such a task it was necessary to make a number of simplifying assumptions at the outset. First, changes in the actual level of activity or production of emission sources were made only according to available information from planning, commerce, and air pollution agencies. No attempt was made to analyze changes in manufacturing processes as they would influence emissions (definitely outside the scope of this study).

Secondly, changes in habits or patterns such as the amount of heat that would be required per square foot for a dwelling or an office building were made only where it was strongly evident. Otherwise a conservative approach was used and the heat requirement that was found for the current inventory was carried forward to 1990.

Thirdly, changes in overall fuel use patterns were again made with conservatism. Major shifts such as from coal to oil and gas were naturally taken into account. However, unless there was strong evidence to the contrary the fuel use propensity for individual sources was kept the same in 1990 as found in 1969. For new sources and particularly for sources resulting from the Meadowlands Plans, logical design fuels were assigned. The most important assumption was that there would not be as drastic a switch to natural gas as has been suggested by numerous sources. This switch was tempered in our analysis due to more recent appraisals of the supply. Sulfur content of fuels burned in the study area has major direct effect on the determination of sulfur dioxide emissions. The 1968 New Jersey sulfur regulations were used for all calculations of the current inventory. This consists of anthracite coal .7% sulfur, bituminous coal 1% sulfur, residual oil 1% sulfur and distillate oil .7% sulfur. For all sources in New York and Connecticut, EPA had used the most applicable sulfur contents in calculating the emissions for their regional update inventory[5]. These emissions were used directly in this study. In calculating the 1990 emissions the appropriate sulfur regulations for the State of New Jersey as promulgated were used in determining 1990 emission factors.

Fourthly, in determining emission factors for 1990 published feasible control technology for fuel burning was used wherever appropriate. However, process control for that time period is unclear and more of a problem to incorporate into the emission factors for several reasons. In many cases the appropriate indices for determining process rate are not available. Furthermore, new emission regulations for processes were being promulgated while the study was being conducted, but were not yet available at the time decisions had to be made. Therefore, a proportional reduction emission factor for sources that exist now was used in consultation with the appropriate air pollution agencies and a proportion of the fuel emissions was applied for industrial separate process sources occurring as a result of the Meadowlands Plans. As the requisite information becomes available it can be incorporated into the procedures and into the data sets of the AQUIP system.

Fifthly, it was necessary to derive default stack height and plume rise values for numerous fuel and process stacks in the current inventory. Furthermore, for 1990 with the exception of power plant design parameters, it was necessary to rely on the existing stack height and plume rise values adjusted for an increase in plume rise of approximately 20% where a default values was necessary.

In summary, it was possible to incorporate the latest control technology only insofar as it could be determined for the fuel emission factors, as explained in the literature. There were insufficient data to adequately assess process emissions control and we did not examine changes in manufacturing processes themselves were not examined, this being beyond the scope of this study.

3.2 Emission Control Regulations

Various federal, state and local air pollution agencies have promulgated or will be promulgating emission control regulations. These limit the amount of effluent that may be released from a stack under various conditions. It is possible for a future time period such as 1990 that with the most appropriate emission factors and control technology information a source may still not meet the applicable emission control regulations. Therefore, it is important to include as a final step in the emissions projection methodology a check against applicable emission control regulations. If the emissions as determined do not meet regulations then a feed back loop in the process becomes necessary to re-determine activities or fuel.

As a part of the study, therefore, it was necessary to determine the applicable emission control regulations affecting the Meadowlands and the influence region. As a result of the available information the existing or proposed regulations as of August 1971 were used as representative of 1990 control, thereby unavoidably introducing a weakness into the analysis. It should be recognized that several of the involved federal, state and local agencies are presently contemplating changing their emission regulations and certainly new regulations will be promulgated in the future. However, it was beyond the scope of this study to try to determine the nature of these possible regulations. As a part of any future analysis the appropriate emission control regulations should be updated to reflect the most recent information.

There are six major jurisdictions that formulate and enforce emission control regulations in the study area. These are Federal, State of New Jersey, State of New York, New York City, State of Connecticut, and the Hackensack Meadowlands Commission. Because the Hackensack Meadowlands Commission regulations had not been finalized at the time of analysis and because they dealt with density controls, it was decided to use only the applicable New Jersey regulations for that area. Unfortunately there is a pyramiding effect in the areas controlled by the respective agencies. Local agencies have jurisdiction over the immediate vicinity, state agencies over the entire state, including the local areas, and the federal agency has jurisdiction over the entire 17 county region. Accordingly, a particular source such as a power plant in New York City may be subject to the emission control regulations of at least three jurisdictions. It is likewise possible for a single agency to have more than one regulation affecting the emission of any particular pollutant from a specific source.

3.2.1 Quantifying the Regulations

An emission standard or control regulation is a limit on the amount of a pollutant emitted from a source. The concentration in the effluent may be stated subjectively in terms of its appearance to the observer or objectively in terms of the stack height or rated heat input. Subjective standards based on visual measurements could not be analyzed in this study since the regulation could not be quantified for comparison purposes. Since fuel regulations are incorporated into the emission factor analysis those regulations which can be tested for 1990 are those which directly limit emissions based on weight or volumetric bases. Accordingly, the respective emission control regulations of the Federal government, the States of New York, New Jersey and Connecticut and the City of New York were analyzed to determine the applicable regulations based on weight or volumetric consideration.

It was found that the regulations promulgated by the various agencies for the same pollutant often consider a different parameter as the basis for control. For instance, particulate emissions may be regulated based on indices of stack height, distance from property line, boiler capacity, percent of exit gas volume or weight of the gas. Because of the great variation in the regulations and in the manner in which they are stated a number of simplifications and definitions were made for the purpose of the analysis.

1. An emission control regulation or standard is a mechanism which controls the emission of one of the five major air pollutants by restriction based on some characteristic of the source. For the purpose of this study the regulations quantify the restriction.

2. Restrictions on fuel composition (specifically on the content of sulfur) are not considered to be emission regulations per se and are incorporated into the 1990 emission factors.

3. Regulations on the opacity of smoke which generally employ the Ringelmann Charts are not considered emission regulations although they may indirectly control particulates. Opacity cannot be quantified for use. Furthermore, many factors besides particulate emissions can and do effect the use of opacity charts.

3.2.2 Applicable Regulations

When these various problems and assumptions were taken into account twenty-seven regulations were found to be appropriate for consideration in the study. These are summarized in Figure I-5. The regulations were discussed at the Milestone 5 meeting* and the following decisions made. All federal regulations were eliminated from analysis under the assumption that the appropriate state regulations were more stringent and therefore should supersede the federal regulations. Secondly, a number of regulations were eliminated from further consideration because no sources existed in the inventory to which the regulations would apply. The remaining regulations were analyzed in greater detail to determine the ability to quantify their restrictions and to use them in the study.

Unfortunately, the remaining three regulations applying to the State of New Jersey were found to be inappropriate for analysis because insufficient data were available through the emission inventory to assess whether or not the particular sources could meet the emission control regulation. These regulations require a great deal of detailed information about the particular source and in most cases cannot be assessed adequately without stack testing. In brief there was not sufficient information in the current point source inventory to allow accurate analysis of the regulations. Therefore, it would be impossible to try to project parameters forward to 1990 to test the regulations. Furthermore, the type of averaged parameters that can be estimated for point sources occurring in the Meadowlands do not lend themselves at all to this type of analysis.

* A series of Milestone meetings were held throughout the study between EPA, NJDEP, and ERT to review progress and approve aspects of both the approach and data used. Many decisions stated herein are a result of these meetings.

FIGURE I-5

Emission Control Regulations

Pollutant	Jurisdiction	Regulation	Sources	Analysis
Particulates	Federal	Sect. 3.4.1	Fuel Burning (Solid)	No*
Particulates	Federal	Sect. 3.4.21	Fuel Burning (Oil)	No*
Particulates	Federal	Sect. 3.5.1	Process	No*
Particulates	Federal	Sect. 3.3.1	Incineration	No*
Particulates	N.J.	Sect. 5.2.1	Solid Fuel	None in 1990, assumed
Particulates	N.J.	Sect. 7.2.15 & .16	Process	Insufficient data: rate
Particulates	N.J.	Sect. 11.1	Incineration	Insufficient data: exhaust volume
Particulates	N.Y.	Sect. 202.2	Solid Fuel, power	None in 1990, assumed
Particulates	N.Y.	Sect. 187.3a	Process	None in inventory
Particulates	N.Y.	Sect. 194.4	Incineration	Yes
Particulates	N.Y.	Sect. 188.3	Ferrous Jobbing Foundaries	None in inventory
Particulates	N.Y.C.	Sect. 1403.2-9.09 (a)(2)	Fuel Burning	Yes
Particulates	N.Y.C.	Sect. 1403.2-9.23	Process	None in inventory
Particulates	N.Y.C.	Sect. 1403.2-9.09 (a)(1)	Incineration	Yes
Particulates	Conn.	Sect. 19-13 G38	Fuel Burning	Yes
Particulates	Conn.	Sect. 19-13 B32	Process	None in inventory
Particulates	Conn.	Sect. 19-13 G16a	Incineration	None in inventory
Sulfur Oxides	Federal	Sect. 4.12	Fuel Burning	No*
Sulfur Oxides	Federal	Sect. 4.1.3	Refineries	No*
Sulfur Oxides	Federal	Sect. 4.2.1	Sulfuric Acid Plants	No*
Sulfur Oxides	Federal	Sect. 4.4.1	Nonferrous Smelters	No*
Sulfur Oxides	Federal	Sect. 4.5.1	Sulphyte Pulp Mills	No*
Sulfur Oxides	N.J.	Sect. 8.22 (a) & (b)	Sulfur Compounds	Insufficient data: stack
Sulfur Oxides	N.Y.C.	Sect. 1403.2-9.07b	Fuel Burning	Yes
Sulfur Oxides	N.Y.C.	Sect. 1403.2-9.07(a)	Processes	None in inventory
Oxides of Nitrogen	Federal	Sect. 7.1.1-7.12	Fuel Burning	No*
Oxides of Nitrogen	N.Y.C.	Sect. 1403.2-9.13	Fuel Burning	Yes

*Agreed upon between ERT, EPA, and NJDEP not to consider any federal regulations.

3.2.3 Regulations Tested

As a result of these decisions six regulations were chosen as appropriate for analysis. Four of these regulations concerned particulates and one each for sulfur oxides and oxides of nitrogen. Three of the regulations concerned fuel burning in New York City (for particulates, sulfur oxides and nitrogen oxides). The remaining three regulations affecting particulates were for New York City incineration, incineration for the remaining counties of New York State within the study area, and fuel burning in Connecticut.

Since the greatest efforts of the study were concentrated on New Jersey sources, particularly point sources, the information available to test the regulations for New York and Connecticut was not as good as might be hoped for. Furthermore, the projection methodology to determine 1990 point sources was also concentrated on the New Jersey area and, therefore, 1990 point source decisions for New York and Connecticut were based predominately on exogenous factors and existing data extrapolated forward to 1990. In particular, this includes the power plant and incinerator projections made independently from the projection methodology due to the special expertise of the study team in these areas.

3.2.4 Summary of Findings

The actual comparison of the six regulations to the appropriate point sources is discussed under the area on background point sources. However, the following points should be made in summary:

1. In no case could a satisfactory comparison be made resulting in a yes or no decision as to whether a source would meet an emission control regulation.

2. In no case were the available data sufficient to characterize the individual point source to the level of detail required by the regulations.

3. The relationship of annual fuel use to the number of hours of operation as expressed in the regulations is inconsistent with the form of the data in the inventory.

4. The use of average emission factors may not be representative of a particular source.

5. The use of existing stack parameters for projected sources when no other information is available skews the analysis further.

6. When all possible margin of error is taken into account it would appear that several New York City power plants may not meet the NO_x emission control regulations. However, it is not possible to make a definitive statement due to the inaccuracies of the data available relative to the analysis requirements.

3.3 Air Quality Standards

One of the major tasks of the study was to examine the air quality resulting from each of the four plans for the Hackensack Meadowlands relative to the appropriate air quality standards. Both federal and state standards have been established for each of the five pollutants. As a result of the Milestone 4 meeting it was determined that the New Jersey State standards would have precedent and that Federal standards would be used only if the New Jersey standards were inappropriate to the time period modeled. Since the modeled air quality represents an annual arithmetic mean (or a seasonal arithmetic mean) it was determined that the only standard for which comparisons could be made would be the annual arithmetic mean. Unfortunately, the standards that have been promulgated are for various time averaging periods as shown in Figure I-6.

FIGURE I-6

Derivation of Air Quality Standards

	μg/m³												Annual Geom. Mean			Annual Arith. Mean			Baseline and Jurisdiction		Annual Arith Mean *	
	1-hr. max			3-hr. max			8-hr. max			24-hr. max											μg/m³	p.p.m.
	P.	S.	N.J.	P.	S.	N.J.	P.	S.	N.J.	P.	S.	N.J.	P.	S.	N.J.	P.	S.	N.J.				
TSP										260.	150.	150.	75.	60.	65.				65.	N.J.	70.1	--
SO_2						468.				365.	260.	260.				80.	60.	53.	53.	N.J.	53.0	0.020
CO	40000.	40000.	15000.				10000.	10000.	10000.										10000.	N.J.	1425.0	1.250
HC				160.	160.	160.													160.	Fed.	160.	0.24
NO_2										250.	250.					100.	100.	100.	100.	N.J.	100.0	0.053

NOTES:

P = Federal primary standard
S = Federal secondary standard
Federal primary and secondary maxima may be exceeded once per year;
New Jersey maxima may be attained once.

Baseline values are in μg/m³ and are for verifying averaging periods as follows:

TSP	annual geometric mean
SO_2	annual arithmetic mean
CO	8-hr maximum
HC	3-hr maximum
NO_2	annual arithmetic mean

Annual arithmetic mean values for TSP and CO derived from above using Larson's model.

* Extrapolation of 3-hour standard to an annual average not considered valid.

It was therefore necessary to determine the appropriate baseline standards and then to translate these into the annual arithmetic mean standard.

As a result of the Milestone 4 meeting the following baseline standards were adopted:

- For particulates, the New Jersey annual geometric mean
- For sulfur dioxide, the New Jersey annual arithmetic mean
- For carbon monoxide, the New Jersey eight-hour maximum value
- For hydrocarbon, the federal secondary three-hour maximum value
- For nitrogen dioxide, the New Jersey annual arithmetic mean.

In each of the three cases where the baseline standard was not the annual arithmetic mean a standard procedure incorporating Larson's model[6] was to be used to calculate the annual arithmetic mean. Larson's model requires information on the standard deviation of measurements. Accordingly, information from recent New Jersey measurement programs was used to determine appropriate standard deviations. The last two columns in Figure I-6 show the annual arithmetic means to be used in the analysis, in terms of micrograms per cubic meter and parts per million.

The air quality standards did not enter into the emission inventory procedure directly in any way. Rather they were determined at this stage in the analysis for later use in assessing the impact of each of the land use plans on air quality.

4. DEVELOPMENT OF THE METHODOLOGY

4.1 General Philosophy

Air pollutant emissions are generally determined as multiple or area sources because: 1) it is not possible to survey all single source emitters individually; 2) for most modeling and control purposes many small sources can be treated as one area-wide source; and 3) the data handling and modeling procedures have practical limits on the total number of sources to be considered. Furthermore, when future sources of pollution are considered, projective data does not usually exist to handle emissions on a single source basis. In fact, land use planners rarely deal with information that would indicate individual sources of pollution. Rather, they are concerned with general zones of land use which may or may not be sources of pollution.

Accordingly, there is no correct scale or scope of analysis for area source data. Flexibility is needed for updating, for cell aggregation and disaggregation, conversion to single source information, and computerized interfacing for the uses desired, such as modeling. In traditional approaches to emission inventories[7], area-wide sources have generally been based too heavily on population variables with emissions allocated to grid cells on a gross scale.

4.1.1 Development of New Approaches

More reliable and detailed area-wide emission inventories can be developed utilizing available socio-economic and planning data, including the censuses of population, housing, manufacturing and fuel use. Further, a computerized system can be used to allocate the emissions to grid cells of varying size.

Such techniques are aptly suited to continuous updating and projecting analyses. Area source emissions can be categorized as to whether they are population and housing or employment related. For instance, residential space heating is housing related; commercial activities may fall into two types: central area clustering related to employment and localized scattering related to population. Industrial activities, exclusive of those emitters considered to be point sources, are related to industrial employment. Institutional emissions may be population related with the exception of major institutional complexes which are handled in a manner similar to commercial clustering. Finally, the information may be melded into a continuously updated inventory on the most consistent data base possible, generally by counties, cities and often by census tracts in the central part of the region.

By orienting our thinking to such procedures for current emission inventories we are in a much better position to develop techniques for future emission inventories. This is because future inventories must depend directly upon planning related data. Furthermore, it is only through an excellent understanding of the relationship between planning and emissions for current inventories that the necessary conversion factors can be developed to project future emissions.

Too often emission inventories are tied heavily to the grid cell used for modeling purposes. Much of the original information by land use zones or political jurisdiction is lost in the process of transferring to the grid system. The grid cell size cannot be changed at a later date for different purposes and a great deal of manual input of data must be undertaken.

To avoid these problems, a powerful and innovative technique was developed to make the processing of information independent of grid size. The key to the technique is the initial listing of land use activities and characteristics in a computer data bank by geographical coordinates and land use zones. Emissions data for each land use zone are computed by referencing the conversion factors catalog. Finally, any specified grid size can be superimposed and the emissions contained within each grid cell calculated.

If changes are desired in the initial land use data or if a different grid cell system is desired incremental changes can be made without destroying the entire data system. Such a system provides for the maximum in updating and flexibility of use.

4.1.2 Constraints

To put such a philosophy into practice requires assumptions and compromises: the data may not be available according to the land use zones and political jurisdictions desired; many of the parameters necessary for the conversion factors catalog may be missing from the data base. The flexibility of the system is essential in the first case. Since any size land use zone and any grid cell size can be used, information can initially be coded by large jurisdictions, such as counties in a regional analysis. When more detailed information becomes available on a town or census tract basis, this information can be incorporated and more detailed values assigned to any arbitrary grid system.

For missing data the concept of "default parameters" was developed. If information is desired according to an industrial classification (such as the 4-digit SIC code) for the propensity to use different fuels and the data are only available as a total for all industries in the region, a default parameter is used to assign the industry-wide factor to each individual industry. If, at a later date, specific information for an industry is known, it can be used in place of the default parameter.

The development of the conversion factors catalog itself requires a great deal of analysis since numerous steps are involved to translate activities into emissions. These steps vary according to the land use code. Some activities produce fuel emissions whereas others produce only non-fuel or process emissions.

Finally, the step by step procedures and checking methods required to develop and verify the default parameters involve careful coordination between existing data and future requirements.

4.2 Use of a Multi-Step Approach

The first step in developing an emission projection methodology useful to planners involved identifying the major requirements or constraints of the methodology. Four broad requirements were defined as follows:

1. All procedures should be compatible with both the planning-related data (inputs) and the diffusion modeling formats (outputs).

2. All assumptions should be applicable to other situations and not specific to the Meadowlands; likewise, the scale of analysis should be sensitive to individual land use activities and not just to overall development plans.

3. All data needed for future time periods should be derivable from existing information, unless normally supplied by planners.

4. All assumptions and constraints should be updatable as new information becomes available.

The first requirement was the most important. Land use and transportation planning data are typically in the form of:

1. Parcels of land of arbitrary size and shape, with their associated permitted uses and densities of development.

2. Tables of statistics (such as employment projections by industrial category), capital improvement plans and other non-spatial information.

3. Vehicular travel (assigned to network links or aggregated by zones). In all cases a "level of activity" is specified or implied; however, this may give little indication of the pollution-generating potential of the activity.

On the other hand the modified Martin-Tikvart diffusion model[1,2] used for the study requires the specification of point, line and area source locations together with their associated emission strengths and relevant stack dispersion data. The procedures, therefore, must be capable of transforming the land use and transportation planning data - representing levels of activities for oddly shaped land use zones, specific point locations, and highway links - into emission strengths for any configuration of area source grid cells required by the diffusion model, and for those individual point and line sources not aggregated into these area cells. Ideally, source emission "size criteria", used to determine which points and lines are treated separately and which are aggregated into area cells, should be completely responsive to the modeling decisions which govern the detail of the pollutant isopleths and be fixed during emission inventory development.

In many cases, emission inventories have been developed for a specific use as a function of the limited data available. As a second requirement of the study all decisions regarding procedures to be used were to preserve the adaptability of the techniques to other regions, to other development plans and time periods for the same region, and to the analysis of component activities of a land use plan as well as to overall comparison between plans. Because of the time and budget constraints of the study, this requirement demanded compromise: the sensitivity to component activities could not be analyzed and it is not possible to assess how readily translatable are all techniques.

The third requirement was the most complicated. In order to have a system that would require only planning-related data as routine input, all other data should take the form of "default parameters" which the planner would override only when he has more appropriate information for his region or time period. All of these parameters had to be estimated from available national data (as in the case of fuel and process emission factor trends for 1990) or be derived empirically from the existing emission inventories for the New York - New Jersey area (as in the case of the percent of fuel used for heating for each activity category).

To satisfy the last requirement it was necessary to have all assumptions and constraints fully disclosed and documented in this report and at the Milestone meetings, and all default parameters capable of modification or specification in greater detail by either activity category or geographical area. Most emission inventories have suffered from their static nature since 1) assumptions and procedures are not well explained; 2) new information cannot be incorporated into the inventory because of the aggregation procedures; and 3) accuracy tests can rarely be performed.

The nature of the procedures as defined and implemented tended to preserve this requirement. However, the particular development characteristics of the Meadowlands plans and the default parameters that had to be incorporated in response to these characteristics limit the dynamic aspects of the techniques.

4.2.1 Procedures for Determining Emissions

Research presently being conducted on procedures for estimating emissions from land use and transportation planning data often emphasizes empirical derivation of emission indices as a direct one-step function of activity categories. For this study, however, a multi-step approach was necessary, so that all assumptions and constraints involved in transforming the levels of activities into emission strengths could be examined, and the procedures for updating the default parameters specified.

In response to the four requirements identified above, a five-step procedure was formulated as shown in Figure I-7:

Step 1 - activities: For all land use and transportation planning data the level of activity is specified.

Step 2 - activity indices: For each category of activity, default parameters for determining fuel requirements are developed.

Step 3 - fuel use: For each category of activity (and geographical area) default parameters for the propensity to use different fuels are applied to the fuel requirements.

Step 4 - emission factors: For each category of activity, engineering estimates of fuel and process source emission factors are developed and applied to fuel use and process rates.

Step 5 - emissions: Emissions calculated from fuel and process sources are adjusted for seasons, based on temperature variation (degree days) and default parameters representing the percent of fuel used for heating purposes.

Furthermore, a two-phase procedure was employed as portrayed in Figure I-8. In the first phase current planning data and current fuel use are correlated to produce projecting indices. In the second phase these projecting indices are modified to reflect future time periods and are applied

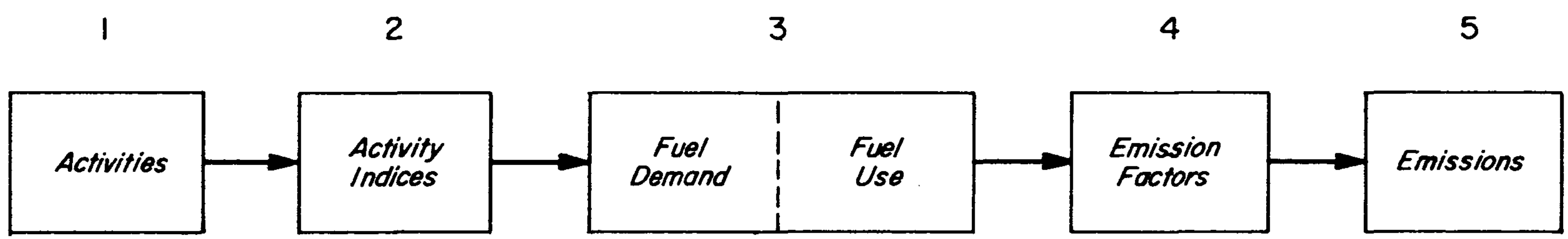

FIGURE I-7 FIVE STEPS TO DETERMINE EMISSIONS FROM ACTIVITIES

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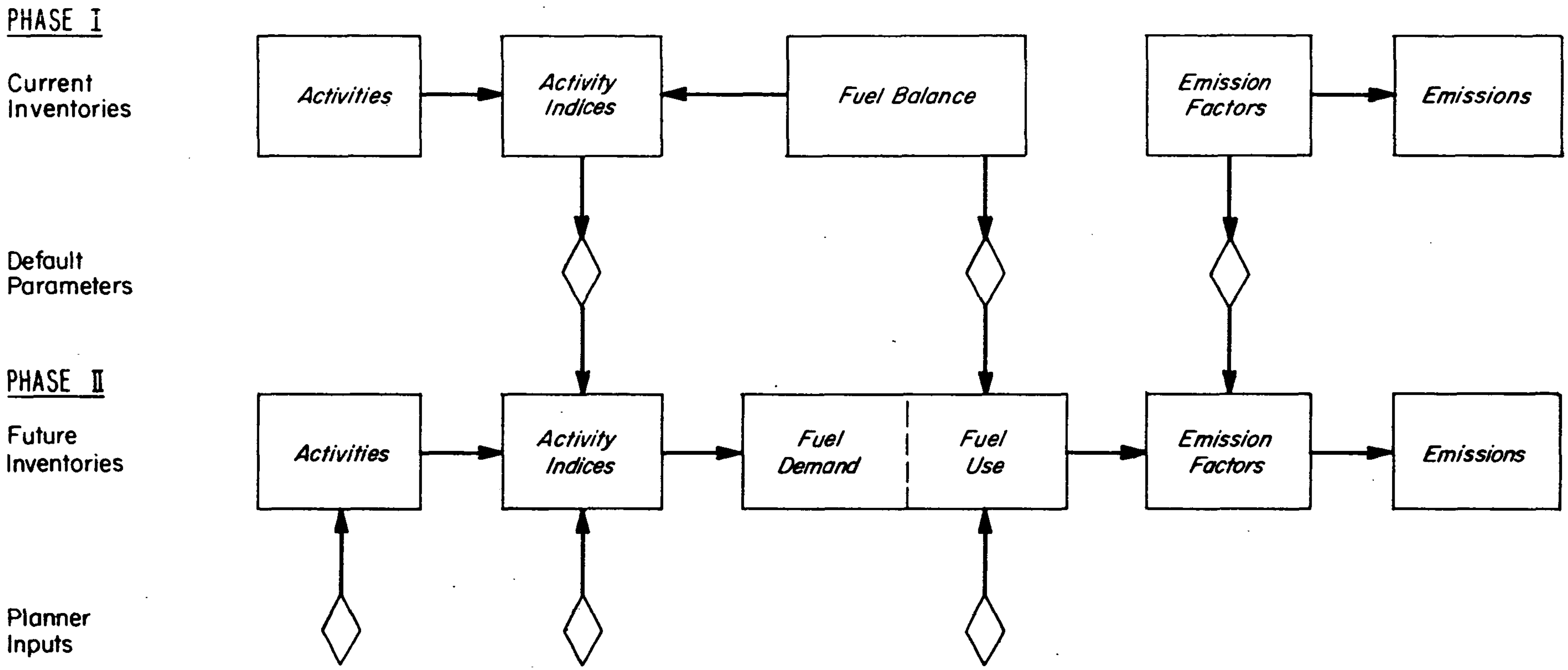


Figure I-8 Two Phases to Projecting Emissions to planning data so as to generate future fuel demand and emission levels.

Current data on fuel use and emission factors are likewise used to predict future information. The Phase I analysis provides the majority of the default parameters to be used in Phase II in conjunction with the planner inputs. Phase I and Phase II can actually represent the same time period if an iterative process is used.

4.2.2 Examples of the Procedures

Examples of the information needed to proceed from activities to emissions are illustrated in Figure I-9. The three examples show, respectively, 1) a residential land use zone represented as an area source; 2) an industrial activity represented as a point source; and 3) a highway segment represented as a line source. The upper row of boxes deals with the kind of information that the planner must provide; the next row summarizes some of the necessary default parameters; and the bottom rows show typical dimensional units for each step. In practice a conversion must be made in the last step to the dimensional units required by the diffusion model.

First, looking specifically at the residential land use category shown in Figure I-9 there are several planning inputs that are required:

Step 1: The density and acreage can be used to determine the number of dwelling units.

Step 2: The average number of rooms and type of dwelling unit can be used to determine the heating requirement per dwelling unit.

Step 3: The mix of single family homes, town houses and apartments can be used to determine what fuels will be burned and with what size equipment.

Figure I-9

Examples of Steps in Determining Emissions

	Step 1 Activities	Step 2 Activity Indices	Step 3 Fuel Demand: Fuel Use	Step 4 Emission Factors	Step 5 Emissions
Planner Inputs					
i) area	dwelling units per acre	rooms per dwelling unit	type of development		
ii) point	sq.ft. of industrial floor space	floors per building	type of development		
iii) line	number of vehicles	n.a.	n.a.		
Default Parameters					
i) area		BTU per dwelling unit	type of fuel used	factors by fuel type	
ii) point		BTU per sq.ft.;% fuel for space heat	type of fuel used	factors by fuel and process type	
iii) line		n.a.	n.a.	factors by vehicle type	
Dimensional Units used in the study					
i) area	d.u./acre	x BTU/d.u.	= BTU/acre : gal./acre	x lbs/gal	= lbs/acre
ii) point	sq.ft.	x BTU/sq.ft.	= BTU : gal.	x lbs/gal	= lbs
iii) line	veh.	n.a.	n.a.	x lbs/veh-mi.	= lbs/mi.
Corresponding metric Dimensional units					
i) area	d.u./km^2	x Cal./d.u.	= Cal./km^2 :liter/km^2	x g/liter	= g/km^2
ii) point	m^2	x Cal./m^2	= Cal. :liter	x g/liter	= g
iii) line	veh.	x n.a.	n.a.	x g/veh-km	= g/km

The examples shown are for

i) area - a residential land use zone
ii) point - an industrial activity
iii) line - a highway segment

BTU is British Thermal Units, a measure of heating requirements.
The dimensional analysis assumes the use of fuel oil for heating.

Note: the terms 'dwelling unit' and 'housing unit' are used interchangeably in this study.

n.a. = not applicable.

Neither the planning nor emissions inventory data given to use for our study were in metric units; therefore, we have used the original units throughout this report since conversion of all data was outside the scope of the study.

Several default parameters may also be required, as shown in Step 2. Current data on activity levels and fuel use can be used to calculate a default parameter for heating demand - British thermal units (or Calories) per dwelling unit (BTU/d.u.); this value can be adjusted for a future time period and for differences between residential categories, particularly for the number of rooms per dwelling unit. In practice, the results of the first phase -- empirically deriving parameters from the existing data -- may not be conclusive; engineering judgement may be very important in determining the actual values to be used in the second phase which is concerned with the future time period.

The level of activity shown in Step 1 (d.u./acre) is multiplied times the activity index shown in Step 2 (BTU/d.u.) to produce the fuel demand for the residential land use zone shown in Step 3 (BTU/acre). It is then necessary to answer several important questions concerning how this fuel demand will be satisfied:

1. What fuel will be used (oil, coal, gas, steam or electricity).

2. What other home activities in addition to heating will use the fuel (cooking, hot water).

3. What type of fuel-burning apparatus will be used (individual home heating, or a central heating system for several thousand dwelling units).

National or regional default parameters can usually be relied upon to answer the first two questions, but the third question is basically a planning decision. There is a significant trend towards centralized heating and cooling systems for reasons of economy in large-scale developments such as the Meadowlands. The governing factor is the scale of the individual development, particularly:

1. The density, which governs the number of units.

2. The clustering, which governs the heating distribution system necessary with central heating facilities.

3. The overall size, which governs whether a developer will put up the capital for a central system.

Finally, for each fuel and type of fuel burning equipment (individual house or central system), the appropriate EPA emission factors, as depicted in Step 4, are used to translate the amount of fuel burned into the quantity of emissions for various pollutants as represented by Step 5. The size of the fuel-burning installation determines which factors should be used and whether or not emission control devices are apt to be used.

4.2.3 Problems in Obtaining Data

For an industrial activity such as that shown as example 2 in Figure I-9, the problem may be more complex. For an existing major emitter represented as a point source, there may be adequate emissions information from a current inventory; however, neither the present level of activity nor projected changes in that level may be known. Conversely, planning information tends to deal with industries by broad categories and rarely with a specific firm and its characteristics which will influence the level of emissions at a particular location. The land use planner does work with parameters such as acres and lot coverage which can yield an estimate of the number of square feet of floor space for a new facility as shown in Step 1 of Figure I-9.

Empirically derived estimates of BTU's per square foot for heating purposes (Step 2) show great variation. Even greater variation is exhibited in the empirical data for the percent of fuel used by industries for heating; it may be 100% for a warehouse and close to zero for a foundry. Propensities to use different fuels (Step 3) may be empirically derived by industrial category, such as the 2-digit or 4-digit Standard Industrial Classification (SIC) adopted by the U.S. Census.

For example, in the first phase of the procedures existing fuel use data from the current emission inventories can be examined and homogeneous categories derived. These are then modified according to national, regional, and local trends, by category, and employed in the second phase to produce fuel use propensities for the appropriate future time period.

The least reliable information involves separate process emissions from industrial sources, such as the evaporation from a tank farm or area-wide solvent evaporation. Source emission inventories have generally been incomplete in this area; therefore, little empirical data are available from which to derive default parameters. Furthermore, where emission factors have been determined, they are related to process rate: the total quantity of material processed per unit time for the operation producing the emissions. Process rate has not as yet been correlated with parameters that are readily available to the planner; virtually no planning effort would include projections of process rate. Therefore, very crude default parameters have been developed in this study to relate process emission by activity category directly to fuel emissions or to activity level, such as employment. In general, if reasonable engineering data are not available for process emissions for a particular source, current land use planning based estimating procedures will not yield satisfactory results; the estimation procedures described here have been included in the analysis merely for completeness rather than for accuracy. Complete data by even the most detailed classification schemes, such as the 4-digit SIC code, will not solve the problem: both nitric and sulfuric acid plants can be found in the same 4-digit SIC category.

If an activity such as the industrial land use example shown in Figure I-9 reaches a certain scale, by virtue of its emissions, it should be considered a point source rather than an area source for modeling purposes. It is possible to determine default "size criteria" for each activity category to allow the planner to decide, objectively, whether a development should be considered a point source or not.

Example 3 in Figure I-9 shows the procedure for determining line source emissions from a highway network. Activities (Step 1) are multiplied directly by emission factors (Step 4) to produce emissions (Step 5). The emission factors vary by vehicle class: cars and light-duty trucks, heavy-duty gasoline trucks, and diesel trucks and buses; in addition certain pollutants vary with speed. Transportation planners routinely determine all of the activity data needed although not necessarily on a detailed basis; default parameters for vehicle class mix, model year mix and average speed can be used where local data are not available. Whether or not a particular traffic segment should be a line source or an area source can be determined by a "size criteria", based on vehicle miles per unit time.

The procedures to go from activity levels (Step 1) to emission strengths (Step 5) for all other activities represent combinations of and modifications to the three examples shown in Figure I-9. In many cases commercial, institutional or transportation activity emissions can be determined as a function of the residential activities they serve. This is particularly relevant when a planned development is involved, with apartments, offices, stores and parking areas built as one unit.

4.3 Current Inventory Data

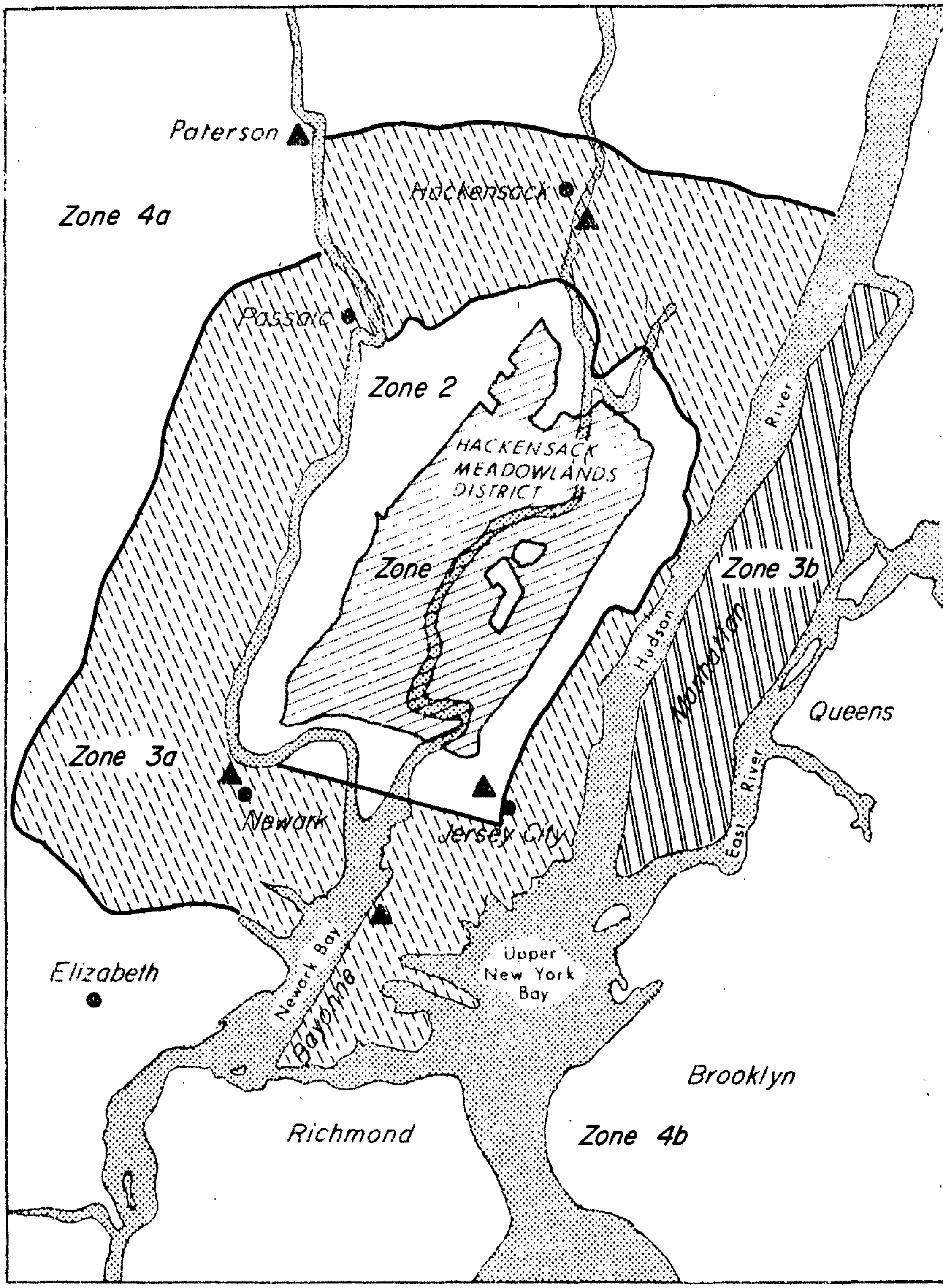
The current emission inventory was developed for three very specific purposes: 1) validation of the model for the Meadowlands area; 2) as a basis for the background inventory to be used for 1990; and 3) as a basis for developing activity and default parameters to be used with the Meadowlands plans.

The first purpose required the most detailed spatial information, since the accuracy of the emissions inventory determines in large part the success of the validation procedure. The first decision to be made involved the size of the region to be inventoried. This was governed mainly by the availability of information for a 17 county area around New York City[3,4] and formed the boundary of the initial influence region.

The second decision involved the detail of data to be gathered within this region. There were three criteria to consider: 1) the availability of information; 2) the requirements of the model; and 3) the necessity of having accuracy to validate the model and to characterize future emissions in and around the Meadowlands.

4.3.1 Zones of Analysis

Accordingly the region was divided into several zones approximating concentric circles around the Meadowlands. For each zone a differing level of detail for data gathering was assigned. Figure I-10 shows the analysis zones derived for the current inventory. In brief, zone 1 is the Meadowlands district; the zone 2 boundary is approximately 1 mile outside the Meadowlands - it is defined by town boundaries everywhere except to the south in the cities of Newark and Jersey City; the zone 3 boundary is a circle approximately 5 miles



▲ Validation Sites

Note: Actual boundaries between zones usually followed town boundaries; they were developed only to define differing levels of detail and have no physical or political significance.

Figure I-10 Analysis Zones for Current Inventory outside the Meadowlands - it also is defined by town lines and includes only Manhattan in the New York part of the region; finally, zone 4 includes all of the remaining parts of New Jersey and New York contained within the 17 county abatement region.

4.3.2 Initial Criteria

Separate rules were established for point, line and area sources fo. each of these zones. The criteria proposed for point sources were reviewed at the Milestone 4 meeting and agreed upon by EPA and NJDEP. They were based upon several general rules for selection including: 1) that all significant point sources within and immediately surrounding the Meadowlands would be treated as point sources; 2) that a point of diminishing returns concerning model accuracy is reached when approximately 100 separate point sources are considered; and 3) beyond about 5 miles from the Meadowlands boundary the specification of individual stack parameters is no longer important to model accuracy within the Meadowlands. At that time the selection rules for point sources were tentatively given as follows:

1. For zone 1 all sources with rates greater than 100 tons per year for any one single pollutant would be considered. For sources with multiple stacks having different stack parameters,separate point sources would be specified.

2. For zone 2 the criteria would be the same as zone 1, except that all stacks for a plant would be aggregated into one source using major stack parameters.

3. For zone 3 the same criteria as zone 2,except that much of the data would have to be estimated and the cutoff for the point sources might be raised to 200 tons per year.

4. Zone 3B, a separate part of zone 3, was defined for Manhattan; the criteria were the same as for New Jersey zone 3, except that the cutoff would be 500 tons per year. This was determined for two reasons:

a) The area sources for Manhattan have much greater emissions than other areas of equal size; therefore, 100 tons per year is less significant as a point source in relation to the area source density; and

b) There are a manageable number of point sources in Manhattan greater than 500 tons per year but too many greater than 100 tons for the model to handle reasonably.

5. For zone 4A, the remainder of Bergen, Passaic, Essex and Union counties, a point source cutoff of 500 tons per year would be used.

6. For zone 4B, the remainder of the 17 county region plus the Connecticut area of the Air Quality Control Region (as of 1969), a cutoff of 1,000 tons per year would be used. Only point sources in Connecticut were considered in the analysis.

The criteria established for line sources were as follows:

1. For zones 1 and 2 all major highway links as provided by the New Jersey Department of Transportation would be considered as separate line sources.

2. For zones 3 and 4 all transportation emissions would be treated as a part of the area source data.

Finally, the tentative criteria for area sources were defined as follows:

1. For zone 1, within the Meadowlands, emissions would be handled on a scale of approximately 1 km cells.

2. For zone 2 emissions would be projected from Tri-State Transportation Commission data on a one square mile basis or from census tract information.

3. For zone 3 emissions would be developed from data by townships or

the one square mile grid; special procedures would be developed for Manhattan if necessary.

4. For zone 4 emissions would be grouped according to counties.

4.3.3 Final Criteria

As the development of the current emission inventories and determination of the validation procedures progressed, a number of modifications to these tentative criteria had to be made. For point sources very few cases were found in zones 2 and 3 where data existed for more than one stack group for a single source; therefore, all information was used separately and no data were aggregated to a single stack for a particular source. Furthermore, there were so few sources in the 100 to 200 ton range that the 100 ton criterion was kept for all of zones 1 through 3.

For area sources, based upon computer running times and efficiencies as well as availability of information on a sub-county level, it was determined that the following breakdown would be more useful:

1. For zones 1, 2, and part of 3, 2 km grid cells would be used, with the option of using 1 km cells where emission density variation warranted their use.

2. For the remainder of zone 3 and part of zone 4, 8 km cells would be used.

3. For the outer parts of zone 4, 16 km cells.

When the final validation runs were made only the 8 and 16 km cells were used for several reasons: 1) The initial runs had shown the area sources to be a very small part of the total emissions. When this was later found to be questionable, there was not sufficient time to assemble census and one square mile data to develop accurate 2 km grid cell area sources. 2) Reason-

able current data did not exist at the sub-county level; it was not meaningful to allocate the county data below approximately an 8 km grid size.
3) Sensitivity tests with the model were inconclusive as to the effect the smaller grid cells would have on the validation sites.

Figure I-4 shows the actual area source grid used for the current inventory runs. Figure I-11 summarizes both the criteria used for point source determination and the number of separate point sources found. For New Jersey the separate stack groups are also noted. All but 34 of these point sources fall within the 8 km area source region shown in Figure I-4; 17 fall outside in New Jersey and 17 in New York.

4.3.4 General Approach

The current inventory as developed for use with the Meadowlands study is very much a function of the available information and the specific requirements for validation. Further, it represents a point in time for a specific region and, therefore, it is difficult to translate more than the general criteria to other regions. However, the three main criteria used - the availability of information, the requirements of the model used,and the development of sufficient accuracy for both the validation sites and to characterize the areas in and around the immediate study area - will hold for any region studied.

4.4 Background Inventory Criteria

The criteria used to develop the background emissions inventory were a logical outgrowth of those used with the current inventory. In developing the current inventory only emissions data already available from federal, state, and local authorities were used. New sources for which data did not exist were not inventoried, nor were fuel use or separate process emissions

FIGURE I-11

Current Inventory Point Source Criteria

Criteria		Number of Sources				
		N.J.	(stack groups)	N.Y.City	New York State & Conn.	Total
Zone 1	100 tons	8	(13)	--	--	8
Zone 2	100 tons	16	(23)	--	--	16
Zone 3a	100 tons	28	(30)	--	--	28
Zone 3b	500 tons	--		12	--	12
Zone 4a	500 tons	13	(14)	--	--	13
Zone 4b	1000 tons	18	(19)	14	18	50
TOTAL	--	83	(99)	26	18	127

determined where they were not known. In many cases, however, where emissions were not known for all five pollutants, the remaining pollutant emissions were determined in the study, based upon the known fuel use and current emission factors.

For the background inventory, however, it was necessary to start with basic activity data, in most cases, and to develop fuel-use profiles directly. Because of the magnitude of this task alone, and the necessity to keep it of secondary importance to the analysis of the Meadowlands plans, strict criteria were set up at the outset.

For point sources these included the following:

1. No new sources would be considered, other than power plants and incinerators for which Burns & Roe could independently project the necessary information from available sources; such new sources were automatically scheduled as area sources but were not treated in detail.

2. For existing New Jersey industrial sources, changes in the level of activity would be made only insofar as projective activity data could be made available from government agencies and clarification made in consultation with these agencies.

3. No changes in the level of activity for non-New Jersey sources would be considered unless readily available information existed.

4. Changes in activity indices, fuel use propensity and related factors, would be made only insofar as published trends were available and clarification could be made in conjunction with appropriate agencies.

5. Projections for emission factors were confined to non-process sources.

Most of these decisions and the way in which they were implemented are described in later sections of the report. For line sources all data were to be derived from the New Jersey Department of Transportation and the Tri-State Transportation Commission figures as available. Area source data were to be developed from Tri-State population, employment and square feet of floor space projections to 1985, and from regional trends in fuel use.

4.4.1 Zones of Analysis

As a result of the validation procedures, it was decided that nearly the same zones should be used for 1990 as were used for 1969. Figure 1-1 shows the analysis zones for the 1990 inventory. Point source projections for zone 1 were made in consultation with the Hackensack Meadowlands Commission. For zones 2 and 3 the Tri-State and New Jersey Bureau of Labor and Industry data were used to project activity levels for existing point sources. Existing sources for both New Jersey and New York were treated identically for zones 3 and 4. Nearly all new point sources are in zone 4.

Line sources were treated for zones 1 and 2 in the same manner as with the current inventory. Finally, area sources were determined on a county basis as in the current inventory and then allocated to the 16 and 8 km grid shown in Figure I-4.

4.4.2 Changes in Criteria

One of the major reasons for the similarity between the criteria used in the background inventory and in the current inventory was so that consistency could be maintained for modeling purposes. Figure I-13 summarizes the point source criteria used in the background inventory. An initial decision had been made to use a criteria of 100 tons per year as used with the current inventory. However, fuel burning emission factors - particularly for particulates, sulfur dioxide and oxides of nitrogen (the largest point sources in 1969) - were reduced significantly from 1969 to 1990.

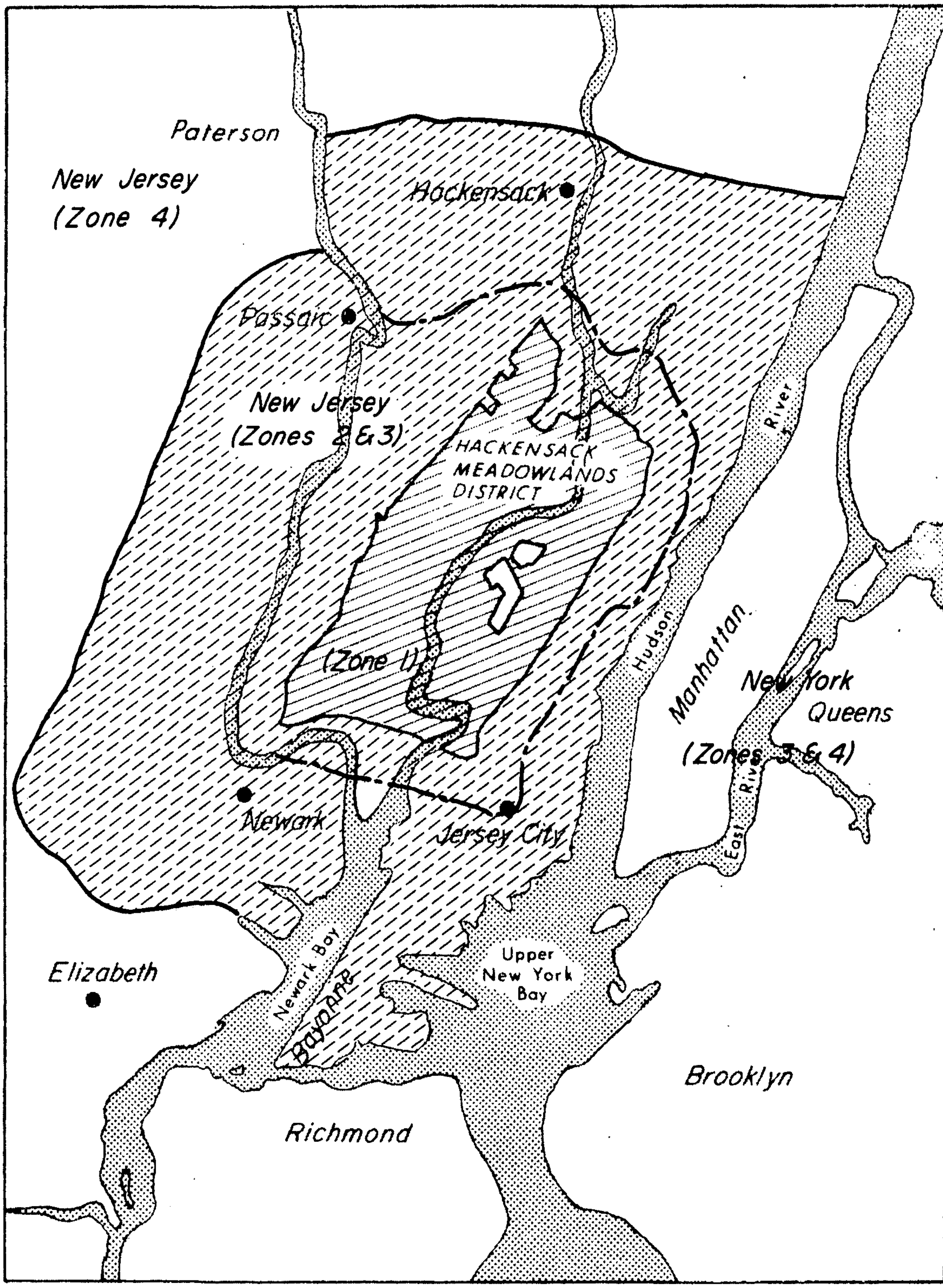


Figure I-12 Analysis Zone for 1990 Inventory

FIGURE I-13

1990 Background Inventory Point Source Criteria

Criteria		Number of Sources: Changes				
		N.J. [1969·New·Removed]	(stack groups)	N.Y.City [1969·New]	N.Y.State & Conn. [1969·New]	Total [1969·New·Removed]
Zone 1	25 tons	8 + 1 - 1 = 8	(13)	--	--	8 + 1 - 1 = 8
Zone 2	25 tons*	16 + 1 - 0 = 17	(24)	--	--	16 + 1 - 0 = 17
Zone 3	25 tons	28 + 0 - 4 = 24	(26)	12 + 0 = 12	--	40 + 0 - 4 = 36
Zone 4	25 tons	31 + 9 - 0 = 40	(42)	14 + 6 = 20	18 + 9 = 27	63 +24 - 0 = 87
TOTAL	--	83 +11 - 5 = 89	(105)	26 + 6 = 32	18 + 9 = 27	127 +26 - 5 =148

*One source at 24 tons was retained.

Zone 1 New Source is the Meadowlands Incinerator, assumed at only one location.

A criteria of 25 tons per year for any one pollutant was ultimately decided upon. One of the major deciding factors was the desire to keep as many of the 1969 point sources in the inventory as possible for model consistency purposes; no distinction was made by zone. Figure I-13 shows the 1969 point sources, the new point sources and the 5 sources removed from the inventory. One was removed because it was anticipated that it would shut down; the other four were removed because emissions did not exceed 25 tons per year for any of the pollutants. The new source shown in zone 1 is the Meadowlands incinerator, while the source in zone 2 accounts for the provision of expanded power plant facilities at an existing site. All of the new sources in zone 4 are power plants and incinerators.

4.4.3 General Approach

As with the current inventory, the criteria used to develop the background inventory are highly related to the information available and the specific requirements of the study. However, a general approach should not differ greatly from what was attempted here. Current data should be used as much as possible to develop the background inventory. For consistency purposes, sources in the current inventory should be carried forward to the future time period and only the most significant new sources added as point sources. Regional and national projective data and "control totals" as to fuel use, population and employment should be used in conjunction with the most reasonable activity indices. Many of these indices, such as the heating demand per square foot, need not vary greatly from region to region, except with variation in temperature. Others, such as propensity to use different fuels, are highly a function of current uses in the particular region.

5. ASSUMPTIONS AND CONSTRAINTS

5.1 Activity Data

The most important aspect of the data gathering involved the planning or land use data - generally termed "activity data" in this study. It is important to determine what data can and should be provided by the planner, as opposed to the information that should be standard or default as a part of the AQUIP system. It was necessary, therefore, to assess how detailed the planning data was for the Meadowlands plans as well as how unique. In general it can be said that the data provided for the Hackensack Meadowlands plans were excellent in terms of the details required for the methodology; however, they were often unique, both in terms of the degree of detail and the peculiar types of development and heating requirements involved. On the other hand, the type of data available for the background region (which is quite representative of regional planning) lacks the detail necessary to create a reasonably accurate inventory; this is reflected in the analysis of the background.

5.1.1 The Four Land Use Plans

Figures I-14 through I-17 show each of the four land use plans analyzed in the study. Plan 1 is the Master Plan developed by the Hackensack Meadowlands Commission. Plans 1A and 1B represent two alternative plans previously developed, the first embodying a New Town concept and the second representing an expansion of this portion of the existing New York metropolitan area. Finally, Plan 1C represents no plan at all. It shows what would result if the normal development pressures (taking into account zoning ordinances) were allowed to take their course. Figure I-18 summarizes the distribution of land use for the existing development and the additional land uses for each of the four plans. Plan 1B

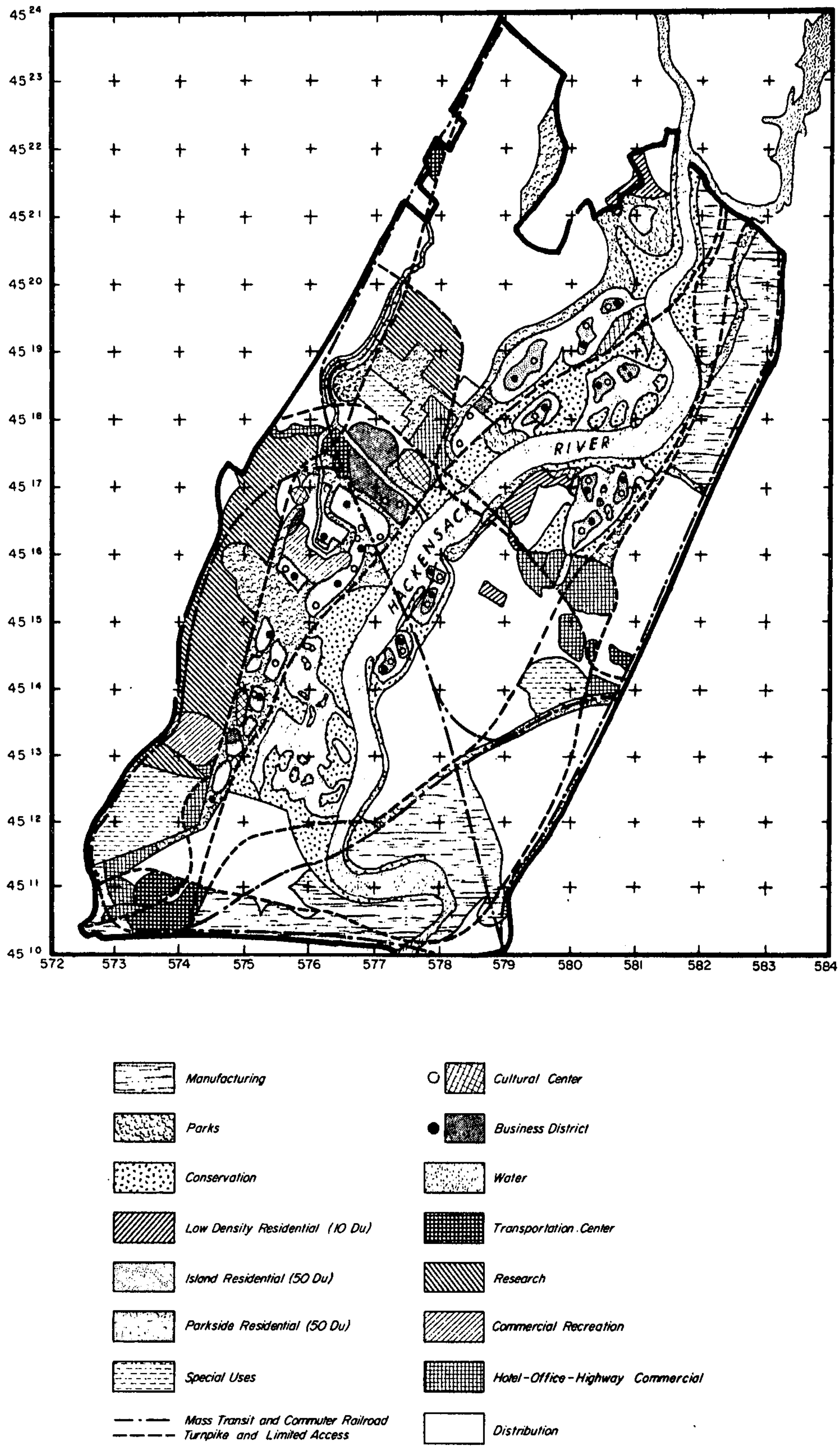


Figure I-14 Plan 1

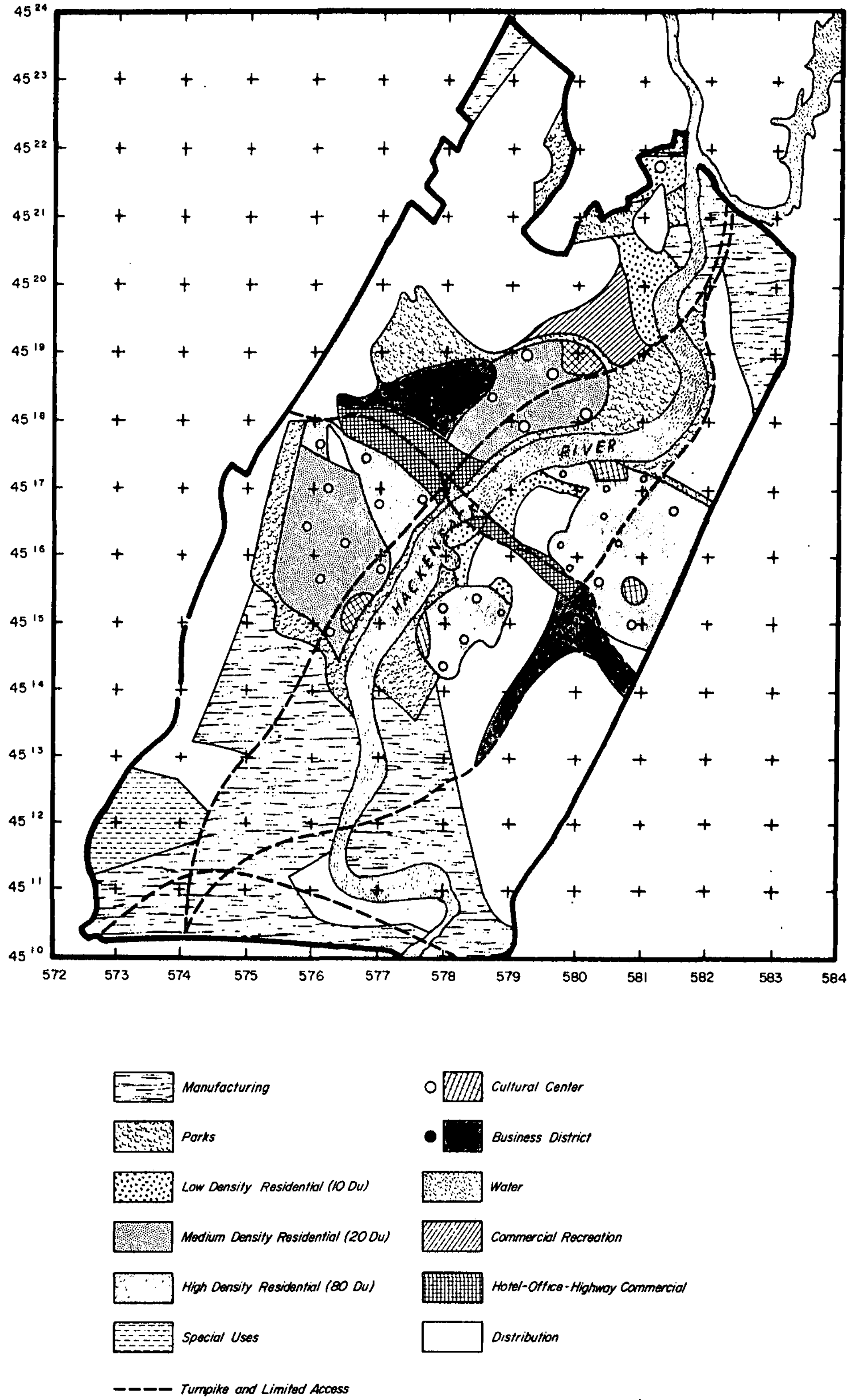


Figure I-15 Plan 1A

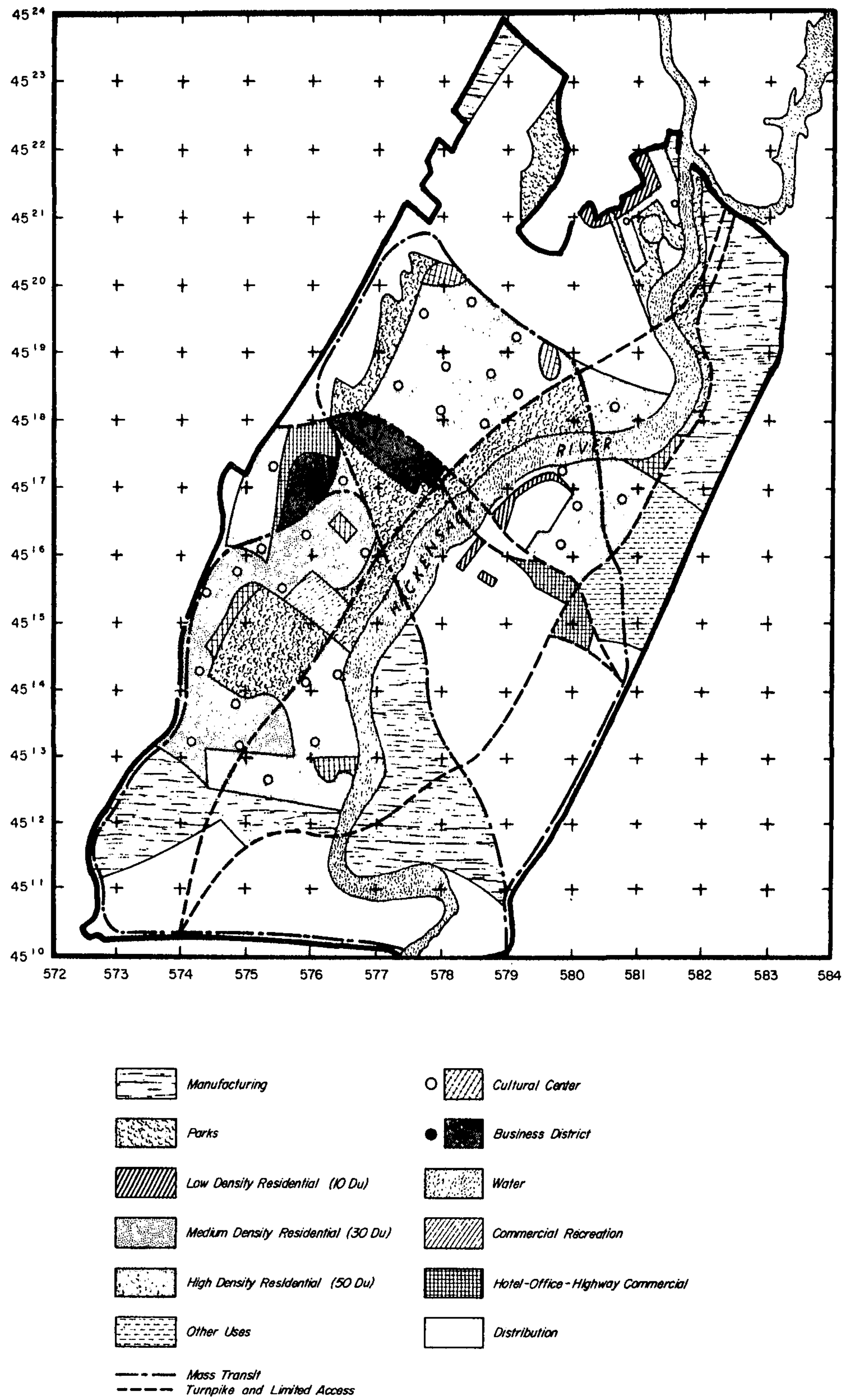


Figure I-16 Plan 1B

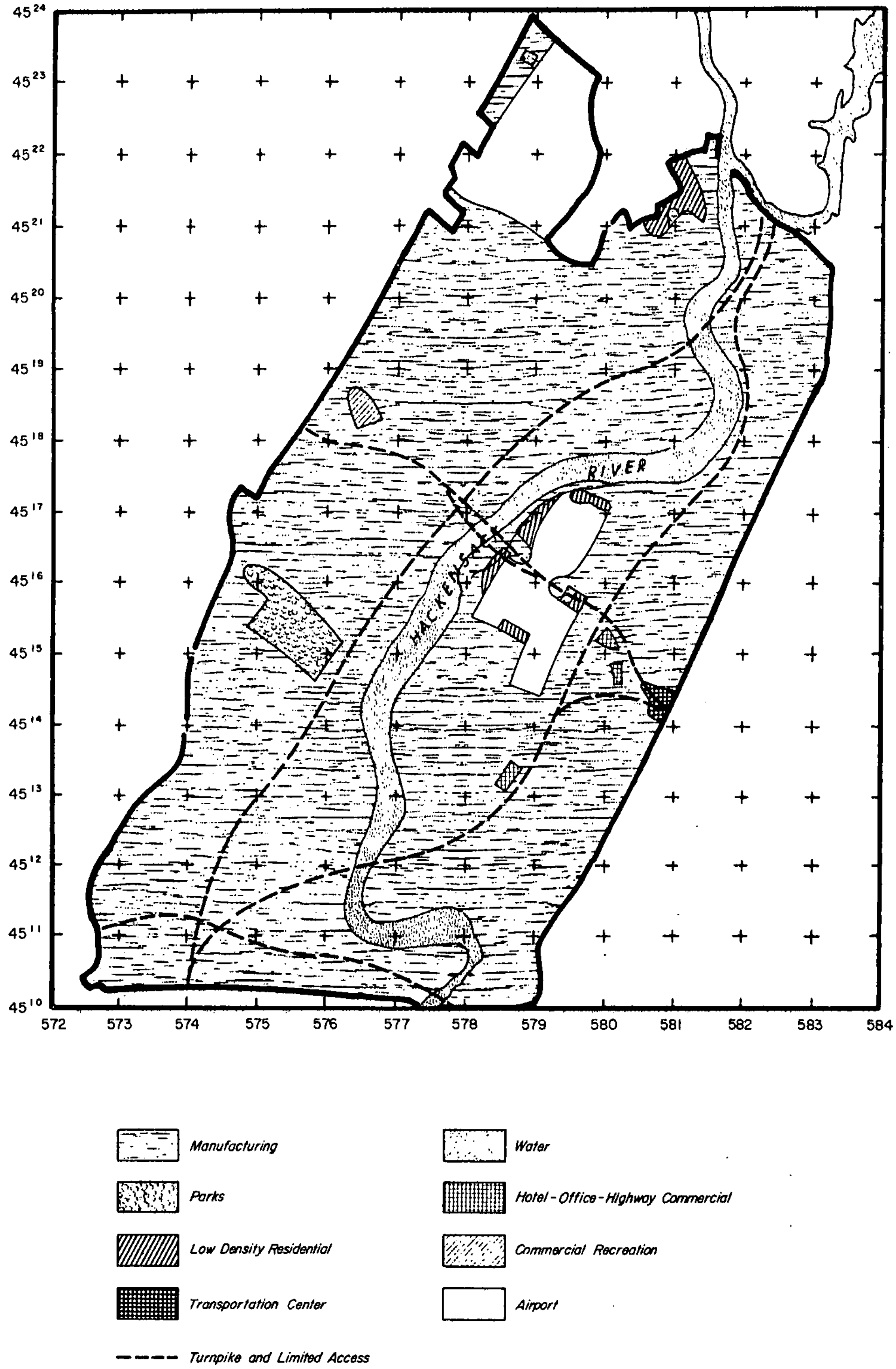


Figure I-17 Plan 1C

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Figure I-18

Distribution of Land Uses for the Four Alternative Plans

Areas, in acres

Land Use Types	Existing Land Use	Additional Land Use: Plan 1: Master Plan	Plan 1-A: New Town	Plan 1-B: Expansion	Plan 1-C: Zoning
low density residential	235	-	235	-	-
medium density resid.	-	-	1250	1000	-
high density resid.	-	1400	1250	2800	-
schools	-	250	400	450	-
special uses	-	750	500	400	-
commercial	190	575	800	400	-
manufacturing and research	800	2100	2400	2200	11675 (manufacturing and research; distribution)
distribution	1800	2200	2500	2500	
airport and transport. center	670	230	100	100	100
parks and recreation	105	2895	1900	1480	200
water	1400	800	-	-	-
highways and railroads	1995	1205	1070	1075	430
Total	7195	12405	12405	12405	12405
Population	6000	180,000	320,000	445,000	-

projects the highest population whereas Plan 1C is almost totally devoted to industrial development.

5.1.2 Sources of Data

One of the major premises established was the use of the planning data provided by the Hackensack Meadowlands Commission in its original form as much as possible and reliance upon default parameters wherever additional information was necessary. Furthermore, since computerized procedures were being developed to determine the emissions, it was necessary to set up numerous rules to estimate missing information and resolve conflicting information as to how each of the four plans would be developed.

Four different sources of information were provided by the Meadowlands planners. These were:

1. The four land use maps shown in Figures I-14 through I-17.

2. An extensive zoning code.[8,9]

3. A set of summary statistics, including tables similar to that shown in Figure I-18.[10]

4. Clarifying information solicited from the planners through numerous working sessions.

Use of Land Use Maps

The maps were used to provide the basic information for all land uses except manufacturing. For instance, the total number of acres of residential land for low density in Plan 1 as analyzed in the study represents those areas shown in Figure I-14, rather than the total acreage shown in Figure I-18 (which was derived from the summary statistics). In the case of manufacturing land use, the Meadowlands planners had developed a list of 10 acre lots to be devoted to manufacturing for each plan. The list contained the location of the centroid of each 10 acre lot, together with the 4-digit SIC code most representative of the development that would take place there. This 10 acre lot served as the module for all industrial development. However, in cases where adjoining lots were assigned the same 4-digit SIC code, this was taken to represent a single larger industrial facility covering 20, 30, 40, or more acres.

Use of Zoning Codes

The zoning code was used to determine the intensity of most development. For instance, for each residential category a permissible maximum density of dwelling units per acre is given in the zoning code. This value was used as the value assumed for development. When the total acreage from the land use plan is multiplied by the dwelling units per acre for each land use and the average population per dwelling unit given in the zoning regulations,it does not produce the population figures shown in Figure I-18. This is not surprising, due to the averaging procedures used to develop the summary statistics. However, to be consistent our analyses used information from the plan together with the zoning code, rather than the data shown in Figure I-18.

Use of Summary Statistics and Clarifying Information

The summary statistics were used only for the manufacturing category. In general, the fourth type of information - the clarifying information obtained through the working sessions - overrode any other source.

5.1.3 Problems with Data Hierarchy

Although this hierarchy of decisions proved very workable during the study, it did introduce one significant error into the final analysis. In the land use summary shown in Figure I-18 for Plan 1C, the acreage for distribution and manufacturing were not separately stated. Likewise, for Plan 1C in Figure I-17 the areas representing both these land uses were shaded with the same code. Accordingly, when the land use zones were computerized according to the established procedures, it was assumed that all of this land use was assigned to manufacturing as in the other three plans. However, manufacturing 10 acre lots taken from the summary statistics in actuality cover only a little over 3,000 of the more than 11,000 acres assigned to the joint category.

Since the distribution land use had not been separately shown on Plan 1C, it was never identified as such nor transferred to a computer form and was, therefore, not included in the analysis. Since all of the procedures set up for checking information referred back to the original premises of using either the plan maps or the industrial SIC list as a guide, this error was never discovered until the final analyses were being made as a part of plan evaluation. in Task 3.

Error Introduced

Although the acreage involved is large, the error introduced is not as significant as might be expected because the land use category of distribution is a low producer of fuel emissions per acre. A calculation was done after the fact to determine the relative emission rate of the distribution area compared with the manufacturing land uses for Plan 1C. This showed that inclusion of the emissions from distribution would increase the total emission rate by only about 10%.

Effect On Evaluation

In the discussions of the air quality resulting from the plans, a new code of Plan 1D has been assigned to the Plan 1C land uses actually examined. In other words, Plan 1D consists of the original Plan 1C minus the distribution land use. This is the same as assuming that more than 8,000 acres zoned for distribution were not developed in Plan 1D. This assumption may not be that much further from reality than what was proposed in Plan 1C, since the Plan 1C distribution land use assumed extremely intensive development of warehousing and distribution without any provision for the necessary ancillary services, including transportation networks.

5.1.4 Summary of Planning Decisions

A great many planning decisions had to be developed out of the working sessions with the Meadowlands planners. All of these decisions relate to the basic premises of what land uses are to be heated under what conditions and what other types of emission sources exist. Any land uses that were not considered to be significant sources of fuel or process emissions were not analyzed.

Since this study was confined to estimating emissions on an annual or seasonal average basis, sources such as a sports complex (which is heated only a few days a year) do not become significant sources on an annual basis; likewise peak-hour traffic congestion and open-burning landfall fires are averaged out to be negligible sources. Of the land uses shown in Figure I-18, parks, recreation, water and railroads were all eliminated from consideration on an annual and seasonal basis. Residential categories, commercial, distribution, manufacturing and research, special uses, schools and the transportation center were all considered to be significant sources of fuel and heating-related emissions. The airport, highway systems and parking lots in the sports complex were considered to be sources of non-fuel emissions.

5.1.5 Determination of Development Characteristics

Having decided what categories of land use would have fuel or heating-related emissions, the next question was how would each of these land uses be in fact heated. The Meadowlands area has a peculiarity which affects both the manner in which it will be developed and the way in which the development will be heated. This condition results from the large open tracts available for development and the individual ownership of very large parcels. It is also influenced by the great demand for development. All of these combine to indicate that extremely large developments will be built at one time with central heating and cooling systems.

In conjunction with the Meadowlands planners a series of large residential and commercial zones were identified which would be developed at a single time. The individual residential and commercial areas were then assigned to these large zones and locations defined for the new central heating systems. Figure I-19 shows a schematic of this type of development for an island residential land use in the Master Plan. Three residential islands to be comprised of high rise apartments with some lower developments are shown numbered 1, 2, and 3. Each has a school associated with it: numbers 4, 5 and 6. The schools will be built individually by the appropriate government agencies. Each of the residential islands has neighborhood commercial shopping associated with it (numbers 8, 9 and 10). Since these will be built as part of the residential complex their heating will also be served by the central heating system. Land uses 7 and 11 show, respectively, a secondary

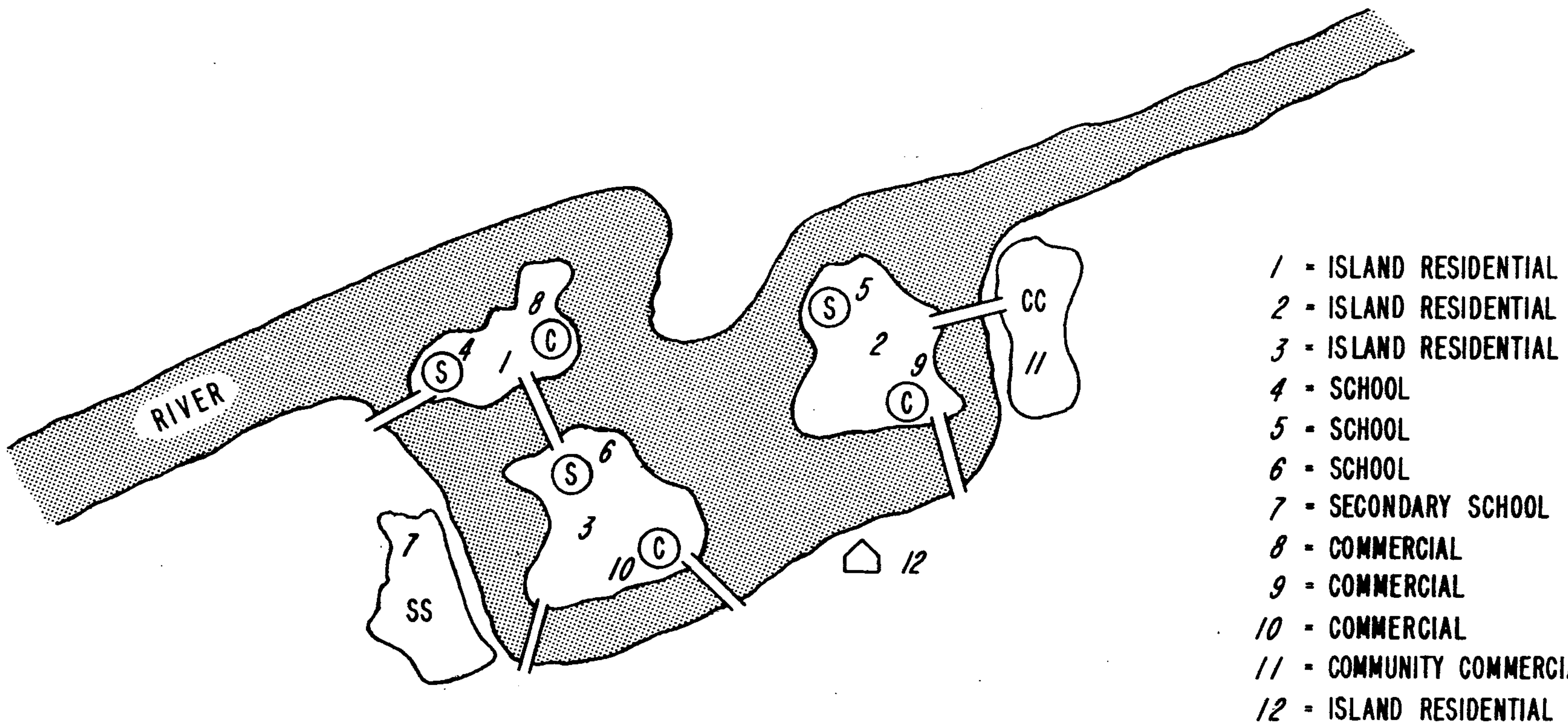
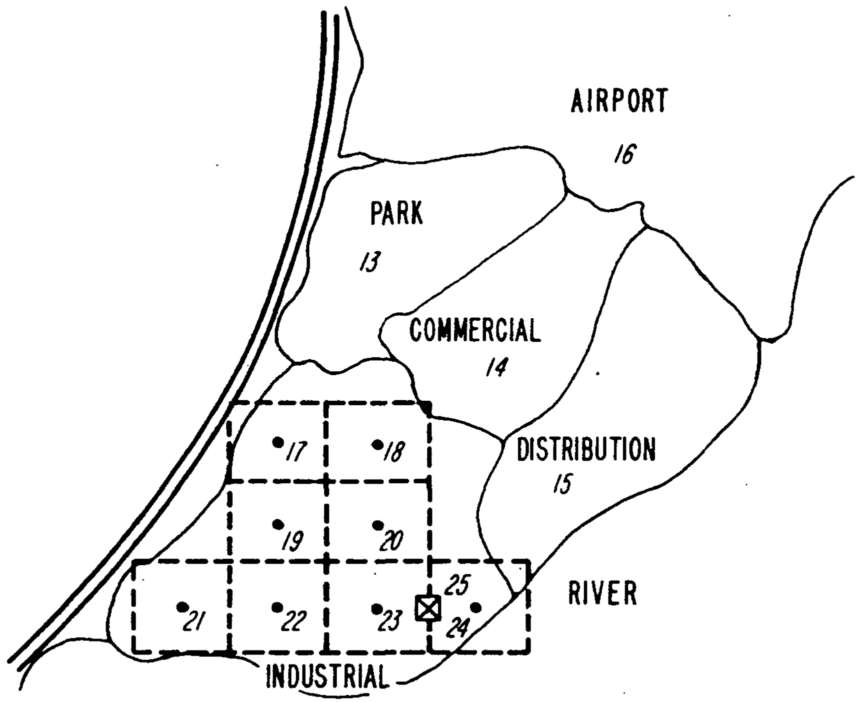


FIGURE I-19 SCHEMATIC OF ISLAND RESIDENTIAL LAND USES school and community commercial facilities that would be built and heated separately.

The central heating system has been located at number 12. Therefore, as far as fuel emissions are concerned, the sources of pollution for Figure I-19 consist of the three schools (numbers 4, 5 and 6), the secondary school (number 7), the commercial area (number 11) and the central heating system (number 12). In reality the residential areas 1, 2 and 3 and the commercial areas, 8, 9 and 10, do not enter into the final pattern of emissions - spatially. This is a fundamental characteristic of the way in which the Meadowlands will be developed and the complex procedures used to translate land use planning data into fuel-related emissions. In one other type of case - the Berry's Creek Shopping Center - several separate land use zones assigned to commercial use would all be built at one time as part of a major shopping center with a central heating system. Similar linking of land use zones for heating purposes were therefore assigned to this area.

All other fuel-related land uses were treated individually as shown in Figure I-20. The intensity of development assigned to the commercial area, number 14, and the distribution area, number 15, would determine the total heating demand. This would be assigned uniformly to the whole area shown and then reassigned by the LANTRAN program to the area source grid cells used for modeling. Numbers 17 through 24 in Figure I-20 represent 10 acre industrial lots. In the case of numbers 23 and 24 the same 4-digit SIC is involved; therefore, these would be combined as one 20 acre lot and a single heating system located at number 25.



13 = PARK
14 = COMMERCIAL
15 = DISTRIBUTION
16 = AIRPORT
17 = INDUSTRIAL - 2011
18 = INDUSTRIAL - 2012
19 = INDUSTRIAL - 3214
20 = INDUSTRIAL - 3310
21 = INDUSTRIAL - 3840
22 = INDUSTRIAL - 2390
23 = INDUSTRIAL - 3150
24 = INDUSTRIAL - 3150
25 = INDUSTRIAL - 3150

FIGURE I-20 SCHEMATIC OF COMMERCIAL AND INDUSTRIAL LAND USES

5.1.6 Determination of Heating Requirements

The next step was to determine how much heat would be required for each of the land use zones. All of the necessary planning information was available from the zoning codes or through discussion with the Meadowlands planners.

For residential land uses the heating demand is a function of the number of dwelling units and the permissible dwelling units per acre, which is part of the zoning code. For commercial land uses related to the residential area, such as points 8, 9 and 10, in Figure I-19, the heating demand is a function of the number of square feet of commercial space. The zoning code describes an allowable percentage of residential square footage to be put into commercial development. By knowing the square feet per dwelling unit and this allowable percent, the total square footage of commercial development in the complex was determined.

For commercial development in hotel and highway commercial areas or in the Berry Creek Shopping Center lot coverage and floor area ratios from the zoning code were used to develop the number of square feet of commercial space for each land use area. Assumptions had to be made in conjunction with the Meadowlands planners as to what the net lot coverage would be for various land use categories.

Likewise for distribution, manufacturing and research areas, lot coverage and floor area ratios were used to develop square foot figures. It was decided in working sessions with the Meadowlands planners that such land use categories as special use, transportation centers and cultural centers would be treated in the same manner as the distribution category, since more specific information was lacking.

The heating demand for schools was a function of the number of classrooms. In all cases the size of a school was directly related to the residential area served; therefore, knowing the number of dwelling units and the average pupil per dwelling unit ratio for the particular residential code, the total number of pupils in a residential area could be derived. Using the estimated percentage of pupils who would go to either the primary or secondary schools as contained in the summary statistics, the number of pupils could be assigned to a school. A representative figure of pupils per classroom by school type was developed in conjunction with the Meadowlands planners yielding the assumed number of classrooms for each school. If, as in certain residential areas, more than one school would serve the students, it was assumed that each school would take an equal number of students.

5.1.7 Determination of Non-Heating Emissions

Several planning decisions were necessary for the non-heating and fuel-related sources. The Hackensack Meadowlands Commission estimated on a regional basis the number of flights per year that could be expected from Teterboro Airport. The final number used was 400,000. The emissions from these flights were distributed uniformly over the area of the airport. If the study had been examining sources of emissions on a more detailed basis than the annual and seasonal averages used, other sources at the airport (such as motor vehicle traffic, the heating plant and the actual location of runways) would have become significant. Similarly, because of the averaging to annual and seasonal conditions, the only significant source included in the new sports complex was a point source representing the idling of vehicles in the parking lots during congestion periods. An estimate was made in conjunction with the Meadowlands planners that 4,500,000 vehicles per year would idle for approximately one hour; however, when this idling time is averaged over a year it is not as significant a source as might be expected.

Consideration was given to assigning transportation emissions to each land use zone according to the intensity of development. In fact, the LANTRAN program can accommodate this approach. However, the Hackensack Meadowlands planners felt that assigning all motor vehicle emissions to the highway network would adequately represent the situation, because, as a part of the land use plans, far less local automobile traffic is expected than would normally be the case, particularly for the Master Plan.

Other Planning Decisions

The remaining planning decisions were a function of the activity indices rather than the activity data themselves. Planning-related inputs included decisions as to the percent process heat and the number of hours of operation for each of the types of land uses. These again were made in consultation with the Meadowlands planners.

5.1.8 Industrial Sources

A great deal of time was spent discussing the possible industrial sources within the Meadowlands boundary. Existing point sources were handled separately since the Meadowlands planners had reasonable information as to the future activities of these sources. In one case it was assumed that a facility would shut down.

The industrial sources are of special significance because of the uncertainty as to the amount of fuel required for process heating and the incidence of separate process emissions. Efforts to develop a statistical sample of the propensity to use fuel for process heating by industrial category, based upon the current emission inventory, were not successful. It was possible to divide the industrial SIC codes into only two major categories of "relatively clean" and "relatively unclean" industries. The clean industries were assumed to operate fewer hours per year and use a greater percentage of their fuel for space heating.

Process Emissions

A separate study of process emissions corresponding to the 4-digit SIC industries proposed for the Meadowlands was made. With the exception of possible sources in the chemical and petrochemical and primary metals area, the SICs proposed for the Meadowlands are not significant separate process emitters. There are some potential emissions of particulates and hydrocarbons from selected SICs. These were accounted for by adding a percentage of the fuel burning emissions to determine the total emissions since no information was available on process rate. The Meadowlands planners felt that there would be no petrochemical or primary metals smelting operations in the Meadowlands.

5.1.9 Data Procedures

Once these decisions had been made, it was possible to set up the computerized procedures for transferring the data from the land use maps, zoning codes and statistical tables into the various data banks used. Each plan is referenced to the Universal Transverse Mercator (U.T.M.) grid system. This grid system was laid out on base maps of the Meadowlands district at the same scale as the existing plans. The land use data for each plan were then transferred to the new maps for those areas that had a significant emission potential; parks, water areas and recreation were not transferred. Areas for residential, commercial, distribution and related zones were coded as enclosed polygons composed of the three or more line segments approximating as close as possible the curvalinear shapes of the original zones.

The X and Y location of each vertex in UTM coordinates and the land use code were recorded. Sources such as local schools and community shopping centers which were represented on the plan as a round dot were transferred as discrete points. The roadways contained in the proposed plan were coded separately as line sources composed of straight line segments approximating as closely as possible the curvalinear roadways on the plans.

5.1.10 Existing Land Uses

In order to prevent duplication of sources from existing land uses within the areas adjacent to the Meadowlands, a template was prepared showing all major industrial land uses in the area. This template was then compared to each plan to locate zones where the proposed land uses overlapped existing ones. In most instances where there was an overlap the existing land use was retained and the proposed land use disregarded.

5.1.11 Changes in the Plans

A number of changes were made by the Meadowlands planners in the course of the study. The only one of significance involved the development of the sports complex which is to be located in the western part of the Meadowlands just north of Route 3. It was assumed that this complex would be built in all four plans. Land uses that existed in this area were eliminated, although in a few cases residential zones and associated schools were moved to another location, replacing industry or distribution zones. The land use type most consistently eliminated was industrial, although some net loss in residential and commercial land exists as well.

A cutoff was established in August 1971 for incorporating any new changes into the land use plans as considered for this study. Figures I-14 through I-17 show those land uses that were actually considered with the exception of the modifications for the sports complex and the elimination of the distribution land use from Plan 1C. It should be realized that the Meadowlands plan as it currently exists does differ, in some cases significantly, from Plan 1 as analyzed.

5.1.12 Background Activity Data

Because of the amount of time that had to be devoted to the Meadowlands activity data and the complexities involved, a rather strict approach was taken to the amount of activity data to be obtained for the background area. For, the current emissions inventory existing information and the activity data associated with it formed the entire base, although a great deal of time had to be spent to verify certain portions of the inventory. For the 1990 background inventory the following criteria were set up regarding the obtaining of activity data:

1. All activity data would be estimated by Burns & Roe for power plants and incinerators, due to their particular expertise in that area.

2. No other new point sources were to be considered outside the Meadowlands.

3. For existing point sources regional and local projections of employment changes from the New Jersey Bureau of Labor and Industry and the Tri-State Transportation Commission were to be used to project forward employment for existing firms; this parameter would then be used to project forward heating demand for 1990.

4. All available published information on process change would be assembled; however, in the final analysis decisions as to changes in process emissions had to be made in consultation with the New Jersey Department of Environmental Protection on an industry by industry basis.

5. For line sources all activity data would be supplied directly by the New Jersey Department of Transportation and any missing information would be determined in consultation with them and the Hackensack Meadowlands planners.

6. For area sources, regional and national fuel use projections, population, employment and square feet of floor space data from the Tri-State Transportation Commission for 1985, together with parameters from the current inventory were to be used. New point sources not otherwise considered were automatically included in this category.

5.2 Activity Indices

The most complicated part of the emission projection methodology and the area of most usefulness and interest to the planner is the development of the activity indices which relate land use and transportation planning data to emission characteristics, such as fuel use and process emissions. Figures I-21, I-22, I-23 and I-24 summarize all of the decisions that had to be made in this study.

5.2.1 Activity Indices for Meadowlands Plans

Figure I-21 summarizes the activity indices required for the Meadowlands plans. It shows how the example indices of Figure I-9 were actually applied. All of the activity-related indices in columns 1, 2 and 3 were discusses in the previous section and reference was made to the heat requirements, schedule and percent process heat as planner inputs in columns 4, 5 and 6. The step by step procedures for each land use category are discussed below briefly.

FIGURE I-21

Activity Indices for Meadowlands Plans

	Activity 1	Related 2	Indices 3	Heat Requirement 4	Schedule 5	Process Heat 6	Fuel Propensity 7
Residential	d.u./acre	(pupils/d.u.)	(sq.ft./d.u.)	BTU/d.u.	} hr.	% proc. ht.	% ea. fuel
-neighborhood commercial	% sq. ft.			BTU/ft^2			
-neighborhood schools	% primary	pupils/class		BTU/classroom	hr.	% proc. ht.	% ea. fuel
Commercial	% coverage	F.A.R.		BTU/ft^2	hr.	% proc. ht.	% ea. fuel
Distribution	% coverage	F.A.R.		BTU/ft^2	hr.	% proc. ht.	% ea. fuel
-transportation center	% coverage	F.A.R.		BTU/ft^2	hr.	% proc. ht.	% ea. fuel
-special uses	% coverage	F.A.R.		BTU/ft^2	hr.	% proc. ht.	% ea. fuel
-cultural center	% coverage	F.A.R.		BTU/ft^2	hr.	% proc. ht.	% ea. fuel
Research	% coverage	F.A.R.		BTU/ft^2	hr.	% proc. ht.	% ea. fuel
Industrial	% coverage	F.A.R.	acres/lot	BTU/ft^2	hr.	% proc. ht.	% ea. fuel
-4 digit SIC's	% coverage	F.A.R.	acres/lot	BTU/ft^2	hr.	% proc. ht.	% ea. fuel
Airport	flights/yr.			--	--	--	--
Parking Lot	veh./day			--	hr. idling	--	--
Water	--			--	--	--	--
Parks	--			--	--	--	--
Conservation	--			--	--	--	--
Commercial Recreation	--			--	--	--	--

F.A.R. = floor area ratio; ratio of total square footage to ground floor square footage

B.T.U. = British Thermal Units; measure of heating requirements used in the study. (metric units are Cal/d.u., Cal/m^2, and Cal/classroom)

FIGURE I-22

Activity Indices for Background Inventory

Point Sources

Indices sought	Current Activity Data (1969 inventory)	Derived Indices: By Individual Source	Derived Indices: By SIC Category	Exogenous Data
1969				
·All Sources				
% process heat			% process heat by SIC	
1990				
·N.J. Industrial				
	employees enclosed space gross area	BTU/hr/employee (space heating)	BTU/hr/employee by SIC (space heating)	ratio 1980 to 1969 employment by county and SIC ratio 1985 to 1963 employment by Tri-State 1 sq. mi. grid
% process heat	% process heat	BTU/hr	% process heat by SIC	
schedule	schedule		Schedule by SIC	
fuel use	fuel use		Fuel propensity by SIC	Fuel use trends by SIC and county
process emission	process rate	proc. rate/employee	proc. rate/employee by SIC	Process control by SIC
·N.Y. Industrial				
% process heat	% process heat			
schedule	schedule			
fuel use	fuel use			Fuel use trends by county
·All Power Plants				
schedule				Schedule, duty, heat rating
fuel use				System fuel propensity
·Existing Incinerators				
emissions	emissions emission factors	refuse per day		
·New Incinerators				
emissions				Refuse per day

Notes: Current activity date and exogenous data were used to derive indices to be applied to the point sources to produce the indices sought; the derived indices by SIC category may be modified for future time periods.

FIGURE I-23

Activity Indices for Background Inventory

Area Sources - Fuel Burning

Indices Sought	Existing Activity Data		Derived Indices	Exogenous Data	
	1965 Inventory	1969&1970 Inventory		Tri-State Transportation	Other
1969 Fuel Burning % process heat	fuel use		% process heat, by category and county		
1990 Fuel Burning heat demand	fuel use % process heat		(1965 space heat BTU, by state) BTU/sq. ft. by state	1963 Resid & Non-Resid sq.ft. by state 1985 Resid & Non-Resid sq.ft., by county	Meadowlands BTU/sq.ft.
% process heat	fuel use % process heat		(1985 space heat BTU, by state) % process heat by state space heat multiplier by state	% increase in non-resid. sq.ft., 1963-1985 by state	trend in Resid. Assume non-resid interpolate betw. % now & % if fixed amount trend in commerc.
fuel propensity	N.Y. Fuel Tables	1969 N.J. Fuel Tables	% oil, gas for resid, non-resid. by state		NYC trend in gas
emission factors	% residual oil % Indust., Commerc. use by fuel & state	% residual oil trend	% residual oil trend weighted averages of fuel use by state		Resid., Commerc., Indust. Emiss. Factors for oil and gas

[* in general, "by state" means: N.J., N.Y.C., N.Y. other]

Notes: Data from the 1965 inventory refer to the N.Y. Region Abatement Inventory; Data from the 1969 and 1970 inventory refer to the state inventory and the EPA regional update for the N.Y. area. Other exogenous data are for 1990 unless otherwise stated.

FIGURE I-24

Activity Indices for Background Inventory

Area Sources - Non-Fuel Burning

Indices Sought	Existing Activity Data: 1965 Inventory	Existing Activity Data: 1969&1970 Inventory	Derived Indices	Exogenous Data: Tri-State Transportation	Exogenous Data: Other
1990					
·Non-Fuel Burning					
·Incineration process rate					refuse by county
·Power heat input					heat input by utility company; assigned by counties served.
·Evaporation emissions				1985 population by county	EPA emiss/capita
·Motor Vehicles					
veh-mi	pop. by county gas. consumpt. by county		(1965 gals/capita by county) N.J. veh-mi/capita by county N.J. mi/gal by county N.Y. mi/gal by county N.Y. veh-mi/capita by county	1985 N.J. pop. by county 1985 N.Y. pop. by county	N.J.DOT veh-mi by county (categorize mi/gal)
vehicle mix		1969 N.J. veh. mix			N.J. veh. mix
·Aircraft emissions		1969 N.J. emiss. by county 1970 N.Y. emiss. by county 1969 commercial aircraft emission factors	ratio 1990/1969 Emiss. Factors		commercial aircraft emiss. factors trend in flights for region
·Other					
process emissions		1970 emissions by county			trend to 1975
other transp. emiss.		1970 emissions by county			trend to 1975
gas. marketing emiss.		1970 emissions by county			trend to 1975

Notes: Data from the 1965 inventory refer to the N.Y. Region Abatement Inventory; Data from the 1969 and 1970 inventory refer to the state inventory and the EPA regional update for the N.Y. area. Other exogenous data are for 1990 unless otherwise specified.

Residential

For all residential zones the dwelling units per acre are multiplied times the number of acres for the land use zone to produce total dwelling units. The space heating requirement is then derived by multiplying the number of dwelling units by the BTUs per dwelling unit shown in column 4. All of the numbers for the parameter shown in this column, "Heat Requirement", were developed as design parameters by engineers at Burns & Roe, using standard published engineering manuals.[11, 12]. This approach was thought to be more accurate than developing default parameters from the incomplete data of the current inventory. The information on schedule and process heat was developed in conjunction with the Meadowlands planners for each category.

Fuel propensity for each land use was assigned by the study team in consultation with the Meadowlands planners, taking into account: 1) regional fuel use propensities by land use category; 2) expected fuels due to design criteria; and 3) the type and scale of development anticipated. In most cases it was assumed that distillate oil would be burned, although natural gas was assigned to low density residential development.

Other Land Uses

The activity indices for the neighborhood commercial land use category are a bit more complicated since the heating demand is a function of the residential area served. The dwelling units per acre times the assumed square feet per dwelling unit and the percentage of square feet in the complex that will be devoted to commercial use yields the total number of square feet for the commercial facility. For this and the remaining fuel-burning land uses the procedures for columns 4, 5, 6 and 7 are the same as discussed under Residential and the necessary information was obtained in the same way.

Neighborhood schools are also a function of the residential area. Dwelling units per acre, pupils per dwelling unit and percent pupils going to a particular school yield the number of students at that school; dividing by the pupils per classroom yields the number of classrooms for the school. All of the remaining fuel-related land uses: commercial, distribution, transportation centers, special uses, cultural center, research and industrial, use the same parameters: number of acres of land use, the percent lot coverage allowed, and the floor area ratios. These yield the total square footage to be heated. In all cases this information was determined in consultation with the Meadowlands planners.

In theory the heating requirements, schedules, percent process heat and fuel propensity would be determined individually for each 4-digit SIC code. In practice this was not possible because of the available information. All industries were divided into only two categories of activity indices: the BTUs per square foot were the same for both categories but the schedule, process heat and fuel propensity varied.

The information for the remaining land uses - the airport and the parking lot - was all provided as planning input in conjunction with the Meadowlands planners. No exogenous activity indices were required.

Quality of Data

In summary, although the procedures required to develop the activity indices for the Meadowlands plans are in theory quite complex, the actual numbers required fall into a few rather simple categories. These consist of the BTUs per dwelling unit, square foot, or classroom that represent the heat requirement, the schedule, the percentage of heat used for space heating versus process heating and the relative propensity of fuel use for each of the categories. The design information for the first category is as accurate as the distinctions that the planner can make in land use codes. Fairly reasonable estimates can be made of the number of hours of operation for each type of facility and for process heat for all categories except industrial. Lack of information and tremendous variation in this variable as experienced in the point source inventory affects the results of the Meadowlands analysis as well. Finally, with the uncertainty in international fuel supplies even one to two years in the future it is virtually impossible to make reasonable estimates by land use category for 1990 as to fuel usage. In using the activity indices the planner is constrained by the national and regional availability of fuel-use related data.

The actual numbers used are discussed in Part II and their role in the activities packages of LANTRAN is covered in the Appendix to Task 1. the individual source and by SIC categories, as well as data on current employees,

5.2.2 Activity Indices for Background Point Sources

Figure I-22 shows the activity indices developed for the background inventory for point sources. As can be seen from the first entry a default parameter was required in the current inventory for percent process heat for many of the sources. The required values were developed from a statistical sample of other current point sources. This of necessity affects the accuracy involved in projecting this parameter forward to 1990, since the accuracy of any activity index in the future time period is conditioned by our present knowledge of its behavior.

<u>New Jersey Industrial Sources</u>

An elaborate system was set up to project percent process heating, schedule, fuel use propensity and process emissions for existing New Jersey industrial sources to 1990. Indices derived from current activity data for the individual source and by category as well as data on current employees, enclosed space and gross plant area were requested for each industrial source in our inventory.[13] The data obtainable for a large number of sources were the number of employees; therefore, this parameter was used as the major projective variable.

For each point source the number of BTUs for space heating per hour and per employee was derived. It was assumed that this parameter would not vary significantly by industrial category; however, when summaries were made by industrial category, wide variation was found and no statistical conclusions could be drawn. This is no doubt due in part to the inaccuracy in the percent process heat variable from which the amount of space heating versus process heating is derived.

Information was determined on the ratio of 1980 to 1969 employment by county and SIC code from the New Jersey Bureau of Labor and Industry. Quite a few assumptions had to be made because of the categories of SIC codes for which that data are available and the labor market areas (cutting across county boundaries) for which information is assembled.

A ratio of 1985 to 1963 total employment by Tri-State one square mile grid areas was also developed for zones 1 through 3. It was intended to project 1990 space heating directly in BTUs per hour using the employment ratios and any assumed change in the BTU per hour and employee index. This would then be combined with a new projection of percent process heat to yield total BTU heat demand for a source for 1990. Accordingly, information on current percent process heat was used to develop an index of percent process heat by SIC. This parameter yielded two broad categories of industrial use. It was therefore, concluded that present information was not sufficient to carry through the analysis as intended.

The employment ratio was applied to the total BTUs per hour per employee to generate a 1990 total BTUs per hour. No distinction could be made between space heating and process heating. In this way the same implied percent process heat figure was carried forward to 1990. When more accurate percent process heating data can be determined, projections for these figures can be more reliably made for future time periods.

Information on number of hours of operation for each source was aggregated into industrial categories. Again no clear cut patterns could be found. Accordingly, the current schedule for each firm was carried forward to 1990. Unfortunately similar findings were made for fuel use. No significant fuel propensity by SIC could be determined. Again, two broad categories of fuel use were derived and these were applied to the Meadowlands industrial sources.

Furthermore, no exogenous information on fuel use trends by industry or county could be determined. Accordingly, the fuel use for point sources was assumed to maintain the current proportions for 1990, except for switches from coal to oil or gas which were analyzed separately.

Attempts were made to adequately assess changes in process emissions for each source for 1990. The necessary information includes the current process rate and the number of employees. An index of process rate per employee was to be developed by industrial category and then national and regional information on process control by category applied to this index. Adequate information on process rate does not exist for most of the current sources. Furthermore, very little information exists on process control in a form that could be used. Therefore, blanket percent reductions in emissions by industrial category were applied to each source in consultation with the New Jersey Department of Environmental Protection.

In summary, of all the elaborate procedures involving activity indices set up for use with the background point source inventory, the only one that could be implemented was the ratioing of future to current employment by industrial category and geographic area. In all other cases current information had to be extrapolated forward or engineering judgement used.

New York Industrial Sources

Since the primary concern was for the New Jersey sources and the current information for New York sources was so incomplete, no attempt was made to do a detailed analysis for them. Current percent process heat was carried forward to 1990, as was schedule. For fuel use the current propensities were used, except for general trends identified by counties. The only trends that could be ascertained in practice were a few shifts from coal to oil and gas.

Power Plants

Information on schedule and fuel use for all power plants, both existing and new, was determined separately,based upon the expertise of Burns & Roe.[14-17] Using the information on schedule, duty assignment, heat input rating and system fuel use propensities the schedule and fuel use for each power plant were determined. All other information was carried forward to 1990 for existing sources; data were developed from design parameters or on the basis of current sources for new plants where needed.

Incinerators

Emissions for existing incinerators for 1990 were based upon current data. The amount of refuse per day burned was assumed to remain constant and only the emission factors were changed. For those sources where the current amount of refuse burned per day was not known, current inventory data on emissions and emissions factors were used to generate the necessary information. For new incinerators emissions were developed from the separate estimates of Burns & Roe on refuse per day.[18-21]

5.2.3 Activity Indices for Background Area Sources

The procedures established to determine the 1990 background area source inventory involved a complex use of activity indices as shown in Figures I-23 and I-24. As with the point source inventory the data necessary to carry forward these procedures were often lacking.

<u>Fuel Burning Sources</u>

Figure I-23 shows all of the activity indices required for estimating 1990 fuel burning emissions. Four parameters were used; heat demand, percent process heat, fuel use propensity and weighted emission factors. Again existing activity data, derived indices and exogenous data were relied upon.

The first column indicates all existing data developed from the 1965-1966 Abatement Region inventory, whereas, the second column shows data derived from the 1969 New Jersey Fuel Tables or the 1970 Implementation Plan inventories,[22] except as noted. The derived indices are all for 1990, except where otherwise shown. Finally, the exogenous data represents 1990 estimates either from the Tri-State Transportation Commission[23] or from other sources, except where other dates are shown.

Heating demand estimates relied upon current fuel use and percent process heat data from the Abatement Region inventory. 1969 data did not exist for the New York portion of the region and were not in sufficient detail for the New Jersey areas. From these data 1965 estimates of space heating BTUs by "state" were developed. The state breakdown, as referred to here, means the three jurisdictions of New York City, New Jersey, and the remaining counties in the 17 county region of New York outside of New York City. Using the space heating BTUs and Tri-State information on 1963 residential and non-residential square feet of floor space by state, an index of the BTUs per square foot by state was developed. Great variation was found in what was thought to be a relatively simple index. The calculations were, therefore, tempered by the design factors found for the Meadowlands and applied to the 1985 square feet of residential and non-residential floor space from the Tri-State Transportation Commission. This yielded a county by county heating demand value for residential and non-residential use.

The percent process heat was likewise estimated using 1965 data on fuel use and percent process heat. The 1965 space heating demand and the Tri-State percent increase in non-residential square feet from 1963 - 1985 was used to determine the 1985 space heating demand for non-residential use. Assuming that the non-residential percent process heat could be approximated by a number in-between the present percent and the percent that would be derived empirically by projecting space heating while holding actual process heat constant, a new percent process heat value for non-residential land use was derived. On the other hand, local trends in residential process heat were used to develop the residential index. From these, multipliers were derived for each state and applied to the space heating demand to produce total BTUs for both space and process heating.

Projection of fuel propensity for residential and non-residential use relied upon the 1965 New York Fuel Tables.[1] Estimates were made of the percent of oil and gas used for residential and non-residential purposes taking into account regional trends such as the increase in natural gas usage for New York City. Lacking additional information, a conservative approach was taken and the 1969 percent distribution was generally used for 1990.

Fuel Emission Factors

Although the emission factors were generally developed independently from the activity indices, a special circumstance existed for the 1990 area source data. Because the projective planning data from the Tri-State Transportation Commission were broken down into only two categories - residential and non-residential - the 1990 emission factors for industrial and commercial land uses had to be weighted to produce a single set of emission factors for non-residential land use. As can be seen from Figure I-23 this was done by using current information on the percentage of residual versus distillate oil, and the percentage use by fuel and state for industrial and commercial purposes. From these a percentage residual oil trend was derived, as well as the weighted averages of fuel use by state. Using the projected 1990 emission factors for oil and gas, a new set of weighted emission factors were derived.

Non-Fuel Burning Sources

Less information was available for projecting 1990 non-fuel burning emissions than for the fuel burning ones. As can be seen from Figure I-24 the activity indices were highly tempered by the available data. In the case of incineration and power the Burns & Roe data were used directly. In the case of evaporative emissions the 1985 Tri-State population by county and an estimate from EPA of emissions per capita were used.

When the evaporations category is considered relative to the entire inventory it is found to be extremely important, accounting for nearly one-half of the hydrocarbon emissions predicted for 1990. An estimate of 20 pounds per capita rather than the 30 used would reduce the hydrocarbon emissions for the region by nearly 100,000 tons. Furthermore, the use of some other index rather than population distribution would greatly change the spatial allocation of hydrocarbon emissions for the region. However, it is unclear how the spatial patterns might change in the Meadowlands area since local variations are probably more the result of local transportation and process sources. The population density surface does not exhibit significant local variations in our analysis.

The activity indices for motor vehicle estimation shown in Figure I-24 are different from those originally intended. The simplest procedure would have been to use the Tri-State 1985 vehicle mile data aggregated by county and to apply the 1990 emission factors directly to them. However, since the aggregated county data were not available at the time of the calculation, the New Jersey Department of Transportation county estimates for the New Jersey portion were relied upon, together with a series of assumptions as follows for determining the New York estimates:

1. 1965 population and gasoline consumption by county were used to determine gallons per capita.

2. From the New Jersey vehicle miles per capita based on projected population and vehicle miles, the implied miles per gallon for New Jersey could be derived. These were categorized and similar assignments made to the New York counties for miles per gallon.

3. When the gallons per capita were applied to the 1985 estimates of population, vehicle miles for each county were derived.

Although this approach is not as accurate as could be achieved and is not recommended, it is presented here for documentation because it was the one actually followed in practice. Current New Jersey vehicle mix data and projective data from the New Jersey Department of Transportation and the Hackensack Meadowlands Commission were used to derive a vehicle mix estimate to be applied to the entire region.

Aircraft emissions were extrapolated forward from current emissions by county, using a general regional trend in the number of flights, 1990 estimates of emission factors and the current emission factors. Knowledge of regional trends in aircraft flights is in the same state of chaos as fuel use propensities; however, a general doubling in the number of flights uniformly for all counties was assumed.

For all other sources of non-fuel emissions (including area-wide process emission, other transportation sources and gasoline marketing) the 1970 emissions from the Implementation Plan inventories,[22,24] taking into account 1975 trends, were extrapolated forward to 1990.

5.3 Fuel Supply and Demand

The projection of fuel consumption for 1990 made in this study was based largely on national trends. Little information is available on the different regional areas such as the New York metropolitan area. Furthermore, it was beyond the scope of the study to undertake a detailed regional fuel projection analysis. Several nationwide projections are available, the results of which are inconsistent with each other. The majority of these projections were made before 1965 and all projections make assumptions that are suspect. These assumptions are:

1. That the reserves of all types of fuel are sufficiently abundant to meet the anticipated demands. Frankly, with the current rationing practices in the natural gas supply, this is difficult to agree with.

2. That the recent environmental concern will not affect traditional growth trends in fuel consumption. With the kind of fuel switching currently being carried out, for environmental control purposes, this assumption has been violated already.

In addition, all projections of 1990 fuel demand include fuel consumption by mobile sources. Since 1990 emissions from mobile sources were projected separately on a vehicle mile basis and the fuel projection to be used was based on stationary sources only, it was therefore, necessary to modify the 1990 baseline fuel projections made by others to remove fuel consumed by mobile sources.

5.3.1 Current Fuel Consumption

Figures I-25 and I-26, following, are the 1965 and current fuel consumption totals in the 17 county region by fuel and source type. The totals have been converted to a BTU basis because in the energy form the proportional use of each of the fuels can be compared and changes for 1990 can be mitigated by known differences between the New York region and the national totals.

Throughout this study the following conversion factors were used for heating demand, taken from the 1965 New York Abatement Region Report.

Anthracite Coal	26,000,000	BTU per ton
Bituminous Coal	26,000,000	BTU per ton
Residual Oil	152,000	BTU per gallon
Distillate Oil	142,000	BTU per gallon
Natural Gas	1,100	BTU per cubic foot

In addition, coal gas was assumed to yield 1,100 BTU per cubic foot for use with the 1990 inventory.

As can be seen from the figures, coal is used predominately by a few power plants and some of the larger industries. Its use has declined significantly in the region in the last 10 years, as evidenced by the decrease for New Jersey from 1965 to 1969. Residual oil has become the mainstay for energy production in the industrial sector and the use of distillate oil and natural gas is significant in the area source category (residential and commercial space heating). Figure I-27 shows the summary of fuel use developed for 1990. The following sections explain how it was determined.

FIGURE I-25

Summary of Fuel Use

1965

	Residential	Commercial	Industrial	Power	Total	BTU
New Jersey						
Coal	959.	316.	1110.	3429.	5805.	151.
Resid. Oil	21.	637.	886.	476.	2019.	303.
Distil. Oil	1289.	138.	183.	--	1610.	242.
Gas	97.	24.	44.	21.	185.	204.
						900.
New York City						
Coal	509.	265.	77.	5251.	6104.	159.
Resid. Oil	982.	454.	264.	886.	2586.	388.
Disti. Oil	1074.	365.	61.	--	1500.	225.
Gas	68.	23.	11.	65.	167.	184.
						956.
New York State						
Coal	89.	34.	188.	474.	786.	21.
Resid. Oil	28.	38.	49.	139.	254.	38.
Distil. Oil	440.	107.	26.	--	573.	86.
Gas	21.	17.	2.	17.	56.	62.
						207.

Units:		Source:
coal	10^3 tons	1965 N.Y. Region Abatement Report
oil	10^6 gallons	
gas	10^9 cu. ft.	
BTU	10^{12} BTU	

FIGURE I-26

Summary of Fuel Use

1969

	Residential	Commercial	Industrial	Power	Total	BTU
New Jersey						
Coal	379	130	793	2086	3388	88
Resid. Oil	21	791	1134	859	2805	420
Distil. Oil	1347	129	194	--	1670	250
Gas	92	31	59	31	213	234
						992

Units:	coal	10^3 tons
	oil	10^6 gallons
	gas	10^9 cu. ft.
	BTU	10^{12} BTU

Source: 1969 NJDEP county fuel use tables

FIGURE I-27

SUMMARY OF FUEL USE

1990

	Residential	Non-Residential	Industrial Point	Power*	Total	BTU
New Jersey						
Oil	1487	1889	629	1278	5283	792
Gas	110	95	15	----	220	242
						1034
New York City						
Oil	2079	1216	----	3167	6462	970
Gas	100	56	----	----	156	172
						1142
New York State						
Oil	673	395	----	934	2002	300
Gas	31	36	----	----	67	74
						374

Units: Oil -- 10^6 gallons

Gas -- 10^9 cubic feet

BTU -- 10^{12} BTU

Source: Derived from 1990 background inventory

*In addition, power plants will consume 228 x 10^9 cubic feet coal gas, representing 251 x 10^{12} BTU and use 11 x 10^{12} BTU input of natural gas in gas turbines.

5.3.2 Total Fuel Consumption - 1990

The baseline used for 1990 fuel consumption was the "Energy Model for the United States" prepared by the U.S. Department of the Interior, July 1968.[25] This estimate was used for convenience since it separates out transportation sources and provides a breakdown by the same consumption sectors used in this study. The bottom half of Figure I-28, following, presents that projection; it was used to check the 1990 fuel use totals (shown in Figure I-27 and the top of Figure I-28) that resulted from the fuel allocation process. As can be seen from the table, total energy consumption is expected to increase 50% between 1970 and 1990. The use of the fluid fuels will increase 50% and the use of coal will decline in all sectors except in power production where it will nearly double.

Fuel Assignment

Area sources in the background inventory for the Tri-State region were assigned fuels based on existing fuel use for the same source category, weighted by regional trends.

Figure I-29 summarizes the resulting fuel demand per square foot of residential and non-residential space. Decreases in demand reflect design efficiencies postulated in heating as well as differing assumptions made in determining total BTU demand.

5.3.3 1990 Point Source Fuel Use

The 1990 fuel use by existing (1969) sources was projected to be the same as at present with the following exceptions. The use of coal by industrial point sources will decrease and be replaced by residual oil. The other known cases of fuel switching presently being made were incorporated

FIGURE I-28

Comparison of Fuel Use Propensities

NEW YORK REGION

	[1965]				[1990]			
	Coal	Oil	Gas	Total	Coal	Oil	Gas	Total
Resident. & Commercial	56	835	275	1166	0	1160	573	[illegible]
Industrial**	36	220	62	318	0	94	17	[illegible]
Power	238	225	112	575	0	806	262*	1068
TOTAL	330	1280	449	2059	0	2060	752	2812

NATION

	[1970]				[1990]			
	Coal	Oil	Gas	Total	Coal	Oil	Gas	Total
Resident. & Commercial	508	5979	7350	13837	160	4470	14600	19290
Industrial	5901	5481	8988	20370	3875	10097	14640	[illegible]
Power	8035	856	2589	11480	15618	861	3552	20031
TOTAL	14444	13316	18927	45687	19653	15428	32792	[illegible]

Units are 10^{12} BTU

*Includes coal gas and gas turbines

**For 1965, all industrial sources; however, for 1990 only point sources - area sources are included with the residential and commercial.

Figure I-29

Comparison of Total Fuel Demand

	BTU $x10^{12}$	Sq.Ft. $x10^{9}$	BTU/sq.ft. $x10^{3}$
Year	(1965)	(1963)	-
Residential	820.	5.3	155.
Non-Residential*	664.	2.8	237.
Power**	575.	8.1	71.
Year	(1990)	(1985)	-
Residential	902.	8.0	113.
Non-Residential*	842.	4.3	196.
Power**	1068.	12.3	87.

* For 1965, combination of commercial and industrial fuel use from Figure I-25; for 1990 combination of non-residential and industrial point source fuel use from Figure I-27.

** Sq.ft. used to compare power BTU is sum of residential and non-residential.

Source: BTU from Figures I-25 through I-27; sq. ft. from Tri-State Transportation Commission; 1985 values are for 'Plan C'.

into the projection. The use of coal by power plants in the region was replaced by increases in gas consumption using coal gas supplemented by natural gas. New sources from any of the Meadowlands plans were assigned a fuel demand based on the existing industrial mix or a fuel propensity based on SIC classification. New power plants were assigned fuel based on individual utility fuel consumption patterns.

5.3.4 1990 Area Source Fuel Use

The various area sources in the Meadowlands district were assigned fuels individually according to the type and scale of development of each source.

5.4 Emission Factors

Emission factors are usually given as pounds of pollutant emitted per unit quantity of fuel burned; or for process emissions, pounds of pollutant per ton of finished product. It was one of the tasks of the study to develop a list of emission factors to be used to validate the 1969 inventory, to discuss the various ways that emission factors may change in the future and, finally, to estimate what the emission factors will be in 1990.

<u>Scope</u>

The emission factor analysis did not attempt to cover all changes that may effect emissions. For instance, a cessation of a particular activity at a source or sources was not covered by the emission factor analysis. A change in fuel type such as a switch from oil to gas, or a change in raw material for an industrial process were likewise not covered. These types of emission changes, while they may result from the application of a total air pollution control strategy, are not changes in emission factors, as defined, and their effects were covered elsewhere in the study.

Given an activity that presently exists and will also exist in 1990 the emission factor analysis covered how each activity emits the five subject pollutants both now and in 1990.

5.4.1 Present Emission Factors

Figure I-30, following, is a listing of all the major emission factors used for this study. The classification of emission activities are by fuel burning and non-fuel burning source categories. Each classification is subdivided into small subclasses of emissions. For instance, within non-fuel burning, refuse incineration includes open burning, domestic incineration, apartment house incineration, commercial incineration and central station municipal incineration. For each identifiable activity to be found in the study an emission factor was recorded if data were available. While the dimensional units may not be the ones used in the modeling, they are the ones for which emission data were published at the time of the analysis and carried through the emission factor modification process. The table includes those categories which account for approximately 95% of the emissions of the five basic pollutants. Emissions from industrial processes were deleted from the list. These emissions are discussed at the end of this section.

Following the listing of the activities and the emission factor dimensional unit are the current emission factors for the five subject pollutants. These are taken from the document Compilation of Emission Factors published by the Public Health Service.[26-28] The current emission factors were used for the 1969 inventory and they incorporate the New Jersey sulfur standards existing at that time. The emission factors for automobile travel were obtained by private communication from EPA since the most up-to-date information had not been published at the time of the analysis.

Figure I-30
Summary of Emission Factors

A. FUEL BURNING		English	Metric	Conversion Factors (1)	Current Emission Factors (2)					Total Modification (2)					1990 Emission Factors (2)				
					PART	SO_2	CO	HC	NO_2	PART	SO_2	CO	HC	NO_x	PART	SO_2	CO	HC	NO_2
A-1 Power Plants	Anthracite Coal	#/ton	g/kg	0.5	3	27	5	0.1	12	75	90	-	-	60	0.75	3	5	0.1	4.8
	Bituminous Coal	#/ton	g/kg	0.5	4	38	1	0.3	36	75	90	-	-	60	1.0	3.8	1	0.3	14.4
	Residual Oil	#/1000 gal	g/liter	1.2×10^5	6	159	0.04	5	105	90	85	-	-	70	0.6	24	0.04	5	31
	Natural Gas	#/10^6 ft^3	g/m^3	1.6×10^{10}	15	0.6	0.4	40	390	NEF.	NEG.	-	-	70	15	0.6	0.4	40	117
	Coal Gas	#/10^6 ft^3	g/m^3	1.6×10^{10}	-	-	-	-	-	-	-	-	-	-	30	0.2	0.3	80	400
	Turbine-D-Oil (base)	#/10^6 BTU input	g/cal.	1.8×10^6	-	-	-	-	-	-	-	-	-	-	0.12	0.1	-	-	0.845
	Turbine-D-Oil (peak)	#/10^6 BTU input	g/cal.	1.8×10^6	-	-	-	-	-	-	-	-	-	-	0.11	0.1	-	-	0.895
	Turbine-N-Gas (base)	#/10^6 BTU input	g/cal.	1.8×10^6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.57
	Turbine-N-Gas (peak)	#/10^6 BTU input	g/cal.	1.8×10^6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.64
A-2 Industrial	Anthracite Coal	#/ton	g/kg	0.5	15	27	5	0.1	12	75	90	-	-	60	3.75	3	5.0	0.1	4.8
	Bituminous Coal	#/ton	g/kg	0.5	12	38	2	1	15	75	90	-	-	60	3.0	3.8	2.0	1.0	6
	Residual Oil	#/1000 gal	g/liter	1.2×10^5	23	159	0.2	3	60	-	85	-	-	70	23	24	0.2	3.0	18
	Distillate Oil	#/1000 gal	g/liter	1.2×10^5	15	43	0.2	3	60	-	85	-	-	70	15	6	0.2	3.0	18
	Natural Gas	#/10^6 ft^3	g/m^3	1.6×10^{10}	18	0.6	0.4	40	175	-	-	-	-	20	18	0.6	0.4	40	140
A-3 Commercial	Anthracite Coal	#/ton	g/kg	0.5	10	36	90	2.5	3	-	80	-	-	-	10	7	90	2.5	3
	Bituminous Coal	#/ton	g/kg	0.5	18	38	10	3	6	-	80	-	-	-	18	7.6	10	3	6
	Residual Oil	#/1000 gal	g/liter	1.2×10^5	23	159	0.2	3	60	-	75	-	-	60	23	40	0.2	3	24
	Distillate Oil	#/1000 gal	g/liter	1.2×10^5	15	43	0.2	3	60	-	75	-	-	60	15	11	0.2	3	24
	Natural Gas	#/10^6 ft^3	g/m^3	1.6×10^{10}	19	0.6	20	8	100	-	-	-	-	20	19	0.6	20	8	8
A-4 Residential	Coal	#/ton	g/kg	0.5	20	38	90	20	3	-	80	-	-	-	20	7.6	90	20	3
	Distillate Oil	#/1000 gal	g/liter	1.2×10^5	10	43	0.2	3	12	-	85	-	-	60	10	6.5	0.2	3	4.8
	Natural Gas	#/10^6 ft^3	g/m^3	1.6×10^{10}	19	0.6	20	8	50	-	-	-	-	-	19	0.6	20	8	50
B. NON-FUEL BURNING																			
B-1 Incineration	Open Burning	#/ton refuse	g/kg refuse	0.5	16	1	85	30	6	-	-	-	-	-	16	1	85	30	6
	Incineration (Domestic)	#/ton refuse	g/kg refuse	0.5	35	0.5	300	100	2	-	-	-	-	-	35	0.5	300	100	2
	Incineration (Apartment)	#/ton refuse	g/kg refuse	0.5	30	0.5	20	15	3	90	-	-	-	-	3	0.5	20	15	3
	Commercial (1 Chamber)	#/ton refuse	g/kg refuse	0.5	15	1.5	20	15	2	-	-	-	-	-	15	1.5	20	15	2
	Commercial (2 Chamber)	#/ton refuse	g/kg refuse	0.5	7	1.5	10	3	3	-	-	-	-	-	7	1.5	10	3	3
	Municipal	#/ton refuse	g/kg refuse	0.5	14	1.5	1	1.5	2	90	-	-	-	50	1.5	1.5	1	1.5	1
B-2 Motor Vehicle	Cars	#/1000 veh.mi	g/veh.km	2.82×10^5	1.3	0.4	139	12.9	14.9	50	-	92	92	90	0.7	0.4	11	1.0	1.5
	Trucks - Gas	#/1000 veh.mi	g/veh.km	2.82×10^5	1.3	0.4	500	66	24	50	-	97	97	91	0.7	0.4	15	2.0	2.2
	Trucks - Diesel	#/1000 veh.mi	g/veh.km	2.82×10^5	5	9	65	13	68	50	-	87	66	72	2.5	9	8	0.8	1.7
B-3 Aircraft	Commercial	#/flight	g/flight	454	8	2	28	17	5	-	-	80	80	30	8	2	6	4	3.5
	General Aviation	#/flight	g/flight	454	0.2	2	12	0.4	0.2	-	-	50	50	-	0.2	2	6	0.2	0.2
B-4 Evaporation	Solvents	#/capita	g/capita	454	-	-	-	-	-	-	-	-	-		-	-	-	30	-

(1) Multiply English units by indicated conversion factor to obtain metric units.

(2) English units.

5.4.2 Projection Methodology

It is anticipated that these current emission factors will change substantially by 1990. Changes will occur from the application of more restrictive emission controls recently promulgated and also because of improved methods of testing. Changes of the latter type are largely speculative at this time. Changes in emission factors due to the proposed emission controls will cause significant reduction in future emission levels. There are three types of changes that would affect current emission factors. The first type of change is called a process change. This type of change includes such things as the development of a more efficient internal combustion engine and modification in operating procedures for fuel burning equipment. The second type of change is fuel modification which includes such things as the removal of ash from coal or sulfur from oil. It would also include a change in raw material for an industrial process. The third type of change will result in improvements in flue gas cleaning technology.

A literature search was made for information concerning the application of each type of change to the control of the five subject pollutants.[29-36] Generally, each possible change is directed toward one specific pollutant. For instance, a more efficient electrostatic precipitator is developed to control particulates; therefore, the literature will have information concerning the removal of particulates. However, no information will be available concerning the effect of this device on the remaining four pollutants. In cases like these the other pollutants have been assumed to pass through unchanged.

The columns labeled TOTAL MODIFICATION represent a subjective estimate of the total reduction in 1990 emission factors based on the components of change discussed above. These factors were reviewed and approved by EPA and NJDEP at the Milestone 5 meeting. These percentages were applied to the current (1969) factors to produce the 1990 emission factors projections. Recent reductions in particulate emissions have been brought about in part by process change, fuel modification and the installation of flue gas cleaning equipment. It is believed that this will be the case for future emissions factor changes as well. Rather than 100% reduction by gas cleaning, a partial reduction will be made by process change, by fuel modification and by the installation of devices.

Not all five pollutants from each source category are considered to be critical from an air pollution point of view. It would be expected that resources would be concentrated on the control of emissions for a pollutant placed high on the list. Since relatively little effort is being expended toward the control of emissions of those pollutants at the bottom of the list, little future reduction would be expected in these emission factors. Priority ratings can be set up for the major categories of emission as shown in Figure I-31.

5.4.3 1990 Emission Factors

Power Plants

A great deal of research is being conducted on air pollution emissions from power plants. Particulates can be controlled under current technology to 98% efficiency. New electrostatic precipitator/scrubber combinations are expected to have a capacity of 99.5% (a reduction of 75% over current) when applied to coal burners. The installation of precipitators to oil burning plants is anticipated, with an overall reduction in emission factors of 90%. A reduction in particulates from gas burning power plants is not anticipated.

Figure I-31

Pollutant Priority Rating

	Particulates	Sulfur Dioxide	Carbon Monoxide	Hydrocarbon	Nitrogen Dioxide
Fuel Burning					
Power Plants	1	2	4	5	3
Industrial	1	2	4	5	3
Commercial	1	2	4	5	3
Residential	1	2	3	5	4
Non-Fuel Burning					
Incineration	1	5	2	4	3
Motor Vehicle	4	5	1	2	3

Significant reductions in SO_2 emissions from power plants are anticipated. This will be accomplished in part by the reduction of sulfur concentrations in coal and fuel oil and in part by advances in the gas cleaning technology. There are presently available several processes for the reduction of 90% of SO_2 from power plants. This level is considered to be a realistic overall goal that is attainable.

NO_x control from power plants will be accomplished largely by modifications to fuel burning equipment and changes in operating procedures. The limestone injection system is a flue gas cleaning system that is directed toward SO_2 control but also reduces NO_x emissions significantly. Significant reductions in CO and HC emissions from power plants are not anticipated.

Industrial Fuel Burning

The same 75% reduction in particulates is predicted from industrial coal burners as for power plants. However, since these emission factors are currently higher, the 1990 emission factors will also be higher. SO_2 control will be provided by sulfur reduction in the fuel. NO_x emission factors will be reduced by process change and no substantial changes in emission factors from CO and HC are anticipated.

Refuse Incineration

The use of open burning and domestic incineration have largely been banned in the New York - New Jersey areas. There is no feasible method of emissions control for this activity to the levels required by current regulations. For these reasons, it is expected that these methods will largely disappear and therefore, no effort is anticipated in emission factor reduction.

The upgrading of apartment house incinerators has been ordered in New York City. The order is being met, in some cases, by the installation of auxiliary burning equipment and scrubbing devices; in other cases the incinerators are being shut down in favor of compactor units. It is anticipated that there will be a reduction of about 90% in particulate emission factors. While reductions in CO and NO_x emissions factors are anticipated, no data are available on the extent of the reductions in these areas. For municipal incinerators, the installation of electrostatic precipitators and scrubber/precipitator combinations will reduce particulate emission factors by 95% over the time period considered. CO emissions from new installations are already sufficiently low, with good operating practice. The installation of water walls for the purpose of steam generation will reduce the NO_x emission factor by providing a mechanism for the control of furnace temperatures; this waste heat recovery will probably be standard in the area by 1990.

Transportation

The reduced emission factors for gasoline burning vehicles were extracted directly from the information supplied by EPA, urban traffic data were used (with an average speed of 25 mph) for this analysis. Significant reductions in particulate and sulfur oxide emissions are not expected, since these are not presently considered troublesome with respect to gasoline burning vehicles. Little information was available as to possible reductions in the emission factors for aircraft although emission standards were soon to be promulgated at the time of the analysis. The greater emissions from the new larger aircraft will probably be offset to a great extent by more efficient controls, and thus result in a relatively small change in emissions per flight.

Commercial and Residential Fuel Burning

Emissions from these sources will be largely affected by changes in fuels and fuel substitution. The installation of complex fuel gas cleaning devices is not economical in these small sizes. Some operational changes can be made to effect a reduction in NO_x emissions. These, however, would tend to increase CO and HC emissions.

Several emission factors were ascertained for 1990 that were not necessary for the current emission inventory. These included the coal gas and gas turbine data for power plants and emission from solvent evaporation. All of the information was obtained directly from EPA after the Milestone 5 meeting with the exception of coal gas estimates which were determined by Burns & Roe.

Industrial Separate Process Emissions

Industrial separate process emissions need to be handled on an individual source by source basis because emission factors are greatly affected by detailed information on product type, production rates, equipment types and age. Using a standard factor for all refinery operations as an example would be greatly misleading. Even 4-digit SIC categories do not give sufficient delineation - sulfuric acid and nitric plants are in the same category.

5.5 Emission Characteristics

The emission inventories prepared as a part of this study represent only the average annual day, the average summer day and the average winter day. The average annual day, for example, assumes that all total fuel and non-fuel emissions for the year are divided equally by 365 days. Any variations that occur between weekday and weekend, month of the year, hour of the day, in the level of activity or in the type of fuel used are completely averaged out. This means that sources which occur intermittently are generally obscured and considered negligible. This includes such things as heating of a stadium or a sports complex a few weekends a year, open burning from land fires and rush hour traffic jams. Therefore, the inventory that has been prepared is a statistical one. It does not truly exist at any one time.

The annual activity level for a particular source is multiplied by the activity index to produce the annual fuel use. The fuel or fuels assigned are multiplied times the average emission factor to yield a fuel emission for the year. For non-fuel emissions, the annual activity level is multiplied times the average emission factor.

The summer and winter seasonal inventories were developed simply by ratioing the space heating portion of fuel use according to the number of degree days (as shown in Figure I-32) and the percentage of fuel used for space heating for each source or source category. In many cases, the percentage of fuel used for space heating was not known. For point sources, default parameters were developed directly from the known current point sources. These are shown in Figure I-32. The same default parameters were used for 1969 and 1990 sources. The only new sources were power plants and incinerators, all of which have 0% space heating factor. 1969 assumptions for percent space heating for area sources are shown in Figure I-32. These were

Figure I-32

Seasonal and Stack Parameters

	no. of days	degree days	avg. daily degree days	ratio to annual	ambient temp.
Annual	365.	4859.	13.3	1.0	285.60°K
Winter	91.	2780.	30.5	2.3	276.00°K
Summer	91.	0.	0.	0.	295.00°K

Percent of Fuel Used for Space Heating

Point Sources:

Industrial (SIC 20-29)	10%
Industrial (SIC 30-39)	25%
Power Plants	0%
Institutional	90%

Area Sources (New Jersey)

Industrial	25%
Commercial	100%
Residential	90%

Area Sources (New York)

Industrial	25-50%
Commercial	100%
Residential	70-85%

Default Stack Height *

Point Sources:

Fuel Burning	100 feet
Separate Process	50 feet

Line Sources: 0

Area Sources:

(as a function of population density)

$>$50,000 pop/mi^2	100 feet
10,000-50,000	50 feet
1,000-10,000	30 feet
$<$1,000 pop/mi^2	20 feet

*in each case the average effective stack height is 1.5 times the height shown; this is for a 4 m/sec wind speed and changes with wind speed as a function of the stability class.

developed from the 1965 - 1966 New York Abatement Region inventory. The 1990 percent space-heating figures were developed separately and are discussed in the section on the background area source inventory.

In addition to information on location of each source and emission rate for each of the five pollutants, the model requires information on stack height and plume rise factor. These are used to calculate the effective stack height in MARTIK for each source. The equation for determining plume rise is as follows:

$$\text{plume rise } (m^2/\text{sec}) = 0.0929 \times \text{velocity (ft/sec)} \times \text{Diameter (ft)} \times 1.5 + \left\{ 8.17 \times 10^{-4} \times 1000 \times \frac{\text{Temp } (^{o}K) - \text{Temp.ambient}}{\text{Temp}} \times \text{Diameter(ft)} \right\}$$

As a part of the data gathering for the current point source inventory information on stack height, diameter, exit velocity and exit temperature were obtained. In many cases, the information was not available and default parameters had to be used. These default parameters were developed in conjunction with the modeling decisions of Task 2: if any of the three parameters needed to develop plume rise were missing, the plume rise factor was automatically set at 1/2 times the height, multiplied by a wind speed of 4 meters per second. Within MARTIK, the plume rise is divided by wind speed (a function of stability class) to derive the effective stack height. Accordingly, the effective stack height used for modeling is variable with stability class but averages one and one-half the times the actual stack height in the default case.

Where stack height itself was not known, a default value of 100 ft. was used for fuel burning stacks, 50 ft. for separate process stacks and 100 ft. for combined stacks or cases where the stack type was not known.

Actual and effective stack height of 0 was used for all line sources. Very little information exists on what are the appropriate stack heights and effective stack heights to use for area sources, because of the multiplicity of sources contributing to an area-wide grid cell. A procedure was developed to relate the stack height to the population density of the cell under consideration. It was felt that population density was one of the most readily available parameters that could be used to indicate the general height of buildings for an area-wide source. Figure I-32 shows the assumed stack heights (also taken to be the effective stack heights) for various population densities representative of the study region.

One important but controversial feature of a land use planning methodology is the use of dimensional units which can be understood by the planner. Recent emission inventories have been assembled in both metric and English units. The units associated with the Meadowlands plans and the current state and federal inventories were mainly English units, and were used in this study unaltered. Although EPA is stressing the use of the metric system for all air pollution work, it is still necessary as part of a land use planning approach to use units that the planner currently works with. Accordingly, all calculations were performed in the units most commonly found in planning and related literature and then transformed as a final step to the metric units used by MARTIK. These consist of the following: For point source grams per second, for line sources grams per meter-second, and for area sources grams per meter^2 second. The figures in Part II of this report generally present point sources in units of tons, pounds or tons per year. Line sources are generally discussed in the transportation units of vehicle miles per day or vehicle miles per year, while area sources are usually presented as tons or pounds per square mile per year. In the discussion of the land use plans the areal unit, acres, is generally used.

PART II:

DISCUSSION OF THE EMISSION INVENTORIES

PREFACE TO PART II

Part II presents the discussion of each of the emission inventories, including the way in which they were developed, the problems encountered, areas for improvement, and a summary of the component data sets themselves. The actual data sets and their description are found in Appendix A and Appendix B; the reasons for developing the inventories in the manner chosen have been discussed in Part I.

The first section of Part II describes the overall emission catalog specifications and the interrelationships of the components of the inventories. The following two sections present the data associated with the current and background inventories. The final section of Part II covers the major efforts of the study: the actual application of the techniques to the Meadowlands plans and the translating of the activity data into emissions using the conversion factors catalog.

1. EMISSION CATALOG SPECIFICATIONS

1.1 AQUIP Emission Data Sets

Figure II-1 shows each of the emission data sets used in the study, together with the flow of information from these data sets to the inventories used as inputs to MARTIK. The creation of each labeled box for each of the emission inventories is discussed in the following sections. Furthermore, this figure illustrates the actual data sets which are discussed in the Appendix.

As can be seen from Figure II-1, the current emission inventory has three components: point, line, and area sources. The current inventory was used for three purposes. First of all, and most importantly, it was used for the validation runs from which the calibration constants were developed. Secondly, it provided some of the projective data used for the background emission inventory. Finally it provided projective data used in the actual conversion factors catalog for the Meadowlands plans. Similarly, the background emission inventory has three major components: point, line, and area, as well as a special separate component included for the Meadowlands Incinerator. Finally, the 1990 Hackensack Meadowlands plans each have three components: Point, line and area. The point and area inventories are created with the conversion factors catalog and the LANTRAN Program. Each plan's line sources are handled in a similar manner as the current and background line sources.

The right hand side of Figure II-1 shows three of the four components required to run MARTIK for 1990 air quality. The fourth component is the meteorological data.

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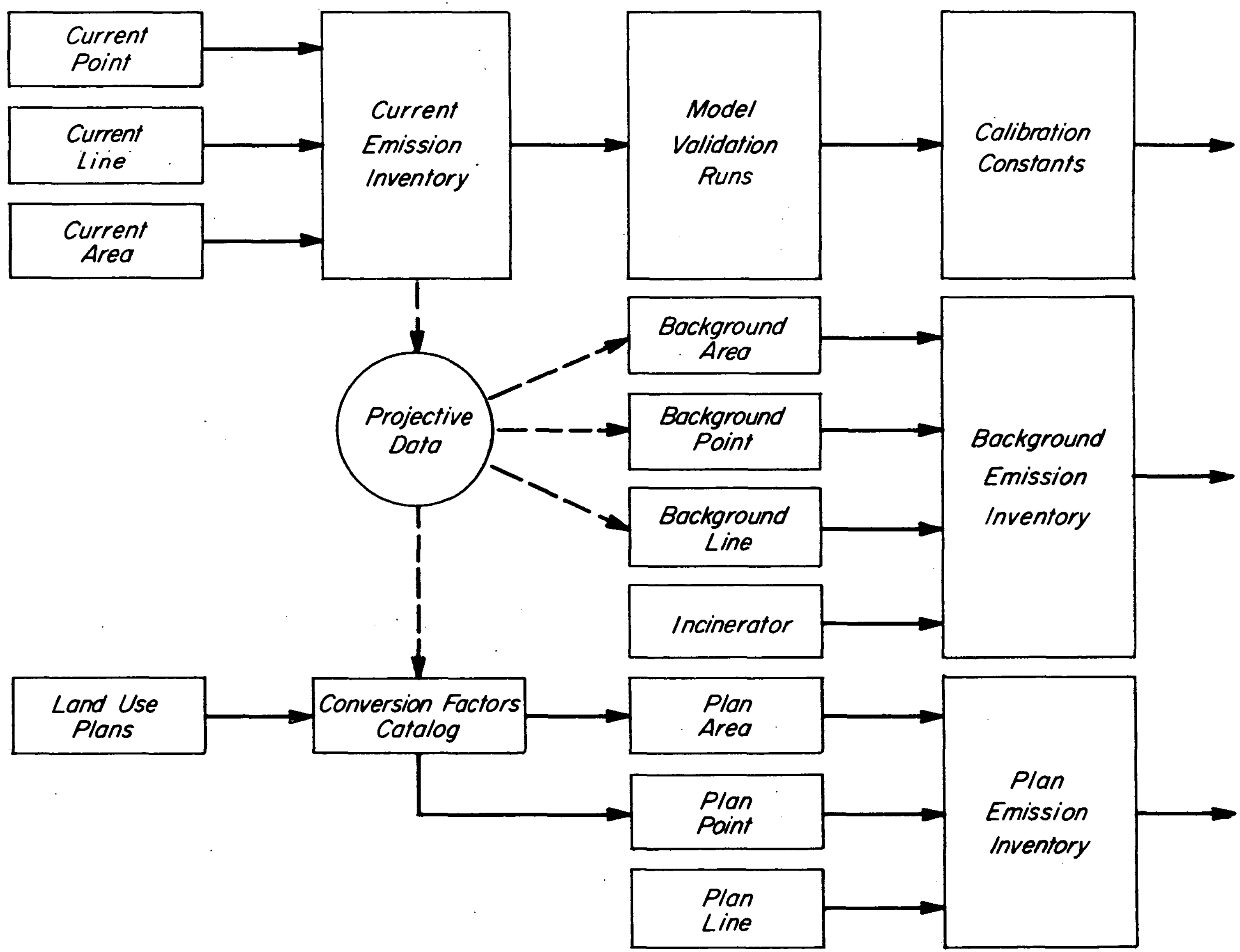


Figure II-1 Flow of Information for 1990 Model Inputs

1.2 Sources of Data

The most time-consuming part of the study was locating, obtaining, and verifying the information necessary to create the emission inventories. In Figure II-2, along the left side are listed the major agencies and other sources of information used. Along the top of the figure are listed categories of data which were obtained. In terms of a land use planning methodology this table is quite revealing, since information on only three categories of data were obtained from the planning agency, the Hackensack Meadowlands Commission. This included the majority of the data on the land use plans and some of the information on activity indices and the background point inventory.

The regional planning agency, the Tri-State Transportation Commission, was able to provide data on activity indices, fuel use, background point sources, and background area sources. The Environmental Protection Agency (EPA) provided information of a more national nature in the form of emission factors and standards, and of a regional nature for fuel use and current point sources. However, it was necessary to resort to local and state air pollution and other government agencies for a large portion of the data. The New Jersey Department of Environmental Protection and the New Jersey Department of Transportation we have heavily relied upon, as Figure II-2 shows. These data were supplemented with information from the New Jersey Bureau of Labor and Industry and the New York State Division of Air Resources, as well as the New York City Division of Air Resources.

The initial literature search was of great use in the areas of activity indices, fuel use, emission factors, background point sources,

	Plans	Activity Indices	Fuel Use	Emission Factors	Current Point	Current Line	Current Area	Background Point	Background Line	Background Area	Regulations	Standards
Hackensack Meadowlands Commission	X	X						X				
USEPA			X	X	X							X
N.J.Dept.Envir.Protection		X			X		X	X		X		X
N.J.Dept.of Transportation						X			X	X		
N.J. Bureau Labor & Industry		X						X				
N.Y.State Div.Air Resources					X		X			X		
N.Y.City Div. Air Resources					X		X			X		
Tri-State Transportation		X	X					X		X		
literature search		X	X	X				X			X	X
professional judgment	X	X			X		X	X		X		

Figure II-2

Relation of Sources of Information

regulations and standards. The last line indicates that professional judgment was a significant input in the interpretation of the plans, the development of activity indices, the interpretation of the current point and area source inventories, as well as the development of the background point and area source inventories. This indicates some of the areas where problems will be encountered in translating the results to other regions, because of the necessity of using state and local air pollution data, as well as the need for professional judgment.

In reviewing the following sections the assumptions and constraints discussed in Part I, Emission Projection Methodology, should be kept in mind. In particular, it should be stressed that the projecting indices had to be developed as well as applied as a part of this study; this affects the accuracy obtainable. Likewise, it should be stressed that the first priority was in preparing emissions inventories for the Meadowlands plans; all other emission inventories were subserviant to this task since they do not directly affect either the modeling or the performance of the AQUIP system.

2. CURRENT EMISSION INVENTORY

2.1 Components of the Inventory

The current emission inventory was divided into three components - point, line, and area sources - because of the separate model requirements and the availability of information. Point source information was constructed from existing federal and state inventories with individual source verification. Line source information was developed entirely from data supplied by a separate transportation agency. Finally, area source information was assembled from many sources to form a residual inventory when the most reasonable level of detail had been reached in characterizing the point and line sources.

The discussion of the point source inventory covers: (1) the sources of data; (2) approach to data acquisition; (3) development of the data; (4) types of information sought; (5) supplemental data required; (6) data completeness and quality; and (7) the use of default parameters. The discussion of the line source inventory covers the simple steps required to assemble and use the traffic data.

The section on the current area source inventory discusses: (1) data sources; (2) New Jersey fuel emissions; (3) New Jersey non-fuel emissions; (4) New York City emissions; (5) New York State emissions; (6) an inventory summary; and (7) accuracy of analysis.

2.2 Current Point Source Inventory

The major source of data for the point source inventory was the files of the New Jersey Department of Environmental Protection. From the Trenton office the following sources were utilized:

1. Initial screening of all large sources which included plant name, county location, UTM coordinate, average daily emission in tons/ day for particulates and SO_2.

2. Fuel consumption for all major point sources, annual quantities by fuel type as well as recent and projected changes.

3. The 1965-1966 and 1969 N.Y. Region EPA inventories. These questionnaires provided some information on operating schedules, fuel distribution and air pollution control data.

The second largest source of information was the enforcement files located in the department's field office. These files provided the most extensive information on stack parameters and separate process emissions. However, because of voluminous amounts of material contained in these files they were only examined for those sources nearest the Meadowlands (first 60 sources in Figure II-3).

The New Jersey Department of Commerce provided some projective information on plant employment, enclosed space and plant area. Additional employment data were provided by the New Jersey Department of Labor and Industry.

Another significant source of information was the 1969 regional update printout provided by EPA. This source provided the bulk of the point source inventory data for the New York-Connecticut region as well as many of the stack parameters for the zone 3 and zone 4 sources in New Jersey.

Figure II-3
Summary Information for all Point Sources
Current Inventory

	County	Zone	Disposition	Comments	Process	Code	Default Parameters* 1	2	3
1	Bergen	3				39		X	
2	Bergen	3				26			
3	Bergen	2	removed	< 100 tons					
4	Bergen	1				38		X	X
5	Bergen	2			X	36			
6	Bergen	2				26			
7	Bergen	1				28			
8	Bergen	2	removed	< 100 tons					
9	Bergen	1				49			
10	Bergen	2			X	28			X
11	Bergen	3	removed	insuffici-ent data					
12	Bergen	3				28			
13	Bergen	1				28		X	
14	Hudson	1			X	32			
15	Hudson	2	removed	< 100 tons					
16	Hudson	1				80		X	
17	Hudson	1	removed	< 100 tons					
18	Hudson	2			X	35			
19	Hudson	3			X	27		X	X
20	Hudson	3				44		X	X
21	Hudson	3				20		X	
22	Hudson	3	removed	< 100 tons					
23	Hudson	2	removed	< 100 tons					
24	Hudson	2			X	34		X	
25	Hudson	2			X	28			
26	Hudson	3	removed	< 100 tons					
27	Hudson	2				49			X
28	Hudson	1				49			X
29	Hudson	2				49			X
30	Hudson	2			X	34			
31	Hudson	2	removed	< 100 tons					
32	Hudson	3				40			
33	Hudson	2				36		X	X
34	Hudson	1			X	29		X	X
35	Hudson	3	removed	< 100 tons					
36	Hudson	3			X	28		X	
37	Hudson	3				32		X	
38	Hudson	3	removed	< 100 tons					
39	Hudson	3				40			
41	Hudson	3	removed	insuffici-ent data					
42	Hudson	3				39	X	X	X

*1 = height, 2 = plume rise, 3 = % process heat.

Figure II-3 Cont'd

	County	Zone	Disposition	Comments	Process	Code	Default Parameters* 1	2	3
43	Hudson	3	removed	< 100 tons		49-1			
44	Hudson	3		1970 data	X	29	X	X	
45	Hudson	3				20		X	X
46	Hudson	3		1970 data	X	29	X	X	X
47	Essex	3				28		X	
48	Essex	4	removed	< 500 tons					
49	Essex	3	removed	< 100 tons					
50	Essex	3	removed	< 100 tons					
51	Essex	3	removed	< 100 tons					
52	Essex	3				20	X	X	
53	Essex	3	removed	< 100 tons					
54	Essex	2							
55	Essex	2	removed	< 100 tons					
56	Essex	2				20		X	
57	Hudson	2				33		X	
58	Hudson	2				30			
59	Hudson	3				28		X	
60	Hudson	2				28		X	X
61	Hudson	3	removed	< 100 tons					
62	Essex	3				28		X	X
63	Essex	3	removed	< 100 tons					
64	Hudson	3	removed	insufficient data					
65	Hudson	2			X	28			
66	Hudson	3	removed	< 100 tons					
67	Hudson	3				20		X	X
68	Passaic	3				26			
69	Passaic	3				30		X	
70	Passaic	3				30			
71	Passaic	3				34	X	X	X
72	Passaic	3			X	34	X	X	X
73	Passaic	3				28	X	X	X
74	Passaic	3				28		X	X
75	Passaic	3	removed	insufficient data					
76	Passaic	3	removed	insufficient data					
77	Passaic	3				30			
78	Bergen	1	removed	< 100 tons					
79	Passaic	3	removed	insufficient data					
80	Bergen	4				26		X	
81	Union	4			X	28			
82	Union	4			X	28			
83	Union	4			X	28			
84	Union	4		1970 data	X	29	X	X	

*1 = height, 2 = plume rise, 3 = % process heat.

Figure II-3 Cont'd

	County	Zone	Disposition	Comments	Process	Code	Default Parameters * 1	2	3
85	Union	4			X	28		X	
86	Union	4				49			
87	Union	4				26			
88	Union	4			X	28			
89	Union	4	removed	< 500 tons					
90	Unio	4	removed	< 500 tons					
91	Bergen	4			X	35	X	X	
92	Bergen	4	removed	< 500 tons					
93	Bergen	4	removed	< 500 tons					
94	Bergen	4	removed	< 500 tons					
95	Essex	4	removed	< 500 tons					
96	Union	4	removed	< 500 tons					
97	Passaic	4				26		X	
98	Morris	4				26			
99	Essex	4			X	39			
100	Morris	4				28		X	X
101	Morris	4				90			
102	Middlesex	4	removed	< 1000 tons					
103	Middlesex	4			X	28			
104	Middlesex	4		1970 data	X	29			
105	Middlesex	4			X	33			
106	Middlesex	4		1970 data		49		X	
107	Middlesex	4				49			
108	Middlesex	4	removed	unresolved emissions					
109	Middlesex	4			X	33			X
110	Middlesex	4		1970 data		49		X	
111	Middlesex	4			X	33			
112	Middlesex	4			X	28	X	X	
113	Middlesex	4		1970 data	X	29			
114	Middlesex	4			X	39		X	
115	Somerset	4			X	39			
116	Somerset	4	removed	< 1000 tons					
117	Somerset	4	removed	< 1000 tons					
118	Somerset	4	removed	< 500 tons					
119	Somerset	4			X	28			X
120	Bronx	4				49			
121	Queens	4				49			
122	Queens	4				49			
123	Richmond	4				49			
124	Manhattan	3				49			
125	Manhattan	3				49			
126	Manhattan	3				49			
127	Manhattan	3				49			
128	Manhattan	3				49			
129	Manhattan	3				49			
130	Manhattan	3				49			
131	Brooklyn	4				49			

*1 = height, 2 = plume rise, 3 = % process heat

Figure II-3 Cont'd

	County	Zone	Disposition	Comments	Process	Code	Default Parameters* 1	2	3
132			removed	insufficient data					
133			removed	shutdown					
134			removed	insufficient data					
135	Nassau	4				49			
136	Queens	4				49			
137	Nassau	4				49			
138	Rockland	4				49			
139	Connecticut	4				49			
140	Connecticut	4				49			
141	Westchester	4				49			
142	Connecticut	4				49			
143	Connecticut	4				49			
144	Connecticut	4				49			
146	Westchester	4				49			X
147	Connecticut	4				34			X
148	Westchester	4				35			X
149	Rockland	4	removed	< 1000 tons					
150	Richmond	4				28			X
151	Bronx	4				49-1			
152	Queens	4				49-1			
153	Bronx	4				49-1			
155	Brooklyn	4				49-1			
156	Brooklyn	4				49-1			
157	Nassau	4				49-1		X	
158	Nassau	4				49-1			
159	Nassau	4				49-1			
160	Manhattan	3				49-1			
161	Manhattan	3				49-1			
162	Manhattan	3				49-1			
163	West chester	4				49-1			
164	Brooklyn	4	removed	< 1000 tons					
165	Rockland	4				80			
166	Brooklyn	4	removed	< 1000 tons					

*1 = height, 2 = plume rise, 3 = % process heat.

Figure II-3 Cont'd

	County	Zone	Disposition	Comments	Process	Code	Default Parameters* 1	2	3
167	Richmond	4				80			
168	Manhattan	3				80			
169	Manhattan	3				80			
170	Brooklyn	4	removed	< 1000 tons					
171	Middlesex	4		1970 data	X	35	X	X	X
172	Middlesex	4	removed	< 1000 tons					
173	Union	4		1970 data	X	34			X

Notes:

Zones defined in Part I, Figure I-10; criterion for removing sources from point source inventory related to the zone.

1969 data used except where noted that 1970 data were used.

An "X" under process means that the source has separate process emissions (excludes incinerators).

An "X" under default parameters means that the data were missing and a default parameter for the value had to be used.

Code is the activity code assigned to each source as follows:

- 20-39 Manufacturing sources - corresponds to the 2-digit SIC (Standard Industrial Classification) Codes used by the U.S. Census.
- 40 Warehouse, distribution, etc.
- 44 Railroad
- 49 Power plants
- 49-1 Incinerators
- 80 Hospitals, other institutions
- 90 U.S. Government facilities

The New York City Environmental Protection Administration and the New York State Department of Environmental Conservation were also contacted. The latter provided clarification of the New York data contained in the 1969 EPA regional update.

2.2.1 Approach to Data Acquisition

Figure II-3 shows the summary information for all point sources in the current inventory. The county name, AQUIP zone number, and two-digit SIC code are included. The approach to data acquisition for the point sources as well as the sources of information (as shown in Figure II-2) for point sources depended upon the location of the various points with respect to the four AQUIP zones. In general, effort was concentrated on those sources which are closest to the Meadowlands region. For these points it is felt that all possible data sources have been exhausted and that the most complete set of consistent data available has been compiled. For those sources in the outer reaches of Zone 3 and for all sources in New York and Connecticut information from the appropriate state and federal agencies was relied upon, and only a minimum of original work was performed as a part of the study to supply missing information.

2.2.2 Development of the Data

The completion of the point source inventory included assembly of the useful information from the above-mentioned sources as well as initial generating of some of the input. Input from the study was concentrated on those sources in zones 1 and 2 and the inner region of zone 3. The inventory was developed roughly as follows:

Sources 1-60

The largest amount of time was spent on these sources since they are located within and immediately surrounding the Meadowlands. An onsite inspection was made of each of these sources to determine their exact location. These locations were plotted, in the field, on USGS series 1:20,000 topographic maps which contain the UTM coordinate system. In this manner the exact location of each source was determined. The fuel data were provided by the New Jersey Dept. of Environmental Protection with some small supplement for fuel consumption by power plants. The Trenton files of the NJDEP as well as the enforcement files in Springfield, N.J., were examined in detail for each of these sources. The Trenton files produced the information on operating schedules and fuel distribution. The enforcement files produced most of the stack parameters and separate process emission data. Some stack parameters were obtained from the 1969 regional update printout. The Commerce Data Guide gave the only information on enclosed space and gross plant area that could be obtained; it also contained much of the information on plant employment. The remaining employment data were obtained from the Bureau of Labor and Industry. Emissions of the five pollutants were generated in the study directly from the fuel data using standard emission factors and employing the current 1969 N.J. fuel regulations.

Sources 61-119 and 171-173

These sources are located in the outer regions of zones 3 and 4. This information was largely accepted without modification from the central office files of the New Jersey Department of Environmental Protection.

This information included all aspects of plant location, the emissions for particulates and SO_2, the fuel data and separate process emission. Some stack parameters for the largest sources were obtained from the EPA 1969 update. The study team prepared the emissions inventory for CO, HC and NO_x from fuel burning based on the current emission factors.

<u>Sources 120-170</u>

These sources are located in New York and Connecticut. The entire inventory was taken from the 1969 EPA regional update printout. The study team again generated the emissions for CO, HC and NO_x from fuel burning using standard emission factors.

2.2.3 Types of Information Sought

The data search for point sources, particularly in the New Jersey portion of the study area, was very comprehensive in view of the importance which this part of the inventory has to the total program. The following types of information were sought, particularly for New Jersey sources examined in detail:

<u>Plant Name and Location</u>

The current name of each plant is very important since many of the country's largest corporations are included in our inventory and these companies have plants at several locations in the region; only some of which are major emitters. The correct municipality and county location for each plant is necessary because incorrect location of a major source can cause discrepancies in county totals, producing large errors in the area source inventory derived therefrom. The UTM coordinate location is used to reference each source for modeling purposes.

Stack Parameters

Standard stack parameters sought for each of the sources included the total number of stacks at each location and the designation of each as a process stack or a fuel-burning stack; the maximum spread between individual stacks; and the plume rise parameters of stack height, stack diameter, exit gas temperature, exit gas velocity and mass flow rate.

Fuel Data

The total 1969 consumption by each plant of the four major fuels, coal (anthracite and bituminous), residual oil, distillate oil and natural gas was sought. In addition, any information on seasonal usages of individual fuels was sought.

Plant Operation Schedule

The plant operating schedule was sought. This included the number of eight hour shifts per day; the number of days operated in the week and the number of weeks operated annually. The percentage of fuel burned for space heating and for process operation was also sought. This factor provides an estimate of that part of the fuel burning emission that is constant and the part which varies with ambient temperature.

Boiler Data and Air Pollution Control Equipment

This information was concerned with coal burning boilers only. For these boilers the burner configuration was determined, as was the rated capacity in millions of BTUs per hour which affects emission potential, and the type and efficiency of particulate collection equipment which affects the controlled emissions.

Separate Process Data

For those sources that have separate process emissions the average process rate was sought; this usually is stated in terms of tons of product produced by each process on an hourly time basis. In addition, the average emission of the five pollutants from each process source was sought.

Projecting Data

In addition to the process rate, other information was sought relative to the point sources which would be useful for projection of both existing point sources and any new ones that might emerge in the Meadowlands. These parameters include the identification of the various products produced at each plant, the number of employees at each plant, the gross plant area, and the total enclosed space.

2.2.4 Supplemental Data

At the Milestone 4 meeting a list of the 60-odd New Jersey point sources in zones 3 and 4 was submitted to the NJDEP and assistance requested in filling in missing data. The additional information received was incorporated into the inventory. A final check with the department (over some of the larger sources) was required prior to finalizing the inventory. This resulted from some discrepancies in county total emissions. The result of this check were changes in some of the separate process emissions. Figures II-4 and II-5 show the fuel emissions and process emissions for each source. Figure II-4 also shows fuel emissions from New York and Connecticut sources; no point source process emissions outside New Jersey met criteria for inclusion.

Figure II-4

1969 Point Source Fuel Emissions

Source ID	Particulates	SO_2	CO	HC	NO_x
New Jersey -Zone 1					
4	63	432	-	9	204
7	64	445	-	8	202
9	2600	74800	988	322	32700
13	61	419	-	10	204
14	20	-	4	44	253
16	32	218	-	4	99
28	1400	61200	516	990	28700
34	175	120	10	5	80
-Zones 2 & 3					
1	103	714	-	14	324
2	35	238	-	5	108
5	582	1590	80	1	632
6	230	938	38	4	383
10	41	282	-	5	128
12	96	664	-	13	303
18	142	355	10	2	219
19	12	85	-	2	39
20	40	278	-	5	126
21	105	857	51	67	652
24	35	246	-	5	113
25	39	240	-	14	164
27	1620	27600	8	1010	21400
29	375	6420	2	218	4920
30	1020	162	60	9	152
32	1450	921	34	7	614
33	75	517	-	10	234
36	20	-	-	46	200
37	102	687	-	20	350
40	2640	418	31	16	232
42	46	319	-	6	144
43*	1038	501	157	241	435
44	1590	5490	14	208	4140
45	76	527	-	10	243
46	44	160	-	6	137
47	212	1470	-	29	630
52	67	460	-	9	208
54	1030	17400	6	680	13800
56	138	954	-	18	432
57	53	364	-	7	168
58	95	655	-	12	297
59	51	349	-	7	162

units are 10^3 pounds of pollutant per year; * means incinerators

Figure II-4 Cont'd

Source ID	Particulates	SO_2	CO	HC	NO_x
60	168	1160	-	22	525
62	58	434	-	8	183
65	24	165	2	3	75
67	174	1210	-	23	546
68	207	1430	-	27	648
69	51	356	-	7	161
70	1510	240	9	27	303
71	32	219	-	4	99
72	27	187	-	4	85
73	41	286	-	5	130
74	46	318	-	6	144
77	4760	756	28	56	504
-Zone 4					
80	161	1110	1	21	504
81	11	87	-	2	39
82	115	795	1	15	360
83	400	2770	3	52	1250
84	1230	8520	11	161	3860
85	345	2380	3	45	1080
86	143	22000	21	314	7530
87	386	1740	-	7	176
88	6	44	-	-	20
91	161	1110	1	21	504
97	771	5330	-	7	178
98	770	5340	7	101	2410
99	2	13	-	-	10
100	221	1530	2	29	691
101	2430	1770	93	47	701
103	5340	4950	240	152	2570
104	401	1170	4	184	1490
105	282	1440	2	42	752
106	1380	26700	595	423	21500
107	594	13700	141	306	9720
109	236	2800	-	12	229
110	1770	45600	26	158	30800
111	529	3660	5	69	1660
112	2420	2240	118	59	885
113	1590	5490	1	216	4190
114	169	280	1	22	528
115	545	3600	5	68	1630
119	3620	22100	1	-	9
171	81	560	-	11	254
173	22	151	-	3	68

units are 10^3 pounds of pollutant per year; * means incinerators.

Figure II-4 Cont'd

Source ID	Particulates	SO_2	CO	HC	NO_X
New York					
-Zone 3					
124	686	8120	14	2070	4960
125	1320	18600	26	393	9430
126	577	7380	2	288	6040
127	431	4910	9	129	3100
128	1010	11500	20	301	7230
129	4640	19300	54	428	11500
130	458	3800	6	92	2230
160*	1340	298	198	298	397
161*	2530	702	467	702	936
162*	3430	503	335	503	670
168	132	1560	1	20	476
169	1510	117	1	17	418
-Zone 4					
120	1380	18400	-	690	14500
121	4350	68600	1040	1230	78500
122	6240	66100	1760	613	101000
123	2830	41300	1010	386	57200
131	2970	39600	60	894	21400
135	905	25600	112	728	20500
136	445	5940	9	134	3220
137	17	27200	3	430	9040
138	5980	42200	543	257	33000
141	379	5470	8	114	3030
146	11200	4800	54	17	3000
148	934	2190	-	46	982
150	174	2000	-	73	1050
151*	1090	109	73	109	145
152*	2750	402	268	402	535
153*	8080	950	633	950	1270
154*	8770	1030	687	1030	1370
155*	5350	667	445	667	890
156*	8510	1000	667	1000	1330
157*	5410	720	480	720	960
158*	2630	438	292	438	585
159*	4100	548	365	548	730
163*	1200	160	107	160	213
165	2460	1500	219	66	131
167	3460	1730	292	88	175

units are 10^3 pounds of pollutant per year; * means incinerators.

Figure II-4 Cont'd

Source ID	Particulates	SO_2	CO	HC	NO_x
Connecticut -Zone 4					
139	646	87000	850	256	46800
140	5840	84800	730	538	46800
142	795	6340	60	305	9180
143	1200	3280	48	15	2660
144	2360	77800	1	174	3700
145	1700	22600	3	342	7200
147	212	3240	-	45	944

units are 10^3 pounds of pollutant per year

Figure II-5

1969 Point Source Industrial Process Emissions

Source ID	Particulates	SO_2	CO	HC	NO_x
New Jersey					
-Zone 1					
14	432				
34	840				
-Zones 2 & 3					
5	21				
10				20	
18	536				
19				7300	
24	860				
25	172	28			
30				2600	
36	332				
44	100			400000	4140
46				4350	
65	189	3090			
72				3300	
-Zone 4					
81		8480			
82	39	850			
83	1230	1140			
84	2800	13300	4760		
85		228			
88		6800			
91				3200	
99	3370				
103					2300
104	900	3030	155000	5760	
105	142	112			44
109	1180				
111	9990				
112	29000			84	
113				18700	
114			2080	2500	
115	472				
119		10000			
171				1800	
173			4400	3880	

units are 10^3 pounds of pollutant per year

2.2.5 Data Completeness and Quality

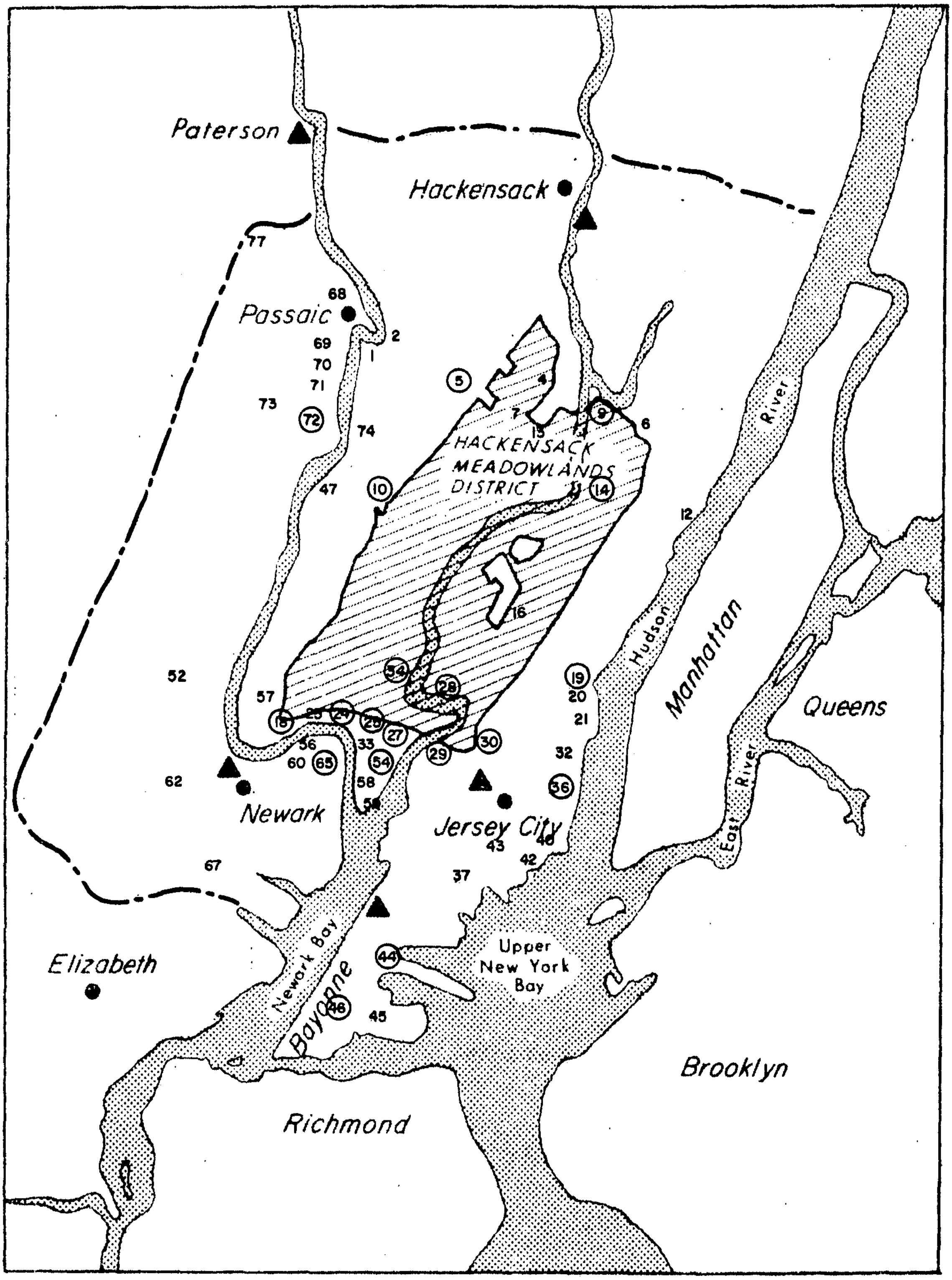
Some general comments on the completeness and quality are necessary at this point. The information used in the inventory is complete in some aspects and very spotty in others. In terms of the general information categories sought the data used have the following quality.

Locations

Field inspection of the Meadowlands and surrounding areas provided a check on the completeness and locations of the initial point source list provided. With a few exceptions -- for some plants which appeared to be significant emitters and for a few minor changes in UTM locations -- the inspection confirmed these data. The point source locations for zones 1 through 3 are shown in Figure II-6. It is assumed that the information for the balance of the N.J. region is at least as good. The location of some of the New York City power plants was checked against base maps, and again reasonable agreement was found. The data on point source screening and location is considered to be good.

Stack Parameters

About 75 percent of the stack heights for the point source list could be obtained. For the balance of the required stack parameters fewer than 50% were available. (These are shown as parameters 1 and 2 in Figure II-3.) There was no way to check the accuracy of any of these other than visual observation. The New York stack parameters had fewer missing values, but there was no way of checking the accuracy or completeness of that inventory. The stack data are considered to be poor.



Note: Locations are only schematic,
Power Plants and Process sources are circled; numbers refer to the source ID used in the study.

Figure II-6 New Jersey Point Sources for Zones 1 through 3

Fuel Data

The fuel data for all point sources in New Jersey and New York was quite complete. The New Jersey information compared well with the county-wide totals after adjustments were made through consultation with the NJDEP. The New York data could not be checked as completely. The information is considered to be excellent.

Plant Operation and Seasonality

Fuel distribution data (space heating versus process heating) were available for about 50% of the New Jersey firms and for none of those in New York and Connecticut. (This is shown as parameter 3 in Figure II-3, for industrial sources.) However, since fuel distribution information is obtained from subjective estimates of the various plant managers, and there is no consistency in this information it is considered to be questionable. The operating schedule information is good and quite complete as shown by parameter 2 in Figure II-7.

Separate Process Data

Since separate process information does not lend itself to emission factor analysis as well as do fuel burning emissions, it was not possible to check the accuracy of these emissions. Several estimates were obtained from different sources and for different time periods for many of the industrial process emitters in the inventory; some of the data, particularly for refineries were for 1970, rather than 1969. The discrepancies in these separate findings are very large. There are other industrial sources, whose operations indicated significant process emission, for which no record of process emission was available from any source.

Figure II-7

Point Source Activity Data

Source ID	Parameters 1	2	3	4	5	10^3 BTU/employee/hour Heat Demand
Zone 1						
4		a	x			
7	x	x	x	x		24
13	x	x	x		x	36
14	x	x	x	x	x	16
16	x	x	x			27
34			x	x		
Zone 2 & 3						
1	x	x	x			370
2	x	x	x			10
5	x	x	x		x	25
6	x	x	x			80
10			x			
12	x	x	x			130
18	x	x	x		x	16
19			x			
20			x	x		
21	x	x	x		x	5
24	x	x	x			72
25	x	x	x			16
30	x	x	x			310
32	x	x	x			460
33		x	x		x	
36	x	x	x			140
37	x	x	x	x		0
40	x	x				
42		a	x			
44	x	x	x			24
45			x			
46			x			
47	x	x	x	x		56
52	x		x			
56	x	x	x	x		26
57	x	a	x	x	x	
58	x	x	x	x		28
59	x	x	x			6
60			x			
62			x	x	x	
65	x	x	x			20
67			x	x		
68	x	x	x			12

Figure II-7 Cont'd

Source ID	1	2	3	4	5	10^3 BTU/employee/hour Heat Demand
	Parameters					
69	x		x			
70	x	x	x			230
71		x	x			
72		a	x			
73			x			
74			x			
77	x		x			
Zone 4						
80	x	x	x	x	x	23
81	x	x	x	x		3
82	x	x	x	x		0
83	x	x	x	x		50
84	x	x	x	x		0
85	x	x	x			67
87	x	x	x			78
88	x	x	x			53
91	x	a	x			
97	x		x			
98	x	x	x			11
99	x	x				0
100		x	x			180
101	x	x				
103	x	x	x			42
104	x	x	x			710
105	x	x	x	x		62
108	x		x			
109		x	x			
111	x	x	x			240
112	x	a	x			
113	x	x	x	x		3100
114	x		x			
115	x	x	x			12
119			x			
171		a	x			
173		a				

Notes to Figure II-7

parameters: 1 - percent fuel for space heating
2 - hours of operation per yeat
3 - number of employees
4 - gross area
5 - enclosed plant area

An 'x' means that the information was available.

Figure II-7 Cont'd

Estimates were made as follows:

for percent heating, SIC 20-29, 10%
SIC 30-39, 25%
Institutional , 90%

for hours of operation, if marked with an "a", 4800 hrs.
all others, 8736 hrs.

Heat Demand is 10^3 BTU/employee/hour for space heating only and is derived from fuel use and the first three parameters.

The separate emission data are considered to be poor. The information is presented in Figures II-3 and II-5.

Projective Data

Of the four projective factors sought (in addition to stack and fuel distribution information) -- production rates, employment, enclosed space, and gross plant area -- only the data received on employment were sufficient to be of any use. We believe this category to be poor in general, as shown under parameters 3 through 5 in Figure II-7. No consistency in heat demand per employee per square foot could be found (Figure II-7), making it impossible to develop projective parameters by industrial category.

2.2.6 General Comments on Future Information Gathering

In view of the apparent weakness of the inventory as regards separate process data and projective information, it is necessary to comment on the reasons for this and how subsequent studies of this type might improve the quality of the information.

The New Jersey Air Pollution Control Program, as well as those from most states, is based on compliance with specific emission control regulations. In connection with each regulation, there are specific forms and procedures to determine compliance. However, unless a complaint against a particular source is filed, the department is not authorized to enter private property to gather information. Complaints may originate from private citizens or may be initiated by the Department in the course of their areawide surveillance activities. In the process of checking a complaint, it is not standard practice to check for all violations of the code but rather to concentrate on the specific complaint.

In the course of making their inspection the inspectors take comprehensive information including, in some cases, source testing. From these forms and appendixed material comes the most detailed information on specific sources. However, since not all large sources have been flagged for violations, many sources do not have these detailed forms.

In addition, the department periodically makes statewide surveys of major sources using questionnaire and follow-up procedures. While the information requested in these forms is often valuable, the procedure places heavy emphasis on the cooperation and judgment of individual plant managers. These people have no direct positive incentive for compliance or completeness of their information, often cannot spend the time to gather the required information, and often are not technically competent to provide the required information. Therefore much of the information requested often is not provided. An alternate approach that was brought to light too late in the study to be adopted was the use of a limited telephone canvas of the major firms requesting the required information on production rates, employment, plant area and enclosed space. Since this information does not directly affect emissions, there would be no reason for the appropriate company official to refuse. However, since the study team was requested not to contact industrial firms directly, this procedure was not used in the study.

2.2.7 Default Parameters

In place of missing data, default parameters were substituted to expedite subsequent work (as specified in the methodology). These parameters were developed from the balance of the inventory and the experience of the project members. Figure II-3 shows which sources required default parameters for stack height, plume rise, and percent fuel used for process heat. The default parameters themselves are shown in Figure I-32.

Size criteria were established for each state and zone as shown in Figure I-11. When these criteria were applied to the current point source inventory several sources were removed as shown in Figure II-3. In a few cases sources were removed due to insufficient data for determining reasonable emission levels.

Emission rates for each source for the summer and winter seasons were developed from the numbers in Figure II-4 according to the percent of fuel used for space heating and the number of degree days per season shown in Figure I-32.

2.3 Current Line Source Emission Inventory

Motor vehicle emissions were represented as line sources in this study only for zones 1 and 2. For other portions of the region motor vehicle emissions were characterized as area sources. The 1969 emissions were determined almost entirely from data supplied by the New Jersey Department of Transportation. This consisted of vehicle counts per day by highway links for 1969. These links are shown in Figure II-10. Figure II-8 shows a summary of the line source parameters for both 1969 and 1990.

Since the published emission factors vary by speed and vehicle type, it is usually necessary to determine vehicle counts for each link according to speed and vehicle type. The first assumption made was that for the entire study region an average urban speed of 25 mph would not introduce significant error. Therefore, the EPA Urban Emission Factors could be used directly and it was not necessary to vary emissions with speed. Secondly, vehicle type was derived empirically from vehicle counts taken

Figure II-8

Summary of Line Source Parameters

Source ID	Road Type	1969 Veh.	Estimate Code	1990 Veh.	Est.Yr.&Veh.	
1	A	85		122		
2	A	49		86		
3	A	83		137		
4	B	-	2	28		
5	B	-	2	23		
6	A	-	1	106		
7	B	37		34		
8	B	40		71		
9	B	45		63		
10	B	33		73		
11	B	45		54		
12	B	65		64		
13	A	39	8	120		
14	C	28	4,7	40	(87)	39
15	B	-	2	20		
16	B	-	2,7	20	(87)	18
17	C	36	7	50	(87)	46
18	C	-	2	11		
19	C	17	7	15	(80)	14
20	B	44	7	60	(80)	49
21	C	25	7	25	(85)	26
22	A	39	8	40		
23	A	-	1	80		
24	C	32		45		
25	B	-	2,7	25	(85)	16
26	B	8	4,7	35	(85)	27
27	B	36	7	50	(80)	40
28	B	33	7	60	(85)	52
29	A	39	8	40		
30	B	86	7	100	(80)	86
31	B	13	7	18	(80)	15
32	B	68	7	120	(85)	109
33	B	89		110		
34	B	8		22		
35	A	-	1	43		
36	B	93	3	131		
37	B	85	3	115		
38	B	93	4	131		
39	C	30	4	42		
40	B	85	4	115		
41	C	-	2	19		
42	B	85		106		
43	B	170	3	213		
44	C	18	5	27		
45	B	36		57		
46	A	75		79		

Veh. units are 10^3 vehicle counts/day (both directions)

Figure II-8 Cont'd

Source ID	Road Type	1969 Veh.	Estimate Code	1990 Veh.	Est.Yr.&Veh.
47	B	33	4	51	
48	B	-	2	26	
49	C	48	6	62	
50	B	15	6	34	
51	B	18		40	
52	B	18		40	
53	C	18	5	27	
54	A	75		79	
55	B	-	2	26	
56	A	-	1	47	
57	A	-	1	47	
58	A	-	1	93	
59	B	30		50	
60	B	12		82	
61	B	30		50	
62	C	64	4,6	82	
63	A	20		73	
64	B	12		14	
65	A	-	1	67	
66	A	-	1	67	
67	A	75	3	174	
68	B	50	5	76	
69	B	-	2	52	
70	C	-	2	52	
71	C	-	2	26	
72	B	-	2	128	
72	A	-	1	67	
74	C	-	2	60	
75	C	-	2	50	

Notes

Estimate Codes:

1 = future construction - used for 1990 only

2 = insufficient data for 1969 - used for 1990 only

3 = incomplete data for 1969 - estimated as equalling adjacent link

4 = incomplete data for 1969 - estimated from ratio of adjacent link for 1969 & 1990 values

5 = incomplete data for 1969 - no sound basis for estimate

6 = incomplete data for 1990 - estimated from adjacent links

7 = incomplete data for 1990 - estimate from 1980, 1985 and 1987 vehicle data according to balanced network.

8 = incomplete data for 1969 - estimated from N.J. Turnpike data.

Determination of vehicle mix:

Road type	% auto and light truck	% heavy duty truck	% diesel
A	84	12	4
B	81	14	5
C	65	20	15

by the New Jersey Department of Transportation at about 10 sites in and around our region of interest. From this information three categories of road use were developed, termed A, B, and C as shown in Figure II-8. Type A represents the highest percentage of automobile and light truck such as would be found on an interstate highway. Type B represents an intermediate percentage of automobile usage such as would be found on major roads like Route 3. Finally, type C represents high truck usage such as would be found in an industrial area containing local service roads. The actual percentage breakdowns for auto and light truck, heavy duty truck and diesel usage as found empirically are shown in the notes to Figure II-8.

Although estimates have been made by the New Jersey Department of Transportation (NJDEP) of vehicle counts for almost all the links shown in Figure II-10 for 1990, no information was available for many of the links for 1969. Accordingly, estimates were made for all links within zone 1. Where information was not available for links in zone 2, these were left out of the 1969 inventory. Figure II-8 shows the codes for the different forms of estimation procedure used. For some cases, as shown by code 1, future construction was involved and therefore there were no emissions for 1969. In other cases however, as shown by codes 3, 4, and 8, estimates were made from New Jersey Turnpike data or adjacent links for which information was known. In a number of cases, as shown by code 5, no sound basis for an estimate existed; therefore, an estimate was made in conjunction with the New Jersey Department of Transportation. Using the vehicle counts shown in Figure II-8 the emission factors in Figure I-30, and the vehicle mix by road type shown in Figure II-8, the emissions were calculated for each link. These are summarized in Figure II-9.

FIGURE II-9

Summary of Line Source Emissions

	10^6	10^6 pound/year				
	Veh-Mi/Yr	Particulates	SO_2	CO	HC	NO_x
1969						
-Zone 1	505	0.7	0.2	69.5	6.5	7.5
-Zone 2	453	0.6	0.2	63.0	5.9	6.8
1990						
-Zone 1	930	0.7	0.4	10.3	0.9	1.4
-Zone 2	931	0.7	0.4	10.3	0.9	1.4

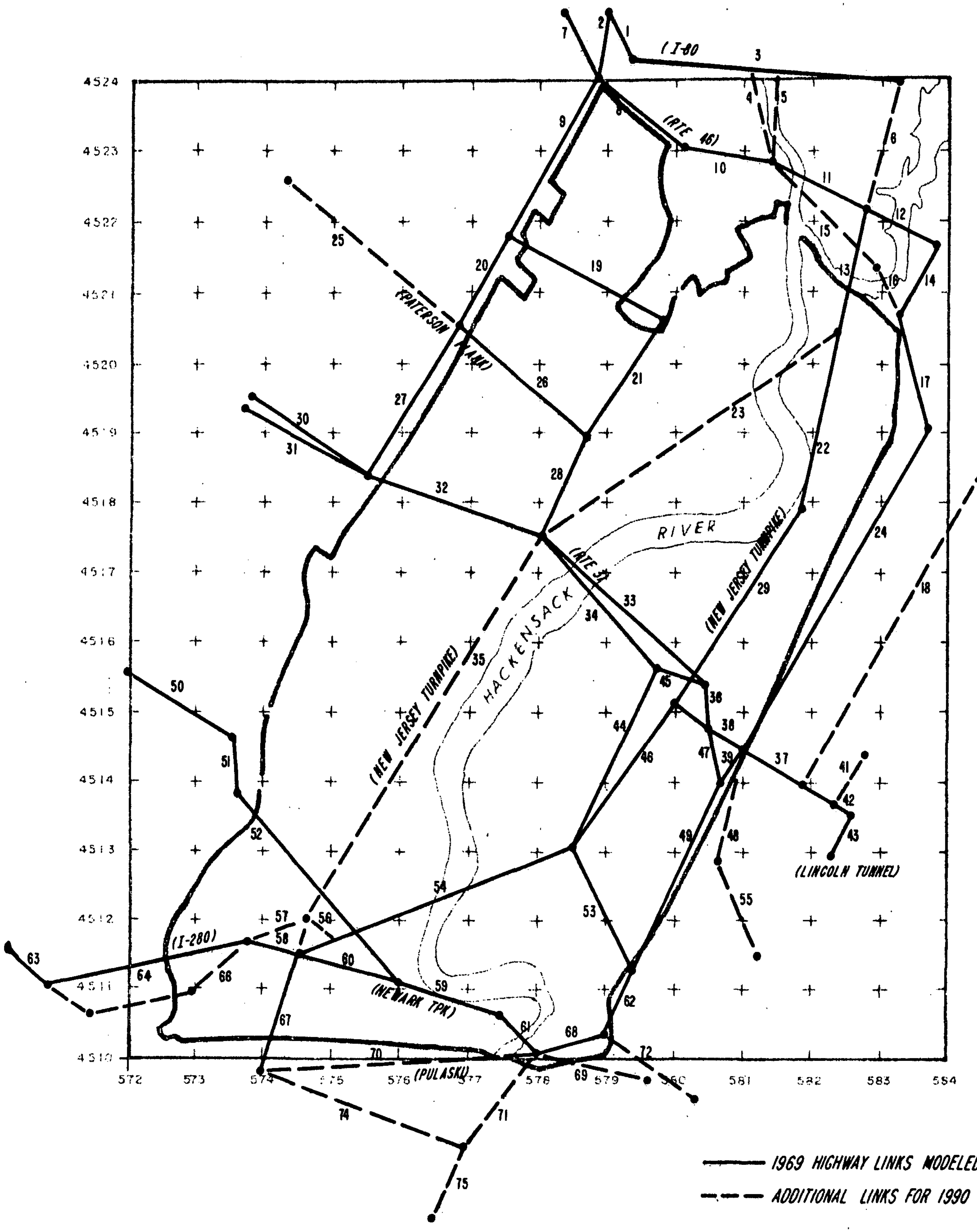


Figure II-10 Planned Highway Links for 1969 and 1990

Note: Numbers refer to source ID for each link.

Information on monthly variation in vehicle flow for this area was obtained from the New Jersey Department of Transportation. It showed that for road types A, B, and C in the study area, no more than 2% variation could be found between the summer, winter and annual average vehicle flow. Therefore, the same emissions were used for the summer and winter seasons. As shown in Figure I-32 a stack height and plume rise of zero were assumed for motor vehicle emissions modeled as line sources.

2.4 Current Area Source Emission Inventory

Although the current point source inventory required the greatest effort because of the amount of information involved, the current area source inventory involved more subjective input. It had been the original intention to develop a reasonable area source inventory from existing information particularly the 1965, 1966 and 1969 federal inventories for the New York Abatement Region. However, it became evident near the beginning of the study that this would not be possible for several reasons:

1. There were considerable changes in fuel use patterns from 1965 to 1969. This precluded the use of most of the 1965 and 1966 detailed fuel use information for the current inventory.

2. The procedures used to derive intermediate fuel and emission totals in the federal inventories were not always available nor readily usable.

3. The 1969 federal regional update was of little use insofar as the area sources were concerned because it consisted of a grid cell by grid cell proportional update of the 1965/1966 data.

4. Since, by definition, the area source inventory was the residual of total emissions minus those specified as point and line sources, and, since new point and line source inventories had been developed in the study, it was necessary to derive a new residual set of sources.

Therefore, it was decided to use the best available current state information to develop the area source inventory. This consisted of the following:

1. For New Jersey, 1969 fuel use information by counties and source categories, and a mix of 1969 and 1970 non-fuel emissions by counties.

2. For New York City, total emissions by four categories for the five boroughs combined.

3. For the remainder of New York State, a breakdown by source category of emissions for each county; some of this information was for 1970 rather than for 1969.

It is, therefore, evident that we have neither a consistent set of information for each county nor consistency within the nominal year for the inventory. In general, we have reasonable estimates of fuel emissions for all counties for 1969 but varying degrees of accuracy for the non-fuel emissions. It was not possible to obtain a more recent data base than the 1965/1966 one or greater detail than the county breakdown used.

2.4.1 New Jersey Fuel Emissions

The New Jersey fuel-related emissions were developed from county fuel use totals supplied by the New Jersey Department of Environmental Protection. These totals included fuel use for both point and area sources; therefore, it was necessary to subtract out point source fuel use by county from the total. When this was done it was discovered that for a number of counties there was more coal used by point sources than the total supposedly consumed in the county. This necessitated checking back through all of the fuel use data with the New Jersey Department of Environmental Protection. The discrepancies had arisen because of differing assumptions in the shift in coal use from 1965-1969 and was resolved, but not without a great deal of extra time and expended effort.

Percentages for fuel used for space heating and non-space heating by county and source category (the source categories being residential, industrial, and commercial, including institutional and government) were developed from the 1965 Abatement Region Report information. These were the only default parameters needed for the 1969 area inventory. From this information emissions by season (summer, winter, and annual average) were developed from the fuel use data, using the appropriate emission factors in Figure I-30.

2.4.2 New Jersey Non-Fuel Emissions

All of the information for New Jersey non-fuel emissions (with the exception of motor vehicle emissions) was obtained directly from the New Jersey Department of Environmental Protection. In all cases the data were for 1970 rather than 1969. Information was provided on solvent and gasoline marketing evaporative emissions, area wide incineration, and aircraft emissions by county. Area wide process emissions were considered to be negligible.

In the case of motor vehicle emissions 1969 vehicle-mile data by county were obtained from the New Jersey Department of Transportation. An average urban speed of 25 mph was assumed to hold for the entire region and the vehicle mix was assumed to average 80% automobile and light truck, 15% heavy duty truck, and 5% diesel, comparable to road type B in our line source inventory. The 1969 motor vehicle emission factors in Figure I-30 were used to calculate the emissions for each county.

Figure II-11 shows the annual area source fuel emissions by county for New Jersey, rounded to the nearest million pounds per year. Similarly, Figure II-12 shows the annual area source non-fuel emissions. Fuel emissions predominate only for sulfur dioxide, are nearly equal for particulates, and represent about 1% of the total for carbon monoxide. The largest single source in several categories is motor vehicle emissions -- particularly for carbon monoxide and hydrocarbons.

2.4.3 New York City Emissions

Total emissions in tons per year for each of the pollutants were obtained for 1969 for the five boroughs of New York City by five source categories: space heating, motor vehicle transportation, industrial process, incineration, and evaporation. Point sources for space heating and incineration were subtracted from these totals. Allocations were then made to the five boroughs based upon the distribution of emissions in the 1965 inventory. More up-to-date information has become available since the time this analysis was undertaken, in particular the 1970 borough by borough source inventory developed as a part of the State Implementation Plan. However, it was not available at the time the current area source allocation had to be made and it might not increase significantly the accuracy of the analysis.

FIGURE II-11

Area Source Fuel Emissions

1969 New Jersey

10^6 pounds/year

	Particulates	SO_2	CO	HC	NO_x
Bergen	10	50	5	3	20
Essex	12	56	8	4	24
Hudson	9	46	5	3	20
Middlesex	10	50	4	3	22
Monmouth	3	12	3	1	5
Morris	4	19	3	3	8
Passaic	5	26	4	2	11
Somerset	4	15	3	9	7
Union	9	44	4	3	20

Note: Due to aggregation and rounding procedures, this table is presented only for report summary purposes.

FIGURE II-12

Area Source Non-Fuel Emissions

1969 New Jersey

10^6 pounds/year

	Particulates	SO_2	CO	HC	NO_X
Bergen	16	5	900	112	90
Essex	11	4	652	82	66
Hudson	6	2	278	36	28
Middlesex	11	3	788	90	80
Monmouth	9	4	602	86	60
Morris	6	2	438	56	50
Passaic	5	2	400	54	40
Somerset	4	2	252	30	26
Union	8	4	576	70	58

Note: Due to aggregation and rounding procedures, this table is presented only for report summary purposes.

2.4.4 New York State Emissions

The 1969 emissions were obtained from the New York State Division of Air Resources for those counties in New York State outside of New York City. This included total emissions for transportation, process, power generation, space heating, refuse, and evaporation. As with the other jurisdictions, point sources in the inventory were subtracted from the area totals for a particular category. Difficulties were resolved in consultation with the New York State Division of Air Resources. However, the accuracy of both the point and area source results for these counties is more questionable than for New Jersey and New York City.

2.4.5 Summary of Inventory

Figure II-13 shows the complete current area source emission inventory in the units used for input to the dispersion model, MARTIK. The emission densities show variations of 1 to 2 orders of magnitude, indicating that the area source background cannot be considered uniform for modeling. Similar emissions were generated for the summer and winter seasons, based upon variations in the percent space heating for each of the applicable source categories.

The average county emission densities were located at the population centroid of each county and the SYMAP computer mapping program was used to interpolate continuous emission density surfaces between the county centroids; then, values were read from each emission density surface at the centroids of the area source grid cells shown in Figure II-14. These were the values used for modeling with MARTIK. Although this may sound complicated, it is merely an objective interpolation procedure used to

FIGURE II-13

Current Area Source Emission Inventory

10^6 g/m^2 - sec

	Particulates	SO_2	CO	HC	NO_X
Bergen	0.63	1.30	21.6	2.8	2.7
Essex	0.98	2.60	28.6	3.7	3.9
Hudson	1.93	5.88	34.9	4.9	6.0
Middlesex	0.38	0.98	14.1	1.7	1.8
Monmouth	0.15	0.18	7.1	1.0	0.8
Morris	0.12	0.26	5.2	0.7	0,7
Passaic	0.29	0.79	11.6	1.6	1.5
Somerset	0.15	0.30	4.6	0.7	0.6
Union	0.89	2.59	31.2	3.9	4.2
Bronx	1.86	12.50	83.5	14.7	12.7
Brooklyn	1.74	12.50	72.6	13.5	11.9
Richmond	0.28	1.97	14.3	2.3	2.1
Manhattan	5.01	32.10	273.0	41.3	37.0
Queens	1.27	5.66	108.0	14.1	11.0
Nassau	0.44	1.05	38.4	6.6	4.3
Rockland	0.12	0.13	7.9	1.3	0.9
Westchester	0.16	0.44	13.7	2.3	1.7

Note: due to rounding, this table is presented only for report summary purposes.

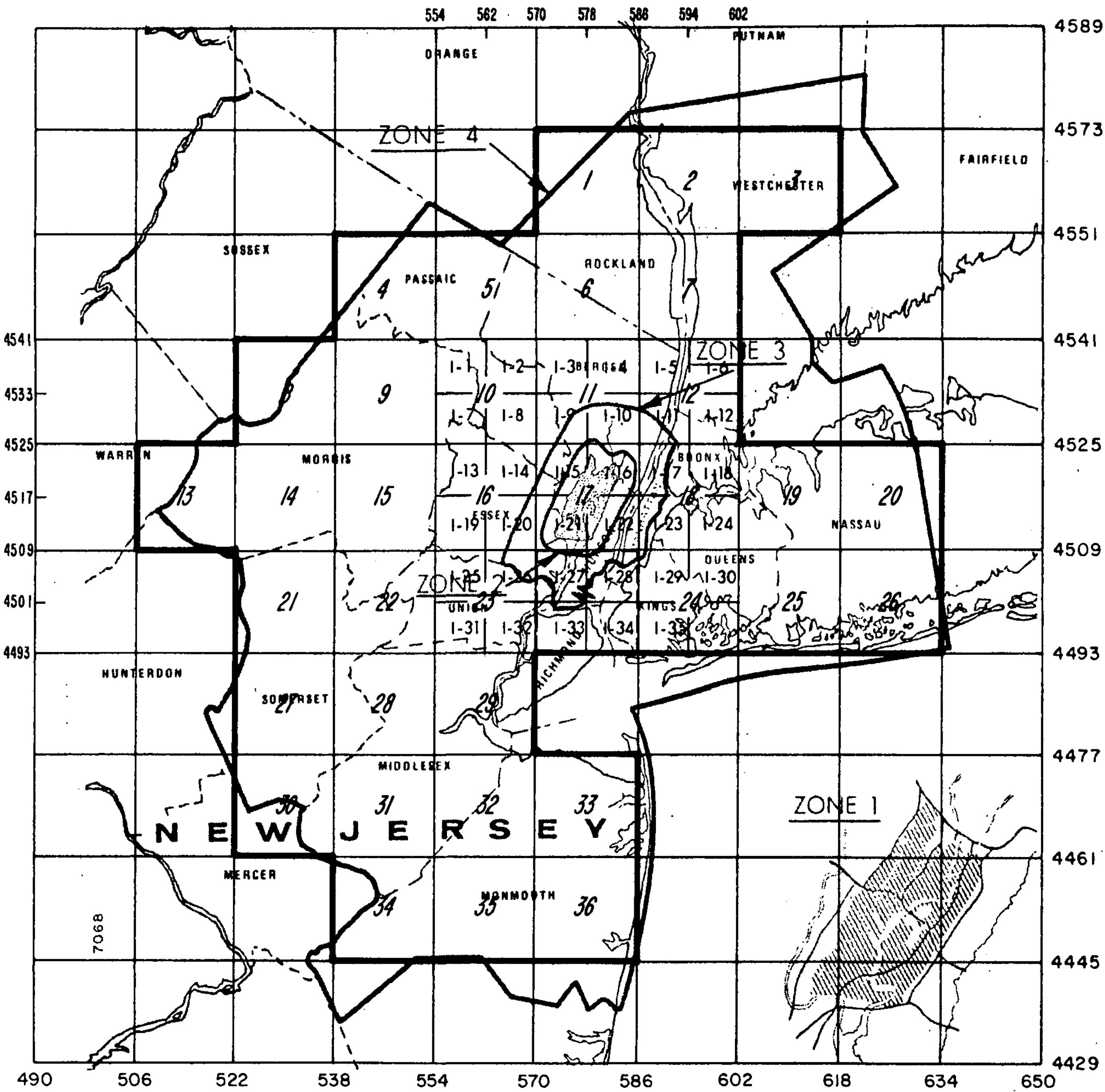


Figure II-14 Area Source Grid System

Notes: Outer 16 km grid has 36 cells; blank cells are water or outside study area. Inner 8 km grid (I-1, etc.) has 35 cells. Area source inventory combined as inner 8 km cells with 24 outer 16 km ones (the 36, minus cell numbers 10, 11, 12, 16, 17, 18, 23, and 24) for a total of 59 cells.
In the 16 km grid, no number is assigned to the cell between numbers 23 and 24 because this area is largely water and assumed to have no emissions; for the same reason no number is assigned to the cell to the right of I-35 in the inner grid.

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transform the area source data from irregularly shaped political jurisdictions to a grid system which is required for modeling. The LANTRAN program is designed to do this type of surface interpolation; however, at the time the particular analysis was done, SYMAP was used because LANTRAN was still undergoing testing.

2.4.6 Accuracy of Analysis

As a part of the validation prpcedures of Task 2, emission densities were determined from the county emission inventory for an 8 kilometer grid in addition to the original 16 km grid. This generated a total of 59 area source cells for the combined 8 and 16 km grid shown in Figure II-14. To examine the sensitivity of the model to different source categories as a part of validation, one square mile area source cells were calculated in the vicinity of the monitoring stations using the 1965 Abatement Region Report inventory as the base for small scale variation in emission densities. No definitive conclusions could be reached as to how much the accuracy of the calculations were increased; however, it is evident from the 1965 data used as a base that significant local variation does occur in area source emissions.

The original intention had been to use county data for the outlying regions and town and census tract data for the inner portions of the study area as the basis for varying area source emissions. However, since the monitoring stations used for validation as shown in Figure I-10 were scattered over the central portion of the region, there was no clear cut distinction between inner areas which would require detail and outlying areas warranting less detail.

Without the sufficient air quality and emissions data to conduct an extremely detailed validation procedure, it is not possible to determine what level of accuracy is necessary -- either in the original data for political jurisdictions or in emissions data for the grid cells used for modeling. It is, therefore, not possible to affirm or deny the choice of grid cell size. As the analysis progressed it became more and more evident that the area source contribution to total emissions is large; therefore, greater detail in this portion of the inventory should increase accuracy. The use of 2 or 4 km cells in the region of greatest interest warrants consideration; the original data by land use zones and political jurisdictions should, therefore, be of a similar scale.

3. BACKGROUND EMISSION INVENTORY

3.1 Components of the Inventory

The background emission inventory was divided into three components parallel to the current emission inventory -- point, line, and area -- again, because of the separate modeling requirements and the availability of information. Point source information was constructed from the current point source inventory, projective data gathered specifically for the task, and from separate data on power plant and incineration requirements. Line source information was again developed from data supplied by a separate transportation agency. The area source information was not assembled to form a residual inventory for 1990; instead, the current area source inventory and separate regional planning data were used to construct the background area source inventory.

The discussion of the point source inventory is divided into three broad areas: (a) industrial point source projecting for both fuel and process sources; (b) power plant projections; and (c) refuse incineration estimates. The discussion of the line source inventory briefly explains the steps required to assemble and use the traffic data.

The section on the background area source inventory discusses: (a) data sources, (b) fuel burning emissions, and (c) non-fuel emissions. It is divided by source type rather than jurisidiction, as in the current area source inventory.

3.2 Background Point Source Emission Inventory

This portion of the analysis was concerned with some of the changes and additions to the point source inventory that are likely to occur by 1990. Some of the changes will result from the evolution of the existing point sources and others will be contingent upon realization of the alternate Meadowlands plans themselves. The types of changes to be covered in this section include cessation of operations, additions of new sources, increases and declines in point source activities, and changes in the methods used to carry out certain activities. Changes in the manner in which the various specific activities emit the five pollutants were incorporated in the emission factor analysis along with the regulations concerning fuel constituents shown in Figure I-30.

The types of sources for which specific projections were made are industrial plants, power plants and refuse incinerators. Together, these three categories account for over 95% of the point sources in the 1969 inventory and over 99% of the emissions from point sources. While there are a few additional point sources, namely institutional and governmental facilities, they were too few in number and too small in size to warrant special projective considerations.

3.2.1 Industrial Point Source Projections

The projections of changes in the industrial point sources proved to be the most difficult to make since the range of activities is very broad and the data available to make projections are scarce and diffused among widely scattered sources. The industrial point source projection covers two components: fuel use and process sources.

Industrial Fuel Emission Projections

Several basic information sources were used to project fuel emissions from industrial point sources for New Jersey. The Meadowlands Development Commission is thoroughly familiar with the sources and industries within its jurisdiction and was able to predict both cessation of operations as well as new industrial background sources in its area. The New Jersey Department of Labor and Industry provided a listing of possible new sources to be constructed between 1969 and 1975 based on enclosed space for all counties in the study. There was not sufficient information, however, to incorporate these into the inventory.

Changes in level of activity for industrial background sources were based on changes in employment. This expediency was used since the initial data search for production rates and changes, enclosed space and gross plant area produced only limited information as shown in Figure II-7. The only consistent set of projective data are changes in employment. Estimates of total employment without regard to industrial classification were available on a one square mile grid from the Tri-State Transportation Commission for 1985 as shown in Figure II-15. Estimates of employment changes by two, three, and in some cases four digit SIC for the various labor market regions in the study area were also available. This information was provided by the N.J. Department of Labor and Industry.

Figure II-16 shows the appropriate ratio of 1980 to 1969 employment for each New Jersey industrial source for the Bureau of Labor and Industry, Tri-State, and Hackensack Meadowlands Commission assumptions. It also shows the actual ratio decided upon by subjectively weighting these three sources of information. For non-industrial sources (hospitals, etc.) or sources where employment was not known, an implied ratio of 1.0 was used.

The ratio was applied directly to 1969 heating demand to determine 1990 heating demand; the same fuels were used as in 1969 except for fuel switching from coal to gas or oil as determined in consultation

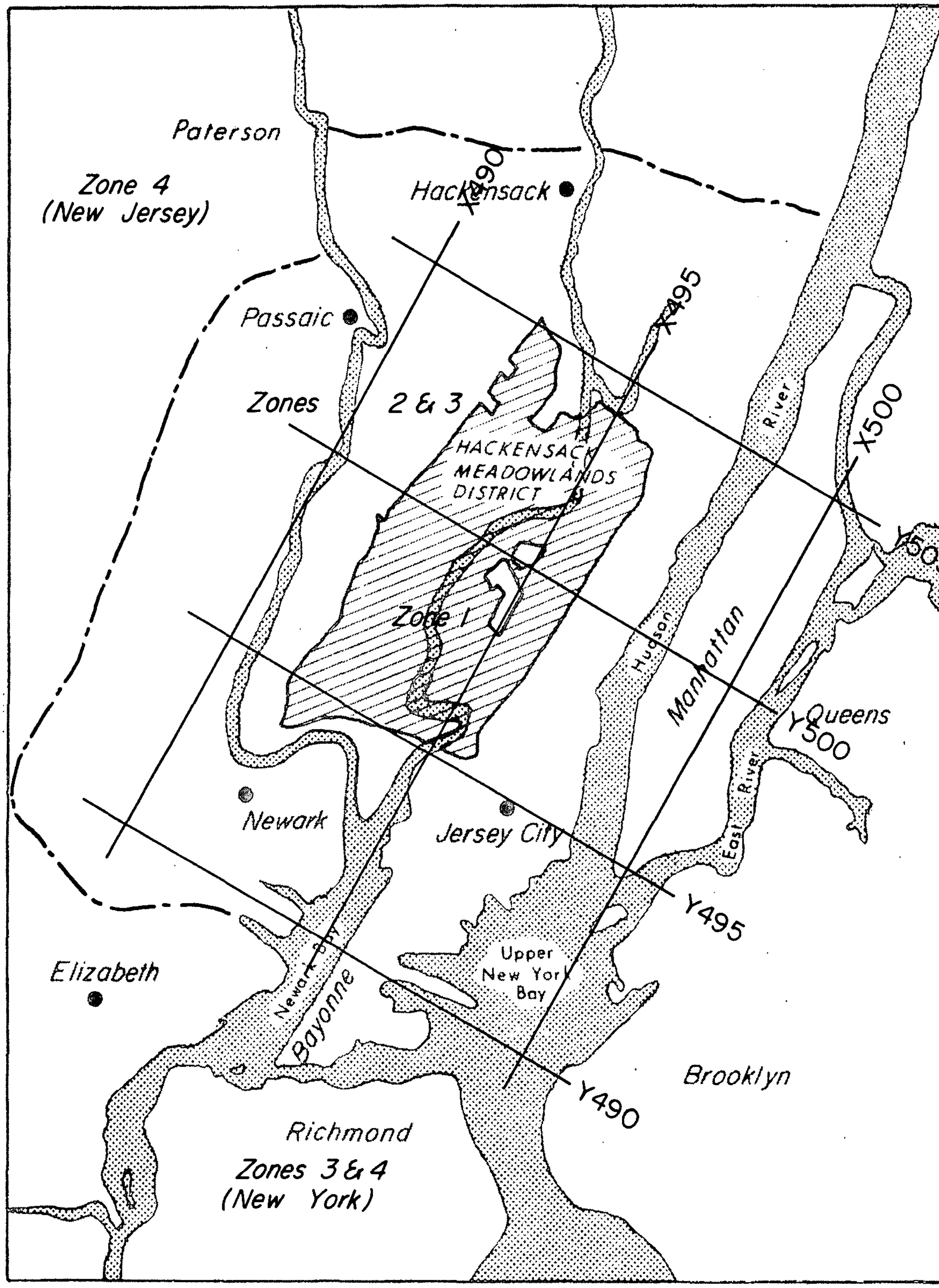

Figure II-15 Tri-State Grid

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Figure II-16

Point Source Projecting Data

Source ID	BL&I	Tri.	HMC	Actual	Fuel Change
Zone 1					
4	1.10	0.95	1.00	1.00	
7	1.60	1.15	1.00	1.00	
13	1.60	0.90	1.00	1.00	
14		1.29	1.00	1.00	
16			1.00	1.00	
34			0	0	
Zones 2&3					
1	1.55	0.95		1.00	
2	1.20	0.95		1.00	
5	1.05	1.14		1.10	Coal to gas
6	1.20	1.20		1.20	Coal to oil
10	1.60	2.87		1.60	
12	1.60	0.95		1.25	
18	0.70	1.21		1.00	Coal to oil
19	0.85	0.85		0.85	
20				1.00	
21	0.90	0.90		0.90	
24	0.70	1.21		1.00	
25	0.95	1.73		1.00	
30	0.70	0.95		0.75	Coal to gas
32				1.00	Coal to oil
33	0.95	1.23		1.00	
36	0.95	0.90		0.95	
37	1.00			1.00	
40				1.00	Coal to oil
42	1.55	1.10		1.25	
44	1.00			1.00	
45	0.90	1.00		1.00	
46	1.00			1.00	
47	1.25	1.25		1.25	
52	0.80	0.95		0.95	
56	1.80	1.12		0.90	
57	0.55	0.92		0.90	
58	1.70	1.35		1.00	
59	1.25	2.00		1.25	
60	1.25	0.93		1.00	
62	1.25	1.10		1.15	
65	1.25	1.13		1.15	
67	0.80			1.00	
68	1.20	1.00		1.00	
69	1.70	0.95		1.00	
70	1.70	1.00		1.00	Coal to gas
71	1.40	0.95		1.00	
72	1.40	0.95		1.00	
73	1.60	1.20		1.40	
74	1.60	0.95		1.00	

Figure II-16 Cont'd

Source ID	BL&I	Tri.	HMC	Actual	Fuel Change
Zones 2&3					
77	1.75	1.25		1.00	Coal to oil
Zone 4					
80	1.20			1.20	
81	1.25			1.25	
82	1.25			1.25	
83	1.25			1.25	
84	1.00			1.00	
85	1.25			1.25	
87	1.00			1.00	Coal to oil
88	1.25			1.25	
91	1.45			1.45	
97	1.20			1.20	
98	1.00			1.00	
99				1.00	
100	1.25			1.25	
101				1.00	Coal to oil
103	1.30			1.30	
104	1.00			1.00	
105	0.55			0.55	
108	0.55			0.55	
109	0.55			0.55	
111	0.55			0.55	
112	1.30			1.30	Coal to oil
113	1.00			1.00	
114	1.30			1.30	
115	1.55			1.55	
119	1.30			1.30	Coal to oil
171	1.10			1.10	
173				1.00	

NOTES to Figure 41

Employment changes - ratio of years in parentheses.

- BL&I - N.J. Bureau of Labor and Industry, according to industrial category and labor market area (1980-1969)
- Tri - Tri-State Transportation Commission total (1985-1963) employment data per square mile grid.
- HMC - Hackensack Meadowlands Commission, subjective estimates (1972-1990)
- Actual - Decision reached as to fuel use index to be used (1990-1969).

Fuel Changes -

No changes were made in the propensity to use different fuels except for the shifts from coal to oil and gas as shown.

with the NJDEP. The 1990 emission factors from Figure I-30 were then applied to calculate the fuel emissions shown in Figure II-17. The point source cut-off criteria of 25 tons for any one pollutant as shown in Figure I-13 was derived empirically from Figure II-17 by considering:

1. The general level of point source emissions as reflected in the 1990 emission factors.
2. Consistency in the number and location of point sources for the 1969 and 1990 model runs.

Only five sources were removed from the inventory.

All existing New York industrial and institutional sources were assumed to remain the same for 1990, except for the fuel switching shown in Figure II-18 and the use of the 1990 emission factors. It was beyond the scope of this analysis to either determine changes in the level of activity for these sources or ascertain new sources. In general, they are not significant compared to the New Jersey industrial sources or the New York and Connecticut power plants and incinerators. Because of the shift away from coal and the 1990 emission factors their 1990 emissions are greatly reduced; they are shown to be negligible, by comparison, in the summary of 1990 fuel use shown in Figure I-27.

Industrial Process Emission Projections

Very little information with which to project changes in 1990 industrial process emissions was available; it was not possible to adequately characterize current activities to produce a base for projecting either 1990 activities or 1990 emission factors. Accordingly, the default procedure shown in Figure II-19 was used. Where estimates could be made by the

Figure II-17

1990 Point Source Fuel Emissions - New Jersey

Source ID	Particulates	SO_2	CO	HC	NO_x	Comments
Zone 1						
4	58	50	-	8	45	<50 tons
7	64	67	-	8	50	<50 tons
9	981	6	10	2616	13080	
13	61	61	-	10	54	<50 tons
14	20	-	-	44	154	
16	32	55	-	4	33	<50 tons
28	1635	11	16	4360	21800	
34						removed: shut down
Zones 2&3						
1	104	108	-	14	81	<100 tons
2						removed: <25 tons
5	20	-	-	44	155	<100 tons
6	127	133	1	17	100	<100 tons
10	65	68	-	8	51	
12	120	124	1	16	95	<100 tons
18	141	147	1	18	110	
19	10	11	-	1	8	
20						removed: <25 tons
21	106	98	1	15	91	<100 tons
24	36	37	-	5	28	
25	39	36	-	14	60	
27	53	2112	3	440	2728	
29	13	504	-	105	651	
30	4	-	-	10	35	
32	135	140	1	18	105	<100 tons
33	75	78	-	10	59	<100 tons
36	20	-	-	44	153	
37	102	104	-	20	101	<100 tons
40	61	64	-	8	48	<100 tons
42	58	60	-	8	45	<100 tons
43*	25	961	2	201	1240	
44	783	816	7	102	613	
45	76	78	-	10	61	<100 tons
46	44	46	-	6	34	
47	266	276	2	36	212	
52	63	66	-	8	50	<100 tons
54	32	1272	2	265	1643	
56	124	130	1	16	97	<100 tons
57	47	48	-	6	38	<100 tons
58	95	98	-	12	74	<100 tons

Units are 10^3 pounds of pollutant per year;
*Means incineration.

Figure II-17 Cont'd

Source ID	Particulates	SO_2	CO	HC	NO_x	Comments
Zones 2&3						
59	63	64	-	8	51	<100 tons
60	168	175	1	22	131	<100 tons
62	67	70	-	9	53	<100 tons
65	28	29	-	4	22	
67	175	182	2	23	137	<100 tons
68	207	216	2	27	162	
69	52	54	-	7	40	<100 tons
70	15	-	-	33	117	
71						removed: < 25 tons
72	27	28	-	4	21	
73	58	61	-	8	45	<100 tons
74						removed: <25 tons
77	110	115	-	14	86	<100 tons
Zone 4						
80	193	202	2	25	151	
81	16	16	-	2	12	
82	144	150	1	19	113	
83	499	521	4	65	391	
84	1233	1286	11	161	965	
85	430	449	4	56	337	
86	113	4512	8	940	5828	
87	150	156	1	20	117	<100 tons
88	8	8	-	1	7	
91	232	242	2	30	182	
97	69	72	-	9	54	<100 tons
98	771	804	7	101	603	
99	2	-	-	-	2	
100	276	288	2	36	216	
101	184	320	2	24	192	
103	909	806	778	58	1000	
104	401	355	4	184	755	
105	213	215	2	32	184	
106	440	3	4	1184	5920	
107	99	-	-	264	1320	
108	2484	2592	22	324	1944	Not in 1969 inventory.
109	30	23	-	7	55	
110	199	7944	13	1655	10250	
111	290	302	3	38	227	
112	301	314	3	39	236	
113	1238	1179	12	388	1727	
114	219	229	2	29	172	
115	805	840	7	105	630	
119	3	3	-	-	2	
171	89	93	-	12	70	
173	22	23	-	3	17	

Units are 10^3 pounds of pollutant per year; *means incineration.

* Means incineration.

Figure II-17 Cont'd

Source ID	Particulates	SO_2	CO	HC	NO_X	Comments
Zone 4						
206*	360	360	240	360	240	
207*	225	225	156	225	150	
208*	225	225	150	225	150	
209*	270	270	180	270	180	
210*	270	270	180	270	180	
217	170	6816	11	1420	8804	
218	188	7512	13	1565	9703	
219	-	-	-	-	1843	
220	-	-	-	-	922	
221	-	-	-	-	979	

Units are 10^3 pounds of pollutant per year; *means incineration.
* Means incineration.

Figure II-18

Point Source Fuel Use Changes

New York

Source ID	
146	shift from coal & distillate to residual
147	no change
148	no change
150	no change
165	shift from coal to residual
167	shift from coal to residual
168	no change
169	no change

Notes: In all cases the 1969 BTU heat demand, percent fuel for space heating, and hours of operation were used for 1990; only shifts in fuel use as noted were made.

Figure II-19

1990 Point Source Industrial Process Emissions - New Jersey

Source ID	Decision	Change	Particulates	SO_2	CO	HC	NO_x
Zone 1							
14	HMC	1.00	432				
Zones 2 & 3							
5	Override	1.00	21				
10	NJDEP	1.00				20	
18	NJDEP	0.90	482				
19	BL&I	0.85				6200	
24	NJDEP	0.90	774				
25	NJDEP	1.00	172	28			
30	BL&I/Tri.	0.79				1950	
36	BL&I	0.95	315				
44	NJDEP	0.50	50			200000	2070
46	NJDEP	0.50				2180	
65	NJDEP	1.00	189	3090			
72	NJDEP	0.90				2970	
Zone 4							
81	NJDEP	1.00		8480			
82	NJDEP	1.00	39	850			
83	NJDEP	1.00	1230	1140			
84	NJDEP	0.50	1400	6650	2380		
85	NJDEP	1.00		228			
88	NJDEP	1.00		6800			
91	NJDEP	0.90				2880	
99	Override	1.00	3370				
103	NJDEP	1.00					2300
104	NJDEP	0.50	450	1510	77500	2880	
105	BL&I	0.55	78	62		24	
108*	BL&I	0.55	225	9790			
109	BL&I	0.55	649				
111	BL&I	0.55	5490				
112	NJDEP	1.00	29000			84	
113	NJDEP	0.50				9350	
114	Override	1.00			2000	2500	
115	Override	1.00	472				
119	NJDEP	1.00		1000			
171	NJDEP	0.90				1620	
173	NJDEP	0.90			2960	3490	

*Not in 1969 inventory.

Units are 10^3 pounds of pollutant per year

Notes to Figure II-19:

EXPLANATION OF DECISIONS

HMC - Estimate made by Hackensack Meadowlands Commission; all point sources in Meadowlands stay the same, except 34, which would shut down.

NJDEP - Estimate made in conjunction with New Jersey Department of Environmental Protection; all refinery process emissions would be 0.50 times present, all machinery and fabricated metals process emissions would be 0.90 times present, all chemicals would be equal to present.

BL&I - Based on ratio of 1980 to 1969 employment.

BL&I/Tri.- Estimates of the New Jersey Bureau of Labor and Industry, by labor market area and industrial category; where Tri. State Transportation Commission data also known (change in number of employees total per square mile) from 1963 to 1985, the two indices were subjectively weighted.

Override - If the estimate in any case were greater than 1.0, this value was used as an override; e.g., in no case were process emissions increased.

Hackensack Meadowlands Commission, these took precedent. For four industrial categories - chemicals, refineries, fabricated metals, and machinery (SIC's 28, 29, 34, and 35) - across-the-board percentage reductions in process emissions were made subjectively in conjunction with the NJDEP. For other categories the Bureau of Labor and Industry and Tri-State 1980 to 1969 employment ratios were used, as with the fuel emissions.

Finally, to reflect the strict and necessary attitude for process control in New Jersey, where the employment ratios showed an increase in emissions, a value of 1.0 was used as an override so that in no case would process emissions for a source increase from 1969 to 1990.

This portion of the background point source inventory, as with the 1990 emission factors, requires the greatest amount of continued analysis.

3.2.2 Power Plant Projection

Projections of all power plants and incinerators in the study area -- both existing and new -- were made independently of the general projection methodology because of the special expertise of Burns and Roe in this area. Summary information for all new point sources (power plants and incinerators) is shown in Figure II-20.

The basic approach to power plant projections was presented at the Milestone 5 meeting in Trenton and it was suggested at that time that the concerned utilities be contacted to solicit (i) their comments on the approach, and (ii) their assistance in providing detailed information concerning total energy consumption, additional new installations and plans for

Figure II-20

Summary Information for all New Point Sources

Source ID	County	Zone	Code	1 Default	2 Parameters*	3
201	Richmond	4	49-1	x	x	
202	Bronx	4	49-1	x	x	
203	Queens	4	49-1	x	x	
204	Brooklyn	4	49-1	x	x	
205	Connecticut	4	49-1	x	x	
206	Passaic	4	49-1	x	x	
207	Monmouth	4	49-1	x	x	
208	Morris	4	49-1	x	x	
209	Middlesex	4	49-1	x	x	
210	Union	4	49-1	x	x	
211	Nassau	4	49-1	x	x	
212	Westchester	4	49-1	x	x	
213	Westchester	4	49-1	x	x	
214	Rockland	4	49	x	x	
215	Queens	4	49	x	x	
216	Brooklyn	4	49-GT	x	x	
217	Union	4	49	x	x	
218	Middlesex	4	49	x	x	
219	Essex	4	49-GT	x	x	
220		4	49-GT	x	x	
221	Middlesex	4	49-GT	x	x	
222	Nassau	4	49-GT	x	x	
223	Nassau	4	49-GT	x	x	
224	Rockland	4	49-GT	x	x	
225	Connecticut	4	49	X	x	

* 1 = Height, 2 = plume rise, 3 = % process.

Code is that used in Figure II-3:

49	Power plant
49-GT	Power plant, Gas Turbine
49-I	Incinerator

retiring old equipment. Since this information could not be made available in time for the study, it was necessary to base the projections on the latest information currently available.

Projection was based on matching total installed generating capacity (both existing and proposed) against total energy demand in 1990. Using appropriate assumptions based on plant age and type, each plant was assigned to a specific duty cycle in each utility system and the annual hours of operation from which emissions can be computed were thereby determined. The basic assumption was that essentially all energy required in the region will be generated within the region; individual utilities within the region may export and import from a neighbor utility to take advantage of the best economic usage of total installed equipment.

Utilities in the 17-County Region

There are eight major utilities in the 17-county region. They are as follows:

Consolidated Edison

Public Service Electric & Gas

Long Island Lighting

New Jersey Power & Light

Orange & Rockland Utilities

Connecticut Power & Light

Hartford Electric

United Illuminating

The study was expanded, at the start, to include all installed capacity, existing and proposed, in the area served as well as the entire energy demand in the region.

Installed Capacity

Figure II-21 is a summation of the total presently installed capacity for all utilities in the region broken down by category of unit (fossil fuel, nuclear, hydro-electric and peaking) and by location inside or outside the 17 county region. The total presently installed capacity as shown in the Table is 21,367 MW.

In addition, all information on proposed new capacity for the eight utilities in the region who assembled. This additional capacity amounts to some 26,962 MW which, when added to the existing capacity, makes a total generating capacity in 1990 of some 48,329 MW.

System Load Factor

A utility system load factor represents the percentage of time the equipment of a utility is operated at capacity. For the eight utilities in the 17 county region, the system load factor averaged 0.55 for the years 1969 and 1970. The average load factor for the fifty largest electric utilities in the nation for the same period was 0.60. There are two reasons for the poor performance of the region utilities. The main reason is the age of the equipment, primarily in the Con Edison and Public Service inventories. The other reason is the extreme peaks experienced in regional demand, particularly in the summer periods, which require additional standby equipment. A gradual improvement in the load factor for the regional utilities is expected as the peaking factors are moderated and new equipment is built. Therefore, a 1990 system load factor of 0.60 for the region's utilities was used.

Figure II-21

INSTALLED CAPACITY FOR REGION'S POWER PLANTS

	Inside 17 County Area				Outside 17 County Area			
	Fossil	Nuclear	Hydro	Peak	Fossil	Nuclear	Hydro	Peak
1969 Existing Capacity								
Con Ed.	7,565	275	-	199	-	-	-	-
PSE&G	3,806	-	-	507	1,493	-	165	180
Lilco	800	-	-	50*	1,188	-	-	120*
Conn. L&P	334	-	-	100	657	-	122	115
UN. Illum.	746	-	-	39	135	-	-	-
JCP&L	468	-	-	-	276	530	165	-
Hart Elec.	54	-	-	-	632	-	10	74
Orange & Rock	518	-	-	-	-	-	44	-
	14,291	275	-	895	4,381	530	506	489
1980 Proposed Additional Capacity								
Con. Ed	2,578	7,068	-	636	480	210	4,000	-
PSE&G	880	-	-	1,035	-	3,888	-	-
Lilco	-	-	-	313	-	800	-	56
Conn L&P	-	-	-	-	400	130	-	-
Un. Illum.	-	-	-	-	400	-	-	-
JCP&L	-	-	129	366	-	2,000	-	155
Hart Elec.	-	-	-	-	1,200	130	-	-
Orange & Rock	-	-			-	-	-	54
	3,458	7,068	129	2,404	2,480	7,158	4,000	265

Summary

	Inside 17 County Area	Outside 17 County Area	Total
1969	15,461	5,906	21,367
Proposed	13,059	13,903	26,962
1980 Total	28,520	19,809	48,329

*Estimated
Units are megawatts.

Projection of Regional Energy Demand

The energy consumption in 1969 for the area was used to provide a baseline estimate of energy demand for the region. The sales to customers in the region amounted to some 85,691 x 10^6 Kwh. Adding 5% for transmission losses, these utilities generated some 89,975 x 10^6 Kwh in 1969. Using an annual compounded growth in energy demand of 5% the 1990 energy demand becomes 238,000 x 10^6 Kwh. This compares with the Tri-State Transportation Commission estimate of 200,000 x 10^6 Kwh in 1985. A comparative figure may be calculated from the total installed capacity and system load factor as follows:

net generation = installed capacity x load factor x annual hours

$$NG = 48{,}329 \times 10^3 \times (0.60) \times 8760$$
$$= 254{,}000 \times 10^6 \text{ Kwh}$$

There is a reasonable agreement among these three estimates; therefore the 1990 baseline energy demand for the eight utilities in the region was set as follows:

Consolidated Edison	-	31,810 x 10^6 Kwh
Public Service	-	24,800 x 10^6 Kwh
Long Is. Lighting	-	9,450 x 10^6 Kwh
Conn. Power & Light	-	7,550 x 10^6 Kwh
United Illuminating	-	3,950 x 10^6 Kwh
N. J. Power & Light	-	5,650 x 10^6 Kwh
Hartford Electric	-	4,280 x 10^6 Kwh
Orange & Rockland Utility	-	2,360 x 10^6 Kwh

Determination of Total Energy Generated

Using the plant capacities, the annual hours of operation and the system load factor, determination of the total energy produced by each utility was obtained for the particular duties assigned to each of its units. This number was then compared to the projected energy demand calculated above. Any differences between the two numbers were rectified by successive iterations using revised duty assignments and hours allowing for exports or imports of power and removal of aging equipment from service. Basically, the projection method worked well. There seemed to be adequate capacity in the major utilities nearest to the Meadowlands. Some of Con Edison's oldest equipment was assumed to shift from high service power generation to low pressure steam generation following a pattern presently used by the system. A major export of power from New Jersey Power and Light to Public Service provided a much needed balance of capacity for these two systems which already are highly integrated. There was a significant under capacity in some of the smaller utilities in the outer regions. No attempt was made to cover these shortages since these utilities are entirely in Zone 4 and additional capacity is unlikely to constitute significant emission sources.

Determining Total BTU Expended

Having allocated the total energy demand to the individual plants in 1990, the scope was narrowed from the total utility system to fuel. These are the only power plants that are air pollution sources in the study area. To determine the total heat consumed by each power plant as shown in Figure II-22 the plant heat rates were used; these, within fairly close

Figure II-22

Point Source Power and Incineration Assumptions

Source ID Incinerators	County	Incineration (tons/day)
201	Richmond	5000
202	Bronx	3200
203	Queens	5000
204	Brooklyn	6000
205*	Fairfield, Conn.	985
206*	Passaic	800
207*	Monmouth	500
208*	Morris	500
209*	Middlesex	600
210*	Union	600
211*	Nassau	810
212*	Westchester (north)	430
213*	Westchester (south)	1000

Power Plants Source ID	County	Load (10^{12} BTU) heat input/year	Fuel Assigned
9	Bergen	36	Coal Gas
27	Hudson	13	R-oil
28	Hudson	60	Coal Gas
29	Hudson	31	R-oil
54	Essex	8	R-oil
86	Union	29	R-oil
106	Middlesex	16	Coal Gas
107	Middlesex	4	Coal Gas
110	Middlesex	50	R-oil
120	Bronx	6	R-oil
121	Queens	86	R-oil
122	Queens	56	** D-oil
123	Richmond	30	** D-oil

Note: All power plant load estimates have been rounded; only fossil fuel estimates are included.

* These are hypothetical locations at county population centers; all other sites are proposed or under construction.

Fuel Abbreviations:
R-oil: Residual oil
D-oil: Distillate oil
N-gas: Natural gas

** Denotes major fuel shift, generally from coal to coal gas, or to a second fuel currently being used.

Figure II-22 Cont'd

Power Plants Source ID	County	Load (10^{12} BTU) heat input/year	Fuel Assigned
124	Manhattan	88	D-oil
125	Manhattan	62	D-oil
126	Manhattan	2	R-oil
127	Manhattan	8	D-oil
128	Manhattan	14	D-oil
129	Manhattan	8	** D-oil
130	Manhattan	4	D-oil
131	Brooklyn	8	D-oil
135	Nassau	15	** R-oil
136	Queens	5	D-oil
137	Nassau	15	R-oil
138	Rockland	31	** Coal Gas
139	Fairfield, Conn.	20	** Coal Gas
140	Fairfield, Conn.	31	** Coal Gas
141	Westchester	6	D-oil
142	Fairfield, Conn.	24	** Coal Gas
143	Fairfield, Conn.	7	** Coal Gas
144	Fairfield, Conn.	40	R-oil
145	Fairfield, Conn.	6	R-oil
214	Rockland	49	D-oil
215	Queens	79	D-oil
216	Brooklyn	3 (Turbine)	N-Gas
217	Union	43	R-oil
218	Middlesex	48	R-oil
219	Essex	3 (Turbine)	N-Gas
220	Burlington	1 (Turbine)	N-Gas
221	Middlesex	2 (Turbine)	N-Gas
222	Nassau	2 (Turbine)	N-Gas
223	Nassau	1 (Turbine)	N-Gas
224	Rockland	1 (Turbine)	N-Gas
225	Fairfield, Conn.	22	** Coal Gas

Fuel Abbreviations: R-oil : Residual oil
D-oil : Distillate oil
N-gas : Natural gas

** denotes major fuel shift, generally from coal to coal gas, or to a second fuel currently being used.

limits, are a function of plant age (actually a function of the year constructed). Some of Con Edison's oldest equipment may have heat rates as high as 14,000 BTU per kilowatt hour. The newest plants may have heat rates as low as 9000 BTU per Kwh.

Determination of Power Plant Emission

With the total heat requirement for each plant known, assignment was made of the particular fuel to be used. Knowing the average heat content of each fuel, the quantities of fuel consumed at each plant could be determined. It was assumed that the fuels currently burned would continue to be burned in 1990, except for complete switching from coal to coal gas, or to oil if both coal and oil were currently used. The 1990 emission factors in Figure I-30 were then used to calculate emissions.

For existing power plants the 1969 stack parameters were used unchanged for 1990; for new plants default parameters (as shown in Figure II-20) were used based upon a plant currently under construction. Since it was not possible to contact the utilities directly for design information, no better estimates of stack data could be made.

Comparison of Emissions with Emission Control Regulations

Each of the power plants was tested against the applicable N.Y.C. and Connecticut regulations as shown in Figure II-23. Twelve of the power plants failed at least one regulation and five failed to meet the regulations for both SO_2 and NO_X.

As discussed in an earlier section no definitive conclusions could be made about the validity of these findings because of the inadequacy of the information used. Capacity, fuel use, emission factors, schedule of operations, and stack parameters all enter into the calculation

Figure II-23

Summary of Tests against Emission Regulations

Source	Following Pollutant(s) Failed Test	Significant *
120	SO_2, NO_X	
121	SO_2, NO_X	SO_2, NO_X
122	SO_2, NO_X	NO_X
123	NO_2,	
124	SO_2, NO_X	NO_X
125	SO_2, NO_X	NO_X
127	NO_2, NO_X	
128	NO_X	
131	NO_X	
142	Particulates	
215	NO_X	
216	NO_X	

Notes: all but no. 142 are N.Y.C. power plants subject to fuel burning regulations; no. 142 is a Connecticut power plant subject to a fuel burning regulation.

* For these sources and pollutants, the wide margin of error possible in determining allowable emissions is probably not sufficient to explain the actual pollutant levels calculated.

Test for N.Y.C. NO_X and SO_2 is summarized as follows:
actual emissions < (constant) x (diameter)^2 x (exit velocity) x (hours of operation)

with a different constant for each pollutant.

Test for Conn. particulates is summarized as follows:
actual emissions < (hours of operation) x (allowable emissions per hour) where allowable read from table as a function of the BTU rating of the boiler.

of emissions and allowable emissions; all of these parameters were determined by different means with different assumptions, based upon the available information. The equations for allowable emissions in N.Y.C. for SO_2 and NO_X are a function of stack diameter, exit gas velocity, and hours of operation. When the same amount of fuel was assumed to be burned over a full year of operation (base load) rather than some shorter period, and with design rather than current exit gas velocities, the allowable emission rates increased an average of 400%. However, even under these assumptions, four N.Y.C. power plants as shown in Figure II-23 still failed to meet one or more regulations. Although the violations cannot be quantified it can be determined from the analysis that these four cases are significant emitters with respect to emission limitations and therefore need further study.

Discussion of Detailed Projection Approach

The approach used in this study relied heavily on extracting relationships from the operation of existing plants in the area and using these relationships with only minor modification to estimate 1990 emissions. Since the present energy crisis is apt to introduce a great deal of change in the manner that electric power is generated and consumed in 1990, this type of projection has obvious weaknesses. It was not the study team's first choice for an approach to determining 1990 power plant emissions.

The preferred approach would have been to obtain certain projective data directly from the seven major utilities serving the area. (The 17 County - Tri-State area). Much of the data needed is prepared by these utilities on a regular basis. This information is used to explain the companies' operation to their stockholders, to support bonding requests and to support applications for licensing before the Federal Power Commission, the AEC and others.

The work to be done would have included the following:

Step 1 - Establish existing power plant inventory - This was done under the current point source summary (Figure II-3). Some additional statistics such as total energy produced per year per KW of installed capacity (use factor), plant age, etc. are available from other sources.

Step 2 - Determine location, size and fueling characteristics for new and planned plants. - Much of this is available and has already been extrapolated to 1980. The estimates of the separate utilities for new plant construction between 1980 and 1990 would be a useful addition.

Step 3 - Projection of peak demand (KW) load factor, and total energy demand for 1990 - This is where the official projection of peak demand would permit the specification of the gap in capacity above that of the existing plus proposed future plants. This gap will have to be filled with hypothetical installations. The total annual energy demand would permit the determination (albeit with several limiting assumptions) of the total energy produced by each plant. This is a better index of emissions than installed capacity. The curves for an average, peak and minimum day would allow differentiation between the three cases normally specified. Projections should cover the entire area serviced by each utility and not just those parts that are in the study area. All seven utilities should be canvassed. The contributions of Con Edison and N.J. Public Service alone are not enough because their share of the region's energy supply will diminish while those of the other utilities will increase between now and 1990.

Step 4 - The disposition of existing old plants must be determined - The assumption that plants older than 25 years will be dismantled is not consistent with current status. Both Con Edison and Public Service have several plants over fifty years old that are still heavily used. The utilities themselves would be better able to estimate the 1990 disposition of the older plants still in service.

Step 5 - Rules for System Operation - The projected 1990 capacity must be matched against anticipated demands to determine the usage of each plant in the system as in the approach followed. New nuclear capacity will generally be assigned to base load duty (more than 4000 hours per year of operation). Gas turbines and pumped storage plants will usually be assigned to intermediate and/or intermittent duty (2000-4000 hours per year operation).

Step 6 - Determine 1990 Emissions - Having assigned the total demand to the individual generating units, it would then be possible to narrow the scope to only those fossil fuel plants located in the study area, as in the approach followed. Knowing the hours of operation at rated capacity and the amount and types of fuels being used as contemplated for use, the 1990 emissions can be determined by employing the emission factors determined previously.

3.2.3 Refuse Incineration

A number of factors combine to make central station refuse incineration a larger factor in future solid waste management in the region. Among these are increased populations and a decrease in open space suitable for landfilling operation; the closing down of smaller residential and commercial incinerators for air pollution control reasons and the resultant increase in solid waste quantities; and the rapidly emerging technologies in waste heat utilization and air pollution control relative to these facilities. Competing with refuse incineration will be new concepts of materials utilization and recycling which are currently receiving a large share of the Federal solid waste research and development funds. Implicit in the approach used in this study is the hypothesis that all wastes produced in the region will be disposed of in the region. The current interest in exporting solid waste materials from the densely populated suburban and exurban rings is a temporary expediency and will most likely not stand the reaction which can be expected from these outlying communities.

Study Basis

The basic political unit for handling the solid waste management problem will be the county. The states of New York and New Jersey have taken official positions supporting the county-wide approach, and both have programs of financial support for studies of county-wide solid waste management systems. An exception to this is New York City where refuse quantities may be moved interborough for disposal purposes. Another exception is likely to be the Meadowlands district where the Development Commission seeks to find an alternate solution for disposal of wastes from large parts of Bergen, Hudson and Essex Counties.

Population Projections

Population estimates were used as a base in the projection as shown in Figure II-24. For the New York State and Connecticut counties, population estimates of the Tri-State Transportation Commission were used. These were prepared for 1985. For the New Jersey counties, population estimates were taken from the State-Wide Solid Waste Management Plans and are projections for 1987.

Figure II-24
DETERMINATION OF INCINERATION

	10^3 People Population	% Incineration	Tons/day Incineration amounts			
			Demand	Existing	Proposed	Additional
Bergen	1114	50	2890	-		250
Essex	1021	75	2690	-	6000	300
Hudson	613	75	1750	324		180
Middlesex	884	50	970	-	-	970
Monmouth	758	25	700	-	-	700
Morris	657	25	590	-	-	590
Passaic	604	25	930	-	-	930
Somerset	462	25	495	-	-	495
Union	682	50	1055	-	-	1055
Bronx	1531	75	4310	300	3200	
Brooklyn	2600	75	7400	1355	6000	0
Richmond	340	50	635	-	5000	
Manhattan	1632	75	4760	1650	-	
Queens	1872	75	5260	590	5000	
Nassau	1368	50	2560	1750	-	810
Rockland	2814	25	214	-	-	214
Westchester	1211	50	2275	845	-	1930
Fairfield, Conn.	435	25	407	-	-	407
Bridgeport, Conn.	350	75	985	-	-	985

Notes: Population estimates for New Jersey are 1987 State-wide Solid Waste Disposal Plan; for New York and Connecticut, 1985 Tri-State.

Solid waste estimate used to determine incineration amount based on State-wide plan for New Jersey and 7.5 #/capita/day for New York and Connecticut.

Proposed include Meadowlands and N.Y.C. proposed capacity.

Refuse Quantities

Refuse quantities for the New Jersey counties were also taken from the State-Wide Plan and include domestic, commercial and industrial wastes but exclude agricultural wastes. For the New York and Connecticut areas an average present per capita waste generation rate of 5#/day was used; a compounded growth rate of 2% per year for twenty years was also used to obtain 1990 refuse generation rates.

Waste Recycling

A significant increase in material recycling activities is anticipated by 1990. Materials that can conceivably be recycled include glass, various ferrous and non-ferrous metals and paper. Together these components account for approximately half of the total weight of whole mixed refuse. It is not logical to assume that markets for all of this potentially recyclable materials can be created, nor even that all these components can be economically separated in an uncontaminated condition. Therefore a recycle factor of 25% of the total refuse generated has been used and applied to all counties.

Currently, less than 10% of the region's refuse is incinerated. This is due to several factors.

1. Up to now, there has been sufficient landfill area for disposal of refuse at a cost significantly less than incineration in most parts of the region.

2. Current incinerators are large emitters of particulates and are found objectionable by the surrounding population.

The situation for 1990 is estimated to be such that the above two factors will not be applicable. First, little area will remain available for landfill in most counties. The Meadowlands itself, the last large area available for landfilling, is seeking to halt the present dumping operations in favor of large incinerators. Second, advances have been made in electrostatic precipitator, high energy scrubber and other air pollution control device technology that will enable achievement of significantly reduced emissions from municipal incinerators. Offsetting those factors that tend to increase the volume of refuse incinerated will be the increase in material recycling.

Refuse Quantities Incinerated

The basis for determining the split between sanitary landfill and incineration in central stations was population density in the various counties in 1990. The higher the population density, the less land available for landfilling and the higher the percentage of refuse incinerated. For population densities greater than 5000 persons per square mile it was assumed that virtually all materials not recycled are incinerated. This means that, with recycled materials removed, 75% of the refuse generated in these counties will be incinerated. For those counties with 1990 population densities between 2500-5000 persons per square mile, an estimated 50% of the refuse generated will be incinerated; for densities less than 2500 only 25% will be incinerated. These quantities incinerated in each county are recorded in Figure II-24.

Existing and Proposed Incinerators

All existing incinerators are included in the 1990 projection. This assumes that old incinerators are abandoned and replaced at the same location by new units of the same capacity and same operating parameters. New proposed incinerators for the region have also been included at the locations and capacities proposed by their sponsors. The proposed Meadowlands incinerator was figured at 6000 tons/day and will service areas in Bergen, Hudson and Essex County as proposed by the Meadowlands Commission.

Additional Incineration Capacity

The existing and proposed capacity was subtracted from the total refuse incinerated and the balance recorded in Figure II-24. This additional amount of refuse to be incinerated was allocated as follows: Central county incinerators of at least 500 tons per day were located at the county center of population. These will service an area of about 200 square miles (the area of a circle with a radius of about 15 miles centered on the centroid of the county). This will insure a round trip haul from the furthest collection route to the site of the incinerator of about one hour. Additional central incinerators were located in counties where one unit cannot serve widely spaced population centers. The refuse per day for these new incinerators is shown in Figure II-22.

3.3 Background Line Source Emission Inventory

Unlike the background point source emission inventory no elaborate projection methodology was needed for the line sources. Information was obtained from the New Jersey Department of Transportation for 1990 vehicle counts by links in exactly the same form as the 1969 vehicle counts. Furthermore, the inventory was more extensive and fewer estimates were necessary. Figure II-10 shows all of the links for which vehicle counts were determined. Figure II-8 shows the actual vehicle counts used for 1-90. In a number of cases the New Jersey Department of Transportation estimates were for earlier years -- 1980, 1985 and 1987. These counts were extrapolated to 1990 according to rules set up in accordance with a balanced network for adjacent links. accordance with a balanced network for adjacent links.

In consultation with the Hackensack Meadowlands Commission road types A, B, and C were assigned to the new links. There was no evidence that the road types developed for the 1969 links warranted changes for 1990. The same percentages for vehicle mix were carried forward to 1990 as well, as the result of consultation with the Hackensack Meadowlands Commission. Using the 1990 vehicle counts shown in Figure II-8, the 1990 emission factors in Figure I-30, and the percentage distribution by road type shown in Figure II-8, emissions were determined for each link. These are summarized in Figure II-9. No significant variation was assumed by season as in 1969 and, therefore, the same emissions were used for the summer and winter seasons. Stack height and plume rise of zero were assumed as with the current inventory.

3.4 Background Area Source Emission Inventory

The requirements for the background area source emission inventory were slightly different from the current area source inventory. First of all, a general but representative background inventory for all sources outside the Meadowlands excluding point and line sources was desired. As with the current inventory the most consistent data base for analysis was the county.

Unlike the current inventory the area source calculations do not represent the residual of total fuel use and emissions less point sources. In the case of the current inventory the base parameter for fuel burning was, generally, actual fuel use by county; the known point source fuel use was subtracted from the known total fuel use to generate a residual area source fuel use. For 1990, however, the base parameter is generally square feet of residential and non-residential land use. The amount of square footage associated with the point sources is relatively small compared to the county totals of square footage. This is not surprising since, in general, the major point sources are intensive users of land in terms of their fuel use and emissions. They are most often power plants, incinerators, large process sources or large users of fuel for process heat. Accordingly, it was assumed that the error introduced by not subtracting the point source square footage from total square footage would be negligible.

For validation with the current area source inventory, the concern was with air quality at a number of locations throughout the 17-county region; however, for 1990, the concern was with air quality only in a very small portion of the region: the Meadowlands. Because variations in the area source inventory are not as significant in this case, the background inventory (1990) did not have to be as detailed as the current one (1969). The available information for 1990 influenced the procedures for determining the 1990 inventory. This information consisted of the current emission inventories, Tri-State Transportation planning data, New Jersey Department of Transportation highway data, the 1975 Implementation Plans for New Jersey and New York, certain regional fuel projections, and engineering judgment for the remainder of the information required.

In summary, the purpose of the inventory and the availability of the information to determine the inventory governed the manner in which the approach embodied in the activity indices shown in Figures I-23 and I-24 could be put into effect.

3.4.1 Determination of Fuel Burning Emissions

Figure II-25 shows the steps by which the procedures in Figure I-23 were carried out for the background area source inventory. The first step was to determine the actual space heating demand by county for the portion of the Tri-State planning region coterminous with the 17-county area. Since fuel information was available for only New Jersey for 1969, the "consistent data base" was the 1965 N.Y. Abatement Region inventory.

From the fuel data in this inventory, total BTUs were determined separately for (i) New Jersey, (ii) New York City, and (iii) the remainder of New York State. Then, the percent space heating from the 1965 and 1969 inventories, as shown in Figure II-25, was applied to calculate the BTUs used for space heating alone. Tri-State Transportation Commission 1963 floor space data on residential and non-residential land uses was then used to determine indices of BTUs per square foot. It was assumed that residential fuel use was comparable to the Tri-State residential square foot figures and

Figure II-25

Background Area Source Assumptions

Fuel Demand and Use

A. Space Heating Demand

1. Determine total BTU from 1965 data

2. Apply percent space heating (1965 & 1969)

	Resid.	Indust.	Commerc.
N.J.	90	25	100
N.Y.C.	85	50	100
N.Y.State	85	25	100

3. Calculate BTU for space heating

4. Determine BTU/sq.ft. using Tri-State 1963 floor space data.

	10^3 BTU/sq.ft.	
	Resid.	Non-Resid.
N.J.	214	203
N.Y.C.	125	150
N.Y.State	123	134
N.J.(1969)	188	-
Meadowlands	90	120
Actual used	125	150

B. Percent Fuel for Space Heating

1. Determine existing weighted average.

	Resid.	Non-Resid.
N.J.	90	54
N.Y.C.	85	86
N.Y.State	85	78

2. Assume Resid. = 90%

3. For non-resid. assume interpolate between present percent and implied percent if actual non-space heating fuel amount held constant.

	NJ	NYC	NY State
Tri-State increase in floor space ('63-'85)	160%	125%	160%
present	54	86	78
implied	65	91	85
interpolated & adjusted.	59	91	83

C. Propensity to Use Fuels

1. Determine percent oil & gas from 1969 data for N.J. and 1965 data for N.Y.

2. Adjust gas up 5% for N.Y.C.

Residential

	oil	gas
N.J.	65	35
N.Y.C.	75	25
N.Y. State	75	25

Non-Residential

	oil	gas
N.J.	75	25
N.Y.C.	75	25
N.Y. State	60	40

Resid. = Residential
Non-Resid. = Non-Residential
Indus. = Industrial
Commerc. = Commercial

Figure II-25 contd.

Background Area Source Assumptions

Emission Factors

Non-Residential Fuel Burning	Particulates	SO_2	CO	HC	NO_X	Units
Oil - New Jersey	22.0	20*	0.2	3.0	20.0*	lb/1000 gal
New York	22.0	25*	0.2	3.0	22.0*	lb/1000 gal
Gas - New Jersey	18.0	0.6	8.0*	30.0*	100.0*	lb/10^6 cu.ft.
New York	18.0	0.6	20.0*	15.0*	35.0*	lb/10^6 cu.ft.

*These weighted average emission factors were derived as follows:

For oil, averaging of the use of residual and distillate oil by industrial and commercial users. From 1965 Abatement Report it was determined that for New Jersey 60% of the use is industrial; for New York 20%; there is a shift towards residual - 80% of the industrial oil was residual, 60% of the commercial, except for New York City.

For gas, averaging of industrial and commercial users. New Jersey has 70% of use industrial, while New York has only 30%.

Those factors not marked '*' and all residential factors are unchanged from those in Figure I-30.

All non-fuel burning factors are unchanged from those in Figure 25 except for aircraft emissions; a weighted average was made which resulted in ratios of 1990 to 1969 factors of 1.0 for particulates and SO_2, 0.25 for CO and HC, and 0.7 for NO_2.

that the combination of commercial and industrial fuel use was comparable to the Tri-State non-residential square foot figures.

As can be seen in Figure II-25, significant variation was found in the BTU per square foot indices. Variation in the non-residential category can be explained by differences in the percent of commercial vs. industrial square foot land use and the intensity of use. However, there appears no clear explanation for the differences in the residential category. The actual values decided upon, taking into account the Meadowlands design figures, were much closer to the New York figures than the New Jersey ones. It is felt that efficiencies in heating and the tendency towards multiple family units will make this assumption bear out. However, this is a parameter that one may wish to vary in the future to better reflect the historical New Jersey information. The variation found in this index also explains the different numbers for BTUs per square foot shown in Figure I-29 for the inventory as a whole.

The second step in calculating fuel burning emissions was to estimate the percentage of fuel that would be used for space heating in 1990. Because all of the fuel projections were based upon square foot heating intensity, the factor that divides space heating from process heat demand becomes an extremely important multiplier. Unfortunately, as pointed out previously, this is an area where there is not sufficient information to make accurate judgments. First, a weighted average was determined for the existing percent space heating for non-residential land uses. This involved combining the commercial and industrial figures from the 1965 inventory as shown in Figure II-25.

The current New Jersey average residential figures was carried forward to 1990 for all portions of the region. This assumes that in the New York portion of the region more cooking and heating will be done by electricity in the future than at present. However, it should be pointed out that there are no clear trends one way or the other and that the figure of 90% is, at best, a guess based on current information.

Assumptions also had to be made for the non-residential percent space heating. At the two ends of the spectrum are (i) the use of the present percent space heating carried forward to 1990, and (ii) the estimate that total process heat would remain constant, thereby generating a new implied percentage. Lacking any further information, it was decided to interpolate a value midway between the values that would be derived from these two assumptions. The Tri-State data on the increase in floor space from 1963 to 1985 gave an index of the increase in space heating demand, assuming the same demand per square foot. From this an implied space heating percent was derived which assumed the constant value for process heat; finally, as shown in Figure II-25, the adjusted percent space heating values were determined.

The third step was to estimate 1990 propensity to use different fuels. Because of the uncertain nature of fuel shifts in this region from year to year and with no clear trends, a conservative approach was taken: most source categories were assumed to use the same percentages of fuels in 1990 as at the present time. The only exception to this was an adjustment upward in the percent using gas for New York City because of a concerted effort to bring natural gas into this area. Similar suggestions have been put forth as to trends for eastern portions of northern New Jersey but discussions with the New Jersey Department of Environmental Protection indicated that this may not be realistic.

The 1969 fuel data for New Jersey and 1965 data for New York were used to determine the current percentage use of oil and gas for residential and non-residential heating. The percentages as adjusted for use with the 1990 data are shown in Figure II-25. Because the different fuels vary widely in their emission factors, this is another portion of the inventory that may require significant change in the future as more information becomes available.

Using the 1985 Tri-State square foot data for residential and non-residential land use by county, the BTU per square foot values, the percent fuel for space heating, and the propensities to use various fuels, the amount of fuel for each county was calculated. The emission factors for 1990 fuel burning as presented in Figure I-30 are broken down into the categories of residential, commercial and industrial. It was necessary to perform a weighted average of the commercial and industrial factors, to produce a non-residential fuel burning factor for 1990. The procedures and calculations are shown in Figure II-25. Emission factors were applied to the fuel data to produce the area source fuel emissions as shown in Figure II-26.

3.4.2 Determination of Non-Fuel Emissions

Less information was available to determine non-fuel emissions than fuel emissions. In general, the same categories were used for 1990 as had been used in 1969. These are summarized in Figure I-24 together with the activity indices necessary for determining the emissions. Independent projections were made of area source incineration and power as described in the section on the background point source inventory. Figure II-27 shows for each county the number of tons per day of refuse incineration and the number of BTUs heat input from gas turbines.

Hydrocarbon emissions from evaporative losses are an extremely important part of the 1990 inventory. Little information is known on how

Figure II-26

Area Source Fuel Emissions

1990 for New Jersey

10^6 pounds/year

	Particulates	SO_2	CO	HC	NO_x
Bergen	10	8	1	3	9
Essex	10	8	1	2	9
Hudson	7	6	-	2	7
Middlesex	7	5	1	2	6
Monmouth	6	5	1	2	5
Morris	5	4	-	1	5
Passaic	5	4	-	1	5
Union	6	5	-	1	7

NOTE: Due to aggregation and rounding procedures, this table is presented only for report summary purposes.

Figure II-27

Area Source Power and Incineration Assumptions

Counties/Boroughs	Incinerations (tons/day of refuse)	Gas Turbines (10^{12} BTU heat input/year)
Bergen	250	) 12.7 *
Essex	300	)
Hudson	180	)
Middlesex	370	1.8
Monmouth	200	-
Morris	90	-
Passaic	130	-
Somerset	495	-
Union	455	*
Bronx	500	) 1.8
Brooklyn	1000	)
Richmond	100	)
Manhattan	600	)
Queens	700	)
Nassau	-	1.5
Rockland	215	-
Westchester	-	-

Note: * Gas turbine heat input were divided up equally for those counties served by a single utility; 1.8×10^{12} BTU were divided up equally for the five boroughs of New York City, and 12.7×10^{12} BTU for Bergen, Essex, Hudson, and Union counties.

best to characterize this source since it had not been heavily emphasized in any of the current emission inventories. Evaporation emissions were included, however, in the 1969 data. For 1990 Tri-State population estimates by county for 1985 and an emission factor per capita as supplied by EPA were used to calculate the hydrocarbon emissions. Very high numbers were generated by this process, aggregating some 250,000 tons per year for the study area and comprising nearly 50% of all hydrocarbon emissions. Whenever more specific information becomes available on evaporation emissions it should be incorporated into the inventory; any analysis of hydrocarbon air quality should recognize the importance of this source and the lack of definitive information on emission levels.

Motor vehicle emissions were estimated in two ways, as shown in Figure II-28 New Jersey Dept. of Transportation vehicle-mile data by county were used directly in conjunction with estimates of vehicle mix and the 1990 emission factors. A more involved process was used for the counties in New York State. First of all information on population by county and gasoline consumption by county from the 1965 inventory were used to determine the gallons per capita on a county basis. This was combined with the New Jersey vehicle-mile per capita data for 1990, derived from the 1985 population estimates, to produce the number of miles per gallon assumed for each county in New Jersey.

These were categorized and assumptions made as to the similarity of this parameter for various counties in New York. These assumed miles per gallon for the New York counties were multiplied times the gallons per capita to yield vehicle miles per capita. Finally, using the 1985 population estimates vehicle miles per county were derived. A more straightforward procedure would have involved the use of the Tri-State Transportation Commission estimates on vehicle mile use per square mile. However, this

Figure II-28

Derivation of Area Source Transportation Emissions

New Jersey counties	10^6 1965 Population	10^6 1965 fuel consumption	1965 gallons/capita	10^6 1985 Population	10^9 1990 veh-mi/yr	85'-90' veh mi/capita	miles/gal
column & procedure:	1	2	3 = 2 / 1	4	5	6 = 5 / 4	7 = 6 / 3
1. Bergen	0.85	360	425	1.223	7.02	5750	15 (15)
2. Essex	0.95	340	360	0.958	4.27	4460	12 (10)
3. Hudson	0.60	165	275	0.622	1.87	3000	11 (10)
4. Middlesex	0.55	170	310	0.994	6.18	6230	20 (20)
5. Monmouth	0.44	140	320	0.749	5.82	7770	24 (25)
6. Morris	0.30	120	390	0.631	5.38	8520	22 (20)
7. Passaic	0.45	140	310	0.519	3.35	6470	21 (20)
8. Somerset	0.15	50	330	0.528	3.42	6300	19 (20)
9. Union	0.55	215	390	0.562	3.49	6200	16 (15)
New York counties							
column & procedure:	1	2	3 = 2 / 1	4	5 = 6 X 4	6 = 3 X 7	7 = Estimate
10. Bronx	1.45	195	135	1.531	2.07	1350	(10)
11. Brooklyn	2.65	300	115	2.600	2.99	1150	(10)
12. Richmond	0.25	45	180	0.340	0.61	1800	(10)
13. Manhattan	1.70	340	200	1.632	3.26	2000	(10)
14. Queens	2.00	570	285	1.872	5.34	2850	(10)
15. Nassau	1.40	545	390	1.368	8.00	5850	(15)
16. Rockland	0.20	75	375	0.281	2.39	8500	(22.5)
17. Westchester	0.85	340	400	1.211	9.69	8000	(20)

Sources: 1965 NY Abatement Region report
1985 Tri-State population estimates
1990 NJDOT veh-mi estimate

information was not available to the study at the time the specific analysis was undertaken.

Estimates of 1990 aircraft emissions were made based upon current emission levels and regionwide projections in aircraft use. Unfortunately, aircraft use projections have varied widely in the last few years and there are no consistent trends. An average doubling of aircraft use per county for the entire region was assumed as a reasonable estimate. Using current emission levels and emission factors, and the ratio of 1990 to 1969 emission factors derived from Figure I-30, 1990 emissions were calculated.

The remaining non-fuel burning emissions consist of area process sources, other transportation sources, and gasoline marketing. In each case the 1970 Implementation Plan inventories and the 1975 inventory trends were used to calculate emissions for 1990. No additional information was available to adjust the current emission levels to some better estimate of the 1990 levels.

3.4.3 Summary of Inventory

Figure II-29 shows the total area source non-fuel emissions for the New Jersey counties for 1990 and Figure II-30 shows the combined fuel burning and non-fuel burning emissions for the entire study area in the units for input to the model. The same assumptions as to degree days and percent space heating as used in the 1969 inventory were used for the background inventory. The only exception involved the use of weighted average percent space heating for the non-residential category. The county emission densities were allocated to the 16 and 8 km grid cells shown in Figure II-14 according to the same procedures used with the current inventory.

Figure II-29

Area Source Non-Fuel Emissions

1990 for New Jersey

10^6 pounds/ year

	Particulates	SO_2	CO	HC	NO_x
Bergen	13	8	97	58	18
Essex	8	3	59	46	10
Hudson	2	3	23	25	7
Middlesex	6	11	74	40	13
Monmouth	6	8	70	36	13
Morris	7	4	68	31	11
Passaic	3	1	38	22	6
Somerset	4	2	44	25	7
Union	3	3	42	28	9

NOTE: Due to aggregation and rounding procedures, this table is presented only for report summary purposes.

FIGURE II-30

Background Area Source Emission Inventory

10^6 g $/m^2$-sec

	Particulates	SO_2	CO	HC	NO_X
Bergen	0.55	0.37	2.3	1.4	0.6
Essex	0.75	0.48	2.6	2.1	0.8
Hudson	1.33	1.16	2.9	3.3	1.7
Middlesex	0.23	0.27	1.3	0.8	0.3
Monmouth	0.14	0.14	0.8	0.4	0.2
Morris	0.15	0.09	0.8	0.4	0.2
Passaic	0.22	0.17	1.1	0.7	0.3
Somerset	0.15	0.10	0.8	0.5	0.2
Union	0.50	0.42	2.3	1.6	0.8
Bronx	1.26	0.89	3.5	7.2	1.2
Brooklyn	1.21	0.85	3.0	11.7	1.4
Richmond	0.24	0.20	0.7	3.0	0.5
Manhattan	5.70	5.07	11.0	15.9	6.5
Queens	1.45	0.49	3.7	5.0	1.5
Nassau	0.25	0.18	1.6	1.4	0.4
Rockland	0.13	0.08	0.9	0.4	0.2
Westchester	0.18	0.13	1.4	0.7	0.3

Note: due to rounding, this table is presented only for report summary purposes.

4. 1990 LAND USE PLANS

4.1 Introduction

The major part of the study involved the application of the emission projection methodologies to the Hackensack Meadowlands alternative land use plans. Because one aspect of this methodology was the development and implementation of the software to transform land use activities directly into emissions, all of the procedures described in this section parallel the software steps involved. These software steps are accomplished for the most part by the compute routines of the LANTRAN program described in the Appendix.

Figure II-31 shows the flow of information from activities to emissions. The first step involves the land use figures (the zone areas and separate points, as shown in Figures I-19 and I-20) with their associated activity codes. The specific activity or land use codes used are presented in Figure II-32.

4.1.1 Major Land Use Categories

The numerous land use categories as shown in Figures I-18 and I-21 were aggregated into six major categories for purposes of analysis. These are open space, institutional, residential, commercial, industrial and transportation as shown in Figure II-31. Emissions from open space were considered negligible on an annual average basis and not treated in the analysis. Emissions from institutional, residential and commercial were considered to be only fuel use related, whereas emissions from industrial sources included both fuel and process emissions.

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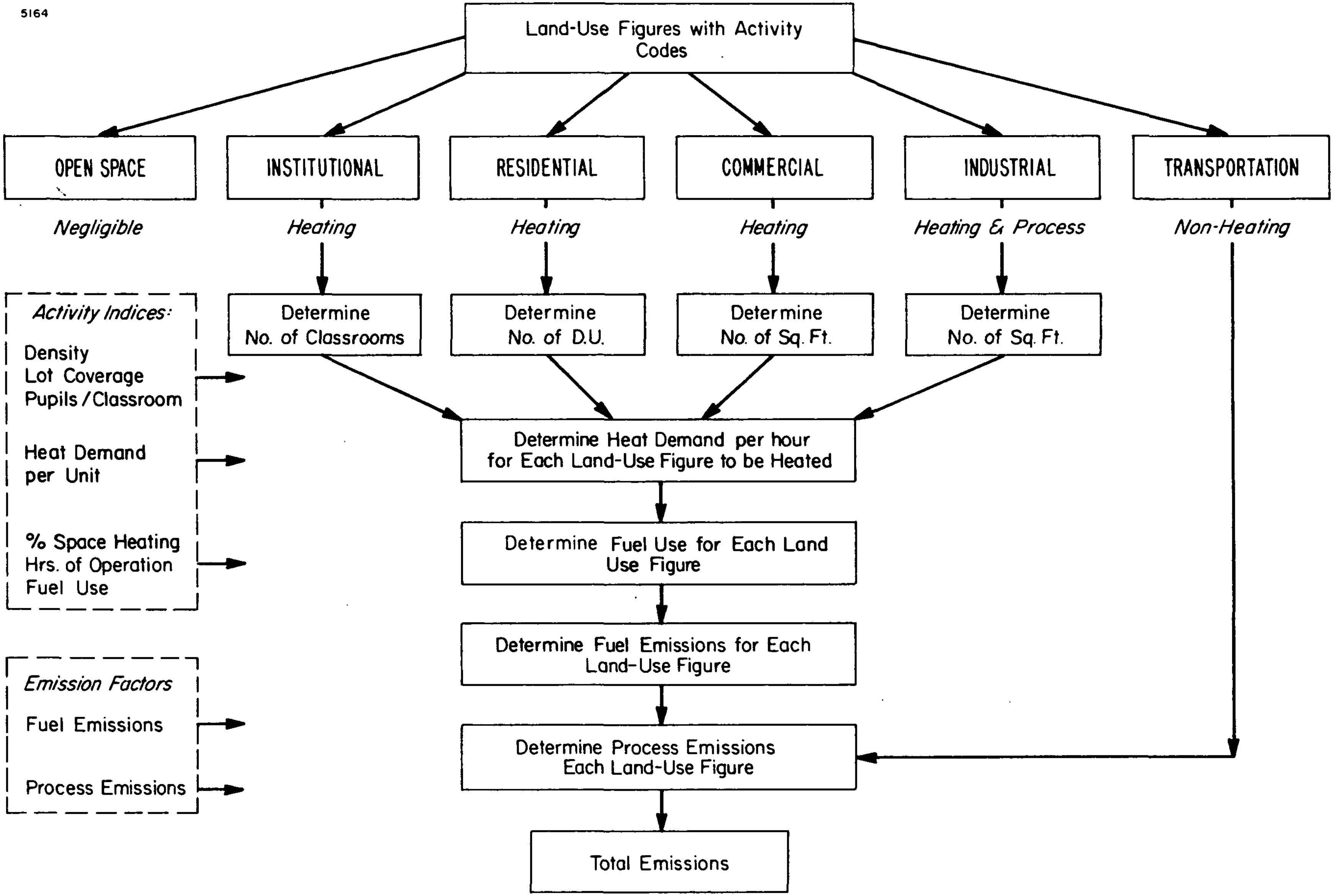

Figure II-31 Flow of Information from Activities to Emissions

Figure II-32

Land Use Plan Activities

Category	Code	Plan 1	1A	1B	1C
Residential					
low density (10 du/acre)	R01	X	X	X	X
medium density (20 du/acre)	R21		X		
medium density (30 du/acre)	R31			X	
high density (50 du/acre)	R32			X	
high density (80 du/acre)	R22		X		
island resid. (50 du/acre)	R11	X			
parkside resid. (50 du/acre)	R12	X			
Commercial					
business-neighborhood	C11	X			
business-community	C12	X	X	X	
business-Berry's Creek Center	C31	X		X	
hotel & highway	C21	X	X	X	X
Institutional					
primary schools	I11	X	X	X	
secondary schools	I12	X	X	X	
cultural center	I71	X			
special uses	I90	X	X	X	
Industrial					
manufacturing	S20xx-S39xx	X	X	X	X
distribution	S42	X	X	X	
research	S89	X			
Transportation					
transportation center	T10	X			X
airport	T20	X	X	X	X
stadium parking lot	T30	X	X	X	X
Open Space					
conservation	Z11	X			
parks	Z12	X	X	X	X
water	Z20	X	X	X	X
commercial recreation	Z31	X	X	X	X

Notes:

Code pertains to the land use activity codes as used with the LANTRAN program; the above is the complete list used in the study. Four-digit SIC codes (2000-3999) were used for manufacturing activities. Other codes were developed for this study and do not correspond to any published classification system. The activity indices and emission factors used with the Meadowlands Plans are referenced to this activity code list.

Transportation emissions were divided into several categories. Discussions with the Meadowlands planners indicated that all highway emissions should be treated as line sources separately from the plans. Railroad emissions were considered negligible since most propulsion involves electric engines. Emissions from water transportation vehicles were considered negligible as well. The airport was handled as a non-fuel burning source with emissions related directly to the number of flights. A further refinement could have involved the specification of terminal areas as separate fuel-burning sources, but these were considered to be negligible in the regional scale annual average case. The parking lots for the sports stadium were also treated as separate non-fuel burning sources of emissions related to the number of vehicles idling at any one time. Actual transportation centers (similar to a bus terminal) were treated like any other commercial fuel-burning land use.

4.1.2 Determining Heating Refinements

Figure I-21 shows that for each land use a heating requirement had to be determined in terms of BTUs per dwelling unit, classroom or square foot. Accordingly, as shown in Figure II-31, it was necessary to determine the number of classrooms, dwelling units, or square feet for the respective categories of land use. The activity indices such as density, lot coverage, and pupils per classroom that are a part of the conversion factors catalog were used to convert the land use data into the number of classrooms, dwelling units, and square feet. Once this information is known activity indices for heat demand per unit of activity can be used to determine the heat demand per hour for each land use figure that is to be heated.

4.1.3 Calculating Emissions

The next step was to incorporate the fuel use information,including the schedule, percent process heat, and fuel use propensity as shown in Figure I-21, into the analysis to determine the fuel used for each land use figure, as shown on the fifth line of Figure II-31. The final step in determining the fuel emissions involved the incorporation of the appropriate fuel emission factors.

Process emissions for each land use figure that involved industrial sources were calculated by use of the process emission factors. Similarly, process type emission factors for transportation, the airport, and parking lot were used to determine the transportation related emissions. The summation of fuel and process emissions yielded the last line in Figure II-31, representing the total emissions for each land use figure.

The following sections describe in more detail each of the steps required in this process.

4.2 Activities and Activity Indices

Each of the land use activities shown in the plans in Figures I-14 through I-17 was assigned an activity code. These are listed in Figure II-32, grouped according to the six land use categories shown in Figure II-31. There are seven possible categories of residential land use although no more than three occur in any one plan. These are generally low, medium and high density residual use with densities defined by the Meadowlands planners. However, in Plan 1, the Master Plan, no distinction is made between medium and high density; rather, the distinction is between island and riverside development called "island residential" and "parkside-residential", respectively.

4.2.1 Description of the Activity Categories

The four commercial categories are distinguished by their relationship to residential land use. Neighborhood and community business are generally directly related to residential use whereas the Berry's Creek center is a single large shopping complex. The fourth category (hotel and highway commercial) contains all the separate commercial development to be found in all plans.

Institutional land use is generally reserved for primary and secondary schools. In all cases these are directly related to the residential areas they serve. Provision is made in the Master Plan for a Cultural Center. Although it is coded as an institutional land use, it is generally treated in the same manner as a distribution land use for heating purposes.

The industrial category is by far the largest in terms of percent land area as well as emissions. It is subdivided into manufacturing, distribution, and (in the case of the Master Plan) research parks. The manufacturing land use category is further subdivided into four-digit SIC categories.

The transportation category is subdivided into the transportation center (treated similarly to a distribution activity), the airport, and the stadium parking lot; roadways were handled as separate line sources and, therefore, not coded for use with the LANTRAN program.

Four categories of open space were identified: conservation, parks, water and commercial recreation. None of these were thought to have significant emission levels. However, they are important "receptors" of the air quality calculated.

Figures I-19 and I-20 depict the spatial arrangements characteristic of these various land uses for the Master Plan. Residential sources may be large areas of single family homes with individual heating or they may be clusters of island residential apartment towers all heated from a central facility. Similarly, commercial establishments may be separate stores or hotels with individual heating systems, the large Berry's Creek shopping center with a central system, or neighborhood stores heated by the central residential heating system. Schools were all assumed to be built as individual buildings; however, the amount of space involved is a function of the residential area served.

Distribution is generally considered to be a land use zone with homogeneous heating requirements served by individual systems. It is, therefore, characteristic of an area-wide source. For simplicity, the cultural center, most special uses, the transportation centers, and research activities were assumed to behave in a similar manner as distribution. All manufacturing activity was specified as a function of individual 10-acre lots. However, where adjacent lots are of the same four-digit SIC this implies a large facility of 20, 30, 40 or more acres with a single heating system. The airport was assumed to be an area-wide source; emissions were not allocated to individual runways. Because of the uncertainty as to where parking lots will be in the stadium complex, a single point source was used to represent the idling emissions from automobiles in the parking lots.

4.2.2 Decisions Affecting Heating Demand

It became apparent that the particular ways in which each of the four plans would be built and have their heating requirements satisfied required a complex procedure for determining heating demand. The steps in the procedure developed are shown in Figure II-33 for each of the four major categories of fuel-related emissions: institutional, residential, commercial and industrial. Each of these will be discussed in detail.

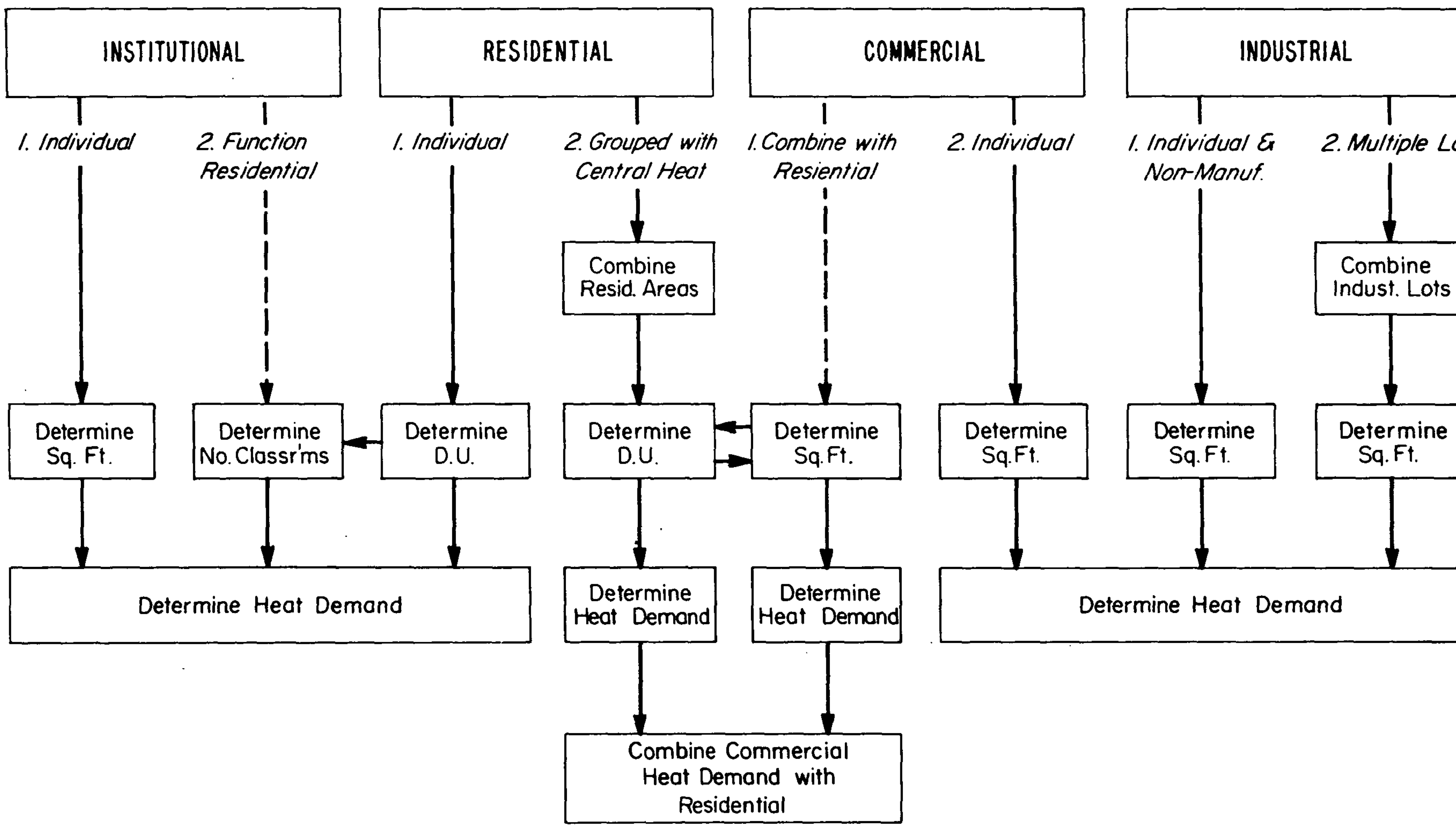

Figure II-33 Decisions Affecting Heating Demand

Institutional

The few cases of institutional land use that were to be treated on an individual basis (the cultural center and special uses) involve only one step to determine the number of square feet heated as a function of the area of the land use zone. The information required is shown in Figure I-21. Since the cultural center was to be treated similarly to a distribution source, it is listed in that table under "distribution". Columns 1 and 2 in Figure I-21 show that the percent lot coverage and the floor area ratio are necessary to perform the calculation. The number of acres of land use, and the percent lot coverage tell us how many square feet of the lot will be built upon; the floor area ratio (as used here) shows how many floors will exist in the building. Figure II-34 shows the actual numbers assigned to the parameters in Figure I-21. If we read down the left-hand column until we encounter Example no. 1, activity code I-71 (the code for cultural center) and we read across to the columns labeled A-1 and A-2 we see the number 40 (the percent lot coverage) and the number 1 (the floor area ratio).

Having determined the number of square feet assigned to the cultural center we can multiply by the BTU per square foot to calculate the heat demand. The appropriate number for BTUs per square foot is found in the first column of Figure II-34, labeled ACTV; the value is 12.5.

The majority of institutional land uses are the schools; their heat demand is a function of the number of classrooms. The number of classrooms is related to the number of pupils per classroom, the number of pupils per dwelling unit, and the number of dwelling units in the residential area which the school serves. Figure I-21 shows that two of these parameters (the number of dwelling units and the pupils per dwelling unit) are activity

Figure II-34 Plan Activity Indices

EXAMPLE NO.		KEY-ACTIVITY	ACTIVITY	ACTIVITY NAMES ACTV	A1	A2	A4
2,3	Low Density	R01		18750,000	10,000	1,500	0,0
4,5	Mid Density	R11		7500,000	50,000	0,500	1500,000
		R12		7500,000	50,000	1,000	2000,000
		R21		13750,000	20,000	1,000	0,0
		R22		4000,000	80,000	0,500	0,0
		R31		8750,000	30,000	1,000	0,0
		R32		7500,000	50,000	1,000	0,0
5	Neighborhood Commercial	C11		16,250	0,500	1,000	0,0
		C12		16,250	1,500	1,000	0,0
		C21		16,250	35,000	0,750	0,0
6	Berry's Creek	C21	C31	16,250	35,000	0,750	0,0
2	Primary School	I11		15000,000	25,000	0,450	0,0
		I12		15000,000	30,000	0,200	0,0
1	Cultural Center	I71		12,500	40,000	1,000	0,0
		T10		12,500	40,000	1,000	0,0
		T20		0,0	0,0	0,0	0,0
		T30		0,0	0,0	0,0	0,0
7	Distribution	S42		12,500	30,000	1,000	0,0
		S42	I90	12,500	30,000	1,000	0,0
9	Manufacturing	S39		27,500	40,000	1,000	0,0
		S39	S2031	27,500	40,000	1,000	0,0
		S39	S2032	27,500	40,000	1,000	0,0
		S39	S2033	27,500	40,000	1,000	0,0
		S39	S2034	27,500	40,000	1,000	0,0
		S39	S2304	27,500	40,000	1,000	0,0
		S39	S2307	27,500	40,000	1,000	0,0
		S39	S2041	27,500	40,000	1,000	0,0
		S39	S2043	27,500	40,000	1,000	0,0
		S39	S2045	27,500	40,000	1,000	0,0
		S39	S2051	27,500	40,000	1,000	0,0
		S39	S2052	27,500	40,000	1,000	0,0
		S39	S2082	27,500	40,000	1,000	0,0
		S39	S2086	27,500	40,000	1,000	0,0
		S39	S2087	27,500	40,000	1,000	0,0
		S39	S2095				

Figure II-34 Cont'd

		27,500	40,000	1,000	0,0
S39	S2098	27,500	40,000	1,000	0,0
S39	S2295	27,500	40,000	1,000	0,0
S39	S2661	27,500	40,000	1,000	0,0
S39	S2721	27,500	40,000	1,000	0,0
S39	S2815	27,500	40,000	1,000	0,0
S39	S2816	27,500	40,000	1,000	0,0
S39	S2818	27,500	40,000	1,000	0,0
S39	S2819	27,500	40,000	1,000	0,0
S39	S2831	27,500	40,000	1,000	0,0
S39	S2833	27,500	40,000	1,000	0,0
S39	S2834	27,500	40,000	1,000	0,0
S39	S2842	27,500	40,000	1,000	0,0
S39	S2843	27,500	40,000	1,000	0,0
S39	S2844	27,500	40,000	1,000	0,0
S39	S2851	27,500	40,000	1,000	0,0
S39	S2992	27,500	40,000	1,000	0,0
S39	S3275	27,500	40,000	1,000	0,0
S39	S3291	27,500	40,000	1,000	0,0
S39	S3292	27,500	40,000	1,000	0,0
S39	S3431	27,500	40,000	1,000	0,0
S39	S3433	27,500	40,000	1,000	0,0
S39	S3551	27,500	40,000	1,000	0,0
S39	S3552	27,500	40,000	1,000	0,0
S39	S3554	27,500	40,000	1,000	0,0
S39	S3555	27,500	40,000	1,000	0,0
S39	S3561	27,500	40,000	1,000	0,0
S39	S3562	27,500	40,000	1,000	0,0
S39	S3566	27,500	40,000	1,000	0,0
S39	S3567	27,500	40,000	1,000	0,0
S39	S3573	27,500	40,000	1,000	0,0
S39	S3581	27,500	40,000	1,000	0,0
S39	S3582	27,500	40,000	1,000	0,0
S39	S3585	27,500	40,000	1,000	0,0
S39	S3589	27,500	40,000	1,000	0,0
S39	S3613	27,500	40,000	1,000	0,0
S39	S3635	27,500	40,000	1,000	0,0
S39	S3636				

Figure II-34 Cont'd

				27,500	40,000	1,000	0.0
		S39	S3639	27,500	40,000	1,000	0.0
		S39	S3641	27,500	40,000	1,000	0.0
		S39	S3642	27,500	40,000	1,000	0.0
		S39	S3643	27,500	40,000	1,000	0.0
		S39	S3644	27,500	40,000	1,000	0.0
		S39	S3651	27,500	40,000	1,000	0.0
		S39	S3652	27,500	40,000	1,000	0.0
		S39	S3661	27,500	40,000	1,000	0.0
		S39	S3662	27,500	40,000	1,000	0.0
		S39	S3691	27,500	40,000	1,000	0.0
		S39	S3692	27,500	40,000	1,000	0.0
		S39	S3693	27,500	40,000	1,000	0.0
		S39	S3715	27,500	40,000	1,000	0.0
		S39	S3714	27,500	40,000	1,000	0.0
		S39	S3841	27,500	40,000	1,000	0.0
		S39	S3842	27,500	40,000	1,000	0.0
		S39	S3843	27,500	40,000	1,000	0.0
		S39	S3861	27,500	40,000	1,000	0.0
8	Research	S89		20,000	25,000	1,000	0.0
		S39	S2841	27,500	40,000	1,000	0.0
		S39	S3634	27,500	40,000	1,000	0.0
		S39	S2731	27,500	40,000	1,000	0.0
		S39	S2035	27,500	40,000	1,000	0.0
		S39	S2037	27,500	40,000	1,000	0.0
		S39	S3521	27,500	40,000	1,000	0.0
		S39	S3569	27,500	40,000	1,000	0.0
		S39	S2720	27,500	40,000	1,000	0.0

indices related directly to the residential area. If the school serves a single family, low density area we would look in Figure II-34 under the activity code R-01 (Example No. 2). The value (10.) in the column labeled A-1 is the number of pupils per dwelling unit. Therefore, each acre of low density land has 15 pupils assigned to the school serving that area. Since both primary and secondary schools exist it is important to know what percentage of the eligible pupils go to each of the different types of schools. If we are interested in the heat demand for a primary school, we would look in Figure II-34 under activity code I-11. The column labeled A-2 contains the number .45 which means that 45% of the school children would be going to the primary school.

Finally, using the value in column A-1 of 25 pupils per classroom we can determine the total number of classrooms necessary in primary schools to serve the particular residential area. If we have 100 acres of low density residential land, this would yield 1500 pupils, 45% of which is 675 primary school pupils; at 25 pupils per classroom this yields 27 classrooms. Multiplying by the BTUs per classroom found in the first column, 15,000, would yield the heat demand for that school.

Residential

Residential land uses have two sub-categories similar to institutional: individual heating and heating provided by central facilities. In the case of the individual heating (found in low-density housing) the heat demand is a direct function of the number of dwelling units . In Figure II-34 for Example no. 3, under activity R-01 (low density residual), the column labeled A-1 shows 10 dwelling units per acre. Multiplying this times the BTU per dwelling unit value of 18,750 would yield the heat demand for an acre of low-density residential land use.

Most of the medium and high density development in the Meadowlands Master Plan and alternative Plans 1-A and 1-B would be satisfied by central facilities. A more complicated process is therefore required. First of all, it is necessary to determine which residential land use zones should be grouped together to be heated by a particular central system. The grouping results in a total number of dwelling units to be heated, assigned to a particular heating facility. This is accomplished by summing the acreage of all the affected land use zones and multiplying times the dwelling units per acre.

For instance, for island residential with a code of R-11, Figure II-34 Example no. 4, shows a value of 50 dwelling units per acre in column A-1. Because the average dwelling unit size in high density development is smaller and the efficiency of a central heating system is greater the BTU per dwelling unit value is only 7500 for this land use category. When the total heat demand is determined it is assigned to the location of the central facility.

Commercial

Community and neighborhood shopping facilities are entirely a function of the residential land uses they serve. In the Master Plan these are the island and parkside residential areas. First of all, the actual square footage of commercial development must be determined as a direct function of the number and size of the dwelling units in the residential area; this procedure is depicted in Figure II-33. Neighborhood shopping with a code of C-11 (Example no's) has a BTU per square foot demand of 16.25 as shown in Figure II-34. The number in the column labeled A-1 tells us that 0.5% of the square footage of the residential development will be assigned to commercial use; this is the number specified in the Hackensack Meadowlands zoning regulations. But, for an island residential area with a code of R-11, how do we determine what the total square feet of residential area is? Figure II-34, column A-4, gives us a value of 1500 square feet per dwelling unit. When this is multiplied by the number of dwelling units, we obtain the total residential square feet. Once the heating demand in BTUs per hour is determined for this commercial use it must be added to the heat demand for the residential area since all heating will be taken care of by the central facility.

Separate commercial facilities such as the Berry's Creek shopping center will be heated individually. The number of square feet is a function of the lot coverage and the floor area ratio. The code for Berry's Creek (C-31) does not appear in the left column of Figure II-34 (Example no. 6); it is indented and the code C-21 for hotel and highway appears in the left column. This indicates an assumption that Berry's Creek will be heated according to the same parameters as hotel and highway (C-21). Column A-1 gives us the lot average, and Column A-2 the floor area ratio. Multiply the number of square feet times the value of 16.25 BTUs per square foot yields the total heat demand per hour. Some of the special facilities such as Berry's Creek may consist of more than one land use zone with a central heating facility. In this case, the procedure is similar to the island residential. The commercial areas are combined before the activity indices are applied to the total acreage.

Industrial

Most industrial land uses are handled in a similar manner to the separate commercial facility. All distribution, research, and individual 10-acre lots are heated separately. In the case of a large distribution area this would take the form of homogeneous area-wide emissions from numerous distribution facilities. In the case of a 10-acre manufacturing lot this would probably mean emissions from a single facility. In Figure II-34, columns A-1 and A-2, respectively, give the percent lot coverage and floor area ratio for Example no. 7, distribution (S-42), Example no. 8, research (S-89), and Example no. 9, manufacturing (S-39). All four-digit SIC code manufacturing activities are assumed to behave in a similar manner as S-39 for the purposes of heating. This assumption was made simply because of the available information.

Where adjacent 10-acre industrial losts have the same SIC code and are, therefore, to be combined as a single facility, the total acreage is added together and assigned to a single central heating system, at a point. Then the same procedures are used to calculate BTUs per hour.

Other Categories

Since no heat demand is assumed to occur for the transportation sources, they are not involved in this part of the analysis.

4.3 Fuel Decisions

parameters are necessary to translate heat demand in BTUs per hour into quantities of fuel used for both space heating and process heating purposes. These are: the schedule (number of hours of operation per year), the percent fuel used for process heat, and the percent of fuel demand satisfied by each of the fuels. Figure I-21 showed that these parameters are the same for all land uses. The actual values used are shown in Figure II-35.

Figure II-35 Plan Fuel Use Allocation

	KEY-ACTIVITY	ACTIVITY	ACTIVITY NAMES SCHED	PROC	R-OIL	D-OIL	N-GAS	PROC1	PROC2
Residential	R01		10 D.U. 8760.000	10.000	0.0	0.0	1.000	0.0	0.0
	R11		ALL MULTI-RES. 8760.000	10.000	0.0	1.000	0.0	0.0	0.0
	R11	R12	8760.000	10.000	0.0	1.000	0.0	0.0	0.0
	R11	R21	8760.000	10.000	0.0	1.000	0.0	0.0	0.0
	R11	R22	8760.000	10.000	0.0	1.000	0.0	0.0	0.0
	R11	R31	8760.000	10.000	0.0	1.000	0.0	0.0	0.0
	R11	R32	8760.000	10.000	0.0	1.000	0.0	0.0	0.0
Commercial	C11		ALL COMMERCIAL 3000.000	0.0	0.0	1.000	0.0	0.0	0.0
	C11	C12	3000.000	0.0	0.0	1.000	0.0	0.0	0.0
	C11	C21	3000.000	0.0	0.0	1.000	0.0	0.0	0.0
	C11	C31	3000.000	0.0	0.0	1.000	0.0	0.0	0.0
Institutional	I11		ALL SCHOOLS 1600.000	0.0	0.0	1.000	0.0	0.0	0.0
	I11	I12	1600.000	0.0	0.0	1.000	0.0	0.0	0.0
Transportation	T20		AIRPORT-FLIGHTS/YEAR 1.000	0.0	0.0	0.0	0.0	0.0	1.000
	T30		PARKING LOTS- VEHICLES/YR 1.000	0.0	0.0	0.0	0.0	1.000	0.0
Miscellaneous Distribution	S42		DISTRIBUTION 3600.000	0.0	0.0	1.000	0.0	0.0	0.0

Notes: sched = schedule (hours per year for fuel burning)
proc = percent of fuel for non-space heating purposes.
R=oil = percent of heat demand satisfied by residual oil (1.0 = 100%)
D=oil = percent of heat demand satisfied by distillate oil (1.0 = 100%)
N-Gas = percent of heat demand satisfied by natural gas (1.0 = 100%)
Proc1 = percent of process rate applying to first process (1.0 = 100%)
Proc2 = percent of process rate applying to second process (1.0 = 100%)

Figure II-35 Cont'd

Research	S89		RESEARCH 2000,000	0.0	0.0	1.000	0.0	0.0	0.0
Transportation Center	T10		TRANSP. CTR 8760,000	0.0	0.0	1.000	0.0	0.0	0.0
Cultural Center	I71		CULTURAL CTR. 1000,000	0.0	0.0	1.000	0.0	0.0	0.0
Special Uses	I90		SPECIAL USES 3600,000	0.0	0.0	1.000	0.0	0.0	0.0
<u>Manufacturing</u>	S39		MANUF- GEN. 3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S20		8760,000	90.000	0.750	0.0	0.250	0.0	0.0
	S39	S3551	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3552	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3554	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3555	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3561	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3562	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3566	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3567	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3573	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3581	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3582	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3585	3600,000	75.000	0.950	0.0	0.050	0.0	0.0
	S39	S3589							

Figure II-35 Cont'd

		3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3613	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3635	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3636	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3639	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3641	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3642	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3643	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3644	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3651	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3652	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3661	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3662	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3691	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3692	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3693	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3715	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3714	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3841	3600.000	75.000	0.950	0.0	0.050	0.0	0.0

Figure II-35 Cont'd

S39	S3842	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3843	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S39	S3861	3600.000	75.000	0.950	0.0	0.050	0.0	0.0
S20	S2031	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2032	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2033	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2034	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2304	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2307	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2041	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2043	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2045	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2051	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2052	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2082	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2086	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2087	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2095	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2096							

Figure II-35 Cont'd

		8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2295	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2561	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2721	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2731	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2815	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2816	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2818	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2819	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2831	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2833	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2834	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2842	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2843	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2844	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2851	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2992	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S3275	8760.000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S3291	8760.000	90.000	0.750	0.0	0.250	0.0	0.0

Figure II-35 Cont'd

S20	S3292	8760,000	90.000	0,750	0.0	0.250	0.0	0.0
S20	S3431	8760,000	90.000	0,750	0.0	0.250	0.0	0.0
S20	S3433	8760,000	90.000	0.750	0.0	0.250	0.0	0.0
S39	S3634	3600,000	75.000	0,950	0.0	0.050	0.0	0.0
S39	S3621	3600,000	75.000	0,950	0.0	0.050	0.0	0.0
S20	S2341	8760,000	90.000	0,750	0.0	0.250	0.0	0.0
S20	S2035	8760,000	90.000	0.750	0.0	0.250	0.0	0.0
S20	S2037	8760,000	90.000	0,750	0.0	0.250	0.0	0.0
S39	S3569	3600,000	75.000	0,950	0.0	0.050	0.0	0.0
S20	S2720	8760,000	90.000	0,750	0.0	0.250	0.0	0.0

The column labeled SCHED gives the number of hours per year of operation assumed for each land use code. The column labeled PROC gives the percent of fuel used for process heat. The next three columns show the portion of total fuel demand assigned to residual oil, distillate oil, and natural gas.

Sufficient information existed to divide four-digit manufacturing SICs into two categories for these parameters. One is ooded S-20 and the other S-39; all industrial lots are assigned to one of these two categories. S-20 represents heavier industry, operating almost continuously throughout the year and using 90% of the fuel for process heat. S-39 represents 12-hour per day operation, 6 days a week with only 75% of the fuel used for process heat. S-39 type industries are much more apt to use oil, as evidenced by existing point sources in the current inventory.

4.4 Emission Factors

The emission factors used in conjunction with the Meadowlands plans are shown in Figure II-36 for each activity code and fuel used by that activity. Emission factors for each of the five pollutants are shown in the same units used in Figure I-30. Fuel burning was aggregated into residential, commercial and industrial.

For the airport the names PROC 1 and PROC 2 were used, respectively, for commercial and general aviation emissions. In Figure II-35 for activity T-20 the last two columns show values of 0. for PROC 1 and 1.0 for PROC.2. This means that all aircraft assigned to the airport are of the general aviation (PROC 2) category. For T-30 in Figure II-36 the emission factors assigned to PROC 1 represent automobile idling. These factors were developed independently of the emission factor analysis and solely for the purposes of the parking lot emissions. This was done because of the emission factor analysis

List of Plan Emission Factors as Printed by the LANTRAN program.

		TSP	SO_2	CO	HC	NO_x	
Residential	R11			RES, FUEL BURNING			
	*********	FUELNAME NOT FOUND IN AVNAM(LOCATIONS 3 TO 7).					FUEL IS B-COA
	D-OIL	10.0000	6.5000	0.2000	3.0000	4.8000	
	N-GAS	19.0000	0.6000	20.0000	8.0000	5.0000	
Commercial & Institutional	C11			COMMERC, FUEL BURNING			
	*********	FUELNAME NOT FOUND IN AVNAM(LOCATIONS 3 TO 7).					FUEL IS A-COA
	*********	FUELNAME NOT FOUND IN AVNAM(LOCATIONS 3 TO 7).					FUEL IS B-COA
	R-OIL	23.0000	40.0000	0.2000	3.0000	24.0000	
	D-OIL	15.0000	11.0000	0.2000	3.0000	24.0000	
	N-GAS	19.0000	0.6000	20.0000	8.0000	8.0000	
Manufacturing	S39			INDUST, FUEL BURNING			
	*********	FUELNAME NOT FOUND IN AVNAM(LOCATIONS 3 TO 7).					FUEL IS A-COA
	*********	FUELNAME NOT FOUND IN AVNAM(LOCATIONS 3 TO 7).					FUEL IS B-COA
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	18.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
Airport	T20			AIRPORTS- 1=COMMERC, 2=GEN, AVIATION			
	PROC1	8.0000	2.0000	6.0000	4.0000	3.5000	
	PROC2	0.2000	2.0000	6.0000	0.7000	0.2000	
Parking Lot	T30						
	PROC1	4.3000	4.4000	12.2000	2.7000	0.9000	
	S2031						
	R-OIL	23.0000	24.0000	0.2000	3.0000	16.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	16.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	10.0000	0.0	0.0	200.0000	0.0	
4-Digit SIC Manufacturing	S2041						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	18.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	25.0000	0.0	0.0	0.0	0.0	
	S2051						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	16.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	10.0000	0.0	0.0	0.0	0.0	
	S2082						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	16.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	10.0000	0.0	0.0	100.0000	0.0	
	S2095						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	15.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	25.0000	0.0	0.0	25.0000	0.0	
	S2295						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	18.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	10.0000	0.0	0.0	200.0000	0.0	
	S2661						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	18.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	25.0000	0.0	0.0	0.0	0.0	
	S2843						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	18.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	25.0000	0.0	0.0	0.0	0.0	
	S2851						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	15.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	10.0000	0.0	0.0	0.0	0.0	
	S3275						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	18.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	10.0000	0.0	0.0	0.0	0.0	
	S3292						
	R-OIL	23.0000	24.0000	0.2000	3.0000	16.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	18.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	10.0000	0.0	0.0	0.0	0.0	
	S3691						
	R-OIL	23.0000	24.0000	0.2000	3.0000	18.0000	
	D-OIL	15.0000	6.0000	0.2000	3.0000	18.0000	
	N-GAS	18.0000	0.6000	0.4000	40.0000	140.0000	
	PROP	0.0	25.0000	0.0	0.0	0.0	

Figure II-36 Cont'd

	C11	I12
	C11	I71
	C11	I90
	C11	T10
	C11	S42
	C11	S89
(Other Codes Linked to above Factors)	R11	R01
	R11	R12
	R11	R21
	R11	R22
	R11	R31
	R11	R32
	C11	C12
	C11	C21
	C11	C31
	C11	I11
	S39	S2032
	S39	S2033
	S39	S2034
	S39	S2304
	S39	S2307
	S39	S2043
	S39	S2045
	S39	S2052
	S39	S2086
	S39	S2087
	S39	S2098
	S39	S2721
	S39	S2731
	S39	S2815
	S39	S2816
	S39	S2818
	S39	S2819
	S39	S2831
	S39	S2833
	S39	S2834
	S39	S2842
	S39	S2844
	S39	S2992
	S39	S3291
	S39	S3431

Figure II-36 Cont'd

S39	S3433
S39	S3551
S39	S3552
S39	S3554
S39	S3555
S39	S3561
S39	S3562
S39	S3565
S39	S3567
S39	S3573
S39	S3581
S39	S3582
S39	S3585
S39	S3589
S39	S3613
S39	S3635
S39	S3636
S39	S3639
S39	S3641
S39	S3642
S39	S3643
S39	S3644
S39	S3651
S39	S3652
S39	S3661
S39	S3662
S39	S3692
S39	S3693
S39	S3714
S39	S3715
S39	S3841
S39	S3842
S39	S3843
S39	S3861
S39	S2841
S39	S3634
S39	S2035
S39	S2037
S39	S3621
S39	S3569
S39	S2720

Notes: Units vary according to fuel. See Figure I-30 for explanation of units. The use of this data set is covered in the Appendix to Task 1, under the discussion of the case study. It is shown here merely to present the complete list of data used in the study.

had been concluded prior to the identification of the stadium and its parking lots as a land use. The most current information on idling emission rates was obtained from EPA as a part of another study. Lacking further information, it was assumed that the same percent reduction in urban vehicle speed emission factors from 1969 to 1990 would apply to the idling emission factors. This produced the numbers shown in Figure II-36 in pounds per thousand hours of vehicle idling time.

Each of the four-digit industrial codes for the Meadowlands Plans analyzed as to its propensity to produce process emissions, twelve 4-digit SIC categories were identified as significant process sources; these are shown in Figure II-36. Because no specific information was available as . result of the emission factor analysis, and because no activity data had been developed as a part of the plans which would indicate process rates or even process type, the emission factors were determined as proportionate to fuel emissions. They are labeled PROP in Figure II-36. The fuel emission factors for these SICs are the same as those given for industrial fuel burning. As mentioned under the discussion of current background emissions the subject area of process emission sources requires the most additional work.

The fuel emission factors were applied to the fuel uses as calculated according to the procedures discussed. Industrial process emissions were then proportioned to these. Emissions from the airport and the parking lot were calculated as a direct function of the activity (number of aircraft flights per year, and thousand hours of automobile idling per year).

4.5 Criteria for Determining Point Sources

The procedures discussed produced total emissions by season for each of the land use figures. The figures consisted of both land use zones, such as distribution areas or low density residential areas, and individual point locations, including manufacturing sources, schools, and central heating systems for large residential areas. For these point sources it remained to be determined which ones should be treated as separate point sources for modeling and which should be aggregated into the area source grid cells.

The size criterion established for point source status was 25 tons per year of any one pollutant, the same as that used for the background point source inventory. For each plan most of the industrial sources resulting from zones greater than 10 acre lots became point sources, as did several of the large residential areas.

Figure II-37 shows the information flow for allocating the emissions to point and area sources, based upon the size criteria. In the case of the point sources stack parameters had to be assigned. The default numbers in Figure I-32 were used and the information formatted for input to the model. No emission control regulations for New Jersey sources could be quantified for testing. In the case of the area sources, the land use figures were assigned to the grid cells in terms of emission densities, using the LANTRAN allocation procedures, and the data formatted for direct input to the model.

4.6 Highway Emissions

In addition to the background line sources resulting from the regional highway network in and around the Meadowlands, each of the four land use plans contained additional through and local streets. Because no network assignments were made in conjunction with vehicle trip mile demand, it was necessary to develop a highway allocation procedure. Initially, two types

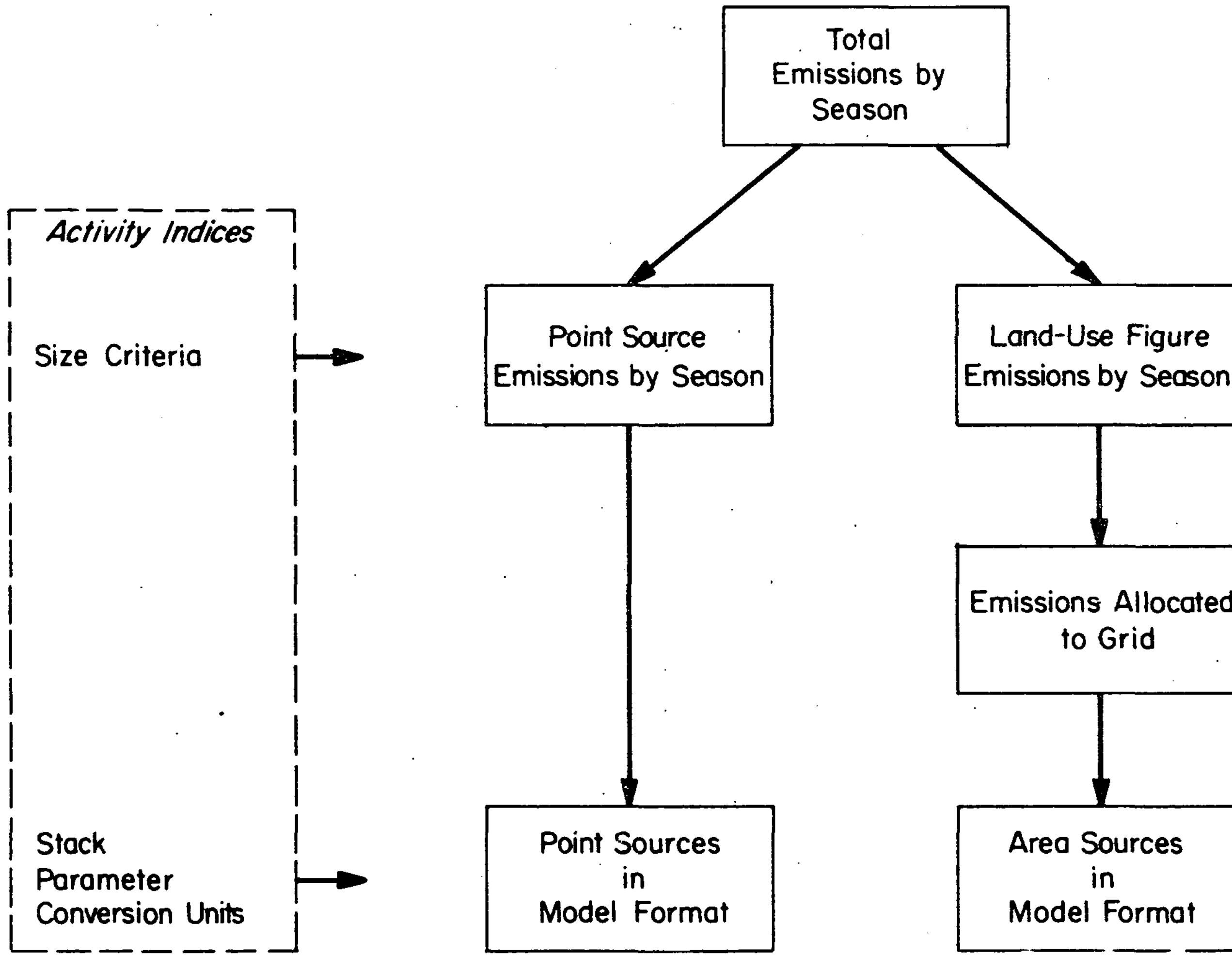

Figure II-37 Allocation of Emissions to Point and Area Sources of roads were postulated. One with a 50,000 vehicle per day design volume and the other with 25,000. Using the initial network from each of the plans, the total number of vehicle miles per day as satisfied by the plan highway network, was calculated. This is shown in Figure II-38 at the bottom, under the heading First Round Calculation.

At the same time the estimated number of vehicle miles per day, as a demand from each of the four plans, was determined, based upon the population and employment associated with each plan. This procedure is shown in Figure II-38. The number of vehicle miles per day was determined as a function of the total work trips; the work trips were assumed to be a function of the people who (1) live in the Meadowlands and work both inside and outside the Meadowlands, and (2) those who live outside the Meadowlands but work inside. Since very little development of a non-regional nature was anticipated in Plan 1-C, it was assumed that the regional and plan network should directly satisfy the demand of Plan 1-C. Using this assumption a net demand not satisfied by the regional network was determined as shown in Figure II-38 and compared to the first round calculation from the highway network. The ratio of these two showed that the Plan 1 network was over-built, whereas the Plan 1-A and Plan 1-B networks would be overloaded as the assumed vehicle mile design figures. For consistency the net demand figures were assigned to the network, yielding figures for total vehicle miles per year for each plan used in the analysis.

4.7 Meadowlands Incinerator Emissions

At the request of the Hackensack Meadowlands Commission, emissions from the two proposed sites for the Hackensack Meadowlands incinerator were

Figure II-38

Plan Highway Allocation

	10^3 people						10^3 veh-mi/day
	Population	(1) Work	(2) Live in, Work in	(3) Total Work in	(4)=(3)-(2) Live out, Work in	(1)+(4) Total Work Trips	Estimated Total Demand***
Plan 1	185	(50%) 92	(50%) 46	186	140	232	1392
1A	325	(50%) 162	(60%) 96	326	230	392	2352
1B	450	(60%) 270	(20%) 54	234	180	450	2700
1C	6	- -	- -	200	200	200	1200

	10^3 veh-mi/day				AADT Assignments		
	Estimated Total Demand-Rounded	Net Demand	1st Round Calculation	Adjustment Factor	Old 50000 / New	25000	Comment
Plan 1	1400	300	1500	0.2	10000	5000	overbuilt
1A	2400	1300	1000	1.3	66000	33000	overloaded
1B	2700	1600	1200*	1.3	66000**	-	overloaded
1C	1200	100	100	1.0	-	25000	

Comments: Employment assumptions from Hackensack Meadowlands Commission.

* By definition factor = 1.0 for Plan 1C, thereby determining that 1100 veh-mi/day will be satisfied for all plans by the regional highway network.

** For Plan 1B all 25000 veh-mi/day capacity roads were 'upgraded' to 50000 veh-mi/day at the start of round one; otherwise the factor would have been 2.6.

*** Assume total travel at rate of 6 mile/day. per work trip.

calculated separately from the background emissions inventory. The proposed southern location of the incinerator is in the vicinity of Source #28 in Figure II-6; the proposed northern site is in the vicinity of Source #9 in Figure II-6. Only the emissions from the southern incinerator were included in the actual background inventory used for modeling purposes.

As a part of the study of regional incineration, an incinerator of 6,000 tons per day capacity was assigned to the Meadowlands region, as proposed by the Meadowlands Commission. However, since only five of the six units would be used at any one time, the actual emission rate is based on 5,000 tons of refuse per day. The incinerator would operate 24 hours a day, six days a week and 52 weeks a year. This would yield approximately 1.5 million tons of refuse burned per year.

Using the 1990 incinerator emission factor in Figure I-30, this yields 1,125 tons per year each of particulates, sulfur dioxide, and hydrocarbons and 750 tons per year of carbon monoxide and nitrogen oxides. For modeling purposes, the height was estimated to be 300 feet and the effective stack height, 345 feet, as estimated by the Meadowlands Commission.

Any source emitting over a thousand tons per year of any pollutant, particularly in 1990, must be considered a major point source. To ascertain the relative importance of this facility, it was compared to the other major point sources in the area. Examining Figure II-6, it is seen that there are 14 point sources clustered neat the southern edge of the Meadowlands, in the vicinity of the southern incinerator. Using the 1990 fuel and process emissions from Figures II-17 and II-23, the following totals are found: For particulates, 2000 tons per year; sulfur dioxide, 2400 tons; and nitrogen oxides, 14,000 tons. The emissions for the four power plants and three process sources alone are: 1,600, 2,000 and 13,500 tons per year, respectively.

If the projected emissions from the incinerator are added to these, the contribution of the incinerator, out of the new total of 15 point sources in the area, would be 35% for particulates, 30% for sulfur dioxide, and 5% for nitrogen oxides. This may serve as a useful measure of the relative importance of the incinerator's emissions.

The northern incinerator has the same emission levels; however, due to the predominant winds in the region, more of the emissions from the northern incinerator would fall outside the Meadowlands boundary. There are five point sources shown in Figure II-6 in the general vicinity of the northern incinerator location. For 1990 they would contribute 625 tons of particulates, 125 tons of sulfur dioxide, and 6,750 tons of nitrogen dioxide. The one power plant and single-process source would contribute 500, zero, and 6,600 tons, respectively. If the emissions for the northern incinerator are added to these totals, this incinerator would contribute the following percentages of the total emission from the six sources in the area: 65% for particulates, 90% for sulfur dioxide, and 19% for nitrogen oxides.

Because very little of the fuel use for these point sources is for space heating, we would not expect the emission levels to vary significantly for the summer and winter seasons.

REFERENCES

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Activity, Activity Level - basic land use and transportation planning units of intensity of use - vehicles per day on a highway, acres of residential land use, square feet of industrial plant space.

Activity Index - a numerical conversion factor to transform the level of activity specified for a land use category into demand for fuel for heating purposes.

Air Quality Contour - a contour line in a plane (usually the horizontal or vertical) representing points of equal concentrations for a specified air pollutant.

Air Quality Criteria - factors used in this study that represent a basis for decision-making, for example ambient air quality standards.

Air Quality Prediction - the calculation of current or future air pollutant concentrations at specified receptor points resulting from the action of meteorological conditions on source emissions.

Albedo - the fraction of solar radiation reflected from the ground surface.

Ambient Air - that portion of the atmosphere, external to buildings, to which the general public has access.

Ambient Air Quality - concentration levels in ambient air for a specified pollutant and a specified averaging time period within a given geographic region.

Ambient Air Quality Standard - a level of air quality established by federal or state agencies which is to be achieved and maintained; primary standards are those judged necessary, with an adequate margin of safety, to protect the public health; secondary standards are those judged necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

AQUIP - an acronym for Air Quality for Urban and Industrial Planning, a computer-based tool for incorporating air pollution considerations into the land use and transportation planning process.

Atmospheric Boundary Layer - the lower region of the atmosphere (to altitudes of 1 to 2 km) where meteorological conditions are strongly influenced by the ground surface features.

Atmospheric Dispersion Model - a mathematical procedure for calculating air pollution concentrations that result from a specified array of emission sources and a specified set of meteorological conditions.

Average Receptor Exposure - a measure of the average impact of air quality levels on specific receptors; the measure is based on the integrated receptor exposure divided by the total number of receptors in the study region.

Background Air Quality - levels of pollutant concentrations within a study region which are the result of emissions from all other sources not incorporated in the model for the study region.

Background Emissions - the emissions inventory applicable to the background region; that is, all emission sources not explicitly included in the inventory for the study region.

Climatology - the study of long term weather as represented by statistical records of parameters such as winds, temperature, cloud cover, rainfall, and humidity which determine the characteristic climate of a region; climatology is distinguished from meteorology in that it is primarily concerned with average, not actual, weather conditions.

Concentrations - a measure of the average density of pollutants usually specified in terms of pollutant weight per unit (typically in units of micrograms per cubic meter), or in terms of relative volume of pollutant per unit volume of air (typically in units of parts per million).

Default Parameters - values associated with a parameter for a category of activities (such as heavy manufacturing) assigned to the activity parameter for a subcategory of activities (such as electrical machinery production) when the actual value for the subcategory is not known.

Degree Days (Heating Degree Days) - the sum of negative departures of average temperature from 65°F; used to determine demand for fuel for heating purposes.

Effective Stack Height - the height of the plume center-line when it becomes horizontal.

Emission Factor - a numerical conversion factor applied to fuel use and process rates to determine emissions and emission rates.

Emissions - effluents into the atmosphere, usually specified in terms of weight per unit time for a given pollutant from a given source.

Emissions Inventory - a data set describing the location and source strength of air pollution emissions within a geographical region.

Emissions Projection - the quantitative estimate of emissions for a specified source and a specified future time.

Equivalent Ambient Air Quality Standards - air quality levels adopted in this study to permit analysis of all air pollutants in terms of annual averages; in cases where state and federal annual standards do not exist, the adopted levels are based on the extrapolation of short period standards.

Fuel Related Sources, Fuel Emissions - fuel related sources use fuel to heat area, or to raise a product to a certain temperature during an industrial process, or for cooking in the house; they produce fuel emissions. (See also Non-Fuel Related Sources.)

Fuel Use Propensity, Fuel Demand - the total heat requirement (space heating plus process heating) determines the fuel demand; the propensity to use a particular fuel or fuels determines the actual amounts of various fuels used to satisfy the heat requirement.

Heating Requirements - the demand for fuel is specified in terms of the heating requirements:

space heating - the fuel used to heat area, such as the floor space of a school in the winter, is that required for space heating; the heat content or value of that fuel defines the space heating requirement (BTUs, British Thermal Units of heating content).

non-space heating, process heating - the fuel used to raise a product to a certain temperature during an industrial process or for cooking (with gas) in the home is that required for process heating or non-space heating. It is generally not related to outside temperature whereas space heating requirements are.

percent space heating, percent process heating - the relative proportion of a fuel or its heat content that is used for space heating or process heating defines,respectively, the percent space heating or percent process heating.

Impact Measure (or Parameter) - a quantitative representation of the degree of impact on air quality or specific receptors resulting from concentrations of specified pollutants.

Influence Region - the influence region for a study area is the geographical region containing the emission sources responsible for at least 90% of the ground level concentrations (averaged throughout the study area) of all pollutants considered.

Integrated Receptor Exposure - a measure of the total impact of air quality levels on specific receptors; the measure is based on the summation within the study region of the number of receptors times the concentration levels to which they are exposed.

Inventories - the aggregation of all fuel and process emissions sourcc is called the emissions inventory; the components for use with the model:

current inventory - all sources for 1969

background inventory - all sources for 1990 not directly relatec to the meadowlands plans.

plan inventories - all sources for 1990 related to the Meadowlands plans; this excludes any source outside the Meadowlands boundar and also excludes existing major single sources and the highway network.

Isopleth - the locus of points of equal value in a multidimensional space.

Land Use Intensity - the level of activity associated with a given land use category, for example the population density of residential areas.

Land Use Mix - the percent of total study region area allocated to specific land use categories.

Meteorology - the study of atmospheric motions and phenomena.

Microscale Air Quality - the representation of air quality in a geographical scale characterized by distances between source and receptor ranging from a few meters to a few tens of meters.

Mixing Depth - the vertical distance from the ground to the base of a stable atmospheric layer (also called inversion height).

Model Calibration - the process of correlating model predictions with observed (measurements) data, usually to determine calibration factors relating predicted to observed values for each pollutant.

Model Validation - the detailed investigation of model results by comparison with measured values to identify systematic discrepencies that may be corrected by alterations of model parameters or model mechanics.

Non-Fuel Related Sources, Process Emissions, Separate Process Emissions - non-fuel related sources do not burn fuel primarily for heating purposes or do not burn fuel at all; these include transportation sources, incineration, and certain industrial processes; they produce process or separate process emissions. (See also Fuel Related Sources.)

Ranking Index - a quantitative representation of the net impact on air quality or specific receptors resulting from all pollutants being considered.

Receptor - a physical object which is exposed to air pollution concentrations; objects may be animate or inanimate, and may be arbitrarily defined in terms of size, numbers, and degree of specificity of the object.

Receptor Point - a geographical point at which air pollution concentrations are measured or predicted.

Regional Air Quality - the representation of air quality in a geographical scale characterized by large areas, for example, on the order of 50 square kilometers or greater.

Schedule - number of hours per year a fuel burning activity will consume fuel; used to determine heating requirements.

Source - any stationary or mobile activity which produces air pollutant emissions.

Source Geometry - all sources for modeling purposes are considered to exist as a point, line, or area, defined as follows:

point source - a single major emitter located at a point.

line source - a major highway link, denoted by its end points.

area source - a rectangular area referenced to a grid system; includes not only area-wide sources, such as residential emitters, but single emitters and highway links deemed too small to be considered individual point or line sources by the model.

Stability Category - a classification of atmospheric stability conditions based on surface wind speed, cloud cover and ceiling, supplemented by solar elevation data (latitude, time of day, and time of year).

Stability Wind Rose - a tabulation of the joint frequency of occurrences of wind speed and wind direction by atmospheric stability class at a specific location.

Total Air Quality - the air quality at a receptor point resulting from background emission sources and from emission sources specifically within the study region.

Trapping Distance - the distance downwind of a source at which vertical mixing of a plume begins to be significantly inhibited by the base of the stability layer, and gaussian vertical distribution can no longer be assumed.

Wind Sector - a 22-1/2 degree wind direction range whose center-line is one of the sixteen points of the compass.

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16. ABSTRACT

The Hackensack Meadowlands Air Pollution Study consists of a summary report and five task reports. The summary report discusses the procedures developed for considering air pollution in the planning process and the use of these procedures to evaluate four alternative land use plans for the New Jersey Hackensack Meadowlands for 1990. The task reports describe (1) the emission projection methodology and its application to the Hackensack Meadowlands; (2) the model for predicting air quality levels and its validation and calibration; (3) the evaluation and ranking of the land use plans; (4) the planning guidelines derived from the analysis of the plans; and, (5) the software system.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Land Use Planning and Zoning Local Governments County Governments State Governments Regional Governments Air Pollution Control		

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