An Overview Of The Lake Michigan Ozone Study

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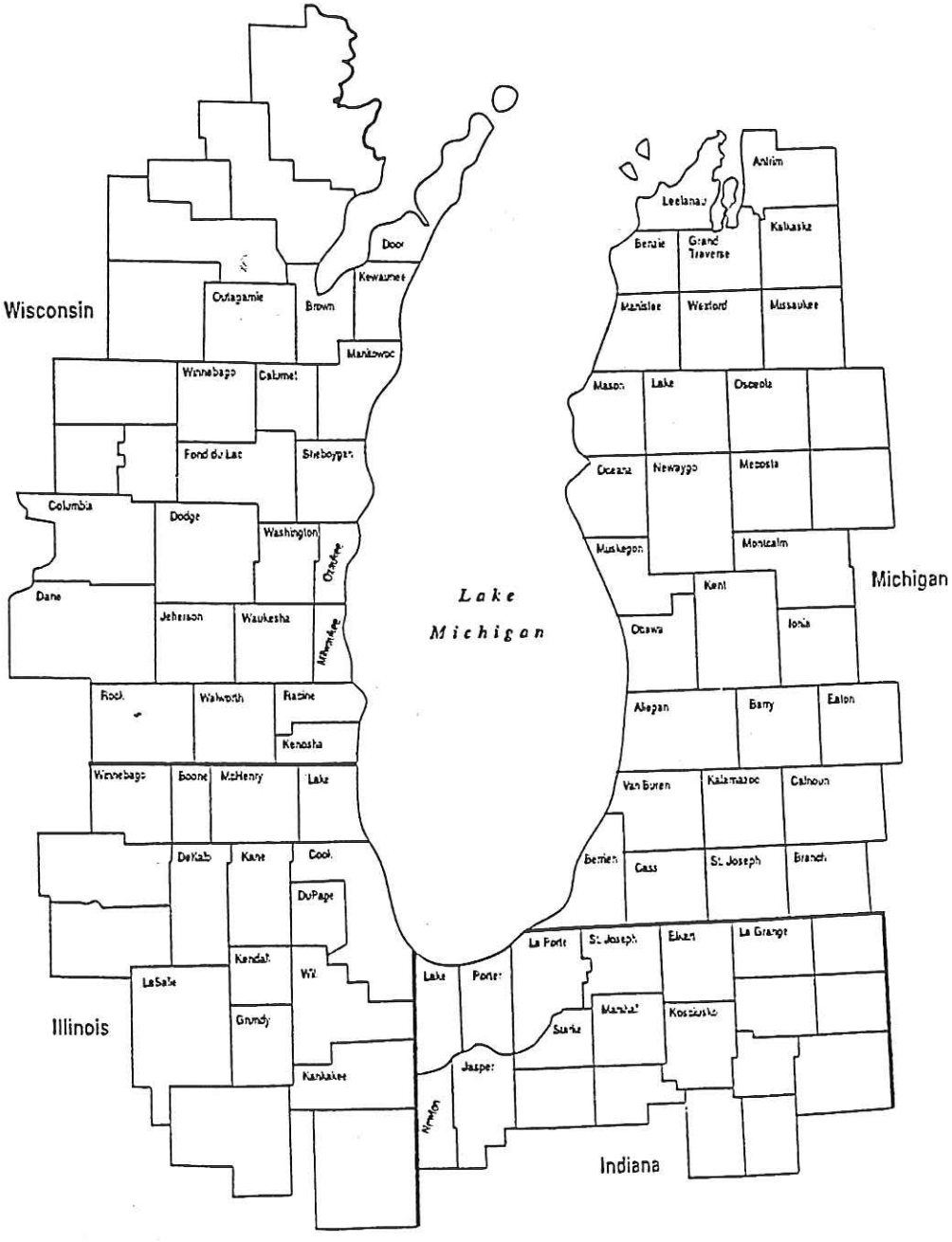

ABSTRACT

The states of Illinois, Indiana, Michigan, and Wisconsin and the United States Environmental Protection Agency (USEPA) have joined together to study ambient air quality levels of ozone in the Lake Michigan area. The Lake Michigan Ozone Study (LMOS) stems both from the mutual recognition of the need for a regional solution to the regional ozone problem and a Court Order which requires the expeditious development and application of a photochemical grid model for this area. This paper presents an overview of the LMOS.

The LMOS will involve the collection of data bases (i.e., air quality, meteorology, and emissions); the development and evaluation of photochemical, meteorological, and emissions models; and the establishment of a technically credible modeling system for the Lake Michigan area. Air quality and meteorological data are being gathered during special field programs and emissions data are being compiled by the States. The successful archive of the field and emissions data by the end of 1991 will allow the subsequent data analysis and model evaluation activities to be completed by the spring of 1993.

AN OVERVIEW OF THE LAKE MICHIGAN OZONE STUDY

The persistent, regional nature of the ozone nonattainment problem in the Lake Michigan area has necessitated a new air quality planning approach. During the past two decades, the Lake Michigan area, which includes portions of the States of Illinois, Indiana, Michigan, and Wisconsin (see Figure 1), has experienced violations of the National Ambient Air Quality Standard for ozone. Ambient exceedances have been measured on more than 30 days during some summers and have been as high as 250 parts per billion. In addition, exceedances frequently occur over a fairly large geographic area.

Past regulatory efforts have focused on each State developing control plans to address the violations measured in the vicinity of specific urban areas. Despite these efforts, violations have continued. The failure to look at the region as a whole (i.e., account for the transport of ozone and ozone precursors into and within the area) may be an important reason why these control plans have not succeeded. The Lake Michigan Ozone Study (LMOS) has, therefore, been initiated to deal with the numerous technical and political issues associated with this interstate problem.

BACKGROUND OF LMOS

In recognition of the need for a regional solution and in response to Notices of State Implementation Plan Deficiencies issued by the U. S. Environmental Protection Agency (USEPA) to all four Lake Michigan States, the States began to work together in 1988 on their common air quality problem. A scoping study was performed to improve understanding of the existing ozone problem, to identify an effective photochemical modeling tool, and to identify data collection activities needed to support the application of a photochemical model (Haney, et al., 1989).

Independent of this collaborative State effort, USEPA and the States of Illinois and Wisconsin were engaged in litigation concerning ozone control in the Chicago area. In April 1987, over concerns about transport into southeast Wisconsin from the Chicago area, the State of Wisconsin filed suit against USEPA. On January 18, 1989, the U. S. District Court for the Eastern District of Wisconsin ordered USEPA to promulgate a Federal Implementation Plan (FIP) for ozone for the greater Chicago area within 14 months (Wisconsin v. Reilly, No. 87-C-0395, E.D. Wis., Jan. 18, 1989). USEPA, Illinois, and Wisconsin subsequently signed a settlement agreement in an attempt to resolve the litigation. On November 6, 1989, the Court vacated its prior order and ordered all further proceedings stayed pending performance of the settlement agreement.

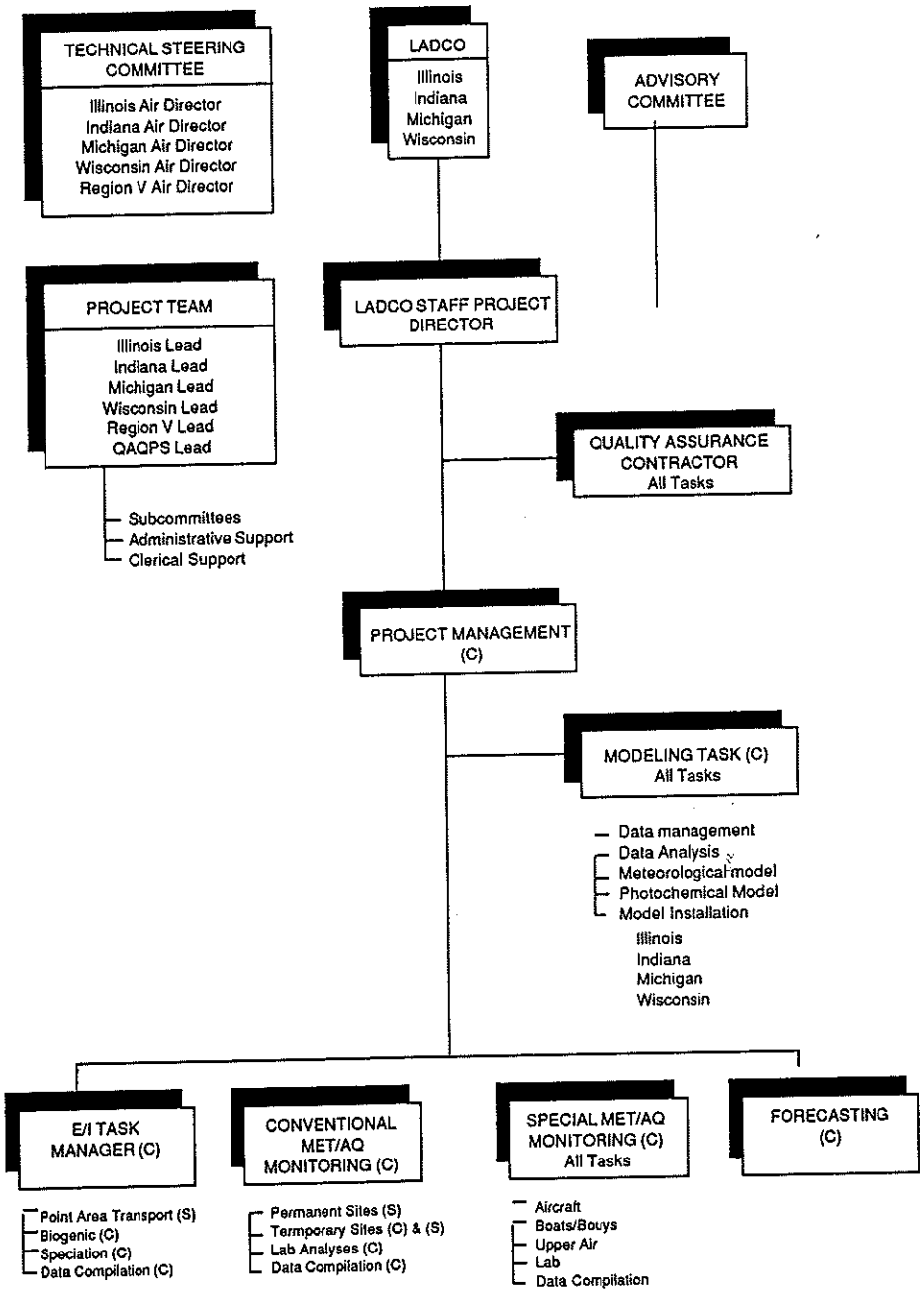

Figure 2 LMOS Organizational Structure

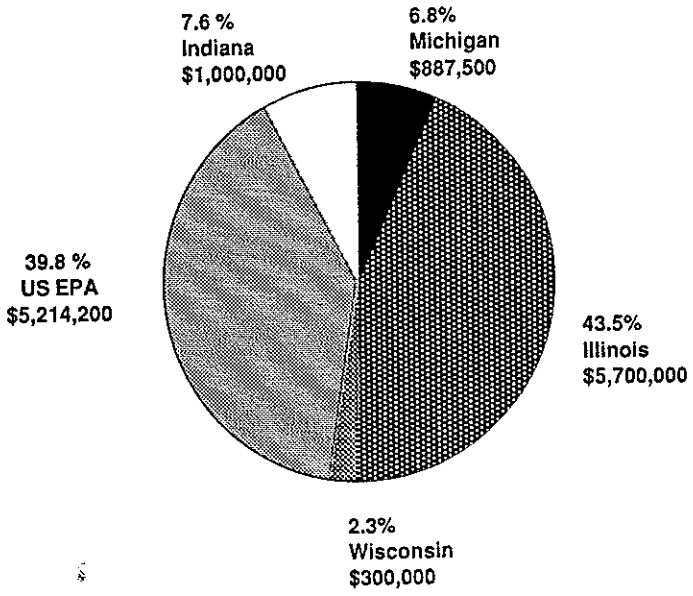

Figure 3a LMOS Funding Contributions

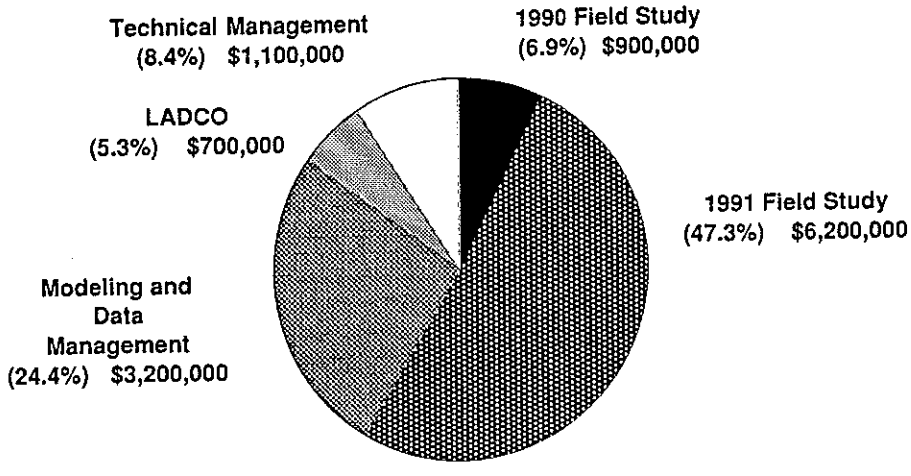

Figure 3b LMOS Funding Expenditures

The settlement agreement calls for the use of a more sophisticated air quality model, allows more time for USEPA to promulgate a FIP using this model, and requires interim emission reductions while the modeling study is underway (pursuant to a provision in the settlement agreement, the requirement for USEPA to promulgate FIP has been superceded by the requirement in the Clean Air Act Amendments of 1990 for Illinois and Indiana to submit revised implementation plans by November 1994 for the Chicago CMSA "severe" area.). To support the more sophisticated photochemical grid modeling, the LMOS was established pursuant to a Memorandum of Agreement (MOA) signed by USEPA and the four Lake Michigan States. Subsequent activities, such as control strategy assessments and attainment demonstrations, will also be necessary, but are beyond the scope of the current MOA.

STUDY OVERVIEW

The LMOS is a multi-year, multi-million dollar study sponsored by the four Lake Michigan States and USEPA which will involve the collection of data bases (air quality, meteorology, and emissions); the development and evaluation of appropriate photochemical, meteorological, and emissions models; and the establishment of a technically credible modeling system (Bowne and Shearer, 1990 and Bowne, et al., 1991).

It should be noted that the Lake Michigan ozone situation presents two challenging technical problems which distinguish it from ozone problems studied previously, such as in California: (1) the presence of a very large body of water which influences the formation and transport of ozone, and (2) the absence of a "clean" upwind boundary (i.e., there is significant transport into the Lake Michigan area).

FIELD DATA - Air quality and meteorological data were collected during the summers of 1990 and 1991 using routine and non-routine (special) sampling. Special monitoring platforms, which were deployed on forecasted high ozone days (i.e., intensive operating periods or IOPs), included aircraft, ships, tracers, volatile organic compound (VOC) and carbonyl sampling, and various upper air systems (e.g., rawinsondes, radar wind profilers, tethersondes, and acoustic sounders). The field data will be used either to provide input data to the photochemical and prognostic meteorological models, or to provide information to evaluate the performance of these models.

The 1990 field program was a preliminary study to provide data and experience needed to plan and perform the more extensive field program in 1991. The 1990 field program consisted of the following parts: (1) concentrated air quality and meteorological measurements in an east-west plane

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located along the Illinois-Wisconsin stateline and extending across the Lake to South Haven, Michigan (referred to as a 2-dimensional data plane or 2DDP), (2) air quality and meteorological monitoring along the boundaries of the study area, (3) continuation and enhancement of the States' existing air quality and meteorological monitoring networks, and (4) special studies involving tetroons, and VOC and carbonyl sampling (ENSR, 1990a). Two IOPs were conducted: July 2-4 and July 16-19. Despite the relatively low ozone concentrations which occurred in the region, the field program was successful in providing testing with specialized measurement systems and in improving the ability of the four States (and many contractors) to work together to collect and archive a large data base (ENSR, 1990b).

The 1991 field program was intended to provide a complete data set for model development and evaluation. An important concern of the program was to ensure a balance between the need for extensive geographic coverage throughout the study domain and the need for high resolution in certain key areas of the domain. Particular attention was given to measurements over the Lake and measurements aloft, where historically there have been few observations. Several east-west 2DDPs were established to concentrate monitoring resources in specific areas to study certain aspects of ozone formation and transport. The 1991 field program consisted of the following parts: (1) land-based surface air quality and meteorological data throughout the LMOS domain and along the boundary, (2) surface and aloft air quality and meteorological data from ships over the Lake, (3) upper air measurements of meteorological data, and (4) aloft air quality and meteorological data from aircraft over the Lake, near the shoreline of the Lake, and along the boundary of the domain (ENSR, 1991). Two IOPs were conducted: June 25-28 and July 16-18. The data from these two events, as well as several other elevated ozone periods during the summer, should provide a sufficient data base for model testing.

Quality assurance and information management contractors are responsible for assessing the validity of, and archiving, the field data. Another contractor will analyze the field data to characterize the spatial and temporal distribution of air quality levels and associated meteorological conditions during IOPs, and develop a conceptual model of the processes responsible for the formation and transport of ozone in the LMOS area.

EMISSIONS DATA - A comprehensive inventory of sources of ozone precursor emissions (VOC, oxides of nitrogen, and carbon monoxide) is being prepared for point, area, and mobile sources. The four States are developing preliminary and 1990 (or 1991) emission estimates for point sources, as well as day-specific emissions for some major point sources during the 1991 field program. In

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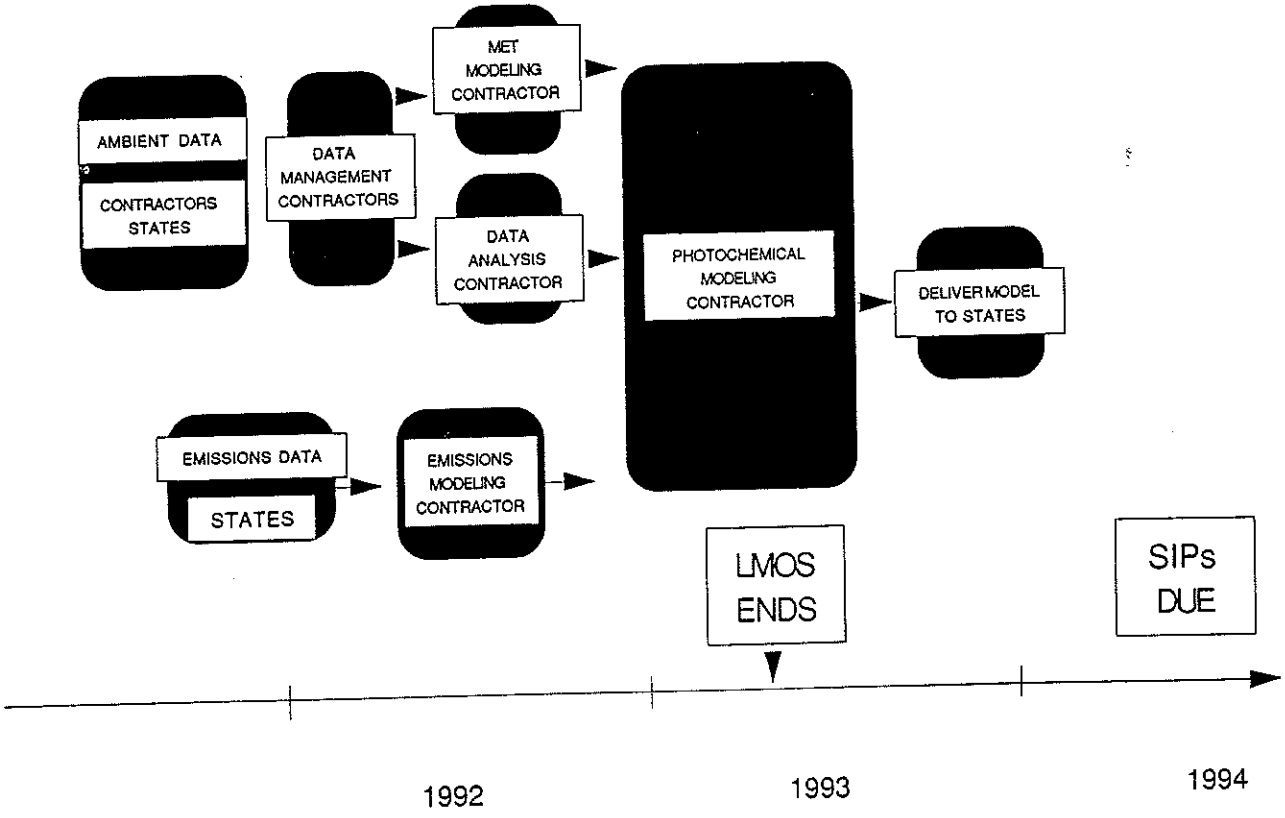

Figure 4 LMOS Schedule

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addition, the States will develop preliminary and 1990 (or 1991) countywide-average emission estimates for anthropogenic area sources and general information for mobile sources (i.e., data on vehicle miles travelled and input data for the MOBILE4.1 emission factor model). The Emissions Contractor will be responsible for: (1) creating an emissions modeling system (EMS) to process and manipulate the emissions data for input to the photochemical grid model, and (2) developing an emissions data base suitable for photochemical modeling by application of the EMS to the emissions data developed by the States and supplemented by the Contractor (e.g., biogenic emissions).

QUALITY ASSURANCE - The project sponsors have made quality assurance of the ambient and emissions data a high priority. To guide this effort, a Quality Assurance Project Plan and an Emissions Inventory Quality Assurance Plan were developed and approved by USEPA. These plans outline the quality control procedures to be followed by the field contractors and States in collecting and processing ambient data, and preparing emission estimates. System audits (review of operational and quality control procedures to assess whether they are adequate to assure valid data which meet desired levels of accuracy and precision) and performance audits (establishment of whether predetermined specifications for accuracy are being achieved in practice) will be conducted by the Quality Assurance contractors.

MODELING - The LMOS modeling system consists of four main models: the EMS which will provide emissions data, a prognostic meteorological model (CAL*RAMS) which provide meteorological data, the Regional Oxidant Model (ROM) which will provide boundary conditions, and an enhanced version of the Urban Airshed Model (UAM-V) which will provide air quality concentrations. The modeling will be conducted in two phases: (1) initial system testing using the July 21-23, 1987 ozone episode, and (2) formal model evaluation using the episodes from the 1991 field program. Each model will be evaluated in accordance with the procedures (i.e., performance measures and rejection criteria) defined in a protocol document.

LMOS ORGANIZATIONAL STRUCTURE

To provide management and technical resources for the LMOS, many State and contractor services are needed. Figure 2 shows the Project Organization for the LMOS. This organizational structure has been established in accordance with the conditions in the MOA and the by-laws of the Lake Michigan Air Directors Consortium.

The Consortium was formed by the Air Directors of the Lake Michigan States to facilitate the coordination of the LMOS. Its primary responsibilities consist of managing, directing, and contracting the LMOS. The Consortium is comprised of the four State Air Directors (who serve as the Board of Directors), an Executive Director, and a Technical Director. It should be noted that the LMOS Quality Assurance contractors report only to the Executive Director and the Technical Director.

The Technical Steering Committee, which was established by the MOA, provides the overall policy direction for the LMOS and serves as the forum for dispute resolution. It is comprised of the four State Air Directors and the Director of the Air Management Division for USEPA, Region V.

The Project Team, which was also established by the MOA, provides the technical direction for the LMOS. It is comprised of two representatives from each of the four Lake Michigan States, one representative from USEPA, Region V, and one representative from USEPA, OAQPS. Various subcommittees have been created by the Project Team to address specific technical subjects.

FUNDING AND BUDGET

All funding for the LMOS is being provided by State and Federal governments. The relative contributions for the States was specified in the settlement agreement and the MOA. A breakdown of the contributions from these five parties is presented in Figure 3a. It should be noted that the State agencies are also supplying considerable in-kind support.

The total budget for the LMOS is approximately $13 million. An allocation of the costs for each of the major project elements (1990 field program, 1991 field program, modeling, and management) is presented in Figure 3b. The relative expenditures for these elements was determined to provide the proper balance of data collection (and quality assurance), data analysis, and modeling.

PROJECT SCHEDULE

A summary of the major project milestones over the next few years is presented in Figure 4. Briefly, the key milestones are: (1) delivery of the ambient and emissions data by the end of 1991, (2) complete evaluation of the meteorological model by the middle of 1992, (3) begin evaluation of the photochemical model by the June 1992, (4) complete evaluation of the photochemical model by February 1993, and (5) delivery of the modeling system to the Lake Michigan States by March 1993. At that time, the States will begin their control strategy modeling.

SUMMARY

The LMOS is a cooperative State and Federal regulatory project with specific technical objectives, a Court-ordered schedule, clearly defined deliverables, and a fixed budget. It represents a new planning approach to deal with the regional air quality problem in the Lake Michigan area. The ultimate goal of the LMOS is to deliver a technically credible modeling system to the Lake Michigan States by March 1993.

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