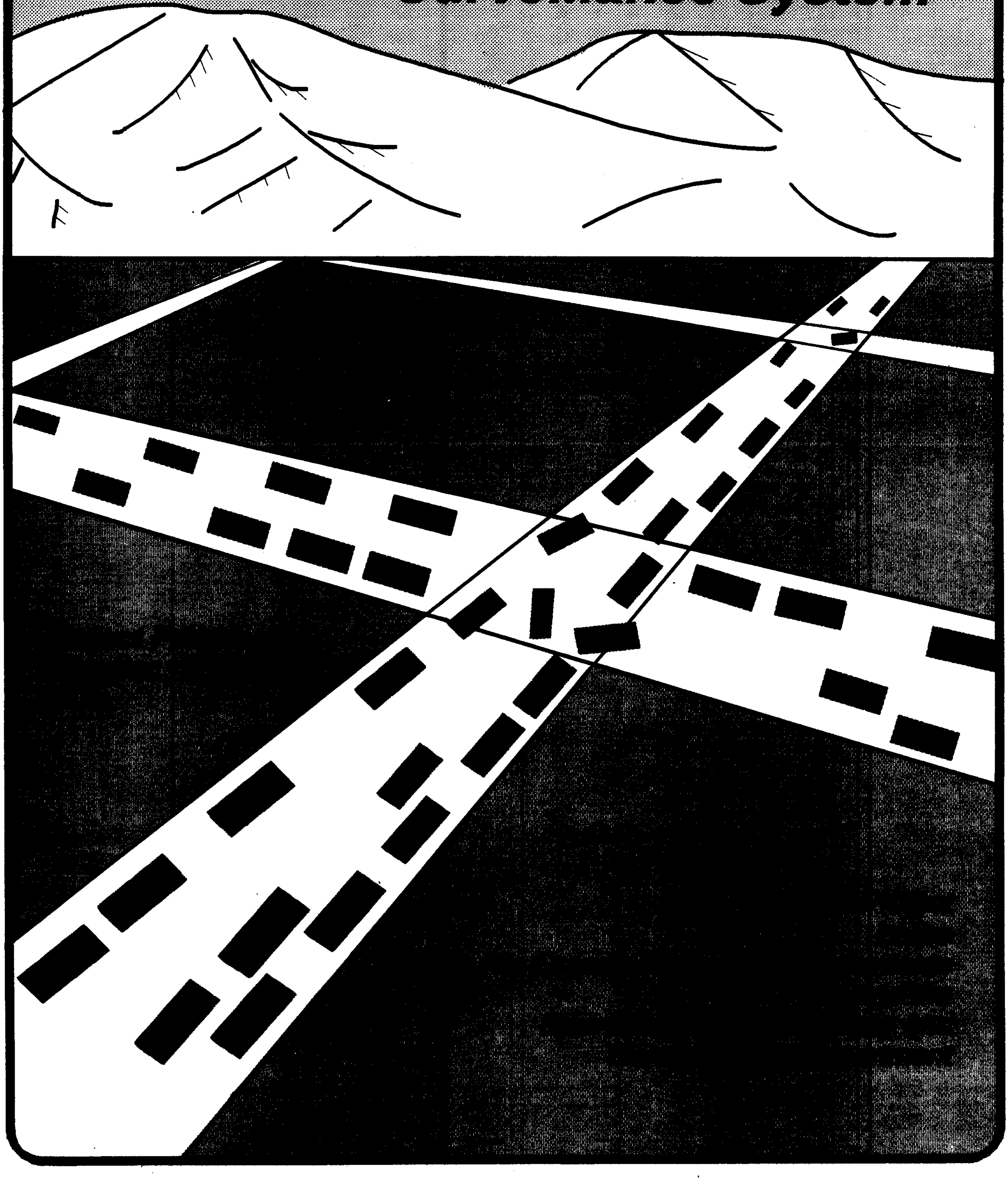
Congestion Information Surveillance System



Project Proposal

CONGESTION INFORMATION SURVEILLANCE SYSTEM

A Joint Project of the Middle Rio Grande Council of Governments and the New Mexico State Highway and Transportation Department

Middle Rio Grande Council of Governments of New Mexico
317 Commercial, NE
Albuquerque, New Mexico 87102

October 14, 1992

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Congestion Information Surveillance System
Project Overview

Synopsis

This document advances a proposal to implement a *Congestion Information Surveillance System (CISS)* for the Albuquerque metropolitan area. The CISS will offer agencies in the region responsible for transportation and air quality management a new capability to monitor traffic and air quality conditions. Simplistically stated, the project is to utilize LIDAR technology on a macro scale to identify sources of pollutants, particularly CO, and their movements within the metropolitan area, and on a micro scale, to provide traffic volumes, vehicle classifications, turning movements, delays, and air quality data by intersection. This capability is critical to successful management of congestion and air quality called for in the Clean Air Act Amendments (CAAA) of 1990 and the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991.

The proposal for the CISS is integral to MRGCOG's responsibilities for the development of a Congestion Management System (CMS) required under ISTEA. Congestion management in the region will require careful consideration of various types of mobility programs, possibly encompassing carpooling incentives, traffic reduction measures, and optimization of the traffic signal control system. Whatever measures are employed in the future, prudent public policy will require accurate assessments of congestion levels with detailed knowledge of occurrence and severity. The objective of the CISS is to deliver this information.

The proposal for the CISS also addresses the *other* critical problem facing the metropolitan area. Since Bernalillo County is in non-attainment of National Ambient Air Quality Standards (NAAQS) for carbon monoxide, the region is mandated to take a number of measures intended to improve air quality. In a worst case scenario, the metropolitan area runs the risk of highway sanctions. Inasmuch as the relationship between prevailing traffic conditions and impacts on air quality are poorly understood, prudent public policy dictates that this relationship be further explored so that effective decisions can be made in the future.

Another objective of the CISS is to clarify the relationships between traffic and air quality and to establish a vastly improved air quality surveillance program capable of serving the needs of the region for years to come.

LIDAR Technology

The concept of the CISS revolves around *Light Detection and Ranging (LIDAR)* technology. LIDAR is a well-established technology used in a variety of intelligent remote sensing equipment developed for the Department of

Energy and the Department of Defense. The technology has been successfully employed in plume detection and missile tracking systems. In recent years, the technology has successfully migrated to the civil arena and has found a number of successful applications in agricultural and forestry research.

LIDAR technology has also been employed as an air quality measurement instrument. So-called *macro-LIDAR* is capable of providing real-time 3-dimensional images of air pollution concentrations throughout the air cell above cities and can track pollution over time. It quite literally offers public officials a CAT-scan of the air shed in a metropolitan area, and therefore offers a vastly improved capability to understand air quality conditions without parallel in the industry. Macro-LIDAR air quality surveillance instruments have been successfully demonstrated in Mexico City and Barcelona.

LIDAR proponents also claim that the same technology can offer vastly improved capabilities for traffic surveillance. At a minimum, traffic surveillance equipment predicated on LIDAR can offer more *accurate* and more *reliable* traffic counting capabilities. More ambitiously, LIDAR offers the potential for a quantum improvement in the ability to record traffic behavior -- not only including traffic volumes, but also including lane volumes, turns, vehicle classifications, and vehicular speeds and delays occurring within the field of vision. Capabilities to monitor traffic speed and delay relate directly to the detection of congestion. Another advantage is that LIDAR instrumentation is non-intrusive to the roadway, thereby reducing maintenance requirements for both highways and monitoring equipment.

The objective of this project is to integrate LIDAR technology into the Congestion Information Surveillance System.

Project Organization

The CISS Program is proposed to be a joint effort between the Middle Rio Grande Council of Governments (MRGCOG), the association of local governments, and the New Mexico State Highway and Transportation Department. In particular, the City of Albuquerque and Bernalillo County will be major contributors to the program. Technical support will be provided by the Alliance for Transportation Research (ATR). The MRGCOG will be the Lead Agency and Project Manager for the program.

A consortium of private industries will be engaged to build the system. Santa Fe Technologies, an entrepreneurial venture licensed by Los Alamos National Laboratories to manufacture and distribute these applications with LIDAR technology, will head the team. They will be supported by IBM for software development. Traffic and air quality expertise will be acquired from professional consulting engineering firms.

Project Funding

The CISS Program has been budgeted at $3.5 million, with 85% funded from federal Congestion Management Air Quality (CMAQ) funds earmarked for the region. The source of local matching funds has not been finalized.

The MRGCOG Urban Transportation Planning Policy Board (UTPPB) approved the dedication of CMAQ funds for this program over a two year period: $2.0 million in 1992-93 and $1.5 million in 1993-94. This project was approved in the regional Transportation Improvement Program on September 8, 1992.

Project Objectives

The objectives of the CISS Program are as follows:

- To employ macro-LIDAR technology in the greater Uptown Center area, the most sensitive air quality environment in the region. This surveillance will serve to clarify traffic and air quality problems in the area and will also demonstrate the latest version of macro-LIDAR instrumentation.
- To adapt the macro-LIDAR instrument for use in hot-spot analysis as a micro-environment instrument.
- To develop preliminary plans for a regional Congestion Management System, identifying the needs for traffic and air quality surveillance requirements which will be met by the CISS.
- To investigate the feasibility of refining LIDAR technology to operate as traffic surveillance equipment.
- To build and make operationally ready a Congestion Information Surveillance System for the region, based on remote air quality (based on LIDAR technology) and traffic congestion sensors.
- As part of CISS implementation, to evaluate appropriate and effective technologies for traffic surveillance, to be integrated into the system.

Project Overview

The MRGCOG's approach to this project encompasses two phases.

> *Phase I Uptown Demonstration Project:* Macro-scale LIDAR air quality surveillance equipment will be deployed in the greater Uptown area to diagnose air quality and traffic problems at this most sensitive location in the urban area. This project serves two aims: first, to settle immediate questions concerning the degree to which vehicular emissions are responsible for NAAQS violations in Uptown; second, to offer further demonstration of the impressive power and capability presented by LIDAR technology.
>
> Another objective of the Phase I program will be to demonstrate the adaptation of LIDAR technology to a micro-scale instrument suitable for hot-spot analysis at arterial intersections.
>
> *Phase II Congestion Information Surveillance System:* LIDAR air quality surveillance and advanced technology traffic surveillance equipment will be integrated into a regional Congestion Information Surveillance System. Systems engineering design principles will be employed to assure project success. An initial design phase will evaluate various engineering approaches to the project, resulting in a detailed performance specification. Installation and performance evaluation will establish the basis for acceptance.

Phase I of the program will be performed during the first year of the two year program. *Phase II* will run concurrently with the latter stages of Phase I through the second year of the program.

Project Benefits

The CISS program responds to new federal initiatives by providing MRGCOG with:

- *Surveillance capabilities* to monitor air quality and traffic conditions throughout the metropolitan area using advanced technology remote sensing equipment.

- *Analysis capabilities* to identify, interpret, and diagnose significant air quality and traffic events as they occur on the street system.

Both of these capabilities advance the region's ability to respond to the Congestion Management System mandate put forth by ISTEA. In addition, a clear understanding of the immediate problem involving relationships between air quality and traffic in Uptown Center will be achieved, resulting in an ability to structure appropriate regulations and controls to insure Albuquerque's future.

The CISS is not a study, it is a *fully operational system*. Drawing on the latest technology for laser sensing, artificial intelligence, computer visualization, and geographic information systems, the metropolitan area will have unprecedented capabilities to monitor traffic and air quality conditions on a continuous basis for years to come.

The CISS program also advances the emerging concept of managing mobility on a real-time basis, a potential future application of Intelligent Vehicle Highway Systems (IVHS), the national Peace Dividend initiative involving the Alliance for Transportation Research and New Mexico's two National Laboratories and also called for in ISTEA. While the feasibility of this approach to mobility management remains a research question at this time, CISS clearly represents a sound and practical step toward advanced technology mobility management concepts while providing the region with an effective and needed answer during the interim.

Relationship with Other Macro-LIDAR Project Proposals

The Funds-In Agreement No. DE-FI04-92AL73680, Revision #2, dated July 31, 1992 is a proposal to refine the work that had already been done in Barcelona, Spain and to provide some preplanning effort for the Macro-LIDAR studies proposed in the MRGCOG CISS project. The Funds-In Agreement proposal will perform the following functions:

- Analysis of the data collected in Barcelona to show the effect that traffic restrictions can have on air quality;
- Further refinement of the software to permit a greater data visualization capability of air quality and traffic;
- Further study/work to determine if the macro models developed and used in Barcelona to predict weather and wind pattern effects are applicable for use in Albuquerque;
- Determination of technical requirements for conducting LIDAR studies in the Albuquerque area.

The Uptown and areawide studies proposed as part of the CISS Program are focused on the collection, analysis, and interpretation of data collected in Albuquerque to aid in the implementation of a CISS that will eventually feed into a Mobility Management System.

Air Quality Problems

The Albuquerque Metropolitan Area (AMA) is located in the central portion of New Mexico (FIGURE 1). It stretches generally north-south along the Rio Grande valley west of the Sandia/Manzano mountains. The largest urban area in New Mexico, it has grown from a population of approximately 300,000 in 1970 to almost 500,000 in 1990. The metropolitan planning organization (MPO) for the Albuquerque Metropolitan Planning Area (AMPA) is the Middle Rio Grande Council of Governments (MRGCOG), an association of local governments for State Planning and Development District 3.

As this growth has occurred over the past 20 years, highway congestion and air quality problems have increased. Bernalillo County, in which the City of Albuquerque is located, was designated non-attainment for carbon monoxide in the 1970s. Although air quality has improved dramatically over the years from 25 violations in 1984 to 2 violations in 1991, violation of the standard remains a serious concern.

Within the overall region, the Uptown Area appears to have the most significant air quality problems. The original focus was on the two regional shopping malls located on either side of Louisiana Boulevard between I-40 and Menaul. However, as the area has sustained more development, the area of concern and the complexity of the problem has increased. The Uptown Area has historically suffered from relatively poor air quality. Over the last ten years, violations of the eight-hour federal ambient air quality standard for carbon monoxide have occurred frequently at monitor sites situated in and near Uptown. High concentrations of ozone, approaching but not exceeding federal standards, have also been measured in this area. Elevated levels of these pollutants are attributed primarily to motor vehicle traffic attracted to and traveling within the Uptown area, and to a lesser extent, the use of fireplaces and wood stoves in the surrounding residential neighborhoods.

The federal government has established primary and secondary ambient air quality standards for six criteria pollutants:

- Carbon monoxide (CO)
- Ozone
- Nitrogen Dioxide
- Inhalable Particulates (PM-10)
- Lead
- Sulfur Dioxide

State Planning and Development District III

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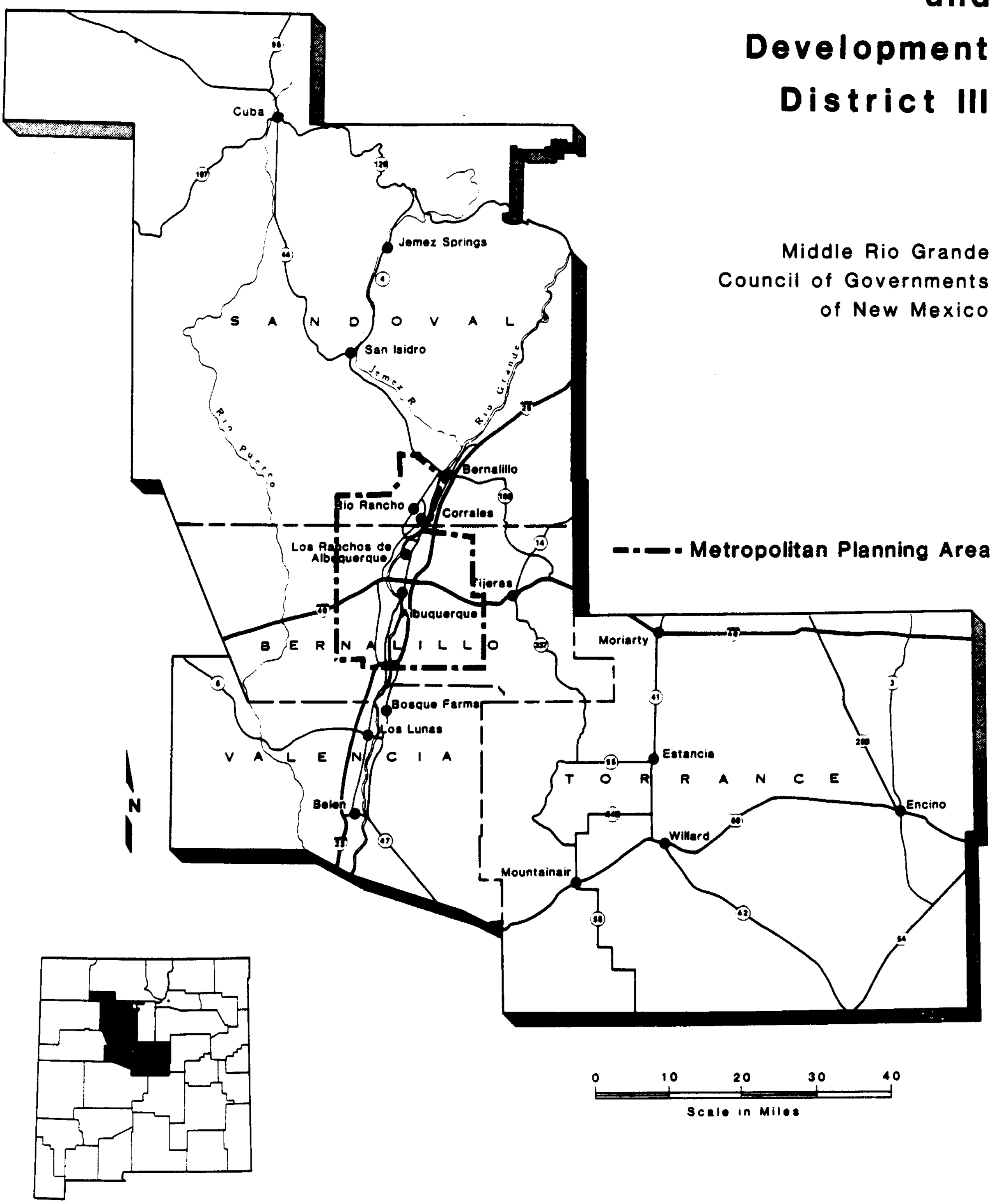

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Council of Governments
of New Mexico
317 Commercial N.E., Suite 300
Albuquerque, N.M. 87102 (505) 247-1750

JULY 1989

Figure 1

Due to high concentrations in Uptown, only CO and ozone are of special interest.

CO concentration is currently monitored at six locations within the County. Of these six sites, two are located in close proximity to Uptown. They are:

- 2ZK San Mateo, immediately north of Menaul Boulevard
- 2ZE Zuni Park, east of Louisiana Boulevard

VIOLATIONS OF THE FEDERAL EIGHT-HOUR STANDARD
AT 2ZK AND 2ZE BY YEAR

Monitor	1991	1990	1989	1988	1987	1986	1985	1984
2ZK	2	3	6	5	14	14	4	26
2ZE	0	0	0	1	5	7	3	6

A third site of interest to the north of the area is the 2ZM site at San Mateo and Montgomery Boulevards.

The potential for areas to develop high concentrations of pollutants depends on the quantity of pollutants emitted in a specific location and the ability of the atmosphere to disperse them. The Uptown area, as well as the Albuquerque region in general, is influenced by physiographic and meteorological conditions that limit dispersion. The sheltering affect of the surrounding terrain and nightly cold air drainage from the adjacent mountains result in frequent winter occurrences of stable atmospheric conditions and temperature inversions. Temperature inversions also occur as a result of high pressure areas passing through the region. Regardless of the source, low wind speed and temperature inversions limit atmospheric dispersion.

An apportionment study to determine the sources of carbon monoxide in Albuquerque was undertaken in 1982 by the Albuquerque Environmental Health Department, Air Pollution Control Division, and Sandia National Laboratories. The results of this study determined that, during typical winter conditions, approximately 66% of ambient CO in the vicinity of 2ZE was the result of automobile operation.

It is probable that within the boundaries of Uptown, the portion of automobile generated CO is even greater due to land use and transportation system conditions. Within Uptown, land use is relatively intense and the mixture is such that the plan area functions as both a major employment center and regional commercial site. These factors result in a considerable amount of traffic operating within the area. Heavy traffic volumes begin during the morning commute, continue through the day, and finally subside in the late evening after the two shopping malls close. Traffic volumes also increase during peak shopping periods resulting in greater volumes than normally occur on a daily basis. An additional factor compounding traffic conditions within Uptown is the presence of commuter traffic traveling through the plan area to access the interstate or other major employment centers.

Several years ago a fireplace burning ordinance was enacted whereby fireplace burning during certain weather conditions in the winter was illegal. This apparently has had a positive effect on the problem although the exact contribution to improving the air quality is unknown. Regardless violations continue at a micro-scale monitor located at the corner of San Mateo and Menaul Boulevards (2ZK). The specific causes of the problem at this location are unknown.

Increasingly more emphasis is being placed on the motor vehicle and congestion in the Uptown area as the major contributor to the problem. However, currently there is no way to analyze the exact cause of the violations and the relationship of congestion to the air quality measurements. As can be seen from the air monitoring graph (FIGURE 2), a more complex situation may exist and simply attributing the problem to congestion may not be appropriate. Because of the mandated deadlines imposed by the Clean Air Act Amendments of 1990 (CAAA), identification of the specific causes and determining potential solutions is a clear goal.

In addition to the mandates of the CAAA, the passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) created new demands for the more efficient use of our highways. Urban areas of over 200,000 population are required to develop a congestion management system within the next few years. In an attempt to better assess the congestion problem, the MRGCOG has reviewed the operational traffic monitoring equipment and its monitoring capabilities as well as defining the data requirements of a congestion management system. In 1991, the MRGCOG and the New Mexico State Highway and Transportation Department (NMSHTD) undertook a small-scale project, utilizing available equipment, to attempt to measure point and system congestion along Wyoming Boulevard in the Northeast Heights. Traffic on all legs of six intersections on Wyoming Boulevard was measured using standard TCIII traffic monitoring devices. These machines were used since the loops in the pavement for the traffic signalization system measured only traffic entering the intersection with no measuring capability for the lanes leaving the intersections. The data were input to the Albuquerque Geographic Information System (AGIS). While the increase in traffic could be monitored and displays generated showing increasing volumes along the roadway, the delays encountered and congestion at the intersections could not be measured. There was also no way to determine the classification of the vehicles on the roadway through the intersection or the turning movements of the vehicles at the intersections and how those affected the level of service. This supported the premise that existing monitoring devices used in the region could not provide sufficient data to be able to determine congestion at a given location. It was also obvious that using this approach on an areawide basis because of the volume of equipment needed would not be feasible.

Existing Monitoring Equipment

The MRGCOG conducts an areawide traffic counting program using TCIII counting machines utilizing either rubber tubes or loop detection devices. The program which provides for standard traffic counts on every link of the major street system once every three years has been under way for almost four years. The monitoring devices allow for the measurement of total volumes on a roadway by direction in 15-minute time periods. No capability to measure traffic by lane exists using these devices. Using a double-tube setup, vehicle classification data can be collected by direction under most conditions. Vehicle classifications can not be reliably collected during heavy congestion or stop-and-go driving. Turning movement data is collected manually using one or two persons to collect am,pm, and mid-day peak period data. The MRGCOG currently employs two staff members to collect both machine and manual data. The data is stored in summary form on the Albuquerque Geographic Information System (AGIS) established by the City of Albuquerque.

Other traffic data is available through the loop detection features of the traffic signalization system operated by the City of Albuquerque and, to a limited degree, by Bernalillo County. The City of Albuquerque operated over 400 traffic signals many of which are part of several signal timing systems within the City. The system can provide traffic volumes by lane for the approaches at the signalized intersections. No turning movement data or delay data can be collected. All devices used are, to one degree or another, intrusive to the pavement.

Air monitoring devices to collect carbon monoxide, ozone, and other pollutant concentration data are located at various sites throughout the region. No capability to analyze or identify individual micro-scale air masses and their movement exists. This capability would be most beneficial in order to identify generators by location and tract the pollution movement.

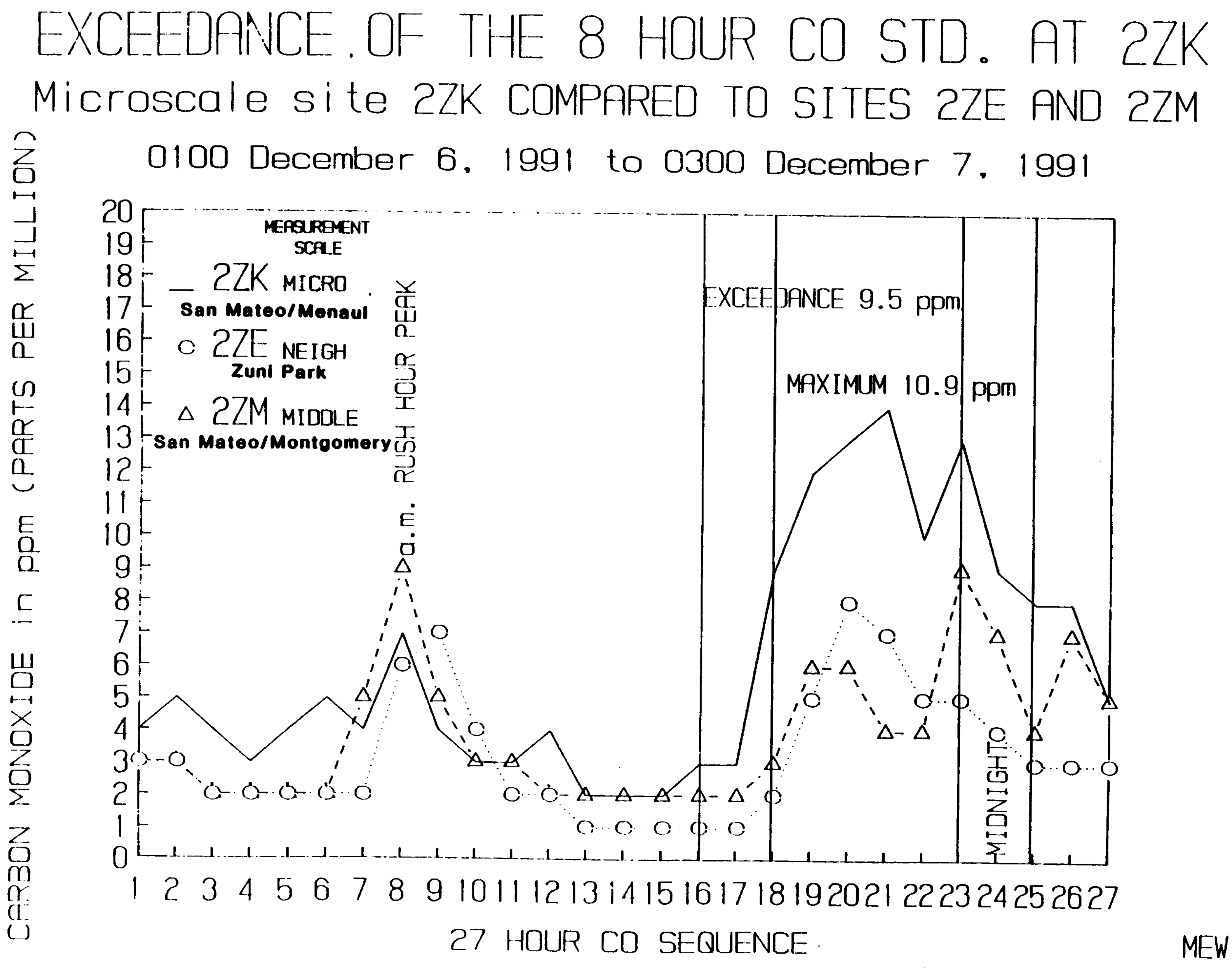
EXCEEDANCE OF THE 8 HOUR CO STD. AT 2ZK
Microscale site 2ZK COMPARED TO SITES 2ZE AND 2ZM
0100 December 6, 1991 to 0300 December 7, 1991
CARBON MONOXIDE in ppm (PARTS PER MILLION)
MEASUREMENT SCALE
2ZK MICRO
San Mateo/Menaul
2ZE NEIGH
Zuni Park
2ZM MIDDLE
San Mateo/Montgomery
a.m. RUSH HOUR PEAK
EXCEEDANCE 9.5 ppm
MAXIMUM 10.9 ppm
MIDNIGHT
27 HOUR CO SEQUENCE
MEW

Figure 2

Congestion Management System

ISTEA directs regions, through their Metropolitan Planning Organizations (MPO), to initiate the development of a *Congestion Management System*. The broadly defined aims of a regional congestion management system are to enhance regions' ability to effectively and efficiently manage the transportation system serving local areas, specifically with respect to the reduction of congestion.

MPOs already have several other related requirements for transportation systems analysis and management.

First and foremost, MPOs are already responsible for developing regional transportation improvement programs which prescribe project-level budgets for mobility improvements, addressing the roles and needs of all modes of urban transportation: traffic and highways, transit, ridesharing, bicycling and pedestrian. The TIP represents, among other things, the region's commitment to eliminating congestion.

Furthermore, a conformity analysis must be conducted to assure that the transportation program is in conformance with the State Implementation Plan and enhances air quality. Regions which are in non-attainment with federal air quality standards, as Bernalillo County is, must develop a CMS which will ameliorate these problems.

At this early stage, precise definitions of CMS are only at the formative stage. There is no common understanding of what the features of CMS should be, what exactly a CMS is, how it should work, characteristics of the mobility system which will be investigated, and how regions will identify CMS problems and react to them. The types of analysis which will be routinely performed, potentially including forecasting studies, capacity studies, traffic control operational studies, etc. are not known. The degree to which operational improvements (signal optimization, etc.) will play a role in the CMS is not known.

But clearly, ISTEA directs MPOs to begin working in this direction.

No matter how the concept of the CMS evolves, it will have to incorporate needs for (1) data surveillance programs, (2) transportation systems analysis leading to the identification of systemwide or localized instances of congestion, and (3) development of transportation improvement programs which respond to congestion mitigation needs.

In the near future regions will begin developing CMS data collection programs, annual study updates, and procedures for implementing the CMS. Left to their own devices, these programs will doubtlessly involve a combination of automated and manual monitoring and analysis techniques. And finally, these programs will doubtlessly have to address a variety of technical issues, such as how congestion should be *defined*, how it can be *detected*, and what to do about it.

At the same time, recent technological advances present opportunities for regions to significantly improve congestion management capabilities. New technology will offer regions better capabilities for:

- Detecting congestion in the traffic system
- Predicting level of service and congestion
- Predicting the consequences of various traffic control and mobility measures
- Evaluating mobility options to mitigate congestion.
- Efficiently operating the traffic system

The Congestion Information Surveillance System

With this project, the MRGCOG proposes to implement a *Congestion Information Surveillance System (CISS)* for the Albuquerque metropolitan area. The CISS will provide local agencies with vastly superior capabilities to collect information on air quality and traffic congestion occurring throughout the region, information which is critical to effective air quality and mobility management decisions mandated by the federal government. CISS will provide the region with a continuous monitoring and surveillance capability, directly linking air quality measurements with underlying traffic sources responsible for generating air pollution problems and the targets of FHWA and EPA regulatory controls.

The MRGCOG considers the implementation of the CISS to be of paramount importance to the region. Effective public management in the metropolitan area will depend on *accurate* information and a *strong understanding* of the relationships between traffic and air quality. Assurance of attainment with NAAQS by 1995 will depend on prudent and cost-effective decisions on behalf of mobility and air quality control measures. The successful development of a Congestion Management System depends on accurate and high quality traffic information.

Integral to the development of CISS is the use and deployment of macro-LIDAR technology. Unlike present technology, macro-LIDAR air quality sensing devices provide real time air quality measurement capabilities and generate 3-dimensional views of air chemistry throughout the aircell over the metropolitan area. For the first time, air quality control personnel can visibly identify emission sources and visually track the effects of winds, inversions, and other significant meteorological events. Macro-LIDAR technology has proven to be a vastly superior air quality monitoring device and has been successfully tested in Mexico City and Barcelona, Spain.

In addition, the CISS project calls for the adaptation of LIDAR technology into a micro-scale device suitable for use in micro-environments. Micro-LIDAR units will be deployed at selected signalized intersections throughout the metropolitan area permitting the same real-time animated 3-dimensional views of air quality at localized hot spots.

Finally, the CISS project proposes the deployment of permanent automated traffic count equipment throughout the metropolitan area. With an eye toward the needs of the CMS, the MRGCOG will investigate the feasibility of vastly improved traffic monitoring equipment capable not only of gross measurements of traffic volumes, but also capable of observing turning movements, vehicle classifications, vehicle speeds, and delay. The latter two elements provide a direct ability to detect level-of-service conditions in the transportation network without resorting to off-line capacity and level-of-service methods. For this effort, MRGCOG will investigate the feasibility of adapting LIDAR technology. MRGCOG will also assess other technologies before committing to this element of the system.

Advances in remote sensing technology are key developments which make CISS possible. In addition to developing and manufacturing remote sensing units needed by the system, though, emphasis in this project also will be placed on the development of a *practical and operational system*. Engineering requirements of the system, such as overall system architecture, system design, hardware configuration, performance specifications, software development requirements, operational testing, etc. all will be addressed in the project. The MRGCOG is committed to a sound, organized, and comprehensive *systems analysis* approach to assure project success.

The MRGCOG is convinced that CISS will vastly improve the region's ability for air quality and traffic surveillance. Specifically, the CISS will give the Albuquerque metropolitan area:

- An integrated and comprehensive capability to track air quality and traffic conditions throughout the region, thereby presenting engineers and planners with accurate information on which to base public decisions. For the first time, explicit relationships between air quality and traffic can be established.

- An effective ability to detect and diagnose root causes of air pollution episodes and traffic congestion.

- An unparalleled ability to see the consequences of air and traffic control measures taken to mitigate problems.

- A necessary step toward an ultimate goal of real-time intervention into the traffic control system, eventually giving regions the ability to operationally manage transportation.

CISS Architecture

Figure 3 presents a logical view (not necessarily a physical view) of the ultimate architecture proposed for the Congestion Information Surveillance System.

- *Centralized Database Management and Control System:* The CISS provides centralized control and processing equipment which will be the host for air quality and traffic database management systems. These database management systems are envisioned to operate within a geographic information system framework, specifically the ARC/INFO system which supports the *Albuquerque Geographic Information System* (AGIS). In addition, the centralized control system will involve the implementation of specialized application programs. Functions provided by the centralized control system are:

  Interface and Control Functionality:
  - Macro-LIDAR Air Quality Sensor Network
  - Micro-LIDAR Air Quality/Traffic Surveillance Network
  - Existing Traffic Signal Control System
  - Existing MRGCOG Regional Traffic Count Program
  - Existing City Air Quality Monitoring Program

  DataBase Management Functionality:
  - Traffic Count Database Management System
  - Air Quality Database Management System
  - Underlying AGIS Databases
  - Linkage with Highway Capacity and Level of Service Software
  - Linkage with Air Quality Modelling Software

A Possible Logical System Structure, Congestion Information Surveillance System

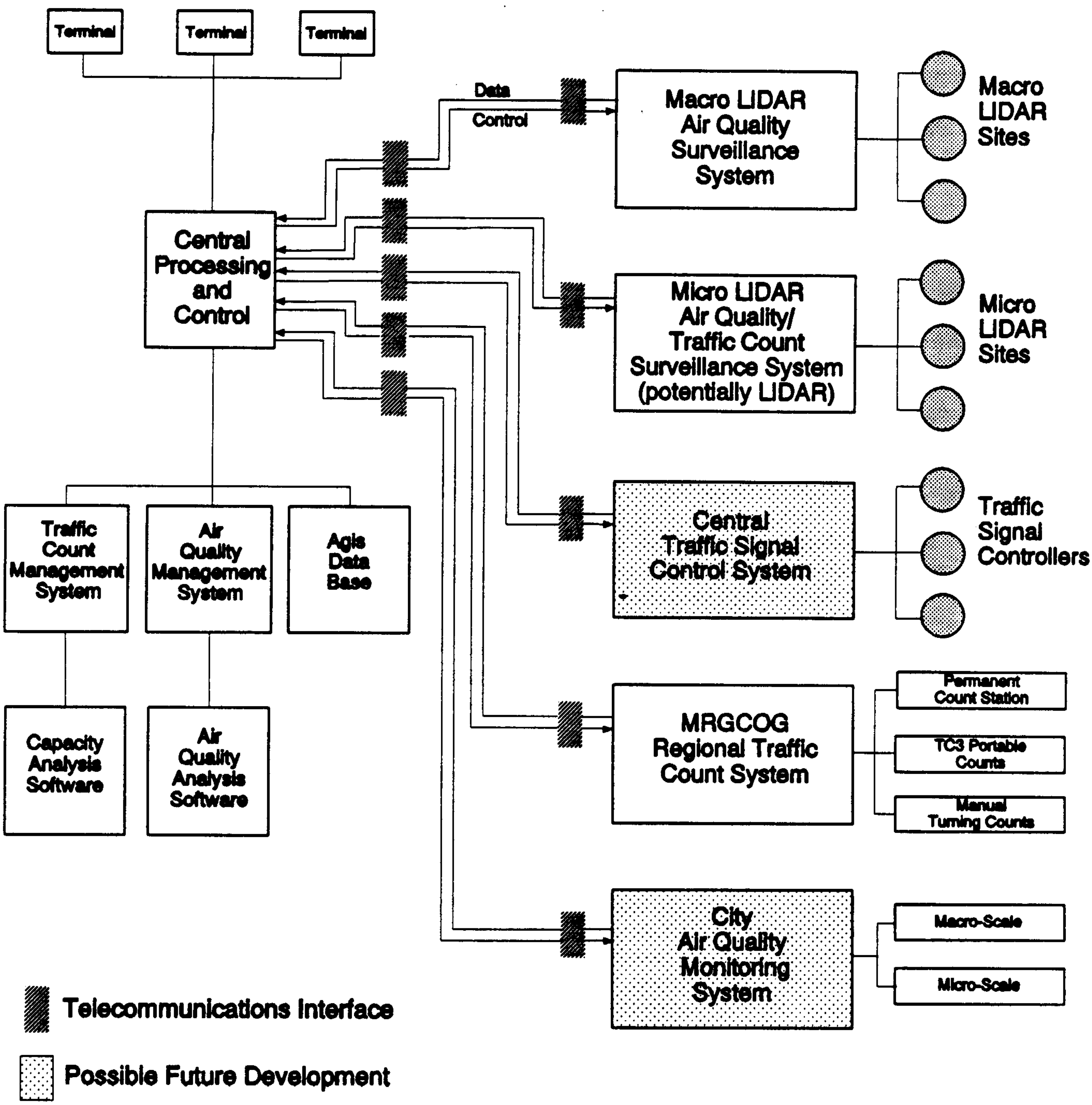

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Figure 3

- *Remote sensing:* The CISS will acquire data from networks of sensing devices located at remote sites in the field. These field subsystems involve a combination of existing equipment and new equipment which will be built as part of the project. For example, a new micro-LIDAR air quality sensoring network will be constructed and deployed in the field. Also, a new automated traffic count network will be installed, possibly to involve LIDAR technology. Further, information being acquired by existing systems for air quality and traffic information will be integrated into the system. Altogether, data will be acquired from five subsystems in the field:

  - Macro-LIDAR Air Quality Sensor Network (proposed in Phase I)
  - Micro-LIDAR Air Quality/Traffic Surveillance Network (proposed in Phase II)
  - Existing Traffic Signal Control System
  - Existing MRGCOG Regional Traffic Count Program
  - Existing City Air Quality Monitoring Program

- *Telecommunication Interfaces and Controls*: From a logical point of view, the Centralized Database Management System will be connected to sensing systems in the field, offering the capability to query and poll units for information automatically across the telecommunication network. In addition, a capability to control the actions of external field sensing units will be provided. This subsystem requires hardware connections and control and interface software.

- *User Access and Terminals*

  Arrangements to allow access to the CISS from various users in local departments and agencies will be provided. An important feature of CISS emphasizes the need for application programs to permit access and queries with minimal training.

CISS Development

This being said, there are a number of central issues which need to be resolved in the course of the project:

- The actual physical structure of the system has not been established. Details and specifications for individual components of the system need to be determined in a cost-effective manner.

- There remain a number of key engineering questions concerning performance specifications of subsystem components. For example, the degree of autonomy exhibited by remote field units has not been determined. Data transfer bandwidth requirements have not been established. The desirability of *real-time* monitoring, as opposed to periodic *off-line data polling*, has not decided. A real-time feature would substantially change the specifications for the system. While micro-LIDAR technology shows potential for traffic count applications, opportunities for approaches involving *other* technologies have not been evaluated.

- The overall system plan described here will not be developed *in its entirety* as part of this project. Instead, the CISS Program should be viewed to be a phased program, involving future enhancements to incorporate added functionality. How this should be done in a cost-effective manner has not been determined.

Therefore, our approach in Phase II will involve several steps:

- First, a systems design study will be conducted to establish an overall system architecture for CISS. This systems design study will consider various logical views of CISS and translate them into physical system options. An evaluation of these options will result in the adoption of the system's architecture.

- Second, cost studies will provide the basis for making decisions about the scope of the system which will be developed in this project.

- Third, once a scope and staging plan for CISS has been established, budgets and schedules for that scope will be set forth. Performance specifications for hardware and software components of the system will be established.

- Fourth, a first stage CISS will be built and deployed. Testing and evaluation will provide the basis for validating the performance of the system according to specific acceptance criteria.

The philosophy controlling the development of CISS includes these viewpoints:

- Emphasis will be placed on the development of a feasible overall system plan.

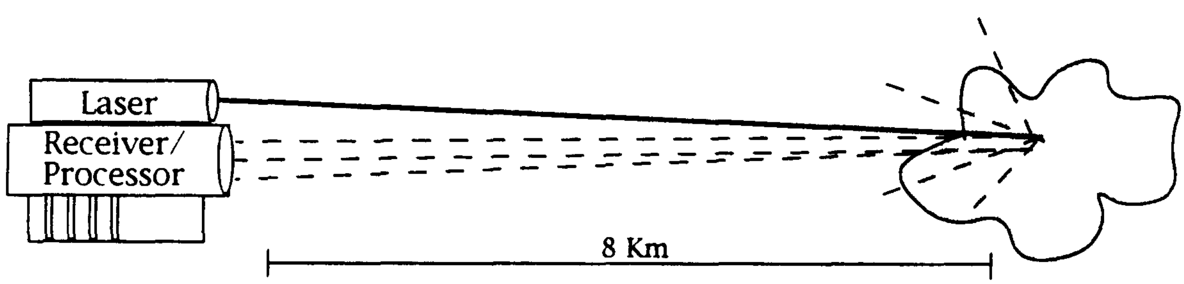
- Emphasis will be placed on developing performance specifications for components of the system. These specifications set the basis for design and acceptance criteria.

- Emphasis will be placed on delivering a practical and successful operational system. This means that emphasis in the project will be placed on attainable specifications, attention on cost-effectiveness issues, and a methodical and comprehensive approach to design, installation, and testing. Key milestone decision points will be placed throughout the project.

Macro-LIDAR

Particular pollutants are of interest due to vehicle emissions, evaporation of fuels and photochemical reactions. These pollutants are hydrocarbons, NO & No_2 produced during combustion, CO from incomplete combustion, SO_2 from combustion of sulfur impurities in the fuel and O_3 which is produced through photochemical reaction. It is important to measure these chemicals areawide (macro) to accommodate the larger weather effects in their production, diffusion and migration. For example, a highway interchange may be a large localized pollution source with hills modifying the wind pattern and affecting the pollution migration.

LIDAR air quality surveillance instrumentation is a new technology development and the only technology available with the capability to source and track pollutants over a wide area. LIDAR is a laser based system operating on the same principals as radar. A light beam sensitive enough to detect individual particles is emitted. That light source is reflected back when it encounters a particle and the return signals is collected through a photometer and analyzed.



There are five (5) variations of LIDAR technology designed for different purposes. All of these systems are in various stages of development at the Los Alamos National Laboratory and comprises different functions for different attributes. Only type (1) is being considered for the CISS. It is specifically designed as a laser radar for detection and tracking of pollutants across a wide area. It is the only system that has been proven and operated in a major metropolitan area to source and track transportation related pollution.

(1) *Light Detection And Ranging (LIDAR)* is the optical equivalent to radar. A laser beam is emitted and backscattered light is detected. Backscattered light returned at the same wavelength as the laser can be used to measure the spatial distribution of pollution plumes and their migration caused by wind. Backscattered light at other wavelengths can be used to identify individual pollutant species.

Most recently, this LIDAR system was used to source and track pollutants over the Barcelona metropolitan area during the 1992 Olympics. The system effectively identified pollutants and their sources from both fixed sites and traffic related. The migration patterns were tracked in real-time to analyze the effects of various weather conditions. The design objective of this LIDAR system is to monitor transportation induced pollution in order to analyze corrective actions such as that done in Barcelona.

(2) *Fourier Transform Infrared (FTIR)* spectroscopy uses a spatially separated light source and spectrometer over a shorter range to simply measure average pollution concentrations at a given site.

(3) *Fourier Transform Spectrometry (FTS)* can identify a variety of pollutants by means of their individual infrared light absorption signatures. The transmitting laser is tunable throughout the entire infrared band. This system is in an early stage of development and a relatively high cost device designed for particle identification only.

(4) *Laser Diode Absorption* is a relatively uneconomical technique which utilizes a separate laser diode for each pollutant species to be monitored. This system is designed for single point pollutant identification.

(5) *Differential absorption Lidar (DIAL)* uses two ore more laser beams to make atmospheric measurements. The wavelength of one beam is carefully selected to be within the absorption band of a certain pollutant. The other beam traveling over the same path at the same time is at a different frequency or wavelength. Measuring the difference in absorbed energy between the two light sources can provide quantitative information about pollutants. This system van be effective in detecting weaker absorbing pollutants and detail chemical specification.

Phase I of the CISS program will utilize the Macro-LIDAR to accomplish the Uptown area air quality data collection. Existing traffic flow maps will then be correlated with the pollution data and an analysis will be made of various traffic flow reduction methods. Following the Uptown area project, the Albuquerque metropolitan area will have the capability for continuous air quality monitoring.

Uptown Data Collection

Macro-LIDAR data collection will be performed in accordance with the Phase I Work Program. A single LIDAR system will be set over the Uptown area and operated by Santa Fe Technologies (SFT). Measurement criteria will outline those pollutants of interest and the system will identify pollution sources (both static and mobile) and tract the migration patterns of those pollution plumes in order to determine transportation induced pollution. All measurements will be made in real-time and under varying weather and traffic conditions.

The air quality information will be integrated with the existing GIS based on traffic data system currently in use by MRGCOG. The LIDAR software environment, developed by IBM, will allow software compatibility and permit 3-dimensional mapping presentation of traffic flows and pollution plumes.

Figure 4
LIDAR Schematic

<to be provided when available>

SFT or MRGCOG will competitively bid and select a qualified traffic engineering firm to perform a detailed assessment of the effects that certain traffic flow reduction programs will have on Uptown air quality. With pollution migrations into and out of the Uptown area monitored in relation to both weather and traffic flow, a determination can be made whether a traffic reduction program will affect the transportation induced pollution in that area. Concurrently, an analysis will also determine the reduction in traffic volume required to impact air quality measurements.

Regional Macro-LIDAR Air Quality Surveillance System

SFT will produce, install and operate three (3) Macro LIDAR units to provide overlapping coverage of the Albuquerque Metropolitan Area. Continuous air quality monitoring will be available to establish a baseline for metro area pollution sources, migration patterns, weather effects and the identification of transportation induced pollution.

The information will be processed through the IBM system software and can be centrally controlled at a single operator workstation. The system will interface directly with the existing MRGCOG GIS based traffic data system to overlay metro-wide pollution data with traffic flow maps.

Micro-LIDAR Demonstration

The Macro-LIDAR system, with the ability to measure and track pollution particles at an 8 kilometer distance, has the inherent ability to be downsized to measure pollution plumes at a 100 meter distance. SFT will provide a proof of concept demonstration with the use of a low power eye-safe laser transmitter and miniaturized receiver to detect pollution plumes at the intersection level.

The intersection scanning LIDAR (or Micro-LIDAR) also has the inherent capability to measure return signals caused by individual vehicles. The LIDAR will be monitoring return signals throughout the intersection. Laser reflections will include those made by vehicles traveling through the laser's path. An integrated microcomputer processor will filter extraneous data and create a return image (similar to radar) for each vehicle that it intercepts. A target signature will be recorded and compared to a look-up table in order to determine vehicle classification.

The system scan rate is in the milliseconds and this will allow the system to track location and time of individual vehicles through the LIDAR's 100 meter field of view. The intersection scanning LIDAR will be able to demonstrate the capability of identifying vehicle volume, classification, speed and direction (turning movements) within the 100 meter intersection area.

The prototype device will be designed for installation atop a corner light post. The laser will scan 270 degrees at 100 meter diameter. The laser transmitter and receiver/signal processor will be designed for safe operation in a traffic environment. The hardware and software designs are preliminary and intended for testing purposes. Processing will occur on-site and be interfaced with a portable PC system to record traffic data.

Operational test will provide critical information of the CISS specifications development. Key components such as desired vehicle information (stopped time, turning movements, speed, etc.) and frequency of air quality measurements can be analyzed with respect to system processing requirements, modem transmission specifications and design cost impact.

MRGCOG's current strategy is to demonstrate the adaptation of LIDAR technology as a micro-environment air quality sensing device during Phase I. During Phase II, features offering the capability for traffic surveillance will be introduced.

The Uptown Center area has long since been a continuing source of concern since it has been here that National Ambient Air Quality Standards (NAAQS) have been violated. In addition to regional efforts to improve air quality through a variety of controls and programs, the Uptown Center area itself has been the specific target of several studies aimed at reducing vehicular traffic in the area. In 1990, the City Transit and Parking Department proposed expansion of the bus system to support improved transit service to Uptown Center (however these improvements have never been implemented due to budget shortfalls). In 1992, the MRGCOG completed a study of various strategic and tactical methods to promote alternative modes of mobility, particularly ridesharing.

Now, with even greater emphasis on meeting air quality standards brought forth by the Clean Air Act Amendments and ISTEA, there are continued concerns about efforts to reduce air pollution. As has been discussed earlier, however, the interrelationships between traffic and air quality and the contributory effects of weather are poorly understood. A major priority facing the region is to develop a better understanding of those relationships so that an appropriate public policy response can be developed.

While the region is well prepared with technical and policy background information on potential mobility options facing the City, risks to air quality posed directly by vehicular sources in Uptown Center is not clearly understood.

Macro-LIDAR technology offers clear hope that a better understanding can be achieved.

During Phase I, Macro-LIDAR air quality surveillance equipment will be deployed in the Uptown area. The primary objective for this sampling program will be to identify emission sources and track key pollutants in the air cell above the study area. An assessment of the relationships among the various traffic and meteorological agents at work in Uptown will be made. At the same time, this research will offer an opportunity to demonstrate the use of LIDAR instrumentation in Albuquerque.

The immediate goals of the project are to:

- Monitor air chemistry in the study area in order to identify emission sources and to allow potential control strategies to be fully evaluated.

- Identify and quantify, to the extent possible, major CO sources responsible for causing NAAQS violations.

Phase I
Organization Structure

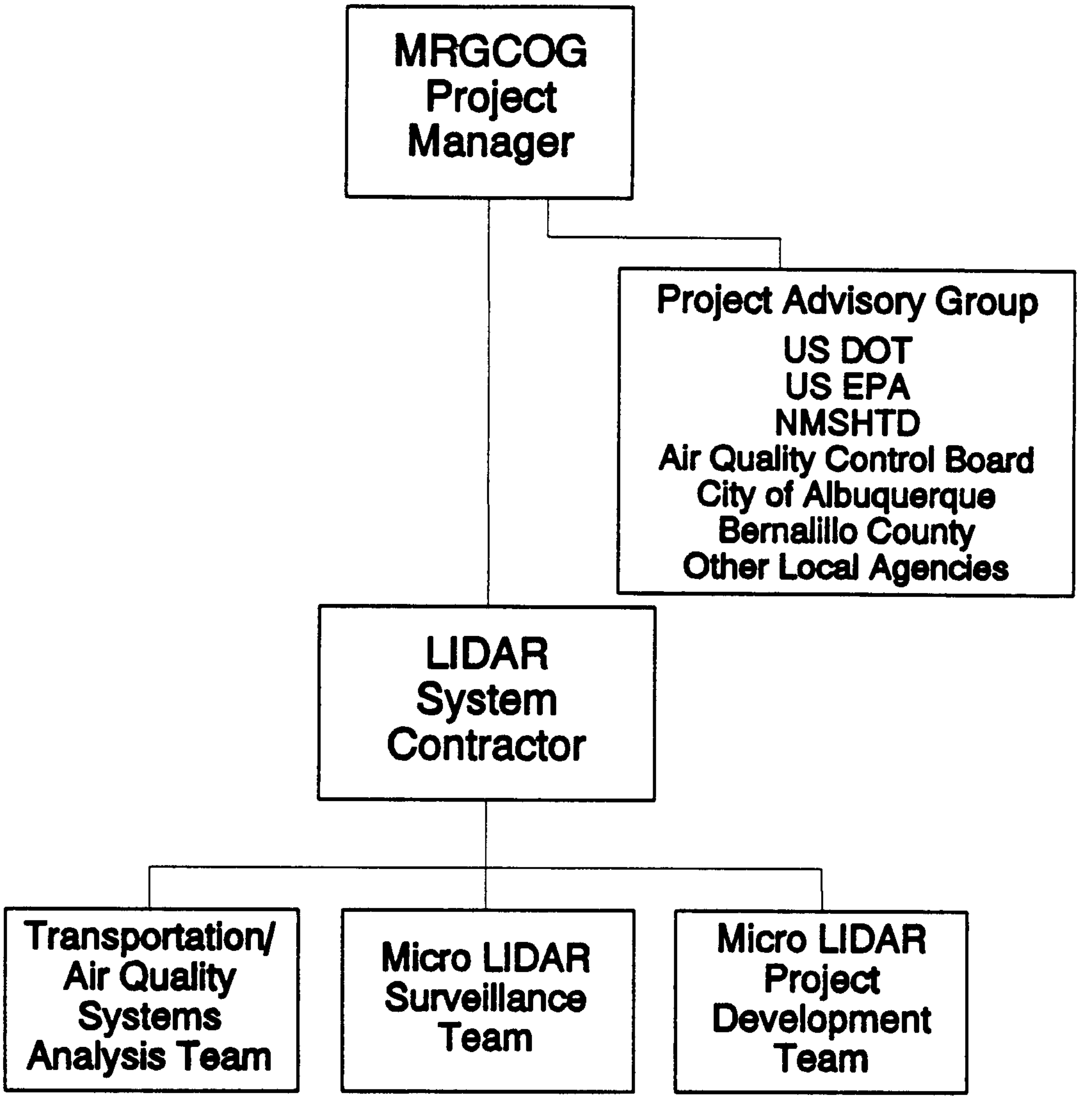


Figure 5

- Determine and quantify, to the extent possible, factors most responsible for causing CO levels to violate NAAQS.

- Through modelling and sensitivity testing, determine the impacts on air quality associated with reductions in traffic levels and improvements in speed.

LIDAR technology proposed for this investigation is a macro-scale device capable of portraying air quality conditions across a wide area. The same fundamental technology can also be applied locally in micro-scale environments for use in hot-spot analysis. Therefore, another goal of the study is to adapt the technology into small micro-scale LIDAR units suitable for use as a freestanding sensing device and for potential incorporation into a areawide air quality surveillance system (in phase II). This equipment, too, will be demonstrated.

Historically, air pollution events most often occur during the winter months, where heavy Christmas traffic loads attracted to the malls combine with unfavorable meteorological conditions. *For this reason, it is imperative that the air quality sampling program proposed in this project be initiated in the immediate future.*

Permanent arrangements for use of the LIDAR equipment at other times of the year for pollutants other than CO will be made, providing a *before-and-after* analysis capability for areawide projects implemented for air quality control.

PHASE I WORK PROGRAM

TASK 1. STUDY METHODOLOGIES

A refined work program will be developed in this task. The work program will provide additional direction on the air quality sampling plan, data reduction and analysis techniques, and modeling and simulation proposals proposed to meet the objectives of the study.

Task 1.1 Air Quality Sampling Plan

The objective of the air sampling program is to identify major sources of emissions of CO and other elements determined to be of interest in the study. A sampling plan will be devised to single out various traffic and stationary sources of these pollutants, including traffic on arterial roadways, on Interstate 40, at major intersections, parking lots, and other sites of vehicle activity. In addition, the plan will identify other potential sources, such as wood burning fireplaces. The sampling plan will be devised so as to trace the contribution to overall air quality problems from these sources. In addition, the air sampling plan will be sufficient to diagnose other contributory factors, particularly those related to weather.

The air quality sampling plan will describe a program of field studies for sampling air quality in the Uptown area, with reliance on macro-LIDAR technology. The plan will identify pollutants which will be measured, certainly to include CO. The plan also will address the possibility of measuring other signature elements which may be of value to distinguish between multiple CO sources. The plan will provide schedule and budget details. The plan will describe the number and locations of macro-LIDAR instruments necessary to fulfill the objectives of the program.

The air quality sampling plan will provide for some capability to respond to unexpected events, such as sudden shifts in meteorological conditions, traffic events such as accidents, etc.

Finally, the sampling plan will provide opportunities for demonstrating the technology under a variety of conditions and in hostile environments.

Task 1.2 Analysis Methodologies

This task provides for the preparation of other supporting methodologies required by the investigation. Two elements are specifically called for:

- *Predictive Model and Sensitivity Testing:* Decisions concerning the nature of the air quality predictive model will be made in this task. Choices include consideration of existing air quality modelling techniques (e.g., MOBILE-4.1) and the potential for building new empirical techniques predicated on data acquired through the macro-LIDAR survey of the Uptown area. If selected, properties of LIDAR-based model, intended to relate prevailing traffic characteristics with air quality conditions, will be implemented in this task. Independent and dependent variables will be identified and the basic model form will be described. The predictive model will be used to perform a sensitivity analysis in the Uptown area. The sensitivity analysis will establish goals for traffic reductions or improvements in levels of service necessary to achieve improved air quality.

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Phase I
Uptown Demonstration Project

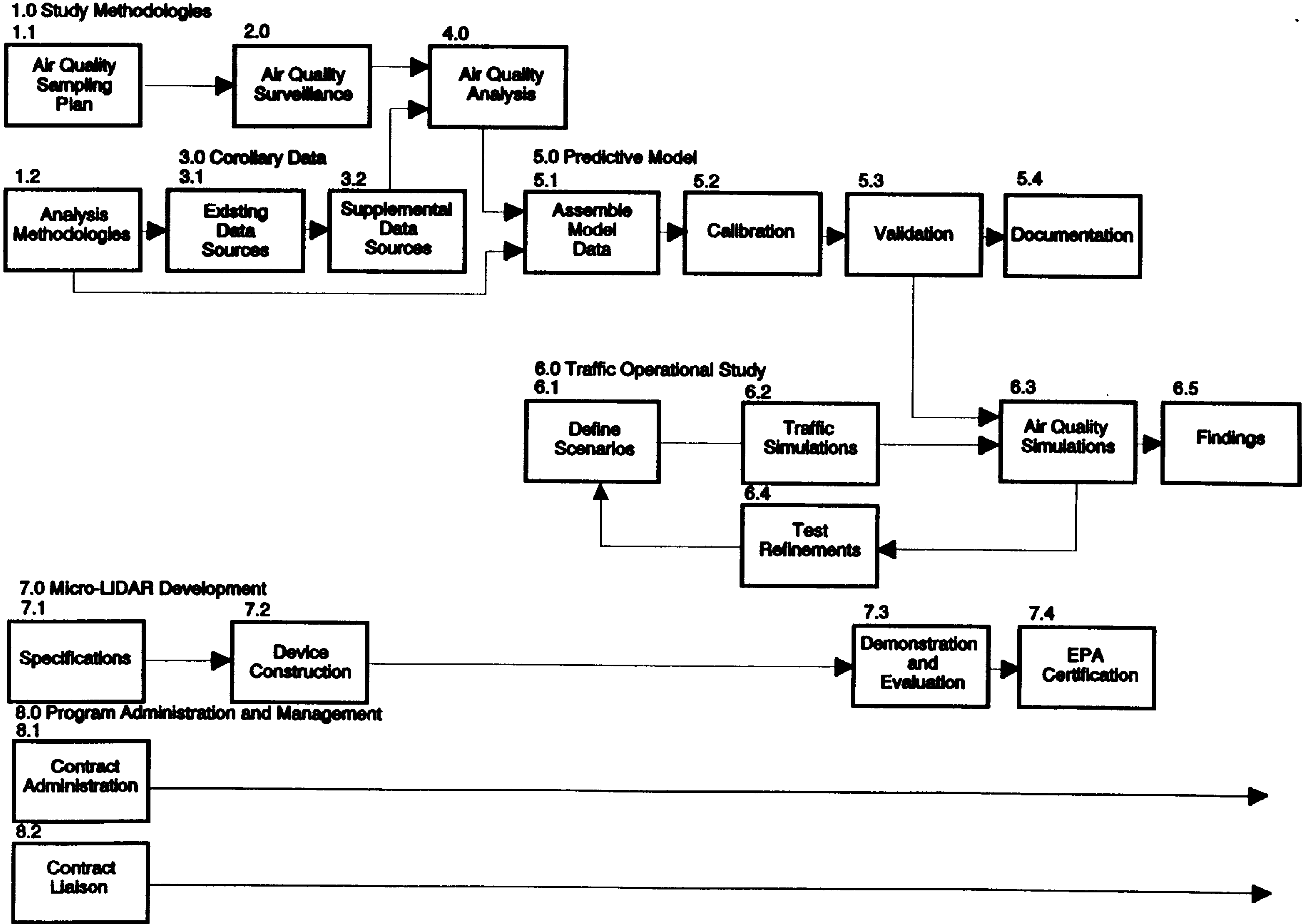

Figure 6

- *Traffic Operational Analysis:* A second element of the program will test the hypothesis that real-time management of the traffic signal control system offers real-time benefits to traffic flow and air quality. The technical approach to this study, perhaps involving the use of TRANSYT-7F, NETSIM, and other traffic flow simulation software, will be determined in this task.

- *GIS Integration:* The intent in this program is to create a GIS framework for the display and analysis of results. This task provides for a definition of how this will be achieved.

TASK 2. AIR QUALITY SURVEILLANCE

This task provides for the performance of the air quality surveillance program specified in Task 1. All operations associated with the program, including deployment of LIDAR units, security arrangements, liability responsibilities, performance of air quality measurements, and data reduction, will be covered in this task. The task will provide for close working relationships between MRGCOG and the contractor in order to monitor performance, review preliminary results, modify schedules, etc.

TASK 3. COROLLARY DATA

This task provides for the collection and assembly of corollary data required to support the air quality investigation in Uptown Center. Historical air quality, traffic, transit, and travel information will be assembled and reviewed. The needs for supplemental data will be identified and obtained. ARC/INFO based databases will be created to facilitate the display and analysis of the air quality investigation.

Task 3.1 Assemble and Assess Existing Data Sources

Uptown Center has been the subject of a number of studies in recent years, leading to the availability of a number of databases describing traffic and travel characteristics in the area. These include, but are not limited to:

- Results from continuous air quality monitoring sites in the greater Uptown area.
- Ongoing traffic counts of various types, including automatic traffic counters, turning counts, classification counts, and occupancy counts.
- A number of travel surveys, including an Uptown commuter survey in 1988, onboard transit rider surveys in 1989 and 1991, and personal-intercept shopper surveys in 1990.
- Vehicular speed studies on streets in the Uptown area in 1992.

This task creates the opportunity to review these and other data relevant to mobility and air quality in the Uptown area. In addition to providing a background of information on which to draw, these databases will also be assessed for their relevance to the current assessment. A determination will made about the needs for supplemental data collection activities as a result of this assessment.

Task 3.2 Supplemental Data Collection

This task provides for supplemental data collection activities determined to be needed to augment existing information. Weekend traffic counts, for example, is one such activity that may be so provided. Once supplemental data needs are established and budgeted, arrangements for performing these activities will be made. Data collection, data reduction, data analysis, and data summaries will all be conducted under this task.

TASK 4. ANALYZE UPTOWN AREA AIR QUALITY RESULTS

Air quality results forthcoming from the air quality surveillance program in Uptown Center and will provide an assessment as to the source and cause of pollution in the area. Corollary traffic data will be analyzed at the same time, providing a basis for linking air quality with underlying traffic and meteorological factors.

TASK 5. PREDICTIVE MODEL

This task provides for the refinement of an air quality predictive model predicated empirical results collected through Uptown field studies, if so determined during Task 1. Model calibration and validation will be conducted in the task.

Task 5.1 Assemble Relevant Traffic and Air Quality Data

This task provides for the acquisition and assembly of relevant traffic and air quality data on which the predictive model will be based. A calibration data set will be assembled.

Task 5.2 Calibrate Predictive Model

The predictive model will be calibrated in this task. The task covers the development of any computer software packages considered to be integral to the operation of the model.

Task 5.3 Validation of Results

Validation criteria will be established at the outset of this task, with LIDAR field data providing the database on which validation data will be predicated. A variety of model experiments will be run with results compared with actual data. Appropriate statistical analysis will be conducted to determine the range of accuracy and error.

Task 5.4 Model Documentation

Several types of model documentation will be prepared in this task. First, user documentation will be prepared to instruct the client's personnel on the operation of the model. Second, technical documentation will be prepared which details the theoretical underpinnings of the model and reports the results of calibration and validation tests. Finally, source codes for any computer software implemented on behalf of the model will be documented and submitted.

TASK 6. TRAFFIC OPERATIONS STUDY

This task provides for an analysis of the impact of various traffic control measures on air quality in the Uptown area. The types of control measures are meant to include (1) various traffic reduction measures which have been studied in previous work in the region, including high-occupancy-vehicle programs, transit programs, and travel demand management strategies, and (2) traffic signal phasing and timing modifications and optimizations. These tests will serve to confirm the impact that different types of mobility programs would potentially have on congestion and air quality. Successful tests will provide the basis for the implementation of these mobility tactics in Uptown Center. In addition, these tests will provide an initial examination of the feasibility and cost-effectiveness of real-time traffic management concepts. Traffic simulation and air quality models prepared in earlier work will provide the technical tools needed to perform this analysis.

Task 6.1 Establish Scenarios

Various experimental test scenarios will be defined in this task. The objective of the test scenarios is to establish conditions under which to simulate traffic flow and resultant emissions under various meteorological conditions in Uptown Center. The scenarios will reflect the implementation of various types of mobility programs of interest, including improved transit services as suggested by Sun Tran's Uptown Transit Study, ridersharing and travel demand reduction measures as suggested by MRGCOG's Uptown Mobility Study, as well as modified traffic signal control schemes which might be implemented in Uptown Center.

Task 6.2 Traffic Simulations

Traffic simulations will be conducted in this task in order to determine traffic characteristics and levels of service associated with the scenarios identified in Task 6.1. Appropriate traffic simulation software, such as TRANSYT-7F and NETSIM, will be used to generate simulations of those traffic characteristics.

Task 6.3 Air Quality Simulations

Air quality simulations will be conducted based on traffic characteristics simulated for each scenario. The predictive model, calibrated in the previous task, will provide the basis for evaluating impact on air quality.

Task 6.4 Test Refinements

This task provides an opportunity to refine the test scenarios originally set forth in Task 6.1, based on the air quality impact results established in Task 6.3. This task essentially establishes a *feed-back loop* in order to revise strategies.

Task 6.5 Findings and Conclusions

Findings and conclusions related to the concepts tested in this study will be evaluated in this task. Findings and conclusions from previous mobility studies, for example the Uptown Transit Study and the Uptown Mobility Study, will be related to conclusions about traffic reduction targets reached here. Recommendations relevant to the advancement of various mobility options discussed in this previous work will be made.

TASK 7. MICRO-LIDAR AIR QUALITY DEVICE CONSTRUCTION

This task provides for the implementation of a micro-scale LIDAR-based device which offers the same attributes of macro-LIDAR, including 3-dimension real-time depiction of air quality conditions, but oriented as a micro-scale air quality measurement instrument for hot spot analysis. A prototype micro-LIDAR air quality device will be constructed and demonstrated.

Task 7.1 Establish Specifications for Micro-LIDAR Instrumentation

Specifications for the micro-LIDAR device will be prepared. The specifications will cover all attributes of the instrument, including performance, electrical, and physical specifications. Various optional features will be considered. Also, specifications will apply to any applicable software associated with the instrument. Safety issues associated with the equipment will be addressed. Quantities of prototype devices will be established and details connected with the demonstration installation will be defined.

Task 7.2 Construction of Micro-LIDAR Device

Based on the specifications set forth in Task 9.1, a prototype device will be constructed. This task includes all in-laboratory performance testing necessary to conform to specification. Final test results of the device will be published.

Task 7.3 Deployment, Demonstration, and Testing of Micro-LIDAR Device

The micro-LIDAR test device will be deployed and demonstrated in this task. Field calibration procedures will be established. The performance of the device will be tested and evaluated.

Task 7.4 EPA Certification

This task calls for EPA certification of macro-LIDAR and micro-LIDAR technologies as recognized air quality surveillance instruments. Relationships with EPA will be established, certification process requirements identified, and appropriate tests and documentation will be undertaken.

Task 8. PROGRAM ADMINISTRATION AND MANAGEMENT

This task provides for contract management and administration among study team members. The Uptown study program will require liaison between MRGCOG and the contractors and will also require contractors to participate with MRGCOG advisory committee(s) and boards.

Task 8.1 Contract Administration

MRGCOG will establish contract administration procedures, covering progress reports, invoices, and payments. In addition, a project monitoring program establishing schedules and milestones will be established.

Task 8.2 Contract Liaison

MRGCOG will establish an advisory committee(s) to coordinate activities among the various agencies and departments participating in the study. Also, regular reports and presentations will be delivered to various established groups, including the MRGCOG Board of Directors, the MRGCOG Urban Transportation Planning Policy Board, and the Transportation Coordinating Committee. This liaison program will also include other established groups in the City of Albuquerque, such as the Air Control Board.

Congestion Information Surveillance System
Phase II: Congestion Information Surveillance System

The goal of the phase II project is to implement a surveillance system capable of providing comprehensive and accurate measures of traffic performance and air quality conditions to support the regional Congestion Management System. This is not proposed to be a single time snapshot of traffic and air quality conditions which must be updated periodically. Instead, the system will provide the region with a surveillance system and information database on which to develop traffic control plans and improvement priorities, air quality actions, *before and after* studies on a continuing basis for years to come.

Phase II WORK PROGRAM

Task 0. WORK PROGRAM

This task provides for a review and refinement of the preliminary work program which follows. Contract task descriptions, language, schedules, and budgets will be reviewed and revised accordingly.

Task 1. CMS CONCEPT DEFINITION

The purpose of this task is to prepare a concept working paper offering an early *conceptual* definition of a Congestion Management System for the Albuquerque metropolitan area. Clearly, the needs of a CISS can not be fully understood without appropriate consideration of the requirements of a CMS.

The conceptual definition should offer a philosophical orientation for CMS, should emphasize realistic and feasible approaches to CMS, and should outline a logical structure for CMS. It should encompass elements of data collection, problem identification, operational analysis, alternatives evaluation, and project programming. The concept should *not* be confined *only* to automated elements of data collection, modelling, and analysis, but should *also* address *wider* issues involving ongoing planning programs, such as the TIP, Conformity Findings, short-range and long-range planning, etc. It also should address interagency relationships and responsibilities.

Phase II
Organization Structure

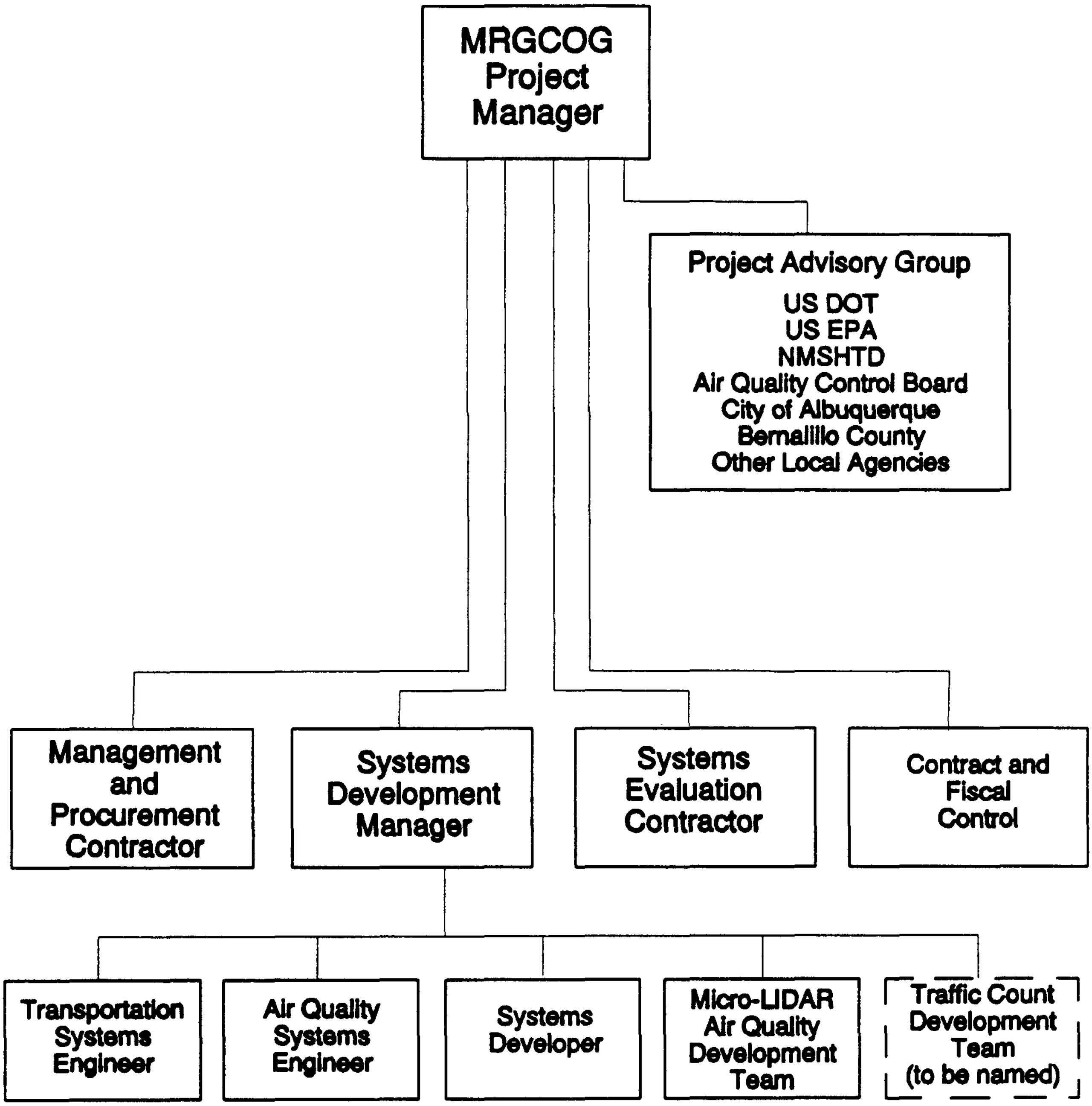

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Figure 7

One of the key technical issues to be addressed in this task concerns the *definition of congestion*, and the implication of this definition on surveillance requirements and off-line analysis.

The emphasis here is on a first-cut description of CMS, in principle. The concept of the CMS will continue to evolve outside this project scope, so it is not necessary and is not mandated that all of the issues expected to surface will be resolved. The overriding objective, though, is to develop a common understanding of the general strategy for CMS and a clear statement of the needs for surveillance and monitoring.

Task 1.1 National and Peer Group Perspectives

A review of the national perspective will be undertaken in this task. Emergent federal thinking on guidance, regulations, and direction that CMS is likely to take will be described. Discussions with other regions will be undertaken to clarify the direction evolving in other metropolitan areas. A technical conference will be organized and conducted for the benefit of local agencies.

Task 1.2 Draft Discussion Paper

A draft working paper should be prepared, intended to foster discussion among member agencies about CMS. The paper should cover philosophical, technical, and procedural elements of CMS. In addition, the paper should highlight problems, issues, and questions associated with CMS. A prototypical idea for CMS should be prepared, perhaps including flow charts describing data flow and procedural requirements.

The purpose of this task is to begin to address the notion of what CMS is envisioned to be. Issues would involve, for example, the degree of automation which CMS is expected to incorporate, policies and procedures and the role of member agencies, the potential expected of online real-time operation of the traffic control system, the role and expectation of systemwide analysis updates, the role of ongoing project level studies,etc.

Task 1.3 Local Area Discussion and Concept Definition

A review and discussion of the concept for CMS will be organized in this task. Invitations will be extended to local participating agencies in the program, as well as federal agencies (e.g., U.S.D.O.T, E.P.A.) involved with the program. After discussions with participating agencies, the Concept Definition paper will be finalized. While the emphasis in this project focuses directly on the surveillance system, this task provides guidelines about how the surveillance system will be integrated into an overall process, procedures, and techniques for congestion management. *In addition to providing a foundation for CISS specifications, this paper will provide background documentation needed by potential technology vendors in later tasks.*

Task 2. PRELIMINARY CISS GOALS AND OBJECTIVES

A preliminary view of goals and objectives for the CISS will be prepared in this task. The goals and objectives should be specifically and explicitly address surveillance requirements expected of the system. Elements which should be addressed include:

Traffic Information Needs: A statement outlining CISS data requirements will be prepared, for example to include volumes, turns, vehicle classification, delays, reporting periods and other parameters associated with traffic surveillance will be developed. In addition, integration of existing sources of traffic information from MRGCOG's regional traffic counting program will be addressed. The parametric needs of the CISS will be tied directly to the concept of congestion.

Phase II
Congestion Information Surveillance System
(1 of 2)

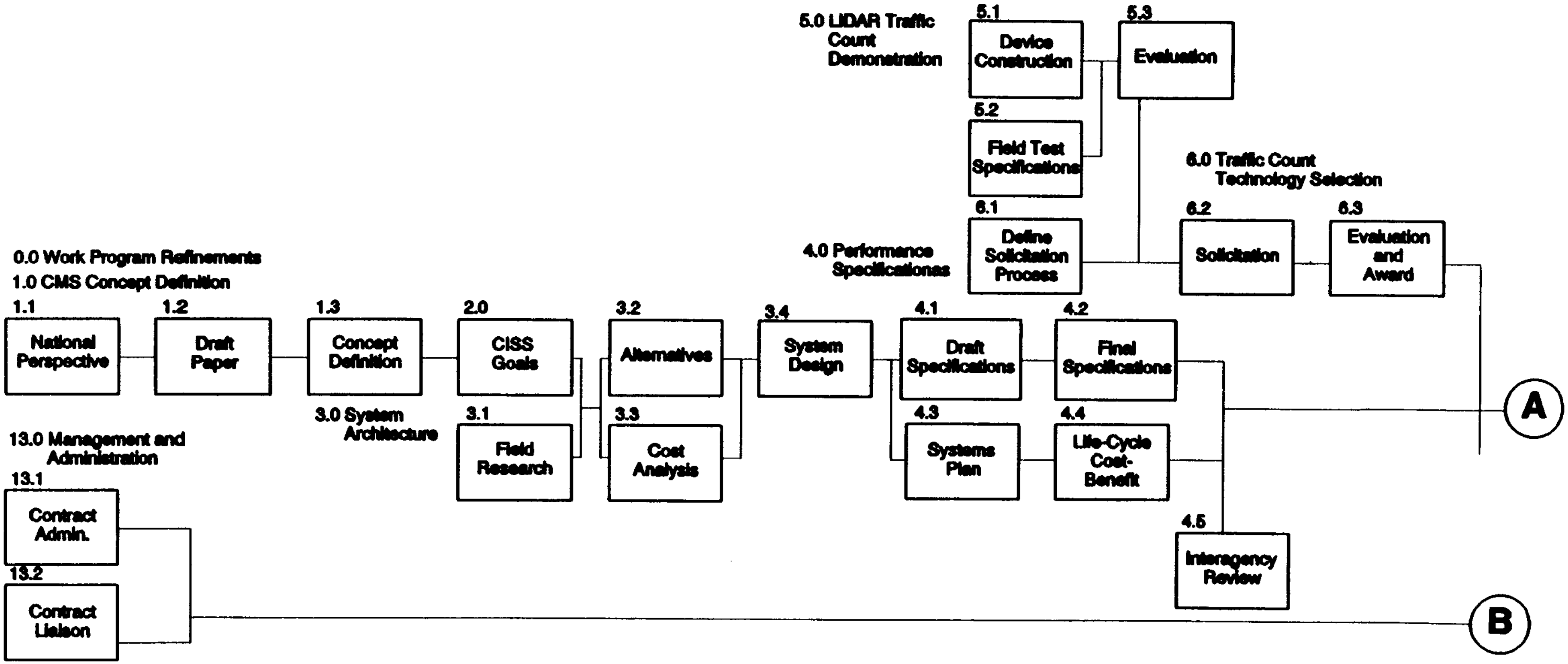

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Figure 8

Phase II
Congestion Information Surveillance System
(2 of 2)

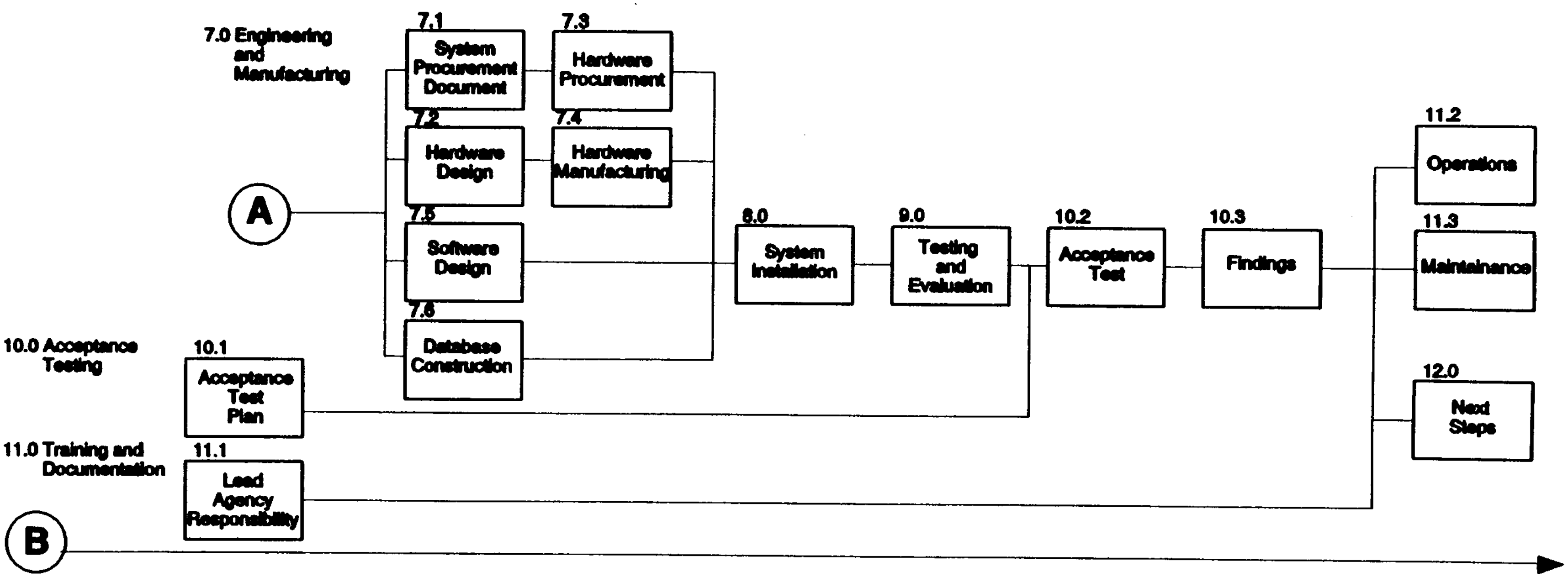

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Figure 8

Air Quality Information Needs: A statement of goals for the program which identifies surveillance area, pollutants, and concentrations of interest In addition, integration of existing sources of air quality monitoring information will be addressed.

CISS Capabilities: A statement outlining database management, interface, and control expectations of the centralized processing system will be prepared. Special attention will be devoted to needs for interfaces with existing air quality and traffic capacity modelling and analysis software.

The CISS goals and objectives established in this task should be considered preliminary and desirable for full system deployment. Cost analyses in the next task will actually establish the objectives which will be considered attainable within the budget provisions of this first stage project.

Task 3. SYSTEM ARCHITECTURE

Figure 3 provided a logical view of the system architecture for the CISS, where the various modular subsystem components of CISS were illustrated, including Remote Sensing, Data Transmission, Centralized Database and Control. A variety of relevant technical issues are raised by this logical view, including desirable features associated with various components, appropriate level of centralization of functionality, database design issues, software requirements, models, and algorithms.

The objective in this task is to prepare an overall plan for the architecture of the system, using both top-down and bottom-up design approaches. Several alternative views of overall system architecture are expected to be generated, if necessary. Logical views of system architecture will be translated into an expression of physical requirements, including both hardware and software. Features associated with each system component will be explicitly defined.

A cost analysis will be conducted to facilitate decisions about the scope and extent of features to be incorporated into the system at this stage. A staging program will be prepared which indicates the potential for future system enhancements.

The goal of this task is to develop a common understanding of CISS system design, identifying component subsystems, software development needs, performance expectations, etc. This system design will provide the basis for the system development to follow.

Task 3.1 Field Research

This task provides for a field review of operational and performance features of various air quality and traffic count programs already in place. Problems associated with integrating these systems into the overall CISS will be identified. Further, implications of linkages with existing software packages, models, etc, currently in operation in the region will be investigated to clarify interface requirements.

Task 3.2 System Architecture Alternatives

Logical and physical views of CISS architecture will be developed in this task. Functions associated with individual component subsystems will be explicitly recognized. This task is meant to flush out details connected with the overall system design. This task should also provide for the need to generate alternative architectures when legitimate technical design issues are encountered. Key technical design questions should be identified, along with an evaluation methodology needed to clarify the issues and facilitate system design decisions.

Task 3.3 Cost Analysis

In this task a cost analysis will be prepared to provide MRGCOG with the capability to determine desirable features which should be incorporated into CISS at this time. The cost analysis will be structured so as to facilitate those decisions and to develop an understanding of the consequences on project cost forthcoming from pursuing various optional development objectives.

Task 3.4 System Design

Two systems designs will be prepared in this task as a result of direction from MRGCOG about CISS features. One system design will represent the plan and architecture of CISS as it ultimately will be configured. The other systems design will represent the interim specification for CISS as it will be implemented immediately in this project.

Task 4. PERFORMANCE SPECIFICATIONS

In this task performance specifications for individual components of the system will be developed. Design documents will be created on behalf of each component which will offer explicit performance specifications. Design documents on behalf of software components are also to be addressed in this task. Concepts for database structures, algorithms, methodologies, and user-interface designs should be described in these documents.

Finally, acceptance criteria will be specified for each component of the system.

Task 4.1 Draft Specifications

Draft specifications for each component of the CISS will be prepared. Software engineering and database specifications are intended to be addressed in this task also. Furthermore, warranties, technical support, and other aspects of the CISS system acquisition will be determined. The exact scope of the work covered in this task depends on the ultimate proposal for system configuration decided in Task 3.

Task 4.2 Review, Comment, and Final Specifications

This task provides for a review and comment of the final specifications by MRGCOG and by advisory groups associated with the program. Revisions to specifications will be made as a result of this review.

Task 4.3 Systems Plan

A systems site plan will be developed in this task, permitting decisions concerning the number and location of remote sensing units which will be deployed in the field so as to provide for effective surveillance of the regional air basin and transportation network. Site location criteria will be established. Existing sources of air quality and traffic information will be referenced so as to determine regional needs. A site reconnaissance program will be performed. Based on this information, a system deployment proposal will be advanced.

It is anticipated that cost and budget issues will be raised at this time, applicable to decisions about the extent and scale of system deployment. If necessary, provisions for several system plan alternatives will be made with appropriate analysis of cost implications and evaluations of impacts on system accuracy and integrity.

In addition, the scope of the systems plan will also address issues related to the installation and operation of the centralized processing and control function. Spacial, staffing, and hardware requirements will be addressed at this time, along with capital outlay and ongoing operation costs associated with the unit.

Decisions concerning local agency authority and responsibility for the unit will be made at this time.

Task 4.4 Life Cycle Cost-Benefit Analysis

In this task a full life-cycle cost analysis will be prepared on behalf of the CISS. This cost analysis will explore all aspects of design, construction, and installation costs as well as ongoing maintenance and operations costs for CISS.

Further, a benefit analysis will be conducted at this time, and appropriate findings related to cost-effectiveness will be rendered. The benefit cost analysis will provide the basis for commitments to the balance of the program.

Task 4.5 Early Review

Based on the performance specifications set forth in this task, liaison will be established with appropriate governmental authorities and public utilities to review the plan. Approvals and certifications required for the permit process will be clarified. City and state authorities will be consulted to establish proposal requirements and the review and approval process which will be relied upon to control deployment of the system. Liability questions will be resolved.

Task 5. LIDAR TRAFFIC COUNT APPLICATION DEMONSTRATION

Proponents of LIDAR technology have asserted claims that the same LIDAR technology used in air quality sensing equipment offers vastly superior capabilities for traffic surveillance, as well. In addition to traffic volume, micro-LIDAR units offer the potential for measuring vehicle flow, turning volumes, vehicle classifications, and vehicle speed and delay. These units are also non-intrusive to the roadway surface. This task provides for the construction, testing, and evaluation of a prototype traffic count unit based on LIDAR technology as a demonstration of these capabilities.

Task 5.1 Construction of Micro-LIDAR Traffic Surveillance Device

This task provides for the construction of a micro-LIDAR traffic surveillance device according to specifications accorded to this element of the surveillance system in Task 4.

Task 5.2 Field Test Specifications

A field test for the micro-LIDAR device will be established in this task, with reliability and accuracy being two important considerations in the evaluation. An appropriate test location will be selected and the device will be deployed in the field. A testing program will be designed. The testing program will specify methods by which the accuracy of micro-LIDAR traffic surveillance devices will be established. It is anticipated that the field test program will be the responsibility of an independent third party.

Task 5.3 Performance Analysis and Evaluation

Field tests of micro-LIDAR unit(s) will be conducted in this task. A performance analysis will be conducted based on these field tests and a performance evaluation report will be prepared. It is intended that performance analysis and evaluation will be the responsibility of an independent third party.

Task 6. TRAFFIC COUNT SURVEILLANCE TECHNOLOGY SELECTION

Questions regarding the nature of technology which will be used for traffic surveillance will be resolved in this task. Issues related to technology selection and potential sole-source procurements have not been resolved. Accordingly, this task provides for a competitive technological evaluation, if it should be determined that this is needed.

One approach for a technological evaluation, described here, is to create a competitive solicitation process. Based on performance criteria established for remote traffic sensing devices established in Task 3, industry manufacturers will be invited to submit statements of interest and qualifications. A technology evaluation process will be established and proposals will be evaluated. On the basis of this solicitation, an appropriate technology will be selected and responsibility for construction of remote traffic surveillance equipment will be awarded to a private contractor.

Task 6.1 Solicitation Process and Documents

The solicitation process will be established in this task if it is determined that a competitive technology solicitation is required. It potentially could involve an RFI/RFQ or RFP process. A technology evaluation process will be defined, which could require technical documentation, cost proposals, presentations, and perhaps a technology demonstration. This process will be defined in this task. In addition, background materials for prospective proposers will be developed in this task.

Task 6.2 Competitive Solicitation

This task provides for competitive solicitation activities and procedures, if a competing technology is identified.

Task 6.3 Evaluation and Award

This task provides for all of the activities planned for an evaluation of competing technologies. An evaluation team will be established, possibly involving an independent third party. Based on the evaluation of technologies and proposers, a contract will be awarded.

Task 7. ENGINEERING AND MANUFACTURING

This task covers the engineering and manufacturing of CISS system components. It is anticipated that some system components will be commercially available and will be procured through conventional bidding procedures from qualified vendors. Other system components will be designed and constructed as part of the system. A manufacturing and assembly facility will be established. Following conventional software engineering principles, system software will be created and tested.

Task 7.1 System Procurement Document

A system procurement document will be prepared in this task. The system procurement document will specify the equipment which will be procured as part of the CISS, including quantities, costs, and bidding procedures. The procurement document will provide the basis for the procurement of components from commercial vendors. Any applicable US DOT, State, or local contracting and bidding regulations applicable to the procurement of components will be manifested in the procurement document.

Task 7.2 Hardware Design

This task provides for the design of new hardware components to be constructed as part of the CISS project. Based on specifications set forth in Task 4, this task covers the preparation of design documents and specifications associated with the equipment.

Task 7.3 Hardware Procurement

This task covers the contract procurement process determined in Task 7.1 for all commercially available components.

Task 7.4 Hardware Manufacturing

This task provides for manufacturing and assembly of system components.

Task 7.5 Software Design

Software will be implemented in accordance with specifications established in Task 4. This task covers coding and algorithm development. Software will be brought to alpha-test acceptance conditions.

Task 7.6 Corollary Database Construction

This task provides for the development and assembly of auxiliary databases needed by CISS. Street networks, signal locations, and other external data to be accessed through CISS must be assembled and installed into the system database. This task provides for data collection and data assembly as required.

Task 8. SYSTEM INSTALLATION

A system installation plan will be prepared, showing site locations, installation details, and any other relevant information required by government authorities and public utilities. Based on that plan, CISS remote devices will be installed and made operational.

Task 9. OPERATIONAL TESTING, EVALUATION, AND REFINEMENTS

This task provides for operational testing, evaluation, and refinements to the system. This will essentially be considered to be a beta-test of the system. Testing procedures will be established and exercised. Refinements will be installed as a result of the detection of anomalies. The testing and evaluation phase provides the opportunity for several iterations of system refinements.

Task 10. ACCEPTANCE TESTING

This task sets the stage for testing and evaluation of the system, possibly by an independent third party, specifically with respect to contract acceptance. Batteries of test procedures will be established to verify system performance with respect to criteria established earlier. System tests will then be performed and a Findings Report will be prepared. Successful completion of this system will signal that the CISS is operationally ready.

Task 10.1 Acceptance Testing Plan

In accordance with performance specifications established in Task 4, an appropriate testing plan will be developed. The acceptance testing plan will involve a combination of laboratory and field testing, both for individual components of the system as well as for the system as a whole. The plan will establish test procedures meant to evaluate performance of the system with respect to acceptance criteria. This plan will be developed early in the program so that all parties have been alerted to the acceptance criteria and procedures.

Task 10.2 Acceptance Testing

This task provides for performing acceptance testing in accordance with the plan adopted in Task 10.1

Task 10.3 Findings

Technical documentation will be prepared displaying the results of acceptance tests performed in Task 10.2. A findings report will be prepared outlining findings and recommending contract disposition.

Task 11 TECHNICAL DOCUMENTATION, TRAINING, AND OPERATIONAL START-UP

This task provides for the development of internal capabilities for operating and maintaining the CISS, and is meant to cover the preparation of technical documentation and training programs. The CISS will become an operational unit in this task.

Task 11.1 Finalize Lead Agency Responsibilities

Lead agency responsibilities for maintaining and operating the CISS will be resolved in this task. The MRGCOG may become the lead agency responsible for the CISS, but there are other options as well. For example, MRGCOG might be responsible for initial operation during system shakedown before shifting permanent responsibility to another unit as a completed turnkey system. Also, opportunities exist for follow-on contractual arrangements with the system supplier to respond to performance problems, bugs, etc. No matter what organizational decisions are made, procedures for access to information in CISS among the participating agencies and departments will be clarified. Also, an initial set of operating parameters will be established to establish operating procedures, recurring periodic reports, performance standards, etc.

Task 11.2 Operations

This task covers responsibilities associated with making the CISS operational. It requires the preparation and acquisition of budgets and funding for the unit. Also, staffing for the unit will be recruited. Finally, technical and user documentation describing operation of the system will be created. Finally, a training program will be established for unit operators.

Task 11.3 Maintenance

This task covers responsibilities associated with ongoing maintenance and repair of the CISS. Similar in scope to task 11.2, matters addressed in this task cover maintenance. Lead agency responsibilities will be assigned, budget and funding established, and staff recruited. Conditions of warranties and ongoing technical support will be implemented. Appropriate technical documentation and training will be created. Budget considerations for ongoing maintenance responsibilities will also address the needs for specialized tools or parts inventories.

Task 12 NEXT STEPS

This task calls for the preparation of a plan for CISS enhancements. Priorities associated with the ultimate system plan adopted in Task 3 will be assessed, and a program for continued development of the system will be prepared. This plan will also address schedule, budget, and funding issues.

Task 13 MANAGEMENT AND ADMINISTRATION

This task provides for contract management and administration among study team members. System development will require liaison between MRGCOG and the contractors and will also require contractors to participate with MRGCOG advisory committee(s) and boards.

Task 13.1 Contract Administration

MRGCOG will establish contract administration procedures, covering progress reports, invoices, and payments. In addition, a project monitoring program establishing schedules and milestones will be established.

Task 13.2 Contract Liaison

MRGCOG will establish an advisory committee(s) to coordinate activities among the various agencies and departments participating in the study. Also, regular reports and presentations will be delivered to various established groups, including the MRGCOG Board of Directors, the MRGCOG Urban Transportation Planning Policy Board, and the Transportation Coordinating Committee. This liaison program will also include other established groups in the City of Albuquerque, such as the Air Control Board.

Congestion Information Surveillance System
Organization Structure and Contracting Arrangements

Phase I

MRGCOG will be the project manager for the Phase I program, to be assisted by an advisory group with membership invitations extended to relevant local agencies and departments as well as appropriate units of the federal and state governments. A close working relationship with the U.S. Department of Transportation and the Environmental Protection Agency will be established through the advisory groups. The New Mexico State Highway and Transportation Department, the City of Albuquerque, Bernalillo County, and the Air Quality Control Board will also participate through the advisory group mechanism.

In addition, MRGCOG standing boards and committees, including the Board of Directors, the Urban Transportation Planning Policy Board, and the Transportation Coordinating Committee, will be involved.

MRGCOG is proposing to offer a contract to a joint venture led by Santa Fe Technologies on a sole source basis. The basis for the sole source procurement will be predicated on Santa Fe Technologies being the sole licensee for LIDAR air quality sampling technology, worldwide.

A conventional firm fixed price contract is envisioned for Phase I, with progress payments based on completion of contract scope.

Phase II

MRGCOG will continue to manage the Phase II program as Lead Agency with support from advisory groups as established in Phase I.

MRGCOG sees the need for three contractors for the Phase II program:

- System Developer
- Management and Procurement Assistance
- Independent Third-Party System Evaluation

System Developer

Inasmuch as the CISS will employ LIDAR technology for air quality surveillance, it is likely that the current licensee will be heavily involved in this program, perhaps as the systems developer. Issues connected with appropriate technology for traffic surveillance equipment have not been resolved. Provisions for a competitive solicitation for this element of the system will be made if it is determined that there are competing technologies which warrant consideration. The traffic surveillance equipment developer would report to the systems developer.

Independent Third-Party Evaluation

MRGCOG intends to solicit the services of a technically qualified contractor for testing and evaluation of the CISS.

Management and Procurement Assistance

If a competitive solicitation for a traffic surveillance equipment developer is pursued, along with a technology assessment, MRGCOG intends to seek outside assistance to manage this process and to perform the technology evaluations.

Congestion Information Surveillance System
Project Budget and Schedule

Project Budget

The CISS Program is a $3.5 million program which we be developed over a two year time frame with 85% federal CMAQ funding. Funding breakdown is as follows:

Year	Federal	Total
1st Year	$1,627,000	$2,000,000
2nd Year	$1,275,000	$1,500,000

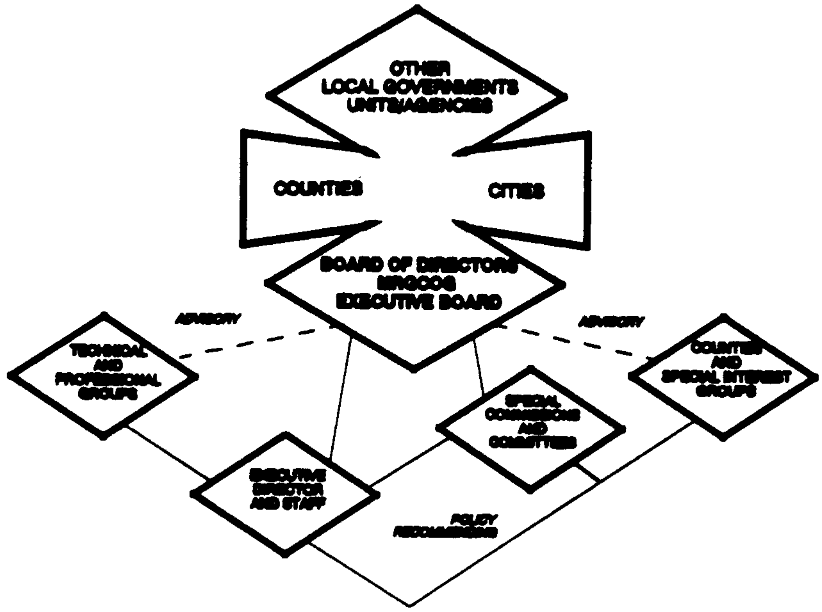
<details to be provided>

Project Schedule

<details to be provided>

Middle Rio Grande Council of Governments of New Mexico

An association of local government entities working cooperatively toward desirable areawide development



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PROGRAM ADMINISTERED BY: Albert I. Pierce, Executive Director

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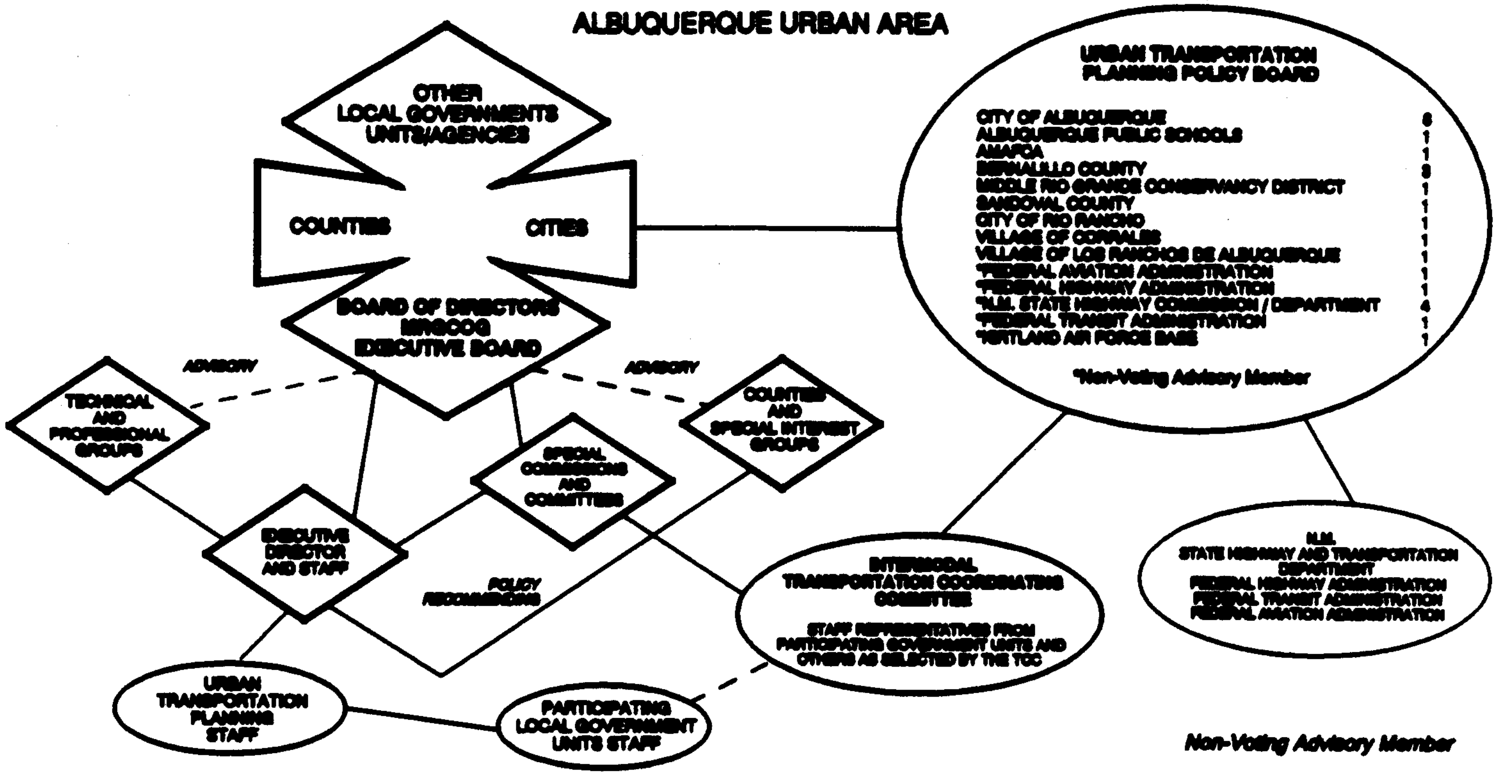
URBAN TRANSPORTATION PLANNING PROGRAM

ALBUQUERQUE URBAN AREA



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