



FINAL REPORT

# **Evaluation of Episodic and Seasonal Emission Controls for Transportation in Illinois**

**Project IIIA-H1, FY 99**

Report No. ITRC FR 99-1

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# **EVALUATION OF EPISODIC AND SEASONAL EMISSION CONTROL FOR TRANSPORTATION IN ILLINOIS**

**ITRC Project number: 99-IIIA-H1**

Final Report  
Submitted to

**Illinois Transportation Research Center  
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<b>16. Abstract</b> <p>The Illinois Transportation Research Center, Illinois Department of Transportation commissioned this study to evaluate the cost-effectiveness of episodic and seasonal transportation control measures for ozone in two areas of Illinois. During the 1995 – 2000 period, twelve ozone alert days were issued in the Greater Chicago Metropolitan Area (GCMA), and five ozone alert days were issued in the Saint Louis Metropolitan Area in 2000, in anticipation of exceeding the 1-hour standard of 0.12 ppm. In July 1997, the U. S. Environmental Protection Agency (USEPA) revised the National Ambient Air Quality Standard (NAAQS) for ozone from 0.12 ppm to 0.08 ppm, and changed the standard from a 1-hour averaging time to an 8-hour averaging time. The 8-hour ozone standard has not been implemented yet by USEPA.</p> <p>Episodic and seasonal controls target emission reductions when those reductions are most valuable, during an “ozone episode” and “ozone season.” Thus, episodic and seasonal control measures are expected to be more cost-effective than most fixed emission control measures, which reduce emissions on a continual basis throughout the year. A nationwide survey was conducted to find the most favorable, politically and economically, existing episodic and seasonal control programs. Based on the survey results, several episodic and seasonal control programs were identified as potentially effective and selected for further analysis. The analysis presented evaluates selected episodic and seasonal control measures for their cost-effectiveness and identifies the most cost-effective episodic and seasonal control measures.</p>			
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## ACRONYMS

AQCR	Air Quality Control Regions
AQI	Air Quality Index
CAAA	Clean Air Act Amendments of 1990
CAP	The Bay Area Clean Air Plan
CATS	Chicago Area Transportation Study
CBD	Central Business District
CMAQ	Congestion Mitigation and Air Quality program
CPI	Consumer Price Index
CPP	Cost Per Rating Point
CRP	Gross Rating Percentage
DOT	Department of Transportation
EIM	Enhanced Inspection and Maintenance
ERMS	Emission Reduction Market System
EWGCC	East-West Gateway Coordinating Council
GCMA	Greater Chicago Metropolitan Area
GIS	Geographic Information System
GUI	Graphic User Interface
IDOT	Illinois Department of Transportation
I/M programs	Inspection and Maintenance programs
IEPA	Illinois Environmental Protection Agency
ITRC	Illinois Transportation Research Center
MDE	Maryland Department of the Environment
MODOT	Missouri Department of Transportation
MPO	Metropolitan Planning Organization
NAAQS	National Ambient Air Quality Standards
NESHAPS-MACT	National Emissions Standard for Hazardous Air Pollutants - Maximum Achievable Control Technology
NESHAP-SOCMI	National Emissions Standard for Hazardous Air Pollutants-Synthetic Organic Chemical Manufacturing Industry
NO <sub>x</sub>	Nitrogen Oxides
OD (or O/D)	Origin/Destination
OKI	Greater Cincinnati area, Ohio & Northern Kentucky Regional Council of Government
PFCA	Partners For Clean Air
PM10	Particular Matter
RACT	Reasonably Available Control Technology
RCRA	Resource Conservation and Recovery Act
RFG	Reformulated Gasoline

ROP	Rate-of-Progress
RTA	Regional Transportation Authority
SCAQMD	South Coast Air Quality Management District
SIP	State Implementation Plan
SLMA	St. Louis Metropolitan Area
SLRCAP	The St. Louis Regional Clean Air Partnership
TAZ	Traffic Analysis Zones
TCM	Transportation Control Measures
TEA-21	Transportation Equity Act for the 21 <sup>st</sup> Century
TRP	Technical Review Panel
TSDF	Treatment, Storage and Disposal Facilities
USEPA	United States Environmental Protection Agency
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compounds
VOR	Vehicle Occupancy Rate

# Executive Summary

The Illinois Transportation Research Center, Illinois Department of Transportation commissioned this study to evaluate the cost-effectiveness of episodic and seasonal transportation control measures for ozone in two areas of Illinois. During the 1995-2000 period, twelve ozone alert days were issued in the Greater Chicago Metropolitan Area (GCMA), and five ozone alert days were issued in the Saint Louis Metropolitan Area in 2000, in anticipation of exceeding the 1 hour ozone standard of .12 ppm. In July 1997, the U.S. Environmental Protection Agency (USEPA) revised the National Ambient Air Quality Standard (NAAQS) for ozone from 0.12 ppm to 0.08 ppm, and changed the standard from a 1-hour averaging time to an 8-hour averaging time. The 8-hour ozone standard has not been implemented yet by USEPA.

Episodic and seasonal controls target emission reductions when those reductions are most valuable, during an "ozone episode" and "ozone season." Thus, episodic and seasonal control measures are expected to be more cost-effective than most fixed emission control measures, which reduce emissions on a continual basis throughout the year. The analysis presented here evaluated selected episodic and seasonal control measures for their cost-effectiveness and identifies the most cost-effective episodic and seasonal control options among them to recommend to the state of Illinois for implementation.

The research team conducted a nationwide survey to find the most favorable, politically and economically, existing episodic and seasonal control programs. Based on the survey results, the research team identified the following episodic and seasonal control programs as potentially effective, and selected them for further analysis.

## 1. Alert Programs

- Air Quality Announcements on Road Signs, Color Coded to Air Quality Index Categories
- e-ALERT Real Time Notification
- Alerts on Radio Stations
- Alerts during Local Weather Report
- Website Notification

## 2. Incentive Programs

- Parking Cash-Out Program
- Commuter Bucks

## 3. Alternative Programs

- Gas Cap Replacement Program
- Postponement of Lawn Mowing

Cost-benefit analysis is the principal tool used to evaluate public policy decisions. It requires estimating all costs and benefits, tangible or intangible, that will accrue to all members of society. An alternative version of the cost-benefit analysis is known as the cost-effectiveness analysis. In it, the measurement of costs and benefits can be in different units, with no need to search for a common metric such as the amount of dollar per ton of Volatile Organic Compounds (VOC) reduction for each alternative measure. Because of the difficulties in estimating all societal costs and benefits, in this report we adopted the cost-effectiveness as the unit of measurement.

The results of the analysis indicate that the five most effective programs in reducing VOCs and Nitrogen Oxides (NO<sub>x</sub>) in 2000 (1999 for the incentive programs) for the Chicago area, in rank order of reduced amounts,<sup>1</sup> are:

1. Parking Cash Out and Commuter Bucks combined (About 5.09 to 5.26 tons/day for VOC and 10.04 to 10.37 tons/day for NO<sub>x</sub>)
2. Gas Cap Replacement Program (5.23 tons/day for VOC only<sup>2</sup>)
3. Postponement of Lawn Mowing (1.9 tons/day for VOC and 0.02 tons/day for NO<sub>x</sub>)
4. Road Sign Notification (1.68 tons/day for VOC and 3.31 tons/day for NO<sub>x</sub>)
5. Television Notification (0.9 tons/day for VOC and 1.77 tons/day for NO<sub>x</sub>)

In terms of dollars per ton of VOC and NO<sub>x</sub> reductions, however, the rankings in order of dollar per ton of VOC reductions are:

1. Gas Cap Replacement Program (\$452/ton for VOC only)
2. Road Sign Notification (\$1,301/ton for VOC and \$659/ton for NO<sub>x</sub>)
3. e-ALERT (\$3,066/ton for VOC and \$1,554/ton for NO<sub>x</sub>)
4. Radio Notification (\$6,721/ton for VOC and \$3,406/ton for NO<sub>x</sub>)
5. Television Notification (\$21,550/ton for VOC and \$10,921/ton for NO<sub>x</sub>)

The five most effective programs in reducing VOCs and NO<sub>x</sub> in 2000 for the St. Louis area, in rank order of reduced amounts, are:

1. Gas Cap Replacement Program (1.41 tons/day for VOC only)
2. Postponement of Lawn Mowing (0.64 tons/day for VOC and 0.006 tons/day for NO<sub>x</sub>)
3. Parking Cash Out and Commuter Bucks combined (about 0.25 to 0.29 tons/day for VOC and 0.5 to 0.57 tons/day for NO<sub>x</sub>)
4. Television Notification (0.26 tons/day for VOC and 0.5 tons/day for NO<sub>x</sub>)
5. Road Sign Notification (0.18 tons/day for VOC and 0.36 tons/day for NO<sub>x</sub>)

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<sup>1</sup> Rank order in terms of NO<sub>x</sub> reduction is different from the rank order of VOC reduction. Table 7-1 shows a comprehensive overview of the reduction amounts of all programs analyzed.

<sup>2</sup> NO<sub>x</sub> emissions are not relevant in the gas cap replacement program.

In terms of dollar per ton of VOC and NO<sub>x</sub> reductions, however, the rankings in order of dollar per ton of VOC reductions are:

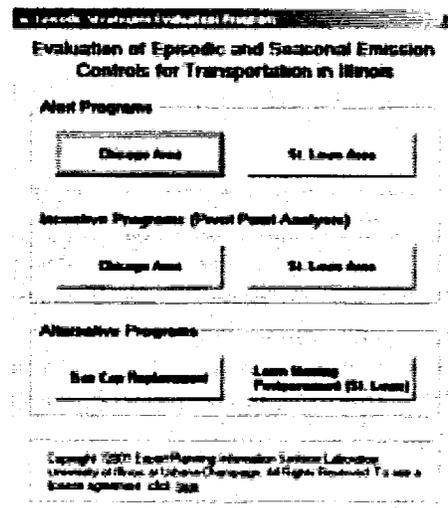
1. Gas Cap Replacement Program (\$511/ton for VOC only)
2. Road Sign Notification (\$4,742/ton for VOC and \$2,403 for NO<sub>x</sub>)
3. Television Notification (\$16,572/ton for VOC and \$8,398 for NO<sub>x</sub>)
4. Radio Notification (\$23,525/ton for VOC and \$11,921 for NO<sub>x</sub>)
5. E-alert (\$56,775/ton for VOC and \$28,772 for NO<sub>x</sub>)

**It is important to note, however, that the results shown above are based on various assumptions that may vary in time and place.** The variability of many factors in estimating effectiveness of episodic control programs led the research team to document the research tools that were developed and used based on the national data, and made it user-friendly by providing a graphic user interface (GUI). They are documented in detail in Appendix D: User Manual for Episodic Strategies Evaluation Programs (ESEP). A compact disc (CD) that includes the ESEP is also included as a part of the final report. The figure below shows the GUI for ESEP.

By releasing these tools, it is hoped that others can use them to derive new results, once they find new data and incorporate different assumptions. Policy makers in other parts of the country will be able to evaluate selected episodic strategies for their own purposes with these tools. In the years to come, when new socioeconomic data and new air quality data are collected, these tools may shed light on how to evaluate strategies of coping with a changed environment.

At the same time, implementation of those episodic control measures can contribute to the fulfillment of Illinois' State Implementation Plan (SIP) requirement, since significant ozone reductions can be achieved through implementation of the recommended episodic control measures.

### Graphic User Interface of the Episodic Strategies Evaluation Programs



To obtain a CD for the ESEP for your own analysis, please contact Prof. Tschangho John Kim using [t-kim7@uiuc.edu](mailto:t-kim7@uiuc.edu).

# Chapter 1 Introduction

## 1.1 Background

As of November 1990, Chicago was one of eight metropolitan areas in the United States with ambient ozone concentrations in excess of 180 parts per billion (ppb), high enough to receive the designation of “severe” nonattainment for the 1-hour standard of 120 ppb.<sup>3</sup> In July 1997, the U.S. Environmental Protection Agency (USEPA) adopted a new 8-hour National Ambient Air Quality Standard (NAAQS) of 0.08 parts per million (ppm). The St. Louis (Missouri, Illinois) area is one of 96 areas in the United States that are currently designated as nonattainment for ozone. This area has been ranked according to the 1990 CAAA requirements as a moderate ozone nonattainment area.

Following promulgation of a new or revised air quality standard, the Clean Air Act (CAA) requires the Governor to recommend initial designations of the attainment status for all areas of the state. Areas can be classified as nonattainment (does not meet, or contributes to a nearby area that does not meet, the NAAQS); attainment (meets the NAAQS); or unclassifiable (cannot be classified based on available data).

The Illinois Environmental Protection Agency (IEPA) recommended that the boundaries of the existing attainment/nonattainment areas in Illinois, which were promulgated for the previous 1-hour standard, remain the same for the 8-hour standard when implemented. The proposed attainment/ nonattainment area designations are provided in Map 1-1.

Under the USEPA’s 8-hour ozone standard of 0.08 ppm, when implemented, additional counties of the state may be designated as ozone nonattainment areas.<sup>4</sup> This may pose a particularly difficult economic challenge for the state. Consequently, Illinois policymakers may face the necessity of implementing tighter emission requirements at higher levels of marginal control cost. This foreseeable scenario poses many challenging questions such as:

- ▶ What approaches are available to reduce ozone concentrations?

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<sup>3</sup> The seven other severe nonattainment areas were Baltimore, Houston, Milwaukee, New York City, Philadelphia, Sacramento, and Ventura County, CA [<http://www.epa.gov/oar/oaqps/greenbk/nc.html>]. Los Angeles has an “extreme” ozone nonattainment designation with exceedences in excess of 280 ppb. The ozone level used in determining attainment is equal to the fourth highest 1-hour concentration of ozone in a year. For a region to meet the 1-hour standard, the average over three years of this ozone level cannot exceed 120 ppb. The rounding rule used by USEPA renders the standard to actually be a 1-hour concentration threshold of 125 ppb.

<sup>4</sup> The new standard is based on the fourth highest 8-hour running average concentration of ozone in a year. The average over three years of this value cannot exceed 0.08 ppm. The rounding rule used by USEPA renders this to actually be an 8-hour concentration threshold of 0.085 ppm.

- ▶ Among the alternatives available, which are the most cost efficient?

With these questions in mind, the research team, composed of transportation planners at the University of Illinois at Urbana-Campaign (UIUC) and economists at Stratus Consulting, analyzed and evaluated various options for episodic and seasonal controls, and recommend a workable set of episodic and seasonal programs that would have an economic benefit to Illinois. It is thus the goal of this study to provide Illinois policymakers with quantitative information on the benefits of developing episodic and seasonal control programs for transportation and their costs relative to fixed control measures.

## 1.2 Objective and Scope

Conventional regulatory methods of emission control, both command-and-control and market-based approaches, reduce emissions throughout the year. These are known as fixed controls. In contrast, seasonal control measures are effective only for specific periods of time, such as the USEPA-designated summer ozone season from April 1 to October 31.

An extension of seasonal controls that more narrowly addresses the time scale of ozone events is episodic emission controls. Episodic measures differ from seasonal and fixed controls by reducing precursor emissions during forecasted periods or days of peak ozone concentrations rather than consistently reducing precursor emissions levels over a longer period of time. Episodic measures are intermittent, being triggered by a forecast of high ozone conditions 12 to 48 hours in advance. Episodic controls may be called on between 5 to 20 days during a summer season. The episode days are highly correlated with the hottest days of the summer.<sup>5</sup>

Policy decision makers as well as practicing air quality and transportation specialists, however, have some doubt whether command-and-control types of episodic control programs, such as restricted driving privileges, can ever be effective. This study emphasizes the selection of workable and yet effective episodic "programs" for Illinois, which are not command-and-control types, but instead are voluntary. Implementing those programs during critical episode days would reduce emissions when reductions are needed most.

Toward this end, four major tasks were carried out. A brief description of each task is presented below:

### 1.2.1 TASK A: Conduct a Comprehensive Literature Review

A comprehensive literature review was conducted to identify all pertinent USEPA regulations and policies, the impacts of the Transportation Equity Act for the 21st Century (TEA-21), and other government initiatives that are applicable as described in Chapter 2 of the report.

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<sup>5</sup> Hagler Bailly Services, Inc., 1998, "Economic and Air Quality Analysis of Episodic Controls to reduce Ozone Concentrations in the State of Illinois", Final Report to DCCA/OCDM, State of Illinois.

### **1.2.2 TASK B: Develop and Administer a Questionnaire and Identify Feasible Measures for Illinois**

The research team developed a questionnaire in conjunction with the project Technical Review Panel (TRP) and the IEPA to solicit information from other state departments of transportation (DOT), air quality agencies such as California Air Resources Board, and metropolitan planning organizations (MPOs) on transportation control programs in use or suggested for use in other states for episodic and seasonal emission controls. Stratus Consulting developed the questionnaire and identified contacts. UIUC administered the questionnaire, evaluated the results, and commented on the effectiveness, appropriateness, and feasibility of applying various measures in Illinois, as described in Chapter 3.

### **1.2.3 TASK C: Consult with TRP and IEPA**

The team developed and submitted to the project TRP a technical memorandum summarizing the results of Tasks A and B in April 2001. The team met with the TRP and staff from IEPA to develop a list of potential emission control measures for further evaluation.

### **1.2.4 TASK D: Develop and Test Methods to Quantify Impacts of Feasible Measures for Illinois**

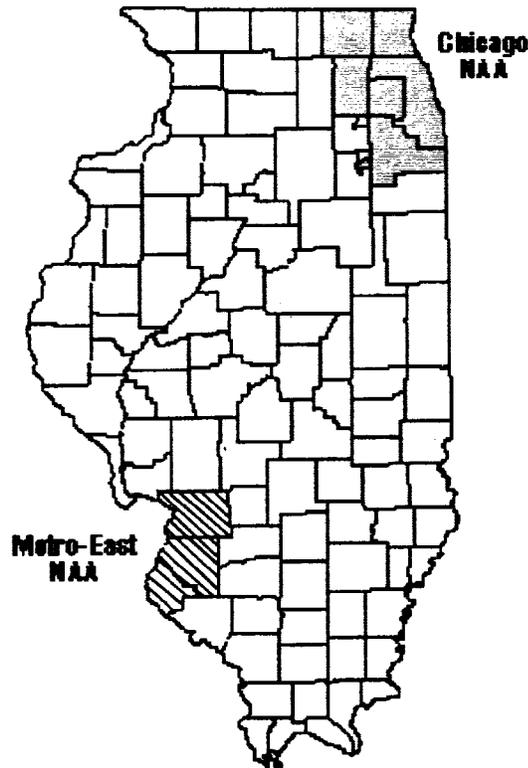
The research team developed a set of methods to quantify impacts of a selected list of potential emission control measures chosen by the project TRP from the memorandum of Task C, and performed cost and effectiveness analyses for both the Greater Chicago Metropolitan Area (GCMA) and the St. Louis area. Chapter 4 of the report describes the following in detail:

- ▶ methods for implementing recommended controls from institutional, regulatory, political, marketing and educational viewpoints,
- ▶ methods for quantifying the effect of recommended episodic and seasonal controls, and
- ▶ methods for estimating costs of implementation of recommended controls.

### **1.2.5 Study Area Covered**

Illinois has two ozone nonattainment areas, as shown in Map 1-1. After consulting with members of the TRP, the research team selected the two nonattainment areas as the domain areas of the project: the GCMA and the St. Louis region, the area covered by the East-West Gateway Coordinating Council (EWGCC).

**Map 1-1. 1-hour Ozone Nonattainment Areas in Illinois<sup>6</sup>**



### **1.3 Overview of the Report**

This report is organized as follows. Chapter 2 reviews the episodic and seasonal controls for transportation, including current regulations and policies, and opportunities and challenges for improving air quality in the transportation sector. Chapter 3 describes the survey conducted, the analysis of the survey results, and recommended episodic and seasonal programs for Illinois. Chapter 4 describes the detailed method of quantifying costs and effectiveness of the recommended alert programs, Chapter 5 describes the method for incentive programs, and Chapter 6 describes the method for alternative programs. Chapter 7 summarizes possible policy implications.

There are several appendices. Appendix A lists episodic and seasonal ozone programs in the United States. Appendix B presents the survey questionnaire, Appendix C lists the organizations surveyed, and Appendix D is the user manual for estimating effectiveness of recommended programs. Appendix D includes a GIS based computer program which would be useful for any analyst who is estimating the effectiveness of episodic and seasonal control measures developed under different scenarios and assumptions in any region within the United States.

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<sup>6</sup> Source: [http://www.epa.state.il.us/air/monitoring/8hr\\_naa.html](http://www.epa.state.il.us/air/monitoring/8hr_naa.html)

## 1.4 Overview of Method of Analysis

Cost-benefit analysis is the principal tool used to evaluate public policy decisions. It requires estimating all costs and benefits, tangible or intangible, that will accrue to all members of society.<sup>7</sup>

Episodic and seasonal control programs considered in this report are voluntary measures in nature, providing incentives to encourage the general public and private companies to change their activities. These programs consist of two categories: informational/educational programs and economic/incentive programs. The former is generally designed to give ozone information and to increase public awareness and participation for ozone episodic days or the ozone season, and the latter is to change behavior by offering an incentive. Estimating costs and benefits of these episodic measures are difficult, and sometimes not quantifiable and/or hard to compare directly.

An alternative version of the cost-benefit analysis is known as the cost-effectiveness analysis. In it, the measurement of costs and benefits can be in different units, with no need to search for a common metric such as the amount of dollar per ton of VOC reduction for each alternative measure. Because of the difficulties of estimating all societal costs and benefits, in this report we adopt cost-effectiveness as the unit of measurement.

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<sup>7</sup> Stockey Edith and Richard Zeckhauser. 1978. *A Primer for Policy Analysis*, W.W. Norton & Company, New York, NY.

## **Chapter 2 Episodic and Seasonal Controls**

### **2.1 Regulations and Policies**

#### **2.1.1 Pertinent USEPA Regulations and Policies**

##### **2.1.1.1 Clean Air Act Amendments of 1990**

The Clean Air Act Amendments of 1990 (CAAA) increased the responsibility of states to demonstrate progress toward attainment of the NAAQS. The 1990 CAAA set additional requirements for ozone, carbon monoxide, and particulate nonattainment areas, depending on states' levels of noncompliance. To help states prepare appropriate programs, economic incentive provisions are provided in section 182 and 108 of the amendments. Those sections led states to develop policies to achieve air quality goals and promote the creation of voluntarily mobile source air quality programs.

##### **2.1.1.2 State Implementation Plan**

Section 110 of the 1990 CAAA requires states to develop air pollution regulations and control strategies to ensure that state air quality meets NAAQS established by USEPA. Each state must submit these regulations and control strategies to USEPA for approval and incorporation into the federally enforceable State Implementation Plan (SIP).

Each state must prepare a SIP document that describes existing air quality conditions and measures that will be taken for nonattainment pollutants to attain and maintain NAAQS. The federal CAAA require that the SIP be submitted to the USEPA indicating what will be done to meet the attainment deadline.

Each state must devise a plan that will result in attainment of each NAAQS for each Air Quality Control Region (AQCR) in the state. This can be accomplished by implementing strategies such as emission permits, transportation controls, and inspection and maintenance of vehicles. If an AQCR achieves the applicable NAAQS, it is considered an attainment area for that pollutant. Otherwise, it is a nonattainment area. Nonattainment areas may be subject to stricter controls and sanctions, such as cutoff of federal highway funds, or a moratorium on new permits.

SIPs are subject to USEPA approval. Once approved, both the USEPA and the state may enforce them. While the 1977 Amendments postponed the deadline for attainment of NAAQSs to the end of 1982 (primary) and 1987 (secondary), many areas still failed to meet the attainment deadlines. As a result, the 1990 CAAA set forth additional requirements for nonattainment

areas. Ozone nonattainment areas are classified into six categories from marginal to extreme, and subjected to a schedule to come into attainment (CAAA section 181 (a)). For example, in marginal ozone areas, reasonably available control technologies (RACT) must be employed by sources of 100 tons/year or more of VOCs, new sources are allowed an offset of 1.1 to 1, and the areas are required to reach attainment within 3 years. These requirements become progressively more stringent as the classification of the nonattainment area worsens.

Title I of the 1990 CAAA calls for all states to revise and submit SIPs for any areas in nonattainment of the NAAQS for ozone.<sup>8</sup> Section 182(b)(1) of the CAAA requires all ozone nonattainment areas classified as moderate and above to submit a SIP revision by November 15, 1993. This SIP revision describes how the areas will achieve an actual emissions reduction of at least 15% during the first 6 years after enactment of the CAAA. Section 182 (c)(2) of the CAAA also requires that all serious and above ozone nonattainment areas submit a SIP revision, which provides for a reduction in ozone precursors. This revision provides for a reduction in ozone precursors of at least 3 % per year averaged over each consecutive 3-year period starting six years after enactment of the CAAA until the area attains the ozone standard. The portion of the SIP revision that illustrates the plan for achievement of this emissions reduction is defined by USEPA as the rate-of progress (ROP) plan.

Section 182(a)(1) of the CAAA requires all ozone nonattainment areas to submit, within 2 years of enactment, a comprehensive, accurate, and current inventory of ozone season typical weekday emissions from all sources. The IEPA completed draft base year inventories for the Metro East (the St. Louis area) and the Chicago ozone nonattainment area and submitted them to USEPA. The final base year inventories should be submitted within a year of the enactment to determine the target level of emissions and these are the basis for ROP plans. The 1990 base year emissions inventories for the Metro East portion of the St. Louis and the Chicago ozone nonattainment area were approved by USEPA in 1995.

### **2.1.2 Illinois State Implementation Plan for Ozone in the Chicago Area**

The Chicago area was designated as a severe ozone nonattainment area on November 6, 1991. The Illinois portion of the Chicago nonattainment area includes Cook, DuPage, Kane, Lake, McHenry and Will counties; Aux Sable Township and Goose Lake Township in Grundy County; and Oswego Township in Kendall County. The Illinois Environmental Protection Agency developed and implemented the required 15% ROP plan for Chicago. Some of the control measures implemented in the Chicago area are summarized in Table 2-1.

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<sup>8</sup> Source: IEPA. 1997. 9% Rate-of-Progress Plan for the Chicago Ozone Nonattainment Area 1997-1999 Revision to the Illinois State Implementation Plan for Ozone. Springfield, IL.

**Table 2-1. Control Measures For the Chicago Ozone Nonattainment Area<sup>9</sup>**

<b>Control measures for mobile sources</b>	<b>VOC reduction credit accepted (tons/day)</b>
<ul style="list-style-type: none"> <li>▪ Conventional TCMs</li> <li>▪ National Energy Policy Act of 1992</li> <li>▪ Post-1994 Tier 1 Vehicle Emission Rates</li> <li>▪ 1995 Reformulated Gasoline</li> <li>▪ 1992 Vehicle I/M Program Amendments</li> <li>▪ Federal Detergent Additive Gasoline</li> <li>▪ Federal Nonroad Small Engine Standards</li> </ul>	<p>2.00</p> <p>0.20</p> <p>2.40</p> <p>112.79</p> <p>8.40</p> <p>2.20</p> <p>4.37</p>
<b>Total of Mobile Source Measures</b>	<b>132.36</b>

**Table 2-2. Control Measures For the St. Louis Ozone Nonattainment Area<sup>10</sup>**

<b>Control measures for mobile sources</b>	<b>VOC reduction credit accepted (tons/day)</b>
<ul style="list-style-type: none"> <li>▪ Conventional TCMs</li> <li>▪ Post-1994 Tier 1 Vehicle Emission Rates</li> <li>▪ 7.2/8.2 psi RVP Conventional Gasoline</li> <li>▪ 1992 Vehicle I/M Program Amendments</li> <li>▪ Federal Detergent Additive Gasoline</li> <li>▪ Federal Non-road Small Engine Standards</li> </ul>	<p>0.20</p> <p>0.19</p> <p>8.55</p> <p>0.20</p> <p>0.20</p> <p>0.42</p>
<b>Total of Mobile Source Measures</b>	<b>9.76</b>

### **2.1.3 Illinois State Implementation Plan for Ozone in the St. Louis Area**

The St. Louis (Missouri, Illinois) area is one of 96 areas in the United States that are currently designated as nonattainment areas for ozone. The nonattainment area is composed of Madison, Monroe and St. Clair Counties in Illinois and Franklin, Jefferson, St. Charles and St. Louis Counties and the independent City of St. Louis in Missouri. This area has been ranked according to the 1990 CAAA requirements as a moderate ozone nonattainment area.<sup>11</sup> The IEPA prepared a comprehensive set of control strategies based on the target emissions level to control VOC emissions, sufficient to comply with the CAAA 15% emissions reduction requirement. Some of

<sup>9</sup> Source: EPA. 1997. Approval and Promulgation of State Implementation Plan; Illinois. Federal Register Vol. 62, No. 243.

<sup>10</sup> Source: EPA. 1997. Approval and Promulgation of State Implementation Plan; Illinois. Federal Register Vol. 62, No. 243.

<sup>11</sup> In June 26, 2001, the St. Louis region obtained Attainment Demonstration approval and extension of deadline to November 15, 2004.

the control measures adopted for the Metro East portion of the St. Louis area are summarized in the Table 2-2.

The SIP document identified the approach used by IEPA in developing the 15% ROP plan, the specific measures selected for the 15% ROP strategy, and the estimated emissions reduction potential from each measure. It provides the necessary documentation to support that this strategy complies with the CAAA Section 182 (b)(1) requirements and satisfies USEPA technical guidance for achieving a 15% emissions reduction for reasonable further progress.

#### **2.1.4 Implications of TEA-21**

The Transportation Equity Act for the 21<sup>st</sup> Century (TEA-21), which was enacted in 1998, is an act “to authorize funds for Federal-aid highways, highway safety programs, transit programs, and for other purposes.”<sup>12</sup> The act authorizes funding of \$218 billion for the six years from 1998 to 2003. This fund for public programs will be spent on improving public safety, protecting the environment, and expanding transportation opportunities.

TEA-21 emphasizes environmental concerns and provides several programs and provisions to enhance the environment. The act creates and increases funding for congestion mitigation and air quality (CMAQ) programs, transit enhancements programs, and various alternative modes of transportation. These provisions of TEA-21 will affect state and local agencies because more funds will be available when they include the measures to improve air quality in their environmental programs and transportation projects.

## **2.2 Issues in Improving Air Quality**

While the Clean Air Act has undergone several revisions since its inception, including the 1990 CAAA, its basic mission remains unchanged: to establish and enforce air quality standards that protect public health with an adequate margin of safety.<sup>13</sup>

### **2.2.1 The Role of Local Government in a Regional Problem**

Some air pollution problems are localized, for example, limited to a construction site, a particular road intersection, or a few blocks within one community, but air pollution is to a large extent a regional problem. Pollutants generated in one community frequently drift, causing air quality problems in other areas within and even outside the region. As a result, regional agencies have had to work together to help guide air quality planning. We provide California examples because these are some of the successful instances of local and regional cooperation. For

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<sup>12</sup> Transportation Equity Act for the 21st Century (Public Law 105-178), Available at: <http://www.fhwa.dot.gov/tea21/pl105178.pdf>.

<sup>13</sup> Huebner, Stephen and Kenneth Chilton. 1997. EPA’s Case for New Ozone and Particulate Standards: Would Americans Get Their Money’s Worth?. Center for the Study of American Business: Washington University of St. Louis. Available: <http://wc.wustl.edu/New%20WC%20Site/CSAB%20publications/CSAB%20pubs-pdf%20files/Policy%20Studies/PS139%20Huebner-Chilton.pdf>.

example, a nine-county Air District was instituted in the San Francisco Bay Area to help create better pollution control. Air pollution controls on industries and automobile exhaust have dramatically improved the region's air quality. However, the Bay Area has achieved most of the benefits these measures can produce. To continue to reduce air pollution, the leadership of local officials recognizes the need to start exercising land use authority through local programs. The cumulative effect of local actions can significantly improve air quality.<sup>14</sup>

#### 2.2.1.1 California Local Plans and Programs

The Bay Area Clean Air Plan (CAP), in California, encourages all cities and counties to address air quality issues in their comprehensive plans. The comprehensive plan is the foundation upon which all local planning and development policies and programs are built. Whether communities develop a separate air quality element in their plan, or integrate air quality throughout the other elements of the general plan, consistency and implementation are important.

California planning law requires that local policies and programs demonstrate consistency on several levels. First, all of the elements of the local general plan must be consistent with one another. Second, policies in local general plans should have goals and strategies that are consistent with the plans and policies of regional, state, and federal agencies. Finally, local implementation plans should make commitments to clean air.

Implementation programs can help shape a community's daily activities. To address air quality in all local planning and decision-making, local jurisdictions should adopt air quality-sensitive implementation programs across all phases of their work including subdivision and zoning ordinances, congestion management programs, environmental review procedures, mitigation monitoring programs, capital improvement programs, transportation plans and projects, site design guidelines, and construction practices.

#### 2.2.1.2 Benefits Derived from Transportation Control Measures

While improving local and regional air quality, many of the recommended measures can help cities and counties address several other important issues. Air quality-sensitive planning strategies can help localities achieve the following benefits<sup>15</sup>:

- Reduce traffic congestion
- Increase mobility
- Conserve energy
- Improve water quality preserving open space, agriculture, and other land resources
- Use infrastructure and land more efficiently
- Reduce roadway construction and maintenance costs
- Develop more cohesive communities

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<sup>14</sup> <http://www.abag.ca.gov/abag/overview/pub/aqual.html>

<sup>15</sup> <http://www.abag.ca.gov/abag/overview/pub/aqual.html>

Land use and transportation strategies that offer residents alternatives to long daily commutes by car are particularly beneficial. Measures that make it pleasant and convenient to walk, bike or take transit to shops, schools, and services have similar and complementary effects.

### 2.2.1.3 Regional Planning for Air Quality

State government and regional planning agencies in California have ruled that every nonattainment region must prepare a plan describing how it will achieve and maintain clean, healthy air. Required components in the plans usually include air quality monitoring data, emissions sources and inventories, land use and transportation measures, controls on industries and other direct sources of air pollution, and controls on area sources such as paints and varnishes.<sup>16</sup> The CAP, for example, is a "blueprint" for the Bay Area's plan for cleaner air. Designed to make progress toward attainment of the stringent state standards, the CAP explains what all regional agencies, cities and counties, industries, businesses, and individual citizens can do to improve air quality.

A primary goal of the CAP is to reduce the number of single-occupant vehicle trips that Bay Area residents make. The CAP includes "a variety of transportation control measures (TCMs) designed to achieve this goal. TCMs intending to provide alternatives to driving alone include expanding rail, bus and ferry services, improving carpooling facilities, and providing bicycle lanes and sidewalks. Demand management strategies include "market-based" TCMs, which seek to make the price of driving a vehicle more accurately reflect true costs."<sup>17</sup>

The CAP includes local land use measures as an essential complement to transit, carpooling, and bicycle improvements. The CAP also encourages local jurisdictions to adopt land use, transportation, housing, employment, and other programs that would encourage residents and employees to use transportation alternatives that create less pollution.

## 2.3 Current Programs for Transportation<sup>18</sup>

### 2.3.1 Types of Current Programs

#### 2.3.1.1 Trends in Programs

Voluntary and incentive programs are becoming a popular approach to help reduce ozone precursor VOC and NOx emissions, particularly during the summer ozone season or high ozone episode days. As summarized in Appendix A, over 20 programs were identified and investigated, in addition to those identified in the 1996 USEPA survey.<sup>19</sup> Many U.S. cities recently established episodic and seasonal programs, actively upgraded program components on

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<sup>16</sup> <http://www.abag.ca.gov/abag/overview/pub/aqual.html>

<sup>17</sup> <http://www.abag.ca.gov/abag/overview/pub/aqual.html>

<sup>18</sup> All of the programs listed in this section and Appendix A were retrieved from web sites operated by state and local agencies and other various organizations. Thus, more detailed information on the programs shown on this study can be found by visiting the web sites listed in the references.

<sup>19</sup> See the details in <http://www.epa.gov/oms/www/reports/episodic/finding.htm>

the basis of the previous experience, and are considering implementation of these programs. Several cities such as Indianapolis, St. Louis, Sacramento, and San Francisco have developed a variety of public education and outreach programs, commuter incentives to alternative use of transportation, and ozone forecasting methods and notification programs.

Even though the level of effort made by each city is different, most practices usually focus on voluntary measures and incentives to encourage the general public and private companies to change their activities. Examples of voluntary measures for transportation commonly suggested in these programs are as follows:

- Taking public transportation.
- Limiting driving by ridesharing, carpooling, walking or biking.
- Combining trips and errands.
- Taking lunch to work or walking to lunch.
- Not refueling on an ozone action day or refueling after 7:00 p.m.
- Not topping off the tank when refueling.
- Avoiding excessive idling.
- Keeping the car well tuned.
- Deferring the use of gasoline-powered equipment such as outboard motors and off-road vehicles.

In comparison with programs surveyed by the USEPA in 1996, current episodic and seasonal programs being implemented tend to be incentive-based programs, public notification programs, and employee-targeted programs. This trend is based on the idea that smaller sources such as businesses and individuals are the main challenges in the effort to reduce air pollutant emissions.

Some examples of incentive programs examined include the "Clean Air Pass" in the St. Louis area,<sup>20</sup> commuter incentives to rideshare in the San Francisco Bay area,<sup>21</sup> and tax benefits for ridesharing in the Cincinnati area.<sup>22</sup> Incentives are usually monetary, for example, tax benefits, checks, and cash allowances. Public notification programs are intended to maximize public awareness during the ozone season or on specific episode days. Several cities have developed methods to alert the public, such as animated ozone forecasts on websites and ozone alerts by e-mail. Alternative commuting programs such as carpooling and vanpooling are very common, and various benefits are provided to users.

A broad variety of voluntary ozone reduction programs in other cities and states were examined (listed in Appendix A). The programs include some unique ozone forecasting measures, rideshare programs, and transportation emission control programs.

### 2.3.1.2 Overview of Ozone Programs

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<sup>20</sup> See the St. Louis Regional Clean Air Partnership web site, <http://www.cleanair-stlouis.com>

<sup>21</sup> See for the San Francisco Bay area at <http://www.rides.org/lv2rewards/lv3county/county.html>.

<sup>22</sup> See the Cincinnati program at <http://www.oki.org/commuter/rideshare.php3>.

Target pollutants for all programs in Appendix A are NO<sub>x</sub> and VOCs because these pollutants when combined generate ozone, and come from similar sources such as automobiles, lawnmowers, and off-road engines. These existing ozone programs can be classified into several summary categories:

Target Domain

- 1) Vehicle miles traveled
- 2) The number of vehicle trips
- 3) Emissions per mile
- 4) Evaporative emissions

Subject Domain

- 1) General public
- 2) Employers/employees
- 3) Other

Program Location

- 1) State level
- 2) Regional level
- 3) Local level
- 4) Other

Target Period

- 1) Fixed control (year round)
- 2) Seasonal control
- 3) Episodic control

Program Type

- 1) Voluntary program
- 2) Incentive program
- 3) Notification program

Incentive Type

- 1) Monetary awards
- 2) Pricing/charge
- 3) Other

## **2.4 Existing Seasonal and Episodic Ozone Programs in Illinois**

### **2.4.1 The Greater Chicago Metropolitan Area**

The Chicago area has various seasonal and episodic ozone programs for transportation that target the general public, employees, and industrial sectors. Most programs in this region focus on commuting alternatives that offer tax benefits and cash incentives, and voluntary programs targeting employees and the general public.

#### 2.4.1.1 Partners For Clean Air

Partners For Clean Air (PFCA) is a coalition of businesses, industries, and public organizations formed to contribute to improve air quality on ozone action days. The ozone action day is a voluntary ozone episodic program in the Chicago area, which is run by PFCA. When an ozone action day alert is issued, Chicago residents are asked to avoid activities that help causing VOC and NO<sub>x</sub> emissions. PFCA notifies the public of ozone information through various media and electronic sources such as television, radio, newspapers, and e-mail.

#### SMOGALERT

SMOGALERT is a public e-mail notification program that is operated by PFCA. When unhealthy ozone levels are forecasted in the Chicago area, a SMOGALERT e-mail is automatically sent to its subscribers.

#### 2.4.1.2 Regional Ridesharing Initiative

##### Chicago Area Rideshare Services

The Chicago Area Transportation Study (CATS) runs a ridesharing program to provide the public with free computerized carpool matchlists. This service is for residents of Cook, DuPage, Kane, Lake, McHenry and Will counties in northeastern Illinois, or anyone commuting from Wisconsin or Indiana to northeastern Illinois. This matching service is available for those individuals interested in carpooling to and from home and work. They also operate a cost savings calculator on their website so that potential riders can learn how much money they could save by ridesharing.

##### Pace Vanpooling

Pace, which is a suburban bus division of Regional Transportation Authority (RTA), operates a program entitled Vanpool Incentive Program (VIP) for the six counties in the Chicago region. Groups of 5 to 15 people who live and work near one another are the main users of this program. Pace pays for fuel, maintenance, and insurance. The driver rides for free, and passengers pay a low monthly fare. A Guaranteed Ride Home Program is also served by Pace. In emergency cases, vanpool participants can use this program to get a reimbursement up to \$100 annually for alternative transportation costs home.

#### 2.4.1.3 Clean Air Counts

Clean Air Counts is a campaign program that involves businesses, industries, and institutions. The primary purpose of this program is to seek voluntary commitments to implement clean air strategies that could reduce business operating costs and/or improve revenues in addition to addressing smog.<sup>23</sup> The campaigns are targeted to five audiences: businesses, developers, local

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<sup>23</sup> Clean Air Counts campaign fact sheet.

governments, households, and state and federal agencies. Clean air strategies have four categories: transportation, operation and maintenance, energy management, and physical development. These strategies include activities such as workplace transportation options, natural landscaping, and energy efficient lighting.

#### **2.4.2 The St. Louis Metropolitan Area**

Seasonal and episodic ozone programs are mainly coordinated by The St. Louis Regional Clean Air Partnership (SLRCAP), which is a public-private partnership dedicated to increasing awareness of regional air quality issues and encouraging voluntary actions to reduce ozone precursors in St. Louis. The SLRCAP was formed in 1995 by a coalition of the American Lung Association, the St. Louis Regional Chamber and Growth Association, Washington University, and other partners. Several kinds of public outreach programs and incentive programs are actively being operated on the state, regional, and local levels. Key parts of the public outreach programs are presented here according to their program types (voluntary, incentive, and notification).

##### **2.4.2.1 Voluntary Program: Ozone Action Day**

An ozone action day is a public outreach program to encourage voluntary actions to help reduce ozone precursors. On days when air quality is forecasted to be orange or red, which have over 100 AQI (Air Quality Index), the SLRCAP and the American Lung Association issue an ozone action day notice. Several action tips are recommended to reduce ozone precursors, such as using transit and vanpool/carpool, not topping off the gas tank, and refueling after 7:00 p.m.

##### **2.4.2.2 Incentive Programs**

###### Clean Air Pass

This is an incentive program for the public to reduce trips during the ozone season and is operated by the transit provider, the Bi-State Development Agency. The purpose of Clean Air Pass is to allow the public to affordably use public transportation to reduce ozone emissions. This pass is effective during the ozone season from June 01 to August 31, giving unlimited rides by bus and MetroLink. The price of one pass is \$90 for three months, which is a savings of \$30 over the regular fare.

###### RideFinders

RideFinders is a rideshare agency for the St. Louis area. It is operated by Madison County Transit as a public service. Its primary purpose is to reduce transportation congestion and air emissions by giving commuters alternatives such as vanpooling, carpooling, mass transit, and alternative work arrangement. The program also includes a Guaranteed Ride Home element, which participants can use in case of medical emergencies or late working hours. The main funding source is the Congestion Mitigation and Air Quality (CMAQ) Program fund.

Under the Transit/Vanpool Benefit Program, an employee can receive from his/her employer up to \$65 a month for taking mass transit, vanpooling, or using a combination of these alternatives. A vanpool is defined as any vehicle that has a seating capacity of at least six adults (not

including the driver), and at least 80% of the mileage must be used for transporting employees to work.<sup>24</sup>

Another kind of incentive program served by RideFinders is a parking cash-out program. Employers often offer their employees subsidized or free parking. Thus, employees can choose between keeping their parking benefit or giving it up to receive equivalent taxable cash, tax-free transit, or vanpool benefits. While the employer would incur tax liabilities for employees who choose taxable cash, it offers an opportunity to help employers reduce their parking costs and encourage commuting modes.

#### 2.4.2.3 Notification Programs

##### E-mail notification system: Air Quality Alert

Air quality alerts by e-mail are issued and notified by the SLRCAP. The day before a forecasted orange or red day, SLRCAP sends an e-mail to e-ALERT subscribers. For company subscribers, a workplace Clean Air Coordinator will receive the e-mail alert and distribute it to the employees. This e-mail notification encourages behaviors that reduce ozone concentrations.

##### The 4 Warn Aircast

The 4 Warn Aircast is an ozone-forecasting program on TV. KMOV Channel 4 works with the American Lung Association and other air quality and health experts to bring a daily air quality forecast. Currently, Channel 4 broadcasts daily ozone levels four times a day, at noon, 5:00 p.m., 6:00 p.m., and 10:00 p.m.

##### Road Sign Notification

Once the American Lung Association and KMOV Channel 4 provide ozone forecasts, the forecast for the next day is automatically displayed on road signs during peak traffic times to inform vehicle users and commuters. The road signs are solar powered, changeable message signs. Messages shown to the public include: "Please Reduce Travel," "Please Car Pool," "Refuel after 7 p.m.," and "Consider Mass Transit," depending on the day's forecasted ozone level. Currently, there are five road signs in the St. Louis area, on I-44, I-55, I-64, and I-70. These road signs are for air quality information only, and are operated by the Missouri Department of Transportation and the Illinois Department of Transportation.

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<sup>24</sup> More detailed information can be found at <http://www.ridefinders.org/tea21.htm>

## **Chapter 3 Survey and Feasible Measures for Illinois**

### **3.1 Overview of Survey**

To recommend feasible strategies for Illinois, the research team developed a questionnaire to solicit information from other state DOTs, air quality programs, and MPOs on transportation control programs in use or suggested for use in other states for episodic and seasonal emission controls. The survey (see Appendix B) consisted of five sections:

1. The first section asked for general information, agency affiliation, contact names, geographic area of coverage, program history, and implementation milestones.
2. The second section consisted of program design questions. These questions asked for program goals, travel-related suggestions made to the public and to companies on episode days, any policy changes that the program encourages companies to make on episode days, forecasting episode days, notification programs, and education/outreach programs.
3. The third section covered program funding and administration. The section inquired about budget information, in kind contributions, staffing, and total costs.
4. The fourth section involved program participation. The section asked the agency about predicted participation levels, actual participation levels, incentives offered to encourage employer and employee participation, and incentives offered for public participation.
5. The final section covered program evaluation. This section inquired how data was collected for program evaluation, any quantitative analysis of the effectiveness of the proposed programs, specific problems with evaluation, and important successful programs.

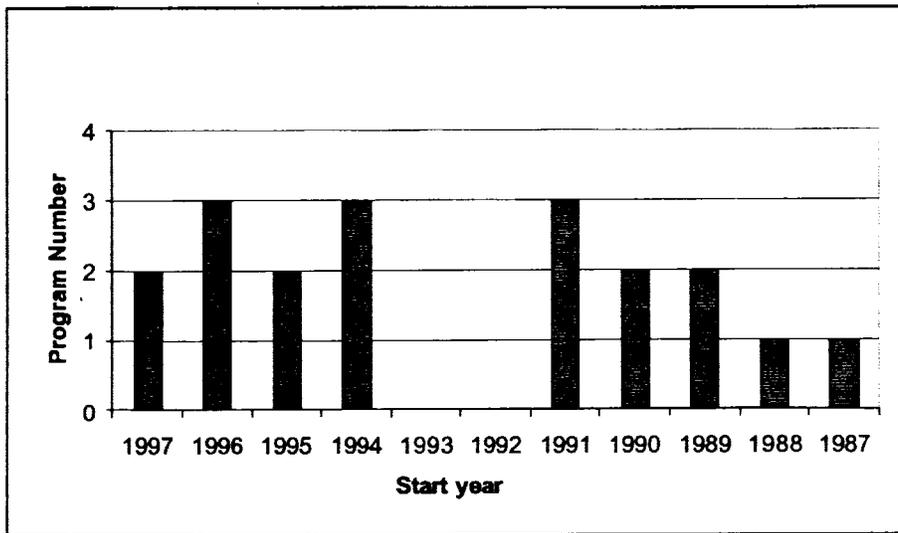
In June 2000, after a review with the members of the TRP and with staff from the IEPA, the research team compiled a list of questions according to these five topics for the survey. This survey was sent to thirty-one air control commissions, environmental protection agencies, and air quality programs across the United States, and twenty-two responses were received (see Appendix C for the list of entities surveyed and contact persons). Telephone calls were made to some entities for follow-up to questions that were not answered clearly.

### **3.2 Analysis of Survey Results**

#### **3.2.1 General Information**

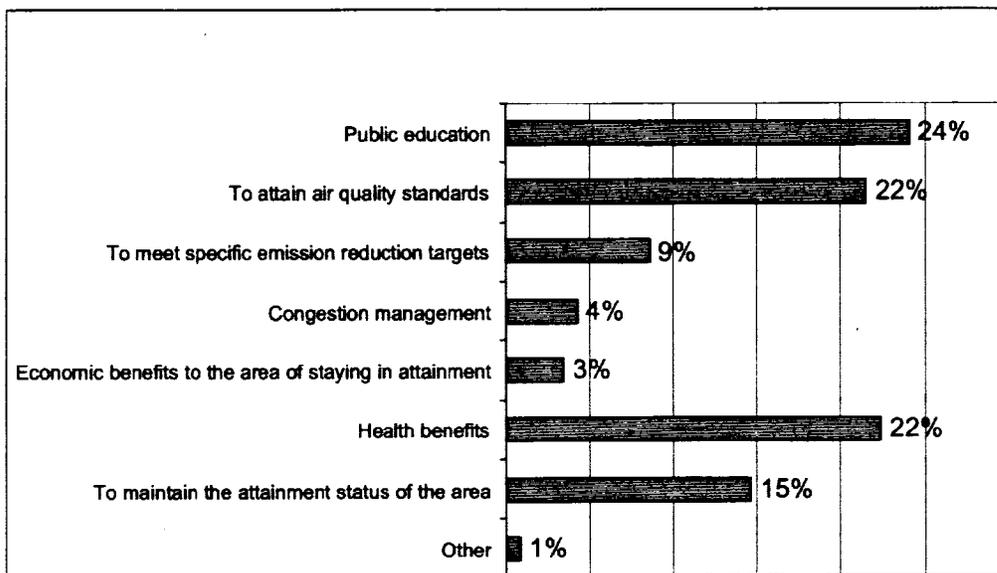
The entities surveyed were received from were all relatively new. While many started in the early 1990s and late 1980s, we also found that many new air control programs and agencies started up in just the last five years. Most of these agencies have had significant results in achieving their goals, showing us that with good management and staff, it is possible to see fast results in a short period of time. Figure 3-1 shows the starting years of the surveyed programs.

**Figure 3-1. Program history**



Most agencies have several goals they hope to achieve over a specific time period. Figure 3-2 displays these goals; public education, health benefits, and air quality are the most frequent named goals, followed by meeting attainment standards.

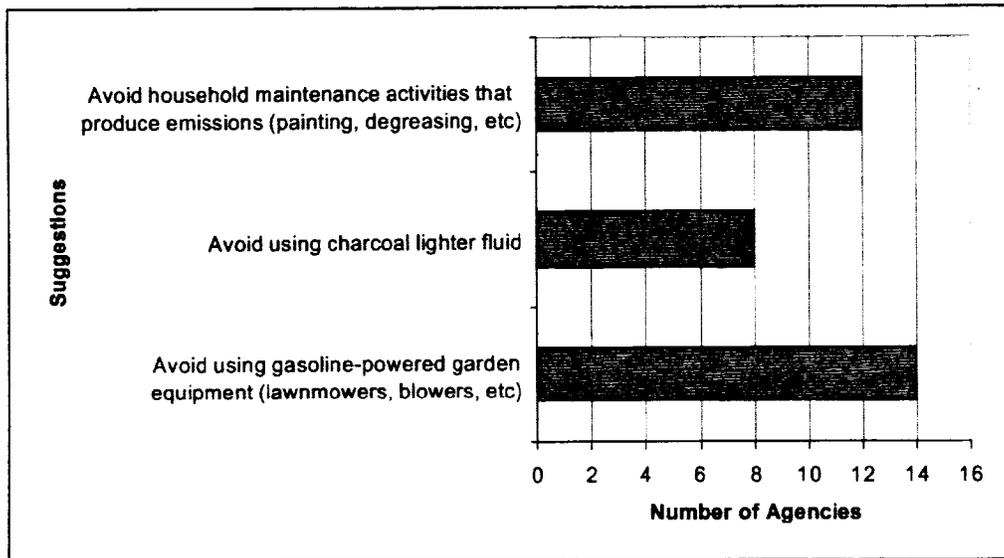
**Figure 3-2. Stated Program Goals**



Beyond the stated goals, there were also specific suggestions made to the public on pollution episode days to reduce area source emissions. For example, the air quality agencies and

programs stressed that people at home during the day needed to minimize the use of gasoline powered lawn equipment, charcoal lighter fluid, and doing maintenance work on their homes. Figure 3-3 shows the most frequent suggestions recommended to the public.

**Figure 3-3. Suggestions made to the public on episode days**



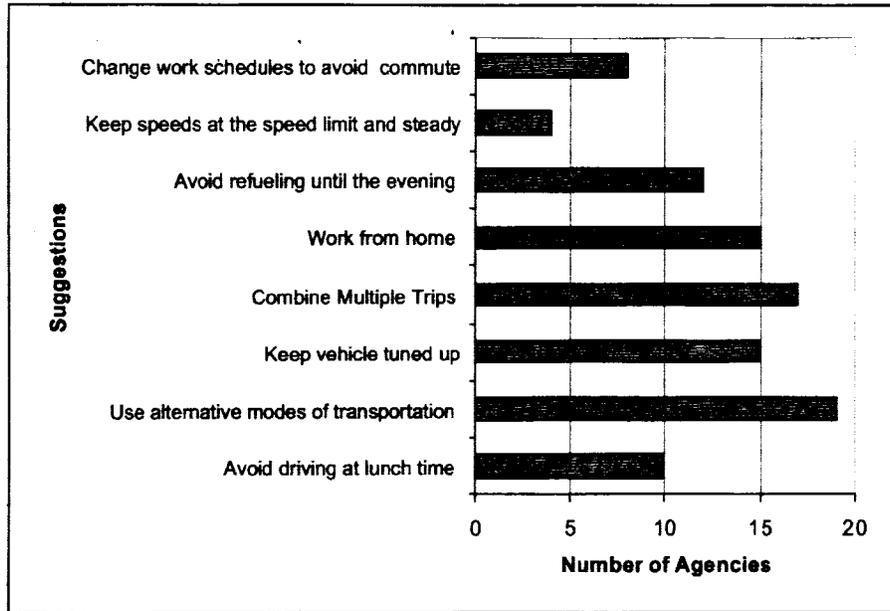
Other suggestions to reduce emission on specific episode days made by those surveyed were to:

- Limit boating activity
- Delay refueling of vehicles to non smog-alert days
- Consider buying more energy-efficient appliances and vehicles
- Use water-based paints and environmentally safe household products
- Do not use uncertified wood burning fireplaces or wood stoves.

### 3.2.2 Trip Related Programs

Many agencies/programs surveyed gave several trip related suggestions to the general public on pollution episode days. Almost all suggest using alternative modes of transportation when traveling. They also suggest trying to work from home, cutting down on multiple trips, keeping your car tuned up, and avoiding refueling until after 6 p.m. Figure 3-4 shows the trip related programs recommended by the surveyed agencies.

**Figure 3-4. Trip related suggestions made to the public**



Some other trip related comments suggested by the air control agencies are:

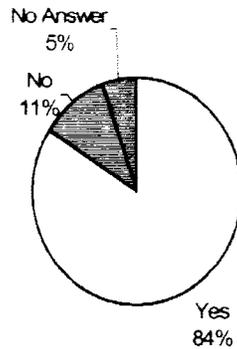
- Turn off vehicle air conditioning on the morning commute
- Encourage biking and walking
- Ride free on public transportation on specific code red days
- Have proper tire inflation

### **3.2.3 Employer Participation**

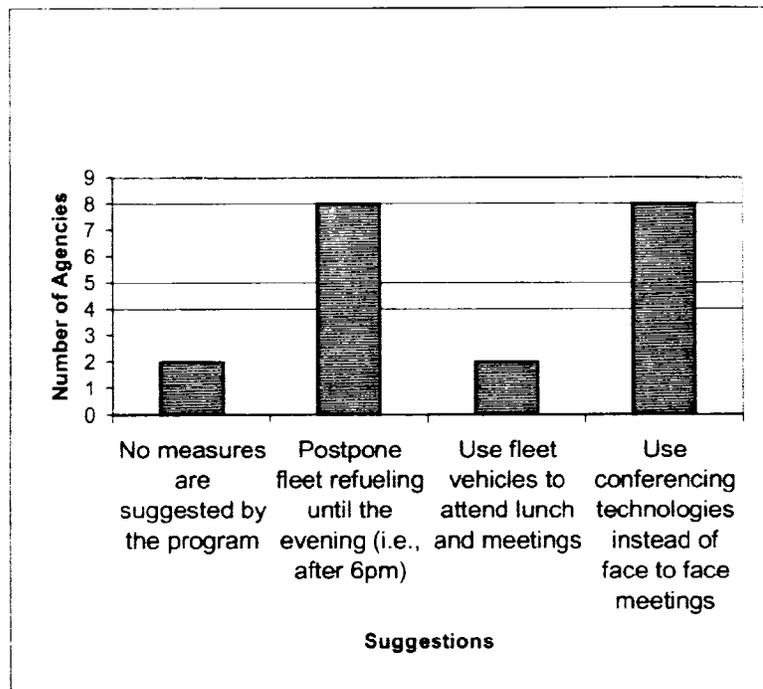
Many respondents mentioned company participation programs, whereby local businesses notify their employees when an air pollution episode occurs and inform them of actions they can take to help. Figure 3-5 shows that 84% of those surveyed participated with Employer Participation Programs.

The respondents also indicated that they encourage companies to use cars or trucks to refuel in the evening, use vans or buses to transport several people to meetings, and use teleconferencing technology instead of driving or flying to a meeting. Figure 3-6 shows the actions encouraged by the entities surveyed.

**Figure 3-5. Company Participation Element**



**Figure 3-6. Suggestions to encourage companies to reduce emission on episode days**



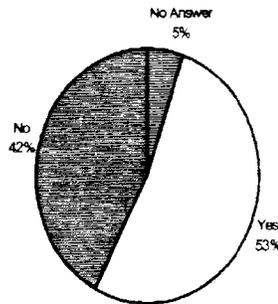
They also offer other suggestions to help companies reduce emissions on specific episode days:

- Postpone or delay maintenance operations – for example, painting and lawn care
- Reduce product loading and maintenance activities that produce emissions of ozone precursors
- Provide parking incentives for carpoolers
- Hold meetings in the afternoons
- Avoid using gasoline-powered lawn and garden equipment on the grounds.

Many of the entities surveyed have programs that include stationary source elements, whereby participating industries (stationary sources) voluntarily take actions to reduce emissions on pollution episode days. Figure 3-7 shows that about 50% of the programs involved a stationary source.

**Figure 3-7. Stationary Source Element**

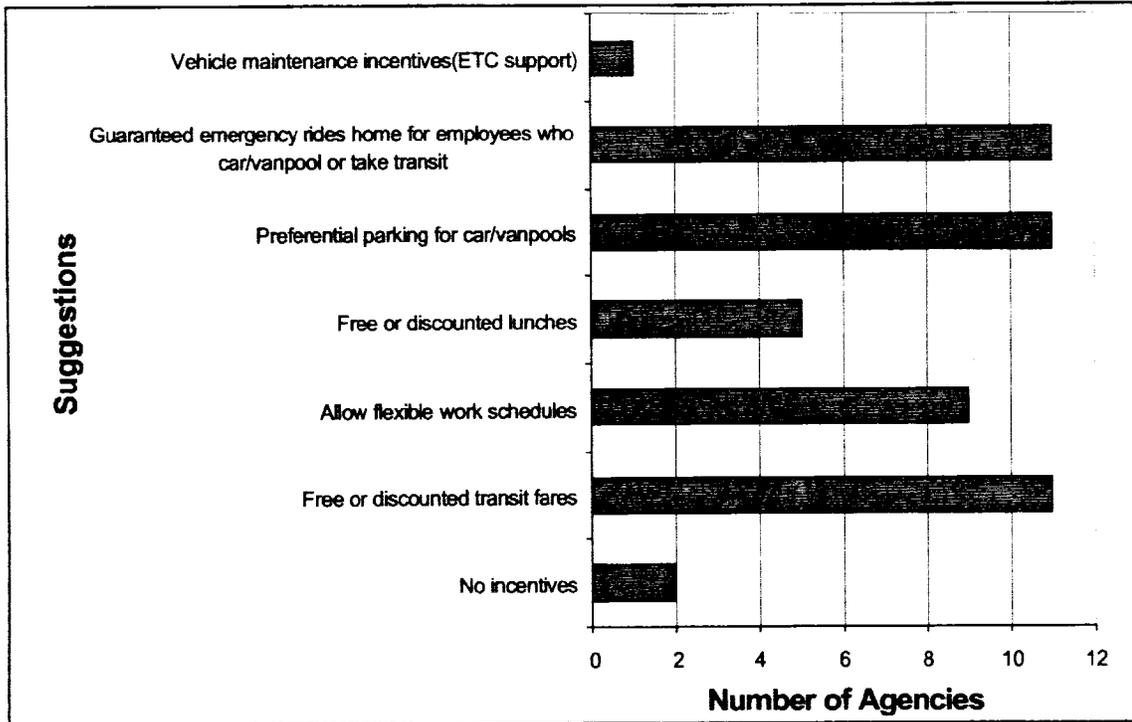
**Do you have a stationary source element?**



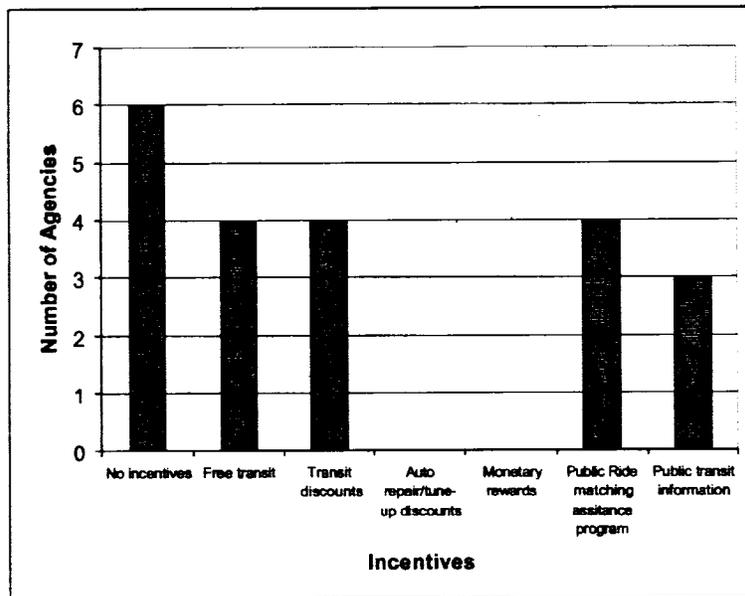
Many agencies also reported that employers in the area have done several things to encourage participation by their employees. Figure 3-8 shows that many agencies guaranteed emergency rides home, provided preferential parking for carpools and vanpools, and provided free or discounted lunches for employees who voluntarily used episodic and seasonal control measures.

Several agencies have offered incentives to encourage participation by the general public. Figure 3-9 illustrates that offering free information about transit and free transit is a popular way to encourage episodic and seasonal emissions control.

**Figure 3-8. Employer tactics in encouraging employee to take action**



**Figure 3-9. Incentives offered for public participation**



### **3.2.4 Use of Media**

All the respondents mentioned the successful use of media. When implementing air quality improvements, it is important to use as many ways as possible to notify the general public. Most agencies use media sources such as local television, radio stations, and newspapers to get the word out. Other ways of notifying the public is getting participation from stationary sources and other cooperative businesses. Others have also had help from gas stations. When there is a pollution episode, most agencies notify newspapers, televisions news stations, and radio stations to help inform the public of the emission emergency. Many report gas stations will notify the public with the use of large signs on each gas pump.

Air quality control agencies have also stated that a successful website campaign can help notify the public. On the website it is possible to inform the public of air quality standards, where they can go to get more information on cutting down on emissions, what they can do currently at home to cut down on emissions, and even about upcoming public meetings on the subject. Many agencies also reported using public education booths at community events, and providing workshops for schools, industry, and the general public.

### **3.2.5 Summary of the Survey**

The largest emphasis of most of those surveyed was lowering ozone precursors during the peak hours of the day. All reported a direct correlation between the amount of media coverage they have received and the success of the program. Many have found that because of constant coverage in the local media, the public's perceptions about air quality have changed.

The respondents also reported that education was an important way to notify the public. They pass out information at public meetings, and in schools to help encourage students to become involved. They advertise on the radio, television, and in the print media. They also have emergency updates when code red days are announced.

By far the most popular way to reduce emissions was to have people use alternative forms of transportation to work, school, and other daily activities. Many reported that they worked closely with the local transit authorities in order to reduce transit costs during the summer and on high emission days.

One notable report on a successful program was the Gas Cap Replacement Program. The Regional Council of Government of Ohio and Kentucky (OKI) used this program. In 1996, Ohio's inspection and maintenance program was suspended by the Ohio EPA. The area needed an innovative program that was cost effective, and capable of reducing emissions from mobile sources. After hearing of a similar program in Pittsburgh, they decided to try a Gas Cap Replacement Program. The program was extremely successful and was able to replace approximately 23,000 leaking gas caps, eliminating 1,297 tons of VOC emission annually from the regions air.

### **3.3 Selected Episodic and Seasonal Programs for Further Analysis**

Based on the survey results, the research team selected the following episodic and seasonal control programs for further analysis as reported in the chapters that follow.

#### **4. Alert Programs**

- Color Coded Air Quality Announcements on Road Signs
- e-ALERT Real Time Notification
- Alerts on Radio Stations
- Alerts during Local Weather Report
- Website Notification

#### **5. Incentive Programs**

- Parking Cash-Out Program
- Commuter Bucks

#### **6. Alternative Programs**

- Gas Cap Replacement Program
- Postponement of Lawn Mowing

### **3.4 Alert Programs**

#### **3.4.1 Air Quality Announcements on Road Signs, Color Coded to Air Quality Index Categories**

The road signs are usually solar powered changeable message signs and recommend that the public "Please Reduce Travel," "Please Car Pool," "Refuel after 7 p.m.," and "Consider Mass Transit," according to the day's forecasted ozone level.

Currently, there are five (four are publicly funded) road signs in the St. Louis area, on I-44, I-55, I-64, and I-70. These road signs are only for air quality information and were funded by CMAQ. Missouri Department of Transportation and the Illinois Department of Transportation operates these road signs. Once the American Lung Association and KMOV Channel 4 in St. Louis provide ozone forecasts, the forecast for the next day is automatically displayed on the road signs to inform to vehicle users and commuters during evening hours, the peak traffic time. In the Chicago area, there are 20 operating expressway signs. These signs are operational during the entire ozone season.

The Maryland Department of the Environment (MDE) forecasts ozone levels for the Baltimore and Washington, D.C. metropolitan area. MDE also gives current ozone levels, which are measured at MDE monitoring sites throughout the state. The information is communicated to outside parties immediately, by fax, throughout the summer ozone season (from May to September). Each day, MDE faxes pre-approved "green," "yellow," "orange," and "red" labeled messages at 4:30 p.m., depending on the level of ozone. If the forecast changes, a subsequent forecast is issued at 11:30 the next morning. The faxes are distributed by computer to local

media. When a violation occurs, an immediate "Notice of Unhealthful Air" is issued and faxed to all parties. These ozone messages are then placed on the overhead highway signs throughout the state.

#### **3.4.2 e-ALERT Real Time Notification**

The e-ALERT notification system is a free service that automatically notifies the public by e-mail, text pager, and/or digital cellular phone any time ozone reaches unhealthy levels in the region. Those who wish to participate simply complete the "Subscribe to e-ALERT" form and then they will be automatically notified of ozone episodes throughout the summer smog season, May through October. The e-ALERTs are issued on days when ozone concentrations reach "Unhealthy for Sensitive Groups," "Unhealthy," or "Very Unhealthy" levels. The e-ALERTs are also sent to notify all subscribers when there is a Spare The Air day.

The e-ALERT notification system is operational seven days a week, 8:00 a.m. - 10:00 p.m. The e-ALERTs are automatically sent to the participants' e-mail address at home or at work, and can also be sent to alpha-numeric text pagers and digital cellular phones that have e-mail addresses. The e-ALERTs are issued whenever a single monitor anywhere in the 24-monitor, multi-county network reaches the notification level you select. The e-ALERTs are not customized to reflect ozone readings in subscribers' specific city or community.

#### **3.4.3 Alerts on Radio Stations, Alerts during Local Weather Reports, Website Notification**

All three of these methods are ways to educate and inform the public about ozone action days and what they can do to help reduce the effects of ozone. Radio advertising has shown to be an effective way to get information out to the public. Television weather reporters have helped this program by announcing ozone action days and alerts during the local weather report. In both the radio and television advertising, the public is informed of a website address to find more information on the topic. These websites can explain the problems caused by ozone, provide up to date alert notices, and provide tips and reminders about what to do on an ozone action day. Websites can also forecast the weather, show movies about how emissions can damage the ozone, and show current pollution levels.

### **3.5 Incentive Programs**

#### **3.5.1 Parking Cash-Out Program**

This program would mandate certain employers who provide subsidized parking for their employees to offer a cash allowance in lieu of a parking space. Parking cash-out programs are not only regulated by state law in California, but also are an option available to employers for compliance with the South Coast Air Quality Management District's Rule 2202 – On-Road Motor Vehicle Mitigation Options. It was enacted in California after studies showed cash allowances in lieu of parking encourage employees to find alternate means of commuting to work, such as public transit, carpooling, vanpooling, bicycling, or walking. Parking cash-out

offers the opportunity to improve air quality and reduce traffic congestion by reducing vehicle trips and emissions.

### **3.5.2 Commuter Bucks**

This is a cash incentive program for using vanpooling. Commuter Bucks give employers an easy way to encourage their employees to vanpool. A provision of the Comprehensive National Energy Policy Act of 1992 enables employers to offer tax-free fringe benefit to employees who vanpool to work. Under federal law, the first \$65 provided to an employee each month for vanpooling purposes is not considered taxable income. Commuter Bucks can be provided to employees as rewards or incentives.

## **3.6 Alternative Programs**

### **3.6.1 Gas Cap Replacement Program**

The greater Cincinnati area, Ohio & Northern Kentucky (OKI) Regional Council of Government reports that their Gas Cap Replacement Program has been successful. Under this new program, Lexington residents (KY) with leaking gas caps could get them tested and replaced for free.

The Urban County Government's Lexington-Bluegrass Mobility Office offered free gas caps to any motorist in the Lexington-Fayette County or Nicholasville-Jessamine County areas who had a leaking or missing gas cap. The offer was first-come, first-served. An estimated 4,000 gas caps were replaced under the program.

Motorists could stop at any designated auto centers for a replacement cap if their caps were missing or for testing to determine if their caps were leaking. The store gave them a free replacement cap if needed (up to \$10 in value). If the store did not have a cap or the motorist did not want to wait for one, the store would give them a coupon for reimbursement for a cap they can purchase later. Users simply mailed in the coupon and the receipt for the gas cap and received a check for up to \$10.

### **3.6.2 Postponement of Lawn Mowing**

Several respondents said that they encourage postponing lawn mowing on specific episode days. While this will not eliminate VOC emissions, it does reduce the overall effects of ozone on high-level ozone days.

Lawn mowers and other lawn and garden equipment that use gasoline engines can cause an increase in VOC emissions. Much like the automobiles in the gas cap replacement program, while one lawn mower may not make a considerable contribution to the production of VOC emissions, the aggregation of lawn and garden equipment use can create high VOC emissions. While postponing the use of lawn and garden equipment is recommended by air quality agencies, it is not easy to quantify the effects of postponing lawn mowing.

## **Chapter 4 Cost-Effectiveness of the Alert Programs**

### **4.1 Measuring Cost-Effectiveness of the Alert Programs**

As mentioned above, the main purpose of alert programs is to provide the public with ozone information. Thus, many efforts have been made to maximize public notification during ozone episode days or seasons. Currently, many states and cities have developed various alert programs such as ozone websites, ozone alerts by e-mail messaging, ozone campaigns on television and radio channels, and announcements on road signs. While each program is different in the way it delivers the information on ozone, they all have the same intention: to increase awareness of ozone formation. The ultimate goal of these alert programs is to help reduce ozone precursor emissions.

Alert programs are very popular among government organizations for two reasons. The first reason is that these programs are cheap to implement. The second reason is that they can be very effective in reducing  $\text{NO}_x$  and VOC emissions. This effectiveness is a relative factor, which is estimated in comparison to the cost of implementing alert programs. Typically, these alert programs have low implementation costs and a relatively high effectiveness.

Even though the alert programs are believed to be effective in informing the public about ozone information during ozone episode days or seasons, it is hard to find an accurate estimate of the beneficial effects of the programs. Although the ultimate goal is reducing ozone emissions in ozone nonattainment areas, the first objective of these alert programs is to deliver ozone information to the general public. The second is to measure the number of people who actually changed their behavior to improve air quality. Thus, the program effect in this case can be measured as the number of people who are informed and who change their behavior because of these programs.

The number of people who change behavior ultimately leads to emission reductions and an improvement in air quality, and effectiveness would be measured by the amount of emission being saved. Thus, the cost-effectiveness of alert programs would be estimated by dollar spent per ton of emission reductions.

#### **4.1.1 Limitations and Assumptions**

It is difficult to determine the actual costs and effects of alert programs because of both theoretical and practical issues. Theoretically, separating the actual costs and effects of alert programs from many other ozone controls in the cost-effectiveness analysis is very difficult, even if not impossible. Thus, marginal effects of alert programs cannot be determined. In

addition, there are practical difficulties such as the limitation of information to conduct sufficient analysis.

In estimating the cost-effectiveness of alert programs, we made the following assumptions.

- 1) For road sign notification programs, all passengers of all vehicles passing the signs receive the ozone information displayed on road signs. For e-ALERT programs, all e-mail messages sent to the subscribers are correctly delivered and read.
- 2) The effectiveness of the alert programs is measured by the number of persons who change their behavior because of the program. The 1999 survey results of "Partners for Clean Air" are used to measure the effects. The survey reports that among those who heard the Ozone Action Day declaration, 56% took ozone-reducing actions. Of those that took ozone-reducing actions, 30% limited their driving or reduced their trips.<sup>25</sup> Since there is no clear definition of "limited driving," we assume that only 20% of trips are curtailed.<sup>26</sup>
- 3) The specific number of announcements and when the announcement is made are not considered. Thus, it is assumed that alert information is given once a day during the overall ozone season.

#### 4.1.2 Framework of the Analysis

The alert programs analyzed are road sign notification programs, electronic notification programs using e-mail messaging, Internet websites, and media such as television and radio. Figure 4-1 illustrates how ozone alerts reach the public. In this figure, the costs for alert programs include the cost of notifying action, the cost of methods to communicate alert, and the initial and maintenance cost for road signs and Internet websites and personnel salary to operate the program. For the measurement of effectiveness, the total cost is divided by either emission amounts (tons) or by the number of people affected.

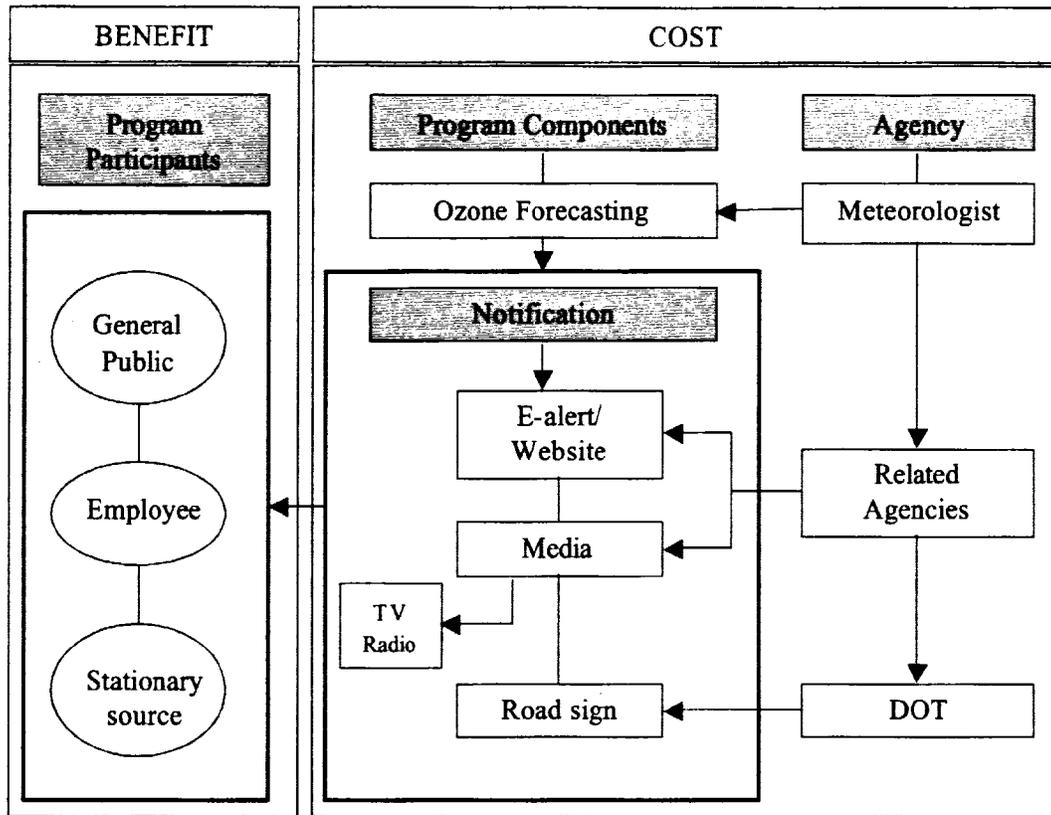
Alert programs using road signs are called visual/sign notification programs. E-mail messages, Internet websites, and media outlets are referred to as electronic/media notification programs. Table 4-1 and Table 4-2 list the data needed to estimate costs and benefits of alert programs.

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<sup>25</sup> IEPA's 1999 survey of the Chicago area residents for Partners for Clean Air Steering Committee as given by e-mail from Mr. Terry Sweitzer dated, July 3, 2001. These figures are drawn by the survey for PFCA for Chicago area. It is assumed that the survey results of the Chicago area will be applicable to the St. Louis area.

<sup>26</sup> Argonne National Laboratory's 1977 study assumed that 10% of those trips were curtailed.

**Figure 4-1. Process by Which Alert Programs Notify the Public**



**Table 4-1. Cost Data Needed for Visual/Sign Notification Programs**

Cost Category		Data
Cost	Initial cost	- Installation cost for road signs - The number of road signs
	Maintenance cost	- The amount of money spent on maintaining the signs during 2000
	Personnel salary	- The number of people doing this work - Annual salary - The portion of work for notification
Benefit	The number of people affected by the signs	- Number of days in ozone season - Number of vehicle trips past the signs per year - Average number of people per vehicle - Percentage of those who changed their behaviors

**Table 4-2. Cost-Benefit Data Needed for Electronic/Media Notification Programs**

	<b>Program</b>	<b>Category</b>	<b>Data</b>
<b>Cost</b>	e-ALERT notification program	Personnel salary	- Number of program operators - Annual salary - Portion of work for notification
	TV	Money spent on TV announcement	- Budget for TV broadcasting
	Radio	Money spent on radio campaign	- Budget for radio broadcasting
	Ozone forecasting on Internet	Initial cost	- Amount of money spent on making website
		Maintenance cost for website	- Money spent on maintaining the website
		Personnel salary	- Number of program operators - Annual salary - The portion of work for notification
<b>Effectiveness</b>	TV	Number of persons affected by the program	- TV rating
	Radio		- Radio rating
	e-ALERT notification program		- Number of e-mail subscribers
	Ozone forecasting on Internet		- Number of website visitors counted

#### 4.2 Cost-Effectiveness Of Visual/Sign Notification Programs

Of the five roadside signs displaying ozone levels in the St. Louis area, one is in East St. Louis, Illinois and the other four are in Missouri.<sup>27</sup> Currently, signs are installed on the highways passing through the St. Louis area such as I-44, I-64, I-55, and I-70. The signs are on outbound lanes and so all vehicle passengers traveling through St. Louis receive information on forecasted ozone levels for the next day and action tips.

In the Chicago area, there are twenty operating expressway signs. These signs are operational during the entire ozone season. Since cost data was not available in the Chicago area, we assume that the unit cost per road sign obtained from the St. Louis area is applicable to the Chicago area.

<sup>27</sup> Among those four road signs located in Missouri, one sign is operated privately. The others are operated by the Missouri Department of Transportation. Thus, we analyzed four road signs in St. Louis area excluding the one privately operated sign.

#### 4.2.1 Notification Cost for Road Signs

As mentioned before, cost information needed for road sign services include the initial construction, maintenance, and personnel wages. Thus, the cost for road sign notification is calculated by summing this data.

Initial costs for each road sign in 1997 were \$21,000. Adjusting the cost for 2000 prices gives a cost of \$22,530.<sup>28</sup> Thus, the initial cost for four road signs would be \$90,124 in 2000 prices.

Operating and maintaining a road sign costs approximately \$1,000. This cost includes labor, equipment usage, and maintenance of the solar batteries. Beside the fixed cost for usual maintenance, there are variable costs involved in operating road signs. In 2000, \$1,100 was spent to replace 16 solar batteries in two signs. Vehicle crashes also incur cost. Damages to signs due to vehicle crashes into two signs in 2000 equated to \$9,000. These costs are not spent annually, but considered a part of operating and maintenance cost. Therefore, in this instance, the maintenance cost for 2000 was \$14,100 for all signs.

Another cost is personnel wages. Programming or switching the daily message takes only a fraction of one worker's time. Currently, on-duty personnel work about 20 to 30 minutes a day out of an 8-hour workday. Hourly payment for this work ranges from \$14/hour (weekday) to \$20/hour (weekend). Table 4-3 shows the calculation for personnel wages for one week.

**Table 4-3. Weekly Personnel Wages for Road Sign Notification Program**

	Payment per hour	Amount paid for 30 min. work per day	Unit wages (one week)	Total wages for one week	Total paid for one year
<b>Weekdays</b>	\$14/hour	\$7	\$35	\$55	\$935 (= \$55*17 weeks <sup>29</sup> )
<b>Weekend</b>	\$20/hour	\$10	\$20		

Currently, the St. Louis area forecasts ozone levels during the 123 days from May 16 to September 15, which is 17 weeks. Based on the above calculation on personnel wages, total personnel wages for ozone season are estimated to be \$935.

Thus, the estimated initial cost for four road signs is \$90,124, the maintenance cost is \$14,100, and the personnel wages are \$935. In total, notification costs for four road signs is \$105,159 in 2000 present value.

<sup>28</sup> According to The Consumer Price Index (CPI), the average change over time in the prices shows an inflation rate of 7.29% from 1997 to 2000. For detailed information, see <http://stats.bls.gov/cpihome.htm>.

<sup>29</sup> The official ozone season in Missouri is from April 1 to October 31, the same as in Illinois. However, ozone forecasting goes from May 16 to September 15. These 123 days represent the key part of the ozone season.

#### 4.2.2 Effectiveness of Road Sign Notification

The measure for effectiveness of road signs is the number of persons who are affected by the sign. Therefore, this effectiveness can be calculated by multiplying the number of vehicles on those highways or expressways and the average number of people per vehicle. In the St. Louis area, the average number of passengers per vehicle, or average vehicle occupancy ratio (VOR), is 1.26 persons.<sup>30</sup> In the Chicago area, the VOR is estimated at 1.24.<sup>31</sup>

Table 4-4 shows the number of vehicle trips per day for those highways in the St. Louis area. The total number of vehicle trips per day on the four highways that installed the road sign is 245,731. Thus, multiplying the VOR of 1.26 by total trips, the number of people who see the road signs is estimated to be 309,621 in St. Louis.

**Table 4-4. The Number of Vehicle Trips per Day Past the Road Signs in St. Louis<sup>32</sup>**

Highway	Number of Vehicles/Day
I-44	43,175
I-64	62,462
I-55	45,773
I-70	94,321
Total	245,731

Table 4-5 shows average daily traffic (ADT) passing the road signs in Chicago area of 2,017,400 trips. Multiplying by the VOR of 1.24, the number of people who see the road signs is estimated to be 2,500,769 in Chicago.

<sup>30</sup> See EWGCC. 1999. *Transportation Redefined II: Building on a Solid Foundation for 2020*.

<sup>31</sup> Hagler Bailly's report applies a VOR of 1.15 for work related vehicle trips and 1.29 for other trips. Based on these figures, overall VOR, which is 1.24, is estimated as weighted average of 36% for work related trips and 64% of other trips.

<sup>32</sup> This information was obtained from MODOT by e-mail.

**Table 4-5. Average Daily Traffic past Expressway Ozone Action Day Signs in the Chicago Area<sup>33</sup>**

Interstate Highway	Average Daily Traffic (ADT)	
	Street name intersected	The number of trips
Kennedy – outbound	Damen	121,100
	Reverse at Webster	121,100
	Canfield	95,600
	Foster	85,400
	Pulaski	128,600
	Reverse at Kimball	111,400
	Augusta	124,700
Eisenhower – inbound	Damen	119,300
Eisenhower – outbound	Post Office	57,300
Dan Ryan – inbound	Taylor	146,500
	River	136,700
	37 <sup>th</sup>	61,000
	57 <sup>th</sup>	100,300
	69 <sup>th</sup>	120,300
Dan Ryan – outbound	Taylor	146,500
Stevenson – inbound	California	61,700
Stevenson – outbound	Martin Luther King Dr.	55,000
Edens – inbound	Niles Center Rd.	83,200
	Tower	60,800
Kingery – outbound	Lorenz	80,900
Total ADT		2,017,400

The number of people estimated to change their behavior because of the road signs in both areas is summarized in the Table 4-6. The number of people estimated to reduce their trips per day in the Chicago area is 280,086. The number of people estimated to reduce their trips per day in the St. Louis area is 34,678.

<sup>33</sup> This information was obtained from IEPA by fax based on 1997 data.

**Table 4-6. The Number of Persons Affected by the Road Signs per Day**

		Number of people informed (I)	Number of people changing behavior (C)	Number of people reducing their trips (R)
Percentage		100%	56 % of I <sup>34</sup>	20% of C <sup>34</sup>
The number of persons per day	Chicago	2,500,769	1,400,431	280,086
	St. Louis	309,621	173,388	34,678

**Table 4-7. Summary of Cost-Effectiveness of Road Signs**

Components			Results	
Cost (Cs)	Chicago		\$466,368	
	St. Louis		\$105,159	
Effectiveness (Es)	Number of persons who reduced trips per day	Chicago	280,086	
		St. Louis	34,678	
	VMT reduced per day	Chicago	2,352,719 miles (VOR=1.24, average trip length=10.4 mile <sup>35</sup> )	
		St. Louis	253,201 miles (VOR=1.26, average trip length=9.2 mile <sup>36</sup> )	
	Emission savings per day <sup>37</sup>	Chicago	VOC	1.68 ton
			NO <sub>x</sub>	3.31 ton
St. Louis		VOC	0.18 ton	
		NO <sub>x</sub>	0.36 ton	
Cost-effectiveness (Es/Cs)	Dollar per person-trip	Chicago	\$2,179 <sup>38</sup> /280,086 = \$0.01/person-trip	
		St. Louis	\$855/34,678 = \$0.02/person-trip	
	Dollar per VMT reduced	Chicago	\$0.0009/mile	
		St. Louis	\$0.0034/mile	
	Dollar per ton of emission saving	Chicago	VOC	\$1,301/ton
			NO <sub>x</sub>	\$659/ton
St. Louis		VOC	\$4,742/ton	
		NO <sub>x</sub>	\$2,403/ton	

<sup>34</sup> See section 4.2.1 above for detailed assumptions.

<sup>35</sup> Dividing total VMT of 178,009,674 by total trips of 17,095,572, average trip length would be 10.4 miles in 2000 in Chicago. This figure is calculated from the raw data on CATS, 2020 TIP Appendix A.

<sup>36</sup> See EWGCC, 1999, Transportation Redefined II: Building on a Solid Foundation for 2020.

<sup>37</sup> We assume 0.712 g/mile for VOC and 1.405 g/mile for NO<sub>x</sub>.

<sup>38</sup> The total cost of \$105,159 was for the period of May 16 to September 15, roughly for 17 weeks.

### **4.2.3 Cost-Effectiveness of Road Sign Notification**

Table 4-7 summarizes the cost-effectiveness of road sign programs. It costs \$0.01 in the Chicago area to reduce one person-trip, and in the St. Louis area, it costs \$0.02 to reduce one person-trip. As a result, \$1,301 and \$659 are needed to reduce one ton of VOC and NO<sub>x</sub>, respectively, in the Chicago area and \$4,742 and \$2,403 in the St. Louis area.

## **4.3 Cost-Effectiveness of Media/Electronic Notification Programs**

Three types of media notification programs are analyzed in this report: e-mail alerts, Internet websites, and mass media. Among them, e-mail and Internet websites are usually low cost options but they also have a low amount of usage. On the other hand, while media such as television and radio will have stronger influence on the public, they have much higher costs, for advertising or television and radio announcements.

The e-mail and Internet website options require only the management of the website and e-mail addresses by a small number of staff. The effectiveness is difficult to determine since the benefits of these programs are not easily measured and the information on the users/beneficiaries is not easily identified. The method used here is the same as the method for road sign notification programs.

### **4.3.1 E-ALERT Notification Program**

E-ALERT notification programs inform the public of ozone levels via fast and friendly e-mail messages. Many agencies across the nation use this type of program because it is easy to implement and is low cost. However, the effects of this program have not been reported because of the reasons mentioned above. As a measure to estimate the cost-effectiveness of an e-ALERT program, we use the number of persons who get information on e-alerts. Thus, the measure would be the number of e-ALERT subscribers.

Currently, 250 individuals and 300 companies are registered as e-ALERT subscribers by SLRCAP in the St. Louis area. With company subscribers, a company representative forwards the alert to all employees. Therefore, summing the number of individuals and employees increases the total number of people who get e-ALERT. However, since there is limited information on the number of employees per establishment, it is assumed that an establishment employs an average of 100 people. Thus, the total number of e-ALERT subscribers assumed for the St. Louis area is 30,250.<sup>39</sup> In Chicago, we used the 1998 Partners for Clean Air Survey results and assumed the number of e-mail subscribers to be the 202,647 employees who received ozone action day alerts from the Partners for Clean Air. In addition, we assume the same number of individual subscribers as in St. Louis area, i.e., 250 individuals. Thus, the total number of e-ALERT subscribers for the Chicago area is estimated to be 202,897.

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<sup>39</sup> (300 companies x 100) + 250 individual subscribers

Table 4-8 shows how the number of people who reduced trips due to the e-ALERT programs is calculated. A total of 22,724 people in the Chicago area and 3,388 people in the St. Louis area are estimated to have reduced trips per day due to the e-ALERT programs.

**Table 4-8. The Number of Persons Affected by the e-ALERT Program per Day**

		Number of persons who are informed (I)	Number of persons who changed behavior (C)	Number of persons who reduced trips (R)
<b>Percentage</b>		100%	56% of I	20% of C
<b>Number of persons per day</b>	<b>Chicago</b>	202,897	113,622	22,724
	<b>St. Louis</b>	30,250	16,940	3,388

On the other hand, notification costs consist of just personnel salary. In fact, this program does not require any additional computer equipment and a very small amount for operating the computers is needed. Thus, we assume that the measure for notification cost includes only the salary of persons who are in charge of this e-ALERT notification programs.

Currently, 2.5 persons are employed for the work in the St. Louis area, spending less than 10% of daily workload. The average salary was assumed to be \$ 20,000 per year.<sup>40</sup> Considering all those factors, the e-ALERT program in St. Louis spends a total of \$5,000 per year for personnel salary.<sup>41</sup>

As shown in Table 4-9, the cost-effectiveness for the e-ALERT notification program in the Chicago area is estimated to be \$0.02 per person. That is, for each person who reduced trips, \$0.02 was spent and for each VMT reduced, \$0.0021 was spent. To reduce one ton of VOC, the Chicago area needs to spend \$3,066. To reduce one ton of NO<sub>x</sub>, the area needs to spend \$1,554. For the St. Louis area, the cost-effectiveness for the e-ALERT notification program is estimated to be \$0.30 per person. That is, for each person who reduced trips, \$0.30 was spent and for each VMT reduced, \$0.04 was spent. In the St. Louis area, \$56,775 is needed to reduce one ton of VOC and \$28,772 to reduce one ton of NO<sub>x</sub>.

<sup>40</sup> The personnel cost data were provided by the American Lung Association of Eastern Missouri.

<sup>41</sup> We assume that the e-ALERT cost for Chicago area is same as that of the St. Louis area.

**Table 4-9. Summary of Cost-Effectiveness of e-ALERT Program**

Components			Results	
Cost (Ce)	Total personnel salary <sup>42</sup>		\$5,000	
Effectiveness (Ee)	Number of persons who reduced trips per day	Chicago	22,724	
		St. Louis	3,388	
	VMT reduced per day <sup>43</sup>	Chicago	190,885 miles	
		St. Louis	24,738 miles	
	Emission savings per day <sup>44</sup>	Chicago	VOC	0.14 ton
			NO <sub>x</sub>	0.27 ton
		St. Louis	VOC	0.02 ton
NO <sub>x</sub>			0.03 ton	
Cost-effectiveness (Ee/Ce)	Dollar per person-trip <sup>45</sup>	Chicago	$\$417/22,724 = \$0.02/\text{person-trip}$	
		St. Louis	$\$1,000/3,388 = \$0.30/\text{person-trip}$	
	Dollar per VMT reduced	Chicago	\$0.0022/mile	
		St. Louis	\$0.04/mile	
	Dollar per ton of emission saving	Chicago	VOC	\$3,066/ton
			NO <sub>x</sub>	\$1,554/ton
		St. Louis	VOC	\$56,775/ton
NO <sub>x</sub>			\$28,772/ton	

#### 4.3.2 Ozone Website Notification Program

Internet websites are frequently used to provide people with general ozone information and ozone forecasting, including ozone episode days and related action tips. An Internet website can be classified as a passive notification program, because it depends on the voluntary visits of Internet users. However, this is a useful way to deliver information for year-around, seasonal, and episodic days. Considering the tremendous numbers of Internet users, this program could have high effectiveness in comparison to the cost of implementation.

<sup>42</sup> The cost and effectiveness were assumed to occur during the ozone orange days in St. Louis reported by the St. Louis Partners for Clean Air; see [www.cleanair-stlouis.com/2000data.htm](http://www.cleanair-stlouis.com/2000data.htm). The forecasted number of orange days in 2000 was 5. For the Chicago area, 12 ozone action days would be expected during a summer season with average weather conditions, as was reported in "PARTNERS News" in Winter 2000.

<sup>43</sup> We assumed as before that St. Louis has a VOR of 1.26, and an average trip length of 9.2 miles. In Chicago, the VOR was 1.24, and the average trip length was 10.4 miles.

<sup>44</sup> We assume 0.712 g/mile for VOC and 1.405 g/mile for NO<sub>x</sub>.

<sup>45</sup> The total cost of \$ 5,000 was divided by 12 days for Chicago area and 5 days for St. Louis area to obtain per day cost.

Generally, the structure of cost spent is similar to road sign notification, even though this program uses an electronic device, similar to the e-ALERT programs. Internet website notification programs include the initial cost to construct the homepage, operation and maintenance costs to manage the website, and personnel salary.

The effectiveness of this program is assessed in a similar way to e-ALERT programs. That is, the measure for effectiveness would be the number of ozone website visitors. For this measure, we use the counted number of visitors to the website. Of course, this number includes duplicate numbers of visits by one person. Because of the limitation on the information, it is assumed that the counted number as visitors on the website reflects the number of visitors. The number of website visitors in the Chicago area is estimated to be 106,145 per year (See Table 4-10). In 2000, the number of website visitors in St. Louis was estimated at 10,000. The number of persons who reduced trips would be 11,888 persons per year in Chicago area and 1,120 persons per year in St. Louis area, as shown in Table 4-11.

**Table 4-10. Usage Statistics for Partners for Clean Air Website <sup>46</sup>**

<b>Month</b>	<b>Daily average number of hits</b>	<b>Monthly total number of hits</b>
October 2000	153	4,754
November 2000	132	3,709
December 2000	142	4,416
January 2001	140	4,343
February 2001	208	5,824
March 2001	214	6,661
April 2001	214	6,428
May 2001	281	8,716
June 2001	477	14,314
July 2001	460	14,269
August 2001	491	15,249
September 2001	698	17,462
<b>Total</b>		<b>106,145</b>

<sup>46</sup> This information was received from Terry Sweitzer of the Illinois Environmental Protection Agency.

**Table 4-11. Number of Persons Affected by Internet Website Notification Program**

		Number of persons informed (I)	Number of persons who changed behavior (C)	Number of persons who reduced trips (R)
<b>Percentage</b>		100%	56% of I	20% of C
<b>Number of persons per year</b>	<b>Chicago</b>	106,145	59,441	11,888
	<b>St. Louis</b>	10,000	5,600	1,120
<b>Number of persons per day</b>	<b>Chicago</b>	290.8	162.9	32.6
	<b>St. Louis</b>	27.3	15.3	3.1

**Table 4-12. Summary of Cost-Effectiveness for Internet Website Notification Program**

Components			Results	
Cost (Cw)	Personnel salary		\$5,000	
	Operating and initial costs		\$2,000	
	Total Cost		\$7,000	
Effectiveness (Ew)	The number of persons who reduced per day <sup>47</sup>	Chicago	32.6	
		St. Louis	3.1	
	VMT reduced per day <sup>48</sup>	Chicago	274 miles	
		St. Louis	22 miles	
	Emission savings <sup>49</sup> per day	Chicago	VOC	0.00020 ton
			NO <sub>x</sub>	0.00038 ton
St. Louis		VOC	0.00002 ton	
		NO <sub>x</sub>	0.00003 ton	
Cost-effectiveness (Ew/Cw)	Dollar per person who reduced trips	Chicago	\$0.59/person-trip	
		St. Louis	\$6.25/person-trip	
	Dollar per VMT reduced	Chicago	\$0.07/mile	
		St. Louis	\$0.86/mile	
	Dollar per ton of emission saving	Chicago	VOC	\$98,451/ton
			NO <sub>x</sub>	\$49,891/ton
St. Louis		VOC	\$1,202,217/ton	
		NO <sub>x</sub>	\$609,237/ton	

<sup>47</sup> See Table 4-11.

<sup>48</sup> We assumed as before that St. Louis has a VOR of 1.26, and an average trip length of 9.2 miles. In Chicago, the VOR=1.24, and the average trip length=10.4. Thus, for Chicago,  $3.1 \times 10.4/1.24=26$  and for St. Louis,  $3.1 \times 9.2/1.26=22$ .

<sup>49</sup> We assume 0.712 g/mile for VOC and 1.405 g/mile for NO<sub>x</sub>.

In St. Louis, the cost of creating and maintaining the website is approximately \$2,000 per year.<sup>50</sup> Personnel salary is equivalent to that of the e-ALERT program. These figures consist of the notification cost for Internet website notification program. We assume the same cost for web site as the Chicago area.

Table 4-12 summarizes the results of the analysis. To reduce the trips of one person, the Chicago area needs to spend \$0.59 for the Internet website notification program. The St. Louis area must spend \$6.25 for one person to reduce trips. Thus, the Chicago area needs to spend \$98,451 to reduce one ton of VOC and \$49,891 to reduce one ton of NO<sub>x</sub>. In the St. Louis area, \$1,202,217 is needed to reduce on ton of VOC and \$609,237 to reduce one ton of NO<sub>x</sub>.

### 4.3.3 Radio Notification Programs

As mentioned earlier, the cost of radio notification programs can be estimated as the yearly budget spent on the radio campaign or notification program. The total cost of broadcasting on the radio in Chicago area was \$396,740 for 1,712 radio spots. Table 4-13 summarizes the total cost and costs per the station for 2000.<sup>51</sup>

**Table 4-13. Cost Spent on Radio Broadcasting in 2000 in Chicago Area**

Station	Spot	Cost	CPP	GRP
WBBM-AM	384	\$80,340	\$250.75	320.4
WCKG-FM	190	\$45,750	\$431.60	106.0
WGN-AM	68	\$17,800	\$136.09	130.8
WLEY-FM	234	\$36,660	\$324.14	113.1
WLIT-FM	74	\$15,050	\$236.64	63.6
WNUA-FM	200	\$50,500	\$309.82	163.0
WTMX-FM	208	\$55,000	\$324.68	169.4
WVAZ-FM	240	\$66,600	\$346.88	192.0
WXRT-FM	114	\$29,040	\$484.00	60.0
<b>Average</b>	<b>1712</b>	<b>\$396,740</b>	<b>\$300.95</b>	<b>1,318.3</b>

Source: Partners for Clean Air: Northeastern Illinois. 2000. 2000 Clean Air Education and Outreach Campaign

Effectiveness for radio can be measured by the radio station rating. Table 4-13 shows the key terms for the number of listeners. As shown in the table, average cost per rating point (CPP)<sup>52</sup> is \$300.95 and gross rating percentage (GRP) for all spots is 1318.3. GRP is the most frequently

<sup>50</sup> Costs in St. Louis area would be far less than general market price. They lowered the initial and maintenance costs through volunteer participation. Thus, the general cost of initial and operation costs for website would be higher than the costs analyzed here. However, this St. Louis case shows that it is possible to lower the costs for this program.

<sup>51</sup> We assume the same radio broadcasting cost for the St. Louis area.

<sup>52</sup> CPP is the cost to deliver a single rating point and drawn by the next equations:  $CPP = (\text{Average Unit Cost} \cdot \text{Rating } \%)$  or  $(\text{Total Schedule Cost} \cdot \text{GRPs})$ . For more information, see Nielsen Media Research. 1998. Report on Television. p.49.

used term for related markets to measure radio ratings. This gross percentage can draw the total number of listeners by dividing one single rating number of persons. Single rating means the 1% of target audience. Target audiences for radio stations are usually the demographics of people 18 years of age or older. Currently, this target population for Chicago area is 6,684,900.<sup>53</sup> This is the total adult population for Chicago area. Based on this GRP, the total number of listening of radio listeners can be estimated. As assumed earlier, we apply the same CPP and GRP to the St. Louis area. Target audience for the St. Louis area would be 2,197,100 in 2000.<sup>54</sup>

Here, CPP means that \$300.95 was spent to reach the 1% of target audience. Thus, the number of persons who listen to the radio per dollar can be calculated. Overall, \$1 reaches 222 people in the Chicago area, as shown in Table 4-14, and 73 people in St. Louis.<sup>55</sup>

**Table 4-14. Radio Campaign Cost and Rating Summary in Chicago Area**

Station	Chicago	
	Audience <sup>56</sup>	Persons per dollar
<b>WBBM-AM</b>	21,418,420	267
<b>WCKG-FM</b>	7,085,994	155
<b>WGN-AM</b>	8,743,849	491
<b>WLEY-FM</b>	7,560,622	206
<b>WLIT-FM</b>	4,251,596	282
<b>WNUA-FM</b>	10,896,387	216
<b>WTMX-FM</b>	11,324,221	206
<b>WVAZ-FM</b>	12,835,008	193
<b>WXRT-FM</b>	4,010,940	138
<b>Average</b>	88,127,037	222

Source: Partners for Clean Air: Northeastern Illinois. (2000). 2000 Clean Air Education and Outreach Campaign, and estimated by the research team.

Since the total Chicago audience of 88,127,037 is the gross number for the entire 270-day campaign period,<sup>57</sup> the number of listeners for one day can be estimated. A total audience of 36,556 people per day was affected by the radio notification program in the Chicago area and an audience of 12,015 people per day would be affected in the St. Louis area as shown in Table 4-15.

<sup>53</sup> See Standard Rate and Data Service. Winter 2001. SRDS TV & Cable Source. p. 189.

<sup>54</sup> See Standard Rate and Data Service. Winter 2001. SRDS TV & Cable Source. p. 883.

<sup>55</sup> By the same calculation, a total of 28,946,369 listeners and 73 reached persons per dollar were assumed by the reasoning that the St. Louis area will have the same cost as the Chicago area.

<sup>56</sup> The number of audience represents the gross number for the entire campaign period.

<sup>57</sup> Cost and audience data for radio programs were provided by Partners for Clean Air. The total audience for radio was collected from January 17 to October 15, 2000, for 270 days.

**Table 4-15. The number of people affected by radio notification program**

		Number of audience that are informed (I)	Number of audience that changed behavior (C)	Number of audience that reduced trips (R)
<b>Percentage</b>		100%	56% of I	20% of C
<b>Audience per day</b>	<b>Chicago</b>	326,396	182,782	36,556
	<b>St. Louis</b>	107,275	60,074	12,015

**Table 4-16. Summary of Cost-Effectiveness for Radio Notification Program**

Components				Results	
Cost (Cr)	Budget for radio broadcasting <sup>58</sup>			\$396,740	
Effectiveness (Er)	The number of Audience who changed their behavior per day	Chicago	36,556		
		St. Louis	12,015		
	VMT reduced per day <sup>59</sup>	Chicago	307,073 miles		
		St. Louis	87,727 miles		
	Emission savings per <sup>60</sup> per day	Chicago	VOC	0.22 ton	
			NO <sub>x</sub>	0.43 ton	
St. Louis		VOC	0.06 ton		
		NO <sub>x</sub>	0.12 ton		
Cost-effectiveness (Er/Cr)	Dollar per person who reduced trips	Chicago	\$0.04/person-trip		
		St. Louis	\$0.12/person-trip		
	Dollar per VMT reduced	Chicago	\$0.0047/person		
		St. Louis	\$0.0168/person		
	Dollar per one ton of emission saving	Chicago	VOC	\$6,721/ton	
			NO <sub>x</sub>	\$3,406/ton	
St. Louis		VOC	\$23,525/ton		
		NO <sub>x</sub>	\$11,921/ton		

The emission reduction is summarized in Table 4-16. To reduce the trips of one person, Chicago must spend \$0.04 for the radio notification program in Chicago. The St. Louis area must spend

<sup>58</sup> The total cost was for the period of January 17 to October 15, 2000, as provided by Partners for Clean Air.

<sup>59</sup> We assumed as before that St. Louis has a VOR of 1.26, and an average trip length of 9.2 miles. In Chicago, the VOR=1.24, and the average trip length=10.4.

<sup>60</sup> We assume 0.712 g/mile for VOC and 1.405 g/mile for NO<sub>x</sub>.

\$0.12 to get the same reduction. The corresponding emission reduction is 0.000149 ton per dollar for VOC and 0.000294 ton per dollar for NO<sub>x</sub> in Chicago. In St. Louis, the emission reduction was 0.000043 ton per dollar for VOC and 0.000084 ton per dollar for NO<sub>x</sub>. Thus, the Chicago area needs \$6,721 to reduce one ton of VOC and \$3,406 to reduce one ton of NO<sub>x</sub>. In the St. Louis area, \$23,525 is needed to reduce one ton of VOC and \$11,921 is needed to reduce one ton of NO<sub>x</sub>.

#### 4.3.4 Television Notification Programs

Television is the most effective media type to deliver information. Currently, KMOV Channel 4 uses to notify people of ozone forecasting in St. Louis area.<sup>61</sup> This information is announced four times per day, at noon, 5:00 p.m., 6:00 p.m., and 10:00 p.m. For the cost for this broadcasting, the airtime is donated. This makes it difficult to track the cost for television announcements. Thus, an average rate is applied. Table 4-17 shows the average CPP and the broadcasting cost for a 10-second announcement in the Chicago and St. Louis areas. It is assumed that the airtime per each announcement would be 10 seconds.

**Table 4-17. The Average CPP for TV<sup>62</sup>**

Time of news	Central Time	Average CPP		Cost for 10 seconds	
		Chicago	St. Louis	Chicago	St. Louis
Day	8:00 a.m. to 3:00 p.m.	\$220	\$55	\$110	\$27.50
Early news	5:00 p.m. to 6:00 p.m.	\$372	\$81	\$186	\$40.50
Prime access	6:00 p.m. to 7:00 p.m.	\$518	\$124	\$259	\$62.00
Late news	10:00 p.m. to 10:30 p.m.	\$820	\$164	\$410	\$82.00
Total	-	-	-	\$965	\$212.00

To measure the effectiveness, television ratings are needed to estimate the audience who watches certain television stations. We assume the gross rating for four announcements as 20%.<sup>63</sup> Thus, the number of people who are informed to television notification is calculated by multiplying 20 rating points by 1% of the target audience, which would be 66,849 for Chicago and 21,971 for St. Louis (see the Table 4-18). On the other hand, costs per day for television notification can be figured by multiplying the same rating by the CPP. Thus, the cost for the Chicago area is \$231,600 for 12 alert days, or \$19,300 per day. For the St. Louis area, the cost would be \$21,200 for 5 forecasted alert days, or \$4,240 per day.

<sup>61</sup> The other four local channels in the St. Louis area broadcast ozone forecasting information when they see fit.

<sup>62</sup> These figures are calculated on the basis of information gained from this Standard Rate & Data Service. 2001. TV & Cable Source. Wilmette, IL.

<sup>63</sup> Nielsen Media Research reports the top 20 ratings for week of June 18 to June 24, 2001, in <http://tv.yahoo.com/nielsen/>. Dateline News Program at 10:00 p.m. of NBC is ranked in top 20 programs, with a 6.9 rating. Based on this information, we assume the average rating for news program to be 5%, and the gross rating for four announcements to be 20%.

**Table 4-18. The Number of People who are Affected by Television Notification Programs**

		Number of persons informed (I)	Number of persons who changed behavior (C)	Number of persons who reduced trips (R)
<b>Percentage</b>		100%	56% of I	20% of C
<b>Number of persons per day</b>	<b>Chicago</b>	1,136,980	748,709	149,742
	<b>St. Louis</b>	439,420	246,075	49,215

**Table 4-19. Summary of Cost-Effectiveness for Television Notification Programs**

Components			Results	
Cost (Ct)	Television broadcasting cost <sup>64</sup>	Chicago	\$231,600 for 12 alert days	
		St. Louis	\$21,200 for 5 alert days	
Effectiveness (Et)	Number of audience who changed their trips per day	Chicago	149,742 persons per day	
		St. Louis	49,215 persons per day	
	VMT reduced per day <sup>65</sup>	Chicago	1,257,828 miles per day	
		St. Louis	359,348 miles per day	
	Emission savings per day <sup>66</sup>	Chicago	VOC	0.90 ton
			NO <sub>x</sub>	1.77 ton
St. Louis		VOC	0.26 ton	
		NO <sub>x</sub>	0.50 ton	
Cost-effectiveness (Et/Ct)	Dollar per person who reduced trips	Chicago	\$0.13/person-trip	
		St. Louis	\$0.09/person-trip	
	Dollar per VMT reduced	Chicago	\$0.02/mile	
		St. Louis	\$0.01/mile	
	Dollar per one ton of emission saving	Chicago	VOC	\$21,550/ton
			NO <sub>x</sub>	\$10,921/ton
		St. Louis	VOC	\$16,572/ton
			NO <sub>x</sub>	\$8,398/ton

<sup>64</sup> As assumed earlier, cost can be calculated by multiplying 20 rating point, CPP for single rating point, and the number of alert days.

<sup>65</sup> We assumed as before that St. Louis has a VOR of 1.26, and an average trip length of 9.2 miles. In Chicago, the VOR=1.24, and the average trip length=10.4.

<sup>66</sup> We assume 0.712 g/mile for VOC and 1.405 g/mile for NO<sub>x</sub>.

This reduction also leads to the emission savings. Table 4-19 presents the results and emission savings. The Chicago area needs to spend \$21,550 to reduce one ton of VOC and \$10,921 to reduce one ton of NO<sub>x</sub>. The St. Louis area needs to spend \$16,572 to reduce one ton of VOC and \$8,398 to reduce one ton of NO<sub>x</sub>.

#### 4.4 Summary Of Cost-Effectiveness Of Alert Programs

**Table 4-20. Summary of Cost-Effectiveness of Alert Programs**

Programs	Area	Cost		Effectiveness			Cost-Effectiveness	
		Period (days)	Dollar	Affected persons per day	VMT reduced per day	Reduced emission (ton/day) VOC (NO <sub>x</sub> )	Dollar per affected person	Reduced emission (\$/ton) VOC (NO <sub>x</sub> )
Road sign notification program	Chicago	214	\$466,368	280,086	2,352,179	1.68 (3.31)	0.01	1,301 (659)
	St. Louis	123	\$105,159	34,678	253,201	0.18 (0.36)	0.02	4,742 (2,403)
E-ALERT notification program	Chicago	12 alerts	\$5,000	22,724	190,885	0.14 (0.27)	0.02	3,066 (1,554)
	St. Louis	5 alerts	\$5,000	3,388	24,738	0.02 (0.03)	0.3	56,775 (28,772)
Website notification program	Chicago	365	\$7,000	32.6	274	0.00020 (0.00038)	0.59	98,451 (49,891)
	St. Louis		\$7,000	3.1	22	0.00002 (0.00003)	6.25	1,202,217 (609,237)
Radio notification program	Chicago	270	\$396,740	36,556	307,073	0.22 (0.43)	0.04	6,721 (3,406)
	St. Louis		\$396,740	12,015	87,727	0.06 (0.12)	0.12	23,525 (11,921)
Television notification program	Chicago	12 alerts	\$231,600	149,742	1,257,828	0.90 (1.77)	0.13	21,550 (10,921)
	St. Louis	5 alerts	\$21,200	49,215	359,348	0.26 (0.50)	0.09 <sup>67</sup>	16,572 <sup>68</sup> (8,398) <sup>69</sup>

<sup>67</sup> See section 4.3.4 Television Notification Programs for detailed explanation.

<sup>68</sup> See section 4.3.4 Television Notification Programs for detailed explanation.

<sup>69</sup> See section 4.3.4 Television Notification Programs for detailed explanation.

The results, which are summarized on Table 4-20, indicate that it is important to make it easy to access ozone information for a notification program to be effective. Television and radio notification programs, which reach people easily, show the highest effectiveness per day. These programs can deliver information to more people. Also, road sign notification programs show relatively high effectiveness because they involve highways, which have many users. Considering the cost, the road sign notification program shows the highest cost-effectiveness because of the relative low cost of implementation. Although television and radio notification programs have high effectiveness, relatively high broadcasting costs for the programs make the cost-effectiveness lower than that of the road sign notification programs. The e-ALERT notification program, despite the relatively small numbers of e-ALERT subscribers, is effective because of low implementation costs.

## Chapter 5 Cost-Effectiveness of Incentive Programs

### 5.1 Measuring the Effectiveness of Incentive Programs

The incentive programs evaluated in this chapter are the Parking Cash-Out and the Commuter Bucks programs. For both programs, we assume that employers provide a cash allowance to employees in lieu of a parking space or a cash incentive for using vanpooling. One possible means of estimating the effectiveness of the programs is to survey those who have actually been exposed to the programs. Another possible method is to ask people hypothetical questions such as “Would you take mass transit if your employer paid you \$1.00 in lieu of parking?” or “Would you be willing to vanpool, if your employer paid you \$1.00 for not driving alone?”

Rather than performing a hypothetical survey, we took a different approach: we assumed that the amount received makes employees more attracted to mass transit and vanpooling and less attracted to automobiles. We quantified this by assuming that the amount paid by the employer, say \$1.00, would have the same effect as reducing the cost of using mass transit by \$1.00 or increasing the cost of driving an automobile by \$1.00. Based on these assumptions, we used pivot point analysis to estimate the percentage of users shifted from automobile to non-automobile modes, based on the amount paid by the employer for both incentive programs.

### 5.2 Pivot Point Analysis

The pivot point analysis evaluates episodic emission control options for mobile sources, focusing on highway vehicle travel. Total transportation sector emissions are primarily the product of six variables: emissions per mile,<sup>70</sup> evaporative emissions,<sup>71</sup> vehicle miles traveled (VMT), vehicular speed, engine temperature, and number of vehicle trips (Kim and Hoskote 1983). Although policies to reduce mobile source emissions can target any combination of these variables, episodic and seasonal policies usually focus on the two components of actual travel: VMT and number of trips.

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<sup>70</sup> Vehicle emission rates (emissions per mile) are the product of many different variables. Tailpipe emissions vary according to the age, make, and model of the vehicle; the speed of the vehicle; the temperature of the engine and atmosphere; the state of repair and tuning of the engine; the components of the fuel; and the quality and effectiveness of emission control devices installed in the engine and exhaust system.

<sup>71</sup> Evaporative emissions come from the fuel system whether the vehicle is running or not, and include running, diurnal, and hot-soak losses. Evaporative emissions vary with the volatility and composition of the fuel, the effectiveness of the emission control devices on the fuel storage and distribution system, fuel temperature, and atmospheric conditions. All of these are fixed in the short run, and so are not amenable to episodic control, with two exceptions. First, fueling a vehicle releases some fuel vapor into the air, even with new nozzles. Postponing fueling reduces this release; multiplied by several million cars, the effect can be helpful. Second, “topping off” the fuel tank reduces the amount of space in the tank for vapor, and can increase vapor releases.

This section discusses the methodology of the pivot point analysis. We provide details of the data, equations, and modeling assumptions used in the pivot point model for analyzing the impacts of the proposed incentive programs. The pivot point model is designed to estimate commuter responsiveness to changes in the costs of two modes of transportation: private vehicle use and public transportation. As noted above, the changes in commuter responsiveness are assumed to be reflected by changes in costs of a mode. Thus, the pivot point model was used to determine changes in probabilities of choosing a particular mode due to changes in the cost of another mode. We developed this model based on the CATS (Chicago Area Transportation Study) mode choice model and EWGCC (East West Gateway Coordinating Council) mode choice model. The model is designed to determine the effect of incentive programs such as a Parking Cash-Out Program and Commuter Bucks on trips taken and vehicle miles traveled in the Greater Chicago Metropolitan Area (GCMA) and the St. Louis Metropolitan Area (SLMA) (see Table 5-1).

**Table 5-1. Episodic Incentive Program Scenario**

Type of Strategy	Study Area	Scenario Number*	Incentive
Incentive Programs	Greater Chicago Metropolitan Area	C1	\$1.00 for inner city, \$0.75 for outer city, and \$0.50 for sub urban
		C2	\$1.00 incentives
	St. Louis Metropolitan Area	S1	\$1.00 for inner city, \$0.75 for outer city, and \$0.50 for sub urban
		S2	\$1.00 incentives

\* Each scenario has two sub-scenarios corresponding to a certain year: GCMA (1999 and 2007) SLMA (2000 and 2020)

The trip tables produced by the model show the shift of person trips from the automobile to transit modes, induced by the increase in driving costs and/or decrease in transit costs imposed by each scenario. CATS and EWGCC provided the necessary data to run the pivot point analysis.

### 5.3 Raw Data

#### 5.3.1 Data from CATS

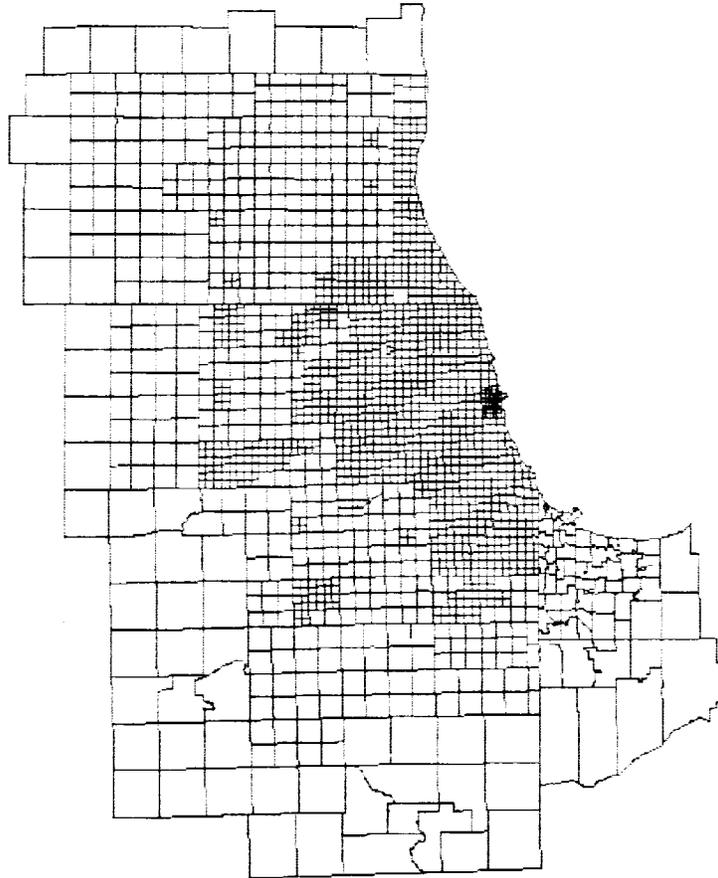
CATS provided the research team with the following raw data:

- 1) Arc/Info coverage for traffic analysis zone (TAZ) map as shown in Map 5-1,
- 2) Trip tables for 1999 and 2007 covering 1778 by 1778 zones,
- 3) Mode choice coefficients related to the cost of either driving or riding transit as shown in Table 5-2,
- 4) VOR as shown in Table 5-3, and
- 5) Total VMT as shown in Table 5-4,

Detailed descriptions on the data include:

1. TAZ map - ArcInfo Coverage (see Map 5-1)

**Map 5-1. CATS Transportation Analysis Zones (1778 zones)**



2. 12 trip tables from CATS: 1999 and 2007 tables for 1778 by 1778 zones.

The 12 trip tables are:

- 1) 1999 Home Based Work Auto Person Trip
- 2) 1999 Home Based Other Auto Person Trip
- 3) 1999 Non-Home Based Auto Person Trip
- 4) 1999 Home Based Work Transit Person Trip
- 5) 1999 Home Based Other Transit Person Trip
- 6) 1999 Non-Home Based Transit Person Trip
- 7) 2007 EAI Home Based Work Auto Person Trip
- 8) 2007 EAI Home Based Other Auto Person Trip
- 9) 2007 EAI Non-Home Based Auto Person Trip
- 10) 2007 EAI Home Based Work Transit Person Trip
- 11) 2007 EAI Home Based Other Transit Person Trip
- 12) 2007 EAI Non-Home Based Transit Person Trip

\* EAI: Existing Airport Improvement

3. Table 5-2 shows mode choice coefficients that are related to the cost of either driving an automobile or riding transit.

**Table 5-2. Mode Choice Coefficients by CATS<sup>72</sup>**

Value	Purpose
0.0072	For work related and for non-CBD destination
0.0085	For work related and for CBD
0.0329	For nonwork related

4. Table 5-3 shows VOR for different purposes.

**Table 5-3. Vehicle Occupancy Rate (VOR) by CATS**

VOR	Purpose
1.15	For work related
1.29	For other

5. Table 5-4 shows total vehicle miles traveled,<sup>73</sup> by year.

**Table 5-4. Total Vehicle Miles Traveled (VMT) by CATS**

Year	VMT (miles)
2000	178,009,774
2007	195,641,955

### 5.3.2 Data from EWGCC

EWGCC shared the following data with the research team:

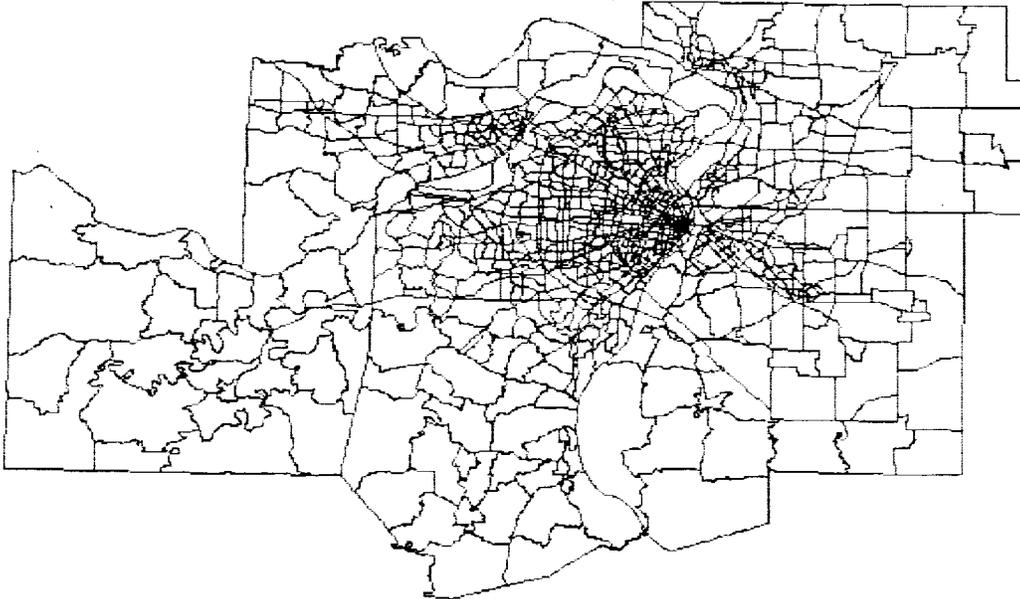
- 1) TAZ map (ESRI ArcView Shape File) as shown in Map 5-2.
- 2) The 1999 and 2007 trip tables for 1109 by 1109 zones (Zones 1067-1109 are used for analysis of external trips only),
- 3) Transit Share data as shown in Table 5-5,
- 4) Transit Network (Bus and MetroLink) as shown in Map 5-3 and Map 5-4,
- 5) Mode choice coefficients related to the cost of either driving or riding transit as shown in Table 5-6,
- 6) Vehicle Occupancy Rates (VORs) as shown in Table 5-7, and
- 7) Projected Average Summer Weekday Vehicle Miles Traveled (VMT) as shown in Table 5-8.

<sup>72</sup> Chicago Area Transportation Study (November 1997), 2020 Regional Transportation Plan: Transportation Improvement Program for Northeastern Illinois -Appendix B. Chicago, IL: 66

<sup>73</sup> Chicago Area Transportation Study (November 1997), 2020 Regional Transportation Plan: Transportation Improvement Program for Northeastern Illinois -Appendix A. Chicago, IL: C-32, D-25

1. TAZ map - ESRI ArcView Shape File (Map 5-2)

**Map 5-2. EWGCC Transportation Analysis Zone (1066 Zones)**



2. 6 trip tables from EWGCC: 2000 and 2020 tables for 1109 by 1109 zones (Zones 1067-1109 are used for analysis of external trips only)

The 6 trip tables are:

- 1) 2000 Home Based Work Total Person Trip
- 2) 2000 Home Based Other Total Person Trip
  - a. Home based shop trips
  - b. Home based drop passenger/school trips
  - c. Other home based trips
- 3) 2000 Non-Home Based Total Person Trip
- 4) 2020 Home Based Work Auto Person Trip
- 5) 2020 Home Based Other Auto Person Trip
  - a. Home based shop trips
  - b. Home based drop passenger/school trips
  - c. Other home based trips
- 6) 2020 Non-Home Based Auto Person Trip

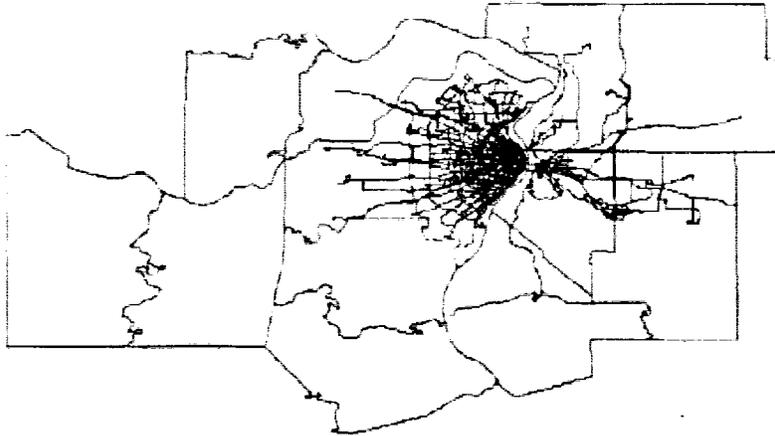
3. Transit share data is shown in Table 5-5.

**Table 5-5. Overall Transit Share by EWGCC**

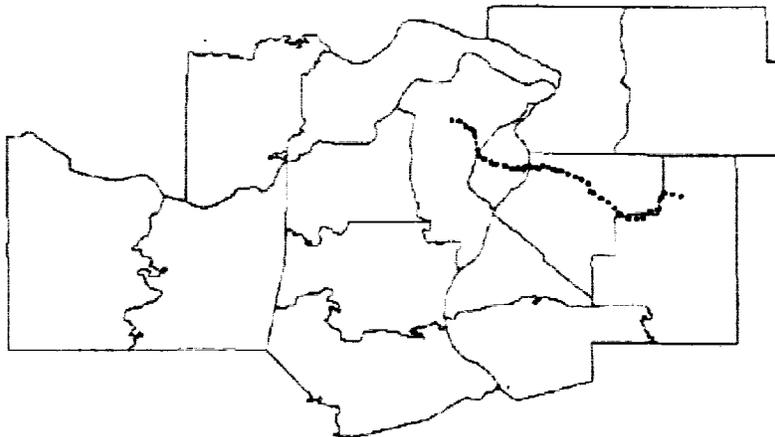
<b>Year</b>	<b>Transit Share (%)</b>
1990	1.42
1996	1.93
2000	1.76
2003	1.73
2010	1.64
2020	1.74

4. Bus transit network is shown Map 5-3 and MetroLink network can be seen in Map 5-4.

**Map 5-3. Bus Route Network for SMA**



**Map 5-4. MetroLink Network for SMA**



5. Table 5-6 shows mode choice coefficients that are related to the cost of either driving or riding transit in St. Louis.

**Table 5-6. Mode Choice Coefficients by EWGCC<sup>74</sup>**

Value	Description
0.0117	For home based work
0.0245	For home based other
0.0237	For nonhome based

6. VORs for St. Louis can be seen in Table 5-7.

**Table 5-7. Vehicle Occupancy Rates (VOR) by EWGCC<sup>75</sup>**

Purpose	VOR by year	
	2000	2020
Home based work	1.104	1.100
Home based shop trips	1.331	1.326
Home based drop passenger/school trips	1.600	1.600
Other home based trips	1.331	1.326
Nonhome based trips	1.232	1.228

7. Projected average summer weekday (ASW) vehicle miles traveled (VMT) is shown in Table 5-8.

**Table 5-8. Total Vehicle Miles Traveled (VMT) by EWGCC<sup>76</sup>**

Year	VMT (miles)
2000	70,035,000
2020	88,032,000

## 5.4 Input Data to Pivot Point Analysis

The original data has been rearranged as input to the pivot point model. Main tasks involved are 1) aggregating the original TAZs, 2) aggregating the original O/D matrix (origin/destination matrix), and 3) generating a distance matrix among the analysis zones.

Once the mode share changes from the pivot point analysis was obtained, we then estimated the total VMT changes which, in turn, became the basis for estimating changes in VOC and NO<sub>x</sub>.

<sup>74</sup> Carol Lawrence, East-West Gateway Coordinating Council (2001) - Fax: 4-6

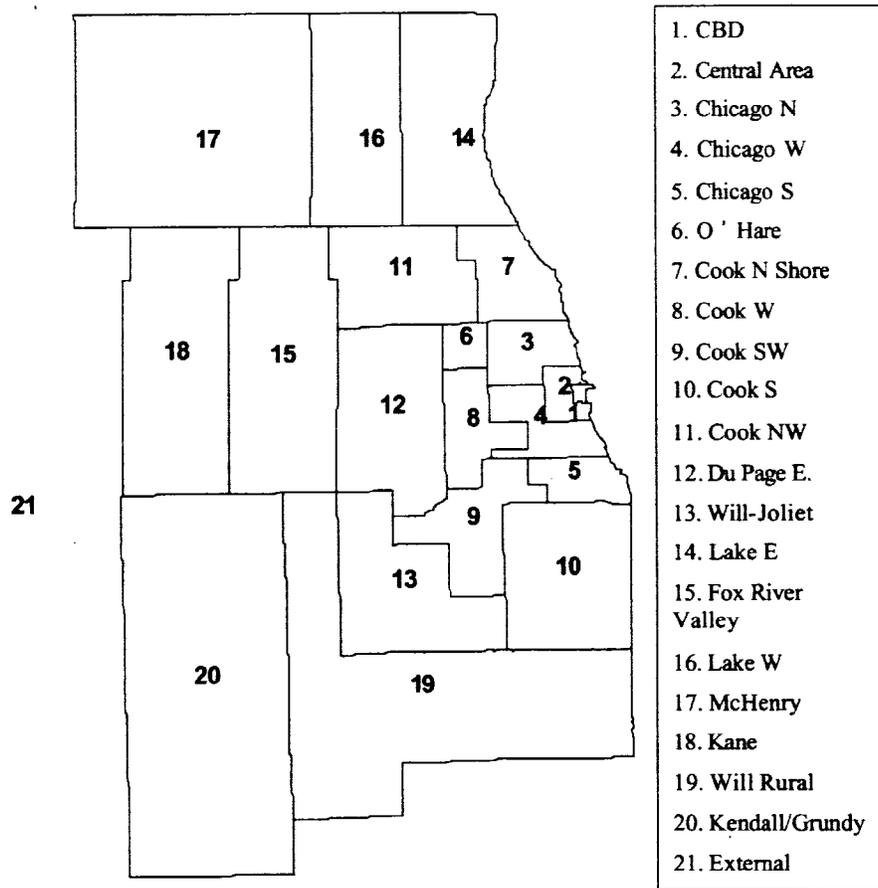
<sup>75</sup> East-West Gateway Coordinating Council (1999), Air Quality Conformity Finding and Documentation-The St. Louis Regional Long-Range Transportation Plan. St. Louis, MO: D-7

<sup>76</sup> East-West Gateway Coordinating Council (1999), Air Quality Conformity Finding and Documentation-The St. Louis Regional Long-Range Transportation Plan. St. Louis, MO: D-11

### 5.4.1 The Greater Chicago Metropolitan Area (GCMA)

We divided the entire analysis area into 21 zones, including an external zone, based on Transportation Analysis Zone (TAZ) of CATS (Map 5-5). The transit OD (origin/destination) matrix and automobile OD matrix are aggregated according to this analysis zone. The mode shares for transit and auto are calculated based on this data.

**Map 5-5. Analysis Zone for GCMA**

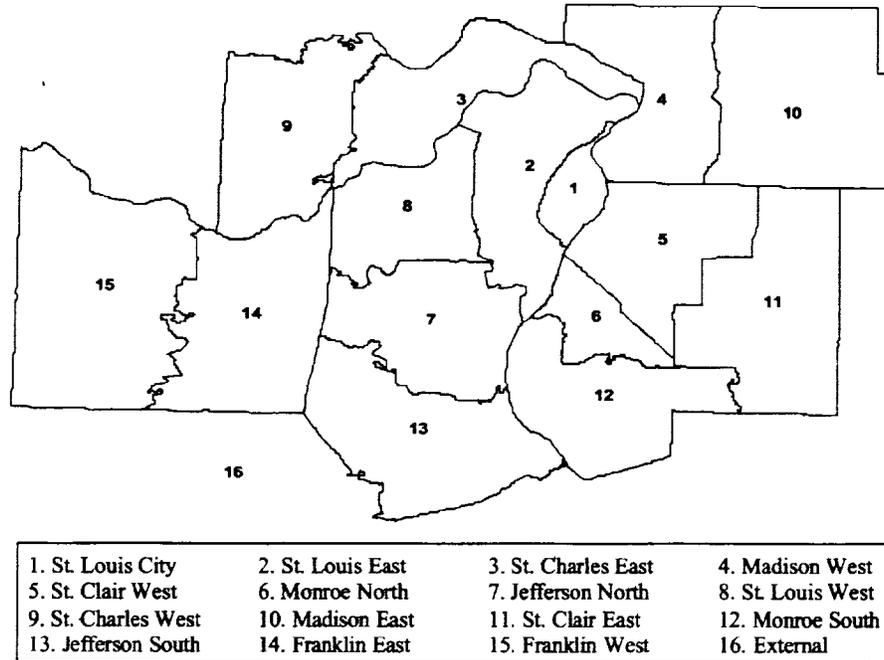


In addition, using GIS software we generated a distance matrix of the analysis zone to calculate the VMT. We adjusted the possible errors that might have generated by reducing 1,778 zones to 21 zones in estimating the total VMT in using the distance matrix. Factors to calculate emissions are 0.7849 g/mile for VOC, and 1.5487 g/mile for NO<sub>x</sub>.

### 5.4.2 The St. Louis Metropolitan Area (SLMA)

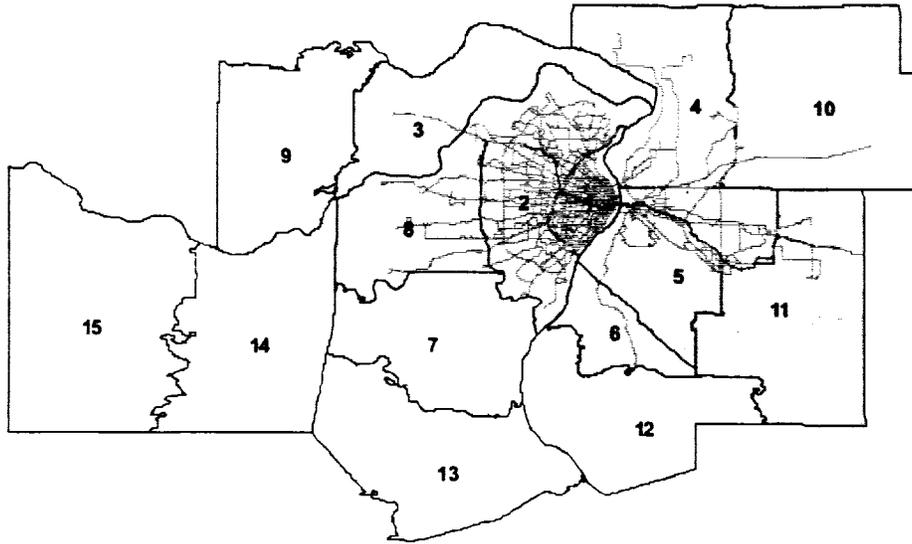
Sixteen analysis zones for our model are designed based on the TAZ of EWGCC (Map 5-6).

**Map 5-6. Analysis Zones for SLMA**



As we did in the Chicago area analysis, we generated a distance matrix of the analysis zone to calculate the VMT by using GIS software for the St. Louis areas. We adjusted the possible errors that may have been generated by reducing 1,109 zones to 15 zones by estimating the total VMT with the distance matrix. Factors to calculate amount of emissions are 1.0886 g/mile for VOC in 2000, 2.1355 g/mile for NO<sub>x</sub> in 2000, 0.5400 g/mile for VOC in 2020, and 0.9918 g/mile for NO<sub>x</sub> in 2020.

**Map 5-7. Analysis Zones with Transit Networks for SLMA**



## 5.5 The Model

The pivot-point model used for the impact analysis of episodic and seasonal transportation controls on mode choice is as follows:

$$\Delta p_A^{sk} = -\beta(1 - p_A^{sk})(p_A^{sk})(\Delta c_A^{sk}),$$

where:

- $\Delta p_A^{sk}$ : changes in probability of choosing automobile for the trip purpose  $k$  under scenario  $s$
- $k$ : trip purposes; = 1, home to work trip  
= 2, work to home trip  
= 3, home to nonwork trip  
= 4, nonwork to home trip  
= 5, nonhome to nonhome trip
- $s$ : scenarios
- $\beta$ : mode choice coefficients related to the cost of either driving or riding transit estimated by CATS
  - 0.0072 for work related and for non-CBD destination
  - 0.0085 for work related and for CBD (CBD = zone 1)
  - 0.0329 for nonwork related
- by EWGCC
  - 0.0117 for home based work
  - 0.0245 for home based other
  - 0.0237 for nonhome based

$\Delta c_A^{sk}$ : changes in costs for driving an automobile for the trip purpose  $k$  under scenario  $s$   
 $\Delta c_B^{sk}$ : changes in costs for riding transit for the trip purpose  $k$  under scenario  $s$ .

Derivation of the model is as follows: Using a typical multinomial logit mode choice model such as:

$$P_A = e^{-\alpha T_A - \beta C_A} / [e^{-\alpha T_A - \beta C_A} + e^{-\rho T_B - \delta C_B}],$$

where:

$T_A(T_B)$ : time related costs for mode A (B)  
 $C_A(C_B)$ : out of pocket costs for using mode A (B).

We can simplify the above model by defining that:

$$e^{-\alpha T_A - \beta C_A} = e^{-A}$$

$$e^{-\rho T_B - \delta C_B} = e^{-B}$$

Then,

$$P_A = e^{-\alpha T_A - \beta C_A} / [e^{-\alpha T_A - \beta C_A} + e^{-\rho T_B - \delta C_B}] = e^{-A} / [e^{-A} + e^{-B}].$$

If we take a partial derivative of  $P_A$  with respect to the cost variable, i.e.,:

$$\begin{aligned} \partial P_A / \partial C_A &= -\beta e^{-A} (e^{-A} + e^{-B}) + \beta e^{-A} e^{-A} / (e^{-A} + e^{-B})^2 \\ [\partial P_A / \partial C_A] C_A / P_A &= \left\{ -\beta + \beta e^{-A} / [e^{-A} + e^{-B}] \right\} C_A \\ &= -\beta \left\{ 1 - e^{-A} / [e^{-A} + e^{-B}] \right\} C_A \\ &= -\beta \{1 - P_A\} C_A \end{aligned}$$

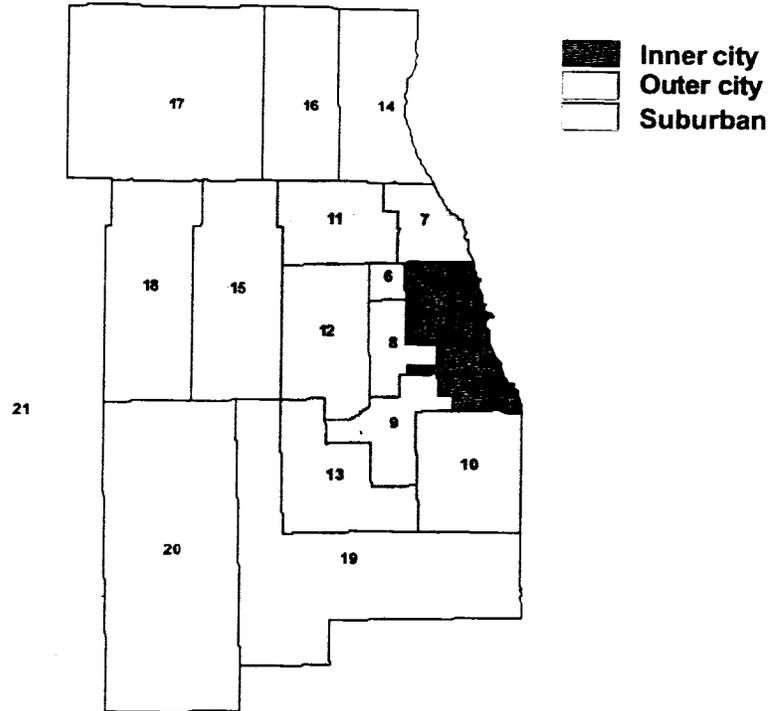
Thus,

$$\Delta P_A = -\beta [1 - P_A] P_A \Delta C_A \quad \text{Q.E.D.}$$

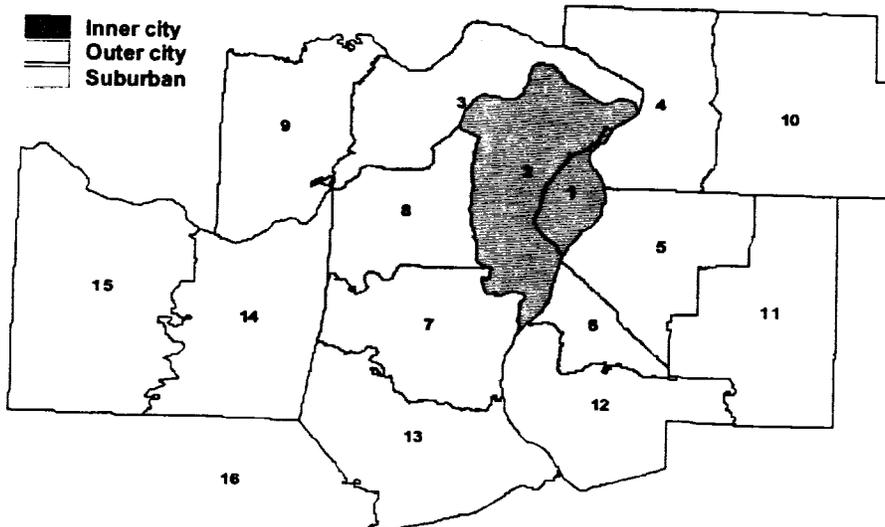
We assume that both the Parking Cash-Out and Commuter Bucks programs would affect only automobile trips for home-based work purposes. In the scenarios C1 and S1, the incentive amount is assumed to vary depending on the area of the city, such as inner city, outer city, or suburban areas.

To estimate the changes in the probability of choosing automobiles, we assign incentive values of \$1.00, \$0.75, or \$0.50 corresponding to inner city, outer city or suburban area in scenario S1. In scenario S2, we assume \$1.00 for all regions (Map 5-8 and Map 5-9).

**Map 5-8. Analysis Regions of GCMA**



**Map 5-9. Analysis Regions of SLMA**



However, this pivot point model is designed to observe the elasticity of travel cost rather than incentive value. Therefore, we assume that the users interact with the incentive value as cost decreases. Using this assumption, the model forecasts an increased probability of choosing automobiles as the cost of using them decreases. We assume that if the users have an incentive of a certain amount, the probability of choosing automobiles would decrease by the same amount.

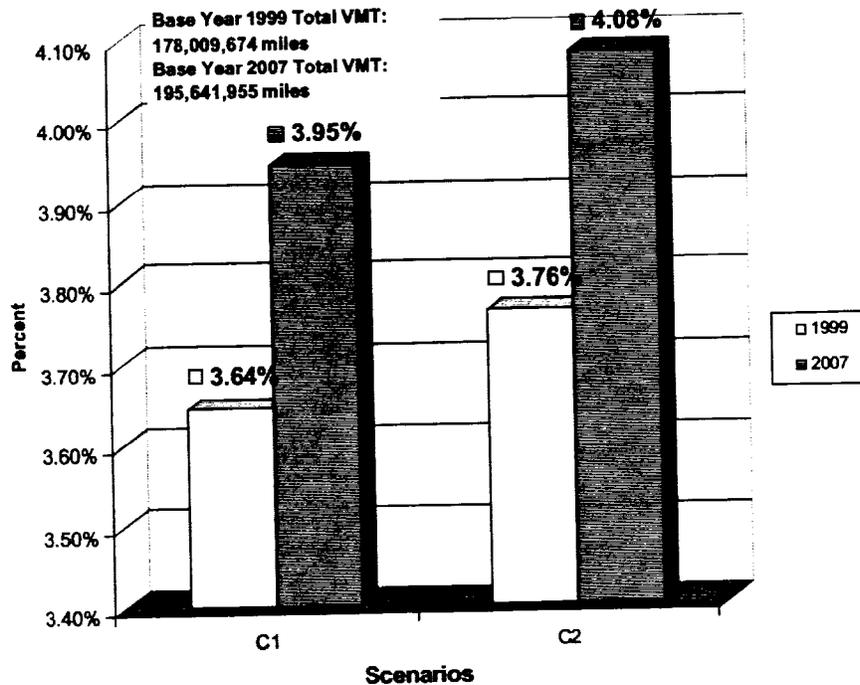
This assumption results in 3.64% of the VMT reduction in scenario C1. However, if we assumed that the ratio of an incentive (\$) to a penalty (\$) is 0.5, the VMT reduction in scenario C1 would be 1.92%. Note that you could obtain the result of analysis with various ratios by using the software (Episodic Strategy Evaluation Program) provided.

## 5.6 Measuring the Cost-Effectiveness of Incentive Programs

### 5.6.1 The Greater Chicago Metropolitan Area (GCMA)

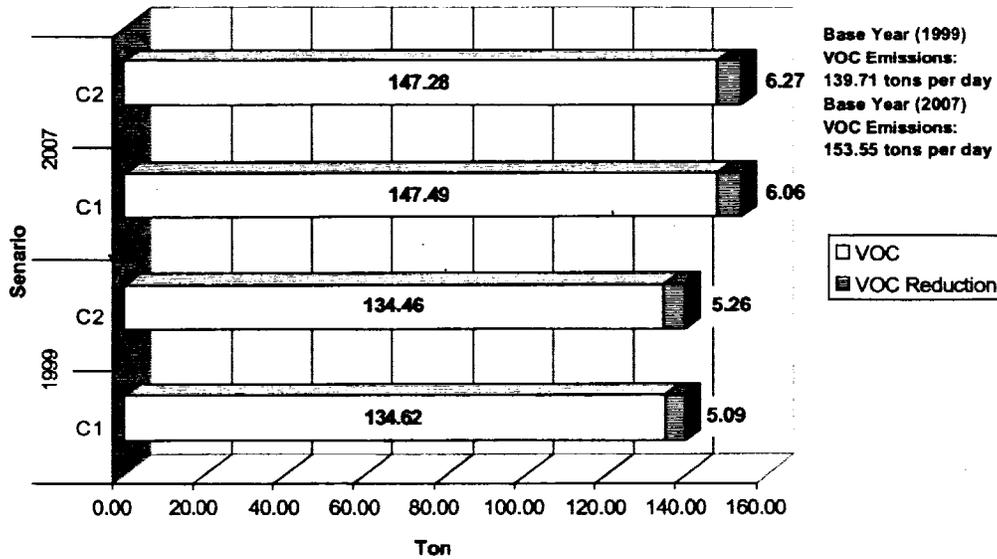
The results show that an incentive program with \$1.00 for all zones (C2) would produce more emissions reductions than an incentive program with different values for each zone (C1) in the Chicago area for both 1999 and 2007. For example, it could reduce VMT as much as 3.76 % in 1999 and 4.08% in 2007. In estimating emission reductions, we used the average VOC and NO<sub>x</sub> per mile emissions rate for the Chicago light duty fleet at the average speed of the study area. The VMT reductions made by each scenario in each year are summarized in Figure 5-1.

**Figure 5-1. Percent Reduction in Total VMT by Scenario and Year (GCMA)**



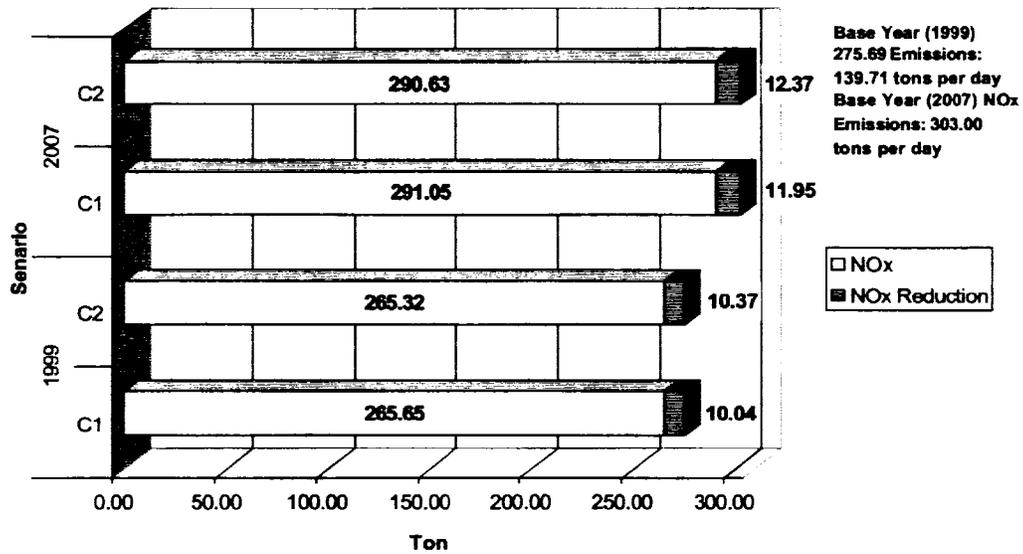
**Figure 5-2. Comparison of Alternative Scenarios for VOC Reduction (GCMA)**

(C1) Various incentive values: \$1.00 for inner city, \$0.75 for outer city, \$0.50 for suburban  
 (C2) An incentive value for all regions: \$1.00



**Figure 5-3. Comparison of Alternative Scenarios for NO<sub>x</sub> Reduction (GCMA)**

(C1) Various incentive values: \$1.00 for inner city, \$0.75 for outer city, \$0.50 for suburban  
 (C2) An incentive value for all regions: \$1.00



The C1 program, with varying incentive values by area, could reduce VMT by 3.64% in 1999 and 3.96% in 2007.

These VMT reductions would reduce VOC and NO<sub>x</sub> as shown in Figure 5-2 and Figure 5-3. The amount of VOC reduction by scenario C1 is 5.09 tons in 1999 and 6.06 tons in 2007. Also, the NO<sub>x</sub> reduction by scenario C1 is 10.04 tons in 1999 and 11.95 tons in 2007

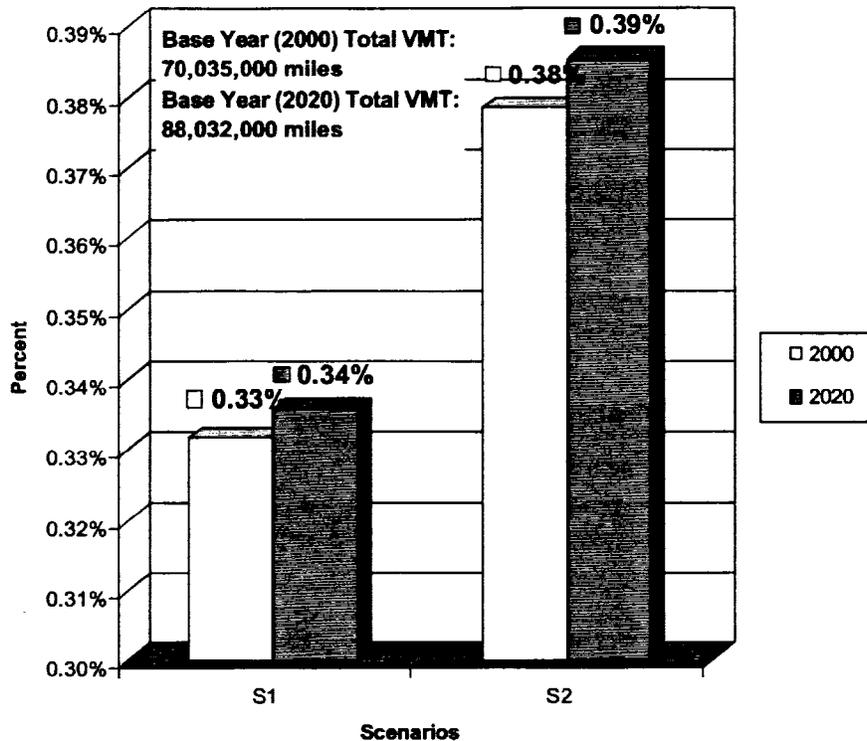
### 5.6.2 The St. Louis Metropolitan Area (SLMA)

As in the Chicago area, the incentive program with \$1.00 for all regions (S2) would produce more emissions reductions than the program with different values for each region (S1) in the St. Louis area for both year 1999 and year 2007. However, the amount of reduction is much less than the reduction in the Chicago area. For example, it could reduce VMT by 0.38 % in 2000 and 0.39% in 2007. The VMT reductions by each scenario in each year are summarized in Figure 5-4 below.

The S1 program, with varying incentive values by area, could reduce VMT and emissions by 0.33% in 2000 and 0.38% in 2007.

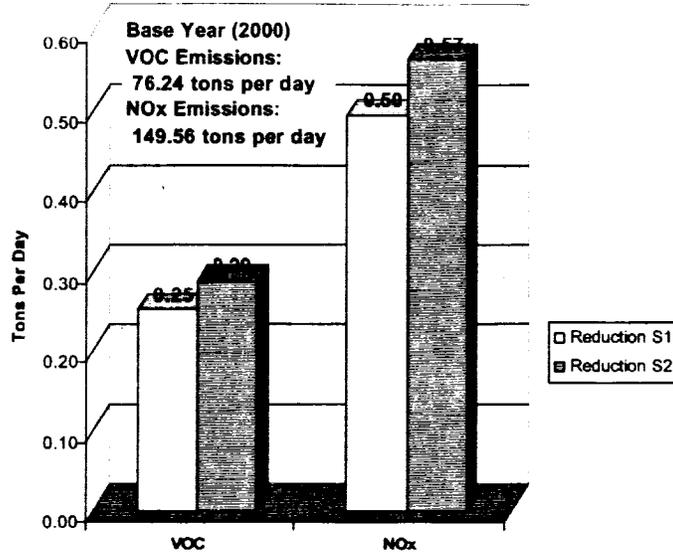
These VMT reductions would result in VOC and NO<sub>x</sub> reductions as shown in Figure 5-5 and Figure 5-6. The VOC reduction by scenario S1 is 0.25 tons per day in 2000 and 0.16 tons per day in 2007. The NO<sub>x</sub> reduction by scenario S1 is 0.50 tons per day in 2000 and 0.29 tons per day in 2007.

**Figure 5-4. Percent Reduction in Total VMT by Scenario and Year (SLMA)**



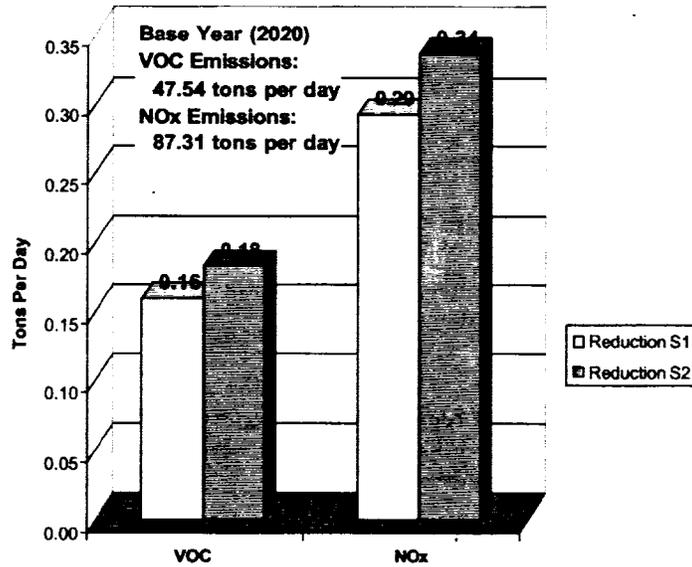
**Figure 5-5. Comparison of Alternative Scenarios for Emission Reduction in 2000 (SLMA)**

(S1) Various incentive values: \$1.00 for inner city, \$0.75 for outer city, \$0.50 for suburban  
 (S2) An incentive value for all regions: \$1.00



**Figure 5-6. Comparison of Alternative Scenarios for Emission Reduction in 2020 (SLMA)**

(S1) Various incentive values: \$1.00 for inner city, \$0.75 for outer city, \$0.50 for suburban  
 (S2) An incentive value for all regions: \$1.00



The reason there is less emission reduction is because we calculate the emission factors based on the total VMT and given emission amount. The given amount is calculated for 2000 and 2020 following the Transportation Improvement Program scenarios.<sup>77</sup>

### 5.6.3 Cost-Effectiveness

Table 5-9 shows the cost-effectiveness of the incentive programs by scenario. The most cost-effective scenarios are C1 and S1, in which we assigned various incentive values to the inner city area, the outer city, and the suburban area. The results for the Chicago area using the 1999 data show that the cost per ton of VOC reduction of C1 is \$60,098.89, which is lower cost than C2 (\$65,302.13/ton). This is an interesting result since the total VOC reduction per day in C2 (5.26 tons per day) is higher than that of C1 (5.09 tons per day). The similar result can be seen in NO<sub>x</sub> reduction. Likewise, the cost-effectiveness of the incentive programs in St. Louis shows similar results both VOC and NO<sub>x</sub> reductions in 2000 and 2020.

**Table 5-9. Cost-Effectiveness of Incentive Programs by Scenario**

Area	Year	Scenario	Cost		Affected Persons		Reduced Emission	
			(\$/day)	(person/day)	(\$/person)	VOC	NO <sub>x</sub>	
Chicago	1999	C1	\$313,599	332,479 <sup>†</sup>	0.943	60,099	30,456	
		C2	\$343,209	343,209 <sup>†</sup>	1.000	65,302	33,093	
	2007	C1	\$342,389	364,363 <sup>†</sup>	0.939	55,045	27,895	
		C2	\$377,119	337,119 <sup>†</sup>	1.000	60,180	30,497	
St. Louis	2000	S1	\$18,435	20,390 <sup>†</sup>	0.904	72,892	34,133	
		S2	\$21,964	21,964 <sup>†</sup>	1.000	76,098	35,634	
	2020	S1	\$19,299	21,620 <sup>†</sup>	0.893	120,882	65,822	
		S2	\$23,501	23,501 <sup>†</sup>	1.000	128,207	69,810	

<sup>†</sup> Person trips per day.

(C1), (S1) Variable incentive values: \$1.00 for inner city, \$0.75 for outer city and \$0.50 for suburban  
(C2), (S2) Fixed incentive value for all areas: \$1.00

The cost for each scenario is calculated based on the changed number of person trips, as determined by the pivot point model. The calculating methods among the scenarios are different because C1 and S1 have varying incentive values depending on the regions. The following shows the formula for each scenario:

Scenario (C1) and (S1):

$$\text{COST} = \text{RPT}_{\text{inner}} \cdot \$1.00 + \text{RPT}_{\text{outer}} \cdot \$0.75 + \text{RPT}_{\text{suburban}} \cdot \$0.50$$

Scenario (C2) and (S2):

$$\text{COST} = \text{RPT}_{\text{inner}} \cdot \$1.00 + \text{RPT}_{\text{inner}} \cdot \$1.00 + \text{RPT}_{\text{suburban}} \cdot \$1.00$$

where,

<sup>77</sup> East-West Gateway Coordinating Council (1999), Air Quality Conformity Finding and Documentation-The St. Louis Regional Long-Range Transportation Plan. St. Louis, MO: E-6

$RPT_{inner}$  :Reduced number of Person Trips in Inner city region  
 $RPT_{inner}$  :Reduced number of Person Trips in Outer city region  
 $RPT_{suburban}$  :Reduced number of Person Trips in Suburban region

After calculating the daily costs, the dollar per affected persons per day, dollar per VOC reduction per day, and dollar per NO<sub>x</sub> reduction per day are computed by following formula:

$$\text{Dollar per Affected Persons} = \text{Daily Cost} \cdot \text{Affected Person}$$

$$\text{VOC Reduction (dollar/ton)} = \text{Daily Cost} \cdot \text{VOC Reduction}$$

$$\text{NO}_x \text{ Reduction (dollar/ton)} = \text{Daily Cost} \cdot \text{NO}_x \text{ Reduction}$$

#### 5.6.4 Comparative Analysis

In the emission reduction summary shown in Table 5-10, we observed a distinctive difference in reduction between the two areas. In the Chicago area, the incentive program under the scenario C2 could reduce VOC emissions by 5.26 tons per day and NO<sub>x</sub> by 10.37 tons per day in 1999, while in the St. Louis area, the same scenario (S2) could reduce 0.29 tons per day for VOC and 0.57 tons per day for NO<sub>x</sub> in 2000. Therefore, the incentive program seems to be more effective in the Chicago area than in St. Louis area because of a distinct difference in the availability of alternative modes of transportation and their respective network coverage. In the Chicago area, most of the region is covered by a transit network, while only half of the region is covered by public transit in St. Louis.

**Table 5-10. Emission Reduction Summary**

Unit: Tons per day	GCMA				SLMA			
	1999		2007		2000		2020	
	C1	C2	C1	C2	S1	S2	S1	S2
Total VOC with Program	134.62	134.46	147.49	147.28	75.99	75.95	47.38	47.36
Reduction	5.09	5.26	6.06	6.27	0.25	0.29	0.16	0.18
Total NO <sub>x</sub> with Program	265.65	265.32	291.05	290.63	149.07	149.00	87.01	86.97
Reduction	10.04	10.37	11.95	12.37	0.50	0.57	0.29	0.34

(C1), (S1) Various incentive values: \$1.00 for inner city, \$0.75 for outer city, \$0.50 for suburban  
 (C2), (S2) An incentive value for all regions: \$1.00

It is important to note that while this analysis evaluates episodic controls, it is based on non-episodic data. The model results, therefore, may not accurately reflect travelers' response to price changes over a short-term period, since short-term and long-term transportation price elasticities are different. At the same time, the question of applying a point elasticity observed for small price changes to longer changes is also a serious shortcoming of this approach.

At the same time, the method used here does not account for the emissions benefits that would result from reduced traffic congestion since the model does not explicitly include the number of vehicle trips. Because reducing the number of vehicles on the road also reduces traffic

congestion, these transportation controls would allow for a higher average vehicle speed and thereby reduce emissions per mile of all vehicles on the road. Because the effect of congestion on traffic speed is nonlinear, a small reduction in the number of vehicles on the road due to the episodic control programs can have a large impact on average vehicle speed. This also suggests that the emission reductions produced by the pivot point model may be conservative estimates.

# Chapter 6 Cost-Effectiveness of Alternative Programs

## 6.1 Gas Cap Replacement Program

Faulty gas caps are a common cause of evaporative system losses in light duty vehicles. A gas cap replacement program is a new innovative public service that can create significant, cost-effective reductions of air pollutants. In creating a cost-benefit analysis for implementing such a program, it is necessary to estimate the emission rate of a faulty gas cap in vehicles, particularly of those vehicles that are 10 years or older (model years between 1971 and 1989). To quantify the costs, we attempted to add up all fixed and societal costs as well. To measure benefits, we used the reduced amount of daily emissions and multiplied it by the amount of vehicles that have a faulty gas cap. To date, several government institutions throughout the nation have found gas cap replacement programs to be successful in reducing up to 2 tons of daily emissions and over 700 tons of annual VOC emissions.

Ground level ozone is the main ingredient in smog. Ground level ozone is formed in the atmosphere through chemical reactions involving VOCs and NO<sub>x</sub> in the presence of strong sunlight. As a result, high ozone levels occur most frequently on hot summer afternoons when the flow of air is stagnant and adequate amounts of VOC and NO<sub>x</sub> are present. Sources of these gases include a variety of industrial and commercial combustion processes, automobile combustion, gasoline vapors, and evaporative emissions and vapors from evaporation of solvents. In many urban areas at least a third of those pollutants come from cars, buses, trucks, and off-highway mobile sources.<sup>78</sup>

Emissions from an individual car are generally low, especially when compared to industrial sources of air pollution. However, in several locations, the aggregated effect of personal vehicle use is the single greatest source of ozone pollution. Pollutant emissions from the millions of vehicles on the road contribute to about one-third to one-half of the total ozone problem in many areas.<sup>79</sup>

Emissions from cars can occur at several different stages:

- Diurnal losses occur when fuel evaporation increases as the temperature rises during the day, heating the fuel tank and releasing fuel vapors.

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<sup>78</sup> These figures are based on information from the *Protocol of Determination of VOC Reductions from the Replacement of Gas Caps on Light Duty Gasoline Vehicles* prepared for Sun Company, 1997 by M.J. Bradley and Associates

<sup>79</sup> These figures are based on information from the *Protocol of Determination of VOC Reductions from the Replacement of Gas Caps on Light Duty Gasoline Vehicles* prepared for Sun Company, 1997 by M.J. Bradley and Associates

- When a vehicle is being operated (the vehicle's temperature is elevated), running losses occur.
- When an engine is turned off, evaporation continues in resting losses.
- While these resting losses are considered minimal, emission during a "Hot Soak" are seen as substantial. A "Hot Soak" occurs after an engine is turned off. The heat from the vehicle exhaust and the engine result in a temperature increase to the vehicle fuel tank. A "Hot Soak" event occurs every time a vehicle is turned off or parked.
- Emissions are produced when refueling a vehicle, as vapors are released out of the gas tank.

Gas caps are actually part of the evaporative control system. Without a properly operating gas cap, fuel vapors from the gas tank would escape. On some vehicles, a missing gas cap will also cause the evaporative system canister to purge incorrectly. Evaporative losses account for 40% of VOC emissions from mobile sources.

A gas cap's effective life is considered to be 10 years, however, the emission reductions associated with replacing a faulty gas cap with a new one is assumed to be creditable for a period of three years. Vehicles eight years old and older account for more than 70% of the total evaporative losses from motor vehicles.<sup>80</sup>

Significant VOC emission reductions can be obtained by implementing a gas cap replacement program. In looking at the cost effectiveness of a gas cap replacement program, it is necessary to make several assumptions because the degree of vapor leakage varies considerably between gas caps.

### 6.1.1 Calculating Benefits

To calculate the benefits of replacing gas caps, one must take the emission benefits of replacing one cap and multiply it by the VMT of the number of failing cars.

VOCs reduced (ton/yr) = EM \*(VMT \* PF)

EM = emission factor benefit of one pressure failure (g/mi)

VMT = total vehicle miles traveled for area

PF = percentage of failing cars in area

(Total VMT in St. Louis Area: 70,035,000 miles, Total VMT in Chicago Area: 178,009,774 miles)

Studies have shown that by replacing a faulty gas cap with an efficient cap, it is possible to reduce VOC emissions by 1.03 g/mile.<sup>81</sup> While a large amount of gas cap emissions occur in the summer months, often considered the "ozone season," gas cap emissions occur all throughout the

<sup>80</sup> These figures are based on information from the *Protocol of Determination of VOC Reductions from the Replacement of Gas Caps on Light Duty Gasoline Vehicles* prepared for Sun Company, 1997 by M.J. Bradley and Associates

<sup>81</sup> This figure is based on information from the *Protocol of Determination of VOC Reductions from the Replacement of Gas Caps on Light Duty Gasoline Vehicles* prepared for Sun Company, 1997 by M.J. Bradley and Associates. The figure may be a tad over estimated for it will be lower in the winter season.

year. Instead of just focusing on seasonal control of ozone, a gas cap replacement program fights the ozone problem all year round. Table 6-1 shows the number of possible tons of VOCs in the St. Louis counties that can be reduced by a gas cap replacement program.

**Table 6-1. VOC Reduction in the St. Louis Area**

St. Louis Area	Total Automobile	I & M failure Rate	# of Failed Automobiles	Total VMT of Failed Vehicles	Daily VOC Reduction (tons) <sup>82</sup>
Missouri	1,404,395	1.75%	24,576	1,003,164	1.03
Illinois	311,357	2.85%	8,873	362,186	0.37
<b>Total</b>	<b>1,715,752</b>		<b>33,449</b>	<b>1,365,349</b>	<b>1.41</b>

Current inspection and maintenance programs in St. Louis have reported a gas cap failure rate of 1.75%. Inspection and maintenance programs in Illinois show a slightly higher rate at 2.85%. Once the total VMT of these faulty vehicles is calculated, a total VOC reduction can be figured. Replacing faulty gas caps can reduce 1.41 tons of VOC emissions daily in the St. Louis area.

This amount does not include costs for staffing, media coverage, advertising, and public relations. These numbers have varied throughout several gas cap replacement programs across the United States.

In Chicago, results show more savings simply because there are a larger number of automobiles. The inspection and maintenance programs report a 2.85% failure rate for Illinois. Table 6-2 shows the possible VOC reduction in Chicago.

**Table 6-2. VOC Reduction in Chicago Area**

Area	Total VMT	I & M failure rate	VMT by faulty automobiles	Daily VOC reduction (tons)
Chicago	178,009,774	2.85%	5,073,278	5.23

Therefore we estimate that by the replacement of gas caps it is possible to reduce about 5.23 tons of daily VOC emissions in the Chicago area.

### 6.1.2 Replacement Costs

Gas caps cost about \$5 to \$8. It is interesting to note, however, that past gas cap replacement programs have always had donations from local charities, foundations, and state DOTs. These programs often make a deal with gas cap manufacturers and the retailers and acquire them for a discounted price.

To determine the costs per day of implementing a gas cap replacement program, we first found the overall costs of replacing faulty gas caps. In both cities, we divided the total VMT driven by

<sup>82</sup> Partners for Clean Air Steering Committee's 1999 survey of the Chicago area residents given by e-mail from Mr. Terry Sweitzer dated, July 3, 2001. These figures are drawn by the survey made by the Partners for Clean Air for Chicago area. It is assumed that the survey results of the Chicago area will be applicable to the St. Louis area.

the faulty vehicles from Table 6-1 and Table 6-2 by the average trip length (10.4 miles for Chicago and 9.2 miles for St. Louis). By multiplying the result by \$5, we obtained the present value of the replacement cost. Assuming a 4% discount rate/year, compounded daily for 3 years (which is assumed to be the life cycle of a replaced gas cap), we estimated that the total cost per day is \$2,364 in Chicago, and \$719 in St. Louis.<sup>83</sup>

### 6.1.3 Assumptions

Every benefit-cost analysis examining the potential effects of changing environmental protection requirements is limited by data gaps, limitations in model capabilities (such as geographic coverage), and uncertainties in the underlying scientific and economic studies used to configure the benefit and cost models. The primary components of an emission factor model include the base emission factors, characterization of the vehicle fleet, fuel characteristics, vehicle operating conditions, the effect of local ambient conditions, the effect of alternative I&M programs, and the effect of tampering and misfueling. None of these factors is static: technology is continually evolving, leading to a change of in-use emission performance. Changes in fuel prices and economic conditions lead to changes in vehicle sales and travel patterns. A substantial effort is required to accurately quantify these factors and to stay current with the influence of all of these factors on vehicular emission levels.

Interpretation of the daily reduction amount reported here needs some explanation. If there were no I/M programs detecting faulty gas caps in both Missouri and Illinois, the total amount reported here as daily reduction would be new additional emission reduction. The daily VOC reduction on the Missouri side of the St. Louis area computed, however, represents no new savings because current I/M programs cover the entire area, detecting faulty gas caps and implementing replacements. In Illinois, however, current I/M programs cover 93.7% of the GCMA and Metro-East, therefore 6.3% of the daily VOC reduction reported here can be considered new savings

### 6.1.4 Replacement Programs

There are two popular ways of conducting an effective gas cap replacement program, both of which have been proven similarly effective: direct mailing and actual replacement.

#### 6.1.4.1 Direct Mailing

This method involves mailing gas caps to selected owners of cars dating from 1989 or before. They are mailed a new gas cap that will fit their car and an informational packet. They are also

<sup>83</sup> These numbers were computed using the following equation.

$$\text{Cost (daily)} = \text{Present Value of Cost} \times \frac{r/m}{1 - [1 + (r/m)]^{-nm}}$$

where r = Annual Interest Rate (4%)  
m = Daily Adjustment (=365)  
n = Period (3 years)

given a pre-stamped envelope to return the old gas cap to the cap testing facility. There, the gas caps are tested for leakage. From this data, an annual reduction is computed. These numbers are based on the assumption that the selected participants have put the new gas cap in and that it functions.

#### 6.1.4.2 Actual Replacement

This method involves actually testing cars and replacing any caps that fail. While this guarantees that a new cap is put on old cars, it relies on people to drive into testing station and volunteer their car for testing. Often, people in these areas are mailed reminders about the testing sites and requirements.

Both replacement programs offer the participants free vouchers for gasoline, food, or other local incentives.

## 6.2 Postponement of Lawn Mowing

Lawn mowers and other lawn and garden equipment that use gasoline engines can cause an increase in VOC emissions. Much like the automobiles in the gas cap replacement program, while one lawn mower may not make a considerable contribution to the production of hazardous gases, the aggregation of region-wide lawn and garden equipment use can create quite significant VOC production. Several agencies surveyed said that they encouraged the postponement of lawn mowing on specific episode days. While postponing lawn mowing will not eliminate VOC emissions, it will reduce the overall effects of ozone on high-level ozone days.

**Table 6-3. NO<sub>x</sub> Emissions from Lawn Mowing in the St. Louis Area<sup>84</sup>**

Engine type	Acres	NO <sub>x</sub> (g/hr)	NO <sub>x</sub>	NO <sub>x</sub> emission (tons/day <sup>85</sup> )
2-stroke	123,700	1.45	215,237	0.0029
4-stroke	82,466	4.85	239,977	0.0033
Total	206,166			0.0062

In computing the amount of NO<sub>x</sub> and VOC in the St. Louis area, we made several assumptions. Of the 206,166 mowable acres, 4-stroke engines will mow about 40%, and 2-stroke engines will mow the remaining 60%. People generally mow their lawns about once a week, particularly in the summer. It takes approximately 35 minutes to mow an acre with a riding lawnmower, and 70

<sup>84</sup> NO<sub>x</sub> (g/mi) figures were taken from the *Emission Estimation Technique Manual for Aggregated Emissions from Domestic Lawn Mowing, 1999* by the Department of the Environment of Western Australia.

<sup>85</sup> Partners for Clean Air Steering Committee's 1999 survey of the Chicago area residents given by e-mail from Mr. Terry Sweitzer dated, July 3, 2001. These figures are drawn by the survey made by the Partners for Clean Air for Chicago area. It is assumed that the survey results of the Chicago area will be applicable to the St. Louis area. Thus, we applied the factor of 9.52% in estimating VOC emission due to postponement of mowing (Of the 56% of people who took actions, only 17% postponed lawn mowing). We assumed that during the summer, lawns are mowed once a week.

minutes to mow an acre with a push mower. Table 6-3 and Table 6-4 show the amount of NO<sub>x</sub> and VOC emissions that would come from the entire St. Louis area.

**Table 6-4. VOC Emissions from Lawn Mowing in the St. Louis Area<sup>86</sup>**

Engine type	Acres	VOC (g/hr)	VOC	VOC emission (tons/day <sup>87</sup> )
2-stroke	123,700	304	45,125,614	0.613
4-stroke	82,466	41.1	2,033,621	0.027
Total	206,166			0.640

The results indicate that, on specific ozone episode days, it is possible to reduce NO<sub>x</sub> emissions by 0.0062 tons and VOC emissions by 0.64 tons. For the Chicago area, 20.2 tons<sup>88</sup> per day are emitted from lawn and garden equipment. Again assuming that only 56% of people take action on high ozone days and 17% of the 56% say they defer their lawn mowing, 1.9 tons of VOC emissions can be reduced in the Chicago area on a specific day. We assume that the ratio of VOC/NO<sub>x</sub> in St. Louis is the same in Chicago, therefore by postponing lawn mowing, 0.018 tons of NO<sub>x</sub> can be reduced in the Chicago area on a specific day. We assume that there are no costs involved in postponing lawn mowing.

### 6.3 Summary

Table 6-5 summarizes the cost-effectiveness of both gas cap replacement and postponement of lawn mowing programs. With the Gas Cap Replacement Program, in the Chicago area, as much as 5.23 tons of VOC per day could be reduced while as much as 1.41 tons of VOC in the St. Louis area.

<sup>86</sup> VOC (g/mi) figures were taken from the *Emission Estimation Technique Manual for Aggregated Emissions from Domestic Lawn Mowing, 1999* by the Department of the Environment of Western Australia.

<sup>87</sup> See footnote 85 above.

<sup>88</sup> This figure is from *Economic and Air Quality Analysis of Episodic Controls to Reduce Ozone Concentrations in the State of Illinois, 1998* by Hagler Bailly.

**Table 6-5. Cost-Effectiveness of Gas Cap Replacement and Lawn Mowing Postponement Programs**

Program	Cost		Effectiveness		Cost Effectiveness	
	Period	Dollar	I & M failure rates	Reduced Emissions /day <i>VOC (NOx)</i>	Affected Persons (\$/person)	Reduced VOC Emission (\$/ton)
<b>Gas Cap Replacement Chicago</b>	1 day	\$2,364	2.85%	5.23 tons/day	0.004	\$452
<b>Gas Cap Replacement St. Louis</b>	1 day	\$719	1.75% - MO 2.85% - IL	1.41 tons/day	0.004	\$511
<b>Postpone Lawn Mowing - Chicago</b>	12 Alert Days <sup>89</sup>	-	-	1.9 tons/day <i>(0.018 tons/day)</i>	-	-
<b>Postpone Lawn Mowing - St. Louis</b>	5 Alert Days <sup>90</sup>	-	-	0.64 tons/day <i>(0.0062 tons/day)</i>	-	-

<sup>89</sup> Average number of alert days in Chicago per year from 1995 to 2000.

<sup>90</sup> Forecasted number of alert days in St. Louis in the year 2000.

## **Chapter 7 Summary and Policy Implications**

### **7.1 Summary**

What approaches are available to reduce ozone concentrations?  
Among the alternatives available, which are the most cost efficient?

With these questions in mind, the research team analyzed and evaluated various options for episodic and seasonal controls, and recommended a workable set of episodic and seasonal programs that may have an economic benefit to Illinois.

To effectively prescribe feasible strategies for Illinois, the team developed a questionnaire to solicit information from other state DOTs, air quality agencies, and MPOs on transportation control programs in use or suggested for use in other states for episodic and seasonal emission controls.

The biggest emphasis expressed by most respondents was lowering ozone emission during the peak hours of the day. By far the most popular way to do this was to have people use alternative forms of transportation to work, school, and other daily activities. Most reported they worked closely with the local transit authority to help reduce transit costs during the summer and on high emission days.

All of the respondents reported a direct correlation between the amount of media coverage they had received and the success of the program. Many found that because of constant coverage in the local media, the public's ideas have changed about air quality. They also report education as an important way to notify the public. They advertise on the radio, television, and in the print media. They also have emergency updates when days are announced as high ozone days. One notable report on a successful program was a Gas Cap Replacement Program. Through this program they were able to replace approximately 23,000 leaking gas caps, eliminating 1,297 tons of emissions annually from the regions air.

Based on the survey results, the research team selected the following episodic and seasonal control programs, in consultation with the members of the project's technical review panel (TRP), for further analysis as reported in Chapter 3.

**1. Alert Programs**

- Color Coded Air Quality Announcements on Road Signs
- e-ALERT Real Time Notification
- Alerts on Radio Stations
- Alerts during Local Weather Report
- Web-site Notification

**2. Incentive Programs**

- Parking Cash-Out Program
- Commuter Bucks

**3. Alternative Programs**

- Gas Cap Replacement Program
- Postponement of Lawn Mowing

As stated in earlier chapters, it is difficult to determine the actual costs and effects of the selected programs. It is partly because of theoretical limitations of a method and partly because of practical limitations. Theoretically, separating the actual costs and effects of these selected programs from many other ozone controls in the cost-effectiveness analysis is very difficult, if not impossible. Thus, marginal effects of alert programs cannot be clearly determined. In addition, there are practical difficulties such as the limitation of information to conduct sufficient analysis.

Because of the difficulties of estimating all societal costs and benefits, the cost-effectiveness as the unit of measurement was adopted in this research, an alternative version of the cost-benefit analysis. In it, the measurement of costs and benefits can be in different units, with no need to search for a common metric such as the amount of VOC reduction per dollar cost for each alternative measure.

Table 7-1 shows the summary results of the cost-effectiveness analysis. The results of the study indicate that the five most cost-effective programs in reducing VOC and NO<sub>x</sub> in 2000 (1999 for the incentive programs) for the Chicago area, in rank order of VOC reduced amounts, are:

1. Parking Cash Out and Commuter Bucks combined (About 5.09 to 5.26 tons/day for VOC and 10.04 to 10.37 tons/day for NO<sub>x</sub>)
2. Gas Cap Replacement Program (5.23 tons/day for VOC only<sup>91</sup>)

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<sup>91</sup> Rank order in terms of NO<sub>x</sub> is different from the rank order of VOC reductions. Table 7-1 shows a comprehensive overview of the reduction amounts of all programs analyzed.

3. Postponement of Lawn Mowing (1.9 tons/day for VOC and 0.02 tons/day for NO<sub>x</sub>)
4. Road Sign Notification (1.68 tons/day for VOC and 3.31 tons/day for NO<sub>x</sub>)
5. Television Notification (0.9 tons/day for VOC and 1.77 tons/day for NO<sub>x</sub>)

In terms of dollar per ton of VOC and NO<sub>x</sub> reductions, however, the rankings in the order of dollar per ton of VOC reduction are:

1. Gas Cap Replacement Program (\$452/ton for VOC only)
2. Road Sign Notification (\$1,301/ton for VOC and \$659/ton for NO<sub>x</sub>)
3. e-ALERT (\$3,066/ton for VOC and \$1,554/ton for NO<sub>x</sub>)
4. Radio Notification (\$6,721/ton for VOC and \$3,406/ton for NO<sub>x</sub>)
5. Television Notification (\$21,550/ton for VOC and \$10,921 for NO<sub>x</sub>)

Note that postponement of lawn mowing has no cost-effectiveness measure since we assume that there is no cost involved in the program. There would be some tangible costs, for example, hiring mowers after 6:00 p.m. would cost more than hiring them during the daytime. If we obtain those costs and recalculate the cost-effectiveness, we believe this option would be the most cost-effective in terms of VOC reduction per dollar.

The five most cost-effective programs in reducing VOC and NO<sub>x</sub> in 2000 for the St. Louis area, in rank order of reduced VOC amounts, are:

1. Gas Cap Replacement Program (1.41 tons/day for VOC only)
2. Postponement of Lawn Mowing (0.64 tons/day for VOC and 0.006 tons/day for NO<sub>x</sub>)
3. Parking Cash Out and Commuter Bucks combined (0.25 to 0.29 tons/day for VOC and 0.5 to 0.57 tons/day for NO<sub>x</sub>)
4. Television Notification (0.26 tons/day for VOC and 0.5 tons/day for NO<sub>x</sub>)
5. Road Sign Notification (0.18 tons/day for VOC and 0.36 tons/day for NO<sub>x</sub>)

In terms of dollar per ton of VOC and NO<sub>x</sub> reductions per dollar, however, the rankings in order of dollar per ton of VOC reductions are:

1. Gas Cap Replacement Program (\$511/ton for VOC only)
2. Road Sign Notification (\$4,742/ton for VOC and \$2,403/ton for NO<sub>x</sub>)
3. Television Notification (\$16,572/ton for VOC and \$8,398/ton for NO<sub>x</sub>)
4. Radio Notification (\$23,525/ton for VOC and \$11,921/ton for NO<sub>x</sub>)
5. e-ALERT (\$56,775/ton for VOC and \$28,772/ton for NO<sub>x</sub>)

Table 7-1. Summary of Cost-Effectiveness of the Recommended Programs

Program Category	Programs		Program Period (days)	Cost	Effectiveness				Cost-Effectiveness					
	Program Title	Area			Dollar	Measures		Total Emission		Reduced Emission		Affected Persons (\$/person)	Reduced Emission	
						Affected Persons <sup>2</sup> (per day)	Reduced VMT (per day)	VOC	NO <sub>x</sub>	VOC	NO <sub>x</sub>		VOC	NO <sub>x</sub>
Alert Programs	Road Sign Notification	Chicago	214	\$466,368	280,086	2,352,179	-	-	1.68	3.31	0.01	1,301	659	
		St. Louis	123	\$105,159	34,678	253,201	-	-	0.18	0.36	0.02	4,742	2,403	
	E-alert	Chicago	12 Alert Days	\$5,000	22,724	190,885	-	-	0.14	0.27	0.02	3,066	1,554	
		St. Louis	5 Alert Days	\$5,000	3,388	24,738	-	-	0.02	0.03	0.30	56,775	28,772	
	Website Notification	Chicago	365	\$7,000	32.6	274	-	-	0.00020	0.00038	0.59	98,451	49,891	
		St. Louis		\$7,000	3.1	22	-	-	0.00002	0.00003	6.25	1,202,217	609,237	
	Radio Notification	Chicago	270	\$396,740	36,556	307,073	-	-	0.22	0.43	0.04	6,721	3,406	
		St. Louis		\$396,740	12,015	87,727	-	-	0.06	0.12	0.12	23,525	11,921	
	Television Notification	Chicago	12 Alert Days	\$231,600	149,742	1,257,828	-	-	0.90	1.77	0.13	21,550	10,921	
		St. Louis	5 Alert Days	\$21,200	49,215	359,348	-	-	0.26	0.50	0.09	16,572	8,398	
Incentive Programs	C1 <sup>93</sup>	Chicago	1 Day in 1999	\$313,599	332,479	6,485,101	134.62	265.65	5.09	10.04	0.943	60,095	30,456	
		Chicago	1 Day in 2007	\$342,389	364,363	7,719,020	147.49	291.05	6.06	11.95	0.939	55,045	27,895	
	C2 <sup>94</sup>	Chicago	1 Day in 1999	\$343,209	343,209	6,696,441	134.46	265.32	5.26	10.37	1.000	65,302	33,093	
		Chicago	1 Day in 2007	\$377,119	337,119	7,984,363	147.28	290.63	6.27	12.37	1.000	60,180	30,497	
		St. Louis	1 Day in 2000	\$18,435	20,390	232,326	75.99	149.07	0.25	0.50	0.904	72,892	34,133	
		St. Louis	1 Day in 2020	\$19,299	21,620	295,642	47.38	87.01	0.16	0.29	0.893	120,882	65,822	
Alternative Programs <sup>95</sup>	S2 <sup>94</sup>	St. Louis	1 Day in 2000	\$21,964	21,964	265,141	75.95	149.00	0.29	0.57	1.000	76,098	35,634	
		St. Louis	1 Day in 2020	\$23,501	23,501	339,445	47.36	86.97	0.18	0.34	1.000	128,207	69,810	
	Gas Cap Replacement	Chicago	1	\$2,363 <sup>96</sup>	604,891	5,073,278	-	-	5.23	-	0.004	452	-	
		St. Louis		\$719 <sup>96</sup>	187,002	1,365,414	-	-	1.41	-	0.004	511	-	
	Postpone Lawn Mowing	Chicago	12 Alert Days	-	-	-	-	-	1.90 <sup>97</sup>	0.02 <sup>98</sup>	-	-	-	
		St. Louis	5 Alert Days	-	-	-	-	-	0.64	0.006	-	-	-	

<sup>92</sup> The unit is person per day except that the unit for the Incentive Programs is person trips per day.

<sup>93</sup> Incentive values vary: \$1.00 for inner city, \$0.75 for outer city, \$0.50 for suburban area.

<sup>94</sup> Incentive values are fixed for all regions for \$ 1.00.

<sup>95</sup> The faulty gas cap rate for the Chicago area is assumed to be 33.7%. For the St. Louis area, it is 29.4% for Missouri counties and 50.2% for Illinois counties.

<sup>96</sup> Assume 4% discount rate/year, compounded daily for 3 years which is assumed to be the life cycle of the replaced gas cap.

<sup>97</sup> Source: Hagler Bailly (1998), Table 2-13 in p. 2-43.

<sup>98</sup> We assume that the ratio between VOC/NO<sub>x</sub> in St. Louis is the same in Chicago.

Again, note that postponement of lawn mowing has no cost-effectiveness measure since we assume that there is no cost involved in the program. There would be some tangible costs, for example, hiring mowers after 6:00 p.m. would cost more than during the daytime. If those costs are obtained and the cost effectiveness is recalculated, this option is believed to be the most cost-effective in terms of VOC reduction per dollar.

## 7.2 Policy Implications

As was documented in Kim and Hanley (1996) and Hagler Bailly (1998), certain strategies that would provide economic incentives/disincentives potentially reduce VMT, and thus, emissions significantly. The large emissions reductions are a function of price responsiveness to private and public transportation options, and the level of public support. The results shown in both studies indicate that large emissions reductions could be achieved by a combination of making transit less expensive and making driving more expensive during the period of high ozone conditions that typically occur during 5 to 20 days of the summer season.

The unanswered question, however, is how well people would respond to the disincentive programs. Would they respond as they do to the incentive programs? Voluntary and incentive programs are becoming a popular approach to help reduce ozone emissions, particularly during the summer ozone season or high ozone episode days. As summarized in Appendix A, over 20 programs were identified and investigated, in addition to the 1996 survey of EPA. Many U.S. cities recently established episodic and seasonal programs, actively upgraded program components on the basis of the previous experience, and are considering implementation of these programs. Several cities such as Indianapolis, St. Louis, Sacramento, and San Francisco have developed a variety of public education and outreach programs, commuter incentives to alternative use of transportation, and ozone forecasting methods and notification programs.

Policy for making automobile driving more expensive can be very sensitive politically and difficult to implement. Charging additional fees temporarily at parking garages would not be terribly difficult to implement, but again, very unpopular politically. Reducing transit fare temporarily would not be difficult to implement. However, it would be easier to have employers pay, say \$1.00, to employees either in lieu of providing free parking and/or as incentive to join vanpooling, and thus indirectly reducing fares for alternative modes of travel, making automobiles less attractive, and parking more expensive.

As summarized in Chapter 4, it has proven to be important to make it easy to access ozone information to show the best performance of a notification program. Road sign notification programs show the highest cost-effectiveness per dollar spent because it involves highways, which have many users. Also, television and radio notification programs, which reach the public easily, show relatively high effectiveness. These programs can deliver information to more people. In case of e-ALERT notification programs, despite the relatively small numbers of e-ALERT subscribers, a low implementation cost of the program makes its cost-effectiveness increase.

The biggest surprise came from the cost-effectiveness analysis for the gas cap program. We estimated \$ 452/ton for VOC reduction in the Chicago area and \$ 511/ton for VOC reduction in the St. Louis area. They are the most cost-effective programs in both areas. We arrived at this conclusion assuming that about 1.75 % of the existing fleet in the Missouri counties in the St.

Louis area, and 2.85% of the existing fleet in both the Chicago and the Illinois counties of the St. Louis area, have faulty gas caps.<sup>99</sup>

There are two popular ways in conducting an effective gas cap replacement program: direct mailing and actual replacement. Direct mailing involves mailing gas caps to selected owners of old cars, say 10 years and older. A pre-stamped envelope should be included to return the old gas cap to the cap testing facility. There, the gas caps are tested for leakage and an annual reduction can be computed. Actual replacement involves a staff actually testing cars and replacing any caps that fail. While this guarantees that a new cap is put on old cars, it relies on people to drive into testing station and volunteer their car for testing. The replacement program could accompany with incentives such as free vouchers for gasoline, food, or other local incentives.

Postponement of lawn mowing after 6:00 p.m. would be effective, particularly since there would be no cost or small amount of cost such as marginal difference in hiring lawn mowers during the daytime and after 6:00 p.m. Thus, it is a very cost-effective voluntary program.

At the same time, further research is needed to evaluate the full costs and benefits of all available options before adopting measures, including those that are non-incentive options. Until then, the options evaluated here could remain as a guide for policy makers as courses of action to take in reducing ozone concentration during the episodic days in hot season of summer.

### **7.3 Evaluative Tools for Strategies**

The research team deeply appreciates members of the technical review panel (TRP) for their time and efforts to guide the study team, frequently sending useful materials. The research team is also grateful to CATS and EWGCC for the data, without which the analysis in this report could not have been done.

While we conscientiously searched for the right data, time to time, we had to substitute, assume differently, or generated alternative data for the analysis. It is important to note, however, that the results shown in this report are based on various assumptions that may vary time-to-time, and place-to-place. The variability of many factors in estimating effectiveness of episodic control programs has led the research team to document the research tools have been developed and used based on the national data, making it user-friendly by providing a graphic user interface (GUI). They are documented in detail in Appendix D: User Manual for Episodic Strategies Evaluation Programs (ESEP). A compact disc (CD) that includes the ESEP program is also included as a part of the final report. Figure 7-1 to Figure 7-9 below show the GUI for ESEP.

By releasing these tools, it is hoped that other researchers could use them to derive new results, once they find new data and have to have different assumptions. Other policy makers in other

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<sup>99</sup> The percentages of the faulty gas caps are from the current inspection and maintenance programs in Illinois and Missouri.

parts of the country could also evaluate selected episodic strategies for their own purposes with these tools.

At the same time, implementation of those episodic control measures can contribute to the fulfillment of Illinois' state implementation plan (SIP) requirement since significant ozone reductions can be achieved through the implementation of the recommended episodic control measures.

**Figure 7-1. Graphic User Interface of the Episodic Strategies Evaluation Programs**

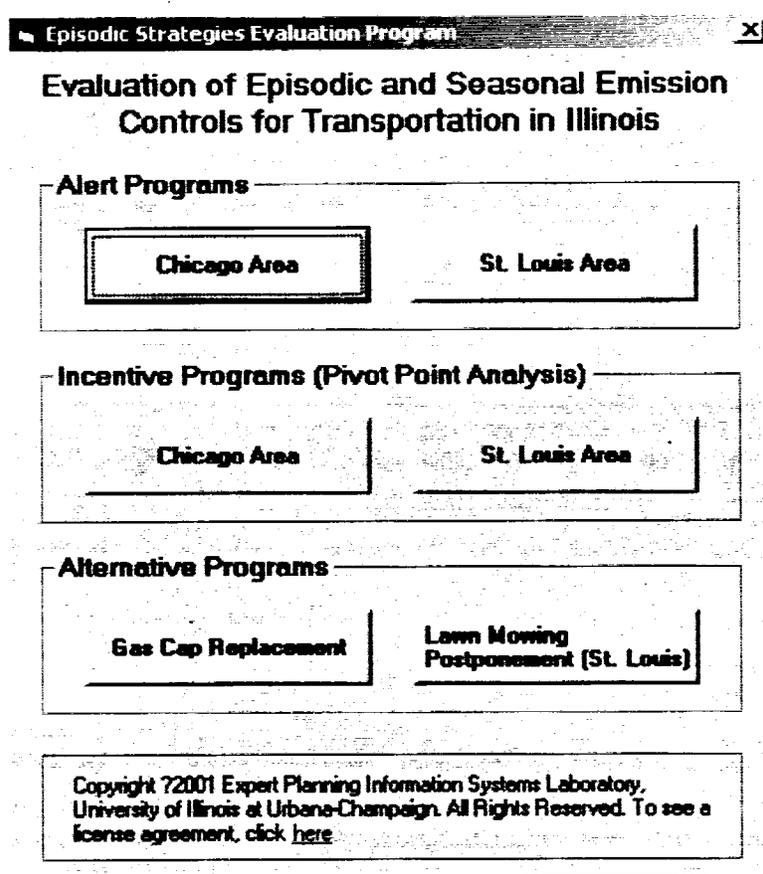


Figure 7-2. Alert Programs -Chicago

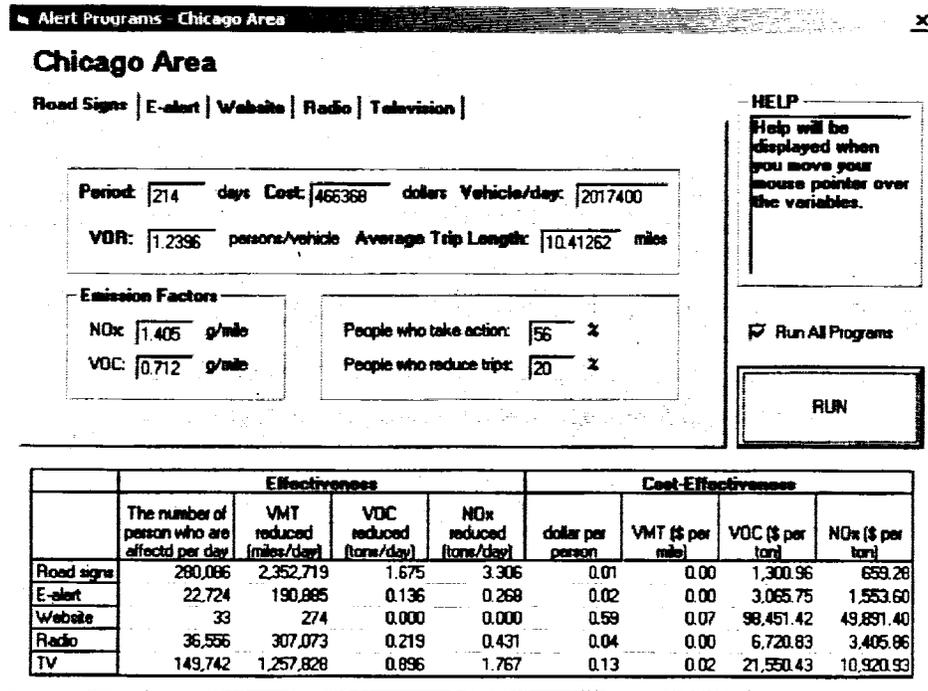


Figure 7-3. Alert Programs -St. Louis

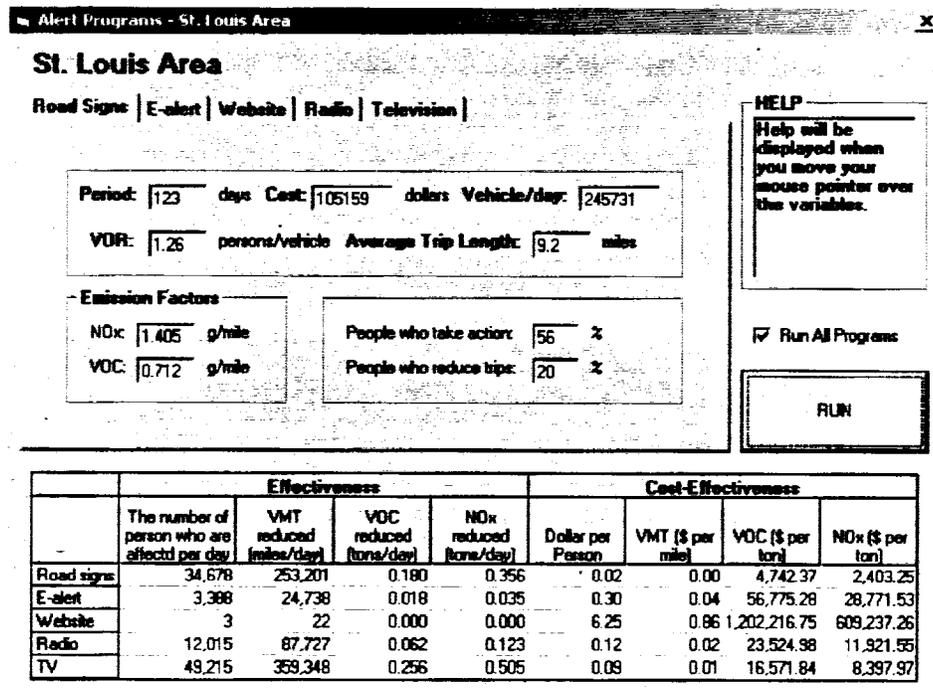


Figure 7-4. Incentive Programs – Chicago Area (1999)

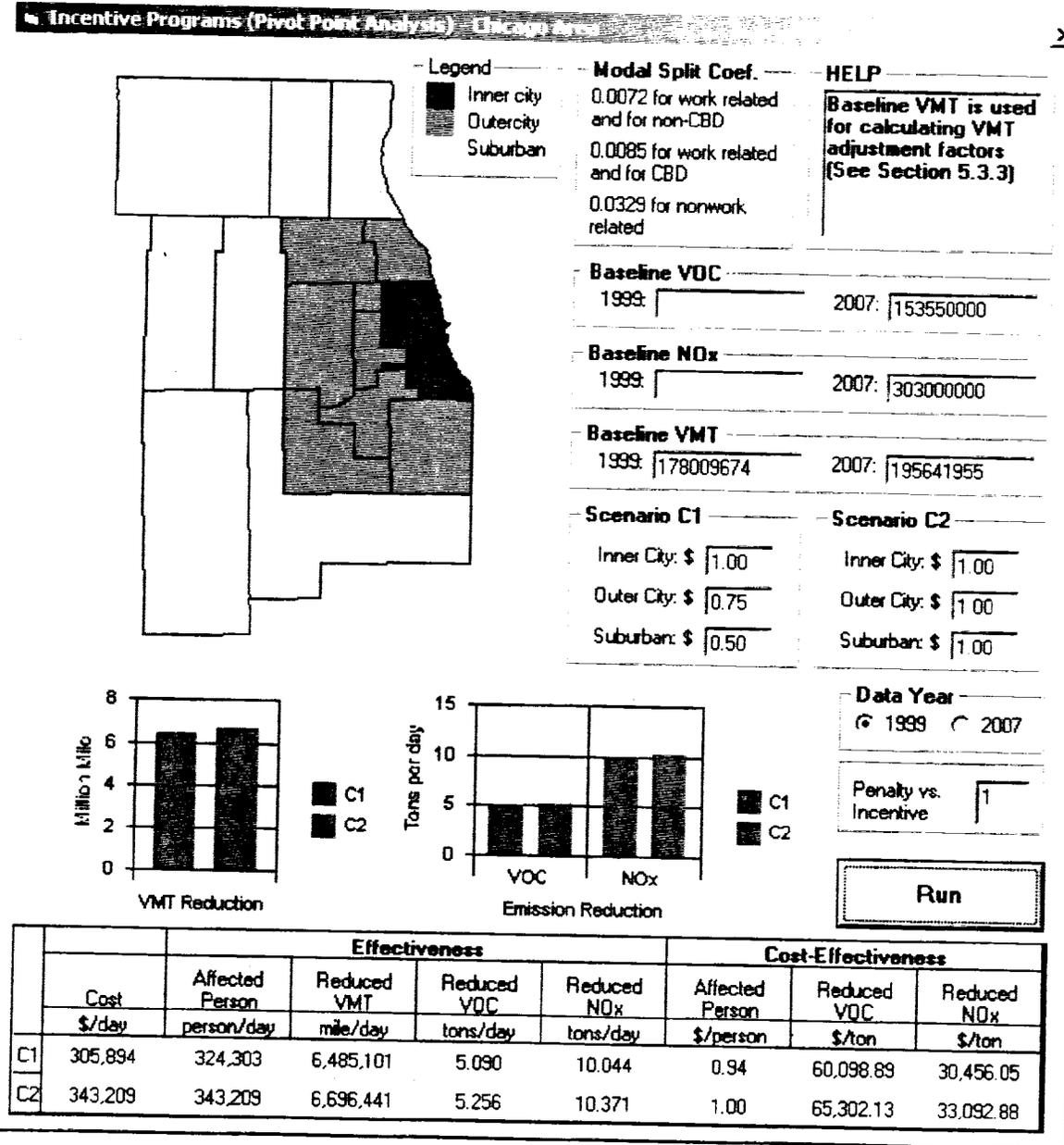


Figure 7-5. Incentive Programs – Chicago Area (2007)

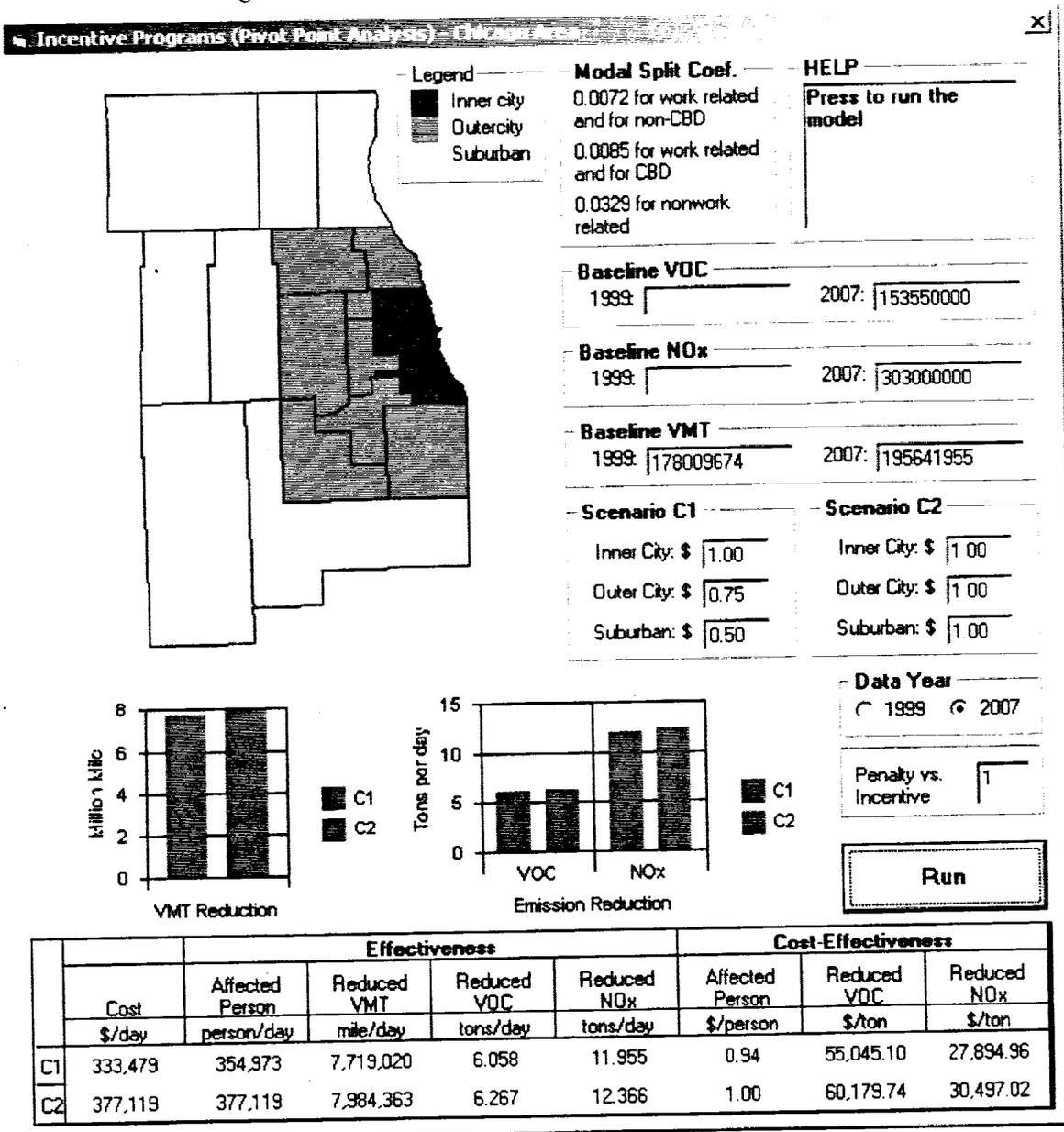


Figure 7-6. Incentive Programs – St. Louis (2000)

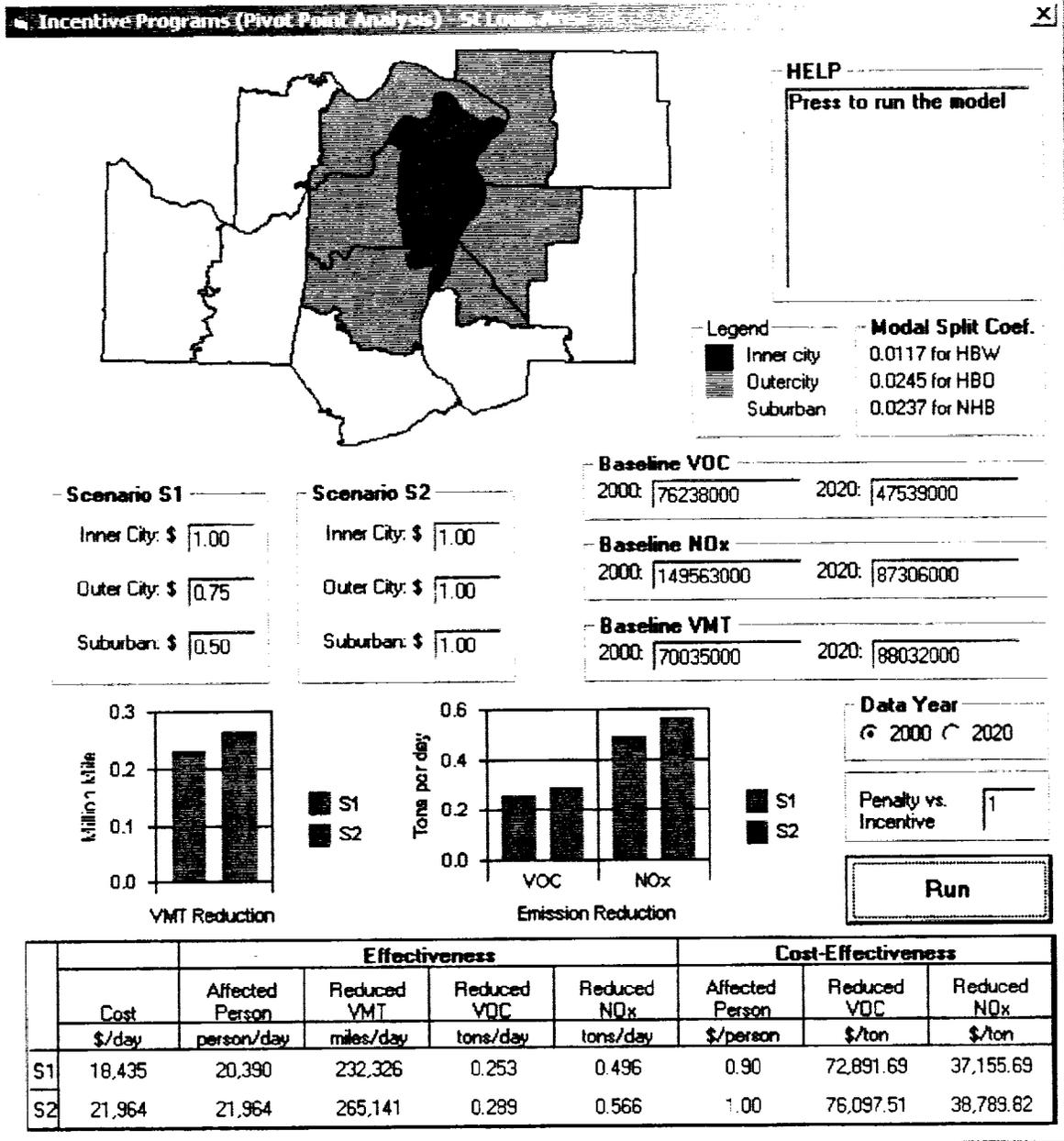


Figure 7-7. Incentive Programs – St. Louis (2020)

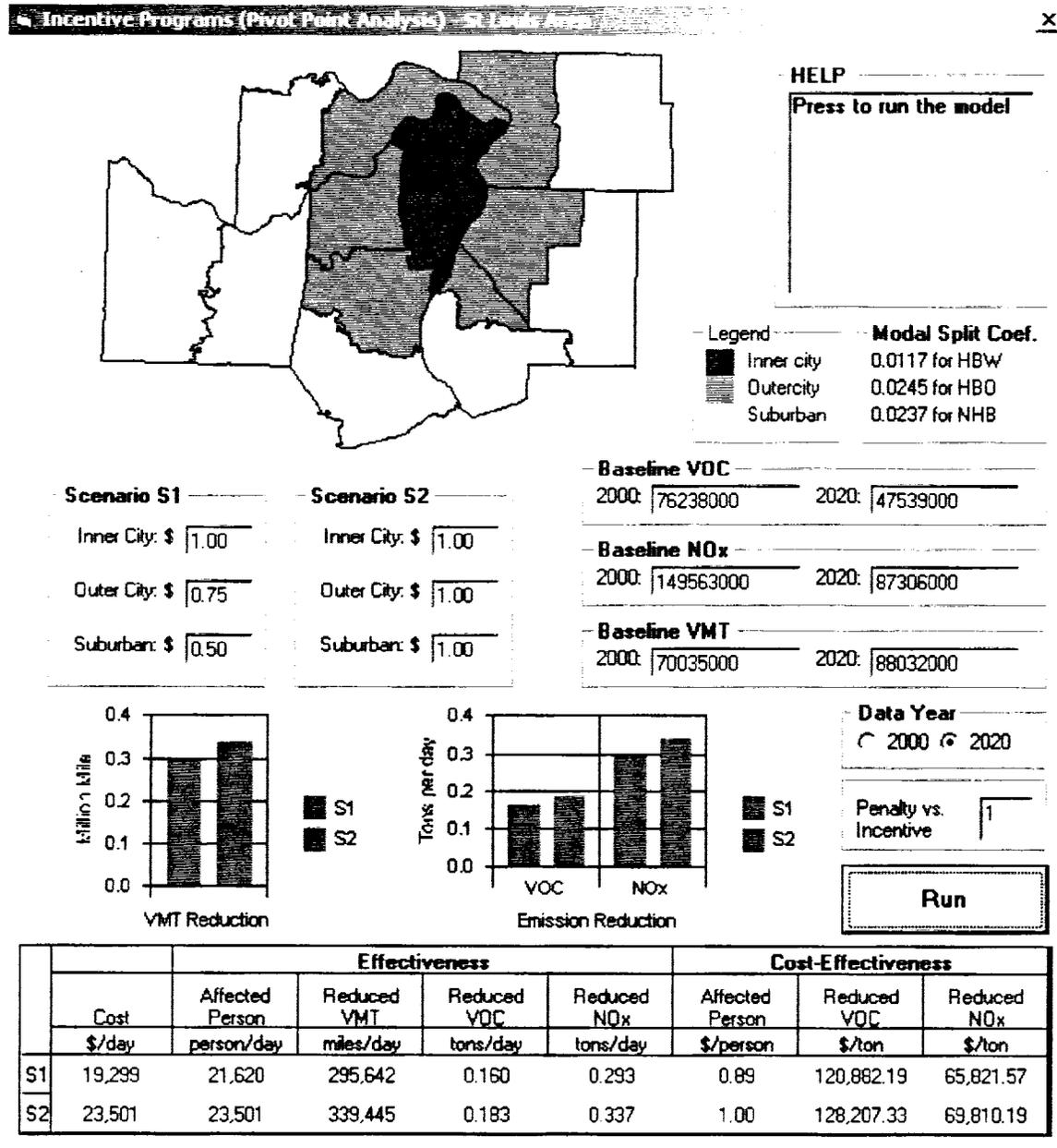


Figure 7-8. Alternative Programs (Gas Cap Replacement)

Gas Cap Replacement Program
X

### Chicago Area

Total VMT:  miles

Percentage of Vehicles 10+ years:  %

Gas Cap Replacement Cost:  \$ for a gas cap

VOR:  Average Trip Length:  miles

VOC amount by faulty Gas Cap:  g/mile

People who take action:  %

Gas Cap Life Span:  years

Annual Interest Rate:  %

RUN

Cost	Effectiveness			Cost-Effectiveness	
	Affected Person	Reduced VMT	Reduced VOC	Affected Person	Reduced VOC
\$/day	person/day	miles/day	tons/day	\$/person	\$/ton
2.364	604,891	5,073,278	5.225	0.004	452.38

**St. Louis Area**

	Number of Vehicle	I & M Failure Rate
Missouri	1404395	1.75
Illinois	311357	2.85

Total VMT:  miles

VOC amount by faulty Gas Cap:  g/mile

Average Trip Length:  miles

Gas Cap Replacement Cost:  \$ for a gas cap

People who take action:  %

Annual Interest Rate:  %

Gas Cap Life Span:  years

VOR:

RUN

Cost	Effectiveness			Cost-Effectiveness	
	Affected Person	Reduced VMT	Reduced VOC	Affected Person	Reduced VOC
\$/day	person/day	miles/day	tons/day	\$/person	\$/ton
719	187,002	1,365,414	1.406	0.004	511.39

**HELP**

Help will be displayed when you move your mouse pointer over the variables.



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## WEBSITES FOR OZONE PROGRAMS

### Sacramento region, CA

- Spare the air <<http://www.sparetheair.com/>>
- Air alert <<http://www.myairalert.net/>>
- Smog city <<http://www.smogcity.com/>>
- SECAT <<http://www.airquality.org/>>
- Guaranteed Ride Home Program <<http://www.sacramento-tma.org/app-grh.html#rules>>
- Commuter Bucks <<http://www.vpsiinc.com/>>

### San Joaquin valley, CA

- Spare the Air <<http://www.valleyair.org/sta/staidx.htm>>
- Light-Duty and Medium-Duty Vehicle Incentive Program  
<<http://www.valleyair.org/transportation/LDV%20Program/trans-LDV.htm>>
- Heavy-Duty Engine Incentive Program  
<<http://www.valleyair.org/transportation/heavydutyidx.htm>>

### South Coast Air Quality Management District, CA

- Carl Moyer Program  
<[http://www.aqmd.gov/news1/Technology/Moyer\\_brochure2.htm](http://www.aqmd.gov/news1/Technology/Moyer_brochure2.htm)>
- "Clean Air Choice" Car Labeling Program  
<[http://www.aqmd.gov/news1/Clean\\_Air\\_Choice.htm](http://www.aqmd.gov/news1/Clean_Air_Choice.htm)>
- Cut-Smog smoking vehicle program <<http://www.aqmd.gov/smog/cutsmog.html>>

### Ventura County, CA

- Employer Trip Reduction Program & commuter survey  
<<http://www.vcapcd.org/rule211.htm#background>>

### Santa Barbara, CA

- Vanpool Rider Rebate Program <<http://www.sbcag.org/vanreb.html>>
- Emergency ride home <<http://www.sbcag.org/erhmain.htm>>
- Old Car Buyback Program <<http://www.sbcapcd.org/ocbb.htm>>

### Bay Area Air Quality Management District, CA

- Spare the air <<http://www.sparetheair.org/>>
- Spare the air Employer <<http://www.sparetheair.org/employer/employer.htm>>
- Vehicle buy back program  
<<http://www.baaqmd.gov/planning/plntrns/buyback/vhbybck2.htm>>
- Vehicle incentive program <<http://www.baaqmd.gov/planning/plntrns/vip.htm>>
- Smoking vehicles program <<http://www.baaqmd.gov/pie/smv.htm>>
- RIDES <<http://www.rides.org>>
- Commuter check <<http://www.rides.org/lv2rewards/lv3cck/cck.html>>
- Parking cash-out  
<<http://www.rides.org/lv2rewards/lv3commchoice/commchoice.html>>

### New Jersey

- Ozone Action Days <<http://www.state.nj.us/dep/airmon/ozact.htm>>
- NJ TRANSIT, OZONEPASS <<http://www.ridewise.org/ozone/oz01pass.htm>>

### Pennsylvania

- Ozone Action <<http://www.dep.state.pa.us/hosting/ozoneaction/default.htm>>

### Philadelphia, PA

- Mobility Alternatives Program <<http://www.dvrpc.org/transportation/map.htm>>

### Atlanta, GA

- Clean Air Campaign <<http://www.cleanaircampaign.com/>>

### Louisville, KY

- Air Pollution Control District of Jefferson County website.  
<<http://apcd.org/index.html>>

### Northern KY

- Do Your Share for Cleaner Air  
<<http://www.nr.state.ky.us/nrepc/dep/daq/outreach/smog.html>>

### North Carolina

- NC Air Awareness <<http://daq.state.nc.us/Ozone/airaware/>>
- Mecklenburg county's Smokin' and Chokin' Program  
<<http://www.co.mecklenburg.nc.us/coenv/air/vehicle.htm>>

### South Carolina

- Ozone forecast, spare the air. <<http://www.scdhec.net/baq/>>

### Cincinnati, OH

- Clean air fare <[http://www.tankbus.org/tank\\_frame.html](http://www.tankbus.org/tank_frame.html)>
- Clean cities <<http://www.rcc.org/oem/clean.html>>

### Dayton, OH

- Miami valley regional commission, ozone action days,  
<<http://www.mvrpc.org/tr/ozoneprog.htm>>
- RideShare <<http://www.mvrpc.org/tr/rideshare.htm>>

### Milwaukee area, WI

- Lake Michigan Ozone action!, Ozone action days  
<<http://www.dnr.state.wi.us/org/aw/air/ozone/OzActionNotice.htm>>

#### Texas

- e-mail alert <<http://www.tnrcc.state.tx.us/ozone.html#program>>
- Houston's Ozone watch <<http://www.khou.com/news/stories/2168.html>>

#### Rapid city, South Dakota

- Air Quality Alert "High Winds"  
<<http://www.state.sd.us/state/executive/denr/DES/AirQuality/NEAP/neapalert.htm#Meteorological>>

#### Denver, CO

- Ozone alert kit, <<http://www.raqc.org/ozone-kit.htm>>
- Put a Cap on Ozone, <<http://raqc.org/gascap2000.PDF>>
- Connoco's car care, <<http://raqc.org/clinic%20flyer.PDF>>

#### Kansas city, MO

- Skycast <<http://www.marc.org/alt-Clean>>
- Clean air pledge <<http://www.marc.org/airquality/skycast>>

**Appendix A:**

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**Episodic and Seasonal Ozone Programs in USA**



# Appendix A: Episodic and Seasonal Ozone Programs in USA

State	Area	Programs Name	Target Domain				Subject Domain			Program Location				Target Period			Program Type			Incentive Type				
			VT	Trip	Emission per mile	Evaporative emission	Public	Employer/Employee	Others	State	Regional	Local	Others	Fixed	Seasonal	Episodic	Voluntary	Notification	Incentive	Monetary	Pricing	Others		
CA	Los Angeles & South Coast area	Cut-Smog Smoking Vehicle Program			•		•						•											
		"Clean Air Choice" Car Labeling Program			•		•						•					•				•		
		Carl Moyer Program			•		•						•					•						
		Spare the air		•	•	•	•						•											
		Commuter Bucks		•	•								•										•	
		Guaranteed ride home program		•	•								•										•	
		Air alert		•	•	•	•	•					•											
		Smog City		•	•	•	•	•					•											
		Emergency Clean Air and Transportation Program (SECAT)				•																		
		Employer Trip Reduction Program		•	•	•	•	•																
Ventura County		Commuter Survey																						
		Spare the Air		•	•	•	•	•																
		Heavy-Duty Engine Incentive Program			•		•																•	
San Joaquin Valley area	Light-Duty and Medium -Duty Vehicle Incentive Program			•		•																	•	
		Old Car Buy Back Program			•		•																	•
Santa		Old Car Buy Back Program			•		•																	•



State		Area		Programs		Target Domain				Subject Domain			Program Location				Target Period			Program Type			Incentive Type						
						VT	Trp	Emission per mile	Evaporative emission	Public	Employer/Employee	Others	State	Regional	Local	Others	Fixed	Seasonal	Episodic	Voluntary	Notification	Incentive	Monetary	Pricing	Others				
NC	Statewide	NC Air Awareness																											
		Ozone Action Day																											
SC	Charlotte	Smokin' and Chokin' Program																											
		Spare the Air																											
OH	Cincinnati area	Ozone Action Day																											
		Smog Alert																											
		Clean Air Fare																											
		Clean cities																											
	Dayton	Ozone Action Days																											
		RideShare Program																											
		Ozone Action Days																											
WI	Milwaukee	Lake Michigan Ozone Action!																											
		Ozone Action Day																											
IN	Statewide	OZONE WEB																											
		NOZONE ACTION DAYS																											
		Ridesharing program																											
		Lower Reid Vapor Pressure (RVP) Gasoline Program																											
	Southern area	Ozone Action Day																											
		Partners for Clean Air																											
MI	Detroit	OZONE ACTION!																											
		Rideshare																											



**Appendix B:**  
**Survey Questionnaire**

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# Appendix B: Survey Questionnaire

## EPISODIC CONTROL PROGRAM – SURVEY OF MANAGERS

### **G** GENERAL INFORMATION

**G1** Name of Respondent (Title): \_\_\_\_\_

**G2** Area of Expertise: \_\_\_\_\_

**G3** Agency Affiliation: \_\_\_\_\_

**G4** Phone #: \_\_\_\_\_ **G5** E-mail: \_\_\_\_\_

**G6** Names of Additional Contacts: \_\_\_\_\_

### **B** BASIC PROGRAM INFORMATION

**B1** Name: \_\_\_\_\_

#### **B2** *Geographic Area of Coverage*

**a** Cities/State: \_\_\_\_\_

**b** Counties: \_\_\_\_\_

**c** Attainment Status (CO / PM10 / O3): \_\_\_\_\_

**B3** Implementing Agency/Agencies: \_\_\_\_\_

#### **B4** *Program History*

**a** Start Date: \_\_\_\_\_ **b** End Date: \_\_\_\_\_

**c** Implementation Milestones (i.e., program phases or major changes):

**D PROGRAM DESIGN**

**D1** Stated Program Goals (Please circle all that apply and then rank the three most important, with 1 being the most important and 3 being the least):

- |   |  |             |
|---|--|-------------|
| 1 | Public education                                       | rank: _____ |
| 2 | To attain air quality standards (NAAQS)                | rank: _____ |
| 3 | To meet specific emission reduction targets            | rank: _____ |
| 4 | Congestion management                                  | rank: _____ |
| 5 | Economic benefits to the area of staying in attainment | rank: _____ |
| 6 | Health benefits  | rank: _____ |
| 7 | To maintain the attainment status of the area          | rank: _____ |
| 8 | Other (Please specify): _____                          |             |
- 

The following questions ask about specific actions that can be taken by program participants to reduce emissions from mobile, area and stationary sources. While many of the choices provided may be effective means to reduce emissions, **please choose only those which are explicitly recommended by the program.**

**D2** Specific Travel-Related Suggestions Made to the General Public on Pollution Episode Days (Circle all that apply.):

- 1 No travel-related suggestions are being made
  - 2 Avoid driving at lunch time (take lunch to school or work)
  - 3 Use alternative modes of transportation (car/vanpools, transit, etc) instead of driving alone
  - 4 Keep vehicle tuned-up
  - 5 Combine multiple auto trips throughout the day
  - 6 Work from home (telecommute)
  - 7 Avoid refueling until the evening (i.e., after 6 p.m.)
  - 8 Keep travel speeds at the speed limit and steady
  - 9 Change work schedules to avoid the commute
  - 10 Other (Please specify): \_\_\_\_\_
-

**D3** Specific Suggestions being Made to the Public on Pollution Episode Days to Reduce Area Source Emissions (Circle all that apply):

- 1 No suggestions are made to the public to reduce area source emissions
  - 2 Avoid using gasoline-powered garden equipment (lawnmowers, blowers, etc)
  - 3 Avoid using charcoal lighter fluid
  - 4 Avoid household maintenance activities that produce emissions (painting, degreasing, etc)
  - 5 Other (Please specify): \_\_\_\_\_
- 

**D4** Does the program include a *company participation element* whereby local businesses notify their employees when an air pollution episode occurs and inform them of actions they can take to help?

- 1 Yes
- 2 No (Skip to Question **D7**)

**D5** Specific Travel-Related Suggestions that the Program Encourages Companies to Make to Their Employees on Pollution Episode Days (Circle all that apply):

- 1 No measures are suggested by the program
  - 2 Use alternative modes of transportation for the commute to and from work (car/vanpools, transit, etc)
  - 3 Avoid driving at lunch time (eat lunch at work)
  - 4 Keep vehicle tuned-up
  - 5 Work from home (telecommute)
  - 6 Avoid refueling until the evening (i.e., after 6 p.m.)
  - 7 Keep travel speeds at the speed limit and steady
  - 8 Change work schedules to avoid the peak-hour commute
  - 9 Other (Please specify): \_\_\_\_\_
- 

**D6** Temporary Policy Changes that the Program Encourages Companies to Make on Pollution Episode Days (Circle all that apply):

- 1 No measures are suggested by the program
  - 2 Postpone fleet refueling until the evening (i.e., after 6 p.m.).
  - 3 Use fleet vehicles to attend lunch and meetings
  - 4 Use conferencing technologies instead of face to face meetings
  - 5 Other (Please specify): \_\_\_\_\_
-

**D7** Does the program include a *stationary source element* whereby participating industries voluntarily take actions to reduce emissions on pollution episode days?

- 1 Yes
- 2 No (*Skip to Question D9*)

**D8** Specific Suggestions made to Stationary Sources on Pollution Episode Days (*Circle all that apply*):

- 1 Reduce high-emitting production activities
- 2 Avoid maintenance activities (painting, degreasing, tank cleaning, etc)
- 3 Postpone landscaping activities (lawn mowing, tractor & backhow use, etc.)
- 4 Switch to cleaner burning fuels
- 5 Other (*Please specify*): \_\_\_\_\_  
\_\_\_\_\_

**D9** Forecasting Pollution Episodes:

**a** Agency or organization providing the weather forecasts: \_\_\_\_\_

**b** Agency or organization forecasting the pollution episodes: \_\_\_\_\_

**c** *Standards/methodologies used for making pollution episode determinations:*

**c<sub>1</sub>** Parameters examined to forecast episode day: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**c<sub>2</sub>** Method used to forecast episode day (*Circle all that apply*):

- 1 Persistence
- 2 Empirical
- 3 Meteorological Intuition
- 4 Algorithm based
- 5 Other (*Please specify*): \_\_\_\_\_

**c<sub>3</sub>** Please discuss how the method was developed: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**c<sub>4</sub>** Please discuss how accurate the method is and whether data on accuracy are available: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**D10** Groups Notified of a Forecasted Pollution Episode (Circle all that apply):

- |   |                                  |   |
|---|----------------------------------|---|
| 1 | Television stations              | Method of notification (fax, phone, etc): _____ |
| 2 | Radio stations                   | Method of notification (fax, phone, etc): _____ |
| 3 | Newspapers                       | Method of notification (fax, phone, etc): _____ |
| 4 | Participating Stationary Sources | Method of notification (fax, phone, etc): _____ |
| 5 | Participating Employers          | Method of notification (fax, phone, etc): _____ |
| 6 | Gas stations                     | Method of notification (fax, phone, etc): _____ |
| 7 | Other (Please specify): _____    |   |

**a** After being notified of a pollution episode, how do the *television stations* report this information to the public?  
(Circle all that apply. → skip this question if television stations are not notified)

- 1 Mentioned in the news report
- 2 Discussed in the weather forecast
- 3 A public service announcement is broadcast
- 4 Other (Please specify): \_\_\_\_\_

**b** After being notified of a pollution episode, how do the *newspapers* report this information to the public?  
(Circle all that apply. → skip this question if newspapers are not notified)

- 1 Included with the Pollutant Standard Index (PSI) report
- 2 Mentioned in an article
- 3 Space is allocated for an announcement
- 4 Other (Please specify): \_\_\_\_\_

**c** After being notified of a pollution episode, how do the *radio stations* report this information to the public?  
(Circle all that apply. → skip this question if radio stations are not notified)

- 1 A public service announcement is broadcast
- 2 Radio hosts make announcements
- 3 Mentioned in the news report
- 4 Other (Please specify): \_\_\_\_\_

**d** After being notified of a pollution episode, how do the *gas stations* report this information to the public?  
(Circle all that apply. → skip this question if gas stations are not notified)

- 1 Through the use of gas station flags
- 2 Messages on gas pumps
- 3 Other (Please specify): \_\_\_\_\_

**D11** Education/Outreach

**a** Agency/organization in charge of public education & outreach: \_\_\_\_\_  
\_\_\_\_\_

**b** Methods used to inform the public about the program (*Circle all that apply*):

- 1 Television advertisements      2 Radio advertisements
- 3 Newspaper advertisements      4 Billboard advertisements
- 5 Internet web site      6 Workshops (for schools, industry, public)
- 7 Public education booths at community events
- 8 Creation and dissemination of public education materials
- 9 Provide information to participating employees through their employers
- 10 Other (*Please specify*): \_\_\_\_\_

**c** Was a survey conducted, or is one being planned, to establish a baseline of existing knowledge about the program?

- 1 Yes
- 2 No (*Skip to Question D12*)

**d** Was a follow up survey conducted, or is one being planned, to test the effectiveness of the outreach program?

- 1 Yes
- 2 No

**D12** Legal Authority

Are there any local or state laws/regulations that mandate the existence of the program?

- 1 Yes      **a** *If Yes, please specify the law or regulation:* \_\_\_\_\_  
\_\_\_\_\_
- 2 No

**D13** Enforceable Commitments

Is the program included in a State Implementation Plan (SIP) or maintenance plan or do stationary sources include it in their permits?

- 1 Yes
- 2 No

**F PROGRAM FUNDING AND ADMINISTRATION**

**F1 Funding Sources for Each Agency Involved in the Program**

*In the spaces below please provide the funding source for each agency, and the funding duration (i.e., year long or seasonal funding).*

	<u>Agency</u>	<u>Funding Source</u>	<u>Funding Duration</u>
<i>Example:</i>	APCD	ISTEA, CMAQ	Seasonal (May - Sept.)
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

**F2 Budget**

1999/2000 Budget: \_\_\_\_\_

**F3** *In the spaces provided below please provide a budget breakdown for each budget area (i.e., administration, public outreach, data collection etc):*

	<u>Agency</u>	<u>Budget Area</u>	<u>Amount (\$)</u>
<i>Example:</i>	APCD	Administration	\$75,000 / yr
	APCD	Public outreach	\$25,000 / yr
	ABC Consultant	Analysis	\$25,000 / yr
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

**F4** Is the program's current fiscal year (1999/2000) budget an adequate amount of funding to fulfill the programs goals? ?

- 1 Yes
- 2 No

**a** How would the program use an additional \$100,000? \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**b** How would the program use an additional \$200,000? \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**F5** In-Kind Contributions (Donations, Services Provided by Corporations/Agencies):

---

---

**F6** Staffing (For each category below, please indicate the number of staff working on the episodic control program)

	<u>Paid</u>	<u>Volunteer</u>	<u>Total</u>
<b>a</b> Number of full-time staff (or full-time equivalents) at the <i>main agency</i> implementing the program	_____	_____	_____
<b>b</b> Number of full-time staff (or full-time equivalents) at <i>other agencies</i> affiliated with the program	_____	_____	_____

**F7** Total Cost of Program

---

**P** **PROGRAM PARTICIPATION**

**P1** Predicted Participation Levels:

Were estimates of participation levels made prior to the start of the program?

- 1 Yes
- 2 No (Skip to Question **P2**)

**a** If Yes, please indicate the predicted number of participants for each of the following groups:

	<i>Number</i>
Stationary sources	_____
Employers	_____
Individual drivers	_____
Users of non-road engines (garden equipment, etc)	_____
Users of woodburning stoves	_____
Other (Please specify): _____	_____

**P2** Actual Participation Levels:

Are actual program participation levels being tracked?

- 1 Yes
- 2 No (*Skip to Question P3*)

**a** *If Yes, please indicate the number of participants for each of the following groups:*

	<i>Number</i>
Stationary sources	_____
Employers	_____
Individual drivers	_____
Users of non-road engines (garden equipment, etc)	_____
Users of wood burning stoves	_____
Other ( <i>Please specify</i> ): _____	_____

**P3** Incentives Offered to Encourage Employer Participation:

- 1 Public recognition
- 2 Flexibility on local permits
- 3 Other (*Please specify*): \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**P4** Incentives Offered by Employers to Encourage Participation by their Employees:  
(*Circle all that apply*):

- 1 No incentives are being offered
- 2 Free or discounted transit fares
- 3 Allow flexible work schedules
- 4 Free or discounted lunches
- 5 Preferential parking for car/vanpools
- 6 Guaranteed emergency rides home for employees who car/vanpool or take transit
- 7 Other (*Please specify*): \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**P5** Incentives Offered to Encourage Participation by the General Public (Circle all that apply):

- 1 No incentives are being offered
- 2 Free transit
- 3 Transit discounts
- 4 Auto repair / tune-up discounts
- 5 Monetary rewards
- 6 Other (Please specify): \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**P6** Data Collected to Estimate Participation Levels (Circle all that apply):

- 1 No data is being collected
- 2 Transit ridership levels
- 3 Gas sales data
- 4 Traffic counts
- 5 Employee participation rates provided by participating employers
- 6 Information provided by participating stationary sources
- 7 Information provided by participating companies that use non-road engines (i.e., landscaping companies reporting that they didn't use lawn mowers for the day)
- 8 Other (Please specify): \_\_\_\_\_  
\_\_\_\_\_

**E** **PROGRAM EVALUATION**

**E1** How was the participation data collected in Question **P6**? (Circle all that apply):

- 1 Surveys completed by the general public
- 2 Surveys completed by participating stationary sources and companies/employers
- 3 Communication with participating stationary sources and companies/employers via telephone, fax, e-mail, or in-person interview.
- 4 Received gas sales data from oil companies & refineries
- 5 Received transit ridership level data from transit agency
- 6 Other (Please specify): \_\_\_\_\_

**E2** Did the collected data include a Trip Table (origin/destination table)?

- 1 Yes **a** If yes, was this:
  - 1 by mode
  - 2 by destination
  - 3 Other (Please specify): \_\_\_\_\_
- 2 No





**Appendix C:**  
**List of Organizations Surveyed**

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## Appendix C: List of Organizations Surveyed

No.	Program Name	Area of Coverage	Targeted Pollutant	Attainment Status	Agency	Program Start Year	Contact		
							Contact Person	Address (Phone)	Email
1	Ozone Alert Program	Tulsa Metro area	CO PM10 O <sub>3</sub>	Attainment for all	Council of Government - Tulsa	1991	Nancy Graham	210 West 5th Street, Suite 600 Tulsa, OK 74103 (918-584-7526)	Ngraham@incog.org
2	ENDZONE Partners	Baltimore, MD and Washington, D.C.	O <sub>3</sub>	Severe Non-attainment for 1 hr ozone (Baltimore)	Metropolitan Washington Council of Governments, MD Dept. of the Environment, & Baltimore Metropolitan Council	1995	Randy Mosier	410-631-3240	rmosier@md.e.state.md.us
3*1	Partnership for a Smog-Free Georgia	13 county Metro Atlanta area	O <sub>3</sub>	Serious Non-attainment	Georgia Environmental Protection Division	1997	Marlin R. Gottschalk	404-363-7024	Marlin_gottschalk@mail.dnr.state.ga.us
4	Hi Pollution Advisory Program	Denver, CO	CO PM10/ O <sub>3</sub>	Serious Non-attainment	Colorado Dept. of Public Health and Environment	1987	Christopher E. Dann	303-692-3281	Christopher.dann@state.co.us
5	Spare the Air	San Joaquin Valley area	O <sub>3</sub> PM10 CO	Severe Non-attainment Serious Non-attainment Attainment	San Joaquin Valley Air Pollution Control District	1996	Josette Merced Bello	1990 E. Gettysburg Ave, Fresno, CA 93726-0244 (559-230-5800)	
6	Ozone Action Days	State of MD, Baltimore - Washington metro area	O <sub>3</sub>	Non-attainment	Endzone Partners, Baltimore Metropolitan	1996	Bob Maddox	410-631-3265	rmaddox@md.e.state.md.us
7	Woodstove Burn Bans	Seattle, Tacoma, Everett, Bremerton, WA	CO/PM10/ O <sub>3</sub>	Attainment for all	Puget Sound Clean Agency	1988	Jim Nolan	110 Union Street, Suite 500 Seattle, WA 98101-2038 (206-689-4053)	jimm@psclease.nair.org

\* : Agencies answered that their programs were effective.

No.	Program Name	Area of Coverage	Targeted Pollutant	Attainment Status	Agency	Program Start Year	Contact		
							Contact Person	Address (Phone)	Email
8	Episodic Voluntary Ozone Control Program	PA & NJ	O <sup>3</sup>	Severe Non-attainment	Delaware Valley Regional Planning Commission	1996	Steve Luxenberg	Bourse Blvd 8th floor 111 S Independence Mall East Philadelphia, PA 19106-5215 (215-238-2860)	sluxenberg@dvrpc.org
9	Ozone Alert!	Detroit, MI Metro region	CO/PM10/ O <sup>3</sup>	Attainment for all	Clean Air Coalition of Southeast Michigan	1994	Anita Blasius	313-961-4266	blasius@semcog.org
10*	Regional Ozone Coalition	Greater Cincinnati area-Ohio & Northern Kentucky	O <sup>3</sup>	Attainment	OKI Regional Council of Governments	1994	Judi Craig	801-B West 8th Street, Suite 400 Cincinnati, OH 45203 (513-333-4741)	-
11	Wintertime Pollution Advisory/ Carbon Monoxide Pollution Alerts	Albuquerque, NM	CO PM10/ O <sup>3</sup>	Attainment under a maintenance plan (1996) Attainment	Air Quality Division	1989	Dan Warren	P.O.Box 1293 Albuquerque, NM 87103 (505-768-2637)	dwarren@ca bq.gov
12	-	Washington State	PM10	Non-attainment in north Thurston County	Olympic Air Pollution Control Authority (OAPCA)/ Washington State Dept. of Ecology (DOE)	1991	Craig Weckasu	909 Sleater-Kinney Road SE, Suite 1 Lacey, WA 98503 (360-438-8768)	-
13	Spare the Air	Sacramento region, CA	O <sup>3</sup> / CO	Non-attainment Attainment	Sacramento Metropolitan Air Quality Management District(SMAQMD)	Spare the Air : 1995	Kerry Shearer	8411 Jackson Road, Sacramento, CA 95826 (916-874-4810)	kshearer@airquality.org

No.	Program Name	Area of Coverage	Targeted Pollutant	Attainment Status	Agency	Program Start Year	Contact		
							Contact Person	Address (Phone)	Email
14*	Air Quality Research and Planning	Corpus Christi, TX	O <sup>3</sup>	Attainment	City of Corpus Christi, Texas A&M at Kingsville, Texas A&M at Corpus Christi, and Air Quality Committee	1995	Ronald K. Barnartl	361-857-1848	fvcrew@aol.com
15	Air Watch (winter air quality advisory program)	Spokane County, WA	CO PM10	Serious Non-attainment Moderate Non-attainment	Spokane County Air Pollution Control Authority/ Spokane Transit	1997	Lisa Woodard	1101 West College, Suite 403 Spokane, WA 99201 (509-477-4727ext#115)	publicinfo@scapca.org
16	Air Quality Planning	North Central Texas	CO/ PM10	-	North Central Texas Council of Government/ North Texas Clean Air Coalition	1990	Christopher klaus	2124 Park 35 Circle Austin, TX 78711 (817-695-9286)	cklaus@dfninfo.com
17	ENDZONE	Northern VA, Richmond area	O <sup>3</sup>	Non-attainment	ENDZONE Partners/ Richmond Ridefinders	Over a decade	David J. Kinsey	804-698-4432	djkinsey@deq.state.va.us
18	ENDZONE Partners	Baltimore, MD and Washington, D.C.	O <sup>3</sup>	Severe Non-attainment for 1 hr ozone (Baltimore) Serious Non-attainment for 1 hr ozone (Washington, D.C.)	Metropolitan Washington Council of Governments, MD Dept. of the Environment, Baltimore Metropolitan Council, Virginia Dept. of Transportation, MD Dept. of Transportation, D.C. Dept. of Public Works, Virginia Dept. of Environmental Quality, D.C. Dept. of Health	1994	Joan Rohlfis	202-962-3358	jrohlfis@mw cog.org
19*	Spare the Air/Spare the Air Tonight (winter)	Bay Area, CA	O <sup>3</sup> PM10 CO	Non-attainment Attainment Attainment	Cities, Counties, Private & Public Industry, Bay Area Citizens and The Bay Area Air Quality Management District	1991	Teresa Lee	415-749-4900	Tlee@baaq md.gov



**Appendix D:**

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**User Manual for Episodic Strategies Evaluation  
Program (ESEP)**



# **Appendix D: User Manual for Episodic Strategies Evaluation Program (ESEP)**

## **D.1 Overview of ESEP**

We developed the Episodic Strategies Evaluation Program (ESEP) hoping that users could derive new results without much difficulty using different set of data. Policy makers in other parts of the country could evaluate selected episodic strategies for their own purposes ESEP. We hope also that in the years to come when new socio-economic data as well as other air quality data are collected, the provided tools could shed light on the evaluation of new strategies to cope with the new environment.

ESEP consists of three parts corresponding to our Episodic Strategies. These are 1) Alert Program, 2) Incentive Program (Pivot Point Analysis), and 3) Alternative Program. For every data entry, we provided default values, the same data we used in this report.

The tools to develop ESEP are Microsoft Visual Basic 6.0 and ESRI MapObject 2.0.

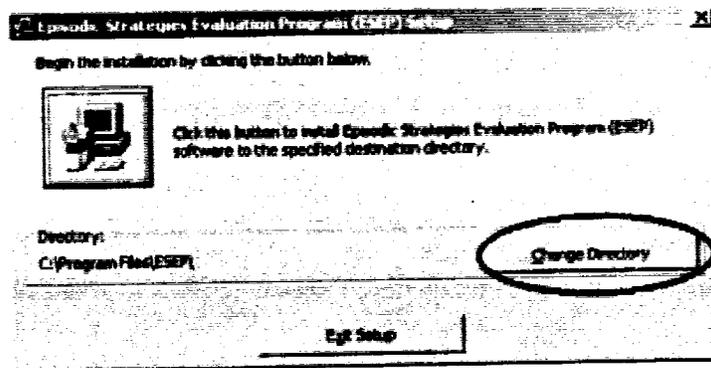
## **D.2 ESEP Installation**

To install ESEP in your system, you must have following files:

**Setup.exe**  
**Setup.lst**  
**ESEP1.cab**  
**ESEP2.cab**  
**ESEP3.cab**  
**ESEP4.cab**  
**ESEP5.cab**

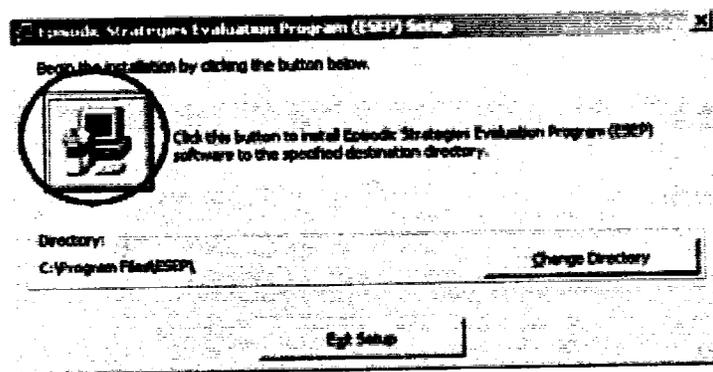
Executing **setup.exe** will install ESEP to your system.

The default location of installed ESEP is "C:\Program Files\ESEP". If you want to change the location, click on "Change Directory" button in the dialog box shown below and select new location.



**Figure D-1. Change Directory Button**

After changing the location (or with the default location), Click the installation button (shown below) to proceed to the installation.



**Figure D-2. Installation Button**

### **D.3 ESEP Operations**

When you start ESEP, you will see the main window as shown below:

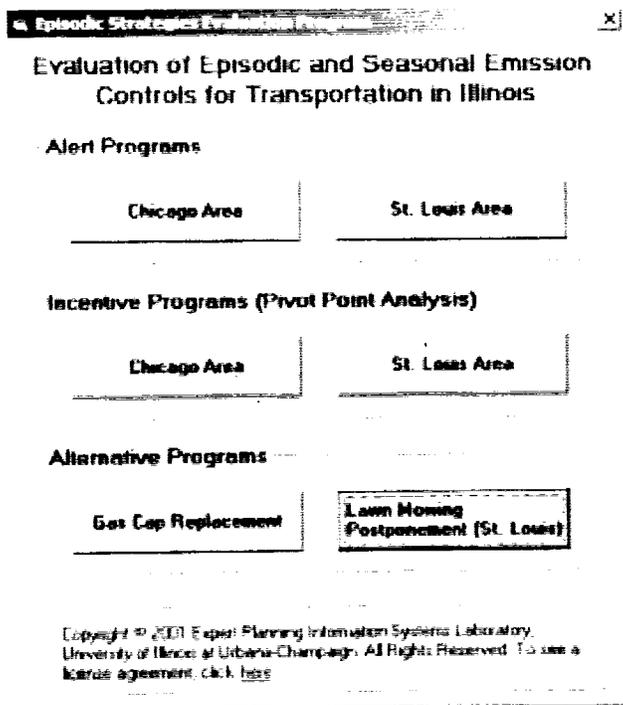


Figure D-3. Main Window

This window contains series of buttons for various analyses. If you click on one of the buttons, you will have new window for the analysis of your choice. After finishing your analysis, if you close the analysis window, the main window shown above will display again for you to choose another analysis.

There are three main operations in ESEP you should know. First, when you move your mouse pointer over the input data fields, the help statement will be displayed in "Help" box as shown below. The help statement includes the explanation or definition of the input data and/or the section number of this report for further descriptions.

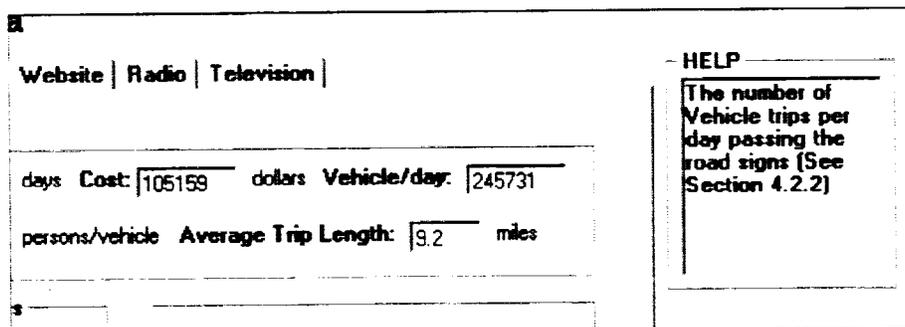


Figure D-4. Displaying Help Statement





