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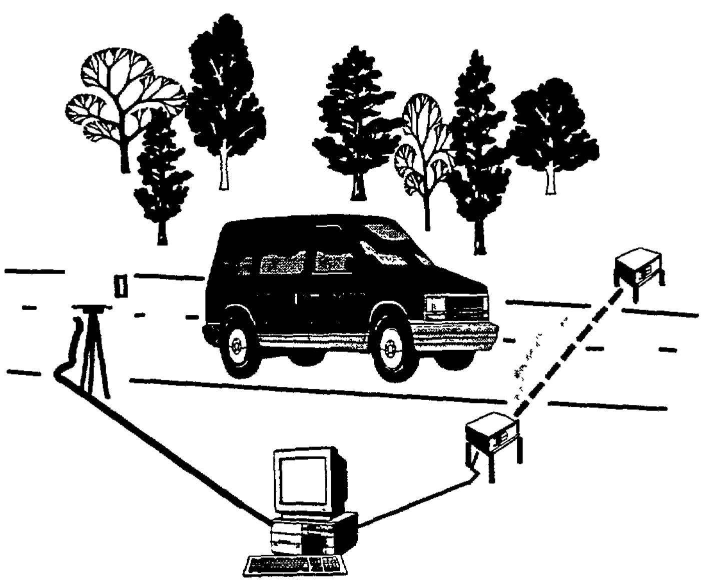
Ada Planning Association

No. 15-96

Individual Evaluation Test Plan Report #1

Origin and Destination Survey and Emissions Monitoring at External Stations



Final Report
April 1996

Clair M. Bowman
Executive Director

Erv Olen
Deputy Director

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List of Acronyms

ACHD	Ada County Highway District
APA	Ada Planning Association
AQB	Air Quality Board
C O	Carbon Monoxide
EPA	Environmental Protection Agency
FHWA	Federal Highway Administration
HC	Hydrocarbon
I&M	Inspection and Maintenance
ISTEA	Intermodal Surface Transportation Efficiency Act
ITD	Idaho Transportation Department
ITS	Intelligent Transportation Systems
LPR	License Plate Recognition
MOE	Measures of Effectiveness
O/D	Origin and Destination
PM10	Particulate Matter (10 parts per billion)
RSD	Remote Sensing Devices

CH2M HILL
Engineers
Planners
Economists
Scientists

March 11, 1996

108807.OT

Cathy Garner
Federal Highway Administration
3050 LakeHarbor, Suite 126
Boise, ID 83703

Subject: Independent Review of the Individual Evaluation Test Plan Report #1 for the Travel Demand Management -- Emissions Detection ITS Operational Test

Dear Cathy:

Ada Planning Association (APA) is conducting the subject project and CH2M HILL is providing independent evaluation services to APA. As independent evaluators, we are required to review the final analyses/reports and provide comments to be incorporated as part of the final documents. The review is complete and this letter represents the results.

Introduction

The Independent Evaluation Team included Dr. Michael Kyte (University of Idaho) and Dr. Patrick Shannon (Boise State University), and was led by Fred Kitchener (CH2M HILL). The evaluation model for this ITS Operational Test, approved by FHWA, was for the primary team members conducting the test (APA, Idaho Transportation Department, and the Air Quality Board) to also conduct the analyses of the test data. The role of the Independent Evaluation Team was one of observation, review, and participation where appropriate. This included the opportunity to perform separate analyses of the data, with the intent of confirming or rejecting the conclusions of the project team.

The Independent Evaluation Team has been actively involved in this project helping to guide the planning, conduct, and data analyses of this ITS test. During the planning process, we played an active support role assisting in the development of the detailed evaluation test plan documents. In addition, we observed the data collection and provided input to the data analyses throughout the conduct of the test phases.

Independent Evaluation Approach

Specific to this final report, the Independent Evaluation Team performed the following activities in support of the test evaluation:

- Observed the conduct of test data collection at multiple sites on separate testing days. This included participating in a phone interview to determine public perceptions regarding this data collection approach.
- Participated in review meetings discussing preliminary test results in an effort to determine the primary conclusions.
- Reviewed drafts of this report and provided comments.
- Conducted analyses of selected test data and provided input to APA.
- Reviewed the final version of this report and provided the Independent Evaluation Team response contained in this letter.

The Project Team which conducted this test were open and responsive to the thoughts, ideas, inputs, and suggestions from the Independent Evaluators throughout the entire performance of this project.

Findings and Conclusions

As with any project that attempts to implement advanced technology in a new application, this project was confronted with significant challenges not known at the time of planning and required adjustments to test data collection approaches and expansion of the level of data analyses in order to clearly understand the conclusions. This in one sense limited the evaluation of the test, however, in another sense provided insight into previously unknown and unanticipated results. These challenges and limitations are defined in the final test report.

Having said this, the team which conducted the tests and analyzed the data did an excellent job adjusting to the test conditions in order to achieve the project goals. The operations of the test and management of the data was well organized which led to meaningful results. What was the primary reason for this commitment? Our observation is that the parties involved believed the benefits of this technology application (to provide useful information to solve transportation problems) were important enough to justify the extra effort. This is important to note in light of many other ITS Operational Tests which have not been able to meet the challenges confronting them which resulted in either significantly reducing the extent of testing or, in extreme cases, terminating the project. This project should be recorded as a successful example of what can be accomplished when a group of people from different agencies are determined to work together to accomplish common goals.

Specific noteworthy findings and conclusions are as follows:

- This test supports all the specific national ITS goals to improve safety, reduce congestion, enhance productivity/efficiency of existing transportation systems, and reduce harmful environmental impacts. The results of this test have direct application in other cities of similar size across the nation and should be referenced prior to consideration of ITS applications.
- The application of this technology to conduct origin/destination studies (with the appropriate implementation adjustments as described in the final report) to collect necessary data in support of transportation planning activities has promise and should be considered as an appropriate alternative to traditional methods.
- This technology can provide valuable emissions data (carbon monoxide only was the focus of this test) from moving vehicles to support planning of emissions testing programs. Phase III of this test will determine whether this technology can be a useful tool to augment existing testing programs.
- No significant legal or institutional issues arose during or after this test. The majority of people surveyed support the use of this technology to collect the test specific data and did not find it an invasion of their privacy.

In conclusion, we support the conduct, evaluation, and conclusions as described in this final report. We have appreciated the opportunity to contribute the success of this project.

Sincerely,

CH2M HILL

Patrick Shannon

Fred M. Kitchener
ITS, Project Manager

Patrick Shannon
Boise State University

Michael Kyte

Michael Kyte
University of Idaho

c: Jeff Fuller, CH2M HILL
Ali Bonakdar, APA

Executive Summary

Ada County was chosen to be a part of the national Operational Test for Intelligent Transportation Systems (ITS). ITS applies new technologies and concepts to improve transportation systems, efficiency, mobility, energy and environmental impacts, and create a viable industry.

During the week of April 23-29, 1995, two individual ITS tests were conducted in Ada County. These two tests were part of a three-phase operational test. The third phase is discussed in a separate Evaluation Test Plan Report.

Tests were designed to find out if Remote Sensing Devices (RSD) can be used to achieve these goals:

- Phase I - Make it simpler and less costly to conduct Origin/Destination (O/D) studies which are used to gather travel pattern data in Treasure Valley.

- Phase II - Measure and compare emissions levels of autos which are tested regularly with those not tested.

RSD used infrared sensors to measure pollutant levels in an auto's exhaust while the auto was moving at normal speed on roadways and highways. This technology also used a video camera to take a picture of the auto's license plate. With these data, an auto could be identified and an O/D survey mailed to its owner.

This executive summary identifies key results and conclusions of chapters in this Evaluation Test Plan Report: 1) test objectives which relate to both Phases I and II; 2) O/D survey; 3) emissions testing at external stations; and 4) institutional, legal, and public acceptance issues.

I. Test Operations

Overall, the RSD system performed well and transportation impacts were minimal. The Evaluation Team for this project indicated they were impressed with the overall operations and would use it again. The key results and findings for the test operations that relate specifically to Phases I and II are:

- License plate recognition equipment (LPR) can transcribe video images of license plates into text output. Seventy-six percent of the license plates were readable by the LPR equipment with minimal staff assistance.

- The percent uptime for the equipment was approximately 98 % . The mean time between failures was over 11 hours. The modal repair time was 5 minutes.

- Electronic interchange (downloading, storing, sorting, and retrieving data) and matching license plate data with State vehicle registration data were performed very efficiently without any major problems.

- From among the 20 test sites, only one traffic incident occurred which a created traffic safety concern. This may have been avoided by having an earlier set up time and by minimizing the number of personnel and vehicles at that test site.

- Driver performance through the test sites were affected by the LPR/RSD equipment and traffic control. However, this could be expected with any type of construction or traffic control along the roadside.

II. Origin and Destination Survey

The LPR technology was capable of conducting an external O/D survey. The automation of the travel survey process created a quick turnaround time and high quality responses. This methodology minimized hazardous driving incidents, eliminated disruption of traffic flow, and reduced the inconvenience to the motorists. While the cost effectiveness of LPR methodology compared to traditional methodology was not conclusive, the hidden costs to the motorists and field technicians (i.e., convenience, safety, etc.) would justify its use for future O/D surveys. Key results and findings for the O/D survey are:

- Survey return rate for the LPR/RSD method was 37 % . The quick turnaround time using LPR technology to get the O/D surveys into the hands of the vehicle owners created a high quality response and a high return rate.

- Cost per returned survey ($8.86) using LPR method was more expensive than other survey methods used by the Salem/Albany survey project. However, factors affecting the higher costs for the Ada County project are lower traffic volumes captured at all the survey sites, more survey stations, and longer operating hours. Cost per survey site may be more reflective. It was $5,120 for LPR methodology which was less than other survey methods.

III. Emissions Monitoring at External Stations

Based upon the findings, non-tested vehicles had higher emissions levels than tested vehicles. RSD technology provided a valuable opportunity to enhance existing air quality programs. RSD technology was capable of capturing license plate and emissions data to determine whether non-tested vehicles produce more emissions than tested vehicles. This information will support the consideration of enhancements to existing air quality programs. The key results and findings for the emissions monitoring at external stations are:

- Tested (Ada County) vehicles had significantly lower emissions levels on average compared to non-tested vehicles (10- 15 %) .

- Controlling for speed, acceleration, and vehicle age, a tested vehicle can be expected to have a lower RSD emissions level from approximately ,035 to .135 units on average.

- Controlling for speed, acceleration, and whether the vehicle had been tested, each additional year of age added an average from .125 to .133 units to the RSD emissions level.

IV. Institutional, Legal, and Public Acceptance Issues

Overall, policy makers and the public gave LPR/RSD technology a favorable rating to implement its use to conduct a travel survey and to monitor vehicle emissions. The key results and findings for institutional, legal, and public acceptance issues are:

- No legal or institutional issues arose before, during, or after the Operational Test.

- The majority of telephone survey participants and policy makers did not consider it an invasion of privacy to take a video of the license plate and identify a vehicle owner's name and address in the motor vehicle records to mail them a travel survey.

- Over 86% of the telephone survey participants preferred LPR method over the stop-and-ask method. Approximately 78% thought this new survey method would encourage more participation.

- Approximately 72% of the telephone survey participants preferred RSD method over the idle emissions test station method. Over 82% indicated this method would encourage more support for emissions testing.

National ITS Goals

Six goals were developed for the National Intelligent Transportation System (ITS) Project. Five of the six goals relate specifically to the first individual test, Origin and Destination Survey. These goals are: 1) improve safety of nation's surface transportation system; 2) enhance personal mobility, convenience, and comfort of the surface transportation system; 3) reduce energy and environmental costs associated with traffic congestion; 4) enhance present and future productivity; and 5) create an environment in which the development and deployment of ITS can flourish. The latter three goals also relate to the second individual test, Emissions Monitoring at External Stations. Findings of these tests in relation to ITS goals are:

Improve Safety of Nation's Surface Transportation System: RSD technology is a valuable tool to use to conduct an external O/D survey. Metropolitan areas find it more difficult to conduct travel surveys due to increased traffic volumes and speeds on major roadways and increased costs to perform them. With current data on traffic patterns through the use of this technology, existing and future transportation system deficiencies and improvements can be identified.

Enhance Personal Mobility, Convenience, and Comfort of the Surface Transportation System: Identification of system deficiencies and improvements will enhance personal mobility and provide greater predictability about travel times. Travelers will also have confidence in using the roadway system and other transportation modes when improvements are made to the transportation system. They will experience less stress in using them. RSD methodology provides travel data for transportation planners and policy makers to base their decisions.

Reduce Energy and Environmental Costs Associated with Traffic Congestion: By having the needed transportation information to develop and implement management or policy strategies, congested roadways conditions can be improved through new and/or expanded roadways and transit service projects. Air pollution and energy use can be reduced.

RSD technology provides the opportunity to identify "high emitting" vehicles earlier than an annual emissions test program. Identification of these "high emitting" vehicles sooner and requiring the vehicle to be repaired or adjusted reduces air pollution and its associated costs. In addition, more efficient operating vehicles reduce gasoline consumption.

Enhance Present and Future Productivity: By identifying system deficiencies and improvements, the transportation system can be improved. This affects productivity of the workforce (i.e., delivery of services and goods, and less stress on the employees).

Identification of "high emitting" vehicles sooner and requiring better operational efficiency of these vehicles, energy supply demands decrease. as well as energy costs. Both individuals and businesses reap the rewards.

Create an Environment in Which the Development and Deployment of ITS Can Flourish: This individual test provides an opportunity to use and evaluate RSD technology in "real world" situations. During this test, valuable insights in its use were identified and will assist in the advancement of ITS. Improvements to the LPR system such as an automatic camera aperture were identified. A wide range of roadway configurations were used and evaluated including the Interstate. One Interstate site was successful and the other unsuccessful. No conclusive findings were developed on the comparison of survey costs using license plate recognition technology and the traditional method. Hidden costs to the public need to be considered such as traffic delays, inconvenience to motorists, and traffic safety.

Conclusions

Data collected during the test will be used for transportation and air quality purposes in Ada County. The responses from the O/D survey were processed and used to develop trip tables for transportation modeling purposes for current and future travel forecasting. This travel data already were used to determine travel patterns between Canyon and Ada Counties in the Treasure Valley Alternative Transportation Analysis.

The results of the emissions analysis of non-tested vehicles and tested vehicles will be forwarded to Ada County Air Quality Board for their consideration. This analysis provides the basis for future consideration of enhancements to the existing emissions testing program. If the AQB determines to take action, they could consider: 1) requiring emissions inspections of vehicles registered to out-of-county commuters, or 2) expanding the existing boundary.

This technology is transferrable to other localities. The LPR methodology to conduct a travel survey can be used to capture license plate data on all types of roadways with the use of road tubes. The emissions monitoring of vehicles in Ada County shows non-tested (out-of-county) vehicles have higher emissions than tested ones. Numerous communities throughout the nation are dealing with this issue of non-tested vehicles from outside the air quality boundary contributing to the air quality problems. RSD technology can identify those non-tested vehicles and the emissions levels. With these supporting data, jurisdictions can make the justification of enhancing existing inspection and maintenance programs.

As for recommendations to the Operational Test, the Evaluation Team suggested that these two individual tests not be conducted simultaneously again. While many of the objectives were identical and the test site locations were the same, the individual tests had two different purposes. Survey sites on the Interstate should have used road tubes as a triggering device for the video camera instead of the emissions sensors. Traffic congestion and early termination of the I-84 Canyon County test site would have been eliminated. Vehicles traveling on both travel lanes would have been captured. In addition, more license plates would have been captured because calibration of the sensors would have been eliminated. Calibration required taking the system off line.

The purpose of emissions monitoring at external stations was to measure and compare vehicle emissions of non-tested (non-Ada County) and tested (Ada County) vehicles. The test site locations were driven by the test sites for the O/D survey. The Interstate did not need to be monitored to capture emissions from non-tested vehicles. Data needed to analyze this objective could have been obtained from other types of roadways.

Introduction

Northern A& County has been designated by the Environmental Protection Agency (EPA) as a "not classified non-attainment area" for carbon monoxide (CO). This means CO levels in the area are neither "rate" nor "Serious" according to EPA's classification of non-attainment areas. Rapid growth in the county affects both air quality and transportation management is an issue of high significance to both policy makers and the public. Travel Demand Management/Emission Detection Operational Test for A& County will help planners and policy makers manage traffic growth and air quality in a more efficient manner.

In November 1994, an overall Evaluation Plan was developed for and approved by Federal Highway Administration (FHWA) for the ITS project. This Operational Test included three distinctive phases which were to: 1) conduct a travel survey; 2) monitor emissions from "out-of-county" vehicles; and 3) monitor all vehicles in Ada County. A Detailed Operational/Evaluation Plan incorporating four Individual Evaluation Test Plans was developed and submitted to FHWA. In April 1995, FHWA approved the Detailed Operational Evaluation Plan to allow the local participants -- Ada Planning Association (APA), Ada County Air Quality Board (AQB), Ada County Highway District (ACHD), and Idaho Transportation Department (ITD) – to proceed with the Operational Test. This document is the final report for the first two phases of Ada County's ITS Operational Test Project which occurred simultaneously and have common objectives.

Organization of Document

The Evaluation Research Team in concurrence with the Independent Evaluator determined four separate Individual Evaluation Test Plans were needed to address three phases of this project and additional evaluation elements. The four Individual Evaluation Test Plans guided the Evaluation Research Team through the Operational Test and were used to monitor the progress of the test.

After reviewing the first draft evaluation documents for Phases I and II, the Evaluation Research Team decided these two documents should be combined. Many of the operational elements, objectives, and measures of effectiveness (MOEs) as well as institutional, legal, and public acceptance issues were the same. Two individual tests were conducted simultaneously. Therefore, this document incorporates three of the Individual Evaluation Test Plans for the Travel Demand Management/Emissions Detection Operational Test for Ada County (Origin and Destination Survey, Emissions Monitoring at External Stations, and Institutional, Legal, and Public Acceptance Issues). This test report includes the project goals, description and summary of the operational test, data analysis, conclusions, and recommendations. An overview of the two phases of this test follows:

Phase I - Origin and Destination Survey

Treasure Valley is growing faster than the national average. Such growth heightens many travel concerns and problems about inter-county trips. Having better knowledge of travel between counties will help planners and policy makers better manage traffic growth. To help guide their decisions, an external O/D study was performed. The last one was completed 20 years ago. O/D surveys are done to obtain detailed data on current travel demand and travel characteristics for those drivers who enter or leave a given study area. Travel demands are then projected into the future to determine if current roadways and transportation services can meet future demands and identify future needs. Phase I read license plates of moving vehicles and matched them to license plate numbers in the Idaho Transportation Department Motor Vehicle data base. This was done using a video camera and computer software and hardware. O/D surveys that were mailed to and completed by vehicle owners provided valuable travel data on where trips began and ended in Treasure Valley.

This test was done to determine if an O/D survey can be conducted more efficiently using license plate recognition (LPR) equipment and software, elements of Remote Sensing Devices (RSD) technology. Data collection for this test occurred April 24-28, 1995 simultaneously with Phase Il, Emissions Monitoring at External Stations. Data analysis transpired May through January 1996.

Phase II - Emissions Monitoring at External Stations

Emissions testing programs have proven to decrease the overall pollutants from tested vehicles. Vehicles not tested regularly are likely to produce more pollutants. Nationwide studies have show about 10% of the vehicles provide 50% or more of the air pollution. By using RSD technology, CO emissions from moving vehicles were measured and stored in a data base file. The video camera, at the same time, recorded license plates of moving vehicles. These files matched vehicles with high levels of CO emissions with their license plates. Relative emissions readings of non-Ada and Ada County vehicles were compared to determine whether or not non-tested vehicles produced more pollutants than regularly tested vehicles. Lastly, a random sample of vehicle owners registered outside Ada County were informed about their vehicle's emission problem without making them take any special steps for such an inspection test. Incentives which included free emission tests and a discount for an engine tune-up were provided to a random sample of vehicle owners to encourage them to repair their vehicles.

This test compared the relative CO emissions readings of non-emissions tested vehicles entering Ada County to Ada County vehicles which are tested regularly using RSD equipment and software. Also, it also evaluated the effectiveness of incentives for voluntary repairs of "high-emitting" vehicles. Data collection occurred April 24-28, 1995 simultaneously with Phase I, Origin and Destination Survey. Data analysis transpired May through January 1996.

Institutional, Legal, and Public Acceptance Issues

As with any transportation and air quality management program, institutional, legal, and public acceptance issues need to be addressed to guide in the development and implementation of a program. Jurisdictional coordination and cooperation, legal opinions, and public acceptance are needed to implement transportation and air quality programs with the consensus of policy makers and the public. To ensure the test ran smoothly, all affected transportation and air quality agencies in Ada County participated in the test planning. Legal opinions were obtained from appropriate legal representatives. A public awareness campaign included presentations to policy makers in the affected cities and counties and media coverage before and during the test.

This test evaluated the effects of institutional, legal, and public acceptance issues of using RSD technology to conduct the O/D survey and to monitor vehicle emissions during the test and for future deployment. Data collection occurred March through August 1995. Data analysis transpired July through January 1996.

LPR and RSD Technology

Performance of the LPR and RSD system, transportation system impacts, system benefits on air quality, and the system's costs were also evaluated.

This Test Plan Report used the Intelligent Vehicle Highway Systems Operational Test Evaluation Guidelines, prepared by the MITRE Corporation, as a guideline for document preparation. Appendices include supporting documents for the evaluation. The final report for each phase will answer the following questions:

- What were the test configurations and conditions?
- What data and information were collected?
- When and how were the data and information collected?
- What data and information were analyzed?
- When and how were the data and information analyzed?
- What are the results and conclusions from the data analysis?

Description of RSD Technology

RSD technology included a freeze-frame video camera, acceleration equipment (radar gun), infrared source and receiver (emissions sensors), and a computer system housed in a van. The infrared source shot a beam of light across a travel lane or roadway to a sensor in the receiver. When a vehicle broke the beam, the receiver was activated. As soon as the beam was re-established, the receiver measured the exhaust pollutants, cataloged them, and stored them for permanent documentation in the computer. At the same time, a video camera took a snapshot of the license plate number which was read by the computer in the van. In addition, the radar gun read the speed at the instant the infrared beam was broken. A subsequent speed reading was taken and compared to the first one to give the acceleration. Both speed readings and acceleration of each vehicle were recorded as it passed the test site. Test site locations, time and date, emissions, speed, and acceleration data, and text output of the license plate were stored on a computer disk to be transferred to a data base.

LPR subsystem was a integral component of RSD technology. It consisted of the video camera, service monitor, separate computer and software, and triggering device for the video camera. In this test, it was the infrared source and receiver.

A more detailed description is available in Appendix A - Basic Information about Remote Sensing. By being able to both measure vehicle emissions and record vehicle license plates, both emissions detections and travel demand management can be incorporated into this one Operational Test.

Schedule of Events

The Operational Test began March 1, 1995 when APA staff members met with all elected/appointed officials and administrative staff within Ada County and its surrounding counties to distribute stakeholder surveys. These surveys were to assess the public's acceptance of this new technology to conduct an O/D survey and to monitor CO emissions. Data collection for Phases I and II occurred April 24-28. Additional data were collected through August for the various follow-up stakeholder and public acceptance surveys. Data analysis transpired May through January 1996. A final report for Phases I and II was completed in February 1996 at the end of this test. Detail schedules of test activities are included in this final report.

Chapter 1
Operational Field Test for Phases I & II

1.0 Purpose of Individual Tests

The origin and destination (O/D) survey and emissions monitoring at external stations occurred simultaneously during the last week of April 1995. This section describes the purpose of each individual test and the identical test operations and measures of effectiveness (MOEs) for these tests.

1.1 Origin and Destination Survey

To determine if current transportation facilities and services are adequate to meet future transportation needs, transportation planners must know about travel demands and characteristics. Many transportation needs relate to external travel patterns (those trips crossing county lines). Transportation planners conduct external O/D studies for information from motorists traveling to and from a study area. Typically, external O/D studies use roadside interviews. Such interviews require stopping vehicles on high-volume roadways (with possible -high speeds) and either asking drivers a series of questions or distributing a survey about their travel patterns and characteristics. This procedure is very labor intensive and costly, creates traffic safety concerns, and inconveniences motorists. These are some of the reasons why no O/D survey has been performed in 20 years in Ada County.

As metropolitan areas continue to grow, external O/D surveys become more difficult to conduct due to increased traffic volumes and speeds on major roadways and increased costs to perform them. This has occurred in Ada County. The last time Ada County conducted an external O/D survey was in 1975, only 10% of the motorists traveling on the Interstate were stopped and interviewed during the peak travel periods. Without sufficient origin and destination data, local transportation planning agencies can not' adequately project transportation needs by using travel forecasting models. This test looked at whether an O/D survey can be conducted more efficiently and effectively by using license plate recognition (LPR) equipment and software, a component of Remote Sensing (RSD) technology.

1.2 Emissions Monitoring

Over 30 years ago, the nation began its largest public works project - the construction of the Interstate highway system. Urban portions of the roadway system were developed by state, county, and local governments. The national highway system has increased Americans' levels of mobility. However, over the years, this increased auto mobility has generated many quality-of-life concerns and problems, including air quality. Studies show that as few as 10 % of the vehicles may contribute as much as 50% or more of the air pollutants.

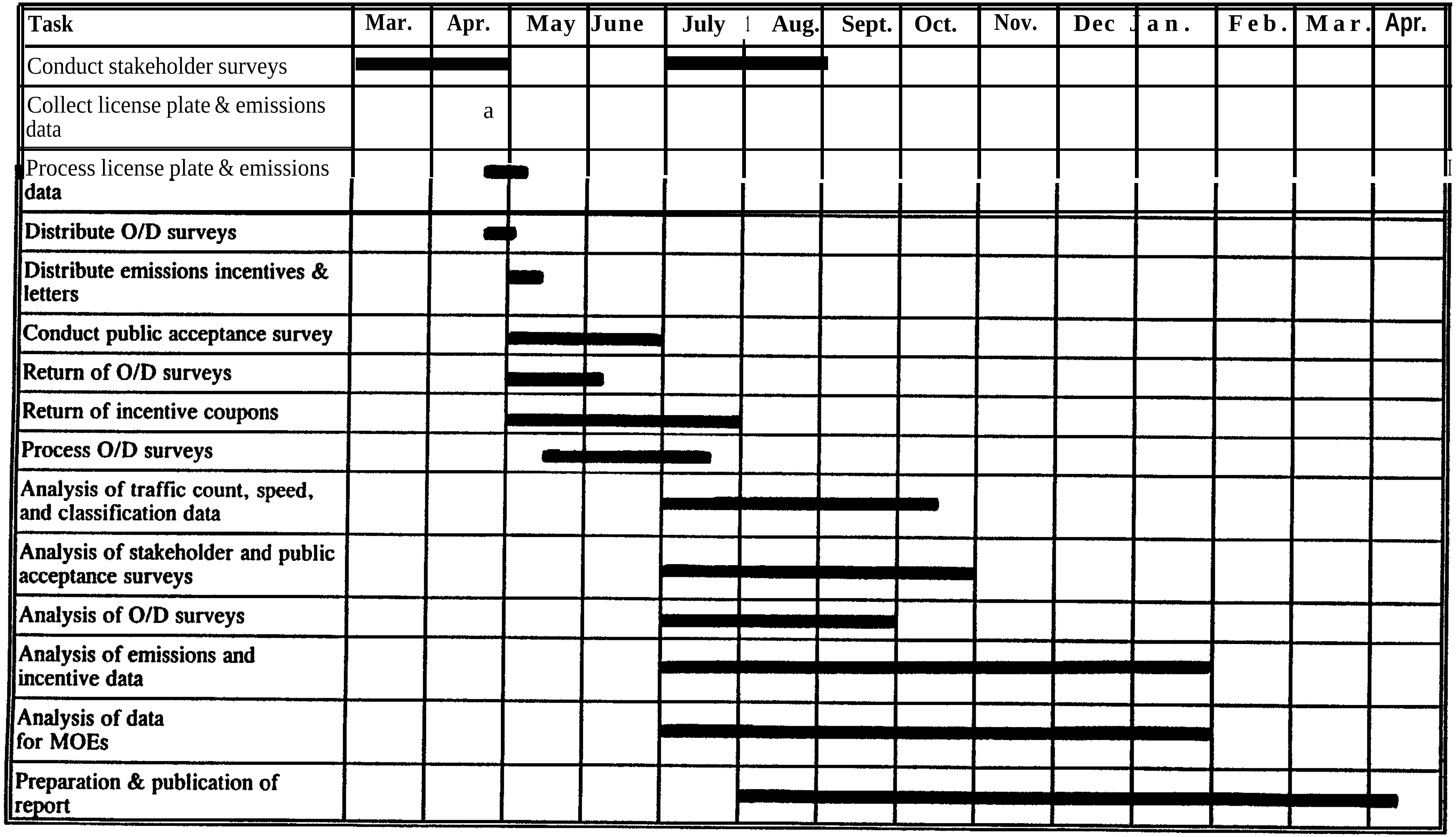
Ada County has been unable to meet national air quality standards. Today, the County is a "not classified non-attainment area" for carbon monoxide (CO) which is primarily a vehicle-based emissions problem. ("Not classified area" means any non-attainment area which the Environmental Protection Agency has not classified as either moderate or serious.) Since 1984, Ada County inspected vehicles for excess emissions of CO and required repairs of 'high emitting" vehicles. ("High emitting" vehicles are defined as vehicles which discharge more than an identified threshold of CO for that vehicle make and age.) The program was proven effective in lowering ambient levels of CO, and the area has maintained the National Ambient Air Quality Standards since 1987. However, maintaining air quality standards may become more difficult because an increasing number of trips originate outside the County where no inspection and maintenance (I&M) programs exist.

No local (Ada County), state, or federal mandate exists that requires adjoining counties to participate in the inspection program. This test compared the relative emissions readings of non-tested vehicles entering Ada County to Ada County vehicles (tested regularly) using RSD equipment and software. Also, it evaluated the effectiveness of incentives for voluntary repairs of "high-emitting" vehicles.

2.0 Duration

Data collection, processing, and analysis occurred over au ll-month period beginning in March 1995 and ending in January 1996 for these two individual tests. The following project schedule shows the duration of each major work task conducted during this test.

Project Schedule



3.0 Summary of Test Configuration and Conditions

Two individual tests were performed simultaneously using RSD components available with Hughes' "Smog Dog."

- Test One: An external O/D survey to obtain travel demand and travel characteristic information from motorists entering or exiting the study area, Ada County, was conducted to identify existing and future transportation demands.

- Test Two: Emissions of cross-boundary vehicles were monitored to assess relative CO emissions readings of non-Ada County vehicles. An attempt was also made to get voluntary repairs of out-of-county vehicles determined to be "high emitters." The repair rate of non-Ada County "high emitting" vehicles and the effect of the incentives was tracked during the study.

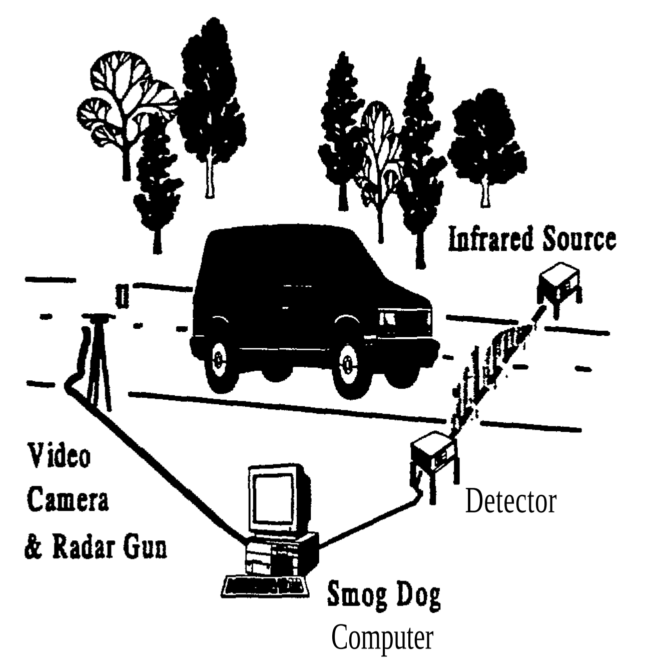
An additional three goals of the test were to evaluate: 1) the RSD system performance; 2) transportation system impacts; and 3) RSD system costs for which extra data were collected. These evaluation goals, findings, and recommendations will also be related to national ITS goals.

3.1 Test Operations

During the test week, field technicians collected license plate and emissions data from moving vehicles on primary and secondary roadways in Ada County. This was done to conduct an O/D survey and to compare relative CO emissions readings of non-Ada and Ada County vehicles (i.e., non-tested and tested vehicles, respectively). They also documented weather changes, equipment calibrations and problems, and traffic incidents and accidents that occurred during the test. This was done to evaluate the performance of the RSD system, transportation system impacts, RSD system benefits, and effects on CO emissions levels. In addition, traffic counters collected vehicle classification, traffic volume, and speed data to evaluate transportation system impacts. The following section describes test operations for Phases I and II.

Each morning prior to data collection, either Ada County Highway District (ACHD) or ITD staff set up traffic control signs and cones at each test site which were marked by traffic counters. ITD staff remained at test sites located on the State roadway system to ensure traffic control equipment was in place throughout the test day. These test sites were primarily high-volume roadways.

Once the traffic control was set up, field technicians positioned the "Smog Dog" van outside the travel lanes, usually on the right roadway shoulder. The RSD system was set up, consisting of a video camera, an infrared source and receiver (emissions sensors), radar gun, and a RSD computer system, a service monitor, and a separate LPR computer system housed in a van.



F'igure 1 - Remote Sensing Devices System

The video camera and radar gun were placed upstream of the van. The infrared source and detector were located downstream of the van (see Figure 1). The infrared source shot a beam of light across a travel lane or roadway to the detector. During the test, the infrared source was projected across two travel lanes on low-volume roadways near the County line and across one travel lane on high-volume roadways as shown in Appendix B, Emissions Sensor Set Up. When a vehicle broke the beam, the emissions detector was activated. As soon as the beam was re-established, the emissions detector measured the exhaust pollutants, cataloged them, and stored them for permanent documentation. At the same time the video camera was triggered and took a snapshot of the rear license plate number which was read by the computer in the van.

The computer in the "Smog Dog" van used LPR software to "read" license plates from the photo images and transcribed them to a computer readable text file. In addition, the radar gun read the vehicle speed the instant the beam was broken. A second speed reading was taken and compared to the first one to give the acceleration. Both the speed and acceleration of each vehicle was recorded as it passed the test site. Emissions readings, speed and acceleration data, and text output of the license plate were displayed on the computer monitors and stored in the computer to be transferred into a relational data base program for processing at the Air Quality Board (AQB).

Technicians at the test site performed the following tasks:

- Monitored RSD software, hardware, traffic control equipment, and data recordings;
- Calibrated the emissions detector and radar gun when necessary;
- Adjusted hardware such as the camera angle and lens; and
- Maintained a data log.

Data logs documented weather condition changes, operator's shift changes, traffic incidents such as traffic delays, traffic accidents, and RSD operating times, calibrations, and other problems. This information was used to assess performance of the operational system and transportation impacts, and is discussed in Section 4.0, Data Analysis.

Prior to data collection at each test site, ITD staff placed traffic counters (capable to identify vehicle classification and measure traffic speed and volume) to capture traffic information prior, during, and after the test. Traffic counters were checked several times a day by ITD staff to ensure they were operational. The Saturday following the test week, floppy disks containing traffic data were retrieved from the traffic counters. These floppy disks were taken to ITD office. Traffic data were imported into TRADIS, traffic software, to generate a traffic summary report. Traffic data were used as a quality control measure, to provide a correlation with the survey sample size, and to access roadway and driver impacts of the operational system which are addressed in Section 4.0, Data Analysis.

At the end of each day's observation, the collected data (emissions, speeds, acceleration, and license plates) were downloaded from "Smog Dog" computer system onto floppy disks. It was delivered immediately to the AQB office where it was imported into the data base program for processing. An operations data log was maintained to record any data processing or data transfer problems which arose throughout this operation. Once the data were transferred to the AQB computer, two copies of the data base existed.

At this point, each license plate record was manually reviewed for accuracy in transcribing the video license plate image to the digitized license plate number stored in the data base. During this process, it was determined that one more county code should have been added to the license plate recognition file by the vendor prior to testing. After each license plate record was reviewed, the data base was sorted to remove all unreadable, dealer, out-of-state, and distant Idaho county (not adjacent to Ada County) license plates. Distant Idaho counties are those which AQB did not have direct access to the vehicle registration data base. AQB only had access to vehicle registrations for Ada, Boise, Canyon, Elmore, Gem, and Valley Counties and some Owyhee County vehicles. Reference to non-Ada counties includes these identified counties, excluding Ada County.

Then the sorted data base of readable license plates (Ada and non-Ada counties) was matched with state motor vehicle registration records to identify vehicle owner's name and address and vehicle make and age. This information was then added to the data base matching the appropriate license plate and vehicle owner.

3.2 Test Schedule, Weather, and Site Location

The initial test for Phases I and II were scheduled simultaneously at 18 test sites on primary and secondary roadways near the Ada County line. The test occurred over a five-day period, April 24-28, 1995.

Four "Smog Dog" vans with RSD equipment were to monitor four test sites each day from 7:00 a.m. to 7:00 p.m. This test schedule was revised during the second day of operations when the field test at the Interstate 84 (I-84) site at Canyon County was terminated within 30 minutes of start up. There were safety concerns with the set up of a gas powered generator in the roadway. An attempt was make to reduce the number of travel lanes from two to one. One lane could not handle the traffic capacity and the test was terminated within 30 minutes of the initial set up (see Appendix C for more detailed information). Motorists began gawking at test

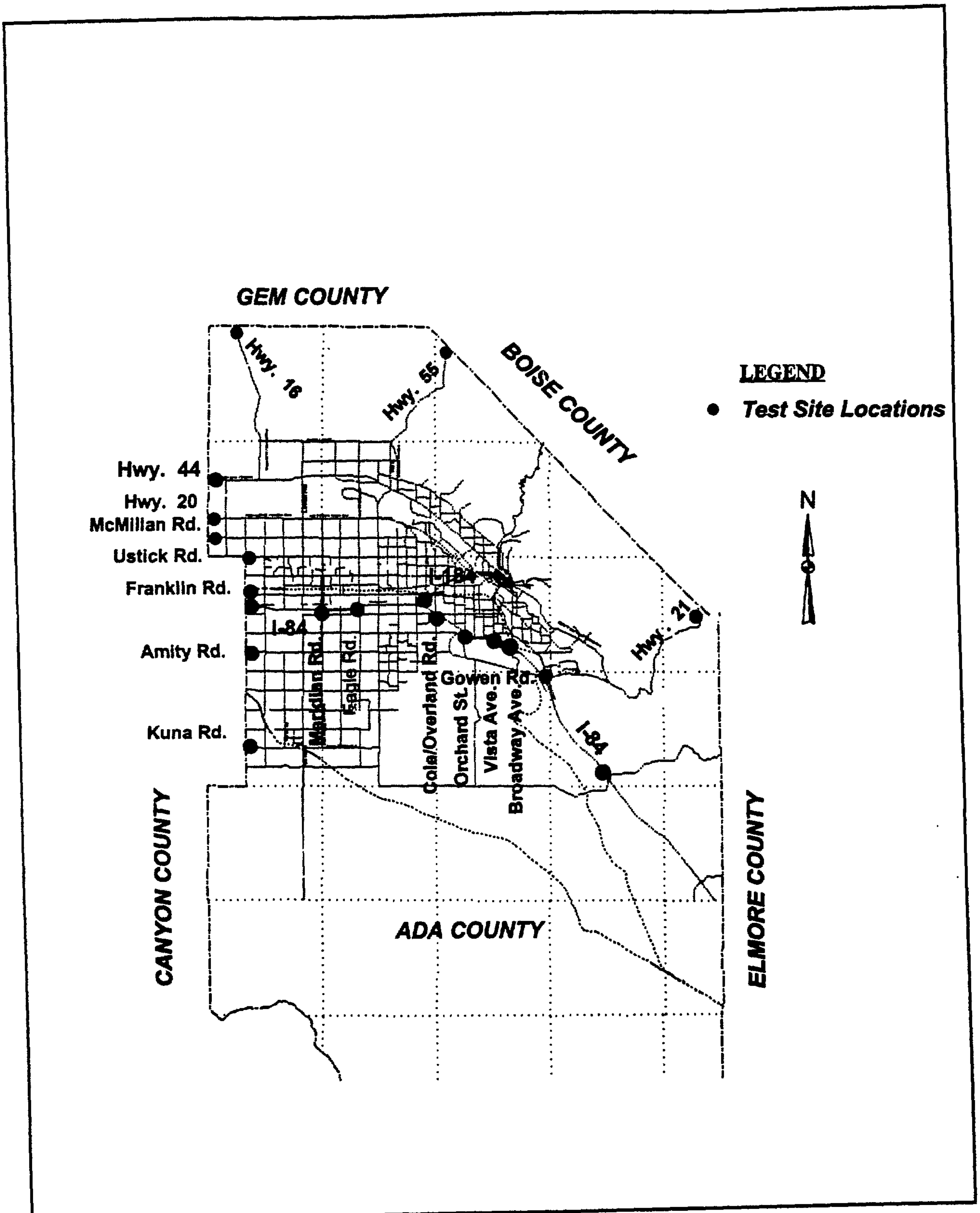
Table 1
Test Site Schedule, Weather, and Locations

Test Day	Test Hours	Operating Time (Hours)	Weather Conditions	Roadway	Location	Number of Travel Lanes	Speed	Roadway Characteristics
April 24	8:30 am to 7:02 pm	10.53	Partly cloudy & windy	Franklin Rd.	E/O McDermott Rd. - gravel shoulder	Two	55 mph	Rural setting - straight/flat roadway
April 24	11:15 am to 7:00 pm	7.75	Partly cloudy & windy	Kuna Rd.	E/O McDermott Rd. - gravel shoulder	Two	50 mph	Rural setting - straight/flat roadway
April 24	8:50 am to 7:00 pm	10.17	Partly cloudy & windy	Ustick Rd.	E/O Can Ada Rd. - canal road	Two	50 mph	Rural setting - straight roadway
April 24	9:00 am to 6:55 pm	9.92	Partly cloudy & windy	McMillan Rd.	E/O Can Ada Rd. - gravel shoulder	Two	50 mph	Rural setting - straight/fiat roadway
April 25	8:00 am to 8:30 am	0.50	Partly cloudy & windy	I-84 Canyon County	Mile Post 41 - gravel shoulder	Four lane separated highway	65 mph	Rural setting - straight/flat roadway
April 25	8:15 am to 7:01 pm	10.77	Partly cloudy & windy	I-84 Elmore county	Mile Post 68.8 - gravel shoulder	Four lane separated highway	65 mph	Rural setting - straight/flat roadway
April 25	9:00 am to 7:00 pm	10.00	Partly cloudy & windy	Hwy. 21	Mile Post 17.5 - gravel shoulder	Two	55 mph	Rural setting - straight/flat roadway
April 25	8:21 am to 7:00 pm	10.65	Partly cloudy & windy	Amity Rd.	E/O McDermott Rd. - gravel shoulder	Two	50 mph	Rural setting - straight/flat roadway
April 26	8:00 am to 7:01 pm	11.02	Partly cloudy & windy	Hwy. 20 (Chinden Blvd.)	E/O Can Ada Rd. - gravel shoulder	Two	55 mph	Rural setting - straight/flat roadway

Test Day	Test Hours	Operating Time (Hours)	Weather Conditions	Roadway	Location	Number of Travel Lanes	Speed	Roadway Characteristics
April 26	8:25 am to 7:00 pm	10.58	Partly cloudy & windy	Hwy. 44 (State St.)	E/O Can Ada Rd. - gravel shoulder	Two	55 mph	Rural setting - straight/flat roadway
April 26	7:30 am to 7:00 pm	11.50	Partly cloudy & windy	Hwy . 16 (Emmett HWY)	Mile Post 7.5 - gravel turnout	Two	55 mph	Rural setting - straight/flat roadway
April 26	7:30 am to 7:00 pm	11.50	Partly cloudy & windy	Hwy. 55 (Horseshoe Bend Rd..)	Mile Post 52 - gravel turnout	Two	55 mph	Rural setting - straight/flat roadway
April 27	7:30 am to 6:55 pm	11.42	Partly cloudy & windy	l-84 On-ramp	Broadway Ave. (westbound) - shoulder	One	*	Slight downhill grade
April 27	7:30 am to 5:21 pm	9.77	Partly cloudy & windy	I-84 On-ramp	I-184 (westbound) - shoulder	One	*	Slight downhill grade
April 27	7:10am to 6:35 pm	11.42	Partly cloudy & windy	1-84 On-ramp	Eagle Rd. (westbound) - shoulder	One	*	Slight downhill grade
April 27	7:30 am to 6:45 pm	11.25	Partly cloudy & windy	l-84 On-ramp	Meridian Rd. (westbound) - shoulder	One	*	Slight downhill grade
April 28	7:10 am to 7:00 pm	11.83	Partly cloudy & windy	1-84 On-ramp	Gowen Rd. (westbound) - shoulder	One	*	Slight downhill grade
April 28	8:20 am to 6:50 pm	10.50	Partly cloudy & windy	I-84 On-ramp	Orchard St. (westbound) - shoulder	One	*	Slight downhill grade
April 28	7:00 am to 7:00 pm	10.23	Partly cloudy & windy	I-84 On-ramp	Vista Ave. (westbound) - shoulder	One	*	Slight downhill grade
April 28	8:00am to 490 pm	8.00	Partly cloudy & windy	I-84 On-ramp	Cole/Overland Rd. (westbound) - shoulder	One	*	Slight downhill grade

*** NOTE: Vehicles** on **these on-ramps merge onto the Interstate which is posted 55 mph.**

Map 1
Test Site Locations



site activities and traffic began to get congested. This test site, I-84 at Canyon County, carried over 40 % of the total traffic volume of the original test sites. An alternative needed to be identified and implemented to capture this potentially lost data. The solution was to monitor all eight I-84 westbound on-ramps. This required dropping three of the low-volume roadways to be monitored. Data collection expanded from 18 to 20 test sites on primary and secondary roadways at the Ada County line and on the I-84 on-ramps (westbound) in Ada County (see Table 1, Test Site Schedule, Weather, and Locations, and Map 1, Test Site Locations on the previous pages).

As noted, the original test schedule specified daily operations from 7:00 a.m. to 7:00 p.m., 12 hours per day. Due to unforeseen circumstances, operational hours at each test site ranged from 7-12 hours per day with the exception of the I-84 at Canyon County. Reasons for shorter operational times were: longer equipment set up time; longer driving times to the test sites; and early termination of some test sites due to concerns of negative public perception or weather conditions. This is discussed in more detail in Appendix C.

Weather played a role in the quantity and quality of data collected at the 20 test sites. Overall, the weather conditions were sunny with intermittent clouds and wind. Lighting conditions caused by the sun and clouds required the field technicians to manually adjust the video camera aperture. The aperture controls the amount of light into the camera. If the license plate image is either too light or dark, the LPR computer has difficulty transcribing them.

Field technicians documented weather conditions affecting the test on data logs for each day and test site. Three test sites experienced rain which ceased test operations for 10-44 minutes (see Table 2, Weather Conditions Affecting Data Collection). In addition to the rain, wind conditions created a sandstorm in the vicinity of the I-84 on-ramp at Eagle Road during the last 25 minutes of the test period which shut down operations for the day. Appendix D, Preliminary Local Climatological Data for April 1995 from the National Weather, provides more detailed information on the weather conditions during the test week.

Table 2
Weather Conditions Affecting Data Collection

Test Site Location	Date of Problem	Time of Problem	Time Back in Operation	Down Time	Weather Condition/Problem
I-84 Elmore County (Eastbound)	April 25	10: 10 a.m.	10:54 a.m.	44 min.	Rain and stiff winds. Placed plastic bags over camera and sensor, then shut off source generator.
1-84 On-ramp at Eagle Road (Westbound)	April 27	6:35 p.m.	Shut down for the day.	25 min.	Rain/sandstorm.
I-84 On-ramp at Vista Avenue (Westbound)	April 28	6:50 p.m.	Shut down for the day.	10 min.	Rain.

Also, wind had an effect on the quantity and quality of license plate and emissions data captured at the test site. LPR system is a component of RSD technology and is activated by the infrared emissions sensors. Each time the emissions sensors needed to be calibrated, the full RSD system was taken off-line. Because the video camera was an integral component of the RSD technology, the number of license plates collected were reduced when the emissions sensors needed calibration. In order not to lose any license plate and emissions data while calibrating the emissions sensors, the field technicians attempted to perform calibrations when gaps in traffic occurred. This was not always possible on high-volume roadways. The calibration process took anywhere one to ten minutes depending upon whether the emission sensors needed adjustment. Average time to calibrate and to adjust the emissions sensors was 4.6 minutes. Average number of calibrations per test site was 3.2. During the majority of the time, calibration occurred quickly. (See Appendix E, Calibration of Emissions Sensors for more detailed information on the recorded calibrations by the field technicians.)

If the only goal of this test was to collect license plate readings, then the collection of emissions data should not have occurred simultaneously with the individual test for the O/D survey. More license plates would have been collected by using a different triggering device than the emissions sensors to the video camera. Also, the emissions sensors required taking the equipment off-line to calibrate them.

4.0 Data Analysis

This section describes data collected and data analysis used to evaluate similar goals and objectives identified for Phases I and 11, Origin and Destination Survey and Emissions Monitoring at External Stations, respectively. This section addresses the evaluation of the operational performance of the test and transportation system impacts common in both phases, since they were done simultaneously. Chapter 2 discusses the operations, evaluation goals, and the hypotheses that relate directly to the O/D survey which were tested. Chapter 3 addresses the operations, the evaluation goals, as well as the hypotheses to be tested that relate directly to the emissions monitoring at the external stations. Chapter 4 will address the evaluation of the institutional and legal issues and public acceptance of using RSD to conduct an O/D survey and to monitor emissions of non-tested (non-Ada County) vehicles.

4.1 Evaluation Goal 1: Performance of the System

Objective A: Assess LPR system's overall reliability for data collection. (RSD system reliability is addressed in Chapter 3, Emissions Monitoring at External Stations.)

Findings

Findings of the LPR's overall reliability for data collection are:

- License plate recognition (LPR) equipment transcribed video images of license plates into text output.
- Seventy-six percent of the license plates were readable by the LPR equipment with minimal staff assistance.
- Lighting conditions, location, and condition of the vehicle license plate, and equipment set up affected the readability of the license plate.
- LPR technology was only used to read license plates of passenger and delivery vehicles.
- Special identifier codes had to manually be entered to the data for those duplicate license plate numbers with different types of license plates (i.e., Wildlife, Purple Heart, National Guard, etc. for Idaho license plates).

Data Collection and analysis

During this individual test, vehicle license plates were captured as moving vehicles passed the LPR system at the test sites. LPR computer was programmed to identify the characters on Idaho license plates. The program calculates a confidence factor for how well it has read each license plate and includes this confidence factor with the stored data record. A separate program can then be used later in non-real time to review or "truth" all transcribed data with a confidence level below a selected value. Confidence levels (assigned by the LPR program) were generally reliable indicators of how accurately the license plate number was transcribed to computer readable characters.

Table 3, Summary of License Plate Collection, on the following page provides a summary of the number of observed license plates. It is broken down by readable license plates (Ada County, Non-Ada County, and No Identified Counties, Out-of-State, and Dealer Plate) and by unreadable license plates (No Plate"). "No plate" contains video snapshots of the back end of the vehicles (taillights, bumpers, bumper stickers, decals, etc.) where a license plate is not located or readable or the license plate number is obstructed by a ball hitch or another object.

Approximately 45,000 license plates were observed at 20 test sites. Seventy-six percent of these license plates were readable by the LPR equipment with minimal assistance from staff. (This means few revisions to the license plate text output were needed to be done manually by staff.) Approximately 70% were Idaho license plates. The remaining 6 % were out-of-state license plates.

The remaining 24 % snapshots captured unreadable license plates, bumpers, taillights, bumper stickers, decals, or vehicles traveling in the opposition direction. On many low-volume roadways, the RSD set up (across both travel lanes due to the roadway width) required

Table 3
Summary of License Plate Collection

License Plates	Total	Percent of Total Observed
1. Total Observed	45,263	
II. Unreadable		
No Plate	10,923	24%
Total	**10,923**	**24%**
III. Readable		
Ada County	18,063	40%
Non-Ada County	11,145	25%
No County Identified	2,429	5%
Dealer Plate	183	0%
out-of-State	2,520	6%
Total	34,340	76%
Note: "No Plate" category contains those video snapshots of the back end of vehicles (taillights, bumpers, etc.) where a license plate is not located or readable or the license plate number is obstructed. "No County Identified" category contains those license plates without the county identifier codes such as Wildlife, Purple Heart, Centennial, etc.		

filtering out the opposing traffic. Many times the technicians were unable to filter out the opposing vehicle as vehicles passed through the site at the same time.

The majority of Idaho license plates consisted of a county identifier and up to six digits. County identifiers are less than half the size of regular plate numbers and have the first letter of the county. When more than one county starts with the same letter, the identifier is a small number over the first letter of the county. Due to a misunderstanding early in preparation for the field test, the vendor's programmers did not originally program the LPR software to recognize county codes on license plates. This error was discovered just one week prior to the start of the field test and the vendor managed to include the computer recognition of local county identifiers (i.e., Ada County and its adjacent counties) with the exception of one surrounding county. It was anticipated that the LPR program would have difficulty distinguishing between some of the county identifiers which are very similar (such as 6B and 8B or 2C and 20) due to the small size. During "truthing" of the data, it was observed that the LPR program, when it assigned a high confidence factor, had indeed identified the difference between these problem characters. However, there were more lower confidence numbers for these problem identifiers.

In addition to the uniqueness of the county identifier, Idaho also issues duplicate numbers on different types of license plates. The same three digit number could be on a Wildlife, National Guard, or Purple Heart license plate. While the LPR system could transcribe the characters, it could not transcribe the background or type of license plate. Table 4 identifies types of Idaho license plates and characters. To ensure that these license plates were matched to the correct vehicle owner, data operators reviewed the data and entered a special code for the type of license plate.

Table 4
Types of Idaho License Plates

Type of License Plate	**Type of Characters**
Centennial	Three numbers and three letters.
county	County designation (one letter & one number), and one **to** six letters.
Wildlife	One to four numbers.
Personalized	Seven characters (combination of letters and/or numbers).
Military Reservist	Type of Service (Army, US Coast Guard, etc.), and one to three numbers.
National Guard	Four numbers.
Disabled Veterans	DV and four numbers.
Purple Heart	Two to four numbers.

As the LPR system did not recognize all county codes and as Idaho issues duplicate numbers on different license plate types, it was decided to "truth" all observed license plates. Because of this extensive review, an in-depth knowledge of the type of transcription problems likely to occur was developed. Table 5 on the next page lists many of the problems which occurred repeatedly. It should be noted that the majority of listed problems were accompanied by confidence levels which would have triggered a review by the "truthing" process. Also, this developed knowledge could be used to improve the LPR program and increase the number of license plates read correctly.

No count was maintained of license plate numbers modified during the review or "truthing" process. This was due to the short turnaround time available to review the license plate data and prepare and mail the O/D surveys (i.e., turnaround time was 12 hours or less) for each day of data collection.

Table 5
Observed Readability Problems of LPR System

Type of Problem	Description of Problem
Condition of License Plate	Mud covered license plates. Warped license plates. License plates had plastic license plate covers.
Location of License Plate	Vehicles lacked license plate on the back bumper. License plate was on an unconventional location such as rear window or one side of the bumper. Hitch ball covered a portion of the license plate. Shadow of spare tire covered license plate (usually utility vehicles). License plate mounted at an angle. Deep seated plates created shadows.
Location of Vehicle in Travelway	Vehicle did not travel in the center of the lane. One vehicle tailgated another. Vehicles were inadequately spaced due to traffic congestion (i.e., traveled too slow or stop and go traffic).
Lighting Conditions	Lighting conditions changed rapidly due to weather changes. Shadows created by the angle of the sun. Glare from sun washed out the image.
Readability of Images on License Plates	License plates with picture of a tree on the right side were interpreted as the letter "L". Some letters were interpreted as numbers and vice versa such as the letter "B" and the number "8" License plate type or county identifier were not programmed into the LPR computer.
Triggering Process	Emissions detection equipment required calibration (i.e., the system was taken off-line) and eliminated the collection of additional data.

Objective B: Assess RSD system's overall operational reliability.

Findings

Findings of the RSD's system's overall operational reliability are:

- One of the four vans contributed 78 % of the total down time.
- Mean time between failures was 11.07 hours.
- Mean time to repair was 13.94 minutes.
- The modal repair time was 5 miuutes.
- The percent uptime was approximately 98 % .

Data Collection and Analysis

Field technicians maintained data logs to document equipment problems and calibrations at each test site. Equipment problems ranged from loose cables to tbe generator stopping to the computer system crashing. Table 6, RSD Problems and Associated Down Time, documents types of equipment problems, actions to resolve problems, and down time to repair them.

Table 6
RSD Problems and Associated Down Time

Location	Date	Description of Problem	Action to Resolve Problem	Failure Tie starting Time	Failure Tie Ending Time	Down Time (min.)
Kuna Rd.	24-Apr-95	Sensor did not work.	Connected loose power cable.	1:45 pm	1:50 pm	5
I-84 Elmore County	25Apr-95	LPR computer froze.	Rebooted (soft).	8:15 am	8:35 am	20
1-84 Elmore County	25-Apr-95	Source generator quit.	Filled tank with gas.	3:30 pm	3:35 pm	5
1-84 Elmore County	25-Apr-95	LPR did not digitize County codes.	Moved tripod back and resized.	4:00 pm	4:10 pm	10
I-84 Elmore County	25-Apr-95	"Smog Dog" computer bombed.	Typed "Smog Dog" at prompt.	5:53 pm	5:54 pm	1
Hwy. 20 (Chinden Blvd.)	26-Apr-95	LPR computer froze.	Rebooted (soft).	8:07 am	8:10 am	3
Hwy. 44 (State St.)	26-Apr-95	LPR computer froze.	Rebooted.	8:25 am	8:27 am	2
Hwy. 44 (State St.)	26-Apr-95	Uninterrupted Power Source (U.P.S.) failed.	Connected loose U.P.S. cable.	5:05 pm	5: 10 pm	5
Hwy. 16 (Emmett Hwy.)	26- Apr-95	"Smog Dog" kicked out of program.	Rebooted "Smog Dog" computer.	2:25 pm	2:30 pm	5
Hwy. 55 (Horseshoe Bend Rd.)	26-Apr-95	Circuit breaker tripped - power loss.	Reset circuit breaker.	7:00 am	7:15 am	15
I-84 On-ramps (Westbound)						
Broadway Ave.	27-Apr-95	LPR computer froze.	Installed AUTOEXEC .BAT file & rebooted.	7:30 am	7:35 am	**5**
I-184	27-Apr-95	"Smog Dog" kicked out of program.	Rebooted.	12:30 pm	12:32 pm	2
Meridian Rd.	27-Apr-95	LPR stopped processing.	Rebooted LPR program.	11:05 am	11:12 am	7
Meridian Rd.	27-Apr-95	"Smog Dog" recovery time was long.	Rebooted "Smog Dog".	12: 19 pm	12:31 pm	12
Gowen Rd.	28-Apr-95	"Smog Dog" computer quit.	Rebooted system.	1:27 pm	1:28 pm	**1**
Vista Ave.	28-Apr-95	Source generator quit.	Cleaned spark plug/adjustec throttle.	7:15 am	8:43 am	88
Vista Ave.	28-Apr-95	Image froze on license plate screen.	Reconnected cables to/from camera.	2:20 pm	2:25 pm	**5**
Vista Ave.	28-Apr-95	Emissions/license plate data were missing.	Rebooted "Smog Dog" computer.	3:00 pm	4:00 m	60
Total Down Time						251

Table 7
Summary of Mean Time between Failures and Mean Time to Repair

Van Number	Test Sites with Equipment Failures	Operating Hours	Number of Failures	Mean Time between Failures (Hr.)	Down Time (Min.)	Mean Time to Repair (Min.)
Van #1	Franklin Road, l-84 Canyon County, Hwy. 16 (Emmett Hwy.). l-84 on-ramp at l-184 (westbound), l-84 on-ramp at Gowen Road (westbound)	44.13	3	14.71	8	2.67
van #2	Kuna Road, Amity Road, Hwy. 44 (State St.), l-84 on-ramp at Eagle Road & at Cole/Overland Road (westbound)	48.40	3	16.13	12	4.00
van #3	Ustick Road, Hwy. 55 (Horseshoe Bend Rd.), Hwy. 21, I-84 on-ramp at Meridian Road & at Orchard Road (westbound)	53.42	3	17.81	34	11.33
Van #6	McMillan Road, I-84 Elmore County (eastbound), Hwy. 20 (Chinden Rd.), l-84 on-ramp at Broadway Avenue & at Vista Avenue (westbound)	53.36	9	5.93	197	21.89
Grand Mean Time between Failures		**199.31**	**18**	**11.07**	**251**	**13.94**

Approximately 18 equipment problems occurred at 20 test sites over the five-day period. It required approximately 25 1 minutes to repair. Down/repair time ranged from 1 to 88 minutes.

Table 7, Summary of Mean Time between Failures and Mean Time to Repair, on the previous page provides a breakdown of the number of failures, down time, mean time between failures, and mean time to repair RSD equipment throughout the five-day test period. A failure was defined as any RSD or LPR equipment problem that stopped the operation of the test. Overall mean time between failures was 11.07 hours. Overall mean time to repair was 13.94 minutes.

As shown in the table, Van #6 experienced more equipment problems and subsequently 78 % of the total down time of the four vans. Van #6 at the I-84 On-ramp at Vista Avenue experienced two occurrences where the down time was 60 minutes or more which skews the distribution. It was more appropriate to examine the down time using the statistical modal repair time which was 5 minutes. The percent uptime was approximately 98 % .

Objective C: Assess the performance of the electronic data interchange.

Findings

Findings of the performance of the electronic interchange are:

- Electronic interchange (downloading, storing, sorting, and retrieving data) was performed very efficiently without any major problems.
- No problems were encountered when matching the license plate data with the State vehicle registration data.

Data Collection and Analysis

At the end of each day, data were downloaded from the “Smog Dog” computer onto floppy computer disks and delivered immediately to the AQB office where it was imported into the data base for processing. Each license plate record was then manually reviewed for accuracy in transcribing the video license plate image to the digitized license plate number stored in the data base. Once the records were reviewed, the data base was sorted to remove all unreadable, dealer, out-of-state, and distant Idaho county (non-adjacent counties to Ada-County) license plates. License plate data were used to query state vehicle registration records to add the vehicle owner’s name and address and vehicle make and age of each Ada and non-Ada (adjacent) County vehicle. AQB only maintained address data on adjacent counties. Mailing labels for the O/D survey were printed using this information along with the test site location, travel direction, vehicle license plate number, and time and date of test. Survey preparation process (typically done manually) was automated during this individual test.

In addition, non-Ada County “high emitting” vehicles were identified and three hundred of these vehicles were randomly selected and divided into three groups. Two groups received incentive coupons and one group (control group) received an informational letter. Mailing label and pertinent information from the data base file was printed on the incentive coupon/letter.

During the electronic data interchange and data processing, only one incident was recorded. A field technician accidently restarted the “Smog Dog” computer system and reset the key number which ties the .TIF (graphic files of the license plates) to emissions data. This occurred after the van had observed 1729 vehicles. When the data were downloaded from the van’s computer, only 130 vehicle observations were in the data base. The project data officer was able to access the van’s computers through the disk operating system (DOS) and recovered all of the original license plates observed except 130 which were overwritten by further data collection. Overall, the data storage and transfer process from the “Smog Dog” was well designed and operated smoothly.

The project data officer also indicated no problems occurred retrieving data. The data base operated efficiently in storing and retrieving collected data. Data were sorted, matched, and retrieved to perform data operations of this test. Data were tallied to obtain summaries and breakdowns on specified data (i.e., like the number of readable and unreadable license plates and valid and invalid emissions readings of Ada and non-Ada County registered vehicles). In addition, the data base (including vehicle owner’s name, address, vehicle make and age, and the observed data) was used to evaluate emissions data. Floppy disks containing the data base was provided disks to a consultant to conduct the public acceptance survey element of this Operational Test. The public acceptance survey is discussed in Chapter 4.

Approximately 45,000 observations were recorded during the test. The data recorded by the “Smog Dog” computer system is shown in Appendix F, Format of Collected Data by RSD Technology. All readable license plates for Ada and non-Ada Counties (31,637) were matched with a vehicle owner’s name and address in the Idaho Motor Vehicle Registration Data base. The number of matches were highly reliable because Idaho law does not allow the transfer of vehicle license plates to another vehicle owner. An individual selling a vehicle keeps the license plates.

Of the 45,263 observations, approximately 93 records from the McMillan Road test site were unable to be reviewed (truthed) by the data operator. This lost data were caused by an error committed at the van during training of the local technician, the first day of the test. Fortunately, this test site was a low-volume roadway and lost data involved a small number.

Objective D: Assess any net safety impacts.

Findings

Findings of the net safety impacts are:

- One incident occurred during the test which created concerns for traffic safety. This test site, I-84 at the Canyon County line, was terminated within 30 minutes of full operation.

Assessment of this incident by ITD staff and "Smog Dog" technicians indicated that minimizing the number of vehicles and an earlier set up time would have improved the traffic situation at the test site.

- Due to the traffic incident at I-84 Canyon County line, two other test sites were terminated early to eliminate any negative public perception that the test created traffic safety problems.

- No major traffic safety incidents occurred at the other 19 test sites including I-84 at the Ehnore County line.

- Two concerns arose relating to the field technician's safety when working with the gas powered generators. First, generators needed to be filled with gasoline every 3-4 hours while still operating. Second, technicians needed to cross high-speed, high-volume local roadways and state highways to fill the generators.

- Lessons Learned: Set up RSD equipment prior to morning peak hour and minimize the number of vehicles and staff at test sites.

- Adequate roadway width is needed for protection of the gas powered generator.

Data Collection and Analysis

This test attempted to collect license plate data from moving vehicles at two freeway locations. One test at the freeway site was successful and the other unsuccessful, terminating within 30 minutes of starting. The following assessment discusses the safety impacts of this test, primarily focusing on the unsuccessful test on I-84 at Canyon County.

The tests were to collect data between 7:00 a.m. and 7:00 p.m. and to capture both morning and evening peak travel periods (normally from 7:00 a.m. to 9:00 a.m. and from 4:00 p.m. to 6:00 p.m). RSD set up was to occur prior to 7:00 a.m. when traffic volumes are lower; however, this did not occur at many sites. Field technicians setting up equipment during the morning peak period tended to create a distraction to motorists. On low-volume roadways, this occurrence did not create any major safety impacts, primarily due to low volumes and the large gaps in traffic. However, driver reaction did affect the traffic flow on I-84 at Canyon County, causing a major concern of ITD.

The test site at I-84 at Canyon County line carried approximately 40% of the traffic volume for O/D survey and emissions monitoring. Due to traffic safety concerns, a number of ITD personnel and their vehicles were at the site to oversee the safety of both field technicians and motorists. To monitor this test site, it was decided to taper two travel lanes into one lane through the test site. Field technicians set up the equipment between 7:00 a.m. and 8:00 a.m. They had to run back and forth across the roadway. This caused motorists to slow down and to gawk at the activity. Traffic backed up approximately 1 1/2 miles west of the test site. ITD personnel requested the technicians to remove the equipment within 30 minutes of starting the test. Observation by ITD personnel was that field technicians had little experience working on a high-volume, high-speed roadway like the Interstate.

It was later reported that a semi-truck and trailer rear-ended another one in the traffic congestion. No injuries occurred. The semi-trucks were moved from the travelway onto the roadway shoulder. No tort claims have been filed with ITD.

Discussions with “Smog Dog” and local technicians indicated that minimizing the number of ITD vehicles and personnel at the test site and an earlier set up time would have improved the traffic situation. Whether these actions would have minimized the traffic congestion and prolonged the test site operation to capture 12 hours worth of data, cannot be determined.

Traffic impacts on I-84 near the Canyon County test site can be attributed to this test. Two other test sites had early termination, primarily to avoid any negative public perception that the test was creating safety issues.

- The test site on I-84 on-ramp (westbound) at I-184 was terminated due to traffic congestion on the freeway ramp and local access streets. Unfortunately, this site normally experiences traffic congestion.

- In the case of the test site on the I-84 ramp at Cole/Overland Road, field technicians witnessed numerous potential rear-end accidents from motorists stopping to merge onto the freeway throughout the day. This was attributed to motorists driving behavior and not the test. This interchange was under construction so the merge lane was shorter than the future designed ramp.

Besides motorists’ safety on the roadway, field technicians’ safety needs to be assessed. Two concerns arose which relate specifically to field technician’s safety working with the gas powered generators. First, gas powered generators periodically needed to be filled while still operating -- creating a potentially dangerous situation. Second, field technicians needed to cross the roadway to fill up the generators which were opposite the “Smog Dog” van. On low-volume roadways, this did not create a problem. On high-volume roadways, like the Interstate; mixing pedestrians and high-speed traffic was unsafe and also disrupted motorists, creating a potential for rear-end accidents.

Another issue was the placement of a gas powered generator in the middle of a roadway or along a roadway shoulder. This was a concern of the State Highway Engineer about the I-84 test sites. Sufficient roadway width is needed to adequately protect the generator from being hit by a vehicle. On narrow county roads, the generator and emissions sensor were placed along roadway shoulders. On the Interstate, two travel lanes were reduced to one to provide the generator and sensor adequate protection from the traffic.

Objective E: Assess the transferability of the system, as implemented in the operational test, to other localities.

Findings

Findings of the transferability of the system are:

- The LPR computer needs to be programmed to identify license plate characters.
- Roadways that can be monitored are: low-volume two-lane roadways, three lane roadways (with continuous left-turn lane), freeway ramps, and separated highways and freeways with two travel lanes with certain equipment set up specifications.
- High-speed Interstates can be monitored if traffic control can handle the traffic capacity (i.e., reducing the travel lanes from two to one, or channelizing the traffic around the emissions sensor and generator in the center of the roadway).
- LPR technology is capable of reading license plates, however, additional manual effort is required of the data operator when the same license plate number is issued for different types of license plates (Wildlife, Purple Heart, etc.).
- Weather conditions, both sunny and rainy, create some problems for the LPR. An automatic aperture and longer camera hood (shading the lens) should be added to the video camera to regulate the amount of light into the camera.
- The current RSD system used for this study did not identify vehicles with “cold starts.”

Data Collection and Analysis

The RSD system with the LPR subsystem, allowed this local jurisdiction to conduct an O/D survey by collecting license plates from moving vehicles. It also provided the opportunity to monitor emissions from out-of-county vehicles. Data collection using RSD technology minimized the inconvenience to vehicle owners and in many cases, other motorists on the roadway system. Potential issues that need to be addressed to use RSD technology in other localities are identified as:

1. Roadway Characteristics

Traffic volumes and the number of travel lanes have a major impact upon the transferability of the existing RSD/LPR system. Existing RSD technology is capable of collecting license plates and monitoring tailpipe emissions of moving vehicles on the following types of roadways:

- Low-volume, two-lane roadways where the infrared beam can be shot across two travel lanes,

- Three-lane roadways where the source generator and infrared sensor can be placed in the continuous center left-turn lane,
- Freeway ramps, and
- Separated highways and freeways with two-lanes in one direction where the travel lanes can be reduced into one travel lane. This is only feasible when one travel lane can handle the roadway capacity.

During this test, no five-lane roadways were monitored as none existed at the Ada County line. Traffic volume, traffic control, and RSD set up need to be reviewed carefully when considering multiple lane roadways. "Smog Dog" vans and RSD equipment should be positioned outside the travelway along a wide shoulder.

Existing RSD technology is incapable of monitoring high-speed, high-volume freeways without addressing numerous traffic safety issues. As mentioned in the previous objective on safety impacts, a high-volume freeway was monitored with major traffic safety problems. Unfortunately, due to the set up time by the field technicians and additional field staff and vehicles at the site, the Interstate was not given an adequate test. Several lessons were learned at this test site. First, field technicians need to have experience working on high-volume, high-speed roadways. Second, equipment needs to be in place prior to the peak travel periods. Third, the existing roadway characteristics (i.e., location of the next on-ramp, etc.) need to be analyzed closely when reducing the number of travel lanes. Fourth, whether the freeway or highway can be reduced to one travel lane (in the same direction) and handle the traffic demand, or the width of the freeway is adequate to divert the traffic safety around equipment in the middle of the roadway.

2. RSD Equipment

Prior to using RSD equipment to capture and transcribe license plates, the LPR computer system needs to be programmed to identify the characters on license plates. The program calculates a confidence factor for how well it has read each license plate and includes this confidence factor with the stored data record. A separate program can then be used in non-real time to review or "truth" all transcribed data with a confidence factor below a selected value. Confidence levels as assigned by the LPR program were generally reliable indicators of how accurately the license plate number was transcribed to computer readable characters.

A primary obstacle of using the existing LPR/"Smog Dog" system was the source generator that activated the emissions sensors. The sensors tripped the video camera. The source generator was located approximately 20-30 feet from the infrared sensor. It was gas powered and required filling every 3-4 hours. Performing this task on high-volume, high-speed (45 mph) roadways created numerous safety concerns for the field technician crossing traffic.

In addition, the source generator and infrared sensor need to be placed on the centerline to monitor one travel lane on high-volume roadways. This placement created some traffic control and safety concerns. A gas powered generator in the middle of the roadway was not desirable.

To monitor low-volume, two-lane roadways, the source generator can be placed on the opposite shoulder to the travel lane. Opposing traffic should be filtered out by the field technician. Recent discussions with the vendor indicate they are working on the elimination the gas powered generator.

Discussions occurred with the “Smog Dog” vendor to use road tubes similar to those used with automatic traffic counters to trip the video camera for the O/D survey. Elimination of infrared sensors would enable this technology to be used on high-volume roadways.

The amount of different types of license plates and duplicate issuance of license plate numbers impacted readability of Idaho license plates by the LPR system. While LPR system can transcribe license plate characters, graphic background of the license plate was not interpreted by the computer. If a locality has several different types like Idaho, this will require additional programming of the LPR, or it may require additional effort in reviewing license plate data and re-entering information.

In addition, the current RSD system did not identify vehicles with “cold starts.” Original test sites were identified at the County line where the majority of vehicles would not be in a “cold start” condition. Unfortunately, several of the test sites were moved internally near high traffic generators like the regional shopping mall and large employment centers. The current technology used in this test did not allow identification of these “cold start” vehicles.

3. Weather Conditions

Weather conditions played a major role in the use of RSD equipment. This test experienced good weather the majority of time, but rain can terminate emissions monitoring. In addition, wind conditions created problems with blowing dirt and required calibration of the emissions equipment more regularly.

Intermittent cloudy days affected readability of the license plates. On these days, the field technician had to manually adjust the camera aperture to regulate the amount of light into the camera. The technician was required to perform this task which can be very tedious if lighting conditions constantly change. An automatic aperture should be added to the current LPR system.

4.2 Evaluation Goal 2: Transportation System Impacts

Objective A: Assess the impacts on the transportation system of using RSD equipment.

Findings

Findings of the system impacts on the transportation system are:

- Field operators did not notice platooning of vehicles on the low-volume roadways. This may be due to the RSD set up along each roadway shoulder.

- Interstate on-ramps experienced noticeable platooning of vehicles due to traffic cones and RSD equipment which created a funneling effect.

- One test site, I-84 at Canyon County, experienced traffic congestion which caused termination of the test.

Data Collection and Analysis

Observations by field technicians indicated the RSD equipment in the roadway had noticeable impacts on the platooning of vehicles (groups of vehicles). Field technicians did not log specific numbers because other responsibilities precluded them from performing this task. Technicians monitored equipment and performed other operational tasks such as filtering out semi-trucks and other vehicles with trailers or vehicles traveling in the opposite direction (set up across two travel lanes) from data collection. These vehicles were filtered from the data collection due to the height of the tailpipes or location of the license plates.

RSD equipment set up required the “Smog Dog” van, video camera, radar gun, and detector be placed on the right side of the roadway, many times approximately three feet from the edge of pavement or shoulder line. The source generator and infrared sensor were on the left shoulder or centerline (if roadway width permitted it with adequate traffic control). The following observations were made:

Low-volume roadways at the county line did not experience any noticeable platooning of vehicles which created traffic congestion. This was primarily due to low volumes and distances between vehicles traveling in the same direction. Motorists tended to reduce speed through the test site. This was due to the location of equipment along the narrow roadway or placement of traffic control to ensure a vehicle did not straddle the centerline. If the vehicle straddled the centerline, the license plate might not be captured. Driver performance is discussed later in Objective B.

On high-volume roadways at the county line and the I-84 Elmore County test site, more platooning of vehicles was seen. Different driving speeds was the primary cause. Field technicians did not note any significant speed reductions that created traffic congestion or safety problems at these sites.

The test site at I-84 Canyon County experienced the most noticeable speed reduction in the platoon of vehicles. As previously discussed (Section 3.2, Test Schedule, Weather, and Location, and in Goal 1, Objective D, Assess Any Net Safety Impacts) vehicles backed up prior to the full test operation. Discussions with ITD personnel and “Smog Dog” technicians at the test site indicated earlier set up and minimizing the number of vehicles and personnel at the site would have improved the test operation. Unfortunately, the test at this test site was not given a fair chance to be successful.

Eight I-84 westbound on-ramps also experienced noticeable speed reductions in the platoon of vehicles. Some on-ramps currently experience traffic congestion throughout the day due to the ramp's location to major traffic generators. Discussion with field technicians and motorists who traveled through test sites indicated traffic cones along the left shoulder line and "Smog Dog" equipment on the right shoulder created a funneling effect (i.e., creating the perception of a narrower travel lane). Normally, motorists reduce speed if they see vehicles and equipment which they don't expect to see along the roadway.

Objective B: Assess the change in driver performance at the test site.

Findings

Findings of the change in driver performance are:

- Driver performance through the test sites were affected by the LPR equipment and traffic control along the roadway. Travel speed reductions ranged from approximately 9% to 38%.

- The Interstate experienced less reduction in speed than other test sites. I-84 at Elmore County experienced speed reductions of approximately 9% on the test day when compared to two days without the RSD equipment.

Data Collection and Analysis

Traffic/speed equipment was placed at each test site to capture vehicle speeds on the test day and days surrounding the test day to determine the change in driver performance. Speed data were retrieved from traffic equipment and copies from a computer disk onto the ITD computer system. Data were then sorted to remove data occurring outside the test hours. Speed data that occurred during the test and days without the RSD equipment on the roadway were analyzed to develop mean speed, mean difference from study mean, standard deviation, and probability at each test site (see Appendix G). Table 8 shows a summary of speed comparisons by roadway type with posted speed for that roadway, mean speed of test day, and speed reduction during the test compared to days without RSD equipment.

These data showed drivers' behavior changed when RSD equipment was along the roadway. Adequate speed data were not available for 30 minutes that the field test was operational on I-84 at Ada/Canyon County due to traffic congestion. This was discussed earlier in this section. Of the remaining 19 test sites, ten sites experienced travel speed reductions of less than 20% of the speeds without the RSD equipment. Eight test sites experienced a 20-30% reduction. One test site, McMillan Road, experienced a 38% reduction in travel speeds. The data log for the McMillan site reported the site experienced a low traffic volume during the day and was used as a training site. Presence of field technicians along the roadway would cause noticeable changes in driver performance.

Table 8
Summary of Travel Speed Comparisons

			Reduction between Mean Speed of Non-test Day and Test Day	
Site Location	**Posted Speed (mph)**	**Mean Speed of Test Day (mph)**	**First Day (Percent)**	**Second Day (Percent)**
Freeway				
I-84 at Ada/Elmore County Line	65	63.4	9.3	8.9
I-84 Freeway On-ramps				
Eagle Rd.	*	52.4	12.5	**
I-184 (Flying Y)	55	47.1	20.4	**
Meridian Rd.	*	45.0	15.4	**
Gowen Rd.	*	39.4	14.0	**
Vista Ave.	*	38.5	16.8	**
Orchard Rd.	*	37.4	15.4	**
Broadway Ave.	*	36.4	21.1	20.4
Cole/Overland Rd.	*	31.2	14.6	**
State Highways				
Hwy. 16 - Emmett Hwy.	55	49.9	13.7	15.1
Hwy. 20 - Chinden Blvd.	55	44.2	21.4	22.2
Hwy. 21	55	43.9	22.3	22.4
Hwy. 44 - State St.	55	43.2	22.0	22.0
Hwy. 55 - Horseshoe Bend Rd.	55	41.5	27.8	27.4
Local Roadways				
Franklin Rd.	55	42.5	16.8	16.2
Ustick Rd.	55	40.4	16.2	17.7
Amity Rd.	50	39.4	22.7	21.9
Kuna Rd.	50	36.6	30.0	29.5
McMillan Rd.	50	26.9	38.9	38.4

NOTE: * Vehicles on these on-ramps were merging onto the Interstate which is posted **55 mph.**
** No data were available for second day. These sites were added to the test at the last minute due to schedule modifications.

During the test day, I-84 Elmore/Ada County experienced a mean speed of 63.4 mph. On days without the RSD equipment, mean speed was 69.6 mph and 69.9 mph. Posted speed is 65 mph. Minimal reduction in speed on the Interstate at this location was encouraging since the test site at the westerly county line required early termination.

Interstate on-ramps experienced less change in driving speeds than sites on State highways and local roadways near the County line. This may be due to one merge lane with wide shoulders and the RSD set up. Also, these test sites were located in an urban setting. Urban motorists may experience more obstacles on urban roadways and may not alter their driving performance as much. Whereas, drivers traveling rural roadways may react more to parked vehicles and traffic control in the countryside.

5.0 Conclusion

This chapter analyzes the data and develops findings for the performance of the LPR/RSD system and the transportation system impacts.

Overall, the RSD system performed adequately. LPR equipment transcribed video images of license plates into text output. Approximately 76 % of the license plates were readable by the LPR equipment with minimal staff assistance. LPR technology only read license plates of passenger and delivery vehicles. License plates of semi-trucks or other vehicles with trailers or vehicles driving too close to another were unreadable. A number of observed readability problems were identified. Many readability problems may not be resolved since they deal with license plate conditions, vehicle location in the travelway, and lighting conditions on the license plate. Some improvements may reduce the number of misinterpreted characters. One valuable component of the existing LPR system is the flagging of license plates with a low confidence factor. The data operator can identify these data quickly and make corrections if needed.

Operational reliability was good. Overall, total operating uptime was 98 % . Mean time between failures was over 11 hours. Mean time to repair was approximately 14 minutes. With the Ada County ITS project, one of four vans contributed 78% of the total down time, while the other three vans had the remaining 22 % . Therefore, modal repair time may reflect the operational reliability better. Modal repair time was 5 minutes.

Performance of the electronic data interchange did exceptionally well. Electronic interchange (downloading, storing, sorting, and retrieving data) was performed very efficiently without any major problems. No problems were encountered matching the license plate data with the State vehicle registration data.

Only one incident caused a concern for traffic safety. That site, I-84 at Canyon County, was terminated within 30 minutes of full operation. Traffic congestion became a safety concern. Participating agencies in the test indicated that setting up equipment prior to morning peak hour, and minimizing the number of personnel and vehicles at the site would have improved the traffic situation. In addition, it was suggested that field technicians have training to work in high-volume, high-speed roadway environments. The other 19 test sites experienced no traffic safety problems. During the evening peak period, two test sites were terminated to avoid any negative public perception. These test sites normally experience traffic congestion during this time.

Originally, equipment set up at the I-84 Canyon County test site caused some safety concerns from the State Traffic Engineer. The generator and emissions sensor were to be placed on the centerline of a two lane separated highway, and two westbound travel lanes were to be maintained. This set up was modified to close one lane. The other Interstate test site at Elmore County with the same traffic control was operational for approximately 11 hours. This site experienced no safety problems or traffic congestion which was very encouraging.

Two concerns arose about safety of field technicians. First, generators needed to be filled with gasoline every 3-4 hours while still in operation. Second, technicians needed to cross high-speed, high-volume roadways to access the generator. The generator was located either in the middle of the roadway or on the opposite shoulder. Further discussions with the vendor indicated they are working on elimination of the generator in the roadway.

RSD technology is transferable to other localities. Existing RSD system is capable of capturing license plates and of monitoring emissions from moving vehicles. This technology can be used on the majority of roadways (two and three lane, freeway ramps, and highways). However, traffic volume and traffic control must be reviewed thoroughly. Additional effort is required when equipment set up is across two travel lanes. Opposing traffic must be filtered out. Also, more manual effort is required when same license plate numbers are issued for different type of license plates (i.e., Wildlife, Purple Heart, etc.) like Idaho.

Weather conditions affected the quality of collected data. Sunny, cloudy, and rainy periods affected the quality of the license plate readability. An automatic aperture and longer camera hood on video camera should be added to regulate the amount of light into the camera. Windy conditions required additional calibration of the sensors. One component missing from the RSD system was the ability to identify vehicles with “cold starts.”

RSD equipment and traffic control on the roadway affected driver’s performance. Travel speed reductions ranged from 9 % (l-84 at Elmore County) to 38 % (two-lane rural roadway) during the test. Normally, traffic engineers target driving speeds within 10 miles of the posted speed (high or low). This would be approximately 20% more or less than the posted speed at the Ada County test sites. Most of the speeds during the test were within this range.

Overall, RSD system performed well and the transportation impacts were minimal. The Evaluation Team for Ada County ITS project indicated they were impressed with the overall operation of the RSD system and would use it again.

Chapter 2
Origin and Destination Survey

The previous chapter discussed the purpose of the test, summary of the test configuration and test conditions, test operations, test schedule, weather, and site location, and data analysis that were similar in both Phases I and II, Origin and Destination (O/D) Survey and Emissions Monitoring at External Stations. This chapter discusses the data processing and analysis for the O/D survey, measures of effectiveness, hypotheses, national goals that relate directly to the O/D survey, and the conclusions from this individual test.

1.0 Test Operations

This test used LPR technology available with Hughes' "Smog Dog" to conduct an external O/D (travel) survey. External O/D surveys obtained travel characteristic information from motorists entering or exiting the study area, Ada County, to identify existing and future transportation demands.

Data collection was discussed in Chapter 1, Section 3.1, Test Operations. This section describes the data processing and analysis which occurred to conduct the O/D survey.

Collected data for each day were transferred to the data base program in the AQB computer. Each license plate record was manually reviewed for accuracy in transcribing the video license plate image to the digitized license plate number stored in the data base. During this process, it was determined an additional county code should have been added to the license plate recognition file by the vendor prior to testing. After each license plate record was reviewed, the data base was sorted to remove all unreadable, dealer, out-of-state, and distant Idaho 'county license plates. The distant Idaho counties are those counties in Idaho which AQB did not have access to the vehicle registration data base. AQB only had access to vehicle registrations for Ada, Boise, Canyon, Elmore, Gem, and Valley Counties and some Owyhee County vehicles. Reference to non-Ada counties will include these previously identified counties, excluding Ada County.

The sorted data base of readable license plates (Ada and non-Ada counties) was matched with state motor vehicle registration records to identify vehicle owner's name and address and vehicle make and age. This information was then added to the data base matching the appropriate license plate and vehicle owner.

Mailing labels using information from the Idaho Motor Vehicles Registration data base and test site location, direction of travel, vehicle license plate number, and date and time from the RSD data base were printed directly onto the O/D surveys. These surveys were hand-folded and prepared for mailing by AQB staff. All vehicle owners identified through LPR and Motor Vehicle Registration data base were mailed an O/D survey.

O/D surveys where mailed the morning following the test day that the vehicle was observed. It was important to deliver surveys to vehicle owners as soon as possible to ensure a higher survey return and to obtain the most accurate travel information on the recorded trip. One exception occurred when the collected data on Friday was unable to be mailed on Saturday. The bulk mailing department of the U.S. Post Office was not open on the weekend. These surveys were mailed the following Monday morning.

O/D surveys with prepaid postage were returned to ITD Planning Division for data processing. Survey participants were given one month to complete and return them before any data processing began. Approximately 3 1,637 surveys were mailed during the test period and 11,556 surveys were returned to receive a 37 % rate. The 11,556 surveys were those completed, but may or may not be useable due to the completeness of the survey. Blank surveys, surveys returned to sender, surveys where the forwarding address expired, or surveys where there was no such address were not included in the 11,556 survey total. The goal of the original test proposal was to receive a 25 % return rate.

ITD staff sorted the O/D surveys by test site, completeness of the survey, and external or internal trip. Because the I-84 at Canyon County (westbound) test site was terminated early and freeway ramps were then monitored to collect westbound traffic on I-84, internal trips were captured. Internal trips are those trips where both the origin and destination are in Ada County. This survey was to collect data on external trips. The internal trip information from this O/D survey can be used for transportation modeling purposes. Unfortunately, due the test site revisions of monitoring the Interstate on-ramps, westbound through trips on the Interstate were not captured. If the test site at I-84 at Canyon County line were monitored, the westbound through trips on the Interstate would have been captured.

Returned O/D surveys that were not completed were sorted into four groups: blank surveys, surveys returned to sender, surveys with no such address, or surveys where the forwarding address expired. The origin and destination on the completed surveys were identified and coded with a transportation analysis zone (TAZ) within Ada County. Those origins and destinations outside of Ada County were assigned a code based on the city or town reported. At the same time, other information relating to the survey questions was also coded on the O/D survey such as trip purpose, number and frequency of trip(s).

Following the manual assignments of coding the surveys, this information was entered onto a data entry screen (VISUAL BASIC) by ITD personnel. It was then stored in an ASCII file. This file was imported into Statistical Analysis System (SAS), computer software, to analyze the data and to use as a quality control measure. A similar process is used for traditional O/D surveys ("stop-and-ask" or "stop-anddistribute").

2.0 Data Analysis

This section describes the data collected for the O/D survey and the analysis of that data.

2.1 Evaluation Goal 1: Performance of the System

Objective A: Assess the capability of LPR technology to conduct external O/D surveys.

Findings

Findings of the capability of LPR to conduct external O/D surveys are:

- Survey return rate to surveys mailed was 37 % using LPR technology.
- Survey return rate to traffic volume during test period was 21% .

- Quick turnaround time using LPR technology to get the surveys into the hands of vehicle owners created a high quality response and a high return rate.

Data Collection and Analysis

External surveys are primarily used to obtain travel information on external trips by vehicles at strategic points located near the planning area boundary. The type of survey to be used depends upon the roadway characteristics of the interview stations and the size of the study area. Three types of external surveys are used: 1) roadside interviews; 2) roadside distribution of postcard surveys; and 3) videotape surveys (license plate identification with postcard survey distribution).

1. Roadside Interviews

This type of survey involves stopping motorists along the roadside and asking a series of questions. Responses are either hand-entered onto a survey form or entered directly into a portable laptop computer for subsequent processing. This type of survey is used only when the interview location is deemed to be safe and stopping traffic is not overly disruptive to the traffic flow. Roadside interviews are normally limited to non-freeways with adequate travel lanes, shoulder width, and sight distance.

2. Roadside Mailback Surveys

Roadside interviews can vary in length from three minutes or more to complete. Stopping vehicles for this length of time on major roadways may create safety problems or may be highly disruptive to traffic flow. For some of these sites, a mailback survey technique is used. Vehicle drivers are handed a survey to complete and are requested to mail them back at their convenience. This type of survey is appropriate where vehicles are required to stop at signalized intersections.

3. Videotape Surveys

For high-volume highways or freeways, neither of the previously mentioned surveys may be appropriate due to high-speed traffic or limited sight distance. In these conditions, video taping license plates and mailing surveys to vehicle owners may be the best way to obtain travel information. Video traffic surveys have been proven to work in collecting travel information and are currently being used.

Video traffic surveys use video equipment to take a snapshot of the vehicle's license plate. At the end of the day, video tapes are taken to a nearby recovery center where they are played back on high resolution VCR's and all legible license plate numbers are keyed by a team. The team consists of one person operating the VCR and reading license plates, and the other one keying the data in standard ASCII format into a microcomputer. A pre-established coding convention is adopted for identifying and recording the types of all vehicles observed. For those with legible license plates, the license number is also entered. This data entry, which is a labor-intensive task, is nevertheless typically completed by the end of the day following video taping. Output from this step is a license plate data base file for each direction and time period of the survey. The license plate is then matched with motor vehicle registration files to obtain vehicle owners' name and address. Then, O/D surveys are mailed to the vehicle owners. A survey return greater than 30% with this technique is not usual. (See Appendix H - Traffic Survey Applications for more information.)

This last survey is very similar to the LPR technology that was tested in Ada County. Both survey methods: use video cameras to take snapshots of license plates from moving vehicles; do not interrupt traffic flow by stopping motorists on the roadway; do not require numerous staff to operate an interview site; and are able to distribute surveys to registered vehicle owners identified through a State Vehicle Motor Registration data base. Both of these video survey methods attempt to improve or provide alternatives which minimize staffing of the survey sites, minimize disruption to the traffic flow, and provide survey participants an opportunity to respond to the survey at their convenience. However, the LPR technology used in Ada County focused on automating the survey process, therefore, minimizing manual tasks.

LPR technology and data processing associated with this test were capable of eliminating or minimizing any manual tasks associated with the previously discussed traffic video survey. It read license plates and printed address labels and other necessary information directly onto the survey form. Minimizing the manual tasks associated with the survey enables a quick turnaround time, less than one day, which was a real bonus to mailout surveys. Data collection ended at 7:00 p.m. and surveys were mailed by noon on the following day.

ITD staff processing the returned surveys indicated that the quality of the survey data was good. As with all mailout surveys, some people interpreted the questions differently and some of the respondents reversed the trip origin and destination. Therefore, the coder reversed them. This is the standard practice when direction of travel at the site location (such as westbound travel) does not match the direction traveling from the origin to the destination. Direction of travel was printed directly onto the surveys. Only outbound traffic was captured for this O/D survey. With this information, the coder knew the correct direction of travel from origin to destination.

Turnaround time to get surveys in vehicle owner's hands was approximately two days (data/survey processing and mail time) which also improved the quality of the data. This can be seen in the good survey response rate as shown in Table 9, Summary of Survey Responses.

The table also calculates percentage of surveys returned compared to the traffic volume during the test period. Overall, surveys were returned by 21% of the traffic volume for the survey hours. An external travel survey report for the Salem/Albany area in Oregon, reflected a return rate of 17% of the traffic volume during the survey period. The Salem/Albany O/D survey included 18 roadside interview sites, three roadside mailback sites, and three video mailback sites. While this was only one O/D survey conducted by another jurisdiction, it provided some reference to what LPR method can accomplish.

The quality of the travel data obtained in an interview survey is very high since the driver is asked on the spot the origin, destination, and other specifics of the trip. However, the interview survey has many drawbacks such as disrupting traffic flow, inconveniencing motorists, and traffic safety issues. The mailout survey method that is involved in the roadside mailback, the LPR method, and the travel video method requires the driver to recall specifics about the trip after the trip is completed. The quick turnaround time using the LPR technology to get the O/D surveys into the hands of the vehicle owners creates a high quality response and a high return rate.

Table 9
Summary of Survey Responses

Site Location	Total Surveys Mailed	Surveys Returned	Survey Return Rate (to Mailed Surveys)	Traffic Volume (Outbound)	Survey Return Rate (to Traffic Volume)
Franklin Rd.	905	335	37%	1,605	21%
Kuna Rd.	335	116	35%	549	21%
Ustick Rd.	108	38	35%	566	19%
McMillan Rd.	13	1	8%	99	1%
I-84 canyon County (on-ramps only)*	23,036	8,337	36%	39,796	20%
I-84 @ Elmore County	1,484	499	34%	3,569	14%
Hwy.	21 480	189	39%	934	20%
Amity Rd.	542	223	41%	1,005	22%
Hwy. (Chinden Blvd.}	201,162	434	37%	1,917	23%
Hwy. 44 (State St.)	927	335	36%	1,596	21%
Hwy. 16 (Emmett Hwy .)	1,474	586	40%	2,226	26%
Hwy. 55 (Horseshoe Bend Rd.)	924	369	40%	1,317	28%
Total	**31,390**	**11,462**	**37%**	**55,179**	**20%**

Note: * I-84 Canyon County site in this table includes only trip data captured at the eight I-84 on-ramp sites.

2.2 Evaluation Goal 2: Transportation System Impacts

Objective A: Assess the potential transportation impacts for planning.

Findings

Findings of the potential transportation planning impacts are:

- Responses from the O/D survey can be used to develop trips tables for transportation modeling purposes for current and future forecasting of travel patterns.

Data Collection and Analysis

O/D surveys were mailed to owners of vehicles registered in Ada County and its surrounding five counties. Questions included in this survey are similar to questions included in other O/D surveys and asked the following:

- Where did this trip begin?
- Describe the type of location that you began your trip such as home, work, school, etc.
- Where did this trip end?
- Describe the type of location that you ended your trip such as home, work, school, etc.
- How often is this trip made?
- How many people were in this vehicle during this trip?
- Approximately how long did this trip take?

Responses from this O/D survey can be used to develop trip tables for the transportation model for Ada County. This updated travel pattern and travel characteristics will provide valuable information that will assist in future forecasting of travel patterns. Appendix I, Tables l- 6, shows responses received from the O/D surveys. The test occurred throughout a five day period. Each test site captured license plates of cross-county commuters for a 7-12 hour period. Only outbound vehicles were monitored and mailed O/D surveys.

Trip destination data were broken down into two groups; the first group contains all test sites along the Ada/Canyon County line (western) and the second group contains all test sites along the northern and eastern Ada County lines. The majority of trips from Ada County heading westbound were destined for Nampa and Caldwell. Most motorists using Hwy. 16 (Emmett Hwy.) traveling north from Ada County were destined for Emmett. Hwy. 55 which connects Ada County and the Horseshoe Bend area had several major destination: Lowman, Horseshoe Bend, Cascade, and McCall. I-84 eastbound at the Elmore County line identified the major destination as Mountain Home. With Hwy . 21, the major destination was Idaho City.

Origin Trip Type and Destination Trip Type describe the location of the trip origin and destination such are home, work, school/day care, medical, recreation, shopping, or specifying one. The majority of origin trip types were work trips with home trips following right behind it. Most destination trip types were the reverse of origin trip type (home trips with work trips following it). This information will be used to develop the trip purposes such as home based work, home based non-work, non-home based work, and non-home based other. Home based work had one trip end at home and the other at work. Home based non-work had one trip end at home and the other at a non-work location such as shopping, recreational, etc. Non-home based work had one trip end at work and the other at a non-home location such as shopping. Non-home based other had neither trip end at work or at home.

The percentage of breakdown in trip making frequency at each survey site was developed. Over 40% of the respondents from each test site indicated they make the trip five times or more a week with the exception of motorists using Hwy. 55 (Horseshoe Bend Rd.), I-84 at Ehuore County, and Amity andUstick Roads. These respondents used these roadways l-2 times per month.

The percentages of surveyed vehicles with one, two, and three or more occupants at each test site were developed. This information was also broken down by the number of people in the vehicle by age (under and over 16 years old). Seventy percent or more of the vehicle occupants were over 16 years old. The majority of these people are driving alone ranged between 56.9 % to 82.8 % depending on the test site. Hwy . 55 had the lowest drive alone percentage and Ustick Road experiences the highest drive alone percentage. Two to three person cat-pools occurred at most of the survey sites. It varied in range from 13.8 % to 3 1.7 % . Three survey sites, Hwy . 55, Hwy. 21, and I-84 at Ehnore County, experienced over 30% of the motorists carpooling with one or two other people.

Trip travel time in minutes for each survey site was also obtained from the motorists. The majority of respondents indicated their travel time ranged from 30 to 40 minutes. Two survey sites, Franklin and Kuna Roads, indicated the majority of motorists using these roadways have a trip travel time of 20 minutes. Survey sites, I-84 at Ehnore County, Hwy. 21, and Hwy. 16, showed approximately 30% of the roadway users having trip travel times of 50-60 minutes. Hwy.55 (Horseshoe Bend Road) survey site showed 40% of the roadway users traveling 90 minutes or more between Ada County and their destination.

2.3 Evaluation Goal 3: System Cost

Objective A: Document the costs for the operational test: LPR capital costs, operating costs, and staff costs.

Findings

Findings of the operational test costs are:

• LPR costs (leasing four “Smog Dog” vans and technicians)	$31,500
• Operating costs (rental phones, printing and mailing surveys, purchasing hard drive, disk drive, and back up tapes)	10,310
• Labor costs (local staff, consultants, and temporary staff)	90,328
Total	**$132,138**

Objective B: Assess the cost effectiveness of O/D survey using LPR versus traditional O/D methodology.

Findings

Findings of the cost effectiveness of O/D survey using the LPR method versus the traditional method are:

- Cost per survey site using LPR method for Ada County project ($5,120) was less than other survey methods used by the Salem/Albany, Oregon survey project.

- Cost per returned survey using LPR method for Ada County ($8.86) was more expensive than other survey methods used by Salem/Albany survey project. Factors that may have generated higher per survey costs were more survey sites, longer survey hours, and lower traffic volumes during the Ada County project.

Data Collection and Analysis

APA's Administrative Director was responsible for collecting all project billings, including material and services expenditures and labor costs. Costs associated with conducting an O/D survey using LPR technology are as follows:

• Lease and insurance on four "Smog Dog" vans (Four technicians with overtime, 15 hours per day for one week)	**$64,000**
• Public relations consultant	**200**
• O/D surveys (printing & mailing)	**14,000**
• Computer materials (disk drives & tapes)	**1,700**
• Labor (O/D field operations, survey processing, data coding, data entry & clean up, and data analysis)	**22,500**
Total	**$102,400**

The cost to conduct an O/D survey at 20 survey sites was $102,400 or $5,120 per site using RSD/LPR technology.

Willamette Valley Council of Governments was contacted for a copy of the 1994 Salem/Albany (Oregon) Survey report. DKS Associates conducted an external O/D survey at 24 sites in the Salem/Albany area using the roadside interview, roadside mailback, and video mailback survey techniques. The video mailback survey was used at three Interstate locations.

The roadside mailback was used at three river crossings. The roadside interview was conducted at the remaining 18 surveys sites (roadways with two to five-travel lanes). The following table provides a comparison of these three survey techniques and the LPR **method.**

Table 10
Cost Per Sunrey Site

Type of Survey Method	Per Site Costs
LPR mailback method	$5,120
Roadside interview	$6.450
Roadside mailback	$12,750
Video mailback	$21,000
NOTE: These costs include: survey design, traffic control, field work, printing and postage, survey processing, data coding, data entry and cleanup, and data analysis.	

Cost per survey site of the RSD/LPR was less than other survey methods used by Willamette Valley Council of Governments. A comparison of cost per returned surveys was analyzed. The table below reflects these costs.

Table 11
Cost Per Survey

Type of Survey Method	Number of Survey Sites	Traffic Volume during Survey Period	Total Survey Cost	Number of Returned Surveys	cost per Survey
RSD/LPR Mailback	20	55,000	$102,400	11,557	$8.86
Roadside Interview	18	127,600	$116,100	31,222	$3.72
Roadside Mailback	3	60,600	$38,250	6,634	$5.77
Video Mailback	3	87,400	$63,000	8,676	$7.26

This table is somewhat misleading when comparing cost per survey. Closer analysis of the survey sites for Salem/Albany revealed a total traffic volume of approximately 275,600 vehicles during the survey test period. The breakdown is shown in the Cost Per Survey Table. Traffic volume at the Ada County survey sites was approximately 55,000 vehicles during the survey period. The survey method with the closest traffic volume was the roadside mailback. The traffic volume at these sites was captured at only three survey sites, when compared to Ada County's 20 survey sites. The cost at the Ada County sites tended to be higher since more labor was required for these 20 survey sites. In addition, the survey sites in Ada County were planned to be monitored 12 hours a day when compared to eight hours with the Salem/Albany survey.

3.0 Hypotheses

As part of this evaluation, four hypotheses were identified to be tested during the test. Hypotheses to be tested and a brief discussion of each follows.

Using LPR methodology (collecting O/D data using video imaging equipment, accessing license registration data files, and mailing O/D surveys) compared to traditional O/D methodology (where automobiles are flagged off the road and drivers were asked questions or handed an O/D survey) captured trip origin, destination, and purpose in such a way that:

a. There were fewer hazardous driving incidents reported by Ada County technicians than reported by traditional methodology observers;

b. There were fewer interruptions of traffic flow observed by Ada County technicians than reported interruption with the traditional methodology;

c. There was less inconvenience to individual drivers by LPR methodology than the traditional methodology; and

d. The cost per returned/completed survey to ITD using LPR methodology was less than that for the traditional methodology.

Definitions

- Hazardous driving incidents were traffic accidents or hazardous maneuvers performed by motorists.
- Interruptions of traffic flow referred to impeding traffic movement such as slowing or stopping vehicles in travel lanes.
- Inconvenience to individual drivers related to hindering the motorists' travel speed which affects their travel time.

3.1 Hypothesis A: There are fewer hazardous driving incidents reported by Ada County technicians than reported by traditional methodology observers.

Findings

- LPR technology did not require stopping vehicles on the roadway and reduced the potential for rear-end accidents.
- LPR technology eliminated the need to have people in the roadway asking questions or distributing O/D surveys.
- LPR technology minimized the mixing of pedestrians and vehicular traffic in the roadway.

Data Collection and Analysis

APA staff contacted ITD and ACHD to discuss this hypothesis with personnel who participated in O/D surveys in the past. There was no recorded information about the number of hazardous driving incidents that occurred with the traditional methods, "stop-and-ask" or *"stop-and-distribute" O/D surveys. However, ITD and ACHD personnel indicated that on high-volume, high-speed roadways like the Interstate or other State highways, stopping traffic caused numerous safety concerns. First, stopping traffic when motorists least expect it increased the potential for rear-end accidents. Second, many times opposing traffic began to slow down and gawk at the activities which also created potential for rear-end accidents.

LPR technology had the capability of obtaining needed travel data by eliminating the need to stop traffic on these high-volume, high-speed roadways. Travel speeds were reduced, but possibly no more than caused by a road crew working along the roadway. LPR technology minimized traffic maneuvers which created hazardous driving incidents like the traditional method of stopping motorists in the roadway. A public acceptance survey which was conducted with this test is discussed in Chapter 4 and revealed many of the motorists didn't notice or remember noticing the LPR equipment on the roadway.

3.2 Hypothesis B: There are fewer interruptions of traffic flow observed by Ada County technicians than reported interruptions with the traditional methodology.

Findings

- LPR technology did not disrupt the traffic flow. The use of road tubes to activate the video camera eliminated traffic flow disruptions on high-volume roadways like the Interstate.

Data Collection and Analysis

As discussed in the previous hypothesis, traditional methods require stopping motorists and asking questions or distributing a travel survey. If successful, the majority of motorists traveling low-volume roadways are stopped and approximately 10% of the motorists on the freeway or high-volume highways are stopped. Overall, this tends to be a large number of motorists which are stopped and whose trips are interrupted.

LPR method did not require stopping motorists on the roadway. Motorists tended to reduce speed through the survey sites, but their trips were not interrupted. (Change in driving performance was discussed in Chapter 1, Section 4.0, Data Analysis.) While I-84 at Canyon County (westbound freeway) experienced an interruption in the traffic flow, this incident can be avoided by using road tubes to activate the video camera instead of the emissions sensors that were used.

3.3 Hypothesis C: There is less inconvenience to individual drivers by LPR methodology than the traditional methodology.

Findings

- LPR technology allowed vehicle owners to complete an O/D survey at their convenience without interrupting their trip.

Data Collection and Analysis

One traditional methodology involves stopping motorists along the roadway and asking a series of questions. Responses to the questions are either hand-entered onto a survey form or entered directly into a portable laptop computer for subsequent processing. On low-volume roadways, motorists may be interviewed immediately and the interview process takes approximately three minutes. On high-volume roadways, the motorist may be delayed up to four minutes before being interviewed. Delay on high-volume roadways can range from three to seven minutes. If delay is over five minutes, normally interviewers allowed the motorists to continue their trip without interviewing them.

With the other stopping method, hand distribution of the survey, delay time can be reduced by half. This method allows motorists to complete the survey at their convenience.

LPR methodology took the previous methodology one step further and did not stop motorists on the roadway. This methodology took a snapshot of the vehicle license plate. With this information, a travel survey was mailed to the vehicle owner. Like the previous" stop-and-distribute" mailback survey, the motorist completed the survey at their convenience. LPR method was more convenient.

3.4 Hypothesis D: The cost per returned/completed survey to ITD using LPR methodology will be less than that for the traditional methodology.

Findings

- Comparison of survey costs using LPR and the traditional methods did not provide a conclusive finding. LPR methodology reduces hidden costs associated with traditional methods such as traffic delays and inconvenience to motorists.

Data Collection and Analysis

Comparison of cost per returned survey using LPR to the traditional methods was somewhat misleading. This hypothesis was discussed in Evaluation Goal 3; Objective B. Cost per survey was approximately $8.86 compared to $3.72 for the roadside interview, $5.77 for the roadside mailback, and $7.26 for the video mailback (Salem/Albany, Oregon survey). Ada County survey project had 20 survey sites to capture approximately 55,000 vehicles (volume through the survey site). Conditions for the Albany/Salem survey varied. The roadside interview used 18 sites and captured 127,600 vehicles. The roadside mailback and video mailback used three sites each to capture 60,600 and 87,400 vehicles, respectively. Ada County's project also captured data for a 12-hour period. Whereas, the Salem/Albany survey project only captured travel data for an 8-hour period. Cost for the A& County project tended to be higher due to the increased labor costs for additional sites, longer operating period, and to smaller traffic volume captured. Cost per survey site using LPR was less than the traditional methods.

4.0 National ITS Goals

Six goals were developed for the National ITS Program. The following section addresses five of the six goals which relate to this specific test of the ITS Project for Ada County.

4.1 Improve Safety of Nation's Surface Transportation System

This test provided a valuable tool to conduct an external O/D survey. As previously mentioned, metropolitan areas find it more difficult to conduct travel surveys due to increased traffic volumes and speeds on the major roadways and increased costs to perform them. Without current data on travel demands and characteristics, existing and future transportation system deficiencies and improvements can not be identified. LPR technology can be used to conduct an external O/D survey. It can capture travel demand and characteristics on high-volume, high-speed roadways where stopping motorists unexpectedly would cause potentially hazardous conditions (i.e., potential for rear-end accidents). With minor improvements to the LPR technology (using road tubes to activate the video camera), the potential exists to monitor multi-lane freeways without causing any major disruptions in traffic speeds or traffic safety concerns.

4.2 Reduce Energy and Environmental Costs Associated with Traffic Congestion

As more vehicles travel the roadways and travel demand exceeds the roadway capacity, travel conditions become more congested. With this congestion, higher levels of air pollution are produced and energy consumption is increased. By identifying existing and future roadway and transit service deficiencies and improvements, transportation agencies can plan for future roadway and transit service projects.

Air quality does not stop at a county line, nor does mobility. Mobility has improved over the years and has created other associated impacts such as increased air pollution and energy use. By having the needed transportation information to develop and implement management or policy strategies, air pollution and energy use can be reduced. LPR technology has this capability to provide needed data on travel demand and characteristics to make these decisions.

4.3 Enhance Present and Future Productivity

This objective is to reduce transportation costs for all users of the transportation system. With good travel demand and characteristics, transportation models can identify system deficiencies and improvements. Transportation system improvements can reduce operating and manufacturing costs which are affected by travel times and energy costs. Transportation system management can improve productivity of the workforce. This information may minimize the need for additional facilities by making better use of existing facilities and identifying options to meet transportation needs. This technology, LPR, has the capability of improving the quality and cost efficiency associated with the collection and use of data necessary for transportation planning, operations management, roadway construction and maintenance.

4.4 Enhance Personal Mobility, Convenience and Comfort of the SurfaceTransportation System

Travel surveys provide valuable transportation data. Identification of system deficiencies and improvements can improve personal mobility and provide greater predictability about travel times. Travelers can have greater confidence in using the roadway system and other transportation modes. They can experience less stress in using them. LPR technology can provide the travel data for transportation planners and policy makers to base their decisions.

4.5 Create an Environment in Which the Development and Deployment of ITS Can Flourish

An objective of the national ITS program is to assist both public/private agencies in the development of hardware, software, and services and the deployment of this technology. This program can assist the U.S. to achieve substantial domestic market penetration and strong international presence.

Ada County’s test of LPR technology provided valuable insights on how to advance towards this goal. First, the existing camera system required manual adjustments of the aperture to control the amount of light into the camera. When cloudy conditions existed, the technician needed to regularly adjust the aperture to ensure quality license plate images. The camera system can be improved with an automatic aperture. This would enhance the quality of license plates and would reduce the number of unreadable license plates and license plates needed to be manually entered into the data base. It would also improve roadway safety by minimizing the amount of time the technician mixes with traffic.

Second, acceleration equipment was used for the first time with emissions sensors, video camera, and computer software. Acceleration equipment identified whether the vehicle was accelerating, cruising, or decelerating. These data were evaluated to determine if acceleration had an impact upon driver performance through the test sites. An objective of using LPR technology to collect travel was not to affect driving behavior or interrupt traffic flow which affect the operation of the roadway system.

Third, the test occurred on various types of roadways, from minor rural two-lane roadways to multi-lane freeways. This test is one of the first to capture license plates images and to monitor vehicle emissions on a freeway. While one test site on the freeway was successful and the other unsuccessful, the test produced some valuable results. It showed:

- Field technicians need experience working in high-volume, high-speed conditions;

- RSD equipment should be set up prior to morning peak period; and
- The number of vehicles and personnel at the test site should be minimal.

High-volume roadways can be monitored if existing roadway capacity can be accommodated with adequate traffic control. In addition, if road tubes are used to activate the video camera, high-volume, multi-lane roadways could be monitored for O/D surveys.

Lastly, comparison of cost per survey using LPR method compared to traditional methods did not provide any conclusive findings. When comparing the survey costs, hidden costs to the public should also be considered such as traffic safety and delays, and inconvenience to motorists. Other issues such as public acceptance of using this technique over traditional methods should be considered and is addressed in Chapter 4 of this document.

5.0 Conclusion

This chapter analyzes data and develops findings on whether LPR technology is effective. LPR technology is capable of conducting an external Origin and Destination survey. Automation of the travel survey process created a quick turnaround time. Once the license plate data were transferred from "Smog Dog" computer to Air Quality Board's computer system, the data processing required 12 hours or less. This data processing included review of license plate numbers, matching license plate numbers with State motor vehicle registration data base, and preparing O/D survey for mailing. Surveys were mailed the morning after data collection.

The fast turnaround time to get the surveys in the vehicle owner's hands improved the survey response rate received from typical mailback surveys and provided a high quality response. This survey had a 37% response rate. Responses from the O/D survey can be used to develop trip tables for transportation modeling purposes for current and future forecasting of travel patterns.

When comparing cost effectiveness of the LPR method with the traditional methods, results are not conclusive. Cost per survey of traditional methods used by the Salem/Albany survey (i.e., roadside interview, roadside mailback, and video mailback) were less expensive than the LPR method. Closer analysis of those survey sites revealed a total traffic volume of approximately 275,600 vehicles during the survey period. Total traffic volume at the Ada County sites was approximately 55,000 vehicles during the survey period. The survey method with the closest traffic volume was the roadside mailback. Traffic volumes at these sites were captured at only three survey sites, when compared to Ada County's 20 survey sites. Cost at the Ada County sites tended to be higher since more labor was required for these 20 survey sites. In addition, the survey period was longer for the Ada County project.

A comparison of cost per survey site revealed the LPR method was less expensive than the other three traditional methods used in the Salem/Albany survey. Overall, comparison of cost effectiveness between these methods with varying number of test sites, traffic volumes, and survey periods was difficult at best.

Based upon findings of this test, there were fewer hazardous driving incidents using LPR methodology than traditional survey practices. LPR method did not require stopping vehicles on the roadway and reduced the potential of rear-end accidents. Additionally, it eliminated the need to have people in the roadway asking questions or distributing O/D surveys.

There were fewer interruptions of traffic flow and less inconvenience to individual drivers using LPR methodology compared to traditional methodology. Motorists tended to reduce travel speeds through the survey sites, but their trip was not interrupted. Surveys were mailed to the vehicle owner to complete at their convenience. The use of road tubes to activate the video camera would reduce traffic flow disruptions on high-volume roadways like the Interstate. Since Phase I and II were conducted simultaneously, the emissions sensors were needed to monitor the emissions of vehicles passing through the test sites.

In conclusion, members of the Evaluation Team indicated they would use the LPR method to conduct an O/D survey again. The methodology minimized hazardous driving incidents, and reduced the disruption of traffic flow and inconvenience to the motorists. This method provided a high response rate and high quality of survey responses for future transportation modeling purposes. Members recommended a different triggering device be used instead of the emissions sensors, possibly road tubes. This modification in the LPR equipment would improve operations on the roadway, especially highways and freeways. While the cost effectiveness of LPR methodology compared to traditional methodology was not conclusive, the hidden costs to the motorists (i.e., inconvenience, safety, etc.) would clearly justify its use for future O/D surveys.

Chapter 3
Emissions Monitoring at External Stations

Chapter 1 discussed the purpose of the test, summary of the test configuration and test conditions, test operations, test schedule, weather, and site locations, and data analysis that were similar in both Phases I and II, Origin and Destination (O/D) Survey and Emissions Monitoring at External Stations. This chapter will address data processing for emissions monitoring at external stations, measures of effectiveness, hypotheses, national goals that relate directly to the emissions monitoring, and the conclusions from this individual test.

1 .0 Test Operations

This test used RSD technology available with Hughes' "Smog Dog" to monitor emissions of cross-boundary vehicles (traveling between Ada County and other Idaho counties) to assess the relative carbon monoxide (CO) emissions readings of non-Ada County vehicles. An attempt was made to get voluntary repairs of out-of-county vehicles determined to be "high emitters. The repair rate of non-Ada County "high emitting" vehicles and the effect of the incentives was tracked during the study.

Data collection for the test operations was discussed in Chapter 1, Section 3.1, Test Operations. This section describes the data processing and analysis which occurred to determine the relative CO emissions readings of non-Ada County "high emitting" vehicles and effectiveness of the available incentives.

The day's observation and the collected data were transferred to the data base program in the Air Quality Board (AQB) computer. Each license plate record was manually reviewed for accuracy in transcribing the video license plate image to the digitized license plate number stored in the data base. After each license plate record was reviewed, the data base was sorted to remove all unreadable, dealer, out-of-state, and distant Idaho county license plates. Distant Idaho counties are those which AQB did not have access to the vehicle registration data base. AQB only had access to vehicle registrations for Ada, Boise, Canyon, Elmore, Gem, and Valley Counties and some Owyhee County vehicles. Reference to non-Ada counties included these previously counties, excluding Ada County.

The sorted data base of readable license plates (Ada County and non-Ada counties) was matched with state motor vehicle registration records to identify vehicle owner's name and address and vehicle make and age. This information was then added to the data base matching the appropriate license plate and vehicle owner.

During the week following data collection, data were sorted into two groups, Ada County and non-Ada counties, using the domicile of the vehicle from the license plate readings. "High emitting" vehicles from non-Ada counties were identified and 100 vehicles were randomly selected for three groups to receive informational/incentive letters. Two of these groups received incentive coupons. The remaining group was used as a control group. Two incentive coupons/letters were for a free emissions test or a $20 discount for a tune-up. The control group received an informational letter urging them to repair their vehicle (see Appendix J - Incentive/Informational Letters).

When the three groups were created, mailing labels were printed and vehicle owner's name, date, vehicle make, and license plate number were printed directly onto the incentive/informational letters. Mailing labels and letters were matched to ensure the appropriate incentive/informational letters were mailed to the correct vehicle owners. Letters were hand-folded and placed in envelopes matching the appropriate mailing labels. Vehicle owners receiving the incentive letter had approximately three months to redeem it. The expiration date printed on the incentive coupons was July 31, 1995. When an incentive coupon was redeemed at a participating business, it was returned to AQB.

The control group was contacted the week following the expiration of the incentive coupons to determine any voluntary repair to their "high emitting" vehicles. In addition, participating businesses were contacted to ensure all redeemed incentive letters (coupons) were returned to AQB.

2.0 Data Analysis

This section describes the data collected for the emissions monitoring and the analysis of that data.

2.1 Evaluation Goal 1: Performance of the System

Objective A: Assess RSD systems overall reliability for data collection.

Findings

Findings of the RSD systems overall reliability are:

- RSD recorded 88 % valid CO readings and 64 % valid CO and acceleration readings at the 20 test sites.

Data Collection and Analysis

In addition to collecting license plate data of moving vehicles, emissions readings were collected at each test site. Table 12, Summary of Valid Emissions and Acceleration Readings from Idaho Vehicles, provides a breakdown of emissions readings in two categories: valid CO readings and valid CO and acceleration readings from Idaho vehicles with readable license plates captured at the County line and the on-ramps. The RSD computer is programmed to calculate a confidence factor for reading the emissions and acceleration. If the computer determines it's not adequate, the computer will enter nines in the CO or acceleration field for that record.

For this analysis, 31,637 Idaho vehicles (Ada, non-Ada, and other Idaho Counties) identified with readable license plates were used. Additionally, test sites were divided into two groups: those at the county Iine and those along the Interstate on-ramps. Test sites at the county line recorded 78 % valid CO readings and 62 % valid CO and acceleration readings of the total Idaho vehicles with readable license plates. Test sites at the Interstate on-ramps experienced a higher percentage of valid CO readings, 92 % , and approximately the same percentage of valid CO and acceleration readings as the test sites at the county line. Overall, RSD recorded 88% valid CO readings and 64% valid CO and acceleration readings from Idaho vehicles with readable license plates.

Table 12
Summary of Valid Emissions and Acceleration Readings from Idaho Vehicles

Site Location	Total Useable Idaho Licenses	Valid CO	Valid CO & Acceleration
At County Line	8,561	6,666	5,344
Percent of Subtotal		78%	62%
At I-84 On-ramps	23,076	21,207	15,052
Percent of Subtotal		92%	65%
Total	**31,637**	**27,873**	**20,396**
Percent of Total		**88%**	64%

NOTE: Total **useable** Idaho licenses **are defined** as Ada, non-Ada. and other Idaho Counties.

2.2 Evaluation Goal 2: Transportation System Impacts

Objective A: Assess the potential for transportation/air quality planning.

Findings

Findings of the potential for transportation/air quality planning are:

- Overall, non-tested vehicles have approximately 10-15% higher emissions readings than regularly tested vehicles.

- This test provided emissions data to support consideration of expanding the existing I&M program to include non-tested vehicles driving in the designated I&M area. The I&M program could expand its existing boundaries or implement a commuter program.

Data Collection and Analysis

An attempt was made to record emissions of all vehicles passing through designated test sites in Ada County using RSD technology. The procedure for data collection was discussed in Section 3.1, Test Operations, and is discussed in more detail later in this Chapter (Evaluation Goal 3, Objective B). A brief summary of the test is included in this evaluation (average emissions readings of non-Ada County vehicles).

License plates, emissions, and speed readings were recorded as vehicles passed test sites and stored in the RSD computer system. After collection of these data, license plates numbers were reviewed for accuracy and corrected manually if necessary. License plates were then sorted to remove those license plates with county designations outside Ada County. These license plates were then matched with the Idaho Department of Motor Vehicles data base to obtain age of vehicle. Records with incomplete data on speed, emissions, acceleration, and year of manufacture were deleted. This left a data base with slightly fewer than 18,000 records, some of which represented duplicated observations of the same vehicle. An index was created using vehicle license plates as the first sorting variable followed by a random number which was assigned to the record. Subsequently, all duplicate records for a single license plate were eliminated, leaving a randomly selected observation within the data base for any vehicle which had more than one observation. These data contained approximately 16,000 record. Data were sorted again to contain only those vehicles which were captured at County line test sites. These vehicles were unlikely to be in a “cold start” condition and affect the emissions readings. These data contained approximately 4,260 vehicles which were then used to analyze emissions of Ada County and its surrounding counties vehicles.

Analysis for the data were conducted using SPSS-PC + , the Statistical Package for the Social Sciences. Various groupings of variables were used to analyze the data (i.e., test station groups, acceleration, tested versus non-tested, and automobile year). Measure of effectiveness (MOE) for this objective identified average emissions readings of non-Ada County vehicles. However, to use these data for any purposes, emissions readings of non-Ada County vehicles should be compared to emissions readings of Ada County vehicles.

Table 13, showing t-test analysis for the dependent variable carbon monoxide emissions, represents the most direct information related to the performance measures for this objective. Specifically, the issue is whether CO varies as a function of whether a vehicle is tested or not tested controlling for four groupings of automobile manufacture years and three groupings of acceleration.

Table 13
Carbon Monoxide Readings at County Line

	Acceleration							
	Deceleration		Constant		Acceleration		Total	
Autos	Tested	Not Tested	Tested	Not Tested	Tested	Not Tested	Tested	Not Tested
1951 - 1980	N: 35 M: 2.17 SD: 2.4	N: 93 M: 2.67 SD: 2.4	N: 90 M: 2.24 SD: 2.1	N: 208 M: 2.74 SD: 2.4	N: 53 M: 2.89 SD: 3.2	N: 109 M: 2.73 SD: 2.4	N: 178 M: 2.42 SD: 2.5	N: 410 M: 2.73 SD: 2.4
	Significance: .294 (ns)		Significance: .090		Significance: .726 (ns)		Significance: .169 (ns)	
1981 - 1985	N: 41 M: 1.41 SD: 1.9	N: 112 M: 1.21 SD: 1.6	N: 90 M: 1.19 SD: 1.8	N: 272 M: 1.39 SD: 1.8	N: 53 M: 1.44 SD: 1.7	N: 153 M: 2.08 SD: 2.4	N: 184 M: 1.31 SD: 1.8	N: 537 M: 1.55 SD: 1.9
	Significance: .512 (ns)		Significance: .353 (ns)		Significance: .038		Significance: .144 (ns)	
1986 - 1990	N: 86 M: 0.50 SD: 0.8	N: 187 M: 0.86 SD: 1.8	N: 234 M: 0.72 SD: 1.5	N: 496 M: 0.78 SD: 1.4	N: 137 M: 0.95 SD: 1.6	N: 269 M: 0.64 SD: 1.0	N: 457 M: 0.74 SD: 1.4	N: 952 M: 0.76 SD: 1.4
	Significance: .020		Significance: .544 (ns)		Significance: .042		Significance: .850 (ns)	
1991 - 1995	N: 108 M: 0.43 SD: 0.9	N: 182 M: 0.40 SD: 1.0	N: 269 M: 0.34 SD: 0.8	N: 533 M: 0.39 SD: 0.8	N: 160 M: 0.46 SD: 1.0	N: 290 M: 0.36 SD: 0.5	N: 537 M: 0.40 SD: 0.8	N: 1005 M: 0.38 SD: 0.8
	Significance: .730 (ns)		Significance: .397 (ns)		Significance: .209 (ns)		Significance: .749 (ns)	
Total	N: 270 M: 0.83 SD: 1.5	N: 574 M: 1.08 SD: 1.8	N: 683 M: 0.83 SD: 1.5	N: 1509 M: 1.03 SD: 1.7	N: 403 M: 1.08 SD: 1.9	N: 821 M: 1.09 SD: 1.8	N: 1356 M: 0.90 SD: 1.6	N: 2904 M: 1.05 SD: 1.7
	Significance: .034		Significance: .008		Significance: .917 (ns)		Significance: .006	

* Casewise deletion

Key: N = Number
M = Mean
= Standard Deviation

Of the 12 comparisons among categories of automobile manufacture years and acceleration, three of them are significant beyond the .05 level of significance. One of them is for vehicles which are accelerating and manufactured in the years 1981-1985; the second and third are for automobiles which are decelerating and accelerating and manufactured in the period of 1986-1990. In all cases, tested vehicles have significantly lower CO emissions than non-tested vehicles.

The overall analysis of whether CO emissions differ for tested versus non-tested vehicles regardless of the other groupings variables, showed a highly significant difference between the two with tested vehicles having approximately 1–15% lower CO emissions than do non-tested vehicles. This conclusion is confirmed in the lower right comer of Table 13.

Nevertheless, there are five of 12 analyses inside Table 13 where non-tested vehicle have lower CO emissions than do tested vehicle, although none of them reach levels of significance. In three of the four categories of acceleration and the automobiles manufactured in the years 1951-1980, 1986-1990, and 1991-1995 that non-tested vehicles have lower levels of CO emissions than do tested vehicles. Other cells where this result occurs are for decelerating vehicles manufactured in the years 1981-1985 and 1991-1995.

Overall, these results show that tested vehicles will have lower CO emissions than non-tested vehicles, all other things being equal. This information can then be utilized for air quality planning to determine whether air quality issues need to be addressed. In this case, regardless of the other groupings variables, CO emissions differ for tested and non-tested vehicles.

The other MOE addresses the identification of management or policy strategies for future consideration. Two potential strategies that may be considered in the future to address emissions contributions from out-of-county vehicles are: 1) require emissions inspections of vehicles registered to out-of-county commuters; and 2) expand the existing boundary.

APA staff contacted Environmental Protection Agency (EPA) staff in both Boise and Washington, D.C. to identify other existing programs that have implemented management or policy strategies targeting out-of-county vehicles. The Alaska Department of Environmental Conservation and Oregon Department of Environmental Quality were contacted as potential resources of information. The two previously mentioned strategies were either being implemented or considered by these two states.

The Alaska Department of Environmental Conservation (ADEC) expanded the existing Anchorage I&M program to include commuters from the Mat-Su Valley region (northeast of Anchorage). The program had been in operation for approximately one year and they were still working on the administration of it. As part of this program, ADEC looked at the potential of capturing program evaders. At the present time, ADEC staff was reviewing the existing automobile registration information to identify conflicting information such as the county the vehicle was registered in and the registration mailing address.

The Oregon Department of Environmental Quality (DEQ) indicated the State Legislature authorized an Environmental Quality Commission develop administrative rules to expand the existing boundary in the Portland Metropolitan Area. While administrative rules were developed, they have not been adopted. These administrative rules will be considered during the next Legislative session.

Both Alaska and Oregon have identified potential enhancements to their existing emissions programs. These two potential strategies will be briefly discussed in relation to Ada County.

1. Require Emissions Inspections of Vehicles Registered to Out-of-County Commuters

This strategy has the greatest chance of receiving support from policy makers from surrounding counties. Since commuters are targeted for emissions inspections, either using RSD technology or idle emissions tests, not every resident in the surrounding counties are affected. A majority of policy makers in adjacent counties understand the air quality problems in Ada County and are more receptive of this strategy than of expanding the existing boundary. Since daily commuters contribute to the air quality problems, policy makers perceive commuters should also help solve the problems. This feedback was received by staff when presenting a project overview to policy makers in surrounding counties. (This is discussed more in Chapter 4, Institutional, Legal, and Public Acceptance Issues.)

Ada County and surrounding counties are rapidly growing. More people are residing outside of Ada County due to availability of affordable housing and a good transportation system linking communities. In order to implement a commuter program, people who live outside Ada County and regularly drive into Ada County would need to be identified. With the use of RSD technology, commuters can be identified by the snapshot of the Idaho vehicle license plate with the county registration code. Development and implementation of such a program would need approval from the Ada County Air Quality Board (AQB). Policy makers from adjacent counties would be informed and asked for their comments. This program could be very effective in identifying those out-of-county vehicles which contribute to Ada County's air quality problems.

There are several possibilities using RSD technology. Since the intent of any type of enhancement program would be to improve emissions of out-of-county vehicles, RSD technology is capable of targeting and identifying those vehicles. Like the existing program, records would be maintained on those vehicles requiring an annual emissions tests, either RSD technology or idle emissions. Administration and enforcement of this program could be incorporated into the existing idle emissions program for Ada County.

The use of RSD technology provides a great advantage in taking small steps to improve air quality in Ada County and to obtain support from surrounding jurisdictions. If the use of alternative fuels, promotion of alternative transportation, and implementation of an enhanced I&M program, including out-of-county commuters, did not provide adequate results, the County can then target expansion of its boundaries.

2. Expansion of Existing Boundary

There are two ways to expand the existing boundary. In the first way, adjacent counties voluntarily implement a country-wide I&M program. In the second way, the State Legislature mandates adjacent counties to participate in an emissions testing program. While these strategies should not be overlooked, they would require a great deal of support for approval from policy makers and for implementing a strategy.

During the last legislative session, the Idaho legislature considered a bill which would have mandated Canyon County, the second largest county in Idaho and Ada County‘s westerly neighboring county, to implement an I&M program. This bill was not adopted by the legislature. Adjacent counties made their voice heard through this action. These strategies may need to be considered at a future date after consideration of a commuter program,

2.3 Evaluation Goal 3: System Benefits; Assess the Effect on CO Emissions Levels

Objective A: Assess the adjustment/repair rate of out-of-county "high emitters" and the effect of each incentive compared to the control group.

Findings

Findings of the repair rate of out-of-county "high emitters" are:

- Incentives were not effective in the encouragement of repairing "high emitting" vehicles. Only 8 % of the recipients of the free inspection test coupon redeemed them. No coupons for a discounted tune-up were used. Of the control group which telephone numbers were identified, approximately 33 % indicated they repaired their vehicle,

Data Collection and Analysis

Owners of three hundred "high emitting" vehicles were randomly selected and divided into three equal groups. One group received an incentive coupon for a free inspection test. Another group received an incentive coupon for a $20 discount on a tune-up. The remaining group received au informational letter encouraging them to repair their vehicle. The incentive coupons expired July 31, 1995. These incentive/informational letters were distributed the week after the vehicles were observed traveling through the test site. Participating businesses were reimbursed for the free inspection test up to $12 and the engine tune-up $20; respectively.

Of the 200 incentive coupons distributed, AQB received only eight redeemed coupons for a free inspection test which costed the program $96.

Seventy members of the control group were contacted by telephone by a research consultant during the first week of August, the week following the expiration of the incentive coupons. Interviews were completed with 37 of these 70 vehicle owners. Respondents were asked, "Have you had your vehicle repaired or adjusted as suggested in the letter?" Results were:

Answer	Number of Respondents	Total (%)
Yes	12	32.4
No	18	48.6
No - It was checked and not needed.	3	8.1
No - It was NOT checked, but not believed to be needed.	1	2.7
Don't know	3	8.0
Total	37	100.0

Approximately 32.4 % of the respondents indicated they repaired their vehicle. Another 8.1% indicated they had their vehicle's emissions checked and found repairs were not needed.

If the vehicle had not been repaired, respondents were asked, "Do you expect to have your vehicle repaired or adjusted in the near future?" Results were:

Answer	Number of Respondents	Total (%)
Yes	6	24.0
No	9	36.0
No - Car is not used.	1	4.0
Don't know/no answer.	9	36.0
Total	25	100.0

Among respondents who indicated they did not have repairs made, 24% reported they were planned in the near future. If these six respondents were added to the 12 who indicated they already had the repairs made, the percent compliance would be approximately 49% of all respondents. However, comparing any of these percentages with the incentive redemption rates will be theoretically difficult. A follow-up telephone survey may have provided more information for the other two groups.

Objective B: Assess the relative CO readings of non-Ada County vehicles and compare them with CO readings of Ada County vehicles.

Findings

Findings of the relative CO readings of non-Ada County vehicles are:

- Ada County vehicles (tested) have significantly lower emissions levels on average compared to non-tested vehicles.
- Controlling for speed, acceleration, and vehicle age, a tested vehicle can be expected to have a lower "Smog Dog" emissions level by approximately .035 to .134 units on average.
- Controlling for speed, acceleration, and whether the vehicle has been tested, each additional year of age adds an average from .125 to .133 units to the "Smog Dog" emissions level.

Data Collection and Analysis

Using RSD technology, an attempt was made to record the following information for all vehicles passing through each test site:

Data Element	Description
Automobile License Number	This is the actual automobile license number as resolved from the video of each license plate. Out-of-State and dealer license plates were specially coded and removed from the data base.
RSD Date	This is the day of the year on which the RSD observation was made.
RSD Time of Day	This is the time of day at which the RSD observation was made.
Site Number	This is a 2-digit number assigned to each RSD observation location (sites 01-18 were at the County perimeter, other sites were internal to Ada County).
Speed-one	This is the first speed of travel observation made by the RSD radar monitors.
Speed-two	This is the second speed of travel observation made by the RSD radar monitors.
Acceleration	This is the computed vehicle acceleration based upon speed-one and speed-two. It ranges from approximately -15 (deceleration) to +9 (acceleration).

Data Element	Description
Carbon Monoxide (CO)	This is the observed carbon monoxide in exhaust emissions recorded a: a percentage of total emissions.
Carbon Dioxide (C02)	This is the observed carbon dioxide in exhaust emissions recorded as a percent of total emissions.
Hydrocarbon	This is the observed hydrocarbon in exhaust emissions recorded as a percent of total emissions.
Sensor	This is the van and sensor number of the RSD equipment.
Slope, Carbon Monoxide	Technical data used to validate the emissions readings.
Slope, Hydrocarbons	Technical data used to validate the emissions readings.
Code, Carbon Monoxide	Technical data used to validate the emissions readings.
Code, Hydrocarbons	Technical data used to validate the emissions readings.
Maximum Carbon Dioxide	Technical data used to validate the emissions readings.

After RSD data were recorded for a vehicle and a license number was correctly converted from the video, all vehicles with an Idaho license plate were matched with the Idaho Transportation Department, Department of Motor Vehicles data base and the following data were added to the record:

Data Element	Description
Registration Date	This is the last date on which this vehicle was registered in the State of Idaho.
Year of Manufacture	This is the model year of manufacture for the vehicle.
County	This is Idaho County, designated by the vehicle owner's primary county of residence.
Vehicle Owner's Name	This is the owner's name as it appears on the vehicle registration,
Vehicle Owner's Address	This is the address of the vehicle owner as it appears on the vehicle registration .

This process yielded slightly over 20,000 records with all or major portions of the data complete. From this number, records were eliminated as follows:

1. Vehicles with incomplete data on the speed-one, speed-two, CO, acceleration or County data were deleted.

2. Records with incomplete data for vehicle registration date, year of manufacture, or County of residence within the State of Idaho were deleted. This left a data base with slightly fewer than 18,000 records, some of which represented duplicated observations for the same vehicles. Therefore, an index was created using vehicle license plates as

the first sorting variable followed by a random number which was assigned to the record. Subsequently, all duplicate records for a single license plate were eliminated, leaving a randomly selected observation within the data base for any vehicle which had more than one observation. This data base contained approximately 16,000 records which were then used for the following analyses.

The four grouping variables which were selected for further analysis are:

- Acceleration groups;
- Test station groups (inside Ada County and at Ada County border);
- Tested versus non-tested group; and
- Automobile manufacture year groups.

Three interval level analysis variables were explored:

- Acceleration;
- Carbon monoxide tailpipe emissions; and
- Radar measured speed.

Analysis for the data were conducted using SPSS-PC + , the Statistical Package for the Social Sciences. Procedures included FREQUENCIES, DESCRIPTIVES, MEANS, CROSSTABS, T-TEST. Table 14 presents data summation for the three variables used throughout this analysis. CO was used as the dependent variable, and acceleration and speed was used as independent variables. Descriptive and frequencies analyses are included in Table 15.

Table 14
Summaries of Emissions and Speed Variables

Variable	Mean	Standard Deviation	Minimum	Maximum	Number	Label
ACCEL	0.65 feet per second	4.32	-9.00	9.00	15,775	Acceleration
C O	1.01 kilograms	1.71	.00	17.71	15,775	Carbon Monoxide
SPEED1	40.78 miles per hour	10.71	.00	84.04	15,775	Radar-Measured Speed

Table 15
Frequency Distributions

l. AUTOMOBILE MANUFACTURE YEAR/SPEED GROUPS

A. 19514980 Automobiles

Value Label	Value	Frequency
Not in Group	0	13,924
Decelerating	1	412
Constant speed	2	860
Accelerating	3	579
	Total	15,775

B. 1981-1985 Automobiles

Value Label	Value	Frequency
Not in Group	0	13,325
Decelerating	1	548
Constant speed	2	1,117
Accelerating	3	785
	Total	15,775

C. 1986-1990 Automobiles

Value Label	Value	Frequency
Not in Group	0	10,475
Decelerating	1	1,185
Constant speed	2	2,422
Accelerating	3	1,693
	Total	15,775

D. 1991-1995 Automobiles

Value Label	Value	Frequency
Not in Group	0	9,601
Decelerating	1	1,286
Constant speed	2	2,934
Accelerating	3	1,954
	Total	15,775

2. ACCELERATION GROUPS

Value Label	Value	Frequency
-9.00 to -2.99 Acceleration	1	3,431
-3.00 to +3.00 Acceleration	2	7,333
+3.01 to +9.00 Acceleration	3	5,011
	Total	15,775

3. COUNTY PREFIX GROUPS

Value Label	Value	Frequency
Ada County	1A	9,798
Bannock County	1B	2
Gem County	1G	838
Payette County	1P	8
Adams County	2A	3
Canyon County	2C	4,080
Minidoka County	2M	1
Owyhee County	2O	7
Twin Falls County	2T	1
Boise County	6B	444
Bonneville County	8B	3
Elmore County	E	398
Idaho County	I	1
Valley County	V	190
Washington County	W	1
	Total	15,775

4. TEST STATION GROUPS

Value Label	Value	Frequency
Inside Ada County	1	11,515
At County Border	2	4,260
	Total	15,775

5. TESTED VS. NON-TESTED GROUPS

Value Label		
CO-Tested Vehicles	1	9,798
Not CO Tested Vehicles	2	5,977
	Total	15,775

6. AUTOMOBILE MANUFACTURE YEAR GROUPS

Value	Frequency
1951	1
1953	3
1955	3
1956	2
1957	6
1958	2
1960	2
1961	2
1962	6
1963	8
1964	12
1965	20
1966	25
1967	29
1968	38
1969	55
1970	59
1971	41
1972	82
1973	93
1974	88
1975	81
1976	144
1977	205
1978	254
1979	307
1980	281
1981	279
1982	351
1983	395
1984	644
1985	781
1986	903
1987	944
1988	1,138
1989	1,191
1990	1,124
1991	1,276
1992	1,279
1993	1,427
1994	1,567
1995	625
Total	15,775

'7. **AUTOMOBILE MANUFACTURE YEAR GROUPS**

Value Label	Value	Frequency
1951-1980 Vehicles	1	1,851
1981-1985 Vehicles	2	2,450
1986-1990 Vehicles	3	5,300
1991 & Newer Vehicles	4	6,174
	Total	15,775

The basic research question is whether CO emission levels differ for vehicles which have been tested in the Ada County testing program compared to vehicles which are not subject to the emissions test program. Table 16 shows the mean CO emissions for the 9,798 tested vehicles in the study to be approximately .969 This figure compares to a mean CO level for the 5,977 non-tested vehicles of approximately 1.079. An analysis of variance test [equivalent to a two sample t-test from independent populations] was conducted to determine whether the difference in sample means is statistically significant. The ANOVA results shown in Table 16 indicate that tested vehicles have significantly lower CO emissions levels on average compared to non-tested vehicles. Based on these test data, tested vehicles are estimated to produce between .055 and .165 less units of CO emissions on average than untested vehicles. This estimate assumes a 95 % confidence level.

Table 16
Summaries of Carbon Monoxide Emissions by Test Groups

Value	Label	Mean	Staudard Deviation	sum of Squares	Cases
1	CO Tested Vehicles	.9694266	1.6585591	26,949.7655	9,798
2	Not CO Tested Vehicles	1.0786658	1.7948331	19,251.2414	5,977
'Within Groups	**Total**	1.0108163	1.7114672	46,201.0069	15,775

Analysis of Variance

Source	sum of Squares	Degrees of Freedom	Mean Square	F Scores	Signifance
Between Groups	44.3005	1	44.3005	15.1242	.000l
Within Groups	46,201.0069	15,773	2.9291		

As previously discussed in this report, data on vehicle speed, rate of acceleration, and age of the vehicle were collected for each vehicle for which CO emissions were recorded. At issue is whether these factors could influence the "Smog Dog" emissions readings. If so, before reaching any firm conclusions about the positive impact of emissions testing, these factors need to be controlled. Statistical control is achieved by using multiple regression analysis with "Smog Dog" CO emissions as the dependent variable. Independent variables in the analysis will be speed, rate of acceleration, vehicle year, and a binary [dummy] variable indicating whether the vehicle has been tested in Ada County [0 if not tested, 1 if tested]. If, in the presence of the other three variables, the binary variable for test status is statistically significant in explaining the variation in CO emissions, a stronger case can be made about the value of testing.

Table 17 on the following page shows the results of the multiple regression analysis. With all four independent variables (test dummy, speed, acceleration, and vehicle year) included, the model explains a statistically significant proportion of the variation in "Smog Dog" CO emissions between vehicles. (See the Analysis of Variance section in Table 17.) Since the overall model is statistically significant, it is meaningful to test the significance of the individual variables in the regression equation. The column labeled "SIG T" shows the significance levels of each variables. Value of SIG T below .05 indicate statistical significance. This means that the variable, controlling for the other variables, explains a significant percentage of the "Smog Dog" CO emissions variation from vehicle to vehicle if SIG T is less than .05. Two variables are significant, YEAR and TESTDUMM. A negative sign in the B column (the regression coefficients) indicates that, on average, the newer the vehicle, the lower the CO emissions level. Likewise, on average, tested vehicles have significantly lower CO emissions than untested vehicles. Neither speed or acceleration rate are significant variables in explaining CO emissions levels when vehicle age and tests status are considered.

From the regression results in Table 17, it is possible to estimate the magnitude of the impact Ada County's vehicle testing has on "Smog Dog" CO emissions levels. The B value of TESTDUMM is -.084295 and the standard error (SE B) is .025219. Using a 95 percent confidence level, the range of B is:

$$-.084295 \pm 1.96(.025219)$$

-.0348658 ------------- -.1337242

Thus, controlling for speed, acceleration, and age of the vehicle, a tested vehicle can be expected to have a lower "Smog Dog" CO emissions level by anywhere from approximately .035 to .134 units on average.

Vehicle age is even more significant in explaining CO emissions as measured by the "Smog Dog". The B value for YEAR is -.128739 with a standard error (SE B) of .002103. Thus, at 95 percent confidence, the range of B is:

$$-.128739 \pm 1.96(.002103)$$

-.1246172 -------------- -.1328608

Thus, controlling for speed, acceleration, and whether the vehicle has been tested, each additional year of vehicle age adds au average from .125 to .133 units to the "Smog Dog" CO emissions level.

Table 17
Multiple Regression Analysis

Variable Label	Variable Description
TESTDUMM	Vehicle Test Dummy Variable
ACCEL	Acceleration
SPEED	Radar-measured Speed
YEAR	Automobile Manufacture Year

Multiple R	.4393 1
R Square	.19299
Adjusted R Square	.19278
Standard Error	1.53836

ANALYSIS OF **VARIANCE**

	Degrees of Freedom	Sum of Squares	Mean Square
Regression	4	8924.86029	2231.21517
Residual	15770	37320.44667	2.36655

F = 942.81463 Significant F = ..0000

VARIABLES IN THE EQUATION

Variable	B	Standard Error of B	Beta	T	Significant T
TESTDUMM	-.084295	.025219	-.024199	-3.342	.0008
ACCEL	-8.26796E-04	.002837	-.002085	-.291	.7708
SPEED	-.001608	.001148	-.010061	-1.400	.1614
YEAR	-. 128739	.002103	-.441489	-61.203	.0000
Constant	257.031756	4.183122		61.445	.0000

The importance of vehicle age is clearly illustrated in Table 18, which shows the mean CO emissions for vehicles in four age categories. Vehicles that were built between 1991 and the present had average CO levels less than one sixth the average for vehicles built prior to 198 1.

Vehicles built between 1981 and 1985 had average CO readings four times greater than the 1991 and newer vehicle group.

Table 18
Carbon Monoxide Emissions
by Automobile Manufacture Year Groups

Vehicle Age	Mean	Standard Deviation	Cases
1951 to 1980 Vehicles	2.6903149	2.5563873	1,851
1981 to 1985 Vehicles	1.6729583	2.1278748	2,450
1986 to 1990 Vehicles	.8242360	1.4201944	5,300
1991 and Newer Vehicles	.4047062	.7669315	6,174

A concern exists about the effect of vehicle warm-up status on the "Smog Dog" CO emissions levels. That is, could the previous conclusions about testing and vehicle age be adversely influenced by engine temperature. This concern arises because the regression model displayed in Table 17, while statistically significant, explains only 19 percent of the total variation in "Smog Dog" CO emissions readings from vehicle to vehicle. Other factors, such as engine temperature, could be accounting for the unexplained portion of the variation. No data were collected on engine temperature during this study. Therefore, it is not possible to directly control for this potential influence. However, a possible surrogate measure for engine temperature can be analyzed. This comes from the fact that some test locations (Franklin, Kuna, Ustick, McMillan, and Amity Roads, I-84 at Canyon and Elmore County lines, and Highways 16, 20, 21, 44, and 55) were in more remotely populated areas than others. Thus, vehicles tested at these locations were less likely to be "cold" vehicles than at the test sites closer to residential and business areas. A new dummy variable called SITEDUMM was formed to indicate whether the measurement came from a "warm site" or a "cold site."

Table 19 shows the results of the multiple regression analysis with "Smog Dog" CO emissions as the dependent variable and speed, acceleration, vehicle year, test dummy, and site dummy at the independent variables. Two conclusions are evident. First, the new variable for test site added virtually nothing to the percentage of explained variation which is still just slightly higher than 19 percent. Second, in the presence of the other variables, SITEDUMM is not significant at reasonable levels of significance. (See the SIG T = .1620 for SITEDUMM.) Thus, either the sites don't adequately substitute for engine temperature, or engine temperature is not important in explaining "Smog Dog" CO emissions when the other variables are controlled. Most likely, engine temperature is an important factor but the site variable is not an effective surrogate. Future research should attempt to control for engine temperature.

Table 19

Multiple Regressions Analysis

Variable label	Variable Description
SITEDUMM	Warm vs "Cold Start" Dummy Variable
ACCEL	Acceleration
YEAR	Automobile Manufacture Year
SPEED	Radar-measured Speed
TESTDUMM	Vehicle Test Dummy Variable

Multiple R	.43942
R Square	.19309
Adjusted R Square	.19283
Standard Error	1.53831

ANALYSIS OF VARIANCE

	Degree of Freedom	Sum of Squares	Mean Square
Regression	5	8929.4895	1785.89759
Residual	15769	37315.81941	2.36640

F = 754.68848 significant F= .0000

VARIABLES IN THE EQUATION

Variable	B	Standard Error of B	Beta	T	Significant T
SITEDDUMM	-068018	.048642	-.010165	-1.398	.1620
ACCEL	-8.950886E-04	.002838	-.002256	-.315	.7524
YEAR	-.128653	.002104	-.441195	-61.138	.0000
SPEED	-.001828	.001159	-.011436	-1.577	.1148
TESTDUMM	-.080630	.025354	-.023147	-3.180	.0015
(Constant)	256.930994	4.183616		61.414	.0000

2.4 Evaluation Goal 4: System Costs (This is Evaluation Goal 6 in the Evaluation Plan.)

Objective A: Document the costs for the operational test: RSD capital costs, operating costs, and staff costs.

Findings

• RSD costs (leasing four "Smog Dog" vans and hiring their technicians)	$31,500
• Operating costs (renting phones, printing and mailing incentives, purchasing hard disk drive, removable disk) drive, and back up tapes	1,334
• Labor costs (local technicians, consultants, and temporary staff)	78,833
Total	**$111,667**

Objective B: Evaluate high emitter adjustment incentive program on cost/benefit basis.

Findings

- No conclusion can be made with the data available. The cost/benefit was approximately $33 per participant using the free inspection coupon and was approximately $14 for each participant in the control group (i.e., who indicated they repaired their vehicle). Comparing these data is like comparing apples and oranges.

Data Collection and Analysis

Owners of the highest 300 high emitting vehicles registered outside Ada County were identified. These owners/vehicles were randomly divided into three groups. The vehicle owner then received either an incentive or informational letter to encourage them to repair their vehicle. Redeemed incentive coupons were returned to AQB and were used as a means of identifying who adjusted or repaired their vehicle. Some vehicle owners may have voluntarily repaired their vehicle without using the incentive coupon. This information is not known since no follow-up contact was made.

The control group who just received the informational letter was contacted by telephone to determine their action in repairing or adjusting their vehicle. Telephone numbers were located for only 37 vehicle owners in this group and were later contacted. The following is a breakdown of the cost/benefit of the two incentive groups and the control group.

- **Coupon for Free Inspection**

The cost for printing, mailing, and reimbursement of the incentive coupon was approximately $263. Eight participants of this group redeemed free inspection coupons. The cost/benefit was approximately $33 per participant using the incentive.

- **Coupon for $20 Discount on Tune-Up**

The cost for printing and mailing the incentive coupon was $167. No vehicle owner in this group redeemed the incentive coupon.

- **Informational Letter**

The cost for printing and distributing the informational letters notifying them of a possible emissions problem and the benefits of repairing or adjusting their vehicle was $167.17. Twelve vehicle owners in this group indicated they repaired or adjusted the vehicle. The cost/benefit was approximately $14 for each participant who repaired or adjusted the vehicle.

As mentioned in Evaluation Goal 3, Objective A, addressing the effect of each incentive compared to the control group, it is theoretically difficult to compare these two groups. It appears from the telephone survey of the control group that the informational letter encouraged more vehicle owners (15) to have their vehicle checked or repaired/adjusted. However, the question arises whether these individuals are answering the question truthfully.

3.0 Hypotheses

As part of this evaluation, two hypotheses were identified to be tested and were discussed in the previous Evaluation Goal Sections. The hypotheses to be tested and a brief discussion of each follows:

3.1 Hypothesis A - Non-Ada County vehicles per model year have higher emissions readings than Ada County vehicles.

Findings

- Overall, tested vehicles have 10-15 % lower emissions readings than non-tested vehicles.

Data Analysis

In reviewing Table 16, there is significant differences in CO readings of non-Ada and Ada County vehicles. It shows a highly significant difference between the two with the tested vehicles having 10-15 % lower CO emissions than non-test vehicle. Table 17 shows the results of the multiple regression analysis. From this table, it is possible to estimate the magnitude of the impact Ada County's vehicle testing program has on "Smog Dog" emissions levels. Controlling for speed, acceleration, and vehicle age, a tested vehicle can be expected to have a lower "Smog Dog" emissions level by approximately -035 to .134 units on average. Controlling for speed, acceleration, and whether the vehicle has been tested, each additional year of age adds an average from .125 to .133 units to the "Smog Dog" emissions level.

3.2 Hypothesis B - Owners of non-Ada County "high-emitting" vehicles who receive incentives will be more inclined to adjust or repair their vehicles than the control group.

Findings

- It is difficult to compare the effectiveness of the incentives with the control group due to the type of response. Approximately 33 % of the 37 participants in the control group indicated they repaired their vehicle and only 8 % of the 100 participants receiving the free inspection coupon redeemed them.

Data Analysis

Evaluation Goal 3, Objective A, assesses the repair rate of out-of-county "high emitters" and the effect of each incentive compared to the control group. Only eight of the 100 free emissions inspection coupons were redeemed. This is 8 % . No discount tune-up coupons were redeemed. Of the 37 vehicle owners in the control group who were contacted by telephone, 12 individuals indicated had their vehicles adjusted or repaired. This is approximately 33 % .

The question arises whether the participants in the control group were truthful in their response. It is difficult to compare these incentives with the control group. The telephone follow-up contact did not involve 100 vehicle owners in the control group.

4.0 National ITS Goals

Six goals were developed for the National ITS Program. The following section addresses three of the six goals which relate to this specific phase of the ITS Project for Ada County.

4.1 Reduce Energy and Environmental Costs Associated with Traffic Congestion

As more vehicles travel the roadways and travel demand exceeds the roadway capacity, travel conditions become more congested. With this congestion, higher levels of air pollution are produced and energy consumption is increased. The emissions monitoring of moving vehicles creates an opportunity to reduce air pollutants produced by vehicles and to reduce energy consumption.

This test used RSD technology to compare the relative CO emissions readings of Ada County (annually inspected) and non-Ada County (not inspected) vehicles. Ada County, the only county in Southwest Idaho, has an I & M program; the surrounding counties do not. Air quality does not stop abruptly at a county line, nor does mobility. Mobility has improved over the years and has created other associated impacts such as increased air pollution. RSD technology can assist local jurisdictions in the identification of the origin of non-tested vehicles that may be contributing to the local air quality problems. With this information, local jurisdictions can develop and implement management or policy strategies to improve the air quality.

A vehicle which produces higher levels of emissions is also operating inefficiently. An inefficient vehicle will use more fuel which impacts local, state, and national energy supplies. Identifying these high polluting vehicles and having vehicle owners repair or adjust the vehicle will produce a positive effect on energy conservation.

4.2 Enhance Present and Future Productivity

This objective is to reduce transportation costs for all users of the transportation system. By identifying high emitting vehicles and requiring the vehicle owner (individual or business) to adjust or repair the vehicle, the operation effkiency of the vehicle increases and reduces the demand on the energy supply. Demand for fuel decreases, the energy costs decrease. Both individuals and businesses reap the rewards, better operating efficiency and cost-effectiveness of their vehicles. RSD technology provides the opportunity to identify high emitters earlier than idle emissions testing. This earlier detection provides the opportunity to correct the emissions problems sooner.

4.3 Create an Environment in Which the Development and Deployment of ITS Can Flourish

An objective of the national ITS program is to assist public/private agencies in hardware, software, and services development and the deployment of this technology. Through this program, the U.S. can achieve substantial domestic market penetration and strong international presence.

The use of RSD technology in Ada County provided valuable insights in this new technology which will assist in its advancement. First, the existing camera system required manual adjustments of the aperture to control the amount of light into the camera. When cloudy conditions existed, the technician needed to regularly adjust the aperture to ensure the quality of the license plate image. The camera system can be improved by incorporating an automatic aperture and a longer camera hood to regulate the amount of light into the camera. This improvement would improve the quality of the license plates. It would reduce the number of unreadable license plates and the need to be manually entered into the data base. It also would improve safety on the roadway by minimizing the amount of the time the technician works in traffic.

Second, acceleration equipment was used for the first time with emissions sensors, camera, and computer software. Acceleration was identified and evaluated to determine whether it had an impact upon the emissions data. In the case of this test, it did not.

Third, the test occurred on various types of roadways, from minor rural two-lane roadways to multi-lane freeways. This test is one of the first to monitor vehicle emissions on a freeway. While one test site on the freeway was successful and the other unsuccessful, the test produced some valuable results. It showed that field technicians need experience working in high-volume, high-speed traffic conditions. Depending upon the traffic control on the freeway, the high-volume roadway can be monitored if the existing roadway capacity can be accommodated. If road tubes are used to activate the video camera, high-volume, multi-lane roadways could possibly be monitored.

Fourth, improvements need to be made in the set up of the source generator and sensors. Placement of the source generator in the middle of the roadway near the infrared sensor created numerous safety concerns for both the motorists and the technicians. Motorists can easily hit them. In addition, technicians needed to fill them which required them to work in traffic.

Fifth, RSD technology provides an opportunity to identify cross-county commuters and determine whether these vehicles contribute to the air quality problems in a non-attainment area. With this information, jurisdictions have valuable data to support any needed changes in existing air quality programs.

5.0 Conclusion

This test was to monitor emissions of vehicles passing through the test sites. Emissions data were used to assess relative CO readings of non-tested vehicles (non-Ada County) and to compare these emissions readings to tested (Ada County) emissions readings.

Therefore, emissions data were not being analyzed to determine whether it was accurate or not. This had already been done. RSD system was being evaluated on its performance to collect reliable data. It had a fair performance providing reliable emissions and acceleration data. The RSD computer is programmed to calculate a confidence factor for reading emissions and acceleration data. If the computer determines it's not adequate, the computer will enter nines in the CO or acceleration field. For all the test sites, 88% of the CO readings were valid and 64 % of the carbon monoxide and acceleration readings. This is the first time that acceleration equipment was incorporated into the RSD technology.

This emissions data were analyzed to determine whether CO levels differ for vehicles which have been tested in Ada County testing program compared to vehicles which are not subject to an emissions testing program. The CO mean was .969 for Ada County tested vehicles. For non-tested vehicles, the CO mean was 1.079. Non-tested vehicles had 10-15% higher emissions. Further analysis showed that a tested vehicle can be expected to have a lower "Smog Dog" CO level from .035 to ,134 units on average when controlling for speed, acceleration, and vehicle age. In addition, vehicle age has a significant relation to CO emissions. Each additional year of vehicle age adds an average from .125 to .133 units to the "Smog Dog" CO emissions level when controlling for speed, acceleration, and whether the vehicle has been tested.

The data support to develop management or policy strategies to address emissions contributions from out-of-county (non-tested) vehicles is provided. Potential strategies to address this issue are: 1) require emissions inspections of vehicles registered to out-of-county commuters, and 2) expand the existing boundary.

The first one has the greatest chance of receiving support from policy makers from surrounding counties. Policy makers from adjacent counties indicated this when APA staff presented a project overview prior to the Operational Test. However, many issues need to be discussed with them. Additionally, the AQB Board needs to approve this revision to Ada County's emissions testing program.

The second one was discussed during the last State Legislative session. A bill was proposed, but was not adopted by the Legislature. This strategy should be retained, but the commuter program should be the first considered. RSD technology provides the capability to identify out-of-county commuters, which targets the contributors to the air quality problems.

Lastly, incentives were not effective in the encouragement of adjusting or repairing high emitting vehicles (non-tested). Only 8 % of the recipients of free inspection test coupons redeemed them. No coupons for a discounted tune-up were used. Approximately 33 % of the control group indicated they repaired their vehicle. This high response by the control group tends to be a little suspicious. Therefore, the cost/benefit of the incentive program may not reflect what really occurred. The cost/benefit for the free inspection coupon was approximately $33. For no incentive, it was approximately $14.

Based upon the findings, non-Ada County vehicles per model year have higher emissions reading than Ada County vehicles. RSD technology provides a valuable opportunity to enhance existing air quality programs. This technology can capture license plate and emissions data to determine whether non-tested vehicles produce more CO emissions than tested vehicles, If this is the case, the data can be used to justify enhancements to existing air quality programs. Findings of this analysis will be forwarded to Air Quality Board for their consideration, whether to pursue a revision to the existing emissions testing program to include commuters from outside Ada County.

Chapter 4 - Institutional, Legal, and Public Acceptance Issues

1.0 Purpose of Test

As with any transportation and air quality management program, institutional, legal , and public acceptance issues need to be addressed in order to guide in the development and implementation of a program. Jurisdictional coordination and cooperation, legal opinions, and public acceptance need to be obtained to implement transportation and air quality programs with consensus of policy makers and the public. The purpose of this test is to evaluate possible institutional and legal barriers toward the implementation and to assess the public's acceptance of Intelligent Transportation System (ITS) technology.

In most metropolitan areas, traffic and air quality management is scattered across political jurisdictions. This creates institutional barriers. In some cases, these responsibilities are also dispersed across separate agencies within that jurisdiction. If communication and cooperation among these public agencies is limited, then implementation of public projects is much more difficult. This may be the case when public agencies try to coordinate and implement an ITS Program.

Besides these institutional issues, some ITS programs employ automated surveillance technologies which raise concerns over public privacy. The Harris-Equifax Consumer Privacy Survey (1991) revealed that Americans are ambivalent about their feelings towards privacy issues. Individuals want their privacy protected, but they also want benefits that require everyone's privacy be reduced.

Determination of public acceptance is an important element that participating agencies integrated into the ITS Project for Ada County. New technology is changing society and the world. Government must be sensitive to the fact that dealing with such fundamental changes can have profound effects, positive and negative, on the public. Remote Sensing Devices (RSD) technology can have such an effect. The public must be provided a basic understanding of the technology if they are to accept it.

Transportation and air quality agencies in Ada County and the State of Idaho formed a partnership to conduct an Origin & Destination (O/D) study and to monitor vehicle emissions using RSD. These governmental agencies tested this advanced technology to assess whether an O/D survey and vehicle emissions tests can reduce costs and transportation system impacts of current methods, minimize the inconvenience to the public, and improve the overall efficiency of the projects.

2.0 Test Operations

As part of the ITS Project for Ada County, a three-phase operational test was developed and implemented to test RSD technology. RSD can read vehicle license plates and monitor vehicle emissions. Phase I used video imaging technology to conduct an O/D survey. Phase II used the video imaging technology, plus emissions sensors to determine emissions levels of non-tested vehicles entering Ada County, as compared to Ada County vehicles which are tested regularly. Phases I and II were conducted simultaneously during the last week of April 1995.

Phase III used the RSD technology to determine the feasibility of enhancing the current Inspection and Maintenance (I&M) program in Ada County. Data collection occurred primarily during the month of May 1995.

As stated in Section 1 .0, Purpose of Test, an important element of the ITS Project was to evaluate institutional and legal barriers that may arise before, during, and after the Operational Test. Some institutional and legal (i.e., privacy) issues which may arise are:

Institutional Barriers

- The need for cooperation among all local and state transportation agencies;
- The need for cooperation among those transportation agencies and the air quality agency; and
- The need for cooperation of City, County, and State law enforcement and emergency agencies.

Legal (Privacy) Barriers

- Taking a photograph of the vehicle license plate;
- Using the State Motor Vehicle Registration data base to obtain names and addresses; and
- Receiving a letter indicating that the driver was observed on a certain date and time and at a certain location.

For this test, transportation and air quality agencies in Ada County and the State of Idaho formed a partnership to conduct the travel survey and to monitor vehicle emissions using RSD technology. Ada Planning Association (APA) was the coordinating agency for this test. Participating agencies included: Air Quality Board (AQB); Ada County Highway District (ACHD); Idaho Transportation Department (ITD; Federal Highway Administration (FHWA); Environmental Protection Agency (EPA); and Idaho Division of Environmental Quality (DEQ). Other participants included Hughes Santa Barbara Research Center, “Smog Dog” vendor, and CH2M-Hill, the independent evaluator for the Operational Test. The participating public agencies had a good working relationship on regional issues prior to this individual test. Each of these agencies had a large stake in the success of the test to ensure any institutional issues be resolved as soon as possible.

During the initial development of this ITS Project, a legal opinion was requested from ITD legal counsel before the project proceeded. Under the Freedom of Information Act, as interpreted by ITD legal counsel, data in the State Motor Vehicle Registration files is available to the public. ITD legal counsel stated that the public good derived from this action of identifying "high emitting" vehicles and tracking origin and destination would outweigh any harm which may arise as a result of invasion of privacy rights. While a legal opinion was obtained from the State's Transportation Department, the Evaluation Research Team suggested another legal opinion be obtained from the State Attorney General prior to the Operational Test.

A letter from the State Attorney General's office indicated that capturing license plates on a video camera, obtaining information from the motor vehicle registration data base, and mailing the vehicle owner a travel survey did not appear to violate any constitutionally recognized right to privacy. To proceed with this action is solely a policy decision of the planning agency (see Appendix K) .

A public awareness campaign targeting elected and appointed officials, public administrators, vehicle owners, and the general public was developed and implemented prior and throughout the Operational Test. The public awareness campaign included:

- All emergency agencies in Ada County and its surrounding counties were notified about the specific operational hours and test sites.
- A press release kit which included information on the ITS Project for Ada County and on other published ITS articles during the week prior to the Operational Test was distributed to all regional newspapers, radio and television stations.
- Newspaper, radio and television interviews were held and aired during the week of the Operational Test.
- A press conference for news media was held the first day of the Operational Test.
- Press releases prior, during, and after the Operational Test were distributed.
- Public inquiries were answered as soon as possible about the ITS Project by APA , AQB, ACHD, and ITD staff.

Prior to the Operational Test, APA presented a synopsis of the ITS Operational Test to all stakeholders; elected and appointed officials and administrative staff from Idaho Transportation Board, AQB, five affected counties, seven affected highway districts, and twelve affected cities. During this presentation, stakeholders were asked to complete a stakeholder survey to assess public acceptance of using RSD/LPR technology. APA received 145 completed surveys.

In August 1995, a follow-up survey was distributed by mail to these same stakeholders to determine whether their opinions had changed over the course of the Operational Test. A total of 28 stakeholders completed the follow up survey. Only 11 of the 28 stakeholders completed the both surveys.

In May and June 1995, a telephone survey was conducted with 811 vehicle owners who passed through the test sites for these two individual tests and for the last individual test which monitored vehicle emissions from all vehicles in Ada County. These 811 vehicle owners were randomly selected from the collected test data. Participants were residents in Ada County or its surrounding counties. The interviewing process occurred as soon after the actual RSD data collection as possible.

3.0 Data Analysis

This section describes the data collected during the Test and the data analysis used to evaluate the goals and objectives identified in the Individual Evaluation Test Plan 4, Institutional, Legal, and Public Acceptance Issues. In addition, hypotheses identified in that plan are addressed.

3.1 Legal Barriers

3.1.1 Evaluation Goal 1: Effects of legal issues on the Operational Test and future deployment.

Objective A: Identify all legal issues encountered and appraise the extent of their impacts.

Findings

The findings of the legal issues encountered are:

- No legal issues arose before, during, or after the Operational Test.

Data Analysis

As mentioned previously, a legal opinion was obtained from both the Idaho Department of Transportation legal counsel and the State Attorney General's office. Both legal counsels did not indicate any legal problems with capturing license plate information, identifying the vehicle owner through the State's motor vehicle registration data base, and sending the vehicle owner a travel survey. In addition, no legal issues arose during or after these two individual tests.

Objective B: Assess citizens' perceptions of legal issues.

Findings

The findings of citizens' perceptions of legal issues are:

- Prior to the Operational Test, over 70% of the stakeholders indicated that the use of RSD technology to conduct a travel survey and to monitor emissions was not too intrusive.

- The second stakeholder survey did not receive a large response, only 28 surveys returned. Approximately 50% of these stakeholders indicated that the use of RSD was not too intrusive. Of the 28 returned surveys, approximately 21% were from stakeholders representing an Ada County community which is not currently participating in the Inspection and Maintenance (I&M) Program.

- Approximately 75 % of the telephone survey participants indicated they did not consider taking a video of the license plate, and identifying their name and address in the motor vehicle records to mail a travel survey as an invasion of their privacy.

- Of the 189 survey respondents who indicated a seriousness in the invasion of privacy, approximately 60% indicated that it was somewhat or not very serious.

- In addition, these survey respondents indicated that video taping the license plate (50%) followed by obtaining their name from the Division of Motor Vehicles (41%) was the most serious invasion of privacy.

Data Analysis

Public inquiries and comments were logged during the Operational Test. Less than 1% of the vehicle owners passing through the test sites contacted the APA office. Half of these vehicle owners inquired about the Test or asked questions pertaining to the travel survey. The remaining half voiced negative comments relating to the test. Approximately half of these comments pertained to "Big Brother" watching you.

The 8 11 telephone survey participants, who drove through the test sites, were asked whether taking a video of their license plate, identifying their name and address in the Division of Motor Vehicles data base, and sending them a survey to aid in transportation planning and to clean up the air is considered an invasion of their privacy. Approximately 75 % indicated that it was not an invasion of privacy and 23 % indicated that it was an invasion. The remaining 2 % had no opinion.

Survey participants who indicated the RSD technology and process was an invasion of privacy were asked another question. This related directly to how serious they felt the invasion of privacy. Figure 2 shows these results. Approximately 40 % stated the invasion of privacy was extremely or very serious. These survey participants were then asked what do they consider the MOST SERIOUS invasion of privacy. Fifty percent indicated the video taping of the license plate was the most serious invasion of their privacy, and getting their name from DMV followed (see Figure 3).

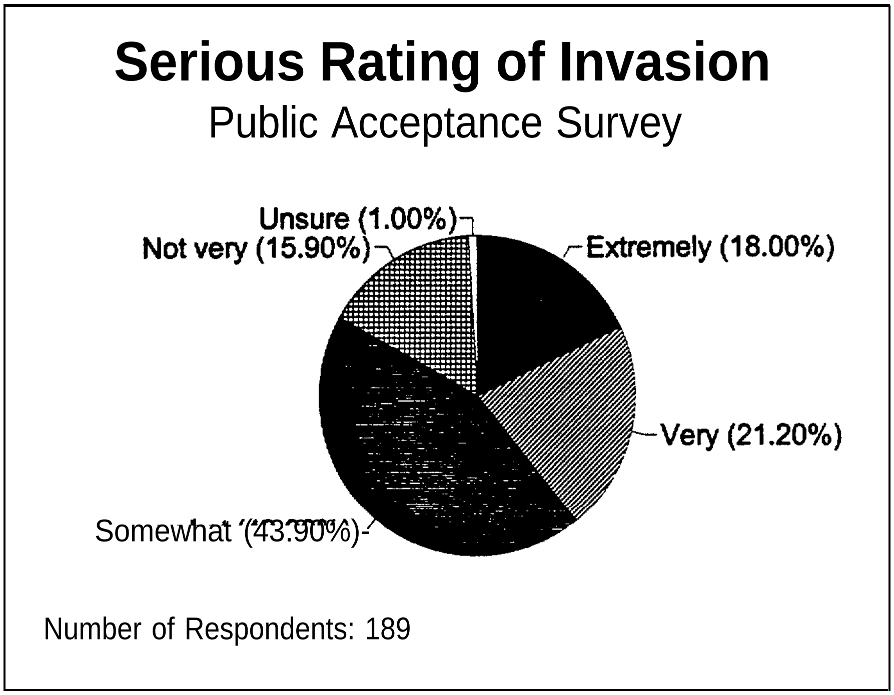


Figure 2 - Serious Rating of Invasion

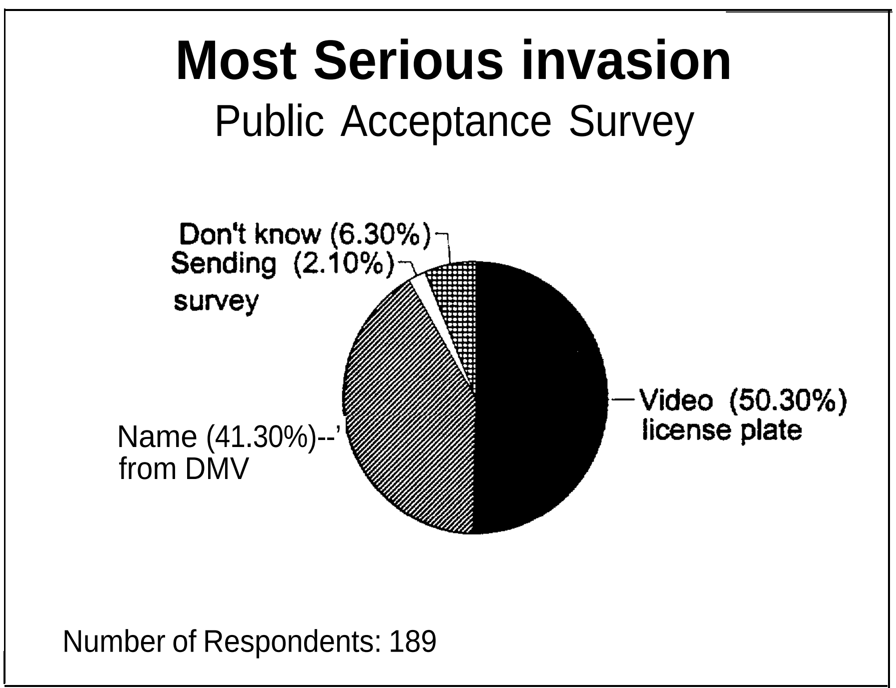


Figure 3- Most Serious Invasion

A stakeholder survey was distributed to elected and appointed officials and administrative staff from the Idaho Transportation and Ada County Air Quality Boards, five affected counties, seven affected highway districts, and twelve affected cities prior to the Operational Test to assess public acceptance of using RSD/LPR technology. APA received 145 completed stakeholder surveys which were distributed prior to the test.

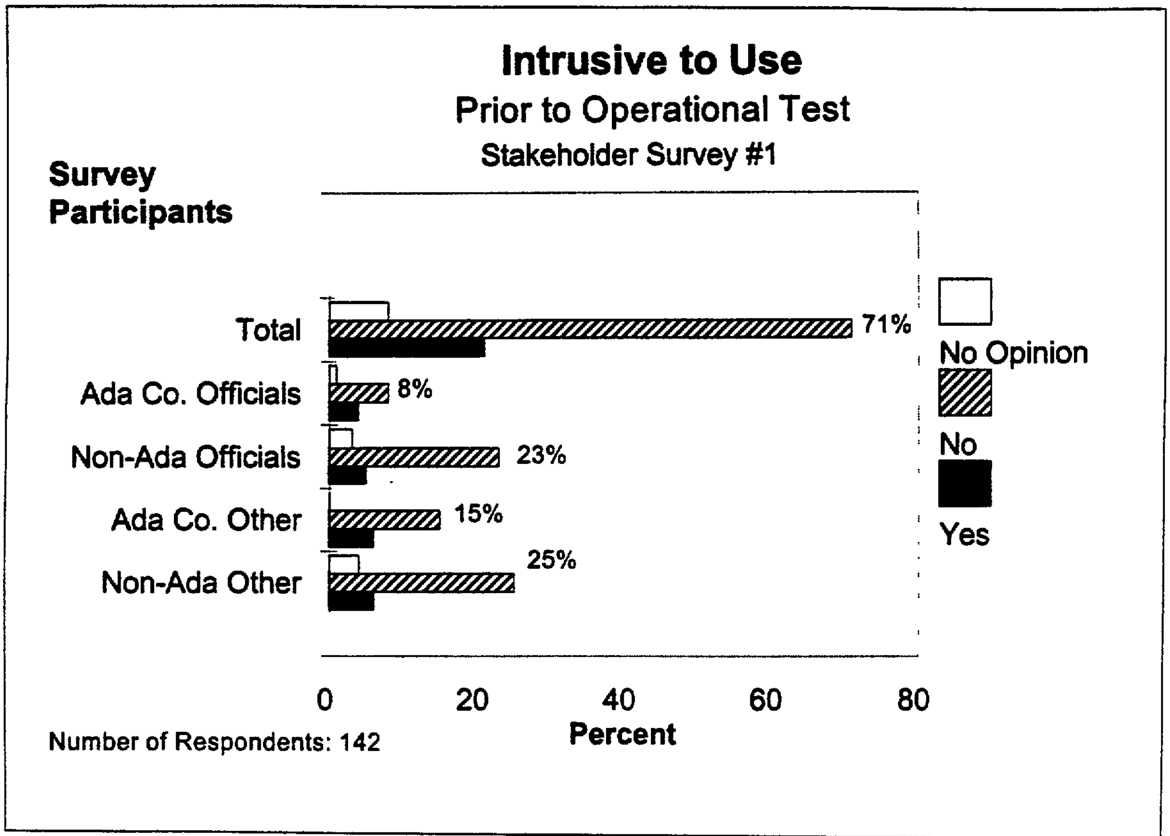


Figure 4 - Intrusive to Use: Prior to Test

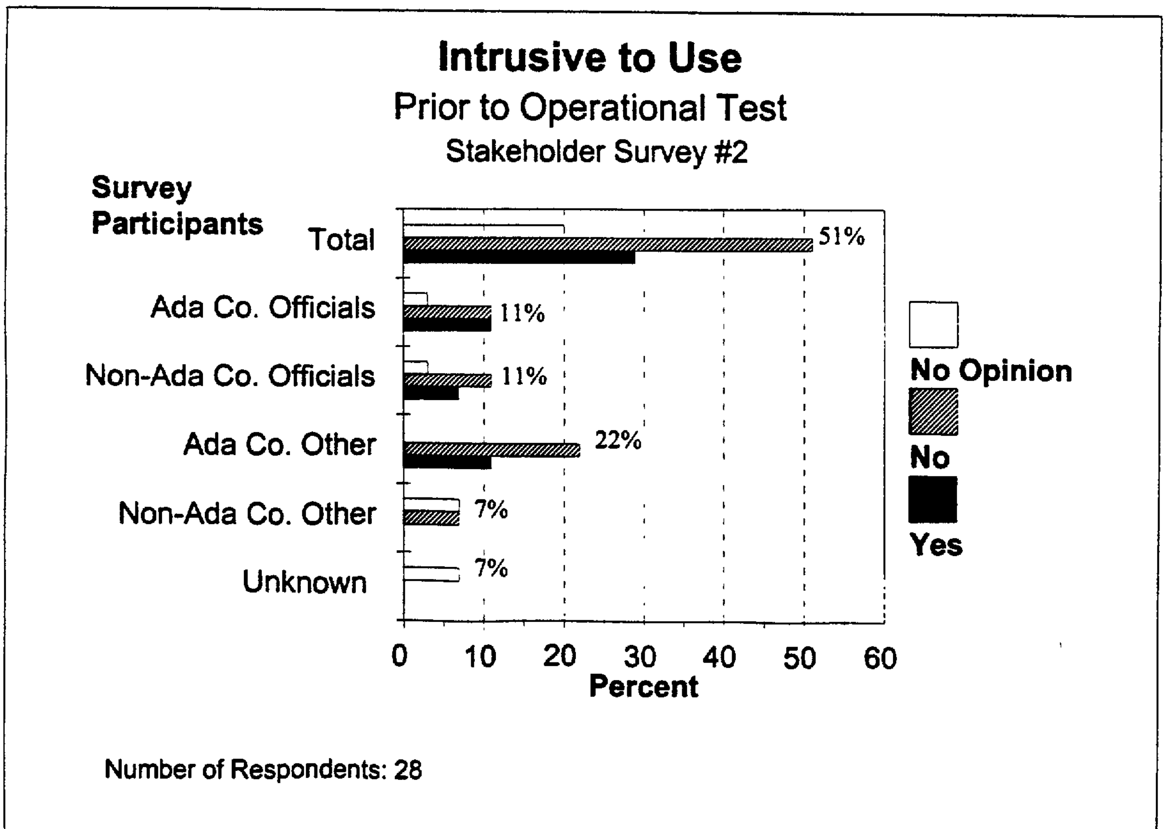


Figure 5 - Intrusive to Use: After Test

Stakeholders were asked whether they thought using RSD technology is too intrusive for a public agency to use. Seventy-one percent of the respondents indicated that RSD technology is not too intrusive for a public agency to use (see Figure 4 on the previous page). Twenty-one percent of the stakeholders felt the technology was too intrusive with 8 % having no opinion. Overall, the majority of elected officials in both Ada County and its surrounding counties did not think RSD technology is too intrusive.

In August 1995, a follow-up survey was distributed by mail to the previous survey participants. APA received only 28 completed surveys. Only 11 of these survey participants completed the first survey. The same question was asked on this survey about whether RSD technology is too intrusive for a public agency to use. Fifty-one percent of the stakeholders felt RSD technology was not too intrusive (see Figure 5 on the previous page). Approximately 29% indicated it was intrusive and 20% had no opinion.

Closer review of the data from the second survey revealed that 21% of the respondents were from the only Ada County community which is not currently participating in the Inspection and Maintenance Program. Since only a small number (28) of stakeholders completed and returned the surveys to APA and 21% were from this non-I&M participating community, the results tend to weigh towards the intrusiveness of this test.

3.2 Institutional Barriers

Transportation and air quality agencies in Ada County and the State of Idaho formed a partnership to conduct this O/D survey and to monitor vehicle emissions using RSD technology. APA was the coordinating agency for the Operational Test. Participating agencies included AQB, ACHD, ITD, FHWA, Environmental Protection Agency (EPA), and Idaho Department of Environmental Quality (DEQ). Also, participants included Hughes Santa Clara, SMOG DOG vendor, and CH2M-Hill, the independent evaluator for the Operational Test.

Operations and evaluation meetings were held regularly with these participants to plan the operations and evaluation of the Operational Test.

3.2.1 Evaluation Goal 1: Effects of Institutional issues on the Operational Test and future RSD deployment.

Objective A: Identify all institutional issues encountered and appraise the extent of their impacts.

Findings

The findings of institutional issues encountered are:

- No institutional issues were encountered before, during, or after the Operational Test.

Data Analysis

Meetings were held to discuss details of the Operational Test. No institutional barriers were identified prior, during, or after the test. Minor problems did occur which were resolved immediately to ensure the operation of the tests. These minor operational problems included:

1) Hughes technicians were unable to train the local technicians prior to the Operational Test. To ensure good data collection, the Hughes technicians remained at the test sites throughout the test, working approximately 15hour days.

2) The week prior to the Operational Test, ITD staff raised a concern about the RSD equipment being placed in the middle of the Interstate. This was immediately resolved with an alternative traffic control plan.

The partnership of the participating agencies is unique in that one agency is responsible for the local and county roadway system (ACHD); one agency is responsible for the county-wide air quality program (AQB), and one agency is responsible for all the transportation planning in the cities and county (APA). Such cooperation requires a history of good working relationships. These agencies, including ITD, worked effectively and successfully over the years on numerous transportation and air quality issues. During this test, each agency had a large stake in the success of the entire project. Each agency wanted either the travel survey information or emissions data or both for their use.

3.3 Public Acceptance

This section uses the survey responses to assess public acceptance of using RSD technology.

Initially, 145 surveys were returned by the stakeholders. Only 28 stakeholders returned the second survey, of which 11 had completed the first survey. It was difficult to determine why the response during the second survey was so low. The first survey was distributed by APA staff and either completed and returned during ITS presentations to stakeholder groups or immediately mailed back to APA. The second survey was mailed to the stakeholders. A follow-up telephone contact was made to each jurisdiction to ensure they distributed them to the appropriate officials. Many officials may have felt their initial survey completion was adequate as their opinions had not changed.

A second survey was conducted with 8 11 vehicle owners who passed through the test sites. They were asked by telephone survey to evaluate their perceptions of this new technology. The survey included over 400 vehicle owners each (Ada County and its surrounding counties) from Phases I/II (Origin and Destination Survey and Emissions Testing at External Stations) and Phase III (Emissions Monitoring of All Vehicles in Ada County). The interview was conducted soon after the actual RSD testing by a private research consultant.

Public inquiries and comments were logged during the Operational Test. Less than 1% of vehicle owners passing through the test sites called the APA office. Most asked questions about how to complete the O/D survey or said they were unable to complete the survey as they couldn't track their business vehicles' origins and destinations at the time on the survey. However, APA did receive some negative contacts about the use of RSD technology and the impacts upon the roadway system. These contacts, either by telephone or by mail, were responded to and documented.

3.3.1 Evaluation Goal 1: Users' acceptance as reflected in expressed attitudes and frequency of response rates.

Before asking specific questions about the Operational Test, determining prior opinions about air quality monitoring and transportation planning was needed.

During the telephone survey, the participants were asked the importance of having specific and accurate data for transportation planning and the importance of monitoring air quality in Southwest Idaho. Survey participants viewed this to be important. Over 93 % of the respondents viewed monitoring air quality as somewhat, very, or extremely important (see Figure 6). More than 88 % of the respondents indicated gathering data for transportation planning was somewhat, very, or extremely important (see Figure 7 on the following page).

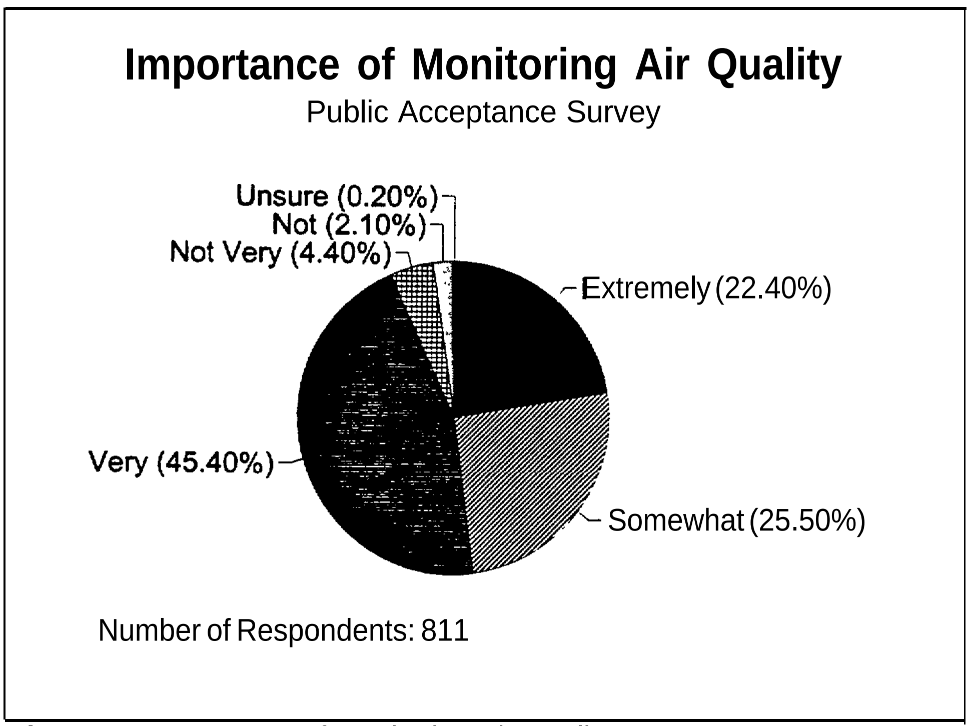


Figure 6 - Importance of Monitoring Air Quality

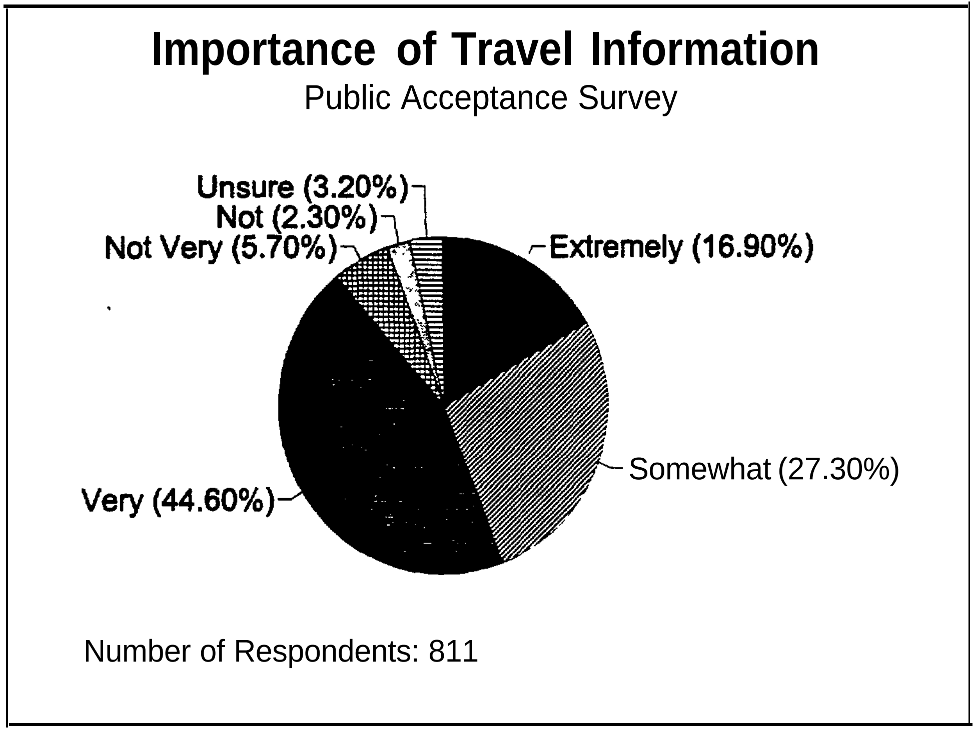


Figure 7 - importance of Travel Information

Objective A: Assess vehicle owners, elected or appointed officials and/or public administrators estimates of value (importance and convenience) of using RSD technology for traffic and air quality management.

Findings

Telephone survey participants responded:

- Approximately 60% indicated that RSD technology would provide the best travel information.
- Only 49 % thought RSD technology would reduce emissions and improve air quality.
- Less than 11% who saw the RSD equipment were inconvenienced. Most were only slightly inconvenienced.
- Over 78% who saw the RSD equipment on the roadside indicated it was not a safety hazard.

Stakeholder survey participants responded:

- Approximately 86 % indicated that RSD technology was a convenient way to gather travel data.
- About 89% who answered the second survey indicated that RSD technology was a convenient way to monitor vehicle emissions.

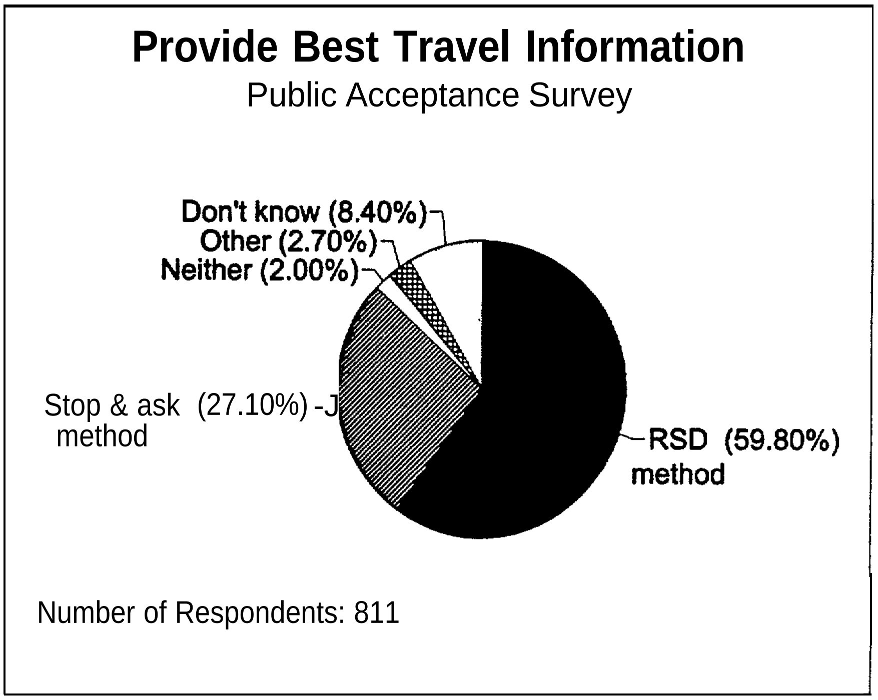


Figure 8 - Provide Best Travel information

Data Analysis

Telephone survey respondents were asked which travel survey method would provide the best travel information for transportation planning and be most effective in reducing emissions and improving air quality. Approximately 60 % indicated that RSD method would provide the best travel information (see Figure 8). Only 49% thought RSD technology would reduce emissions and improve air quality (see Figure 9).

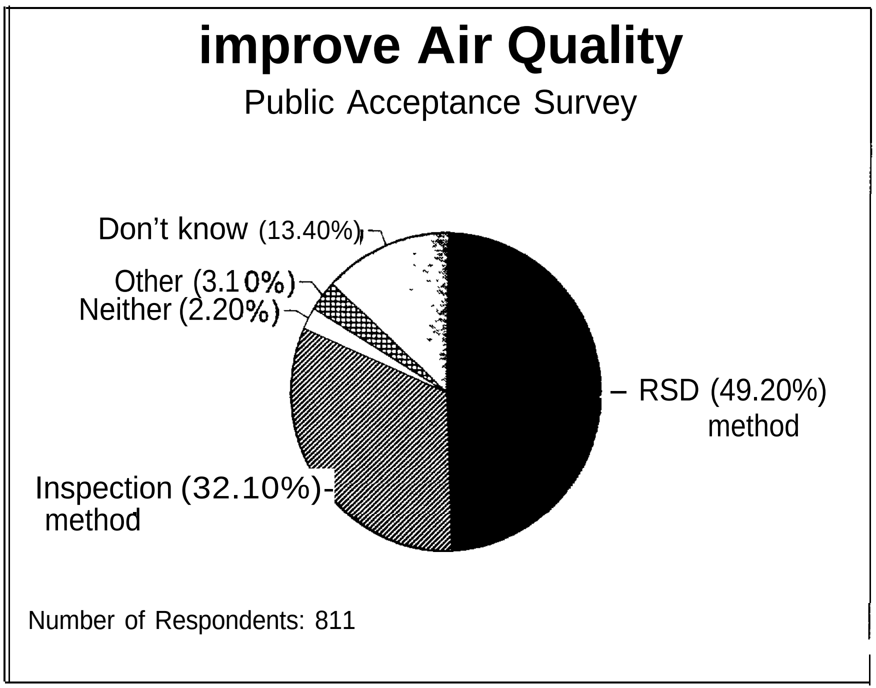


Figure 9 - improve Air Quality

Approximately 68% of the survey respondents indicated they read or heard about RSD equipment. Of these, 50% had seen the SMOG DOG equipment on the roadside. They were then asked if the SMOG DOG/RSD equipment caused them any inconvenience. Less than 11% indicated they experienced an inconvenience (see Figure 10). Most of these respondents were only slightly inconvenienced. In addition, inconvenienced respondents were asked if they considered SMOG DOG/RSD equipment on the roadside to be a safety hazard. Over 78% stated the equipment was not a safety hazard (see Figure 11).

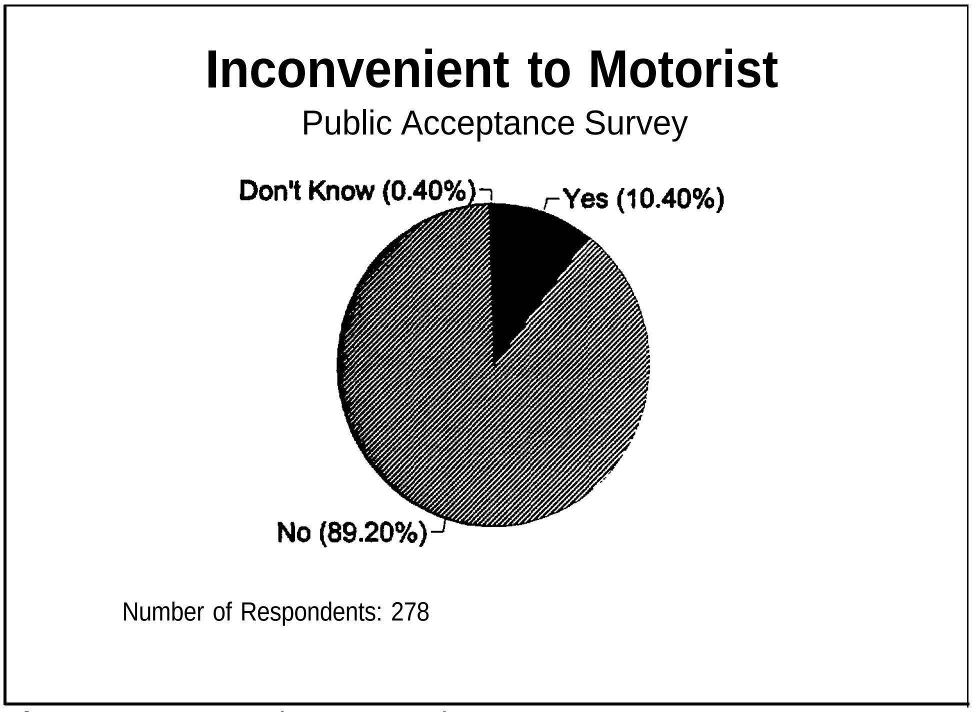


Figure 10 - Inconvenient to Motorist

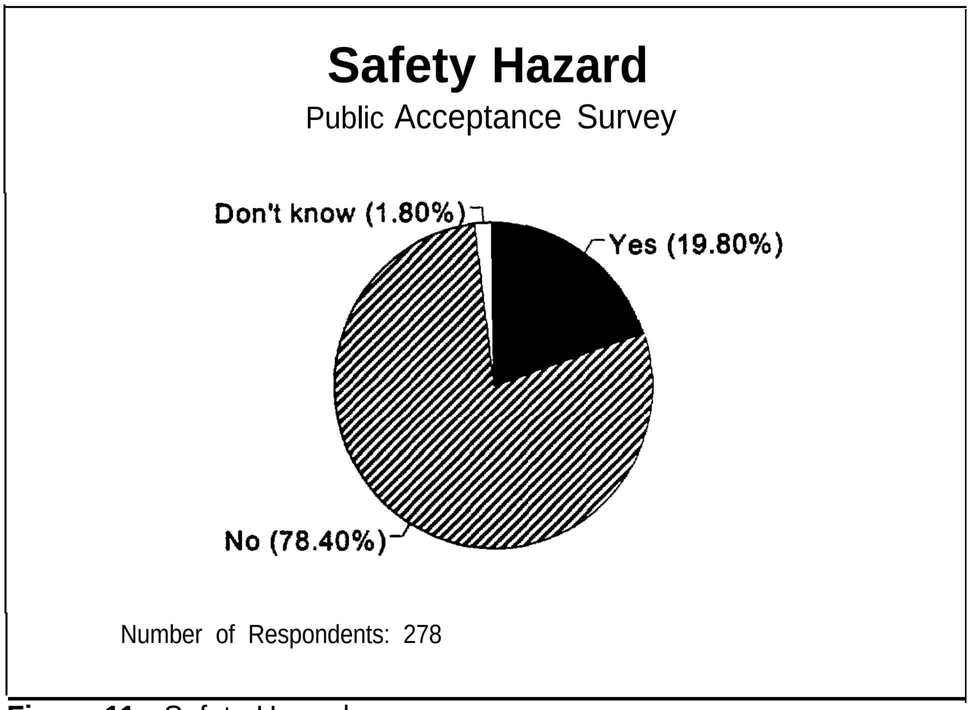


Figure 11 - Safety Hazard

Stakeholders were asked after the operational field test whether gathering travel information and monitoring vehicle emissions using RSD technology was convenient. Only 28 stakeholders responded to this survey. Approximately 85 % indicated that gathering travel data using RSD technology was convenient to the traditional method (see Figure 12). Over 89% indicated that monitoring air quality using RSD technology was convenient to the idle emissions test (see Figure 13).

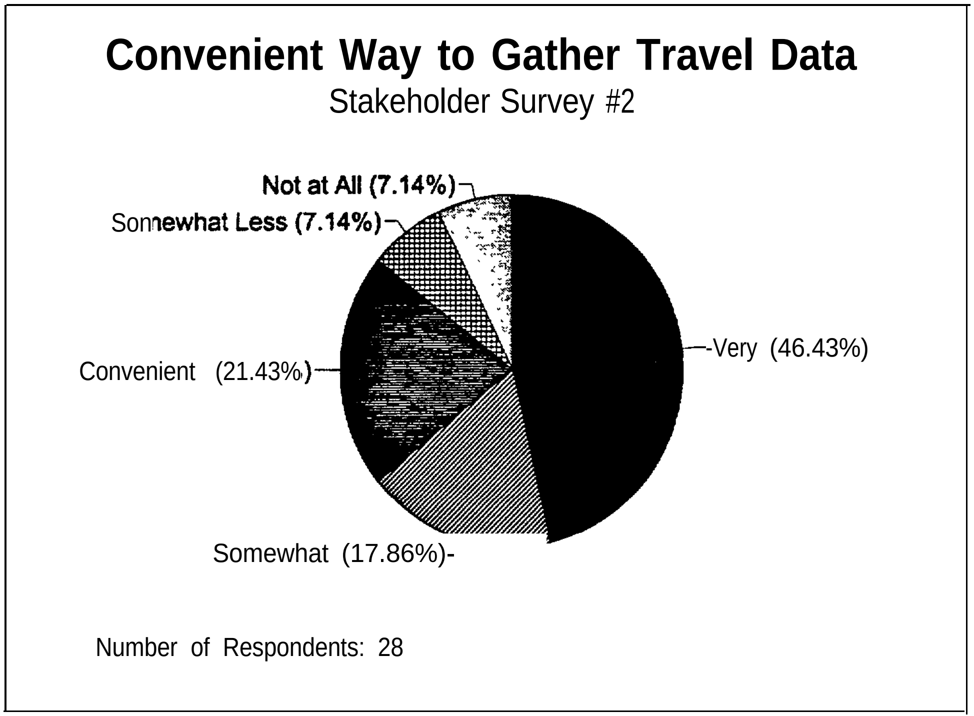


Figure 12 - Convenient Way to Gather Travel Data

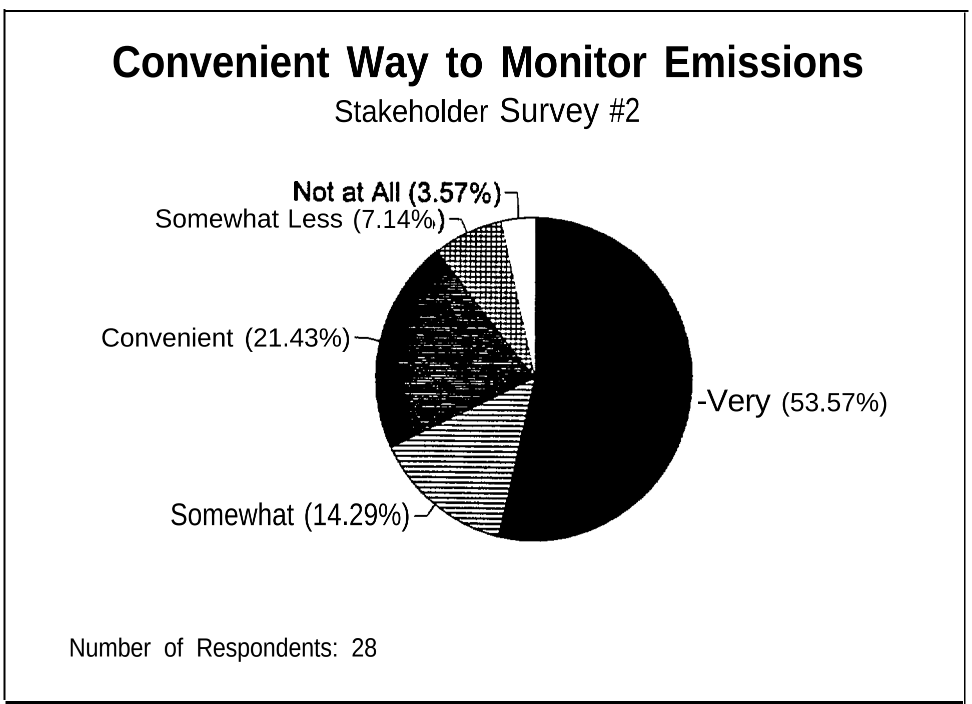


Figure 13 - Convenient Way to Monitor Emissions

Objective B: Assess vehicle owners, elected or appointed officials and/or public administrators estimates of preference for using RSD technology.

Findings

- Over 86% of the telephone survey participants chose the RSD survey method over the stop-and-ask method. Approximately 78% thought the RSD method would encourage more participation.
- Approximately 72% of the telephone survey participants preferred the RSD method over the idle emissions test station method. Over 82% indicated this method would encourage more support for emissions testing.
- Stakeholders in both the before and after surveys thought approximately 50% or less of the public would prefer using the RSD technology.

Data Analysis

The telephone survey respondents (vehicle owners passing through the test sites) were asked several questions about their preference for using RSD technology to conduct a travel survey and to monitor vehicle emissions. In addition, stakeholders were asked before and after the Operational Test their perception of the public's preference to either use RSD technology or traditional methods to conduct a travel survey or monitor vehicle emissions.

Over 86% of respondents indicated they preferred the RSD survey method over the stop-and-ask method (see Figure 14), Approximately 78 % thought the RSD method would encourage more participation in the survey (see Figure 15).

Less preferred using the RSD method for emissions monitoring than the travel survey. However, it was still over 72% (see Figure 16). Over 82% indicated this method would encourage support for the emissions testing (see Figure 17).Stakeholders were asked their perception of public preference. The survey prior to the operational field test revealed 50% of stakeholders thought the public would prefer the RSD method and another 23 % thought the public would prefer the traditional method. Second survey results were similar (see Figures 18 and 19).

Stakeholders were also asked their perception of public preference on use of RSD technology to monitor vehicle emissions. Prior to the operational field test, 52% thought the public would prefer RSD technology over the idle emissions test (see Figure 20) . Twenty-nine percent either had no opinion or did not answer the question. The second survey did not reveal a large difference between the RSD and idle emission testing (see Figure 21). Over 46% of the stakeholders had no opinion or did not answer the question.

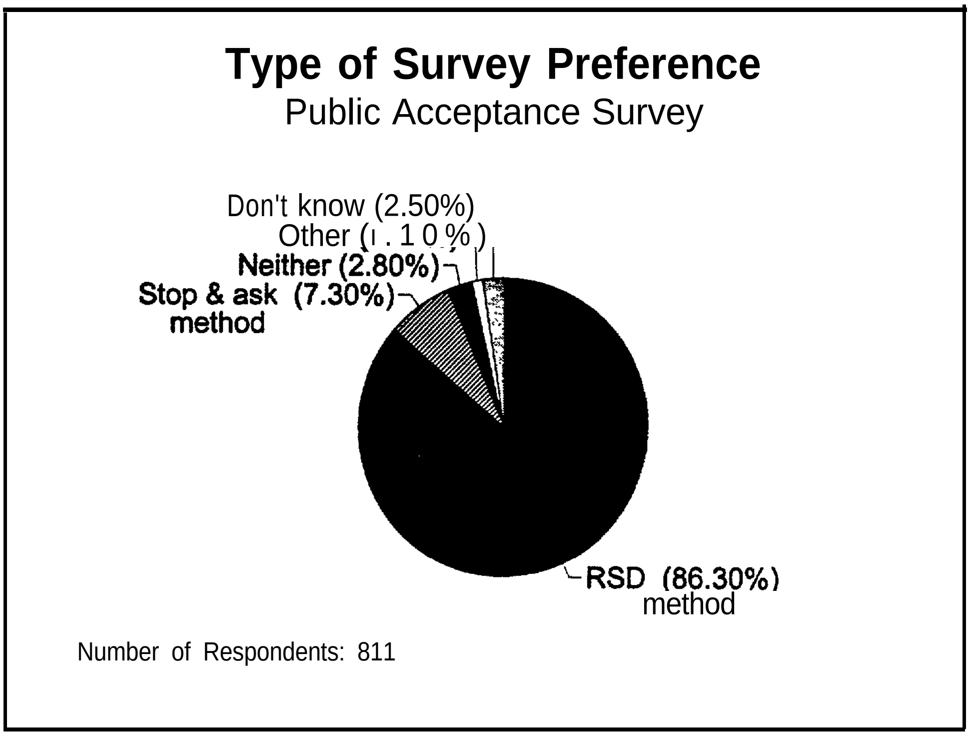


Figure 14 - Type of Survey Preference

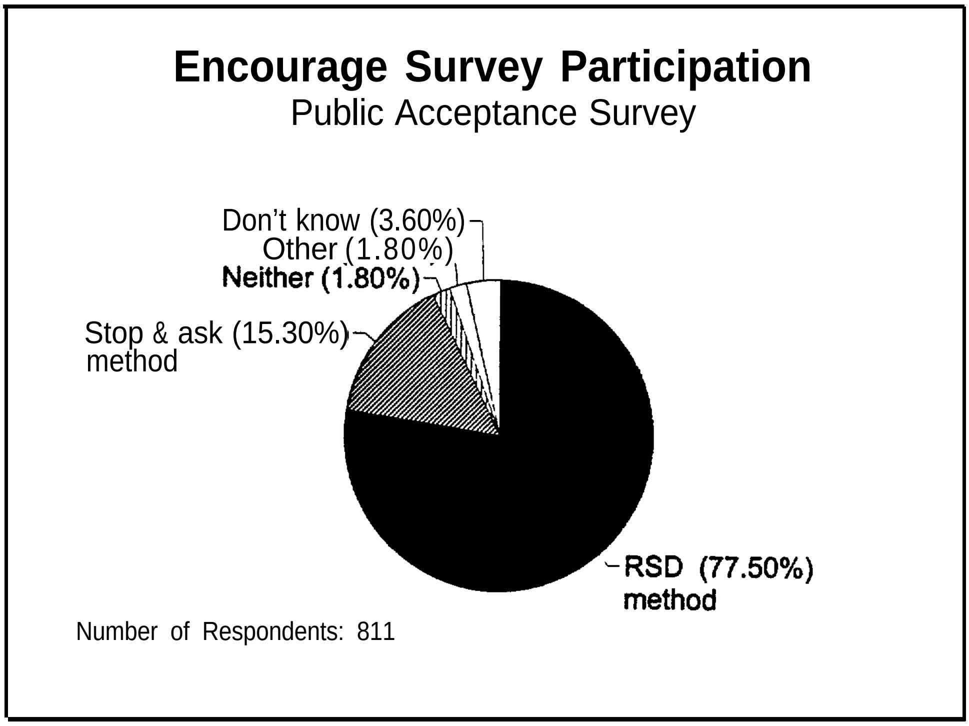


Figure 15 - Encourage Survey Participation

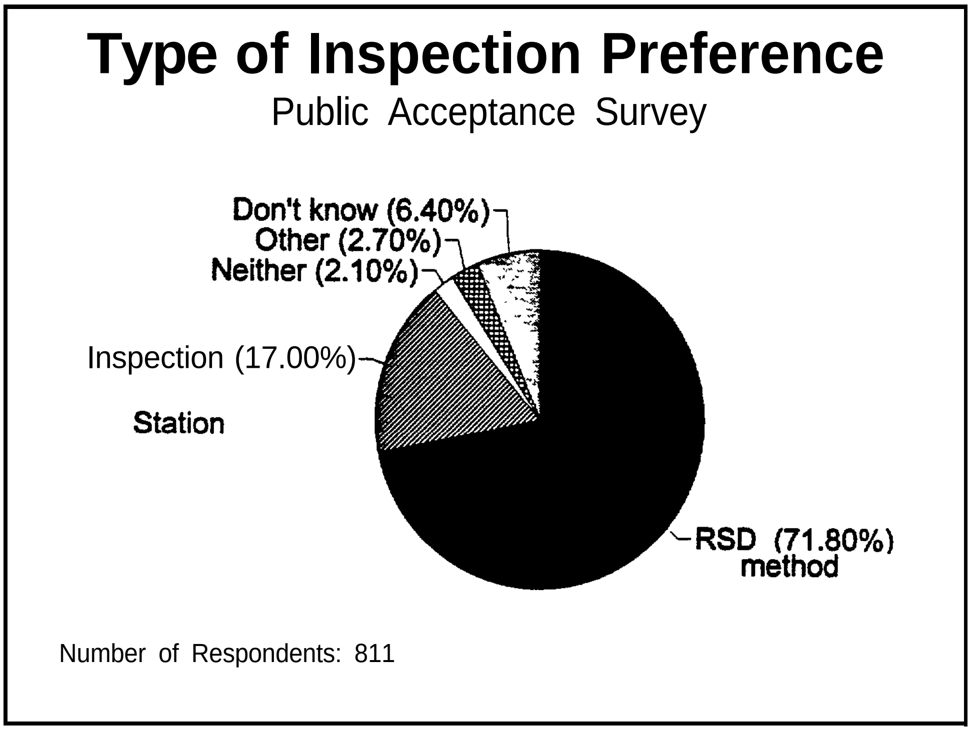


Figure 16 - Type of Inspection Preference

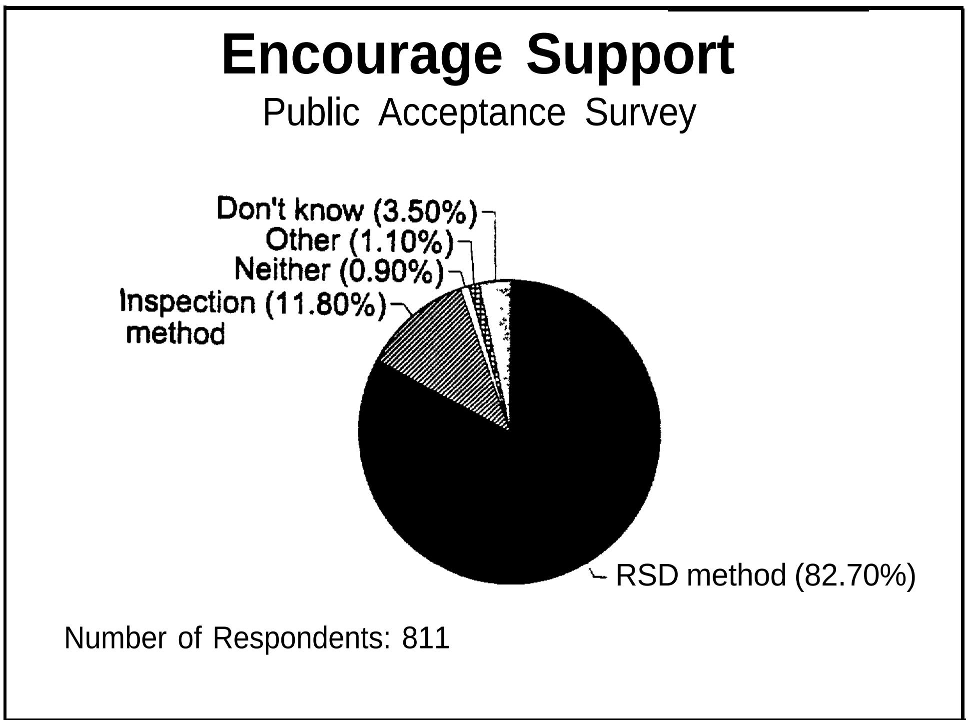


Figure 17 - Encourage Support

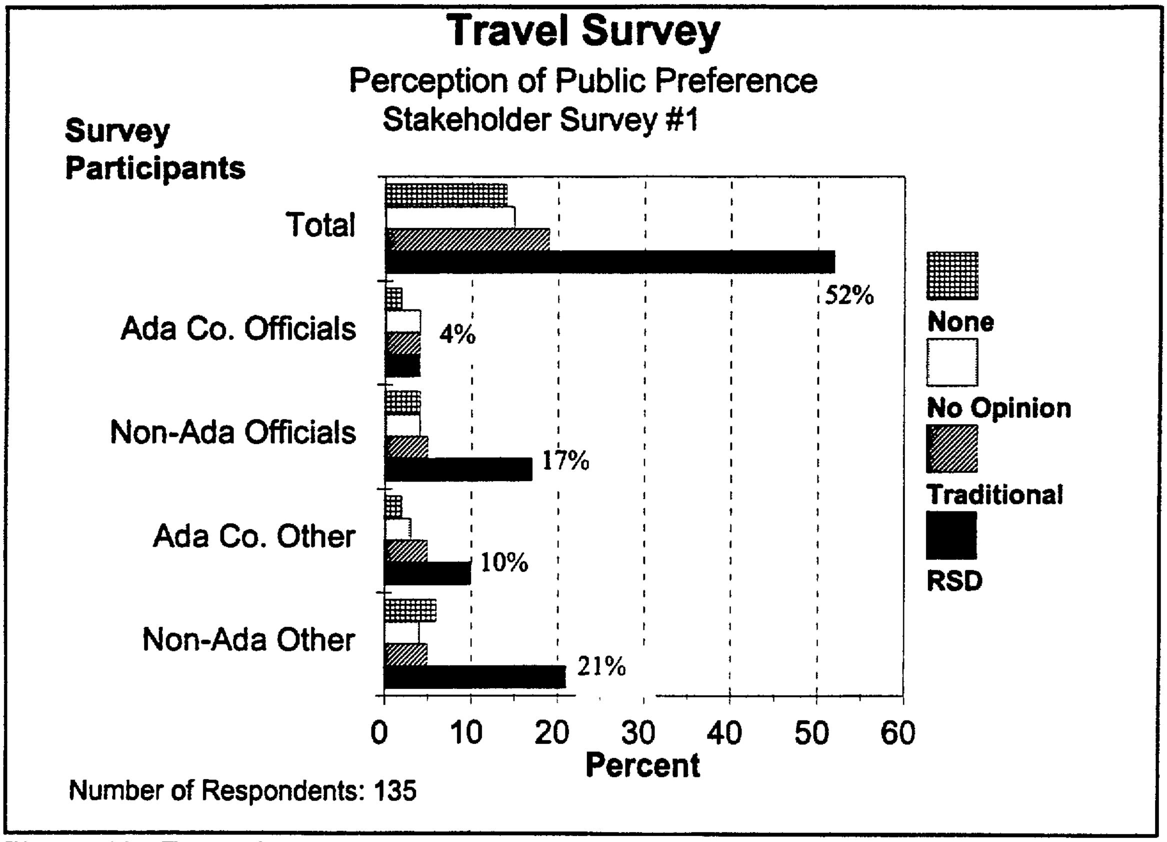


Figure 18 - Travel Survey: Perception of Public Preference (Survey #1)

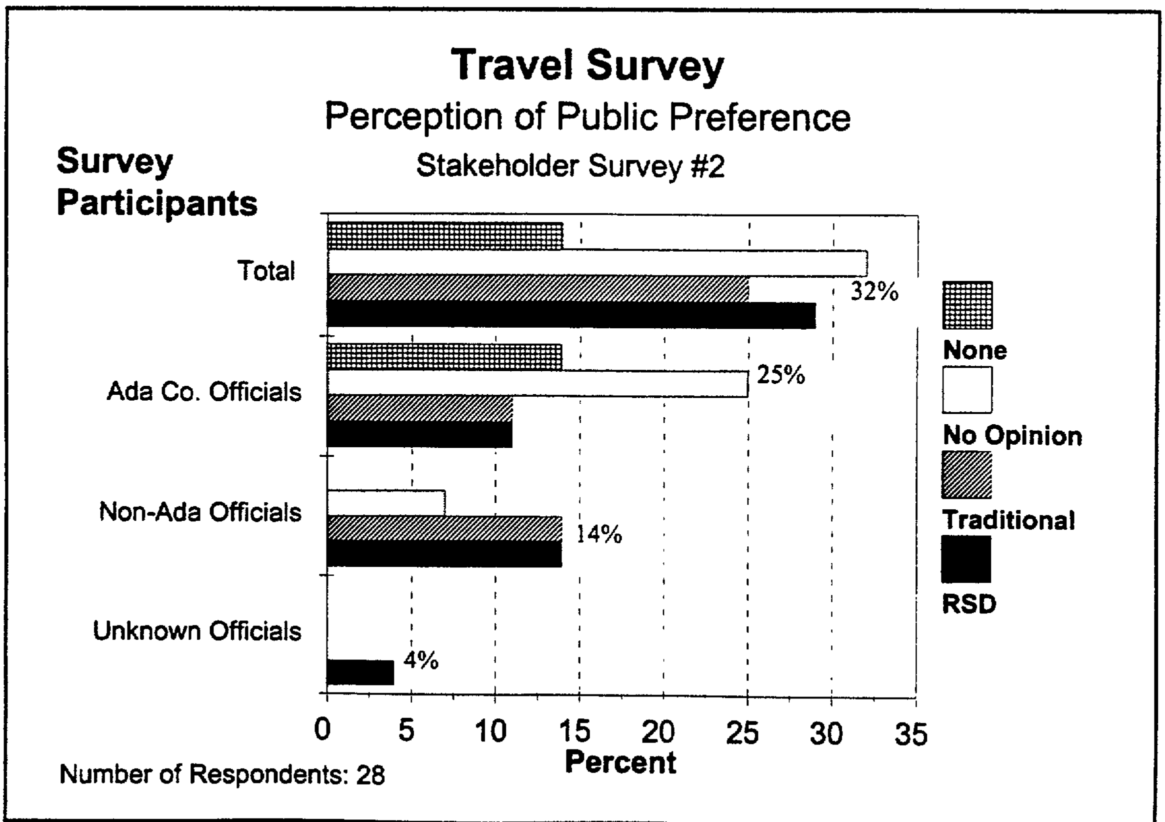


Figure 19 - Travel Survey: Perception of Public Preference (Survey #2)

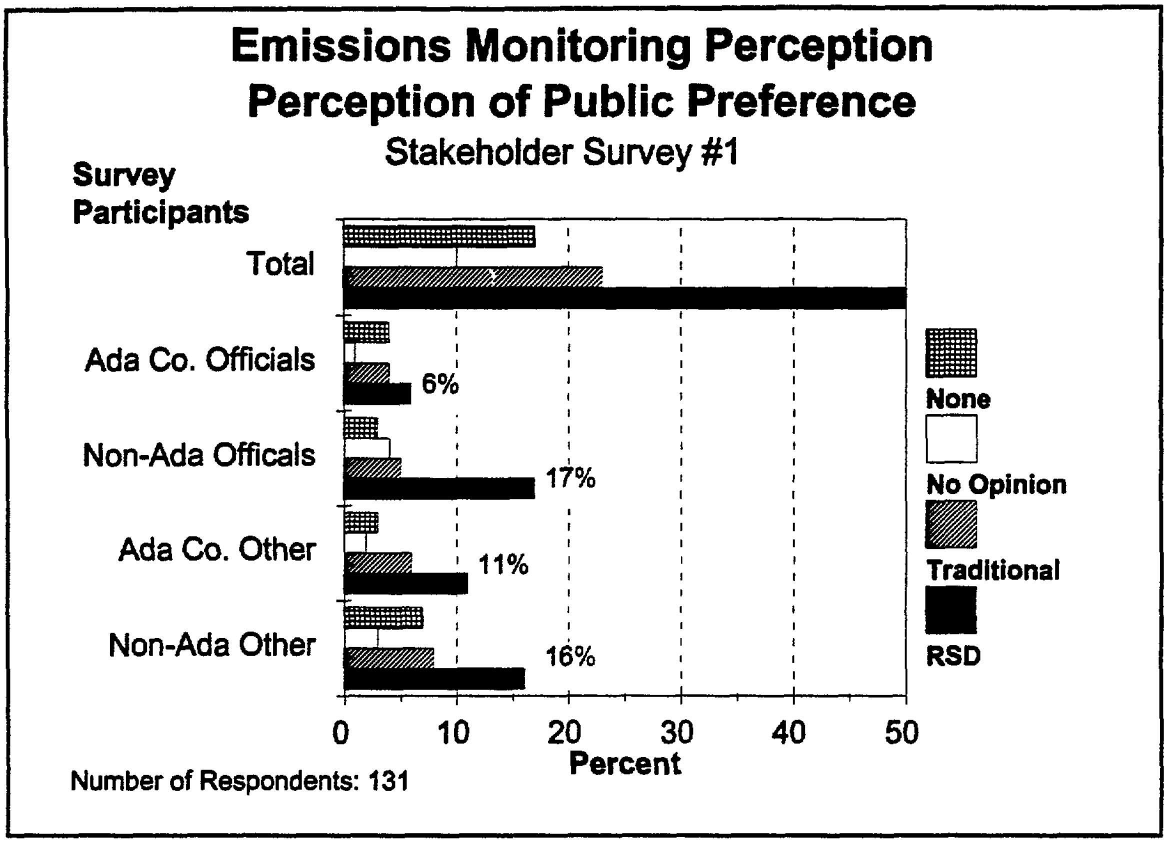


Figure 20 - Emissions Monitoring: Perception of Public Preference (Survey #1)

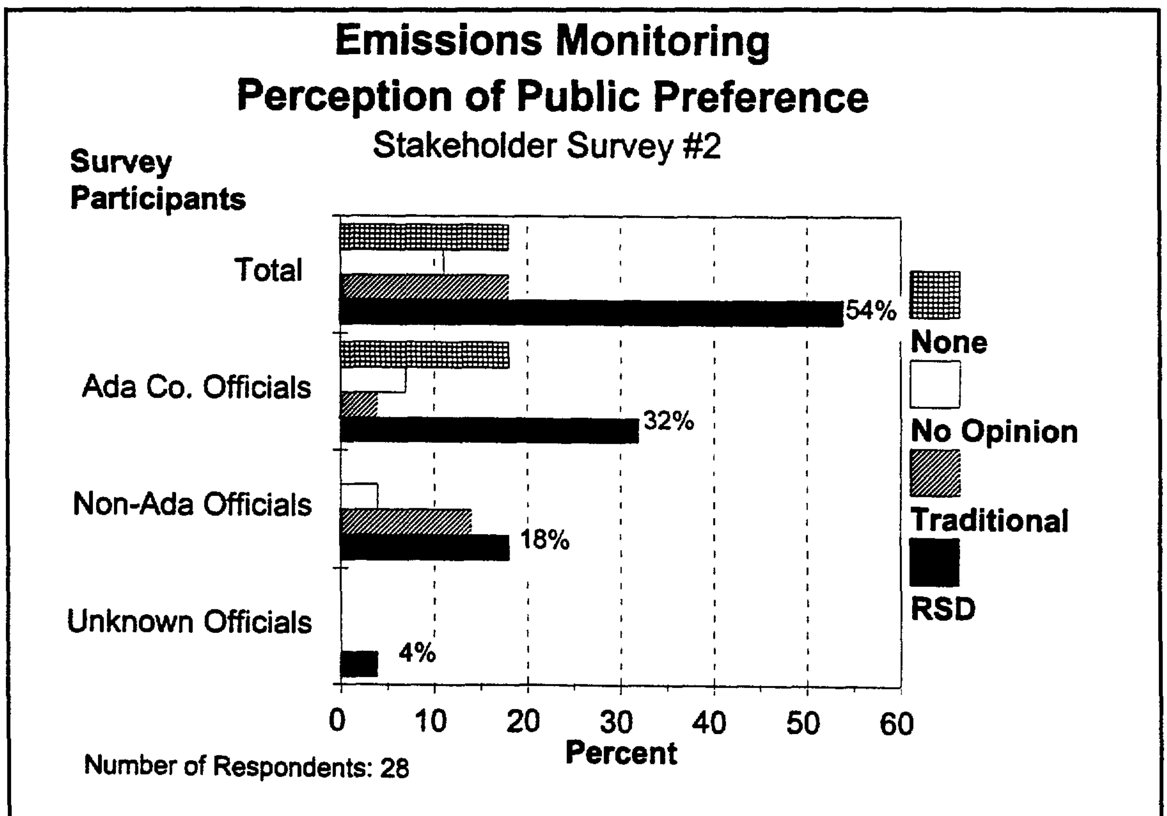


Figure 21 - Emissions Monitoring: Perception of Public Preference (Survey #2)

4.0 Hypotheses

As part of this evaluation, three hypotheses were identified about issues of institutional and legal concerns and public acceptance.

4.1 Hypothesis A: There is no impediment in the way of collaboration of cognizant transportation and air quality agencies to implement/LPR technology.

Findings

- No institutional barriers were encountered before, during, or after the Operational Test.

Data Analysis

During the Operational Test, no institutional barriers were encountered to impede the use of RSD technology to conduct a travel survey and monitor vehicle emissions. The partnership of the participating agencies is unique in that one agency is responsible for the local and county roadway system (ACHD); one agency is responsible for the county-wide air quality program (AQB), and one agency is responsible for all the transportation planning in the cities and county (APA). Such cooperation among these local and state agencies requires a history of good working relationships. These agencies including ITD have worked effectively and successfully over the years on numerous transportation and air quality issues..

4.2 Hypothesis B: There is no legal problem with the implementation of RSD/LPR in terms of invasion of privacy.

Findings

- No legal issues arose before, during or after the Operational Test.

Data Analysis

As stated in Evaluation Goal 1, Objective A of this section, no legal issues arose before, during, or after conducting these two individual tests. Both the legal counsel for the Idaho Transportation Department and the Idaho Attorney General's office identified no legal issues to stop the Operational Test. Over 70% of the stakeholders (public officials and staff) and vehicle owners indicated that the use of RSD technology to conduct a travel survey and to monitor emissions was not an invasion of privacy. Of the 23 % who thought RSD technology was an invasion of privacy, approximately 60% indicated it was somewhat or not very serious invasion of privacy.

While a public awareness campaign was done, some of the participating agencies thought the combination of Phases I and II hurt public acceptance of RSD technology. The news media targeted the emissions testing and the benefits to the vehicle owner. The travel survey was given very little coverage by the news media. The separation of these two phases may have increased the awareness and acceptance of the RSD technology and its uses.

4.3 Hypothesis C: The public prefers the use of RSD/LPR over the use of traditional methods.

Findings

- Over 86% of the public survey respondents indicated they preferred the LPR/RSD method over the stop and ask/distribute method.

- Approximately 72% of the respondents preferred RSD method over the idle emissions test station method.

Data Analysis

As stated in Evaluation Goal 2, Objective A and B, telephone survey participants tended to prefer the use of RSD methods over traditional methods. Over 86% of the respondents preferred the RSD survey method over the stop-and-ask method. Approximately 78 % thought the RSD method would encourage more participation in the travel survey.

Approximately 72% of the respondents preferred RSD method over the idle emissions test station method. These respondents included both vehicle owners who currently are and are not subjected to emissions testing. Over 82% indicated this method would encourage more support for emissions testing.

5.0 Conclusion

This chapter analyzes data to determine whether institutional or legal issues arose and to determine public acceptance of using RSD technology to conduct a travel survey or to monitor vehicle emissions.

No legal issues arose before, during, or after the Operational Test. Both legal counsels for the ITD and the State Attorney General's office did not indicate any legal problems with capturing license plate information, identifying the vehicle owner through the State's motor vehicle registration data base, and sending the vehicle owner a travel survey. Approximately, 70% of elected or appointed officials and administrative staff indicated that such use of RSD technology to conduct a travel survey and to monitor emissions was not too intrusive (prior to the Operational Test). During the Operational Test, less than l/4 of one percent of the telephone contacts from the public referenced an invasion of privacy using RSD technology. Of the public acceptance(telephone) survey respondents, approximately 75 % did not consider using RSD an invasion of privacy. Of the remaining respondents who indicated a seriousness in the invasion of privacy, approximately 60% indicated that it was somewhat or not very serious.

No institutional issues were encountered before, during, or after the Operational Test. The partnership of the participating agencies is unique in that one agency is responsible for transportation planning, for the local and county roadway system, and for the county-wide air quality program. These agencies, in addition to the Idaho Department of Transportation, have a history of good working relationships. These agencies have worked effectively and successfully over the years on numerous transportation and air quality issues. For the ITS Project, each agency had a large stake in the success of the entire project. Each agency wanted either the travel survey information or emissions data or both for their use.

Overall, the majority of the public and stakeholders indicated that RSD technology provided important travel and emissions data and was a convenient way to conduct an O/D survey and to monitor vehicle emissions. Approximately 60% of the public acceptance survey respondents indicated that LPR/RSD would provide the best travel information. Only 49% of the survey participants thought RSD technology would reduce emissions and improve air quality.

Less than 11% of the survey participants who saw the LPR/RSD equipment on the roadway were inconvenienced. The majority of these respondents were only slightly inconvenienced. Of these survey participants who saw the LPR/RSD equipment on the roadway, approximately 20% indicated that it was a safety hazard. The perception of safety by the motorists needs to be improved during future operations. This may have been a drawback of combining both individual tests for the O/D survey and emissions. The news media primarily covered the emissions testing. More information could have been provided to the public by the news media on the O/D survey and the field operations.

Most importantly, the majority of the public acceptance survey respondents preferred the LPR/RSD method to conduct a travel survey and to monitor vehicle emissions when compared to traditional methods. Over 86% indicated they preferred the LPR/RSD method to conduct the O/D survey. Approximately 78% stated they thought this survey method would encourage more participation. For the emissions monitoring, 72% preferred the RSD method over the idle emissions test method. However, over 82% of the respondents indicated the RSD method would encourage more support for an emissions testing program.

In conclusion, stakeholders and the public gave LPR/RSD technology a favorable rating to implement its use to conduct a travel survey and to monitor vehicle emissions.

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Appendix A
Basic Information about Remote Sensing

What is Remote Sensing?

Remote sensing is a way to measure pollutant levels in a vehicle's exhaust while the vehicle is traveling down the road. Unlike most equipment used to measure vehicle emissions today, remote sensing devices (RSD) do not need to be physically connected to the vehicle. The concept of RSD as an efficient tool to monitor the vehicle fleet and identify excessive polluters has great appeal as a complement to traditional mobile source emission control programs. A number of instrument manufacturers are actively developing RSD systems.

What Pollutants are Measured by RSD?

RSD systems can measure hydrocarbons, carbon monoxide, and oxides of nitrogen in the exhaust stream. RSD cannot, however, measure :evaporative" emissions - gasoline vapors that vent into the air from hot engines and fuel systems. Fuel evaporation is a very significant source of hydrocarbon pollution that can exceed tailpipe emissions on hot days.

How does Remote Sensing Work?

Commercial RSD systems employ an infrared absorption principle to measure HC and CO emissions. These systems operate by continuously projecting a beam of infrared radiation across a roadway. It is expected that RSD systems for NO, will use either a beam of ultraviolet light, or light from a tunable diode laser projected across the road.

As a vehicle passes through the RSD beam, the device measures the ratio of CO (and exhaust HC) to carbon dioxide (CO,) in front of the vehicle and in the exhaust plume behind. The system uses the "before" measurement as a base and calculates the vehicle's CO emission rate by comparing the "behind" measurement to the expected ratio for ideal combustion. Exhaust HC is calculated in a somewhat similar manner by comparing the total carbon content of exhaust HC, CO, and CO, to the total carbon content of the gasoline the vehicle burns. The CO_2:CO ratio determined by current RSD systems will still be needed to calculate NO, emissions.

RSD systems employ a freeze-frame video camera and equipment to digitize an image of the license plate number so that it can be processed by a computer. This allows the computer to store emissions information for each monitored vehicle, based on the license plate number. Appropriate authorities can then identify and contact owners of vehicles with high RSD readings.

Methods to measure a vehicle's speed and acceleration as it passes through the infrared beam may also be used. This is important because the operating mode (e.g. acceleration, cruise, etc.) can significantly affect the instantaneous emission level from a vehicle. Some types of operation during an RSD test may be cause for invalidating a particular test.

Computerized diagnostic technologies may also play a role in future RSD systems. Vehicle onboard diagnostic systems, capable of identifying certain malfunctions in a vehicle's emission control system, are required beginning with 1994 models. The malfunctions could be reported to roadside RSD systems by a small electronic device on the vehicle called a radio frequency transponder. Similar transponder concepts have been used to time runners in marathons and transponder systems are being used to assess toll road fees in some areas.

Will Enhanced Inspection and Maintenance Programs Include RSD?

Yes. RSD and other “on-road” emission measurement methods will be an important part of state strategies to reduce emissions from motor vehicles. The Act requires that enhanced I/M programs include on-road emission testing of a portion of the eligible vehicle fleet. RSD technology is expected to play a major role in these supplemental emission measurements:

- RSD will likely be used to identify vehicles with malfunctioning emission controls between scheduled I/M tests. Air quality benefits can result from early repair of vehicles that would otherwise not be identified or repaired until the next annual or biennial test.

- EPA studies have shown that properly repaired vehicles maintain low emissions for a long time. However, some individuals may tamper with their vehicle’s emission control systems. The mobility of the RSD provides a way to identify tampered vehicles between periodic I/M tests and a way to enforce repair requirements on those vehicles found to be dirty. Other studies have found that RSD is more effective in identifying tampered vehicles than the currently used random roadside pull-overs.

- RSD can detect unregistered or improperly registered vehicles. This will allow authorities to pick out drivers who cheat on registration or register out-of-area to avoid participating in an I/M program.

- To take advantage of RSD’s potential to identify dirty cars, EPA is requiring enhanced I/M programs to conduct supplemental emission measurements on at least 0.5 % of vehicles subject to I/M testing each year. Vehicles that fail a RSD test would be required to be retested by the regular I/M test. Repairs would be required for any vehicle failing this out-of-schedule I/M emissions check.

Can RSD Replace Enhanced Inspection and Maintenance Programs?

No. The Clean Air Act provides for use of RSD as a supplement to enhanced I/M programs but not as a substitute for periodic emission testing. While RSD can be extremely useful, it does have some limitations:

- RSD fails vehicles that do not need repair and passes many that do. Studies by EPA, the California Air Resources Board, and others have found that when RSD measurements are compared to emissions measurements made by accepted testing methods, the RSD incorrectly fails vehicles that are not in need of repair.

- The Clean Air Act mandates that enhanced I/M programs include an interrogation of the onboard diagnostic system to check for emission control system malfunctions on 1994 and newer vehicles. Current RSD systems cannot access the onboard diagnostic system.

- The emission reductions from the evaporative emission tests are essential to meeting the enhanced I/M performance standard. RSD cannot conduct this test.

The RSD false failure rate has been around 20% or more for CO and as high as 60 % for HC. More importantly, for clean air, EPA studies indicate that RSD does not identify 80 % to 90% of the dirty vehicles that need repair. This means RSD alone could not be used to meet the enhanced I/M performance standard. EPA believes that these results do not reflect on the instantaneous measurement accuracy of the RSD. Rather, EPA believes these results are indicative of changes in vehicle emission levels that typically occur when a vehicle is operated under driving conditions different than those observed by the RSD. A bibliography of studies is attached.

Implementing RSD in Inspection and Maintenance Programs

There are a number of administrative factors to consider in establishing I/M programs that include RSD. Some RSD advocates have suggested that RSD is capable of monitoring much more than 0.5% of the fleet. EPA agrees that RSD could be used by the I/M programs to measure emissions from more cars, given adequate resolution of the following issues:

- **Placement of Roadside Monitors**

  Current RSD technology can only measure emissions of vehicles driving in a single lane of traffic. It is not easy to find enough sites where appropriate single traffic lanes exist to monitor the majority of vehicles subject to I/M testing. Restricting multiple lanes to a single lane for RSD measurement may not be practical in many cases, particularly during times of heavy traffic such as rush hour. Yet RSD testing during peak traffic periods would probably be necessary to avoid missing high-emitting vehicles that could be parked during business hours.

  EPA has successfully used RSD monitors along multiple lane roadways in some studies without restricting traffic to a single lane. But pylons had to be placed between the lanes to protect some of the RSD equipment. With such a set-up, drivers could choose not to drive through the measuring lane.

  Another issue involves limiting RSD placement to locations where representative vehicle operation will be observed. It will be important for I/M programs to avoid creating situations where a measurable portion of vehicles fail RSD monitoring at one location but pass at another location. For example, sites of high acceleration would likely be avoided because emissions tend to be higher during acceleration than during steady-speed driving.

- **Appropriate Pass/Fail Levels**

  A difficult issue involves selecting an emission standard (cutpoint) for the RSD that will identify vehicles that need repair while minimizing false failures. EPA studies indicate that RSD misidentification of clean vehicles as dirty is substantially reduced by measuring emissions from the same vehicle several times. However, multiple measurements also result in more dirty vehicles passing the test.

- **Notification**

  Administrative systems need to be established so authorities can follow up with owners of vehicles that register high emissions during an RSD check. Whether vehicle owners are pulled over immediately at the time of the check or notified later by mail, oversight will be necessary to ensure that dirty vehicles undergo further testing and repair if necessary.

- **Driver Behavior**

  To date, RSD emissions testing has occurred only in demonstration type projects with no consequences for drivers whose vehicles fail the test. In the future, RSD failures in enhanced I/M programs will result in mandatory retesting and repair. These consequences may prompt drivers to change their driving route or regime (e.g., observing RSD testing in the opposite lane on the way to work, and choosing a different route home), or otherwise alter their driving behavior to avoid passing an RSD monitor. The political implications of ailing motorists, especially falsely, with this type of program may be a significant problem.

The prototype studies conducted to date do not provide the type of practical information I/M program managers need to effectively use RSD on a day-to-day basis. However, EPA believes that most of these administrative issues will be resolved with experience, as states begin to integrate RSD into actual I/M programs. By starting out with a small fraction of the fleet (0.5 %), I/M program offices can begin to develop administrative systems that will allow RSD to achieve its potential as a full player in the vehicle emission control program of the future.

Appendix B
Emission Sensor Set Up

Roadway	Location	Roadway Characteristics	1995 ADT	Number of Travel Lanes	Emission Sensors Set Up
Franklin Rd.	E/O McDermott Rd.	Rural setting – Straight/flat roadway	2,525	Two	Across both lanes
Kuna Rd.	E/O McDermott Rd.	Rural Setting – Straight/flat roadway	1,048	Two	Across both lanes
Ustick Rd.	E/O Can Ada Rd. (gravel shoulder)	Rural setting – Straight/flat roadway	421	Two	Across both lanes
McMillan Rd.	E/O Can Ada Rd. (gravel shoulder)	Rural Setting – Straight/flat roadway	76	Two	Across both lanes
I-84 Canyon County	Mile Post 41 (gravel shoulder)	Rural setting – Straight/flat roadway	**	Four lane Separated Highway	Across one lane (tapered from two to one lane)
I-84 Elmore County	Mule Post 68.8 (gravel shoulder)	Rural Setting – Straight/flat roadway	8,118	Four lane Separated Highway	Across one lane (tapered from two to one lane)
Hwy. 21	Mile Post 17.5 (gravel shoulder)	Rural setting – Straight/flat roadway	1,808	Two	Across both lanes
Amity Rd.	E/O McDermott Rd. (gravel shoulder)	Rural Setting – Straight/flat roadway	1,586	Two	Across both lanes
Hwy. 20 (Chinden Blvd.)	E/O Can Ada Rd. (gravel shoulder)	Rural setting – Straight/flat roadway	2,813	Two	Across both lanes
Hwy. 44 (State St.)	E/O Can Ada Rd. (gravel shoulder)	Rural Setting – Straight/flat roadway	2,382	Two	Across both lanes
Hwy. 16 (Emmett Hwy.)	Mole Post 7.5 (gravel shoulder)	Rural setting – Straight/flat roadway	2,869	Two	Across both lanes
Hwy. 55 (Horseshoe Bend Rd.)	Mile Post 52 (gravel turnout)	Rural Setting – Straight/flat roadway	2,463	Two	Across one, then Two lanes
I-84 On-ramp (westbound)	Broadway Ave. (shoulder)	Slight downhill grade	9,939	One	Across both lanes
I-84 On-ramp (westbound)	I-184 (paved shoulder)	Slight downhill grade	9,040	One	Across both lanes
I-84 On-ramp (westbound)	Eagle Rd. (shoulder)	Slight downhill grade	3,139	One	Across both lanes
I-84 On-ramp (westbound)	Meridian Rd. (shoulder)	Slight downhill grade	2,577	One	Across both lanes
I-84 On-ramp (westbound)	Gowen Rd. (shoulder)	Slight downhill grade	5,960	One	Across both lanes
I-84 On-ramp (westbound)	Orchard St. (shoulder)	Slight downhill grade	2,868	One	Across both lanes
I-84 On-ramp (westbound)	Vista Ave. (shoulder)	Slight downhill grade	5,149	One	Across both lanes
I-84 On-ramp (westbound)	Cole/Overland Rd. – (shoulder)	Slight downhill grade	7,704	One	Across both lanes

NOTE: * 1995 ADT is for the outbound direction only, the travel direction of the vehicles being monitored.
**** No 1995 count is available for this test site.**

Appendix C
I-84 at Canyon County Test Site

This test attempted to collect license plate and emissions data from westbound vehicles on the Interstate at the Ada/Canyon County line by tapering the two westbound travel lanes into one. The one travel lane was unable to handle the traffic demand and a 1 1/2 mile traffic back up occurred on the freeway. Initially, the RSD equipment set up by the field technicians was to occur by 7:00 a.m. prior to the morning peak period. This set up was completed at 8:00 a.m. The field technicians' activities on the freeway during morning peak period had a noticeable impact on the travel behavior of the motorist. Motorists began gawking at the activities along the roadway and slowed down which created traffic hazards. The test site was in operation for approximately 30 minutes when ITD requested the test be terminated. This test site, I-84 at Canyon County, carried over 40% of the total traffic volume of the original test sites and an alternative site needed to be identified to capture this potentially lost data.

After lengthy discussions, project coordinators from APA, ITD, and Hughes ("Smog Dog" vendor) recommended that all I-84 westbound on-ramps (eight) in Ada County be monitored to capture the data lost from the freeway at the Canyon County line. Previously, Hughes technicians had been very successful in monitoring the freeway ramps during other operations around the country. With this recommendation, the test schedule and locations were revised. All eight I-84 westbound on-ramps were monitored instead of the remaining three low-volume arterials (Columbia, Greenhurst, and Victory Roads) which had an average daily traffic volume ranging between 400 and 1000. These three minor test sites carried only 2% of the total traffic volume of the original test sites.

Cherry Lane, a low-volume roadway, which was on the initial test schedule was dropped due to roadway construction. While construction schedules were checked for possible conflicts, the project team was notified of this work the week prior to the test. This test site carried only 2% of the original traffic volume of all the test sites.

With the elimination of these four minor test sites, all eight freeway on-ramps were able to be monitored in order to capture the license plate and emissions data from vehicles traveling westbound on the Interstate. Data collection expanded from 18 to 20 test sites on primary and secondary roadways near the Ada County line and on I-84 on-ramps (westbound) in Ada County.

In addition, the original test schedule specified daily operational hours beginning at 7:00 am and ending at 7:00 pm (12 hours). Unforeseen circumstances occurred which affected the morning starting time. Each test site was monitored approximately 7-12 hours per day with the exception of I-84 at Canyon County (see Table 1). First, there was a miscommunication of the meeting location which delayed the operations of the first morning. Second, two local technicians were trained by the Hughes representatives on the initial set up and take down of the RSD equipment at two of the test sites during this test week. The set up time, which was the most critical, doubled in length. These two local technicians were responsible for the complete field operation during the final phase (Emissions Monitoring of All Vehicles in Ada County) of this test. Third, the driving time from the central operations location to the test site locations at the County line were longer than expected. The shorter daily operational hours greatly reduced the number of vehicles monitored during the morning peak hour at the majority of County line test sites. Lastly, the incident at I-84 Canyon County site had a lasting affect upon the future operations whenever a perception existed that the test may cause traffic congestion or delays.

The test site at I-84 on-ramp (westbound) at I-184 was terminated at 5:21 p.m. due to traffic congestion. This on-ramp experiences traffic congestion on a daily basis; however, the operations team recognized that the test may be blamed for it. Just prior to terminating operations at this site, a flying traffic reporter noticed the traffic congestion and the "Smog Dog" van in the vicinity. The reporter broadcasted that the test was the cause of the traffic congestion and delays.

The test site at I-84 on-ramp at Cole/Overland Roads was terminated at 4:00 p.m. This interchange is currently under construction and a short merge lane exists. Motorists were observed stopping in the merge lane and waiting for an adequate gap in traffic to access the freeway. A concern of the operational team was that this driving maneuver would create more noticeable traffic problems during the evening peak period and would be attributed to the "Smog Dog" van and the test.

In addition, tests were terminated 10-30 minutes early at two other test sites, I-84 on-ramp at Vista Avenue and at Eagle Road due to weather conditions.

Appendix D
Preliminary Local Climatological Data for April 1995

Preliminary Local Climatological Data (WS Form: F-6)

Station: WSFO BOISE, IDAHO **Month: APR** **Year: 1995**

Latitude +43.57 **Longitude** +116.22 **Gnd Elev. 2858 ft. Std Time: MST**

Temperature in Fahrenheit				Precip (in)			snow: Wind Columns			Fastest 2-Min:			Sunshine:		Shy	Peak wind		
-1- Da	-2- Max	-3- Min	-4- Avg	-5- Dep	-6a- HDD	-6b CDD	-7- Water	-8- Snow	-9- Depth	-10- Avg	-11- Speed	-12- Dir	-13- Mins	-14- %PSBL	-15- SR-SS	-16- weather	-17- Speed	-18 Dir
1	54	38	46	0	19	0	T	0.0	0	11.8	20	32	283	37	10		25	NW
2	58	27	43	-3	22	0	0.00	0.0	0	8.5	16	33	763	100	1		23	NW
3	69	32	51	5	14	0	0.00	0.0	0	5.7	10	13	678	88	9		15	W
4	73	47	60	14	5	0	T	0.0	0	8.9	14	13	686	89	9		18	SE
5	67	46	57	10	8	0	0.16	0.0	0	5.6	16	24	443	57	8		23	S
6	55	48	52	5	13	0	0.30	0.0	0	6.4	10	12	23	3	10		14	E
7	63	47	55	8	10	0	0.12	0.0	0	11.1	38	25	193	25	9		38	SW
8	51	37	44	-3	21	0	0.13	T	0	11.1	29	25	349	45	6		33	W
9	50	34	42	-5	23	0	0.01	T	0	13.6	23	31	382	49	6		29	NW
10	54	25	40	-8	25	0	0.00	0.0	0	6.7	14	29	755	96	2		20	NW
11	58	40	49	1	16	0	T	0.0	0	4.8	09	30	413	52	10		12	NW.
12	67	41	54	6	11	0	T	0.0	0	10.1	17	16	266	33	10		24	SE
13	56	38	47	-1	18	0	0.04	0.0	0	13.1	21	33	79	10	10		28	N
14	49	28	39	-10	26	0	0.00	0.0	0	13.8	24	30	670	84	4		31	NW
15	53	21	37	-12	28	0	0.00	0.0	0	4.6	10	30	740	92	3		14	NW
16	58	30	44	-5	21	0	0.00	0.0	0	7.3	15	32	748	93	8		21	NW
17	58	31	45	-4	20	0	0.00	0.0	0	7.6	16	31	640	79	6		24	NW
18	67	40	49	-1	16	0	T	0.0	0	12.0	21	31	589	73	7		28	NW
19	53	34	44	-6	21	0	0.00	0.0	0	12.0	18	32	693	85	5		26	NW
20	45	35	40	-10	25	0	0.09	0.0	0	12.1	18	29	0	0	10	1	23	NW
21	60	36	48	-2	17	0	0.00	0.0	0	16.7	23	31	820	100	1		31	NW
22	63	29	46	-5	19	0	0.00	0.0	0	7.5	18	30	797	97	1		24	NW
23	65	32	49	-2	16	0	0.00	0.0	0	6.9	14	31	789	96	1		18	NW
24	74	41	58	7	7	0	0.00	0.0	0	8.0	14	13	708	85	5		20	S
25	64	40	52	1	13	0	T	0.0	0	12.1	23	31	658	79	6		29	NW
26	68	36	52	0	13	0	0.00	0.0	0	8.4	14	14	709	85	9		20	SE
27	73	42	58	6	7	0	0.02	0.0	0	9.7	30	24	497	59	9		43	SW
28	60	38	49	-3	16	0	0.00	0.0	0	6.7	10	11	0	0	10		20	SW
29	54	42	48	-5	17	0	0.13	0.0	0	9.4	18	13	0	0	10	1	29	W
30	63	42	53	0	12	0	0.03	0.0	0	8.7	14	30	207	24	7		16	N
Sum	1792	1097			499	0	1.03	T		208.09			14578		202			
Avg	59.7	36.6								9.4 Fast			Dir Psbl	%	6.7		Max	(mph)
								Misc______		38			25 24142	60			043	SW

Notes
Column 9 readings are taken at 0500
Column 17 Peak Wind in M.P. H.

Appendix E
Calibration of Emissions Sensors

Test Day	Test Station	Number of Calibrations Recorded per Site	Total Time to Calibrate (min.)
April 24	Franklin Rd.	3*	13
April 24	Kuna Rd.	2*	18
April 24	Ustick Rd.	64*	38
April 24	McMillan Rd.	1*	5
April 25	I-84 Elmore County	3*	21
April 25	Hwy. 21	3*	10
April 25	Amity Rd.	5*	19
April 26	Hwy. 20 (Chinden Blvd.)	4	N/A**
April 26	Hwy. 44 (State St.)	3*	34
April 26	Hwy. 16 (Emmett Hwy.)	1	3
April 26	Hwy. SS (Horseshoe Bend Rd.)	6*	12
April 27	l-84 On-ramp @ Broadway Ave.	1	N/A**
April 27	I-84 On-ramp @ I-184	8	20
April 27	I-84 On-ramp @ Eagle Rd.	3*	15
April 27	I-84 On-ramp @ Meridian Rd.	2*	13
April 28	I-84 On-ramp@ Gowen Rd.	1	1
April 28	1-84On-ramp @ Orchard St.	4	N/A**
April 28	I-84 On-ramp @ Vista Ave.	5	10
April 28	I-84 On-ramp @ Cole/Overland Rd.	2	3
Total with Recorded Time **- Average**		**51*** 3.2"	235 4.6
Total without Recorded Time		**9**	**N/A****

NOTE:
*** These calibrations involved training technicians and/or readjusting sensor height.**
**** Technician did not record time to calibrate.**

Appendix F
Format of Collected Data by RSD Technology

Data Name	Data Description	Type	Structure
License Plate Number	This is the actual automobile license number as resolved from the video of each license plate	Alpha	Integer 10
TCODE	County code.	Alpha	2
Observation Date	This is the day of the year on which the RSD observation was made.	Date	MM/DD/YY
Observation Time	This is the time of day during which the RSD observation was completed.	Time	HH/MM/SS
Location	This is the number assigned to each RSD location (01-18 were at the County perimeter, 19-26 were internal to Ada County).	Alpha	2
Speed 1	This is the first speed of travel observation made by the RSD monitors.	Fixed Numeric	2.2
Speed 2	This is the second speed of travel recorded by the RSD technology.	Fixed Numeric	2.2
Acceleration	This is the computed acceleration of the vehicle based upon speed 1 and speed 2.	Fixed Numeric	3.2
Carbon Monoxide (CO)	This is the observed CO recorded as a percentage of total exhaust emissions.	Fixed Numeric	5.5
Carbon Dioxide (CO,)	This is the observed CO, in exhaust emissions recorded as a percent of total emissions.	Fixed Numeric	5.5
Hydrocarbon (HC)	This is the proportion of hydrocarbon in the exhaust emissions recorded as a percent of total emissions.	Fixed Numeric	5.5
Sensor	This is the van and sensor number to tracked the equipment used.	Fixed Numeric	6
Slope CO	This is technical data used to validate the emissions readings.	Fixed Numeric	5.5
Slope HC	This is technical data used to validate the emissions readings.	Fixed Numeric	5.5
Code CO	This is technical data used to validate the emissions readings.	Alpha	3
Code HC	This is technical data used to validate the emissions readings.	Alpha	3
Max. CO	This is technical data used to validate the emissions readings.	Fixed Numeric	5.5

Appendix G
Travel Speed Comparisons

COMPARING MEAN SPEEDS FROM SMOGDOG STUDY DAY TO MEAN SPEEDS OF OTHER WEEKDAYS DURING THE SAME TIME PERIOD PASSENGER VEHICULES ONLY

Van 1 at FRANKLIN RD Segment code: 004740 MP: 2.3 Station 1407-0300

Study day was 04/24/95 from 8:30 to 19:02
Count during study period: 3004 Mean epeed during study: 42.5

Other days compared to study day:

Date	Count	Mean Speed	Mean Diff from study mean	Std Dev of diff	Std of	T Value of diff	Prob of **T value**
04/25/95	2917	51.1	8.6 mph	5.468	0.101	**84.501**	**0**
04/26/95	**3015**	**50.7**	8.2 mph	6.075	0.111	74.292	**0**
04/27/95	**3096**	**50.4**	7.9 mph	5.810	0.104	**75.824**	**0**

Van 1 at I-84 CANYON Segment code: 001010 MP: 43.63 Station: 01271-0700

Study day was 04/25/95 from 8:00 to 8:30
Count during study period: 799 Mean speed during study: 67.7

Other days compared to study day:

Date	Count	Mean Speed	**Mean** diff from study	Std Dev of diff	Std Err of diff	T Value of diff	Prob of **T value**
04/26/95	**1363**	**70.2**	**2.5** mph	5.418	0.147	16.782	1.344331E-57
04/27/95	1405	69.0	1.2 mph	4.981	0.133	9.331	3.935152E-20
04/28/95	1347	70.2	2.4 mph	5.291	0.144	16.910	2.581693E-58

Van 1 at SH-16 EMMETT Segment code: 001390 Mp: 6.382 Station: 01095-0800

Study day was 04/26/95 from 7:30 to 19:00
Count during study period: 4148 Mean speed during study: 49.9

Other days compared to study day:

Date	Count	Mean Speed	Mean of from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/24/95	4019	58.4	8.5 **mph**	**4.991**	**0.079**	**107.333**	**0**
04/25/95	4275	57.8	7.9 mph	**5.217**	**0.080**	**98.702**	**0**
04/27/95	**4078**	58.8	8.9 mph	5.134	0.080	110.488	0

COMPARING MEAN SPEEDS FROM SMOGDOG STUDY DAY TO
MEAN SPEEDS OF OTHER WEEKDAYS DURING THE SAME TIME PERIOD
PASSENGER VEHICLES ONLY

Van 1 at I-184 Segment code: 002410 MP: 0.269 Station: 01277-0600

Study day was 04/27/95 from 7:35 to 17:21
Count during study period: 8577 Mean speed during study: 47.1

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/28/95	10790	59.3	12.1 mph	6.603	0.064	190.941	0

Van 1 at GOWEN IC RAMP Segment code: 001124 MP: 0.13 Station: 01281-0940

Study day was 04/28/95 from 7:10 to 19:00
Count during study period: 6023 Mean speed during study: 39.4

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/27/95	6121	45.8	6.4 mph	5.052	0.065	99.256	0

Van 2 at KUNA RD Segment code: 002550 MP: 9.641 Station:01132-0300

Study day was 04/24/95 from 11:15 to 19:00
Count during study period: 973 Mean speed during study: 36.6

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/25/95	934	52.0	15.4 mph	7.572	0.248	62.092'	0
04/26/95	1024	51.9	15.3 mph	7.109	0.222	68.866	0
04/27/95	1029	51.8	15.3 mph	6.829	0.213	71.721	0

COMPARING MEAN SPEEDS FROM SMOGDOG STUDY DAY TO
MEAN SPEEDS OF OTHER WEEKDAYS DURING THE SAME TIME PERIOD
PASSENGER VEHICLES ONLY

Van 2 at AMITY RD Segment code: 002600 MP: 3.07 Station: 14353-0300

Study day was 04/25/95 from 8:21 to 19:00
Count during study period: 1878 Mean speed during study: 39.4

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/24/95	1881	51.0	11.6 mph	7.504	0.173	67.002	0
04/26/95	1877	50.6	11.1 mph	7.538	0.174	63.947	0
04/27/95	1929	50.2	10.8 mph	7.284	0.166	65.211	0

Van 2 at SH-44 STATE ST Segment code: 002130 MP: 9.66 Station: 14133-0300

Study day was 04/26/95 from 8:27 to 19:00
Count during study period: 2755 Mean speed during study: 43.2

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/24/95	2768	55.6	12.3 mph	6.065	0.115	107.076	0
04/25/95	2767	55.4	12.2 mph	6.582	0.125	97.153	0
04/27/95	2884	55.3	12.1 mph	6.154	0.115	105.654	0

Van 2 at EAGLE IC RAMP Segment code: 008628 MP: 0.285 Station: 01268-0940

Study day was 04/27/95 from 7:lO to 18:35
Count during study period: 3167 Mean speed during study: 52.4

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/28/95	3190	59.9	7.5 mph	6.275	0.111	67.385	0

COMPARING MEAN SPEEDS FROM SMOGDOG STUDY DAY TO
MEAN SPEEDS OF OTHER WEEKDAYS DURING THE SAME TIME PERIOD
PASSENGER VEHICLES ONLY

an 2 at COLE/OVRLD RAMP Segment code: 016047 MP: 0.15 Station: 01162-0941

Study day was 04/28/95 from 8:00 to 16:00
Count during study period: 2533 Mean speed during study: 31.2

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
4/27/95	1753	36.4	5.3 mph	6.957	0.166	31.687	1.39546E-174

an 3 at USTICK RD Segment code: 000232 MP: 100.1 Station: 01016-0300

Study day was 04/24/95 from 8:50 to 19:00
Count during study period: 566 Mean speed during study: 40.4

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/25/95	607	48.2	7.8 mph	8.657	0.351	22.229	1.636723E-80
04/26/95	568	49.1	8.7 mph	9.408	0.395	22.048	2.891625E-78
04/27/95	624	48.7	8.3 mph	8.250	0.330	25.128	9.406189E-97

Jan 3 at SH-2 1 Segment code: 002140 MP: 17.44 Station: 01094-0100

Study day was 04/25/95 from 9:00- to 19:00
Count during study period: 1575 Mean speed during study: 43.9

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value' of diff	Prob of T value
04/24/95	1741	56.5	12.6 mph	6.134	0.147	85.918	0
04/26/95	1609	56.6	12.7 mph	5.879	0.147	86.826	0
04/27/95	1562	56.0	12.1 mph	5.944	0.150	80.604	0

COMPARING MEAN SPEEDS FROM SMOGDOG STUDY DAY TO
MEAN SPEEDS OF OTHER WEEKDAYS DURING THE SAME TIME PERIOD
PASSENGER VEHICLES ONLY

Van 3 at SH-55 Segment code: 001990 MP: 53.382 Station: 01018-0500

study day was 04/26/95 from 7:15 to 19:00
Count during study period: 2480 Mean speed during study: 41.5

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/24/95	2524	57.8	16.3 mph	6.733	0.134	121.511	0
04/25/95	2526	57.5	16.0 mph	5.722	0.114	140.587	0
04/27/95	2599	57.2	15.7 mph	6.273	0.123	127.629	0

Van 3 at MERIDIAN RAMP Segment code: 001101 MP: 0.11 Station: 01271-0940

Study day was 04/27/95 from 7:30 to 18:45
Count during study period: 2607 Mean speed during study: 45

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/28/95	2774	53.2	8.2 mph	5.478	0.104	78.870	0

Van 3 at ORCHARD RAMP Segment code:001112 MP: 0.09 Station: 01279-0940

Study day was 04/28/95 from 8:20 to 18:50
Count during study period: 2815 Mean speed during study: 37.4

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff-	Prob of T value
04/26/95	2888	41.8	4.4 mph	4.534	0.084	52.428	0
04/27/95	2809	41.1	3.7 mph	4.170	0.079	47.088	0

COMPARING MEAN SPEEDS FROM SMOGDOG STUDY DAY TO MEAN SPEEDS OF OTHER WEEKDAYS DURING THE SAME TIME PERIOD PASSENGER VEHICLES ONLY

Van 6 at MCMILLAN RD   Segment code: 002812 MP: 10.177   Station: 01015-0300

study day was 04/24/95 from 9:00 to 18:55
Count during study period: 101   Mean speed during study: 26.9

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/25/95	51	44.0	17.1 mph	10.098	1.414	12.073	1.960957E-16
04/26/95	64	43.8	16.8 mph	12.254	1.532	10.990	2.768664E-16
04/27/95	65	45.0	18.0 mph	13.254	1.644	10.955	2.56387E-16

Van 6 at I-84 ELMORE   Segment code: 001010 MP: 63.891   Station: 01270-0400

Study day was 04/25/95 from 8:35 to 17:53
Count during study period: 6413   Mean speed during study: 63.4

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/26/95	6820	69.9	6.5 mph	5.117	0.062	104.624	0
04/27/95	5860	69.6	6.2 mph	5.622	0.073	84.275	0

Van 6 at US-20 CHINDEN   Segment code: 002070 MP: 32.39   Station: 14056-0300

Study day was 04/26/95 from 8:00 to 19:0l
Count during study period: 3661   Mean speed during study: 44.2

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T value
04/24/95	3632	56.2	12.0 mph	6.531	0.108	110.994	0
04/25/95	3606	56.8	12.6 mph	5.551	0.092	136.606	0
04/27/95	3728	56.6	12.4 mph	5.555	0.091	136.396	0

COMPARING MEAN SPEEDS FROM SMOGDOG STUDY DAY TO
MEAN SPEEDS OF OTHER WEEKDAYS DURING THE SAME TIME PERIOD
PASSENGER VEHICLES ONLY

Van 6 at BROADWAY RAMP Segment code: 001120 MP: 0.11 Station: 01280940

Study day was 04/27/95 from 7:35 to 18:55
Count during study period: 8858 Mean speed during study: 36.4

Other days compared to study day:

Date	Count	Mean Speed	Mean diff from study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T Value
04/26/95	9106	46.0	9.7 mph	5.185	0.054	177.714	0
04/28/95	9849	45.7	9.3 mph	5.215	0.053	177.720	0

Van 6 at VISTA RAMP Segment Code: 001116 MP: 0.105 Station: 01280-0940

Study day was 04/28/95 from 8:43 to 15:00
Count during study period: 2769 Mean speed during study: 38.5

Other days compared to study day:

Date	Count	Mean Speed	Mean Diff from Study mean	Std Dev of diff	Std Err of diff	T Value of diff	Prob of T Value
04/27/95	2498	46.3	7.8 mph	5.064	0.101	76.576	0

Appendix H
Traffic Survey Applications

VIDEO ASSIST FOR ORIGIN & DESTINATION ANALYSIS

BACKGROUND:

Growth patterns in urban and congested areas are critical for the successful planning of vehicular, public transportation and air quality control within these areas. It has become necessary for planning personnel to develop better techniques to analyze these shifts in population density. One such technique employs the use of high-speed video cameras to gather license plate data from the major highway systems.

Upon securing the license plate data base, the address information for each registered vehicle owner can be obtained from the motor vehicle license department of the State. A suitable inquiry form can then be mailed to each registered owner requesting information regarding the point of origin, destination, and/or purpose of the trip as well as other pertinent data. The responses from these inquiries can then assist the planning department to make critical decisions regarding future construction and road management requirements.

ATD Northwest has developed a mobile and air-transportable acquisition unit that is designed to collect license plate data from multiple lanes of a busy corridor. All of these elements of the system are housed in air transportable ATA cases that are specifically fitted to house the color high-speed video cameras, mounting equipment, the stop motion VCR's, Monitors, and Computers. Safety cones, signage, vests and helmets are available when required. For night time operations, portable amber search lights may also be supplied.

Under typical operating conditions, a freeway overpass is selected as the recording site. Rented mobile units are moved into position early in the morning and cameras are located over each lane of traffic to be observed. Long lenses are used to obtain a field of view approximately 8 feet wide. High-speed shutters are used to stop the motion of the vehicles. Approximately three pictures are obtained of each license plate. A continuous motion recording is made on a high-resolution stop-motion VCR associated with each lane of traffic. At the end of each hour the video tape is removed from each VCR and forwarded to the computer evaluation site.

At the processing site, a number of high-resolution evaluation stations are provided. Each station has a stop-motion video player which is integrated into a package with a multi-media portable computer and a high resolution color display. The processing unit scans the video tape until a vehicle is identified. The operator stops the video tape so that a clear image of the license plate can be observed. The license plate numbers are then entered into the data base using prearranged criteria. At the close of each session, the data disks from all the terminals are consolidated into one master data base and forwarded to the proper authority. The data is matched to the DMV data base and address labels may then be printed. These labels are turned in and attached to the questionnaires, stamped, and mailed to the recipients with a preprinted return postage card.

The return information is tabulated and evaluated by planning personnel and integrated into the master planning program. A return greater than 30% of the mailed questionnaires is not unusual.

ATD Inc. provides the equipment, facilities, and personnel to conduct these license plate surveys. To receive a free information video tape covering this process, call 206-869-8877.

ADT NORTHWEST

ADVANCED TELEVISION DEVELOPMENT
System Integration, Engineering and Consulting Services
P.O. Box 566, WOODINVILLE, WA 98072 **PH: 20618694877 FAX: 206-869-1832**

Appendix I
Travel Survey Summaries

Ia. TRIP DESTINATIONS FROM ADA COUNTY BY TEST SITE (Test Sites at West Ada County Line)

Trip Destination	Franklin Rd.	Kuna Rd.	Ustick Rd.	I-84 @ Canyon County*	Amity Rd.	Hwy. 20 (Chinden Blvd.)	Hwy. 44 (State St.)
Bowmont		1%					
Caldwell	13%	2%	41%	23%	2%	52%	17%
Fruitland						1%	
Greenleaf						2%	
Homedale						1%	
Marsing	1%					1%	
Melba		15%		1%			
Middleton				2%		4%	59%
Nampa	85%	80%	59%	67%	96%	33%	17%
Notus						1%	
Parma		2%		1%		1%	2%
Payette				1%			
Weiser				1%			
Wilder				1%			
Other					2%	1%	1%
Out-of-State	3%			3%		2%	4%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Total Responses	257	66	29	2,222	178	351	239

*** NOTE: I-84 @ Canyon County includes data from all eight I-84 westbound on-ramps.**

1b. TRIP DESTINATIONS FROM ADA COUNTY BY TEST SITE (Test Sites at North and East Ada County Lines)

Trip Destination	Hwy. 16 (Emmett Hwy.)	Hwy. 55 (Horseshoe Bend Rd.)	I-84 @ Elmore County	Hwy. 21
Banks		3%		
Buhl			1%	
Burley			1%	
Cascade		14%		
Challis		1%		
Donnelly		4%		
Emmett	96%			
Garden Valley	1%			3%
Gardenia		2%		
Glenns Ferry			4%	
Horseshoe Bend		22%		
Idaho City		2%		97%
Idaho Falls			1%	
Jerome			1%	
Lewiston		1%		
Lowman		27%		
McCall		14%		
Mountain Home			68%	
Pocatello			1%	
Rupert			1%	
Sweet	1%			
Twin Falls			7%	
Other	2%	9%	9%	
Out-of-State		1%	6%	
Total	100%	100%	100%	100%
Total Responses	503	306	418	147

2. ORIGIN TRIP TYPE

Site Location	Home	Work	School	Medical	Recreational	Shopping	Other	No Response	Total	No. of Completed Surveys
Franklin Rd.	51.0%	33.1%	1.6%	1.9%	6.2%	5.4%	0.8%	0.0%	100%	257
Kuna Rd.	19.8%	48.4%	22.7%	0.0%	3.0%	6.1%	0.0%	0.0%	100%	66
Ustick Rd.	58.7%	20.7%	10.3%	0.0%	3.4%	6.9%	0.0%	0.0%	100%	**29**
1-84 @ Canyon county	32.2%	47.2%	3.2%	3.6%	4.1%	7.7%	2.0%	0.0%	100%	**2,222**
1-84 @ Elmore County	28.7%	47.4%	5.5%	6.5%	3.8%	5.7%	2.4%	0.0%	100%	**418**
Hwy. 21	17.0%	63.9%	3.4%	2.7%	4.1%	8.2%	0.7%	0.0%	100%	**147**
Amity Rd.	36.0%	39.9%	8.4%	1.1%	7.9%	6.7%	0.0%	0.0%	100%	**178**
Hwy. 20 (Chinden Blvd.)	31.6%	51.9%	1.4%	3.7%	3.7%	6.8%	0.9%	0.0%	100%	**351**
Hwy. 44 (State St.)	21.3%	54.0%	4.2%	7.1%	6.7%	5.4%	1.3%	0.0%	100%	239
Hwy. 16 (Emmett Hwy .)	22.1%	50.5%	2.2%	8.5%	5.2%	8.0%	3.5%	0.0%	100%	503
Hwy. 55 (Horseshoe Bend Rd.)	33.3%	36.3%	1.6%	7.2%	2.3%	11.8%	7.5%	0.0%	100%	305

3. DESTINATION TRIP TYPE

Site Location	Home	Work	School	Medical	Recreational	Shopping	Other	No Response	Total	Number of Responses
Franklin Rd.	37.7%	29.2%	2.7%	3.9%	12.5%	10.5%	3.5%	0.0%	100.0%	257
Kuna Rd.	72.5%	13.6%	3.3%	7.6%	0.0%	3.0%	0.0%	0.0%	100.0%	66
Ustick Rd.	38.0%	31.1%	3.4%	3.4%	17.2%	0.0%	6.9%	0.0%	100.0%	29
l-84 @ Canyon County	51.7%	32.1%	2.7%	2.3%	7.1%	2.9%	1.2%	0.0%	100.0%	2,222
l-84 @ Elmore County	57.3%	22.7%	1.0%	4.3%	9.4%	2.4%	2.9%	0.0%	100.0%	418
Hwy. 21	74.8%	8.2%	2.0%	0.0%	11.6%	2.7%	0.7%	0.0%	100.0%	147
Amity Rd.	54.5%	15.7%	3.9%	5.1%	12.4%	6.7%	1.7%	0.0%	100.0%	178
Hwy. 20 (Chinden Blvd.)	52.7%	29.6%	1.7%	2.0%	6.3%	6.0%	1.7%	0.0%	100.0%	351
Hwy. 44 (State St.)	69.4%	17.2%	0.8%	1.7%	8.8%	1.3%	0.8%	0.0%	100.0%	235
Hwy. 16 Emmett Hwy.)	71.3%	18.3%	0.6%	1.4%	5.6%	1.8%	1.0%	0.0%	100.0%	503
Hwy. 55 (Horseshoe 3end Rd.)	56.1	20.3	0.7	1	16.3	1	4.6	0.0%	100.0%	305

4. FREQUENCY OF TRIPS

Site Location	5+ Times Per Week	3-5 Times Per Week	l-2 Times Per Week	l-2 Times Per Month	No Response	Total	Number of Completed Surveys
Franklin Rd.	45.1%	9.3%	15.6%	23.0%	7.0%	100.0%	257
Kuna Rd.	56.1%	18.2%	10.6%	13.6%	1.5%	100.0%	66
Ustick Rd.	34.5%	20.7%	13.8%	24.1%	6.9%	100.0%	29
I-84 @ Canyon County	46.0%	10.1%	12.9%	24.6%	6.4%	100.0%	2,222
l-84 @ Elmore County	32.3%	6.9%	9.3%	40.7%	10.8%	100.0%	418
Hwy. 21	52.4%	10.2%	10.2%	24.5%	2.7%	100.0%	147
Amity Rd.	38.8%	12.9%	16.3%	25.3%	6.7%	100.0%	178
Hwy. 20 (Chinden Blvd.)	46.3%	8.8%	14.2%	25.6%	5.1%	100.0%	351
Hwy. 44 (State St.)	45.6%	10.0%	15.1%	24.7%	4.6%	100.0%	239
Hwy. 16 (Emmett Hwy.)	49.5%	9.7%	11.7%	23.1%	6.0%	100.0%	503
Hwy. 55 (Horseshoe Bend Rd.)	21.2%	7.2%	21.2%	43.5%	6.9%	100.0%	305

5a. PERCENTAGE OF PEOPLE IN THE VEHICLE UNDER 16

Site Location	None	One	Two	Three	Four	Five	Six	six or more	No Response	Total	Number of Completed Surveys
Franklin Rd.	82.8	7.8	3.5	1.6	0.0	0.0	0.0	0.0	4.3	100	257
Kuna Rd.	69.7	13.6	6.1	3.0	1.5	0.0	0.0	0.0	6.1	100	66
Ustick Rd.	72.5	6.9	10.3	6.9	0.0	0.0	0.0	0.0	3.4	100	29
I-84 @ Canyon County	91.2	5.2	2.0	0.7	0.4	0.0	0.0	0.0	0.5	100	2,222
I-84 @ Elmore county	90.0	5.5	1.4	0.2	0.0	0.0	0.0	0.0	2.9	100	418
Hwy. 21	82.2	11.6	4.8	0.7	0.7	0.0	0.0	0.0	0.0	100	147
Amity Rd.	80.9	14.6	2.8	1.1	0.6	0.0	0.0	0.0	0.0	100	178
Hwy. 20 (Chinden Blvd.)	93.7	3.4	1.4	0.3	0.0	0.0	0.3	0.0	0.6	100	351
Hwy. 44 (State St.)	86.6	8.4	2.9	1.3	0.0	0.0	0.0	0.0	0.8	100	239
Hwy. 16 (Emmett Hwy.)	92.8	5.2	2.0	0.0	0.0	0.0	0.0	0.0	0.0	100	503
Hwy. 55 [Horseshoe Bend Rd.)	87.3	4.9	2.0	0.3	0.3	0.0	0.0	0.0	5.2	100	305

5b. PERCENTAGE OF PEOPLE IN THE VEHICLE OVER 16

Site Location	None	One	Two	Three	Four	Five	Six	six or more	No Response	Total	Number of Completed Surveys
Franklin Rd.	1.9	72.4	18.7	2.7	0.0	0.0	0.0	0.0	4.3	100	257
Kuna Rd.	3	71.2	18.2	0.0	0	1.5	0.0	0.0	6.1	100	66
Ustick Rd.	0.0	82.8	13.8	0.0	0.0	0.0	0.0	0.0	3.4	100	29
I-84 @ Canyon County	0.9	80.6	15.3	1.9	0.6	0.1	0.0	0.2	0.4	100	2,222
1-84 @ Elmore County	1.0	61.5	28.2	5.0	0.7	0.5	0.0	0.2	2.9	100	418
Hwy. 21	2.0	63.9	31.4	2.0	0.7	0.0	0.0	0.0	0.0	loo	147
Amity Rd.	0.0	78.6	19.7	1.7	0.0	0.0	0.0	0.0	0.0	loo	178
Hwy. 20 (Chinden Blvd.)	0.0	78.0	19.4	1.4	0.3	0.0	0.0	0.3	0.6	100	351
Hwy. 44 (State St.)	1.7	72.8	21.8	2.1	0,8	0.0	0.0	0.0	0.8	100	239
Hwy. 16 Emmett Hwy.)	0.6	72.9	22.7	2.6	0.6	0.4	0.2	0.0	0.0	100	503
Hwy. 55 Horseshoe Bend Rd.)	1.0	56.9	31.7	3.6	1.3	0.3	0.0	0.0	5.2	100	305

6. TRIP TRAVEL TIME IN MINUTES

Site Location	10	20	30	40	50	60	70	80	90 to 120	130 to 160	170 to 200	210 or more	No Response	Total	No. of completed Surveys
Franklin Rd.	1.6%	24.1%	19.8%	9.3%	0.8%	3.1%	0.0%	0.4%	3.9%	0.0%	0.0%	0.4%	36.6%	100%	257
Kuna Rd.	4.5%	28.9%	21.2%	22.7%	3.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.5%	1.%	16.7%	100%	66
Ustick Rd.	0.0%	6.9%	20.8%	6.9%	0.0%	3.4%	0.0%	0.0%	6.8%	0.0%	0.0%	0.0%	55.2%	100%	29
I-84 @ Elmore County	0.1%	3.1%	32.2%	18.6%	2.9%	4.5%	0.9%	0.3%	3.4%	0.7%	0.9%	0.9%	31.5%	100%	2,222
I-84 @ Elmore County	0.0%	0.0%	2.2%	18.9%	17.5%	16.3%	5.7%	1.4%	12.4%	5.3%	5.0%	8.6%	6.7%	100%	418
Hwy. 21	0.0%	0.0%	11.6%	37.3%	12.9%	18.4%	3.4%	2.7%	5.5%	0.%	1.4%	0.7%	6.1%	100%	147
Amity Rd.	0.0%	12.4%	25.3%	11.2%	0.6%	3.4%	0.6%	0.6%	3.9%	1.1%	0.0%	0.6%	40.3%	100%	178
Hwy. 20 (Chinden Blv.)	0.9%	2.8%	29.5%	23.4%	3.4%	5.7%	0.9%	0.3%	4.3%	0.6%	2.0%	0.3%	25.9%	100%	351
Hwy. 44 (State St.)	2.1%	5.4%	23.0%	29.8%	4.2%	5.0%	0.4%	0.4%	6.7%	0.8%	0.0%	1.3%	20.9%	100%	239
Hwy. 16 (Emmett Hwy.)	0.0%	1.2%	14.3%	39.7%	18.5%	10.5%	1.2%	0.6%	3.8%	0.6%	1.8%	2.2%	5.6%	100%	503
Hwy. 55 (Horseshoe Bend Rd.)	0.0%	0.0%	3.6%	11.4%	6.9%	7.2%	11.0%	4.2%	19.4%	11.5%	4.3%	7.8%	2.3%	100%	305

Appendix J
Incentive/Informational Letters

CHECK HOW WELL YOUR CAR'S ENGINE IS PERFORMING WITH A
FREE EMISSIONS TEST

TO:

Vehicle Description
License:
Year:
Make:
Discount valid only for this vehicle

Dear Vehicle Owner:

On your vehicle described above was observed crossing the Ada County line and became a part of an important traffic survey of inter-county traffic being conducted by the Idaho Transportation Department. You should already have received a survey form requesting information on the travel you were performing. I hope you have taken the time to fill out and return the form as it is important for future planning efforts in Southwestern Idaho.

The equipment used to identify your vehicle also has the capability to measure the levels of carbon monoxide pollutants coming from each vehicle. <u>We are not going to use this data for any enforcement action against vehicles producing high levels of pollution.</u> However, since high emissions of carbon monoxide indicate poor vehicle fuel efficiency and possibly reduced engine life, we felt it was important that owners of high emitting vehicles be made aware of the condition. Your vehicle was one of the vehicle apparently in need of adjustment or repairs.

Since any efforts to improve the performance of your vehicle would help us to improve air quality in Ada County we are offering you an incentive to get the vehicle repaired. If you present this letter, on or before , to any of the idle emissions testing facilities in Ada County they will give you a free emissions test worth up to $12.00. This is an excellent way to see just how well your vehicle is operating since it can only pass an emissions test if it is tuned up properly. (Free inspection offer void after date shown above.)

Finally, let me restate that no enforcement action can or will be taken as a result of this measurement of your vehicle's emissions. We merely felt it was in both your and our interest to bring this to your attention and request your help in reducing the emissions of pollutants in our air. If you have any questions or we can provide any further information on this program, please call the Air Quality Board at 345-9191.

GET $20.00 OFF THE PRICE OF AN ENGINE TUNE-UP

CARE ABOUT AIR

TO:

Vehicle Description
License:
Year:
Make:
Discount valid only for this vehicle

Dear Vehicle Owner:

On your vehicle described above was observed crossing the Ada County line and became a part of an important traffic survey of inter-county traffic being conducted by the Idaho Transportation Department. You should already have received a survey form requesting information on the travel you were performing. I hope you have taken the time to fill out and return the form as it is important for future planning efforts in Southwestern Idaho.

The equipment used to identify your vehicle also has the capability to measure the levels of carbon monoxide pollutants coming from each vehicle. <u>We are not going to use this data for any enforcement action against vehicles producing high levels of pollution.</u> However, since high emissions of carbon monoxide indicate poor vehicle fuel efficiency and possibly reduced engine life, we felt it was important that owners of high emitting vehicles be made aware of the condition. Your vehicle was one of the vehicle apparently in need of adjustment or repairs.

Since any efforts to improve the performance of your vehicle would help us to improve air quality in Ada County we are offering you an incentive to get the vehicle repaired. If you present this letter, on or before , to any of the repair facilities listed below they will give you $20.00 off their regular price for an engine tune-up. (Discount offer void after date shown above.)

Finally, let me restate that no enforcement action can or will be taken as a result of this measurement of your vehicle's emissions. We merely felt it was in both your and our interest to bring this to your attention and request your help in reducing the emissions of pollutants in our air. If you have any questions or we can provide any further information on this program, please call the Air Quality Board at 345-9191.

REPAIR FACILITIES HONORING THIS CERTIFICATE:

PLEASE HELP US KEEP OUR AIR CLEAN

TO:

Vehicle Description
License:
Year:
Make:

Dear Vehicle Owner:

On your vehicle described above was observed crossing the Ada County line and became a part of an important traffic survey of inter-county traffic being conducted by the Idaho Transportation Department. You should already have received a survey form requesting information on the travel you were performing. I hope you have taken the time to fill out and return the form as it is important for future planning efforts in Southwestern Idaho.

The equipment used to identify your vehicle also has the capability to measure the levels of carbon monoxide pollutants coming from each vehicle. We are not going to use this data for any enforcement action against vehicles producing high levels of pollution. However, since high emissions of carbon monoxide indicate poor vehicle fuel efficiency and possibly reduced engine life, we felt it was important that owners of high emitting vehicles be made aware of the condition. Your vehicle was one of the vehicle apparently in need of adjustment or repairs.

We hope you will have your vehicle checked out, and if necessary repaired or adjusted, thereby reducing its emissions of pollutants. One possible way to do this is to drop by one of our emissions testing stations for an emissions test. For $12.00 or less you can get a diagnostic analysis of your vehicle's performance and many times the emissions technician can make FREE adjustments which will reduce emission of pollution and increase your vehicle's fuel efficiency.

Finally, let me restate that no enforcement action can or will be taken as a result of this measurement of your vehicle's emissions. We merely felt it was in both your and our interest to bring this to your attention and request your help in reducing the emissions of pollutants in our air. If you have any questions or we can provide any further information on this program, please call the Air Quality Board at 345-9191.

Appendix K
Attornery Genekal's Letter

ADA PLANNIING ASSOCIATION

APR 17 1995

STATE OF IDAHO
OFFICE OF THE ATTORNEY GENERAL
STATEHOUSE, ROOM 210
P.O. Box 83720
BOISE 83720-0010

ALAN G. LANCE
ATTORNEY GENERAL

Telephone (208) 334-2400
Fax (208) 334-2530
Criminal Law Division
Fax (208) 334-2942
Natural Resources Division
Fax (208) 334-2690

April 14, 1995

Via Facsimile 345-5279 and 384-4420
and regular U.S. Mail

Brent Coles, Chairman
Ada Planning Association Board of Trustees
413 W. Idaho, Suite 100
Boise, Idaho 83702

Dear Mayor Coles:

The Attorney General recently received a letter from Clair Bowman concerning a proposed questionnaire that the Ada Planning Association wishes to send to selected motor vehicle users throughout Ada County. Apparently, motor vehicle owners would be selected by placing a remote video-tape camera on selective roadways. The Ada Planning Association would then use the license plate number recorded on the video-tape along with information from the Depamnent of Transportation, to determine the owner's address. The owner would then be sent a questionnaire the Ada Planning Association. The question presented was whether or not this violates the vehicle owner's right of privacy.

It does not appear that any constitutionally recognized right to privacy would be violated by this method of gathering data. Whether or not the Ada County Planning Association wishes to do this is solely a policy decision.

If you have any questions, or would like to discuss this matter further, please do not hesitate to call upon me.

Yours very truly,

Wm A. von Tagen

WILLIAM A. VON TAGEN
Director, Governmental and
Public Affairs

Appendix L
Public Acceptance Survey Tables

The following tales correspond to the graphic figures in the institutional, legal and public acceptance section (i.e., starting with Figure 2 in this final report). The Public Acceptance survey was conducted by a private research consultant. The consultant prepared a report, Remote Sensing Device Testing Program Survey which summarized the results of the survey.

The stakeholder surveys were conducted by APA and the results are incorporated into this document.

Serious Rating of Invasion	
	Percent
Extremely	18.0
Very	21.2
Somewhat	43.9
Not Very	15.9
Unsure	1.0
Total	100.0
Public Acceptance Survey Number of Respondents = 189	

Figure 2

Most Serious Invasion	
	Percent
Video License plate	50.3
Name from DMV	41.3
Sending survey	2.1
Don't Know	6.3
Total	100.0
Public Acceptance Survey Number of Respondents = 189	

Figure3

Intrusive to Use – Prior to Operational Test (in Percent)			
	Yes	**No**	**No Opinion**
Ada Co. Officials	4.0	8.0	1.0
Non-Ada Co. Officials			27.1
Ada Co. Other	6.0	15.0	0.0
Non-Ada Co. Other	6.0	25.0	4.0
Total	20.0	71.0	9.0
Stakeholder Survey #1 Number of Respondents = 142			

Figure 4

Intrusive to Use – After Operational Test (in Person)			
	Yes	**No**	**No Opinion**
Ada Co. Officials	11.0	11.0	4.0
Non-Ada Co. Officials	8.0	11.0	4.0
Ada Co. Other	11.0	21.0	0.0
Non-Ada Co. Other	0.0	7.0	7.0
Unknown Officials	0.0	0.0	7.0
Total	30.0	50.0	20.0
Public Acceptance Survey Number of Respondents = 28			

Figure 5

Importance – Monitoring Air Quality	
	Percent
Extremely	22.4
Very	45.4
Somewhat	25.5
Not Very	4.4
Not	2.1
Unsure	0.2
Total	100.0
Public Acceptance Survey Number of Respondents = 811	

Figure 6

Importance – Collecting Travel Data	
	Percent
Extremely	16.9
Very	44.6
Somewhat	27.3
Not Very	5.7
Not	2.3
Unsure	3.2
Total	100.0
Public Acceptance Survey Number of Respondents = 811	

Figure 7

Provide Best Travel Information	
	Percent
RSD Method	59.8
Stop & Ask Method	27.1
Neither	2.0
Other	2.7
Don't Know	8.4
Total	100.0
Public Acceptance Survey Number of Respondents = 811	

Figure 8

Improve air Quality	
	Percent
RSD Method	49.2
Stop & Ask Method	32.1
Neither	2.2
Other	3.1
Don't Know	13.4
Total	100.0
Public Acceptance Survey Number of Respondents = 811	

Figure 9

Inconvenience to Motorist	
	Percent
Yes	10.4
No	89.2
Don't Know	0.4
Total	100.0
Public Acceptance Survey Number of Respondents = 278	

Figure 10

Safety Hazard	
	Percent
Yes	19.8
No	78.4
Don't Know	1.8
Total	100.0
Public Acceptance Survey Number of Respondents = 278	

Figure 11

Convenient Way to Gather Travel Data		
	Number	**Percent**
Very	13	47.0
Somewhat	5	18.0
Convenient	6	21.0
Somewhat Less	2	7.0
Not at All	2	7.0
Total	28	100.0
Stakeholder Survey #2 Number of Respondents =28		

Figure 12

Convenient Way to Monitor Emissions		
	Number	**Percent**
Very	15	54.0
Somewhat	4	14.0
Convenient	6	21.0
Somewhat Less	2	7.0
Not at All	1	3.0
Total	28	100.0
Stakeholder Survey #2 Number of Respondents = 28		

Figure 13

Type of Survey Method Preference	
	Percent
RSD Method	86.3
Stop & Ask Method	7.3
Neither	2.8
Other	1.1
Don't Know	2.5
Total	100.0
Public Acceptance Survey Number of Respondents = 811	

Figure 14

Encourage Survey Participation	
	Percent
RSD Method	77.5
Stop & Ask Method	15.3
Neither	1.8
Other	1.8
Don't Know	3.6
Total	100.0
Public Acceptance Survey Number of Respondents = 811	

Figure 15

Type of Emissions Inspection Preference	
	Percent
RSD Method	71.8
Inspection Stations	17.0
Neither	2.1
Other	2.7
Don't Know	6.4
Total	100.0
Public Acceptance Survey Number of Respondents = 811	

Figure 16

Encourage Emission Testing Support	
	Percent
RSD Method	82.7
Inspection Test	11.8
Neither	0.9
Other	1.1
Don't Know	3.5
Total	100.0
Public Acceptance Survey Number of Respondents = 811	

Figure 17

Travel Survey: Perception of Public Preference				
	Percent			
	RSD	Traditional	No Opinion	None
Ada Co. Officials	4.0	4.0	4.0	2.0
Non-Ada Co. Officials	17.0	5.0	4.0	4.0
Ada Co. Other	10.0	5.0	3.0	2.0
Non-Ada Co. Other	21.0	5.0	4.0	6.0
Total	52.0	19.0	15.0	14.0
Stakeholder Survey #1 Number of Respondents = 135				

Figure 18 – Stakeholder Survey #1

Travel Survey: Perception of Public Preference				
	Percent			
	RSD	Traditional	No Opinion	None
Ada Co. Officials	11.0	11.0	25.0	14.0
Non-Ada Co. Officials	14.0	14.0	7.0	0.00
Unknown	4.0	0.0	0.0	0.0
Total	29.0	25.0	32.0	14.0
Stakeholder Survey #2 Number of Respondents = 28				

Figure 19 – Stakeholder Survey #2

Emissions Monitoring: Perception of Public Preference				
	Percent			
	RSD	Traditional	No Opinion	None
Ada Co. Officials	6.0	4.0	1.0	4.0
Non-Ada Co. Officials	17.0	5.0	4.0	3.0
Ada Co. Other	11.0	6.0	2.0	3.0
Non-Ada Co. Other	16.0	8.0	3.0	7.0
Total	50.0	23.0	10.0	17.0
Stakeholder Survey #1 Number of Respondents = 131				

Figure 20 – Stakeholder Survey #1

Emission Monitoring: Perception of Public Preference				
	Percent			
	RSD	Traditional	No Opinion	None
Ada Co. Officials	32.0	4.0	7.0	18.0
Non-Ada Co. Officials	18.0	14.0	4.0	0.0
Unknown	4.0	0.0	0.0	0.0
Total	54.0	18.0	11.0	18.0
Stakeholder Survey #2 Number of Respondents = 28				

Figure 21 – Stakeholder Survey #2