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Oregon Green Light CVO Evaluation

Detailed Test Plan # 1

Measure 1.1.1 Examine changes in proportion of trucks compliant with Federal Motor Carrier Safety Regulations (FMCSR) within Oregon

Measure 1.1.2 Assess Green Light's effect on targeting procedures at sites incorporating electronic screening

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1 DETAILED TEST INTRODUCTION

1.1 BACKGROUND

This Detailed Test Report is the first of 13 test reports that will be submitted as part of the independent technical evaluation of the Oregon Green Light CVO project. The Oregon Department of Transportation (ODOT) is in the process of implementing their Intelligent Vehicle Highway System Strategic Plan for Commercial Vehicle Operations (now referred to as ITS/CVO). Through Green Light, Oregon is installing twenty-two mainline preclearance systems featuring weigh-in-motion (WIM) devices and automatic vehicle identification (AVI) at the major weigh stations and ports-of-entry throughout the state. In addition, certain sites will be equipped with data collection systems for use in regulatory enforcement (ITEN sites) while other sites will be equipped with safety enhancements that regulate road conditions and speed.

The purpose of these documents is to provide detail to procedures taken when testing the various measures proposed in the Green Light Evaluation. The Detailed Test Plans will cover all of the test measures described in Exhibit 2-1 of The Oregon “Green Light” CVO Project - Evaluation Plan [1].

Each of the tests conducted by the research team for the evaluation of Green Light will address one of five goals of the evaluation as documented in the Evaluation Plan. These are:

- Assessment of Safety
- Assessment of Productivity
- Assessment of User Acceptance
- Assessment of Mainstreaming Issues
- Assessment of Non-Technical Interoperability Issues

The objectives associated with each goal are given in detail in The Oregon "Green Light" CVO Project - *Individual Test Plans* (ITP) [2]. In addition, condensed one-page tables are contained in the appendices of the ITP, outlining the measures to be conducted for each of the stated objectives. The detailed test plan documents will expand on the information provided in the ITP and provide in detail the activities carried out for each *evaluation measure* during the course of the evaluation in regards to the stated objectives.

1.2 PURPOSE AND SCOPE

This particular detailed test plan outlines the test measures employed to obtain the objective *determining change in safety compliance*, one of three objectives in support of the goal of assessing safety. Like the accompanying Detailed Test Plans, this document is not meant to be exclusive of the ITP, but rather an extension of that document to provide scope and direction for the research team.

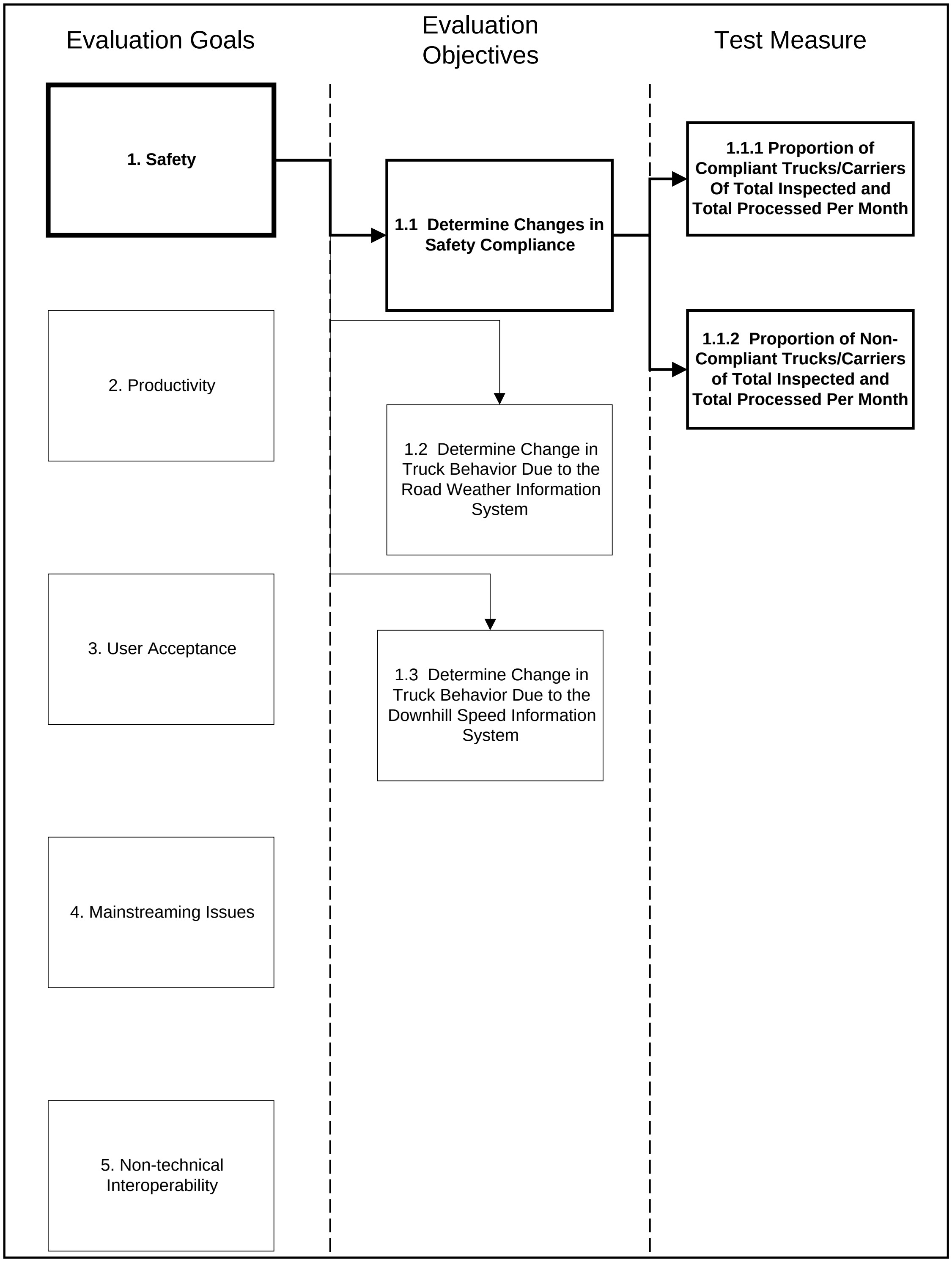
The evaluation measures used to determine change in safety compliance are stated below:

- **1.1.1 Examine changes in proportion of trucks compliant with Federal Motor Carrier Safety Regulations (FMCSR) within Oregon.**
- **1.1.2 Assessment of targeting procedures at sites incorporating electronic screening.**

A description of the hypothesis to be tested as well as the test methodology and deliverables is described in detail in Chapter 2. Chapter 3 provides a detailed test schedule and budget for the test measure.

The scope of this detailed test plan within the context of the overall Green Light Evaluation is shown in Exhibit 1-1. The test measures outlined in this document are highlighted for reference.

Exhibit 1-1 Evaluation Goals, Objectives, and Measures

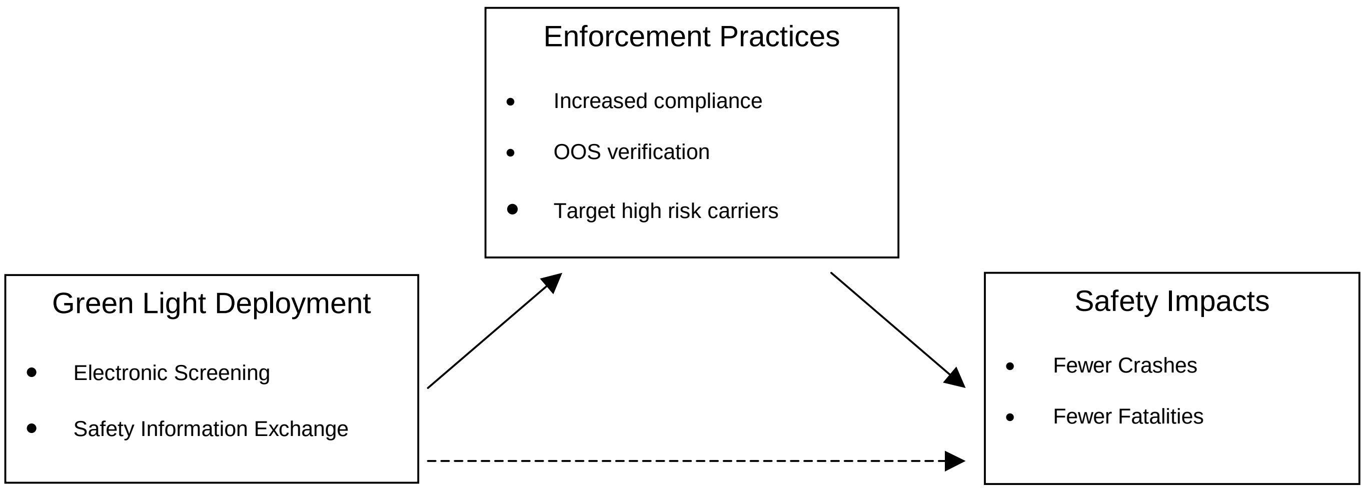


1.3 BACKGROUND

According to the Federal Highway Administration's (FHWA's) Office of Motor Carriers (OMC), over 150,000 trucks (including commercial and private vehicles) were involved in highway accidents in 1994 [*1994 Truck and Bus Accident Fact Book*, October 1996]. These accidents caused injuries to 110,000 persons and resulted in 5,500 deaths. To combat this problem, state and federal agencies employ various strategies such as stricter enforcement of traffic laws, improving vehicle and highway designs, and developing and using on-board safety systems (e.g., driver warning systems). For commercial vehicles, the strategy also includes improved enforcement of Federal Motor Carrier Safety Regulations (FMCSR) and Hazardous Materials Regulations (HMR). In 1996, OMC estimated that 32 percent of the vehicles traveling the nation's highways are out of compliance with applicable commercial vehicle regulations [*OMC National Fleet Safety Survey*, 1996]. Green Lights use of roadside screening is expected to have significant impacts on roadside safety enforcement practices. In particular, Green Light will result in more efficient enforcement operations, increased compliance with safety regulations, and, ultimately, safer highways.

The main focus of this study will be on the relationship between Green Light deployment and its impact on enforcement practices. The relationship between enforcement practices and safety impacts (i.e., reduced crashes and fatalities) also needs to be established to link safety benefits to the deployment of Green Light. Results from the literature, as well as new analyses, will help determine this relationship. This two-step approach is illustrated in Exhibit 1-2. The third relationship (indicated by the dashed line between Green Light deployment and safety impacts) will also be studied using empirical methods. However, this approach has significant challenges because the Green Light -related reduction in crashes and fatalities is expected to be small compared to the impacts of other factors (e.g., weather, road construction, traffic changes).

Exhibit 1-2 Relationships Between Green Light Deployment, Enforcement Practices, and Safety Impacts.



Green Light technologies are expected to help improve compliance with safety regulations in two ways both resulting from increased effectiveness of roadside inspection operations. The direct, but smaller, impact is the removal of unsafe drivers and vehicles from the highways. It is anticipated that the screening and safety information exchange technologies will allow inspectors to rapidly select commercial vehicles for inspection based on the carrier's safety record. Also, on-line access to driver violation records and results of recent truck inspections will help target unsafe drivers and trucks.

The indirect effect, which is expected to be much larger, is that drivers and carriers will modify their behavior to avoid inspections. Specifically, it is assumed that carriers will expend more resources to ensure that their vehicles stay in compliance. Carriers with good safety records (low risk) will have a small probability of being inspected. High-risk carriers will try to improve their safety rating to avoid increased inspections. Of course, if Green Light does not help inspectors target the high-risk carriers, there will not be any *added* incentive for a carrier to maintain a good safety rating.

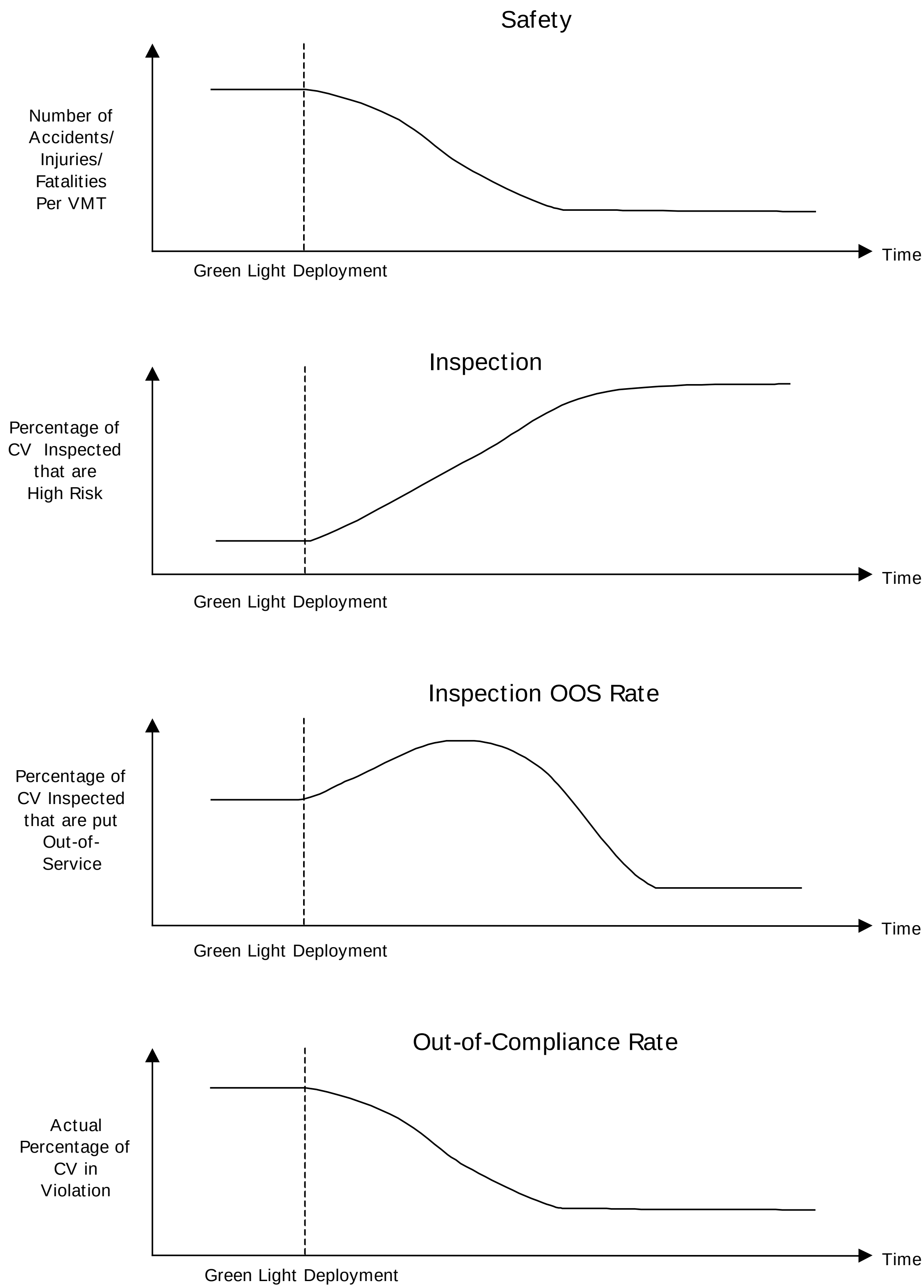
The impacts of Green Light on safety will be difficult to quantify. In fact, these impacts will probably take effect over a long period of time. Initially, the high-risk carriers must perceive an increase in the cost of doing business resulting from increased fines and more frequent delays at roadside inspection sites. The hypothesis is that these operators will then adjust their safety program in order to improve compliance rates. Of course it is possible that they will, instead, choose to employ avoidance tactics. This impact also needs to be investigated. Assuming that a high-risk carrier chooses to improve its safety program, the improvement in compliance rates will eventually result in improved safety performance.

Estimating the impact of Green Light in terms of safety simply by analyzing accident data is not feasible for a number of reasons. First, because accidents are rare events, their associated consequences (property damage, etc.) are highly variable, and therefore may provide limited evidence of a change from a short period of deployment and evaluation. Second, even if an effect is measured, it may be difficult to attribute the effect to the introduction of the technology.

Using compliance rates as a surrogate for accident rates will help to address both of these issues. Estimating compliance rates is much more feasible than estimating rates of accidents that are attributable to safety violations. Also, the hypothesis that Green Light affects safety by improving motor carrier compliance can be tested separately.

Exhibit 1-3 qualitatively illustrates the relationships among key data elements in this approach. The first panel shows a decrease in the number of accidents, injuries, and fatalities that is anticipated following the deployment of Green Light. However, in order to infer that an observed decrease in accidents was caused by the deployment of Green Light, a more detailed analysis of the process is required. It is anticipated that the deployment of the electronic clearance components of Green Light will improve compliance enforcement through better targeting of high-risk carriers and more efficient use of inspection resources. Thus, as illustrated in the second panel, it is expected that there will be an increase in the percentage of vehicles inspected that belong to high-risk carriers. High-risk in this context refers to carriers that are more likely than others to be put out of service (OOS) for failing to comply with the FMCSR. Alternative definitions of high-risk carriers based on accident and fatality rates will also be investigated. The third panel reflects how the percentage of vehicles that are put OOS is expected to rise initially because of the improved targeting of high-risk carriers. Eventually, the carriers will modify their behavior to improve compliance. Thus, assuming that enforcement procedures do not change, the OOS rate is expected to decrease. The fourth panel shows how the out-of-compliance rate (percent of violators on the road) is expected to change. This decrease is then expected to result in the safety improvement.

Exhibit 1-3 Relationships Between Key Elements in the Green Light Safety Analysis



2 TEST METHODOLOGY

2.1 PHYSICAL DESCRIPTION

This section discusses in detail the activities carried out in the safety evaluation of the mainline preclearance systems installed in the state of Oregon under Green Light. The ultimate measures of safety include numbers of accidents, injuries, and fatalities. However, accidents are very rare events, and there are many factors that influence their occurrence. As a result, much of the evaluation of the safety impacts of Green Light is directed at measuring its impact on the processes that is expected to most directly affect. This section will describe two tests conducted for this portion of the evaluation:

1. Random Inspection Study - to measure the rate of compliance with the FMCSR
2. Screening Assessment Study – to measure how much of an effect Green light has on an inspector’s ability to target unsafe trucks

2.1.1 Random Inspection Study

The purpose of this test is to measure the rate of compliance with safety regulations by motor carriers traveling in the northern I-5 corridor in Oregon. This study will incorporate random selection of vehicles to ensure that the screening practices usually followed by the inspectors do not bias the compliance rate estimates. The random sampling conducted under this study is not intended to improve enforcement efficiency. Rather the results will be used to infer whether the advances introduced under Green Light result in reduced rates of violation by average carriers, thereby addressing the evaluation objective to determine whether Green Light has a positive impact on safety.

This test is designed to measure whether the new technologies introduced under Green Light help to deter violations of safety regulations. To measure this, we plan to test whether if there is a change in commercial vehicle safety violation rates. Towards this end, we would like to estimate the compliance rate of the commercial vehicle population at large – not only those that are targeted for inspection. This requires some degree of random inspection. The compliance rate study will be conducted along the northern I-5 corridor Oregon.

A survey design will be used to select sites, dates and times to conduct inspections, and to select vehicles at those sites for inspection. Two or three, month-long random inspection campaigns will be conducted six months apart. The first campaign will be conducted in January of 1998.

The data collected will be analyzed by standard survey methods, based on a random sample. Trends will be estimated, and comparisons will be made across sites and over time based on linear models.

Successful conduct of the test requires cooperation on the part of Oregon DOT Motor Carrier transportation Branch (MCTB) staff, both for the design and conduct of the test. MCTB staff support is crucial for characterizing Oregon's regular inspection program. Because MCTB staff will be involved in the conduct of the random inspections, understanding their normal operations is critical to the development of a feasible test plan. ODOT's acceptance of the random inspection schedule is required before the test can begin.

2.1.1.1 Assumptions and Constraints

Several assumptions and constraints are necessary in the design of the random sampling plan.

- The selected sites cover a network representing same truck compliance rate as the entire area.

- The volume counts made during the course of the inspections are representative of the traffic that passes that site.
- An assumption is made that the compliance rate during the night shift is the same as that during the "swing shift."

Some of the key constraints in Oregon are:

- Due to safety, inspections can only be conducted at night at the ports of entry. It will be necessary to assume that these locations have similar compliance properties with the other types of sites.
- Participants in Green Light are subject to scrutiny with regard to their safety status. Those meeting high safety standards may be enrolled as premium carriers or "Trusted Carrier Partners" . Upon meeting these qualifications the carriers are not subject to random selection – *at the Green Light (transponder reader) sites*. At the sites where all vehicles are recorded manually, basic enrollees can be included in the random selection process.

The test will be conducted in one-month intervals. At present two intervals of random inspection are planned. The first will be conducted during January of 1998. The test will be repeated every six months until the program is over. The schedule of random inspections planned for the first month is provided in Exhibit 2-1. The table is generated based on past inspections conducted in Oregon. For instance, if the vast majority of inspections are conducted at the ports-of-entry, this schedule will be generated so that the same proportion of randoms will be done at the ports-of-entry as well. Many of the selected sites will have conflicts, especially those sites that were randomly chosen for night inspections, but are not equipped. These sites will be changed to daytime inspections.

Those inspections that are conducted at non-fixed sites, i.e. Multnomah Co. and Yamhill Co., will be conducted at sites routinely chosen by the inspectors who work that area.

Exhibit 2-1 Site Selections For January 1998

Date of Shift	Site ID (Scale No)	Location	Day of Shift	Time of Shift
02JAN98	1404	Cascade Locks POE	Friday	Day
	3602	Dayton.	Friday	Day
06JAN98	2677	Multnomah Co.	Tuesday	Day
07JAN98	1404	Cascade Locks POE	Wednesday	Day
	2409	Woodburn POE	Wednesday	Day
	2677	Multnomah Co.	Wednesday	Day
08JAN98	0261	Blodgett, WB	Thursday	Day
	1404	Cascade Locks POE	Thursday	Day
			Thursday	Day
09JAN98	2408	Woodburn POE	Friday	Day
			Friday	Day
			Friday	Day
	1404	Cascade Locks	Friday	Day
	2677	Multnomah Co.	Friday	Day
10JAN98	2004	Lombard and N. Simmons	Saturday	Day
11JAN98	2409	Woodburn POE	Sunday	Day
12JAN98	1404	Cascade Locks POE	Monday	Day
13JAN98	2601	Rocky Point	Tuesday	Day
	2408	Woodburn NB	Tuesday	Night
	2409	Woodburn POE	Tuesday	Day
			Tuesday	Night
	3677	Yamhill Co.	Tuesday	Day
	2677	Multnomah Co.	Tuesday	Day
14JAN98	0261	Blodgett, WB	Wednesday	Day
	2409	Woodburn POE	Wednesday	Day
			Wednesday	Night
15JAN98	2409	Woodburn POE	Thursday	Day
			Thursday	Day
	0307	Brightwood, WB	Thursday	Day
	2601	Rocky Point	Thursday	Day
	2677	Multnomah Co.	Thursday	Night
16JAN98	304	Rock Creek	Friday	Night
	2677	Multnomah Co.	Friday	Day
	2409	Woodburn POE	Friday	Day
18JAN98	1404	Cascade Locks POE	Sunday	Day
19JAN98	2601	Rocky Point	Monday	Day
	2409	Woodburn POE	Monday	Day
			Monday	Day
20JAN98	2002	Walterville	Tuesday	Day
21JAN98	2002	Walterville	Wednesday	Day
	2205	Foster	Wednesday	Day
	2409	Woodburn POE	Wednesday	Day
22JAN98	2407	Hubbard	Thursday	Night
	1404	Cascade Locks POE	Thursday	Night

Date of Shift	Site ID (Scale No)	Location	Day of Shift	Time of Shift
	2409	Woodburn POE	Thursday	Day
			Thursday	Day
			Thursday	Night
23JAN98	2677	Multnomah Co.	Friday	Day
	2701	Eola	Friday	Day
25JAN98	2409	Woodburn POE	Sunday	Day
26JAN98	2409	Woodburn NB	Monday	Day
	2601	Rocky Point	Monday	Day
	3677	Yamhill Co.	Monday	Day
27JAN98	2601	Rocky Point	Tuesday	Night
28JAN98	2409	Woodburn POE	Wednesday	Day
29JAN98	0304	Rock Creek	Thursday	Day
	2409	Woodburn POE	Thursday	Day
			Thursday	Day
			Thursday	Day
			Thursday	Day

The Exhibit below provides a list of random non-fixed locations to inspect within Multnomah County and are randomly selected from a list of six locations provided by the Multnomah Co. inspectors. The two days assigned to non-fixed random inspections in Yamhill Co. should be chosen by the inspectors to reflect characteristics of vehicles using I-5 in the northwest corridor.

Exhibit 2-2 Specific Locations to Sample in Multnomah County

Date	Day	Time	Location
January 6	Tuesday	Day	Lombard and N. Simmons
January 7	Wednesday	Day	NE 223rd and NE Glisan
January 9	Friday	Day	NE Marine Drive and NE 223rd
January 10	Saturday	Day	Lombard and N. Simmons
January 13	Tuesday	Day	NE 223rd and NE Glisan
January 15	Thursday	Night	NE 223rd and NE Glisan
January 16	Friday	Day	NE 122nd and NE Inverness
January 23	Friday	Day	NE 122nd and NE Inverness

The primary supporting data used to design the study include:

- Oregon’s past inspection data, as downloaded from SafetyNet for the period October 1996 through September 1997. This was used to characterize their existing inspection program.
- A list of non-fixed inspection sites for Multnomah Co. that are indicative of truck travel in that county. Ideally, these inspection sites would be mutually exclusive and selectively exhaustive of trucks travelling in the county.
- Estimates of truck volume at the inspection locations in the northern I-5 corridor

2.1.2 Screening Assessment Study

The screening assessment study will be conducted to evaluate Green Light's effect on the targeting of vehicles for inspection. The efficiency of the vehicle selection process will be characterized before and after introduction of Green Light. This will be measured by estimating the proportion of high-risk vehicles that are inspected under both processes.

A sample of sites will be selected for data collection. At least two classes of sites will be evaluated before and after deployment of transponder technology:

1. Fixed scales only
2. WIM with bypass lanes

This experiment will involve characterizing operations as they are performed, without affecting them. This will entail going out to a collection of inspection sites at different times of the day and collecting information such as DOT numbers on vehicles entering the sites, or bypassing the sites in order to characterize the ability of the process to target high-risk carriers for inspection. Using MCMIS or a similar database, an examination of the inspection history of each vehicle will be reviewed.

2.1.3 Hypotheses

The following hypotheses are given in support of the two measures and will be tested according to accepted statistical techniques:

1.1.1 There is no change in rates of compliance with commercial vehicle safety regulations associated with the introduction of Green Light.

1.1.2 Targeting of trucks for inspection will not improve as a result of Green Light.

2.2 PRE-TEST ACTIVITIES

2.2.1 Description

Pre-test Activities for the test primarily involved developing a feasible sampling design for the random inspections. A briefing was given to Gregg Dal Ponte on October 15 to gain support for Oregon's involvement in the program.

The baseline data includes compliance data and will be obtained during the field test.

One of the concerns raised early on with conducting a random inspection study was the uniformity in the selection of vehicles and conduct of inspections. To alleviate this concern it was decided that, although five agencies conduct inspections in the northern I-5 corridor in Oregon, as few agencies as possible should be included in the inspection process. Almost all of the random inspections will be done by MCTB staff (motor carrier enforcement officers or MCEOs. Some non-fixed inspections will have to be conducted by Multnomah Co. staff.

The primary unit of hardware used in the test is a vehicle classifier that will be used to estimate truck traffic volume and a 486-66 MHz laptop computer for collecting the data on location. Two different classifiers will be used so that shifts occurring on the same day at different sites can be counted. These are the

- Diamond Products Traffic Tally 2001 Classifier and
- Timemark Corporation's Lamda Classifier

Both classifiers are being provided by ODOT's Research Division. 100 ft. of pneumatic tube will be purchased by OSU for use in the study. The classifiers are used in lieu of hand counting trucks to minimize the expenses of data collection and will be used at all fixed locations where ramp counters are not available. Each unit has its own software program for uploading and analyzing the binary files that are stored on the classifiers as well as RS232 cables for connecting the laptop computer to the portable units.

Battelle developed a sampling software program to help select a random sample of sites and another program to select the date and time of day to conduct the inspections. The sampling software had to be modified to take into account past inspection history in determining the selection probabilities at sites where inspections have been conducted, and use truck traffic volume to determine probabilities on the remaining links. In addition it gives the user the option of selecting the degree of emphasis that should be placed on past sites. The program then selects a stratified sample and prints to a file the selected links in order that a report can be quickly generated for review with ODOT.

2.2.2 Scope of Survey

Although about 30,000 inspections are conducted on trucks throughout Oregon each year, it was decided that the desired information could probably be obtained from a corridor study, provided that enough data could be collected there.

Using the information obtained about where most of the inspections were done and by whom, and using judgement to identify sites that could be used to characterize compliance characteristics of vehicles traveling in the I-5 corridor, a geographic scope was decided upon. This scope is illustrated in Figure 1. One-month long random inspection campaigns are expected to be conducted every six months for at least three campaigns.

The determination of a number of random inspections to conduct involved a tradeoff of desired precision with the impact that a random campaign would, itself, have on compliance characteristics. Specifically, the CVISN deployment introduces technologies that are supposed to improve the state's vehicle selection protocols – and supposedly, this will have a deterrence effect on violators. Random inspections displace targeted inspections, and conducting too many random inspections might have its own effect on compliance rates. This would obscure the effect of CVISN on compliance rates.

Therefore, it was decided that no more than 10 percent of the inspections conducted in the region of interest during the course of a year should be devoted to the evaluation because of the potential impact on operations. In the targeted corridor, this means that about 600 to 700 random inspections should be performed per year as part of the evaluation. With two campaigns per year, this reduces to 300 to 350 per campaign.

2.2.3 Sampling Design

To enable an inference that is representative of all the sites within the geographic scope illustrated in Figure 1, a random sample of sites must be identified for conduct of inspections. In addition, it is necessary that all sites within that region have a positive, known probability of being selected. However, it is neither necessary nor practical to give each location the same probability of selection. Sites where several inspections are conducted can be emphasized, and sites where inspections are conducted only rarely can be included with only very low probability and still achieve an unbiased estimate of the true compliance rate.

The following is a detailed description of the approach used to stratify the region and select sites, dates, and times of day for conducting inspections.

The 48 sites in the northern I-5 corridor were divided into four strata: Ports of Entry (POEs), Green Light sites, fixed non-GL sites, and non-fixed sites. Based on the historical allocation of inspections to these strata, Exhibit 2-2 illustrates the allocation of random inspections to these strata for the first campaign.

Exhibit2-3 Allocation of Inspections to Strata

Stratum	Inspections conducted 10/1/96 through 9/30/97	Planned Random Inspections for January, 1998
Ports of Entry	3381	32
Green Light Sites	793	8
Fixed Sites (non-GL)	932	10
Non-Fixed Sites	954	10

Exhibit 2-1, on page 20, reflects the schedule of random inspections that was planned for the month of January, 1998, developed based on the algorithms described above. There were slight departures resulting from weather and illness, but it was mostly adhered to.

Training was not necessary, except clear communication of the requirements to the inspectors from their managers (Owen Herzberg, John Stockton, Shirley Gardipee).

2.3 TEST CONDUCT ACTIVITIES

2.3.1 Participants

John Kinateder , Battelle –is the safety study area leader for the CVISN evaluation, and is the person primarily responsible for designing and conducting the test, assembling the data package, performing the analysis, and writing the test results document.

Paul Montagne, OSU – Data Collection and safety study leader for the Green Light Evaluation and is responsible for leading all of the field work and data collection needed for this test.

Harry Eubanks, ODOT – will provide historical inspection data used in the design, as well as the results from the random inspections.

Owen Herzberg, ODOT – the point of contact at ODOT will provide concurrence on scheduling and locations; needs to identify staff to conduct inspections

Eric Brooks, ODOT– will provide OSU with classifiers

ODOT is responsible for conducting the random inspections according to the schedule supplied to them.

Paul Montagne is responsible for overseeing the random inspection effort, ensuring that correct procedures are being followed by inspectors, looking for inconsistencies between inspectors and sites. He is also responsible for determining means of obtaining volume counts at all sites. This may be done by manual counts, portable automated classifier, or in-line classifier.

Staff are required for conducting counts at sites where it is impossible to obtain an automated vehicle count.

300 to 350 random inspections will be conducted during each month of the test. Two to three

months of inspections will be conducted, depending on the resources available. Daytime inspections are to be conducted during first shift. Night time inspections are to be conducted during night or swing shifts.

Three different methods will be used for collecting volume counts at the inspection sites. These are:

1. WIM Scale Data- Ports of Entry have weigh-in-motion (WIM) devices located on the freeway exit ramps, that count any truck approaching the scale.
2. Hand Counting- Several of the non-fixed locations will be drawing truck traffic from both travel lanes or from an intersection of two roads. In this case students will be used to count trucks that have the opportunity to be selected for inspection.
3. Portable Classifiers- Wherever possible, portable classifiers will be used to track inspectable trucks passing the inspection site. Pneumatic tubes placed across the lanes of travel use the pulses of passing vehicles as an identifier of vehicle type.

<u>WIM Scale Data</u>

This method will be used at the Woodburn POE, Woodburn NB, and Cascade Locks POE for all of the shifts scheduled there. The WIM device located on the ramp approaching the scale house is used as a sorter mechanism to divert traffic back to the freeway based on weight. The WIM sorter also counts the number of vehicles passing over the device so ODOT can determine the number of vehicles bypassing the scale house. The inspectors will simply record the number at the beginning of their first inspection and the number at the end of their last inspection. Subtracting the two gives the total number of trucks that passed the scale and were available for inspection over the course of the shift.

<u>Hand Counting</u>

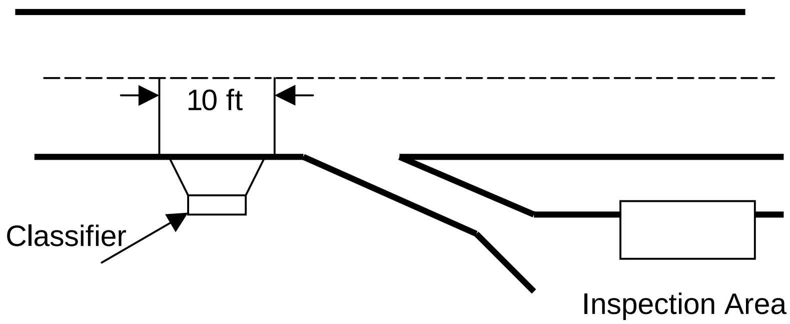
Hand counting will be conducted at those sites where a portable classifier cannot be used. This is normally the case at non-fixed sites where trucks are selected from traffic travelling in both directions or from an intersection. In this case students from OSU will travel to the inspection site and count traffic using a hand counter while the inspections are conducted.

Portable Classifiers

Two different portable classifiers will be used for data collection. The first is a Traffic Tally 2001 classifier built by Diamond Products. The second is a Lamda classifier made by Timemark Inc. Both use the same 13 vehicle classification system as suggested by FHWA.

The process of setting up the classifier and collecting the data involves finding a safe site as close to the off ramp as possible, fixing the pneumatic hoses to the pavement, and programming the classifier using a laptop computer or the touchpad resident on the classifier. The classifier is then removed at the end of the shift, and data is downloaded from the classifier onto a laptop for processing. The classifiers run on rechargeable batteries and are capable of holding several days of raw data in their internal memory before downloading is necessary. A typical set up is shown below.

Figure 2-1 Typical Classifier Layout



Hoses were set into the asphalt using 2.5" PK nails, driven into the pavement with a hammer. The ends of the hoses typically were fixed at the yellow center line (as shown above). All of the necessary precautions were taken in this endeavor. Traffic cones and reflective clothing were used to make the area as conspicuous as possible.

In the case of four-lane highways, only the right lane was monitored for truck traffic. This did not present any problems as all of the weigh stations have signs typically ½ to 1 mile upstream from the exit ramp stating that the weigh station is open. Trucks will naturally be travelling in the right lane as they prepare to exit.

2.4 POST-TEST ACTIVITIES

2.4.1 Reporting Procedures for Individual Test

A report will be prepared for these test measures according to the guidelines given in the Evaluation Plan and will proceed as follows:

1. Preparation of a draft report for each test to be submitted to the steering committee (SC) for their approval.
2. Approval of the SC at a scheduled meeting.
3. Preparation of a final test report, incorporating SC recommendations.
4. Submittal of 1 hardcopy original, 1 electronic original, and ten bound copies of the report to ODOT's project management team.
5. Transmittal of the report by ODOT to FHWA.

2.4.2 Reporting Schedule

The reporting schedule for the individual test reports is shown below:

Exhibit 2-2 Reporting Schedule - Individual Test Reports

Deliverables	Schedule	Scheduled Due Date*
Drafts of Individual Test Reports	July 1-August 30, 1999 (60 days)	September 1, 1999
Review of Individual Test Reports by Steering Committee	September 1-30, 1999 (30 days)	October 1, 1999
Final Test Reports	October 1-November 30, 1999 (60 days)	December 1, 1999

2.4.3 Data Retention/Archival Procedures

Data collected and documents produced over the course of the evaluation will be archived and submitted to ODOT project management. In addition, a document summarizing the data and reports will be produced as follows:

1. Preparation of a summary document describing data analyzed and reports prepared over the course of the evaluation.
2. Submittal of a data archive containing raw data files and all reports in compressed format.

2.4.4 Reporting Schedule for Data Retention/Archival Procedures

The reporting schedule for the archiving of data and the preparation of a summary document is given below:

Exhibit 2-3 Reporting Schedule - Data Archiving

Deliverables	Schedule	Scheduled Due Date*
Drafts of a Data Summary Report	Dec 1, 1999 - Jan 30, 2000 (60 days)	February 1, 2000
Review of Data Summary Report by Steering Committee	Feb 1 - Feb 28, 2000(28 days)	March 1, 2000
Data Summary Report (Final) and Data Archive	Mar 1 - Mar 30, 2000 (30 days)	April 1, 2000

2.4.5 Test Summary Report Procedures

A test summary report will be prepared highlighting findings from all of the test measures. The document will be produced as follows:

1. Preparation of a draft report summarizing the results of all the individual test reports for submittal to the SC.
2. Approval of the SC at a scheduled meeting.
3. Preparation of a final test summary report, incorporating SC recommendations.
4. Submittal of 1 hardcopy original, 1 electronic original, and ten bound copies of the summary report to ODOT's project management team.
5. Transmittal of the test reports by ODOT to FHWA.
6. Reporting Schedule for Test Summary

A reporting schedule is shown below for the test summary report:

Exhibit 2-4 Reporting Schedule - Test Summary Reports

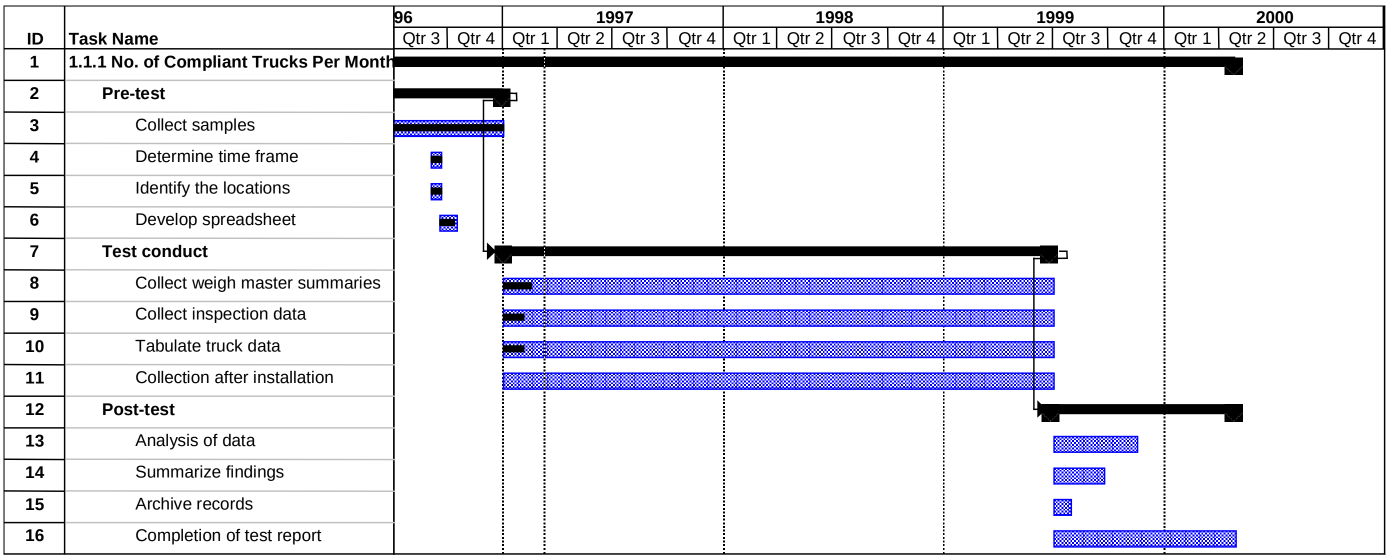
Deliverables	Schedule	Scheduled Due Date*
Drafts of Test Summary Report	Dec 1, 1999 - Jan 30, 2000 (60 days)	February 1, 2000
Review of Test Summary Report by Steering Committee	Feb 1 - Feb 28, 2000 (28 days)	March 1, 2000
Test Summary Report (Final)	Mar 1 - Mar 30, 2000 (30 days)	April 1, 2000

3 TEST MANAGEMENT PLAN

3.1 DETAILED TEST SCHEDULE

A detailed test schedule is shown below in Exhibit 3-1.

Exhibit 3-1 Project Timeline for Test Measures 1.1.1 and 1.1.2



3.2 COST BREAKDOWN BY MEASURE

A cost breakdown for these measures is shown below in Exhibit 3-2. These figures are only estimates and are subject to revision as the evaluation progresses.

Exhibit 3-2 Cost Breakdown for Test Measures 1.1.1 and 1.1.2

Organization: Oregon State University (TRI)					
DTP	**Measure**	**Researcher**	**Hours**	**Cost**	**Totals**
1	1.1.1	C A Bell	80	$3,400	
		P E Montagne	416	$6,656	
					$10,056
	Payroll Exp:	C A Bell	32%	$1,088	
		P E Montagne	37%	$2,463	
	Subtotal:				$3,551
	Supplies:			$300	
	Travel:			$547	
	Subtotal:				$847
	Overhead		42%		$6,071
	Total:				**$20,524**

Organization: Oregon State University (TRI)					
DTP	**Measure**	**Researcher**	**Hours**	**Cost**	**Totals**
1	1.1.2	C A Bell	80	$3,400	
		P E Montagne	416	$6,656	
					$10,056
	Payroll Exp:	C A Bell	32%	$1,088	
		P E Montagne	37%	$2,463	
	Subtotal:				$3,551
	Supplies:			$300	
	Travel:			$547	
	Subtotal:				$847
	Overhead		42%		$6,071
	Total:				**$20,524**

4 REFERENCES

1. Bell, C.A., B. McCall, and, C.M. Walton, A “The Oregon ‘Green Light’ CVO Project, Evaluation Plan” GLEV9601, Oregon State University, Transportation Research Institute, September 1996.

2. Bell, C.A., B. McCall, and, C.M. Walton, AThe Oregon >Green Light’ CVO Project, Individual Test Plan AGLEV9602, Oregon State University, Transportation Research Institute, October 1996.

3. ODOT Research and New Technology, Transportation Development Branch, “Oregon Green Light CVO Project - Overview and Phase III Workplan” Oregon Department of Transportation, Salem OR, January 1997.

4. Bell, C.A., S.U. Randhawa, P. Ryus, and, Z. Xu, “Development of an Integrated System For Evaluation of Oregon’s Truck Data - Phase I: Database Development and Preliminary Evaluation of Data” TNW93-05 Transportation Northwest Final Report, August 1993.

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Oregon Green Light CVO Evaluation

Detailed Test Plan #2

Measure 1.2.1 Ratio of mean speeds in inclement weather to that in "good" weather, before and after installation of Road Weather Information System

TABLE OF CONTENTS

TABLE OF EXHIBITS

1 DETAILED TEST INTRODUCTION

1.1 BACKGROUND

This Detailed Test Report is the second of 14 test reports that will be submitted as part of the independent technical evaluation of the Oregon Green Light CVO project. The Oregon Department of Transportation (ODOT) is in the process of implementing their Intelligent Vehicle Highway System Strategic Plan for Commercial Vehicle Operations (now referred to as ITS/CVO). Through Green Light, Oregon is installing twenty-two mainline preclearance systems featuring weigh-in-motion (WIM) devices and automatic vehicle identification (AVI) at the major weigh stations and ports-of-entry throughout the state. In addition, certain sites will be equipped with data collection systems for use in regulatory enforcement (ITEN sites) while other sites will be equipped with safety enhancements that regulate road conditions and speed.

The purpose of these documents is to provide detail to procedures taken when testing the various measures proposed in the Green Light Evaluation. The Detailed Test Plans will cover all of the test measures described in Exhibit 2-1 of The Oregon “Green Light” CVO Project - Evaluation Plan [1].

Each of the tests conducted by the research team for the evaluation of Green Light will address one of five goals of the evaluation as documented in the Evaluation Plan. These are:

- Assessment of Safety
- Assessment of Productivity
- Assessment of User Acceptance
- Assessment of Mainstreaming Issues
- Assessment of Non-Technical Interoperability Issues

The objectives associated with each goal are given in detail in The Oregon "Green Light" CVO Project - *Individual Test Plans* (ITP) [2]. In addition, condensed one-page tables are contained in the appendices of the ITP, outlining the measures to be conducted for each of the stated objectives. The detailed test plan documents will expand on the information provided in the ITP and provide in detail the activities carried out for each *evaluation measure* during the course of the evaluation in regards to the stated objectives.

1.2 PURPOSE AND SCOPE

This particular detailed test plan outlines the test measure employed to obtain the objective *determining change in truck behavior due to the Road Weather Information System (RWIS)*, one of three objectives in support of the goal of assessing safety. Like the accompanying Detailed Test Plans, this document is not meant to be exclusive of the ITP, but rather an extension of that document to provide scope and direction for the research team.

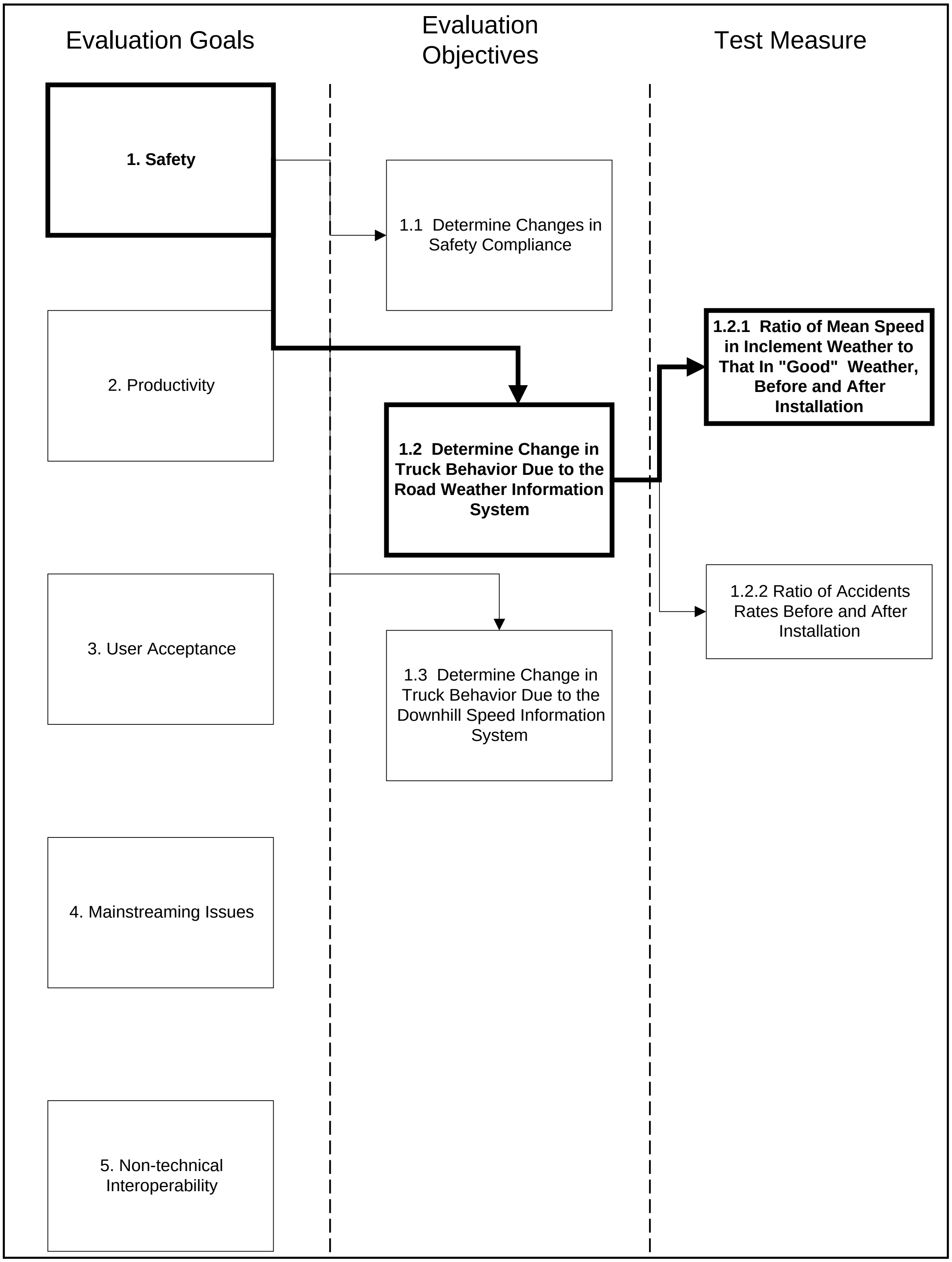
The evaluation measure used to determine change in truck behavior due to the RWIS is stated below:

- **1.2.1 Comparison of truck speeds before and after installation of the Road Weather Information System.**

A description of the hypothesis to be tested as well as the test methodology and deliverables is described in detail in Chapter 2. Chapter 3 provides a detailed test schedule and budget for the test measure.

The scope of this detailed test plan within the context of the overall Green Light Evaluation is shown in Exhibit 1-1. The test measure outlined in this document is highlighted for reference.

Exhibit 1-1 Summary of Detailed Test Plans



1.3 DISCUSSION

Currently, most highway agencies rely on regional forecasts supplied by the National Weather Service for operation planning with regards to snow and ice control and travel advisories. In an effort to collect more timely data with accurate shot-term predictions of snowfall or icing on a small stretch of highway or county road, Road Weather Information Systems are currently being used primarily by maintenance crews as an aid in reducing costs for snow and ice control. The information has been shown to reduce the costs of winter maintenance by as much as 10% [3]. Recently, these systems have been incorporated into intelligent transportation systems (ITS) as a means of aiding vehicle operators.

In general, the technologies incorporated into an RWIS include a combination of pavement sensors, subgrade sensors, meteorological sensors, roadway thermography, pavement and weather forecasts, and communication hardware such as variable message signs (VMS) or computer monitors for the dissemination of information. The system configuration is typically one or more remote weather stations and/or pavement sensors each with its own on-site computer or remote processing unit (RPU). A central processing unit (CPU) polls each of the RPUs and creates a database for output. A description of the weather systems slated for construction under Green Light are given in the report “The Green Light CVO Project-Phase 1, Road Weather Information Services Scope of Work [4]. A progress report from January 1997 appends the “Scope of Work” document and provides recent changes including the proposal for an additional RWIS at Siskiyou Summit [5].

Remote processing units will be installed in three locations under the auspices of Green Light. These locations are identified in Exhibit 2-1. Several other RPU locations are being upgraded to create a statewide weather information database that can provide information to motorists via the Traffic Management Operations Center in Portland, through message signs located around the state, information kiosks, and on the internet.

Initially, the research team will focus evaluation efforts on the Ladd Canyon installation on I-84 east of LaGrande. The Ladd Canyon RWIS will be located near the center of the canyon adjacent to the existing rest areas at approximately milepost (MP) 270. A single remote processing unit will be placed at this location for integration with existing variable message signs at either side of the canyon. Currently, the signs are manually activated via computer and modem to deliver weather warnings to passing traffic. Existing signs are located at MP 263 westbound (WB) at the North Powder exit and at MP 286 eastbound (EB) just south of LaGrande. Each of these signs were installed because of the dangerous conditions that develop in the microclimates of Ladd Canyon, namely high winds, drifting snow and poor visibility. The canyon is frequently closed to mobile home use during winter months.

It is uncertain at this time how the other two locations will be integrated into ITS systems i.e., using existing signs, information kiosks, or building new signs.

Exhibit 1-2 Green Light RWIS Locations

- Green Light RWIS Locations

1.4 OTHER STUDIES

The scope of RWIS as it pertains to Green Light focuses on the dissemination of weather information to motorists. Several states have begun to use RWIS in this fashion and have attempted to document improvements in safety. Mostly this has been done through the analysis of accidents in the area of RWIS. At a recent conference "Mesoscale Weather Forecasting: Technological and Institutional Challenges", held at the Volpe Center on July 16, 1996, participants cited significant savings for states employing RWIS technologies as well as reduced environmental impacts of deicing chemicals and abrasives (because less is used). Participants also indicated increased safety as a result of RWIS deployment, though it was pointed out that this is extremely difficult to quantify) [6].

In North Dakota where RWIS have been installed since 1992, four years of accident data was examined to establish any trends in the number of accidents before and after installation [7]. The result of their analysis was mainly inconclusive. Some of the extraneous factors affecting their analysis included:

1. The roadway being reconstructed from two lanes to three
2. Improved sight distance and lighting
3. Improved skid resistant surface
4. Improved access ramps and turn lanes

All of these factors as well increasing traffic led the NDDOT researchers to conclude “The (RWIS) is just a tool to help in planning maintenance activities and is not a guarantee to reduce the number of accidents. “

2 TEST METHODOLOGY

2.1 PHYSICAL DESCRIPTION

This section discusses in detail the activities carried out in the evaluation of the Ladd Canyon RWIS system on I-84 east of La Grande. This test may be repeated in part if evaluation of the future RWIS installations in the Columbia Gorge and at Siskiyou Summit is possible.

2.1.1 Purpose

This test will focus on the collection and analysis of message sign logs and vehicle speed data under a variety of climatic conditions in order to determine the effectiveness of the RWIS system in controlling driver behavior. Of primary concern are what effects the existing variable message signs in Ladd Canyon have on vehicle speeds, and how that impact will change once the RWIS has been deployed. The test is a before/after study in which comparisons will be made between similar data sets collected before and after the system is installed.

2.1.2 Hypothesis

The following hypothesis is given in support of the test measure and will be tested according to accepted statistical techniques:

> **1.2.1 Vehicle speeds will decrease after the installation of RWIS message boards in inclement weather.**

2.2 PRE-TEST ACTIVITIES

Pre-test activities for this measure will focus on the sources, quality and availability of data, developing a time frame for establishing benchmarks, and determining site locations. These steps are discussed in detail below.

1) Data Sources and Availability

The five primary data sources used for this test measure are:

1. Speed records collected by existing weigh-in-motion (WIM) loops in Ladd Canyon
2. Records of displayed messages appearing on the VMSs in Ladd Canyon
3. Activity logs of construction activities during the study period
4. Daily records of pavement conditions
5. New speed data collected by radar gun in Ladd Canyon (spot speed surveys)

Speed records in the vicinity of Ladd Canyon exist through a mainline WIM device located in the right lane of I-84 at MP 263 EB. The device was installed in 1990 as part of the Strategic Highway Research Project (SHRP). The WIM is run for two-week periods four times a year in the spring, summer, fall and winter. The WIM collects speed and weight data in the form of binary files that must then be processed using the DOS program “REPORTER”, software that was developed by ODOT. REPORTER outputs data in the form of ASCII tables that shows distributions of speed by hour of day and by vehicle configuration. It can calculate total vehicles by speed, average speed, median speed, and 85th percentile speed as well. The tables are useful but will require a considerable amount of effort by the research team to import them into EXCEL for compilation and analysis. Unfortunately, each day of data has to be compiled individually by REPORTER and imported into EXCEL for analysis.

Logs of the various messages displayed to motorists from the Ladd Canyon VMSs are kept at the ODOT’s’ District 13 offices in La Grande. The logs are stored on a database and can be accessed by date. The output from the database is ASCII text in columns with date, time and the message displayed. Each time the VMS is changed or the system is down or rebooted, a new entry is made in the database. The messages displayed can be keyed by the research team into EXCEL and correlated with the WIM speed data to give the researchers an historical record for driver behavior as it relates to the existing signs.

Major construction projects can have an effect on speed data collected from the WIM and need to be accounted for. Activity logs of construction taking place during the study period will be collected to monitor any potential conflicts. The District 13 office in LaGrande keeps these records on file and will submit copies of these to the research team.

Road conditions in the study area will also need to be considered when analyzing historical WIM data. The ODOT Road Report is compiled within ODOT for distribution on the Internet via ODOT's gopher server. The report is only available from November through May of each year and is generated twice daily at 9:30am and 1:30pm. Ladd Canyon is one of the stations that record road condition information for the report.

The collection of new speed data will be used as a measure of testing seasonal variations in driver behavior. It will be used as supplementary data to that already collected by the WIM. In order to have an accurate assessment, data must be collected at the same time each year, day of week, and under similar weather conditions. The speed data will be collected using a calibrated radar gun at pre-determined locations in Ladd Canyon. Speeds will be logged by hand into data collection sheets that ODOT will provide. Data can then be keyed into a speed analysis program called SPEEDZONE, a DOS program developed by ODOT. This software produces speed curves and calculates cursory statistics much the same as those produced by REPORTER using the WIM data.

2) Determination of Benchmark Timeframe

Since this study is largely a before/after type test, benchmarks need to be set to establish trends. WIM speed data is available from 1991 and will continue to be collected over the course of the study period by ODOT barring equipment malfunctions. VMS logs are available from 1992 and will continue to be collected by ODOT over the course of the study. Due to the limitations of time and resources, not all of this historical data can be analyzed. Records for calendar year 1994 up until the RWIS installation in 1997 is deemed sufficient for benchmark data. This should be adequate in limiting any seasonal variations that occur from year to year and month to month.

2.3 TEST CONDUCT ACTIVITIES

2.3.1 Descriptions/Participants

- Transportation Research Institute (Chris Bell, Paul Montagne, staff) - will conduct the research, including collection and analysis of data.
- Eric Brooks, ODOT Research Office – will provide the speed data collected from the WIM and the DOA software REPORTER.
- Jim Brown, Office Manager, ODOT District 13 – will provide the research team with VMS logs of the messages displayed to motorists and any activity logs of construction projects during the study period.
- Michael Topik , ODOT – will provide the research team with ODOT Road Reports for the WIM data collection period.
- Joe Grey, Traffic Specialist, ODOT District 13 - will provide the radar gun, log sheets for collecting the speed data, and the calibration history for the gun.

2.3.2 Procedures

Over the course of the study, the following steps will be conducted:

1) Collection and Analysis of WIM Data

1a) Collect all available WIM data for the years 1994 up to the time of installation

WIM data is collected four times per year by ODOT in two-week intervals. It processes vehicles in the right lane only and is collected for 24 hours, Monday through Friday. The daily binary output files will be submitted to the research team on 3.5" diskettes.

1b) Process the daily binary files using REPORTER

The software REPORTER was designed specifically by ODOT for processing the WIM data collected around the state. It is a menu driven system that creates tables summarizing the data by weight, speed, and vehicle classification. Each day of data used in the study must be processed separately using REPORTER. For the purposes of this study, speed tables will be used. These tables summarize the data for each 24-hour period and contain the following:

- Speed by vehicle classification (20 different vehicle classifications)
- Speed by hour of day
- Total vehicles, average speed, median speed, and 85^{th} percentile speed
- Total traffic and percentage of vehicles travelling greater than 55mph, 60mph, etc. up to 70 mph.

The tables are printed to files that can be formatted using a macro in MS Word. It is estimated that 140 days of data will be collected prior to the RWIS installation.

1c) *Import the data into Excel Spreadsheets*

The ASCII text tables contain too much formatting for direct import into Excel, as the columns do not parse out evenly. Daily totals will be keyed into EXCEL by the research team and totaled using the same cursory statistics as used by REPORTER. In addition, data will be summarized by week.

2) Collection and Analysis of VMS Message Logs

2a) Collect VMS message logs

The VMS message logs will be submitted to the research team as printed copies of the logs kept on the system computer. Output is text in columns with the date, time, VMS ID number, and the action taken. A request will be made for those days when the WIM data was collected.

2b) Correlate VMS logs with WIM data in EXCEL

For all the daily WIM data compiled in EXCEL, a separate column will be created that tabulates the message that motorists were displayed at the time the speed was recorded.

3) Collection and Analysis of Construction Activity Logs

3a) Collect construction logs

The construction logs will be submitted to the research team as printed copies of the logs kept at the district offices. Output is text in columns with the date, time, and a description of the task, including any rerouting of traffic. A request will be made for those days when the WIM data was collected.

3b) Correlate VMS logs with WIM data in EXCEL

For all daily WIM data compiled in EXCEL, a separate column will be created that tabulates any construction activities that may have an effect on speeds recorded by the WIM.

4) Collection of ODOT Road Reports

4a) Collect ODOT Road Reports

The ODOT Road Reports will be submitted to the research team as printed copies of the logs kept on the system computer. Output is text in columns with the date, location, temperature, mobile home traffic status, new snow, roadside snow, weather, pavement conditions, and any special advisories for motorists. Reports will be requested for those days when the WIM data is collected.

4b) Correlate road conditions with WIM data in EXCEL

For all daily WIM data compiled in EXCEL, a separate column will be created that tabulates the pavement conditions for that day. For those days when the Road Report is not being generated (i.e., April through October), bare pavement will be assumed.

5) Collection of new speed data (spot speed surveys)

5a) Acquire vehicle and radar gun

The vehicle used for the speed study will be an inconspicuous, white mini-van, provided by the state motor pool at Oregon State University. There are no distinct markings on the van other than a “state motor pool” bumper sticker and state issued license plates.

The radar gun will be provided by ODOT. The same gun will be used throughout the study. It is regularly serviced and calibrated and is reasonably accurate. The research team will keep a calibration history of the gun.

5b) Determine when to collect data

Spot speed surveys will be used as a control measure for the study and as a standard against which both the before and after speed data can be compared. It is necessary, therefore to focus the data collection on those periods when the RWIS is most likely to be relaying valuable information via the VMSs to drivers. In the case of Ladd Canyon, this would be periods of high winds or snowy and icy conditions. Some data collection should also occur under “normal” conditions to illustrate any fluctuations the WIM data may produce from being a right-lane-only collection system. There are two lanes in each direction in Ladd Canyon.

Other important facets of data collection of this type are the seasonal and weekly variations in traffic. If data is collected during the first week in February on a Wednesday for instance, a speed survey needs to be repeated the following February at precisely the same time. If the weather conditions turn out to be clear one year and adverse the next year, adjustments will have to be made to the sampling plan and the study may have to be pushed up one week.

The research team will collect data when it knows that the conditions are favorable for the VMSs to be active. The research team will remain flexible about when it gathers data and will mobilize as the opportunities present themselves. Windstorms are frequent during the spring months and a spot speed study may be conducted then. If not, it may be late fall 1997 before additional speed data is collected by radar gun.

As an example, some data collection has already been done in Ladd Canyon during the second week of January 1997. Another speed survey will be collected in the second week of January 1998 and again in 1999 to complement this data.

Overall, the research team hopes to collect data three times each year. For each trip to La Grande, four speed surveys will be conducted over two days. Data will be collected at two locations, one eastbound and one westbound, each day. This totals twelve speed surveys each year and should provide the researchers with enough data for the evaluation. Similar tests being conducted at nearby Emigrant Hill (Test Measure 1.3.1) for Green Light should allow these duties to be combined with other measures for an efficient use of time and resources.

5c) Conduct the spot speed survey

The data will be collected from the vehicle. The van will be parked on the right hand shoulder in a conspicuous location away from any overpasses or exits. A recent interview with OSP who patrol Ladd Canyon suggested spots in the study area that are not heavily monitored by radar. The road will be straight and level at the data collection site. The gun will be mounted on the dashboard and covered with a newspaper or other inconspicuous camouflage.

A speed log or tally sheet, used by ODOT for their speed zone studies, will be used for counting vehicles in each speed category. Speeds are in 1-mile increments from 40 to 100 mph. For each car gunned a check will be put in the appropriate box. The log sheets record three categories: trucks cars and busses. Only three-axle vehicles and above will be tallied as trucks. Pickups with trailers, step-vans and smaller delivery and maintenance vehicles will be counted as cars.

A total of two hours of data or two hundred vehicles will be gunned in each spot survey. This protocol is used by ODOT in its speedzone studies and represents approximately 5% of the average daily traffic in Ladd Canyon.

A log will be kept of the messages displayed to motorists by the VMSs during the survey as well as any construction activities or adverse weather conditions that would alter driver behavior.

5d) Compile data using SPEEDZONE

SPEEDZONE is a menu driven DOS program developed by ODOT for use with spot survey data. It generates speed tables, a speed curve, and cursory statistics similar to those generated with REPORTER including 85^{th} percentile speed.

Data will be entered from the tally sheets after the vehicles have been counted. SPEEDZONE then compiles the data into speed tables and generates a speed curve.

5e) Import the data into EXCEL spreadsheets

Data compiled using SPEEDZONE will be imported into EXCEL spreadsheets if possible. If the data does not import, the research team will key in the data by hand. Data will be correlated with the road conditions, construction activities and VMS messages. Data will be summarized using the same descriptive statistics used in the analysis of the WIM data. Speeds by vehicle classification and by road conditions will be graphed out over time to illustrate trends.

6) Collection of Data after Installation

Data will continue to be collected using the same protocols established in the steps listed above after the RWIS has been installed. All data will be processed in the exact same manner as the "before" data for analysis.

6a) WIM data collection

The WIM will be used to collect data after the RWIS installation using the same steps listed in Step 1 above. Collection of data will continue through August of 1999.

6b) VMS data collection

Logs of the VMS messages displayed from the RWIS will be noted to supplement the WIM data. Any changes in wording due to the detail that is provided by the RWIS will also be accounted for in the final test report.

6c) Construction logs and road conditions

Construction logs and road reports will be collected for correlation with speed data collected after the RWIS installation as outlined in Steps 3 and 4 above.

6d) Spot speed studies

Spot speed surveys will be conducted by the research team according to the protocols established in Step 5 above.

2.4 POST-TEST ACTIVITIES

2.4.1 Reporting Procedures for Individual Test

A report will be prepared for this test measure according to the guidelines given in the Evaluation Plan and will proceed as follows:

1. Preparation of a draft report for each test to be submitted to the steering committee (SC) for their approval.
2. Approval of the SC at a scheduled meeting.
3. Preparation of a final test report, incorporating SC recommendations.
4. Submittal of 1 hardcopy original, 1 electronic original, and ten bound copies of the report to ODOT’s project management team.
5. Transmittal of the report by ODOT to FHWA.

2.4.2 Reporting Schedule

The reporting schedule for the individual test reports is shown below:

Exhibit 2-1 Reporting Schedule - Individual Test Reports

Deliverables	Schedule	Scheduled Due Date*
Drafts of Individual Test Reports	July 1-August 30, 1999 (60 days)	September 1, 1999
Review of Individual Test Reports by Steering Committee	September 1-30, 1999 (30 days)	October 1, 1999
Final Test Reports	October 1-November 30, 1999 (60 days)	December 1, 1999

2.4.3 Data Retention/Archival Procedures

Data collected and documents produced over the course of the evaluation will be archived and submitted to ODOT project management. In addition, a document summarizing the data and reports will be produced as follows:

1. Preparation of a summary document describing data analyzed and reports prepared over the course of the evaluation.
2. Submittal of a data archive containing raw data files and all reports in compressed format.

2.4.4 Reporting Schedule for Data Retention/Archival Procedures

The reporting schedule for the archiving of data and the preparation of a summary document is given below:

Exhibit 2-2 Reporting Schedule - Data Archiving

Deliverables	Schedule	Scheduled Due Date*
Drafts of a Data Summary Report	Dec 1, 1999 - Jan 30, 2000 (60 days)	February 1, 2000
Review of Data Summary Report by Steering Committee	Feb 1 - Feb 28, 2000(28 days)	March 1, 2000
Data Summary Report (Final) and Data Archive	Mar 1 - Mar 30, 2000 (30 days)	April 1, 2000

2.4.5 Test Summary Report Procedures

A test summary report will be prepared highlighting findings from all of the test measures. The document will be produced as follows:

1. Preparation of a draft report summarizing the results of all the individual test reports for submittal to the SC.
2. Approval of the SC at a scheduled meeting.
3. Preparation of a final test summary report, incorporating SC recommendations.
4. Submittal of 1 hardcopy original, 1 electronic original, and ten bound copies of the summary report to ODOT's project management team.
5. Transmittal of the test reports by ODOT to FHWA.
6. Reporting Schedule for Test Summary

A reporting schedule is shown below for the test summary report:

Exhibit 2-3 Reporting Schedule - Test Summary Reports

Deliverables	Schedule	Scheduled Due Date*
Drafts of Test Summary Report	Dec 1, 1999 - Jan 30, 2000 (60 days)	February 1, 2000
Review of Test Summary Report by Steering Committee	Feb 1 - Feb 28, 2000 (28 days)	March 1, 2000
Test Summary Report (Final)	Mar 1 - Mar 30, 2000 (30 days)	April 1, 2000

3 CONCLUSIONS

4 REFERENCES

1. Bell, C.A., B. McCall, and, C.M. Walton, A “The Oregon ‘Green Light’ CVO Project, Evaluation Plan” GLEV9601, Oregon State University, Transportation Research Institute, September 1996.

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Oregon Green Light CVO Evaluation

Detailed Test Plan # 3

Measure 1.2.2 Ratio of accidents before and after installation of Road Weather Information System

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TABLE OF EXHIBITS

1 DETAILED TEST INTRODUCTION

1.1 BACKGROUND

This Detailed Test Report is the third of 14 test reports that will be submitted as part of the independent technical evaluation of the Oregon Green Light CVO project. The Oregon Department of Transportation (ODOT) is in the process of implementing their Intelligent Vehicle Highway System Strategic Plan for Commercial Vehicle Operations (now referred to as ITS/CVO). Through Green Light, Oregon is installing twenty-two mainline preclearance systems featuring weigh-in-motion (WIM) devices and automatic vehicle identification (AVI) at the major weigh stations and ports-of-entry throughout the state. In addition, certain sites will be equipped with data collection systems for use in regulatory enforcement (ITEN sites) while other sites will be equipped with safety enhancements that regulate road conditions and speed.

The purpose of these documents is to provide detail to procedures taken when testing the various measures proposed in the Green Light Evaluation. The Detailed Test Plans will cover all of the test measures described in Exhibit 2-1 of The Oregon “Green Light” CVO Project - Evaluation Plan [1].

Each of the tests conducted by the research team for the evaluation of Green Light will address one of five goals of the evaluation as documented in the Evaluation Plan. These are:

- Assessment of Safety
- Assessment of Productivity
- Assessment of User Acceptance
- Assessment of Mainstreaming Issues
- Assessment of Non-Technical Interoperability Issues

The objectives associated with each goal are given in detail in The Oregon “Green Light” CVO Project - *Individual Test Plans* (ITP) [2]. In addition, condensed one-page tables are contained in the appendices of the ITP, outlining the measures to be conducted for each of the stated objectives. The detailed test plan documents will expand on the information provided in the ITP and provide in detail the activities carried out for each *evaluation measure* during the course of the evaluation in regards to the stated objectives.

1.2 PURPOSE AND SCOPE

This particular detailed test plan outlines the test measure employed to obtain the objective *determining change in truck behavior due to the Road Weather Information System (RWIS)*, one of three objectives in support of the goal of assessing safety. Like the accompanying Detailed Test Plans, this document is not meant to be exclusive of the ITP, but rather an extension of that document to provide scope and direction for the research team.

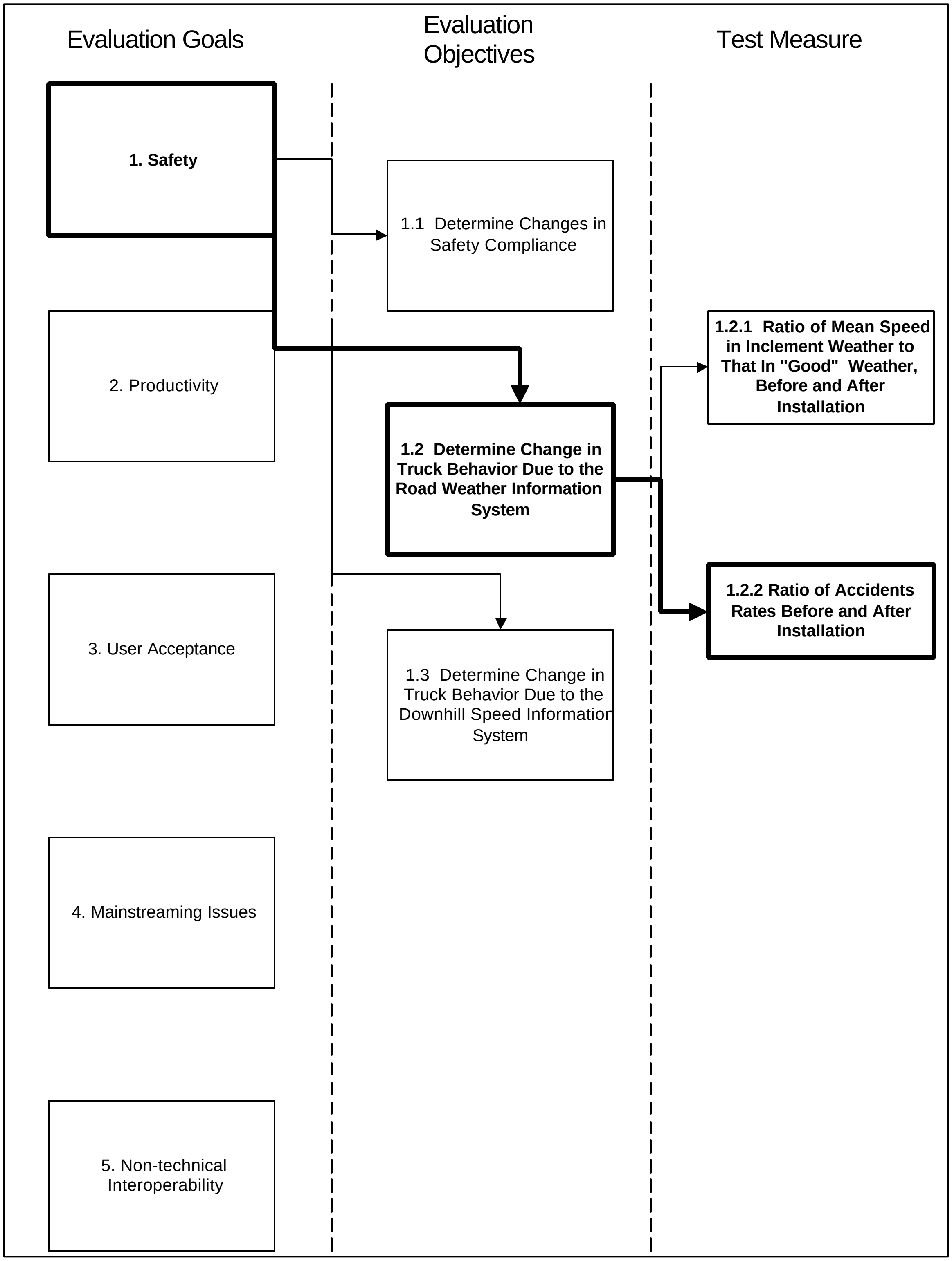
The evaluation measure used to determine change in truck behavior due to the RWIS is stated below:

- **1.2.2 Comparison of accidents before and after installation of the Road Weather Information System.**

A detailed description of the hypothesis to be tested as well as the test methodology and deliverables is described in detail in Chapter 2. Chapter 3 provides a detailed test schedule and budget for the test measure.

The scope of this detailed test plan within the context of the overall Green Light Evaluation is shown in Exhibit 1-1. The test measure outlined in this document is highlighted for reference.

Exhibit 1-1 Evaluation Goals, Objectives, and Measures



1.3 DISCUSSION

Currently, most highway agencies rely on regional forecasts supplied by the National Weather Service for operation planning with regards to snow and ice control and travel advisories. In an effort to collect more timely data with accurate shot-term predictions of snowfall or icing on a small stretch of highway or county road, Road Weather Information Systems are currently being used primarily by maintenance crews as an aid in reducing costs for snow and ice control. The information has been shown to reduce the costs of winter maintenance by as much as 10% [3]. Recently, these systems have been incorporated into intelligent transportation systems (ITS) as a means of aiding vehicle operators.

In general, the technologies incorporated into an RWIS include a combination of pavement sensors, subgrade sensors, meteorological sensors, roadway thermography, pavement and weather forecasts, and communication hardware such as variable message signs (VMS) or computer monitors for the dissemination of information. The system configuration is typically one or more remote weather stations and/or pavement sensors each with its own on-site computer or remote processing unit (RPU). A central processing unit (CPU) polls each of the RPUs and creates a database for output. A description of the weather systems slated for construction under Green Light are given in the report “The Green Light CVO Project-Phase 1, Road Weather Information Services Scope of Work [4]. A progress report from January 1997 appends the “Scope of Work” document and provides recent changes including the proposal for an additional RWIS at Siskiyou Summit [5].

Remote processing units will be installed in three locations under the auspices of Green Light. These locations are identified in Exhibit 2-1. Several other RPU locations are being upgraded to create a statewide weather information database that can provide information to motorists via the Traffic Management Operations Center in Portland, through message signs located around the state, information kiosks, and on the internet.

Initially, the research team will focus evaluation efforts on the Ladd Canyon installation on I-84 east of LaGrande. The Ladd Canyon RWIS will be located near the center of the canyon adjacent to the existing rest areas at approximately milepost (MP) 270. A single remote processing unit will be placed at this location for integration with existing variable message signs at either side of the canyon. Currently, the signs are manually activated via computer and modem to deliver weather warnings to passing traffic. Existing signs are located at MP 263 westbound (WB) at the North Powder exit and at MP 286 eastbound (EB) just south of LaGrande. Each of these signs were installed because of the dangerous conditions that develop in the microclimates of Ladd Canyon, namely high winds, drifting snow and poor visibility. The canyon is frequently closed to mobile home use during winter months.

It is uncertain at this time how the other two locations will be integrated into ITS systems i.e., using existing signs, information kiosks, or building new signs.

Exhibit 1-2 Green Light RWIS Locations

- Green Light RWIS Locations

1.4 OTHER STUDIES

The scope of RWIS as it pertains to Green Light focuses on the dissemination of weather information to motorists. Several states have begun to use RWIS in this fashion and have attempted to document improvements in safety. Mostly this has been done through the analysis of accidents in the area of RWIS. At a recent conference 'Mesoscale Weather Forecasting: Technological and Institutional Challenges", held at the Volpe Center on July 16, 1996, participants cited significant savings for states employing RWIS technologies as well as reduced environmental impacts of deicing chemicals and abrasives (because less is used). Participants also indicated increased safety as a result of RWIS deployment, though it was pointed out that this is extremely difficult to quantify) [6].

In North Dakota where RWIS have been installed since 1992, four years of accident data was examined to establish any trends in the number of accidents before and after installation [7]. The result of their analysis was mainly inconclusive. Some of the extraneous factors affecting their analysis included:

1. The roadway being reconstructed from two lanes to three
2. Improved sight distance and lighting
3. Improved skid resistant surface
4. Improved access ramps and turn lanes

All of these factors as well increasing traffic led the NDDOT researchers to conclude “The (RWIS) is just a tool to help in planning maintenance activities and is not a guarantee to reduce the number of accidents. “

2 TEST METHODOLOGY

2.1 PHYSICAL DESCRIPTION

This section discusses in detail the activities carried out in the evaluation of the Ladd Canyon RWIS system on I-84 east of La Grande. This test may be repeated in part if future evaluation of the RWIS installations in the Columbia Gorge and at Siskiyou Summit is possible.

2.1.1 Purpose

This test will focus on the collection and analysis of accident data occurring in the vicinity of Ladd Canyon. The test will be conducted by evaluating what effects weather patterns and road conditions have on vehicular accidents, and how that impact will change once the RWIS has been deployed. In addition, the test will attempt to evaluate what effect the existing variable message signs had on vehicular accidents. The test is a before/after study in which comparisons will be made between similar data sets before and after the RWIS is installed.

2.1.2 Hypothesis

The following hypothesis is given in support of the measure and will be tested according to accepted statistical techniques:

> **1.2.1 Accidents in the vicinity of the RWIS system will decrease as timely information on road conditions is provided to motorists.**

2.2 PRE-TEST ACTIVITIES

Pre-test activities for this measure will focus on the sources, quality and availability of accident data, developing a time frame for establishing benchmarks, and determining site locations. These steps are discussed in detail below.

1) Data Sources and Availability

The four primary data sources used for this test measure are:

1. Oregon DOT's accident records database
2. Records of displayed messages appearing on the VMSs in Ladd Canyon
3. Activity logs of construction activities during the study period
4. Daily records of pavement conditions

Data is compiled from ODOT's CRASH data system. The database can provide accident statistics with a wide array of data fields containing physical descriptions of the accidents. Accidents can be sorted by any one of these data fields in order to target accidents meeting a given criteria. Some of the data elements pertinent to examining changes in accidents as a result of the RWIS installation are:

- Location (dictated by milepost marker)
- Reported weather observations
- Reported road conditions
- Causative factors
- Time of day
- Vehicle configuration

Raw data will be submitted in the form of two printed reports for each year queried. The first report is an accident detail list which includes detail on each of the accidents that occurred that year in the location specified. Detail includes, but is not limited to, the elements listed above. A second report generated from the CRASH database is the accident location list, which provides a one-line summary of the accidents, and provides added detail. Jack Sheppard has also prepared a basic spreadsheet he uses in his everyday duties that imports pertinent information from these reports into EXCEL. These spreadsheets will also be provided by ODOT and will be used as the building blocks for the research analysis.

ODOT establishes a variety of “measuring sticks” for evaluating problem areas on Oregon’s highways. These analysis tools usually incorporate the number of accidents with some combination of other values such as average daily traffic (ADT), the length of the segment of road under scrutiny, and the number of days over which the ADT and number of accidents is valid. Values such as the accident rate can be calculated for Ladd Canyon and used in evaluating the impact of the RWIS system.

Logs of the various messages displayed to motorists from the Ladd Canyon VMSs are kept at the ODOT’s’ District 13 offices in La Grande. The logs are stored in a database and can be queried by date. The output from the database is ASCII text in columns with date, time and the message displayed. Each time the VMS is changed or the system is down or rebooted, a new entry is made in the database. The messages displayed can be keyed by the research team into EXCEL and correlated with the accident data to give the researchers an historical record for driver behavior as it relates to the existing signs.

Major construction projects can have an effect on accident data collected and must be accounted for. Activity logs of construction taking place during the study period will be collected to monitor any potential conflicts. The District 13 office in LaGrande keeps these records on file and will submit copies of these to the research team.

Road conditions in the study area will also need to be considered when analyzing historical accident data. The ODOT Road Report is compiled within ODOT for distribution on the Internet via ODOT's gopher server. The report is only available from November through May of each year and is generated twice daily at 9:30am and 1:30pm. Ladd Canyon is one of the stations that record road condition information for the report.

2) Determination of Benchmark Timeframe

Since this study is largely a before-after type test, benchmarks need to be set to establish trends. Available accident data for 1994-1996 will be analyzed in detail and compared to accidents occurring after the RWIS is deployed in 1997.

2.3 TEST CONDUCT ACTIVITIES

2.3.1 Descriptions/Participants

- Transportation Research Institute (Chris Bell, Paul Montagne, staff) - will conduct the research, including collection and analysis of data.
- Jack Sheppard, ODOT Accident Data Unit - will provide access to the accident data and will assist in statistical analysis.
- Jim Brown, Office Manager, ODOT District 13 – will provide the research team with VMS logs of the messages displayed to motorists and any activity logs of construction projects during the study period.
- Michael Topik , ODOT – will provide the research team with ODOT Road Reports for the data collection period

Procedures

Over the course of the study, the following steps will be conducted:

1) Collection and Analysis of Accident Data

1a) Collect all recorded accidents between milepost 263 and 286 up to RWIS installation

Accidents will be requested from ODOT beginning in 1994 and continuing up until the installation of the Road Weather Information System. The accidents will be summarized yearly. Data is submitted in the form of accident summary reports and accident location reports that provide detail on all the accidents between the two mileposts for a given year. In addition, a spreadsheet, developed by Mr. Sheppard, will also be provided.

1b) Tabulate accident data into EXCEL spreadsheets

The spreadsheet developed by Mr. Sheppard will be modified significantly to focus on the elements pertinent to our study. All of the accidents will be examined and sorted by the following factors to identify any trends that might be relevant:

- Accident Cause
- Vehicle Type
- Accident Type (i.e., sideswipe, rear-end collision, etc.)
- Weather and Light Conditions
- Hour of Day and Day of Week
- Direction of Travel

1c) From the accident data calculate the accident rate for the section of highway in question

Since the number of accidents for the area of Ladd Canyon between the two message signs is relatively low (less than 25 accidents per year), an accident rate value will be used in comparing before and after data. In addition to examining accident rates for Ladd Canyon before and after, an accident rate can be calculated for any section of highway for use as a control. Ladd Canyon's accident rate can be compared to several other accident rates including:

- I-84 accident rates
- All Oregon interstate (4-lane) accident rates

This analysis will enable the researchers to eliminate statewide factors beyond the scope of local effects in Ladd Canyon.

The Accident Rate is calculated as follows:

$$\text{Accident Rate (accidents}/\,10^6\text{ vehicle miles)} = \frac{\text{Number of accidents} * 1{,}000{,}000}{\text{Length of Section} * \text{ADT} * \text{Number of Days}}$$

The Length of Section is miles.

The ADT is the Average Daily Traffic.

The Number of Days is the number of days in which the number of accidents and the ADT is valid.

2) Collection and Analysis of VMS Message Logs

2a) Collect VMS message logs

The VMS message logs will be submitted to the research team as printed copies of the logs kept on the system computer. Output is text in columns with the date, time, VMS ID number, and the action taken. A request will be made for those days when the accidents took place.

2b) Correlate VMS logs with WIM data in EXCEL

For all the accident data compiled in EXCEL, a separate column will be created that tabulates the message that motorists were displayed at the time the accident took place.

3) Collection and Analysis of Construction Activity Logs

4a) Collect construction logs

The construction logs will be submitted to the research team as printed copies of the logs kept at the district offices. Output is text in columns with the date, time, and a description of the task, including any rerouting of traffic. A request will be made for those days when the accidents took place.

4a) Correlate VMS logs with WIM data in EXCEL

For each accident compiled in EXCEL, a separate column will be created that tabulates any construction activities that may have had an effect on the accident.

4) Collection of ODOT Road Reports

3a) Collect ODOT Road Reports

The ODOT Road Reports will be submitted to the research team as printed copies of the logs kept on the system computer. Output is text in columns with the date, location, temperature, mobile home traffic status, new snow, roadside snow, weather, pavement conditions, and any special advisories for motorists. Reports will be requested for those days when the WIM data is collected.

3b) Correlate road conditions with WIM data in EXCEL

For each accident, a separate column will be created that tabulates the pavement conditions for that day. For those days when the Road Report is not being generated (i.e., April through October), bare pavement will be assumed. This will be checked with the data provided from the accident database.

5) Collection of Data after Installation

Data will continue to be collected using the same protocols established in the steps listed above after the RWIS has been installed. All data will be collected and processed using the same protocol outlined in steps 1-4 above.

5a) Accident data collection

Accident data will continue to be collected after the RWIS installation using the same steps listed in Step 1 above. Collection of the data will continue through August of 1999.

5b) VMS data collection

Logs of the VMS messages displayed from the RWIS will be noted to supplement the accident data. Any changes in wording due to the detail provided by the newly installed RWIS will be accounted for in the final test report.

5c) Construction log collection

Construction logs will be collected for correlation with speed data collected after the RWIS installation as outlined in Step 3 above.

5d) Road condition report collection

Road reports will be collected for correlation with speed data collected after the RWIS installation as outlined in Step 4 above.

6) Detailed Analysis of Accident Data

A detailed analysis will be conducted using the data collected. Accidents will be placed in a matrix that quantifies the frequency of occurrence by various factors including:

- vehicle type
- weather and road condition
- displayed message
- accident type
- accident cause
- direction of travel

In addition, an accident rate calculated for accidents occurring prior to the installation as well as after. The accident rate will be compared with rates calculated for I-84 and for all four lane interstates in Oregon over the same time period. This will allow researchers to note any general trends that may be occurring over the evaluation period.

2.4 POST-TEST ACTIVITIES

2.4.1 Reporting Procedures for Individual Test

A report will be prepared for this test measure according to the guidelines given in the Evaluation Plan and will proceed as follows:

1. Preparation of a draft report for each test to be submitted to the steering committee (SC) for their approval.
2. Approval of the SC at a scheduled meeting.
3. Preparation of a final test report, incorporating SC recommendations.
4. Submittal of 1 hardcopy original, 1 electronic original, and ten bound copies of the report to ODOT's project management team.
5. Transmittal of the report by ODOT to FHWA.

2.4.2 Reporting Schedule

The reporting schedule for the individual test reports is shown below:

Exhibit 2-1 Reporting Schedule - Individual Test Reports

Deliverables	Schedule	Scheduled Due Date*
Drafts of Individual Test Reports	July 1-August 30, 1999 (60 days)	September 1, 1999
Review of Individual Test Reports by Steering Committee	September 1-30, 1999 (30 days)	October 1, 1999
Final Test Reports	October 1-November 30, 1999 (60 days)	December 1, 1999

2.4.3 Data Retention/Archival Procedures

Data collected and documents produced over the course of the evaluation will be archived and submitted to ODOT project management. In addition, a document summarizing the data and reports will be produced as follows:

1. Preparation of a summary document describing data analyzed and reports prepared over the course of the evaluation.
2. Submittal of a data archive containing raw data files and all reports in compressed format.

2.4.4 Reporting Schedule for Data Retention/Archival Procedures

The reporting schedule for the archiving of data and the preparation of a summary document is given below:

Exhibit 2-2 Reporting Schedule - Data Archiving

Deliverables	Schedule	Scheduled Due Date*
Drafts of a Data Summary Report	Dec 1, 1999 - Jan 30, 2000 (60 days)	February 1, 2000
Review of Data Summary Report by Steering Committee	Feb 1 - Feb 28, 2000(28 days)	March 1, 2000
Data Summary Report (Final) and Data Archive	Mar 1 - Mar 30, 2000 (30 days)	April 1, 2000

2.4.5 Test Summary Report Procedures

A test summary report will be prepared highlighting findings from all of the test measures. The document will be produced as follows:

1. Preparation of a draft report summarizing the results of all the individual test reports for submittal to the SC.
2. Approval of the SC at a scheduled meeting.
3. Preparation of a final test summary report, incorporating SC recommendations.
4. Submittal of 1 hardcopy original, 1 electronic original, and ten bound copies of the summary report to ODOT's project management team.
5. Transmittal of the test reports by ODOT to FHWA.
6. Reporting Schedule for Test Summary

A reporting schedule is shown below for the test summary report:

Exhibit 2-3 Reporting Schedule - Test Summary Reports

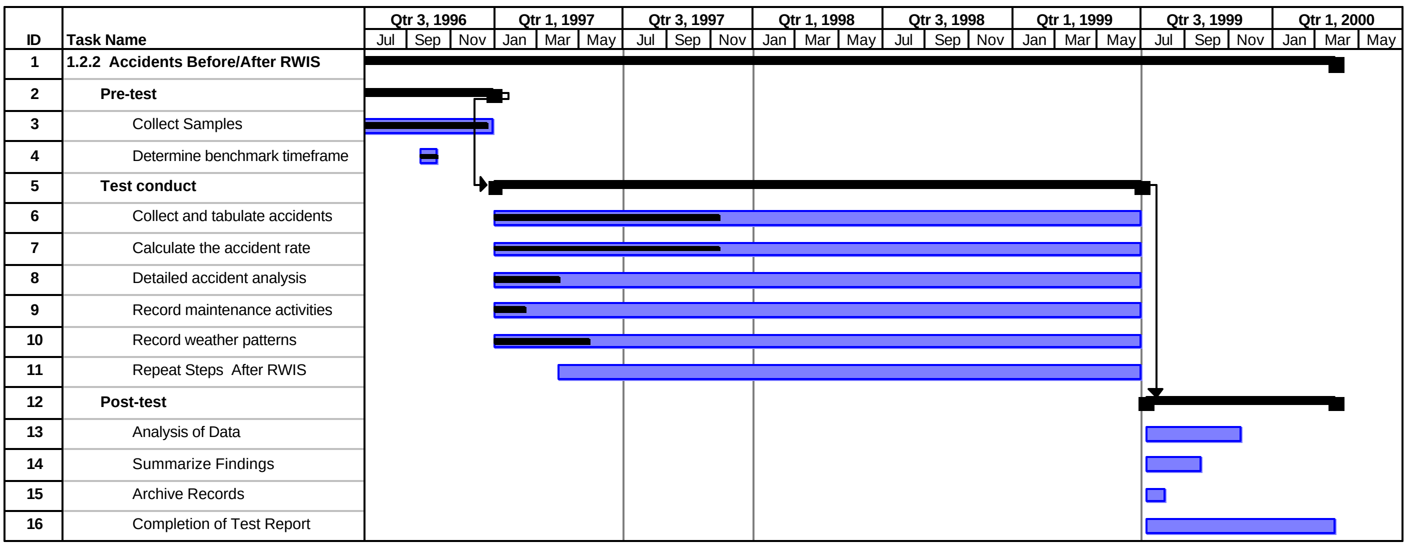
Deliverables	Schedule	Scheduled Due Date*
Drafts of Test Summary Report	Dec 1, 1999 - Jan 30, 2000 (60 days)	February 1, 2000
Review of Test Summary Report by Steering Committee	Feb 1 - Feb 28, 2000 (28 days)	March 1, 2000
Test Summary Report (Final)	Mar 1 - Mar 30, 2000 (30 days)	April 1, 2000

3 TEST MANAGEMENT PLAN

3.1 DETAILED TEST SCHEDULE

A detailed test schedule is shown in Exhibit 3-1.

Exhibit 3-1 Project Timeline for Test Measure 1.2.2



3.2 COST BREAKDOWN BY MEASURE

A cost breakdown for this measure is shown below in Exhibit 3-2. These figures are only estimates and are subject to revision as the evaluation progresses.

Exhibit 3-2 Cost Breakdown for Test Measure 1.2.2

Organization: Oregon State University (TRI)					
DTP	**Measure**	**Researcher**	**Hours**	**Cost**	**Totals**
3	1.2.2	C A Bell	40	$1,700	
		P E Montagne	208	$3,328	
					$5,028
	Payroll Exp:	C A Bell	32%	$544	
		P E Montagne	37%	$1,231	
	Subtotal:				$1,775
	Supplies:			$600	
	Travel:			$600	
	Subtotal:				$1,200
	Overhead		42%		$3,361
	Total:				**$11,365**

4 REFERENCES

1. Bell, C.A., B. McCall, and, C.M. Walton, A "The Oregon 'Green Light' CVO Project, Evaluation Plan" GLEV9601, Oregon State University, Transportation Research Institute, September 1996.

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4. Research and New Technologies Unit, Policy Section, Transportation Development Branch, and Automation and Weighing Facilities Unit, Motor Carrier Services, Oregon Department of Transportation, "The Green Light CVO Project Phase 1, Road Weather Information Systems (RWIS) - Scope of Work for federal Highway Administration" , January 1996.

5. "Project Green Light CVO Project - Progress Report, Vehicle Operator Weather Advisory System" January 1997.

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