TP 14358E

Feasibility Study of a Remote Control Weigh Station

Prepared for:
Transport Canada

by:
International Road Dynamics Inc.

March 2005

TP 14358E

Feasibility Study of a Remote Control Weigh Station

by:
Jeremy Breker, P. Eng.
International Road Dynamics Inc.

March 2005

NOTICES

This report reflects the views of the authors and not necessarily those of Transport Canada.

Transport Canada does not endorse products or manufacturers. Trade or manufacturers' names appear in this report only because they are essential to its objectives.

This project is part of Canada's Intelligent Transportation Systems (ITS) R & D Plan, *Innovation Through Partnership*, funded by the ITS office of Transport Canada under the Strategic Highway Infrastructure Program (SHIP).

The Transportation Development Centre of Transport Canada served as technical authority for this project.

PROJECT TEAM

Jeremy Breker, P. Eng., Project Manager, International Road Dynamics Inc.
Brian Taylor, P. Eng., International Road Dynamics, Inc.
John Fung, P. Eng., Constance Consultants, Ltd.
Ted Stobbs, P. Eng., Saskatchewan Highways and Transportation
Curtis Berthelot, P. Eng., University of Saskatchewan

Un sommaire français se trouve avant la table des matières.

Transport Canada / Transports Canada

PUBLICATION DATA FORM

1. Transport Canada Publication No. TP 14358E	2. Project No.	3. Recipient's Catalogue No.
4. Title and Subtitle Feasibility Study of a Remote Control Weigh Station		5. Publication Date March 2005
		6. Performing Organization Document No. 10310
7. Author(s) Jeremy Breker		8. Transport Canada File No. 2450-GP014
9. Performing Organization Name and Address International Road Dynamics Inc. 702 43rd Street East Saskatoon, Saskatchewan Canada S7K 3T9		10. PWGSC File No. 052ss.T8663-030015
		11. PWGSC or Transport Canada Contract No. T8663-030015/010/SS
12. Sponsoring Agency Name and Address ITS Office – Transport Canada Place de Ville, Tower C, Floor 27 330 Sparks Street Ottawa, Ontario Canada K1A 0N5		13. Type of Publication and Period Covered Final
		14. Project Officer Pierre Bolduc

15. Supplementary Notes (Funding programs, titles of related publications, etc.)

This project is part of Canada's Intelligent Transportation Systems (ITS) R&D Plan, *Innovation Through Partnership*, funded by the ITS Office of Transport Canada under the Strategic Highway Infrastructure Program (SHIP). The Transportation Development Centre of Transport Canada served as technical authority for this project.

16. Abstract

This report provides a detailed conceptual model for a remote control weigh station, including the functional requirements and high-level system characteristics of the technology.

The design is based on a literature review of existing technology and the analysis of survey responses from the industry, enforcement agencies, and transportation planning agencies. As a result of the effort, a technologically and economically viable model for such technology has been captured and serves as the basis for implementation and testing of the system.

An economic analysis is included in the report that supports the model with a benefit-cost result significantly greater than 1.

17. Key Words Intelligent Transportation Systems, ITS, Remote Control Weigh Station, commercial weight enforcement, commercial vehicle safety enforcement, weigh-in-motion	18. Distribution Statement Limited number of copies available from the Transportation Development Centre Electronic version available from Transport Canada Web site: www.tc.gc.ca

19. Security Classification (of this publication)	20. Security Classification (of this page)	21. Declassification (date)	22. No. of Pages	23. Price
Unclassified	Unclassified	—	xviii, 72, apps	Shipping/ Handling

Transports Canada / Transport Canada

FORMULE DE DONNÉES POUR PUBLICATION

1. N° de la publication de Transports Canada TP 14358E	2. N° de l'étude	3. N° de catalogue du destinataire
4. Titre et sous-titre Feasibility Study of a Remote Control Weigh Station		5. Date de la publication Mars 2005 6. N° de document de l'organisme exécutant 10310
7. Auteur(s) Jeremy Breker		8. N° de dossier - Transports Canada 2450-GP014
9. Nom et adresse de l'organisme exécutant International Road Dynamics Inc. 702 43rd Street East Saskatoon, Saskatchewan Canada S7K 3T9		10. N° de dossier - TPSGC 052ss.T8663-030015 11. N° de contrat - TPSGC ou Transports Canada T8663-030015/010/SS
12. Nom et adresse de l'organisme parrain Bureau STI – Transports Canada Place de Ville, Tour C, 27e étage 330, rue Sparks Ottawa, Ontario Canada K1A 0N5		13. Genre de publication et période visée Final 14. Agent de projet Pierre Bolduc

15. Remarques additionnelles (programmes de financement, titres de publications connexes, etc.)

Ce projet fait partie du Plan de R&D du Canada sur les systèmes de transports intelligents STI), *Innover par l'établissement de partenariats*, financé par le Bureau des STI ainsi que par Transports Canada dans le cadre du programme stratégique d'infrastructures routières (PSIR). Le Centre de développement des transports de Transports Canada a agi comme responsable technique pour ce projet.

16. Résumé

Le rapport présente un modèle conceptuel détaillé de poste de pesage automatisé, y compris les exigences fonctionnelles de la technologie et les caractéristiques qui en font un système de haut niveau.

Le modèle conceptuel a été élaboré à la suite d'une recherche documentaire sur les technologies existantes et après analyse des réponses à une enquête réalisée auprès de l'industrie, de corps policiers et d'organismes de planification des transports. Il en est résulté un modèle à la fois faisable sur le plan technologique et viable économiquement, qui servira de base à la mise en œuvre et l'essai du système.

Le rapport comprend aussi les résultats d'une analyse économique qui confirme l'intérêt du modèle, lui attribuant un rapport avantages-coûts largement supérieur à 1.

17. Mots clés Systèmes de transports intelligents, STI, poste de pesage automatisé, contrôle de la conformité aux règles sur le poids des véhicules utilitaires, contrôle de sécurité des véhicules utilitaires, pesage dynamique	18. Diffusion Le Centre de développement des transports dispose d'un nombre limité d'exemplaires. Version électronique disponible à partir du site Web de Transports Canada : www.tc.gc.ca

19. Classification de sécurité (de cette publication)	20. Classification de sécurité (de cette page)	21. Déclassification (date)	22. Nombre de pages	23. Prix
Non classifiée	Non classifiée	—	xviii, 72, ann.	Port et manutention

CDT/TDC 79-005
Rev. 96

Canada

ACKNOWLEDGEMENTS

The Technical Steering Committee is acknowledged for its guidance early in the project. The Technical Steering Committee comprised representatives from Transport Canada, Alberta Infrastructure and Transportation, the ministère des Transports du Québec, Saskatchewan Transportation and Highways, and the Société de l'assurance automobile du Québec. Their contributions helped ensure that the conceptual model can be applied throughout Canada and North America.

Representatives from the industry, enforcement agencies, and government planning who completed surveys and provided feedback that contributed to the functional requirements of the remote control weigh station application are also acknowledged.

The contributions of Pierre Bolduc, P. Eng., Transport Canada Scientific Authority, who provided input into the project, offered insightful comments during progress meetings, and guided the project team, are gratefully acknowledged.

EXECUTIVE SUMMARY

This report discusses a new cost-effective model of an automated weigh station that can be operated either attended or unattended, at all times or any time, as required on a daily basis. The Remote Control Weigh Station (RCWS) effectively extends an agency's ability to enforce regional regulations without incurring costs associated with conventional methods of enforcement. The RCWS is a new concept that builds from industry experience with present technologies, such as weigh-in-motion (WIM), video capture, traffic control signs, e-screening, internet monitoring and remote control.

The RCWS model was based on a literature review of existing technologies. Once the conceptual model was created, users and stakeholders from the industry and various government organizations were solicited for input via a questionnaire developed by the design team. The results of the survey were used to refine the RCWS model, which became the basis for a system design and an evaluation of technical and economic viability.

As a result of the development process it was determined that the necessary features of the RCWS include the capacity to conduct:

- Weight and dimensions enforcement
- Company/carrier/operator licence check
- Company/carrier/operator permit check
- Vehicle licence/registration check
- Vehicle mechanical fitness check
- Vehicle visible mechanical defects check
- Driver hours of service log check
- Load tie-down/containment check
- Safe loading check

It was determined that the best architecture for the system was a modular system that allows a jurisdiction to customize the elements of the RCWS to the regional enforcement program and budget. Basic elements require minimal infrastructure conversion, and more advanced systems require a more significant investment in technology and construction. The system components allow a remote operator to pre-screen commercial vehicles dynamically and perform a more detailed secondary screening function if desired. All of the controls are remotely managed by a single remote enforcement operator using standard PC-based peripherals (i.e., mouse, keyboard, monitor and CPU).

It is plausible that the RCWS system could be deployed with minimal technological development as most of the subsystems exist as standalone original equipment manufacturer components that are readily available in the marketplace. Radio Frequency Identification systems, dynamic weigh-in-motion scales, electronic static scale controllers, licence plate readers, etc., are all readily available in Canada and North America. Most components have been automated in some form and the concept of automated sorting and static scale weighing has been successfully deployed in the U.S. for several years (Florida Department of Transportation electronic screening systems; Nogales, Arizona Port-of-Entry Expedited Processing at International Crossings (EPIC) system; Oregon Green Light WIM systems).

The economic analysis of agency, user, and environmental benefits and costs were favourable over a conventional weigh station, even when considering low commercial traffic volumes of 200 trucks per day. When agency and user costs and benefits were considered together, the benefit-cost ratios varied from 1.47 to 19.52 for a basic RCWS, depending on the truck volumes and the level of enforcement. If some of the technology is moved onto the highway and pre-screening occurs before the weigh station, the benefit-cost ratios range from 1.23 to 32.8, depending on the level of enforcement.

As a result of this effort, a functional specification and a system design were developed that can be used for follow-on activities. These activities include the development of a tender document, detailed hardware designs, software designs, and the development of a remote control weigh station.

This project was made possible under the Strategic Highway Infrastructure Plan, a federal government initiative that provides funding support for innovative ITS projects developed by Canadian companies.

SOMMAIRE

Le rapport présente un nouveau modèle de poste de pesage automatisé offrant un bon rapport coût-efficacité et pouvant fonctionner avec ou sans préposé, à n'importe quelle heure du jour. Le poste de pesage automatisé (PPA) accroît la capacité d'un corps policier de contrôler la conformité des véhicules à la réglementation, sans qu'il ait à assumer les coûts récurrents associés aux méthodes classiques d'application de la loi. Le PPA est un nouveau concept qui fait appel à des technologies déjà connues dans l'industrie, comme le pesage dynamique, l'imagerie vidéo, les signaux routiers, le filtrage électronique des véhicules, la surveillance Internet et la télécommande.

Le modèle de PPA a été élaboré à la suite d'une recherche documentaire sur les technologies existantes. Il a ensuite été présenté aux utilisateurs et intervenants de l'industrie, de même qu'à divers organismes gouvernementaux, qui ont été invités à faire part de leurs commentaires en répondant à un questionnaire préparé par l'équipe de recherche. On s'est inspiré des résultats de cette consultation pour perfectionner le modèle, qui a servi de base pour la conception d'un système et l'évaluation de sa viabilité technique et économique.

Au terme du processus de développement du produit, il a été déterminé que le PPA devait posséder les caractéristiques nécessaires pour réaliser les fonctions suivantes :

- contrôle de la conformité aux règles sur les poids et dimensions
- vérification des autorisations de l'entreprise/du transporteur/du conducteur
- vérification des permis de l'entreprise/du transporteur/du conducteur
- vérification de la plaque/l'immatriculation du véhicule
- vérification du bon fonctionnement mécanique du véhicule
- vérification des anomalies mécaniques visibles du véhicule
- vérification du carnet des heures de service du conducteur
- vérification de l'arrimage/du confinement du chargement
- vérification de la sûreté du chargement

Il a été déterminé qu'un système modulaire représentait la meilleure architecture pour le système, car chaque autorité/corps policier serait libre de le personnaliser selon son programme d'application de la loi et le budget qu'il y consacre. Les éléments de base nécessitent une adaptation minime de l'infrastructure, mais un système complet exige des investissements dans la technologie et l'infrastructure matérielle. Le système permet à un préposé à distance de filtrer les véhicules en mouvement, puis de les inspecter de façon plus approfondie, au besoin. Tout le processus est géré à distance par un préposé unique, qui utilise les périphériques standard d'un PC (souris, clavier, écran, unité centrale).

Le déploiement du système PPA exigera probablement peu de travaux de développement technologique, car la plupart des sous-systèmes existent déjà sur le marché en tant que composantes autonomes. En effet, les étiquettes radiofréquences (RFID, *Radio Frequency Identification*), les bascules de pesage dynamique, les contrôleurs électroniques de bascules de pesage statique, les lecteurs de plaques d'immatriculation, etc. sont tous des équipements que l'on peut facilement se procurer au Canada et en Amérique du Nord. La plupart des composantes ont été automatisées sous une forme ou une autre; d'ailleurs, le tri automatisé et le pesage statique sont des

technologies déployées avec succès depuis plusieurs années aux États-Unis (systèmes de filtrage électronique du Département des transports de Floride; système de traitement accéléré aux frontières [EPIC *Expedited Processing at International Crossings*] à Nogales, en Arizona; système de pesage dynamique Oregon Green Light).

L'analyse économique des coûts et avantages du système, à la fois du point de vue du corps policier, de l'utilisateur et de l'environnement, a révélé la supériorité du PPA par rapport au poste de pesage classique, même lorsque le nombre des pesées ne dépasse pas 200 par jour. En combinant les coûts et les avantages que représente le système pour le corps policier et l'utilisateur, les rapports avantages-coûts variaient de 1,47 à 19,52 pour un PPA de base, selon le nombre de véhicules et le niveau de l'application de la loi. Lorsqu'une partie de la technologie est transférée sur la route et qu'un tri est effectué en amont du poste de pesage, les rapports avantages-coûts varient de 1,23 à 32,8, selon le zèle mis à appliquer la loi.

Les travaux ont mené à l'élaboration d'une spécification fonctionnelle et d'un avant-projet de système qui pourront servir aux activités subséquentes. Ces activités comprennent la préparation d'un appel d'offres, la conception détaillée de matériels, le développement de logiciels, et le développement d'un poste de pesage automatisé.

Le projet a été réalisé sous l'égide du Programme stratégique d'infrastructures routières, une initiative du gouvernement fédéral qui accorde une aide financière aux projets de STI novateurs proposés par des entreprises canadiennes.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

Abbreviation	Description	Function
ASTM	Association of Standard Test Methods	
AVIS	Automatic Vehicle Identification System	Allows the RCWS to automatically and positively identify a vehicle without operator input.
BAS	Brake Analysis System	Identifies potentially faulty brakes.
B/C	Benefit-Cost Analysis	
CMS	Changeable Message Sign	
CS	Communication System	Provides the communication link between the Station Control System and the Remote Operator Interface.
CVISN	Commercial Vehicle Information Systems and Networks	Allows the RCWS to automatically screen vehicle credentials in an EDE database.
DATAS	Data Collection System	Provides the full range of the data storage requirements for the RCWS.
DCS	Driver Communication System	Allows a remote operator to communicate with a driver who has entered the local kiosk.
DIS	Document Inspection System	Allows a remote operator to inspect various documents that a driver may be required to produce after having reported to the kiosk.
DWDS	Dynamic Weight and Dimension System	Increases the capacity of the RCWS at high-volume sites.
EDE	Electronic Data Exchange	A generic description of a data exchange method similar to CVISN.
ESAL	Equivalent Single Axle Load	
FHWA	Federal Highway Administration(U.S.)	
ITS	Intelligent Transportation System	
LOI	Local Operator Interface	Allows an operator to run the RCWS on site.
OEM	Original Equipment Manufacturer	

RCWS	Remote Control Weigh Station	
RFID	Radio Frequency Identification	
RIS	Regulatory Information System	Allows commercial vehicle operators to investigate commercial vehicle operation regulations for up to five predefined jurisdictions.
ROI	Remote Operator Interface	Allows an operator to run the RCWS from a remote location.
SAFER	Safety and Fitness Electronic Records	
SBDS	Station Bypass Detection System	Detects commercial vehicles bypassing the RCWS
SCS	Station Control System	Controls all subsystems at the remote site and is the access point for all remote communication.
SWAS	Static Weight Analysis System	Allows a remote operator to statically weigh commercial vehicles.
TCRP	Transit Cooperative Research Program	
VCS	Vehicle Communication System	Allows a remote operator to control the movement of traffic within the RCWS.
VIS	Vehicle Inspection System	Allows a remote operator to visually inspect and identify vehicles that have reported to the RCWS.
WIM	Weigh In Motion	

1. INTRODUCTION

The purpose of this project was to develop a model for a remote control weigh station (RCWS) that would effectively extend an agency's ability to enforce regional commercial regulations without incurring costs associated with conventional methods of enforcement. The primary objectives were to determine the functional requirements of the RCWS, capture the requirements in a functional specification, produce a high-level system design, and evaluate the economic feasibility of such as system.

This report does not provide detailed hardware or software designs for construction (i.e., tender); however, it includes follow-on activities should an agency decide to continue to explore the implementation of an RCWS model.

1.1. Background

To effectively maintain the quality of the highway infrastructure, it is necessary to have information and data on the uses of the highway system, the safety and security aspects of the highway system, traffic operations of the highway system, evolvement of regulations and policies towards the use of the highway system, and user compliance to the regulations and policies. Commercial Vehicle Operations (CVO) is the source for such information and the basis to regulate and enforce compliance. CVO information is useful for planning and implementing programs and affects user compliance enforcement and improvements on the efficiency, safety, security, productivity and increased capacity of the highway system.

Traditionally, transportation agencies use weigh stations (truck inspection stations), Weigh-in-Motion (WIM) systems and static scales at scale houses to collect transportation data and perform compliance enforcement activities. WIM systems are also installed on highways and some roadways to collect traffic and transportation data. Whenever and wherever possible, enforcement officers verify licensing, weight, dimensions, credentials, and safety and security compliance of the motor carrier, the carrier company and the driver under CVO activities. Besides weigh stations, enforcement officers patrolling highways sometimes use mobile systems, such as portable scales, in-vehicle notebook computers and wireless communication links, to perform compliance enforcement activities. Mobile operations are generally less efficient due to mobilization, demobilization and static weighing operations but nevertheless necessary to extend CVO activities to highways and roadways that do not have fixed weigh stations or manned weigh stations.

Most existing weigh stations were built prior to the 1990s and now require repairs, replacements or upgrades with modern technologies and system implementations in order to sustain the effectiveness of CVO. Regardless of which route to take, it is a large expense that must be weighed against its costs and benefits. Whether to continue operating these weigh stations, with a shortage of funds, is a question that needs to be considered and answered. Even if these weigh stations were repaired, retrofitted and upgraded to be fully capable of performing most, if not all, CVO activities, there would still be the question of how to operate these stations effectively and continuously on a daily basis, with a shortage of funds and human resources. To extend CVO coverage to a large geographic area with a large number of inspection sites, whether fixed or mobile, is expensive and severely limited by available funds and manpower resources.

A more modern enforcement concept is a remote control weigh station (RCWS), which can be deployed cost effectively at low and medium-volume sites where traffic volumes or building maintenance costs prohibit full-time staff or infrastructure support costs. The RCWS model developed is scalable and can be transferred to existing sites with a minimum investment into the infrastructure.

1.2. Basic System

A large number of existing weigh stations are run on a part-time basis in attempt to reduce the high operating costs of stations located on roads with low truck traffic volumes. Part-time operation provides a less effective form of weight enforcement, monitoring only a small portion of the passing truck traffic. In the past, weigh stations have been constructed in various isolated regions, with the intent of obtaining truck weight and traffic information in a variety of areas. Some sites may be as far away as 200 km from any form of substantial urbanization and require staff to periodically travel to the site to operate the facility.

Staffing of part-time weigh stations can be a large part of operational costs. Inefficient spending occurs through time spent traveling to the sites and opening the weigh stations for operation. The level of safety that the operator faces also becomes a real concern for the transportation agency. Remote locations have the potential of becoming dangerous for a lone operator. Another downfall is that the effectiveness of weigh stations decreases once the trucking community becomes familiar with the schedule and finds other travel routes to avoid the weigh scales.

RCWS systems provide a possible solution to this serious problem. Through web-based communication, existing weigh stations can be controlled and operated from a central location. The benefits of increasing the operation of a wide range of weight enforcement systems are far reaching. Data collection, road preservation, employee efficiency and operational savings are just some of the traditional problem areas that will improve from increased weight enforcement. With random and intermittent operation it is difficult, if not impossible, for the industry to determine the operation time pattern.

With the addition of basic RCWS communication and monitoring modules to an enforcement program, only one remote operator is required to manage a number of RCWSs which may extend over a district, region, or county. Situated at a central location the operator controls the stations on a random and intermittent basis. From a commercial vehicle operator’s perspective, each weigh station continues to operate virtually the same as when it had an operator on site. RCWS systems provide excellent opportunities for improved CVO enforcement at a fraction of the cost.

RCWS systems adapt existing on-site systems for long range communication and operation. A typical RCWS system consists of the following subsystems:

- Static scale
- Video camera monitoring system
- Communication system
- Lane control system

- Communication kiosk
- WIM scale
- Axle sensor
- Inductive loops (optional)
- Brake analysis system (optional)

The RCWS can be built by adding equipment to existing on-site systems to attain a high level of automation. Such equipment is the WIM system and its accessories, which are necessary to provide automated weight and dimension enforcement.

1.3. Advanced System

The advanced RCWS system comprises four subsystems that enhance the basic RCWS system but would also be significant enhancements to a conventional weigh station. The subsystems provide increased automation of information gathering and expand an enforcement officer's and vehicle operator's access to information outside of the regional area. The following subsystems are included in the advanced system:

- Automatic vehicle identification system
- Electronic data exchange (EDE) interface
- Regulatory information system
- Electronic logbook data transfer

1.4. Functional Overview

The RCWS duplicates the typical manual weight enforcement process. Commercial vehicles are separated from the general traffic stream and analyzed to determine whether the vehicle, carrier, driver, etc. requires a secondary screening for compliance with the weight enforcement policies and other safety requirements criteria. Vehicles that are compliant with the enforcement screening criteria are returned back to the general traffic stream. Target vehicles in violation of the screening criteria are retained for processing.

Subsequent sections of this report further define the basic functions described above. A functional specification, which defines the minimum requirements for the RCWS, was developed by the design team by executing a nationwide survey and conducting a literature review of existing systems. A system design was developed based on the functional specification. The system design defines the subcomponent requirements, including failure modes.

2. FUNCTIONAL REQUIREMENTS

2.1. Overview of Methodology

The RCWS is designed to satisfy user requirements in accordance with its intended uses and applications as described in the functional requirements. The RCWS is not intended to replace any existing or future fixed-site weigh station. Rather, it is intended to extend the reach, service and service hours of most weigh stations, without incurring large construction and operational costs. In other words, the RCWS either complements or supplements the operation of a weigh station. The RCWS presents opportunities for efficient and effective weigh station operation at minimum incremental costs.

User requirements are categorized into two areas: functional requirements and performance requirements. Functional requirements cover those functions that the RCWS should provide. Performance requirements determine the operating conditions and responses that the RCWS should achieve.

The RCWS design incorporates provisions for the following functions:

- Weight enforcement
- Weight and dimensions enforcement
- Company/carrier/operator licence check
- Company/carrier/operator permit check
- Vehicle licence/registration check
- Vehicle mechanical fitness check
- Vehicle visible mechanical defects check
- Driver hours of service log check
- Load tie-down/containment check
- Safe loading check
- Automatic credential check
- EDE capability for self-serve safety check reporting
- EDE interface for inter-provincial and international data exchange, probably for safety, security and credential information, used by transportation authorities and/or other government agencies in border crossing situations

The RCWS model has the following performance provisions:

- High-volume traffic operation of 50 commercial vehicles maximum hourly and 500 commercial vehicles maximum daily for fixed-site operation
- Medium-volume traffic operation of 15 commercial vehicles maximum hourly and 150 commercial vehicles maximum daily for mobile-site operation
- Each mobile-site weigh station has the capability to operate as RCWS
- Each RCWS operates at extended hours

The functional and performance requirements were derived from design team input, a user survey of industry and enforcement personnel, and a literature review of existing technology and weighing applications. Sections 2.2 and 2.3 describe the methodology of capturing the requirements (User Survey) and the scope of each requirement (Functional Specification), respectively.

2.2. User Survey

2.2.1. Purpose of Questionnaire

User requirements were used to shape the design of the RCWS and represent the needs of the users. In order to solicit inputs from users and achieve user consensus, a questionnaire was used. Responses from questionnaire respondents were used to identify and confirm user requirements in functions and performance.

2.2.2. Target Respondents

For the RCWS to be successful in terms of implementation, acceptance and approval to various users, it must meet the expectation of those users who may have different interests towards the operation and presence of the RCWS.

Three groups of respondents were targeted:

- Transportation industry representatives
- Field operation officers from provincial departments of transportation
- Program management; planning, enforcement management, and policy officers from provincial departments of transportation

Three forms of a questionnaire were used, one for each target group above.

2.2.3. Questionnaire Design

All three forms of questionnaire consisted of questions relating to functional and performance requirements. Additional questions/inputs were designed into the two forms of questionnaire for the provincial transportation department respondents.

For provincial transportation department field operation officers and enforcement management, the first form of questionnaire consisted of questions relating to:

- Functions
- Station control and display components
- Station operation
- Recorded traffic volume
- Operation/performance

The first form had slight variations for field operation officers and enforcement management.

For provincial transportation department planning and policy officers, the second form of questionnaire consisted of questions relating to:

- Functions
- Recorded traffic volume
- Operation/performance

For transportation industry representatives, the third form of questionnaire consisted of questions relating to:

- Functions
- Operation/performance

To prevent confusion and multiple choices for responses, the questionnaire was designed with simple short questions requiring non-ambiguous answers. Almost all questions on functional and performance requirements required non-descriptive answers. This allowed the answers to be tabulated and quantified.

Functional requirements questions required responses of:

- Yes “Y” or No “N” answer to a described function
- Importance rating of the function (1 to 5, 1 being the most important)
- Whether the function is considered a “must-have” function

Performance requirements included questions regarding recorded traffic volume and operation/performance of RCWS. These questions required responses of:

- Maximum daily commercial traffic volume (Low, Medium, High; <50, 51-150, 151-500)
- Maximum hourly commercial traffic volume (Low, Medium, High; <5, 6-15, 16-50)
- Yes “Y” or No “N” answer to a described operation

There were a small number of questions allowing for descriptive answers. Responses to these questions did not alter the tabulated results. These responses were typically useful as user comments, clarifications and considerations for planning purposes, including determining locations of RCWS and other desirable enhancements for RCWS implementation.

Questions pertaining to “station control and display components” and “station operation” were used to identify the required design interfaces of the RCWS to various externally connected components. Responses to these questions were considered for implementation in the RCWS design.

2.2.4. Questionnaire Methodology

The questionnaire design allowed tabulation of responses in numerical quantities for confirming and verifying functional and performance requirements.

Questions were grouped into three categories: functions, traffic volume and operation/performance. Responses on functions were used to identify and confirm functional requirements of the RCWS. Responses on traffic volume and operation/performance were used to identify and confirm performance requirements of the RCWS.

Responses to questions on functions required multiple entries. There were three components in determining the significance or importance of a function to a particular user:

- It is first determined whether the function is a “must have” function. This component identifies the degree of necessity if given a budgetary constraint.
- It is next determined whether the function is an important function.
- The function’s relative importance or unimportance is then determined. This component identifies the scale of the function’s necessity.

A respondent enters a check mark to a function question to indicate that it is a “must have” function. All check marks to a function are summed for all respondents.

A respondent enters a Yes “Y” or No “N” to a function question to indicate whether it is an important or irrelevant function.

For a function to be considered important, a respondent must enter its rating of importance to have a meaningful interpretation. A rating of 1 to 5 is used for such interpretation, 1 being the highest rating. Corollary, if a function is considered irrelevant, a respondent must also enter its rating of irrelevance to have a meaningful interpretation, 1 being the highest negative rating or most irrelevant.

The rating of importance or irrelevance is then accumulated for a function from all respondents. A rating of importance is counted as a +1 whereas irrelevance is counted as a –1. Responses with ratings are accumulated in the tabulation for analysis.

If a respondent does not enter a rating for a “Y” or “N” function entry, then the response cannot be accurately interpreted and tabulated. Such response is not useful and is not used in subsequent analysis.

In tabulation, “Y”s and “N”s are accumulated if they are associated with rating entries. A 1 “Y” and a 1 “N” cancel out, resulting in a “0” entry. Thus, a 1 “Y” and a 2 “N” entry result in a “-1” entry.

Responses to questions on performance requirements required only single entries on selections. Responses were summed up in the tabulation for analysis. The largest tabulated number in each category determined the minimum performance requirement to be designed into the RCWS.

The respondents considered functions with the largest tabulated numbers in the “must have” entries to be the “must have” functions.

The respondents considered functions with the largest accumulation of “Y” s in tabulation to be the desirable functions.

2.2.5. Questionnaire Responses

Responses from distributed questionnaires were received from 15 respondents representing all three targeted organizations.

Representing the transportation industry were two respondents: one from the Private Motor Truck Association of Canada and the other one from the BC Trucking Association.

Representing the provincial transportation department field operation officers were five respondents: one from Alberta, two from Saskatchewan, one from Quebec, and one from New Brunswick.

Representing the provincial transportation department planning, enforcement management and policy officers were eight respondents: one from Alberta, three from Saskatchewan, two from New Brunswick, one from Quebec, and one from Manitoba.

2.2.6. Analysis of Responses

The tabulation of responses from the 15 respondents is shown in Appendix A.

Analysis was based on responses to the questionnaire by the respondents using the questionnaire methodology described in section 2.2.4.

In the functional requirements category of questions, only one respondent from the provincial transportation department field officer group failed to enter responses.

In the performance requirements category of questions, four respondents failed to enter responses for recorded traffic volumes. Two of the respondents were from the transportation industry and were not given the questions to respond, and two of the respondents were from the provincial transportation department program management.

Also in the performance requirements category of questions, one of the respondents from the provincial transportation department program management group failed to enter responses for operation/performance questions.

A small number, 26 in total, of responses to questions in the functional requirements category could not be tabulated: 23 due to missing importance/irrelevance rating and 3 due to descriptive answers. These responses are not included in the tabulation.

Overall, the questionnaire responses were good and sufficient to produce meaningful analysis.

2.2.7. Functional Requirements Analysis

In the functional requirements category, the maximum “must have” tabulated number for each function is 14, i.e. 14X in the tabulation. However, individual respondents do not consider all “must have” functions of highest importance. Such a situation exists when a respondent has less constraint to include a “must have” function of lesser importance. This is evidenced by the tabulated “must have” number equal to or larger than the tabulated importance rating of 1 for that function.

It is reasonable to sort the functions according to their “must have” numbers to determine the relative position of each function. It is also reasonable to assume that the “must have” number has direct correlation with the importance rating of 1 for a function. The higher the relative position of the function is, the more desirable it is for the function to be considered a “must have” function. The closer the correlation of the function’s importance rating of 1 is to its “must have” number, the more likely the function is to be considered a “must have” function.

With the tabulation results, it is easy to identify a number of “must have” functions simply by looking at their high numeric values. The desirability of functions can also be determined or ranked according to the correlation between “must have” number and highest importance rating number.

The analysis is summarized as:

- Except for the functions of “Company/carrier/operator operation check” and “Driver operation record check”, all described functions in the questionnaire were rated of various degrees of importance.
- The functions considered to be of significant importance (rating of 1) were:
    - Weight enforcement
    - Weight and dimensions enforcement
    - Company/carrier/operator licence check
    - Company/carrier/operator permit check
    - Vehicle licence/registration check
    - Vehicle mechanical fitness check
    - Vehicle visible mechanical defects check
    - Driver hours of service log check
    - Load tie-down/containment check
    - Safe loading check
- Weight and dimensions enforcement was unanimously considered a “must have” function
- In addition to “Weight and dimensions enforcement”, the following functions were considered highly desirable functions, just short of “must have” status:
    - Vehicle mechanical fitness check
    - Vehicle visible mechanical defects check
    - Load tie-down/containment check
    - Safe loading check

2.2.8. Performance Requirements Analysis

In the performance requirements category, only single alphabet (H, M, L, Y and N) entries were required of the responses. Entries were then accumulated into the tabulation.

The analysis is summarized as:

- For fixed-site operation, the RCWS should be designed for “High-Volume Traffic” operation of 50 commercial vehicles maximum hourly and 500 commercial vehicles maximum daily.
- For mobile-site operation, the RCWS should be designed for “Medium-Volume Traffic” operation of 15 commercial vehicles maximum hourly and 150 commercial vehicles maximum daily.
- All respondents believed that the RCWS concept could and would contribute to the public safety.

- All mobile site weigh stations should have the capability to operate as RCWS.
- All RCWS should be operable at extended hours.

2.2.9. Analysis Results

Based on the functional and performance requirements analyses, the results are re-iterated and summarized as:

- All respondents believed the concept of RCWS would contribute to public safety.
- All mobile sites should be able to operate as RCWS.
- It would be desirable for fixed sites to have RCWS capability.
- RCWS should be operable at extended hours.
- All respondents picked “weight and dimension enforcement” as the “must have” function of the RCWS.
- Other most desirable functions in descending order were:
    - Load tie-down/containment check
    - Safe loading check
    - Vehicle visible mechanical/electrical defects check
    - Vehicle mechanical fitness check
- The “must have” and most desirable functions were recommended for implementation of the RCWS.
- Other respondent noted functions of significant importance were:
    - Company/carrier/operator licence check
    - Company/carrier/operator permit check
    - Vehicle licence/registration check
    - Driver hours of service log check
- These noted functions are executable by the operator actions and practices. These functions may be automated in the advanced model of the RCWS.

2.3. Functional Requirements

Conceptually, the RCWS may be designed into one of two models: basic and advanced. The advanced model has all the functions and features of a basic model, plus additional functions and features. Each RCWS comprises all equipment necessary for providing the following functions from a remote location.

The functional requirements of the basic system determined in the User Survey Analysis can be further translated into system requirements. The basic system comprises the following technical requirements:

- Weight and dimension measurements
- Vehicle classification
- Compliance verification on weights and dimension
- Safety checks of signals - brake lights, turn signals, taillights and headlights
- Detection of non-functional brakes
- Vehicle data collection

The advanced model comprises:

- Automatic credential check
- EDE capability for self-serve safety check reporting
- EDE tie-in capability for inter-provincial and international data exchange, probably for safety, security and credential information, used by transportation authorities and/or other government agencies in border crossing situations
- Electronic log book download

2.3.1. Functional Requirements – Basic Model

The basic model of the RCWS allows an operator at a remote location (e.g. central office) to control its local operation. The operator has all of the necessary tools to examine the vehicle condition, safely control traffic movement and communicate with the driver.

Typically, the RCWS is operated remotely by an operator in a central office. Nevertheless, the RCWS can be operated locally on-site by an operator or in a semi automated mode which allows an operator at the RCWS site to control a portion of the system while a remote officer controls other components in parallel. For example, a remote operator may control one direction of a bi-directional station while the local operator controls the opposite direction.

The RCWS operator can monitor and direct traffic movement at the remote location using direct communication with the driver or through automated processes. For traffic screening purposes the system allows the operator to identify commercial vehicles that have failed to report to the weigh station when it is open and to identify commercial vehicles that have reported to the weigh station.

The RCWS screens the commercial vehicles that are reporting to the weigh station allowing the enforcement operator to verify that it is in compliance with the local transportation regulations. For example, this may be statically weighing each axle on a static scale or a more detailed visual inspection of length, width, height, load safety, etc. Once the data is obtained the system provides both manual and automated tools which permit the officer to verify that the data is within the local regulations which are being screened. This includes the operation of brake lights, turn signals, taillights and headlights of the target vehicle and can include capturing data which can predict a high probability of faulty brakes. Analysis of the screening data allows the operator to verify proper load distribution of the target vehicle and provides the tools necessary to have reasonable confidence that the load has been properly secured.

The RCWS features include the capability to identify the licence plate of a vehicle which has reported to the static scale and can incorporate transponder devices intended for Dedicated Short Range Communication (DSRC). Licence plate information and transponder tag number permit officers to search other data clearinghouses (such as an EDE system or a national police archive). A transponder may also carry vehicle and transportation data, which provides officers with additional information for CVO activities.

If an officer determines that a vehicle should be processed further, the operator has the tools to direct a driver to report to a remote kiosk located in the weigh station. The regulatory agency can communicate directly with a driver and check licence, registration, and log book information. The kiosk communication interface is configurable as French or English, and is designed to easily implement additional languages as required. The RCWS records all data in metric; however, the user interface is configurable to display in either imperial or metric units.

2.3.2. Performance Requirements – Basic Model

The performance requirements for the basic system were derived from the survey analysis, the experience of the design team, and a literature review of existing similar ITS technology used for enforcement purposes. The performance requirements in the subsequent pages identify limitations of design factors such as the mean time to repair, latency of communication between the regional control centre and the RCWS, operating temperatures, etc.

One of the primary performance requirements is to manage the site safely. A key factor in safe traffic management is the ability for the enforcement operator to rapidly control signalling and communication with the driver of the target commercial vehicles. The latency of control for any device necessary for the operation of the weigh station and shall have a negligible delay, of 0.5 seconds or less, from the time the RCWS operator makes a change on a control device to the time the change is executed and displayed by the control device. Traffic control devices include such items as stop lights, lane signals, changeable message signs, and other visual signals necessary for the operator to direct a vehicle for normal or emergency purposes.

A single operator shall be able to operate the RCWS effectively when subject to maximum traffic volumes of 50 commercial vehicles per hour and up to 500 commercial vehicles per day. A capacity limit was placed on the design to provide a reference for planning and to aid in reducing system costs. In general, as volumes increase, traffic management devices necessary for safe site management increase adding cost to the deployment of the RCWS. Further RCWS development is necessary for volumes that exceed the above requirements.

The design of the RCWS has provisions to convert an existing weigh station to an on-demand RCWS. This includes modular design structure, minimal infrastructure investment, and the ability to operate the system in a manual, data collection, or automated condition. In a manual mode, a local operator can control the site with the traditional weigh station management practices. In data collection mode, the system collects and stores data for future analysis. In an automated condition, a remote operator can assist a local operator by controlling elements of the system or can operate the system in its entirety.

The RCWS shall automatically save all available data regarding commercial vehicles, which have failed to report to the weigh station when it is open. This data, which is saved for a minimum of 30 days, includes vehicle classification, time, date and speed of its passage. Optionally additional data such as vehicle images, licence plate images, or DSRC transponder tag numbers, can be stored to aid in the identification of the vehicle.

The RCWS provides the operator with the capability to store data of commercial vehicles, which have reported to the weigh station. This data, which is saved for a minimum of 10 days, includes the following:

- Static weights of each axle
- Type and classification of vehicle
- Licence plate of the vehicle
- Driver licence and logbook information
- Vehicle/carrier/operator safety record
- Check items status
- Operator entered information on vehicle

All data collected by the system can be transferred electronically using a file transfer system. Files transferred shall be in a format which can be viewed using industry standard OEM software such as Microsoft™ or Corel™ office products. The system has the capability to create hardcopies of data files at the control centre (i.e. tickets, summary data, etc.).

The control centre and/or maintenance personnel shall have system tools to verify the RCWS component health. The control centre and/or maintenance personnel shall have the ability to run diagnostics remotely to diagnose or verify system health.

The RCWS shall operate reliably in the typical Canadian environment. The RCWS shall achieve operational availability of at least 98.5% measured over a period of 90 days. A high operational availability was considered paramount to the success of the system since continued maintenance in remote areas would greatly affect the effectiveness of an enforcement program and reduce the benefit-cost (B/C) ratio.

The RCWS is designed for a Mean Time To Repair of 2 hours and designed to operate in an ambient temperature range of -45°C to +45°C. All components shall not be adversely affected when stored in an ambient temperature range from -65°C to +65°C.

If a kiosk is provided, the driver interface shall be designed for the Commercial Vehicle Operations Trade which includes clear directions on how to use the system. The kiosk, although mentioned throughout this model, is not specifically required to operate a weigh station remotely. Remote zoom cameras, for viewing log books, permits, and driver's licence, and ticket printers that are environmentally hardened are readily available and could be mounted next to the static scale lane outside of a kiosk.

The system shall be designed consistent with the National Electrical Code and the Manual of Uniform Traffic Control Devices (TAC, 1998). The system shall meet local and national building and safety regulations at both the remote station and the control station. The system shall be designed to meet or exceed municipal, provincial, and federal data security regulations.

2.3.3. Functional Requirements – Advanced Model

The advance system increases the ability of operators to screen commercial vehicles on credentials and other broader criteria which requires access to data held by other institutions or data clearinghouses. The advanced system requires greater interface development with agencies and allows an enforcement program to extend provincial, national, or international screening criteria to the RCWS.

Under bilateral and/or bi-national data interchange agreement, safety, security and credential information of vehicle/driver/carrier/operator may be supportable for use by transportation authorities and other government agencies. The advanced model has the capability to support and integrate with EDE for inter-provincial and international/inter-state data exchange. Using various technologies, such as DSRC or optical character recognition, the advanced model of the RCWS automatically performs credential checks on commercial vehicles identified by the system.

If the interface to the data clearinghouse (e.g. CVISN) is incorporated, it was determined that vehicle operators should have the capability to reference regulations and their own safety data. The advanced system supports an interface which permits vehicle operators and kiosk visitors to check their safety rating on the local jurisdiction's web site and permits vehicle operators and kiosk visitors to look up regional and inter-provincial regulations related to commercial transportation.

2.3.4. Performance Requirements – Advanced Model

There are only two performance requirements necessary to achieve the functional requirements described above. The advance system should append the following data to the data stored by the basic system:

- EDE information on safety check reporting
- Available inter-provincial and/or international/interstate data exchange information through EDE
- Vehicle safety record
- Other available information such as documents and information from commercial transportation regulatory agencies.

It is anticipated that the local RCWS system will require direct communication with the data clearinghouses of other agencies. As a result, the transmission rate and bandwidth requirement of the RCWS is upgraded accordingly.

2.4. System Design

2.4.1. Design Methodology

The RCWS model comprises all equipment and software necessary for providing the following functions from a remote location:

- Weight and dimension measurements
- Vehicle classification
- Compliance verification on weights and dimension
- Safety checks of signals - brake lights, turn signals, taillights and headlights
- Detection of non-functional brakes
- Vehicle data collection
- Automatic credential check

- EDE capability for self-serve safety check reporting
- EDE tie-in capability for inter-provincial and international data exchange, probably for safety, security and credential information, used by transportation authorities and/or other government agencies in border crossing situations
- Electronic logbook download

There are a significant number of general design requirements that apply to all components of the RCWS. The requirements were developed considering the fact that the weigh stations are remote and the cost of servicing the subsystems could significantly detract from the benefit of the model. Other considerations included the environment under which the system is expected to operate and the underlying expectation that any system which involves the public should also protect the safety of its users.

The subsystems share the following general design requirements:

- The target cost to the user for a basic RCWS which allows the user to perform weight and dimension enforcement should be $300,000 or less.
- The design of the RCWS shall facilitate the conversions of existing sites to a RCWS. The system shall achieve operational availability of at least 98.5% measured over a period of 90 days.
- Any failure identified as high impact in the failure mode analysis sections of this document will cause the system to be deemed unavailable.
- The RCWS also has a mean time to repair for a high impact failure of 2 hours or less.
- The system shall be designed to run 24 hours per day, 7 days per week.
- Any components of the RCWS that are outdoors will be designed for an operational temperature range of -45 degrees Celsius to +45 degrees Celsius and an ambient storage temperature of -65 degrees Celsius to +65 degrees Celsius.
- The RCWS shall be designed consistent with the National Electrical Code and Manual of Uniform Traffic Control Devices (TAC, 1998).
- The RCWS shall meet local and national building and safety regulations at both the remote station and the control station.
- The RCWS shall be designed to meet or exceed municipal, provincial, and Federal Data Security regulations.

2.4.2. System Architecture

The RCWS is constructed with a modular architecture in which the major functional requirements are met by independent subsystems. This modular approach allows the RCWS to be configured in an almost limitless number of configurations ranging from the basic model to the advanced model thereby allowing the RCWS to support the varied situations under which it is to be deployed. A block diagram of the RCWS architecture is provided in Figure 1.

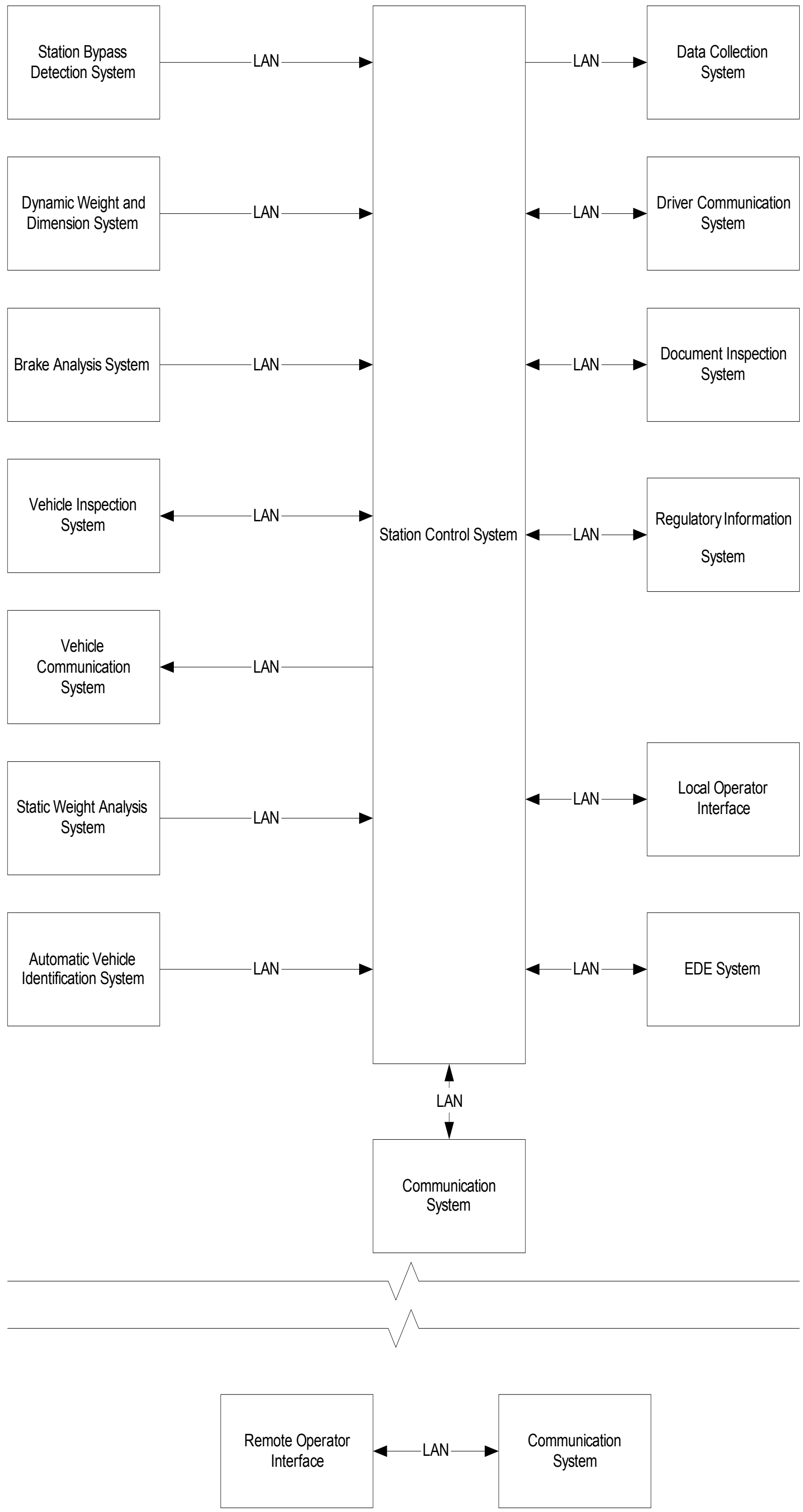

Figure 1. Remote Control Weigh Station Block Diagram

2.4.3. Driver Walk Through – Remote Management of a RCWS

Figure 2 illustrates a typical application of the RCWS components. As the vehicle approaches the weigh station the target vehicle is advised to report to the weigh station through the vehicle communication system (VCS). In this case, the driver is instructed to report to the weigh station via an OPEN/CLOSED changeable message sign.

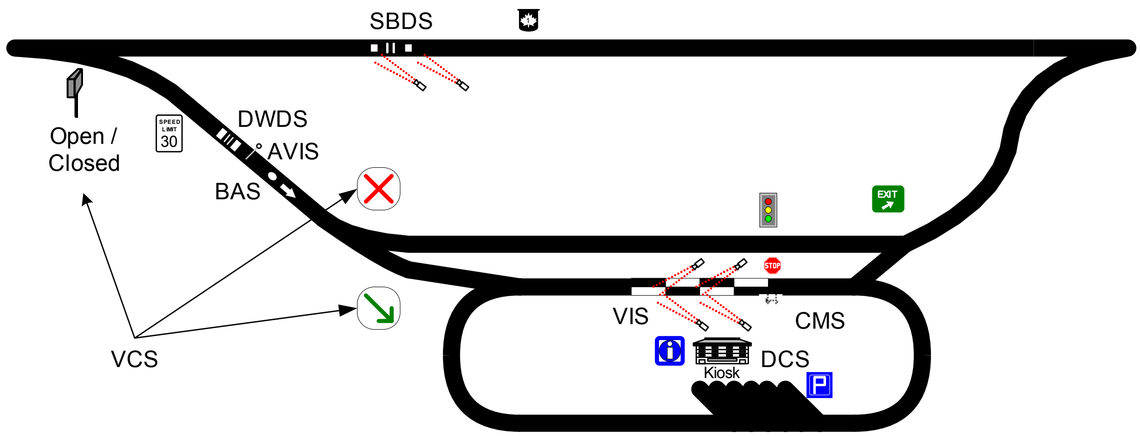

Figure 2. Remote Control Weigh Station System Layout

A vehicle that fails to report is identified by the SBDS tracking system and instantly captures images of the vehicle and its licence plate. Figures 3 and 4 are sample images from an existing virtual weigh station system in operation in the City of Saskatoon, Saskatchewan. An alarm is triggered in the remote location and the information displayed on the remote operator interface. The remote operator can log the violation, generate a report, store the information for future processing, or dispatch an officer to intercept the target vehicle.

Figure 3. SBDS Sample Image – Truck Running Scale

Figure 4. SBDS Sample Licence Plate Image – Truck Running Scale

If the target vehicle complies with the report sort decision it proceeds through a pre-screening area where more detailed analysis of the vehicle can be accomplished. This includes a Dynamic Weight and Dimensions System (DWDS) (Figure 5) and a Brake Analysis System (BAS). Information is collected and merged into a vehicle record which can be interpreted manually by a remote officer or automatically using predetermined criteria. An Advanced system also has a co-located AVIS system which includes the ability to read RFID transponders registered in an EDE program and/or a licence plate reader which could output a licence plate number for similar referencing.

Figure 5. Dynamic Weight and Dimension System (DWDS)

As the vehicle approaches the secondary screening area the enforcement officer can manually direct the vehicle to report to the secondary inspection station using the VCS (overhead lane control signals, a changeable message sign, or a simple red/green traffic signal). If desired, the RCWS can automatically sort the target vehicle based on the pre-established screening criteria and post the sort decision through the VCS.

The secondary screening area allows an enforcement officer to statically weigh the vehicle through the Static Weight Analysis System (SWAS), visually inspect the vehicle using the Visual Inspection System (VIS), and reference EDE information pertaining to the conveyance. Following the measurement of the final axle, a summation of the individual axle weights is calculated to determine the gross vehicle weight. The gross vehicle weight is presented on the operator weight display, as seen in Figure 6, and optionally on a Variable Message Sign (VMS) as part of the Driver Communication System (DCS).

3	4	8	2	0	KG

Figure 6. SWAS Vehicle Weight Display

If further screening is required or an officer desires direct communication with the driver, the enforcement officer posts a message on a changeable message sign (Figure 7) or a VMS advising the driver to park and report to the Kiosk.

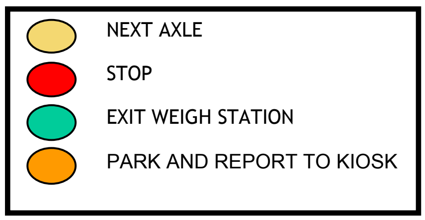

Figure 7. VCS Changeable Message Sign

The kiosk, which can be either a portable building or an existing weigh station structure, is used to communicate with the driver directly through the Driver Communication System (DCS), review driver documentation (drivers licence, vehicle permits, log books, capture driver mugshot, download electronic logbook data, etc.), and allow a vehicle driver an opportunity to look up regulatory information such as weight restrictions or traffic restrictions. If necessary, an enforcement officer can generate a ticket using the DCS in the kiosk.

Voice instructions for the weighing process may also be given to the truck driver with the use of an intercom controlled by the operator. The communication link for the intercom is through the Internet. The intercom speaker is positioned near the static scale and is activated and controlled remotely. The intercom communication link can also be located in the communication kiosk. The operator has control of the system at all times by way of the VCS or the intercom and may periodically instruct random commercial vehicles to report to the kiosk for further inspection.

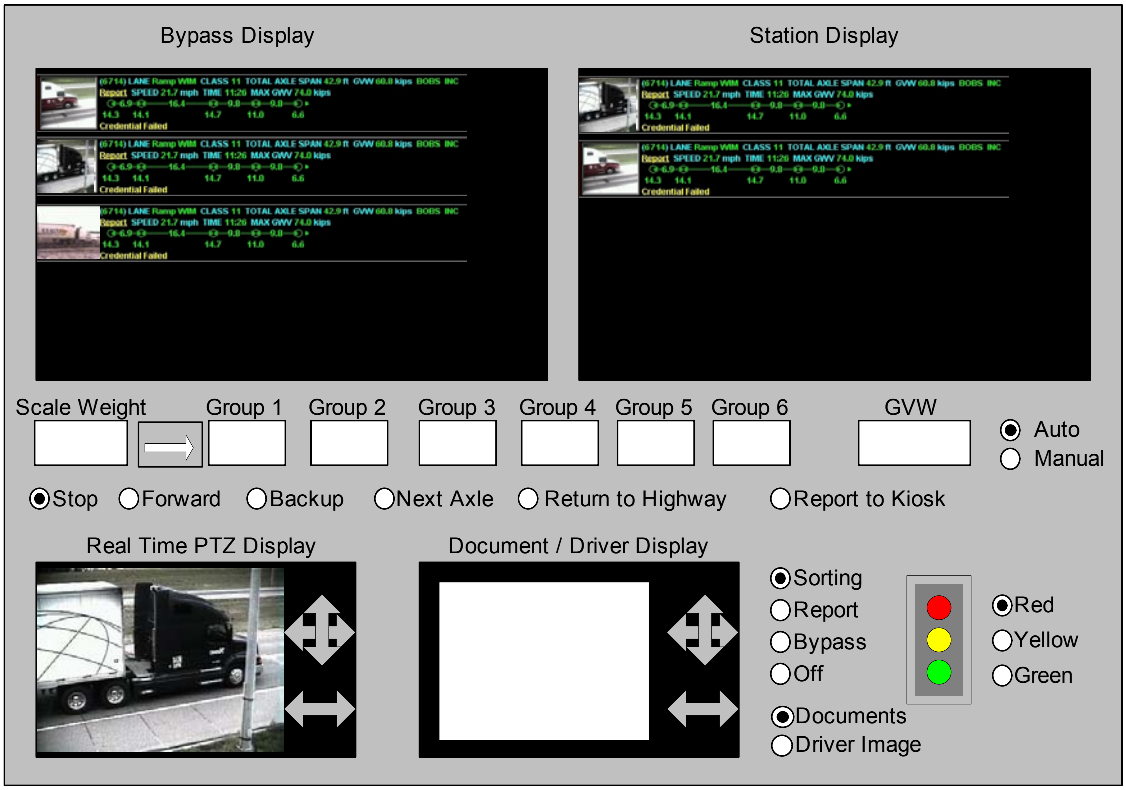

Figure 8. Mock-Up of the Remote Operator's Interface

After an officer has processed the vehicle the system retains data locally for post event processing. The remote officer can retrieve the data and process it at the central location if desired. Once the vehicle has been processed the enforcement officer directs the vehicle to return to the traffic stream.

Figure 8 is an example mock up of a remote operator's interface.

2.5. Failure Modes

Since the system is being controlled remotely, the design team assessed and defined the failure modes for each subcomponent. Each component of the failure mode analysis includes the identification of the component, the effect of the failure, the impact of the failure, and the action that the system will take in the event of the failure (i.e. bypass mode, shutdown, restart, etc.).

In each case, the component was evaluated for impact on driver safety and the impact on the ability of the remote operator to screen commercial vehicles. For example, a confusing traffic signal or message could direct a vehicle to return to the highway or create confusion if the status changed unexpectedly. In this case, alarms may sound and the system reverts to a "safe mode". By contrast, if the BAS stops functioning, it is not critical to the primary function of weighing the vehicle or managing the traffic on site and the system will allow the operator to continue screening commercial vehicles.

2.6. Basic System Subcomponents

The details in the subsequent sections provide the necessary design data to meet the requirements in the functional specification. Further definition of each subsystem is possible; however, the more detailed software and hardware designs were considered part of the follow-on activities for development of the system.

2.6.1. Station Control System (SCS)

2.6.1.1. Operational Concept

All of the subsystems connect to the Station Control System. The System is located at the remote station in either an environmentally controlled cabinet or a kiosk if it exists on site. The Station Control System coordinates all RCWS functionality which receives and distributes the data necessary for each of the subsystems to function properly.

The Station Control Subsystem consists of only one part: the SCS Controller. The SCS controller contains the necessary interfaces to each subsystem including the software and hardware components necessary to process and act on any high priority message within 100 ms. The Station Control System has the ability to process 50 commercial vehicles an hour up to 500 commercial vehicles a day. It monitors the subsystem Health Check Response messages and determines the overall system status.

2.6.2. Station Bypass Detection System (SBDS)

2.6.2.1. Operational Concept

The Station Bypass Detection System (SBDS) is an optional system intended to allow the operator to identify commercial vehicles that have failed to report to the RCWS. It comprises four main components:

- Vehicle Sensors
- Vehicle Camera (optional)
- Licence Camera (optional)
- SBDS Controller

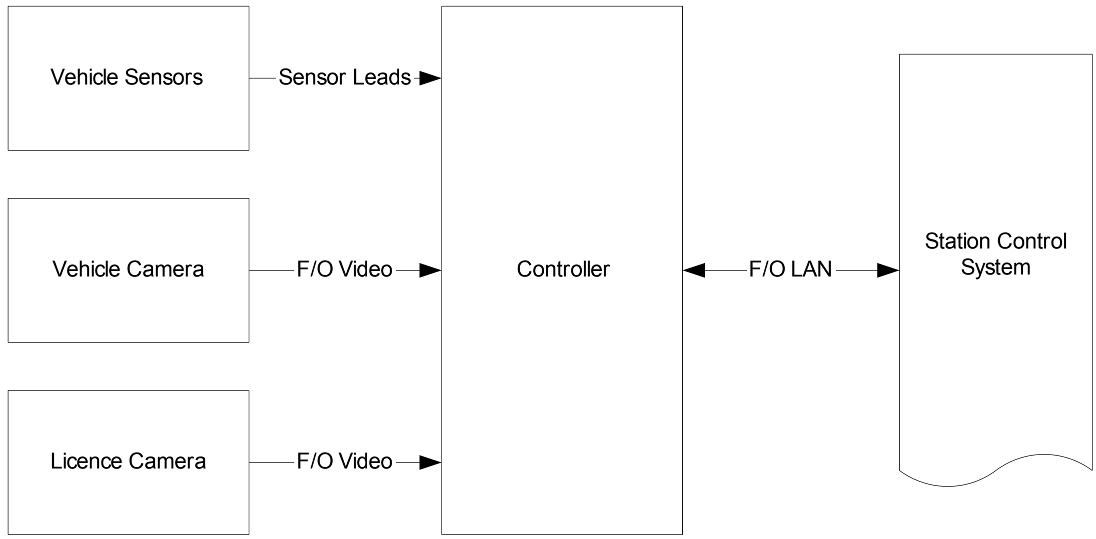

Figure 9. SBDS Component Diagram

2.6.2.2. Vehicle Sensors

The vehicle sensors include all the sensors necessary to classify a vehicle as a commercial vehicle. This may include, but is not limited to, inductive loops, axle detection sensors, weigh in motion sensors, and height detection sensors. The sensors are monitored by the SBDS controller which converts the sensor signals into vehicle characteristics.

2.6.2.3. Vehicle Camera

The SBDS accepts input from a Vehicle Camera. The Vehicle Camera is used to capture recognizable images of commercial vehicles traveling at speeds up to 130 km/h. During the day the images are in colour and at night the vehicle camera works in concert with an infrared illuminator to provide monochrome images. The vehicle camera is triggered by a presence or axle detector sensor connected to the SBDS.

The vehicle camera typically captures a side image of the target vehicle with sufficient resolution to distinguish the vehicle from other vehicles in the general traffic stream. The image is a profile side view of the vehicle.

2.6.2.4. Licence Camera

The SBDS is designed to optionally accept input from a Licence Camera. The Licence Camera is used to capture human readable images of licence plates of commercial vehicles traveling at speeds of up to 130 km/h. The images are monochrome and are capture pictures in both day and night conditions.

2.6.2.5. SBDS Controller

The SBDS Controller accepts input from the Vehicle Sensors and uses this information to determine when a commercial vehicle fails to report to the RCWS. The SBDS Controller captures images from the Vehicle Camera and the Licence Camera and associates them with commercial vehicles that are identified as failing to report to the RCWS. The controller merges the information and stores the date and time for commercial vehicles identified as failing to report to the RCWS and then transmits this information to the Station Control System within 2 seconds of the vehicle passing the vehicle sensors.

Long term data storage is performed by the data collection system (DATAS). However, the SBDS Controller stores all records of commercial vehicles failing to report to the RCWS along with any captured images of these vehicles for 5 days up to a maximum of 100 commercial vehicles.

In the event of loss of communication with the Station Control System the SBDS Controller continues to store vehicle information. The SBDS Controller also transmits a health check message no less than once every 5 minutes. This message includes the status of the SBDS Controller, the Vehicle Sensors, the Vehicle Camera, and the Licence Camera. The SBDS Controller synchronizes date and time to the Station Control System and is always within +/- 250 ms.

2.6.3. Dynamic Weight and Dimension System (DWDS)

2.6.3.1. Operational Concept

The DWDS is an optional system intended to increase the capacity of the RCWS at high volume sites. It gathers information as commercial vehicles travel down the entrance ramp to the RCWS. This information can be used to perform dimension compliance checks, automate the static weighing process, or to pre-screen commercial vehicles to determine if static weighing is required. The DWDS comprises four main components:

- Classification Sensors
- Weight Sensors (optional)
- Overheight Sensors (optional)
- DWDS Controller

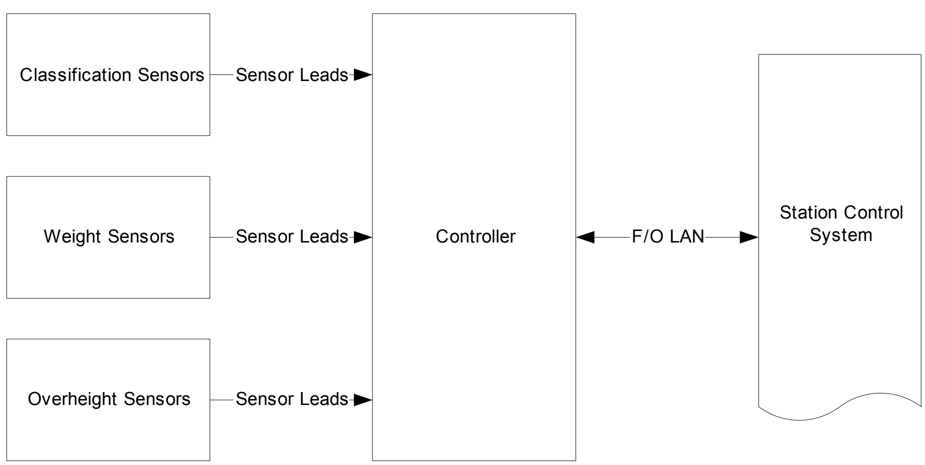

Figure 10. DWDS Component Diagram

2.6.3.2. Classification Sensors

The Classification Sensors include all the sensors necessary to classify a vehicle according to the local compliance scheme. This may include but is not limited to inductive loops and axle sensors.

2.6.3.3. *Weight Sensors*

The DWDS interfaces to ASTM Type I, Type II and Type III WIM sensors. When interfaced to the ASTM Type I, II, or III the DWDS controller conforms to the specifications outlined in ASTM E1318-02. Table 1 lists the functional performance requirements of each type of WIM sensor as defined in ASTM E1318-02. These accuracies assume that the road condition requirements as defined in ASTM E1318-02 have been met such that dynamic loading from site conditions is minimized or eliminated.

Table 1. Functional Performance Requirements for Weigh-In-Motion Systems

Functional Performance Requirements for WIM Systems (Tolerance for 95% Probability of Conformity)			
Function	Type I	Type II	Type III
Wheel Load	+/- 25%		+/- 20%
Axle Load	+/- 20%	+/- 30%	+/- 15%
Axle-Group Load	+/- 15%	+/- 20%	+/- 10%
Gross Vehicle Weight	+/- 10%	+/- 15%	+/- 6%
Speed	+/- 2 km/h (1 mph)		
Axle-Spacing	+/- 0.15 m (0.5 ft)		

2.6.3.4. *Overheight Sensors*

The Height Sensors includes all the sensors necessary to determine if a commercial vehicle exceeds the local height restrictions. The height sensor interfaces directly to the DWDS controller.

2.6.3.5. *DWDS Controller*

The DWDS Controller gathers information from the Classification Sensors. Based on the number of axles and the spacing between axles the DWDS Controller classifies commercial vehicles according to the local compliance scheme. When connected to an ASTM Type II WIM Sensor the DWDS Controller also records the weight of each axle. The DWDS uses this information to determine if the vehicle is in compliance with the local weight restrictions and the enforcement officers screening criteria.

When connected to an ASTM Type I (e.g. piezoelectric sensor), II (e.g. bending plate sensor), or III (e.g. hydraulic load cell) WIM Sensor the DWDS Controller compares the individual axle weights with the commercial vehicles other axle weights to determine if the front to back load distribution is in accordance with local compliance requirements. The DWDS Controller also records the weight of each side of each axle to further analyze compliance with the local weight restrictions. The DWDS Controller compares the driver side and passenger side weights of each axle to determine if the side to side load distribution is within guidelines.

The DWDS Controller gathers information from the Overheight Sensors and uses this information to determine if commercial vehicles are in compliance with local height restrictions. The DWDS Controller combines all information gathered for each vehicle along with the date and time and transmits this information to the Station Control System within 500 ms of the vehicle clearing the last sensor.

Long term data collection is performed by the Data Collection System however, the DWDS Controller stores all vehicle information it gathers along with the date and time for 5 days up to a maximum of 2500 commercial vehicles.

In the event of loss of communication with the Station Control System the DWDS Controller continues to store vehicle information. The DWDS Controller transmits a health check message no less than once every 5 min. This message includes the status of the DWDS Controller, the Classification Sensors, the Weight Sensors, and Overheight Sensors. The DWDS Controller also synchronizes date and time to the Station Control System and will always be within +/- 250 ms.

2.6.4. Brake Analysis System (BAS)

2.6.4.1. Operational Concept

The BAS is an optional system that is intended to identify potentially faulty brakes. The BAS gathers and analyzes brake information as commercial vehicles are traveling down the entrance ramp to the RCWS. Based on the information collected the BAS identifies commercial vehicles with potentially faulty brakes and transmits it to the Station Control System.

The BAS comprises the following components:

- Brake Sensors
- BAS Controller

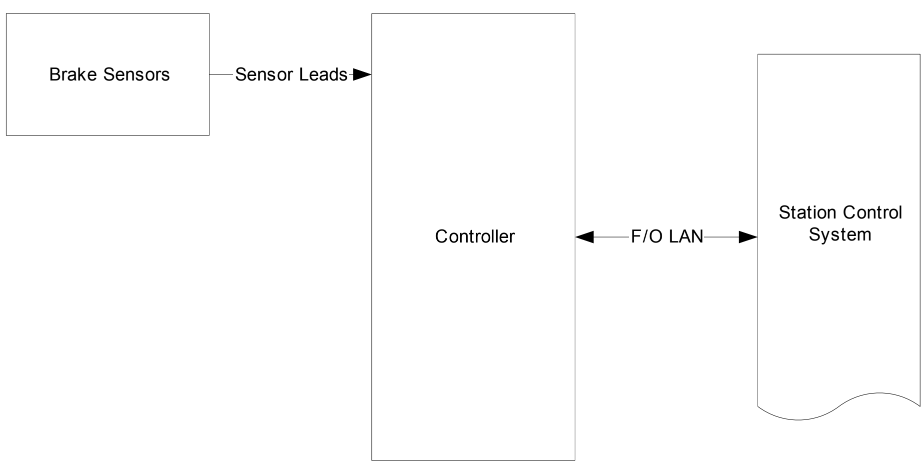

Figure 11. BAS Component Diagram

2.6.4.2. Brake Sensors

BAS systems employ either infrared or shear force technology. The BAS infrared systems produce profile images of the vehicle as it approaches the secondary screening area. Shear systems measure the variations in shear as axles cross a sensor imbedded in the road. The output from either of the BAS systems are analysed by the BAS controller and transmitted to the ROI.

2.6.4.3. *BAS Controller*

The BAS Controller gathers and analyzes information from the Brake Sensors. Based on the analysis of the brake sensor output the BAS Controller determines if the vehicle is likely to have faulty brakes. The BAS Controller merges the results of the analysis for each vehicle with the date and time and transmits this information to the Station Control System within 500 ms of the vehicle clearing the last sensor.

The BAS Controller does not store any information locally and transmits a health check message no less than once every 5 minutes. This message includes the status of the BAS Controller and the Brake Sensors. The BAS synchronizes the date and time to the Station Control System and is always within +/- 250 ms.

2.6.5. Visual Inspection System (VIS)

2.6.5.1. *Operational Concept*

The VIS is an optional system intended to allow a remote operator to visually inspect and identify vehicle that have reported to the RCWS and comprises the following major components:

- Video Clip Camera(s) (optional)[2]
- Licence Plate Camera (optional)[2]
- Real-Time Pan Tilt Zoom (PTZ) Camera (optional)[2]
- VIS Controller

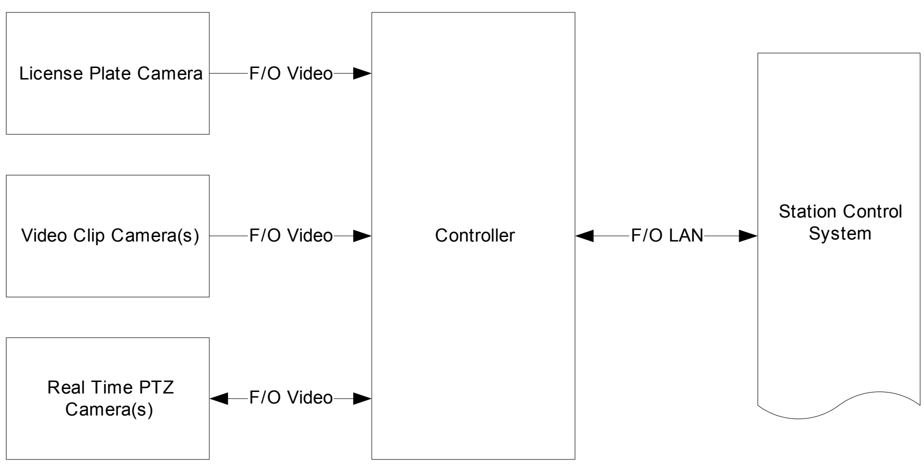

Figure 12. VIS Component Diagram

2: At least one of the optional cameras is required for the operation of the VIS

2.6.5.2. *Video Clip Camera(s)*

Video clip cameras record a short video of the vehicle in the secondary screening area. The video clip cameras allow an operator to review an entire vehicle from front to back for safety issues and replay the transmission should further analysis be required. There are typically two Video Clip Cameras; one camera for each side of the commercial vehicle.

The Video Clip Cameras provide video at a minimum of 320 x 240, 32 bit colour at 15 frames per second and have sufficient resolution to allow an operator to determine whether:

- the load is properly secured
- the load is properly distributed
- the brake lights, signal lights, and headlights are intact

2.6.5.3. *Licence Plate Camera*

The VIS is designed to accept input from a Licence Plate Camera which is used to capture human readable images of licence plates of commercial vehicles traveling at speeds of up to 50 km/h. The images are a minimum of 640 x 480 8 bit grayscale.

2.6.5.4. *Real-Time Pan Tilt Zoom (PTZ) Camera(s)*

The VIS supports up to two Real-Time PTZ Cameras which allow the operator to perform a detailed inspection of a commercial vehicle that is parked in the secondary screening area. The Real-Time PTZ Cameras are able to zoom out to a field of view of 15 m x 11 m which permits an officer to read 40 cm tall text. The cameras possess the ability to zoom in to a field of view of 2 m x 1.5 m which allows the enforcement officer to view 5 cm tall text. The cameras possess 4 frames per second at a resolution of 320 x 240 and 32 bit colour and provide colour video under white light (i.e. illumination is required at night).

2.6.5.5. *VIS Controller*

The VIS Controller accepts inputs from the various camera options. It captures and compresses video clips from the Video Clip Cameras at 320 x 240, 32 bit colour at 15 frames per second which outputs a 500KB file for a 2 second video. If a licence plate camera is added the controller combines the video clip(s) along with the image of the licence plate and the date and time and transmits this data to the Station Control System within 1 second of the vehicle leaving the field of view of the cameras. The controller stores data locally for 1 day up to 500 video clips (250 commercial vehicles if there are two Video Clip Cameras.) Similarly, the VIS Controller stores licence plate images for 1 day up to 500 images.

The VIS Controller receives video from the Real-Time PTZ Cameras, compresses the video, and transmits this video to the Station Control System. There is no more than a 1 second delay when transmitting the compressed video. The VIS Controller receives PTZ commands from the Station Control System and controls the PTZ of the Real-Time PTZ Cameras. The remote operator controls the camera through the ROI which transmits the commands to the Station Control System.

The VIS does not store any Real-Time PTZ Camera video and transmits a health check message no less than once every 5 minutes. This message includes the status of the VIS Controller and each of the cameras. The VIS Controller synchronizes date and time to the Station Control System and is always within +/- 250 ms.

2.6.6. Vehicle Communication System (VCS)

2.6.6.1. Operational Concept

The VCS is an optional system intended to allow a remote operator to safely control the movement of traffic within the RCWS. The VCS components are consistent with the design guidelines for the Manual of Uniform Traffic Control Devices (TAC, 1998).

The VCS comprises the following vehicle communication devices:

- Lane Control Signals (optional)
- Changeable Message sign (optional)
- Variable Message sign (optional)
- Open / Closed sign (optional)
- VCS Controller

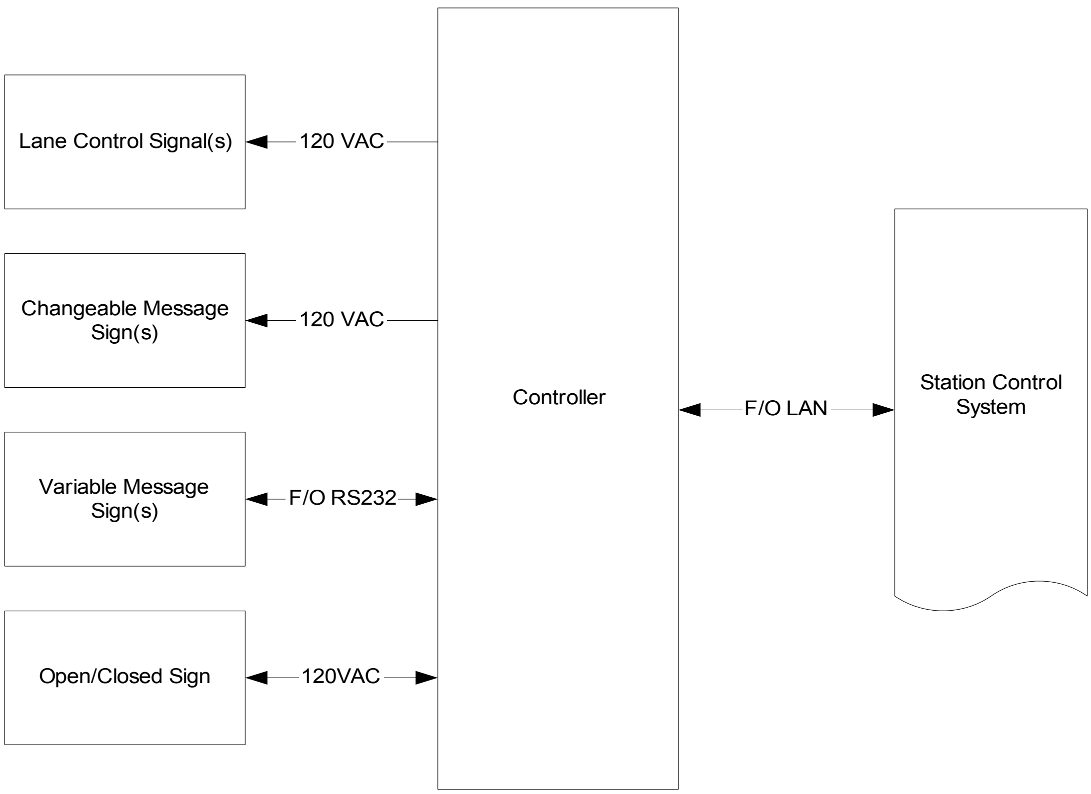

Figure 13. VCS Component Diagram

2.6.6.2. Lane Control Signals

The VCS Controller supports an interface to either a Red/Green Traffic signal or a Red X and Green Arrow traffic signal similar to the one in Figure 14. All traffic signals are clearly visible at a distance ranging from 7 m to 65 m and are either fibre optic or LED technology.

Figure 14. Typical Lane Control Signals (Red X Green Arrow)

2.6.6.3. Changeable Message Sign (CMS)

The CMS accommodates up to 6 messages and typically consists of a painted message sign with an indicator light next to each message. The CMS sign text and indicator lights are visible at distances ranging from 7 m to 30 m. Typical messages may be, but are not limited to:

- Forward
- Next Axle
- Stop
- Backup
- Report to Kiosk
- Return to Highway

2.6.6.4. Variable Message Sign (VMS)

The VMS has up to 2 lines of text with up to 28 characters per line. The VMS messages are visible at distances ranging from 7 m to 30 m. Typical messages are, but are not limited to:

- Forward
- Next Axle
- Stop
- Backup
- Report to Kiosk
- Return to Highway

These messages are programmable through the sign vendor's interface but are not programmable through the RCWS system. In addition to basic traffic management messages, the VMS is capable of displaying the static scale weights for axles, axle groups, and GVW. The VMS sign is normally located in the field of view of the truck driver when they approach or are on the static scale and ideally when within the field of view of at least one PTZ camera (for diagnostic purposes).

2.6.6.5. Open / Closed Sign (OCS)

The Open/Closed Sign is clearly visible at distances ranging from 15 m to 110 m. The OCS is typically either fibre optic or LED technology and interfaces to the VCS controller. The sign is located prior to the weigh station entrance ramp and the status controlled by the enforcement officer remotely.

2.6.6.6. VCS Controller

All of the components of the VCS system connect to the VCS Controller. The VCS controller is activated by the Station Control System. When a VCS Controller receives a message to activate one of the Vehicle Communication Devices, the target device will activate, or change the message and reach full intensity in less than 100 ms. Should the device fail to activate, the VCS Controller reports the failure to the Station Control System within 2 seconds. The VCS Controller transmits a health check message no less than once every minute which includes the status of the VCS Controller as well as the status of each of the vehicle communication devices.

In the event of loss communication with the Station Control System that lasts more than 2 minutes the VCS Controller sets the Open/Closed sign to closed, changes all traffic signals to green, and changes all message signs to indicate that commercial vehicles should return to the highway.

The VCS Controller synchronizes date and time to the Station Control System and is always within +/- 250 ms.

2.6.7. Static Weight Analysis System (SWAS)

2.6.7.1. Operational Concept

The SWAS is intended to allow a remote operator to statically weigh commercial vehicles. Optionally the SWAS Controller can automate the static weighing process. This automation requires input from the DWDS and output to the VCS.

The SWAS Controller supports a serial interface to a scoreboard display or the VMS in the DCS in order to display the weight currently on the scale, the axle group weight, and or the GVW.

The SWAS comprises the following major components:

- Static Scale and Static Scale Totalizer
- SWAS Controller

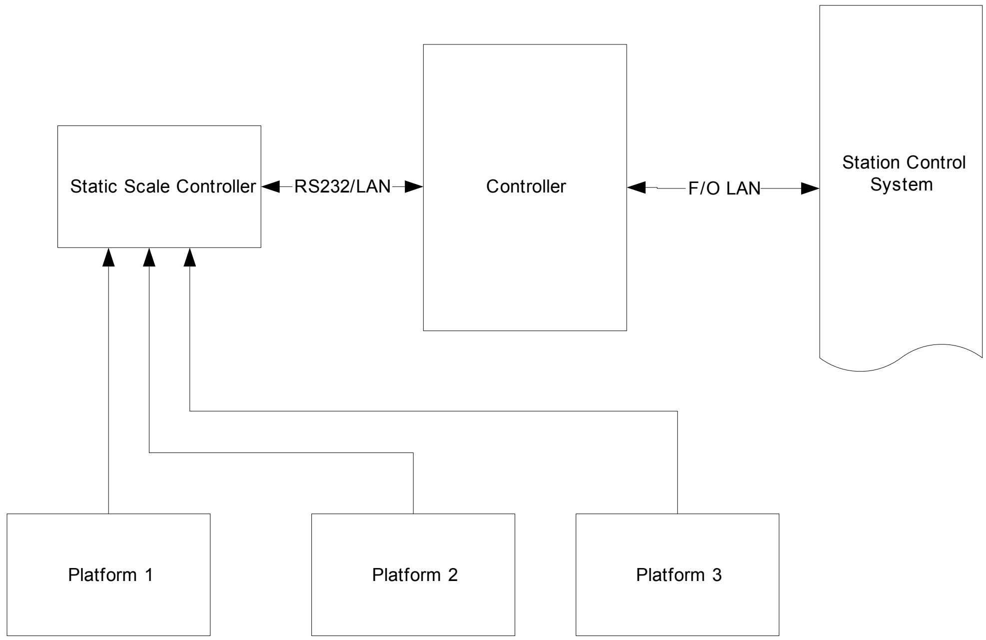

Figure 15. SWAS Component Diagram

2.6.7.2. Static Scale

The SWAS Controller interfaces to new or existing static scales with up to 3 platforms. The SWAS Controller interfaces to static scale weighing platforms with OEM digital controllers that have an industry standard communication output such as an RS 232/422 serial connection or a TCP/IP 10BaseT network interface. The SWAS controller does not interface directly to digital or mechanical static scale load cells.

2.6.7.3. SWAS Controller

Manual Mode

The SWAS Controller receives weights from the static scale controller at rates of up to 2 measurements per second per platform for up to 3 platforms. As an axle(s) rolls onto the scale the SWAS Controller determines when the weight has stabilized and captures the static weight. The SWAS Controller transmits captured static weights to the Station Control System within 1 second of their capture.

Auto Mode

With input from the DWDS and with output to the VCS the SWAS Controller can automate the static weighing process. In auto mode, without operator intervention, the SWAS Controller receives vehicle classification information, determines and transmits the appropriate messages for the VCS to display, captures the static weights for each axle group, and transmits the static weights to the Station Control System. In auto mode the SWAS Controller combines the static weights with the date and time and transmits them to the Station Control System within 2 seconds of the vehicle leaving the static scale. The SWAS Controller takes no longer than 1 minute to weigh a 5 axle truck and automatically releases the vehicle if there are no errors and the vehicle is in compliance with local weight restrictions. If the vehicle is non-compliant with the screening criteria, the system holds the vehicle for a predetermined time and waits for operator input (i.e. if no operator input is received, the vehicle is released).

The SWAS Controller transmits a health check message no less than once every 5 minutes. This message includes the status of the Controller as well as the static scale. The SWAS Controller synchronizes date and time to the Station Control System and is always within +/- 250 ms. While in auto mode, the SWAS Controller stores the static weights for 1 day up to 500 commercial vehicles.

2.6.8. Driver Communication System (DCS)

2.6.8.1. Operational Concept

The DCS is intended to allow a remote operator to communicate with a driver that is on the Static Scale or has entered the local Kiosk. The DCS is essentially an intercom that can be remotely controlled through the Internet, an existing telephone line, or a closed network.

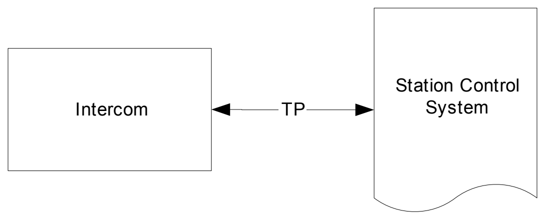

Figure 16. DCS Component Diagram

2.6.8.2. Intercom

The DCS has a Frequency Response of 200 Hz to 8 kHz, +/- 3 dB. The DCS speaker is capable of producing 98 dB @ 1 m and is packaged in a vandal-resistant manner. The DCS speaker volume is manually adjustable on site or remotely.

2.6.9. Document Inspection System (DIS)

2.6.9.1. Operational Concept

The DIS is intended to allow a remote operator to inspect various documents that a driver may be required to produce after the driver has reported to the kiosk. The driver positions the documents on the DIS after receiving instruction through the DCS (intercom).

The DIS consists of the following components:

- Zoom Camera
- DIS Controller
- Driver still image Camera

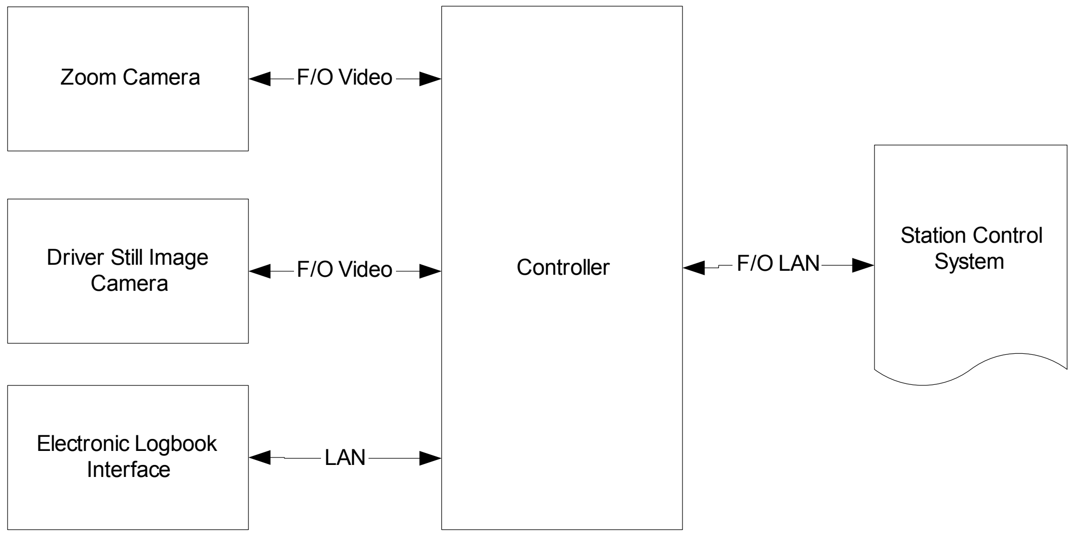

Figure 17. DIS Component Diagram

2.6.9.2. Zoom Camera

The Zoom Camera provides images of the documents in real time to the remote operator. The colour camera is positioned above a countertop and has the ability to zoom out to a field of view of 20 cm x 15 cm. At this field of view, 5 mm text is readable. If required, an operator can zoom in to a field of view of 10 cm x 7.5 cm which allows 2.5 mm characters to be read. The Zoom Camera provides video at a minimum of 4 frames per second at a resolution of 320 x 240 and 32 bit colour. The field of view is illuminated during adverse lighting conditions and at night.

2.6.9.3. Driver Still Image Camera

The Driver Still Image Camera provides an image of the driver in the kiosk. The camera is positioned in front of the driver such that it captures a passport style photograph of the average driver when activated through the remote operator interface. The field of view is 65 cm wide x 90 cm tall a distance of 100 cm from the camera. The colour image is 32 bit colour and has a minimum resolution of 320 x 240. The image camera transmits the image to the controller.

2.6.9.4. DIS Controller

The DIS Controller receives video from the Zoom Camera, compresses the video or image, and transmits this video or image to the Station Control System. There is no more than a 1 second delay when transmitting the compressed Zoom Camera video. The DIS Controller receives zoom and image capture commands from the Station Control System and controls the zoom of the Zoom Camera.

The DIS controller receives the image from the Driver Still Image Camera, compresses the image, and transmits this video to the Station Control System. There is no more than a 5 second delay when transmitting the image to the ROI. The DIS Controller receives the image capture command from the Station Control System.

The controller does not store any video or still images; however, it transmits a health check message no less than once every 5 minutes. This message includes the status of the DIS Controller and the Zoom Camera.

The DIS Controller should have the capability to interface to electronic log books through a portable data device such as a USB jump drive interface, smart card, or other RF communication methods (see Gysel, 2002, for further details). The DIS controller transmits the log information to the Station Control System.

2.6.10. Data Collection System (DATAS)

2.6.10.1. Operational Concept

The DATAS is intended to meet the full range of the data storage requirements for the RCWS. The DATAS collects data from the components through the Station Control system and stores the information on a non-volatile device. The DATAS is not a critical component for the real-time operation of the weigh station and as such, the remainder of the RCWS functionality remains intact if the DATAS is non operational or disabled.

The DCS consists of the following components:

- Data Storage
- DCS Controller

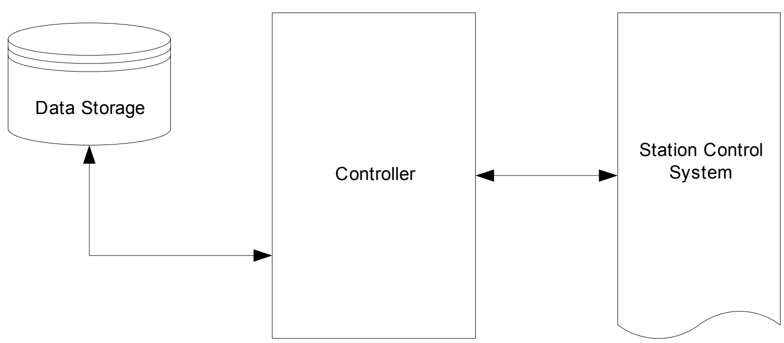

Figure 18. DATAS Component Diagram

2.6.10.2. Data Storage

Data storage capacity is shown in Table 2. Where measurements are concerned, all data is stored in metric.

Table 2. DATAS Estimated Storage Requirements

Item	Length of time	Storage Requirement
SBDS Sensor Information	500 B * 30 Days@ 500 Vehicles / Day	7.5 MB
SBDS Vehicle Camera	40 KB * 30 Days@ 500 Vehicles / Day	600 MB
SBDS Licence Camera 40 KB	40 KB * 30 Days@ 500 Vehicles / Day	600 MB
DWDS Sensor Data	500 B * 10 Days@ 500 Vehicles / Day	2.5 MB
BAS Brake Data	500 B * 10 Days@ 500 Vehicles / Day	2.5 MB
VIS Video Clips 500 KB	500 KB * 10 Days@ 500 Vehicles / Day *2 videos per vehicle	5 GB
VIS Licence Plate Camera 35 KB	40 KB * 30 Days@ 500 Vehicles / Day	600 MB
VCS	None	
SWAS Static Weigh Information	500 B * 10 Days@ 500 Vehicles / Day	2.5 MB
DCS	None	
AVIS RF Tag	5 B * 10 Days@ 500 Vehicles / Day	25 KB
AVIS Licence Plate Number	5 B * 10 Days@ 500 Vehicles / Day	25 KB
DIS Driver Still Image	30 KB * 10 Days@ 500 Drivers /Day	0.15 GB
DIS Zoom Camera Image	30 KB * 10 Days@ 500 Drivers /Day	0.15 GB
ROI / LOI	500 KB * 10 Days@ 500 Vehicles / Day	2.5 GB
	Total	**9.615 GB**

2.6.10.3. DATAS Controller

The Station Control System transmits a single record for each vehicle that includes the combined data from all the various subsystems along with the date and time. The DATAS Controller receives and stores data in real time and can retrieve data based on a date and time range. The DATAS Controller supports windows FTP file transfers of the data in industry standard formats such as ASCI, JPEG, and MPEG formats. The DATAS Controller includes an interface to configure the data elements that are stored to ensure compliance with regional legislation for the storage of information.

The DATAS Controller transmits a health check message no less than once every 5 minutes. This message includes the status of the DATAS Controller and the Data Storage Device.

2.6.11. Remote Operator Interface (ROI)

2.6.11.1. Operational Concept

The ROI is intended to allow an operator to run the RCWS from a remote location. The Remote Operator Interface can run in parallel with one or more remote and local operator interfaces. All data received by the user interface is in metric; however, it is possible to configure all user interfaces to display in metric or imperial units. All operator displays are designed for multi-language support and will initially be implemented in

English and French. It is possible for the operator to print and save certain information contained in the Remote Operator Interface Displays.

The Remote Operator Interface consists of the following interfaces:

- Bypass Display
- Station Display
- Real-Time PTZ Display
- Document / Driver Display
- Status Display

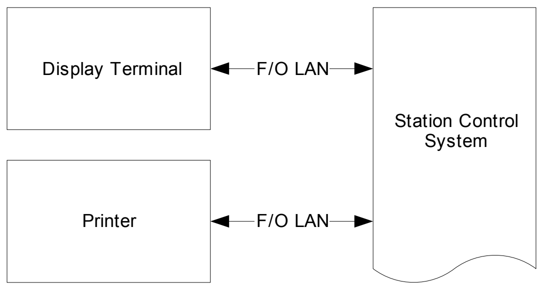

Figure 19. Remote Operator Interface Component Diagram

2.6.11.2. Bypass Display

The Bypass Display normally runs in the background. If a commercial vehicle is detected bypassing the station the Bypass Display gives an audible alert and comes to the foreground on the operator terminal.

The Bypass Display contains the following information for the most recent bypass vehicle:

- Vehicle class
- Vehicle length
- Vehicle axle spacing
- Vehicle speed
- Date and time
- Images from the Vehicle Camera (if present)
- Images from the Licence Plate Camera (if present)

The Bypass Display allows the operator to scroll back in time 5 days of up to 100 commercial vehicles.

2.6.11.3. Station Display

The Station Display has controls for the following:

- The VCS
- Switching between automatic and manual static weighing
- Manual controls for static weighing

The Station Display displays the following:

- The licence plate image of the vehicle on the static scale
- The video clips of the vehicle on the static scale (including controls to play, pause, fast forward, and fast reverse)

- A scrollable screen that allows the operator to view the static weights for the last 20 commercial vehicles that have been on the static scale.

The Station Display also provides the operator with the ability to:

- conduct a historical look up that allows the operator to view records for commercial vehicles that have been on the static scale in the last day up to 500 commercial vehicles.
- view the licence plate image and the video clip of a historical vehicle
- view any of the stored data based on time and date
- print vehicle data and images
- enter and store up to 500 KB of data regarding the vehicle currently on the static scale including driver's licence and logbook information (physical or electronic), checked items status, driver image, and remote operator entered notes.

2.6.11.4. Real-Time PTZ Display

The Real-Time PTZ Display is a 320 x 240, 32 bit colour video with 20:1 compression. The PTZ Display normally runs at 1 frame per 15 seconds and has the controls to pan, tilt, and zoom the camera. While the PTZ Display is selected the Station, Document, and Status Displays are disabled. No new data will be displayed until the PTZ Display is deactivated.

2.6.11.5. Document / Driver Display

The Document Display is a 320 x 240, 32 bit colour video with 20:1 compression. The Document Display normally runs at 1 frame per 15 seconds. The Document Display provides the operator with the controls to zoom the camera. While the Document display is selected the Station, PTZ, and Status Displays are disabled. No new data will be displayed until the Document Display is deactivated.

The operator is able to freeze an image of the driver in the kiosk who is positioned in front of the still image camera using the ROI. The operator has the capability to store the image if desired and associate it with the screening event.

2.6.11.6. Status Display

The Status Display shows the current status of each of the subsystems as reported in the health check messages.

2.7. Local Operator Interface (LOI)

2.7.1. Operational Concept

The LOI is intended to allow an operator to run the RCWS on site. The LOI has the same functionality as the ROI. See section 2.6.11 for details.

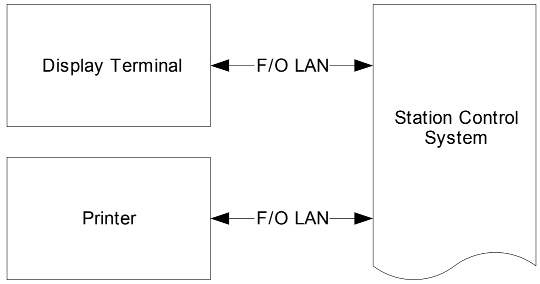

Figure 20. Component Diagram of the LOI

2.8. Communication System (CS)

2.8.1. Operational Concept

The CS is intended to provide the communication link between the Station Control System and the Remote Operator Interface. The communication system employs a firewall at the RCWS site. The firewall is configured to allow access to the RCWS from approved remote operator stations but will block all access from all other locations. In general, any message designated as high priority takes no longer than 300 ms to pass through the communication system.

RCWS with a Real-Time PTZ Camera or a Document Camera require a communication link with a minimum upload data rate of 100 KB/s. In remote locations these data rates can be provided through a commercial satellite service provider.

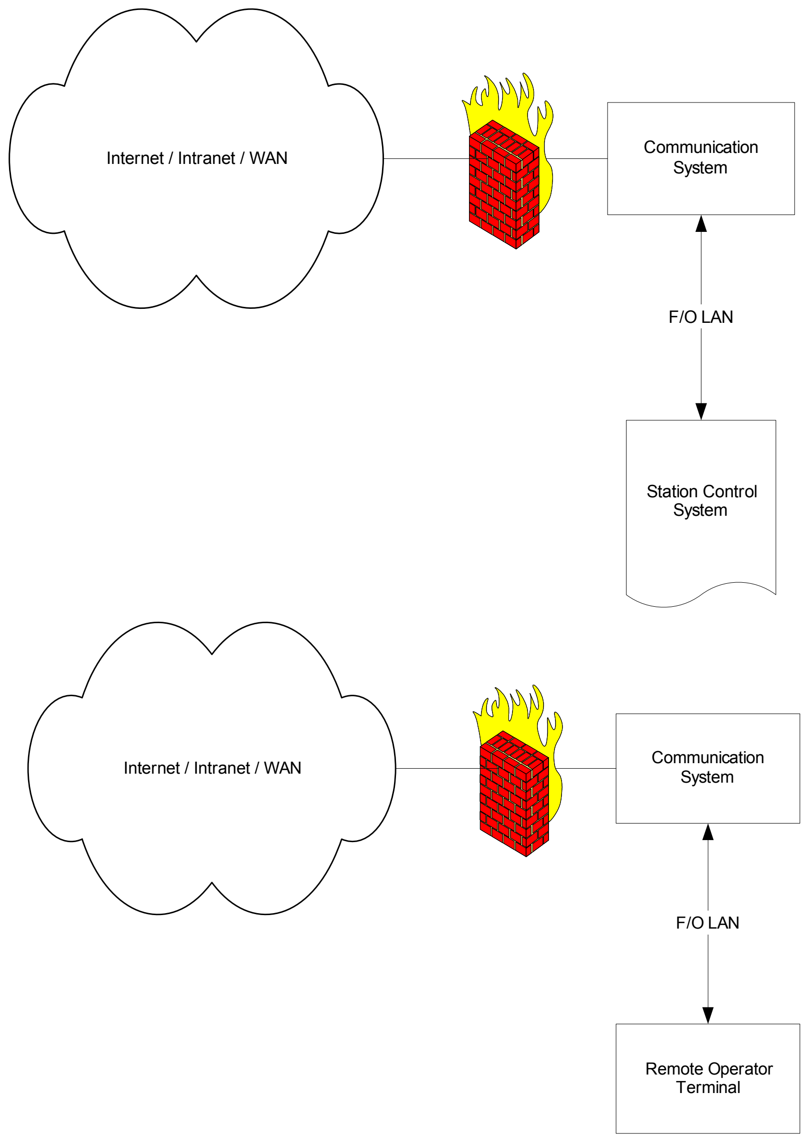

Figure 21. Component Diagram of the CS

2.9. Advanced System Subcomponents

The advanced RCWS system comprises three subsystems which enhance the basic RCWS systems and would also be significant enhancements to a conventional weigh station. The subsystems provide increased automation of information gathering and expand an enforcement officer's and vehicle operator's access to information outside of the regional area. The following subsystems are described in subsequent sections:

- Automatic Vehicle Identification System
- EDE interface
- Regulatory Information System

It is also plausible to move the SWAS, AVIS, and elements of the DCS subsystems in advance of the weigh station ramp. High speed screening is in operation throughout North America and could be added to the Basic or Advanced Systems without significant additional design and development. The Mainline component, although referenced in the economic analysis, was not part of the design process. The integration of the mainline elements is considered a follow-on activity.

2.9.1. Automatic Vehicle Identification System (AVIS)

2.9.1.1. Operational Concept

The AVIS is an optional system that is intended to allow the RCWS to automatically and positively identify a vehicle without operator input. This can be accomplished through the use of either radio frequency identification (RFID) or object character recognition (i.e. a licence plate reader). The AVIS output can be used to look up commercial vehicle information in an EDE database and is typically co-located with the DWDS.

The AVIS consists of the following components:

- High Speed RFID system
- Licence Plate Reader (optional)
- AVIS Controller

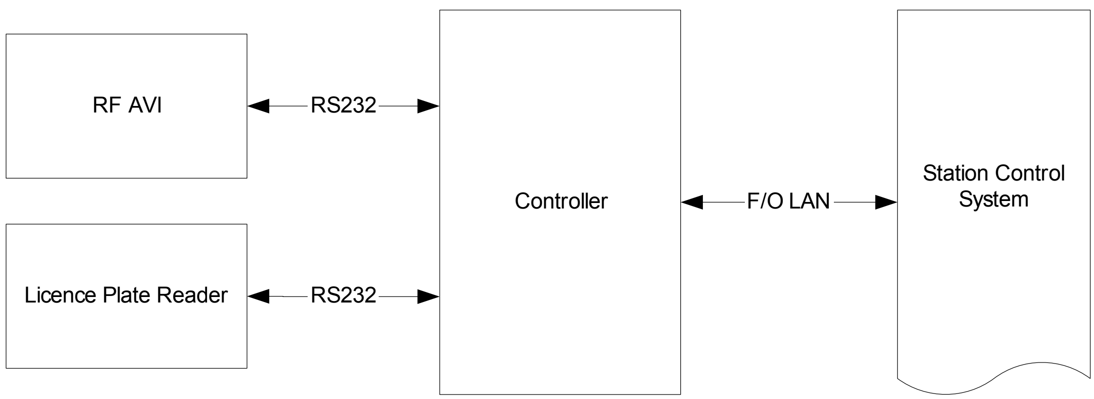

Figure 22. AVIS Component Diagram

2.9.1.2. RFID AVI

The RF AVI reads RF transponders which are compliant with ASTM v6 Slotted-Aloha Time Division Multiple Access (TDMA) protocol. The RFID system transmits the RF transponder number to the AVIS Controller. The RF reader reads RF transponders in vehicles traveling at speeds from 0 to 60 km/h and successfully reads 99% of the compliant transponders.

2.9.1.3. Licence Plate Reader (LPR)

The LPR captures images of commercial vehicle licence plates and performs Optical Character Recognition (OCR) to determine the licence plate number and the plate issuing jurisdictions. The LPR performs the OCR within 30 seconds of imaging a readable licence plate on vehicles traveling at speeds from 0 to 60 km/h.

The LPR performs OCR for licence plates from a minimum of 3 predefined jurisdictions and successfully identifies the licence number and jurisdiction for 60% of the licence plates from the predefined jurisdictions.

2.9.1.4. AVIS Controller

The AVIS Controller receives AVI information from the RFID system and/or Licence Plate Reader. The controller combines the AVI information with the date and time and transmits this data to the Station Control System within 1 second of receiving it. The Station Control System processes the information and provides the interface to external data clearinghouses such as an EDE database.

The AVIS Controller transmits a health check message no less than once every 5 minutes which includes the status of the AVIS Controller as well as the RFID system and the LPR. The AVIS stores AVI information for one day up to 500 commercial vehicles. The AVIS Controller synchronizes date and time to the Station Control System and is always within +/- 250 ms.

2.9.2. Regulatory Information System (RIS)

2.9.2.1. Operational Concept

The RIS is intended to allow commercial vehicle operators to examine Commercial Vehicle Operations regulations for up to 5 predefined jurisdictions. The RIS also has an interface which permits vehicle operators and kiosk visitors to check their safety rating on the local jurisdiction’s web site.

The RIS consists of the following components:

- Driver Terminal
- RIS Controller

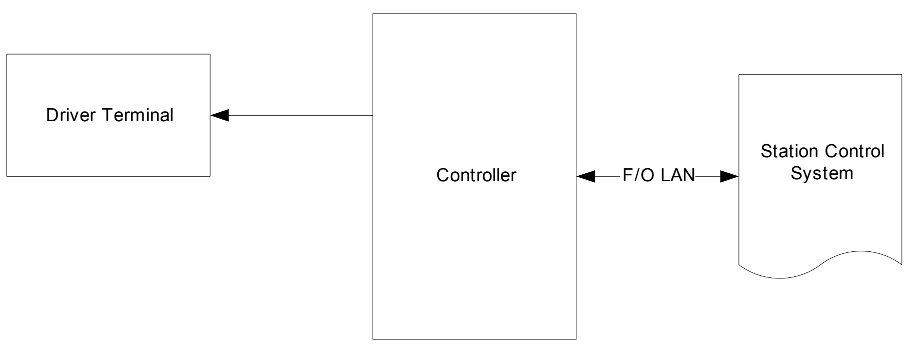

Figure 23. RIS Component Diagram

2.9.2.2. Driver Terminal

The Driver Terminal is packaged in a rugged vandal resistant manner and has a simple user interface designed for users who are not familiar with computers.

2.9.2.3. RIS Controller

The RIS Controller accepts information updates from the Station Control System. The RIS Controller transmits a health check message no less than once every 5 minutes.

2.9.3. Electronic Data Exchange (EDE) System

2.9.3.1. Operational Concept

The EDE System is intended to automatically screen commercial vehicles credentials in an EDE database using the output from the AVIS system, permit the remote operator to establish EDE screening criteria, and retrieve data on specific vehicles. The EDE System is SAFER 4.2 compliant and consists of the following components:

- EDE Controller
- EDE Data Storage

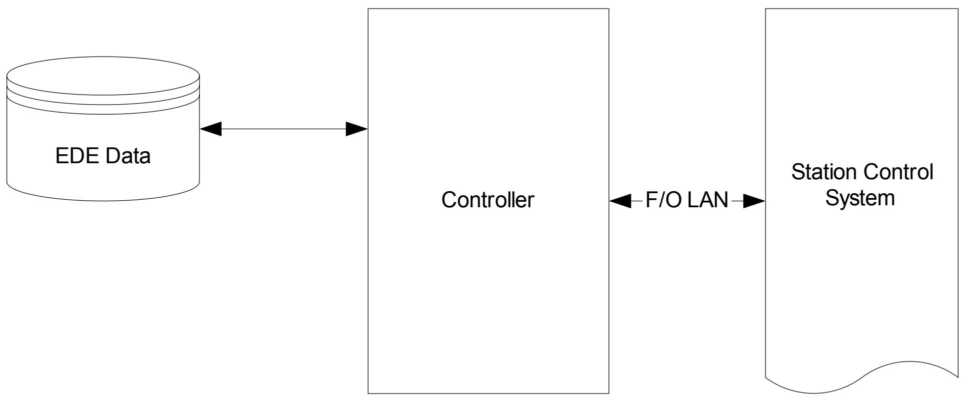

Figure 24. EDE Component Diagram

2.9.3.2. EDE Controller

The EDE controller receives AVIS system data and retrieves snapshot carrier data from the EDE database. The EDE information is transmitted to the Station Control System in real time and used for automated screening or as additional information for the remote enforcement operator.

2.9.3.3. EDE Data

The EDE data is a snapshot of the national data and is updated through an automated process. Data is downloaded to site through existing enforcement jurisdiction systems. The data is secured against both electronic and physical theft to ensure confidentiality.

2.10. Sources of Funding

One of the advantages of the RCWS is its low cost to implement and operate compared to a conventional weigh station and inspection facility. Despite an estimated capital investment of less than $300,000.00 and low operating costs, funding must be secured to implement RCWS system. There are two methods for funding a project such as the remote control weigh station. The first is the traditional method, whereby an agency obtains funding from a government and the second is in a Public Private Partnership (PPP).

Under a more traditional model, the agency must develop a plan to use the systems, based on the benefits, and positive B/C analysis such as the one included in this report. The agency develops a budget to incorporate these systems into their existing program. Money will thereby be available from the agency (in this case provincial) infrastructure, and operational funds. In most cases, these state or provincial funds may be supplemented by federal funds for innovative applications of technology (such as the ITS Office), or through other capital project deployment pools that are generally operational in nature.

Regardless, if an agency opts to fund the systems, the agency will have to develop the plans and specifications, and develop a purchasing method consistent with the procurement policies. The agency will also have to decide on the issue of maintenance and repairs to equipment. The agency could procure the RCWS, maintain it and plan for upgrades, or decide to buy the initial systems, and hire the supplier to perform maintenance. There is a risk to the agency under these types or arrangements as the agency is responsible to justify the continued funding for maintenance and upgrades.

Under a PPP, there is an arrangement where the agency simply defines the operational standards required and then enters into an agreement with a partner to use systems as a service. Under a PPP, the supplier is responsible for managing the maintenance and upgrades, as part of the supply and installation. Under a PPP, the agency may take responsibility to supply and manage the hard assets such as poles, concrete, buildings and other elements that are more easily accommodated within the normal civil construction practices. But in general, the concept is for the third part private sector supplier to accept responsibility to supply, maintain and upgrade the systems to meet an operational standard.

3. HOLISTIC BENEFIT-COST ANALYSIS OF A REMOTE CONTROL WEIGH STATION

3.1. Background

Cross-border trade throughout North America has increased considerably over the past two decades. As well, transport deregulation and rationalization has resulted in a significant modal shift to road transport. As a result, the transportation industry throughout North America has experienced significant and rapid growth. Consequently, the number of commercial vehicles on roads today, as well as their average tonne-kilometres hauled, has increased significantly.

Currently there are over 700 commercial vehicle inspection stations operating throughout North America. It is estimated that these enforcement facilities conduct approximately 160 million commercial vehicle weight-checks and 1 million vehicle/driver safety inspections per year. However, with the increasing transportation demands over recent years, conventional commercial vehicle inspection stations are becoming incapable of effectively monitoring commercial vehicle weights and dimensions, as well as safety compliance. This growth in commercial trucking has caused many commercial vehicle inspection stations to exceed their original traffic design capacities.

Originally, commercial vehicle enforcement facilities were strategically placed to provide optimal enforcement across the entire road network. However, increasing commercial trucking and the expansion of a diverse North American road system since the 1960s have resulted in decreased effective commercial vehicle monitoring and enforcement in many jurisdictions. As well, many of the facilities at permanent weigh stations are currently in need of retrofit in order to meet present day building code and occupational health and safety (OH&S) requirements.

Due to increasing commercial traffic and worsening performance of many public roads, there is a growing need for commercial vehicle monitoring and enforcement, not only on primary haul corridors, but also on lower-volume, high-tonnage arterial and collector roads subjected to high portions of commercial vehicle traffic in both rural and urban networks. However, the capital required for the construction and operation of additional fixed weigh station facilities is costly, as summarized in Table 3.

Table 3. Construction and Operational Costs of a Conventional Weigh Facility

	$/Facility
Annual Personnel Costs	$ 150,000
Annual Maintenance	$ 50,000
Facility Capital – low capital upgrade	$ 1,000,000
Facility Capital – high capital upgrade	$ 2,500,000

Over recent years, there have been significant improvements in ITS for application to commercial vehicle enforcement. Therefore, road owners are now investigating the use of intelligent commercial vehicle monitoring systems, such as remote weight enforcement and video surveillance technology, to assist in the monitoring of heavy trucks operating within their specific jurisdictions. Given the advancements of semi-automation of many of these technologies, remote controlled surveillance of the road network, including lower-volume/high-tonnage roads, as well as improved coverage of primary roads, is now both technically and economically feasible.

In more extreme cases of overloaded vehicles, the additional damage inflicted onto the roadway can significantly accelerate rutting, fatigue cracking, and eventual structural failure. The potential increased occurrence of overloaded commercial vehicles can cause a decrease in the life span of a roadway by decreasing the roadways serviceability, as depicted in Figure 25.

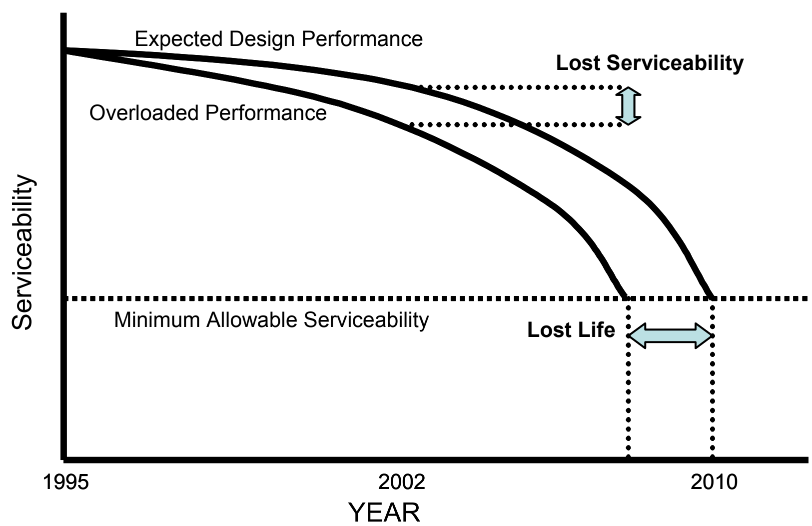

Figure 25. Loss of Serviceability and Life Due to Excess Loading
(Bushman and Berthelot, 2003)

3.2. Benefit-Cost Analysis Framework

Given the diversity of available technologies, as well as their associated costs, accuracies, and reliability, road agencies require a whole-life cycle benefit-cost analysis framework from which to evaluate various potential deployments and integration of various enforcement technologies. This analysis framework can then be used to best serve the overall objective of the road agency structural asset and logistics management strategy. This chapter provides a whole life cycle benefit-cost analysis framework from which to evaluate remote controlled commercial vehicle monitoring and enforcement systems. The financial evaluation framework categorizes road transport costs and benefits in terms of the road agency, road users and society as a whole.

3.2.1. Road Agency Financial Factors

Agency costs and benefits are generally used to assess the efficiency of implementing various infrastructure systems. These costs are directly related to the capital, preservation and operation required by an agency when managing a system. Agency costs are typically categorized as follows:

- Capital infrastructure of road and supporting facilities
- Roadway land value
- Whole life preservation, maintenance and operations activities
- Policy and administration
- Enforcement operation
- Enforcement facility capital
- Whole life infrastructure capital asset deterioration

Remote control weigh stations can be used as a tool to optimize road asset preservation initiatives by improving the effectiveness of enforcement efforts. The overall amount of savings that can be realized through the integration of remote control weigh station technologies depends heavily on the desired level of enforcement, the effectiveness of the new level of enforcement, and the extension of roadway infrastructure life that is realized as a result of the system implementation. However, previous studies conducted by Trischuk and Berthelot (2002), which were based on bypassing vehicles converted into Equivalent Single Axle Loads (ESALs), have shown the WIM systems to be effective at:

- Reducing the overall number of ESALs bypassing a weigh station at facilities near higher traffic areas, and;
- Increasing the accuracy of overweight truck detection at enforcement facilities.

These results indicate that a remote control weigh station with mainline sorting WIM technology could have significant potential to increase the overall effectiveness of commercial vehicle monitoring at weigh facilities, and may significantly reduce the costs associated with rehabilitating existing weight stations, as well as significantly reduce costs associated with operating and maintaining weigh stations.

3.2.2. Road User Financial Factors

Road user costs and benefits are those directly quantifiable from the user's actions of owning, operating and maintaining a vehicle for transportation use. These costs can increase in strong relation to roadway deterioration and congestion. User costs and benefits may be categorized as follows:

- Vehicle operating costs
- Vehicle capital and financing costs
- Travel and delay time, related to roadway congestion and weigh station inspections
- Safety costs, such as direct crash damages, personal security and public health

The user benefits resulting from economic prosperity, which are dependent on transport, can also be considered when performing the user cost analysis of a roadway. In addition, road users need to be grouped into public users and commercial road users, as the severity of roadway damage differs between the two groups.

3.2.3. Society and Environmental Financial Factors

Due to the significant impacts that vehicle emissions have on the environment as outlined in The Kyoto Protocol (1997), environmental costs are now becoming a significant analysis component of transport activities and are being included in transportation investment and management decisions. As a result, world transportation agencies are becoming increasingly aware of the importance of including environmental costs in addition to conventional agency and user costs in order to protect the environment. By including environmental impact costs, road agencies will be able to explicitly quantify environmentally sustainable transportation systems that account for the reduction of greenhouse gas emissions and pollution. As well, eventual proactive emissions prevention and mitigation systems can be further developed to significantly reduce environmental health damages from transportation activities. Social financial factors relating to transport can be categorized into the following:

- Air pollution, including greenhouse gas emissions
- Noise pollution
- Water pollution caused by changes in the groundwater quality and flow due to surface changes
- The consumption of natural resources, such as petroleum, asphalt cement, aggregates, etc.
- Waste disposal of harmful solids and materials
- Land use issues created by transportation activities and infrastructure management
- Pavement damages causing reduced infrastructure performance
- Safety from the public's perspective
- Economic productivity as related to transport and benefit to Canada

To quantify savings in fuel consumption and therefore emissions generation, environmental costs involved with transportation must be quantified. However, transportation costs related to air pollution are known to be external, variable, and non-market (Bein, 1997). External (or indirect) means there are several steps between an activity and its ultimate outcome. Variable (or marginal) costs are incremental and result from an incremental change in consumption, and so reflect costs that can be reduced by decreased consumption. Non-market goods are those that are not regularly traded in the market, such as clean air. Because of these characteristics, these costs are difficult to quantify, and it has been common practice to ignore them in transport financial decisions and/or to incorporate them qualitatively rather than quantitatively.

However, it is better to quantitatively approximate environmental costs to avoid the tendency to value environmental damages as being irrelevant to the specific analysis being performed. Although, valuing non-market goods is often a difficult and indirect science, one technique for quantifying non-market goods is through measuring the value of marginal change in these resources, in terms of damage costs, or control/prevention methods.

Air pollution costs are one of the most often cited external costs resulting from transport activities. External air pollution costs comprise both human health and environmental damage. Therefore quantifying air pollution costs requires information about vehicle emissions rates, the impacts these pollutants have on human mortality, crop damages, wildlife, aesthetics, and climates; as well as unit values on each of these impacts (Bein, 1997).

One method for calculating a financial statement of emissions costs is emissions resulting directly from fuel consumption. For the case of this research, a fuel based emissions model for heavy trucks was used. Specifically the model combines vehicle activity data through volume of fuel consumed, with emissions factors normalized to fuel consumption such as mass of pollutant emitted per unit volume of fuel burned (Dreher and Harley, 1998).

To ensure that non-market environmental goods have consistent values, it is necessary to have uniform reference values of costs per unit of impact or incremental impact reduction. Transportation project evaluation increasingly incorporates shadow prices of non-market costs and benefits, including valuation of travel-time savings, accident reduction, and environmental impacts.

Under the Kyoto Protocol (1997), Canada has committed to reduce its greenhouse gas emissions by 15% below 1990s levels during the 2008-2012 period. Reduction in emissions produced by various modes of transportation is one of the largest components in meeting the target. Transportation emissions in Canada accounted for 26% of total greenhouse gas emissions production in 2001. Road transportation contributed to 71% of the total emissions, 32% of which was from heavy duty vehicles. This translates to 43 megatonnes of greenhouse gas emissions, or 23% of the total Canadian emissions in 2001.

Also heavy freight vehicles account for a large portion of the vehicle kilometres traveled, combined with relatively low fuel mileage as compared to private vehicles reducing emissions produced by heavy vehicles would significantly lower the overall production of transportation emissions. However, truck traffic has been increasing over recent years due to the evolution of trade, as well as the need for suppliers to deliver goods in just-in-time in order to optimize serviceability with the transportation and logistics costs. To illustrate, in Canada about 671,000 commercial trucks were registered in 2001 (Nix, 2003).

There are also significant short-heavy haul operations in Canada, especially related to Canada's heavy resource industry. An inherent disadvantage to short-heavy haul is the relatively high proportion idle time during loading and unloading, as well as stop-and-go operational conditions. As well, short heavy haul is often concentrated in resource based regions operating on undeveloped terrain with poorer road structural conditions. This further results in lower overall vehicle fuel efficiency because of increased road roughness and low structural road stiffness, increasing dynamic load effects and rolling resistance of heavy trucks. All these factors further reduce fuel efficiency and significantly increase air emissions.

As a result, from a road transport policy perspective designed to optimize social impacts, there is a need to calculate the environmental benefits of changing policies related to commercial vehicle operations. For that reason, the development of an advanced commercial vehicle operations model will significantly improve the ability to quantify alternate transport policies in terms of emissions costs is warranted.

The emissions unit rates calculated in the model were compared to national published emissions volumes. Unit emissions costs were estimated in order to quantify typical emissions costs, based on published values from researchers and agencies worldwide, including:

- U.S. FHWA (Federal Highway Cost Allocation Study – 1997)
- Victoria Transport Policy Institute, B.C. (Transportation cost and benefit analysis – June 2003)
- U.S. Transportation Research Board (Estimating the benefits and costs of public transit project – TCRP Report 78 -2002)
- U.S. Transportation Research Board (TRB – 1999)
- IBI Group (Inclusion of environmental costs in transportation pricing – 1996)
- Australian Greenhouse Office (25th Australian Transport Research Forum – October 1996)
- European Commission (Transportation cost and benefit analysis – June 2003)
- UC Davis Institute of Transportation Studies (Delucchi et al. report – 1996)
- Transfund New Zealand

Unlike road user and road agency financial factors, society factors are often not directly quantifiable. These costs are generally non-market and indirect, leading to difficulties in determining a quantifiable relationship between a transportation infrastructure and its impact on society. The incorporation of RCWS into a commercial vehicle weight enforcement program is projected to have the following effects on the societal factors of transportation:

- An overall reduction in the amount of vehicle congestion due to the creation of more favourable free-flow traffic conditions
- An increase in the amount of emissions generated by truck traffic stop-and-go conditions due to a level of enforcement effort that is greater than present efforts
- An increase in enforcement exposure, which will reduce the occurrence of overloading and therefore reduce incremental safety impacts
- An overall improvement in roadway and driver safety
- Improved pavement level of service due to free-flow traffic conditions and reduced occurrences of commercial vehicle overloading

3.3. Remote Control Weigh Station Benefit-Cost Analysis

The increasing costs associated with providing efficient and effective road transport and the excessive demand put on the North American commercial vehicle monitoring systems has caused road agencies to look for methods of creating more effective and efficient commercial vehicle enforcement systems. The proposed remote control weigh station technology provides alternate solutions that can be incorporated into existing inspection facilities or be used to replace proposed new facilities.

The personnel costs of maintaining and operating weigh station facilities is rising continuously. As well, many permanent weigh stations are currently in need of major overhaul in order to meet required building codes. Upgrading a weigh station has been estimated to cost anywhere from $1,000,000 to $2,500,000. Although the projected life span of these facilities are approximately 30 years, when considering the part-time manning of many of the permanent facilities, the benefit cost return appears to be economically unrealistic in terms of returned value of enforcement time relative to the investment made.

3.3.1. Incremental Agency Benefit-Cost Analysis

A conventional weigh station generates annual operation costs of approximately $200,000 for personnel and maintenance requirements. The estimated cost associated with upgrading substandard weigh facilities is approximately $1,000,000 as a low-level upgrade estimate, and $2,500,000 for the sites requiring more extensive upgrades. Assuming an inflation rate of 4% per year, the estimated costs to construct and operate a conventional weigh station as considered over a 30-year time frame are summarized in Figures 26 and 27.

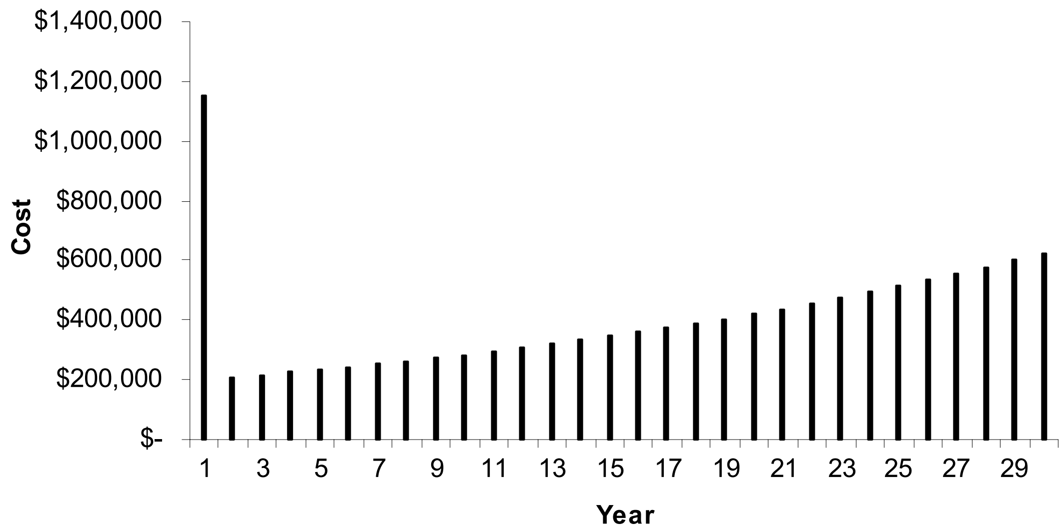

Figure 26. 30 Year Agency Cost Analysis of a Low-Upgrade Conventional Weigh Station

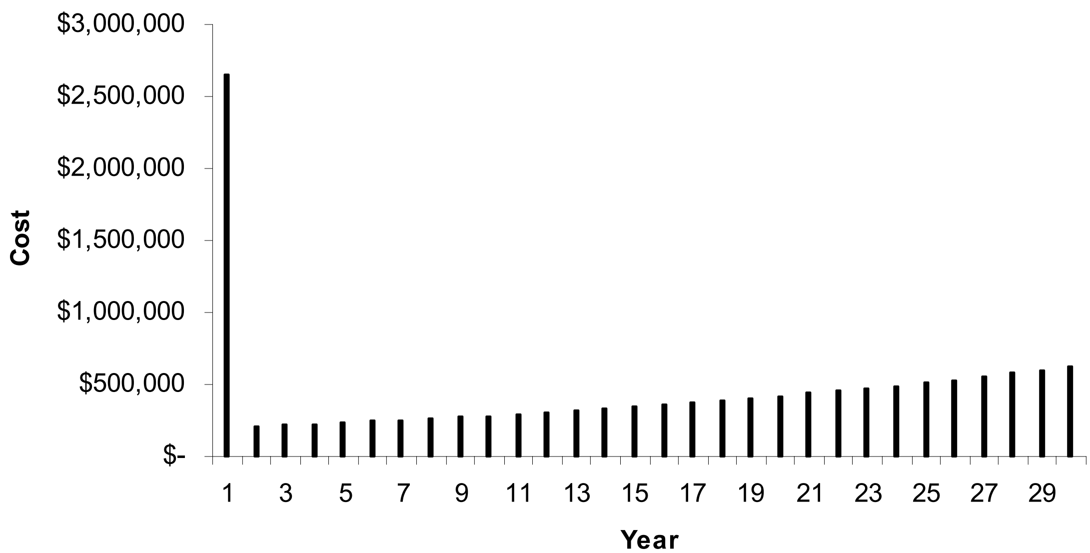

Figure 27. 30 Year Agency Cost Analysis of a High-Upgrade Conventional Weigh Station

The 30-year cost flow of a conventional weigh station was analyzed based on the capital cost of facility upgrade being assumed in the first year of operation and subsequent maintenance performed thereafter. However, the weight enforcement facility is assumed to be operational throughout the entirety of the 30-year time frame, therefore requiring personnel every year of the analysis. The present worth of the annual costs associated with running a conventional weigh station over a 30-year period, as well as those associated with upgrading said weigh station, is estimated to range approximately from $6,950,000 to $8,450,000. This equates to an equivalent annual cost of approximately $232,000 and $282,000 per weigh station facility, respectively.

In contrast, the initial capital cost of integrating a Remote Control with or without a Mainline WIM system into an existing weigh facility is approximately $300,000 to $200,000, respectively. This cost includes automated weighing, video capture technology and internet access to the WIM system output. Static scales may also be integrated in order to facilitate the transition from high to low volume traffic. This system is controlled remotely and allows for numerous sites to be operated from the same location on a continuous basis, thereby requiring less personnel effort to maintain the efficiency of enforcement initiatives. In addition, the implementation of an RCWS system will provide significantly higher enforcement coverage on a continuous basis, as opposed to a random basis.

In order to maintain the operational status of the RCWS, annual standard maintenance of approximately 15% of the capital cost should be forecasted. With such maintenance, the system can be expected to perform for approximately 10 years without requiring further upgrades. To provide for an indefinite life span of the remote system, including technological upgrades, approximately 20% of the capital cost should be forecasted to ensure the technical relevance of the overall system and operation, as well as preventive maintenance. This latter option is especially relevant when dealing with facilities operating with truck traffic exposure of 100 trucks per hour or more. The remote WIM maintenance cost alternatives, as well as the installation and labour cost estimates used for this benefit-cost analysis are as summarized in Table 4.

Table 4. Remote Control and Mainline WIM Weigh Station Capital and Operation Costs

Capital/Operation Cost Category	Conventional Weigh Station Cost Estimate	RCWS Cost Estimate	RCWS with Mainline WIM Cost Estimate
Capital Installation	$ 1,000,000 to $ 2,500,000	$ 200,000	$ 300,000
Standard Annual Maintenance	$ 50,000	$ 30,000	$ 45,000
Preventative Annual Maintenance	$ 50,000	$ 40,000	$ 60,000
Annual Personnel Costs	$ 50,000	$ 50,000	$ 50,000

Based on a 30-year time frame at an assumed inflation rate of 4%, the remote weigh station cash flow analyses for both the 15% (annual basic maintenance) and 20% (annual maintenance and upgrades) maintenance regimes are summarized in Figures 28 and 29, respectively.

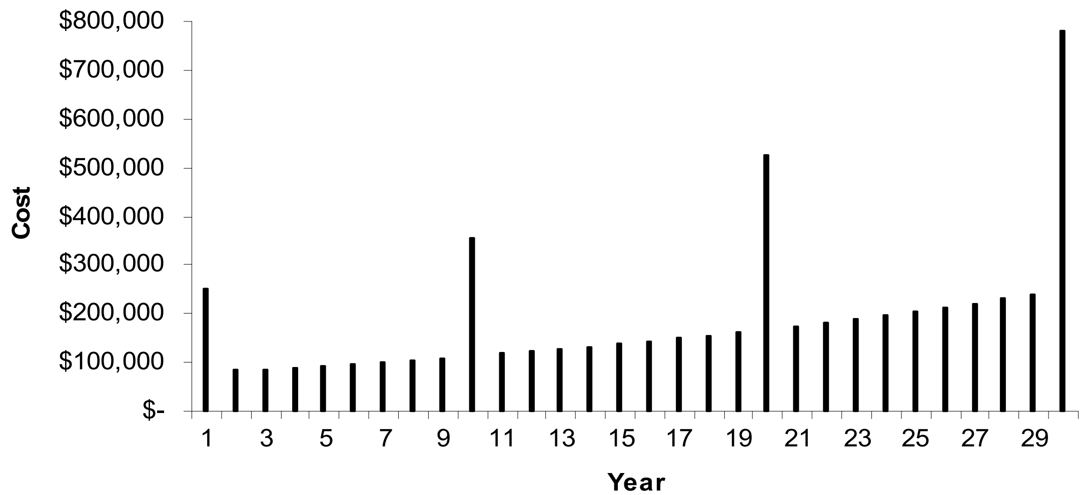

Figure 28. 30 Year Agency Cost Analysis of an RCWS with Basic Annual Maintenance

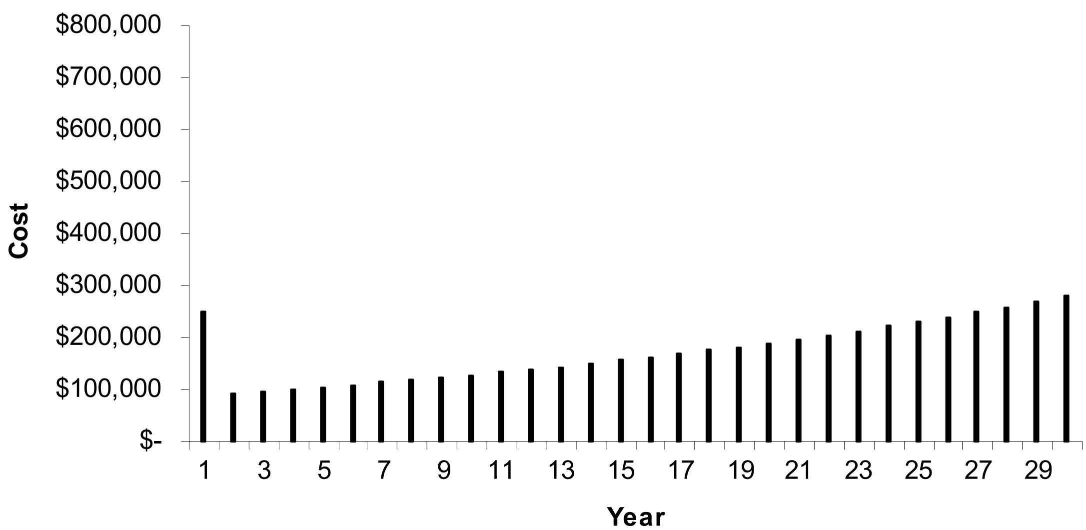

Figure 29. 30 Year Agency Cost Analysis of an RCWS with Preventive Maintenance

Based on the same 30-year time frame at an assumed inflation rate of 4%, the remote weigh station with mainline WIM cash flow analyses for both the 15% (annual basic maintenance) and 20% (annual maintenance and upgrades) maintenance regimes are summarized in Figures 30 and 31, respectively.

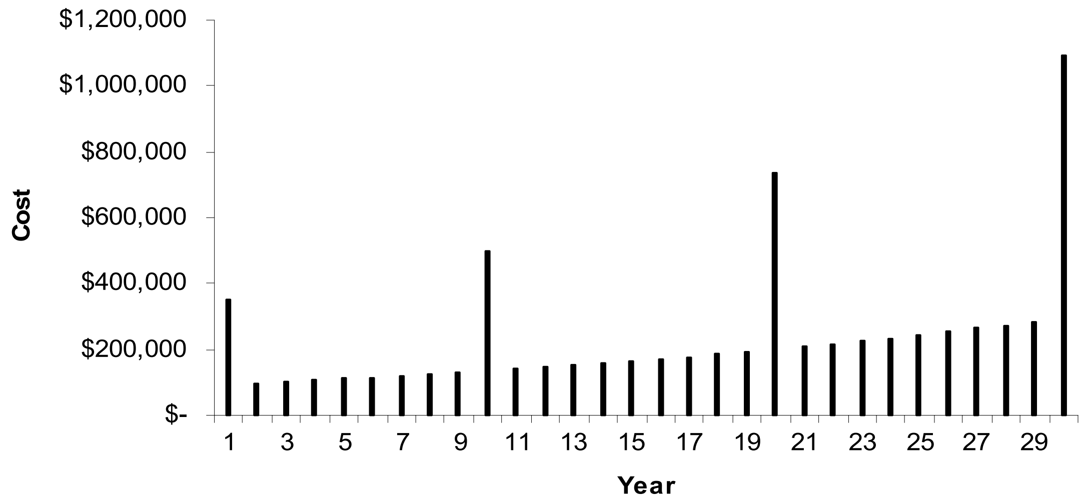

Figure 30. 30 Year Agency Cost Analysis of an RCWS with Mainline WIM Sorting and Standard Maintenance

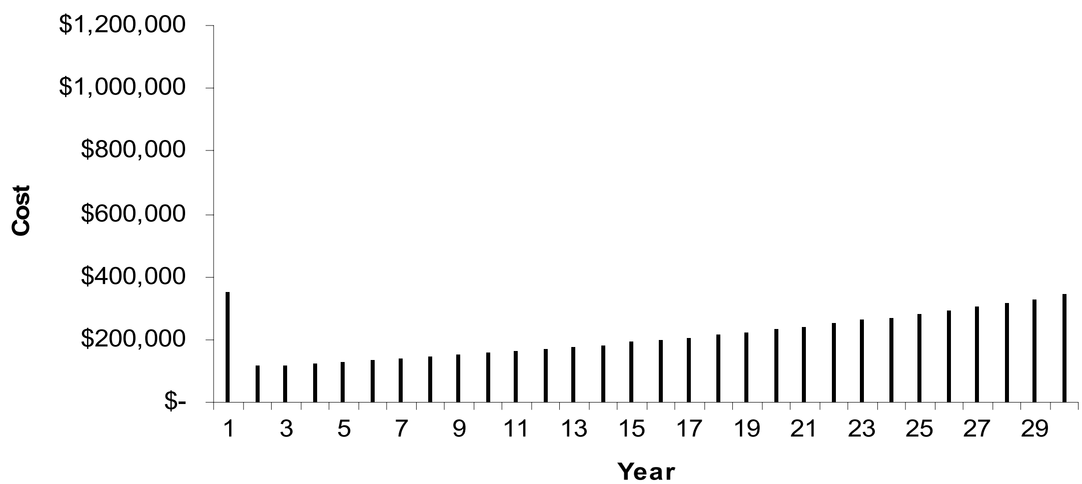

Figure 31. 30 Year Agency Cost Analysis of an RCWS with Mainline WIM Sorting and Preventive Maintenance

The 30 year analysis of the conventional weigh station requiring a low estimated upgrade of $1,000,000 vs. the RCWS with and without mainline WIM sorting alternatives produces total capital and operational costs, as well as present and annual worth estimates as summarized Table 5.

Table 5. 30 Year Agency Capital-Operation Cost Analysis

30 Year Cost Category	Conventional Weigh Station	RCWS		RCWS with Mainline WIM Sorting	
		Standard Maintenance	Preventive Maintenance	Standard Maintenance	Preventive Maintenance
Facility Upgrade	$ 1,000,000	$ 950,000	$ 200,000	$ 1,350,000	$ 300,000
Maintenance	$ 1,450,000	$ 810,000	$ 1,160,000	$ 1,215,000	$ 1,740,000
Personnel	$ 4,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000	$ 1,500,000
Present Worth	$ 6,950,000	$ 3,260,000	$ 2,860,000	$ 4,065,000	$ 3,540,000
Annual Worth	$ 231,667	$ 108,667	$ 95,333	$ 135,500	$ 118,000

Based on the present worth costs of the remote and mainline WIM sorting weigh station alternatives as compared to the conventional weigh station operating costs with a $1,000,000 estimated capital upgrade cost, the estimated 30 year savings are as summarized in Table 6 and Figure 32.

Table 6. 30 Year Agency Savings for an RCWS with and without Mainline WIM Sorting

RCWS		RCWS with Mainline WIM Sorting	
Standard Maintenance	Preventive Maintenance	Standard Maintenance	Preventive Maintenance
$ 3,690,000	$ 4,090,000	$ 2,885,000	$ 3,410,000

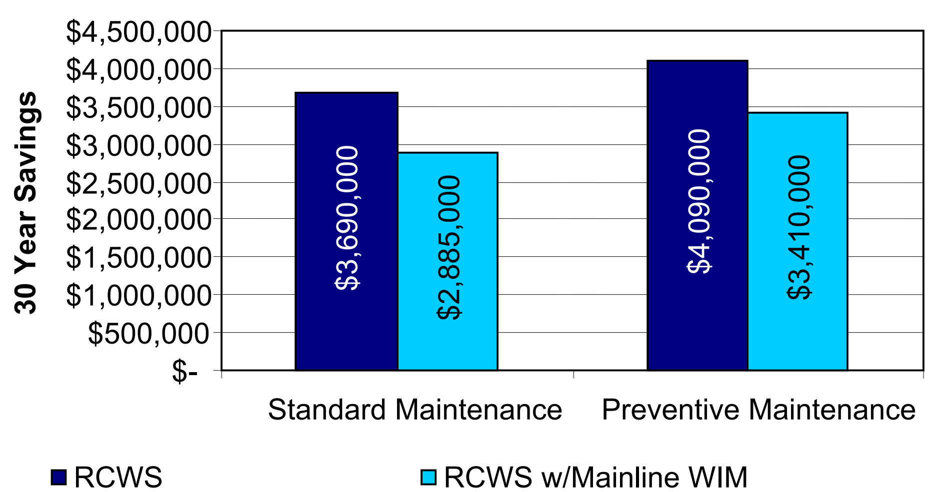

Figure 32. 30 Year Agency Savings Analysis of an RCWS with and without Mainline WIM Sorting

The subsequent 30 year benefit-cost ratios of the remote weigh station alternatives with and without mainline WIM sorting are as summarized in Table 7 and Figure 33:

Table 7. Remote Control and Mainline WIM Sorting Weigh Station Agency Benefit-Cost Analysis

Benefit-Cost Ratio	RCWS		RCWS with Mainline WIM Sorting	
	Standard Maintenance	Preventive Maintenance	Standard Maintenance	Preventive Maintenance
	1.13	1.43	0.71	0.96

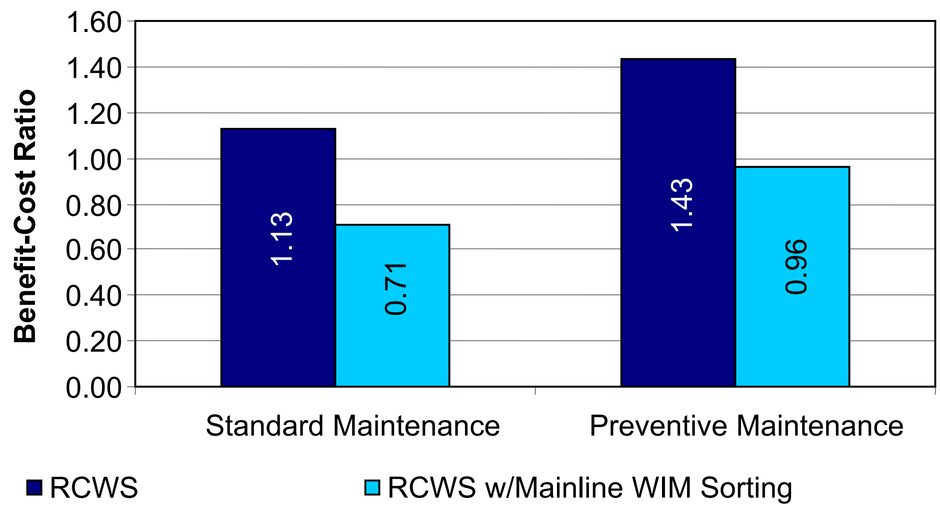

Figure 33. Agency Benefit-Cost Analysis of Remote Control WIM vs. Mainline Sorting WIM Weigh Facilities

Based on a comparison of the capital cost of $2,500,000 required to upgrade a conventional weigh station facility vs. the remote weigh station with and without mainline WIM sorting, the following benefit-cost ratios, as summarized in Table 8 and Figure 34, are achievable:

Table 8. Remote Control and Mainline WIM Sorting Station Agency B/C Analysis for High-Cost Conventional Station Upgrades

Benefit-Cost Ratio	RCWS		RCWS with Mainline WIM Sorting	
	Standard Maintenance	Preventive Maintenance	Standard Maintenance	Preventive Maintenance
	1.59	1.95	1.08	1.39

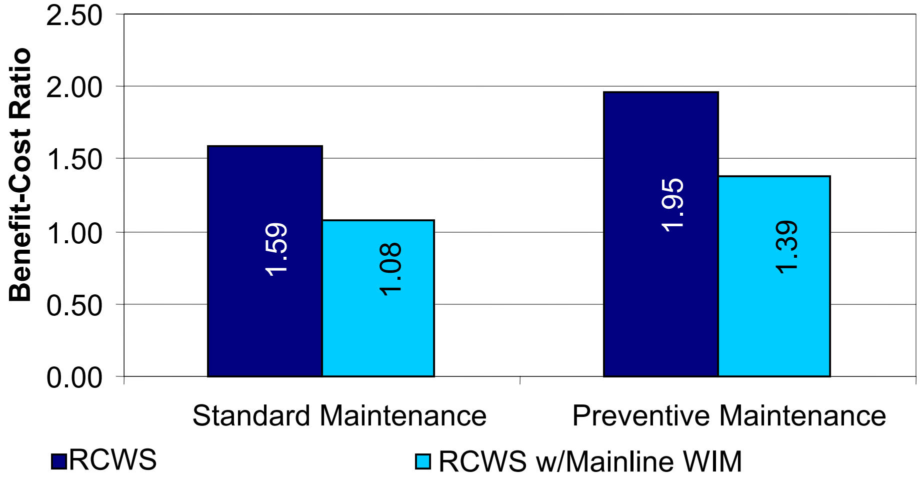

Figure 34. Agency B/C Analysis of Remote Control WIM vs. Mainline Sorting WIM Weigh Facilities for High-Cost Conventional Station Upgrades

3.3.2. Agency Benefit-Cost per Truck Analysis

A 30-year analysis of conventional weigh station facilities (with capital upgrades of $1,000,000) vs. remote weigh stations with or without mainline WIM sorting stations that the capital and maintenance costs as compared to the number of commercial vehicles weighed at a facility generally equates to a low cost-per-truck monitoring system. Based on traffic volumes of 200, 400 and 600 trucks per day (T/day), and assuming 10% and 90% enforcement level scenarios to account for periods of inactivity, the cost per truck enforced over a 30-year time frame is as summarized in Table 9, Figure 35, and Figure 36, respectively.

Table 9. Agency Cost per Vehicle per Enforcement Alternative

Traffic Volume (T/day)	Enforcement Level	Conventional Weigh Station	RCWS		RCWS with Mainline WIM Sorting	
			Standard Maintenance	Preventive Maintenance	Standard Maintenance	Preventive Maintenance
200	10%	$ 31.74	$ 14.89	$ 13.06	$ 18.56	$ 16.16
400	10%	$ 15.87	$ 7.44	$ 6.53	$ 9.28	$ 8.08
600	10%	$ 10.58	$ 4.96	$ 4.35	$ 6.19	$ 5.39
200	90%	$ 3.53	$ 1.65	$ 1.45	$ 2.06	$ 1.80
400	90%	$ 1.76	$ 0.83	$ 0.73	$ 1.03	$ 0.90
600	90%	$ 1.18	$ 0.55	$ 0.48	$ 0.69	$ 0.60

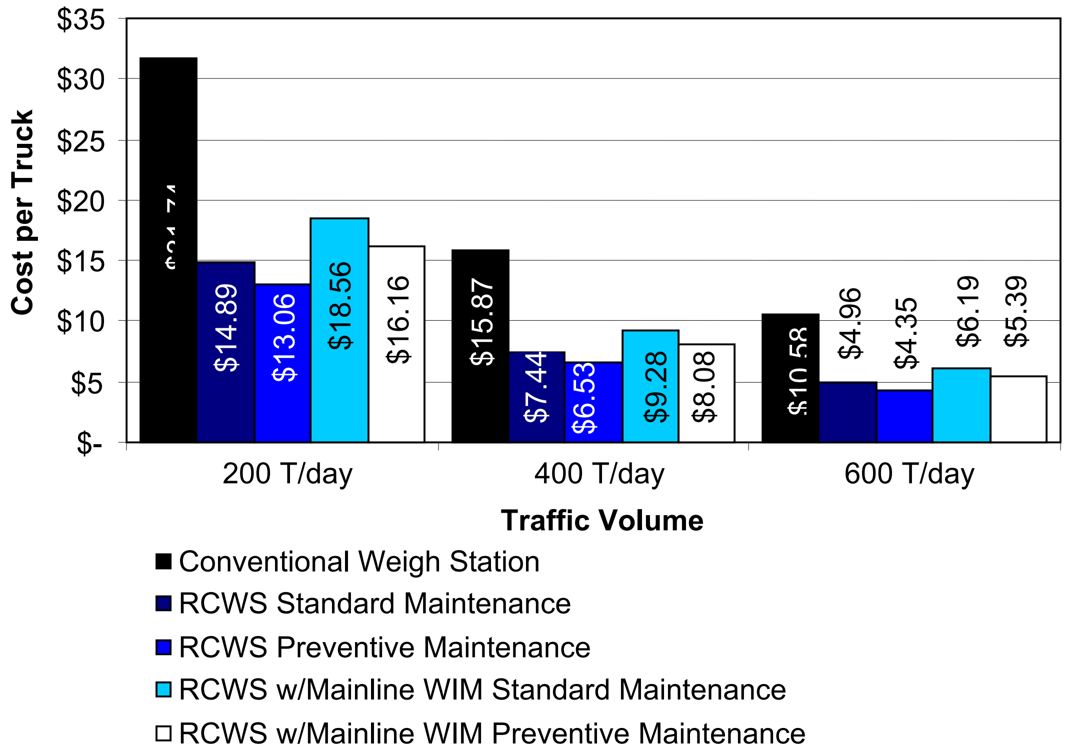

Figure 35. Agency Cost per Truck (10% Enforcement Scenario)

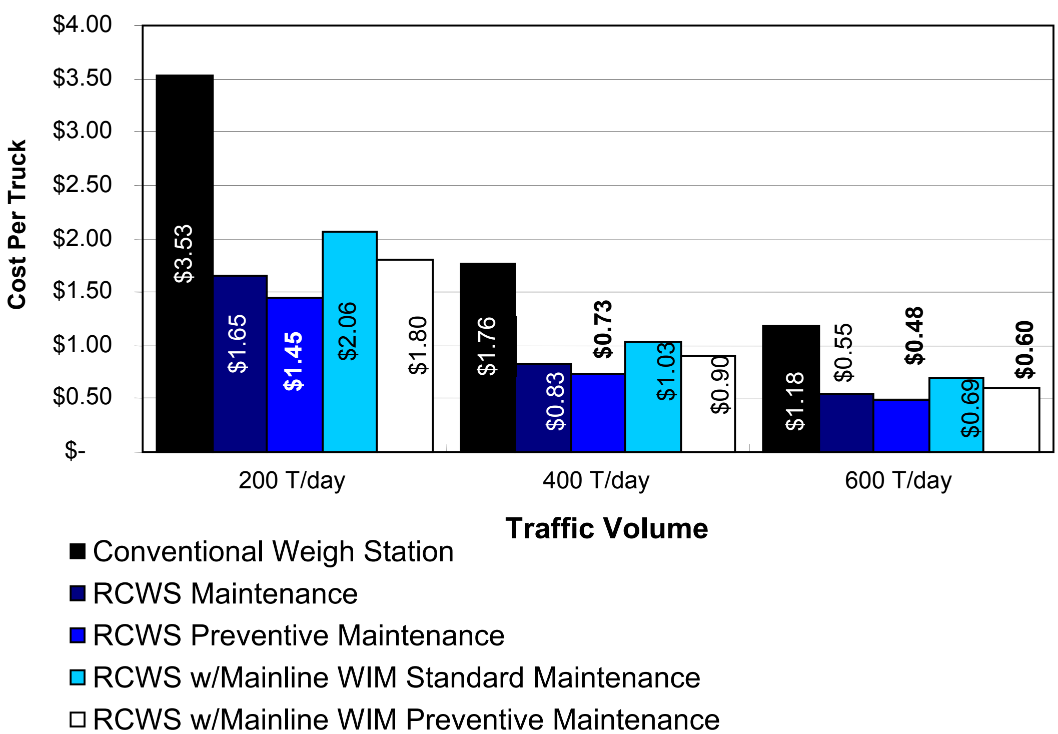

Figure 36. Agency Cost per Truck (90% Enforcement Scenario)

Assuming that more capital is required to upgrade the conventional weigh station facility ($2,500,000), the following Table 10, Figure 37 and Figure 38 summarize the agency cost per truck for 10 and 90% enforcement levels:

Table 10. Agency Cost per Vehicle per Enforcement Alternative (Upgrade of Conventional Weigh Station)

Traffic Volume	Enforcement Level	Conventional Weigh Station	Remote Control WIM		Mainline Sorting WIM	
			Standard Maintenance	Preventive Maintenance	Standard Maintenance	Preventive Maintenance
200 T/day	10%	$ 38.58	$ 14.89	$ 13.06	$ 18.56	$ 16.16
400 T/day	10%	$ 19.29	$ 7.44	$ 6.53	$ 9.28	$ 8.08
600 T/day	10%	$ 12.86	$ 4.96	$ 4.35	$ 6.19	$ 5.39
200 T/day	90%	$ 4.29	$ 1.65	$ 1.45	$ 2.06	$ 1.80
400 T/day	90%	$ 2.14	$ 0.83	$ 0.73	$ 1.03	$ 0.90
600 T/day	90%	$ 1.43	$ 0.55	$ 0.48	$ 0.69	$ 0.60

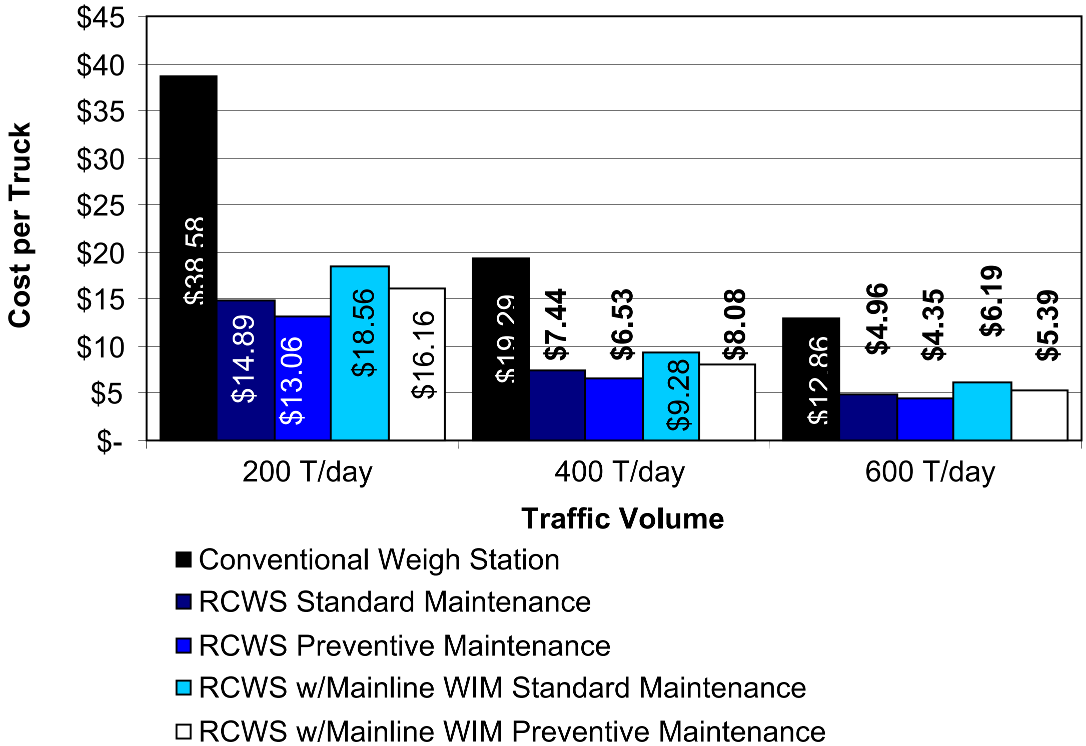

Figure 37. Agency Cost per Truck Considering a Conventional Weigh Station Upgrade (10% Enforcement Scenario)

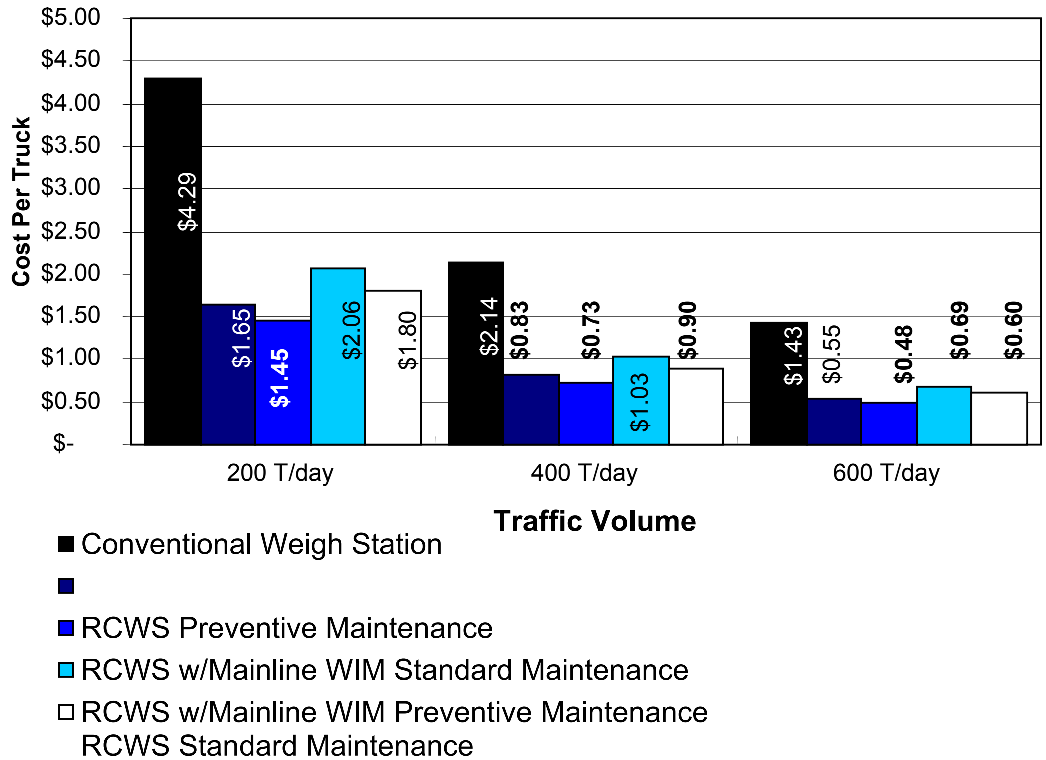

Figure 38. Agency Cost per Truck Considering a Conventional Weigh Station Upgrade (90% Enforcement Scenario)

3.3.3. Agency Internal Rate of Return Analysis

Comparing the 30 year agency cost analysis for RCWS options (with and without mainline WIM sorting capabilities) with the proposed expenditures for a low level upgrade ($1,000,000) to a conventional weigh station facility produces agency internal rates of return (IRR) as summarized in Table 11 and Figure 39.

Table 11. Agency IRR Analysis

RCWS System Type	IRR	
	Standard Maintenance	Preventive Maintenance
RCWS	278%	277%
RCWS w/Mainline WIM	150%	147%

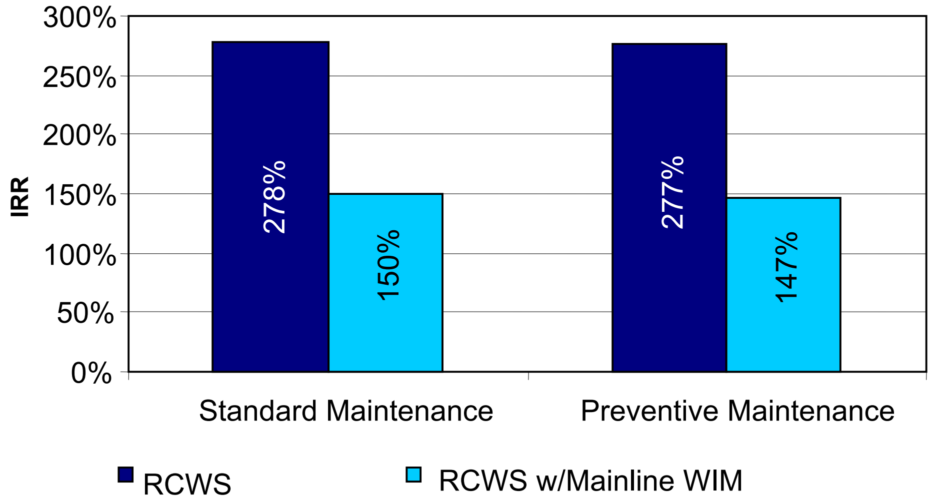

Figure 39. Agency Internal Rate of Return

Based on the 30 year IRR analysis, the remote weigh station option with no mainline WIM sorting capabilities produces the best return at 278% and 277% for standard and preventative maintenance measures, respectively. However, the remote weigh station with mainline WIM sorting also produces positive IRR values of 150% and 147% return for standard and preventative maintenance measures, respectively.

The same 30 year agency cost analysis for the remote weigh station with and without mainline WIM sorting technology as compared to a conventional weigh facility requiring capital upgrades of $2,500,000 produces significantly higher IRR values, as summarized in Figure 40.

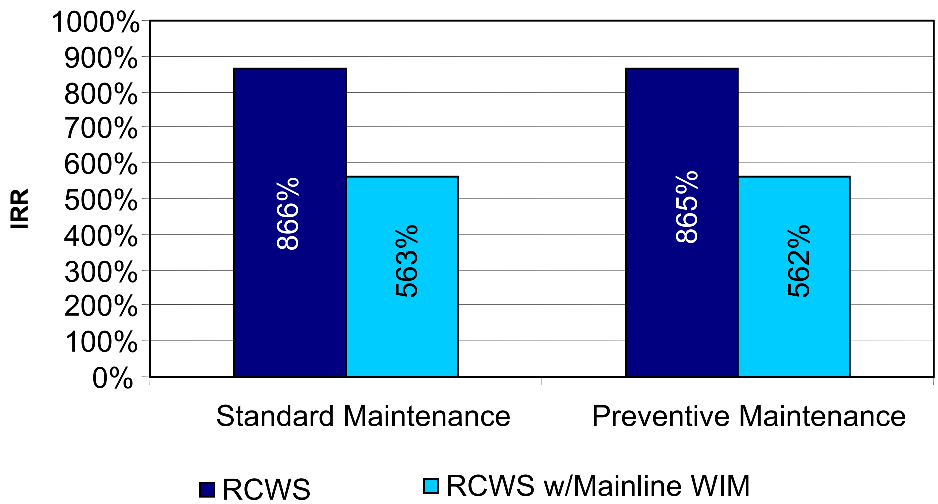

Figure 40. Agency Internal Rate of Return High Capital Analysis

3.3.4. Remote Control Weigh Station Incremental User Benefit-Cost Analysis

It is currently estimated that delays of 9, 12 and 18 minutes per vehicle are required for the proper enforcement of commercial vehicles at a conventional weigh stations operating under traffic volumes of 200, 400 and 600 T/day, respectively. However, with the incorporation of remote WIM technology into a weigh station facility, these delays can be significantly decreased to 5, 8 and 11 minutes per vehicle, respectively. The addition of a mainline sorting system to the weigh station would produce delay times comparable to those produced by the remote WIM alternative, but at a lesser extent due to the assumed 75% free flow criteria. Table 12 summarizes the user delay costs associated with conventional and alternative WIM weigh stations based on a 30-year time frame, under scenarios of 10% and 90% enforcement effort, at a direct user cost of $1.25 per minute.

Table 12. User Delay Cost Estimate

Traffic Volume	Enforcement Level	Conventional Weigh Station	RCWS	RCWS with Mainline WIM
200 T/day	10%	$ 2,463,750	$ 1,368,750	$ 342,188
400 T/day	10%	$ 6,570,000	$ 4,380,000	$ 1,095,000
600 T/day	10%	$ 14,782,500	$ 9,033,750	$ 2,258,438
200 T/day	90%	$ 22,173,750	$ 12,318,750	$ 3,079,688
400 T/day	90%	$ 59,130,000	$ 39,420,000	$ 9,855,000
600 T/day	90%	$ 133,042,500	$ 81,303,750	$ 20,325,938

Reducing the required amount of time delay per truck for commercial vehicle enforcement allows for direct user delay savings in the commercial transportation industry. The application of remote weigh station technology with and without mainline WIM sorting technology to existing weigh station facilities allows for direct user savings with 30-year benefit-cost ratios as summarized in Table 13, Figure 41, and Figure 42.

Table 13. User B/C Ratio Analysis of Remote Control Weigh Station

Traffic Volume (T/day)	Enforcement Level	RCWS		RCWS with Mainline WIM Sorting	
		Standard Maintenance	Preventive Maintenance	Standard Maintenance	Preventive Maintenance
200	10%	0.34	0.38	0.52	0.60
400	10%	0.67	0.77	1.35	1.55
600	10%	1.76	2.01	3.08	3.54
200	90%	3.02	3.45	4.70	5.39
400	90%	6.05	6.89	12.12	13.92
600	90%	15.87	18.09	27.73	31.84

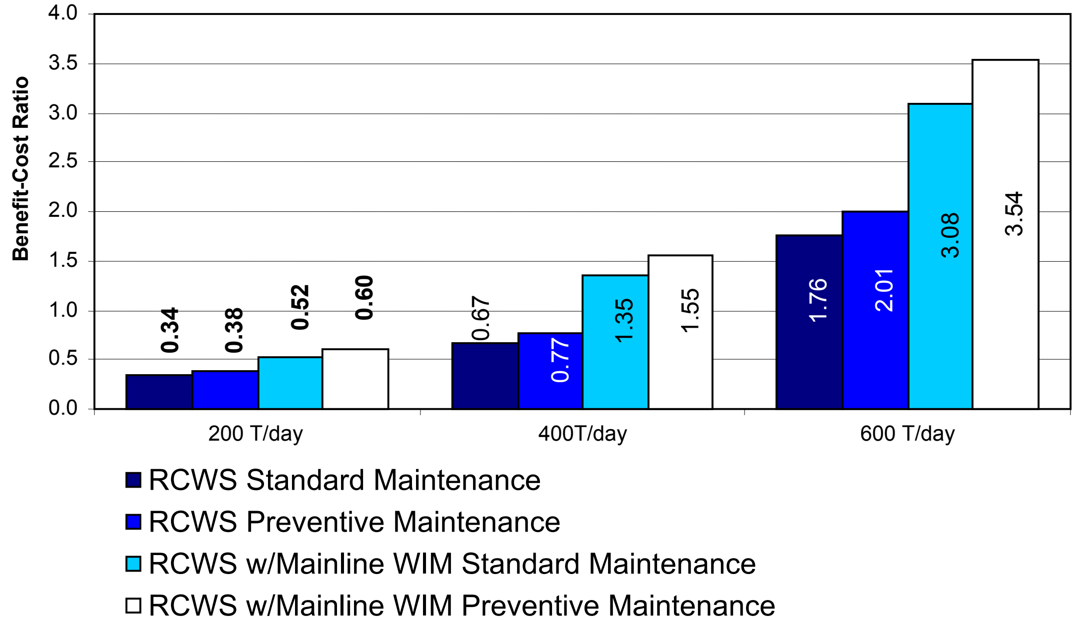

Figure 41. User B/C Ratio Analysis of an RCWS at a 10% Enforcement Level

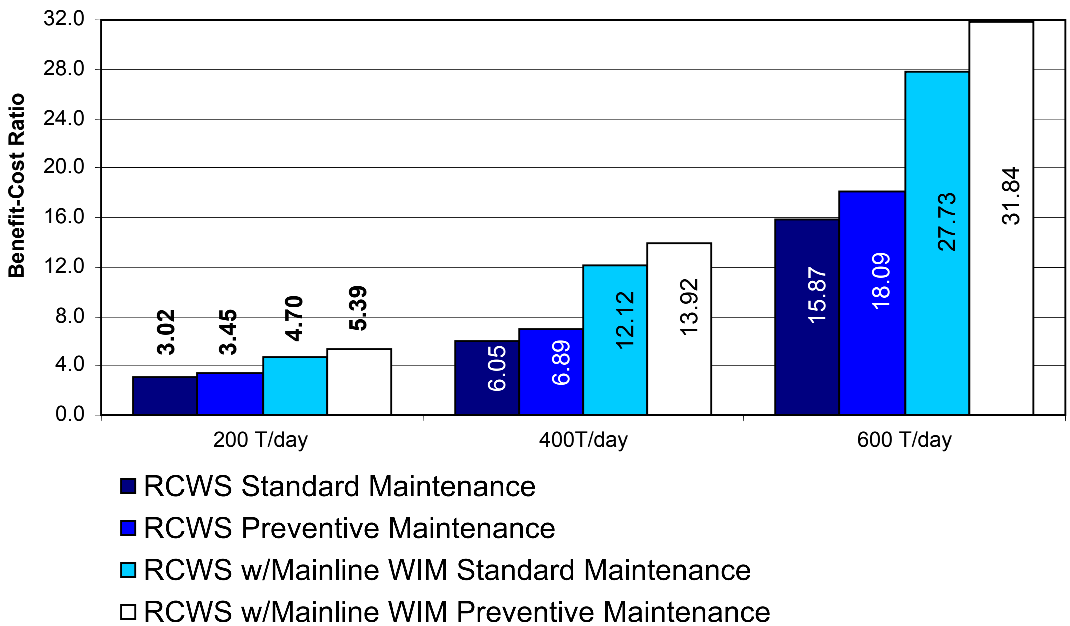

Figure 42. User B/C Ratio Analysis of an RCWS at a 90% Enforcement Level

The analysis of the remote weigh station at 10% enforcement is representative of the benefit-cost analysis of a typical conventional weigh station and the analysis of the remote weigh station at 90% enforcement representative of the integration of the base-line technologies proposed in this report. The above 30 year user benefit-cost analysis shows a direct relationship between the level of enforcement effort, the traffic volume and the resulting benefit-cost ratio return. A decrease in traffic volume directly correlates to a significant decrease in the resulting benefit-cost ratio, producing a return that is less than one. However, integrating the remote weigh station technologies at higher enforcement levels (at a 90% effort) results in significantly higher benefit-cost ratios, ranging from 3.02 to 18.09 for the remote weigh station without mainline WIM sorting scenario, and from 4.70 to 31.84 for the remote weigh station with mainline WIM Sorting capabilities analysis scenario.

3.3.5. Holistic Agency and User Benefit-Cost Analysis

A combined agency-user cost analysis provides for a holistic overview of the benefit-cost return attainable through the implementation of remote control weigh station technology with and without mainline WIM sorting capabilities. Table 14, Table 15, Figure 43 and Figure 44 summarize the 30 year design life total cost and benefit-cost analysis using the combined agency and user delay costs, assuming a $1,000,000 capital upgrade cost for a conventional weigh station facility, as determined in sections 3.3.1 and 3.3.3.

Table 14. 30 Year Holistic Agency and User Cost Analysis

Traffic Volume (T/day)	Enforcement Effort	Conventional Weigh Station	RCWS		RCWS w/Mainline WIM Sorting	
			Standard Maintenance	Preventive Maintenance	Standard Maintenance	Preventive Maintenance
200	10%	$ 9,413,750	$ 4,628,750	$ 4,228,750	$ 4,407,188	$ 3,882,188
400	10%	$ 13,520,000	$ 7,640,000	$ 7,240,000	$ 5,160,000	$ 4,635,000
600	10%	$ 21,732,500	$ 12,293,750	$ 11,893,750	$ 6,323,438	$ 5,798,438
200	90%	$ 29,123,750	$ 15,578,750	$ 15,178,750	$ 7,144,688	$ 6,619,688
400	90%	$ 66,080,000	$ 42,680,000	$ 42,280,000	$ 13,920,000	$ 13,395,000
600	90%	$139,992,500	$ 84,563,750	$ 84,163,750	$ 24,390,938	$ 23,865,938

Table 15. 30 Year Holistic Agency and User Benefit-Cost Analysis

Traffic Volume (T/day)	Enforcement Level	RCWS		RCWS w/Mainline WIM Sorting	
		Standard Maintenance	Preventive Maintenance	Standard Maintenance	Preventive Maintenance
200	10%	1.47	1.81	1.23	1.56
400	10%	1.80	2.20	2.06	2.51
600	10%	2.90	3.44	3.79	4.50
200	90%	4.15	4.88	5.41	6.36
400	90%	7.18	8.32	12.83	14.88
600	90%	17.00	19.52	28.44	32.80

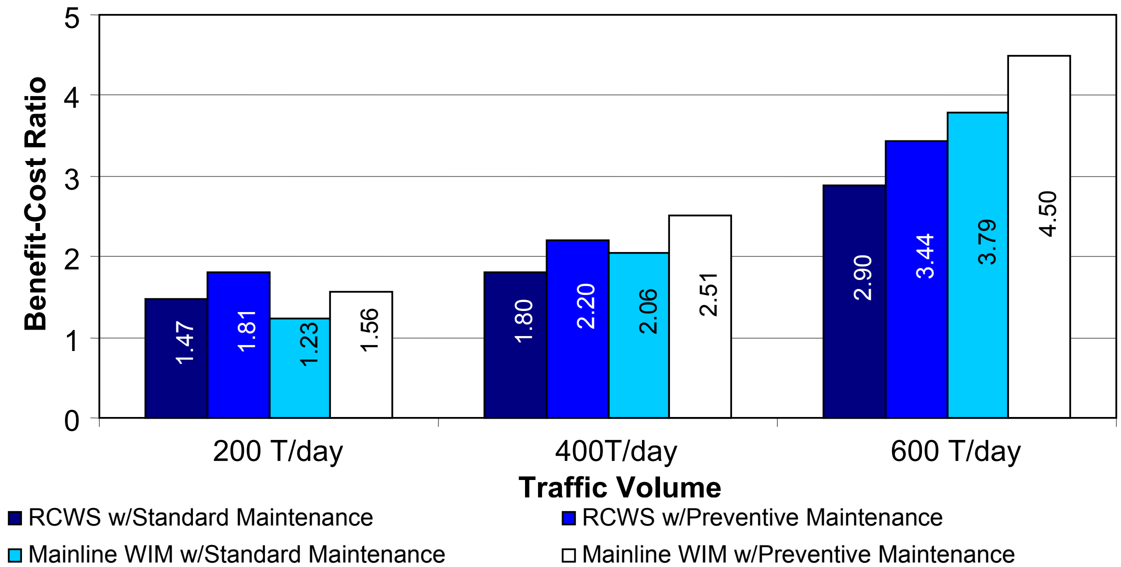

Figure 43. 30 Year Holistic Benefit-Cost Analysis at 10% Enforcement Level

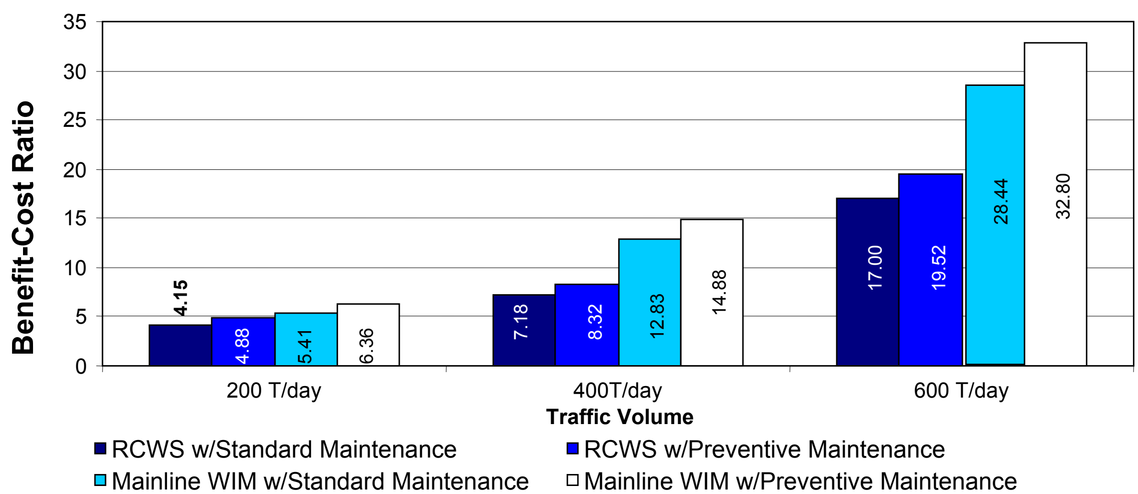

Figure 44. 30 Year Holistic Benefit-Cost Analysis at 90% Enforcement Level

The RCWS analysis performed at 10% enforcement effort is representative of the benefit-cost return attainable through conventional weigh station operation and displays a distinct decreasing trend in benefit-cost return with increasing traffic volume due to the subsequent increase in user delay costs. This analysis scenario produces benefit-cost ratios ranging from 1.47 to 3.44. The remote weigh station analysis at 90% enforcement effort, which is representative of remote weigh station technology without mainline WIM sorting capabilities, also displays this same trend due to an increase in traffic congestion with an increase in traffic volume. The benefit-cost ratios determined through this scenario range from 4.15 to 19.52.

In contrast, the integration of a remote weigh station with mainline WIM sorting capabilities shows an increasing benefit-cost ratio trend with increasing traffic volume and increasing enforcement effort. This occurrence is due to the allowance of 75% free flow using the mainline WIM sorting system, thereby decreasing the motor vehicle congestion at higher traffic volumes. The analysis of this operating scenario returned benefit-cost ratios ranging from 1.23 to 4.50 for 10% enforcement effort, and ranging from 5.41 to 32.80 for 90% enforcement effort.

The same analysis based on capital upgrade costs of $2,500,000 for a conventional weigh station facility produce the benefit-cost ratios as summarized in Figure 45 and Figure 46 for 10 and 90% enforcement levels, respectively.

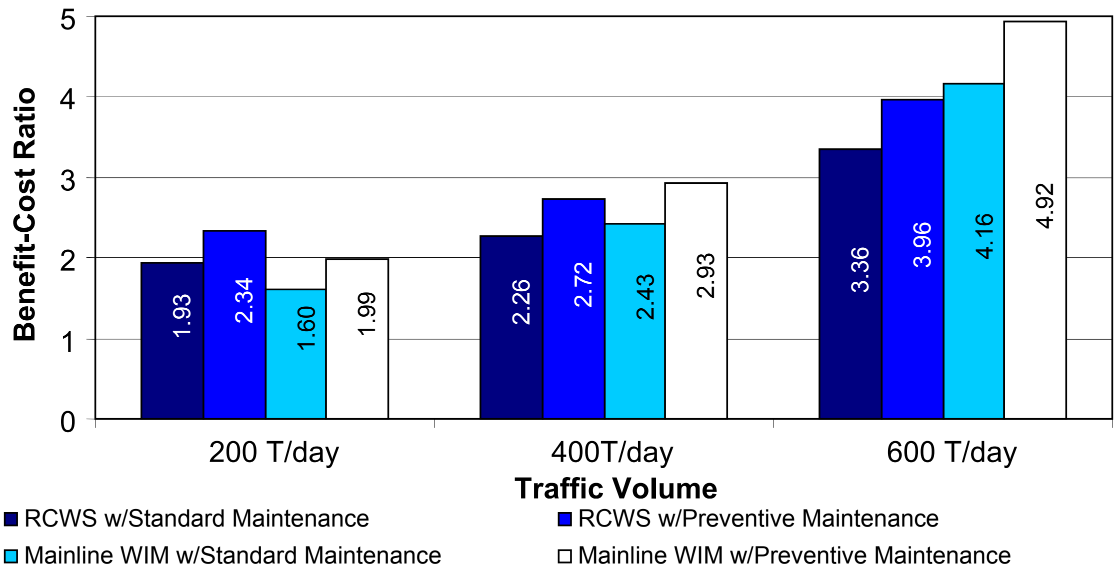

Figure 45. 30 Year Holistic Benefit-Cost Analysis at 10% Enforcement Considering a Conventional Weigh Station Upgrade

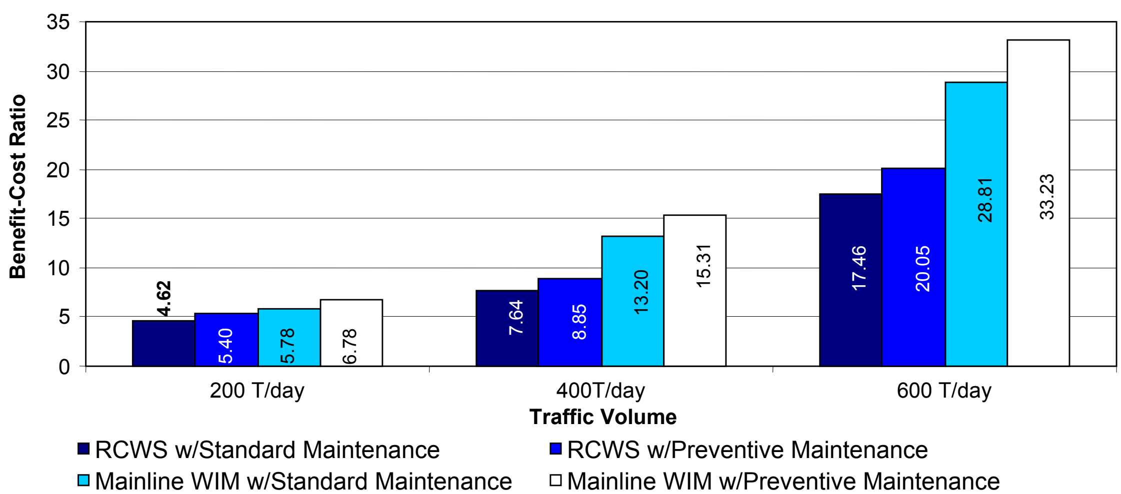

Figure 46. 30 Year Holistic Benefit-Cost Analysis at 90% Enforcement Considering a Conventional Weigh Station Upgrade

4. CONCLUSIONS

The results of the technical and economic analysis support the concept that a Remote Control Weigh Station (RCWS) could:

- be operated either attended or unattended, and at all times or any time as required on a daily basis;
- effectively carry out CVO activities with limited funding and manpower resources;
- extend weigh station operation to highways with low commercial traffic or remote regions with higher volumes;
- extend CVO coverage to an increased number of existing and new inspection station sites with minimum increase in manpower requirements; and
- create the public perception of a full-time implementation of compliance verification on a 24/7 basis, for selected CVO activities.

It was determined that the best architecture for the system was a modular system that allows a jurisdiction to customize the elements of the RCWS to the regional enforcement program and budget. Basic elements require minimal infrastructure conversion, and more advanced systems require a more significant investment in technology and construction. The system components allow a remote operator to pre-screen commercial vehicles dynamically and perform a more detailed secondary screening function if desired. All of the controls are remotely managed by a single remote enforcement operator using standard PC-based peripherals (i.e., mouse, keyboard, monitor, and CPU).

It is plausible that the RCWS system could be deployed with minimal technological development as most of the subsystems exist as standalone original equipment manufacturer components that are readily available in the marketplace. Radio Frequency Identification systems, dynamic weigh-in-motion scales, electronic static scale controllers, licence plate readers, etc. are all readily available in Canada and North America. Most components have been automated in some form and the concept of automated sorting and static scale weighing has been successfully deployed in the U.S. for several years (Florida Department of Transportation electronic screening systems; Nogales, Arizona Port-of-Entry Expedited Processing at International Crossings [EPIC] system; Oregon Green Light weigh-in-motion systems).

The economic analysis of agency, user, and environmental benefits and costs were favourable over a conventional weigh station even when considering low commercial traffic volumes of 200 trucks per day. When agency and user costs and benefits were considered together, the benefit-cost ratios varied from 1.47 to 19.52 for a basic RCWS, depending on the truck volumes and the level of enforcement. If some of the technology is moved onto the highway and pre-screening occurs before the weigh station, the benefit-cost ratios range from 1.23 to 32.8, depending on the level of enforcement.

4.1. Recommendations

The Remote Control Weigh Station concept is a viable ITS solution for monitoring commercial vehicles in jurisdictions that have one or more of the following:

- lower traffic volume roads
- a limited monitoring program
- agencies with remote hauling operations
- high-volume sites that have high enforcement costs
- a vast road network

The design team recommends that a prototype be developed, deployed, tested, and further evaluated for validation of the system architecture and economic models. The follow-on activities described in section 4.2 focuses on the implementation of a prototype system and the further evaluation of the technology.

4.2. Follow-on Activities

Effective and efficient transportation systems are essential to the economic and social well-being in all countries. Most jurisdictions have goals and objectives that provide for a safe, efficient and sustainable transportation system that enhances the quality of life for their people. To meet this vision, jurisdictions are turning to solutions that involve ITS.

In Canada, these ITS solutions fall within a strategy with four objectives:

- Promote transportation safety and security
- Support trade and tourism through more productive and smarter transportation systems
- Improve our quality of life by promoting a more sustainable transportation system
- Sustain a strategic investment in transportation

As with all research there are risks involved that must be managed to reach success. Part of that management is to limit or share the risks by entering into partnerships. Private/public partnerships are proven in today's societies. Key components of these partnerships, which certainly apply to this project, include technical expertise, project management expertise, shared costs and funding opportunities, demonstrated working relationships and well-defined roles and responsibilities.

Once a willing partnership is in place, a project plan is required to enhance the success of the prototype. Details of that plan must include a well-defined scope of the prototype project that is broad enough to demonstrate efficiencies but limited to reduce risks for the partnership. The plan must include key milestones that include but are not limited to an analysis of suitable sites based on pre-described site specifications; a review of legislation to determine revisions that can be implemented to enhance the effectiveness and efficiency of the system; and an operational program developed to include enforcement and education policies and procedures, training and public communication.

The success of this prototype will be determined if it meets all the objectives of the partnership. A transparent review will be required as part of the project plan.

4.2.1. Developing RCWS Prototype

Activities pertaining to the development of RCWS prototype include:

- A willing private/public partnership that is not limited and minimizes risks for all partners
- Key components of the partnership, including technical expertise, project management expertise, shared costs, funding opportunities, demonstrated working relationships and well-defined roles and responsibilities
- The preparation of a project plan that ensures the success of the project as described in Figure 47
- Determining which modules of the functional design will be included in the prototype
- Preparation of a location specification that minimizes risks and costs to the participating partners
- An analysis of site location options based on the specifications prepared
- Preparation of a discussion paper to provide enabling legislation to enhance the use of the system for enforcement purposes
- A communication release to the industry and public explaining the benefits of the project
- A project plan that includes key milestones for reporting the success of the project to the partners
- Continued planning based on the results of the prototype for further implementation of the system at other locations and enhancement of functionality at the prototype location

4.2.2. Investigating and Field Testing an Infrared/Shear Force Brake Failure Monitor

In the development of the RCWS conceptual design, the idea of using technology to enhance commercial transportation and public safety has been investigated. The application of a technology to detect potential brake failure or improperly functioning system was considered. This technology is still emerging as a technology for weight enforcement purposes. It has been deployed with some success by various organisations and should be investigated further in isolation prior to the deployment as a module for the RCWS. The technology to investigate should include the use of either infrared thermal detection or/and shear force measurements of brake activities while the vehicle is in motion.

The investigation of a BAS should follow a similar process as described in Section 4.2.1.

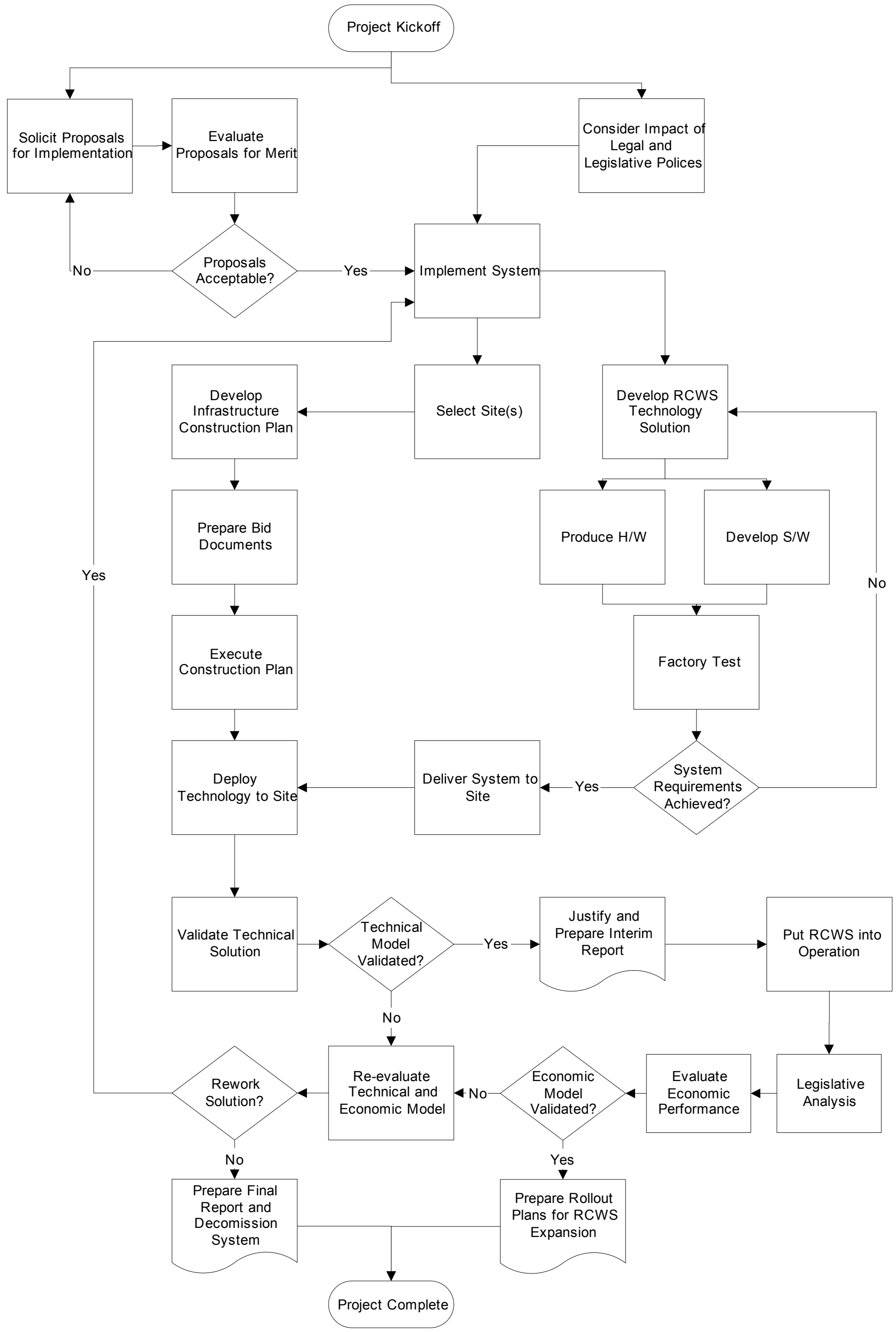

Figure 47. Follow-on Implementation and Prototype Project Plan

REFERENCES

Bein, P. "Monetization of Environmental Impacts of Road". Highway and Policy Branch. Information Section Management. March 1997.

Bushman, R., Berthelot, C., and Taylor, B. 2003. Commercial Vehicle Overloading of Urban Pavements. Transportation Association of Canada Annual Conference Proceedings. St. John's, Newfoundland.

Dreher, D.B. and Harley, R.A. "A Fuel-Based Inventory for Heavy-Duty Diesel Truck Emissions". Air and Waste Management Association. Vol 48. April 1998.

Gysel, F. Field Testing of On-Board Recorder, Smart Card and Digital Signature Technologies, Phase 1: Preliminary Study. TP 13893E. Transportation Development Centre of Transport Canada. March 2002.

Kyoto Protocol to the United Nations Framework Convention on Climate Change. Article 2. 1997.

Nix, F.P. Truck Activity in Canada – A Profile. TP 14164E. Motor Carrier Policy Branch of Transport Canada. March 2003.

Transportation Association of Canada (TAC). Manual of Uniform Traffic Control Devices for Canada. 1998.

Trischuk, D. and Berthelot, C. "Weigh-in-Motion Applications for Intelligent Transportation Systems-Commercial Vehicle Operations". Transportation Research Record. N1816. 2002.

APPENDIX A – USER SURVEY QUESTIONNAIRES AND RESULTS

ITS R&D - Remote Controlled Weigh Station
Enforcement Management Questionnaire

A Remote Controlled Weigh Station is defined as a conceptual model for a physical weigh station which can be operated remotely by enforcement officers to perform a number of CVO functions.

For the purpose of this R&D project, a weigh station may be a fixed site or mobile site station. A fixed site weigh station is defined herein as a typical station complete with a building, power and communication utilities, and probably a static scale and other computer equipment. A mobile site weigh station is defined herein as a roadside lot or a lay-by station, with probable access to or plug-in facility for power and communications. A mobile site is typically used as a temporary facility for occasional CVO functions.

The following is a questionnaire useful for creating the conceptual model. Your input to this questionnaire is extremely valuable to help us to better understand your operating environment. Your input enlightens our thoughts in preparing the ITS R&D application - Remote Controlled Weigh Station, which may be beneficial to your operation.

Thank you for agreeing to take the time to fill in the questionnaire. Many questions require either a single-character answer or a numbering answer, or a combination of character and number answer. You may also choose your own words in answering some questions.

QUESTIONNAIRE

PLEASE FILL IN YOUR NAME AND AREA OF RESPONSIBILITY

NAME: ____

RESPONSIBILITY AREA:	FIELD OFFICER	( )
	ENFORCEMENT MANAGEMENT	( )
	TRANSPORTATION PLANNING	( )

IDENTIFY FUNCTIONS OF A WEIGH STATION

Please mark the following items in terms of:
- Importance - mark "Y" for yes, and "N" for no
- Importance Rating - 1 to 5, 1 being the most important
- Must Have function - check "√"

Although most functions at a weigh station may be considered important, there are many functions that are more important than others. And among these more important functions, there are certain functions that must be performed or otherwise the weigh station operation cannot be effective.

Certain features or functions may not be easily provided due to unavailability of funding or equipment. For example, if you do not have the means or the time to perform all the checks, then you probably have to select the must-be-done checks as the minimum activities afforded in a weigh station.

This sequence of marking helps to define the minimum, typical and desirable features of a Remote Controlled Weigh Station.

As an example for marking, if you consider the following item "Weight and dimensions enforcement" is of utmost importance and a must-have function in a weigh station, then you would mark the item as
√ Y 1 • Weight enforcement

In your opinion, please mark the relative importance and necessity of the following functions:
- Weight enforcement
- Weight and dimensions enforcement

- Company/carrier/operator license check
- Company/carrier/operator permit check
- Company/carrier/operator operation record check
- Vehicle licence/registration check
- Vehicle operation safety record check
- Vehicle mechanical fitness check
- Vehicle visible mechanical defects (brake overheating, tail lights not working, head lights not working, signal lights not working) check
- Driver licence check
- Diver certification check
- Driver operation record check
- Driver criminal record check if officers deem it necessary for officer safety reasons
- Driver hours of service log check
- Hazmat permit check
- Hazmat inspection
- Load tie-down/containment check
- Safe loading check
- An office for the industry or our officers to make contact for educational purposes
- A location for the industry to use facility for self compliance purposes

Can you think of other important functions that are not listed in the above-described items? If you do, please list and mark them below.

- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________

Are fixed site weigh stations equipped with, A (All), S (Some), N (None), of:

- Static scale ______
- Message signs to direct vehicles into the station ______
- Traffic signals in the station ______
- Outside weight display in the station ______
- Computer(s) in the station ______
- Voice communications to drivers in the station ______
- Data communication facility ______
- Broadband transmission facility ______
- Radio communication facility ______
- Other (please specify) ______________________ ______

Are mobile site weigh stations equipped with, A (All), S (Some), N (None), of:

- Static scale _____
- Message signs to direct vehicles into the station _____
- Traffic signals in the station _____
- Outside weight display in the station _____
- Computer(s) in the station _____
- Voice communications to drivers in the station _____
- Data communication facility _____
- Broadband transmission facility _____
- Radio communication facility _____
- Other (please specify) ______________________ _____

GENERAL OPERATION OF A WEIGH STATION

Are fixed site weigh stations operating
On seven days a week? Y (Yes), N (No), S (Sometimes/Occasionally) _____
On twenty-four hours? Y (Yes), N (No), S (Sometimes/Occasionally) _____
On single shifts only? Y (Yes), N (No), S (Sometimes/Occasionally) _____
On multiple shifts? Y (Yes), N (No), S (Sometimes/Occasionally) _____

Are mobile site weigh stations operating
On seven days a week? Y (Yes), N (No), S (Sometimes/Occasionally) _____
On twenty-four hours? Y (Yes), N (No), S (Sometimes/Occasionally) _____
On single shifts only? Y (Yes), N (No), S (Sometimes/Occasionally) _____
On multiple shifts? Y (Yes), N (No), S (Sometimes/Occasionally) _____

Do you currently perform at fixed site weigh station, A (All), S (Some), N (None), of
Licensing and permitting checks _____
Compliance checks for safety, weight, dimensions _____
Company/carrier/operator credential checks _____
Driver operating, licence checks _____
Driver hours of service check _____
Other (please specify) ____________________ _____

Do you currently perform at mobile site weigh station, A (All), S (Some), N (None), of
Licensing and permitting checks _____
Compliance checks for safety, weight, dimensions _____
Company/carrier/operator credential checks _____
Driver operating, licence checks _____
Driver hours of service check _____
Other (please specify) ____________________ _____

Are all commercial vehicles required to enter a weigh station when the station is opened?
Y (Yes), N (No), S (Sometimes) _____

What would you do when a commercial vehicle does not enter a weigh station even though the station is opened? Please describe.

____
____

Do you currently have access or have means to access vehicle license information from other jurisdictions? And who are they? Please describe.

____
____

What type of information you can get from other jurisdictions? Please describe.

____
____
____

And is it in real-time, or simply put, is it timely? Y (Yes) or N (No) _____

Any other type of information you can get from other jurisdictions? Please describe.
____
____

If you find a vehicle with serious safety, operation or credential problems, do you impound the vehicle? If not, what do you do next? Please describe.
____
____

IDENTIFY THE OPERATION OF A REMOTE CONTROLLED WEIGH STATION

This R&D project is to determine the application and operation of a Remote Controlled Weigh Station. Do you believe that the concept would and could contribute to the public safety? Y (Yes) or N (No) _____

Where do you think a Remote Controlled Weigh Station should be located? Please describe.

____
____
____

Would you expect a Remote Controlled Weigh Station to have all the functions of a fixed site weigh station? Y (Yes) or N (No) _____
And what are these expected functions? Please describe.

____
____
____
____

Should fixed site weigh stations have the capability to operate as Remote Controlled Weigh Stations? Y (Yes) or N (No) _____

Should mobile site weigh stations have the capability to operate as Remote Controlled Weigh Stations? Y (Yes) or N (No) _____

Should Remote Controlled Weigh Stations be operable at extended hours?
Y (Yes) or N (No) _____

Should Remote Controlled Weigh Stations be allowed to operate in self-service mode?
Y (Yes) or N (No) _____
If yes, what would be the minimum checks required? Please describe.

____
____
____
____

Would you allow commercial vehicle drivers to use Remote Controlled Weigh Stations to check the weights of their vehicles at all times? Y (Yes) or N (No) _____

When you operate a Remote Controlled Weigh Station and determine a vehicle having non-compliance violation(s), what action(s) would you take which could be practical and effective? Please describe.

____
____
____
____

Is it essential to stop or impede continuing journey of a vehicle at a Remote Controlled Weigh Station, after the vehicle has been found with serious safety or licensing violations? Please describe.

____
____
____
____
____

ITS R&D - Remote Controlled Weigh Station
Field Officer Questionnaire

A Remote Controlled Weigh Station is defined as a conceptual model for a physical weigh station which can be operated remotely by enforcement officers to perform a number of CVO functions.

For the purpose of this R&D project, a weigh station may be a fixed site or mobile site station. A fixed site weigh station is defined herein as a typical station complete with a building, power and communication utilities, and probably a static scale and other computer equipment. A mobile site weigh station is defined herein as a roadside lot or a lay-by station, with probable access to or plug-in facility for power and communications. A mobile site is typically used as a temporary facility for occasional CVO functions.

The following is a questionnaire useful for creating the conceptual model. Your input to this questionnaire is extremely valuable to help us to better understand your operating environment. Your input enlightens our thoughts in preparing the ITS R&D application - Remote Controlled Weigh Station, which may be beneficial to your operation.

Thank you for agreeing to take the time to fill in the questionnaire. Many questions require either a single-character answer or a numbering answer, or a combination of character and number answer. You may also choose your own words in answering some questions.

QUESTIONNAIRE

PLEASE FILL IN YOUR NAME AND AREA OF RESPONSIBILITY

NAME: ____

RESPONSIBILITY AREA:	FIELD OFFICER	( )
	ENFORCEMENT MANAGEMENT	( )
	TRANSPORTATION PLANNING	( )

IDENTIFY FUNCTIONS OF A WEIGH STATION

Please mark the following items in terms of:

- Importance - mark "Y" for yes, and "N" for no
- Importance Rating - 1 to 5, 1 being the most important
- Must Have function - check "√"

Although most functions at a weigh station may be considered important, there are many functions that are more important than others. And among these more important functions, there are certain functions that must be performed or otherwise the weigh station operation cannot be effective.

Certain features or functions may not be easily provided due to unavailability of funding or equipment. For example, if you do not have the means or the time to perform all the checks, then you probably have to select the must-be-done checks as the minimum activities afforded in a weigh station.

This sequence of marking helps to define the minimum, typical and desirable features of a Remote Controlled Weigh Station.

As an example for marking, if you consider the following item "Weight and dimensions enforcement" is of utmost importance and a must-have function in a weigh station, then you would mark the item as
√ Y 1 • Weight and dimensions enforcement

In your opinion, please mark the relative importance and necessity of the following functions:

- Weight enforcement
- Weight and dimensions enforcement

- Company/carrier/operator license check
- Company/carrier/operator permit check
- Company/carrier/operator operation record check
- Vehicle licence/registration check
- Vehicle operation safety record check
- Vehicle mechanical fitness check
- Vehicle visible mechanical defects (brake overheating, tail lights not working, head lights not working, signal lights not working) check
- Driver licence check
- Diver certification check
- Driver operation record check
- Driver criminal record check if officers deem it necessary for officer safety reasons
- Driver hours of service log check
- Hazmat permit check
- Hazmat inspection
- Load tie-down/containment check
- Safe loading check
- An office for the industry or our officers to make contact for educational purposes
- A location for the industry to use facility for self compliance purposes

Can you think of other important functions that are not listed in the above-described items? If you do, please list and mark them below accordingly.

- ____
- ____
- ____
- ____
- ____

Do you work in fixed site weigh stations equipped with, A (All), S (Some), N (None), of:

- Static scale ______
- Message signs to direct vehicles into the station ______
- Traffic signals in the station ______
- Outside weight display in the station ______
- Computer(s) in the station ______
- Voice communications to drivers in the station ______
- Data communication facility ______
- Broadband transmission facility ______
- Radio communication facility ______
- Other (please specify) ____________________________

Do you work in mobile site weigh stations equipped with, A (All), S (Some), N (None), of:

- Static scale _____
- Message signs to direct vehicles into the station _____
- Traffic signals in the station _____
- Outside weight display in the station _____
- Computer(s) in the station _____
- Voice communications to drivers in the station _____
- Data communication facility _____
- Broadband transmission facility _____
- Radio communication facility _____
- Other (please specify) ___________________________

GENERAL OPERATION OF A WEIGH STATION

Do you currently operate in a fixed site weigh station? Y (Yes), N (No), S (Sometimes).
____

Do you currently operate in a mobile site weigh station? Y (Yes), N (No), S (Sometimes).
____

Do you currently perform at fixed site weigh station, A (All), S (Some), N (None), of
- Licensing and permitting checks _____
- Compliance checks for safety, weight, dimensions _____
- Company/carrier/operator credential checks _____
- Driver operating, licence checks _____
- Driver hours of service check _____
- Other (please specify) ________________________________

Do you currently perform at mobile site weigh station, A (All), S (Some), N (None), of
- Licensing and permitting checks _____
- Compliance checks for safety, weight, dimensions _____
- Company/carrier/operator credential checks _____
- Driver operating, licence checks _____
- Driver hours of service check _____
- Other (please specify) ________________________________

Are all commercial vehicles required to enter a weigh station when the station is opened? Y (Yes), N (No), S (Sometimes) _____

What would you do when a commercial vehicle does not enter a weigh station even though the station is opened? Please describe.
____

If you find a vehicle with serious safety, operation or credential problems, do you impound the vehicle? If not, what do you do next? Please describe.
____

OBSERVED TRAFFIC VOLUME

For the purpose of this R&D project, traffic volume will be counted as:
Hourly volume - Low (less than 5), Medium (6 to 15), High (16 to 50)
Daily volume - Low (less than 50), Medium (51 to 150), High (151 to 500)

For fixed site

- What is the highest hourly commercial vehicle traffic volume observed or recorded in a fixed site weigh station? Low ( ), Medium ( ), High ( )
- What is the highest daily commercial vehicle traffic volume observed or recorded in a fixed site weigh station? Low ( ), Medium ( ), High ( )
- What is the typical hourly commercial vehicle traffic volume observed or recorded in a fixed site weigh station? Low ( ), Medium ( ), High ( )
- What is the typical daily commercial vehicle traffic volume observed or recorded in a fixed site weigh station? Low ( ), Medium ( ), High ( )

For mobile site

- What is the highest hourly commercial vehicle traffic volume observed or recorded in a mobile site weigh station? Low ( ), Medium ( ), High ( )
- What is the typical hourly commercial vehicle traffic volume observed or recorded in a mobile site weigh station? Low ( ), Medium ( ), High ( )

IDENTIFY THE OPERATION OF A REMOTE CONTROLLED WEIGH STATION

This R&D project is to determine the application and operation of a Remote Controlled Weigh Station. Do you believe that the concept would and could contribute to the public safety? Y (Yes) or N (No) _____

Where do you think a Remote Controlled Weigh Station should be located? Please describe.

____
____
____

Would you expect a Remote Controlled Weigh Station to have all the functions of a fixed site weigh station? Y (Yes) or N (No) _____
And what are these expected functions? Please describe.

____
____
____

Should fixed site weigh stations have the capability to operate as Remote Controlled Weigh Stations? Y (Yes) or N (No) _____

Should mobile site weigh stations have the capability to operate as Remote Controlled Weigh Stations? Y (Yes) or N (No) _____

Should Remote Controlled Weigh Stations be operable at extended hours?
Y (Yes) or N (No) _____

Should Remote Controlled Weigh Stations be allowed to operate in self-service mode?
Y (Yes) or N (No) _____
If yes, what would be the minimum checks required? Please describe.

____
____
____

Would you allow commercial vehicle drivers to use Remote Controlled Weigh Stations to check the weights of their vehicles at all times? Y (Yes) or N (No) _____

When you operate a Remote Controlled Weigh Station and determine a vehicle having non-compliance violation(s), what action(s) would you take which could be practical and effective? Please describe.

___

___

___

Is it essential to stop or impede continuing journey of a vehicle at a Remote Controlled Weigh Station, after the vehicle has been found with serious safety or licensing violations? Please describe.

___

___

___

ITS R&D - Remote Controlled Weigh Station
Industry Questionnaire

A Remote Controlled Weigh Station is defined as a conceptual model for a physical weigh station which can be operated remotely by enforcement officers to perform a number of CVO functions.

For the purpose of this R&D project, a weigh station may be a fixed site or mobile site station. A fixed site weigh station is defined herein as a typical station complete with a building, power and communication utilities, and probably a static scale and other computer equipment. A mobile site weigh station is defined herein as a roadside lot or a lay-by station, with probable access to or plug-in facility for power and communications. A mobile site is typically used as a temporary facility for occasional CVO functions.

The following is a questionnaire useful for creating the conceptual model. Your input to this questionnaire is extremely valuable to help us to better understand your viewpoints and concerns towards the concept. Your input enlightens our thoughts in preparing the ITS R&D application - Remote Controlled Weigh Station, which may be beneficial to the trucking industry and your members.

QUESTIONNAIRE

IDENTIFY FUNCTIONS OF A WEIGH STATION

Please mark the following items in terms of:

- Importance - mark "Y" for yes, and "N" for no
- Importance Rating - 1 to 5, 1 being the most important
- Must Have function - check "√"

Although most functions at a weigh station may be considered important, there are many functions that are more important than others. And among these more important functions, there are certain functions that must be performed or otherwise the weigh station operation cannot be effective.

Certain features or functions may not be easily provided due to unavailability of funding or equipment. This sequence of marking helps to define the minimum, typical and desirable features of a Remote Controlled Weigh Station.

As an example for marking, if you consider the following item "Weight and dimensions enforcement" is of utmost importance and a must-have function in a weigh station, then you would mark the item as

√ Y 1 • Weight enforcement

In your opinion, please mark the relative importance and necessity of the following functions:

- Weight enforcement
- Weight and dimensions enforcement
- Company/carrier/operator license check
- Company/carrier/operator permit check
- Company/carrier/operator operation record check
- Vehicle licence/registration check
- Vehicle operation safety record check
- Vehicle mechanical fitness check
- Vehicle visible mechanical defects (brake overheating, tail lights not working, head lights not working, signal lights not working) check
- Driver licence check
- Diver certification check
- Driver operation record check
- Driver criminal record check if officers deem it necessary for officer safety reasons

- Driver hours of service log check
- Hazmat permit check
- Hazmat inspection
- Load tie-down/containment check
- Safe loading check
- An office for the industry or our officers to make contact for educational purposes
- A location for the industry to use facility for self compliance purposes

Can you think of other important functions that are not listed in the above-described items? If you do, please list and mark them below.

- ____
- ____
- ____
- ____
- ____

IDENTIFY THE OPERATION OF A REMOTE CONTROLLED WEIGH STATION

This R&D project is to determine the application and operation of a Remote Controlled Weigh Station. Do you believe that the concept would and could contribute to the public safety? Y (Yes) or N (No) _____

Where do you think a Remote Controlled Weigh Station should be located? Please describe.

____
____
____

Would you expect a Remote Controlled Weigh Station to have all the functions of a fixed site weigh station? Y (Yes) or N (No) _____
And what are these expected functions? Please describe.

____
____
____
____

Should fixed site weigh stations have the capability to operate as Remote Controlled Weigh Stations? Y (Yes) or N (No) _____

Should mobile site weigh stations have the capability to operate as Remote Controlled Weigh Stations? Y (Yes) or N (No) _____

Should Remote Controlled Weigh Stations be operable at extended hours?
Y (Yes) or N (No) _____

Should Remote Controlled Weigh Stations be allowed to operate in self-service mode?
Y (Yes) or N (No) _____
If yes, what would be the minimum checks required? Please describe.

____
____
____

ITS R&D - Remote Controlled Weigh Station
Transportation Planning Questionnaire

A Remote Controlled Weigh Station is defined as a conceptual model for a physical weigh station which can be operated remotely by enforcement officers to perform a number of CVO functions.

For the purpose of this R&D project, a weigh station may be a fixed site or mobile site station. A fixed site weigh station is defined herein as a typical station complete with a building, power and communication utilities, and probably a static scale and other computer equipment. A mobile site weigh station is defined herein as a roadside lot or a lay-by station, with probable access to or plug-in facility for power and communications. A mobile site is typically used as a temporary facility for occasional CVO functions.

The following is a questionnaire useful for creating the conceptual model. Your input to this questionnaire is extremely valuable to help us to better understand your planning processes. Your input enlightens our thoughts in preparing the ITS R&D application - Remote Controlled Weigh Station, which may be beneficial to your operation.

Thank you for agreeing to take the time to fill in the questionnaire. Many questions require either a single-character answer or a numbering answer, or a combination of character and number answer. You may also choose your own words in answering some questions.

QUESTIONNAIRE

PLEASE FILL IN YOUR NAME AND AREA OF RESPONSIBILITY

NAME: ____

RESPONSIBILITY AREA:	FIELD OFFICER	( )
	ENFORCEMENT MANAGEMENT	( )
	TRANSPORTATION PLANNING	( )

IDENTIFY FUNCTIONS OF A WEIGH STATION

Please mark the following items in terms of:
- Importance - mark "Y" for yes, and "N" for no
- Importance Rating - 1 to 5, 1 being the most important
- Must Have function - check "√"

Although most functions at a weigh station may be considered important, there are many functions that are more important than others. And among these more important functions, there are certain functions that must be performed or otherwise the weigh station operation cannot be effective.

Certain features or functions may not be easily provided due to unavailability of funding or equipment. For example, if you do not have the means or the time to perform all the checks, then you probably have to select the must-be-done checks as the minimum activities afforded in a weigh station.

This sequence of marking helps to define the minimum, typical and desirable features of a Remote Controlled Weigh Station.

As an example for marking, if you consider the following item "Weight and dimensions enforcement" is of utmost importance and a must-have function in a weigh station, then you would mark the item as
√ Y 1 • Weight enforcement

In your opinion, please mark the relative importance and necessity of the following functions:
- Weight enforcement
- Weight and dimensions enforcement

- Company/carrier/operator license check
- Company/carrier/operator permit check
- Company/carrier/operator operation record check
- Vehicle licence/registration check
- Vehicle operation safety record check
- Vehicle mechanical fitness check
- Vehicle visible mechanical defects (brake overheating, tail lights not working, head lights not working, signal lights not working) check
- Driver licence check
- Diver certification check
- Driver operation record check
- Driver criminal record check if officers deem it necessary for officer safety reasons
- Driver hours of service log check
- Hazmat permit check
- Hazmat inspection
- Load tie-down/containment check
- Safe loading check
- An office for the industry or our officers to make contact for educational purposes
- A location for the industry to use facility for self compliance purposes

Can you think of other important functions that are not listed in the above-described items? If you do, please list and mark them below.

- ____
- ____
- ____
- ____
- ____

RECORDED TRAFFIC VOLUME

For the purpose of this R&D project, traffic volume will be counted as:
Hourly volume - Low (less than 5), Medium (6 to 15), High (16 to 50)
Daily volume - Low (less than 50), Medium (51 to 150), High (151 to 500)

For fixed site

- What is the highest hourly commercial vehicle traffic volume observed or recorded in a fixed site weigh station? Low ( ), Medium ( ), High ( )
- What is the highest daily commercial vehicle traffic volume observed or recorded in a fixed site weigh station? Low ( ), Medium ( ), High ( )
- What is the typical hourly commercial vehicle traffic volume observed or recorded in a fixed site weigh station? Low ( ), Medium ( ), High ( )
- What is the typical daily commercial vehicle traffic volume observed or recorded in a fixed site weigh station? Low ( ), Medium ( ), High ( )
- What is the total number of operational fixed sites _____

For mobile site

- What is the highest hourly commercial vehicle traffic volume observed or recorded in a mobile site weigh station? Low ( ), Medium ( ), High ( )
- What is the typical hourly commercial vehicle traffic volume observed or recorded in a mobile site weigh station? Low ( ), Medium ( ), High ( )
- What is the total number of operational mobile sites _____

IDENTIFY THE OPERATION OF A REMOTE CONTROLLED WEIGH STATION

This R&D project is to determine the application and operation of a Remote Controlled Weigh Station. Do you believe that the concept would and could contribute to the public safety? Y (Yes) or N (No) _____

Where do you think a Remote Controlled Weigh Station should be located? Please describe.

____
____
____

Would you expect a Remote Controlled Weigh Station to have all the functions of a fixed site weigh station? Y (Yes) or N (No) _____
And what are these expected functions? Please describe.

____
____
____

Should fixed site weigh stations have the capability to operate as Remote Controlled Weigh Stations? Y (Yes) or N (No) _____

Should mobile site weigh stations have the capability to operate as Remote Controlled Weigh Stations? Y (Yes) or N (No) _____

Should Remote Controlled Weigh Stations be operable at extended hours?
Y (Yes) or N (No) _____

Should Remote Controlled Weigh Stations be allowed to operate in self-service mode?
Y (Yes) or N (No) _____
If yes, what would be the minimum checks required? Please describe.

____
____
____
____

	Paul Landry (BC Trucking Association)	Bruce Richards (Private Motor Truck Council of Canada (PMTC))	John Mead (Saskatchewan Highways and Transportation, Enforcement Management)	Diane Nash (NewBrunswick DOT, Policy Officer, Transportation Planning)	Tedd Stobbs (Saskatchewan Highways and Transportation, Enforcement Management)	Peter Deis (Saskatchewan Highways and Transportation, Field Officer)	Harvey White (Saskatchewan Highways and Transportation, Field Officer)	Kelvin Davidson (Saskatchewan Highways and Transportation, Enforcement Management)	Dave Tippe (Alberta Transportation and Utilities, Enforcement Management)	John Tkachuk (Alberta Transportation and Utilities, Field Officer)	CUE Supervisor (NewBrunswick DOT, Field Officer)	Ed Peterson (NewBrunswick DOT, Enforcement Management - Compliance)	Dwight Solon (Manitoba DOT, Enforcement Management - Compliance)	Jacques Chapdelaine (MTQ, Field Officer - Enforcement)	Paul Sauve (SAAQ, Enforcement Management - Compliance)	Analysis: Must Have Feature	Importance Rating 1	2	3	4	5	Un-rated "Y"	Un-rated "N"
Functions of a Remote Controlled Weigh Station																							
Weight enforcement	Y 1	X Y	X Y 1	X Y 1	X Y 1		X Y 1	X Y 1	X Y 1	X Y 3	X Y 1	X Y 1	X Y 1	X Y 1	X Y 1	12X	12		1			1	
Weight and dimensions enforcement	X Y 1	X Y 1	X Y 1	X Y 1	X Y 1		X Y 1	X Y 1	X Y 1	X Y 1	X Y 1	X Y 1	X Y 1	X Y 1	X Y 1	14X	14						
Company/carrier/operator licence check	N 5	Y 1	Y 2	X Y 1	X Y 3		Y 3	X Y 1	X Y 1	X Y 1	Y 3	Y 3	X Y 1	X Y 2	X Y 1	8X	7	2	4		-1		
Company/carrier/operator permit check	N 5	Y 1	X Y 1	X Y 1	X Y 3		Y 3	Y 2	X Y 1	X Y 1	Y 5	N 2	X Y 1	X Y 2	X Y 1	8X	7	1	2		0		
Company/carrier/operator operation record check	N 5		Y 3	X Y 2	X Y 3		N	Y 4	X Y 3	X Y 2	Y 4	X Y 1	X Y 1	X Y 4	X Y 1	8X	3	2	3	3	-1		1
Vehicle licence/registration check	Y 3	Y	X Y 1	X Y 1	X Y 3		Y 3	X Y 1	X Y 1	X Y 1	X Y 2	X Y 2	X Y 1	X Y 1	X Y 1	11X	8	2	3			1	
Vehicle operation safety record check	N 4	X Y	Y 2	X Y 1	X Y 3		N	Y 5	X Y 2	X Y 2	X Y 2	Y 2	X Y 1	N	X Y 1	8X	3	5	1	-1	1	1	2
Vehicle mechanical fitness check	X Y 2	X Y 1	X Y 2	Y 3	X Y 1		X Y 1	Y 2	X Y 1	X Y 1	X Y 1	N 2	X Y 1	X Y 2	Y 3	10X	7	3	2				
Vehicle visible mechanical/electrical defects check	Y 2	Y	X Y 1	X Y 2	X Y 1		X Y 1	Y 1	X Y 1	X Y 1	Y 2	X Y 1	X Y 1	N	X Y 1	9X	9	3				1	1
Driver licence check	X Y 1	Y	X Y 2	X Y 2	X Y 5		Y 2	X Y 1	X Y 1	N	X Y 2	X Y 3	X Y 1	X Y 1	X Y 1	11X	6	4	1		1	1	1
Driver certification check		Y	Y 3	X Y 2	X Y 5		Y 3	Y 2	X Y 1	N	Y 2	Y 2	X Y 1	N	X Y 1	5X	3	4	2		1	1	2
Driver operation record check		N	Y 2	Y 2	X Y 5		Y 4	Y 3	X Y 3	Y 3	Y 3	Y 3	X Y 1	N	X Y 1	4X	2	2	5	1	1		2
Driver criminal record check (for officer safety reasons)	N 4	Y	N	Y 2	N 5		X Y 1	Y 4	X Y 2	X Y 1	Y 5	Y 2	X Y 1	X Y 1		5X	4	3		0	0		1
Driver hours of service log check	Y 3	X Y 1	X Y 1	Y 2	X Y 3		Y 3	Y 1	X Y 1	X Y 1	X Y 1	X Y 1	X Y 1	X Y 2	X Y 1	10X	9	2	3				
Hazmat permit check	N 4	Y	N	Y 1	X Y 1		Y 4	Y 5	X Y 1	Y 3	Y 4	N 3	X Y 1	X Y 2	X Y 1	5X	5	1	0	1	1	1	1
Hazmat inspection	Y 2		Y 2	note 5	X Y 1		Y 3	Y 3	X Y 1	X Y 1	Y 4	N 3	X Y 1	N	X Y 1	5X	5	2	1	1			1
Load tie-down/containment check	X Y 1	Y	X Y 1	X Y 1	X Y 1		X Y 1	Y 1	X Y 1	X Y 1	X Y 1	X Y 1	X Y 1	X Y 3	X Y 1	12X	12		1			1	
Safe loading check		Y	X Y 1	X Y 1	X Y 1		X Y 1	Y 2	X Y 1	X Y 1	X Y 1	X Y 1	X Y 1	X Y 3	X Y 1	11X	10	1	1			1	
Office for educational purposes	N 5	Y	Y 3	note 6	X Y 3		Y 2	X Y 1	X Y 2	X Y 3	N 4	N 2	N	Y 3	Y 5	4X	1	1	4	-1	0	1	1
Facility for self compliance checks	N 5	Y	X Y 1	note 7	X Y 3		Y 1	X Y 1	X Y 1	X Y 2	N 4	N 2	X Y 1	Y 3	Y 5	6X	5	0	2	-1	0		
Other important functions not identified above						note 14			note 23	note 27					note 35								
Recorded Traffic Volume																		H	M	L			
Fixed Sites																							
Highest hourly commercial vehicle traffic volume observed			H	H	H	H	H	H	H	L	H		H	H				10		1			
Highest daily commercial vehicle traffic volume observed			H	H	H	H	H	H	H	H	H		H	H				11					
Typical hourly commercial vehicle traffic volume observed			M	H	H	M	H	H	H	L	H		H	H				8	2	1			
Typical daily commercial vehicle traffic volume observed			M	H	H	M	H	H	H	H	H		H	H				9	2				
Total number of operational fixed sites			13	8	15	12	2	15						3									
Mobile Sites																							
Highest hourly commercial vehicle traffic volume observed			H	M	H	M	H	H	M	M	M		M	H				5	6				
Typical hourly commercial vehicle traffic volume observed			M	M	M	M	M	M	L	L	M		M	H				1	8	2			
Total number of operational mobile sites			6	51	30	1	1	30						2									
																Y	N						
Operation/Performance of a Remote Controlled Weigh Station																							
Do you believe the concept contributing to public safety?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y		Y	Y	13	0						
Where should a RCWS be located?			note 2	note 8	note 11	note 15	note 18	note 20	note 24	note 28	note 31	note 32		note 33	note 36								
Should a RCWS have all the functions of a fixed site WS?	N	N	N	N	N	N	N	Y	Y	Y	N	N		N	N	3	11						
Additional comments to the above entry		note 1	note 3	note 9	note 12	note 16	note 19	note 21	note 25	note 29				note 34	note 37								
Should fixed site WS have the capability to operate as RCWS?	Y	Y	Y	N	Y	N	Y	Y	N	Y	Y	Y		N		9	4						
Should mobile site WS have the capability to operate as RCWS?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	14	0						
Should RCWS be operable at extended hours?	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N		Y	Y	13	1						
Should RCWS be allowed to operate in self service mode?			Y	N	Y	Y	Y	Y	Y	Y	N	N		N		7	4						
Additional comments to the above entry			note 4	note 10	note 13	note 17		note 22	note 26	note 30													

NOTES:

1 Vehicle mechanical & permit check; Driver licence; Driver logbook; Weight & dimensions check
2 Provincial border crossings
3 (Self) weight check, visual cargo securement, dimension check, heat check on hub/brake, light check, classification check, driver credentials
4 Weight, dimensions, safety checks
5 Manual/physical process
6 Not necessary for all locations, but some key sites should be important
7 They should be compliant before they take to the road
8 On routes whereby commercial vehicles take to bypass inspection sites, or where permanent sites are not feasible
9 It should be able to capture vehicle ID, classification, weights and dimensions information; ideally, vehicle and driver credentials, logbook info
10 Not convinced how self-service would and could work
11 Hwy 1 west of Regina, Hwy 16 at Clavet, major TIS locations which would automate vehicle inspection to the point where only 1 traffic officer is required during normal hours of work
12 See opinion above. The ones that are marked Y1 are important
13 Weight, light checks, as circle check area
14 Driver impairment - drugs, alcohol and/or fatigue; Load/shipment documentation; Legality of load - contraband; match manifest
15 It could work in a limited capacity - Prince Albert, Moose Jaw
16 Weight, limited dimension, limited visual inspection for obvious safety defects
17 Records weights and plate numbers; Would like to see VIN & other information; Transmitted to local receiver to gather information and compile with weights
18 At this time, a RCWS in the Moose Jaw area to weigh vehicles on Highways 39 and 1
19 Ability to self weigh; Ability to record unattended and attended operation; Print capabilities
20 Regina - Highway 1 westbound; Possibly Clavet - distance from Langham may prohibit
21 Capture weights and dimensions; Communicate with driver; Capture document information
22 Self service weighing
23 Mandatory commercial vehicle inspection check
24 Highway 2A south of Leduc, Alberta
25 Weights, dimensions, vehicle visible mechanical defects; Operator licence, registration, permit, CVIP, infrared for brake concern detection; Some type of video/audio record
26 Weights and dimensions
27 Thermal imaging technology; Road weather information systems; Dynamic message signs
28 On any heavily travelled corridor or on arteries utilized by industry to bypass or elude fixed site weigh stations
29 Weights and dimensions monitoring; Thermal imaging technologies; Vehicle visible mechanical defects (overheated brakes, head lights, tail lights, turn signals not working); Overhead message signs informing drivers of weights and dimensions & mechanical fitness status; Hazmat inspection and permit check; Company/carrier/operator licence, permit and operation record check
30 Weights and dimensions; Thermal imaging technologies to detect faulty wheel bearings and brakes; Visible mechanical defects (lights not working, brakes overheating);Load/tie-down containment check; Company/carrier/operator licence, permit and operation record check; Hazmat inspection and permit check
31 On a trade corridor in conjunction with other fixed facilities
32 Adjacent to highway
33 On provincial highways having no fixed site, but with a high traffic volume
34 Weights, measures, logs, permits, hazmat
35 Data collection for planning and management of highway control, road maintenance and production of indicators
36 On strategic places like weigh station bypass road, harbour access, intermodal yard access road
37 Weight and dimension enforcement, AVI, WIM, data collection

METHODOLOGY

1 Questions are grouped into three categories: Functions, Traffic Volume and Operation/Performance.
2 Responses on Functions are used to identify and confirm Functional Requirements.
3 Responses on Traffic Volume and Operation/Performance are used to identify and confirm Performance Requirements of the RCWS.
The following procedures are used in the Analysis:
4 For each function listed on the Questionnaire, the response consists of three parts:
If the function is considered important, it is identified by a "Y" entry, otherwise a "N" entry.
A respondent enters a rating of 1 to 5 to indicate the relevant importance or irrelevance. Highest rating is 1.
If the function is considered a MUST-HAVE one, a respondent enters a check mark on the function.
5 If a function is entered with a "Y" and a rating, it is counted as a +1 towards that rating in the Analysis.
If a function is entered with a "N" and a rating, it is counted as a -1 towards that rating in the Analysis.
6 If a function is not entered with a rating, the result is not included in the tabulation for Analysis. This applies to both "Y" and "N" entries.
7 In tabulation, "Y"s and "N"s are accumulated if they are associated with rating entries. A 1"Y" and a 1"N" will cancel out resulting in a "0" entry.
Thus, a 1"N" and 2"Y" will result in a "+1" entry and a 2"N" and a 1"Y" will result in a "-1" entry, corresponding to the rating.
8 Responses to questions requiring single selection are summed up in the tabulation for Analysis.
9 Comments in the responses are useful for clarifications and for planning processes for site locations and other desirable features.
10 Functions with the largest numerical number are considered most desired MUST-HAVE functions by respondents.
11 Functions with large accumulation of high rating of "Y"s are considered desirable functions by respondents.

ANALYSIS

Based on responses to the Questionnaire by respondents, preliminary results appear to be:

1 Except for the functions of "Company/carrier/operator operation record check" and "Driver operation record check",
all described functions are rated of various degree of importance.
2 The following functions are considered to be of significant importance (rating of 1)
Weight enforcement
Weight and dimensions enforcement
Company/carrier/operator licence check
Company/carrier/operator permit check
Vehicle licence/registration check
Vehicle mechanical fitness check
Vehicle visible mechanical defects check
Driver hours of service log check
Load tie-down/containment check
Safe loading check
3 Weight and dimensions enforcement is unanimously considered "Must Have" functions
4 In addition to the "Weight and dimensions enforcement", the following functions are considered highly "Must Have" functions
Vehicle mechanical fitness check
Vehicle visible mechanical defects check
Load tie-down/containment check
Safe loading check
5 For fixed site operation, the RCWS should be designed for "High Volume Traffic" operation of 50 vehicles maximum hourly and
500 vehicles maximum hourly
6 For mobile site operation, the RCWS should be designed for "Medium Volume Traffic" operation of 15 vehicles maximum hourly
and 150 vehicles maximum hourly
7 All respondents believe that the RCWS concept would and could contribute to the public safety
8 All mobile site weigh stations should have the capability to operate as RCWS
9 All RCWS should be operable at extended hours

RESULTS

Based on the Analysis, the results are summarized as:

1 All respondents believe the concept of RCWS will contribute to public safety.
2 All mobile sites should be able to operate as RCWS.
3 It would be desirable for fixed sites to have the RCWS capability.
4 RCWS should be operable at extended hours.
5 All respondents pick weight and dimensions enforcement as the MUST-HAVE function of the RCWS.
6 Other most desirable functions in descending order are:
   Load tie-down/containment check
   Safety loading check
   Vehicle mechanical fitness check
   Vehicle visible mechanical/electrical safety check
7 The MUST-HAVE and most desirable functions are recommended for implementation of the RCWS.
8 Other respondents noted functions of significant importance are:
   Company/carrier/operator licence check
   Company/carrier/operator permit check
   Vehicle licence/registration check
   Driver hours of service log check
9 These noted functions are implementable by the operator actions. These functions may be automated in the Advanced Model of RCWS.

APPENDIX B – FUNCTIONAL AND PERFORMANCE REQUIREMENTS

TABLE OF CONTENTS

1. SCOPE

1.1. Identification

This document describes the requirements for the Remote Controlled Weigh Station (RCWS). These requirements were derived mainly from discussions with key people and with a customer survey. They aim to capture the system requirements for the equipment from our customer's perspective.

1.2. System Overview

The operation of Remote Controlled Weigh Stations requires one operator, situated at a central location, who controls multiple weigh stations on a random and intermittent basis, and on an as-required basis. District, region or the province may determine one or a few central location(s). Each RCWS operates as if it has an operator on-site. Remote Controlled Weigh Stations provide excellent opportunities for extending service coverage in weight and dimensions compliance checks and limited mechanical fitness checks on commercial vehicles at modest costs.

1.3. Conceptual Model

Conceptually, the Remote Controlled Weigh Station may be designed into one of two models - Basic and Advanced. The Advanced model has all the functions and features of a Basic model, plus additional functions and features. Each RCWS comprises all equipment necessary for providing the following functions from a remote location

The Basic model:

- Weight and dimension measurements;
- Vehicle classification;
- Compliance verification on weights and dimension;
- Safety checks of signals - brake lights, turn signals, taillights and headlights;
- Detection of non-functional brakes; and
- Vehicle data collection.

The Advanced model:

- Automatic credential check
- CVIEW capability for self-serve safety check reporting; and
- CVISN tie-in capability for inter-provincial and international data exchange, probably for safety, security and credential information, used by transportation authorities and/or other government agencies in border crossing situations.

1.3.1. Functional Requirements – Basic Model

The RCWS Basic Model provides the following functions:

1.3.1.1. The RCWS shall allow an operator at a remote location (e.g. central office) to control its local operation. The operator shall have the necessary system tools to:

- Examine vehicle condition;
- control traffic movement; and
- communicate with the vehicle driver

1.3.1.2. Typically, the RCWS is operated remotely by an operator in a central office. Nevertheless, the RCWS shall be possible to be operated locally on-site by an operator or in a semi automated mode which allows an operator at the RCWS site to control a portion of the system while a remote officer controls other components in parallel. For example, a remote operator may control one direction of a bi-directional station while the local operator controls the opposite direction.

1.3.1.3. The RCWS operator shall be able to direct traffic movement.

1.3.1.4. The RCWS operator shall be able to communicate to the driver of vehicle being monitored all the information necessary to meet the requirements listed in this document.

1.3.1.5. The RCWS shall, with additional equipment, allow the operator to identify commercial vehicles that have failed to report to the weigh station when it is open.

1.3.1.6. The RCWS shall allow the operator to identify commercial vehicles that have reported to the weigh station.

1.3.1.7. The RCWS shall allow the enforcement operator to verify that a target vehicle which is reporting to the weigh station is in compliance with the local transportation regulations. For example, this may be statically weighing each axle on a static scale or a more detailed visual inspection of length, width, height, load safety, etc.

1.3.1.8. The RCWS shall allow the operator to perform weight and dimension compliance checks for a vehicle, which has reported to the weigh station.

1.3.1.9. The RCWS shall allow the operator to verify the operation of brake lights, turn signals, taillights and headlights of a vehicle, which has reported to the weigh station.

1.3.1.10. The RCWS shall allow the operator to identify vehicles with a high probability of faulty brakes.

1.3.1.11. The RCWS shall allow the operator to verify proper load distribution of a vehicle, which has reported to the weigh station.

1.3.1.12. The RCWS shall allow the operator to verify a vehicle, which has reported to the weigh station whether its load has been properly secured.

1.3.1.13. The RCWS shall allow the operator to identify the license plate of a vehicle, which has reported to the static scale.

1.3.1.14. The RCWS shall be designed to support the development of interfaces to devices intended for Automatic Vehicle Identification.

1.3.1.15. The RCWS shall allow the operator to direct a driver to report to a remote kiosk located in the weigh station.

1.3.1.16. The RCWS shall allow personnel with the regulatory agencies responsible for the enforcement of the inspection criteria to communicate with a driver that has reported to a remote kiosk.

1.3.1.17. The RCWS shall allow the operator to check license, registration, and log book information for a driver that has reported to the kiosk

1.3.1.18. The user interface shall be configurable as French or English, and will be designed to easily implement additional languages as required.

1.3.1.19. The RCWS shall be switchable between local and remote operations.

1.3.1.20. The RCWS shall record all data in metric.

1.3.1.21. The user interface shall be configurable to display in either Imperial or metric units.

1.3.1.22. The Basic configuration of the RCWS shall cost the user between $200,000 and $300,000.

1.3.2. Functional Requirements – Advanced Model

In addition to the functions identified under Section 1.3.1, the RCWS Advanced Model shall provide the following functions:

The RCWS shall automatically perform credential checks on vehicles identified by the system

1.3.2.1. The system shall support an interface which permits vehicle operators and kiosk visitors to check their safety rating on the local jurisdictions web site.

1.3.2.2. The RCWS shall have the capability to support and integrate with CVISN tie-in for inter-provincial and international/inter-state data exchange. Under bilateral and/or bi-national data interchange agreement, safety, security and credential information of vehicle/driver/carrier/operator may be supportable for use by transportation authorities and other government agencies.

1.3.2.3. The system shall include an interface which permits vehicle operators and kiosk visitors to look up regional and inter-provincial regulations related to commercial transportation.

1.3.3. Performance Requirements – Basic Model

The RCWS Basic Model shall meet the following performance requirements:

1.3.3.1. In the remote operation of a control device as described in Section 1.3.1.1 or any other similar device necessary for the operation of the weigh station, there shall be negligible delay, probably around 0.5 second, from the time the RCWS operator makes a change on a control device to the time the change is executed and displayed by the control device.

1.3.3.2. The RCWS shall accommodate maximum traffic volumes of 50 vehicles per hour and up to 500 vehicles per day.

1.3.3.3. At the stated traffic volumes, a single operator shall be able to operate the RCWS effectively.

1.3.3.4. The design of the RCWS shall facilitate the conversion of an existing weigh station to an on-demand RCWS.

1.3.3.5. The RCWS shall automatically save all available data regarding vehicles, which have failed to report to the weigh station when it is open. This data shall be saved for a minimum of 30 days. Typically, available vehicle data shall include vehicle classification, time, date and speed of its passage. Optionally additional data can be stored to aid in the identification of the vehicle

1.3.3.6. The RCWS shall allow the operator to store data of vehicles, which have reported to the weigh station. This data shall be saved for a minimum of 10 days, and shall include the following:

- Static weights of each axle
- Type and classification of vehicle
- Licence plate of the vehicle
- Driver license and logbook information
- Vehicle/carrier/operator safety record
- Check items status
- Operator entered information on vehicle

1.3.3.7. Communication between the operation center and the RCWS shall be fast enough to support the action as stated in Section 1.3.3.1.

1.3.3.8. All data collected by the system shall be transferable electronically using a file transfer system. Files transferred shall be in a format which can be viewed using industry standard OEM software such as Microsoft or Corel office products.

1.3.3.9. The system shall have capability to create hardcopies of data files at both the remote site and the control center (i.e. tickets, summary data, etc.).

1.3.3.10. The RCWS shall achieve operational availability of at least 98.5% measured over a period of 90 days.

1.3.3.11. The RCWS shall be designed for a Mean Time To Repair of 2 hours.

1.3.3.12. The Kiosk user interface shall be designed for the Commercial Vehicle Operations Trade which includes clear directions on how to use the system.

1.3.3.13. The system should be designed to operate in an ambient temperature range of -45 degree Celsius to +45 degrees Celsius.

1.3.3.14. All components shall not be adversely affected when stored in a temperature range from -65 degrees Celsius to +65 degrees Celsius.

1.3.3.15. The control center and / or maintenance personnel shall have system tools to verify the RCWS component health.

1.3.3.16. The control center and / or maintenance personnel shall have the ability to run diagnostics remotely to diagnose or verify system health.

1.3.3.17. The system shall be designed consistent with the National Electrical Code and Manual of Uniform Traffic Control Devices.

1.3.3.18. The system shall meet local and national building and safety regulations at both the remote station and the control station.

1.3.3.19. The system shall be designed to meet or exceed municipal, provincial, and Federal Data Security regulations.

1.3.4. Performance Requirements – Advanced Model

The RCWS Advanced Model shall meet the performance requirements as stated for the Basic Model. In addition, the RCWS Advanced Model shall meet the following performance requirements:

1.3.4.1. The RCWS shall allow the operator to store data of vehicles that have reported to the weigh station. This data shall be saved for a minimum of 10 days, and shall include the following additional information:

- CVIEW information on safety check reporting
- Available Inter-provincial and/or international/inter-state data exchange information through CVISN tie-in
- Vehicle safety record
- Other available information such as documents and information from commercial transportation regulatory agencies.

1.3.4.2. The transmission rate and bandwidth requirement of the RCWS shall be upgraded accordingly.