A Reliable System for Monitoring Truck Movements and Characteristics in Manitoba

by

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ABSTRACT

Reliable truck data and information is required to perform several transportation-related engineering functions in Manitoba. Truck data requirements can only be met through the development and implementation of a reliable truck monitoring system that is based on the specific types of data required to fulfill user needs, fundamental principles governing data quality, and efficient data collection methods.

The existing truck monitoring system in Manitoba does not meet all user requirements, particularly with regards to truck volume, classification, and weights. The recommended system includes initial placement of up to 54 permanent vehicle classification stations operating continuously to obtain truck volume and classification data, with future implementation of electronic weight sensors to obtain truck weight data. The available low-cost WIM technology does not yet achieve recommended reliability levels to proceed with wide-scale equipment acquisition.

The recommended sampling program is intended to provide system-wide estimates and monitor historic trends for those engineering functions requiring general truck information. The sampling program should not be implemented until electronic equipment can be acquired to monitor sampling sites for continuous 48-hour periods.

The monitoring system should be re-evaluated periodically to ensure that it continues to efficiently provide required information at recommended reliability levels.

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ACRONYMS

AADT:	Annual Average Daily Traffic
AADTT:	Annual Average Daily Truck Traffic
AVC:	Automatic Vehicle Classification
AVKT:	Annual Vehicle-Kilometres Travelled
C-SHRP:	Canadian-Strategic Highway Research Program
CCS:	Coverage Count Stations
COV:	Coefficient of Variation
DHV:	Design Hourly Volume
EAL:	Equivalent Axle Load
FHWA:	Federal Highway Administration (U.S.)
LTPP:	Long-Term Pavement Performance
MDHT:	Manitoba Department of Highways and Transportation
PCS:	Permanent Counting Station
PD:	Percent Difference
PMS:	Pavement Management System
PR:	Provincial Road
PTH:	Provincial Trunk Highway
SHRP:	Strategic Highway Research Program
TAC:	Transportation Association of Canada
TEF:	Traffic Equivalency Factor

TLF: Truck Load Factor

WIM: Weigh-in-Motion

CHAPTER 1. INTRODUCTION

1.1 Purpose

The goal of this research is to establish the requirements and specifications for a truck information system that provides reliable data regarding truck movements and characteristics. The information system is developed specifically to service the planning and design needs of Manitoba's highways.

An efficient truck information system consists of a comprehensive data base that reliably and economically serves the needs of its users. Therefore, the specific objectives of this research are to:

- document and assess the existing system;
- determine who the users are and establish the engineering needs for truck data, including the specific functions requiring truck information, the types of truck data needed to provide the required information, and the desired report format;
- define the principles governing the total information system, with reliability and cost-efficiency at the forefront;
- evaluate data collection methods available for developing required data bases;
- develop the system, including the number and general locations of data collection sites, reliability requirements, equipment requirements, and data types to be collected.

To summarize, the objectives of this research are to establish and define each element of the following diagram:

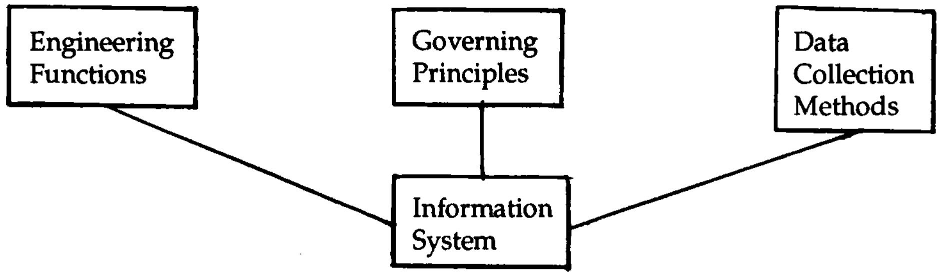

Figure 1-1. Elements of a Reliable Information System

1.2 Problem

Truck data and information is required by several engineering functions, including: pavement design and management, pavement performance analysis and research, bridge design and rating, transportation planning, highway design, enforcement, traffic engineering, safety and programming [Albright, 1990; Clayton et al., 1985; Cunagin, 1990]. In most cases, several data elements are essential for the functions to be performed in a reliable manner.

Historical:

In the 1960's, North American highway agencies generally used manual and mechanical data collection methods, resulting in labour-intensive programs. At that time, resources for all types of transportation projects were more readily available, so a wide variety of data types were collected whether or not the data was utilized [Bottiger and Kilareski, 1987].

During the 1970's and early 1980's, when truck travel was increasing, many highway agencies were required to reduce resource allocation to construction, maintenance, and "expendable" programs [Bottiger and Kilareski, 1987; Cunagin et al., 1986; Massuco, 1988]. In general, data collection programs were considered expendable, even though data is an essential and integral part of the overall planning and design of the transportation network [Bottiger and Kilareski, 1987; Ritchie, 1986].

Although most agencies recognized that some data was required to perform engineering functions, data collection programs were reduced to collecting a minimum amount of data, without regard to the quantity and types of data required to perform engineering functions efficiently. Many agencies collected data just for the sake of collecting data, with no clear, well-defined plan to establish who the users were, the required data types, the required reliability levels, and the best methods to manipulate, present and store the information [McElhaney, 1990]. In several cases, data bases were under-utilized because they did not provide the required information, or the information was not stored in an easily accessible manner [White, 1989]. Therefore, it appeared as though data collection was wasting time and resources.

General

The data collection branch within a highway agency generally does not use the data. Therefore, the branch is responsible for determining who the users are, and how the users are best served. Based on the requirements of the users, the data collection branch must develop the most efficient and cost-effective system, and implement it promptly, rather than collecting data based on the principle "that is the way we have always done it" [McElhaney, 1990].

When information is available, a general assumption is that the underlying data was actually measured, and then manipulated to produce the information. However, quite often the data is either estimated (i.e. not actually measured), or else it is not current [Albright and Wilkinson, 1990]. Often no provision is made to inform the user as to how the data and resulting information is obtained.

Consideration must also be given to the methods of data manipulation. For example, annual average daily traffic (AADT) is similarly defined among agencies. AADT represents the average daily traffic at a location based on traffic counts. However, several methods exist to calculate AADT, all of which are technically correct, but which affect the final result [Albright and Wilkinson, 1990]. AADT may be calculated from a count over a period of several hours, from one day's traffic count, or from 365 days of continuous traffic counts. The latter gives a true AADT, yet all are acceptable.

The users often do not question the data's origin and reliability. They may be content to use published values at face value, but their responsibility is to first establish whether the data has an adequate reliability level to be incorporated into designs, plans, etc. However, the users should have the ability to determine how and when the published values were obtained or calculated.

To summarize:

- the published values may not be reliable, and should be presented, handled, and used accordingly;
- the best or most cost-effective designs and/or plans may not be found based on the published values, or on "educated guess" values;
- a highway agency's ability to develop long-term, cost-effective and efficient programs may be hindered in many areas, such as pavement design, pavement management, highway design, and transportation project planning due to inadequate data collection.

Manitoba

The problems regarding a well-defined data collection system, described in the previous section, also exist in Manitoba. More specifically, the problems are as follows:

- The engineering functions requiring truck data were not established prior to developing the current data collection system. Therefore, the system does not collect all required data types.
- The methods used to collect and manipulate the data are not clearly defined for the users.
- A general lack of communication exists between branches as to what truck data is available.
- The reliability of the truck data is unknown, except at the exact locations where data has recently been collected. Information reported for other locations may be outdated or estimated, but are not reported as such.
- Several planning and design functions are dependent on reliable truck data but do not have access to it, which raises the question of whether cost-effective plans and designs are being developed based on truck data approximations.
- In general, the data users are not aware of the sensitivity of their analyses and designs to the data inputs.

The problems are reflected in the following issues:

- providing appropriate data for SHRP (Strategic Highway Research Program);
- decisions regarding expansion of the WIM (Weigh-in-Motion) network;
- pavement design for truck routes;
- load impact studies;
- percentage of overweight trucks in Manitoba.

The above factors contribute to a general deficiency in understanding the movements and operating characteristics of the existing truck population. To compensate for this, designers and planners in Manitoba rely on load and performance characteristics from design vehicles rather than actual vehicles, on data from outside the province, or on assumptions.

1.3 Scope

This research considers only the *engineering* needs for truck data within the Manitoba Department of Highways and Transportation (MDHT). Other functions, such as the Vehicle Registration branch, are involved in provincial commercial vehicle operations and have special data needs, but are not considered as a part of this study.

Descriptions of the perceived and actual engineering needs for truck data at this time are provided. The explanations given for the perceived needs are the views expressed by engineers at MDHT. The explanations are supplemented by comments regarding the actual needs that exist as explained in the literature, but were not recognized during the interviews.

The needs are established by surveys conducted throughout MDHT, and by pre- and post-survey discussions held with engineers requiring truck data. Also, a literature review was performed to develop the survey format and to develop a list of potential truck data types required for various engineering functions.

The post-survey interviews are also used to establish potential users of the SHRP and C-SHRP (Canadian SHRP) data bases. However, if the entire data collection program will be upgraded province-wide to incorporate similar equipment to that used at the SHRP sites, further analysis will be required to ensure that the highest priority data will be collected, analyzed, and summarized in the formats that best benefit the users. Since the needs may change over time, they should be re-evaluated periodically.

The data collection methods considered are only those that are currently available in Manitoba. Consideration was not given to any equipment or technology that is currently in the experimental stages, or does not provide low-cost alternatives (e.g. WIM utilizing low-speed platform sensors).

Development of the overall truck data collection system is based on presently available data and information. The intent is to apply the *methodology* used extensively in the U.S. to develop sampling techniques and to locate general data collection sites. The data used in some areas is outdated, but there are no alternatives to using available data. The methodology is used to show how the data collection system can be evaluated based on available data to provide a statistically representative sample of truck movements and characteristics. If such a network is put into place, it should be periodically evaluated and upgraded based on the available information.

General guidelines regarding monitoring equipment and locations are presented. Specific recommendations for equipment and location requirements necessitate further study of available technology and the provincial highway network.

CHAPTER 2: MANITOBA'S CURRENT DATA COLLECTION AND INFORMATION SYSTEM

This chapter defines Manitoba's existing data collection and information system.

2.1 Traffic Counting Program

2.1.1 Permanent Counting Stations (PCS)

There are 48 PCSs in Manitoba that provide hourly traffic counts for, ideally, 365 days per year (see Appendix A, Fig. A-1). The station locations are chosen to obtain geographically representative traffic counts on various road classes [Lucas, 1993].

The PCSs typically consist of induction loops imbedded in the pavement surface of each lane to detect vehicles. The loops are connected to a Golden River counter that records the number of vehicles passing over the site in each direction. The equipment operates on solar-powered batteries, eliminating the need for an electrical power supply. The counters have internal memory capacity, so tapes and cassettes are not needed at the station. Retrieval of traffic data is via telephone modem.

The incoming data is stored on cassette tapes compatible with the PC in the Planning Office at MDHT. Historical data is stored on the mainframe computer, but is presently being converted to PC format, because:

- the costs incurred by analyzing, printing, and storing data on the mainframe;
- the convenience of accessing PCs as opposed to mainframe computers;
- the lack of personnel capable of accessing mainframe computers [Lucas, 1993].

Traffic data from PCSs is "considered to be the most accurate data [provided by the MDHT] and is available for at least 25 years" [WACHO, 1988]. This statement is made because of the 25 year time period that the data has been collected at those sites at hourly intervals. The counts are relatively complete when compared to data collected less often at other locations.

Data collected at PCSs is used to provide the following information:

- *Annual Average Daily Traffic (AADT)*: AADT at a location is calculated by summing the daily counts and dividing by 365. Any erroneous or missing data is replaced or filled in[1] to obtain complete daily counts. AADT represents the daily volume of traffic expected at a location, and is a major factor in many transportation decisions.
- *Design Hourly Volume (DHV):* DHV is the average volume of traffic expected at a location in any one hour time interval. The projected value is used to establish required lane and highway capacity for a highway section to maintain a desired level of service. The MDHT uses the 30th highest hourly volume[2] for general highway routes, and the 50th highest hourly volume for recreational routes.
- *Weekly Expansion Factors for Short-Term Counts:* Weekly expansion factors are calculated as the ratio of the PCS AADT to the average weekly traffic for each week of the year. AADTs for short-term count sites are calculated by applying the factors to short-term counts (24 hours), and averaging the expanded estimates for all counts conducted during the year [Lucas, 1993].
- *Traffic Growth Rates:* The growth rate at each PCS is a ratio of the current year's AADT to the previous year's AADT.
- *Traffic Growth Prediction:* Future traffic growth rates at PCSs are predicted by averaging the annual growth rates for the previous 10 years. Each road section is assigned a growth rate that is reviewed every three years. The

---

[1] See Endnotes.

three-year period is based on the assumption that, in general, traffic growth rates do not significantly change within a three-year period [WACHO, 1988].

- *Peak Hour Flow:* Peak hour flow represents the highest hourly volume within a 24-hour period. Generally, all PCSs indicate the peak flows tend to occur during the same, or similar, hours of the day. For example, commuter routes[3] such as PTH 59 display definite peak flows in the morning and afternoon in different directions. Inter-provincial routes, such as PTH 1, show a gradual afternoon peak, or less discernible morning and afternoon peaks, in both directions [Lucas, 1993]. Peak hour flows assist in establishing traffic patterns at, and near, PCSs.

Although PCSs provide a substantial quantity of data and information regarding general traffic volume, PCS equipment is not programmed to differentiate between vehicle types. Therefore, vehicle classification cannot be determined from PCS data, resulting in other collection methods being used to provide vehicle class information.

2.1.2 Coverage Count Stations (CCSs)

There are currently 1962 CCSs monitored throughout the province [Lucas, 1993]. The stations are generally located at intersections of provincial trunk highways (PTHs) and provincial roads (PRs). Stations equipped with induction loops are counted every year, and stations utilizing pneumatic tube counters are counted every two years.[4] Counts on remote northern roads are conducted twice during the summer every two years.

CCSs equipped with induction loops provide actual vehicle counts. The loops are capable of detecting a vehicle, but cannot differentiate between vehicle types. CCSs equipped with pneumatic tube counters provide axle counts, which require axle conversion factors to estimate the number of vehicles.

AADTs at CCSs are estimated using expansion factors developed from PCS data. The criteria for assigning a CCS to one or more PCSs are: relative distance between the CCS and PCS(s); similarity of traffic characteristics; and general knowledge regarding the highway system [Lucas, 1993].

2.1.3 Town Counts

Short-term volume counts are taken for 24 or 48 hours on a three-year cycle on town roads under provincial jurisdiction. All town counts are conducted in June because the June average daily traffic flows are believed to be close to the actual AADT [Lucas, 1993]. However, the counts are not included in published reports, since the reliability of the counts is unknown.

2.1.4 Special Counts

Special counts are conducted on an "as required" basis, and are undertaken to supplement existing information [WACHO, 1988].

A. Special Turning Movement Surveys

Special turning movement surveys are conducted primarily as a check to ensure that substantial traffic at intersections has not been missed by the regular program. Secondary reasons for performing the special surveys are to assist in determining the need for traffic signals or pedestrian corridors, and for intersection design studies. The duration of the surveys is 14 hours over two days.

B. Licence Plate Surveys

Licence plate surveys are performed to determine the routes used by vehicles in a specific area. For example, a survey may be designed to determine the number of vehicles that pass directly through a town, or layover in the town, to decide whether or not a town bypass is required. Another example is to conduct a licence plate survey on a minor road that links two major routes to establish the extent that the minor road is used as a shortcut from one major route to the other. The results of such a survey would indicate whether or not the link should be upgraded to support the traffic volume (see Appendix A, Fig. A-2).

C. Origin-Destination Studies

Manitoba does not routinely conduct origin-destination studies [WACHO, 1988]. Data collected in past studies includes: origin, destination, trip purpose, layover made, money spent at layover, length of layover, and commodity carried. The data is used as input for modelling line volumes between specific origins and destinations [WACHO, 1988]. The survey duration depends on the size of area to be studied and the number of locations required for interviews.

D. Trucking Industry Studies

These studies are used to establish the growth of truck travel. Information collected includes: types of vehicle combinations used, number of trips per week, weight of loads, route used, and time of trip. The vehicle growth rate is based on a calculated growth rate for the current truck traffic projected over a twenty-year period.

2.2 Vehicle Classification Program

2.2.1 Manual Vehicle Classification and Turning Movement Surveys

Data obtained through the manual vehicle classification and turning movement surveys constitutes the basis for the majority of readily available truck information within MDHT. Until 1989, the survey program involved monitoring an average of 26 intersections four times per year.[5] Since 1990, the number of monitored intersections has decreased to an average of 20 intersections per year due to staff reductions.

The criteria for choosing a survey location are: requests by any branch at MDHT that requires data at a specific location; traffic volume at a location; and the time passed since the last survey.[6]

Until 1992, the surveys consisted of field staff using visual classification and manual counters with field sheets to classify vehicles into one of 44 classes. The completed sheets were submitted to the Planning Support Branch at MDHT for verification and batching, prior to data entry to the mainframe computer. Mainframe programs were used to output summaries regarding vehicle classification at intersections (see Appendix 1, Fig. A-3).

Recent acquisition of Titan electronic counting boards has eliminated the need for field sheets, manual data entry to mainframe, and mainframe computer programs. The Titan electronic boards have internal memory and battery power capabilities, with keys assigned for up to 15 vehicle classes traversing the intersection and executing any turning movement. The observer records the data by key-punching relevant data. The boards are configured to download data directly into a microcomputer.

Classification Schemes

There are currently three vehicle classification schemes used within the MDHT:

- *Manitoba-44* : An extensive 44-class scheme that was used for manual vehicle classification surveys. The 44-class scheme has recently been discontinued because of its incompatibility with the new electronic equipment (see Appendix A, Fig. A-4).

- *FHWA-13* : A 13-class scheme standard in the United States. This scheme is required for participation in SHRP, and is used at all SHRP sites in Manitoba (see Appendix A, Fig. A-5).

- *Manitoba-15* : A 15-class scheme that extends the FHWA-13 scheme to include two additional classes for 8- and 9-axle trucks (see Appendix A, Fig. A-6).

The Transportation Association of Canada (TAC) is currently developing a 22-class uniform vehicle classification scheme for Canada (see Appendix A, Fig. A-7). The Planning Support Branch at MDHT intends to utilize this uniform scheme upon completion of its development.

The following information is obtained from turning movement and vehicle classification surveys:

- *Vehicle Class Distribution:* the volume and percentage of vehicles in each vehicle class that pass through an intersection from each direction;

- *Turning Movements:* the number of vehicles making turning maneuvers at an intersection;

- *Truck Percentages:* the total percentage of trucks in the traffic stream;

- *Annual Average Daily Truck Traffic (AADTT):* the average daily truck traffic on a road section. It is estimated by multiplying the AADT by the percentage of trucks;

- *Axle Conversion Factors:* applied to short-term pneumatic counts to estimate the traffic volume at the count site. The factors are calculated from truck percentages obtained through vehicle classification surveys.

2.2.2 Length Classification

Length classifiers are electronic loop devices that operate with equipment similar to automatic counters. They can be easily installed at PCSs, since they utilize the same telemetry equipment. The purpose of length classification is to determine general vehicle types passing over the sensors by measuring the total length of each vehicle.

The length of each vehicle that passes over the sensor array is measured, based on the vehicle's speed[7] and the length of time required for a vehicle's front end to pass over the first sensor to the back end passing over the second sensor. The computer "files" the vehicle into a "length bin", based on programmed length ranges, and counts up +1 for each vehicle in that bin.

Manitoba currently has four length classifiers that operate at various locations. The classifiers are set to a maximum of four length bins, with the following ranges:

BIN	LENGTH (FEET)	LENGTH (METRES)
1	0 - 20	0 - 6.1
2	20 - 41	6.1 - 12.5
3	41 - 56	12.5 - 17.1
4	> 56	> 17.1

The number of vehicles in each bin provides general vehicle classification without indicating individual truck types. Bin 1 represents cars and bins 2 to 4 represent various classes of commercial trucks. The total number of vehicles in bins 2-4 indicates the total number of trucks in the traffic stream. The percentage of trucks is the ratio of the total number of vehicles in bins 2-4 and the total number of vehicles in bins 1 to 4.

The MDHT has found that cars with trailers are classified in bin 2, resulting in artificially high truck percentages, particularly during summer months. Therefore, the MDHT is considering using length classifiers only as traffic counters.

2.2.3 Automatic Vehicle Classification (AVC)

Automatic classifiers utilize electronic equipment similar to electronic counters and length classifiers. The processing unit[8] requires additional programming capability to determine vehicle classification, so the counter and classifier computers are not directly interchangeable. Automatic classifiers also require axle sensors and additional induction loops.

The processor detects a vehicle when it enters the loop, and the speed is calculated.[9] The following data is also collected for each vehicle: total number of axles, number of axles in an axle group, axle spacing, and axle spread. The processor classifies vehicles based on axle configurations and spacings, and stores the number of vehicles in each class on a vehicle-by-vehicle basis, or for a given time interval.

A principle advantage of using electronic equipment is their effective response to collecting data at any time of day, and over long periods of time. A disadvantage is the storage space required for the incoming data.

The AVC program was initiated in Manitoba in 1991 to fulfill data requirements for SHRP and C-SHRP. AVC equipment is located at five SHRP and two C-SHRP sites (see Appendix A, Fig. A-8), and collect data on a continuous basis. The processors are currently programmed to classify vehicles using the FHWA-13 classification scheme, but are capable of classifying up to 15 vehicle classes.

Since SHRP requires raw data only, no data manipulation is conducted prior to submission to SHRP researchers in Minnesota, or to C-SHRP researchers in Ottawa. The MDHT intends to eventually utilize the data to provide permanent vehicle classification information for those locations.

2.3 Truck Weights

2.3.1 Truck Weight Surveys

Truck weight surveys were conducted for 23 years.[10] The surveys were discontinued in 1986 due to their high labour costs and the apparent lack of interest in the resulting data and information. The extensive data base still remains in storage on mainframe computer.

Surveys were conducted at 13 locations per year, on a rotational basis, to obtain a representative sample of trucks in the province. Locations included permanent weigh scale stations, which were repeated every five years, and other roadside sites using portable scales.

The survey crews were responsible for obtaining the following data: axle/axle group weights, gross vehicle weights, overall dimensions, axle spacings, origin, destination, province of registration, commodity carried, moving distance, truck type, fuel used, and tire sizes. From this data, the following information was published annually:

- directional truck volumes (N, S, E, W);
- vehicle class distribution, where the 37 heavy vehicle classes were reported in nine class ranges;
- equivalent axle load (EAL) applications per vehicle (see Appendix A, Fig. A-9);
- total equivalent applications assigned to each vehicle type;
- summary of transported commodities.

This information was stored on mainframe and annual reports were compiled at year end. The information was intended to be used for design, construction, maintenance, and evaluation functions. The objective of the system was to "provide an error-free file of data that was easily accessible and structured so as to be open-ended to future (MDHT) applications" (WACHO, 1988).

The truck weight survey data and information was under-utilized at MDHT. Therefore, the survey program was reduced to monitoring three locations per year. The surveys were limited to permanent weigh scale stations to reduce survey staff requirements and reduce costs. The surveys were eventually terminated in 1986 [WACHO, 1988].

Until 1986, while the truck weight surveys were conducted, the pavement design methods used by the Materials Branch of MDHT did not use EAL information, but used only truck percentages. In 1987, pavement design formulae were changed to include EAL information for overlay design. However, staff resources and equipment required to conduct truck weight surveys had been transferred to other MDHT branches.

Since Manitoba truck weight data is still not collected, pavement designers at MDHT obtain EAL estimates from outside the province and apply the EALs to Manitoba's truck configurations to design flexible pavements. The reliability of combining Manitoba's truck configurations with another province's EAL estimates is unknown. No formal analysis has been published to date that compares Manitoba's EAL estimates with those from other provinces.

2.3.2 Weigh-in-Motion (WIM)

WIM equipment is similar to AVC equipment. The Golden River M-600 processing unit requires an additional weight card, and weight sensors must be imbedded in the pavement surface, but the induction loop array is the same. Individual axle weights are reported by WIM in addition to the data provided by AVC.

MDHT has installed Golden River WIM capacitance strip sensors at existing SHRP sites. Since each strip is a capacitor, it responds to the downward pressure of an axle rolling over the surface. The vertical pressure deflects the strip's surface, and the time and change in capacitance, when linked with vehicle speed, estimates the axle weight [Morin, 1984]. Cable connections link the road installation to the M-600 processing unit.

Manitoba acquired WIM equipment as part of SHRP, and has installed WIM sensors at all five SHRP sites in the test lane only. AVC equipment is installed in the other lanes. The WIM installations place the MDHT in a position to eventually obtain a large amount of truck axle weight data that may be used by various engineering functions. At present, the equipment is not functioning properly at some sites due to problems with the software. Golden River Corporation is attempting to correct the problems.

2.4 Annual Publications

2.4.1 Traffic Flow Map

The traffic flow map provides information obtained through the turning movement and vehicle classification surveys and the traffic count program. The map indicates the AADT and the AADTT for all roadway sections in the province (see Appendix A, Fig. A-10).

2.4.2 Traffic Map Statistics

The traffic map statistics publication also uses the information obtained through the turning movement and vehicle classification surveys, as well as the traffic count program. The publication reports AADT and the percentage of trucks (% trucks) by location (see Appendix A, Fig. A-11).

2.4.3 Turning Movement and Vehicle Classification Surveys

This publication reports the turning movements, AADT, vehicle class distribution and total percentage of trucks. The statistics are reported by intersections surveyed seasonally in a given year, with one annual average summary for each intersection.

2.4.4 Vehicle-KM's on PTH's and PR's

This publication reports DHV, AADT, percentage of trucks, and vehicle-kilometres by control section. The information is used to estimate the annual amount of travel on all highways in Manitoba.

The traffic map statistics publication, together with the traffic flow map are "thought to meet the requirements of most users" [WACHO, 1988]. However, prior to this research no study regarding user requirements of truck data had been performed to design an appropriate data collection and information system to meet the user needs.

In terms of traffic counts, the publications are relatively complete. For truck traffic, the publications do not provide the timely information required by several engineering functions in MDHT.

2.5 Manitoba Issues Requiring Traffic/Truck Data

This section illustrates the weaknesses of available truck information by addressing issues faced by MDHT that required truck information to answer key questions.

2.5.1 Interprovincial Memorandum of Understanding

In 1988, the Transportation Ministers from each Canadian province endorsed a Memorandum of Understanding (MOU) designed to improve uniformity in weight and dimension regulations for commercial vehicles operating between provinces and territories on a nationwide highway system. Under the terms of this MOU, each of the provinces and territories permit vehicles which comply with the appropriate weight and dimension specifications outlined in the agreement to travel on a designated highway system in their jurisdiction [Interjurisdictional Committee on Vehicle Weights and Dimensions, 1989].

Manitoba's responsibility in determining the province's designated highway system for the specified vehicles was to analyze the impact, in terms of accelerated deterioration, of increased weights on the infrastructure. Since the impact of the existing truck population on the roads and bridges was not known due to the lack of truck weight data and EAL information, this question could not be properly addressed. No published analysis was found to estimate the future impact on the infrastructure of allowing the standardized vehicles to use designated (RTAC) routes.

2.5.2 Twinning of PTH #75

PTH #75 is a major truck route between Manitoba and the U.S. When the decision was made to increase the highway from two to four lanes, pavement designers were unsure as to the type of pavement that should be used. MDHT uses AASHTO standards for pavement design in Manitoba. For rigid pavement design, AASHTO recommends using load transfer dowels between concrete slabs for a high number of EAL applications, since dowels double the EAL capacity [AASHTO, 1986].

Pavement designers were faced with the following questions:

(1) What is the current number of EAL applications on the pavement?

(2) What is the projected number of EAL applications over the service life of the pavement?

(3) Does the projected number of EAL applications warrant the use of dowels in the pavement design?

(4) What additional costs are incurred by including dowels in the pavement design?

(5) What additional costs are incurred if dowels are not included in the design, but are required, and the pavement fails sooner than expected?

Since the information necessary to answer the first three questions was not available, pavement designers decided to use a standard rigid pavement design with 250 mm slab thickness without dowels. Discussions with pavement designers indicate they suspect that the number of EAL applications is higher than predicted and dowels should have been placed.

2.5.3 Branchline Abandonment

In 1986, Transport Canada studied the impact of branchline abandonment on provincial and municipal roads in Manitoba [ADI Limited, 1986]. The report indicated a very low financial impact on the roads, which prompted the Transportation Policy Branch of MDHT to further analyze the original report. The

MDHT report noted several discrepancies in the ADI report, some of which resulted from the lack of adequate truck data available to provide the necessary information.

The following critiques the significant factors as noted by MDHT contributing to the ADI discrepancies caused by a lack of truck information:

(1) *The original report did not include all significantly affected roads.* However, the lack of truck route information, particularly in agriculture areas, may have contributed to the oversight.

(2) *The AADTTs are based on traffic counts, presumably closest to a road section in question, multiplied by the percentage of trucks.* The accuracy of the counts and truck percentages are questionable, since no information is given as to when or how the underlying count and truck percentage data was collected.

(3) *Discrepancies occurred within the EAL information used in the report.* Perhaps *current* EAL information was not available for the roads in question. However, truck weight data was collected in Manitoba up to 1986, the year of the study.

2.5.4 Heavy Commodity Haul Studies

Pavement design for heavy commodity haul routes is difficult at the present time. Some routes are used by specific types of trucks hauling specific commodities. However, seasonal load information is required by pavement designers to determine whether or not the routes require design reassessment due to the types of trucks and loads carried on the route.

For example, in agricultural areas, trucks may haul grain to elevators during any season. Since spring thaw creates the most critical subgrade conditions, information regarding truck percentages by vehicle class would assist pavement designers in determining design criteria. Perhaps the pavement of a heavy haul route should be redesigned to account for the additional EALs during the critical spring months to decrease the roadways' deterioration.

During the winter months, roads can handle an approximate load increase of 10% due to the frozen subgrade conditions. For routes used more during these months, information regarding truck percentages by vehicle class is required to determine if the road is adequately designed, or if a less stringent road design may be used in the future to create a more cost-effective design.

2.5.5 SHRP Historical Data Requirements

From the onset of the Long Term Pavement Performance (LTPP) portion of SHRP, the MDHT was required to submit a substantial amount of historical data for the five SHRP sites. Included in the requirements were traffic counts, vehicle classifications, truck percentages, and EALs. Although current traffic counts were available, there were difficulties in providing the required vehicle classification, truck percentage, and EAL information.

In most cases, recent vehicle surveys had not been performed at or near the SHRP sites, which resulted in having to use outdated vehicle classification and truck percentage information from some distance away from the site. Since the information was required in 1990, the most recent EAL information available was from pre-1986 truck weight surveys.

Having to provide the necessary information to SHRP prompted the MDHT to develop a more comprehensive truck information system, which is the goal of this research.

CHAPTER 2 - ENDNOTES

1. Erroneous or missing data is replaced or filled in using known data from other counts on the same days of the week, or the same weeks of the year, depending on the quantity of data that requires manipulation.

2. The DHV refers to the 30th and 50th highest hourly volumes as ranked from Jan. 1 to Dec. 31 of the same year.

3. Commuter routes refer to those routes used by commuters living outside the city and working inside, or, to a lesser extent, vice versa.

4. In the survey year, two counts are taken: one for 24 hours and one for 48 hours. The counts are performed on Mondays to Fridays, between May and October.

5. The vehicle classification and turning movement surveys are conducted 14 hours per day, five days per week, and one week in each climatic season.

6. High-volume intersections are surveyed once every five years, and lower-volume intersections are surveyed once every five to twenty years.

7. The vehicle's speed is calculated by dividing the known sensor distance (16 feet) by the time lapse between the vehicle's front end passing over the first and second sensors.

8. The AVC processing units are Golden River Marksman 600 (M-600) units.

9. The automatic classifier calculates the speed by the same method as the length classifier.

10. The truck weight surveys utilized a field crew with a set of portable scales (at non-permanent weigh-scale locations). The surveys were conducted for seven hours per day (14 hours per day in summer), five days per week, and one week in each season.

CHAPTER 3. THE ENGINEERING NEEDS FOR TRUCK DATA AND INFORMATION

The engineering needs for truck data constitute one element of a truck data collection and information system, as shown in Chapter 1, Fig. 1-1. An efficient system continuously provides the required quantity and quality of each necessary data type, and is consistently reviewed to ensure the data and information remains useful [McElhaney, 1990].

This chapter describes and assesses the engineering needs for truck data. The needs were identified through a combination of discussions and surveys with practicing engineers employed with the MDHT, and information obtained in literature. The objectives are to:

- establish the engineering functions within MDHT that require truck data;
- determine the types of truck data used by each function, and the priority rating given to each data type to perform that function;
- determine the data manipulation and presentational formats that provide the most beneficial information;
- assess which functions could benefit from the SHRP and C-SHRP data bases.

3.1 Manitoba's Truck Data Requirements

Truck data is required for several engineering functions within the MDHT. The specific requirements for each function are determined through surveys and discussions with engineers, and information available in literature.

3.1.1 The Truck Data Collection Survey

A survey was conducted in May 1991 within three divisions of MDHT: Planning, Design and Land Surveys Division; Engineering and Technical Services Division; and Construction and Maintenance Division. Within these divisions, ten engineering functions requiring truck data were identified: pavement design; pavement management; pavement research and performance analysis; pavement rating and programming; bridge design; bridge rating; highway design; traffic engineering; transportation planning; and enforcement. All functions required at least one truck data element presently missing from the current data collection program.

The basic survey format used in this research was designed for the Saskatchewan Department of Highways and Transportation [Hossack, 1991]. However, the survey format was expanded to include temporal and presentational options for reporting data and information summaries. The survey form is shown in Appendix B, Fig. B-1.

The survey required participants to list the truck data types that were beneficial for their functions. A "master" list of truck data types was included with each survey form. Participants were asked to rate each data type as:

1 = related, but not required for the engineering function;
2 = related, and very helpful for the engineering function;
3 = essential, and required for the engineering function.

For example, pavement designers rate axle weight data as "3", which means that the data is essential to perform the pavement design function. Any data type not rated for a function was assumed to be irrelevant, and therefore rated as "0".

The survey participants were asked to list any statistical calculations or other mathematical manipulations to be performed on the raw data, as well as the temporal characteristics (i.e. daily, weekly, monthly, annually, or seasonally) for summarizing the results and the required summary report formats (i.e. tables, graphs, bar charts, etc.). Discussions with the participants were conducted before and after the survey was completed to obtain any additional information and clarifications.

Table 3-1 summarizes the ratings given to various data types by the survey participants. Because some related engineering functions required the same data types, they were combined into one column. The table also shows the total "score" given to each data type. A high score indicates that the data type has a high demand, and should be given top priority.

Table 3-2 summarizes all data types rated as "3" and Table 3-3 summarizes all data types rated as "2". The tables show the statistics or manipulations required, as well as the temporal and presentational characteristics requested by each branch to summarize the information.

3.2 Engineering Functions Requiring Truck Data

This section defines the engineering functions that require truck data and information, and how that data and information is used for each function.

3.2.1 Pavement Design and Management:

A. Pavement Design

The pavement design function involves calculating the required pavement thickness to service a specific control section, or group of control sections, over a desired design life. Based on AASHTO pavement design formulae [AASHTO, 1986], the Materials Branch[1] identified the following types of data as essential to perform the pavement design function: truck counts, truck distributions by lane and direction, axle configurations, and axle weights. The data is used to obtain the following information:

1. **Vehicle Classification:** Axle configurations are used to classify vehicles. The pavement design function requires detailed vehicle classification distributions for all significant vehicle types using the roads in Manitoba. Each vehicle type affects the pavement differently.

The 44-class system previously used within MDHT provided excessive vehicle classification. The FHWA-13 system does not provide adequate detail regarding vehicles with more than 7 axles. For example, all trucks with more than 7-axles are categorized as class 13. However, the Materials Branch requires further breakdown of 8-axle trucks as A/C-trains or B-trains. The axle spacings and configurations differ, and therefore impact the pavement differently. The Manitoba 15-class system, or the proposed RTAC 22-class system, would provide sufficient detail for the pavement design function.

Vehicle classification information is required on annual and seasonal bases. The seasonal breakdowns are necessary since certain truck types and loads are more prevalent in specific areas at various times of the year. For example, loaded grain trucks are common in rural areas predominantly during the summer and fall months, although grain hauls can occur during any season. Other significant seasonal hauls include sugar beets, logging, and gravel.

2. **Equivalent Single Axle Loads (ESALs):** ESALs represent the relative damage to pavement by various types of axles or axle groups (i.e., single, tandem, tridem), and are the basis of pavement design calculations. ESAL calculations in Manitoba are based on axle and axle group weights, truck load factors (TLF), AADT, and truck percentages. The TLF formulae are shown in Appendix B, Fig. B-2. The average TLF values are shown in Appendix B, Fig. B-3. The ESAL formulae are shown in Appendix B, Fig. B-4. Other design formulae are presented in appendix B, Figs. B-5 to B-7. The TLF values used in the ESAL calculations are based on out-of-province data, since axle weight data is not currently available in Manitoba.

The Materials Branch requires ESALs by truck type (vehicle class) and by axle group configuration. The ESALs should be reported by route on seasonal and annual bases. The seasonal breakdowns are necessary to monitor changes in loading patterns as commodities change.

Forecasting the number of ESALs that a pavement is expected to service over its design life is a crucial factor within the pavement design function. The projected ESALs provide the basis for the pavement design. Errors in the ESAL forecast can significantly affect a pavement's serviceability.

Traffic, particularly truck, loading is a major design factor that can significantly change over the design life, depending on changes in land use, economic regulations, and vehicle design. Adequately projecting truck traffic is difficult, particularly when inadequate data exists regarding the current truck population. The Materials Branch would benefit from monitoring historical trends in traffic growth.

3. **Direction:** The directional distribution of trucks by route or control section is required. Currently, 50% of trucks is assumed to travel in each direction. However, the loading patterns may differ in each direction. For example, a gravel haul route may carry 50% of vehicles in each direction, but the trucks travel loaded in one direction and unloaded in the other.

4. **Lane Used:** The percentage of trucks in each lane of a four-lane highway is required. The lane distributions are assumed to be 80% of trucks in the travelling lanes (i.e., design lanes) and 20% in the passing lanes. However, designers suspect there may be more trucks travelling in the passing lane.

Directional and lane distribution information would allow variable lane design based on the expected number of ESALs in each lane.

5. **Truck Percentages:** The percentage of trucks is calculated as the ratio of truck volume and total traffic volume. Truck percentages are direct inputs to pavement design calculations, and are required by route.

Other data, such as axle spacings, tire types, tire sizes, tire pressures, and tare weights were rated as very helpful for the pavement design function, but not essential. "Worst case" scenarios are known for those combinations that are allowed by the governing regulations [Clayton et al., 1985].

B. Pavement Management

Pavement management involves developing "accurate and aggressive pavement rehabilitation and construction strategies at the lowest life cycle cost", as stated by pavement engineers at MDHT. No formal Pavement Management System (PMS) exists in Manitoba, but is a consideration for the future.

PMS is an engineering need for Manitoba because of diminishing resources available for pavement construction. The pavement engineers at MDHT recognize that more effort should be put into preserving the infrastructure by developing a systematic procedure for budgeting and distributing maintenance resources.

The main requirement for initiating a PMS is an extensive, detailed data base that includes the same truck data listed for pavement design. A reliable PMS requires a reliable, up-to-date, data base.

Traffic and truck data from the highway network represents input to the PMS algorithm. Any errors introduced by input data that are invalid or not current will bias the decision strategies recommended by the PMS [Kilareski et al., 1985]. Therefore, truck data is required to better understand the existing truck population, and to provide knowledge regarding current pavement loading.

3.2.2 Pavement Research and Performance Analysis

Truck data similar to that for pavement design and management is required for pavement research and performance analysis. Some data types rated as essential for pavement design and management are given a "0" rating for pavement research. The survey participants rated the data for pavement research as though the data required for pavement design was already available. The various data types are essential for analyzing how various axle combinations impact the pavement. As stated in correspondence from the Materials and Research Branch responsible for pavement engineering in Manitoba, the data for this function "are not considered as important because they are not required for operational and management functions" (as in the cases of pavement design and management). However, if the required data were made available for pavement design and management, MDHT pavement engineers would be in a position to perform pavement research projects. At the present time, widescale research projects are not feasible.

Various truck data elements can provide factors affecting pavement performance. Research is required to establish pavement impacts caused by changes in vehicle design (e.g. axle configuration, suspension type) or vehicle regulations (e.g. maximum allowable weights, tire sizes, tire pressures, suspension). Pavement analysis depends on identifying the differences in the vehicular and operational characteristics of the truck population, monitoring the pavement's response to changes, and better understanding the vehicle-pavement interface. New procedures and designs could be developed to better service the existing and future traffic population.

Pavement engineers are concerned with the presence of illegally overweight vehicles. Although information regarding permitted overweight vehicles can be obtained from the Enforcement branch, there is no system in operation to monitor the total number of overweight vehicles, and the extent by which the overweight vehicles exceed the maximum allowable weight limits.

3.2.3 Pavement Rating and Programming

The pavement rating function involves analyzing the pavement condition of a control section based on various condition factors, such as rutting, settlement, roughness, cracking, patching, and potholes. A pavement condition rating (PCR) based on a 0 - 100 scale is given to a control section.

The Programming Branch[2] is responsible for decisions concerning the control sections most in need of rehabilitation, reconstruction, or upgrading. Projects are planned for a three-year period and are given priority based on: the control section location, the PCR, AADT, and the percentage of trucks, as well as costs and engineering judgment.

The truck data required for programming are: truck counts, direction, number of truck-related accidents, axle weights, gross vehicle weights, origin-destination, and route used. The data is used to obtain the following information:

1. **Truck Percentage:** Truck percentage is a direct input to the decision-making process for prioritizing construction projects. Since higher truck percentages are generally associated with increased pavement damage, the programming function would benefit from reliable truck percentages reported by control section for each highway.

Programming involves assessing control sections. The truck percentages available from the existing data base are determined by intersection. The reliability of assuming or extrapolating truck percentages between two known points is unknown.

2. **Direction:** The direction distribution of trucks is not currently used in the programming function. However, the information is potentially useful for deterioration forecasting and condition rating.

3. **Safety:** The number of truck-related accidents is one factor in considering the safety at project locations. Locations with high accident rates generally require changes in geometric design, in addition to rehabilitation. The cost of repairs is increased, as well as the project's priority.

4. **Vehicle Weights:** Information regarding vehicle weights would be beneficial in studying and predicting pavement deterioration. Together with truck percentages, the information could provide reasons for accelerated pavement rates. Overweight vehicles are of special concern because of their greater impacts on pavement, particularly during restricted seasons.

5. **Truck Routes:** Knowledge regarding major truck routes between specified origins and destinations are of importance. Truck routes tend to deteriorate faster and require consistent rehabilitation or repair.

In general, knowledge regarding truck travel is beneficial to better understand Manitoba's truck population and to make more informed decisions when prioritizing projects.

3.2.4 Bridge Design and Bridge Rating

A. Bridge Design

The bridge design function[3] involves developing the requirements of a new structure to meet specifications for expected traffic loading, soil conditions, land restrictions, and costs. Uncertainties at the design stage arise because the structure is designed for uncertain loads over its lifetime, with the future structure's behavioral response not fully known [Verma and Moses, 1988].

The live load effect depends on traffic composition using the bridge, which in turn depends on site location and its proximity to potential sources of overloaded vehicles. Uncertainties can be reduced by monitoring traffic, thereby obtaining reliable estimates of *actual* live load conditions [Verma and Moses, 1988]. Another source of uncertainty is the probable gradual increase in loading over the bridge's design life. The rate of increase over time is not known during the design stage and can only be estimated.

Basic data requirements are as follows: axle configurations, axle spacings, vehicle dimensions, tire combinations (i.e. single, dual), truck counts, axle weights, gross vehicle weights, permit status, and overweight status. The data is used to obtain the following information:

1. **"Worst Case" Situations**: Designers require information regarding extreme cases of loading, axle configurations, axle spacings, tire combinations, and length. Currently, design vehicles are used to provide the most extreme situations that could be encountered. However, the designers do not have any information regarding actual extremes that exist.

2. **Vehicle Classification:** Vehicle class distributions provide relevant information regarding truck volumes and actual vehicle types utilizing the structures.

3. **Vehicle Weights**: Monitoring truck weights provides estimations of the actual loading encountered by the structures. Two major concerns are:

(a) the actual overweight vehicles using the structures. Although the number of permitted overweight vehicles is known, there is no existing method of monitoring the number of illegally overweight vehicles, or the excessive weights they transport.

(b) the number of B-trains loaded to maximum GVW (62,500 kg).

Both factors affect the bridge design and service life.

By obtaining reliable information, the live load uncertainties may be reduced to some degree. The overall bridge reliability level depends on the proper tools made available to the designer, with one major tool being accurate truck information regarding the various operational characteristics of trucks using the bridge structures. By obtaining the appropriate information for bridge design, the cost to society and risk to the road user are both minimized. The financial investment in the structures should be protected, yet the structures must facilitate the economic and efficient movement of goods [Verma and Moses, 1988].

B. Bridge Rating

Bridge Rating engineers are responsible for determining the structural adequacy of the bridges throughout their design lives. The structural components must be periodically evaluated to ensure they are capable of supplying sufficient resistance to maintain the known dead load and the more elusive live load (i.e. traffic load).

If the live load is not known, or is inadequately estimated, the rating factor may not provide an actual representation of the bridge's condition. Fortunately, safety factors imposed during the design stage greatly reduce the influence of inadequate data.

Presently, the annually published Traffic Flow Map is used to obtain AADT and the AADTT on the road segments of interest (i.e. those containing bridges). However, the available vehicle classification data are not presently used for bridge design and rating.

Discussions with bridge engineers indicated a general need to determine the vehicle classification distribution together with the operational characteristics of the existing truck population utilizing the bridge network similar to the bridge design function. The information is required in order to post proper restrictions for structures unable to support the existing loads. However, the restrictions must be enforced to be beneficial.

The bridge rating engineers must also decide if the vehicle configurations and weights can be permitted to use the existing bridges. Non-complying vehicles (i.e. overweight or overdimension) must be checked prior to issuing permits.

Load postings minimize the risk to the structure and maximize benefits to the user by considering economic and engineering factors. Structures located on highways in close proximity to permanent truck scales attain the highest level of confidence. The types of trucks (i.e. vehicle configurations) using the bridges should be known to post the appropriate restrictions.

3.2.5 Highway Design

The highway design function[4] is responsible for developing the conceptual, functional, and geometric designs for roadway projects. The major design factors are: horizontal and vertical alignment, stopping sight distance, passing sight distance, roadway widths, and vertical clearance under a structure. Traffic volumes are considered in all phases of the designs.

Truck counts constitute the only data type rated as essential for highway design, and are used to ensure the project is capable of handling the existing and projected traffic volumes. If a large number of trucks is expected to use a project area, special consideration is given to the lengths and radii of turning lanes, the radii of exit and entrance ramps, intersection dimensions, and truck climbing lanes.

Other data of interest on a site-specific basis are:

- turning movements: used for intersection design, such as channelization measures [Lucas, 1993];
- direction: distributions are useful for designing the required number of lanes;
- number of truck-related accidents: for safety studies at a project location with regard to causal factors of an accident, such as passing sight distance or stopping site distance.

3.2.6 Traffic and Safety Engineering

Traffic Engineers are primarily concerned with traffic flow issues such as capacity, level of service analysis, speed-flow relationships, and vehicle-performance characteristics [Clayton et al., 1985]. Safety related issues of concern are road-side signing, lane markings, road conditions, traffic signal timing, intersection illumination, and accident statistics. The accident reports are stored on mainframe computer dating from 1974 to present day. The actual reports are stored in manual files for five years.

No truck data was rated as essential to perform traffic or safety engineering functions.[5] However, interest was expressed by engineers to obtain more truck data, in terms of quantity and types, that would be helpful for performing the functions.

Truck data helpful for performing various studies and analyses are: vehicle dimensions, articulation characteristics, acceleration-deceleration ability (all related to vehicle weight and dimension regulations), axle configurations, vehicle defects, truck counts, speed distributions, lane and directional distributions, number of truck related accidents, overweight status, and stopping distance.

The branch uses AADT estimations obtained from turning movement surveys for analyzing projects, such as locating controlled intersections, recording queue length at an intersection (based on length of traffic signal cycles), and illumination needs at approaches or uncontrolled intersections. Trucks in particular are considered in determining traffic signal cycles, operating speeds in traffic stream, and overhead height of structures.

Clayton et al. [1985] noted that current traffic engineering in Manitoba is fairly insensitive to the actual trucking activity on the province's highways and that truck data is required to perform several studies regarding truck travel on Manitoba's highways, such as:

- the potential effect on safety of permitting larger vehicles to use the highways. Data related to exposure levels of various vehicle combinations is limited in Manitoba, making it impossible to analyze this concern;
- the effect of shifting lane markings to spread wheel loads on a pavement surface, possibly decreasing the extent of rutting and extend the pavement life;
- the effect of lengthening vehicles on the passing sight distance requirements of passenger cars.

3.2.7 Transportation Planning

The Planning Branch[6] is responsible for prioritizing long-range goals for roadway improvements. Projects include developing priority lists for interchanges, highway relocation studies, highway twinning, town by-passes, and rest stop areas. Environmental impact studies are performed for each project. Future goals lie in developing regional traffic models to establish priorities for areas requiring improvements.

Truck counts constitute the only type of truck data considered essential for the transportation planning function. The total truck volume on a highway is particularly significant for planning town by-pass and highway twinning projects. For example, the decision to twin PTH 75 was based on the high truck volume utilizing the highway [Lucas, 1993].

Other data of interest are: speed, lane and directional distributions, number of truck-related accidents, gross vehicle weights, commodity type, route used, and place of registration. Although these data types are not considered essential, reliable data is useful to assist in all levels of the decision-making process.

3.2.8 Enforcement

Enforcement[7] is indirectly related to engineering functions. Operating under the Construction and Maintenance Division, the Transport Compliance Branch is responsible for protecting the province's investment in infrastructure by ensuring large trucks comply with provincial regulations. The ability of enforcement personnel to perform their duties affects the service life of pavements and bridges, and therefore affects the cost of constructing and maintaining the infrastructure.

Personnel require the following operator data with respect to their non-compliance with the provincial regulations: valid driver's license, logged hours, ownership status, and driving record. Although this information is important, it is difficult to collect through a conventional data collection system. Enforcement personnel have the opportunity to collect this information at permanent and portable weigh scales.

Interest is also expressed in truck data for general knowledge of the truck population. Examples are: vehicle classification, truck volumes, location of known occurrences of overweight vehicles, and average weights per vehicle class. By monitoring truck traffic, enforcement would be informed of any routes that are commonly used by vehicles operating outside the provincial weight and dimension regulations. This information could be used in two ways:

1. A more comprehensive mobile enforcement network could be developed due to prior knowledge of problem areas;

2. The non-compliance rate of trucks could be evaluated. That is, the total number of trucks operating outside the existing weight and dimension regulations vs. the number of trucks with permits could be estimated.

The Transport Compliance section records and publishes the following information:

- number of permits issued annually;
- revenue obtained from permits;
- number of tickets issued province-wide;
- number of convictions received through court cases regarding non-compliance issues.

3.1.9 SHRP (Strategic Highway Research Program)

The main purpose of the Long-Term Pavement Performance (LTPP) portion of SHRP and C-SHRP is to extend pavement life through the use of improved design and rehabilitation strategies, and predict the future performance of existing pavements. The focus of program activities is on measuring the pavement performance and establishing a data base for pavement performance analyses [NRC, 1989; NRC, 1991]. The program is currently gathering data from about 1000 general and specific pavement sections located throughout North America in a wide range of climates, pavement types, traffic loadings, and subgrade conditions. The data will be used to determine a pavement's performance based on the traffic loading, profile, distress, climate, and material properties [NRC, 1991].

In order for SHRP and C-SHRP researchers to achieve their goals, participating highway agencies are responsible for providing traffic data (historic and current). SHRP has probably been the single most influential phenomenon that has changed the way many highway agencies, including Manitoba, view their data collection programs. Manitoba's participation in the research projects made the MDHT recognize the need to reassess their current data collection program and upgrade where necessary.

SHRP requested each agency to supply historical traffic information for each test site, from construction to June, 1989. The information included traffic counts, vehicle classifications, truck weights, ESAL estimates, and descriptions of the data collection methods used to collect the data. During the data gathering stage, the Planning Support Branch realized that the historical records regarding truck data were deficient in terms of quantity and quality. At some SHRP test sites, no recent vehicle classification surveys were performed in close proximity to the site, which reduces the reliability of the vehicle classification information. Even if surveys had recently been performed to reliably classify the traffic, the available ESAL calculations were derived from pre-1986 truck weight surveys, which again reduces the reliability level.

Manitoba has now installed equipment at the SHRP sites to collect required data, which includes: vehicle volumes crossing the pavement section, vehicle classification distributions, and the axle weights for each vehicle type.

The data collection plan preferred by SHRP is continuous axle weight data obtained by weigh-in-motion equipment from each pavement test section. Since SHRP recognized that this may not be possible, they also accept a more achievable (desired) plan of continuous vehicle classification with four week-long, seasonal weigh-in-motion measurements at each study site [Hallenbeck, 1990]. The minimum acceptable plan is at least one year of continuous vehicle classification during each five-year SHRP funding period, with four weekend and four weekday weigh-in-motion measurements spread throughout the seasons during that time period.

Manitoba's involvement in SHRP has given the province the opportunity to test the preferred data collection plan and system for accuracy and reliability, and to later decide if such a system should be expanded throughout the province.

3.3 Analysis of Survey Results

3.3.1 Required Data

The survey results indicate a pattern in the data types required to perform the engineering functions. The "scores" shown in the last column of Table 3-1 indicate a priority rating for the various data types. Considering only those scoring greater than or equal to 10 (chosen arbitrarily), the following data types have the highest priority:

(1) Truck counts: the number of trucks passing a location per unit time. The counts are used to determine the percentage of trucks in the traffic stream;

(2) Tractor/trailer axle weights: the weights of single axles or axle groups;

(3) Gross vehicle weights: the sum of each axle weight or axle group weight per vehicle;

(4) Overweight status: the number of overweight vehicles in the traffic stream, extent to which they are overweight, the routes they use, the time of day, and the season;

(5) Direction: the directional distribution of trucks using a specific route;

(6) Vehicle configuration: the vehicle design with respect to the number of axles, axle spacing, and axle group spread, in order to determine vehicle classification;

(7) Length: the total length of a truck;

(8) Origin-destination: the starting point and destination of a truck, and the route used in between.

Table 3-4 shows a summary of the highest priority data types. Also given are the required statistics, the time frame for summarizing the results, and the presentation format.

Although most of the above data was previously collected during the truck weight surveys, the data was relatively unused by engineers. The most likely reason for this occurrence was that the data was not stored in an easily usable form. To obtain information outside the range of the annually published results required the engineers to access the massive data base and develop a program to supply the desired information. The additional effort required to do so acted as a deterrent from using the available data. A second reason for engineers not utilizing the available data was that they were not aware of the contents of the data base. Also, the engineers may not have understood the sensitivity of their functions to the data inputs.

3.3.2 Required Information

From the collected data, the following required information should be summarized and published by route:

(1) Truck AADT and % trucks, directionally distributed;

(2) ESALs distributed by truck type, axle group configuration;

(3) % distribution of axle weights by axle group configuration and vehicle class;

(4) % distribution of gross vehicle weight by vehicle class;

(5) % trucks loaded to maximum allowable limit distributed by vehicle class;

(6) % distribution of overweight trucks vs. total % of trucks;

(7) % distribution of overweight trucks by vehicle class;

(8) % distribution of vehicle classes;

(9) % distribution of vehicles exceeding maximum allowable length by vehicle class.

The above should be summarized quarterly (i.e. seasonally) and annually in tabular format, and reported by location to each engineering branch. Over the first quarter, summaries should be reported bi-weekly or monthly to supply initial results to the engineers.

3.3.3 Observations

There are three main observations from this survey:

1. All of the required data types, except origin-destination, can be provided by the SHRP and C-SHRP data bases. Although the SHRP sites are located only on PTH 1, PTH 75, and PTH 101, and the C-SHRP sites are located on PTH 2 and PR 428, beneficial information regarding those routes can be supplied to the engineers. All participants in the survey expressed interest in obtaining output from the SHRP and C-SHRP data base: Site-specific data obtained from SHRP and C-SHRP sites include:

    (a) total traffic counts;
    (b) vehicle classification (based on the number of axles, axle configuration, and axle spacings of each vehicle);
    (c) total vehicle length;
    (d) travel lane;
    (e) direction;
    (f) individual axle weights;
    (g) gross vehicle weight;
    (h) speed.

2. Several engineering functions (Pavement Design and Management, Pavement Research and Performance Analysis, Highway Design, Traffic, and Planning) listed turning movement data as either required or desired. Further discussions with the survey participants identified only Highway Design that used the actual turning movements on a project-specific basis. The others

require the statistics that are obtained from the current turning movement and vehicle classification surveys (i.e. truck counts, vehicle classification). The installation of electronic equipment may eventually eliminate the need for a widescale turning movement survey network.

3. The required reliability levels for truck data collection were not determined in this survey. Discussions with engineers participating in the survey did not provide conclusive results regarding accuracy requirements. In general, the participants could not identify the accuracy requirements, since none had performed sensitivity analyses regarding the effect of truck data reliability on their functional results.

Table 3-1. Priority Ratings of Truck Data Types by Engineering Functions at MDHT

DATA TYPES	ENGINEERING FUNCTIONS								TOTAL RATINGS			
	PAVEMENT DESIGN/ MANAGEMENT	PAVEMENT RESEARCH/ PERFORMANCE ANALYSIS	PAVEMENT RATING/ PROGRAMMING	BRIDGE DESIGN/ BRIDGE RATING	HIGHWAY DESIGN	TRAFFIC	PLANNING	ENFORCEMENT	NUMBER OF "ONE" RATINGS	NUMBER OF "TWO" RATINGS	NUMBER OF "THREE" RATINGS	TOTAL SUM OF RATINGS
A) VEHICLE CHARACTERISTICS												
OVERALL:												
1. AXLE CONFIGURATION	0	3	1	3	0	0	1	2	2	1	2	10
2. AXLE SPACINGS	0	2	0	3	0	0	1	2	1	2	1	8
3. LENGTH	0	0	1	3	1	2	1	2	3	2	1	10
4. WIDTH	0	0	1	2	1	2	1	2	3	3	0	9
5. HEIGHT	0	0	1	0	1	2	1	2	3	2	0	7
6. TIRE TYPE	0	2	0	0	0	0	0	0	0	1	0	2
7. TIRE SIZE	0	2	0	2	0	0	0	2	0	3	0	6
8. TIRE PRESSURE	0	2	0	0	0	0	0	0	0	1	0	2
9. TIRE COMBINATIONS	0	0	0	3	0	0	0	0	0	0	1	3
10. ARTICULATION CHARACTERISTICS	0	0	0	0	1	2	1	2	2	2	0	6
11. ACCELERATION/DECELERATION ABILITY	0	0	0	0	1	2	1	0	2	1	0	4
12. TARE WEIGHT	0	2	0	0	0	0	1	0	1	1	0	3
13. AERODYNAMICS	0	0	0	0	0	0	0	0	0	0	0	0
TRACTOR:												
14. CAB STYLE	0	0	0	0	0	1	0	0	1	0	0	1
15. MODEL YEAR	0	0	0	0	0	0	0	0	0	0	0	0
16. FUEL CONSUMED	0	0	0	0	0	0	1	0	1	0	0	1
17. ENGINE SIZE/POWER	0	0	0	0	0	0	1	0	1	0	0	1
18. SUSPENSION TYPE	0	0	0	0	0	0	0	0	0	0	0	0
19. DEFECTS	0	0	0	0	0	1	0	3	1	0	1	4
TRAILER:												
20. BODY TYPE	0	0	0	0	0	0	0	0	0	0	0	0
21. SUSPENSION TYPE	0	2	0	0	0	0	0	0	0	1	0	2
22. DEFECTS	0	0	0	0	0	1	0	3	1	0	1	4
B) TRAFFIC FLOW CHARACTERISTICS												
23. TURNING MOVEMENTS	2	0	0	0	2	2	3	0	0	3	1	9
24. SPEED	0	0	1	0	1	2	2	0	2	2	0	6
25. DIRECTION	3	0	3	0	2	2	2	0	0	3	2	12
26. LANE USED	3	0	1	0	1	2	2	0	2	2	1	9
27. TRUCK COUNTS (VOLUMES)	3	0	3	2	3	2	2	3	0	3	4	18
28. NUMBER OF TRUCK-RELATED ACCIDENTS	0	0	3	0	2	2	2	0	0	3	1	9
C) OPERATIONAL CHARACTERISTICS												
VEHICLE:												
29. TRACTOR AXLE WEIGHTS	3	0	3	3	0	0	1	3	1	0	4	13
30. TRAILER AXLE WEIGHTS	3	0	3	3	0	0	1	3	1	0	4	13
31. GROSS VEHICLE WEIGHTS	0	2	3	3	0	0	2	3	0	2	3	13
32. PAYLOAD WEIGHT	0	0	1	0	0	0	1	0	2	0	0	2
33. COMMODITY TYPE	0	0	0	0	0	0	2	0	0	1	0	2
34. ORIGIN-DESTINATION	0	2	3	2	0	0	2	1	1	3	1	10
35. ROUTE USED	0	0	3	2	0	0	2	0	0	2	1	7
36. PERMIT STATUS	0	0	0	3	0	0	0	3	0	0	2	6
37. TRIP LENGTH	0	0	0	0	0	0	1	0	1	0	0	1
38. NOISE	0	0	0	0	0	0	1	0	1	0	0	1
39. OVERWEIGHT STATUS	0	2	3	3	0	0	1	3	1	1	3	12
40. OVERDIMENSION STATUS	0	0	0	0	0	2	1	3	1	1	1	6
41. TICKETABLE OFFENSES	0	0	0	0	0	2	0	3	0	1	1	5
OPERATOR:												
42. VALID DRIVER'S LICENCE	0	0	0	0	0	0	0	3	0	0	1	3
43. LOGGED HOURS	0	0	0	0	0	0	0	3	0	0	1	3
44. OWNERSHIP STATUS	0	0	0	0	0	0	0	3	0	0	1	3
45. DRIVING RECORD	0	0	0	0	0	0	0	3	0	0	1	3
D) REGISTRATION CHARACTERISTICS												
46. TYPE OF LICENCE	0	0	0	0	0	0	0	0	0	0	0	0
47. PLACE OF REGISTRATION	0	0	0	0	0	0	2	0	0	1	0	2
48. CARRIER NAME	0	0	0	0	0	0	0	0	0	0	0	0
49. CARRIER TYPE	0	0	0	0	0	0	1	0	1	0	0	1
50. REGISTERED WEIGHTS	0	0	0	0	0	0	1	3	1	0	1	4
51. REGISTERED COMMODITY	0	0	0	0	0	0	1	2	1	1	0	3
52. NUMBER OF REGISTERED TRUCKS	0	0	0	0	0	0	1	0	1	0	0	1
53. NUMBER OF TRUCKS OPERATING	0	0	0	0	0	0	1	0	1	0	0	1
E) OTHER												
54. STOPPING DISTANCE	0	0	0	0	0	2	0	0	0	1	0	2

Rating Scale:
0 = Not Related
1 = Related, not required
2 = Related, very helpful
3 = Essential, required

Table 3-2. Statistical Calculations Required for Various Engineering Functions at MDHT

Truck Data Type	Statistical Calculation Mathematical Mani;ulation	Time Frame (*)	Format (**)	Function
AXLE CONFIGURATION	% Distribution by Truck Type	S, A	T	Pavement Design/Management
	% Distribution by Vehicle Class and Route	A	T, B	Bridge Design/Bridge Rating
AXLE SPACINGS	% Distribution by Vehicle Class and Axle Weights	A	T, B	Bridge Design/Bridge Rating
LENGTH	% Distribution by Vehicle Class	A	T, B	Bridge Design/Bridge Rating
TIRE COMBINATIONS	% Distribution by Vehicle Type	A	T, B	Bridge Design/Bridge Rating
TRACTOR DEFECTS	% of Vehicles Operating with Defects	M	T	Enforcement
TRAILER DEFECTS	% of Trailers Operating with Defects	M	T	Enforcement
TURNING MOVEMENTS	Volume and % Trucks on each Control Section	A	T	Planning
DIRECTION	Directional Truck Distribution by Route or Control Section	S, A	T	Pavement Design/Management
	% Trucks Distributed by Highway or Control Section	A	T	Programming
LANE USED	% Trucks per Lane by Route or Control Section	A	T	Pavement Design/Management
TRUCK COUNTS	Total Number of Vehicles and % Trucks by Route	S, A	T	Pavement Design/Management
	% Distribution of Trucks by Highway	A	T	Programming
	% Trucks and AADTT	A, CS	T	Highway Design
	Number of Vehicles Distributed by Vehicle Type and Highway	M	T	Enforcement
NUMBER OF TRUCK-RELATED ACCIDEN	% of Truck-Related Accidents per Highway	A	T	Programming
TRACTOR/TRAILER AXLE WEIGHTS	ESAL by Truck Type and Axle Group Configuration Distributed by Route	S, A	T	Pavment Design/Management
	Distribution by Weight Classification and Highway	A	T	Programming
	% Distribution by Vehicle Class	A	T, B	Bridge Design/Bridge Rating
	% Distribution by Vehicle Configuration and Highway Class	M	T	Enforcement
GROSS VEHICLE WEIGHT	Distribution by Weight Classification and Highway	A	T	Programming
	% Trucks Loaded to Maximum Allowable Limit by Vehicle Type	A	T, B	Bridge Design/Bridge Rating
	% Distribution by Vehicle Configuration and Highway Class	M	T	Enforcement
ORIGIN-DESTINATION	Distribution by Highway	A	T	Programming
ROUTE USED	Major Truck Routes per Highway	A	T	Programming
PERMIT STATUS	Number of Permitted and Non-Permitted OW and OD Trucks by Route	A	T	Bridge Design/Bridge Rating
	% of Vehicles in Non-Compliance with Regulations per Route	M	T	Enforcement
OVERWEIGHT STATUS	% of Overweight Trucks vs. Total % Trucks Distributed by Highway	A	T	Programming
	% Distribution of Non-Permitted Overweight Trucks per Route	A	T	Bridge Design/Bridge Rating
	% Distribution of Overweight Trucks by Vehicle Class	M	T	Enforcement
OVERDIMENSION STATUS	% Distribution of Overdimension Trucks by Vehicle Class	M	T	Enforcement
TICKETABLE OFFENSES	% of Vehicles in Non-Compliance with Existing Regulations	M	T	Enforcement
VALID DRIVER'S LICENCE (OPERATOR)	% of Operators with Invalid Licences	M	T	Enforcement
LOGGED HOURS (OPERATOR)	% of Operators Exceeding the Maximum Hours Allowed	M	T	Enforcement
OWNERSHIP STATUS	% of Non-Registered Vehicles; Number of Owner/Operators	M	T	Enforcement
DRIVING RECORD	Specific Driving Records for Court Purposes	CS	T	Enforcement
REGISTERED WEIGHTS	% of Vehicles Exceeding Registered Weight Limits	M	T	Enforcement

LEGEND:

* S = Seasonal
A = Annual
M = Monthly
CS = Case-specific

** T = Tables
B = Bar charts
G = Graphs

Table 3-3. Statistical Calculations Helpful for Various Engineering Functions at MDHT

Truck Data Type	Statistical Calculation Mathematical Mani;ulation	Timeframe (*)	Format (**)	Function
AXLE CONFIGURATION	% Distribution by Vehicle Type	M	T	Enforcement
AXLE SPACINGS	Average and Range by Truck and Axle Types	A	T, G	Pavement Research/Analysis
	% Distribution by Vehicle Type	M	T	Enforcement
LENGTH	% Exceeding Maximum Allowable Size; % at Maximum Allowable Size	M, A	G	Traffic
	% Distribution by Vehicle Class	M	T	Enforcement
WIDTH	% Distribution by Vehicle Class	A	T, B	Bridge Design/Bridge Rating
	% Exceeding Maximum Allowable Size; % at Maximum Allowable Size	M, A	G	Traffic
	% Distribution by Vehicle Type	M	T	Enforcement
HEIGHT	% Exceeding Maximum Allowable Size; % at Maximum Allowable Size	M, A	G	Traffic
	% Distribution by Vehicle Type	M	T	Enforcement
TIRE SIZE	Average and Range by Truck and Axle Type	A	T, G	Pavement Research/Analysis
	Average forVehicle and Axle Type	A	T, B	Bridge Design/Bridge Rating
	% Distribution by Vehicle Class	M	T	Enforcement
ARTICULATION CHARACTERISTICS	% Distribution by Vehicle Size	M, A	G	Traffic
	% Distribution by A-, B-, and C-Trains	M	T	Enforcement
TURNING MOVEMENTS	Total Number and % Trucks by Route	S, A	T	Pavement Design/Management
	% Trucks by Highway Classification or Route	A, CS	T	Highway Design
	Truck Volume by Control Section	M, A	B	Traffic
SPEED	85th Percentile of Truck Travel Speeds vs. Other Traffic Speeds	M, A	G	Traffic
	Average Speed Distributed by Truck Type per Control Section	A	T	Planning
DIRECTION	AADTT by direction and and Highway Control Section	A, CS	T	Highway Design
	% Trucks by Direction	M, A	G	Traffic
	Volume and % Trucks per Control Section	A	T	Planning
LANE USED	% Distribution of Trucks by Lane	M, A	G	Traffic
	Volume and % Trucks per Control Section	A	T	Planning
TRUCK COUNTS	AADTT by Route and Control Section	A	T	Bridge Design/Bridge Rating
	% Distribution of Trucks	M, A	G	Traffic
	Volume and % Trucks per Control Section	A	T	Planning
NUMBER OF TRUCK-RELATED ACCIDEN	Number of Accidents per Million Vehicle-Kilometres of Travel	A	T	Highway Design
	Number of Accidents per Vehicle Class vs. Total Number of Accidents	M, A	G	Traffic
	% Distribution by Control Section	A	T	Planning
GROSS VEHICLE WEIGHT	% Distribution by Truck Type and Route	S, A	T	Pavement Research/Analysis
	Volume and % Trucks by Control Section	A	T	Planning
ORIGIN-DESTINATION	Routes To/From Major Destinations	A	T	Pavement Research/Analysis
	Major Truck Origins and Destinations in Manitoba	A	T	Bridge Design/Bridge Rating
	Truck Volume between Communities	A	T	Planning
ROUTE USED	Routes used by Non-Permitted Overweight Vehicles	A	T	Bridge Design/Bridge Rating
	Truck Volume between Communities by Route	A	T	Planning
OVERWEIGHT STATUS	% Distribution of Overweight Trucks by Truck Type and Route	S, A	T	Pavement Research/Analysis
OVERDIMENSION STATUS	% Exceeding Maximum Allowable Size; % at Maximum Allowable Size	M, A	G	Traffic
TICKETABLE OFFENSES	Number of Violations Distributed by Type of Violation	M, A	B	Traffic

LEGEND:

* S = Seasonal
A = Annual
M = Monthly
CS = Case Specific

** CS = Case-specific
T = Tables
B = Bar Graphs
G = Graphs

Table 3-4. Summary of Required Truck Data Types with Highest Priority

Truck Data Type	Statistical Calculation/ Mathematical Manipulation	Time Frame (*)	Format (**)
AXLE CONFIGURATION	% Distribution by Vehicle Class and Route	S, A	T, B
AXLE SPACINGS	Average and Range by Truck and Axle Types	A	T, G
	% Distribution by Vehicle Class and Axle Weights	A	T, B
LENGTH	% Distribution by Vehicle Class	A	T, B
	% Exceeding Maximum Allowable Size; % at Maximum Allowable Size	A	T
DIRECTION	AADTT; % Trucks Directionally Distributed by Highway or Control Section	S, A	T
TRUCK COUNTS	AADTT; % Trucks Distributed by Vehicle Class and Highway	S,A,CS,M	T
TRACTOR/TRAILER AXLE WEIGHTS	ESAL by Truck Type and Axle Group Configuration per Route	S, A	T
	% Distribution by Vehicle Class and Highway Class	A	T
GROSS VEHICLE WEIGHT	% Distribution by Vehicle Class and Highway or Control Section	M, A	T
	% Trucks Loaded to Maximum Allowable Weight Limit by Vehicle Type	A	T, B
ORIGIN-DESTINATION	Major Truck Origins and Destinations	A	T
	Truck Volume between Communities	A	T
OVERWEIGHT STATUS	% of Overweight Trucks vs. Total % Trucks Distributed by Highway	A	T
	% Distribution of Non-Permitted Overweight Trucks by Route	A	T
	% Distribution by Vehicle Type and Route	M	T

LEGEND:

* S = Seasonal
A = Annual
M = Monthly
CS = Case-Specific

** T = Tables
B = Bar Graphs
G = Graphs

Chapter 3. Endnotes

1. Mr. Ray van Cauwenberghe, Senior Pavement Engineer (Materials and Research Branch) provided survey information regarding pavement design, management, research, and performance analysis.

2. Mr. Travor Curtis, Senior Programming Engineer (Programming Branch) provided survey information regarding pavement rating and programming.

3. Mr. Lorne Lautens, Chief Design Engineer, and Mr. Al Nelson, Rating Engineer (Bridges and Structures Branch) provided survey information regarding bridge design and bridge rating, respectively.

4. Mr. Don McRitchie, Senior Design Engineer (Design Branch) provided survey information regarding highway design.

5. Mr. Harold Larsen, Traffic Safety Engineer (Traffic Engineering Branch) provided survey information regarding traffic and safety engineering.

6. Mr. Heinz Lausmann, Systems Planning Engineer (Planning Branch) provided survey information regarding transportation planning.

7. Mr. Norm Barr, Operations Manager, and Mr. Greg Cateeuw, General Manager (Transport Compliance Branch) provided survey information regarding enforcement.

CHAPTER 4. PRINCIPLES GOVERNING THE INFORMATION SYSTEM

Truck and general traffic data is summarized and used as input variables to many different engineering functions, as noted in the previous chapter. Therefore, serious consideration must be given to all aspects of data collection prior to program design and implementation.

An effective information system is governed by several fundamental principles that underlie the data collection procedures, data base, and subsequent information derived from the data base. The main objective of these principles is to minimize the inconsistencies in traffic data prevalent in many data bases [Albright, 1990].

This chapter discusses and assesses the fundamental principles developed and implemented by SHRP researchers for the data base obtained through the LTPP [Albright, 1990], as well as standards and recommendations made by the Joint Task Force on Traffic Monitoring Standards [Houghton et al., 1991], the Federal Highway Administration for the Highway Performance Monitoring System (HPMS) [Hajek et al., 1985] and the ASTM Standard Practice for Highway Traffic Monitoring [ASTM, 1991]. The principles are simple, yet wide-reaching, and may be applied to any information system in order to enhance the results.

Although the principles were developed on the assumption that electronic or mechanical devices are used for data collection, they may be extended to manual data collection methods. However, non-manual methods are considered to be the most efficient since they minimize labour requirements [Ritchie, 1986].

4.1 Data Equivalency

The principle of data equivalency refers to data measured with the same, or similar, types of equipment, recording comparable data, for the same period of time at each collection site [Albright, 1990]. In this way, data between sites can be compared without any differences in data quality to interfere with the results.

The principle of data equivalency implies that each required data type should be collected at each collection site. The equipment used for data collection should provide the required data in the most efficient manner. This would suggest that an electronic device, such as weigh-in-motion equipment, should be installed at each site. However, this is very costly for any highway agency, since each WIM site costs a minimum of $12,000 (low-cost WIM) and up to $200,000 (deep-pit bending plate WIM).

Although the principle of data equivalency is preferred for the information provided, the availability of resources may limit Manitoba's ability to immediately implement such a system. However, a long-range goal of the MDHT should be to eventually have a system in place that provides data equivalency.

4.2 Truth-in-Data

Albright [1990] and Hallenbeck [1990] define the principle of truth-in-data as the identification of qualitative and quantitative differences in traffic and truck data. The purpose of doing so is to indicate, or "label", the data collection location, the type of equipment or method used to collect the data, the type of data collected at each data collection site, and the time periods during which data is collected. By doing so, data and information users can identify the quality of the information and use the information accordingly.

Example

A hypothetical example for applying the truth-in-data principle is as follows. Suppose a bridge is designed based on published values available for AADT and percentage of trucks, projected to estimate the traffic volume expected to use the bridge. Over time, the bridge is observed to service the traffic level and deteriorates at a normal rate. Now, a second bridge is to be constructed in an area with similar soil conditions, land uses, and land restrictions. Once again, the published values are used to supply estimates for AADT and percentage of trucks. Since the traffic and truck loadings appear to be similar to the first site, the designers decide to use a comparable bridge design.

Over time, the bridge shows rapid deterioration, and requires rehabilitation and weight restrictions prior to the anticipated rehabilitation period. The designers discover that the first bridge had a data collection site using electronic equipment on a daily basis in close proximity to the bridge site. The published information provided reasonable estimates of the actual traffic population. However, the second site had a five-day per season manual data collection site some distance away from the bridge location, with several main roads joining the bridge road in between the structure and the data collection site. If the published values had indicated the methods used and the accuracy level of the information, the bridge designers may have avoided a costly error.

The MDHT could benefit from adopting the principle of truth-in-data. By indicating the quality and quantity of data supporting traffic statistics on a site-by-site basis, those requiring the statistics would have the option of using the information or not, depending on the accuracy level provided and the accuracy level required. Also, data users would have the option of comparing equivalent sites.

4.3 Base Data Integrity

Albright [1990] describes the principle of base data integrity as maintaining only the traffic data that are actual measurements, and notes the following:

- few, if any, permanently installed traffic monitoring devices operate without interruption or error throughout the year. Mechanical devices periodically malfunction, whether measuring volume, classification, or weight;
- missing mechanical measurements are often completed within traffic data bases using various imputation techniques. Where imputation is used, "there is no simple way to disaggregate the dataset and differentiate between actual measurements and those values imputed to appear as measurements".

Within the SHRP database, the actual mechanical measurements are stored separate from any other values, and are the basis for all traffic summary statistics [Hallenbeck, 1990]. The same level of integrity can be extended to Manitoba's individual data base to provide the most truthful information at each collection site.

Example

Suppose equivalent quality data is collected at two sites. After one year of data collection, one site shows a 9% data loss through mechanical malfunction, and the second site shows a 6% data loss. If imputation was used to complete the data sets, the two sites could no longer be compared on the basis of data equivalency and the data sets would require labelling to indicate data quality. Also, the period of equipment malfunction would probably be different, resulting in higher errors during certain seasons.

Base data uncertainty is commonly accepted for some traffic applications, but is unacceptable for site-specific research applications [Albright, 1990]. For example, engineering functions requiring only general truck information would be more tolerant of data base uncertainties than pavement research projects that require information for a specific control section.

4.4 Computational Consistency

The previously discussed principles refer to data collection methods and data bases, which are used to develop traffic summary statistics. The principle of computational consistency refers to consistently utilizing the same computation methods to estimate summary statistics from the data base, and to inform users of the computation method used [Albright, 1990].

Summary statistics should be calculated in a consistent manner based on what is known, but also in a manner that leaves the possibility of applying new methods in the future [Albright, 1990]. The expectation of the SHRP database is that new methods to calculate summary statistics will be found due to new technologies and statistical procedures. Therefore, highway agencies should retain their base data in order to take advantage of any new procedures that may be developed by SHRP, and apply them to their historical database.

Example

AADT is a commonly reported traffic statistic, and when multiplied by the percentage of trucks in the traffic stream, provides the AADTT. Therefore, AADT is a fundamental statistic used in traffic and truck studies.

Albright and Wilkinson [1990] compared three different methods commonly used for calculating AADT from continuously collected data. The methods and the authors' analyses of the methods are as follows:

(1) The most common method is to calculate AADT as the sum of daily traffic divided by 365. However, since very few permanent traffic recording devices operate and measure traffic volume 365 days of the year, this method implies that some imputation method must be used to fill in the missing data. As mentioned earlier, imputing missing data reduces the integrity of the base data;

(2) The second commonly used method is to calculate AADT by taking the arithmetic mean of available (edit-accepted) days of traffic data. This approach results in a straight-forward variance calculation, but may not adequately represent the central tendency of traffic throughout the year if the valid days are not evenly distributed throughout the year;

(3) The third method involves using a mean weighted by calendar days of edit-accepted data. This approach ensures that AADT represents the seasonal distribution of traffic data, but results in a difficult variance calculation.

The purpose of comparing these three methods is to demonstrate that there are different methods available to calculate a particular statistic, but each method has a different result. Therefore, the computational methods used should be chosen on the basis of providing the most reliable statistics. The chosen computation method should consistently be used to calculate the statistics from all data collection sites, and from data collected over similar time periods. Albright and Wilkinson [1990] noted that different methods should not be applied to data from site to site because the statistics cannot be compared in terms of quality or equivalency.

4.5 Accuracy, Precision, and Reliability

Accuracy, precision, and reliability are three related fundamental principles that should govern a data collection system, but have been overlooked in the past when emphasis was on quantity, rather than quality [McElhaney, 1990]. For the purposes of this research, they are defined as follows:

(1) *Accuracy:* refers to the number of times a sample estimate represents the true population, and is expressed as a percentage. For example, 95% accuracy (i.e., confidence) means that 95 times out of 100 the sample estimate adequately represents the true population. Generally, accuracy is expressed in conjunction with precision limits.

(2) *Precision:* refers to the amount by which a sample estimate can vary from the true value to be considered representative of the true population. For example, 10% precision means that a sample estimate can vary by ±10% from the true value.

(3) *Reliability:* refers to the ability of a sample to represent the true population based on required accuracy and precision levels.

Highway agencies are beginning to collect data "based on objective statistical procedures designed to meet the desired objective while minimizing cost", with emphasis on quality rather than quantity [McElhaney, 1990]. The introduction of electronic technology has created the ability to improve quality while obtaining a large quantity of data at acceptable resource levels. However, the first priority must be to provide required data at acceptable reliability levels.

The new technology available for data collection has also created the possibility of achieving precision without accuracy [Robinson et al., 1989], as illustrated in the following examples:

(1) Weigh-in-motion sensors can measure the weight of each axle passing over a site. However, if the sensors are not calibrated properly, each measurement may be incorrect, giving biased estimates of the actual loading at that site;

(2) Data regarding count, classification and weight data may be collected at a particular site on an hourly basis. Assuming the equipment is functioning at acceptable reliability levels, the data obtained would be accurate and precise at that location. However, if the site is the only data collection location along a given highway, it may not be representative of the traffic stream using the highway. That is, the measurements are precise but the information derived from the data, if extrapolated for the highway, may not be accurate.

(3) Weigh-in-motion sensors precisely measure axle weights as a truck passes over. However, Gyenes and Mitchell [1992] showed that the weight measurement changes over time and distance, so that the measurement is dependent on the sensor location. That is, the sensors will give different weight measurements, depending on where the sensors are placed, due to the bounce and dynamic loading patterns of vehicles.

The issue of achieving adequate reliability levels within a traffic database has been widely addressed within the transportation industry [Albright, 1991a; Albright, 1991b; Mendall and Reinmuth, 1978; Ritchie, 1986; Ritchie and Hallenbeck, 1986; Young, 1985; Houghton, 1991]. The U.S. is in the process of standardizing traffic monitoring procedures between states in an attempt to improve the quality of the traffic data and information which supports decisions at all levels of the transportation profession [Young, 1985; Houghton et al., 1991]. Highway agencies are also encouraged to use statistical sampling methods associated with the HPMS sample and "the complete integration of the estimation and data collection processes at every level to produce reliable, directly-linked estimates which minimize data collection and eliminate duplication" [Hajek et al., 1985].

The Joint Task Force on Traffic Monitoring Standards developed the "AASHTO Guidelines for Traffic Data Programs" [June, 1991]. These guidelines were developed to improve the quality of traffic data for decision making, to estimate the data variability in order to meet the truth-in-data principles, to move toward common traffic monitoring practices, and to develop practical and achievable implementation programs [Houghton et al., 1991].

The Joint Task Force and the FHWA have recommended the following guidelines for accuracy and precision levels:

(1) The accuracy (confidence) level for traffic summary statistics should be 90% [Houghton et al., 1991, p. 8]. The precision and bias of summary statistics should be reported to the user. If the precision estimates are not available, the method and duration of the traffic count should be reported with the summary statistics.

(2) An acceptable precision is ±10% for portable equipment and ±2% for permanently installed equipment. Classifiers should be accurate to 90% of *all* vehicles in the traffic stream [Houghton et al., 1991, p.35].

(3) The Traffic Monitoring Guide [Young, 1985] recommends the reliability levels as 95% confidence with 10% precision for each data group collected, which means that the estimate lies within 10% of the true value 95 times out of 100 trials [FHWA, 1985].

The MDHT should attempt to achieve the 95% confidence level with a precision of 10%, based on the confidence levels recommended by the FHWA and the reasonable sample sizes required to achieve this level.

The Need for Data Reliability: Pavement Rehabilitation Example

Pavement-related functions in Manitoba are the most directly dependent on truck data, as shown in Chapter 3. Therefore, a pavement rehabilitation design is used to perform a sensitivity analysis that illustrates the dependency of pavement thickness on truck data.

The following truck-related information is required for pavement rehabilitation design:

(1) *% Trucks:* the percentage of trucks within the total vehicle fleet using the road section under design;

(2) *Vehicle Classification:* the number of trucks in each vehicle class are required to determine the number of single, tandem, and tridem axles;

(3) *EAL:* Equivalent Axle Loads for single, tandem, and tridem axles, based on estimated TEF values.

(4) *Axle Weights:* the actual weights of each axle type;

(5) *TLF:* Truck Load Factors are required to estimate relative "damage" expected on each highway class, based on the axle weights and the number of each axle type.

(6) *AADT:* Average Annual Daily Traffic refers to total traffic, which includes truck traffic.

The flexible pavement design formulae used in Manitoba are shown in Appendix B.

The TLF values used in Manitoba are those estimated from Alberta's truck population, and the EAL values are those estimated from the Canroad Study [RTAC, 1986]. There is insufficient data quantity and quality available in Manitoba regarding current axle weights and the number of each axle type to calculate provincial TLF and EAL values. The TLF and EAL values currently used may or may not reflect the actual values for truck using Manitoba's highways.

The pavement rehabilitation overlay design for a portion of Control Section 02 200 4 was chosen arbitrarily for this example. The chosen section consists of 7.8 km of PR #200, between PR #311 and 0.6 km south of PR #210. PR #200 is a two-way, undivided, asphalt surface-treated (AST) highway. The 1989 AADT and truck percentage are estimated at 1100 and 10%, respectively. The actual design used to rehabilitate the control section is summarized in Table 4.1. The complete design is shown in Appendix C, Table C-1.

The AADT was obtained from the 1989 Traffic Map Statistics publication [MDHT, 1989]. However, the data collection location and method used are not provided. The truck percentage of 10% was probably extrapolated from an earlier study, since no vehicle classification was performed in the vicinity of the control section since 1982[1].

In the following analyses, only B1 loading[2] is considered because PR #200 is classified as a B1 highway.

Analysis 1

The first analysis is performed to calculate variations in pavement base thickness requirements when the truck percentage estimates are varied by ±4%, and all other factors remain constant. The results are shown in Table 4-2.

The values shown in Table 4-2 indicate that a truck percentage estimation error of +4% results in a base thickness requirement error of 53 mm. This estimation error is significant in terms of material and cost requirements. For example, if the actual truck percentage is 6%, but is estimated at 10%, the design overestimates the base thickness by 53 mm. This design overestimation translates to an additional 5,374 m^3 of granular base over the 7.8 km control section, assuming a road width of 13 m, at an approximate cost of $160,700.[3]

If similar errors exist over a 20-km project, the excess material amounts to 13,780 m^3, at a cost of $412,000. If ten such projects are performed provincially in one year, the annual cost of excess material amounts to $4,120,000, which plays a significant role in overspending on highway rehabilitation.

The second observation made from the values in Table 4-2 is that a truck percentage estimation error of -4% results in a base thickness requirement error of -37 mm. For example, if the actual truck percentage is 14%, but is assumed as 10%, the additional thickness required to achieve a 20-year service life is 37 mm. In this case, the additional expense of $112,000 required to provide a sufficient quantity (3,752 m^3) of granular base is negligible when compared to the cost incurred by pavement failure prior to the anticipated service life of 20 years. The reduction in material quantity could decrease the service life by five years[4].

Analysis 2

The second analysis involves calculating base thickness requirements by varying AADT and truck percentages. Although AADT refers to general traffic rather than to trucks specifically, trucks are included in the general traffic population. An analysis of pavement rehabilitation would not be complete without considering the influence of AADT on base thickness requirements.

Researchers have estimated that traffic volumes can vary by +/- 20% on a daily basis [Albright, 1990]. Assuming AADT could vary by the same amount, and applying these values to the control section presented earlier, the actual AADT could range between 880 - 1320. The truck percentages are again varied between 6 - 14%.

The values presented in Tables 4-2, 4-3, and 4-4 are shown in Figure 4-1.

To illustrate the impact of the analysis, the extreme cases are considered. For example, suppose AADT is 880 and the truck percentage is 6%, but are assumed at 1320 and 14%, respectively. The result is an excess of 132 mm of base thickness, which is an overestimation of 13,385 m^3 over the entire highway section at a cost of $400,200.

Conversely, suppose AADT is 1320 and % Trucks is 14%, but are assumed at 880 and 6%, respectively. The 20-year service life could decrease by 14 years, resulting in capital expenditure much sooner than expected. The material cost of $400,200 to provide the required base thickness is small in comparison.

Analyses Summary

The analyses presented are based on an AST highway, where the granular base is required to carry the traffic load. The asphalt surface is of standard thickness regardless of traffic load. The cost analyses would be significantly higher if asphalt costs would also be considered.

The cost analyses did not consider any external costs, such as operation and maintenance, required annually to maintain the highway. Had such costs been considered, the savings may be less. However, the findings were substantial in terms of material cost savings and losses, depending on over- or under-estimating the traffic load.

Further study should be performed by MDHT to more precisely determine the costs involved. The capital cost of implementing a more reliable truck information system could be minimal when compared to the savings that may be realized by implementing such a system.

In theory, the above example shows the importance of providing accurate truck percentage data in order to develop cost-effective pavement designs. However, in reality, the differences are not as severe for a low-volume road, such as that used in this example. Since the minimum base thickness requirement established by the Materials Branch at MDHT is 150 mm, the significance of providing a truck percentage of less than 10% is negligible *in this particular case,* since the 10 % truck percentage requires a base thickness of 156 mm. However, the argument presented earlier regarding underestimating the truck percentage remains unaltered.

Figure 4-1 Equivalent Base Thickness Estimations Based on Various AADT and Truck Percentages

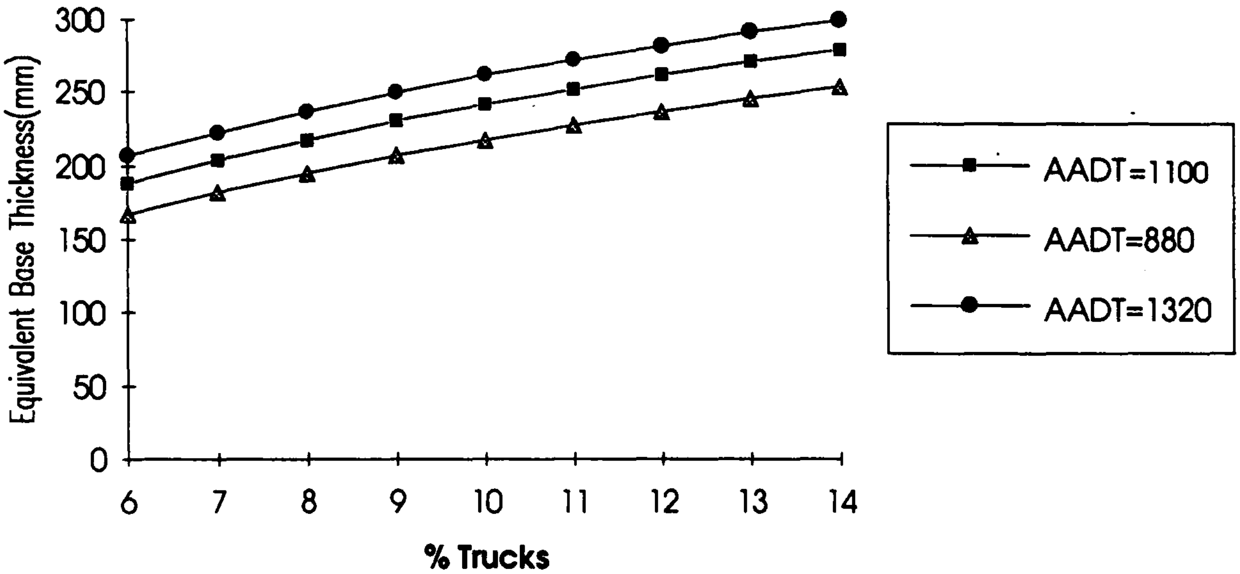

Table 4-1. Equivalent Base Thickness used in Overlay Design

1989 AADT	1989 % TKS	Equiv. Base Thickness (mm)
1100	10.0	241

Table 4-2. Base Design Thickness for Various Truck Percentages (AADT = 1100)

% TKS	Equiv. Base Thickness (mm)
6.0	188
7.0	204
8.0	217
9.0	230
10.0	241
11.0	251
12.0	261
13.0	270
14.0	278

Table 4-3. Base Design Thickness for Various Truck Percentages (AADT = 880)

% TKS	Equiv. Base Thickness (mm)
6.0	167
7.0	182
8.0	195
9.0	207
10.0	217
11.0	227
12.0	236
13.0	245
14.0	253

Table 4-4. Base Design Thickness for Various Truck Percentages (AADT = 1320)

% TKS	Equiv. Base Thickness (mm)
6.0	207
7.0	222
8.0	236
9.0	249
10.0	261
11.0	271
12.0	281
13.0	291
14.0	299

Endnotes

1. A 1982 Vehicle Classification and Turning Movement Survey was performed at the intersection of PR #200 and PR #429.

2. B1 loading assumes TLF = 1.0.

3. The material cost is calculated on the basis of A-Base material at a premium cost of $13/tonne. The weight of 1 m^3 of material is estimated 2.3 tonnes. Although the granular base would be made up of A- and C-Base, only the A-Base was considered in cost calculations.

4. The reduction in service life was calculated by comparing the time required to accumulate the expected number of ESALs on pavement base thicknesses of 241 mm and 278 mm, respectively.

CHAPTER 5. EVALUATION OF AVAILABLE DATA COLLECTION METHODS

This chapter evaluates truck data collection methods available in Manitoba. The evaluations are based on their reliability and efficiency to provide truck data necessary for the engineering functions at MDHT.

5.1. Manual Methods

5.1.1 Manual Turning Movement and Vehicle Classification Surveys

These surveys currently provide hourly, seasonal, and annual information regarding truck volumes, turning movements, and vehicle classification at selected intersections. The number of annually monitored intersections decreased from 26 in 1990 to a projected 15 or 16 in 1993 due to resource reductions.

A. Reliability: The reliability level of data obtained from the surveys has not been evaluated in Manitoba. Lucas [1993] suggests that the survey procedures[1] used by MDHT probably reduce the level of statistical error associated with using short-term counts to estimate traffic characteristics.

The survey results are reliable at each surveyed intersection. However, the reliability of extrapolating the information over road sections between two surveyed intersections is not known.

B. Efficiency: Only one engineering function, Highway Design, requires turning movements on a site-specific basis, rather than an annual basis. The turning movements could be eliminated from the annual monitoring program with surveys performed only by special request.

Vehicle classification and truck volumes are essential overall for engineering functions on annual and seasonal bases. Engineers prefer vehicle class distributions reported by route and/or control section rather than by intersection. Truck volume data is required to provide AADTT and the number of vehicles in each highway class.

To provide required vehicle class and truck count data implies that an electronic method should be used, since a large quantity of data is required to reliably report volume and classification by route or control section. System-wide volume and classification information should be obtained using automatic vehicle classifiers, with manual surveys only used for special studies.

5.1.2 Truck Weight Surveys

The truck weight surveys conducted until 1986 at MDHT provided a substantial quantity of data regarding axle weights, gross vehicle weights, axle configurations, axle spacings, origins-destinations, commodities, and operator characteristics. The surveys were terminated due to their high labour costs and the apparent lack of interest in the survey results.

A. Reliability: The reliability of data obtained during the truck weight surveys has not been assessed. The surveys were intended to obtain a random sample of trucks representative of the truck population at each survey location and, ideally, for the surrounding region.

The survey results may have adequately represented trucks operating within the terms of governing regulations. However, surveyors were aware of trucks purposely avoiding survey locations. These trucks may have been operating in violation of the regulations, and therefore were not represented in the survey results. If a significant portion of illegally operating trucks avoided the survey locations, the true truck population was not represented in the survey results.

Since surveys generally occur weekdays during daylight hours, the survey results do not represent trucks operating at night or on weekends, where trucks may have variable operating patterns.

B. Efficiency: The surveys are labour-intensive and costly, and only cover a small number of sites per year. Trucks included in the random sample are not known to represent regional operating characteristics.

Initiating a widescale truck weight survey program at this time is not recommended for general truck weight data. However, site-specific surveys may be requested by pavement designers and researchers to estimate loading expected at a project location.

Permanent weigh stations are equipped to collect static weight data, but would require installation of electronic recording devices to store the incoming data. However, the truck population may not be adequately represented at weigh stations because trucks operating in violation of regulations can avoid the stations by travelling after hours or selecting alternate routes.

Collecting truck weight data efficiently implies the use of electronic WIM devices. The sensors monitor each truck traversing the location without being an obvious weigh site. Ideally, a WIM network could be designed to collect reliable truck volume, classification, and weight data. However, WIM technology requires further study to determine whether it adequately represents static weights, or if new techniques are required to incorporate the dynamic weight data.

5.2. Electronic Methods: AVC and WIM

5.2.1 Background

AVC and WIM technology is new in Manitoba. The technology was recently introduced in order to collect vehicle classification data and axle weight data as required by SHRP. The first AVC loops and WIM sensors were installed at the Glenlea SHRP site, located on PTH #75, in September, 1990. Since that time, loops and sensors have been installed at the remaining four SHRP sites, which are: Brokenhead (located on PTH #1, east of Winnipeg), Symington (located on PTH #100, South Perimeter Highway), MacGregor, and Oak Lake (both located on PTH #1, west of Winnipeg). At this time, all are continuously collecting data.

The LTPP portion of SHRP requires site specific weight, classification, and count data for all vehicles passing over each SHRP site for a twenty year period [NRC, 1990]. Although SHRP had set the deadline for initializing data collection and submission as June, 1991, several participating agencies, including MDHT, were finding the deadline difficult to meet [Hallenbeck, 1990; NRC, 1990].

The WIM and AVC equipment installed in Manitoba has encountered a series of problems originating from the software. Each new software version installation corrected several old problems but introduced new ones. Some problems were:

classifying vehicles incorrectly, sensors turning off on their own, and difficulty with collecting and storing data surveys.

5.2.2 Evaluation of WIM and AVC

A formal study of the WIM and AVC equipment and software is presented in the following sections. The purpose of the study is to determine the functioning capability of the latest software version by calculating the reliability of axle load estimates obtained from the WIM sensors, and vehicle classification data from the AVC loops. Knowledge regarding the reliability level of the data measurements is necessary to determine the reliability of the information obtained from the data.

SHRP did not provide quality standards regarding WIM and AVC data, which could be detrimental to the integrity of the LTPP portion of the SHRP project [Albright, 1990]. MDHT should determine the data quality level prior to utilizing the resulting information in Manitoba. The only guidelines available are the preliminary standards proposed by ASTM, and the experience of other agencies that have been using WIM and AVC equipment for several years and have learned on a trial and error basis.

The following evaluation considers only the WIM and AVC equipment used in Manitoba, which involves capacitive strip sensor technology with wire inductive loops, and does not attempt to predict the reliability of other types of equipment.

The method used for equipment calibration is as suggested by Golden River Corporation, which is the manufacturer of the WIM and AVC equipment used in Manitoba, and is not the only method that can be used. Other methods are available that are more time consuming, but could result in more accurate calibration factors.

5.2.3 WIM Theory

The fundamental premise of WIM technology is that the weight sensors measure and record only the vertical component of the dynamic weight of a vehicle moving over the sensors at any speed [Izadmehr and Lee, 1987]. The vertical wheel weight component of a moving vehicle should theoretically be the same as the wheel weight of a vehicle that is statically measured, if the vertical acceleration is zero [Lee and Machemehl, 1985].

By definition, the total vehicle mass remains constant [Lee and Machemehl, 1985]. Although the load may be transferred from one axle to another, the gross vehicle weight remains the same [Davies and Sommerville, 1987]. However, it is estimated that external factors, such as a bump on the road surface, can result in the dynamic force of a rolling wheel on the highway ranging from double the static weight just after the bump, to zero during the rebound [Davies and Sommerville, 1987].

There are several factors that contribute to the differences between static and dynamic weights of vehicles:

- Static scales measure a vehicle section by section. Each time the vehicle moves, the suspension system shifts and redistributes the load between the axles to some degree, resulting in an error for each individually measured axle or axle group weight and in the gross vehicle weight obtained by summing the individual axle weights [Morin, 1984]. When a vehicle is in motion, the load transfer occurs to a greater extent, introducing an additional error;

- Ideally, the vertical acceleration of all vehicle elements should be zero [Morin, 1984]. However, this is not attainable in practise, so it adds to the difference in the WIM results;

- Many physical external variables at a WIM site can affect the accuracy of WIM measurements [Izadmehr and Lee, 1987]. If any of the variables are not ideal, a difference may be introduced. Some factors are: vehicle suspension type, pavement surface condition (i.e. smoothness of a road surface), environmental conditions, and roadway geometry (i.e. cross-slope, grade, super-elevation);

- Internal errors associated with measuring equipment can contribute significantly to discrepancies between static and dynamic weights [Davies and Sommerville, 1987].

- Some researchers report that, regardless of the external and internal conditions, WIM may not be able to measure axle weights equal to static weights due to the random nature of dynamic loading patterns [Gyenes and Mitchell, 1992].

To summarize, the theory is that if all road, environmental, and equipment conditions are ideal, and a vehicle is travelling in a vacuum with no tire distortion over a WIM sensor, the sensor should measure the wheel weights exactly as reported by a static scale, given that both the static scale and the WIM sensors are perfectly calibrated [Izadmehr and Lee, 1987].

However, in practise this is unattainable. Differences do occur when comparing static axle weights to dynamic axle weights. The inability to achieve ideal conditions, and the random dynamic loading pattern, are quantified as the difference between measured static and dynamic axle weights.

The percentage of difference contributed by each factor is not known. Therefore, it is necessary to study the measured differences to determine if the quality level achieved is appropriate to render the data reliable for data collection purposes.

5.2.4 Description of WIM and AVC equipment

MDHT has purchased and installed Golden River WIM and AVC equipment at their SHRP sites. The WIM sensor consists of a capacitive strip sensor built into an aluminum tube for protection. The sensor is placed onto levelling screws seated in a slot over the width of a traffic lane. When installation is complete, the sensor seats securely on top of the screws and lies flush to the road surface so that it is not damaged by snow ploughs or studded tires [Golden River Corporation, 1990].

At one end of the sensor, there is a small circuit board containing the primary signal. When a vehicle passes over the sensor, the sensor deflects, causing a change in capacitance. The vertical wheel force is determined by measuring the magnitude and duration of the capacitance change, based on the vehicle's weight and speed. The sensor is designed for consistent performance so that it should not matter where a wheel passes over the sensor [Golden River Corporation, 1990]. However, in practise it is unknown whether this is the case. Further study could be performed to determine if there is a difference between the percentage differences for vehicles passing directly over the centre of the sensors and those to either side of the centre.

Cable connections link the road installation to a Marksman 600 processor, which is programmed for weight, classification, and count output requirements. The Marksman software analyzes the raw sensor signal to reduce the error in reading the signal [Golden River Corporation, 1990].

The equipment measures each wheel weight, sums the weight on one axle, and reports each individual axle weight. The gross vehicle weight is reported by summing all the axle weights.

The entire system at a SHRP site consists of the Golden River WIM strip sensors, inductive loops for the vehicle detection, count, and classification, the Golden River Marksman 600 Traffic Data Management System, and the telemetry equipment needed for remote management, data retrieval, and analysis. The inductive loops operate as described in Section 2.2.3. The number of WIM sensors vary from site to site. At the Glenlea SHRP site, which was chosen for the WIM and AVC analysis, there are two sensors located in each wheel path, for a total of four sensors.

The Marksman 600 collects and stores the data in bins defined by the software. Golden River developed the program to be compatible with the output needed for SHRP. The bins are: vehicle number, date, time, speed, individual axle weights, GVW, length, wheelbase, vehicle classification (based on the FHWA-13 classification scheme - see Appendix A, Fig. A-5), and axle spacings, which are only on the printout unless otherwise specified. The information can be collected on a vehicle-by-vehicle basis, which is required by SHRP, or in predetermined time intervals.

5.2.5 Equipment Calibration

A. Site Description

The SHRP site used for the WIM and AVC study is located at Glenlea on PTH #75, approximately 800 m south of the Junction of PTH #75 and PR #420. Figures D-1, D-2, and D-3 in Appendix D show a general location map, a site map, and the sensor array layout, respectively. The sensors and loops are placed in the travelling lane of the Northbound roadway.

In general, the site appears to fulfill SHRP's location requirements for superelevation, pavement surface stress, gradient, and curvature. However, there is a slight rise in the travelling lane approximately 30 m south of the sensor array, which could affect the measurements taken by the sensors.

B. *Calibration Technique*

The equipment was calibrated as per specifications provided by the Golden River WIM Strip Sensor Manual [Golden River Corporation, 1990]. The truck used to perform the calibration was provided by the Maintenance Division of MDHT. The wheel weights, shown in Table 5-1, were measured using a portable scale provided by the Transport Compliance Branch. A compliance officer was present throughout the calibration process to reweigh the truck for any weight reduction caused by fuel consumption.

The calibration vehicle was a two-axle, six-tire truck (FHWA Class 5) with a wheelbase of 450 cm and a gross vehicle weight of approximately 12090 kg. The truck met all required criteria except for the gross vehicle weight, which was recommended as 15 tonnes. The truck was loaded prior to arriving at the WIM site, and there was no opportunity to return to Winnipeg to load additional weight.

The calibration process requires a truck with known wheel weights to be driven repeatedly over the sensor array. Each time the vehicle passes over the sensors, the Marksman 600 calculates four calibration factors for each axle. The calibration factors are averaged and input to the M600 as the working parameters for the WIM sensors at that site.

The truck driver was instructed to drive at approximately 100 km/hr without accelerating or braking for at least 100 m before reaching the sensors. The specifications request that the speed of the calibration runs be similar to the expected mean traffic speed. Ten runs were performed at or near this speed, which is the minimum number suggested by Golden River. The equipment was therefore optimized for dynamic error cancellation at the speed of 100 km/hr [Golden River Corporation, 1990]. The truck appeared to drive in the correct wheel path, directly over the centre of the sensors. The turnaround time for each run was approximately eight minutes.

The calibration factors are shown in Table 5-2. The table shows the calibration factors as calculated for the front axle only, the rear axle only, and averaged together to determine the final factors. Ideally, the calibration factors for each sensor will be the same. However, a truck with poorly damped suspension that passes over a bump prior to reaching the sensors will show a scatter in the calibration factors. The scatter is more common in the factors obtained from the rear axle, and can be seen in the results shown in Table 5-2. The slight rise in the road prior to the sensor array caused the truck to bounce when traversing the sensors.

Upon completion of the calibration runs, the factors were input to the M600.

C. *Analysis of Calibration Results*

Following the calibration runs, five test runs were performed to compare the known static weights to the measured dynamic weights. The dynamic weights are shown in Table 5-3. The vehicle was classified correctly in all cases.

The percent differences between the dynamic and static weight measurements are shown in Table 5-4.

Upon initial statistical analysis, Table 5-5 shows the statistical inferences obtained from the calibration data.

Table 5-5 shows that the means of percent differences are above the ideal of 0% in all cases, which indicates that the WIM sensors tend to overestimate the static weights. The front axle weights were dynamically measured closest to the ideals of 0%, with a +4.5% mean of percent differences, a sample variance of 11.8, and a sample standard deviation of 3.4%.

Since the mean of percent differences, sample variance, and sample standard deviation for the front axles are lower than for the rear axles, this indicates that, on average, there are larger differences between the dynamic and static weights of the rear axle. The larger sample variance indicates a higher variability in the rear axle weight data, which in turn indicates that the sample mean of percent differences for the rear axle weights are a less dependable inference from the data than that for the front axle data. The lower the variability (i.e. variance), the more likely the data is representing the actual population. Table 5-4 shows that there is a larger scatter between percent differences for the rear axles than for the front axles, which causes the higher variance value for the rear axle data.

The inference values for the GVW data all lie between those for the front and rear axle data. This is expected because the gross vehicle weights are dependent on both the front axle weights and the rear axle weights.

Since the above findings were based on only five test runs, the results can only be used as an indicator of what may be expected from a more comprehensive test. The next step is to perform a test based on a sample of trucks from the traffic stream to determine the reliability level of WIM and AVC data.

5.2.6 Reliability Testing

A study was performed to evaluate the WIM and AVC data reliability. The method used was to obtain classifications and static weights for trucks in the traffic stream and compare them to classifications and weights obtained by WIM and AVC equipment for the same vehicles. Statistical analyses were used to determine the reliability of the data.

A. Sampling Procedure

The method used to choose a sample size was that presented by Davies and Sommerville [1987]. They stated that WIM reliability can be evaluated by comparing the absolute or percentage differences between static and dynamic weights. Absolute differences are appropriate if weighing differences are approximately equal, independent of vehicle type or axle weight. Percent differences are more appropriate if the size of the weight differences increases in proportion to the mass of the axle being weighed, which is usually the case. The percent difference (PD) was chosen to be the basis of comparison for the data obtained in this study, where:

$$PD = \frac{WIM\ weight - Static\ weight}{Static\ Weight} \cdot 100\%$$

(Equation 5.1)

The estimated requirement for the number of observations was calculated using the following expression [Davies and Sommerville, 1987]:

$$n = \left(\frac{SD}{SE_m}\right)^2$$

(Equation 5.2)

where: n = the number of data points required for the sample;

SD = standard deviation (%)

SE_m = standard error of the mean (%)

Ideally, the true mean of percent differences between static and dynamic weights would equal "0". However, for the purposes of sampling, an acceptable sample mean of percent differences is ±1%.

From expression 5.2, both n and SE_m are unknown. SE_m can be calculated with 95% confidence where the mean of percent differences is ±1%:

$$\frac{\overline{PD} - \mu}{SE_m} = z_{95\%}$$

(Equation 5.3)
[Davies and Sommerville, 1987]

where: $\overline{PD}$ = sample mean of percent differences (±1%);
μ = true mean of percent differences (0%);
SE_m = standard error of mean (%);
$z_{95\%}$ = 95% confidence limits for a normally distributed population (±1.96).

Therefore, the SE_m is calculated as 0.51%. Davies and Sommerville [1987] stated "previous experience indicates that the standard deviation (SD) of the PD distribution will be around 10%." Using these values in Equation 5.2, the minimum sample size n is calculated to be 384 observations.

Assuming a truck has an average of three axles, a minimum of 128 trucks are required to obtain 384 data points. It was estimated that 128 trucks could be observed over only a few days.

Between August 12 and August 26, 1991, five days were spent at the Glenlea SHRP site collecting data. A summer student was situated at the Emerson permanent truck weigh station approximately 75 km south of Glenlea, observing all Northbound trucks and recording their cab and trailer descriptions, the time, vehicle class, and axle/axle group weights. Contact between Emerson and the Glenlea site was made about every 45 minutes. The student gave descriptions of the trucks that came through the Emerson scale, which were then observed passing over the SHRP site, provided they had not taken another route. A laptop computer that displayed vehicle-by-vehicle information was connected to the M600.

Upon completion of each day's observations, the data was analyzed to ensure it could be used in the final analyses. The majority of trucks observed at Emerson also passed over the Glenlea site. Occasionally the equipment incorrectly classified the trucks, or did not pick up all the truck axles and therefore the data for that vehicle was not included in the WIM analysis. However, vehicles incorrectly classified were included in the AVC analysis. On three occasions, the static scale missed an axle or axle group, but in those cases the data was retained for comparing the remaining axles, even though the gross vehicle weight data for those trucks could not be used.

Over the course of five days, data from 183 trucks were obtained, which translates into approximately 900 data points, since most of the trucks had five axles rather than three. For the first two days of the study (85 trucks), the calibration factors were set as an average of the front and rear axles of the calibration vehicle as specified by the Golden River manual. However, upon analysis of the data, there was a wide scatter among the weight data points. The calibration factors were changed to those calculated for the front axle only in order to compare the two data sets. The last three days of data (98 trucks) were obtained using these calibration factors. Both sets of data are presented in the following section, and a variance test is performed to determine if the data sets can be joined, or if they are significantly different and must remain separate. If the data sets can be combined, this would indicate that there was not a significant difference in the variances of the two samples to render one set of calibration factors better than the other.

B. Statistical Analysis of WIM Data

The weight data was compared as a percentage difference between the dynamic and static weight. All data is shown in Appendix D.

1. Calibration Factors = Front and Rear Axle. Table D-1 shows the combined data for single axle, tandem axle, and gross vehicle weights obtained during the first two days of data collection. This data set was obtained using the calibration factors calculated from averaging the front and rear axles of the calibration vehicle. The data is plotted in Figure 5-1.

Tables D-2 to D-7 show the results of the mean of percent differences and the statistical inference calculations obtained from the data in Table D-1. The tables break down the single and tandem axle data, as well as the gross vehicle weight data.

Single Axle Weights. Figure 5-2 shows a scatter plot of the single axle data points, along with the 1:1 ratio plot for the ideal static vs. dynamic relationship. As shown in the diagram, the dynamic weights tend to underestimate the static weights of the single axles, which is the opposite of what was found during the calibration runs. From Table D-3, the average percent difference is quite low at -0.4%, which indicates that the differences approach the ideal of 0%. The variance is high at 239.5, and therefore the standard deviation is also high at 15.5%. This indicates that the sample mean of the differences (average PD) is not as reliable due to the large spread about the mean, indicated by the high variance. The 95% confidence range is quite large because of the unreliability of the sample mean. This means that, with a 95% confidence level, the actual mean of differences lies between -30.8% and +29.9%.

Tandem Axle Weights. Table D-4 shows the average percent differences for tandem axles. The majority of trucks (92%) traversing the WIM sensors were five axle trucks (class 9). Therefore, there were two tandem axle groups on almost every truck that passed the site. Figure 5-3 shows a scatter plot of the static vs. dynamic weights for each of the tandem axle groups. The data points appear to be fairly well scattered on either side of the ideal line, except for the static weight of about 16000 kg. At that point, the dynamic weights seem to be widely scattered, ranging from 7500 kg to 22000 kg. The exact reason for this scatter is unknown, since a variety of factors may have caused it. Examples of the reasons for the scatter occurring are poor suspension, the equipment is not able to handle heavy weights, load shifting, or the vehicle may have been unloaded between Emerson and Glenlea.

Table D-5 shows a summary of the statistical inferences derived from the tandem axle group data. The mean of differences is 4.4% for the sample, meaning that the dynamic weights tended to be higher than the static weights. The variance was quite high at 272.3, with a standard deviation of 16.5%. This makes the 95% confidence range large, at -28.0 to 36.7%.

Gross Vehicle Weights. Table D-6 shows the percent differences for the gross vehicle weights of the trucks. The data is plotted in Figure 5-4, which shows a wide scatter, with the dynamic weights tending to be higher than the static weights. Table D-7 shows the mean of differences as 3.1%, which indicates the WIM sensors tend to overestimate the static weights. The variance is quite high at 232.9, resulting in a standard deviation of 15.3%. The 95% confidence interval is -26.8 to 33.1%, which is a large range. The results do not provide a high level of confidence in the data due to the large variance in the data points.

2. Calibration Factors = Front Axle Only. Table D-8 shows a summary of all the truck data collected over the last three days of the study. The calibration factors used were from the front axle only of the calibration vehicle.

Tables D-9 to D-14 show the percent differences and statistical inferences derived from the data in Table D-8. Figure 5-5 shows the scatter plot of all the data points obtained during the final three days of the study, and Figures 5-6 to 5-8 show the plots of the data for single and tandem axle weights, and for gross vehicle weights.

Table 5-6 shows a summary of the statistical inferences obtained from all the data. Also shown are the values from the proposed ASTM WIM standards.

Single Axle Weights. The single axle percent differences have a variance of 141.7 and a standard deviation of 11.9%. Compared to the calculations from the first two days, where the variance was 239.5 and the standard deviation was 15.5%, the use of the calibration factors for the front wheels only appears to improve the single axle static weight estimates.

The test for equality of variance (shown in Appendix D, Fig. D-4) resulted in the variances being unequal at the 95% confidence level. This indicates that the two sets of data cannot be combined into one large data set because the variances are significantly different. Using the calibration factors from the front wheels only creates a significant difference in the results.

Tandem Axle Weights. The tandem axle WIM measurements give a sample variance of 185.6 and a sample standard deviation of 13.6%, which is an improvement over the earlier results of 272.3 and 16.5% for the sample variance and sample standard deviation, respectively. The mean of percent differences is -5.0%, which indicates that the WIM sensors are underestimating the static weights of the tandem axles.

The equality of variance test for the tandem axle data also shows that there is a significant difference in the variances from the two data sets. At the 95% confidence level, the two data sets cannot be combined. Once again, using the calibration factors for the front axle only makes a significant difference in the WIM results.

Gross Vehicle Weights. The GVW data shows a mean of differences of -4.8%, with a sample variance of 150.7 and a sample standard deviation of 12.3%, which is improved over the previous variance and standard deviation of 232.9 and 15.3%, respectively.

The equality of variance test for the GVW data sets showed that the two data sets could be combined. The variances can be considered equal at the 95% confidence level. However, the variance ratio is equal to the upper confidence limit, which indicates that the ratio borders on not being acceptable to combine the two data sets. Caution should be used prior to combining the two sets. Since the single axle and tandem axle data sets cannot be combined, it is recommended that the GVW data sets not be combined.

C. AVC Analysis

To assess the reliability of AVC equipment, the actual vehicle class[2] of a truck observed traversing the loop detectors is compared to the classification provided by the computer. A total of 214 trucks were classified during the five-day data collection period, but not all truck classes were represented. The complete comparison is presented in Appendix D, Table D-15. A summary of results is shown in Table 5.7.

The recommended reliability level of AVC data is 90% for individual truck classes, and 95% for the total truck population [Albright, 1990]. The results show that the AVC correctly classified 87% of the total truck population, with a range of 0-100% for individual classes.

Although the recommended reliability levels are not achieved for most observed classes, it is inappropriate at this time to make firm recommendations regarding AVC. Class 9 is the only truck class adequately represented in the observed sample (93% of total trucks observed), and therefore, is the only class that allows some conclusions to be drawn.

Class 9 trucks are classified correctly in 88% of observed cases. Although 88% is slightly below the target reliability level of 90%, the difference is small enough to tentatively recommend utilizing AVC equipment for classifying class 9 trucks.

The results in Table 5-7 regarding truck classes other than class 9 is only useful for indicating possible trends in AVC reliability. For example, Class 13 trucks[3] are classified correctly in 78% of observed cases. If this value was based on an adequate sample size of Class 13 trucks, the result would be unacceptable when compared to the recommended reliability level.

Class 13 trucks are of particular concern on most highways in Manitoba because of their relative pavement damage and manoeuvrability. The MDHT would benefit from reliable classification data for all truck types, but particularly for class 13 trucks, to remain informed of the volume of trucks in a specific area or on a specific route. This knowledge could be used to either upgrade a highway or place restrictions on it, depending on the cost involved.

Further study should be performed to determine whether AVC can provide *reasonable* estimates of all truck classes.

5.2.7 Comparison of Results to Proposed ASTM WIM Standards

According to the proposed ASTM standards [ASTM, 1990], Manitoba's WIM system is designated as a Type I system, which is "designed for permanent or semi-permanent installation in up to four lanes at a traffic data-collection site and shall be capable of accommodating highway vehicles moving at speeds from 10 to 70 mph (16 - 113 km/h), inclusive." The equipment also provides for counting and classifying.

A. WIM System Performance Test

The proposed WIM performance standards use Equation 5.4 for calculating the percentage of non-conforming data items to indicate whether or not the data is acceptable [ASTM, 1990]:

$$d = 100[(C - R)/R] \qquad \text{(Equation 5.4)}$$

where: d = difference in the value of the data item produced by the WIM system and the corresponding reference value expressed as a percent of the reference value;

C = value of the data item produced by the WIM system;

R = corresponding reference value for the data item.

Once the number of calculated differences which exceed the tolerances shown in Table 5.6 for each data item has been determined, the number is expressed as a percent of the total number of observed values of this item by the following relationship:

$$P_{de} = 100[n/N] \qquad \text{(Equation 5.5)}$$

where: P_{de} = percent of calculated differences which exceeded the specified tolerance value;

n = number of calculated differences which exceeded the specified tolerance value;

N = total number of observed values of the data item.

The results are shown in Table 5-6. All weight data sets are outside the 95% conformity range. Although the data sets obtained using the calibration factors for the front wheels only are closer to the 95% conformity range than are the data sets obtained using the calibration factors for all wheels, the improvement is not enough to bring the data within the acceptable range.

The above indicates that the data sets are inaccurate as specified by the proposed ASTM WIM standards. The WIM system failed the acceptance test for the dynamic weights.

5.2.8 Evaluation Summary

Since the data failed the acceptability test, it is recommended that the equipment be re-calibrated using a more stringent calibration method, perhaps as outlined in the proposed ASTM standards [ASTM, 1990], and the data retested for acceptability. The majority of data currently obtained using WIM equipment significantly differs from the static weights. This does not mean that the data cannot be used, but new methods to evaluate and incorporate the data are required.

Two main premises of low-cost, high-speed WIM are as follows:

(a) WIM should provide *reasonable* estimates of the actual truck traffic;

(b) differences between measured static and dynamic weights should be due to load shifting rather than system errors.

From the test results, the data does not seem to provide reasonable estimates of static weights. The dynamic weight of an axle of known static weight can fluctuate from 47% to 138% of the actual weight when measured dynamically, as seen in the case of the tandem axle static weight of 16000 kg.

Also, if load shifting was the only factor causing measured differences, the gross vehicle weights should be equal when measured statically or dynamically. However, the test results show that this is not the case. The gross vehicle weight results do not conform to the proposed standards, indicating that other factors cause the differences between the measured weights.

Three questions arise from the above analysis:

(a) Is WIM a useful tool for collecting truck weight data for SHRP? Based on the test results, the accuracy level does not prove that the WIM system installed in Manitoba is reliable for estimating static weights. However, WIM may provide reliable dynamic weights, and new techniques are required to analyze and utilize the data.

(b) Does WIM provide the answers regarding loads actually traversing the pavement section that is under study? The dynamic axle weights fluctuate along each point of the road, whereas WIM only measures the dynamic weights at one point in time. The axles may generate completely different loads just upstream or downstream from the WIM sensor location.

(c) What is WIM actually measuring? It is supposed to estimate static weights from a vehicle that is moving, but the weight being measured is influenced by the vehicle's movement. There is speculation regarding whether or not the SHRP researchers will be able to incorporate the dynamic influence prevalent in the WIM data into useful input for pavement design and pavement performance analyses.

Figure 5-1. **Summary of Static and Dynamic Weights (Calibration Factors = Front and Rear Axles)**

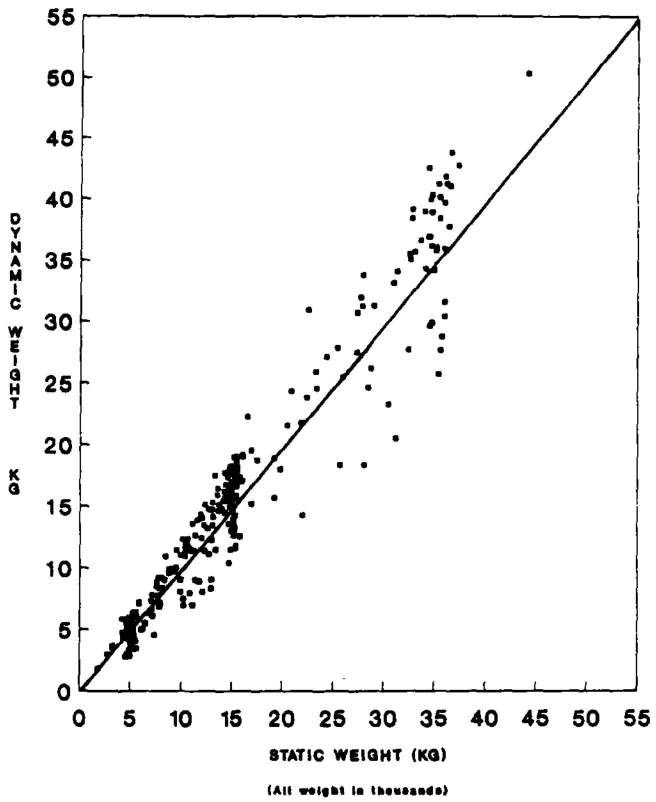

Figure 5-2. **Single Axles - Static vs. Dynamic Weights (Calibration Factors = Front and Rear Axles)**

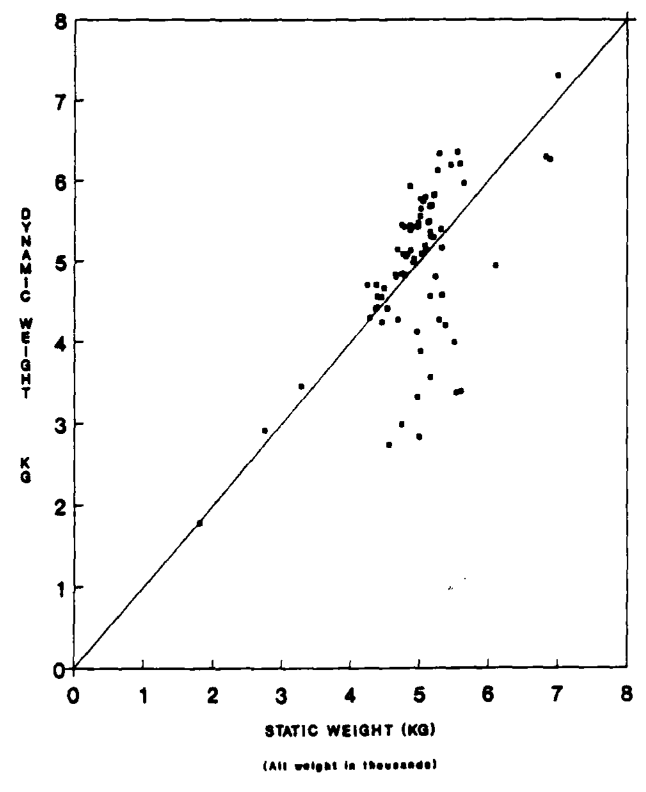

Figure 5-3. Tandem Axles - Static vs. Dynamic Weights (Calibration Factors = Front and Rear Axles)

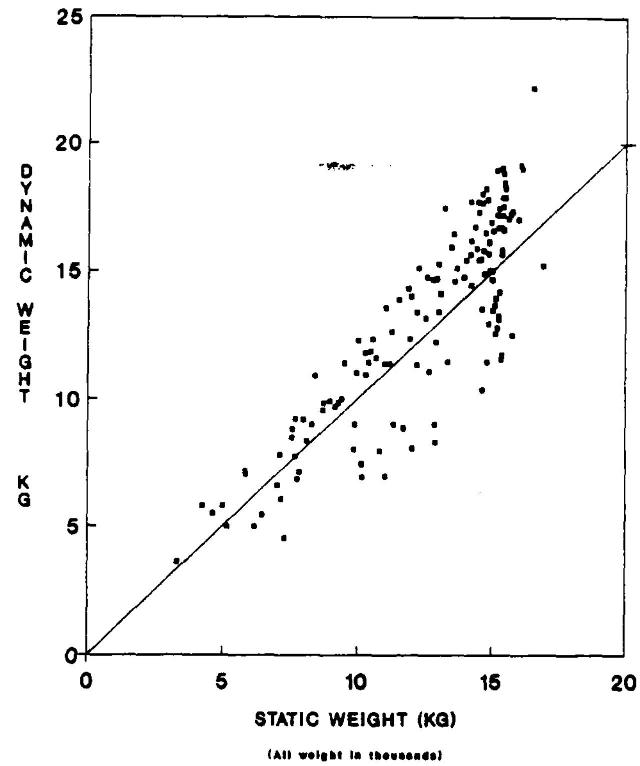

Figure 5-4. Gross Vehicle Weight - Static vs. Dynamic Weights (Calibration Factors = Front and Rear Axles)

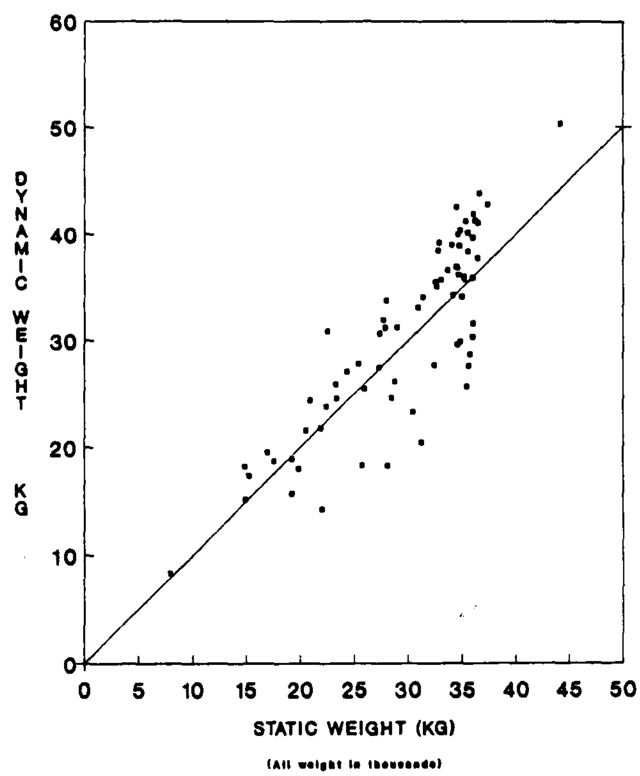

Figure 5-5. Summary of Static and Dynamic Weights (Calibration Factors = Front Axle Only)

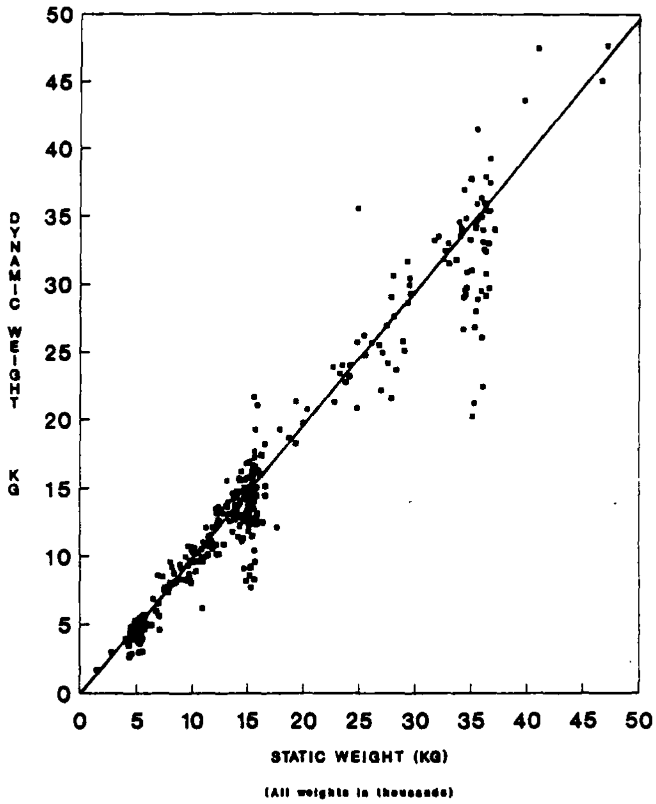

Figure 5-6. Single Axles - Static vs. Dynamic Weights (Calibration Factors = Front Axle Only)

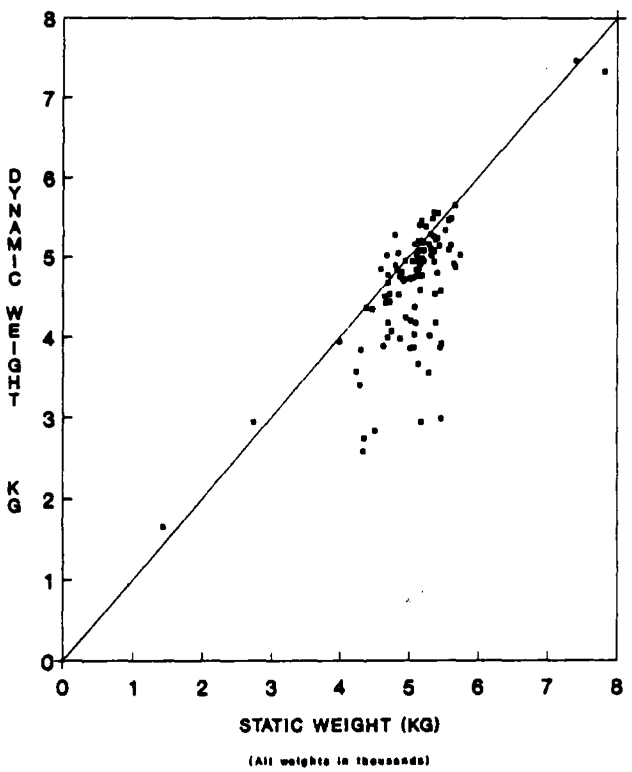

Figure 5-7. Tandem Axles - Static vs. Dynamic Weights (Calibration Factors = Front Axle Only)

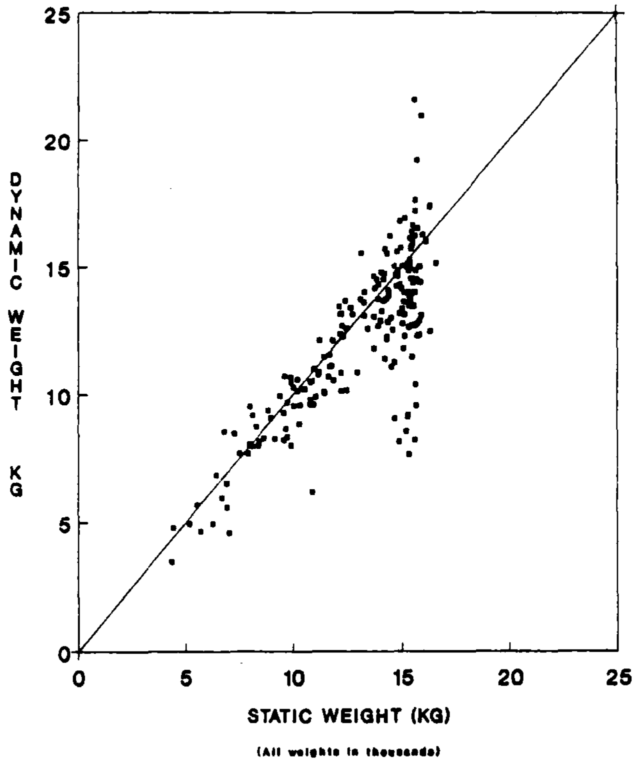

Figure 5-8. Gross Vehicle Weight - Static vs. Dynamic Weights (Calibration Factors = Front Axle Only)

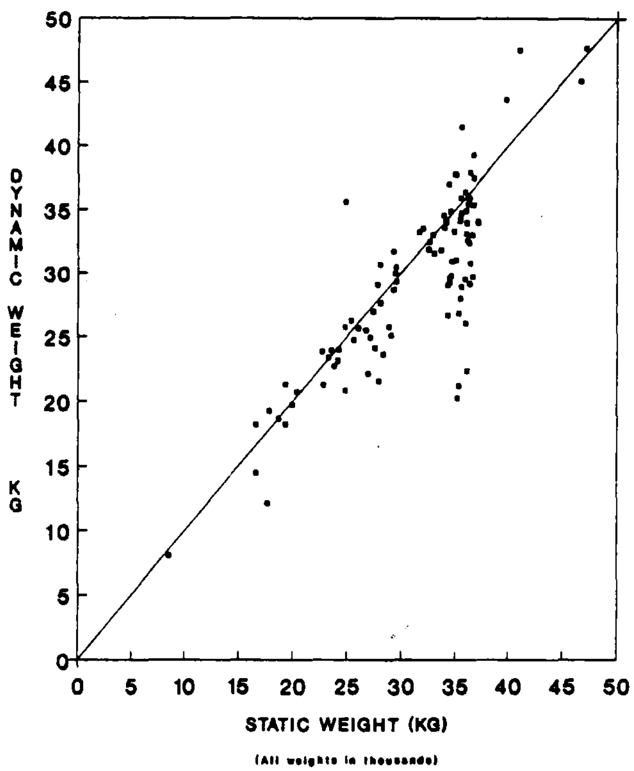

Table 5-1. Wheel and Axle Weights of the Calibration Vehicle

	WHEEL		
	LEFT	RIGHT	AXLE
FRONT*	1940	1870	3810
REAR*	4080	4200	8280

* All Weights in KG.

Table 5-2. Calculation of Calibration Factors

Site: Glenlea Date: August 7, 1991

Run #	Speed	Front Axle				Rear Axle			
		1	2	3	4	1	2	3	4
1	98	736	968	683	583	735	1454	612	637
2	100	774	927	561	568	555	2105	421	504
3	99	761	915	626	608	542	1076	1184	685
4	99	804	936	655	617	590	1288	439	580
5	98	699	875	569	567	805	1068	455	431
6	99	754	1057	608	626	708	933	463	850
7	97	743	903	625	611	1277	1066	641	554
8	95	740	1035	638	619	723	2352	529	739
9		821	978	679	639	1019	1362	632	762
10	95	740	903	672	606	1928	778	442	637
Total		**7572**	**9497**	**6316**	**6044**	**8882**	**13482**	**5818**	**6379**
Average		**757**	**950**	**632**	**604**	**888**	**1348**	**582**	**638**
Rear Wheels		**888**	**1348**	**582**	**638**				
Subtotal		**1645**	**2298**	**1213**	**1242**				
Calibration Factors		**823**	**1149**	**607**	**621**				

Table 5-3. Dynamic Weights for Five Calibration Test Runs

Run No.	Speed	Front Axle*	Rear Axle**	GVW***
1	98	4070	8270	12340
2	97	3930	9300	13230
3	100	4130	8740	12870
4	99	3910	8190	12100
5	77	3870	9960	13830

* Static Weight of Front Axle = 3810 kg
** Static Weight of Rear Axle = 8280 kg
*** Static Weight of GVW = 12090 kg

Table 5-4. Percent Differences Between Static and Dynamic Weight Measurements

Run No.	Weight*	Static Weight (kg)	Dynamic Weight (kg)	D** (kg)	PD*** (%)
1	F	3810	4070	260	6.8
	R	8280	8270	-10	-0.1
	GVW	12090	12340	250	2.1
2	F	3810	3930	120	3.1
	R	8280	9300	1020	12.3
	GVW	12090	13230	1140	9.4
3	F	3810	4130	320	8.4
	R	8280	8740	460	5.6
	GVW	12090	12870	780	6.5
4	F	3810	3910	100	2.6
	R	8280	8190	-90	-1.1
	GVW	12090	12100	10	0.1
5	F	3810	3870	60	1.6
	R	8280	9960	1680	20.3
	GVW	12090	13830	1740	14.4

* F = Front Axle
R = Rear Axle
GVW = Gross Vehicle Weight

** D= Dynamic Weight - Static Weight
*** PD. = (Diff/Static Weight)*100%

Table 5-5. Statistical Inferences from Five Calibration Test Runs

	All Axle Weights	Front Axle Weights	Rear Axle Weights	GVW Weights
Mean of Differences (%)	6	4.5	7.4	6.5
Sample Variance	41.9	11.8	82.7	33
Sample standard Deviation (%)	6.5	3.4	9.1	5.7
95% confidence Limits (%)	-6.7 to 18.7	-2.2 to 11.2	-10.4 to 25.2	-4.6 to 17.7

Table 5-6. Summary of Statistical Inferences from WIM vs. Static Weight Data

Statistical Inference	Data Items: Calibration Factors = Both Axles: Single Axle	Tandem Axle	GVW	Calibration Factors = Front Axle: Single Axle	Tandem Axle	GVW
Number of Observations (N)	77	145	72	103	196	99
Mean of Percent Differences (%)	-0.4	4.4	3.1	-8	-5	-4.8
Sample Variance	239.5	272.3	232.9	141.7	185.6	150.7
Sample Standard Deviation (%)	15.5	16.5	15.3	11.9	13.6	12.3
Mean Static Weight (KG)	4957	12360	29589	5051	12798	31057
Mean Dynamic Weight (KG)	4921	12924	30507	4642	12100	29446
95% Confidence Interval	-30.8 to 29.9	-28.0 to 36.7	-26.8 to 33.1	-31.3 to 15.3	-31.7 to 21.7	-28.9 to 19.3
ASTM Tolerance for 95% Conformity	+/- 20%	+/- 15%	+/- 10%	+/- 20%	+/- 15%	+/- 10%
Number of Observations not in Conformity (n)	11	63	41	14	41	31
Percentage of Observations not in Conformity (%)	14.3	43.4	56.9	13.6	20.9	31.3

Table 5-7. Summary of AVC Analysis

Vehicle Class	No. of Vehicles Observed	%. of Vehicles Observed	Vehicles Classified Correctly	% of Vehicles Correctly Classified
3	2	0.9	1	50
5	1	0.5	0	0
8	2	0.9	2	100
9	199	93.0	176	88
10	1	0.5	1	100
13	9	4.2	7	78
TOTALS	214	100	187	87

CHAPTER 5 - ENDNOTES

1. The manual turning movement and vehicle classification surveys are performed five days per week (Wednesday to Sunday), once during each season. The combination of weekdays and weekend days probably reduces the statistical error, since the majority of the error is derived from the variability of weekend traffic.

2. The AVC equipment is programmed to classify vehicles using the FHWA-13 classificaiton scheme.

3. Class-13 vehicles are seven- or more-axle multi-trailer trucks.

CHAPTER 6: DESIGN OF TRUCK DATA COLLECTION AND INFORMATION SYSTEM

This chapter defines the preliminary design parameters for a reliable truck data collection and information system in Manitoba. The objective is to apply methodologies used in the U.S. and in Saskatchewan to improve the system currently in operation. The design is based on the engineering needs for truck data and information, data collection methods and equipment available, and recommended reliability levels.

The procedures outlined in the "Traffic Monitoring Guide" [FHWA, 1985] and in the Saskatchewan Department of Highways and Transportation publication "Collection of Truck Weight Data" [Wyatt, 1985] are used as guidelines to develop the system.

6.1. Traffic Monitoring Guide Procedures

The Traffic Monitoring Guide procedures are designed to develop "a statistical sampling program for estimating traffic volume, annual vehicle miles of travel (AVMT), annual average daily traffic (AADT), vehicle classification, and truck weights, with known levels of reliability " [FHWA, 1985]. The sampling program is intended to support the continuous monitoring program, rather than replace it. The procedures emphasize the interrelationships between traffic volume, classification, and weight, and are intended to minimize the quantity of data collected by eliminating duplication.

A "nesting" procedure is used to collect data, where truck weighing sessions are conducted as a subelement of vehicle classification sessions, and vehicle classification sessions are a subelement of volume counting sessions as shown in Fig. 6-1. Collection sites are chosen to obtain the most representative traffic samples on a system-wide basis.

The FHWA procedures are directly linked to the Highway Performance Monitoring System (HPMS) sample, which is currently operating in all of the United States. The HPMS is a stratified random sample consisting of short-term coverage counts on numerous highway sections.

Although Manitoba does not have a *complete* HPMS in operation, coverage counts are performed on highways classified as Provincial Roads. For major highways, information is obtained from permanent counting stations (PCS) and vehicle classification surveys. The site-specific information is reliable for those locations and time periods, but the reliability of transferring the information along a road section, or system-wide, is not known.

The fundamental procedures recommended by the FHWA for traffic monitoring are as follows:

- develop a permanent monitoring system;
- set up an HPMS (coverage) element over the entire highway system;
- volume samples are taken from the HPMS sample;
- vehicle classification samples are taken from the volume samples;
- truck weight samples are taken from the classification samples.

The above procedures are recommended to ensure an efficient and reliable data collection system without duplication. Without the complete coverage element in operation, a system for Manitoba designed to collect volume, classification and weight data may have reduced efficiency and reliability levels. The coverage element is considered necessary to remain informed of any changes in traffic trends on highway sections [FHWA, 1985]. Implementation of a complete coverage sampling program in Manitoba could be achieved as a long-term goal by gradually increasing the number of counters and classifiers available to perform short-term coverage counts. However, a sampling program should not be implemented until a continuous monitoring program is in place. The sampling program is intended to only support the continuous program.

The scope of this research is directly linked to the truck-related portion of the FHWA procedures, which is comprised of vehicle classification and truck weight continuous monitoring and sampling. However, the relationships between all data elements (volume, classification, and weights) necessitate consideration of all areas of the proposed plan.

A report by Lucas for MDHT prepared simultaneously with this research assesses the traffic volume portion of the FHWA procedures. The design of vehicle classification and truck weight monitoring and sampling are linked to the volume sample.

6.2. Application of Traffic Monitoring Procedures to Manitoba

The following stages are required to determine the number of permanent and sample data collection locations for vehicle classification and weight data:

- separate all roadways by functional classification;
- assess the annual vehicle-kilometres of travel (AVKT) by functional class of highway;
- determine the number of permanent vehicle classification and truck weight stations based on AVKT and truck AADT;
- calculate the number of data collection sampling sites required for reliable vehicle classification data based on the coefficient of variation (COV), standard deviation, and vehicle percentages for each functional highway class;
- calculate the number of data collection sampling sites required for reliable truck weight data based on COV, AVKT, and vehicle percentages for each functional highway class.
- determine the equipment requirements and locations for each data collection site.

6.2.1: Functional Classification of Highways

Table 6-1 describes general guidelines used by the MDHT to define the five functional highway classes[1]. All provincial highways, except those classified as local, are considered in the system design.

The classifications are similar to those recommended in the Traffic Monitoring Guide. However, the FHWA procedures include an additional classification strata that further separates each class by rural and urban areas. The result is a total of eight functional classes, which doubles the number of reporting strata, and approximately doubles the total number of samples[2].

For Manitoba, the highway class categories are assumed as rural because the majority of the province's highways are located in rural areas. This reduces the sample size requirement and the cost of data collection [FHWA, 1985].

The ability to utilize functional highway classes to estimate vehicle classification and truck weight sample sizes is based on the assumption that highways with similar design and operating characteristics tend to have similar vehicle fleet characteristics[3]. Although this may not always occur, the MDHT Classification Study [1986] shows that the similarities are more than accidental.

The district maps shown in separate document Appendix E, Exhibits 1 - 12, illustrate the functional classes of highways.

6.2.2: Annual Vehicle-Kilometres of Travel (AVKT)

The following relationships are used to calculate the daily and annual vehicle-kilometres of travel[4] on each highway section:

$$DVKT = AADT * DISTANCE \qquad \text{(Equation 6.1)}$$

$$AVKT = DVKT * 365 \qquad \text{(Equation 6.2)}$$

where:

DVKT = daily vehicle-kilometres travelled;

AADT = annual average daily traffic on a specific highway section;

DISTANCE = the length of a highway section (km);

AVKT = annual vehicle-kilometres of travel.

Table 6-2 summarizes the DVKT and AVKT by highway class. The complete tables and calculations are presented in separate document Appendix E, Tables E-1 to E-8.

6.2.3: Estimation of Vehicle Classification Sample Size

The vehicle classification sample is a subelement of the volume estimation sample. Data duplication is eliminated because vehicle classification equipment and procedures also include total volume counts. The functional highway classes are used to report vehicle classification. The total sample is allocated to each functional class proportional to truck AVKT. The truck AVKT is used because it accounts for both mileage and truck volume, and is estimated from existing truck AADT and mileage data.

Standard statistical theory is used to estimate the vehicle classification sample size. Assuming a normal distribution of the percentage of each truck type, equation 6.3 is used to estimate the sample size that achieves a specific precision level [FHWA, 1985]:

$$n = \left(\frac{Z_{d/2}}{D}\right)^2 \times C^2 \qquad \text{Equation 6.3}$$

where:

n =	sample size;
$Z_{d/2}$ =	value of two-sided normal distribution for d level of significance (value = 1.96 for 95% confidence level);
C =	coefficient of variation (COV);
D =	desired level of precision as a percentage of the estimate.

The validity of the above relationship depends on obtaining reasonable coefficient of variation (COV)[5] estimates for each highway class. However, the COV estimates are quite poor due to the lack of available system-wide data. The annual vehicle classification and turning movement survey program provides a substantial quantity of site-specific data for a small number of sites. That is, the twenty survey locations chosen annually tend to be distributed over several highways, resulting in a small quantity of data for any particular highway. The surveys do not provide reliable data for estimating the average percentage of vehicles per vehicle class, and therefore the COV, on a system-wide basis.

To obtain improved COV estimates, the data base was expanded to include vehicle classification surveys performed during a ten-year period (1981 - 1991), thereby increasing the available number of data points. Only those highways with at least two surveys during that period were used in the sample size analysis.

Growth factors were not considered when using data from previous years, which could underestimate the average percentage of vehicles, and increase the COV, if the standard deviation remains constant. Considering the changes made to vehicle weight and dimension regulations over the ten-year analysis period, the truck population has grown, and the fleet mix has changed to include a greater percentage of 6, 7 and 8-axle vehicle configurations. The truck classes are divided into the class ranges shown in Table 6-3.

The truck class ranges are used because the vehicle classification surveys are published using these class ranges. However, since the vehicle fleet mix has changed in the past ten years, the MDHT should review the vehicle class ranges and consider presenting other vehicle types separately, such as:

- Type 14: 5-axle, semi-trailer
- Type 15: 6-axle, semi-trailer
- Types 41-42: 7 & 8-axle B-train
- Types 29-36: 7 & 8-axle A-train combinations

A. COV Estimation

The first stage in estimating COV is to estimate the average percentage of vehicles in each vehicle class per highway. These are obtained from the vehicle classification and turning movement surveys during the ten-year analysis period[6]. The standard deviation is estimated using standard statistical procedures [Neter et al, 1985].

The average vehicle percentages were separated by functional highway class and by highway number. The COV was estimated for each highway within each functional class. An average COV for each functional class was calculated by averaging the COVs estimated for each highway.

The complete COV and average percentage of vehicles tables are shown in separate document Appendix E, Tables E-9A to E-9H (Expressways), E-14A to E-14K (Primary Arterials), E-19A to E-19Q (Secondary Arterials), and E-24A to E-24S (Collectors). Summaries are shown in Tables E-10 to E-12 (Expressways), E-15 to E-17 (Primary Arterials), E-20 to E-22 (Secondary Arterials), and E-25 to E-27 (Collectors). A total summary is presented in Table 6-4.

B. Sample Size Estimates

Based on the functional class COV estimates and using equation 6.3, the sample sizes required to achieve a 95% confidence level with 10% precision (95-10 reliability level) for each highway class are calculated. The complete tables are shown in separate document Appendix E, Tables E-13, E-18, E-23, and E-28. The summary is presented in Table 6-5.

From Table 6-5, the sample size requirements for each functional class ranges from 200 to 400. The sample size chosen should achieve the 95-10 levels for all truck types. The truck class range 26-42 on the collector highway class represents the critical range to consider when choosing the sample size. That is, if fewer than 400 samples are used, the 95-10 levels would not be achieved for the truck class range 26-42.

Immediate implementation of 400 sample sites would be very costly and is not recommended, since the quality of the data used for this analysis is questionable. Instead, the FHWA recommends implementing the number of samples that achieves the target precision distributed over a three-year cycle, resulting in approximately 130 sampling sites annually. Table 6-6 shows the annual number of classification sites required to achieve the 95-10 levels over a three year period. The total number of sites are distributed system-wide proportional to the truck AVKT on each functional class.

The three-year cycle is based on the controversial assumption that truck traffic does not significantly change during a three year period [FHWA, 1985]. Distributing the sample over three years allows the opportunity to continuously analyze incoming data, thereby reassessing the ideal number of sample sites required. The reassessment is more beneficial than investing a significant amount of time and money into an extensive sampling program based on questionable data used for the preliminary system design.

Each sampling location should be monitored for a continuous 48-hour period if automatic equipment is used. If manual methods are used, shorter periods of 24-hours may be necessary until automatic classification equipment can be set up. Longer periods increase the data reliability by reducing random variation, but also increase data collection cost. FHWA analysis has shown that the number of vehicles for several vehicle types may vary with a daily COV of about 100%. Therefore, using a 48-hour monitoring period "would help to stabilize this variation [and] would not extend beyond the capability of portable classification equipment" [FHWA, 1985].

The classification samples should be seasonally distributed to account for temporal variation. Studies have shown that truck traffic may not be as affected by seasonal volumes system-wide as passenger vehicle volumes. But some seasons show increased truck travel on specific routes.

Details regarding equipment and location requirements are discussed later in Section 6-3.

6.2.4. Estimation of Truck Weight Sample Size

To estimate truck weight sample size, FHWA recommends using the same procedures as for vehicle classification. However, the equivalent axle load (EAL) COV is the basis used in equation 6.3, rather than the average percentage of trucks.

The lack of current EAL data available in Manitoba makes the application of this method difficult. Instead, a procedure suggested by Wyatt [1985] is utilized.

The method proposed by Wyatt continues to use vehicle percentage COV as the basis of analysis. The weighted average truck COVs[7] for each functional class are shown in Table 6-7b, and the average percentages of each vehicle type/range are shown in Table 6-7a.

A province-wide system COV is calculated by taking a weighted average[8] of the functional class COVs, presented in Table 6-8. The resulting system COV is 44.5%, which is the value inserted into equation 6.3 to estimate the total number of sample sites, as shown in Table 6-9.

The high cost of truck weight data collection may necessitate a reduction in the data reliability level. The 90-10 reliability level should be initially targeted as a goal, resulting in 54 sites monitored annually. As in the case of vehicle classification samples, one-third of the required number of sites could be monitored annually to achieve the target precision after three years. The number of sites on each highway class are proportional to the truck AVKT, as shown in Table 6-10.

The equipment and location requirements are discussed in section 6.3.

6.3 Equipment and Location Requirements for Sampling Program

This section discusses the general requirements for truck sampling site equipment and locations. Specific requirements necessitate further study of the provincial highway network and available technology.

6.3.1 Equipment Requirements

A. Vehicle Classification

Vehicle classification sampling sites should be equipped with portable automatic equipment, and monitored for a continuous 48-hour period. Portable sensing loops are available for this purpose, but the reliability levels should be determined prior to wide-scale equipment acquisition.

If manual methods are used, a 24-hour continuous monitoring period may be used to reduce costs until automatic classification equipment is acquired.

B. Truck Weights

Monitoring 19 truck weight sampling sites per year would require some type of portable electronic equipment. Portable WIM involves acquiring a weight pad and the necessary electronics that are transferred from location to location, rather than permanently imbedded in the road. Manual methods are costly, due to the amount of labour required.

The WIM analysis in Chapter 5 indicated that using that type of WIM as a method of obtaining axle weight data comparable to static weight data is not reliable. If techniques can be found to utilize the dynamic weight data, WIM could be very useful as a data collection tool. However, further study of portable WIM equipment should be conducted prior to equipment acquisition.

A complete truck weight sampling program should not be implemented until reliable electronic equipment and new techniques for utilizing the dynamic data becomes available. In the interim, axle weight data obtained at permanent weigh scales and project-specific data obtained using portable scales could benefit engineers, particularly pavement designers, at MDHT. However, further study is required to determine the ability of these samples to reliably represent the truck population.

6.3.2 Location Requirements

Using informed judgement to select sampling locations is necessary, since only a few sites can be selected out of potentially thousands [Wyatt, 1985]. The main objectives of the sampling program are to obtain representative province-wide data and to monitor historic trends.

The following list provides general guidelines for selecting sampling locations for both vehicle classification and truck weights:

- Locate sites in areas with high truck AADT. An arbitrary volume of 200 trucks/day is considered high volume.
- Monitor roads in close proximity to existing weigh scales, as well as at the weigh scales, during daylight and at night. Since overweight trucks may attempt to avoid weigh scales, survey sites located on alternate routes could provide more reliable results of the entire truck population, and not only those within legal weight limits.
- Remain informed of the seasonal variations in truck volume and commodities hauled. Monitoring roads with high seasonal truck volumes and low off-season volumes could result in a seasonal bias of the annual results, particularly if the roads are only monitored once per year.
- Monitor roads with localized truck haul only for special studies. The results could be misleading if averaged over the entire network.

6.4 Permanent Truck Monitoring Stations

Data from permanent monitoring stations is required for the following reasons:

- monitor daily, weekly, monthly, seasonal, and annual variations in traffic flows, truck flows, fleet mix and truck weights;
- estimate regional expansion factors required to expand short-term vehicle classification counts utilizing axle counters [Lucas, 1993];
- estimate regional axle conversion factors for application to volume counts;
- determine growth factors on monitored roads, and estimate regional growth factors for sampled roads.

Permanent monitoring stations typically require a computer and telephone modem at the chosen location, as well as sensors permanently imbedded in the pavement. The expense involved in acquiring, installing, and moving such equipment requires that careful consideration be given to the number of permanent stations and location of each station.

6.4.1 Permanent Counters

Permanent counters provide relatively reliable traffic counts on monitored roads. Details regarding a proposed permanent counter network are specified in a separate study for MDHT [Lucas, 1993]. The proposed network is designed to minimize the variability of data obtained along major routes, and decrease the statistical error associated with the application of estimated expansion factors to short-term counts.

6.4.2 Permanent Vehicle Classification

Permanent vehicle classification monitoring stations in Manitoba should consist of electronic AVC equipment capable of programming up to 22 vehicle classes[9]. The maximum benefits from permanent vehicle classification stations are realized when located on major truck routes that carry a representative sample of a large number of trucks on a daily basis. Therefore, RTAC routes[10] are chosen for placement of the permanent stations. However, the reliability of the type of AVC equipment selected to provide the vehicle classification data should be determined prior to equipment acquisition. The AVC equipment should provide the reliability levels discussed in Chapter 4.

RTAC routes carry approximately 60% of all provincial truck AVKT. In addition, they are the only routes that allow maximum weight limits and vehicle dimensions, as specified in the Manitoba Vehicle Weight and Dimension Regulations. Therefore, the routes maintain the most representative sample of all truck types, including A- and B-trains, allowed to travel in the province.

The number of permanent stations required is estimated by identifying links of each RTAC route that maintain relatively stable truck AADT values[11]. The research conducted to identify the links does not include choosing specific station locations. Further research within the MDHT is required to choose specific station locations. The links are identified in separate document Appendix E, Table E-29.

A priority rating is given to each link in Table E-29. Only those links that carry over 200 trucks per day on average are given top priority. The 200 trucks per day limit is chosen arbitrarily due to the apparent division of the data at that value[12].

There are 54 links/stations identified in this study. Table 6-11 summarizes the number of links by priority and by functional highway class. Permanent classification stations replace the same number of sampling locations on a functional highway class, as discussed in Section 6.2.4. A permanent vehicle classification station also replaces a permanent counter station, since AVC provides complete vehicle counts.

Table 6-11 indicates that the links rated as "1" currently have AVC equipment operating. The links rated as "2" could easily be converted to AVC stations. For future upgrading, the priority ratings provide the order in which links should be upgraded.

6.4.3 Permanent Truck Weigh Stations

Permanent continuous truck weigh stations are required to provide estimates of axle weight and gross vehicle weight distributions. Together with vehicle classification data, the Materials branch could then adequately estimate ESALs on given roadways, and possibly transfer the ESAL information over the entire highway network.

However, permanent truck weigh stations require some form of electronic equipment to continuously monitor trucks. The continuous data cannot be obtained using manual methods due to the large expense involved. Based on the WIM analysis in Chapter 5, the WIM equipment currently operating in the province is not recommended for expanding the truck weight data collection network over the entire provincial highway system until the dynamic weights can be incorporated into analyses and designs. The WIM data currently collected at SHRP sites can be used as the basis for developing new analyses and design techniques.

Although many trucks pass through the static scale stations located on major highways and the stations are located on RTAC routes, it is not known at this time whether a representative sample of trucks could be obtained by monitoring only the permanent weigh stations. Further study is required to determine the reliability of truck weight data obtained at static scale stations.

At this time, the recommendation is to begin a sampling program as discussed in section 6.2.5, including the static scale stations as some of the sampling locations, to better understand where permanent weigh stations could be located. Over time, WIM data interpretation may improve so that WIM equipment could be installed at permanent stations on major truck routes.

Figure 6-1. Traffic Monitoring Sample Structure
(Source: FHWA, 1985)

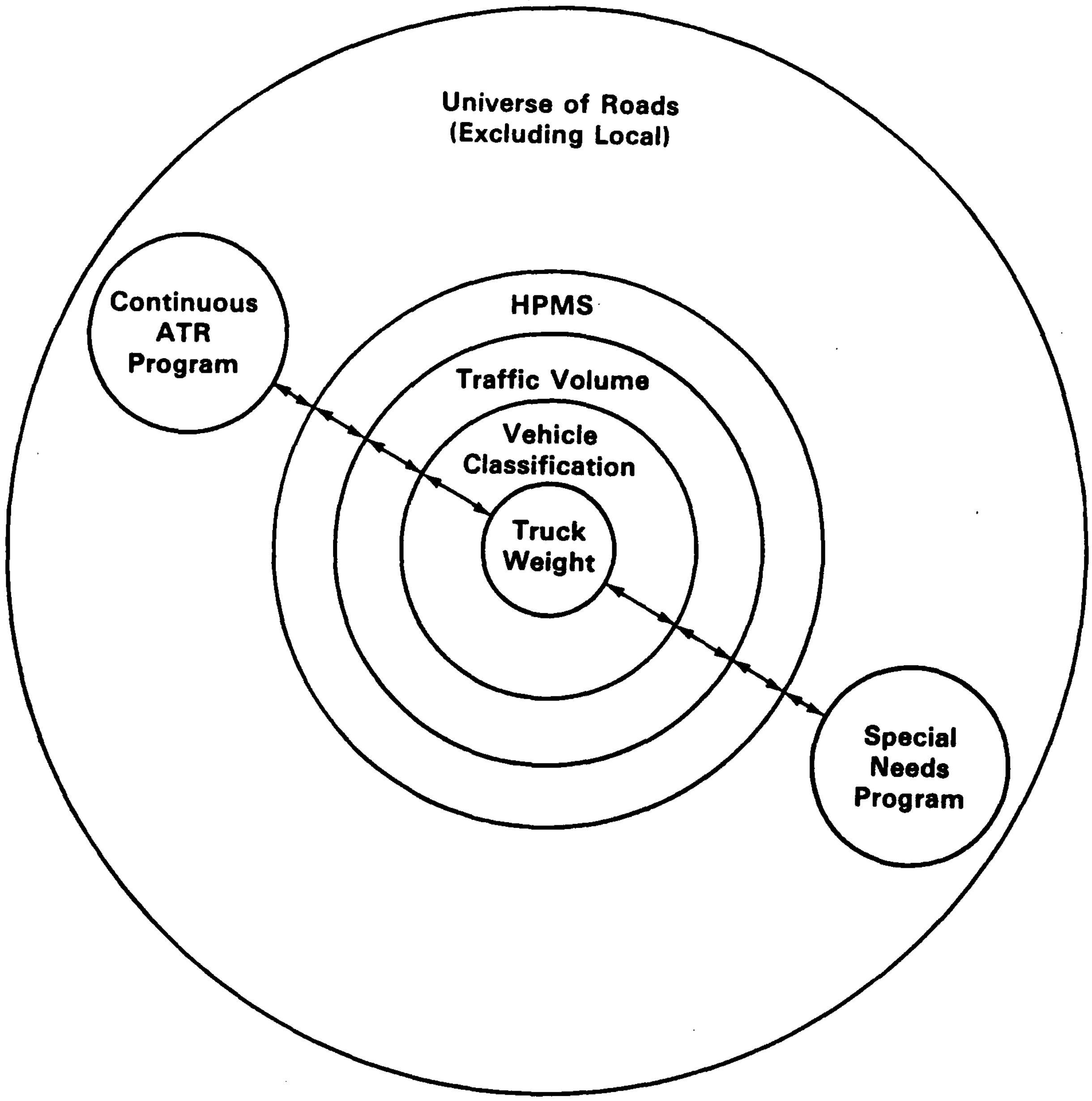

Table 6-1. Guidelines for Functional Classification of Highways

Expressways	Primary Arterials	Secondary Arterials	Collectors	Locals
- Multi-lane divided - Existing or future PTH - Single Axle Load limit of 9100 kg - Provides interprovincial and international connections to larger population centres - Connects centres with populations > 10000 - Provides traffic movement with high restriction level of direct property access - 20-year AADT > 5000 - finished pavement surface width of 13.4 m	- Existing or future PTH - Single Axle Load limit of 9100 kg - Provides interprovincial and international connections to larger population centres - Connects centres with populations > 10000 - Provides traffic movement with medium restriction level of direct property access - 20-year AADT > 1000 - finished pavement surface width of 12.4 m	- Existing or future PTH - Single Axle Load limit of 9100 kg - Provides interprovincial and international connections to smaller population centres - Connects centres with populations > 1000 - Provides traffic movement with low restriction level of direct property access - 20-year AADT > 500 projected - finished pavement surface width of 11.4 m	- Existing PR - Single Axle Load limit of 8200 kg - Connects centres with populations < 1000 - Provides equally for traffic movement and land access through partial control of property access - 20-year AADT < 500 - finished pavement surface width of 10.4 m	- Lower standards than PR's - Provides only for land access

Table 6-2 Summary of Vehicle-Kilometres Travelled

Highway Class	Daily Veh-km	Annual Veh-km	Daily Truck Veh-km	Annual Truck Veh-km	% of Annual Veh-km By Truck
Expressway	4.46E+06	1.63E+09	5.16E+05	1.88E+08	11.6
Primary Arterial	4.19E+06	1.53E+09	4.19E+05	1.53E+08	10.0
Secondary Arterial	2.82E+06	1.03E+09	2.44E+05	8.89E+07	8.6
Collector	2.81E+06	1.03E+09	2.16E+05	7.89E+07	7.7
TOTALS	**1.43E+07**	**5.21E+09**	**1.39E+06**	**5.09E+08**	**10.00%**

Table 6-3 Truck Class Ranges

Truck Class Range	Description
Type 8	2-axle, 6-tire single unit vehicle
Type 9	3-axle, 6-tire single unit vehicle
Type 10 - 15	3-6 axle, single semi-trailer vehicle
Type 16 - 25	3-6 axle, single trailer vehicle
Type 26 - 42	5-10 axle, multi-trailer vehicle

Table 6-4. Summary of COV Estimates (%)

CLASS	Truck Types				
	8	9	10 - 15	16 - 25	26 - 42
Expressways	21.8	43.5*	32.0	49.1	55.4
Primary Arterials	31.1	44.0	63.8	53.0	76.3
Secondary Arterials	38.9	51.5	51.4	56.2	91.9
Collectors	29.5	36.5	55.0	56.5	93.5

* For example, the COV for truck type 9 on Expressways is 43.5%, which represents the ratio of the standard deviation and the average percentage of type 9 trucks on that highway class.

Table 6-5. Summary of Sample Size Estimates

Highway Class	Truck Types				
	8	9	10 - 15	16 - 25	26 - 42
Expressways	20	100	50	100	200
Primary Arterials	50	100	200	100	300
Secondary Arterials	100	100*	100	200	300
Collectors	50	50	200	200	400

* For example, 100 sample sites are required per year to monitor type 9 trucks and achieve a 95-10 reliability level.

Table 6-6. Annual Number of Vehicle Classification Sampling Sites per Highway Class

Highway Class	% of Total Truck AVKT	Number of Sites
Expressways	37	48*
Primary Arterials	30	39
Secondary Arterials	17	22
Collectors	15	20

* For example, Expressways carry 37% of the total truck AVKT in Manitoba. Therefore, 48 classification sampling sites should be placed on various highways classified as Expressways.

Table 6-7a. Average % Trucks of Each Truck Class/Range by Highway Class

Highway Class	Truck Types				
	8	9	10 - 15	16 - 25	26 - 42
Expressways	1.8*	1.4	6.2	0.6	0.8
Primary Arterials	2.4	1.2	4.2	0.8	1.1
Secondary Arterials	2.8	1.5	2.6	0.9	0.4
Collectors	2.6	1.4	2.2	0.8	0.4

* For example, type 8 trucks constitute 1.8% of all vehicles in the traffic fleet.

Table 6-7b. COV of Each Truck Class/Range by Highway Class

Highway Class	Truck Types					Weighted Averages
	8	9	10 - 15	16 - 25	26 - 42	
Expressways	21.8*	43.5	32.0	49.1	55.4	34.5**
Primary Arterials	31.1	44.0	63.8	53.0	76.3	53.9
Secondary Arterials	38.9	51.5	51.4	56.2	91.9	49.7
Collectors	29.5	36.5	55.0	56.5	93.5	44.8

* For example, the COV for type 8 trucks on expressways is 21.8%.

** The weighted average COV for all trucks on expressways is 34.5% (weighted by average percentage of trucks in each truck class/range).

Table 6-8. Estimation of Systemwide COV

Highway Class	% Truck AVKT	Weighted COV (%)
Expressway	37*	34.5**
Primary Arterials	30	53.9
Secondary Arterials	17	49.7
Collectors	15	44.8
AVG.		44.5

* Trucks constitute 37% of AVKT on Expressways
** For example, the weighted average COV for expressways is 34.5% (obtained from Table 6-7b)

Table 6-9. Truck Weight Sample Size Estimates

Sample Size	Confidence Level	Precision Achieved
304	95%	5%
76	95%	10%
216	90%	5%
54*	90%	10%
132	85%	5%
34	85%	10%

* For example, 54 truck weight sampling sites are required to achieve the 90-10 reliability level.

Table 6-10. Number of Truck Weight Sample Sites per Highway Class

Highway Class	% Truck AVKT	Total Number of Stations	Annual Number of Stations
Expressways	37	20*	7**
Primary Arterials	30	17	6
Secondary Arterials	17	9	3
Collectors	15	8	3

* 20 truck weight sampling sites are required on expressways to achieve the 90-10 reliability level (based on trucks constituting 37% of AVKT on expressways)
** 7 truck weight sampling sites are required on expressways to achieve the 90-10 reliability level over a three-year period

Table 6-11. Priority Rating and Functional Classification of Highway Links Identified for AVC Installation

Priority Rating*	Functional Classification			
	Expressways	Primary Arterials	Secondary Arterials	Collectors
1	5	2	0	0
2	1	2	0	0
3	9	5	2	1
4	0	1	0	0
5	0	6	0	0
6	1	14	3	3
Totals	**16**	**30**	**5**	**4**

* **PRIORITY RATING:**

1 = More than 200 trucks/day; SHRP/C-SHRP site equipped with AVC.

2 = More than 200 trucks/day; ATR equipment could be upgraded to include AVC.

3 = More than 200 trucks/day; no permanent data collection equipment in area.

4 = Less than 200 trucks/day; SHRP/C-SHRP site equipped with AVC.

5 = Less than 200 trucks/day; ATR equipment could be upgraded to include AVC.

6 = Less than 200 trucks/day; no permanent data collection equipment in area.

Chapter 6 - Endnotes

1. Source: "Manitoba Highways Classification Study", MDHT, 1986.

2. Each reporting strata requires approximately the same number of samples. The total sample size is approximated as the number of samples in a stratum times the number of strata [FHWA, 1985].

3. Vehicle fleet characteristics refer to fleet mix and vehicle weights.

4. No seasonal factors were considered in the daily and annual vehicle-kilometres travelled calculations. The values are based strictly on an annual average, assuming constant travel, over a 365-day period.

5. COV is the ratio of the standard deviation to the average percentage of vehicles within each vehicle class. COV represents the variability of each vehicle class on each highway.

6. Only the annual average values were utilized. Ideally, the analysis should separate vehicle percentages by season, which increases the complexity of the analysis.

7. Weighted by average percentage of vehicles in a truck class or range.

8. Weighted by truck AVKT.

9. The Planning Support Branch responsible for the majority of truck data collection and analysis at MDHT intends to utilize the 22-class system currently being drafted by TAC as a uniform vehicle classification system for Canada [Billing, 1992].

10. The majority of RTAC routes are also classified as expressways.

11. Generally, the truck AADT variation within a link does not exceed 30%.

12. Only 17% of the identified links have truck AADT values within +/- 20% of the 200 trucks per day limit. 85% of the links maintain truck AADT values above 240 or below 160.

CHAPTER 7. OBSERVATIONS, CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

The goal of this research was to develop a truck monitoring system for Manitoba. The system is based on the engineering needs for truck data, fundamental principles governing data quality, and available data collection methods.

7.1 Observations and Conclusions

Two main observations were made during this research:

- A general lack of communication regarding the extent of available truck data and information exists between the engineering branches of the Manitoba Department of Highways and Transportation (MDHT). Each engineering branch needs to be informed of the truck information available to avoid data collection duplication.

- The engineers at MDHT were generally not aware of the sensitivity of their functions to the quality of available truck information. Decisions made by an engineering branch with high sensitivity to truck information input are significantly affected by the reliability of the underlying data.

Based on the research, the following conclusions are drawn:

1. Needs for improved truck data and information exist in Manitoba. The truck data collection survey conducted within the MDHT identified that each engineering function requires at least one type of data that is not provided by the existing monitoring program.

2. Understanding the existing truck population is a necessity. A loaded truck has a more negative impact on the infrastructure than a smaller vehicle. Therefore, trucks are recognized as the critical vehicle, particularly in pavement and bridge engineering, and data should be collected accordingly.

3. User needs should shape the truck monitoring program rather than collecting data for the sole purpose of increasing the size of the database. The majority of required data and information can be provided by upgrading and expanding the current vehicle classification program, and including a truck weight monitoring program as technology improves.

4. All required truck data and information should be reported by control section and/or route, rather than by intersection. All engineering functions are concerned with the highway links between intersections, and would benefit from information extrapolated along the links.

5. Turning movement surveys should be eliminated from the annual monitoring program, and only performed on a site-specific basis by request. Most users do not require turning movements, but are interested in the vehicle classification portion of the surveys.

6. Data quality should be given top priority to improve the reliability of the monitoring system. The identified fundamental principles that govern data quality are: data equivalency, truth-in-data, base data integrity, computational consistency, and accuracy and precision levels. The data sources should be included with all published information, and no data generation methods should be used to fill in missing data.

7. The sensitivity analysis performed in Chapter 4 shows that pavement rehabilitation design is sensitive to the quality of truck and traffic data. A difference of +/- 4% in the percentage of trucks can result in a substantial difference of material quantity required to rehabilitate a highway section.

8. The analysis of weigh-in-motion (WIM) technology in Chapter 5 shows that WIM does not reliably reproduce static weights. That is, the average percentage of differences between the dynamic and static axle weights exceeded the differences tolerated by the proposed ASTM standard for WIM. This does not mean that WIM data is useless. Rather, the dynamic influence of a moving vehicle significantly affects the loading at each point along a road. Methods to incorporate the dynamic data must be determined rather than substituting the WIM data for static weights.

9. The automatic vehicle classification (AVC) analysis in Chapter 5 shows that AVC equipment reliably classifies FHWA class 9 trucks (3-S2 trucks). However, the small sample sizes of the remaining truck classes produced inconclusive results regarding AVC's ability to classify trucks other than FHWA class 9.

10. Several analyses were used to design the information system presented in Chapter 6. The results are as follows:

    (a) Truck travel constitutes approximately 10% of all annual vehicle-kilometres travelled (AVKT) in Manitoba.

    (b) 54 highway links were identified as potential permanent AVC monitoring sites. The permanent stations should be placed on RTAC routes, where truck travel accounts for approximately 60% of AVKT. Highest priority should be given to routes with an average truck AADT of 200 trucks per day or more. Seven of the identified links currently have AVC equipment operating at SHRP and C-SHRP sites, and ten others have traffic counters in place that could be upgraded to include AVC capability.

(c) There is a need for a permanent weight monitoring program . However, the high costs and small coverage areas associated with manual truck weight surveys make large-scale truck weight monitoring inefficient. Currently, low-cost WIM technology does not provide weight data comparable to static weights. The SHRP researchers may eventually develop methods to incorporate dynamic weights into design formulae. In the meantime, weight monitoring could be conducted at existing static scale stations to provide some provincial weight data, but the ability of the data to reliably represent the total truck population should be assessed.

(d) Upon implementation of the permanent AVC monitoring program, a vehicle classification sampling program is required to provide supplementary information regarding truck travel on all functional classes of highways. The program is intended to estimate the volume of truck travel, identify links between major truck routes, and remain informed of seasonal variations in truck volumes and classes throughout the entire province. 130 sampling sites per year are recommended to achieve 95% confidence and 10% precision (95-10 reliability level) after three years, based on presently available information. However, the size of the sampling program should be reassessed using the methodology presented in Chapter 6 when information from the permanent AVC sites becomes available.

(e) A system-wide truck weight sampling program is not recommended until a permanent system is implemented, except on a special request basis. Some engineers, particularly pavement designers, could benefit from site-specific truck weight data.

11. The entire truck monitoring program should be periodically reviewed to assess its performance. Changes or modifications should be made as required, such as eliminating certain data types that are not used, or adding additional monitoring sites.

7.2 Recommendations for Further Study

Based on the conclusions and observations, the following recommendations for further study are made:

1. Further monitoring of trucks during industrial seasons, such as logging, agriculture, gravel, and sugar beet hauls. The extent to which these seasonal hauls affect the highways, and the specific routes used for each industry, should be determined.
2. A more detailed sensitivity analysis of pavement design with regards to truck input data should be performed that expands the analysis presented in Chapter 4. The study should consider all factors of pavement design as a function of truck data input.
3. Each engineering function should assess the sensitivity of its activities and decisions to the reliability of truck data. Most engineers were not aware of the specific reliability they require for their functions. However, by assessing the sensitivity of the decisions to truck input data, the monitoring program could provide the optimal reliability levels. Then, the monitoring program will be made more efficient by providing the minimum reliability levels required.
4. The reliability levels and costs of manual data collection methods are not covered in this research. Further assessment is required to compare the manual costs and reliability to those of electronic equipment.

5. Evaluation of all the available electronic monitoring equipment options, such as low-cost WIM and AVC, is required to determine the most efficient and economical alternatives that meet the requirements of data users.

6. The capability of AVC to reliably classify all trucks, especially those with seven or more axles, should be determined. The analysis performed during this research was not conclusive because of the low volume of multi-trailer trucks on PTH #75.

7. Further analysis of WIM data obtained at SHRP sites is required to evaluate the dynamic impact of vehicles on the infrastructure. Since WIM equipment measures the dynamic axle weights, it may provide a more accurate assessment of the actual loading that occurs on the infrastructure. If WIM data can be utilized in design formulae, the infrastructure may provide actual service levels that more closely resemble the projected service levels. However, MDHT should perform their own analyses with the available WIM data collected at SHRP sites.

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APPENDIX A

Figure A-1. PCS Locations in Manitoba.

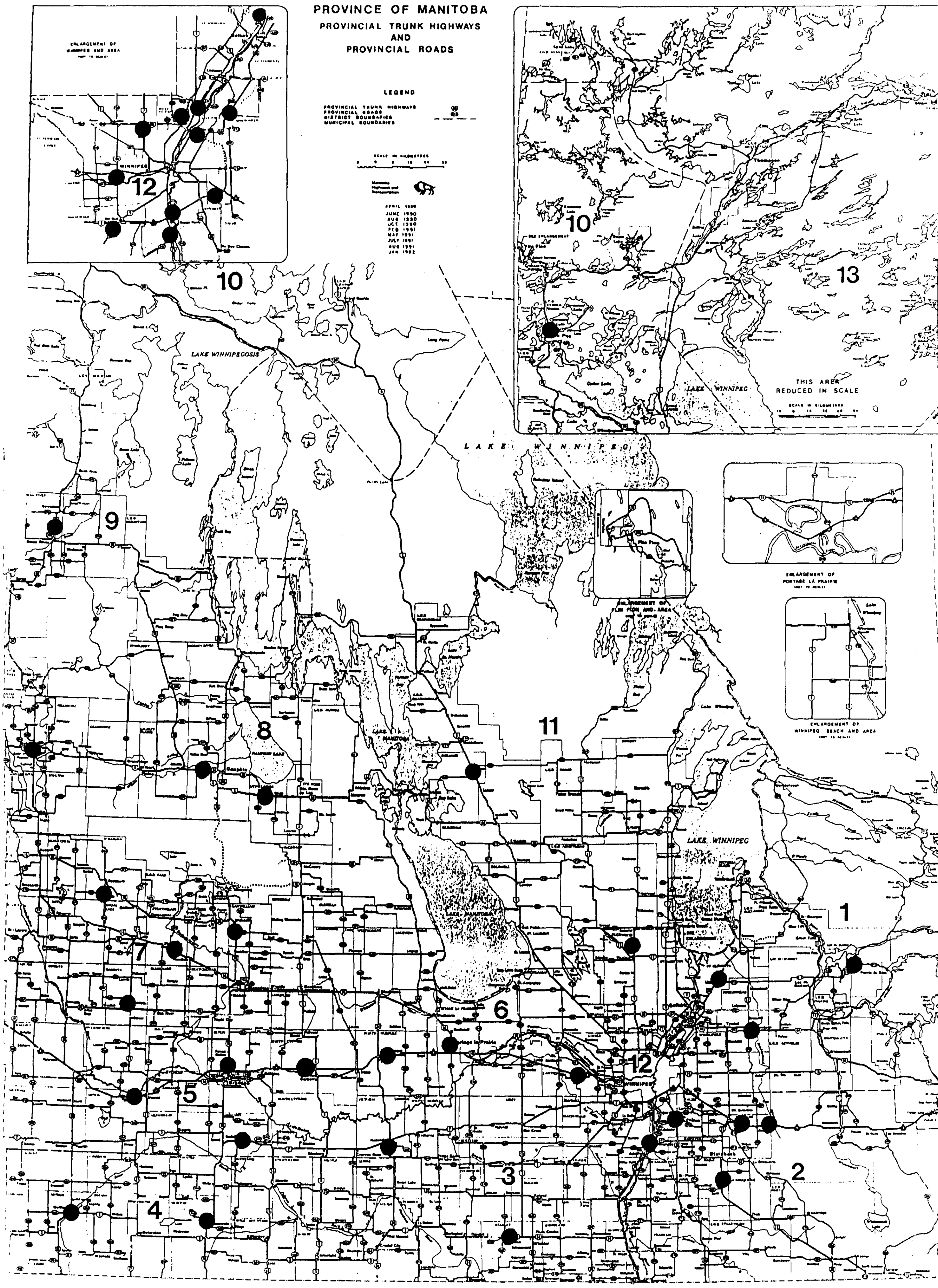

Figure A-2. Licence Plate Survey Field Sheet.

NAME________________________ DIRECTION______________

LOCATION____________________ DATE ______________

STA. NO.	VEH. TYPE	LICENCE NUMBER	TIME 24-HR. CLOCK	SPECIAL COMMODITY
1	2	3 … 8	9 … 12	13
1	2	3 … 8	9 … 12	13

COL. NO.s

STA. NO.	VEH. TYPE	LICENCE NUMBER	TIME 24-HR. CLOCK	SPECIAL COMMODITY
1	2	3 … 8	9 … 12	13
1	2	3 … 8	9 … 12	13

COL. NO.s

NOTES:- FOR VEHICLE TYPES, USE TURNING MOVEMENT FIELD SHEETS AS GUIDE.

COLUMN #2 : BLANK FOR TYPES 1 (CARS), 5 & 6 (BUSES) & 7 (SMALL TRUCKS)

: CODE 'R' IN COLUMN #2 FOR TYPES 2, 3 & 4 (RECREATIONAL VEHICLES)

: CODE 'T' FOR TRUCKS (8 TO 43)

COLUMN #13 : CODE 'H' (HAZARDOUS GOODS) & 'P' (PULP LOGS OR CHIPS)

Figure A-3. Typical Data Summary of Turning Movement and Vehicle Classification Surveys

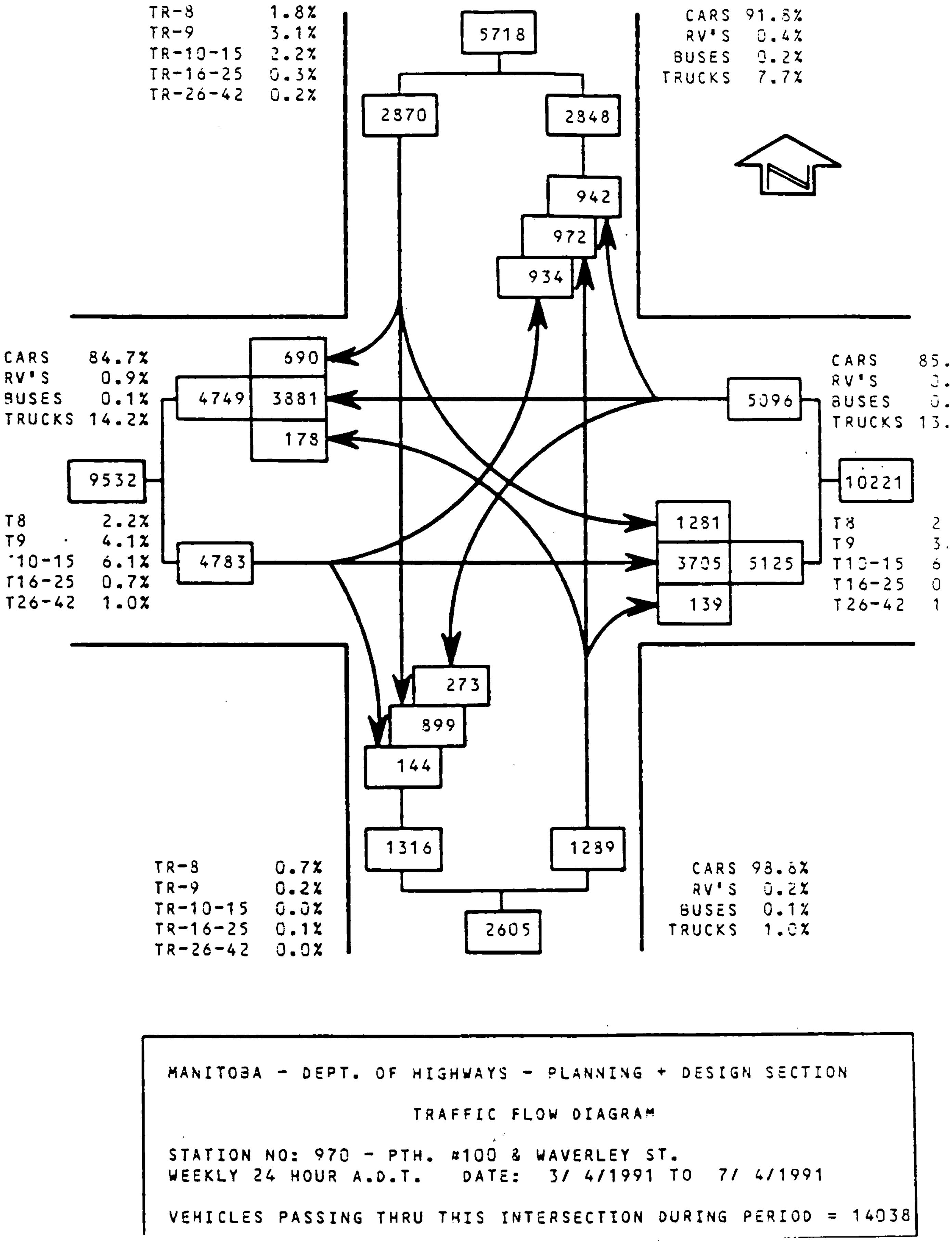

Figure A-4. Manitoba - 44 Vehicle Classification Scheme

Density, Classification and Turning Movement Tally Sheet

Manitoba
Highways and
Transportation
Planning and Design

STA. No. ______ 2-5 LOCATION ______ WEATHER ______

DAY ______ 6-7 MON. ______ 8-9 YR. ______ 10-11 HR. ______ 12-13 SURFACE ______ RECORDER ______

TYPE	VEHICLE SILHOUETTE	W→N	N S	N→E	N E	W→E	E S	S E	N S	W S	W S	W→E	W N
14-15		16 19	20 23	24 27	28 31	32 35	36 39	40 43	44 47	48 51	52 55	56 59	60 63
1													
2													
3													
4	T.C. M.H.												
5	SCH. BUS												
6	COM. BUS												
7	SINGLE REAR TIRE												
8	DUAL REAR TIRE												
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14-15		16 19	20 23	24 27	28 31	32 35	36 39	40 43	44 47	48 51	52 55	56 59	60 63

NOTE:-
KEY PUNCH A IN CC 1, DUP CC 1 - 11

MG-984

Figure A-5. FHWA - 13 Vehicle Classification Scheme

Class	*Description*
1	Motorcycles
2	Passenger Cars
3	Other 2-axle, 4-tire, single unit vehicles
4	Buses
5	Single unit truck, 2 axles, 6 tires
6	Single unit truck, 3 axles
7	Single unit truck, 4 or more axles
8	Single trailer truck, 4 or less axles
9	Single trailer truck, 5 axles
10	Single trailer truck, 6 or more axles
11	Multi-trailer truck, 5 or less axles
12	Multi-trailer truck, 6 axles
13	Multi-trailer truck, 7 axles

Source : FHWA *Traffic Monitoring Guide*

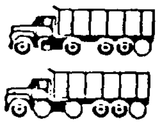
Figure A-6. Manitoba - 15 Vehicle Classification Scheme

Class	*Description*
1	Motorcycles
2	Passenger Cars
3	Other 2-axle, 4-tire, single unit vehicles
4	Buses
5	Single unit truck, 2 axles, 6 tires
6	Single unit truck, 3 axles
7	Single unit truck, 4 or more axles
8	Single trailer truck, 4 or less axles
9	Single trailer truck, 5 axles
10	Single trailer truck, 6 or more axles
11	Multi-trailer truck, 5 or less axles
12	Multi-trailer truck, 6 axles
13	Multi-trailer truck, 7 axles
14	Multi-trailer truck, 8 axles
15	Multi-trailer truck, 9 or more axles

The last two classifications are specific to Manitoba. The standard Scheme F ends with class 13, which includes all multi-trailer trucks with 7 or more axles.

Sources: FHWA *Traffic Monitoring Guide* and Manitoba Department of Highways

Figure A-7. TAC Proposed 22-Class Standardized Vehicle Classification Scheme

Class	Description	Axle Configuration
1	Motorcycle (with trailer)	
2	Car, pickup or light van	
3	Class 2 with trailer	
4	2-axle light truck, tractor or short RV	
5	Class 4 with trailer	
6	Bus or large RV	
7	2-axle single unit truck	
8	3-axle single unit truck or tractor	
9	4+ axle single unit truck	
10	2-axle truck with 1- or 2-axle trailer	
	2-axle tractor with 1- or 2-axle semitrailer	
11	3-axle truck with 1-axle trailer	
	3-axle tractor with 1-axle semitrailer	
12	3-axle tractor with 2-axle semitrailer (3S2)	

Class	Description	Axle Configuration
13	Other 5-axle single trailer combinations	
14	3-axle tractor with 3-axle semitrailer (3S3)	
15	Other 6+ axle single trailer combinations	
16	5-axle double	
17	6-axle double	
18	7- or 8-axle double or triple	
19	6-axle B-train double	
20	7-axle B-train double	
21	8-axle B-train double	
22	9+ axle multi-unit vehicles	
23	For vehicles of special interest to provinces	Must be sub-sets of Classes 1 - 22
24		
25		

NOTE: ⊙ = Axle always present ○ = Axle may be present

SOURCE: Lucas, 1993

Figure A-8. Existing AVC Sites in Manitoba

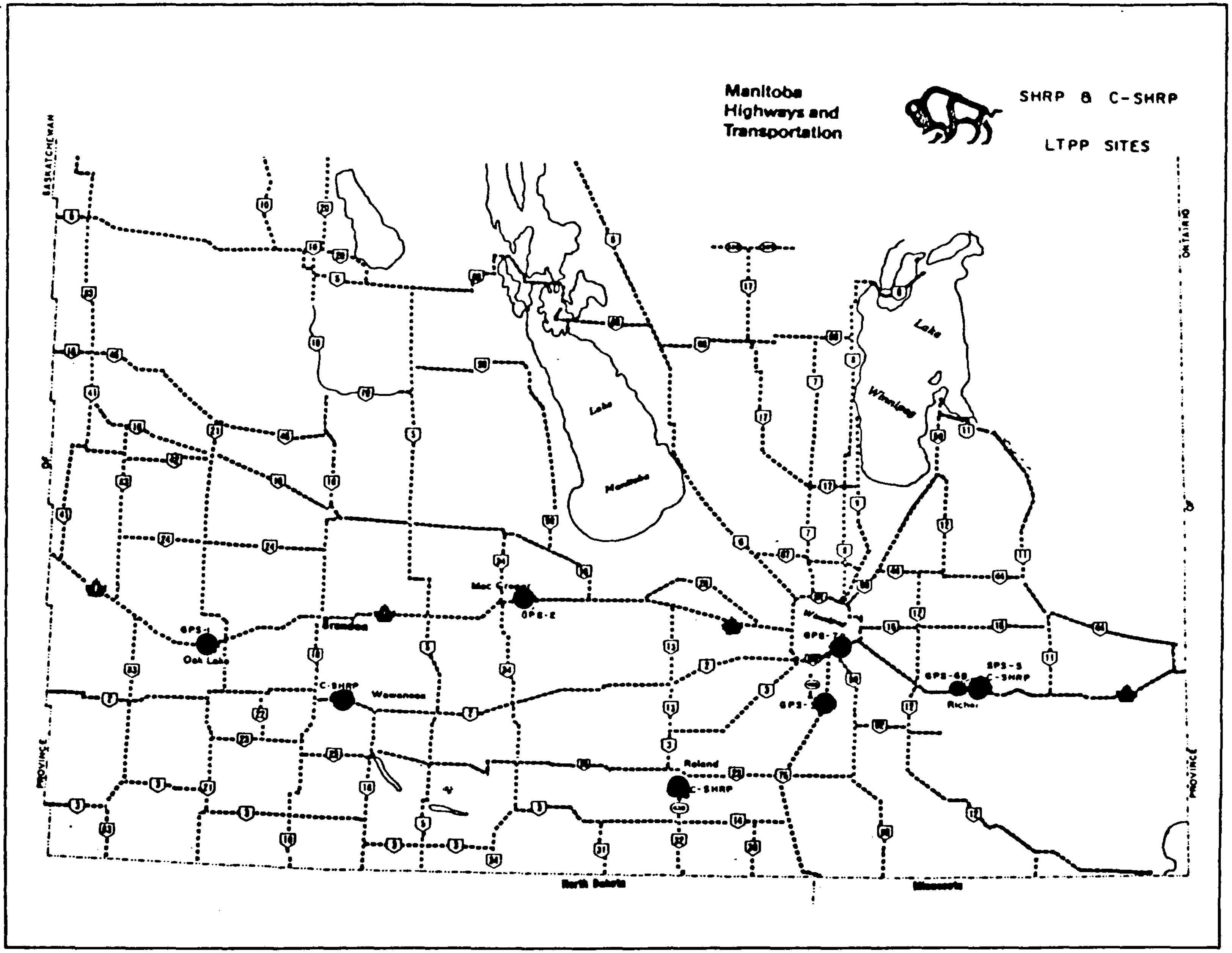


Figure A-9. Equivalent Load Application Calculations

The following calculations were used to evaluate weight data obtained from the historical Truck Weight Surveys:

1. An axle load factor was calculated by using the Shook and Finn Formulae, given by:

   $AXLE\ LOAD\ FACTOR = 10^{(0.12088)*(L-18)}$

   where: L = single (or randem) axle load * 0.581 (kips)

2. The truck load factor was obtained by summing the axle load factors for each truck type and averaging the summation.

3. The Equivalent 18-kip Single Axle Load (ESAL) applications for a one-year period was calculated by using the following:

   $EA_c = AADT * PT/100 * TLF * 365$

   where: EA_c = ESALs for one-year period;
   AADT = average annual daily traffic;
   PT = percent trucks;
   TLF = truck load factor

4. The ESALs for any time period were calculated by using the following:

   $EA_t = (EA_c) * n * [(1+i) * (e^{(n-1)}/i*n)]$

   where: EA_t = ESALs over n years;
   n = period of analysis;
   i = rate of growth

Figure A-10. Typical Example of Traffic Flow Map Publication

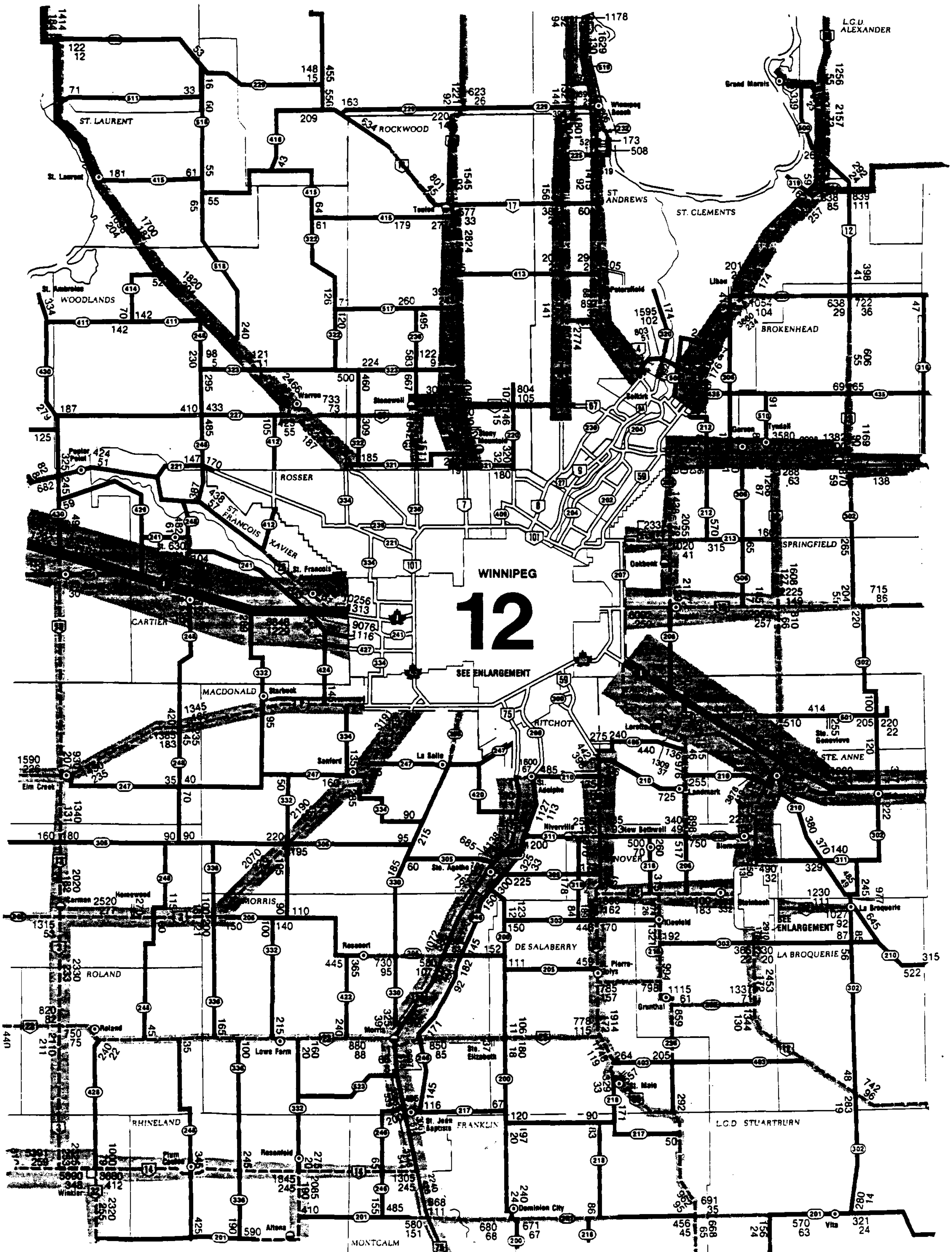


Figure A-11. Typical Example of Traffic Map Statistics Publication

LOCATION OF COUNT	COUNT NO..	AADT	TRUCK %
P.T.H. NO. 1			
WEST OF ONTARIO BDRY. (E.B.)	101	1375	13.9
WEST OF ONTARIO BDRY. (W.B.)	101	1375	13.9
0.5 KM E. OF FALCON LAKE ACCESS	641	2932	13.9
0.5 KM W. OF FALCON LAKE ACCESS	642	3112	13.9
EAST OF P.T.H. #11 (E.B.)	148	1632	13.2
EAST OF P.T.H. #11 (W.B.)	148	1632	13.2
WEST OF P.T.H. #11(E.B.)	146	1581	13.9
WEST OF P.T.H. #11(W.B.)	146	1581	13.9
5.8 KM E. OF P.T.H. #12 (E.B.)	13	1861	13.6
5.8 KM E. OF P.T.H. #12 (W.B.)	13	1920	13.6
WEST OF P.T.H. #12 (E.B.)	144	3139	11.6
WEST OF P.T.H. #12 (W.B.)	144	3139	11.6
E. OF E. JCT. P.T.H. #100 (E.B.)	1925	4109	8.7
E. OF E. JCT. P.T.H. #100 (W.B.)	1925	4109	8.7
W. OF E. JCT. P.T.H. #100 (E.B.)	1924	3432	8.8
W. OF E. JCT. P.T.H. #100 (W.B.)	1924	3432	8.8
W. OF W. JCT. P.T.H. #100 (E.B.)	591	6159	12.4
W. OF W. JCT. P.T.H. #100 (W.B.)	591	6159	12.4
E. OF E. JCT. P.T.H. #26 (E.B.)	592	4409	12.8
E. OF E. JCT. P.T.H. #26 (W.B.)	592	4409	12.8
W. OF E. JCT. P.T.H. #26 (E.B.)	1851	4053	12.3
W. OF E. JCT. P.T.H. #26 (W.B.)	1851	4053	12.3
4.0 KM E. OF P.R. #332 (E.B.)	48	3718	12.6
4.0 KM E. OF P.R. #332 (W.B.)	48	3741	12.6
EAST OF P.T.H. #13 (E.B.)	374	3439	15.1
EAST OF P.T.H. #13 (W.B.)	374	3439	15.1
WEST OF P.T.H. #13 (E.B.)	373	3760	14.8
WEST OF P.T.H. #13 (W.B.)	373	3760	14.8

APPENDIX B

Figure B-1. Truck Data Collection Survey

Please complete prior to May 15, 1991.

Truck Data Collection Survey

Section 1:

This section involves identifying the various truck data needs of your branch. The instructions are as follows:

1. State your name, phone number, title, and branch in the spaces provided.

2. Specify the engineering function (e.g., pavement design, bridge rating, enforcement, etc.) for which you are completing this survey.

3. In column 1, list all data types (from the list on the last two pages) that pertain to your work.

4. In column 2, code the data types, with respect to the stated engineering function, in the following manner:

   0 = not related
   1 = related, not required
   2 = related, very helpful
   3 = essential, required

5. In column 3, state all types of statistical calculations, or other mathematical manipulations, that could be performed on the data to benefit your branch's activities (you need only to expand on the data types coded as "2" or "3").

6. In column 4, state the time frame in which the results from column 3 should be received (i.e., daily, weekly, monthly, annually, seasonally, etc.).

7. In column 5, state the preferred format for the results (i.e., tables, X-Y graphs, etc.)

8. For example:

Data Type	Statistical Calculation	Time Frame for Results	Format
Axle weights	% Distribution by configuration and highway class	Seasonally, annually	Tables
Axle Weights	ESALs by truck type	Seasonally	Tables
Truck Counts	% trucks by highway class	Monthly, annually	Tables

etc.

Section 1

Name: Phone:

Title: Branch:

ENGINEERING FUNCTION:

Data Type	Code	Statistical Calculation	Time Frame	Format

Section 2

Please provide any additional information that may be beneficial to your branch regarding truck data collection in the province (e.g., comments on required truck data accuracy, methods and/or equipment used for truck data collection, quantity/quality of current truck data collection, etc.)

List of Data Types

A. Vehicle Characteristics

1. Overall:

1. axle configuration
2. axle spacings
3. length
4. width
5. height
6. tire type
7. tire size (i.e., radius, width)
8. tire pressure
9. tire combinations (i.e., single, dual, etc.)
10. articulation characteristics
11. acceleration/deceleration ability
12. tare weight
13. aerodynamics

2. Tractor:

14. cab style
15. model year
16. fuel consumed
17. engine size/power
18. suspension type
19. defects

3. Trailer(s):

20. body type
21. suspension type
22. defects

B. **Traffic Flow Characteristics**

23. turning movements
24. speed
25. direction
26. lane used
27. truck counts (volumes)
28. number of truck-related accidents

C. Operational Characteristics

1. Vehicle

29. tractor axle weights (i.e., steering, drive)
30. trailer axle weights (i.e., axle groups - single, tandem, etc.)
31. gross vehicle weight
32. payload weight
33. commodity type
34. origin-destination
35. route used
36. permit status
37. trip length
38. noise
39. overweight status
40. overdimension status
41. ticketable offences

2. Operator

42. valid driver's licence
43. logged hours
44. ownership status
45. driving record

D. **Registration Characteristics**

46. type of licence
47. place of registration
48. carrier name
49. carrier type
50. registered weights
51. registered commodity
52. number of registered trucks
53. number of trucks operating

Figure B-2. Truck Load Factor (TLF) Formulae*

$$TLF = \frac{\Sigma EAL \text{ for all trucks weighed}}{\text{Number of trucks weighed}}$$

$$EAL = (TEF) * (\text{No. of Axles})$$

$$TEF_{(s)} = (\text{Single Axle Load}/8000 \text{ kg})^4$$

$$TEF_{(ta)} = (\text{Tandem Axle Load}/13000 \text{ kg})^4$$

$$TEF_{(tr)} = (\text{Tridem Axle Load}/17500 \text{ kg})^4$$

where:

TLF = truck load factor;

EAL = equivalent axle load for each type of axle (single, tandem, tridem);

TEF = traffic equivalency factor for each range of axle loads;

$TEF_{(s)}$ = single axle equivalency factor;

$TEF_{(ta)}$ = tandem axle equivalency factor;

$TEF_{(tr)}$ = tridem axle equivalency factor.

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* Taken from: AASHTO Guide for Design of Pavement Structures, 1986.

Figure B-3. Average TLFs Used in Manitoba*

Highway Classification	Highway Class Definition	Average TLF
RTAC	Routes allowing RTAC trucks, as specified in the Manitoba Weight Policy [1990];	1.5
A1	Standard PTH classification, except when designated as RTAC. Some PR's are also designated as A1;	1.3
B1	All PR's not designated as RTAC routes or Class A1 highways;	1.0
Residential	Non-regulatory designation inserted for Pavement Design purposes to define highways which may have very little truck traffic;	0.8
Special Truck Haul Routes	Specific highways that have a known amount or type of truck traffic; the TEF is based on the actual or projected truck haul scenario.	

* Taken from: MDHT *Pavement Policy Strategy and Design Manual*, 1990.

Figure B-4. ESAL Formulae*

ESALD = AADT (%TKS/100) (DLF) (TLF)

ESALA = AADT (%TKS/100) (DLF) (TLF) (365)

where:

ESALD = daily equivalent single axle applications in the design lane, based on a single axle, dual wheel load of 8,165 kg;

ESALA = annual equivalent single axle applications in the design lane, based on a single axle, dual wheel load of 8,165 kg;

AADT = average annual daily traffic, both directions, in year 1;

%TKS = percent of AADT which are trucks;

TLF = average truck load factor;

DLF = design lane factor, based on the following table:

Configuration	AADT	DLF
two-lane highway	two-way	0.5
four-lane highway	two-way	0.4
four-lane highway	one-way	0.8

* Taken from: MDHT *Pavement Policy Strategy and Design Manual*, 1990.

Figure B-5. Accumulated ESAL Formulae*

ACCESAL = (AADT) (%TKS/100) (DLF) (TLF) (AAF)

where:

ACCESAL = accumulated ESAL applications for n years, based on a single axle, dual wheel load of 8,165 kg;

AAF = amount of annuity factor: $([(1 + r) - 1]^{n})/r$

r = rate of ESAL growth (%).

The growth rates are considered to be as follows:

Highway Class	ESAL GROWTH RATE[1]	AADT GROWTH RATE[2]
RTAC	2.0 X AADT GRTH RATE	3.0
A1	1.5 X AADT GRTH RATE	2.5
B1	AADT GRTH RATE	2.0
RESIDENTIAL	AADT GRTH RATE	1.0

1. Default ESAL Growth Rate Values until appropriate traffic studies are conducted;
2. Default AADT Growth Rate Values when valid information is not available.

* Taken from: MDHT *Pavement Policy Strategy and Design Manual*, 1990.

Figure B-6. Deflection Formulae*

$$BBRD = 10^{(1.80618 - 0.30103 \log ACCESAL)}$$

where:

BBRD = Benkelman Beam Rebound Deflection - used to design pavement and asses pavement performance;

ACCESAL = the projected accumulated ESAL for the design period.

Figure B-7. Pavement Overlay Thickness Equation*

$$TEB = 889 + \log \frac{\frac{0.369}{0.0394-0.01}+3.493}{\frac{0.369}{0.394\ BBRE - 0.01}+3.493}$$

where:

TEB = thickness of an equivalent granular base course overlay required to strengthen flexible pavement (measured in mm);

BBRD = the design Benkelman Beam Rebound, mm;

BBRE = the existing Benkelman Beam Rebound, mm.

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*Taken from: MDHT *Pavement Policy Strategy and Design Manual*, 1990.

APPENDIX C

Table C-1. Design used for Pavement Rehabilitation of PR#200, 1989

1990 Pre Inventory Data, AST, 2-way Undivided District 2					Traffic Data			Pavement Data					B1 Loading		
Control Section	km Start	km End	Total km	Description	1989 AADT	20-yr AADT 2% GTH	1989 %TKS	Potential Increase/ (Decrease) in % TKS	Surfacing Year	1990 PCR	Exist. BBR (mm)	Max Spring Restrict Level (kg/mm)	Accessal (TF=1.0)	Design BBRD	Equiv. Base Thick (mm)
02 200 1	1.4	2.6	1.2	DOMINION ST TO RR XING (EMERSON)	230	356	10.0	YES	78	74	4.0	6.0	106120	1.96	156
02 200 1	2.6	19.5	16.9	RR XING (EMERSON) TO PR 201	225	348	9.8	YES	82	70	4.0	6.0	101506	1.99	152
02 200 2	0.0	1.0	1.0	PR 201 TO RR XING (DOMINION CITY)	213	329	9.9	YES	68		3.0	6.0	96892	2.02	94
02 200 2	0.9	1.8	0.9	RR XING TO HUNTER ST (DOMINION CITY)	200	309	10.0	YES	74		3.0	6.0	92278	2.05	90
02 200 2	1.8	14.0	12.2	HUNTER ST (DOMINION CITY) TO S JCT PR 217	183	283	9.8	YES	88	86	3.0	6.0	83050	2.12	81
02 200 2	14.0	25.7	11.7	S JCN PR 217 TO TH 23	150	232	10.0	YES	86	71	3.0	6.0	69209	2.23	67
02 200 4	6.0	12.0	6.0	PR 305 TO PR 311	295	456	9.8	YES	80	52	2.9	6.0	133804	1.83	113
02 200 4	12.0	19.8	7.8	PR 311 TO 0.6 KM S OF PR 210	1100	1701	10.0	YES	80	52	2.9	6.0	507531	1.23	241
	Total km		57.7												

Note: Shaded area indicates portion of Highway #200 used for analysis in Chapter 4, Section 4.5

APPENDIX D

FIGURES

Figure D-1. General Location Map of Glenlea SHRP Site

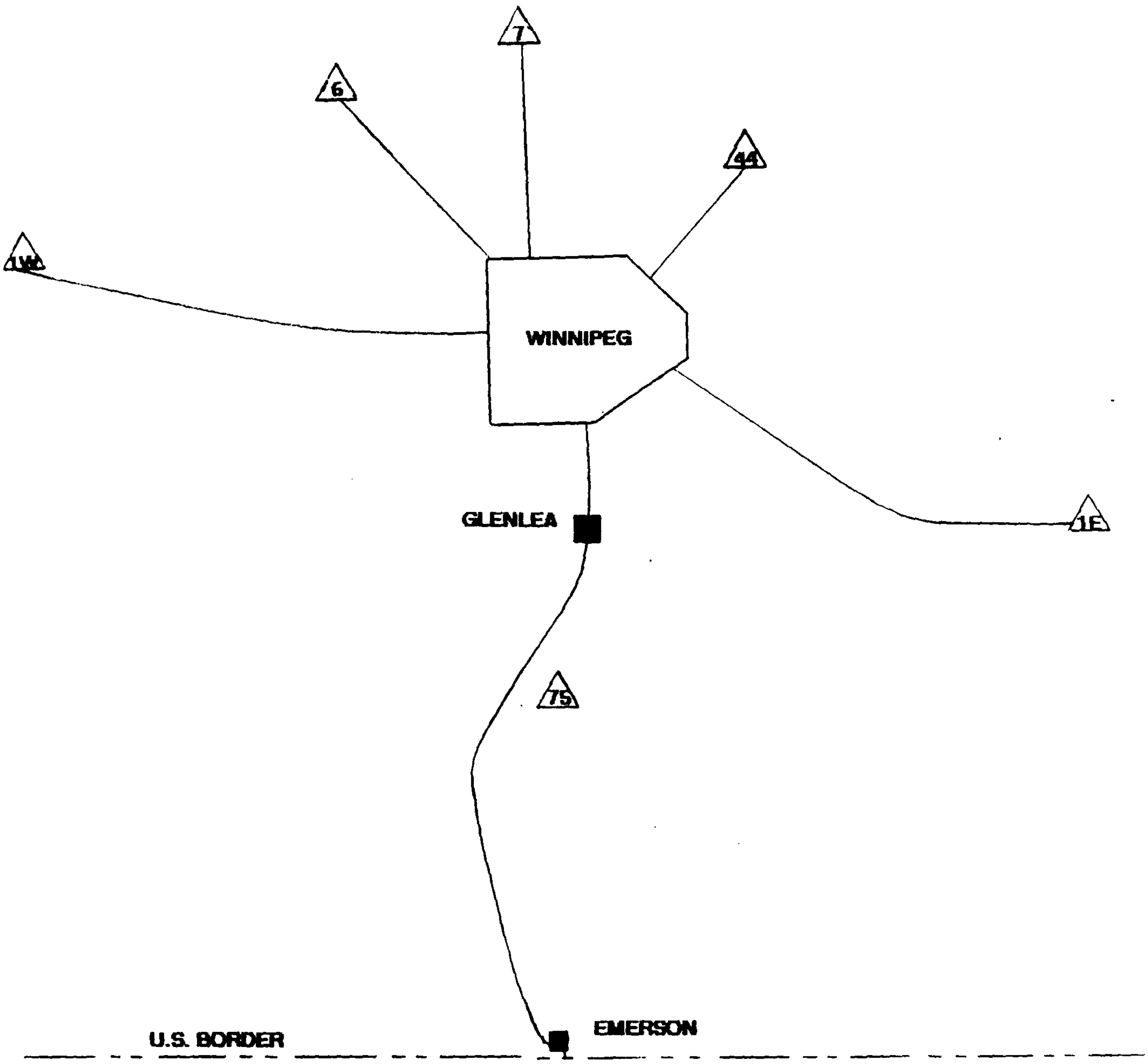


Figure D-2. Glenlea SHRP Site

SHRP# 833802

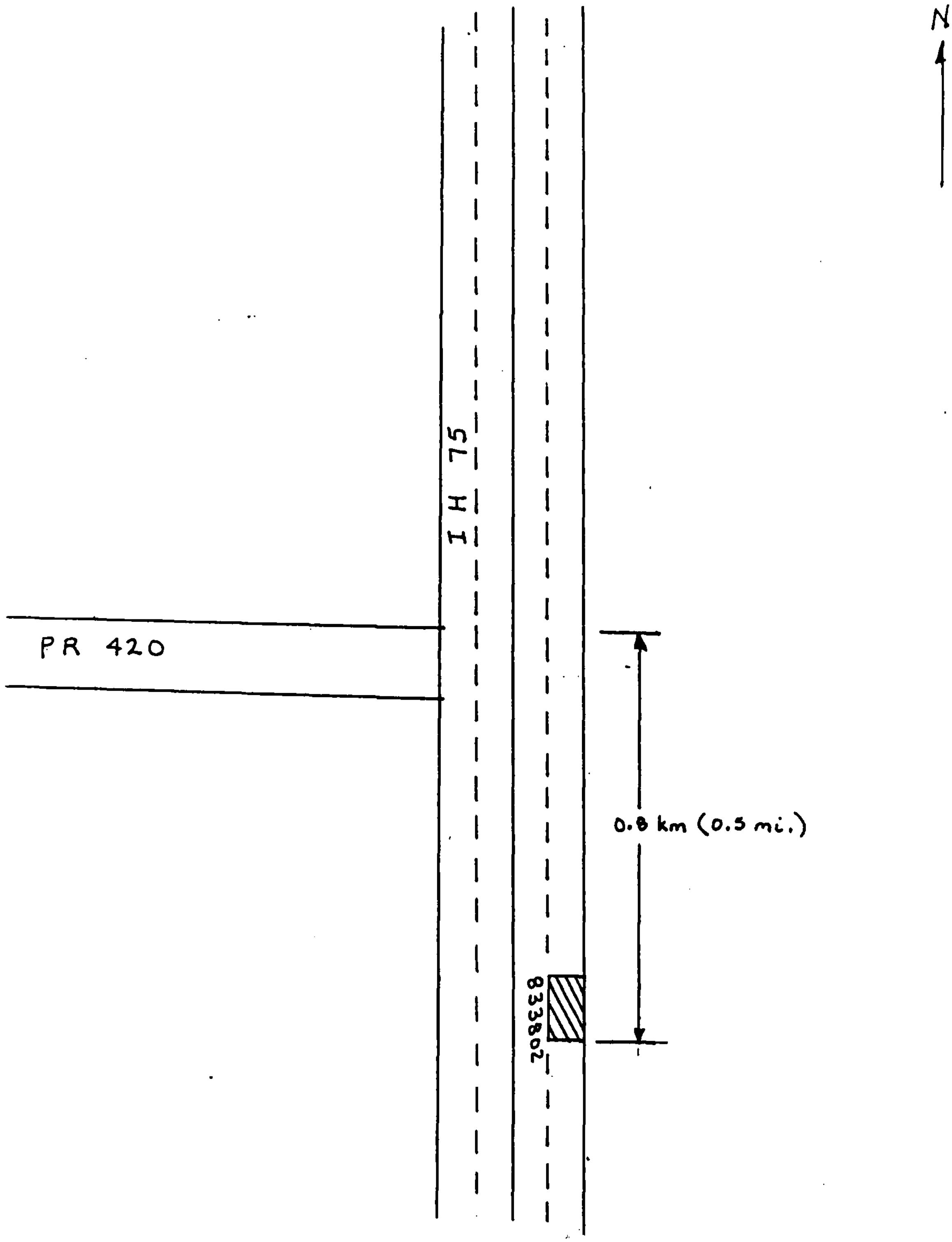
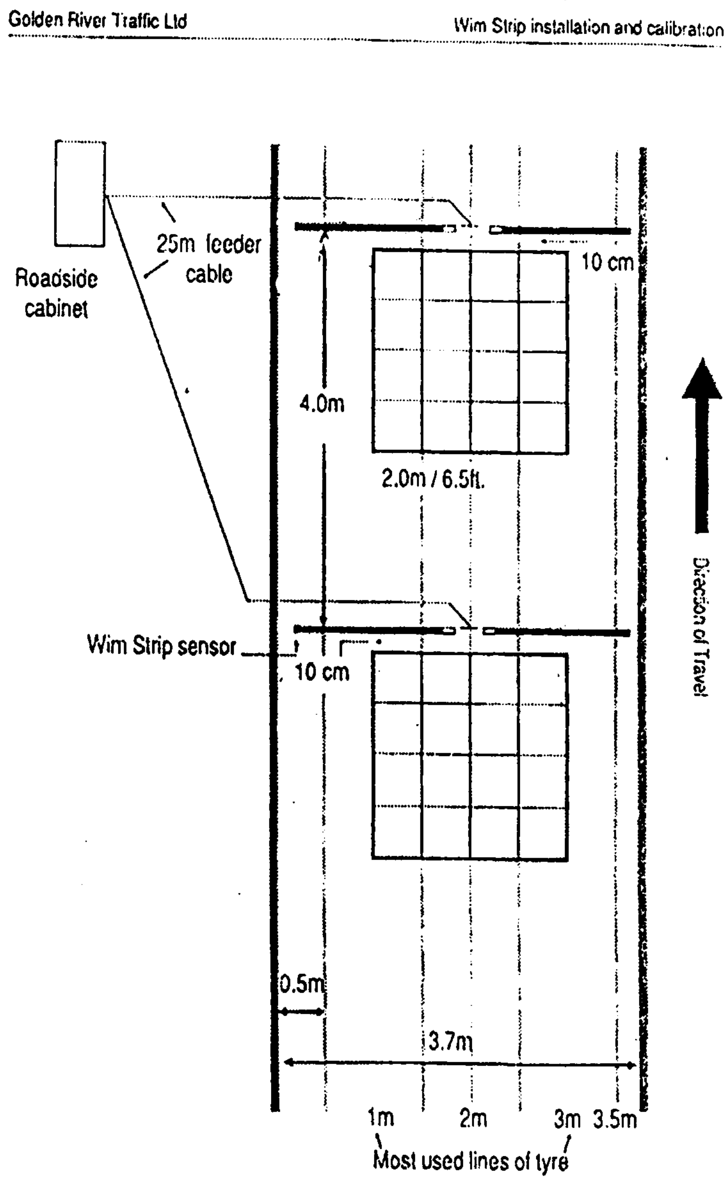


Figure D-3. Sensor Array Layout



Typical sensor array layout

Source: Golden River WIM Strip Sensor Manual Golden River Corporation, 1990

Figure D-4. Test for Equality of Variances

The test used for the analysis is taken from Neter et al., pp. 18 - 19 [Neter et al., 1985].

The alternatives are:

$H_0 : \sigma_1 = \sigma_2$

$H_a : \sigma_1 \neq \sigma_2$

The decision rule is:

If: $F(\alpha/2; n_1\text{-}1, n_2\text{-}1) < \frac{s_1}{s_2} < F(1\text{-}\alpha/2; n_1\text{-}1, n_2\text{-}1)$:

conclude H_0;

otherwise, conclude H_a.

1. <u>Equality of Variances for Single Axle Data:</u>

Assuming 95% confidence:

$\alpha = 0.05$ $\quad n_1 = 93$

$\alpha/2 = 0.025$ $\quad n_2 = 102$

$1 - \alpha/2 = 0.975$

$$F(0.025; 92, 101) = \frac{1}{F(0.975; 101, 92)} = \frac{1}{1.52} = 0.66$$

$F(0.975; 92, 101) = 1.50$

The decision rule is:

If $0.66 < \frac{s_1}{s_2} < 1.50$, conclude H_0; otherwise, conclude H_a.

Since $\frac{s_1}{s_2} = \frac{239.5}{141.7} = 1.69$, conclude H_a.

Therefore, the variances are not equal at the 95% confidence level.

2. Equality of Variances for the Tandem Axle Data:

Assuming 95% confidence:

$\alpha = 0.05$ $n_1 = 165$
$\alpha/2 = 0.025$ $n_2 = 194$
$1 - \alpha/2 = 0.975$

$$F(0.025; 164, 193) = \frac{1}{F(0.975; 193, 164)} = \frac{1}{1.41} = 0.71$$

$F(0.975; 164, 193) = 1.41$

The decision rule is:

If $0.71 < \frac{s_1}{s_2} < 1.41$, conclude H_0; otherwise, conclude H_a.

Since $\frac{s_1}{s_2} = \frac{272.3}{185.6} = 1.47$, conclude H_a.

Therefore, the variances are not equal at the 95% confidence level.

3. Equality of Variances of Gross Vehicle Weight Data:

Assuming 95% confidence:

$\alpha = 0.05$ $n_1 = 82$
$\alpha/2 = 0.025$ $n_2 = 98$
$1 - \alpha/2 = 0.975$

$$F(0.025; 81, 97) = \frac{1}{F(0.975; 97, 81)} = \frac{1}{1.56} = 0.64$$

$F(0.975; 81, 97) = 1.55$

The decision rule is:

If $0.64 < \frac{s_1}{s_2} < 1.55$, conclude H_0; otherwise, conclude H_a.

Since $\frac{s_1}{s_2} = \frac{232.5}{150.7} = 1.55$, conclude H_0.

Therefore, the variances are equal at the 95% confidence level. However, the test statistic is equal to the upper limit of the allowable range. Caution is advised against immediately concluding that the data sets should be combined, since the other data sets resulted in the opposite conclusion.

APPENDIX D

TABLES

Table D-1. Truck Weights Used for WIM Data Analysis (Calibration Factors = average of front and rear wheels)

		Static Weights			Dynamic Weights		
Veh. No.	Veh. Class	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)
1	8	3270	-	14880	3450	-	15160
		6880			6260		
		4730			5450		
2	9	5170	14650	34360	5690	15780	36920
			14540			15450	
3	12	4480	11850	32420	4660	14300	35500
		6980			7440		
		5330			5420		
		3780			3680		
4	9	4970	12530	28650	5420	14750	26120
			11150			11370	
5	9	5190	14310	36370	5810	16720	37720
			16870			15190	
6	9	4750	15390	35440	5080	16600	38360
			15300			16680	
7	9	4850	10250	27260	5440	11790	30630
			12160			13400	
8	9	5010	14810	34520	5650	17790	39920
			14700			16480	
9	9	4790	14860	34480	5050	16130	36840
			14830			15660	
10	9	5140	15360	34660	5310	17880	38840
			14160			15650	
11	9	5290	12970	31240	5390	15260	34060
			12980			13410	
12	9	5110	15410	35980	5480	18450	41800
			15460			17870	
13	9	4230	14980	34050	4700	13460	34250
			14840			16090	
14	13	4360	11010	-	4400	13560	49990
			10460			11840	
			-			11220	
			9870			8970	
15	9	5220	12820	28000	4800	8990	18300
			9960			4510	
16	9	5190	11960	24270	5290	14000	27070
			7120			7780	
17	8	1790	3300	7830	1780	3590	8280
		2740			2910		
18	9	5490	15190	35880	3990	13240	30330
			15200			13100	
19	9	4780	14460	32680	4820	17690	38420
			13440			15910	
20	9	4820	15310	31130	1950	11550	20440
			11000			6940	

Table D-1. Truck Weights Used for WIM Data Analysis (continued)
(Calibration Factors = average of front and rear wheels)

		Static Weights			Dynamic Weights		
Veh. No.	Veh. Class	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)
21	9	5310	12210	27800	5160	15110	31180
			10280			10920	
22	12	4960	9840	34700	3320	7990	29840
		6820			6290		
		6990			7300		
		6090			4940		
23	9	4730	10790	25640	2980	7920	18300
			10120			7400	
24	9	5140	14470	32360	5680	17300	37650
			12750			14650	
25	9	5000	15960	36410	5770	17010	40990
			15450			18210	
26	9	4670	8720	20430	5140	9820	21550
			7040			6600	
27	9	4910	9270	23330	5020	9820	24520
			9150			9670	
28	9	4680	14920	33590	4270	16890	
			13990			15420	
29	13	5140	14740	44130	5360	18220	50310
			14180			16170	
			10070			10560	
30	9	4850	13520	27850	5920	16420	33720
			9480			11380	
31	9	4950	10370	25330	4120	11400	27790
			10010			12270	
32	9	4530	12170	28390	4410	11340	24580
			11690			8850	
33	9	4430	12000	29290	1630	8040	17940
			12860			8280	
34	9	5270	14960	34880	4260	14980	34140
			14650			14890	
35	9	5150	7850	19180	3560	7110	15650
			6180			4980	
36	9	4880	11250	27630	5420	12610	31900
			11500			13870	
37	9	4970	10650	23220	5470	11610	25870
			7600			8800	
38	9	5040	7690	19180	5740	7720	18890
			6450			5430	
39	9	4640	7680	16910	4830	9200	19520
			4590			5490	
40	9	4520	10100	21920	2290	7430	14250
			7300			4520	

Table D-1. Truck Weights Used for WIM Data Analysis (continued)
(Calibration Factors = average of front and rear wheels)

		Static Weights			Dynamic Weights		
Veh. No.	Veh. Class	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)
41	9	5390	11680	30390	2980	8830	23240
			13320			11440	
42	9	5730	15330	35650	3460	11720	28700
			14590			13520	
43	9	4440	16490	36510	4550	22190	43750
			15580			17020	
44	9	4380	5830	15180	4420	7150	17350
			4970			5790	
45	9	5430	14600	33940	6190	18010	38950
			13910			14760	
46	9	5270	14960	35100	6330	14650	36000
			14870			15030	
47	9	4450	12870	27250	4240	12220	27440
			9930			10990	
48	9	5310	15240	35910	4570	14170	35890
			15360			17150	
49	9	4370	15330	34700	4700	19030	40290
			15000			16560	
50	9	4810	7780	19760	5080	6830	17970
			7170			6060	
51	9	4440	16490	36510	4550	22190	43750
			15580			17020	
52	9	4380	5830	15180	4420	7150	17350
			4970			5790	
53	9	5430	14600	33940	6190	18010	38950
			13910			14760	
54	9	5270	14960	35100	6330	14650	36000
			14870			15030	
55	9	4450	12870	27250	4240	12220	27440
			9930			10990	
56	9	5310	15240	35910	4570	14170	35890
			15360			17150	
57	9	4370	15330	34700	4700	19030	40290
			15000			16560	
58	9	4810	7780	19760	5080	6830	17970
			7170			6060	
59	9	5570	10540	22460	6200	12330	30870
			11920			12340	
60	9	5630	-	-	5960	17070	40330
			15720			17300	

Table D-1. Truck Weights Used for WIM Data Analysis (continued) (Calibration Factors = average of front and rear wheels)

		Static Weights			Dynamic Weights		
Veh. No.	Veh. Class	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)
61	9	4740	13640	30870	4840	15100	33100
			12490			13150	
62	9	4380	7980	17510	4560	9170	18700
			5150			4990	
63	9	5140	16070	37230	4560	18990	42690
			16020			19130	
64	9	5020	15390	34590	5090	16580	36120
			14180			14440	
65	9	5080	12900	28940	5140	14690	31200
			10960			11360	
66	9	5130	15430	35900	5490	18310	39630
			15340			15820	
67	9	5000	14470	32530	5550	15420	35070
			13060			14110	
68	9	4860	15370	35450	5130	17510	40080
			15220			17440	
69	9	4270	12620	35850	4290	11060	25240
			8960			9890	
70	9	5360	15300	34380	4200	7810	20280
			13720			8260	
71	9	4650	9400	22360	4800	9970	23760
			8310			8980	
72	9	5010	8700	21820	3880	9540	21750
			8110			8330	
73	9	4850	15190	35100	5380	16690	35730
			15060			13660	
74	9	5590	14780	35510	3390	11440	27610
			15140			12770	
75	9	5510	15320	35910	3370	15630	31560
			15080			12550	
76	9	4990	15730	35330	2830	12490	25650
			14610			10340	
77	9	-	11320	-	2350	8980	18230
			10140			6900	
78	9	4550	15100	34470	2730	13920	29590
			14820			12940	
79	10	5240	13560	32970	6120	14850	35680
			14170			14980	
			(Tridem)			(Tridem)	
80	9	4890	8400	20860	4980	10880	24320
			7570			8460	

Table D-1. Truck Weights Used for WIM Data Analysis (continued)
(Calibration Factors = average of front and rear wheels)

		Static Weights			Dynamic Weights		
Veh. No.	Veh. Class	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)
81	9	5200	14390	32770	5820	15870	39140
			13180			17450	
82	9	5070	15130	34370	5790	18950	42450
			14170			17710	
83	9	4760	5850	14830	5420	7020	18230
			4220			5790	
84	9	5530	14600	35280	6350	17650	41180
			15150			17180	
85	9	5070	15390	36130	5190	18800	41220
			15670			17220	

Table D-2. Single Axles - Static vs. Dynamic weight (Calibration Factors = front and rear wheels)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
1	3270	3450	180	6
	6880	6260	-620	-9
	4730	5450	720	15
2	5170	5690	520	10
3	4480	4660	180	4
4	4970	5420	450	9
5	5190	5810	620	12
6	4750	5080	330	7
7	4850	5440	590	12
8	5010	5650	640	13
9	4790	5050	260	5
10	5140	5310	170	3
11	5290	5390	100	2
12	5110	5480	370	7
13	4230	4700	470	11
14	4360	4400	40	1
15	5220	4800	-420	-8
16	5190	5290	100	2
17	1790	1780	-10	-1
	2740	2910	170	6
18	5490	3990	-1500	-27
19	4780	4820	40	1
21	5310	5160	-150	-3
22	4960	3320	-1640	-33
	6820	6290	-530	-8
	6990	7300	310	4
	6090	4940	-1150	-19
23	4730	2980	-1750	-37
24	5140	5680	540	11
25	5000	5770	770	15
26	4670	5140	470	10
27	4910	5020	110	2
28	4680	4270	-410	-9
29	5140	5360	220	4
30	4850	5920	1070	22
31	4950	4120	-830	-17
32	4530	4410	-120	-3
33	5270	4260	-1010	-19
34	5150	3560	-1590	-31
35	4880	5420	540	11
36	4970	5470	500	10
37	5040	5740	700	14
38	4640	4830	190	4

* D = Dynamic Weight - Static Weight

** PD = ((Dynamic Weight - Static Weight)/Static Weight) * 100%

Table D-2. Single Axles - Static vs. Dynamic Weight (cont'd)
(Calibration Factors = Front and rear wheels)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
39	4440	4550	110	2
40	4380	4420	40	1
41	5430	6190	760	14
42	5270	6330	1060	20
43	4450	4240	-210	-5
44	5310	4570	-740	-14
45	4370	4700	330	8
46	4810	5080	270	6
47	5570	6200	630	11
48	5630	5960	330	6
49	4740	4840	100	2
50	4380	4560	180	4
51	5140	4560	-580	-11
52	5020	5090	70	1
53	5080	5140	60	1
54	5130	5490	360	7
55	5000	5550	550	11
56	4860	5130	270	6
57	4270	4290	20	0
58	5360	4200	-1160	-22
59	4650	4800	150	3
60	5010	3880	-1130	-23
61	4850	5380	530	11
62	5590	3390	-2200	-39
63	5510	3370	-2140	-39
64	4990	2830	-2160	-43
65	4550	2730	-1820	-40
66	5240	6120	880	17
67	4890	4980	90	2
68	5200	5820	620	12
69	5070	5790	720	14
70	4760	5420	660	14
71	5530	6350	820	15
72	5070	5190	120	2
Totals	**381700**	**378930**		-33

Table D-3. Statistical Inferences from Single Axle Data

Statistical Inference	Value
Average percent difference , PD (%)	-0.4
Sample variance	239.51
Sample standard deviation (%)	15.48
Mean static weight (kg)	4957
Mean dynamic weight (kg)	4921
Mean of absolute differences (%)	11
95% confidence interval (%)	-30.8 to 29.9

Table D-4. Tandem Axles - Static vs. Dynamic Weights (Calibration Factors = front and rear wheels)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
1	16490	22190	5700	35
	15580	17020	1440	9
2	5830	7150	1320	23
	4970	5790	820	16
3	14600	18010	3410	23
	13910	14760	850	6
4	14960	14650	-310	-2
	14870	15030	160	1
5	12870	12220	-650	-5
	9930	10990	1060	11
6	15240	14170	-1070	-7
	15360	17150	1790	12
7	15330	19030	3700	24
	15000	16560	1560	10
8	7780	6830	-950	-12
	7170	6060	-1110	-15
9	10540	12330	1790	17
	11920	12340	420	4
10	15720	17300	1580	10
11	13640	15100	1460	11
	12490	13150	660	5
12	7980	9170	1190	15
	5150	4990	-160	-3
13	16070	18990	2920	18
	16020	19130	3110	19
14	15390	16580	1190	8
	14180	14440	260	2
15	12900	14690	1790	14
	10960	11360	400	4
16	15430	18310	2880	19
	15340	15820	480	3
17	14470	15420	950	7
	13060	14110	1050	8
18	15370	17510	2140	14
	15220	17440	2220	15
19	12620	11060	-1560	-12
	8960	9890	930	10
21	9400	9970	570	6
	8310	8980	670	8
22	8700	9540	840	10
	8110	8330	220	3
23	15190	16690	1500	10
	15060	13660	-1400	-9

* D = Dynamic Weight - Static Weight

** PD = ((Dynamic Weight - Static Weight)/Static Weight) * 100%

Table D-4. Tandem Axles - Static vs. Dynamic Weights (Calibration Factors = front and rear wheels)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
24	14780	11440	-3340	-23
	15140	12770	-2370	-16
25	15320	15630	310	2
	15080	12550	-2530	-17
26	15730	12490	-3240	-21
	14610	10340	-4270	-29
27	11320	8980	-2340	-21
	10140	6900	-3240	-32
28	15100	13920	-1180	-8
	14820	12940	-1880	-13
29	13560	14580	1020	8
30	8400	10880	2480	30
	7570	8460	890	12
31	14390	15870	1480	10
	13180	17450	4270	32
32	15130	18950	3820	25
	14170	17710	3540	25
33	5850	7020	1170	20
	4220	5790	1570	37
34	14600	17650	3050	21
	15150	17180	2030	13
35	15390	18800	3410	22
	15670	17220	1550	10
36	14650	15780	1130	8
	14540	15450	910	6
37	11850	14300	2450	21
38	12530	14750	2220	18
	11150	11370	220	2
39	14310	16720	2410	17
	16870	15190	-1680	-10
40	15390	16600	1210	8
	15300	16680	1380	9
41	10250	11790	1540	15
	12160	13400	1240	10
42	14810	17790	2980	20
	14700	16480	1780	12
43	14860	16130	1270	9
	14830	15660	830	6
44	15360	17880	2520	16
	14160	15650	1490	11
45	12970	15260	2290	18
	12980	13410	430	3

Table D-4. Tandem Axles - Static vs. Dynamic Weights (Calibration Factors = front and rear wheels)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
46	15410	18450	3040	20
	15460	17870	2410	16
47	14980	13460	-1520	-10
	14840	16090	1250	8
48	11010	13560	2550	23
	10460	11840	1380	13
	9870	8970	-900	-9
49	12820	8990	-3830	-30
50	11960	14000	2040	17
	7120	7780	660	9
51	3300	3590	290	9
52	15190	13240	-1950	-13
	15200	13100	-2100	-14
53	14460	17690	3230	22
	13440	15910	2470	18
54	15310	11550	-3760	-25
	11000	6940	-4060	-37
55	12210	15110	2900	24
	10280	10920	640	6
56	9840	7990	-1850	-19
57	10790	7920	-2870	-27
	10120	7400	-2720	-27
58	14470	17300	2830	20
	12750	14650	1900	15
59	15960	17010	1050	7
	15450	18210	2760	18
60	8720	9820	1100	13
	7040	6600	-440	-6
61	9270	9820	550	6
	9150	9670	520	6
62	14920	16890	1970	13
	13990	15420	1430	10
63	14740	18220	3480	24
	14180	16170	1990	14
64	13520	16420	2900	21
	9480	11380	1900	20
65	10370	11400	1030	10
	10010	12270	2260	23
66	12170	11340	-830	-7
	11690	8850	-2840	-24

Table D-4. Tandem Axles - Static vs. Dynamic Weights (Calibration Factors = front and rear wheels)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
67	12000	8040	-3960	-33
	12860	8280	-4580	-36
68	14960	14980	20	0
	14650	14890	240	2
69	7850	7110	-740	-9
	6180	4980	-1200	-19
70	11250	12610	1360	12
	11500	13870	2370	21
71	10650	11610	960	9
	7600	8800	1200	16
72	7690	7720	30	0
	6450	5430	-1020	-16
73	7680	9200	1520	20
	4590	5490	900	20
74	10100	7430	-2670	-26
	7300	4520	-2780	-38
75	11680	8830	-2850	-24
	13320	11440	-1880	-14
76	15330	11720	-3610	-24
	14590	13520	-1070	-7
Totals	1792260	1874000		638

Table D-5. Statistical Inferences from Tandem Axle Data

Statistical inference	Value
Average percent difference, PD (%)	4.4
Sample Variance	272.33
Sample standard deviation	16.50
Mean static weight (kg)	12360
Mean dynamic weight (kg)	12924
Mean of absolute differences (%)	14.72
95% confidence interval	-28.0 to 36.7

Table D-6. Gross Vehicle Weight - Static vs. Dynamic Weight (Calibration Factors = front and rear wheels)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
1	14880	15160	280	2
2	34360	36920	2560	7
3	32420	35500	3080	10
4	28650	26120	-2530	-9
5	36370	37720	1350	4
6	35440	38360	2920	8
7	27260	30630	3370	12
8	34520	39920	5400	16
9	34480	36840	2360	7
10	34660	38840	4180	12
11	31240	34060	2820	9
12	35980	41800	5820	16
13	34050	34250	200	1
14	28000	18300	-9700	-35
15	24270	27070	2800	12
16	7830	8280	450	6
17	35880	30330	-5550	-15
18	32680	38420	5740	18
19	31130	20440	-10690	-34
20	27800	31180	3380	12
21	34700	29840	-4860	-14
22	25640	18300	-7340	-29
23	32360	27650	-4710	-15
24	36410	40990	4580	13
25	20430	21550	1120	5
26	23330	24520	1190	5
27	33590	36580	2990	9
28	44130	50310	6180	14
29	27850	33720	5870	21
30	25330	27790	2460	10
31	28390	24580	-3810	-13
32	34880	34140	-740	-2
33	19180	15650	-3530	-18
34	27630	31900	4270	15
35	23220	25870	2650	11
36	19180	18890	-290	-2
37	16910	19520	2610	15
38	21920	14250	-7670	-35
39	30390	23240	-7150	-24
40	35650	28700	-6950	-19
41	36510	43750	7240	20
42	15180	17350	2170	14
43	33940	38950	5010	15

* D = Dynamic Weight - Static Weight

** PD = ((Dynamic Weight - Static Weight)/Static Weight) * 100%

Table D-6. Gross Vehicle Weight - Static vs. Dynamic Weight (Calibration Factors = front and rear wheels)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
44	35100	36000	900	3
45	27250	27440	190	1
46	35910	35890	-20	0
47	34700	40290	5590	16
48	19760	17970	-1790	-9
49	22460	30870	8410	37
50	30870	33100	2230	7
51	17510	18700	1190	7
52	37230	42690	5460	15
53	34590	36120	1530	4
54	28940	31200	2260	8
55	35900	39630	3730	10
56	32530	35070	2540	8
57	35450	40080	4630	13
58	25850	25420	-430	-2
59	22360	23760	1400	6
60	21820	21750	-70	0
61	35100	35730	630	2
62	35510	27610	-7900	-22
63	35910	31560	-4350	-12
64	35330	25650	-9680	-27
65	34470	29590	-4880	-14
66	32970	35680	2710	8
67	20860	24320	3460	17
68	32770	39140	6370	19
69	34370	42450	8080	24
70	14830	18230	3400	23
71	35280	41180	5900	17
72	36130	41220	5090	14
Totals	**2130410**	**2196520**		**226**

Table D-7. Statistical Inferences from Gross Vehicle Weight Data

Statistical Inference	Value
Average percent difference, PD(%)	3.1
Sample variance	232.9
Sample standard deviation (%)	15.3
Mean static weight (kg)	29589
Mean of absolute differences (%)	12.9
95% confidence interval (%)	-26.9 to 33.1

Table D-8. Truck Weights for the WIM Data Analysis (Calibration factors = front wheels only)

		Static Weights			Dynamic Weights		
Veh. No.	Veh. Class	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)
1	9	5140	12410	29260	4950	12570	28620
			11710			11110	
2	9	5170	14130	34050	4760	14740	34130
			14750			14630	
3	9	5000	10270	29460	4720	8850	29280
			14190			15710	
4	9	4840	12150	27840	4520	10830	21520
			10850			6160	
5	9	4930	7230	16540	4940	8460	18180
			4380			4780	
6	9	5300	14620	33950	5150	8270	23110
			14030			9680	
7	9	5280	9130	24110	5150	8270	23110
			9700			9680	
8	9	4810	14990	35390	4830	12760	27950
			15590			10370	
9	9	5070	15300	34520	4370	13970	29720
			14150			11380	
10	9	5190	14870	34980	5170	16780	37710
			14920			15750	
11	9	5510	9870	23470	5330	10650	23940
			8090			7970	
12	9	4900	12700	29390	4690	13120	29910
			11790			12100	
13	9	5310	13700	32870	5090	14160	32980
			13860			13720	
14	9	4370	11630	25550	4360	11080	23720
			9550			9280	
15	9	5140	15300	35910	5400	14970	34900
			15470			14530	
16	9	4880	14810	35240	4800	8140	21150
			15550			8210	
17	9	5570	15400	36610	5080	15780	35350
			15640			14480	
18	9	5180	7930	18620	4970	8000	18630
			5510			5660	
19	9	5370	15270	35970	4170	14850	33080
			15330			13700	
20	8	3990	6920	16550	3940	5580	14430
		5640			4900		

Table D-8. Truck Weights for the WIM Data Analysis (continued) (Calibration factors = front wheels only)

		Static Weights			Dynamic Weights		
Veh. No.	Veh. Class	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)	Single Axle (kg)	Tandem Axle (kg)	GVW (kg)
21	9	4460	16230	36270	4340	17350	37890
			15580			16210	
22	9	5100	16540	37050	4940	15140	34030
			15410			13950	
23	9	5350	15580	36620	5560	17180	39230
			15690			16500	
24	8	1430	4320	8480	1650	3460	8050
		2730			2940		
25	9	5120	9570	22620	5060	10710	23830
			7930			8060	
26	9	4670	15140	35090	3990	8540	20180
			15280			7640	
27	9	5330	14700	35380	5480	14230	34250
			15350			14530	
28	9	4710	8280	19890	4430	8740	19690
			6900			6520	
29	9	5150	15230	34480	5200	15120	34840
			14100			14520	
30	9	4650	10910	26030	4420	10990	25620
			10470			10220	
31	9	5350	15850	35490	4930	20950	41390
			14290			15520	
32	9	4640	11180	24770	4500	12100	25690
			8950			9090	
33	9	4790	12350	29250	4890	13660	31690
			12110			13130	
34	9	4580	12070	27770	4840	13430	29030
			11120			10760	
35	10	5100	15410	39680	5020	16370	43580
			19170			22190	
			(Tridem)			(Tridem)	
36	9	4830	12180	25370	5040	13140	26200
			8360			8010	
37	9	4780	8100	19280	5270	9180	21280
			6400			6840	
38	9	5120	15240	35980	3660	9110	22330
			15620			9550	
39	9	5230	15410	35890	5380	11450	26020
			15250			9190	
40	13	4220	10780	46640	3560	10490	45060
			10180			10580	
			11150			10860	
			10310			9580	

Table D-8. Truck Weights for the WIM Data Analysis (continued) (Calibration factors = front wheels only)

Veh. No.	Veh. Class	Static Weights Single Axle (kg)	Static Weights Tandem Axle (kg)	Static Weights GVW (kg)	Dynamic Weights Single Axle (kg)	Dynamic Weights Tandem Axle (kg)	Dynamic Weights GVW (kg)
41	9	5150	14100	32470	5080	13660	31830
			13220			13080	
42	9	5210	16080	37060	5070	15990	33930
			15770			12880	
43	9	5120	12220	24810	5200	12670	25570
			7470			7700	
44	9	5600	15580	36640	5480	17620	37460
			15460			14360	
45	9	5340	15260	35350	5250	14000	34090
			14750			14840	
46	9	4680	14870	35480	4170	14300	34710
			15930			16250	
47	9	5150	14670	34860	4900	14720	33230
			15040			13610	
48	9	5730	11610	27030	5020	11540	24900
			9690			8340	
49	9	4290	9360	24170	4620	15330	35420
			10520			15470	
50	9	4620	15330	35420	3880	16120	35900
			15470			15900	
51	9	5450	15060	36070	4570	13970	32550
			15560			14000	
52	9	5200	11380	27410	4940	11450	26910
			10830			10520	
53	9	4680	7970	17800	4670	9530	19210
			5150			4930	
54	9	5050	15200	34110	4740	14300	33980
			13860			14950	
55	9	5070	15790	36250	5160	15010	35870
			15390			15700	
56	9	4710	7870	19260	4530	7700	18190
			6680			5950	
57	9	5010	15710	36520	4200	14410	32990
			15800			14390	
58	9	5410	15110	34300	5550	16910	36960
			13780			14500	
59	9	5660	13640	29490	5650	14620	30420
			10190			10140	
60	9	4680	8820	20300	4770	9370	20690
			6800			8540	

**Table D-8. Truck Weights for the WIM Data Analysis (continued)
(Calibration factors = front wheels only)**

Veh. No.	Veh. Class	Static Weights Single Axle (kg)	Static Weights Tandem Axle (kg)	Static Weights GVW (kg)	Dynamic Weights Single Axle (kg)	Dynamic Weights Tandem Axle (kg)	Dynamic Weights GVW (kg)
61	10	5170	15660	40940	5460	19190	47480
			20110			22840	
			(Tridem)			(Tridem)	
62	9	5090	13200	34560	4830	13590	30880
			16270			12460	
63	9	5060	12410	28240	3870	10150	23600
			10770			9580	
64	9	4500	10760	24790	2830	9760	20810
			9530			8210	
65	9	4280	11000	28950	3390	9900	25070
			13670			11780	
66	9	5360	15080	36290	4530	13110	30740
			15850			13090	
67	9	5290	14850	35820	4010	13170	29460
			15680			12290	
68	9	5200	15440	36220	5080	12680	32360
			15580			14860	
69	9	5150	16260	33880	4580	17400	34530
			13370			12560	
70	9	5370	15360	34990	5210	13540	30990
			14260			12240	
71	9	5310	14410	31980	5010	16210	33480
			12260			12270	
72	9	5450	14980	34410	2980	13350	29200
			13980			12870	
73	9	5440	14330	34240	3860	14070	29010
			14470			11080	
74	9	4850	14470	34360	4740	13000	29530
			15040			11790	
75	9	4910	9890	23200	4710	10450	23340
			8400			8170	
76	9	4940	12140	22760	4240	12350	21220
			5680			4640	
77	9	5010	15460	35820	4730	16620	36350
			15350			14990	
78	9	5660	14990	36110	4860	15040	35940
			15460			16040	
79	9	5460	15300	36530	3910	13460	29690
			15770			12330	
80	9	4860	9870	26880	3970	8000	22090
			12150			10120	

Table D-8. Truck Weights for the WIM Data Analysis (continued)
(Calibration factors = front wheels only)

Veh. No.	Veh. Class	Static Weights Single Axle (kg)	Static Weights Tandem Axle (kg)	Static Weights GVW (kg)	Dynamic Weights Single Axle (kg)	Dynamic Weights Tandem Axle (kg)	Dynamic Weights GVW (kg)
81	9	5390	15340	36010	4790	15270	33930
			15280			13870	
82	9	5130	10020	23750	4850	9550	22690
			8600			8290	
83	9	4670	13090	31620	5010	15520	33200
			13860			12670	
84	9	5350	14750	32990	5060	15590	31940
			12890			10840	
85	9	5060	15560	34880	4030	21590	37780
			14260			12160	
86	9	5350	9990	26720	5070	10270	25450
			11380			10100	
87	9	5110	13670	27980	4750	13030	30620
			14310			12830	
88	9	5430	15350	36120	5130	15070	35400
			15340			15190	
89	9	5560	15100	35280	5460	12270	26780
			14620			9050	
90	9	5270	14550	35500	3550	12530	28850
			15680			12770	
91	9	4320	6240	17570	2580	4930	12080
			7010			4580	
92	9	4340	14610	34230	2740	11260	26630
			15280			12610	
93	9	5600	11810	28810	5140	10540	25720
			11400			10040	
94	9	5010	10900	27490	3860	9580	24110
			11580			10680	
95	9	5160	15520	36260	2940	13450	29100
			15580			12700	
96	13	4730	13980	47140	4070	14790	47650
		7400	13220		7460	14100	
		7810			7330		
97	9	5040	14940	32580	4940	14120	32430
			12600			13380	
98	9	5080	14230	33640	4170	13750	31790
			14330			13860	

Table D-9. Single Axles - Static vs. Dynamic Weights (Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
1	5140	4950	-190	-4
2	5170	4760	-410	-8
3	5000	4720	-280	-6
4	4840	4520	-320	-7
5	4930	4940	10	0
6	5300	5280	-20	0
7	5280	5150	-130	-2
8	4810	4830	20	0
9	5070	4370	-700	-14
10	5190	5170	-20	0
11	5510	5330	-180	-3
12	4900	4690	-210	-4
13	5310	5090	-220	-4
14	4370	4360	-10	0
15	5140	5400	260	5
16	4880	4800	-80	-2
17	5570	5080	-490	-9
18	5180	4970	-210	-4
19	5370	4170	-1200	-22
20	3990	3940	-50	-1
21	4460	4340	-120	-3
22	5100	4940	-160	-3
23	5350	5560	210	4
24	5640	4900	-740	-13
25	1430	1650	220	15
	2730	2940	210	8
26	5120	5060	-60	-1
27	4670	3990	-680	-15
28	5330	5480	150	3
29	4710	4430	-280	-6
30	5150	5200	50	1
31	4650	4420	-230	-5
32	5350	4930	-420	-8
33	4640	4500	-140	-3
34	4790	4890	100	2
35	4580	4840	260	6
36	5100	5020	-80	-2
37	4830	5040	210	4
38	4780	5270	490	10
39	5120	3660	-1460	-29
40	5230	5380	150	3
41	4220	3560	-660	-16
42	5150	5080	-70	-1
43	5210	5070	-140	-3
44	5120	5200	80	2
45	5600	5480	-120	-2

Table D-9. Single Axles - Static vs. Dynamic Weights (continued)
(Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
46	5340	5250	-90	-2
47	4680	4170	-510	-11
48	5150	4900	-250	-5
49	5730	5020	-710	-12
50	4290	3830	-460	-11
51	4620	3880	-740	-16
52	5450	4570	-880	-16
53	5200	4940	-260	-5
54	4680	4670	-10	0
55	5050	4740	-310	-7
56	5070	5160	90	2
57	4710	4530	-180	-4
58	5010	4200	-810	-16
59	5410	5550	140	3
60	5660	5650	-10	0
61	4680	4770	90	2
62	5170	5460	290	6
63	5090	4830	-260	-5
64	5060	3870	-1190	-24
65	4500	2830	-1670	-37
66	4280	3390	-890	-21
67	5360	4530	-830	-15
68	5290	4010	-1280	-24
69	5200	5080	-120	-2
70	5150	4580	-570	-11
71	5370	5210	-160	-3
72	5310	5010	-300	-6
73	5450	2980	-2470	-45
74	5440	3860	-1580	-29
75	4850	4740	-110	-2
76	4910	4710	-200	-4
77	4940	4240	-700	-14
78	5010	4730	-280	-6
79	5660	4860	-800	-14
80	5460	3910	-1550	-28
81	4860	3970	-890	-18
82	5390	4790	-600	-11
83	5390	5230	-160	-3
84	5130	4850	-280	-5
85	4670	5010	340	7

Table D-9. Single Axles - Static vs. Dynamic Weights (continued) (Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
86	5350	5060	-290	-5
87	5060	4030	-1030	-20
88	5350	5070	-280	-5
89	5110	4760	-350	-7
90	5430	5130	-300	-6
91	5560	5460	-100	-2
92	5270	3550	-1720	-33
93	4320	2580	-1740	-40
94	4340	2740	-1600	-37
95	5600	5140	-460	-8
96	5010	3860	-1150	-23
97	5160	2940	-2220	-43
98	4730	4070	-660	-14
	7400	7460	60	1
	7810	7330	-480	-6
99	5040	4940	-100	-2
100	5080	4170	-910	-18
TOTALS	**520300**	**478150**		**-819**

Table D-10. Statistical Inferences from Single Axle Data

Statistical inference	**Value**
Average percent difference, PD (%)	-8.0
Sample variance	141.72
Sample standard deviation (%)	11.90
Mean static weight (kg)	5051
Mean dynamic weight (kg)	4642
Mean of absolute differences (%)	10
95% confidence interval (%)	-31.3 to 15.3

Table D-11. Tandem Axles - Static vs. Dynamic Weights (Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
1	12410	12570	160	1
	11710	11110	-600	-5
2	14130	14740	610	4
	14750	14630	-120	-1
3	10270	8850	-1420	-14
	14190	15710	1520	11
4	12150	10830	-1320	-11
	10850	6160	-4690	-43
5	7230	8460	1230	17
	4380	4780	400	9
6	14620	15020	400	3
	14030	13250	-780	-6
7	9130	8270	-860	-9
	9700	9680	-20	0
8	14990	12760	-2230	-15
	15590	10370	-5220	-33
9	15300	13970	-1330	-9
	14150	11380	-2770	-20
10	14870	16780	1910	13
	14920	15750	830	6
11	9870	10650	780	8
	8090	7970	-120	-1
12	12700	13120	420	3
	11790	12100	310	3
13	13700	14160	460	3
	13860	13720	-140	-1
14	11630	11080	-550	-5
	9550	9280	-270	-3
15	15300	14970	-330	-2
	15470	14530	-940	-6
16	14810	8140	-6670	-45
	15550	8210	-7340	-47
17	15400	15780	380	2
	15640	14480	-1160	-7
18	7930	8000	70	1
	5510	5660	150	3
19	15270	14850	-420	-3
	15330	13700	-1630	-11
20	6920	5580	-1340	-19
21	16230	17350	1120	7
	15580	16210	630	4
22	16540	15140	-1400	-8
	15410	13950	-1460	-9
23	15580	17189	1609	10
	15690	16500	810	5

Table D-11. Tandem Axles - Static vs. Dynamic Weights (continued)
(Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
24	4320	3460	-860	-20
25	9570	10710	1140	12
	7930	8060	130	2
26	15140	8540	-6600	-44
	15280	7640	-7640	-50
27	14700	14230	-470	-3
	15350	14530	-820	-5
28	8280	8740	460	6
	6900	6520	-380	-6
29	15230	15120	-110	-1
	14100	14520	420	3
30	10910	10990	80	1
	10470	10220	-250	-2
31	15850	20950	5100	32
	14290	15520	1230	9
32	11180	12100	920	8
	8950	9090	140	2
33	12350	13660	1310	11
	12110	13130	1020	8
34	12070	13430	1360	11
	11120	10760	-360	-3
35	15410	16370	960	6
36	12180	13140	960	8
	8360	8010	-350	-4
37	8100	9180	1080	13
	6400	6840	440	7
38	15240	9110	-6130	-40
	15620	9550	-6070	-39
39	15410	11450	-3960	-26
	15250	9190	-6060	-40
40	10780	10490	-290	-3
	10180	10580	400	4
	11150	10860	-290	-3
	10310	9580	-730	-7
41	14100	13660	-440	-3
	13220	13080	-140	-1
42	16080	15990	-90	-1
	15770	12880	-2890	-18
43	12220	12670	450	4
	7470	7700	230	3

Table D-11. Tandem Axles - Static vs. Dynamic Weights (continued)
(Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
44	15580	17620	2040	13
	15460	14360	-1100	-7
45	15260	14000	-1260	-8
	14750	14840	90	1
46	14870	14300	-570	-4
	15930	16250	320	2
47	14670	14720	50	0
	15040	13610	-1430	-10
48	11610	11540	-70	-1
	9690	8340	-1350	-14
49	9360	9930	570	6
	10520	10190	-330	-3
50	15330	16120	790	5
	15470	15900	430	3
51	15060	13970	-1090	-7
	15560	14000	-1560	-10
52	11380	11450	70	1
	10830	10520	-310	-3
53	7970	9530	1560	20
	5150	4930	-220	-4
54	15200	14950	-250	-2
	13860	14300	440	3
55	15790	15010	-780	-5
	15390	15700	310	2
56	7870	7700	-170	-2
	6680	5950	-730	-11
57	15710	14410	-1300	-8
	15800	14390	-1410	-9
58	15110	16910	1800	12
	13780	14500	720	5
59	13640	14620	980	7
	10190	10140	-50	0
60	8820	9370	550	6
	6800	8540	1740	26
61	15660	19190	3530	23
62	13200	13590	390	3
	16270	12460	-3810	-23
63	12410	10150	-2260	-18
	10770	9580	-1190	-11
64	10760	9760	-1000	-9
	9530	8210	-1320	-14
65	11000	9900	-1100	-10
	13670	11780	-1890	-14

Table D-11. Tandem Axles - Static vs. Dynamic Weights (continued)
(Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
66	15080	13110	-1970	-13
	15850	13090	-2760	-17
67	14850	13170	-1680	-11
	15680	12290	-3390	-22
68	15440	12680	-2760	-18
	15580	14860	-720	-5
69	16260	17400	1140	7
	13370	12560	-810	-6
70	15360	13540	-1820	-12
	14260	12240	-2020	-14
71	14410	16210	1800	12
	12260	12270	10	0
72	14980	13350	-1630	-11
	13980	12870	-1110	-8
73	14330	14070	-260	-2
	14470	11080	-3390	-23
74	14470	13000	-1470	-10
	15040	11790	-3250	-22
75	9890	10450	560	6
	8400	8170	-230	-3
76	12140	12350	210	2
	5680	4640	-1040	-18
77	15460	16620	1160	8
	15350	14990	-360	-2
78	14990	15040	50	0
	15460	16040	580	4
79	15300	13460	-1840	-12
	15770	12330	-3440	-22
80	9870	8000	-1870	-19
	12150	10120	-2030	-17
81	15340	15270	-70	0
	15280	13870	-1410	-9
82	13030	13710	680	5
	9640	8660	-980	-10
83	10020	9550	-470	-5
	8600	8290	-310	-4
84	13090	15520	2430	19
	13860	12670	-1190	-9

Table D-11. Tandem Axles - Static vs. Dynamic Weights (continued)
(Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
85	14750	15590	840	6
	12890	10840	-2050	-16
86	15560	21590	6030	39
	14260	12160	-2100	-15
87	9990	10270	280	3
	11380	10100	-1280	-11
88	13670	13030	-640	-5
	14310	12830	-1480	-10
89	15350	15070	-280	-2
	15340	15190	-150	-1
90	15100	12270	-2830	-19
	14620	9050	-5570	-38
91	14550	12530	-2020	-14
	15680	12770	-2910	-19
92	6240	4930	-1310	-21
	7010	4580	-2430	-35
93	14610	11260	-3350	-23
	15280	12610	-2670	-17
94	11810	10540	-1270	-11
	11400	10040	-1360	-12
95	10900	9580	-1320	-12
	11580	10680	-900	-8
96	15520	13450	-2070	-13
	15580	12700	-2880	-18
97	13980	14790	810	6
	13220	14000	780	6
98	14940	14120	-820	-5
	12600	13380	780	6
99	14230	13750	-480	-3
	14330	13860	-470	-3
Total	**2521140**	**2383759**		**-989**

Table D-12. Statistical Inferences from Tandem Axle Data

Statistical Inference	**Value**
Average percent difference, PD (%)	-5.0
Sample variance	185.60
Sample standard deviation (%)	13.62
Mean static weight (kg)	12798
Mean dynamic weight (kg)	12100
Mean of absolute differences (%)	8.5
95% confidence interval	-31.7 to 21.7

Table D-13. Gross Vehicle Weight - Static vs. Dynamic Weights (Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
1	29260	28620	-640	-2
2	34050	34130	80	0
3	29460	29280	-180	-1
4	27840	21520	-6320	-23
5	16540	18180	1640	10
6	33950	33560	-390	-1
7	24110	23110	-1000	-4
8	35390	27950	-7440	-21
9	34520	29720	-4800	-14
10	34980	37710	2730	8
11	23470	23940	470	2
12	29390	29910	520	2
13	32870	32980	,110	0
14	25550	24720	-830	-3
15	35910	34900	-1010	-3
16	35240	21150	-14090	-40
17	36610	35350	-1260	-3
18	18620	18630	10	0
19	35970	33080	-2890	-8
20	16550	14430	-2120	-13
21	36270	37890	1620	4
22	37050	34030	-3020	-8
23	36620	39230	2610	7
24	8480	8050	-430	-5
25	22620	23830	1210	5
26	35090	20180	-14910	-42
27	35380	34250	-1130	-3
28	19890	19690	-200	-1
29	34480	34840	360	1
30	26030	25620	-410	-2
31	35490	41390	5900	17
32	24770	25690	920	4
33	29250	31690	2440	8
34	27770	29030	1260	5
35	39680	43580	3900	10
36	25370	26200	830	3
37	19280	21280	2000	10
38	35980	22330	-13650	-38
39	35890	26020	-9870	-28
40	46640	45060	-1580	-3
41	32470	31830	-640	-2
42	37060	33930	-3130	-8
43	24810	35570	10760	43
44	36640	37460	820	2

Table D-13. Gross Vehicle Weight - Static vs. Dynamic Weights (continued)
(Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
45	35350	34090	-1260	-4
46	35480	34710	-770	-2
47	34860	33230	-1630	-5
48	27030	24900	-2130	-8
49	24170	23960	-210	-1
50	35420	35900	480	1
51	36070	32550	-3520	-10
52	27410	26910	-500	-2
53	17800	19210	1410	8
54	34110	33980	-130	0
55	36250	35870	-380	-1
56	19260	18190	-1070	-6
57	36520	32990	-3530	-10
58	34300	36960	2660	8
59	29440	30420	980	3
60	20300	20690	390	2
61	40940	47480	6540	16
62	34560	30880	-3680	-11
63	28240	23600	-4640	-16
64	24790	20810	-3980	-16
65	28950	25070	-3880	-13
66	36290	30740	-5550	-15
67	35820	29460	-6360	-18
68	36220	32360	-3860	-11
69	33880	34530	650	2
70	34990	30990	-4000	-11
71	31980	33480	1500	5
72	34410	29200	-5210	-15
73	34240	29010	-5230	-15
74	34360	29530	-4830	-14
75	23200	23340	140	1
76	22760	21220	-1540	-7
77	35820	36350	530	1
78	36110	35940	-170	0
79	36530	29690	-6840	-19
80	26880	22090	-4790	-18

Table D-13. Gross Vehicle Weight - Static vs. Dynamic Weights (continued) (Calibration factors = front wheels only)

Veh. No.	Static Weight (kg)	Dynamic Weight (kg)	D*	PD**
81	36010	33930	-2080	-6
82	28060	27590	-470	-2
83	23750	22690	-1060	-4
84	31620	33200	1580	5
85	32990	31490	-1500	-5
86	34880	37780	2900	8
87	26720	25450	-1270	-5
88	27980	30620	2640	9
89	36120	35400	-720	-2
90	35280	26780	-8500	-24
91	35500	28850	-6650	-19
92	17570	12080	-5490	-31
93	34230	26630	-7600	-22
94	28810	25720	-3090	-11
95	27490	24110	-3380	-12
96	36260	29100	-7160	-20
97	47140	47650	510	1
98	32580	32430	-150	0
99	33640	31790	-1850	-5
TOTALS	**3074660**	**2915160**		**-479**

Table D-14. Statistical Inferences from Gross Vehicle Weight Data

Statistical Inference	Value
Average percent difference, PD (%)	-4.8
Sample variance	159.69
Sample standard deviation (%)	12.28
Mean static weight (kg)	31057
Mean dynamic weight (kg)	29446
Mean of absolute differences (%)	8
95% confidence interval (%)	-28.87 to 19.7

Table D-15. Vehicle Classificiations - Actual vs. AVC

Vehicle Number	Actual Class	AVC Class	Vehicle Number	Actual Class	AVC Class	Vehicle Number	Actual Class	AVC Class
1	8	8	73	9	9	145	9	9
2	9	9	74	9	9	146	9	9
3	13	13	75	9	9	147	9	9
4	9	9	76	9	9	148	9	9
5	9	9	77	9	9	149	9	9
6	9	9	78	9	9	150	9	9
7	9	9	79	9	9	151	9	9
8	9	9	80	9	9	152	9	9
9	9	9	81	9	9	153	9	9
10*	9	8	82	9	9	154	9	9
11	9	9	83	9	9	155*	9	8
12	9	9	84	10	10	156	9	9
13	9	9	85	9	9	157	9	9
14	9	9	86	9	9	158	9	9
15	9	9	87	9	9	159*	9	2
16	13	13	88	9	9	160*	9	10
17	9	9	89	9	9	161*	5	2
18	9	9	90	9	9	162	9	9
19	3	3	91	9	9	163	9	9
20	9	9	92	9	9	164	9	9
21	9	9	93	9	9	165	9	9
22	9	9	94	9	9	166	9	9
23	9	9	95*	9	8	167	9	9
24	13	13	96	9	9	168	9	9
25	9	9	97	9	9	169	9	9
26	9	9	98	9	9	170	9	9
27	9	9	99	9	9	171	9	9
28	9	9	100	9	9	172	9	9
29	9	9	101	9	9	173	9	9
30	9	9	102	9	9	174	9	9
31	13	13	103	9	9	175	9	9
32	9	9	104	9	9	176	9	9
33	9	9	105	9	9	177	9	9
34	9	9	106	9	9	178	9	9
35	9	9	107	9	9	179	9	9
36	9	9	108	9	9	180	9	9
37	9	9	109	9	9	181	9	9
38*	9	-	110	9	9	182	9	9
39*	9	8	111	9	9	183	9	9
40*	13	8	112*	9	11	184	9	9
41*	9	8	113	9	9	185	9	9
42*	9	4	114*	9	7	186	9	9
43*	9	-	115	9	9	187	9	9
44*	9	-	116	9	9	188	9	9
45*	9	6	117	9	9	189	9	9
46	9	9	118	13	13	190	9	9
47	9	9	119	8	8	191	9	9
48	9	9	120	9	9	192	9	9

Table D-15. Vehicle Classificiations - Actual vs. AVC (continued)

Vehicle Number	Actual Class	AVC Class	Vehicle Number	Actual Class	AVC Class	Vehicle Number	Actual Class	AVC Class
49	9	9	121	9	9	193	9	9
50*	3	2	122	9	9	194	9	9
51	9	9	123	9	9	195	9	9
52	9	9	124	9	9	196	9	9
53	9	9	125	9	9	197*	9	8
54	9	9	126	9	9	198*	9	8
55	9	9	127*	9	8	199	9	9
56*	13	12	128	9	9	200	9	9
57	9	9	129	9	9	201	9	9
58	9	9	130	9	9	202	9	9
59	9	9	131	9	9	203	9	9
60	9	9	132*	9	10	204*	9	8
61	9	9	133	9	9	205	9	9
62	9	9	134	9	9	206*	9	8
63	9	9	135*	9	-	207	13	13
64	9	9	136	9	9	208	9	9
65	9	9	137	13	13	209	9	9
66	9	9	138	9	9	210	9	9
67	9	9	139	9	9	211	9	9
68	9	9	140	9	9	212*	9	1
69	9	9	141	9	9	213*	9	2
70	9	9	142	9	9	214	9	9
71	9	9	143	9	9			
72	9	9	144	9	9			

* Vehicles incorrectly classified

A Reliable System for Monitoring Truck Movements and Characteristics in Manitoba

by

Angela E. Ostroman

A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements for the Degree of

Master of Science

Department of Civil Engineering
University of Manitoba
Winnipeg, Manitoba

A RELIABLE SYSTEM FOR MONITORING TRUCK MOVEMENTS AND CHARACTERISTICS IN MANITOBA

BY

ANGELA E. OSTROMAN

A Thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

APPENDIX E -
Supplement to
"A Reliable System for Monitoring Truck Movements and Characteristics in Manitoba"

by

Angela E. Ostroman

A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements for the Degree of

Master of Science

Department of Civil Engineering
University of Manitoba
Winnipeg, Manitoba

APPENDIX E

This document includes all truck data and analyses used to develop the number of permanent and sampling sites for truck data collection in Manitoba, as specified in the M.Sc. Thesis, entitled "A Reliable System for Monitoring Truck Movements and Characteristics in Manitoba", by Angela E. Ostroman.

Exhibits 1-12 illustrate the functional classes of all highways, excluding local, in each District of Manitoba. The maps were obtained from the "Manitoba Highways Classification Study" [MDHT, 1986].

Tables E-1 to E-8 report the Daily Veh-km and Daily Truck Veh-km for each highway in each functional class (Expressways, Primary Arterials, Secondary Arterials, and Collectors). The distances were obtained from the "Distances on Provincial Trunk Highways and Provincial Roads" [MDHT, 1990]. The AADT and AADTT values were obtained from the "Traffic Flow Map" publication [MDHT, 1989].

Tables E-9A to E-9H report the COV calculations and the average percentage of trucks by truck type and location of each highway classified as an expressway.

Tables E-10 to E-12 summarize the average percentage of trucks, standard deviations, and COV for all expressway routes.

Tables E-14A to E-14K report the COV calculations and the average percentage of trucks by truck type and location of each highway classified as primary arterial.

Tables E-15 to E-17 summarize the average percentage of trucks, standard deviations, and COV for all primary arterial routes.

Tables E-19A to E-19Q report the COV calculations and the average percentage of trucks by truck type and location of each highway classified as secondary arterial.

Tables E-20 to E-22 summarize the average percentage of trucks, standard deviations, and COV for all primary arterial routes.

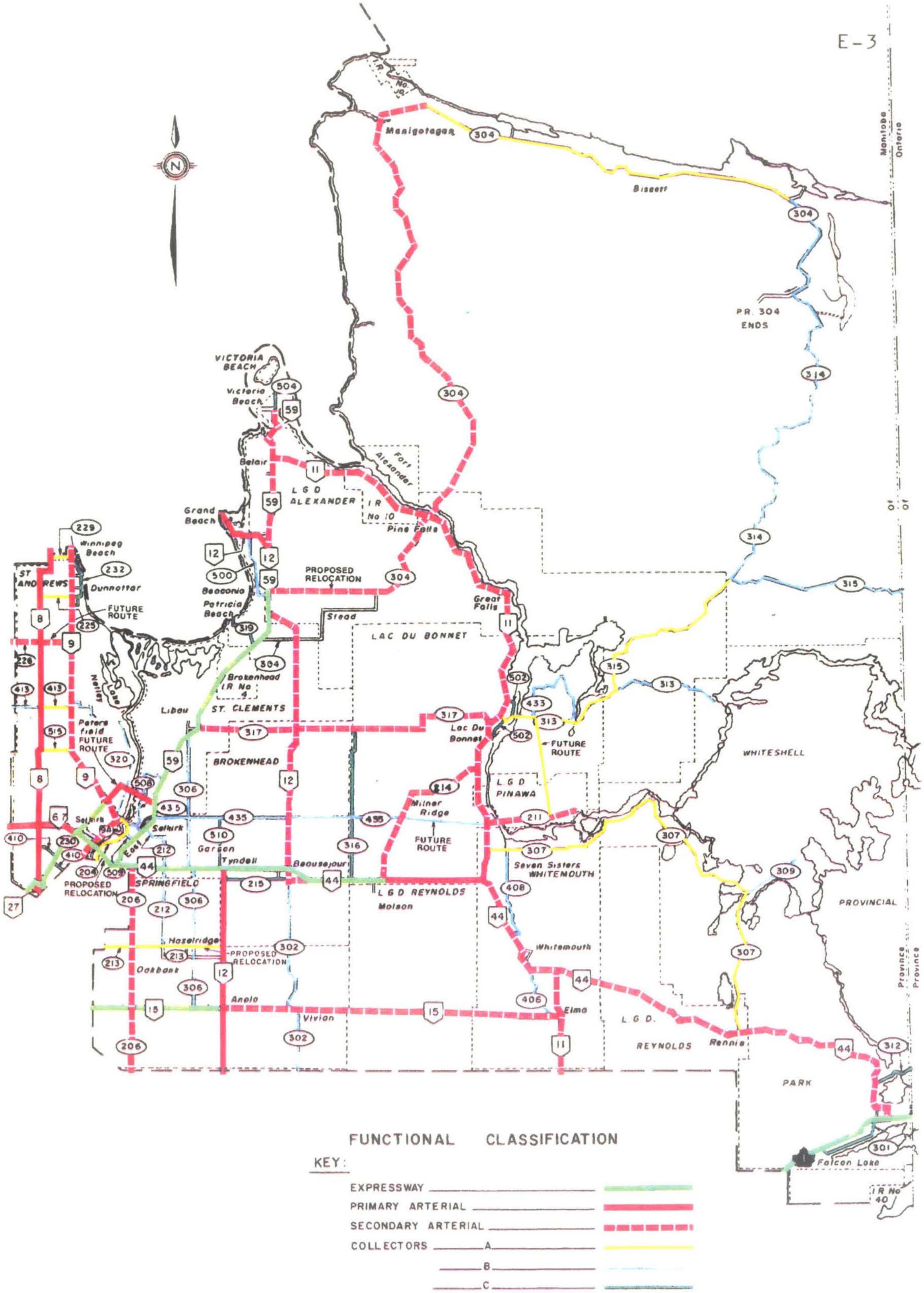
Tables E-24A to E-24S report the COV calculations and the average percentage of trucks by truck type and location of each highway classified as collector.

Table E-25 to E-27 summarize the average percentage of trucks, standard deviations, and COV for all collector routes.

Tables E-13, E-18, E-23, E-28 report the sample size required to achieve various precision levels for each truck type on each functional highway class.

Table E-29 reports all RTAC route links considered for Permanent Vehicle Classification sites.

APPENDIX E



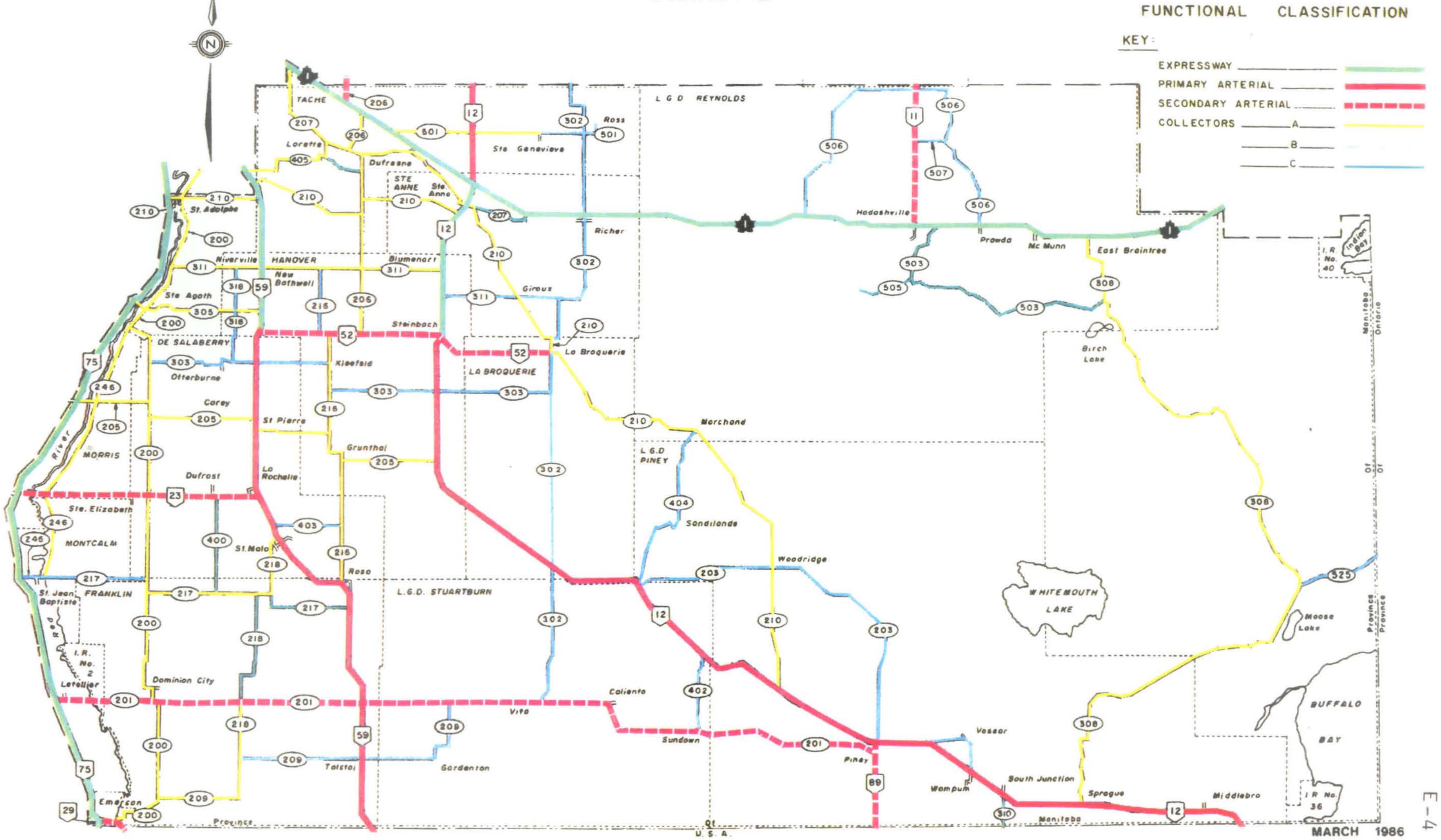
District 1

MARCH 1986

Manitoba Highways and Transportation

Exhibit 1

District 2



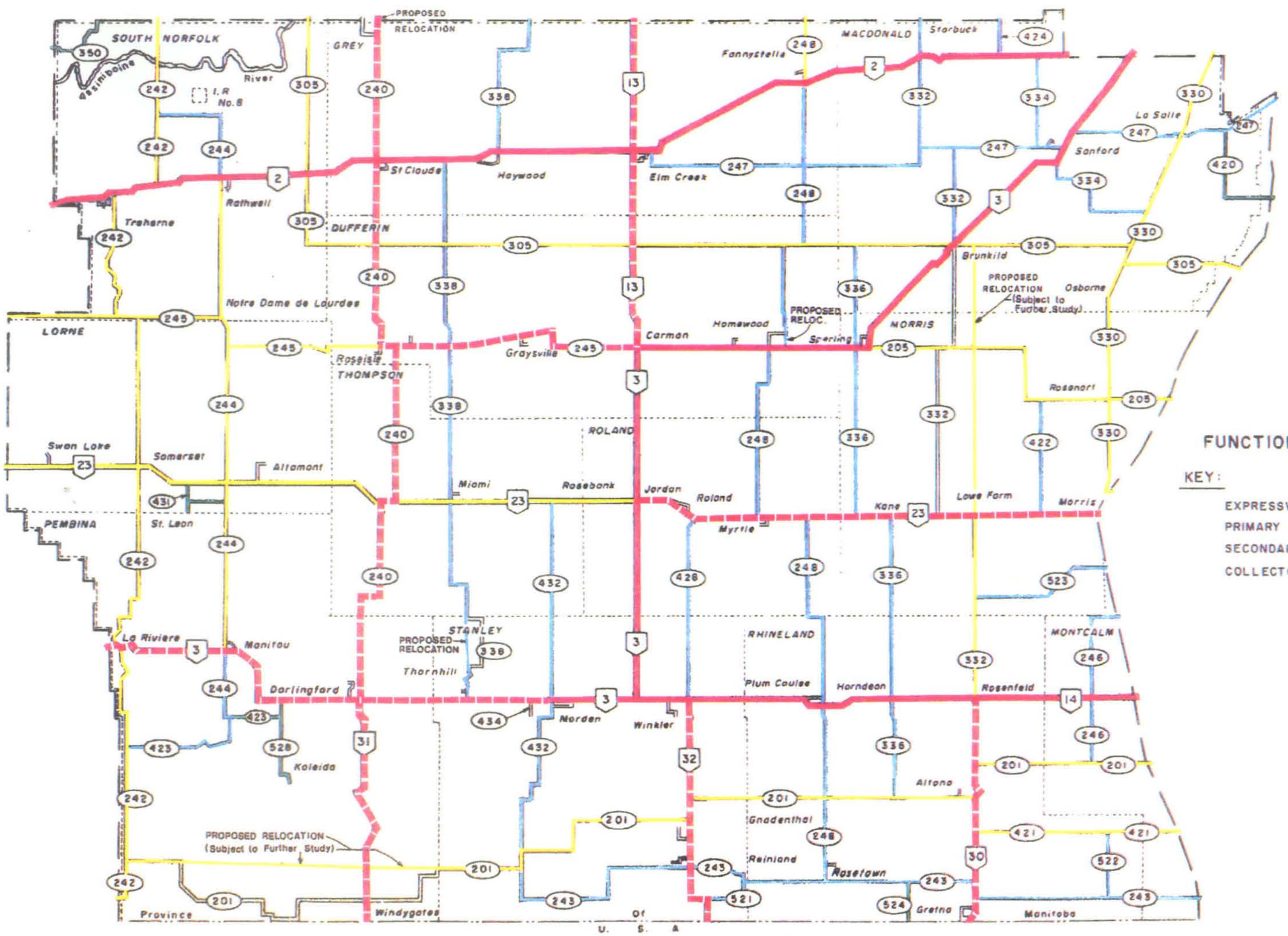
MARCH 1986

Manitoba Highways and Transportation

Exhibit 2

E-4

District 3



FUNCTIONAL CLASSIFICATION

KEY:

EXPRESSWAY

PRIMARY ARTERIAL

SECONDARY ARTERIAL

COLLECTORS A

B

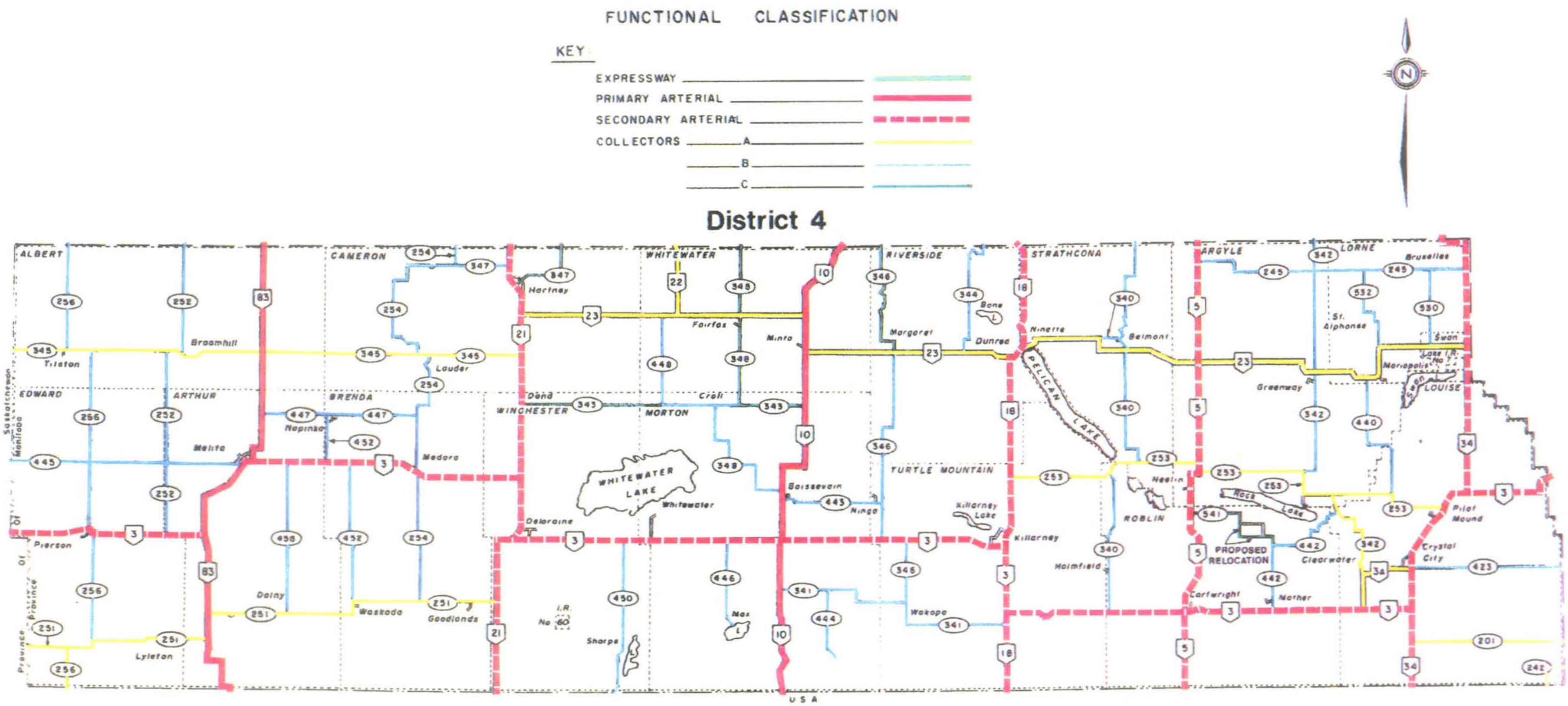
C

E-5

Manitoba Highways and Transportation

MARCH 1986

Exhibit 3

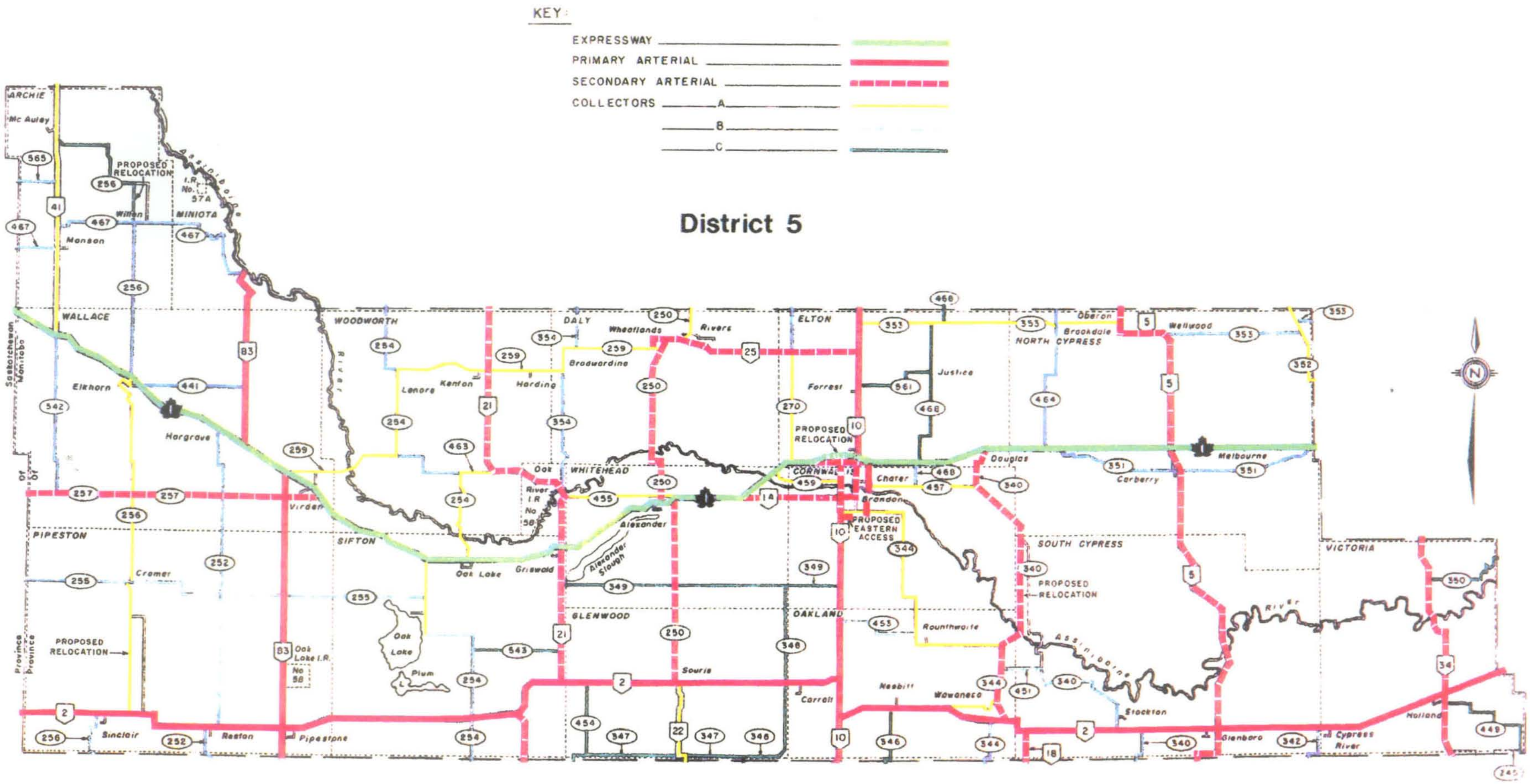


MARCH 1986

Manitoba Highways and Transportation

Exhibit 4

FUNCTIONAL CLASSIFICATION

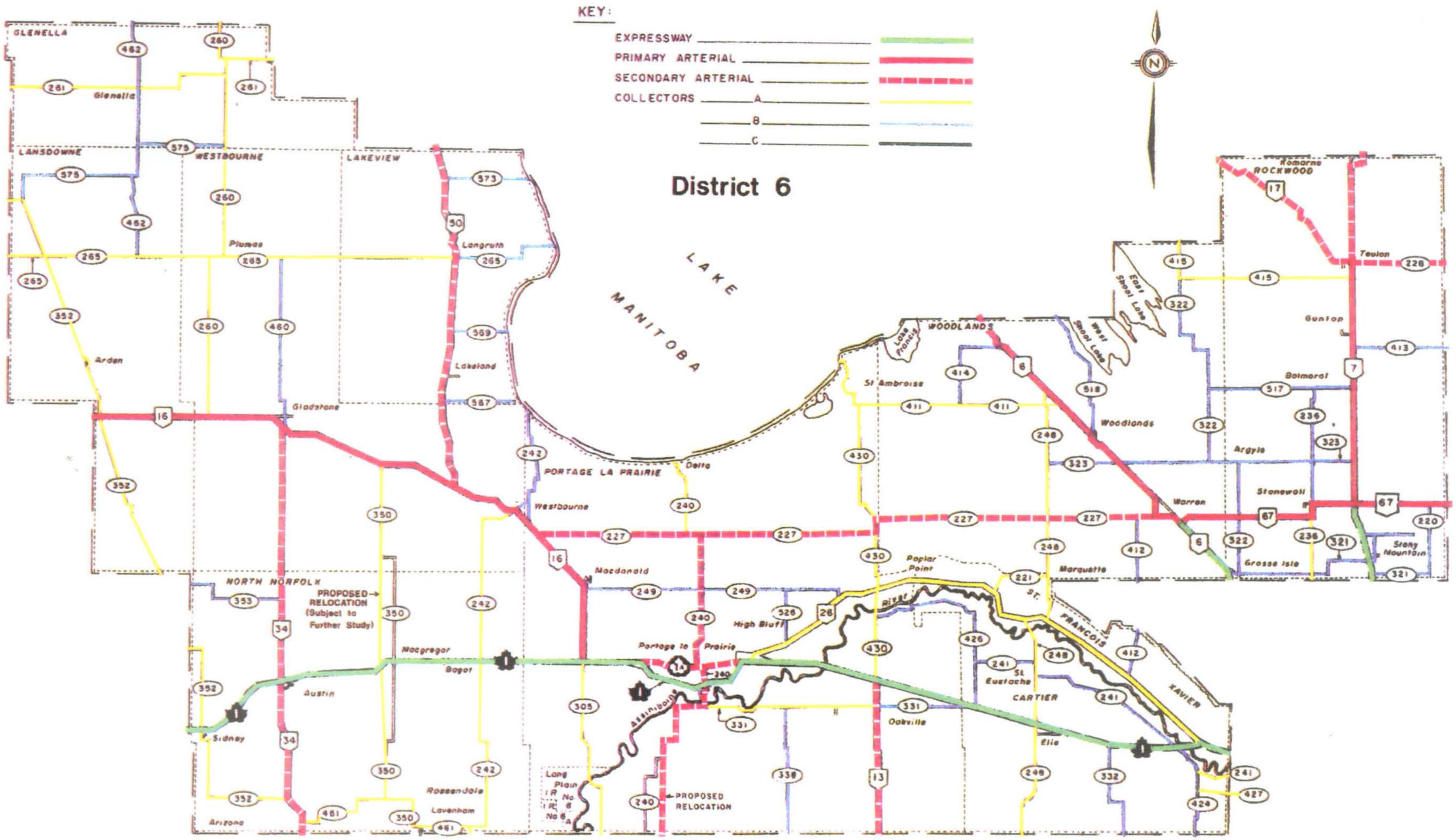


MARCH 1986

Manitoba Highways and Transportation

Exhibit 5

FUNCTIONAL CLASSIFICATION



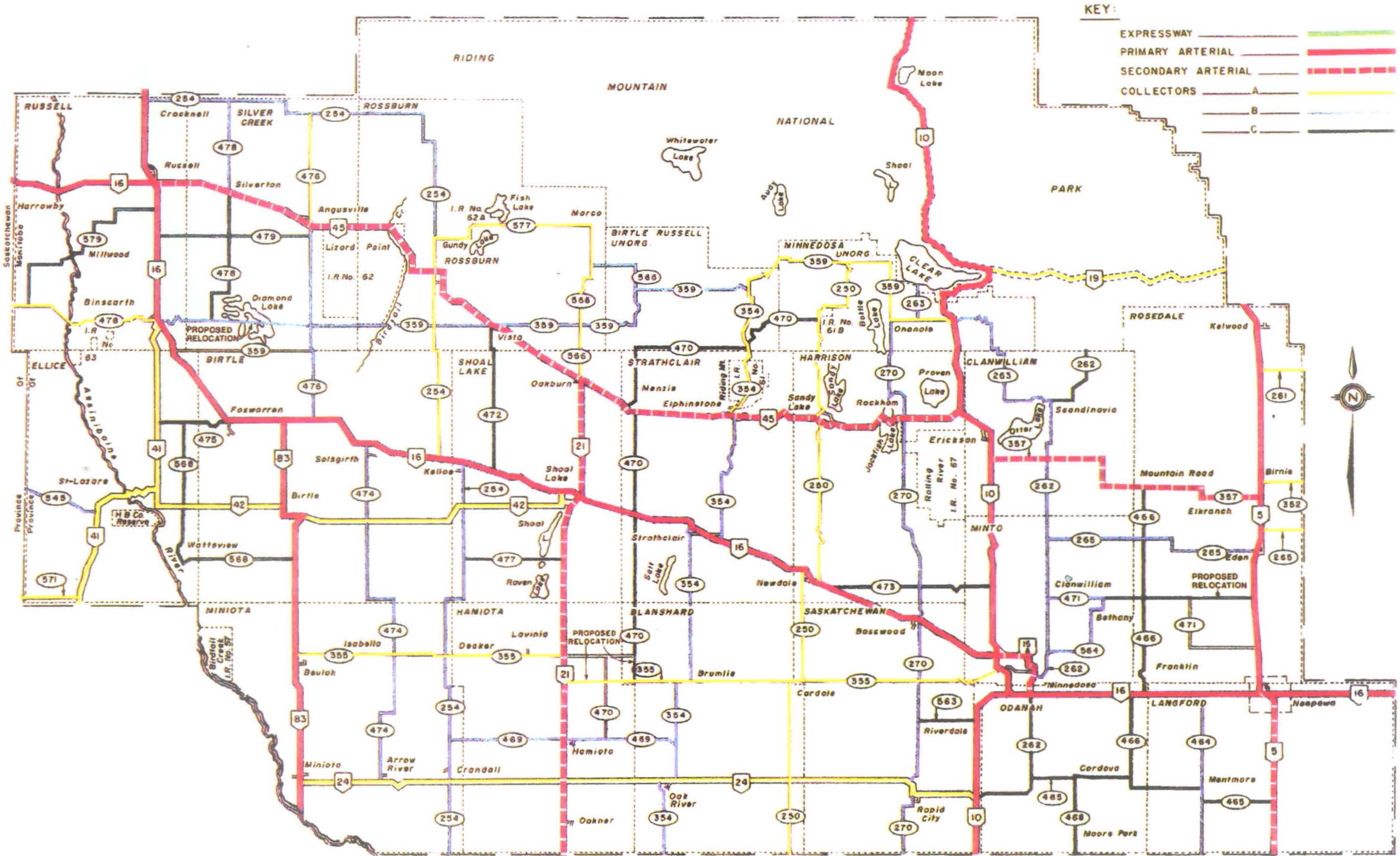
MARCH 1986

Manitoba Highways and Transportation

Exhibit 6

District 7

FUNCTIONAL CLASSIFICATION



MARCH 1986

Manitoba Highways and Transportation

Exhibit 7

District 8

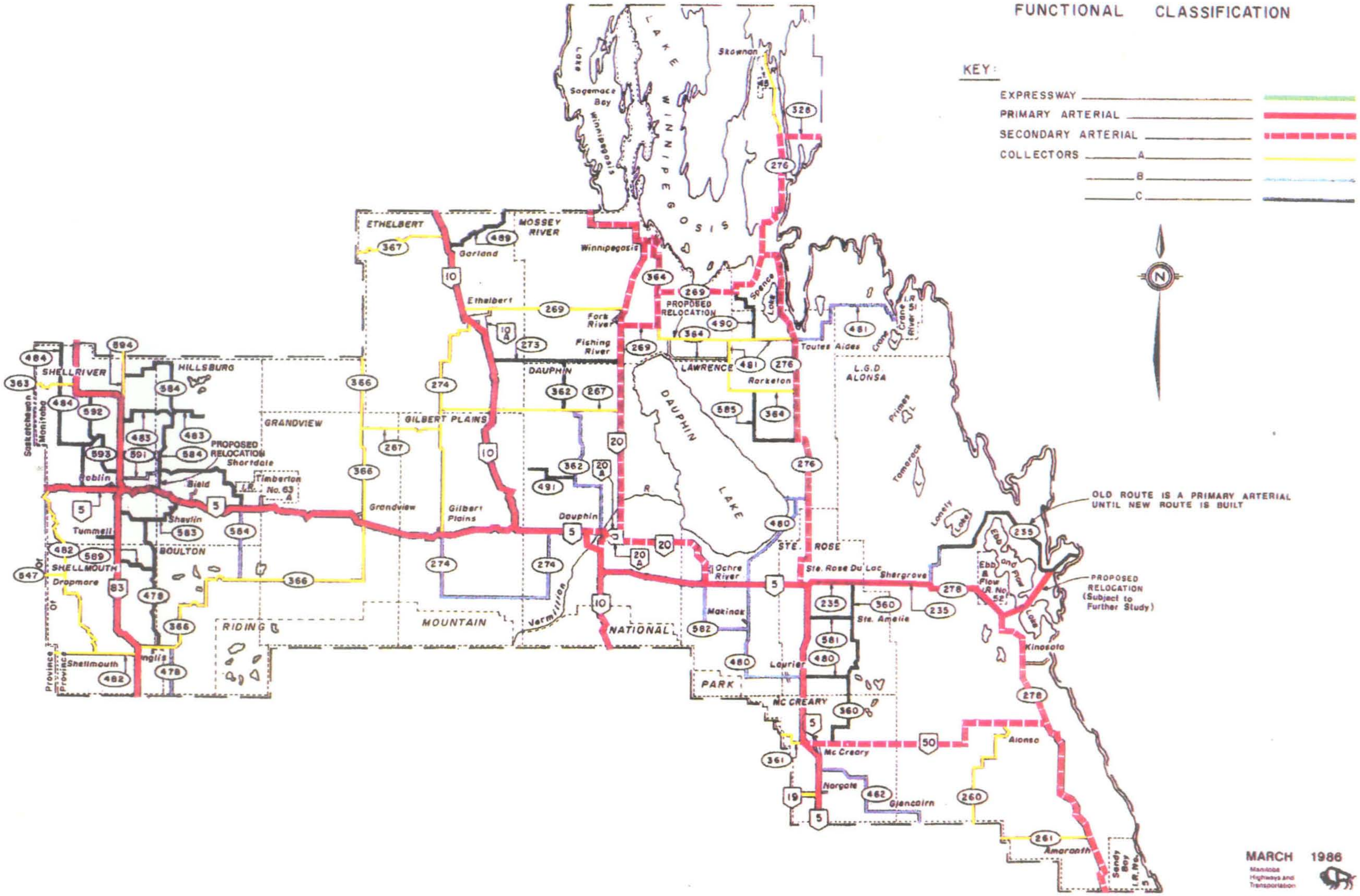
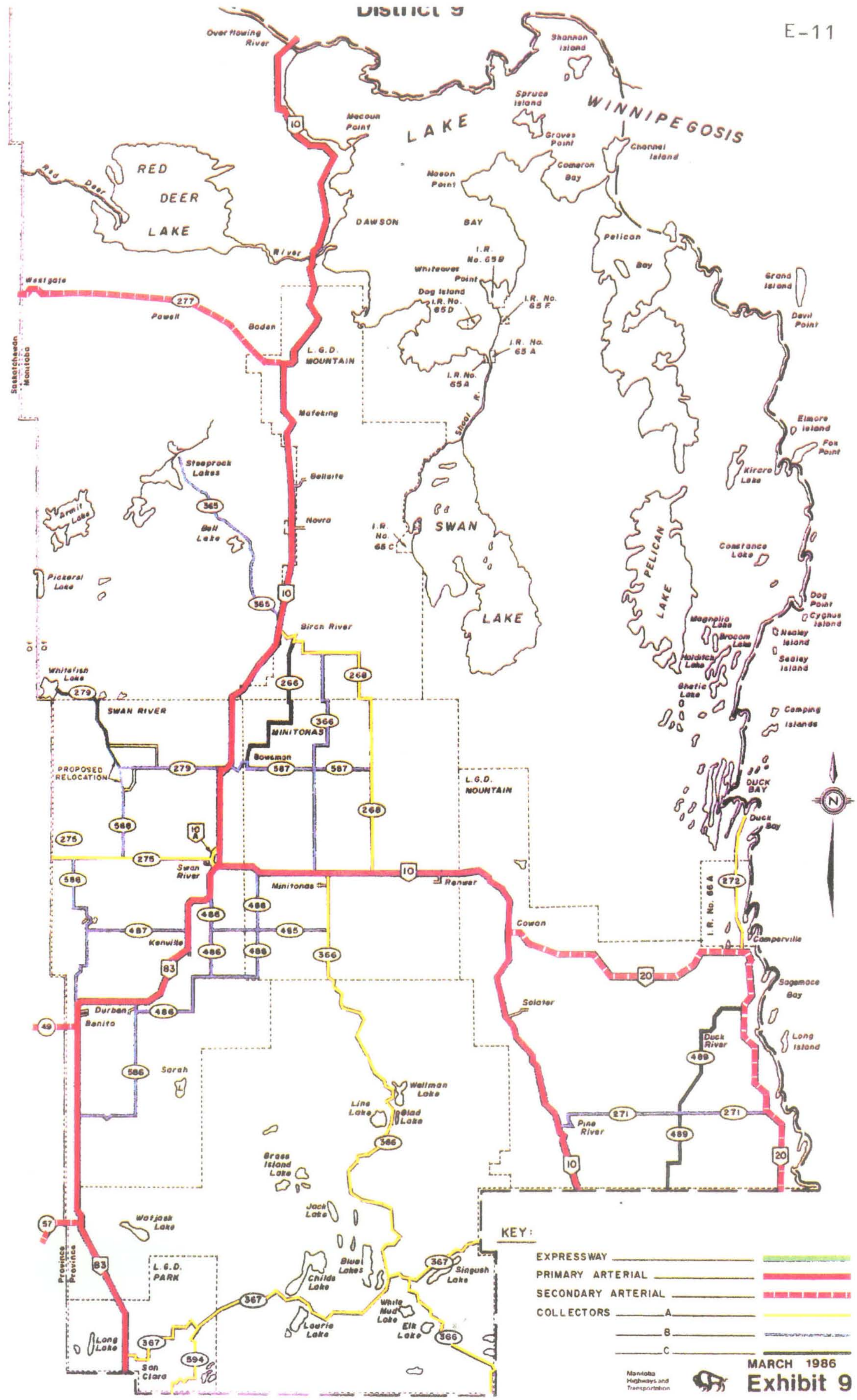
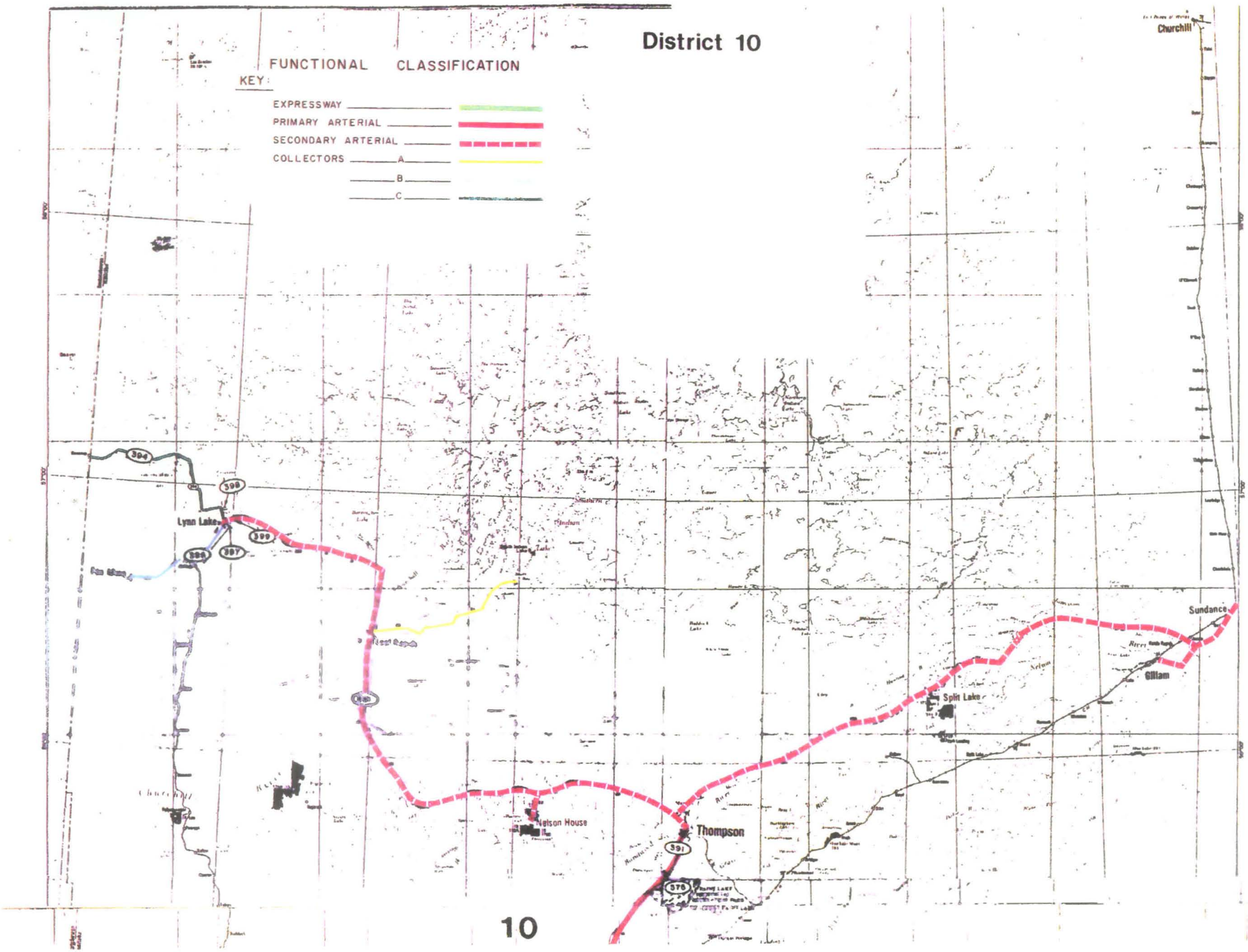
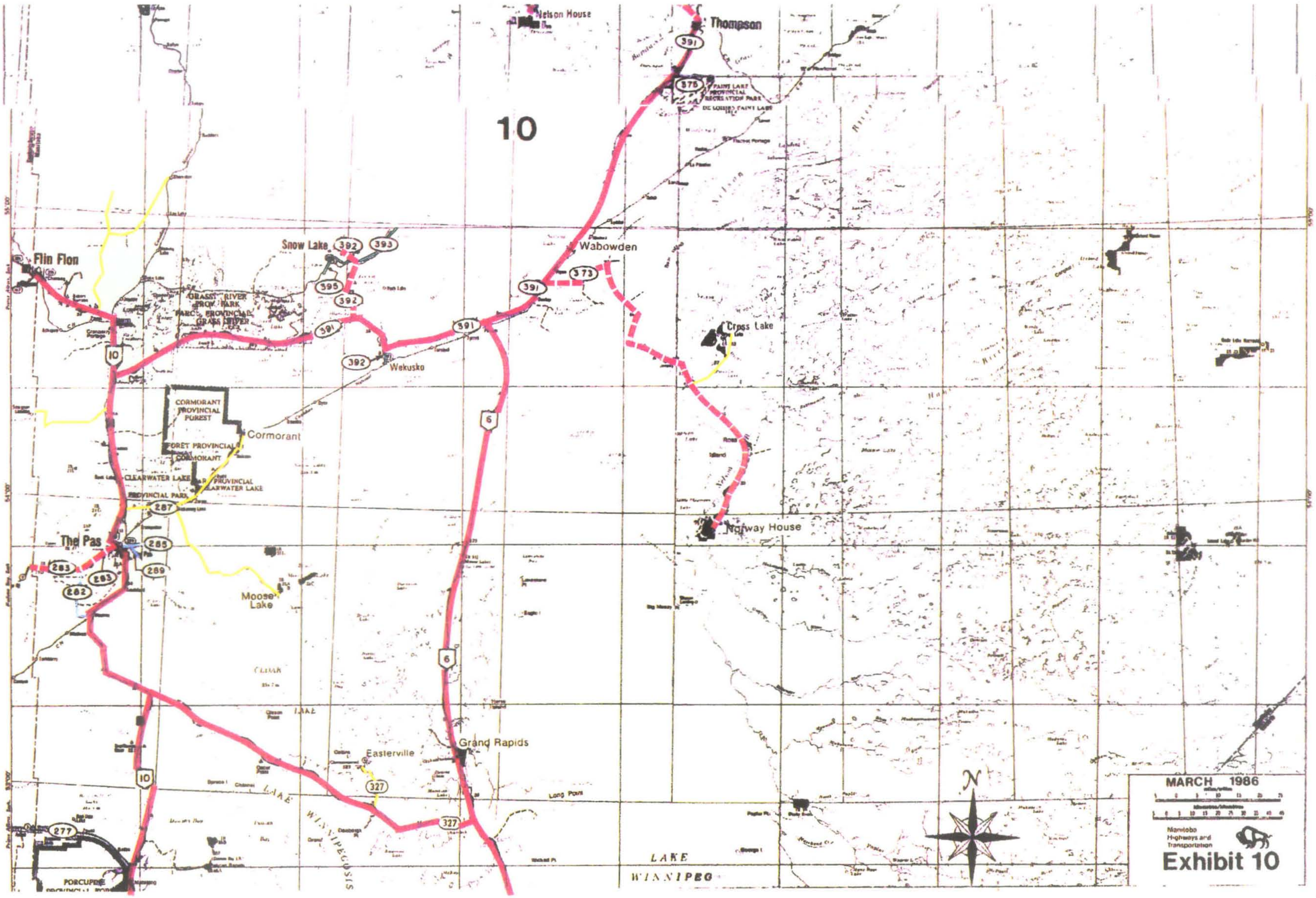


Exhibit 8


District 9
LAKE WINNIPEGOSIS
RED DEER LAKE
DAWSON BAY
SWAN LAKE
PELICAN LAKE
L.G.D. MOUNTAIN
SWAN RIVER
MINITONAS
L.G.D. PARK
PROPOSED RELOCATION
Overflowing River
Westgate
Powell
Baden
Mafeking
Bellsite
Novra
Birch River
Bowsman
Swan River
Minitonas
Renwer
Cowan
Camperville
Duck Bay
Kenville
Durban
Benito
Sarah
Sclater
Pine River
Duck River
San Clara
Saskatchewan
Manitoba
KEY:
EXPRESSWAY
PRIMARY ARTERIAL
SECONDARY ARTERIAL
COLLECTORS A
B
C
MARCH 1986
Manitoba Highways and Transportation
Exhibit 9


District 10
FUNCTIONAL CLASSIFICATION
KEY:
EXPRESSWAY
PRIMARY ARTERIAL
SECONDARY ARTERIAL
COLLECTORS A
B
C
Churchill
Sundance
Gillam
Split Lake
Thompson
Nelson House
Lynn Lake
394
396
397
398
399
391
375
10

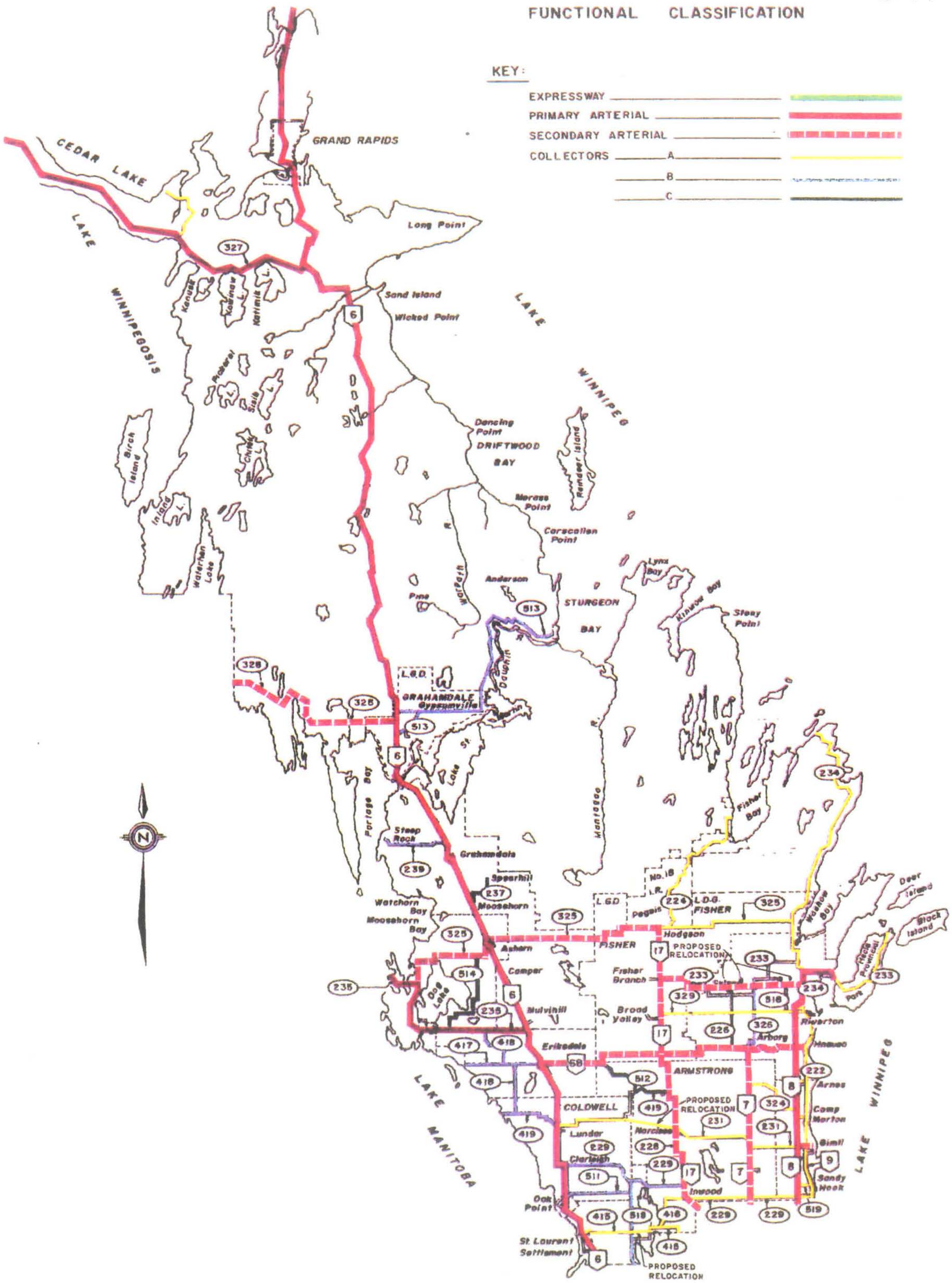


Thompson
Nelson House
10
Flin Flon
Snow Lake
Wabowden
Cross Lake
Wekusko
CORMORANT PROVINCIAL FOREST
Cormorant
CLEARWATER LAKE PROVINCIAL PARK
The Pas
Moose Lake
Norway House
Grand Rapids
Easterville
LAKE WINNIPEGOSIS
LAKE WINNIPEG
Long Point
MARCH 1986
Manitoba Highways and Transportation
Exhibit 10

E-14

District 11

FUNCTIONAL CLASSIFICATION

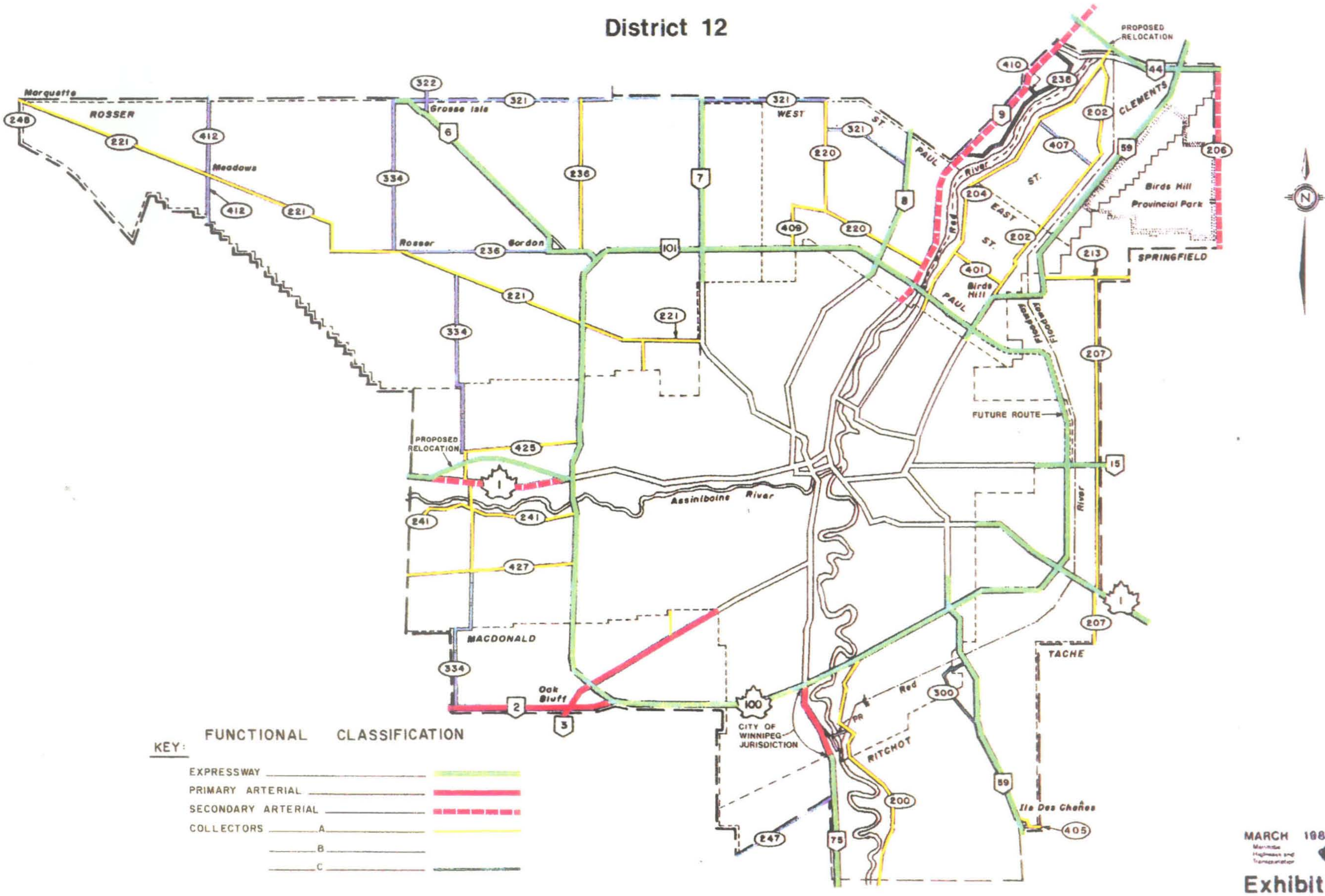


MARCH 1986

Manitoba Highways and Transportation

Exhibit 11

District 12



MARCH 1986

Exhibit 12

Table E-1. Daily Vehicle-km of Travel (Expressways)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 1							
1	ONTARIO BOUNDARY	PR 301	15.1	3309	459	49966	6931
	PR 301	S. BDRY OF WHITESHELL	5.1	3144	436	16034	2224
44	PR 214	PTH 12	16.4	2864	135	46970	2214
	PTH 12 (W. JCT.)	PR 206	14.8	3200	160	47360	2368
	PR 206	PTH 59	2.3	3200	160	7360	368
59	PTH 4	PR 306	10.9	415	95	4524	1036
	PR 306	PTH 12 (S. JCT.)	23.7	2100	175	49770	4148
230	PTH 8	PTH 9	10.6	2460	66	26076	700
Totals:			**98.9**			**248059**	**19987**
District 2							
1	S. BDRY. WHITESHELL	PTH 11	38.8	3890	512	150932	19866
	PTH 11	BROKENHEAD RIVER	26.9	3718	516	100014	13880
	BROKENHEAD RIVER	PTH 12	27.7	4685	636	129775	17617
	PTH 12	PR 207	25.3	7464	864	188839	21859
12	PTH 52	PTH 1	19.8	2225	155	44055	3069
59	PTH 52	PR 405	79.6	4512	451	359155	35900
75	U.S. BORDER	PTH 29	2.3	1750	228	4025	524
	PTH 29	PTH 14	22.5	2130	406	47925	9135
	PTH 14	PTH 23 (N. JCT.)	18.5	3435	515	63548	9528
	PTH 23 (N. JCT.)	PR 210	41.2	3946	496	162575	20435
Totals			**302.6**			**1250843**	**112191**
District 3							
No Expressways							
District 4							
No Expressways							
District 5							
1	PR 351 (E. JCT.)	PTH 5	18.2	4102	696	74656	12667
	PTH 5	PR 340	24.8	4563	733	113162	18178
	PR 340	PTH 10 (E. JCT.)	17.1	5510	924	94221	15800
	PTH 10 (E. JCT.)	PTH 1A (W. JCT.)	16.3	3678	598	59951	9747
	PTH 1A (W. JCT.)	PR 250 (E. JCT.)	8.5	4100	622	34850	5287
	PR 250 (E. JCT.)	PTH 21	16.9	3546	640	59927	10816
	PTH 21	ROUTLEDGE	26.1	3181	622	83024	16234
	ROUTLEDGE	PTH 83 (E. JCT.)	14.5	3100	580	44950	8410
	PTH 83 (E. JCT.)	PTH 83 (W. JCT.)	6.3	3033	567	19108	3572
	PTH 83 (W. JCT.)	SASKATCHEWAN BOUND	35.6	2512	605	89427	21538
Totals			**184.3**			**673278**	**122251**
District 6							
1	E. BDRY. ST. FRANCOIS	PTH 26 (E. JCT.)	3.9	9964	1274	38860	4969
	PTH 26	PR 248	18.5	8814	1004	163059	18574
	PR 248	PTH 13	18.8	7800	1176	146640	22109
	PTH 13	PTH 26 (CUT OFF)	14.8	8722	1160	129086	17168
	PTH 26 (CUT OFF)	PR 240 (PORTAGE BYPAS	5.3	5476	930	29023	4929
	PR 240 (PORTAGE BYPASS)	PTH 1A (W. JCT.)	8.9	5412	936	48167	8330
	PTH 1A (W. JCT.)	PTH 16	6.6	8742	1170	57697	7722
	PTH 16	PTH 34	35.1	4800	800	168480	28080
	PTH 34	PR 351 (E. JCT.)	13.7	4716	758	64609	10385
6	PR 321	PTH 67	8.5	2480	183	21080	1556
7	PR 321	PTH 67	8.5	4900	580	41650	4930
Totals			**142.6**			**908350**	**128751**

Table E-1 (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 7							
No expressways							
District 8							
No expressways							
District 9							
No expressways							
District 10							
No expressways							
District 11							
No expressways							
District 12							
1	PR 207	PTH 100 (E. JCT.)	2.6	11124	990	28922	2574
	PTH 100 (E. JCT.)	PLESSIS ROAD (CITY BDF	5.5	8750	770	48125	4235
	PTH 100 (W. JCT.)	W.BDRY.ST.JAMES-ASSIN	9.2	15600	1934	143520	17793
6	PTH 101	PR 321	13.8	150	15	2070	207
7	PTH 101	PR 321	8	6906	682	55248	5456
8	PTH 101	PTH 27	8.2	6800	210	55760	1722
15	PR 207	PTH 101	1.8	7575	499	13635	898
44	PTH 59	PR 204 (W. JCT.)	4.5	1972	156	8874	702
	PR 204 (W. JCT.)	PTH 9	1.8	4425	115	7965	207
59	PR 405	PTH 100	12.9	5000	470	64500	6063
	PTH 100	JOHN BRUCE ROAD	1.3	7876	1118	10239	1453
	PTH 101	PR 213	5.6	16456	1174	92154	6574
	PR 213	PTH 44	14.0	8328	241	116592	3374
75	PR 210	N. BDRY. RM RITCHOT	7.2	6129	649	44129	4673
100	PTH 1 (E. JCT.)	PTH 59	6.8	4248	326	28886	2217
	PTH 59	ST. MARY'S ROAD	5.5	8396	1174	46178	6457
	ST. MARY'S ROAD	PTH 75	3.5	12999	1312	45497	4592
	PTH 75	PTH 3	12.2	8116	1095	99015	13359
	PTH 3	PR 241	10.1	7800	915	78780	9242
	PR 241	PTH 1 (W. JCT.)	1.8	22237	1177	40027	2119
101	PTH 1 (E. JCT.)	PTH 15	5.8	2152	218	12482	1264
	PTH 59	PR 204	3.9	16038	1812	62548	7067
	PR 204	PTH 9	0.8	22140	2214	17712	1771
	PTH 9	PTH 8	2.9	14698	1836	42624	5324
	PTH 8	PTH 7	8.9	9770	1152	86953	10253
	PTH 7	PTH 6	5.8	5750	540	33350	3132
	PTH 6	PTH 1 (W. JCT.)	12.2	7810	850	95282	10370
Total			**176.6**			**1381066**	**133098**
District 13							
No expressways							

Table E-2. Summary of Vehicle-km of Travel (Expressways)

District	Distance (km)	Daily Veh-km	Daily Truck Veh-km	Annual Veh-km	Annual Truck Veh-km
1	98.9	248059	19987	90541681	7295292
2	302.6	1250843	112191	456557622	40949715
3	0.0	0	0	0	0
4	0.0	0	0	0	0
5	184.3	673278	122251	245746397	44621506
6	142.6	908350	128751	331547823	46994079
7	0.0	0	0	0	0
8	0.0	0	0	0	0
9	0.0	0	0	0	0
10	0.0	0	0	0	0
11	0.0	0	0	0	0
12	176.6	1381066	133098	504089200	48580807
13	0.0	0	0	0	0
Totals	**905**	**4461597**	**516278**	**1628482723**	**188441397**

Table E-3. Daily Vehicle-km of Travel (Primary Arterials)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 1							
8	PTH 27	PTH 67	10.0	2800	130	28000	1300
	PTH 67	PR 515	11.3	2465	133	27854.5	1502.9
	PR 515	PTH 17	16.6	2260	124	37516	2058.4
	PTH 17	PR 225	6.4	2225	153	14240	979.2
	PR 225	PR 229	7.7	1055	119	8123.5	916.3
67	PTH 9	PTH 8	9.2	1100	100	10120	920
	PTH 8	W. BDRY @ ST. ANDREWS	4.8	800	100	3840	480
12	S. BDRY RM SPRINGFIELD	PTH 15	9.7	785	63	7614.5	611.1
	PTH 15	PTH 44 (W. JCT.)	21.4	1550	122	33170	2610.8
44	PTH 11 (N. JCT.)	PR 214	15.8	1365	95	21567	1501
Total			**112.9**			**192046**	**12880**
District 2							
59	U.S. BORDER	PR 201	15.0	450	62	6750	930
	PR 201	PTH 23	30.4	1200	100	36480	3040
	PTH 23	PTH 52	20.1	1800	170	36180	3417
12	PTH 1	N. BDRY. RM TACHE	11.1	1020	78	11322	865.8
	U.S. BORDER	PR 308	20.6	520	62	10712	1277.2
	PR 308	PTH 89	26.6	735	78	19551	2074.8
	PTH 89	PR 302	47.2	695	60	32804	2832
	PR 302	PTH 52	34.0	2410	168	81940	5712
Total			**205.0**			**#######**	**######**
District 3							
2	PR 334 (E. JCT)	PTH 13	45.2	1329	163	60070.8	7367.6
	PTH 13	PR 244	40.9	1450	175	59305	7157.5
	PR 244	W. BDRY. RM NORFOLK	17.4	1000	150	17400	2610
3	PTH 2	PR 336	41.4	2400	240	99360	9936
	PR 336	PTH 13	21.2	2505	275	53106	5830
	PTH 13	PTH 23	14.8	2324	232	34395.2	3433.6
	PTH 23	PTH 14	19.6	2100	210	41160	4116
	PTH 14	PTH 31	26.4	3500	230	92400	6072
	PTH 31	W. BDRY. RM PEMBINA	29.6	1130	110	33448	3256
Total			**256.5**			**#######**	**######**
District 4							
10	U.S. BORDER	PTH 3	20.3	550	60	11165	1218
	PTH 3	PTH 23 (S. JCT.)	27.7	1050	121	29085	3351.7
	PTH 23 (S. JCT.)	PTH 23 (N. JCT.)	5.0	1250	126	6250	630
	PTH 23 (N. JCT.)	N. BDRY. RM WHITEWATER	11.3	1310	121	14803	1367.3
83	U.S. BORDER	PTH 3 (S. JCT.)	21.4	280	22	5992	470.8
	PTH 3 (N. JCT.)	N. BDRY. RM ALBERT	30.9	1500	128	46350	3955.2
Total			**116.6**			**113645**	**10993**

Table E-3. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 5							
2	E. BDRY. RM VICTORIA	PTH 34	6.2	1240	138	7688	855.6
	PTH 34	PR 342	17.4	1073	149	18670.2	2592.6
	PR 342	PTH 5	13.2	1084	108	14308.8	1425.6
	PTH 5	PTH 18	25.6	1116	98	28569.6	2508.8
	PTH 18	PTH 10 (S. JCT.)	25.6	1105	85	28288	2176
	PTH 10 (S. JCT.)	PTH 10 (N. JCT.)	4.2	2273	172	9546.6	722.4
	PTH 10 (N. JCT.)	PTH 22	21.6	1529	160	33026.4	3456
	PTH 22	PTH 21 (E. JCT.)	14.8	924	72	13675.2	1065.6
	PTH 21 (E. JCT.)	PTH 21 (W. JCT.)	8.2	1033	77	8470.6	631.4
	PTH 21 (W. JCT.)	PTH 83	32.0	705	75	22560	2400
	PTH 83	SK BDRY.	34.1	404	56	13776.4	1909.6
10	S. BDRY. RM OAKLAND	PTH 2 (S. JCT.)	6.0	1336	106	8016	636
	PTH 2 (N. JCT.)	PTH 1A	24.3	8000	350	194400	8505
	PTH 1A	PTH 1 (W. JCT.)	5.0	6593	520	32965	2600
	PTH 1 (E. JCT.)	PTH 25	15.0	3362	302	50430	4530
	PTH 25	N. BDRY. ELTON	5.0	3169	291	15845	1455
83	S. BDRY. RM PIPESTONE	PTH 2	3.2	711	68	2275.2	217.6
	PTH 2	PR 255	18.0	781	82	14058	1476
	PR 255	PTH 1 (E. JCT.)	16.3	800	105	13040	1711.5
	PTH 1 (W. JCT.)	ASSINIBOINE RIVER	24.3	426	24	10351.8	583.2
Total			**320**			**539961**	**41458**
District 6							
6	PTH 67	N. BDRY. RM WOODLANDS	33.5	2000	220	67000	7370
7	PTH 67	PTH 17	28.0	2900	176	81200	4928
	PTH 17	PR 229	14.2	1608	95	22833.6	1349
16	PTH 1	PTH 50	28.2	2700	330	76140	9306
	PTH 50	PTH 34	21.2	2425	310	51410	6572
	PTH 34	W. BDRY. RM LANSDOWNE	21.6	3335	376	72036	8121.6
67	E. BDRY. RM ROCKWOOD	PTH 7	9.8	770	100	7546	980
	PTH 7	PR 236 (S. JCT.)	6.4	2900	176	18560	1126.4
	PR 236 (S. JCT.)	PTH 6	14.8	680	68	10064	1006.4
Total			**177.7**			**#######**	**######**
District 7							
5	PTH 16 (E. JCT.)	PTH 16 (W. JCT.)	1.4	2710	188	3794	263.2
	PTH 16 (W. JCT.)	PR 357	23.2	2200	180	51040	4176
	PR 357	N. BDRY. RM ROSEDALE	23.3	1925	154	44852.5	3588.2
10	S. BDRY. R. ODANAH	PTH 24	6.6	3000	291	19800	1920.6
	PTH 24	PTH 16 (S. JCT.)	15.3	2800	350	42840	5355
	PTH 16 (S. JCT.)	PTH 16 (N. JCT.)	6.1	850	80	5185	488
	PTH 16 (N. JCT.)	PTH 45	30.6	2000	110	61200	3366
	PTH 45	RIDING MTN. NAT'L PARK	13.7	1800	100	24660	1370
16	E. BDRY. RM LANGFORD	PTH 5 (E. JCT.)	15.1	3750	364	56625	5496.4
	PTH 5 (W. JCT.)	PTH 16A (S. JCT.)	26.2	3340	267	87508	6995.4
	PTH 16A (S. JCT.)	PTH 10 (S. JCT.)	1.9	950	128	1805	243.2
	PTH 10 (N. JCT.)	PR 270	9.7	1995	263	19351.5	2551.1
	PR 270	PR 250 (W. JCT.)	15.0	2003	260	30045	1600
	PR 250 (W. JCT.)	PTH 21	29.3	1600	250	46880	7325
	PTH 21	PTH 83 (S. JCT.)	37.7	1335	276	50329.5	10405
	PTH 83 (S. JCT.)	PTH 41	19.6	1255	259	24598	5076.4

Table E-3. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 7 (continued)							
	PTH 41	PTH 83 (N. JCT.)	19.5	1800	265	35100	5167.5
	PTH 83 (N. JCT.)	SK BDRY.	15.8	1155	220	18249	3476
83	ASSINIBOINE RIVER	PTH 24	3.1	693	60	2148.3	186
	PTH 24	PTH 42 (S. JCT.)	32.0	950	70	30400	2240
	PTH 42 (N. JCT.)	PTH 16 (S. JCT.)	9.8	445	47	4361	460.6
	PTH 16 (N. JCT.)	PR 254	9.8	1045	120	10241	1176
Total			**364.7**			**671013**	**72926**
District 8							
5	S. BDRY. RM McCREARY	PTH 50	15.3	1047	115	16019.1	1759.5
	PTH 50	PTH 68	31.5	1200	130	37800	4095
	PTH 68	PTH 20	19.5	1650	175	32175	3412.5
	PTH 20	PTH 10 (S. JCT.)	20.3	854	92	17336.2	1867.6
	PTH 10 (S. JCT.)	PTH 5A (N. JCT.)	5.1	2098	132	10699.8	673.2
	PTH 5A (N. JCT.)	PTH 10 (N. JCT.)	14.8	2531	245	37458.8	3626
	PTH 10 (N. JCT.)	PR 366	28.6	1400	105	40040	3003
	PR 366	PTH 83 (E. JCT.)	48.8	1200	80	58560	3904
	PTH 83 (E. JCT.)	SK BDRY.	13.7	950	60	13015	822
10	N. BDRY. RIDING MTN.	PTH 5 (S. JCT.)	6.6	1023	45	6751.8	297
	PTH 5 (N. JCT.)	PR 267	24.6	940	93	23124	2287.8
	PR 267	N. BDRY. RM ETHELBERT	41.0	845	92	34645	3772
83	PR 254	PR 482	8.2	898	100	7363.6	820
	PR 482	PTH 5	34.8	850	65	29580	2262
Total			**312.8**			**#######**	**######**
District 9							
10	S. BDRY. LGD MOUNTAIN	PTH 20	39.3	732	76	28767.6	2986.8
	PTH 20	PR 268 (S. JCT.)	26.4	767	70	20248.8	1848
	PR 268 (S. JCT.)	PTH 10A (S. JCT.)	21.6	1600	170	34560	3672
	PTH 10A (S. JCT.)	PR 266	16.3	1820	129	29666	2102.7
	PR 266	PR 268	21.1	1080	90	22788	1899
	PR 268	PTH 77	38.1	800	55	30480	2095.5
	PTH 77	OVERFLOWING RIVER	55.0	565	55	31075	3025
83	S. BDRY. LGD PARK	PTH 57	21.6	428	42	9244.8	907.2
	PTH 57	PTH 49	25.1	653	39	16390.3	978.9
	PTH 49	PTH 10A	40.6	1691	135	68654.6	5481
Total			**305.1**			**#######**	**######**
District 10							
6	DEVIL'S LAKE	PTH 60	67.3	400	56	26920	3768.8
	PTH 60	PR 633 (GRAND RAPIDS)	33.3	320	55	10656	1831.5
	PR 633	WILLIAM RIVER	85.1	320	70	27232	5957
10	OVERFLOWING RIVER	S. LIMIT OF BOG	10.9	565	55	6158.5	599.5
	S. LIMIT OF BOG	PTH 60	13.8	565	55	7797	759
	PTH 60	PR 282	40.7	600	70	24420	2849
	PR 282	SASKATCHEWAN RIVER	34.1	1072	107	36555.2	3648.7
	SASKATCHEWAN RIVER	PR 287	18.7	1674	152	31303.8	2842.4
	PR 287	ROOT LAKE	11.6	927	125	10753.2	1450
	ROOT LAKE	PR 631	14.2	500	80	7100	1136
	PR 631	PR 613	25.4	500	80	12700	2032
	PR 613	PTH 39	4.2	733	96	3078.6	403.2
	PTH 39	PR 611	16.6	369	71	6125.4	1178.6

Table E-3. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 10 (continued)							
	PR 611	EAST BAKER'S NARROWS	24.3	823	78	19998.9	1895.4
	EAST BAKER'S NARROWS	PTH 10A (E. JCT.)	20.3	228	50	4628.4	1015
	PTH 10A (E. JCT.)	PTH 10A (W. JCT.)	6	228	50	1368	300
	PTH 10A (W. JCT.)	SK BDRY.	0.6	995	89	597	53.4
39	PTH 6	PR 392 (S. JCT.)	44.7	216	30	9655.2	1341
	PR 392 (S. JCT.)	PR 392 (N. JCT.)	18	245	25	4410	450
	PR 392 (N. JCT.)	PTH 10	101.5	369	71	37453.5	7206.5
60	PTH 6	PR 327	43.6	215	24	9374	1046.4
	PR 327	PTH 10	108.6	238	31	25846.8	3366.6
327	PTH 60	EASTERVILLE	21.2	120	10	2544	212
Total			**764.7**			**326676**	**45342**
District 11							
6	S. BDRY. ST. LAURENT	PR 229	34.1	1660	199	56606	6785.9
	PR 229	PTH 68 (S. JCT.)	32.5	1400	200	45500	6500
	PTH 68 (S. JCT.)	PTH 68 (N. JCT.)	10.6	1365	184	14469	1950.4
	PTH 68 (N. JCT.)	PR 325 (S. JCT.)	28.8	1147	172	33033.6	4953.6
	PR 325 (S. JCT.)	PR 239	32.3	1100	148	35530	4780.4
	PR 239	PR 513	37.2	1060	160	39432	5952
	PR 513	DEVIL'S LAKE	81.6	500	65	40800	5304
8	PR 229	PR 231	14.8	1200	110	17760	1628
	PR 231	PTH 68	29.5	1500	80	44250	2360
	PTH 68	PR 329	10.0	930	62	9300	620
	PR 329	HECLA ISLAND CAUSEWAY	22.0	695	48	15290	1056
	HECLA ISLAND CAUSEWA	GULL HARBOUR DOCK ROA	32.2	460	15	14812	483
Total			**365.6**			**366783**	**42373**
District 12							
2	PTH 100	PTH 3	1.6	1162	102	1859.2	163.2
	PTH 3	PR 334 (E. JCT.)	6.3	1988	202	12524.4	1272.6
3	BRADY ROAD	PTH 100	8.2	4570	438	37474	3591.6
	PTH 100	PTH 2	1.1	3925	408	4317.5	448.8
Total			**17.2**			**56175.1**	**5476.2**
District 13							
6	WILLIAM RIVER	PTH 39	89.6	290	75	25984	6720
	PTH 39	PR 606	46.8	435	84	20358	3931.2
	PR 606	PR 375	78.4	778	77	60995.2	6036.8
	PR 375	THOMPSON	28.8	929	74	26755.2	2131.2
Total			**243.6**			**#######**	**######**

Table E-4. Summary of Vehicle-km of Travel (Primary Arterials)

District	Distance (km)	Daily Veh-km	Daily Truck Veh-km	Annual Veh-km	Annual Truck Veh-km
1	112.9	192046	12880	70096608	4701091
2	205.0	235739	20149	86044735	7354312
3	256.5	490645	49779	179085425	18169226
4	116.6	113645	10993	41480425	4012445
5	320	539961	41458	197085692	15132134
6	177.7	406790	40759	148478204	14877181
7	364.7	671013	72926	244919672	26617917
8	312.8	364568	32602	133067430	11899584
9	305.1	291875	24996	106534412	9123577
10	764.7	326676	45342	119236558	16549830
11	365.6	366783	42373	133875649	15466255
12	17.2	56175	5476	20503912	1998813
13	243.6	134092	18819	48943726	6869008
Total	**3562.4**	**4190007**	**418552**	**1529352446**	**152771371**

Table E-5. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 3							
13	PTH 3	PTH 2	20.0	1650	155	33000	3100
	PTH 2	N. BDRY. RM GREY	13.0	918	204	11934	2652
14	PTH 75	PTH 30	16.7	1281	240	21393	4008
	PTH 30	PTH 32	28.6	3644	408	104218	11669
	PTH 32	PTH 3	5.0	5825	343	29125	1715
23	PTH 75	PR 336 (W. JCT.)	24.9	869	86	21638	2141
	PR 336 (W. JCT.)	PTH 3	22.2	743	74	16495	1643
30	U.S. BORDER	PTH 14	21.9	1500	160	32850	3504
31	U.S. BORDER	PTH 3	22.7	307	30	6969	681
32	U.S. BORDER	PTH 14	22.7	2286	251	51892	5698
240	PTH 3	PTH 23 (W. JCT.)	21.2	80	6	1696	127
	PTH 23 (E. JCT.)	PR 245 (E. JCT.)	15.0	90	9	1350	135
	PR 245 (W. JCT.)	PTH 2	18.2	250	31	4550	564
	PTH 2	N. BDRY. RM GREY	14.8	227	19	3360	281
Total			**266.9**			**340470**	**37918**
District 4							
3	E. BDRY. RM LOUISE	PTH 34 (N. JCT.)	10.9	745	61	8121	665
	PTH 34 (N. JCT.)	PTH 34 (S. JCT.)	18.3	850	80	15555	1464
	PTH 34 (S. JCT.)	PTH 5	29.1	500	40	14550	1164
	PTH 5	PTH 18 (S. JCT.)	23.2	540	44	12528	1021
	PTH 18 (S. JCT.)	PTH 18 (N. JCT.)	9.2	935	59	8602	543
	PTH 18 (N. JCT.)	PTH 10	29.3	725	45	21243	1319
	PTH 10	PTH 21 (S. JCT.)	33.5	720	67	24120	2245
	PTH 21 (S. JCT.)	PTH 21 (N. JCT.)	8.5	766	69	6511	587
	PTH 21 (N. JCT.)	PTH 83 (N. JCT.)	35.1	600	50	21060	1755
	PTH 83 (N. JCT.)	PTH 83 (S. JCT.)	12.7	745	58	9462	737
	PTH 83 (S. JCT.)	SASKATCHEWAN BOUNDARY	24.5	500	50	12250	1225
5	U.S. BORDER	PTH 3	10	230	10	2300	100
	PTH 3	PR 253 (S. JCT.)	20.8	200	10	4160	208
	PR 253 (S. JCT.)	PTH 23	14.8	250	27	3700	400
	PTH 23	N. BDRY. RM ARGYLE	16.9	400	42	6760	710
18	U.S. BORDER	PTH 3 (S. JCT.)	10	390	36	3900	360
	PTH 3 (N. JCT.)	PTH 23 (W. JCT.)	24.9	1000	80	24900	1992
	PTH 23 (W. JCT.)	PTH 23 (E. JCT.)	2.4	760	79	1824	190
	PTH 23 (E. JCT.)	N. BDRY. RM STRATHCONA	14.8	620	43	9176	636
21	U.S. BORDER	PTH 3 (S. JCT.)	22.4	275	30	6160	672
	PTH 3 (N. JCT.)	PTH 23	21.4	500	45	10700	963
	PTH 23	N. BDRY. RM CAMERON	10.9	560	50	6104	545
22	PTH 23	N. BDRY. RM WHITEWATER	9.8	270	24	2646	235
23	PTH 34	PTH 5	39.8	520	58	20696	2308
	PTH 5	PTH 18 (N. JCT.)	25.4	500	56	12700	1422
	PTH 18 (S. JCT.)	PTH 10 (S. JCT.)	26.6	545	60	14497	1596
	PTH 10 (N. JCT.)	PTH 21	36.2	325	35	11765	1267
34	U.S. BORDER	PTH 3 (S. JCT.)	9.7	220	29	2134	281
	PTH 3 (N. JCT.)	PTH 23	19.5	420	45	8190	878
	PTH 23	N. BDRY. RM LORNE	16.4	475	59	7790	968
Total			**587.0**			**314103**	**28453**
District 5							
5	S. BDRY. RM S. CYPRESS	PTH 2	4.8	354	42	1699	202
	PTH 2	CARBERRY	35.1	600	80	21060	2808
	CARBERRY	PTH 1	6.0	1676	150	10056	900
	PTH 1	N. BDRY. RM N. CYPRESS	24.3	650	20	15795	486
18	S. BDRY. RM S. CYPRESS	PTH 2	3.2	598	52	1914	166

Table E-5. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
21	S. BDRY. RM SIFTON	PTH 2 (W. JCT.)	6.1	474	48	2891	293
	PTH 2 (E. JCT.)	PTH 1	18.2	580	55	10556	1001
	PTH 1	N. BDRY. RM WOODWORTH	39.3	460	33	18078	1297
22	S. BDRY. RM GLENWOOD	PTH 2	11.1	466	41	5173	455
25	PTH 10	PR 250 (E. JCT.)	21.9	925	75	20258	1643
	PR 250 (E. JCT.)	PR 259	6.3	637	50	4013	315
34	S. BDRY. RM VICTORIA	PTH 2	7.9	588	44	4645	348
	PTH 2	N. BDRY. RM VICTORIA	23.5	498	50	11703	1175
41	PTH 1	PR 571	33.2	220	20	7304	664
250	PTH 2	PTH 1	24.6	250	30	6150	738
	PTH 1	PTH 25 (W. JCT.)	23.2	205	29	4756	673
	PTH 25 (E. JCT.)	N. BDRY. RM DALY	3.9	703	56	2742	218
257	PTH 1	PTH 83	4.7	2000	100	9400	470
	PTH 83	PR 256	19.6	1152	140	22579	2744
	PR 256	SASKATCHEWAN BOUNDARY	13	600	60	7800	780
340	S. BDRY. RM S. CYPRESS	PTH 2 (E. JCT.)	4	35	0	140	0
	PTH 2 (W. JCT.)	PR 344 (S. JCT.)	21.8	368	20	8022	436
	PR 344 (S. JCT.)	PTH 1	32.6	750	40	24450	1304
344	S. BDRY. RM OAKLAND	PTH 2 (E. JCT.)	5.5	114	10	627	55
	PTH 2 (E. JCT.)	PTH 2 (W. JCT.)	8.5	400	46	3400	391
	WAWANESA	PR 340 (S. JCT.)	5.8	200	15	1160	87
	PR 340 (N. JCT.)	PTH 10	39.5	77	5	3042	198
Total			**447.6**			**229412**	**19846**
District 6							
13	S. BDRY. RM PORTAGE	PTH 1	17.4	1485	184	25839	3202
17	E. BDRY. RM ROCKWOOD	PTH 7	10	570	32	5700	320
	PTH 7	W. BDRY. RM ROCKWOOD	20.3	775	43	15733	873
26	PTH 1	PR 248 (W. JCT.)	24.3	825	100	20048	2430
	PR 248 (W. JCT.)	PR 430	20.6	425	51	8755	1051
	PR 430	PTH 1A	19.5	1990	85	38805	1658
34	S. BDRY. RM N. NORFOLK	PTH 1	18	545	45	9810	810
	PTH 1	PTH 16	29.3	675	62	19778	1817
50	PTH 16	N. BDRY. RM LAKEVIEW	39.6	600	55	23760	2178
227	PTH 6	PR 430 (N. JCT.)	33.1	410	53	13571	1754
	PR 430 (S. JCT.)	PR 240 (E. JCT.)	19.8	115	10	2277	198
	PR 240 (W. JCT.)	PTH 16	16.9	265	15	4479	254
240	S. BDRY. RM PORTAGE	PR 331	19.3	375	25	7238	483
	PR 331	PTH 1	3.4	450	30	1530	102
	PTH 1	PTH 1A (E. JCT.)	2.3	3930	125	9039	288
Total			**293.8**			**206360**	**17415**
District 7							
5	S. BDRY. RM LANGFORD	PTH 16 (E. JCT.)	18.2	895	47	16289	855
21	S. BDRY. RM HAMIOTA	PTH 24	8.2	515	29	4223	238
	PTH 24	PTH 16	34.6	750	50	25950	1730
	PTH 16	PTH 45	14.5	570	63	8265	914
45	PTH 10	PR 250	17.1	670	57	11457	975
	PR 250	PTH 21	29.5	315	31	9293	915
	PTH 21	PR 254	22.4	315	31	7056	694
	PR 254	PR 476	17.4	545	43	9483	748
	PR 476	PTH 16	19.8	750	50	14850	990
357	PTH 5	PR 466	14.5	255	19	3698	276
	PR 466	PTH 10	21.1	438	43	9242	907
Total			**217.3**			**119805**	**9241**
District 8							

Table E-5. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
20	PTH 5	DAUPHIN BEACH	12.4	978	68	12127	843
	DAUPHIN BEACH	PTH 20A (S. JCT.)	12.4	2068	117	25643	1451
	PHT 20A (S. JCT.)	PR 267	24.8	950	70	23560	1736
	PR 267	PR 618 (WINNIPEGOSIS)	32.8	650	50	21320	1640
	PR 618 (WINNIPEGOSIS)	N. BDRY. RM MOSSEY	16.6	420	29	6972	481
50	S. BDRY. LGD ALONSA	PR 261	10.3	300	30	3090	309
	PR 261	PR 278	26.2	290	24	7598	629
	PR 278	PTH 5	47.3	300	30	14190	1419
68	LAKE MANITOBA NARROWS	PR 278	45.4	418	150	18977	6810
	PR 278	PTH 5	23.5	628	75	14758	1763
276	PTH 5	PR 364	40.2	450	45	18090	1809
	PR 364	PR 269	29.9	320	32	9568	957
	PR 269	PR 328	25.1	237	20	5949	502
	PR 328	SKOWNAN	19.2	204	10	3917	192
278	PTH 50	PTH 68	41.7	325	38	13553	1585
328	E. BDRY. LGD ALONSA	PR 276	7.6	200	7	1520	53
364	PR 276	PR 269 (S. JCT.)	38.6	150	10	5790	386
	PR 269 (N. JCT.)	PTH 20	9.2	135	10	1242	92
Total			**463.2**			**207864**	**22656**
District 9							
20	S. BDRY. LGD MOUNTAIN	PR 272	34.3	250	20	8575	686
	PR 272	PTH 10	36.7	250	20	9175	734
49	PTH 83	SASKATCHEWAN BOUNDARY	1.6	431	33	690	53
57	PTH 83	SASKATCHEWAN BOUNDARY	1.6	250	25	400	40
77	PTH 10	SASKATCHEWAN BOUNDARY	41.5	200	17	8300	706
Total			**115.7**			**27140**	**2218**
District 10							
283	PTH 10	PR 282	17.9	372	37	6659	662
	PR 282	SASKATCHEWAN BOUNDARY	21.9	189	20	4139	438
392	N. BDRY. RM WEKUSKO	PTH 39 (S. JCT.)	8.4	23	2	193	17
	PTH 39 (N. JCT.)	PR 393	29.1	260	26	7566	757
	PR 393	SNOW LAKE	5.3	879	70	4659	371
Total			**82.6**			**23216**	**2245**
District 11							
7	PR 229	PR 231 (N. JCT.)	18	830	65	14940	1170
	PR 231 (N. JCT.)	PTH 68	26.2	820	75	21484	1965
17	E. BDRY. LGD ARMSTRONG	PR 231	25.3	350	35	8855	886
	PR 231	PTH 68	25.7	345	30	8867	771
	PTH 68	PR 233	21.4	750	65	16050	1391
	PR 233	PR 325	14.8	640	48	9472	710
68	PTH 8	PTH 7	15	700	60	10500	900
	PTH 7	PTH 17	27.5	620	60	17050	1650
	PTH 17	PTH 6	38.6	355	25	13703	965
	PTH 6 (N. JCT.)	LAKE MANITOBA NARROWS	59.1	380	53	22458	3132
233	PR 234	PR 226 (S. JCT.)	30.6	120	10	3672	306
	PR 226 (N. JCT.)	PTH 17	22.8	230	23	5244	524
	PTH 17	PR 325	24.6	600	50	14760	1230
325	PR 234	PTH 17	42.0	130	10	5460	420
	PTH 17	PTH 6 (N. JCT.)	55.7	270	20	15039	1114
	PTH 6 (S. JCT.)	PTH 68	29.8	581	21	17314	626
328	PTH 6	PROULX CREEK	39.3	120	10	4716	393
	PROULX CREEK	BDRY. LGD ALONSA	16.9	120	10	2028	169
Total			**533.3**			**211611**	**18322**

Table E-5. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 12							
9	S. BDRY. W. ST. PAUL	PTH 101	1.3	14026	840	18234	1092
	PTH 101	PTH 27	8.5	8048	482	68408	4097
	PTH 27	PTH 44	7.7	8040	280	61908	2156
206	PTH 52	PR 207	22	870	50	19140	1100
	PR 207	PTH 1	4.8	675	54	3240	259
Total			**44.3**			**170930**	**8704**
District 13							
373	NORWAY HOUSE	CROSS LAKE ROAD	79.8	250	20	19950	1596
	CROSS LAKE ROAD	PR 603	71	140	10	9940	710
	PR 603	PTH 6	24.8	172	45	4266	1116
391	THOMPSON	PR 280	13.8	1500	100	20700	1380
	PR 280	PR 602 (NELSON HOUSE)	64.4	260	20	16744	1288
	RUTTAN LAKE	LYNN LAKE	104.1	220	20	22902	2082
Total			**357.9**			**94502**	**8172**

Table E-6. Summary of Vehicle-km of Travel (Secondary Arterials)

District	Distance (km)	Daily Veh-km	Daily Truck Veh-km	Annual Veh-km	Annual Truck Veh-km
1	726.9	709529	53547	258977939	19544582
2	199.9	169063	14837	61707813	5415396
3	266.9	340470	37918	124271368	13840180
4	587.0	314103	28453	114647413	10385491
5	447.6	229412	19846	83735526	7243644
6	293.8	206360	17415	75321218	6356475
7	217.3	119805	9241	43728752	3373075
8	463.2	207864	22656	75870214	8269550
9	115.7	27140	2218	9905954	809680
10	82.6	23216	2245	8473767	819316
11	533.3	211611	18322	77238125	6687676
12	44.3	170930	8704	62389377	3177033
13	357.9	94502	8172	34493084	2982780
Total	**4336.4**	**2824002**	**243575**	**1.031E+09**	**88904875**

Table E-7. Daily Vehicle-km of Travel (Collectors)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 1							
204	PTH 44	PTH 9A	11.3	1780	142	20114	1605
211	E. END OF ROAD	PTH 11	14	1245	99	17430	1386
212	PR 213	PTH 44	11.6	377	45	4373	522
	PTH 44	PTH 59	8.4	85	4	714	34
	PTH 59	PR 204	3.7	1765	124	6531	459
213	PTH 12	PR 207	21.6	348	24	7517	518
215	PTH 44	PTH 12	9.8	1255	75	12299	735
225	PR 232	PTH 9	1.3	505	40	657	52
	PTH 9	PTH 8	5	510	15	2550	75
229	PTH 9	PTH 8	3.2	685	27	2192	86
232	PTH 9 (S. JCT.)	PTH 9 (N. JCT.)	10	603	48	6030	480
301	PTH 1	PTH 44	11.6	425	35	4930	406
302	S. BDRY. RM SPRINGFIELD	PTH 15	10	161	13	1610	130
	PTH 15	PTH 44	20.1	510	87	10251	1749
306	PTH 15	PTH 44 (E. JCT.)	21.4	149	12	3189	257
	PTH 44 (W. JCT.)	PTH 59	20.9	140	11	2926	230
307	PTH 44	PR 309	23.3	370	22	8621	513
	PR 309	OTTER FALLS	34.4	361	29	12418	998
	OTTER FALLS	PTH 11	20.4	616	43	12566	877
309	PR 307	BIG WHITESHELL LAKE	12.2	225	22	2745	268
312	PTH 44	ONTARIO BOUNDARY	5.5	315	20	1733	110
313	POINTE DUBOIS	PR 315	19	155	16	2945	304
	PR 315	PTH 11	20.8	740	59	15392	1227
314	PR 315	CAT LAKE	23.2	45	5	1044	116
	CAT LAKE	PR 304	50.9	30	2	1527	102
315	PR 313	PR 314	30.9	391	39	12082	1205
	PR 314	ONTARIO BOUNDARY	28.8	70	7	2016	202
316	PTH 44	PR 317	23.7	65	5	1541	119
319	PTH 59	PATRICIA BEACH	6	155	12	930	72
320	PTH 9A	PTH 4	6.1	2932	176	17885	1074
	PTH 4	NETLEY CREEK	11.9	175	14	2083	167
406	PTH 15	PTH 11	9.0	228	18	2052	162
408	PTH 11	PR 307	13.7	325	26	4453	356
410	PTH 9	PR 230	2.4	625	50	1500	120
413	PTH 9	PTH 8	5	280	25	1400	125
	PTH 8	W. BDRY. RM ST. ANDREWS	4.8	190	25	912	120
433	PR 313 (E. JCT.)	PR 313 (W. JCT.)	19.6	163	13	3195	255
435	PR 214	PR 316	7.6	50	4	380	30
	PR 316	PTH 12	9.8	60	5	588	49
	PTH 12	PTH 59	21.4	95	8	2033	171
	PTH 59	PR 212	3.5	40	3	140	11
500	PTH 12 (S. JCT.)	PTH 12 (N. JCT.)	11.7	240	19	2808	222
502	PTH 11	PR 313	5.6	2463	123	13793	689
	PR 313	PTH 11	3.4	132	11	449	37
504	PTH 59	OLAFSON ROAD	2.3	220	18	506	41
508	PR 212	PTH 4	5.6	806	56	4514	314
	PTH 4	PTH 59	7.2	407	33	2930	238
509	PTH 59	PR 204	1.6	1580	126	2528	202
510	PTH 44	PR 435	8.2	385	23	3157	189
515	PTH 9	PTH 8	5	865	35	4325	175
520	PR 211	PR 213	14.5	175	14	2538	203
Total			**662.9**			**253038**	**19784**

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
District 2							
200	PTH 75	PR 201 (E. JCT.)	19.5	487	49	9497	956
	PR 201 (W. JCT.)	PTH 23	25.7	531	53	13647	1362
	PTH 23	N. BDRY. RM DE SALABERRY	19	580	58	11020	1102
	N. BDRY. RM DE SALABERRY	PR 210	20.4	652	65	13301	1326
203	PTH 12 (S. JCT.)	PR 210	30.3	67	5	2030	152
	PR 210	PTH 12 (N. JCT.)	16.1	45	4	725	64
205	PTH 12	PTH 59 (S. JCT.)	16.1	45	4	725	64
	PTH 59 (N. JCT.)	PR 200 (S. JCT.)	13.4	308	25	4127	335
	PR 200 (N. JCT.)	PTH 75	8.2	260	31	2132	254
207	PTH 1 (E. JCT.)	PTH 12	9.8	1173	94	11495	921
	PTH 12	PR 206	14.6	775	47	11315	686
	PR 206	PTH 1	15.4	2211	66	34049	1016
209	PR 201	PTH 59	14.8	117	15	1732	222
	PTH 59	PR 200	29.8	130	10	3874	298
210	PTH 12	PR 203	14	87	8	1218	112
	PR 203	E. BDRY. RM LA BROQUERIE	27.5	225	18	6188	495
	E. BDRY. RM LA BROQUERIE	PTH 52	14.2	570	46	8094	653
	PTH 52	PR 207 (E. JCT.)	19.6	419	38	8212	745
	PR 207 (W. JCT.)	PTH 12	1.6	1380	55	2208	88
	PTH 12	PR 206 (N. JCT.)	12.1	277	19	3352	230
	PR 206 (S. JCT.)	PTH 59 (N. JCT.)	12.9	621	50	8011	645
	PTH 59 (S. JCT.)	PR 200	9.5	325	26	3088	247
	PR 200	PTH 75	1.4	1575	63	2205	88
216	PTH 59	PR 205 (S. JCT.)	15.1	563	45	8501	680
	PR 205 (N. JCT.)	PTH 52 (E. JCT.)	11.4	1213	97	13828	1106
	PTH 52 (W. JCT.)	PR 311	8.2	277	22	2271	180
217	PTH 59	PR 200 (S. JCT.)	26.4	87	7	2297	185
	PR 200 (N. JCT.)	PR 246	11.4	87	7	992	80
218	PR 209	PR 201	6.6	173	14	1142	92
	PR 201	PR 217 (W. JCT.)	14.8	118	9	1746	133
	PR 217 (E. JCT.)	PTH 59	8	280	25	2240	200
246	PTH 75	PTH 23	12.1	640	45	7744	545
	PTH 23	PR 200	23.2	157	73	3642	1694
302	PR 201	PTH 12	17.2	230	14	3956	241
	PTH 12	PTH 52	24.5	72	6	1764	147
	PR 210	PTH 1	18.2	295	24	5369	437
	PTH 1	N. BDRY. RM TACHE	16.4	151	12	2476	197
303	PR 302	PTH 12	14.6	160	13	2336	190
	PTH 12	PR 216 (S. JCT.)	13.2	240	17	3168	224
	PR 216 (N. JCT.)	PTH 59	8.2	175	14	1435	115
	PTH 59	PR 200	13.5	565	45	7628	608
305	PTH 59	PR 200	13.7	205	16	2809	219
	PR 200	PTH 75	1.4	705	56	987	78
308	PTH 12	MOOSE LAKE ENTRANCE	35.4	288	26	10195	920
	MOOSE LAKE ENTRANCE	CARIBOU TOWER	34.9	88	7	3071	244
	CARIBOU TOWER	PR 503	22.7	68	5	1544	114
	PR 503	PTH 1	9.3	118	13	1097	121
310	U.S. BORDER	PTH 12	4.0	240	7	960	28
311	PR 302	PTH 12 (S. JCT.)	13.5	397	32	5360	432
	PTH 12 (N. JCT)	PTH 59	21.2	1477	118	31312	2502
	PTH 59	PR 200	10.8	369	48	3985	518
318	PR 303	PR 311	11.9	230	18	2737	214
400	PR 217	PTH 23	11.6	50	4	580	46
402	PR 201	PTH 12	10.1	60	4	606	40
403	PR 216	PTH 59	7.6	225	18	1710	137

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
404	PTH 12	PR 210	24.1	55	4	1326	96
405	PR 206	W. BDRY. RM TACHE	15.6	150	12	2340	187
501	RR TRACKS	PTH 12	16.4	318	25	5215	410
	PTH 12	PTH 1	9.8	430	34	4214	333
503	PR 308	PR 505	25.7	12	1	308	26
	PR 505	PTH 1	8.9	25	2	223	18
505	PR 503	WHITEMOUTH RIVER	5.1	10	1	51	5
506	PTH 1 (E. JCT.)	PTH 11	22.5	105	8	2363	180
	PTH 11	PTH 1 (W. JCT.)	26.6	22	2	585	53
507	PR 506	PTH 11	4	100	8	400	32
525	U.S. BDRY.	PR 308	9.7	100	8	970	78
Total			**1005.4**			**319726**	**26147**
District 3							
23	PTH 3	W. BDRY RM THOMPSON	30.4	780	80	23712	2432
	E. BDRY. RM LORNE	PTH 34	32.0	750	80	24000	2560
201	PTH 75	PTH 30 (N. JCT.)	17.7	487	83	8620	1469
	PTH 30 (S. JCT.)	PTH 32 (N. JCT.)	28	562	40	15736	1120
	PTH 32 (S. JCT.)	PTH 32	39.4	135	11	5319	433
	PTH 31	PR 242	29.0	62	5	1798	145
242	W. BDRY. RM PEMBINA	PTH 3 (E. JCT.)	25.6	221	18	5658	461
	PTH 3 (W. JCT.)	PTH 23	20.4	126	10	2570	204
	PTH 23	PTH 2 (W. JCT.)	28.3	376	34	10641	962
	PTH 2 (E. JCT.)	PR 461	17.5	188	17	3290	298
243	PTH 75	PTH 30 (S. JCT.)	22.2	137	14	3041	311
	PTH 30 (N. JCT.)	PTH 32	29.6	216	17	6394	503
	PTH 32	PR 201	23	118	13	2714	299
244	PR 423	PR 3	7.1	306	31	2173	220
	PTH 3	PTH 23	16.4	610	61	10004	1000
	PTH 23	PR 245 (S. JCT.)	13.2	482	48	6362	634
	PR 245 (S. JCT.)	PTH 2	16.6	537	48	8914	797
	PTH 2	PR 242	13.2	110	9	1452	119
245	PTH 3	PR 244 (S. JCT.)	41.4	700	56	28980	2318
	PR 244 (N. JCT.)	PR 242 (E. JCT.)	7.9	287	23	2267	182
	PR 242 (W. JCT.)	PTH 34	11.3	95	8	1074	90
246	PR 201	PTH 14	6.6	153	12	1010	79
	PTH 14	PTH 75	11.4	65	5	741	57
247	PTH 75	PR 330 (N. JCT.)	11.3	300	21	3390	237
	PR 330 (S. JCT.)	PTH 3 (N. JCT.)	9.8	270	16	2646	157
	PTH 3 (S. JCT.)	PTH 2	43.5	75	6	3263	261
248	PR 243	PTH 14	17.4	360	29	6264	505
	PTH 14	PTH 23 (E. JCT.)	20.6	106	8	2184	165
	PTH 23 (W. JCT.)	PTH 3	18	51	4	918	72
	PTH 3	PR 305 (W. JCT.)	11.7	112	9	1310	105
	PR 305 (E. JCT.)	PTH 2	16.7	153	21	2555	351
	PTH 2	N. BDRY RM GREY	6.3	414	33	2608	208
305	PTH 75	PR 330 (S. JCT.)	12.1	136	19	1646	230
	PR 330 (N. JCT.)	PTH 3	17.5	191	15	3343	263
	PTH 3	PTH 13	31.1	197	16	6127	498
	PTH 13	PR 240	24.8	112	9	2778	223
	PR 240	PTH 2	13.4	144	16	1930	214
	PTH 2	N. BDRY. RM S. NORFOLK	16.3	390	27	6357	440
330	PTH 75	PR 247 (N. JCT.)	38.3	330	30	12639	1149
	PR 247 (N. JCT.)	PTH 100	9	1005	80	9045	720
332	PTH 14	PTH 23 (W. JCT.)	18.2	216	22	3931	400
	PTH 23 (W. JCT.)	PR 205 (W. JCT.)	16.6	212	17	3519	282
	PR 205 (E. JCT.)	PTH 3	10.3	193	15	1988	155

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
	PTH 3	PR 247 (E. JCT.)	9.5	50	4	475	38
	PR 247 (W. JCT.)	PTH 2	10	193	15	1930	150
	PTH 2	N. BDRY. RM MACDONALD	3.4	265	21	901	71
334	PR 330	PTH 3	14.5	281	22	4075	319
	PR 247	PTH 2	9.8	132	11	1294	108
336	PR 201	PTH 14	9.8	190	15	1862	147
	PTH 14	PTH 23 (E. JCT.)	18	168	13	3024	234
	PTH 23 (W. JCT.)	PTH 3	16.6	171	15	2839	249
	PTH 3	PR 305	10	100	16	1000	160
338	PTH 3	PTH 23	24.8	132	11	3274	273
	PTH 23	PR 245	14.8	255	20	3774	296
	PR 245	PTH 2(W. JCT.)	18.7	164	13	3067	243
	PTH 2 (E. JCT.)	N. BDRY RM GREY	16.4	152	12	2493	197
350	W. BDRY RM S. NORFOLK	PR 461	8.7	41	3	357	26
420	PTH 75	PR 247	11.9	130	10	1547	119
421	PTH 75	PTH 30	20.6	356	28	7334	577
422	PTH 23	PR 205	11.6	299	24	3468	278
423	PR 528	PR 242	17.7	70	6	1239	106
424	PTH 2	N. BDRY RM MACDONALD	3.4	180	14	612	48
428	PTH 14	PTH 23	18.3	415	37	7595	677
431	PR 244	PTH 23	6.6	175	14	1155	92
432	PR 201	PTH 3	17.7	269	22	4761	389
	PTH 3	PTH 23	19.8	618	49	12236	970
434	LAKE MINNEWASTA	PTH 3	1.4	413	33	578	46
521	PR 243	PTH 32	5.1	180	14	918	71
522	PR 243	PR 421	6.6	60	5	396	33
523	PTH 75	PR 332	15.3	61	9	933	138
524	U.S. BORDER	PR 243	3.2	77	6	246	19
528	NEIL ST. (KALEIDA)	PTH 3	7.1	159	13	1129	92
Total			**1202.4**			**329419**	**29496**
District 4							
201	PR 242	PTH 34	19.8	87	7	1723	139
242	U.S. BORDER	E. BDRY. RM LOUISE	3.4	94	8	320	27
245	PTH 34	PTH 5	35.6	65	5	2314	178
251	PTH 21	PR 452	18	337	30	6066	540
	PR 452	PTH 83 (N. JCT.)	19.8	225	23	4455	455
	PTH 83 (S. JCT.)	PR 256 (N. JCT.)	14.8	95	10	1406	148
	PR 256 (S. JCT.)	SASK BDRY	5.0	55	4	275	20
252	PTH 3	PR 345 (W. JCT.)	24.8	37	3	918	74
	PR 345 (E. JCT.)	N. BDRY RM ALBERT	15.4	132	1	2033	15
253	PTH 3	ROCKK LAKE CORNER	19.2	273	25	5242	480
	ROCK LAKE CORNER	PTH 5 (S. JCT.)	16.6	167	13	2772	216
	PTH 5 (N. JCT.)	PTH 18	25.6	119	10	3046	256
254	PR 251	PTH 3 (E. JCT.)	16.9	160	13	2704	220
	PTH 3 (W. JCT.)	PR 345 (E. JCT.)	16.1	77	6	1240	97
	PR 345 (W. JCT.)	N. BDRY. RM CAMERON	25.9	52	4	1347	104
256	U.S. BORDER	PTH 3 (E. JCT.)	23	160	13	3680	299
	PTH 3 (W. JCT.)	PR 345 (E. JCT.)	24.6	214	17	5264	418
	PR 345 (W. JCT.)	N. BDRY RM ALBERT	15	92	7	1380	105
340	PTH 3	PR 253 (W. JCT.)	18.3	55	4	1007	73
	PR 253 (E. JCT.)	PTH 23 (E. JCT.)	16.1	130	10	2093	161
	PTH 23 (E. JCT.)	PTH 23 (W. JCT.)	4.8	385	31	1848	149
	BELMONT	N. BDRY RM STRATHCONA	15.6	87	7	1357	109
341	PTH 18	PTH 10	34	76	7	2584	238
342	PTH 3A	PR 253 (S. JCT.)	13.7	165	13	2261	178
	PR 253 (N. JCT.)	PTH 23	14.8	95	8	1406	118

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
	PTH 23	N. BADRY RM ARGYLE	17.1	85	7	1454	120
343	PTH 10	PTH 21	36.2	38	3	1376	109
344	PTH 23	N. BDRY RM RIVERSIDE	17.2	104	8	1789	138
345	PTH 21	PTH 83	33	100	7	3300	231
	PTH 83	SSASSK BDRY	32.2	118	9	3800	290
346	PR 341	PTH 3 (E. JCT.)	8.4	85	7	714	59
	PTH 3 (W. JCT.)	PTH 23	26.2	120	10	3144	262
	PTH 23	N. BDRY RM RIVERSIDE	17.1	37	3	633	51
347	N. DBDRY. RM CAMERON	PTH 21	12.1	104	8	1258	97
	PTH 21	PR 254	6.6	120	10	792	66
348	PR 343 (E. JCT.)	PTH 23	11.6	73	6	847	70
	PTH 23	PR 347	9.8	44	4	431	39
423	PR 242	PTH 3	19.8	120	13	2376	257
440	PR 253	PTH 23	19.2	100	8	1920	154
442	PTH 3	PR 342	19.2	112	9	2150	173
443	PR 346	PTH 10	13.4	292	23	3913	308
444	WILLIAM LAKE	PR 341	8.4	55	4	462	34
445	PTH 3	SSASK BDRY	29.3	190	15	5567	440
446	LLAKE MAX	PTH 3	12.1	40	3	484	36
447	PR 254	PTH 83	20.1	57	5	1146	101
448	PTH 10	PR 343	23	23	2	529	46
	PR 343	PTH 23	11.6	80	10	928	116
450	U.S. BORDER	PTH 3	20.8	205	16	4264	333
452	PR 251	PTH 3	18.2	300	24	5460	437
	PTH 3	PR 447	6.6	210	25	1386	165
458	PR 251	PTH 3	19.8	90	11	1782	218
530	PTH 23	PR 245	10	83	7	830	70
532	PTH 23	PR 245	11.6	90	7	1044	81
541	PR 442	PTH 5	15.8	75	6	1185	95
Total			**963.2**			**113701**	**9410**
District 5							
252	S. BDRY RM PIPESTONE	PTH 2 (W. JCT.)	3.2	329	20	1053	64
	PTH 2 (E. JCT.)	PTH 1	40.2	86	9	3457	362
254	S. BDRY RM SIFTON	PTH 2	5.0	38	3	190	15
	PTH 2	PTH 1 (W. JCT.)	28.0	151	9	4228	252
	PTH 1 (E. JCT.)	PR 259 (S. JCT.)	22.0	103	6	2266	132
	PR 259 (S. JCT.)	PR 259 (N. JCT.)	11.3	276	22	3119	249
	PR 259 (N. JCT.)	N. BDRY RM WOODWORTH	10.0	85	7	850	70
255	PR 254	PTH 83	18.0	93	7	1674	126
	PTH 83	PR 256 (N. JCT.)	21.2	76	6	1611	127
	PR 256 (N. JCT.)	SASK BDRY.	13.4	112	9	1501	121
256	S. BDRY. RM PIPESTONE	PTH 2 (W. JCT.)	5.6	124	10	694	56
	PTH 2 (E. JCT.)	PR 255 (S. JCT.)	17.9	193	21	3455	376
	PR 255 (N. JCT.)	PR 257	11.4	308	34	3511	388
	PR 257	PTH 1	15.9	304	18	4834	286
	PTH 1	PTH 41	43.6	88	7	3837	305
259	PR 250	PTH 21	26.6	227	18	6038	479
	PTH 21	PR 254 (N. JCT.)	11.9	232	23	2761	274
	PR 254 (S. JCT.)	PTH 1 (E. JCT.)	14.3	460	46	6578	658
	PR 259 N.	PTH 1 (W. JCT.)	3.5	180	14	630	49
270	PTH 1	PTH 25	14.6	1127	45	16454	657
	PTH 25	N. BDRY RM ELTON	5.0	135	5	675	25
343	S. BDRY RM S. CYPRESS	PTH 2	4.2	131	10	550	42
346	S. BDRY RM OAKLAND	PTH 2	7.1	44	4	312	28
347	PR 348	PTH 22 (E. JCT.)	8.4	57	5	479	42
	PTH 22 (W. JCT.)	S. BDRY RM GLENWOOD	13.4	81	6	1085	80

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
348	PR 347	PTH 2	14.8	55	4	814	59
	PTH 2	PR 349	13.2	27	2	356	26
349	PTH 10	PTH 21	36.4	114	14	4150	510
350	PTH 34	E. BDRY RM VICTORIA	12.1	41	3	496	36
351	PTH 1 (E. JCT.)	PTH 5	18	344	24	6192	432
	PTH 5	PTH 1 (W. JCT.)	17.2	467	28	8032	482
352	E. BDRY RM N. CYPRESS	N. BDRY RM N. CYPRESS	10	103	8	1030	80
353	E. BDRY RM N. CYPRESS	PR 352 (N. JCT.)	1.6	150	12	240	19
	PR 352 (S. JCT.)	PTH 5 (S. JCT.)	17.9	134	11	2399	197
	PTH 5 (N. JCT.)	PTH 10	34.4	254	54	8738	1858
354	PR 21	PR 259 (S. JCT.)	14.8	79	6	1169	89
	PR 259 (N. JCT.)	N. BDRY RM DALY	5	90	7	450	35
441	PTH 83	PTH 1	13.8	179	14	2470	193
449	PR 245	PTH 34	16.4	82	7	1345	115
453	PR 344	PTH 10	11.4	120	5	1368	57
454	PR 347	PTH 2	9.8	75	6	735	59
455	PR 250	PTH 21	11.3	177	14	2000	158
457	PR 340	PTH 1A	16.7	2312	22	38610	367
459	PTH 10	PTH 1	9.8	501	40	4910	392
463	PTH 21	PR 254	3.7	71	6	263	22
464	PTH 1	PR 353	17.9	115	12	2059	215
	PR 353	N. BDRY RM N. CYPRESS	1.6	95	8	152	13
467	PTH 83	PR 256 (E. JCT.)	18	77	6	1386	108
	PR 256 (W. JCT.)	PTH 41 (N. JCT.)	10	52	4	520	40
	PTH 41 (S. JCT.)	SAK BDRY.	4.8	90	7	432	34
468	PR 457	PTH 1	3.5	216	2	756	7
	PTH 1	PR 353	19.8	92	7	1822	139
	PR 353	N. BDRY RM ELTON	1.6	55	4	88	6
542	PR 257	PTH 1	21.2	97	12	2056	254
543	PTH 21	PR 254	11.6	69	6	800	70
561	PR 468	PTH 10	11.6	105	8	1218	93
565	PTH 41	SASK. BDRY.	5	74	6	370	30
Total			**790.6**			**169268**	**11456**
District 6							
220	S. BDRY RM ROCKWOOD	PTH 67	8.2	149	15	1222	123
	PTH 67	OAK HAMMOCK MARSH	4.0	80	6	320	24
221	PR 248	PTH 26	8.2	138	11	1132	90
227	PTH 6	PR 430 (N. JCT.)	33.1	410	53	13571	1754
	PR 430 (S. JCT.)	PR 240 (E. JCT.)	19.8	115	10	2277	198
	PR 240 (W. JCT.)	PTH 16	16.9	265	15	4479	254
236	S. BDRY RM ROCKWOOD	PTH 67 (S. JCT.)	6.6	1355	108	8943	713
	PTH 67 (N. JCT.)	PR 517	13.2	544	44	7181	581
240	S. BDRY RM PORTAGE	PR 331	19.3	375	25.0	7238	483
	PR 331	PTH 1	3.4	450	30	1530	102
	PTH 1	PTH 1a (E. JCT.)	2.3	3930	125	9039	288
	PTH 1A (W. JCT.)	DELTA	25.7	435	43	11180	1105
241	E. BDRY RM CARTIER	PTH 1	8.0	425	30	3400	240
	PTH 1	PR 248 (S. JCT.)	19.5	100	10	1950	195
	PR 248 (N. JCT.)	PR 426	6.6	625	50	4125	330
242	PR 461	PTH 1	21.4	292	26	6249	556
	PTH 1	PTH 16 (W. JCT.)	19.6	190	23	3724	451
	PTH 16 (CENTER JCT.)	E BDRY RM WESTBOURNE	2.1	211	13	443	27
	PTH 16 (E. JCT.)	LYNCH'S POINT	15.4	762	61	11735	939
248	S BDRY RM CARTIER	PTH 1	13.2	342	27	4514	356
	PTH 1	PTH 26 (W. JCT.)	12.1	645	65	7805	787
	PTH 26 (E. JCT.)	PTH 6	26.7	332	27	8864	721

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
249	PTH 26	PTH 16	29.6	130	13	3848	385
260	PTH 16	N BDRY RM GLENELLA	48.4	269	24	13020	1162
261	E BDRY RM GLENELLA	PR 260 (N. JCT.)	5	50	4	250	20
	PR 260 (S. JCT.)	W BDRY RM GLENELLA	25.6	191	17	4890	435
265	BIG POINT	PTH 50	12.7	125	10	1588	127
	PTH 50		12			0	0
	PR 260 (W. JCT.)	W BDRY RM LANSDOWNE	23	180	14	4140	322
305	S BDRY RM PORTAGE	PTH 1	20.1	716	50	14392	1005
321	PR 220	PTH 7 §S. JCT.)	6.6	175	14	1155	92
	PTH 7 (N. JCT.)	PTH 6	205	16		3280	0
322	PTH 6	PTH 67	6.9	300	24	2070	166
	PTH 67	PR 415	34.4	220	18	7568	619
323	PTH 7	PR 322 (E. JCT.)	13.2	172	14	2270	185
	PR 322 (W. JCT.)	PTH 6	10.1	120	11	1212	111
	PTH 6	PR 248	8	105	5	840	40
331	PTH 1	PTH 13	8.4	410	29	3444	244
	PTH 13	PR 240	19.6	631	50	12368	980
332	S BDRY RM CARTIER	PTH 1	11.4	265	21	3021	239
338	S BDRY RM PORTAGE	PR 331	15.3	130	10	1989	153
350	PR 461	PTH 1	24.6	179	14	4403	344
	PTH 1	PTH 16	24.8	138	11	3422	273
352	PTH 34	PTH 1	18.8	160	13	3008	244
	PTH 1	W BDRY RM N. NORFOLK	10.6	113	8	1198	85
	S. BDRY. RM LANDSDOWNE	PTH 16	19.6	172	19	3371	372
	PTH 16	PR 265	19.5	292	38	5694	741
	PR 265	W BDRY RM LANDSDOWNE	8.9	85	7	757	62
353	PTH 34	W BDRY RM N. NORFOLK	13.2	150	12	1980	158
411	PTH 6	PR 430	22.9	127	10	2908	229
412	PTH 26	N BDRY RM ST FRANCOIS	5.5	125	10	688	55
	S BDRY RM WOODLANDS	PR 227	6.6	100	8	660	53
413	E BDRY RM ROCKWOOD	PTH 7	10	190	25	1900	250
414	PR 411	PTH 6	11.6	62	5	719	58
415	PTH 7	PR 322	19.8	285	23	5643	455
	PR 322	N BDRY RM WOODLANDS	5	60	5	300	25
424	S BDRY RM CARTIER	PR 241	6.8	180	14	1224	95
426	PTH 1	PR 430	25.3	80	6	2024	152
427	E BDRY RM CARTIER	PR 424	3.5	173	14	606	49
430	PTH 1	PTH 26	10.6	210	19	2226	201
	PTH 26	ST AMBROISE BEACH	28.2	268	21	7558	592
460	PTH 16	PR 265	20	165	13	3300	260
461	PR 242	PR 350 (E. JCT.)	5.6	115	9	644	50
	PR 350 (W. JCT.)	PTH 34	11.9	60	5	714	60
462	PR 265	PR 261	20.4	166	13	3386	265
	PR 261	N BDRY RM GLENELLA	8.5	136	11	1156	94
517	PTH 7	PR 322	16.4	235	16	3854	262
518	PTH 6	N BDRY RM WOODLANDS	14.8	176	14	2605	207
526	PTH 26	PR 249	6.3	445	36	2804	227
567	WHITEMUD RIVER	PTH 50	7.6	40	3	304	23
569	LAKE MANITOBA	PTH 50	5.8	45	4	261	23
573	LAKE MANITOBA	PTH 50	8.2	50	4	410	33
575	PR 260	PR 462 (N. JCT.)	9.8	80	6	784	59
	PR 462 (S. JCT.)	PR 352	15.8	30	2	474	32
Total			**1267.5**			**273246**	**22691**
District 7							
24	PTH 10	PR 270 (N. JCT.)	8.9	639	32	5687	285
	PR 270 (N. JCT.)	PR 250	14.2	403	32	5723	454

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
	PR 250	PTH 21	26.1	609	37	15895	966
	PTH 21	PTH 83	31.4	433	26	13596	816
41	PR 571	PTH 42	19.3	334	33	6446	637
	PTH 42	PTH 16	18.2	290	17	5278	309
42	PTH 16	PTH 83 (S. JCT.)	33.5	488	29	16348	972
	PTH 83 (N. JCT.)	PTH 41	16.3	367	40	5982	652
250	S BDRY RM BLANSHARD	PTH 24	8.2	591	59	4846	484
	PTH 24	PTH 16 (W. JCT.)	26.4	196	20	5174	528
	PTH 16 (E. JCT.)	PTH 45	19.6	111	12	2176	235
	PTH 45	PR 359	21.9	151	12	3307	263
254	S BDRY RM MINIOTA	PTH 24	8.2	55	4	451	33
	PTH 24	PR 355	15.1	125	14	1888	211
	PTH 42	PTH 16 (E. JCT.)	5.0	75	6	375	30
	PTH 16 (W. JCT.)	PTH 45	22.4	224	18	5018	403
	PTH 45	PTH 83	54.4	124	10	6746	544
261	E BDRY RM ROSEDALE	PTH 5	4.8	195	20	936	96
262	PTH 10	PTH 16	18.0	123	10	2214	180
	PTH 16A	PR 265	16.7	460	37	7682	618
	PR 265	PR 357	10.0	130	10	1300	100
	PR 357	N BDRY RM CLANWILLIAM	17.9	57	5	1020	90
263	PR 262	PTH 10	22.4	140	11	3136	246
	PTH 10	S BDRY RIDING MTN	7.1	290	23	2059	163
265	E BDRY RM ROSEDALE	PTH 5 (N. JCT.)	5.0	105	8	525	40
	PTH 5 (S. JCT.)	PR 262	25.1	123	10	3087	251
270	S BDRY RM SASKATCHEWAN	PTH 24 (S. JCT.)	7.2	145	12	1044	86
	PTH 24 (N. JCT.)	PTH 16	19.5	155	11	3023	215
	PTH 16	PTH 45	25.4	76	6	1930	152
	PTH 45	PR 263	17.1	175	14	2993	239
352	E BDRY RM ROSEDALE	PTH 5	5	210	15	1050	75
354	S BDRY RM BLANSHARD	PTH 24 (W. JCT.)	8.2	90	7	738	57
	PTH 24 (E. JCT.)	PTH 16 (W. JCT.)	32	117	9	3744	288
	PTH 16 (E. JCT.)	PTH 45	15.5	97	7	1504	109
	PTH 45	PR 359	16.1	187	15	3011	242
355	PTH 16A	PTH 10	2.7	1175	82	3173	221
	PTH 10	PR 270	11.4	207	17	2360	194
	PR 270	PR 250 (E. JCT.)	12.7	137	11	1740	140
	PR 250 (W. JCT.)	PR 354 (E. JCT.)	11.4	145	12	1653	137
	PR 354 (W. JCT.)	PTH 21	16.4	63	5	1033	82
	PTH 21	PTH 83	31.1	126	10	3919	311
359	PR 270	PR 354	26.7	117	9	3124	240
	PR 354	PTH 45	33	77	6	2541	198
	PTH 45	PR 476 (N. JCT.)	21.1	62	5	1308	106
	PR 476 (S. JCT.)	PTH 16	17.2	37	3	636	52
464	S BDRY RM LANGFORD	PTH 16	13.2	122	10	1610	132
465	PTH 5	PR 464 (S. JCT.)	8.2	45	4	369	33
	PR 464 (N. JCT.)	PR 262	21.2	40	3	848	64
466	PR 465	PTH 16 (W. JCT.)	10	80	6	800	60
	PTH 16 (E. JCT.)	PR 357	25.6	80	6	2048	154
468	S BDRY RM ODANAH	PR 465	8.2	55	4	451	33
469	PR 354	PTH 21	13.5	95	8	1283	108
	PTH 21	PR 254	13	195	16	2535	208
470	PR 469	PR 355 (S. JCT.)	6.6	60	5	396	33
	PR 355 (N. JCT.)	PTH 16	20.1	65	5	1307	101
	PTH 16	PTH 45 (E. JCT.)	1.9	70	6	133	11
	PTH 45 (W. JCT.)	PR 354 (S. JCT.)	20.9	40	3	836	63
	PR 354 (N. JCT.)	PR 250	10	85	7	850	70

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
471	PTH 5	PR 262	30.9	96	8	2966	247
472	PTH 16	PTH 45	17.2	70	6	1204	103
473	PTH 10	PTH 16	19.6	71	6	1392	118
474	PTH 24	PR 355	15.9	60	5	954	80
	PR 355	PTH 42	19.8	70	6	1386	119
	PTH 42	PTH 16	9	130	10	1170	90
475	PTH 16	PTH 41	8.4	205	16	1722	134
476	PTH 16	PTH 45	23	100	7	2300	161
	PTH 45	PR 254	13	161	11	2093	143
477	PTH 21	PR 254	11.6	120	10	1392	116
478	SASK BDRY	PTH 16	18	221	18	3978	324
	PTH 16	PTH 45	24.6	112	8	2755	197
	PTH 45	PR 254	10.6	125	10	1325	106
479	PR 476	PTH 16	18	57	4	1026	72
545	PTH 41	SASK BDRY	8.9	57	4	507	36
563	PTH 10	PR 270	6.6	150	12	990	79
564	PR 262	PR 471	13.2	60	5	792	66
566	PTH 45	PR 359 (N. JCT.)	22.2	131	10	2908	222
568	PTH 83	PTH 42	20.3	82	7	1665	142
	PTH 42	PR 475	9.8	35	3	343	29
571	PTH 41	SASK BDRY	6.6	145	12	957	79
577	PR 566	PR 254	24.8	145	12	3596	298
579	PTH 16	PR 478	26.4	43	3	1135	79
Total			**1356.6**			**219439**	**16858**
District 8							
19	PTH 5	RIDING MTN PARK	5.0	150	11	750	55
260	N BDRY RM GLENELLA	PTH 50	24.5	91	7	2230	172
261	PTH 50	E BDRY RM GLENELLA	17.4	140	13	2436	226
267	PTH 20	PR 362 (E. JCT.)	8.5	189	19	1607	162
	PR 362 (E. JCT.)	PTH 10	15.3	164	15	2509	230
	PTH 10	PR 366	27.0	68	5	1836	135
269	PR 276	PTH 20 (S. JCT.)	40.2	550	39	22110	1568
	PTH 20 (N. JCT.)	PTH 10A	28.3	140	11	3962	311
273	PTH 20	PTH 10	24	55	4	1320	96
274	PTH 5 (E. JCT.)	PTH 5 (W. JCT.)	45.2	199	16	8995	723
	PTH 5 (W. JCT.)	PR 267 (S. JCT.)	20.8	374	30	7779	624
	PR 267 (N. JCT.)	PTH 10	22.5	188	15	4230	338
276	PTH 5	PR 364	40.2	450	45	18090	1809
	PR 364	PR 269	29.9	320	32	9568	957
	PR 269	PR 328	25.1	237	20	5949	502
	PR 328	SKOWNAN	19.2	204	10	3917	192
278	PTH 50	PTH 68	41.7	325	38	13553	1585
328	E BDRY LGD ALONSA	PR 276	7.6	200	7	1520	53
360	PTH 50	PTH 68	37	45	4	1665	148
361	PTH 5	RIDING MTN PARK	6.8	255	20	1734	136
362	PTH 5A	PR 267 (E. JCT.)	29.3	531	42	15558	1231
363	PTH 83	SASK BDRY	8.9	197	20	1753	178
364	PR 276	PR 269 (S. JCT.)	38.6	150	10	5790	386
	PR 269 (N. JCT.)	PTH 20	9.2	135	10	1242	92
366	PTH 83	PR 584	32.8	156	12	5117	394
	PR 584	PTH 5	34.4	156	12	5366	413
	PTH 5	S BDRY DUCK MTN PROV PAI	31.5	133	12	4190	378
367	PTH 10	W BDRY RM ETHELBERT	16.4	148	15	2427	246
462	N BDRY RM GLENELLA	PTH 5	28.2	41	3	1156	85
478	PR 254	PR 366 (E. JCT.)	9.7	78	6	757	58
	PR 366 (W. JCT.)	PR 583	26.4	99	8	2614	211

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
480	PR 360	PTH 5 (S. JCT.)	8.2	52	3	426	25
	PTH 5 (S. JCT.)	PR 582	21.6	192	15	4147	324
	PR 582	PTH 5 (N. JCT.)	8.2	246	20	2017	164
	PTH 5 (N. JCT.)	PR 276	23.7	63	5	1493	119
481	PTH 68	CRANE RIVER	50.5	135	11	6818	556
	CRANE RIVER	PR 276	27.7	157	13	4349	360
	PR 276	PR 364	16.1	60	5	966	81
482	PTH 83	PTH 5	46.7	178	14	8313	654
483	DUCK MTN FOREST RESERVE	PTH 83	19	75	6	1425	114
484	PTH 5	PR 363	24.6	70	6	1722	148
	PR 363	N BDRY RM SHELL RIVER	8.4	25	2	210	17
489	PTH 10	N BDRY RM ETHELBERT	15.9	176	19	2798	302
490	PR 481	PR 269	12.9	55	4	710	52
491	PR 362	CROSS OF FREEDOM	9.2	110	9	1012	83
547	PR 482	SASK BDRY	3.2	130	10	416	32
581	PR 360	PTH 5	8.2	173	14	1419	115
582	PR 480	PTH 5	16.4	133	11	2181	180
583	PTH 5	PTH 83	15.3	130	10	1989	153
584	PR 366	PTH 5	14.5	111	9	1610	131
	PTH 5	PR 483 (S. JCT.)	36.4	77	6	2803	218
	PR 483 (N. JCT.)	PR 594	23	41	3	943	69
585	PR 276	PR 364	18	54	5	972	90
589	PR 478	PTH 83	8.4	57	5	479	42
591	PR 584	PTH 83	8.7	184	15	1601	131
592	PR 484	PTH 83	13	38	3	494	39
593	PTH 83	PR 592	9.7	117	1	1135	10
594	PTH 83	N BDRY RM SHELL RIVER	7.2	111	9	799	65
Total			**1226.3**			**214974**	**17961**
District 9							
266	PTH 10	PR 268	23.8	92	7	2190	167
268	PTH 10 (S. JCT.)	PTH 10 (N. JCT.)	45.5	188	19	8554	865
271	PTH 20	PTH 10	32.3	111	10	3585	323
272	PTH 20	DUCK BAY	21.6	340	31	7344	670
275	PTH 10A	SASK BDRY	23.3	645	52	15029	1212
279	PTH 10	WHITEFISH LAKE	32.8	118	9	3870	295
365	PTH 10	STEEPROCK RIVER	29.6	70	6	2072	178
366	S BDRY DUCK MTN PROV PAI	PR 367 (E. JCT.)	22.2	74	6	1643	133
	PR 367 (W. JCT.)	WELLMAN LAKE	30.6	166	13	5080	398
	WELLMAN LAKE	PTH 10 (E. JCT.)	36.6	174	14	6368	512
	PTH 10 (W. JCT.)	PR 268	32.7	99	8	3237	262
367	E BDRY DUCK MTN PROV PAI	PR 366 (E. JCT.)	13.0	139	13	1807	169
	PR 366 (E. JCT.)	CHILD'S LAKE	22.4	161	13	3606	291
	CHILD'S LAKE	PTH 83	29.2	177	14	5168	409
485	PR 366	PR 486	16.4	111	9	1820	148
486	PR 586	PTH 83	26.9	178	14	4788	377
487	PR 83	PR 588	15.1	127	10	1918	151
488	PR 486	PTH 10	21.6	97	8	2095	173
489	S BDRY LGD MOUNTAIN	PTH 20	34.1	54	5	1841	171
586	PTH 83 (S. JCT.)	PTH 83 (N. JCT.)	24.5	79	24.5	1936	600
587	PR 268	PR 266	19.3	119	10	2297	193
588	PTH 83	PR 275 (W. JCT.)	22.7	124	10	2815	227
	PR 275 (E. JCT.)	PR 279	17.7	129	10	2283	177
594	S BDRY LGD PARK	PR 367	12.7	111	9	1410	114
Total			**606.6**			**92757**	**8212**
District 10							
282	PTH 10	PR 283	23.8	67	6	1595	143

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
283	PTH 10	PR 282	17.9	372	37	6659	662
	PR 282	SASK BDRY	21.9	189	20	4139	438
285	PTH 10	CREEK AT EAST END	15.3	857	86	13112	1316
287	PTH 10	ATIKAMEG RR STATION	19	764	61	14516	1159
289	PR 285	GRACE LAKE	3.9	230	18	897	70
291	PTH 10	PTH 10A	4.5	349	31	1571	140
393	PR 392	OSBORNE LAKE MINE GATE	19	695	56	13205	1064
395	PR 392	CHISEL LAKE	13	400	40	5200	520
Total			**138.3**			**60893**	**5512**
District 11							
9	N BDRY WINNIPEG BEACH	PR 231	25.3	350	35	8855	886
222	PTH 9	PR 324	8.4	765	61	6426	512
	PR 324	PR 613 (HNAUSA)	21.4	418	33	8945	706
	PR 613 (HNAUSA)	PR 329	12.9	217	17	2799	219
224	PR 325	FISHER BAY	45.1	585	53	26384	2390
226	PTH 68	PR 233 (N. JCT.)	18.1	253	23	4579	416
229	PTH 8	PTH 7	14.6	390	12	5694	175
	PTH 7	PTH 17 (E. JCT.)	17.9	192	13	3437	233
	PTH 17 (W. JCT.)	PTH 6	40.4	95	9	3838	364
231	PTH 9	PTH 8	1.6	2390	72	3824	115
	PTH 8	PTH 7 (S. JCT.)	14.8	822	49	12166	725
	PTH 7 (N. JCT.)	PTH 17	22.4	85	8	1904	179
234	PTH 8	MATHESON ISL LANDING	89.5	197	16	17632	1432
237	SPEARHILL	PTH 6	8.7	165	15	1436	131
	PTH 6	WATCHORN BAY	11.3	165	15	1865	170
239	PTH 6	STEEPROCK	20.1	275	50	5528	1005
324	PR 222	PTH 8 (S. JCT.)	1.6	280	22	448	35
	PTH 8 (N. JCT.)	PTH 7	18	77	6	1386	108
326	PTH 68	PR 233	16.3	406	32	6618	522
329	SANDY BAR	PTH 8	6.3	383	19	2413	120
	PTH 8	PR 226	20	192	15	3840	300
	PR 226	PTH 17	21.6	127	10	2743	216
415	S BDRY LGD ARMSTRONG	PTH 6	35.7	83	7	2963	250
416	PR 415	PTH 17	14.8	127	10	1880	148
417	PTH 6	E BDRY INDIAN RES #46	24.6	175	14	4305	344
418	PR 419	PR 417 (E. JCT.)	14.8	100	8	1480	118
	PR 417 (W. JCT.)	PTH 68	14.3	60	5	858	72
419	PTH 17	PTH 6	44.1	99	8	4366	353
	PTH 6	SANDY POINT	18	175	14	3150	252
511	PR 518	PTH 6	20	45	4	900	80
512	PR 419	PTH 68	15.6	32	3	499	47
513	PTH 6	SUTHERLAND AVE, GYPSUM\	10.1	491	25	4959	253
	SUTHERLAND AVE	LAKE WINNIPEG	71.6	128	10	9165	716
514	PTH 68	PR 325	29.5	86	7	2537	207
516	PR 329	PR 233	14.8	60	5	888	74
518	S BDRY RM ST LAURENT	PR 415 (S. JCT.)	8.5	60	5	510	43
	PR 415 (N. JCT.)	PR 229	15	31	2	465	30
519	PTH 9	PTH 8	2.7	190	15	513	41
Total			**810.4**			**172195**	**13984**
District 12							
200	PR 210	N BDRY FLOODWAY	11.1	2349	70	26074	777
202	PTH 59	PR 204	15	1727	121	25905	1815
204	GLENWAY AVE.	PTH 101	0.8	6999	420	5599	336
	PTH 101	PTH 44	17.5	2607	182	45623	3185
207	PTH 1	PTH 15	7.4	790	63	5846	466
213	PR 207	PTH 59	2.7	4608	461	12442	1245

Table E-7. (continued)

Route	From	To	Distance (km)	AADT	AADTT	Daily Veh-km	Daily Truck Veh-km
220	PTH 9	PTH 8	2.9	548	49	1589	142
	PTH 8	N BDRY RM W. ST. PAUL	9.2	467	47	4296	432
221	E BADRY RM ROSSER	PTH 101	6.8	6584	856	44771	5821
	PTH 101	PR 248	33	398	32	13134	1056
236	PR 221	PTH 6 (W. JCT.)	7.4	150	12	1110	89
	PTH 6 (E. JCT.)	N BDRY RM ROSSER	8.2	1045	31	8569	254
238	PTH 9	PTH 44	10	578	52	5780	520
241	PTH 100	W BDRY RM CHARLESWOOD	9.8	2207	154	21629	1509
300	PTH 59 (S. JCT.)	PTH 59 (N. JCT.)	5.3	262	18	1389	95
321	PTH 8	PR 220	5	281	22	1405	110
334	PTH 2	PR 241 (E. JCT.)	11.3	162		1831	0
	PR 241 (W. JCT.)	PTH 1 (E. JCT.)	1	2160	173	2160	173
	PTH 1 (W. JCT.)	PR 221 (E. JCT.)	12.4	164	13	2034	161
	PR 221 (W. JCT.)	PTH 6	14			0	0
401	PR 202	PR 204	3.1	2060	165	6386	512
405	E BDRY RM RITCHOT	PTH 59	0.8	1165	58	932	46
407	PR 202	PR 204	3.7	94	8	348	30
409	PTH 101	PR 220	4.7	546	55	2566	259
410	PR 238	PTH 9	0.8	762	61	610	49
412	S BDRY RM ROSSER	N BDRY RM ROSSER	6.6	119	10	785	66
425	PTH 101	PR 334	6	88	5	528	30
427	PTH 100	W BDRY CITY OF WPG.	9.3	248	22	2306	205
Total			**225.8**			**245646**	**19382**
District 13							
280	PR 391	PR 604 (SPLIT LAKE)	126.3	125	10	15788	1263
	PR 604 (SPLIT LAKE)	PR 290	135.0	102	8	13770	1080
	PR 290	BUTNEAU ROAD (GILLAM)	30.6	303	24	9272	734
290	PR 280	LIMESTONE	20.8	573	46	11918	957
373	NORWAY HOUSE	CROSS LAKE ROAD	79.8	250	20	19950	1596
	CROSS LAKE ROAD	PR 603 (SIPIWESK LAKE)	71	140	10	9940	710
	PR 603 (SIPIWESK LAKE)	PTH 6	24.3	172	45	4180	1094
375	PAINT LAKE	PTH 6	6	320	13	1920	78
391	BURNTWOOD DR., THOMPSO	PR 280	13.8	1500	100	20700	1380
	PR 280	PR 602 (NELSON HOUSE)	64.4	2600	20	167440	1288
	PR 602 (NELSON HOUSE)	RUTTAN LAKE MINE ROAD	140.3	175	15	24553	2105
	RUTTAN LAKE MINE ROAD	SILVER & SHERITT LYNN LAK	104.1	220	20	22902	2082
394	SILVER & SHERITT LYNN LAK	ZED LAKE	19.2	179	14	3437	269
	ZED LAKE	SASK BDRY - CO-OP POINT	81.8	35	3	2863	245
396	FOX LAKE	PR 397	45.4	105	8	4767	363
397	SILVER & SHERITT LYNN LAK	LYNN LAKE AIR SERVICE	5.5	500	40	2750	220
398	PR 394	BERGE LAKE	1.8	120	10	216	18
399	PR 391	LYNN LAKE RR STATION	0.5	250	20	125	10
Total			**970.6**			**336490**	**15492**

Table E-8. Summary of Vehicle-km of Travel (Collectors)

District	Distance (km)	Daily Veh-km	Daily Truck Veh-km	Annual Veh-km	Annual Truck Veh-km
1	662.9	253038	19784	92359016	7221087
2	1005.4	319726	26147	116699990	9543509
3	1202.4	329419	29496	120238008	10765858
4	963.2	113701	9410	41501011	3434760
5	790.6	169268	11453	61782930	4180330
6	1753.8	282970	22409	103283941	8179380
7	1356.6	219439	16858	80095053	6153097
8	1226.3	214974	17961	78465401	6555802
9	606.6	92757	8212	33856159	2997435
10	138.3	60893	5512	22225982	2011734
11	810.4	172195	13984	62851285	5104306
12	225.8	245646	19382	89660717	7074576
13	970.6	336490	15492	122818704	5654434
Total	**11712.9**	**2810516**	**216099**	**1025838194**	**78876307**

Table E-9A*. Average Percentage of Trucks by Truck type and Location on PTH #1 (Expressway)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #1												
# 16	1991	6	14.2	17.0	15.6	7225	1127	1.5	0.8	9.7	1.0	2.7
#248	1991	6	13.3	14.0	13.7	8423	1150	1.6	0.8	8.3	1.0	2.0
# 11	1991	2	14.0	14.7	14.4	2038	292	0.8	0.6	9.1	1.3	2.7
#302	1990	2	14.9	14.1	14.5	4208	610	1.0	1.0	9.0	0.8	2.4
# 13	1990	6	15.1	15.0	15.1	8251	1242	1.4	0.7	9.7	0.8	2.4
# 5	1990	6	18.3	17.4	17.9	4661	832	1.1	0.9	11.7	1.0	3.3
#207(W)	1989	2	10.4	8.9	9.7	9943	959	1.3	1.1	5.3	0.5	1.5
# 21	1989	5	18.1	19.6	18.9	3363	634	1.2	0.7	12.8	1.3	3.1
# 10(W)	1989	5	12.8	16.3	14.6	4946	720	1.4	1.1	9.2	0.9	1.9
# 41	1988	5	28.7	29.9	29.3	1988	582	1.2	0.4	21.1	0.9	5.7
# 83(W)	1988	5	22.1	24.9	23.5	2588	608	1.9	0.5	15.7	1.1	4.4
#259(E)	1987	5	6.7	8.6	7.7	2090	160	3.2	0.8	2.4	0.7	0.7
#241	1986	6	11.1	11.4	11.3	8709	980	1.8	0.9	6.5	0.4	1.9
# 34	1986	6	17.2	16.1	16.7	4362	726	1.9	0.8	10.7	0.6	2.8
#240	1986	6	17.6	18.5	18.1	4881	881	1.5	1.2	11.1	0.6	3.8
#270	1985	5	20.5	30.9	25.7	2259	581	2.6	1.0	10.4	1.4	5.0
#257	1983	5	17.4	18.7	18.1	2520	455	2.7	0.8	11.6	0.5	2.5
#207(W)	1983	2	10.1	8.7	9.4	7116	669	1.8	1.6	5.1	0.3	0.8
# 83(E)	1983	5	18.6	19.3	19.0	2476	469	2.6	0.9	12.1	0.5	2.9
# 5	1983	5	17.0	16.1	16.6	3848	637	1.8	1.1	11.3	0.2	2.3
#301	1981	1	14.3	13.7	14.0	3074	430	1.5	0.9	9.1	1.0	1.7
#240	1981	6	15.8	15.8	15.8	5322	841	1.9	1.2	10.2	0.9	1.8
# 83(W)	1981	5	21.6	23.2	22.4	2545	570	2.7	0.7	15.3	1.2	2.6
# 16	1981	6	14.7	16.8	15.8	7154	1127	2.4	1.5	9.5	1.0	1.4
# 10(W)	1981	5	14.8	17.9	16.4	4129	675	2.9	1.4	9.6	0.9	1.6
# 10(E)	1981	5	16.8	15.4	16.1	4353	701	2.4	1.3	9.8	1.0	1.6
# 44	1982	1	13.9	13.8	13.9	2806	389	1.6	0.9	9.5	0.3	1.7
# 41	1982	5	24.5	24.9	24.7	1857	459	2.1	1.0	17.4	0.9	3.3
# 13	1982	6	15.1	14.8	15.0	6603	987	2.3	1.1	9.5	0.3	1.9
# 11	1982	2	13.2	13.9	13.6	3013	408	1.8	0.8	9.0	0.4	1.7
Totals					**496.6**	**125910**	**20910**	**55.9**	**28.5**	**311.7**	**23.7**	**74.1**
Averages					**16.6**	**4197**	**697**	**1.9**	**1.0**	**10.4**	**0.8**	**2.5**

* Data obtained from the MDHT "Turning Movement and Vehicle Classification Surveys", 1981-1991

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #1):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.37	0.61	0.328	32.8
9	0.08	0.28	0.297	29.7
10 - 15	13.09	3.62	0.348	34.8
16 - 25	0.11	0.33	0.420	42.0
26 - 42	1.29	1.14	0.461	46.1

Table E-9B*. Average Percentage of Trucks by Truck type and Location on PTH #6 (Expressway)

Location	Year of Survey	District	Total % Trucks E. Leg.	Total % Trucks W. Leg.	Total % Trucks N. Leg.	Total % Trucks S. Leg.	Avg. % Trucks	Avg. AADTT	Avg. Truck AADT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #6														
#236	1991	12	7.5	6.7			7.1	4576	325	1.1	0.7	3.5	1.2	0.8
#101	1988	12			0	8.5	8.5	4849	412	1	1	4.4	0.5	1.7
# 67	1986	6			7.1	7.4	7.3	2634	191	1.7	0.7	3.1	0.3	1.5
#236	1982	12	5.2	6.1			5.7	2565	145	1.6	0.6	2.8	0.3	0.5
#101	1981	12			0	10	10.0	3614	361	1.6	1.8	4.8	1	0.8
Totals							38.5	18625	1435	7	4.8	18.6	3.3	5.3
Averages							7.7	3725	287	1.4	1	3.7	0.7	1.1

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #6):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.11	0.32	0.231	23.1
9	0.25	0.49	0.516	51.6
10 - 15	0.73	0.85	0.229	22.9
16 - 25	0.18	0.42	0.634	63.4
26 - 42	0.27	0.51	0.486	48.6

* Data obtained from the MDHT "Turning Movement and Vehicle Classification Surveys", 1981-1991

Table E-9C. Average Percentage of Trucks by Truck Type and Location on PTH #7 (Expressway)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #7												
#101	1987	12	9.9	10.4	10.2	7953	807	1.4	1.5	6.2	0.3	0.9
#321(N)	1985	1	13.5	10.8	12.2	4660	566	1.7	2.1	7.8	0.3	0.4
#101	1981	12	11.7	8.9	10.3	5530	570	1.9	1.9	5.5	0.3	0.8
Totals					**32.6**	**17826**	**1944**	**5.0**	**5.5**	**19.5**	**0.9**	**2.1**
Averages					**10.9**	**5942**	**648**	**1.7**	**1.8**	**6.5**	**0.3**	**0.7**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #7):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.07	0.25	0.153	15.3
9	0.10	0.31	0.168	16.8
10 - 15	1.39	1.18	0.181	18.1
16 - 25	0.00	0.00	0.000	0.0
26 - 42	0.07	0.26	0.378	37.8

Table E-9D. Average Percentage of Trucks by Truck Type and Location on PTH #44 (Expressway)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #44												
# 12	1991	1	0.0	7.4	7.4	239	18	2.1	0.4	3.6	0.8	0.4
#214	1988	1	9.4	7.6	8.5	1980	168	2.2	1.0	4.4	0.7	0.4
#206	1983	1	5.4	4.7	5.1	3509	177	2.2	0.6	2.1	0.2	0.1
# 12	1982	1	2.9	7.4	5.2	669	34	2.4	1.2	1.2	0.4	0.1
Totals					26.1	6397	397	8.9	3.2	11.3	2.1	1.0
Averages					6.5	1600	100	2.2	0.8	2.8	0.5	0.3

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #44):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.02	0.13	0.058	5.8
9	0.13	0.37	0.456	45.6
10 - 15	2.08	1.44	0.511	51.1
16 - 25	0.08	0.28	0.527	52.7
26 - 42	0.03	0.18	0.730	73.0

Table E-9E. Average Percentage of Trucks by Truck Type and Location on PTH #59 (Expressway)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #59												
#311	1990	2	8.8	9.3	9.1	4028	365	1.7	3.7	2.5	1.1	0.2
# 4	1990	1	4.1	3.8	4.0	3908	154	0.9	0.5	1.5	1.0	0.3
#213	1989	12	2.5	4.6	3.6	11898	422	0.8	0.5	1.9	0.2	0.2
# 12	1988	1	3.3	3.1	3.2	1785	57	0.7	0.4	1.7	0.4	0.0
#101	1986	12	6.9	9.2	8.1	17030	1371	1.6	1.8	3.7	0.3	0.9
#317	1985	1	5.7	6.4	6.1	2416	146	1.5	0.4	3.8	0.1	0.4
# 52	1985	2	7.7	7.1	7.4	2560	189	1.9	2.2	2.8	0.4	0.2
# 12	1982	1	2.3	2.2	2.3	1914	43	1.1	0.5	0.6	0.1	0.0
Totals					43.5	50815	2747	10.2	10.0	18.5	3.6	2.2
Averages					5.4	6352	343	1.3	1.3	2.3	0.5	0.3

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #59):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.21	0.46	0.358	35.8
9	1.48	1.22	0.973	97.3
10 - 15	1.22	1.11	0.478	47.8
16 - 25	0.15	0.39	0.873	87.3
26 - 42	0.08	0.29	0.959	95.9

Table E-9F. Average Percentage of Trucks by Truck Type and Location on PTH #75 (Expressway)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #75														
#421	1988	2			17.0	16.4	16.7	1809	302	0.9	0.6	13.7	0.5	1.1
# 14	1986	2			17.3	19.1	18.2	2243	408	2.1	1.4	12.2	0.8	1.8
#210	1986	2			10.6	13.1	11.9	4207	499	2.1	1.2	6.4	0.5	1.8
#201	1983	2			19.5	21.2	20.4	1729	352	1.4	2.5	14.5	0.4	1.8
#421	1981	2			23.9	22.8	23.4	1289	301	1.9	1.6	17.6	1.4	1.0
#243	1981	2			21.6	20.9	21.3	1368	291	2.0	1.5	16.1	0.9	0.8
# 29	1981	2	15.7	14.8			15.3	1356	207	1.6	1.2	11.5	0.8	0.3
Totals							127.0	14001	2360	12.0	10.0	92.0	5.3	8.6
Averages							18.1	2000	337	1.7	1.4	13.1	0.8	1.2

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #75):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.20	0.45	0.261	26.0
9	0.33	0.57	0.402	40.2
10 - 15	13.31	3.65	0.278	27.8
16 - 25	0.12	0.35	0.454	45.4
26 - 42	0.35	0.59	0.482	48.2

Table E-9G. Average Percentage of Trucks by Truck Type and Location on PTH #100 (Expressway)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #100														
N/A	1991	12	13.3	13.6			13.5	10144	1364	1.8	3.9	5.7	1.0	1.2
N/A	1986	12	14.5	14.0			14.3	7217	1028	2.1	2.1	7.6	0.6	1.7
N/A	1986	12	14.1	10.1			12.1	8893	1076	2.0	2.1	6.2	0.5	1.5
# 2	1986	12	13.2	8.8			11.0	3141	346	2.7	1.8	4.7	0.8	1.2
# 3	1986	12	9.6	7.8			8.7	4320	376	2.5	1.6	3.4	0.4	1.0
#330	1983	12	11.0	11.4			11.2	4912	550	2.4	2.0	5.5	0.4	1.1
N/A	1983	12	13.1	13.5			13.3	5543	737	3.2	3.4	5.3	0.4	1.0
N/A	1981	12	15.9	15.9			15.9	5716	909	2.9	3.8	7.8	0.9	0.6
N/A	1981	12	16.0	12.4			14.2	6556	931	2.7	2.7	7.1	1.1	0.7
# 3	1981	3			12.4	14.3	13.4	4432	592	2.6	1.7	6.9	1.2	1.0
# 2	1981	3			14.7	0.0	14.7	3419	503	2.6	1.9	7.9	1.2	1.0
Totals							142.2	64295	8412	27.5	27.0	68.1	8.5	12.0
Averages							12.9	5845	765	2.5	2.5	6.2	0.8	1.1

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #100):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.17	0.41	0.163	16.3
9	0.74	0.86	0.350	35.0
10 - 15	2.04	1.43	0.230	23.0
16 - 25	0.11	0.33	0.423	42.3
26 - 42	0.10	0.31	0.288	28.8

Table E-9H. Average Percentage of Trucks by Truck Type and Location on PTH #101 (Expressway)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #101														
#425	1991	12			12.8	11.0	11.9	9783	1164	1.4	1.5	6.6	0.9	1.6
# 6	1988	12	9.4	6.1			7.8	4812	373	1.2	1.0	3.7	0.5	1.4
# 7	1987	12	10.5	9.1			9.8	7084	694	1.6	1.4	4.9	0.5	1.6
#221	1987	12			10.4	13.2	11.8	5605	661	1.3	1.3	6.3	0.0	2.9
# 59	1986	12	0.0	11.3			11.3	14201	1605	2.1	2.6	5.3	0.3	0.8
# 15	1983	12	5.5	4.3			4.9	5860	287	1.5	1.2	2.1	0.3	0.1
# 7	1981	12	10.8	9.4			10.1	4976	503	1.9	1.6	5.4	0.6	0.9
# 6	1981	12	10.0	7.5			8.8	3542	310	1.7	1.4	4.0	0.8	0.9
Totals							**76.3**	**55863**	**5597**	**12.7**	**12.0**	**38.3**	**3.9**	**10.2**
Averages							**9.5**	**6983**	**700**	**1.6**	**1.5**	**4.8**	**0.5**	**1.3**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #101):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.09	0.30	0.192	19.2
9	0.23	0.48	0.321	32.1
10 - 15	2.18	1.48	0.308	30.8
16 - 25	0.08	0.29	0.596	59.6
26 - 42	0.68	0.82	0.647	64.7

Table E-10. Average Percentage of Trucks on Expressway Routes

ROUTE	% TRUCKS
1	16.6
6	7.7
7	10.9
44	6.5
59	5.4
75	18.1
100	12.9
101	9.5
AVG.	11.0

Table E-11. Summary of Average Percentage of Trucks, Standard Deviation, and COV (Expressways)

Route	Truck Type 8			Truck Type 9			Truck Type 10-15			Truck Type 16-25			Truck Type 26-42		
	% Trucks	Std. Dev. (%)	COV (%)	% Trucks	Std. Dev. (%)	COV (%)	% Trucks	Std. Dev. (%)	COV (%)	% Trucks	Std. Dev. (%)	COV (%)	% Trucks	Std. Dev. (%)	COV (%)
1	1.9	0.6	32.8	1.0	0.3	29.7	10.4	3.6	34.8	0.8	0.3	42.0	0.4	1.1	46.1
6	1.4	0.3	23.1	1.0	0.5	51.6	3.7	0.9	22.9	0.7	0.4	63.4	1.1	0.5	48.6
7	1.7	0.3	15.3	1.8	0.3	16.8	6.5	1.2	18.1	0.3	0.0	0.0	0.7	0.3	37.8
44	2.2	0.1	5.8	0.8	0.4	45.6	2.8	1.1	51.1	0.5	0.3	52.7	0.3	0.2	73.0
59	1.3	0.5	35.8	1.3	1.2	97.3	2.3	1.1	47.8	0.5	0.4	87.3	0.3	0.3	95.9
75	1.7	0.5	26.0	1.4	0.6	40.2	13.1	3.7	27.8	0.8	0.3	45.4	1.2	0.6	48.2
100	2.5	0.4	16.3	2.5	0.9	35.0	6.2	1.4	23.0	0.8	0.3	42.3	1.1	0.3	28.8
101	1.6	0.3	19.2	1.5	0.5	32.1	4.8	1.5	30.8	0.5	0.3	59.6	1.3	0.8	64.7
Totals	**14.3**	**2.9**	**174.3**	**11.3**	**4.7**	**348.3**	**49.8**	**14.5**	**256.3**	**4.9**	**2.3**	**392.7**	**6.4**	**4.1**	**443.1**
Averages	**1.8**	**0.4**	**21.8**	**1.4**	**0.6**	**43.5**	**6.2**	**1.8**	**32.0**	**0.6**	**0.3**	**49.1**	**0.8**	**0.5**	**55.4**

Table E-12. Average Percentage of Trucks, Standard Deviation and COV (Expressways)

Truck Type	% Trucks	Std. Dev. (%)	COV (%)
8	1.8	0.4	21.8
9	1.4	0.6	43.5
10 - 15	6.2	1.8	32.0
16 - 25	0.6	0.3	49.1
26 - 42	0.8	0.5	55.4

Table E-13. Precision vs. Sample Size (Expressways)

Truck Type	Sample Size	% Precision Achieved with 95% Confidence
8	10	14
	20	10
	30	8
	50	6
	100	4
	200	3
9	10	27
	20	19
	30	16
	50	12
	100	9
	200	6
10 - 15	10	20
	20	14
	30	11
	50	9
	100	6
	200	4
16 - 25	10	30
	20	22
	30	18
	50	14
	100	10
	200	7
26 - 42	10	34
	20	24
	30	20
	50	15
	100	11
	200	8

Table E-14A. Average Percentage of Trucks by Truck Type and Location on PTH #2 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #2														
# 13	1991	3	13.4	11.7			12.6	1698	213	2.6	2.0	5.0	1.9	1.3
# 21(E)	1991	4	7.5	7.7			7.6	190	14	1.9	1.5	2.4	1.3	0.6
# 3	1990	3	9.1	9.9			9.5	1695	161	1.9	2.0	3.4	1.2	1.0
# 83	1989	4	9.3	8.6			9.0	911	82	1.9	0.9	3.7	1.3	1.2
# 5	1988	3	11.4	9.6			10.5	1248	131	2.5	1.0	3.7	1.5	1.9
# 10(S)	1988	3	7.7	0.0			7.7	1172	90	2.6	0.8	2.5	0.9	0.9
#305	1988	3	12.6	12.0			12.3	1291	159	3.1	2.3	4.3	1.1	1.7
#248	1986	3	12.3	13.2			12.8	1278	163	2.9	2.2	5.5	0.9	1.3
#100	1986	12			14.2	0.0	14.2	4293	610	2.0	1.8	8.0	0.5	2.0
# 10(N)	1985	5	10.3	0.0			10.3	1253	129	2.7	1.9	4.3	0.8	0.5
# 21(W)	1985	4	9.9	11.0			10.5	364	38	2.6	0.7	5.6	1.3	0.4
# 21(E)	1983	5	7.9	7.5			7.7	989	76	3.1	1.1	2.7	0.5	0.3
# 10(S)	1982	5	7.2	0.0			7.2	1157	83	2.6	1.0	2.5	0.8	0.2
#100	1981	12	13.3	8.1			10.7	2559	274	2.8	1.8	4.8	1.0	0.5
# 13	1981	3	16.4	14.2			15.3	1396	214	4.6	2.6	6.7	1.2	0.3
Totals							**157.7**	**21494**	**2437**	**39.8**	**23.6**	**65.1**	**16.2**	**14.1**
Averages							**10.5**	**1433**	**162**	**2.7**	**1.6**	**4.3**	**1.1**	**0.9**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #2):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.46	0.68	0.256	25.6
9	0.38	0.61	0.390	39.0
10 - 15	2.68	1.64	0.377	37.7
16 - 25	0.14	0.37	0.344	34.4
26 - 42	0.37	0.61	0.645	64.5

Table E-14B. Average Percentage of Trucks by Truck Type and Location on PTH #3 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #3														
# 2	1990	3			7.8	7.0	7.4	3725	276	2.1	1.3	2.5	0.7	0.8
# 14	1989	3	5.9	4.8			5.4	5602	300	1.5	1.1	1.8	0.4	0.6
# 31	1988	3	10.0	10.2			10.1	1343	136	2.3	1.9	4.2	0.7	1.2
# 31	1987	3	7.5	7.7			7.6	288	22	3.0	2.1	1.8	0.5	0.3
# 13	1987	3			4.9	7.2	6.1	5110	309	2.0	1.0	2.2	0.4	0.7
#100	1986	12			12.6	14.1	13.4	5311	709	1.9	2.0	7.1	0.5	2.1
N/A	1985	3	5.0	5.1			5.1	5254	265	1.5	1.0	2.1	0.3	0.3
#100	1981	12	10.0	10.0			10.0	4052	405	2.9	1.6	4.6	0.8	0.2
Totals							**64.9**	**30685**	**2422**	**17.2**	**12.0**	**26.3**	**4.3**	**6.2**
Averages							**8.1**	**3836**	**303**	**2.2**	**1.5**	**3.3**	**0.5**	**0.8**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #3):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.32	0.57	0.264	26.4
9	0.21	0.46	0.307	30.7
10 - 15	3.53	1.88	0.572	57.2
16 - 25	0.03	0.17	0.337	33.7
26 - 42	0.39	0.63	0.810	81.0

Table E-14C. Average Percentage of Trucks by Truck Type and Location on PTH #5 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #5														
# 68	1991	8			0.0	9.2	9.2	266	24	3.0	0.8	2.3	2.4	0.7
#261	1991	7			9.5	9.3	9.4	1098	103	2.5	0.9	3.1	2.1	1.0
#484	1990	9	5.9	6.2			6.1	1086	66	1.0	0.3	2.3	1.5	1.2
# 20	1990	8	8.2	9.2			8.7	1174	102	1.7	0.8	3.7	1.2	1.5
# 5A(W)	1989	8			10.0	12.7	11.4	334	38	4.8	1.4	2.9	1.7	0.8
# 5	1989	8	7.4	8.1			7.8	2817	218	2.7	1.9	1.9	0.9	0.4
#480(S)	1988	7			12.3	13.3	12.8	994	127	3.1	0.7	5.0	2.5	1.6
#366	1987	8	9.4	12.6			11.0	1002	110	3.4	2.3	3.2	1.1	1.1
# 5A(S)	1987	8	0.0	12.6			12.6	463	58	2.4	0.6	6.5	1.0	2.0
# 5	1987	8			4.3	5.6	5.0	2331	115	2.0	0.4	1.8	0.5	0.3
# 16(E)	1986	7			0.0	4.1	4.1	1002	41	1.9	1.1	0.6	0.4	0.1
#482	1986	8	6.8	7.4			7.1	769	55	1.2	0.4	2.8	1.1	1.6
# 10(N)	1985	8	8.9	7.6			8.3	1676	138	3.1	1.0	2.9	0.8	0.6
#471	1983	7			9.0	8.7	8.9	1915	169	4.1	1.4	2.4	0.5	0.6
#235	1983	8	7.3	8.4			7.9	1489	117	2.9	1.0	3.1	0.4	0.4
# 50	1982	8			11.3	11.5	11.4	917	105	3.4	1.5	5.0	0.7	0.9
# 10	1982	8	10.8	7.4			9.1	508	46	3.9	1.8	2.4	0.9	0.2
Totals							**150.5**	**19841**	**1632**	**47.1**	**18.3**	**51.9**	**19.7**	**15.0**
Averages							**8.9**	**1167**	**96**	**2.8**	**1.1**	**3.1**	**1.2**	**0.9**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #5):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	1.04	1.02	0.367	36.7
9	0.32	0.57	0.529	52.9
10 - 15	1.94	1.39	0.456	45.6
16 - 25	0.45	0.67	0.578	57.8
26 - 42	0.31	0.55	0.628	62.8

Table E-14D. Average Percentage of Trucks by Truck Type and Location on PTH #6 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #6														
#328	1987	8			18.2	15.5	16.9	477	80	1.0	0.2	8.3	0.6	6.9
#325(S)	1987	11			11.4	15.1	13.3	1405	186	1.7	0.7	4.7	0.6	5.6
#415	1987	6			11.7	11.9	11.8	1631	192	1.5	0.5	5.1	0.5	4.3
#327	1986	10			17.3	14.2	15.8	305	48	2.3	0.6	7.3	0.7	4.9
#391	1985	13			0.0	26.1	26.1	201	52	0.9	0.7	14.5	0.5	9.4
#235	1983	11			12.6	12.7	12.7	919	116	2.2	0.9	7.3	0.5	1.9
#239	1981	11			12.4	13.2	12.8	745	95	2.4	0.8	6.1	1.1	2.5
Totals							**109.2**	**5683**	**769**	**12.0**	**4.4**	**53.3**	**4.5**	**35.5**
Averages							**15.6**	**812**	**110**	**1.7**	**0.6**	**7.6**	**0.6**	**5.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #6):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.38	0.62	0.360	35.9
9	0.05	0.23	0.366	36.7
10 - 15	10.87	3.30	0.433	43.3
16 - 25	0.05	0.22	0.342	34.2
26 - 42	6.61	2.57	0.507	50.7

Table E-14E. Average Percentage of Trucks by Truck Type and Location on PTH #7 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #7												
# 67	1991	6	12.0	9.4	10.7	4692	502	1.4	1.5	6.6	0.8	0.5
# 17	1983	11	6.0	5.5	5.8	1785	103	3.2	1.2	1.2	0.3	0.1
#517	1982	11	6.3	6.4	6.4	2001	127	3.0	1.4	1.6	0.3	0.2
#323	1982	6	6.6	6.5	6.6	2208	145	2.7	1.6	1.8	0.3	0.2
Totals					29.4	10686	877	10.3	5.7	11.2	1.7	1.0
Averages					7.3	2672	219	2.6	1.4	2.8	0.4	0.3

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #7):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.66	0.81	0.315	31.5
9	0.03	0.17	0.122	12.2
10 - 15	6.48	2.55	0.909	90.9
16 - 25	0.06	0.25	0.592	59.2
26 - 42	0.03	0.18	0.730	73.0

Table E-14F. Average Percentage of Trucks by Truck Type and Location on PTH #8 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #8												
# 68	1990	11	5.9	5.7	5.8	980	57	1.5	0.7	2.1	1.4	0.2
#234	1988	11	8.0	5.1	6.6	469	31	2.5	1.6	1.4	1.1	0.1
#229	1987	1	10.9	11.3	11.1	1091	121	1.8	1.3	7.4	0.3	0.3
#329	1987	11	4.2	3.8	4.0	940	38	1.9	0.5	1.1	0.5	0.1
# 27	1983	12	3.3	3.4	3.4	4796	161	1.2	0.9	1.1	0.1	0.1
#230	1982	11	4.4	3.6	4.0	3209	128	1.6	0.8	1.3	0.3	0.1
# 67	1982	12	4.7	4.8	4.8	2013	96	1.8	0.9	1.7	0.2	0.2
#234(S)	1981	11	12.4	7.3	9.9	340	33	3.8	2.4	2.0	1.8	0.0
#515	1981	11	5.5	5.4	5.5	2106	115	2.2	0.8	1.9	0.5	0.1
#413	1981	11	6.4	5.9	6.2	1962	121	2.3	0.9	2.0	0.8	0.1
Totals					61.0	17906	901	20.6	10.8	22.0	7.0	1.3
Averages					6.1	1791	90	2.1	1.1	2.2	0.7	0.1

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #8):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.53	0.73	0.352	35.2
9	0.31	0.56	0.516	51.6
10 - 15	3.48	1.87	0.848	84.8
16 - 25	0.32	0.57	0.808	80.8
26 - 42	0.01	0.09	0.692	67.8

Table E-14G. Average Percentage of Trucks by Truck Type and Location on PTH #10 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #10														
#349	1991	5			5.9	6.0	6.0	3734	222	1.9	0.8	1.6	1.4	0.4
# 23(N)	1990	4			8.8	9.9	9.4	1534	143	1.6	0.8	4.3	1.5	1.2
# 16(S)	1990	7			14.4	0.0	14.4	2407	347	1.5	0.8	7.8	1.6	2.7
#367	1989	8			10.8	10.3	10.6	621	66	3.4	1.2	3.5	1.8	0.8
# 24	1989	7			6.7	6.4	6.6	2802	184	1.7	0.8	2.2	1.2	0.8
# 1	1989	5			6.0	7.9	7.0	3715	258	1.9	1.1	2.9	0.7	0.5
# 60	1988	10			13.4	13.3	13.4	441	59	1.5	0.9	5.6	0.5	5.0
# 2	1988	3			7.0	8.0	7.5	1758	132	1.7	0.7	3.5	0.9	0.8
# 39	1988	10			11.9	13.1	12.5	682	85	2.1	0.4	4.0	0.6	5.6
# 10A(S)	1987	9			3.8	10.0	6.9	2198	152	4.4	0.9	0.9	0.6	0.2
# 10	1987	9	5.1	4.2			4.7	5342	248	2.4	0.7	0.9	0.5	0.3
# 3	1987	4			9.6	10.1	9.9	1004	99	2.6	1.1	4.0	1.2	1.0
# 77	1987	9			9.8	7.8	8.8	889	78	1.1	0.7	4.9	0.7	1.5
#241	1986	?			11.0	9.5	10.3	488	50	1.3	0.7	5.6	1.2	1.6
# 16(N)	1985	7			4.6	11.8	8.2	1793	147	2.3	0.8	4.0	0.4	1.0
# 45	1985	7			5.3	5.0	5.2	1691	87	2.7	0.5	1.4	0.4	0.2
# 5	1985	8			9.9	24.0	17.0	495	84	3.7	3.5	8.9	0.7	0.3
# 20	1985	8			9.2	10.9	10.1	489	49	2.9	1.3	4.0	1.5	0.5
N/A	1983	10			7.1	3.0	5.1	4389	222	1.7	0.9	2.2	0.2	0.3
# 391	1982	10			11.5	9.2	10.4	559	58	3.2	0.8	4.3	0.4	1.7
# 23(S)	1982	4			10.1	11.6	10.9	1044	113	3.5	2.3	4.3	0.6	0.2
#327	1982	10			11.2	9.9	10.6	463	49	3.0	0.8	5.6	0.5	0.8
# 5	1982	8			7.1	4.4	5.8	1314	76	2.2	1.0	1.8	0.5	0.1
# 2	1982	5			6.5	7.8	7.2	1708	122	2.5	1.1	2.7	0.7	0.2
# 25	1981	7			9.2	9.0	9.1	3044	277	3.4	1.4	3.2	1.1	0.1
# 16(S)	1981	7			11.5	0.0	11.5	2452	282	2.2	1.1	6.6	0.9	0.7
# 1	1981	5			5.8	8.8	7.3	2992	218	3.0	1.2	2.3	0.7	0.3
# 1	1981	5			6.2	6.3	6.3	5221	326	2.5	0.9	2.1	0.6	0.2
Totals							**251.8**	**55269**	**4233**	**67.9**	**29.2**	**105.1**	**23.6**	**29.0**
Averages							**9.0**	**1974**	**151**	**2.4**	**1.0**	**3.8**	**0.8**	**1.0**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #10):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.67	0.82	0.336	33.6
9	0.36	0.60	0.572	57.2
10 - 15	3.92	1.98	0.528	52.8
16 - 25	0.18	0.43	0.510	51.0
26 - 42	1.82	1.35	0.301	130.1

Table E-14H. Average Percentage of Trucks by Truck Type and Location on PTH #12 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #12														
# 89	1990	2	12.8	14.3			13.6	722	98	1.2	0.6	10.3	1.3	0.3
# 15	1989	1			6.6	8.1	7.4	1571	115	1.8	1.5	2.8	1.1	0.3
#205	1989	2			7.0	9.7	8.4	1868	156	1.3	1.1	4.9	1.0	0.2
#210	1985	2			10.8	9.0	9.9	3591	356	2.9	3.1	3.3	0.4	0.3
# 44(W)	1983	1			6.2	5.3	5.8	363	21	3.4	1.2	0.8	0.4	0.0
#215	1982	1			6.0	6.9	6.5	725	47	2.6	1.3	0.9	0.3	0.0
Totals							**51.4**	**8840**	**793**	**13.2**	**8.8**	**23.0**	**4.5**	**1.1**
Averages							**8.6**	**1473**	**132**	**2.2**	**1.5**	**3.8**	**0.8**	**0.2**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #10):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.81	0.90	0.410	41.0
9	0.73	0.86	0.583	58.3
10 - 15	12.42	3.52	0.920	92.0
16 - 25	0.19	0.44	0.581	58.1
26 - 42	0.02	0.15	0.809	80.9

Table E-14I. Average Percentage of Trucks by Truck Type and Location on PTH #16 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #16														
# 1	1991	6			12.6	8.7	10.7	2088	222	1.9	1.1	4.7	1.0	2.1
# 45	1991	7	5.0	9.7			7.4	2392	176	2.0	0.7	2.9	1.0	0.9
# 10	1990	7	14.8	6.9			10.9	2551	277	1.9	0.9	5.0	1.4	1.8
#250(W)	1989	7	21.2	19.2			20.2	1384	280	1.9	0.5	12.5	1.2	4.1
# 21	1989	7	18.8	23.2			21.0	1397	293	1.9	0.7	13.2	1.1	4.3
# 50	1988	6	13.6	14.8			14.2	2347	333	1.6	0.7	8.2	0.7	3.0
# 42	1988	7	22.7	20.7			21.7	1230	267	2.6	0.8	12.3	1.3	4.9
# 5	1986	7	10.2	8.7			9.5	3792	358	2.6	1.1	4.1	0.5	1.2
# 41	1986	7	10.2	16.7			13.5	1451	195	2.3	1.2	9.8	1.1	3.7
N/A	1986	?	19.1	19.1			19.1	1097	210	2.1	0.7	10.7	0.9	4.8
# 83(S)	1983	7	20.7	18.6			19.7	1149	226	3.0	1.3	13.0	0.4	2.0
# 45	1983	7	5.9	11.0			8.5	1747	148	2.9	1.0	3.9	0.3	0.5
# 16A(E)	1981	7	11.2	11.9			11.6	2171	251	2.6	1.1	6.1	1.2	0.7
# 16	1981	7			6.6	6.0	6.3	1120	71	3.8	0.7	1.3	0.5	0.1
# 10	1981	7	11.6	8.1			9.9	2421	238	2.7	1.2	4.5	1.1	0.4
# 1	1981	6			13.6	12.8	13.2	1868	247	3.4	2.3	5.7	1.3	0.7
Totals							**217.0**	**30205**	**3792**	**39.2**	**16.0**	**117.9**	**15.0**	**35.2**
Averages							**13.6**	**1888**	**237**	**2.5**	**1.0**	**7.4**	**0.9**	**2.2**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #16):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.38	0.62	0.251	25.1
9	0.18	0.42	0.420	42.0
10 - 15	15.93	3.99	0.542	54.2
16 - 25	0.12	0.35	0.376	37.6
26 - 42	2.86	1.69	0.769	76.9

Table E-14J. Average Percentage of Trucks by Truck Type and Location on PTH #67 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #67												
# 7	1991	6	11.2	6.8	9.0	2805	252	2.1	1.8	4.1	1.0	0.2
# 6	1986	6	5.7	3.3	4.5	381	17	1.9	0.8	1.3	0.3	0.4
# 9	1983	12	5.7	0.0	5.7	806	46	1.5	1.3	2.6	0.2	0.1
# 8	1982	12	12.5	13.0	12.8	679	87	2.3	1.5	8.6	0.5	0.1
Totals					**32.0**	**4671**	**402**	**7.8**	**5.4**	**16.6**	**2.0**	**0.8**
Averages					**8.0**	**1168**	**101**	**2.0**	**1.4**	**4.2**	**0.5**	**0.2**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #67):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	0.12	0.35	0.179	17.8
9	0.18	0.42	0.314	31.4
10 - 15	10.11	3.18	0.766	76.6
16 - 25	0.13	0.36	0.712	71.2
26 - 42	0.02	0.14	0.707	70.7

Table E-14K. Average Percentage of Trucks by Truck Type and Location on PTH #83 (Primary Arterial)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. %. Trucks
PTH #83												
#482	1990	7	7.0	6.5	6.8	816	55	1.4	0.9	2.3	1.4	0.9
#363	1990	8	9.4	8.5	9.0	420	38	2.7	0.5	3.0	2.1	0.7
# 3	1990	5	12.1	13.9	13.0	486	63	3.2	1.1	5.5	2.1	1.3
# 2	1989	4	10.6	9.6	10.1	748	76	2.1	0.9	4.5	1.5	1.2
# 24	1989	7	7.3	8.8	8.1	893	72	3.3	1.0	1.1	2.6	0.2
# 42	1988	7	0.0	6.9	6.9	878	61	3.7	0.4	1.6	1.0	0.2
# 49	1988	9	6.6	6.0	6.3	833	52	2.6	0.4	2.0	0.5	1.9
# 1	1988	5	5.8	27.2	16.5	225	37	2.1	1.6	9.3	1.7	1.9
# 42	1987	7	0.0	4.9	4.9	211	10	2.6	0.4	1.1	0.7	0.1
# 3	1987	4	7.1	7.2	7.2	926	66	4.8	0.6	1.2	0.6	0.1
#257	1985	5	18.1	10.2	14.2	791	112	4.1	3.3	4.3	1.7	0.8
# 16	1983	7	6.6	10.7	8.7	241	21	3.8	1.2	3.1	0.6	0.1
# 1	1981	5	10.3	23.1	16.7	175	29	5.1	1.1	5.6	4.5	0.6
Totals					**128.1**	**7643**	**692**	**41.5**	**13.4**	**44.6**	**21.0**	**10.0**
Averages					**9.9**	**588**	**53**	**3.2**	**1.0**	**3.4**	**1.6**	**0.8**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #83):

TRUCK TYPE	VARIANCE	STD. DEV.	COV	% COV
8	1.09	1.05	0.328	32.8
9	0.56	0.75	0.723	72.3
10 - 15	5.24	2.29	0.667	66.7
16 - 25	1.10	1.05	0.651	65.1
26 - 42	0.39	0.63	0.819	81.9

Table E-15. Average Percentage of Trucks (Primary Arterials)

Route	% Trucks
2	10.5
3	8.1
5	8.9
6	15.6
7	7.3
8	6.1
10	9.0
12	8.6
16	13.6
67	8.0
83	9.9
TOTAL	**105.6**
AVG.	**9.6**

Table E-16. Summary of Average Percentage of Trucks, Standard Deviation, and COV (Primary Arterials)

	Truck Type 8			Truck Type 9			Truck Type 10-15			Truck Type 16-25			Truck Type 26-42		
Route	% Trucks	Std. Dev. (%)	COV (%)	% Trucks	Std. Dev. (%)	COV (%)	% Trucks	Std. Dev. (%)	COV (%)	% Trucks	Std. Dev. (%)	COV (%)	% Trucks	Std. Dev. (%)	COV (%)
2	2.7	0.7	25.6	1.6	0.6	39.0	4.3	1.6	37.7	1.1	0.4	34.4	0.9	0.6	64.5
3	2.2	0.6	26.4	1.5	0.5	30.7	3.3	1.9	57.2	0.5	0.2	33.7	0.8	0.6	81.0
5	2.8	1.0	36.7	1.1	0.6	52.9	3.1	1.4	45.6	1.2	0.7	57.8	0.9	0.6	62.8
6	1.7	0.6	35.9	0.6	0.2	36.7	7.6	3.3	43.3	0.6	0.2	34.2	5.1	2.6	50.7
7	2.6	0.8	31.5	1.4	0.2	12.2	2.8	2.6	90.9	0.4	0.3	59.2	0.3	0.2	73.0
8	2.1	0.7	35.2	1.1	0.6	51.6	2.2	1.9	84.8	0.7	0.6	80.8	0.1	0.1	67.8
10	2.4	0.8	33.6	1.0	0.6	57.2	3.8	2.0	52.8	0.8	0.4	51.0	1.0	1.4	130.1
12	2.2	0.9	41.0	1.5	0.9	58.3	3.8	3.5	92.0	0.8	0.4	58.1	0.2	0.2	80.9
16	2.5	0.6	25.1	1.0	0.4	42.0	7.4	4.0	54.2	0.9	0.4	37.6	2.2	1.7	76.9
67	2.0	0.4	17.8	1.4	0.4	31.4	4.2	3.2	76.6	0.5	0.4	71.2	0.2	0.1	70.7
83	3.2	1.1	32.8	1.0	0.8	72.3	3.4	2.3	66.7	1.6	1.1	65.1	0.8	0.6	81.3
Totals	26.4	8.2	341.6	13.2	5.8	484.3	45.9	27.7	701.8	9.1	5.1	583.1	12.5	8.7	839.7
Averages	2.4	0.7	31.1	1.2	0.5	44.0	4.2	2.5	63.8	0.8	0.5	53.0	1.1	0.8	76.3

Table E-17. Average Percentage of Trucks, Standard Deviation and COV (Primary Arterials)

Truck Type	% Trucks	Std. Dev. (%)	COV (%)
8	2.4	0.7	31.1
9	1.2	0.5	44.0
10 - 15	4.2	2.5	63.8
16 - 25	0.8	0.5	53.0
26 - 42	1.1	0.7	76.3

Table E-18. Precision vs. Sample Size (Primary Arterials)

Truck Type	Sample Size	% Precision Achieved with 95% confidence
8	10	19
	20	14
	30	11
	50	9
	100	6
	200	4
	300	4
9	10	27
	20	19
	30	16
	50	12
	100	9
	200	6
	300	5
10 - 15	10	40
	20	28
	30	23
	50	18
	100	13
	200	9
	300	7
16 - 25	10	33
	20	23
	30	19
	50	15
	100	10
	200	7
	300	6
26 - 42	10	47
	20	33
	30	27
	50	21
	100	15
	200	11
	300	9

Table E-19A. Average Percentage of Trucks by Truck Type and Location on PTH #3 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #3												
# 83(S)	1990	4	6.1	11.3	8.7	239	21	2.3	1.4	2.3	1.8	1.0
# 18(S)	1990	3	10.1	0.0	10.1	470	47	3.2	1.2	2.4	2.3	0.9
# 21(N)	1989	4	13.0	8.4	10.7	248	27	3.1	2.8	1.7	2.6	0.7
# 10	1987	4	8.3	10.6	9.5	576	54	3.8	1.2	2.5	1.6	0.5
# 83(N)	1987	4	8.3	11.3	9.8	878	86	4.3	1.1	2.7	1.4	0.5
#458	1985	4	12.4	12.3	12.4	733	91	4.1	2.0	4.7	1.4	0.4
# 5	1982	4	7.2	7.7	7.5	587	44	3.2	1.2	2.0	1.0	0.1
Totals					**68.6**	**3731**	**370**	**24.0**	**10.9**	**18.3**	**12.1**	**4.1**
Averages					**9.8**	**533**	**53**	**3.4**	**1.6**	**2.6**	**1.7**	**0.6**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #3):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.47	0.69	0.201	20.1
9	0.40	0.63	0.404	40.4
10 - 15	0.96	0.98	0.374	37.4
16 - 25	0.31	0.56	0.322	32.2
26 - 42	0.10	0.31	0.526	52.6

Table E-19B. Average Percentage of Trucks by Truck Type and Location on PTH #5 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #5												
# 1	1990	6	7.5	10.9	9.2	1312	121	2.0	2.4	3.1	1.2	0.7
# 2	1988	3	10.8	11.9	11.4	466	53	3.6	1.5	2.8	2.8	0.8
# 23	1985	4	10.8	10.9	10.9	295	32	3.9	1.6	2.3	2.4	0.7
# 1	1983	5	5.8	9.0	7.4	1255	93	3.0	1.8	2.2	0.3	0.3
# 3	1982	4	7.5	4.5	6.0	192	12	3.4	0.7	1.2	0.8	0.1
Totals					**44.8**	**3520**	**311**	**15.9**	**8.0**	**11.6**	**7.5**	**2.6**
Averages					**9.0**	**704.0**	**62**	**3.2**	**1.6**	**2.3**	**1.5**	**0.5**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #5):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.54	0.74	0.232	23.2
9	0.38	0.61	0.383	38.3
10 - 15	0.53	0.73	0.313	31.3
16 - 25	1.13	1.06	0.709	70.9
26 - 42	0.09	0.30	0.585	58.5

Table E-19C. Average Percentage of Trucks by Truck Type and Location on PTH #9 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #9														
# 4	1990	1	4.1	3.1			3.6	3455	124	1.4	1.0	0.6	0.6	0.1
#230	1983	12			3.2	3.4	3.3	1747	58	1.5	0.9	0.8	0.1	0.0
# 67	1983	12			3.1	3.5	3.3	7047	233	1.3	0.7	1.2	0.1	0.1
# 9A(N)	1983	12	3.4	4.5			4.0	916	36	2.9	0.7	0.3	0.1	0.0
# 9	1983	12			2.6	3.3	3.0	1965	58	1.7	0.8	0.4	0.2	0.0
# 9A(S)	1983	12			3.1	3.1	3.1	7120	221	1.3	0.7	1.0	0.1	0.1
# 9	1983	12	0.0	2.4			2.4	1225	29	1.3	0.5	0.4	0.1	0.0
Totals							**22.6**	**23475**	**759**	**11.4**	**5.3**	**4.7**	**1.3**	**0.3**
Averages							**3.2**	**3354**	**108**	**1.6**	**0.8**	**0.7**	**0.2**	**0.0**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #9):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.34	0.58	0.356	35.6
9	0.03	0.17	0.222	22.2
10 - 15	0.12	0.35	0.521	50.9
16 - 25	0.04	0.19	1.007	100.7
26 - 42	0.00	0.05	0.247	124.7

Table E-19D. Average Percentage of Trucks by Truck Type and Location on PTH #11 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
# 1	1991	2			9.3	7.0	8.2	242	20	1.2	1.2	4.5	0.9	0.6
# 59	1989	1	9.6	0.0			9.6	503	48	2.6	0.9	5.2	0.7	0.3
#307	1989	1			4.3	3.7	4.0	1184	47	1.4	0.7	1.2	0.5	0.3
#317	1987	1			2.5	2.8	2.7	1122	30	1.6	0.4	0.5	0.3	0.0
#304	1982	1			5.6	5.4	5.5	1395	77	2.8	0.5	1.4	0.3	0.0
# 15	1982	1			5.2	7.0	6.1	657	40	2.5	0.9	2.1	0.7	0.0
# 1	1982	2			10.7	6.0	8.4	328	27	2.7	2.1	2.6	0.7	0.4
Totals							**44.4**	**5431**	**289**	**14.8**	**6.7**	**17.5**	**4.1**	**1.6**
Averages							**6.3**	**776**	**41**	**2.1**	**1.0**	**2.5**	**0.6**	**0.2**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #11):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.47	0.68	0.324	32.4
9	0.33	0.57	0.599	59.9
10 - 15	3.06	1.75	0.700	70.0
16 - 25	0.05	0.23	0.388	38.8
26 - 42	0.06	0.24	1.041	104.1

Table E-19E. Average Percentage of Trucks by Truck Type and Location on PTH #12 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #12														
# 44(E)	1991	1			4.9	5.7	5.3	301	16	2.3	0.6	1.8	0.6	0.2
# 59(N)	1990	1	0.0	2.4			2.4	930	22	1.1	0.3	0.5	0.4	0.0
# 59(S)	1988	1	9.0	0.0			9.0	169	15	2.9	2.8	2.2	1.1	0.0
N/A	1983	1	7.2	5.6			6.4	1925	123	2.7	1.5	1.9	0.2	0.2
#317	1982	1			10.4	10.2	10.3	399	41	4.9	3.3	1.6	0.6	0.0
# 59(S)	1982	1	8.1	0.0			8.1	239	19	3.7	2.4	1.7	0.3	0.0
# 44(E)	1982	1			7.7	6.2	7.0	1391	97	3.3	1.9	0.5	0.1	0.0
Totals							48.5	5354	333	20.9	12.8	10.2	3.3	0.4
Averages							6.9	765	48	3.0	1.8	1.5	0.5	0.1

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #12):

Truck Type	Variance	Std. Dev.	COV	% COV
8	1.40	1.18	0.396	39.6
9	1.23	1.11	0.607	60.7
10 - 15	0.47	0.69	0.468	46.8
16 - 25	0.11	0.34	0.714	71.4
26 - 42	0.01	0.11	1.890	189.0

Table E-19F. Average Percentage of Trucks by Truck Type and Location on PTH #13 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #13														
# 2	1991	3			19.2	14.0	16.6	1260	209	2.8	1.2	7.8	1.7	2.2
# 1	1990	6			16.5	13.7	15.1	1079	163	2.6	2.9	7.3	1.2	2.3
# 3	1987	3	4.7	2.9			3.8	3664	139	2.0	1.0	2.2	0.4	0.7
# 1	1982	6			9.4	12.4	10.9	749	82	4.1	2.3	3.8	0.5	0.4
# 2	1981	3			16.4	14.2	15.3	1396	214	6.0	3.5	9.3	1.5	0.3
Totals							**61.7**	**8148**	**807**	**17.5**	**10.9**	**30.4**	**5.3**	**5.9**
Averages							**12.3**	**1630**	**161**	**3.5**	**2.2**	**6.1**	**1.1**	**1.2**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #13):

Truck Type	Variance	Std. Dev.	COV	% COV
8	2.54	1.59	0.455	45.5
9	1.16	1.08	0.494	49.4
10 - 15	8.77	2.96	0.487	48.7
16 - 25	0.35	0.59	0.554	55.4
26 - 42	0.98	0.99	0.838	83.8

Table E-19G. Average Percentage of Trucks by Truck Type and Location on PTH #14 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #14														
N/A	1989	3			1.0	2.7	1.9	2159	40	0.6	0.5	0.2	0.1	0.5
# 3	1989	3			10.9	14.6	12.8	1193	152	2.7	2.7	5.2	1.2	1.2
# 30	1987	3	16.7	13.3			15.0	1482	222	3.1	2.0	7.5	0.8	1.7
# 75	1986	2	15.2	18.8			17.0	611	104	5.0	3.2	6.8	1.0	1.2
# 32	1986	3	11.2	9.7			10.5	3814	399	2.4	2.6	4.5	0.5	0.6
N/A	1985	3	8.9	7.9			8.4	4252	357	2.3	1.8	3.6	0.3	0.6
Totals							**65.5**	**13511**	**1274**	**16.1**	**12.8**	**27.8**	**3.9**	**5.8**
Averages							**10.9**	**2252**	**212**	**2.7**	**2.1**	**4.6**	**0.7**	**1.0**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #14):

Truck Type	Variance	Std. Dev.	COV	% COV
8	2.02	1.42	0.530	53.0
9	0.90	0.95	0.444	44.4
10 - 15	6.80	2.61	0.563	56.3
16 - 25	0.18	0.43	0.656	65.6
26 - 42	0.23	0.48	0.494	49.4

Table E-19H. Average Percentage of Trucks by Truck Type and Location on PTH #15 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #15												
# 12	1989	1	6.7	6.0	6.4	2719	173	1.5	1.4	2.1	0.7	0.8
#207	1988	1	4.1	6.6	5.4	6618	354	1.2	1.0	2.5	0.3	0.4
#306	1985	1	6.0	6.0	6.0	2751	165	2.0	1.4	2.1	0.2	0.4
# 11	1982	1	0.0	4.3	4.3	680	29	2.3	0.6	0.9	0.5	0.0
#206	1981	1	6.4	5.6	6.0	4045	243	2.1	1.2	2.1	0.7	0.0
Totals					28.0	16813	964	9.1	5.6	9.7	2.4	1.6
Averages					5.6	3363	193	1.8	1.1	1.9	0.5	0.3

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #15):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.21	0.46	0.250	25.0
9	0.11	0.34	0.299	29.9
10 - 15	0.37	0.61	0.314	31.4
16 - 25	0.05	0.23	0.477	47.7
26 - 42	0.11	0.34	1.048	104.8

Table E-19I. Average Percentage of Trucks by Truck Type and Location on PTH #17 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #17														
#325	1983	11			0.0	7.5	7.5	594	45	4.1	1.5	1.5	0.4	0.0
# 68	1983	11			8.8	7.9	8.4	405	34	4.2	0.9	2.7	0.6	0.1
# 7	1983	11	5.7	5.6			5.7	1077	61	3.4	1.2	0.9	0.2	0.1
Totals							**21.5**	**2076**	**140**	**11.7**	**3.6**	**5.1**	**1.2**	**0.2**
Averages							**7.2**	**692**	**47**	**3.9**	**1.2**	**1.7**	**0.4**	**0.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #17):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.19	0.44	0.112	11.2
9	0.09	0.30	0.250	25.0
10 - 15	0.84	0.92	0.539	53.9
16 - 25	0.04	0.20	0.500	50.0
26 - 42	0.01	0.07	1.061	106.1

Table E-19J. Average Percentage of Trucks by Truck Type and Location on PTH #20 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #20														
# 5	1990	8			6.1	5.5	5.8	571	33	1.7	1.1	1.6	1.3	0.4
#267	1989	8			7.1	7.3	7.2	851	61	2.9	0.8	1.4	1.7	0.5
# 10	1985	8	7.1	10.8			9.0	454	41	4.2	1.9	1.7	1.1	0.2
# 20A(S)	1985	8			11.5	33.9	22.7	320	73	12.3	6.4	2.1	1.3	0.3
# 20	1985	8	5.7	6.3			6.0	1946	117	3.1	1.2	1.0	0.6	0.1
Totals							**50.7**	**4142**	**325**	**24.2**	**11.4**	**7.8**	**6.0**	**1.5**
Averages							**10.1**	**828**	**65**	**4.8**	**2.3**	**1.6**	**1.2**	**0.3**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #20):

Truck Type	Variance	Std. Dev.	COV	% COV
8	14.54	3.81	0.788	78.8
9	4.37	2.09	0.917	91.7
10 - 15	0.13	0.36	0.233	23.3
16 - 25	0.13	0.36	0.298	29.8
26 - 42	0.02	0.14	0.471	47.1

Table E-19K. Average Percentage of Trucks by Truck Type and Location on PTH #21 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #21												
# 45	1991	7	17.0	13.2	15.1	340	51	8.0	2.0	3.7	1.3	0.2
# 2	1991	4	8.1	0.0	8.1	84	7	1.0	1.0	4.1	1.3	0.8
# 16	1989	7	9.3	7.3	8.3	927	77	3.6	1.3	2.4	0.8	0.3
# 3	1989	4	9.5	9.1	9.3	630	59	3.0	1.9	2.3	1.6	0.6
# 1	1989	5	7.2	8.6	7.9	567	45	2.1	1.2	2.3	2.1	0.5
# 2	1983	5	9.0	18.6	13.8	241	33	3.3	7.2	2.7	0.5	0.2
Totals					**62.5**	**2789**	**272**	**21.0**	**14.6**	**17.5**	**7.6**	**2.6**
Averages					**10.4**	**465**	**45**	**3.5**	**2.4**	**2.9**	**1.3**	**0.4**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #21):

Truck Type	Variance	Std. Dev.	COV	% COV
8	5.75	2.40	0.685	68.5
9	5.61	2.37	0.974	97.4
10 - 15	0.62	0.79	0.270	27.0
16 - 25	0.32	0.57	0.449	44.9
26 - 42	0.06	0.24	0.565	56.5

Table E-19L. Average Percentage of Trucks by Truck Type and Location on PTH #23 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #23												
#428	1991	3	13.2	12.7	13.0	946	123	3.0	1.5	5.7	1.5	1.3
# 18	1991	4	6.5	8.3	7.4	137	10	2.6	0.6	2.9	0.9	0.6
# 34	1990	3	8.2	6.6	7.4	740	55	2.1	1.2	1.9	1.7	0.7
# 10	1990	4	9.4	10.3	9.9	225	22	3.6	1.6	2.0	2.1	0.6
# 59	1987	2	4.8	14.8	9.8	390	38	2.4	2.6	3.2	1.3	0.6
# 5	1985	4	10.8	10.6	10.7	503	54	4.4	1.3	2.8	1.8	0.5
# 10	1982	4	14.4	16.3	15.4	279	43	3.3	6.6	4.9	0.5	0.2
Totals					**73.5**	**3220**	**345**	**21.4**	**15.4**	**23.4**	**9.8**	**4.5**
Averages					**10.5**	**460**	**49**	**3.1**	**2.2**	**3.3**	**1.4**	**0.6**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #23):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.62	0.79	0.258	25.8
9	4.12	2.03	0.923	92.3
10 - 15	2.07	1.44	0.430	43.0
16 - 25	0.30	0.55	0.393	39.3
26 - 42	0.11	0.33	0.520	52.0

Table E-19M. Average Percentage of Trucks by Truck Type and Location on PTH #45 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #45														
# 21	1991	7	9.2	9.4			9.3	227	21	2.6	1.1	3.5	1.6	0.6
# 16	1991	7			4.9	11.9	8.4	1266	106	2.5	0.6	3.5	0.8	1.1
# 10	1985	7	0.0	8.6			8.6	600	52	3.8	1.1	3.2	0.5	0.1
# 16	1983	7			0.0	12.6	12.6	1835	231	3.0	1.0	7.3	0.4	0.9
Totals							**38.9**	**3928**	**410**	**11.9**	**3.8**	**17.5**	**3.3**	**2.7**
Averages							**9.7**	**982**	**103**	**3.0**	**1.0**	**4.4**	**0.8**	**0.7**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #45):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.35	0.59	0.199	19.9
9	0.06	0.24	0.258	25.8
10 - 15	3.82	1.95	0.447	44.7
16 - 25	0.30	0.54	0.660	66.0
26 - 42	0.19	0.44	0.646	64.6

Table E-19N. Average Percentage of Trucks by Truck Type and Location on PTH #68 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #68												
# 5	1991	8	6.8	7.5	7.2	323	23	2.2	0.9	1.9	1.4	0.9
# 8	1990	11	3.9	4.3	4.1	540	22	1.6	0.9	0.6	1.0	0.2
#325	1988	11	8.0	9.0	8.5	228	19	0.9	0.3	5.5	0.8	1.1
# 17	1983	11	10.2	8.5	9.4	407	38	5.5	1.4	1.8	0.7	0.1
Totals					**29.1**	**1498**	**102**	**10.2**	**3.5**	**9.8**	**3.9**	**2.3**
Averages					**7.3**	**375**	**26**	**2.6**	**0.9**	**2.5**	**1.0**	**0.6**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #68):

Truck Type	Variance	Std. Dev.	COV	% COV
8	4.15	2.04	0.799	79.9
9	0.20	0.45	0.515	51.5
10 - 15	4.49	2.12	0.865	86.5
16 - 25	0.10	0.31	0.319	31.9
26 - 42	0.25	0.50	0.870	87.0

Table E-190. Average Percentage of Trucks by Truck Type and Location on PR #206 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #206												
#207	1990	2	3.8	3.8	3.8	946	36	1.8	0.8	0.7	0.6	0.0
# 44	1983	1	3.5	7.6	5.6	313	17	2.5	0.7	2.1	0.3	0.1
#213	1981	1	3.5	4.2	3.9	1656	64	1.5	0.6	0.8	1.0	0.0
# 15	1981	1	3.8	4.9	4.4	1068	46	2.3	0.8	0.7	0.5	0.1
Totals					**17.6**	**3983**	**163**	**8.1**	**2.9**	**4.3**	**2.4**	**0.2**
Averages					**4.4**	**996**	**41**	**2.0**	**0.7**	**1.1**	**0.6**	**0.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #206):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.21	0.46	0.226	22.6
9	0.01	0.10	0.138	13.8
10 - 15	0.47	0.69	0.638	63.8
16 - 25	0.09	0.29	0.491	49.1
26 - 42	0.01	0.08	1.633	163.3

Table E-19P. Average Percentage of Trucks by Truck Type and Location on PR #317 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #317												
# 11	1987	1	6.1	9.9	8.0	1188	95	1.5	3.5	2.0	0.7	0.3
# 59	1985	1	9.8	11.9	10.9	513	56	3.7	1.0	6.6	0.1	0.1
# 12	1982	1	5.0	4.5	4.8	563	27	2.5	1.1	0.7	0.6	0.0
Totals					**23.6**	**2264**	**178**	**7.7**	**5.6**	**9.3**	**1.4**	**0.4**
Averages					**7.9**	**755**	**59**	**2.6**	**1.9**	**3.1**	**0.5**	**0.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #317):

Truck Type	Variance	Std. Dev.	COV	% COV
8	1.22	1.10	0.429	42.9
9	2.01	1.42	0.759	75.9
10 - 15	9.61	3.10	1.000	100.0
16 - 25	0.11	0.32	0.694	69.4
26 - 42	0.03	0.16	1.186	118.6

Table E-19Q. Average Percentage of Trucks by Truck Type and Location on PR #325 (Secondary Arterial)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. %. Trucks	Type 9 Avg. %. Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #325														
# 68	1988	11			7.7	8.8	8.3	278	23	1.5	0.4	2.8	1.8	1.0
# 6	1987	11	0.0	3.8			3.8	589	22	1.1	0.6	1.0	0.6	0.5
# 17	1983	11	6.3	3.6			5.0	479	24	2.3	1.2	1.2	0.3	0.0
Totals							**17.0**	**1346**	**69**	**4.9**	**2.2**	**5.0**	**2.7**	**1.5**
Averages							**5.7**	**449**	**23**	**1.6**	**0.7**	**1.7**	**0.9**	**0.5**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #325):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.38	0.61	0.375	37.5
9	0.18	0.42	0.570	57.0
10 - 15	0.98	0.99	0.592	59.2
16 - 25	0.63	0.79	0.882	88.2
26 - 42	0.25	0.50	1.000	100.0

Table E-20. Average Percentage of Trucks (Secondary Arterial)

ROUTE	% TRUCKS
3	9.8
5	9.0
9	3.2
11	6.3
12	6.9
13	12.3
14	10.9
15	5.6
17	7.2
20	10.1
21	10.4
23	10.5
45	9.7
68	7.3
206	4.4
317	7.9
325	5.7
TOTAL	**137.2**
AVG.	**8.1**

Table E-21. Summary of Average Percentage Trucks, Standard Deviation, and COV (Secondary Arterials)

Route	Truck Type 8 % Trucks	Truck Type 8 Std. Dev. (%)	Truck Type 8 COV (%)	Truck Type 9 % Trucks	Truck Type 9 Std. Dev. (%)	Truck Type 9 COV (%)	Truck Type 10-15 % Trucks	Truck Type 10-15 Std. Dev. (%)	Truck Type 10-15 COV (%)	Truck Type 16-25 % Trucks	Truck Type 16-25 Std. Dev. (%)	Truck Type 16-25 COV (%)	Truck Type 26-42 % Trucks	Truck Type 26-42 Std. Dev. (%)	Truck Type 26-42 COV (%)
3	3.4	0.7	20.1	1.6	0.6	40.4	2.6	1.0	37.4	1.7	0.6	32.2	0.6	0.3	52.6
5	3.2	0.7	23.2	1.6	0.6	38.3	2.3	0.7	31.3	1.5	1.1	70.9	0.5	0.3	58.5
9	1.6	0.6	35.6	0.8	0.2	22.2	0.7	0.3	50.9	0.2	0.2	100.7	0.0	0.1	124.7
11	2.1	0.7	32.4	1.0	0.6	59.9	2.5	1.8	70.0	0.6	0.2	38.8	0.2	0.2	104.1
12	3.0	1.2	39.6	1.8	1.1	60.7	1.5	0.7	46.8	0.5	0.3	71.4	0.1	0.1	189.0
13	3.5	1.6	45.5	2.2	1.1	49.4	6.1	3.0	48.7	1.1	0.6	55.4	1.2	1.0	83.8
14	2.7	1.4	53.0	2.1	1.0	44.4	4.6	2.6	56.3	0.7	0.4	69.6	1.0	0.5	49.4
15	1.8	0.5	25.0	1.1	0.3	29.9	1.9	0.6	31.4	0.5	0.2	47.7	0.3	0.3	104.8
17	3.9	0.4	11.2	1.2	0.3	25.0	1.7	0.9	53.9	0.4	0.2	50.0	0.1	0.1	106.1
20	4.8	3.8	78.8	2.3	2.1	91.7	1.6	0.4	23.3	1.2	0.4	29.8	0.3	0.1	47.1
21	3.5	2.4	68.5	2.4	2.4	97.4	2.9	0.8	27.0	1.3	0.6	44.9	0.4	0.2	56.6
23	3.1	0.8	25.8	2.2	2.0	92.3	3.3	1.4	43.0	1.4	0.6	39.3	0.6	0.3	52.0
45	3.0	0.6	19.9	1.0	0.2	25.8	4.4	2.0	44.7	0.8	0.5	66.0	0.7	0.4	64.6
68	2.6	2.0	79.9	0.9	0.5	51.5	2.5	2.1	86.5	1.0	0.3	31.9	0.6	0.5	87.0
206	2.0	0.5	22.6	0.7	0.1	13.8	1.1	0.7	63.8	0.6	0.3	49.1	0.1	0.1	163.3
317	2.6	1.1	42.9	1.9	1.4	75.9	3.1	3.1	100.0	0.5	0.3	69.4	0.1	0.2	118.6
325	1.6	0.6	37.5	0.7	0.4	57.0	1.7	1.0	59.2	0.9	0.8	88.2	0.5	0.5	100.0
Totals	**48.4**	**19.6**	**661.5**	**25.5**	**14.9**	**875.6**	**44.5**	**23.1**	**874.2**	**14.9**	**7.6**	**955.3**	**7.3**	**5.2**	**1562.2**
Averages	**2.8**	**1.2**	**38.9**	**1.5**	**0.9**	**51.5**	**2.6**	**1.4**	**51.4**	**0.9**	**0.4**	**56.2**	**0.4**	**0.3**	**91.9**

Table E-22. Average Percentage of Trucks, Standard Deviation, and COV (Secondary Arterials)

TRUCK TYPE	% TRUCKS	STD.DEV. (%)	COV (%)
8	2.8	1.2	38.9
9	1.5	0.9	51.5
10 - 15	2.6	1.4	51.4
16 - 25	0.9	0.4	56.2
26 - 42	0.4	0.3	91.9

Table E-23. Precision vs. Sample Size (Secondary Arterials)

Truck Type	Sample Size	% Precision Achieved with 95% Confidence
8	10	24
	20	17
	30	14
	50	11
	100	8
	200	5
	300	4
9	10	32
	20	23
	30	18
	50	14
	100	10
	200	7
	300	6
10 - 15	10	32
	20	23
	30	18
	50	14
	100	10
	200	7
	300	6
16 - 25	10	35
	20	25
	30	20
	50	16
	100	11
	200	8
	300	6
26 - 42	10	57
	20	40
	30	33
	50	25
	100	18
	200	13
	300	10

Table E-24A. Average Percentage of Trucks by Truck Type and Location on PTH #24 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #24												
# 21	1991	7	7.7	7.2	7.5	477	36	2.9	0.8	1.2	2.2	0.4
# 10	1989	7	9.3	4.7	7.0	325	23	3.1	0.8	1.8	1.0	0.4
# 83	1989	7	6.0	7.3	6.7	290	19	2.3	0.8	0.9	2.6	0.2
Totals					**21.1**	**1092**	**78**	**8.3**	**2.4**	**3.9**	**5.8**	**1.0**
Averages					**7.0**	**364**	**26**	**2.8**	**0.8**	**1.3**	**1.9**	**0.3**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH 24):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.18	0.42	0.151	15.1
9	0.00	0.00	0.000	0.0
10 - 15	0.21	0.46	0.353	35.3
16 - 25	0.70	0.83	0.431	43.1
26 - 42	0.02	0.12	0.367	36.7

Table E-24B. Average Percentage of Trucks by Truck Type and Location on PTH #42 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #42														
# 83(E)	1988	7	5.4	6.6			6.0	839	50	3.4	0.6	1.0	0.8	0.2
# 16	1988	7			10.7	6.9	8.8	205	18	4.7	2.3	0.6	0.7	0.6
# 83(E)	1987	7	5.4	4.9			5.2	195	10	3.2	0.4	0.6	0.9	0.3
Totals							**20.0**	**1239**	**78**	**11.3**	**3.3**	**2.2**	**2.4**	**1.1**
Averages							**6.7**	**413**	**26**	**3.8**	**1.1**	**0.7**	**0.8**	**0.4**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PTH #42):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.67	0.82	0.216	21.6
9	1.09	1.04	0.949	94.9
10 - 15	0.06	0.23	0.320	32.0
16 - 25	0.01	0.10	0.125	12.5
26 - 42	0.05	0.21	0.579	57.9

Table E-24C. Average Percentage of Trucks by Truck Type and Location on PR #207 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #207														
#206	1990	2	3.5	2.8			3.2	1067	34	1.4	0.8	0.5	0.5	0.0
# 1	1989	2			11.8	2.2	7.0	2032	142	1.5	1.3	3.1	0.6	0.6
# 15	1988	1			18.6	6.2	12.4	1230	153	1.4	2.3	7.7	0.5	0.7
# 1	1983	2			11.5	3.7	7.6	1508	115	2.4	1.6	3.0	0.3	0.3
Totals							**30.2**	**5837**	**444**	**6.7**	**6.0**	**14.3**	**1.9**	**1.6**
Averages							**7.5**	**1459**	**111**	**1.7**	**1.5**	**3.6**	**0.5**	**0.4**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #207):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.24	0.49	0.290	29.0
9	0.39	0.63	0.418	41.8
10 - 15	9.01	3.00	0.840	84.0
16 - 25	0.02	0.13	0.272	27.2
26 - 42	0.10	0.32	0.791	79.1

Table E-24D. Average Percentage of Trucks by Truck Type and Location on PR #210 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #210												
# 75	1986	2	4.2	13.1	8.7	761	66	2.6	1.6	3.5	0.4	0.7
# 12	1985	2	3.4	6.0	4.7	692	33	3.0	1.2	0.3	0.2	0.1
Totals					**13.4**	**1453**	**99**	**5.6**	**2.8**	**3.8**	**0.6**	**0.8**
Averages					**6.7**	**727**	**50**	**2.8**	**1.4**	**1.9**	**0.3**	**0.4**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #210):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.08	0.28	0.101	10.1
9	0.08	0.28	0.202	20.2
10 - 15	5.12	2.26	1.191	119.1
16 - 25	0.02	0.14	0.471	47.1
26 - 42	0.18	0.42	1.061	106.1

Table E-24E. Average Percentage of Trucks by Truck Type and Location on PR #213 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #213												
# 59	1989	12	9.8	2.9	6.4	2383	151	1.1	0.6	4.3	0.3	0.2
#206	1981	1	4.0	3.3	3.7	1138	42	1.4	0.6	1.0	0.7	0.0
Totals					**10.0**	**3521**	**193**	**2.5**	**1.2**	**5.3**	**1.0**	**0.2**
Averages					**5.0**	**1761**	**97**	**1.3**	**0.6**	**2.7**	**0.5**	**0.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #213):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.05	0.22	0.179	17.9
9	0.00	0.00	0.000	0.0
10 - 15	5.45	2.33	0.881	88.1
16 - 25	0.08	0.28	0.566	56.6
26 - 42	0.02	0.14	1.414	141.4

Table E-24F. Average Percentage of Trucks by Truck Type and Location on PR #215 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #215														
# 44	1982	1			5.7	6.8	6.3	1210	76	2.9	1.0	1.7	0.7	0.1
# 12	1982	1	4.9	5.1			5.0	533	27	2.6	1.3	0.9	0.3	0.0
Totals							**11.3**	**1743**	**103**	**5.5**	**2.3**	**2.6**	**1.0**	**0.1**
Averages							**5.6**	**872**	**52**	**2.8**	**1.2**	**1.3**	**0.5**	**0.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #215):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.05	0.22	0.081	8.1
9	0.05	0.22	0.194	19.4
10 - 15	0.16	0.40	0.308	30.8
16 - 25	0.08	0.28	0.566	56.6
26 - 42	0.01	0.10	2.000	200.0

Table E-24G. Average Percentage of Trucks by Truck Type and Location on PR #221 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #221														
#101	1987	12	17.0	7.0			12.0	1914	230	2.5	1.6	5.9	0.0	2.1
N/A	1982	12			2.1	5.0	3.6	3339	119	1.5	0.9	1.0	0.2	0.1
Totals							**15.6**	**5253**	**349**	**4.0**	**2.5**	**6.9**	**0.2**	**2.2**
Averages							**7.8**	**2627**	**175**	**2.0**	**1.3**	**3.5**	**0.1**	**1.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #221):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.50	0.71	0.354	35.4
9	0.25	0.50	0.400	40.0
10 - 15	12.01	3.47	1.005	100.5
16 - 25	0.02	0.14	1.414	141.4
26 - 42	2.00	1.41	1.286	128.6

Table E-24H. Average Percentage of Trucks by Truck Type and Location on PR #229 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #229												
# 7	1990	1	4.2	4.8	4.5	537	24	1.3	0.5	0.8	1.9	0.0
# 8	1987	1	5.7	3.2	4.5	408	18	1.7	0.9	1.5	0.4	0.0
Totals					**9.0**	**945**	**42**	**3.0**	**1.4**	**2.3**	**2.3**	**0.0**
Averages					**4.5**	**473**	**21**	**1.5**	**0.7**	**1.2**	**1.2**	**0.0**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #229):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.08	0.28	0.189	18.9
9	0.08	0.28	0.404	40.4
10 - 15	0.25	0.50	0.435	43.5
16 - 25	1.13	1.06	0.924	92.4
26 - 42	0.00	0.00	N/A	N/A

Table E-24I. Average Percentage of Trucks by Truck Type and Location on PR #234 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #234												
# 8	1988	11	3.3	0.0	3.3	443	15	1.6	0.9	0.5	0.4	0.0
# 8	1981	11	4.2	0.0	4.2	322	14	2.0	1.1	0.6	0.5	0.0
Totals					7.5	765	29	3.6	2.0	1.1	0.9	0.0
Averages					3.8	383	15	1.8	1.0	0.6	0.5	0.0

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #234):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.08	0.28	0.157	15.7
9	0.02	0.14	0.141	14.1
10 - 15	0.01	0.10	0.182	18.2
16 - 25	0.01	0.10	0.222	22.2
26 - 42	0.00	0.00	N/A	N/A

Table E-24J. Average Percentage of Trucks by Truck Type and Location on PR #235 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #235														
# 6	1983	11	0.0	14.0			14.0	339	47	2.1	1.2	8.0	0.6	2.1
# 5	1983	8			0.0	9.5	9.5	1414	134	3.6	1.4	3.5	0.4	0.5
Totals							**23.5**	**1753**	**181**	**5.7**	**2.6**	**11.5**	**1.0**	**2.6**
Averages							**11.8**	**877**	**91**	**2.9**	**1.3**	**5.8**	**0.5**	**1.3**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #235):

Truck Type	Variance	Std. Dev.	COV	% COV
8	1.13	1.06	0.373	37.3
9	0.02	0.14	0.109	10.9
10 - 15	10.13	3.18	0.554	55.4
16 - 25	0.02	0.14	0.283	28.3
26 - 42	1.28	1.13	0.870	87.0

Table E-24K. Average Percentage of Trucks by Truck Type and Location on PR #236 (Collector)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PTH #236												
# 6	1991	12	10.3	3.8	7.1	1067	75	1.3	0.6	2.5	2.2	0.5
# 6	1982	12	3.0	3.3	3.2	465	15	1.0	0.9	0.9	0.4	0.1
Totals					10.2	1532	90	2.3	1.5	3.4	2.6	0.6
Averages					5.1	766	45	1.2	0.8	1.7	1.3	0.3

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #236):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.05	0.22	0.194	19.4
9	0.05	0.22	0.298	29.8
10 - 15	1.28	1.13	0.666	66.6
16 - 25	1.62	1.27	0.979	97.9
26 - 42	0.08	0.28	N/A	N/A

Table E-24L. Average Percentage of Trucks by Truck Type and Location on PR #241 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #241														
# 1	1986	6			6.5	5.4	6.0	380	23	2.9	1.6	0.9	0.5	0.2
# 10	1986	N/A	20.1	0.0			20.1	76	15	2.2	5.1	9.7	3.1	0.0
Totals							**26.1**	**456**	**38**	**5.1**	**6.7**	**10.6**	**3.6**	**0.2**
Averages							**13.0**	**228**	**19**	**2.6**	**3.4**	**5.3**	**1.8**	**0.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #241):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.25	0.50	0.196	19.6
9	6.13	2.48	0.739	73.9
10 - 15	38.72	6.22	1.174	117.4
16 - 25	3.38	1.84	1.021	102.1
26 - 42	0.02	0.14	1.414	141.4

Table E-24M. Average Percentage of Trucks by Truck Type and Location on PR #248 (Collector)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #248												
# 1	1991	6	7.4	6.4	6.9	1808	125	2.8	1.2	1.3	1.3	0.4
# 2	1986	3	17.7	19.1	18.4	378	70	10.6	4.8	2.4	0.5	0.2
Totals					**25.3**	**2186**	**195**	**13.4**	**6.0**	**3.7**	**1.8**	**0.6**
Averages					**12.7**	**1093**	**98**	**6.7**	**3.0**	**1.9**	**0.9**	**0.3**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #248):

Truck Type	Variance	Std. Dev.	COV	% COV
8	30.42	5.52	0.823	82.3
9	6.48	2.55	0.849	84.9
10 - 15	0.61	0.78	0.422	42.2
16 - 25	0.32	0.57	0.629	62.9
26 - 42	0.02	0.14	0.471	47.1

Table E-24N. Average Percentage of Trucks by Truck Type and Location on PR #270 (Collector)

Location	Year of Survey	District	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #270												
# 25	1987	5	8.7	3.8	6.3	599	37	3.6	0.7	0.8	1.2	0.2
# 1	1985	5	4.4	0.0	4.4	1134	50	2.5	0.5	0.6	0.7	0.0
Totals					**10.7**	**1733**	**87**	**6.1**	**1.2**	**1.4**	**1.9**	**0.2**
Averages					**5.3**	**867**	**44**	**3.1**	**0.6**	**0.7**	**1.0**	**0.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #270):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.61	0.78	0.256	25.6
9	0.02	0.14	0.236	23.6
10 - 15	0.02	0.14	0.202	20.2
16 - 25	0.13	0.36	0.380	38.0
26 - 42	0.02	0.14	1.414	141.4

Table E-24O. Average Percentage of Trucks by Truck Type and Location on PR #307 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #307														
# 44	1989	1			3.9	0.0	3.9	473	18	1.3	0.4	1.0	0.8	0.2
# 11	1989	1	2.9	0.0			2.9	861	25	1.4	0.6	0.3	0.6	0.0
Totals							**6.8**	**1334**	**43**	**2.7**	**1.0**	**1.3**	**1.4**	**0.2**
Averages							**3.4**	**668**	**22**	**1.4**	**0.5**	**0.7**	**0.7**	**0.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #307):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.01	0.10	0.074	7.4
9	0.02	0.14	0.283	28.3
10 - 15	0.25	0.50	0.769	76.9
16 - 25	0.02	0.14	0.202	20.2
26 - 42	0.02	0.14	1.414	141.4

Table E-24P. Average Percentage of Trucks by Truck Type and Location on PR #311 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #311												
# 59	1990	2	7.5	7.3	7.4	1885	139	1.8	3.2	1.7	0.8	0.1
# 12	1982	2	6.9	7.0	7.0	1168	81	3.1	2.9	0.8	0.3	0.1
Totals					**14.4**	**3053**	**220**	**4.9**	**6.1**	**2.5**	**1.1**	**0.2**
Averages					**7.2**	**1527**	**110**	**2.5**	**3.1**	**1.3**	**0.6**	**0.1**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #311):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.85	0.92	0.376	37.6
9	0.05	0.22	0.073	7.3
10 - 15	0.41	0.64	0.512	51.2
16 - 25	0.13	0.36	0.656	65.6
26 - 42	0.00	0.00	0.000	0.0

Table E-24Q. Average Percentage of Trucks by Truck Type and Location on PR #327 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #327												
# 6	1986	?	0.0	11.6	11.6	183	21	1.8	0.4	4.8	0.4	4.2
# 10	1982	10	13.8	0.0	13.8	137	19	5.5	0.5	5.9	0.6	1.3
Totals					**25.4**	**320**	**40**	**7.3**	**0.9**	**10.7**	**1.0**	**5.5**
Averages					**12.7**	**160**	**20**	**3.7**	**0.5**	**5.4**	**0.5**	**2.8**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #327):

Truck Type	Variance	Std. Dev.	COV	% COV
8	6.85	2.62	0.717	71.7
9	0.01	0.10	0.222	22.2
10 - 15	0.61	0.78	0.146	14.6
16 - 25	0.02	0.14	0.283	28.3
26 - 42	4.21	2.05	0.746	74.6

Table E-24R. Average Percentage of Trucks by Truck Type and Location on PR #421 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #421												
# 75	1988	2	6.1	4.3	5.2	73	4	1.4	2.6	0.9	0.2	0.1
# 75	1981	2	9.1	10.0	9.6	81	8	5.3	2.6	1.0	0.5	0.2
Totals					14.8	154	12	6.7	5.2	1.9	0.7	0.3
Averages					7.4	77	6	3.4	2.6	1.0	0.4	0.2

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #421):

Truck Type	Variance	Std. Dev.	COV	% COV
8	7.61	2.76	0.823	82.3
9	0.00	0.00	0.000	0.0
10 - 15	0.01	0.10	0.105	10.5
16 - 25	0.05	0.22	0.639	63.9
26 - 42	0.01	0.10	0.667	66.7

Table E-24S. Average Percentage of Trucks by Truck Type and Location on PR #482 (Collector)

Location	Year of Survey	District	Total % Trucks - E. Leg.	Total % Trucks - W. Leg.	Total % Trucks - N. Leg.	Total % Trucks - S. Leg.	Avg. % Trucks	Avg. AADT	Avg. Truck AADTT	Type 8 Avg. % Trucks	Type 9 Avg. % Trucks	Type 10-15 Avg. % Trucks	Type 16-25 Avg. % Trucks	Type 26-42 Avg. % Trucks
PR #482														
# 83	1990	7	9.6	5.4			7.5	172	13	1.7	1.0	1.2	3.1	0.4
# 5	1986	8			0.0	3.7	3.7	173	6	1.6	0.0	0.7	1.1	0.2
Totals							**11.2**	**345**	**19**	**3.3**	**1.0**	**1.9**	**4.2**	**0.6**
Averages							**5.6**	**173**	**10**	**1.7**	**0.5**	**1.0**	**2.1**	**0.3**

COEFFICIENT OF VARIATION (COV) CALCULATIONS (PR #482):

Truck Type	Variance	Std. Dev.	COV	% COV
8	0.01	0.10	0.061	6.1
9	0.50	0.71	1.414	141.4
10 - 15	0.13	0.36	0.380	38.0
16 - 25	2.00	1.41	0.673	67.3
26 - 42	0.02	0.14	0.471	47.1

Table E-25. Average Percentage of Trucks (Collectors)

Route	% Trucks
24	7.0
42	6.7
207	7.5
210	6.7
213	5.0
215	5.6
221	7.8
229	4.5
234	3.8
235	11.8
236	5.1
241	13.0
248	12.7
270	5.3
307	3.4
311	7.2
327	12.7
421	7.4
482	5.6
TOTAL	**138.8**
AVG.	**7.3**

Table E-26. Summary of Average Percentage of Trucks, Standard Deviation, and COV (Collectors)

	Truck Type 8			Truck Type 9			Truck Type 10-15			Truck Type 16-25			Truck Type 26-42		
Route	% Trucks	Std. Dev (%)	COV (%)	% Trucks	Std. Dev (%)	COV (%)	% Trucks	Std. Dev (%)	COV (%)	% Trucks	Std. Dev (%)	COV (%)	% Trucks	Std. Dev (%)	COV (%)
24	2.8	0.4	15.1	0.8	0.0	0.0	1.3	0.5	35.3	1.9	0.8	43.1	0.3	0.1	36.7
42	3.8	0.8	21.6	1.1	1.0	94.9	0.7	0.2	32.0	0.8	0.1	12.5	0.4	0.2	57.9
207	1.7	0.5	29.0	1.5	0.6	41.8	3.6	3.0	84.0	0.5	0.1	27.2	0.4	0.3	79.1
210	2.8	0.3	10.1	1.4	0.3	20.2	1.9	2.3	119.1	0.3	0.1	47.1	0.4	0.4	106.1
213	1.3	0.2	17.9	0.6	0.0	0.0	2.7	2.3	88.1	0.5	0.3	56.6	0.1	0.1	141.4
215	2.8	0.2	8.1	1.2	0.2	19.4	1.3	0.4	30.8	0.5	0.3	56.6	0.1	0.1	200.0
221	2.0	0.7	35.4	1.3	0.5	40.0	3.5	3.5	100.5	0.1	0.1	141.4	1.1	1.4	128.6
229	1.5	0.3	18.9	0.7	0.3	40.4	1.2	0.5	43.5	1.2	1.0	92.4	0.0	0.0	N/A
234	1.8	0.3	15.7	1.0	0.1	14.1	0.6	0.1	18.2	0.5	0.1	22.2	0.0	0.0	N/A
235	2.9	1.1	37.3	1.3	0.1	10.9	5.8	3.2	55.4	0.5	0.1	28.3	1.3	1.1	87.0
236	1.2	0.2	19.4	0.8	0.2	29.8	1.7	1.1	66.6	1.3	1.3	97.9	0.3	0.3	N/A
241	2.6	0.5	19.6	3.4	2.5	73.9	5.3	6.2	117.4	1.8	1.8	102.1	0.1	0.1	141.4
248	6.7	5.5	82.3	3.0	2.6	84.9	1.9	0.8	42.2	0.9	0.6	62.9	0.3	0.1	47.1
270	3.1	0.8	25.6	0.6	0.1	23.6	0.7	0.1	20.2	1.0	0.4	38.0	0.1	0.1	141.4
307	1.4	0.1	7.4	0.5	0.1	28.3	0.7	0.5	76.9	0.7	0.1	20.2	0.1	0.1	141.4
311	2.5	0.9	37.6	3.1	0.2	7.3	1.3	0.6	51.2	0.6	0.4	65.6	0.1	0.0	0.0
327	3.7	2.6	71.7	0.5	0.1	22.2	5.4	0.8	14.6	0.5	0.1	28.3	2.8	2.1	74.6
421	3.4	2.8	82.3	2.6	0.0	0.0	1.0	0.1	10.5	0.4	0.2	63.9	0.2	0.1	66.7
482	1.7	0.1	6.1	0.5	0.7	141.4	1.0	0.4	38.0	2.1	1.4	67.3	0.3	0.1	47.1
Totals	**49.7**	**18.3**	**561.1**	**25.9**	**9.6**	**693.1**	**41.6**	**26.6**	**1044.5**	**16.1**	**9.3**	**1073.6**	**8.4**	**6.7**	**1496.5**
Average	**2.6**	**1.0**	**29.5**	**1.4**	**0.5**	**36.5**	**2.2**	**1.4**	**55.0**	**0.8**	**0.5**	**56.5**	**0.4**	**0.4**	**93.5**

Table E-27. Average Percentage of Trucks, Standard Deviation, and COV (Collectors)

Truck Type	% Trucks	Std. Dev. (%)	COV (%)
8	2.6	1.0	29.5
9	1.4	0.5	36.5
10 - 15	2.2	1.4	55.0
16 - 25	0.8	0.5	56.5
26 - 42	0.4	0.4	93.5

Table E-28. Precision vs. Sample Size

Truck Type	Sample Size	% Precision Achieved with 95% Confidence
8	10	18
	20	13
	30	11
	50	8
	100	6
	200	4
	300	3
9	10	23
	20	16
	30	13
	50	10
	100	7
	200	5
	300	4
10 - 15	10	34
	20	24
	30	20
	50	15
	100	11
	200	8
	300	6
16 - 25	10	35
	20	25
	30	20
	50	16
	100	11
	200	8
	300	6
26 - 42	10	58
	20	41
	30	33
	50	26
	100	18
	200	13
	300	11
	400	9

Table E-29. Highway Links Considered for Permanent Vehicle Classification Sites

RTAC Route	From	To	Priority Rating	Highway Class	Avg. AADT	Avg. AADTT	No. of Existing ATR Sites	No. of Existing C-SHRP* or SHRP sites	Total % Trucks	Dist.	Truck AVKT
1	ON BDRY	PTH 12	1	E	3749	512	2	1	13.7	113.6	21229568
	PTH 12	PTH 100(E)	3	E	9294	927	-	-	10.0	27.9	9440105
	PTH 100(W)	PTH 26(W)	2	E	10180	1310	1	-	12.9	65.2	31175380
	PTH 26(W)	PTH 16	3	E	6543	1012	-	-	15.5	20.8	7683104
	PTH 16	PTH 10(E)	1	E	4738	783	1	1	16.5	108.9	31123076
	PTH 10(E)	SK BDRY	1	E	3307	605	1	1	18.3	124.2	27426465
2	PTH 100	PTH 13	6	PA	1493	156	-	-	10.4	53.1	3023514
	PTH 13	PTH 10(S)	4	PA	1153	129	1	1	11.2	146.3	6888536
	PTH 10(N)	SK BDRY	6	PA	919	88	-	-	9.6	110.7	3555684
3	WPG BDRY	PTH 2	3	PA	4248	423	-	-	10.0	9.3	1435874
	PTH 13	MORDEN(W)	1	PA	2212	221	1	1	10.0	60.8	4904432
5	PTH 16(E)	PTH 10(S)	5	PA	1655	148	1	-	8.9	134.5	7265690
	PTH 10(S)	PTH 10(N)	5	PA	2315	189	1	-	8.2	19.9	1372802
	PTH 10(N)	SK BDRY	6	PA	1183	82	-	-	6.9	91.1	2726623
6	PTH 101	PTH 68(N)	6	PA	1510	167	-	-	11.1	124.5	7588898
	PTH 68(N)	PR 513	5	PA	1102	160	1	-	14.5	98.3	5740720
	PR 513	PTH 60	6	PA	450	61	-	-	13.6	148.9	3315259
	PTH 60	THOMPSON	6	PA	512	73	-	-	14.3	362.0	9645490
9	PTH 101	PTH 9A(S)	3	SA	8043	348	-	-	4.3	20.9	2654718
10	US BDRY	PTH 2(S)	5	PA	1100	107	1	-	9.7	70.3	2745567
	PTH 2(S)	PTH 1A	3	PA	8000	350	-	-	4.4	24.3	3104325
	PTH 1	PTH 16(N)	2	PA	2636	263	1	-	10.0	48.0	4607760
	PTH 5(N)	PTH 10A(S)	5	PA	977	101	1	-	10.3	152.9	5636659
	PTH 60	PR 285	6	PA	836	89	-	-	10.6	74.8	2429878
11	PTH 59	PINE FALLS	6	PA	1000	100	-	-	10.0	28.5	1040250
12	US BDRY	PR 302	6	PA	650	67	-	-	10.3	94.4	2308552
	PR 302	PTH 52	5	PA	2410	168	1	-	7.0	34.0	2084880
	PTH 52	PTH 1	6	E	2225	155	-	-	7.0	19.8	1120185
13	PTH 3	PTH 2	6	PA	1050	155	-	-	14.8	20.0	1131500
	PTH 2	PTH 1	6	PA	1202	194	-	-	16.1	30.4	2152624
14	PTH 75	PTH 3	3	SA	3583	330	-	-	9.2	50.3	6058635
15	PTH 101	PTH 12	3	PA	5788	373	-	-	6.4	23.2	3158564
16	PTH 1	PTH 16A(S)	2	PA	3110	330	1	-	10.6	112.3	13526535
	PTH 16A(S)	SK BDRY	3	PA	1512	240	-	-	15.9	148.5	13008600
25	PTH 10	PR 259	6	SA	781	63	-	-	8.1	28.2	648459
29	US BDRY	PTH 75	3	E	1915	413	-	-	21.6	4.0	602980
30	PTH 14	PR 201(S)	6	SA	1500	160	-	-	10.7	21.9	1278960
44	PTH 15	GARSON	6	PA	3200	160	-	-	5.0	4.5	262800
50	PTH 16	PR 278	6	SA	397	37	-	-	9.3	76.1	1027731
59	PTH 101	PR 213	3	E	16456	1174	-	-	7.1	5.6	2399656
	PR 213	PTH 4	3	PA	6064	271	-	-	4.5	27.0	2670705
	PTH 4	PTH 11	6	PA	1829	156	-	-	8.5	47.8	2721732
	PTH 100	JOHN BRUCE F	3	E	7876	1118	-	-	14.2	1.3	530491
60	PTH 6	PTH 10	6	PA	227	28	-	-	12.3	152.2	1555484
75	PTH 29	PTH 14	3	E	1940	317	-	-	16.3	24.8	2869484
	PTH 14	PTH 100	1	E	4503	553	1	1*	12.3	59.7	12050147
100	PTH 1(E)	PTH 75	1	E	8548	938	2	1	11.0	15.8	5409446
	PTH 75	PTH 1(W)	3	E	12718	1063	-	-	8.4	24.1	9350680
101	PTH 1(W)	PTH 8	3	E	7777	847	-	-	10.9	26.9	8316270
	PTH 8	PTH 59	3	E	17625	1954	-	-	11.1	7.6	5420396
221	1.8 KM W OF 101	WPG BDRY	3	C	6584	856	-	-	13.0	6.8	2124592
239	PTH 6	STEEP ROCK	6	C	275	50	-	-	18.2	20.1	366825
305	1KM S OF PORTAGE	PTH 1	6	C	716	50	-	-	7.0	20.1	366825
320	PTH 9A	PTH 4	6	C	2932	176	-	-	6.0	6.1	391864
									TOTALS:	3353.2	312675973

LEGEND

N/A: Data is not available.

*: C-SHRP site.

PRIORITY RATING:

1 = More than 200 trucks/day; SHRP/C-SHRP site equipped with AVC.
2 = More than 200 trucks/day; ATR equipment could be upgraded to include AVC.
3 = More than 200 trucks/day; no permanent data collection equipment in area.
4 = Less than 200 trucks/day; SHRP/C-SHRP site equipped with AVC.
5 = Less than 200 trucks/day; ATR equipment could be upgraded to include AVC.
6 = Less than 200 trucks/day; no permanent data collection equipment in area.

TOTAL PROVINCIAL TRUCK AVKT = 0.51 x 10^9

% TRUCK AVKT ON RTAC ROUTES = 61.4%

HIGHWAY CLASS:

E = Expressway
PA = Primary Arterial
SA = Secondary Arterial
C = Collector