UNDERSTANDING FREIGHT FOR HIGHWAY ENGINEERING AND PLANNING

BY

SCOTT MINTY, B.Sc., E.I.T.

A Thesis
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In Partial Fulfillment of the Requirements
For the Degree

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ABSTRACT

The purpose of this research is to apply methods and readily available information systems to help understand and estimate truck freight movements from freight flow data relevant for highway engineering and planning purposes. The research is a fundamental part of an on-going program to design, develop and implement the Manitoba Truck Traffic Information System and is directed at enhancing the expert knowledge and freight traffic components of Manitoba Truck Traffic Information System. The geographical scope of the research focuses on dominant truck routes in Manitoba.

The thesis: (1) develops a comprehensive GIS-T analytical platform for spatial and temporal analysis; (2) identifies freight system characteristics of importance to engineers and planners; (3) outlines pragmatic methods of translating freight flows into truck flow estimates; and (4) provides illustrative applications of how these methods can be used to derive truck freight movements.

The research reveals a wide list of questions and issues that highway agencies face concerning trucking matters. Most involve the need for improved knowledge about trucking and truck movements on the road system, and how these movements might change in response to a variety of engineering and planning decisions.

ACKNOWLEDGEMENTS

First, I would like to thank my Advisor Professor Alan Clayton for his guidance, perseverance and encouragement throughout my master's program and this research. Without his encouragement this research would not have been possible.

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CHAPTER 1

INTRODUCTION

1.1 THE RESEARCH

This research applies methods and readily available information systems to help understand and estimate truck freight movements from freight flow data relevant for highway engineering and planning purposes.

The research is a fundamental part of an on-going program to design, develop and implement the Manitoba Highway Truck Traffic Information System (MHTTIS). This is a research and development partnership between students and faculty of the Department of Civil Engineering (Transportation) at the University of Manitoba and the Manitoba Department of Infrastructure and Transportation (MIT) (UMTIG, 2000).

The thesis is particularly directed at enhancing the expert knowledge and freight traffic components of MHTTIS, and synthesizing and illustrating the use of other components of the system. Figure 1.1 shows the conceptual design of the MHTTIS idea as visualized in this research.

1.2 BACKGROUND AND NEED

Reliable information on the movement of freight is needed to inform policy and decision-makers about road costing, traffic impacts, cost allocation, environmental needs and assessment, highway system planning, traffic patterns, transportation safety and security, land use planning, and truck size and weight policy.

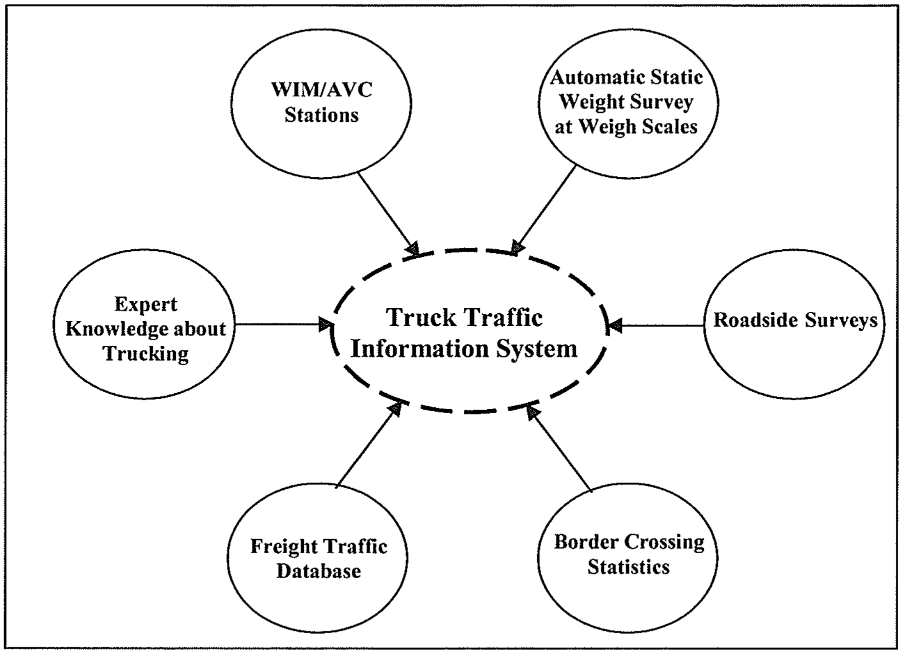


Figure 1.1 Conceptual Design of the Manitoba Highway Truck Traffic Information System

Many of these issues have become more difficult and complicated today than they were even 20 years ago (TRB, 2002). Over the past decade, new technologies have increasingly allowed for easier, less costly and more objective acquisition of truck volume and weight data. To improve the quality and volume of trucking information in Manitoba, MIT has established an extensive network of Automated Vehicle Classifier (AVC) and Weigh-In-Motion (WIM) devices over the past five years (Tang et al., 2002). In addition, an automated weigh scale survey of static weights has been designed and implemented (Tan, 2002). While these endeavors enhance the information of truck weights and truck volumes in Manitoba, there is a need to improve the information concerning truck freight on provincial highways and the linkages between freight movements and truck flows.

While truck data quantity and availability has improved, transportation engineers and planners are faced with the corresponding challenge of drawing meaningful information and understanding from this data. Figure 1.2 illustrates the principle of progression from data collection, to development of information, to understanding the information necessary in making informed decisions. While the data process is important, it must be realized that maybe 80 percent of results required can be obtained with 20 percent of the effort (Pareto's theory of Predictable Imbalance). An example of this is that the vast majority of highway freight activity takes place on a relatively small portion of the highway network (TR News, 2005). This research focuses on extracting better information and understanding from readily-available data—not the collection of more data.

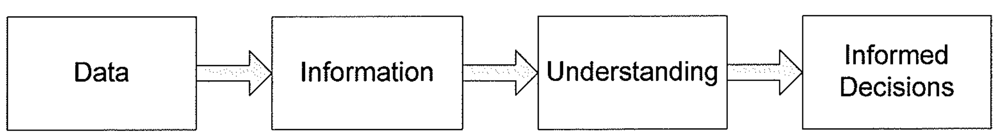


Figure 1.2 Decision Process

For purposes of this research, these terms as applied to the transportation engineering field are defined as follows (Synthesis of Heywood et al., 1998, U.S. Bureau of Transportation Statistics, Clayton et al.,--lecture notes):

- Data – observations made from monitoring the real world.

- Information – data processed to give it meaning and context.

- Understanding – grasping the meaning and being able to interpret or explain information to oneself.

- Informed Decisions - require continual updating of our understanding of the transportation system, how it is used, what it contributes, and what it affects.

While intimate knowledge and understanding of past and existing truck information such as volume and weights are important in specific areas of engineering and planning (TR News, 2005), they are not onto themselves able to readily address many of the key questions facing highway agencies:

- What truck volumes, types and weight characteristics can be expected to utilize a new or improved link in the provincial highway system? A principal Manitoba example is the development of the northeast quadrant of the Perimeter Highway around the City of Winnipeg, starting as nothing, then becoming an undivided highway, and soon ending as a divided highway.

- How will truck flows increase or change with the development of a new major freight generating operation? A good Manitoba example of this is the proposed development of the Olywest hog processing facility to be located in the St. Boniface industrial park (CBC, 2006).

- How will developments in intermodal freight transportation impact Manitoba's major highways? Intermodal freight is the fastest growing market of the western Canadian rail system (RAC, 2003). What will this mean for truck flows on Manitoba highways? How will the relocation of Canadian National's (CN) intermodal terminal from Route 90 to Symington Yards impact truck use in the City of Winnipeg over time? How will these flows or impacts translate into infrastructure design needs or deterioration rates, and ultimately cost.

- How will infrastructure development in the Prairie Region impact the growth of turnpike double trailer operations? What will the effects of this be to truck – rail competition?

- What is the relative contribution of different commodity groups to the design and deterioration of pavement systems and related capital and maintenance costs? What does this mean for cost allocation considerations and potential road use tax policies?

- How would potential changes in truck size and weight policy impact truck flows? Possible Manitoba examples include: banning certain RTAC routes in spring periods; specially-permitted long combination vehicle operations on undivided highways without paved shoulders (Clayton et al., 2003); authorizing modifications to existing RTAC truck size and weight (TS&W) regulations (e.g., lift axles, split tandems, wide-based tires, long semitrailers, short/long wheelbase tractors); rationalizing and harmonizing seasonal weight limits.

- How would transportation network developments in adjacent jurisdictions impact provincial highway trucking? For example, how would extensions of the Chief Peguis Trail in North Winnipeg modify truck flows on the North Perimeter Highway?

- How would transportation network modifications associated with the Winnipeg Floodway expansion affect network use, major shippers, and transport efficiency to/from Winnipeg?

- What commodity movements, industrial sectors and communities would be affected, and to what extent, by changes in seasonal weight limits governing trucking operations due to possible climate change scenarios (e.g. shortening of the winter weight premium period)?

These and other transportation engineering and planning issues require more objective capabilities to understand and forecast freight and related truck movements on provincial highways in Manitoba and elsewhere. This research is directed at helping to develop these capabilities.

1.3 OBJECTIVES AND SCOPE

Specific objectives of the research are:

1. To identify and assess readily available freight data sources and examples of methodologies for utilizing such data for highway engineering and planning.

2. To develop a GIS-T platform for the research.

3. To discuss, define, and characterize key aspects of the Manitoba freight system relevant to the research. These are: vehicles, freight characteristics, the demand system, industry perspectives, and the truck planning network as part of the general highway system.

4. To analyze and characterize Manitoba freight flows using readily-available freight databases and information sources.

5. To apply methodologies to estimate truck volumes from freight flows for selected sections of the Manitoba highway system.

6. To recommend further research and development requirements.

The geographical scope of the research focuses on dominant truck routes in Manitoba, as defined by the Manitoba Truck Planning Network (Tang et al., 2003a). This network is a sub set of the provincial highway system accounting for nearly 90 percent of Truck-Kilometers of Travel (TKT) in the province (based on 1999 estimates).

1.4 GIS-T PLATFORM

A GIS-T platform was developed and utilized throughout the research for visualization and understanding purposes. Many transportation systems are complicated and continuously changing. Implementation of GIS-T allows transportation planners and engineers to visualize the complexity of the transportation system and readily update the data within the system (Isaacs, 2005).

1.4.1 Spatial Data

Spatial data is defined as a set of geographic features used to visualize the real-world features they represent. Spatial datasets are comprised of three types of features namely, points, lines and polygons. Spatial data is also referred to as "basemap" in GIS terminology. The spatial data features are coupled with coordinate information to correctly represent the real-world entities (Han, 2001).

Key geographic datasets used in the research are:

- 2002 Manitoba road network – single centerline basemap for the province of Manitoba.
- 2002 UMTIG Manitoba Truck Planning Network – subset of the Manitoba road network.
- 2002 Winnipeg road network – single centerline basemap for the city of Winnipeg.
- Canada road network – single centerline basemap for major Canadian connecting highways in adjacent jurisdiction.
- U.S. road network – single centerline basemap for major U.S. connecting highways in adjacent jurisdictions.
- Boundaries – census divisions, provincial boundaries and state boundaries relevant to the research.
- Border Crossings – Manitoba / U.S. border crossings relevant to the research.

1.4.2 Attribute Data

Attribute datasets are various types of information collected to reflect characteristics of real-world features. These datasets are either directly imbedded into the spatial data or joined to the spatial data using a traditional database.

For this research, traditional databases containing a variety of highway inventory, traffic and commodity data were attached to the listed spatial datasets. The principal attribute datasets used in the research are:

- 2000 Manitoba Highway Inventory.
- 1999 and 2002 Manitoba truck traffic data.
- the 1999 Canadian Roadside Survey, developed by the Conference of Motor Transport Authorities (CCMTA).

- the 1997 Canadian For-Hire Truck Survey, developed by Statistics Canada.
- the 2002 Trans-Border Surface Freight Database, developed by the United States Bureau of Transport Statistics (BTS).
- the 2002 Manitoba Automated Weigh Scale Survey, developed by the University of Manitoba Transport Information Group (UMTIG).
- special roadside and industrial surveys, conducted by UMTIG.

1.4.3 Software

Multiple software packages are used in the research to ensure data interoperability. The key GIS package used is Maptitude. All maps presented in this report were generated using Maptitude based on the spatial and attribute datasets developed for this research. Other GIS software packages, including TransCAD, GeoMedia, ArcView and AutoCAD Map were utilized for data conversion purposes. Additional software packages, Microsoft products (Excel and Access) and Corel Paradox were used for data storage, analysis and preparation for integration into the GIS-T platform. All spatial and attribute datasets utilized in this research could be integrated for use in other GIS software packages (for example, MapInfo).

1.4.4 GIS-T Platform Development

The GIS-T platform consists of two basic components: (1) the transportation system, servicing freight and truck flows on the provincial highway system; and (2) the demand system, generating and attracting these freight and truck flows.

The developed GIS platform is an aggregation of spatial and attribute data sources used to represent the demand system and the transport system responsible for truck freight movements. The platform is used for linking and interpreting freight activity for highway engineering and planning purposes relevant to the research.

The platform is developed using a layered approach. Each layer provides a level of abstraction for developing an understanding of the freight system responsible for truck movements. Three general feature classes are displayed within the GIS: boundaries, point locations and road networks.

Boundary feature classes display geographic, political and economic areas. These area features are also used to link freight data to the GIS. Point locations display intermodal terminals, grain elevators, trucking facilities, border crossings, and other locations of freight sinks and sources. They help in understanding the demand placed on the road infrastructure supporting their location and freight quantities. The various road network layers contained in the GIS display urban and highway road infrastructure used for truck freight transportation.

1.5 ORGANIZATION

Chapter 2 discusses findings from a comprehensive environmental scan concerning the research. The environmental scan consists of three parts: a review of relevant literature; a synthesis of current sources of readily available freight data; and a review of current approaches and methodologies for utilizing freight data for highway engineering and planning.

Chapter 3 characterizes the freight demand and freight transportation systems in Manitoba. Characteristics of freight movements and interfaces are discussed. The results of a Manitoba freight industry survey are presented, discussed and synthesized.

Chapter 4 uses publicly available freight data described in Chapter 2 to analyze and characterize freight flows related to the demand and transport systems.

Chapter 5 applies the methods developed in this research to translate freight knowledge into estimated truck movements. For this research, truck movements are estimated in terms of truck volumes per unit of time on highway sections. Two different situations lent themselves to illustrative applications: (1) estimating truck traffic impacts from the construction of a new major dam project (i.e. the Wuskwatim Dam) now under development in northern Manitoba; and (2) the translation of particular freight flows to truck volumes on select sections of the Manitoba Truck Planning Network.

Chapter 6 presents the conclusions of this research.

CHAPTER 2

ENVIRONMENTAL SCAN

This chapter discusses findings from a comprehensive environmental scan concerning the research. The environmental scan consists of three parts: a review of relevant literature; a synthesis of current sources of readily available freight data; and a review of current approaches and methodologies for utilizing freight data for highway engineering and planning. The scan was assisted by active participation in professional conferences and symposia related to freight information, and regular interaction with officials and engineers from different highway and state agencies regarding the estimation of truck volumes from freight data sources.

2.1 LITERATIURE REVIEW

A variety of sources were considered during the literature review. Some of these include: (1) readily available research papers; (2) conference proceedings; (3) guidelines and special reports; and (4) jurisdictional approaches for utilizing freight data.

The main goal of this search was to identify current and relevant use of freight information for engineering and planning applications. Some key findings of importance to this research from the literature review are:

- Freight flow and future freight flow forecasts can be used as a measure to determine the size for new and existing infrastructure. Infrastructure size is generally determined and limited by capacity (NCHRP 338, 1997).
- Freight movements can be used to assess the adequacy of existing highway links in a specified corridor, and can be subsequently used to determine or predict when upgrading may be required (NCHRP 338, 1997)

- Information on freight movements can be used to estimate fuel consumption and subsequent air quality impacts resulting from the freight transportation sector (TRB, 2003).

- Freight movements are important for infrastructure design and management. Information on freight can assist in estimating truck volumes, weights, temporal patterns, and future trends (NCHRP 8-47, 2005).

- Freight information on origin – destination patterns, commodity detail and tonnage can provide valuable information on the potential use of specially-permitted vehicles. For example, Long Combination Vehicles (LCV) offer productivity and efficiency gains for low density or cubic commodity movements (Regehr et al., 2006).

- Freight data and industry knowledge can provide a link between freight system productivity and the transportation system. For example, indicators of labor productivity (e.g., ton-miles per employee) and equipment utilization (e.g., percent of truck-miles empty) can provide useful understanding of freight system and transportation system performance (Hagler, 2000).

- Freight data can provide valuable information on the value of transportation-related goods and services delivered to customers, providing a measure for the economy associated with the transportation industry (Hagler, 2000).

- Understanding freight flows on a state or provincial level requires information on freight flows. This assists engineers and planners with decisions about infrastructure design and maintenance (TRB, 2003b).

- The use of commodity flow data with special roadside surveys can provide a good basis to estimate truck volumes on specific highways and corridors (Portland, 2006).

- The ability to forecast freight flows on a transportation network is of prime importance to transportation planners. Predictions of freight flows would aid identifying potential problems along the transportation network (Demetsky et al., 2000).

- Knowledge about freight issues, national commodity flows, and a variety of freight databases are critical to good transportation planning (ITE, 1999).

- Developing knowledge of commodity flow and freight issues can assist in providing answers to the challenge of freight planning (ITE, 1999).

2.2 READILY AVAILABLE FREIGHT DATA

The freight data sources that were principally utilized during the course of this research are summarized in Table 2.1. Relevance of each source to this research is discussed in this section.

U.S. Commodity Flow Survey

The Commodity Flow Survey (CFS) is designed to provide data on the flow of commodities by mode of transport. The survey is available for the years 1993, 1997, and 2002. The CFS is an improved extension of the statistics collected as part of the Commodity Transportation Survey from 1963 through 1997 (ITE, 1999). CFS samples U.S. domestic establishments randomly selected from a population of about 800,000 establishments engaged in mining, manufacturing, wholesale, warehouses, and some selected activities in retail and service (BTS, 2006). Sampled establishments are solicited about their shipments: zip code of origin and destination, 5-digit Standard Classification of Transported Goods (SCTG) code, weight, value, and mode of transport. Hazardous material shipments are identified in the 1997 and 2002 CFS.

Transborder Surface Freight Database

The Transborder Surface Freight Database provides North American merchandise trade data by commodity type, surface mode of transportation (rail, truck, pipeline, mail and other), and geographic detail for U.S. exports, and imports from Canada and Mexico. This data, available since April 1993, is a subset of official U.S. international

Table 2.1 Freight Data Sources

Title	Mode	Description	Release Period	Detail Level	Publisher	Availability
Commodity Flow Survey	All	Data on flow of goods and materials by mode of transport	Not Specified	U.S. Totals and 89 National Transportation Analysis Regions	U.S. Department of Transportation, Bureau of Transportation Statistics	Available for Purchase
Transborder Surface Freight Data	All – except aviation	Annual tonnage and value data by commodity type and by surface mode of transportation	Monthly	U.S., Canada and Mexico totals	U.S. Department of Commerce, Bureau of the Census, Foreign Trade Division	www.bts.gov/ntda/tbscd
BTS Border Crossing / Entry Data	Truck	Truck crossings at major ports of entry	Monthly	U.S., Canada and Mexico crosssings	U.S. Department of Transportation, Bureau of Transportation Statistics	www.bts.gov
CCMTA Roadside Survey	Truck	Profile of the volume and characteristics of truck traffic using Canada's Highways	Not Specified	Canada National Highway System	Canadian Council of Motor Transport Administrators (CCMTA)	Contact CCMTA
For Hire Trucking Survey	Truck	The purpose of this survey is to measure outputs of the Canadian for-hire trucking industry by providing estimates of inter-city commodity movements	Yearly	Canada totals	Statistics Canada	Available for Purchase
Transearch	All	Comprehensive market research data service	Every five years, years ending in 3 and 8	Counties	Reebie Associates	Available for Purchase

merchandise trade data. The purpose of the database, updated on a monthly basis, is to provide transportation information on North American trade flows (BTS, 2006a).

The Transborder Surface Freight Dataset can provide origin-destination (O-D) patterns, freight value, freight weight and two stick commodity codes for commodities imported and exported from the United States.

BTS Border Crossing/Entry Data

Although the Bureau of Transportation Statistics (BTS) Border Crossing/Entry Data does not quantify freight movements, it does quantify southbound truck and truck container border crossings which can be used as an indicator of freight movements. The border crossing data provides information on vehicles/equipment, passenger and pedestrians entering the United States through land ports at the U.S./Canada and U.S./Mexico borders. These datasets represent the number of border crossings, not the number of unique vehicle crossings (BTS, 2006b).

CCMTA Roadside Survey

The National Roadside Study is a joint project by federal, provincial and territorial transportation officials to describe the volume and characteristics of freight carrying truck traffic on Canada's highway system. The study collects raw data at sites distributed across the highway system, the raw data at each site consists of (Strategis, 2006):

- Counts of trucks passing the site during a continuous 7-day period, with the count categorized by day, hour-of-day, and class of truck; and
- Interviews of random samples of trucks passing the site during the 7-day period.

For-Hire Trucking Survey

The purpose of the For-Hire Trucking Survey is to measure outputs of the Canadian for-hire trucking industry by providing estimates of inter-city commodity movements. Information is provided on shipments, revenue, weight, and distance. Canada-based for-hire trucking companies with annual operating revenues of one million dollars or more, mainly derived from long distance deliveries, are surveyed (Statscan, 2006a).

Transearch Database

Transearch freight market data is developed by Reebie Associates in the U.S.. Transearch is a multimodal freight movement database specifically designed for public and private sector freight planning. Transearch's geographic O-D pairs are produced at the county, zip code, metropolitan area, state or province level. Freight is defined by commodity, with quantities in terms of loads, tonnage or value. The Reebie database converts tonnages of commodity movements by truck into the number of annual loaded truck movements by origin-destination combinations. In addition, Transearch provides estimates of empty truck movements by origin-destination combinations (TRB, 2003).

2.3 CURRENT APPROACHES AND METHODOLOGIES OF UTILIZING FREIGHT DATA

Over the last decade, the incorporation of freight issues into policy, planning, and programming activities by provincial and state transportation departments, and metropolitan planning organizations (MPO) has received significant focus from Federal transportation agencies, business and industry leaders (NCHRP 8-47, 2005). As a result, transportation engineers and planners are increasingly utilizing information on the movement of freight. Reliable freight data is an essential decision-making tool for policy development and infrastructure investments (TRB, 2003).

Freight datasets are useful for a wide range of highway engineering and planning applications and provide a capability to estimate and understand:

- Truck volumes and truck volume trends
- Major origin – destination patterns
- Major commodity movements
- Major freight transportation infrastructure
- Infrastructure investment needs
- Freight shipment related congestion

Current approaches for utilizing freight data based on the environmental scan are:

<u>Freight Analysis Framework & Freight Analysis Framework 2</u>

The Freight Analysis Framework (FAF) is designed as a starting point for understanding state and local freight flows. FAF provides graphical information on commodity flows in the United States. It covers local and long distance domestic shipments, imports and exports of all commodities. FAF-2 is the second generation of the FAF, updated to the 2002 Economic Census and utilizing the 2002 Commodity Flow Survey and 15 other commodity movements not included in the CFS scope (TRB, 2003a).

<u>Wuskwatim Project – Materials Transportation Research Study</u>

The University of Manitoba Transport Information Group (UMTIG) under contact from Manitoba Hydro used data on the movement of key commodities to estimate truck traffic expected during the construction of a new northern hydro electric generating facility. From the analysis, modifications to the existing Truck Size and Weight Policy were postulated and the resulting truck traffic determined (Minty et al., 2004).

Truck Accommodation Design Guidance Project – Texas Transport Institute

Freight data assisted the Texas Transport Institute in determining current levels of trucking activity on major Texas highways for their Truck Accommodation Design Guidance Project. The data facilitated an understanding of major truck commodities transported, major truck origin – destination patterns (O-D), and an estimate of truck volumes traveling between O-D pairs (Middleton et al., 2003).

Brownsville MPO

The Brownsville MPO uses data on truck and rail flows to monitor border crossing trends. Upward trends or growth in freight flow can indicate growing traffic volumes and possible capacity issues at the border crossings as well as increased truck and rail congestion in the MPO region (TRB, 2003a). Downward freight flow trends have the opposite effect and potential economic problems as much of the Brownsville economy depend on trade with Mexico. The MPO would like to have more information about the commodities, particularly hazardous materials, being carried across the border, but the trucking companies have been very reluctant to release that information. Obtaining information about the origin and destination of goods moving across the border has proven to be even more difficult (TRB, 2003a).

The Duluth-Superior Metropolitan Interstate Committee (MIC)

Freight data used by the MIC include data for detailed commodity, mode data, port-level freight shipments, and rail frequencies (not commodities). This data is combined with existing truck traffic counts to produce a truck traffic forecast (Cambridge, 2005).

Minnesota Statewide Multimodal Freight Flow Study

The goal of this study was to provide data, recommendations, and direction regarding Minnesota freight flows to Minnesota Department of Transportation (MnDOT) and the Minnesota Freight Advisory Committee (Cambridge, 2005). These include:

- The volume, density, and character of major freight flows in the State by mode and corridor;
- The origins and destinations of freight flows by mode to and from major regional centers in the State;
- Critical freight transportation planning, infrastructure, and policy issues; and
- Data, freight system performance measures, and recommendations to support and compliment the Interregional Corridors Study, which identified priority and at-risk interregional highway corridors connecting the State's regional trade centers.

Oregon Commodity Flow Forecast

The report identifies freight flow forecasts to 2030 for Oregon by transportation mode, area and commodity group. Although comprised of commodities growing at different rates, this study forecasts that the total of all commodity tonnage in the state will increase 81 percent between 1997 and 2030 (Oregon, 2005).

CHAPTER 3

FREIGHT SYSTEM CHARACTERISTICS

This chapter characterizes the freight demand and freight transportation systems in Manitoba. Characteristics of freight movements and interfaces are discussed. The results of a Manitoba freight industry survey are presented, discussed and synthesized.

Freight encompasses tangible products consumed or utilized by individuals, business, and society. This includes raw materials, agriculture products, forestry products, intermediate products from factories, waste and recycling products, and final products found in retail stores (TRB, 2003). These goods become freight only when they are transported, and for the purpose of this research only when they are transported by truck.

The chapter is structured within a framework facilitating freight transportation system analysis in this research as defined by Manheim (1979). The framework includes three basic variables: (1) the freight transportation system (T); (2) the freight demand system (D); and (3) the freight flow system (F). The relationships between the three variables are illustrated in Figure 3.1.

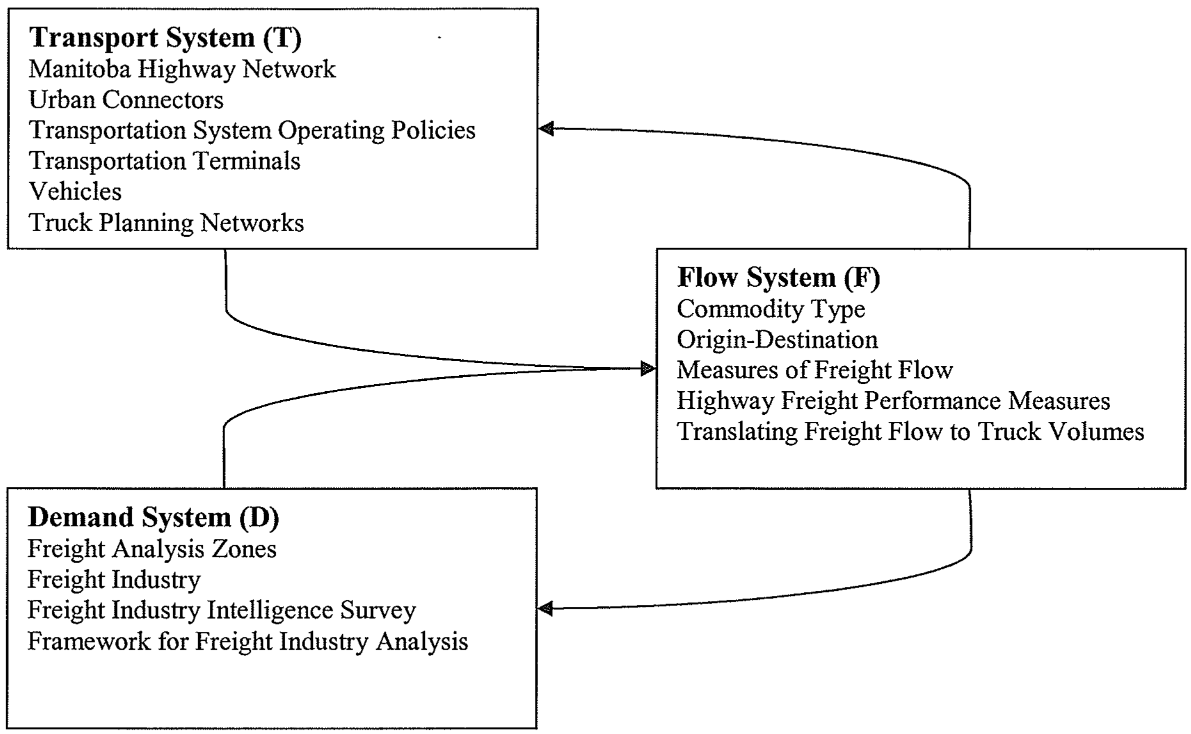


Figure 3.1 Basic Relationships between T, A and F

3.1 TRANSPORT SYSTEM

For the purpose of this research, the transport system services principal truck freight flows and related truck movements in Manitoba. The system consists of urban connectors, highways, and major transportation terminals including intermodal terminals. Transportation system operating policies are included in the transport system because they effect the movement of commercial heavy truck traffic. Transportation system operating policies considered are policies in Manitoba and adjacent jurisdictions as they impact the movement of truck traffic in, into, from and through Manitoba.

3.1.1 Manitoba Highway Network

Manitoba has nearly 18,000 kilometers of roads where trucks operate. The highway network in Manitoba is divided into three load classes, namely RTAC, A1 and B1. Figure 3.2 shows the Manitoba highway network by load class in the context of its connection to adjacent jurisdictions. Table 3.1 shows the highway route kilometers and network percentage by load class.

Table 3.1 Highway Centerline Kilometers by Load Class in Manitoba

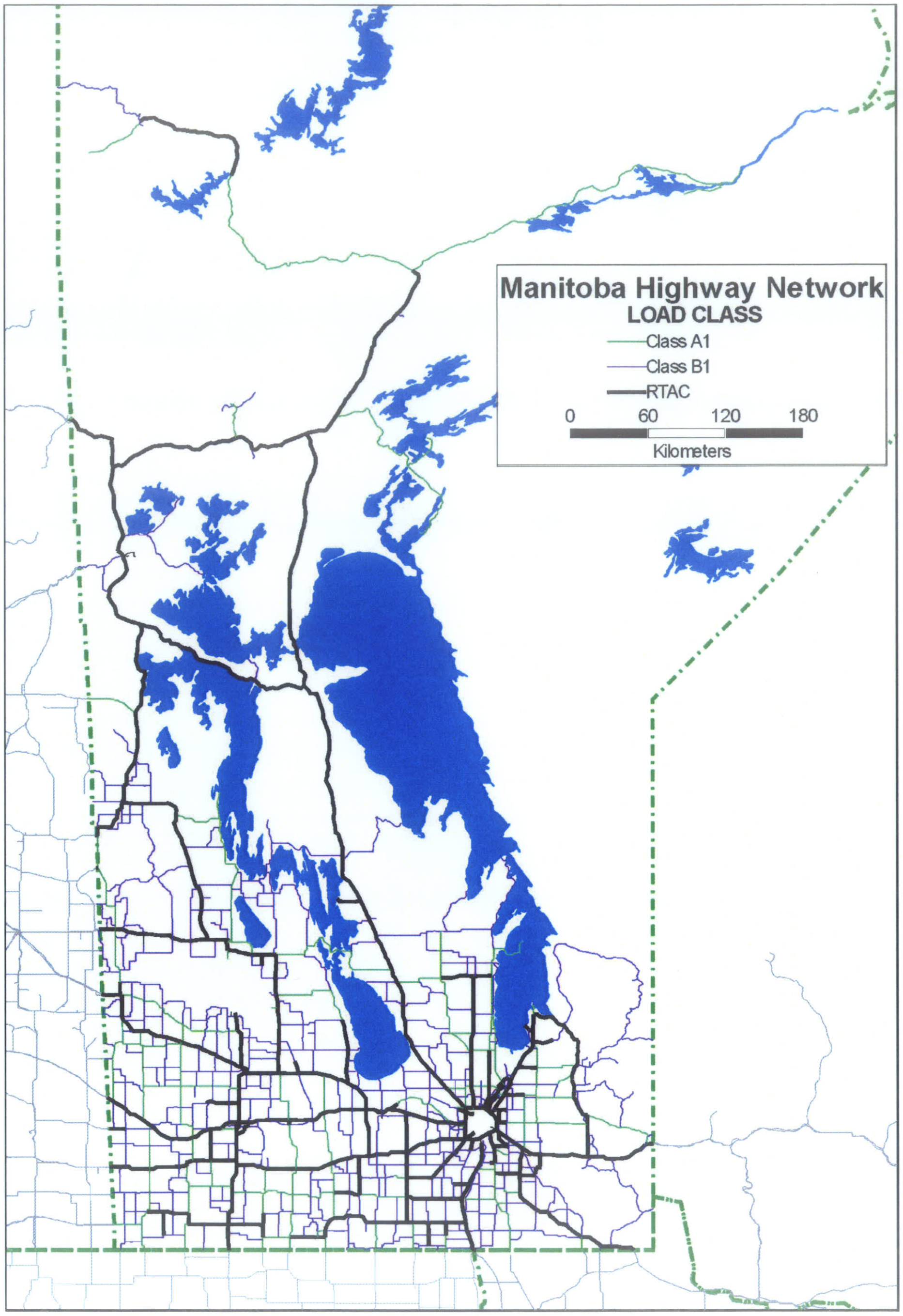
Weight Class	Route Kilometer (km)	Percentage of Route km
RTAC	5,127	29.1
Seasonal RTAC	1,510	8.6
A1	3,011	17.1
B1	7,991	45.3
Total	17,639	100.0

Source: Tang et al., 2003

RTAC, the highest load class, has allowable gross vehicle weight limits (GVW) of up to 62.5 tonnes for 8-axle B-train trucks, 46.5 tonnes for 6-axle trucks, and 39.5 tonnes for 5-axle trucks. RTAC highways account for approximately one third of the highway network but carry three quarters of the truck traffic (Tang, 2003).

3.1.2 Urban Connectors

Much of Manitoba's trucking originates in, is destined for, or passes through Winnipeg. Winnipeg has truck-related by-laws influencing truck routing. This typically requires commercial trucks to stay on the designated network, only exiting the network for pickup or delivery purposes.



F:\Thesis\GIS\Maps\Manitoba Highway Loadclass.map

Figure 3.2 Manitoba Highway Network Load Classification

The City of Winnipeg currently has two types of truck routes: full time and part-time routes. A part-time route is defined as a designated truck route where time restrictions are enforced. Currently all vehicles with six or more axles are designated as trucks and restricted to operation on truck routes, although they are permitted to operate on any street for the purpose of conducting business.

The GVW of all trucks operating on City of Winnipeg truck routes is limited to the RTAC load level of up to 62.5 tonnes for 8-axle (3-S3-S2) B-train trucks, 46.5 tonnes for 6-axle (3-S3) trucks, and 39.5 tonnes for 5-axle (3-S2) trucks.

Within the City, spring weight restrictions and winter weight premiums are imposed each year during the period from March 18 to May 31, and from December 1 to February 28 inclusive, unless the Director declares otherwise. Weight restrictions are imposed on all affected streets in the City of Winnipeg as follows:

- Maximum loading of 5,500 kg on a steering axle.
- 90% of normal loading on all other axle groups.
- Allowable weight based on 10 kilograms / mm of tire width to a prescribed maximum.

Winter weight premiums allow for a 10 percent increase on all non steering axles.

3.1.3 Transportation System Operating Policies

Transportation system operating policies govern the operations and movement of commercial vehicles (trucks) in Manitoba. These policies establish truck routing, scheduling, special vehicles, and truck sizes and weights.

Truck size and weight policy are the principal regulations governing truck operations on Manitoba highways and urban roads. They influence route selections, vehicle selection and operating strategy. There are numerous details in the basic truck size and weight regulations.

Table 3.2 shows basic weight regulations by vehicle configuration governing commercial vehicle operations in Manitoba. The most common vehicle configurations are shown. The basic weight regulations for Manitoba are further divided by seasonal regulations. Spring weight restrictions (SWR) and winter weight premiums (WWP) restrict GVW and allow increased GVW during their applied seasonal period. Details as to how this works is discussed in Montufar, 2002.

Table 3.2 Manitoba Basic Weight Regulations by Vehicle Configuration

Truck Configuration	Gross Vehicle Weight (kg)		
	RTAC	A1	B1
5-axle tractor semi-trailer	39500	37500	34500
6-axle tractor semi-trailer	46500	44500	40000
7-axle A-train double	53500	53500	47630
8-axle B-train double	62500	56500	47630

Source: Montufar, J., (Heavy Truck Safety in the Prairie Region: Applying Exposure-Based Analysis and the System Safety Review Concept)
Note: All limits are subject to proper axle spacing and adequate tire and axle capacity, and required weight distribution between vehicle components.
In Manitoba, these weights apply only to RTAC vehicles.

3.1.4 Transportation Terminals

Transportation terminals are a key part of the transportation system in Manitoba. These terminals can attract a significant amount of truck traffic depending on their size and services offered. Transportation terminal facilities offer various transportation options on moving freight generated and attracted by industries and the population in Manitoba.

Terminals offer truck transport services, freight warehouse facilities, cross docking facilities, logistics management services and more recently options involving intermodal transportation.

Intermodal transportation facilities are a special type of transportation terminal as they offer two distinct modes of transportation services. Intermodal terminals also form the essential link between different transportation networks. At the terminal an exchange of goods between transport modes takes place. Infrastructural and organizational relationships with other terminals, such as number and frequency of transport services are relevant as well.

3.1.5 Vehicles

Manitoba uses the U.S. Federal Highways Administration's (FHWA) 13-Category Vehicle Classification System for truck traffic classifying purposes. Figure 3.3 illustrates the FHWA vehicle classification system. A truck is defined as any vehicle from Class 5 to 13 inclusive (U.S. DOT, 2001). In Manitoba these are large single unit trucks with 2 or 3, and sometimes 4 axles (class 5-7), tractor-single semitrailer combinations (classes 8-10) nearly always having 5 or 6 axles, and double-trailer combinations having 7 or more axles (classes 11-13), with 8 axle B-trains being the most common. Additionally, specially-permitted vehicles are allowed to operate on a restricted basis on certain highways in Manitoba. A principal example of specially-permitted vehicles operating on certain Manitoba highways is long combination vehicles (LCVs). LCV operations in

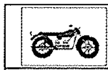
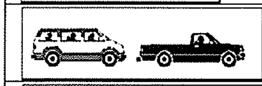
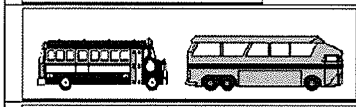
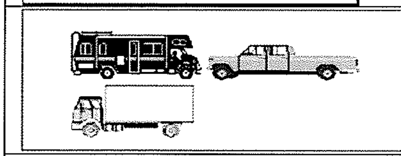
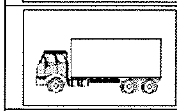
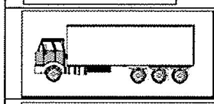
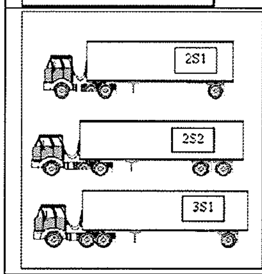
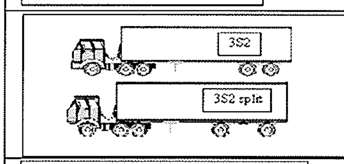
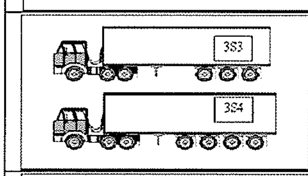
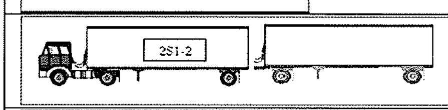
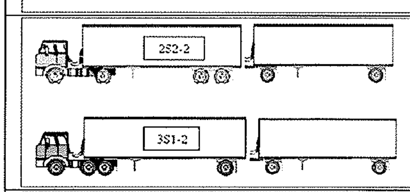
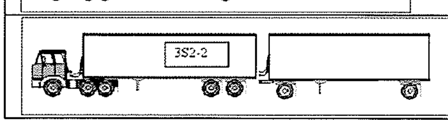
	*FHWA Class 1 – Motorcycles*
	**FHWA Class 2 – Passenger Cars (With 1- or 2-Axle Trailers)**
	**FHWA Class 3 – 2 Axles, 4-Tire Single Units, Pickup or Van (With 1- or 2-Axle Trailers)**
	**FHWA Class 4 – Buses**
	**FHWA Class 5 – 2D - 2 Axles, 6-Tire Single Units (Includes Handicappe-Equipped Bus and Mini School Bus)**
	**FHWA Class 6 – 3 Axles, Single Unit**
	**FHWA Class 7 – 4 or More Axles, Single Unit**
	**FHWA Class 8 – 3 to 4 Axles, Single Trailer**
	**FHWA Class 9 – 5 Axles, Single Trailer**
	**FHWA Class 10 – 6 or More Axles, Single Trailer**
	**FHWA Class 11 – 5 or Less Axles, Multi-Trailers**
	**FHWA Class 12 – 6 Axles, Multi-Trailers**
	**FHWA Class 13 – 7 or More Axles, Multi-Trailers**

Figure 3.3 FHWA Vehicle Classification System

Manitoba utilize either rocky mountain double, turnpike double, or triple trailer combinations. Regulatory details regarding these operations are discussed in Clayton et al., (2003). Operational considerations are discussed in Regehr (2006).

This research focuses on single and double combination units (FHWA classes 8 – 13) used for national, regional, inter-provincial and international freight movements. In Manitoba the prevalent truck configurations falling into this general description are Class 9 (3-S2) or 5-axle tractor-semitrailer, Class 10 (3-S3) or 6-axle tractor-semitrailer, and Class 13 (3-S3-S2) or 8-axle B-train. Combined, these three vehicle configurations represent over 80 percent of the truck traffic operating on Manitoba's highways (Tang, 2003; Tan, 2002; Regehr et al., 2004).

While vehicle configuration determines the number of axles and their arrangement on the vehicle, there are many different truck body types associated with each individual configuration. Each vehicle configuration and body type use their payload and cubic capacity differently. Dominant body types in Manitoba are:

- Van
- Refrigerated Van
- Flat deck
- Grain Body
- Dump Truck
- Tanker, Liquid or Gas
- Tanker, Dry Bulk
- Pole, Logging
- Automobile Transporter

Knowledge about body types is useful for many highway engineering and planning purposes. For example, liquid tankers hauling petroleum are typically operated fully loaded in the outbound direction and empty on their return trip. Most petroleum movements in Manitoba originate at two locations (the Esso and Shell distribution facilities located on PR 206 and Panet Road), except those destined for the western edge of Manitoba (often originating in Regina). Industrial knowledge of this type can contribute significantly to the interpretation of freight data in terms of its meaning for truck flows and related engineering and planning considerations.

In addition to the various vehicle configurations and body types, the operation of intermodal containers can play a significant role in transportation engineering and planning issues. Iintermodal transportation is defined as the movement of goods in the same loading unit or vehicle which uses successive moves of transportation without the handling of the goods themselves in changing mode of transportation (TR News, 2006). Containers used for intermodal freight transportation are defined as large reusable receptacles that accommodate smaller cartons, unit shipments and dry bulk shipments. The main advantage of using containers for intermodal transportation is the seamless, efficient movement of cargo in standardized units that is handled with standardized equipment. This reduces handling costs and increases freight system efficiency. The most common modal options for intermodal freight transportation are truck, rail, and sea. This research addresses the truck-rail and rail-truck interfaces.

Intermodal containers transported by truck are transported using flat deck chassis modified and equipped to handle intermodal containers of various lengths. Container trucks are typically 5 or 6 axle tractor semitrailer combinations. Containerization of freight for intermodal transportation is a rapidly growing market in the freight transportation industry (TR News, 2006). Intermodal growth is expected to be the highest growth area within the freight transportation industry over the next five years (TRB, 2003).

Two distinct types of intermodal containers are in use today domestic and international. Domestic containers are typically 48 or 53 feet in length compared to the 20-and 40-foot international containers.

There are two types of intermodal transportation options used today: trailer on flat car (TOFC) and container on flat car (COFC). TOFC is a conventional dry van trailer unit with its chassis placed on a rail flat car. TOFC units are typically 53 or 48 foot trailer units. No special equipment or handling procedures are necessary for freight transport companies to use this service. This type of service is ideally suited for remote locations where special handling equipment is unavailable. TOFC operations of this sort are routinely operated to Thompson, Manitoba, involving trucking south and rail north into Churchill and other northern communities. The trailer unit is simply driven on or off a rail flat car with the use of loading ramps.

COFC is a standard domestic or international shipping container placed on a rail flat car and is the most common type of intermodal transportation in use today. In Canada, COFC operations dominate intermodal transportation today.

3.1.6 Truck Planning Networks

Traditionally highway planning and engineering networks are identified to illustrate the importance of specific highway routes. Criteria used to define highway importance include route connectivity to major centres or adjacent jurisdictions, traffic volumes, truck traffic volumes, and connection to other modes of transport. Two examples of highway engineering and planning networks are Canada's National Highway System (Canada NHS) and the U.S. National Highway System (U.S. NHS).

Canada's NHS was officially identified in 1989 in response to a growing recognition for the importance of highway transportation to the Canadian economy and the need for action to preserve Canada's highway infrastructure. Criteria applied in each region of the country to define the NHS are any existing primary route that provides for the inter-provincial movement of people and goods by connecting a major provincial population or commercial center in Canada with (Christopher, 1998):

1. Another major provincial/commercial center;
2. Another major population/commercial center in an adjacent province or territory;
3. Major port of exit/entry to the US; and
4. Another transportation mode directly served by the highway mode.

Canada's NHS network consists of approximately 25,000 kilometers of highway. This represents three percent of Canada's road infrastructure, and carries about 30 percent of all vehicle traffic (Transport Canada, 2006).

Similarly, the U.S. NHS was approved in 1995 with the idea of focusing on a limited number of high-priority routes and improving them with federal funds. The U.S. NHS consists of interconnected urban and rural routes including: all interstate highways; principal arterials; the strategic highway network; major strategic highway connectors; and intermodal connectors. The U.S. NHS serves major population centers, international border crossings, ports, airports, public transportation facilities, intermodal facilities and major travel destinations (FHWA, 2006).

Criteria for selecting U.S. NHS routes are: connections between principal metropolitan cities or industrial centers; connection to major traffic generators; and connection to ports, intermodal facilities, airports and other transportation terminals (FHWA, 2006).

Primary freight specific criteria for U.S. NHS route consideration include: 100 trucks per day in each direction; connection to terminals that handle more than 50,000 TEU per year or other volumetric based units that convert to more than 100 trucks per day in each direction; and connection to bulk commodity terminals that handle more than 500,000 tons per year by highway transportation mode or 100 trucks per day in each direction (FHWA, 2006).

Currently the U.S. NHS consists of 256,000 kilometers of highway, representing four percent of the U.S. highways, 40 percent of all highway traffic and 75 percent of heavy truck traffic (FHWA, 2006).

3.1.6.1 Manitoba Truck Planning Network

The purpose of creating the MTPN was to define and characterize the Manitoba Highway network from the perspective of integration into the MB Truck Traffic Information System (TTIS).

The approach of the MTPN is to first divide the current Manitoba Highway Network into a three tiered truck network:

1. Tier 1 routes consisting of primary truck highways, these routes combined account for nearly 90 percent of the annual Truck Kilometers of Travel (TKT) using the 1999 truck data.
2. Tier 2 routes consist of secondary highways responsible for supporting the primary routes.
3. Tier 3 routes are made of all remaining highways not included in Tier 1 and 2 routes.

The main rationale in developing the MTPN is, truck operations are highly affected by Truck Size and Weight regulations. For example, RTAC routes allow maximum weight limits and therefore provide the most efficient way to move freight from trucking industry perspective. Generally, RTAC routes connect to major urban centers and carry the major freight movements inside and across the province and crossing the border to the U.S. In addition, part of the RTAC routes allow Long Combination Vehicles to operate on them, these routes are the LCV network in the province.

Seasonal RTAC highways are Class A1 or B1 highways that are upgraded to RTAC weight limits during the winter months. They typically experience significant truck traffic during that period due to the WWP policy. These routes are typically the key connectors for specific commodity movement (e.g. logging season in winter months). Certain Class A1 and B1 highways are included in the Tier 1 network because they provide the link between primary truck routes and truck traffic sinks/sources.

Other criteria include network connectivity and integrity (integrating highways connecting two major truck routes and major truck sinks/sources), the Manitoba LCV network, connecting routes to adjacent provinces and the U.S., industrial intelligence about trucking at specific locations, and engineering judgment.

Designation of the MTPN was completed in August 2003. The rationale and procedure used to create the network are recorded in a report produced by Tang et al., (2003). Figure 3.4 illustrates the Manitoba Truck Planning Network and its major external connectors to adjacent provinces and the United States. The UMTIG-Manitoba Truck Planning Network (UMTIG-MTPN) is a subset of the provincial highway system accounting for nearly 90 percent of the TKT in the province (based on 1999 data).

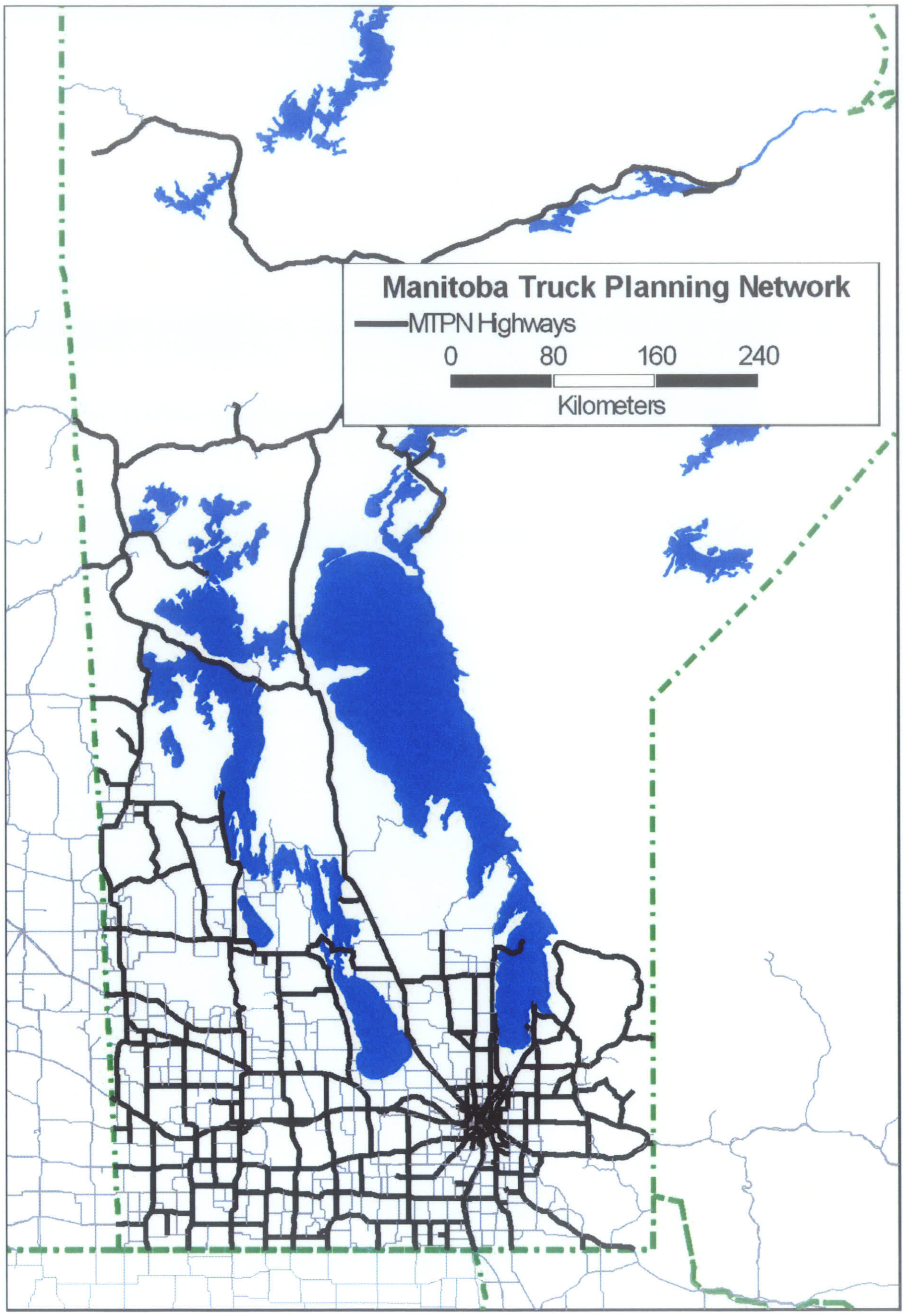


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Figure 3.4 Manitoba Truck Planning Network

3.1.6.2 Manitoba Trucking Association Truck Network

The Manitoba Trucking Association (MTA) truck network was developed to highlight key highway routes of high economic importance and their associated supporting highways to the heavy truck freight transport industry.

The network was created around a three level approach. Level one routes are of the highest importance to the trucking industry, these routes are year around RTAC roads providing mobility between major centers, adjacent jurisdictions and ideally connects to major terminals. Level two routes support and provide access to the level one routes, these routes are typically year round RTAC and provide access to major origins and destinations. Level three routes are all remaining highways not included in one and two, and are primarily B1 non-seasonal RTAC highways. Figure 3.5 illustrate the MTA Truck Network.

The following list of highways are included in the level one MTA trucking network: TransCanada Highway PTH 1; Yellowhead Highway PTH 16; Perimeter Highway of Winnipeg (PTH 100 and 101); PTH 75 connecting to the U.S., PTH 6, 10, 12, 59.

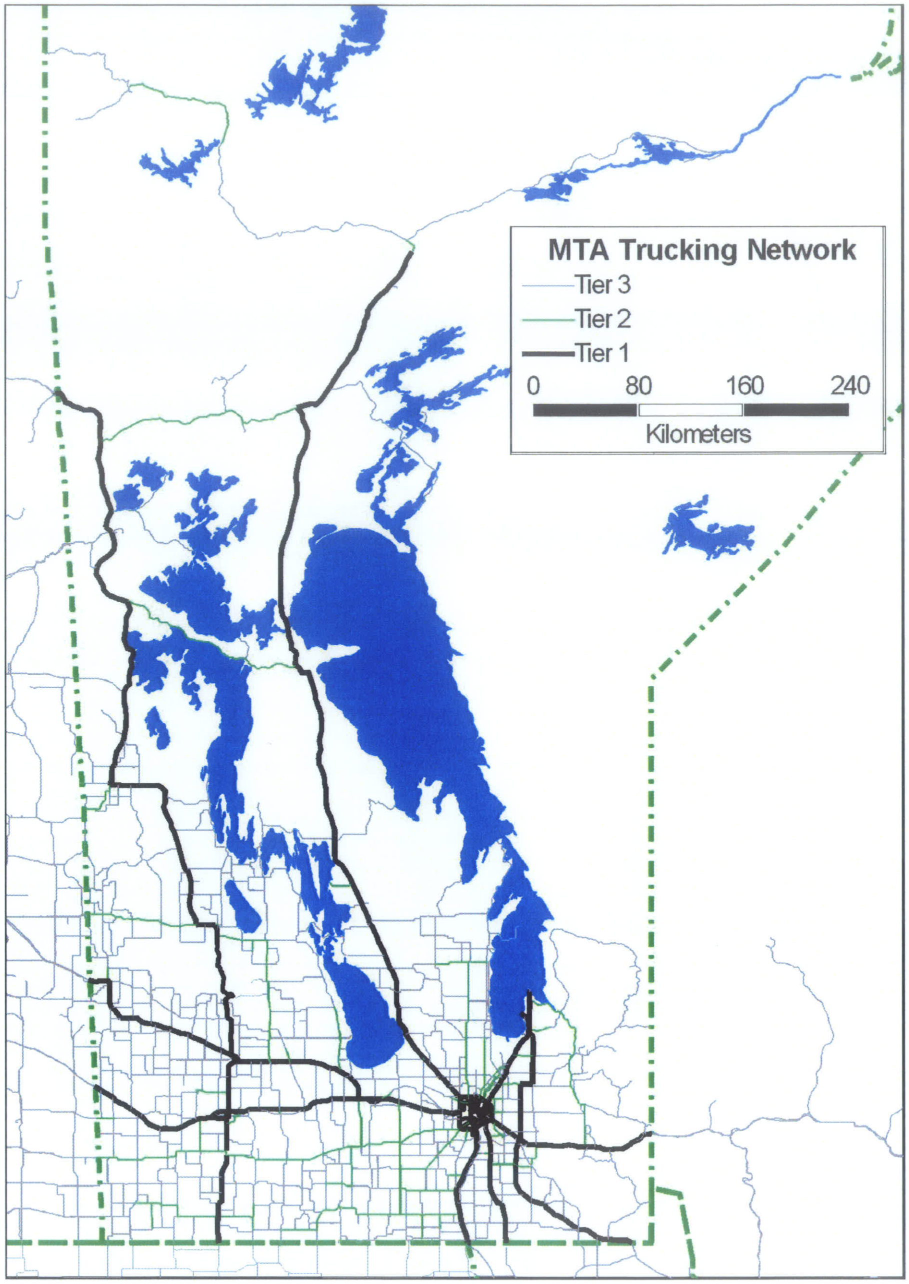

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Figure 3.5 MTA Truck Network

3.2 FLOW SYSTEM

3.2.1 Commodity Type

Freight can be classified by commodity type. Commodity codes are commonly used to classify freight into similar categories. Common commodity code classification systems with specific usage and details are:

Harmonized Commodity Classification System

The harmonized system (HS) is an international commodity classification system with six digit commodity codes developed under the authority of the World Customs Organization, an independent intergovernmental body. The HS is based on the principle that goods are classified by what they are, and not according to their stage of fabrication (Statscan, 2006). The system is logically structured by economic activity or component material. For example, animals and animal products are found in one section. The HS is divided into 21 sections which group together goods produced in the same sector of the economy. Each section consists of one or more chapters, with 97 chapters in total. The commodity classification within the HS is hierarchal, with two, four or six digits used to define the classified commodity, increasing in level of detail. Figure 3.6 illustrates an example of the hierarchal structure.

Canada and the U.S. both compile their merchandise trade statistics in terms of the HS. However, they use different annotations beyond the basic 6-digit codes. Canada extends the HS to 10-digit codes to track imports; these codes correspond to the Canada Customs Tariff. Information on exports is extended to 8-digit codes by Statistics Canada. The

U.S. extends the 6-digit codes of the HS to 10-digits to track imports; this corresponds to the Harmonized Tariff Schedule (Statscan, 2006).

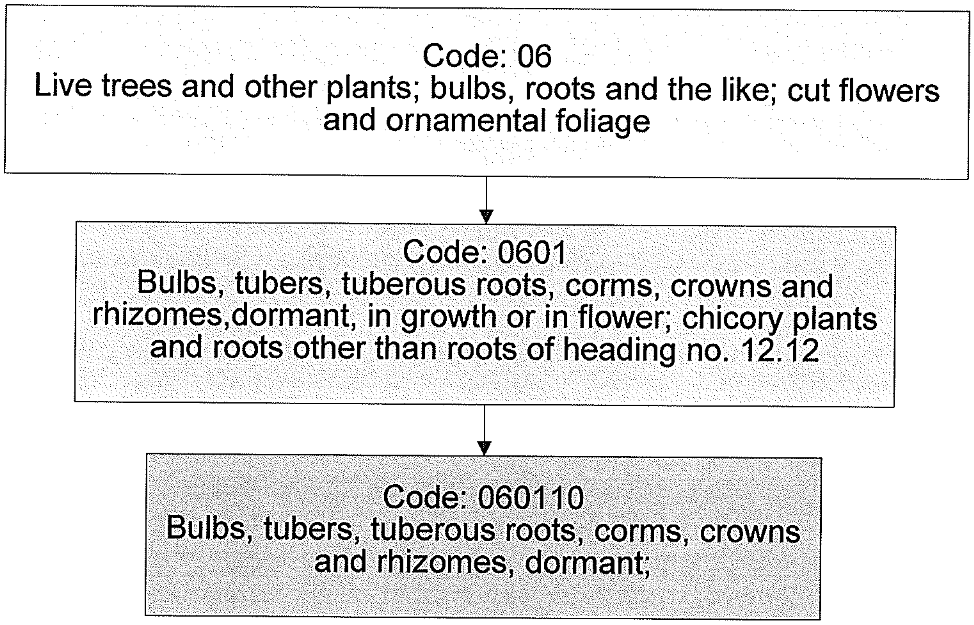

Figure 3.6 HS Commodity Classification Hierarchy

North American Industry Classification System

The North American Industry classification System (NAICS) is an industry classification system developed by the statistical agencies of Canada, Mexico and the United States. NAICS was created as part of the North American Free Trade Agreement. It is designed to provide common definitions for the industrial structure of the three countries and a common framework for analysis. NAICS replaced the Standard Industry Classification (SIC) in 1987. NAICS like SIC, is a system for arranging producing units into industries. This classification has been developed as a method of grouping businesses that produce similar products and services. The NAICS structure is hierarchal, with five levels:

sectors, sub-sectors, industry groups, industries and country of origin. Digit levels used representing industries vary between two and six (NAICS, 2006).

Standard Classification of Transported Goods

The Standard Classification of Transported Goods (SCTG) is a combination of transportation characteristics, commodity similarities, and industry-of-origin considerations. The commodity codes are structured at the less-detailed levels according to the Harmonized System, and at more-detailed levels according to patterns of industrial activity. SCTG is a Canada-U.S. initiative and was designed to provide categories for the 1997 U.S. Commodity Flow Survey (CFS), and to improve the integration of Canadian transportation data, particularly for marine, truck, and rail (Statscan, 2006).The classification is also designed to permit comparison of Canadian and U.S. transportation data. In addition, because of its HS basis, SCTG can be used for other international comparisons. The structure of the SCTG is hierarchical, consisting of four levels from two to five digits that contain groupings based on HS. These levels range from a minimum of 42 categories to a maximum of 512 categories (Statscan, 2006).

Harmonized Tariff Schedule

The Harmonized Tariff Schedule (HTS) used by the U.S. was made active in 1989 replacing the former tariff schedules. The HTS comprises a hierarchical structure for describing all goods in trade for duty and statistical purposes. This structure is based upon the international Harmonized System. The 4- and 6-digit HS categories are subdivided into 8-digit unique U.S. rate lines and 10-digit statistical reporting (HTS, 2006).

The hierarchal approach of commodity classification systems provides varying degrees of commodity detail. Increasing the digit level used to define the commodity increases the detail level for the commodity. Greater detail is not necessarily better when utilizing freight data for highway engineering and planning purposes and most public and private freight datasets use base two digit commodity code classification systems.

Another method of classifying commodities is to aggregate commodities into a smaller set of general commodity categories. Common examples of these categories are (Felsburg, 2002):

- Bulk materials
- Farm products
- Food
- Manufacturing
- Wood
- Other miscellaneous freight

The smaller set of commodity categories simplifies the compiling of commodity information, and allows for enhanced conversions of commodity quantity into truck traffic volumes. It also facilitates the understanding of the relationship between commodity type and selected vehicle configuration and body type. For example, bulk liquid products will predominantly be hauled by tanker body types, with B-train configurations, selected for longer distance highway movements, and 5-or 6-axle configurations selected for short, more urban movements depending on weight regulations.

3.2.2 Origin-Destination

To assist in the understanding of freight movement, it is necessary to evaluate the freight system on an origin-destination (O-D) basis. This allows the movement of freight from one location to another to be quantified. Freight is principally quantified by commodity type, weight and value.

Freight shipment origin is intended to reflect the province, state or location where the goods were grown, manufactured or otherwise produced. The freight shipment destination is intended to reflect the province, state, or location where the goods are consumed, retailed or remanufactured or valued added (TRB, 2003). O-D systems are commonly represented by geographic, census tracts, and established economic trade zones. Examples of geographic O-Ds are provincial, state, county and municipal boundaries. An example of an economic trade zone system is the U.S. National Transportation Analysis Region (NTAR). NTARs refer to groupings of U.S. postal zip codes to denote certain geographic locations derived by the Bureau of Economic Analysis (BEA).

Additionally, the BEA has developed economic areas defining the relevant regional markets surrounding metropolitan areas. They consist of one or more economic nodes and statistical areas that serve as regional centers of economic activity. Also included are the surrounding counties that are economically related to the nodes themselves. These developed areas are referred to as BEA areas.

Different sources of freight data may use different O-D systems. This complicates the combining or aggregating of freight databases enhancing coverage, sample size, and commodity sectors.

3.2.3 Measures of Freight Flow

Depending on the application, it is necessary to quantify or provide a convenient unit of measure for the amount of freight transported between O-D pairs. Different business sectors and freight data sources use and provide various measures for freight flow. Commonly used measures are:

- Tonnage, representing the total quantity of freight moved in tonnes;
- Value, or the total amount of freight moved in terms of dollar value;
- Tonne-miles, the total distance the freight was moved multiplied by total number of tonnes shipped;
- Twenty foot equivalent units (TEU), commonly used in intermodal freight to represent the equivalent number of twenty-foot containers transported. One forty-foot container would represent two TEU's; and
- Meter cube, total volume of freight moved measured in cubic meters.

Of these measures for freight flow, tonnage and tonne-miles are of the greatest interest to engineers and planners. These two measures can form the basis for estimating truck flow, infrastructure impacts and cost allocation using freight data as the primary information source.

3.2.4 Highway Freight Performance Measures

Increasingly highway engineers and planners are asked to provide indications of operational efficiency relating to freight movements. These indicators assist engineers and planners with cost allocation and future truck traffic projections, as well as determinations of the relative importance of specific highway routes to the economy and how future changes in land-use will affect the freight transportation.

Practical measures of freight system operational efficiency for engineering and planning purposes are (NCHRP 446, 2000):

- Average fuel consumed per trip
- Tonne-miles per gallon of fuel
- Cost per tonne-mile
- Cost per tonne of freight
- Cost by commodity
- Revenue per tonne-mile
- Proportion of freight traffic on network

Existing publicly-available freight data sets can provide meaningful input for highway engineers and planners to develop highway freight performance measures.

3.2.5 Translating Freight Flow to Truck Volumes

It is common to quantify freight flow from origins to destinations by tonnes and by commodity (and sometimes by value) of freight transported in a given time period. While this method of quantifying freight provides some degree of understanding of movement, it is often difficult to visualize the relationship(s) or linkage(s) of these parameters to highway infrastructure, truck traffic volumes, vehicle types, pavement and bridge loadings, enforcement issues, highway routing, or changes in highway important determinants of matters such as truck size and weight regulations. Indeed, most typically, those who think about, analyze and produce freight data, information and insights often have trouble communicating with engineering needs, and vice versa.

Finding ways to more effectively utilize freight flow information into truck traffic information may assist engineers and planners in better accommodating trucks in planning and design. This is a goal of many transportation agencies today, as seen in NCHRP 446, Truck Accommodation Design Guidance (Middleton et al., 2003), the development of the FAF-2 in the U.S., and many metropolitan transportation planning and design efforts.

Two methods have been used in the past to effect an engineering-oriented translation of freight flows and vehicle movements. The first method is called the Reebie Commodity-Derived Truck Trip Procedure. The second is called the UMTIG H-Truck Method. Neither provides a perfect translation, but both can provide new and better ways to communicate between freight insights and engineering design.

(a) The Reebie Procedure

This procedure was developed using the Reebie freight database from the U.S., as part of the Freight-Analysis-Framework (FAF) Project of the U.S. Federal Highway Administration (FMO, 2006). It has been refined in various ways, and recently used in a transportation study in the state of Texas (TTI Research Report 0-4364-1).

The Reebie procedure starts with the creation of a series of origin-destination matrices of freight movements, by mode (truck in this case), by commodity, by typical payload weight and/or density properties, by number of loaded/empty truck trips, for a standard freight analysis zone system used in the U.S. (called Bureau of Economic Analysis Areas) for a given time period.

Using this database, the calculated freight flows can be converted into loaded truck trips for any origin-destination combination. This can be multiplied by a calibration factor relating the proportion of truck trips which are run empty (varying by commodity). This provides a method of estimating the distribution of truck trips between O-D pairs particularly relevant in Texas, where 3-S2s at the 80,000 pound limit prevail.

Currently, the method used for assigning these trips to the highway network is pragmatic and judgmental and relies on expert opinion and knowledge.

(b) The UMTIG Procedure

The UMTIG H-Truck Method described in the Prairie Provinces Freight Transportation Systems Study (1999) had a different purpose than the Reebie Procedure. Its purpose was to translate freight movement expressed in tonnes per year into a transportation-sensitive physical measure of merit onto itself, but also of merit when comparing mode split between truck and rail.

This method relies on the fact that the 5-axle tractor-semitrailer (the 3-S2) is the dominating truck on major highways in western Canada and the one most people think of when they think of large trucks (i.e. the 18-wheeler).

On primary highways, the 3-S2 can operate at a GVW of 39.5 tonnes. With a tare weight of (on average) 14.5 tonnes, the payload handling capability of the vehicle is 25 tonnes. If one of these trucks loaded with 25 tonnes makes a loaded trip each day of the year between an origin and a destination, its total handlings will equal 25 x 365 = 9125 tonnes (about 10000 tons). Define 25 tonnes of product movement as 1-H truck.

From the rail perspective, many large trains in the prairie region often consist of 100-100 ton payload railcars. Such a train can handle 10000 tons of payload in one movement. This is equal to about 9100 tonnes. Therefore, 9100 tonnes of movement can be defined as 1-K train.

For visualization purposes, 1-H truck of movement per day for 365 days = 1 K-train of movement per year. Thus, if one is to move 910,000 tonnes of potash between two points in one year, it can be done by 100 K-trains in 1 year (or about 2 trains a week) or 100 H-trucks each operating for 365 days in a year (or an AADTT of 100 trucks per day). Two trains a week and 100 trucks a day makes physical transportation sense, whereas 910,000 tonnes per year does not.

Conversions can translate an H-truck into a 3-S3 (46.5 tonnes - 16.5 tonnes = 30.0 tonnes = 1.2 H-trucks), or an 8-axle B-train, and in turn, a truck traffic estimate effect. Similarly, other factors could be used for the same purpose to account for lower product densities.

Thus, like the Reebie method, the UMTIG method can estimate truck trips on highways from freight data, but does so in a different way (while at the same time having a physical reference point in its major competing mode the railway). Similar to the Reebie method, the UMTIG method relies on pragmatic judgment for route assignment.

3.3 DEMAND SYSTEM

For this research, the demand system (D) is defined as the freight origins and destinations giving rise to freight movements by truck on Manitoba highways. Its purpose is to measure and characterize the freight movements. The freight system is depicted in two ways: (1) by a system of analysis zones; and (2) by understanding key freight sink and source locations, and the nature of individual (or in some cases groups of) truck freight sinks and sources in Manitoba.

3.3.1 Freight Analysis Zones

Freight analysis requires the establishment of freight analysis zones (FAZs) or boundaries from which the freight transportation trips will originate and end at their destination. Freight analysis zones are defined as a group of geographically bounded areas used to collect and analyze freight data and information between pairs of pre-defined geographic boundaries (Transport Canada, 1998). The size and density of a FAZ depends upon the type of freight demand modeling. Typically, a denser FAZ is required for micro planning (urban) than for macro planning (national). Common examples of FAZ systems currently employed in the U.S. and Canada are National Transportation Analysis Regions (NTAR), Census Division (CD), Bureau of Economic Analysis areas (BEA) and State or Provincial boundaries.

The freight demand system in this research is represented by a Freight Analysis Zone system. The FAZ's illustrate the geographic relationship of freight generation and attraction in an intra-provincial, inter-provincial and international context. The geographic boundaries for the zonal system used in this research are shown in Figure 3.7. The zonal boundaries are:

1. Census Divisions (CD): Statistics Canada reports for-hire trucking survey O-D data between pairs of CD boundaries. The analysis of this database was carried out by aggregating CD boundaries as indicated in the 1998 Transport Canada Prairie Provinces Transportation Systems Study. Individual CD's are retained for Manitoba, Saskatchewan and Alberta.

2. State and Provincial Boundaries: Transborder Surface Freight database and CCMTA roadside survey are both reported by the geographical boundary of each province in Canada and each State in the US. These boundaries are used to analyze freight movements within Canada and Canada – US freight movements.

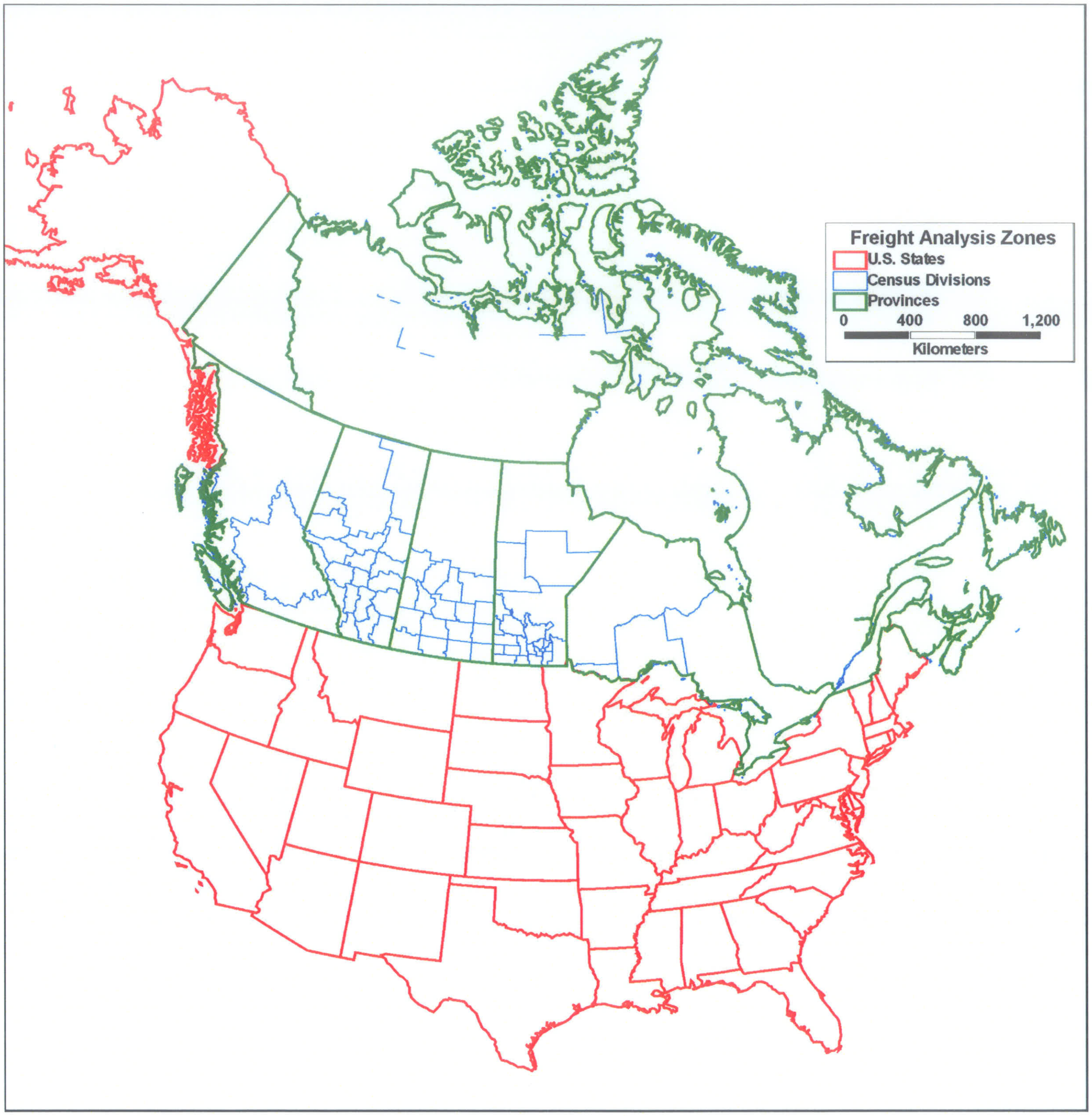

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Figure 3.7 Freight Analysis Zones

3.3.2 Freight Industry

To facilitate understanding truck freight demand in Manitoba, the freight demand system is divided by industry sector. Figure 3.8 illustrates the ten industries selected to represent the Manitoba freight demand system. Specific examples of freight industry units are also shown.

Selected freight industries were developed through direct communication with Manitoba trucking industry experts and the completion of the environmental scan. The ten industries are representative of freight demand in Manitoba. These industries could also be used to represent freight system demand in other Provinces or States with some modifications.

Separating the freight system by industry assists in understanding truck weights, truck volumes, major origin-destination patterns, truck configurations, truck body types, and major commodities associated with freight movements on Manitoba's highways.

Relevant freight sinks and sources considered in this research are those that produce an average of thirty or more truck trips per day on Manitoba's highways. At the freight sink or source level one freight movement is responsible for two truck trips, the inbound movement and the outbound movement. For example, grain delivered to an elevator generates two truck trips; the inbound loaded trip and the outbound unloaded trip.

3.3.3 Freight Industry Intelligence Survey

Interviews with 15 selected transportation industry experts were conducted to enhance the research's understanding of truck related freight movements on Manitoba's highways. The industry experts selected are involved with transportation facility management, commercial vehicle policy, commercial vehicle enforcement, the agriculture industry and specialized business economics.

Objectives of the interviews were to obtain expert understanding on levels of freight demand in Manitoba's and to enhance the research's knowledgebase of how freight moves in heavy trucks. The interview process aimed at understanding freight demand in Manitoba grouped by industry. The interviews also identified specific locations generating truck traffic, although this was not the goal of the interviews it assisted in understanding freight movements for specific industries.

In addition to obtaining general background information on individual operations and regional perspectives, the following matters were discussed throughout the interviews:

- Locations, areas or centers developing significant truck freight movements and responsible for truck traffic on Manitoba's highways segregated by individual industry. In situations where individual industries have numerous truck traffic generating locations the individual locations are suppressed and a general understanding for that industry is presented.

- What commodities contribute to truck traffic on Manitoba's highways? These commodities can be grouped by industry to enhance understanding.

- What are major origin destination patterns?

- What highway routes are predominantly utilized for transporting and accessing the freight sink or sources between O-D pairs?

- What quantity of truck traffic is generated by individual sinks or sources? These can be grouped by industry.

- What are predominant vehicle characteristics associate with specific locations or commodities?

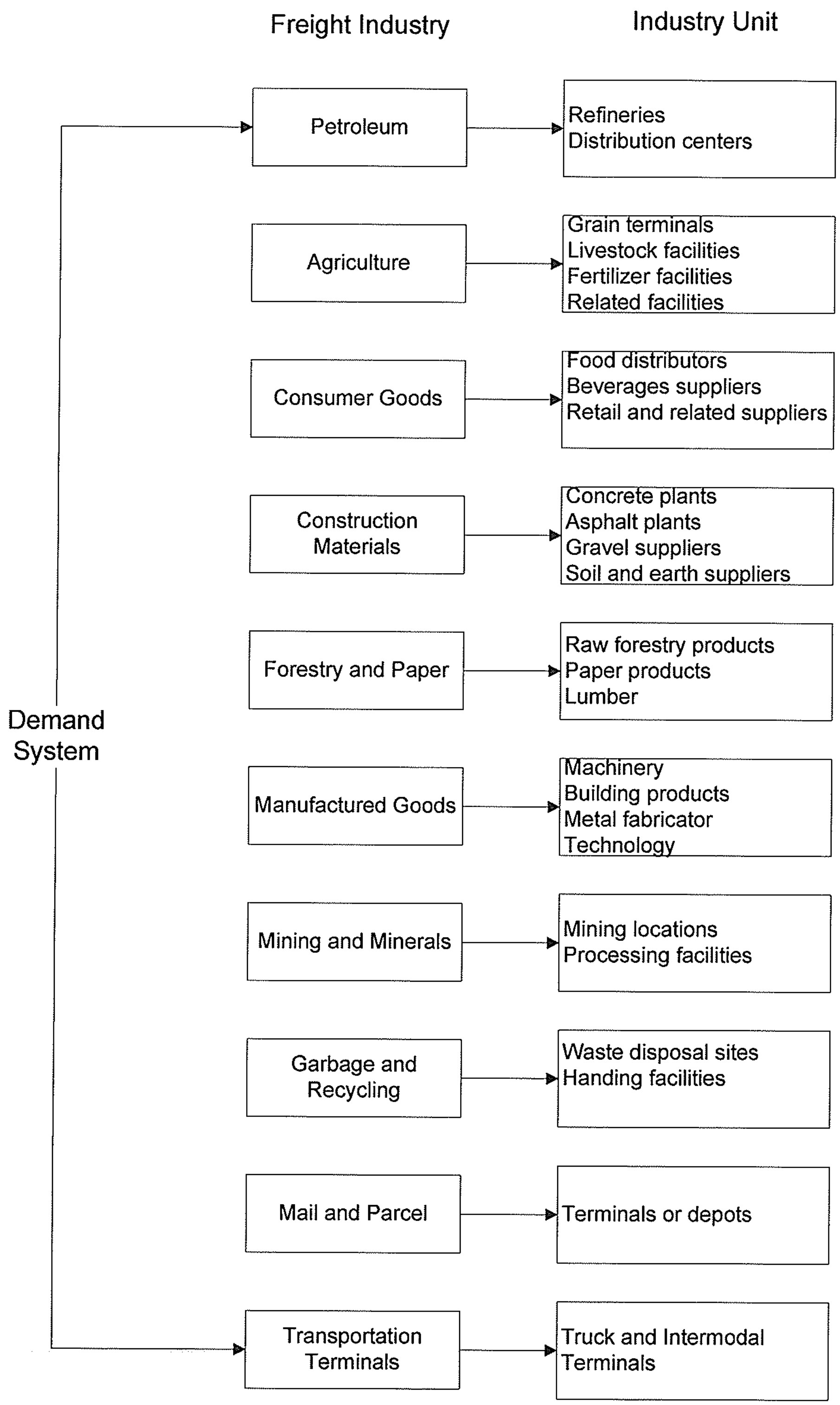


Figure 3.8 Manitoba Freight Industries

- Is there evident seasonally or temporal distribution in the freight movements? This can be location specific or grouped by industry.

- Could this location or industry utilize intermodal transportation for their shipping needs?

3.3.4 Framework for Freight Industry Analysis

In order to characterize and summarize the truck freight industries of interest to this research, the following terminology and rating scales were defined by this research and used throughout the proceeding section. The ratings defined below are grouped under Demand System, Transportation System, and Flow System and are used to make observations about the ten freight industries discussed in the research.

<u>Demand System</u>

- The approximate area serviced by freight industry. This service area represents the practical limit for freight movements.
- Major commodities
- Numbers of possible Origins - Destinations (O-D) pairs for the freight traffic within the service area is described using:
    - Few (1-9)
    - Several (10-49)
    - Many (>50)

<u>Transportation System</u>

- Major highways utilized for freight transportation between origins and destinations are detailed.
- Locations of major facilities

<u>Flow System</u>

- Truck traffic volumes generated or attracted by freight industry are described in terms of truck volumes per day:
    - Low (20-60)
    - Average (61-150)
    - High (150-300)
    - Very High (>300)

- Truck traffic seasonality associated with freight industries are described as:
    - Low (<10 percent)
    - Average (10-20 percent)
    - High (>20 percent)

- Truck traffic associated with the freight industries or facilities is described by predominant vehicle configuration and body type.

3.4 MANITOBA FREIGHT INTELLIGENCE

3.4.1 Freight Industry Survey Results

Using the framework developed previously, expert opinions obtained from the interviews by industry sector representing the demand system are summarized in Table 3.3. Detail discussion from the industry survey is shown in Appendix A.

3.4.2 Freight Transportation System Perspective

Throughout the industry interview process several freight transportation system perspectives were highlighted. They are:

- The industry survey highlighted an estimated 3000 truck trips per day using Manitoba's highways for intra-provincial, inter-provincial, and international trucking movements.

- Intermodal transportation is rapidly growing and major trucking operations are offering indermodal shipping services. Railways are providing dedicated intermodal shipments at guaranteed delivery schedules. Potential for commodities to shift from truck only transportation to intermodal is based on cost and delivery schedules. Whenever transportation cost is less for the intermodal option and the shipment arrives within the appropriate time frame the system shifts.

Table 3.3 Freight Industry Survey Summary

Freight Industry	O-D Pairs	Major Highways Utilized	Truck Volume Estimates	Predominant Vehicle Configurations	Vehicle Body Types	Seasonality
Petroleum	Few - Many	PTH - 100, 101, 1, 6, 10, 16, 75	Very High	3-S2 3-S3-S2	Tanker	Average
Agriculture	Many - Many	PTH - 100, 101, 1, 3, 6, 10, 16, 75	Very High	3-S2 3-S3 3-S3-S2	Grain Dump Livestock	High
Consumer Goods	Several - Many	PTH - 100, 101, 1, 3, 6, 8, 10, 16, 75	High	3-S2 3-S3	Van Ref. Van	Average
Construction Materials	Few - Many	PTH – 100, 101, 1, 3, 10, 16, 75	Very High	3-S2 3-S3 S-S3-S2	Tanker Flat Deck Dump	High
Forestry and Paper	Few - Several	PTH – 1, 59, 75	Average	3-S2 3-S3-S2	Van Poll Logging	Average
Manufactured Goods	Several - Many	PTH – 100, 101, 1, 3, 10, 16, 75	High	3-S2	Van Flatdeck Intermodal	Average
Mining and Minerals	Few - Few	PTH – 6, 10	Low	3-S3-S2 Special	Dump	Low
Garbage and Recycling	Many – Few	PTH - 100, 101	Very High	3-S2 3-S3 3 – Axle	Chassis Garbage	Low
Mail and Parcels	Few - Many	PTH – 1, 2, 3, 6, 7, 8, 10, 75	Low	3-S2 LCV	Van	Average
Transportation Terminals	Many - Many	PTH – 100, 101, 1, 6, 8, 10, 12, 59, 75	Very High	3-S2 3-S3 3-S3-S2	All Intermodal	Low

- Major truck transportation facilities are increasingly offering short term freight warehousing, freight cross docking, logistics management services, and intermodal transportation services with guaranteed delivery schedules.

- Bulk construction materials, petroleum, general freight, and chemicals in the agriculture industry represent a significant amount of truck traffic on Manitoba's highways. Portions of these freight industries are highly seasonal.

- Principal dominant highways supporting the freight industries highlighted from the freight industry interviews are: Provincial Trunk Highways 1, 2, 6, 10, 12, 16, 59, 75, 83.

- Key boundaries for the service area are eastern Saskatchewan, Northern Ontario, and the northern tier U.S. States. These boundaries represent the approximate economic based freight transportation limits for the freight industries considered. The boundary limits are capable of being serviced or supplied by non Manitoba based suppliers and industries.

- The western edge of Manitoba represents a definite break in the truck freight transportation industry. The area east of PTH 10 is principally supplied from the east (i.e. distribution centers located in Winnipeg), while the area to the west is supplied from distribution centers located in Regina or Saskatoon.

CHAPTER 4

MANITOBA TRUCK FREIGHT MOVEMENTS

This chapter uses publicly available freight data described in Chapter 2 to analyze and characterize freight flows related to the demand and transport systems.

The principal analysis in this chapter is organized to discuss domestic movements and international movements of freight. Within each section, the discussion is organized by database type used in the analysis and within each database O-D pattern and commodities are analyzed.

It is important to note the survey years (which are different) and detailed results (which are year dependent and survey method dependent) are not the particular concern of this research. The concern is how this type of data may be used to better understand highway engineering and planning issues.

4.1 DOMESTIC FREIGHT MOVEMENTS

Two databases are used for considering domestic freight movements by truck in Manitoba, Statistics Canada Fore-Hire Trucking Survey and the CCMTA Roadside Survey. In this analysis, the research illustrates ways in which they might be used to improve understanding about the domestic component of trucking in Manitoba.

4.1.1 Statistics Canada For-Hire Trucking Survey

The Statistics Canada For-Hire Trucking Survey used in the research was developed for the period April 1, 1996 to March 31, 1997. Later results were not available to this research without cost. The survey estimates the tonnage of freight movements for for-hire carriers with annual revenues greater than 1 million Canadian dollars. The research specifically expands the Manitoba-based O-D patterns reflected in the database.

Origin-Destination Pattern

Table 4.1 and Figure 4.1 show the origin-destination pattern of intra-provincial, inter-provincial and international freight movements for Manitoba, by direction of movement. The O-D matrix used in this analysis is derived from the freight analysis zones discussed in chapter 3. Demand for freight movements are quantified in terms of tonnes of freight per year and translated to H-trucks per day for all commodities combined.

From Table 4.1 and Figure 4.1 the following observations based on weight handled by for-hire carriers can be drawn:

- Manitoba highways handle 1454 H-trucks per day of freight movement:
    - 27 percent (389) is between O-Ds within Manitoba
    - 24 percent (348) is between Manitoba and western Canada
    - 24 percent (345) is between western Canada and eastern Canada
    - 14 percent (205) is between Manitoba and eastern Canada
    - 11 percent (167) is between Manitoba and the U.S.

Table 4.1 For-Hire Trucking Survey

Truck Traffic Origin – Destination Patterns

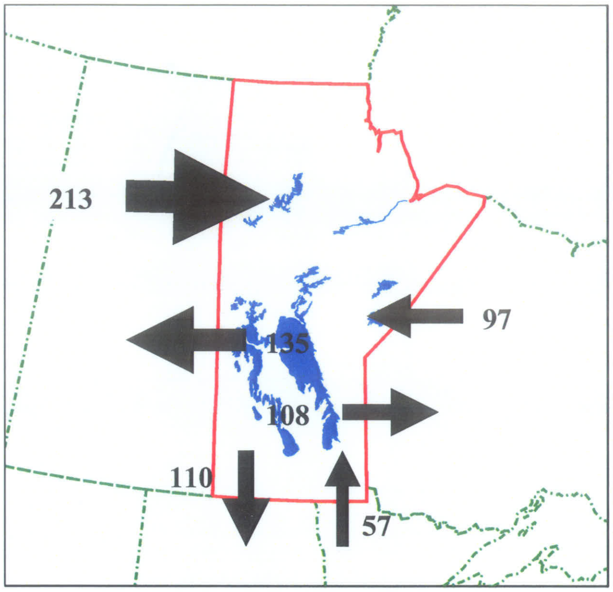
Tonnes per Year						
	Destination					
Origin	East Canada	Manitoba	West Canada	North	USA	Total
East Canada	--	887,662	2,045,131	--	--	--
Manitoba	981,193	3,546,897	1,233,027	1,498	1,006,058	6,768,673
West Canada	1,100,975	1,942,934	--	--	--	--
North	--	166	--	--	--	--
USA	--	518,868	--	--	--	--
Total	--	6,896,527	--	--	--	--
25 Tonne Trucks Trips per Day (H-Truck)						
	Destination					
Origin	East Canada	Manitoba	West Canada	North	USA	Total
East Canada	--	97	224	--	--	--
Manitoba	108	389	135	*	110	742
West Canada	121	213	--	--	--	--
North	--	*	--	--	--	--
USA	--	57	--	--	--	--
Total	--	756	--	--	--	--

Note: * Denotes less than 1 H-Truck per day; -- outside of geographical scope

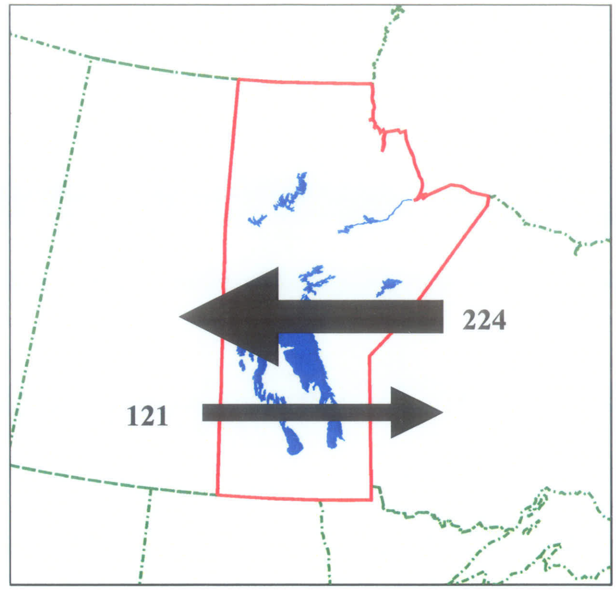
Thus:

- Two-thirds is inter-provincial (principally routed on the Trans-Canada Highway-PTH 1).
- One-quarter is intra-provincial.
- One-tenth is international (principally routed on PTH 75).
- One-quarter uses Manitoba as a corridor.
- No one-way inter-provincial movement with Manitoba involves more than 1 K-train per day. Western Canada to and from Manitoba involve 1-2 K-trains every 3 days.

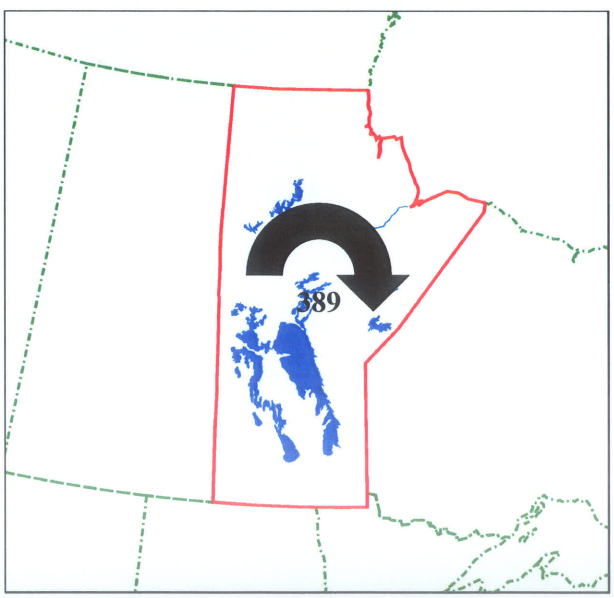
Figure 4.1 For-Hire Trucking Survey H-Truck Volumes



East/West and North/South
Movements To/From Manitoba



East/West Movements
Through Manitoba



Manitoba Intra-Provincial

For illustrative purposes, three examples offer further potentially valuable insights that can be derived from such data with the application of expert opinion:

1. The corridor movement (east or west through Manitoba movement) creates 57 percent of the loading effected on Manitoba highways by inter-provincial for-hire trucking.

This is based on the following assumptions and calculations:

Assumption 1: Travel distances

- SK/MB border to Brandon = 120 km
- Brandon to Winnipeg = 235 km
- Winnipeg to MB/ON border = 155 km

Assumption 2: Traffic routing

- All corridor traffic travels the Trans-Canada Highway (or longer on PTH1/PTH 16).
- All Manitoba-Eastern Canada traffic travels the Trans-Canada Highway between MB/ON and Winnipeg.
- 3/4 of Manitoba-Western Canada traffic travels the Trans-Canada Highway between SK/MB and Winnipeg.
- 1/4 of Manitoba-Western Canada traffic travels the Trans-Canada Highway between SK/MB and Brandon.

Assumption 3: Payloads

- All payload is handled in H-trucks with a gross weight of 39.5 tonnes.

Calculation:

- The rolling gross tonne-kms/year of the above inter-provincial movements are (H-Trucks per day x GVW x Distance Traveled x 365 days per year):

-	Corridor =	345 x 39.5 x 510 x 365	=	2537 million
-	MB-West =	348 x 0.75 x 39.5 x 355 x 365 +		
		348 x 0.25 x 39.5 x 120 x 365	=	1486 million
-	MB-East =	205 x 39.5 x 155 x 365	=	458 million
-	Total			4481 million

- Thus, the corridor accounts for 2537/4481 x 100 = 57 percent of pavement loading produced by this group of trucks.

2. More than one third of Manitoba's pavement loading created by for-hire trucking results from vehicle tare weight.

3. Considering that all of the Prairie Region Western Canada is within about a 1-day drive of Winnipeg, the ability of rail to compete for intra-western Canadian trucking movements may be limited (i.e., the volumes may not be large enough, and the distances not far enough, to provide necessary competitive advantage to rail in such a particular market). The Western Canada/Manitoba to/from Eastern Canada markets point to the prospect of another possible scenario (i.e. with the volume available and the extra day of driving required that much of the trucking between Toronto and Winnipeg, or Toronto and Calgary/Edmonton, is vulnerable to or already captured on intermodal rail services).

Commodities

Domestic commodity movements for Manitoba from the For-Hire Survey are listed in Tables 4.2 and 4.3. The ten most common commodities are identified for inter-provincial and intra-provincial movements.

Four commodity groups (petroleum, general freight, chemicals, and food) account for more than one-half of all for-hire trucking in the Province. Of these products, petroleum and chemicals would nearly always move in bulk, weight-out in the outbound direction (typically from few origins), and empty in the inbound direction. These commodities are usually transported in 5, 6, or 8-axle B-train units intra and inter-provincially, and in 7-axle A-trains for international movements into North Dakota operating at U.S. GVWs.

Non-metallic minerals, mainly gravel, account for 7.1 percent of the for-hire intra-provincial freight movement. Movement of this product is highly seasonal and coincides with the spring to fall construction season. Gravel is almost always transported in 5-axle end-dump combinations with weight-out outbound and empty inbound characteristics. 5-axle dump units lend themselves to a multitude of applications (i.e. hauling gravel, bulk fill, and snow). O-D patterns and the quantities of product moved are typically very project specific (e.g. large construction project). Some 6-axle and 8-axle B-train units maybe used for particular purposes; these are typically belly-dump body styles. The main constraint with utilizing these larger more productive combinations is their higher GVWs are a concern on construction sites where the lack of solid stable ground can be a concern.

Table 4.2 For-Hire Trucking Survey

Manitoba Inter-Provincial Commodity Movements

Inbound Truck Movements by Tonnage		Outbound Truck Movements by Tonnage	
Major Commodity	**Percentage**	**Major Commodity Group**	**Percentage**
General or Unclassified Freight	25.1	General or Unclassified Freight	18.6
Other Foods, Food Materials	10.9	Petroleum and Coal Products	16.0
Petroleum and Coal Products	8.4	Other Foods, Food Materials	13.0
Chemicals and Related Products	6.1	Chemicals and Related Products	7.9
Wood and Fabricated Materials	5.8	Meat and Meat Preparations	3.4
Cereal Grains	4.3	Vegetables and Products	3.1
Iron, Steel and Alloys	3.5	Iron, Steel and Alloys	2.8
Beverages	2.9	Live Animals	2.3
Non-Metallic Minerals	2.4	Crude Vegetable Products	2.2
Paper and Paperboard	2.1	Furniture and Fixtures	1.9
All Other Commodities Combined	28.3	All Other Commodities Combined	28.6

Thus, simple data about the quantity of movement of this type of commodity, with the application of expert knowledge about project sites and quantities of materials required, can be translated into useful engineering and planning insights.

Another useful insight to engineering and planning of our highway network that can be extracted from commodity knowledge is the relatively small amount of grain hauled by for-hire carriers. This commodity, while very important to the Manitoba economy, is far from being the dominant commodity moved on Manitoba's highways. Grain O-Ds are quite limited and the road networks are in particularly focused areas in the province.

Regehr (2002) discusses how particular road loadings from grain movements, using industrial intelligence can be better estimated for engineering and planning purposes.

Table 4.3 For-Hire Trucking Survey

Manitoba Intra-Provincial Commodity Movements

Intra Manitoba Movements by Tonnage	
Major Commodity	**Percentage**
Petroleum and Coal Products	28.6
Chemicals and Related Products	14.4
Other Foods, Food Materials	8.6
Non-Metallic Minerals	7.1
Dairy Products, Eggs	4.5
Beverages	4.0
Cereal Grains	3.3
Crude Non-Metallic Minerals	3.3
Metal Fabricated Basic Products	3.1
General or Unclassified Freight	3.1
All Other Commodities Combined	20.0

4.1.2 CCMTA Roadside Survey

The CCMTA Roadside Survey information provides a basis for understanding origin-destination patterns and commodities transported by commercial trucks operating on primary inter-provincial and international highways. The survey discussed in this research was conducted for one week in 1999. The results of subsequent CCMTA Roadside Surveys have not been made available to this research.

The CCMTA Roadside Survey is concentrated on the National Highway System. The primary highway network for the survey in Manitoba consists of: PTH 1, PTH 16, and PTH 75. This focus restricts the scope and coverage for certain types of freight movements, but does access information about non for-hire trucking. The survey tends to be characterized by large with questions and small in sample size. In utilizing databases like this, engineers must take care in interpreting results and comparing and contrasting them with other surveys like the For-Hire Trucking Survey. In this particular research this database was analyzed in terms of O-D and commodity.

Origin-Destination Patterns

Table 4.4 and Figure 4.2 show estimates of the origin-destination pattern of intra-provincial, inter-provincial and international freight movements for Manitoba as developed from the roadside survey.

Table 4.4 CCMTA Roadside Survey

Truck Traffic Origin – Destination Patterns

Tonnes per Year						
	Destination					
ORIGIN	East Canada	Manitoba	West Canada	North	USA	Total
East Canada	--	887,276	1,467,329	--	--	--
Manitoba	744,048	2,534,937	3,571,302	197	2,065,705	8,916,189
West Canada	1,071,546	2,980,343	--	--	--	--
North	--	**	--	--	--	--
USA	--	320,273	--	--	--	--
Total	--	6,722,829	--	--	--	--
25 Tonne Trucks Trips per Day (H-Truck)						
	Destination					
ORIGIN	East Canada	Manitoba	West Canada	North	USA	Total
East Canada	--	97	161	--	--	--
Manitoba	82	278	391	*	226	977
West Canada	117	327	--	--	--	--
North	--	*	--	--	--	--
USA	--	35	--	--	--	--
Total	--	737	--	--	--	--

Note: * Denotes less than 1 H-Truck per day;** denotes less than one tonne per year; -- outside of geographical scope

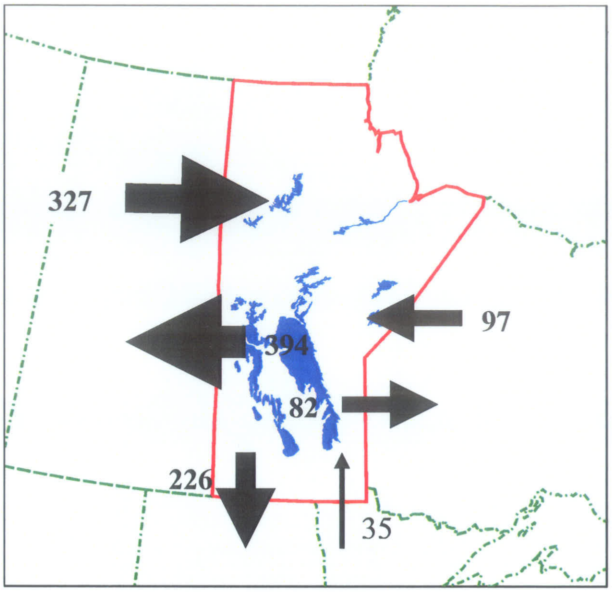
Observations which can be directly construed from Table 4.4 and Figure 4.2 are:

- Manitoba highways handle 1787 H-trucks per day of freight movement:
  - 16 percent (278) is between O-Ds within Manitoba
  - 44 percent (791) is between Manitoba and western Canada
  - 16 percent (278) is between western Canada and eastern Canada
  - 10 percent (179) is between Manitoba and eastern Canada
  - 14 percent (261) is between Manitoba and the U.S.

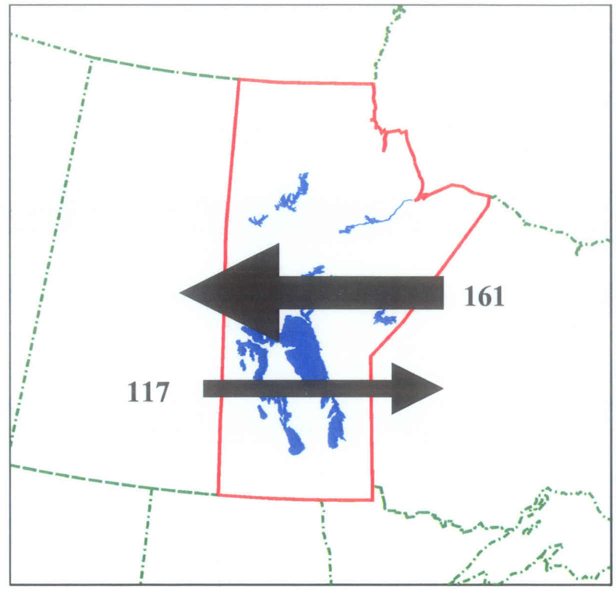
- Intra-provincial movements are 30 percent lower than the For-Hire Survey.
- Western movements are double that of the For-Hire estimate.
- Possible reasons for these are:
  - CCMTA is an on road survey capturing all trucking not solely for-hire carriers.
  - Survey locations are located only on major inter-provincial and international routes (i.e. PTH 1, 16, and 75). This will intensify certain types of freight movements and suppress others (i.e. inter-provincial moments).
  - Depending on time of year for the survey, certain commodities can be over represented (i.e. more prevalent grain movement in the fall months).
  - The CCMTA database is wide with questions but not deep with data observations.
  - Survey years of two databases are different.

- The CCMTA survey—like the for-hire truck survey—is indicative of the importance of the corridor movement of trucking through Manitoba to total road loading in this province. Based on the CCMTA database, the corridor rolling gross-tones accounts for 37 percent of the inter-provincial road loading.
- From the CCMTA data, the Manitoba west movement shows to be about 2 K-trains per day. This would not be directed at single O-D pair, probably between Manitoba and Saskatoon, Regina, Calgary, Edmonton, Prince Rupert, and Vancouver. Thus, no single O-D movement would capture the 2 K-train per day movement shown. Thus again, it is not unreasonable to conclude that the ability of rail to compete for intra-western Canadian trucking movements may be quite limited.

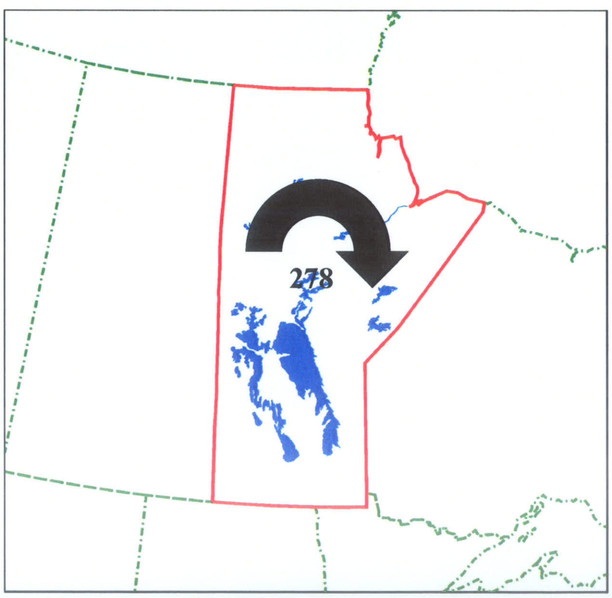
Figure 4.2 CCMTA Roadside Survey H-Truck Volumes



East/West and North/South
Movements To/From Manitoba



East/West Movements
Through Manitoba



Manitoba Intra-Provincial

Commodities

This section considers the commodity movements identified in the CCMTA Roadside Survey moving to/from Manitoba. Tables 4.5 and 4.6 illustrate the ten most common commodities by tonnage identified in the CCMTA Roadside Survey.
The commodity categories used in the CCMTA database are different than the categories used in the for-hire survey. Therefore direct comparisons are difficult.

Nonetheless from the CCMTA Survey, three commodity groups: petroleum products, general freight and food products including beverages are similar to the for-hire survey. Chemicals were not identified in the top ten commodities in the CCMTA Survey.

The three major commodity groupings account for nearly fifty percent of the 897 H-Trucks per day of freight moving inter-provincially. This is supporting the For-Hire Survey conclusions that these commodity groups dominate Manitoba freight movements.

The CCMTA Survey also indicated relatively high quantities of gravel in the intra-provincial context at about 10 percent. This is shown to be an important commodity and is similar to the For-Hire Survey.

Grain is shown relatively high for both intra and inter-provincial movements. This is a commodity that is important, possibly over emphasized in the CCMTA Survey. It is also one that requires a strong understanding of the continual changing production, distribution, marketing, and modal competitive issues around this product from the engineering and planning standpoint.

Table 4.5 1999 CCMTA Roadside Survey

Manitoba Inter-Provincial Commodity Movements

Inbound Truck Movements by Tonnage		Outbound Truck Movements by Tonnage	
Major Commodity	**Percentage**	**Major Commodity**	**Percentage**
Wood Fabricated Materials	12.5	Food & Beverages	14.6
Food & Beverages	9.5	General Freight	10.7
General Freight	9.1	Less Than Truck Load Freight	9.2
Crude Petroleum	8.2	Paper and Paperboard	8.2
Cereal Grains	6.6	Vegetables and Products	6.4
Less Than Truck Load Freight	6.6	Meat and Meat Preparations	5.9
Fuel Oils	5.9	Wood Fabricated Materials	5.4
Milled Grain Products	3.5	Cereal Grains	5.2
Meat and Meat Preparations	3.5	Motor Vehicles & Parts, &	4.9
Live Animals	3.4	Base Metals	4.6
All Other Commodities Combined	31.1	All Other Commodities Combined	25.1

Table 4.6 CCMTA Roadside Survey

Manitoba Intra-Provincial Commodity Movements

Intra Manitoba Truck Movements by Tonnage	
Major Commodity	**Percentage**
Food & Beverages	10.1
Gravel and Crushed Stone	10.0
Cereal Grains	9.2
Non-metallic Mineral Products	9.1
Fuel Oils	8.2
Vegetables and Products	6.8
Milled Grain Products	6.3
Wood Fabricated Materials	6.0
Meat and Meat Preparations	4.9
Live Animals	4.5
All Other Commodities Combined	24.8

4.2 INTERNATIONAL MOVEMENTS

Three international freight databases were examined in this section: (1) Bureau of Transportation Statistics (BTS) - 2002 Transborder Surface Freight Database; (2) Statistics Canada - 1997 For-Hire Trucking Survey; and (3) CCMTA - 1999 Roadside Survey. Each database includes information on origin – destination patterns, commodities, and freight quantities. The For-Hire Trucking Survey and CCMTA Roadside Survey use estimated tonnage to quantify the freight movement. The Transborder Surface Freight Database uses freight value to quantify the freight movement in the north and south bound directions, and freight tonnage to further quantify the southbound movement only. Similar analysis is available in Minty et al., 2002.

4.2.1 BTS Transborder Surface Freight Database

Origin-Destination Patterns

Freight data from the 2002 Transborder Surface Freight Database was analyzed in two ways: truck freight movements through the border crossings connecting to PTHs 1, 10, and 75 and truck freight movements to and from Manitoba. Figure 4.3 illustrates the origin – destination patterns of international truck movements for Manitoba by direction of movement. The values shown in the figure represent percentage of freight value for all commodities combined for the year 2002.

In 2002, $4.6 billion U.S. of freight was shipped from the U.S. to Manitoba by truck. Of this, 13 percent originated in each of Illinois and Minnesota, 7 percent originated in Wisconsin and 6 percent originated in Texas. During the same year $3.2 billion U.S. of freight was shipped from Manitoba by truck destined for the U.S.. Fifty (50) percent of this total was destined for 5 states. Eighteen (18) percent was destined for Minnesota, 12 percent for North Dakota, and 5 percent was destined for each of Illinois, California and Wisconsin.

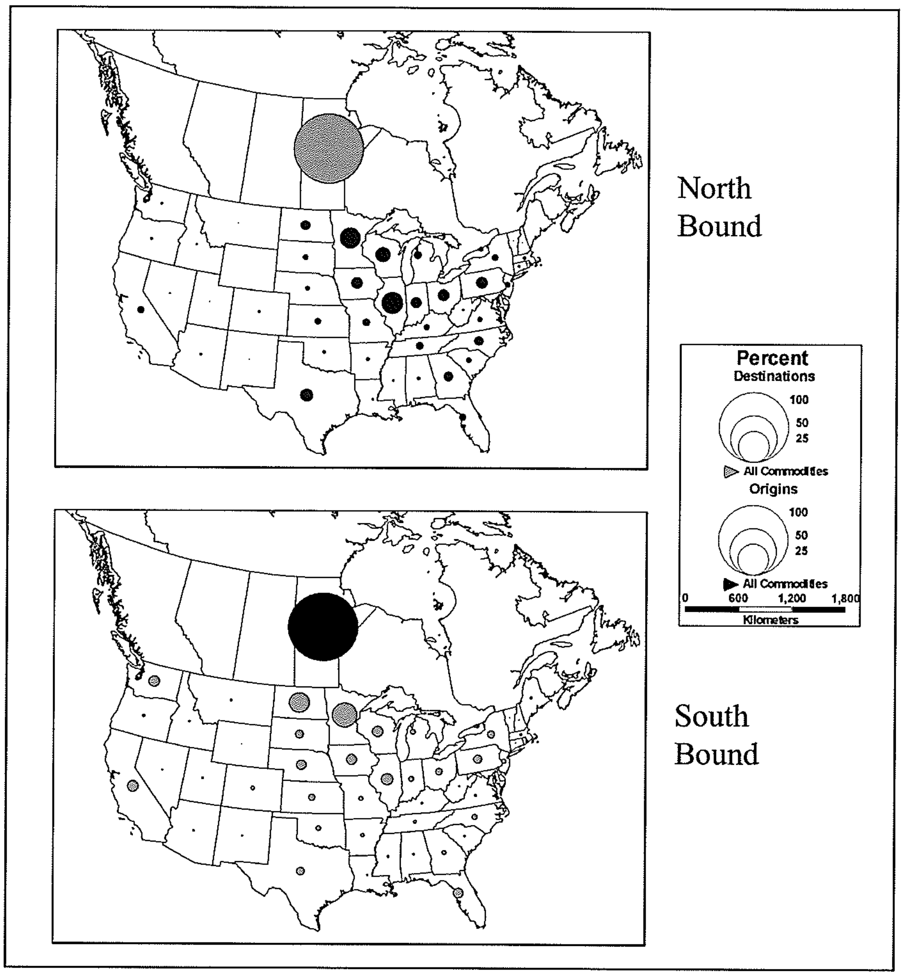


Figure 4.3 Transborder Surface Freight Database

Origin – Destination of Freight Movements to and from Manitoba

(figure shows percent distribution of freight value)

Combined O-D patterns of value related truck movements through the three border crossings are shown in Figure 4.4 by direction of freight movement. Of the truck freight movements destined for Manitoba entering through the Emerson – Pembina (PTH 75), Boissevain – Dunseith (PTH 10), and Sprague – Warroad (PTH 12) border crossings, 14 percent originated in Illinois, 10 percent in Minnesota, 8 percent in Wisconsin, and 6 percent in Texas. Truck freight movements destined for the U.S. through the three border crossings, 19 percent is destined for Minnesota, 12 percent for North Dakota, 6 percent for Illinois, and 5 percent for each of Wisconsin, Iowa, Florida, Nebraska, and California. Figure 4.5 illustrates the origin – destination patterns for the three border crossings individually.

Truck freight shipped south bound through the three border crossings in 2002 amount to 2.9 million tonnes of freight shown in Table 4.7. This translates into 314 H-Trucks per day. 209 H-Trucks or 1.9 million tonnes of this freight originated in Manitoba destined for the U.S. through the border crossings.

Figure 4.6 illustrates the origin - destination patterns of truck freight originating in Canada and destined for the U.S. through the three border crossings. Truck freight movements are quantified in terms of percent of freight tonnage.

Table 4.7 Transborder Surface Freight Database South Bound Truck Volumes

Border Crossing	Tonnes per Year South Bound	H-Trucks per Day
Pembina – Emerson (PTH 75)	2,472,875	271
Boissevain – Dunseith (PTH 10)	364,890	40
Sprague – Warroad (PTH 12)	36,530	4

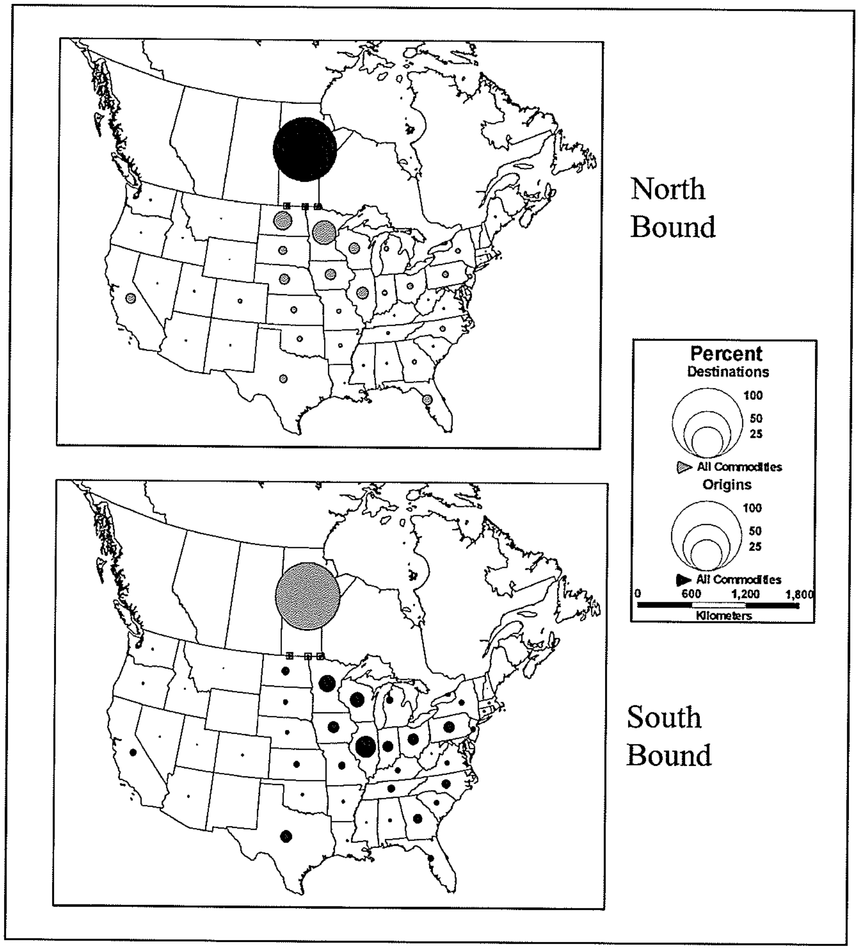


Figure 4.4 Transborder Surface Freight Database

Origin-Destination of Truck Freight Movements to and from Manitoba Through the

Border Crossings

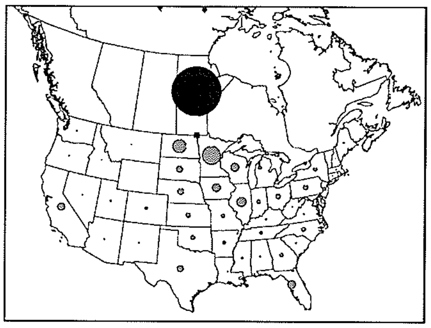
(figure shows percent distribution of freight value)

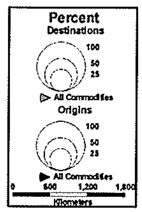
Figure 4.5 Transborder Surface Freight Database Origin-Destination of Truck Freight Movements to and from Manitoba Through Individual Border Crossings

(figure shows percent distribution of freight value)

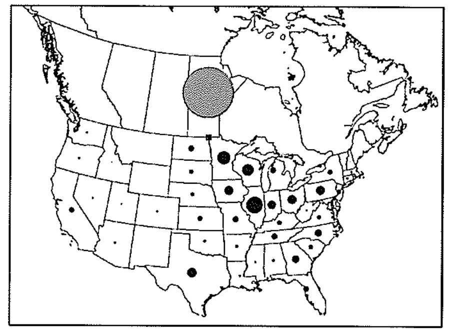
Origin Destination of Truck Freight Movements Though PTH 75 (Emerson – Pembina)

South Bound

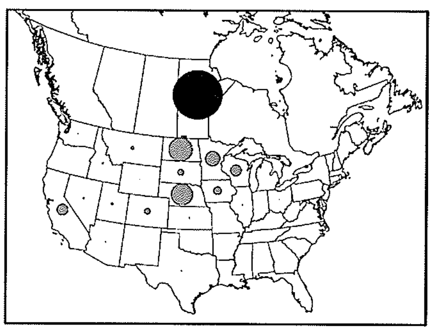


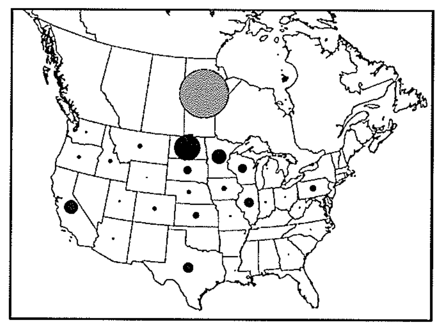


North Bound

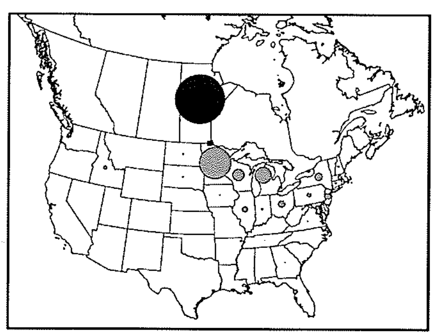


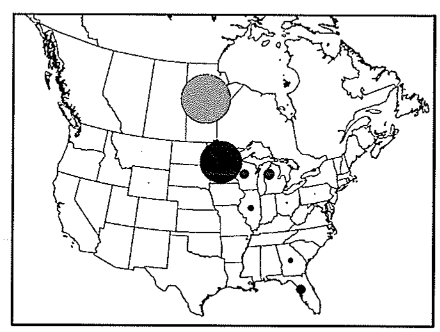
Origin Destination of Truck Freight Movements Though PTH 10 (Boissevain - Dunseith)





Origin Destination of Truck Fright Movements Though PTH 12 (Sprague - Warroad)





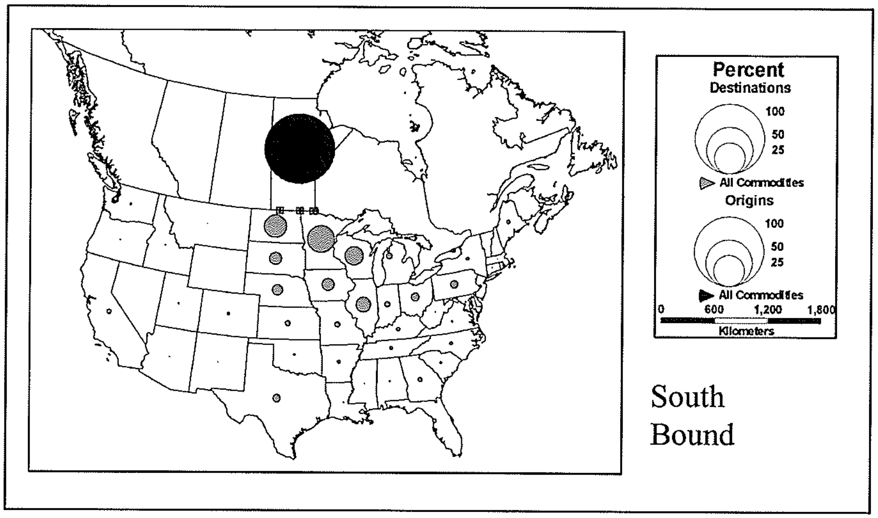


Figure 4.6 Transborder Surface Freight

Origin – Destination of Truck Freight Movements Through the Border Crossings

(figure shows percent distribution of freight tonnage)

<u>Commodities</u>

The ten most common commodities identified by the 2002 Transborder Surface Freight Database moving to and from Manitoba are listed in Table 4.8. Three commodities account for nearly 50 percent of the truck freight by value destine for Manitoba. Machinery and appliances account for 24.7 percent, vehicle and parts 16.4 percent, and electrical machinery account for 6.2 percent. Major commodities exported to the U.S. highlighted from the Transborder Surface Freight Database include: machinery and appliances, vehicles and parts and live animals. Together these three commodities represent over one third of the commodities by value exported to the U.S. from Manitoba.

Table 4.8 Transborder Surface Freight Database

International Commodity Movements

Inbound Truck Movements by Tonnage		Outbound Truck Movements by Tonnage	
Major Commodity	**Percentage**	**Major Commodity Group**	**Percentage**
Machinery & Appliances	24.7	Machinery & Appliances	12.7
Vehicles and Parts	16.4	Vehicles and Parts	11.7
Electrical Machinery	6.2	Live Animals	10.8
Plastics & Products	4.9	Furniture & Fixtures	8.0
Printed Material	3.9	Plastics & Products	5.4
Chemical Products	3.3	Aircraft	5.0
Paper and Paperboard	3.1	Meat	4.4
Iron or Steel Products	3.0	Wood & Products	3.7
Rubber & Products	2.1	Paper and Paperboard	3.2
Optical Equipment	1.9	Printed Material	3.1
All Other Commodities Combined	30.4	All Other Commodities Combined	32.0

4.2.2 Statistics Canada For-Hire Trucking Survey

The international truck freight component for the analysis of the For-Hire Truck Survey focuses on truck movements to and from the U.S. and Mexico. For the purposes of this research only international truck movements to and from the U.S. are examined. Trucking movements to and from Mexico are small and are not included in the research.

<u>Origin-Destination Patterns</u>

Origin – destination patterns of international truck movements to and from Manitoba are illustrated in Figure 4.7. The values listed in this figures represent a percentage of freight tonnage. The For-Hire Trucking Survey highlighted 1.0 million tonnes (110 H-Trucks per day) of freight transported by truck from Manitoba to the U.S. Of this tonnage, 16 percent is destined for Minnesota, 14 percent for North Dakota, 11 percent for Illinois and 10 percent for Wisconsin. Of the 0.5 million tonnes (57 H-Trucks per day) of freight moved by truck from the U.S. to Manitoba, 23 percent originates in Minnesota, 13 percent in Illinois, 8 percent in Wisconsin, and 6 percent in each of North Dakota and Iowa.

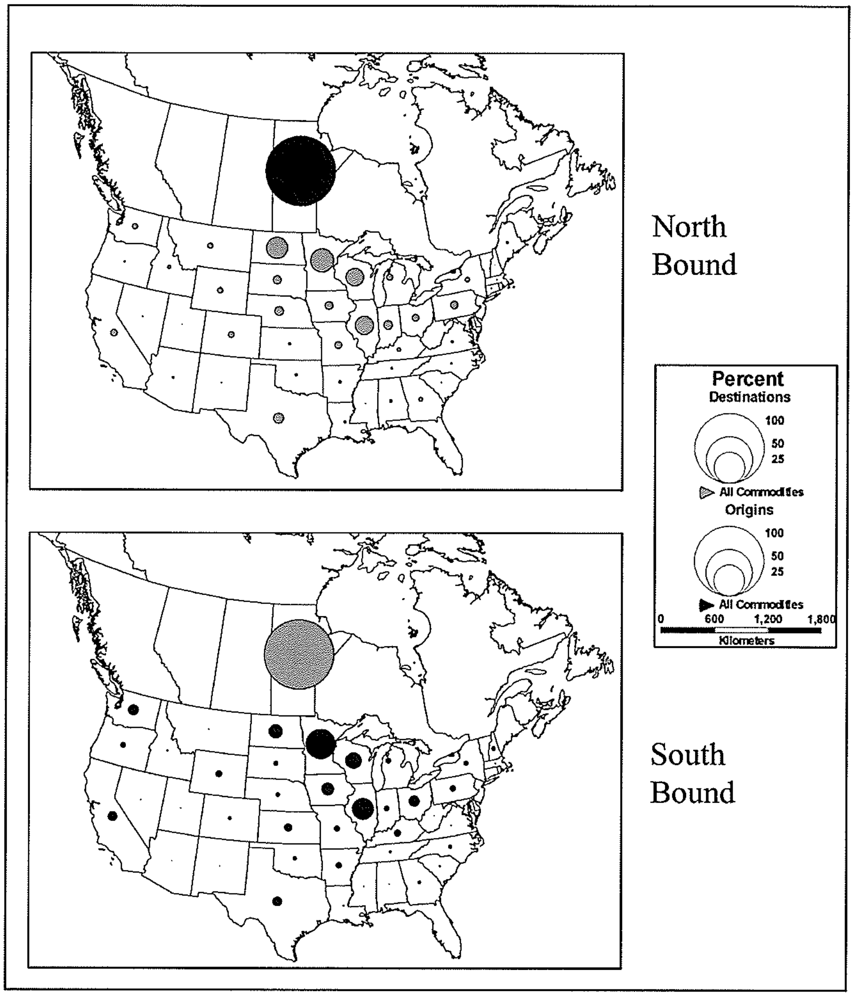


Figure 4.7 For-Hire Trucking Survey

Origin – Destination of Freight Movements to and from Manitoba

(figure shows percent distribution of freight tonnage)

Commodities

The ten most common commodities identified by the For-Hire Trucking Survey moving to and from Manitoba and the U.S. are listed in Table 4.9. Of the 110 H-Trucks per day originating in Manitoba and destined for the U.S. these movements are dominated by: chemicals, vegetables, and paper. Together these three commodities account for over one third of the freight tonnage transported. Major inbound commodity movements are: general freight, chemicals, feed, and wood materials. Together these four commodities account for 38 percent of the 57 H-Trucks per day originating in the U.S. and destined for Manitoba.

Table 4.9 For-Hire Trucking Survey

International Commodity Movements

Inbound Truck Movements by Tonnage		Outbound Truck Movements by Tonnage	
Major Commodity	**Percentage**	**Major Commodity Group**	**Percentage**
General or Unclassified Freight	18.8	Chemicals and Related Products	11.4
Chemicals and Related Products	9.8	Crude Vegetable Products	9.4
Fodder and Feed	6.9	Paper and Paperboard	9.4
Crude Non-Metallic Minerals	5.2	Wood Fabricated Materials	8.2
Crude Vegetable Products	4.9	General or Unclassified Freight	6.9
Iron, Steel and Alloys	4.7	Iron, Steel and Alloys	6.4
Vegetables and Products	4.6	Cereal Grains	6.4
Metal Ores, Metal in Ores	3.4	Vegetables and Products	5.8
Agricultural Machinery	3.4	Live Animals	5.2
Other Foods, Food Materials	3.2	Metal Fabricated Basic Products	3.3
All Other Commodities Combined	35.0	All Other Commodities Combined	27.6

4.2.3 CCMTA Roadside Survey

The international component of the CCMTA Roadside Survey examines truck freight movements to the U.S., Mexico and other global destinations. For the purposes of this research only international truck movements to and from the U.S. are examined.

Origin-Destination Patterns

Origin – destination patterns of international truck movements to and from Manitoba are illustrated in Figure 4.8. The values listed in this figure represent percentage of freight tonnage. The CCMTA Roadside Survey highlighted 2.1 million tonnes (226 H-Trucks per day) of freight transported by truck from Manitoba to the U.S.. Of this tonnage 57 percent is destined for South Dakota, 12 percent for Minnesota, 6 percent for North Dakota and 5 percent for Wisconsin. Of the 0.3 million tonnes (35 H-Trucks per day) of freight moved by truck from the U.S. to Manitoba, 25 percent originates in North Dakota, 19 percent in Minnesota, and 7 percent in each of Illinois, Texas, Florida and New Jersey.

Commodities

The ten most common commodities identified by the CCMTA Roadside Survey moving to and from Manitoba and the U.S. are listed in Table 4.10. Of the 226 H-Trucks per day originating in Manitoba and destined for the U.S., freight movements are dominated by: vegetables, wood materials, general freight, and products of petroleum. Together these three commodities account for 52 percent of the freight tonnage transported.

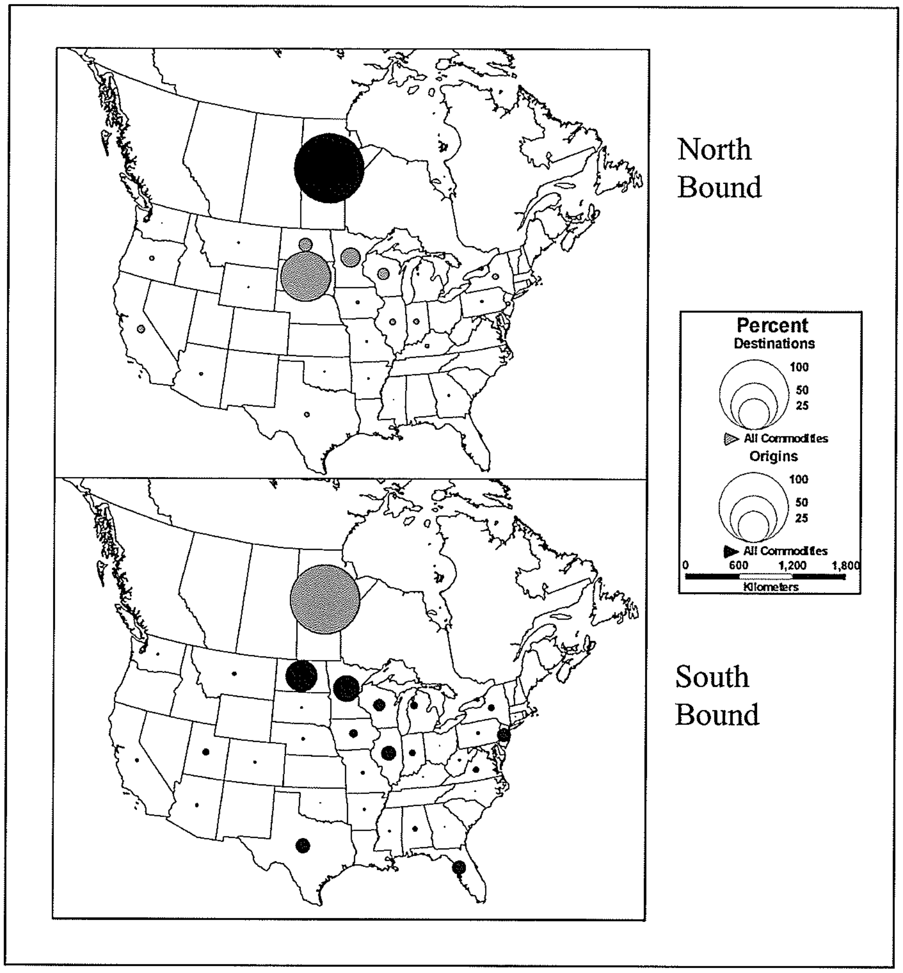


Figure 4.8 CCMTA Roadside Survey

Origin – Destination of Freight Movements to and from Manitoba

(figure shows percent distribution of freight tonnage)

Major inbound commodity movements are: cereal grains, vegetables, paper, and feed. Together these four commodities account for 78 percent of the 35 H-Trucks per day originating in the U.S. and destined for Manitoba.

Table 4.10 CCMTA Roadside Survey

International Commodity Movements

Inbound Truck Movements by Tonnage		Outbound Truck Movements by Tonnage	
Major Commodity	**Percentage**	**Major Commodity**	**Percentage**
Cereal Grains	49.0	Vegetables and Products	16.3
Vegetables and Products	17.5	Wood Fabricated Materials	14.5
Paper and Paperboard	5.7	General Freight	12.3
Animal Feed	5.3	Products of Petroleum Refining	8.8
Food & Beverages	3.3	Paper and Paperboard	7.9
Base Metals	2.7	Food & Beverages	6.8
Fertilizers	1.9	Base Metals	6.0
Motor Vehicles & Parts, &	1.7	Plastics and Rubber	3.7
Machinery & Equipment	1.6	Motor Vehicles & Parts, &	2.4
Waste and Scrap	1.6	Meat and Meat Preparations	2.1
All Other Commodities Combined	9.8	All Other Commodities Combined	19.1

4.2.4 Observations Relevant to Highway Engineering and Planning

The following observations are based on a consideration of the data and information present in section 4.2 concerning international freight movements by truck to/from Manitoba.

1. U.S. Size and Weight Regulation

Figure 4.9 illustrates a schematic dividing the eastern and western states by the extension of the Minnesota-Dakota boundaries. Movements to the east of this dividing line are controlled by basic U.S. federal axle weight limits, U.S. Bridge Formula B, and a GVW limit of 80,000 pounds. For the most part, movements to the west of this dividing line are controlled by basic U.S. federal axle weight limits and U.S. Bridge formula B, but with higher GVW caps, and in particular 105,500 pounds in North Dakota.

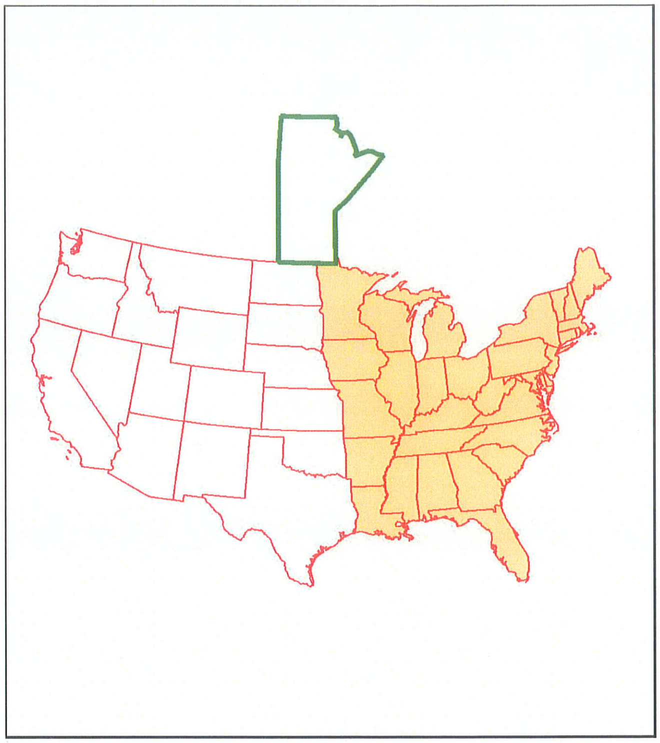


Figure 4.9 U.S. Eastern – Western Regions

Vehicles for western movements can be 5 or 6 axle tractor semitrailers or 6 or 7 axle A-train combinations. Additionally, movements south of Kansas City are largely limited by the 80,000 pound GVW requirement of U.S. truck size and weight laws (there is some variation to these limits in winter weight and spring ban periods and some variation in the types of vehicles allowed– Clayton et al, 2003). Table 4.11 illustrates the results of a specially commissioned survey illustrating dominant vehicle and body types observed at the Emerson weigh scale located on PTH 75 near the Manitoba U.S. border.

Table 4.11 UMTIG Static Weigh Scale Survey – Emerson (PTH 75)

Body Type	Configuration			Percent of Fleet
	3-S2	3-S3	3-S3-S2	
Dump	0.3	0.1	0.0	**0.4**
Flatbed	17.4	1.9	0.1	**19.4**
Grain	15.2	0.9	1.6	**17.8**
Livestock	5.8	0.9	0.1	**6.8**
Other	1.5	0.1	0.0	**1.7**
Tanker	3.8	0.1	0.0	**3.9**
Van	44.0	0.5	0.0	**44.5**
Other	--	--	--	**5.5**
Percent of Fleet	**88.1**	**4.6**	**1.9**	**94.5**

Source: UMTIG 2002 Static Weigh Scale Survey

The implication of this for highway engineering and planning in Manitoba is that the U.S. size and weight regulations are largely controlling vehicle characteristics operating between Manitoba and the U.S. In practical terms this means 5-axle tractor semi-trailers are the dominant vehicle and their weight characteristics are governed by U.S. regulations.

2. Road Loadings

Based on H-Trucks and the Emerson translated truck volumes (doubled from the 2002 surface freight database), the total rolling gross-tonnes on the PTH 75 route (assuming 100km in length and all traffic moves to/from Winnipeg), associated with international movements would be 782 million per year. This is about 15 percent of the extra-provincial road loadings in Manitoba.

3. Origin – Destination Patterns of Manitoba International Freight Movements

Considering the data presented in this chapter, Manitoba's truck related association with the U.S. is dominated by connectivity with North Dakota, Minnesota, Wisconsin, Illinois, Pennsylvania, and other North Central U.S. States. This holds true for both value and weight related measures and are most likely dominated with shorter weight related movements and longer value related movements. Some variations are observed from year to year because of sampling issues, but the basic theme remains the same.

Understanding this envelope of interaction should direct engineers and planners to the appropriate thinking regarding partnerships of investment strategizing, cooperative associations, ITS applications, and advancements in special permitting arrangements. For example, partnerships with jurisdictions in the north central states like Illinois would likely provide larger benefits with the use of similar compatible technologies for vehicle routing or pre-screening at border crossings.

4. Commodities

While four or five significant commodity groups are apparent in these particular databases (i.e. machinery & vehicles, agriculture products, paper, general freight, and live animals), these do change from year to year and between classification systems. In recent years the hazardous material classification has become increasingly important for monitoring and control from and engineering and planning standpoint. Dominating vehicle body types associated with these commodities from Table 4.11 are largely van, flat deck and grain body styles.

Generally it would be difficult to separate flow matters of consequence to engineering and planning by commodity. PTH 75 does function similar to PTH 1 in that there are a wide range of commodities and operating vehicle weights.

CHAPTER 5

FREIGHT DERIVED TRUCK VOLUMES

This chapter applies the methods developed in this research to translate freight knowledge into estimated truck movements. For this research, truck movements are estimated in terms of truck volumes per unit of time on highway sections. Two different types of situations lent themselves to illustrative applications: (1) estimating truck traffic impacts from the construction of a new major dam project (i.e. the Wuskwatim Dam) now under development in northern Manitoba; and (2) the translation of particular freight flows to truck volumes on select sections of the Manitoba Truck Planning Network.

5.1 FREIGHT FLOW TO TRUCK VOLUME ESTIMATES FOR THE WUSKWATIM PROJECT

The Wuskwatim Generating Project on the Burntwood River is one of three hydroelectric projects envisioned for development in northern Manitoba by Manitoba Hydro. Figure 5.1 illustrates the project location.

This element of the research uses part of the Wuskwatim Project Material Transportation Study (Minty et al., 2004) to estimate truck volumes from freight flows. The purpose of that study was to investigate opportunities for reducing Manitoba Hydro's transportation costs for the Wuskwatim Generating Station project, and to provide a transportation cost evaluation tool for future projects.

Specifically, the study provided an opportunity to help develop, and then apply, the methodologies discussed earlier to a major Manitoba engineering project and the Manitoba highway system. The planning for the Wuskwatim project necessitated estimating associated material quantities and related scheduling required for the project. This in turn provided matrices of material flow by commodity, quantity, and temporal properties. In all cases the destination of the materials was known (i.e. Wuskwatim). In many cases, the origin of movements could be determined from expert knowledge. This provided the basis for estimating truck volumes.

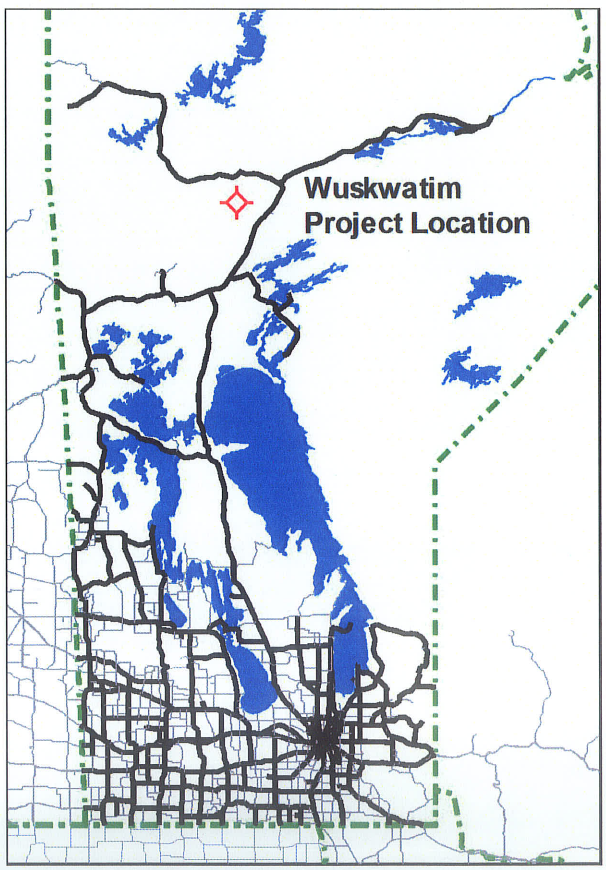


Figure 5.1 Wuskwatim Project Location

Freight Flow to Truck Volumes

Table 5.1 details the material flow by commodity type with quantity and yearly scheduling estimates used in the project, the actual project schedule has been moved forward a year or two but is of no consequence to this research. Total material tonnage to be transported is approximately 81,000 tonnes over a 5-year period, with cement, fuel, reinforcing steel, and construction materials accounting for 80 percent of the total.

The total inbound movement is about 3100 H-trucks or 10 K-trains. Over 90 percent of this movement is expected to occur in years 3,4, and 5 of the project, probably in fairly concentrated time periods during the heavy construction phases of the work.

Truck trips to the project site for all materials were translated from unit weights into unit payloads. Truck trips were estimated using two unit payload approaches, the standard 25-tonne 5-axle truck trips and preferred vehicle truck trips. The 25-tonne truck trip provides a good average estimate of truck payload per trip. The preferred vehicle approach accounts for individual material's physical properties such as non-divisible weights and dimensions, and bulk or packageable goods.

Using material estimates, Table 5.2 illustrates material specific information about non-divisible weights and outlines preferred vehicle options by material type. Total truck trips to the project site for each material are estimated using the 25-tonne unit payload (H-Truck) and the preferred vehicle approach shown. Total H-Truck trips to the site are estimated at 3084 trips over the 5 year project construction period. Total preferred truck trips are estimated at 2177 over the construction period.

Table 5.1 Wuskwatim Project Material Flow

Material	Total (Tonnes)	2004	2005	2006	2007	2008	2009	Percent of Total
Site Facilities	360	360						*
Vehicles	70	70						*
Mobile Homes	1040	200	700	140				*
Cement	39000			11000	21990	6010		49
Reinforcing Steel	5850			1800	3600	450		7
Embedded Materials	630				630			1
Fuel	10470	300	800	3000	3000	2500	870	13
Intake Gates / Bulk Head	790					700	90	1
Spillway Main Gates	560				560			1
Spillway Beams	730			730				1
Power House Crane	230					230		*
Draft Tube Gate Crane	20					20		*
Draft Tube Gates	110					110		*
Trash Racks	100					100		*
Stop Logs	100					100		*
Superstructural Steel	440				100	300	40	1
Roof, Deck, Cladding, ETC	170					100	70	*
Consumer Goods	4760	70	110	1190	2090	1050	250	6
Construction Materials	4830		100	1000	1730	1500	500	6
Misc. 10% of Total	5990	80	140	1500	2640	1320	310	8
Transformers	390						390	*
Generators and Components	940					1500	1040	1
Turbines and Components	2540					600	340	3
Transmission Line	670					370	300	1
Diversion Equipment	270			270				*
Total	**81060**	**1080**	**1850**	**20630**	**36340**	**16960**	**4200**	**100**

Source: Pasloski, G., Northern Development Materials Transportation Study: Wuskwatim Project (updated in 2002)
* denotes materials with less than one percent of total

Bulk materials benefit from using a high payload vehicle. This reduces the number of truck trips required and also reduces handling of materials. Depending on the material density, packageable goods benefit from high cubic capacity vehicles like 53 foot 5-axle truck trailer combinations. Denser materials may require a higher payload vehicle like a 6-axle truck trailer combination. The inability to separate certain materials based on their unit weights and dimensions further influences vehicle selection.

Assigning Truck Volume Estimates to the Highway Network

Estimated truck trips are assigned to the highway network servicing the Waskwatim project. Factors used to determine the highway network relevant to the project included: commodity origins, trip time, and truck size and weight regulations. For example, it was determined the majority of the cement would originate in Calgary or Edmonton and the majority of consumer goods would originate in Winnipeg.

The transportation of cement would require RTAC routing while only certain types of consumer goods may require RTAC routing. Figure 5.2 illustrates the project's principal road network.

Truck volumes for the major commodities were assigned to appropriate highway sections as follows:

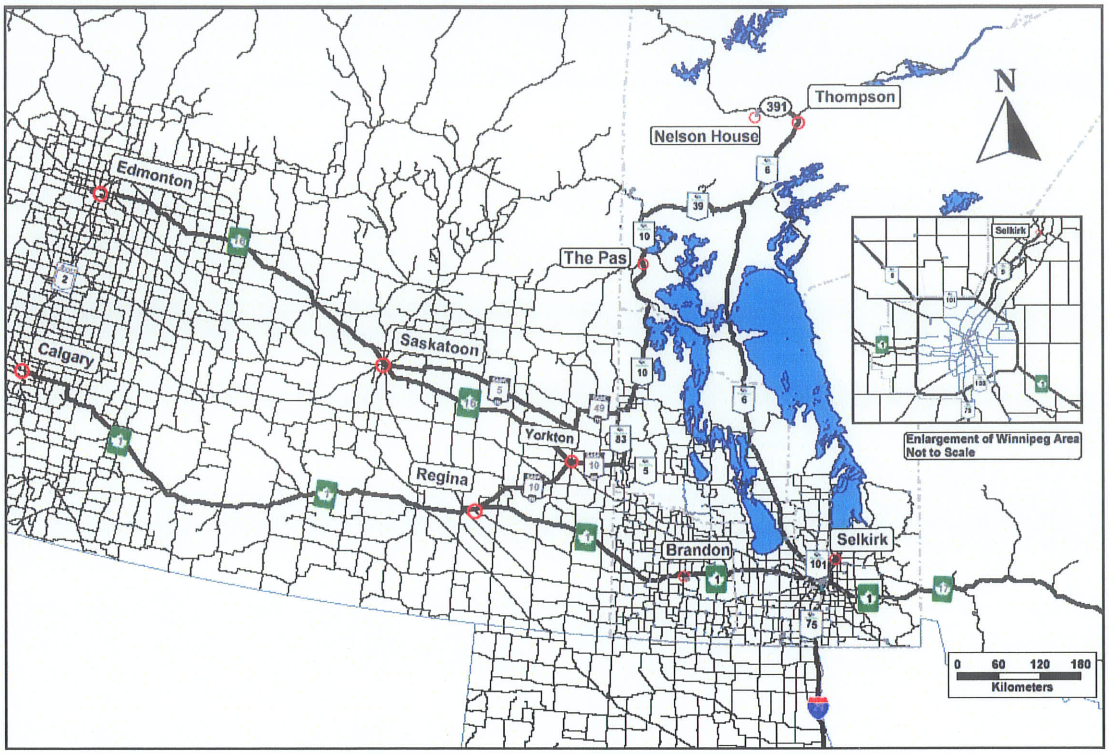
- All 3084 northbound truck volumes were assigned to the highway section connecting Ponton to Thompson on PTH 6, and Thompson to the Wuskwatim Project cutoff on PR 391.
- Commodities depending on their origin were assigned to: (1) PTH 6 (Ponton to Winnipeg); and or (2) PTH 39 (Ponton to PTH 10 with connections to PTH 10 and the west). The four major inbound commodities (cement, fuel, reinforcing steel, and construction materials)—which together account for 80 percent of the inbound movement--could originate in Winnipeg (and therefore assigned to PTH 6), could originate in Alberta or Regina (with potential assignment to PTH 10 and PTH 39), or could originate in some combination of these with accompanying routing implications. In all cases the direction of payload, loaded and empty rolling gross-tonne miles, and temporal patterns of movement could be estimated as the project proceeds. Actual assignment becomes clearer and indeed exact, as the contract details are determined. A series of matrices and project outcomes for certain parts of the highway network can be estimated quite exactly even before the project begins. For other aspects of this scenario, estimates can be quite reasonably made and would become increasingly certain as the project timeline and contract details progress. In the final analysis, close to total certainty can be established. This approach to engineering and planning can be highly facilitated by spatial thinking and analysis.

Table 5.2 Material Transportation Truck Flow Estimate

Material	Total Tonnage (Tonnes)	Non-Divisible Weight	Preferred Vehicle	25 Tonne Truck Trips (H-Truck)	Preferred Vehicle Truck Trips
Site Facilities	360		3-S2	14	14
Vehicles	70		3-S2	3	3
Mobile Homes	1040		3-S2	42	40
Cement	39000		B-Train	1560	874
Reinforcing Steel	5850		3-S3	234	185
Embedded Materials	630		3-S3	25	20
Fuel	10470		B-Train	419	238
Intake Gates / Bulk Head	790	15.9 tonnes	3-S2	50	30
Spillway Main Gates	560	181.5 tonnes	*	*	*
Spillway Beams	730		3-S2	29	28
Power House Crane	230		3-S2	9	9
Draft Tube Gate Crane	20		3-S2	1	1
Draft Tube Gates	110		3-S2	4	4
Trash Racks	100		3-S2	4	4
Stop Logs	100		3-S2	4	4
Superstructural Steel	440		3-S3	18	14
Roof, Deck, Cladding, ETC	170		3-S2	7	7
Consumer Goods	4760		3-S2	190	251
Construction Materials	4830		3-S2	193	186
Misc. 10% of Total	5990		3-S2	240	230
Transformers	390	130 tonnes	*	*	*
Generators and Components	940	160 tonnes	*	*	*
Turbines and Components	2540	80 tonnes	*	*	*
Transmission Line	670		3-S2	27	26
Diversion Equipment	270		3-S2	11	10
Total	**81060**	--	--	**3084**	**2177**

Source: Wuskwatim Project Materials Transportation Study: Opportunities for Cost Savings
Note: * denotes special vehicle (not calculated)

- Thus, in terms of the rating system developed in chapter 4, this inbound movement during the heavy construction years would be characterized as few O-D pairs, highly seasonal traffic, operating at "low" truck volumes. But, for the road in question these truck volumes would be relatively large—accounting in the 2-way direction for maybe one-quarter of the total AADTT on PTH 6 north of Ponton.



Source: Wuskwatim Project Materials Transportation Study: Opportunities for Cost Savings

Figure 5.2 Wuskwatim Project Principal Road Network

5.2 FREIGHT FLOW TO TRUCK VOLUME ESTIMATES FOR ELEMENTS ON THE MANITOBA TRUCK PLANNING NETWORK

This component of the research assigns freight derived truck volumes to select sections of the Manitoba Truck Planning Network. The highway sections selected for truck volume estimation and assignment are linked to specific origin-destination pair movements discussed in Chapter 5 and illustrated in this section.

<u>Assignment Process</u>

The process of assigning truck trips to specific sections on the Manitoba Truck Planning Network is similar to a standard four step transportation demand modeling process (Trip

Generation, Distribution, Mode Split, and Assignment). The key difference is the removal of the modal split step before the truck trip assignment process. The use of truck freight data allows for the removal of this step since freight transport by truck is the mode choice.

The first step in assigning truck trips to specific highway sections is trip generation/attraction. This involves information about the quantity of freight shipped by truck to and from each zone. The quantification of freight can then be translated into truck trips by the unit payload approach, for example the H-Truck. This determines the number of truck trips beginning or ending at a particular zone. These can be subsequently modified by appropriate density and preferred vehicle factors.

In the second step, trip ends are joined together to form an origin-destination pattern, through the process of trip distribution. Trip distribution is used to represent the process of destination choice.

In the third and final step, the specific path used to travel from a trip origin to a trip destination must be found. This is represented by the highway network. Trips are then assigned to the highway section or series of sections in the trip assignment process. Highway sections are identified as connections between origin – destination pairs. In certain circumstances the calculation of the shortest path from origin – destination pair or the calculation of trip time may assist in identifying relevant highway sections. This is further complicated with highway network density and the addition of truck size and weight regulations and related restrictions.

For certain types of data, it may only be possible to assign trips to a few sections of the highway network with certainty. This can result from increasing network density and low level origin-destination information. For example, freight movements from Manitoba to Alberta would largely originate in Winnipeg but may be destined for Edmonton or Calgary, or elsewhere. This would influence the highway network selection as movements to Edmonton could utilize PTH 1 and then PTH 16, while movements to Calgary would utilize only PTH 1. Therefore, all trips could be assigned to PTH 1 from Winnipeg to the PTH 16 cutoff with good certainty, but become less certain as the network density increases.

Once highway sections between origin – destination pairs are identified, truck trips are then assigned to the highway sections providing a freight data derived truck traffic volume estimate in terms of trucks per day.

Trip Assignment

For the trip generation component in this scenario the 1999 CCMTA Roadside Survey, 1997 For-Hire Trucking Survey, 2002 BTS Transborder Surface Freight Database, and the BTS Border Crossing / Entry Data were used. Freight movements were translated from tonnes per year into H-Trucks per day for the Roadside Survey, For-Hire Trucking

Survey, and the Surface Freight Database. This provides the basis for truck volume per day estimates.

Trip distributions for inter-provincial and international truck movements for the 1999 Roadside Survey are listed in Table 4.4 and illustrated in Figure 4.2 of Chapter 4. Trip distributions for inter-provincial and international truck movements for the 1997 For-Hire Trucking Survey are listed in Table 4.1 and illustrated in Figure 4.1. Trip distribution of south bound international truck movements for the 2002 Surface Freight Database is listed in Table 4.7. Freight movements considered categorized by origin – destination pair and their relevance for each database are defined and listed in Table 5.3.

Table 5.3 Freight Database Movement Categories

Origin - Destination Combination		Database		
		CCMTA	For-Hire	Transborder
West Canada – Manitoba	(WCMB)	√	√	
East Canada – Manitoba	(ECMB)	√	√	
East - West Canada	(EWC)	√	√	
U.S. – Manitoba	(USMB)	√	√	√*

*South bound direction only.

Highway sections linked to the estimated freight derived truck volumes are identified in Table 5.4 and illustrated in Figure 5.3.

Table 5.4 Highway Sections Estimated For Derived Truck Volumes

Highway	From	To	Highway Section
PTH 1	PTH 16	PTH 101	1-1
PTH 1	PTH 101	ON Border	1-2
PTH 10	PTH 3	U.S. Border	10-1
PTH 12	PTH 89	U.S. Border	12-1
PTH 75	PTH 14	U.S. Border	75-1

Characteristics of the selected highway sections are:

PTH 1 and PTH 75

- Major inter-provincial or international highway with connection to major urban centers.
- No single commodity dominates as presented in Chapter 5. These highways could be described as all commodity routes with four or five principal commodities.
- U.S. size and weight regulation govern all international vehicle operation on PTH 75.
- PTH 75 connects to a major international border-crossing and U.S. highway network.

PTH 10 and PTH 12

- Lower volume PTH highways connecting to international border-crossings and U.S. highway network.
- Agricultural and industrial commodities represent a significant portion of freight activity.
- U.S. size and weight regulation govern international vehicle operations.

Freight movements considered by freight database for each highway section are listed in Table 5.5.

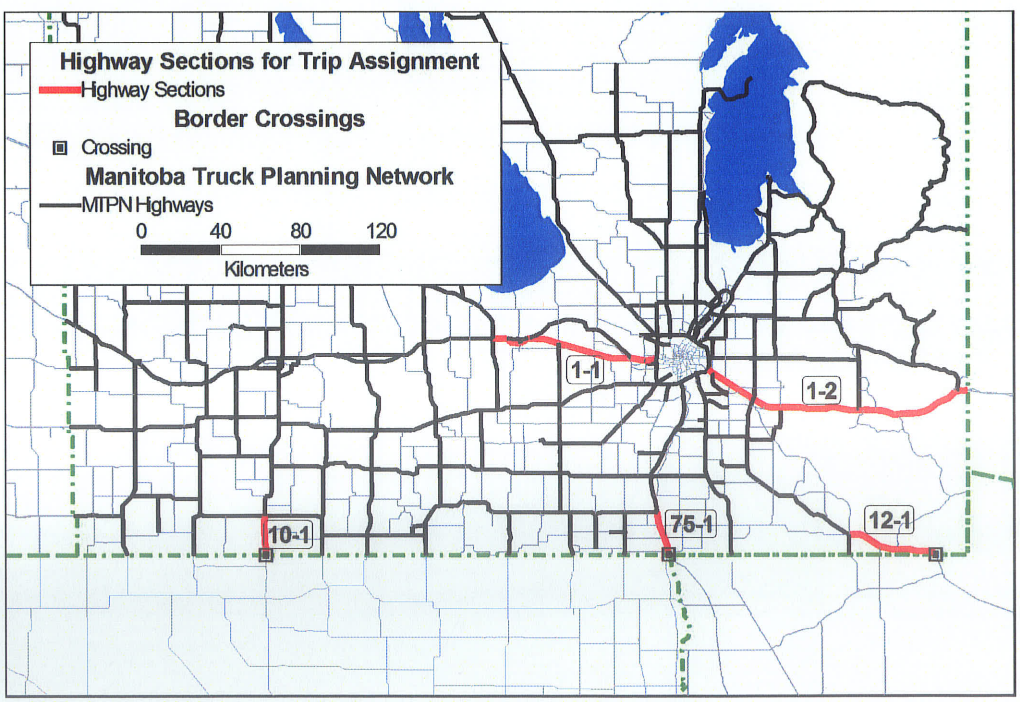


Figure 5.3 Truck Volume Estimated Highway Sections

Table 5.5 Freight Movement by Highway Section

Highway Section	Freight Movement		
	CCMTA	For-Hire	Transborder
1-1	WCMB, EWC	WCMB, EWC	--
1-2	ECMB, EWC	ECMB, EWC	--
10-1	--	--	USMB*
12-1	--	--	USMB*
75-1	USMB	USMB	USMB*

*South bound direction only.

Illustrating from Table 5.5 for the CCMTA survey freight O-D movements from East Canada to Manitoba (ECMB) can be determined for highway section 1-2 (PTH 1 east of Winnipeg). This movement can also be determined using the For-Hire survey but not with the Transborder database for highway section 1-2.

Freight derived truck volumes (H-Truck per day) are assigned to the highway section. Table 5.6 lists the truck volume estimates and compares the estimates to the annual average daily truck traffic (AADTT) estimate and truck volume estimate category developed in Tang, 2003.

Observations comparing freight data derived truck volume estimates to actual AADTT estimates are:

- Freight derived truck volumes (H-Trucks per day) underestimate actual AADTT estimates. This would be expected as each freight data source in this research is estimate a different type of freight activity (e.g. For-Hire Survey and CCMTA). Density and preferred vehicle factors could modify the results.

Table 5.6 Freight Derived Truck Volume Estimates

Highway Section	Freight Derived Truck Volume (H-Trucks per Day)			AADTT	
	CCMTA	For-Hire	Transborder	Category	Average Estimate
1-1	999	693	--	1921-3840 Very High	2100
1-2	457	550	--	481-960 Medium	910
10-1	--	--	40*	0-240 Very Low	120
12-1	--	--	4*	0-240 Very Low	90
75-1	261	167	271*	481-960 Medium	850

*South bound direction only.

- Freight derived truck volumes for the low and medium AADTT category estimates are within or very close to the lower range of the category.
- Freight derived truck volumes (H-Trucks per day) when compared to the calculated AADTT estimates are consistently one-third to one-half of order of magnitude smaller.

These findings are not unexpected. Estimates based on the for-hire survey by definitions do not deal with all truck traffic. The freight database surveys are based on differing years of measurement and would have to be normalized for accurate comparisons. The CCMTA survey is an on-road survey at only a few locations and for a relatively small survey period. Freight volume to H-truck translation lacks the factoring capabilities including the preferred truck necessary to accurately reflect related truck volumes. International data quality for engineering and planning purposes is more refined and timely.

CHAPTER 6

CONCLUSIONS

The research applied methods and readily available information systems to help understand and estimate truck freight movements from freight flow data relevant for highway engineering and planning purposes.

The research revealed a wide list of questions and issues that highway agencies face concerning trucking matters. Most involve the need for improved knowledge about trucking and truck movements on the road system, and how these movements might change in response to a variety of engineering and planning decisions. Many agencies, researchers and practitioners continue to pursue development of this improved knowledge base for engineering and planning purposes.

The environmental scan conducted in the research involved identification and analysis of literature, readily available data sources, and current approaches employed by different agencies concerning data use supports these findings.

The following section present conclusions regarding: (1) the GIS-T platform developed for analysis; (2) the characteristics of the current freight system; (3) Manitoba truck freight movements; and (4) methods for translating freight flow into truck volumes. The last section of this chapter presents future research opportunities in this area.

6.1 THE GIS-T PLATFORM

Fundamental to this research was the creation of a GIS-T platform designed to service engineering and planning functions. This platform was designed to help visualize and analyze the spatial and temporal nature of Manitoba's freight demand and transport systems. Without this platform, readily available freight data and information sources (e.g., the CCMTA Roadside Survey database relevant to Manitoba) are difficult to comprehend, and to translate into useful inputs for transportation engineering and planning purposes.

The platform consisted of three principal parts: (1) relevant spatial data; (2) attribution datasets concerning the highway inventory, truck traffic, roadside surveys, large scale statistical surveys, transborder freight movements, truck weight surveys, and industrial intelligence gathering conducted for this research; (3) software, involving Maptitude, TransCAD, GeoMedia, ArcView and AutoCAD Map from the GIS perspective, and Excel, Access and Paradox from the database perspective. Interoperability of the various aspects of the resulting platform was an important goal in its development.

Key technical issues addressed in the compilation of the geographic base data and attribute data used in this research are:

- Simplifying the spatial base data to focus on the highways in Manitoba of particular importance to trucking. The Manitoba Truck Planning Network was created. This network addresses about 80 percent of all trucking in Manitoba, on a highway sub-system that is much smaller than the provincial system in general. The relationships between freight movements and road routing options become much clearer using the MTPN.

- Transforming and integrating freight databases from multiple sources and time periods with different software packages facilitating analysis and further integration into the GIS-T platform.
- Designing and developing appropriate templates for information presentation.
- Densifying, normalizing and linking spatial and attribute data into a single integrated GIS-T platform that is interoperable, functional, current, and updatable.

The developed platform made it possible to manage, manipulate, analyze, visualize and present highway networks, geographic boundaries, border crossings, terminal locations, origin and destinations of truck flow data, freight flow data itself, and conversions of that data into truck flow movements. The maps and most of the insights developed in this research result from the use of this GIS-T platform.

Key aspects of the platform and related instruction are provided in Appendix B. Necessary software and spatial data relating to the highway network must be provided by the user.

6.2 FREIGHT SYSTEM CHARACTERISTICS

Many freight system characteristics were identified for this research. Predominant characteristics important to engineering and planning from a Manitoba perspective are:

- Prevalent truck configurations are Class 9 (3-S2) or 5-axle tractor-semitrailer, Class 10 (3-S3) or 6-axle tractor-semitrailer, and Class 13 (3-S3-S2) or 8-axle B-train. Combined, these three vehicle configurations represent over 80 percent of the truck traffic operating on Manitoba's highways.
- A variety of body types operate on Manitoba's highways, but only few are prevalent. This research classified vehicles into the following nine categories: van, refrigerated van, flat deck, grain body, dump truck, tanker (liquid or gas), tanker (dry bulk), pole logging, and automobile transporter. In practice probably four or five of these

dominate the system and would be useful from the engineering and planning perspective. These are the van, flat deck, tanker, grain hopper bottoms, and dump body styles.

- Two distinct types of intermodal containers are in use today, domestic (typically handled on a light weight chassis) and international (typically handled on a flat deck or more substantial chassis). Domestic containers are typically 48 or 53 feet in length. International containers are nearly always 20 or 40 feet in length. Being able to distinguish between domestic and international containers is useful for many engineering and planning purposes because these units typically vary in their weight and dimensional characteristics.

- This research has made some headway in understanding intermodal freight movements. However, much remains to be done particularly concerning truck-rail tradeoffs, continuing development in the intermodal networks themselves, and continuing changes in intermodal technologies and the use of containers.

- Many commodities are transported on Manitoba's highways. Freight databases use varying commodity classification systems to describe commodities. For many engineering and planning purposes, the use of smaller and more descriptive commodity categories can simplify the compilation of commodity information, and facilitate more pragmatic conversions of commodity quantity into truck traffic volumes. It also facilitates the understanding of the relationship between commodity type and selected vehicle configuration and body type. Principal commodity categories in Manitoba determined in this research are: petroleum, chemicals, general freight.

- The origin-destination systems used in the course of this research were the Canadian Census Divisions, Provincial and State boundaries, and Bureau of Economic Areas (BEAs—as defined by the Bureau of Transport Statistics in the U.S.). Various groupings of these are made in this research to address particular matters. For example, by grouping Canada-East as an origin/destination with more detailed Census Division in Manitoba and to the West freight movements along PTH 1 and PTH 75 can be deduced with a fair degree of accuracy from the various freight data sets. This intern facilitates estimating truck volume, truck configurations and probably certain weight characteristics from the freight data. Combining freight databases with expert knowledge, cross-border statistics, and on-road vehicle observations allows for the enhancement of truck flows from the freight data.

- Rolling gross tonne-kilometers estimates deduced from freight data are of particular interest to engineers and planners. They can form the basis for estimating infrastructure needs and impacts, and cost allocation questions on selected routes.

6.3 MANITOBA TRUCK FREIGHT MOVEMENTS

Three freight databases were used in this research: the Statistics Canada For-Hire Trucking Survey; the CCMTA Roadside Survey; the U.S. Bureau of Transport Statistics Transborder Surface Freight Database. Proprietary information (e.g. carrier and/or shipper specific data, Transport Canada railway data) is generally not in the public domain nor available for engineering and planning uses.

This research demonstrates how analyzing truck freight movements can help illuminate, quantify and focus important engineering and planning issues. Illustrative examples revealed by the research are:

<u>Intra and inter-provincial movements</u>

- Both the CCMTA and For-Hire Truck Surveys highlight the importance of the corridor movement of trucking through Manitoba relative to total road loading (as measured by rolling gross tonne-kilometers) in the province (maybe 40-50 percent). At least on the surface, corridor movements may not contribute much to the Manitoba economy, but clearly can significantly impact road design and deterioration. While this research did not pursue this matter in depth, the observation (along with others) helps focus what traffic is responsible for what infrastructure needs in the province, and who may/may not be paying for what effects.

- More than one-third of Manitoba's pavement loading is created by vehicle tare weight and for many commodities, this could be one-half or more. This tare weight effect is very large. Two weighted-out 3-S2s crossing the province would create 40,290 rolling gross-tonne kilometers of pavement loading. Replacing this movement with one turnpike double would create 32,895 rolling gross-tonne kilometers of loading, a reduction of 18 percent. Analysis of freight data helps illustrate potential opportunities for new thinking about how the province might create more efficiency in infrastructure investment.

- Four commodity groups--petroleum, general freight, chemicals, and food--account for more than half of total weight of goods moved by truck on provincial highways. Of these commodities, petroleum and chemicals would nearly always move in bulk, weight-out in the outbound direction (typically from few origins), and empty inbound. They would usually be transported in 5, 6, or 8-axle B-trains intra or inter-provincially, and single semitrailer or 7-axle A-trains into North Dakota. Knowing the important commodities, the types of vehicles used for their transport, and much of their O-D pattern, informed estimates of related truck movements by route can often be deduced.

- Gravel also accounts for an important part of intra-provincial trucking. Movement of this product is highly seasonal, coinciding with the spring to fall construction seasons. It is almost always transported in 5-axle end-dump combinations, loaded outbound and empty inbound. The units lend themselves to other applications such as bulk fill and snow. O-D patterns are typically very project specific (e.g. a large construction project), and quantities may be easily determined. Linking freight flow data to industrial intelligence concerning this and related products can lead to important estimates of truck flows on key links.

International movements

Analysis of freight databases concerning international movements to/from Manitoba indicated the following:

- The U.S. TS&W law governs most vehicle characteristics associated with freight movements between Manitoba and the U.S. To Minnesota and generally east of the Missouri River, international trucking would be in 5-axle tractor semitrailers subject to an 80,000 GVW cap, U.S. axle load limits, and Bridge Formula B. Between Manitoba and North Dakota south, the same would apply except that the GVW cap is 105,500 pounds. This allows 7-axle A-trains to handle some of the Manitoba-North Dakota south and west traffic.

- Five-axle units account for nearly 90 percent of all trucking across the Manitoba-U.S. border. This has not changed for many years, and will not until there is a major break in U.S. TS&W regulation.

- International trucking on PTH 75 generates about 15 percent of extra-provincial road loadings in Manitoba.

- Origin-destination patterns of international freight movements demonstrate that Manitoba's truck-related association with the U.S. is heavily dominated by connections with North Dakota, Minnesota, Wisconsin, Illinois, Pennsylvania, and other North Central U.S. states (i.e. the north eastern and north central first and second tier states).

- The commodity mix on international movements to/from Manitoba is varied and changes from year to year and between commodity classification systems. Analysis of this issue is not overly helpful to estimating trucking activity on major U.S. connecting routes.

6.4 METHODS FOR TRANSLATING FREIGHT FLOWS INTO TRUCK FLOW ESTIMATES

The research considered two methods of translating freight flows into truck flows--the Reebie Method and the H-truck method. Both were found to be helpful although not without limitation. Both methods require expert opinion to assign freight to particular routes. For simple networks--like many of those experienced in less dense rural settings--these assignments are often quite obvious, and in many cases, effectively certain. In densely populated and industrialized areas, route assignments can be difficult.

The Reebie method is particularly useful where freight flow knowledge is more sophisticated--as is the case for regional flows for large areas of the United States. Total freight flow quantities and typical payload weights facilitate relatively straightforward conversions into typical truck movements, particularly where truck configuration options are limited by TS&W rules (e.g. in the U.S., 80,000 pound GVW limits, Federally-imposed axles weight limits, and Bridge Formula B).

The H-truck method, which starts with an assumed payload in a standard 3-S2 combination, does facilitate traffic estimation using simple factoring for low density commodities (e.g. a cube out commodity handled in payload quantities of 12.5 tonnes = 0.5 H-truck), or preferred trucks (e.g. a 3-S3 combination is a 1.2 H-truck). This has some advantages in Canada, where TS&W rules generally provide more vehicle options than are experienced in parts of the United States.

A key advantage of the H-truck/K-train method is that it allows the engineer to convert and relate total quantities of the O-D movement of freight into visual traffic movements expressed in terms of typical 5-axle tractor-semitrailer trucks (per day) which are directly comparable to typical 100 car-100 ton trains (per year). Both truck and rail equivalencies could be easily factored to account for variations in density or preferred vehicles.

Applications

The methods summarized above were applied to two different types of situations: (1) a large development project; (2) specific roadway links with substantial freight flow knowledge.

1. Large Developmental Project

Converting anticipated freight flows into likely truck movements for a large developmental project like the Wuskwatim dam in Northern Manitoba proved feasible. Important insights into likely truck flows were gained utilizing material and project scheduling estimates (routinely produced for such projects) when coupled with expert knowledge.

This research was able to estimate total truck movements (in H-trucks and in likely preferred vehicles), by year (and probably season), by direction, and by route--with different degrees of certainty. It also demonstrated that degrees of certainty of preferred vehicle and route estimates can be improved, as contracting commitments and details become clearer. As such, transportation engineering and planning details about certain aspects of a project such as Wuskwatim can be firmly estimated even before the project begins--others would become increasingly known as the project proceeds--and only few would occur without the ability to input prior engineering knowledge.

The relative importance of this type of project to highway needs and highway deterioration covering a large area and many kilometers of highway could be estimated--some before, some early into the project, and some closer to actual occurrence--facilitating better engineering decisions about what to do, when.

2. Roadway Links Experiencing Substantial Freight Flows

In this case truck flow estimates were made using the freight flow databases themselves (not project specific material and scheduling estimates). Estimates were made on five separate road sections using data from the CCMTA Roadside Survey, the Statistics Canada For-Hire Trucking Survey, and the BTS Transborder Surface Freight Database.

The methodology used was an adaptation of the simple four step transportation demand model (minus the mode share component because only trucking movements were considered). An origin destination matrix and a distribution matrix were estimated from the databases and converted to H-trucks. As was the case in the earlier example, assignment was completed in a deductive manor similar to the major project application.

That process requires understanding the road network, the commodity flow itself, and the input expert opinion and knowledge.

For certain types of data it was only possible to assign trips to a few sections of the highway network with certainty. In the cases presented movements from Manitoba to Alberta could be reasonably assigned to PTH 1 from Winnipeg to the PTH 16 cutoff but further west would be assigned with less certainty as the network density increases.

Estimates developed from this method were compared with actual AADTT estimates. As expected the databases used and the method employed produced lower truck volumes than would be observed (i.e. for-hire does not represent total trucking, CCMTA Roadside Survey data represents limit survey locations). Nonetheless basic truck volume estimates were developed, the reasons for underestimation were clarified, and expert judgment could better quantify the types of results this analysis could produce.

In general the major project application provides more certainty for truck volume estimation purposes. Additional work is required for further quantifications of estimated truck volumes on selected highway sections.

6.5 FUTURE RESEARCH OPPORTUNITIES

This research has identified the following areas of particular research need. These are:

- Development and evaluation of the rolling gross-tonne method of rating highway use, correlating it with highway design and deterioration, and relating it to load spectra-based truck loading estimation procedures.

- Investigation of the importance of tare weights in road design and deterioration and related opportunities for better balancing of freight movements and improving vehicle design and utilization to reduce the proportion of tare weight movement on the highway system. Does the expanded use of international containers lead to the movement of more tare weight?

- Further simplification and characterization of the Manitoba Truck Planning Network and its use for engineering and planning.

- Development of modification factors (pertaining to commodities and preferred vehicles) to help refine the H-truck method of traffic estimation. This assists engineers and planners in visualizing freight movements spatially and temporally.

- Improved understanding of past and present truck volumes, by vehicle type, route, and related characteristics to better calibrate and validate freight to truck relationships and truck-rail competition.

- Improved understanding of the nature and possible implications of developments in intermodal transport which may impact Manitoba (e.g. 53 foot international containers, CN routing through Prince Rupert, expanded railway penetration into the intermodal buisiness).

- Better design and utilization of existing freight databases for engineering purposes. The CCMTA Roadside Survey (which Manitoba participates in) provides opportunities yet to be considered. The U.S. BTS database managers are cooperative in considering different ways of analyzing the datasets they create.

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APPENDIX A

Freight Industry Survey

Freight Industry Survey

The following discusses significant findings from interviews with 15 selected transportation industry experts by industry sector.

1. Petroleum

- There are two main petroleum distribution facilities in Manitoba and one ethanol production plant. Both are located in the Winnipeg area. The Esso facility (PR 206 - Henderson Highway north of the perimeter) and the Shell facility (Panet Road). An ethanol production plant operated by Husky Energy is located in Minnedosa, Manitoba.

- Esso and Shell distribution facilities service eastern, southern and northern Manitoba and North Western Ontario. Western Manitoba is serviced from these facilities but also from distribution facilities located in Regina.

- Major commodities distributed are gasoline, diesel fuel, propane, and fuel heating oil. Petroleum products are supplied to the facilities by pipeline and distributed by truck and rail, truck being the major distribution mode. Some products are supplied to the distribution centre by truck these are typically additives and represent less than 5 percent of the total products.

- Truck volumes generated by petroleum distribution facilities average 200 heavy trucks per day for each facility. Vehicle configurations vary between 5,6 and 8-axle tankers. The facilities operate on a 24 hour 7 day schedule although, highest truck volumes are observed during normal working hours 6:00am-6:00pm. There is some seasonal variation in the truck volumes: fuel is transported into remote northern locations during period when winter roads are accessible. Fuel heating oil transported during the fall and winter months, and is more prevalent in colder winters.

- Truck traffic entering and exiting the Esso facility utilize the Henderson Highway access and the perimeter highway for routing throughout the province.

- Truck traffic entering and exiting the Shell facility utilize the Panet Road access and Dawson Road to Lagimodiere Boulevard for access to the perimeter highway for routing throughout the province.

- An ethanol production plant located in Minnedosa attracts truck traffic delivering grain for ethanol production. The produced ethanol is delivered to the Shell and Esso distribution facilities. Truck volumes attracted and generated are less than 10 trucks per day. The major truck configuration used for transport is the 8-alxe B-train grain body for grain deliveries and tanker configuration for ethanol distribution.

- Legislation of mandatory ten percent ethanol in all gasoline fuels will increase the production at the Minnedosa facility substantially. The increased demand for ethanol could increase truck volumes by a factor of eight. This will produce average daily truck trips to and from the facility of 50 to 80 trucks per day.

- Major highways utilized for petroleum transport are PTH 100, 101, 1, 6, 10, 16, 75.

2. Agriculture

- The agriculture industry in Manitoba is primarily represented by grain elevators, agriculture processors, animal processors, and the fertilizer industry.

- All of these agriculture sectors generate significant amounts of truck traffic.

Grain Elevators

- Grain elevators receive grain from individual producers and ship this grain to agricultural processors or port terminals for export. There are 113 licensed grain elevators in Manitoba with a total storage capacity of 1,054,200 tonnes (Canadian Grain Commission, 2002).

- Of the 113 grain elevators, 33 are high throughput elevators (HTE), representing 29 percent of all elevators in Manitoba. HTE represent 63 percent of the elevator storage.

- Key aspects of high throughput elevators relevant to the trucking industry are increased storage capacity, faster grain elevation rates and receiving bays long enough for 8-axle B-trains. Other technical upgrades at these facilities, for example on-site drying and improved blending capabilities help to increase their grain catchment.

- For the 1998-1999 crop year, Trimac Consulting Service estimated a total of 413,334 trucking movements from the producer to the grain elevator. The total quantity of grain moved is estimated at 5,275,800 tonnes. Trimac estimates 15 percent of the grain deliveries were made by 5-axle or larger heavy trucks, this equates to an average of 170 truck movements per day.

- The movement of grain is highly seasonal with the largest volumes occurring between August to October.

- The dominant heavy truck used for producer related grain movements is the 5-axle. This vehicle is typically operated by a commercial carrier. There is a continual shift towards commercial carriers hauling for private producers. This is replacing the common agricultural straight truck with larger more productive vehicles. Reasons for the shift are simply the cost of transport, estimated at five dollars per tonne.

- Intra grain elevator movement by truck, typically 8-axle B-trains, is unpredictable in time, quantity and O-D pattern. It is strictly a market issue, and is estimated to be a very small component of the grain related truck traffic observed on the highway system in general.

Agricultural Processors

- Agricultural processing facilities have experienced significant growth in the last ten years. Major locations within the agricultural processors sector in Manitoba are:

    - Prairie Flour Mills, Ltd. (flour) – Elie
    - ADM Agri-Industries, Ltd. (flour) – Winnipeg
    - Can Amera Foods (canola) – Altona
    - CanAmera Foods (canola) – Harrowby
    - Seagrram's Whiskey – Gimili
    - Dominion Malting Limited – Winnipeg
    - Can Oat Milling (oats) – Portage la Prairies
    - Emerson Milling (oats) - Emerson
    - Simplot (potatoes) – Portage la Prairies
    - Feed Rite (animal feed) – Winnipeg
    - Dow BioProducts – Elie
    - Central Grain Company - Winnipeg
    - Parrheim Foods (peas) – Portage la Prairies

- The principal heavy truck used for agriculture producer movements is the 5-axle tractor-semitrailer, although 6 and 8 axle tractor-semitrailers are also used. Body types selected are dependent on the commodity type for example pneumatic dry tankers for flour, grain bodies for grain transport, or end dumps for potatoes.

- The use of 8-axle B-train tractor-semitrailers can depend on whether facilities have been upgraded to handle larger vehicles.

- Seasonality associated with agriculture producers varies significantly by producer. Generally producers that utilize crops harvested during the fall harvest season in Manitoba receive their shipments at this time. Other producers receive their shipments throughout the year or on a month schedule.

Animal Processors

- The dominant animal processing facility in Manitoba is the Maple Leaf hog plant located just outside Brandon.

- Produced pork products travel by truck transport to Winnipeg for further production, sales, transport to other markets by intermodal shipment, and the US. Some pork products are trucked to other distributors in the U.S. and Canada directly from the Maple Leaf plant.

- Vehicles delivering live animals to the plant are 5-axle combination units with livestock bodies. Inbound truck volumes are estimated at 200 truck trips per day. Outbound vehicles are 5-axle refrigerator van bodies, also estimated at 200 truck trips per day.

- The plant services hog production operations in southern and central Manitoba as well as Saskatchewan.

- Plant hog deliveries and processed pork products are currently geared around a single labor shift per day. There is some consideration being given to the plant increasing their operation to two labor shifts per day. This would effectively double the truck traffic to and from the facility.

<u>Fertilizer Industries</u>

- Four companies handle nearly all the fertilizer transported in Manitoba, they are: JR Simplot Company, Westco, Agrium and Saskferco. All companies operate fertilizer warehouse facilities in Manitoba. JR Simplot Company located near Brandon operates the only fertilizer production facility in Manitoba.

    - Fertilizer warehouse locations are located in:
    - Elm Creek (Simplot)
    - Harrowby (Simplot)
    - Oak Bluff (Simplot)
    - Brandon (Westco)
    - Portage la Prairie (Agrium)
    - Carman (Saskferco)

- Fertilizer moves from a few large supply points to many small attractions points (farms). Warehouse facilities typically receive bulk fertilizer by rail car and ship out by truck.

- Fertilizer transport varies by fertilizer type – either granular, liquid or anhydrous ammonia. Bulk granular fertilizers may be hauled in truck bodies similar to those used for grain movement. Liquid and anhydrous ammonia fertilizers are transported using bulk liquid tankers.

- 5-axle end dump bodies are the principle vehicle selected for fertilizer transport, although 6, 7 and 8 axle vehicles are used. The 5-axle end dump vehicle offers the greatest flexibility as this style can deliver and unload product at almost every fertilizer consumer's facility.

- Typically 900,000 – 1,000,000 tonnes of fertilizer are sold in Manitoba in one crop year. This equates to an average of 115 truck trips per day.
- The seasonality associated with fertilizer movements is very high, generally fertilizer is sold and transported in late fall and early spring.

3. Consumer Goods

Goods considered in this industry are food, beverages and the retail industry.

- Major distributors of food and beverage products in Manitoba are: Safeway, Soybees, Coca-Cola, Pepsi Cola, Manitoba Liquor Commission and the Manitoba Beer Distributors. Combined, these two food and four beverage distributors deliver the majority of food and beverage products for rural Manitoba, Eastern Saskatchewan and Northern Ontario.
- Shipments originate in Winnipeg with major destinations being Brandon, Portage and Southern Manitoba. Shipments are destine for areas of consumption.
- Total quantities of generated truck traffic are 100-120 truck trips per day. Shipments are scheduled on 5 or 7 day schedules. Truck trip geographic distributions are: 15-20 trips per day for Western Manitoba and Saskatchewan, 5 trips per day to southern Manitoba and Northern Ontario each, and 1- 2 trips per day to Northern Manitoba, primarily Thompson. The remaining 90 truck trips are within the City of Winnipeg.
- Utilized vehicle configurations are 5 and 6 axle van and refrigerator units. The 6-axle vehicles are used to transport the denser commodities such as liquids and canned goods. Some of the beverage transport vehicles are 3-axle combinations units, these are typically for local deliveries.
- There is varying seasonality associated with food and beverage transport. Food is relatively stable throughout the year with beverage demand considerable higher between May and September. It is estimated that over 50 percent of the beverages consumed are during this period.
- In house transportation services typically operate in an outbound loaded and inbound empty operation.
- For-hire carriers providing transportation services to the food and beverage industries typically supplement their provided service with less than-truck-load freight services. These vehicles operate loaded in all directions, outbound and inbound to some degree of capacity when possible. This type of operation will have different or varying routing depending on origins and destinations.

4. Construction Materials

Construction materials considered are lumber, prefabricated building products, aggregates and cement.

Aggregates

- Main locations for the supply of aggregates in Manitoba are Birds Hill, Stonewall and East Brandon aggregate supply.

- Birds Hill and Stonewall supply sand, gravel and limestone. Each location is responsible for approximately 100,000 truck trips annually, with typical daily volumes of 300-400 trucks per day during construction season for each location.

- The aggregate supply located east of Brandon supplies sand and gravel. Typical daily truck volumes during construction season are 100 trucks per day.

- Seasonality associated with aggregate trucking is very high. The construction season generally starts in April and continues into November. Largest truck volumes are during the construction season, the volumes can be as much as 10 times higher than in winter months. Quantity of aggregates transported is dependent on construction demand.

- Major destinations for aggregates are Winnipeg and the surrounding area for the Birds Hill and Stonewall supply areas, and Brandon for the aggregate supply east of Brandon. Some quantity of aggregate are trucked to all southern and central areas of the province depending on demand and local supply, this varies from year to year and is typically small compared the main movements.

- The predominant vehicle configuration for aggregate transportation is the 5-axle unit in either the end dump or belly dumb body type. Average payload for this configuration is between 22 and 23 tonnes.

Cement and Prefabricated Concrete Products

- Two major cement companies supply Winnipeg and the surround areas with cement and prefabricated concrete products, they are Lafarge and Inland Cement.

- The majority of cement is transported to Winnipeg by rail from Alberta. Approximately 5 percent or 15,000 tonnes of cement are transported to Winnipeg by truck. This equates to 6 trucks per week on average.

- Vehicle configurations used for cement transport are dry tankers in 8-axle B-trains configuration for long distance hauls and 5-axle configuration for shorter hauls and urban movements, with payloads of 39 and 22 tonnes respectively.

- Seasonality associated with cement movement is high. Storage facilities are generally filled during the winter months and depleted during the late spring to early fall construction season. Truck transportation, shipping cement from origin in Alberta to Winnipeg is typically demand driven and hard to predict.

- Urban cement transport is generally the movement of cement from large scale storage facilities to a remote cement plant. The amount transported depends on the construction project demands. Typical average daily volumes are 1 or 2 trucks per day, construction season volumes can result in 5 trucks per day.

- Prefabricated cement products are constructed at a centralized facility and transported to the construction site for installation. Winnipeg is the major origin, with destinations being southern Manitoba, Northern tier states, Northern Ontario and Eastern Saskatchewan.

- Prefabricated cement products are transported in all vehicle types depending on the quantity of material transported and the sized of the prefabricated products. Typical truck volumes are 10-20 trucks trips per day destine for locations east, west and south of Winnipeg.

Lumber

- Lumber yards and home centres primarily McDiarmid Lumber, Home Depot, Revy, and Star Building materials receive goods from producers outside the city. Products are either delivered by rail to Winnipeg and then truck transported or delivered by truck directly.

- Vehicle configurations used for lumber transportation are 5-axle tractor-semitrailers and 8-axle B-trains. Volumes generated by the lumber industry are 20-30 truck trips per day, typically operating on a 5 day schedule depending on demand. International shipments are typically intermodal 40 foot containers.

- Major origins and destination for lumber shipments are in the Winnipeg area, with distribution to all of Manitoba and northern Ontario.

- Seasonality associated with the lumber industry varies, in previous years the construction season peaked in the summer months and fell during the winter months. In recent years the construction is more constant throughout the year with some peaking during the summer months.

5. Forestry and Paper

- Major forestry companies operating in Manitoba are Louisuina-Pacific Canada Ltd., Tembec Industries Inc., and Tolko Industries Ltd.

- Manufactured products include paper and paperboard, newsprint, lumber, waferboard and other paper products.

- Total truck demand for the forestry and paper industries is estimated at 200 truck trips per day.

- The major export market for forestry and paper products is the US. An estimated 20-30 trucks per day are destine for the U.S. from Manitoba with forestry and paper products.

- Predominant vehicles used for transport include 5-axle van type vehicles for paper and paper products while raw material products are transported in 8-axle B-trains due to their higher density and weight out characteristics.

- Seasonality associated with this industry sector varies. Paper and paper products show little seasonality while raw forest products have a high seasonality with higher movement during the winter months as winter weight premiums allow higher axle weight and increased productivity for transporting weight out type raw materials.

6. Manufacturing

- The manufacturing industry in Manitoba has expanded significantly in the past ten years. Consequently the manufactured goods produced by this industry in Manitoba have risen sharply. Over this period the quantity of manufactured goods exported has doubled.

- Major manufacturing industries in Manitoba are: heavy machinery, steel manufacturing, agriculture equipment, aircraft, windows, furniture, cabinets, truck equipment and bus manufacturing,

- Goods produced from the manufacturing industry in Manitoba are shipped North America wide and in some cases globally. Direct truck is the primary mode of transport. Intermodal transportation is used for inter-continental shipments and is increasingly used for certain domestic shipments. Truck volume estimate were determined for this industry sector to be within the high range.

- 5 or 8 axle vehicle configurations in either flat-deck or van body styles are used for transport, the 6 axle vehicle configuration is sometimes used when weight is an issue on Canadian shipments.

7. Mining, Minerals and Related Wastes

- Mining demand is primarily located near the Flin Flon, Snow Lake and Thompson areas.

- Major raw materials mined are copper and nickel, each accounting for approximately 40,000 tonnes of material produced annually.

- Truck traffic generated by this industry is estimated at 15-30 truck trips per day of produced raw material.

8. Garbage, Recycling and Wastes

- There are two major garbage and waste disposal sites in Manitoba. They are the Brady Road landfill located south of Winnipeg and the BFI waste disposal site located north of Winnipeg. Both facilities are accessed utilizing the Perimeter Highway.

- The predominant vehicle configuration used is the 3 axle straight truck. They account for 80 percent of the truck trips. 5 and 6 axle combination units account for 10 percent of the trips with passenger trucks accounting for the remaining 10 percent.

- The Brady Road facility generates on average 400 truck trips per day and the BFI facility generates 200 truck trips per day. Both are operated on a 7 day daily operation schedule.

- The 5 and 6 axle truck units are used for garbage transport.

- Seasonal truck traffic is approximately 1.5 times higher in summer than in winter.

9. Mail and Parcels

- The mail and parcel industry group includes Canada Post and courier service like Federal Express, United Postal Service, CanPar, and Purolator.

- 5-axle truck trailer combination units are typically used, although 3 and 4 axle truck trailer combinations are also used.

- Estimated truck trips are 30-40 per day, with some seasonality observed during the Christmas holidays. The majority of truck trips generated are linehaul operations delivering to and picking up from.

- There is an equal distribution of truck trips east, west and south of Winnipeg.

10. Transportation Terminals

- The Canada – U.S. Free Trade Agreement, NAFTA, make Manitoba and Winnipeg and their geographical location an economically viable operational and distribution centre for a large number of trucking companies and two intermodal service providers.

- Major trucking and intermodal terminals located in the Winnipeg area are:

    - Arnold Bros. Transport
    - Trimac Transportation Services
    - Kindersly Transport
    - Paul's Hauling Ltd.
    - Yankee North Transport
    - Reimer International
    - Liquid Carbide Inc.
    - Trans-X Ltd.
    - Bison Transport
    - Kleysen Ltd.
    - Penner International Ltd.
    - C.P. Intermodal
    - C.N. Intermodal

- Truck and intermodal facilities are increasingly providing more than truck only transportation options. Major services provided are warehousing, cross docking, logistics management and scheduled intermodal transportation services.

- CN and CP intermodal terminals are offering truck competitive pricing and guaranteed delivery services. CN and CP are completing approximately 230 and 90 intermodal movements per day.

- Traffic estimates from this sector are in the very high range. From industry knowledge it is difficult to determine exactly how many truck movements take place daily.

APPENDIX B

GIS-T Platform