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CANADIAN TRUCKING
RESEARCH INSTITUTE

Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement

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Abstract

In 1988 and 1989, a Memorandum of Understanding (MoU) on Vehicle Weights and Dimensions came into effect in Canada. The agreement allowed larger and heavier trucks to operate across Canada on designated highways, and introduced a greater degree of uniformity than had existed previously.

This report examines the effects of the MoU on trucking in Canada from 1988 to 1992. Specifically, this study focuses on truck fleet composition, transportation costs, total trucking costs, infrastructure costs (geometric design, pavements maintenance, bridges, other highway users), and safety. The impact data are aggregated at the regional and provincial levels, and at the national level.

to accomplish this impact assessment, the study develops and proposes methodologies appropriate to calculating these effects on the trucking industry, and suitable for making projections to the year 2002.

The study also identifies significant deficiencies that exist in the collection, analysis, coordination and availability of trucking data in Canada, and make recommendations for correcting deficiencies and bridging gaps.

Please note: This report does not assess the impact on of the MoU on railway transportation

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Résumé

En 1988 et 1989, un protocole d'entente sur les poids et dimensions des véhicules à été mis en oeuvre au Canada. Ce protocole autorisait l'exploitation sur des routes désignées du pays de camions plus lourds et de plus grandes dimensions. Il a également favorisé dans ce domaine un degré d'uniformisation jamais atteint auparavant.

Le présent rapport traite des incidences de la mise en oeuvre du protocole d'entente sur le camionnage au Canada au cours de la période de 1988 à 1992. Plus précisément, cette étude porte sur la composition des parcs de camions, les coûts de transport, les coûts totaux de camionnage, les coûts d'infrastructure (conception géométrique des routes, chaussées, entretien, ouvrages d'art, autres usagers de la route) et la sécurité routière. Les données réunies dans ce contexte sont à la fois d'intérêt régional, provincial et national.

Aux fins d'exécuter cette évaluation des impacts de la mise en oeuvre du protocole d'entente, les responsables de l'étude ont élaboré et proposé des méthodes de calcul des incidences visées sur l'industrie du camionnage. D'autre part, ces méthodes se prêtent à l'établissement de prévisions d'ici à l'an 2002.

L'étude cerne également d'importantes lacunes au chapitre de la collecte et de l'analyse normalisées des données sur le camionnage au Canada ainsi que de l'accès à ces dernières. Toutefois, elle contient des recommandations visant à corriger les carences et les problèmes en question.

Note : Ce rapport ne traite pas des incidences de la mise en oeuvre du protocole d'entente sur le transport ferroviaire.

Mots-clés

8018	Canada
1556	Législation
9112	Étude d'impact
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9014	Dimension
1236	Poids lourd
6488	Longueur
1122	Transport de marchandises
0188	Calcul économique
0165	Économie
0178	Frais d'exploitation
9020	Évaluation
8623	Saisie de données
9102	Méthode

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TRANSPORTATION ASSOCIATION
OF CANADA

CANADIAN TRUCKING
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IMPACTS OF CANADA'S HEAVY VEHICLE WEIGHTS AND DIMENSIONS RESEARCH AND INTERPROVINCIAL AGREEMENT

EXECUTIVE SUMMARY

SOMMAIRE

OCTOBER, 1994

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Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement

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EXECUTIVE SUMMARY

SOMMAIRE

Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement - Executive Summary

BACKGROUND

A Memorandum of Understanding (MoU) on Vehicle Weights and Dimensions documented an agreement among the provinces, territories and the federal government on truck weights and dimensions regulations. The MoU was intended to harmonize regulations across Canada. This agreement was based on the extensive Vehicle Weights and Dimensions Study carried out by the Roads and Transportation Association of Canada (RTAC) and the Canadian Council of Motor Transport Administrators (CCMTA). The MoU, which was signed in February, 1988, came into effect during 1988 and 1989 and was substantially implemented for most vehicle types across Canada by July 1, 1989. The agreement allowed larger and heavier trucks to operate across Canada on designated highways, introducing a greater degree of uniformity than had existed previously. As part of the RTAC/CCMTA research program a report was produced in 1987 titled "Economics of Truck Sizes and Weights in Canada" (prepared by IBI/ADI on behalf of RTAC/CCMTA) which provided estimates for the changes in truck utilization, fleet composition and size which were anticipated from four scenarios of vehicle weights and dimensions regulations, and the impacts of these on trucking productivity, infrastructure costs, freight flows by mode, and overall economic costs and benefits.

The passage of five years and the experience and evidence which have accumulated since the MoU came into effect provide an excellent basis for assessing changes in truck fleet composition and size which have actually occurred to date and related impacts on transportation costs and benefits, and to develop methodologies for this purpose and apply these to provide projections for the next 5-10 years.

Such an assessment is timely as a means of "taking stock" of the current situation and looking ahead to ways in which further productivity increases and cost reductions can be achieved. It also provides an opportunity to assess the usefulness of the original Vehicle Weights and Dimensions research program while, at the same time, providing improved data and methodologies for ongoing use by public and private sector participants with truck transportation responsibilities and interests.

OBJECTIVES

This study has two objectives, which received essentially equal weight during the course of the work:

1. "Developing methodologies that would estimate truck fleet composition, and its impact on transportation costs and savings (including trucking operations, shippers, energy, etc.), total trucking costs, infrastructure costs, and safety as a function of changes in truck weights and dimensions regulations. The methodologies shall be applicable to provinces, or to regions for all provinces having sufficiently similar regulations and trucking activity."

2. The aggregation of provincial and regional estimates to a national level, to assess the effect of regulatory harmonization on trucking in Canada, from the base year of 1988 to 1992, and to provide projections to 1997 and 2002."

It should be noted that the Terms of Reference for this study, do not include an examination of the impact of the MoU on Canada's railways. They do, however, include a broad benefit/cost assessment of the TAC Heavy Vehicle Weights and Dimensions Research program in light of any cost savings attributable to the MoU which may be identified in the study.

Since the implementation of the MoU there have been a number of qualitative comments made on the impacts. However, such evaluations can easily be contradicted by other qualitative evaluations. Therefore this study has developed, wherever possible, quantitative estimates of impacts to back up the qualitative assessments and opinions that are also included in the report.

ACKNOWLEDGE-MENTS

This study was commissioned by the Transportation Association of Canada (TAC) and the Canadian Trucking Research Institute (CTRI). The study was directed by a Steering Committee with representatives from the trucking industry and governments, and from TAC and CTRI staff. The members of the Steering Committee are listed on Exhibit S-1. The study team would like to thank the Steering Committee for their considerable efforts and assistance in this project.

The study could achieve its successful conclusion only through the cooperation and assistance of the trucking industry. A detailed survey on the existing and expected future use of various truck configurations was developed and sent to for-hire and private trucking companies. Without the efforts of the members of the trucking industry to complete this survey, this project could not have been done. A list of

the addressees of the survey is included in Appendix D. In addition several case studies were conducted requiring more effort by trucking industry representatives.

STRUCTURE OF THE STUDY AND REPORT

The study was carried out in three phases:

1. The first phase defined and analyzed alternative **methodologies** to be used in the study. The preferred methodologies were discussed and approved by the Steering Committee.

2. In the second phase various **data** and other information needed to analyze impacts **were collected.**

3. In the third phase the **impacts were estimated.**

Parts I, II and III of this report present, respectively, the work content and results of each of the three study phases.

FINDINGS

The major findings of this study can be summarized as follows:

- **Quantifiable Cost Savings Due to the MoU** - Net annual quantifiable cost savings attributable to the introduction of the Memorandum of Understanding (MoU) of 1988 for the NHS are estimated at about $142 million per year in 1992, $180 million in 1997 and $222 million in 2002, expressed in 1992 dollars. These estimates are based on trucking cost savings less slightly increased infrastructure costs. The net present value of these cost savings as of 1994 for the period 1988 to 2002 expressed in 1992 dollars is about $1.87 billion. These savings refer only to truck traffic on the National Highway System. If the results are extrapolated to the total network designated under the MoU, net truck cost savings attributable to the MoU would be about double those on the NHS.

- **Main Sources of Savings** - Virtually all of the above cost savings come from the reduced operating costs per tonne-km resulting from the shift to larger, heavier and more efficient truck configurations for interprovincial movements allowed as a result of the MoU. While these vehicles are heavier than the vehicles which they replace, they also have more axles, so that the individual axle loading is reduced, on average, with a slightly positive impact on pavement wear and road maintenance costs. This is offset by small additional bridge strengthening/modification costs, weigh scale costs, etc. attributable to use of the larger, heavier vehicles, such that the infrastructure cost due to the MoU is estimated at about $2.75 million per year. This was subtracted from the trucking cost savings to produce the above net present value savings of $1.87 billion attributable to the MoU.

- **Road Safety Impacts** - Data limitations precluded producing quantitative cost impacts regarding road safety and as experienced by shippers, and these findings were therefore more qualitative. Conclusions have been drawn based on results of the carrier survey and case studies, and drawing on other information sources including the extensive truck handling characteristics testing program conducted for TAC and other research by the University of Michigan Transportation Research Institute (UMTRI). It is concluded that the impact of the TAC B-Train and of the longer semitrailers, which were the main configurations brought into larger use by the MoU, on road safety has been essentially neutral, with reduced vehicle-km to carry a given volume of tonne-km providing a positive impact which may be offset by marginal increases in the difficulty of overtaking manoeuvres (e.g. by private automobiles) in connection with the longer trailers and longer combination vehicles. Test track and anecdotal information from drivers suggests that the TAC B-Train and longer, 6-axle tractor semitrailer vehicles are no less safe (and may, in fact, be safer), in terms of their road-worthiness and handling characteristics, than the shorter tractor semitrailer and the A and C-Train double combinations which they have, to some extent, replaced. More information on the handing and stability characteristics of vehicles operating under the MoU weights and dimensions regulations, and their accident rates in actual operations, should be obtained to provide more quantitative information regarding this conclusion.

- **Impacts on Shippers** - Cost and other impacts experienced by shippers as a result of the MoU also had to be treated qualitatively as a result of data limitations. Based on results of the carrier survey and carrier and shipper case studies carried out as part of this assignment, it is concluded that, while some shippers reported capital costs to modify terminals and loading facilities to accommodate the larger truck configurations, these investments were relatively small and were recovered usually within one year or so from the reduced trucking rates experienced by the shippers.

Responses by both the carriers and shippers suggest strongly that most of the cost reductions resulting from the introduction of larger/heavier/more efficient trucks due to the MoU were passed on by the carriers to their customers, the shippers. This resulted both from the downward pressure on rates due to the 1987 NTA, the recession, and U.S. carrier competition and also from the fact that many shippers are extremely knowledgeable about the unit cost characteristics of various truck configurations and applied this knowledge effectively in negotiating with carriers to use the more efficient vehicles and pass on most or all of the savings to the shippers.

- **Impacts on Trailer Manufacturers** - The introduction of the MoU has had a postive effect on Canadian manufacturers of trailers. Carriers have invested in new equipment to take advantage of the changes in regulations. In addition, a "niche" for Canadian trailer manufacturers has been developed.

- **Reliability of Results** - There are significant uncertainties in the above trucking cost savings estimates owing to data limitations: primarily gaps in data and inconsistencies in the coverage and extent of data from province to province and also the small sample size of key data sources, including the 1991 CCMTA roadside trucking survey and the carrier survey and case studies carried out as part of this study. A number of cross checks were carried out, however, in instances where control totals from one data source could be checked against results from another source (e.g. the two sources just referred to and trucking surveys conducted by Statistics Canada); these comparisons were reassuring in terms of the reasonableness of the results obtained by the study, as discussed in Section 15.1.6 in Part II.

- **Implications of Large Savings Estimates** - Perhaps the most important factor in considering reliability of the results relates to the large size of the estimated savings. Even if the estimates were overstated considerably, they would still be very large in comparison with the cost of the TAC research program and other costs of implementing the MoU changes. While the estimated cost savings are very large, they represent only about 2% of the very broadly estimated total cost of trucking operations on the national highway system in 1992, and a saving of this amount in percentage terms does not seem unreasonable given the significant efficiencies attributable to greater use of TAC vehicles and longer semitrailers made possible by the MoU, particularly in British Columbia and the Prairie Provinces and to a lesser extent in Ontario, Quebec, Atlantic Canada and the Territories.

CONCLUSIONS

Major conclusions from the study are summarized as follows:

- **Positive Economic Impacts** - Introduction of the 1988 MoU has contributed greatly to more efficient trucking movements for Canadian-based products, particularly for interprovincial movements and, to a lesser extent, movements to and from the United States. These savings have been enjoyed in particular by Canadian shippers, through lower rates resulting from the cost savings, and to a lesser extent, by carriers; the overall Canadian economy has benefitted significantly in terms of greater efficiency and increased competitiveness vis-à-vis Canada's trading partners.

- **Benefit/Cost Assessment of the TAC Research Program** - The research and truck testing funds invested during the 1980's by the Canadian provinces and territories, the Government of Canada and the Canadian trucking industry under the TAC Heavy Vehicle Weights and Dimensions Research Program have been repaid many times over in terms of these cost savings and economic benefits. The net present value of the cost savings (estimated at $1.87 billion for the 15 years from 1988 to 2002 inclusive) relative to the net present value of the research program cost ($5.7 million) yields a benefit/cost ratio of 328:1, an extremely handsome rate of return. This ratio is estimated to be about twice as high if the net savings for truck traffic using the entire MoU designated network (about twice as big as the NHS network) are included.

- **Regional Benefits** - The most significant benefits from the MoU were experienced in Western Canada, but all regions of the country have experienced substantial net positive benefits. In 1992 Ontario accounted for 40% of the estimated cost savings, the Prairie Provinces for 27%, B.C. for 19%, Quebec for 11%, the Atlantic Provinces for 2.5% and the Territories for 0.3%.

- **Canadian Regulations Largely in Place** - With the recent regulatory changes (since the carrier survey and case studies were completed) to allow 53 foot semitrailers in Ontario, Quebec and the Atlantic Provinces, it would appear that most of the cost reductions in interprovincial trucking movements possible under the MoU have already been achieved or are coming into effect as the industry responds to the new regulations. As suggested by the projected cost savings to 2002, continuing annual savings will be experienced relative to the situation which would have been experienced had the MoU not been brought into effect.

- **Future Harmonization of Cross-Border Regulations** - Perhaps the next major cost savings due to use of more efficient trucks can be achieved with regard to Canadian-U.S. truck movements. In general, under the MoU, Canadian vehicle weights and dimensions regulations are more generous than those on the U.S. interstate highway system although they are generally matched by those of some states, for example, Michigan. A fruitful course of action may therefore be to negotiate with the U.S. federal government and relevant state governments for a commensurate relaxation of their weights and dimensions regulations, which would allow cost savings to carriers and shippers involved in cross-border movements. We understand that there are studies being undertaken in this area.

- **Improved Methodologies** - As pointed out in the Introduction to this report, a major objective of this study was to develop methods and procedures for producing reliable estimates of truck movements by configuration type, trucking cost changes, infrastructure cost changes, road safety impacts and shipper impacts of changes in the volume and mix of truck configurations used on Canada's primary highway system, in particular for interprovincial movements. The study included a systematic assessment of several alternative methodologies for the various components of the estimating procedure, and the methods and models developed and used for the study reflected this evaluation in the context of available data and new data collected as part of this assignment. A useful set of procedures and models has been developed and documented during the course of the study, and these are available for ongoing application.

- **Addressing Data Limitations** - Reflecting the very challenging data limitations which had to be addressed during the study, a major conclusion must be the desirability of implementing an ongoing data collection program, on a regular basis. This is addressed further in the following section.

SUGGESTED FUTURE DIRECTIONS

Major comments regarding future directions in this field, resulting from the insights gained through the study, are as follows:

- **Repetition of Key Surveys** - The study could not have produced quantitative cost savings estimates at the achieved level of reliability without the information provided by the CCMTA Roadside Trucking Survey, truck volume and classification counts data for the National Highway System links provided by the provincial ministries, and the carrier survey and case studies carried out as part of this study. While the relatively small sample size of the CCMTA survey and the carrier survey and case studies is a matter of concern regarding the reliability of study results, sample size uncertainties can be reduced through routine repetition of the surveys, which also provides invaluable time-series data.

- **Regular CCMTA Surveys** - It is therefore recommended that the provincial governments and the federal government, working through the CCMTA and TAC, conduct a roadside trucking survey similar to the 1991 CCMTA survey on a regular basis, say every three to five years. Under such a program, the next survey could be conducted in 1996.

- **Additional Questions and Analysis** - If this recommendation is acted on, consideration should be given to adding a few additional questions to the CCMTA survey: for example, a question to identify the semitrailer length (e.g. 48 feet, 53 feet) of 5- and 6-axle tractor semitrailer combinations. In addition, the complete set of questions should be asked at all survey stations and if possible for trucks moving in both directions, and the locations of survey stations should be reviewed to achieve coverage of intra- as well as inter-provincial and international truck movements. This would add greatly to the completeness and usefulness of the survey. The provincial and federal governments should also consider a program to conduct more analysis of the wealth of data provided by the 1991 CCMTA survey and to carry out comparative studies of that survey with the 1996 and subsequent CCMTA roadside surveys if these are carried out. The cost of such analysis would be small relative to the cost of the actual surveys, and the additional insights into trucking trends, efficiencies and cost implications would be extremely useful as a basis for ongoing transportation policies and programs and to assist carriers and shippers in their ongoing business decisions.

- **Low Response Rate of Carrier Survey** - While the response rate of the carrier survey (about 15%) was relatively low, it was high in comparison with other surveys of trucking companies, which generally run below 10%. This higher response rate is attributable in part to the extensive call-back process followed during the survey, and possibly to the fact that survey staff emphasized to the carriers that the results of this survey and the MoU cost savings study could result in identifying significant benefits to trucking firms and ongoing improvements in trucking regulations.

- **Regular Carrier Surveys and Improved Response Rate** - While it is recognized that senior executives in the trucking industry are under considerable time pressures, it is essential that adequate information be available on this industry which is so important to the economy. We understand that efforts are being made to broaden the existing Statistics Canada surveys of the trucking industry to include information on the use of various vehicle configurations. This would be a very welcome development. If such broadening is not done it would be desirable to repeat a carrier survey to collect information on truck configurations used similar to the survey carried out in this study, perhaps every three or five years.

- **Wide Dissemination of Study Results** - It is also recommended that a summary of the study results be made widely available to trucking firms through the Canadian Trucking Association, provincial trucking associations and TAC, and the benefits of cooperating in the required data collection for studies of this type be emphasized as part of this information program.

The study has demonstrated that very substantial economic benefits to carriers, shippers and the economy at large have been achieved through cooperative efforts to reduce barriers to efficient trucking movements between Canadian provinces. Further improvements are possible, in particular for movements between Canada and the U.S., and the insights gained from this study should prove very helpful in negotiating appropriate regulatory changes with the United States government and the governments of various border States.

EXHIBIT S-1

MEMBERS OF STEERING COMMITTEE

MEMBER	AFFILIATION
Mr. Keith Scott, Chairman	Alberta Economic Development and Tourism
Mr. John Erik Albrechtsen	Paul's Hauling Ltd., Winnipeg, Manitoba
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Mr. Louis-Paul Tardif	Canadian Trucking Research Institute
Dr. Clement Thomas	Transport Canada
Mr. Jack Walker	Sunbury Transport Ltd., Fredericton, New Brunswick
Mr. H. Keith Walker	Keith Walker Consulting, Red Deer, Alberta

Sommaire du rapport d'étude sur les incidences des recherches sur les poids et dimensions des véhicules lourds au Canada ainsi que la mise en oeuvre de l'entente interprovinciale en la matière

CONTEXTE

Un protocole d'entente sur les poids et dimensions des véhicules lourds a été ratifié par les administrations fédérale, provinciales et territoriales responsables de la réglementation en la matière. Ce protocole d'entente visait à harmoniser, à l'échelle du pays, la réglementation des poids et dimensions des véhicules de transport routier. L'entente en question s'inspirait de l'Étude sur les poids et dimensions des véhicules exécutée conjointement par l'Association des routes et transports du Canada (ARTC) et le Conseil canadien des administrateurs en transport motorisé (CCATM). Signé en février 1988, le protocole est entré en vigueur au cours des années 1988 et 1989. La majorité des véhicules de transport circulant au Canada ont été globalement assujettis aux dispositions de l'entente avant le 1er juillet 1989. Cette dernière autorisait l'utilisation au pays de véhicules plus longs et plus lourds sur des routes désignées, ce qui du même coup a permis d'en arriver à un degré d'uniformité en la matière jamais atteint auparavant. Dans le contexte du programme de recherches mis en oeuvre par l'ARTC/le CCATM, la firme IBI/ADI a déposé, en 1987, un rapport intitulé Economics of Truck Sizes and Weights in Canada. Ce rapport analysait les incidences probables des modifications qu'il était proposé d'apporter aux plans des méthodes d'exploitation et de la composition des parcs de camions, le tout aux termes de quatre scénarios de réglementation des poids et dimensions des véhicules. Cette étude traitait aussi des effets de tels changements sur la productivité de l'industrie, sur les coûts d'infrastructure, sur le trafic-marchandises par mode ainsi que sur les économies de coûts et les avantages économiques globaux escomptables d'une telle démarche.

L'expérience et les données acquises depuis la mise en oeuvre de ce protocole d'entente, il y a cinq ans, fournissent une excellente base d'analyse des changements apportés au cours de cette période aux parcs de camions et aux dimensions de ces derniers, y compris les incidences de ces modifications sur les coûts de transport et les autres avantages en découlant. De fait, l'information ainsi réunie a permis d'élaborer différentes méthodes d'évaluation qui ont servi à établir des projections pour les cinq à dix prochaines années.

Dans les circonstances, cet exercice d'analyse ne saurait tomber plus à propos pour ce qui est de faire le point sur la situation et d'envisager à la fois des moyens d'accroître la productivité et de réduire les coûts des transporteurs routiers. En outre, une telle évaluation offre l'occasion de mesurer l'utilité du programme original de recherches sur les poids et dimensions des véhicules tout en favorisant la mise au point de données et de méthodes dont les différents intervenants des secteurs public et privé que le camionnage intéresse sauront ensuite tirer parti.

OBJECTIFS

La présente étude poursuivait deux objectifs auxquels, tout au long de ses travaux, l'équipe responsable a accordé une égale valeur.

1. Élaborer des méthodes d'analyse de la composition des parcs de camions et des incidences d'une telle composition au regard des points ci-après : les coûts de transport et les économies à réaliser dans ce contexte (y compris aux plans de l'exploitation des camions, des expéditeurs, de la consommation d'énergie, etc.), les coûts totaux de camionnage, les coûts d'infrastructure ainsi que l'effet sur la sécurité routière des modifications qui pourraient être apportées à la réglementation des poids et dimensions des véhicules. De plus, les méthodes ici visées devaient pouvoir être appliquées dans les provinces ou des régions de celles-ci partageant suffisamment de similitudes en termes de réglementation et d'activités de camionnage.

2. Recueillir des données d'intérêt provincial et régional permettant de mesurer à l'échelle nationale l'incidence de l'harmonisation des réglementations sur le camionnage au Canada et ce, à la fois au regard de la période de 1988 à 1992 et de manière à pouvoir établir des projections jusqu'en 1997 et en l'an 2002.

Il convient ici de souligner que le mandat de cette étude exclut tout examen des incidences du protocole d'entente sur les chemins de fer canadiens. En revanche, elle prévoit une analyse globale coûts-avantages du programme de recherches de l'ATC sur les poids et dimensions des véhicules lourds, le tout dans la perspective des économies de coûts qui pourraient être associées à la mise en oeuvre du protocole d'entente.

Depuis l'entrée en vigueur du protocole, un certain nombre d'observations de nature qualitative ont été formulées quant aux incidences de ce dernier. Toutefois, les responsables de cette étude reconnaissent d'emblée qu'il est facile de leur opposer des arguments contradictoires. Aussi, dans la mesure du possible, ces derniers se sont efforcés d'établir des prévisions quantitatives des incidences cernées afin d'étayer les évaluations et les opinions de nature qualitative énoncées dans leur rapport.

REMER-CIEMENTS

Cette étude a été commandée par l'Association de transport du Canada (ATC) et l'Institut canadien de recherche en camionnage. L'étude a été exécutée sous la gouverne d'un comité directeur composé de représentants de l'industrie du camionnage, des gouvernements ainsi que des deux organismes susmentionnés. La liste des membres du comité directeur apparaît à la page suivante. L'équipe responsable de cette étude tient en outre à remercier le comité directeur de l'aide et des efforts considérables qu'il a consentis à ce projet.

Le succès de cette étude était indéniablement tributaire de la collaboration et de l'aide de l'industrie du camionnage. Aussi, un questionnaire détaillé d'enquête sur les utilisations existantes et prévues des divers types de véhicules de transport routier a été mis au point et envoyé aux entreprises de camionnage privées ou exerçant leurs activités pour compte d'autrui. N'eût été de la collaboration des membres de l'industrie à cette enquête, ce projet d'étude n'aurait sans doute jamais abouti. Une liste des destinataires du questionnaire d'enquête apparaît à l'annexe D. Enfin, précisons que les représentants de l'industrie du camionnage au sein du comité directeur ont généreusement accepté de fournir des efforts supplémentaires qui ont permis d'effectuer plusieurs études de cas.

EXÉCUTION DE L'ÉTUDE ET FORMULATION DU RAPPORT

L'étude s'est déroulée en trois étapes.

1. La première étape visait à définir et à évaluer les différentes **méthodes** d'analyse qui seraient appliquées dans le contexte de l'étude. Les méthodes retenues ont ensuite été examinées en détail et approuvées par le comité directeur.

2. La deuxième étape avait pour but de **réunir diverses données** et d'autres renseignements nécessaires à l'analyse des incidences cernées.

3. La troisième étape portait sur **l'évaluation des incidences** elles-mêmes.

Les parties I, II et III du rapport traitent respectivement des travaux exécutés à l'appui de chacune des trois étapes précitées et des résultats obtenus dans chaque cas.

CONSTATS

Les principaux constats issus de cette étude peuvent se résumer comme ci-après.

- **Économies de coûts quantifiables découlant de la mise en oeuvre du protocole d'entente** - Les économies de coûts nettes annuelles quantifiables que l'on peut associer à la mise en oeuvre du protocole d'entente de 1988, pour l'ensemble du réseau routier national, sont estimées (en dollars de 1992) à environ 142, 180 et 222 millions de dollars en 1992, 1997 et 2002, respectivement. Ces prévisions sont fondées sur les économies de coûts de transport routier, soustraction faite des coûts d'infrastructure, pour lesquels une légère hausse a été calculée. En 1994, la valeur actuelle nette de ces économies (toujours en dollars de 1992), pour la période de 1988 à l'an 2002, serait de l'ordre de 1,87 milliard de dollars. Précisons que ces économies n'ont trait qu'au camionnage exécuté sur le réseau routier national. Si des résultats comparables avaient dû être extrapolés pour l'ensemble du réseau désigné dans le protocole d'entente, les économies de coûts nettes découlant de la mise en oeuvre de ce dernier seraient environ du double de celles établies pour le réseau routier national.

- **Principales sources d'économie** - En définitive, presque toutes les économies de coûts précitées découlent d'une réduction des dépenses d'exploitation par tonne-kilomètre, réduction attribuable à l'utilisation des types de véhicules plus lourds, de plus grandes dimensions et plus efficients que prévoit le protocole d'entente. Même si les véhicules ici visés sont plus lourds que ceux qu'ils étaient destinés à remplacer, ils sont également dotés d'un plus grand nombre d'essieux, de sorte qu'en moyenne la charge par essieu s'en trouve réduite ce qui en retour a une incidence légèrement méliorative sur le taux d'usure des chaussées et les coûts d'entretien des routes. En revanche, cet avantage est en partie atténué, d'une part, par les dépenses quelque peu supérieures qu'il a fallu engager au titre du renforcement et de la modification des ouvrages d'art et, d'autre part, par une légère augmentation des coûts aux postes de pesée, etc. Ces derniers coûts sont évidemment attribuables à l'emploi de véhicules plus lourds et de plus grandes dimensions. Compte tenu des données recueillies à ce sujet, il a été établi que les coûts d'infrastructure associés à la mise en oeuvre du protocole d'entente sont de l'ordre de 2,75 millions de dollars par année. Cette somme a été défalquée des économies de coûts calculées pour l'industrie du camionnage. C'est de cette manière que l'économie nette susmentionnée de 1,87 milliard de dollars a été mesurée.

- **Incidences sur la sécurité routière** - Les limites inhérentes aux données utilisées dans le cadre de l'étude empêchent toute détermination des incidences de la mise en oeuvre du protocole d'entente sur la sécurité routière, en termes de coûts pour les expéditeurs. Aussi, les conclusions avancées à ce titre sont-elles davantage d'ordre qualitatif. Elles sont concrètement fondées sur les résultats de l'enquête auprès des transporteurs et de différentes études de cas. Elles sont également dérivées d'autres sources d'information, dont le vaste programme d'essai des caractéristiques de conduite des camions mis en oeuvre pour le compte de l'ATC par le University of Michigan Transportation Research Institute (UMTRI) ainsi que d'autres travaux exécutés par cet organisme. À la lumière des données ainsi réunies, les responsables de l'étude en sont arrivés à la conclusion que l'utilisation de trains doubles de type B et de semi-remorques plus longues (deux types de véhicules préconisés par l'ATC et dont l'usage s'est accru du fait de la mise en oeuvre du protocole d'entente) n'avaient eu que peu d'incidence sur la sécurité routière. Dans ces cas précis, soulignons toutefois que les gains qu'il est possible de réaliser au plan de la sécurité routière, du fait de la réduction du nombre de véhicules par kilomètre et ce pour le transport d'une charge donnée (tonnes-kilomètres), peuvent être en quelque sorte neutralisés par la hausse relative du degré de difficulté (notamment pour les conducteurs de voitures particulières) associé au dépassement de remorques et de véhicules articulés de plus grandes dimensions. Les résultats d'essais sur piste et les renseignements recueillis auprès de conducteurs donnent à entendre que les trains doubles de type B et les véhicules articulés plus longs à six essieux dont l'ATC préconise l'usage ne sont certes pas moins sûrs (et, de fait, le sont peut-être davantage), au plan de la tenue de route et des caractéristiques de conduite, que les véhicules articulés plus courts et les trains doubles des types A et C que, dans une certaine mesure, ils ont remplacés. Afin de pouvoir étayer cette conclusion de données quantitatives, il faudra réunir davantage d'information sur les taux d'accident en circonstances d'exploitation réelles et sur les caractéristiques de conduite et de stabilité des véhicules exploités aux termes des limites de poids et de dimensions prescrites dans le protocole d'entente.

- **Incidences sur les expéditeurs** - Que ce soit du point de vue des coûts ou sous d'autres aspects, les incidences de la mise en oeuvre du protocole d'entente sur les expéditeurs ont également dues être analysées de façon qualitative en raison des limites inhérentes aux données disponibles sur le sujet. D'après les résultats de l'enquête auprès des transporteurs et de différentes études de cas concernant des transporteurs et des expéditeurs, il est permis de conclure que si certains expéditeurs ont indiqué avoir été contraints d'engager certaines dépenses d'immobilisation aux fins de modifier leurs installations terminales et de chargement, pour pouvoir y accueillir des véhicules de plus grandes dimensions, le fait demeure que ces investissements ont été relativement peu élevés et qu'ils ont habituellement pu être récupérés au cours d'une période d'environ un an à la faveur des tarifs réduits de transport exigés de ces mêmes expéditeurs.

  À la lumière des renseignements recueillis auprès des transporteurs et des expéditeurs, il apparaît clairement que les premiers ont refilé à leurs clients, c'est-à-dire les expéditeurs, les réductions de coûts attribuables à l'utilisation des véhicules plus efficients, plus lourds et de plus grandes dimensions que prévoit le protocole d'entente. Ces réductions de coûts sont le fruit des pressions à la baisse dont ont fait l'objet les tarifs de transport en raison notamment de l'entrée en vigueur de la *Loi de 1987 sur les transports nationaux*, de la récession, de la concurrence des transporteurs américains et également du fait que nombre d'expéditeurs connaissent extrêmement bien les paramètres de détermination des coûts unitaires des divers types de véhicules de transport et qu'ils ont mis à profit ces connaissances dans le contexte de leurs négociations avec les transporteurs, le tout aux fins d'utiliser des véhicules plus efficients et de bénéficier au maximum des économies correspondantes.

- **Incidences sur les fabricants de remorques** - La mise en oeuvre du protocole d'entente a eu un effet bénéfique sur les fabricants canadiens de remorques. Les transporteurs ont investi dans de nouveaux équipements afin de tirer parti des changements apportés à la réglementation. En outre, un nouveau créneau a ainsi pu être créé pour les fabricants canadiens de remorques.

- **Crédibilité des résultats de l'étude** - En raison des limites inhérentes aux données ayant servi à établir les prévisions susmentionnées d'économies de coûts dans le secteur du camionnage, les auteurs du rapport d'étude se doivent d'avouer que les résultats de leurs travaux sont entachés d'importantes incertitudes et ce, pour un certain nombre de raisons : d'abord l'insuffisance d'information sur certaines questions, ensuite le manque d'uniformité en ce qui a trait à la nature des renseignements recueillis par chaque province et enfin l'envergure restreinte des sources de données clés (dont l'enquête routière sur le camionnage effectuée par le CCATM en 1991, l'enquête auprès des transporteurs menée à l'appui de la présente étude et les différentes études de cas exécutées en complément de cette dernière). Ceci dit, un certain nombre de vérifications ont été pratiquées dans les cas où les données recueillies auprès d'une source pouvaient être avalisées à la lumière des renseignements puisés à une autre source (par exemple, l'information réunie à la faveur des deux enquêtes précitées a été vérifiée au regard des résultats d'enquêtes sur le camionnage de Statistique Canada). Le cas échéant, ces vérifications ont permis de rehausser le degré de fiabilité des conclusions de la présente étude. La section 15.1.6 de la partie II traite plus en détail de cette question.

- **Fiabilité des prévisions d'économies de coûts importantes** - L'aspect le plus important à considérer au chapitre de la fiabilité des résultats de la présente étude est sans doute l'ampleur des économies de coûts qui y sont énoncées. Même si les données avancées dans ce contexte devaient se révéler largement surévaluées, le fait demeure qu'en comparaison des coûts du programme de recherches entrepris par l'ATC et des autres coûts de mise en oeuvre des modifications qu'il est proposé d'apporter au protocole d'entente, les économies à réaliser demeureraient néanmoins très importantes. Soulignons par ailleurs que si les économies de coûts ici prévues peuvent sembler considérables, elles ne représentent globalement que 2 % des coûts totaux estimatifs des activités de camionnage sur le réseau routier national en 1992. Dès lors, il n'est certes pas déraisonnable d'envisager une économie de cet ordre de grandeur lorsqu'on considère les gains importants, en termes d'efficience, qu'il est possible de tirer de l'utilisation accrue des véhicules préconisés par l'ATC ainsi que des semi-remorques de plus grandes dimensions que prévoit le protocole d'entente et ce, tout particulièrement en Colombie-Britannique et dans les Prairies et dans une moindre mesure, en Ontario, au Québec, dans les provinces de l'Atlantique ainsi que dans les Territoires-du-Nord-Ouest et le Yukon.

CONCLUSIONS

Les principales conclusions de cette étude peuvent se résumer comme ci-après.

- **Impacts économiques positifs** - La mise en oeuvre du protocole d'entente de 1988 a largement contribué à améliorer l'efficience du transport par camion des produits d'origine canadienne, tout particulièrement dans le contexte du transport interprovincial. Dans une moindre mesure, le trafic transfrontalier a également bénéficié de cette entente. Les économies de coûts ici visées ont notamment profité aux expéditeurs canadiens, du fait de la réduction des tarifs de transport. Pour leur part, les transporteurs ont également été en mesure de tirer parti des améliorations de l'efficience du camionnage, à telle enseigne que l'économie canadienne a retiré de toute cette démarche des avantages importants et ce, non seulement en termes de rentabilité des activités d'exploitation, mais encore de compétitivité accrue face aux partenaires commerciaux traditionnels du pays.

- **Évaluation des coûts-avantages du programme de recherches mis en oeuvre par l'ATC** - Les sommes que les provinces et les territoires du Canada, le gouvernement fédéral et l'industrie nationale du camionnage ont consacrées au cours des années 1980 à la R-D en transport routier, le tout dans le contexte du Programme de recherches de l'ATC sur les poids et dimensions des véhicules lourds, ont depuis largement rapporté des dividendes en termes d'économies de coûts et d'avantages d'ordre économique. Estimée globalement à 1,87 milliard de dollars pour la période de 15 ans s'échelonnant de 1988 à 2002, la valeur de ces économies, lorsque comparée à la valeur nette actuelle du coût du programme de recherches précité, soit 5,7 millions de dollars, correspond donc à un ratio coûts-avantages de 328 pour 1, certes un taux de rendement des plus appréciables. De l'avis des responsables de l'étude, si les économies nettes associées à tout le réseau routier désigné dans le protocole d'entente étaient prises en compte (réseau équivalant environ au double du réseau routier national), le ratio susmentionné serait à peu près deux fois plus élevé.

- **Avantages pour les régions** - Les principaux avantages tirés de la mise en oeuvre du protocole d'entente se sont surtout concrétisés dans l'Ouest du Canada. En revanche, toutes les régions du pays ont néanmoins enregistré des gains nets notables à ce titre. En 1992, les économies de coûts réalisées dans ce contexte ont été estimées à 40 % en Ontario, à 27 % dans les Prairies, à 19 % en Colombie-Britannique, à 11 % au Québec, à 2,5 % dans les provinces de l'Atlantique et à 0,3 % dans les Territoires-du-Nord-Ouest et le Yukon.

- **Entrée en vigueur généralisée de la réglementation canadienne sur les poids et dimensions des véhicules** - Compte tenu des récents changements apportés à la réglementation des véhicules de transport routier (notamment à la suite de l'enquête auprès des transporteurs et de l'analyse des différentes études de cas retenues aux fins du présent examen), changements dont le but était d'autoriser l'utilisation de semi-remorques de 53 pieds de longueur en Ontario, au Québec et dans les provinces de l'Atlantique, il appert que la majorité des réductions des coûts de camionnage interprovincial envisagées aux termes du protocole d'entente ont déjà été réalisées sinon se concrétiseront dans les prochains mois, au fur et à mesure que l'industrie s'adaptera à la nouvelle réglementation. Aussi, si l'on s'en tient aux prévisions d'économies de coûts prévues pour l'an 2002, c'est donc dire que d'autres réductions annuelles des coûts de transport routier continueront d'être enregistrées d'ici à cette date ce qui, certes, n'aurait pu être le cas si le protocole d'entente n'avait pas été mis en oeuvre.

- **Future harmonisation des réglementations des transporteurs exerçant des activités transfrontalières** - Au fil des prochaines années, c'est sans doute dans le domaine du transport routier canado-américain de marchandises que seront enregistrées les économies les plus notables et ce, en raison de l'utilisation de véhicules plus efficients. En règle générale, le protocole d'entente prévoit des limites de poids et de dimensions plus élevées pour les véhicules canadiens que celles auxquelles sont assujettis les transporteurs routiers empruntant le réseau américain inter-États. Toutefois, soulignons que les limites imposées par certains États se comparent assez bien à celles que prévoit le protocole d'entente, notamment au Michigan. Dès lors, il serait sans aucun doute avisé de la part des autorités canadiennes de négocier avec les États visés et l'administration fédérale des États-Unis l'adoption de certaines mesures de mitigation de leurs réglementations sur les poids et dimensions des véhicules, le tout de manière à permettre aux transporteurs et expéditeurs exerçant des activités transfrontalières de profiter des économies de coûts correspondantes. Les responsables de la présente étude croient savoir que certaines démarches ont été entreprises dans ce domaine.

- **Méthodes améliorées** - Comme il en est fait mention dans l'introduction aux présentes, l'un des principaux objectifs de l'étude était d'élaborer des méthodes prévisionnelles fiables du trafic-marchandises par route et ce, notamment au regard des types de véhicules routiers utilisés, des incidences sur les coûts de transport par camion, des coûts d'infrastructure et de la sécurité routière ainsi que des impacts sur les expéditeurs des changements préconisés quant aux types et à la capacité de chargement des véhicules utilisés sur le réseau routier canadien, dont aux fins du transport interprovincial. L'étude a notamment porté sur l'évaluation systématique de plusieurs méthodes d'analyse des divers éléments susmentionnés. Les méthodes et les modèles mis au point et appliqués dans ce contexte sont inspirés des renseignements existants ou nouveaux que l'équipe d'analystes a pu réunir aux fins de s'acquitter de son mandat. Toute une gamme de méthodes d'analyse et de modèles ont ainsi été élaborés, données justificatives à l'appui, au fil du déroulement de cette étude. Il va sans dire que ces méthodes et modèles prévisionnels conserveront toute leur utilité et leur fiabilité au cours des années à venir.

- **Limites inhérentes aux données disponibles** - Compte tenu des limites inhérentes aux renseignements qui ont pu être réunis aux fins de l'étude, limites qui ont soulevé de sérieux défis, il n'est guère surprenant que les responsables de cette dernière en soient notamment arrivés à la conclusion qu'il était plus que souhaitable de mettre en oeuvre un programme permanent de collecte de données pertinentes, ce dont traite d'ailleurs plus en détail la section qui suit.

FUTURES ORIENTATIONS PROPOSÉES

À la lumière de l'expérience acquise au fil de cette étude, les responsables de cette dernière ont jugé à propos de formuler les observations ci-après quant aux principales orientations futures à poursuivre.

- **Fréquence des enquêtes permettant de réunir des données clés** - Dans le contexte de l'étude dont il est ici rendu compte, il n'aurait pas été possible de mesurer quantitativement et avec suffisamment de précision les économies de coûts découlant de la mise en oeuvre du protocole d'entente, n'eût été des renseignements fournis dans le cadre de l'enquête routière sur le camionnage du CCATM, de la compilation des données sur le chargement et la classification des véhicules empruntant le réseau routier national, données fournies par les ministères provinciaux des Transports, et de l'information tirée de l'enquête auprès des transporteurs ainsi que de l'analyse de différentes études de cas. Bien que l'envergure de l'enquête du CCATM, de l'enquête auprès des transporteurs de même que des études de cas susmentionnées ait pu influer sur la fiabilité des résultats de la présente étude, il n'en demeure pas moins que les problèmes auxquels se sont heurtés les responsables de cette dernière pourraient être éliminés si de telles enquêtes étaient exécutées de façon régulière, d'autant plus qu'une telle pratique permettrait de réunir des données de grande valeur au plan chronologique sinon évolutif.

- **Enquêtes régulières du CCATM** - Dès lors, il est recommandé que les gouvernements fédéral et provinciaux participant aux travaux du CCATM et de l'ATC exécutent régulièrement auprès des camionneurs, soit à tous les trois ou cinq ans, une enquête routière semblable à celle effectuée en 1991 par le CCATM. Le cas échéant, la prochaine enquête pourrait avoir lieu en 1996.

- **Besoins en renseignements complémentaires** - S'il était donné suite à la recommandation susmentionnée, il conviendrait alors d'envisager la possibilité d'étoffer le questionnaire d'enquête du CCATM, par exemple en y ajoutant une question concernant la longueur des semi-remorques (48, 53 pieds) des véhicules articulés à 5 et 6 essieux. En outre, toutes les questions d'enquête devraient être posées à chacun des postes de contrôle et, si possible, aux camionneurs circulant dans les deux sens. Qui plus est, le choix des emplacements des postes de contrôle devrait permettre de réunir des renseignements sur le trafic-marchandises intraprovincial, interprovincial et international. De telles mesures ajouteraient grandement à l'intégrité et à l'utilité de l'enquête. Les gouvernements fédéral et provinciaux devraient également envisager de mettre en oeuvre un programme axé, d'une part, sur l'analyse plus poussée des données recueillies lors de l'enquête de 1991 du CCATM et, d'autre part, sur la comparaison de ces données avec celles que pourraient permettre de réunir les enquêtes que le CCATM exécutera éventuellement en 1996 et au cours des années subséquentes. Les coûts de mise en oeuvre d'un tel programme seraient relativement peu élevés par rapport à ceux des enquêtes elles-mêmes. En revanche, l'information supplémentaire qui pourrait ainsi être établie au regard des tendances dans le secteur du camionnage, de l'amélioration de l'efficience des activités et des économies de coûts possibles serait non seulement extrêmement utile aux fins de l'élaboration de politiques et de programmes permanents de transport, mais encore de la prise de décisions d'affaires par les transporteurs et les expéditeurs mêmes.

- **Faible taux de réponse à l'enquête auprès des transporteurs** - Même si d'aucuns pourraient juger que le taux de réponse à l'enquête auprès des transporteurs (soit environ 15 %) est relativement faible, il convient ici de souligner qu'un tel taux n'en est pas moins élevé lorsqu'on le compare à ceux obtenus dans le cadre d'autres enquêtes menées auprès des entreprises de camionnage. Dans ces derniers cas, les taux de réponse étaient de façon générale inférieurs à 10 %. Le taux plus élevé de réponse obtenu lors de l'enquête auprès des transporteurs est en partie attribuable au vaste processus de suivi mis en oeuvre à l'appui de cette dernière et aussi, dans une certaine mesure, au fait que l'équipe chargée de cette enquête a su faire valoir auprès des répondants que les résultats escomptés de celle-ci, tout comme les économies de coût découlant de la mise en oeuvre du protocole d'entente, pourraient éventuellement se traduire par des avantages notables pour les entreprises de camionnage et des améliorations marquées de la réglementation de leurs activités.

- **Enquêtes régulières auprès des transporteurs et amélioration des taux de réponse à celles-ci** - Nul ne saurait mettre en doute le fait que les cadres supérieurs des entreprises de camionnage ont très souvent un emploi du temps des plus chargés. Néanmoins, il est essentiel de constituer une banque d'information adéquate sur cette industrie qui revêt une grande importance pour l'économie canadienne. Les responsables de la présente étude sont conscients des efforts consentis en vue d'élargir le champ d'application des enquêtes actuelles de Statistique Canada sur l'industrie du camionnage, de manière à obtenir des renseignements complémentaires sur l'utilisation des divers types de véhicules de transport routier. Concrètement, ces efforts ne pourront donner que des résultats utiles. En revanche, si ces efforts ne devaient pas produire les résultats escomptés, il serait alors souhaitable de répéter l'enquête auprès des transporteurs aux fins de réunir l'information pertinente sur les types de véhicules utilisés et ce, vraisemblablement à tous les trois ou cinq ans.

- **Diffusion à grande échelle des résultats de la présente étude** - Il est également recommandé qu'un résumé des résultats de la présente étude soit diffusé à grande échelle au sein de l'industrie du camionnage, notamment par l'entremise de l'Association canadienne du camionnage, des associations provinciales de camionneurs et de l'ATC. Dans le contexte d'une telle stratégie d'information, il serait également important de bien faire valoir les avantages que retireront éventuellement les intervenants visés de leur collaboration à la constitution d'une banque de données sur leur industrie.

Cette étude a démontré que les efforts de collaboration déployés aux fins d'atténuer les obstacles à l'efficience du camionnage interprovincial ont permis aux transporteurs, aux expéditeurs et même à l'économie en général de tirer parti d'avantages très importants. Ceci dit, d'autres améliorations peuvent encore être apportées, notamment au chapitre du trafic-marchandises canado-américain. Quoi qu'il en soit, les résultats obtenus dans le contexte de cette étude devraient se révéler des plus utiles aux fins de négocier les changements réglementaires qui s'imposent avec l'administration fédérale des États-Unis et les États frontaliers de ce pays.

COMPOSITION DU COMITÉ DIRECTEUR

MEMBRES	ADMINISTRATION/ORGANISME
M. Keith Scott, président	Ministère du Développement économique et du Tourisme de l'Alberta
M. John Erik Albrechtsen	Paul's Hauling Ltd., Winnipeg (Manitoba)
M. John Billing	Ministère des Transports de l'Ontario
M. Ralph Campbell	Association des transports du Canada
M. Jean Couture	Ministère des Transports du Québec
M. Grant Godwin	Ministère de la Voirie et des Transports de la Saskatchewan
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M. Rafael Sanchez	Ministère des Transports du Québec
M. Bill Sokil	Sokil Express Line Ltd., Edmonton (Alberta)
M. Louis-Paul Tardif	Institut canadien de recherche en camionnage
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TRANSPORTATION ASSOCIATION
OF CANADA

CANADIAN TRUCKING
RESEARCH INSTITUTE

IMPACTS OF CANADA'S HEAVY VEHICLE WEIGHTS AND DIMENSIONS RESEARCH AND INTERPROVINCIAL AGREEMENT

PART I: METHODOLOGIES

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IBI GROUP / ADI

Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement

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PART I: METHODOLOGIES

Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement - Part I: Methodologies

1. INTRODUCTION TO PART I

As noted in the Introduction, Part I of this report describes alternative methodologies which could be used in the study, evaluates the alternatives, and presents the recommended approach in each case. This part of the report presents in Chapter 2 an overview of trucking data, followed by a summary of the initial contacts and literature review, presented in Chapter 3. Chapter 4 describes alternative road networks which could be used as the basis for the study, the advantages and disadvantages of each, and the recommended study network. Chapters 5 through 9 describe alternative methodologies, an evaluation of the alternatives, and a recommended methodology in each case for the following components of the study, respectively:

- Truck Fleet Composition and Use (Chapter 5);
- Trucking Costs (Chapter 6);
- Infrastructure Costs (Chapter 7);
- Road Safety Impacts (Chapter 8); and
- Shipper Costs (Chapter 9).

Chapter 10 summarizes the design of the carrier survey and case studies of carriers, provincial ministries, shippers and trailer manufacturers/distributors. Chapter 11 provides a summary of the recommended methodologies which were agreed to by the Steering Committee as the basis for the study.

2. TRUCKING DATA OVERVIEW

This section identifies the major national and provincial data sources which are available for this study. The key characteristics of these sources are summarized in Exhibit 1.1.

2.1 NATIONAL DATA

- **CCMTA Roadside Survey:** A roadside survey was conducted in June 1991 by all provinces and territories. This survey was administered at 31 inspection locations across the country and is a good source of information for tractor-trailer configurations on extraprovincial trips, i.e. on trips between provinces and to and from the U.S. The survey covers both for-hire and private trucks. Data collected include configuration type, GCW, GVW, payload, number of axles, cargo weight and cube. It is the first trucking survey in which the same data was collected across Canada. As no similar survey was conducted prior to 1989, this survey is of limited benefit in a comparative assessment of the impact of the MoU. However, it provides a realistic 1991 estimate for the extraprovincial portion of the industry, and it was an essential data source for the study, as described in subsequent sections of this report. It was also particularly useful for the Prairie provinces, where certain vehicle types did not exist prior to the MoU, and therefore the presence of these vehicles, as detected by the CCMTA survey was directly related to the MoU.

- **Statistics Canada For-Hire Trucking (Commodity Origin/Destination) Survey:** The data include:

    - Commodity origin and destination statistics of Canadian intercity commodity movements of distances greater than 25 km of Canadian-domiciled for-hire trucking companies with annual intercity freight revenues of $1 million or more. Specific data include revenues, tonnes, tonne-kilometres and number of shipments. In addition, non-commodity origin and destination data are provided on composite parameters, such as revenue per tonne-kilometre, weight per shipment, distance per shipment, etc.;

    - Commodity origin and destination statistics of Canada-U.S. truck traffic by Canadian-domiciled carriers, including interline traffic. Specific data in this portion of the survey include estimated

EXHIBIT 1.1

MAJOR DATABASES ON CANADIAN TRUCKING

DATABASE	KEY CHARACTERISTICS
CCMTA Road Side Survey	• A sample survey of tractor-trailer units at 31 inspection locations across Canada in 1991. • Identifies configuration type, GCW, number of axles, cargo weight and cube.
Statistics Canada For-Hire Trucking Survey	• Revenues, tonnes, tonne-kilometres and no. of shipments between each province and territory by commodity type. • Covers movements greater than 25 km. by Canadian-domiciled for-hire trucking firms with annual freight revenues above $1 million. • Annual survey.
Statistics Canada Annual Motor Carriers of Freight, Financial and Operating Statistics Survey	• Trucking firm operating revenues and expenses, average fleet size, total distance travelled, fuel costs by province, equipment operated. • Covers for-hire carriers with annual freight revenues above $1 million. • No breakdown on configuration types operated.
Statistics Canada Quarterly Motor Carrier Freight Survey	• Itemized operating revenue and expenses for freight. • Covers all Canadian-domiciled for-hire trucking carriers with annual gross operating revenues of $1 million or more.
Statistics Canada Private Trucking Survey	• Tonnes, tonne-kilometres and no. of shipments between each province and territory by commodity type. • Covers movements greater than 25 km. by Canadian-domiciled private carriers with annual expenses above $1 million. • Survey conducted periodically.
Operating Costs of Trucks in Canada	• Factor prices for Canadian trucking industry. • Equipment prices, labour rates, productivity assumptions, average haul distances, depreciation rates, etc. • Survey conducted bi-annually.
Provincial Trucking Databases	• Truck volumes by highway section. • Road-side truck classification surveys. • Weigh scale surveys. • Tractor & trailer registrations. • Truck origin-destination surveys. • Quality and quantity of data varies among the provinces and territories.

revenues, tonnes, tonne-kilometres, shipments and distance.

The most recent publication available when this project started in mid-1993 was dated 1991; 1991 data became available and 1992 data were obtained prior to publication by special request.

- **Statistics Canada Annual Motor Carriers of Freight Survey, Financial and Operating Statistics:** The data include:

    - financial and operating statistics based on a census of Canadian-domiciled for-hire carriers of freight which earned gross operating revenues of at least $1 million per year. Specific data include itemized operating revenues and expenses, operating ratio, number of employees, assets, liabilities and equipment operated.

    - General operating statistics of Canadian-domiciled for-hire carriers and owner operators with annual gross operating revenues between $25 thousand and $1 million (based on a sample). The data in this portion of the survey focuses on itemized operating revenues and expenses, but also includes own/lease data, commodity data and fuel consumption data.

    The data does not include a breakdown of the types of configurations operated. The most recent publication is dated 1991.

- **Statistics Canada Quarterly Motor Carrier Freight Survey:** The data include itemized operating revenues and expenses for freight covering all Canadian-domiciled for-hire trucking carriers with annual gross operating revenues of $1 million or more.

    The most recent publication is dated 1993.

- **Statistics Canada Private Trucking Survey:** The data include freight traffic in tonnes, tonne-kilometres and number of shipments between each province and territory by commodity type for movements greater than 25 km by Canadian-domiciled private carriers with annual expenses (of their trucking operations) above $1 million. The survey is produced periodically.

The most recent publication is dated 1989.

- **Operating Costs of Trucks in Canada**: Trimac Consulting Services Ltd., prepares a report every two years which includes factor prices for a large range of aspects of the trucking industry, such as equipment prices, labour rates, productivity assumptions, average haul distances, depreciation rates, fuel consumption, fuel prices, maintenance costs, tire costs, load and unload rates, cleaning costs and overheads.

  The most recent publication is dated 1992.

2.2 PROVINCIAL DATA

- **Provincial Trucking Data Bases:** Provincial data is available from a number of data bases in each province. The quality and quantity of data varies among the provinces. The data include:

  - truck volumes by highway section;
  - weigh scale surveys;
  - tractor and trailer registrations; and
  - truck origin-destination surveys.

Updated information on provincial data and issues associated with this data have been obtained through contacts with provincial authorities, and is described in Section 3.1.

2.3 KEY DATA LIMITATIONS

Consistent and exhaustive data on trucking in Canada are notably nonexistent, though data on parts do exist. These, however, make definitive comparisons between time periods and on an all-inclusive and country-wide basis difficult. Examples of the difficulties that arise include a number of factors such as the following:

- the division of trucking operations into for-hire and private trucking (it is easier to collect data for the former);
- stratification by size of trucking company (in most surveys a lower threshold in terms of revenue, expenses or other characteristic is used, so that smaller companies are not included);

- exclusion of specialized carriers (e.g. couriers, freight forwarders);
- surveys covering only a single province, a subgroup of truck/body types, trip lengths, and/or origin/destination categories (such as intercity or interprovincial).

The practicalities of the survey process also present data limitations. In order to retain the cooperation of survey participants, it is important that confidential information on individual carriers not be exposed. Therefore a degree of aggregation is required which limits the degree of cross-tabulation that is feasible. For example, a provincial origin-destination matrix showing tonnage will not expose individual carriers, but if subdivided by carrier size and commodity, the numbers of carriers may become small enough to allow the identification of individual carriers.

Provincial truck registration records list tractors with the maximum weights they are allowed to haul (gross combination weights - GCW), but this does not mean that they always do haul that much. Similarly, spot surveys may overestimate data such as tonnes and tonne-kilometres by extrapolating a local movement to the entire trip. Therefore in most analyses of the trucking industry a number of assumptions have to be made and the data often require a certain amount of interpolation and/or inference.

3. INITIAL CONTACTS AND LITERATURE REVIEW

This section briefly outlines the key issues affecting the measurement of impacts, identified in our correspondence and telephone interviews with provincial highway officials. Also indicated are the results of a literature search on related issues. This literature review continued throughout the study, and publications are identified in the text where relevant.

3.1 RESULTS OF INITIAL CONTACTS

Provincial highway officials were contacted by mail and telephone to investigate trucking data available through motor vehicle registrations and traffic studies, as well as the issues and any limitations associated with this data. In addition, preliminary telephone contacts were made with others having information about industry data. The results of the responses to the initial contacts are summarized below.

3.1.1 Motor Vehicle Registrations

Provincial registrars were contacted to determine the nature of any vehicle registration data that might be available to assist in the analysis. In summary, there is very little data available that would be useful. Basically trailers are registered by the gross vehicle weight of the power unit. Hence, trailers are often registered for weights that are higher than when in actual use. Only Prince Edward Island and Nova Scotia are able to provide information by axle type and spacing. Two of the provinces indicated there are problems with their databases as they have not recently been "cleansed" of trailers no longer registered.

To be truly useful for this study, information on trailer length by number of axles would be required. This information is not collected, severely limiting the usefulness of registration data for purposes of this study. For those provinces where there was an increase in the gross vehicle weight as a result of the MoU, the data could provide an indication of the industry uptake of the heavier weights in terms of number of trailers registered at the new levels. However, this could only be taken as an indication of industry intent to use these vehicles at the higher limit and would not reflect actual usage of the new limits. Results could therefore be misleading. Overall, the limited usefulness of the registration data does not justify use of the limited study resources to collate and analyze these data. The industry survey, case studies and provincial traffic data will provide much more insight into how industry has reacted to the regulations.

Each provincial highways department has a traffic counting program that allows them to estimate average annual daily traffic for each link in their network. Results are often published in the form of maps or reports that are readily available. ADI has used these reports and maps to produce an historical database of traffic volumes for the National Highway System. These estimates of traffic volumes are normally accomplished using a series of permanent and temporary (short duration) traffic count stations. These stations typically count total vehicles and classification surveys are taken to estimate traffic flow by vehicle type, such as passenger car, truck, etc.

3.1.2 Provincial Traffic Data

Each provincial highway department was contacted to determine what data additional to their basic counts of average annual daily traffic (AADT) they have that would be of benefit to this study. This includes such information as trucking origin-destination surveys, truck classification counts and axle weight data. In summary, sufficient data are generally available to provide estimates of average annual daily truck traffic for provincial highways and hence the MoU designated system. The quality and detail of the available data vary by province, but present indications are that a database of total truck traffic (total vehicle-kilometres of travel) can be produced. Such a database would have uses that extend beyond this study as it would be a useful monitoring tool for future similar studies, industry growth and activity levels, etc.

To make the truck traffic database of greatest benefit to this study it was necessary to obtain breakdowns of truck volumes by truck type, trailer length, axle grouping and axle weights. Several provinces indicated they would collect supplementary data, if required. Comments regarding provincial data and data collection initiatives follow:

- **British Columbia** has vehicle classification data for several stations, collected during the 1991-93 period. The data classified truck traffic by light and heavy trucks;

- **Alberta** has five category classification systems for trucks and systematically collects this data over their entire network. The Province indicated they could supply/collect supplementary data from their portable and permanent scale sites;

- **Saskatchewan** has an ongoing vehicle classification program with trucks being classified into 14 categories (FHWA classification). A truck axle weight survey was undertaken in the summer of 1993 at 20 portable and all permanent scale sites;

- **Manitoba** has relatively detailed vehicle classification information throughout their network. Limited weigh-in-motion data is also available from SHRP and C-SHRP sites;

- **Ontario** has detailed truck classification estimates for their entire network. Additional classification data is available from eight weigh-in-motion sites;

- **Quebec** has truck classification estimates for several stations across the Province, collected during the 1990-93 period;

- **New Brunswick** has trucking origin-destination survey (1991) data for the Fredericton-Moncton-Saint John corridors;

- **Nova Scotia** has truck classification estimates (1993) for several stations across the Province. In addition, data from a few weigh-in-motion sites are also available;

- **Prince Edward Island** has vehicle classification data for four weight-in-motion sites. In addition, classification counts for 42 Archer classification sites, based on a 48 hour period per season, are also available. The classification is based on FHWA vehicle categories.

It was concluded that there was sufficient data to prepare estimates of vehicle kilometres of truck travel by truck type on each link of the Designated Study Network. Vehicle classification count data was used to break travel down by type of truck and weigh-in-motion (WIM) data provided details on axle weight by truck type and length, this being the basic information required to properly assess the impact of the TAC vehicles.

The above data, in combination with the 1991 CCMTA Roadside Survey, were used to estimate the total amount of travel across the study network for each of the TAC vehicle types and hence estimate the resulting savings in trucking costs. The data were not as detailed as one would like and in some cases required application of considerable professional judgement. This approach will also provide a monitoring tool for future years as the estimates could be updated annually at rather modest cost.

Recognizing the limitations of this approach as noted above it was recommended that the industry survey and case study results be used to the extent feasible to provide independent estimates of trucking volumes/patterns by truck configurations so that the two estimates would serve as a useful crosscheck on one another. This approach was followed, as described further in Part III.

3.1.3 Other Industry Data

Telephone interviews were conducted with key individuals who could provide supplementary data and background on impacts of the 1988 Memorandum of Understanding. The main points of discussion in each of these interviews are summarized below:

Bill Raney
Manager
Transportation Costing and Productivity Office
Ministry of Transportation, Ontario

Topic:

- Availability of data from the pilot survey undertaken in preparation for the 1994 Commercial Vehicle Survey;
- Availability of other relevant data to the study.

Discussion:

Mr. Raney stated that surveys were conducted during the summer of 1992 at the Windsor and Sarnia inspection stations, but that not enough resources were available to survey Eastern Ontario. Other information which could be relevant to the study includes a Queen Elizabeth Way survey, the 1988 Commercial Vehicle Survey Report, a report on the Survey Methodology for Intercity Trucking Activity in Ontario and the CCMTA Survey analysis. Databases could be provided on surveys conducted through his office tailored to specific parameter aggregations specified by the study team for the purpose of the TAC study.

Al Tucker
Canadian Transportation Equipment Association

Topic:

- Availability of truck manufacturing company data which would enable comparison of truck sales before and after 1988, to reflect the impact of the 1988 MoU;
- General information on the Canadian Transportation Equipment Association.

Discussion:

Mr. Tucker stated that, to his knowledge, statistical data on Canadian truck manufacturers is virtually non-existent. One reason that it is difficult to access this information is that the relatively small commercial vehicle manufacturing sector is aggregated with the much larger automotive sector, and meaningful data about commercial vehicle manufacturers is buried. Another reason is the reluctance of truck manufacturers to be surveyed. Truck manufacturers are only just beginning to feel that they are part of an association, and do not yet acknowledge the benefits that industry surveys can provide.

Mr. Tucker referred to an Industrial Science Technology Canada (ISTC) report based on a 1990 survey of about 50 percent of the Canadian commercial vehicle manufacturers. This report presents a gloomy picture of the industry, based on a decline of around 40 percent at that time.

The Canadian Transportation Equipment Association currently has about 80 members, most of which are small to medium sized companies. Mr. Tucker indicated that most of the commercial vehicle manufacturing done by the companies in the Association is in response to specific customer demands. In his experience, any changes in regulations which stand to improve carrier costs are quickly implemented by the carriers (i.e. the customers) and therefore by the manufacturing industry.

Barry Prentice
Transport Institute
University of Manitoba

Topic:

- Results of research on driver perceptions of large trucks.

Discussion:

Mr. Prentice's research on how Canadian drivers perceived large trucks involved a telephone survey of 2,000 individuals across Canada during the Fall of 1988. The timing of the survey was targeted to measuring changes due to deregulation under the 1987 National Transportation Act. The results of the survey were published in a report entitled ***Perceptions of Large Trucks by Canadian Drivers***. The main findings of the research are summarized below:

- The greatest safety concerns with trucks reported by the survey respondents ranked as follows:
    - 1: speed;
    - 2: lack of visibility;

- 3: spillage from uncovered loads;
- 4: size of truck;

- Of the drivers surveyed, 17 percent were concerned because of the trucks themselves, 34 percent were concerned because of the truck drivers, and 2 percent had praise for large trucks and their drivers;
- Of the drivers surveyed, 46 percent were aware that trucks had increased in size, and 53 percent were unaware of truck size increases;
- Concern with larger trucks increases geographically from west to east, probably as a function of weather and terrain;
- Drivers tended to be significantly more concerned with trucks on two-lane roads than on four-lane roads;
- Drivers tended to be more concerned about large trucks on the open road than on local city/town streets, probably due to greater vehicle speeds on the open road;
- Frequency of driving had an impact on the response, with more frequent drivers being less concerned with large trucks;
- Female drivers tend to be more concerned about large trucks than male drivers, and older drivers more concerned than younger drivers.

3.2 LITERATURE REVIEW

This section summarizes the documents reviewed to date. More detailed reviews are provided in Appendix A (Annotated Bibliography). In all reviews we have put special emphasis on the data sources used, as this is of particular interest for this study.

3.2.1 Motor Carrier Transport Study: The Impact of Weight and Dimension Regulations on Trucking

This report was prepared by F.P. Nix in July 1992 for the National Transportation Act Review Commission. As this is the report most relevant to the current study, we have presented its annotation to greater depth than we have the others. This report is to a great extent qualitative owing to the relatively short period since the introduction of the agreement. The purpose of this study was to consider preliminary evidence on the impacts of the 1988 Memorandum of Agreement.

The study found that there have been noticeable changes in the truck fleets of the Prairie provinces, the Atlantic provinces and Quebec. The impact in Ontario was mainly on trucks for interprovincial movements.

While the impact of the MoU in British Columbia is less certain, it appears that the TAC B-train has gained importance in movements between British Columbia and the Prairie provinces.

Although some large truck combinations are marginally less safe than smaller trucks, the total impact, taking reduced vehicle miles into consideration, is an improvement in safety. The report also concludes that the agreement lowered pavement loads. The report could not quantify the savings, but concluded that trucking costs were reduced.

3.2.2 Economics of Liftable Axles

This report was written by F.P. Nix and Michel Boucher, and published by the Vehicle Technology Office of the Ontario Ministry of Transportation in April 1991. Liftable axles are permitted only in the Atlantic provinces, Quebec and Ontario. Their use is generally not supported by road authorities due to pavement damage caused by liftable axles. Based on extensive and detailed costing, the authors come to the conclusion that there are alternative trucks available which do not have liftable axles and which do not increase trucking costs by more than 1%, though some individual operations may experience higher increases.

3.2.3 New Trucks for Greater Productivity and Less Road Wear: an Evaluation of the Turner Proposal (TRB Special Report 227)

This report was published by the Transportation Research Board of the National Research Council in Washington D.C. in 1990. The Turner truck is a configuration designed to increase freight transportation productivity while at the same time reducing wear and tear on road pavement, mainly through a larger number of axles. The purpose of the study is to estimate the impacts on freight productivity, safety, traffic, bridges and pavements if the Turner trucks were used nationwide, and the consequences of more restrictive adoption. The analysis concludes that the overall savings from reduced pavement wear would exceed the increased costs for bridge replacement and new bridges. Although an individual Turner truck may have a slightly higher accident rate, the overall safety would be improved due to the reduced total vehicle-miles.

3.2.4 Truck Weight Limit: Issues and Options (TRB Special Report 225)

Also published by the Transportation Research Board of the National Research Council, Special Report 225 examines four topics. These are the elimination of grandfather provisions for truck weights by the states, alternative methods for determining gross vehicle weight, the adequacy of the current federal bridge formula and the treatment of specialized hauling vehicles.

In this report, background information is provided on the effects of truck weight regulations on trucking productivity, and a methodology is described for estimating the impacts of alternative truck weight regulatory scenarios on truck traffic, diversion to or from rail, and transport costs. The methodology described in the TRB report is assessed in this study for both the determination of truck fleet composition (see Section 5.1.1) and trucking costs (see Section 6.1.3).

The study led to the following recommendations:

- Replacement of the current federal bridge formula on Interstate highways;

- Broadening the process for exemptions to allow for the establishment of permit programs for heavier vehicles, provided that such programs included provisions to control the characteristics and operations of permit vehicles. Special permits would eliminate the necessity for states to claim grandfather exemptions in order to operate vehicles over the federal gross weight limit;

- Preventing future expansion of grandfather claims, without having Congress take action to restrict grandfather rights already claimed by states;

- Use of a portion of the revenues from overweight permits to increase efforts to enforce truck weight laws, particularly on non-Interstate highways, which are more susceptible to damage by illegally overweight trucks;

- Pursuing opportunities for standardizing limits and permit practices at the regional level.

4. STUDY NETWORK

Our approach to the study was based on using a study network upon which impacts would be assessed, and then factored up to reflect the entire MoU designated road system. It is important that the selected study network include virtually all interprovincial truck traffic, and a major portion of the intraprovincial truck traffic. In addition, data on traffic and physical characteristics by highway section are required to be readily available for the selected study network.

Three possibilities existed for the study network. They were:

1. The primary and secondary highways as designated by the Canadian Highway System Study. This was the network used in the 1987 RTAC prospective study on anticipated MoU impacts: ***Economics of Truck Sizes and Weights in Canada***, by IBI Group in association with ADI Limited;
2. The more recently designated National Highway System (NHS);
3. The system designated by the MoU.

Alternative 3 was preferred by the Steering Committee; however, this presents some difficulties. The extent of the road network covered by the MoU has been increased by the various provinces several times.

4.1 CANADIAN HIGHWAY SYSTEM

This network was originally developed by Transport Canada during the 1970's and last updated in 1987. Using a series of criteria to identify nodes, roads of national and regional importance which the System was to connect were identified. These criteria included population nodes, resource nodes, recreation nodes, defence establishments and transportation terminals.

Roads were classified as primary, secondary and local. Primary roads connect the large population and activity centres. Secondary roads complement the primary roads by providing linkages to a series of nodes while local roads connect all nodes falling off the primary and secondary roads. In total just over 68,000 kilometres were identified; 27,269 primary, 26,011 secondary, and 15,313 local.

The primary and secondary routes formed the basis for the study network for the 1987 prospective analysis.

4.2 NATIONAL HIGHWAY SYSTEM

Phase 1 of the National Highway Policy Study, completed in October 1988, identified a national system of highways using the following criteria:

- A national highway is any existing, primary route that provides for the interprovincial movement of people and goods by connecting as directly as possible a major provincial/commercial centre in Canada with:

- another major provincial population/commercial centre;
- another major population/commercial centre in an adjacent province or territory;
- a major port of exit/entry to the USA;
- another transportation mode directly served by the highway mode (eg. ferry terminal).

These criteria were used to identify a national system of 24,459 highway kilometres. Most of these highways were classified as primary in the earlier Canadian Highway System.

4.3 MoU DESIGNATED SYSTEM

Each province designated a system of roadways over which the TAC vehicles could be used. The extent of the designated system varies widely, from basically the entire provincial highway systems in two provinces to only the major interprovincial routes in other provinces.

In total, the system designated by the 1988 MoU includes 50,000 kilometres. Exhibit 4.1 summarizes the differences between the 1987 study network and the 1988 MoU designated system. Generally speaking, the 1987 study system was more extensive, with the exceptions of British Columbia and Ontario where the MoU system includes the provincial highway systems in their entirety. As well, routes in the territories were excluded from the 1987 study. It should be noted that those portions of the 1987 study network not included in the MoU designated network tend to be lower volume roads.

4.4 RECOMMENDED NETWORK

The preferred solution is to use the MoU designated system, as it was the one officially adopted and therefore included all the highways on which the TAC vehicles can be used. With the notable exceptions of British Columbia and Ontario, the MoU network is similar to the 1987 study network. It was noted, however, that the networks in British Columbia and Ontario might have to be reduced to reflect highways for which reasonable data on truck traffic volumes, configurations and axle loads are available. The process as actually applied is presented in Part III of this report; it used the NHS as the basis for detailed truck volume and trucking cost changes (with and without the MoU) and the estimated cost savings were then expanded to the MoU network based on broad trucking volume factors.

EXHIBIT 4.1

DIFFERENCES BETWEEN 1987 STUDY NETWORK AND THE MoU DESIGNATED SYSTEM

Province	A	B	C	A-B+C
	1987 MoU Designated System (km)	Roads Exclusive to MoU Designated System (km)	Roads Exclusive to 1987 Study Network (km)	1987 Study Network (km)
British Columbia	6,860	2,860	0	4,000
Alberta	4,051	0	1,091	5,142
Saskatchewan	6,810	1,845	109	5,074
Manitoba	3,925	248	963	4,640
Ontario	15,875	5,645	0	10,230
Quebec	1,950	0	5,383	7,333
New Brunswick	1,947	51	96	1,992
Nova Scotia	1,838	0	544	2,382
Prince Edward Island	371	21	210	560
Newfoundland	1,584	0	1,339	2,923
Northwest Territories	2,034	2,034	0	0
Yukon	2,945	2,945	0	0
TOTAL	50,190	15,649	9,735	44,276

5. TRUCK FLEET COMPOSITION

In this section, we describe various alternative methodologies for determining truck fleet composition changes resulting from the 1988 MoU, assess the alternatives, and the recommended approach to be followed in the next phase of the study.

5.1 ALTERNATIVE METHODOLOGIES

Based on the literature review and other research, we developed alternative methodologies which could be used to estimate the impacts of the 1988 MoU on the mix of tractor-trailer configurations used to carry freight in Canada. Exhibits 5.1-5.4 depict four possible methodologies in the form of flowcharts, with each flowchart summarizing the content and sequence of the major steps involved in the methodology. Steps which represent key outputs of the methodology are indicated by grey shading.

Each of the four alternative methodologies is discussed below:

5.1.1 Methodology 5A (Not Recommended)

Methodology 5A, shown in flowchart form in Exhibit 5.1, is the same methodology which was applied in the ***Transportation Research Board Special Report 225: Truck Weight Limits (1990)*** to analyze the impacts of proposed changes to U.S. Federal weight limits on Interstate highways on both truck fleet composition and trucking costs. The methodology was developed to forecast the long-term impacts of potential regulatory changes, as opposed to assessing the impacts following actual changes to the regulations, as is required in this study. The major steps in the methodology are as follows:

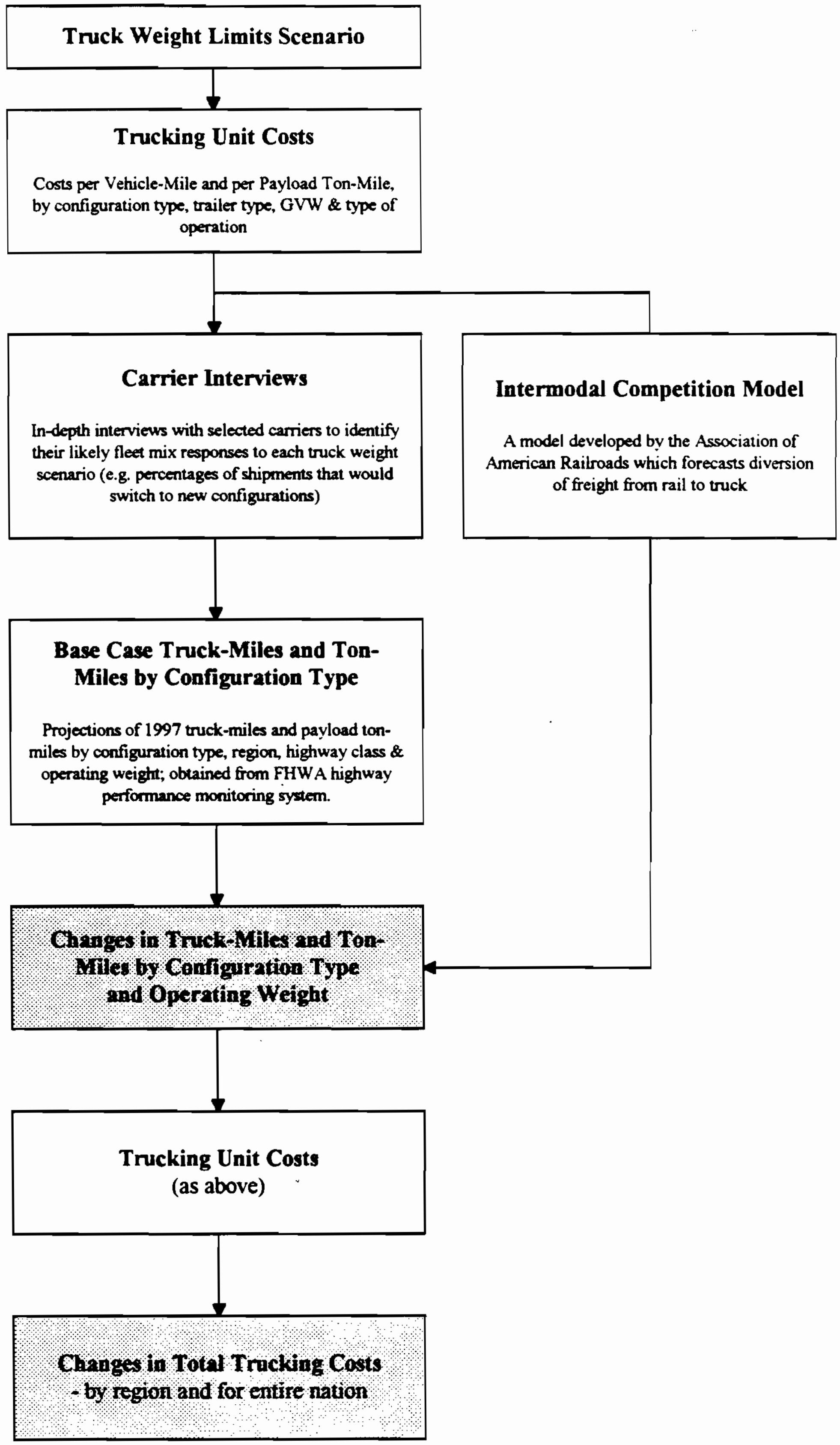
(i) **Specify Truck Weight Limits Scenario** - A set of changed truck weight limits is specified;

(ii) **Trucking Unit Costs** - The costs per vehicle-mile and per payload ton-mile for hauling freight are estimated for each truck configuration type as a function of trailer types used, operating weight and the type of operation (i.e. truckload or less-than-truckload (LTL)). These unit costs are estimated for both existing truck configurations and new configurations which would be allowed under the changed truck weight regulations;

(iii) **Carrier Interviews** - Detailed interviews are carried out with a sample of carriers chosen to represent a cross-section of the trucking industry (32 carriers were interviewed in the U.S. TRB Special Report 225 study). The interviews are used to identify likely shifts in the truck configurations carriers will use for different types of trucking operations, in response to the changed truck weight limits. The unit cost estimates for trucks operating under the old and new weight limits, provided by the preceding

EXHIBIT 5.1

TRUCK FLEET COMPOSITION IMPACTS METHODOLOGY 5A (U.S. TRB SPECIAL REPORT 225)



step, are used to help identify opportunities for reducing truck transport costs. This cost information is provided to the carriers being interviewed to assist them in predicting their long-term fleet mix responses to the changed regulations. In identifying their likely shifts of shipments from one truck configuration type to another, the carriers are also asked to take into account operational constraints (such as loading/unloading requirements) and other factors which would affect their fleet adjustments;

(iv) **Intermodal Competition Model** - The trucking unit costs estimated in Step (ii) are fed into this model, developed by the Association of American Railroads, in order to forecast the freight tonnage which would be diverted from rail to truck as a result of the changed truck weight regulations;

(v) **Base Case Truck-Miles And Ton-Miles By Configuration Type** - Future truck-miles and payload ton-miles by configuration type, region of the country, highway functional class and truck operating weight are estimated under the assumption of no changes in truck size and weight limits. These base case measures of trucking activity levels are estimated by scaling up current year figures on vehicle-miles of travel (VMT) of eight truck categories, by state and highway system, which are routinely estimated by the U.S. Federal Highway Administration (FHWA) highway performance monitoring system;

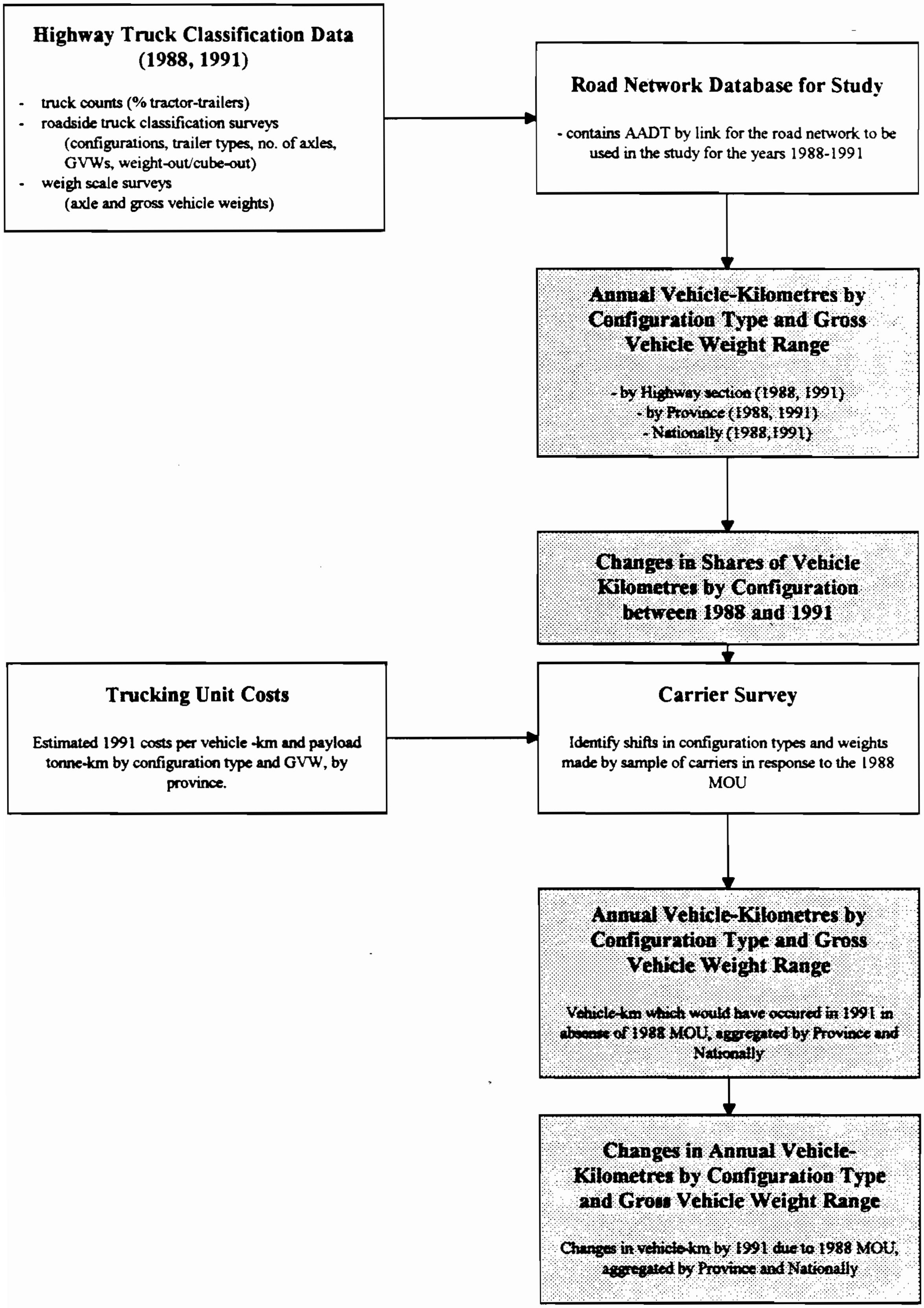
(vi) **Estimate Changes In Truck-Miles And Ton-Miles By Configuration Type And Operating Weight** - The proportions of payload ton-miles expected to switch among configuration types and operating weight ranges, identified through the carrier interviews in Step (iii), and the output of the intermodal competition model are applied to the base case ton-miles developed in Step (v) to forecast the net changes in ton-miles and truck-miles by configuration type and operating weight due to the changed truck weight limits. These net changes are estimated separately for each region. This step provides a key output of the methodology in terms of estimated impacts of the changed regulations on truck fleet composition.

5.1.2 Methodology 5B (Recommended as the Main Method)

Methodology 5B, shown in flowchart form in Exhibit 5.2, is a modified version of the methodology which was applied in the 1987 RTAC "Economics of Truck Sizes and Weights in Canada" study to estimate the long-term impacts of four alternative sets of truck size and weight limits on the mix of tractor-trailer configurations used in Canada. The main modification is the addition of a carrier survey to collect empirical

EXHIBIT 5.2

TRUCK FLEET COMPOSITION IMPACTS METHODOLOGY 5B



data on the shifts in configuration types actually made by carriers in response to the 1988 MoU.

The main steps in Methodology 5B are as follows:

(i) **Obtain Highway Truck Classification Data** - The first step is to collect heavy truck volume and classification data from each province and territory. The data to be collected includes: truck volumes on various roads; data from roadside truck classification surveys providing breakdowns of heavy truck traffic by configuration type, trailer type, number of axles, gross vehicle weight, load type (i.e. weight-out or cube-out), and other characteristics as available; and distributions of gross vehicle weights and axle weights from highway weigh scale surveys. This data is to be collected for the most recent year available (1991 if unpublished database information from the Statistics Canada databases can be made available), and also for 1987 so that truck traffic characteristics before and after the implementation of the MoU can be compared; the base years used in the study are 1987 and 1992, with projections to 1997 and 2002 as noted earlier.

(ii) **Update Study Road Network Database** - Information on Average Annual Daily Traffic (AADT), geometric design and pavement characteristics for each road section in the study road network are obtained from the provinces and territories for 1987 and 1992. The AADT information is already available for the National Highway System on a database that has been developed and maintained in-house by ADI Limited. This database would be expanded to include other data and other highway links in the study road network defined in Section 4;

(iii) **Estimate Annual Vehicle-Kilometres By Configuration Type For Each Highway Section** - This output is obtained as follows. Average Annual Daily Truck Traffic (AADTT) on each highway section in the study road network is estimated by multiplying the AADT by the percentage of heavy trucks in the traffic stream collected in Step (i). The total AADTT for each highway section is then broken down by truck configuration type and gross vehicle weight range, based on the frequency distributions of configuration types and operating weights observed at the nearest roadside truck classification survey site having similar traffic characteristics to those on the highway section in question. For each highway section, the estimated AADTT for each configuration type and weight range is then multiplied by the length of the section in kilometres, and then by 300 (working days per year), to estimate annual vehicle-kilometres by configuration type and operating weight range on that section. This process would be applied to data for both the years 1987 and 1992;

(iv) **Estimate Annual Vehicle-Kilometres by Configuration Type by Province and Nationally** - The results of Step (iii) are summed over all road sections in the study road network to obtain estimates of total annual vehicle-kilometres by configuration type and operating weight range for each province and territory and for Canada as a whole. The provincial, territorial and national estimates of annual vehicle-kilometres by configuration type would be generated for both 1987 and 1992;

(v) **Estimate 1987-1992 Changes In Shares Of Vehicle-Kilometres By Configuration Type** - The estimated shares of total truck vehicle-kilometres carried by each configuration type for each province and territory are compared for 1987 and 1992 to observe any significant shifts in the configurations used;

(vi) **Trucking Unit Costs** - 1992 costs per vehicle-kilometre and payload tonne-kilometre are estimated for each configuration type and by gross vehicle weight for each province and territory, using the truck cost model. These unit costs are calculated both for lowest-cost weight-out and freight-out configurations allowed prior to the 1987 MoU and new configurations allowed subsequent to the MoU;

(vii) **Carrier Survey** - A representative sample of carriers is surveyed to identify shifts among configuration types, as well as changes in payload weights and cubes carried by a given truck configuration, which have been made in response to the 1988 MoU. These actual responses are identified by requesting information from each carrier on typical configuration types, payloads, gross vehicle weights and trailer and combination lengths operated on routes within and between provinces and on transborder routes, in 1987 and in 1992. The trucking unit costs estimated in the preceding step are used as a check on the reasonableness of the truck mix responses identified by the carriers;

(viii) **Annual Vehicle-Kilometres by Configuration Type Without MoU** - This critical step estimates the annual vehicle-kilometres by configuration type and weight range **which would have occurred in 1992 in the absence of the changes to truck size and weight limits made after the 1988 MoU.** This is done by adjusting the estimated 1992 annual vehicle-kilometres for each configuration type and weight range from Step (iv) to net out the effects of the shifts in configuration types and weights identified through the carrier survey. Consider, for example, the case of 62 tonne 8-axle B-trains operated in the Prairie provinces in 1992. These trucks were not allowed prior to the 1988 MoU. Assuming that the carrier survey shows that these 8-axle B-trains replaced 53.5 tonne 7-axle B-trains (the heaviest trucks allowed before 1989), the 1992 vehicle-kilometres for 7-axle B-trains in the absence of the 1988 MoU would be estimated by increasing the actual 1992 vehicle-kilometres by the amount required to carry the freight actually moving in 8-axle B-trains. Similar adjustments are made to the estimates of "actual" 1992 annual vehicle-kilometres for each configuration type to obtain estimates of what the annual vehicle-kilometres would have been for each configuration type if the truck size and weight limits existing prior to the 1988 MoU had remained unchanged;

(ix) **Changes in Annual Vehicle-Kilometres Due to MoU** - Estimate the changes in annual vehicle-kilometres by configuration type and gross vehicle weight range in 1992 which are due to the 1988 MoU, by subtracting the output of Step (iv) from the output of Step (viii). These changes are calculated for each province and territory and then aggregated to national totals.

5.1.3 Methodology 5C (Recommended as the Backup Method to the Extent Feasible)

Methodology 5C, shown in flowchart form in Exhibit 5.3, would rely heavily on a carrier survey to assess the impacts of the 1988 MoU on truck fleet composition.

The methodology includes the following three major steps:

(i) **Carrier Survey** - A comprehensive survey is conducted among a sample of carriers across Canada. Although a random or stratified sample would improve the uniformity of the results, this would not be possible without access to confidential data (e.g. specific carriers within the Statistics Canada database). The survey collects the following information from each carrier:

- Typical configuration types, gross vehicle weights, payloads, and trailer and combination lengths operated in 1992 and in 1987 on major routes served by the carrier. A route is defined as a movement within a province/territory, between one province/territory and another province/territory (e.g. Alberta to Ontario), or between a province/territory and a region of the United States;

- Current annual tonne-kilometres or vehicle-kilometres by truck type for each major route served;

EXHIBIT 5.3

TRUCK FLEET COMPOSITION IMPACTS METHODOLOGY 5C

Select Sample of Carriers from Across Canada

↓

Carrier Survey

Collect information from each carrier on:

- typical configuration types, payloads, GVW's and trailer and combination lengths currently operated on routes within and between provinces and on international routes;
- current (1992) annual tonne-kilometres by truck type by route;
- same information as above for 1987; routes where change in truck type used is due to 1988 MoU;
- current and 1987 tractor registration by GVW range;
- current and 1987 trailer percentages of fleet total, by length (48' and 53' trailers)

↓

Changes in Annual Vehicle-Kilometres by Configuration Type and Gross Vehicle Weight Range

Changes in vehicle kms between 1992 & 1987 due to MoU for carrier surveyed

↓

Expansion to Provincial and National Totals

Expansion using factors based on characteristics of surveyed carriers versus provincial and national statistics

↓

Changes in Annual Vehicle-Kilometres by Configuration Type and Gross Vehicle Weight Range

Changes in vehicle kms between 1992 & 1987 due to MoU by Province and Nationally

- An indication of the routes where a change in truck type used between 1988 and 1992 is believed by the carrier to be due to the 1988 MoU;

- Current and 1988 tractor registrations by gross vehicle weight range;

- Current and 1988 trailers by length and body type.

(ii) **Changes in Annual Vehicle-Kilometres by Configuration Type for Carriers Surveyed** - Based on the information collected through the carrier survey, estimates are made of changes in annual vehicle-kilometres by configuration type and weight range in 1992 due to the 1988 MoU **for the carriers surveyed**. These estimates are developed by adjusting the estimates of "actual" 1992 annual vehicle-kilometres by truck type to reflect the effects of the shifts among configuration types and among weight ranges within a given configuration type that have been identified through the carrier survey;

(iii) **Changes in Annual Vehicle-Kilometres by Configuration Type by Province and Nation** - The changes in annual vehicle-kilometres estimated in Step (ii) are for the sample of carriers surveyed. These results need to be expanded to estimate provincial and national totals as called for by the study Terms of Reference. This would be accomplished using expansion factors developed to reflect the proportions of total annual truck-kilometres in each province/territory that are carried by the trucking firms responding to the survey. Lacking a universe of carriers from which a properly stratified and random list of carriers to be surveyed can be drawn, the expansion factors would require professional judgement in their development and application.

5.1.4 Methodology 5D (Not Recommended)

Methodology 5D, depicted in Exhibit 5.4, would rely entirely on truck registration data to assess the impacts on truck fleet composition of the 1988 MoU. This methodology consists of the following two steps:

(i) **Collect Provincial And Territorial Truck Registration Data** - The following information is collected from each province and territory for the years 1988 and 1992 (or most recent year available):

- Numbers of tractors by registered gross vehicle weight;

- Numbers of trailers by body type.

EXHIBIT 5.4

TRUCK FLEET COMPOSITION IMPACTS METHODOLOGY 5D

Provincial and Territorial Truck Registration Data for 1987 & 1992

Collect information on:

- numbers of tractors by Gross Vehicle Weight;
- numbers of semi-trailers and trailers by body type

↓

Changes in Distributions of Tractor Registered GVW's and Trailler Types

Changes in registrations between 1992 & 1987 due to MoU by Province/Territory and Nationally

The registered gross vehicle weight information is summarized by weight ranges selected to allow testing of the impacts of the 1988 MoU. For example, 53 tonnes would be one logical breakpoint since it represents the maximum allowable gross vehicle weight for B-trains in the three Prairie provinces prior to 1989;

(ii) The frequency distributions of tractors by registered gross vehicle weight and of trailers by body type are developed for 1988 and 1992 for each province and territory. The 1988 and 1992 distributions are then compared to provide insights into the impacts of the 1988 MoU on the mix of registered truck weights and trailer types.

5.2 ASSESSMENT OF ALTERNATIVES

The four alternative methodologies for estimating the impacts of the 1988 MoU on truck fleet composition across Canada were assessed against a set of evaluation criteria. These evaluation criteria included the following:

- **Reliability Of Estimates**: The statistical reliability of the impact estimates generated by the methodology, to measure the targeted changes. This is a function of both the reliability of the input data and the number and accuracy of the assumptions made within the methodology;

- **Availability/Quality Of Input Data**: The extent to which input data required by the methodology are available from existing sources, and the reliability of the input data currently available;

- **Start-up Costs**: The relative costs and level of effort needed for the initial application of the methodology;

- **On-going Application Costs**: The relative costs and level of effort required to re-apply the methodology in future years;

- **Ease Of Application/Understanding**: The relative ease with which the methodology can be applied and explained to a non-technical audience;

- **Ease Of Updating**: The relative ease with which the methodology can be re-applied in future years as new data become available and further changes in the trucking industry occur;

- **Flexibility For Sensitivity Testing**: The degree to which the methodology allows sensitivity testing of the impacts under different assumptions and values for key input variables;

- **Ability To Measure Key Changes**: Relative ability of the methodology to measure all important impacts of the 1988 MoU for the impact category covered by the methodology.

Exhibit 5.5 summarizes the assessment of each alternative methodology against the eight assessment criteria outlined above. A three-point rating scale - low, medium and high - has been used to measure the relative desirability of each methodology with respect to each assessment criterion. The ratings shown in Exhibit 5.5 are subjective assessments which reflect the consensus of the study team.

The following synopsis of the relative advantages and disadvantages of each of the four alternative methodologies highlights the results shown in Exhibit 5.5.

5.2.1 Methodology 5A (Not Recommended)

Methodology 5A has several important advantages. Foremost among these are the comprehensive nature of the method and its ability to provide detailed measures of the impacts of regulatory changes on the actual on-road usage of a large number of truck configuration types. This methodology is also sufficiently flexible to permit sensitivity testing of its results under different assumptions about trucking unit costs, carrier fleet mix responses, rail/truck competition and truck traffic volumes. Furthermore, the fact that this methodology has been successfully applied previously in US TRB Special Report 225 demonstrates that it is practical and can provide useful estimates of truck fleet composition impacts.

While Methodology 5A has been successfully applied in the U.S., there is an important barrier to applying it to estimate impacts on truck fleet composition in Canada. There is currently no equivalent in Canada of the U.S. FHWA Highway Performance monitoring system which regularly collects information on truck-miles and payload ton-miles by configuration type in each jurisdiction. In the Canadian context, this information would have to be developed from a variety of sources as outlined in Methodology 5B.

There is at present no Canadian equivalent of the Intermodal Competition Model which has been developed by the Association of American Railroads to estimate the diversion of freight from rail to truck resulting from reduced trucking unit costs. However, the Terms of Reference for this study state that any impacts which the 1988 MoU may have had so far in shifting freight between the rail and truck modes are to be excluded from consideration in this study. Therefore, this drawback is not critical.

EXHIBIT 5.5

ASSESSMENT OF ALTERNATIVE METHODOLOGIES TRUCK FLEET COMPOSITION IMPACTS

Criteria	Methodology			
	5A	5B	5C	5D
Reliability of Estimates	◎	◎	○	○
Availability/Quality of Data	○	◎	◎	○
Start-up Costs	○	◎	○	◎
On-going Application Costs	◎	●	○	●
Ease of Application/Understanding	○	◎	◎	○
Ease of Updating	◎	◎	○	◎
Flexibility for Sensitivity Testing	●	●	○	○
Ability to Measure Key Changes	●	●	◎	○

Legend:
● - High Desirability
◎ - Medium Desirability
○ - Low Desirability

In addition, Methodology 5A is problematic in that it uses a limited number of carrier surveys to represent the entire national industry. In the TRB study, results for the entire U.S. industry were obtained on the basis of only 32 carrier interviews. Unless the number of surveys were to be increased to the scope of a survey like the Statistics Canada For-Hire Trucking Survey, the limitations of having to extrapolate a few results to describe the Canadian industry universe would still remain.

A further limitation of Methodology 5A is its predictive nature. If actual before/after data is available, it does not make sense to use a predictive methodology. For the above reasons, Methodology 5A is not seen as being suitable to meet the objectives of this study.

5.2.2 Methodology 5B (Recommended as Primary Method)

Methodology 5B offers several advantages relative to the other methodologies. As noted above, Methodology 5B is a modified version of the basic methodology used in the 1987 RTAC study ***Economics of Truck Sizes and Weights in Canada*** to estimate the long-term impacts of four alternative sets of truck weights and dimension regulations on the mix of truck configurations used in each province and territory, measured in terms of truck-kilometres of usage. As such, Methodology 5B is expected to be a practical means of obtaining useful estimates. As part of a larger economic model, the main output of Methodology 5B (provincial and national change in annual vehicle-kilometres due to the MoU) feeds neatly into the other parts of the study, namely trucking costs (Section 6) and infrastructure costs (Section 7).

Another key advantage of this methodology is, that after it is developed and applied the first time, it should be relatively easy to update the estimates in future years simply by inputting updated highway truck classification data (including future repeats of the CCMTA roadside survey data, and data from the weigh-in-motion (WIM) sites), updated truck volumes by link on the study road network, and changes in trucking unit costs. The methodology also allows testing of the sensitivity of the estimates to alternative assumptions for a wide range of input values, including truck traffic levels and truck configuration mixes at various locations on the study road network. The inclusion of a carrier survey as a fundamental component of the methodology helps to ensure that the method captures "real world" experience of carriers in adjusting their mix of configuration types in response to the 1988 MoU.

The major drawback of Methodology 5B is that the reliability of its estimates, at least in its initial applications, would be at best moderate. Limitations on the reliability of the estimates arise for two reasons. Firstly, as discussed in Section 2.2, the quality and quantity of available roadside truck classification information varies considerably from one roadside truck classification information varies considerably from one province to another. In several provinces, there is a serious lack of detail on the configuration types observed at roadside survey sites, and in some cases, roadside surveys are conducted infrequently and procedures and definitions may vary from survey to survey. However, some good roadside survey results are available, for example the 1991 CCMTA survey, which provides reliable estimates of extra provincial flows by truck type, axle weight, etc., and data from a number of WIM sites. In addition, some provinces have indicated a willingness to collect data from permanent and temporary weigh scale sites to address data deficiencies.

Secondly, the procedure in the methodology whereby it is assumed that the truck configuration mix observed at one highway location can be assumed to apply equally to other roads in the vicinity introduces errors where truck traffic characteristics vary widely at different locations on the study road network. This assignment procedure is obviously somewhat crude, but the level of error it introduces is smaller in jurisdictions where trucks are surveyed at a large number of locations. In any event, the provincial authorities administering these surveys are aware of these difficulties and organize their surveys so as to minimize such sources of error. Furthermore, where such errors occur, provincial vehicle classification counts are normally available.

It is believed that Methodology 5B can provide estimates of truck fleet composition impacts which are sufficiently reliable to draw useful conclusions about the impacts of the 1988 MoU, and that the quality of the estimates is likely to improve in future years as improvements are made to the trucking data collected by the provinces and if the CCMTA Roadside Survey is conducted on an on-going basis. Also, it will be possible to specify the data that should be captured from WIM sites, further improving the accuracy and reliability of this methodology.

5.2.3 Methodology 5C (Recommended as Back-Up Method)

The main advantages of Methodology 5C, which relies on a carrier survey is that it is simple and easy to understand and that the quality of the data actually collected through the carrier survey is expected to be quite high. However, some carriers may not have kept records of the details that would be sought after in the survey.

On the other hand, the methodology has a number of serious limitations. The cost to carry out the detailed carrier survey is expected to be quite significant, since a large number of carriers would have to be surveyed in order to provide representative estimates at the provincial/territorial level required in this study. Another key problem involves how to expand the changes in annual vehicle-kilometres by configuration type made by the carriers included in the survey to obtain totals by province and nationally. Performing this expansion would require an estimate of the total annual truck-kilometres generated by all types of carriers including small carriers. This total trucking activity figure is not available from any existing sources, since the Statistics Canada for-hire and private trucking surveys currently exclude trucking firms with annual freight revenues below $1 million, and therefore a total "universe" of trucking firms (for-hire carriers and private fleet operators) is not available. Another problem is that, since the methodology is based entirely on a carrier survey, it does not allow sensitivity testing of the impact estimates. Further, random sampling and stratification is not practical due to the difficulty in identifying the universe of trucking firms and categorizing individual carriers.

5.2.4 Methodology 5D (Not Recommended)

Methodology 5D, based on comparing truck and trailer registrations for 1988 (pre-MoU) in 1992 (post-MoU) is very easy to apply and to update as new provincial and territorial registration data become available. It uses input data which in theory should produce reliable estimates of changes in registered gross vehicle weights of tractors and in trailer types. In practice, however, vehicles no longer in use are not removed from registration lists, so that a realistic indication of the operational fleet is not provided.

This methodology has another serious limitation. Since the registered gross vehicle weight of a tractor does not indicate the actual weights at which it is operated on the road nor the number of kilometres over which it travels at different weights, changes in tractor registered gross vehicle weights are very imperfect indicators of changes in truck operating weights on the road network. Furthermore, since provincial trailer registration data does not provide any information on trailer length, this methodology is incapable of any measurement of the impacts of the 1988 MoU on the use of 53' semi-trailers and longer combination trucks. For these reasons, Methodology 5D is essentially an inadequate methodology for estimating truck fleet composition impacts, and will remain so unless provincial registration databases can be improved in the future to classify trailers by length and purge trailers which are no longer in operation.

5.3 RECOMMENDED METHODOLOGY

Based on the above assessment of the alternative methodologies for estimating truck fleet composition impacts, **it was recommended that Methodology 5B be the main methodology used in Phase 3 to estimate the truck fleet composition impacts of the 1988 MoU.** The recommended methodology as depicted in Exhibit 5.2 was adopted, with the agreement of the Steering Committee, as the general framework to be used to estimate the truck fleet composition impacts in Phase 3, it being understood that limited modifications might be required during the course of the work to address data limitations.

While truck fleet composition and use was essentially be derived through Methodology 5B, **we proposed also to use some or all of Methodology 5C as appropriate, to supplement the main methodology, and to provide controls and checks to compensate for data gaps and inconsistencies that might affect the reliability of results from Methodology 5B.** Using this dual approach, the study benefitted from the insight provided by comparing and, in some cases, combining the two approaches.

6. TRUCKING COSTS

In Section 6, various alternatives are described for estimating the cost impacts on carriers due to the 1988 MoU. These alternatives are then assessed, and a recommendation is proposed for Phase 2 of the study.

6.1 ALTERNATIVE METHODOLOGIES

Exhibits 6.1 and 6.2 depict two alternative methodologies for estimating the impacts of the 1988 MoU on trucking costs in each province and territory, and for Canada as a whole. A third alternative for estimating trucking cost impacts comes out of Methodology 5A, described in Section 5 and shown in flowchart form in Exhibit 5.1 (this methodology can also be used to estimate truck fleet composition impacts, as discussed in Section 5). The major steps in each of these three methodologies are summarized below.

6.1.1 Methodology 6A (Recommended as the Main Method)

Methodology 6A, as shown in Exhibit 6.1, is similar to the methodology which was applied in the 1987 RTAC ***Economics Of Truck Sizes And Weights*** study to estimate the long-term changes in trucking costs resulting from four alternative scenarios of increased truck sizes and weights to apply across Canada. The methodology consists of three main steps, as follows:

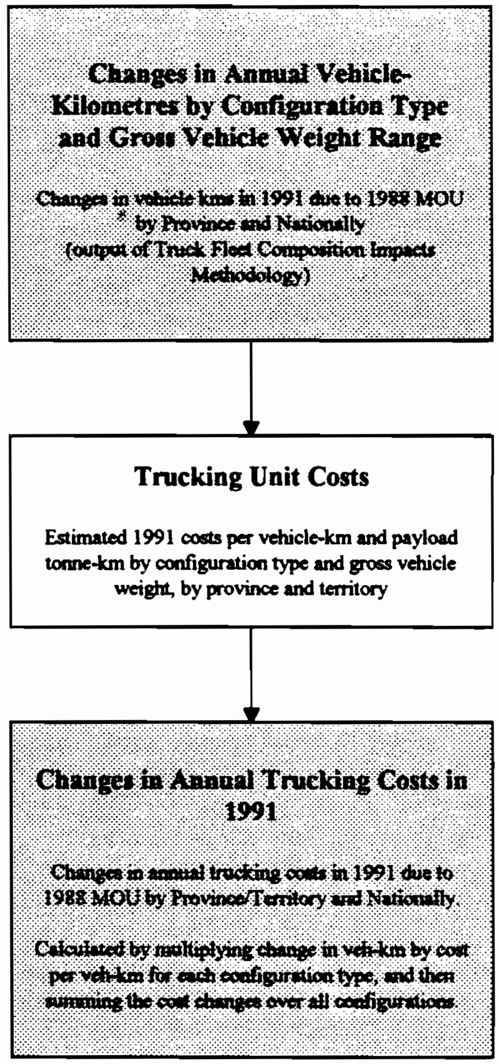
(i) **Changes in Annual Vehicle-Kilometres Due to MoU** - The first step is to obtain estimates of changes in annual vehicle-kilometres by configuration type and gross vehicle weight range in 1991 due to the 1988 MoU, which is the output of the recommended methodology for estimating truck fleet composition impacts (Methodology 5B). This information should be available by individual province and territory;

(ii) **Trucking Unit Costs** - 1991 truck operating costs per vehicle-kilometre and per payload tonne-kilometre are estimated for various configuration types and gross vehicle weights, with separate estimates for each province and territory. These costs are developed by applying the IBI Group Truck Cost Model for tractor/trailer combinations allowed prior to the 1988 MoU as well as new configurations only permitted after the 1988 MoU was signed. Different unit costs are also developed for movements between different pairs of provinces and for transborder movements, using average input costs (e.g. fuel costs) for the jurisdictions traversed, and tabulated for both years;

(iii) **Estimate Changes In Annual Trucking Costs In 1991 Due To 1988 MoU** - These are estimated by multiplying the changes in annual vehicle-kilometres from Step (i) by the cost per vehicle-kilometre for each configuration type from Step (ii). The resulting estimated cost changes are then summed over all

EXHIBIT 6.1

TRUCKING COST IMPACTS METHODOLOGY 6A



configuration types in each province and territory by adding together all the matrix cells.

6.1.2 Methodology 6B (Recommended as Back-Up Method)

Methodology 6B, shown in Exhibit 6.2, relies on an in-depth carrier survey to directly collect information on actual changes in truck operating costs which have been experienced by carriers as a result of the 1988 MoU. The methodology includes the following major steps:

(i) **Select Sample Of Carriers Across Canada** - A sample of trucking firms across Canada is drawn;

(ii) **Carrier Cost Survey** - A detailed survey of each carrier in the sample is conducted which collects the following information from each carrier:

- Typical current costs per vehicle-kilometre and per payload tonne-kilometre incurred by the carrier for hauling freight on routes within and between specific provinces and on transborder routes;

- The unit costs on the same routes incurred in 1988, converted to current costs using an appropriate inflation index;

- Identification of the proportions of the cost changes which are attributable to the 1988 MoU;

- Current annual tonne-kilometres of freight hauled by route.

(iii) **Changes in Annual Trucking Costs** - Using the information collected in the carrier cost survey, the changes in annual trucking costs in 1992 due to the 1988 MoU are estimated for the carriers surveyed;

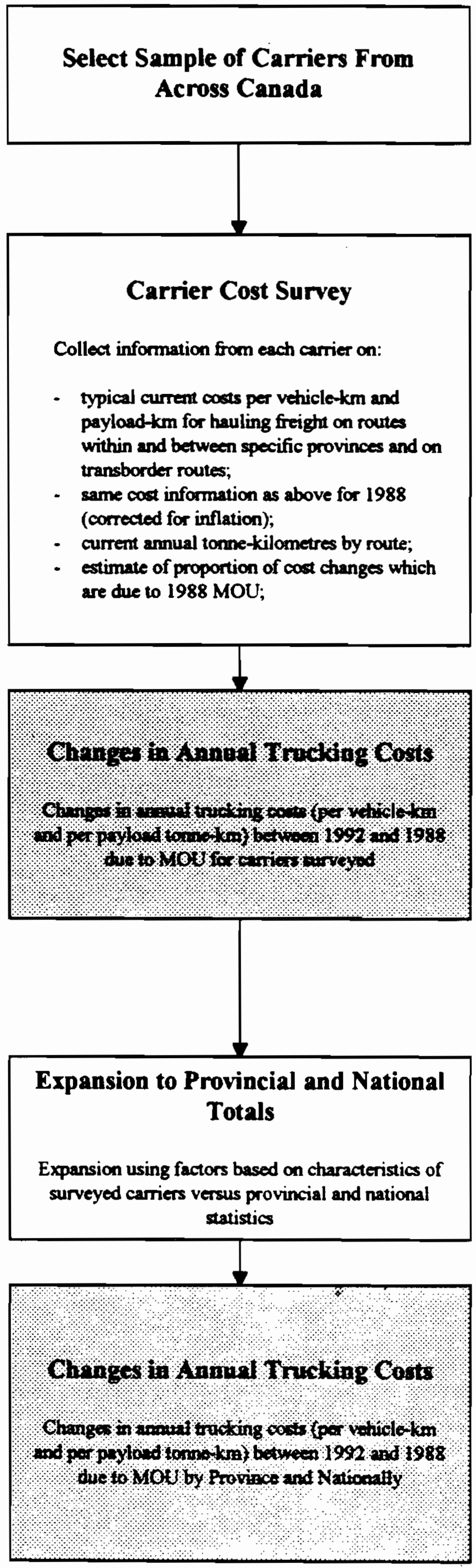
(iv) **Estimate Changes In Annual Trucking Costs In 1992 Due To 1988 MoU By Province And Nation** - These are estimated by expanding the results of Step (iii) to provincial and national totals using expansion factors which reflect the proportions of total tonne-kilometres of trucking in each province accounted for by the surveyed carriers.

6.1.3 Methodology 6C (Not Recommended)

Methodology 6C, depicted in Exhibit 5.1, is the methodology which was applied in US TRB Special Report 225 to estimate trucking cost impacts. The first six steps in this combined methodology are described in Section 5.1. The output of the front end of the methodology is a set of estimates of changes in truck-miles and ton-miles by configuration

EXHIBIT 6.2

TRUCKING COST IMPACTS METHODOLOGY 6B



type and operating weight by region of the country, resulting from the changes in truck size and weight limits being tested. The changes in truck-miles are then multiplied by the trucking costs per vehicle-mile estimated in Step (ii) for various configuration types in order to estimate changes in total trucking costs by region and for the country as a whole.

6.2 ASSESSMENT OF ALTERNATIVES

Exhibit 6.3 shows the results of the assessment of the three alternative methodologies for estimating trucking cost impacts. The assessment procedure was the same as that applied in Section 5 for the truck fleet composition methodologies. A summary of the relative advantages and disadvantages of each methodology is provided below.

6.2.1 Methodology 6A (Recommended as Main Method)

Since it is an extension of Methodology 5B, Methodology 6A shares the relative advantages and disadvantages of Methodology 5B which are described in Section 5.2 The main advantages of Methodology 6A include its practicality for obtaining useful estimates of trucking cost changes, its ease of updating in the future as updated information on trucking input costs is received, and its ability to allow testing of the sensitivity of estimated trucking cost impacts to different assumptions about trucking unit costs. Like Methodology 5B, its main disadvantage lies in the limited reliability of the estimates of truck fleet mix changes (as discussed in more detail in Section 5.2). On the other hand, the estimates of truck operating costs per kilometre and per tonne-kilometre obtained from the truck cost model are expected to be highly reliable.

6.2.2 Methodology 6B (Recommended as Back-Up Method)

The main advantage of Methodology 6B is that it can be easily explained and understood. As well, the quality of the unit trucking cost data to be collected through the carrier cost survey is expected to be at least moderate, since the data is obtained directly from carriers. However, some of the carriers surveyed would very likely not be able to provide cost information broken down by specific route, due to a lack of detailed records. Methods of allocating overhead and joint costs to individual truck movements would also probably differ from carrier to carrier.

Methodology 6B has several important drawbacks, closely related to those of Methodology 5C. Firstly, the cost to conduct the carrier cost survey would be significant, since a large number of carriers would need to be surveyed to provide statistically significant results at the provincial/territorial level. Secondly, it would be difficult or impossible to expand the changes in annual trucking costs identified by the surveyed carrier to provincial and national totals for the trucking industry as a whole. This is because, as mentioned in Section 5.2, there are no figures available on total annual truck-kilometres performed on

EXHIBIT 6.3

ASSESSMENT OF ALTERNATIVE METHODOLOGIES TRUCKING COST IMPACTS

Criteria	Methodology		
	6A	6B	6C
Reliability of Estimates	◎	○	◎
Availability/Quality of Data	◎	◎	○
Start-up Costs	◎	○	○
On-going Application Costs	●	○	○
Ease of Application/Understanding	◎	●	○
Ease of Updating	◎	○	◎
Flexibility for Sensitivity Testing	●	○	●
Ability to Measure Key Changes	●	◎	●

Legend:
● - High Desirability
◎ - Medium Desirability
○ - Low Desirability

Canadian roads since Statistics Canada surveys exclude trucking firms with annual revenues below $1 million. Thirdly, since the methodology is based solely on a carrier survey, it does not permit sensitivity testing of its output with respect to changes in input values. Finally, the methodology is not easy to update in the future, as each update would require that TAC conduct another carrier cost survey.

6.2.3 Methodology 6C (Not Recommended)

Since Methodology 6C is essentially the "back end" of Methodology 5A, it has the same advantages and disadvantages as Methodology 5A. These are described in Section 5.2.

6.3 RECOMMENDED METHODOLOGY

Based on the above assessment, **it was recommended that Methodology 6A be used in Phase 3 to estimate the impacts of the 1988 MoU on annual trucking costs.** It was noted that some modifications to the methodology might be necessary if problems arise with the quality of available trucking cost data during the data collection phase of the study.

Again, to mitigate data limitations and to provide additional checks and balances on the Methodology 6A results, **it was recommended that a carrier survey (Methodology 6B) be conducted in concert with, and to augment and check, the principal methodology. It was recommended that the carrier survey components (Methodologies 5C and 6B) be amalgamated into one integrated survey.**

These recommendations were approved by the Steering Committee.

7. INFRASTRUCTURE COSTS

Infrastructure costs associated with changed vehicle weights and dimensions generally fall into one of the following categories:

- Geometric Design
- Pavements Impacts
- Roadway Maintenance
- Bridges
- Effects on Others Users

In this section, methodologies proposed for estimating costs associated with vehicle configurations and weights introduced by the MoU are discussed for each of these areas. Infrastructure costs are different from other types of estimates dealt with in this study (i.e. truck fleet composition, trucking costs, road safety impacts) in that they consist of a number of components which are calculated according to established industry standards. Therefore, with the exception of pavement impacts, assessments of alternative methodologies are not included in this section. Instead, the emphasis lies in capturing all relevant and significant cost components.

In estimating infrastructure costs, certain cost components (e.g. pavement impacts) assume data on truck fleet composition before and after the implementation of the MoU. The output of the methodology recommended in Chapter 6 (Truck Fleet Composition) would serve as input to the various infrastructure cost component estimates, thereby maintaining continuity and consistency within the study.

7.1 GEOMETRIC DESIGN

Heavy vehicles control certain elements of highway design standards. For example clearances for overhead structures, such as truss bridges, are controlled in large part by truck height limits. Lane width standards are affected by vehicle width.

The TAC vehicle performance criteria affecting geometric design parameters remain the same as, or are superior to, the typical 5-axle tractor trailer in use at the time the criteria were being developed. Therefore, there should be no costs associated with changed roadway geometrics and a formal assessment of methodologies is not applicable. **It was recommended that each provincial highway department be consulted to identify any areas where these vehicles may nevertheless be influencing geometric design. Any such cases would be documented and, where possible, independently analyzed by study team members to confirm the connection between the vehicle performance and such costs.** This was approved by the Steering Committee.

One issue related to geometric design has been the question of safe passing sight distance for 25 metre vs 23 metre lengths. This issue was recently examined in a TAC study, with the conclusion that the 25 metre length has no significant effect on passing length requirements compared to the 23 metre length. **It was therefore agreed that there would be no requirement to pursue this further as part of this study.**

7.2 PAVEMENT IMPACTS

The condition and performance of highway pavements depend upon many factors:

- thickness of the various pavement layers;
- quality of construction material and practices
- maintenance;
- environmental conditions;
- the loads to which the pavements are subjected.

The concept of equivalent single axle load (ESAL) is widely used to measure the effects of traffic loadings on pavements. All studies of pavement wear by heavy vehicles we have examined use this concept, which was developed in the 1950's from the AASHTO Road test. In this concept, an 18,000 pound axle is 1.00 ESAL. The ESAL values for other axles express their relative effect on pavement wear. Recent Canadian research has developed specific methods for calculating ESALs (or LEFs - load equivalency factors - as they are more commonly referred to). **It was recommended and approved by the Committee that these LEFs would be used in this study as they are developed for Canadian conditions.** If desired, calculations could also be performed using the AASHTO and other (such as Waterloo) equivalency factors to test sensitivity of findings to this parameter.

The AASHTO Road Test in the United States and the Brampton Road Test in Canada have provided valuable information to predict pavement performance reliability. The AASHTO Road Test, having been carried out over a relatively short time span, proved that the accumulation of the number of 18 kip axle loads contributes significantly to pavement surface deterioration as measured by the American serviceability index, PSI, which is a subjective panel rating of road roughness on a scale from 0 to 5, or as measured by the equivalent Canadian measure, the riding comfort index, RCI, which is a subjective panel rating on a scale from 0 to 10. Results from the Brampton Road Test also confirmed these conclusions. Since this latter test was conducted over an extended length of time, it was found that cycles of freezing and thawing and other environmental factors also significantly contribute to pavement deterioration.

The Ontario flexible pavement deterioration model, OPAC, developed from the results of the above noted road tests, is the most relevant model of pavement deterioration for Canadian conditions. It is one of the few models which separates load from climate associated deterioration. It has been used in a number of studies throughout Canada to predict loss of pavement life due to changes in truck traffic levels. This model and procedures for its use are described in the TAC Pavement Management Guide.

New pavements typically have an initial RCI of 8 to 9. This decreases over time due to the effects of traffic and weather. On major highways, pavements are normally considered to be at an unacceptable state of deterioration when the RCI has deteriorated to a level of 4.5. At this point the pavement will be resurfaced with an overlay. Generally, flexible pavements in Canada will be overlaid twice in a span of 40 to 50 years before being reconstructed. Exhibit 7.1 indicates this graphically.

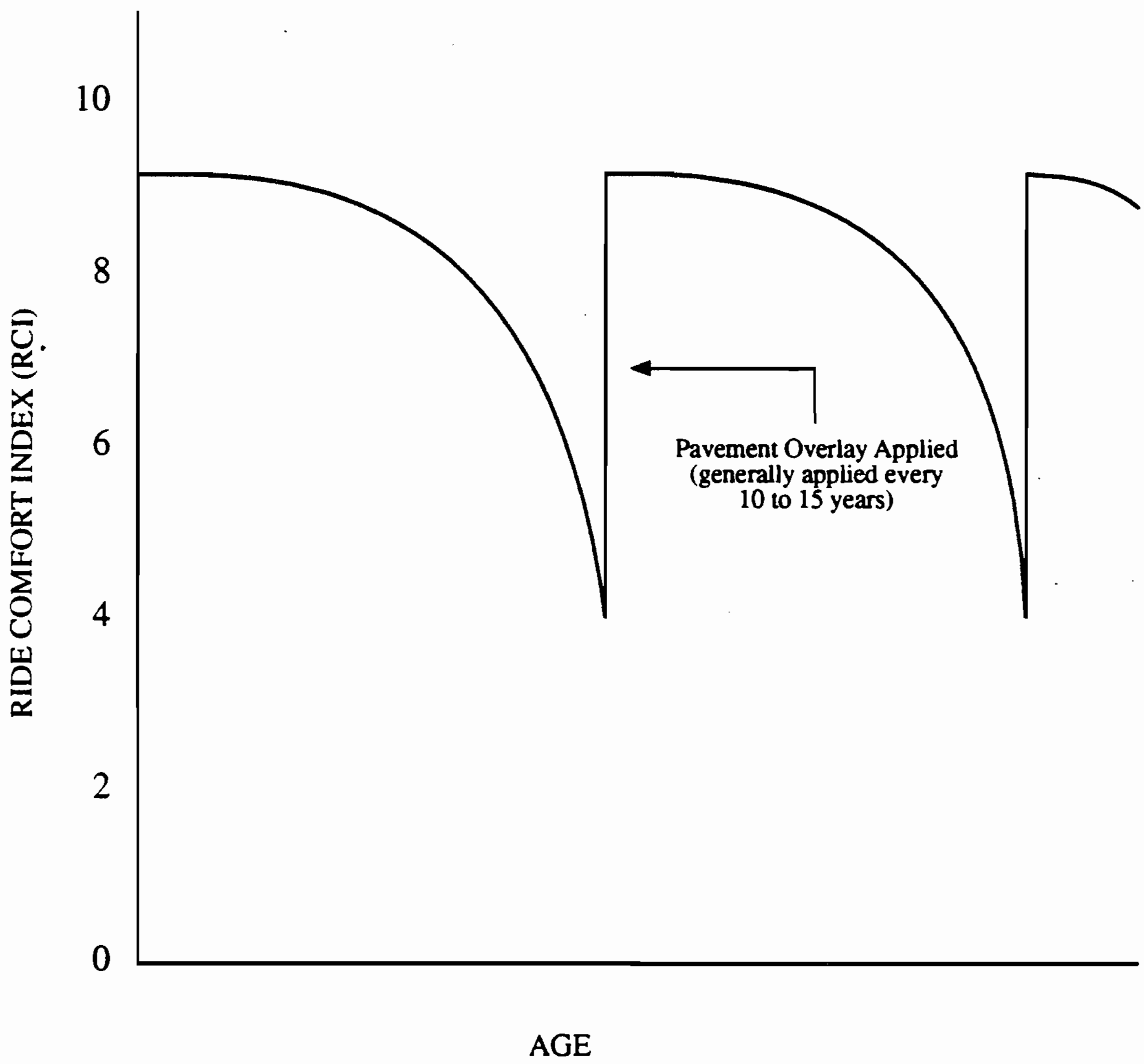
Additional truck traffic on a pavement will cause it to deteriorate more quickly. As a result the roadway will have to be resurfaced sooner. This earlier expenditure of funds on paving represents the cost of the additional traffic and is often referred to as the "build sooner costs". This is illustrated by Exhibit 7.2. Some of the TAC vehicles would actually reduce the number of LEFs applied per tonne of freight carried; for example, use of the 8-axle B-train compared to the previous 5-axle tractor trailer. This would in fact reduce pavement wear and hence increase pavement life.

An alternative to estimating "build sooner" costs is to determine the cost of the additional asphalt thickness required to maintain the pavement life at its previous level. The pavement design charts used by each province are referenced to determine the additional thickness required to handle a change in LEFs. Exhibit 7.3 illustrates the use of these charts. Using a base course granular thickness of 300 mm, an asphalt thickness of 150 mm is required for a traffic load of 100000 (10^5) ESALs. If traffic load is increased to 1,000,000 (10^6) ESALs the total asphalt thickness required is 210 mm. This means the additional 900,000 ESALs requires an incremental 60 mm of asphalt.

Our recommended approach was to use the "build sooner" methodology as it is more commonly used, since it incorporates environmental impact and allows one to identify a cost even when roadway resurfacing would not be undertaken because only a limited additional thickness of asphalt is required. In addition, the "build sooner" approach is more applicable where pavement life is lengthened and allows this benefit to be quantified in dollar terms. The design chart approach would identify the thickness of asphalt that would have

EXHIBIT 7.1

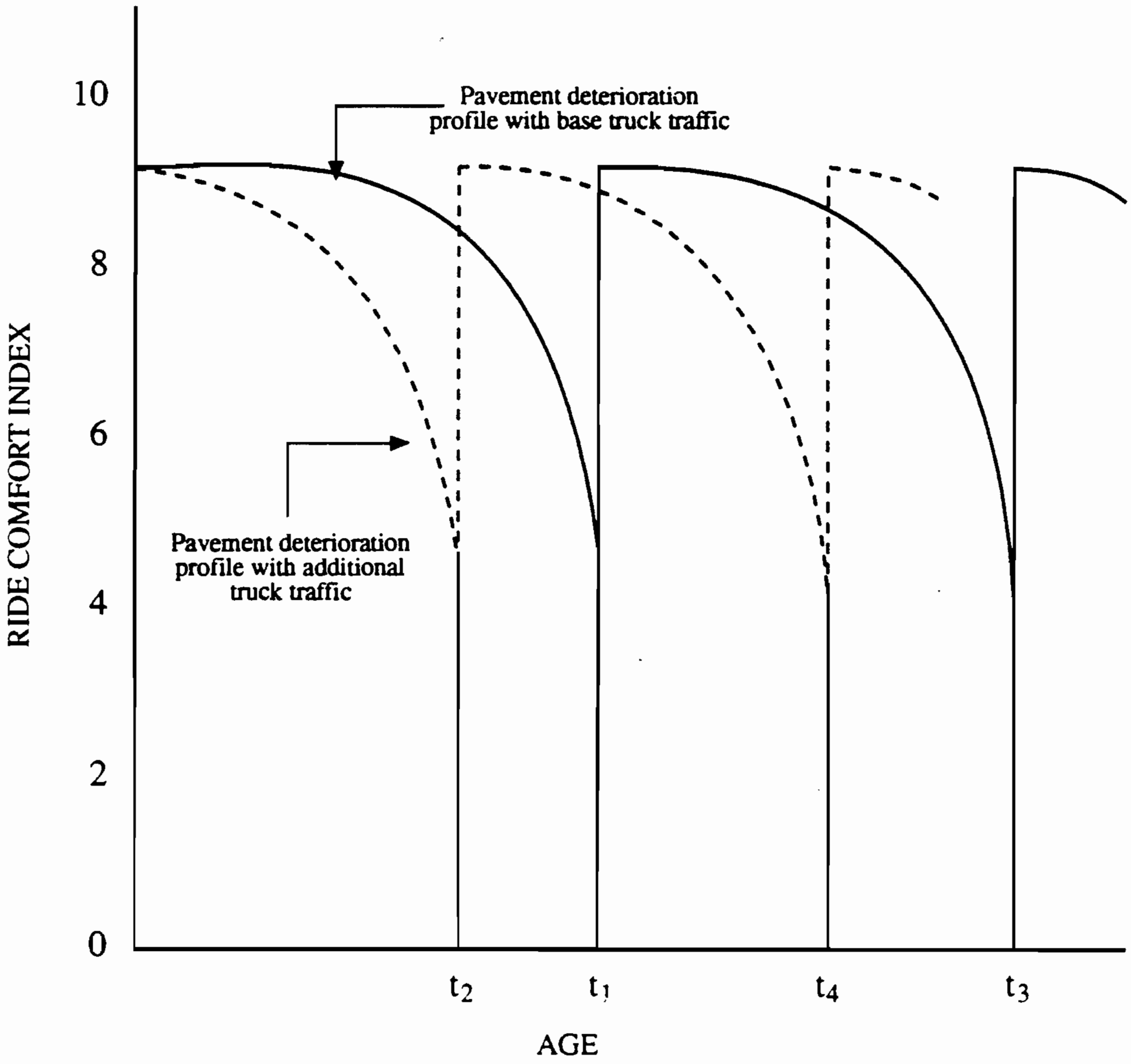
EFFECTS OF PAVEMENT OVERLAY ON RCI



IBI GROUP / ADI

EXHIBIT 7.2

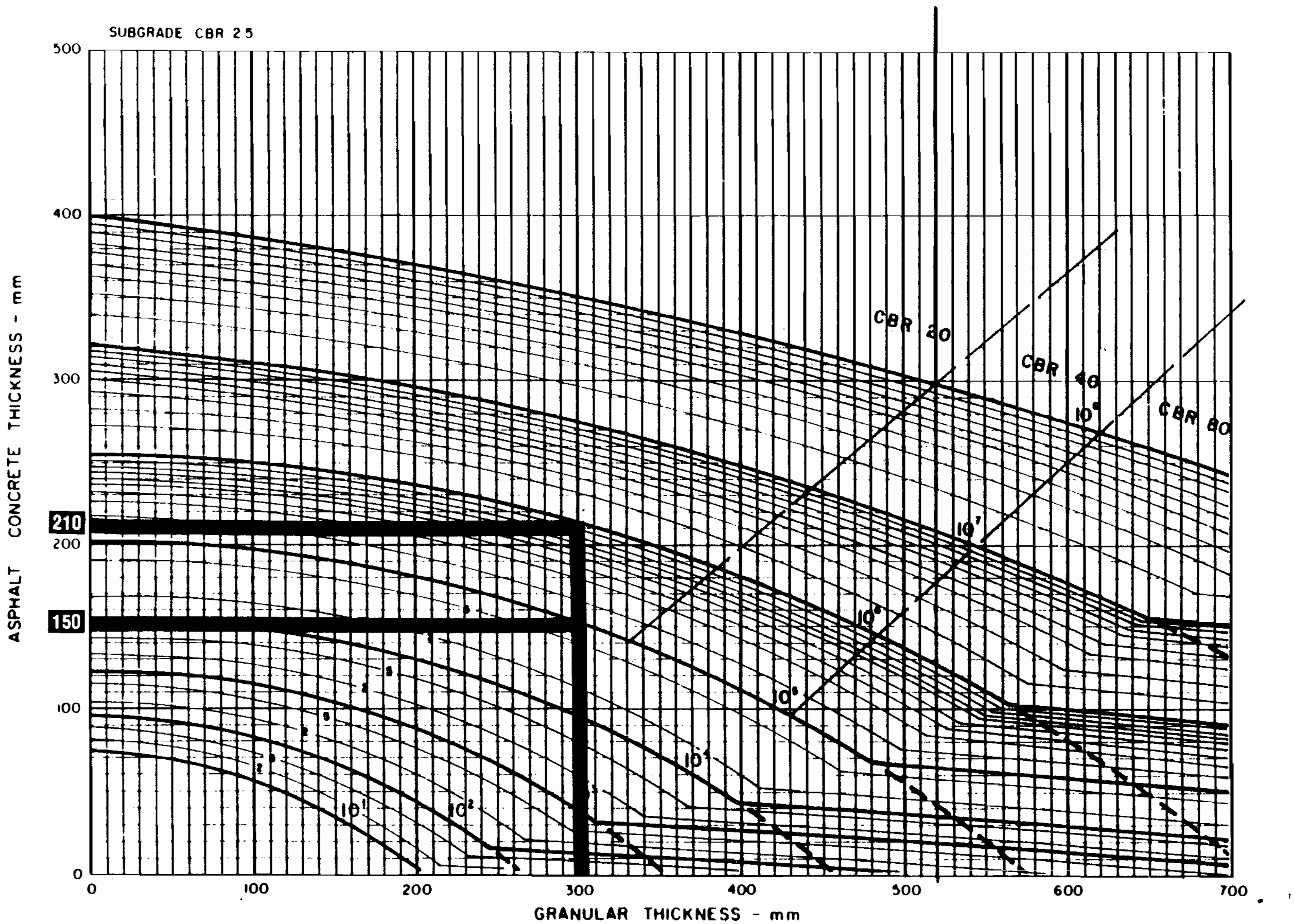
ILLUSTRATION OF BUILD SOONER COSTS



Time (t_1 - t_2) and Time (t_3 - t_4) represent an advancement in timing of the pavement overlay, and hence a "build sooner" cost

EXHIBIT 7.3

EXAMPLE: USE OF PROVINCIAL PAVEMENT DESIGN CHARTS



Source: Saskatchewan Surfacing Manual, October, 1981 to be removed from an existing pavement, something which would not occur. The Steering Committee agreed with this recommendation.

7.2.1 Application of ESAL Concept to Estimate Pavement Requirements

Exhibit 7.4 illustrates the general methodology used by virtually all studies of this nature to estimate the pavements impact of a regulatory change in allowable axle loads. First, the truck composition for the section of roadway being studied is determined, and the planning horizon (normally 15 years) calculated. Next, the traffic composition is estimated under the revised regulations and the ESALs the revised traffic will produce over the same planning horizon is estimated. Incremental ESALs due to the regulatory change are then calculated by subtracting the revised ESALs from the original ESAL total. This is the change in pavement loading due to the regulatory change. Through the use of pavement performance models, reduced (or enhanced) life of the pavement is calculated. Alternatively, design charts are referred to and the additional (or reduced) pavement thickness required under the revised traffic loading determined.

7.2.1.1 Pavement Performance Model to Application Alternatives

Several options exist for applying the recommended pavement performance model, and accompanying methodology, to roadways experiencing changes in truck composition, and hence ESALs due to the regulatory changes. These include:

- Performing the calculations for all affected roads;
- Selecting a sample of road sections typical of the network and expanding to represent system totals;
- Using a series of representative sites;
- Using C-SHRP sites.

The advantages and disadvantages of each of these approaches are discussed below.

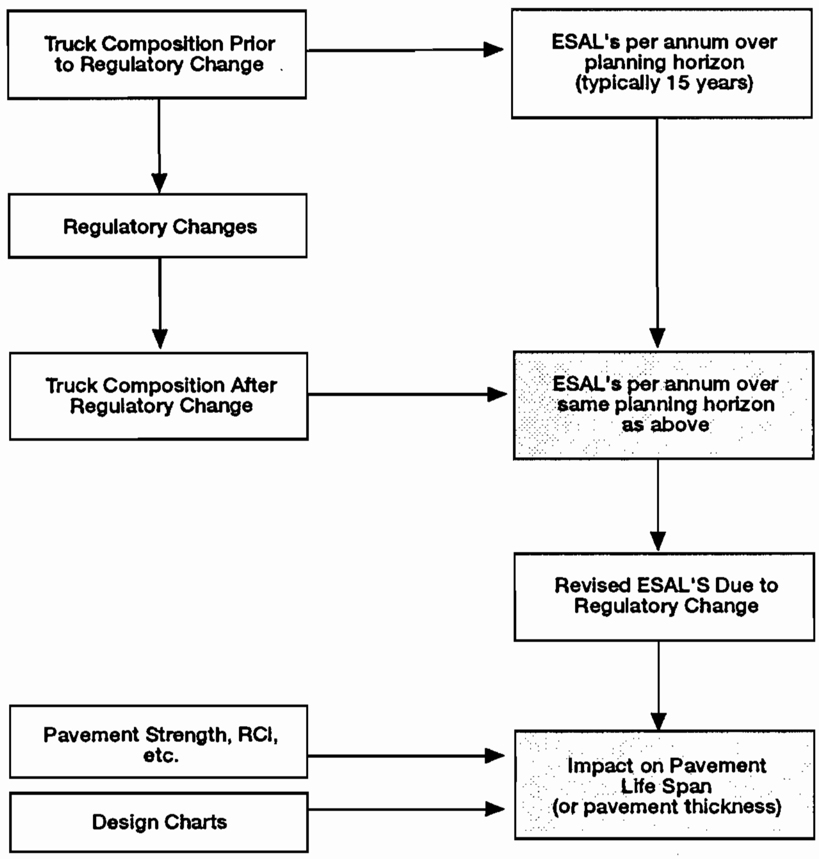
7.2.1.2 Assessment of Alternatives

All Affected Roads

The main advantage of this approach is its thoroughness as each section of road is individually examined. Estimates of the change in ESALs due to the regulatory change would be made for each link in the study network. With a typical section length of 20 to 25 kilometres, and an initial designated network of 50,000 kilometres (since expanded to over 200,000 kilometres), over 2,000 sections of road would be examined individually. While thorough, this approach requires an extensive database to be built and extensive computer runs to estimate the impact of the changes on pavement life. Each province would have to spend considerable effort organizing the required data on pavement strength and condition.

EXHIBIT 7.4

PAVEMENT IMPACTS GENERAL METHODOLOGY



Selected Sample

This approach was used in the 1987 Vehicle Weights and Dimensions Study. It has the advantage of being relatively thorough (a 20% sample was used in the previous study), while reducing data and computing requirements to more manageable levels. The 1987 study included approximately 400 sections, each 20 to 25 kilometres in length. Given a designated system length of approximately 50,000 kilometres, and a similar section length as the 1987 study, this approach for this study would consist of 400 to 500 sample sections. Compared to the " all affected roads " approach there would be a small loss of accuracy in estimating total pavement costs due to sampling. This should not be of any consequence to this study as the level of accuracy associated with the truck composition estimates (both prior to and post regulatory change) will be the primary factor controlling overall accuracy of the final estimates. Also compared to the " all affected roads approach " there would be a reduced requirement from the provinces for information, although the remaining effort is still substantial.

Series of Representative Sites

These sites would be selected to reflect the range of highway types affected in each province, with possibly an average of 3 to 5 sites per province. This would allow conclusions to be reached regarding the possible magnitude of the impact the changed regulations would have on pavement costs on a province-by-province basis. However, any estimates for the entire designated network could have a wide confidence level associated with them if the impact varies even to a limited extent on a site by site basis. Data requirements from the provinces would be limited and one of the main site selection criteria would be ready availability of provincial data.

The major benefit of this approach is that data requirements are limited compared to the two approaches noted above. The main disadvantage is the limited accuracy of any estimates of total pavement costs on the entire affected network. This accuracy can only be determined after the impacts at each site can be calculated. However, it is anticipated pavement costs will be minor or possibly slightly negative (i.e. longer pavement life resulting in cost savings). With small pavement impacts compared to the truck cost savings expected, a large confidence interval on pavement costs can be accepted as it will not unduly influence overall study results. Should (unexpected) significant impacts prove to be the case, the number of sites sampled could be increased as required to achieve desired level of accuracy.

C-SHRP/SHRP Sites

This is similar to the "representative site" option noted above except that sampled sites are purposely limited to those being monitored on a long term basis under the SHRP/C-SHRP programs. This option has the advantage of having, relatively speaking, readily available traffic and pavement data. Using these sites will also aid in future monitoring of the effects of weight and dimension regulations, as long term monitoring of these sites is already in place. Exhibit 7.5 illustrates C-SHRP sites. In total there are 24 sites and 64 road sections (i.e. different design standards) involved. These may have to be supplemented to ensure sections representative of the entire designated network are considered.

7.2.1.3 Recommended Alternative

In light of anticipated results that pavement impacts will be marginal, **the C-SHRP/SHRP option was recommended** for the following reasons:

- Requirements for pavement data from the provinces will be minimal if there are any at all.

- Weigh-in-motion scales at these sites provide the best data possible on truck configurations and axle weights. (In actual fact little WIM data proved to be available for a number of reasons ranging from technical difficulties with the WIM equipment to lack of resources at the provincial level to calibrate and process the data.)

- A long term monitoring program for these sites is already in place.

- The number of sites involved should be sufficient to establish the relative magnitude of pavement impacts due to the changed regulations. If these impacts are limited as expected then this number of sites should be sufficient for purposes of this study. If not, then additional sites would need to be sampled. Until the magnitude of the pavement impacts for some sample sections are calculated it is not possible to project the need to include additional sites nor the number that may be required.

This recommendation was accepted by the Steering Committee.

EXHIBIT 7.5
C-SHRP PERMANENT COUNT STATIONS

JURISDICTION	C-SHRP ID#	SITE LOCATION	DATE OF REHAB
Alberta (1 site, 4 sections)	8104041-4	Hwy 16 Wolf Creek to W. of Jct. Hwy 32	Oct. 15, 1990
British Columbia (3 sites, 6 sections)	8202051-2	Hwy 19 - near Port McNeil	Sept. 1990
	8205021-2	Hwy 99 - near White Rock - north site	July 1990
	8206051-2	Hwy 99 - near White Rock - south site	July 1990
Manitoba (2 sites, 7 sections)	8304031-3	Hwy 2 (11.5km E. of Hwy 10) - Wawanesa - Westbound lane	July 6, 1990
	8308011-4	Hwy 1 (27km E. of Hwy 12) - Brokenhead River - Westbound lane	Sept. 13, 1989
New Brunswick (3 sites, 9 sections)	8401011-3	Hwy 15 - Moncton - District 3 (Painsec) Shediac	July 31, 1989
	8402041-2	Hwy 101 - Oromocto River - District 6 (Central Blissville) Fredericton Junction	July 11, 1989
	8406041-4	Hwy 2 on TCH (Mactaquc), in Control Section 19 (Pokiote)	Aug. 28, 1989
Newfoundland (3 sites, 6 sections)	8502011-2	TCH Route 1 - Bonavista	July 31, 1989
	8502061-2	TCH Route 1 - Red Cliff	Aug. 20, 1990
	8506011-2	TCH Route 1 - Kelly's Pond	Sept. 25, 1989
Nova Scotia (2 sites, 6 sections)	8605011-3	Hwy 102 - Hilden, near Brookfield	Oct. 10, 1989
	8606031-3	Hwy 103 - Hebbs Cross	July 25, 1989

EXHIBIT 7.5 (Cont'd)

C-SHRP PERMANENT COUNT STATIONS

JURISDICTION	C-SHRP ID#	SITE LOCATION	DATE OF REHAB
Ontario (4 sites, 10 sections)	8701021-2	Hwy 80 - Sarnia or Petrolia (E. of Brigden)	July 4, 1989
	8705041-2	Hwy 11 - Bracebridge (SHRP site #87B310, 87B311)	Sept. 1990
	8705051-4	Hwy 57 - New Castle or Bowmanville	1990
	8707011-2	Hwy 31 - Greely or Ottawa	Aug. 16, 1990
Prince Edward Island (1 site, 4 sections)	8802031-4	Route 2 - E. of Route 254	Sept. 26, 1989
Quebec (2 sites, 6 sections)	8905031-4	Autoroute 40 - Pointe-aux-trembles	Sept. 8, 1989
	8907021-2	Autoroute 73 - Ste Marie de Beauce	July 26, 1991
Saskatchewan (3 sites, 7 sections)	9004021-2	Hwy 5 - east of Humboldt	Oct. 2-26, 1989
	9008021-3	Hwy 10-03 - west of Yorkton	June 27-July 21, 1989
	9008031-2	Hwy 1-06B - west of Indian Head	July 25-Oct. 14, 1989
TOTAL NUMBER OF SITES: 24 **TOTAL NUMBER OF SECTIONS: 65**			

7.2.2 Other Vehicle Characteristics Affecting Pavement Wear

There is a growing body of evidence that suggests vehicle characteristics, in addition to axle loads, also affect pavement wear. They include:

- tire pressure;
- suspension system;
- single (versus dual) tires and tire width.

The vehicles used in the road tests noted above had bias-ply tires with inflation pressures of 75 to 80 psi. Today most trucks (nearly 90% according to a recent roadside survey by ADI) use radial tires. These typically have a tire pressure of 100 psi. This higher pressure of radial tires is felt to accelerate pavement wear, particularly rutting.

As a truck moves along a highway, vehicle loads applied to the pavement surface fluctuate above and below their average values. This is often referred to as dynamic loading and is affected by the type of suspension the vehicle uses. Unfortunately very little is known quantitatively about the effects of different suspensions. Work by the OECD indicates that reductions in dynamic loads by improved suspension systems such as air ride suspensions may reduce pavement wear.

Past investigations of pavement wear effects have found that single tires induce more pavement wear than dual tires. Compensating factors include unbalanced loads of dual tires, and more wander by trucks with single tires (which reduces pavement wear by spreading it over a larger area), nevertheless, the effects of single tires versus duals is still significant. With respect to tire width, wider tires spread the impact over a larger area, reducing pavement wear.

It was recommended and agreed by the Committee that the trucking company survey and case studies be used to identify the extent to which changes in vehicle configurations may have affected the use of different suspension systems, different tire widths, tire pressures and single vs. dual tires and hence may have had a potential impact on pavement costs. While it was not possible to quantify the impact of any such changes, it would be of value to determine if there has been any shift that may influence pavement wear, either positively or negatively.

7.3 ROADWAY MAINTENANCE

Not all road maintenance costs are directly affected by traffic volumes. For example, roadside mowing, ditch and culvert cleaning are largely unaffected. The main area experiencing a change in cost due to a change in truck traffic is surface maintenance costs. This includes such items as cleaning and filling cracks, and patching potholes. Little quantitative data exists to relate traffic loads and pavement maintenance costs. A pavement in relatively good condition requires little maintenance; as pavement conditions worsen, routine maintenance costs increase. The effect of a traffic increase would be relatively insignificant if resurfacing programs were adjusted to reflect the build sooner time frame as there would not be any change in average pavement condition over time which is the main factor affecting roadway surface maintenance costs. None of the studies we have reviewed to date have included roadway maintenance costs primarily for this reason. Nevertheless **it was recommended that the study team contact each provincial highway agency to determine if they have any evidence of TAC vehicles and other truck fleet composition changes affecting roadway maintenance costs (other than "build sooner costs") either positively or negatively.** This recommendation was accepted by the Committee.

7.4 BRIDGES

In most provinces, bridges comprise a significant component of the highway system and the effects of increased vehicle loading, particularly on the weaker bridges in the highway system, must be considered. While bridges are designed in widely differing ways and constructed with a variety of materials, they generally consist of three components: a substructure (piers, abutments, etc.), a superstructure (girders, trusses, etc.) and the deck or roadway. Each element is sized to accommodate traffic load as well as the dead load of the structure and various environmental loads such as wind, earthquake and thermal forces.

In Canada, bridges are generally designed in accordance with specifications published by the Canadian Standards Association (CSA)[1] or the Ontario Bridge Code. These standards specify loads and load patterns that must be applied in a manner consistent with the materials and configuration of the bridges.

Safety factors are applied in the form of allowable material stresses in service load design methods (traditional approach) and through load factors and material performance factors in ultimate strength design methods (modern approach). Component steel members and connections must also be designed to resist fatigue under load repetition over the expected life of the bridge.

Truck loading patterns used for bridge design are specified for various bridge design standards. The most common bridge design standards for the highway system being evaluated are MS230, HS25 and HS20. H20

[1] *Design of Highway Bridges,* Canadian Standards Association, 175 Rexdale Boulevard, Rexdale, Ontario, M9W 1R3

and HS15 are encountered less frequently and are generally located on the secondary, lower volume roadways.

Bridges designed since 1977, which followed the CSA S6 code provisions, were designed to MS250, MS200 and MS150 loadings, these being about 10% greater in magnitude than HS25, HS20 and HS15 respectively. The former loadings are in metric units from the 1978 Canadian code while the latter are imperial from older Canadian and current U.S. codes. The current Canadian bridge code is CSA S6-88 which uses a CS-W designation with W referring to total vehicle load. This is recommended in the Code to be 600 kN on three major and one minor axle grouping.

Two bridge responses must be considered in evaluating the effect of heavy vehicles: overstress and fatigue. Overstress concerns the possibility of severe damage and possible collapse caused by a single extreme loading event. Fatigue concerns the cumulative damage caused by repeated heavy load passages which can cause cracks or rupture key elements of the structure.

7.4.1 Overstress

The key issue with respect to overstress is how the maximum stresses induced by the TAC vehicles compare to the maximum stresses induced by the standard (design) loading patterns and the previously allowed gross vehicle and axle weight limits. If the maximum stresses are less than the design load stresses in an existing bridge, no change in the service life of the bridge is expected nor are any retrofits or replacements required to increase load-bearing capacity. If the stresses caused by the new vehicles are greater than the design load stresses the bridge must be investigated for strengthening or a loss in service life may be expected.

For the truck weights and dimensions being considered, bending moments in the main bridge girders or chord members are the critical stresses to examine. Axle spacing, loading and overall wheelbase all affect the magnitude of the bending moment. As bridge span length increases the critical axle loads and spacing also change due to the greater number of axles which can be on one span at any given time.

The bending moments for various span lengths would be calculated for each TAC vehicle configuration and the critical vehicle identified for each span length. In general, the shortest axle spacings and highest loads allowed would result in the highest live load moments on bridge components. **It was recommended that these moments produced by the critical TAC vehicle would be compared to the bending moment produced by the standard truck loading pattern. In this way, span lengths where the critical TAC vehicle(s) produce bending moments in**

excess of the design load would be identified. This was agreed by the Committee.

7.4.1.1 Permissible Overstress Factor

Maximum loads for standard bridge designs are based on a permissible overstress factor. This factor is estimated by comparing the limiting service stress of the girder system material to the working stresses used in the original design criteria. Frequent stresses above this limiting stress tend to significantly reduce a bridge's life. Permissible overstress factors very depending on local practice or judgement.

Overstress factors used in the 1987 analysis for several different bridge constructions were;

- Reinforced concrete: 0.35
- Structural steel: 0.23
- Prestressed concrete: 0.12
- Wood: 0.23

It was recommended that these would be reviewed with the provincial bridge engineers to determine if they require updating. It would then be determined if the TAC vehicles generate stresses above accepted permissible overstresses for different span lengths and bridge types. Where overstress occurs, the bridges would require strengthening or replacement.

7.4.1.2 Strengthening Costs

Having identified the bridge types and span lengths where unacceptable overstress would occur, the available bridge inventory files maintained by each province would be reviewed to identify which bridges may require replacement or rehabilitation to ensure that an acceptable service life would be maintained. Each bridge so identified should then be rigorously evaluated with on site strength testing and follow-up detailed structural analysis to determine the exact nature of upgrading required and the cost to perform this work. Obviously, this is beyond the scope of this project. For example, British Columbia has indicated such an evaluation would cost $1 million for the bridges they identified as being unacceptably overstressed using the above procedures. Instead, **it was recommended that generalized cost figures, based on the study team's and provincial engineers' experience be developed to reflect the costs of any required improvements. This approach would be somewhat conservative by overestimating bridge costs. Bridges on low volume roads that could be posted for the (previous) lower limits rather than strengthened would also be identified.**

7.4.2 Fatigue

Fatigue is not a significant factor with the change in load and configuration, since the number of TAC vehicles will be low compared to the total traffic and fatigue considerations are based on the "average" truck, even for bridges carrying a high percentage of the revised trucks. However, stress range may be increased particularly in members that undergo stress reversal.

The bridges susceptible to fatigue are a small fraction of the total population. In general, fatigue problems are experienced only by some welded steel bridges, particularly those having fatigue sensitive details. Bolted and riveted steel, reinforced concrete, pre-stressed concrete, and timber bridges are typically not affected by fatigue. Age of the bridge is also important in the consideration of fatigue in that the design code in effect at the time of design will determine the details required to minimize fatigue problems.

Other factors will also be considered in selecting bridges from the population that may require assessment for fatigue under the revised loading. These factors include:

- Multi-span continuous bridges may be fatigue sensitive at negative moment regions, particularly at the termination of longitudinal stiffeners.
- Skewed bridges produce secondary stresses through diaphragms that may initiate cracking in main members.
- Bridges having redundant load paths, such as multi-girder bridges, are not normally fatigue-sensitive, since loss of one main member is not likely to result in total collapse.
- Short span bridges (i.e. less than 15 metres) may not be as susceptible to fatigue problems, since they are often fabricated using rolled beams with a minimum of connections and secondary members, providing fewer fatigue sensitive connections.

It was recommended that detailed calculations of fatigue parameters not be undertaken for any susceptible bridges in the study, but an assessment of the numbers and characteristics of bridges that may be suspect would be made.

The evaluation approach would be based on

> **Moses, F./Schilling, C.G./Raju, K.S.**
> ***Fatigue Evaluation Procedures for Steel Bridges***
> **National Co-operative Highway Research Program Report #299**
> **Transportation Research Board**
> **National Research Council**
> **Washington D.C., November 1987**

These recommendations were accepted by the Committee.

Any resultant projected reduction of service life and increased maintenance costs will be estimated conservatively. We are of the opinion that fatigue costs will not be a major factor as only a small number of bridges are likely to be significantly affected.

7.4.3 Survey of Provincial Bridge Engineers

A survey of each provincial bridge engineering department was proposed to obtain the results of any specific analysis they may have conducted to determine how the MoU may have affected bridge costs. Where this gave more specific and detailed information than the methodology proposed above, the results of the provincial analysis was used. This proved to be the case in most provinces.

7.5 EFFECTS ON OTHER HIGHWAY USERS

Changes in pavement condition affect highway users by increasing or decreasing vehicle repair costs, speed, and fuel economy. As with routine maintenance, changes in traffic loadings would have little effect on user costs provided the expenditures by highway agencies were adjusted (upwards or downwards) so there was no change in pavement condition. ADI has developed models for determining changes in user costs due to changes in pavement conditions. These models would be used to identify the magnitude of any changes in user costs, although intuition and our past experience suggests these would be insignificant.

8. ROAD SAFETY IMPACTS

The objective of the road safety analysis is to estimate the impact of the 1988 MoU on heavy truck accidents across Canada. In order to normalize the impact analysis for differences in the volume of goods transported by truck before and after the introduction of the MoU, it is important to estimate the change in truck accident rates per tonne of goods transported by heavy trucks. In this section, alternative methodologies for road safety analysis are described and assessed, and a proposed course of action is recommended.

8.1 ALTERNATIVE METHODOLOGIES

8.1.1 Methodology 8A (Not Recommended)

A basic approach for this analysis would involve estimating accident rates for the various heavy truck configuration types, estimating the total number of accidents that would have occurred in 1992 if the fleet mix had been the same as in 1988 and comparing this with the actual number of heavy vehicle accidents in 1992.

This basic approach can be applied to determine relative impact of the MoU on accident rates. In addition, available data on heavy truck accidents could be obtained from appropriate provincial ministries in order to estimate the absolute magnitude of accident impacts associated with heavy trucks. This estimate can be used to define the potential importance of accident impacts with respect to other issues.

8.1.2 Methodology 8B (Recommended)

Methodology 8B is based on the methodology applied in US TRB Special Report 227 "New Trucks for Greater Productivity and Less Road Wear". This report evaluates the Turner Proposal for trucks with lower axle weights but higher gross weights.

In order to determine the nature (positive or negative) and the order of magnitude of the road safety impacts of the MoU, Methodology 8B considers the following:

- changes in annual vehicle kilometres by configuration type and gross vehicle weight range;
- the relative handling and stability characteristics of various tractor/trailer configurations and the associated implications on truck accident rates;
- traffic operations characteristics and possible impacts on the road safety of non-truck traffic sharing the road with various tractor/trailer configurations, such as impacts of

changes in passing sight distance requirements on automobile accidents during passing manoeuvres.

Estimates of changes in vehicle kilometres will be an output of the Truck Fleet Composition component of the study. These estimated changes can be used as indicators of what the road safety impacts would be if the various tractor/trailer configurations had similar road safety characteristics.

Performance characteristics, as documented by TAC (e.g. rollover stability, swing-out, etc.), would be reviewed to determine if the new types/configurations have better performance characteristics than vehicle types/configurations that are being replaced under the new regulations. This information will be supplemented with the results of any relevant studies identified in the literature review.

8.1.3 Methodology 8C (Recommended)

Interviews/surveys are conducted with a sample of truck drivers, fleet supervisors and safety officers to obtain their assessments of the relative stability and safety performance of various tractor-trailer combinations based on driving experience. These interviews are carried out through case studies; relevant questions on safety performance of various vehicle types could also be added to the trucker survey questionnaire.

The results of earlier surveys and studies on the reaction of auto drivers to long/heavy trucks would be incorporated into the analysis. This assessment would focus on identifying any perceived differences in the road safety of new vehicle types/configurations versus ones that are being replaced under the new regulations.

8.2 ASSESSMENT OF ALTERNATIVES

There are a number of significant limitations with the Methodology 8A approach:

- the annual numbers of accidents across Canada involving the less common truck configuration types are small, making accident rate estimates subject to high levels of statistical error;

- limitations in the quality of provincial accident data and interprovincial differences in accident reporting methods;

- a host of factors in addition to configuration type affect truck accident rates, and these factors were also changing over the study period. These other factors include the road network and configuration, the introduction of the National Safety Code, the degree of enforcement of various types of safety regulations, and levels of driver and company experience.

Because of these limitations, it will not be possible to use this basic approach to obtain reliable estimates of the impacts of the 1988 MoU on the number of heavy truck accidents in Canada.

Although general accident data may not define the relative road safety of various tractor/trailer configurations, available highway accident data could be reviewed, however, to determine the relative importance of the road safety issue.

Methodology 8B can be applied to estimate the nature (positive or negative) and possibly the order of magnitude of the road safety impacts of the MoU with the following limitations:

- the potential impact of performance characteristics will be based on published analyses. Some of the more comprehensive analyses (e.g. TRB Special Report 227) do not deal specifically with the TAC vehicle;

- the implications on traffic operations will be assessed in a qualitative manner.

The use of surveys and studies (Methodology 8C) would not result in specific quantitative data, but would have the benefit of bringing in qualitative observations and issues related to actual experience. Methodologies 8B and 8C would complement one another if carried out in parallel.

8.3 RECOMMENDED METHODOLOGY

The recommended methodology for estimating the road safety impacts of the changes in regulations was to perform Methodologies 8B and 8C together. This recommendation is summarized as follows:

- use available heavy truck accident data to estimate the scale of this issue relative to others;

- use the results of surveys/interviews (supplemented with the results of other studies) to identify the relative road safety characteristics of different tractor/trailer configurations;

- use changes in annual vehicle-kilometres by configuration type to determine potential road safety impacts based on key stability and handling characteristics by configuration type;

- integrate the information above with qualitative information on the perceived impacts of long/heavy trucks on non-truck traffic.

This recommendation was agreed to by the Steering Committee. It was realized that data limitations may limit results of the analysis to the qualitative level.

9. SHIPPER COSTS

Changes in shippers' costs associated with changed vehicle weights and dimensions generally fall into one of the following areas:

- freight rates paid by shippers using for-hire truckers, or truck operating costs in the case of private truck operations;
- terminal infrastructure or capital costs;
- terminal operating costs.

Due to the competitive nature of the trucking business, it is anticipated that over the long run most of the savings in truck operating costs resulting from changes to vehicle weights and dimensions regulations will be passed on to the shipper. Companies with private trucking operations will realize the full savings. A methodology to determine this change in truck operating costs per tonne km is presented in Section 6.

Changes in terminal infrastructure requirements, as well as loading and unloading procedures, will be strongly related to the type of goods being shipped. Since the geometric design requirements of the new TAC tractor/trailer configurations are similar to or less restrictive than those of a standard 5-axle tractor/semi-trailer, required changes to terminal yard and road facilities are probably insignificant in most cases. Nevertheless, B-trains are not easily integrated into conventional tractor-trailer loading docks due to their axle overhang. On the other hand, since the new larger trucks can carry larger payloads, some shippers may be able to reduce the number of truck loading bays at their terminals.

It was recommended that the prime source of information on terminal impacts be interviews and surveys designed to obtain information from shippers and trucking firms. The methodology would draw on shippers' comments regarding changes in loading and parking facilities which may have increased or decreased their capital and operating costs. The sample of shippers would be representative of different shipping operations and type of commodities. This was agreed to by the Committee.

It was anticipated that changes to shippers' costs (excluding freight rates) would not be significant relative to other cost considerations. Since the shipper will usually have the option of specifying an older configuration at a higher freight rate, any increase to shippers' costs should not exceed the reduction in freight rates. The net positive impact on shippers of the MoU should range from zero (reflecting a continuation of past operations) to a full capture of the reduced freight rates (assuming no changes in loading/unloading costs).

10. SURVEYS AND CASE STUDIES

Part of the Phase 2 work (Tasks 2.3 and 2.4) involved conducting a mail-out survey to a sample of approximately 200 trucking firms across Canada, as well as case studies to provide greater insight into the range of impacts which the 1988 MoU has had on agencies involved in, or affected by, the industry.

Previous sections of this document have mentioned the survey of carriers and the case studies, which would be used as a means of supplementing and checking other methodologies. These direct industry contacts provided both qualitative and quantitative data related to all of the main areas of the study, including:

- truck fleet composition;
- trucking costs;
- infrastructure costs;
- road safety impacts;
- shipper costs.

Under the original study design the survey and case studies were to be designed and carried out in Phase 2. However, we performed this work in Phase 1 so that it could be discussed with the Steering Committee at the meeting held in September, 1993; committee approval, received at that time, allowed the survey and case studies to be carried out during the late fall of 1993 and early 1994, without the need for another committee meeting.

The design of the carrier survey and case studies, as developed during Phase 1, is therefore included in Part I. Minor changes occurred during Phase 2 as the survey and case studies were actually carried out; these are noted in Part II which also presents the results of this major data collection effort. The survey questionnaire included in Appendix B and the case study questionnaires in Appendix C are those actually used in conducting the work.

10.1 SURVEY OF MAJOR TRUCKING FIRMS

10.1.1 Survey Questionnaire

The survey of 200 trucking firms provided supplementary data and information on carriers' experiences, opinions and perceptions regarding the impacts of the changed truck size and weight regulations. Appendix B contains a copy of the questionnaire used. The survey obtained "before" and "after" data on fleet compositions and on vehicle-kilometres travelled by configuration type, for specific routes and commodities. Carriers were also requested to provide qualitative input on the following issues:

- impact of MoU on fleet mix, markets served, unit operating costs, shipping rates, shipper service, and safety;
- constraints of current truck size and weight limits in operational jurisdictions;
- impediments to increased use of TAC B-train vehicles.

The questionnaire format was designed to facilitate the filling out process, as well as the coding of replies:

- Where possible, responses were completed by filling in cells of tables, circling answers or checking off boxes. The number of essay-type questions was minimized. (This feature also facilitated coding of the replies);
- Questions were oriented to the type of information trucking firm representatives are readily aware of: e.g. rather than asking for annual vehicle-kilometres, the respondent was asked to specify a route (by origin and destination) and the number of runs per week;
- The questionnaire was limited to two double-sided pages.

A cover letter introduced the questionnaire, providing information on the purpose and sponsorship of the study, the role of the questionnaire within the study, the requested response date, and persons to contact in the event of respondent queries.

10.1.2 Survey Coverage

In order to respect the confidentiality of individual company information, the names of firms included in the survey are not provided in this report. Exhibit 10.1 summarizes the numbers of firms selected, according to province and type classification (i.e. from the top 100 for-hire carriers, from the top 100 private carriers, and other).

As there is not a documented universe of carriers from which a sample can be drawn, this is not a scientific sample. The lack of a universe with accompanying data on fleet size, type and area of operations also makes it difficult to apply consistent selection criteria. The industry experience of the Steering Committee members was therefore drawn on in ensuring that a reasonable variety of firms was surveyed in each region. In Exhibit 10.1 carriers are shown in the region in which their head office is located. Many of these firms have operations across Canada or in several provinces and into the U.S. This means that firms listed, for example, in Ontario also provided valuable information as to how their operations in various regions have been affected by the regulatory changes, for example, in the Prairie Provinces.

In developing the list of carriers to be surveyed the following selection criteria and procedures were used. First the TAC bulletin board was used to obtain the top 100 for-hire carriers and top 100 private carriers according to fleet size. It was considered that these fleets should be surveyed as they would account for a large portion of benefits received as a result of the revised regulations, especially for extraprovincial movements. Those private fleets that did not have any tractor trailers (e.g. municipal fleets, utility companies) were then excluded along with firms known to be no longer in operation. Due to the large number of the companies listed having their corporate headquarters in Ontario, half of the Ontario based carriers on the list were deleted.

Ship-By-Truck and transportation directories as well as mailing lists from previous surveys by the study team were then consulted to supplement this list. These carriers were selected to represent a more regional scope of operations. Overall about 225 firms were selected to account for possible deletions by the Steering Committee, firms which have gone out of business, mergers, acquisitions, etc. As the regulatory changes were greatest in the Prairie Provinces, there is a bias to interviewing firms operating in this region. Exhibit 10.2 provides the distribution of trucking firms surveyed by Statistics Canada with annual operating revenues exceeding $1 million, which can be compared with the selected survey sample given on Exhibit 10.1.

EXHIBIT 10.1

SUMMARY OF FIRMS FOR SURVEY BY PROVINCE/TERRITORY

Province/Territory	**For-Hire (from top 100)**	**Private (from top 100)**	**Others**	**Total**
Atlantic Provinces	6	2	14	22
Quebec	9	9	18	36
Ontario	23	9	11	43
Manitoba	13	1	8	22
Saskatchewan	3	3	11	17
Alberta	13	7	23	43
British Columbia	6	2	24	32
Territories	-	-	2	2
Total	73	33	111	217

EXHIBIT 10.2

1990 TRUCKING INDUSTRY PROFILE BY PROVINCE FOR FOR-HIRE CARRIERS WITH ANNUAL REVENUES >$1 MILLION (SOURCE: "TRUCKING IN CANADA", 1990, PAGE 34)

REGION	NO. OF CARRIERS REPORTING TO STATISTICS CANADA	1990 TOTAL OPERATING REVENUE REPORTED
ATLANTIC	102	639,893
QUEBEC	319	1,352,292
ONTARIO	441	3,634,475
PRAIRIES	279	1,920,264
BRITISH COLUMBIA	199	770,205
YUKON	4	N/A
NORTHWEST TERRITORIES	6	34,031
	1,350	$8,351,160

10.2 INDUSTRY CASE STUDIES

10.2.1 Case Study Questionnaires

The industry case studies were designed to provide more detailed insights into the impacts of the 1988 MoU, as enabled by face-to-face dialogues and telephone interviews. The work program specified case studies with trucking firms, provincial and territorial highway ministries, and shippers. In addition, truck and trailer manufacturers were included in the list as a result of discussions at the first Steering Committee meeting.

Appendix C contains a copy of the case study questionnaires used. The questionnaires were mailed to the selected coverage list in advance of the person-to-person interviews, to enable the interviewees to consider their responses, as opposed to having to respond in an impromptu situation. The interviewer used the questionnaire form both to structure the interview and to document the responses. Since the case study questionnaires served as the basis for interviews, the questions were primarily open-ended, conducive to generating verbal discussion and eliciting opinions and reasons, as well as facts.

The following topics were among those covered in the case study questionnaires:

Carriers

- Truck configurations used by route and major commodity type, in 1987 and 1992. This data was used by the study team to develop an understanding of major origin-destination movements and truck types, for both the "before" and "after" years;
- Reasons for changes, and for lack of changes, in the matrix cells for 1987 and 1992;
- Cost changes and safety impacts related to the configuration changes;
- New markets opened as a result of the MoU;
- Impediments to operations due to existing jurisdictional inconsistencies;
- Anticipated future changes in configurations.

Ministries

- Changes in heavy truck patterns between 1988 and 1992;
- Impacts of MoU on highway infrastructure;
- Impacts of MoU on highway and terminal operations;
- Impacts of MoU and preceding research on design and analysis of highway infrastructure.

Shippers

- Impact of MoU on truck shipping rates;
- Impact of MoU on terminals;
- New markets made available as a result of the MoU.

Truck/Trailer Manufacturers

- Changes in equipment sales from 1988 to 1992;
- Regional impacts of sales;
- Anticipated changes in equipment sales patterns over next five years.

The case studies also asked for comments on regional differences regarding impacts of the MoU.

10.2.2 Case Study Coverage

A total of 50 case studies was included in the design, broken down as follows:

- 20 carriers;
- 12 provincial/territorial ministries;
- 15 shippers;
- 3 truck/trailer manufacturers.

A further breakdown of these categories into regions is shown in Exhibit 10.3.

The carriers to be interviewed for the case studies were chosen from

EXHIBIT 10.3

REGIONAL BREAKDOWN OF CASE STUDIES

<table>
<tr><th>Region</th><th>Carriers</th><th>Ministries</th><th>Shippers</th><th>Manufacturers</th><th></th></tr>
<tr><td>Atlantic Provinces</td><td>3</td><td>4</td><td>3</td><td rowspan="2">1</td><td></td></tr>
<tr><td>Quebec</td><td>3</td><td>1</td><td>3</td><td></td></tr>
<tr><td>Ontario</td><td>3</td><td>1</td><td>3</td><td>1</td><td></td></tr>
<tr><td>Prairie Provinces</td><td>5</td><td>3</td><td>3</td><td rowspan="2">1</td><td></td></tr>
<tr><td>British Columbia</td><td>4</td><td>1</td><td>3</td><td></td></tr>
<tr><td>Territories</td><td>2</td><td>2</td><td></td><td></td><td></td></tr>
<tr><td>TOTAL</td><td>20</td><td>12</td><td>15</td><td>3</td><td>50</td></tr>
</table>

the carrier survey sample. The following general considerations were used in selecting firms for the case studies:

- Regional representation;
- Cross-section of firms of different sizes;
- Experience relevant to the questions asked (e.g. the earlier implementation of the MoU in the Western Provinces is the basis for a heavier weighting of western carriers).

Case study lists for provincial/territorial ministries, shippers and truck/trailer manufacturers were compiled using similar criteria, and on the basis of input and advice from the Steering Committee.

11. SUMMARY OF RECOMMENDED METHODOLOGIES

Part I of the report has summarized the results of the background investigations with regard to data sources, literature reviews, and preliminary contacts made with provincial authorities and other industry representatives. An assessment of alternative road networks was included, leading to the recommendation that the MoU designated system to be the study network. Part I also examines alternative methodologies for the different components of the study, assesses these alternatives, and recommends the preferred methodology in each case. In addition, preliminary design work done in preparation for the Phase 2 surveys and case studies is included in Part I.

The recommendations for the five major study components are summarized below:

11.1 TRUCK FLEET COMPOSITION

- Use Methodology 5B, a modified version of the methodology (changes in vehicle-kilometres by configuration type on representative highway links) which was applied in the 1987 RTAC "Economics of Truck Sizes and Weights in Canada" study, as the main methodology.

- Also perform Methodology 5C (carrier surveys) to supplement the main methodology and to provide controls and checks to compensate for data gaps and inconsistencies in the main methodology.

11.2 TRUCKING COSTS

- Use Methodology 6A, a modified version of the methodology (unit costs applied to vehicle-kilometre changes by configuration type) which was applied in the 1987 RTAC "Economics of Truck Sizes and Weights in Canada" study, as the main methodology.

- Use Methodology 6B (carrier surveys) in concert with the principal methodology to mitigate data limitations and to provided additional checks and balances on the Methodology 6A results.

11.3 INFRASTRUCTURE COSTS

Geometric Design:

- There should be no changes in roadway geometrics and associated costs attributable to the MoU, and a formal assessment of methodologies is not applicable.

- Consult provincial highway departments to identify any areas where TAC vehicles may nevertheless be influencing geometric design. Document representative examples of any such cases and analyze them to confirm the connection between the vehicle performance and such costs.

Pavement Impacts:

- Use load equivalency factors (LEFs) developed through recent research for Canadian conditions. Also perform calculations using other equivalency factors to test the sensitivity of findings to this parameter.

- Use the Ontario flexible pavement deterioration model, OPAC, to model pavement performance, and use "build sooner costs" to estimate pavement deterioration costs. Use C-SHRP/SHRP sites as representative locations for applying the pavement performance model.

- Use the trucking company survey and case studies to identify the extent to which changes in vehicle configurations may have affected the use of different suspension systems, different tire widths, tire pressures and single versus dual tires, and hence may have had a potential impact on pavement costs.

Roadway Maintenance:

- Changes in roadway maintenance costs attributable to the MoU are expected to be insignificant and not readily quantifiable.

- Contact each provincial highway agency to determine if they nevertheless have any evidence of TAC vehicles and other truck fleet composition changes affecting roadway maintenance costs (other than "build sooner costs") either positively or negatively.

Bridges:

- To determine overstress, compare bending moments produced by the critical TAC vehicles to the bending moments produced by the standard truck loading pattern. Identify span lengths where the critical TAC vehicles produce bending moments in excess of the design load.

- Determine if TAC vehicles generate stresses above accepted permissible overstresses for different span lengths and bridge types. Where overstress occurs, the bridges would require strengthening or replacement.

- Develop generalized cost figures based on the experience of the study team and provincial engineers, to reflect the costs of any required improvements.

- For fatigue, assess the numbers and characteristics of bridges that may be suspect. Use the evaluation approach documented in the "Fatigue Evaluation Procedures for Steel Bridges" TRB Report.

- Survey provincial bridge engineering departments to obtain results of any specific analysis they may have conducted.

Effects on Other Highway Users:

- Use ADI models to identify the magnitude of any changes in costs experienced by other highway users, although intuition and our past experience suggest these would be insignificant.

11.4 ROAD SAFETY IMPACTS

- Use both Methodology 8B (changes in annual vehicle-kilometres by configuration together with safety characteristics of each configuration) and Methodology 8C (surveys and interviews). Methodology 8B is based on the methodology documented in the "New Trucks for Greater Productivity and Less Road Wear" TRB Report.

11.5 SHIPPER COSTS

- Conduct interviews and surveys to obtain information from shippers and trucking firms.

TRANSPORTATION ASSOCIATION
OF CANADA

CANADIAN TRUCKING
RESEARCH INSTITUTE

IMPACTS OF CANADA'S HEAVY VEHICLE WEIGHTS AND DIMENSIONS RESEARCH AND INTERPROVINCIAL AGREEMENT

PART II: DATA COLLECTION AND MODELS

OCTOBER, 1994

IBI GROUP / ADI

Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement

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PART II: DATA COLLECTION AND MODELS

List of Exhibits (Cont'd)

Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement - Part II: Data Collection and Models

12. INTRODUCTION TO PART II

Part II of this report describes the data collection as carried out during the study and summarizes the results of the data collection effort. Also included in this part of the report are descriptions of the models used for estimating truck fleet impacts, truck cost impacts, infrastructure cost impacts, road safety impacts, shipper cost impacts and the comprehensive impacts model which draws these results together.

The major survey of trucking firms carried out as part of the study is described in Chapter 13.

Case studies of carriers, ministries, shippers and trailer manufacturers/distributors are described in Chapter 14.

Chapter 15 describes the collection of other data sets, including truck volumes and origin/destination patterns on the designated highway network and data used as input for estimating trucking costs, infrastructure costs and road safety impacts.

The comprehensive impacts model and its various components are described in Chapter 16.

13. SURVEY OF TRUCKING FIRMS

A major part of the information collection conducted in Phase 2 of this project was a mail-out survey of trucking firms. The survey form asked for information on the types and configurations of trucks used on various routes of the company in 1987 and 1992 in order to explore the impacts of the implementation of the MoU. Respondents were also asked a number of other questions such as whether they had any problems with inconsistencies in regulations between jurisdictions and other aspects of vehicle weights and dimensions in Canada.

13.1 SURVEY PROCESS

The procedure used was a mail-out, self-administered questionnaire. The envelope with the questionnaire included a letter explaining the purposes of the survey as well as diagrams indicating the truck types about which questions were being asked. A copy of the list of addressees and the letter, questionnaire and diagrams is included in Appendix B.

The questionnaire was drafted and presented to the Steering Committee at the end of Phase 1. After comments had been received, the questionnaire was finalized. To assist in this review process, carrier members of the Steering Committee actually applied the questionnaire to their own operations.

French versions of the questionnaire and covering letter were developed and used for all respondents in the Province of Québec.

It was desired to gain representation of carriers across Canada. Exhibit 13.1 shows the number of questionnaires mailed out by region. Because it was known that the potential impacts of implementation of the MoU were much greater in the Prairie provinces than in some of the other regions of Canada, a larger sample was drawn in this region.

The questionnaires were originally mailed out on October 18. Responses were very slow in coming in. After approximately one month, follow up phone calls were made to those who had not responded. Even with multiple phone calls, however, responses were quite disappointing. It was found that many carriers were not responsive to appeals for the "good of the industry".

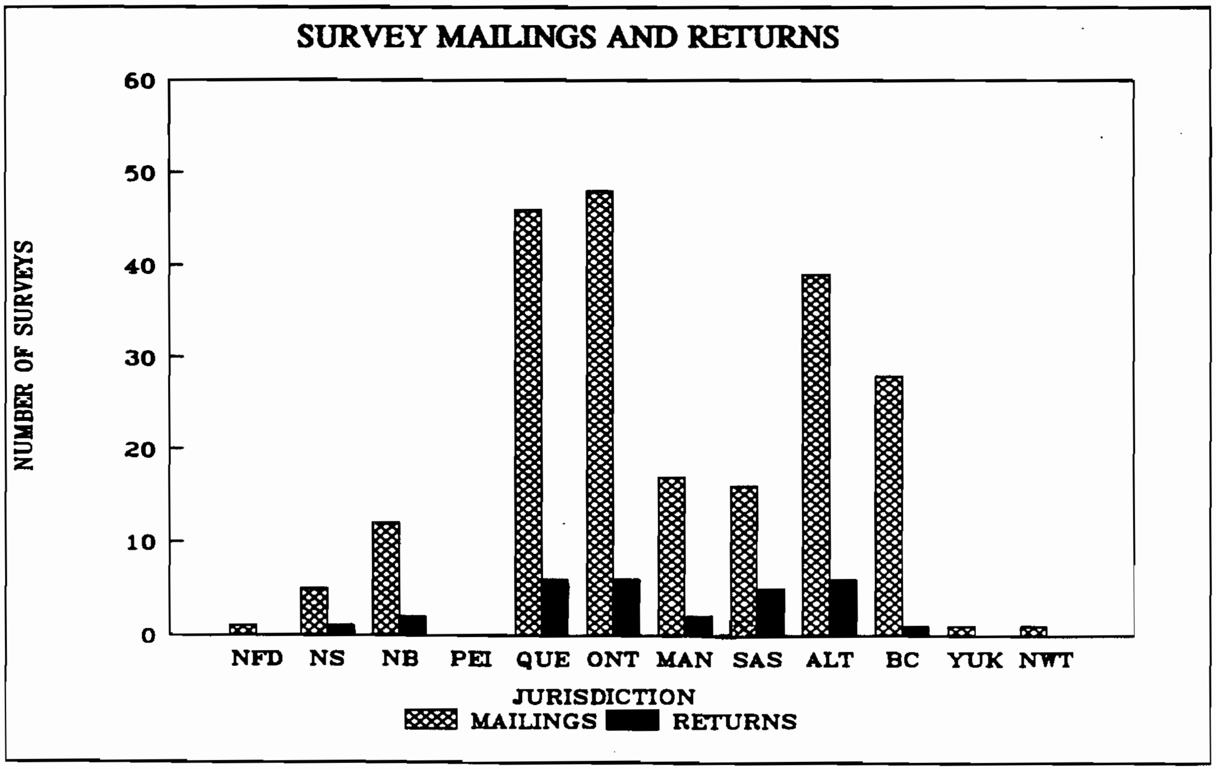
13.2 SURVEY RESPONSE

The carrier survey form was mailed out to over two hundred carriers, and twenty-nine of these were returned. The distribution of surveyed carriers and responses by jurisdiction across Canada is shown in Exhibit 13.1. There were responses from all jurisdictions except for Prince Edward Island, Newfoundland and the two Territories; this was not surprising given that each of those areas contained at most one surveyed firm. Carriers in Saskatchewan had the best rate of response

EXHIBIT 13.1

TAC MoU SURVEY : DISTRIBUTION OF RETURNS

JURISDICTION	NUMBER OF MAILINGS	NUMBER OF RETURNS	RETURN RATE
Newfoundland	1	0	0.0%
Nova Scotia	5	1	20.0%
New Brunswick	12	2	16.7%
Prince Edward Island	0	0	
Quebec	46	6	13.0%
Ontario	48	6	12.5%
Manitoba	17	2	11.8%
Saskatchewan	16	5	31.3%
Alberta	39	6	15.4%
British Columbia	28	1	3.6%
Yukon	1	0	0.0%
Northwest Territories	1	0	0.0%
NATIONAL TOTAL	214	29	13.6%



on a provincial basis; British Columbia, despite a substantial number of carriers, yielded only one response.

There were numerous reasons for not responding given by the firms contacted during the survey follow-up process. These included:

- intraprovincial carriers felt that their input was not valid, given that they operate in only one jurisdiction;

- companies with a majority of business to and from the United States felt that carriers crossing provincial borders were more appropriate to the study;

- firms within British Columbia had apparently recently been surveyed for a provincial study. One manager actually stated that he was participating in a project run by AASHTO because it was more relevant to his business than a Canadian study would be. He also indicated that this would be the reason for a lack of response from other B.C. firms;

- many operators wanted to maintain privacy of their affairs, and in particular objected to the numerical questions. One person wanted an explanation of the connection of the federal and provincial ministries to the TAC before even considering a response to the survey, and another explained that company policy was to ignore all surveys;

- the intended party often never received the survey form, especially if no contact name was available at the time of mailing. Many of the responses were generated by making follow-up phone calls to inform the firms that they were subjects of the study, and sending an additional form. Lack of time and "over-surveying" were often cited by people that refused to respond and by those that returned only partial responses;

- some of the smaller operators had either changed address or gone out of business since the preparation of the mailing list; and

- other operators were local carriers (i.e. within a city or small region) or they were long distance carriers with intermodal operations. The trucking part of the operation would be on a short-haul basis to and from rail terminals, thus making their input of questionable use.

Roughly half of the survey responses were received by mid-November, and 29 were returned in time for use in the final analysis of results. Two Quebec firms did not respond until late January; only their numerical responses have been fully integrated into the analysis, although their other answers have been considered during preparation of this report.

13.3 ANALYSIS OF SURVEY RESULTS

When considering the results of this carrier survey, one must be aware that an unexpanded sample does not produce truly representative results. Many of the trends in the Canadian trucking industry will be illuminated by interpretation of the survey responses, but not all statements apply to the industry as a whole. In particular, one should keep in mind that the uneven response rate across the country will introduce regional biases in the totals. Any of the numbers found in the text, tables or graphs in the following section are for purposes of comparison, based on the valid responses from the survey sample. Some numbers reflect only a single carrier company and are therefore biased to giving an indication of the changes experienced by that one carrier.

13.3.1 Carrier Regions of Operation

The operating regions information collected on twenty-seven of the returns was used to classify those companies for aggregation purposes throughout the analysis procedure. The first division of firms was on the basis of being eastern (Atlantic Provinces/Quebec/Ontario), western (Prairies/British Columbia/Territories) or a cross-Canada operator (those with more than 5% of business on each side of the Manitoba-Ontario border). The second division of companies qualified them according to whether or not, in 1992, they had significant (greater than 5%) business in the United States.

Exhibit 13.2 illustrates the distribution of the surveyed carriers according to the classification groupings and shows the number of operators serving each region in 1987 and 1992. Two operators, one western and one eastern, became cross-Canada firms between 1987 and 1992. However, one firm with American business in 1987 experienced a drop in that percentage to below 5%. The number of companies operating in each of the regions either stayed constant or increased over the five year period. The general observation is that on the average, the surveyed companies increased the geographic scope of their business.

By adding the percentages of business in each region across the twenty-three valid responses, one obtains a crude measure of the overall distribution of business for the respondents. The most notable trends were increases in business in Quebec, Ontario, North Central U.S. and Southeastern U.S., and a sizable drop in the proportion of business in the Prairie provinces. This indicates two things: first, that business is

EXHIBIT 13.2

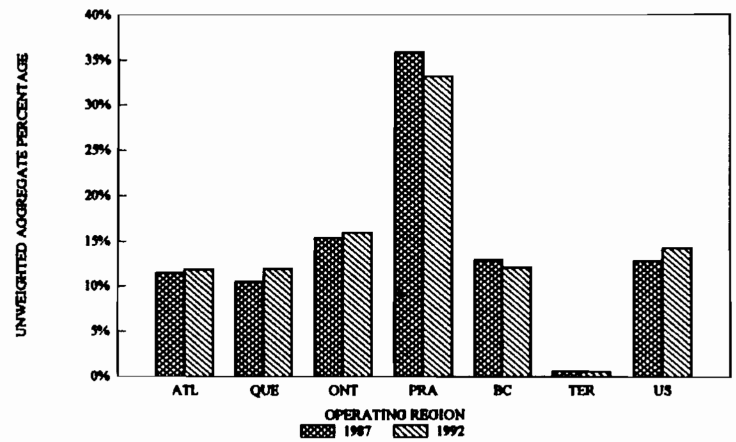
CARRIER REGIONS OF OPERATION

CLASSIFICATION OF SURVEY RESPONSES

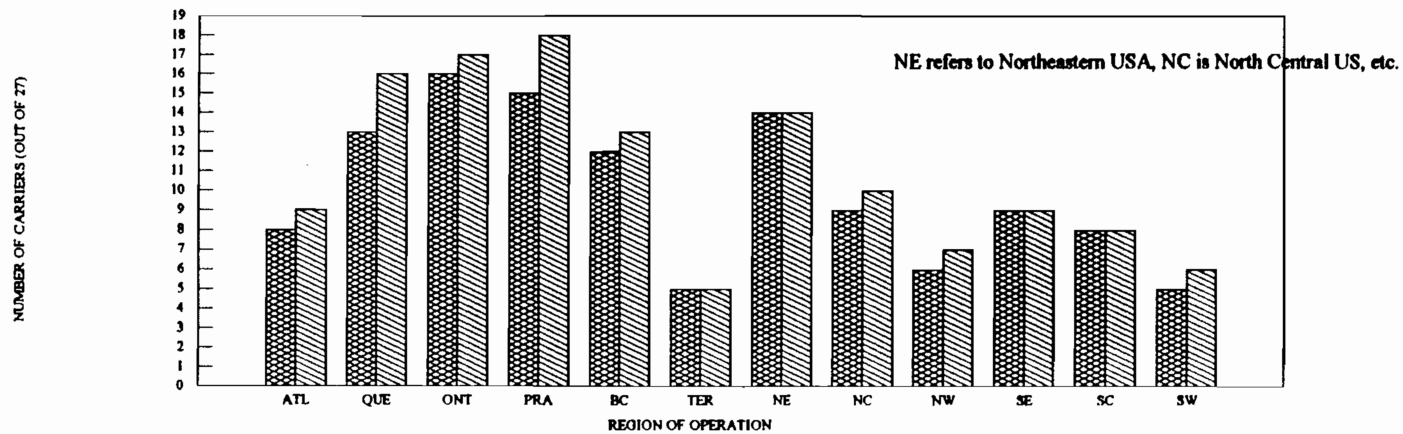
Classification		1987	1992
Western		9	8
Eastern		11	10
Cross-Canada	(1)	7	9
With U.S.		13	12
No U.S.	(2)	14	15

Notes:
(1) More than 5% of business on each side of the Ont./Man. border.
(2) Less than 5% of business in the United States.
(3) 27 companies classified here. All survey information in other tables comes from valid responses given by a subset of these 27 companies.

APPROXIMATE DISTRIBUTION OF BUSINESS (23 CARRIERS)



GEOGRAPHIC SCOPE (CANADA/U.S.) OF 27 SURVEYED CARRIERS



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shifting towards a north-south orientation (especially in the west); second, that business has been spread somewhat across the country, with a shift from western to eastern Canada. These observations are only true with regard to the surveyed companies, many of which are located in the Prairie provinces.

13.3.2 Fleet Composition

Detailed information was provided by twenty-five companies on their truck and trailer fleet composition in 1987 and 1992. Sixteen of those companies also provided projections of their fleet sizes in 1997 and 2002, allowing an estimation of the future shifts in truck fleet composition. Firms were asked to indicate the number of tractors as well as the truck and trailer counts, but the numbers frequently made little sense (far too low) given the number of trailers in the fleet. Most likely the question was misinterpreted, therefore the information provided was not used in the fleet composition analysis.

13.3.2.1 Observed Changes (1987-1992)

The primary set of observations derived from the survey deal with the changes in fleet composition between 1987 and 1992, as reported by 25 of the respondents. Analysis was done at the level of specific configurations, and by general trailer types. Exhibit 13.3 presents information on the overall fleet composition by specific configuration types, with an indication of the absolute and relative changes in composition over the five year period. Exhibit 13.4 summarizes the fleet composition by general trailer groups, subdivided by the geographic company groups (as explained in Section 13.3.1), to illustrate differences that are linked to the scope of the carriers' service territory.

The major findings can be summarized as follows:

- the tractor semitrailer combination was the most prominent combination in 1987, and had increased in proportion by 1992. The eastern companies' fleets were approximately 90% semitrailers in both 1987 and 1992, while the western companies' fleets were about 60% semitrailers in 1987 increasing to 64% in 1992. The companies with U.S. business showed the greatest shift between 1987 and 1992 (from 87% to 91%) in ownership of semitrailers, supporting their comments about the increasing importance of the north/south haul.

- western operators showed an increase in use of B-Trains and A-Trains, with the former showing a greater relative increase. Cross-Canada operators demonstrated a marked shift away from C-Trains and A-Trains and toward the ownership of B-Trains;

EXHIBIT 13.3

SUMMARY OF VEHICLE COMPOSITION INFORMATION (1987 / 1992)

CONFIGURATION		NO. OF USERS	AGGREGATED FLEET COMPOSITION 1987 #	1987 %	1992 #	1992 %	CHANGE (1987-1992) DIFF.	% (OF 1987)
STRAIGHT TRUCKS		12	413	6.8%	560	5.5%	147	35.6%
SEMI - TRAILERS		25	5,198	85.3%	8,966	88.4%	3,768	72.5%
5-AXLE	Up to 14.6m	18	1,922	31.5%	3,613	35.6%	1,691	88.0%
5-AXLE	Over 14.6m	13	935	15.3%	2,125	21.0%	1,190	127.3%
6-AXLE (FIXED)	Up to 14.6m	9	1,202	19.7%	1,195	11.8%	(7)	-0.6%
6-AXLE (FIXED)	Over 14.6m	7	11	0.2%	152	1.5%	141	1281.8%
6-AXLE (W/LIFT)	Up to 14.6m	6	536	8.8%	887	8.7%	351	65.5%
6-AXLE (W/LIFT)	Over 14.6m	4	323	5.3%	682	6.7%	359	111.1%
7-AXLE	Up to 14.6m	5	246	4.0%	289	2.8%	43	17.5%
7-AXLE	Over 14.6m	4	23	0.4%	23	0.2%	0	0.0%
TANDEM TRAILERS		19	482	7.9%	615	6.1%	133	27.6%
A - TRAINS		12	333	5.5%	319	3.1%	(14)	-4.2%
7-AXLE	Up to 18.5m	5	187	3.1%	122	1.2%	(65)	-34.8%
7-AXLE	Over 18.5m	5	89	1.5%	106	1.0%	17	19.1%
8-AXLE	Up to 18.5m	4	48	0.8%	61	0.6%	13	27.1%
8-AXLE	Over 18.5m	3	9	0.1%	14	0.1%	5	55.6%
9-AXLE	Over 18.5m	1		0.0%	16	0.2%	16	NEW
B - TRAINS		17	93	1.5%	248	2.4%	155	166.7%
6-AXLE	Over 18.5m	1		0.0%	2	0.0%	2	NEW
7-AXLE	Up to 18.5m	6	79	1.3%	62	0.6%	(17)	-21.5%
7-AXLE	Over 18.5m	6	4	0.1%	43	0.4%	39	975.0%
8-AXLE	Up to 18.5m	6	5	0.1%	35	0.3%	30	600.0%
8-AXLE	Over 18.5m	7	5	0.1%	106	1.0%	101	2020.0%
C - TRAINS		6	56	0.9%	48	0.5%	(8)	-14.3%
7-AXLE	Up to 18.5m	2	8	0.1%	5	0.0%	(3)	-37.5%
7-AXLE	Over 18.5m	3	23	0.4%	19	0.2%	(4)	-17.4%
8-AXLE	Up to 18.5m	1	5	0.1%	1	0.0%	(4)	-80.0%
8-AXLE	Over 18.5m	3	20	0.3%	23	0.2%	3	15.0%
OVERALL TOTAL FROM FLEETS		25	6,093	100.0%	10,141	100.0%	4,048	66.4%

SUMMARY OF CONFIGURATION LENGTHS

CONFIGURATION		USERS	#(1987)	%(1987)	#(1992)	%(1992)	DIFF	% CHG
SEMI - TRAILERS	Up to 14.6m	25	3,906	64.1%	5,984	59.0%	2,078	53.2%
	Over 14.6m		1,292	21.2%	2,982	29.4%	1,690	130.8%
A - TRAINS	Up to 18.5m	12	235	3.9%	183	1.8%	(52)	-22.1%
	Over 18.5m		98	1.6%	136	1.3%	38	38.8%
B - TRAINS	Up to 18.5m	17	84	1.4%	97	1.0%	13	15.5%
	Over 18.5m		9	0.1%	151	1.5%	142	1577.8%
C - TRAINS	Up to 18.5m	6	13	0.2%	6	0.1%	(7)	-53.8%
	Over 18.5m		43	0.7%	42	0.4%	(1)	-2.3%

* Number of users is based on operation of a configuration in 1987 and/or 1992.

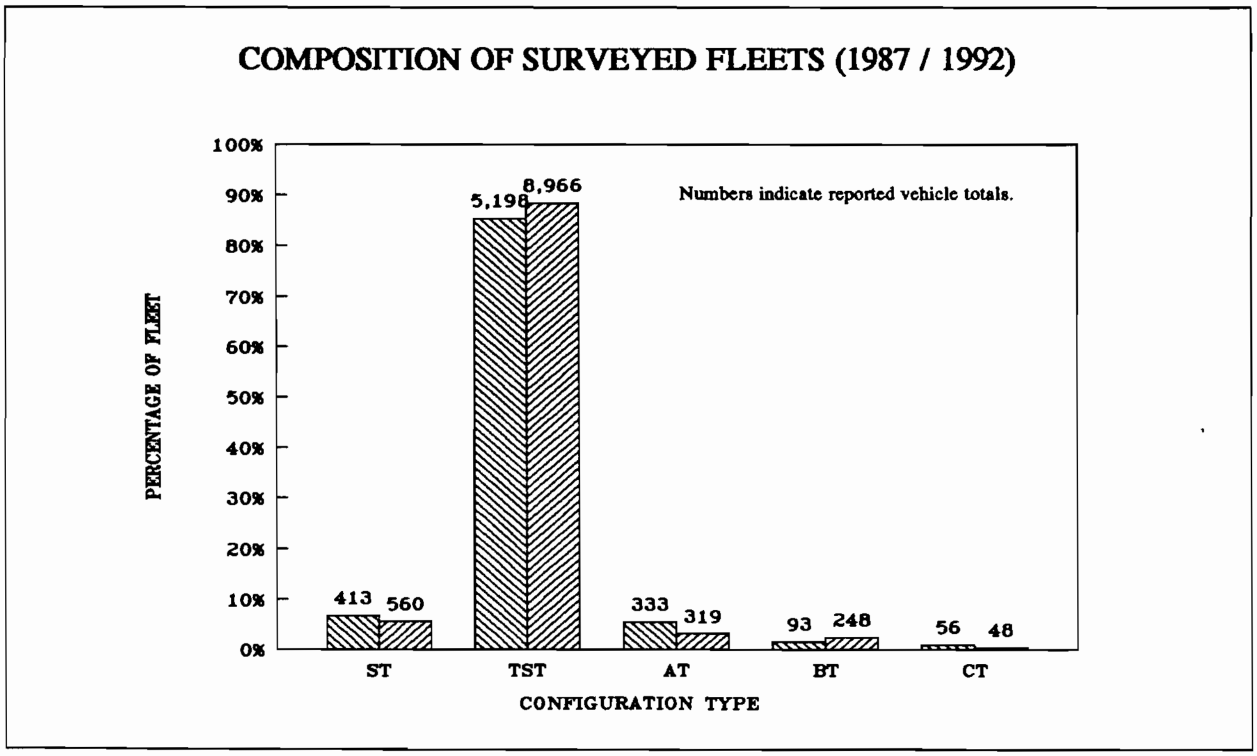
Source : Carrier Survey (25 / 29 responses)

EXHIBIT 13.4

SUMMARY OF FLEET COMPOSITION IN 1987 AND 1992

X-TAB	NUMBER OF TRUCKS/TRAILERS						PERCENTAGE OF TOTAL FLEET				
GROUP	ST	TST	AT	BT	CT	TOTAL	ST	TST	AT	BT	CT
CROSS - TABULATION GROUP ONE : (WEST/EAST/CROSS-CANADA OPERATORS)											
ALL 87	413	5,198	333	93	56	6,093	6.8%	85.3%	5.5%	1.5%	0.9%
ALL 92	560	8,966	319	248	48	10,141	5.5%	88.4%	3.1%	2.4%	0.5%
WEST 87	105	396	56	63	28	648	16.2%	61.1%	8.6%	9.7%	4.3%
WEST 92	92	518	77	91	30	808	11.4%	64.1%	9.5%	11.3%	3.7%
EAST 87	308	3,153	78	5		3,544	8.7%	89.0%	2.2%	0.1%	0.0%
EAST 92	468	6,297	111	54		6,930	6.8%	90.9%	1.6%	0.8%	0.0%
CRCAN 87		1,649	199	25	28	1,901	0.0%	86.7%	10.5%	1.3%	1.5%
CRCAN 92		2,151	131	103	18	2,403	0.0%	89.5%	5.5%	4.3%	0.7%
CROSS - TABULATION GROUP TWO : (OPERATORS WITH OR WITHOUT SIGNIFICANT U.S. BUSINESS)											
ALL 87	413	5,198	333	93	56	6,093	6.8%	85.3%	5.5%	1.5%	0.9%
ALL 92	560	8,966	319	248	48	10,141	5.5%	88.4%	3.1%	2.4%	0.5%
W/US 87	130	3,078	262	54	28	3,552	3.7%	86.7%	7.4%	1.5%	0.8%
W/US 92	286	6,368	169	149	18	6,990	4.1%	91.1%	2.4%	2.1%	0.3%
NO US 87	283	2,120	71	39	28	2,541	11.1%	83.4%	2.8%	1.5%	1.1%
NO US 92	274	2,598	150	99	30	3,151	8.7%	82.5%	4.8%	3.1%	1.0%

NOTES:
Cross - Canada operators are those with at least 5% of their business both east of and west of the Ontario/Manitoba border.
Significant U.S. business is defined as 5% or more of total operations
TST = Tractor/Semi-Trailer, AT = A-Train, CT = C-Train, BT = B-Train, ST = Straight Truck



Source : Carrier Survey (25 of 29 responses)

- on the average, carriers with or without U.S. business experienced a decrease in C-trains and an increase in the use of B-Trains. Companies with U.S. business have decreased their ownership of A-Trains; however, other firms have actually increased the number and percentage of A-Trains since 1987;

- a more detailed look at the percentage changes in the number of particular configurations owned shows that all respondents reported using semitrailers, two-thirds used B-Trains, less than one-half used A-Trains or Straight Trucks, while only one-quarter reported ownership of any C-train tandem trailers;

- B-Trains increased in number at double the average rate of the whole fleet, while semitrailers slightly outpaced the average. A-Trains and C-Trains actually decreased in absolute numbers, with a greater decline for the C-Trains;

- one of the eight types of semitrailer (6-axles, fixed; up to 14.6 m trailer length) decreased in number. Six of the other types in the survey all increased in number by at least one-half, in particular the 5-axle and 6-axle semitrailers over 14.6 m. This suggests a shift towards the 53 ft. semitrailer;

- A-Trains underwent a decline, with a large decrease in the short ($\leq$ 18.5 m) combinations, and a small increase in use of the units longer than 18.5 m. One company in Alberta started to use a 9-axle A-Train combination (a turnpike double);

- the shorter ($\leq$ 18.5 m) 7-axle B-Trains declined in number, but the dramatic increase in the longer ($\geq$ 18.5 m) B-Trains more than compensated for this. The overall effect was to more than double the number of B-Trains. In particular, the long 8-axle B-Train was identified as an important addition to several of the fleets;

- eastern companies underwent the greatest average growth in fleet size, nearly doubling in size. All fleet components grew by 42% or more, except for the C-Train, which none of the eastern companies reported owning. In particular, all types of B-Trains and 53 ft. semitrailers were increased substantially; and

- companies with significant U.S. Business showed the same degree of growth as the eastern grouping, perhaps due to an overlap of the companies within each. However, these companies showed growth only in straight trucks, semitrailers, and B-Trains. The characteristic decline of A-Trains and C-Trains was quite evident among these carriers.

13.3.2.2 53 Foot Semitrailers/8-Axle B-Trains

Exhibit 13.5 shows the recent changes (and future changes that are anticipated by the respondents) with respect to two specific configurations, the 16.2 m semitrailer, commonly referred to as the 53 foot semitrailer, and the long (>18.5 m) 8-axle B-train. These were expected to be the most significant configurations in terms of the uptake of vehicles due to the TAC MoU. The most notable observations are:

- fifteen of twenty-five companies reported ownership of long (≥ 14.65 m) semitrailers. Most or all of these are 53 foot trailers. Seven respondents reported percentage increases in the 53 foot semitrailer, five reported small percentage drops, and the other thirteen indicated that no relative changes (i.e. a difference in percentage of this trailer type) had occurred. However, two of the firms (#6, #4) reporting no relative change increased the size of their fleets (all 53 foot semis) substantially, while another (#11) actually tripled the use of this configuration, but registered a percentage drop because of their greater overall growth of truck fleet;

- two firms reported dramatic shifts toward the use of 53 foot semis; shifts in percentage of fleet were from 48% to 97% for one carrier and 10% to 53% for the other;

- cross-Canada operators experienced the greatest changes with regard to 53 foot semis, followed by western firms. The overall change for the 25 respondents was from 21% of the fleet in 1987 to 29% in 1992. This was caused largely by the tremendous growth of certain heavy users (firms #4, 11, 26) of the 53 foot semi, and by shifts at other firms (#25, 27, 8) to this longer semitrailer option;

- eight of the sixteen full responses to the survey question indicated current or upcoming use of the long (>18.5m) 8-axle B-train;

- three of the companies that did not use this type of B-train in 1987 expect it to have at least a 10% share of the trailer

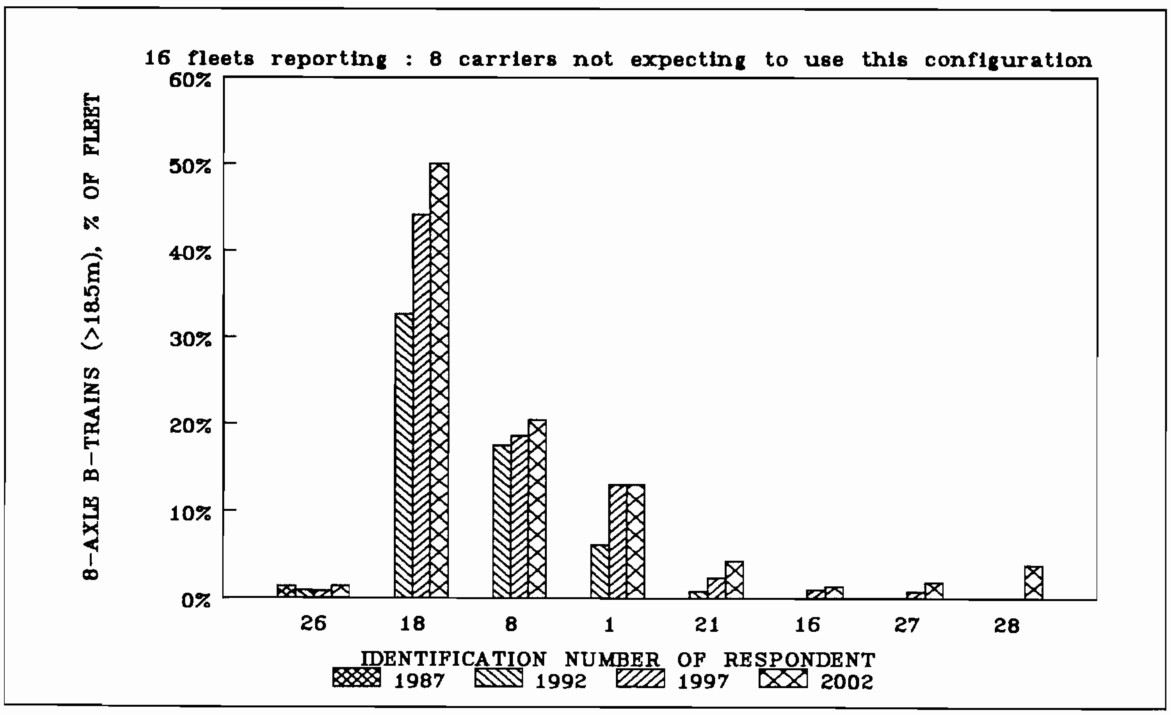
EXHIBIT 13.5

SPECIFIC FLEET COMPOSITION CHANGES : THE 53 FOOT SEMI-TRAILER

ID	1987							1992							1987–1992
	Tractor/semi-trailers >14.65m (over 48 feet)							Tractor/semi-trailers >14.65m (over 48 feet)							
#	5-axle	6-axle(f)	6-axle(l)	7-axle	Semis >14.6m	TOTAL FLEET	% LONG SEMIS	5-axle	6-axle(f)	6-axle(l)	7-axle	Semis >14.6m	TOTAL FLEET	% LONG SEMIS	CHANGE IN %
CROSS-CANADA FIRMS															
25	15			20	35	73	47.9%	210				210	217	96.8%	48.8%
6	30				30	30	100.0%	70				70	70	100.0%	0.0%
22		3		3	6	9	66.7%		3		3	6	9	66.7%	0.0%
4	600				600	600	100.0%	950				950	950	100.0%	0.0%
14			8		8	145	5.5%			8		8	157	5.1%	-0.4%
13	50				50	50	100.0%	140	11			151	157	96.2%	-3.8%
Subtotal	695	3	8	23	729	1901	38.3%	1370	14	8	3	1395	2403	58.1%	19.7%
EASTERN FIRMS															
27					0	920	0.0%	75	75		15	165	1470	11.2%	11.2%
28					0	410	0.0%	50				50	632	7.9%	7.9%
2	30		7		37	69	53.6%	30		5		35	62	56.5%	2.8%
11	49		284		333	720	46.3%	414		618	5	1037	2572	40.3%	-5.9%
1	76		24		100	100	100.0%	30	12	51		93	99	93.9%	-6.1%
Subtotal	155	0	315	0	470	3544	13.3%	599	87	674	20	1380	6930	19.9%	6.7%
WESTERN FIRMS															
8	3				3	31	9.7%	3	18			21	40	52.5%	42.8%
26	68	8			76	279	27.2%	141	28			169	476	35.5%	8.3%
15	10				10	187	5.3%	10	5			15	185	8.1%	2.8%
24	4				4	52	7.7%	2				2	48	4.2%	-3.5%
Subtotal	85	8	0	0	93	648	14.4%	156	51	0	0	207	808	25.6%	11.3%
TOTAL	935	11	323	23	1292	6093	21.2%	2125	152	682	23	2982	10141	29.4%	8.2%

NOTE : TOTAL AND SUBTOTALS INCLUDE UNLISTED FIRMS THAT DO NOT USE 53 FOOT SEMI-TRAILERS.

FLEET COMPOSITION (1987–2002) : LONG 8-AXLE B-TRAINS (>18.5 m)



Source: Carrier Survey (semis 25/29 and B-trains 16/29 responses) fleet by 2002, including one carrier (now over 30%) that predicts that half their fleet will be long 8-axle B-trains by 2002; and

- referring to Exhibit 13.6, this particular type of tandem trailer combination will rise in fleet share from 0.1% to 2.9%, on the average for the sixteen fleets. Only the longer A-trains and certain types of 53 foot semitrailer are expected to display this type of growth.

13.3.2.3 Projected Changes (1987-2002)

Additional comments can be made based on the information provided by the sixteen companies that estimated their fleet sizes for 1997 and 2002. The overall trailer type breakdown in Exhibit 13.6 presents a slightly different picture of the trends over the 1987-1992 period, and permits speculation on future fleet changes. Several points worth noting are:

- the absolute growth and relative increases in each successive five year period are anticipated to decline. This result may be due to reduced optimism about business, uncertainty about the need to increase fleet size, or the fact that many fleet upgrades had already been carried out by 1992, making changes either less necessary or less feasible (for financial reasons) between 1992 and 2002;

- truck fleets in 2002 are likely to consist of the same percentages of semitrailers and straight trucks as in 1987;

- the semitrailers over 14.65 m (i.e. over 48 ft., meaning basically the 53 foot semi) are predicted to increase from 18% of the fleet (in 1987) and 23% (in 1992) to 32% by 2002. The survey was performed before Ontario, Quebec and the Atlantic Provinces indicated that they would permit 53 foot semitrailers. The estimates therefore may understate the potential use of these types of vehicles;

- A-Trains have declined in percentage over the past few years and will continue to do so until at least 2002. C-Trains in use will decrease to a negligible figure; and

- B-Trains have more than doubled in importance since 1987, and are expected to almost triple in use by 2002. This uptake of B-Trains by the carriers is foreseen to compensate for the drops in other tandem combinations, with the net result of a fairly stable combined percentage of tandem combinations.

EXHIBIT 13.6

SUMMARY OF VEHICLE COMPOSITION INFORMATION – FLEET COMPOSITION PROJECTIONS (1987 to 2002)

CONFIGURATION		NO. OF USERS	FLEET COMPOSITION 1987 #	FLEET COMPOSITION 1987 %	CHANGE (1987–1992) DIFF.	CHANGE (1987–1992) % INC.	FLEET COMPOSITION 1992 #	FLEET COMPOSITION 1992 %	CHANGE (1992–1997) DIFF.	CHANGE (1992–1997) % INC.	FLEET COMPOSITION 1997 #	FLEET COMPOSITION 1997 %	CHANGE (1997–2002) DIFF.	CHANGE (1997–2002) % INC.	FLEET COMPOSITION 2002 #	FLEET COMPOSITION 2002 %
STRAIGHT TRUCKS		9	275	5.9%	23	8.4%	298	4.5%	111	37.2%	409	4.9%	25	6.1%	434	4.9%
SEMI – TRAILERS		16	3,979	85.8%	1,753	44.1%	5,732	87.5%	1,483	25.9%	7,215	87.1%	433	6.0%	7,648	85.6%
5–AXLE	Up to 14.6m	13	1,631	35.2%	893	54.8%	2,524	38.5%	283	11.2%	2,807	33.9%	(115)	-4.1%	2,692	30.1%
5–AXLE	Over 14.6m	9	787	17.0%	502	63.8%	1,289	19.7%	656	50.9%	1,945	23.5%	485	24.9%	2,430	27.2%
6–AXLE (FXD)	Up to 14.6m	7	1,042	22.5%	(5)	-0.5%	1,037	15.8%	203	19.6%	1,240	15.0%	15	1.2%	1,255	14.0%
6–AXLE (FXD)	Over 14.6m	7	11	0.2%	130	1181.8%	141	2.2%	205	145.4%	346	4.2%	29	8.4%	375	4.2%
6–AXLE (W/LFT)	Up to 14.6m	4	221	4.8%	156	70.6%	377	5.8%	83	22.0%	460	5.6%	(10)	-2.2%	450	5.0%
6–AXLE (W/LFT)	Over 14.6m	3	39	0.8%	25	64.1%	64	1.0%	(5)	-7.8%	59	0.7%	4	6.8%	63	0.7%
7–AXLE	Up to 14.6m	3	245	5.3%	37	15.1%	282	4.3%	58	20.6%	340	4.1%	25	7.4%	365	4.1%
7–AXLE	Over 14.6m	2	3	0.1%	15	500.0%	18	0.3%	0	0.0%	18	0.2%	0	0.0%	18	0.2%
TANDEM TRAILERS		12	382	8.2%	140	36.6%	522	8.0%	137	26.2%	659	8.0%	192	29.1%	851	9.5%
A – TRAINS		8	267	5.8%	(12)	-4.5%	255	3.9%	30	11.8%	285	3.4%	46	16.1%	331	3.7%
7–AXLE	Up to 18.5m	4	187	4.0%	(95)	-50.8%	92	1.4%	(17)	-18.5%	75	0.9%	(3)	-4.0%	72	0.8%
7–AXLE	Over 18.5m	4	32	0.7%	49	153.1%	81	1.2%	26	32.1%	107	1.3%	23	21.5%	130	1.5%
8–AXLE	Up to 18.5m	4	48	1.0%	13	27.1%	61	0.9%	(6)	-9.8%	55	0.7%	(2)	-3.6%	53	0.6%
8–AXLE	Over 18.5m	2	0	0.0%	5	NEW	5	0.1%	23	460.0%	28	0.3%	24	85.7%	52	0.6%
9–AXLE	Over 18.5m	1		0.0%	16	NEW	16	0.2%	4	25.0%	20	0.2%	4	20.0%	24	0.3%
B – TRAINS		10	62	1.3%	158	254.8%	220	3.4%	112	50.9%	332	4.0%	149	44.9%	481	5.4%
6–AXLE	Over 18.5m	0		0.0%	0			0.0%	0			0.0%	0			0.0%
7–AXLE	Up to 18.5m	4	49	1.1%	11	22.4%	60	0.9%	17	28.3%	77	0.9%	23	29.9%	100	1.1%
7–AXLE	Over 18.5m	5	4	0.1%	27	675.0%	31	0.5%	4	12.9%	35	0.4%	25	71.4%	60	0.7%
8–AXLE	Up to 18.5m	4	5	0.1%	24	480.0%	29	0.4%	25	86.2%	54	0.7%	5	9.3%	59	0.7%
8–AXLE	Over 18.5m	8	4	0.1%	96	2400.0%	100	1.5%	66	66.0%	166	2.0%	96	57.8%	262	2.9%
C – TRAINS		4	53	1.1%	(6)	-11.3%	47	0.7%	(5)	-10.6%	42	0.5%	(3)	-7.1%	39	0.4%
7–AXLE	Up to 18.5m	1	8	0.2%	(4)	-50.0%	4	0.1%	(4)	-100.0%	0	0.0%	0	0.0%	0	0.0%
7–AXLE	Over 18.5m	2	20	0.4%	(1)	-5.0%	19	0.3%	(4)	-21.1%	15	0.2%	(3)	-20.0%	12	0.1%
8–AXLE	Up to 18.5m	1	5	0.1%	(4)	-80.0%	1	0.0%	(1)	-100.0%	0	0.0%	0	0.0%	0	0.0%
8–AXLE	Over 18.5m	3	20	0.4%	3	15.0%	23	0.4%	4	17.4%	27	0.3%	0	0.0%	27	0.3%
OVERALL TOTAL FROM FLEETS		16	4,636	100.0%	1,916	41.3%	6,552	100.0%	1,731	26.4%	8,283	100.0%	650	7.8%	8,933	100.0%

Number of users is based on operation of a configuration in any or all of the years in question.

Source: Carrier Survey (16/29 responses)

IBI GROUP / ADI

13.3.3 Configuration Usage

Only fourteen of the respondents gave enough information for both of the survey years, 1987 and 1992, to allow tabulations of results. Of those, only twelve provided numbers of movements per year in their data. Many of the companies presented this information as one or two lines showing their major routes, without distinguishing between trailer types. This had to be disaggregated on the basis of fleet composition and information on operating regions to make comparisons of configuration usage. Therefore, counter-intuitive results may occur in some of the tabulations due to the small sample size, and the necessity of estimating information to compensate for the lack of precision found in some responses.

Several types of information can be obtained from the responses to the survey question on vehicle usage. The changes in vehicle types are important input for the study, and these can be looked at in a variety of ways:

- by grouping companies together (e.g. western, eastern, etc.) according to their scope of operations;
- by considering total responses, for particular vehicle configurations, by type and number of axles; and
- by examining the reported region-to-region usage.

13.3.3.1 General Trends in Trailer Usage

Exhibit 13.7 is a summary of the major configuration types used by carriers in Canada, subdivided according to the scope of operations, as described in Section 13.3.1 of this report. Exhibit 13.8 is a graphical presentation of the same information. Trends highlights are as follows:

- there was an absolute decline in the vehicle-kilometre use of A-trains and straight trucks, and also a decline in the percentage of C-train usage;
- a substantial increase in usage of semitrailers took place, accounting for the bulk of the increase in vehicle-kilometres operated. This also resulted in a percentage increase in use of semis;
- B-trains became more used than A-trains and C-trains combined, among the companies responding. There was a dramatic percentage increase in the use of B-trains; overall it rose from 0.3% in 1987 to 5.5% in 1992;

EXHIBIT 13.7

SUMMARY OF CONFIGURATION USAGE IN 1987 AND 1992

X-TAB	DISTANCE OPERATED (,000 km)						PERCENTAGE OF TOTAL DISTANCE				
GROUP	TST	AT	CT	BT	ST	TOTAL	TST	AT	CT	BT	ST
CROSS - TABULATION GROUP ONE : (WEST/EAST/CROSS-CANADA OPERATORS)											
ALL 87	121,919	17,398	1,174	486	408	141,385	86.2%	12.3%	0.8%	0.3%	0.3%
ALL 92	247,624	8,188	1,349	14,874	338	272,373	90.9%	3.0%	0.5%	5.5%	0.1%
WEST 87	3,084	2,276	1,174	127	250	6,911	44.6%	32.9%	17.0%	1.8%	3.6%
WEST 92	8,519	2,932	1,222	2,473	225	15,371	55.4%	19.1%	8.0%	16.1%	1.5%
EAST 87	43,680			359	158	44,197	98.8%	0.0%	0.0%	0.8%	0.4%
EAST 92	119,954	378		140	113	120,585	99.5%	0.3%	0.0%	0.1%	0.1%
CRCAN 87	75,155	15,122				90,277	83.2%	16.8%	0.0%	0.0%	0.0%
CRCAN 92	119,151	4,878	127	12,261		136,417	87.3%	3.6%	0.1%	9.0%	0.0%
CROSS - TABULATION GROUP TWO : (OPERATORS WITH OR WITHOUT SIGNIFICANT U.S. BUSINESS)											
ALL 87	121,919	17,398	1,174	486	408	141,385	86.2%	12.3%	0.8%	0.3%	0.3%
ALL 92	247,624	8,188	1,350	14,874	338	272,373	90.9%	3.0%	0.5%	5.5%	0.1%
W/US 87	96,385	16,322				112,707	85.5%	14.5%	0.0%	0.0%	0.0%
W/US 92	199,928	6,078	127	12,861		218,994	91.3%	2.8%	0.1%	5.9%	0.0%
NO US 87	25,534	1,076	1,174	486	408	28,678	89.0%	3.8%	4.1%	1.7%	1.4%
NO US 92	47,696	2,110	1,222	2,013	338	53,379	89.4%	4.0%	2.3%	3.8%	0.6%

NOTES:

Cross - Canada operators are those with at least 5% of their business both east of and west of the Ontario/Manitoba border.

Significant U.S. business is defined as 5% or more of total operations

TST = Tractor/Semi-Trailer, AT = A-Train, CT = C-Train, BT = B-Train, ST = Straight Truck

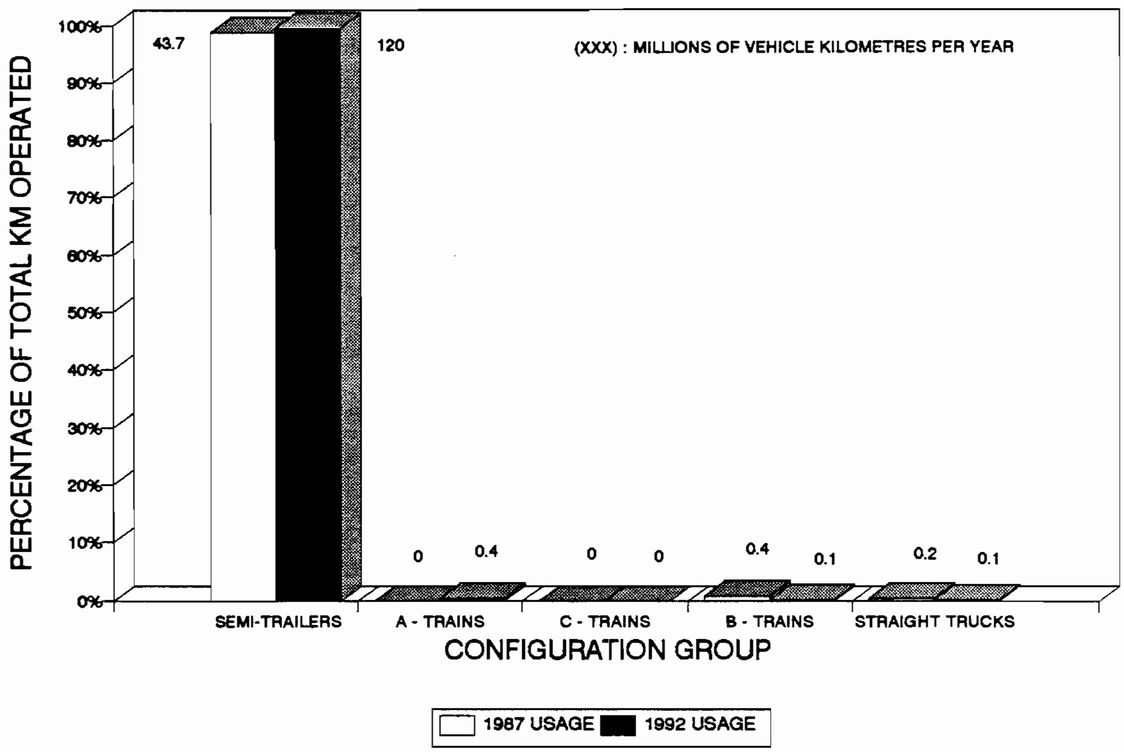
Some distances were derived from fleet composition (G2) and total veh-km reported (G3 and G1).

IBI GROUP / ADI

Source : Carrier Survey (15/29 responses)

EXHIBIT 13.8 (2/3)

CONFIGURATION USAGE (VEH-KM)
EASTERN OPERATORS : 7 FLEETS REPORTING



CONFIGURATION USAGE (VEH-KM)
CROSS-CANADA OPERATORS : 4 FLEETS

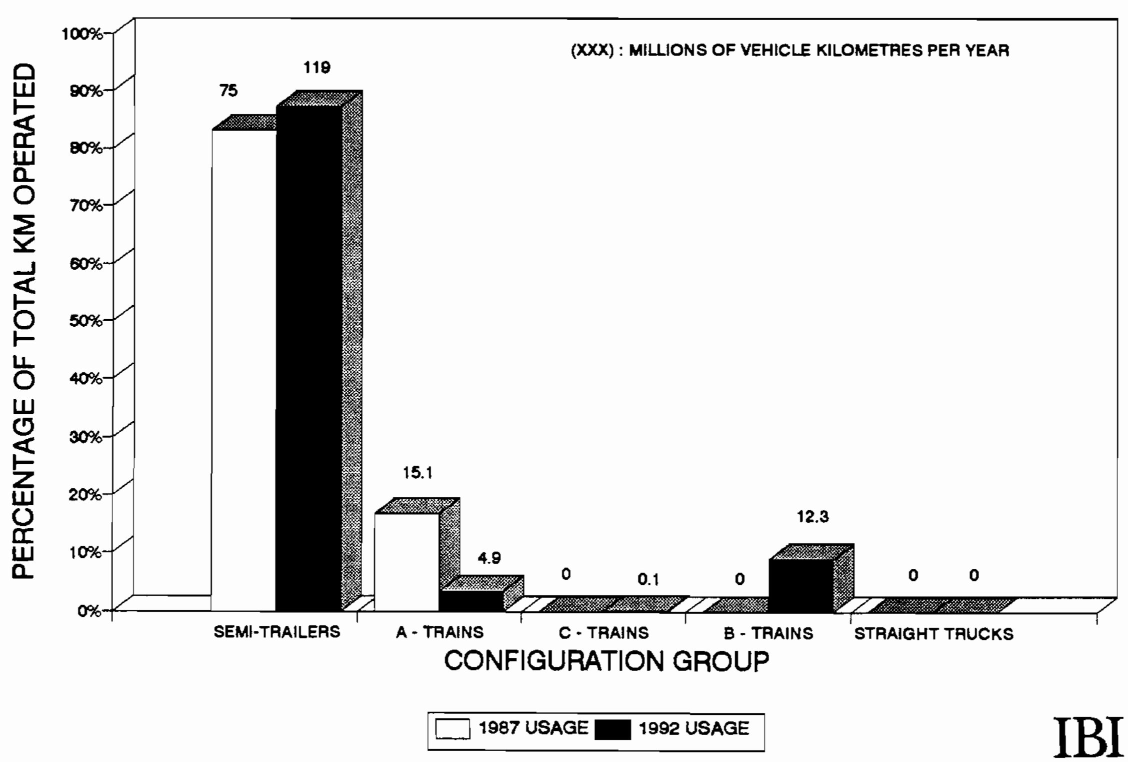


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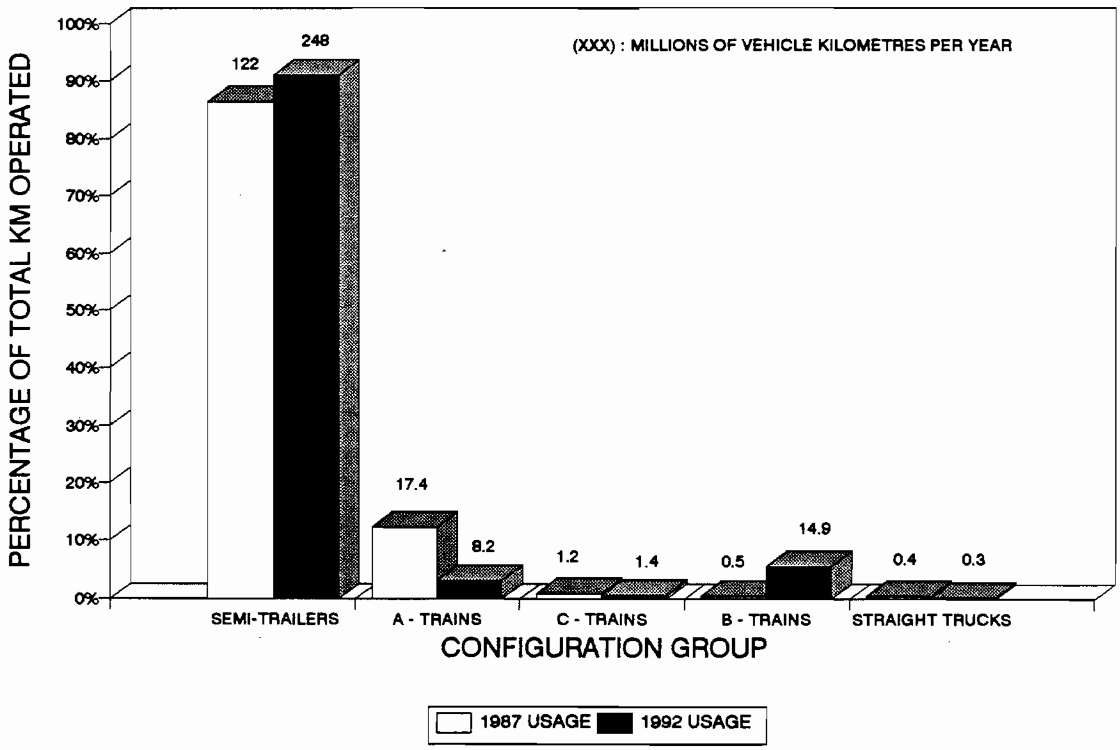
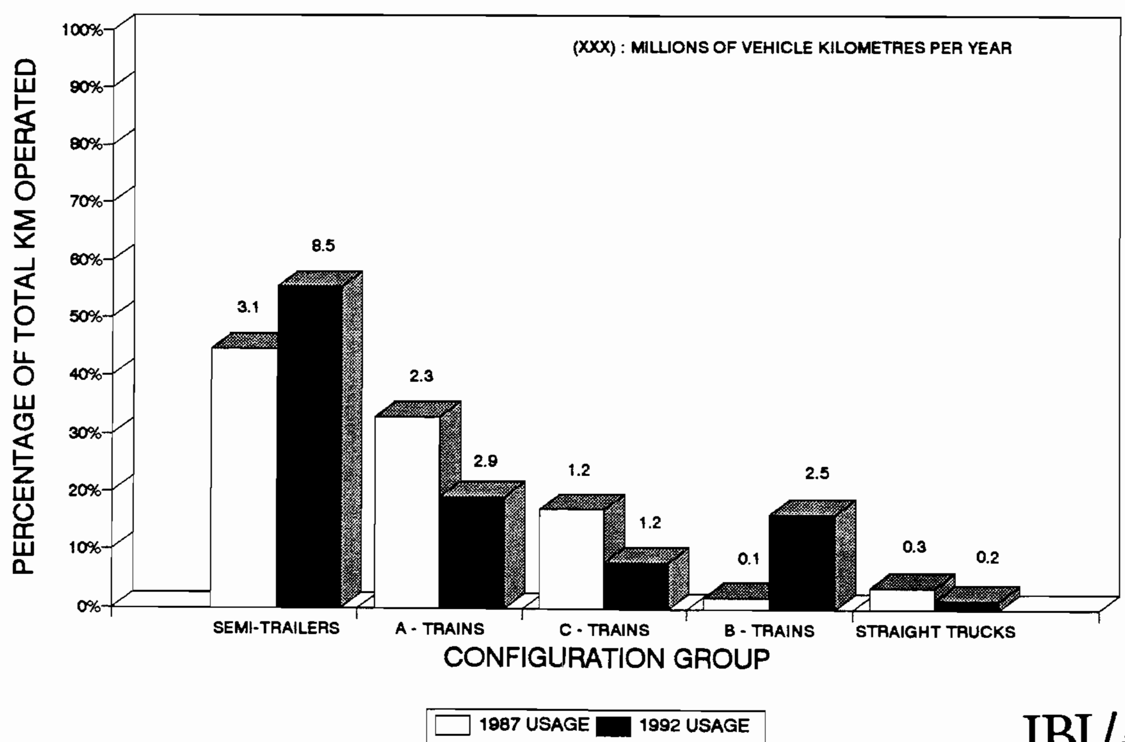
EXHIBIT 13.8 (1/3)

CONFIGURATION USAGE (VEH-KM)
OVERALL TOTAL : 15 FLEETS REPORTING



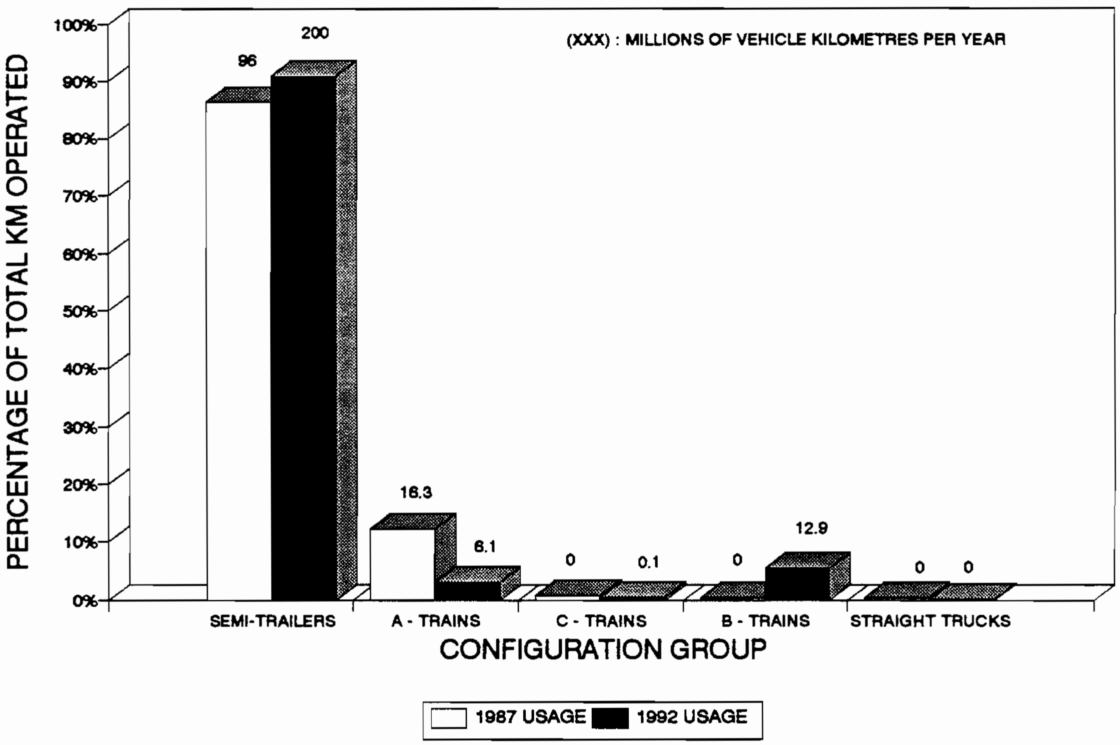
CONFIGURATION USAGE (VEH-KM)
WESTERN OPERATORS : 4 FLEETS REPORTING



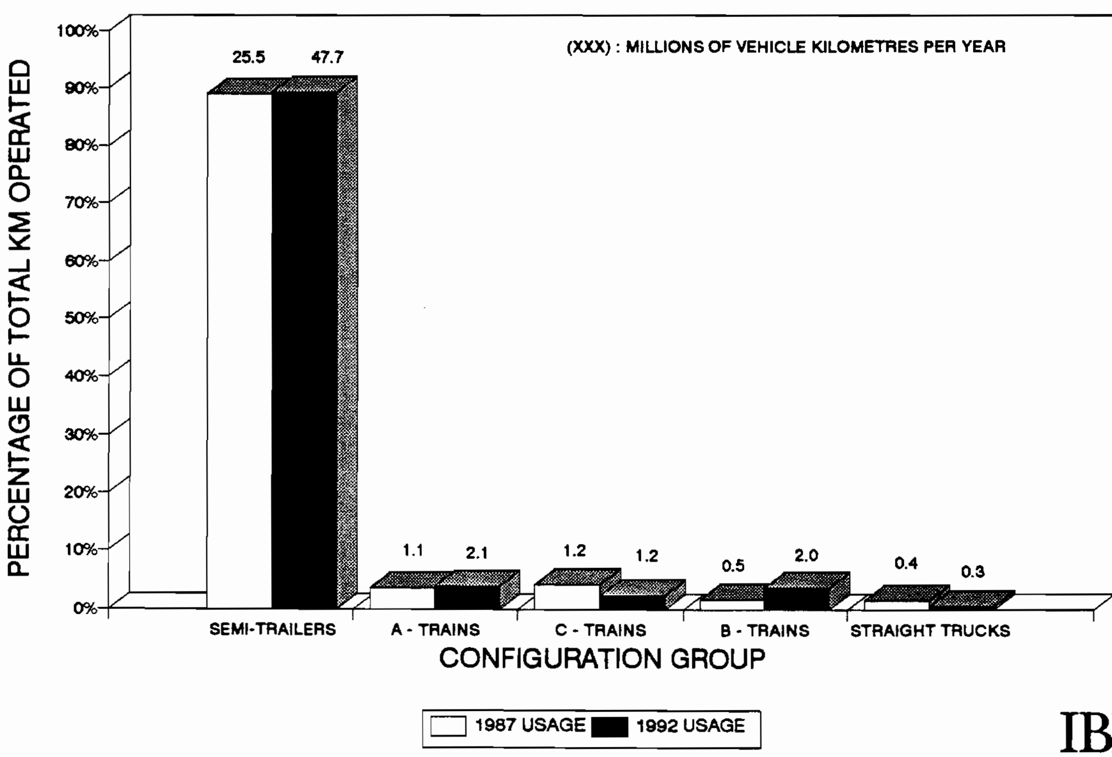
IBI GROUP / ADI

EXHIBIT 13.8 (3/3)

CONFIGURATION USAGE (VEH-KM)
EIGHT FIRMS WITH OVER 5% U.S. BUSINESS



CONFIGURATION USAGE (VEH-KM)
SEVEN FIRMS WITH UNDER 5% U.S BUSINESS



IBI GROUP / ADI

- semitrailers were very predominant (over 98% of reported veh-km) among eastern operators, while cross-Canada and western operators are more progressive in their use of double trailers. Western firms appear to use B-trains most frequently of all groups, although they also use a larger proportion of A-trains;

- cross-Canada operators now use more semitrailers and B-trains than in 1987, at the expense of A-train usage;

- western carriers seem to use significant percentages of all configuration types, with semitrailers and B-trains gaining in importance over the 1987-92 period;

- the eastern firms that responded to the survey all used semitrailers and little else; and

- firms with significant business in the U.S. showed an increase in semitrailer operations, together with a shift from A-trains to B-trains (probably in their Canadian operations) while the eight other firms (with under 5% U.S. business) showed a drop in C-trains with an increase in B-trains.

13.3.3.2 Usage of Specific Configurations

Truck configuration usage is reported by vehicle kilometres and number of commodity movements for all fifteen valid responses in Exhibit 13.9. It is partly a function of the parallel disaggregation of the responses on movements and distances, that the percentages of movements by number and by vehicle-kilometres are similar. Due to the fact that two respondents did not report movements, the numbers in the Exhibit cannot be used to estimate average distances.

Some of the new observations, made on the basis of these tabulations, include:

- uptake of the B-train is spread among 6, 7 and 8-axle vehicles, with the 8-axle vehicles achieving the greatest popularity;

- increases of semitrailer usage took place for 5-axle and 6-axle trailers, with a larger proportional increase in 6-axle vehicles; and

- comparison of the distribution of movements and vehicle-kilometres cannot be made directly, but the numbers suggest that 6-axle semis are used for longer-than-average hauls. This is a reasonable conclusion considering that 10%

EXHIBIT 13.9

TRAILER TYPE USAGE REPORTED BY SURVEYED FIRMS

TRAILER TYPE	ESTIMATED 1987 TRUCK MOVEMENTS				ESTIMATED 1992 TRUCK MOVEMENTS			
	#/YR.	% (#)	VEH-KM	%(KM)	#/YR.	% (#)	VEH-KM	%(KM)
SEMI-TRAILERS	235,186	86.5%	121,919,134	86.2%	331,322	87.9%	247,623,809	90.9%
A-TRAINS	28,226	10.4%	17,398,249	12.3%	13,850	3.7%	8,187,942	3.0%
C-TRAINS	2,581	0.9%	1,173,894	0.8%	2,745	0.7%	1,349,760	0.5%
B-TRAINS	1,097	0.4%	486,003	0.3%	24,486	6.5%	14,874,110	5.5%
STRAIGHT TR.	4,900	1.8%	407,700	0.3%	4,700	1.2%	337,650	0.1%
ALL	271,990		141,384,979		377,103		272,373,270	

CONFIGURATIONS USED BY SURVEYED FIRMS

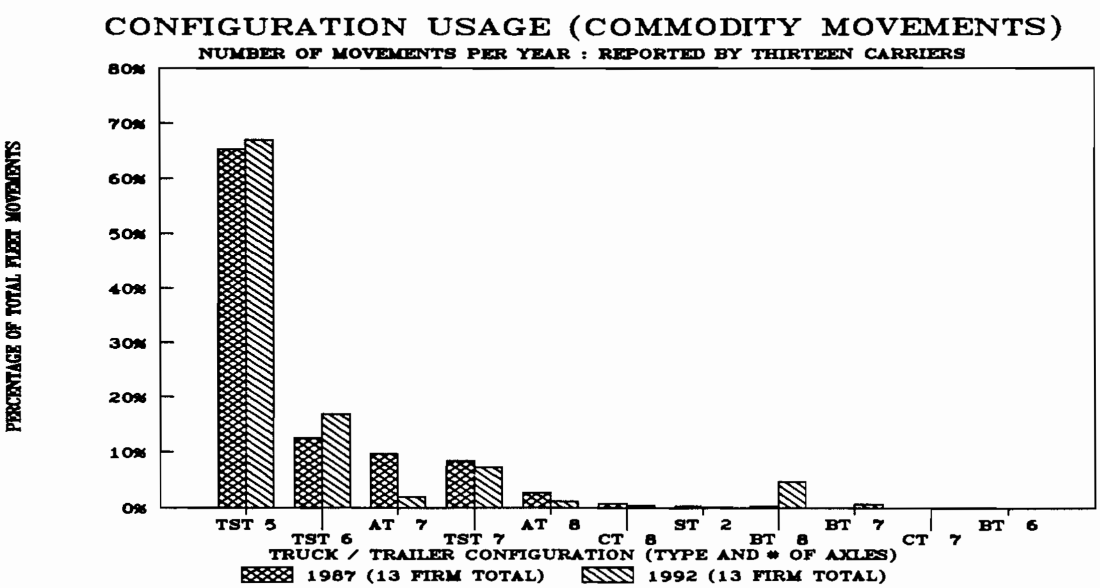
CONFIGURATION AND # OF AXLES	ESTIMATED 1987 TRUCK MOVEMENTS				ESTIMATED 1992 TRUCK MOVEMENTS			
	#/YR.	% (#)	VEH-KM	%(KM)	#/YR.	% (#)	VEH-KM	%(KM)
TST 5	194,808	71.6%	92,442,649	65.4%	270,949	71.9%	182,440,261	67.0%
TST 6	20,519	7.5%	17,631,484	12.5%	36,058	9.6%	45,600,960	16.7%
TST 7	19,860	7.3%	11,845,000	8.4%	24,315	6.4%	19,582,588	7.2%
BT 8	843	0.3%	380,084	0.3%	20,931	5.6%	12,918,819	4.7%
AT 7	22,363	8.2%	13,686,051	9.7%	8,928	2.4%	5,250,254	1.9%
AT 8	5,863	2.2%	3,712,198	2.6%	4,922	1.3%	2,937,688	1.1%
BT 7	254	0.1%	105,919	0.1%	3,305	0.9%	1,655,291	0.6%
CT 8	2,500	0.9%	1,140,000	0.8%	2,300	0.6%	1,050,000	0.4%
ST 2	4,900	1.8%	407,700	0.3%	4,700	1.2%	337,650	0.1%
BT 6		0.0%		0.0%	250	0.1%	300,000	0.1%
CT 7	81	0.0%	33,894	0.0%	445	0.1%	299,760	0.1%
TOTAL	271,990		141,384,979		377,103		272,373,270	

NOTES:

Shading indicates a 50% or greater RELATIVE increase (ratio of 1992/1987) in the proportion of veh-km or movements.

Vehicle kilometres derived from 15 responses.

Number (#) of commodity movements determined from 13 responses.



Source : Carrier Survey (15/29 responses)

of movements and 17% of vehicle-kilometres are attributed to the 6-axle semitrailer.

13.3.3.3 Regional Trends

The reported carrier operations are broken down into region-to-region movements in Exhibit 13.10. The most notable trend is, again, the uptake of B-trains. It is not surprising that the movements involving region number 4 (the Prairies) seem to account for almost all of the B-train usage. The drop in use of B-trains in Québec reflects the experience of only one company and is not necessarily indicative of industry trends.

Exhibit 13.11 shows the truck movements from a different perspective. The movements to, from and within the operating regions are summarized to illustrate the differences between groups of jurisdictions. Again, the characteristic shift towards B-trains for bulk commodities is illustrated, particularly in the Prairie Provinces and British Columbia. In the provinces east of Manitoba, the reported changes were quite marginal.

13.3.4 Impact of MoU on Carrier Operations

This question examined the perceived input of the MoU on carrier operations, with emphasis on fleet mix, markets served, unit operating costs, shipping rates, shipper service, and safety.

The **fleet mix** registered the most change, with 60% of the respondents indicating at least some effect. The trucking firms within western Canada experienced the greatest changes, citing equipment upgrades and the replacement of some models (with an emphasis on switching to B-trains) as a significant reason for the change. Companies mentioning a switch to B-trains, were influenced by the increased allowable Gross Vehicle Weights.

The **markets served** were not affected to any great extent; however, for one company, the decision to serve Ontario required larger TAC vehicles. One company that uses primarily 5-axle tractor semitrailers found that its operations were no longer as competitive in east-west hauls [in Canada] as those of companies using the 6, 7 and 8-axle vehicles.

Unit operating costs generally increased due to maintenance costs; however one company observed decreases in costs due to the use of tridem axles (because they became more efficient on a per tonne-kilometre basis) and another cited reductions in the number of overload shipments due the increases in permitted weights.

Shipping rates have eroded over the past five years, largely due to competition among carriers. Deregulation of the industry (more

EXHIBIT 13.10

REGION-TO-REGION CONFIGURATION USAGE

CONFIG	VEH-KM (1987)	VEH-KM (1992)	R1	R2
TST	480,000	400,000	1	1
BT		140,000	1	1
TST	1,294,900	10,393,000	1	2
TST	6,000,000	4,750,000	1	3
TST	9,217,050	41,166,600	2	2
BT	358,900	0	2	2
ST	157,700	112,650	2	2
AT		378,400	2	2
TST	13,073,900	41,621,200	2	3
TST	476,200	961,785	2	4
BT		31,845	2	4
CT		6,370	2	4
TST	5,588,800	13,584,785	2	7
BT		31,845	2	7
CT		6,370	2	7
TST	35,501,600	78,479,900	3	3
TST	16,533,800	15,610,250	3	4
AT	777,624		3	4
BT	0	1,691,758	3	4
CT		57,325	3	4

CONFIG	VEH-KM (1987)	VEH-KM (1992)	R1	R2
TST	18,000,000	14,250,000	3	5
TST	7,523,800	13,406,050	3	7
BT		286,625	3	7
CT		57,325	3	7
AT	15,831,221	6,727,184	4	4
TST	5,247,721	6,987,023	4	4
CT	1,149,525	1,103,757	4	4
ST	250,000	225,000	4	4
BT	35,720	11,609,681	4	4
TST	862,871	4,866,790	4	5
BT	83,068	1,057,297	4	5
AT	49,841	579,341	4	5
CT	22,151	115,868	4	5
TST	55,497	121,850	4	6
BT	9,354	28,150	4	6
TST	2,069,160	1,037,963	4	7
AT	734,574	489,288	4	7

1987 TOTAL	1992 TOTAL
141,384,977 veh-km	**272,373,275 veh-km**

Veh-km shown are estimates of two-way traffic ONLY for the surveyed companies

REGIONS :

(1) Atlantic
(2) Quebec
(3) Ontario
(4) Prairie Provinces
(5) British Columbia
(6) Territories
(7) United States

Source : Carrier Survey (15/29 responses)

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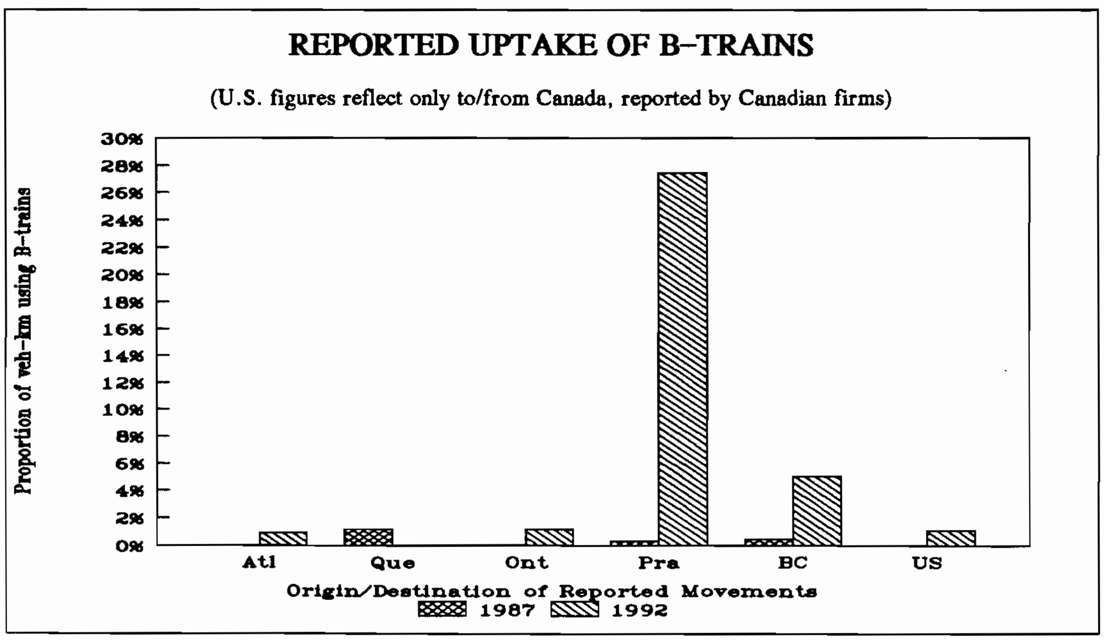
EXHIBIT 13.11

CONFIGURATION USAGE CHARACTERISTICS (VEH-KM OPERATED)

	1987 VEH-KM	1987 %	1992 VEH-KM	1992 %
To / From / Within Atlantic Provinces				
TST	7,774,900	100.0%	15,543,000	99.1%
BT	0	0.0%	140,000	0.9%
TOTAL	7,774,900	100.0%	15,683,000	100.0%
To / From / Within Quebec				
ST	157,700	0.5%	112,650	0.1%
TST	29,650,850	98.3%	107,727,370	99.5%
AT	0	0.0%	378,400	0.3%
BT	358,900	1.2%	63,690	0.1%
CT	0	0.0%	12,740	0.0%
TOTAL	30,167,450	100.0%	108,294,850	100.0%
To / From / Within Ontario				
TST	96,633,100	99.2%	168,117,400	98.8%
AT	777,624	0.8%		0.0%
BT	0	0.0%	1,978,383	1.2%
CT	0	0.0%	114,650	0.1%
TOTAL	97,410,724	100.0%	170,210,433	100.0%

	1987 VEH-KM	1987 %	1992 VEH-KM	1992 %
To / From / Within Prairie Provinces				
ST	250,000	0.6%	225,000	0.4%
TST	25,245,249	57.1%	29,585,661	55.1%
AT	17,393,260	39.4%	7,795,813	14.5%
BT	128,142	0.3%	14,705,356	27.4%
CT	1,171,676	2.7%	1,340,645	2.5%
TOTAL	44,188,327	100.0%	53,652,475	100.0%
To / From / Within British Columbia				
TST	18,862,871	99.2%	19,116,790	91.6%
AT	49,841	0.3%	579,341	2.8%
BT	83,068	0.4%	1,057,297	5.1%
CT	22,151	0.1%	115,868	0.6%
TOTAL	19,017,931	100.0%	20,869,296	100.0%
United States To / From Canada				
TST	15,181,760	95.4%	28,028,798	97.0%
AT	734,574	4.6%	489,288	1.7%
BT	0	0.0%	318,470	1.1%
CT	0	0.0%	63,695	0.2%
TOTAL	15,916,334	100.0%	28,900,251	100.0%

NOTE: These numbers cannot be summed to produce a national total, due to double counting of inter-regional trips.
Information derived from only fifteen valid responses and some numbers may indicate trends that are contrary to what is expected and/or to what is actually taking place. Survey data based on major routes only; some configurations are under-represented.



Source : Carrier Survey (15/29 responses)

competition) and the use of larger GVW vehicles (shippers know that costs per tonne-km are lower and insist on lower rates) have also been contributing factors. This impact was reported across the country, with the exception of the Atlantic provinces.

Carriers felt that there have been only slight changes in **shipper service.** In some cases, the truckers reported that shipper service had improved due to equipment enhancements. It was noted by one company that shippers demand B-Trains, but they are found to be difficult to load [without modifications to their facilities].

In general there was little reported effect on **safety**, although one company did note better driver standards and also a higher level of safety in newer vehicles due to the fact that B-trains are inherently more stable than A-trains.

13.3.5 Impact on Road Safety

This question examined the effect of configuration types and driver training on the number of accidents experienced by the carrier companies in 1987 and in 1992. Due to the limited availability of statistical data it was difficult to acquire a quantitative indication of effects in this area. Problems included different definitions of "reportable" accident, since at least two respondents indicated completely different benchmark levels (i.e. minimum $ value) for an accident. A carrier operating in the western provinces has switched to B-trains and "Super B's" as they found A-trains to be less safe. Several companies indicated that equipment upgrades were being made with TAC vehicles as their existing fleet aged, due in part to the better safety characteristics of the B-trains.

13.3.6 Effect of TAC Vehicles on Growth, Profit and Territory

Most carriers felt that the use of TAC vehicles requires a substantial initial cost to purchase the new vehicles, yet eventually results in a competitive edge, especially for east-west routes. The implementation of the new vehicles leads to reduced operating costs and a decline of overload trips. The most common disadvantages include the cost of the vehicles, the decrease in shipping rates and a greater wear on the tractors.

13.3.6.1 Impact of the Economic and Regulatory Environment

The survey respondents were asked to rate the level of impact of various factors relative to the effects of the MoU. The factors were : deregulation, the Free Trade Agreement, economic conditions, competition from U.S. carriers, and increases in intermodal and container shipping.

Deregulation, especially in Ontario, was perceived to have a greater impact than the MoU on the carriers. In general, carriers seemed to benefit from it due to the increased freedom to serve a larger market area. One Quebec carrier directly identified deregulation as the reason for increases in the scope of their service area. On the other hand, some carriers noted a drastic increase in competition, attributed mainly to deregulation, including one case where the carrier underwent considerable downsizing and abandoned the petroleum market.

The largest change observed due to the **Free Trade Agreement** was an increase in North-South movements. Naturally, the largest impact was felt by carriers with business in the U.S., especially those located in the western provinces.

Eighty percent of the carriers stated that **economic conditions** had a greater impact than the MoU. Factors contributing to this effect were: generally poor economic conditions, shrinking markets leading to increased competition, and a reduction in east-west movements.

The impact of **competition from U.S. carriers** was felt mainly by the eastern and cross-country companies, especially those operating in U.S. regions. There was some competition from the U.S. carriers, leading to lower Southbound rates, yet a carrier from Alberta indicated more U.S. alliances as an advantage. More competition is anticipated in the future.

Increased intermodal/container traffic especially impacted east-west traffic. It appears that, lately, rail has become more focused on quality, leading to an increase of rail competition. The degree of impact also depended on the freight being carried; for example, petroleum tanker companies expected to experience little competition, because rail is not used to carry this commodity to the markets served by these carriers.

13.3.7 Constraint on Operations

This question investigated the implications of truck size and weight limits, regional inconsistencies, variation in enforcement practices and the extent of the Designated Highway System on trucking operations. 70% of the respondents indicated that at least a minor constraint existed to the use of TAC vehicles.

Weights and dimensions regulations impacted carriers throughout the country. Generally, the difference in regulatory details between jurisdictions hinders Cross-Canada movement. Within certain provinces, such as Ontario and British Columbia, there are higher weight allowances. This means that trucks weighing out are restricted to within the province. Crossing borders creates problems, because the most restrictive regulations have to be met as one moves commodities between jurisdictions. Trucking companies noted that often at least two vehicles were required to travel to the destination (between British Columbia and New Brunswick, and between Manitoba and Ontario). Inconsistencies in vehicle dimension allowances have also caused considerable problems. For example, the fact that 53 ft. trucks are not allowed into Quebec (and until very recently, were restricted from Ontario) has posed problems for some eastern firms. Other inconsistencies included the prohibition of longer combination vehicles in British Columbia and Ontario, while in Saskatchewan, "C" dollies are required for longer combination vehicles. One commonly held opinion was that carriers would benefit if they were able to operate without special permits (i.e. trip permits).

The **Designated Highway System** has been responsible for constraints on operations of some carriers, especially those in eastern and central Canada, while the western companies seem to experience fewer problems, due to the inclusion of a greater percentage of roadways. Specific problem areas include the Toronto/Niagara region and the Province of Quebec. One carrier noted the improvements made in Alberta, where the Designated Highway System has increased tremendously to include all provincial and arterial highways.

Variation in enforcement practices has a considerable impact on operations for western and central provinces, while the eastern provinces suffered significantly less criticism. It was reported that British Columbia is more strict than other provinces with respect to vehicle inspections but less strict on safety issues. It was also asserted by one firm that enforcement variations lead to artificial trade barriers within Canada.

13.3.8 Impediments to Increased Use of TAC Vehicles

Some constraints on the use of TAC vehicles were identified by the carriers. These include:

- weights on the 16 ft. tri-axles as compared to the 12 ft. spreads;
- access problems for trucks in excess of 48 feet (14.65 m) in urban areas;
- loading characteristics of some commodities;
- insufficient weight and flexibility (box length too short on tandems, width too narrow for special loads) to meet requirements;
- cost of purchasing new vehicles;
- limits of U.S. standards for north-south hauls;
- Ontario's incompatibility on regulations.

13.3.9 Future Fleet and Operations

The impact of various factors on future fleets and operations were discussed. The factors which seemed to have the most significant implications were the increasing influx of U.S. carriers and the trend towards use of longer combination vehicles.

Due to the increasing influx of U.S. carriers, better marketing would be required. There is a resulting decrease in border-bound traffic available to Canadian carriers.

The increases in permissible vehicle weights and dimensions are pushing many carriers to invest in new equipment purchases.

It was also noted that the implementation of NAFTA (the North American Free Trade Agreement) is expected to lead to an increase in movements to Mexico and to the south-western U.S. This in return would affect the equipment specifications. The majority of carriers believed that NAFTA would have a positive effect on business for Canadian firms.

13.3.10 Influences on the Future of the Trucking Business

Lack of uniformity across Canada and throughout the United States was seen as the most significant impediment to the trucking business today. The standardization of weights and dimensions across North America, it was felt, would greatly enhance business opportunities for most companies. It was also suggested that uniform enforcement practices for the monitoring of weight and dimension specifications and freight movements would be advantageous. The shift to larger vehicles has had an effect and will continue to influence the future of the trucking business by increasing the efficiency and reducing rates of most carriers. The implementation of NAFTA is also thought to have the potential to benefit many Canadian businesses.

13.3.11 Broad Issues

These are the issues that carriers felt were worth special mention:

- shipping rates need to be increased, to allow acquisition of new vehicles and pay for new driver training;
- public relations of the industry need improvement;
- three carriers had concerns about inconsistencies in the enforcement of safety regulations such as the National Safety Code;
- continuing differences between jurisdictions on weight and dimensions regulations; and
- the creation of a built-in disadvantage in cross-border traffic

for Canadian carriers in comparison with American carriers. This occurs because the American carriers have equipment designed for the lower limits in place on many of the roads in the United States. This equipment has lower tare weights than that of Canadian carriers and thus lower operating costs and higher payloads.

14. CASE STUDIES

14.1 CASE STUDY PROCESS

To supplement the results of the carrier surveys, a series of case studies was conducted to provide insights into the range of impacts which the 1988 MoU had on trucking firms, road providers, shippers and trailer manufacturers/distributors in various regions of the country. The objective of the carrier, provincial/territorial ministry and shipper case studies was to provide further insights into the impacts of the MoU on the trucking industry, on shippers and on the road system. The trailer manufacturer/distributor case studies were not in the original work program but were added subsequently at the request of the Steering Committee; these case studies were intended to capture changes in fleet configuration trends by investigating changes in sales trends, including regional variations within the trends. The trailer manufacturer/distributor case studies also considered the impact on vehicle characteristics (e.g. suspension systems), the quickness of response of truckers to the MoU in purchasing new equipment, and future anticipated trends in sales. The content of the four case study questionnaires is summarized in Exhibit 14.1, and the actual questionnaires used to conduct the case studies, revised to reflect comments from the Steering Committee, are included in Appendix C.

Twelve ministry case studies were to be conducted, one for each province and territory. For each province/territory, however, more than one interview was typically required to capture experience and expertise in different areas, e.g. pavement, bridges, new construction, maintenance, etc. The carrier, shipper and trailer manufacturer case studies firms, as outlined in Part I of this report, were distributed throughout the five regions of Canada (Atlantic Provinces, Quebec, Ontario, Prairie Provinces and British Columbia), with more emphasis in Western Canada where the potential changes brought about by the MoU were more extreme, and less emphasis in Ontario where there was less scope for change through the MoU. Another criterion for selection of carriers and shippers for case studies was that the extent of participation of the firms in interprovincial business should be such that the firms could take full advantage of the MoU. Another objective in firm selection was to include a variety and balance of types of firms, e.g. including some for-hire carriers and some private carriers, firms of various sizes, representation of a variety of commodities, etc. A draft list of case study firms was compiled through our own experience, recommendations from the Steering Committee, recommendations of carriers from provincial trucking associations, and recommendations of shippers from the Canadian Industrial Transportation League (CITL).

EXHIBIT 14.1

CONTENT OF CASE STUDY QUESTIONNAIRES

CARRIER CASE STUDIES	
C1	Changes in Configuration for Major Routes
C2	New Markets
C3	Regional Inconsistencies
C4	Vehicle Characteristics
C5	Future Vehicle Configurations
C6	Regulatory Changes
MINISTRY CASE STUDIES	
M1	Changes in Heavy Truck Patterns
M2	Physical Impact on Roads and Bridges
M3	Influence on Jurisdictional Practices
M4	Impact on Highway Infrastructure Design and Analysis
M5	Other Factors Affecting Implementation
M6	Changes in Highway Design Over Next Five Years
SHIPPER CASE STUDIES	
S1	Impact of the Memorandum of Understanding (MoU)
S2	Changes to Dock Areas
S3	Impact of Other Factors
S4	New Markets
S5	Other Opportunities
TRAILER MANUFACTURER / DISTRIBUTOR CASE STUDIES	
F1	Changes in Sales from 1987 to 1992
F2	Changes Specific to Provinces / Regions
F3	Changes in Vehicle Characteristics
F4	Speed of Response to Changes
F5	Changes Over Next Five Years

When the case study firm list was assembled, all companies on the list were contacted to determine their willingness to participate, to confirm that their operations were interprovincial, and to identify a contact person if one was not already available. For firms that agreed to participate, questionnaire forms were forwarded to allow the firms to prepare for the interviews. However, a number of firms refused to participate, primarily due to lack of time, but also due to confidentiality concerns. Other firms could not even be approached, since contact persons and alternate contact persons refused to return calls, even after numerous messages (often 10 to 20) were left. Consistent with the carrier survey experience, carriers in British Columbia were the least cooperative. In these cases, substitute firms were approached. For reasons of confidentiality, we have retained the final list of case study participants.

Most of the case studies were conducted as face-to-face interviews at the firm's offices, to get a better sense of operating environment and to encourage more extended dialogue. Some case studies were conducted over the telephone due to limitations on the interviewee's time, to allow for wider geographic coverage (e.g. to include firms located in isolated areas), or to facilitate consultation with more than one person from each agency. Case study questionnaire forms were completed by the case study interviewer. However, to respect the confidentiality concerns expressed by the interviewees, the completed case study forms are not included in this report. It is intended that the summary analyses in the following sections will address the main issues without identifying specific firms.

14.2 ANALYSIS OF RESULTS

For each of the four groups of case studies, the results are discussed on a question-by-question basis, and key themes are then summarized. The discussion is structured to reflect the regional aspects of each topic.

14.2.1 Carrier Case Studies

Exhibit 14.2 provides a profile of the carrier firms which participated in the carrier case studies. For each carrier, the exhibit indicates the region of domicile, type of carrier (for-hire or private), regions of operation, major commodities carried and information on current fleet.

14.2.1.1 Changes in Configuration for Major Routes (C1)

Question C1 from the carrier case study questionnaire requested information on the most important configurations for the firm's highest volume North American routes in 1987 and 1992. The reason for each configuration change (or lack of change) was also requested. Even though the question was presented in a simple, clear format, all case study participants without exception found the question difficult to answer because of the intrinsic difficulty of obtaining or estimating the information. Some companies had the answers in their records, but

EXHIBIT 14.2
PROFILE OF CARRIER CASE STUDIES

Region of Domicile	Type of Carrier	Regions of Operation	Major Commodities	Fleet
Quebec	For-hire	Quebec, Ontario, U.S.	Canned goods	100 straight trucks, 350 tractors, 15 A-trains, 10 B-trains
Praries	For-hire			
British Columbia	For-hire	British Columbia, (some in Yukon)	General freight, lumber, concrete blocks, building materials, forestry equipment	80 trailers (45' vans, flatdecks, super B-trains, low-boys), 12 tractors
Ontario	For-hire	Ontario, Quebec, North U.S.	General freight, machinery, steel	48' vans, flat beds, drop decks, a few A-trains and B-trains
Atlantic Canada	For-hire	Ontario, Quebec, Maritimes	General freight	Tractors, B-trains
Atlantic Canada	For-hire	Atlantic Canada, Ontario	General freight	Trailers
Praries	For-hire	Prairies, Northwest U.S.	Petroleum	A-trains, Super B-trains
Atlantic Canada	For-hire	Eastern U.S., Atlantic Canada	Petroleum, dry and liquid chemicals	Tankers, flat-beds, B-trains
Praries	For-hire	Cross-Canada	Mail, durable goods, foodstuffs, farm machinery, lumber, parcels	Vans, flat-beds
Ontario	Private	Cross-Canada, mainly Ontario/ Quebec	Machinery, lumber, steel, building products	450 tractors, 1100 semi-trailers, 50 A-trains, 3 B-trains

EXHIBIT 14.3 (Cont'd)
CHANGES IN CONFIGURATIONS ON MAJOR ROUTES

Commodity Group	Region of Domicile	Origin	Destination	Rank of Route Within Firm	Commodities Shipped	Fleet (1987)	Fleet (1992)	% Difference vehicle-km (1987-1992)
O	Alberta	Alberta	Alberta	1	oil field equipment, drilling rigs	TST-5	TST-6	N/A
O	Alberta	Alberta	British Columbia	1	groceries	TST-5	TST-6	N/A
O	Alberta	British Columbia	Alberta	2	building materials and lumber	TST-5	TST-6	N/A
O	Alberta	British Columbia	Alberta	1	pipe	TST-5	TST-6	N/A
O	British Columbia	British Columbia	British Columbia	1	pulp mill freight	TST-5	BT-8	N/A
O	British Columbia	British Columbia	British Columbia	1	lumber	TST-5	BT-8	N/A
O	British Columbia	British Columbia	NW U.S.	1	containers	TST-5	TST-6	N/A
GFT	Atlantic	NE U.S.	Atlantic	5	perishable food	TST-5	TST-5, TST-6	-16
GFT	Atlantic	NE U.S.	Ontario	3	perishable food	TST-5	TST-5, TST-6	12

Legion:

GFL General Freight Less-than Truckload
GFT General Freight Truckload

DB Dry Bulk
LB Liquid Bulk
O Other

EXHIBIT 14.3
CHANGES IN CONFIGURATIONS ON MAJOR ROUTES

Commodity Group	Region of Domicile	Origin	Destination	Rank of Route Within Firm	Commodities Shipped	Fleet (1987)	Fleet (1992)	% Difference vehicle-km (1987-1992)
GFL	Atlantic	Atlantic	Atlantic	1	food, fish, grocery, frozen food	TST-5, TST-6	TST-5, TST-6	-5
GFL	Atlantic	Atlantic	Quebec	5	frozen food, fish	N/A	TST-5, TST-6, BT-8	-3
GFL	Atlantic	Atlantic	Ontario	4	frozen food, fish	N/A	TST-5, TST-6, BT-8	-3
GFT	Atlantic	Atlantic	Ontario	4	potatoes, fish	TST-5	TST-5, TST-6	12
GFT	Atlantic	Atlantic	NE U.S.	2	potatoes, fish	TST-5	TST-5, TST-6	0
GFL	Atlantic	Quebec	Atlantic	3	grocery	N/A	TST-5, TST-6, BT-8	7.5
GFT	Ontario	Quebec	NE U.S.	3	newsprint	TST-5	TST-5	0
GFL	Atlantic	Ontario	Atlantic	2	grocery	N/A	TST-5, TST-6, BT-8	-1
GFT	Atlantic	Ontario	Atlantic	1	perishable food	TST-5	TST-5, TST-6	24
GFT	Ontario	Ontario	Quebec	4	auto parts, food, building material	TST-5	TST-5	0
O	Alberta	Ontario	Alberta	3	pipe	TST-5	TST-6	N/A
GFT	Ontario	Ontario	NE U.S.	1	auto parts, food, building materials	TST-5	TST-5	0
DB	Ontario	Ontario	NE U.S.	5	steel for automotive industry	BT-8, AT-8	BT-8, AT-8	0
O	Alberta	Manitoba	Alberta	1	steel products, building materials and lumber	TST-5	TST-6	N/A

EXHIBIT 14.2 (CONT'D)
PROFILE OF CARRIER CASE STUDIES

Region of Domicile	Type of Carrier	Regions of Operation	Major Commodities	Fleet
British Columbia	For-hire	British Columbia, Alberta, Yukon, Northwest U.S.	Pulp mill freight, lumber, building products	Flat decks, low beds, tankers in single and B-train configurations
Prairies	For-hire	North America	General merchandise	1000 trailers, 450 power units. (48' vans, 10 B-trains)
Prairies	Private	Prairies, British Columbia, Ontario, Quebec	Groceries	Tractor Semi-Trailers
British Columbia	For-hire	British Columbia, Alberta, Saskatchewan	Oil field pipe, casings, cement	110 tractors, 3300 trailers (B-trains)
Prairies	For-hire	Prairies, British Columbia	Oil field equipment, drill rigs	Flat-decks
Quebec	Private	Quebec, Ontario, Northeast U.S.	General freight	31 tractors, 67 semi-trailers,
Quebec	For-hire	Quebec, Ontario, U.S.	General freight	170 tractors, 57 straight trucks, 545 semi-trailers
Quebec	Private	Quebec, Ontario	Alcan goods	B-trains, 53' trailers

could not afford to take the time required (1 to 5 full working days) to retrieve and compile the information. In some cases only data for 1992 was available which, while useful, precludes a comparison with 1987. In other cases major changes in scope of operation through major expansions and mergers do not permit meaningful comparisons.

In order to respect the time constraints of the interviewees and to make the best of a lack of data, the number of routes investigated was reduced from ten to as many as time permitted, only selected information was solicited, and interviewees were asked to give their best estimates where more firm figures were not at hand. Therefore, rather than a rigorous analysis of configuration changes over intra- and inter-provincial/state routes, this question yielded more qualitative information on configuration trends associated with specific routes and commodities.

Exhibit 14.3 summarizes the information from Question C1, where available. While this exhibit provides a general indication of the configurations used for the main routes of the carriers interviewed, it is not complete without investigating the reasons for why the changes took place. In addition, carriers which did not attempt to answer the question as stated usually provided some indication of configurations used for their most important routes, and how and why these configurations changed over the recent years. The following general discussion addresses these areas.

The Atlantic carriers interviewed tended to operate routes within the Atlantic Provinces, to and from Ontario/Quebec and to the Northeast U.S. Two out of the three Atlantic-based carriers transport food items (e.g. frozen food, potatoes, fish) while the third transports petroleum and chemical products, chiefly in transborder shipments. The three carriers in this sample generally do not serve markets west of Ontario as of yet. However, there is significant interest in serving Ontario itself. The Atlantic-based carriers wish to develop Ontario markets opened up through deregulation, and juggle their other routes in order to get vehicles into Ontario. This trend accounts for the increase in traffic from the Northeast U.S. to Ontario, and the decrease in traffic between the Northeastern U.S. and the Atlantic region (since shipments from Ontario are more desirable backhauls).

The major configuration trend that has emerged is the use of 6-axle tractor semitrailer combinations in addition to the 5-axle units used prior to the introduction of the MoU. Tractor semitrailer configurations are still preferred, except for the petroleum tankers, where the B-train GVW allowances can be more readily applied. Overall, there is an interest in the use of the B-train, and the estimated

5 percent rate reduction associated with its use serves as an incentive. However, the B-train is not widely used in the Atlantic because of technical difficulties, e.g. constraints imposed by the Designated Highway System, lack of appropriate loading/unloading facilities, unsuitability for multiple delivery points, etc. In one case, a carrier had actually invested in B-trains, but abandoned the configuration due to poor utilization.

The two Quebec-based carriers surveyed deal mainly in TL and LTL shipments of general freight by tractor semitrailer along intra-Ontario/Quebec routes, but also operate to/from other points in Canada and the U.S.

For the Quebec carriers studied, the MoU did not bring about any significant changes. Since both carriers generally carry loads that weigh out before they cube out, the additional length allowed by the MoU did not effect them, and Quebec was already exceeding the GVW limits set out in the MoU. Except for specialized applications, the two Quebec-based carriers do not use TAC B-trains due to the constraints imposed by the Designated Highway System (few of their regular routes are covered) and because B-trains (and 53-foot trailers if allowed) are not practical for their general freight routes, which require more flexibility than these configurations can offer. Both carriers mention deregulation as a much more influential factor than the MoU. Deregulation supported expansion through acquisitions in Quebec and Ontario, and provided incentive for expansion into the U.S.

One of the two Ontario-based carriers surveyed is a Toronto centred operation hauling to Ontario, Quebec and the Northeast U.S. The majority of the volume carried consists of general freight on 5-axle tractor semitrailers with 48-foot trailers, although a small percentage of the firm's business involves carrying steel for the automotive industry from Hamilton to Michigan on A-trains and B-trains. The firm reported no change in routes or configurations used over the last five years.

The other Ontario-based carrier surveyed operates throughout North America and into the U.S., carrying primarily general freight (e.g. refrigerated and heated, machinery, lumber, steel and building products) in tractor semitrailers. Movements from Ontario/Quebec represent the largest share of the business. A small number of B-trains, which pre-date TAC specifications and therefore do not conform to the TAC B-train profile, were custom purchased for a specific London-Chicago contract. While the operations of the firm in Western Canada were strongly impacted by the MoU, this impact resulted in the purchase of tridem semitrailers to replacc the B-trains, rather than the purchase of

TAC B-trains. The switch from B-trains to tridem semitrailers was attributed by the company to reduce operating costs and increase safety.

Five carriers domiciled in the Prairie Provinces were interviewed, including one Manitoba-based carrier, one Saskatchewan-based carrier and three Alberta-based carriers. None of the five carriers have increased the number of TAC B-trains in their fleets; in fact in some cases the number of B-trains actually decreased. All the Alberta-based carriers, however, took advantage of the MoU to switch from 5-axle to 6-axle semitrailers. The major route-based configurations of the five carriers, and the reasons for configuration changes occurring within the past five years are summarized below:

- The highest volume routes for one carrier are in Western Canada and between Ontario and the West, hauling mainly general freight truckload and dry bulk commodities on tractor semitrailers, A-trains and B-trains. This carrier is decreasing the number of TAC B-trains in its fleet, since they did not turn out to be the most economically feasible solution based on the firm's actual routes. The main impediments to using TAC B-trains are Designated Highway System constraints and lack of flexibility in splitting the train to sub-divide loads.

- A Saskatchewan based carrier which operates across Canada and throughout the U.S. has switched from B-trains to stabilized A-trains. The respondent said that in Saskatchewan stabilized A-trains have been shown to be safer than B-trains.

- A carrier operating intraprovincially in Alberta and between Alberta and British Columbia switched from 5-axle to 6-axle tractor semitrailers to obtain higher GVW and increased operational flexibility. The carrier did not switch to B-trains, since its suppliers and customers deal in loads that are better sized to a 48-foot or 53-foot trailer, and because tri-axles, as opposed to tandems, provide added flexibility to accommodate their weigh-out loads as well as added flexibility for load placement.

- A specialized flat deck carrier, carrying oil field equipment and drill rigs between the Prairies, British Columbia and the U.S. changed from 5-axle to 6-axle tractor semitrailers on their Western Canada routes to take advantage of the greater allowable GVW. The change provided them increased competitiveness against the rail mode.

- A truckload general freight carrier operates 48-foot trailers across North America in all provinces and states. Due to market conditions, the carrier switched from 5-axle to 6-axle tractor semitrailers on its top routes, which involve movements from British Columbia, Manitoba and Ontario to Alberta. This carrier also reduced its B-train fleet threefold because of reduced flexibility, increased safety risks (over tractor semitrailers), loading facility costs, unadaptability for certain customer demands, and high empty costs, and now limits the configuration to specific custom haul routes.

Of the three carriers interviewed in British Columbia, two have switched from 5-axle tractor semitrailers to 8-axle B-trains over the past few years. One firm uses the configuration to transport pulp mill freight from Vancouver to the Mackenzie Valley, and as a result of the switch, the annual number of movements have decreased by 25 percent with 50 percent of the savings associated with larger payloads for lower unit costs staying with the firm. Other commodities hauled by the firm include pulp mill freight, lumber, building supplies and other flat deck commodities on tractor semitrailer and B-train configurations. The main areas of operation are British Columbia, Alberta, the Yukon and the Northwestern U.S.

The other British Columbia-based carrier that has made the change from 5-axle semitrailers to 8-axle B-trains has applied it to the haul of lumber intraprovincially. Through using B-trains, fewer units are needed for the "bridging" service, which involves transporting lumber from the mill to the rail yard. The firm felt that the change was required in order to remain competitive. The firm operates almost exclusively within British Columbia, using 45-foot trailers and B-trains to carry lumber, concrete block, building materials, forestry equipment and oversize and overweight loads.

The third British Columbia-based carrier interviewed operates primarily in British Columbia, Alberta, Saskatchewan, and Washington state. The main commodities carried include containers on flatdecks and container carriers, oil field pipe and casings, and Tilbury Cement on super B-trains or tri-axles. The impact of the MoU was manifest in the switch from 5-axle to 6-axle tractor semitrailers for hauling containers from Vancouver to Seattle. The efficiencies resulting from the MoU have caused some diversion of the market from the rail and marine modes.

14.2.1.2 New Markets (C2)

Question C2 investigated whether the firms were able to serve any new markets as a result of new vehicle types allowed by the 1988 TAC MoU. While most of the case study carriers reported that no new markets were opened up by the MoU, there were some specific new markets created in the west, or involving movements between east and west. These include the following:

- foodstuffs from Western Canada;
- produce from the Port of Montreal to Western Canada;
- lumber and building products in Western Canada by 53-foot trailers and B-trains, winning over some customers from rail;
- one carrier reported that he was now carrying pipe in 60-foot lengths from British Columbia to Alberta on 53-foot trailers (although this is not contemplated by the MoU).

Other carriers offered the following comments related to this issue:

- in the Atlantic, 6-axle tractor semitrailers are seen as a means of making Atlantic-based carriers more competitive west of Ontario in the near future;
- a Prairies-based carrier reported that the use of tri-axles and long combination vehicles (LCVs) such as triples, Rocky Mountain doubles and Turnpike doubles resulted in reduced inventories and a consolidation in warehousing;
- for the Quebec-based carriers interviewed, the MoU had virtually no impact on operations; therefore no new markets became available through the MoU.

14.2.1.3 Regional Inconsistencies (C3)

Question C3 investigated whether regional inconsistencies in truck size and weight limits on the Designated Highway System constrained operations in the jurisdictions served. All carriers felt strongly about the existence of regional inconsistencies and gave examples which specifically impacted their operations. The one concern that was echoed throughout the country was the prohibition of 53-foot trailers from Quebec and especially Ontario [2], except by special permit.

2 Since the date of the case studies Ontario, Quebec and most Atlantic Provinces have changed their regulations to allow 53-foot trailers.

Another concern expressed by carriers domiciled in every region was the incompatibility of axle spreads and associated permissible weights from jurisdiction to jurisdiction.

Other comments are summarized below:

- Atlantic-based carriers reported that the banning of 53-foot trailers in the Atlantic Provinces, and adjacent Quebec, directly affected their competitiveness west of Quebec. Other concerns include:
  - inability to operate twin 45-foot trailers on roads other than Quebec's major highways;
  - limitations of overall length regulations in the Atlantic Provinces;
  - regional inconsistencies in axle spreads if tri-axles are to be replaced by tridems;
- an Ontario carrier related that differences between allowable vehicle configurations, axle configurations and axle spreads between Ontario, Quebec, Michigan and Indiana posed a major constraint to their general freight operations;
- some of the carriers based in the Prairie Provinces had serious concerns about the lack of 53-foot trailers in Ontario and Quebec, to the point that they did not buy them for operations in their own region, where they are allowed. For other carriers, the Ontario/Quebec ban on 53-foot trailers has a minimal impact, since due to the nature of their operations, they rely on 48-foot trailers;
- a Prairies-based carrier was constrained by the weight allowances on tridem axles for specific spreads being less in Alberta than in British Columbia;
- another Prairies-based carrier was generally against larger vehicles (A-trains, B-trains, C-trains and larger), since they are more difficult to drive and handle, and are not as safe as tractor semitrailers;
- a Manitoba-based carrier suggested that automobile driver perceptions in more densely populated areas (i.e. Eastern

Canada) had a direct impact on the severity of truck weight and size regulations;

- British Columbia-based carriers were not as constrained by regional inconsistencies as were carriers domiciled elsewhere in the country. Most carriers interviewed concentrated their operations in Western Canada. However, they reported that if they hauled more frequently to Ontario, the regional inconsistencies could present operational drawbacks;

- one British Columbia-based carrier remarked that, given the significant number of oversize and overweight loads running within the province, there is a lack of consistency in rules governing these movements.

14.2.1.4 Vehicle Characteristics (C4)

Question C4 inquired about how changes in truck configurations experienced between 1987 and 1992 affected in general vehicle characteristics, such as suspension systems, tire widths, tire pressures and use of single versus dual tires. Most of the regions reported increased use of air ride suspensions, although they commented that this change is not necessarily related to the MoU. The western carriers tended to have far more comments on this question than their eastern counterparts. Comments from carriers based in the Prairie Provinces and British Columbia are summarized below:

- one carrier reported that suspensions have not kept pace with vehicle weights and therefore inflict damage on the roads. Another carrier agreed that this may be the case, but it was too early to know with certainty. A third carrier commented that suspension systems and tire width are now being specified to accommodate heavier loads;

- one carrier said that tire pressures have been lowered with new tire designs;

- wider tires have resulted in additional tire wear and, together with more axles, have reduced fuel economy by increasing rolling resistance.

14.2.1.5 Future Vehicle Configurations (C5)

Question C5 asked carriers what changes in vehicle configurations were anticipated for the firm over the next five years, and the reasons for these changes. In general, across the country, the trend towards using larger, heavier vehicles - either TAC B-trains or 53-foot semitrailers - was apparent. A clear desire to move toward 53-foot trailers in the future was expressed in Quebec and Ontario. In the Atlantic provinces, carriers preferred to either remain with 5-axle semitrailers or switch over to B-trains and 53-foot semitrailers, particularly if 25-metre overall lengths would be allowed.

In British Columbia, carriers in general have already picked up on the trends and purchased new equipment to take advantage of the changes brought about by the MoU. At this point they would like to capitalize on their investments, rather than again renewing their fleets. However, if new purchases are made, they would include tri-axles, super B-trains and stronger tractors to accommodate the heavier configurations.

The carriers interviewed in the Prairies showed the greatest diversity, as a region, in their approach to this issue. One carrier advocated the elimination of all 7-axle and 8-axle units since the carrier has deemed them unsafe, and because they provide no incremental benefits to the carrier (i.e. all savings are passed on to the shipper). Another carrier's approach was the diametric opposite: to increase the use of long combination vehicles, such as Rocky Mountain doubles and Turnpike doubles, especially on main routes, e.g. between Calgary and Vancouver. Others predicted increasing super B-trains in their fleets, moving more to tridemization and greater use of 53-foot trailers in order to remain competitive. Finally, there was mention of retaining 48-foot tri-axle semitrailers where warranted due to flexibility, and suitability for the routes operated and markets served.

14.2.1.6 Regulatory Changes (C6)

Question C6 queried carriers with regard to further regulatory changes suggested to improve the trucking industry, and the anticipated impact of these regulatory changes. Every carrier interviewed strongly stated that uniformity of truck weight and dimensions regulations across the country is desperately required. It was generally agreed that the MoU harmonization was a welcome step in the right direction, but that there is long way to go before achieving total unity. According to the carriers interviewed, implementing standardized regulations throughout the country would result in:

- more flexibility and better utilization of equipment;
- improved equity in competition;
- increased productivity and profitability of carriers;
- better service to shippers.

The pattern has been established whereby, upon agreeing nationally upon a given aspect of weight and dimensions regulations, individual provinces will then independently exceed the agreed-upon limits in their own jurisdictions, leaving the rest of the country out of sync once again. It was suggested by one respondent that stronger federal authority in this area would be conducive to more standardization. The reasons behind the differences need to be investigated to determine whether the differences are based on purely technical factors, or whether they are merely continuations of "traditions" set out much earlier and which may no longer apply. A recommitment to the goal of uniformity is required prior to sorting out provincial and regional inconsistencies.

Other suggestions for regulatory changes that were mentioned by several regions include more uniform safety standards, standardized hours of operation nation-wide, standardized licensing, uniform enforcement of all aspects of trucking legislation, and improved standardization with the U.S., at least the border states. In addition, the following comments were made by carriers on a regional or individual basis:

- Atlantic carriers suggest that overall vehicle length limits be increased to 25 metres;
- an Atlantic carrier would like to see a grandfather clause allowing use of tri-axles, where integral to the nature of operations;
- Quebec carriers prefer that legislation would specify a maximum size, with one axle spacing and one maximum weight throughout Canada;
- Ontario carriers suggest that regulations standardize the use of multi-axle equipment within Canada;
- one carrier from the Prairies suggested that regulations limit or ban the use of super B-trains due to the lack of infrastructure strong enough to support these vehicles;
- a BC carrier would like to see increased weight allowed on the drive axles of B-trains (from 17,000 to 20,000, without a GVW increase) during winter, for better traction uphill and better braking downhill;
- another BC carrier seeks stability in truck weights and dimensions regulations, to avoid new standards being introduced and quickly replaced by others.

14.2.1.7 Summary

The main themes which emerged from the carrier case studies are summarized below:

- The MoU has been a significant milestone on the road to standardization. Carriers feel that the MoU must be followed up by further regulatory changes to increase the level of uniformity across the country. Increased involvement of the federal government may be a means to achieving this end. Ideally uniformity should also extend to the U.S.

- As might be expected, the degree of impact of the MoU throughout the country is dependent on the nature and magnitude of the changes from pre-MoU conditions. For example, the Prairie Provinces, where GVW increased by 24 percent, reported more changes than Quebec, where there was no maximum GVW increase. However, geographic location and the status of adjacent provinces/regions also had a large bearing on impacts made by the MoU. The Prairie Provinces serve as a bridge between Ontario and British Columbia, both of which were progressive in their pre-MoU regulations, and therefore the Prairie Provinces had much to gain. In the Atlantic Provinces, however, some of the length increases could not be applied to long-distance east-west hauls, since Quebec and, until recently, Ontario had not allowed 53-foot trailers.

- Vehicle configurations are highly dependent on the nature of the routes travelled, the commodities hauled and the geographic areas served. In some cases the availability of longer, heavier configurations does not necessarily mean that using them is more economically feasible, or even possible. The case studies are a useful means of defining individual applications of MoU vehicle usage, or lack of usage.

- Carriers throughout the country have commented that industry traffic patterns have changed within the last five years. North-south volumes have increased and east-west volumes have decreased, as trade with the U.S. has been boosted through the Free Trade Agreement and deregulation. Because of this shift, the impact of the MoU is less than it otherwise would have been if east-west volumes were steady or increasing.

- The role of the "knowledgable shipper" in driving the market was made clear in many of the interviews. Shippers are well aware of the configurations available, and are able to calculate the lowest carrier costs for transporting their goods. Shippers then put pressure on carriers to provide service using a given configuration at a given rate. As a result, with a few exceptions, all benefits of the new configurations are passed on to shippers. The main advantage achieved by carriers who invested in new TAC equipment early on was therefore retention of market share rather than a higher rate of return.

- While the MoU is structured to encourage the use of TAC B-trains, in some cases the MoU actually resulted in firms switching away from B-train configurations to take advantage of tractor semitrailer configurations that were longer and heavier than previously permitted.

- Most carriers interviewed agreed that the TAC B-train is safer than the A-train or C-train. The one anomaly is in Saskatchewan, where it was related that provincial tests indicated that stabilized A-trains may be safer than TAC B-trains. In general, however, it is acknowledged that tractor semitrailer configurations are much safer and easier to handle than any of the "train" configurations.

- For certain markets, e.g. hauling forest products from source to plant, the Designated Highway System poses limitations which preclude the use of TAC-specified vehicles. Provisions for extending the use of TAC vehicles to selected routes just off the Designated Highway System would improve the utilization of these vehicles.

- The MoU, in some cases, has resulted in truck carriers gaining an advantage over the rail and marine modes, and thereby capturing new customers.

14.2.2 Ministry Case Studies

Provincial highway and transportation ministries were contacted to obtain their inputs as to how the TAC vehicles were affecting their roads and bridges. Individual case study results are presented as Appendix F.1. An overall summary of the responses follows for road related items. Impacts on bridges are discussed in Section 16.3.

Basically, all jurisdictions report increasing truck traffic combined with deteriorating pavements, and restricted budgets. It was indicated by several respondents that many roads that are rutted or suffer poor pavement quality have exceeded their design life and should have been rebuilt by now, however, fiscal restraint has delayed rebuilding.

There is a strong perception by some that higher gross weight vehicles are the cause of accelerated pavement deterioration. Others indicated that they are aware the "TAC vehicles" are pavement "friendly" or "neutral" compared to the standard tractor semitrailer. No province has undertaken any survey work to identify the extent of TAC vehicles using their highways nor the impact the vehicles are having compared to other trucks, although information from ongoing traffic collection programs can provide considerable relevant information.

While the TAC vehicles were not reported to have led to changes in practices with respect to road maintenance, resurfacing or new road construction, changes are occurring and others are being explored due to the noted restricted budgets and deteriorating pavement conditions. Changing pavement design standards such as thickness of subgrade vs thickness of asphalt and microsurfacing were items specifically mentioned. Others indicated that the SHRP and C-SHRP research should lead to other changes.

Some specific items of note identified during the case studies include:

Heavy Truck Patterns

- Relatively little uptake of 8 axle trains has occurred in the Atlantic Provinces (they were not permitted prior to MoU). For example, vehicle registration or special permits identified the following number of 8 axle B-trains: Newfoundland, 27; Prince Edward Island, 10; Nova Scotia 350-400.

- The limited designated MoU network has restricted the introduction of the 8 axle B-train in Quebec. Many Quebec based carriers use them on the Montreal-Toronto run. Existing provincial regulations permit other vehicles with similar GVW's, removing incentive to switch to B-trains.

- As in Quebec, previous regulations in Ontario permit GVW's as high as the TAC 8 axle B-train, therefore, there is no real incentive for intraprovincial haulers to switch to B-trains although several have.

- There has been a significant increase in use of vehicles with tridem axle groups in the Prairies and B.C. (i.e. 6 axle tractor trailer and 8 axle double combination vehicles). These axle groups were not permitted prior to the MoU.

- Most carriers in Prairie Provinces that use double combination vehicles are now using super B and triaxle configuration, rather than "A", "C" and "B" train configurations.

Road Design Practices

- British Columbia reports have adjusted pavement designs to reflect the heavier axle loading of TAC vehicles.
- In Alberta, the sight distance required at intersections has been increased for a typical 2 lane highway from 430 m to 560 m for a design speed of 110 km/hr. Alberta also indicated intersection design practices have been impacted due to turning path of B-train truck/trailer limits.
- Longer vehicles adopted in Prairie Provinces (25 m vs 23 m) affect the median width of divided highways with at grade intersections.
- Alberta reported that new ferries have to be built longer and stronger to handle the increased lengths and weights.
- In Manitoba, some intersection ramps built to the design standard of the 1950's and 1960's are no longer adequate.
- Many provinces looking at pavement design and construction practices to improve pavement performance. However, this is not related to the MoU.
- Concern was expressed by some Atlantic Province officials over affect of longer vehicle (25 m vs 23 m) on passing sight distances. No difficulties were reported by officials in provinces where these longer vehicles had already been introduced.

Road Maintenance and Resurfacing

- Most provinces report no change or no measurable impact.
- Prince Edward Island and Manitoba report introducing paved shoulder policies at least partially in response to more trucks and more wheel tracking onto shoulders.

- Nova Scotia is experimenting with microresurfacing to help deal with increased rutting. This is not directly related to the MoU.

Weigh Scales

Scale decks had to be upgraded in Prairie Provinces and British Columbia to handle tridem configurations. Most of these changes have taken place under normal maintenance replacement at minimal cost. Saskatchewan indicated a conversion cost of $1 million.

Roadside Rest Areas

No change. Some sites could require enlargement if enough longer trucks use a site frequently.

Enforcement

British Columbia reported enforcement of vehicle weight and dimension regulations is now easier and simpler, as memorization of the axle spacing/weight allowance table is not required compared with their earlier regulations.

14.2.3 Shipper Case Studies

Exhibit 14.4 shows a profile of the shippers which participated in the carrier case studies. For each carrier, the exhibit indicates the region in which the head office is located, type of firm (shipper, distributor, etc.) regions of distribution, major commodities shipped and other information. One firm is neither a shipper nor a distributor, but a logistics management company, providing leading edge solutions to carrier and shipper issues and concerns. A case study was conducted with this firm, since its knowledge of general current trends, as well as individual applications of MoU configurations, would add considerably to the study.

14.2.3.1 Impact of MoU (S1)

Question S1 asks whether truck shipping rates have been affected by the MoU, and if so, how and to what degree. Other than in the Atlantic Provinces, just about all of the shippers interviewed reported a decrease in shipping rates that could at least partially be attributed to the MoU. As explored further in Question S3, other factors (e.g. deregulation, recession, etc.) also had an influence in lowering shipping rates, and the shippers found it impossible to independently allocate parts of the rate reduction to the different factors involved.

Of the three Atlantic shippers participating in the case studies, two have not taken advantage of the TAC-specified vehicles. One of these continues to ship on straight trucks and 5-axle tractor semitrailers,

EXHIBIT 14.4

PROFILE OF SHIPPER / DISTIBUTOR CASE STUDIES

Region of Domicile	Type of Firm	Regions of Distribution by Truck	Major Commodities Shipped
Atlantic	Shipper	Atlantic	Grocery
Atlantic	Distributor	Atlantic	Forest products
Atlantic	Distributor	Atlantic	Pulp, paper
Quebec	Shipper	Eastern North America	Plates, cups, food packaging
Quebec	Shipper	Cross-Canada	Food products
Quebec	Shipper	Cross-Canada	Automotive
Ontario	Shipper	Cross-Canada	Petroleum products
Ontario	Shipper	Cross-Canada, U.S.	Freezers
Ontario	Distributor	Cross-Canada	Plumbing and electrical supplies
Prairies	Shipper	Cross-Canada, Western U.S.	Fertilizers, chemicals
Prairies	Shipper	British Columbia, Prairies, Western U.S.	Cement
Prairies	Logistics Management		
British Columbia	Shipper	British Columbia, Alberta	Fruit
British Columbia	Shipper	British Columbia, Prairies	Forest products

supplemented by pup trailers as required, since the volume shipped is insufficient to warrant larger configurations. The other shipper has shipments which weigh out; the additional length in tractor semitrailers provided through the MoU therefore cannot be utilized, and the shipper states that B-trains are as of yet not widely available to Atlantic shippers. The third shipper has only begun to consider the benefits of the configuration. The firm, which owns some vehicles in addition to using contract carriers, has purchased one B-train for assessment purposes. The experience thus far has been positive, with the configuration offering a potential 20 percent savings over tri-axles, and the firm plans to purchase additional units in the near future.

Increased allowable lengths and weights both played a part in the rate reductions enjoyed by the shippers interviewed throughout Central and Western Canada. Region-specific and carrier-specific comments are summarized below:

- In Quebec, the shippers interviewed benefitted from the use of longer vehicle configurations for their cube-out cargo. (The Quebec case study carriers tended to haul weigh-out cargo, and therefore were not impacted by the MoU.) One Quebec shipper which took advantage of the extra length available in the 48-foot trailers stated that, if 53-foot trailers were legalized, a further 8 percent cost reduction would result.

- Ontario shippers shipping bulk commodities throughout the country have welcomed the harmonization in GVW brought about by the MoU, as any increase in truck size results in a proportionate savings in unit costs. One shipper stated that tariffs for steel shipments have dropped by 30 percent, since using one truck instead of two saves on fuel, labour and other costs, as well as decreasing handling time for loading and unloading.

- In Ontario, shippers are concerned about the constraints involving the use of 53-foot trailers in Quebec and Ontario. One shipper estimates a 10 percent unit cost reduction in transporting water heaters from Quebec if 53-foot trailers could be used.

- The shippers interviewed in the Prairie Provinces have taken advantage of increased allowable GVWs, which in some cases allow certain shipments to be delivered in one load as opposed to two. One shipper estimates a rate reduction of between 2 percent and 5 percent solely as a result of greater allowable GVW. Another shipper has experienced rate reductions of 15 percent, and in some cases more, due to a combination of the MoU and deregulation, which through changed traffic patters, offered additional opportunities for complimentary traffic. For this firm, average payload increased from 35.9 tonnes to 39.9 tonnes. The firm also experienced a tremendous impact on bulk commodity transfers, e.g. more efficient rail car loading and reduced transportation costs due to using super B-trains to move 50,000 tonne loads of acid and fertilizer from British Columbia to Montana.

- One of the two British Columbia shippers interviewed stated that shipping rates have remained constant since 1982; longer and heavier configurations are being used to haul their products from British Columbia to Alberta. However, due to a turn-over in management staff which occurred after 1988, the exact impact of the MoU cannot be traced. The other British Columbia shipper interviewed experienced rate reductions of 8 percent to 12 percent after the introduction of the MoU.

14.2.3.2 Changes to Dock Areas (S2)

Question S2 inquired about changes required to dock areas operated by each firm to accommodate the larger vehicles allowed for in the MoU (e.g. changes in configuration, changes in operation, etc.). The case study participants were also asked for information on cost impacts associated with these changes. Only three shippers in the sample (one from the Atlantic Provinces and two from the Prairie Provinces) required changes to their dock areas. In each case, costs were weighed against benefits prior to making the decision. A fourth shipper (from British Columbia) was able to take advantage of the larger configurations by minimal and low cost changes to yard fencing and gates, since loading is done onto open trailers in yards and weigh scales are not used.

The following comments were provided by two of the shippers for whom changes to dock areas were required:

- For one of the Prairie shippers, an old 80-foot scale due for replacement was replaced with a 100-foot scale at a marginal cost of $10,000. At another facility operated by the same firm, there is a marginal loss in loading efficiency due to the scale being too short for the combinations used. Overall, the use of higher vehicles with greater payloads resulted in a 10 percent increase in throughput rates, without a significant infrastructure investment. The higher throughput rates are critical to this firm, which must deliver 60 percent of its annual volume within three peak months.

- The second shipper based in the Prairie Provinces required larger scales at two locations, one on the west coast and one is Saskatoon. In both cases, the changes were necessary to keep the firm in business. The costs for these changes were less than $50,000 at each location, with payback periods of less than one year for the west coast facility and 3 years for the Saskatoon facility. For the west coast facility, costs for the scales were shared with the carrier, as the new equipment sizes benefited the carrier by reducing loading times. As a result, the carrier was able to delay an anticipated rate increase.

Several shippers across the country mentioned that B-trains are specifically not used because of loading and unloading issues. One Quebec firm uses its own shunters and would require special training to accommodate B-trains. More time would be required to couple and uncouple the B-train trailers, and either special loading plates would have to be purchased for the front trailers or time spent sliding the rear axles in and out. For this firm, the costs associated with new equipment or additional time requirements would offset any savings in rates.

14.2.3.3 Impact of Other Factors (S3)

Question S3 asked to what degree factors in addition to the 1988 Memorandum of Understanding have affected truck shipping rates between 1988 and 1992 (e.g. deregulation under the 1987 National Transportation Act, poor economic climate, the Free Trade Agreement, influx of U.S. carriers to Canada, increase in intermodal/container traffic, etc.). In the samples of shippers included in the case studies, deregulation was mentioned most often as having a significant impact on shipping rates. The importance of deregulation was particularly great in the Atlantic Provinces and Quebec. A significant part of the impact of deregulation is attributable to the influx of U.S. carriers, which resulted in increased competition. In addition, increased opportunities for complementary traffic and backhaul traffic played a major role. In general, firms could not easily quantify the impact of deregulation (or any of the other factors that reduced truck shipping rates). However, an eastern shipper estimated the reduction in rates to be about 5 percent to 10 percent, and a western carrier estimated that deregulation either stabilized the rates, or reduced them by a small amount (1 or 2 percent).

The economic recession was also high on the list of factors affecting truck shipping rates. Because of the recession, shippers enjoyed a "buyers' market". Again, quantifying the impact was difficult. One Atlantic shipper estimated that the recession resulted in rate reductions of approximately 6 percent, partly due to lower interest rates and declining equipment costs. Another shipper, based in the Prairie Provinces estimated that the increased competition between the trucking and railway industries fuelled by the recession reduced rates by about 2 percent.

Other factors that affected truck rates mentioned by the shipper case study participants are summarized below:

- The impacts of the Free Trade Agreement on truck rates are mixed, and usually dependent on involvement of the individual firm in U.S. trade. An Ontario freezer distributor estimated that Free Trade, together with significant changes in the North American market for freezers, resulted in a 400 percent increase in shipments over the last ten years. Even if Free Trade did not directly impact shippers (e.g. in the case of duty free cargo), the increased north-south traffic generated through the agreement has provided new backhaul opportunities, and thereby reduced rates.

- One firm which has recently undergone a major merger has attributed rate reductions to improved product distribution and ability to combine loads to achieve full volume and weight capacity (e.g. heavier pallets on bottom, lighter cereals on top), as a result of the merger.

- Two shippers (one based in Quebec and one in Ontario) mentioned better use of intermodal/container shipping as important factors in reducing shipping rates. The Quebec firm relies on intermodal shipments for movements between its Maritimes manufacturing plant and its distribution centres. The Ontario firm ranked the use of double stack containers third (after recession and deregulation) in degree of impact on reduction of shipping rates.

- Another Ontario shipper mentioned the importance of "can-van" trailers since they provide additional height, which allows appliances to be stacked in three layers, as opposed to two.

- A British Columbia shipper described how the larger configurations allowed by the MoU have indirectly reduced shipping rates further. Shipments which were previously moved by rail from northern British Columbia can now be shipped by truck as far as Edmonton, which provides access to the lines of two rail companies, and thereby ensures a competitive rail rate for the remainder of the trip.

14.2.3.4 New Markets (S4)

Question S4 queried whether any new markets or extensions of market areas were made available as a result of the MoU. Shippers were asked to identify the new markets and specify the approximate annual volume represented by each. Only one shipper of the fourteen participating in the shipper case studies identified new markets attributable to the MoU. This shipper, based in the Prairie Provinces, cited markets in Toronto/Montreal for bagged chemicals (1000 tonnes) and in Vancouver for blasting component (2500 tonnes). Other shippers spoke of general changes in markets served, including:

- plans to expand supply areas for each of the firm's plants and mills (Atlantic shipper);

- switch from rail mode to truck mode (e.g. for low volume, high value cargo, for time sensitive cargo, etc.) due to more competitive truck rates (shippers in the Atlantic and British Columbia);

- the logistics management firm observed that the MoU allowed access to more distant markets, especially for low cost commodities, e.g. shipping within the Red River corridor (Manitoba, Minnesota, North Dakota);

- another comment made by the logistics firm was that a fundamental difference between Canadian and U.S. firms in pursuing new markets is that, in general, the U.S. carriers are more willing to invest in tenuous markets, absorbing a loss for a time period in order to break into the market. Even within Canada, the provincial restrictions represent a form of protectionism, which makes access to new markets by outsiders more difficult.

For a few of the large national shippers interviewed, the MoU has actually reduced market share. The relaxed weights and dimensions regulations introduced by the MoU have allowed U.S. distributors to become more competitive in Canada, thereby reducing the market share of the major Canadian shippers. For these firms, retaining their large market share is a more critical issue, since they have already penetrated most of the markets available to them.

14.2.3.5 Other Opportunities (S5)

Question S5 asked shippers to outline any other opportunities or changes that have resulted from the implementation of the MoU, e.g. warehousing, relocation opportunities, fewer loading docks, centralization of inventories, etc. While most shippers interviewed stated that no other opportunities or changes resulted because of the MoU, various responses were given by the remainder, as follows:

- one Atlantic shipper stated that, while no additional opportunities have been realized as of yet, future anticipated changes include reduction in number of trucks, better equipment utilization, increased flexibility in sources of supply, and better centralization of inventory;
- a Quebec-based shipper also specified future changes, with regard to the possibility of adjusting future distribution planning with provinces who will accept the new longer 53-foot trailers;
- an Ontario distributor now has access to freight sensitive resource products from further away, e.g. southern U.S.;
- a shipper from the Prairie Provinces mentioned that changing allowable GVWs in the U.S. to match Canadian levels would enable a shift from the rail mode to the truck mode in the U.S.

14.2.3.6 Other Comments

During the case study interviews, shippers provided additional comments, many of which pertain to their use of different configurations in different regions within Canada. These regional comments are summarized below:

- Shippers in Atlantic Canada were very interested in using larger configurations. One shipper would likely switch to 53-foot semitrailers if they were allowed in New Brunswick. Another firm would like to expand the use of B-trains by allowing them to be run on roads other than the restrictive Designated Highway System. This firm is presently seeking special permission to operate B-trains on selected routes in the Atlantic Provinces. The same shipper also has major concerns with a New Brunswick White Paper in reducing the payload of existing tri-axle vehicles.
- All of the Quebec shippers have acknowledged the benefits of longer trailers. One of the firms noted that the 53 foot configuration is very cost effective for truck-rail intermodal traffic between its plant in the Maritimes and its

distribution centres in Quebec and Ontario. The firm plans to expand one of its distribution centres in Quebec or Ontario. The centre to be expanded depends on which province will allow 53-foot trailers at the time the decision is to be made.

- One Quebec shipper with cube-out cargo finds that the additional capacity offered by B-trains does not offset the additional cost associated with loading and unloading. Also, this firm's experience is that drivers find the configuration difficult to handle.

- As in Quebec, the 53-foot trailer issue is a critical one for shippers. The constraints imposed by different allowable trailer lengths in Ontario, Quebec and North America in general has an impact on the firm's percentage per unit distribution cost, which is critical to its competitiveness. If the firm cannot be competitively operated out of Canada, it will be forced to move its operations to its U.S. plant. The U.S. currently accounts for 80 percent of the company total market.

- One shipper in the Prairie Provinces has concerns with the B-train configuration. According to the shipper, trailer manufacturers have had difficulty in achieving full allowable weights safely with a 23-metre B-train design, and with excessive tire wear. Super B-trains (25 metres) are seen to be more efficient than the TAC B-train. In comparison, maintenance costs of the TAC B-train are higher, and the shorter wheelbase results in a poorer quality ride.

- Two Prairie shippers have noted that increased MoU limits on smaller combinations have proved beneficial. One shipper commented that increased allowable GVWs for 5-axle tractor semitrailers allowed carriers to hold/reduce shipping rates, and therefore helped the firm to maintain its level of operations during the recession. Another shipper has specified the following special case scenarios:

    - the 53-foot trailer is used to achieve optimal payload for a product which does not stack well;

    - the increased allowable GVW for 5-axle units translates to a 3 to 5 percent reduction in rates, if the customer has storage or requirement limitations;

- the increased allowable GVW for 6-axles benefits commodities which do not lend themselves to 8-axle equipment due to stacking, storage or delivery access considerations.

- For a British Columbia shipper, the increased allowable GVW for 5-axle and 6-axle vehicle increased payloads, since boxed fruit usually weighs out.

- The logistics firm cited the following example whereby non-uniform regulations across the country pose problems for shippers. Ontario customers pay a premium on each load of steel shipped from Manitoba compared with Alberta customers because of length restrictions in Ontario. Forty-foot steel beams cannot even be transported by truck from Manitoba to Ontario because of Ontario vehicle and load length restrictions, causing users to have to redesign buildings.

- The logistics firm also provided the following observation on TAC B-trains:

  - the number of TAC B-trains have increased over the last three years;

  - TAC B-trains are contributing to making Winnipeg a hub. The transfer of cargo from B-trains running in Western Canada to smaller configurations running in Eastern Canada occurs at Winnipeg;

  - B-trains are very much a niche market. Large national carriers tend not to use TAC B-trains very much. Instead, carriers with about 10 to 20 vehicles are more likely to take advantage of the configuration.

14.2.3.7 Summary

The main themes that have emerged from the shipper case studies are summarized below:

- As already revealed in the carrier case studies, the presence of the "knowledgeable shipper" is very much evident in the shipper case studies. Shippers research market conditions and pressure carriers to provide the configurations which can offer them the best rates. The result is that the shippers interviewed have unanimously enjoyed rate reductions over the past five years.

- Shippers are directly impacted by whether the carriers serving the regions in which they operate were able to take advantages of the changes brought about by the MoU, and other changes (e.g. use of super B-trains, use of 53-foot semitrailers).

- The reduced rates partly attributable to the MoU resulted in shippers and distributors being able to extend their supply area to more distant sources. This trend applies to even low-cost freight-sensitive commodities.

- In addition to the MoU, deregulation under the 1987 National Transportation Act and the economic recession are the major factors which have reduced truck shipping rates. Spin-off impacts include more compatible routes and backhauls, more competitiveness due to the influx of U.S. carriers, and increased competitiveness of the truck mode against the rail mode.

- Most shippers have not changed their dock areas to adapt to the larger MoU configurations. However, some shippers have deliberately avoided these configurations because of cost and time implications associated with loading and unloading. The shippers that have changed their dock areas have generally found that the benefits well exceed the costs.

14.2.4 Trailer Manufacturer/ Distributor Case Studies

Four trailer manufacturer or distributors were interviewed from across Canada two based in Quebec, one in Ontario and one in British Columbia:

All four trailer manufacturers/distributors sell throughout Canada. In the case of the Ontario firm, however, 80 percent of sales are within Ontario or Quebec; most customers are involved in Toronto-Montreal movements or north-south cross-border movements. A B.C. manufacturer of B-trains for hauling wood chips reported sales to the forest products industries in British Columbia, Alberta, Ontario and Atlantic Canada.

14.2.4.1 Changes in Sales from 1987 to 1992 (F1)

Question F1 asked what changes in sales of trailers of different sizes were experienced between 1987 and 1992, and what were the major reasons for these changes. The three eastern manufacturers/distributors all experienced increases in sales for various reasons. The experiences of the firms are summarized below:

- One firm reported increases in sales in all Canadian provinces. Sales of 4-axle semitrailer units in Quebec and Ontario increased due to the new weight legislation under the MoU. Also, B-train sales to brewers in Ontario and some in Quebec increased, since certain sales outlets in those provinces favoured the configuration.

- Another firm experienced an overall increase in sales due to mergers and other changes in distribution patterns within the petroleum products industry, changes in truck weights and dimensions legislation and increased use of B-train configurations.

- The Ontario firm's sales of semitrailers, which account for about 90 percent of the business, increased over the last five years, while sales of B-trains, which account for only about 2 percent of the business, decreased. U.S. manufacturers for the distributor perceive the TAC B-train as a specialty custom piece of equipment, and therefore the price of the unit is high.

- The B.C. manufacturer began building trailers only after the MoU was already in place. The firm's first designs were based directly on MoU specifications. This company has developed one of the lightest B-train units and it is used across Canada for hauling wood chips.

14.2.4.2 Changes Specific to Provinces/Regions (F2)

Question F2 inquired about whether any of the changes identified in response to Question F1 were specific to a certain province/territory or region of Canada. One Quebec firm reported that changes in sales affected all Canadian provinces/territories. As mentioned in the answer to Question F1, many of the increased sales experienced by the other Quebec firm were specific to Ontario. For the Ontario company, Ontario sales were also impacted, especially through the increase in sales of 53-foot trailers with tridem axles. This firm's B-train sales, however, were most remarkable in Western Canada where it has proven to be economically beneficial over long distance runs involving payload increases.

While the B.C. company could not report on before-after changes with regard to the MoU, the firm discussed how regional inconsistencies impacted their designs. Increased allowable lengths for B-trains in British Columbia and increased weight limits in Alberta affected vehicle design. Also, lower axle spread requirements in British Columbia (4 feet) allow for more capacity in chip trailers used in that province, whereas in Ontario, the 17-metre wheelbase limit (as opposed to 17.5 metres in British Columbia) combined with a higher axle spread results in loss of cubic capacity. In the Atlantic Provinces, it is the 23-metre length limit that impacts cubic capacity. Therefore, regional inconsistencies have required that different models be manufactured for different jurisdictions in Canada, with independent designs for British Columbia, Alberta, Ontario and the Maritimes.

14.2.4.3 Changes in Vehicle Characteristics (F3)

Question F3 asked how changes in trailer sales over the past five years have impacted vehicle characteristic, such as suspension systems, tire widths, tire pressures and use of single as opposed to dual tires. All four manufacturers/distributors reported changes in suspension systems as follows:

- The Quebec firms commented that air suspensions replaced most spring suspensions. Air suspensions resulted in improved rides and decreased maintenance, as the air ride systems improved.
- The Ontario firm reported an increased demand for air-ride suspensions, due to better versatility in two-way hauls and decreased weight. A decrease in axle spreads (to less than 6 feet) was also observed, due to the increase in north-south traffic, resulting in a decrease in tire wear.
- The B.C. firm also mentioned the move to air-ride suspensions.

14.2.4.4 Speed of Response to Changes (F4)

Question F4 requested information on the speed of response from carriers to the implementation of less restrictive trailer sizes and configurations, in the form of customer orders. The replies to this question were somewhat contradictory. One Quebec firm stated that intermediate-sized carriers, and those seeking new customers are quick to respond, while large and stable carriers respond only when upgrading vehicles requiring replacement. On the other hand, the B.C. firm observed that rapid response depends on payload issues, and that larger carriers react first, with the smaller carriers following their lead. One firm did not relate rcsponse to carrier size at all, but instead to the benefits to be gained by changes in regulations; for example, with the MoU, Ontario carriers responded very quickly to increased allowances in cube (with 110-inch high trailers) whereas Western carriers responded rapidly to increases in GVW.

14.2.4.5 Changes Over Next Five Years (F5)

Question F5 asked trailer manufacturers/distributors what changes in the manufacture of trucking equipment of various sizes did they anticipate over the next five years, and what were their reasons to support these changes. The responses varied from firm to firm, and can be summarized as follows:

- The first Quebec firm anticipates uniform axle spacing and GVW throughout North America in the future.

- The other Quebec firm believes that future configuration changes will be safety oriented, encompassing features such as brakes, leak containment (safety valves), purging equipment and return haul movements with different commodities, etc. The firm foresees that vehicle size and weight increases will be precluded by the resistance of the driving public, who will object to further increases of this type.

- The Ontario firm predicts that intermodalism will become increasingly important, and that the 53-foot domestic containers used in the U.S. will be the favoured configuration. However, the increased handling time for intermodal traffic presents a trade-off. It was also mentioned that the future would bring about an increase in JIT (Just In Time) traffic. As a result, the number of B-trains is anticipated to decrease, due to the additional handling time required for unloading, specialized expertise required in handling and changes required to loading docks. According to this company, 53-foot semitrailers are the way of the future. Their widespread use could also include allowing 53-foot doubles on major selected highways.

- Like the first company, the B.C. firm anticipates safety-oriented changes to take place in the future. The western manufacturer also expects the allowable length of B-trains in the Atlantic Provinces to increase from 23 metres to 25 metres.

14.2.4.6 Other Comments

Comments supplementing the question responses were offered by the trailer manufacturers and distributors interviewed. The comments fall into two general categories: utilization of specific equipment types following the implementation of the MoU, and truck weights and dimensions regulations. They are summarized below:

Utilization of Equipment Types

- Two firms indicated that increased trailer length has had a large effect on sales, and in the trucking industry overall. According to one, the availability of longer trailers allowed more aggressive carriers to buy new equipment and develop new markets.

- The introduction of the TAC B-train had a comparatively small effect. This configuration has been used only for specific products as a part of specific operations (e.g. Ontario breweries, wood chips). The B.C. firm, which serves a niche market and intentionally does not compete in the 53-foot trailer market, has benefitted from the influence of the MoU in encouraging the use of the TAC B-train. For example, the introduction of the 8-axle B-train in the Maritimes opened up the Atlantic market for this company's wood chip B-trains.

- It was noted that the restriction of quad-axle vehicles in Quebec is too recent as of yet to notice an impact.

Truck Weights and Dimensions Regulations

- All trailer manufacturers/distributors interviewed expressed the opinion that the uniformity of weights and dimensions regulations is very important, from the point of view of production efficiency. The Ontario company used the example of hauling lumber between Ontario and Michigan to illustrate how differences in regulations between jurisdictions (in this case, different rules for lift axles and axle spreads) can create a situation where it is difficult to find one configuration to use for both the outbound and inbound movements. To circumvent inconsistencies, manufacturers strive to build flexibility into equipment, e.g. ability to lengthen/shorten trailers.

- In some cases, the degree of detail found in the MoU has had the effect of reducing allowable weights and sizes, relative to provincial regulations. The Ontario rules, for example, are less strict with regard to load distribution, while the MoU clearly specifies individual axle weight limits. If the axle weight limits govern, overall GVWs allowed by the MoU may not be achievable.

- The configuration of the Designated Highway System needs to be revisited. For example, in Quebec, the Designated Highway System does not serve many saw mills and pulp mills, precluding the use of B-trains for these important applications.

- Areas which should be addressed more carefully in truck weight and dimensions regulations include:
    - the use of lift axles;
    - uniformity in axle spreads relative to weight limits;
    - independent rules for specialist categories, such as dump haulers of aggregates and container vehicles.

14.2.4.7 Summary

The main themes that have emerged from the trailer manufacturer/ distributor case studies are summarized below:

- The impacts of the MoU were felt most strongly in the increased sales of longer trailers. While B-train sales increased in certain specialty sectors, the overall increase in this type of configuration was relatively small.

- Increased loading/unloading time and more difficult handling issues that impact the utilization of B-train configurations and container units are important, since they offset payload benefits.

- The inconsistencies between jurisdictions in truck weights and dimensions regulations constrain customers in finding vehicles suitable for the various markets served and routes travelled, and result in manufacturing inefficiencies.

- Trailer manufacturers have tried to make the best of inconsistencies by flexible equipment designs so that the equipment can be easily altered to variable dimensions.

- Customers response, in the form of equipment purchase, is quickest to regulatory changes that offer them substantial benefits, relative to the regulations superseded. Trailer manufacturers/distributors do not agree on whether large carriers or smaller carriers are the first to respond.

- The most prominent change in vehicle characteristics over the past five years is the increased use of air-ride suspensions.

15. COLLECTION OF DATA SETS

15.1 TRUCK FLEET IMPACTS DATA

15.1.1 MoU Designated Network

The MoU Designated Network currently consists of 205,000 kilometres of roadway, compared to 49,000 kilometres when it was introduced. Exhibit 15.1 summarizes the length of the network by Province. The MoU network and the National Highway System are illustrated, for western and eastern Canada, respectively, in Exhibit 15.2.

The major network changes since the network was first established are in Alberta, where the system was increased from 3,100 kilometres, to 154,000 kilometres and now includes all Provincial highways. The system was also expanded in Saskatchewan, Manitoba, Prince Edward Island and Nova Scotia.

15.1.2 Estimation of NHS Truck Traffic

Truck fleet data were gathered from a number of sources as described below. These data were compiled to provide estimates of vehicle-kilometres of truck travel by type of truck for the National Highway System (NHS). These are shown graphically in Exhibit 15.3. The NHS includes approximately 25,000 kilometres of the major interprovincial highways across Canada. Exhibit 15.2 illustrates that portion of the MoU network accounted for by the NHS.

Estimates of the vehicle kilometres of truck traffic on the NHS (National Highway System) were prepared as follows:

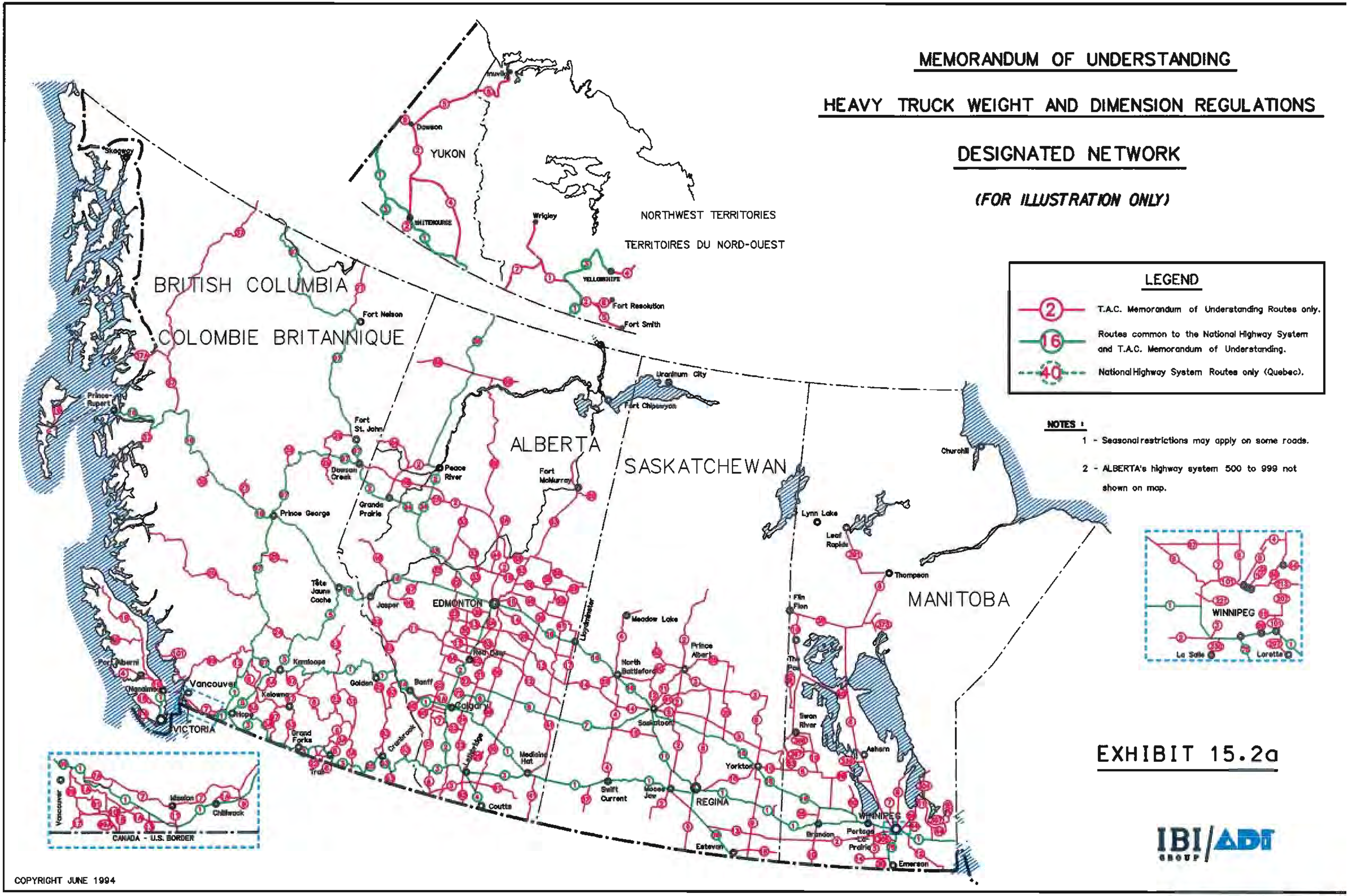
- information for each road section of the NHS was compiled by ADI. This included provincial/territorial counts and estimates of AADT (Average Annual Daily Traffic) from 1986 to 1991, the most recent complete year of data;

- the percentage of trucks in the traffic stream on each highway section was determined for 1991. This was subdivided according to the number of axles (from 5 to 9) with the exception that single-unit trucks were classified separately. The measures of the percentage of trucks in the traffic stream were taken from the nearest possible roadside truck classification site with similar traffic characteristics to those on the highway section in question. The provincial classification counts were used where available for the specific road sections being considered, but the primary

EXHIBIT 15.1

LENGTH OF MEMORANDUM OF UNDERSTANDING DESIGNATED SYSTEM BY PROVINCE

PROVINCE	LENGTH OF DESIGNATED SYSTEM (KM)	
	1988	1993
Newfoundland	950	950
Nova Scotia	1,210	1,300
Prince Edward Island	170	250
New Brunswick	1,890	1,890
Quebec	1,820	1,820
Ontario	16,060	16,060
Manitoba	1,450	6,090
Saskatchewan	6,700	6,980
Alberta	3,090	154,000
British Columbia	11,120	11,120
Northwest Territories	1,680	1,680
Yukon	2,560	2,560
Total	48,703	204,703



MEMORANDUM OF UNDERSTANDING
HEAVY TRUCK WEIGHT AND DIMENSION REGULATIONS
DESIGNATED NETWORK
(FOR ILLUSTRATION ONLY)
LEGEND
T.A.C. Memorandum of Understanding Routes only.
Routes common to the National Highway System and T.A.C. Memorandum of Understanding.
National Highway System Routes only (Quebec).
NOTES :
1 - Seasonal restrictions may apply on some roads.
2 - ALBERTA's highway system 500 to 999 not shown on map.
YUKON
NORTHWEST TERRITORIES
TERRITOIRES DU NORD-OUEST
BRITISH COLUMBIA
COLOMBIE BRITANNIQUE
ALBERTA
SASKATCHEWAN
MANITOBA
Inuvik
Dawson
Whitehorse
Wrigley
Yellowknife
Fort Resolution
Fort Smith
Skagway
Fort Nelson
Uranium City
Fort Chipewyan
Prince Rupert
Fort St. John
Dawson Creek
Peace River
Fort McMurray
Grande Prairie
Prince George
Churchill
Lynn Lake
Leaf Rapids
Thompson
Tête Jaune Cache
Jasper
EDMONTON
Lloydminster
Meadow Lake
Flin Flon
Prince Albert
North Battleford
Red Deer
Kamloops
Port Alberni
Nanaimo
Vancouver
VICTORIA
Golden
Banff
Kelowna
Hope
Calgary
Saskatoon
Swan River
The Pas
Grand Forks
Trail
Cranbrook
Lethbridge
Medicine Hat
Ashern
Yorkton
Swift Current
Moose Jaw
REGINA
Coutts
Estevan
Brandon
Portage La Prairie
WINNIPEG
Emerson
Mission
Chilliwack
CANADA - U.S. BORDER
La Salle
Lorette
EXHIBIT 15.2a
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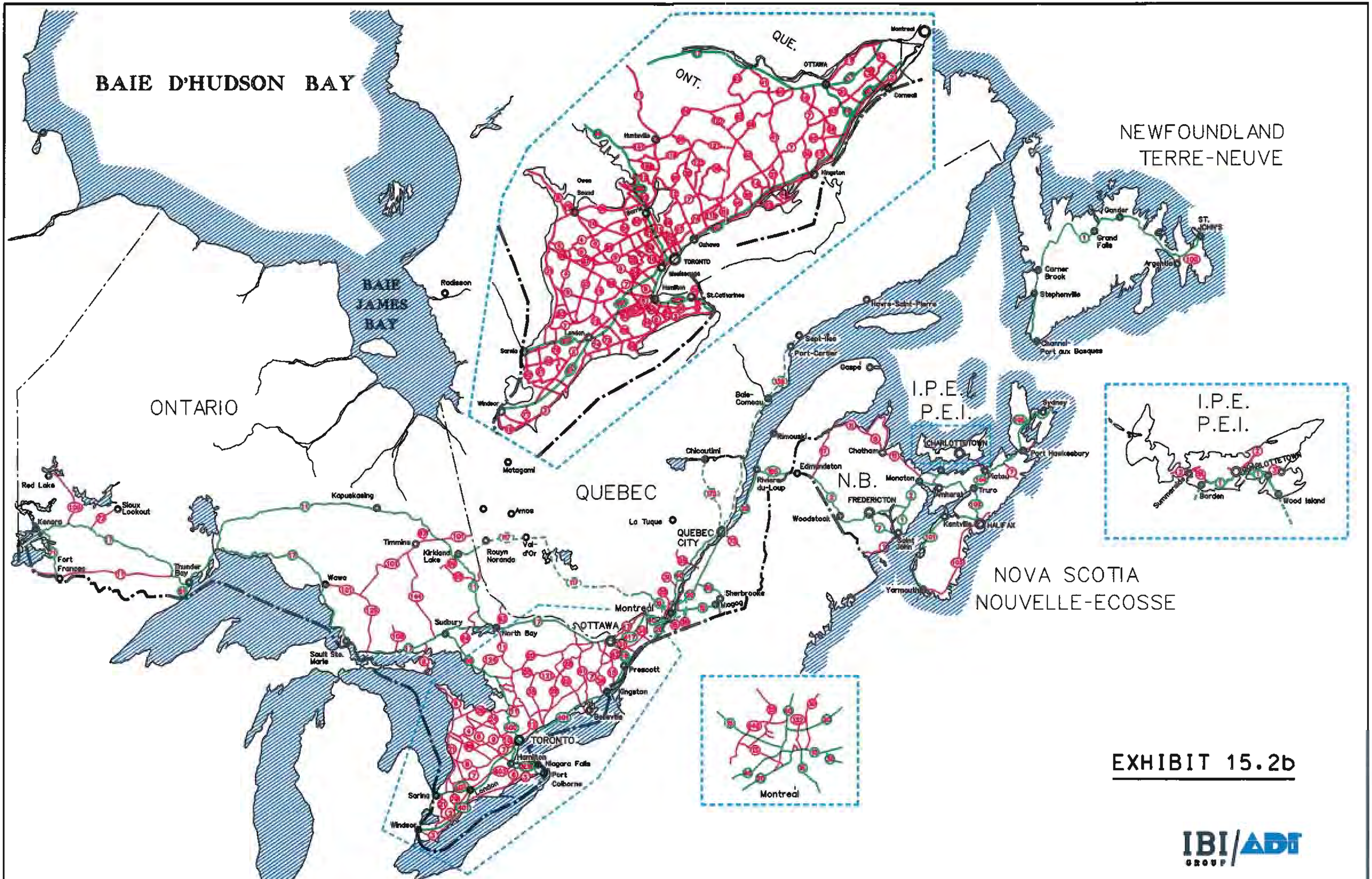
BAIE D'HUDSON BAY
BAIE JAMES BAY
ONTARIO
QUEBEC
NEWFOUNDLAND
TERRE-NEUVE
N.B.
I.P.E.
P.E.I.
NOVA SCOTIA
NOUVELLE-ECOSSE
ONT.
QUE.
TORONTO
OTTAWA
Montreal
QUEBEC CITY
FREDERICTON
HALIFAX
CHARLOTTETOWN
Kingston
Windsor
Sarnia
London
Hamilton
Niagara Falls
Sudbury
North Bay
Thunder Bay
Kenora
Timmins
Sault Ste. Marie
Wawa
Kapuskasing
Red Lake
Fort Frances
Sioux Lookout
Kirkland Lake
Rouyn Noranda
Val-d'Or
Amos
Matagami
Radisson
La Tuque
Chicoutimi
Sherbrooke
Magog
Rimouski
Baie-Comeau
Sept-Îles
Port-Cartier
Gaspé
Havre-Saint-Pierre
Edmundston
Rivière-du-Loup
Woodstock
Saint John
Moncton
Chatham
Amherst
Truro
Pictou
Port Hawkesbury
Sydney
Kentville
Yarmouth
Summerside
Borden
Wood Island
Gander
Grand Falls
Corner Brook
Stephenville
Channel-Port aux Basques
Argentia
ST. JOHN'S
Prescott
Belleville
Port Colborne
EXHIBIT 15.2b
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EXHIBIT 15.3 (PAGE 1/3)

Annual Truck Traffic Distribution on the NHS : Canada - Wide Total

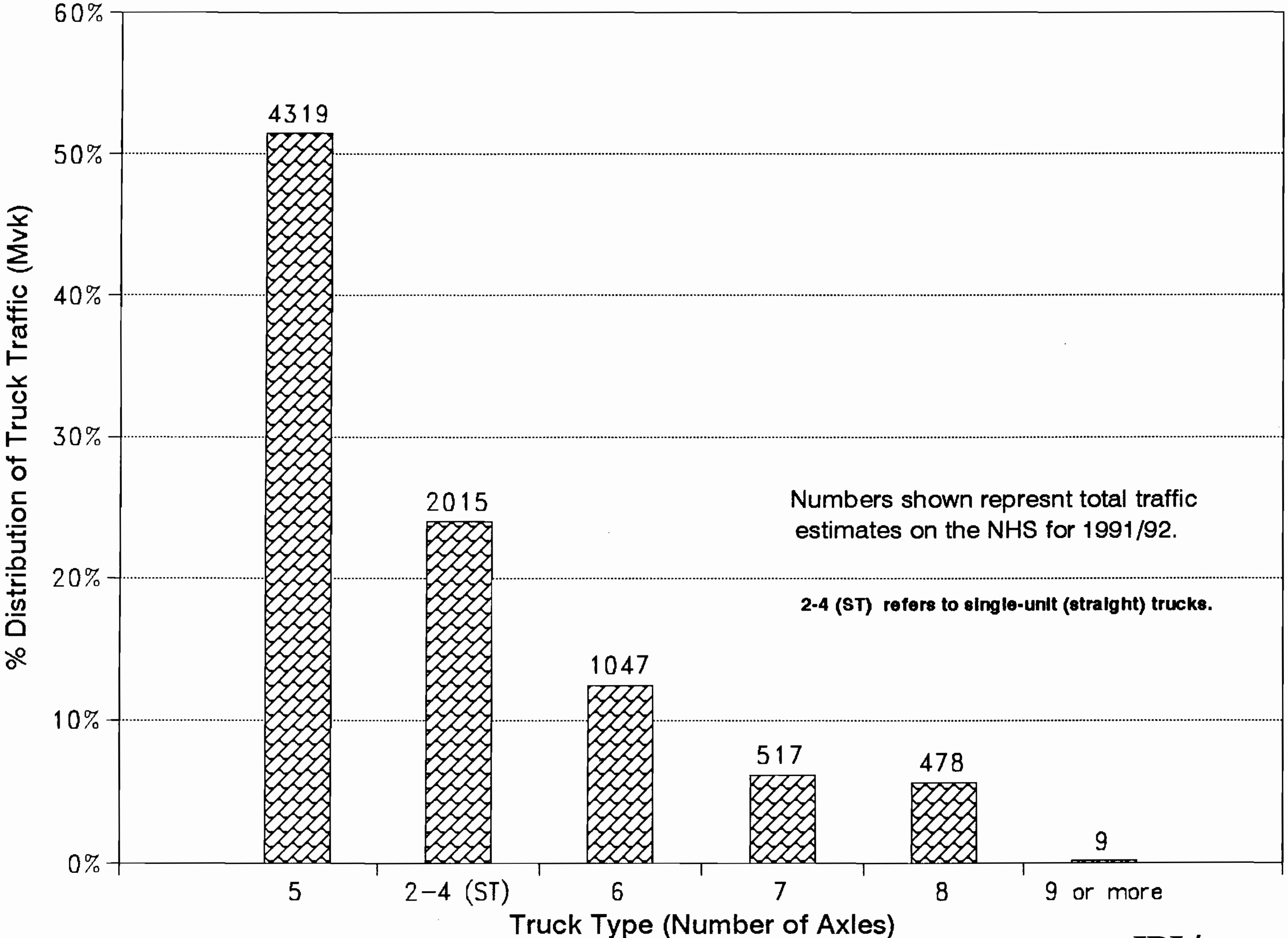

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EXHIBIT 15.3 (PAGE 2/3)
Annual NHS Truck Traffic : Western Canada

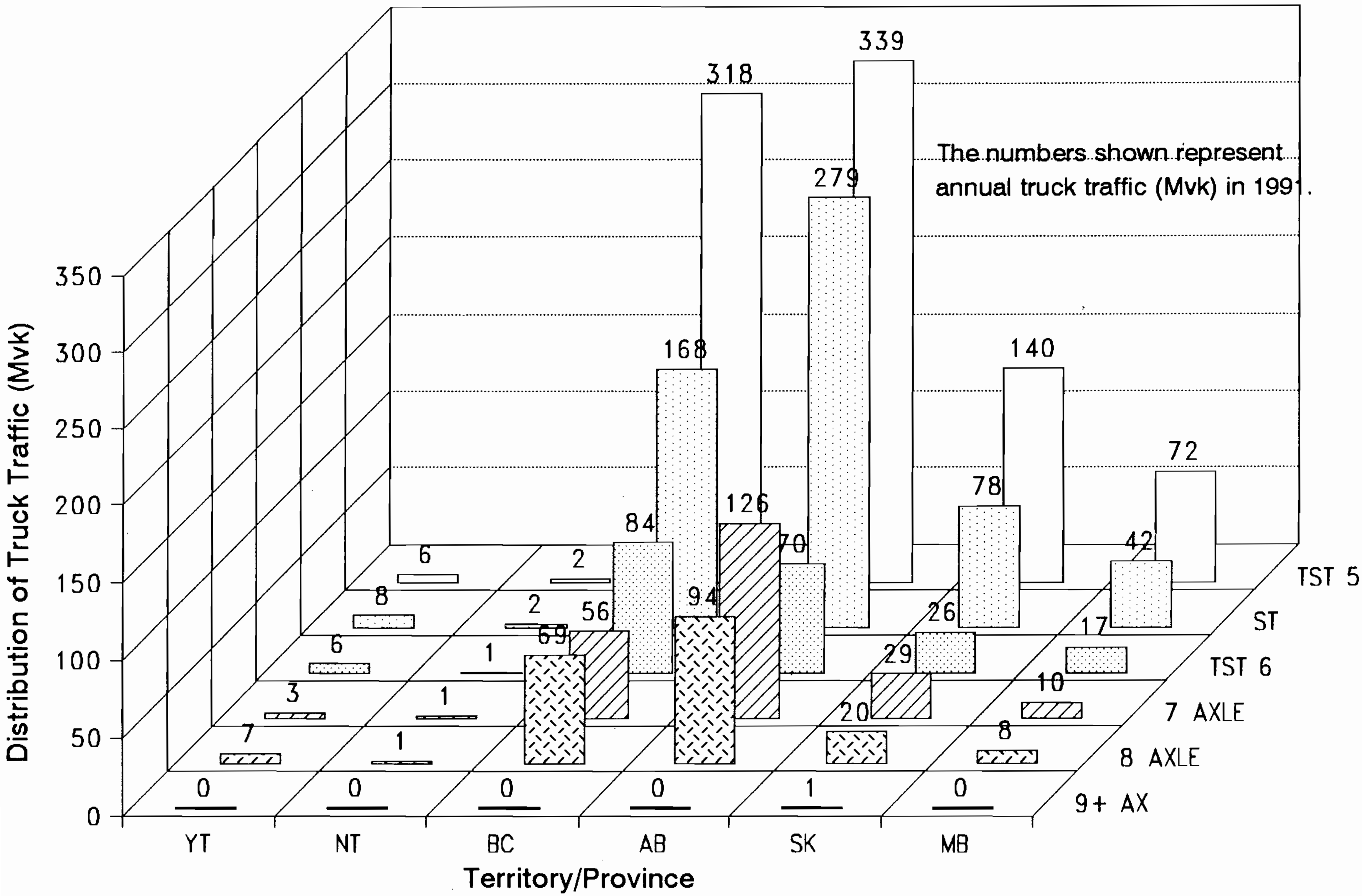

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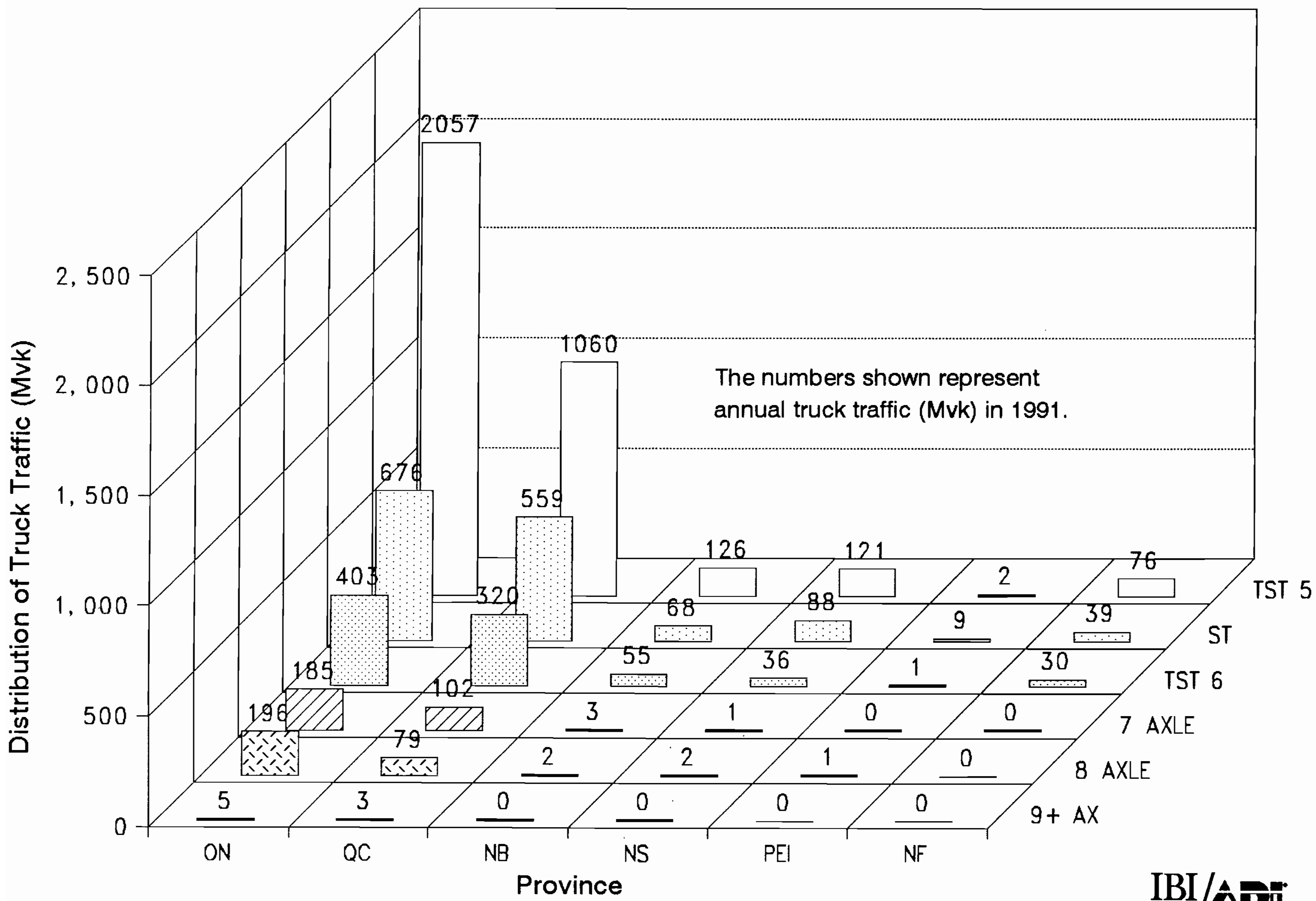
EXHIBIT 15.3 (PAGE 3/3)

Annual NHS Truck Traffic : Central/Eastern Canada



source of information used to subdivide the truck traffic by axle count was the CCMTA National Roadside Survey;

- annual truck traffic (vehicle-km) on each road section, for each class of truck, was estimated by multiplying the road section AADT (average vehicles per day) by the length of the highway section (km), the percentage of trucks (by type) and an annual expansion factor (300 "weekdays" per year). Theoretically, one ought to use AWDT in conjunction with the percentage of trucks (which was measured on weekdays), but a comparison of the monthly variation of AWDT and ADT on different types of highway in Ontario revealed that there was little difference over the year except on highway sections that are highly oriented to recreational traffic on summer weekends. Compensation has been made for weekend traffic by using an expansion factor of 300 (i.e. six working days per week minus holidays), to account for lower amounts [and percentages] of truck traffic on weekends than on weekdays;

- results were aggregated over all highway sections to obtain estimates of vehicle-km of truck travel, by type of truck, on the National Highway System in each province and territory;

- at the provincial/territorial level, 7-axle and 8-axle truck traffic was distributed among tractor semitrailers and double combination units (tandem trailers), with the latter subdivided according to type of connection (A, B or C). This breakdown was derived from the CCMTA results in each province where there was sufficient categorization of trucks according to type and number of engaged axles. Estimates based on the breakdown in neighbouring provinces were used where needed to fill in gaps in the data, except in Ontario and British Columbia where the amount of tandem trailer traffic and differences from neighbouring jurisdictions warranted more detail. In these two provinces, most of the double combination units were not clearly specified as being A-trains, B-trains or C-trains. Relevant information on fleet composition found in the carrier survey was used to estimate the breakdown of tandem trailers in these two provinces;

- provincial and territorial truck traffic was aggregated into regional subtotals and a Canada-wide NHS total. No adjustment was made to the 1991 traffic volumes to produce 1992 figures as there was negligible change in truck volumes between 1991 and 1992 according to sources at Statistics Canada. These estimates of truck traffic were used as the base volumes in the investigation of fleet impacts and cost impacts described in more detail in Part III of this Report.

The NHS was used for this work, as available truck volume and classification information tended to be available for the major routes across the country; i.e. the NHS routes. Data for MoU highways off the NHS were very limited. The NHS also closely parallels the MoU Designated Network in five provinces and is a major component in several others. The provinces of Alberta, British Columbia and Ontario have extended the MoU to include all their provincial highways. This accounts for most of the difference between the NHS network and the MoU network. Almost all of the highway links used for inter-provincial travel are accounted for by the NHS, which is where the main benefits of the MoU were to be found, and most major provincial truck haul routes. Therefore, using the NHS captures a major portion of benefits associated with changes in truck fleet composition due to the MoU. Due to lack of information on truck traffic levels and types on many of the other MoU roads, it is not practical to develop a detailed database on a link-by-link basis for them. It is suspected that these minor roads would generally experience less TAC vehicle traffic, with much greater emphasis on straight trucks.

15.1.3 CCMTA National Roadside Survey

As noted earlier, the CCMTA National Roadside Survey is a major source of information for creating the truck traffic database. The CCMTA National Roadside Survey of commercial vehicles was undertaken in 1991 to assist in assessing the impact of structural and operational changes within the Canadian trucking industry arising from the implementation of new federal legislation (i.e. Motor Vehicle Transport Act, 1987).

The survey was designed to provide data on operating efficiency, truck traffic patterns, private versus for-hire operations, employment characteristics (driver vs owner-operator) as well as details on carrier jurisdictional base. Relevant to this study, it provides information on vehicle type, payload carried, gross vehicle weight and capacity utilization by both volume and weight. The project complements a similar survey of Canada-U.S. truck movements undertaken as part of the Transborder Trucking Competitiveness Studies.

The survey was conducted by respective provincial/territorial authorities in all jurisdictions with the exception of Manitoba where the survey was conducted by Transport Canada's regional office with the assistance and cooperation of provincial transport authorities. Project co-ordination and chairing of task groups was provided by the National Transportation Agency and Transport Canada.

The project consisted of a survey of commercial transport vehicle movements based on driver interviews. The survey was conducted at twenty-nine weigh scale/inspection locations in all twelve jurisdictions during the period June 17-23, 1991. These locations are summarized in Appendix D.

Sites were determined on the basis of their suitability for survey purposes (i.e. on interprovincial routes); the selection of sites at bordering points was coordinated among adjoining jurisdictions to reduce duplication and ensure maximum coverage.

The actual duration of the survey at each location was determined by the respective jurisdictional authority on the basis of the relative contribution of the survey activities at the station to the overall sample target. However, to ensure a reasonable representative sample base on a national scale, a 24 hour period (June 19) was designated as a basic or "mandatory" sampling period applicable across all jurisdictions. Details on survey activities at each sites (dates, direction, etc.) are provided in the CCMTA ***Survey Summary & Out-of-Scope Report.***

The CCMTA Roadside Survey had several applications in this study. First, it was used to provide a breakdown by truck type which was used in conjunction with other roadside surveys to establish estimates of truck travel on the National Highway System. The database also provided considerable relevant data on those vehicles "cubing out" and those "weighting out". Analysis for each of these areas follows.

15.1.4 Fleet Use Projections

15.1.4.1 Travel by Truck Type

Total 1991 truck travel on the NHS is currently estimated at approximately 8.4 billion vehicle kilometres. The 5-axle tractor trailer is the most frequently used vehicle accounting for 52% of total truck traffic. Trucks with four or fewer axles (mostly single unit or "straight" trucks) are the next most common accounting for 24% of total truck traffic. Trucks with 6 or more axles account for 24% of truck traffic. Exhibit 15.3 illustrates travel nationally as well as by Province.

Use of double combination vehicles is highest in Western Canada, accounting for approximately 18% of truck traffic in B.C.; 24% in Alberta, 17% in Saskatchewan and 12% in Manitoba. In Eastern

Canada, Ontario and Quebec double combination vehicles account for 10% of truck traffic; in the Atlantic Provinces, 2%.

15.1.4.2 Uptake of Major Configurations Encouraged by MoU

Preliminary analysis of truck traffic in Western Canada by truck configuration reveals that there is considerable use of the "preferred" TAC vehicles in Western Canada. These provinces did not use different weight limits for 5-axle and 6-axle tractor trailers prior to the MoU, but subsequently all four provinces have adopted a maximum GVW (Gross Vehicle Weight) of 39.5t for 5-axle trailers, and 46.5t for 6-axle trailers. Changes favouring the 8-axle B-train have also been made to the regulations in all four provinces. Exhibit 15.4 summarizes the estimated travel on the NHS of 6-axle tractor-trailers and 8-axle double combinations in Western Canada. It indicates that 19% of the truck traffic is accounted for by these preferred configurations, with British Columbia being particularly progressive (22%). Further discussion of fleet impacts is contained in Part III of this report.

15.1.4.3 Cubing vs. Weighting Out

On a national basis 44% of trucks are fully loaded (i.e. they either "cube out" or "weight out").

Exhibit 15.5 shows that 76% of loaded trucks cube out while 24% weight out. Interestingly, 24% of loaded trucks are within 5% of both weighting out and cubing out. That is, if the truck is fully loaded by volume, it is within 5% of its gross weight. Thirty two percent are within 10%. This suggests that a considerable portion of trucks would need both increased volume and GVW in order to haul appreciably more freight.

On a national basis, the 5-axle tractor trailer, when fully loaded, cubes out approximately 85% of the time, as illustrated by Exhibit 15.6, indicating that increased cube and not weight is the main consideration for improving productivity of this truck type. Given that this configuration accounts for 50% of total truck traffic on the National Highway System, any increases in cube would produce significant savings. Assuming full uptake of 53 foot trailers in favour of 48 foot trailers would produce annual savings of $185 million on the National Highway System alone.

15.1.5 Summary of Data Sources

Exhibit 15.7 summarizes the data sources that were used to establish the final truck traffic database. This database can easily be updated annually as provincial, regional and national surveys are completed. Data from weigh-in-motion scales collected to uniform vehicle classification should become an excellent source of required information; however, many provinces report quality control problems with the output data or a lack of resources to compile the raw data. Hopefully, these problems can be overcome in the near future.

EXHIBIT 15.4

ESTIMATED 1992 TRAVEL BY VEHICLE CONFIGURATIONS ENCOURAGED BY MOU

Province	**Configuration**	**Annual Truck Traffic (Millions of Veh-km)**	**% of Total Truck Traffic**
British Columbia	6 axle tractor trailer	84	22.1%
	8 axle A/B/C trains	69	
Alberta	6 axle tractor trailer	70	18.1%
	8 axle A/B/C trains	94	
Saskatchewan	6 axle tractor trailer	36	15.6%
	8 axle A/B/C trains	20	
Manitoba	6 axle tractor trailer	17	16.5%
	8 axle A/B/C trains	8	
Western Provinces	Total Use of Configurations	388	19.0%

EXHIBIT 15.5
% OF TRUCKS CUBING AND WEIGHTING OUT

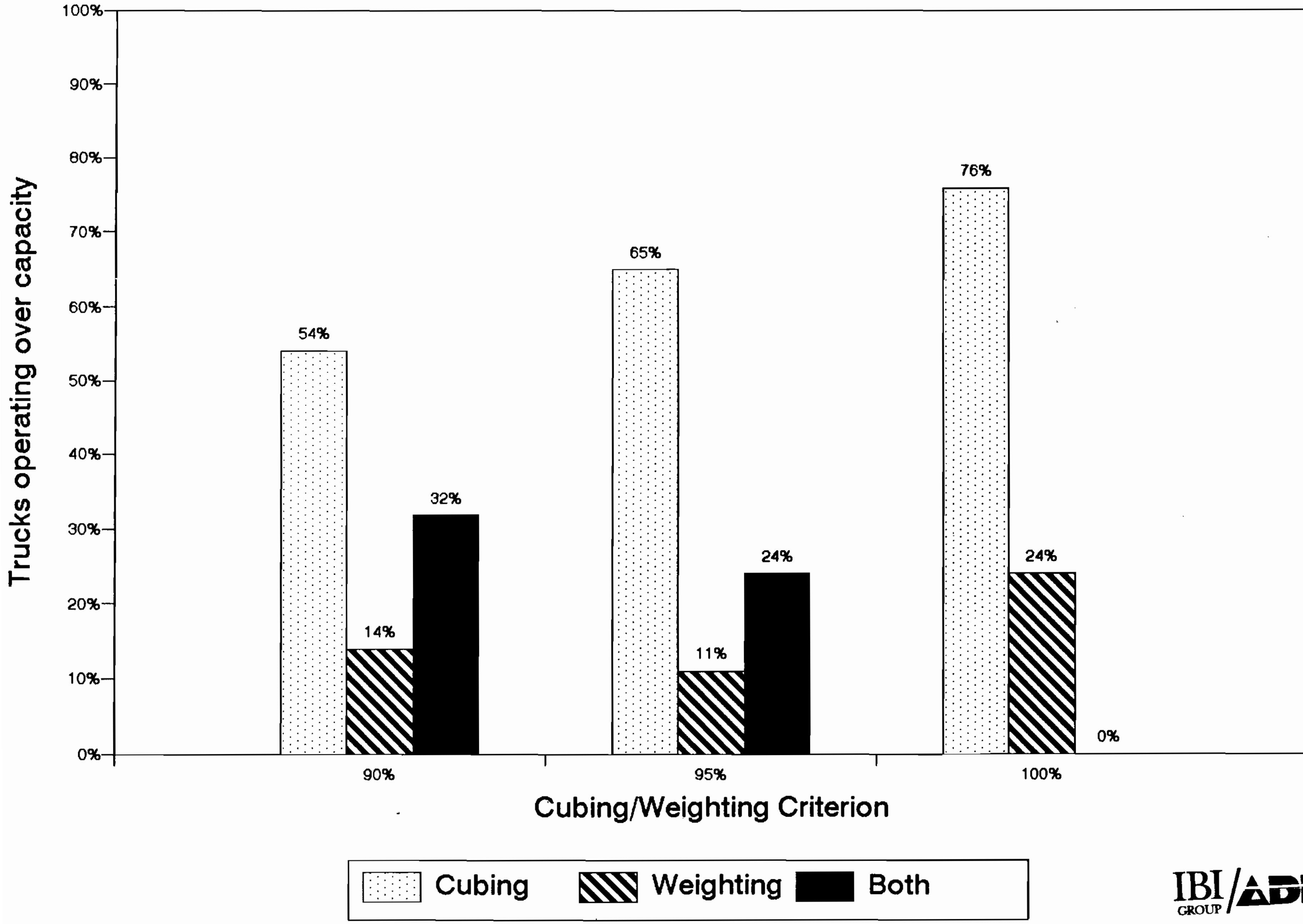


EXHIBIT 15.6
% OF TRUCKS CUBING AND WEIGHTING OUT

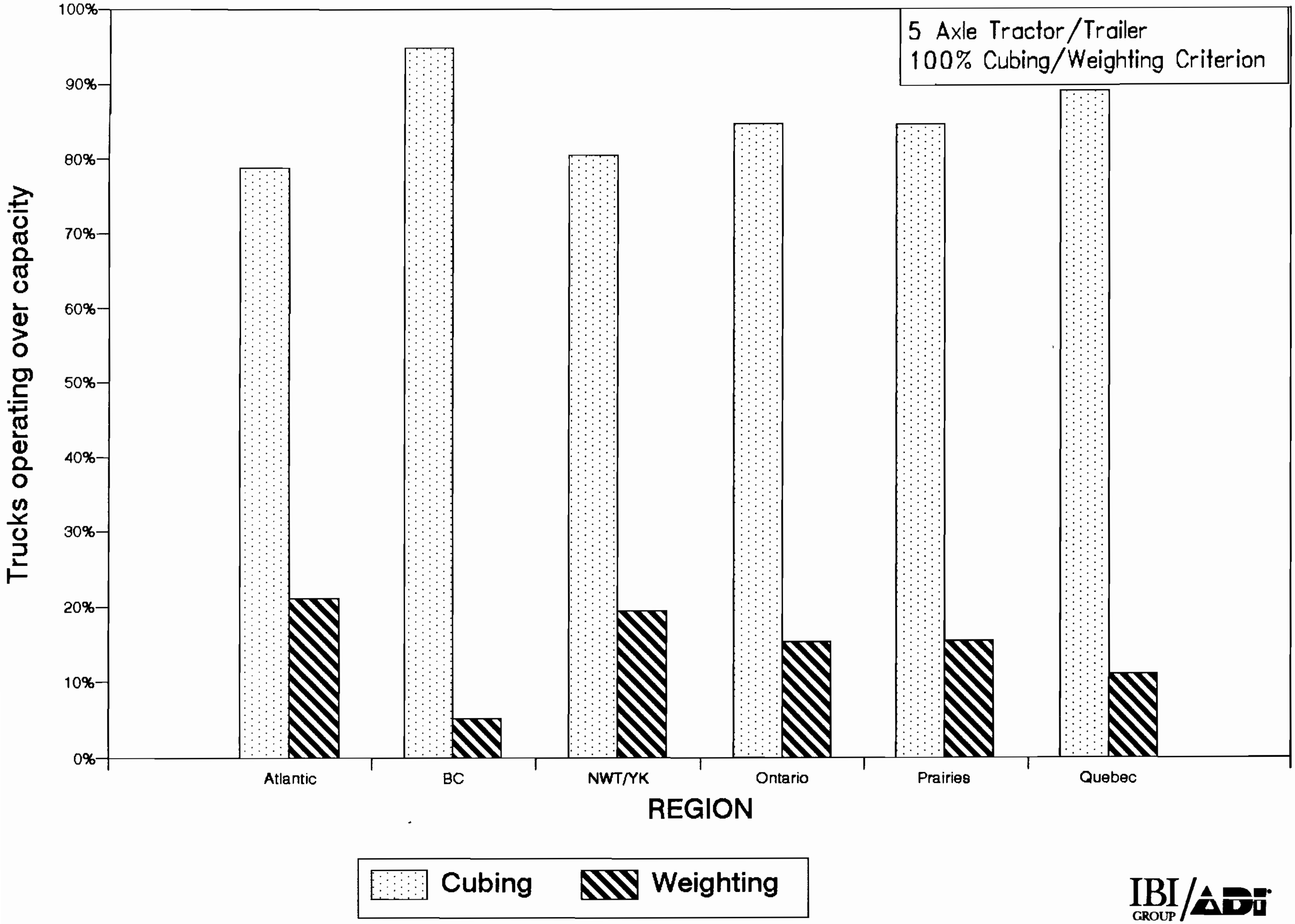


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EXHIBIT 15.7
DATA SETS USED TO ESTIMATE TRUCK CLASSIFICATION FOR THE NHS

Province	Data Sources Used
British Columbia	• CCMTA data (3 sites) • Vehicle classification data (classified as light/heavy trucks, and number of trailers) from 18 sites
Alberta	• CCMTA data (4 sites) • Vehicle classification data (classified as single-unit and tractor-trailer trucks) for the entire network
Saskatchewan	• CCMTA data (7 sites)
Manitoba	• CCMTA data (1 site) • Vehicle classification data (percent truck traffic) for the entire network
Ontario	• CCMTA data (3 sites) • Vehicle classification data (percent truck traffic) for the entire network • Weigh-in-motion data from 3 sites
Quebec	• CCMTA data (3 sites) • Vehicle classification data (percent truck traffic) from 30 sites
New Brunswick	• CCMTA data (1 site)
Nova Scotia	• CCMTA data (1 site) • Vehicle classification data (percent truck traffic) at 12 survey stations • Weigh-in-motion data from 5 sites
Prince Edward Island	• CCMTA data (1 site) • Vehicle classification data from 6 sites (including weigh-in-motion and Archer classification sites)
Newfoundland	• CCMTA data (2 sites)
Yukon Territory	• CCMTA data (1 site)
Northwest Territories	• CCMTA data (1 site)

15.1.6 Data Limitations

The greatest problem facing the study team during this project was the lack of detailed truck traffic information. In order to address inconsistencies and limitations in the data used in this project, attempts were made, where possible, to validate the information using other available sources. A more detailed discussion of the data limitations follows.

In summary, the problems encountered included:

- limited information on the breakdown of semitrailers by box length (i.e. 14.65 m vs. 16.2 m, or 48 feet vs. 53 feet);
- unavailability of measures of the percentage of trucks in traffic and classification by engaged axles for many of the specific road sections;
- imprecise recording of truck configuration in the CCMTA database, making classification of 7- and 8-axle trucks difficult;
- lack of regional O/D pair data except as contained in the CCMTA database, collected at 29 points across the country;
- gaps in the CCMTA data on volume use and payload carried;
- absence of data for the NHS in 1987 to determine the pre-MoU truck configuration mix;
- limited response to the carrier survey, with 16 usable responses on fleet composition in 1987, 1992, 1997 and 2002 and up to 29 useable responses for other questions.

The most significant data limitation was the lack of information on trailer length from any of the roadside surveys. The extent of the uptake of 53 foot (16.2 m) semitrailers in Western Canada had to be estimated using information provided by the carrier survey, specifically a refinement of the numbers in Exhibit 13.6. This use of the carrier survey is sensitive to the experience of the sixteen firms with valid responses, in particular in the Atlantic provinces where one respondent's figures dominated the regional totals. Hopefully, trailer length information will be collected as part of future surveys similar to that performed by the CCMTA in 1991. In future, data from WIM (weigh-in-motion) sites may be used to provide trailer length breakdowns.

Another problem was the lack of specific information for every highway section in the NHS. This has led to the use of data from only three stations to classify all vehicles in both of the territories, for example. Fortunately, this is not really a major problem because the percentage of trucks in traffic was available for many of the road sections across the country, and classification data was available from several of the provinces (as shown in Exhibit 15.7), creating a more accurate NHS database. Due to the procedure of aggregating road section results to produce regional estimates of truck traffic, it is likely that most of the errors (found at the level of specific highway segments, where assumptions about percentage - by truck type - had to be made) will cancel out due to a mix of over- and under-estimation of truck traffic. The estimates of vehicle kilometres (in total, and by axle count) are more sensitive to the assumption that annual truck traffic is equivalent to the volume of 300 weekdays.

Some provinces did not have very precise information on vehicle configurations in the CCMTA Survey. Fairly reliable data on the breakdown of 7- and 8-axle vehicles was required since one of the major impacts of the MoU was a shift in configurations among the A/C and B-trains. This was confirmed by the carrier survey; of particular interest was the uptake of 8-axle B-trains. It was intended to use the CCMTA breakdown, but some of the interviewers did not specify the connection types of many of the tandem trailers. The reported configuration types in each province are summarized in Exhibit 15.8. Survey data in Ontario and British Columbia were particularly poor in this regard; other data had to be used to assist in the classification of these vehicles.

Exhibit 15.9 demonstrates the procedure used to estimate the percentage breakdown of tandem trailers and 7-axle semitrailers for each of the provinces. Ontario and British Columbia were both dealt with by using the carrier survey, with further validation carried out from other sources. The results of surveys carried out in 1991 and 1992 in Ontario at sites in Windsor, Sarnia, and London were very comparable to the numbers produced by the carrier survey. In British Columbia the study team hired observers to count vehicles along the Trans-Canada Highway at several points in May, 1994 for comparison with the percentages actually used in the Base Traffic Model. Exhibit 15.10 shows that the estimates used in the calculations are quite similar to the results of the other truck traffic counts.

As described in Part III of this report, data from the CCMTA were used to develop profiles of configuration usage for the best represented O/D pairs in the survey. Unfortunately, the survey sites were not always

EXHIBIT 15.8

Provincial Configuration Breakdown Reported in the CCMTA Survey

(Number of Interviews Conducted Per Truck Type)

PROVINCE	(S)5	(S)6	A7	B7	C7	T7	S7	A8	B8	C8	T8	S8	S/L	A?	B?	C?	T?	S?	?7	?8	??	SUM
NF	421	195	0	0	0	0	2	0	0	0	0	0	1	15	2	0	0	60	0	0	7	696
NS	1,608	536	0	5	0	3	13	0	7	0	2	5	91	0	2	0	3	115	0	0	1	2,390
PE	493	101	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	5	0	0	0	603
NB	1,066	460	0	0	0	6	20	0	0	0	10	2	27	0	0	0	3	41	0	0	1	1,635
QC	3,946	1,242	20	43	5	5	211	21	125	5	11	50	244	10	11	1	3	204	0	0	9	6,157
ON	2,518	682	9	17	2	113	129	10	35	3	133	25	170	1	2	0	10	64	4	0	3	3,927
MB	1,430	329	59	106	13	9	9	21	111	15	8	5	28	7	7	2	0	30	0	0	0	2,189
SK	1,863	353	103	127	32	92	25	20	177	18	69	5	73	7	12	5	8	71	6	5	1	3,071
AB	1,418	264	75	134	20	70	19	14	146	6	50	7	61	8	10	4	10	29	0	1	0	2,346
BC	2,143	612	9	31	2	380	19	4	60	1	406	9	40	1	1	0	26	49	9	5	10	3,807
NT	76	24	0	0	0	48	8	0	2	0	43	2	17	0	0	0	0	6	1	0	1	227
YT	182	71	4	92	0	10	9	10	125	0	5	3	10	4	9	0	1	7	0	0	0	542
SUM	17,164	4,869	279	555	74	736	464	100	792	48	737	113	762	53	56	12	64	681	20	11	33	27,590

KEY:

- (S)5 5–axle semitrailers
- (S)6 6–axle semitrailers
- A7 7–axle A–trains
- B7 7–axle B–trains
- C7 7–axle C–trains
- T7 7–axle tandems, connection type unspecified
- S7 7–axle semitrailers
- A8 8–axle A–trains
- B8 8–axle B–trains
- C8 8–axle C–trains
- T8 8–axle tandems, connection type unspecified
- S8 8–axle "semitrailers" (Coding error)
- S/L Single unit trucks and LCV's
- A? A–trains, axles not counted
- B? B–trains, axles not counted
- C? C–trains, axles not counted
- T? Tandems (unspecified), axles not counted
- S? Semitrailers, axles not counted
- ?7 7–axle vehicles, configuration not recorded
- ?8 8–axle vehicles, configuration not recorded
- ?? Unidentified trucks

Source : CCMTA Survey Data

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EXHIBIT 15.9
DISAGGREGATION OF 7 AND 8 AXLE CONFIGURATIONS

OBSERVED 7/8 AXLE TRUCK TRAFFIC (1991):

PROV	A7	B7	C7	T7	S7	A8	B8	C8	T8
NF	0	0	0	0	2	0	0	0	0
NS	0	5	0	3	13	0	7	0	2
PE	0	0	0	0	0	0	4	0	0
NB	0	0	0	6	20	0	0	0	10
QC	20	43	5	5	211	21	125	5	11
ON	9	17	2	113	129	10	35	3	133
MB	59	106	13	9	9	21	111	15	8
SK	103	127	32	92	25	20	177	18	69
AB	75	134	20	70	19	14	146	6	50
BC	9	31	2	380	19	4	60	1	406
NT	0	0	0	48	8	0	2	0	43
YT	4	92	0	10	9	10	125	0	5
SUM	279	555	74	736	464	100	792	48	737

NOTES : Ontario and B.C. (shaded) could not be fully disaggregated using these counts.
(A–, B– and C–trains were not well identified in those two provinces – too many unspecified)
Truck type codes are those explained in Exhibit 15.8

BREAKDOWN OF 7–AXLE TRUCKS / **BREAKDOWN OF 8–AXLE TRUCKS**

PROV	A7	B7	C7	S7	A8	B8	C8
NF	0%	0%	0%	100%	0%	100%	0%
NS	0.0%	38.1%	0.0%	61.9%	0%	100%	0%
PE	0.0%	30.6%	0.0%	69.4%	0%	100%	0%
NB	0.0%	23.1%	0.0%	76.9%	0%	100%	0%
QC	7.6%	16.3%	1.9%	74.3%	13.9%	82.8%	3.3%
ON	40.4%	8.4%	3.5%	47.8%	25.7%	73.0%	1.3%
MB	31.6%	56.8%	7.0%	4.6%	14.3%	75.5%	10.2%
SK	36.7%	45.3%	11.4%	6.6%	9.3%	82.3%	8.4%
AB	30.8%	55.0%	8.2%	6.0%	8.4%	88.0%	3.6%
BC	63.3%	30.9%	1.5%	4.3%	4.1%	72.1%	23.7%
NT	28.1%	50.2%	7.5%	14.3%	0%	100%	0%
YT	3.8%	88.3%	0.0%	7.8%	7.4%	92.6%	0.0%

NOTE Shading indicates assumed distribution based on neighbouring province(s).
Ontario and BC based on carrier survey data (see Exhibit 4.10)

Procedure was to estimate proportion of semis out of (A,B,C,T,S), then divide the remaining percentage amongst A, B, and C.
8–axle semitrailers not considered (rare).

Sources : CCMTA Roadside Survey (1991) and Carrier Survey (1993), with calculations.

EXHIBIT 15.10
TANDEM TRAILER PROFILES : ONTARIO AND BRITISH COLUMBIA

CLASSIFICATION OF TANDEM TRAILERS IN ONTARIO :

TYPE	Ontario Survey Information				Carrier Survey Info		
	1988(1)	1992(2)	1993(3)	1992/3 %	7-axle	8-axle	Avg.
A-TRAIN	72%	80	144	42.2%	77.3%	25.8%	42.8%
B-TRAIN	26%	89	177	55.1%	16.0%	73.0%	54.2%
C-TRAIN	2%	5	incl. in A	2.6%	6.7%	1.2%	3.0%
NOT ID'D.	N/A	76	29	N/A			

NOTES:

(1) Most recent province-wide Commercial Vehicles Survey.

(2) Windsor border crossing - full week, 24 hours (sample only).

(3) Sample at three sites: Windsor, Sarnia, London.

Percentage of tandems in truck mix was roughly 5 - 7% in all three years.
NHS estimated total tandem percentage in Ontario was 8%.

CLASSIFICATION OF TANDEM TRAILERS IN BRITISH COLUMBIA

TYPE	B.C. Survey Information				Carrier Survey Information		
	SITE 1	SITE 2	SITE 3	1994 %	7-axle	8-axle	Avg.
A-TRAIN	30 / 15	20 / 12	4 / 10	25.5%	63.3%	4.1%	29.9%
B-TRAIN	42 / 82	12 / 82	8 / 161	72.7%	30.9%	72.1%	54.1%
C-TRAIN	3 / 4	0 / 1	0 / 0	1.9%	1.5%	23.7%	14.0%

NOTES:

B.C. Surveys conducted by study team in May, 1994.
X / Y : X 7-axle vehicles, Y 8-axle vehicles

Survey personnel reported difficulty identifying C-trains - should be about 2% of ALL TRAFFIC
NHS Percentages (Based on Carrier Survey) : 5.5% A, 9.7% B, 2.7% C.

SITE 1: Hwy. 5 south of Kamloops
SITE 2: Hwy.1 EB at Port Mann Bridge (E. of Vancouver)
SITE 3: Hwy.97 south of Prince George

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Sources : MTO Truck Classifications (1992/3), Carrier Survey (1993) and Study Team Counts (BC, 1994).

ideal for this purpose due to their proximity to provincial borders. This automatically leads to a bias in favour of inter-provincial trucking. Some provinces would not have been affected to a great extent due to the nature of travel in those provinces (such as British Columbia, where traffic is largely along one or two major corridors). The results for the central and eastern provinces could have been biased by the location of the survey sites, summarized in Appendix D. Any error would have been derived from differences in the truck type profiles of intra- and inter-provincial traffic. For example, the Province of Quebec had three sites which were all located very close to the New Brunswick or Ontario borders. Most of the intra-provincial traffic would occur between Montreal and Quebec City, which falls between survey locations; this lead to an apparent result that most NHS traffic in Quebec was inter-provincial. Fortunately, there was other highway link information available (percent trucks by axle count, as noted in Section 15.1.2) to offset this problem. Where more detailed information was available, the CCMTA would only have been used to disaggregate the double trailer combinations. This was not expected to be a major source of error, then, as long as the fleet profiles were fairly similar for inter- and intra-provincial traffic.

This assumption was later substantiated by the results shown in Exhibit 18.5 in Part III of this report. A comparison of each of the intra-regional profiles against the overall regional profile revealed very parallel results, with the exception of a slightly greater reliance (about 5-10% more) on straight trucks for intra-regional hauls. Therefore, in those provinces or regions where only CCMTA classifications were used, there would be a reduction in the semitrailer traffic, and thus the savings calculated, if it were possible to correct the traffic profiles by increasing the proportion of intra-provincial traffic. This overestimation of semitrailer traffic would be in the order of 3-5%, about half the difference in use of straight trucks. Given that in only Saskatchewan and some Atlantic Provinces and Territories (carrying about 10-11% of NHS traffic) we were limited strictly to use of the CCMTA, the overall effect of the reduction in semitrailer veh-km (in favour of straight trucks) would be to reduce savings by approximately 1%.

One additional problem with the procedures applied to CCMTA data was that small sample sizes resulted for some calculations. One example was the calculation of average payload, for each specific configuration in each province according to whether it cubed out, weighted out, did both, or was partially loaded. Excluding empties and straight trucks, this left approximately 15,000 of the trucks surveyed to be put into 480 classification bins, resulting in some samples of size zero for calculation purposes. The counts of vehicles in these bins (cube out, weight out, cube/weight out, partial load, empty) were used to calculate distribution factors for the vehicle-km of each truck configuration in each province. The average payload information was eventually used only in the calculation of average operating costs for the country rather than as a factor to convert vehicle-km to tonne-km of truck haul. This meant that these gaps in information did not have a significant impact on the results of the study, except in any cases where the missing information was biased towards one class of truck. (There is no way of correcting for such hidden biases based on existing data).

The Study Network used in 1987 was not quite the same as the MoU Network or the National Highway System. Also, the information available on 1986 traffic volumes (in the 1987 study) concerns only the cube-out and weight-out traffic in 1986. This did not lend itself to application in estimating the pre-MoU truck type breakdown for 1987. Instead, the base 1992 truck traffic volumes and carrier survey responses on fleet configuration trends were combined to estimate the "1987" truck type breakdown to act as the pre-MoU case for the years 1992, 1997 and 2002. Future year configuration usage in each region was subsequently estimated using the same procedure. The major difficulty, as noted earlier, was that only sixteen respondents answered for all four years, and this was expanded to predict truck fleet impacts for the entire NHS. The future year total truck volumes are only approximate estimates, however, and the procedure for breaking this down by truck type is of similar reliability; more data would have contributed to greater reliability, but the 14% response rate achieved in the carrier survey was actually above average for the trucking industry. Exhibit 18.2 in Part III of this report presents the regional profiles as determined from the estimated vehicle-kilometres, versus the results of the carrier survey.

15.2 TRUCK COST IMPACTS DATA

The data used to determine the truck costs consist of detailed unit costs covering the operation of trucks of different configurations and information on the traffic flow. In order to capture the changes which resulted from the introduction of the MoU, relatively detailed resolution of these data is required. Data must be available by province or region, by configuration and by type of loading, i.e. whether the cubic capacity of the trailer or the maximum weight limit determines the size of the load.

The major source of detailed cost figures was the 1992 Trimac survey of trucking costs carried out for Transport Canada. These data are available by province for dry freight and bulk, tractor trailers and trains, for three annual distances travelled and for gravel and paved roads. From these appropriate unit costs were extracted and entered in the spreadsheet model. Information on the costs of tractors and trailers, their economic life, tare weights and details on the physical dimensions of configurations were obtained from a truck dealership. The vehicle purchase costs must be considered as order of magnitude estimates, because of the large range of different vehicles and their associated options. However, we believe that with the cooperation of the dealership we arrived at representative costs for the vehicles.

The traffic data needed similar resolution in order to discern the impacts resulting from the changes introduced by the MoU. Vehicle kilometres were obtained by the process outlined in Section 16.1.1 using data described in Section 15.1.

15.3 INFRASTRUCTURE COST IMPACTS DATA

15.3.1 Geometric Design

The vehicle performance and dimension characteristics provided within the MoU were chosen so as not to require geometric improvements such as lane widths or shoulder width. As a result there are no systematic geometric design improvements required as a result of the MoU. Nevertheless, the provincial transportation ministry case studies did identify some areas as noted in Section 14.2.2. Apart from the Ministry case studies no data collection was required.

15.3.2 Pavement Impacts (LEF's)

The MoU has affected pavement life to the extent that truck traffic characteristics have changed as a result of the MoU. In addition to the annual truck traffic estimates discussed in Section 15.2, key data requirements to estimate the pavement impacts, based on the recommended "build-sooner" approach include:

- relationships between axle loads and the resulting LEF's for various axle group types;
- typical tare weight estimates for the various vehicle types;
- estimating LEF's for various payloads for each vehicle type;
- identifying the regions impacted by the MoU;
- estimating average payload estimates for the affected regions;
- estimating reduction in LEF's due to the MoU;
- determining typical pavement structures for pavement impacts analysis.

15.3.2.1 LEF Relationships

Recent Canadian research (Roads and Transportation Association of Canada; Vehicle Weights and Dimension Study. Ottawa, 1986) developed specific regression equations for calculating LEF's due to various axle loads as follows:

Steering Axle:	$0.004836 \times (\text{Load})^{2.9093}$
Single Axle:	$0.002418 \times (\text{Load})^{2.9093}$
Tandem Axle:	$0.001515 \times (\text{Load})^{2.5430}$
Tridem Axle:	$0.002363 \times (\text{Load})^{2.1130}$

where "Load" is total axle group weight in tonnes. The equations are illustrated graphically in Exhibit 15.11.

15.3.2.2 Typical Tare Weights

The following typical tare weight estimates were obtained from Saskatchewan Highways and Transportation:

Vehicle Type	Tare Weight (Tonnes)
5-axle semitrailer	14.5
6-axle semitrailer	15.5
7-axle A-train	20.1
7-axle B-train	19.0
7-axle C-train	20.1
8-axle A-train	21.8
8-axle B-train	20.0
8-axle C-train	21.8

15.3.2.3 LEF Estimates for Various Payloads

Using the LEF relationships and the typical tare weights, with the axle load specifications as defined in the MoU, LEF's for semitrailers and doubles were calculated for various payloads. The results are shown graphically in Exhibit 15.12. The 5-axle semitrailer is shown in all the graphs, as it represents the base truck type with respect to the MoU. As seen from the Exhibit, all vehicle types produce lower LEF's compared to the 5-axle semitrailer across all payload levels. This is due primarily to the somewhat lower axle weights offered to the 6-axle to 8-axle vehicles.

The exhibits illustrate that the 6-axle tractor trailer and the 8-axle B-train units have the lowest LEF's per tonne of payload carried of all the vehicle configurations examined. **In fact, these vehicles are about 20% more "pavement friendly" than the previously most commonly used truck. This means that if the introduction of these vehicles switched freight from 5-axle tractor trailer and 7-axle double combination trailers then reduced pavement impacts would occur.**

EXHIBIT 15.11

**LOAD EQUIVALENCY FACTORS
DUE TO VARIOUS AXLE GROUP LOADS**

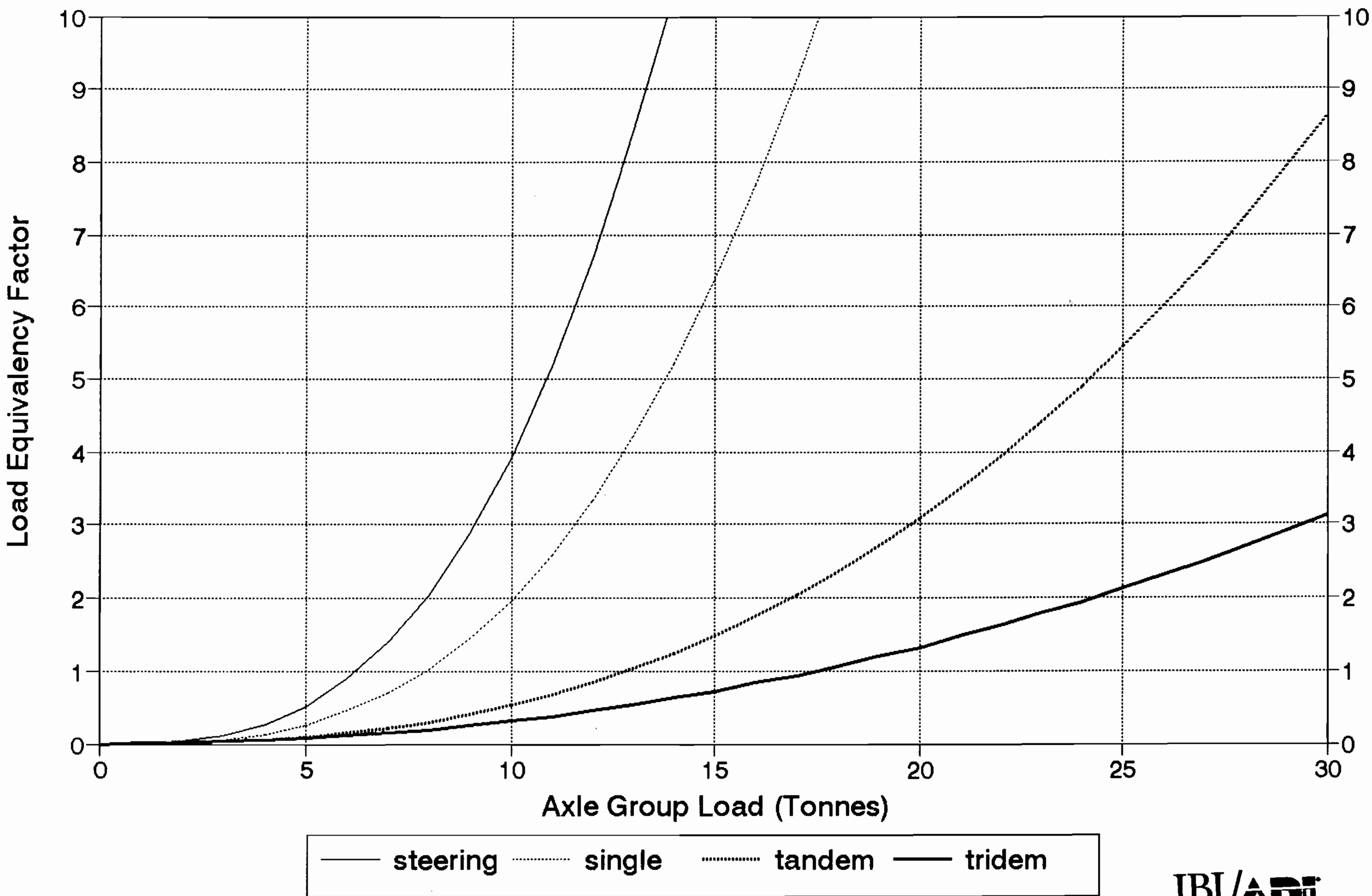
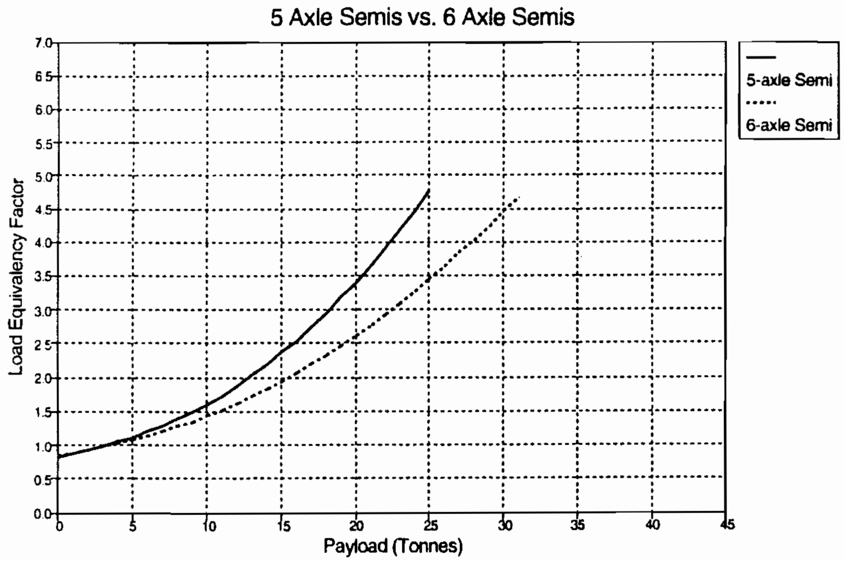
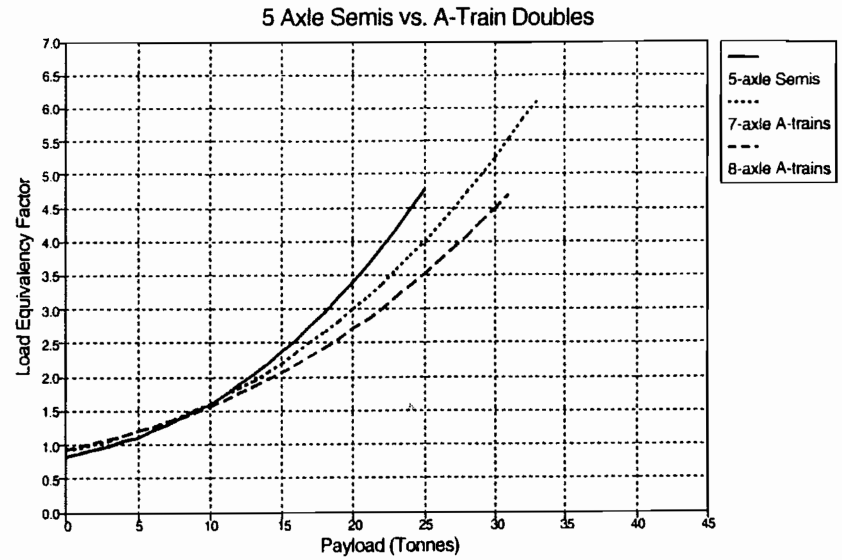
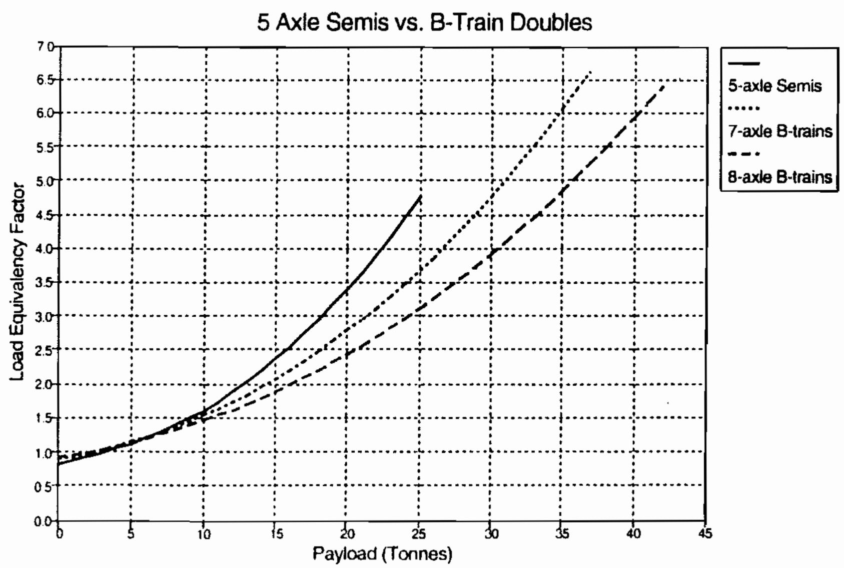


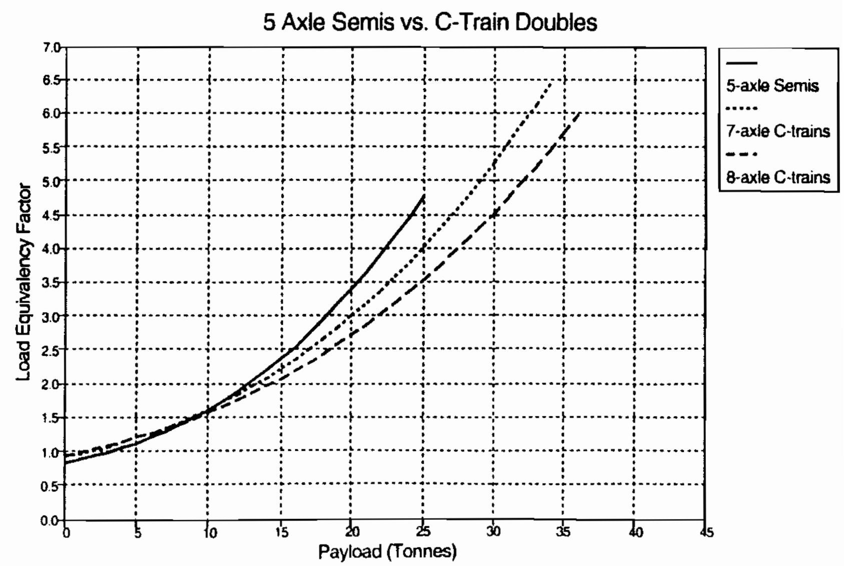
EXHIBIT 15.12

Estimates of Load Equivalency Factors at Various Payloads









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15.3.2.4 Regions Impacted

The Pre-MoU weight limits were already greater than or equal to the MoU designated limits for Quebec, Ontario, and Yukon Territory. This means there would be basically no change in LEF's, and hence no pavement impacts, in these jurisdictions as a result of the MoU. The impacts would be most significant in the Prairies, followed by the Atlantic Provinces, British Columbia, and the Northwest Territories for reasons described below.

Prairies:

In the Prairies, the MoU increased weight limits for several vehicle configurations. The increases (in tonnes) can be briefly summarized as follows:

	Alberta	Saskatchewan	Manitoba
5-axle tractor semitrailer	+0.5	+2	+2
6-axle tractor semitrailer	+7.5	+9	+9
7-axle B-train	+3	+3	+3
7-axle C-train	+1.1	+1.1	+0
8-axle B-train	+9	+9	+9
8-axle C-train	+5	+5	+2

As seen from this summary, increases in limits for 6-axle tractor semitrailers and 8-axle B-trains were most significant. The 6-axle tractor semitrailer limit was increased to 46.5 Tonnes, compared to the Pre-MoU limits of 37.5 Tonnes in Manitoba and Saskatchewan, and 39.0 Tonnes in Alberta. The 8-axle B-train limit was increased to 62.5 Tonnes from 53.5 Tonnes in all three provinces. Prior to the MoU, weight limits for the 6-axle tractor semitrailer were the same as the 5-axle tractor semitrailer, and limits for an 8-axle B-train were same as a 7-axle B-train resulting in limited use of the 6-axle tractor trailer and the 8-axle B-train. Hence, usage of these vehicles increased dramatically after implementation of the MoU. The increases in weight limits for 5-axle tractor semitrailers and 7-axle B-trains were relatively insignificant. It is worth noting that the increased weight limits offered to C-trains are effective only since 1993. Prior to that, weight limits for C-trains were already greater than or equal to the Pre-MoU limits.

Atlantic Provinces:

In the Atlantic Provinces, the Pre-MoU weight limits for tractor semitrailers were already greater than or equal to the MoU limit. With the exception of Prince Edward Island and New Brunswick, where double combination vehicles operated only under special permits, the MoU implied increased weight limits for all double combination trucks.

The increases (in tonnes) for Nova Scotia and Newfoundland are summarized below:

	Nova Scotia	Newfoundland
7-axle A-train	+3.5	+1
7-axle B-train	+6.5	+4
7-axle C-train	+4.6	+2.1
8-axle A-train	+3.5	+1
8-axle B-train	+12.5	+10
8-axle C-train	+8.5	+6

The most significant increases were offered to B-trains. Prior to the revised 1993 MoU limits, the weight limit for A-trains was the same as C-trains.

Northwest Territories:

In the Northwest Territories, the MoU increased the weight limits by 2.9 tonnes for 5-axle tractor semitrailers and 9.9 tonnes for 6-axle tractor semitrailers. The 7-axle B-train limit was increased by 2.5 tonnes and the 8-axle B-train limit was increased by 8.5 tonnes. The 1993 MoU weight limit increase for C-trains also increased the weight limit for 7-axle C-trains (+0.6 tonnes) and 8-axle C-trains (+4.5 tonnes).

British Columbia:

In British Columbia, the Pre-MoU limits for double combination trucks were already greater than or equal to the MoU designated limits. The MoU increased the weight limit for 6-axle tractor semitrailer from 39.5 tonnes to 46.5 tonnes.

Summary

In summary, the pavement impacts due to the MoU are most significant in the Prairies Provinces due to the weight increase offered and the uptake of these increases by industry. The change in truck traffic mix due to the MoU is in the form of increased 6-axle tractor semitrailer and 8-axle B-train traffic. As discussed in Section 15.3.2.4, these truck types have the ability to carry freight in a more "pavement friendly" manner (by up to 20%) compared to the 5-axle tractor semitrailer. Therefore, the MoU has resulted in extended pavement life assuming no net increase in truck traffic as a result of the increased productivity offered by these vehicles. This means the "build sooner" costs become "build later" savings.

15.3.2.5 Average Payload Estimates

The average payloads (by region) were estimated for each vehicle type using the truck weight data from the CCMTA survey. The payloads were estimated for each of the following vehicle categories:

- vehicles with volume exceeding 95% of the cubic capacity (i.e. vehicles cubing out);
- vehicles with GVW exceeding 95% of the weight limit (i.e. vehicles weighting out);
- vehicles cubing and weighting out; and
- partially-loaded vehicles.

The average estimates for the Prairie Provinces are tabulated in Exhibit 15.13.

EXHIBIT 15.13
Average Payload Estimates (Tonnes) for the Prairie Provinces
(Based on CCMTA Survey Data)

Vehicle Type	Cubing	Weighting	Cubing/ Weighting	Partial
5-axle tractor semitrailer	17	41	40	14
6-axle tractor semitrailer	21	33	31	19
7-axle A/C train	21	33	33	14
7-axle B-train	30	36	38	22
8-axle A/C train	24	31	31	15
8-axle B-train	32	41	41	28

15.3.2.6 Estimate of LEF Reductions

As illustrated in Section 15.3.2.4, the pavement impacts would be most significant in the Prairies. To estimate the reduction in LEF's associated with the MoU, the following assumptions (supported by the carrier interviews) were applied to the GVW data obtained from the CCMTA survey for the Prairie sites:

- freight hauled by 8-axle B-trains loaded above the Pre-MoU limit would have been carried in an equivalent number of fully loaded 7-axle B-trains at their Pre-MoU limit of 53.5 tonnes; and

- freight hauled by 6-axle tractor semitrailers loaded above the Pre-MoU limit would have been carried in an equivalent number of fully loaded 5-axle tractor semitrailers at their Pre-MoU limit of 37.5 tonnes.

Using the above assumptions, the CCMTA survey data was analyzed to estimate the reduction in LEF's due to the MoU. The results are

EXHIBIT 15.14

Percent Reduction in LEF's due to the MoU
(Based on CCMTA Survey Data Sample for Prairie Provinces)

Vehicle Type

	Tractor Semitrailers		Double Trailers		
	5-axle	6-axle	7-axle	8-axle	All
Pre-MoU LEF's	3,600	155	1,398	191	5,344
Post-MoU LEF's	3,147	500	852	665	5,164
Change in LEF's due to MoU	-453	345	-546	474	-180
Percent Reduction	2.9%		4.5%		**3.4%**

Notes:

- LEF's indicated are for the truck traffic recorded in the CCMTA survey data at the Prairie sites.
- Percent reduction in LEF's is estimated as 2.9% for tractor semitrailers, and 4.5% for double trailers.
- Net reduction in LEF's due to the MoU is estimated as 3.4%.

summarized in Exhibit 15.14; detailed calculations are presented in Appendix F.2. In summary, the MoU has reduced the LEF's due to tractor semitrailers by 2.9%, and double trailers by 4.5%. Overall, a 3.4% reduction in LEF's is estimated.

15.3.2.7 Pavement Structures Strength Data

While it was originally intended to use SHRP and C-SHRP sites for this analysis, it was determined, contrary to expectations, that available traffic data at these sites were too limited (due to technical problems with the equipment and lack of provincial resources to collect and analyze the output) to produce meaningful results.

Therefore, for the pavement impacts analysis, twelve typical pavement structures used in the Prairie Provinces were selected from guidelines given in the TAC Pavement Management Guide. Exhibit 15.15 summarizes the structures selected.

15.3.3 Pavement Impacts (Other Factors)

As indicated in Part I (Section 7.2.2), there is growing evidence that suggests the following factors, in addition to axle loads, also affect pavement wear:

- tire pressure
- suspension system
- single (versus dual) tires and tire width

The carrier and equipment manufacturer case studies included questions to determine how fleet turnover was affecting each of these factors. These are reported in Sections 14.2.1.4 and 14.2.4.3. All equipment manufacturers and several carriers reported a move to air ride suspensions which, while resulting in improved rides and decreased maintenance, reduce pavement impacts of moving loads. This move is not necessarily related to the MoU. Some carriers also reported lower tire pressures due to new tire design. This would also reduce pavement impact. Again, this is not necessarily related to the MoU.

15.3.4 Roadway Maintenance

As noted in Section 14.2.2, the provincial transportation Ministries indicated they had not changed roadway maintenance practices due to the MoU vehicles. However, changes were occurring due to the impact heavy vehicles in general are having on their roads.

No data collection with respect to this item was undertaken.

15.3.5 Bridges

Potential impacts of changes in weights and dimensions regulations on bridges could include a need for strengthening, bridge fatigue impacts and changes in operation and maintenance costs.

EXHIBIT 15.15
TYPICAL PAVEMENT STRUCTURES FOR PRAIRIE PROVINCES

Pavement Structure (mm)		
Asphalt Surface (mm)	Granular Base (mm)	Granular Subbase (mm)
Weak Subgrade (Lacustrine Clay)		
100	100	205
100	100	305
100	150	355
100	165	345
115	165	355
125	180	370
Medium Subgrade (Glacial Till)		
100	100	125
100	100	205
100	150	180
100	100	305
115	165	180
125	180	190

Notes:

- Typical pavement structures are based on guidelines provided in the TAC Pavement Management Guide.

15.3.5.1 Bridge Strengthening

Bridge engineers in each province were contacted to determine these costs where systematic reviews and assessment of bridge capabilities had been completed. Appendix F contains the letter questionnaire and response from each province.

The costs for Manitoba, Saskatchewan and Alberta were reported by the provincial bridge engineers based on analyses of the bridges in each of their respective jurisdictions. Costs for British Columbia were estimated by the study team as follows: the British Columbia Ministry of Highways and Transportation developed a screening procedure [3], which identified bridges requiring load rating to determine their specific requirements to handle the 8 axle B-train: A cost of $1,000,000 was identified as being required to conduct these load ratings and accompanying field work. Such an investigation was well beyond the Terms of Reference for this study. To develop an order of magnitude estimates of strengthening costs for British Columbia, the cost data for Alberta were referred to. Following discussions with bridge engineers in both Alberta and British Columbia, which confirmed that this procedure should result in reasonably reliable order-of-magnitude estimates of strengthening costs for British Columbia, the Alberta average bridge costs by type (prestressed, steel, etc.) were calculated and applied to those B.C. bridges identified as requiring load rating as well as those bridges where insufficient data were available to pre-screen the bridges. Assuming that all bridges requiring load rating and those that could not be prescreened would require improvements with costs similar to Alberta's, an estimated one time strengthening cost of $19 M resulted. This estimate is considered conservative (i.e. high) as not all bridges requiring rating will, in fact, require strengthening. Other provinces reported no strengthening costs.

Specific responses regarding strengthening costs from each province were as follows:

1. Newfoundland - No strengthening

2. Nova Scotia - No strengthening

3. Prince Edward Island - No strengthening

4. New Brunswick - No bridges on the arterial highway system required strengthening. Other routes have been investigated on

[3] Reid Crowther and Partners. ***Final Report on Development of Loading Rating Screening System.*** Burnaby, B.C. May 5, 1993.

demand basis and remained closed where bridges were inadequate.

5. Quebec indicated no change in loadings from their previous limits and hence no additional costs.

6. Ontario indicated the TAC truck weights and axle loads are lower than the regulatory loads in place and therefore no additional strengthening costs. The increase in allowable loads on tri-axles may have a marginal effect on maintenance frequency.

7. Manitoba indicated that $6 million is being spent on strengthening. In addition, the province also has timber laminated bridges that have experienced a reduced service life.

8. Saskatchewan indicated that no bridges had to be replaced because of increased vehicle weights. However, six bridges required strengthening, at an average cost of $100,000.

9. Alberta indicated that 41 bridges required strengthening to accommodate TAC trucks, at a total cost of approximately $2.5 million.

10. British Columbia indicated they examined 1,000 bridges on their system and determined that 550 required load rating (at a cost of $1 million) to determine ability to carry loading.

15.3.4.2 Bridge Fatigue

Fatigue is not a significant factor with the change in load and configuration, since the number of TAC vehicles are low compared to the total traffic and fatigue considerations are based on the "average" truck, even for bridges carrying a high percentage of the revised trucks. However, stress range may be increased particularly in members that undergo stress reversal.

The bridges susceptible to fatigue are a small fraction of the total population. In general, fatigue problems are experienced only by some welded steel bridges, particularly those having fatigue sensitive details. Bolted and riveted steel, reinforced concrete, pre-stressed concrete, and timber bridges are typically not affected by fatigue. Age of the bridge is also important in the consideration of fatigue in that the design code in effect at the time of design will determine the details required to minimize fatigue problems.

Other items of note regarding fatigue include:

- Multi-span continuous bridges may be fatigue sensitive at negative moment regions, particularly at the termination of longitudinal stiffeners.

- Skewed bridges produce secondary stresses through diaphragms that may initiate cracking in main members.

- Bridges having redundant load paths, such as multi-girder bridges, are not normally fatigue-sensitive, since loss of one main member is not likely to result in total collapse.

- Short span bridges (i.e. less than 15 metres) should not be as susceptible to fatigue problems, since they are often fabricated using rolled beams with a minimum of connections and secondary members, providing fewer fatigue sensitive connections.

15.3.5.3 Bridge Operation and Maintenance Costs

Overall, while there will be increased bridge costs due to fatigue these costs are limited and would require extensive investigations well beyond the scope of this study.

Chief bridge engineers from all provinces responded to questionnaires noting that increased truck loads will have detrimental effects on operational and maintenance costs of their bridge population. Respondents, however, have also been unanimous with their inability to identify the components that will suffer deterioration, or to quantify the increased costs. This is understandable, in that a great many factors contribute to bridge deterioration and proportioning the damage to the traffic stream, let alone a specific component of the traffic, is difficult. Equally apparent, if only through intuition, is the contention that increased truck loads will have some effect on bridge maintenance requirements.

Assuming that a particular bridge has the structural capacity to support the proposed increases in truck loads, the increases in O & M costs can probably be related to the following:

1) Bridge Deck Deterioration - Asphaltic concrete wearing surfaces will bear the brunt of increased truck loads, particularly on hot days when the asphalt softens. Rutting may be more prevalent, and delamination from the substrate may occur. This problem will not be as severe for bridges as that experienced by the remainder of the roadway, however, since the underlying bridge deck is considerably stiffer than granular subgrade materials.

   Concrete or steel bridge decks are not expected to suffer accelerated deterioration from heavier trucks, provided they are structurally able to support the loads. Timber decks may experience loss of rigidity over time, as individually members tend to "give" relative to one another.

In Canada, most of the deterioration experience in bridge decks is a direct consequence of the use of de-icing salt during the winter. Since this cannot be related to the weight of trucks crossing the structure, the proportion of bridge deck O & M costs related to truck load increases is necessarily limited.

2) Fatigue - Additional deterioration of bridges due to fatigue under the increased truck loads has been discussed elsewhere in this report, where it was not considered significant. However, there is arguably some cost attributed to reduced lifespan from this phenomenon.

Overall, while increased bridge O&M costs are anticipated, these are considered by the study team to be minor and nearly impossible to quantify for the reasons cited above.

15.3.6 Effects on Other Highway Users

The marginal impact the MoU is having on pavement life means there would not be any changes in the vehicle operating costs of other vehicles due to changes in pavement condition related to the MoU vehicles. No data collection with respect to this item was undertaken.

15.4 ROAD SAFETY IMPACTS DATA

The handling and performance standards developed by the Vehicle Weights and Dimensions Study Research during the 1980's were considered when developing the weights and dimensions regulations contained in the MoU, with the objective of improving safety by promoting the usage of those vehicles with better handling and performance characteristics.

To assess the impacts of the MoU on safety, the most direct measures of vehicle safety required are accident rate per kilometre travelled and accident severity (defined as proportion of total truck crashes that result in fatalities, nonfatal injuries, and property damage only but no injuries). Using such data combined with estimates of travel substitution by truck type as a result of the MoU, one could estimate the impacts on safety in terms of number of accidents. However, due to the limited experience with the vehicle types involved and the many statistical and technical difficulties involved in establishing accurate accident rates for various truck types under different operating conditions, such an approach is impractical.

Transport Canada publishes nation-wide road accident statistics annually. These statistics provide information on the number of vehicles involved in accidents, by severity and vehicle type. A summary [4] of the number of combination trucks involved in fatal and injury accidents for the 1987-1992 period is presented below:

Year	Fatal	Injury	Total
1987	351	4,483	4,834
1988	292	3,700	3,992
1989	385	4,832	5,217
1990	382	4,083	4,465
1991	337	3,150	3,487
1992	295	3,556	3,851

While the numbers show an improvement in safety with respect to vehicles involved in fatal accidents over the last 4 years, total vehicles involved in fatal or injury accidents do not show any definite trend. It should be noted that the accidents reported above are not necessarily due to any fault of the truck driver. In addition, it is difficult to isolate the safety impacts of the MoU from these numbers because several other changes (eg. enactment of the National Safety Code, deregulation, free trade, economic recession) have affected the trucking industry over the same time period.

Vehicle crashes are complex events involving interactions between the vehicle, its driver and the environment. The driver contributes to the extent that driver action or inaction can prevent or precipitate an accident. This means that trucks with basically good handling and stability characteristics may have poor safety records if operated by inexperienced drivers. On the other hand, experienced drivers with good judgement can safely operate with less-than-ideal stability thresholds or in adverse environmental conditions. Vehicle characteristics generally have a less direct and less significant influence on accidents than the driver and the environment. It is the area of vehicle characteristics that the MoU addressed. It is therefore felt that any safety changes attributable to the MoU, while important, would not be large in magnitude. It should also be noted that vehicle safety has been enhanced recently by increased enforcement and implementation of the National Safety Code.

A related safety issue is the extent to which longer trucks may affect the safety and level of service effects experienced by other vehicles (e.g. passenger autos) seeking to pass trucks travelling the same direction on

4 Transport Canada; Road Accident (Traffic Collision) Statistics in Canada, 1987-92.

two-lane highways. The Transportation Association of Canada published a study in 1991 [5]. The relevant finding of this report is as follows:

"3. The research concluded that as the operating speed increases above 80 km/h, the opportunity exists for instances to arise where the theoretical sight distance required to complete the passing manoeuvre exceeds that provided by the passing zone markings on the pavement. This condition presently exists for passing vehicles at the current 23 m length limit, and would increase with longer vehicle length. However, the research concluded that if the accumulated experience with a 23 m length limit has been favourable, the marginal impacts of increasing vehicle length from 23 m to 25 m could also be considered acceptable."

Following its review of the report, the TAC Technical Committee responsible drew a number of conclusions, including the following:

"- it is not obvious or clear nor is the data available to suggest that a serious problem exists with the performance of TAC's present barrier line roadway marking and the passing of long vehicles;

- there exist potentially more critical safety concerns which should be addressed before more effort is spent on the passing issue."

It is clear from this that quantitative estimates of the impact of longer trucks on the safety of other vehicles using two-lane highways cannot be obtained based on present data, but that the impact of 25 m vehicles relative to 23 m vehicles has been found to be relatively minor.

Due to the increased weight and cube limits, the MoU has reduced total exposure in terms of kilometres travelled per tonne of freight carried. Exhibit 15.16 presents nation-wide estimates of 1992 truck travel on the NHS, by vehicle type and operating conditions (i.e. loading characteristics), for the Pre-MoU and Post-MoU conditions. These figures indicate a net truck traffic reduction of 135 MVK annually (at 1992 traffic levels) as a result of the MoU. (These MVK estimates form part of the output of the truck traffic impacts component of this study, and are described more fully in Chapter 19 of this report). Therefore, to the extent that the accident rates (Acc/MVK) for the vehicle types affected by the MoU are same, the

[5] Transportation Association of Canada: ***The Effect of Vehicle Length on Traffic on Canadian Two-Lane Two-Way Roads,*** 1991.

EXHIBIT 15.16
MoU IMPACTS ON TRUCK TRAVEL (1992 MVK ON THE NHS)

Pre-MoU Truck Traffic on the NHS by Vehicle Type (1992 MVK)

Vehicle type	C	W	CW	P	E	ALL
S5	1644	89	174	1202	1006	4114
S6	340	140	310	192	286	1267
A7	110	14	81	94	140	439
B7	28	7	25	25	39	123
C7	5	6	9	6	13	40
A8	20	8	25	7	22	82
B8	53	25	40	40	43	201
C8	2	19	9	0	18	48
ALL	2202	308	674	1565	1567	6315

Post-MoU Truck Traffic on the NHS by Vehicle Type (1992 MVK)

	C	W	CW	P	E	ALL
S5	1659	71	153	1232	972	4087
S6	343	115	276	186	282	1202
A7	47	5	26	37	56	170
B7	37	8	21	30	41	137
C7	6	3	5	5	8	28
A8	18	8	32	8	21	87
B8	83	51	100	65	126	424
C8	1	14	8	2	19	44
ALL	2194	276	620	1565	1525	6180

Net change (1992 MVK) due to the MoU

	C	W	CW	P	E	ALL
S5	14.7	-17.9	-21.5	30.3	-33.1	-27.5
S6	3.5	-24.4	-34.0	-6.5	-3.8	-65.2
A7	-63.2	-9.3	-55.2	-56.4	-84.7	-268.6
B7	9.6	1.2	-4.0	5.2	2.2	14.1
C7	0.6	-2.8	-4.4	-1.3	-4.8	-12.6
A8	-2.1	-0.6	7.6	1.3	-1.0	5.1
B8	30.0	26.5	59.3	25.0	82.2	222.9
C8	-1.2	-4.4	-1.6	2.3	1.2	-3.7
ALL	-8.2	-31.8	-53.9	-0.0	-41.8	-135.6

Legend:

C : Trucks cubing out

W : Trucks weighting out

CW : Trucks cubing/weighting out

P : Trucks partially loaded

E : Empty Trucks

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safety impacts of the MoU per tonne of goods carried have been positive due to the reduced exposure.

While it is difficult to quantify the change in accident rates as a result of the MoU due to lack of reliable accident rate data for the various vehicle types at various operating conditions, the safety impacts can be assessed more broadly in a qualitative fashion based on the performance (i.e. handling and stability) characteristics of the various vehicle types. Therefore, this analysis appraises the safety impacts due to the MoU by reviewing key performance characteristics of the various vehicle types involved, in collaboration with the responses from industry interviews.

15.4.1 Key Performance Characteristics

The University of Michigan Transportation Institute (UMTRI) study (1983)[6] which led to the current MoU specifications on weights and dimensions, and the TAC study (1986)[7], concluded that three performance characteristics, namely rollover threshold, rearward amplification, and braking efficiency are most firmly related to accident involvement of heavy trucks. Following this, a 1989 study[8] conducted by UMTRI on Turner truck handling and stability properties for the Transportation Research Board (TRB) derived some typical relationships between these performance characteristics and fatal involvement rates of heavy trucks, using accident and exposure data on the U.S. Highways. The relationships are reproduced (in metric units) in Exhibit 15.17. While the absolute accident rates from these relationships are not fully applicable for this assessment, since they do not reflect the full range of vehicle types and operating conditions impacted by the MoU, the relationships are useful in making the following conclusions:

- Fatal rollover rates increase as rollover threshold decreases. At threshold values less than 0.44, the rate increase is relatively steeper.

- Fatal rearward-amplification-related accident rates increase significantly as rearward amplification increases over 1.6.

6 UMTRI; ***Influence of Size and Weight Variables on the Stability and Control Properties of Heavy Trucks,*** March 1983.

7 Roads and Transportation Association of Canada; ***The Influence of Weights and Dimensions on the Stability and Control of Heavy Trucks in Canada,*** July 1986.

8 Fancher et al.; ***Turner Truck Handling and Stability Properties Affecting Safety,*** July 1989.

- Fatal jackknife (i.e. trailer swing) accident rates increase with decreasing braking efficiencies.

In light of the above conclusions, and the change (net decrease) in truck traffic exposure levels due to the MoU, the impacts of the MoU on each of the three performance characteristics are discussed in the following sections.

15.4.1.1 Rollover Threshold

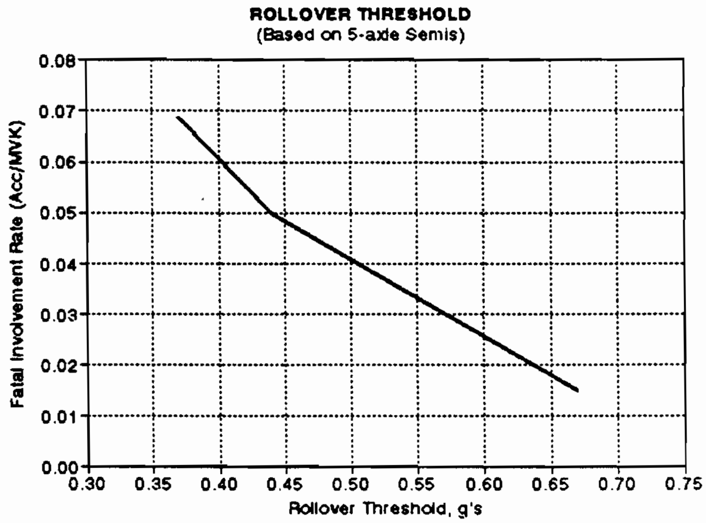
Rollover stability correlates to involvement in rollover accidents. The measure used is termed rollover threshold and is the maximum sustained level of lateral acceleration (in units of the gravitational acceleration constant, g) which the vehicle can tolerate without turning over. The most significant parameter that affects the rollover threshold of a vehicle is the height of its overall centre of gravity. The threshold is typically highest when the vehicle is empty, since the centre of gravity is at the lowest level possible. Therefore, empty vehicles are least prone to rollover. As the vehicle carries more and more freight its centre of gravity is raised, thereby reducing its threshold and increasing its potential to roll over. As a result, the greatest reductions in roll stability occur when the vehicle is fully loaded both in terms of weight and cube.

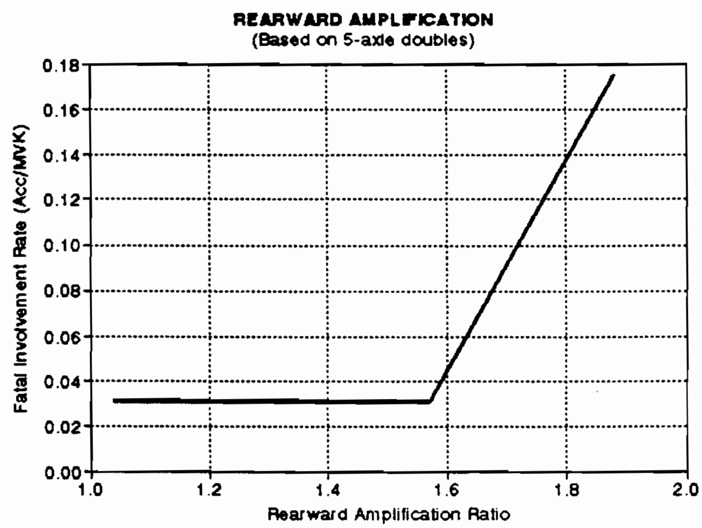
Based on average payload estimates compiled in this study, and assuming that the payloads are distributed uniformly across the trailer(s), the rollover thresholds for each vehicle type and operating condition were rated as "low", "medium" and "high". The ratings correspond to g value thresholds of less than 0.38; 0.38 to 0.45; and greater than 0.45 respectively. The ratings were compiled in discussion with the Commercial Vehicles Branch of the Ontario Ministry of Transportation. In general, they are based on the results of the UMTRI (1983) study.

The vehicle stability characteristics indicated in the UMTRI (1983) study are based on vehicle configurations and loading assumptions which were relevant only prior to the MoU. The specifications under the current MoU are not exactly the same as the ones analyzed in the UMTRI study. In addition, assuming similar payload distribution for the Pre-MoU and Post-MoU conditions poses a limitation in that variations in payload distribution affect the height of the centre of gravity and hence the rollover threshold. In view of these limitations, the ratings should be treated only as approximations.

Interpreting the definitions of "low" as 0.38, "medium" as 0.42, and "high" as 0.55, the rollover threshold estimates for each vehicle type and operating condition are shown in Exhibit 15.18. With these estimates, the aggregate rollover thresholds (i.e. individual threshold values

EXHIBIT 15.17
RELATIONSHIPS BETWEEN KEY PERFORMANCE CHARACTERISTICS AND FATAL INVOLVEMENT RATES





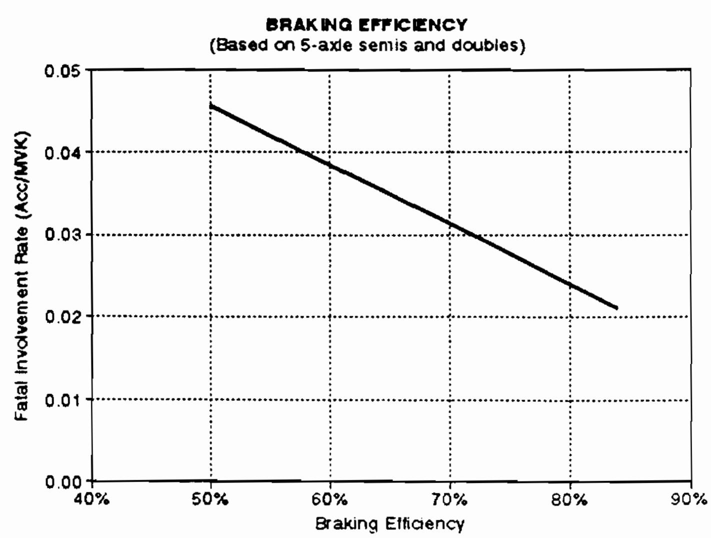


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EXHIBIT 15.18
ESTIMATED MoU IMPACTS ON ROLLOVER THRESHOLD

Pre-MoU Truck Traffic on the NHS by Vehicle Type (1992 MVK)

Vehicle type	C	W	CW	P	E	ALL
S5	1644	89	174	1202	1006	4114
S6	340	140	310	192	286	1267
A7	110	14	81	94	140	439
B7	28	7	25	25	39	123
C7	5	6	9	6	13	40
A8	20	8	25	7	22	82
B8	53	25	40	40	43	201
C8	2	19	9	0	18	48
ALL	2202	308	674	1565	1567	6315

Post-MoU Truck Traffic on the NHS by Vehicle Type (1992 MVK)

	C	W	CW	P	E	ALL
S5	1659	71	153	1232	972	4087
S6	343	115	276	186	282	1202
A7	47	5	26	37	56	170
B7	37	8	21	30	41	137
C7	6	3	5	5	8	28
A8	18	8	32	8	21	87
B8	83	51	100	65	126	424
C8	1	14	8	2	19	44
ALL	2194	276	620	1565	1525	6180

Rollover Threshold Estimates

	C	W	CW	P	E
S5	0.38	0.42	0.38	0.55	0.55
S6	0.38	0.42	0.38	0.42	0.55
A7	0.38	0.38	0.38	0.42	0.55
B7	0.38	0.38	0.38	0.42	0.55
C7	0.38	0.38	0.38	0.42	0.55
A8	0.38	0.42	0.38	0.42	0.55
B8	0.38	0.38	0.38	0.42	0.55
C8	0.38	0.38	0.38	0.42	0.55

Aggregate Rollover Threshold:

Pre-MoU:	**0.458**
Post-MoU:	**0.459**
Change:	**0.001**

Legend:

C : Trucks cubing out

W : Trucks weighting out

CW : Trucks cubing/weighting out

P : Trucks partially loaded

E : Empty Trucks

weighted by the respective MVK estimates) for both the Pre-MoU conditions and Post-MoU conditions are estimated as 0.458 and 0.459 respectively. This indicates a very small net improvement in rollover threshold due to the MoU at an aggregate level. The aggregate rollover threshold estimates are greater than 0.44 for both Pre-MoU and Post-MoU conditions, a value below which the UMTRI (1989) relationships show a steeper increase in fatal rollover accidents.

In summary, with respect to rollover stability, the ratings indicate that **the MoU has replaced 6,315 MVK of truck travel with 6,180 MVK, with virtually no net change in rollover threshold.** Therefore, with a net decrease in travel exposure at an almost constant rollover threshold, the analysis points to a decrease in the involvement of combination trucks in rollover accidents.

15.4.1.2 Rearward Amplification

The second key characteristic with respect to vehicle safety is rearward amplification which is the snaking action set up in multiple trailer units during rapid steering manoeuvres. It is defined as the ratio of the lateral acceleration of the rear trailer to that of the lead unit. Higher values of rearward amplification imply higher probabilities of rear trailer rollover. The term rearward amplification describes how much more severe the rollover impetus is at the last trailer than at the tractor. Tractor-semitrailers have rearward amplification close to 1.0; that is, the lateral acceleration of the trailer is nearly the same as that of the tractor during steering manoeuvres. Therefore, rearward amplification is a unique safety concern for multiple-unit trucks.

The UMTRI (1983) study concluded that as long as vehicles are loaded in a uniform fashion, the distinctions in rearward amplification ratio from one vehicle configuration to another will be determined simply by the length and articulation factors. Rearward amplification generally improves (decreases) with increase in vehicle length. In this respect, the increase in vehicle length from 23 m to 25 m due to the MoU has decreased the average rearward amplification characteristics of double combination trucks. Increasing the number of articulation points increases rearward amplification of a combination vehicle. Longitudinal distance between the vehicle's overall centre of gravity and the towing hitch also plays a significant role in determining the magnitude of rearward amplification. However, the dimensions of the trailers for double combination trucks are restricted within a narrow range by the MoU requirements, and therefore this is considered insignificant with respect to MoU impacts. While increase in payload increases rearward amplification, the effect is considered insignificant.

Precise rearward amplification estimates are not available for the vehicle types most affected by the MoU. However, based on the results of simulations conducted by UMTRI (1983), the following rearward amplification ratios were compiled in discussion with the Commercial Vehicles Branch of the Ontario Ministry of Transportation:

Tractor-semitrailers	*1.0*
7 & 8 axle B/C trains	*1.5*
7 & 8 axle A-trains	*2.0*

Based on these estimates, the aggregate amplification ratios are estimated as 1.12 and 1.09 respectively for the Pre-MoU and Post-MoU conditions (Exhibit 15.19). This indicates a nearly neutral impact. In reality, the aggregate rearward amplification ratio for the Post-MoU is expected to be even lower since the analysis has been conservative in assuming the same rearward amplification ratios for double combination trucks in the pre-MoU and post-MoU cases, considering that vehicle lengths were increased as a result of the MoU. Based on the UMTRI (1989) relationships between rearward amplification and fatal involvement rates, it is worth noting that the aggregate ratios of about 1.1 are lower than 1.6, a value above which fatal involvement rates have been shown to increase significantly.

In summary, with respect to rearward amplification, the estimates indicate that **the MoU has replaced 6,315 MVK of truck travel with 6,180 MVK of truck travel, with very little net change in rearward amplification.** With a very small reduction (improvement) in aggregate rearward amplification and a reduction in travel exposure, the analysis suggests a reduction in the number of combination trucks involved in rearward-amplification-related accidents as a result of the MoU.

15.4.1.3 Braking Efficiency

Braking efficiency is a measure of the likelihood of wheel lockup of a vehicle during braking. It relates to vehicle controllability during brake applications, which depends on the probability that the wheels on one or more axles will lock, potentially leading to instability of the tractor or the dolly commonly known as jackknifing, or trailer swing. Technically, braking efficiency is defined as the ratio of the frictional force utilized by a truck during braking to the frictional force that could be developed under ideal braking.

An ideal value for braking efficiency is 100%. This is only achieved when the brake torque and the frictional torque are equal at each wheel. The truck brake systems are generally designed to provide balanced brake torque capacities under the fully loaded conditions. Therefore, full mobilization of the ideal frictional force is impossible. For this reason, empty or lightly loaded trucks typically have lower braking efficiencies than fully loaded ones. As braking efficiency decreases from 100%, the likelihood of wheel lock-up increases.

EXHIBIT 15.19
ESTIMATED MoU IMPACTS ON REARWARD AMPLIFICATION

Pre-MoU Truck Traffic on the NHS by Vehicle Type (1992 MVK)

Vehicle type	C	W	CW	P	E	ALL
S5	1644	89	174	1202	1006	4114
S6	340	140	310	192	286	1267
A7	110	14	81	94	140	439
B7	28	7	25	25	39	123
C7	5	6	9	6	13	40
A8	20	8	25	7	22	82
B8	53	25	40	40	43	201
C8	2	19	9	0	18	48
ALL	2202	308	674	1565	1567	6315

Post-MoU Truck Traffic on the NHS by Vehicle Type (1992 MVK)

	C	W	CW	P	E	ALL
S5	1659	71	153	1232	972	4087
S6	343	115	276	186	282	1202
A7	47	5	26	37	56	170
B7	37	8	21	30	41	137
C7	6	3	5	5	8	28
A8	18	8	32	8	21	87
B8	83	51	100	65	126	424
C8	1	14	8	2	19	44
ALL	2194	276	620	1565	1525	6180

Rearward Amplification Ratio Estimates

	C	W	CW	P	E
S5	1.0	1.0	1.0	1.0	1.0
S6	1.0	1.0	1.0	1.0	1.0
A7	2.0	2.0	2.0	2.0	2.0
B7	1.5	1.5	1.5	1.5	1.5
C7	1.5	1.5	1.5	1.5	1.5
A8	2.0	2.0	2.0	2.0	2.0
B8	1.5	1.5	1.5	1.5	1.5
C8	1.5	1.5	1.5	1.5	1.5

Aggregate Rearward Amplification:

Pre-MoU:	**1.12**
Post-MoU:	**1.09**
Change:	**-0.02**

Legend:

C : Trucks cubing out
W : Trucks weighting out
CW : Trucks cubing/weighting out
P : Trucks partially loaded
E : Empty Trucks

Estimates of braking efficiencies were obtained from the Commercial Vehicles Branch of the Ontario Ministry of Transportation, for each vehicle type and operating condition. Again, it should be noted that the estimates are based on the assumption that the payload arrangements of the MoU vehicles are similar to those defined in the TAC study (1986). Accordingly, braking efficiencies for the various payload conditions were interpolated from those published in that study.

Based on these estimates, the aggregate braking efficiencies are estimated as approximately 67% (Exhibit 15.20) for both the Pre-MoU and Post-MoU conditions. Therefore, braking efficiency also appears relatively unchanged at an aggregate level.

In summary, with respect to braking efficiency, the estimates compiled indicate that **the MoU has replaced 6,315 MVK of truck travel at 67.5% braking efficiency with 6,180 MVK at an aggregate braking efficiency of 67.3%.** Therefore, with a very small decrease in braking efficiency and a larger relative decrease in travel exposure, the analysis points to a decrease in the involvement of combination trucks in jackknife accidents.

EXHIBIT 15.20
ESTIMATED MoU IMPACTS ON BRAKING EFFICIENCY

Pre-MoU Truck Traffic on the NHS by Vehicle Type (1992 MVK)

Vehicle type	C	W	CW	P	E	ALL
S5	1644	89	174	1202	1006	4114
S6	340	140	310	192	286	1267
A7	110	14	81	94	140	439
B7	28	7	25	25	39	123
C7	5	6	9	6	13	40
A8	20	8	25	7	22	82
B8	53	25	40	40	43	201
C8	2	19	9	0	18	48
ALL	2202	308	674	1565	1567	6315

Post-MoU Truck Traffic on the NHS by Vehicle Type (1992 MVK)

	C	W	CW	P	E	ALL
S5	1659	71	153	1232	972	4087
S6	343	115	276	186	282	1202
A7	47	5	26	37	56	170
B7	37	8	21	30	41	137
C7	6	3	5	5	8	28
A8	18	8	32	8	21	87
B8	83	51	100	65	126	424
C8	1	14	8	2	19	44
ALL	2194	276	620	1565	1525	6180

Braking Efficiency Estimates

	C	W	CW	P	E
S5	69%	77%	76%	66%	57%
S6	75%	87%	86%	72%	57%
A7	71%	78%	78%	69%	57%
B7	68%	79%	78%	58%	42%
C7	70%	78%	70%	70%	57%
A8	63%	70%	70%	62%	52%
B8	70%	79%	78%	62%	57%
C8	66%	70%	70%	66%	52%

Aggregate Braking Efficiency:

Pre-MoU:	**67.5%**
Post-MoU:	**67.3%**
Change:	**-0.2%**

Legend:

C : Trucks cubing out
W : Trucks weighting out
CW : Trucks cubing/weighting out
P : Trucks partially loaded
E : Empty Trucks

16. COMPREHENSIVE IMPACTS MODEL

A number of model components were developed in order to assess the impact of the MoU on Canadian trucking operations and its associated infrastructure and safety. Together these can be considered to form a comprehensive impacts model; Exhibit 16.1 illustrates their interrelationships. The models fall into four major components:

- **Component 1: Truck Fleet Impacts.** This estimates the configuration mix, type of loading and distance travelled in selected years with and without the MoU.

- **Component 2: Truck Cost Impacts.** This estimates the truck operating costs for the scenarios considered above.

- **Component 3: Infrastructure Cost Impacts.** This estimates the changes in both the capital and maintenance costs of road and bridge infrastructure due to changes resulting from the MoU.

- **Component 4: Road Safety Impacts.** This estimates the impact on road safety as the result of the different volume and mix of truck configurations resulting from the MoU.

- **Component 5: Shipper Cost Impacts.** This estimates the impact on shipper costs of the changed truck mix due to the MoU.

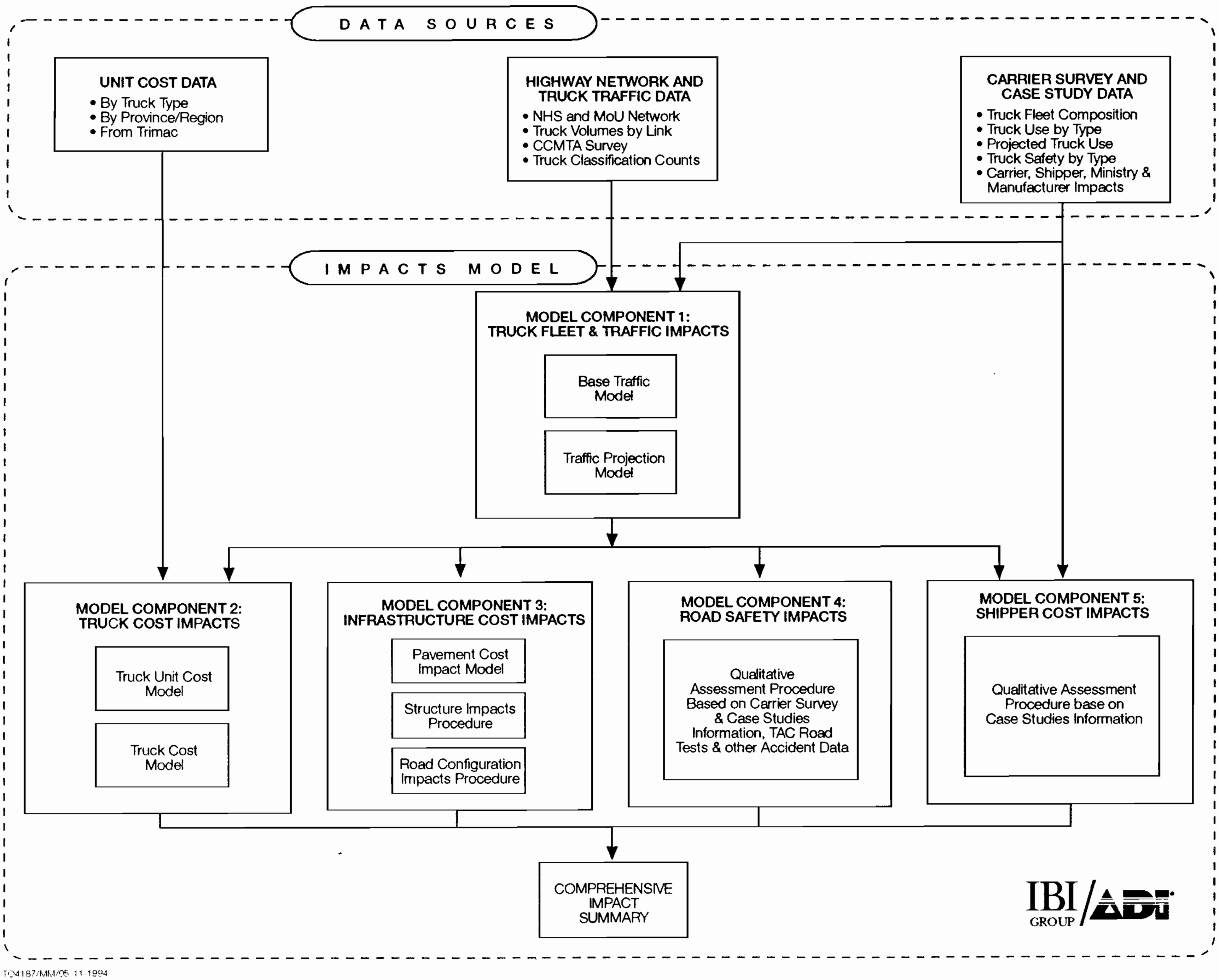
The word model is used here loosely. Due both to the fragmented data and the small sample sizes of some data that is available, some of the models are more akin to procedures or descriptions, rather than to structured processes which can be computerized.

Some facets of trucking have a significant impact on the changes resulting from the MoU. For example, shifts between configurations and whether the load cubes out, weights out or is a part load greatly affect the cost impacts. In order to capture these impacts and present them by province or region of the country requires a level of detail which makes it in some cases necessary to split the computations into a number of subcomponents.

The overall model is therefore a mixture of manual and computerized subcomponents as outlined below:

EXHIBIT 16.1

COMPREHENSIVE IMPACTS MODEL



- **Component 1** involves a manual procedure to expand vehicle-km by truck type from highway links for which this data exists to all designated highway links in each province for 1992 plus computerized models to break these vehicle-km volumes down into origin-destination volumes (among six Canadian regions plus one U.S. region) by truck type, with and without the MoU in effect, and project similar data for 1997 and 2002.

- **Component 2** involves a computerized model which calculates and applies relevant unit costs for each truck type and a second model which produces overall trucking costs for each of the six Canadian regions for 1992, 1997 and 2002 with and without the MoU and calculates the differences to produce estimated trucking cost savings in each Canadian region attributed to adoption of the MoU.

- **Component 3** is a manual procedure which estimates the impact of the different truck volumes by vehicle type resulting from the MoU on pavement wear and highway maintenance costs, bridge costs and road configuration costs based on calculations for typical highway sections and then calculates the change in infrastructure capital and operating costs in each region of Canada attributed to adoption of the MoU.

- **Component 4** is a manual procedure producing qualitative comments on truck safety impacts due to the changing truck type mix attributed to the MoU, based on comments received in the carrier case studies.

- **Component 5** is a manual assessment of the cost changes experienced by shippers as a result of changed truck rates and the need to install new terminal facilities resulting from the post-MoU trucking mix.

The remainder of this section describes the structure of the above five components in greater detail.

16.1 TRUCK FLEET IMPACTS

This component consists of two models. The first establishes the 1992 traffic levels and the second breaks these into O/D volumes with and without the MoU and projects them to 1997 and 2002, both with and without the MoU.

16.1.1 Base Traffic Model

The model which establishes the 1992 traffic levels is of the procedure type, as referred to above, rather than a computerized model. The information was assembled from the CCMTA roadside survey, from other roadside classification count stations, from the carrier survey responses and from provincial traffic counts and vehicle classifications. Information from the survey and traffic counts was extrapolated to the sections of the National Highway System which are in the vicinity of the survey stations. Using absolute numbers and ratios derived from the various data sources, two matrices detailing the likely traffic in 1992 were compiled, as described in Section 15.1.2 of Part II, and Chapter 18 of Part III. The process consisted of repeated data extractions and adjustments in a series of iterations, each determined by the adequacy of the results from the preceding one.

The first matrix consists of the vehicle kilometres and estimated payload for the ten provinces, two territories and Canada as a whole for eight truck configurations. The configurations are:

- semitrailers, 5 axles;
- semitrailers, 6 axles;
- A-trains, 7 axles;
- A-trains, 8 axles;
- B-trains, 7 axles;
- B-trains, 8 axles;
- C-trains, 7 axles;
- C-trains, 8 axles.

Vehicle characteristics, maximum gross vehicle weights (GVWs) as specified in the MoU, typical maximum payloads, and allowable regions of operation are summarized in Exhibit 16.2.

For each configuration the vehicle kilometres and payload were estimated for four load conditions:

- cubed out (haul exceeds 95% of cubic capacity);
- weighted out (haul exceeds 95% of regulated GVW limits);

EXHIBIT 16.2

TRUCK CONFIGURATIONS AND CHARACTERISTICS AS SPECIFIED IN THE MoU

Truck Type ID	Description	Number of Axles	Number of Trailers	Type of Connection	Max. GVW (kg)	Typical Max. Payload Weight (kg)	Max. Trailer Length (m)	Allowable Regions
ST-1	Straight Truck	2	0					All
ST-2	Straight Truck	3	0					All
ST-3	Straight Truck	4	0					All
...								
TST-1	Tractor Semi-trailer	3	1		23,700	9,000	16.15	All
TST-2	Tractor Semi-trailer	4	1		31,600	16,000	16.15	All
TST-3	Tractor Semi-trailer	5	1		39,500	23,000	16.15	All
TST-4	Tractor Semi-trailer	6	1		46,500	30,000	16.15	All
...								
AT-1	A-Train	5	2	A	39,700	20,000	18.5	All
AT-2	A-Train	6	2	A	47,600	27,000	18.5	All
AT-3	A-Train	7	2	A	53,500	32,000	18.5	All
AT-4	A-Train	8	2	A	53,500	32,000	18.5	All
...								
BT-1	B-Train	5	2	B	40,700	21,000	20	All
BT-2	B-Train	6	2	B	48,600	28,000	20	All
BT-3	B-Train	7	2	B	56,500	35,000	20	All
BT-4	B-Train	8	2	B	62,500	41,000	20	All
...								
CT-1	C-Train	5	2	C	39,700	20,000	18.5	All
CT-2	C-Train	6	2	C	47,600	27,000	18.5	All
CT-3	C-Train	7	2	C	53,500	32,000	18.5	All
CT-4	C-Train	8	2	C	53,500	32,000	18.5	All
...								
LCV-1	Long Combination Vehicle	8	2	A	53,500	32,000	32	Man., Sask., Alta.
LCV-2	Long Combination Vehicle	8	2	B	62,500	41,000	32	Man., Sask., Alta.
...								

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- cubed and weighted out (haul exceeds 95% of cubic and GVW limits);
- part load.

In addition to this the vehicle kilometres for empty trucks were also estimated.

The second matrix is similar to the one above, except that the traffic was divided into the major origin-destination (O/D) pairs. This was done because it is believed that the major savings due to the MoU are realized from interprovincial trips. In order to obtain this additional breakdown, scarcity of data dictated that the 12 provinces/territories be consolidated into six regions:

- Atlantic;
- Quebec;
- Ontario;
- Prairies;
- British Columbia;
- Territories.

The second traffic matrix does not include estimates of the average payload, because not enough data were available to calculate these for some of the O/D pairs.

These two traffic estimate matrices form the input into two other models of the comprehensive impacts model. One of these is the Unit Cost Model in Component 2, Truck Cost Impacts, and the other is the Traffic Projection Model in this component.

Examples of the data are shown in Appendix D.

16.1.2 Traffic Projection Model

This model was developed on a Lotus 1-2-3 spreadsheet and projects the basic 1992 traffic matrix developed as described above into corresponding matrices for 1992 without the MoU, and for the years 1997 and 2002, each with and without the MoU.

The difference between the projections for the traffic with and without the MoU is based on following:

- the limits for the weights and dimensions in force before and after the introduction of the MoU are determined for each region and each relevant inter-regional O/D pair;

- the configuration mix is based on the estimated and projected mix reported to us by the trucking companies on returned questionnaires. These mixes cover the years 1987, 1992, 1997 and 2002;

- the traffic volumes for the years 1997 and 2002 are based on the projected sizes of the truck fleet of the trucking companies responding to the carrier survey.

The projections use the above data while keeping the traffic characteristics for each O/D pair constant. For example the estimate for Atlantic to Ontario trips in Quebec in 1992 without the MoU maintains the same "cubic metre-km" (for cubed out loads), "GVW minus tare weight km" (for weighted out and cubed out/weighted out loads) and vehicle km (for part loads) as the base case of 1992 with MoU. In this manner new matrices were generated with the same breakdown as the base case. These are:

- 1992 without MoU;

- 1997 with MoU;

- 1997 without MoU;

- 2002 with MoU;

- 2002 without MoU.

These form part of the input into the Truck Cost Model in Component 2, Truck Cost Impacts.

Guidelines for using the Traffic Projection Model of the Truck Fleet Impacts Component are provided in Appendix G. Appendix E gives examples of the data.

16.2 TRUCK COST IMPACTS

This component consists two models:

- the **Truck Unit Cost Model**, which determines the costs per vehicle-kilometre and per ton-kilometre for a large selection of configurations and loadings;

- the **Truck Cost Model**, which applies the output from the Truck Unit Cost Model to the traffic matrices developed by the Traffic Projection Model in Component 1 in order to estimate the overall truck operation costs by region and Canada as a whole.

Both are Lotus 1-2-3 spreadsheet models.

16.2.1 Truck Unit Cost Model

The model uses truck operation unit costs and the payloads recorded in the CCMTA Survey. The following information and costs are assembled for each configuration in each province:

- estimates of annual operation, such as hours per day, days per week and weeks per year;
- estimates of load and unload times;
- estimate of average trip length;
- average speed;
- maximum allowable gross vehicle weight;
- trailer length;
- tractor tare weight;
- trailer tare weight;
- actual payload;
- tractor purchase price and expected economic life;
- trailer purchase price and expected economic life;
- annual costs of tractor and trailer registrations;
- insurance;
- terminal costs;
- driver hourly rate and wage burden;
- fuel price and fuel consumptions when full and empty;
- tire costs when full and empty for both tractor and trailer(s);

- maintenance costs for both tractor and trailer(s);
- overhead.

Based on this information both the cost per kilometre and per ton-kilometre are calculated. These unit costs can be obtained for any trailer length and GVW for the configurations listed in Section 16.1.1.

It must be recognized that the use of such unit costs on a provincial basis would imply an accuracy which does not exist. For example trucks counted or surveyed in a province are not necessarily based in that province, so that many of the costs listed above are not incurred in that province nor would the driver be paid at that province's wage rate. The available data does not allow the separation of vehicles in a province by O/D pair **and** province of domicile of the trucking operation. In addition, such a breakdown would have been beyond the capacity of a Lotus spreadsheet. For these reasons we used unit costs averaged for Canada as a whole. We also averaged the unit costs within a configuration; for example we used an average cost for a 7 axle B-train with a GVW of 39,500 and 37,500 kg, respectively.

16.2.2 Truck Cost Model

The Truck Cost Model calculates overall truck costs from the cost per vehicle-kilometre estimated by the Truck Unit Cost Model and the traffic matrices produced by the Traffic Projection Model. The truck costs are calculated by O/D pair by region. Any combination of these can therefore be extracted from the results. For this study we list the costs by region. These costs are subject to the limitations mentioned above that all components of these costs are not necessarily incurred in that region.

Data examples from the Truck Cost Impacts Component are provided in Appendix E. Guidelines for its use are given in Appendix G.

16.3 INFRASTRUCTURE COST IMPACTS

As there were no systematic geometric upgrading requirements associated with the vehicle weights and dimensions regulations introduced by the MoU, algorithms (models) for this item were not required. The Provincial transportation Ministry case studies did identify some related costs such as upgraded scales at weigh stations.

With respect to bridges, impacts are based on detailed assessments conducted by the Provincial bridge engineers following procedures outlined by the Canadian Standards Association in the publication "Design of Highway Bridges".

The pavement impacts analysis model involves a set of analytical steps used to estimate potential "build later" savings as a result of the more "pavement friendly" truck configurations promoted by the MoU. The analysis is based on the data collected/compiled in Section 15.3.2. The general procedure is outlined in Exhibit 16.3 and briefly described below. The results are presented for the Prairie Provinces, where the pavement impacts are most significant. Detailed calculations are presented in Appendix F.3.

The average annual LEF's, representing the truck traffic loading on a typical pavement section over the NHS in the Prairies, were calculated using the average payload estimates and the corresponding LEF's. With about 2,751 LEF-MVK distributed annually over 6,407 kilometres of National Highway System in the Prairie Provinces, the average annual load is estimated as 429,336 LEF's. This represents the Post-MoU traffic level.

With the overall reduction in LEF's due to the MoU estimated as 3.4%, the Pre-MoU traffic level is estimated as 444,447 LEF's. Pavement life analysis for the twelve typical pavement structures, using the Ontario flexible pavement design procedures, indicates "build later" savings (i.e. additional pavement life due to the MoU) to be in the order of 1 to 2 months.

16.4 ROAD SAFETY IMPACTS

Due to lack of sufficient accident data for different truck types, and the short period of time since the implementation of the MoU, road safety impacts due to the MoU have not been quantified, nor have any recent accident trends emerged.

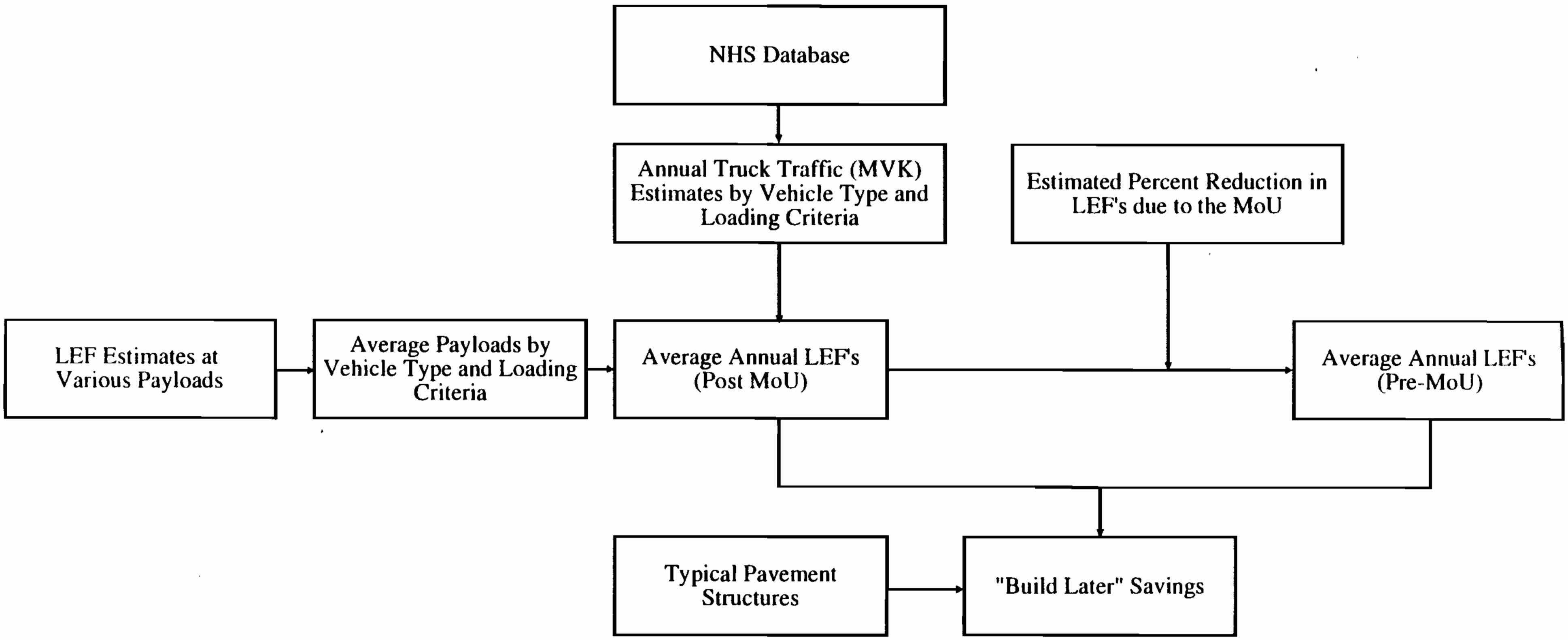
In Section 15.4, three different truck performance characteristics (rollover threshold, rearward amplification, and breaking efficiency) were examined in relationship to the involvement rates in fatal accidents. It was estimated that the changes in truck fleet composition have basically had a neutral effect on all three key performance characteristics. In light of the decreases in truck traffic per tonne of freight carried, due to the increased productivity allowed by the MoU, this suggests a neutral or slightly positive impact of the MoU on road safety. No quantification of this was possible based on the evidence currently available.

16.5 AGGREGATION OF IMPACTS

As described in Part III of this report, the overall impacts are evaluated by summing the various types of impacts.

EXHIBIT 16.3

PAVEMENT IMPACTS ANALYSIS MODEL



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TRANSPORTATION ASSOCIATION
OF CANADA

CANADIAN TRUCKING
RESEARCH INSTITUTE

IMPACTS OF CANADA'S HEAVY VEHICLE WEIGHTS AND DIMENSIONS RESEARCH AND INTERPROVINCIAL AGREEMENT

PART III: STUDY FINDINGS AND CONCLUSIONS

OCTOBER, 1994

IBI GROUP / ADI

Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement

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PART III: STUDY FINDINGS AND CONCLUSIONS

Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement - Part III: Study Findings and Conclusions

17. INTRODUCTION TO PART III

Part III of this report describes the application of the methods, data and models described in Parts I and II (with some modifications, as described in the following chapters) to produce the study results. Also included in this part of the report are an evaluation of the Heavy Vehicle Weights and Dimensions Research Program in comparison with net cost savings resulting from introduction of the MoU, a discussion of future directions of data collection and analyses based on insights drawn from this study, and a section on policy issues and conclusions.

The vehicle configuration impact results are presented in Chapter 18; that is the vehicle-km of travel by various truck types in and between the various regions, with and without the MoU, for the years 1992, 1997 and 2002.

Chapter 19 presents the trucking cost impact results, including the unit costs by truck type used in the calculations, the total trucking costs by region with and without the MoU and the estimated trucking cost savings as a result of the MoU in absolute terms and as the net present value for 1994.

Chapter 20 presents the results regarding other impacts of the MoU including impacts on infrastructure costs, impacts on shipper costs, and impacts on road safety.

Chapter 21 presents an aggregation of the impacts, drawing together the above findings to show the combined cost impacts with and without the MoU, and other more qualitative impacts where costs could not be estimated owing to data limitations. This chapter also contains a section on the reliability of results, which includes a discussion of the major sources of uncertainty and the implications of the uncertainty in interpreting the results.

Finally, Chapter 22 presents a synthesis and study conclusions, including the evaluation of the TAC Heavy Vehicle Weights and Dimensions Research Program effectiveness in light of the overall cost savings resulting from introduction of the MoU, a discussion of future data collection and analysis directions to build on the results of this study, and policy issues and conclusions based on the overall study results.

18. VEHICLE CONFIGURATION IMPACTS

In this section, the procedures used to estimate the effects of the MoU on truck configuration usage are explained, and the basic findings derived from these processes are discussed. Further details such as the inputs into to the Traffic Projection Model are contained in Appendix D.

The overall results of the impact estimating exercise are illustrated on Exhibit 18.1. The most evident change has been a shift from use of 7-axle A-trains (and C-trains) towards greater reliance on the 8-axle B-train. Small declines in the use of straight trucks and 5-axle semitrailers are expected to occur through to 2002, countered by increases in the 6-axle semitrailer. Further details on each of the regions in Canada are presented later in this chapter of the report.

18.1 VEHICLE-KM BY TRUCK TYPE

The 1991 estimates of vehicle-kilometres by truck type were prepared using the NHS and CCMTA databases in conjunction with some data from the carrier survey; these processes are described in Section 15.1 of Part II of this report. In order to estimate the changes that had occurred since the implementation of the MoU, the characteristics of truck use in 1987 had to be determined. In addition, future impacts to 1997 and 2002 were estimated based on trends indicated by the carrier survey.

18.1.1 Estimation of Regional Configuration Profiles

The NHS truck traffic estimates for 1991 were assumed to be applicable to 1992 due to negligible truck traffic growth in that period, as noted earlier. The estimates of NHS traffic were considered to provide the most reliable measures of the use of various truck configurations in 1992, as discussed in Part II.

The absolute numbers of truck configurations reported in use in the survey were initially used for the sixteen firms that provided responses for all four years (1987, 1992, 1997 and 2002). However, it was also decided to normalize the fleet sizes to reduce the influence of two or three of the larger trucking firms on the resulting regional profiles; subsequently the normalized fleets approach was adopted because the profile matched the NHS traffic much more closely. Exhibit 18.2 compares the fleet composition profiles and the NHS traffic breakdown for each region of Canada in 1992.

The regional fleet composition profiles were derived in the following manner:

- The twenty-nine survey responses were reduced to sixteen useable responses by eliminating those firms that did not

EXHIBIT 18.1
Truck Configuration Trends on the NHS

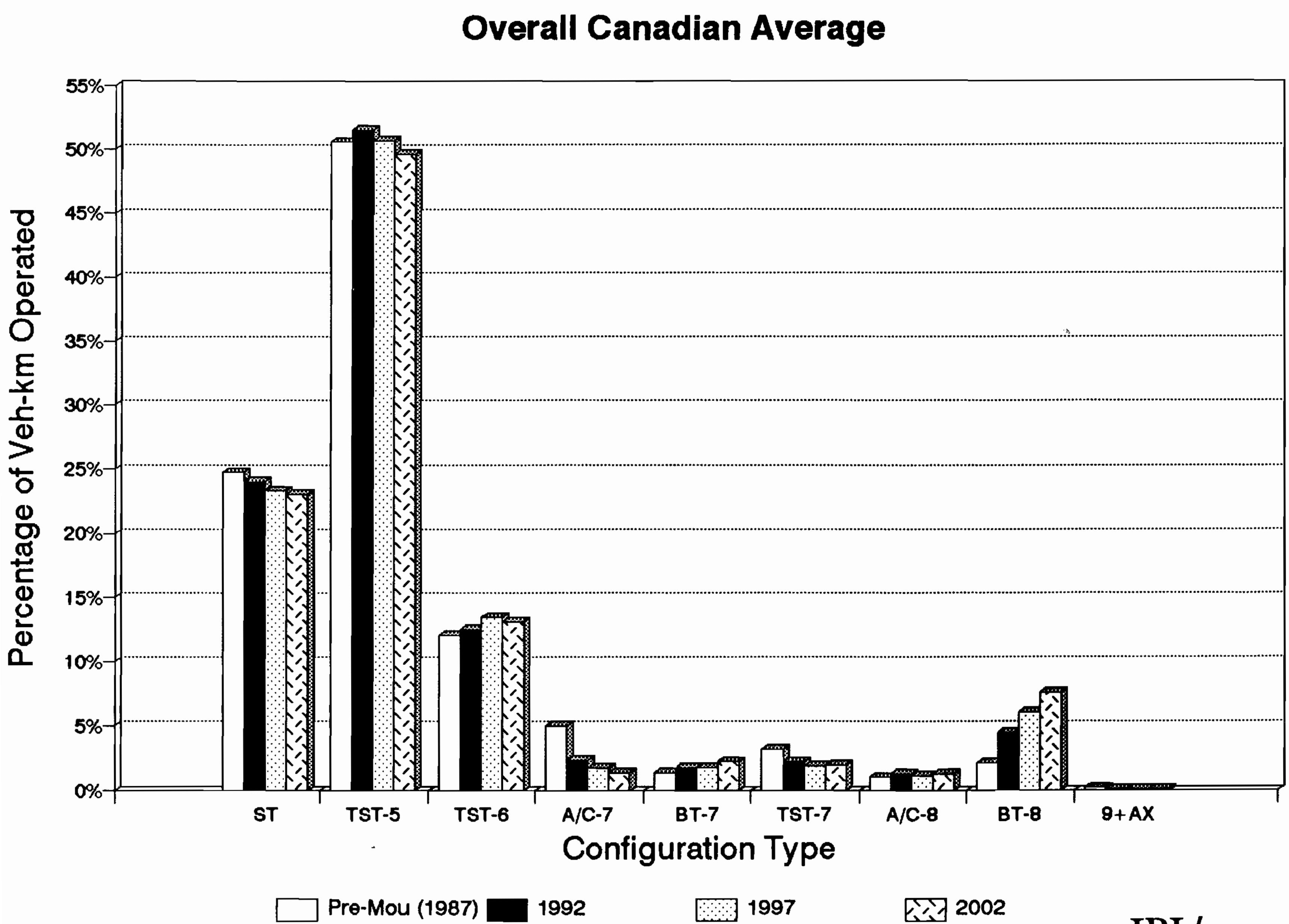

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EXHIBIT 18.2

COMPARISON OF 1992 NHS TRUCK TYPE PROFILES AND IBI CARRIER SURVEY ESTIMATES

REGION	ATLANTIC		QUEBEC		ONTARIO		PRAIRIES		BC		TERRITORIES		CANADA (1)	
TRUCK/ TRAILER	NHS RESULT	SURVEY 1992	NHS RESULT	SURVEY 1992	NHS RESULT	SURVEY 1992	NHS RESULT	SURVEY 1992	NHS RESULT	SURVEY 1992	NHS RESULT	SURVEY 1992	NHS RESULT	SURVEY 1992
STRAIGHT TRUCK	30.9%	0.2%	26.3%	20.3%	19.2%	15.7%	29.6%	2.8%	24.1%	2.1%	26.7%	7.8%	24.0%	12.4%
5-AXLE SEMIS	49.4%	49.3%	50.0%	47.9%	58.4%	60.0%	40.8%	41.1%	45.7%	29.2%	20.5%	55.2%	51.5%	50.5%
6-AXLE SEMIS	18.4%	46.1%	15.1%	27.4%	11.4%	14.6%	8.3%	21.9%	12.1%	43.5%	18.0%	12.7%	12.5%	23.9%
7-AXLE SEMIS	0.53%	0.00%	3.57%	2.30%	2.51%	6.40%	0.73%	8.40%	0.35%	0.00%	1.29%	0.00%	2.15%	4.62%
7-AXLE A-TRAIN	0.00%	0.00%	0.36%	0.40%	2.12%	0.90%	3.88%	6.50%	5.10%	8.60%	1.47%	8.50%	2.04%	2.28%
B-TRAIN	0.18%	0.00%	0.78%	0.10%	0.44%	0.40%	6.50%	3.30%	2.49%	4.20%	10.2%	12.6%	1.69%	1.13%
C-TRAIN	0.00%	0.00%	0.09%	0.00%	0.18%	0.20%	1.06%	1.60%	0.12%	0.20%	0.30%	1.60%	0.28%	0.37%
Subtotal	0.18%	0.00%	1.24%	0.50%	2.74%	1.50%	11.4%	11.4%	7.7%	13.0%	12.0%	22.7%	4.01%	3.77%
8-AXLE A-TRAIN	0.00%	0.30%	0.52%	1.10%	1.43%	0.50%	0.81%	4.20%	0.41%	0.50%	1.31%	0.00%	0.90%	1.23%
B-TRAIN	0.60%	4.10%	3.07%	0.50%	4.06%	1.30%	7.82%	7.30%	7.20%	8.80%	19.7%	1.60%	4.47%	2.91%
C-TRAIN	0.00%	0.00%	0.12%	0.00%	0.07%	0.00%	0.44%	2.80%	2.37%	2.90%	0.0%	0.00%	0.33%	0.69%
Subtotal	0.60%	4.40%	3.71%	1.60%	5.56%	1.80%	9.1%	14.3%	10.0%	12.2%	21.1%	1.60%	5.70%	4.83%
9-AXLE	0.03%	0.00%	0.16%	0.00%	0.13%	0.00%	0.06%	0.10%	0.05%	0.00%	0.47%	0.00%	0.11%	0.02%
TOTAL	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

NOTES: **NHS RESULT is an estimate of truck traffic on road links, while SURVEY 1992 is an estimate of fleet composition.**

NHS RESULT is the product of AADT, % trucks, and CCMTA data and is considered the most reliable estimate of truck vehicle-km on the National Highway System.

SURVEY 1992 is a measurement of the 1992 fleets interpreted from survey responses on vehicle types and regions of operation.

(1) This is a weighted average for the six regions, based on estimated NHS truck traffic.

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provide four different sets of fleet size estimates. Subsequently, the information provided by each firm on its regions of operation and the composition of its fleet was assembled for each year. The regions of operation in 1992 were carried forward to 1997 and 2002, as there was no way to estimate future changes in the markets served by each firm. Where necessary, the information given on markets for 1992 was also used for 1987.

- The percentage, for each firm, that each configuration formed of the entire truck and trailer fleet (excluding tractors) was calculated for each year.

- In each region, the company percentages (for each configuration) were factored according to the approximate proportion of business that company would represent, if all companies were the same size. (e.g. Carrier A has 5% of its business in B.C., and summing all such percentages across the carrier sample - regardless of size - yields a result of 125%, or 1.25 "fleets" of trucks. Carrier A would then represent 5/125 or 4% of the business in B.C. This 4% acts as a weight for the results of Carrier A, when producing an average percentage for each configuration in B.C.) This replaces the earlier method of simply summing the vehicles from each company and distributing them across the country according to market information.

18.1.2 Estimation of NHS Traffic Profiles (1987-2002)

The major differences shown in Exhibit 18.2 between the NHS profiles and the carrier survey data were the low percentage of straight trucks in the survey and the high percentage of 6-axle semitrailers. This is not really surprising, given that the survey respondents were primarily inter-provincial carriers that would not use a large percentage of straight trucks (generally used for short-distance hauls). Also, the survey candidates were selected partly on the basis that they would be most affected by the MoU, hence the exaggerated percentages of 6-axle semis.

The comparison between the survey results and the NHS traffic profile was used to produce factors that could be applied to the survey results for other years. In effect, the NHS traffic profile was used as a control for 1992, and the other years (1987, 1997 and 2002) were varied according to the changes reported in the survey. In brief, the fractions of the 5- to 8-axle configurations reported in the survey were multiplied by the 1992 ratio of the NHS percentage to the Carrier Survey percentage for the year in question. This produced new fractions for each configuration. The 1992 NHS fractions of 9-axle trucks and single-unit trucks were carried forward without change (they were not expected to change due to the MoU; this has been supported by the carrier survey), and all of these provisional estimates were normalized such that the fractions added to 100%. More detail is provided in Appendix D. This analysis was aggregated to the regional level due to the fact that the forecast information could not be produced at the provincial level of detail; vehicle-kilometre information for the four Atlantic Provinces were aggregated as were the data for the three Prairie Provinces and for the two territories. Appendix D provides breakdowns of the vehicle-kilometres by region, subdivided according to the five basic haul categories (i.e. cube-out, weight-out, etc.) for 1992. The overall results of this procedure are illustrated on Exhibit 18.3.

The survey indicated a surprisingly high percentage of trailers over 14.65 m (48 feet). It is possible that some of the firms may have misinterpreted this survey question. It is also possible that the fleet did include many of the longer trailers purchased in anticipation of changes in regulations to permit these vehicles in Eastern Canada. It is likely that the estimates of improved productivity in Chapter 19 would have been higher, given better information about the uptake of longer semitrailers. It is recommended that future roadside surveys incorporate the measurement of trailer box length so that this question can be examined in more detail.

18.1.3 Vehicle Use Impacts

Exhibit 18.3 illustrates the observed and expected changes in truck fleets for the six regions from 1987 (estimated as described above) to 1992. Many of the expected truck fleet impacts based on the carrier survey and the case studies were discussed in Part II, but these regional truck configuration profiles merit further comment, as follows:

- The most significant impact in Atlantic Canada was a shift from 5-axle semitrailers to 6-axle semitrailers. Small increases also took place in the use of 8-axle B-trains.

- The information gathered on Quebec did not reveal major consistent shifts between configurations except for a decrease in single-unit trucks and increases in 6-axle semitrailers. There was also some indication of a gradual increase in the use of 53 foot semitrailers; this may understate the future impact, given that Quebec has recently decided to recognize that length of trailer.

- In Ontario, shifts from 6-axle semitrailers back to the 5-axle variety were revealed. This may be a function of greater

EXHIBIT 18.3 (1/6)
Truck Configuration Trends on the NHS

Atlantic Provinces

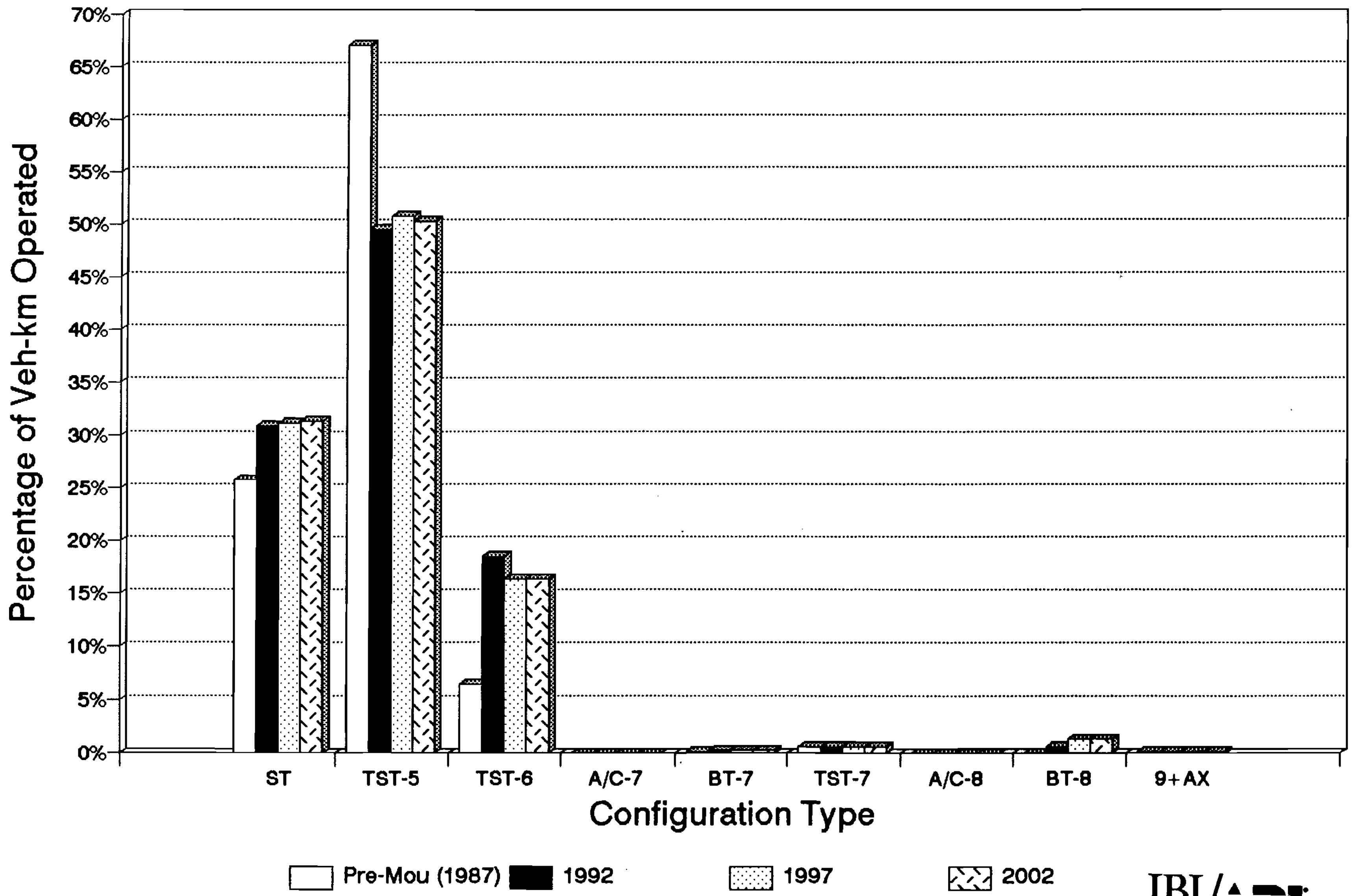

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EXHIBIT 18.3 (2/6)
Truck Configuration Trends on the NHS

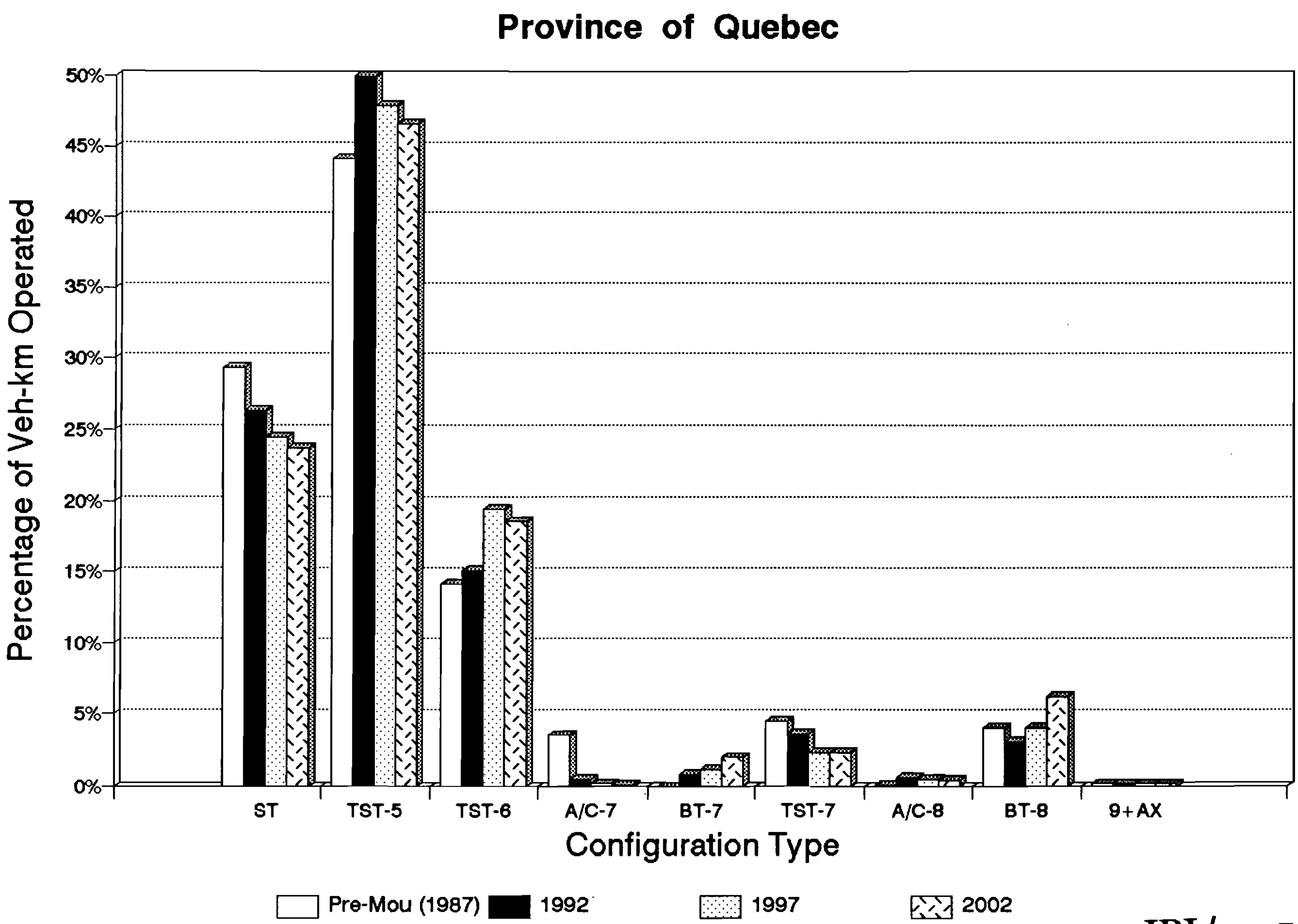

EXHIBIT 18.3 (3/6)
Truck Configuration Trends on the NHS

Province of Ontario

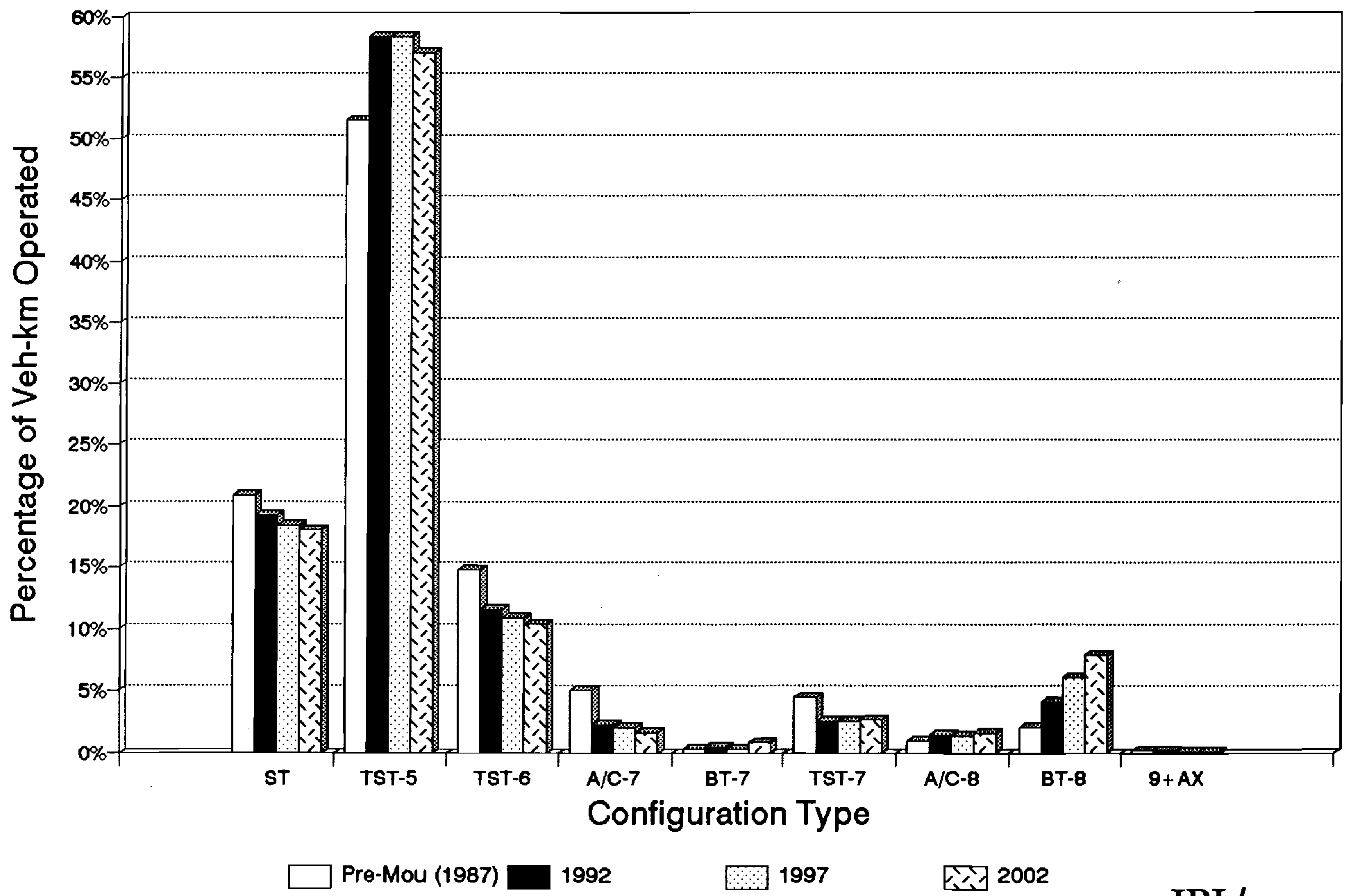

EXHIBIT 18.3 (4/6)
Truck Configuration Trends on the NHS

Prairie Provinces

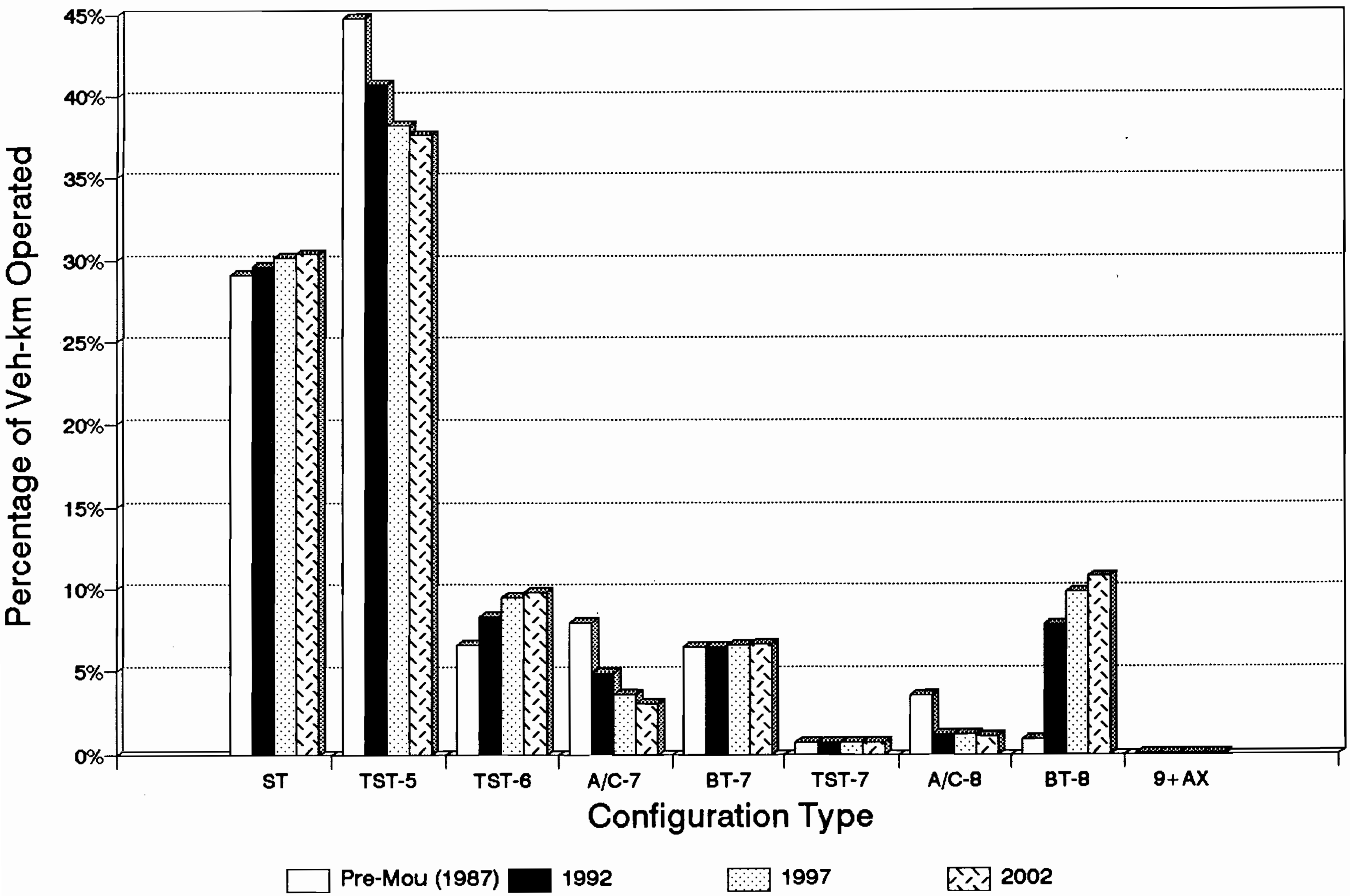

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EXHIBIT 18.3 (5/6)
Truck Configuration Trends on the NHS

Province of British Columbia

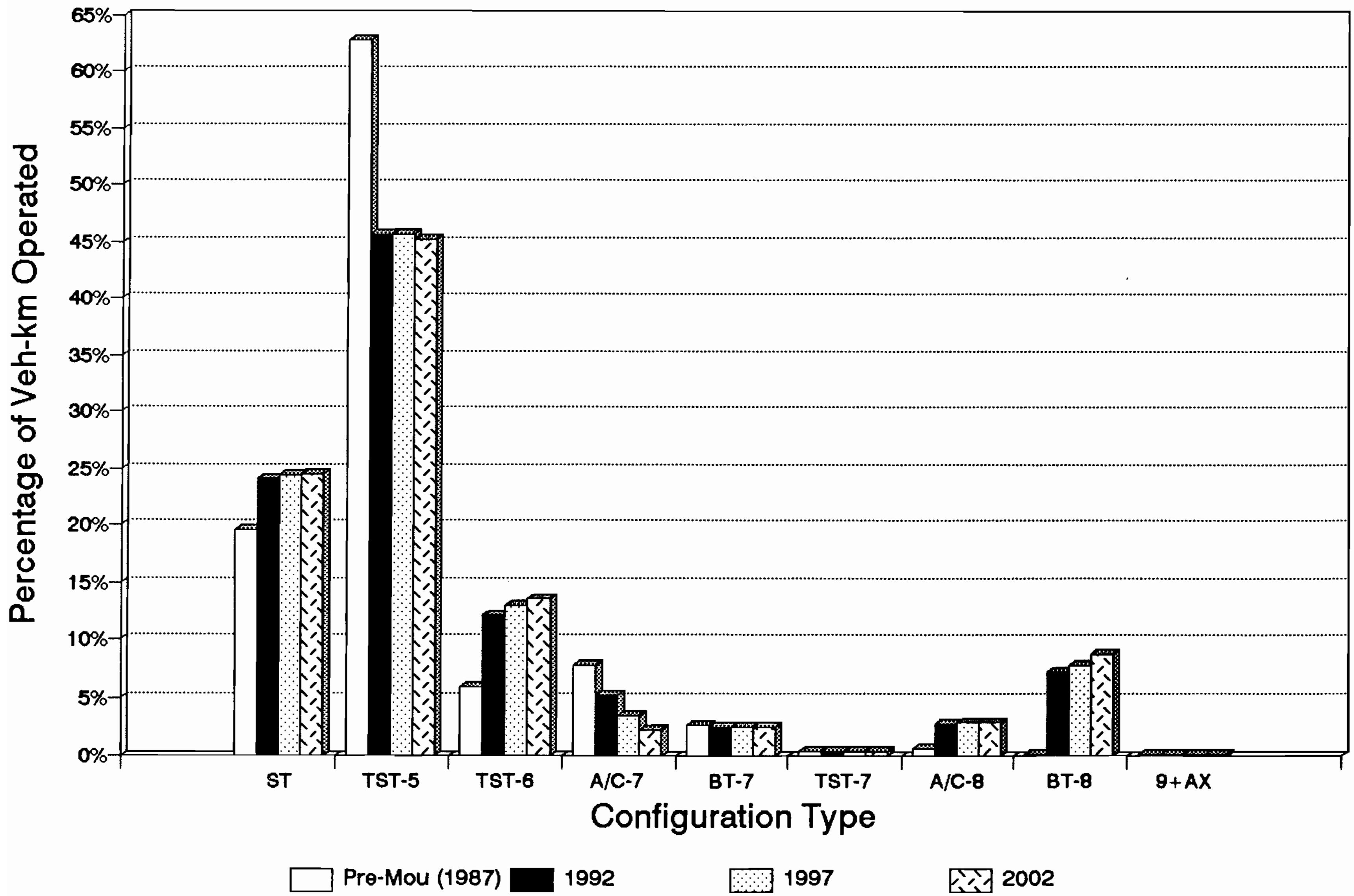

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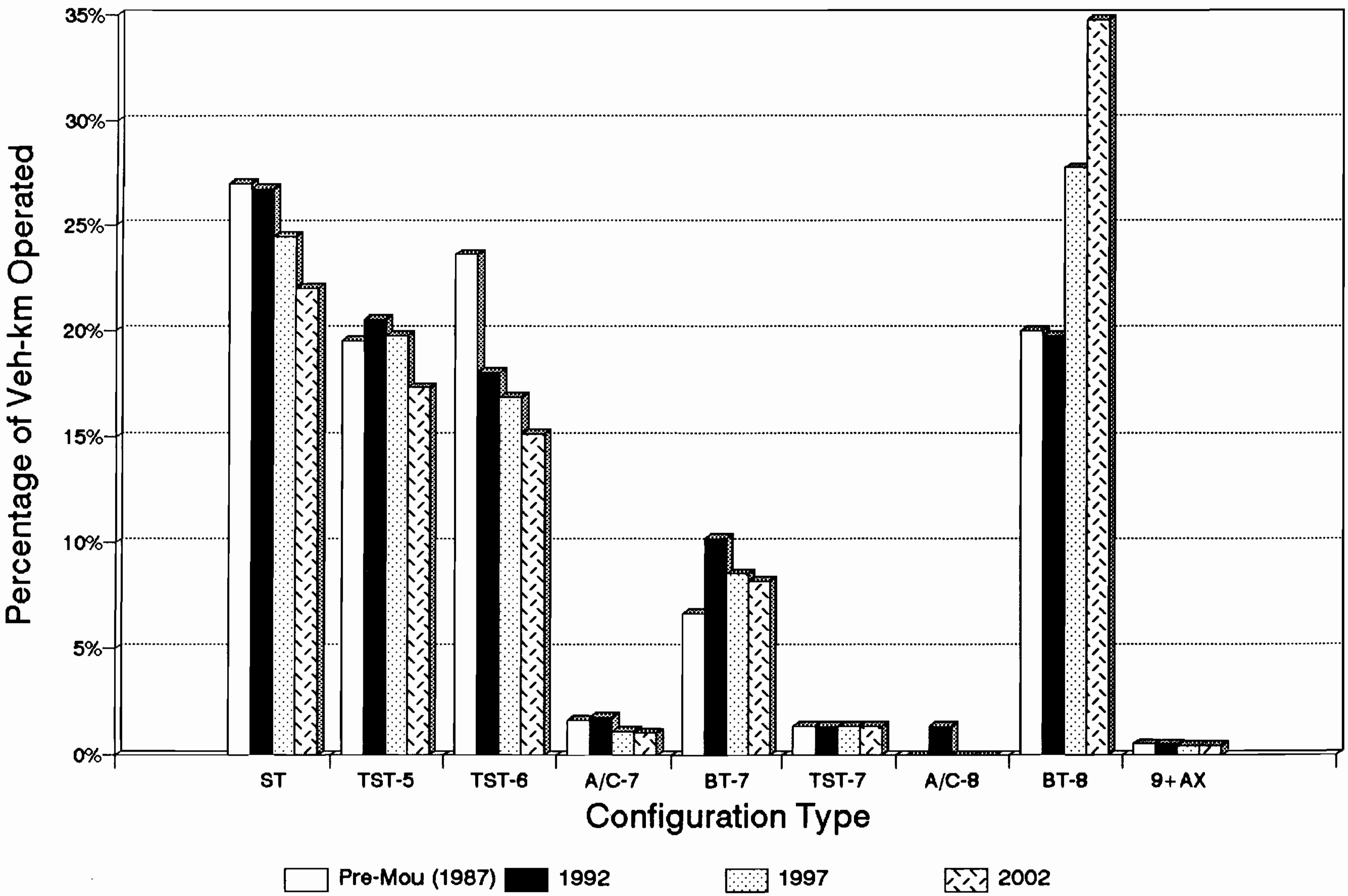
EXHIBIT 18.3 (6/6)
Truck Configuration Trends on the NHS

Yukon and Northwest Territories



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growth of the 5-axle semitrailer (particularly with a box length of 53 feet/16.2 metres) rather than actual abandonment of the 6-axle semi. Drops in A/C-trains (7-axles) and corresponding increases in 8-axle B-trains are more consistent with national trends.

- More noticeable shifts from A-trains to B-trains took place in the Prairie Provinces than in Eastern Canada. The most significant change was from 5-axle to 6-axle semitrailers, accompanied by some increase in 53 foot semitrailers. The increase in 53 foot semitrailers was expected to be the major impact in Western Canada, but the information in Exhibit 18.3 shows that the trend to more use of 8-axle B-trains was also significant.

- Trucking in British Columbia was affected to the greatest degree by the MoU. The usual shifts have taken place from 5-axle to 6-axle semitrailers, along with considerable uptake of the 8-axle B-train. One particularly important change was a dramatic increase in the use of 53 foot semitrailers.

- The configuration mix in the Yukon and North West Territories is markedly different from that in all other regions of Canada. Despite the fact that these forecasts were based on particularly limited data, there appear to be good reasons for the disparity between the territories and other regions. Much of the truck traffic is involved in carrying liquid and dry bulk materials, as the economies of the two territories are based to a significant extent on extraction of raw materials. The emerging dominance of the 8-axle B-train over all other configurations is a function of its past popularity and the country-wide trend of greater use of this configuration.

18.2 VEHICLE-KM BY MAJOR O-D PAIRS

Because the purpose of the MoU was to establish standards for truck size and weight limits across Canada, it was expected that most benefits would be experienced in the realm of inter-provincial trucking. Exhibit 18.4 indicates that there have been numerous changes to the provincial and territorial regulations that were in place prior to the MoU. These changes were meant to influence the choice of configuration by making certain truck types more attractive from a productivity point of view.

Obviously, the greatest barrier to inter-provincial trucking was the disparity between regulations of different provinces. This study divides Canada into six regions where the volume of traffic or similarity of

EXHIBIT 18.4

COMPARISON OF KEY TRUCK SIZE AND WEIGHT LIMITS IN CANADA (1993 VS. 1985)

LIMIT	MOU	NF	NS	NB	PE	QC	ON	MB	SK	AB	BC	YT	NT
Overall Combination Length (m)	23	23 *(21)*	23 *(21)*	SP *(21)*	23 *(21)*	25(SP) *(23)*	25 *(23)*	25 *(23)*	25 *(23)*	25 *(23)*	25 *(23)*	25 *(22.5)*	25 *(24.4)*
Max Semi-Trailer Length (m)	14.65	14.65 *(14.65)*	14.65 *(14.65)*	14.65 *(14.65)*	14.65 *(NR)*	15.5 *(15.5)*	16.2 *(14.65)*	16.2 *(NR)*	16.2 *(14.6)*	16.2 *(NR)*	16.2 *(14.65)*	13.5 *(13.5)*	NR *(NR)*
Maximum Width (m)	2.6	2.6 *(2.6)*	2.6 *(2.6)*	2.6 *(2.6)*	2.6 *(2.6)*	2.6 *(2.6)*	2.6 *(2.6)*	2.6 *(2.6)*	2.6 *(2.6)*	2.6 *(2.6)*	2.6 *(2.6)*	3.05 *(2.6)*	3.05 *(3.05)*
Maximum Height (m)	4.15	4.15 *(4.15)*	4.15 *(4.15)*	4.15 *(4.12)*	4.15 *(4.5)*	4.15 *(4.15)*	4.15 *(4.15)*	4.15 *(4.15)*	4.15 *(4.15)*	4.15 *(4.15)*	4.15 *(4.15)*	4.2 *(4.2)*	4.2 *(4.2)*
Max Single Axle Load (t)	9.1	9.1 *(9.0)*	9.5 *(9.0)*	9.0 *(9.0)*	9.1 *(9.0)*	10.0 *(10.0)*	10.0 *(10.0)*	9.1 *(9.1)*	9.1 *(9.1)*	9.1 *(9.1)*	9.1 *(9.1)*	10.0 *(10.0)*	9.1 *(8.13)*
Max Tandem Axle Load (t)	17.0	18.0 *(18.0)*	17.0 *(18.0)*	18.0 *(18.0)*	18.2 *(18.0)*	19.0 *(20.0)*	19.0 *(19.1)*	17.0 *(16.0)*	17.0 *(16.0)*	17.0 *(16.8)*	17.0 *(17.0)*	19.1 *(19.1)*	17.0 *(16.26)*
Max Tridem Axle Load (t)	24.0	27.0 *(27.0)*	28.5 *(27.0)*	22.5 *(27.0)*	27.0 *(27.0)*	25.0 *(30.0)*	24.8 *(28.6)*	24.0 *(16.0)*	24.0 *(16.0)*	24.0 *(16.8)*	24.0 *(17.0)*	24.0 *(28.6)*	24.0 *(16.26)*
MAXIMUM GVW:													
5-axle TST	39.5	40.5 *(39.5)*	42.5 *(39.5)*	40.5 *(39.5)*	40.7 *(39.7)*	45.5 *(48.5)*	45.4 *(47.2)*	39.5 *(37.5)*	39.5 *(37.5)*	39.5 *(39.0)*	39.5 *(39.5)*	44.0 *(43.2)*	39.5 *(36.6)*
6-axle TST	46.5	49.5 *(48.5)*	52.0 *(48.5)*	49.5 *(48.5)*	49.5 *(48.7)*	55.5 *(54.5)*	54.5 *(52.5)*	46.5 *(37.5)*	46.5 *(37.5)*	46.5 *(39.0)*	46.5 *(39.5)*	54.0 *(52.7)*	46.5 *(36.6)*
7-axle A-Train	53.5	53.5 *(52.5)*	53.5 *(50.0)*	SP *(SP)*	53.5 *(SP)*	57.5 *(57.5)*	61.7 *(63.3)*	53.5 *(55.7)*	53.5 *(53.5)*	53.5 *(53.5)*	53.5 *(57.7)*	63.5 *(SP)*	53.5 *(54.0)*
8-axle A-Train	53.5	53.5 *(52.5)*	54.0 *(50.0)*	SP *(SP)*	53.5 *(SP)*	57.5 *(57.5)*	62.5 *(63.5)*	53.5 *(56.5)*	53.5 *(53.5)*	53.5 *(53.5)*	53.5 *(63.5)*	63.5 *(SP)*	53.5 *(54.0)*
7-axle B-Train	56.5	56.5 *(52.5)*	56.5 *(50.0)*	SP *(56.5)*	56.5 *(SP)*	59.0 *(57.5)*	61.7 *(62.8)*	56.5 *(53.5)*	56.5 *(53.5)*	56.5 *(53.5)*	56.5 *(56.5)*	63.5 *(63.3)*	56.5 *(54.0)*
8-axle B-Train	62.5	62.5 *(52.5)*	62.5 *(50.0)*	SP *(SP)*	62.5 *(SP)*	62.5 *(57.5)*	63.5 *(63.5)*	62.5 *(53.5)*	62.5 *(53.5)*	62.5 *(53.5)*	63.5 *(63.5)*	63.5 *(63.3)*	62.5 *(54.0)*

NOTES: (XX.X) Values for 1985 are in brackets. Unbracketed values relate to Fall 1993.

Length restrictions exist also for the box length, axle spacings and spreads.

Steering axles have more restricted maximum loads.

SP : Special permit required for certain lengths or vehicle types.

NR : No restrictions in place.

Semitrailer lengths were increased to 16.2 m across the country late in 1993 and in early 1994.
These changes have not been incorporated into this table.

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regulations dictated, with the United States forming a seventh region. There was very good reason to believe that the truck use profiles by regional O/D pair would show dramatic differences; this was suggested by the preliminary O/D pair analysis using the carrier survey and has been borne out by the CCMTA and other roadside survey data for the NHS. Two basic reasons exist for differences in the truck types used between regions:

- The type of commodities (general freight, liquid bulk, dry bulk, other) being carried generally dictates what truck configuration would be most desirable from the carrier's standpoint.

- The regulations of the origin and destination jurisdictions, and those of any location between them, determine the limiting volumes and/or payloads carried.

18.2.1 Development of O/D Pair Profiles

The CCMTA roadside survey was the primary source of information for the O/D pair profiles, with modifications carried out based on estimates of truck traffic from the NHS database. The procedure used to develop the profiles required numerous steps, many of which involved manual adjustment using several different computer spreadsheets. In brief, here is the process that was developed:

- Tabulations of the number of CCMTA interviews conducted in each province were prepared, based on the regional O/D pair and configuration type. All O/D pairs that were not logical and those that lacked interviews were deleted.

- All trucks that were not specifically identified (as discussed in Part II, Section 15.1.6) were distributed proportionally among the precise categories of trucks. (e.g. unspecified 7-axle tandems were reclassified as A-, B-, or C-trains, then miscellaneous 7-axle vehicles were redistributed to each type of tandem and to the 7-axle semitrailers, and so on.) The reason for doing so was to maintain the built-in proportions of each vehicle type for each major O/D pair, otherwise certain configurations would have been under-represented in the results.

- Each region was aggregated from the component provinces by weighting the number of trucks in the provincial tabulations by the estimated truck veh-km in each province.

This eliminated biases due to different sampling rates in each jurisdiction.

- The number of "weighted" interviews for each O/D pair in each region was determined and these figures were sorted to determine an acceptance criterion for O/D pairs. It was found that 26 pairs (of a potential 126 - 6 regions with 21 possible combinations each) had from over 100 up to more than 5,000 representative interviews in the CCMTA survey. No pairs had between 87 and 134 interviews, thus it was decided not to consider the O/D's with fewer than 134 interviews; those with less information than that would be highly prone to error if treated as individual O/D movements. All minor pairs in a particular region were therefore treated as "other" truck traffic and analyzed together.

- The CCMTA major O/D pair profiles for each region were compared with the estimated vehicle-kilometres of truck traffic on the NHS in 1992. The surveyed percentages for each configuration were factored by the ratio of the percentage in the NHS breakdown to the overall regional CCMTA percentage for that configuration. The results for each O/D pair were then normalized to add to 100%.

- The O/D pair profiles for each region were converted into provisional estimates of veh-km, then refined such that the O/D pairs (including "other" O/D's) added up to the regional total, for each configuration.

- The O/D pair distances for each of the configurations of interest (5- to 8-axle trucks, excluding 7-axle semis), were subdivided according to the usage category (cube-out, weigh-out, etc.), based on regional distributions for each of the configurations derived from the CCMTA database. This 1992 O/D pair information was then passed to the Traffic Projection Model, to be used in conjunction with the estimates of truck configuration usage in different years, described in Section 18.1.

18.2.2 Discussion of Results

The profiles of truck traffic, by configuration, for the major regional O/D pairs are presented in Exhibit 18.5. The first page of the exhibit presents estimates of vehicle kilometres operated in 1992, whereas the second provides the profiles in the form of percentages. The absolute estimates under-represent the amount of intra-regional traffic; this is

EXHIBIT 18.5 (1/2)

Truck Configuration Profiles : Major Origin – Destination Pairs

(Millions of veh–km on the NHS)

REGION & PAIR	ST	TST 5	TST 6	TST 7	AT 7	BT 7	CT 7	AT 8	BT 8	CT 8	9+AX	TOTAL
(1) ATLANTIC	203.9	326.3	121.3	3.5	0.0	1.2	0.0	0.0	3.9	0.0	0.2	660.3
1–1	150.1	194.6	64.5	1.2	0.0	0.7	0.0	0.0	3.0	0.0	0.1	414.3
1–2	26.1	63.3	36.9	1.7	0.0	0.5	0.0	0.0	0.9	0.0	0.0	129.4
1–3	14.0	45.2	15.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.5
1–7	12.1	19.6	3.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.5
OTHER	1.6	3.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.6
(2) QUEBEC	558.6	1,060.3	319.5	75.8	7.7	16.6	1.9	11.0	65.2	2.6	3.3	2,122.5
1–2	27.3	111.6	40.6	1.1	0.0	0.0	0.7	0.6	5.2	0.0	0.2	187.2
1–3	20.4	65.9	37.0	1.0	0.0	0.4	0.0	0.0	2.1	0.0	0.1	126.9
2–2	169.9	204.8	78.6	10.8	1.8	3.5	0.3	4.0	7.9	0.5	1.0	483.1
2–3	312.0	509.6	143.5	60.8	3.2	9.6	1.0	4.7	44.7	2.1	1.8	1,093.0
2–7	14.2	122.4	11.0	1.6	1.1	1.2	0.0	1.6	3.7	0.0	0.1	156.9
OTHER	14.9	46.0	8.8	0.5	1.6	1.9	0.0	0.0	1.5	0.0	0.1	75.4
(3) ONTARIO	675.9	2,056.5	403.1	88.3	74.6	15.4	6.5	50.5	142.9	2.3	4.6	3,520.7
2–3	372.7	1,007.7	201.2	62.1	3.7	4.7	0.0	18.3	49.1	0.0	2.5	1,722.0
2–4	4.2	68.4	26.9	0.9	5.1	3.5	0.0	8.8	5.9	0.3	0.0	123.9
2–7	18.1	165.8	6.7	0.9	0.0	0.0	0.0	4.6	6.3	0.0	0.1	202.5
3–3	158.2	321.9	70.6	13.6	11.7	4.0	3.7	0.0	30.5	0.8	1.1	616.0
3–4	53.2	301.2	58.9	5.9	54.1	3.1	2.8	17.2	46.7	1.2	0.4	544.8
OTHER	69.5	191.6	38.9	5.0	0.0	0.2	0.0	1.6	4.4	0.0	0.5	311.6
(4) PRAIRIES	399.4	550.6	112.0	9.8	52.3	87.7	14.3	11.0	105.5	5.9	0.8	1,349.2
2–4	2.8	10.6	8.1	0.1	0.2	0.7	0.0	0.2	0.5	0.0	0.0	23.1
3–4	19.8	44.3	10.2	0.3	0.9	3.6	0.0	0.0	4.8	0.0	0.0	84.0
3–5	6.0	18.1	3.3	0.2	0.6	3.3	0.1	0.0	2.8	0.0	0.0	34.5
4–4	295.7	342.8	67.0	7.6	34.4	57.4	8.8	6.6	72.6	4.2	0.6	897.7
4–5	14.7	46.8	12.7	0.2	11.9	15.6	4.0	0.9	15.1	0.8	0.0	122.7
4–7	43.6	68.3	4.1	1.3	2.9	2.5	0.5	2.5	0.5	0.0	0.1	126.3
OTHER	16.7	19.8	6.6	0.2	1.3	4.6	0.9	0.8	9.1	0.8	0.0	60.8
(5) B.C.	167.9	317.6	84.2	2.4	35.5	17.3	0.8	2.8	50.1	16.5	0.3	695.6
3–5	4.0	18.0	3.6	0.1	0.0	0.8	0.0	0.0	2.3	0.0	0.0	28.9
4–5	100.3	194.5	56.0	1.6	20.7	11.8	0.8	0.0	35.0	16.5	0.2	437.4
5–5	53.2	83.4	22.0	0.5	14.1	4.3	0.0	2.5	11.7	0.0	0.1	191.9
OTHER	10.4	21.8	2.6	0.1	0.7	0.4	0.0	0.3	1.1	0.0	0.0	37.4
(6) TERRITORIES	9.8	7.5	6.6	0.5	0.5	3.7	0.1	0.5	7.2	0.0	0.2	36.7
4–6	2.6	2.2	2.1	0.2	0.1	0.6	0.0	0.0	0.1	0.0	0.0	7.9
6–6	5.0	3.7	2.3	0.3	0.4	1.5	0.0	0.1	1.4	0.0	0.1	14.8
6–7	0.4	0.2	0.2	0.0	0.0	1.1	0.0	0.3	5.4	0.0	0.0	7.7
OTHER	1.7	1.4	2.1	0.0	0.0	0.6	0.0	0.1	0.3	0.0	0.0	6.3
CANADA	2,015.4	4,318.8	1,046.7	180.4	170.7	142.0	23.6	75.7	374.9	27.4	9.4	8,384.9

NOTES:

ALL TRAFFIC IS LISTED ACCORDING TO WHERE IT WAS RECORDED. THERE ARE MULTIPLE ENTRIES FOR SOME O/D PAIRS.

Example of O/D Pair labelling:

1–1 is within Atlantic Canada.

1–2 is Atlantic Canada to/from Quebec.

1–3 is Atlantic Canada to/from Ontario.

1–7 is Atlantic Canada to/from the United States.

OTHER refers to minor O/D pairs lacking enough information to be distiguished.

ALL REGIONS ARE NUMBERED IN THE TABLE, EXCEPT (7) UNITED STATES.

EXHIBIT 18.5 (2/2)

Truck Configuration Profiles : Major Origin – Destination Pairs

(Percentage of veh–km operated on the NHS)

REGION & PAIR	ST	TST 5	TST 6	TST 7	AT 7	BT 7	CT 7	AT 8	BT 8	CT 8	9+AX	TOTAL
(1) ATLANTIC	30.9%	49.4%	18.4%	0.5%		0.2%			0.6%		0.0%	100%
1–1	36.2%	47.0%	15.6%	0.3%		0.2%			0.7%		0.0%	100%
1–2	20.2%	48.9%	28.5%	1.3%		0.4%			0.7%		0.0%	100%
1–3	18.5%	59.9%	20.9%	0.7%							0.0%	100%
1–7	34.2%	55.2%	10.4%	0.2%							0.0%	100%
OTHER	29.0%	63.7%	7.3%	0.0%		0.0%					0.0%	100%
(2) QUEBEC	26.3%	50.0%	15.1%	3.6%	0.4%	0.8%	0.1%	0.5%	3.1%	0.1%	0.2%	100%
1–2	14.6%	59.6%	21.7%	0.6%			0.3%	0.3%	2.8%		0.1%	100%
1–3	16.0%	51.9%	29.2%	0.8%		0.3%			1.7%		0.1%	100%
2–2	35.2%	42.4%	16.3%	2.2%	0.4%	0.7%	0.1%	0.8%	1.6%	0.1%	0.2%	100%
2–3	28.5%	46.6%	13.1%	5.6%	0.3%	0.9%	0.1%	0.4%	4.1%	0.2%	0.2%	100%
2–7	9.0%	78.0%	7.0%	1.0%	0.7%	0.8%		1.0%	2.4%		0.1%	100%
OTHER	19.8%	61.0%	11.7%	0.7%	2.2%	2.5%	0.0%	0.0%	2.0%	0.0%	0.1%	100%
(3) ONTARIO	19.2%	58.4%	11.4%	2.5%	2.1%	0.4%	0.2%	1.4%	4.1%	0.1%	0.1%	100%
2–3	21.6%	58.5%	11.7%	3.6%	0.2%	0.3%		1.1%	2.8%		0.1%	100%
2–4	3.4%	55.2%	21.7%	0.7%	4.1%	2.8%		7.1%	4.8%	0.3%	0.0%	100%
2–7	9.0%	81.9%	3.3%	0.4%				2.3%	3.1%		0.1%	100%
3–3	25.7%	52.3%	11.5%	2.2%	1.9%	0.6%	0.6%		5.0%	0.1%	0.2%	100%
3–4	9.8%	55.3%	10.8%	1.1%	9.9%	0.6%	0.5%	3.2%	8.6%	0.2%	0.1%	100%
OTHER	22.3%	61.5%	12.5%	1.6%		0.1%		0.5%	1.4%	0.0%	0.2%	100%
(4) PRAIRIES	29.6%	40.8%	8.3%	0.7%	3.9%	6.5%	1.1%	0.8%	7.8%	0.4%	0.1%	100%
2–4	12.0%	45.6%	35.0%	0.5%	1.0%	3.0%		0.7%	2.1%		0.0%	100%
3–4	23.6%	52.7%	12.2%	0.3%	1.1%	4.3%			5.7%		0.0%	100%
3–5	17.5%	52.4%	9.7%	0.5%	1.8%	9.6%	0.3%		8.0%		0.0%	100%
4–4	32.9%	38.2%	7.5%	0.8%	3.8%	6.4%	1.0%	0.7%	8.1%	0.5%	0.1%	100%
4–5	12.0%	38.1%	10.3%	0.2%	9.7%	12.7%	3.3%	0.7%	12.3%	0.7%	0.0%	100%
4–7	34.5%	54.1%	3.3%	1.0%	2.3%	2.0%	0.4%	2.0%	0.4%		0.1%	100%
OTHER	27.4%	32.5%	10.8%	0.3%	2.2%	7.5%	1.4%	1.4%	15.0%	1.4%	0.1%	100%
(5) B.C.	24.1%	45.7%	12.1%	0.3%	5.1%	2.5%	0.1%	0.4%	7.2%	2.4%	0.0%	100%
3–5	14.0%	62.2%	12.5%	0.5%		2.8%			8.0%		0.0%	100%
4–5	22.9%	44.5%	12.8%	0.4%	4.7%	2.7%	0.2%		8.0%	3.8%	0.0%	100%
5–5	27.7%	43.5%	11.5%	0.3%	7.3%	2.2%		1.3%	6.1%		0.1%	100%
OTHER	27.7%	58.2%	7.0%	0.3%	1.9%	1.0%		0.8%	2.9%		0.1%	100%
(6) TERRITORIES	26.7%	20.5%	18.0%	1.3%	1.5%	10.2%	0.3%	1.3%	19.7%		0.5%	100%
4–6	33.4%	27.5%	26.2%	2.4%	1.6%	7.0%	0.3%		1.0%		0.6%	100%
6–6	33.7%	25.3%	15.3%	1.7%	2.8%	10.2%	0.3%	0.5%	9.8%		0.6%	100%
6–7	5.7%	3.2%	2.5%			14.1%	0.3%	4.2%	69.8%		0.1%	100%
OTHER	27.3%	21.8%	33.3%	0.5%		9.4%	0.3%	1.4%	5.6%		0.5%	100%
CANADA	24.0%	51.5%	12.5%	2.2%	2.0%	1.7%	0.3%	0.9%	4.5%	0.3%	0.1%	100%

NOTES:

ALL TRAFFIC IS LISTED ACCORDING TO WHERE IT WAS RECORDED. THERE ARE MULTIPLE ENTRIES FOR SOME O/D PAIRS.

Example of O/D Pair labelling:

1–1 is within Atlantic Canada.

1–2 is Atlantic Canada to/from Quebec.

1–3 is Atlantic Canada to/from Ontario.

1–7 is Atlantic Canada to/from the United States.

OTHER refers to minor O/D pairs lacking enough information to be distiguished.

ALL REGIONS ARE NUMBERED IN THE TABLE, EXCEPT (7) UNITED STATES.

carried over from the underestimation of intra-provincial traffic as indicated in Section 15.1.6 of Part II of this report. The major points to be made about these profiles include:

- Truck traffic to and from the United States is very predominantly composed of 5-axle semitrailers, more so than it is within Canada. The one exception to this occurs between the Territories and the United States.

- Intra-regional traffic always consists of an above average proportion of straight trucks, while use of 5-axle semitrailers is below average (except in the Territories).

- 6-axle semitrailers are particularly under-represented between the United States and Quebec, the Prairies, and the Territories.

- 7-axle semitrailers are the least significant type of tractor trailer, with most use concentrated within and between Quebec and Ontario.

- A-trains remain in fairly common use to and from the Prairies, and within British Columbia, compared with the national average.

- In Quebec, traffic to and from Ontario shows the greatest use of 8-axle B-trains. In Ontario, there is an even greater use of the B-train for movements to and from the Prairie Provinces. In Western Canada, this configuration accounts for approximately 7-8% of all truck traffic, with greatest use between British Columbia and the Prairies. A much smaller volume of B-train traffic also occurs between the Territories and the United States, but for that particular O/D pair, it accounts for over two-thirds of the truck traffic.

19. TRUCKING COST IMPACTS

This section presents the results obtained from the models described in Sections 16.2.1 and 16.2.2 in Part II of the report. Comments are then provided on the results and their implications.

19.1 TRUCKING UNIT COSTS

Exhibit 19.1 shows the trucking costs per vehicle-kilometre produced by the Truck Unit Cost Model for various configurations. Exhibit 16.2 shows the characteristics of the various configurations used in the development these unit costs. As described in Section 16.2 of this report, the cost data itself was derived from the Trimac Survey of Trucking Cost in 1992 conducted on behalf of Transport Canada. The calculations are based on observations of the actual payloads carried. The use of actual figures introduced some anomalies such as the unit costs of weighted out 6 axle tractor semitrailers (for weighted out and weighted/cubed out loads) bring slightly less than those for 5 axle tractor semitrailer combinations. This was caused by the average actual payloads for 6-axle tractor semitrailers, as reported in the CCMTA survey, being lower than those of the 5 axle tractor semitrailers; although unlikely this is possible and the generated unit costs shown were used.

The unit costs for the A-, B-, and C-trains are, with one exception, in a logical relationship to each other. The exception is that the cost for partly loaded 8 axle C-trains is less than that for 7-axle C-trains. Here again the observed actual average payload is less in the former case. This is a more credible situation than the one discussed above, as part loads on specific configurations could vary considerably.

19.2 TRUCKING COST TRENDS WITH AND WITHOUT THE MoU

Exhibit 19.2 summarizes the total truck operating costs as estimated by the Truck Cost Model for 1992, 1997 and 2002, with the MoU (the actual situation) and the total costs that would have been incurred without the MoU. The exhibit shows the costs for Canada and for each region for vehicles on the NHS. It should be noted that the costs cover only the configurations included in the study. The analysis excludes straight trucks, 7-axle semitrailers and combinations with nine axles or more.

For 1992 implementation of the MoU has resulted in an estimated truck operating cost saving of $145 million. For 1997 and 2002 four values for the annual savings are shown representing different growth rates in total trucking business. The carrier survey indicated an expected aggregate growth rate for the firms surveyed of approximately 6% per year but it was felt that this was too high for the total industry.

EXHIBIT 19.1

TRUCK OPERATING COSTS

PER VEHICLE KILOMETRE

(In 1992 Dollars)

Config.	Axles	c	w	cw	p	e
Semi	5	$1.05	$1.13	$1.13	$1.04	$1.00
Semi	6	$1.09	$1.14	$1.14	$1.07	$1.01
A-Train	7	$1.19	$1.24	$1.24	$1.17	$1.10
A-Train	8	$1.22	$1.28	$1.28	$1.15	$1.10
B-Train	7	$1.18	$1.25	$1.25	$1.18	$1.10
B-Train	8	$1.24	$1.30	$1.30	$1.20	$1.11
C-Train	7	$1.18	$1.24	$1.24	$1.18	$1.10
C-Train	8	$1.23	$1.27	$1.27	$1.14	$1.11

c = Cubed out load
w = Weighted out load
cw = Cubed and weighted out load
p = Part load
e = Empty haul

MAJOR ASSUMPTIONS:

- Annual km: Semi=209,000; A/C-Trains=202,000; B-Train=196,000.
- Economic life: Tractor=750,000 km or 20 years, Trailer=1,200,000 km or 20 years.
- Approximate hours of operation per year: Semi=2,790; A/C-Trains=2,700; B-Trains=2,600.
- Vehicle operation on paved roads.

Source: IBI Truck Cost Model
Truck configurations derived from Exhibit 16.2

A:\KMCOSTSN.WK1

EXHIBIT 19.2

ANNUAL TRUCKING COSTS AND SAVINGS DUE TO THE MoU

ON THE NATIONAL HIGHWAY SYSTEM - IN MILLIONS OF 1992 DOLLARS

		Average Annual Traffic Growth -2%			Average Annual Traffic Growth 0%			Average Annual traffic Growth 2%			Average Annual Traffic Growth 4%		
Year	Region	Cost with MoU[1]	Cost without MoU[2]	Savings[3]	Cost with MoU[1]	Cost without MoU[2]	Savings[3]	Cost with MoU[1]	Cost without MoU[2]	Savings[3]	Cost with MoU[1]	Cost without MoU[2]	Savings[3]
1992	Atlantic	$480.3	$483.8	$3.6	$480.3	$483.8	$3.6	$480.3	$483.8	$3.6	$480.3	$483.8	$3.6
	Quebec	$1,584.6	$1,600.4	$15.8	$1,584.6	$1,600.4	$15.8	$1,584.6	$1,600.4	$15.8	$1,584.6	$1,600.4	$15.8
	Ontario	$2,936.5	$2,994.9	$58.5	$2,936.5	$2,994.9	$58.5	$2,936.5	$2,994.9	$58.5	$2,936.5	$2,994.9	$58.5
	Prairies	$1,023.5	$1,062.7	$39.2	$1,023.5	$1,062.7	$39.2	$1,023.5	$1,062.7	$39.2	$1,023.5	$1,062.7	$39.2
	British Columbia	$569.4	$597.1	$27.8	$569.4	$597.1	$27.8	$569.4	$597.1	$27.8	$569.4	$597.1	$27.8
	Territories	$30.1	$30.5	$0.4	$30.1	$30.5	$0.4	$30.1	$30.5	$0.4	$30.1	$30.5	$0.4
	Canada	$6,624.3	$6,769.5	$145.2	$6,624.3	$6,769.5	$145.2	$6,624.3	$6,769.5	$145.2	$6,624.3	$6,769.5	$145.2
1997	Atlantic	$434.3	$437.3	$3.0	$480.5	$483.8	$3.4	$530.5	$534.2	$3.7	$584.6	$588.7	$4.1
	Quebec	$1,427.2	$1,446.6	$19.3	$1,579.0	$1,600.4	$21.4	$1,743.4	$1,767.0	$23.6	$1,921.2	$1,947.2	$26.0
	Ontario	$2,645.8	$2,707.1	$61.3	$2,927.1	$2,994.9	$67.8	$3,231.8	$3,306.7	$74.9	$3,561.4	$3,644.0	$82.5
	Prairies	$921.3	$960.6	$39.3	$1,019.3	$1,062.7	$43.4	$1,125.4	$1,173.3	$48.0	$1,240.1	$1,293.0	$52.9
	British Columbia	$513.1	$539.8	$26.7	$567.6	$597.1	$29.5	$626.7	$659.3	$32.6	$690.6	$726.5	$35.9
	Territories	$27.2	$27.6	$0.3	$30.1	$30.5	$0.4	$33.3	$33.7	$0.4	$36.7	$37.1	$0.5
	Canada	$5,969.0	$6,118.9	$149.9	$6,603.6	$6,769.5	$165.9	$7,291.0	$7,474.2	$183.2	$8,034.6	$8,236.4	$201.8
2002	Atlantic	$392.4	$395.3	$2.9	$480.3	$483.8	$3.5	$585.5	$589.8	$4.3	$710.9	$716.2	$5.2
	Quebec	$1,285.1	$1,307.7	$22.6	$1,572.8	$1,600.4	$27.6	$1,917.2	$1,950.8	$33.6	$2,328.0	$2,368.9	$40.9
	Ontario	$2,384.7	$2,447.2	$62.5	$2,918.5	$2,994.9	$76.5	$3,557.6	$3,650.8	$93.2	$4,319.9	$4,433.1	$113.2
	Prairies	$831.8	$868.3	$36.6	$1,017.9	$1,062.7	$44.8	$1,240.9	$1,295.4	$54.6	$1,506.8	$1,573.0	$66.3
	British Columbia	$462.4	$487.9	$25.5	$565.9	$597.1	$31.2	$689.9	$727.9	$38.0	$837.7	$883.9	$46.2
	Territories	$24.6	$24.9	$0.4	$30.1	$30.5	$0.4	$36.7	$37.2	$0.5	$44.5	$45.1	$0.6
	Canada	$5,381.0	$5,531.3	$150.4	$6,585.5	$6,769.5	$184.0	$8,027.7	$8,252.0	$224.3	$9,747.8	$10,020.2	$272.4

[1] Annual trucking costs based on estimates of traffic volume and fleet mix for the year shown.
[2] Annual trucking costs based on estimates of traffic volume for the year shown and fleet mix of 1987.
[3] Estimated annual savings in the year shown due to the MoU (difference between [1] and [2]).

Numbers do not necessarily add due to rounding.

Accordingly four annual growth rates in vehicle kilometres were investigated, -2%, 0%, 2% and 4%. In the following sections, we have used the figures that correspond to the 2% annual growth rate for examining potential total savings beyond 1992. The population growth rate in Canada is about 2%. In the past decade, the growth of the trucking industry has been somewhat greater than this figure but, to be conservative, the 2% growth rate has been assumed.

We believe that these estimates, though small in proportion to the total costs, represent real savings. Inaccuracies in traffic and unit cost estimates will to a great extent cancel each other out in the subtraction of the costs **with** the MoU from those **without** the MoU to obtain the savings estimates.

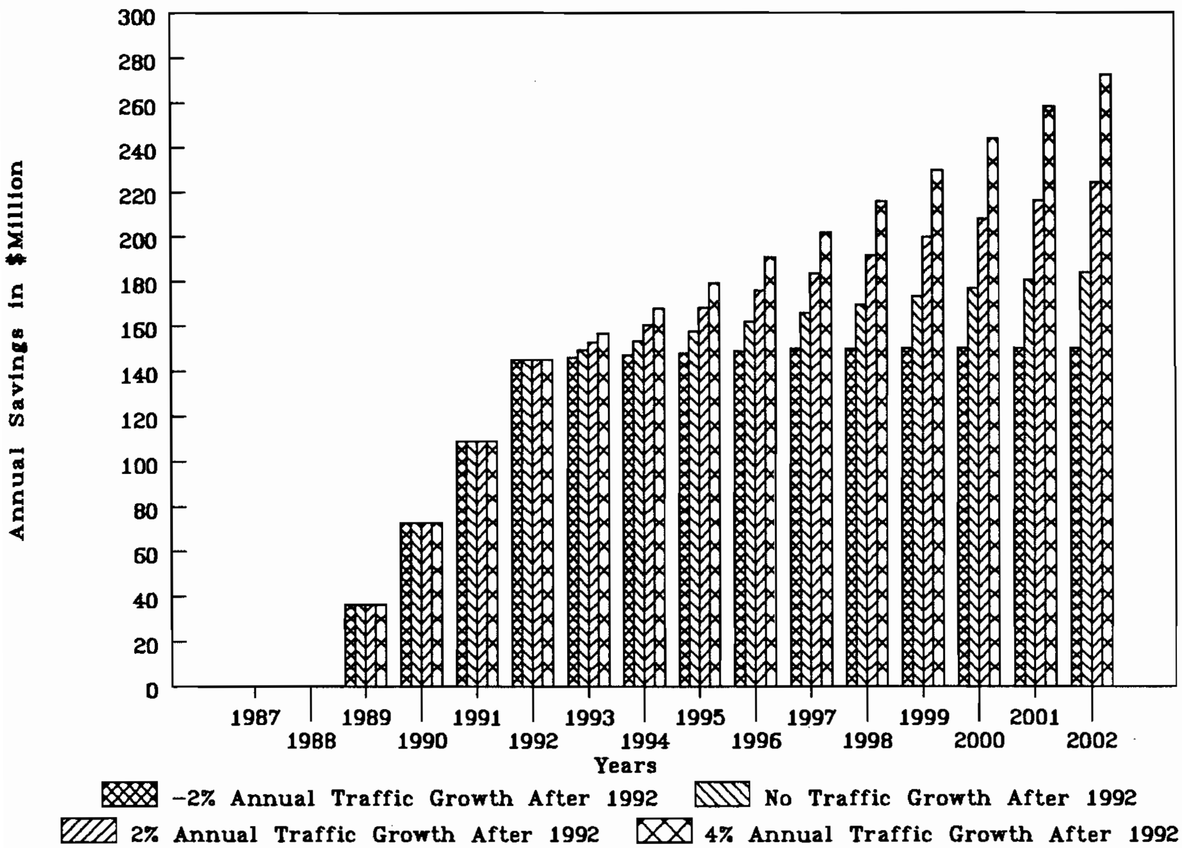
The largest savings are realized in Ontario, reflecting the scale of the trucking industry in that province. The main shifts in Ontario which accounted for the savings are from a number of different configurations to the 8-axle TAC B-trains. The next largest percentage savings from the MoU were realized in the Prairie Provinces, reflecting in particular the shift from 5-axle to 6-axle tractor semitrailers and from 7-axle A- and C-Trains to 8-axle B-Trains. There are also significant savings in British Columbia. The most important reason for the savings in British Columbia is that firms have changed significantly to 53 foot semitrailers and B-trains. The slightly smaller cost savings in Quebec are due to shifts from straight trucks to tractor semitrailers and to 7- and 8-axle B-Trains. In the Atlantic provinces the cost savings are due to a significant shift from 5- to 6-axle tractor semitrailers and a smaller shift to 8-axle B-Trains. Cost savings in the Yukon and Northwest Territories are due to a shift from straight trucks and tractor semitrailers to 7- and 8-axle B-Trains, particularly the latter for future years as projected based on the carrier survey. The shifts in truck configuration usage summarized above are shown in more detail in Exhibit 18.3 (in Chapter 18 in Part III); these shifts provide the underlying basis for the cost savings shown in Exhibit 19.2.

Exhibit 19.3 graphically shows the estimated annual savings due to the MoU for the period 1988 to 2002. Interpolating the savings for the years between 1988, 1992, 1997 and 2002 on a straight line basis and calculating **the net present value at the beginning of 1994 of all annual savings** for the period from 1988 to 2002, expressed in 1992 dollars, we obtain net present value savings of **$1.91 billion**, using a discount rate of 5 percent.

EXHIBIT 19.3

ANNUAL TRUCKING COST SAVINGS DUE TO THE MoU

ON THE NATIONAL HIGHWAY SYSTEM - IN 1992 DOLLARS



Savings for the years 1992, 1997 and 2002 are based on projected traffic volumes and fleet mixes for these years (i.e. with the MoU) and as they were in 1987 (i.e. without the MoU). Savings for the other years are interpolated on a straight line basis. The savings for 1988 are assumed to have been zero.

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From the above it is concluded that the savings obtained from the MoU are substantial in absolute terms, although they are relatively small (2-3%) as a proportion of total costs.

As shown in Exhibit 19.2, the estimated savings in trucking costs for vehicles on the NHS are estimated at about $145 million per year in 1992 (expressed in 1992 dollars). The estimated savings (in 1985 dollars) as given in the 1987 IBI/ADI study for TAC/CCMTA for the two regulatory scenarios most closely resembling that implemented by the MoU were in the range $160 - 193 million per year. Inflation and the growth of truck traffic between 1985 and 1992, as well as differences in the regulatory contexts, are such that the estimates are not directly comparable. In particular, the MoU as implemented did not include the use of 53 foot semitrailers across the whole country. Nevertheless the estimates are similar enough in magnitude to be somewhat reassuring, given that the methodologies and data sets used in the two studies varied significantly.

19.3 EXTRAPOLATION TO THE MOU SYSTEM

All of the above calculations are for traffic using the National Highway System (NHS) network only. As described previously, the relaxed weights and dimensions are useable on a broader network (except in Quebec) established by the MoU (and subsequently enlarged by various provinces). Exhibit 19.4 shows the annual truck traffic (expressed in millions of vehicle-kilometres) on the NHS network and on the MoU designated road network outside the National Highway System. It can been seen that there are almost as many truck vehicle-kilometres on the MoU network outside the National Highway System as on the NHS.

Detailed information on vehicle configurations off the NHS was not readily available for this study, therefore a broad estimate of the total savings on the MoU Network has been carried out using some simple assumptions. It was judged that the trucking cost savings on the remainder of the MoU network would be nearly proportional to the savings on the NHS. The road sections not included in the NHS would carry a much greater percentage of intra-regional and intra-provincial traffic, which consists of a greater proportion of non-TAC trucks (two to four axles), and for this reason a lower percentage of savings has been applied to the vehicle-kilometres of truck travel off the NHS. Investigation of the relative savings from the trucking cost model revealed that intra-regional traffic experienced an estimated relative savings of 1.84%, compared to an overall average savings of 2.14%, as shown on the second page of Exhibit 19.4. In order to be conservative, the lower percentage of savings has been applied to the non-NHS road sections of the MoU.

EXHIBIT 19.4 (1/2)

COMPARISON OF TRUCK TRAFFIC AND COST SAVINGS ON THE NHS AND MoU NETWORKS

ANNUAL TRUCK TRAFFIC ESTIMATES ON THE TAC MoU DESIGNATED ROAD NETWORK

Province/ Territory/ Region	NATIONAL HIGHWAY SYSTEM					MoU NETWORK OUTSIDE THE NHS				MoU SUM
	(A) Length (km)	(B) Truck Traffic MVK	(C) Total Traffic MVK	(D) Average AADT	(E) Percent Trucks	(F) Length (km)	(G) Average AADT	(H) Total Traffic MVK	(I) Truck Traffic MVK	(J) Truck Traffic MVK
NF	893	145	1,174	3,602	12.3%	57	1,000	21	3	147
NS	847	248	2,273	7,352	10.9%	453	2,100	347	38	286
PEI	117	14	218	5,105	6.3%	133	3,400	165	10	24
NB	979	254	2,058	5,759	12.3%	911	2,800	931	115	369
ATLANTIC	2,836	660	5,723	5,529	11.5%	1,554	2,581	1,464	166	826
QUEBEC	2,863	2,123	16,989	16,257	12.5%	(1,043) *	5,758	(2,192)	(274)	1,849
ONTARIO	5,538	3,521	26,849	13,283	13.1%	10,522	5,573	21,403	2,807	6,327
MAN	830	149	1,285	4,242	11.6%	5,260	1,400	2,688	311	459
SAK	2,061	293	2,374	3,156	12.3%	4,919	1,200	2,155	266	558
ALB	3,516	908	7,964	6,206	11.4%	150,484	500	27,463	3,132	4,040
PRAIRIES	6,407	1,349	11,623	4,970	11.6%	160,663	551	32,306	3,708	5,057
BRIT.COL.	5,592	696	9,759	4,781	7.1%	5,528	4,600	9,282	662	1,357
NWT	574	7	58	277	12.4%	1,106	200	81	10	17
YKT	1,050	30	239	624	12.3%	1,510	250	138	17	47
TERRITORIES	1,624	37	297	501	12.4%	2,616	229	219	27	64
TOTAL	24,860	8,385	71,240	7,851	11.8%	179,840	952	62,481	7,095	15,480

* For Quebec, the NHS **exceeds the MoU designated network by 1,043 km.**
The corresponding truck traffic has been deducted using the NHS database.

COLUMN NOTES:

(A) As defined by the National Highway Policy Steering Committee (1990).
(B) Based on study team's NHS database, includes ALL truck types.
(C) Based on NHS database, includes ALL motor vehicles.
(D) Calculated as {(C) / ((A)*365)}; (E) calculated as {(B)/(C)}.
(F) Based on MoU Designated Network, minus (A).
(G) Aggregate estimate of AADT based on provincial data, where available.
(H) Calculated as {(F) / (G) * 365}.
(I) Based on percent trucks on NHS, calculated as {(E) * (H)}.
(J) Estimated truck traffic on the whole MoU network, calculated as {(B) + (I)}.

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EXHIBIT 19.4 (2/2)

COMPARISON OF TRUCK TRAFFIC AND COST SAVINGS ON THE NHS AND MoU NETWORKS

TRUCKING COST SAVINGS ESTIMATES ON THE TAC MoU DESIGNATED ROAD NETWORK

Province/ Territory/ Region	MoU NETWORK TRUCK TRAFFIC			ANNUAL COST SAVINGS IN 1992			NPV, SAVINGS (1988–2002)	
	(B) NHS Traffic (MVK)	(I) Other MoU (MVK)	(J) Total MoU (MVK)	(K) NHS Traffic (1992$)	(L) Other MoU (1992$)	(M) Total MoU (1992$)	(N) NHS Traffic (1992$)	(O) Total MoU (1992$)
NF	145	3	147	$0.8	$0.0	$0.9	$9.6	$9.7
NS	248	38	286	$1.3	$0.2	$1.4	$14.4	$16.3
PEI	14	10	24	$0.0	$0.0	$0.1	$0.4	$0.6
NB	254	115	369	$1.5	$0.6	$2.0	$16.6	$23.1
ATLANTIC	660	166	826	$3.6	$0.8	$4.4	$41.0	$49.7
QUEBEC	2,123	(274)	1,849	$15.8	($1.7)	$14.0	$240.7	$214.1
ONTARIO	3,521	2,807	6,327	$58.5	$40.0	$98.5	$775.2	$1,305.5
MAN	149	311	459	$4.4	$7.9	$12.3	$55.6	$155.3
SAK	293	266	558	$8.9	$6.9	$15.7	$111.7	$198.7
ALB	908	3,132	4,040	$25.9	$76.7	$102.6	$326.9	$1,294.3
PRAIRIES	1,349	3,708	5,057	$39.2	$91.5	$130.7	$494.1	$1,648.2
BRIT.COL.	696	662	1,357	$27.8	$22.7	$50.5	$343.0	$622.9
NWT	7	10	17	$0.1	$0.1	$0.2	$0.9	$1.9
YKT	30	17	47	$0.3	$0.2	$0.5	$3.7	$5.5
TERRITORIES	37	27	64	$0.4	$0.3	$0.7	$4.6	$7.4
TOTAL	8,385	7,095	15,480	$145.2	$153.4	$298.6	$1,898.6	$3,847.8

COLUMN NOTES:

(B), (I) AND (J) as already described on the previous page.

(K) Estimates taken from Exhibits 19.2 and D.7.

(L) Estimated as { (I) / (B) * (K) * 1.84% / 2.14% }
The savings on other MoU roads are estimated to be lower than average.
The small table at the right illustrates that the intra-regional traffic had savings of 1.84% as opposed to the 2.14% average for all NHS traffic.

(M) Calculated as { (K) + (L) }

(N) Taken from Exhibit D.7, based on results of 19.2 and 19.3.
Base case is 2% annual traffic growth beyond 1992, savings discounted at 5% to the beginning of 1994.

(O) Calculated as { (N) * (M) / (K) }

COMPARISON OF ANNUAL SAVINGS BY TRAFFIC TYPE :

Traffic Type	1992 NHS TRUCKING COSTS			
	Actual	Pre-Mou	Savings	% saved
Intra-reg.	$1,882.5	$1,917.8	$35.3	1.84%
Inter-reg.	$4,741.8	$4,851.7	$109.9	2.27%
Total	$6,624.3	$6,769.5	$145.2	2.14%

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The results of the expansion from the National Highway System to the MoU Designated Network are an increase in annual savings in 1992 from $145 million to $299 million, and an increase in the net present value of savings, for the years 1988-2002, from $1.9 billion to $3.85 billion. The expanded MoU network results, as noted above, are less reliable than the NHS estimates because of the broad assumptions about traffic levels and percentage savings used to calculate them.

20. OTHER IMPACTS

This chapter describes the calculations and results for impacts of the MoU on infrastructure costs, on road safety and on shippers. As noted earlier in Part II of this report, quantitative cost impact estimates are developed for infrastructure but road safety and shipper impacts are dealt with more qualitatively, owing to data limitations.

20.1 IMPACTS ON INFRASTRUCTURE COSTS

20.1.1 Pavements (LEF Reductions)

The 3.4% reduction in the load equivalency factors (LEF's) noted in the Prairie Provinces, calculated in Section 15.3.2.4 in Part II, was used to determine pre and post MoU pavement life for twelve typical pavement structures. The results are summarized in Exhibit 20.1. This shows that the reduction in LEF's identified would extend pavement life by 1 to 2 months in a typical 14 year life span. This increase is too small for any realistic monetary benefits to materialize. Extrapolating this over the National Highway System for the Prairies produces a total annual saving of $1 million. Pavement impacts in other regions were even less. Therefore, for all practical purposes, the pavement impacts of the MoU vehicles may be considered as neutral.

20.1.2 Structures

Exhibit 20.2 summarizes the bridge strengthening costs identified by province. These one time costs are estimated at $32 million. Based on a 20 year amortization and 5% discount rate, these costs are annualized to $2.55 million. These numbers are considered to be conservative (i.e. high) due to the procedures used to estimate the costs for British Columbia.

20.1.3 Pavement Savings From Other Factors

The case studies indicated a switch to air ride suspensions, not necessarily related to the MoU. These suspensions are considered more pavement friendly and therefore produce some pavement savings. Procedures for calculating these benefits are not well developed and these savings have not been quantified. They would be very minor especially when considering the total truck traffic stream.

20.1.4 Road Maintenance

No incremental road maintenance costs were identified as being attributable to the MoU. There may be some increased operations and maintenance costs which cannot be quantified as well as some fatigue related costs. However, these costs are considered by the study team to be minor.

EXHIBIT 20.1
TYPICAL PAVEMENT STRUCTURES FOR PRAIRIE PROVINCES

Pavement Structure (mm)			Pavement Life (years)		
Asphalt Surface (mm)	Granular Base (mm)	Granular Subbase (mm)	Post-MoU	Pre-MoU	Additional Life due to MoU
Weak Subgrade (Lacustrine Clay)					
100	100	205	2.82	2.73	0.09
100	100	305	5.31	5.19	0.12
100	150	355	9.03	8.89	0.14
100	165	345	9.40	9.26	0.14
115	165	355	11.00	10.87	0.13
125	180	370	12.86	12.73	0.13
Medium Subgrade (Glacial Till)					
100	100	125	4.62	4.50	0.12
100	100	205	7.48	7.35	0.13
100	150	180	9.35	9.21	0.14
100	100	305	11.15	11.02	0.13
115	165	180	11.76	11.63	0.13
125	180	190	13.83	13.72	0.11

Notes:

- Typical pavement structures are based on guidelines provided in the TAC Pavement Management Guide.
- Subgrade layer coefficient assumed as 5,000 for weak subgrade and 7,000 for medium subgrade.

20.1.5 Road Configurations

No incremental vehicle operating costs for other users of the road system due to effects of the MoU vehicles in the traffic stream were identified.

20.1.6 Summary

Annual infrastructure costs of $2.75 million were identified, including $2.55 million for bridge strengthening and $0.2 million for upgrading weigh scales.

Some minor increases in future bridge O&M costs are anticipated, but these cannot be identified without considerable additional long term research. Minor pavement savings were also identified, but for all practical purposes these are too small to calculate.

Some unidentified costs will be associated with upgrading intersection configurations that were built in the 1950's and 1960's and are deficient by today's standards. This deficiency is aggravated by some of the trucks introduced by the MoU. One province indicated it had upgraded its intersection sight distance design standards to accommodate vehicles introduced by the MoU, but these costs are not readily identifiable.

The above findings relate to the National Highway System. As noted earlier in Section 19.3, more approximate consideration has been given to the trucking savings and possible additional infrastructure costs related to the introduction of the MoU on the remainder of the MoU network. It was not possible to quantify infrastructure cost changes due the MoU on the remainder of the designated MoU network (beyond the NHS) but qualitative comments can be given. Based on discussions with highway departments (particularly in the four western provinces) and previous experience in this field, we broadly conclude that pavement costs would be neutral for the remainder of the MoU network, as estimated for the NHS. Bridge structure costs for the remainder of the MoU are expected to be the same order of magnitude as those for the NHS but somewhat higher because of lower allowed gross vehicle limits on these bridges. In summary, therefore, it is concluded that infrastructure costs on the remainder of the MoU network would probably be more than those on the NHS but that these would be a small fraction of the trucking cost savings, as is the case on the NHS.

20.2 IMPACTS ON ROAD SAFETY

Using accident rates (per MVK) and accident severity for each vehicle type included in the MoU combined with estimates of travel substitution by truck type as a result of the MoU, one could estimate safety impacts in terms of changes in accidents, injuries and fatalities.

EXHIBIT 20.2
BRIDGE STRENGTHENING COSTS

Province	Strengthening Costs	Annualized Cost*
Newfoundland	-	-
Nova Scotia	-	-
Prince Edward Island	-	-
New Brunswick	-	-
Quebec	-	-
Ontario	-	-
Manitoba **	$10,000,000	$800,000
Saskatchewan	$600,000	$50,000
Alberta	$2,500,000	$200,000
British Columbia	$19,000,000	$1,500,000
Total Cost	$32,100,000	$2,550,000

* Based on 5% discount rate and 20 year life span.

** Includes $6,000,000 indicated by Manitoba Highways and Transportation for strengthening plus allowance of $4,000,000 by study team for loss of service life on timber laminated bridges.

However, accident rate and accident severity data sufficiently reliable for such an analysis are not available.

Three key stability and control characteristics correlate well with involvement in fatal accidents; rollover stability, rearward amplification, and braking efficiency. Available information on these three characteristics were reviewed.

Using the results of the UMTRI (1983) study which led to the current MoU specifications on weights and dimensions, estimates of the three performance characteristics were developed for the various vehicle types and operating conditions affected by the MoU. While the estimates were not based on an as detailed analysis as one would wish to perform, the numbers compiled indicate the safety impacts of the MoU to be positive because:

i) Overall, the MoU does not seem to have substantially changed the performance characteristics. Therefore, the redistribution of traffic from one vehicle type (and operating condition) to another seems to have neutralised the safety impacts of the MoU from the point of view of vehicle performance characteristics.

ii) While the aggregate performance characteristics have not been substantially influenced by the MoU, the agreement has reduced the truck traffic exposure by an estimated 135 MVK annually (1992) on the NHS.

Therefore, with no net change observed in the vehicle performance characteristics, the safety impacts of MoU have been positive due to the reduced truck travel. In general, the improved safety due to the MoU is also supported by industry interviews.

While the aggregate analysis performed in this study provides some indication of the safety impacts of the MoU, it is by no means a detailed enough analysis. The MoU specifications on weights and dimensions were originally developed following the analysis/simulations performed in the UMTRI (1983) study with respect to stability and control characteristics of heavy trucks. The current study has provided estimates of truck traffic exposure and average payloads for each of the eight vehicle types (under various operating conditions) affected by the MoU. It is highly recommended that the analysis/simulations in the UMTRI study be reviewed in light of these estimates and additional data that may be available from future trucking surveys, in order to provide more detailed, quantitative estimates of safety impacts of the MoU.

20.3 IMPACTS ON SHIPPERS

Data limitations made it infeasible to produce quantified estimates of cost impacts of the MoU on shippers. A wealth of qualitative information was obtained from the shipper case studies, however, as reported in Section 14.2.3 in Part II of this report.

The case study interviews revealed that most shippers enjoyed significant trucking rate reductions during the 1988-1992 period, a trend which has continued and is expected to continue into the future. The shippers attribute much of these reductions in rates to the introduction and use of more efficient truck configurations, which was made possible by the MoU. Both the carrier case studies and the shipper case studies revealed the presence of "knowledgeable shippers", armed with research on unit costs of the various truck configurations, who have negotiated effectively with carriers to provide more efficient configurations and to pass to the shipper a substantial portion of the resulting cost reductions. Shippers and carriers also noted that other factors, in particular rate deregulation under the 1987 National Transportation Act, the Canada-U.S. Free Trade Agreement, and the recession which began in late 1989, have all exerted downward pressure on trucking rates. The ability of carriers to respond by reducing their costs was, however, enhanced as a result of the MoU and the resulting gains in operating cost-efficiency.

The reduced rates partly attributable to the MoU also allowed shippers and distributors to extend their supply areas to more distant sources and customers. It was noted that this trend applies even to low-cost freight-sensitive commodities.

While most shippers did not report having to change their dock areas to adapt to the larger truck configurations made possible by the MoU, it was noted that some shippers have deliberately avoided these configurations because of cost and time implications associated with loading and unloading. The shippers that have changed their dock areas have generally found that the costs were relatively marginal (e.g. in the $10,000-50,000 range as a one-time investment) and that the pay-back periods (from the resulting lower truck rates) were one year or less.

In summary, therefore, while it was not possible to quantify the net cost savings to shippers, the evidence suggests that shippers have experienced and continue to enjoy cost savings which are a substantial proportion of the trucking cost savings documented in Chapter 19 above, as truckers pass these savings on to their customers in order to respond to pressures for lower rates resulting from the 1987 NTA, the

Canada-U.S. FTA, and the recent recession. Had the MoU not been brought into effect, truckers would not have been able to introduce larger/heavier and more efficient truck configurations to the extent documented in this report, and would have been unable to pass on the resulting lower rates to Canadian shippers. These rate reductions have, in turn, contributed significantly to the economic efficiency of Canada's economy and the country's competitive position as a trading nation.

20.4 IMPACTS ON TRAILER MANUFACTURERS

The impact on Canadian trailer manufacturers of the MoU has been quite positive. This has been because of two factors:

- the changes in vehicle weights and dimensions have encouraged carriers to buy new equipment to take advantage of the new regulations;

- the development of truck configurations specific to Canada has created a "niche" for Canadian manufacturers.

21. AGGREGATION OF IMPACTS

This chapter presents combined trucking cost and infrastructure cost impacts of the MoU and summarizes the impacts on road safety and shipper costs which have been treated more qualitatively owing to data limitations. The chapter also includes a section dealing with the reliability of results, including the major sources of uncertainty and (in one or two cases) the implications of alternative input assumptions on the results.

21.1 COMBINED COST SAVINGS WITH THE MoU

As noted in the previous two chapters, the study has produced quantified cost savings estimates for trucking costs and infrastructure costs, while road safety impacts and impacts on shippers have had to be treated more qualitatively owing to data limitations.

In order to develop a combined set of quantitative cost impacts it is necessary to subtract the net infrastructure costs attributed to the MoU (as presented in Section 20.1 above) from the trucking cost savings presented in Chapter 19 (Exhibits 19.2 and 19.3).

As described in Section 20.1, the use of larger and heavier trucks as a consequence of the MoU has resulted in a generally neutral impact on pavement wear and related infrastructure costs due to the combined effects of changes in axle loading and vehicle-kilometres to move a given number of tonne-kilometres of goods, and other factors. While the overall impact was seen as probably slightly positive (e.g. a slight saving in pavement costs) it was felt that a more conservative, "break-even" interpretation would be appropriate. Detailed estimates of bridge costs, provided by the provincial ministries, indicate an effective additional annual costs for bridge of about $2.55 million per year. Additional implementation costs related to weigh scale stations and associated ramp changes, etc., would contribute a very small additional net cost, estimated at about $200,000 per year. The total net additional infrastructure cost of about $2.75 million per year is very small considering that it applies to the entire country.

Accordingly, the estimated cost savings attributable to the MoU, as shown in Exhibits 19.2 and 19.3 earlier in this part of the report would be reduced by about 2% to account for the above net infrastructure costs. In round numbers, the net cost savings based on a 2% annual growth rate in truck traffic are about $142 million per year in 1992, $180 million per year in 1997, and $222 million per year in 2002, stated in 1992 dollars.

Adjusting for the slight reduction owing to the net infrastructure costs, the net present value at the beginning of 1994 of all annual savings for the period from 1988 through 2002, expressed in 1992 dollars, is $1.87 billion for traffic on the NHS network and probably more than twice this for traffic on the total MoU network.

21.2 RELIABILITY OF RESULTS

The main sources of uncertainty are the gaps in available trucking data and the small sample size of a number of key data sources. This has been discussed earlier in Section 15.1.6 in Part II.

As noted in that discussion, the two areas of greatest concern are:

- **The CCMTA truck classification, O/D and load survey data were available for 29 stations across Canada.** Additional truck classification data were available for other stations across the country (see Exhibit 15.7 in Part II). These data were expanded to all NHS highway links in each province, based on the truck traffic volume data for the links. The extrapolation from a relatively small number of road sections for which detailed truck traffic data was available to all links on the NHS network is clearly a major source of uncertainty. As discussed in Section 15.1.6 (Part II) however, comparisons of traffic breakdowns by truck type, drawn from the CCMTA/classification count sources, the carrier survey conducted as part of this study, and Statistics Canada trucking surveys, showed a reasonable level of consistency among the three types of data, which provides some reassurance that the expanded results have a reasonable degree of realism.

- **The carrier survey and case studies carried out as part of this study represent a small sample of truckers, shippers and manufacturers in Canada.** In particular, the carrier survey was used to provide information (available from no other source) on the breakdown between the 48 foot and 53 foot trailers; the survey also provided information on future (1997, 2002) truck volumes as projected by the carriers and other information on truck use impacts of the MoU (and of other influences such as the 1987 NTA) on the use of individual truck types. Again, while the small sample size of the survey and the lack of information on the "universe" of all trucking firms/operations in Canada are a major source of uncertainty, the consistency between results of the survey and data available from the CCMTA survey, truck classification counts and Statistics Canada trucking surveys suggests that the results are reasonably representative.

The original calculations of trucking cost savings due to the MoU were based on the GVW limits allowed by the MoU using the figures given in the publication ***Heavy Truck Weight and Dimension Regulations for Interprovincial Operations in Canada***, September 1993, published by the Transportation Association of Canada. Using these limits resulted in an estimated loss of $6.8 million in Quebec for 1992 (but savings in the other two years). The team ascribed the loss in Quebec to the significant reduction in the GVWs for both 5 and 6 axle tractor semitrailers from before to after the MoU in that province. Consultation with a knowledgeable source on trucking in Quebec identified different numbers for the GVWs now in use in Quebec, and the latter numbers were used in the base case calculations presented above in Chapter 19.

It is not feasible, owing to the necessity of using judgement and estimates in conjunction with computerized model components, to conduct more extensive quantitative sensitivity studies. It has also been noted that the trucking cost and infrastructure cost savings estimated in this study represent a relatively small difference between two large numbers (total trucking costs with and without the MoU). As stated earlier, it must be emphasized that the absolute levels of the trucking costs with and without the MoU are subject to major uncertainties stemming from the above and other sources and should not be considered as an end product of this work. The **difference** between these two costs, representing the savings which can be attributed to the MoU, are subject to less uncertainty, however, since both of the total cost estimates were developed using the same methodology, so that any systematic errors would tend to cancel each other out. There are also two significant areas in which we believe the methodology employed in this report has underestimated the impacts of changes in vehicle weights and dimensions regulations:

- the report has included only a modest shift from 48 foot to 53 foot semitrailers. Recent changes in regulations will undoubtedly encourage a much greater use of this configuration;

- as discussed previously, most of the quantitative work in this report is based upon the National Highway System (NHS). The MoU actually applies a much broader network. Total benefits on the broader MoU network are probably in the order of two times the savings on the NHS, as noted earlier.

Finally, the large size of the estimated trucking savings net of infrastructure costs is, in itself, an important consideration when assessing the implications of the uncertainty range. The net present value of cost savings, estimated at $1.87 billion as noted in the previous section, is much larger than the relatively modest cost of the TAC research program and MoU implementation costs; this comparison is discussed further in Chapter 22, following.

22. SYNTHESIS AND STUDY CONCLUSIONS

This chapter presents a benefit/cost assessment of the Heavy Vehicle Weights and Dimensions Research Program carried out by TAC. It also summarizes the findings and conclusions based on the overall results of the study and provides a brief discussion of possible future directions of data collection and research, drawing on insights gained from the study.

22.1 EVALUATION OF PROGRAM EFFECTIVENESS

As noted in the Introduction to this report, the Terms of Reference included a requirement that the study include a broad benefit/cost assessment of Canada's Heavy Vehicle Weights and Dimensions Research Program in the light of any trucking, infrastructure and other net cost savings attributable to introduction of the MoU which might be identified and quantified during the course of the study. This section addresses that requirement.

The Transportation Association of Canada and its predecessor, the Roads and Transportation Association of Canada (RTAC) conducted an extensive program of research, analysis and testing regarding the implications of introducing expanded weights and dimensions regulations for heavy vehicles moving between provinces in Canada. This program was prompted by the observation that very significant differences in truck size and weight regulations from province to province placed severe restrictions on the efficiency and cost-effectiveness of interprovincial truck movements. In the interests of greater efficiency, it was noted, an appropriate change would be to relax vehicle weights and dimensions restrictions in those provinces with lower limits, applying the regulations for the least restrictive province across the country. Discussions among provincial governments and highways and transportation ministries revealed concerns about such an approach, however, relating to the impacts on road geometrics, pavement wear, bridge strengthening requirements, road safety and possible net costs to some shippers.

An extensive, cooperative research program was undertaken to address these concerns by providing qualitative, reliable information applying to Canadian conditions. An RTAC technical committee involving knowledgeable professionals from all Canadian provinces/territories, the federal government and the trucking industry studied these issues during the 1970's and 1980's and organized a number of specific technical investigations which were mostly carried out during the period 1983 - 1986. These included extensive investigations of bridge strengthening requirements/costs which would be required to accommodate larger and heavier vehicles on major interprovincial routes in each province, studies of the road geometric and pavement wear impacts of larger vehicles with more axles, and extensive testing of the stability and handling characteristics of various types of large vehicles subjected to sudden stopping and/or lane changing manoeuvres under carefully controlled test track conditions.

The results of this extensive research program provided the necessary information to provincial governments which enabled them and their highways/transportation ministries to reach agreement on the 1988 MoU, which has significantly eased former restrictions on interprovincial trucking movements for important classes of heavy vehicles.

Based on data provided by the Transportation Association of Canada, the estimated cost of the Heavy Vehicle Weights and Dimensions Research Program from its inception to the announcement of the MoU in 1988 was approximately $3 million. Assuming that these expenditures were made during the period 1983-1986 at an approximately constant annual level of expenditure, the net present value of these expenditures as of 1994 (in 1992 dollars) would be about $5.7 million.

As described in the previous three chapters, the present value as of 1994 of the net cost savings attributed to the MoU (in 1992 dollars) is some $1.91 billion for total traffic on the National Highway System (NHS) network and probably more than twice this on the total MoU network. These savings are mostly attributable to trucking cost savings because of efficiencies from the introduction of larger and heavier vehicles, and major portions of these savings were passed on to shippers through lower trucking rates, which contributed to the economic efficiency of the Canadian economy and to Canada's competitiveness vis-à-vis its trading partners.

A simplistic benefit/cost calculation based on these two estimates of net present value (net savings of $1.87 billion, costs of $5.7 million) produces a benefit/cost ratio of 328:1 for the Heavy Vehicle Weights and Dimensions Research Program relative to the cost savings attributed to the MoU on the NHS and about double that ratio if the total MoU network is taken into account. This is an extremely positive example of the economic leverage and benefits which can result from well-directed research, focussed policy development, and productive interprovincial negotiations to achieve greatly improved transportation efficiency in the trucking mode.

It should be pointed out that, as documented in Chapters 13 and 14 in Part II of this report, the MoU was only one of a number of important factors which influenced the volumes and mix of truck types serving interprovincial and international movements. Among the other important influences are the National Transportation Act (NTA) of 1987 (which deregulated rates charged by truckers, railways, airlines and marine shippers), the Canada-U.S. Free Trade Agreement (which encouraged a shift to increased north-south trade and introduced increased competition from U.S. truckers and railways while opening up U.S. markets to Canadian carriers), and the major recession, starting in late 1989, experienced by Canada, the U.S. and other industrialized countries with which they trade (which produced pressures for rate reductions and the introduction of more efficient truck types). While it is true that these and other major influences undoubtedly affected the volumes and mix of truck configurations using Canadian highways, it is also true that the specific configuration and usage changes quantified in this report could not have occurred legally without the changed vehicle weights and dimensions regulations brought about by the MoU. The estimated cost savings were based upon these changes in vehicle configuration and use and, based on this, it is reasonable to attribute these cost savings to the MoU.

As noted earlier in Section 21.2, the benefit/cost ratio is so robust that, even if the cost savings have been overestimated by a factor of 2 the ratio would still be 164:1, a very handsome benefit/cost return under any circumstances. It would appear, therefore, that Canada's Heavy Vehicle Weights and Dimensions Research Program costs were justified many times over by the economic benefits which they have helped bring to truckers, shippers and the Canadian economy as a whole.

22.2 SUMMARY OF FINDINGS, CONCLUSIONS AND SUGGESTED FUTURE DIRECTIONS

This section summarizes the major findings and conclusions resulting from the study and suggestions for developing improved information to support ongoing improvements affecting the trucking industry. The reader is also directed to conclusions presented in Part I, Chapter 11 (regarding recommended methodologies and data sources for the study), and the summaries in Part II of information obtained from the 1993 survey of carriers (Chapter 13) and the case studies of carriers, shippers, provincial ministries and trailer manufacturers (Chapter 14) carried out as part of the study, and the models and procedures developed for use in the study (Chapter 16).

22.2.1 Findings

The major findings of this study can be summarized as follows:

- **Quantifiable Cost Savings Due to the MoU** - Net annual quantifiable cost savings attributable to the introduction of the Memorandum of Understanding (MoU) of 1988 for the NHS are estimated at about $142 million per year in 1992,

$180 million in 1997 and $222 million in 2002, expressed in 1992 dollars. These estimates are based on trucking cost savings less slightly increased infrastructure costs. The net present value of these cost savings as of 1994 for the period 1988 to 2002 expressed in 1992 dollars is about $1.87 billion. These savings refer only to truck traffic on the National Highway System. If the results are extrapolated to the total network designated under the MoU, net truck cost savings attributable to the MoU would be about double those on the NHS.

- **Main Sources of Savings** - Virtually all of the above cost savings come from the reduced operating costs per tonne-km resulting from the shift to larger, heavier and more efficient truck configurations for interprovincial movements allowed as a result of the MoU. While these vehicles are heavier than the vehicles which they replace, they also have more axles, so that the individual axle loading is reduced, on average, with a slightly positive impact on pavement wear and road maintenance costs. This is offset by small additional bridge strengthening/modification costs, weigh scale costs, etc. attributable to use of the larger, heavier vehicles, such that the infrastructure cost due to the MoU is estimated at about $2.75 million per year. This was subtracted from the trucking cost savings to produce the above net present value savings of $1.87 billion attributable to the MoU.

- **Road Safety Impacts** - Data limitations precluded producing quantitative cost impacts regarding road safety and as experienced by shippers, and these findings were therefore more qualitative. Conclusions have been drawn based on results of the carrier survey and case studies, and drawing on other information sources including the extensive truck handling characteristics testing program conducted for TAC and other research by the University of Michigan Transportation Research Institute (UMTRI). It is concluded that the impact of the TAC B-Train and of the longer semitrailers, which were the main configurations brought into larger use by the MoU, on road safety has been essentially neutral, with reduced vehicle-km (135 million vehicle-km per year) to carry a given volume of tonne-km providing a positive impact which may be offset to some degree by marginal increases in the difficulty of overtaking manoeuvres (e.g. by private automobiles) in connection with the longer trailers and longer combination vehicles. Test track and anecdotal information from drivers suggests that the TAC B-Train and longer, 6-axle tractor semitrailer vehicles are no less safe (and may, in fact, be safer), in terms of their road-worthiness and handling characteristics, than the shorter tractor semitrailer and the A and C-Train double combinations which they have, to some extent, replaced. More information on the handing and stability characteristics of vehicles operating under the MoU weights and dimensions regulations, and their accident rates in actual operations, should be obtained to provide more quantitative information regarding this conclusion.

- **Impacts on Shippers** - Cost and other impacts experienced by shippers as a result of the MoU also had to be treated qualitatively as a result of data limitations. Based on results of the carrier survey and carrier and shipper case studies carried out as part of this assignment, it is concluded that, while some shippers reported capital costs to modify terminals and loading facilities to accommodate the larger truck configurations, these investments were relatively small and were recovered usually within one year or so from the reduced trucking rates experienced by the shippers. Responses by both the carriers and shippers suggest strongly that most of the cost reductions resulting from the introduction of larger/heavier/more efficient trucks due to the MoU were passed on by the carriers to their customers, the shippers. This resulted both from the downward pressure on rates due to the 1987 NTA, the recession, and U.S. carrier competition and also from the fact that many shippers are extremely knowledgeable about the unit cost characteristics of various truck configurations and applied this knowledge effectively in negotiating with carriers to use the more efficient vehicles and pass on most or all of the savings to the shippers.

- **Impacts on Trailer Manufacturers** - The introduction of the MoU has had a postive effect on Canadian manufacturers of trailers. Carriers have invested in new equipment to take advantage of the changes in regulations. In addition, a "niche" for Canadian trailer manufacturers has been developed.

- **Reliability of Results** - There are significant uncertainties in the above trucking cost savings estimates owing to data limitations: primarily gaps in data and inconsistencies in the coverage and extent of data from province to province and also the small sample size of key data sources, including the 1991 CCMTA roadside trucking survey and the carrier survey and case studies carried out as part of this study. A number of cross checks were carried out, however, in instances where control totals from one data source could be checked against results from another source (e.g. the two sources just referred to and trucking surveys conducted by Statistics Canada); these comparisons were reassuring in terms of the reasonableness of the results obtained by the study, as discussed in Section 15.1.6 in Part II.

- **Implications of Large Savings Estimates** - Perhaps the most important factor in considering reliability of the results relates to the large size of the estimated savings. Even if the estimates were overstated considerably, they would still be very large in comparison with the cost of the TAC research program and other costs of implementing the MoU changes. While the estimated cost savings are very large, they represent only about 2% of the very broadly estimated total cost of trucking operations on the national highway system in 1992, and a saving of this amount in percentage terms does not seem unreasonable given the significant efficiencies attributable to greater use of TAC vehicles and longer semitrailers made possible by the MoU, particularly in British Columbia and the Prairie Provinces and to a lesser extent in Ontario, Quebec, Atlantic Canada and the Territories.

22.2.2 Conclusions

Major conclusions from the study are summarized as follows:

- **Positive Economic Impacts** - Introduction of the 1988 MoU has contributed greatly to more efficient trucking movements for Canadian-based produce, particularly for interprovincial movements and, to a lesser extent, movements to and from the United States. These savings have been enjoyed in particular by Canadian shippers, through lower rates resulting from the cost savings, and to a lesser extent, by carriers; the overall Canadian economy has benefitted significantly in terms of greater efficiency and increased competitiveness vis-à-vis Canada's trading partners.

- **Benefit/Cost Assessment of the TAC Research Program** - The research and truck testing funds invested during the 1980's by the Canadian provinces and territories, the Government of Canada and the Canadian trucking industry under the TAC Heavy Vehicle Weights and Dimensions Research Program have been repaid many times over in terms of these cost savings and economic benefits. The net present value of the cost savings (estimated at $1.87 billion for the 15 years from 1988 to 2002 inclusive) relative to the net present value of the research program cost ($5.7 million) yields a benefit/cost ratio of 328:1, an extremely handsome rate of return. This ratio is estimated to be about twice as high if the net savings for truck traffic using the entire MoU designated network (about twice as big as the NHS network) are included.

- **Regional Benefits** - The most significant benefits from the MoU were experienced in Western Canada, but all regions of the country have experienced substantial net positive benefits. In 1992 Ontario accounted for 40% of the estimated cost savings, the Prairie Provinces for 27%, B.C. for 19%, Quebec for 11%, the Atlantic Provinces for 2.5% and the Territories for 0.3%.

- **Canadian Regulations Largely in Place** - With the recent regulatory changes (since the carrier survey and case studies were completed) to allow 53 foot semitrailers in Ontario, Quebec and the Atlantic Provinces, it would appear that most of the cost reductions in interprovincial trucking movements possible under the MoU have already been achieved or are coming into effect as the industry responds to the new regulations. As suggested by the projected cost savings to 2002, continuing annual savings will be experienced relative to the situation which would have been experienced had the MoU not been brought into effect.

- **Future Harmonization of Cross-Border Regulations** - Perhaps the next major cost savings due to use of more efficient trucks can be achieved with regard to Canadian-U.S. truck movements. In general, under the MoU, Canadian vehicle weights and dimensions regulations are more generous than those on the U.S. interstate highway system although they are generally matched by those of some states, for example, Michigan. A fruitful course of action may therefore be to negotiate with the U.S. federal government and relevant state governments for a commensurate relaxation of their weights and dimensions regulations, which would allow cost savings to carriers and shippers involved in cross-border movements. We understand that there are studies being undertaken in this area.

- **Improved Methodologies** - As pointed out in the Introduction to this report, a major objective of this study was to develop methods and procedures for producing reliable estimates of truck movements by configuration type, trucking cost changes, infrastructure cost changes, road safety impacts and shipper impacts of changes in the volume and mix of truck configurations used on Canada's primary highway system, in particular for interprovincial movements. The study included a systematic assessment of several alternative methodologies for the various components of the estimating procedure, and the methods and models developed and used for the study reflected this evaluation in the context of available data and new data collected as part of this assignment. A useful set of procedures and models has been developed and documented during the course of the study, and these are available for ongoing application.

- **Addressing Data Limitations** - Reflecting the very challenging data limitations which had to be addressed during the study, a major conclusion must be the desirability of implementing an ongoing data collection program, on a regular basis. This is addressed further in the following section.

22.2.3 Future Directions

Major comments regarding future directions in this field, resulting from the insights gained through the study, are as follows:

- **Repetition of Key Surveys** - The study could not have produced quantitative cost savings estimates at the achieved level of reliability without the information provided by the CCMTA Roadside Trucking Survey, truck volume and classification counts data for the National Highway System links provided by the provincial ministries, and the carrier survey and case studies carried out as part of this study. While the relatively small sample size of the CCMTA survey and the carrier survey and case studies is a matter of concern regarding the reliability of study results, sample size uncertainties can be reduced through routine repetition of the surveys, which also provides invaluable time-series data.

- **Regular CCMTA Surveys** - It is therefore recommended that the provincial governments and the federal government, working through the CCMTA and TAC, conduct a roadside trucking survey similar to the 1991 CCMTA survey on a regular basis, say every three to five years. Under such a program, the next survey could be conducted in 1996.

- **Additional Questions and Analysis** - If this recommendation is acted on, consideration should be given to adding a few additional questions to the CCMTA survey: for example, a question to identify the semitrailer length (e.g. 48 feet, 53 feet) of 5- and 6-axle tractor semitrailer combinations. In addition, the complete set of questions should be asked at all survey stations and if possible for trucks moving in both directions, and the locations of survey stations should be reviewed to achieve coverage of intra- as well as inter-provincial and international truck movements. This would add greatly to the completeness and usefulness of the survey. The provincial and federal governments should also consider a program to conduct more analysis of the wealth of data provided by the 1991 CCMTA survey and to carry out comparative studies of that survey with the 1996 and subsequent CCMTA roadside surveys if these are carried out. The cost of such analysis would be small relative to the cost of the actual surveys, and the additional insights into trucking trends, efficiencies and cost implications would be extremely useful as a basis for ongoing transportation policies and programs and to assist carriers and shippers in their ongoing business decisions.

- **Low Response Rate of Carrier Survey** - While the response rate of the carrier survey (about 15%) was relatively low, it was high in comparison with other surveys of trucking companies, which generally run below 10%. This higher response rate is attributable in part to the extensive call-back process followed during the survey, and possibly to the fact that survey staff emphasized to the carriers that the results of this survey and the MoU cost savings study could result in identifying significant benefits to trucking firms and ongoing improvements in trucking regulations.

- **Regular Carrier Surveys and Improved Response Rate** - While it is recognized that senior executives in the trucking industry are under considerable time pressures, it is essential that adequate information be available on this industry which is so important to the economy. We understand that efforts are being made to broaden the existing Statistics Canada surveys of the trucking industry to include information on the use of various vehicle configurations. This would be a very welcome development. If such broadening is not done it would be desirable to repeat a carrier survey to collect information on truck configurations used similar to the survey carried out in this study, perhaps every three or five years.

- **Wide Dissemination of Study Results** - It is also recommended that a summary of the study results be made widely available to trucking firms through the Canadian Trucking Association, provincial trucking associations and TAC, and the benefits of cooperating in the required data collection for studies of this type be emphasized as part of this information program.

The study has demonstrated that very substantial economic benefits to carriers, shippers and the economy at large have been achieved through cooperative efforts to reduce barriers to efficient trucking movements between Canadian provinces. Further improvements are possible, in particular for movements between Canada and the U.S., and the insights gained from this study should prove very helpful in negotiating appropriate regulatory changes with the United States government and the governments of various border States.

APPENDICES

A- ANNOTATED BIBLIOGRAPHY

B - CARRIER SURVEY MAILING LIST AND QUESTIONNAIRE

C- CASE STUDY QUESTIONNAIRES

D - NETWORK AND TRUCK TRAFFIC DATA

E - TRUCK COST DATA

F - INFRASTRUCTURE COST DATA

G- USER GUIDE FOR COMPREHENSIVE IMPACTS MODEL

APPENDIX A

ANNOTATED BIBLIOGRAPHY

Appendix A - Annotated Bibliography

A1. NATIONAL TRANSPORTATION ACT REVIEW COMMISSION STUDY

Nix, F.P., Motor Carrier Transport Study: The Impact of Weight and Dimension Regulations on Trucking; paper prepared for National Transportation Act Review Commission, Ottawa, July 1992.

The purpose of this study was to consider preliminary evidence on the impacts of the 1988 interprovincial agreement allowing heavy, large trucks to operate across Canada on designated highways.

A1.1 Interprovincial Differences

The three main factors explaining interprovincial differences in truck sizes and weights are length limits, axle load limits, and gross vehicle weight (GVW) limits. Even after the 1988 agreement, there remains considerable diversity in truck weight and dimension regulations among the provinces, and the agreement moved Canadian regulations even farther away from U.S. regulations. While some differences in the regulations may have a technical justification, others may not (e.g. restricting semi-trailer length to less than 16.2 metres).

Regarding axle weight and GVW limits, the major differences among the provinces are:

- multiple axle groups (e.g. tri-axles) are allowed on semi-trailers in the eastern provinces, but are not recognized in the western provinces;

- axle load limits in the western provinces are generally lower than in Eastern Canada. There appears to be no real technical basis for these differences;

- multiple axle semi-trailers make it possible for tractor/semi-trailers to have higher GVWs in Eastern Canada. In practice, many tractor/semi-trailers in Eastern Canada operate at weights over 50 tonnes, while the maximum GVW for tractor/semi-trailers in the western provinces is 46.5 tonnes.

Regarding truck length limits, the 1988 agreement made the maximum box length (distance from the front of the first trailer to the rear of trailer(s)) uniform across Canada at 20 metres for B-trains and 18.5 metres for A-trains. However, the 23 metre overall length limit for doubles in the eastern provinces (compared to 25 metres in the west) seriously restricts the length of the tractor that can be used on B-trains while accommodating the full 20 metre box length available. Also, many carriers find that the B-train is not suited for low-density freight due to operational reasons.

The major difference in length limits across Canada is the allowable length of a semi-trailer: 14.65 metres in eastern Canada versus 16.2 metres in western Canada. Also, four provinces allow long combination vehicles (LCVs) under permit, while the other jurisdictions do not. A major change in length regulations in Atlantic Canada since 1985 is that all types of doubles are now generally accepted on all primary highways in the region.

A1.2 Technical Factors

Four main technical factors underlie truck weight and dimension regulations: road geometry, bridges, pavements, and safety/traffic considerations. Vertical and horizontal curvature on two-lane roads may affect truck length regulations. Heavy trucks have two types of impacts on bridges: (i) bridge stress or overstress, which is a function of GVW or axle loads and spacing; (ii) in steel bridges, fatigue occurs as a function of repetitive truck loads. Starting in 1967, axle loads and spacing and GVWs in Ontario were governed by the Ontario Bridge Formula, and other provinces adopted versions of this formula. The Canadian bridge formula is less conservative with respect to allowable bridge overstress than the U.S. formula.

In both Canada and the U.S., the relationship between various axle loads and pavement performance is measured using load equivalency factors (LEFs). TAC's LEFs are based on equivalent impacts of axle loads on pavement surface deflection. However, there remains considerable controversy about the relationship between axle loads and pavement wear, and even regarding whether axle loads are the major factor determining pavement wear in Canada (e.g. climate may play a large role in pavement deterioration). LEFs currently do not capture all factors affecting pavement wear such as axle suspension systems, vehicle speed, temperature, tire types and tire pressures.

The TAC truck weight and dimension regulations are based on a consideration of heavy truck stability and control characteristics such as vehicle off-tracking, rollover thresholds, friction in turns, and others. In comparing accident rates for various configuration types, however, it is difficult to isolate the effects of truck stability and control characteristics from the effects due to the driver, the environment, and other factors. There are two ways in which the new truck configurations allowed by the 1988 agreement could affect accident rates: (i) by changing truck stability and control characteristics; and (ii) through impacts on other traffic, including potential impacts of heavier trucks on speeds on hills and impacts of longer trucks in reducing passing opportunities on two-lane highways. Even if new larger trucks have slightly higher accident rates than the trucks they replace, they may still decrease total accidents because they reduce total truck-kilometres.

A1.3 Barriers

There are six areas in which the differences in regulations result in barriers to trucking, in the sense that they lead to higher trucking costs than would occur if the barrier did not exist. In descending order of importance, these barriers are:

1. **Semi-Trailer Length Limits**: The restriction of semi-trailer length to 14.63 metres (48 feet) in the six eastern provinces, while the western provinces and most U.S. states allow 16.2 metres (53 feet), is an important barrier to trade between Eastern and Western Canada. The technical evidence in this case seems to be in favour of 16.2 metre semi-trailers.

2. **Canadian versus U.S. Regulations**: Maximum axle weights and GVWs in the U.S. remain considerably lower than those in Canada. For example, GVW is limited to 36.3 tonnes on most U.S. highways, compared to 62 tonnes for the TAC B-train across Canada. The result is that most transborder trucking is done using trucks which meet U.S. regulatory requirements. The international border is roughly ten times as important - in terms of truck tonnages - as the Ontario/Manitoba border. The more restrictive U.S. regulations may give U.S.-based carriers a competitive advantage in transborder trucking, since they can use the same truck fleets for transborder and domestic (i.e. within U.S.) movements.

3. **Eastern versus Western Canada**: Remaining differences in semi-trailer length, overall combination length, axle weights and axle types allowed east and west of the Ontario/Manitoba border represent a real nuisance, inconvenience and a small added cost to truck movements across this border.

4. **Road Classes**: In most provinces, roads are designated into several classes with different vehicle size and weight limits. A barrier exists for those commodities or shippers located on lower class roads compared to other commodities/shippers. This can often be the case for bulk resource commodities.

5. **LCV versus non-LCV Jurisdictions**: Four provinces (Quebec, Manitoba, Saskatchewan, and Alberta) allow LCVs on a permit basis, usually on four- lane highways only, while the other Canadian jurisdictions do not. Trucking costs may therefore be higher on certain corridors in the non-LCV jurisdictions than would be the case if they allowed LCVs.

6. **Municipal versus Provincial Regulations**: One city in Canada - Winnipeg - sets its own weight and dimension regulations, and

these have created problems for truckers to operate both on provincial highways and city streets.

A1.4 Conclusions: Impacts of 1988 Agreement

Based on a review of roadside surveys and some truck registration data, the following significant changes to the truck fleet as a result of the 1988 interprovincial agreement are indicated:

Prairies:

- increased weights for 5-axle tractor/semi-trailers;
- rapid switch to 6-axle tractor/semis from 5-axle tractor/semis;
- significant switch to 8-axle B-trains with GVW of 62 tonnes;
- appearance of 16.2 metre semi-trailers;
- similar changes as above for interprovincial routes to/from Prairies;

Ontario:

- little impact except on interprovincial movements;

Quebec:

- 1,400 B-trains with 62.5 tonnes GVW have appeared;

Atlantic:

- 100 TAC B-trains have been introduced.

Regarding impacts on safety, it should be recognized that accident rates for different truck configurations are controversial because other factors (e.g. driver, road type) may not be constant across configuration types. Three Canadian studies show double trailer combinations to have lower accident rates than tractor/semis, while a major U.S. study estimates that doubles have a slightly higher (by 10 percent) accident rate. This U.S. study nevertheless concluded that introducing more double trailer trucks in the U.S. would lower total accidents, due to the reduced vehicle-miles of travel offered by the more productive doubles. Based on the increases in payload offered by the TAC B-train, and the accident rates reported in the literature, the 1988 agreement probably had a very small positive impact on safety.

To examine the potential impacts of the 1988 agreement on pavements, equivalent single axle loads (ESALs) per tonne of payload were calculated and compared for various pre- and post-TAC configurations. In the Prairie provinces, some of the new configurations (e.g. 5-axle tractor/semi-trailer) have higher ESALs per payload tonne than before the agreement, but most others (e.g. 6-axle tractor/semi-trailer, 8-axle B-train) have lower ESALs per tonne. However, diversion of freight from rail to truck could have increased pavement loads. On balance, the conclusion here is that the 1988 agreement likely lowered pavement loads in Canada.

The impact of the 1988 agreement on trucking productivity and costs is relatively straightforward : big trucks haul freight at a lower cost than small trucks. The study presents estimates of the percentage changes in trucking cost per tonne-kilometre offered by the 8-axle TAC B-train, compared with the largest legal trucks before 1988. The TAC B-train offered the potential to lower trucking costs by as much as 23 percent on some routes. While the truck cost savings achieved could not be quantified, the conclusion is simply that the 1988 agreement did lower trucking costs.

A2. LIFTABLE AXLES

Nix, Fred, and Boucher, Michel, Economics of Liftable Axles, published by the Vehicle Technology Office, Transportation Technology and Energy Branch, Ontario Ministry of Transportation, Toronto, April 1991.

Liftable axles are permitted in the Atlantic Provinces, Quebec and Ontario. They are banned in all prairie and western provinces. Liftable axles increase payloads considerably for small increases in operating costs, but are claimed to be less safe and to damage the pavement. This study examines only the economic aspects of liftable axles, leaving the safety issue and the pavement impact to other investigators.

The study's approach is to estimate the operating costs of five truck configurations which are believed to be similar in operating capacity and capability to the currently used vehicles with liftable axles.

The report consists of detailed discussions of the derivation of the costs of the five configurations. Heavy reliance is made on the Trimac factor prices. Some of these are modified where the authors believe the factor prices from Trimac are not appropriate for this particular analysis. A series of sensitivity analyses are also carried out for the parameters which are considered critical or where the validity and accuracy of the cost estimates are questionable.

The authors come to the conclusion that there are trucks available, other than those with liftable axles, which can perform at an economic level very close to trucks with liftable axles. The average cost increase is no more than 1%, though some individual operations may experience increases in the order of 10% to 20%.

A3. U.S. INITIATIVES

Walton, C. Michael, et al., New Trucks for Greater Productivity and Less Road Wear: An Evaluation of the Turner Proposal, Special Report 227, Transportation Research Board, National Research Council, Washington, D.C., 1990.

In 1984 Federal Highway Administrator Francis C. Turner advocated new configurations of trucks to increase the freight transportation productivity while at the same time reducing the wear and tear on the pavement of the roads. The latter was achieved by providing these trucks with a larger number of axles. This type of truck became known as the Turner Truck. Four prototypes of such trucks were developed. Turner trucks would be restricted to designated routes. Although the trucks would be easier on the roads, bridges would have to be reconstructed in order to carry the additional weight. This study estimated what the impact would be on freight productivity, safety, traffic, bridges and pavements if the Turner trucks came into nationwide use, and the consequences of less than nationwide adoption.

The study estimated that if Turner trucks were adopted nation-wide, they would carry 23% of existing combination-truck miles. Resulting lower truck freight rates would attract from rail about 2% of freight ton-miles in trucks which is about 4% of rail ton-miles. In spite of this increase in total ton-miles, it is estimated that the total combination-truck travel would decrease slightly. Turner trucks would make up about 21% of the total. Turner trucks would average about 12% of line-haul operating costs. Aggregate freight costs savings would be 1.4% of the cost of truck freight shipping.

If no special measures were taken to improve safety, the Turner double-trailer prototype would have an accident rate which is slightly worse than the five-axle tractor-semitrailer it would replace and equal to or a little better than the five-axle twin under ideal conditions. Poorer hill climbing and acceleration of a Turner truck would increase traffic conflicts and thus increase congestion. However, the slight reduction in the number of vehicles on the roads due to the higher productivity would more than compensate for this.

The major cost to highway agencies due to the introduction of Turner trucks is the increase in the design capacity of new bridges and the replacement of many existing bridges on designated routes. Costs of replacement and higher maintenance due to increased fatigue are estimated. The annualized cost of replacing those thought necessary were estimated at $403 million.

The cost savings due to reduced pavement wear are estimated at about $729 million annually. This results in an annual saving of $326 million to highway agencies if the road system were maintained at the current level.

Productivity forecasts are based on:

- a review of past analyses of the effects of changes in size and weight regulations;
- comprehensive interviews with selected motor carriers;
- interviews with manufacturers of trucks, trailers and truck components;
- analyses of the use of longer and heavier combinations in regions where they are now used relatively extensively.

The market potential was assessed by region, freight density, length of haul, frequency of partial loads, private or for-hire carriage, route structure loading and unloading facilities and condition, commodities carried, less-than-truckload, truckload low-density van, truckload high-density van, reefer, flatbed, dry bulk, and petroleum and nonpetroleum tanker.

Safety and traffic aspects of the Turner trucks are developed through extensive and tests and analyses. It is pointed out in the report that driver experience and actions as well as weather and road conditions have a much greater impact on safety than vehicle characteristics. But in order to assess the relative safety of Turner trucks to existing trucks, extensive vehicle simulations were conducted by the University of Michigan Transportation Research Institute. Relationships of these results were compared to those developed from accident rates of existing combinations vehicles to estimate the accident rates of Turner trucks. Physical characteristics of the trucks, operational attributes and traffic aspects are all included in the assessment.

Overstress of existing bridges is developed by:

- determining the worst case legal loadings for existing trucks and Turner trucks;
- compiling information on the load-bearing capacities of existing bridges from the National Bridge Inventory of the FHWA;
- identify load-deficient bridges;
- estimate cost of replacing load-deficient bridges;

- estimate percentage of bridges that need to be replaced in order to provide and adequate designated road network for Turner trucks.

The AASHTO pavement wear model is used to estimate the impact of the different axle loads, axle spacing and number of axles of Turner trucks. These estimates take account of the reduction in the number of trucks due to their greater capacities and the increased traffic due to the diversion of traffic from the rail mode.

A4. TRANSPORTATION RESEARCH BOARD INITIATIVE

Hoel, Lester A., et al, Truck Weight Limits: Issues and Options, Special Report 225, Transportation Research Board, National Research Council, Washington, D.C., 1990.

The federal government in the U.S. restricts truck weights on Interstate highways, but grandfather provisions allow states to retain any higher weight regulations they may have had prior to the enactment of the federal limits. This report describes a study which had the purpose of examining four issues:

- elimination of existing grandfather provisions;

- alternative methods for determining gross vehicle weight (GVW) and axle loadings;

- adequacy of the current federal bridge formula; and

- treatment of specialized hauling vehicles (SHCs), such as garbage trucks, dump trucks, and other trucks with short wheel bases that have difficulty complying with the current federal bridge formula.

The study found:

- elimination of the grandfather provision would increase the truck transportation costs of the U.S. by 3.7%.

- eliminating the GVW as the limiting factor and replacing this with the bridge formula would reduce trucking costs by about 1.6%. This cost reduction would cause a modal shift from the rail mode of about 2.2% of rail traffic;

- a number of alternative formulae are examined. Four of these show promise. They would reduce trucking costs but increase bridge costs, but by a smaller amount than the operational savings. It would, however, be practical difficult for highway authorities to obtain the additional funds;

- the proposed maximum weights proposed by the National Truck Weight Advisory Council (NTWAC) to be overly permissive for special trucks.

The productivity projections are based on vehicle miles of travel (VMT) from the Faucet VMT model and prorated to the FHWA forecasts. Furthermore data from performance monitoring system and truck weight data, both from the FHWA, are also used. In-depth interviews provided the background to the estimates for the traffic with new types of trucks. Modal shifts from the rail mode are based on the Intermodal Competition Model of the Association of American Railroads (AAR).

The impact of different configurations on pavement wear are based on equivalent single-axle loads (ESAL) developed by the American Association of State Highway Officials (AASHO). Furthermore, the pavement impact also takes into account the tire pressure, single (versus dual) tires and tire width, suspension system and axle spacing.

The analysis of the impact on bridges takes into account overstress of existing bridges, fatigue-related damage to existing bridges and upgraded design for new bridges.

The handling and stability properties of new truck sizes and configurations are based on reviews of past research based on vehicle simulations and track tests. Available accident data are also used in the development of the estimates. Handling and stability properties that are included are rollover threshold, rearward amplification, braking, steering sensitivity, low-speed offtracking and high-speed offtracking.

The traffic operating characteristics are evaluated for speed on upgrades, freeway merging, weaving and lane changing, downhill operations, intersection operations, traction ability and longitudinal barriers. These are evaluated with the use of accident data.

APPENDIX B

CARRIER SURVEY
MAILING LIST AND QUESTIONNAIRE

EXHIBIT B.1 (1/3)
MAILING LIST FOR CARRIER SURVEY

Amoco Canada Petroleum	Calgary, AB
Ashton Transport	Fort Saskatchewan, AB
Boychuk Transport	Edmonton, AB
Burns Foods (Transport)	Calgary, AB
Byers Transport	Edmonton, AB
Canadian Freightways	Calgary, AB
Caron Transport	Edmonton, AB
Chinook Carriers	Taber, AB
Crone Bros.	Calgary, AB
Duckering's Transport	Red Deer, AB
Economy Carriers	Calgary, AB
Finnie Hauling and Storage	Balzac, AB
Grimshaw Trucking	Edmonton, AB
Hi-Way 9 Express	Drumheller, AB
Koch Services	Brooks, AB
Lafarge Construction	Calgary, AB
H&K Line Trucking	Langdon, AB
MacDonald's Consolidated	Calgary, AB
Mantel's Transport	Calgary, AB
Matco Trans. Systems	Edmonton, AB
McMillan Transport	Medicine Hat, AB
Medalta Transport	Medicine Hat, AB
Mullen Trucking	Aldersyde, AB
Northern Industrial Carriers	Edmonton, AB
Points North Transp.	Edmonton, AB
Porter Trucking Limited	Calgary, AB
Richardson Transport	Calgary, AB
Robinsons' Trucking	Edmonton, AB
Sheppard Bulk Carriers	Calgary, AB
Sokil Transportation	Edmonton, AB
Speedy Heavy Hauling	Taber, AB
Tri-Line Freight Systems	Calgary, AB
Trimac Transportation	Calgary, AB
Veteran Transfer	Sherwood Park, AB
VLR Carriers	Fort Saskatchewan, AB
Westcan Bulk Transport	Sherwood Park, AB
Arrow Transportation	Richmond, BC
Avalon Moving	Penticton, BC
Bandstra Transportation Systems	Smithers, BC
Browning Ferries Industries	Vancouver, BC
Canfor Weldwood Distribution	Burnaby, BC
Costco Wholesale	Burnaby, BC
DCT Chambers Trucking	Vernon, BC
Dolphin Group of Co.	Burnaby, BC
Gray Beverages	Vancouver, BC
Hunterline Trucking	Salmon Arm, BC
International Chemical Express	Vancouver, BC
Island Farms Dairies Co-op	Victoria, BC
Marpole Transport	Richmond, BC
Mercury Express	Coquitlam, BC
Overland Freight Lines	New Westminster, BC
Richmond Transfer	Port Coquitlam, BC
Rocky Mountain Transport	Vernon, BC
Shadow Lines	Coquitlam, BC
South/East Big Freight	Burnaby, BC
St. George Transportation	Kelowna, BC
Sunshine Transport	Richmond, BC
Tyers Transport Group	Prince George, BC
Vedder Transport	Abbotsford, BC
West Rim Express	Surrey, BC
Williams Moving and Storage	Coquitlam, BC
Zenith Transport	Coquitlam, BC
Arnold Bros. Transport	St. Boniface, MB
Atomic Transportation Systems	Winnipeg, MB
Canada Messenger Transportation	Winnipeg, MB
Canada Safeway	Winnipeg, MB
Gardewine North	Winnipeg, MB
Goodbranson Transfer	Selkirk, MB
Grossman Enterprises	Altoma, MB
Kleyson Transport	Winnipeg, MB
Paul's Hauling	Winnipeg, MB
Penner International	Steinbach, MB
Pepsi-Cola Beverages (West)	Winnipeg, MB
Reimer Express Lines	Winnipeg, MB
Southeast Big Freight	Steinbach, MB
Tailleu Construction	Headingley, MB
Transx Ltd.	Winnipeg, MB

EXHIBIT B.1 (2/3)
MAILING LIST FOR CARRIER SURVEY

Albany Cartage Co.	Havelock, NB
Armour Transport	Moncton, NB
J.W. Baughan Ltd.	Sackville, NB
Brookville Transport	Saint John, NB
Brunswick Bulk Transport	Saint John, NB
Canadian Liquid Air	Moncton, NB
Co-op Atlantic	Moncton, NB
Day and Ross	Hartland, NB
Midland Transport	Moncton, NB
Moosehead Breweries	Saint John, NB
Sunbury Transport	Fredericton, NB
McNeill's Transport	Mount Pearl, NF
Bakery Transport	Halifax, NS
Eassons Transport	Berwick, NS
Harold B. Legge Transport	Port Williams, NS
Maritime-Ontario Freight Lines	Dartmouth, NS
Thompson's Transfer	Middletown, NS
Robinson Trucking	Yellowknife, NT
All-Ontario Transport	Mississauga, ON
Al's Cartage	Kitchener, ON
Apache Freight Lines	Stouffville, ON
Atlas Van Lines	Oakville, ON
Auto Haulaway	Oakville, ON
Buckley Cartage	Mississauga, ON
Canada Building Materials	Toronto, ON
Canada Cartage System	Toronto, ON
Canadian Tire Corporation	Toronto, ON
Challenger Motor Freight	Cambridge, ON
Charron Transport	Chatham, ON
Clarke Railfast	Concord, ON
Coca Cola Beverages	Toronto, ON
Concord Transportation	Markham, ON
Cottrell Transport	Mississauga, ON
CP Express & Transport	Toronto, ON
ERB Transport	New Hamburg, ON
Fairway Inc.	Ancaster, ON
Frederick Transport	Dundas, ON
G&W Freightways	Concord, ON
Harland Veinotte	Morrisburg, ON
Harmac Transportation	Markham, ON
Hendrie Transportation	Brampton, ON
Highland Transport	Markham, ON
Hudson's Bay Co.	Toronto, ON
Hutton Transport	Lakeside, ON
Hyndman Transport	Wroxeter, ON
Imperial Oil	Toronto, ON
Laidlaw Carriers	Woodstock, ON
Loeb Inc.	Gloucester, ON
Manitoulin Transport	Gore Bay, ON
Melburn Truck Lines	Mississauga, ON
Meyers Transport	Peterborough, ON
Motorways	Mississauga, ON
Mowat Express	Mississauga, ON
Network Transport	Mississauga, ON
OK Transportation	Scarborough, ON
Peterborough Freight Lines	Peterborough, ON
Purolator Courier	Mississauga, ON
SLH Transport	Toronto, ON
J.D. Smith and Sons	Downsview, ON
Tallman Transport	Welland, ON
TNT Overland Express	Mississauga, ON
Trans-Provincial Freight Carriers	Sault Ste-Marie, ON
Verspeeten Cartage	Tillsonburg, ON
Weston Bakeries	Toronto, ON
XTL Transport	Etobicoke, ON
Agropur - Coop Agroalimentaire	Granby, QC
A.Bergeron & Fils	Amos, QC
Boily Transport	Montreal, QC
Cammionage Intra-Quebec	Dorval, QC
Clarke Transport	Montreal, QC
Corporation Baxter	Pointe-Claire, QC
Corporation de Tapis Peerless	Longueuil, QC
Cremerie de Trois Rivieres	Trois-Rivieres, QC
Croustilles Yum-Yum Enr.	Warwick, QC
Demenagement J.G. Cotnoir Laval	Vilmont, QC
Dominion Textile	Montreal, QC
Express du Midi	Sainte Catherine, QC

IBI GROUP / ADI

EXHIBIT B.1 (3/3)
MAILING LIST FOR CARRIER SURVEY

Fournier Transport	Lacolle, QC
Gosselin Express	Thetford Mines, QC
Groupe Goyette	Saint Hyacinthe, QC
Groupe Jean Coutu	Boucherville, QC
Groupe Jules Savard	Jonquiere, QC
Groupe Robert	Rougemont, QC
Groupe Transport Cabano	Saint Laurent, QC
Groupe V.A.	Laurier Station, QC
Intermodec Inc.	Saint Leonard, QC
J.E. Fortin	Saint Bernard de Lacolle, QC
Kruger Inc.	Montreal, QC
Levy Transport	St-Henri-de-Levis, QC
Marcan Transport	Portneuf, QC
Max24 LTL Inc.	Montreal, QC
MSAS Cargo International	Dorval, QC
Novacor Chimie (Canada)	Montreal, QC
SCT 2000	Saint-Germain-de-Grantham, QC
Transport Asbestos Eastern	Candiac, QC
Transport Asselin	Quebec City, QC
Transport Belmire	Anjou, QC
Transport Besner	Saint Nicholas, QC
Transport Bourassa	St-Jean, QC
Transport Bourret	Drummondville, QC
Transport R. Gervais	Saint-Narcisse, QC
Transport Herve Lemieux	Saint Laurent, QC
Transport Interprovincial	Boucherville, QC
Transport L'Epiphanie	L'Epiphanie, QC
Transport Morneau	Saint Arsene, QC
Transport Papineau	Saint Jerome, QC
Transport RMT	Richelieu, QC
Transport RPR	Cowansville, QC
Transports Provost	Anjou, QC
Trans-Sonic Transport	Dorval, QC
V. Boutin Express	Plessisville, QC
Barry's Transport	Saskatoon, SK
Braunkohle Transport	Saskatoon, SK
Federated Co-op Ltd.	Saskatoon, SK
Jay's Transport	Regina, SK
Kindersley Transport	Saskatoon, SK
Mile West Trucking	Regina, SK
Phoenix Transportation	Saskatoon, SK
Richards Transport	Regina, SK
Ridsdale Transport	Saskatoon, SK
R&G Transport	Regina, SK
Sam's General Trucking	Coleville, SK
Siemens Transport	Saskatoon, SK
SLH	Regina, SK
Weston's Bakeries	Regina, SK
N. Yanke Transfer	Saskatoon, SK
(BTS) Byers Ltd.	Whitehorse, YT

Survey on Impacts of 1988 TAC Memorandum of Understanding

In February 1988, the Council of Ministers of Transportation and Highway Safety endorsed a **Memorandum of Understanding (MoU)** designed to improve uniformity in regulations covering weights and dimensions of commercial vehicles operating between provinces and territories on a nationwide highway system. The MoU was implemented in July 1989.

Five years after the signing of the MoU, the **Transportation Association of Canada (TAC) Research and Development Council and the Canadian Trucking Research Institute (CTRI)** are jointly sponsoring a research project to assess the extent to which the objectives driving the 1988 MoU have been achieved, and to examine how and why changes to the fleet composition took place. The name of this research project is **"Impacts of Canada's Heavy Vehicle Weights and Dimensions Research and Interprovincial Agreement"**, and it is being undertaken by **IBI Group and ADI Limited.**

The research project involves developing methodologies that would estimate changes in truck fleet composition and use attributable to the MoU, and related impacts on transportation costs and savings (including trucking operations, shippers' costs, energy consumption, etc.), total trucking costs, infrastructure costs, and safety, as a function of changes in truck weights and dimensions regulations. The study conclusions will aim to identify remaining impediments and bottlenecks to achieving the objectives of the MoU, and a framework for addressing these challenges. There will be a strong emphasis on providing a reliable assessment of likely future trends, policy and program implications and ways of **continuing to improve the productivity of Canada's trucking industry.**

In a study of this type and size, **it is important to give Canadian carriers an opportunity to describe how the MoU has affected them, and to provide input into the development of programs which will shape their future.** In addition, insights from those who have been directly affected by the MoU are critical in order to give meaning to the raw numbers found in statistical data sources. Therefore, we request your assistance by filling out the attached five-page carrier survey.

The survey form addresses specific changes in your fleet composition and use between 1987 and 1992, the extent to which this has been influenced by the MoU relative to other factors, projections of your fleet size and composition, and related issues. Your comments are also requested regarding priority actions to help achieve further improvements in Canadian trucking productivity, safety and cost-effectiveness. We recognize that it will be difficult to provide old data dating back to 1987 and future estimates, but we ask that you supply your best estimates. For background reference, we have enclosed weights and dimensions drawings for each vehicle configuration from the MoU (attached to the questionnaire).

Would you please mail in your reply as soon as possible to the address on the fax cover. If you prefer, your reply can also be **faxed to my attention at IBI Group, (416) 596-0644**. We would be pleased to answer any questions you may have. **Contact persons for questions are Lee Sims or Maryann Lovicsek (telephone no.: (416) 596-1930) and Ray Barton (telephone no.: (613) 737-9344).**

We thank you kindly for your involvement, and we look forward to receiving your response.

Sincerely,

IBI GROUP

Neal A. Irwin
Managing Director

NAI/sd
Encl.

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G1. Of the total vehicle-kilometres (or vehicle-miles) operated by your company in 1987 and 1992, what percentage of vehicle-kilometres (or vehicle-miles) were operated in each of the following Canadian and U.S. regions?

	Do You Operate in This Area (Please Check)	1987 (% Total veh-km (veh-miles))	1992 (% Total veh-km (veh-miles))
Atlantic Provinces			
Quebec			
Ontario			
Prairie Provinces			
British Columbia			
Territories			
Northeast U.S.			
North Central U.S.			
Northwest U.S.			
Southeast U.S.			
South Central U.S.			
Southwest U.S.			
Total		100%	100%

G2. Please indicate the approximate composition of your fleet in active use in 1987 and 1992, and the projected compositions in 1997 and 2002 by completing the table below:

a) Straight Trucks, Tractors and Semi-Trailers

Year	# of Straight Trucks	# of Tractors (Including Tractors Used with Tandem Trailer Combinations)	# of Semi-Trailers							
			5-Axle or Less (Including Tractor)		6-Axle (Including Tractor)				7-Axle (Including Tractor)	
					Fixed		W/Lift			
			14.6m (48 ft.) or Less	Greater Than 14.6m (48 ft.)	14.6m (48 ft.) or Less	Greater Than 14.6m (48 ft.)	14.6m (48 ft.) or Less	Greater Than 14.6m (48 ft.)	14.6m (48 ft.) or Less	Greater Than 14.6m (48 ft.)
1987										
1992										
1997										
2002										

b) Tandem Trailer Configurations

Year	# of A-Trains*				# of B-Trains*				# of C-Trains*			
	7-Axle (Including Tractor)		8-Axle (Including Tractor)		7-Axle (Including Tractor)		8-Axle (Including Tractor)		7-Axle (Including Tractor)		8-Axle (Including Tractor)	
	18.5m (60.7 ft.) or Less	Greater Than 18.5m (60.7 ft.)	18.5m (60.7 ft.) or Less	Greater Than 18.5m (60.7 ft.)	18.5m (60.7 ft.) or Less	Greater Than 18.5m (60.7 ft.)	18.5m (60.7 ft.) or Less	Greater Than 18.5m (60.7 ft.)	18.5m (60.7 ft.) or Less	Greater Than 18.5m (60.7 ft.)	18.5m (60.7 ft.) or Less	Greater Than 18.5m (60.7 ft.)
1987												
1992												
1997												
2002												

* Number of tractors also to be included in previous totals (e.g. third column of above table for Question G2 a).

G3. We realize that this information may be difficult to provide, but please, to the best of your ability, indicate your company's usage of the various configurations in 1992 and 1987 by completing the table below. Please provide information for the 10 highest volume configurations used by your company in 1992. For configuration type and commodity, please circle the appropriate abbreviation in each row (abbreviations defined below). When indicating vehicle distances, please indicate whether your reply is in units of vehicle-kilometres or vehicle-miles by checking the appropriate box in the column heading.

Configuration Used		Commodity (Please Circle One)			1987				1992			
Truck Type Used (Please Circle One) ST = Straight Trucks TST = Tractor Semi AT = A-Train BT = B-Train CT = C-Train	# Axles	GFT = General Freight Truckload GFL = General Freight Less than Truck-load DB = Dry Bulk LB = Liquid Bulk O = Other	From (Prov. or State)	To (Prov. or State)	# of Move-ments per Year	Avg. GVW per Move-ment (tonnes)	Total Veh-km ☐1 Veh-Miles ☐2	% Veh-km (Veh-Miles) Empty	# of Move-ments per Year	Avg. GVW per Move-ment (tonnes)	Total Veh-km ☐1 Veh-Miles ☐2	% Veh-km (Veh-Miles) Empty
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										

G4. Based on your own experience, how did the 1988 TAC Memorandum of Understanding impact the factors listed in the following chart? Please check the appropriate box in each row and comment briefly on the nature and, if possible, quantitative extent of the impact.

Factor	Impacted: Greatly	Moderately	A Little	Not at All	Nature of Impact
Fleet Mix	☐1	☐2	☐3	☐4	
Markets Served	☐1	☐2	☐3	☐4	
Unit Operating Costs	☐1	☐2	☐3	☐4	
Shipping Rates	☐1	☐2	☐3	☐4	
Shipper Service	☐1	☐2	☐3	☐4	
Safety	☐1	☐2	☐3	☐4	

G5.a) Please indicate the number and type of reportable highway accidents experienced by your firm in 1987 and 1992 by completing the table below:

Year	# Roll-Overs	# Loss of Control of Trailers	# Other
1987			
1992			

b) What were the major factors contributing to the changes in 1987 and 1992 noted in the above table, and to what degree did each factor impact vehicle safety? Were these impacts positive or negative? Please check the appropriate box in each row and comment briefly on the nature and impact of each factor.

Factor	Impacted: Greatly	Moderately	A Little	Not at All	Nature of Impact
Configuration Type	☐1	☐2	☐3	☐4	
Driver Training	☐1	☐2	☐3	☐4	
Other (Please Specify) ______ ______	☐1	☐2	☐3	☐4	
Other (Please Specify) ______ ______	☐1	☐2	☐3	☐4	

G6.a) How has the implementation of the 1988 TAC Memorandum of Understanding affected your firm (e.g. in terms of growth, profitability, geographic coverage, etc.)?

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b) How would you estimate the impact of the following factors compared with the impact of the 1988 Memorandum of Understanding?

Factor	Impacted: More Impact	About the Same	Less Impact	Don't Know	Comments
Deregulation Under 1987 National Transportation Act	□1	□2	□3	□4	
Free Trade Agreement	□1	□2	□3	□4	
Changes in Economic Conditions	□1	□2	□3	□4	
Competition from U.S. Carriers	□1	□2	□3	□4	
Increase in Intermodal/Container Traffic	□1	□2	□3	□4	
Other (Please Specify) ________	□1	□2	□3	□4	
________	□1	□2	□3	□4	

G7. How much do current truck size and weight limits, regional inconsistencies in these limits, variation in enforcement practices, and the extent of the Designated Highway System constrain your operations in the jurisdictions you serve, and if so, how and to what extent? Please comment on the effects of differences in various regions of Canada where relevant.

Constraint	Degree of Constraint: Considerable	Some	Minor	Not at All	Comments
Weights and Dimensions	□1	□2	□3	□4	
Regional Inconsistencies	□1	□2	□3	□4	
Designated Highway System	□1	□2	□3	□4	
Variation in Enforcement Practices	□1	□2	□3	□4	
Other (Please Specify) ________	□1	□2	□3	□4	
________	□1	□2	□3	□4	

G8. What impediments, if any, are there in your area(s) of operation to the increased use of TAC vehicles?

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G9. In your opinion, what impact will the factors listed in the following chart have on your future fleet and operations? Please check the appropriate box in each row and comment briefly on the anticipated nature and extent of the impact.

Factor	Expected to Impact Fleet/Operations:				Expected Nature of Impact
	Greatly	Moderately	A Little	Not at All	
Increasing Influx of U.S. Carriers	☐1	☐2	☐3	☐4	
Increasing Intermodal Traffic (Containers)	☐1	☐2	☐3	☐4	
Increase in Use of Longer Combination Vehicles	☐1	☐2	☐3	☐4	
Implementation of North American Free Trade Agreement (NAFTA)	☐1	☐2	☐3	☐4	

G10. Do you have any additional comments on Question G9?

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G11. Please add any comments you wish to make, regarding the issues raised in this survey and your views on priority actions to help further improve trucking productivity, safety and cost-effectiveness in Canada. Your comments on related regional issues (e.g. affecting those parts of Canada where your firm is most active) would also be appreciated. (Use more space on reverse side of page if needed.)

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G12. Who is the person that we should contact if we have any questions concerning the information on this form?

Name: ____

Company: ____

Position: ____

Telephone No.: ____________________ Fax No.: ____________________

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G1. Du total de véhicules-kilomètres (ou véhicules-miles) parcourues par votre entreprises entre 1987 et 1992, qu'elle était le pourcentage de véhicules-kilomètres (véhicules-miles) fûrent parcourus dans les régions canadiennes ou américaines?

	Pas d'opération (SVP cochez)	1987 (% Total veh-km (veh-milles))	1992 (% Total veh-km (veh-milles)
Provinces atlantique			
Québec			
Ontario			
Provinces des prairies			
Colombie britannique			
Territoires			
Nord-est É.U.			
Nord Central É.U.			
Nord-ouest É.U.			
Sud-est É.U.			
Sud Central É.U.			
Sud-ouest É.U.			
Total		100%	100%

G2. SVP indiquez la composition approximative de votre flotte active de 1987, ainsi que la composition anticipé pour 1997 et 2002 en complétant la table ci-bas:

a) camions porteurs, tracteurs, semi-remorques

Année	# de camions porteurs	# de Tracteurs (Inclus Tracteurs trainant combinaison double remorques	# de Semi-remorques							
			5-essieux ou moins (Inclus Tracteur)		6-essieux (Inclus tracteur)				7-essieux (Inclus Tracteur)	
					Fixes		avec relevable			
			14.6m (48') ou moins	Plus de 14.6m (48')	14.6m (48') ou moins	plus de 14.6m (48')	14.6m (48') ou moins	Plus de 14.6m (48')	14.6m (48') ou moins	Plus de 14.6m (48')
1987										
1992										
1997										
2002										

b) Remorques à deux essieux

Année	# Trains de type A*				# Trains de type B*				# Trains de type C*			
	7-Essieux (Inclus Tracteur)		8-Essieux (Inclus Tracteur)		7-Essieux (Inclus Tracteur)		8-Essieux (Inclus Tracteur)		7-Essieux (Inclus Tracteur)		8-Essieux (Inclus Tracteur)	
	18.5m (60.7') ou moins	Plus de 18.5m (60.7')	18.5m (60.7') ou moins	Plus de 18.5m (60.7')	18.5m (60.7') ou moins	Plus de 18.5m (60.7')	18.5m (60.7') ou moins	Plus de 18.5m (60.7')	18.5m (60.7') ou moins	Plus de 18.5m (60.7')	18.5m (60.7') ou moins	Plus de 18.5m (60.7')
1987												
1992												
1997												
2002												

* Le nombre de tracteurs doit aussi être inclus dans la colonne précédente (e.g. 3ème ci haut à la question G2 a).

G3. Nous sommes conscient que cette information peut être difficile à fournir, cependant nous vous prions de fournir, au meilleur de vos connaissances, l'usage qu'a fait votre entreprises des différentes configurations de véhicules énumérés plus bas en 1992 et 1987. S'il-vous-plaît fournir l'information concernant les dix configurations les plus utilisées en 1992. Concernant les type de configurations et de commodités, nous vous prions d'encercler l'abréviation appropriée dans la rangée correspondante. (les définitions apparaissent plus bas) Lorsque vous indiquez les distances parcourues, veuillez indiquer si l'unité de mesure utilisée est en kilomètres ou miles en cochant la case appropriée au haut de la colonne.

Configuration Utilisée		Commodité (SVP encercler une)			1987				1992			
Encerclez Genre de camion utilisé ST = Porteur TST = Tracteur Semi AT = Train-A BT = Train-B CT = Train-C	# Essieux	GFT = Général chargement plein GFL = Général lots brisés DB = Vrac sec LB = Vrac liquide O = autre	De (Prof. ou État)	À (Prof. or État)	# de Mouvements par année	MTC moyenpar Mouvement (tonnes)	Total Veh-km □1 Veh-Milles □2	% Veh-km (Veh-Milles) vide	# de Mouvements par année	MTC moyenpar Mouvement (tonnes)	Total Veh-km □1 Veh-Milles □2	% Veh-km (Veh-Milles) vide
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										
ST TST AT BT CT		GFT GFL DB LB O										

G4. Selon votre expérience, comment l'entente ACT de 1988 a t'elle influencer les facteurs indiqués dans la charte plus bas? Veuillez cocher la case appropriée dans chaque rangée et nous fournir un bref commentaire concernant la nature et, lorsque possible, l'étendue quantitative de l'impact.

Facteur	Impact: Grand	Modéré	peut	pas du tout	Nature de l'impact
Composition de la flotte	□1	□2	□3	□4	
Marchés servis	□1	□2	□3	□4	
coûts d'opération par unité	□1	□2	□3	□4	
Taux	□1	□2	□3	□4	
Qualité du service	□1	□2	□3	□4	
Sécurité	□1	□2	□3	□4	

G5.a) S,il-vous-plaît, nous indiquer le nombre et la nature des accidents de la route impliquant votre entreprise en 1987 et 1992 en complétant le tableau ci-bas:

année	# Renversements	# Pertes de contrôles de la remorque	# autres
1987			
1992			

b) Des facteurs notés dans la table plus haut, en 1987 et 1992, quels ont le plus contribués aux changements et que fût l'impact de ces changements sur la sécurité routière? Les impacts ont-ils étés positif ou négatif? S'il-vous plaid cocher la case approprié dans chaque rangée et décrivez brièvement sur la nature et l'impact de chaque facteur.

Facteur	Impact: Grand	Modéré	Peut	Pas du tout	Nature de l'impact
Configuration	□1	□2	□3	□4	
Formation des conducteurs	□1	□2	□3	□4	
Autre (SVP indiquez) ____ ____	□1	□2	□3	□4	
Autre (SVP indiquez) ____ ____	□1	□2	□3	□4	

G6.a) Comment l'implantation de l'entente de 1988 a t'elle affectée votre entreprise? (ex. croissance, rentabilité, territoire servi, etc.).

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b) Comment évalueriez vous l'impact des facteurs suivant lorsque comparés à l'impact de l'entente ATC de 1988?

Facteur	Impact: plus grand	Presque même	moins	Ne sait pas	Commentaires
Déréglementation par la loi sur le transport de 1987	☐1	☐2	☐3	☐4	
Entente de libre échange	☐1	☐2	☐3	☐4	
Changements dans les conditions économiques	☐1	☐2	☐3	☐4	
Compétition des transporteurs américains	☐1	☐2	☐3	☐4	
Accroissement du trafic intermodal/conteneurs	☐1	☐2	☐3	☐4	
Autres (SVP indiquez) ______	☐1	☐2	☐3	☐4	
______	☐1	☐2	☐3	☐4	

G7. Veuillez indiquer comment les limites de masses et dimensions actuelles, les variances dans les méthodes d'applications des règlements, les routes désignées sont des contrainte pour votre entreprise et si oui, l'importance de ces contraintes. S'il-vous-plaît fournir vos commentaires concernant les différences vécues par votre entreprise dans les différentes régions canadiennes lorsqu'elles sont pertinentes.

Contrainte	Influence de la contrainte: Considérable	marqué	Mineur	Aucun	Commentaires
Masses et Dimensions	☐1	☐2	☐3	☐4	
Différents régionaux	☐1	☐2	☐3	☐4	
Système de routes désignées	☐1	☐2	☐3	☐4	
Différents dans les méthodes d'application	☐1	☐2	☐3	☐4	
Autres (veuillez indiquer) ______	☐1	☐2	☐3	☐4	
______	☐1	☐2	☐3	☐4	

G8. Dans votre genre de service, existent-ils des empêchements à l'usage accrue des configurations de véhicules de l'entente ATC?

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G9. Selon vous, quel influence les facteurs énumérés dans la charte plus bas auront-ils sur votre flotte et ses opérations futures? Veuillez cocher la case appropriée de chaque rangée et émettre vos commentaires sur la nature et l'étendue de l'impact.

Facteur	Impact anticipé sur les opération/ flotte:				Commentaires sur l'impact anticipé
	Grand	Modéré	Peut	Pas du tout	
Augmentation d'entré des transporteurs américains	☐1	☐2	☐3	☐4	
Augmentation du trafic intermodal/conteneur s	☐1	☐2	☐3	☐4	
Augmentation de l'utilisation de véhicules longs	☐1	☐2	☐3	☐4	
Mise en oeuvre de L'entente de libre échange nord-américaine	☐1	☐2	☐3	☐4	

G10. Avez vous des commentaires additionnels à la question G9?

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G11. Veuillez nous faire vos commentaires sur les points soulevés dans ce questionnaire ainsi que vos opinions sur les actions prioritaires afin d'aider à accroître la productivité, sécurité de rentabilité du camionnage au Canada. Vos commentaires concernant les dossiers régionaux (ex. les endroits au Canada où votre entreprise est active seraient aussi appréciées. (utilisez l'endos de la formule si nécessaire)

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G12. Qui est la personne à contacter si plus d'information nous est nécessaire concernant vos réponses?

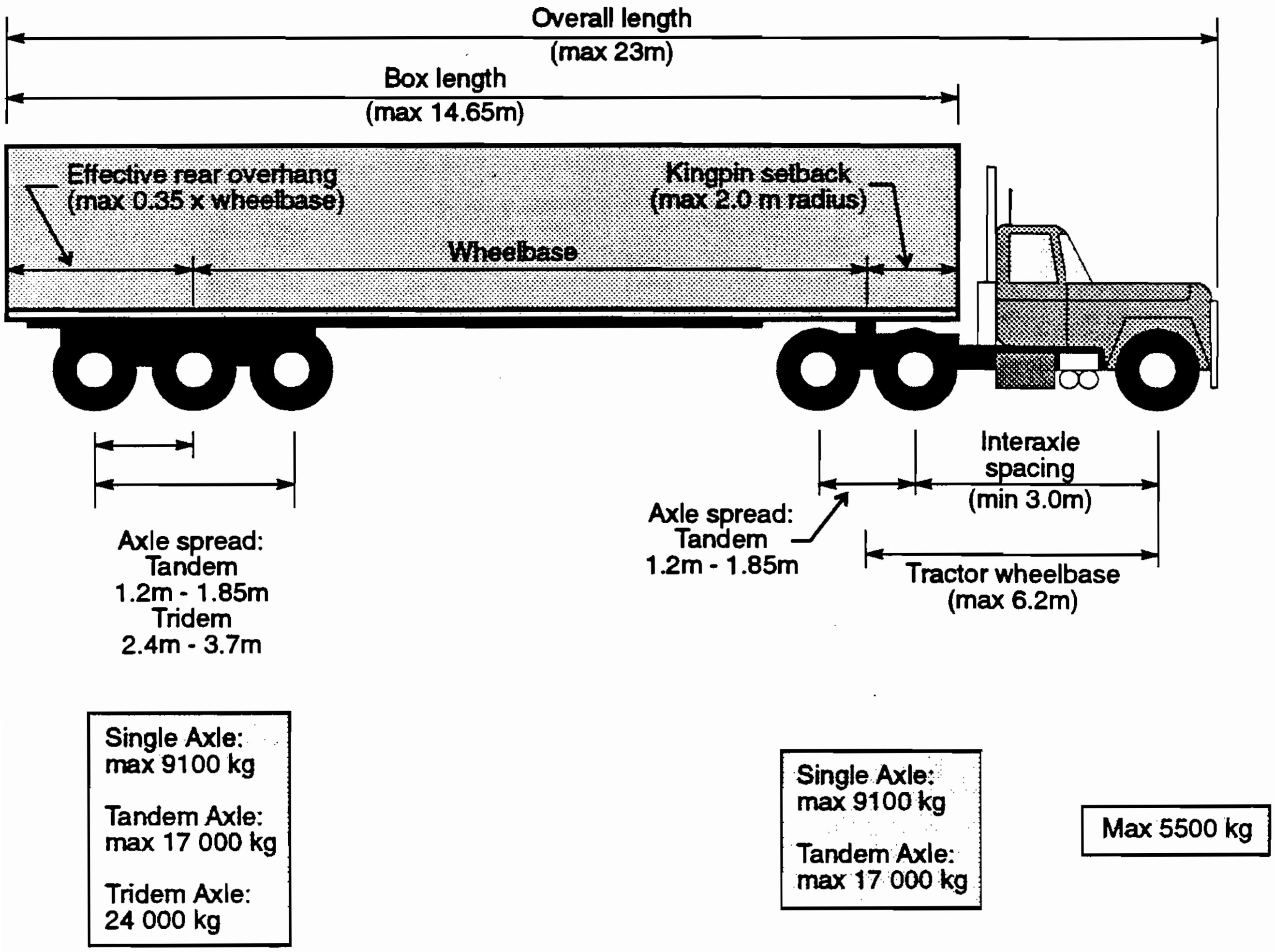
Nom: ______________________________

Entreprise: ______________________________

Titre: ______________________________

Téléphone : ____________________ Fax : ____________________

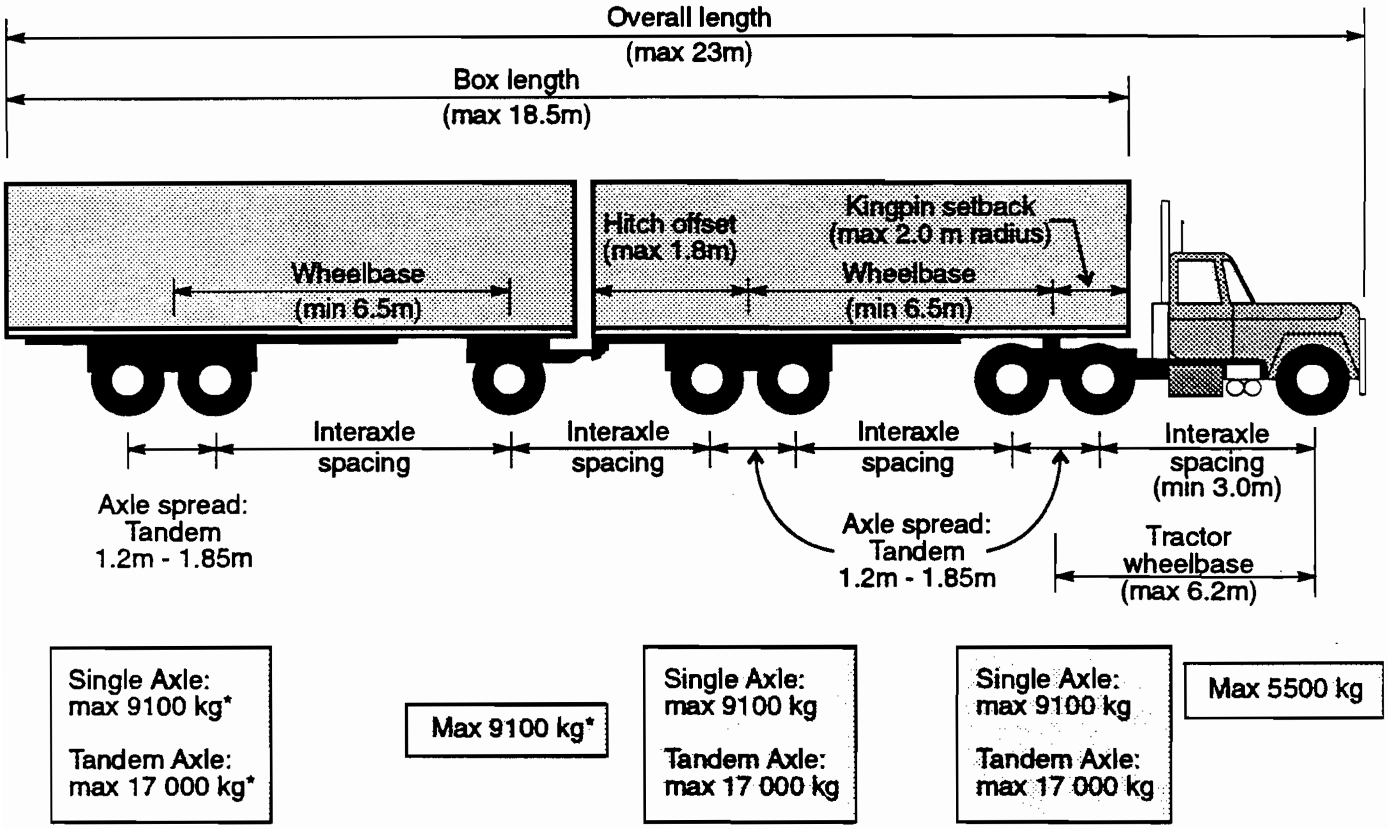
TRACTOR SEMITRAILER



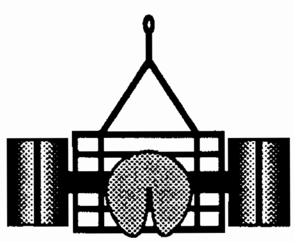
MAXIMUM GROSS COMBINATION WEIGHTS

3 axles......23 700 kg
4 axles......31 600 kg
5 axles......39 500 kg
6 axles......46 500 kg

A TRAIN DOUBLE



* Second trailer limited to a maximum weight of 16 000 kg or weight of lead trailer, whichever is lower.

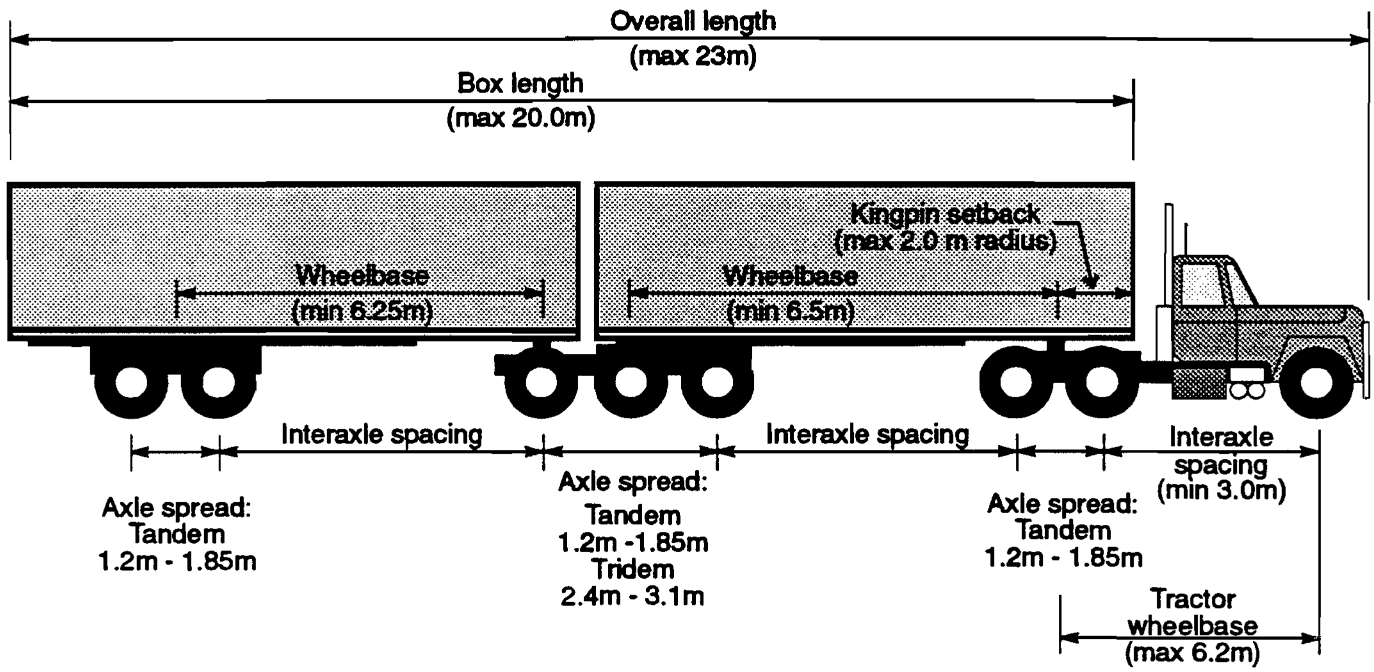


"A" Hitch

MAXIMUM GROSS COMBINATION WEIGHTS

5 axles......39 700 kg
6 axles......47 600 kg
7 axles......53 500 kg
8 axles......53 500 kg

B TRAIN DOUBLE



Single Axle:
max 9100 kg

Tandem Axle:
max 17 000 kg

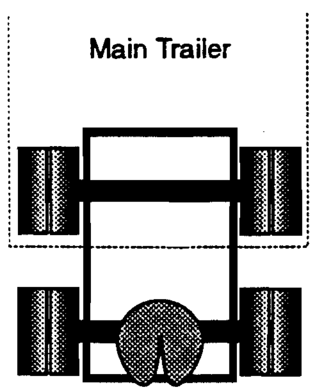
Tandem Axle:
max 17 000 kg

Tridem Axle:
max 23 000 kg

Single Axle:
max 9100 kg

Tandem Axle:
max 17 000 kg

Max 5500 kg

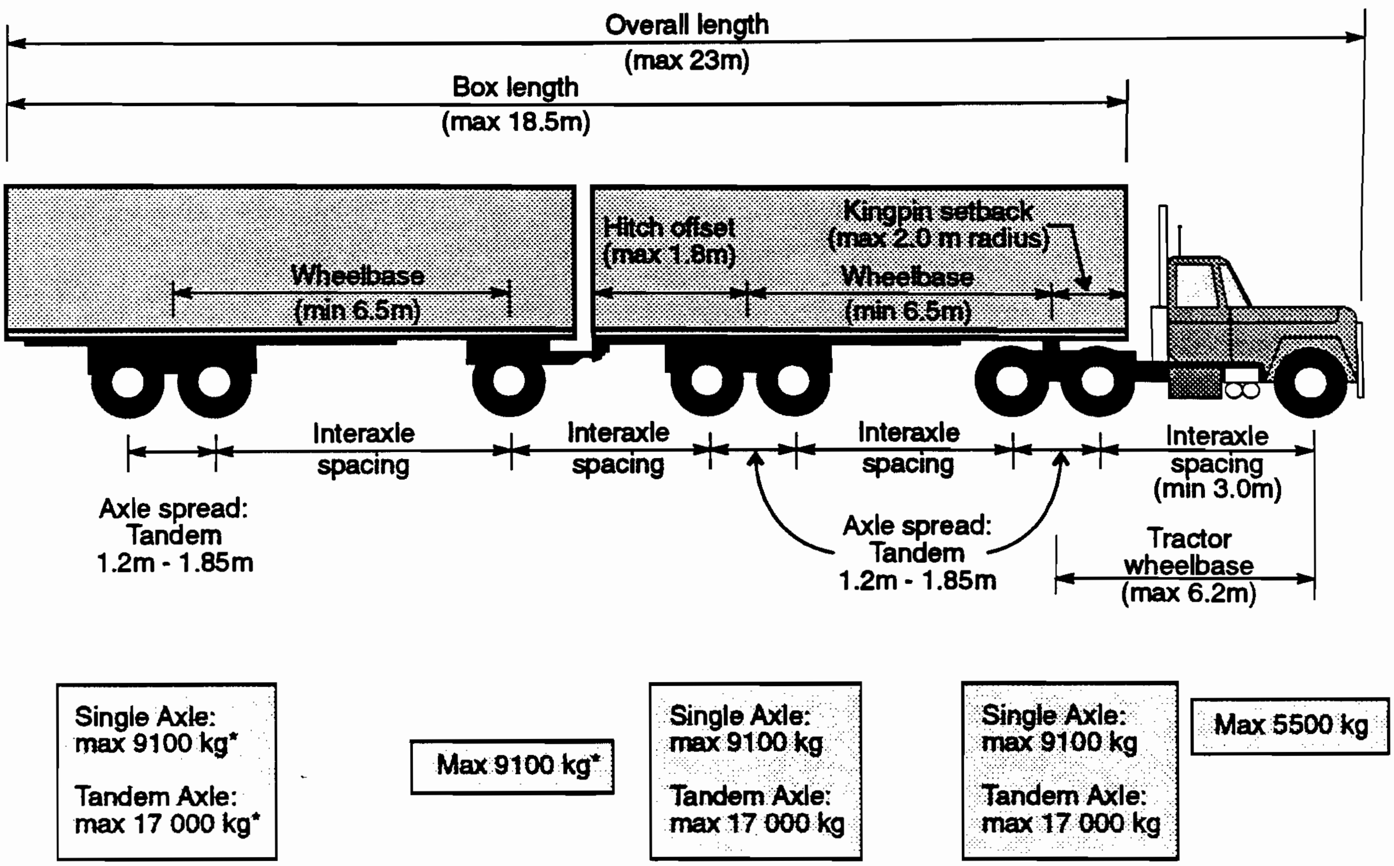


"B" Hitch

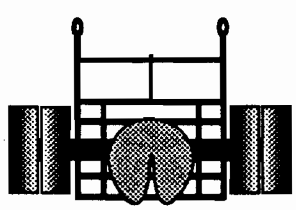
MAXIMUM GROSS COMBINATION WEIGHTS

5 axles......40 700 kg
6 axles......48 600 kg
7 axles......56 500 kg
8 axles......62 500 kg

C TRAIN DOUBLE



* Second trailer limited to a maximum weight of 16 000 kg or weight of lead trailer, whichever is lower.



"C" Hitch

MAXIMUM GROSS COMBINATION WEIGHTS

5 axles......39 700 kg
6 axles......47 600 kg
7 axles......53 500 kg
8 axles......53 500 kg

APPENDIX C

CASE STUDY QUESTIONNAIRES

CARRIER CASE STUDY ON
IMPACTS OF 1988 TAC MEMORANDUM OF UNDERSTANDING

INTERVIEWEE:

GENERAL DESCRIPTION

QUESTIONS:

C1. We realize that this information may be difficult to provide, but please, to the best of your ability, indicate the most important configurations (up to 3 for each year) for specific North American routes in 1987 and 1992, by filling in the following pages. Please provide information for the 10 highest volume routes served by your company in 1992. For commodity and configuration type, please circle the appropriate abbreviation in each row. (Abbreviations defined below.)

For each of the top 10 routes in 1992, please indicate the reasons for change between 1987 and 1992 (e.g. increased loads possible through 1988 MoU, deregulation under the 1987 National Transportation Act, the Free Trade Agreement, economic boom and recession, influx of U.S. carriers into Canada, increase in intermodal/container traffic, tax levels, exchange rate, changes in freight flows, etc.). If no change occurred, why not? Also, please comment on the cost impacts and safety impacts associated with each configuration change.

Type:

ST = Straight Trucks
TST = Tractor Semi-Trailer
AT = A-Train
BT = B-Train
CT = C-Train

Commodity:

GFT = General Freight Truckload
GFL = General Freight less than Truckload
DB = Dry Bulk
LB = Liquid Bulk
O = Other

Route 1

Commodity Group(s) (Please Circle)	Route		Major Commodities (Please List)
	Major Origin	Major Destination	
GFT GFL DB LB O			

Truck Configurations Normally Used				# of Movements Per Year		% Veh-km (Veh-Miles) Empty	
1987		1992					
Type (Please Circle)	# Axles	Type (Please Circle)	# Axles	1987	1992	1987	1992
ST TST AT BT CT		ST TST AT BT CT					
ST TST AT BT CT		ST TST AT BT CT					
ST TST AT BT CT		ST TST AT BT CT					

% of company's total veh-km (veh-miles) represented by this route:

- in 1987 ____________% • in 1992 ____________%

% of company's total revenue represented by this route:

- in 1987 ___________% • in 1992 ___________%

Is the market represented by this route:

Increasing ☐1 Decreasing ☐2 Holding Steady ☐3

Reasons for change or no change (by configuration type):

Route 10

Commodity Group(s) (Please Circle)	Route		Major Commodities (Please List)
	Major Origin	Major Destination	
GFT GFL DB LB O			

Truck Configurations Normally Used				# of Movements Per Year		% Veh-km (Veh-Miles) Empty	
1987		1992					
Type (Please Circle)	# Axles	Type (Please Circle)	# Axles	1987	1992	1987	1992
ST TST AT BT CT		ST TST AT BT CT					
ST TST AT BT CT		ST TST AT BT CT					
ST TST AT BT CT		ST TST AT BT CT					

% of company's total veh-km (veh-miles) represented by this route:

- in 1987 ____________% • in 1992 ____________%

% of company's total revenue represented by this route:

- in 1987 ____________% • in 1992 ____________%

Is the market represented by this route:

Increasing ☐₁ Decreasing ☐₂ Holding Steady ☐₃

Reasons for change or no change (by configuration type): ______________________

____

C2. Has your firm been able to serve new markets as a result of new vehicle types allowed by the 1988 TAC Memorandum of Understanding? If so, what are the major new markets that have become available, and which of the routes identified in Question C1 do they affect and how?

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C3. Do regional inconsistencies in truck size and weight limits on the Designated Highway System constrain your operations in the jurisdictions you serve? If so, what types of constraints do you experience, and which of the routes identified in Question C1. do they affect and how?

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C4. How have the changes in truck configuration experienced by your firm between 1987 and 1992 affected in general the following vehicle characteristics:

a) Suspension Systems: ____________________

____

b) Tire Widths: ____________________

____

c) Tire Pressures: ____________________

____

d) Use of Single vs. Dual Tires: ____________________

____

C5. What changes in vehicle configurations do you anticipate for your firm over the next five years, and what are the reasons for these changes?

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C6. What further regulatory changes would you suggest to improve the trucking industry, and what would you see to be the impact of these regulatory changes?

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QUESTIONS:

C1. Nous sommes conscient que les informations demandées peuvent être difficiles à obtenir, cependant nous vous demandons de bien vouloir nous fournir, au meilleur de vos connaissances, les configurations de véhicules les plus importantes (jusqu'à 3 par année) pour des routes nord-américaines spécifiées en 1987 et 1992. Veuillez nous indiquer les 10 routes à plus haut volume pour votre entreprise en 1992. Concernant les commodités et configurations de véhicules veuillez cercler l'abréviation appropriée dans chaque rangée. (une définition est fournie plus bas).

Pour chacune des 10 routes de 1992, veuillez indiquer les raisons de changements depuis 1987 (ex. augmentation de charge possible via entente de 1988, déréglementation par Loi sur le transport de 1987, entente de libre échange, augmentation économique ou récession, intrusion des transporteurs américains, augmentation du volume intermodal\conteneurs, niveau de taxation, taux d'échange, changements dans le flot de circulation des biens, etc.) Si aucun changement ne s'est produit, quel en est la raison? Veuillez aussi apporter vos commentaire concernant l'impact sur les coûts et la sécurité de chacune des configuration.

Type:		**Commodité:**	
ST	= Camion porteur	GFT	= Générale charges entières
TST	= Tracteur Semi-remorque	GFL	= Générale lots brisés
AT	= Train de type A	DB	= Vrac sec
BT	= Train de type B	LB	= Vrac liquide
CT	= Train de type C	O	= Autre

Route 1

Groupe(s) de Commodité (Veuillez encercler)	Route		Commodité principales (Veuillez inscrire)
	Origine principale	Destination principale	
GFT GFL DB LB O			

Configurations de véhicules généralement utilisées				# de déplacements annuels		% Veh-km (Veh-Milles) vide	
1987		1992					
Type (Veuillez encercler)	Essieux	Type (Veuillez encercler)	Essieux	1987	1992	1987	1992
ST TST AT BT CT		ST TST AT BT CT					
ST TST AT BT CT		ST TST AT BT CT					
ST TST AT BT CT		ST TST AT BT CT					

% du millage total de la compagnie représenté par cette route:

- 1987 ____________%
- 1992 ____________%

% du revenu total de la compagnie représenté par cette route:

- 1987 ____________%
- 1992 ____________%

Le marché représenté par cette route est:

Augmentant ☐1 Décroissant ☐2 Stable ☐3

Raisons des changements ou stabilité (par configuration): ____________________

____

Route 10

Groupe(s) de Commodité (Veuillez encercler)	Route		Commodité principales (Veuillez inscrire)
	Origine principale	Destination principale	
GFT GFL DB LB O			

Configurations de véhicules généralement utilisées				# de déplacements annuels		% Veh-km (Veh-milles) vide	
1987		1992					
Type (Veuillez encercler)	Essieux	Type (Veuillez encercler)	Essieux	1987	1992	1987	1992
ST TST AT BT CT		ST TST AT BT CT					
ST TST AT BT CT		ST TST AT BT CT					
ST TST AT BT CT		ST TST AT BT CT					

% du millage total de la compagnie représenté par cette route:

- 1987 ____________%
- 1992 ____________%

% du revenu total de la compagnie représenté par cette route:

- 1987 ____________%
- 1992 ____________%

Le marché représenté par cette route est:

Augmentant ☐1 Décroissant ☐2 Stable ☐3

Raisons des changements ou stabilité (par configuration): ________________________

____

C2. Votre entreprise a t'elle, grâce à l'entente de 1988, été en mesure de desservir des nouvelles routes? Si oui, quels sont les principaux nouveaux marchés qui sont devenus possible, et quels sont les routes impliquées dans la question C1 et comment le sont-elles?

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C3. Les différences régionales dans les réglementations de masses et dimensions des juridictions que vous desservez affectent-elles vos opérations sur le système de routes désignées? Si oui, quels sont les contraintes qui vous sont imposées, et quelles sont les routes de la question C! qui sont impliquées et comment?

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C4. Comment les changements dans les configurations des véhicules entre 1987 et 1992 ont-ils affectés votre entreprise, concernant les points suivant:

a) Suspensions: ____

____

b) Largeur des pneus: ____

____

c) Pression des pneus: ____

____

d) Utilisation de pneus simples vs pneus jumelés:

____

C5. Quels changements dans la configurations de véhicules anticipez vous dans les prochains cinq ans, et quels en sont les raisons?

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C6. Quels changements apporteriez vous à la législation afin d'améliorer l'industrie du camionnage, et qu'envisagez vous être l'impact de ces changements législatifs?

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COVERAGE:

- 12 Ministry case studies to be conducted, one for each province/territory.

QUESTIONS:

M1. What changes in heavy truck patterns from 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

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M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

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b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

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M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

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b) Resurfacing Practices

c) New Road Construction

d) Bridge Maintenance

e) Bridge Construction

f) Weigh Stations

g) Roadside Rest Areas

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

REGION-SPECIFIC QUESTIONS

Please respond to questions for those regions relevant to your operations.

ATLANTIC PROVINCES

CA1. Based on your own experience, have the following specific changes in Atlantic Canada affected your operations? If so, how and to what extent?

a) Increased allowable length of 23m (75 ft.) for tractor-trailers and doubles on the Designated Highway System only:

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b) Introduction of 8-axle B-train, with allowable GVW of 62.5 tonnes on the Designated Highway System only:

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QUEBEC

CQ1. Based on your own experience, have the following specific changes in Quebec affected your operations? If so, how and to what extent?

a) Introduction of 8-axle B-train, with allowable GVW of 62.5 tonnes and combination length of 25m (82 ft.) on the Designated Highway System only:

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b) Restrictions on multiple axle (e.g. quadaxle) vehicles:

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c) Restrictions on allowable GVW (59 tonne maximum) off the Designated Highway System:

ONTARIO

CO1. Based on your own experience, has the introduction of the 8-axle TAC B-train, with an allowable GVW of 62.5 tonnes, affected your operations? If so, how and to what extent?

CO2. Based on your own experience, has the introduction of the 16 metre (53 foot) trailer affected your operations? If so, how and to what extent?

PRAIRIE PROVINCES

CP1. Based on your own experience, have the following specific changes in the Prairie Provinces affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailer combinations:

b) Increased allowable GVW for 5-axle tractor-trailers:

c) Increased allowable GVW for 6-axle units:

d) Increased allowable GVW for B-trains:

BRITISH COLUMBIA

CB1. Based on your own experience, have the following specific changes in British Columbia affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailers and doubles:

b) Restrictions on previous GVW limits for 6-axle tractor-trailers and A-trains:

TERRITORIES

CT1. Based on your own experience have the following specific changes in the Yukon and Northwest Territories affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailers and doubles:

b) Increased allowable gross vehicle weights (Northwest Territories only):

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QUESTIONS:

S1. Has the 1988 TAC Memorandum of Understanding impacted truck shipping rates charged to your firm? If so, how and to what degree?

S2. Were any changes required to the dock areas operated by your firm to accommodate the larger vehicles allowed for in the 1988 TAC Memorandum of Understanding (e.g. changes in configuration, changes in operation, etc.)? What were the cost impacts, if any, associated with these changes?

S3. In addition to the 1988 TAC Memorandum of Understanding, what other factors have affected truck shipping rates charged to your firm between 1988 and 1992 (e.g. deregulation under the 1987 National Transportation Act, poor economic climate, the Free Trade Agreement, influx of U.S. carriers to Canada, increase in intermodal/container traffic, etc.)? To what degree did each of these factors affect the rates?

S4. Have any new markets or extensions of market areas been made available to your firm as a result of the 1988 TAC Memorandum of Understanding? If so, what are these new markets, and approximately what annual volumes do they represent (e.g. tonnes, cubic metres, etc.)

Location	Commodity	Annual Volume	Unit (tonne, m^3, etc.)

S5. Please outline any other opportunities or changes that have resulted from the implementation of the 1988 TAC Memorandum of Understanding, e.g. warehousing, relocation opportunities, fewer loading docks, centralizing of inventories, etc.

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COVERAGE:

- 3 trailer manufacturer and distributor case studies to be conducted, broken down as follows:
  - Atlantic Provinces/Quebec: 1
  - Ontario: 1
  - Prairie Provinces/British Columbia: 1

QUESTIONS:

F1. What changes in sales of trailers of different sizes has your firm experienced between 1987 and 1992, and what were the major reasons in your view?

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F2. Were any of the changes noted in Question F1. specific to a certain province/territory or region of Canada? If so, which areas were impacted by each of these changes?

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F3. How have the changes in trailer sales between 1987 and 1992 impacted the following vehicle characteristics?

a) Suspension Systems: ______________________________

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b) Tire Widths: ______________________________

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c) Tire Pressures: ______________________________

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d) Use of Single vs. Dual Tires: ______________________________

F4. In general, when regulations allowing less restrictive trailer sizes and configurations are implemented, how does your firm perceive the response from carriers in the form of customer orders (e.g. quick to respond, large/insignificant response, etc.)?

F5. What changes in the manufacture of trucking equipment of various sizes do you anticipate over the next five years, and what reasons support these changes?

TRAILER MANUFACTURER AND DISTRIBUTOR CASE STUDY ON IMPACTS OF 1988 TAC MEMORANDUM OF UNDERSTANDING

REGION-SPECIFIC QUESTIONS

Please respond to questions for those regions relevant to your operations.

ATLANTIC PROVINCES

CA1. Based on your own experience, have the following specific changes in Atlantic Canada affected your operations? If so, how and to what extent?

a) Increased allowable length of 23m (75 ft.) for tractor-trailers and doubles on the Designated Highway System only:

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b) Introduction of 8-axle B-train, with allowable GVW of 62.5 tonnes on the Designated Highway System only:

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QUEBEC

CQ1. Based on your own experience, have the following specific changes in Quebec affected your operations? If so, how and to what extent?

a) Introduction of 8-axle B-train, with allowable GVW of 62.5 tonnes and combination length of 25m (82 ft.) on the Designated Highway System only:

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b) Restrictions on multiple axle (e.g. quadaxle) vehicles:

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c) Restrictions on allowable GVW (59 tonne maximum) off the Designated Highway System:

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ONTARIO

CO1. Based on your own experience, has the introduction of the 8-axle TAC B-train, with an allowable GVW of 62.5 tonnes, affected your operations? If so, how and to what extent?

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CO2. Based on your own experience, has the introduction of the 16 metre (53 foot) trailer affected your operations? If so, how and to what extent?

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PRAIRIE PROVINCES

CP1. Based on your own experience, have the following specific changes in the Prairie Provinces affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailer combinations:

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b) Increased allowable GVW for 5-axle tractor-trailers:

c) Increased allowable GVW for 6-axle units:

d) Increased allowable GVW for B-trains:

BRITISH COLUMBIA

CB1. Based on your own experience, have the following specific changes in British Columbia affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailers and doubles:

b) Restrictions on previous GVW limits for 6-axle tractor-trailers and A-trains:

TERRITORIES

CT1. Based on your own experience have the following specific changes in the Yukon and Northwest Territories affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailers and doubles:

b) Increased allowable gross vehicle weights (Northwest Territories only):

APPENDIX D

NETWORK AND TRUCK TRAFFIC DATA

Appendix D: Network and Truck Traffic Data

TRAFFIC PROJECTION MODEL

Example of Data:

Exhibit D.1 shows a portion of the resulting matrix of traffic after the projection procedure for the year 1997 with the MoU. The entries are vehicle-kilometres. The full matrix is 40 columns by 32 rows, not counting the blank columns and rows used as dividers between configurations and regions. This format matches that of the input from the Base Traffic Model.

Exhibit D.2 presents the estimated truck configuration profiles for the four model years, in each of the six regions, as described in Section 18 of Part III. These numbers are illustrated by Exhibit 18.3 in Part III, and formed part of the input to the Traffic Projection Model.

CCMTA SURVEY SITES

Exhibit D.3 is a list of the CCMTA survey locations, and gives the number of usable interviews conducted in each province.

BASE TRAFFIC MODEL

Exhibit D.4 is a province-by-province summary of estimated traffic volumes, based on the NHS and CCMTA databases and the Carrier Survey. The production of these volumes is described in Part II, Section 15.

Exhibit D.5 is a detailed breakdown, by region, of the vehicle-kilometres operated using all major configurations. This exhibit is a consolidation of the results in D.4; it contains the control totals which were used to modify the Carrier Survey Results for 1992, and subsequently to factor the results for other years. The second page presents the same information, expressed as percentages. Straight trucks, 7-axle semitrailers, and LCV's (9 axles or more) were not considered in the Truck Cost Impacts Component of the Study, but are included here as part of the traffic modelling process.

The estimates of vehicle-km by truck type in 1992, summarized in Exhibit D.5, should be treated with caution - for reasons discussed in Chapter 15 - and are not to be taken as indicators of truck types on non-NHS highway sections.

The vehicle kilometres in Exhibit D.5 were subdivided by major O/D pair to produce an input matrix similar to Exhibit D.1.

EXHIBIT D.1

PART OF OUTPUT MATRIX FROM THE TRAFFIC PROJECTION MODEL

FOR THE YEAR 1997 WITH THE MoU, ANNUAL TRAFFIC GROWTH (192-1997) OF 2% p.a.

ENTRIES ARE VEHICLE-KILOMETRES IN MILLIONS

(9 OF THE 40 COLUMNS SHOWN)

		Configurations									
	O/D	s5x	s5x	s5x	s5x	s5x		c8x	c8x	c8x	c8x
Region	Pair	c	w	cw	p	e		w	cw	p	e
1	1-1	75.01	4.51	7.38	82.41	37.06	....	0.00	0.00	0.00	0.00
1	1-2	24.86	1.49	2.45	27.16	10.47	....	0.00	0.00	0.00	0.00
1	1-3	17.69	1.05	1.75	19.44	8.52	....	0.00	0.00	0.00	0.00
1	1-7	7.56	0.44	0.74	8.34	4.13	....	0.00	0.00	0.00	0.00
1	1-OTH	1.36	0.08	0.13	1.51	0.80	....	0.00	0.00	0.00	0.00
2	1-2	59.17	1.09	3.98	23.75	19.43	....	0.00	0.00	0.00	0.00
2	1-3	33.80	0.63	2.31	13.76	10.13	....	0.00	0.00	0.00	0.00
2	2-2	107.68	1.99	7.37	43.65	35.24	....	0.00	0.00	0.00	0.00
2	2-3	269.03	4.99	18.53	108.30	95.06	....	0.00	0.00	0.00	0.00
2	2-7	67.63	1.32	4.88	27.21	26.44	....	0.00	0.00	0.00	0.00
2	2-OTH	24.86	0.45	1.72	10.13	9.39	....	0.00	0.00	0.00	0.00
3	2-3	381.95	20.10	41.18	385.03	228.56	....	0.00	0.00	0.00	0.00
3	2-4	26.26	1.36	2.82	26.62	14.10	....	0.00	0.00	0.00	0.00
3	2-7	62.54	3.25	6.72	63.11	41.95	....	0.00	0.00	0.00	0.00
3	3-3	121.10	6.10	12.57	122.92	73.25	....	0.00	0.00	0.00	0.00
3	3-4	113.66	5.34	11.34	115.63	71.38	....	0.00	0.00	0.00	0.00
3	3-OTH	73.11	3.96	8.02	73.61	43.97	....	0.00	0.00	0.00	0.00
4	2-4	4.17	0.22	0.39	2.30	3.39	....	0.00	0.00	0.00	0.00
4	3-4	18.09	0.91	1.61	9.99	14.79	....	0.00	0.00	0.00	0.00
4	3-5	7.39	0.37	0.66	4.08	5.91	....	0.00	0.00	0.00	0.00
4	4-4	141.17	7.08	12.79	77.40	110.10	....	2.78	1.43	0.00	2.24
4	4-5	19.31	0.98	1.80	10.55	14.46	....	0.55	0.29	0.00	0.43
4	4-7	29.09	1.63	2.89	16.15	24.60	....	0.00	0.00	0.00	0.00
4	4-OTH	7.90	0.39	0.70	4.29	5.82	....	0.52	0.26	0.00	0.40
5	3-5	4.04	0.11	0.00	3.13	8.81	....	0.00	0.00	0.00	0.00
5	4-5	44.66	1.26	0.00	34.18	75.94	....	12.24	6.06	0.00	17.35
5	5-5	19.24	0.54	0.00	14.79	36.10	....	0.00	0.00	0.00	0.00
5	5-OTH	4.97	0.13	0.00	3.82	11.93	....	0.00	0.00	0.00	0.00
6	4-6	0.61	0.08	0.02	1.27	0.60	....	0.00	0.00	0.00	0.00
6	6-6	1.07	0.12	0.03	2.21	0.78	....	0.00	0.00	0.00	0.00
6	6-7	0.08	0.01	0.00	0.16	0.01	....	0.00	0.00	0.00	0.00
6	6-OTH	0.39	0.05	0.01	0.83	0.36	....	0.00	0.00	0.00	0.00

s5x = 5 axle tractor-semitrailer
s6x = 6 axle tractor-semitrailer
a7x = 7 axle A-Trains
a8x = 8 axle A-Trains
b7x = 7 axle B-Trains
b8x = 8 axle B-Trains
c7x = 7 axle C-Trains
c8x = 8 axle C-Trains

c = load cubes out
w = load weights out
cw = load is c and w
p = part load
e = empty haul

1 = Atlantic Provinces
2 = Quebec
3 = Ontario
4 = Prairie Provinces
5 = British Columbia
6 = Territories
7 = United States

EXHIBIT D.2

ATLANTIC PROVINCES

TRUCK/TRAILER		1987 STANDARD	1992 STANDARD	1997 STANDARD	2002 STANDARD
STRAIGHT TRUCK		0.2575	0.3088	0.3106	0.3124
5-AXLE	48'trlr	0.1730	0.2666	0.2672	0.2616
	53'trlr	0.4982	0.2275	0.2399	0.2413
	Subtotal	0.6712	0.4941	0.5071	0.5030
6-AXLE	48'trlr	0.0100	0.0211	0.0212	0.0218
	53'trlr	0.0551	0.1625	0.1410	0.1419
	Subtotal	0.0651	0.1837	0.1623	0.1636
7-AXLE	A-TRAIN	0.0000	0.0000	0.0000	0.0000
	B-TRAIN	0.0006	0.0018	0.0019	0.0019
	C-TRAIN	0.0000	0.0000	0.0000	0.0000
	SEMI	0.0053	0.0053	0.0053	0.0053
	Subtotal	0.0059	0.0071	0.0072	0.0072
8-AXLE	A-TRAIN	0.0000	0.0000	0.0000	0.0000
	B-TRAIN	0.0000	0.0060	0.0126	0.0134
	C-TRAIN	0.0000	0.0000	0.0000	0.0000
	Subtotal	0.0000	0.0060	0.0126	0.0134
9-AXLE		0.0003	0.0003	0.0003	0.0003
TOTAL		1.0000	1.0000	1.0000	1.0000

QUEBEC

TRUCK/TRAILER		1987 STANDARD	1992 STANDARD	1997 STANDARD	2002 STANDARD
STRAIGHT TRUCK		0.2939	0.2632	0.2439	0.2364
5-AXLE	48'trlr	0.4192	0.4088	0.3644	0.3335
	53'trlr	0.0221	0.0907	0.1140	0.1321
	Subtotal	0.4413	0.4995	0.4784	0.4656
6-AXLE	48'trlr	0.1405	0.1451	0.1848	0.1757
	53'trlr	0.0006	0.0055	0.0097	0.0094
	Subtotal	0.1411	0.1505	0.1945	0.1851
7-AXLE	A-TRAIN	0.0355	0.0036	0.0022	0.0010
	B-TRAIN	0.0000	0.0078	0.0111	0.0205
	C-TRAIN	0.0000	0.0009	0.0000	0.0000
	SEMI	0.0450	0.0357	0.0233	0.0233
	Subtotal	0.0805	0.0481	0.0366	0.0447
8-AXLE	A-TRAIN	0.0010	0.0052	0.0050	0.0042
	B-TRAIN	0.0404	0.0307	0.0402	0.0625
	C-TRAIN	0.0000	0.0012	0.0000	0.0000
	Subtotal	0.0415	0.0371	0.0452	0.0667
9-AXLE		0.0017	0.0016	0.0014	0.0014
TOTAL		1.0000	1.0000	1.0000	1.0000

ONTARIO

TRUCK/TRAILER		1987 STANDARD	1992 STANDARD	1997 STANDARD	2002 STANDARD
STRAIGHT TRUCK		0.2089	0.1920	0.1836	0.1796
5-AXLE	48'trlr	0.2807	0.2950	0.2653	0.2268
	53'trlr	0.2341	0.2891	0.3184	0.3434
	Subtotal	0.5149	0.5841	0.5838	0.5701
6-AXLE	48'trlr	0.1169	0.0878	0.0795	0.0734
	53'trlr	0.0307	0.0267	0.0285	0.0293
	Subtotal	0.1476	0.1145	0.1080	0.1027
7-AXLE	A-TRAIN	0.0478	0.0212	0.0181	0.0140
	B-TRAIN	0.0026	0.0044	0.0036	0.0078
	C-TRAIN	0.0022	0.0018	0.0020	0.0022
	SEMI	0.0443	0.0251	0.0259	0.0270
	Subtotal	0.0969	0.0525	0.0496	0.0510
8-AXLE	A-TRAIN	0.0095	0.0143	0.0138	0.0162
	B-TRAIN	0.0207	0.0406	0.0601	0.0792
	C-TRAIN	0.0000	0.0007	0.0000	0.0000
	Subtotal	0.0303	0.0556	0.0738	0.0954
9-AXLE		0.0014	0.0013	0.0012	0.0012
TOTAL		1.0000	1.0000	1.0000	1.0000

PRAIRIE PROVINCES

CONFIGURATION		1987 STANDARD	1992 STANDARD	1997 STANDARD	2002 STANDARD
STRAIGHT TRUCK		0.2905	0.2960	0.3019	0.3030
5-AXLE	48'trlr	0.3450	0.3336	0.3018	0.2958
	53'trlr	0.1023	0.0745	0.0810	0.0803
	Subtotal	0.4473	0.4081	0.3828	0.3761
6-AXLE	48'trlr	0.0331	0.0440	0.0522	0.0547
	53'trlr	0.0324	0.0391	0.0429	0.0431
	Subtotal	0.0655	0.0830	0.0951	0.0978
7-AXLE	A-TRAIN	0.0659	0.0388	0.0261	0.0232
	B-TRAIN	0.0649	0.0650	0.0662	0.0665
	C-TRAIN	0.0135	0.0106	0.0101	0.0074
	SEMI	0.0071	0.0073	0.0073	0.0073
	Subtotal	0.1514	0.1217	0.1097	0.1044
8-AXLE	A-TRAIN	0.0224	0.0081	0.0069	0.0062
	B-TRAIN	0.0093	0.0782	0.0981	0.1071
	C-TRAIN	0.0131	0.0044	0.0050	0.0047
	Subtotal	0.0448	0.0907	0.1099	0.1181
9-AXLE		0.0006	0.0006	0.0006	0.0006
TOTAL		1.0000	1.0000	1.0000	1.0000

BRITISH COLUMBIA

TRUCK/TRAILER		1987 STANDARD	1992 STANDARD	1997 STANDARD	2002 STANDARD
STRAIGHT TRUCK		0.1964	0.2414	0.2445	0.2458
5-AXLE	48'trlr	0.3690	0.2158	0.2107	0.2087
	53'trlr	0.2595	0.2408	0.2456	0.2437
	Subtotal	0.6285	0.4566	0.4563	0.4524
6-AXLE	48'trlr	0.0587	0.0573	0.0561	0.0567
	53'trlr	0.0007	0.0638	0.0736	0.0788
	Subtotal	0.0593	0.1211	0.1297	0.1355
7-AXLE	A-TRAIN	0.0771	0.0510	0.0350	0.0217
	B-TRAIN	0.0254	0.0249	0.0243	0.0247
	C-TRAIN	0.0015	0.0012	0.0000	0.0000
	SEMI	0.0035	0.0035	0.0035	0.0035
	Subtotal	0.1074	0.0806	0.0628	0.0499
8-AXLE	A-TRAIN	0.0033	0.0041	0.0050	0.0050
	B-TRAIN	0.0013	0.0720	0.0779	0.0875
	C-TRAIN	0.0033	0.0237	0.0232	0.0233
	Subtotal	0.0080	0.0998	0.1061	0.1159
9-AXLE		0.0004	0.0005	0.0005	0.0005
TOTAL		1.0000	1.0000	1.0000	1.0000

TERRITORIES

TRUCK/TRAILER		1987 STANDARD	1992 STANDARD	1997 STANDARD	2002 STANDARD
STRAIGHT TRUCK		0.2692	0.2668	0.2440	0.2199
5-AXLE	48'trlr	0.1167	0.1038	0.0949	0.0837
	53'trlr	0.0784	0.1015	0.1024	0.0895
	Subtotal	0.1952	0.2053	0.1973	0.1732
6-AXLE	48'trlr	0.2005	0.1036	0.0947	0.0830
	53'trlr	0.0358	0.0766	0.0740	0.0678
	Subtotal	0.2362	0.1802	0.1687	0.1509
7-AXLE	A-TRAIN	0.0111	0.0147	0.0108	0.0105
	B-TRAIN	0.0665	0.1019	0.0852	0.0815
	C-TRAIN	0.0049	0.0030	0.0000	0.0000
	SEMI	0.0129	0.0129	0.0129	0.0129
	Subtotal	0.0954	0.1325	0.1089	0.1049
8-AXLE	A-TRAIN	0.0000	0.0131	0.0000	0.0000
	B-TRAIN	0.1993	0.1975	0.2769	0.3473
	C-TRAIN	0.0000	0.0000	0.0000	0.0000
	Subtotal	0.1993	0.2106	0.2769	0.3473
9-AXLE		0.0047	0.0047	0.0043	0.0038
TOTAL		1.0000	1.0000	1.0000	1.0000

EXHIBIT D.3
CCMTA SURVEY SITES

PROVINCE	LOCATIONS	NUMBER OF INTERVIEWS
Newfoundland	Cape Ray Labrador	703
Nova Scotia	Amherst	2,391
Prince Edward Island	Borden	603
New Brunswick	St. Basile	1,636
Quebec	Cabano Les Cedres Vaudreuil	6,166
Ontario	Lancaster Casselman Vermillion Bay	3,930
Manitoba	Portage-la-Prairie	2,189
Saskatchewan	Moosomin Regina South Clavet Borden Lloydminster Kindersley Beverely	3,072
Alberta	Vermillion Dunmore Burmis Grinshaw	2,346
British Columbia	Golden Tete Jaune Cache Laidlaw	3,817
North West Territories	Entreprise	228
Yukon Territory	Watson Lake Whitehorse	542

EXHIBIT D.4 (1/3)

1991/92 Trailer–Truck Traffic (MVK) Estimates on the National Highway System

Province	Straight Trucks	5–Axle Tractor Trailers						6–Axle Tractor Trailers						7–Axle Tractor Trailers
		C	W	CW	P	E	Total	C	W	CW	P	E	Total	
NF	38.6	29.5	1.4	2.9	24.7	17.8	76.3	7.5	3.6	9.7	6.3	2.4	29.6	0.2
NS	88.4	33.0	1.4	3.8	32.3	51.0	121.5	8.9	3.5	17.4	3.9	1.7	35.5	0.6
PEI	9.2	0.5	0.1	0.3	0.9	0.4	2.3	0.2	0.3	0.4	0.2	0.0	1.0	0.3
NB	67.7	49.0	3.2	3.2	66.7	4.2	126.2	16.2	8.8	19.4	10.6	0.1	55.2	2.5
QC	558.6	551.3	11.9	43.7	219.0	234.4	1,060.3	132.1	25.7	104.0	36.4	21.3	319.5	75.8
ONT	675.9	713.8	38.8	77.7	715.0	511.1	2,056.5	110.9	66.5	105.1	92.6	28.0	403.1	88.3
MBA	42.3	33.9	2.5	1.5	25.7	8.2	71.7	6.8	0.9	2.3	4.7	1.9	16.5	0.5
SAK	78	29.2	0.0	1.4	12.8	96.2	139.7	4.2	1.4	0.7	2.1	17.4	25.8	1.9
ALB	279.1	150.0	9.6	18.3	80.2	81.1	339.2	22.4	3.9	13.2	14.5	15.8	69.7	7.5
BC	167.9	66.8	1.8	0.0	50.5	198.5	317.6	32.4	0.0	3.2	13.0	35.6	84.2	2.4
NWT	1.9	0.0	0.1	0.0	1.0	0.9	2.0	0.0	0.1	0.0	0.2	0.3	0.6	0.2
YKT	7.9	1.8	0.2	0.1	3.0	0.5	5.6	1.5	0.3	0.9	1.6	1.7	6.0	0.3
SUM	2,015.5	1,658.9	71.1	152.7	1,231.9	1,204.3	4,318.9	343.0	115.2	276.2	186.0	126.3	1,046.7	180.5
% of config	100.0%	38.4%	1.6%	3.5%	28.5%	27.9%	100.0%	32.8%	11.0%	26.4%	17.8%	12.1%	100.0%	100.0%
% of TOTAL	24.0%	19.8%	0.8%	1.8%	14.7%	14.4%	51.5%	4.1%	1.4%	3.3%	2.2%	1.5%	12.5%	2.2%

LEGEND

C : Cubing Trucks (i.e. haul exceeds 95% of its cubic capacity)
W : Weighting Trucks (i.e. haul exceeds 95% of its regulated GVW limit)
CW : Cubing/Weighting Trucks (i.e. haul exceeds 95% of its cubic capacity as well as regulated GVW limit)
P : Partially loaded Trucks (i.e. haul is less than 95% of its cubic capacity and regulated GVW limit)
E : Empty Trucks

Notes:
SHADED PERCENTAGES ARE WITHIN THE CONFIGURATION; BOTTOM ROW PERCENTAGES ARE RELATIVE TO THE GRAND TOTAL (PAGE 3).
(i) MVK estimates pertain to the road links in the National Highway System only as opposed to the TAC Designated System.
(ii) Percentage of trucks in each haul category (C,W,CW,etc.) estimated from CCMTA Survey.

EXHIBIT D.4 (2/3)

1991/92 Trailer-Truck Traffic (MVK) Estimates on the National Highway System

Province	7-Axle Doubles																		
	A Trains						B Trains						C Trains						Total
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	C	W	CW	P	E	Total	
NF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3
PEI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1
NB	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7
QC	2.4	0.0	1.0	2.4	1.9	7.7	5.5	1.8	1.8	2.3	5.1	16.6	1.4	0.0	0.0	0.0	0.5	1.9	26.2
ONT	24.9	0.0	0.0	24.9	24.9	74.6	5.1	1.0	1.0	4.1	4.1	15.4	2.2	0.0	0.0	2.2	2.2	6.5	96.5
MBA	2.0	0.0	0.0	1.1	0.0	3.1	2.5	0.3	0.3	2.3	0.2	5.6	0.5	0.0	0.0	0.2	0.0	0.7	9.4
SAK	0.7	0.0	1.3	2.6	5.9	10.5	1.2	0.6	2.4	1.8	7.1	13.0	0.0	0.0	0.0	2.6	0.7	3.3	26.8
ALB	8.8	2.2	12.2	3.3	12.2	38.7	21.9	3.6	14.6	12.1	17.0	69.2	1.6	3.2	4.8	0.0	0.8	10.3	118.2
BC	8.1	2.0	11.1	3.0	11.1	35.4	0.0	0.0	0.0	5.7	11.5	17.2	0.2	0.3	0.5	0.0	0.1	1.1	53.7
NWT	0.1	0.2	0.0	0.0	0.1	0.4	0.2	0.2	0.1	0.2	0.1	0.7	0.0	0.1	0.0	0.0	0.0	0.1	1.2
YKT	0.0	0.1	0.0	0.0	0.0	0.1	0.9	0.7	0.4	0.7	0.4	3.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
SUM	47.0	4.5	25.6	37.4	56.1	170.6	37.3	8.3	20.6	29.7	45.9	141.8	5.9	3.5	5.2	5.0	4.2	23.9	336.2
% of config	27.5%	2.6%	15.0%	21.9%	32.9%	100.0%	26.3%	5.8%	14.5%	21.0%	32.4%	100.0%	24.6%	14.9%	22.0%	21.0%	17.6%	100.0%	N/A
% of TOTAL	0.6%	0.1%	0.3%	0.4%	0.7%	2.0%	0.4%	0.1%	0.2%	0.4%	0.5%	1.7%	0.1%	0.0%	0.1%	0.1%	0.1%	0.3%	4.0%

EXHIBIT D.4 (3/3)

1991/92 Trailer-Truck Traffic (MVK) Estimates on the National Highway System

Province	8-Axle Doubles																			9-Axles	**
	A Trains						B Trains						C Trains						Total	or more	GRAND
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	C	W	CW	P	E	Total			TOTAL
NF	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	144.7
NS	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.5	1.6	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.1	248.0
PEI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	13.7
NB	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.1	253.9
QC	5.1	0.7	3.7	1.5	0.0	11.0	24.8	2.4	7.8	15.7	14.5	65.2	0.0	0.0	0.7	0.0	2.0	2.6	78.8	3.3	2,122.5
ONT	5.6	5.6	28.1	5.6	5.6	50.5	30.3	26.0	30.3	30.3	26.0	142.9	0.0	0.0	0.0	2.3	0.0	2.3	195.7	4.7	3,520.7
MBA	0.5	0.0	0.3	0.2	0.2	1.1	1.6	1.2	1.4	1.2	0.8	6.1	0.7	0.0	0.0	0.0	0.1	0.8	8.0	0.1	148.5
SAK	0.0	0.0	0.0	1.0	1.0	1.9	0.9	1.9	4.2	1.9	7.5	16.4	0.0	1.1	0.6	0.0	0.0	1.7	20.0	0.5	292.7
ALB	5.0	1.0	0.0	0.0	2.0	8.0	9.2	12.3	26.1	13.8	21.5	82.9	0.0	2.3	1.1	0.0	0.0	3.4	94.3	0.1	908.1
BC	1.7	0.3	0.0	0.0	0.7	2.8	15.0	5.0	25.0	0.0	5.0	50.0	0.0	11.1	5.6	0.0	0.0	16.7	69.4	0.4	695.6
NWT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	0.0	1.2	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.1	7.2
YKT	0.1	0.0	0.2	0.3	0.0	0.5	0.1	1.2	4.3	0.3	0.2	6.0	0.0	0.0	0.0	0.0	0.0	0.0	6.5	0.1	29.5
SUM	18.0	7.7	32.2	8.5	9.4	75.8	82.8	51.1	99.6	64.6	76.4	374.6	0.7	14.5	7.9	2.3	2.1	27.5	477.8	9.5	8,385.1
% of config	23.8%	10.2%	42.5%	11.2%	12.4%	100.0%	22.1%	13.7%	26.6%	17.2%	20.4%	100.0%	2.5%	52.8%	28.8%	8.4%	7.5%	100.0%	N/A	100.0%	N/A
% of TOTAL	0.2%	0.1%	0.4%	0.1%	0.1%	0.9%	1.0%	0.6%	1.2%	0.8%	0.9%	4.5%	0.0%	0.2%	0.1%	0.0%	0.0%	0.3%	5.7%	0.1%	100.0%

EXHIBIT D.5 (1/2)

REGIONAL ESTIMATES OF 1992 TRUCK TRAFFIC (MVK) ON THE NHS

Region	5-Axle Tractor Trailers						6-Axle Tractor Trailers						Straight Trucks
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	
TERR	1.84	0.24	0.07	3.96	1.48	7.6	1.50	0.42	0.86	1.81	2.01	6.6	9.8
BC	66.77	1.80	0.00	50.53	198.50	317.6	32.38	0.00	3.24	12.95	35.62	84.2	167.9
PRAIR	213.07	12.11	21.19	118.72	185.52	550.6	33.31	6.21	16.11	21.25	35.12	112.0	399.4
ONT	713.83	38.85	77.70	715.04	511.09	2,056.5	110.90	66.54	105.11	92.58	27.97	403.1	675.9
QUE	551.30	11.94	43.67	219.02	234.37	1,060.3	132.12	25.74	103.98	36.38	21.28	319.5	558.6
ATLAN	112.07	6.16	10.10	124.60	73.37	326.3	32.79	16.31	46.91	21.01	4.28	121.3	203.9
CANADA	1,659	71	153	1,232	1,204	4,319	343	115	276	186	126	1,047	2,016

Region	A Trains (7-axle)						A Trains (8-axle)						TST7
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	
TERR	0.13	0.26	0.00	0.00	0.13	0.53	0.06	0.00	0.17	0.28	0.00	0.50	0.5
BC	8.10	2.03	11.14	3.04	11.14	35.44	1.74	0.35	0.00	0.00	0.69	2.78	2.4
PRAIR	11.47	2.21	13.48	7.07	18.07	52.30	5.47	1.00	0.31	1.11	3.11	11.00	9.9
ONT	24.87	0.00	0.00	24.87	24.87	74.60	5.61	5.61	28.06	5.61	5.61	50.50	88.3
QUE	2.41	0.00	0.96	2.41	1.93	7.70	5.13	0.73	3.67	1.47	0.00	11.00	75.8
ATLAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.6
CANADA	47.0	4.5	25.6	37.4	56.1	170.6	18.0	7.7	32.2	8.5	9.4	75.8	181

Region	B Trains (7-axle)						B Trains (8-axle)						9+ axles
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	
TERR	1.11	0.83	0.46	0.83	0.46	3.70	0.05	2.42	4.27	0.31	0.15	7.20	0.18
BC	0.00	0.00	0.00	5.73	11.46	17.18	14.99	5.00	24.98	0.00	5.00	49.97	0.40
PRAIR	25.51	4.56	17.26	16.22	24.25	87.80	11.71	15.32	31.74	16.86	29.77	105.40	0.70
ONT	5.13	1.03	1.03	4.11	4.11	15.40	30.31	25.98	30.31	30.31	25.98	142.90	4.70
QUE	5.53	1.84	1.84	2.31	5.07	16.60	24.75	2.41	7.85	15.70	14.49	65.20	3.30
ATLAN	0.00	0.00	0.00	0.55	0.55	1.10	1.03	0.00	0.40	1.43	1.03	3.90	0.20
CANADA	37.3	8.3	20.6	29.7	45.9	141.8	82.8	51.1	99.6	64.6	76.4	374.6	9

Region	C Trains (7-axle)						C Trains (8-axle)						GRAND TOTAL
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	
TERR	0.03	0.05	0.00	0.00	0.03	0.10	0.00	0.00	0.00	0.00	0.00	0.00	37
BC	0.17	0.33	0.50	0.00	0.08	1.07	0.00	11.10	5.55	0.00	0.00	16.66	696
PRAIR	2.08	3.17	4.75	2.84	1.45	14.30	0.69	3.40	1.70	0.00	0.11	5.90	1,349
ONT	2.17	0.00	0.00	2.17	2.17	6.50	0.00	0.00	0.00	2.30	0.00	2.30	3,521
QUE	1.43	0.00	0.00	0.00	0.48	1.90	0.00	0.00	0.65	0.00	1.95	2.60	2,123
ATLAN	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	660
CANADA	5.9	3.5	5.2	5.0	4.2	23.9	0.7	14.5	7.9	2.3	2.1	27.5	8,385

NOTE : All numbers shown are estimates of truck operations in terms of millions of vehicle-kilometres (MVK).

LEGEND: C : Cubing out (>95% of cubic capacity)
W : Weighing out (> 95% of maximum GVW)
CW : Cubing/Weighing (>95% of cubic capacity and GVW)
P : Partially Loaded (< 95% of both cube and GVW)
E: Empty (backhaul without payload)

EXHIBIT D.5 (2/2)
REGIONAL ESTIMATES OF 1992 TRUCK TRAFFIC DISTRIBUTION ON THE NHS

Region	5-Axle Tractor Trailers						6-Axle Tractor Trailers						Straight
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	Trucks
TERR	5.0%	0.7%	0.2%	10.8%	4.0%	21%	4.1%	1.1%	2.3%	4.9%	5.5%	18%	27%
BC	9.6%	0.3%	0.0%	7.3%	28.5%	46%	4.7%	0.0%	0.5%	1.9%	5.1%	12%	24%
PRAIR	15.8%	0.9%	1.6%	8.8%	13.7%	41%	2.5%	0.5%	1.2%	1.6%	2.6%	8%	30%
ONT	20.3%	1.1%	2.2%	20.3%	14.5%	58%	3.1%	1.9%	3.0%	2.6%	0.8%	11%	19%
QUE	26.0%	0.6%	2.1%	10.3%	11.0%	50%	6.2%	1.2%	4.9%	1.7%	1.0%	15%	26%
ATLAN	17.0%	0.9%	1.5%	18.9%	11.1%	49%	5.0%	2.5%	7.1%	3.2%	0.6%	18%	31%
CANADA	19.8%	0.8%	1.8%	14.7%	14.4%	52%	4.1%	1.4%	3.3%	2.2%	1.5%	12%	24%

Region	A Trains (7-axle)						A Trains (8-axle)						TST7
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	
TERR	0.4%	0.7%	0.0%	0.0%	0.4%	1.4%	0.2%	0.0%	0.5%	0.8%	0.0%	1.4%	1.4%
BC	1.2%	0.3%	1.6%	0.4%	1.6%	5.1%	0.2%	0.0%	0.0%	0.0%	0.1%	0.4%	0.3%
PRAIR	0.9%	0.2%	1.0%	0.5%	1.3%	3.9%	0.4%	0.1%	0.0%	0.1%	0.2%	0.8%	0.7%
ONT	0.7%	0.0%	0.0%	0.7%	0.7%	2.1%	0.2%	0.2%	0.8%	0.2%	0.2%	1.4%	2.5%
QUE	0.1%	0.0%	0.0%	0.1%	0.1%	0.4%	0.2%	0.0%	0.2%	0.1%	0.0%	0.5%	3.6%
ATLAN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
CANADA	0.6%	0.1%	0.3%	0.4%	0.7%	2.0%	0.2%	0.1%	0.4%	0.1%	0.1%	0.9%	2.2%

Region	B Trains (7-axle)						B Trains (8-axle)						9+ axles
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	
TERR	3.0%	2.3%	1.3%	2.3%	1.3%	10.1%	0.1%	6.6%	11.6%	0.8%	0.4%	19.6%	0.5%
BC	0.0%	0.0%	0.0%	0.8%	1.6%	2.5%	2.2%	0.7%	3.6%	0.0%	0.7%	7.2%	0.1%
PRAIR	1.9%	0.3%	1.3%	1.2%	1.8%	6.5%	0.9%	1.1%	2.4%	1.2%	2.2%	7.8%	0.1%
ONT	0.1%	0.0%	0.0%	0.1%	0.1%	0.4%	0.9%	0.7%	0.9%	0.9%	0.7%	4.1%	0.1%
QUE	0.3%	0.1%	0.1%	0.1%	0.2%	0.8%	1.2%	0.1%	0.4%	0.7%	0.7%	3.1%	0.2%
ATLAN	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%	0.0%	0.1%	0.2%	0.2%	0.6%	0.0%
CANADA	0.4%	0.1%	0.2%	0.4%	0.5%	1.7%	1.0%	0.6%	1.2%	0.8%	0.9%	4.5%	0.1%

Region	C Trains (7-axle)						C Trains (8-axle)						GRAND
	C	W	CW	P	E	Total	C	W	CW	P	E	Total	TOTAL
TERR	0.1%	0.1%	0.0%	0.0%	0.1%	0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
BC	0.0%	0.0%	0.1%	0.0%	0.0%	0.2%	0.0%	1.6%	0.8%	0.0%	0.0%	2.4%	100%
PRAIR	0.2%	0.2%	0.4%	0.2%	0.1%	1.1%	0.1%	0.3%	0.1%	0.0%	0.0%	0.4%	100%
ONT	0.1%	0.0%	0.0%	0.1%	0.1%	0.2%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	100%
QUE	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	100%
ATLAN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100%
CANADA	0.1%	0.0%	0.1%	0.1%	0.1%	0.3%	0.0%	0.2%	0.1%	0.0%	0.0%	0.3%	100%

NOTE : All percentages are relative to total veh-km on the NHS in the region. Light shading indicates subtotals for configurations.

SEMITRAILER LENGTH

The other truck fleet impact consideration, besides trailer type, was the length of the semitrailers, as much of the savings to be derived came from the ability to carry larger loads of cube-out commodities. This information was derived from the carrier survey using the procedure explained in Section 18.1.1. Exhibit D.6 presents the percentages used in each region for each of the four years.

As already discussed, some of the figures shown are very sensitive to particular carrier responses, in particular the high percentages of 53 foot semitrailers in 1987 in Atlantic Canada. Given the concern regarding the accuracy of these results, enquiries were made with several of the provincial ministries; enforcement staff indicated that these numbers can be at least partly explained by the use of 53 foot trailers under special permits.

The percentages in Exhibit D.6 are not to be taken as rigorous; they represent the estimate derived from the responses of 16 firms, and are internally consistent in that they come from the same source. Given the surprisingly high percentage of trailers over 14.65 m (48 feet), especially in 1987, it is possible that some of the firms may have misinterpreted the survey question. It is also possible that their fleets did include many of the longer trailers purchased in anticipation of changes in regulations to permit these vehicles in Eastern Canada. If anything, it is likely that the estimates of improved productivity in Chapter 19 would have been higher, given better information about the uptake of longer semitrailers. It is recommended that future roadside surveys incorporate the measurement of trailer box length.

TRUCKING COST SAVINGS, BY PROVINCE

Exhibit D.7 presents estimates of the trucking cost savings over the period 1989-2002. Each of the three modelled years is presented, along with the net present value of savings discounted at 5% to the beginning of 1994. The shaded estimates for the Atlantic and Prairie Provinces and the two Territories are based on the regional total, subdivided according to the proportion of veh-km operated in these provinces. (The ratios were derived considering only TAC vehicles).

The second part of the exhibit is the summary of truck traffic on the National Highway System, by province, that was used to help produce the savings estimates.

EXHIBIT D.6

Reported Usage of Semi-trailers over 14.65 m in Length

REGION		ATLANTIC		QUEBEC		ONTARIO		PRAIRIES		BC		TERRITORIES	
TRUCK/ TRAILER	YEAR	% OF TOTAL VEH-KM	% OF AXLE GROUP	% OF TOTAL VEH-KM	% OF AXLE GROUP	% OF TOTAL VEH-KM	% OF AXLE GROUP	% OF TOTAL VEH-KM	% OF AXLE GROUP	% OF TOTAL VEH-KM	% OF AXLE GROUP	% OF TOTAL VEH-KM	% OF AXLE GROUP
5-axle,	1987	49.8%	74%	2.2%	5%	23.4%	45%	10.2%	23%	26.0%	41%	7.8%	40%
length	1992	22.8%	46%	9.1%	18%	28.9%	50%	7.4%	18%	24.0%	53%	10.2%	49%
over	1997	24.0%	47%	11.4%	24%	31.8%	55%	8.1%	21%	24.6%	54%	10.2%	52%
48 ft.	2002	24.1%	48%	13.2%	28%	34.3%	60%	8.0%	21%	24.4%	54%	9.0%	52%
6-axle,	1987	5.5%	85%	0.1%	0%	3.1%	21%	3.2%	49%	0.1%	1%	3.6%	15%
length	1992	16.3%	89%	0.5%	4%	2.7%	23%	3.9%	47%	6.4%	53%	7.7%	43%
over	1997	14.1%	87%	1.0%	5%	2.8%	26%	4.3%	45%	7.4%	57%	7.4%	44%
48 ft.	2002	14.2%	87%	0.9%	5%	2.9%	29%	4.3%	44%	7.9%	58%	6.8%	45%
Total	1987	55.3%	75%	2.3%	5%	26.5%	42%	13.4%	29%	26.1%	41%	11.4%	32%
Semis	1992	39.1%	64%	9.6%	17%	31.6%	48%	11.3%	28%	30.4%	53%	17.9%	46%
over	1997	38.1%	62%	12.4%	22%	34.6%	53%	12.4%	29%	32.0%	55%	17.6%	49%
48 ft.	2002	38.3%	62%	14.1%	27%	37.2%	58%	12.3%	29%	32.3%	55%	15.8%	49%

NOTES: 14.65 m is approximately 48 feet. Percentage of axle group is proportion of longer trailers out of all trailers with that number of axles.
This information is highly subject to error because no other effort has been made outside this study to collect this data.
Shaded numbers indicate results contrary to expectations.

IBI GROUP / ADI

Source : Carrier Survey (16/29 responses) with modification by the Study Team.

EXHIBIT D.7 (1/2)

PROVINCIAL BREAKDOWN OF ESTIMATED POST-MoU TRUCKING COST SAVINGS

Estimated Annual Trucking Cost Savings on the National Highway System

Province /Territory	TOTAL MVK	*TAC MVK	** ANNUAL SAVINGS USING 2% TRAFFIC GROWTH 1992	1997	2002	N.P.V. (SAVINGS) (1) (1988-2002)
NF	145	106	$0.8	$0.9	$1.0	$9.6
NS	248	159	$1.3	$1.3	$1.5	$14.4
PEI	14	4	$0.0	$0.0	$0.0	$0.4
NB	254	184	$1.5	$1.5	$1.7	$16.6
ATLANTIC	660	453	$3.6	$3.7	$4.3	$41.0
QC	2,123	1,485	$15.8	$23.6	$33.6	$240.7
ONT	3,521	2,752	$58.5	$74.9	$93.2	$775.2
MBA	149	106	$4.4	$5.4	$6.1	$55.6
SAK	293	212	$8.9	$10.8	$12.3	$111.7
ALB	908	621	$25.9	$31.8	$36.1	$326.9
PRAIRIES	1,349	939	$39.2	$48.0	$54.6	$494.1
BC	696	525	$27.8	$32.6	$38.0	$343.0
NWT	7	5	$0.1	$0.1	$0.1	$0.9
YKT	30	21	$0.3	$0.3	$0.4	$3.7
TERRITORIES	37	26	$0.4	$0.4	$0.5	$4.6
SUM	8,385	6,180	$145.2	$183.2	$224.3	$1,898.6

NOTES:

ALL DOLLAR VALUES ARE EXPRESSED AS 1992 CONSTANT DOLLARS.

SHADED VALUES ARE ESTIMATES BASED ON THE PROPORTION OF TAC VEH-KM OF TRAFFIC FROM THE REGION.

* TAC veh-km excludes single-unit/straight trucks, TST 7, and truck/trailers with 9+ axles. (i.e. excludes non-MoU trucks)

** The 2% growth scenario assumes 2% annual growth of truck traffic between 1992 and 2002.
Savings were calculated based on actual/projected traffic and the pre-MoU equivalent that could move the same amount of goods.

(1) Net present value uses savings from 1992, 1997 and 2002, and interpolated figures for other years.
DISCOUNTING WAS PERFORMED TO THE END OF 1993 / BEGINNING OF 1994.
All savings were assumed to be accrued at the end of the year, using a 5% discount rate. (1993 therefore was not discounted.)
Savings at the end of 1988 were assumed to be zero dollars.

EXHIBIT D.7 (2/2)

PROVINCIAL BREAKDOWN OF ESTIMATED POST-MoU TRUCKING COST SAVINGS

Estimated Annual Truck Traffic on the National Highway System

Province /Territory	ST (2-4)	TST 5	TST 6	TST 7	AT 7	BT 7	CT 7	AT 8	BT 8	CT 8	9+ AXLES	GRAND TOTAL
NF	38.6	76.3	29.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	144.7
NS	88.4	121.5	35.5	0.6	0.0	0.3	0.0	0.0	1.6	0.0	0.1	248.0
PEI	9.2	2.3	1.0	0.3	0.0	0.1	0.0	0.0	0.8	0.0	0.0	13.7
NB	67.7	126.2	55.2	2.5	0.0	0.7	0.0	0.0	1.5	0.0	0.1	253.9
ATLANTIC	203.9	326.3	121.3	3.6	0.0	1.1	0.0	0.0	3.9	0.0	0.2	660.3
QC	558.6	1,060.3	319.5	75.8	7.7	16.6	1.9	11.0	65.2	2.6	3.3	2,122.5
ONT	675.9	2,056.5	403.1	88.3	74.6	15.4	6.5	50.5	142.9	2.3	4.7	3,520.7
MBA	42.3	71.7	16.5	0.5	3.1	5.6	0.7	1.1	6.1	0.8	0.1	148.5
SAK	78.0	139.7	25.8	1.9	10.5	13.0	3.3	1.9	16.4	1.7	0.5	292.7
ALB	279.1	339.2	69.7	7.5	38.7	69.2	10.3	8.0	82.9	3.4	0.1	908.1
PRAIRIES	399.4	550.6	112.0	9.9	52.3	87.8	14.3	11.0	105.4	5.9	0.7	1,349.3
BC	167.9	317.6	84.2	2.4	35.4	17.2	1.1	2.8	50.0	16.7	0.4	695.6
NWT	1.9	2.0	0.6	0.2	0.4	0.7	0.1	0.0	1.2	0.0	0.1	7.2
YKT	7.9	5.6	6.0	0.3	0.1	3.0	0.0	0.5	6.0	0.0	0.1	29.5
TERRITORIES	9.8	7.6	6.6	0.5	0.5	3.7	0.1	0.5	7.2	0.0	0.2	36.7
SUM	2,015.5	4,318.9	1,046.7	180.5	170.6	141.8	23.9	75.8	374.6	27.5	9.5	8,385.1
% of TOTAL	24.0%	51.5%	12.5%	2.2%	2.0%	1.7%	0.3%	0.9%	4.5%	0.3%	0.1%	100.0%

Traffic Expressed in Millions of Vehicle Kilometres.

APPENDIX E

TRUCK COST DATA

Appendix E: Truck Cost Data

TRUCK UNIT COST MODEL

Example of Data:

Exhibit E.1 shows a portion of the input data matrix illustrating the detail used for the calculation of the unit costs for each configuration.

TRUCK COST MODEL

Example of Data:

Exhibit E.2 is a similar portion of the output matrix as the example used for the Traffic Projection Model. Here the entries are costs, whereas in the projection model they are vehicle-kilometres. The size of the matrix is again 40 columns by 32 rows.

EXHIBIT E.1

EXAMPLE OF PART OF INPUT TO TRUCK UNIT COST MODEL

(FIRST 6 OF A TOTAL OF 16 CONFIGURATIONS SHOWN)

TRUCK CHARACTERISTICS AND COSTS			Gap between trailers in A, B and C Trains:				1.523	
Configuration Type			1	2	3	4	5	6
			Semi	Semi	Semi	Semi	A-Train	A-Train
			5	5	6	6	7	7
Characteristics/Costs	Trailer length		14.65	16.20	14.65	16.20	18.50	18.50
	GVW		39,500	45,500	49,500	54,500	53,500	61,700
TRACTOR								
Tare Weight (kg)			7,700	7,700	7,700	7,700	8,850	8,850
TRAILER(S)								
Tare Weight (kg)			6,000	6,400	7,100	7,500	9,200	9,200
Cubic Capacity (m3)		2.9	110.5	122.1	110.5	122.1	128.0	128.0
COMBINATION								
Maximum Gross Weight (kg)			39,500	45,500	49,500	54,500	53,500	61,700
Maximum Payload Weight (kg)			25,800	31,400	34,700	39,300	35,450	43,650
			14	14	20	20	23	23
Actual Payload Weight (kg)			14,300	14,300	20,301	20,301	22,791	22,791
CAPITAL COSTS								
Tractor								
Purchase Price ($)			$95,000	$95,000	$95,000	$95,000	$105,000	$105,000
Economic Life (km)	20 Years or	750,000	750,000	750,000	750,000	750,000	750,000	750,000
Trailer(s)								
Purchase Price ($)			$23,500	$25,000	$27,900	$29,500	$36,200	$36,200
Economic Life (km)	20 Years or	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000	1,200,000
ANNUAL FIXED COSTS								
Tractor								
Registration ($)			$1,691	$1,691	$1,691	$1,691	$2,707	$2,707
Trailer(s)								
Registration ($)			$21	$21	$21	$21	$43	$43
Insurance ($)			$5,519	$5,519	$5,519	$5,519	$6,556	$6,556
Terminal								
Capacity (trucks)			100	100	100	100	100	100
Purchase Price ($)			$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000	$3,000,000
Economic Life (yrs)			40	40	40	40	40	40
Interest Rate (%)			10	10	10	10	10	10
Annual Cost ($)			$306,778	$306,778	$306,778	$306,778	$306,778	$306,778
Annual Cost per Truck ($)			$3,068	$3,068	$3,068	$3,068	$3,068	$3,068
OPERATING COSTS								
Tractor								
Driver								
- Rate/h ($)			$15.72	$15.72	$15.72	$15.72	$16.77	$16.77
- Wage Burden (%)			25	25	25	25	25	25
- Cost/km ($)			$0.262	$0.262	$0.262	$0.262	$0.279	$0.279
Fuel								
- Price/litre ($)			$0.532	$0.532	$0.532	$0.532	$0.532	$0.532
- Loaded consumption (km/l)			2.03	2.03	1.88	1.87	1.76	1.76
- Empty consumption (km/l)			2.40	2.39	2.37	2.36	2.28	2.28
- Cost/Loaded km ($)			$0.261	$0.263	$0.284	$0.285	$0.303	$0.303
- Cost/Empty km ($)			$0.222	$0.223	$0.225	$0.226	$0.233	$0.233
Tires								
- Cost/Loaded km ($)			$0.022	$0.022	$0.022	$0.022	$0.026	$0.026
- Cost/Empty km ($)		0.9	$0.020	$0.020	$0.020	$0.020	$0.024	$0.024
Maintenance								
- Cost/km ($)			$0.080	$0.080	$0.080	$0.080	$0.083	$0.083
Trailer(s)								
Tires								
- Cost/loaded km ($)			$0.020	$0.020	$0.022	$0.022	$0.024	$0.024
- Cost/Empty km ($)			$0.015	$0.015	$0.015	$0.016	$0.016	$0.016
Maintenance								
- Cost/km ($)			$0.068	$0.068	$0.068	$0.068	$0.077	$0.077
Overhead & Profit (%)								
- Variable			15	15	15	15	15	15
- Fixed			0	0	0	0	0	0

EXHIBIT E.2

PART OF OUTPUT MATRIX FROM THE TRUCK COST MODEL

FOR THE YEAR 1997 WITH THE MoU, ANNUAL TRAFFIC GROWTH (1992-1997) OF 2% p.a.

ENTRIES ARE IN MILLIONS OF DOLLARS

(9 OF THE 41 COLUMNS SHOWN)

		Configurations									
	O/D	s5x	s5x	s5x	s5x	s5x		c8x	c8x	c8x	Total for
Region	Pair	c	w	cw	p	e		cw	p	e	O/D Pair
1	1-1	$79.05	$5.10	$8.34	$85.63	$37.08	....	$0.00	$0.00	$0.00	$307.6
1	1-2	$26.20	$1.69	$2.77	$28.22	$10.47	....	$0.00	$0.00	$0.00	$120.0
1	1-3	$18.65	$1.19	$1.98	$20.20	$8.52	....	$0.00	$0.00	$0.00	$71.4
1	1-7	$7.96	$0.50	$0.84	$8.67	$4.13	....	$0.00	$0.00	$0.00	$27.0
1	1-OTH	$1.43	$0.09	$0.15	$1.57	$0.80	....	$0.00	$0.00	$0.00	$4.6
2	1-2	$62.35	$1.23	$4.50	$24.68	$19.43	....	$0.00	$0.00	$0.00	$186.1
2	1-3	$35.63	$0.71	$2.60	$14.29	$10.14	....	$0.00	$0.00	$0.00	$124.0
2	2-2	$113.48	$2.25	$8.32	$45.35	$35.26	....	$0.00	$0.00	$0.00	$354.3
2	2-3	$283.53	$5.63	$20.93	$112.52	$95.09	....	$0.00	$0.00	$0.00	$844.7
2	2-7	$71.28	$1.49	$5.51	$28.27	$26.45	....	$0.00	$0.00	$0.00	$164.1
2	2-OTH	$26.20	$0.51	$1.94	$10.53	$9.39	....	$0.00	$0.00	$0.00	$69.9
3	2-3	$402.53	$22.71	$46.52	$400.04	$228.64	....	$0.00	$0.00	$0.00	$1,501.7
3	2-4	$27.67	$1.54	$3.18	$27.66	$14.10	....	$0.00	$0.00	$0.00	$142.0
3	2-7	$65.91	$3.67	$7.59	$65.57	$41.97	....	$0.00	$0.00	$0.00	$213.5
3	3-3	$127.63	$6.89	$14.20	$127.72	$73.28	....	$0.00	$0.00	$0.00	$521.1
3	3-4	$119.79	$6.03	$12.81	$120.14	$71.41	....	$0.00	$0.00	$0.00	$578.4
3	3-OTH	$77.05	$4.48	$9.06	$76.48	$43.99	....	$0.00	$0.00	$0.00	$275.2
4	2-4	$4.39	$0.25	$0.44	$2.39	$3.39	....	$0.00	$0.00	$0.00	$23.7
4	3-4	$19.07	$1.03	$1.82	$10.38	$14.80	....	$0.00	$0.00	$0.00	$74.9
4	3-5	$7.79	$0.42	$0.75	$4.24	$5.91	....	$0.00	$0.00	$0.00	$33.6
4	4-4	$148.78	$8.00	$14.45	$80.42	$110.15	....	$1.82	$0.00	$2.48	$713.0
4	4-5	$20.35	$1.11	$2.03	$10.96	$14.47	....	$0.37	$0.00	$0.47	$131.9
4	4-7	$30.65	$1.85	$3.26	$16.78	$24.61	....	$0.00	$0.00	$0.00	$94.6
4	4-OTH	$8.33	$0.45	$0.79	$4.46	$5.82	....	$0.33	$0.00	$0.44	$53.7
5	3-5	$4.26	$0.12	$0.00	$3.25	$8.82	....	$0.00	$0.00	$0.00	$28.9
5	4-5	$47.07	$1.42	$0.00	$35.51	$75.97	....	$7.66	$0.00	$19.21	$402.7
5	5-5	$20.28	$0.60	$0.00	$15.36	$36.12	....	$0.00	$0.00	$0.00	$164.2
5	5-OTH	$5.24	$0.15	$0.00	$3.97	$11.93	....	$0.00	$0.00	$0.00	$31.0
6	4-6	$0.64	$0.09	$0.02	$1.32	$0.60	....	$0.00	$0.00	$0.00	$6.0
6	6-6	$1.12	$0.14	$0.04	$2.29	$0.78	....	$0.00	$0.00	$0.00	$11.7
6	6-7	$0.08	$0.01	$0.00	$0.17	$0.01	....	$0.00	$0.00	$0.00	$10.1
6	6-OTH	$0.41	$0.05	$0.01	$0.86	$0.36	....	$0.00	$0.00	$0.00	$5.4

s5x = 5 axle tractor-semitrailer
s6x = 6 axle tractor-semitrailer
a7x = 7 axle A-Trains
a8x = 8 axle A-Trains
b7x = 7 axle B-Trains
b8x = 8 axle B-Trains
c7x = 7 axle C-Trains
c8x = 8 axle C-Trains

c = load cubes out
w = load weights out
cw = load is c and w
p = part load
e = empty haul

1 = Atlantic Provinces
2 = Quebec
3 = Ontario
4 = Prairie Provinces
5 = British Columbia
6 = Territories
7 = United States

APPENDIX F

INFRASTRUCTURE COST DATA

F.1 MINISTRY CASE STUDIES

F.2 ESTIMATION OF CHANGE IN LEF'S

F.3 PAVEMENT LIFE CALCULATIONS

F.1 MINISTRY CASE STUDIES

MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: YUKON

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

No surveys have been done however, it is felt that no changes have been experienced in truck patterns.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

No impacts that can be attributed to the MOU.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

No impacts noted. Our existing axle loads and GVW's were already above MOU.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

No impacts (see M2(b))

b) Resurfacing Practices

No impacts.

c) New Road Construction

No changes.

d) Bridge Maintenance

No changes.

e) Bridge Construction

No changes.

f) Weigh Stations

No impact.

g) Roadside Rest Areas

No impact.

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

No changes.

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

No impacts. We have yet to formally introduce the MOU proven regulation.

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

Longer vehicles may require changes in line marking.

REGION-SPECIFIC QUESTIONS

TERRITORIES

CT1. Based on your own experience, have the following specific changes in the Yukon and Northwest Territories affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailers and doubles:

No changes in operations - Traffic volumes are not high in any event. No problems associated with longer lengths have been reported.

b) Increased allowable gross vehicle weights (Northwest Territories only):

No.

MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: NORTHWEST TERRITORIES

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

Heavier B Trains are used.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

No significant impact.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

No impact on bridges.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

No influence.

b) Resurfacing Practices

No influence.

c) New Road Construction

No influence.

d) Bridge Maintenance

No influence.

e) Bridge Construction

No influence.

f) Weigh Stations

No influence.

g) Roadside Rest Areas

No influence.

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

No affect.

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

Not affected by other factors.

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

No changes anticipated.

REGION-SPECIFIC QUESTIONS

TERRITORIES

CT1. Based on your own experience, have the following specific changes in the Yukon and Northwest Territories affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailers and doubles:

No significant affect.

b) Increased allowable gross vehicle weights (Northwest Territories only):

No significant affect.

MINISTRY CASE STUDY ON IMPACTS OF 1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: BRITISH COLUMBIA

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

None

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

We have adjusted designs to consider the heavier axle loading simply by using RTAC Fatigue Curves (ESAL vs Pavement Deflection).

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

See section on bridges.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

No measurable impact.

b) Resurfacing Practices

All designs consider axles loads and frequency, but to date, have not monitored the effects of the Vehicle Weights and Dimensions.

c) New Road Construction

As above.

d) Bridge Maintenance

While the Ministry did shift to privatized road and bridge maintenance in about 1988, we do not believe there have been any changes to bridge maintenance practices due to the 1988 MOU.

e) Bridge Construction

There have been no changes in Ministry bridge construction practices as a result of the 1988 MOU.

f) Weigh Stations

Commercial Vehicle Inspectors in the weigh scales now have the responsibility to look for the TAC label marking displayed on the side of the truck to ensure that it is a TAC vehicle and allow the axle/gross vehicle weight and vehicle dimensional limits accordingly.

Due to the TAC 1988 MOU, all new weigh decks in the weigh scales were specified with the "triple decking" to accommodate the tridem axle group and provide the means to measure the adjacent axle load equalization requirement.

Only minor monetary considerations can be attributed to the MOU due to the gradual upgrading which took place at the scales.

g) Roadside Rest Areas

n/a

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

<u>Bridge Branch:</u> *The Ministry's new bridges are designed to CS-600 loading, which models B Trains more closely than the MS-250 loading we used to prior to 1988.*

<u>Geotechnical & Materials:</u> *ESAL's are an important consideration in the pavement design process. Increased allowable axle loads via the 1988 Memorandum have naturally increased the total ESAL's for pavement design purposes. It is important to note, however, that allowable axle loads for logging trucks in BC exceed TAC allowable loads.*

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

<u>Bridge Branch:</u> *We are not aware of any factors that have prevented the implementation of changes required as a result of the 1988 MOU.*

<u>Geotechnical & Materials:</u> *No information available.*

<u>Motor Vehicle Branch:</u> *Enforcement is easier and simpler, i.e., memorization of the axle spacing/weight allowance table is not required as compared with the earlier British Columbia Commercial Transport Act and Regulations. The TAC 1988 MOU was widely received by the trucking industry due to its extensive industry consultation, uniformity across provincial boundaries, and ease for truckers to understand.*

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

<u>Bridge Branch:</u> *The Ministry will adopt the new Canadian Bridge Design Code when it is completed because we expect it to be an improvement over the current CSA/CAN-S6-88 bridge design code.*

<u>Geotechnical & Materials:</u> *Traditional Benkelman Beam design procedures will be supplemented with the following optional pavement design methods:*
(1) AASHTO (for new construction)
(2) Mechanistic - Empirical (for overlays) ie., ELMOD/WSDOT.
BC's acquisition of Falling Weight Deflectometers for pavement structural assessment and recognition of technologically superior pavement design methods are the reasons for these anticipated changes.

REGION-SPECIFIC QUESTIONS

BRITISH COLUMBIA

CB1. Based on your own experience, have the following specific changes in the British Columbia affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailers and doubles:

<u>Bridge Branch:</u> *There has been no effects on the operations of bridge branch due to increased allowable length for tractor-trailer doubles.*

<u>Geotechnical & Materials:</u> *Arterials, expressways and freeways are designed to accommodate the TS7 RTAC designated vehicle.*

<u>Motor Vehicle Branch:</u> *The increased allowable overall length for tractor-trailers (max. 23 m) and doubles (max. 23 m to 25 m as agreed by all four western provinces) had minimal effect in British Columbia. Some of our intra-provincial logging truck fleets were already operating under these limits, ie., max. 21.5 m for single articulating point logging truck and max. 23 m for two or more articulating points.*

b) Restrictions on previous GVW limits for 6-axle tractor-trailers and A-trains:

<u>Bridge Branch:</u> *There has been no effects on the operations of Bridge Branch due to restrictions on previous GVW limits for 6 axle tractor-trailers and A Trains.*

<u>Geotechnical & Materials:</u> *Not with respect to pavement design procedures. However, studies have been initiated to evaluate logging truck impact on provincial highways, particularly with respect to BC's Restricted Route Permit.*

<u>Motor Vehicle Branch:</u> *With the inclusion of the tridem axle group by the TAC 1988 MOU, the maximum Gross Vehicle Weight (GVW) limit was extended from 39 500 kg to 46 500 kg for 6 axle truck tractor/semi-trailer combination.*

Prior to the TAC 1988 MOU the maximum GVW for an A Train operating in British Columbia was capped at 57 000 kg (for 8 axle combinations) under the British Columbia Commercial Transport Act and Regulations. The MOU reduced the GVW limits for TAC A Trains from 57 000 kg to 53 500 kg and further limited the second trailer to a maximum of 16 000 kg. The trucking industry can still operate the old pre-1988 A Train at maximum GVW at 57 000 kg. The gain in uniformity across jurisdictions even with the reduction of GVW for the then new TAC or formerly RTAC A Train seemed to be acceptable to the trucking industry.

MINISTRY CASE STUDY ON IMPACTS OF 1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: SASKATCHEWAN

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

There has been an increase in the use of double combination trailers. A truck origin-destination survey conducted during the summer of 1993 was provided to the consultant, along with results of a comparable 1986 survey.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

Nobody in the Province has looked at this objectively. The province is seeing different types of failure; especially more rutting. Can't trace anything specifically to TAC vehicles. Pavements are deteriorating in response to both age and more trucks.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

Cost of strengthening and replacing $6.6 million. Some increase maintenance costs are anticipated but these have not been estimated. Fatigue life of bridges not expected to be a concern.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

Nothing specific. Maintenance needs keep increasing. Getting more rutting due to instability in mix which is a factor of type of loading. Role of TAC vehicles play in promoting this rutting is not known.

b) Resurfacing Practices

More strip sealing, microsurfacing to fix rutting.

c) New Road Construction

Nothing specific. Going away from fully paved shoulders for cost reason, but this is unrelated to MOU.

d) Bridge Maintenance

No change but increased bridge maintenance costs expected. These cannot be estimated at this time.

e) Bridge Construction

Need to design new bridges to the higher GVW.

f) Weigh Stations

Design has changed to accommodate longer vehicles. Larger parking and turn around. Now have weigh tridems; only weighed tandems before. Have to redo about one dozen weigh scales at cost of approximately $100,000 each to accommodate this. New weigh scales would be designed to handle this at little or no cost. Also having trouble finding portable scales which will accurately weigh tridems.

g) Roadside Rest Areas

None in Saskatchewan.

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

Not to date.

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

Budgets are smaller due to fiscal restraint making it more difficult to keep pavements in good repair.

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

No changes foreseen. There are some doubts if equivalency factors are right for high axle loads.

REGION-SPECIFIC QUESTIONS

PRAIRIE PROVINCES

CP1. Based on your own experience, have the following specific changes in the Prairie Provinces affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailer combinations:

n/a

b) Increased allowable GVW for 5 axle tractor-trailers:

n/a

c) Increased allowable GVW for 6-axle units:

n/a

d) Increased allowable GVW for B-trains:

n/a

MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: ALBERTA

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

Most carriers now are using super "B" and triaxle configurations rather than "A" train, "C" train and "B" train configurations.

Refer to the attached traffic summary sheet. The information reflects a slight increase in single unit trucks but a drop in the tractor-trailer combinations in the 1987-1991 period. However, the information is not conclusive as being the result of the 1988 TAC Memorandum of Understanding on Weights & Dimensions. Also, the 1990-1992 collision summary sheets show that truck involvement in collections represent a small percentage of the total collisions. There was no details to show the correlation between the collision picture and the change in truck policy.

Province-wide, the percentage of single unit trucks has increased from 7.6 to 9.4 (1.8% increase) and the percentage of tractor trailers has decreased form 7.9 to 7.4. We do not think these changes are reflecting the new TAC regulations. They are rather a result of economic conditions.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

The increases in weights and dimensions of truck units have been a concern to signal timing design because of the difference in acceleration characteristics of the trucks. However, no major problem has been detected since the memorandum came into effect.

Pavement design and pavement performance are related to the number of equivalent single axle loads applied. It could be that the TAC memo has influenced carrier operators to increase loads and so increase the ESALs of a single trip at the same time reducing the number of trips and so number of ESAL repetitions. However, we do not have data to support such assumptions. It is known that in our circumstances of low and very low traffic, traffic loadings influence pavement design and performance to small degree only. Small increase in ESAL's would not change our design practice and pavement performance.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

The introduction of the triple axle has increased the loading on short span bridges (6-12m) while the increased GVW of B-trains has increased the loading on longer spans. We are not aware of any physical damage to our bridges due to increased loading at the present time.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

The M.O.U. has not resulted in changes to the practices within the road maintenance area.

b) Resurfacing Practices

We don't think so.

c) New Road Construction

Geometric design standards for new construction have been enhanced. Sight distance required at intersection has increased. For a typical 2-lane undivided highway, the sight distance required has increased from 430 m to 560 m for a design speed of 110 km/hr.

d) Bridge Maintenance

Our short span bridges (6-12m spans) are carrying heavier loads than previously (up to 10% increase). At the present time, we have not noted any increased maintenance due to the increased loading.

e) Bridge Construction

We have spent approximately $2.5 million to strengthen our bridges on the primary highway system to carry the 8-axle TAC B-train. (See letter dated August 24, 1993).

f) Weigh Stations

Scale decks have been upgraded to handle tridem configurations. This transition from longer scale decks makes the weighing of super "B" axle groups much easier for the enforcement officers. The long decks were replaced with 14 foot decks over a period of time based on normal maintenance replacement needs.

g) Roadside Rest Areas

The Department has its own Rest Area Program but this has nothing to do with the same Memorandum of Understanding. When National Safety Codes come into effect, operators are required to rest for 8 hours after driving continuously for 13 hours. Again, this policy applies across the board and has nothing to do with the said MOU. We had always made provision for large trucks in our rest area parking lots, therefore, no affect of the M.O.U. on these facilities has been noticed.

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

This affects the centre-to-centre spacing of the individual carriage-ways of divided highways. Also, the spacing between a highway and a parallel railway track is very critical.

The TAC memo did not influence our pavement structural design practices.

Intersection design requirements have changed to accommodate the B-train truck and trailer combination.

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

Strengthening of bridges on the primary highway system for the increased TAC truck loads appears to be complete.

Enforcement of the Memorandum of Understanding has only taken place as it pertains to weights. Axle spreads and interaxle spacings to determine allowable weights are enforced but the other TAC measurements are rarely taken. These non enforced measurements are box length, effective rear overhand, king pin set back and tractor wheelbase.

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

1. Design intersection sight distances will be increased.
2. The "All Red" time required at signalized intersections will be increased.

REGION-SPECIFIC QUESTIONS

PRAIRIE PROVINCES

CP1. Based on your own experience, have the following specific changes in the Prairie Provinces affected your operations? If so, how and to what extent?

No effect on bridges.

Our ferry design and construction has been impacted to the extent that we build new ferries longer and stronger to handle the increased lengths and weights. Intersection design practices have been impacted as a result of the turing path of B-train truck/trailer units.

a) Increased allowable length for tractor-trailer combinations:

The overall length of regular tractor-trailer combinations recommended by the 1988 TAC Memorandum of Understanding was 23 m. Since 1988, the 4 western provinces (including Alberta) have permitted a maximum length of 25 m. Operationally, this increase in length has not created a problem on our highways. Alberta permits extended length Long Combination Vehicles on designated highways (Triple Trailers at 35 m; Rocky Mountain Doubles at 30 m: Turnpike Doubles at 35 m). This has increased the sight distances required at major intersections. Typically 430 m was previously required at major intersections (based on a design speed of 110 km/hr). Now, 560 m is required to accommodate the Super B-train (25 m length).

b) Increased allowable GVW for 5 axle tractor-trailers:

There was no change from the previously allowed G.V.W. for 5-axle tractor trailers.

Increases in weights are a general concern with regard to acceleration characteristics, passing and braking.

No data but probably no influence on pavement design.

c) Increased allowable GVW for 6-axle units:

The load effects from the 6-axle tractor trailer are no more severe than those of the 8-axle B-train for bridges.

Increases in weights are a general concern with regard to acceleration characteristics, passing and brading.

No data but probably no influence on pavement design.

d) Increased allowable GVW for B-trains:

We have spent approximately $2.5 million strengthening bridges on the primary highway system for the 8-axle B-train.

The increased allowable GVW for "B" trains originally caused problems for enforcement as it pertained to weight restrictions on bridges. Highways numbered 1 to 99 have bridges which can handle TAC weights, however, some highways in Counties, M.D.'s and (a) and (x) designated roads still have restricted bridges. Enforcement of weight restrictions on these bridges is a hit and miss situation.

Increases in weights are a general concern with regard to acceleration characteristics, passing and braking.

No data but probably no influence on pavement design.

MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: MANITOBA

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

Manitoba has conducted a number of roadside vehicle classification counts and has limited vehicle classification data from WIM sites. Data to be provided.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

Have been treating pavement impact of TAC vehicles as neutral. Have not undertaken any specific studies and don't know if pavements have been impacted or not. System designated in MOU has been considerably expanded. There are 3 levels of road designations (B1, A1, TAC) that need to be rationalized.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

Six bridges required strengthening at a total cost of $10,000,000. Five are strengthened; the sixth is posted until strengthening is completed. Difficult to estimate O&M costs. Main concern is a number of older wooden bridges which are overstressed.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

More tires means more spray when roads are wet and more snow swirl in winter with light dry snow falls. Experiencing rutting problems due to increased weights and increased truck traffic in general. Rutting problem with asphalt overlays on concrete. Many roads that are rutted should have been rebuilt anyway.

b) Resurfacing Practices

Have instituted a policy of paved shoulders, partially in response to more trucks, and more wheel tracking onto shoulders. Fully pave shoulders of 4 lane highways and 2 lane highways where 20 year AADT >2000. Otherwise pave 0.8 metres.

c) New Road Construction

Concerns where roads go through urban areas due to perceptions of more noise; fear for small vehicles.

d) Bridge Maintenance

Some increased O&M costs. Standard inspection and response procedures should identify and correct any problems as they occur.

e) Bridge Construction

There will be some increased O & M costs but these are difficult to quantify.

f) Weigh Stations

n/a

g) Roadside Rest Areas

Longer vehicles and more of them increase parking requirements.

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

A larger median is required for at grade crossings of 4 lane highways which are prevalent in Manitoba. Turning radii of some at grade approach ramps built in 1950's & 1960's need to be increased. Haven't noticed any problems with differences in passing 25m vs 23m vehicles.

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

Capital budget restrictions makes it difficult to keep pavement condition from deteriorating.

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

None

REGION-SPECIFIC QUESTIONS

PRAIRIE PROVINCES

CP1. Based on your own experience, have the following specific changes in the Prairie Provinces affected your operations? If so, how and to what extent?

a) Increased allowable length for tractor-trailer combinations:

Turning radii at some intersection ramps built in 1950's and 1960's no longer adequate. No effect on passing operation noticed. Wider medians required on at grade crossings of 4 lane highways.

b) Increased allowable GVW for 5 axle tractor-trailers:

n/a

c) Increased allowable GVW for 6-axle units:

n/a

d) Increased allowable GVW for B-trains:

n/a

d) Bridge Maintenance

None

e) Bridge Construction

None

f) Weigh Stations

None

g) Roadside Rest Areas

None

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

n/a

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

n/a

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

n/a

REGION-SPECIFIC QUESTIONS

ONTARIO

CO1. Based on your own experience, has the introduction of the 8-axle TAC B-train, with an allowable GVW of 62.5 tonnes, affected your operations? If so, how and to what extent?

n/a

CO2. Based on your own experience, has the introduction of the 16 metre (53 ft.) trailer affected your operations? If so, how and to what extent?

n/a

**MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING**

PROVINCE: ONTARIO

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

Conducted raodside surveys in 1989 and 1993 which can be used to identify changes. 1993 database ready in January. WIm data analysis by John Billing for 3 sites in Southern Ontario.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

GVW's and axle weights were already at or above TAC vehicles. Should not be any adverse impact from TAC vehicles.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

Truck weights and axle loads lower than loads that were in place. Little or no impact on bridges. Marginal increases in allowable axle loads on tandems (16,800 kg to 17,000 kg) and tridems (22,400 kg to 24,00 kg) may have marginal effect on maintenance frequency and fatigue life.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

Impact from TAC vehicles should be no different from heavy vehicles that were already on the highways. Impact of heavy vehicles on highways in general, particularly rutting, is an area of concern.

b) Resurfacing Practices

None

c) New Road Construction

None

MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: QUEBEC

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

Use of longer and heavier vehicles as legal weight was increased. Use of specialised equipment haul wood chips.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

No impact as Quebec allows for heavier legal weight than TAC.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

No impact as legal weight heavier than TAC.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

N/A

b) Resurfacing Practices

N/A

c) New Road Construction

N/A

d) Bridge Maintenance

N/A

e) Bridge Construction

N/A

f) Weigh Stations

N/A

g) Roadside Rest Areas

N/A

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

No changes in design.

REGION-SPECIFIC QUESTIONS

QUEBEC

CQ1. Based on your own experience, have the following specific changes in Quebec affected your operations? If so, how and to what extent?

N/A

a) Introduction of 8-axle B-train, with allowable GVW of 62.5 tonnes and combination length of 25m (82 ft.) on the Designated Highway System only:

N/A

b) Restrictions on multiple axle (e.g. quadaxle) vehicles:

N/A

c) Restrictions on allowable GVW (59 tonne maximum) off the Designated Highway System:

N/A

**MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING**

PROVINCE: NEW BRUNSWICK

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

Use of 8 axle B-trains has increased quickly in last few years. Issued 330 permits for such units (usually 1 permit per truck; any number of trailers) in 1993. In 1992 issued 210. So far in 1994 (January 21) 28 have been issued. About 52 companies involved. Main commodities lumber, grain, petroleum, chemicals, raw forest products, general freight.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

TAC vehicles are more pavement friendly than many of vehicles that were (are) in fleet. It is planned to phase out belly lift axles as they are more pavement damaging. TAC research is proving very useful in reviewing applications for vehicles. It is felt that safer, more productive vehicles are being approved as a result.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

Increased O&M costs but have not strengthened any bridges. Designated network being expanded as bridges are checked out and proven capable of handling loads.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

N/A. There have been some complaints of B-trains blocking traffic on gradients on secondary roads. Getting drive traction is apparently the problem.

b) Resurfacing Practices

Rapid pavement deterioration is taking place. In 1984 25% of paved arterial highways were classified as poor or only fair ride quality; in 1989 it had reached 32% and projected to reach 46% in 1994. Declining budgets a major problem. TAC trucks should contribute less to this problem than others in fleet.

c) New Road Construction

Province recently completed a major engineering review of its pavement design and construction practices. Recommendations from this study are now being implemented with expectation of improved pavement performance.

d) Bridge Maintenance

Increased O&M costs, but these cannot be quantified.

e) Bridge Construction

N/A

f) Weigh Stations

N/A

g) Roadside Rest Areas

N/A

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

Looking at introducing 25 metre vehicle length. This may have some effect on geometric design.

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

The provincial regulations to support the MOU are expected to be in place April 1, 1994. Weight limit enforcement has been beefed up recently with an additional 22 inspectors. This is not necessarily related to MOU.

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

Changes in pavement design and construction practices are being introduced following a consultant review of standards, specifications and procedures. Objective is to improve pavement performance within budget restrictions being faced.

REGION-SPECIFIC QUESTIONS

ATLANTIC PROVINCES

CA1. Based on your own experience, have the following specific changes in Atlantic Canada affected your operations? If so, how and to what extent?

a) Increased allowable length of 23m (75 ft.) for tractor-trailers and doubles on the Designated Highways System only:

No real impact. Do not have to issue as many special permits. 53' trailers to operate under special permit since November 1, 1993. To date (January 21, 1994) there have not been any applications. Carriers may be waiting for Quebec to adopt similar regulations.

b) Introduction of 8-axle B-train, with allowable GVW of 62.5 tonnes on the Designated highway System only:

No effect. MOU designated system being expanded in response to industry requests and bridges are checked to ensure they can handle the weights.

MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: NOVA SCOTIA

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

There has been an increase in truck traffic in general including B-trains. Supporting regulations were put in place only a few months ago, until that time special permits were used. Approximately 450 double combinations received special permits at maximum GVW. About 80% B-trains; rest are mainly A-trains with special overload permits. WIM data can be used for more detail on truck populations. Data from 22 roadside vehicle classification sites provided separately.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

Difficult to tell what impact each specific vehicle has had. There is no program to measure and monitor. There is concern about heavy vehicles as there has been significant deterioration of pavements in last few years. Getting accumulated rutting. Roads were not designed to handle truck volumes/loads currently on them. Newer pavements are better able to handle loads.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

No strengthening or replacement costs. Feel there will be additional maintenance and operation costs. Fatigue life of older bridges will affected.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

Concern about impact of going from 23m to 25m vehicle and impact on passing sight distance and safety. Increased rutting more and heavier trucks in general, can't tell if TAC vehicles are having any greater/lesser effects than heavy trucks.

b) Resurfacing Practices

Have changed designs on pavements now using deflection based overlay method. Also using mixes specifically defined to control rutting. Have experimented with microsurfacing. Generally satisfied with results.

c) New Road Construction

Using stronger pavements (thicker subgrade and pavements) in response to overall increases in truck traffic.

d) Bridge Maintenance

Feel there will be some additional operation and maintenance costs but can't quantify.

e) Bridge Construction

Bridges off designated system may need to be designed to higher standards, if designated system is to be extended.

f) Weigh Stations

No additional costs. Any changes required have been accommodated with other required changes/renovations at little or no extra cost.

g) Roadside Rest Areas

No rest areas at present. These will be installed as part of new construction programs.

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

Due to effect that heavy trucks in general are having have reviewed specifications for aggregates; made changes in approach to pavement design using thicker subgrade materials.

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

By legislation, Nova Scotia has to reduce capital budget by 5% per annum for next 4 years. Can't keep up with pavement deterioration.

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

Will continue to assess SHRP recommendations. Some changes will occur but can't identify any at this time.

REGION-SPECIFIC QUESTIONS

ATLANTIC PROVINCES

CA1. Based on your own experience, have the following specific changes in Atlantic Canada affected your operations? If so, how and to what extent?

a) Increased allowable length of 23m (75 ft.) for tractor-trailers and doubles on the Designated Highways System only:

Going 21m to 23m doesn't seem to have caused a problem but concern about going to 25m and affect on passing.

b) Introduction of 8-axle B-train, with allowable GVW of 62.5 tonnes on the Designated highway System only:

e) Bridge Construction

n/a

f) Weigh Stations

n/a

g) Roadside Rest Areas

n/a

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

No.

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

Restricted capital budgets making it difficult to keep pavements to proper condition.

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

Concerned about effects of going from 23m to 25m length on passing sight distance requirements.

REGION-SPECIFIC QUESTIONS

ATLANTIC PROVINCES

CA1. Based on your own experience, have the following specific changes in Atlantic Canada affected your operations? If so, how and to what extent?

a) Increased allowable length of 23m (75 ft.) for tractor-trailers and doubles on the Designated Highways System only:

Have not noticed anything specific.

b) Introduction of 8-axle B-train, with allowable GVW of 62.5 tonnes on the Designated highway System only:

More requests for use of B-trains under special permit off the designated system.

MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: PRINCE EDWARD ISLAND

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

Don't see a lot of double combination trailers in Prince Edward Island. Only 10 B-trains registered to operate there-all with out of province firms. 7-axle plus trucks account for 3% of total traffic stream at TCH WIM site in 1993 compared to 0.90% in 1990.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

Where roads are being rehabilitated partially paved shoulders are being used. This would call for an extra 4 meters of pavement (7.5m - 11.5m) on 450 km of arterial highways. Partially in response to use of tri-axles. Double combinations only allowed on arterials.

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

Haven't strengthened any yet.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

See above re: paved shoulders

b) Resurfacing Practices

See above re: paved shoulders

c) New Road Construction

n/a

d) Bridge Maintenance

Some increased maintenance costs but not quantified.

MINISTRY CASE STUDY ON IMPACTS OF
1988 TAC MEMORANDUM OF UNDERSTANDING

PROVINCE: NEWFOUNDLAND

QUESTIONS:

M1. What changes in heavy truck patterns from, 1987 to 1992 are you aware of, affecting the roadways in your jurisdiction (e.g. use of longer trucks, use of heavier trucks, use of TAC B-trains, etc.)?

There is very little usage of double combination trailers. Last major truck O-D survey was 1985; also 1991 CCMTA roadside survey.

M2.a) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the roads in your jurisdiction? If so, how and to what degree?

No. Use of B-trains too small to date to make any appreciable difference. Review of commercial vehicle database shows 27 B-trains registered to operate in Newfoundland; mainly by carriers domiciled in other Pronvices (e.g. Day & Ross).

b) Has the implementation of the 1988 TAC Memorandum of Understanding physically impacted the bridges in your jurisdiction? If so, how and to what degree?

No specific studies of additional rehabilitation/replacement costs - estimated subjectively at $1 m per year. Fatigue not a serious problem as not many steel bridges.

M3. Has the 1988 TAC Memorandum of Understanding influenced or changed practices in the following operational areas in your jurisdiction? If so, how and to what degree? What are the monetary implications of each area impacted?

a) Road Maintenance

Not aware of anything.

b) Resurfacing Practices

n/a

c) New Road Construction

n/a

d) Bridge Maintenance

See M2(b) above.

e) Bridge Construction

See above.

f) Weigh Stations

n/a

g) Roadside Rest Areas

n/a

M4. How has the TAC 1988 Memorandum of Understanding and the preceding research affected the design and analysis of the highway infrastructure in your jurisdiction?

Nothing related to TAC vehicles specifically. These have been some minor changes to pavement analysis methods.

M5. To what extent is the implementation of changes required as a result of the 1988 TAC Memorandum of Understanding affected by other factors, e.g. budget restrictions, enforcement, etc.?

n/a

M6. What major changes in highway design and analysis do you anticipate for your jurisdiction over the next five years, and what are the reasons for these changes?

n/a

REGION-SPECIFIC QUESTIONS

ATLANTIC PROVINCES

CA1. Based on your own experience, have the following specific changes in Atlantic Canada affected your operations? If so, how and to what extent?

a) Increased allowable length of 23m (75 ft.) for tractor-trailers and doubles on the Designated Highways System only:

Went from 21m to 23m with no difficulty. Going from 23m to 25m would likely require changes to barrier sight design.

b) Introduction of 8-axle B-train, with allowable GVW of 62.5 tonnes on the Designated highway System only:

n/a

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Based on the CCMTA Survey data for the Prairie sites, a 3.4% reduction in LEF's was estimated as a result of the MoU. This Appendix describes the various steps used to arrive at this estimate.

Step 1:

The frequencies of vehicles observed at the Prairie Sites, by vehicle type and GVW is tabulated in Exhibit 1. The cells highlighted in this exhibit show the 6-axle tractor semitrailers and 8-axle B-trains loaded above their respective Pre-MoU limits. The total data represents a sample size of 1,706 trucks. This includes 1,322 tractor-semitrailers and 384 double combination trucks. Note that the data is based on 1991 CCMTA survey data and therefore represents the Post-MoU traffic mix.

Step 2:

Using the standard "LEF versus Payload" relationships for the various vehicle types, and typical tare weights for each vehicle type, the LEF's per vehicle for each cell of the GVW frequency distribution is determined in Exhibit 2. To illustrate the numbers in this exhibit, for example, a 5-axle tractor semitrailer produces 0.8282 LEF's when empty, and produces 0.9779 LEF's when loaded to a GVW of 18 tonnes. The cells for the 18 tonne GVW are shown as N/A (i.e. not applicable) for double combination trucks since the "typical" tare weights for double combination trucks are greater than 18 tonnes.

Step 3:

By multiplying the frequencies in Exhibit 1 with the corresponding LEF's per vehicle estimated in Exhibit 2, total LEF's are calculated for each cell (Exhibit 3). The total truck traffic observed amounts to a loading of **5,164** LEF's. This includes 3,647 LEF's due to tractor semitrailers and 1,517 LEF's due to double combination trucks.

Step 4:

From the cells highlighted in Exhibits 1 and 3, the figures for 6-axle tractor semitrailers are summarized in Exhibit 4. A total of 94 6-axle tractor semitrailers were loaded above their Pre-MoU limit. Based on a tare weight of 15.5 tonnes for a typical 6-axle tractor semitrailer, these 94 trucks were hauling a total of 2,487 tonnes. These 94 trucks accounted for **345** LEF's. Without the MoU, it is assumed that this freight of 2,487 tonnes would have been hauled in an equivalent number of fully loaded 5-axle tractor semitrailers. The number of fully loaded 5-axle semitrailers required to haul 2,487 tonnes at the Pre-MoU GVW limit of 37.5 tonnes (i.e. payload limit of 37.5 - 14.5 = 23 tonnes) is 2,487/23 ≈ 108 trucks. With 4.1849 LEF's produced per 5-axle tractor semitrailer at a payload of 23 tonnes, these 108 tractor semitrailers would produce 108 x 4.1849 ≈ **453** LEF's.

Therefore, while the Post-MoU traffic level for tractor semitrailers is 3,647 LEF's, the corresponding Pre-MoU traffic level is estimated as 3,647-345+453 ≈ **3,755** LEF's. Therefore, the MoU has reduced the LEF's due to tractor semitrailers by (3,755 - 3,647)/3,755 ≈ 2.9%.

Step 5:

From the cells highlighted in Exhibits 1 and 3, the figures for 8-axle B-trains are summarized in Exhibit 5. A total of 79 8-axle B-trains were loaded above their Pre-MoU limit. Based on a tare weight of 20 tonnes for a typical 8-axle B-train, these 79 trucks were hauling a total of 3,174 tonnes. These 79 trucks accounted for **474** LEF's. Without the MoU, it is assumed that this freight of 3,174 tonnes would have been hauled in an equivalent number of fully loaded 7-axle B-trains. The number of fully loaded 7-axle B-trains required to haul 3,174 tonnes at the Pre-MoU GVW limit of 53.5 tonnes (i.e. payload limit of 53.5 - 19.0 = 34.5 tonnes) is 3,174/34.5 ≈ 92 trucks. With 5.9305 LEF's produced per 7-axle B-train at a payload of 34.5 tonnes, these 92 7-axle B-trains would produce 92 x 5.9305 ≈ **546** LEF's.

Therefore, while the Post-MoU traffic level for double combination trucks is 1,517 LEF's, the corresponding Pre-MoU traffic level is estimated as 1,517-474+546 ≈ **1,589** LEF's. Therefore, the MoU has reduced the LEF's due to double combination trucks by (1,589 - 1,517)/1,589 ≈ 4.5%.

Step 6:

In summary, compared to the Post-MoU traffic level of 5,164 LEF's, the corresponding Pre-MoU traffic level is estimated as 5,344 LEF's (i.e. 3,755 in semitrailers plus 1,589 in doubles). Therefore, the MoU has reduced the traffic level from 5,344 LEF's to 5,164 LEF's (i.e. by 180 LEF's). This represents an overall reduction of 180/5,344 ≈ **3.4%** in LEF's due to the MoU.

Exhibit 1 : GVW Distribution by Vehicle Type for Prairie Provinces
1991 CCMTA Survey Data

	Vehicle Type Frequency							
GVW (tonnes)	5TT	6TT	7A	7B	7C	8A	8B	8C
Empty	302	48	22	28	3	4	38	1
18	44	0	0	0	0	0	0	0
23	117	10	2	2	0	0	3	0
28	143	10	7	2	1	1	0	0
33	188	18	12	7	4	1	1	1
38	279	33	2	4	2	0	3	2
41	5	8	1	0	2	1	1	1
42	2	4	1	0	0	0	0	0
43	4	13	1	0	1	0	0	0
44	4	7	1	0	0	0	1	1
45	4	10	0	0	1	0	0	0
46	3	16	2	3	0	1	0	0
47	5	3	1	1	0	2	0	0
48	0	0	1	3	0	2	1	0
49	2	0	4	2	1	2	0	1
50	3	0	1	9	1	0	1	0
51	0	0	3	7	0	0	1	0
52	1	0	2	5	0	0	2	0
53	3	0	3	9	0	3	2	1
54	3	0	7	9	1	0	0	1
55	2	0	2	9	0	0	3	0
56	1	0	1	6	1	0	3	0
57	1	0	0	4	7	0	2	0
58	0	0	0	0	0	0	6	0
59	1	1	0	2	0	0	10	0
60	1	0	0	1	0	0	15	1
61	0	0	0	1	0	0	16	0
62	1	1	0	0	0	0	19	0
63	1	0	1	2	0	0	5	0
64	0	0	0	0	0	0	2	0
65	17	3	0	1	1	0	2	0
TOTALS	1137	185	77	117	26	17	137	10

Column Notes:

5TT : 5-axle semitrailer
6TT : 6-axle semitrailer
7A : 7-axle A-train
7B : 7-axle B-train
7C : 7-axle C-train
8A : 8-axle A-train
8B : 8-axle B-train
8C : 8-axle C-train

Exhibit 2 : LEF's per vehicle
1991 CCMTA Survey Data

GVW (tonnes)	5TT	6TT	7A	7B	7C	8A	8B	8C
Empty	0.8282	0.8446	0.9217	0.8959	0.9207	0.9456	0.9123	0.9419
18	0.9779	0.9243	N/A	N/A	N/A	N/A	N/A	N/A
23	1.3891	1.2101	1.0710	1.0903	1.0702	0.9883	1.0373	0.9844
28	2.0374	1.6311	1.4314	1.4506	1.4314	1.2656	1.3213	1.2613
33	2.9586	2.2005	1.9529	1.9587	1.9549	1.6611	1.7085	1.6583
38	4.1849	2.9296	2.6591	2.6316	2.6650	2.1895	2.2083	2.1914
41	5.0796	3.4482	3.1811	3.1212	3.1902	2.5761	2.5657	2.5828
42	5.4056	3.6351	3.3725	3.2993	3.3829	2.7172	2.6948	2.7259
43	5.7459	3.8290	3.5729	3.4852	3.5847	2.8647	2.8290	2.8755
44	6.1008	4.0302	3.7825	3.6789	3.7958	3.0185	2.9684	3.0317
45	6.4703	4.2386	4.0014	3.8805	4.0163	3.1788	3.1130	3.1946
46	6.8547	4.4544	4.2299	4.0901	4.2465	3.3457	3.2628	3.3643
47	7.2543	4.6776	4.4680	4.3079	4.4864	3.5193	3.4180	3.5410
48	7.6692	4.9077	4.7160	4.5339	4.7364	3.6997	3.5786	3.7247
49	8.0996	5.1452	4.9740	4.7683	4.9964	3.8870	3.7446	3.9156
50	8.5457	5.3903	5.2421	5.0112	5.2668	4.0813	3.9161	4.1138
51	9.0078	5.6430	5.5207	5.2626	5.5476	4.2827	4.0932	4.3193
52	9.4860	5.9034	5.8097	5.5227	5.8391	4.4912	4.2759	4.5322
53	9.9804	6.1716	6.0987	5.7916	6.1414	4.6998	4.4643	4.7528
54	10.4914	6.4475	6.4234	6.0693	6.4438	4.9347	4.6584	4.9810
55	11.0191	6.7314	6.7457	6.3561	6.7834	5.1653	4.8583	5.2169
56	11.5637	7.0232	7.0792	6.6428	7.1192	5.4036	5.0640	5.4608
57	12.1253	7.3231	7.4241	6.9604	7.4664	5.6494	5.2755	5.7126
58	12.7042	7.6310	7.7806	7.2747	7.8253	5.9030	5.4931	5.9645
59	13.3005	7.9470	8.1488	7.5984	8.1959	6.1645	5.7166	6.2448
60	13.9145	8.2712	8.5290	7.9315	8.5785	6.4339	5.9461	6.5184
61	14.5462	8.6037	8.9211	8.2743	8.9733	6.7113	6.1818	6.8003
62	15.1959	8.9445	9.3255	8.6266	9.3802	6.9968	6.4174	7.0905
63	15.8638	9.2937	9.7422	8.9888	9.7997	7.2905	6.6741	7.3890
64	16.5500	9.6513	10.1715	9.3608	10.2317	7.5925	6.9289	7.6961
65	17.2547	10.0174	10.6134	9.7427	10.6764	7.9029	7.1900	8.0117

Column Notes:

5TT : 5-axle semitrailer
6TT : 6-axle semitrailer
7A : 7-axle A-train
7B : 7-axle B-train
7C : 7-axle C-train
8A : 8-axle A-train
8B : 8-axle B-train
8C : 8-axle C-train

Exhibit 3 : Total LEF Estimates
1991 CCMTA Survey Data

GVW (tonnes)	5TT	6TT	7A	7B	7C	8A	8B	8C
Empty	250	41	20	25	3	4	35	1
18	43	0	0	0	0	0	0	0
23	163	12	2	2	0	0	3	0
28	291	16	10	3	1	1	0	0
33	556	40	23	14	8	2	2	2
38	1168	97	5	11	5	0	7	4
41	25	28	3	0	6	3	3	3
42	11	15	3	0	0	0	0	0
43	23	50	4	0	4	0	0	0
44	24	28	4	0	0	0	3	3
45	26	42	0	0	4	0	0	0
46	21	71	8	12	0	3	0	0
47	36	14	4	4	0	7	0	0
48	0	0	5	14	0	7	4	0
49	16	0	20	10	5	8	0	4
50	26	0	5	45	5	0	4	0
51	0	0	17	37	0	0	4	0
52	9	0	12	28	0	0	9	0
53	30	0	18	52	0	14	9	5
54	31	0	45	55	6	0	0	5
55	22	0	13	57	0	0	15	0
56	12	0	7	40	7	0	15	0
57	12	0	0	28	52	0	11	0
58	0	0	0	0	0	0	33	0
59	13	8	0	15	0	0	57	0
60	14	0	0	8	0	0	89	7
61	0	0	0	8	0	0	99	0
62	15	9	0	0	0	0	122	0
63	16	0	10	18	0	0	33	0
64	0	0	0	0	0	0	14	0
65	293	30	0	10	11	0	14	0
TOTALS	3147	500	240	494	118	49	583	33

Column Notes:

5TT : 5-axle semitrailer
6TT : 6-axle semitrailer
7A : 7-axle A-train
7B : 7-axle B-train
7C : 7-axle C-train
8A : 8-axle A-train
8B : 8-axle B-train
8C : 8-axle C-train

Exhibit 4 : Summary of 6-axle Semitrailers loaded above Pre-MoU limit (1991 CCMTA Survey Data for Prairie Provinces)

Frequency	GVW (Tonnes)	Payload per vehicle (Tonnes)	Total Payload (Tonnes)	LEF's
33	38	22.5	743	97
8	41	25.5	204	28
4	42	26.5	106	15
13	43	27.5	358	50
7	44	28.5	200	28
10	45	29.5	295	42
16	46	30.5	488	71
3	47	31.5	95	14
94			2,487	345

- Based on a typical tare weight of 15.5 tonnes for 6-axle tractor semitrailers.

Exhibit 5 : Summary of 8-axle B-trains loaded above Pre-MoU limit (1991 CCMTA Survey Data for Prairie Provinces)

Frequency	GVW (Tonnes)	Payload per vehicle (Tonnes)	Total Payload (Tonnes)	LEF's
3	55	35	105	15
3	56	36	108	15
2	57	37	74	11
6	58	38	228	33
10	59	39	390	57
15	60	40	600	89
16	61	41	656	99
19	62	42	798	122
5	63	43	215	33
79			3,174	474

- Based on a typical tare weight of 20 tonnes for 8-axle B-trains.

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F.3 PAVEMENT LIFE CALCULATIONS

Additional pavement life due to the MoU is estimated to be in the order of 1 to 2 months for the Prairie Provinces. This Appendix describes the various steps used to arrive at this estimate.

Step 1:

Using the NHS traffic database, the 1991 annual truck traffic (semitrailers and doubles) estimates for the Prairie Provinces are summarized in Exhibit 1. The total estimates are broken down by loading criterion (i.e. whether the vehicle is empty, cubing, weighting, cubing and weighting, or partially loaded). Total traffic amounts to 951 MVK.

Step 2:

The average payload for each cell of Exhibit 1 is summarized in Exhibit 2, based on the 1991 CCMTA Survey data at Prairie Sites. To illustrate the numbers in this exhibit, for example, the average payload for an 8-axle B-train is 32 tonnes when cubing out, and 41 tonnes when weighting out. Note that the payload for an empty truck is zero by definition.

Step 3:

Using the standard "LEF versus Payload" relationships for the various vehicle types, the LEF's per vehicle for each cell of Exhibit 2 is determined in Exhibit 3. To illustrate the numbers in this exhibit, for example, an 8-axle B-train produces 0.9123 LEF's when empty, 4.2759 LEF's when cubing out, and 6.1818 LEF's when weighting out.

Step 4:

By multiplying the truck traffic (MVK) estimates in Exhibit 1 with the corresponding LEF's per vehicle estimated in Exhibit 3, total annual LEF's are calculated in Exhibit 4 for each vehicle type and loading criterion. The total annual truck traffic on the National Highway System in the Prairies amounts to a loading of 2,751 LEF-MVK. For clarification, in terms of ESAL-Miles which is a more common term used in the literature, this amounts to approximately 1,720 Million ESAL-Miles.

Step 5:

With about 2,751 LEF-MVK distributed annually over 6,407 kilometres of National Highway System in the Prairie Provinces, the average annual loading on a typical pavement section is estimated as $2{,}751 \times 10^6/6{,}407 \approx 429{,}336$ LEF's. This is broken down by vehicle type and loading criterion in Exhibit 5.

Step 6:

With an estimated reduction of 3.4% in LEF's due to the MoU, the Pre-MoU traffic level corresponding to the Post-MoU traffic of 429,336 LEF's is estimated as $429{,}336/(1-0.034) \approx 444{,}447$ LEF's.

Step 7:

Applying these loads as the base year traffic level, the pavement life corresponding to the Post-MoU and Pre-MoU LEF's was estimated for twelve typical pavement structures. The pavement life calculations were based on the Ontario flexible pavement design procedures, assuming a 2% annual traffic growth, initial RCI of 7.5, and terminal RCI of 5.0. The results are summarized for the twelve pavement structures in Exhibit 6. To illustrate the pavement life calculations, detailed analysis is presented for pavement structure #12 in Exhibit 7 (for Pre-MoU LEF's) and Exhibit 8 (for Post-MoU LEF's). As seen from the summary of results in Exhibit 6, additional pavement life due to the MoU ranges from 0.09 years (i.e. 33 days) to 0.14 years (i.e. 51 days), based on the pavement strength. Therefore, typical pavement life benefits (i.e. "build later" savings) due to the MoU is estimated to be in the order of 1 to 2 months for the Prairie Provinces.

**Exhibit 1 : Annual Truck Traffic Estimates (1991)
National Highway System (Prairies)**

Vehicle Type	Annual Truck Traffic (MVK) by loading critieria					Total
	E	C	W	CW	P	
5TT	186	213	12	21	119	551
6TT	35	34	6	16	21	113
7A	19	12	2	14	8	56
7B	26	27	5	18	17	94
7C	2	2	3	5	3	15
8A	3	5	1	0	1	11
8B	30	12	15	32	17	105
8C	0	1	3	2	0	6
ALL	301	306	49	109	186	951

Notes:

E : Empty Trucks

C : Cubing Trucks (i.e. haul exceeds 95% of its cubic capacity)

W : Weighting Trucks (i.e. haul exceeds 95% of its regulated GVW limit)

CW : Cubing/Weighting Trucks (i.e. haul exceeds 95% of its cubic capacity as well as regulated GVW limit)

P : Partially loaded Trucks (i.e. haul is less than 95% of its cubic capacity, as well as regulated GVW limit)

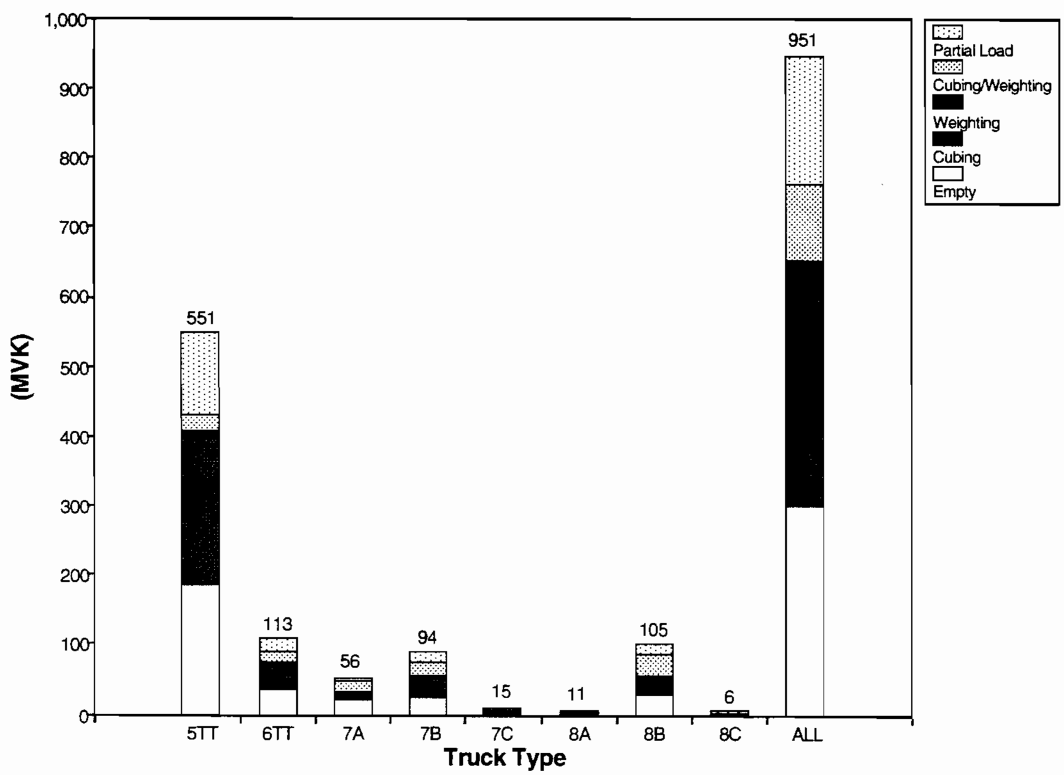

Exhibit 2 : Average Payload Estimates
(Based on 1991 CCMTA Survey Data for Prairie Provinces)

	Payload (Tonnes)				
Vehicle Type	E	C	W	CW	P
5TT	0	17	41	40	14
6TT	0	21	33	31	19
7A	0	21	33	33	14
7B	0	30	36	38	22
7C	0	21	33	33	14
8A	0	24	31	31	15
8B	0	32	41	41	28
8C	0	24	31	31	15

Notes:

E : Empty Trucks (payload=0 by definition)

C : Cubing Trucks (i.e. haul exceeds 95% of its cubic capacity)

W : Weighting Trucks (i.e. haul exceeds 95% of its regulated GVW limit)

CW : Cubing/Weighting Trucks (i.e. haul exceeds 95% of its cubic capacity as well as regulated GVW limit)

P : Partially loaded Trucks (i.e. haul is less than 95% of its cubic capacity, as well as regulated GVW limit)

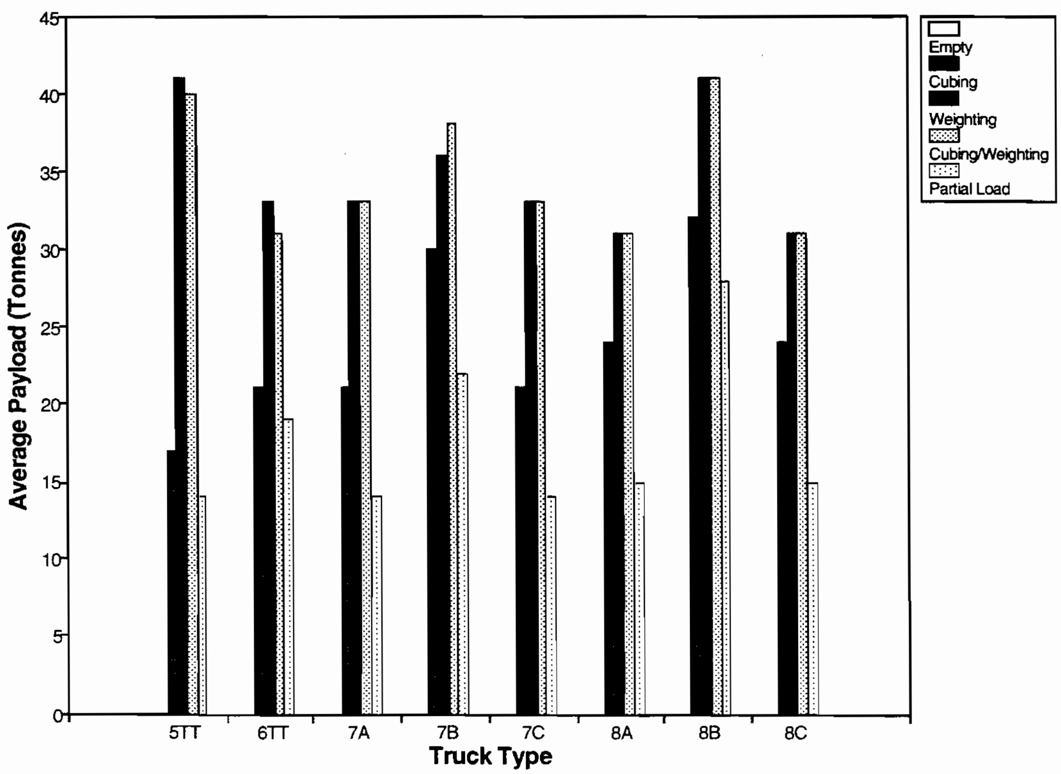

Exhibit 3 : LEF's per vehicle
(Based on "LEF versus Payload" relationships)

	LEF's per vehicle at average payload estimated				
Vehicle Type	E	C	W	CW	P
5TT	0.8282	2.7509	11.5637	11.0191	2.1987
6TT	0.8446	2.7705	5.1452	4.6776	2.4724
7A	0.9217	3.1811	6.0987	6.0987	2.0786
7B	0.8959	4.7683	6.3561	6.9604	3.1212
7C	0.9207	3.1902	6.1414	6.1414	2.0813
8A	0.9456	3.3457	4.6998	4.6998	2.0725
8B	0.9123	4.2759	6.1818	6.1818	3.5786
8C	0.9419	3.3643	4.7528	4.7528	2.0732

Notes:

E : Empty Trucks

C : Cubing Trucks (i.e. haul exceeds 95% of its cubic capacity)

W : Weighting Trucks (i.e. haul exceeds 95% of its regulated GVW limit)

CW : Cubing/Weighting Trucks (i.e. haul exceeds 95% of its cubic capacity as well as regulated GVW limit)

P : Partially loaded Trucks (i.e. haul is less than 95% of its cubic capacity, as well as regulated GVW limit)

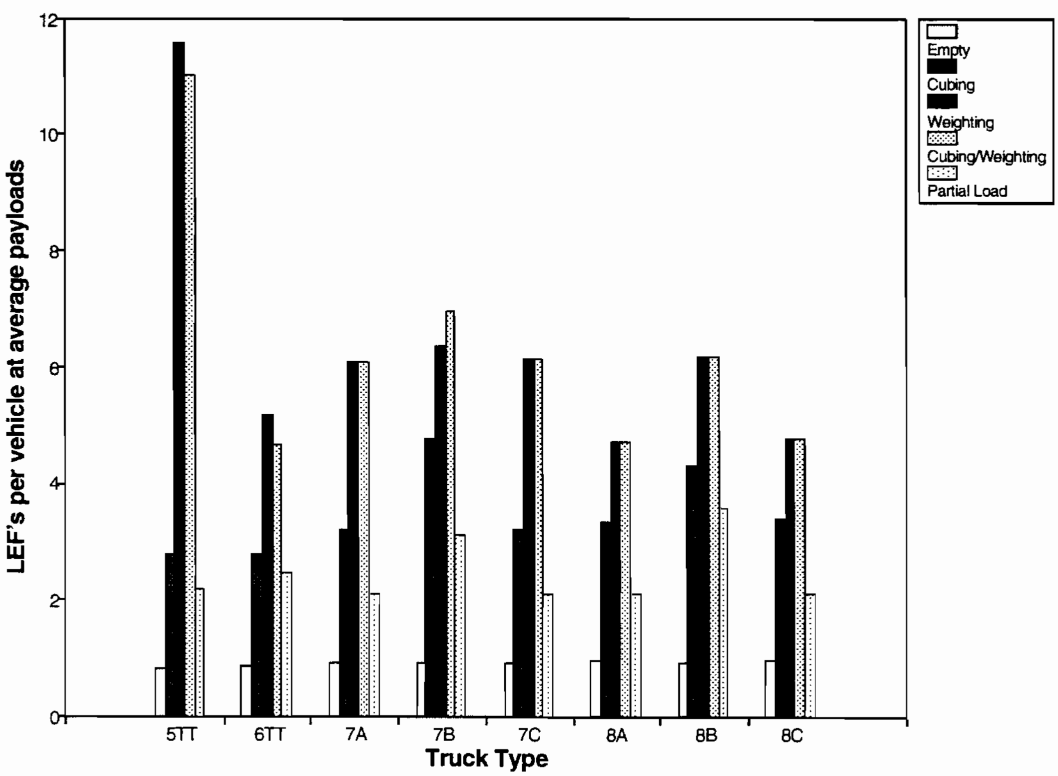

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Exhibit 4 : Annual Truck Traffic Loading (1991)
National Highway System (Prairies)

Vehicle Type	E	C	W	CW	P	Total
	LEF-MVK by loading critieria					
5TT	154	586	140	234	261	1,375
6TT	30	93	32	76	53	284
7A	18	39	14	88	16	175
7B	23	130	31	128	54	366
7C	1	7	21	31	6	67
8A	3	18	5	2	2	30
8B	27	50	94	196	60	428
8C	0	2	16	8	0	27
ALL	256	926	354	762	453	2,751

Notes:

E : Empty Trucks

C : Cubing Trucks (i.e. haul exceeds 95% of its cubic capacity)

W : Weighting Trucks (i.e. haul exceeds 95% of its regulated GVW limit)

CW : Cubing/Weighting Trucks (i.e. haul exceeds 95% of its cubic capacity as well as regulated GVW limit)

P : Partially loaded Trucks (i.e. haul is less than 95% of its cubic capacity, as well as regulated GVW limit)

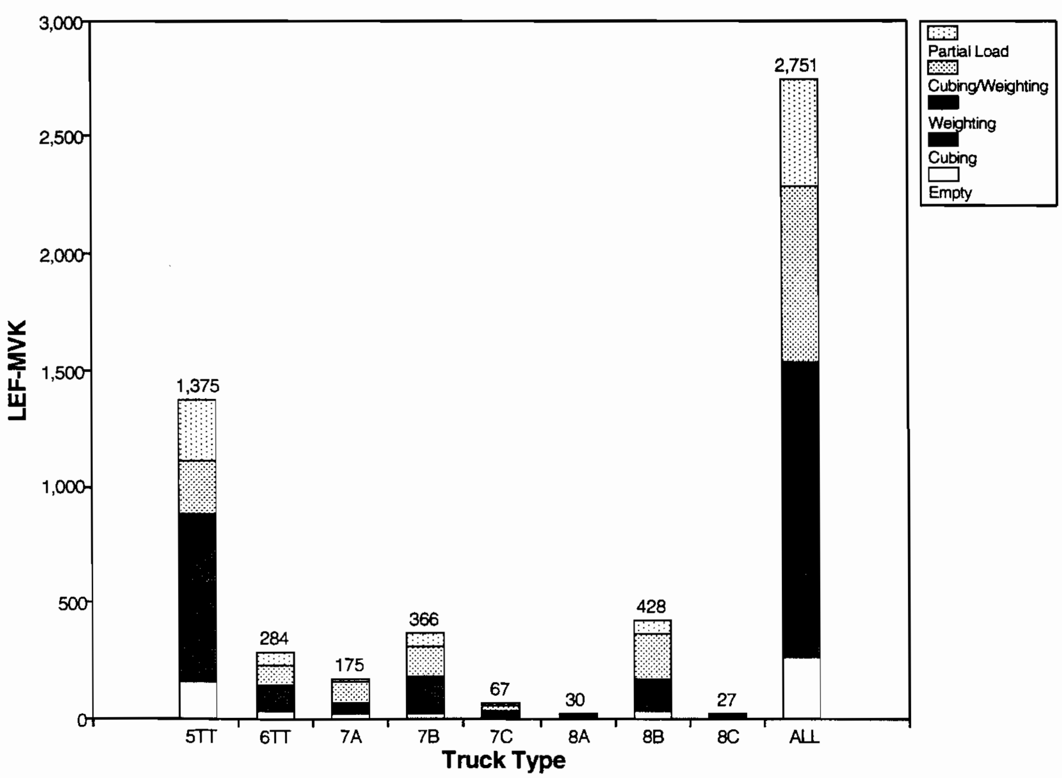

Exhibit 5 : Annual LEF's on a Typical Pavement Section National Highway System (Prairies)

Vehicle Type	Average Annual LEF's E	C	W	CW	P	Total
5TT	24,005	91,533	21,857	36,445	40,770	214,610
6TT	4,664	14,550	5,029	11,854	8,284	44,382
7A	2,788	6,084	2,245	13,702	2,463	27,282
7B	3,629	20,234	4,831	20,020	8,430	57,144
7C	223	1,103	3,246	4,868	988	10,428
8A	454	2,843	727	240	354	4,617
8B	4,233	7,788	14,749	30,561	9,393	66,725
8C	17	367	2,508	1,254	0	4,147
ALL	40,015	144,503	55,192	118,944	70,682	429,336

Notes:

E : Empty Trucks

C : Cubing Trucks (i.e. haul exceeds 95% of its cubic capacity)

W : Weighting Trucks (i.e. haul exceeds 95% of its regulated GVW limit)

CW : Cubing/Weighting Trucks (i.e. haul exceeds 95% of its cubic capacity as well as regulated GVW limit)

P : Partially loaded Trucks (i.e. haul is less than 95% of its cubic capacity, as well as regulated GVW limit)

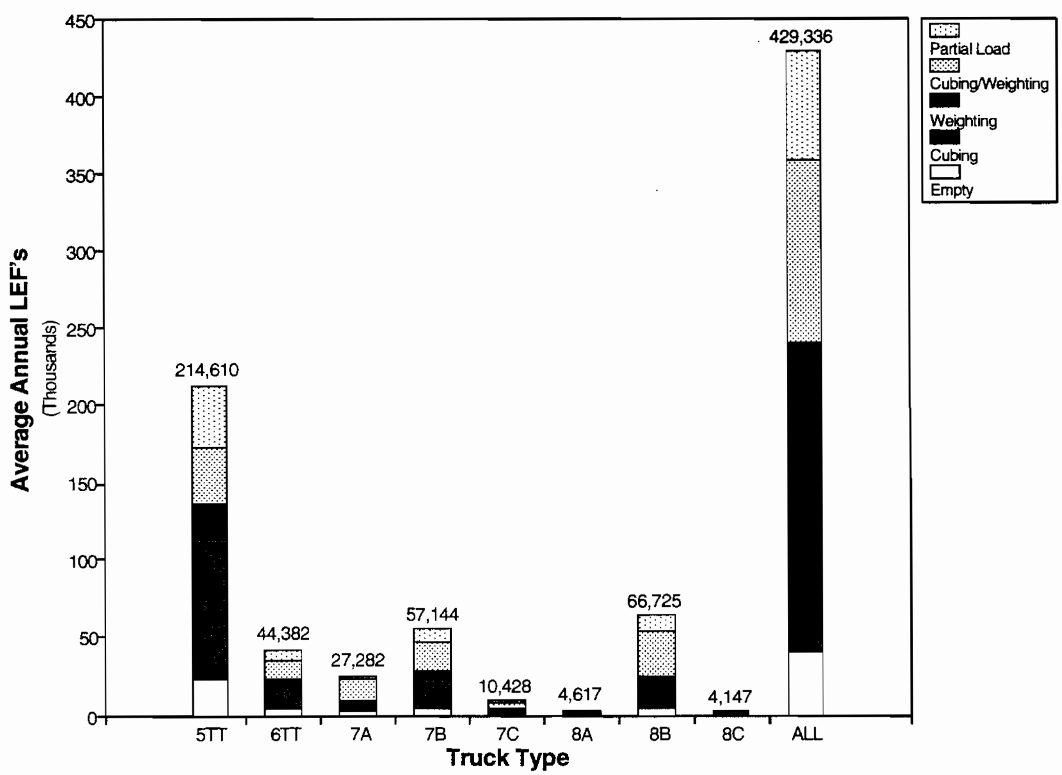

Exhibit 6 : Pavement Life Estimates at Post-MoU and Pre-MoU Traffic Levels

	Pavement Structure (Conventional)				Pavement Life (years)		
	Asphalt Surface (mm)	Granular Base (mm)	Granular Subbase (mm)	Equivalent Granular Thickness	Post-MoU	Pre-MoU	Additional Life due to MoU
	Weak Subgrade (Lacustrine Clay)						
# 1	100	100	205	437	2.82	2.73	0.09
# 2	100	100	305	503	5.31	5.19	0.12
# 3	100	150	355	587	9.03	8.89	0.14
# 4	100	165	345	595	9.40	9.26	0.14
# 5	115	165	355	632	11.00	10.87	0.13
# 6	125	180	370	677	12.86	12.73	0.13
	Medium Subgrade (Glacial Till)						
# 7	100	100	125	383	4.62	4.50	0.12
# 8	100	100	205	437	7.48	7.35	0.13
# 9	100	150	180	470	9.35	9.21	0.14
# 10	100	100	305	503	11.15	11.02	0.13
# 11	115	165	180	515	11.76	11.63	0.13
# 12	125	180	190	557	13.83	13.72	0.11

Notes:
- *Typical pavement structures are based on guidelines provided in the TAC Pavement Management Guide.*
- *Subgrade layer coefficient is assumed as 5,000 for weak subgrade and 7,000 for medium subgrade.*
- *Pavement life calculations are based on Ontario flexible pavement design procedures.*

Exhibit 7 : Loss of RCI due to Traffic and Environment (Pre-MoU Traffic)

Year	LEF's	Cumulative LEF's (N)	Loss of RCI due to traffic	Loss of RCI due to environment	RCI with loss due to traffic only	RCI with loss due to environment only	Net RCI	
0	-	-	0.00	0.00	7.50	7.50	7.50	
1	444,447	444,447	0.02	0.22	7.48	7.28	7.26	
2	453,336	897,783	0.05	0.42	7.45	7.08	7.03	
3	462,403	1,360,186	0.07	0.62	7.43	6.88	6.81	
4	471,651	1,831,836	0.10	0.80	7.40	6.70	6.60	
5	481,084	2,312,920	0.12	0.97	7.38	6.53	6.40	
6	490,705	2,803,625	0.15	1.13	7.35	6.37	6.22	
7	500,520	3,304,145	0.18	1.29	7.32	6.21	6.04	
8	510,530	3,814,675	0.21	1.43	7.29	6.07	5.86	
9	520,740	4,335,415	0.24	1.57	7.26	5.93	5.70	
10	531,155	4,866,571	0.27	1.69	7.23	5.81	5.54	
11	541,778	5,408,349	0.30	1.81	7.20	5.69	5.39	
12	552,614	5,960,963	0.33	1.93	7.17	5.57	5.24	
13	563,666	6,524,629	0.37	2.03	7.13	5.47	5.10	
14	574,940	7,099,569	0.41	2.13	7.09	5.37	4.96	<5
15	586,438	7,686,007	0.45	2.23	7.05	5.27	4.83	<5
16	598,167	8,284,174	0.49	2.32	7.01	5.18	4.70	<5
17	610,130	8,894,305	0.53	2.40	6.97	5.10	4.57	<5
18	622,333	9,516,638	0.58	2.48	6.92	5.02	4.44	<5
19	634,780	10,151,418	0.63	2.55	6.87	4.95	4.32	<5
20	647,475	10,798,893	0.68	2.62	6.82	4.88	4.20	<5
Total	10,798,893							

Pavement Strength and Traffic Growth Parameters:

LEF's (Y=1): 444,447
Annual growth: 2%

Medium subgrade (Glacial Till)			Ms =	7,000
h1 =	125	mm of asphalt surface	M1 =	400,000
h2 =	180	mm of granular base	M2 =	50,000
h3 =	190	mm of granular subbase	M3 =	15,000
He =	557	mm of equivalent gravel		
	22	inches		
			Initial RCI:	7.5
Odemark deflection calculation (w):			Terminal RCI:	5.0
Z =	37.99		Pavement Life:	**13.72 years**
w (inches) =	0.0167			

Exhibit 8 : Loss of RCI due to Traffic and Environment (Post-MoU Traffic)

Year	LEF's	Cumulative LEF's (N)	Loss of RCI due to traffic	Loss of RCI due to environment	RCI with loss due to traffic only	RCI with loss due to environment only	Net RCI	
0	-	-	0.00	0.00	7.50	7.50	7.50	
1	429,336	429,336	0.02	0.22	7.48	7.28	7.26	
2	437,923	867,259	0.05	0.42	7.45	7.08	7.03	
3	446,681	1,313,940	0.07	0.62	7.43	6.88	6.81	
4	455,615	1,769,555	0.09	0.80	7.41	6.70	6.61	
5	464,727	2,234,282	0.12	0.97	7.38	6.53	6.41	
6	474,022	2,708,303	0.14	1.13	7.36	6.37	6.22	
7	483,502	3,191,805	0.17	1.29	7.33	6.21	6.04	
8	493,172	3,684,978	0.20	1.43	7.30	6.07	5.87	
9	503,036	4,188,013	0.23	1.57	7.27	5.93	5.71	
10	513,096	4,701,109	0.26	1.69	7.24	5.81	5.55	
11	523,358	5,224,468	0.29	1.81	7.21	5.69	5.40	
12	533,825	5,758,293	0.32	1.93	7.18	5.57	5.25	
13	544,502	6,302,795	0.36	2.03	7.14	5.47	5.11	
14	555,392	6,858,187	0.39	2.13	7.11	5.37	4.98	<5
15	566,500	7,424,686	0.43	2.23	7.07	5.27	4.84	<5
16	577,830	8,002,516	0.47	2.32	7.03	5.18	4.72	<5
17	589,386	8,591,902	0.51	2.40	6.99	5.10	4.59	<5
18	601,174	9,193,077	0.55	2.48	6.95	5.02	4.47	<5
19	613,198	9,806,274	0.60	2.55	6.90	4.95	4.35	<5
20	625,461	10,431,736	0.65	2.62	6.85	4.88	4.23	<5
Total	10,431,736							

Pavement Strength and Traffic Growth Parameters:

LEF's (Y=1): 429,336

Annual growth: 2%

Medium subgrade (Glacial Till)			Ms =	7,000
h1 =	125	mm of asphalt surface	M1 =	400,000
h2 =	180	mm of granular base	M2 =	50,000
h3 =	190	mm of granular subbase	M3 =	15,000
He =	557	mm of equivalent gravel		
	22	inches		

Initial RCI: 7.5

Odemark deflection calculation (w):

Terminal RCI: 5.0

Z = 37.99

Pavement Life: **13.83 years**

w (inches) = 0.0167

APPENDIX G

USER GUIDE FOR COMPREHENSIVE IMPACTS MODEL

Appendix G: User Guide for Comprehensive Impacts Model

G. INTRODUCTION

In this appendix we provide user instructions for the operation of the three spreadsheet models that were used in the calculation of the traffic projections. These are the:

- Traffic Projection Model;
- Truck Unit Cost Model;
- Truck Cost Model.

In these instructions it was assumed that the user is familiar with Lotus 1-2-3. They are given in point form. The are best followed with the spreadsheet on the screen.

We wish to point out that these three spreadsheets are not "production versions"; they grew with the analyses and were repeatedly amended as the need arose. They are therefore not the most efficient programs and contain many redundancies from earlier stages or experimentation with different approaches.

Exhibits G.1, G.2 and G.3 show flow diagrams of the three spreadsheets.

G.1 TRAFFIC PROJECTION MODEL

The purpose of this model is to project the base traffic for 1992 with the MoU derived form the analyses in the Base Traffic Model to other years and to estimates without the MoU.

The filename of the model is PROJECTN.WK1. The following is the relevant information:

1. The data on the base traffic is in the format as indicated in Range D17..AX53. The regions are:

    1. Atlantic (New Brunswick, Nova Scotia, P.E.I., Newfoundland);
    2. Quebec;
    3. Ontario;
    4. Prairies (Manitoba, Saskatchewan, Alberta);
    5. British Columbia;
    6. Territories;
    7. United States.

EXHIBIT G.1

FLOW DIAGRAM OF TRAFFIC PROJECTION MODEL

SHOWING THE INDIVIDUAL TABLES AND THEIR INTERACTIONS

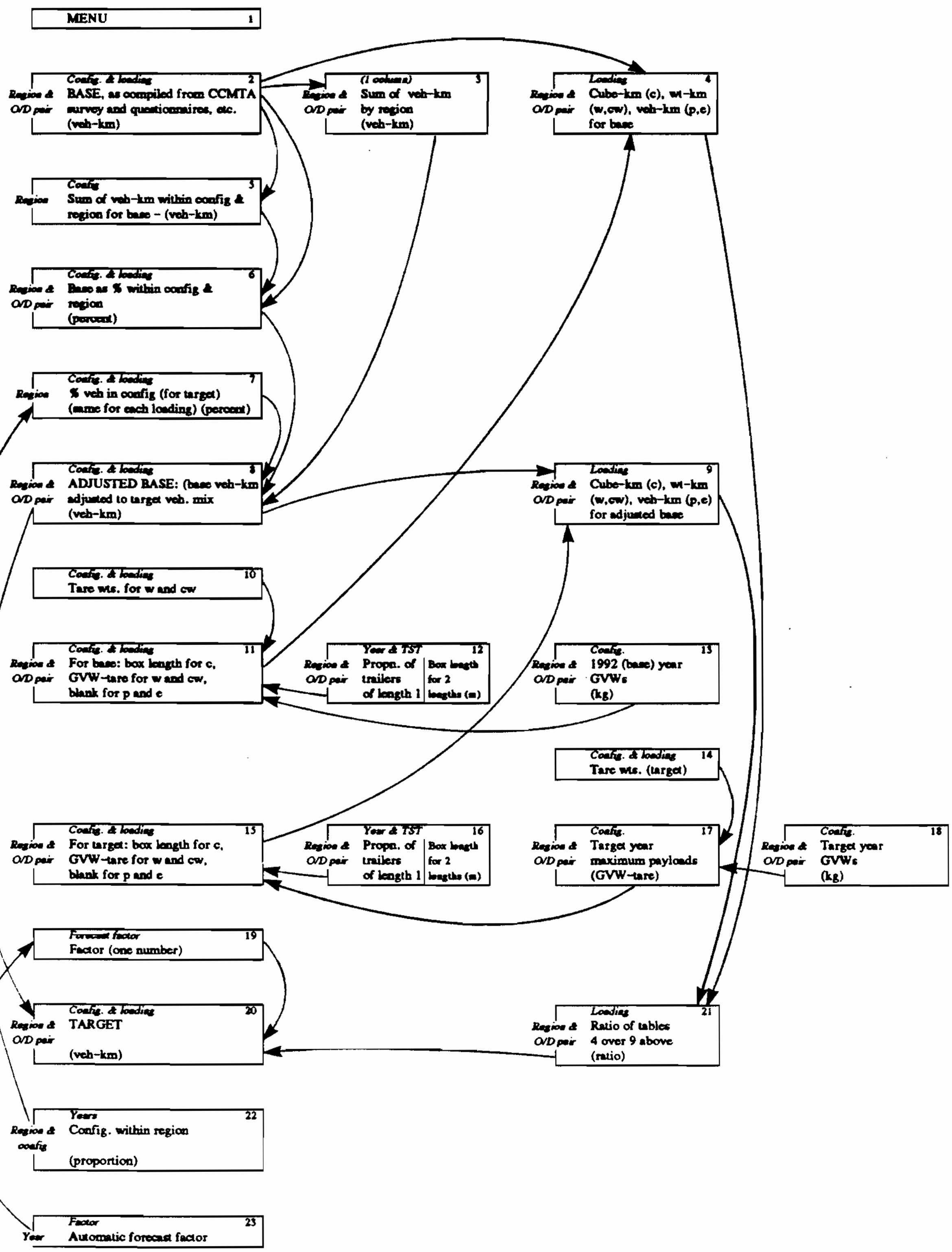

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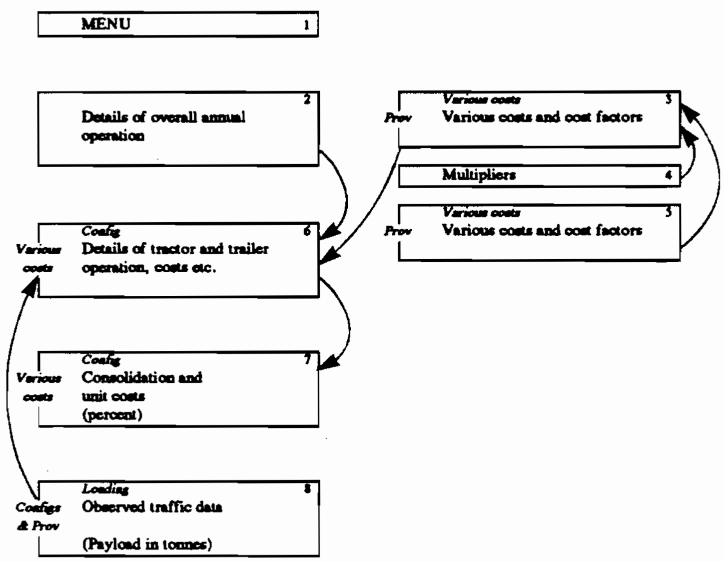
EXHIBIT G.2

FLOW DIAGRAM OF TRUCK UNIT COST MODEL

SHOWING THE INDIVIDUAL TABLES AND THEIR INTERACTIONS



A:\UNITFLOW.WK1/34509.4204

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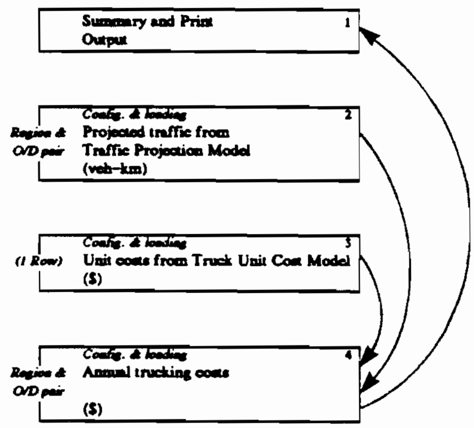
EXHIBIT G.3

FLOW DIAGRAM OF TRUCK COST MODEL

SHOWING THE INDIVIDUAL TABLES AND THEIR INTERACTIONS



A:\COSTFLOW.WK1/34509.4018

2. The traffic within each region is broken down into major origin-destination (O/D) pairs with the same region designations.

3. There are eight blocks of data across the horizontal representing the eight configurations considered. These are:

   s5x: 5 axle tractor-semitrailers;

   s6x: 6 axle tractor-semitrailers;

   a7x: 7 axle A-trains;

   a8x: 8 axle A-trains;

   b7x: 7 axle B-trains;

   b8x: 8 axle B-trains;

   c7x: 7 axle C-trains;

   c8x: 8 axle C-trains;

4. Each of these is divided into five columns representing the following loadings:

   c: load cubed out;

   w: load weighted out;

   cw: load cubed and weighted out;

   p: part load;

   e: empty haul.

5. The numbers are vehicle-kilometres.

6. Range C291..G372 lists the proportion of the configuration in the total vehicle fleet for the six regions and for years: 1992 (the base year), 1987 (the year without the MoU), 1997 and 2002.

7. Range BA165..BJ201 lists the proportion of two lengths of semitrailers by region and major O/D pair. As used here no distinction was made in trailer lengths for different O/D pairs. The last two columns are the trailer lengths in metres. The proportions are for Trailer 1.

8. Range BQ165..CF201 contains the GVW limits in kilograms for the O/D pairs arranged by region with the MoU in

force, i.e. post-1988. (Note that there are duplications for some O/D pairs in different regions).

9. Range E162..AV162 lists the tare weights for post MoU configurations (only in the "c" and "cw" columns).

10. Range CH211..CW247 contains the GVW limits in kilograms for the O/D pairs arranged by region before the MoU, i.e. pre- 1988. (Note that there are duplications for some O/D pairs in different regions).

11. Range BQ206..CF206 lists the tare weights for pre-MoU configurations. These have been assumed here to be the same as the post-MoU ones.

12. Range C377..D389 lists the overall volume factors of the years 1992, 1997 and 2002 relative to 1992. Any other years will result in an error message.

13. The operation of the spreadsheet is controlled by three entries in cells G6, G7 and G9, the year, the "MoU Mode", i.e. with or without the MoU and the traffic volume projection factor, either automatic or specified. The resulting matrix is given in Range "NEW" (D251..AX287). This matrix forms the input to the Truck Cost Model.

14. Macro Alt-S saves this matrix in a separate file to be named by the user as an input during the macro. Note that the macro commences with a {calc} command, so that there is no need to press F9 prior to the macro;

15. The four numbers in the left top corner of the spreadsheet (A1 to A4) show the vehicle-kilometres of the base year (1992) in millions, the same for the forecast year, the change and the percent change respectively.

G.2 TRUCK UNIT COST MODEL

The purpose of this model is to estimate the cost per vehicle kilometre for different configurations. It was initially intended to include the functions of both the Traffic Projection and the Truck Cost Models as well and was meant to include detail which was subsequently found to be out of proportion to the accuracy of the data. Some of this excessive detail of the structure is still found in the model.

The filename of the model is UNITCOST.WK1. The following is the relevant information:

1. The 1992 base vehicle-kilometres (not used) and average payload by configuration, province/territory and Canada with the loading of c, w, cw, p and e resides in Range I182..R320.

2. Various costs in Range V34..AL45. This matrix is transferred to the one directly above it with a multiplier given in the row between the two. This was incorporated in order to facilitate any adjustments to the costs. The cost items are self-explanatory from the column headings above the upper matrix. There are two exceptions. These are columns 14 and 15, headed Tire Const. and Tire Coeff. These are the result of a regression on tire costs in terms of total weight of the vehicle.

3. Further input parameters are shown by the bold figures from Row 23 on down to Row 110. There are 23 parameters; all are self-explanatory. Note that many carry to the right across all configurations.

4. The operation is controlled by the bold entries in F4 to F9. The first parameter is the province/territory (or Canada) for which the unit costs are required. Only prescribed spellings are permitted. These are shown to the right of the entry position. Fuel costs can be chosen as the one applying to the province/territory selected (P) or the average across Canada (A). The same applies to driver wages. The average trip length is the next parameter.

5. In order to obtain the unit costs the model has to be run separately for "c", "w" and "p". The unit costs for "cw" are taken as the same as those for "w". The results are given in Rows 129 and 130 for each of the configurations specified in Rows 53 and 54. To run the model for "c", press Alt-C, obtain results from Rows 129 (for "c"-loaded trucks) and Row 130 (for empty trucks). Repeat for "w" and "p" (In each case the unit costs for empty trucks will be the same). In the analyses for this study the unit cost of the two options in each configuration are averaged. The row with the cost per vehicle-km when loaded and the one directly below for the cost per vehicle-km for empty trucks can be saved in a separate file with macro Alt-U.

6. Alt-K displays on the screen a bar chart of the cost per vehicle-kilometre and Alt-T the cost per tonne-kilometre.

G.3 TRUCK COST MODEL

This model combines the traffic projections developed with the Traffic Projection Model with the costs per vehicle-kilometre form Truck Unit Cost Model to calculate the overall truck operating costs.

The filename of the model is TRCKCOST.WK1. The following is the relevant information:

1. The unit costs derived by the Truck Unit Cost Model must be entered into Range C68..AW68. These are for the different loadings (c, w, cw, p and e) for each of the eight configurations (s5x, s6x, a7x, a8x, b7x, b8x, c7x and c8x).

2. The output from the Traffic Projection Model resides in Range C27..AW63. Its transfer into the model from the file saved by the projection model is handled by macro Alt-T. During execution of the macro the user is prompted for the filename.

3. The results consist of the trucking costs by the six regions and for Canada as a whole. They are available in three forms.

    1. The first is on the screen in Range B5..F19. This portion of the screen is displayed when the spreadsheet is loaded into the machine.

    2. The same information is printed out via ALLWAYS with macro Alt-P. The setup is for a Hewlett-Packard Laser Printer Series II.

    3. Again, the same information can be saved into a separate file with the macro Alt-O. During execution of the macro the user is prompted for the name of the file in which the output is to be saved.

    4. A more detailed breakdown by O/D pairs within a region can be read off the spreadsheet in Range AX71..AX107.