FINAL REPORT

Economic Efficiency of Long Combination Transport Vehicles in Alberta

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Woodrooffe & Associates

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1. EXECUTIVE SUMMARY

Alberta Infrastructure commissioned Woodrooffe and Associates to review the safety and the economic efficiency of Energy Efficient Motor Vehicles (LCV's) in the province of Alberta, as well as to consider the relative efficiency and viability (competitiveness) of the competing railway mode.

Results

The use of LCV's rather than semi-trailer configurations was found to be significantly more efficient from an economic standpoint. If semi-trailer configuration trucks were used instead of LCV's, there would be an 80% increase in numbers of trucking movements and truck kilometers traveled when compared to current activity (the current 58.6 million truck kilometers of activity would translate, as smaller, semi-trailer loads of freight, into 105.3 million truck kilometers).

Costs for undertaking LCV movements as standard semi trailer loads would increase from $104.3 million annually to $146.4 million, a 40% increase in cost for shippers (from 9.2 cents / tonne-km to 13 cents / tonne-km). Viewed differently, on freight carried within the province of Alberta, the use of LCV's represents an annual freight saving of $42.1 million for the provincial economy.

Similar savings in fuel consumption (and greenhouse gas emissions) are also being realized through use of LCV's. The annual diesel fuel needed to move freight using LCV's is reduced by 32%, in comparison to what would be required by the industry if semi trailers were used. This is an annual savings of approximately 15 million liters per year of fuel.

In relation to pavement wear, the use of LCV's was found to represent a reduction from 327.5 million ESAL-km to 195.5 million ESAL-km, a reduction of approximately 40%. (1 ESAL-km = 1 Equivalent Single Axle Load* traveling 1 km on the highway system) For this reason, the pavement wear (resurfacing cost) associated with the use of LCV's is estimated to be reduced by approximately 40% over what would otherwise be the case.

Conclusions

From an economic efficiency and societal benefit point of view, the use of the larger LCV truck configurations in Alberta represents a significant reduction in the number of movements taking place on the highways, a significant transportation cost efficiency for users of truck transportation services, a major reduction in fuel use and greenhouse gas emissions and a large reduction in pavement wear.

Note:

*ESAL, the Equivalent Single Axle Load, is a measure, devised by the American Association of State Highways and Transportation Officials – and accepted by highway design engineers – of the "fatigue loading" on a road surface that is associated with a vehicle traveling over it. In this methodology, every vehicle is expressed as it's decimal equivalent of ESAL "passes". A small passenger auto, for example, is a fractional equivalent of an axle pass. Commercial trucks each represent usually a mixed number, such as 1.5 to 3.5 axle passes per unit. The ESAL equivalency of vehicle units is determined by highway engineers from experimental measurements.

2. INTRODUCTION

Long Combination Vehicles (LCVS)[i] are truck and trailer combinations, consisting of a tractor with two or three trailers, or semi-trailers, in which the number of trailers and/or the combined length of the combination exceeds the regular limits of 25 meters. These vehicles have been operating on Alberta highways since 1969 with the introduction of Triple Trailers. Currently in Alberta, the maximum gross vehicle weight applicable to LCVs is 62,500 kilograms – soon to be 63,500 kg – while the maximum configuration length is 37 metres (121.4 feet).

LCVs are further defined according to size, with three length classifications:

- Rocky Mountain Double. A combination vehicle consisting of a tractor, a 40 to 53 foot semitrailer, and a shorter 24-28-foot semi-trailer. The total length does not exceed 31 metres (102 feet). These vehicles arte typically used when cargo considerations are governed by weight rather than the cubic capacity of the trailer.

- Turnpike Double. A Turnpike Double is a tractor plus double trailers. Each trailer is between 12.2 m (40 feet) and 16.2 m (53 feet) long. The Turnpike Double is typically used for carrying cargo that benefits from the additional cubic capacity of the trailer arrangement.

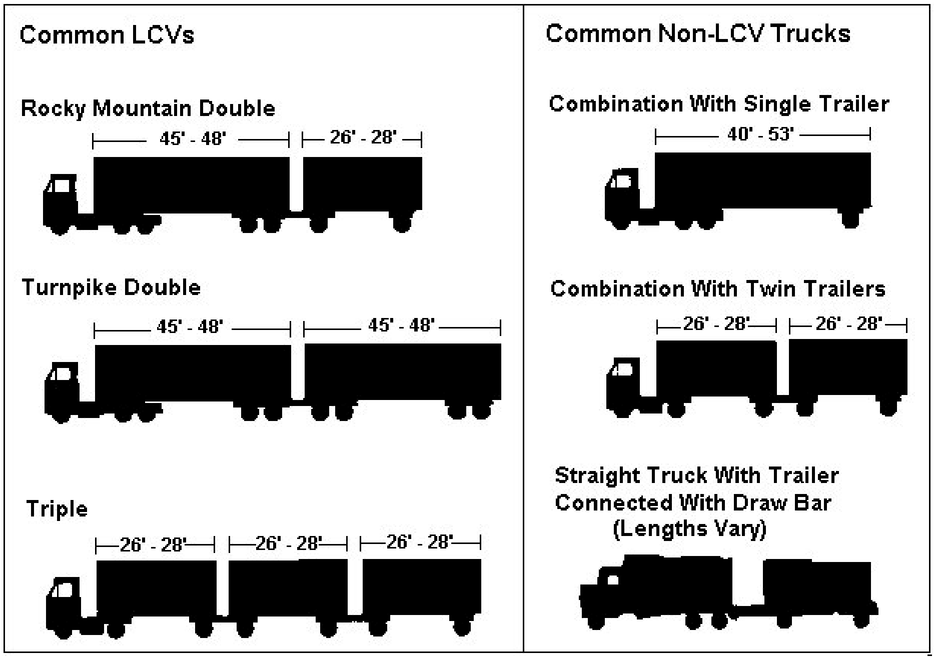
- Triple Trailer. A Triple Trailer Combination consists of a tractor with three trailers of approximately the same length. The typical trailer length is between approximately 7.3 and 8.5 metres (24-28 feet). The Triple Trailer is also used for carrying cargo that benefits from the additional cubic capacity of the trailer arrangement.

All LCV equipment and their drivers operate in Alberta under permits with strict safety requirements and are generally restricted to traveling on 4-lane highways subject to driver and vehicle operational restrictions.

Figure 1 illustrates common LCV configurations in comparison to standard configurations of trucks used on roadways.

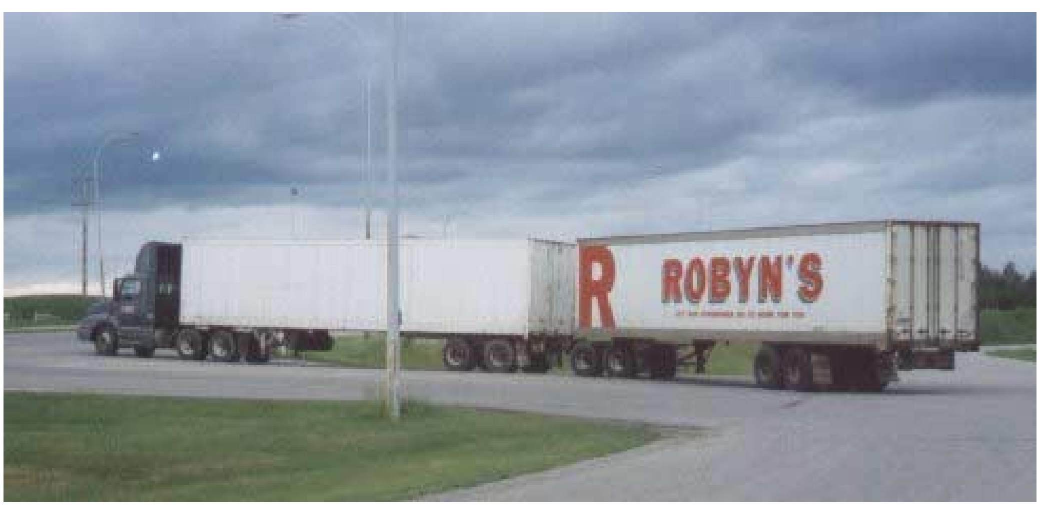
[i] Also known as Energy Efficient Motor Vehicles (EEMV's).

Figure 1: Illustration of Common LCV Configurations
and Standard Configurations



(also referred to in the literature as EEMVs, Energy Efficient Motor Vehicles) *
* Source: Road Management and Engineering Journal

Figure 2: Example of a Turnpike Double Combination



(Photo Copyright Lloyd Ash: Used With Permission)

Figure 3: Example of a Rocky Mountain Double Configuration

(Photo Copyright Lloyd Ash: Used With Permission)

3. PROJECT SCOPE

Alberta Infrastructure's Transportation Policy and Economic Analysis Branch commissioned Woodrooffe and Associates to undertake an in-depth review of economic efficiency of Long Combination Vehicles (LCVs) in Alberta:

Applying an accepted activity based truck operations modeling and costing system, two comparative truck activity estimates (freight hauled in LCV's and freight hauled in semi-trailers) were evaluated in terms of these important efficiency measures:

- User costs for truck transportation,
- Fuel consumed for truck transportation (a direct corollary for estimating greenhouse gas emissions),
- Equivalent single axle passes (i.e. a corollary for the rate of wear of pavements),
- Safety efficiency.

3.1. Methodology

In order to assess the economic efficiency of LCV's, average annual LCV movements were first quantified from available truck traffic statistics.

To accomplish this, the commercial vehicle mix was first estimated using place specific survey statistics gathered at weigh scales within the province in 1999, as part of the National Roadside Survey undertaken by Alberta Infrastructure under the auspices of the CCMTA (Canadian Council of Motor Transport Administrators).

The proportions of various types of LCV, from the CCMTA "classification survey" were then applied to the provincially published AADTT and ASDTT (average annual daily truck traffic and average summer daily truck traffic) records, to estimate segment specific movements of LCV's, on an annual basis, for the time period 1994-95 through 1998-99.

Based on the cubic carrying capacity of the three most common LCV configurations (Rocky Mountain Doubles, Turnpike Doubles and Triples), an estimate was developed of the expected equivalent numbers of movements required to move the same cargo, if standard semi-trailer configuration trucks were used instead to move the cargo over the same route segments.

Applying an accepted activity based truck operations modeling and costing system(*), the comparative truck – km of travel for the two activity estimates (freight hauled in LCV's and freight hauled in semi-trailers) were evaluated in terms of three important efficiency measures:

- User costs for truck transportation
- Fuel consumed for truck transportation (a direct corollary for estimating greenhouse gas emissions), and
- Equivalent single axle passes (i.e. a corollary for the rate of wear of pavements)

Note:

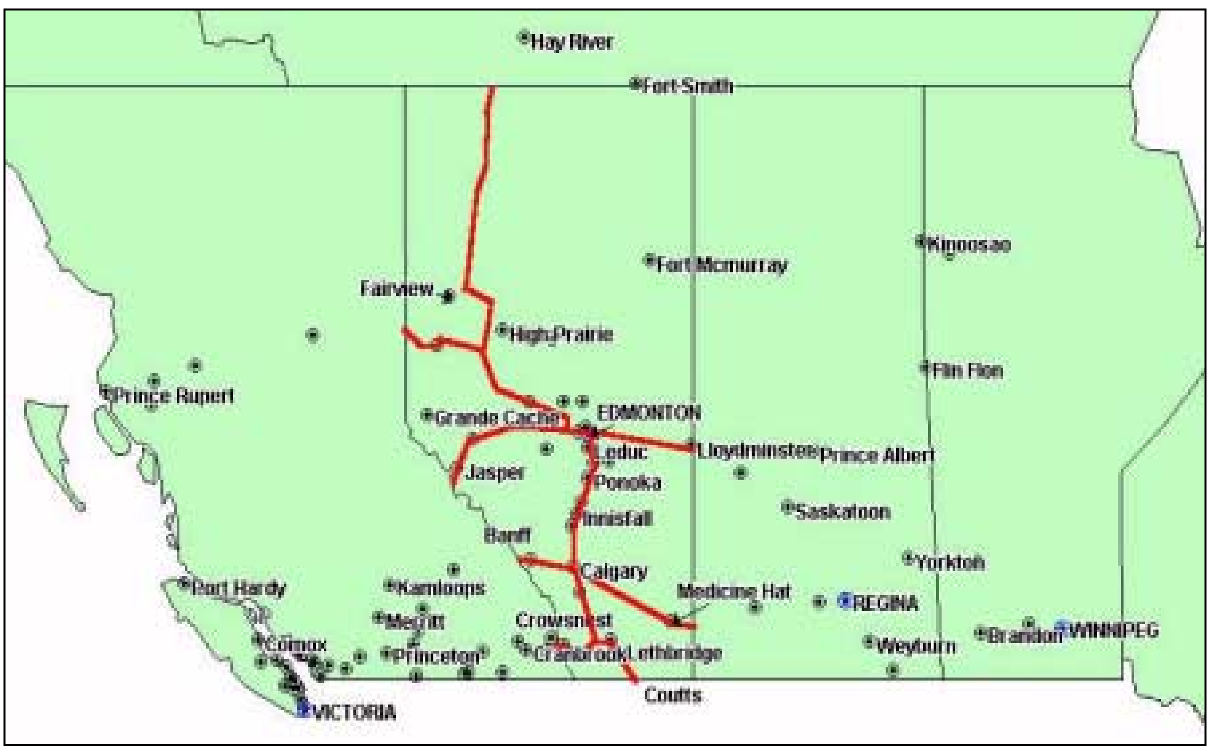
* The Trimac Motor Carrier Fleet Operations and Costing Model is an accepted methodology used in the preparation of the annual report for Transport Canada, entitled, "Operating Costs of Trucks in Canada" and published / distributed by that agency on the internet at http://www.tc.gc.ca. It is also the method used by Trimac Transportation Services Ltd., Canada's largest for-hire trucking fleet and North America's second largest bulk trucking company, to price compensatory transportation services. Trimac Logistics has also applied this methodology for numerous cost efficiency "benchmarking" assignments for fleets such as Canada Post Corporation, Shell Canada Products Ltd. and numerous others.

3.2. Study Location

The operation of LCV's in Alberta is restricted to specific routes (the sub network) within the entire provincial road and highway system. This is in recognition that LCV 's length normally exceeds the allowable overall length of 25 metres for truck-trailer combinations. To facilitate safe passing, Turnpike Double and Triple Trailer combinations are allowed to operate only on four lane highways. Rocky Mountain Doubles can operate on all four lane highways and selected two lane highways in the province.

Of the total provincial network of 13,776 km, this study focuses on the sub network of 2,937 km in which LCVs are permitted to operate. All routes over which the largest LCV configurations (Turnpike Doubles and Triple Trailers), are permitted to operate, are included. That is, all four-lane divided highways in the province of Alberta plus those 2-lane highways where Rocky Mountain Doubles operate. The heavy red line in Figure 4 illustrates the sub network segments for which traffic volume information and collision data was evaluated in this study by the consulting team.

Figure 4: LCV Highway Segments in Alberta (red links)



The specific links evaluated in this project included the following:

Area	Highway	Description	# of Lanes
Area 1	Hwy 4	Coutts to Lethbridge	4
Area 2	Hwy 3	Crowsnest Pass to Jct Hwy 2	2
Area 3	Hwy 3	Jct Hwy 2 to Lethbridge	4
	Hwy 2	Jct Hwy 3 to Calgary	4
	Hwy 1	Banff Park Gates to Calgary	4
Area 4	Hwy 1	Calgary to Alberta/Saskatchewan border	4
Area 5	Hwy 2	Calgary to Red Deer	4
Area 6	Hwy 2	Red Deer to Edmonton	4
Area 7	Hwy 16	Jasper Park Gates to Edmonton	4 (mostly)
Area 8	Hwy 16	Edmonton to Alberta/Saskatchewan border	4
Area 9	Hwy 43	Alberta/BC border to Jct Hwy 16	2 + 4
Area 10	Hwy 49	Jct Hwy 43 to Jct Hwy 2	2
	Hwy 2	Jct Hwy 49 to Jct Hwy 35	2
	Hwy 35	Jct Hwy 2 to Alberta/NWT border	2

4. SCOPE OF VEHICLE OPERATIONS

4.1. Provincial Vehicle Registrations

When Alberta vehicle registrations are reviewed in Table 1, and Figures 5 to 8, it is observed that the total number of non-trucks has increased approximately 23% during the period 1987 to 1998. This reflects the period in which higher gross vehicle weights were introduced. During the same time the total number of all truck configurations declined by 18.6%.

Within the “truck” category, a significant decline has occurred in the number of three axle (small straight) trucks, while significant growth has taken place in the larger truck categories. The major change in the composition of trucks occurred in the 3 axle and 6+ axle configurations. There was a 26% decline in 3 axle and an increase of 221% in 6+ axle vehicles. The decline in the number of three axle trucks represents a significant shift in truck size and productivity in Alberta.

Table 1: Vehicle Registrations in Alberta 1987 to 1998

Year	Total Vehicles	Trucks (> 3,000 kg)				Non Trucks Total
		3 Axle	4,5 Axle	6+ Axle	Total	
1987	1,741,899	245,058	15,447	2,547	263,052	1,478,847
1988	1,757,361	235,012	16,502	3,189	254,703	1,502,658
1989	1,788,739	230,834	17,751	3,926	252,511	1,536,228
1990	1,839,815	226,824	18,287	4,719	249,830	1,589,985
1991	1,857,699	214,489	18,720	5,103	238,312	1,619,387
1992	1,875,212	201,291	18,890	5,045	225,226	1,649,986
1993	1,878,707	191,692	18,988	5,446	216,126	1,662,581
1994	1,910,612	187,995	20,165	6,584	214,744	1,695,868
1995	1,935,076	185,114	21,646	7,551	214,311	1,720,765
1996	1,934,863	178,913	22,029	7,751	208,693	1,726,170
1997	1,962,789	178,730	22,324	7,923	208,977	1,753,812
1998	2,038,687	181,734	24,216	8,174	214,124	1,824,563

Source: Alberta Infrastructure, Infrastructure Policy and Planning, estimated from Alberta Registries – Motor Vehicles, based on registered GVW.

Fewer commercial vehicles in total demonstrate that LCVs reduce the number of trucks required to haul freight even though the Alberta economy has grown by over 10% over the past five years. The reason that fewer trucks are able to do more work is that potential LCV payloads represent an increase in cargo carrying capacity. Thus, fewer trucks are required to move the same amount of cargo. It is important to note that the carrying capacity of the trucking fleet reflects the growth of the population and the economy.

Alberta vehicle registration information is graphically restated in the following Figures 5 through 8.

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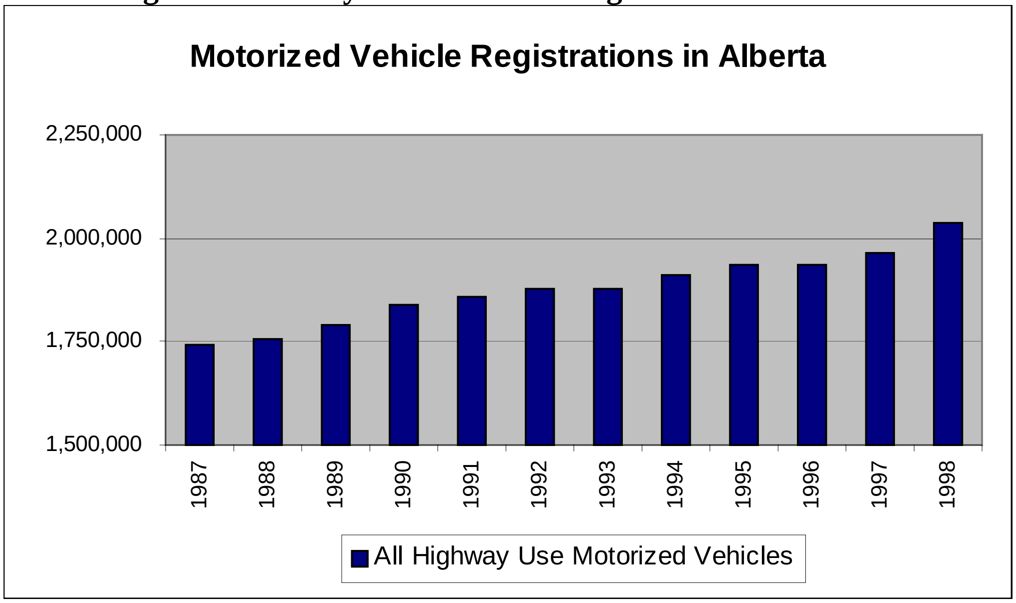
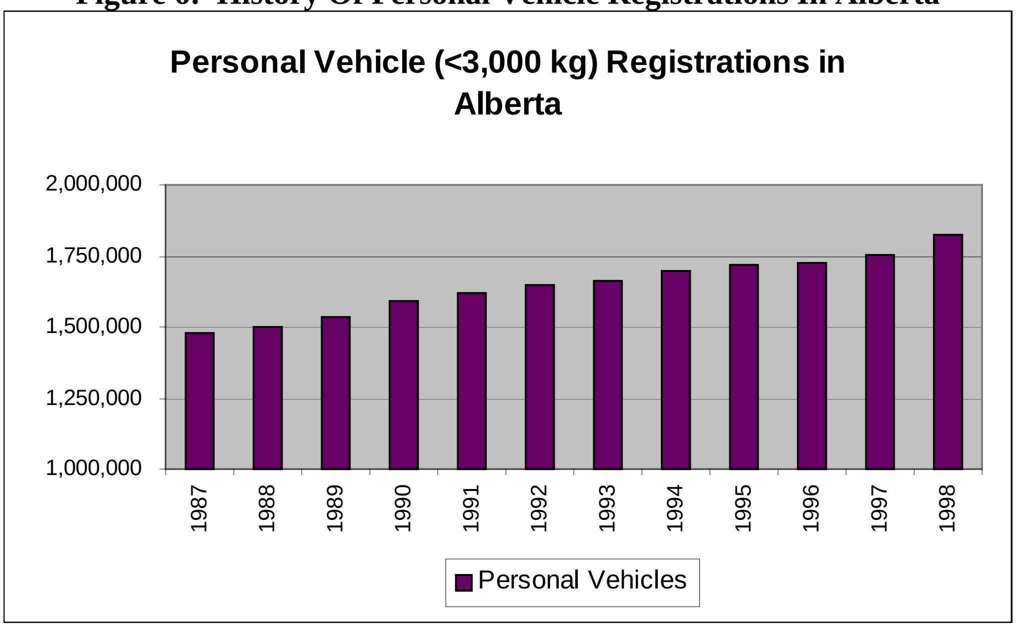
Figure 5: History Of All Vehicle Registrations In Alberta



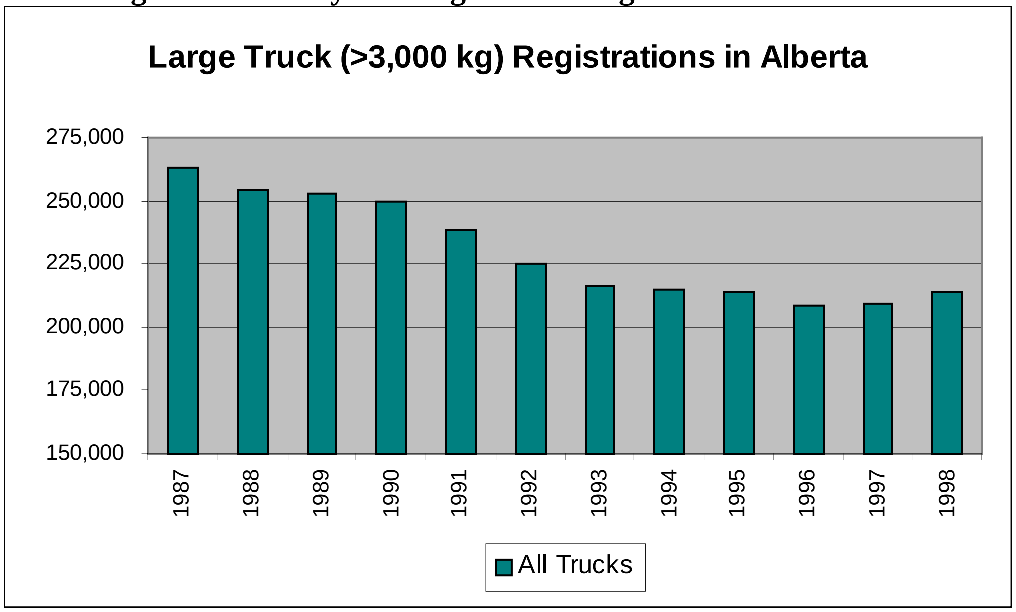
Source: Alberta Infrastructure, Infrastructure Policy and Planning

Figure 6: History Of Personal Vehicle Registrations In Alberta



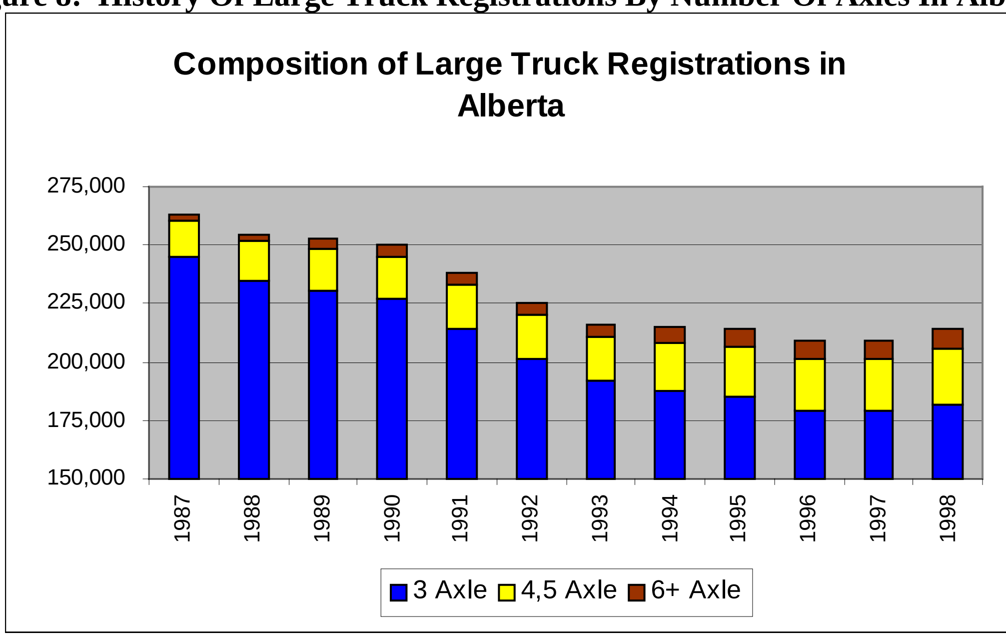
Source: Alberta Infrastructure, Infrastructure Policy and Planning, estimated from Alberta Registries – based on registered GVW

Figure 7: History Of Large Truck Registrations In Alberta



Source: Alberta Infrastructure, Infrastructure Policy and Planning, estimated from Alberta Registries – based on registered GVW

Figure 8: History Of Large Truck Registrations By Number Of Axles In Alberta



Source: Alberta Infrastructure, Infrastructure Policy and Planning, estimated from Alberta Registries – based on registered GVW

4.2. Analysis of Truck Traffic Activity

The Trimac Logistics Motor Carrier Fleet Model was used to undertake a comparison of the economic efficiency of Long Combination Vehicles versus non-Long Combination Vehicles.[i]

The Trimac model relates the total trucking costs, comprised of both fixed and variable, to the "time and distance' factors associated with each truck trip. As such, this model reflects the methodology used by a prudent motor carrier for purposes of competitively "pricing" their trucking services. Trucking activity costs are related to the number of trips undertaken in a given period, the distance driven, the number of hours in service, layover and rest time, and the driving speeds appropriate for the defined routes. For purposes of undertaking the cost comparisons the unit cost factors in Appendix B were used.

4.3. Quantifying Sample Long Combination Vehicle Movements

In order to assess the economic efficiency of LCVs, average annual LCV movements were quantified. Alberta Infrastructure provided the consultant with the Annual Average Daily Traffic (AADT) statistics of vehicle traffic, by highway segment, for all highways in the province, for the years 1995 through 1998. These statistics provide the counts for all vehicles travelling in both directions on each of the route segments.

The estimate of vehicle mix for each of the route segments was based on the 1999 Canadian Council of Motor Transport Administrators (CCMTA) National Road Survey. This survey was conduced at each of the vehicle weigh scale locations indicated in Figure 9. The CCMTA Survey conducted hourly traffic counts, on a continuous basis, during the week of July 13-19th, 1999. Estimates of the fleet composition/vehicle type, within the sub network, were determined from the AADT traffic estimates based on the classification percentages determined from the CCMTA Survey. The results are presented in Table 2. Detailed traffic estimates by highway link are provided in Table 3. These figures are the estimated number of LCV movements on the sub network links each year.

Detailed traffic estimates by highway link are provided in Table 3 and are the estimated LCV movements on links by year.

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[i] For a detailed discussion of the Trimac Motor Carrier Cost Model methodology, interested readers are referred to "Operating Costs of Trucks In Canada", as published by Transport Canada on the Internet at http://www.tc.gc.ca

Figure 9: Weigh Scale Locations
(Vehicle Classification Percentages)

Table 2: Weekly Vehicle Classification Counts – By Survey Location
National Roadside Survey/Effects of Longer Combination Vehicles in Alberta

Location	Direction	Total Vehicles	NRS Vehicles	Bus	Single Truck	Tractor Only	Truck 1 Trailer	Legal Length		**EEMV**		
								Tractor 1 Trailer	Tractor 2 Trailers	**Turnpike Doubles**	**Rocky Doubles**	**Tractor Triples**
Grimshaw	N&S	12,637	1,232	16	154	222	115	238	362	**0**	**125**	**0**
Beaverlodge	N&S	19610	2,619	52	835	58	183	1090	289	**0**	**111**	**1**
Hinton	E	17958	2,085	105	129	8	83	1072	581	**90**	**17**	**0**
Leduc	S	83223	7,928	72	776	195	860	3796	1379	**628**	**162**	**60**
Balzac	N	176306	10,466	332	2077	302	404	4772	1770	**624**	**142**	**43**
Jumping Pound	E	74885	5,249	81	814	57	137	2937	966	**167**	**86**	**4**
Strathmore	E	51414	5,429	97	886	135	106	3219	656	**163**	**147**	**20**
Burmis	E	15974	2,533	40	355	40	256	1082	681	**1**	**78**	**0**
Coutts	N&S	38881	3,971	41	118	49	65	3292	386	**0**	**20**	**0**
Grimshaw	% of All Traffic:			0.13%	1.22%	1.76%	0.91%	1.88%	2.86%	**0.00%**	**0.99%**	**0.00%**
Beaverlodge	% of All Traffic:			0.27%	4.26%	0.30%	0.93%	5.56%	1.47%	**0.00%**	**0.57%**	**0.01%**
Hinton	% of All Traffic:			0.58%	0.72%	0.04%	0.46%	5.97%	3.24%	**0.50%**	**0.09%**	**0.00%**
Leduc	% of All Traffic:			0.09%	0.93%	0.23%	1.03%	4.56%	1.66%	**0.75%**	**0.19%**	**0.07%**
Balzac	% of All Traffic:			0.19%	1.18%	0.17%	0.23%	2.71%	1.00%	**0.35%**	**0.08%**	**0.02%**
Jumping Pound	% of All Traffic:			0.11%	1.09%	0.08%	0.18%	3.92%	1.29%	**0.22%**	**0.11%**	**0.01%**
Strathmore	% of All Traffic:			0.19%	1.72%	0.26%	0.21%	6.26%	1.28%	**0.32%**	**0.29%**	**0.04%**
Burmis	% of All Traffic:			0.25%	2.22%	0.25%	1.60%	6.77%	4.26%	**0.01%**	**0.49%**	**0.00%**
Coutts	% of All Traffic:			0.11%	0.30%	0.13%	0.17%	8.47%	0.99%	**0.00%**	**0.05%**	**0.00%**

Source : Alberta Infrastructure

Table 3: LCV Activity Measures (Estimated from Sample)

1998 EEMV Activity				EEMV Daily Movements			EEMV Annual Movements		
Area	Highway	Range	Distance	Turnpike	Rocky	Triples	Turnpike	Rocky	Triples
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	0.0	2.8	0.0	0	1,014	0
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	0.6	29.4	0.0	219	10,749	0
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	10.3	5.1	0.5	3,742	1,871	170
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	10.9	34.6	0.5	3,961	12,620	170
	Hwy 1	Banff Park Gates to Calgary	197.0	34.6	17.3	1.6	12,615	6,308	573
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	37.8	34.2	4.7	13,782	12,490	1,723
Area 5:	Hwy 2	Calgary to Red Deer	152.0	147.6	33.7	8.4	53,885	12,317	3,079
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	207.1	52.5	19.3	75,582	19,148	7,054
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	30.6	5.5	0.0	11,151	2,007	0
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	20.8	18.9	2.6	7,604	6,891	950
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	0.0	39.3	0.7	0	14,355	252
	Hwy 43	Grande Prairie to Valleyview	95.0	0.0	39.3	0.7	0	14,355	252
	Hwy 43	Valleyview to Jct Hwy 16	287.6	0.0	62.1	0.7	0	22,667	252
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	0.0	22.8	0.0	0	8,311	0
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	0.0	22.8	0.0	0	8,311	0
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	0.0	19.8	0.0	0	7,227	0
			Total	500.1	440.1	39.7	182,541	160,641	14,475
1997 EEMV Activity				EEMV Daily Movements			EEMV Annual Movements		
Area	Highway	Range	Distance	Turnpike	Rocky	Triples	Turnpike	Rocky	Triples
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	0.0	1.0	0.0	0	372	0
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	0.4	20.0	0.0	149	7,297	0
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	9.8	4.9	0.4	3,581	1,791	163
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	10.2	24.9	0.4	3,730	9,088	163
	Hwy 1	Banff Park Gates to Calgary	197.0	32.3	16.2	1.5	11,796	5,898	536
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	34.3	31.1	4.3	12,521	11,347	1,565
Area 5:	Hwy 2	Calgary to Red Deer	152.0	138.0	31.5	7.9	50,359	11,511	2,878
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	182.5	46.2	17.0	66,603	16,873	6,216
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	29.0	5.2	0.0	10,585	1,905	0
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	20.2	18.3	2.5	7,382	6,690	923
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	0.0	37.3	0.7	0	13,606	239
	Hwy 43	Grande Prairie to Valleyview	95.0	0.0	37.3	0.7	0	13,606	239
	Hwy 43	Valleyview to Jct Hwy 16	287.6	0.0	60.2	0.7	0	21,990	239
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	0.0	23.0	0.0	0	8,383	0
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	0.0	23.0	0.0	0	8,383	0
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	0.0	19.0	0.0	0	6,938	0
			Total	456.7	399.1	36.1	166,706	145,678	13,161
1996 EEMV Activity				EEMV Daily Movements			EEMV Annual Movements		
Area	Highway	Range	Distance	Turnpike	Rocky	Triples	Turnpike	Rocky	Triples
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	0.0	1.0	0.0	0	350	0
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	0.4	18.9	0.0	141	6,904	0
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	9.1	4.5	0.4	3,316	1,658	151
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	9.5	23.5	0.4	3,457	8,562	151
	Hwy 1	Banff Park Gates to Calgary	197.0	30.8	15.4	1.4	11,250	5,625	511
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	32.2	29.2	4.0	11,762	10,659	1,470
Area 5:	Hwy 2	Calgary to Red Deer	152.0	127.3	29.1	7.3	46,450	10,617	2,654
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	167.9	42.5	15.7	61,293	15,527	5,721
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	28.3	5.1	0.0	10,330	1,859	0
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	18.6	16.8	2.3	6,786	6,150	848
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	0.0	34.8	0.6	0	12,712	223
	Hwy 43	Grande Prairie to Valleyview	95.0	0.0	34.8	0.6	0	12,712	223
	Hwy 43	Valleyview to Jct Hwy 16	287.6	0.0	56.8	0.6	0	20,734	223
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	0.0	22.0	0.0	0	8,022	0
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	0.0	22.0	0.0	0	8,022	0
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	0.0	18.4	0.0	0	6,721	0
			Total	424.1	374.9	33.4	154,785	136,834	12,175

* estimated from 7-day, 24-hour sample surveys

Table 3, Continued: LCV Activity Measures (Estimated)

1995 EEMV Activity				EEMV Daily Movements			EEMV Annual Movements		
Area	Highway	Range	Distance	Turnpike	Rocky	Triples	Turnpike	Rocky	Triples
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	0.0	0.9	0.0	0	325	0
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	0.4	18.3	0.0	137	6,689	0
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	9.2	4.6	0.4	3,340	1,670	152
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	9.5	22.9	0.4	3,477	8,359	152
	Hwy 1	Banff Park Gates to Calgary	197.0	32.8	16.4	1.5	11,957	5,978	543
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	32.3	29.3	4.0	11,797	10,691	1,475
Area 5:	Hwy 2	Calgary to Red Deer	152.0	125.7	28.7	7.2	45,875	10,486	2,621
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	168.2	42.6	15.7	61,402	15,555	5,731
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	29.5	5.3	0.0	10,768	1,938	0
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	18.5	16.8	2.3	6,763	6,129	845
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	0.0	34.2	0.6	0	12,483	219
	Hwy 43	Grande Prairie to Valleyview	95.0	0.0	34.2	0.6	0	12,483	219
	Hwy 43	Valleyview to Jct Hwy 16	287.6	0.0	57.3	0.6	0	20,902	219
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	0.0	23.1	0.0	0	8,419	0
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	0.0	23.1	0.0	0	8,419	0
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	0.0	18.0	0.0	0	6,577	0
			Total	426.1	375.6	33.4	155,516	137,103	12,176

Annual Average 1995-98 EEMV Activity				EEMV Daily Movements			EEMV Annual Movements		
Area	Highway	Range	Distance	Turnpike	Rocky	Triples	Turnpike	Rocky	Triples
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	0.0	1.4	0.0	0	515	0
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	0.4	21.7	0.0	161	7,910	0
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	9.6	4.8	0.4	3,495	1,748	159
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	10.0	26.5	0.4	3,656	9,657	159
	Hwy 1	Banff Park Gates to Calgary	197.0	32.6	16.3	1.5	11,904	5,952	541
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	34.2	31.0	4.3	12,465	11,297	1,558
Area 5:	Hwy 2	Calgary to Red Deer	152.0	134.6	30.8	7.7	49,142	11,233	2,808
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	181.4	46.0	16.9	66,220	16,776	6,181
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	29.3	5.3	0.0	10,708	1,927	0
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	19.5	17.7	2.4	7,134	6,465	892
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	0.0	36.4	0.6	0	13,289	233
	Hwy 43	Grande Prairie to Valleyview	95.0	0.0	36.4	0.6	0	13,289	233
	Hwy 43	Valleyview to Jct Hwy 16	287.6	0.0	59.1	0.6	0	21,573	233
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	0.0	22.7	0.0	0	8,284	0
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	0.0	22.7	0.0	0	8,284	0
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	0.0	18.8	0.0	0	6,866	0
			Total	451.7	397.4	35.6	164,885	145,065	12,997

* estimated from 7-day, 24-hour sample surveys

4.4. Quantifying Equivalent Non Long Combination Vehicle Movements

If the LCV movements tabulated in section 3.3 were transported as non-LCV trucks, the average load size would be smaller and the number of movements over the sub network would be higher. Therefore, an estimate was developed of the 'expected equivalent number of movements' required to move the same amount of cargo, if standard semi-trailer configuration trucks were used instead in place of the three most common LCV configurations (Rocky Mountain Doubles, Turnpike Doubles and Triples). Since the LCVs and non-LCVs are both of the same width, for each truck configuration, payload is therefore directly proportionality to the unit length of the trailer combinations, as computed in Table 4, following.

Table 4: Load Equivalency Factors LCV's to Standard Semi Trailer Loads

Configuration	LCV Loaded Length	Non-LCV Loaded Length	Load Equivalency (1 LCV = # non-LCVs)
Rocky Mtn Double	45 feet + 26 feet = 71 feet	45 feet (semi)	1.58
Turnpike Double	45 feet + 45 feet = 90 feet	45 feet (semi)	2.0
Triple Trailer	26 feet + 26 feet + 26 feet = 78 feet	45 feet (semi)	1.73

Table 5 presents the equivalent non-LCV activity estimate prepared on the basis of the foregoing non-LCV load equivalency factors.

Table 5: Equivalent (non-LCV) Activity Estimate

				Daily Non-EEMV Activity				
Area	Highway	Range	Distance	1998	1997	1996	1995	AVG 95-98
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	4.4	1.6	1.5	1.4	2.2
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	47.7	32.4	30.6	29.7	35.1
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	29.4	28.1	26.1	26.2	27.5
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	77.1	60.5	56.7	55.9	62.5
	Hwy 1	Banff Park Gates to Calgary	197.0	99.1	92.7	88.4	93.9	93.5
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	137.7	125.1	117.5	117.9	124.5
Area 5:	Hwy 2	Calgary to Red Deer	152.0	363.1	339.4	313.0	309.1	331.2
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	530.4	467.4	430.1	430.9	464.7
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	69.8	66.2	64.6	67.4	67.0
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	76.0	73.7	67.8	67.6	71.3
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	63.2	59.9	56.0	55.0	58.6
	Hwy 43	Grande Prairie to Valleyview	95.0	63.2	59.9	56.0	55.0	58.6
	Hwy 43	Valleyview to Jct Hwy 16	287.6	99.2	96.2	90.7	91.4	94.4
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	35.9	36.2	34.7	36.4	35.8
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	35.9	36.2	34.7	36.4	35.8
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	31.2	30.0	29.1	28.4	29.7
			Total	1,763.4	1,605.7	1,497.4	1,502.6	1,592.3
				Annual Non-EEMV Activity				
Area	Highway	Range	Distance	1998	1997	1996	1995	AVG 95-98
Area 1:	Hwy 4	Coutts to Lethbridge	104.0	1,600	587	552	513	813
Area 2:	Hwy 3	Crowsnest Pass to Jct Hwy 2	101.1	17,398	11,811	11,175	10,828	12,802
Area 3:	Hwy 3	Jct Hwy 2 to Lethbridge &	51.1	10,731	10,270	9,510	9,578	10,024
	Hwy 2	Jct Hwy 3 to Calgary &	157.8	28,128	22,081	20,685	20,406	22,824
	Hwy 1	Banff Park Gates to Calgary	197.0	36,176	33,827	32,261	34,287	34,137
Area 4:	Hwy 1	Calgary to Alberta/Sask border	291.0	50,257	45,658	42,890	43,019	45,455
Area 5:	Hwy 2	Calgary to Red Deer	152.0	132,540	123,868	114,252	112,838	120,874
Area 6:	Hwy 2	Red Deer to Edmonton	146.1	193,602	170,602	157,001	157,280	169,623
Area 7:	Hwy 16	Jasper Park Gates to Edmonton	385.1	25,469	24,176	23,593	24,594	24,456
Area 8:	Hwy 16	Edmonton to Alberta/Sask border	229.0	27,727	26,919	24,745	24,661	26,014
Area 9:	Hwy 43	Alberta/BC border to Gr. Prairie	88.9	23,086	21,882	20,443	20,075	21,371
	Hwy 43	Grande Prairie to Valleyview	95.0	23,086	21,882	20,443	20,075	21,371
	Hwy 43	Valleyview to Jct Hwy 16	287.6	36,200	35,110	33,100	33,358	34,441
Area 10:	Hwy 49:	Jct Hwy 43 to Jct Hwy 2 &	91.0	13,113	13,227	12,657	13,283	13,070
	Hwy 2:	Jct Hwy 49 to Jct Hwy 35 &	82.9	13,113	13,227	12,657	13,283	13,070
	Hwy 35:	Jct Hwy 2 to Alberta/NWT border	477.4	11,403	10,947	10,604	10,377	10,833
			Total	643,628	586,072	546,567	548,455	581,178

The LCV activity estimate calculated in Table 3 indicates that the observed LCV activity in the sub network represented 164,885 link movements* of turnpike doubles, 145,065 link movements of rocky mountain doubles and 12,997 link movements of triple trailer combinations. This represents a total of 322,947 link movements[i] totaled across the study area.

By comparison, if each turnpike double movement represents 2 semi trailer movements, each rocky mountain double represents 1.58 semi trailer movements and each triple trailer represents 1.73 semi trailers, then the estimate for equivalent non-LCV activity (Table 5) indicates that the average total for the years 1995 through 1998 would be 581,178 non-LCV link movements to move the same volume of freight over the system.

*(total movements over the links tabulated in table 3)

Thus, to move the same freight as that carried by LCVs (during an average year between 1995 and 1998) the replacement non-LCV truck traffic would increase by 80%, or an increase in the number of trucking movements of 1.8 over the base estimate (581,178 /322,947). This figure represents a blended average of the link movements tabulated for rocky mountain doubles, turnpike doubles and triple trailers in Table 3, compared with the movements estimated in Table 5 based on "useable floor length" ratios of the respective vehicle combinations.

5. ECONOMIC EFFICIENCY OF LONG COMBINATION VEHICLES

Shippers require access to efficient and low cost transportation services for moving their products to market or receiving inputs for production in what has become a very competitive and integrated world economy. Surface transportation of goods (by truck and rail) tends to be more expensive than water shipments and hence, for a land locked jurisdiction such as Alberta, exporting industries and consumers of goods require the truck and rail carriers to provide efficient service. Without this, access to markets will shrink and job losses will occur. Furthermore, in the absence of efficiency, costs for consumer goods would rise.

To clarify the foregoing issues, we need to consider issues related to efficiency. Economists sometimes discuss "efficiency" in the context of two important types: technical efficiency and allocative efficiency.

5.1. Technical and Allocative Efficiency

Technological efficiency means getting the most output from a given set of inputs (productivity). This is largely a micro economic concept that relates output to productivity of input factors of labour, capital and total factor productivity of the particular process or firm. In the case of LCV's this report calculates the various technical efficiency improvements that have been achieved and which benefit shippers of goods and consumers in the form of lower transportation costs. Further "non user" technical efficiencies are identified in the form of lesser axle loads to move the same volume of freight and reduced fuel use and green house gas emissions are also tracked for the mode.

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The concept of “allocative” efficiency is more of a macro economic viewpoint that takes account of the over-all economy – not just the individual truck or rail firm. In this framework, allocative efficiency is said to be achieved when each sector of the economy is producing the best combination of outputs, using the lowest-cost combination of inputs. From a transportation sector perspective, both competition and modal complementarily contribute to allocative efficiency. This is particularly true for LCV’s where the benefits compared on a cost per tonne-km basis are likely to be exceeded in terms of the impact of “shipment cube” – as the LCV configurations tend to “cube out” rather than “weight out” in terms of the shipments being carried.

Beyond the simple “trucking cost efficiency” aspect of the supply chain, the use of LCV’s is sometimes related to elimination of “rehandle”, or “cross docking” of shipments in the situation where the shorter pups are moved in linehaul formation on the highway – then used locally, for individual pick up and delivery work – as often occurs with triple trailer combinations, for example. Within the LCV configurations, the choice of using a Rocky Mountain Double, a Triple or a Turnpike Double configuration can relate to specific distribution / demand patterns for the business – with the ability to split up the train for different customer locations, or it may reflect the allowable size of unit (eg. the two lane highway segments were the only permitted LCV configuration is the Rocky Mountain Double) or annual dedicated traffic and desired schedule frequency for service.

Thus, when the trucking mode functions efficiently, within itself, customers have access to a set of competitive “best choices” or complementary (eg. intermodal) services or systems. This leads to maximization of production and efficiency of the economy, over all. In a related study, for example, in the province of Saskatchewan, it was shown that the availability of economical trucking services can benefit shippers who are not even using truck – by creating a competitive alternative that the railway companies need to match, in terms of pricing their services.

For Western Canadian and US shippers, LCV trucks have different yet complementary characteristics, to serve their users’ transportation needs. Combined properly and with other modes of transport, LCVs can maximize overall efficiency with seamless services benefiting all transportation users. Truck freight involves high-value goods, perishables (e.g., frozen meats, fruit and vegetables), or time sensitive delivery (e.g., "just-in-time" or "quick response" inventories).

5.2. Evaluation of Movement Costs as Long Combination Vehicles

LCV movements costs were calculated using the estimate of 1) total annual vehicle activity within the sub network; 2) the traffic survey information (AADT) factored according to the trucking survey classification counts; and 3) the Trimac Costing Model. The “average year” vehicle movement results are summarized in Table 6 below.

Table 6 reveals that the LCV movements in the Alberta sub network annually total 58,557,062 kilometers of truck travel by the various LCV configurations. The total costs (fixed and variable) of this activity is estimated to be $104.3 million dollars annually. This represents a total cost of $1.78 per kilometer driven, (blended across LCV configurations) with an hourly operating cost of $74.45 for the LCV truck configuration.

Table 6: Over-All Costs of LCV Movements in the Study Area

CASE:	AVG 1995-1998 All Trucking (Using EEMV's)				
No.	Item	$/Dist	$/hr	% Rev	$Total
1	Power: Driver	$0.58	$24.29	32.60%	$34,031,928
	--Overtime (Subtotal)	$0.04	$1.70	2.30%	$2,381,829
	--Burden (Subtotal)	$0.12	$4.86	6.50%	$6,806,252
2	Power: Fuel	$0.27	$11.14	15.00%	$15,601,204
3	Power: Repairs	$0.06	$2.56	3.40%	$3,583,335
4	Power: Cleaning	$0.00	$0.19	0.20%	$259,458
5	Power: Transport	$0.01	$0.37	0.50%	$518,917
6	Power: Tires	$0.02	$0.99	1.30%	$1,387,534
7	Power: Permits/Tolls				
8	POWER TOTAL VARIABLE:	$0.95	$39.53	53.10%	$55,382,377
9	Power: Depreciation/Leasing	$0.17	$7.26	9.80%	$10,172,043
10	Power: Licenses	$0.03	$1.12	1.50%	$1,566,091
11	Power: Interest	$0.05	$1.99	2.70%	$2,784,537
12	POWER TOTAL FIXED:	$0.25	$10.37	13.90%	$14,522,672
13	POWER TOTAL COST:	$1.19	$49.89	67.00%	$69,905,049
14	Trailer: Repairs	$0.06	$2.55	3.40%	$3,566,151
15	Trailer: Cleaning	$0.01	$0.37	0.50%	$523,881
16	Trailer: Transport	$0.01	$0.38	0.50%	$531,327
17	Trailer: Tires	$0.03	$1.23	1.60%	$1,719,083
18	Trailer: Permits/Tolls				
19	TRAILER TOTAL VARIABLE:	$0.11	$4.53	6.10%	$6,340,443
20	Trailer: Depreciation/Leasing	$0.09	$3.67	4.90%	$5,138,577
21	Trailer: Licenses		$0.01		$20,757
22	Trailer: Interest	$0.04	$1.45	2.00%	$2,037,930
23	TRAILER TOTAL FIXED:	$0.12	$5.14	6.90%	$7,197,264
24	TRAILER TOTAL COST:	$0.23	$9.66	13.00%	$13,537,707
25	Insurance Cost (Variable)	$0.06	$2.61	3.50%	$3,650,621
26	Other Costs (Variable)				
27	Other Costs (Fixed)				
28	TOTAL VARIABLE	$1.12	$46.66	62.70%	$65,373,440
29	TOTAL FIXED	$0.37	$15.50	20.80%	$21,719,936
30	TOTAL DIRECT COST	$1.49	$62.16	83.50%	$87,093,377
31	Administration	$0.21	$8.56	11.50%	$11,994,896
32	P R O F I T	$0.09	$3.72	5.00%	$5,215,172
33	**G R A N D T O T A L**	**$1.78**	**$74.45**	**100.00%**	**$104,303,445**
34	Origin	A L L			
35	Destination	A L L			
36	Product	A L L			
37	Quantity				322,947
38	Payload				1
39	Driven Distance/Trip				181.3
40	Round Trip Hours				4.3
41	No. of Trips				322,947
42	Total Distance				58,557,062

Following Table 7, provides a breakdown of the aggregate LCV activity, shown in Table 6, for each of the individual LCV configuration types investigated in the traffic mix.

Note that while Turnpike Doubles show a higher cost per hour and per km than Rocky Mountain Doubles, the resultant estimated cost per tonne-km is the least for this configuration. As noted previously, use of LCV's is often based on the cubic capacity of the units, and particular 'shipment specific' factors – hence attempting to generalize among the various LCV types shown in Figure 7 – and to label one type "more efficient" than the others may mask other deciding factors as to which type of unit is most appropriate to use for a particular hauling application.

Table 7: LCV Costs For An Average Year of Traffic On the Study Network (1995 – 1998)

Configuration	Km-Operated	Cost (Millions)	Cost/Km	Cost/Hour	Estimated Avg. Payload (Tonnes) (*)	Tonne-Km	Cost/Tonne-Km (Cents)
Turnpike Doubles	29,645,854	$54.32	$1.83	$77.07	25.0	741,146,350	7.3
Rocky Mountain Doubles	26,674,050	$45.34	$1.70	$72.06	13.1	349,430,055	13.0
Triples	2,237,158	$4.64	$2.07	$69.24	17.0	38,031,686	12.2
Total	58,557,062	$104.30	$1.78	$74.45	19.3	1,128,608,091	9.2

***Note: Avg. Payload is Basis Analysis of Weigh In Motion Test Site Data Provided by Alberta Infrastructure For Time Period October 1999 through September 2000

5.3. Evaluation of Movement Costs as non-Long Combination Vehicles

In terms of 'estimated vehicle activity', within the sub network, the total LCV movements of 58.6 million vehicle kilometers traveled would increase to 105.3 million vehicle kilometers. This represents an approximately 80% increase in the number of movements if the freight was hauled using non-LCVs.

Table 8, summarizes the estimated total annual cost for non-LCV trucking movements for the 'average year' movements (1995 to 1998). Semi trailer total operating costs are $1.39 per kilometer driven and $66.38 per hour.

The replacement of existing LCV movements within the Alberta sub network would result in an estimated net transportation cost increase of $42.1 million. The increase in costs from $104.3 million to $146.4 million represents an increase in transportation costs of 40.4%.

In terms of costs per tonne-km, the cost of moving the LCV freight as non-LCV movements would increase from an average cost of 9.2 cents per tonne-km shown in Table 7 to 13 cents per tonne-km ($146.4 million to move 1.129 billion tonne-km of freight), if semi trailer movements were used.

Table 8: Costs of non-LCV Movements on Study Network

CASE:	AVG 1995-1998 All Trucking (Using Semi's)				
No.	Item	$/Dist	$/hr	% Rev	$Total
1	Power: Driver	$0.49	$23.24	35.00%	$51,245,546
	--Overtime (Subtotal)	$0.04	$1.70	2.60%	$3,749,327
	--Burden (Subtotal)	$0.10	$4.65	7.00%	$10,248,974
2	Power: Fuel	$0.22	$10.43	15.70%	$23,004,823
3	Power: Repairs	$0.06	$2.74	4.10%	$6,051,913
4	Power: Cleaning	$0.00	$0.19	0.30%	$408,423
5	Power: Transport	$0.00	$0.19	0.30%	$408,423
6	Power: Tires	$0.02	$0.89	1.30%	$1,973,605
7	Power: Permits/Tolls				
8	POWER TOTAL VARIABLE:	$0.79	$37.68	56.80%	$83,092,734
9	Power: Depreciation/Leasing	$0.14	$6.52	9.80%	$14,376,505
10	Power: Licenses	$0.01	$0.61	0.90%	$1,347,797
11	Power: Interest	$0.04	$1.78	2.70%	$3,935,483
12	POWER TOTAL FIXED:	$0.19	$8.91	13.40%	$19,659,785
13	POWER TOTAL COST:	$0.98	$46.59	70.20%	$102,752,519
14	Trailer: Repairs	$0.06	$2.63	4.00%	$5,790,613
15	Trailer: Cleaning	$0.00	$0.19	0.30%	$408,423
16	Trailer: Transport	$0.00	$0.19	0.30%	$408,423
17	Trailer: Tires	$0.02	$0.92	1.40%	$2,039,996
18	Trailer: Permits/Tolls				
19	TRAILER TOTAL VARIABLE:	$0.08	$3.92	5.90%	$8,647,456
20	Trailer: Depreciation/Leasing	$0.04	$1.85	2.80%	$4,084,234
21	Trailer: Licenses		$0.01		$16,337
22	Trailer: Interest	$0.02	$0.73	1.10%	$1,619,784
23	TRAILER TOTAL FIXED:	$0.05	$2.59	3.90%	$5,720,356
24	TRAILER TOTAL COST:	$0.14	$6.51	9.80%	$14,367,811
25	Insurance Cost (Variable)	$0.05	$2.32	3.50%	$5,124,014
26	Other Costs (Variable)				
27	Other Costs (Fixed)				
28	TOTAL VARIABLE	$0.92	$43.92	66.20%	$96,864,204
29	TOTAL FIXED	$0.24	$11.51	17.30%	$25,380,141
30	TOTAL DIRECT COST	$1.16	$55.43	83.50%	$122,244,345
31	Administration	$0.16	$7.63	11.50%	$16,836,047
32	P R O F I T	$0.07	$3.32	5.00%	$7,320,021
33	**G R A N D T O T A L**	**$1.39**	**$66.38**	**100.00%**	**$146,400,413**
34	Origin	A L L			
35	Destination	A L L			
36	Product	A L L			
37	Quantity				581,179
38	Payload				1
39	Driven Distance/Trip				181.1
40	Round Trip Hours				3.8
41	No. of Trips				581,179
42	Total Distance				105,255,125

5.4. LCVs and Non-LCVs Comparisons Summarized

5.4.1. Annual Cost Comparison

The estimated annual total cost of hauling freight using LCVs compared to non-LCVs, with the sub network, is provided in Table 9. The table also includes an estimate of the 'average year' vehicle activity for the period 1995 to 1998.

Table 9: Comparison of Hauling Using LCVs and non-LCVs by Individual Year on the Study Network

Year	Total EEMV Cost (Million $)	Annual Kilometers as EEMV's (Millions)	Total non-EEMV Cost (Million $)	Annual Kilometers as non-EEMV's (Millions)	Annual Transportation Savings Due to EEMV's (Million $)	Percent Cost Savings Over non-EEMV's	Truck-Km Saved (Millions)	Percent Reduction in Truck-Km
AVG 1995-1998	$ 104.3	58.6	$ 146.4	105.3	$ 42.1	28.8%	46.7	44.3%
1998	$ 114.8	64.3	$ 161.1	115.6	$ 46.3	28.7%	51.3	44.4%
1997	$ 105.1	59	$ 147.6	106.1	$ 42.5	28.8%	47.1	44.4%
1996	$ 98.4	55.3	$ 138.1	99.4	$ 39.7	28.7%	44.1	44.4%
1995	$ 98.9	55.6	$ 138.8	99.9	$ 39.9	28.7%	44.3	44.3%

Table 9 illustrates that the use of LCVs, for all of the individual years of traffic data, results in a similar level of economic efficiency gain. At current traffic levels, the annual savings to shippers from use of these vehicles appears to total approximately $40 million. The cost saving to shippers is in the order of 29% -- representing a reduction in average cost per tonne-km from 13 cents to approximately 9.2 cents.

Within the sub network, LCV traffic represented a 44% reduction over traffic levels if the vehicle movements occurred in non-LCVs trucks.

5.4.2. Fuel Efficiency

Table 10: Fuel Use and Greenhouse Gas Emission Comparisons on Study Location

Year	Fuel Expenditure for EEMV Operations	Litres of Fuel Used For EEMV Operations	Fuel Expenditure (non-EEMV)	Litres of Fuel (non-EEMV Operations)	Reduction in Fuel Use (Litres)	% Energy (and Greenhouse Gas Emissions Reduction)
Average 1995-1998	$ 15,601,204	31,202,408	$ 23,004,823	46,009,646	14,807,238	32.2%
1998	$ 17,137,384	34,274,768	$ 25,273,171	50,546,342	16,271,574	32.2%
1997	$ 15,723,739	31,447,478	$ 23,187,324	46,374,648	14,927,170	32.2%
1996	$ 14,732,082	29,464,164	$ 21,719,142	43,438,284	13,974,120	32.2%
1995	$ 14,812,052	29,624,104	$ 21,840,704	43,681,408	14,057,304	32.2%

The Trimac Motor Carrier Cost Model computes, as one element of operating costs for trucks, the fuel utilized in undertaking hauls. As noted in Table 13, the use of LCVs is significantly reducing the fuel used for truck transportation and the greenhouse gas emissions associated with this activity by approximately 15 million liters of diesel fuel annually, a reduction of 32% for the movements currently undertaken on the study network location.

5.4.3. Wear on Road Pavement Surfaces

A significant agent in the wear on road surfaces is the impact of motor vehicle traffic and the repetitive loading of road pavements by the passage of heavier vehicles such as trucks and buses. This is in addition the impact of weather (principally frost action as road sub bases expand and contract).

The repetitive effect of "wheel passes" from heavier vehicles, contributes to what engineers refer to as a "fatigue failure" of the pavement structure from these loads. The failure often takes the form of:

- Rutting. This is where the road surface deteriorates through repetitive compressing of the road materials in the "wheel paths" followed by the various vehicles in the lane.
- Cracking. This is where the road surface suffers cracks that are longitudinal to the roadway – often along the ruts.

Both of the foregoing factors work to accelerate the "weathering" process, because the ruts frequently become collectors of meltwater and rainwater and the cracks become a means for moisture to enter the roadway structure – thereby accelerating further road damage through erosion and frost action (expansion and contraction of the water contained in the roadway).

As with the fatigue failure in other structures, engineers relate the fatigue damage to pavements to the magnitude of wheel loads as well as the number of load repetitions over the life of the pavement. To reflect the "mix" of passenger cars, small trucks, larger trucks of various sizes and buses, the effect of all motor vehicles is reflected in the measure of each vehicle's impact expressed as a number of standardized ESALs (Equivalent Single Axle Loads). In this approach, every vehicle has an ESAL equivalency, and the total ESALs from all vehicles are "summed" for purposes of estimating road fatigue damage. Hence, the measure / estimation of ESAL passes directly reflects the anticipated "wear" on the road structure from the vehicles passing over it.

While the foregoing measure is appropriate for considering the expected damage on a particular section of roadway, when doing "system comparisons" for all the study location highway links mapped in Figure 4, the appropriate comparison to make is in terms of the "ESAL-km" of activity generated – that is the equivalent number of single axles multiplied times the distance traveled by these equivalent axles over the study location roadways.

Table 11: Comparison of Road Pavement Wear on Study Location (For Annual Average Traffic 1995-1998) of LCVs and non LCVs

Configuration/Scenario	**Assumed Percent Loaded**	**Vehicle-Km of Travel (Average Year 1995-98)**	**ESALs per SingleVehicle Pass ***	**ESAL-kms (millions)**
Turnpike Doubles	100.0%	29,645,854	2.033	60,270,021
Rocky Mtn Doubles	100.0%	26,674,050	4.620	123,234,111
Triple Trailers	100.0%	2,237,158	5.382	12,040,384
Sub-Total (Current)	**100.0%**	**58,557,062**	**3.339**	**195,544,517**
			Weighted Avg.	
Equivalent non-EEMV's (Semi Trailers)	**69.0%**	**105,255,125**	**3.111**	**327,470,754**
			Basis 69% Loaded	
Road Benefit (Reduction of ESALS) from use of EEMVs				**131,926,237**
Percentage (Reduction) Benefit compared to Semi Trailers Only				**40.3%**

** Note ESALS per vehicle pass provided by Alberta Transportation for fully loaded (max GVW) configuration and empty (min GVW) configuration. EEMV scenarios evaluated on assumption of max GVW to maximize the estimate of ESALS (road damage) and Semi Trailer Assumption based on 69% of movements fully loaded and 31% of movements empty (I.e. same tonnage transported as the full EEMV's)*

As can be seen above in Table 11, the substitution of non-LCV (semi trailer) configurations for the current mix of LCV's on the routes would, on average, increase ESAL counts (and pavement damage) by approximately 131.9 million ESAL-km over a base (current, using LCV's) of 195.5 million ESAL-km. This is a percentage increase in highway damage, for moving the same freight of 67.5%. Viewed alternately, the use of LCV's has reduced the number of ESAL-kms by 131.9 Million ESAL-km in comparison to the 327.5 million ESAL-km that would otherwise have occurred if the same freight had moved in semi-trailer loads, a reduction in pavement loading damage to the study location routes of 40.3%.

5.5. Long Combination Vehicle Safety Efficiency

On a macro-economic scale, if the use of LCV's were to be diminished in the face of a constant transportation requirement, there would be a negative impact on road safety. As an example, if the Turnpike Double were to be eliminated, it is estimated that there would be at least 40 more truck collisions per year, and 67 additional annual truck collisions if all LCVs were eliminated.

Assuming a constant transport demand, eliminating EEMV's within the Province of Alberta would result in a substantial increase in tractor semi trailer movements. Based on the analysis of this study, if EEMV's were eliminated and the freight was transported by semi-trailer configurations there would be an approximately 80% increase in the number of movements represented. This would translate into approximately 105,400,000 km of additional tractor semi trailer exposure per year, which at 76.15 collisions per 100 million km would result in approximately 80.25 additional tractor semi-trailer collisions per year or a net increase in truck collisions of 67 truck collisions per year.

On a micro-economic scale, the LCV configurations enable the transport carriers to amortize the costs associated with complying with the LCV permit process and operating requirements over a larger vehicle payload and thus reduces the cost.

6. CONCLUSIONS

6.1. Literature Review of Related Work

Before presenting results of the consultant's investigation of truck transportation cost savings from using LCVs, it is useful to review what the published literature has to say about the subject.

A recent study by Martin Marietta Energy Systems Inc., for the U.S. Department of Energy and the Federal Highway Administration of the U.S. Department of Transportation is on the Internet at http://www.bts.gov/ntl/DOCS/pets.html. It is entitled, "The Productivity Effects of Truck Size and Weight Policies". In this report, the principal findings, of relevance to the current undertaking, are as follows:

> *"A major finding of the study is that, in most cases, use of LCVs would have a significant favorable impact on the annual total logistics cost of truckload shippers. Savings in annual total logistics cost as high as*
> - *59 percent for turnpike doubles and*
> - *52 percent for Rocky Mountain doubles were observed."*

6.2. Alberta Long Combination Vehicle Efficiency Findings

The ability to efficiently use LCVs in the truck sector has been demonstrated to enhance the direct economic cost by 29% and the fuel efficiency by 32% for the trucking mode. It was further demonstrated to minimize greenhouse gas emissions and result in a 40% reduction in pavement wear on highways infrastructure from trucking movements of goods, in comparison to smaller, standard legal semi-trailer truck hauling of the same volume of goods.

In addition to the impact on highway infrastructure, this concern was echoed by the Canadian Transportation Climate Change Table. In the Delcan Report, prepared with assistance of KPMG and A.K. Socio-Technical Consultants, October 1999, entitled, "Assessment of Modal Integration and Modal Shift Opportunities", it was stated, concerning LCVs:

> *"The introduction of longer combination vehicles (LCVs) was also considered to have the potential to reduce GHG emissions. However, it must be demonstrated that rail traffic would not shift to truck in sufficient volume which would offset any gains in GHG emission reductions as a result of this opportunity."*.

In these investigations, the consultant has compared the efficiency of moving the estimated annual quantity of freight, as currently moved in LCV configurations, to standard legal semi trailer movements, for a study area (see Section 2.1, Figure 6) in Alberta. The efficiency comparisons reflect measured traffic samples from AADT survey statistics for the years 1995 through 1998 inclusive, classified on the basis of the CCMTA July 1999 commercial vehicle survey, to estimate the current numbers of LCV movements.

- **Increased Fuel Efficiency, Reduced Greenhouse Gas Emissions and Decreased Truck Traffic for LCV's**

For the study area, in an average year (1995-1998), the reduction in diesel fuel consumption through use of Energy Efficient Motor Vehicles (LCV's) is estimated at 14.8 million liters of fuel annually in comparison to the computed requirements for moving the same freight in non-LCV semi trailer units. This is a 32.2% reduction, from 46 million to 31.2 million liters of diesel fuel consumed annually in the study location.

Expressed in terms of greenhouse gas emissions, there is a proportional corresponding (32.2%) of emissions, from using LCVs rather than a non-LCV truck.

The use of smaller, standard semi trailer configurations is estimated to increase the study area trucking movement numbers by approximately 80 percent, from 58.6 million truck kilometers to 105.3 million kilometers annually, for an average year in this time period. For each individual year in this timeframe, the annual traffic comparisons are of comparable magnitude. For the study area in question, the sampled numbers of LCV movements are seen to represent substantial efficiency gains as compared to use of smaller, standard configuration vehicles, namely:

- **Lower Economic Costs for Shippers and Consumers as a result of LCV Use.**

In terms of economic costs of trucking borne by freight shippers, over the study area, for an average year, the annual cost increase is estimated to be $42.1 million to move the same freight as non-LCV semi trailer units. This increased cost represents a 40 % increase for Alberta transportation users, from $104.3 million annually to $146.4 million for freight movements in the study location. On a per tonne-km basis, the freight movement cost would increase from 9.2 cents per tonne-km to 13 cents.

Interestingly, this estimate is somewhat lower than the estimates published by U.S. researchers (see Section 3.1, Martin Marietta Energy Systems, for the U.S. DOT.), projecting savings of between 52 and 59 percent to be gained from implementation of Rocky Mountain Doubles, or Turnpike Doubles applications.

Although not as high as the U.S. researcher's estimated savings, the freight transportation savings developed herein represent a substantial efficiency gain from use of LCV's.

- **Reduced Roadway Infrastructure Costs and Pavement Deterioration Through the Use of LCVs.**

Expected fatigue wear from truck axle loadings is estimated, by pavement designers, on the basis of the number of ESAL's (Equivalent Single Axle Loads) passing over a given stretch of roadway in a given period of time.

For the study area outlined in Section 2.1 (see Figure 6), if the current freight movements in LCV's are fully loaded (scenario for most damage to roadways from LCV's), this represents a pavement loading scenario of 195.5 million average annual ESAL-kilometers on the system. When the same tonnage of freight is moved in smaller, non-LCV semi trailer loadings, (shown in section 2.3 to represent an 80% increase in the number of truck movements) the ESAL-kilometers of pavement loading increase to 327.5 million ESAL-kilometers annually for the study area. This represents an increase in the expected ESAL loadings of 40.3% and is expected to result in an acceleration of pavement wear (reduction in pavement life due to truck traffic) of 40.3%.

7. APPENDIX A: DETAILED TRAFFIC ESTIMATES BY STUDY AREA HIGHWAY SECTION

The Data Collection Form for Truck Counts (1999 CCMTA Survey)

National Roadside Survey 99
7-day Traffic Count

Date:____________ Location: ______________ Highway: _____________ Direction: ___________

SINGLE TRUCK	TRUCK & 1 TRAILER	TRACTOR ONLY	TRACTOR & 1 TRAILER	TRACTOR & 2 TRAILERS						TRACTOR & 3 TRAILERS		BUS	TIME
				B TRAIN	TURNPIKE DOUBLE		ROCKY MTN DOUBLE		OTHER	A DOLLY	C DOLLY		1 HOUR PERIODS
					A DOLLY	C DOLLY	A DOLLY	C DOLLY					

Source: Alberta Infrastructure