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16. Abstract

This paper shows the economic efficiency of allowing longer combination vehicles in Texas. First, an overview of the truck size and weight policies is explained, with an emphasis on those that affect Texas. Next, LCV operations in other countries are described. Then, an LCV scenario for Texas is chosen, with specific routes and vehicle types. Operational costs for these vehicles are calculated on a cost per mile and cost per ton (or cubic yard) mile. The LCV scenario and the current truck base case are analyzed to find the number of truck trips, the number of mile, and the cost per mile for the chosen routes. These are then compared to estimate the change if LCVs were allowed in Texas.

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THE ECONOMIC EFFICIENCY OF ALLOWING LONGER COMBINATION VEHICLES IN TEXAS

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ABSTRACT

This paper shows the economic efficiency of allowing longer combination vehicles in Texas. First, an overview of the truck size and weight policies is explained, with an emphasis on those that affect Texas. Next, LCV operations in other countries are described. Then, an LCV scenario for Texas is chosen, with specific routes and vehicle types. Operational costs for these vehicles are calculated on a cost per mile and cost per ton (or cubic yard) mile. The LCV scenario and the current truck base case are analyzed to find the number of truck trips, the number of mile, and the cost per mile for the chosen routes. These are then compared to estimate the change if LCVs were allowed in Texas.

EXECUTIVE SUMMARY

BACKGROUND

Like most other U.S. states, Texas is facing a highway funding shortfall, which means fewer miles of new highway and higher levels of congestion. Moreover, freight movement is expected to increase 40% by 2030. One way to move the additional freight without constructing new highway lanes is to allow more productive trucks on the current highway system. More productive trucks will mean an increase in size and weight. This change would reduce the number of trucks, the fuel consumed to move the goods, and the emissions created by the trucking sector. Many other countries, such as Canada and Australia, have successfully increased truck productivity by using Longer Combination Vehicles (LCVs).

The use of LCVs in the United States has been controversial. Although some western states allow them under a grandfather clause, federal law does not allow an increase in truck size and weight beyond 80,000 lb gross vehicle weight. However, a 2002 Transportation Research Board (TRB) Special Report concluded that an opportunity exists for larger trucks to operate under a carefully monitored system. To help understand the impact of LCVs in Texas, this study focuses on the change in truck traffic, total truck miles travelled, and the operational costs concerning the potential use of LCVs.

CHOSEN ROUTES

With increased freight traffic predicted for Texas, key corridors will play an important role. To obtain a broad cross-section, the Project Monitoring Committee (PMC) wanted sections of an existing state corridor, sections of the IH 35 route, and an existing state highway evaluated for LCV operations. The routes are short-haul distances—not competing with rail or other mode types. After discussing with Texas industry shippers such as HEB and PepsiCo/Frito-Lay, the research team chose the following five key routes, depicted in Figure ES.1:

- El Paso to Dallas (IH 20/IH 10)
- Dallas to San Antonio (IH 35)
- San Antonio to Laredo (IH 35)

- Dallas to Houston (IH 45)
- San Antonio to McAllen (IH 37/US 281)

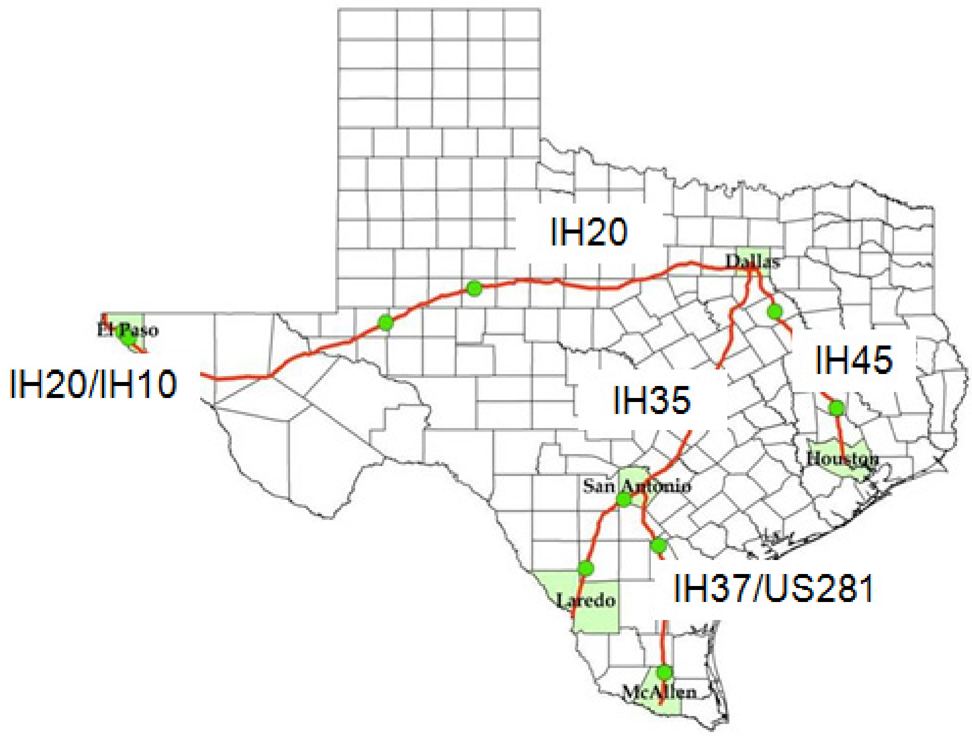

Figure ES.1: Selected Study Routes

REPRESENTATIVE VEHICLES

Different types of LCVs are used in Canada, Australia, and Europe. To decide which types would be safe and appropriate for Texas, the research team contacted companies interested in using LCVs. HEB and PepsiCo were both interested in using their current equipment in different configurations to create the LCVs. The first vehicle chosen was a 97,000 lb tridem semi-trailer. Next, the standard 53ft trailer was used for a combination double 53ft at a maxed-out weight of 148,000 lbs. After discussing with other companies such as Frito-Lay, researchers realized that not all double 53 trailers would be maxed out. Therefore, the idea of a “light” double 53, one that cubes out at 90,000 lbs was also incorporated.

It is impossible to foresee in detail what the industry response would be if LCVs were permitted in Texas. Based on operator surveys and input from industry contacts, the researchers decided, in concert with the PMC, that the following LCV scenario would be realistic for this study:

- LCV approval would affect primarily FHWA (Federal Highway Administration) Class 9 vehicles ("18-wheelers");
- 15% of current truck cargo currently hauled by FHWA Class 9 vehicles would remain in this vehicle class;
- 35% would be transferred to the 97-kip tridems;
- 20% would be transferred to the light doubles; and,
- the remaining 30% would become the 138-kip double 53s.

For the purpose of this analysis, the total amount of cargo remains the same.

OPERATIONAL COSTS

The cost of operating a truck varies based on different factors. Various studies will also use different factors. To stay consistent with work done in Texas by the 2030 Committee, the operational costs of each truck were found using trailer/tractor cost, fuel, driver, maintenance and repair and logistical costs. The tractors for the standard 80 kip truck, the 97 kip Tridem, and the 90 kip Double were the same price of $130,000 with a life of 5 years, and 15% salvage cost. The 148 kip Double tractor was $150,000 with a life of 5 years and a 15% salvage cost. The trailers for the standard 80 kip truck, and both double configurations were $36,000 each (and 2 trailers for each Double for a total cost of $72,000) with a life of 12 years and a 5% salvage value. The tridem trailer was $44,000 with a life of 12 years and a 5% salvage value. The cost of fuel ($3.18/gallon) was based on the cost of diesel at the end of 2010 in Texas. Fuel economy for each truck varied. The 80 kip truck gets 7 miles/gal, the 97 kip tridem gets 6.6 miles/gal, the 90 kip Double gets 6.4 miles/gal, and the 148-kip Double gets 5 miles/gal. Driver pay was based on $/mile. The standard truck driver receives $0.57/mile, the 97 kip tridem driver receives $0.63/mile, and the Double drivers get $0.66/mile. Maintenance and repair costs were similar with $0.25/mile for the standard, $0.28/mile for the tridem and $0.29/mile for the Doubles. Logistical costs were the same for all vehicles, at $0.10/mile. In total, the cost of operating a standard truck is $1.52/mile, for a 97 kip tridem it's $1.63, for a 90 kip Double it's $1.70, and for the 148 kip Double it's $1.86. All costs are shown below:

		Standard	97K Tridem	90K Double	148K Double		
Deprecitation	Tractor	130000	130000	130000	150000	purchase price	
	5 years	5	5	5	5	utilization	
	15%	19500	19500	19500	22500	salvage value	
	Dep per year	22100	22100	22100	25500		
	170000	0.13	0.13	0.13	0.15	$/year	
	Trailer	36000	44000	72000	72000	purchase price	
	12 years	12	12	12	12	utilization	
	5%	1800	2200	3600	3600	salvage value	
	per year dep.	2850	3483.33333	5700	5700		
	$/mile dep	0.02	0.02	0.03	0.03		
	Total cost of depreciation $/mile	0.15	0.15	0.16	0.18		
Fuel	Fuel price $/gal	3.18	3.18	3.18	3.18		
	Fuel consumption miles/gal	7	6.6	6.4	5		
	fuel- $/mile	0.45	0.48	0.50	0.64		
Driver	Driver $/hr						
	Driver $/mile	0.57	0.63	0.66	0.66		
Maintenance and repair		0.25	0.28	0.29	0.29		
Logistical		0.1	0.1	0.1	0.1		
Total cost/mile		1.52	1.63	1.70	1.86		
cost/ton/mile		0.063	0.034		0.039		
cost/cubeft/mile		-	-	0.0002	-		

SUMMARY OF FINDINGS

The findings of this study reference the chosen routes in Texas and representative LCVs defined in this paper. Using the information gathered for routes and cost data, shipping costs for the current truck scenario and a suggested LCV scenario can be calculated. Since the daily truck traffic varies, a minimum, maximum and mean number of trucks per route was used to show the range of possibility. The following is a summary of these findings:

Current Situation			
	Miles/day	Trucks/Day	$/Day
Minimum	3,362,585	11,429	$5,111,129
Maximum	16,873,764	55,633	$25,648,121
Mean	8,055,960	25,648	$12,245,059
LCV Situation			
	Miles/day	Trucks/Day	$/Day
Minimum	2,315,677	7,871	$3,865,751
Maximum	11,620,283	38,312	$19,398,696
Mean	5,547,816	17,663	$9,261,426
Change			
	Miles/day	Trucks/Day	$/Day
Minimum	-1,046,908	-3,558	-$1,245,379
Maximum	-5,253,481	-17,321	-$6,249,426
Mean	-2,508,144	-7,985	-$2,983,633

In total, between $1.2 and $6.2 million can be saved per day if the LCV scenario was applied to current truck traffic on the chosen routes. This means a reduction of between 3,500 to 17,300 trucks per day.

CONCLUSION

Although LCVs are not currently allowed in Texas, a 2010 study found that it is feasible to allow certain LCV types on certain Texas routes. These types were a 97-kip Tridem, a 90-kip Double 53' and a 148-kip Double 53'. The routes were on major key corridor systems spanning from the Mexico-US border to Dallas to El Paso.

The predicted savings to Texas shippers ranges from $374 million to $1.9 billion a year. This amount of estimated savings from using traditional 80-kip trucks can be used to help policy makers pass regulations regarding efficient cost allocation and pricing methods for LCVs. Since LCVs do consume more infrastructure than standard trucks, they will be charged more than current trucks in Texas are charged. However, the benefit is not just to the shipping companies. It was found that allowing those same vehicle types on the same routes produced a decrease in miles, truck trips, and cost per day. A decrease in the number of vehicle miles travelled and the number of truck trips per day can ultimately decrease congestion on these routes, which are shared with the Texas public. These findings could be studied through an LCV pilot test on the routes analyzed. A pilot program would allow engineers and researchers to gain hard data on LCV operations while working closely with the trucking industry to learn what is feasible as well as the safest, most efficient way to allow LCVs in Texas.

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CHAPTER 1: BACKGROUND

Texas, like most other U.S. states, is facing a highway funding shortfall, which means fewer miles of new highway and higher levels of congestion. The highway funding in Texas has been declining after reaching its peak in 2008. However, vehicle miles travelled on these highways are increasing. The population of Texas has been steadily increasing and is projected to increase by 15 million over the next 25 years, increasing the number of passenger vehicle miles by 30% [18]. Moreover, large truck traffic is expected to increase 40% by 2030 [18]. Four of the top 25 freight gateways in the United States are found in Texas [1]. The economy of Texas relies heavily on trucking. In 2008, Laredo handled $89 billion worth of trade in the trucking sector (out of $116 billion total trade) [1]. El Paso handled $42 billion worth of international trade in the trucking sector in the same year. The following table shows Texas shipments [1]:

Table 1: Texas Shipments 2007

2007	Total	Truck	Percentage of total
Value (million)	$1,166,608	$692,717	59%
Tons (thousand)	1,338,753	765,518	57%
Miles (million)	252,819	110,160	44%

The increase expected in freight movement and population, combined with a decrease in highway funding requires a creative solution to keep Texas competitive. More productive trucks could be one answer. Truck productivity can be increased by increasing the weight, length or both of trucks. The Transportation Research Board recognizes the need for change and has stated "the result [of past regulation] has been trucks that are not ideal from the standpoint of highway wear, freight productivity, or safety" [2] However, truck weight and size regulation has been a controversial subject.

There have been increases in productivity in every transportation sector over the last 2 decades except trucking. However, trucking size and weight regulations have not changed since the early 1980s, except regarding trailer length[1]. Truck size and weight must balance safe and efficient

[1] Maximum trailer length has increased; in Texas, 59 ft trailers are allowed.

freight movement to facilitate intra- and inter-state commerce while establishing highway design parameters to manage consumption of the infrastructure.

Motor vehicle size and weight regulations are among the most important factors determining road and bridge design, maintenance requirements and the cost of truck freight transportation [2]. Truck size and weight limits were originally a responsibility of the states. The first federal regulation began with the American Association of State Highway Officials (AASHO). In 1932, they recommended tandem axle weight limits which were based on the distance between axles and also recommended a single axle weight limit of 16,000 lbs. AASHO continued to revise their policies. In 1946, they recommended an 18,000 lb single axle limit and a 32,000 lb standard tandem axle limits. They took it one step further by recommending that the gross vehicle weight should not exceed 73,280 lbs for vehicles having a maximum length of 57 ft between the axles. The Federal Aid Highway Act of 1956 set the maximum gross weight on the interstate highways at 73,280 lbs. In 1974, they raised it to 80,000 lbs as an energy conservation measure and that limit continues through today. However, the Federal Aid Highway Act did include a "grandfather" clause that allowed those states operating heavier vehicles to continue operations and not comply with the lower weight limit.

In 1982, the federal government brought uniformity to interstate transportation by passing the Surface Transportation Assistance Act (STAA-82). One of the many things this act did was make the weights established by the Highway Act mandatory on the entire Interstate Highway System. States with more restrictive limits had to conform to these higher federal standards (which were 80,000 lbs GVW, 20,000 lbs on a single axle and 34,000 lbs on tandem axles) on what became known as the "National Network for Trucks" [3]. The National Network includes the Interstate Highway System and other specified highways (currently about 200,000 miles). STAA-82 also allowed trucks with twin trailer combinations on any segment of the interstate system and set a minimum trailer length of 28 feet for doubles and 48 feet for a single trailer, with no length restrictions on the tractor or overall configuration. Therefore, all states had to allow at least 28' twin trainers and 48' single trailers on the National Network.

The next set of regulations came about in 1991 with the Intermodal Surface Transportation Efficiency Act (ISTEA). This Act limited the operation of LCVs on the Interstate System to configurations that were authorized by state official on or before June 1, 1991 (those that were "grandfathered" under the 1982 Highway Act). Every state had to submit a list of all LCV operations as of June 1, 1991 to the Secretary of Transportation so it could be published in the Federal Register (although there were some state exceptions to this, Texas was not one of them). Route expansions for LCVs were limited and the removal of LCV operating restrictions was prevented under the Act. Truck size and weights were set at the 1982 guidelines set by the STAA. Texas is not one of the grandfathered states, and therefore, has a GVW of 80,000 lbs.

Although policy regulations have not changed since ISTEA, there has been research done in the area of long combination vehicles. The 2002 Transportation Research Board Special Report 267 was a result of the ISTEA. TRB was asked to "conduct a study of the regulations governing the weights, lengths, and widths of commercial motor vehicles operating on highways subject to federal regulation, and to recommend any revisions to the regulations deemed appropriate."[2]

The first conclusion of the Special Report was that "opportunities exist for improving the efficiency of the highway system through reform of federal truck size and weight regulations. Such reform may entail allowing larger trucks to operate." They recommended that an independent public organization, called the Commercial Traffic Effects Institute, be created to develop weight and size standards, manage highway management practices, create regulatory changes, and evaluate implementation of those regulatory changes. The Institute would also be in charge of the report's next recommendation, a pilot study. The pilot study would be heavily controlled and monitored; it would be used to ensure that the use of larger trucks is consistent with public safety and that any increase in infrastructure consumption is covered by user fees. The Institute would collect data under actual operating conditions that could show primary impacts of interest (such as accident information) rather than proxies (such as vehicle stability). The committee recognized that their recommendations would require immediate federal regulation changes. However, to date, their recommendations have not been implemented.

The most recent research done on the use of Long Combination Vehicles was the 2010 study Potential Use of Long Combination Vehicles (LCVs) in Texas [4][5]. This study focused on the impacts on infrastructure, mainly pavement and bridges. The study performed pavement analysis on key Texas routes to estimate potential LCV impacts on these chosen highways. Each of the routes was divided into segments with uniform truck traffic, pavement, and subgrade type. Load spectra were developed for the existing conditions as well as for the LCV scenario. Additional information was obtained, including material properties, tire pressures, and detailed axle configurations for the current traffic level and for a predicted LCV scenario. In total, the researchers analyzed 152 highway segments. For rigid pavements, the LCV scenario had no impact on pavement life. For flexible pavements, the LCV scenario improved the pavement life for all but one route.

The estimated pavement lives were used in calculating the annualized cost of a thick hot-mix overlay at the end of each cycle. Given the wide variation in overlay costs observed in previous studies, the researchers decided to calculate the annualized costs for three unit overlay costs (cost per lane-mile) [5]:

- Median price: $400,000 per lane-mile;
- 60% percentile: $607,000 per lane-mile; and
- Third quartile (75% overlays in the database cost up to that value): $1,219,000 per lane-mile.

Table 2 shows the estimated changes in the annualized costs of periodically overlaying the pavements if LCVs were allowed on these routes [5]. The change in overlay costs is the difference between the annual cost of pavement with LCVs and the annual cost of pavement without LCVs. If the change is negative, it indicated a reduction in cost, shown in the table in parentheses. The Dallas/Houston route does not see a change because it is rigid pavement. Rigid pavement’s fatigue is extremely sensitive to minor variations in the stress on the pavement; therefore, the pavement is constructed with a thickness of at least 8 inches to maximize the number of repetitions so it never experiences a variation of stress. This thick slab of pavement on good foundation means the pavement has a long fatigue life, and therefore, LCVs do not have an impact on rigid pavement [5].

The pavement analysis was conducted using data from available weigh-in-motion stations. Some stations, especially one on IH 20 between Dallas and El Paso, have a considerable amount of overweight tandem axles in Class 9. Some of the positive LCV impacts are due to the fact that the LCV scenario used in this study transfers 85% of this total cargo to LCVs with either legal tandem axles, or heavier tridems, and both are less detrimental to existing pavements than overweight tandems.

Table 2: Pavement Overlay Costs

	Length (mi)	$0.4m	$0.6m	$1.2m
Dallas to El Paso	667	$(15.00)	$(22.77)	$(45.76)
Dallas to Laredo	446	$(2.54)	$(3.85)	$(7.75)
Dallas to Houston	261	-	-	-
San Antonio to McAllen	243	$0.14	$0.22	$0.44
Total	1,617	$(17.40)	$(26.40)	$(53.07)

In total, the Texas study analyzed 1,713 bridges in the route segments. Axle spacing and axle loads were established for the LCV scenario. The bridge analysis was first calculated using the classic model of moment ratios and then a new technique was used that incorporated fatigue. Research indicates that newer bridges (built since the 1980s) can support a 20% overstress, while older bridges can support a 10% overstress. Accordingly, two moment ratios of 1.1 and 1.2 were used to determine which bridges are deemed deficient under the proposed LCV scenarios—1.1 and 1.2 moment ratios indicative of 10% and 20% overstress respectively [5]. Two sets of results were calculated using this traditional approach and by excluding the bridges that are already deficient for the existing traffic. One set used the 10% overstress criteria and one set used the 20% overstress criteria. Both overstress scenarios used the bridge inventory rating recorded in the Bridge Inspection and Appraisal Program (BRINSAP) as the basis. Cost estimates for replacement of these bridges are based on an estimated cost of $190/sq ft of deck area. This unit cost of replacement was determined from 2030 Committee study[2]. The 90-kip double 53 configuration showed no impact on the bridges of the selected case study routes for both overstress ratios. As detailed in Table 3, the 97kip Tridem would require between $1.14 and $2.78 billion in bridge replacing and the 138kip Double 53 would require between $1.0 and $1.18 billion in bridge strengthening.

Not all bridges would have to be replaced immediately depending on the overstress level. To incorporate this concept in the analysis, the project developed a new fatigue approach with the assumption of a 75-year fatigue design life for a bridge. If the moment ratio is between 1.2 and 1.4, the bridge is assumed to have its life shortened by fatigue effects and, depending on its age, trigger an earlier replacement than the assumed 75-year life. Bridges with a moment ratio greater than 1.4 would have to be replaced immediately. Results for this analysis approach (shown in Table 3 [5]) amount to $1.0 billion and $0.8 billion for the 97-kip tridem and 138-kip double 53 respectively, with no impacts for the 90-kip double 53 configuration.

Table 3: Bridge Results

Scenario	**# Bridges**	**Cost $ (billions)**
97-kip Tridem 1.1 Moment Ratio	880	2.78
97-kip Tridem 1.2 Moment Ratio	582	1.14
97-kip Tridem Fatigue Approach	187 and 694	1.03
138-kip Double 53 1.1 Moment Ratio	201	1.18
138-kip Double 53 1.2 Moment Ratio	173	1.00
138-kip Double 53 Fatigue Approach	51 and 150	0.79
Combined LCV Configurations 1.1 Moment Ratio	886	2.80
Combined LCV Configurations 1.2 Moment Ratio	690	1.92

[2] This 2030 Committee study was completed in February 2009. There was another study in March 2011 that went into further detail.

The results of the thesis show that the use of LCVs could provide substantial benefits in lowering ton-mile costs in Texas and builds on the results of the 2010 study. The purpose of this thesis is to evaluate the economic efficiency of allowing LCVs in Texas. Chapter 2 is a discussion of other countries where more productive vehicles are allowed and the traits of those operations. Chapter 3 consists of creating an LCV scenario with vehicle types and specific routes in Texas. Chapter 4 analyzes operational costs for truck companies using various characteristics. Chapter 5 applies the operational costs to different truck scenarios in Texas. Finally, chapter 6 summarizes the findings and makes conclusions and recommendations for future research.

CHAPTER 2: SELECTED LCV OPERATIONS

The concept of using of more productive trucks is not new. Many countries with different political and physical attributes have adopted the use of LCVs. Remaining competitive with other countries is vital to the economy, with the United States being the number one exporter of goods and services. Texas plays an important role in the US trade since it is a main component of the NAFTA trade corridor. Both NAFTA trading partners, Canada and Mexico, allow heavier and longer vehicles. Majority of the European Union trade movements by truck is done on heavier tridems, with different LCV types being tested. Australia has been the leader in LCVs (known as road trains), with a long history of their use and innovative methods to keeping them safe and efficient. These countries provide examples where longer and heavier vehicles have been operating safely under different policies and geography for years.

CANADA

Canada is the largest trading partner of the United States with $1.6 billion traded daily [6]. Trucking plays a large role in the US-Canada trade with 59% of freight by value moved by truck [7]. Trucking is clearly important to Canada's economy. The for-hire truck sector has "annual revenues of $20 billion, which is more than 40% of the transportation component of Canada's GDP [6]". Canada has an economic advantage over the US by allowing Long Combination Vehicles.

Trucking size and weight regulations began later in Canada than in the US, starting in the 1950s. In 1954, the Motor Vehicle Transport Act was passed in Canada, which allowed each province to have their own set of trucking regulations [4]. This caused a lack of uniformity in the trucking sector. The Council of Ministers Responsible for Transportation and Highway Safety recognized this and in 1988, they sought to "improve uniformity in weights and dimensions of commercial vehicles operating between provinces and territories" [4]. The idea was to allow provinces to have liberal limits, but set minimum standards for the country. From this idea, the Memorandum of Understanding on Vehicle Weights and Dimensions (MOU) was created in 1991. The MOU has been amended since then; Table 4 shows the current minimum dimensions each province must allow to help facilitate intra-province trucking [4]. By having a minimum dimension, truck operators know that as long as their truck's gross vehicle weight is within that limit, they can operate trans-continentally.

Table 4: Canadian Truck dimensions

Vehicles	Length m (ft)	Gross Vehicle Weight kg (lbs)	Height m (ft)	Width m (ft)
Tractor Semitrailer (6 axles)	23 (75)	46500 (102,500)	4.15 (13.6)	2.6 (8.5)
A Train Double	25 (82)	53500 (117,900)		
B Train Double	25 (82)	62500 (137,800)		
C Train Double	25 (82)	58500 (129,000)		

However, each province can define greater truck dimensions than those listed in MOU to allow trucks that operate within their boundaries to be heavier or longer. Truck dimensions by province can be found in Appendix 1. Each province also has their own regulations in regards to allowing LCVs. LCVs operate in Alberta, British Columbia, Saskatchewan, Manitoba, Quebec, and the Northwest Territories. There is also a pilot program for LCVs in Ontario. The program was so successful that they are expanding to include 40 additional fleets [9]. There are strict guidelines that dictate the routes, speed limits, times, and various safety regulations in which they are allowed to operate.

According to Woodrooffe and Associates, the cost of operating an LCV in Canada on average is $1.78 per km ($2.87/mi) and $74.45/hour [8]. The cost per vehicle type is shown in Table 5 [8]:

Table 5: Vehicle Costs in Canada

Vehicle Type	Cost/km (cost/mi)	Cost/hr
Turnpike Doubles	$1.83 ($2.95)	$77.07
Rocky Mountain Doubles	$1.70 ($2.74)	$72.06
Triples	$2.07 ($3.34)	$69.24
Average	$1.78 ($2.87)	$74.45

The cost of operating non-LCV trucking movements is $1.39/ km ($2.24/mi) and $66.38/hr. Therefore, LCV movements in Canada on average cost 22% more than non-LCV movements. However, LCVs have reduced the total number of truck-km by 44%. So the cost savings to the shipper is 29%. This is a reduction from \$0.13/ton-km to \$0.09 cents/ton-km. So although the cost per movement increases, the total number of movements decreases, which lowers total cost for Canadian shippers.

MEXICO

Truck size, weight and dimension limits are set by the federal government in Mexico. The state governments are allowed to set different limits on roads in their own jurisdiction; however, to date, none of the states have done this [17]. The Mexican official Norm (NOM) NOM-012-SCT-1995, the document providing the basic framework of truck size and weight, was updated in 2008. Mexico imposes a GVW of maximum 66 tons (about 135,000 lbs) and a length of 102 feet. However, if a vehicle has additional performance, mechanical, and operation requirements, it can operate at a maximum of 80 tons. LCV operators also need a special permit if they want to operate off the LCV-approved routes [4].

EUROPEAN UNION

In regards to trucking regulations, the European Union allows a weight of 40-44 ton (88,185 to 97,003 lb) and a maximum length of 61.5 feet for truck and trailer combinations [4]. However, Members States are allowed to permit longer and heavier trucks in their country. Both Finland and Sweden allow heavier trucks; in the EU the more productive trucks are called gigaliners. Gigaliners can have a weight of up to 60 tons and a length of 25.25 meters. Current permissible weights and dimensions for each country in the EU are shown in Appendix 2.

Use of gigaliners on the trans-European network roads have been projected to reduce transport costs by 23%, reduce the number of trips by 32% and reduce the fuel consumed by 15% [10]. However, the allowance of heavier or longer vehicles is still being debated in the EU. As in the United States, there is concern about infrastructure impacts, geometric design of the road, and safety concerns. Netherlands, Germany, Denmark, and Belgium have all begun pilot tests in their countries to evaluate the pros and cons of allowing a modest increase in length and weight to their trucks [12].

> The general recommendation from the European Commission is "that introducing LHVs in Europe can be done without harming European society as a whole."

AUSTRALIA

Australia is one of the leaders in Long Combination Vehicle use. Australia has one of the lowest population densities in the developed world, with 7.7 million square kilometers and only 20 million people. Given this low density, rail has been limited to metropolitan passenger movement, regional intercity passenger routes and mining operations. All other land-based freight movements have to move by truck. Also, the roads are generally flat and often unpaved for the trucks[3]. Seventy-two percent of total freight moved within Australia is done via truck [4].

The first long combination vehicle introduced to Australia was actually an early design of a road train. In 1934, the government imported this road train from the Oversea Mechanical Transport Directing Committee in Britain. It began operating in the Northern Territory, alternating between Alice Springs and Katherine. However, road trains did not become important to the Austrian freight industry until after World War II. Shipping services were changing, especially in the Northern Territory. Road train operators were able to respond to these changes quicker than the train. Commonwealth railways (Comrails), although a competitor with road trains, proposed to coordinate road and rail services [4]. However, since Hauliers (Austrian haulers) were independent and unorganized, rail and road freight movers could not reach an agreement. Eventually, Territory Transport Association (TTA) was formed by the hauliers; this organization reached an agreement with Comrails that coordinated services, with peak services between 1955 and 1970.

There are few unified regulations for the road train industry in Australia. The Federation does have power over the states/territories but with the National Transportation Council (NTC) having power over road and road transportation, national regulations have been difficult to implement. The NTC has recommended regulation and operational changes for road, rail, and intermodal transportations to the Austrian Transport Council and have tried to help implement these changes in the states/territories. This has been difficult and currently there is just a general regulatory overview (shown in Appendix 3). Nationally, jurisdictions received $1.3 billion in 2007 in revenue from heavy vehicle fees and charges.

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[3] Trucking volume in many part of Australia is very low; unpaved roads can carry LCVs without significant pavement damage.

All of the countries that allow more productive vehicles do so under a carefully monitored system. Each vehicle type is defined either by performance measures or specified characteristics and the vehicles are not allowed to travel over the entire network of roads. Not all freight movement in these countries occur on the LCVs; some cargo and truck trips are more suited to the standard trucks. This would also hold true in Texas. The next chapter defines specific safe and efficient vehicles and routes that Texas shippers would be the most likely to use.

CHAPTER 3: LONG COMBINATION VEHICLE SCENARIO

This thesis estimates the economic impacts of allowing certain types of Long Combination Vehicles most likely to be adopted by the trucking sector in Texas. It evaluates two truck activity scenarios: the base case, freight hauled using the standard 80 kip semi trailer currently in use, and freight hauled using an LCV scenario. The LCV scenario had to be estimated with vehicle type and vehicle mix since LCVs are not allowed in Texas.

VEHICLE TYPE

The term LCV can mean different vehicle types, as shown in the previous chapter. The Federal Motor Carrier Safety Administration (FMCSA)'s definition of a Long Combination Vehicle is any combination of a truck-tractor and two or more trailers or semi-trailers that operation on the Interstate Highway System at a GVW greater than 80 kip (a kip is equivalent to 1000 lbs). However, not all LCV types will be allowed in Texas. Following the structure of the 2010 LCV study in Texas three LCV types were chosen for analysis based on shipper input[4]: a 97 kip tridem, a 90 kip Double 53' and a 138 kip Double 53'[5] [5].

These LCVs are further defined below:

- **Tridem:** This is a tractor with one trailer. The trailer is 53 feet long. The maximum GVW is 97 kip.
- **90-kip Double 53':** This is tractor with two trailers. The trailers are 53 feet long each. The maximum GVW is 90 kip. This vehicle type is typically used for commodities that are volume sensitive and cube out, instead of weight sensitive.
- **148-kip Double 53":** This is tractor with two trailers. Each trailer is 53 feet long. The maximum GVW is 148 kip. This vehicle type is typically used for commodities that are weight sensitive and weight in, instead of cube out.

Figure 1 illustrates these LCV configurations as well as the standard truck:

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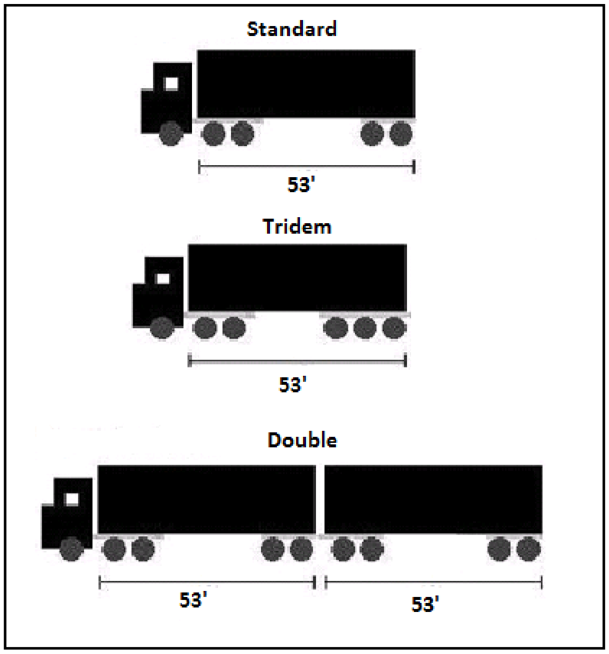
4 A panel of trucking companies was used as an advisory committee for the study.

5 Although a 138-kip Double 53' was used in the previous Texas study, further research shows that a 148-kip Double is more practical; therefore, that weight was used in this study.

Figure 1: Truck Configurations



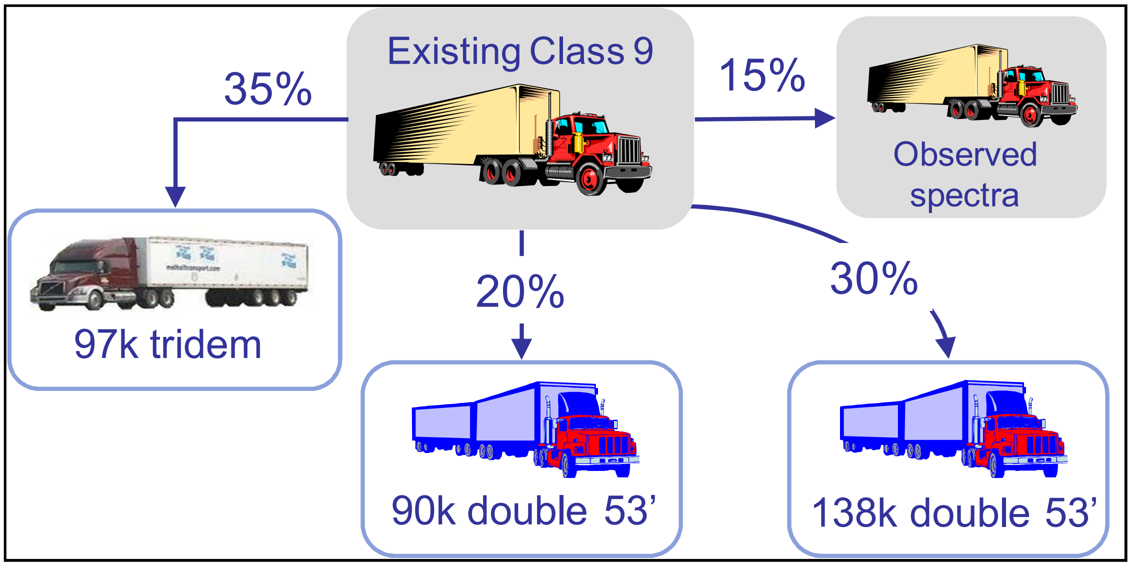
VEHICLE MIX

Since it is unknown what the vehicle mix will be if LCVs were introduced into Texas traffic, estimates were used for different proportions of various types of LCVs for the LCV scenario. These proportions were developed in collaboration with TxDOT, based on information provided by truck operators and the use of LCVs in other states. This scenario is considered the long term equilibrium scenario. Many trucking companies will continue to use their current truck configurations since capital investment in newer vehicles is expensive. They will switch to the more productive vehicles as their current fleet needs to be replaced. Some companies will continue to run the 80 kip truck if it is meets their shipping needs. The long term equilibrium scenario is the following [5]:

- LCVs will impact FHWA Class 9 vehicles ("18-wheelers"). For the purpose of this analysis, other vehicle classes will not change.
- For the purpose of this analysis, cargo amount will stay the same.
- 50% of all cargo hauled by FHWA Class 9 vehicles will be transferred to double 53 trailers
  - 40% of those Double 53s will cube out at 90 kips
  - 60% of those Double 53s will weigh out at 138 kips

- 15% of all cargo hauled by FHWA Class 9 vehicles will stay with this type of vehicle.
- 35% of all cargo hauled by FHWA Class 9 vehicles will run as the 97-kip tridem depicted in Figure 2.

Figure 2: Estimated vehicle mix in LCV scenario



The truck types and truck trips in the base case scenario were quantified from available truck traffic statistics. The statistics are from the 2010 LCV study in Texas. They were found using the most recent annual daily truck traffic (AADT) and truck percentages (2008) from RhiNo and PMIS databases and the most recent WIM data reports (2002-2009) from TxDOT's Transportation Planning and Programming department. Data sources are shown below [5]:

Table 6: Data Overview

Data	*Type*	*Main Sources*
Traffic	Average daily truck traffic	PMIS/RHiNo databases
	Vehicle classification Axle load distribution	TP&P / FHWA WIM data reports
	Tire pressures	FHWA's ME-PDG
	Axle configurations	-FHWA's vehicle classes -This project's LCV scenario

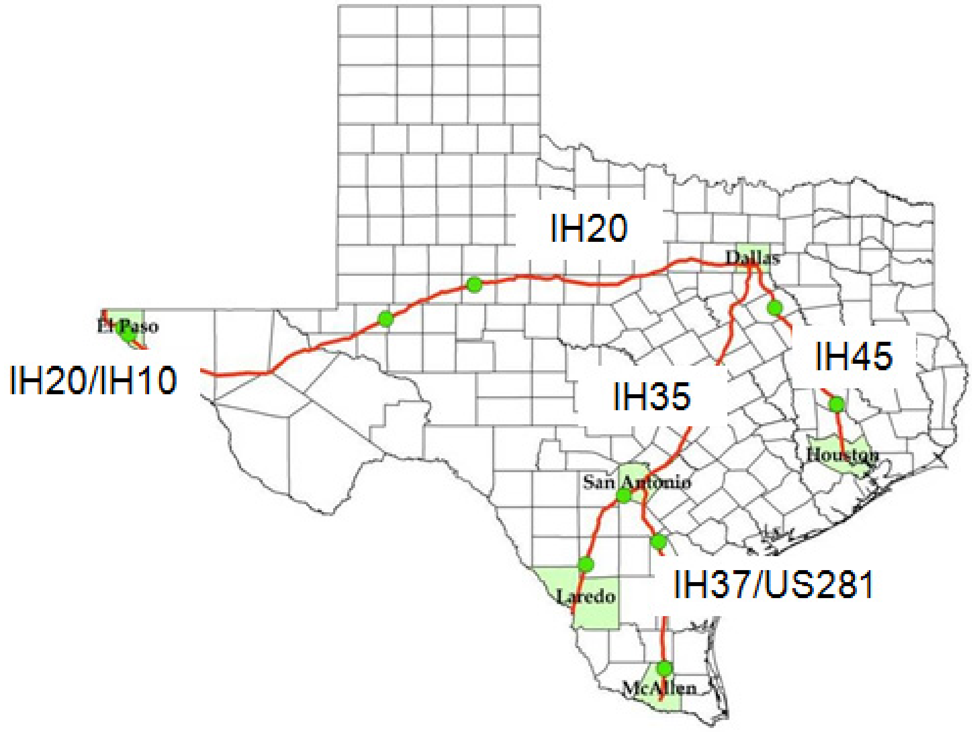
For the LCV scenario, an estimate was developed of the expected equivalent number of movements required to move the same amount of cargo in the base case with the new LCV types and vehicle mix, over the same route segments. These equivalency factors were based on either cubic carrying capacity or weight carrying capacity, depending on the LCV configuration. Therefore, this study makes the assumption that the amount of cargo does not change.

STUDY LOCATION

It is recognized that Long Combination Vehicles would not be allowed on every road in Texas. Therefore, only key corridors were considered for the adoption of LCVs. In order to stay consistent with past work done in Texas, the following routes were chosen for analysis:

- El Paso to Dallas (IH 20/IH 10)
- Dallas to San Antonio (IH 35)
- San Antonio to Laredo (IH 35)
- Dallas to Houston (IH 45)
- San Antonio to McAllen (IH 37/US 281)

Figure 3: Study Routes in Texas



With the exception of the route from El Paso to Dallas, the segments are considered short haul distances and do not compete with the rail[6]. The average daily truck trips on each route were found using the information in Table 6. The number of miles and truck trips of each route are shown in table 7:

Table 7: Truck Miles and Trips on Study Routes

Route	Miles	ADTT (mean)
Dallas to San Antonio	292	8,418
El Paso to Dallas	667	3,900
Dallas to Houston	261	6,726
San Antonio to Laredo	154	4,086
San Antonio to McAllen	243	2,518

[6] According to BTS, in 2002, a ton of truck shipments travels an average of 157 miles while a ton of rail shipments travels an average of 724 miles.

These two scenarios were then evaluated in terms of the following efficiency measures:

- Total number of truck trips
- Total number of truck miles
- User cost for truck transportation

User costs vary based on the vehicle types. Since LCVs are currently not allowed in Texas, operational costs for these vehicles are not readily known. The next chapter shows as estimate of the costs to aid in the evaluation of the scenarios presented.

CHAPTER 4: OPERATING COSTS

Operating costs for each vehicle type is needed in order to evaluate the economics of the base case and the LCV scenario as shown in Chapter 3. Vehicle operating costs are determined by a wide variety of characteristics; different studies use different characteristics to determine the operating cost of a truck. While costs can be contributed to the broad categories of vehicle/driver/company costs, the information that goes into these categories varies by company. Six of the most recent truck operational cost studies are shown in Table 8 to give an idea of the broad range of strategies [13].

Table 8: Operational Cost Studies

Costs in Dollars per Mile	ATA 2001	ATA 2003	ATA 2005-06	Barnes & Langworthy 2003	SKM 2008	ATRI 2008	OOIDA 2003
Driver wages	$0.39	$0.55				$0.441	$0.05
Fuel and Fuel Taxes	$0.17	$0.20		$0.64		$0.69	$0.27
Outside Maintenance	$0.06	$0.07		$0.105	$0.097	$0.092	$0.08
Tax and License	$0.03	$0.03	$0.03			$0.024	$0.02
Tires	$0.02	$0.02		$0.021-$0.04		$0.03	$0.02
Other Wages and Benefits	$0.47	$0.80			$0.15	$0.162	$0.05
Depreciation	$0.10	$0.11	$0.14		$0.19		
Insurance	$0.06	$0.09			$0.11	$0.06	$0.02
Interest	-	-			$0.13		$0.02
Administrative costs	-	-			$0.03		$0.01
Total Cost	$1.30	$1.87				$1.499	$0.55

The most recent operational cost information for Texas was from the 2030 Texas Report. The study used depreciation, driver wage/benefits, fuel, maintenance/repair, and logistical costs for the base of their operating costs estimates. To stay consistent with Texas information, this study will also use those categories for cost estimates.

TRUCK PURCHASE AND DEPRECIATION

While the purchase of the tractor and trailer components can be considered capital costs, the amount they depreciate each year is a marginal cost. A 13-liter engine tractor is typically used for the traditional 80K truck, the 97K tridem, and the 90K Double 53’. The initial purchase price of a 13 L engine is estimated at $130,000 with a usable life of 5 years. The 148K Double needs a

15l engine; it has an initial purchase price of $150,000 and a usable life of 5 years[7]. At the end of the tractors usable life, there is a salvage price estimated to be 15% of its initial purchase price. This amounts to $19,500 for the 13 liter engine and $22,500 for the 15 liter engine.

The standard 53' ft trailer can be used for the 80K truck, the 90K Double, and the 138K Double. This trailer has an initial purchase price of $36,000 (and therefore, $72,000 for the Double 53' since they need two of the trailers) and an estimated life of 12 years. The trailer used on a Tridem costs $44,000 and has as estimated life of 12 years. At the end of the trailer's usable life, there is a salvage price estimated to be 5% of the initial price. This amounts to $1800 for the 80k truck trailers, $2200 for the Tridem trailer, and $3600 for both the 90K and the 148K Double 53' (since there are two trailers per vehicle).

Depreciation of the tractor and trailers occurs because of the passage of time and the use of operating these trucks. While there are different methods for calculating depreciation, this study uses the sum of years' digits (SOYD) method. The SOYD method is an accelerated depreciation method, which is based on the assumption that these tractors/trailers are more useful when they are newer; therefore, more of the costs should be written off in the beginning of its life rather than in the later years [14]. The SOYD formula is

$$D_j = (C-S_n)(n-j+1)/T \text{ where } T=0.5n(n+1)$$

$$=\mathbf{SYD}(C, S_n, n, j)$$

Where C= initial cost Sn=salvage value n=number of useful years [14]

The percentage used to calculate the depreciation for year j is $(n-j+1)/T$ where T is the sum of the digits 1, 2, ... n. T can be calculated as $T=0.5n(n+1)$. The depreciation per year for the tractors and trailers can be found in Appendix 4.

The depreciation value had to be converted on a cost/mile basis in order to be more useful. For each year the unit depreciated, the value found using the SOYD method was divided by the number of annual vehicle miles traveled by the truck. Using information from Texas shippers, an

[7] This usable life is based on intra-state travel for a truckload carrier.

annual vehicle utilization of 170,000 miles was used in this study[8]. This provided a $/mile cost for depreciation for each year. All the years were then averaged to provide a single value for each vehicle type. These calculations are shown in Appendix 5.

Table 9: Depreciation Costs

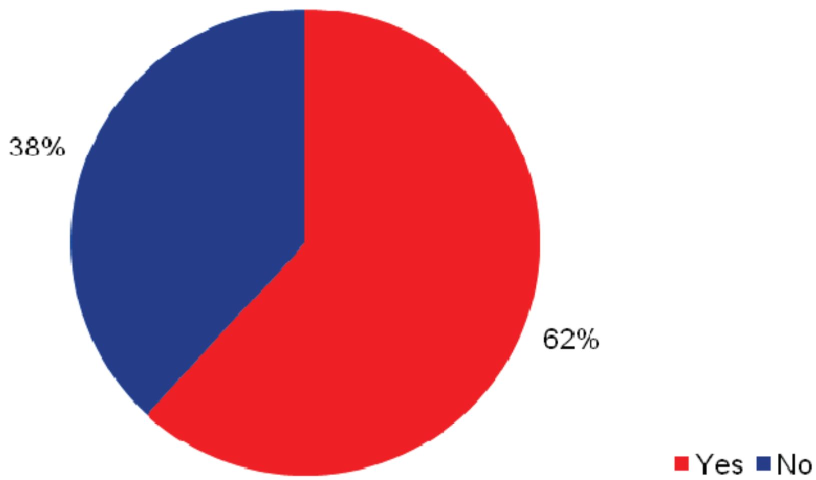
	Standard	97K Tridem	90K Double	148K Double
Tractor	130000	130000	130000	150000
5 years	5	5	5	5
15%	19500	19500	19500	22500
Dep per year	22100	22100	22100	25500
170000	0.13	0.13	0.13	0.15
Trailer	36000	44000	72000	72000
12 years	12	12	12	12
5%	1800	2200	3600	3600
per year dep.	2850	3483.33333	5700	5700
$/mile dep	0.02	0.02	0.03	0.03
Total cost of depreciation $/mile	0.15	0.15	0.16	0.18

DRIVER BASED DIFFERENCES

Driver-based costs are the wages, benefits, and bonuses paid to the driver. A survey done in 2009 found that 62% of LCV drivers in the United States earn more than the standard truck drivers as shown in Figure 4 [4].

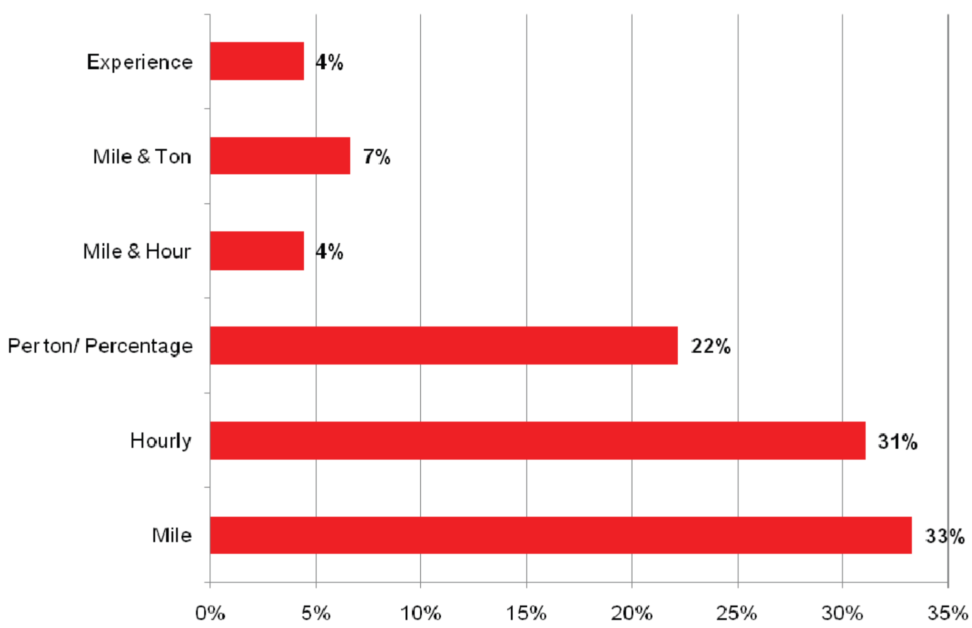
8 It is recognized that this is a high utilization number and will be discussed further in the chapter.

Figure 4: Driver pay



However, it depends on compensation structure of the company. One-third of companies surveyed pay by the mile, another one-third pay by the hour, 22% pay by the tonnage, 4% pay by experience, and the remaining have a combination of the other pay structures. The information is shown in the following graph [4]:

Figure 5: Pay Structure

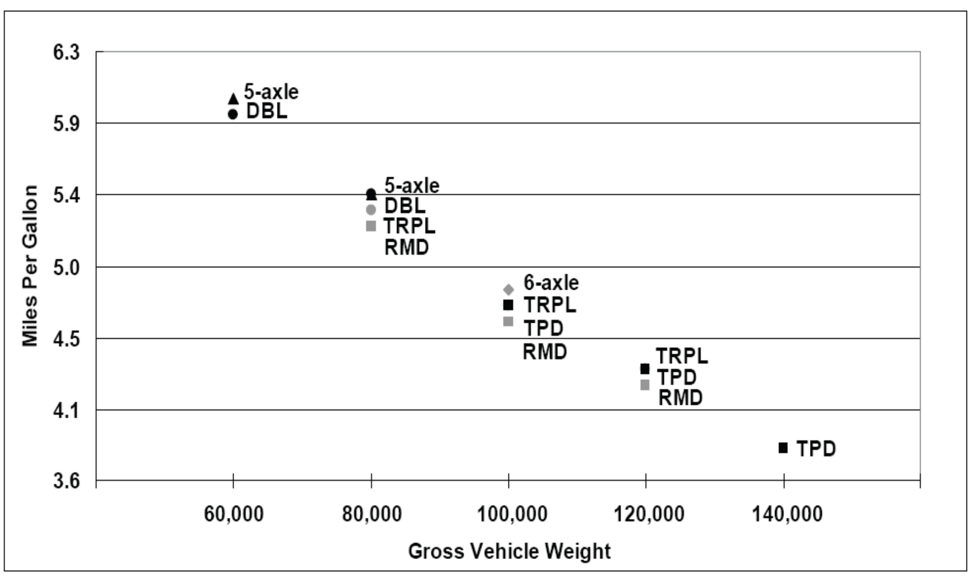


Companies often pay LCV operators more just because they drive a larger, heavier vehicle. For example, of those companies paying by the mile, 73% said that they pay the LCV drivers a premium compared to standard truck drivers. Other LCV operators receive extra payment for the time they have to spend hooking and unhooking the trailers. While the benefits of the drivers would not be more expensive, the bonuses are often based on the percentage of their current wage and would be higher than the standard truck driver. Using information provided by Texas shippers, a base value of $0.57/mile was used for the standard 80K truck. This takes into account wage, benefits and bonuses. Since most companies do pay their LCV drivers more, the assumption was made that Tridem drivers would make 10% more ($0.63/mile), and the Double drivers would make 15% more ($0.66/mile).

FUEL

The most significant vehicle based cost is the fuel cost. The larger, heavier trucks need more engine power to overcome rolling resistance and air resistance; therefore, LCVs have a lower fuel economy than a standard truck. The following shows the basic fuel economy by gross vehicle weight [15]:

Figure 6: Fuel Economy

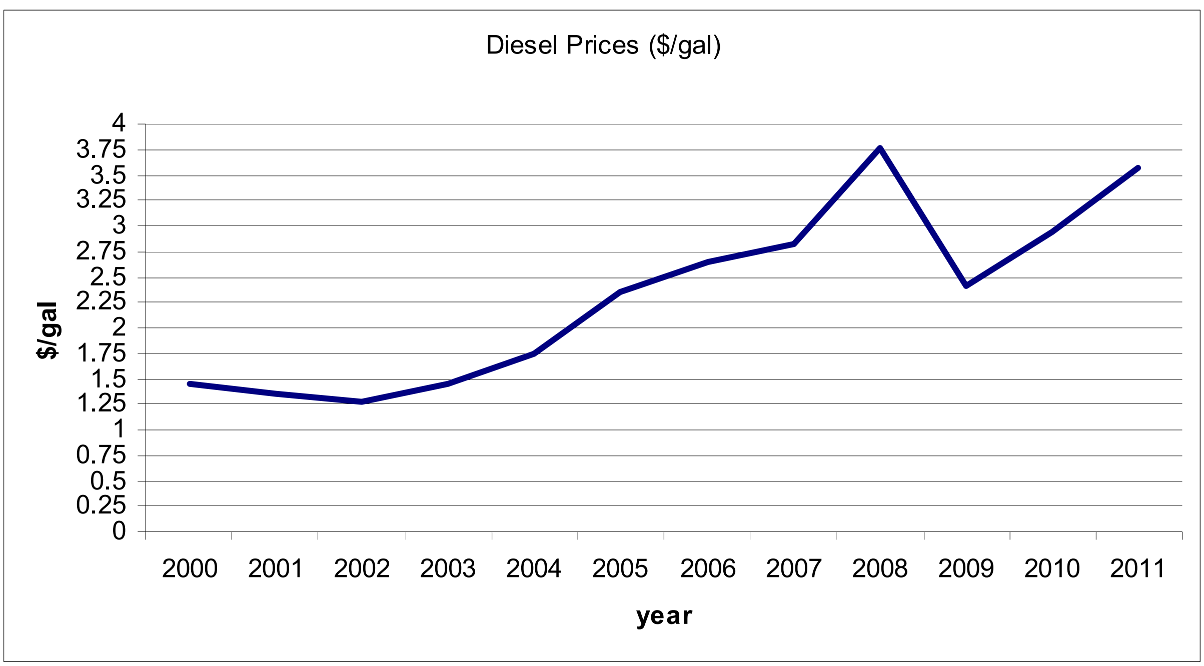


DBL=Double Trailer
TRPL=Triple Trailer
RMD=Rocky Mountain Double
TPD=Turnpike Double

The fully-loaded standard 5-axle truck had a fuel economy of about 5.4 miles per gallon. The 97-kip tridem would have a fuel economy of about 4.8 miles per gallon (about 11% less than the standard), the 148-kip Double 53' would have a fuel economy of about 3.6 miles per gallon (about 33% less than the standard) and the 90-kip Double 53' would have a fuel economy of about 5 miles per gallon (about 7% less than the standard). However, these fuel economy values are not always applicable to every truck. The shippers in Texas often modify their trucks to be more economical; they also restrict speeds to 65 mph to increase their fuel economy. With these changes, fuel economy for the standard 80-kip truck is estimated at 7 mpg, 97-kip tridem is estimated at 6.6 mpg (5.7% lower than the standard), the 90-kip Double at 6.4 mpg (8.5% lower than the standard), and the 148-kip Double at 5 mpg (29% lower than the standard).

The price of fuel has been increasing over the years, and now companies report that it is becoming the greatest operational cost, overtaking driver pay in some companies. Texas is no exception to the increasing price of fuel. The following shows the diesel prices [16]:

Figure 7: Texas Diesel Prices



For this study, the price of diesel fuel in Texas from December 2010, \$3.18/gal, was used. The initial price of fuel was divided by the fuel economy to get a cost/mile fuel operational cost. The following shows the fuel for each vehicle type.

Table 10: Fuel Costs

	Standard	97K Tridem	90K Double	148K Double
Fuel price \$/gal	3.18	3.18	3.18	3.18
Fuel consumption miles/gal	7	6.6	6.4	5
fuel- \$/mile	0.45	0.48	0.50	0.64

OTHER COSTS

The LCV survey also reported that around half (53%) of the companies reported a higher repair and maintenance costs, while 47% said the cost was about the same to maintain as a standard truck. A standard truck maintenance and repair costs are an estimated \$0.57/mile. Using the survey information combined with feedback from Texas companies, the assumption was made that Tridems would cost 10% more to maintain/repair (\$0.28/mile) and the Doubles would cost 15% more to maintain/repair (\$0.29/mile). Logistical costs would remain the same for each vehicle, so an estimated \$0.10/mile was used for the standard truck and the LCV types.

TOTAL COST

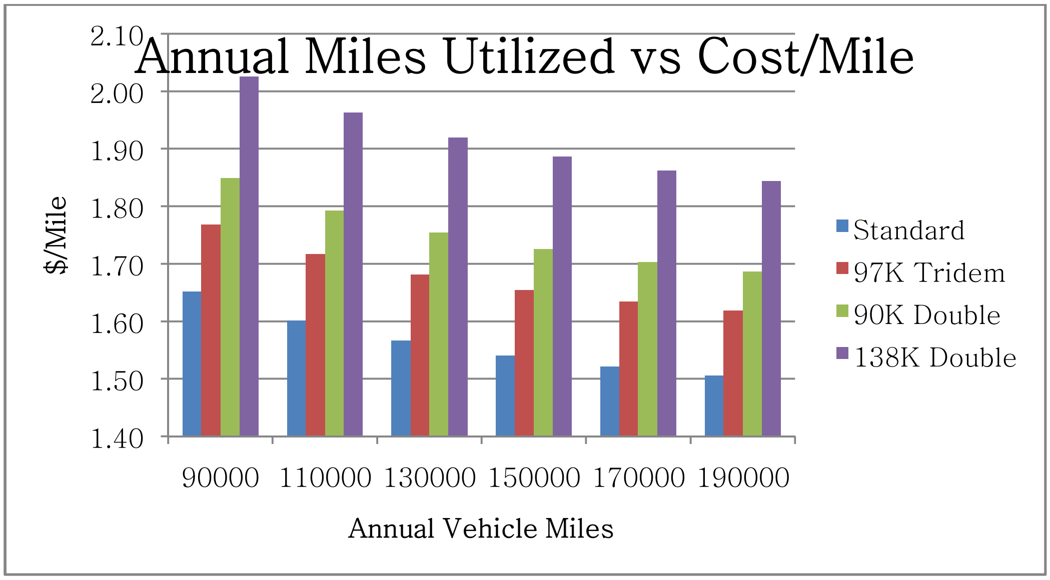
Aggregating the depreciation, driver, maintenance/repair, and logistical costs gives a total cost/mile value for each vehicle. Using the value of 24 tons/trailer and 4,500 cubic feet/trailer, the cost per ton-mile and cost per cubic ft-mile was also found. Each value is found below:

Table 11: Total Truck Costs

	Standard	97K Tridem	90K Double	148K Double
Total cost/mile	1.52	1.63	1.70	1.86
cost/ton/mile	0.063	0.034		0.039
cost/cubeft/mile	-	-	0.0002	-

In total, the 97-kip Tridem is 6.7% more expensive than the standard, the 90-kip Double is 10.5% and the 148-kip Double is 18.2%. As stated above, the number of annual vehicle miles does affect the cost per mile of these vehicles. The following shows the differences when VMT varied:

Figure 8: Variation of Utilization Miles



As expected, the more a vehicle is utilized, the lower the cost/mile of operating. However, the difference between the cost/mile of the LCVs compared to the standard 80-kip truck remained relatively constant; an average of 6.8% for the Tridem, 10.5% for the 90-kip Double and 18.3% for the 148-kip Double. Therefore, the utilization does not affect the results when comparing vehicle types. This study will use 170,000 miles per year to stay consistent with Texas shippers and calculations can be found in Appendix 6, with all calculations provided in Appendix 7. The operational costs shown in this chapter and the scenarios shown in Chapter 3 can be used to evaluate the efficiency of base case and LCV scenario; this evaluation is shown in the next chapter.

CHAPTER 5: EVALUATION OF SCENARIOS

Shipping information for the current truck scenario and a suggested LCV scenario can be calculated using the information gathered for routes and cost data in chapters 4 and 5. The information includes shipping costs, number of truck trips, and total miles travelled. Since the daily truck traffic varies, a minimum, maximum and mean number of trucks per route was used to show the range of possibility. The base case and the LCV scenario will also be compared to show the changes that might occur if certain LCV types were allowed in Texas.

EVALUATION OF NON-LCV TRIPS

The current economic situation of Class 9 vehicles was found. The number of truck trips was multiplied by the number of miles of each trip. This provided the number of miles per day traveled on these routes by class 9 trucks. The number of miles was then multiplied by the operational cost per mile of these trucks. This provided the total dollar amount of shipping costs using the class 9 vehicles, the current practice.

Table 12: Current Truck Scenario

Current Situation			
	Miles/day	Trucks/Day	$/Day
Minimum	3,362,585	11,429	$5,111,129
Maximum	16,873,764	55,633	$25,648,121
Mean	8,055,960	25,648	$12,245,059

The base case has a cost of $5.1 million to $12.2 million a day for shipping costs. The number of trucks vary between 11,000 and 55,600 a day with a range of 3.3 million to 16.9 million miles per day.

EVALUATION OF LCV TRIPS

If the base case movements shown in table 12 were transported as LCVs, it is estimated that the average load size would be greater and the number of trips over the study routes smaller. Therefore, an estimate was developed of the expected equivalent number of movements required to move the same amount of cargo on the same routes, if the LCVs were used instead of the standard semi-trailers. Depending on the LCV type, the equivalency factor will be based either on weight or length. For the shipments that cube out, the 90-kip Double 53' is beneficial based on extra volume; since there is a second trailer with the same cubic volume, the LCV equivalent factor is 2. The amount allowed in a 148-kip Double 53' is also doubled, resulting in an LCV equivalent factor of 2. The Tridem is different since it has a single trailer with an increase in weight capacity. The new weight of the tridem (97 kip) was divided by the standard truck weight of 80 kip to get an LCV equivalent factor of 1.2125.

The number of truck movements per day per route was proportioned to the different truck types using the aforementioned percentages. Once those were calculated, the load equivalency factors were applied to each route. The following table shows the amount of truck movements for the LCV scenario:

Table 13: LCV Scenario

LCV Situation			
	Miles/day	Trucks/Day	$/Day
Minimum	2,315,677	7,871	$3,865,751
Maximum	11,620,283	38,312	$19,398,696
Mean	5,547,816	17,663	$9,261,426

Detailed information by route can be found in Appendix 8.

COMPARISON OF CASES

The difference of the Base Case to the LCV scenario is shown in table 14:

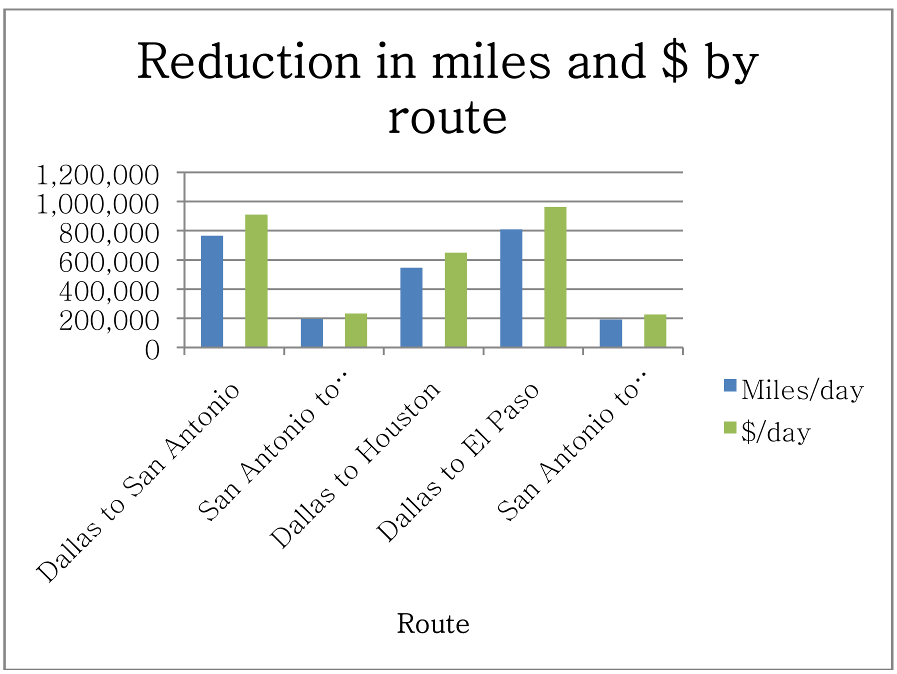
Table 14: Differences in Scenarios

Change			
	Miles/day	Trucks/Day	$/Day
Minimum	-1,046,908	-3,558	-$1,245,379
Maximum	-5,253,481	-17,321	-$6,249,426
Mean	-2,508,144	-7,985	-$2,983,633

On the five designated routes used in this chapter, between $1,245,379 and $6,249,426 could be saved per day by allowing LCVs. For a six day work week, 50 weeks a year scenario, the savings would be between $374 million and $1.9 billion a year on shipping. When compared to the worst scenario of the bridge replacement shown in chapter 1 ($2.8 billion for infrastructure changes) it would only take between two and seven years to break even with costs in terms of increasing productivity. The total number of miles per day was reduced between 1.05 million and 5.25 million, with a yearly reduction of between 314 million to 1.6 billion truck miles travelled. The total number of trucks on these routes reduces as well. Between 3,558 and 17,321 trucks were reduced a day, with a yearly reduction of 1 to 5 million trucks.

The routes that saw the biggest cost reductions were Dallas to El Paso and Dallas to San Antonio. This is because these routes are the longest and have the most truck traffic. The reductions of miles and cost by route are shown below.

Figure 9: Reductions by route



With the results of this analysis known, the next chapter discusses the limitations of the analysis and recommendations for future work.

CHAPTER 6: CONCLUSION

Texas' economy depends on truck freight movements. Other countries that rely on trucks to move their goods allow more productive vehicles. As shown in Chapter 2, these countries vary both politically and physically but all provide examples of how more productive trucks, LCVs, can be used to safely and efficiently transport goods. Although LCVs are not currently allowed in Texas, a 2010 study found that it is feasible to allow certain LCV types on certain Texas routes. These types were a 97-kip Tridem, a 90-kip Double 53' and a 148-kip Double 53'. The routes were on major key corridor systems spanning from the Mexico-US border to Dallas to El Paso. With the infrastructure impacts shown found in that study, the economic impacts were further researched in this paper.

The current truck miles and trips were evaluated using the operational costs of an 80 kip truck. The LCV scenario was created using an LCV conversion factor (since LCV can carry more load) and truck miles, trips, and costs were calculated. The predicted savings to Texas shippers ranges from $374 million to $1.9 billion a year, found by comparing to the two scenarios. This amount of estimated savings from using traditional 80-kip trucks can be used to help policy makers pass regulations regarding efficient cost allocation and pricing methods for LCVs. Since LCVs do consume more infrastructure than standard trucks, they will be charged more than current trucks in Texas are charged. However, the benefit is not just to the shipping companies. It was found that allowing those same vehicle types on the same routes produced a decrease in miles, truck trips, and cost per day. A decrease in the number of vehicle miles travelled and the number of truck trips per day can ultimately decrease congestion on these routes, which are shared with the Texas public. Less trips and miles can also mean a reduction in emissions. Moving freight using a 140,000lb LCV instead of two 80,000 lb standard trucks reduces emissions by an estimated 27% per ton-mile of freight moved. Although a full impact analysis was not done on the external costs, research indicates that LCVs can have a positive impact on the environment. A reduction in emissions is especially important now that more parts of Texas are becoming nonattainment zones.

These results are sensitive to some assumptions made in this study:

- First, this analysis assumes that the amount of cargo does not change. In reality, since shipping by truck seems to get cheaper when introducing LCVs, there may be a shift from other freight modes (such as rail) to trucks. Also, shippers may choose to ship more cargo since the price is reduced and they can carry more per haul. More research is needed to determine what would be the shifts from other modes if there were such changes.
- The second assumption is that the LCV scenario will be the vehicle type split shown in chapter 3. Although this was an educated estimate, the amount of Tridems, Doubles, and Standard vehicles may be different than shown. Further research is needed to determine a more accurate vehicle mix for Texas.
- The third assumption is that the operating costs shown in Chapter 4 are true for every trucking company. Since vehicle types, driver wages, fuel economy, and other economic factors can change from company to company, further research in Texas-specific trucking companies and their operating cost analysis is recommended.

Although this economic analysis is fundamental, it could be used to correctly charge LCVs if they should be allowed in Texas. LCVs need to pay for the amount of infrastructure they consume; however, the economic benefits of using an LCV must outweigh the cost of using one in order for companies to use the more productive vehicles. Trucking and other methods of freight movement are now being recognized in state transportation planning and more data, concerning a variety of areas, are being collected. This new data can be used for further research to address the assumptions above and continue the discussion of allowing LCVs in Texas.

APPENDIX 1: CANADIAN TRUCK DIMENSIONS BY PROVINCE

	MOU	BC	ALTA	SASK	MAN	ONT[12]	ONT[13]	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Overall Height	4.15	*	*	*	*	*	*	*	*	*	*	*	4.2	4.2
Overall Width	2.6	*	*	*	*	*	*	*	*	*	*	*	*	*
Overall Length														
Straight Truck	12.5	*	*	*	*	*	NA	*	*	*	*	*	*	*
Truck & Full Trailer	23	*	*	*	*	*	NA	*	*	*	*	*	*	21
Truck & Pony Trailer	23	*	*	*	*	*	NA	*	*	*	*	*	*	21
Tractor Semitrailer	23	*	*	*	*	*	*	*	*	*	*	*	*	25
A Train Double	25	*	*	*	*	23	*	*	*	*	*	*	*	*
B Train Double	25	*	*	*	*	23	*	*	*	*	*	*	26	*
C Train Double	25	*	*	*	*	23	*	*	*	*	*	*	*	*
Trailer Length														
Full Trailer	12.5	*	*	16.2	*	*	NA	14.65	*	*	*	*	*	NR
Semitrailer	16.2	*	*	*	*	14.65	*	*	*	*	*	*	*	NR
Box Length														
Truck & Full or Pony Trailer	20	*	*	*	*	NR	NA	NR	*	*	*	*	*	NR
A Train Double	18.5	20.0	20.0	20.0	20.0	*	*	*	20.0	20.0	20.0	20.0	*	NR
B Train Double	20	*	*	*	*	18.5	*	*	*	*	*	*	*	NR
C Train Double	20	*	*	*	*	18.5	*	*	*	*	*	*	*	NR
Effective Rear Overhang														
Straight Truck	4	*	*	*	NR	NR	NR	*	*	*	*	*	*	*
Semitrailer	35% of wb	*	*	*	*	NR	*	*	*	*	*	*	*	*
Wheelbase														
Tractor (min)	3	*	*	*	*	NR	*	*	*	*	*	*	*	*
Tractor (max)	6.2	*	*	*	*	NR	*	*	*	*	*	*	NR	*
Full Trailer (min)	6.25	*	*	*	*	NR	NA	NR	*	*	*	*	*	NR
Semitrailer (max)	12.5	*	*	*	*	NR	*	*	*	*	*	*	*	NR
Semitrailer (min)	6.25	*	*	*	*	NR	NR	NR	*	*	*	*	*	NR

Legend: * = Same as MOU NR = Not regulated NA = Not Applicable
Task Force on Vehicle Weights and Dimensions Policy, Council of Ministers Responsible for Transportation and Highway Safety.

Gross Vehicle Weight	MOU	BC	ALTA	SASK	MAN	ONT[14]	ONT[15]	QUE	NB	NS	PEI	NFLD	Yukon	NWT
Truck - 3 axles	24,250	26,000	24,300	*	24,300	28,100	NA	25,300	26,000	26,000	26,000	26,000	26,000	*
Tractor Semitrailer														
- 3 axles	23,700	*	*	*	*	26,300	26,300	*	*	*	*	*	25,500	*
- 4 axles	31,600	32,800	*	*	*	35,800	34,800	*	32,600	32,600	32,600	32,600	34,600	*
- 5 axles	39,500	*	*	*	*	44,100	43,100	41,500	41,500	41,500	41,500	41,500	43,700	*
- 6 axles	46,500	*	*	*	*	50,500	49,500	49,500	49,500	49,500	49,500	49,500	48,600	*
A Train														
- 5 axles	41,900	38,000	*	*	*	45,500	*	*	41,900	41,900	41,900	41,900	45,500	37,500
- 6 axles	49,800	*	*	*	*	54,500	*	*	50,800	50,800	50,800	50,800	53,500	*
- 7 axles	53,500	*	*	*	*	61,700	*	*	*	*	*	*	*	*
- 8 axles	53,500	*	*	*	*	63,500	*	*	*	*	*	*	*	*
B Train														
- 6 axles	48,600	*	*	*	*	54,500	NA	*	50,600	50,600	50,600	50,600	53,700	*
- 7 axles	56,500	*	*	*	*	61,700	60,300	59,000	59,500	59,500	59,500	59,500	62,800	*
- 8 axles	62,500	63,500	63,500	*	*	63,500	63,500	*	*	*	*	*	63,500	*
C Train														
- 5 axles	41,900	*	*	*	*	45,500	*	*	*	*	*	*	45,500	40,700
- 6 axles	49,800	*	*	*	*	54,500	*	*	50,800	50,800	50,800	50,800	54,600	43,500
- 7 axles	54,600	*	57,700	*	*	61,700	*	55,500	55,600	55,600	55,600	55,600	60,500	57,200
- 8 axles	58,500	60,500	60,500	60,500	60,500	63,500	*	*	*	*	*	*	60,500	*
Truck & Pony Trailer														
- 6 axles	45,250	47,000	45,300	*	45,300	56,000	NA	49,500	47,000	47,000	47,000	47,000	50,400	46,500
Truck & Full Trailer														
- 5 axles	41,250	43,000	42,500	40,700	41,300	47,500	NA	43,500	43,000	43,000	43,000	43,000	45,500	40,700
- 7 axles	53,500	57,000	55,300	*	55,300	63,300	NA	55,500	*	*	*	*	57,400	*
Axle loads														
Steering Axle – Tractors	5,500	*	*	*	*	9,000	6,000	*	*	*	*	*	*	7,300
Steering Axle – Trucks	7,250	9,100	7,300	*	*	9,000	NA	*	8,000	8,000	8,000	8,000	7,300	7,300
Single Axle - dual tires	9,100	*	*	*	*	10,000	10,000	10,000	*	*	*	*	10,000	*
Tandem - 1.2 m spread	17,000	*	*	*	*	18,000	18,000	18,000	18,000	18,000	18,000	18,000	17,900	*
Tandem - 1.8 m spread	17,000	*	*	*	*	19,100	19,100	18,000	18,000	18,000	18,000	18,000	19,100	*
Tridem - 2.4 m spread	21,000	24,000	*	*	*	21,300	21,300	*	*	*	*	*	24,000	*
Tridem - 3.0 m spread	23,000	24,000	24,000	*	*	*	*	24,000	24,000	24,000	24,000	24,000	24,000	*
Tridem - 3.7 m spread	24,000	*	*	*	*	25,500	25,500	26,000	26,000	26,000	26,000	26,000	*	*

Legend: * = Same as MOU NR = Not regulated NA = Not applicable
Task Force on Vehicle Weights and Dimensions Policy, Council of Ministers Responsible for Transportation and Highway Safety.

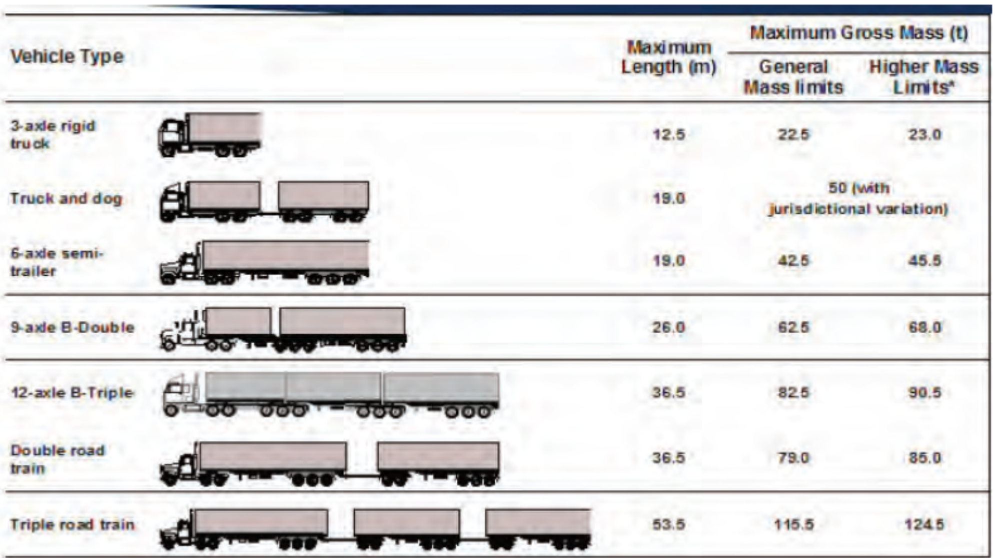
APPENDIX 2: PERMISSIBLE MAXIMUM WEIGHTS AND DIMENSIONS IN EUROPE

PERMISSIBLE MAXIMUM WEIGHTS IN EUROPE (in tonnes)							
Country	Weight per bearing axle	Weight per drive axle	Lorry 2 axles	Lorry 3 axles	Road Train 4 axles	Road Train 5 axles and +	Articulated Vehicle 5 axles and +
Albania	10		18	25	40	44	38
Austria	10	11.5	18	26	36	40	40
Azerbaijan	10				37	37	37
Belarus	10		18	25 (1)	36	38	38
Belgium	10	12	19	26	39	44	44 (2)
Bosnia-Herzegovina	10		20	26	40	40	40
Bulgaria	10	11.5	18	26 (1)	36	40	40
Croatia	10	11.5	18	26 (1)	36	40	40
Czech Republic	10	11.5	18	26 (1)	36	44 (1)	42 / 48
Denmark	10	11.5 (5)	18	26 (1) (5)	38	42 / 48	42 / 48
Estonia	10	11.5	18	26 (1)	36	40	40
Finland (3)	10	11.5	18	26 (1)	36	44	42 / 48
France	13	13	19	26	38	40	40
FYR Macedonia	10		16	22	36	40	40
Georgia	10	11.5			44	44	44
Germany	10	11.5	18	26 (1)	36	40	40
Greece	10	11.5	18	26 (1)	36	40	40
Hungary	10	11	20	24	36	40	40
Ireland	10	10.5	17	26 (1)	35	40	40
Iceland	10	11.5	18	26 (1)	37	40	44
Italy (4)	12	12	18	26 (1)	40	44	44
Latvia	10	11.5	18	26 (1)	40	40	40
Liechtenstein	10	11.5	18	26	36	40	40
Lithuania	10	11.5	18	26 (1)	36	40	40
Luxembourg	10	12	19	26	44	44	44
Malta	10.8	11.5	18	25	36	40	40
Moldova	10		18	24	36	40	40
Netherlands	10	11.5	21.5	33	40	50	50
Norway	10	11.5	19	26	37	46	44
Poland	10	11.5	18	26 (1)	36	40	40
Portugal (4)	10	12	19	26	37	40	40
Romania	10	11.5	18	26 (1)	36	40	40
Russia	10 (6)	10 (6)	18	25	36	38/44 (7)	38/40 (7)
Serbia	10		18	24	36	40	40
Slovakia	10	11.5	18	26 (1)	40	40	40
Slovenia	10	11.5	18	25		40	40
Spain (4)	10	11.5	18	26 (1)	36	40	40
Sweden	10	11.5	18	26 (1)	38	48/60 (10)	48/60 (10)
Switzerland	10	11.5	18	26 (1)	36	40	40
Turkey	10	11.5	18	25/26 (8)	36	40	40/44 (9)
Ukraine	10				38	38	38
United Kingdom	10	11.5	18	26 (1)	36	40	40 / 44

PERMISSIBLE MAXIMUM DIMENSIONS IN EUROPE					
COUNTRY	HEIGHT	WIDTH	LENGTH		
			Lorry or Trailer	Road Train	Articulated Vehicle
Albania	4 m	2.50 m	12 m	18.35m	16.50 m
Austria	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Azerbaijan	4 m	2.50m	12 m	20 m	
Belarus	4 m	2.55 m	12 m	20 m	20 m
Belgium	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Bosnia-Herzegovina	4 m	2.50m	12 m	18 m	17 m
Bulgaria	4 m	2.55 m	12 m	18.75 m	16.50 m
Croatia	4 m	2.55 m (3)	12 m	18.35 m	16.50 m
Czech Republic	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Denmark	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Estonia	4 m	2.55 m	12 m	18.75 m	16.50 m
Finland (1)	4.20 m	2.60 m	12 m	25.25 m	16.50 m
France	not defined	2.55 m (3)	12 m	18.75 m	16.50 m
FYR Macedonia	4 m	2.50m	12 m	18 m	16.50 m
Georgia	4 m	2.50 m	20 m		20 m
Germany	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Greece	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Hungary	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Iceland	4.20 m	2.55 m	12 m	22 m	18 m
Ireland	4.25 m	2.50 m (3)	12 m	18.35 m	16.50 m
Italy (2)	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Latvia	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Liechtenstein	4 m	2.55 m	12 m	18.75 m	16.50 m
Lithuania	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Luxembourg	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Malta	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Moldova	4 m	2.50 m	12 m	20 m	16.50 m
Netherlands	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Norway	not defined	2.55 m (3)	12 m	19.50 m	17.50 m
Poland	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Portugal (2)	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Romania	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Russia	4 m	2.55 m (3)	12 m	20 m	20 m
Serbia	4 m	2.50 m	12 m	18 m	16.50 m
Slovakia	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Slovenia	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Spain	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Sweden	not defined	2.60 m	24 m	24 m	25.25 m
Switzerland	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Turkey	4 m	2.55 m (3)	12 m	18.75 m	16.50 m
Ukraine	4 m	2.65 m	12 m	22 m	22 m
United Kingdom	not defined	2.55 m (3)	12 m	18.75 m	16.50 m

1. For vehicles registered in an EEA member country
2. Increased values are applicable for certain types of transport (i.e. containers, motorcars, etc.)
3. refrigerated vehicles = 2.60 m

APPENDIX 3: AUSTALIRIAN REGULATIONS



Vehicle Type	Maximum Length (m)	Maximum Gross Mass (t)	
		General Mass limits	Higher Mass Limits*
3-axle rigid truck	12.5	22.5	23.0
Truck and dog	19.0	50 (with jurisdictional variation)	
6-axle semi-trailer	19.0	42.5	45.5
9-axle B-Double	26.0	62.5	68.0
12-axle B-Triple	36.5	82.5	90.5
Double road train	36.5	79.0	85.0
Triple road train	53.5	115.5	124.5

Source: Moore, 2007

Figure B1: Allowable truck sizes

Table B1: Equivalencies Length (Approximate)

Meters	12.5	19	26	36.5	53.5
Feet	41	62	85	120	175.5

APPENDIX 4: TRACTOR AND TRAILER DEPRECIATION

Basic Depreciation Calculator

This calculator can be used to perform depreciation calculations for different depreciation methods without the use of half-year, mid-quarter, or mid-month conventions. Do not use this calculator for tax reporting.

HELP: Basic Depreciation

Asset Depreciation Information			
Asset Description			
Category			
Purchase Price (P)	150,000		
Salvage Value (Sn)	22,500		
Depreciation Period (n)	5		
Depreciation Method	SYOD	DB Factor	200%

Depreciation Schedule

Year	Depreciation	Cumulative	Book Value	
1	42,500.00	42,500.00	107,500.00	87,500.00
2	34,000.00	76,500.00	73,500.00	
3	25,500.00	102,000.00	48,000.00	
4	17,000.00	119,000.00	31,000.00	
5	8,500.00	127,500.00	22,500.00	
-	-	-	-	

Basic Depreciation Calculator

This calculator can be used to perform depreciation calculations for different depreciation methods without the use of half-year, mid-quarter, or mid-month conventions. Do not use this calculator for tax reporting.

HELP: Basic Depreciation

Asset Depreciation Information			
Asset Description			
Category			
Purchase Price (P)	130,000		
Salvage Value (Sn)	19,500		
Depreciation Period (n)	5		
Depreciation Method	SYOD	DB Factor	200%

Depreciation Schedule

Year	Depreciation	Cumulative	Book Value	
1	36,833.33	36,833.33	93,166.67	93,166.67
2	29,466.67	66,300.00	63,700.00	
3	22,100.00	88,400.00	41,600.00	
4	14,733.33	103,133.33	26,866.67	
5	7,366.67	110,500.00	19,500.00	
-	-	-	-	
-	-	-	-	

Basic Depreciation Calculator

This calculator can be used to perform depreciation calculations for different depreciation methods without the use of half-year, mid-quarter, or mid-month conventions. Do not use this calculator for tax reporting.

HELP: Basic Depreciation

Asset Depreciation Information			
Asset Description			
Category			
Purchase Price (P)	36,000		
Salvage Value (Sn)	1,800		
Depreciation Period (n)	12		
Depreciation Method	SYOD	DB Factor	200%

Depreciation Schedule

Year	Depreciation	Cumulative	Book Value
1	5,261.54	5,261.54	30,738.46
2	4,823.08	10,084.62	25,915.38
3	4,384.62	14,469.23	21,530.77
4	3,946.15	18,415.38	17,584.62
5	3,507.69	21,923.08	14,076.92
6	3,069.23	24,992.31	11,007.69
7	2,630.77	27,623.08	8,376.92
8	2,192.31	29,815.38	6,184.62
9	1,753.85	31,569.23	4,430.77
10	1,315.38	32,884.62	3,115.38
11	876.92	33,761.54	2,238.46
12	438.46	34,200.00	1,800.00
-	-	-	-

Basic Depreciation Calculator

This calculator can be used to perform depreciation calculations for different depreciation methods without the use of half-year, mid-quarter, or mid-month conventions. Do not use this calculator for tax reporting.

HELP: Basic Depreciation

Asset Depreciation Information			
Asset Description			
Category			
Purchase Price (P)	72,000		
Salvage Value (Sn)	3,600		
Depreciation Period (n)	12		
Depreciation Method	SYOD	DB Factor	200%

Depreciation Schedule

Year	Depreciation	Cumulative	Book Value
1	10,523.08	10,523.08	61,476.92
2	9,646.15	20,169.23	51,830.77
3	8,769.23	28,938.46	43,061.54
4	7,892.31	36,830.77	35,169.23
5	7,015.38	43,846.15	28,153.85
6	6,138.46	49,984.62	22,015.38
7	5,261.54	55,246.15	16,753.85
8	4,384.62	59,630.77	12,369.23
9	3,507.69	63,138.46	8,861.54
10	2,630.77	65,769.23	6,230.77
11	1,753.85	67,523.08	4,476.92
12	876.92	68,400.00	3,600.00
-	-	-	-

Basic Depreciation Calculator

This calculator can be used to perform depreciation calculations for different depreciation methods without the use of half-year, mid-quarter, or mid-month conventions. Do not use this calculator for tax reporting.

HELP: Basic Depreciation

Asset Depreciation Information			
Asset Description			
Category			
Purchase Price (P)	44,000		
Salvage Value (Sn)	2,200		
Depreciation Period (n)	12		
Depreciation Method	SYOD	DB Factor	200%

Depreciation Schedule

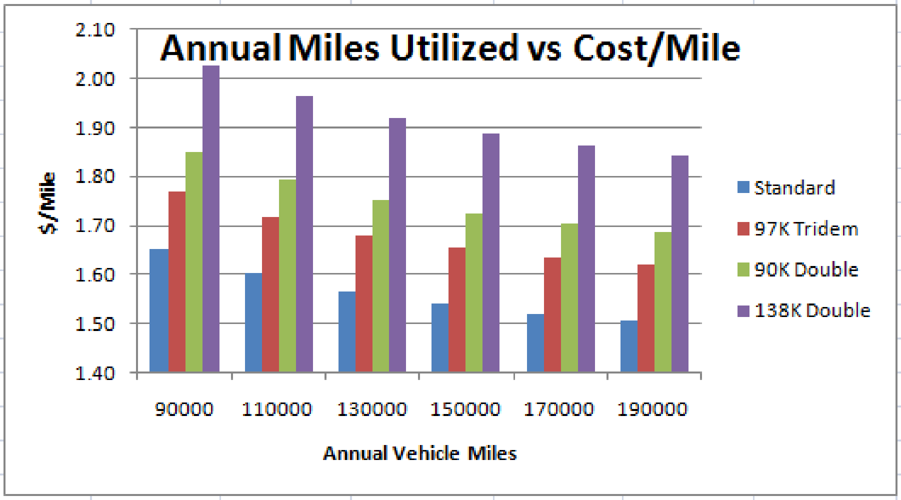
Year	Depreciation	Cumulative	Book Value
1	6,430.77	6,430.77	37,569.23
2	5,894.87	12,325.64	31,674.36
3	5,358.97	17,684.62	26,315.38
4	4,823.08	22,507.69	21,492.31
5	4,287.18	26,794.87	17,205.13
6	3,751.28	30,546.15	13,453.85
7	3,215.38	33,761.54	10,238.46
8	2,679.49	36,441.03	7,558.97
9	2,143.59	38,584.62	5,415.38
10	1,607.69	40,192.31	3,807.69
11	1,071.79	41,264.10	2,735.90
12	535.90	41,800.00	2,200.00
-	-	-	-

APPENDIX 5: FULL DEPRECIATION CALCULATIONS

		Standard	97K Tridem	90K Double	148K Double		
Deprecitation	Tractor	130000	130000	130000	150000	purchase price	
	5 years	5	5	5	5	utilization	
	15%	19500	19500	19500	22500	salvage value	
	1	36833.33333	36833.33333	36833.33333	42500		
		0.216666667	0.216666667	0.216666667	0.25		
	2	29466.66667	29466.66667	29466.66667	34000		
		0.173333333	0.173333333	0.173333333	0.2		
	3	22100	22100	22100	25500		
		0.13	0.13	0.13	0.15		
	4	14733.33333	14733.33333	14733.33333	17000		
		0.086666667	0.086666667	0.086666667	0.1		
	5	7366.666667	7366.666667	7366.666667	8500		
		0.043333333	0.043333333	0.043333333	0.05		
	Average $/year	0.130	0.130	0.130	0.150		
	Trailer	36000	4400	72000	72000	purchase price	
	12 years	12	12	12	12	utilization	
	5%	1800	220	3600	3600	salvage value	
	1	5261.538462	6,430.77	10523.07692	10523.07692		
		0.030950226	0.037828054	0.061900452	0.061900452		
	2	4823.076923	5,894.87	9646.153846	9646.153846		
		0.028371041	0.034675716	0.056742081	0.056742081		
	3	4384.62	5,358.97	8769.230769	8769.230769		
		0.03	0.03	0.05	0.05		
	4	3946.15	4,823.08	7892.31	7892.31		
		0.02	0.03	0.05	0.05		
	5	3507.69	4,287.18	7015.38	7015.38		
		0.02	0.03	0.04	0.04		
	6	3069.23	3,751.28	6138.46	6138.46		
		0.02	0.02	0.04	0.04		
	7	2630.77	3,215.38	5261.54	5261.54		
		0.02	0.02	0.03	0.03		
	8	2192.31	2,679.49	4384.62	4384.62		
		0.01	0.02	0.03	0.03		
	9	1753.85	2,143.59	3507.69	3507.69		
		0.01	0.01	0.02	0.02		
	10	1315.38	1,607.69	2630.77	2630.77		
		0.01	0.01	0.02	0.02		
	11	876.92	1,071.79	1753.85	1753.85		
		0.01	0.01	0.01	0.01		
	12	438.4615385	535.8974359	876.9230769	876.9230769		
		0.002579186	0.003152338	0.005158371	0.005158371		
	Average $/mile	0.0168	0.0205	0.0335	0.0335		
	Total cost of depreciation $/mile	0.147	0.150	0.164	0.184		

APPENDIX 6: UTILIZATION CALCULATIONS

	Standard	97K Tridem	90K Double	138K Double	97K Tridem	90K Double	138K Double
	($/Mile)				(Difference from Standard)		
90000	1.65	1.77	1.85	2.03	6.59	10.67	18.47
110000	1.60	1.72	1.79	1.96	6.72	10.68	18.42
130000	1.57	1.68	1.75	1.92	6.81	10.69	18.38
150000	1.54	1.65	1.73	1.89	6.88	10.70	18.36
170000	1.52	1.63	1.70	1.86	6.93	10.71	18.33
190000	1.51	1.62	1.69	1.84	6.97	10.71	18.32
				Average:	6.82	10.69	18.38



APPENDIX 7: FULL COST CALCULATIONS

		Standard	97K Tridem	90K Double	148K Double		
Deprecitation	Tractor	130000	130000	130000	150000	purchase price	
	5 years	5	5	5	5	utilization	
	15%	19500	19500	19500	22500	salvage value	
	Dep per year	22100	22100	22100	25500		
	170000	0.13	0.13	0.13	0.15	$/year	
	Trailer	36000	44000	72000	72000	purchase price	
	12 years	12	12	12	12	utilization	
	5%	1800	2200	3600	3600	salvage value	
	per year dep.	2850	3483.33333	5700	5700		
	$/mile dep	0.02	0.02	0.03	0.03		
	Total cost of depreciation $/mile	0.15	0.15	0.16	0.18		
Fuel	Fuel price $/gal	3.18	3.18	3.18	3.18		
	Fuel consumption miles/gal	7	6.6	6.4	5		
	fuel- $/mile	0.45	0.48	0.50	0.64		
Driver	Driver $/hr						
	Driver $/mile	0.57	0.63	0.66	0.66		
Maintenance and repair		0.25	0.28	0.29	0.29		
Logistical		0.1	0.1	0.1	0.1		
Total cost/mile		1.52	1.63	1.70	1.86		
cost/ton/mile		0.063	0.034		0.039		
cost/cubeft/mile		-	-	0.0002	-		

APPENDIX 8: FULL LCV SCENARIO CALCULATIONS BY ROUTE

Dallas to San Antonio							292	1.52
	Trucks/day	Observed	97k	90k	148k	Current Miles/Day and $/day		
Minimum	3738	560.7	1308.3	747.6	1121.4		1091496	$1,659,074
Maximum	14110	2116.5	4938.5	2822	4233		4120120	$6,262,582
Mean	8,418	1262.7	2946.3	1683.6	2525.4		2458056	$3,736,245
Trucks/Day								
	Observed	97k	90k	148k	Total			
Equivalent Factors	1	1.2125	2	2				
Minimum	561	1079	374	561	2574			
Maximum	2117	4073	1411	2117	9717			
Mean	1263	2430	842	1263	5797			
Miles/Day								
	Observed	97k	90k	148k	Total			
Minimum	163724	315071	109150	163724	751,669			
Maximum	618018	1189313	412012	618018	2,837,361			
Mean	368708	709542	245806	368708	1,692,764			
$/Day								
	Observed	97k	90k	148k	Total			
	$1.52	$1.63	$1.70	$1.86				
Minimum	$249,033	$514,923	$185,926	$304,942	$1,254,824			
Maximum	$940,037	$1,943,704	$701,823	$1,151,077	$4,736,640			
Mean	$560,824	$1,159,610	$418,706	$686,730	$2,825,871			
Reduction								
	Miles/day	Trucks/day	$/day					
Minimum	339,827	1164	$404,250					
Maximum	1,282,759	4393	$1,525,942					
Mean	765,292	2621	$910,374					

an Antonio to Laredo							154	1.52
	Trucks/day	Observed	97k	90k	148k	Current Miles/Day and $/day		
Minimum	1,830	274.5	640.5	366	549		281820	$428,366
Maximum	11,795	1769.25	4128.25	2359	3538.5		1816430	$2,760,974
Mean	4,086	612.9	1430.1	817.2	1225.8		629244	$956,451
Trucks/Day								
	Observed	97k	90k	148k	Total			
Equivalent Factors	1	1.2125	2	2				
Minimum	275	528	183	275	1260			
Maximum	1769	3405	1180	1769	8123			
Mean	613	1179	409	613	2814			
Miles/Day								
	Observed	97k	90k	148k	Total			
Minimum	42273	81350	28182	42273	194,078			
Maximum	272465	524330	181643	272465	1,250,902			
Mean	94387	181637	62924	94387	433,335			
$/Day								
	Observed	97k	90k	148k	Total			
	$1.52	$1.63	$1.70	$1.86				
Minimum	$64,299	$132,951	$48,005	$78,735	$323,991			
Maximum	$414,432	$856,917	$309,411	$507,473	$2,088,234			
Mean	$143,567	$296,852	$107,186	$175,798	$723,402			
Reduction								
	Miles/day	Trucks/day	$/day					
Minimum	87,742	570	$104,376					
Maximum	565,528	3672	$672,739					

Dallas to Houston						261	1.52
	Trucks/day	Observed	97K Tridem	90K Double	148k	Current Miles/Day	$/day
Minimum	4,491	673.65	1571.85	898.2	1347.3	1,172,151	$1,781,669.52
Maximum	13,587	2038.05	4755.45	2717.4	4076.1	3,546,207	$5,390,234.64
Mean	6,726	1008.9	2354.1	1345.2	2017.8	1,755,486	$2,668,338.72
Trucks/Day							
	Observed	97K Tridem	90K Double	148k	Total		
:quivalent Factors	1	1.2125	2	2			
Minimum	674	1296	449	674	3093		
Maximum	2038	3922	1359	2038	9357		
Mean	1009	1942	673	1009	4632		
Miles/Day							
	Observed	97K Tridem	90K Double	148k	Total		
Minimum	175823	338353	117215	175823	807,213		
Maximum	531931	1023647	354621	531931	2,442,130		
Mean	263323	506738	175549	263323	1,208,933		
$/Day							
	Observed	97K Tridem	90K Double	148k	Total		
	$1.52	$1.63	$1.70	$1.86			
Minimum	$267,435	$552,973	$199,665	$327,475	$1,347,548		
Maximum	$809,094	$1,672,955	$604,062	$990,737	$4,076,849		
Mean	$400,527	$828,167	$299,030	$490,447	$2,018,171		
Reduction							
	Miles/day	Trucks/day	$/day				
Minimum	364,938	1398	$434,122				
Maximum	1,104,077	4230	$1,313,386				
Mean	546,553	2094	$650,168				

Dallas to El Paso							667	1.52
	Trucks/day	Observed	97k	90k	148k	Current Miles/Day and $/day		
Minimum	1,142	171	400	228	343		761714	$1,157,805
Maximum	8,181	1227	2863	1636	2454		5456727	$8,294,225
Mean	3,900	585	1365	780	1170		2601300	$3,953,976
Trucks/Day								
	Observed	97k	90k	148k	Total			
quivalent Factors	1	1.2125	2	2				
Minimum	171	330	114	171	786			
Maximum	1227	2362	818	1227	5634			
Mean	585	1126	390	585	2686			
Miles/Day								
	Observed	97k	90k	148k	Total			
Minimum	114257	219876	76171	114257	524,562			
Maximum	818509	1575138	545673	818509	3,757,828			
Mean	390195	750891	260130	390195	1,791,411			
$/Day								
	Observed	97k	90k	148k	Total			
	$1.52	$1.63	$1.70	$1.86				
Minimum	$173,791	$359,346	$129,751	$212,807	$875,694			
Maximum	$1,244,994	$2,574,261	$929,501	$1,524,497	$6,273,253			
Mean	$593,506	$1,227,187	$443,107	$726,750	$2,990,550			
Reduction								
	Miles/day	Trucks/day	$/day					
Minimum	237,152	356	$282,111					
Maximum	1,698,899	2547	$2,020,972					
Mean	809,889	1214	$963,426					

an Antonio to McAllen							243	1.52
	Trucks/day	Observed	97K Tridem	90K Double	148k	Current	miles/day	$/day
Minimum	228	34	80	46	68		55404	$84,214
Maximum	7,960	1194	2786	1592	2388		1,934,280	$2,940,106
Mean	2,518	378	881	504	755		611,874	$930,048
Trucks/Day								
	Observed	97K Tridem	90K Double	148k	Total			
Equivalent Factors	1	1.2125	2	2				
Minimum	34	66	23	34	157			
Maximum	1194	2298	796	1194	5482			
Mean	378	727	252	378	1734			
Miles/Day								
	Observed	97K Tridem	90K Double	148k	Total			
Minimum	8311	15993	5540	8311	38,155			
Maximum	290142	558349	193428	290142	1,332,061			
Mean	91781	176623	61187	91781	421,373			
$/Day								
	Observed	97K Tridem	90K Double	148k	Total			
	$1.52	$1.63	$1.70	$1.86				
Minimum	$12,641	$26,137	$9,438	$15,479	$63,694			
Maximum	$441,321	$912,514	$329,486	$540,398	$2,223,719			
Mean	$139,604	$288,657	$104,227	$170,945	$703,433			
Reduction								
	Miles/day	Trucks/day	$/day					
Minimum	17,249	71	$20,520					
Maximum	602,219	2478	$716,387					
Mean	190,501	784	$226,616					

REFERENCES

[1] BTS. 2009. America's Freight Transportation Gateway 2009.

[2] Transportation Research Board. 2002. Special Report 267: Regulation of Weights, Lengths, and Widths of Commercial Motor Vehicles. Washington, D.C.

[3] FHWA. President Ronald Reagan and the Surface Transportation Assistance Act of 1982.

[4] Walton, C.M. et al. 2009. Potential Use of Longer Combination Vehicles in Texas: First year report. Austin, TX.

[5] Walton, C.M. et all. 2010. Potential Use of Longer Combination Vehicles in Texas: Second year Report. Austin, TX.

[6] The Canadian Chamber of Commerce. 2009. Find the Balance: Shared Border of the Future.

[7] U.S. Department of Transportation. Research and Innovative Technology Administration. Bureau of Transportation Statistics. 2006. North American Freight Transportation, Washington, DC.

[8] Woodrooffe and Associations. 2001. Economic Efficiency of Long Combination Transport Vehicles in Alberta, Canada.

[9] Truck News. 2005. Ontario LCV program a 'pilot' no more.

[10] Knight, I. 2009. Assessing the likely effects of potential changes to European heavy vehicle weight and dimensions regulations.

[11] Griet De Ceuster, 2006. Effects of adapting the rules on weights and dimensions of heavy commercial vehicles as established within Directive 96/53/EC.

[12] No Mega Trucks. 2009. http://www.nomegatrucks.eu/

[13] Beatriz Rutzen, 2010. Responses of Trucking Operations to Road Pricing in Central Texas. Austin, TX.

[14] Vertex 42. 2011. http://www.vertex42.com/Calculators/depreciation-calculator.html62

[15] American Transportation Research Institute. 2008. Energy and Emissions Impacts of Operating higher Productivity Vehicles Updated.

[16] Gas Buddy. 2011.< www.Texasgasprices.com>

[17] NAFTA Land Transportation Committee. 1997. Harmonization of Vehicle Weight and Dimension Regulations Within the NAFTA Partnership.