1.0 Commerce Effects

Heavier truck weight limits allow motor carriers to move freight at lower-ton-mile costs due to the economies of scale provided by the additional truck capacity. Motor carriers benefit from higher truck size and weight limits on the Interstate highways because each truck carries slightly more freight per load, reducing the total number of trips and reducing operating costs for fuel, vehicle maintenance, and labor. In addition, because speeds are higher on the Interstate system, motor carriers can complete more trips in one day with less equipment, further increasing efficiency and savings. More consistent Interstate speeds also reduce carrier costs through improved vehicle fuel efficiency and reduced wear and tear on equipment.

Shippers might also benefit from lower freight rates charged by motor carriers. Some of the transport cost savings could benefit individual and industrial consumers as carriers and shippers pass along savings. In the State of Vermont, the truck pilot in 2010 provided an opportunity to test these positive expectations for Vermont's businesses.

One potential impact of higher Interstate weight limits is the unintended modal shift of freight tonnage from rail to trucks. In some circumstances, especially on short line railroads moving short haul (<500 miles) traffic, heavy trucks compete with rail, especially heavy and non-time-sensitive commodities like many of those shipped in Vermont. In cases where higher truck size and weight limits allow trucks to capture rail traffic, the additional road user fees collected from those trucks capturing the traffic may not cover the additional highway construction and maintenance costs caused by those trucks.

Several factors complicate the analysis of pilot's effects on commerce, including the short duration of the pilot, the lack of information on origins and destinations of freight moving in study vehicles over Vermont's Interstate system, and how much of the utilization of pilot vehicles during the pilot period was due to the pilot and how much was due to changes in economic activity during the period. Each of these limitations is discussed in turn.

- <u>Short duration of the pilot.</u> The one year duration of the study accommodated only short term operational changes which are not large enough to affect a state economy, even for a state as small as Vermont.
- <u>Lack of origin/destination information.</u> The Interstate system over which the pilot took place provided increased opportunities for Vermont businesses to improve their competitive position in interstate markets, particularly in neighboring states with extensive networks with higher weight limits. The pilot also allowed through traffic, traversing Vermont from origin to destination, to operate at increased weights and/or to divert from neighboring states where Vermont allowed more direct

and/or all Interstate travel. The study cannot distinguish between traffic that would have traveled on Vermont roads whether the pilot took place or not and that which would not have.

- Differentiating between effects of the pilot and those of changes in economic activity in general. In analyzing effects of the pilot on the various impact areas, it was necessary to estimate what the effects of truck traffic would have been on the impacts areas in the absence of the pilot. This is accomplished with the "control" case, estimated from Vermont truck travel during the years 2006 through 2009. In assessing the impacts of the pilot, the study is unable to determine how Vermont's economic activity in 2010 differed from the 2006 through 2009 period from which "control" VMT was estimated. For example, VMT increases in 2010 might be partially attributable to increased hauling of road building materials to support $125 million in projects funded in 2010 with Federal stimulus dollars (American Reinvestment and Recovery Act).

To evaluate the issues described above, an outreach effort with Vermont motor carriers and shippers was held via a focus group meeting in Montpelier, Vermont. The results of a comprehensive shipper/carrier survey conducted by the Vermont Agency of Transportation were also analyzed. To ascertain the effects of the pilot on the railroad industry, the study conducted a railroad focus group meeting, also in Montpelier, Vermont, to understand potential impacts to freight rail traffic in the State.

1.1 INDUSTRY CHANGES

The Vermont industries with the most to gain from the truck pilot are those that currently routinely transport heavy loads off the Interstate system. In Vermont, those industries include forest products, quarry products, and water products. Each of these industries benefitted immediately from the higher weight allowances put into place for the pilot because they were able to shift existing heavy loads onto the Interstate system.

Other industries that benefitted from the higher pilot weights include petroleum, salvage/trash, asphalt, concrete, aggregates, and dairy. This latter set of industries routinely operates on the Interstate system—dairy through a grandfathered allowance of 90,000 lbs. GVW on 5-axles. But during the pilot, these industries had the opportunity to more fully load existing equipment or to upgrade to higher-capacity equipment to accommodate the weight limit loads. The following table describes the configurations used by heavy-hauling industries in Vermont before and during the pilot period and illustrates how each converted.

Table 7.1 Pilot Effects on Truck Configuration by Industry

Industry / Carrier Specialization	Configurations Before / After the Pilot	Configurations During Pilot
Petroleum	80,000 GVW with tandem rear axles	Utilization of 99,000 GVW trailers with tri-axles. Carriers tailor their compartment weights on the scales to avoid overweight axles. Petroleum tank trailers cannot be adapted to 99,000 GVW; must purchase or lease new trailers with tri-axles.
Timber	99,000 GVW tri-axles on secondary system	Using the same equipment, but on the Interstates.
Salvage / Trash	80,000 GVW on Interstates	Conversion to 99,000 GVW aluminum trailers with tri-axles.
Asphalt	3,4,5,6 axle equipment	Carriers have adapted some trucks and have purchased lengthened pup trailers (from the Midwest).
Aggregates	3,4,5,6 axle equipment	Industry utilized 69,600 pound trucks on the Interstates.
Concrete	3,4,5,6 axle equipment	Same equipment but on Interstates where possible.
Dairy	90,000 GVW allowance	Would convert to 99,000 if made permanent.
Utilities	Bucket trucks above 80,000	Same equipment but on Interstates where possible.
Potable Water	80,000 GVW with tandem rear axles	Conversion to 99,000 trailers with tri-axles.

Table 7.2 shows the change in vehicle operating weights during the pilot period. Vehicles that were not affected by the pilot were assumed to experience no change in operating weight distributions during the pilot. The highlighted vehicle classes are those that were affected. The changes in average gross operating weights understate gains in payload during the pilot.

Table 7.2 Pilot Effects on Truck Payload Weights by Configuration

Average Payload Weights						
FHWA Vehicle Class	Control		Pilot		Change	
	Interstate	Other	Interstate	Other	Interstate	Other
5	4,218	5,112	4,218	5,112	0.0%	0.0%
6	6,962	8,908	6,962	8,908	0.0%	0.0%
7	18,167	27,729	25,901	29,794	42.6%	7.4%
8	10,094	9,319	10,094	9,319	0.0%	0.0%
9	23,562	21,533	23,562	21,533	0.0%	0.0%
10	25,540	33,752	32,665	36,247	27.9%	7.4%
11	21,476	10,249	21,476	10,249	0.0%	0.0%
12	26,996	37,112	29,070	48,154	7.7%	29.8%
13	20,647	22,719	20,647	22,719	0.0%	0.0%

1.2 GROSS STATE PRODUCT CHANGES

Vermont's economy is dependent on service and manufacturing industries. The service sector accounts for over 80 percent of Vermont's Gross State Product (GSP) and non-farm employment. Manufacturing provides more than 10 percent of GSP and non-farm employment. The industries best positioned to utilize the pilot, construction, mining and logging together account for less than 6 percent of Vermont's GSP and non-farm employment.

Like the rest of the country, Vermont experienced declines in major industry sector activity during the recession. The rate at which each sector recovered from the recession affected the "typical" freight traffic mix in Vermont, making the Control Case against which Pilot impacts will be assessed difficult to determine.

Table 7.3 shows two economic indicators for the years leading up to and including the pilot, Employment and Gross State Product. Each indicator is indexed to a 2008 base year. The employment index shows a general decline in economic activity over the 6-year period, with the exception of services industries, which remained essentially flat. The industry segments best able to take advantage of the pilot, construction and mining/logging, each experienced employment declines of over 10 percent from the base year during the pilot.

Table 7.3 Vermont Economic Activity Indicators: 2005-2010

INDUSTRY SEGMENT	Employment Index 2008=100						GSP Index 2008=100, NOMINAL DOLLARS					
	2005	2006	2007	2008	2009	2010	2005	2006	2007	2008	2009	2010
MANUFACTURING	105%	103%	102%	100%	89%	88%	97%	105%	93%	100%	91%	99%
CONSTRUCTION	108%	112%	108%	100%	88%	86%	108%	112%	107%	100%	90%	93%
MINING AND LOGGING [1]	100%	106%	100%	100%	94%	88%	154%	124%	83%	100%	129%	149%
SERVICE INDUSTRIES	98%	99%	100%	100%	98%	99%	90%	94%	98%	100%	102%	106%

[1] Employment Index includes Mining and Logging, GSP Index includes Mining only

The GSP index is less consistent in a discernible trend than employment, with the services industries index showing a consistent increase while the employment index for this sector remains flat. This may partially be explained by the fact that GSP is stated in nominal dollars. The GSP indices for manufacturing and construction roughly follow employment indices. The remaining sector, mining and logging shows a divergence in direction after 2008, with employment going down and GSP going up. This is most likely due in some part to the employment data combines mining and logging and the GSP data includes forestry with agriculture and fisheries, making the two series not directly comparable. Despite this difference in definition, the large increase in mining activity indicated by the GSP index shows this segment's share of activity increasing during 2009 and 2010.

1.3 Anecdotal Information on Cost Changes, Market Expansion, and Modal Shifts

Across all commodities, the Interstate pilot allowed carriers to realize labor and equipment savings. Overall, the productivity gains reported by Vermont carriers range from 15 to 25 percent, measured by increased payload, and reduced mileage, number of drivers and number of trips. Vermont carriers reported operating cost savings of 20 percent or greater attributable to lower truck maintenance costs and labor costs. One petroleum carrier reported that the pilot saved 75,000 miles that is the equivalent of one year's worth of truck use. Drivers also participate in the higher productivity gains according to one carrier, with potentially higher pay for driving more miles and trips.

Carriers also reported that Interstate operations could lower haulage rates for some commodities; in some cases by 5 to 6 percent. However, carriers said that it is difficult—during a short pilot period—to estimate the potential for lower rates. For example, the petroleum industry said they might not be able to pass on savings because of the price volatility of the commodity.

The other effect of the pilot reported by carriers is market expansion. The Interstate operations allowed carriers to extend the boundaries of their service markets during the pilot and to haul new commodities.

Vermont is situated in a region were truck weights in bordering jurisdictions often exceed Federal weight limits on the Interstate system – New Hampshire to the east, New York to the west, Massachusetts to the south and Canada to the north. Lower costs from improved truck productivity would improve Vermont's competitive position relative to operations in bordering jurisdictions, but at the same time would provide those external operations more efficient access to markets within Vermont and other markets external to the originating jurisdiction that can be reached most efficiently by traversing Vermont. The impact of the latter could not be determined for this study.

While this study did not estimate the number of loads that shifted from rail to truck during the pilot period, research and outreach with rail carriers and shippers has provided meaningful information to inform this study. According to rail stakeholders, some traffic shifted from rail to truck in 2010, but this shift might have resulted from the recession and not necessarily from the lower truck rates during the pilot and this study is unable to quantify the amount diverted to truck.

Because the pilot was a limited time period, the freight rail industry of Vermont is more concerned about the potential magnitude of future diversion if the Interstate weight limits are permanently lifted. Within Vermont (and other states), the most vulnerable freight rail traffic is short distance moves of 500 miles or less hauled by the State's short line railroads. Vermont's short lines feed rail cars to connecting Class I (national) railroads for longer-distance travel, but this function is increasingly vulnerable to truck diversion. In order to protect Vermont rail traffic, the State's rail industry believes it would need to immediately convert from 286,000-pound railcar capacity to 315,000-pound railcar capacity to compete with the 99,000-pound 6-axle truck.

The study did not assess the impact on highway funding of traffic induced by the change in Interstate weight limits – either from additional volumes generated from increased production within the state or from through traffic traversing Vermont from origin to destination. The volume of induced traffic is critical to what effect a permanent change would have on the State's highway revenues sufficiency for maintaining the highway infrastructure. If the change merely shifts traffic from state roads to the Interstate system, then overall pavement costs would decline. However, the truck activity projected in the study indicates a significant amount of induced traffic, and higher pavement costs.

2.0 Energy Effects

The truck pilot was expected to produce changes to fuel consumption resulting from two factors. First, the shift of loads to heavier trucks increases the economies of scale of trucking operations, meaning that trucks move heavier but fewer loads. For example, 100,000 pound trucks will use more fuel per mile than 80,000 pound trucks but will overall less fuel per ton mile because fewer trips are required to move the equivalent amount of cargo.

Second, because of improved operating characteristics of the Interstates, trucks will shift from non-Interstate roadways to the Interstate system. Trucks operating on the Interstate will travel at a more consistent speed, and a higher average speed, than trucks operating on state routes. Decreased stop-and-go traffic will increase fuel efficiency, but if trucks cruise at higher speeds on the Interstate than on state routes, some of the gains in efficiency may be lost.

While the study utilized the best available data and methods, there are some uncertainties in the calculation of energy benefits.

2.1 Evaluation Methods

Fuel Economy

In order to estimate the change in fuel consumption resulting from the pilot period, the study analyzed changes in VMT and weight by truck configuration and facility type (Interstate versus non-Interstate). Because of the generally linear relationship between payload weight and fuel consumption (e.g. fuel consumption increases with weight), the change in fuel consumption for heavier payloads can be extrapolated from existing data. In this case, the study used the data from the U.S. DOT, Oak Ridge National Laboratory (ORNL), and National Academy of Science (NAS) to develop a range of fuel consumption by weight class. In addition, the US Environmental Protection Agency's MOBILE/MOVES mobile source emissions model was used to estimate the change in diesel fuel consumption and greenhouse gas (GHG) emissions. Table 10.1 presents the sources of fuel economy data.

Table 10.1 Average Fuel Economy by Gross Vehicle Weight Ranges

Gross Vehicle Weight (1000 lbs)	Average fuel economy (mpg)		
	USDOT (2009)	ORNL (2008)	NAS (2010)
10	7.47	9.32	8.09
20	7.22	8.81	7.71
30	6.97	8.31	7.34
40	6.73	7.80	6.99
50	6.48	7.30	6.66
60	6.23	6.79	6.34
70	5.99	6.29	6.04
80	5.74	5.78	5.75
90	5.49	5.28	5.46
100	5.24	4.77	5.19
110	5.00	4.27	4.93
120	4.75	3.76	4.68
130	4.50	3.26	4.45

By using several data sets as a "sensitivity test", this approach removes any biases within a single study towards a specific engine or fleet. Collectively, these three data sources provide the data needed to develop alternative trend lines for fuel consumption versus combined truck cab and payload weight (gross vehicle weight). The change in VMT by gross vehicle weight resulting from the pilot is divided by the average fuel economy by gross vehicle weight class to estimate changes in diesel fuel consumption.

Improved Operating Characteristics

To estimate the improved fuel and emissions characteristics of trucks operating on Interstates at a more constant and higher speed than trucks operating on non-Interstate facilities, the study utilized the findings of two prior studies which examined simulated or measured the efficiency differences of trucks operating on Interstates versus state routes or other roadways:

1. *Estimating Truck Related Fuel Consumption and Emissions in Maine: A Comparative Analysis for 6-Axle, 100,000 Pound Vehicle Configuration* (American Transportation Research Institute (ATRI), 2009).
2. *Modeling the Emissions of Heavy-Duty Vehicles on Interstate 89/189 and US Route 7 in the Burlington Area: Final Research Report* (University of Vermont Transportation Research Center, 2009)

The ATRI study found a 15-20 percent improvement in average fuel efficiency from switching to an Interstate route. The University of Vermont (UVM) study found a considerably greater improvement, on the order of 60 percent. However, the UVM study compared a short (5 mile) stretch of Interstate to a parallel US route in an urban area with relatively high congestion. As a result this comparison was only applicable in the limited urban settings in Vermont. For most highway sections the study utilizes the ATRI values of 15-20 percent improvement.

While the research takes into account all available information, the findings could be strengthened with more complete information on the number of trucks that changed routing as a result of the pilot versus those that were removed from the network completely as a result of increased economies of scale. In addition, the study did not have information on average fuel consumption of trucks on non-Interstate facilities in Vermont

Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions are directly proportional to fuel consumption, because virtually all the carbon content of diesel fuel is converted to CO_2 during the combustion process. Therefore, GHG emission changes are estimated by multiplying reductions in diesel fuel consumption by the appropriate emissions factor as specified in EPA protocol (22.2 lbs CO_2 per gallon).

Fuel and Greenhouse Gas Costs

The fuel and emission impacts are monetized to provide an assessment of their contribution to relative costs and savings of the pilot program. The monetary savings from reduced fuel use is calculated based on the average price of diesel fuel over the duration of the pilot program ($3.08 per gallon based on US Energy Information Administration weekly fuel price data Dec. 16, 2009 to Dec 31, 2010).

The value of GHG emission reductions will be estimated using values for the cost of a ton of carbon under different existing and proposed regulatory approaches. There is a wide range of potential values, ranging from $20 - $70 per ton based on EPA analyses in 2010. This range is consistent with carbon costs found in a broad source of research. There is significant uncertainty in monetizing the value of carbon, therefore the EPA range is used for this analysis.

2.2 Key Findings

Truck Diesel Fuel Consumption

The change in diesel fuel consumption as a result of the pilot program is the key energy metric for the private sector. Table 10.2 presents the changes in diesel fuel consumption by facility type and in total based on the fuel economy sensitivity tests presented in Section 10.1 and the truck volume results presented in Section 3.2.

Table 10.2 VMT and Fuel Consumption by Facility Type

Facility Type	2010 VMT (millions)		Diesel Fuel Consumption Change (1000 gallons)
	2010 Control	2010 Pilot	
Interstate	205.24	208.76	631.0 – 634.6
Non-Interstate	411.08	404.79	(979.0) – (1,000.3)
Total (Net)	**616.32**	**613.55**	**(344.5) – (369.3)**

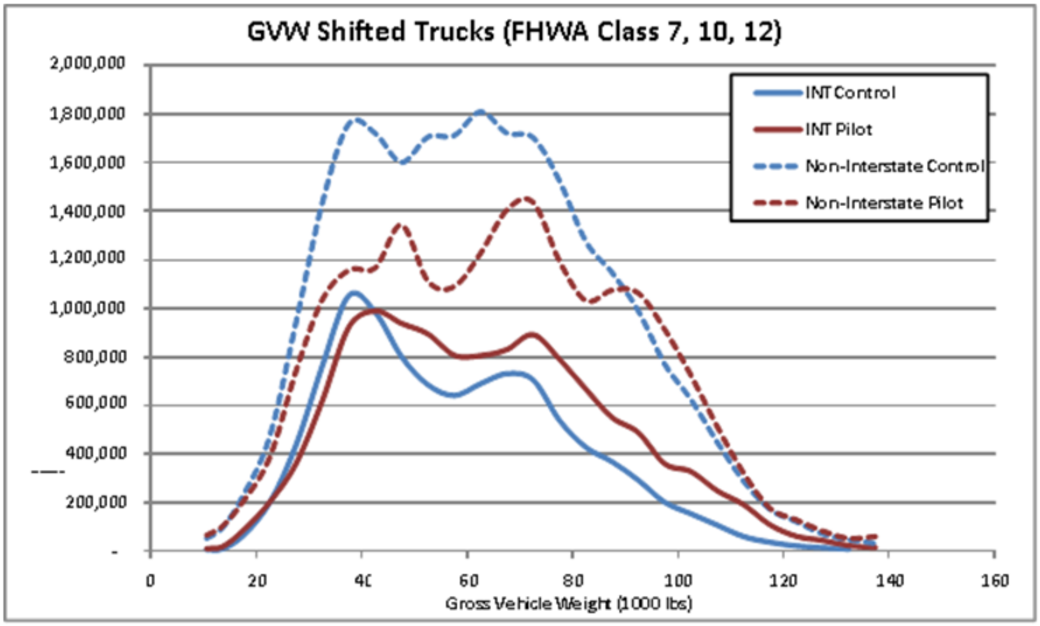
These results demonstrate that the first hypothesis that increased economies of scale will result in a reduction in diesel fuel consumption.

The net change in total Vermont truck VMT from the 2010 Control to Pilot is 2.7 million miles. The total change in VMT is a result of the overall decrease in 80,000 pound and less trucks and the increase in 100,000 pound and greater trucks. Increased fuel consumption resulting from an increase in truck VMT on Interstates is offset by an overall reduction in VMT on non-Interstate facilities. The reduction in diesel fuel consumption ranges from 345.5 to 369.3 thousand gallons depending on fuel economy approach. For those trucks which increase average weights, these reductions in fuel consumption are equivalent to a 6.2 – 6.9 percent reduction based solely on the total change in truck weights and resulting decrease in VMT.

As noted above, not all truck classes are impacted by the pilot. Based on an evaluation of Vermont weigh-in-motion (WIM) data from 2007 through 2009, compared to 2010 WIM data, FHWA Class 7, Class 10, and Class 12 trucks show the most statistically significant changes in average weight. Figure 11.1 presents the change in gross vehicle weight (GVW) by vehicle miles traveled for these three target truck classes. The two primary shifts between the control (blue) and pilot (red) curves are:

1. Non-Interstate truck travel (represented by dashed line) decreases in total VMT, while average GVW slightly increases; and
2. Interstate truck travel (represented by the solid line) shows an increase in total VMT and in average GVW.

Figure 10.1 GVW Shifts by Truck VMT (Vermont 2010 Control to 2010 Pilot)



Some of the increases in VMT and average GVW is the result of shifts in VMT between truck classes. FHWA Class 8, 9, and 11 trucks show notable shifts in VMT between the 2010 control and 2010 pilot. Class 8 and 9 trucks show an overall decrease in total VMT, while Class 11 trucks show an increase. Based on the WIM evaluation however, neither shows statistically significant changes in weight distributions.

Figure 10.2 presents the total distribution of truck VMT by gross vehicle weight for the 2010 control and 2010 pilot across Class 7 through Class 12 trucks (it is assumed that Class 5, 6, and 13 trucks are not affected by the pilot and are thus excluded from the energy analysis).

Figure 10.2 2010 Vermont Distributions of Truck VMT by Gross Vehicle Weight

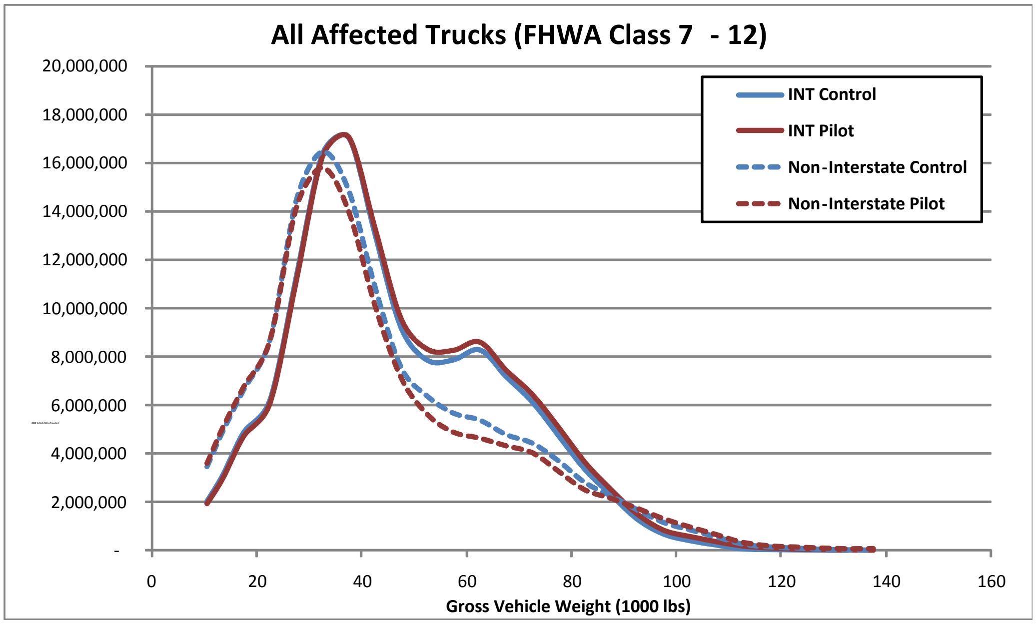


Table 10.3 summarizes the change in fuel consumption by vehicle class and facility type.

Table 10.3 Change Fuel Consumption by Facility Type and Vehicle Class

Facility Type	Change in Fuel Consumption (1000 gallons)		Total Change in Diesel Fuel Consumption
	Class 7, 10, 12	Class 8, 9, 11	
Interstate	414.6 – 417.6	216.4 – 216.9	631.0 – 634.6
Non-Interstate	(686.8 – 705.0)	(295.3 – 292.2)	(979.0) – (1,000.3)
Total (Net)	**(269.3 – 290.4)**	**(75.2 – 78.9)**	**(344.5) – (369.3)**

The results confirm the second hypothesis, that the movement of truck VMT from non-Interstate facilities to Interstates will result in improved operating conditions and reductions in fuel consumption. Pilot Interstate VMT increases by 3.6 million truck miles in 2010 compared to the 2010 control VMT estimate across both single unit and combination trucks.

The actual shift in VMT from non-Interstate facilities to Interstates cannot be determined directly from the available data. Based on insights from shipper surveys, route adjustments from non-Interstates to Interstates was a primary response to the pilot program, which is consistent with the changes in performance from 2010 estimated control to 2010 observed pilot.

While the fuel economy on non-Interstate versus Interstates in Vermont cannot be determined, the conclusion of this analysis indicates that for the 2.5 million or more combination trucks that shift routes from non-Interstate to Interstate facilities, it is expected that per mile, each truck will consume 15-20 percent less fuel than they did on non-Interstates. For example, if the average fuel economy for 80,000 pound vehicles operating on non-Interstates is 5.6 mpg (the current average for 80,000 pound vehicles irrespective of average speed), the change in fuel consumption from the shift of 2.5 million combination trucks to Interstates would range from 57,000 to 73,000 gallons of diesel fuel savings in 2010.

Greenhouse Gas Emissions

The reduction in total diesel fuel consumption as presented in Tables 12.2 and 12.3 (344.5 to 369.3 thousand gallons) plus the potential for as much as an additional 73.0 thousand gallon reduction from improved operating characteristics results in an annual GHG emissions reduction of 4,000 to 4,450 metric tons of CO_2 in 2010. This reduction equates to a 0.88 percent to 0.95 percent GHG emissions reduction for all on-road truck emissions in Vermont in 2010 for both Interstate and non-Interstate highways.

Fuel and Greenhouse Gas Costs

The reduction in total diesel fuel consumption results in cost benefits for both fuel and greenhouse gas emissions. Total fuel savings attributed to a 2010 savings of up to 442.3 thousand gallons equates to $1.36 million. This is equivalent to a savings of 0.2 cents for every truck mile travelled in Vermont in 2010, but results in a decrease in motor fuel tax receipts of $128.3 thousand to Vermont.

Total greenhouse gas savings attributed to a 2010 reduction of up to 4,450 metric tons of CO_2 representing between $89,000 to $312,000 in reduced greenhouse gas emission costs.