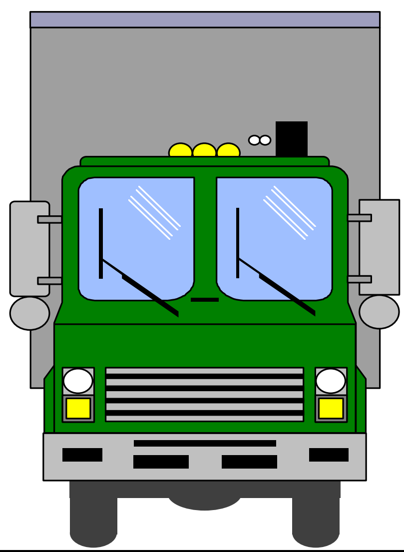
CHAPTER 10

Energy and Environment



INTRODUCTION

The Study scenarios were evaluated in terms of energy consumption, air quality, global warming, and noise emissions. The magnitude of each of the four areas is influenced by the extent of truck travel (vehicle-miles-of-travel — VMT). Other significant variables include vehicle weight, speed, and truck operational parameters.

Fuel consumption, air pollution, and noise emissions occur everywhere trucks operate. The impacts of air pollution and noise emissions relate to highly populated areas (localized sensitive receptors). Energy consumption has a nationwide impact.

Noise pollution has a very localized impact. To be impacted, residences must be within 200 feet of a high volume roadway, such as along urban freeways with closely adjacent residential areas. The social cost of noise is estimated based on the land use adjacent to freeway sections, as reported in the Highway Performance Monitoring System (HPMS) database and on the changes in truck traffic in response to truck size and weight (TS&W) policy changes.

Air pollution impacts are highly dependent on meteorological conditions and to a lesser extent on the geographic features that cause air stagnation. Air pollution tends to be regional with some long distance conveyance in the lower levels of the atmosphere. Also, air pollutant emissions are produced in close relation to energy consumption.

Currently, truck VMT occurring in urban areas is used as a surrogate for air pollution impacts. This will be revised once the Department of Transportation (DOT) and the Environmental Protection Agency (EPA) have determined the best means for evaluating air pollutant impacts.

BASIC PRINCIPLES

ENERGY CONSUMPTION

Exhibit 10-1 illustrates how fuel consumption varies with truck configuration and weight. It shows that a longer configuration at the same weight does not necessarily have a higher rate of fuel use. Inherent for each truck configuration is the selection of the most efficient engine for that configuration and use.

A configuration's impact on diesel fuel use depends on its miles of operation at its given weight, speed, and roadway grade. For this Study each configuration is assumed to operate at the same speed under the same conditions. It is important to note that fuel use does not increase on a one-to-one relationship with vehicle weight.

AIR QUALITY

As indicated earlier, air pollutant emissions by large trucks correlate with VMT. Analytical models of these emissions do not generally differentiate between truck configurations or weight. Consequently, only the available rates for three-axle single unit trucks and heavy trucks, (trucks with four axles or more) on urban routes are reported in Exhibit 10-2.

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EXHIBIT 10-1
DIESEL FUEL USE RATES FOR STUDY TRUCK CONFIGURATIONS (MILES-PER-GALLON)

Configurations	GVW (pounds)					
	40,000	60,000	80,000	100,000	120,000	140,000
Three-axle Single-Unit Truck	5.11	4.42				
Four-axle Single-Unit Truck	4.80	4.15				
Five-Axle Semitrailer		5.44	4.81	4.31		
Six-Axle Semitrailer		5.39	4.76	4.27		
Five-Axle STAA Double		5.95	5.29	4.76		
Seven-Axle Rocky Mt. Double			5.08	4.58	4.36	4.16
Eight-Axle (or more) Double			5.08	4.82	4.58	4.36
Triple-Trailer Combination			5.29	5.01	4.76	4.54

Source: Highway Revenue Forecasting Model

EXHIBIT 10-2
AIR POLLUTANT EMISSION RATES

Configuration	Air Pollutant Emission (grams/VMT)			
	Nitrogen Oxides	Particulate Matter(10)	Volatile Organic Compounds (VOC)	Sulphur Oxides
Three-axle Single Unit	9.55	0.399	1.94	0.111
Other Heavy Trucks	12.65	0.788	1.03	0.520

Source: 1997 Federal Highway Cost Allocation Study

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NOISE EMISSIONS

Truck noise comes from three sources — the engine (as a function of engine revolutions per minute), the exhaust pipe (particularly from the use of engine compression brakes), and tires (tire noise increases significantly with speed and begins to dominate other truck noise sources above 30 miles-per-hour). Truck noise begins to dominate the other vehicle traffic noise once more than 3 percent of the traffic consists of heavy trucks. For example, to produce a noticeable difference in highway noise, such as a decrease of 2.5 decibels, the percentage of trucks in the traffic stream would have to drop from 20 percent to 5 percent of all traffic.

ANALYTICAL APPROACH

ENERGY CONSUMPTION

Truck travel (VMT) and fuel use tax information contained within the *1997 Highway Cost Allocation (HCA) Study* provided the basis for the analysis of annual energy consumption associated with the introduction or elimination of particular vehicle configurations and weights.

Base Case VMT for the Year 2000, which is organized by truck type and operating weight, was obtained from the diversion analysis (see Chapter 4). For each scenario, an alternative Year 2000 VMT distribution was also developed. This was used with the gallons-per-vehicle-mile-of-travel estimates from the Federal Highway Administration's (FHWA's) Highway Revenue Forecasting Model, which was also used in the *1997 HCA Study*.

AIR QUALITY

Little information exists on the impact that larger, heavier trucks have on air quality. As indicated earlier, DOT is working with EPA to develop an air quality impact methodology based on the best and most current information available.

Important factors in estimating the change in air quality costs are the dollar values assigned to mortality (death), morbidity (illness), visibility impairment, soiling, materials damage, and effects on plants and wildlife caused by airborne pollutants. These are extremely difficult to quantify in terms of their effects. Most past studies have focused exclusively on the dollar value of mortality caused by pollution. To date, virtually every comprehensive estimate of air pollution costs has focused on the costs associated with additional deaths and particulate matter.

Some of the key problems in dealing with the issue of air quality include: (1) EPA's analysis has not broken down emission factors by vehicle weight; (2) there are huge variations in the cost-per-mile depending on where the pollution occurs and other situational factors, such as temperature and; (3) a lack of consensus on dollar values for human life.

NOISE EMISSIONS

As previously mentioned, scenario VMT was obtained through the diversion analysis. Using passenger cars as the base, noise equivalency factors were determined under differing

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operating circumstances for each vehicle class and weight group. The cost per noise equivalent was estimated for each vehicle class.

FHWA has developed several models for evaluating the impact of traffic-related changes in noise levels by truck operating weight. These models served as the basis of the noise emission cost calculations. Also, these models were used for the *1997 HCA Study*. HPMS data on VMT by highway class and density of development was used to determine the number of residential units affected. The noise cost estimates were based on perceived changes in residential property value. It is assumed that as noise levels increase, property values decrease.

The noise generated by heavy trucks varies with speed. Noise equivalency factors for trucks relative to passenger cars are shown in Exhibit 10-3.

EXHIBIT 10-3
NOISE PASSENGER CAR EQUIVALENTS FOR TRUCKS

Vehicle Type	Speed (mph)				
	20	30	40	50	60
Passenger-car	1.00	1.00	1.00	1.00	1.00
Truck	84.85	43.82	27.42	19.06	14.16

FEDERAL HIGHWAY ADMINISTRATION
HIGHWAY TRAFFIC NOISE PREDICTION MODEL

The Federal Highway Administration Traffic Noise Model calculates traffic noise levels using updated acoustical algorithms, as well as newly-measured emission levels for five standard vehicle types: automobiles, medium trucks, heavy trucks, buses, and motorcycles. The model considers the sources of truck noise (engine, exhaust stack, and tires) among other factors. It estimates overall weighted sound levels for locations with and without noise barriers. It analyzes:
(1) both constant-flow and interrupted-flow traffic,
(2) attenuation due to rows of buildings and dense vegetation,
(3) effects of parallel noise barriers, (4) results of multiple diffractions, and (5) noise contours.

ASSESSMENT OF SCENARIO IMPACTS

The area-wide impacts of energy consumption, air pollution, and noise all vary directly with VMT. Therefore, the change in VMT from the base case for the truck configurations significantly affected by the scenario policies is shown under each scenario. In addition, air pollution and noise have sensitive receptors, e.g. human populations, which must be considered. For air pollution, these are generally within metropolitan areas. But for noise pollution, the receptors are in the area immediately adjacent to high volume, high speed (urban) roadways . Energy consumption, which has no sensitive receptors, varies directly with truck VMT. As VMT increases or decreases, energy consumption increases or decreases.

For air pollution, meteorological conditions and to a lesser extent geography have a large effect on impact calculations. These conditions determine how concentrated the air pollutant emissions become and the chemical reactions that take place in the atmosphere to produce critical levels of air pollution. As DOT is reviewing air pollution estimation procedures with EPA, no costs for this environmental impact are presented at this time. The impact table for each scenario shows that these costs are "to be determined (TBD)." However, as a surrogate for the costs of air pollution, each impact table shows an estimate of the change in truck VMT on urban roadways that could occur if the scenario policies were implemented.

As significant noise impacts are generated along urban freeways, the change from the base case in heavy truck VMT on these facilities is presented for each scenario along with the costs of these impacts. The change in truck VMT on urban freeways has a more direct relationship to noise impacts than total truck VMT.

UNIFORMITY SCENARIO

For this scenario, it is assumed that much of the freight in those truck configurations that typically operate above the Federal weight limits will divert to those configurations that operate most economically at or below the Federal limits. As seen in Exhibit 10-4, this scenario results in an estimated 3.2 percent increase in heavy commercial truck VMT.

Exhibit 10-5 shows that this increase in VMT resulted in a 2.1 percent increase in fuel use and 0.9 percent increase in noise costs. While air pollution costs have not been determined, truck VMT in urban areas increased 3.2 percent, which indicates that there would be an increase in air pollution costs in areas prone to such impacts.

NORTH AMERICAN TRADE SCENARIOS

For this scenario, with either the 51,000-pound or 44,000-pound tridem-axle weight limit, it is estimated that there would be significant diversion of freight to trucks that have more axles and are allowed more weight. This would be diversion from the three-axle single-unit truck to the four-axle truck. For the five-axle semitrailer, over

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EXHIBIT 10-4
VEHICLE-MILES-OF-TRAVEL BY CONFIGURATION AFFECTED
UNIFORMITY SCENARIO

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Single Unit	3	9,707	9,949	242	2.5
	4	2,893	3,224	331	11.4
Semitrailer	5	83,895	91,205	7,310	8.7
	6 and 7	6,595	3,660	-2,935	-44.5
STAA Double-Trailer	5 and 6	5,994	5,986	-8	-0.1
B-Train Double-Trailer	8	683	178	-505	-73.9
Rocky Mountain Double-Trailer	7	632	290	-342	-54.1
Turnpike Double-Trailer	9	76	20	-56	-73.7
Triple-Trailer	7	126	54	-72	-57.1
Total for Heavy Commercial Trucks	—	128,288	132,351	4,063	3.2
All Highway Vehicles	—	2,693,845	2,697,908	4,063	0.2

EXHIBIT 10-5
ENERGY AND ENVIRONMENTAL IMPACTS
UNIFORMITY SCENARIO

Impact	2000 Base Case	Change from 2000 Base Case	
		Absolute	Percentage
VMT for Heavy Trucks (millions)	2,693,845	4,063	3.2
Energy Consumption (million gallons)	29,947	635	2.1
Urban VMT for Heavy Trucks (millions)	51,625	1,700	—
Air Pollution Costs	TBD	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	27,503	797	—
Noise Cost ($millions)	4,336	40.0	0.9

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70 percent of its freight would divert to the eight-axle B-train double with a small amount to the six-axle semitrailer under either the 51,000-pound or 44,000-pound tridem-axle weight limit. Overall, this results in a 12 percent decrease in heavy commercial truck VMT under both tridem-axle weight limits (see Exhibit 10-6 and Exhibit 10-7). This decrease would result in over a 6 percent decrease in fuel use (see Exhibit 10-8 and Exhibit 10-9). Air pollution costs have not been determined yet, but truck VMT in urban areas would decrease by more than 5 billion miles in both cases, which indicates that there would be a decrease in air pollution costs in those areas prone to these impacts.

Unexpectedly, noise costs increase even though urban freeway VMT decreases by 3 billion. This may be explained by the fact that the VMT decrease is small and that the number of tires in use on the roads increases approximately 15 percent. There would also be an increase in engine noise from greater loads. Consequently, these secondary changes may overwhelm the effect of the small decrease in VMT.

EXHIBIT 10-6
VEHICLE-MILES-OF-TRAVEL BY CONFIGURATION AFFECTED
NORTH AMERICAN TRADE SCENARIO
51,000-POUND TRIDEM-AXLE WEIGHT LIMIT

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Single Unit	3	9,707	8,131	-1,576	-16.2
	4	2,893	3,578	685	23.7
Semitrailer	5	83,895	24,996	-58,818	-70.2
	6 and 7	6,595	6,792	197	3.0
B-Train Double-Trailer	8	683	46,619	45,936	6,726
Total for Heavy Trucks	—	128,288	114,632	-13,656	-10.6
All Highway Vehicles	—	2,693,845	2,680,189	-13,656	-0.5

EXHIBIT 10-7
VEHICLE-MILES-OF-TRAVEL BY CONFIGURATION AFFECTED
NORTH AMERICAN TRADE SCENARIO
44,000-POUND TRIDEM-AXLE WEIGHT LIMIT

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Single Unit	3	9,707	8,529	-1,178	-12.1
	4	2,893	3,595	702	24.3
Semitrailer	5	83,895	22,274	-61,621	-73.5
	6 and 7	6,595	6,755	160	2.4
B-Train Double-Trailer	8	683	49,003	48,320	7,075
Total for Heavy Trucks	—	128,288	114,671	-13,617	-10.6
All Highway Vehicles	—	2,693,845	2,680,228	-13,617	-0.5

EXHIBIT 10-8
ENERGY AND ENVIRONMENTAL IMPACTS
NORTH AMERICAN TRADE SCENARIO
51,000-POUND TRIDEM-AXLE WEIGHT LIMIT

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	-13,656	-10.6
Energy Consumption (million gallons)	-1,870	-6.2
Urban VMT for Heavy Trucks (millions)	-5,163	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	-2,849	—
Noise Cost ($millions)	255	5.9

EXHIBIT 10-9
ENERGY AND ENVIRONMENTAL IMPACTS
NORTH AMERICAN TRADE SCENARIO
44,000-POUND TRIDEM-AXLE WEIGHT LIMIT

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	-13,617	-10.6
Energy Consumption (million gallons)	-1,889	-6.3
Urban VMT for Heavy Trucks (millions)	-5,074	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	-2,895	—
Noise Cost ($millions)	281	6.5

LONGER COMBINATION VEHICLES NATIONWIDE SCENARIO

This scenario has the greatest estimated reduction in heavy commercial truck VMT, 23.2 percent, which is shown in Exhibit 10-10. The nine-axle turnpike double with its high cubic capacity and GVW allowance is expected to be very attractive to freight shippers. Also, the triple-trailer combination attracts virtually all the freight from the Surface Transportation Assistance Act (STAA) double-trailer combinations (twin-trailer vehicles operating at weights less than 80,000 pounds GVW), which are predominately used by less-than-truckload (LTL) carriers.

The reduced heavy commercial truck VMT resulted in a 13.8 percent reduction in fuel consumption but a very modest increase of 0.5 percent or $21 million in noise costs (see Exhibit 10-11). The estimated reduction of 5 billion miles in heavy commercial truck travel on urban roadways indicates that air pollution costs would be reduced in those areas prone to having significant air pollution.

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EXHIBIT 10-10
VEHICLE-MILES-OF-TRAVEL BY CONFIGURATION AFFECTED
LONGER COMBINATION VEHICLES NATIONWIDE SCENARIO

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Semitrailer	5	83,895	19,611	-64,284	-76.6
STAA Double-Trailer	5 and 6	5,994	1,075	-4,919	-82.1
B-Train Double-Trailer	8	683	2,079	1,396	204.4
Rocky Mt. Double-Trailer	7	632	505	-127	-20.1
Turnpike Double-Trailer	9	76	32,418	32,342	42,555
Triple-Trailer	7	126	5,992	5,866	4,656
Total for Heavy Trucks	—	128,288	98,562	-29,726	-23.2
All Highway Vehicles	—	2,693,845	2,664,119	-29,726	-1.1

EXHIBIT 10-11
ENERGY AND ENVIRONMENTAL IMPACTS
LONGER COMBINATION VEHICLES NATIONWIDE SCENARIO

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	-29,726	-23.2
Energy Consumption (million gallons)	-4,129	-13.8
Urban VMT for Heavy Trucks (millions)	-9,168	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	-5,267	—
Noise Cost ($millions)	21	0.5

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H.R. 551 SCENARIO

As shown in Exhibit 10-12, this scenario has virtually no impact on heavy commercial truck VMT. Consequently, there is virtually no impact on energy consumption, air pollution, or noise as seen in Exhibit 10-13.

EXHIBIT 10-12
VEHICLE-MILES-OF-TRAVEL BY CONFIGURATION AFFECTED
H.R. 551 SCENARIO

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Semitrailer	5	83,895	83,916	20	0.03
	6 and 7	6,595	6,597	2	0.03
Total for Heavy Trucks	—	128,288	128,311	23	0.02
All Highway Vehicles	—	2,693,845	2,693,868	23	0.0009

EXHIBIT 10-13
ENERGY AND ENVIRONMENTAL IMPACTS
H.R. 551 SCENARIO

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	23	0.02
Energy Consumption (million gallons)	3.6	0.01
Urban VMT for Heavy Trucks (millions)	6	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	3	—
Noise Cost ($millions)	0.3	0.007

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TRIPLES NATIONWIDE SCENARIO

In this scenario, the triple-trailer combination attracts not only most of the LTL freight from the STAA double-trailer combination vehicles (with STAA double-trailer combination VMT reduced 82.1 percent), but it also attracts both light and heavy density truckload freight (a 72.1 percent reduction in VMT for the five-axle semitrailer combination) because it is the configuration with the most cubic capacity and the highest weight allowance. The scenario resulted in a 20.2 percent reduction in heavy commercial truck VMT as shown in Exhibit 10-14.

This reduced heavy commercial truck VMT and resulted in a 12.8 percent reduction in fuel consumption, but only a very modest reduction in noise costs, 0.2 percent or $7 million, resulted (see Exhibit 10-15). The estimated reduction of 8 billion miles in heavy commercial truck travel on urban roadways indicates that air pollution costs would be reduced in those areas prone to significant air pollution.

EXHIBIT 10-14
VEHICLE-MILES-OF-TRAVEL BY CONFIGURATION AFFECTED
TRIPLES NATIONWIDE SCENARIO

Truck Configuration	Number of Axles	VMT (millions)		Change from Base Case	
		Base Case	Scenario	Absolute	Percent
Semitrailer	5	83,895	23,405	-60,490	-72.1
STAA Double-Trailer	5 and 6	5,994	1,075	-4,919	-82.1
Triple -Trailer	7	126	39,647	39,521	31,366
Total for Heavy Trucks	--	128,288	102,400	-25,888	-20.2
All Highway Vehicles	--	2,693,845	2,667,955	-25,888	-1.0

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EXHIBIT 10-15
ENERGY AND ENVIRONMENTAL IMPACTS
TRIPLES NATIONWIDE SCENARIO

Impact	Change from Base Case	
	Absolute	Percentage
VMT for Heavy Trucks (millions)	-25,888	-20.2
Energy Consumption (million gallons)	-3,819	-12.8
Urban VMT for Heavy Trucks (millions)	-8,010	—
Air Pollution Costs	TBD	TBD
Urban Freeway VMT for Heavy Trucks (millions)	-5,301	—
Noise Cost ($millions)	-7	-0.2

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