EFFECTS OF HEAVY TRUCKS ON TEXAS HIGHWAYS

SUMMARY REPORT
1-8-78-231 INTERIM (S)

RESEARCH PROJECTS
2-8-78-231
3-8-78-241

STATE DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

CENTER FOR HIGHWAY RESEARCH
THE UNIVERSITY OF TEXAS AT AUSTIN

TEXAS TRANSPORTATION INSTITUTE
TEXAS A&M UNIVERSITY

September 1978

The Effects of Heavy Trucks on Texas Highways

by
James L. Brown, Dock Burke, Freddy L. Roberts and C. Michael Walton

Objective

The objective of this study was to assess the effects of projected truck traffic on the highway system of Texas in consideration of the social and economic vitality of the State.

Scope

The study included the evaluation of the costs and benefits for a twenty-year planning horizon. Alternative scenarios of future truck traffic were assessed. *The study did not consider the effects of changes in the size of trucks*, only an increase in the gross weights and axle loads. The study did not evaluate the effects that heavy trucks would have on county roads or city streets.

General Methodology

The study was organized into three phases:

1. The establishment of current and future truck traffic distributions that will most likely occur on the state highway system for each of two conditions or scenarios. The first, Scenario A, was evaluated as the conditions that will develop under the present weight law of a gross weight of 80,000 pounds (Max. Single Axle Load = 20,000 lbs. and Max. Tandem Axle Load = 34,000 lbs.). The second, Scenario B, was evaluated as the conditions developing under a possible future legal weight increase to a gross vehicle weight (GVW) of 120,000 pounds (Max. Single Axle Load = 26,000 lbs. and Max. Tandem Axle Load = 44,000 lbs.). Also, the 120,000 pound GVW represents a maximum likely change and is sufficiently large that estimated results would not be overwhelmed by data inaccuracies. Figure 1 schematically shows the maximum legal loading condition of the four trucks used to represent both scenarios. Figure 2 shows the percentages of these trucks on the highways. Both scenarios considered distributions of all trucks including overloads.

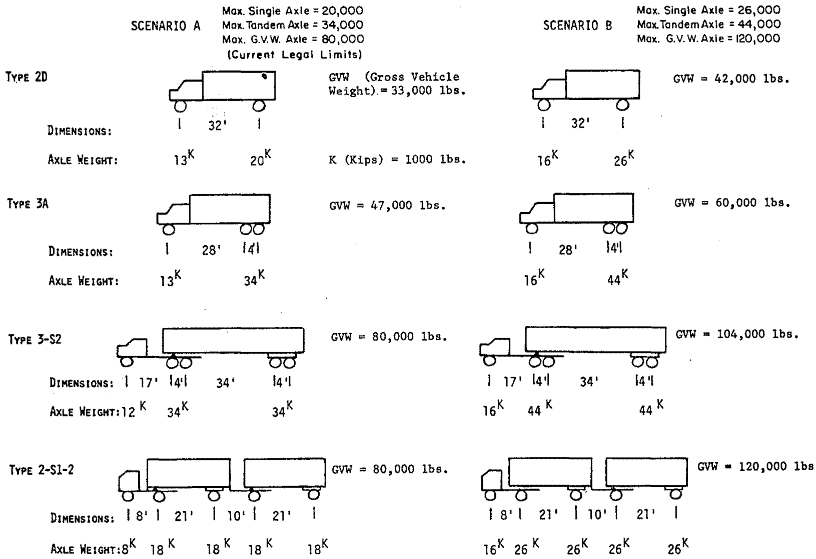

Figure 1. Selected truck configurations for scenarios A and B.

TRUCK TYPE	HIGHWAY TYPE			
	INTERSTATE HIGHWAYS	FARM TO MARKET ROADS	OTHER STATE HIGHWAYS	CITY STREETS / COUNTRY ROADS
2D	8%	23%	11%	Unknown
3A	3%	18%	7%	Unknown
3-S2	84%	59%	80%	Unknown
2-S1-2	5%	0%	2%	Unknown

Figure 2. Distribution of selected trucks by highway types.

2. An evaluation was made of the comparative tax dollar costs required to perpetuate the state highway system in an acceptable condition while carrying the traffic estimated for both scenarios. The basis for this evaluation was the general finding from the AASHO Road Test that showed that heavier axle loads cause pavements to deteriorate at an accelerated rate. Figure 3 shows a typical relationship between the heavier

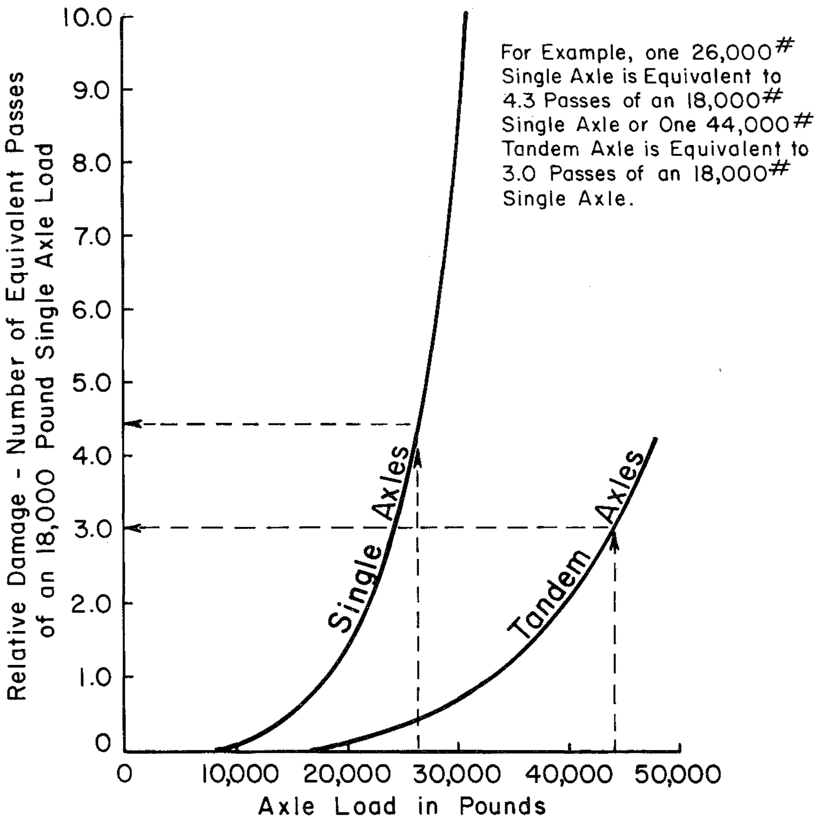

Figure 3. Typical relative damage caused by different sized axles — from the AASHO Road Test.

axle loads and the equivalent damage as represented by an 18,000-pound single axle load (18 KSAL). The additional costs for Scenario B were obtained by subtracting the cost of Scenario A from Scenario B.

3. An evaluation was made of the incremental benefits associated with the variation in conditions inherent in the Scenarios A and B. The benefits as defined in this study are associated with the increased payloads of Scenario B over Scenario A.

Data Limitations

The Scope and General Methodology described above were incorporated to direct the study which proceeded under the limited time available. A primary implication of this time constraint was the definition of a data base sufficient to conduct the analysis. Limitations on the data base were three types:

1. Existing data to describe current traffic, truck costs, and highway inventory were used. None of these data were both complete and current and, consequently, may contain inaccuracies.

2. No statewide data were available for an analysis of heavier trucks operating on city streets and county roads in Texas.

3. Structure related costs were limited to upgrading current structurally deficient bridges to carry the loadings of the two scenarios. The lack of definitive data restricted the inclusion of bridge maintenance and rehabilitation costs associated with truck loadings. Furthermore, the lack of technology regarding the effects of heavy loading and frequency on bridge deterioration has limited the evaluation of differential bridge rehabilitation and replacement costs.

Findings and Conclusions

The differential costs between Scenario A and B associated with heavier truck loads and the corresponding savings in truck operating costs for the 20-year analysis period are presented in the following table:

	Total for Hwy Systems	Interstate Highways	FM Roads	Other State Hwys	Co. Roads & City Streets
Add'l Hwy Costs (in billions of constant 1977 dollars)	3.50	.72	.74	2.04	unknown
Savings in Truck Operating Costs (in billions of constant 1977 dollars)	9.12	4.57	.71	3.84	unknown
Fuel Savings* (in billions of gallons)	2.42	1.21	.18	1.03	unknown

Figure 4 shows the total costs for the various classes of highways.

From the above data, it appears that if weight law changes are undertaken, further analysis would be justified to select those

*Fuel cost savings are included in Savings in Truck Operating Costs.

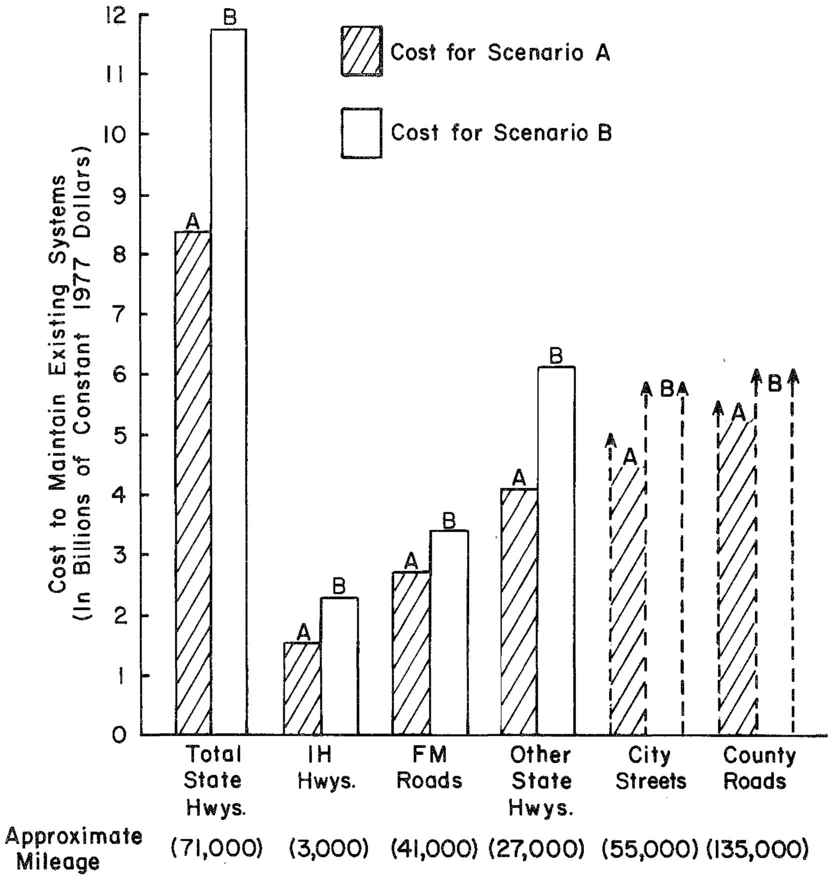

Figure 4. Twenty-year cost (1977-1997) to maintain existing systems. Bridge costs included in totals only reflect expense of upgrading structurally deficient bridges to carry the loading of the respective scenarios. Not included are the costs of bridge maintenance, rehabilitation and replacement due to functional deficiencies and deterioration.

routes that would carry relatively large freight tonnages and would cost relatively less to upgrade.

Figure 5 shows the cost to maintain the existing system for both Scenario A and B on an annual basis. From the data in Figure 5 it can be inferred that once the highways have been upgraded to handle the heavier trucks, the additional cost to maintain the system for the heavier trucks will decrease. In other words, the additional costs beyond 1997 would be less than those costs occurring during upgrading.

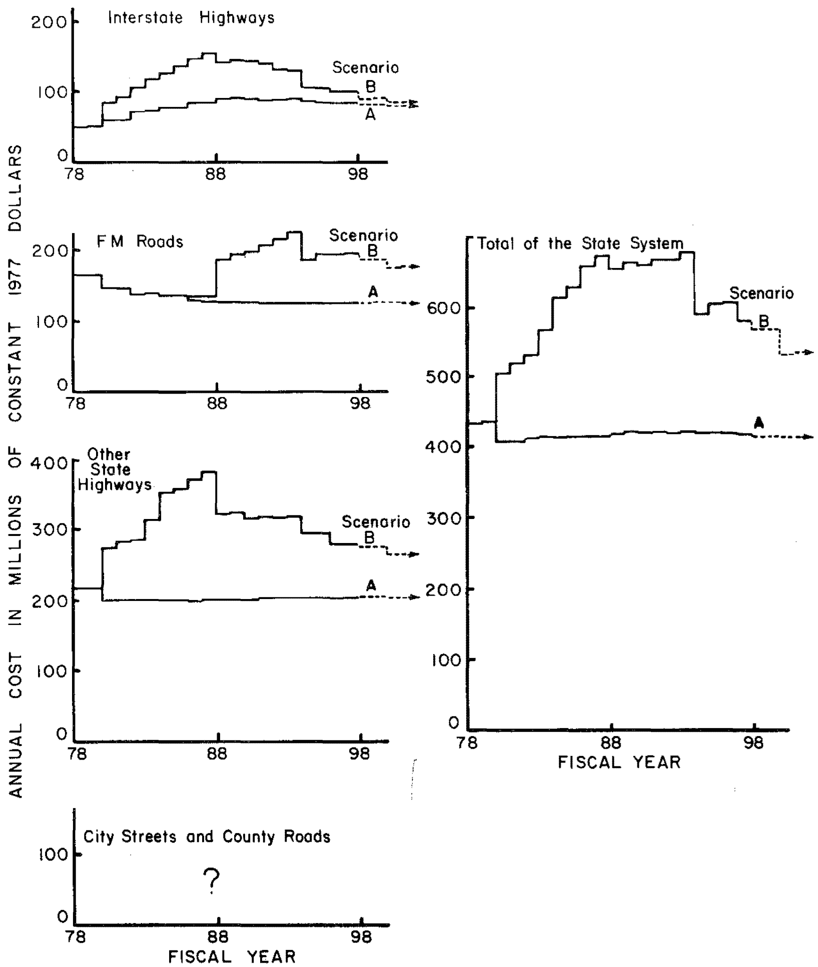

Figure 5. Costs to maintain the existing system (maintenance, replacement, and rehabilitation). Bridge costs included in totals only reflect expense of upgrading structurally deficient bridges to carry the loading of the respective scenarios. Not included are the costs of bridge maintenance, rehabilitation and replacement due to functional deficiencies and deterioration.

Due to the current interest in the energy situation, a separate analysis was conducted to examine what, if any, fuel savings might result from an increase in truck weights. These calculations indicate that fuel saved would be about 1.8 percent of that needed to haul the same amount of truck freight under the present weight law.

Additional analyses were completed in an attempt to relate vehicular pollution and changes in vehicle weights. For the three major Texas metropolitan areas (Dallas-Ft. Worth, Houston-Galveston, and San Antonio), a decrease representing less than a 1 percent reduction in pollution generated by all urban transportation was computed. The available data and research on noise pollution indicated that the hypothesized increases in axle weight limits should generate only small increases in noise along highways.

Other Considerations

The major approach to this study involved the estimation of the comparative maintenance and rehabilitation costs of perpetuating the state highway systems under current weight limitations and on future use under different weight conditions. *These costs were based on alternative weight limitations on truck use and did not consider size alternatives.* An increase in the size of vehicles has significant ramifications beyond the scope of this study and is mentioned only to enable a better appreciation of the limitation implicit in these findings.

Many significant considerations are involved with both size and weight changes in truck usage that were not considered explicitly in this study. These include, but are not limited to, the following:

- geometric design and redesign and construction of streets and highways to accommodate larger trucks, e.g., longer and wider vehicles resulting in modification in lane, median and shoulder widths, passing lanes, turning radii at curves and intersections, signing, safety rest-stops, right-of-way requirements, etc.;
- highway safety considerations reflecting a more diverse mix of vehicles traveling on the highways, e.g., larger, longer or heavier trucks mixed with increasingly smaller automobiles create significant safety issues which may be translated into higher accident rates and a corresponding increase in accident severity;
- other highway operational implications such as wet weather conditions (splash and spray), oversize vehicles, hazardous loads, etc.;
- costs of replacing bridges and pavements on county roads, city streets, private driveways, and parking terminals.

- additional costs of the construction of pavements and bridges to accommodate heavier loads on new locations;
- accelerated bridge deterioration related to heavier and increased frequency loading is known to occur but cannot be quantified with current technology.
- implication of new design trucks and performance, such as their acceleration and braking capabilities, and any modifications in truck climbing lanes and downgrade considerations;
- changes in technology in the goods transportation industries; and
- externalities associated with heavier truck loads and the freight shares of rail, pipelines, and waterways due to modal shifts.

The published version of this report may be obtained by addressing your request as follows:

Phillip L. Wilson, State Planning Engineer, Transportation
Transportation Planning Division
State Department of Highways
and Public Transportation — File D-10R
P. O. Box 5051
Austin, Texas 78763
(Phone: (512) 475-7403 or TEX-AN 822-7403)