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Neil A. Burke
Kubilins Transportation Group, Inc.

Thomas H. Maze
Iowa State University

Michael R. Crum
Iowa State University, mcrum@iastate.edu

David J. Plazak
Iowa State University

Omar G. Smadi
Iowa State University, smadi@iastate.edu

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Dedicated Truck Facilities as Solution to Capacity and Safety Issues on Rural Interstate Highway Corridors

Abstract

This paper identifies the safety and operational benefits of constructing dedicated truck facilities on a rural Interstate corridor. The Interstate highway segment in the case study is a 164-mi section of I-80 from the Iowa-Illinois border to Altoona, Iowa (an eastern suburb of Des Moines, Iowa). Although many studies have considered constructing an additional lane on freeways and designating it for trucks only, this paper considers the construction of a separate four-lane, limited-access facility for trucks. The I-80 corridor was analyzed with the Highway Economic Requirements Software-state edition (HERS-ST) to measure the performance before and after trucks were removed from the general purpose lanes. Several benefit-to-cost ratios were calculated outside of HERS-ST to determine the economic feasibility (but not the financial feasibility) of constructing dedicated truck lanes. Since there are no similar truck-only facilities in the United States, it is unknown what proportion of motor carriers would choose to use a truck-only facility rather than the mixedtraffic lanes (general purpose lanes), and future policy may or may not require trucks to use parallel truck-only facilities. Therefore, a sensitivity analysis was conducted within the benefit-to-cost analysis to determine the benefits of diverting 100%, 75%, 50%, and 25% of trucks to a dedicated truck facility. At all levels of diversion, the benefits exceed the costs. Although the analysis shows that a truck-only facility is desirable, the policy framework to make such a facility physically and financially feasible does not exist in federal or Iowa policy.

Keywords

dedicated truck facility, limited-access facility, truck lanes, HERS-ST

Disciplines

Construction Engineering and Management | Operations and Supply Chain Management | Transportation Engineering

Comments

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Dedicated Truck Facilities as Solution to Capacity and Safety Issues on Rural Interstate Highway Corridors

Neil A. Burke, Tom H. Maze, Michael R. Crum, David J. Plazak,
and Omar G. Smadi

This paper identifies the safety and operational benefits of constructing dedicated truck facilities on a rural Interstate corridor. The Interstate highway segment in the case study is a 164-mi section of I-80 from the Iowa–Illinois border to Altoona, Iowa (an eastern suburb of Des Moines, Iowa). Although many studies have considered constructing an additional lane on freeways and designating it for trucks only, this paper considers the construction of a separate four-lane, limited-access facility for trucks. The I-80 corridor was analyzed with the Highway Economic Requirements Software–state edition (HERS-ST) to measure the performance before and after trucks were removed from the general purpose lanes. Several benefit-to-cost ratios were calculated outside of HERS-ST to determine the economic feasibility (but not the financial feasibility) of constructing dedicated truck lanes. Since there are no similar truck-only facilities in the United States, it is unknown what proportion of motor carriers would choose to use a truck-only facility rather than the mixed-traffic lanes (general purpose lanes), and future policy may or may not require trucks to use parallel truck-only facilities. Therefore, a sensitivity analysis was conducted within the benefit-to-cost analysis to determine the benefits of diverting 100%, 75%, 50%, and 25% of trucks to a dedicated truck facility. At all levels of diversion, the benefits exceed the costs. Although the analysis shows that a truck-only facility is desirable, the policy framework to make such a facility physically and financially feasible does not exist in federal or Iowa policy.

A dedicated truck facility can be defined as a system of roadways used exclusively by trucks with three or more axles (*1*). These exclusive roadways may be tolled or free. Segregating cars from trucks is believed to improve safety, reduce congestion, improve traffic operations, and facilitate the efficiency of commodity movement. Other studies have considered managed lanes on freeways with significant truck volumes, where trucks are restricted to a specific lane (*2–4*). Several studies have indicated that separating combination trucks from other vehicles has benefits related to freight productivity, operations, and safety (*5, 6*).

The purpose of this paper is to present a specific case study conducted on high truck-volume rural Interstate highway segments to illustrate the safety, operational, and productivity benefits of separating trucks from other vehicles. The analysis provides only a conceptual-level analysis and does not answer many of the problematic issues related to creating a policy framework to achieve the benefits identified in this paper. This paper examines the potential crash reduction resulting from the corridor, the impacts that large vehicles may have on delays, and the economic benefits resulting from increased productivity to determine if dedicated truck lanes will improve traffic operations, safety, and freight mobility. The case study is the I-80 corridor between the Illinois border (Mississippi River crossing) and the east side of the Des Moines, Iowa, metro area (Altoona, Iowa). Table 1 presents the average annual daily traffic (AADT) volumes and the percentage of the traffic flow made up of trucks. Trucks generally make up more than 30% of the traffic volume except on segments of urban freeway (Altoona and the I-74 interchange). The Iowa Department of Transportation (DOT) expects truck traffic to continue to grow at a rate of 2% per year and automobile traffic to grow at a rate of 1% per year.

Rural segments of I-80 currently experience congestion, and all the structures are reaching the end of their design life and must be rebuilt. The current plan is to rebuild the entire corridor over the course of 15 years as a six-lane freeway with right-of-way and to add an additional lane in each direction in the future. As an alternative to rebuilding a facility with six general purpose lanes, we propose reconstructing the existing four-lane general purpose facility and adding an additional four-lane truck-only facility. Initially a two-lane truck-only facility was proposed, but because of the high future and present truck volumes in the I-80 corridor, one lane in each direction would simply be insufficient.

The Highway Economic Requirements System–state edition (HERS-ST) software is used to forecast the operating characteristics of separating combination unit trucks from the general purpose lanes. HERS-ST is a state-level version of the Highway Economic Requirements System (HERS) originally created to support the U.S. Department of Transportation's biennial *Highway Condition and Performance* report to Congress (*7*). The base data are input to HERS and describe the highway's condition, capacity, geometry, current volumes, and expected growth. Submodels within HERS then forecast the future performance of the highways in terms of future traffic crashes, operating costs, and travel time. For example, within the basic highway design information (e.g., a four-lane freeway with paved

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N. A. Burke, Kubilins Transportation Group, Inc., 800 West Hill Street, Suite 202, Charlotte, NC 28208. T. H. Maze, Department of Civil, Construction, and Environmental Engineering, and D. J. Plazak and O. G. Smadi, Center for Transportation Research and Education, Iowa State University, 2711 South Loop Drive, Suite 4700, Ames, IA 50010. M. R. Crum, College of Business, Iowa State University, 2200 Gerdin Business Building, Ames, IA 50011. Corresponding author: T. H. Maze, tmaze@iastate.edu.

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TABLE 1 Current Traffic on I-80

Intersection Point	AADT	% of Combination Units	Four Axle % of AADT	Five Axle % of AADT	Six or More Axles % of AADT	% of Multiple Trailers
Altoona, Iowa	36,800	24	6	16	1	1
US-63	26,700	32	8	22	1	2
Coralville, Iowa	34,000	26	7	18	1	1
I-280	31,500	32	8	22	1	2
I-74	48,000	20	5	13	>1	1
Illinois border	33,500	25	6	17	1	1

SOURCE: Iowa DOT.

shoulders and a 60-ft median), crash frequency is largely a function of traffic volumes, and a submodel uses known functions [safety performance functions (SPFs)] to estimate crash frequency.

HERS-ST is the state version of HERS. HERS-ST is intended to provide only planning-level analysis (network analysis) and is suitable for testing conceptual plans. Normally the input to HERS-ST consists of FHWA Highway Performance Monitoring System samples (*8*). However, the Iowa DOT has populated Iowa's HERS-ST database with data for all segments of state-operated highways (including I-80).

HERS-ST is used to provide estimates for the entire corridor (truck-only lanes and general purpose lanes) for operating and travel-time costs. To estimate the improvement in safety, future crash rates were forecast based on past crash rates on I-80, but without some or all of the crashes being caused by the interaction between automobiles and trucks. Facility costs are based on concept-level construction costs and maintenance costs provided by the Iowa DOT.

I-80 CORRIDOR CASE STUDY

This section provides a descriptive data analysis of the I-80 corridor in Iowa from the Illinois border to Milepost 142 in Altoona, Iowa (an eastern suburb of Des Moines, Iowa). This is a rural 164-mi corridor connecting the industrial Upper Midwest and East with the West. I-80 is an important transcontinental corridor for freight, vacationers, and intercity travelers. Interstate 80 parallels North America's first transcontinental highway, the Lincoln Highway, and North America's first transcontinental railroad, the Union Pacific mainline between Chicago, Illinois, and California.

Descriptive Analysis of Commodity Flows on the I-80 Corridor

To understand the types of truck-borne commodities that flow along I-80 and the trip length distribution of truck trips, the Reebie and Associates Transsearch Database from 2001 was analyzed. Because it was difficult to break I-80 into segments, the entire corridor across the state of Iowa was used for this descriptive analysis. Overall, 47% of the trucks traveled more than 100 mi on the I-80 corridor. Although at this point it is only speculation, it is believed that motor carriers making trips over long distances (more than 100 mi) would be more likely to use truck-only facilities. Twenty-one percent of all trucks traveled over 200 mi on the I-80 corridor. Twelve percent of the combination units on the I-80 corridor were classified as bridge trips that had neither an origin nor destination within the state of Iowa.

Food and kindred products were the most commonly hauled commodity on the I-80 corridor, representing 28% of all truck trips in 2001, while expedited parcel services, plastics, steel, and chemical transport represented over 10% each of the total commodities hauled.

Less-than-truckload (LTL) carriers made up 42% of the total truck traffic on the I-80 corridor, followed by truckload (TL) (38%), and private carriers (20%). If longer combination vehicle (LCV) operation were allowed on a truck-only facility, cost savings would be possible if truckloads coupled into turnpike doubles (a tractor pulling two 45-ft. to 48-ft. trailers) and LTL carriers coupled their western double (a tractor pulling two 28-ft trailers) into triples (a tractor pulling three 28-ft trailers) (*9*).

I-80 Corridor Crash Analysis

A 4-year analysis of all crashes involving trucks on the I-80 corridor has been conducted using crash data from 2001 through 2004 to determine the severity of these crashes along with the major causes. The crash data were obtained from the Iowa Traffic Safety Data Service at the Center for Transportation Research and Education at Iowa State University. Figure 1 presents the number of crashes involving at least one truck.

Figure 1 indicates that a one car–one truck crash is the most common collision involving a truck on the I-80 corridor. Figure 2 presents the most common collision types involving one truck and one car on the I-80 corridor. A noncollision crash includes run-off-road and struck-a-fixed-object crashes.

The most common crashes are collisions involving vehicles moving in the same direction (sideswipe and rear-end). These crashes are commonly caused by differences in vehicle speed; differences in speed change performance; and differences in maneuverability when passing, braking, weaving, and merging. This implies that if cars and trucks operated on separate facilities, the crashes observed between trucks and cars caused by difference in performance would be eliminated. The "other" category represents 12 collision types that constituted less than 5% each of the total crashes involving trucks on the I-80 corridor from 2001 through 2004.

To determine the vehicle types that are most likely to cause rear-end and sideswipe–same direction crashes, a comparative analysis was conducted in which the contributing circumstances for each vehicle involved in a crash were compared against the major cause of the crash. If the major cause matched the contributing circumstance in the crash data, then the vehicle was assumed to be at fault. In this analysis,

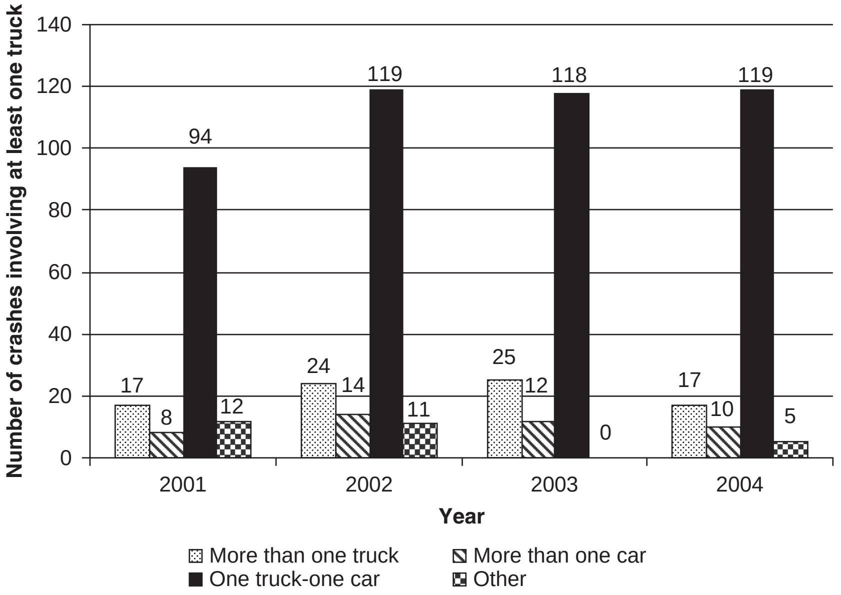

FIGURE 1 Number of vehicles in crashes involving trucks on I-80 corridor.

single-unit trucks, buses, and motor homes were grouped in with cars. A crash was labeled "no fault reported" if the "contributing circumstances" field in the crash database was labeled as unknown. Figure 3 shows the assignment of fault in rear-end crashes, and Figure 4 shows the assignment of fault in sideswipe–same direction crashes.

Figure 3 explains that a higher percentage of cars was found to be at fault in rear-end collisions between 2001 and 2004. Figure 4 indicates that cars have a higher percentage of fault in sideswipe–same direction crashes. Both Figures 3 and 4 illustrate that, in crashes in which fault could be assigned, roughly two-thirds of crashes were not the fault of the truck operator. This is relatively consistent with a study conducted by Kostyniuk et al. in which they analyzed crash data from the Fatality Analysis Reporting System to determine the cause of fatalities in crashes involving heavy trucks and other vehicles (*10*). The study found that car drivers are three times more likely to commit unsafe actions that contribute to fatal car–truck crashes. Kostyniuk et al. attributed the findings to the inability of car drivers to judge truck speed maneuverability, braking, and acceleration.

Crash Rate and Severity Calculation

With I-80 crash data, crash rates were calculated for all vehicles, semitrucks, and vehicles other than trucks. A comparative analysis of the crash rate of all vehicles and trucks was conducted using the Iowa DOT's Geographic Information and Management System. Table 2 displays the crash rates according to the vehicles involved in the crashes on the I-80 corridor and makes use of 3 years of crash data for the entire I-80 corridor. To understand the statistical confidence of the estimates of combined traffic, truck, and car crash rates, the authors made a fairly common assumption that crashes are Poisson distributed, an assumption tested in prior work with Iowa crash data, which showed that Poisson distribution accurately models crash frequency (*11*). The mean (crashes per year) in the Poisson distribution is equal to the variance. With the distribution variance,

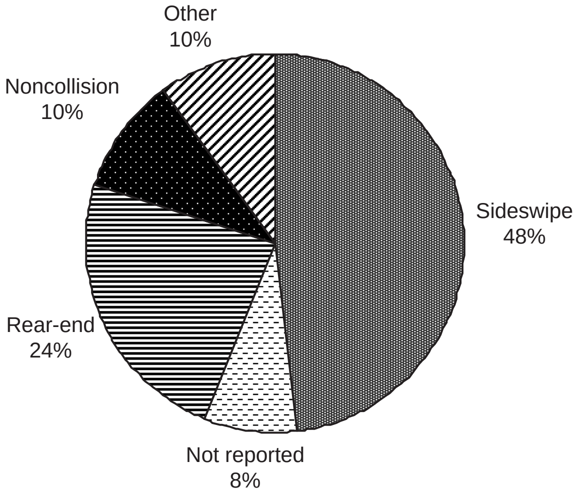

FIGURE 2 Common collision types involving trucks on I-80 corridor, 2001–2004.

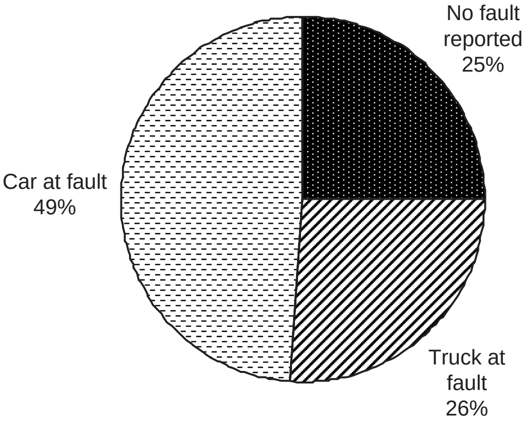

FIGURE 3 Assignment of fault in rear-end crashes, by vehicle type, on I-80 corridor, 2001–2004.

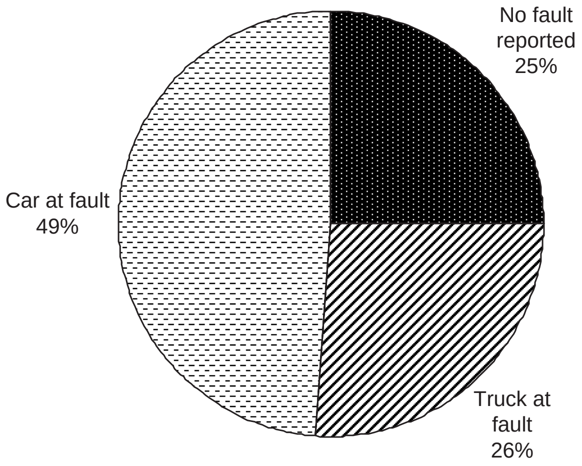

FIGURE 4 Assignment of fault in sideswipe–same direction collisions, by vehicle type, on I-80 corridor, 2001–2004.

the variance of the mean can be calculated and, through the central limit theorem, the mean is known to become large (for example, greater than 30, but certainly for a mean greater than 100) and the occurrence of events normally distributed (*12*). With normal statistics, the 95% confidence intervals around the crash rate are calculated and shown in Table 2. At the 95% confidence level, the mean crash rates for all crash categories are statistically different.

A modified crash severity ranking was calculated to place more weight on serious injuries and fatalities following the KABCO severity injury scale (i.e., K = fatal, A = incapacitating injury, B = noncapacitating injury, C = possible injury, and O = no injury) (*13*). The modified crash rankings range from a no injury crash (weighted 1) to a fatal crash (weighted 5). Table 3 depicts the modified crash rankings for all vehicle crashes and truck crashes and the percent of crashes that involve a major injury or fatality. It is evident that crashes involving trucks are more likely to cause injuries and fatalities, because this group has a higher crash severity ranking than the other groups.

Cost Estimation of Capacity Improvements to the I-80 Corridor

Concept-level cost estimates were obtained from the Iowa DOT Office of Rural Pre-Design for several reconstruction alternatives, as well as a cost estimate for a separate highway facility specifically for trucks. In this analysis, the reconstruction costs for a four-lane facility assume that a dedicated truck facility would be constructed on the I-80 corridor. The current plan for improving the I-80 corridor in eastern Iowa is to reconstruct the current four-lane facility into six general purpose lanes with right-of-way to expand to eight lanes in the future. This option serves as the basic alternative to a truck-only lane facility. The alternative with truck lanes involves the reconstruction of four general purpose lanes with right-of-way to expand to six lanes with an additional four-lane truck-designated facility. Table 4 presents the total cost for the basic I-80 alternative (a six-lane rural freeway) and the cost of reconstructing four general purpose lanes.

TABLE 2 I-80 Corridor Crash Rates for Various Vehicle Types, 2002–2004

	All Crashes	Crashes Involving Trucks	Crashes Not Involving Trucks
VMT	5,531,185	1,527,161	4,004,025
Total crashes	3,571	621	2,950
Crashes per year	1,190	621	983
Crash rate	0.59	0.37	0.67
Crash rate 95% confidence interval	0.609–0.570	0.400–0.342	0.697–0.649

NOTE: Based on millions of vehicle miles.

TABLE 3 I-80 Corridor Modified Crash Severity Rankings for Truck Crashes and All Crashes, 2002–2004

	All Crashes	Crashes Involving Trucks
Modified crash severity ranking	1.46	1.58
Weighted major injury	14%	21%
Weighted fatality	4%	7%

Table 5 presents concept-level estimates for constructing a four-lane rural roadway on a new alignment (the truck-designated facility) in which the pavement in each direction is 26 ft wide (two 12-ft lanes with 1 ft of pavement outside the fogline), has a median 68 ft wide, and has 6-ft and 8-ft granular shoulders (inside and outside shoulders, respectively). The cost for each interchange on the truck-designated facility would be less than interchanges for the general purpose lanes because the interchange bridges are not required to be wide enough to accommodate potential widening of the truck lanes, and it is expected that most but not all locations of an interchange for the general purpose lanes will have a corresponding interchange on the truck-designated facility. Bridges for crossing streams and rivers are assumed to cost the same on the four truck-designated lanes as on the general purpose lanes, only because widening is not expected, these bridge are built for only two lanes in each direction. At this level of analysis, the cost estimates do not take into account the impacts of vehicle wear on the facility. For example, the truck-only lanes would be expected to wear more because of the increased repetitive heavy-axle loads, while the general purpose lanes would be expected to wear less. It is expected that at the project-level analysis (as opposed to the planning- or network-level analysis), highway designers would consider building much thicker and more load-tolerant pavements on the truck-only lanes and perhaps thinner pavement on the general purpose lanes; as a

TABLE 4 Calculated Improvement Costs for Alternatives on I-80 Corridor

Improvement	Six-Lane Freeway ($)	Four-Lane Freeway ($)
Reconstruction cost for 164 mi	885,600,000	721,600,000
Reconstruction cost for 41 interchanges	102,500,000	98,400,000
Reconstruction cost for 158 bridges	103,158,201	69,973,729
Total	1,091,258,201	889,973,729

TABLE 5 Estimated Cost of Constructing a Four-Lane Limited-Access Highway on New Alignment

	Cost per Mile ($)	Total (cost per mile × 164) ($)
Grading	1,000,000	164,000,000
Paving	1,600,000	262,400,000
Land acquisition	630,000	103,320,000
Diamond interchanges	—	54,600,000
Bridges	—	69,973,729
Total	3,230,000	654,293,729
Corridor total (with four-lane reconstruction)	—	1,544,267,458

result, they would reduce total life-cycle cost by using appropriate designs for each application.

The total capital costs for the basic option is $1.1 billion. The total capital costs for the dedicated truck facility includes $890 million for the reconstruction of four general purpose lanes with right-of-way for six lanes, plus $654 million for the construction of a four-lane truck-designated facility, totaling $1.5 billion. The cost of building the truck-only facility is lower than building the multipurpose lanes for several reasons. These include the fact that the new lanes will be built on new right-of-way that is currently largely agriculture fields; therefore, there is no cost involved in demolishing and removing an existing facility. All structures will be built for two lanes only in each direction, and many of the facilities for the general purpose lanes (e.g., rest areas, ramp terminal traffic control) may be shared. However, as will be seen later in the analysis, even if the estimate of the truck-only facility is 20% below the actual costs, the greater cost does not affect the positive benefit-to-cost ratio for even the most pessimistic estimate of truck traffic on the truck-only facility.

HERS-ST AND BENEFIT-TO-COST ANALYSIS OF THE I-80 CORRIDOR

HERS-ST was used to estimate the travel costs (operating costs and travel time costs) of the two options under varying levels of use of the truck-exclusive lanes by motor carriers. The benefit-to-cost analysis was calculated outside of HERS-ST by using Microsoft Excel.

HERS-ST Overview

Truck-only facilities are not a recognized improvement in HERS-ST; therefore, a percentage of the combination truck volumes was removed by hand from the general purpose lanes of I-80 and placed into a data set that represents a dedicated truck facility in HERS-ST. The truck-only facility was modeled with two lanes in each direction with a speed limit of 70 mph. The peak capacity, AADT, future AADT, and percentage of combination truck estimates were recalculated and truck traffic volume on the truck-only facility and the general purpose facility entered by hand into the HERS-ST database for each scenario. The same calculations were recomputed for the general purpose lanes where cars and other vehicles travel.

A series of run scenarios with varying percentages of truck traffic in the general purpose lanes was conducted. Because there are no other dedicated truck facilities of this magnitude in the United States, we could only speculate at the proportion of motor carriers that would voluntarily use the truck-dedicated facility. Four separate levels of diversion to the truck-dedicated facility were assumed to determine the benefits of the facility under varied levels of subscription:

- 25% of all trucks use the dedicated facility, and 75% of trucks use the general purpose lanes;
- 50% of all trucks use the dedicated facility, and 50% of trucks use the general purpose lanes;
- 75% of all trucks use the dedicated facility, and 25% of trucks use the general purpose lanes; and
- 100% of all trucks use the dedicated facility, and 0% of trucks use the general purpose lanes.

Four HERS-ST runs were conducted to model the general purpose segments under the four scenarios, and four runs were executed to represent combination trucks traveling on a truck-only limited-access facility. To provide additional comparison, a full engineering needs analysis was conducted for a six-lane facility without dedicated truck lanes.

Discussion of HERS-ST Analyses

Table 6 presents the total delay over 20 years estimated by HERS-ST for each diversion scenario for the truck-only facility and for the basic option.

It is evident from Table 6 that the scenarios that consider a larger diversion of combination units to the truck-only facility experience fewer hours of delay per vehicle over the 20-year HERS-ST analysis. The six-lane reconstruction scenario (the basic option) has the highest level of delay in the HERS-ST analysis because all combination unit trucks are traveling in mixed traffic on the general purpose lanes.

The HERS-ST analysis provided an estimation of future operating conditions if a dedicated truck facility were constructed on the I-80 corridor in Iowa. When combination trucks were removed from the mainline of I-80, HERS-ST predicted that total crashes

TABLE 6 Total Delay for the I-80 Corridor Throughout 20-Year HERS-ST Analysis

Four General Purpose Lanes Plus Four-Lane Truck-Only Facility				Only General Purpose Lanes
100% Diversion	75% Diversion	50% Diversion	25% Diversion	Six-Lane Reconstruction
131,686,000	191,658,000	810,602,000	981,442,000	1,461,368,000

NOTE: Delay measured in terms of hours.

would decrease modestly. Total delay was reduced substantially when trucks were removed from the general purpose lanes. It was evident from the HERS-ST analysis of the simulated truck facility that one travel lane (in each direction) could not effectively handle the diverted trucks because of the large number of trucks that travel the I-80 corridor; therefore, analysis of a two-lane truck-only facility was not considered. None of the underlying HERS-ST performance models (safety performance, travel time performance, and operating costs performance) were estimated with data from a truck-only facility. Although the authors have confidence in the traffic flow models that estimate delay within HERS-ST, they do not have the same level of confidence in SPFs that estimate future crashes. Therefore, to estimate safety benefits (reduced crashes), the existing crash rates (crashes per million vehicle miles) were weighted by severity and the number of crashes that involve a truck and another type of vehicle were partially or totally reduced. The number of car-and-truck crashes eliminated in the analysis is in proportion to the percentage of trucks diverted to the truck-only facility. For example, if all trucks were diverted to the truck-only facility, it was assumed that all crashes involving a truck and a car would be eliminated. It was felt that this was a reasonable approach considering the lack of actual safety performance data for a dedicated truck facility of this magnitude. As will be seen, the safety benefits are only a fraction of the travel cost benefits; therefore, the resulting recommendations are less sensitive to an error in the safety cost benefits.

Taking this approach and removing all crashes involving a truck and another vehicle assumes that differences in vehicle performance are the predominate cause of rear-end and sideswipe crashes involving a truck and a car. Alternatively, it has been proposed that if trucks were removed from the general purpose lanes, the truck and car crash still might have occurred; only the truck involved might crash into another truck, and the car involved might crash into another car. At this point it is still speculation what the safety performance will be when trucks are separated from other traffic, but this alternative theory seems highly unlikely given the types of crashes that are expected to be eliminated (car–truck rear-end and sideswipe crashes).

Dedicated Truck Facility Benefit-to-Cost Analysis

A 20-year investment period, 2006 through 2027, was used for the benefit-to-cost analysis. The benefits are reduced road user costs, which included reduced operating costs, reduced travel time costs, and reduced safety costs. Operating and travel time costs were derived directly from HERS-ST. Crash cost reductions were estimated by calculating crash rates by severity (property damage only, injury crashes, and fatal crashes) for crashes that involved a car and a truck using actual crash data for the 3-year period from 2002 through 2004. Each type of crash was reduced by 25% for each increasing truck diversion. Hence, the 75% truck diversion would have 50% fewer car-truck crashes than the 25% diversion scenario. The resulting crash rate by severity was multiplied by the vehicle miles traveled expected in each year to arrive at a total number of crashes during the year in both general purpose lanes and the truck-only lanes. Then, the total number of crashes in each category was multiplied by values used by the Iowa DOT to estimate the economic loss for each severity level. The Iowa DOT assigns fatal crashes an economic loss of $1.2 million, all types of injury crashes an average value of $48,000, and noninjury crashes an economic loss of $6,500. The resulting crash rates, modified to show the estimated impact of separating trucks from the general purpose lanes for each scenario, are shown in Table 7.

TABLE 7 Modified Crash Rates for All Vehicles in Several Truck Diversion Scenarios

Facility Type	Property Damage Only[a]	Injury[a]	Fatal[b]
No truck lanes	0.331	0.118	0.48
25% truck diversion	0.314	0.110	0.45
50% truck diversion	0.297	0.102	0.41
75% truck diversion	0.280	0.094	0.36
100% truck diversion	0.262	0.086	0.33

[a] Per million vehicle miles.
[b] Per hundred million vehicle miles.

The benefit-to-cost analysis is shown in Table 8. Interest rates for evaluating highway projects usually have inflation and risk removed, making them lower than market rates. A discount rate of between 3% and 5% is recommended in the guidance on HERS-ST provided by FHWA, 4% is consistent with current Iowa DOT practice, and 4% was used in this analysis to covert all future costs to their net present worth (*14*). Using net present worth and benefit-to-cost-ratio analysis has methodological issues, but it is the commonly accepted method for conducting highway investment analysis (*15*).

The travel costs include travel time costs and vehicle operating costs. Travel cost savings make up the largest portion of the benefits and result from higher average speeds coupled with reduced delay. The facility costs include the capital costs plus the discounted annual winter maintenance and facility maintenance costs over the 20-year period. Compared with the basic option (a six-lane general purpose facility with right-of-way for expansion to eight lanes), all scenarios with truck-only lanes offer greater benefits above the basic option that exceed the added facility costs. The 100% diversion of combination units to the dedicated truck lanes produced the highest benefit-to-cost ratio. The major reason for the highest benefits with 100%

TABLE 8 Benefit-to-Cost Analysis for I-80 Corridor When Percentages of Combination Trucks Divert to Dedicated Truck Facility

	Travel Costs ($)	Crash Costs ($)	Total User Costs ($)	User Benefits ($)	Facility Costs ($)	B-C
Six-lane reconstruction	27,206,883,100	436,572,110	27,643,455,210		1,137,734,941	
25% truck diversion	26,679,473,823	356,567,365	27,036,041,187	607,414,022	1,590,744,198	1.34
50% truck diversion	26,627,802,217	334,243,381	26,962,045,598	681,409,612	1,590,744,198	1.50
75% truck diversion	26,599,064,996	315,696,334	26,914,761,330	728,693,880	1,590,744,198	1.61
100% truck diversion	25,863,239,951	254,430,872	26,117,670,822	1,525,784,388	1,590,744,198	3.37

diversion is that it provides the greatest distribution of all traffic across all lanes. The traffic that remains in the general purpose lanes benefits from travel cost reduction only slightly better than trucks that diverted to the truck-only lanes (approximately 55% general purpose lanes to 45% for trucks moved to truck-only lanes).

The authors were concerned about the accuracy of the construction cost estimates provided by the Iowa DOT. It is not uncommon for the costs for large public works projects, including highway projects, to be underestimated at the planning stages (*16*). However, even for the lowest diversion level (25%), benefits exceed costs by about $150 million; therefore, the estimate of the truck-only lanes, for example, could be almost 25% low, and the benefit-to-cost ratio would still be greater than one.

LCV Sensitivity Analysis

A sensitivity analysis was conducted within the dedicated truck facility benefit-to-cost analysis to compare the potential benefits of truck load carriers coupling trailers into turnpike doubles, and LTL carriers coupling trailers into triples. The baseline percentages used in the benefit-to-cost analysis were based on the assumption that if LCV operation were allowed on a dedicated truck facility, then 5% of the truckload carriers would couple their loads into turnpike doubles, and 5% of LTL carriers would couple into triples. Since HERS-ST is insensitive to the size of the truck, the total number of trucks under the LCV scenario was reduced by the number of combination units that would be eliminated by trailer coupling. A more exact analysis could be conducted to reflect both operating cost differences and the greater road wear of LCVs, but the current level of analysis was deemed appropriate at the conceptual level. To provide a concept-level analysis of the economic impact of permitting LCVs on a truck-dedicated facility, the benefit-to-cost analysis was conducted again under the following scenarios:

- 5% of truckload carriers will couple into turnpike doubles, and 5% of LTL carriers will couple into triples;
- 10% of truckload carriers will couple into turnpike doubles, and 10% of LTL carriers will couple into triples; and
- 15% of truckload carriers will couple into turnpike doubles, and 15% of LTL carriers will couple into triples.

Table 9 presents the results of the LCV sensitivity analysis.

It is evident through the sensitivity analysis that heightened levels of freight productivity and decreased crash costs are possible when the number of trucks is reduced through the coupling of trailers into LCVs. Studies of LCV crash frequency compared with that of other trucks have shown that LCVs can result in even higher safety performance than non-LCV trucks. This has been attributed to the additional restrictions placed on the qualifications and experience of LCV drivers and the fact of their using better-maintained equipment (*17, 18*).

TABLE 9 Results of LCV Sensitivity Analysis

	Scenario 1 B-C	Scenario 2 B-C	Scenario 3 B-C
25% truck diversion	1.38	1.52	1.82
50% truck diversion	2.34	2.55	2.85
75% truck diversion	4.08	4.4	4.85
100% truck diversion	6.71	7.06	7.76

CONCLUSIONS

From this research, several important conclusions can be made concerning the benefits of dedicated truck facilities on rural Interstate highway corridors. The descriptive crash data analysis has shown that crashes involving both trucks and cars are the most common type of crashes involving a truck. The majority of these crashes are the fault of the automobile driver, and most truck–car crashes result from differences in vehicle performance, size, and maneuverability. HERS-ST analysis indicates that capacity improvements would not be required in the general purpose lanes if a truck-only facility were constructed. The benefit-to-cost analysis produced ratios above 1.0 for all truck diversion scenarios. Additional benefits can be found when successive percentages of carriers couple their loads into LCVs.

The greatest benefits found as a result of separating combination trucks from other traffic are traffic operations benefits. In this case, the biggest benefits will be accrued by traffic in the general purpose lanes, although trucks on the truck-only facility will benefit as well from improved traffic flow performance and fewer crashes.

RECOMMENDATIONS

This research has shown that at the conceptual level, a dedicated truck facility would improve the safety and traffic operations for all vehicles and improve freight productivity on the I-80 corridor. Although the project may be economically feasible (the benefits exceed the costs), at this time it is not financially feasible given the current financial position of the Iowa DOT. Tolling is an approach that could make a truck-only facility financially feasible. However, constructing a tolled truck-only facility in the I-80 corridor and restricting trucks to truck-only lanes would require changes in Iowa law and federal transportation policy. Such changes are not recommended at this time, although the concept deserves a more detailed analysis. The challenge for future research is to devise a system to finance truck-dedicated systems that would be financially viable and in which the costs of the facility (or tolls) are proportioned to traffic segments (general purpose versus combination truck traffic) in proportion to their benefits.

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