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3 **Estimating the Cost of Overweight Vehicle Travel on Arizona Highways**  
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**ABSTRACT**

Overweight vehicle enforcement remains a problem in most U.S. states. Most port-of-entry and mobile enforcement crews perceive they are understaffed and/or under funded. There are few ports equipped with cutting edge technology to adequately identify overweight truck violations. Some ports are closed more hours than they are open. Operators of illegally overloaded vehicles often escape penalties. Consequently, there is often little deterrent to illegally overloading vehicles.

Billions of dollars are spent each year to replace and repair U.S. highways. Yet, only a tiny fraction of trucks are weighed. It seems likely that the fees and fines collected from overweight vehicles are not commensurate with the actual cost of pavement damage. This research is intended to explore this problem and attempt to estimate a dollar cost figure for pavement damage due to overweight vehicles operating in the State of Arizona.

Both the literature and our survey indicate that overweight vehicles likely constitute a substantial share of traffic and account for a significant portion of the pavement wear. The rough estimate produced in this research for the State of Arizona implies that there may be a favorable benefit/cost ratio for enhanced motor carrier enforcement efforts. The same may be true for many other states, as well.

## INTRODUCTION

Overweight vehicle enforcement remains a problem in most U.S. states. [1] Most port-of-entry and mobile enforcement crews perceive they are understaffed and/or under funded. There are few ports equipped with cutting edge technology to adequately identify overweight truck violations. Automated systems might be used to effectively monitor overweight vehicles and provide safety and security benefits [2, 3]. These would prove useful, especially when a lack of data precludes accurate counts and weights of vehicles. Also, some ports are closed more hours than they are open [4]. Operators of illegally overloaded vehicles often escape penalties. Consequently, there is often little deterrent to illegally overloading vehicles.

Billions of dollars are spent each year to replace and repair U.S. highways. Yet, less than 1% of the incoming trucks are weighed at some ports-of-entry. It seems likely that the fees and fines collected from overweight vehicles are not commensurate with the actual cost of pavement damage. This research is intended to explore this problem and attempt to estimate a dollar cost figure for pavement damage due to overweight vehicles operating in the State of Arizona. The results of this study not only apply to Arizona, but to other states and countries that face challenges in mobile enforcement and pavement maintenance.

## OVERWEIGHT VEHICLE ENFORCEMENT

In 1979, the General Accounting Office (GAO) suggested that approximately 15% of all loaded trucks were overweight with respect to allowable axle loads or GVW.[5] The Federal Highway Administration (FHWA) found that the judicial system did not adequately address the severe social costs associated with overweight vehicle violations.[6] The FHWA went on to estimate that illegally overloaded trucks cost U.S. taxpayers \$160 to \$670 million per year for pavement damage. By 1987, a published questionnaire distributed to state enforcement agencies resulted in an estimate that between 10% and 25% of all trucks were overloaded. Terrell and Bell reported that majority of state officials that they surveyed perceived truck overloading to be a moderate problem. [7] At that that time, it was estimated that 10 to 25 percent of the trucks were overloaded and that 20 percent of the vehicles operating on federal-aid highways had axle or gross loads in excess of statutory limits. There were annual estimates of \$1 billion impacts on the cost of overloaded vehicles to the federal-aid highway system. Since 1987, however, the number of roads, the volume of overweight truck traffic, and the costs associated with pavement damage have likely increased.

Cottrell suggested that, in Virginia, the limited capacity of weigh stations plays a role in the number of trucks running the weigh stations. Avoidance rates at two weigh stations were examined. Eleven to 14 percent of trucks were found to avoid weigh stations by using bypass routes or waiting until the weigh station closed. In addition, portable WIM was used to measure weight of trucks running weigh stations. Of the "run-by" trucks measured, 38 percent were classified as overweight.[8] In 1994, it was found that approximately 25% of the motor vehicles that passed through weigh stations in Connecticut were illegally overweight and fined.[9] Cunagin, Mickler, and Wright examined Florida corridor and by-pass enforcement activities

through weight station avoidance. They found that the violation rate was significantly reduced through intense enforcement and that weekends were ripe for violations, when ports of entry were typically closed.[10]

In 1997, the State of Arizona Office of the Auditor General (OAG) recommended the “increase use of mobile enforcement crews along Arizona’s highways”. The OAG reported that the Motor Vehicle Division (MVD) placed “little emphasis on intrastate enforcement”. While 5.4 million trucks traveled through the ports during 1995-1996, less than 1% were checked by the MVD. Motor carrier tax evasion was estimated to account for between \$24 million to \$45 million in lost potential revenue.[11]

The challenges of weight inspections and enforcements faced each day by MVDs and Public Safety officials were documented in a 1999 edition of the *Texas Transportation Researcher*. It was reported that approximately 320 Texas Department of Public Safety troopers conducted about 85,000 weight inspections each year on more than 200,000 miles of Texas highways. Dan Middleton, manager of Texas Transportation Institute System Monitoring Program, noted that “This equates to one trooper for every 45 million vehicle-miles traveled by truck in the state — a number far too small to catch every violator.... We need a system to screen trucks in the traffic stream and identify those that have a high likelihood of being overweight... and need to be weighed statically.”[12]

Data on ratios of total overweight permits issued and overweight vehicle violations to heavy truck traffic are shown in tables 1 and 2). The permits include the total “number of overweight permits issued by States for non-divisible and divisible single trip load movements, non-divisible and divisible annual (or multiple use) load movements, and for divisible over-width load movements.”[13] According to the DOT/FHWA, the state weight violations include the total “number of trucks cited or issued civil assessments by the States for violation of weight laws. Also included are the numbers of trucks that were required to off load or shift their load to be in compliance with the weight laws.”[14, 15]

**Table 1: State Permits and Weight Violations, Fiscal Year 2003\***

State	Total overweight permits issued	Total overweight vehicle violations	VMT heavy trucks (millions)	Heavy Trucks (1,000s)	Permits/ million VMT	Violations/ million VMT	Permits/ 1,000 trucks	Violations/ 1,000 trucks
Alabama	25,507	17,693	2,575	54.8	9.9	6.9	465.5	322.9
Alaska	7,058	587	109	5.9	64.8	5.4	1,196.3	99.5
Arizona	83,651	28,457	1,380	31.5	60.6	20.6	2,655.6	903.4
Arkansas	38,787	10,597	482	22.1	80.5	22.0	1,755.1	479.5
California	197,750	77,735	6,889	200.3	28.7	11.3	987.3	388.1
Colorado	15,764	22,077	367	29.0	42.9	60.1	543.6	761.3
Connecticut	64,615	6,714	535	21.1	120.8	12.6	3,062.3	318.2
Delaware	175,281	372	183	6.5	958.9	2.0	26,966.3	57.2
DC	1,578	271	1	0.1	1,753.3	301.1	15,780.0	2710.0
Florida			2,477	76.5	-	-	0.0	0.0
Georgia	69,528	51,009	1,094	50.2	63.6	46.6	1,385.0	1016.1
Hawaii	2,767	1,248	77	5.2	35.9	16.2	532.1	240.0
Idaho	61,444	14,429	1,471	56.8	41.8	9.8	1,081.8	254.0
Illinois	133,619	71,584	11,191	177.5	11.9	6.4	752.8	403.3
Indiana	207,609	10,937	4,552	95.3	45.6	2.4	2,178.5	114.8

State	Total overweight permits issued	Total overweight vehicle violations	VMT heavy trucks (millions)	Heavy Trucks (1,000s)	Permits/ million VMT	Violations/ million VMT	Permits/ 1,000 trucks	Violations/ 1,000 trucks
Iowa	30,544	16,407	976	45.2	31.3	16.8	675.8	363.0
Kansas	43,386	20,104	1,404	52.8	30.9	14.3	821.7	380.8
Kentucky	86,380	7,020	1,025	40.3	84.3	6.8	2,143.4	174.2
Louisiana	85,487	62,811	693	25.5	123.3	90.6	3,352.4	2463.2
Maine	19,373	1,901	231	11.0	83.7	8.2	1,761.2	172.8
Maryland	145,160	21,827	290	15.8	500.7	75.3	9,187.3	1381.5
Massachusetts	69,939	5,715	898	29.8	77.9	6.4	2,346.9	191.8
Michigan	123,492	5,503	2,528	80.3	48.9	2.2	1,537.9	68.5
Minnesota	24,180	3,902	2,536	68.4	9.5	1.5	353.5	57.0
Mississippi	137,057	24,969	675	13.3	203.1	37.0	10,305.0	1877.4
Missouri	43,997	22,006	2,880	68.6	15.3	7.6	641.4	320.8
Montana	13,585	8,203	154	17.4	88.0	53.1	780.7	471.4
Nebraska	54,186	22,925	2,852	54.3	19.0	8.0	997.9	422.2
Nevada	18,514	1,007	263	10.1	70.4	3.8	1,833.1	99.7
New Hampshire	-	2,160	314	12.6	-	6.9	0.0	171.4
New Jersey	9,592	2,826	2,807	75.9	3.4	1.0	126.4	37.2
New Mexico	17,881	1,329	323	13.1	55.4	4.1	1,365.0	101.5
New York	193,970	9,551	1,767	79.7	109.8	5.4	2,433.8	119.8
North Carolina	72,493	32,999	4,327	103.7	16.8	7.6	699.1	318.2
North Dakota	49,794	17,759	35	35.2	1,414.6	504.5	1,414.6	504.5
Ohio	120,775	24,808	4,609	118.5	26.2	5.4	1,019.2	209.4
Oklahoma	37,541	1,847	19,428	233.4	1.9	0.1	160.8	7.9
Oregon	132,381	22,179	615	16.0	215.2	36.1	8,273.8	1386.2
Pennsylvania	112,140	1,453	737	44.0	152.2	2.0	2,548.6	33.0
Rhode Island	15,328	238	91	3.7	169.0	2.6	4,142.7	64.3
South Carolina	54,712	12,170	1,516	31.0	36.1	8.0	1,764.9	392.6
South Dakota	43,443	6,374	646	22.6	67.3	9.9	1,922.3	282.0
Tennessee	104,081	8,558	2,963	59.1	35.1	2.9	1,761.1	144.8
Texas	193,320	71,745	7,616	164.0	25.4	9.4	1,178.8	437.5
Utah	20,286	11,320	1,489	25.2	13.6	7.6	805.0	449.2
Vermont	26,785	1,256	260	8.4	103.2	4.8	3,188.7	149.5
Virginia	79,954	136,120	1,704	44.6	46.9	79.9	1,792.7	3,052.0
Washington	139,369	17,944	1,333	41.5	104.5	13.5	3,358.3	432.4
West Virginia	71,036	3,344	699	21.7	101.7	4.8	3,273.5	154.1
Wisconsin	21,109	8,175	2,653	61.3	8.0	3.1	344.4	133.4
Wyoming	48,221	2,275	279	11.0	172.6	8.1	4,383.7	206.8
Total	2,934,458	769,937	92,002	2,144	31.9	8.4	1,368.7	359.1

VMT = vehicle miles of travel

\*Sources: DOT/FHWA, 2005 and United States Census Bureau,

<http://www.census.gov/svsd/www/02vehinv.html>

We find that Arizona has a higher ratio of permits and violations per heavy truck vehicle-mile of travel (VMT) and per registered heavy truck compared to the average of all the states. This supports the premise that overweight trucks are more prevalent in Arizona than most other states. However, a nationwide comparison may not be as relevant as a neighboring state comparison.

Interstate trucks traveling through Arizona also travel in the neighboring states. A vehicle that is overweight in one state is likely overweight when it enters a neighboring state. Table 2 shows overweight permits and violations for Arizona and its neighboring states.

Table 2 indicates that Arizona is selling more overweight permits per heavy truck VMT and per registered heavy truck than most of its neighboring states. This evidence implies that Arizona is relatively aggressive in its efforts to induce overweight vehicles to purchase permits. In terms of overweight violations, Arizona is issuing more citations than most of its neighboring states. This evidence implies that Arizona is also relatively aggressive in catching violators. Overweight trucks leaving Arizona to enter Utah, for example, do not suddenly become lighter. Yet, Utah has neither a high permit sale nor a high overweight citation ratio. This type of discrepancy suggests that further investigation may yield important information.

**Table 2: Arizona & Neighboring State Permits & Weight Violations, FY 2003**

State	Total overweight permits issued	Total overweight vehicle violations	VMT heavy trucks (millions)	Heavy Trucks (1,000s)	Permits/ million VMT	Violations/ million VMT	Permits/ 1,000 trucks	Violations/ 1,000 trucks
Arizona	83,651	28,457	1,380	31.5	60.6	20.6	2,655.6	903.4
California	197,750	77,735	6,889	200.3	28.7	11.3	987.3	388.1
Colorado	15,764	22,077	367	29.0	42.9	60.1	543.6	761.3
Nevada	18,514	1,007	263	10.1	70.4	3.8	1,833.1	99.7
New Mexico	17,881	1,329	323	13.1	55.4	4.1	1,365.0	101.5
Utah	20,286	11,320	1,489	25.2	13.6	7.6	805.0	449.2
Total	353,846.0	141,925	10,711	309.2	33.0	13.3	1,144.4	459.0

Carey estimates that vehicles in the heaviest weight class, such as those registered at 75,000 lbs. or more, underpay state taxes and fees by the widest margin, irrespective of the highway cost allocation model employed.[16] Using Carey's model, the Arizona Department of Transportation's Financial Management Section estimates that these vehicles impose approximately \$35 million per year in uncompensated pavement wear.[17]

## **SURVEY OF MOTOR CARRIER ENFORCEMENT**

We developed a survey to ascertain the state-of-the-practice of current mobile enforcement activities across the nation. Questionnaires were faxed, e-mailed, and/or queried by telephonic communication to the directors and public safety officials of all 51 U.S. states. Some officials were telephoned for follow-up interviews. Responses were received from 25 states.

Only 12 states provided estimates of the percentage of trucks that were operating in excess of legal weight limits (see Table 3). Arizona's estimate of 30% is by far the highest. Most of the other states perceive the overweight vehicle traffic to amount to less than 10% of the trucks operating on their roadways.

**Table 3: Measured or estimated percentage of in-state travel comprised of vehicles exceeding legal limits (gross or axle or both) on weight**

STATE	PERCENTAGE
Arizona	30
Delaware*	~5 – 20
Indiana*	<2; 3-5
Louisiana	2
Montana	6.9
Nebraska	<0.5
Nebraska	<0.5
Oregon	10
South Dakota	0.5
Utah	<10
Washington	<5
Wisconsin	7
Alaska, Colorado, Georgia, Illinois, Maryland, Missouri, North Dakota, Ohio, Oklahoma, Tennessee, Vermont	Unknown
* varies by route	

Only four states have attempted to estimate the damage caused by overweight vehicles (see Table 4). The quality of these estimates is undetermined. Indiana's seems implausibly high. For that state Interstate Highway system alone, the cost would be in the \$3.5 billion range. This is two billion dollars more than Indiana spends per year for ALL state highway expenses. At the other extreme, Montana's estimate seems implausibly low given the state's \$500 million annual expenditure on state highways. Maryland's estimate is focused on dump trucks. This partial information cannot be extrapolated to other classes of vehicle. South Dakota's data is limited to the impacts on six specific bridges. Vermont's estimate of over a million dollars in damage is a safe statement, but too imprecise to be of much use.

**Table 4: Estimated cost of overweight vehicle damage**

<b>U.S. STATE</b>	<b>ESTIMATED COST OF DAMAGE</b>
Indiana	Rural- \$1 million per lane per mile Urban- over \$1 million per mile due to property costs.
Maryland	\$36 million per year due to overweight dump trucks
Montana	\$700,000
South Dakota	more than \$1.1 million in six county bridge replacements in the last two years.
Vermont	> \$1,000,000
Alaska, Arizona, Arkansas, Colorado, Delaware, Georgia, Illinois, Louisiana, Missouri, Nebraska, North Dakota, Ohio, Oklahoma, Oregon, Tennessee, Utah, Washington, Wisconsin	Not estimated

Only eight states were able to provide an estimate of how much over the limit overweight trucks were (see Table 5).

**Table 5: Average estimated number of pounds (lbs.) over the legal limit as reported by mobile enforcement units**

<b>State</b>	<b>Average Number of Pounds (lbs.) that Weighed Vehicles Exceed Legal Limits</b>
Utah	10,000
Wisconsin	6,500
Illinois	"6,000 over"
Montana	4,500
Alaska	4,000
North Dakota	3,000-8,000
Oregon	"For calendar year 2004 the overall average violation was 2,278 pounds."
Texas	"Data is not available; but usually exceeds the weight allowance by a minimum of 1,000 lbs. before enforcement action is initiated."
Arizona, Arkansas, Colorado, Delaware, Indiana, Maryland, Missouri, Ohio, Tennessee, Vermont	unknown

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These survey results indicate that hard data on overweight vehicles is sorely lacking. The range of estimates for the percentage of vehicles that are overweight ranges from less than one-half-of-one-percent to a high of 30%. Some state officials perceive overweight vehicles to be a serious problem. Others see no significant problem. No state was able to produce a credible estimate of the amount of damage that might be attributed to overweight vehicles.

The damage done by overweight vehicles is insidious rather than immediately overt. Roads are long-lived assets. The increment of damage from one overweight vehicle goes unseen. Consequently, it is difficult to stimulate an effective response to counter the damage. Nonetheless, greater attention to the issue is warranted. At the very least, we need better data.

## PAVEMENT DAMAGE ESTIMATION

Given the absence of good data on the extent of overweight vehicles using our highways, any estimate of the damage caused is going to be subject to a wide range of possibilities. One estimate comes from the ADOT highway cost allocation model employed by the Financial Management Services Section. This model indicates that, at present, heavy vehicles account for about \$170 million per year in planned state highway expenditures.[17] State highway expenditures, though, represent only a fourth of total outlays for roads in Arizona. Local government outlays account for the other three-fourths.[18] The share of expenses due to heavy vehicles for roadways under the jurisdiction of local governments is far smaller than it is for state highways. Most of the heavy vehicle miles of travel are on state highways. Relatively few of the miles are on other roads and streets. Consequently, the estimated amount of local government roadway expenditures attributable to heavy vehicles is probably about a fourth as large as it is for state highways. This would amount to around \$40 million per year. So, in terms of what is actually spent on roadways, heavy vehicles account for around \$210 million per year.

Some would contend that planned expenditures might understate the real cost of serving heavy vehicles. Pavement damage is insidious and incremental. Preservation efforts may be deferred or inadequate to keep pace with actual wear. The USDOT estimates that nationwide, between 2001 and 2020, the cost to maintain pavements at the current level of service will amount to around \$600 billion (exclusive of bridge-related expenditures).[19] Annualized, this comes to \$30 billion per year. Based on traffic, Arizona's share of this anticipated cost would be around 1.4% [18] or about \$420 million per year.

The annual costs of \$210 million to \$420 million estimated above are for all commercial vehicles. The share of roadway costs attributable to the heaviest vehicles (those 75,000 lbs. or more) is about 75% of the total.[17] This would bring the range of costs incurred from the heaviest vehicles to between \$155 million and \$315 million per year. Costs are partially offset by revenues from these heaviest vehicles amounting to around \$90 million per year.[17] This means there is a shortfall of revenues compared to the expenses incurred to provide roadways for these vehicles. Based on the estimates made here, the shortfall would range between \$65 million and \$225 million per year. This shortfall applies to *all* commercial vehicles over 75,000 lbs. The shortfall that is attributable to overweight vehicles will need to be estimated.

To estimate the share of the revenue shortfall that is allocated to overweight vehicles we must estimate the percentage of commercial vehicles that are overweight and the added impact on pavement consumption caused by the excess weight. Since operating overweight vehicles is

illegal, information on its extent is hard to come by. Violators work diligently to conceal their activities. Only a tiny fraction of violations are detected and punished. Consequently, estimates of the extent of illegal activities are prone to wide ranges of error. Published estimates of the percentage of commercial vehicles that might exceed weight limits vary widely. A brief recapitulation of these estimates reported in this study is shown in Table 6.

**Table 6: Estimates of the Percentage of Overweight Vehicles**

ESTIMATE	Source
15%	General Accounting Office report [5]
10% to 25%	Transportation Research Board report [7]
38% of “run-by” trucks	Virginia Transportation Research Council report [8]
25% passing through weigh stations in Connecticut	<i>WasteAge</i> [9]
<1% to 30%	Survey responses [1]

These data suggest that the percentage of overweight vehicles is probably in the range of 15%. Two of the estimates and the high-end figure from our survey imply that the percentage may be higher. The 38% overweight estimate for “run-by” trucks (those intentionally bypassing weigh stations) suggests a higher percentage might be correct. The 25% overweight vehicles passing through the weigh station in Connecticut imply a much higher violation percentage since drivers who know their vehicles are overweight are likely to take efforts to evade the weigh station. Hence, our decision to work with a 15% overweight percentage seems moderate and maybe conservative.

Assigning a straight 15% share of the uncompensated costs of commercial vehicles (\$65 to \$225 million) to the overweight category would produce a range of costs between \$10 million and \$35 million per year. However, this would understate the overweight vehicles’ share of these costs because pavement damage increases exponentially with axle weight. In response to our survey, the North Dakota Highway Patrol reported that it weighs 1,000 trucks per year and that 50% of these trucks are overweight and that the range of excess weight falls between 3,000 and 8,000 lbs.[1] Since the tractor unit normally accounts for about 18,000 lbs., this range implies that, on a total weight basis, overweight trucks are 5% to 13% over the legal load limit. However, for pavement damage purposes it is the axle weight that is most critical. The 3,000 to 8,000 lbs. needs to be distributed over the load-bearing axles of the trailer. If the over-weight is distributed between two tandem axles (two side-by-side axles, each with four wheels), the range of over-weight would be about 4.5% to 12% per axle.

Using the 3.75% figure would give us an overweight vehicle share of between \$14 million and \$50 million per year. Each overweight vehicle would exert about 19% more damage than a truck operating at the 80,000 lb. legal limit ( $1.045^4$ ). Thus, the overweight vehicle share of the costs should be 19% higher than it would be if the vehicle were operating at the legal limit. Using the 12% figure would give us an overweight vehicle share of between \$18 million and \$60 million per year. Each overweight vehicle would exert about 57% more damage than a truck operating at the 80,000 lb. legal limit ( $1.12^4$ ). Thus, the overweight vehicle share of the costs should be 57% higher than it would be if the vehicle were operating at the legal limit.

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4 Thus, our best guess is that overweight vehicles impose somewhere between \$14 million  
5 and \$60 million per year in uncompensated damages to Arizona roadways. Arizona currently  
6 budgets about \$6 million per year for mobile enforcement efforts aimed at, among other things,  
7 penalizing and deterring overweight vehicle operations. If a doubling of the mobile enforcement  
8 budget were 50% effective toward the objective of eliminating overweight vehicles from Arizona  
9 roadways, the savings from avoided pavement damage would range from \$7 million to \$30  
10 million per year. At the lower figure, the expansion of mobile enforcement would be a little  
11 better than a “break-even” proposition. The savings from avoided pavement damage would  
12 slightly exceed the cost of the program. Any safety gains from detecting and taking out-of-service  
13 vehicles with safety deficiencies would come on top of the pavement damage avoidance gains.  
14 At the higher figure, the expansion of mobile enforcement would have about a five-to-one  
15 benefit/cost ratio. That is, for every one dollar invested in motor carrier enforcement there would  
16 be five dollars in pavement damage avoided.

## 17 CONCLUSION

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19 Our studies indicate that overweight vehicles likely constitute a substantial share of traffic and  
20 account for a significant portion of the pavement wear. Heavy trucks create far greater pavement  
21 damage than other motor vehicles. In fact, some engineers neglect car and light trucks with  
22 respect to pavement strength design [20]. The fines, fees, and penalties that illegally overweight  
23 vehicle drivers face do not appear to be proportional to the pavement fatigue costs they cause.  
24 We need to improve data collection techniques to more thoroughly assess the extent of damage  
25 and tighten the range of likely costs due to illegally overloaded trucks. Nevertheless, the rough  
26 estimate produced in this research for the State of Arizona implies that there may be a favorable  
27 benefit/cost ratio for enhanced motor carrier enforcement efforts. The same may be true for  
28 many other states, as well.  
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