REVIEW OF OVERWEIGHT TRUCK FINES IN THE DISTRICT OF COLUMBIA

FINAL REPORT

January 22, 2009

Submitted to:

District Department of Transportation
ITS Systems Integration & Development

DISTRICT DEPARTMENT OF TRANSPORTATION

Prepared by:

HOWARD UNIVERSITY
Transportation Research Center
2366 6th Street, NW Room 130
Washington, DC 20059

SIGNATURE PAGE

Prepared by:	Stephen Arhin, Ph.D., P.E. Errol C. Noel, Ph.D., P.E.	
Signatures of Preparers		Date:
		Date:
Reviewed by:	Kajaz Safarian	
	Patrick Chuang	
Signatures of Reviewers:		Date:
		Date:
Quality Assurance:		
Signature:		Date:
Approved By:	Kajaz Safarian and Patrick Chuang	
Signatures of Approvers:		Date:
		Date:

Technical Report Documentation Page

1. Report No.	2. Report Date
DDOT-TOA-OWTRUCK-001	1/22/2009

3. Title and Subtitle	4. Contract or Grant No.
Review of Overweight Trucks Fines in the District of Columbia	PO 267213

5. Author(s)

Dr. Stephen Arhin, P.E.
Dr. Errol C. Noel, P.E.

6. Performing Organization Name and Address	7. Type of Report and Period Covered.
Howard University Transportation Research Center 2366 Sixth Street NW, Suite 130 Washington, DC 20059	

8. Sponsoring Agency Name and Address

District Department of Transportation
2000 14th Street NW
Washington, DC 20009

9. Supplementary Notes

10. Abstract

Federal regulations required all states and the District of Columbia (District) to enforce vehicle size and weight limits on Federal-Aid highway facilities. Truck weight enforcement is a major part of the City's effort to curb the acceleration of premature pavement damage due to excessive loading. Weight enforcement enhances traffic safety and dampens the growth of costs associated with highway maintenance and reconstruction. Excessive weight of a truck accrues a financial benefit to owners and is often regarded as a cost for doing business, especially in jurisdictions where the fines are low. This report summarizes and compares the fines for overweight trucks in the District of Columbia with those of adjoining states, MD and VA. Based on truck weight data collected at two weigh-in-motion stations, the report concludes that overweight truck fees in the District of Columbia are very low in comparison with Maryland and Virginia. The report recommends an increase in the District's overweight fine schedule to make it comparable to Maryland and Virginia.

11. Key Words	12. Distribution Statement
Overweight Trucks Truck overweight Fines Weigh-in-motion	

13. Security Classif.(of this report)	14. Security Classif.(of this page)	15. No. of Pages	16. Price
Unclassified	Unclassified	44	

DOCUMENT REVISION PAGE

Revision	Description	Revised by	Date
Revision 1.0	Draft Final	Dr. S. Arhin	12/01/2008
Revision 2.0	Final	Dr. S. Arhin	1/22/2009

EXECUTIVE SUMMARY

This report summarizes and compares the fines for overweight trucks in the District of Columbia with those of adjoining states, MD and VA, and presents the basis for the City to increase its fines on excessive loading of trucks. Federal regulations require all states and the District of Columbia (District) to enforce vehicle size and weight limits on Federal-Aid highway facilities. Highway officials are faced with the dilemma of curbing the acceleration of highway deterioration, while planning and implementing new major investments, and maintaining and constructing existing facilities. Each year, nearly five trillion dollars worth of goods is transported on the nation's road network via commercial trucks. Unfortunately, commercial truck traffic, especially overweight trucks, contribute greatly to the cost of deteriorating highways across the nation. The general literature indicates that there is a real economic benefit to the trucking companies in overloading trucks. In jurisdictions where overweight fines and enforcement are not sufficiently robust, truck owners would take advantage of the opportunity.

The scope of this study was limited to only analyzing overweight fines at the two weigh-in-motion sites in the District: I-295 and New York Avenue. The initial intention of this project was to use available data (to be provided by DDOT) attributable to truck overloading (including PCI, IRI, pavement management costs, crash records, etc.) to assess the life of, and the impact on the pavement at the sites. However, the due to data unavailability, the project focused on overweight fines. The study determined the aggregate fines at these two sites and compared them with overweight fines which would have been accrued if those same overweight trucks were cited in MD and VA. DDOT provided the research team with the 12 elements in the database pertinent to the analysis for the two sites for the period from September 2006 to August 2007. The researchers at Howard University Transportation Research Center analyzed the data using visual basic programming and statistical analysis methods.

The results revealed that the fines accrued in the District were at least 150% less than the corresponding fines in MD and VA for the same overweight trucks cited in the District. At the I-295 weigh-in-motion (WIM) site for example, the annual fines accrued for the cited overweight trucks was approximately $64.5 million whereas the states of MD and VA would have accrued approximately $180 million and $157 million respectively. Similarly, at the New

York Avenue WIM site, the computed annual fine for the overweight trucks was approximately $19.5 million, while the projected fines would have been in the region of $54 million and $48 million for the same overweight trucks in MD and VA respectively.

Pavement deterioration and reduced roadway safety are both directly correlated to the overloading of trucks. In order to deter truck operators from overloading in the District, it is recommended that the overweight fines in the City be increased to more in line with those of the adjoining jurisdictions. The sensitivity analysis of the size of the increment conducted in this study suggests that, at a minimum, the fines in the District should be increased by at least 150%. As more WIM sites come on line, further studies should be conducted to analyze the impact of increased fines on the life of pavement, revenue, and highway safety. Although the general literature provides estimates of pavement damage caused by overloading of trucks, the District should conduct its own study to quantify pavement damage experienced in the City based on its pavement data.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Federal regulations require all states and the District of Columbia (District) to enforce vehicle size and weight limits on Federal-Aid highway facilities. Highway officials are faced with the dilemma of curbing the acceleration of highway deterioration, while planning and implementing new major investments to accommodate the increasing demand for highway capacity and implementation of improved traffic management systems. A substantial portion of each state's annual highway budget is typically allocated to maintenance of the highway infrastructure. Each year, nearly five trillion dollars worth of goods are transported on the nation's road network via commercial trucks [1]. Unfortunately, commercial truck traffic, especially overweight trucks, contributes greatly to the cost of deteriorating highways across the nation. The increasing cost and the demand for reconstructing and building new highway facilities pose a formidable challenge to officials responsible for allocating funds for worthy highway projects. Industry experts estimate that there is currently a $300+ billion shortfall in funding to repair roads and bridges [2]. While current weight regulations tend to limit the economic efficiency of commercial operations, they also help to preserve the vast investment in highway infrastructure.

Amidst the challenges of managing all highway assets, vigorous enforcement of truck size and weight policies, including appropriate fines for violators and an efficient permit process is an essential element of any program for improving truck safety and reducing damage of pavement and bridges caused by excessive loading. The analysis of truck size and weight data of the District is an essential undertaking for identifying opportunities for improving the effectiveness of enforcement activities.

The District of Columbia, Virginia and Maryland constitute an integrated economy where there is a tremendous amount of daily travel, which includes truck traffic. Trucks constitute about 5-6 percent of the annual average daily traffic in the District. Truck routes in the City are primarily de facto and are not completely marked. As a consequence, truck drivers often select their preferred arterials and generally avoid residential streets, unless there is a known operational or economic advantage. Enactment of restrictions on certain streets and areas are often based on complaints from residents regarding safety, noise and vibrations. Truck restrictions imposed by the City are generally independent of restrictions in the bordering counties and states. This variation often leads to operators seeking to comply with truck size and weight regulations in areas where enforcement is relatively more active. Consistency in regulatory and enforcement policies could be an important ingredient for changing adverse behavioral attitudes of truck owners and drivers who serve the Washington metropolitan area. The purposes of enforcement are to establish an acceptable level of compliance with vehicle size, weight and safety regulations, and to encourage operators and owners to be more responsible citizens. Although the relationship between high compliance to weight regulations and reduced pavement damage may not be directly correlated, damage to already deteriorating structures could be accelerated by excessive loading.

The City has adopted standards for weight, size and loading for trucks, including policies for managing oversize and overweight vehicles: for example, the maximum overall width for tractor-trailer combination vehicles is 8 ft 6 in; the maximum height of any vehicle, including its load, is 13 ft 6 in; the maximum length of combination vehicles is 55 ft; and the maximum gross vehicle weight, including cargo, is 80,000 lb. The District also uses tables based on the Federal Bridge Formula in determining the maximum weight in pounds for any vehicle. Operators of vehicles that are above the limits require permits based on a fee schedule, and are fined when caught operating in violation. The Motor Coach and Motor Carrier Inspection Division of the Metropolitan Police Department is responsible for enforcing truck size, weight and safety regulations. On a limited basis, truck weight and axel loadings are observed at a few sites equipped with permanent and mobile scales. The collected data can serve as an indicator of compliance on the facilities where the scales are used.

Since September 2006, the District has been collecting truck overweight data and associated fines from two mobile scales, with the aim of analyzing the data to determine trends. The recommendations of previous studies by Volpe and others are also under implementation. The data collected over the period 2006-2007 was analyzed and presented in this report. In addition, policies on overweight trucks, fees and fines in the region (District, Virginia, and Maryland), were examined to identify ideas for improving the District's policies and opportunities for collaboration within the region. Characteristics of overweight fines, including purpose, application and fee structures were explored, in search of opportunities for fee changes that could make fees compatible with actual regulatory cost. Some states have already factored the cost of managing overweight truck programs and truck damage to pavements and bridges in determining fees [1, 4, 8]. At least one local county, Fairfax, Virginia, maintains its own oversize and overweight vehicle program, despite the more comprehensive program managed by Virginia Department of Transportation.

2. LITERATURE REVIEW

The Federal Highway Administration (FHWA) [1] reported that approximately 7.9 million large trucks were on U.S. highways in 2002 compared to 6.2 million in 1990. The freight moved by trucks was estimated to be 71% of the total tonnage and 80% of the total value of United States shipment in 1998. It is also estimated that trucking activities will increase in the coming years. However, the addition of new infrastructure is not expected to follow the pace of that increase in demand of freight transportation. The total cost of moving goods involve two basic components: public cost (construction and maintenance), and private cost (related to truck operations by vehicle owners) [2]. Overloading a truck can benefit the truck operator by reducing the number of trips. On the other hand, a number of studies [2, 4, 8] determined that overweight trucks are more likely to harm the highway pavement and other related infrastructure than trucks operating within the established weight limits. To face the challenge of accommodating the increasing volume of commercial vehicles, while preserving the existing highway infrastructure, states must ensure that vehicles comply with weight standards established by the FHWA and their jurisdictions. Although FHWA has truck weight limits on the Interstate System, several states, especially those with mining industries, issue permits for heavier trucks. The current Federal truck weight limits on the Interstates are the following:

- 80,000 lbs for gross vehicle weight (GVW),
- 20,000 lbs for single-axle,
- 34,000 lbs for tandem-axle, and the application of the Bridge Formula.

The review of past studies on overweight trucks, including administrative policies, fines, fees, is presented in the paragraphs following.

In its Comprehensive Trucks Size and Weight Study [3], the FHWA presented case studies of enforcement practices in nine states, and suggestions on how to improve weight enforcement activities. The study showed that there was an increase in size and weight enforcement in all the States due to the acquisition of new technologies such as weight in motion (WIM), photo imaging, advanced vehicle identification, and advanced vehicle classification (AVC). Nevertheless, enforcement activities were impeded in some states due to inoperable equipment, weather conditions, and personnel constraints. Most of the states used both fixed and mobile enforcement. The choice between fixed facilities and mobile enforcement is determined by factors such as volumes of trucks weighted, cost of construct, staffing requirement, flexibility, and safety. The study found that there was non-uniformity in weight regulations due to "grandfather right application" and frequent changes in weight limits between adjoining states. However, all the states surveyed indicated the need to have regional weight limits or standards that will accommodate neighboring states. The authors recommended the following as ways to improve enforcement: identification of the magnitude and location of the overweight trucks problem, expanding WIM use, prohibition of weight tolerance practices at scales, promoting the use of non-traditional enforcement techniques and considering infrastructure damage factor in permit fees.

James G. Strathman et al. [4] analyzed the relationship between weight violations and enforcement activity in Oregon. Data was collected on the I-5 corridor, which has a weigh station, and has two potential bypass routes that have three WIM scales. Truck weight and volume data were collected before, during, and after I-5 corridor weigh station closure for 70 days. The mean Gross Vehicle Weight (GVW) was estimated for each site to assess change in overloading practices, but the results did not show a consistent pattern across sites. The results of the analysis showed that the proportion of overweight vehicles increased from 2.27% before closure to 3.67% during closure. After the weight station was re-opened, the proportion of overweight reduced to 3.19%. This study suggested that the relatively aggressive weight enforcement in Oregon created a condition where a single weigh station closure did not significantly impact the tendency of overloading. The study also showed that truck operators' awareness of WIM operational characteristics, together with the knowledge that WIM scales operate independent of an open fixed scale, might have influenced overloading decisions.

John Semmens [5] assessed the cost of the damage associated with overweight trucks on Arizona highways. It was estimated that overweight vehicles account for $12 million to $53 million per year in damage on state highways and structures in Arizona. Arizona overweight trucks enforcement program utilizes of a mobile unit that costs $5.8 million per year. Based on a projection by the Arizona Department of Transportation Simplified Highway Cost Allocation Model, if the budget of that mobile enforcement is doubled and was 50% effective toward the objective of eliminating illegally overweight vehicles, savings from avoided pavement damage would range from $6 million to $27 million per year. It was projected that the savings would slightly exceed the cost of the program, and for every dollar invested in motor carrier enforcement efforts, there would be $4.50 in pavement damage avoided.

Freddy L. Roberts et al. [6] analyzed the damage caused by overweight vehicles carrying timber and lignite coal on Louisiana highways. Using different load scenarios for the gross vehicle weight and the tandem axle weight limit, the authors found that the actual tandem weight limit (48,000 lbs) produced more damage on the pavement than the permitted GVW (88,000 lbs) for trucks with equally loaded axles. The results suggested that the permit fee for overweight timber truck, which was $10/truck/year, should be increased to $346/truck/year for a GVW of 86,000 lbs equally loaded, and $4377/truck/year if 48,000 lbs tandem axle were permitted. An increase of the GVW from 88,000 lbs to 100,000 lbs would induce an additional annual maintenance cost of $857 per truck. A tandem axle of 48,000 lbs accounted for $3560/truck/year in bridge maintenance cost.

A study was undertaken in Texas [7] to evaluate the impacts of the overweight permit House Bill (HB) 2060 on the Texas land transportation system. The HB 2060 permit, administered by the state, authorized an additional 5% gross weight and 10% axle weight above the respective GVW and tandem axle weight limits on all roads without the approval of county governments. The HB 2060 permit opened the way for overweight trucks to circulate on roads that were previously controlled by individual counties with loads that far exceed the approved limits. This HB 2060 permit favored the trucking industry since it was valid in all twenty counties in Texas. It however left county officials with concerns about the damage caused to their roads. The study found that 22% of the trucks holding a HB 2060 permit were from industries that routinely operate overweight trucks.

The impacts of overweight trucks on older bridges [8] were examined in Indiana. An important part of the economy of northwestern Indiana is the shipping of steel and other various products to Michigan for the manufacturing of automobiles and other commodities. The extra heavy-duty corridor highway permits allowed truck loads of up to 134,000 lbs. Field measurements were used to determine the spectrum of the truck axle loads in the extra heavy-weight corridor and the influence of those loads on of steel bridges. To evaluate the fatigue strength of the steel bridges along the extra heavy-weight corridor, an accurate evaluation of the types and weights of the trucks that travel the corridor was conducted. The fatigue life was evaluated by predicting the stress ranges generated by those loads. The truck weights were evaluated by using a weigh-in motion sensor installed in the roadway to measure the truck GVW, the individual axle weights, and in determining the class of vehicle. To provide an additional check on the actual live-load stress ranges generated in the bridge superstructure versus those predicted by using the measured truck weights and standard load distribution factors, the strain measurements were made on one bridge structure in the corridor, at a location relatively close to the weigh-in-motion system. The study found that 44% of the trucks travelling over the bridges were Class 9 (5 axles) and 14% were Class 13 (7 or more axles). Fifteen percent of Class 9 trucks traveled with GVW over the 80,000 lbs limits and 26% of Class 13 weighed more than the 135,000 lbs GVW limit. The measured stress data indicated that less than 1% of the trucks produced a stress range that exceeded the variable amplitude fatigue limit.

Cunagin W. et al [9] assessed the problem of weigh stations avoidance by overweight trucks. Data was collected at two permanent weigh stations on I-95 and their four potential bypass routes in Florida. Traffic was monitored on the bypass routes using WIM technology. The data analysis results showed that a higher violation rate on the bypass routes. The proportion of overweight trucks at the fixed weigh stations was less that 1% while it was 19% at the bypass route locations. It was also found that the majority of the weight violations occurred during weekend when weigh stations are usually closed. The study concluded that only intensive enforcement activities could reduce weight violations.

Barros R.T. [10] attempted to quantify the magnitude of pavement damage caused by overweight trucks in New Jersey using weight violations data from New Jersey State Police. The study revealed that the number of overweight trucks detected might be a small fraction of the true population of overweight trucks due to enforcement level. Assuming that the maintenance cost of pavement damaged by overweight trucks is about $20 million per year, the study recommended an increase of the current fines and permit fees of overweight vehicles in

New Jersey.

Paxson D.S. [11] analyzed the cost-benefit of overloading practices in the truck industry. The benefit to the trucker, which is transportation cost reduction, was compared with the cost of overloading that resulted from a combination of permit fees, enforcement fines and the probability of being weighed. The results indicated that the probability of being weighed, estimated from enforcement structure of various states, was low. Also, revenues from weight violation fines and permit fees were very low compared to the maintenance cost for pavement damage caused by overweight trucks. Consequently, the truck operators often benefited from the low frequency of enforcement activities. The study recommended a reform of enforcement programs by increasing fines and permit fees that would account for the amount of overweight and vehicle miles traveled, and balance the pavement damage cost attributed to overweight vehicles.

The problem of weigh stations avoidance by overweight vehicles [12] was examined in the state of Virginia. The study also assessed the frequency of overweight trucks on selected routes, and compared traffic loading data at two fixed weigh stations with data collected using WIM without enforcement on potential bypass routes. The results showed that more than 10% of the trucks detected at the WIM locations were overweight. At one of the permanent weigh stations, the analysis showed that about 50% of the trucks that bypassed the stations were actually overweight. It was also found that the magnitude of overweight trucks varied between 12 and 27% on one Interstate route and two primary routes. Truck weights measured with WIM systems were 30 to 60% higher than the weights collected using static scales at the weigh stations.

The expenses resulting from overweight trucks damage to the highway infrastructures and the level of the weight enforcement program [13] were also analyzed in Texas. The study indicated that a large number of trucks operating on Texas highways were overweight. The revenues from overweight fines and permit fees were low compared to the $48 million yearly maintenance cost due to overweight damage of pavement. The enforcement program was not sufficiently robust to discourage the truck industry from operating above the legal weight limits.

In 2007, the Virginia Transportation Research Council completed two studies about truck overweight issues. The two studies quantified the additional maintenance costs associated with overweight permits issued under legislation HB 1645 [14] and HB 2917 [15]. Overweight vehicles allowed under permit HB 1645 were trucks performing pipe cleaning, hydroexcaving, and water blasting while overweight trucks operating with permit under HB 2917 haul gravel, sand or crushed stone no more than 50 miles from origin to destination in Virginia's counties that apply the coal severance tax. Vehicles with HB 1645 permit were allowed to have tandem axle weighing 44,000 lbs instead of 34,000 lbs which is the federal limit on the highway system. Trucks holding a HB 2917 permit were allowed to have single axle weighing 24,000 lbs, tandem axle weighing up to 45,000 lbs, and a gross vehicle weight of 90,000 lbs (5 axles) and 110,000 lbs (6 axles). Using an equivalent single axle load (ESAL) model and Virginia Department of Transportation cost information, the results of the analysis of the HB 1645 truck data indicated that the annual additional maintenance cost induced by a truck operating with 44,000 lbs tandem axle ranges from \$229 to \$706. The estimated annual additional maintenance cost for a Hydroexcavator operating with the same axle load varies between \$370 and \$569. Results from HB 2917 truck data showed that three-axle sand and gravel trucks would cause an additional maintenance cost of \$1,023, while a four axle truck would cause a \$676 additional cost per truck. Although Virginia legislations HB 1645 and HB 2917 allow trucker to carry higher axle loads, the permit fees stay unchanged or in some cases the permit was obtained at no-cost.

In Texas, a study [16] was conducted to establish the impact of trucks having gross vehicle weight (GVW) up to 125, 000 lbs on the pavement structure through non destructive testing. Ground penetration radar (GPR) and falling weight deflectometer (FWD) tests were conducted on two lanes of a permitted truck route in the City of Brownsville. In addition to the two tests, the cumulative ESAL was determined for both lanes. The results indicate that one of the lanes which had greater amount of overweight trucks traffic presented significant evidence of damage than the other lane.

Green et al. [17] assessed the performance and accuracy of weigh in motion scale as means for weight enforcement in Indiana. The virtual weigh station used in this study consisted of WIM scales that transfer weight data in real time to enforcement officers' laptops by wireless communication. The virtual station is used to pre-screen trucks as they cross the WIM scale, enabling enforcement officers to select more accurately trucks that need to be weighed. The deployment of the virtual weigh station at several locations has improved significantly the detection of overweight trucks. The report recommended the widespread of virtual weight station technology in truck weight enforcement programs.

In 2006, a review of a number of systems [18] that were available for automatic detection of overweight trucks was undertaken in a case study of issues that state of Arizona was facing in enforcing truck weight limit laws. WIM was among the enforcement systems used in the study. The case study estimated the cost of pavement repair related to overweight trucks between $12 and $53 million per year. In addition, the state spent about $5.8 million per year in truck weight enforcement. Since fines and permit fees received from overloading didn’t cover the state’s spending, overloading was determined to cost motorists in Arizona approximately $120 annually.

Across all WIM sites in California, an average of 2.67% of truck axles was found to be overweight. These axles contribute 5.74 percent of the pavement damage at the WIM sites. When these figures were extrapolated to the entire state highway network, this roughly translates to between $20 and $30 million per year spent in maintenance and rehabilitation costs [19].

Commercial vehicle weights and dimension laws are enforced by highway and law enforcement agencies to ensure that excessive damage and hence reduced life is not imposed on the highway infrastructure. The operation of overweight trucks robs the road network of its design life while posing as a safety hazard to the traveling public. The general literature suggests that overloading of highway pavements is exponentially related to the extent of damage [20]. Thus, if trucks are overloaded by as little as 10% above the pavement’s threshold, a 40% increase in road wear could occur. That pattern is depicted as a schematic on Figure 1 [20].

This review indicates that overweight trucks pose a threat to the life of the highway infrastructure in the United States. The trucking industry benefits from operating overweight trucks because, in jurisdictions where the probability of being caught and fined is low and the magnitude of the fine is too small in comparison with the economic values to be gained from the excess weight. States are having limited resources to allocate to highway maintenance. Consequently, there is a need to strengthen truck weight enforcement programs in order to preserve highway infrastructure.

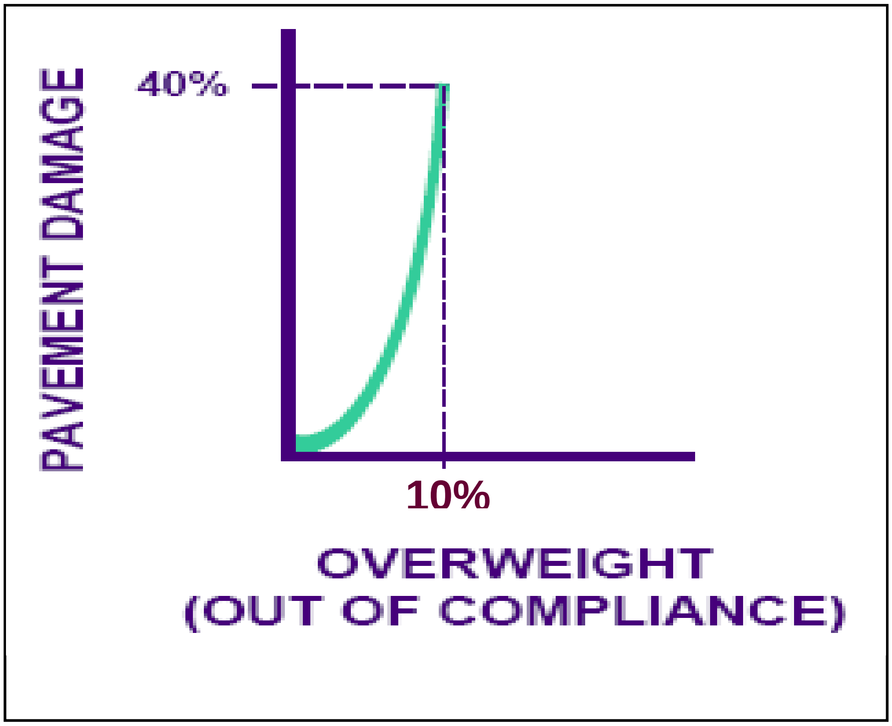


Figure 1: Relationship between Overweight and Pavement Damage [20]

In most of the states, the enforcement system in place struggles to deter the overloading practices due to limited resources and policies to support robust enforcement programs. The fines and permit fees schedule of the weight enforcement are low compared to the cost of the damage attributed to overweight trucks. In some jurisdictions, low fees or fines, rather than discourage overloading, encourage truck drivers to take advantage of the net benefit of the excess weight. A number of states are reviewing their fines and fees to account for damage associated to overweight trucks.

3. TRUCK OVERWEIGHT FINE STRUCTURE IN DC, MD AND VA

Presented in this section are the details of the truck overweight fee structure in the District of Columbia, Maryland and Virginia. The fine computations have been adopted as a policy, largely approved through the states' (or councils) legislature.

3.1 Fines in District of Columbia

- $100 for the first 5,000 pounds of weight over any allowable weight;
- $6 for each 100 pounds of excess weight over 5,000 pounds

3.2 Fines in Maryland

- 1 cent for each pound for the first 1,000 pounds of weight over any allowable weight;
- 5 cents for each pound of excess weight over 1,000 pounds, but less than 5,001 pounds;
- 12 cents for each additional pound of excess weight over 5,000 pounds and less than 10,001 pounds;
- 20 cents for each additional pound of excess weight over 10,000 pounds but less than 20,001 pounds; and
- 40 cents for each additional pound of excess weight over 20,000 pounds.

3.3 Fines in Virginia

In Virginia, the fines are applied based on the axle weight and the gross weight.

Axle Weight

- 1 cent for each pound for the first 2,000 pounds of weight over any allowable weight;
- 3 cents for each pound of excess weight over 2,000 pounds, but less than 4,001 pounds;
- 12 cents for each additional pound of excess weight over 4,000 pounds and less than 8,001 pounds;
- 22 cents for each additional pound of excess weight over 8,000 pounds but less than 12,001 pounds; and
- 35 cents for each additional pound of excess weight over 12,000 pounds.

Gross Weight

- 1 cent for each pound for the first 2,000 pounds of weight over any allowable weight;
- 3 cents for each pound of excess weight over 2,000 pounds, but less than 4,001 pounds;

- 7 cents for each additional pound of excess weight over 4,000 pounds and less than 8,001 pounds;
- 12 cents for each additional pound of excess weight over 8,000 pounds but less than 12,001 pounds; and
- 20 cents for each additional pound of excess weight over 12,000 pounds.

In addition, if the gross weight exceeds the weight limit by 25% to 50%, the assessment is doubled. If the gross weight exceeds the weigh limit by 50%, the assessment is tripled.

4. RESEARCH METHOLOGY

4.1 Weigh-In-Motion Sites and Technology

DDOT provided the research team with the data obtained from the two weigh-in-motion (WIM) sites in the District of Columbia. The two WIM sites are located on New York Avenue at the border with the state of Maryland, and on I-295, close to the border with the state of Virginia and Maryland. Figures 2 and 3 show the two WIM sites. New York Avenue is a major arterial that runs in the east west direction and serves as a gateway to the District from the state of Maryland. Interstate 295 runs in the north-south direction and also serves as a gateway to the District from both Maryland and Virginia.

The WIM technology is an unmanned data collection and monitoring system. The data collection system may comprise of one or more of the following elements:

- a camera to record potential violators image
- pavement sensors
- a downstream pull-off lane
- communication via a wireless network

Figure 2: I-295 WIM Site

Figure 3: New York Avenue WIM Site

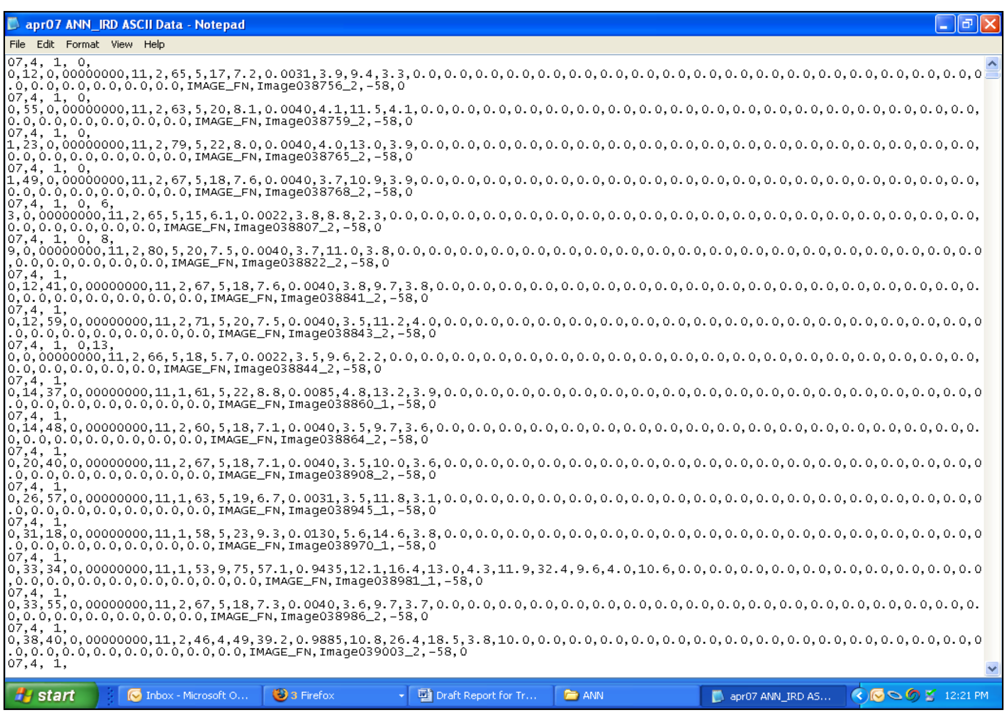
The system also has the capability of being expanded to include full electronic screening of license plate/reading US DOT Numbers, and linkage to Commercial Vehicle Information Systems and Networks (CVISN). Data that can be obtained from the WIM system includes:

- Volume
- Vehicle Classification
- Speed
- GVW (Gross Vehicle Weight)
- Axle weight and axle spacing

Generally, the information gathered is for used for pavement studies, highway monitoring and capacity studies, accident rate calculations, and analysis of truck transport practices.

4.2 Data Coverage

A sample snap shot of the raw data in ASCII format is presented in Figure 4. The data used in this research was retrieved and provided by DDOT and spans from September 2006 through August 2007. The raw data was then exported into Microsoft Access. The records for overweight trucks were then extracted and exported into Microsoft Excel.




```
07,4, 1, 0,
0,12,0,00000000,11,2,65,5,17,7.2,0.0031,3.9,9.4,3.3,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0
.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038756_2,-58,0
07,4, 1, 0,
0,55,0,00000000,11,2,63,5,20,8.1,0.0040,4.1,11.5,4.1,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038759_2,-58,0
07,4, 1, 0,
1,23,0,00000000,11,2,79,5,22,8.0,0.0040,4.0,13.0,3.9,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038765_2,-58,0
07,4, 1, 0,
1,49,0,00000000,11,2,67,5,18,7.6,0.0040,3.7,10.9,3.9,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038768_2,-58,0
07,4, 1, 0, 6,
3,0,00000000,11,2,65,5,15,6.1,0.0022,3.8,8.8,2.3,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038807_2,-58,0
07,4, 1, 0, 8,
9,0,00000000,11,2,80,5,20,7.5,0.0040,3.7,11.0,3.8,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0
,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038822_2,-58,0
07,4, 1,
0,12,41,0,00000000,11,2,67,5,18,7.6,0.0040,3.8,9.7,3.8,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.
0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038841_2,-58,0
07,4, 1,
0,12,59,0,00000000,11,2,71,5,20,7.5,0.0040,3.5,11.2,4.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0
.0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038843_2,-58,0
07,4, 1, 0,13,
0,0,00000000,11,2,66,5,18,5.7,0.0022,3.5,9.6,2.2,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,
0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038844_2,-58,0
07,4, 1,
0,14,37,0,00000000,11,1,61,5,22,8.8,0.0085,4.8,13.2,3.9,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0
.0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038860_1,-58,0
07,4, 1,
0,14,48,0,00000000,11,2,60,5,18,7.1,0.0040,3.5,9.7,3.6,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.
0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038864_2,-58,0
07,4, 1,
0,20,40,0,00000000,11,2,67,5,18,7.1,0.0040,3.5,10.0,3.6,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0
.0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038908_2,-58,0
07,4, 1,
0,26,57,0,00000000,11,1,63,5,19,6.7,0.0031,3.5,11.8,3.1,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0
.0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038945_1,-58,0
07,4, 1,
0,31,18,0,00000000,11,1,58,5,23,9.3,0.0130,5.6,14.6,3.8,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0
.0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038970_1,-58,0
07,4, 1,
0,33,34,0,00000000,11,1,53,9,75,57.1,0.9435,12.1,16.4,13.0,4.3,11.9,32.4,9.6,4.0,10.6,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0
,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038981_1,-58,0
07,4, 1,
0,33,55,0,00000000,11,2,67,5,18,7.3,0.0040,3.6,9.7,3.7,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.
0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image038986_2,-58,0
07,4, 1,
0,38,40,0,00000000,11,2,46,4,49,39.2,0.9885,10.8,26.4,18.5,3.8,10.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0
.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,IMAGE_FN,Image039003_2,-58,0
07,4, 1,
```

Figure 4: A Snapshot of the Data Sample

Only the relevant variables needed for the analysis were extracted for the overweight truck records. These variables are:

- Total weight
- Extent of overweight
- Fine amount for total overweight
- Index of an axle or an axle combination
- Actual weight for an individual axle or an axle combination
- Extent of overweight for an individual axle or an axle combination
- Fine amount from axle overweight
- Index of an individual axle or tandem axle for bridge formula
- Actual weight for an individual axle or tandem axle for bridge formula
- Extent of overweight for an individual axle or tandem axle for bridge formula
- Fine amount from bridge formula
- Final amount of fine

The fine amounts for each overweight truck at the two sites were obtained directly from the data. A Visual Basic Application (VBA) was then developed to compute corresponding fines in Maryland and Virginia (See Appendix 1) for the same overweight trucks using one or more of the variables extracted. The VBA was developed on the basis of the fines structure described in Sections 3.2 and 3.3.

5. DATA ANLYSIS AND RESULTS

Using Microsoft Excel, various statistical measures of central tendency and spread were computed. The analysis was based on both monthly and annual (from September 2006 through August 2007) estimates. The measurements computed and compared include:

- Monthly percentage of overweight trucks per site
- Annual Average percentage of overweight trucks per site
- Type of violations per site and accompanying fines
- Average fine per truck per month per site

- Total Fines per site
- Total fines for the same overweight trucks in MD and VA per site

The various statistics were also displayed graphically using Microsoft Excel.

5.1 General Summaries of Overweight Trucks per Site

From the summarized data, the total number of trucks and number of overweight trucks per month for each WIM site was extracted. The percentage of overweight trucks for each month per site was then computed. This is presented in Table 1. Figure 5 presents the graphical representation of the total number of trucks per month for each site.

Table 1: Total Number of Trucks & Overweight Trucks Recorded at WIM Sites

Month	I-295			New York Avenue		
	Total Trucks	*Overweight Trucks*	*% Trucks Overweight*	*Total Trucks*	*Overweight Trucks*	*% Trucks Overweight*
1	56,528	10,490	18.56	66,951	4,702	7.02
2	37,078	7,293	19.67	38,098	2,306	6.05
3	52,919	13,373	25.27	62,484	4,215	6.75
4	26,254	7,128	27.15	68,139	4,266	6.26
5	51,361	13,101	25.51	63,151	4,396	6.96
6	42,882	10,922	25.47	51,988	3,739	7.19
7	64,582	16,531	25.60	80,467	4,932	6.13
8	63,234	15,077	23.84	78,155	5,115	6.54
9	65,832	13,884	21.09	82,508	5,838	7.08
10	66,795	13,958	20.90	75,379	5,243	6.96
11	68,196	15,077	22.11	70,497	4,699	6.67
12	29,338	5,953	20.29	28,571	1,876	6.57
TOTAL	**624,999**	**142,797**	**22.85**	**766,388**	**51,327**	**6.70**

From Figure 5, the total number of trucks recorded at the New York Avenue site was higher than the number recorded at the I-295 site. A simple student's *t*-distribution test was conducted (see Table 2) at 5% level of significance for the mean difference in the total number trucks at the two sites. The results show that the difference between the total number of trucks is statistically significant. This is because the *p*-value for the test was determined to be less than 5%. This indicates that the two sites are significantly different or independent and that any comparison to be considered should be made exclusively per site.

From Table 1, the results show that at the I-295 site, approximately 23% of the total trucks recorded, on average, were overweight while the New York Avenue site data showed that approximately 7% of total trucks were overweight. The monthly percentage of overweight trucks and the aggregate average percentage of overweight trucks are respectively presented in Figures 6 and 7.

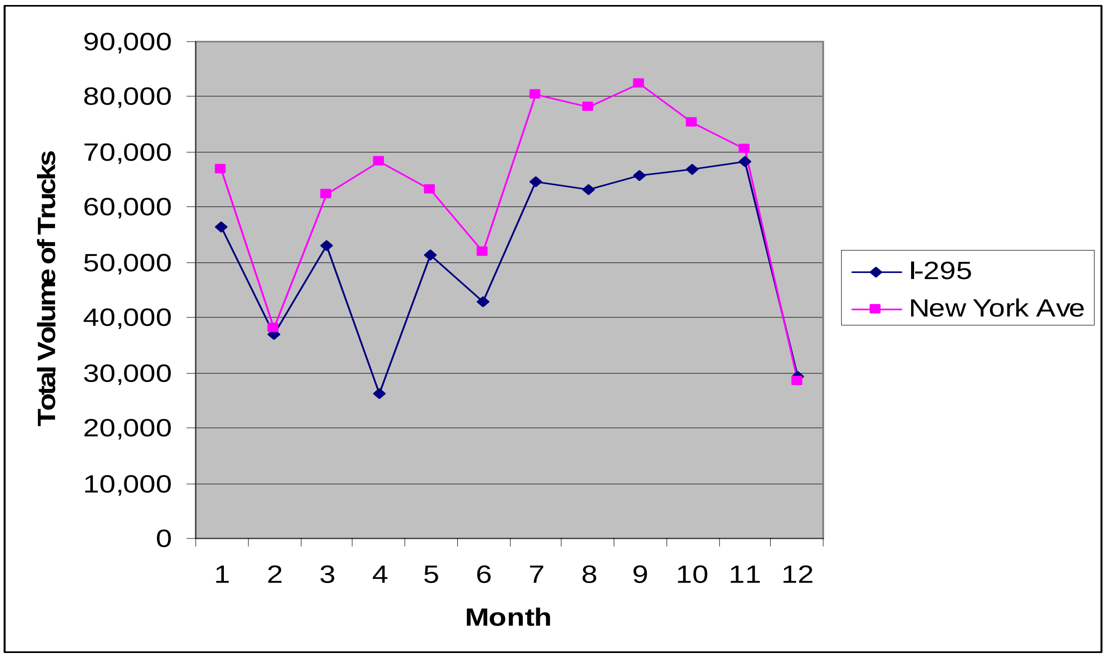


Figure 5: Total Volume of Trucks per WIM Site

Table 2: Results for One-Tailed Test for Difference in Mean Total Trucks

Statistic	***I-295***	***New York Avenue***
Mean	52083.25	63865.67
Variance	223721401.1	280438441
Observations	12	12
Pooled Variance	252079921	
Hypothesized Mean Difference	0	
df	22	
t Stat	-1.817778134	
P(T<=t) one-tail	***0.041371612***	

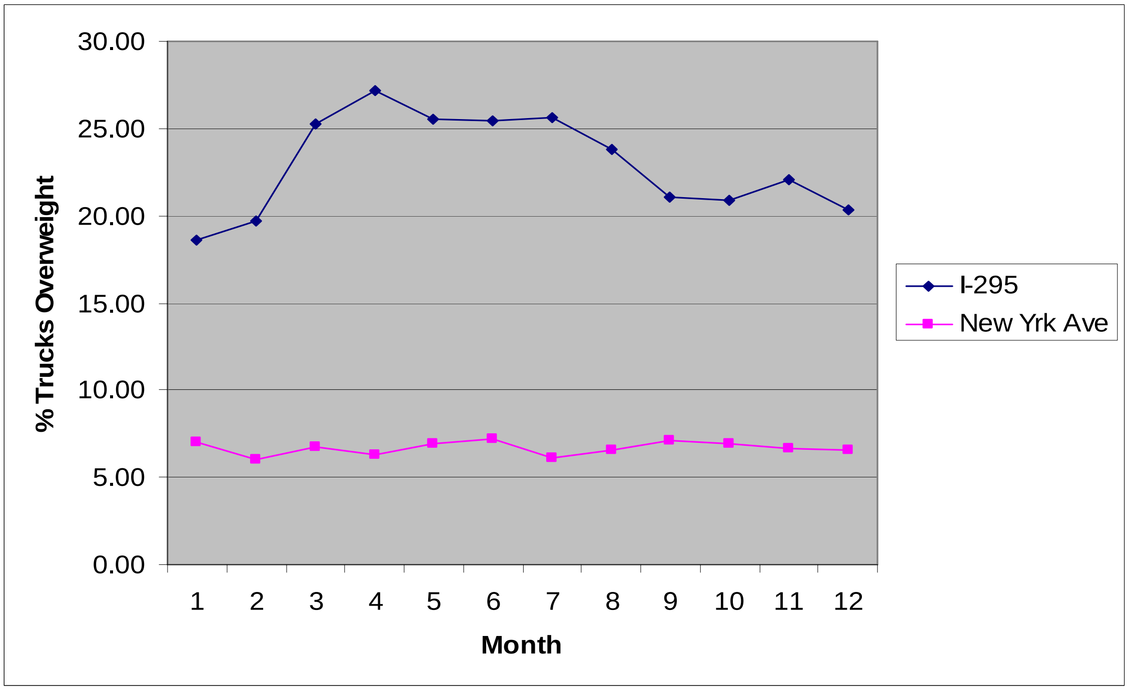


Figure 6: Monthly Percentage of Overweight Trucks per WIM Site

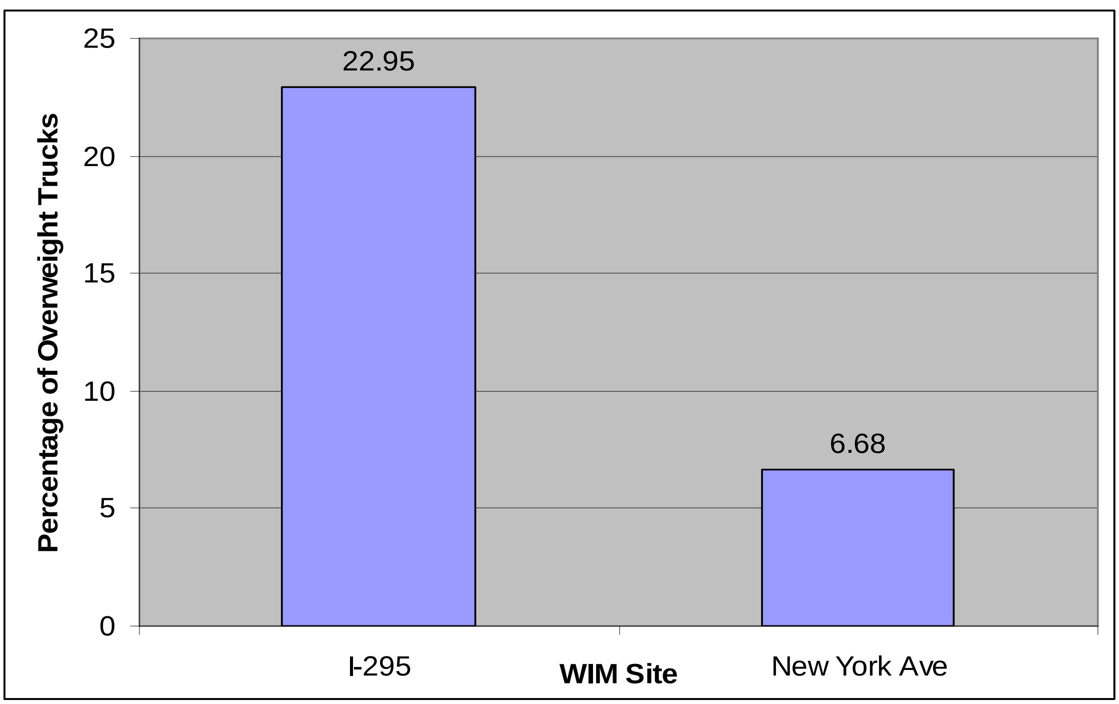


Figure 7: Average Percentage of Overweight Trucks per WIM Site

Although the New York Avenue site recorded a higher total volume of trucks, on average, there was a lower percentage of overweight trucks, compared with the I-295 site. This could be attributed to the fact that the New York Avenue is a high-volume arterial, and is the primary route for truck and bus traffic with a north-eastern orientation, and as a result, receives higher police attention.

5.2 Comparing Fines and Violation Types

It was noted in Section 3 that the fine structure for the three jurisdictions are different. In this section the differences in the fines charged for overweight trucks in DC are compared with those in MD and VA, using the same weights of the overweight truck.

5.2.1 Average Fine per Overweight Truck in DC

The average fine per overweight truck was computed by dividing the total monthly revenue for each site by the total number of overweight trucks. This provides a good estimate for projecting potential fines that can be realized for an estimated number of overweight trucks. The average fine per overweight truck for the two sites is depicted in the Figure 8 and ranges between $378 and $451.

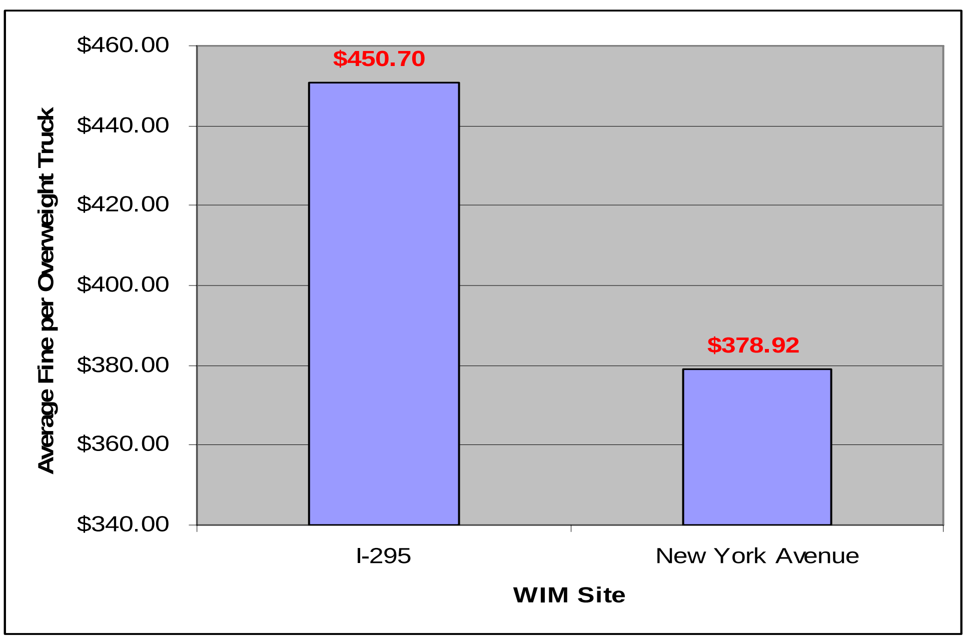


Figure 8: Average Fine per Overweight Trucks at WIM Sites

5.2.2 Comparing Annual Fines in DC with MD and VA

The fines for the overweight trucks for the 12-month duration were computed for MD and VA using the formulation described in Section 3. For each overweight truck, the fine calculations for the two states were applied after which the total fine for the year was computed for each site. These are presented in Figures 9 and 10.

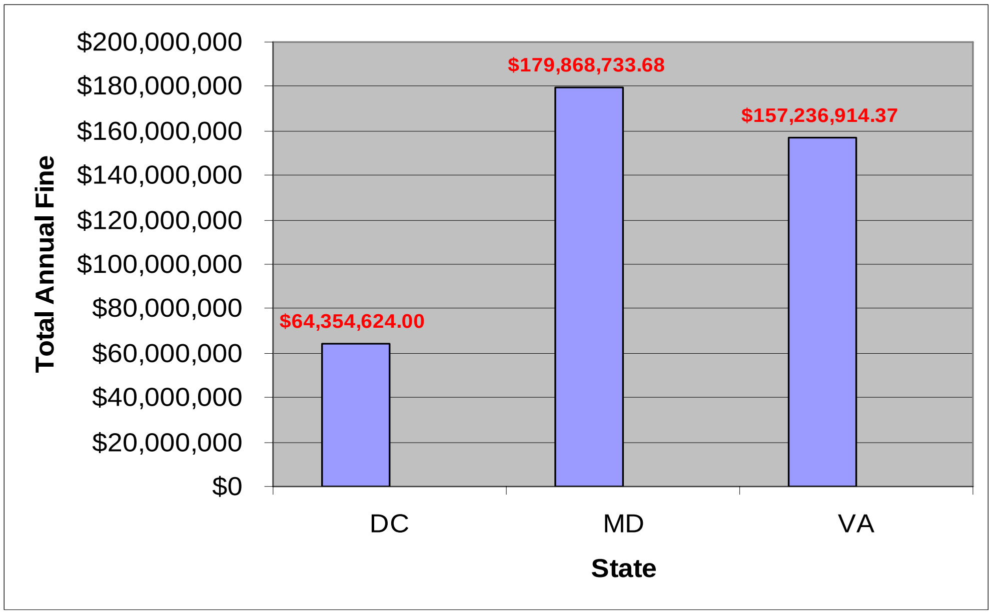


Figure 9: Comparing Annual Fines for Overweight Trucks at I-295 WIM Site

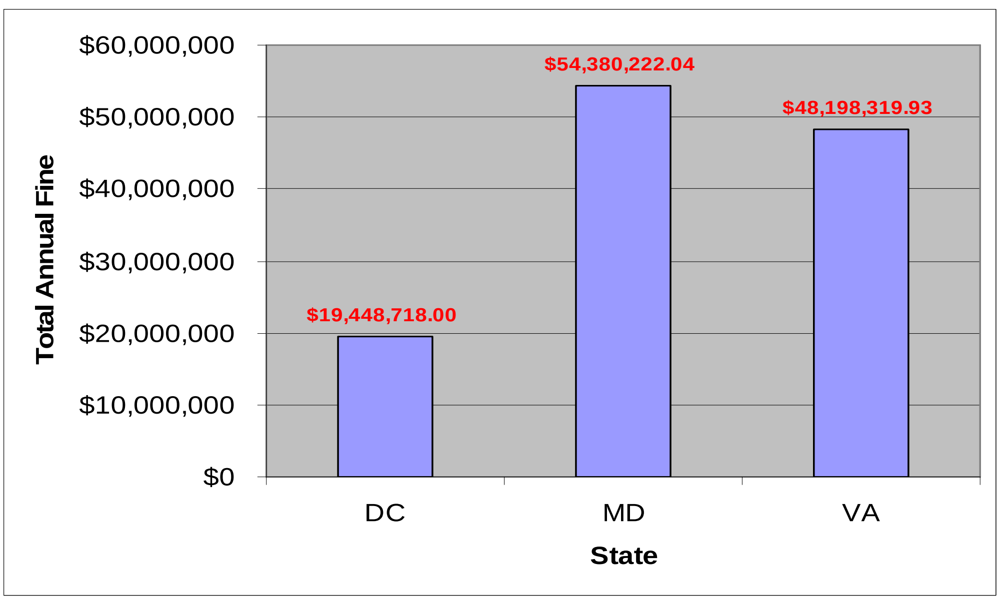


Figure 10: Comparing Annual Fines for Overweight Trucks at New York Ave. WIM Site

From Figures 9 and 10, it is evident that, within the metropolitan area, the District's fines are the least. The fines are higher in of MD than in VA. For the same overweight trucks at the I-295 site, the annual fine accrued was less than that in MD by approximately $115 million (if those overweight trucks were cited in MD). Similarly, at the same site, DC's total fine was less than that in VA by approximately $93 million. At the New York Avenue site, DC's fines were less than MD and VA by approximately $35 million and $29 million respectively.

The monthly total fines for the two sites in the District as compared to the corresponding fines in MD and VA (if those overweight trucks were cited in the two states) is presented graphically in Figures 11 and 12. From the figures, the monthly total fines for the two sites in the District were found to be considerably lower than those in MD and VA.

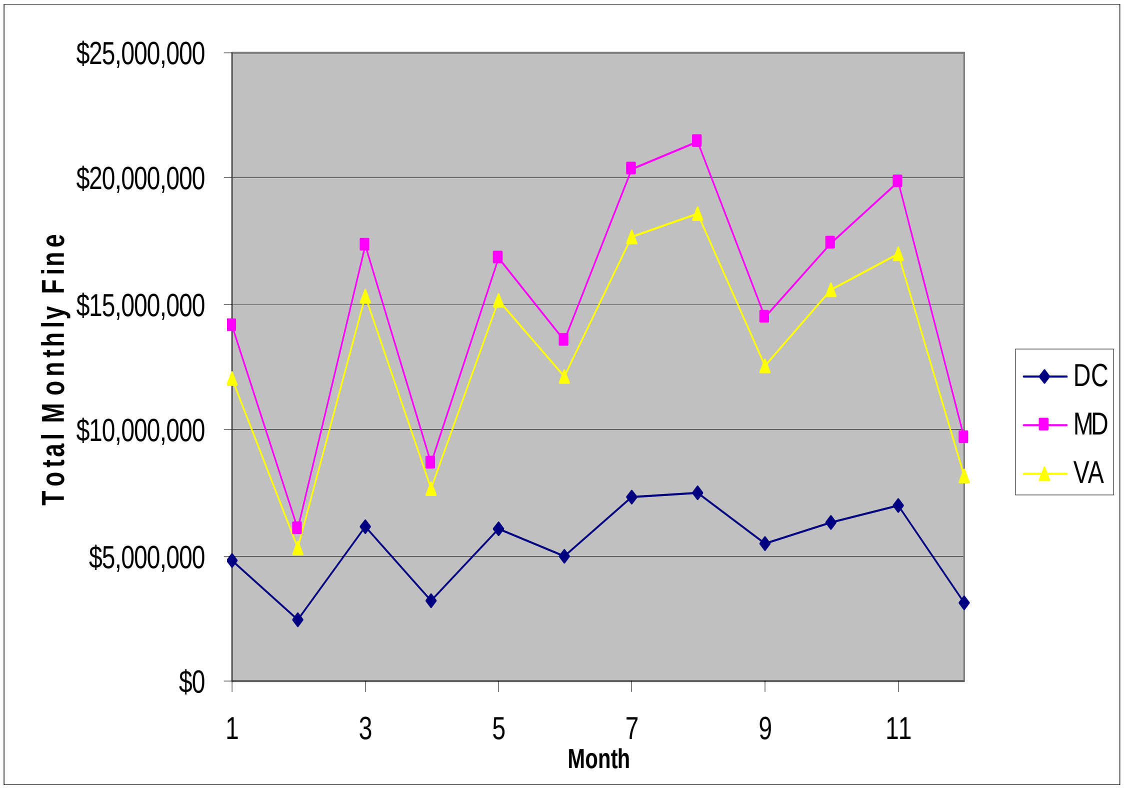


Figure 11: Comparing Monthly Fines for Overweight Trucks at I-295 WIM Site

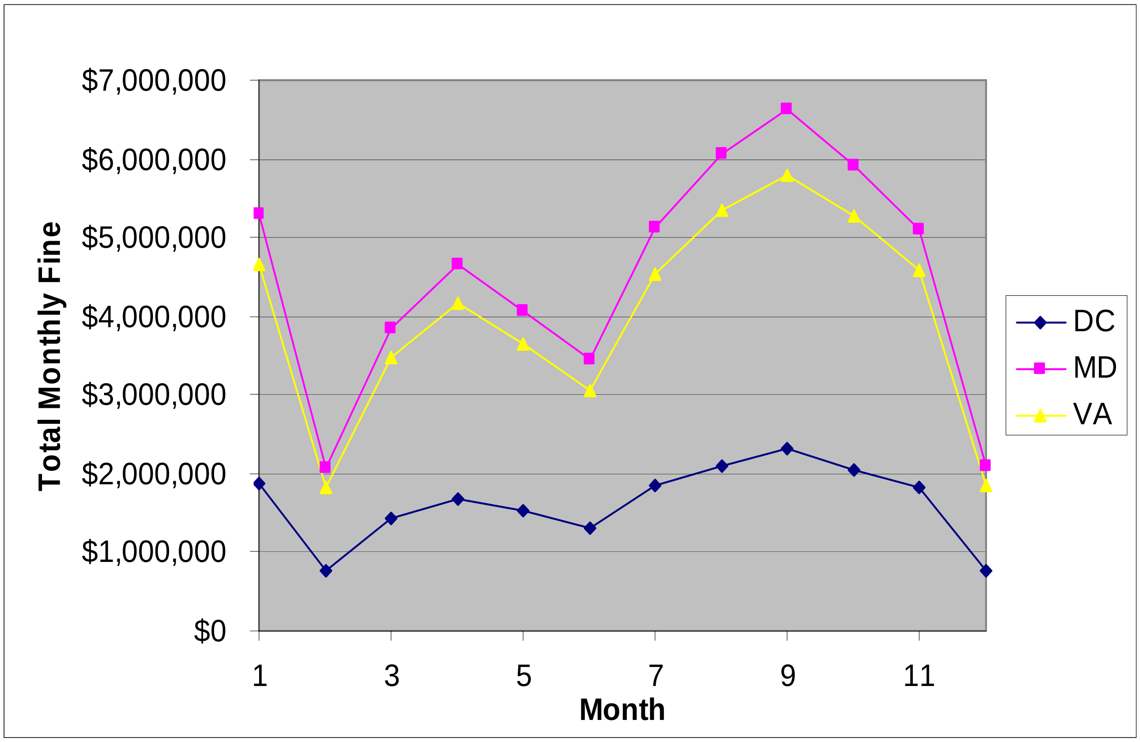


Figure 12: Comparing Monthly Fines for Overweight Trucks at New York Ave. WIM Site

From the analysis of the fines in the District as compared with the adjoining states (MD and VA), it was determined that the fines in DC are the lowest. On average, the fine per an overweight truck in the District ranges between $378 and $451. However, for the same number of overweight trucks at the two sites, the average fine per an overweight truck in MD and VA are respectively $1,060 - $1,260 and $939 - $1,102.

5.2.3 Overweight Violation Types and Corresponding Fines

For each overweight truck, the aggregate fine comprises of fines associated with the gross weight, axle weight and bridge formulation computations. The three overweight types for each truck were extracted from the data provided for the two sites using the VBA presented in Appendix 2.

The violation types and associated fines for the I-295 site are respectively presented in Figures 13 and 14. From Figure 13, the majority of the vehicles at the I-295 WIM site were found to have violated the bridge formula limits the most followed by the axle weight limits.

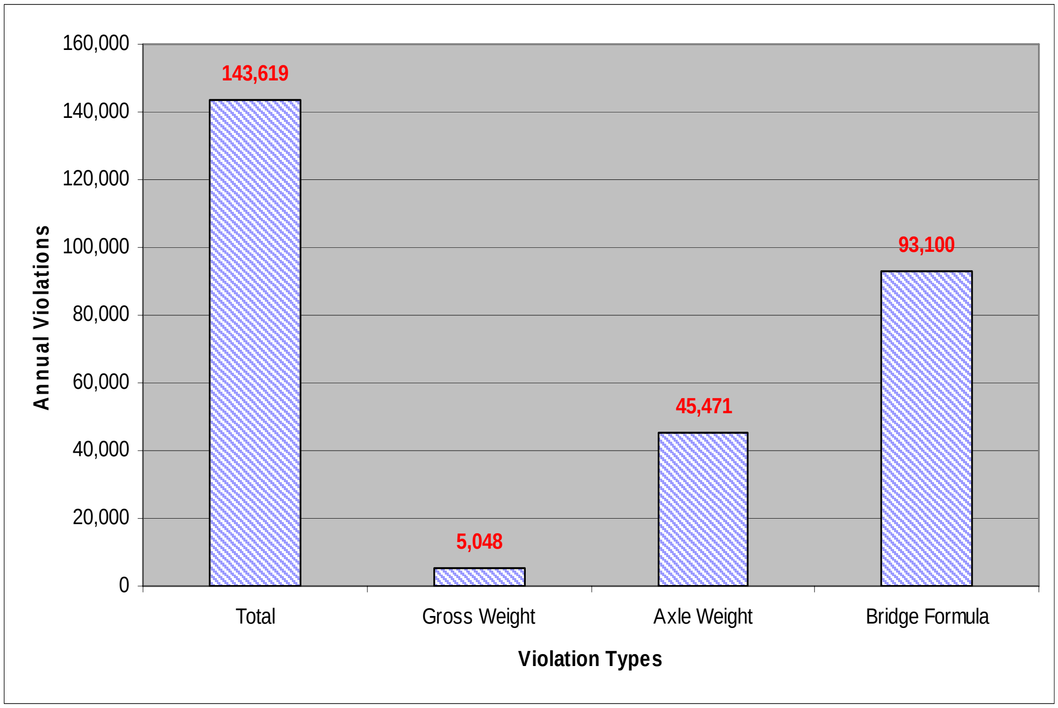


Figure 133: Violation Types for Overweight Trucks at I-295 WIM Site

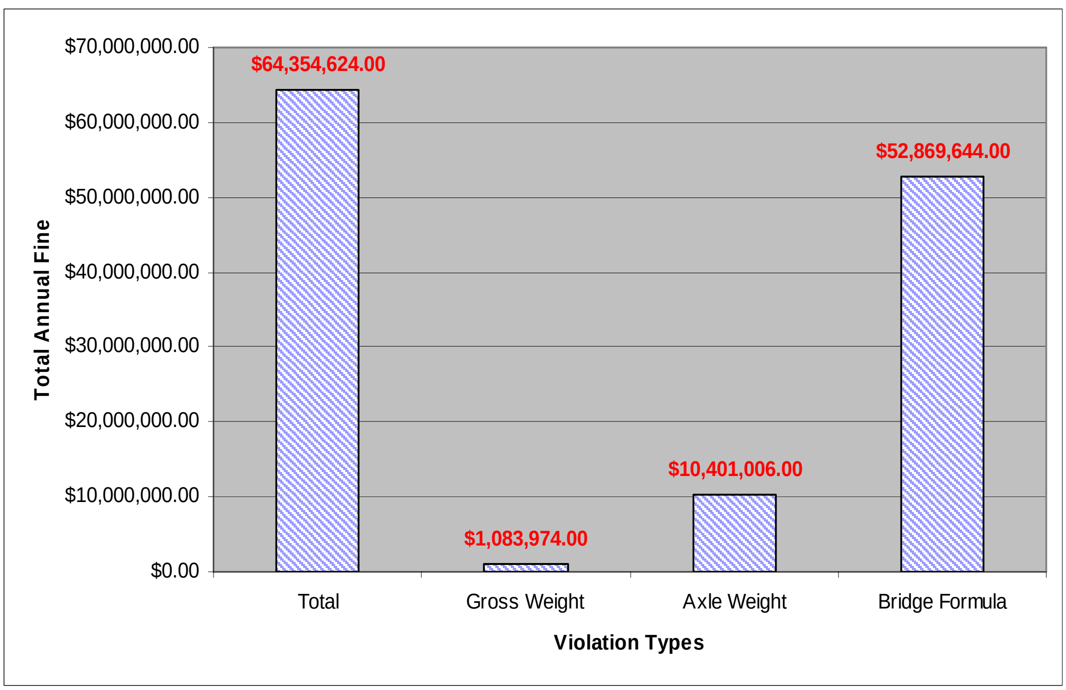


Figure 144: Associate Fines for Violation Types for Overweight Trucks at I-295 WIM Site

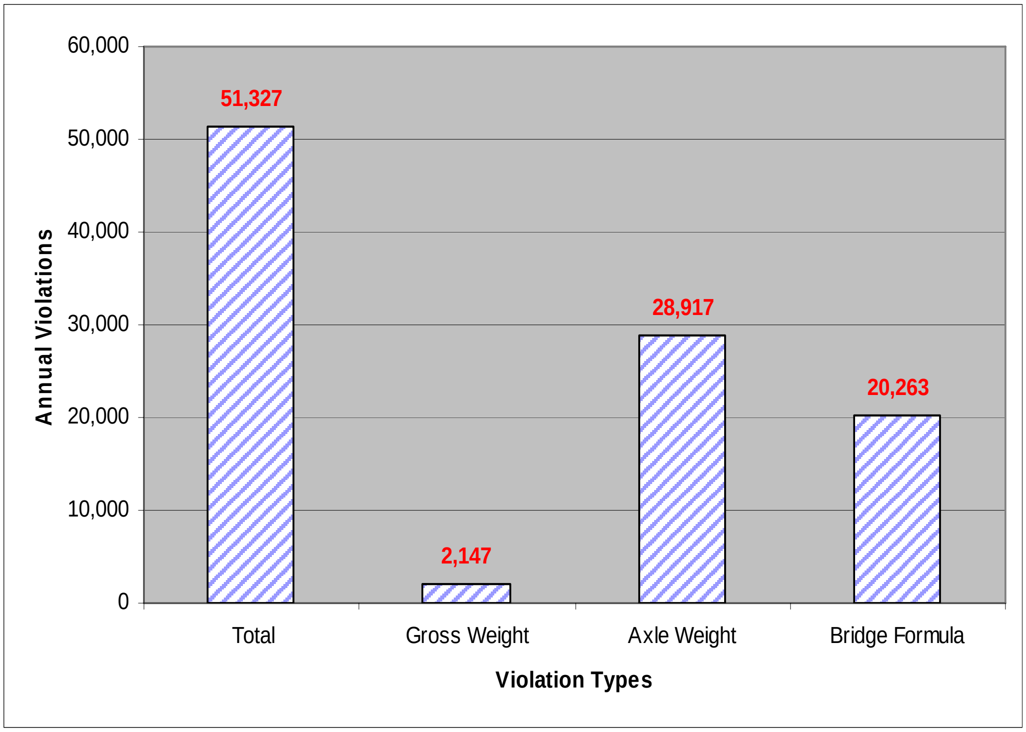


Figure 155: Violation Types for Overweight Trucks at New York Avenue WIM Site

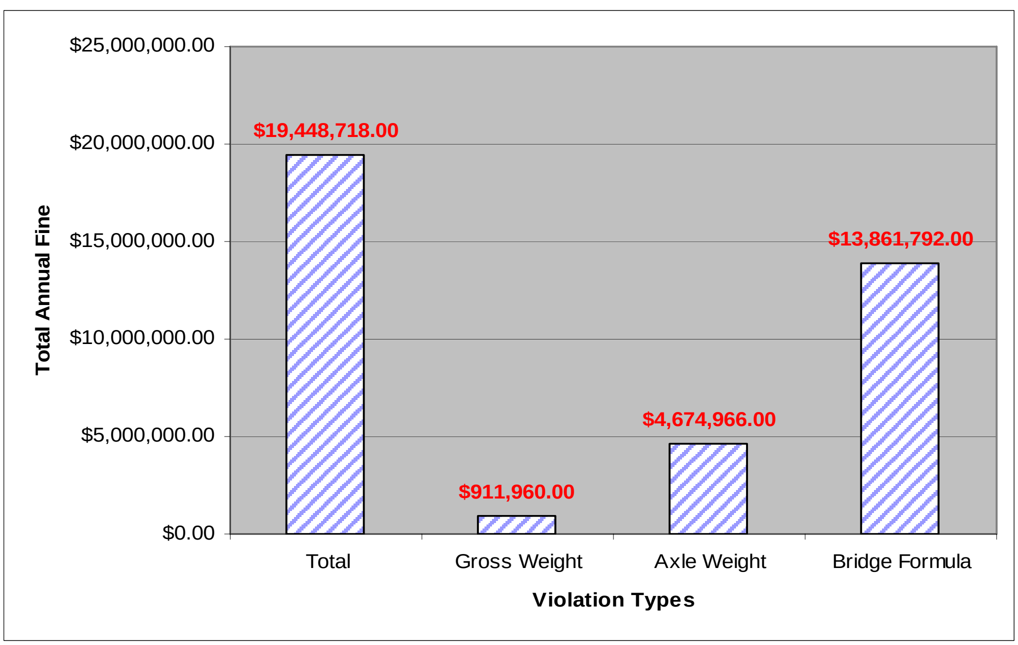


Figure 166: Associate Fines for Violation Types for Overweight Trucks at New York Ave. WIM Site

The gross weight limit was violated the least. This corresponds to the associated fines as shown in Figure 14.

The violation types and the corresponding fines at the New York WIM site are presented in Figures 15 and 16 respectively. In contrast to the violation types at the I-295 site, most of the violations recorded at the New York Avenue site was that of axle weight, followed by the bridge formula violation. Again, the least recorded violation frequency was that of the gross weight. Based on the associated fine computations, violation of the bridge formula was the predominant pattern at the New York Avenue WIM site.

5.2.4 Effect of Overweight Permits on Fines

Under special conditions and instances, truck operators are granted permits to drive overweight and oversize vehicles in the District. The truck operators typically apply for, and are granted the permits in advance before operating an overweight truck in the District. Some of the operators apply for an annual permit or a single haul permit. In the case of the latter permit, a route is confirmed or established based upon size and weight. The analysis of the fines in this report assumed that the overweight trucks do not have such permits since the database did not identify the overweight trucks with permits. If the number of overweight trucks with permits were taken into consideration in the analysis, the aggregate annual fines for overweight trucks would have been lower than the projected amounts for the two sites.

5.2.5 Scenarios for Increasing Overweight Fines

The analyses presented in the previous sections of this report show that overweight fees in the District of Columbia are very low in comparison with Virginia and Maryland. Using the overweight fine schedule of these states, it was shown that the total annual fines for the two sites were more than 150% the total of the District's overweight fine schedule. Thus, a major increase would be needed in the District's rates in order to yield comparable totals with the rates in Maryland and Virginia. Both Maryland and Virginia have based on their current overweight fines an estimated accelerated damage to pavements in those jurisdictions. The District may consider a focused study to correlate pavement damage to various fee schedules. However, since the District, Maryland and Virginia share a common metropolitan area, it is reasonable for the District to make an upward adjustment of its existing fees without a focused study. To bridge the gap shown in the analysis, it would appear that the District fines should be increased by approximately 150%. Scenarios for 50%, 75%, 100% and 150% increases in the current overweight fee structure are presented in Figure 17 for the I-295 site and in Figure 18 for the New York Avenue station.

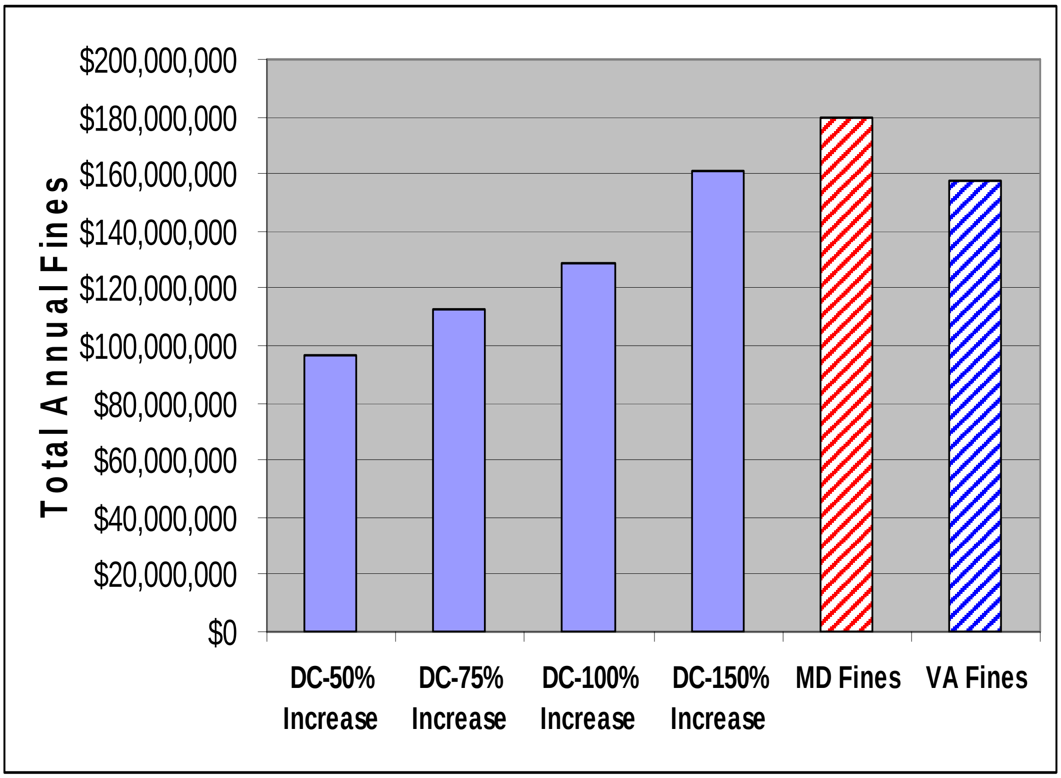


Figure 177: Scenarios for Increasing Fines at I-295 WIM Site

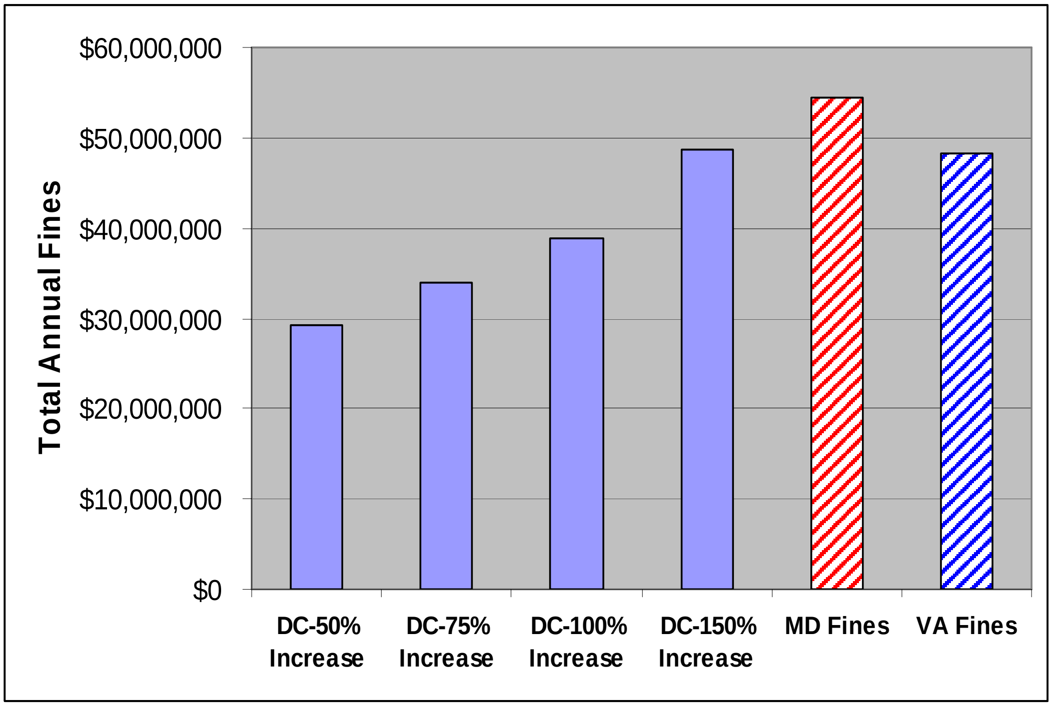


Figure 18: Scenarios for Increasing Fines at New York Avenue WIM Site

6. DISCUSSION

It is clear from the literature review conducted in this study that overloading of trucks contributes to severe pavement damage, while providing a financial benefit to carriers. Drivers of overweight trucks often take advantage of environments where enforcement is lax, and where scales are closed on certain days or at certain times of day. The literature also established the fact that overweight trucks incur significant damage to pavements, estimated in some states to be tens of millions of dollars per year. Such damage is a critical factor used by some states in determining and updating the levels of overweight fines. As axle loads and gross vehicle weight increase for the financial benefit of carriers, overweight fines must be reflective of that trend. Some states monitor overweight trends primarily for making adjustments to fines.

In a region where truck routes cross jurisdictional boundaries and where the overweight fee and fine structures are not closely aligned, carriers often take advantage of such non-uniformity. Drivers of overweight trucks may deliberately seek routes to minimize fines, and carriers are prepared to pay low fines, viewed as business cost covered by the excess weight. In addition to the accelerated pavement damage caused by overweight trucks, the excessive loading places extra stress on the mechanical elements of vehicles, including the braking systems. Thus the overloading of trucks is also a major safety matter. Increasing the overweight fines in the District could have a positive impact on its pavement management and traffic safety programs.

7. RECOMMENDATIONS

In order to deter truck operators from overloading their trucks, the fine structure for overweight trucks should be increased to bring the average fine for overweight trucks in line with fines in Virginia and Maryland. Currently, the average fine per an overweight truck in the District is between $378 and $451. However, for the same number of overweight trucks, the average fine per an overweight truck in MD is $1,060 - $1,260, while in VA the range is $939 - $1,102. The following specific recommendations are presented:

- Due to the vast difference in the District's fines, compared with those of MD and VA, the increase would have to be large; 100% -150% recommended.
- To reduce the impact of this steep increase, a gradual increase over a few years is recommended. Closing the gap between the fines in the District and the adjacent states could enhance truck safety and reduce pavement damage.
- The fines should be reviewed periodically (every 3-5 years) to reflect current trends in the region.
- An additional study to quantify the pavement damage specifically attributable to truck overloading in the District using pavement condition data is also recommended. In this study, the costs and benefits of constructing additional WIM sites (including life of pavement, revenue, roadway safety, etc.) should also be explored.

8. REFERENCES

1. FHWA Office of Operations. "Vehicles Size and Weight", http://ops.fhwa.dot.gov/aboutus/one_pagers/sizeweight.pdf, Assessed September 18. 2008.

2. Adli H. Al-Balbissi. "Economics of Pavement Condition, Axle Load, and Vehicle Operating Cost". ITE Journal, p.22-24, May 1991.

3. Federal Highway Administration. "Comprehensive Truck Size and Weight Study, Vol. 2- Chapter 7, Enforcement of Truck Size and Weight Regulations", US Department of Transportation, Washington DC, 2000.

4. James G. Strathman, Greg Theisen, "Weight Enforcement and Evasion: Oregon Case Study" – Final Report SPR 304-101, Portland State University, Oregon, 2002.

5. John Semmens. Estimating the Cost of Overweight Vehicle Travel on Arizona Highways. Final Report 528, Arizona Department of Transportation, Arizona, 2006

6. Freddy L. Roberts, Aziz Saber. "Effects of Hauling Timber and Lignite Coal on Louisiana Highways and Bridges". Transportation Research Board Annual Meeting, CD- Paper # 06-0769, 2006.

7. Luskin, D.M., Harrison R., Walton C. M., Zhang Z., Jamieson Jr J.L. "Divisible Load Permits for Overweight Trucks on Texas Highways: An Evaluation". Transportation Research Board, Transportation Research Record 1790, 2002.

8. Reisert, J. A, Bowman M. "Fatigue of Older Bridges in Northern Indiana due to Overweight and Oversized Loads, Vol.1: Bridge and Weigh-In-Motion Measurements". Publication No.: FHWA/IN/JTRP-2005/16-1, SPR-2385, 2006.

9. Cunagin W., Mickler W. A., Wright C. "Evasion of Weight-Enforcement Station By Trucks". Transportation Research Board, Transportation Research Record No.1570, 1997.

10. Barros R.T. "Analysis of Pavement Damage Attributable to Overweight Trucks in New Jersey". Transportation Research Board, Transportation Research Record No.1038, 1985.

11. Paxson D.S. "Value of Overweighting to Intercity Truckers" Transportation Research Board, Transportation Research Record No.889, 1982.

12. Cottrell Jr B.H. "The Avoidance of Weigh Stations in Virginia by Overweight Trucks. Final Report". Virginia Department of Transportation, Report No. FHWA/VA-93-R2, 1992.

13. Euritt M.A. “Economic Factors of Developing Fine Schedules for Overweight Vehicles in Texas”. Transportation Research Board, Transportation Research Record No.1116, 1987.

14. Virginia Transportation Research Council. “Overweight Vehicles: Operation of Trucks Hauling Gravel, Sand, or Crushed Stone in the Coal Severance Tax Counties of Virginia”. Virginia Department of Transportation, 2007.

15. Virginia Transportation Research Council. “An Assessment of the Additional Highway Maintenance Costs associated with Overweight Permits for Underground Pipe Cleaning, Hydroexcavanting, and Water Blasting Equipment under Section 46.2-1149.5 of Code of Virginia”. Virginia Department of Transportation, 2007.

16. Ramos-Aparicio, Sonia Ines. “Study of the Asphalt Pavement Damage Through Nondestructive Testing on Overweight Truck Routes”, Texas A&M University, 2004.

17. Green J, Nichols A., Allen E., Nuber L., Thomaz J.,Bullock D., Boruff G., Wasson J., Newland M. “Virtual weigh station”. Indiana department of transportation, Federal Highway administration, 2002.

18. Route One Publishing Limited. “Tackling Highway Heavyweights”. World highways/routes du Monde Vol. 15 No.8, 2006.

19. Santero, N., Nokes, W., Harvey, J. “Virtual Weigh Stations: The Business Case”, Technical Report, Institute of Transportation Studies, PATH, Berkeley, California, 2005.

20. Kishore, A., Klashinsky, R. “Prevention of Highway Infrastructure Damage through Commercial Vehicle Weight Enforcement”, Saskatchewan, November 2000.

9. APPENDICES

APPENDIX 1

Visual Basic for Computing Overweight Fines in MD and VA

```
Sub fine_Checker()


    counter = 2
    sum_dc = 0
    sum_md = 0
    sum_va = 0
    Do Until (IsEmpty(Cells(counter, 1)) = True)
        a = Max(Cells(counter, 2), 0)
        b = Max(Cells(counter, 6), 0)
        c = Max(Cells(counter, 10), 0)
        mdgvw = 0
        vagvw = 0
        mdaxle = 0
        vaaxle = 0
        mdbridge = 0
        vabridge = 0
        'd = Cells(counter, 9) - Cells(counter, 10)
    '*********************************************
    'GVW overweight fine in MD and VA

            'MD
            If a <= 1000 Then
                mdgvw = a * 0.01
                ElseIf a > 1000 And a <= 5000 Then
                mdgvw = 1000 * 0.01 + (a - 1000) * 0.05
                ElseIf a > 5000 And a <= 10000 Then
                mdgvw = 1000 * 0.01 + 4000 * 0.05 + (a - 5000) * 0.12
                ElseIf a > 10000 And a <= 20000 Then
                mdgvw = 1000 * 0.01 + 4000 * 0.05 + 5000 * 0.12 + (a - 10000) * 0.2
                ElseIf a > 20000 Then
                mdgvw = 1000 * 0.01 + 4000 * 0.05 + 5000 * 0.12 + 10000 * 0.2 + (a - 20000) * 0.4
            End If

            'VA
            If a <= 2000 Then
                vagvw = a * 0.01
                ElseIf a > 2000 And a <= 4000 Then
                vagvw = 2000 * 0.01 + (a - 2000) * 0.03
```

```
    ElseIf a > 4000 And a <= 8000 Then
    vagvw = 2000 * 0.01 + 2000 * 0.03 + (a - 4000) * 0.07
    ElseIf a > 8000 And a <= 12000 Then
    vagvw = 2000 * 0.01 + 2000 * 0.03 + 4000 * 0.07 + (a - 8000) * 0.12
    ElseIf a > 12000 Then
    vagvw = 2000 * 0.01 + 2000 * 0.03 + 4000 * 0.07 + 4000 * 0.12 + (a - 12000) * 0.2
End If

If a > 20000 And a <= 40000 Then
    vagvw = 2 * vagvw
    ElseIf a > 40000 Then
    vagvw = 3 * vagvw
End If



'****************************************
'Axle overweight fine in MD and VA

'MD
If b <= 1000 Then
    mdaxle = b * 0.01
    ElseIf b > 1000 And b <= 5000 Then
    mdaxle = 1000 * 0.01 + (b - 1000) * 0.05
    ElseIf b > 5000 And b <= 10000 Then
    mdaxle = 1000 * 0.01 + 4000 * 0.05 + (b - 5000) * 0.12
    ElseIf b > 10000 And b <= 20000 Then
    mdaxle = 1000 * 0.01 + 4000 * 0.05 + 5000 * 0.12 + (b - 10000) * 0.2
    ElseIf b > 20000 Then
    mdaxle = 1000 * 0.01 + 4000 * 0.05 + 5000 * 0.12 + 10000 * 0.2 + (b - 20000) * 0.4
End If

'VA
If b <= 2000 Then
    vaaxle = b * 0.01
    ElseIf b > 2000 And b <= 4000 Then
    vaaxle = 2000 * 0.01 + (b - 2000) * 0.03
    ElseIf b > 4000 And b <= 8000 Then
    vaaxle = 2000 * 0.01 + 2000 * 0.03 + (b - 4000) * 0.12
    ElseIf b > 8000 And b <= 12000 Then
    vaaxle = 2000 * 0.01 + 2000 * 0.03 + 4000 * 0.12 + (b - 8000) * 0.22
    ElseIf b > 12000 Then
    vaaxle = 2000 * 0.01 + 2000 * 0.03 + 4000 * 0.12 + 4000 * 0.22 + (b - 12000) * 0.35
End If
```

```
'******************************************
'Bridge Formula overweight fine in MD and VA

    'MD
    If c <= 1000 Then
       mdbridge = c * 0.01
       ElseIf c > 1000 And c <= 5000 Then
       mdbridge = 1000 * 0.01 + (c - 1000) * 0.05
       ElseIf c > 5000 And c <= 10000 Then
       mdbridge = 1000 * 0.01 + 4000 * 0.05 + (c - 5000) * 0.12
       ElseIf c > 10000 And c <= 20000 Then
       mdbridge = 1000 * 0.01 + 4000 * 0.05 + 5000 * 0.12 + (c - 10000) * 0.2
       ElseIf c > 20000 Then
       mdbridge = 1000 * 0.01 + 4000 * 0.05 + 5000 * 0.12 + 10000 * 0.2 + (c - 20000) *
0.4
    End If

    'VA

    If c <= 2000 Then
       vabridge = c * 0.01
       ElseIf c > 2000 And c <= 4000 Then
       vabridge = 2000 * 0.01 + (c - 2000) * 0.03
       ElseIf c > 4000 And c <= 8000 Then
       vabridge = 2000 * 0.01 + 2000 * 0.03 + (c - 4000) * 0.07
       ElseIf c > 8000 And c <= 12000 Then
       vabridge = 2000 * 0.01 + 2000 * 0.03 + 4000 * 0.07 + (c - 8000) * 0.12
       ElseIf c > 12000 Then
       vabridge = 2000 * 0.01 + 2000 * 0.03 + 4000 * 0.07 + 4000 * 0.12 + (c - 12000) * 0.2
    End If


    'If (c > 0.25 * d) And (c <= 0.5 * d) Then
       'vagvw = 2 * vagvw
       'ElseIf c > 0.5 * 5 Then
       'vagvw = 3 * vagvw
    'End If




 'Results
    Cells(counter, 14) = Format(Max(a, b, c), "##,0")
    Cells(counter, 15) = Format(Cells(counter, 12), "$##0.00")
    Cells(counter, 16) = Format(Max(mdgvw, mdaxle, mdbridge), "$##0.00")
```

```
        Cells(counter, 17) = Format(Max(vagvw, vaaxle, vabridge), "$##0.00")
        sum_dc = sum_dc + Cells(counter, 15)
        sum_md = sum_md + Cells(counter, 16)
        sum_va = sum_va + Cells(counter, 17)

        counter = counter + 1
    Loop

        Cells(counter + 1, 14) = "TOTAL"
        Cells(counter + 1, 15) = sum_dc
        Cells(counter + 1, 16) = sum_md
        Cells(counter + 1, 17) = sum_va

End Sub
Private Function Max(ParamArray values() As Variant) As _
    Variant
Dim i As Integer
Dim max_value As Variant

    max_value = values(LBound(values))
    For i = LBound(values) + 1 To UBound(values)
        If max_value < values(i) Then max_value = values(i)
    Next i

    Max = max_value
End Function
Sub runallsheets()


wb = ActiveWorkbook.Name
Dim ws As Worksheet
For Each ws In ActiveWorkbook.Worksheets
  ws.Select
  Application.Run wb & "!fine_Checker"
Next

End Sub
```

APPENDIX 2

Visual Basic for Extraction of Overweight Violation Types

```
Sub violation_types()


    counter = 2
    col = 14

    counter_gross = 0
    counter_axle = 0
    counter_bridge = 0


    fine_gross = 0
    fine_axle = 0
    fine_bridge = 0

    Cells(1, 14) = "Gross"
    Cells(1, 16) = "Axle"
    Cells(1, 18) = "Bridge"
    Cells(1, 20) = "Total"

    Do Until (IsEmpty(Cells(counter, 1)) = True)
        a = Max(Cells(counter, 2), 0)
        b = Max(Cells(counter, 6), 0)
        c = Max(Cells(counter, 10), 0)

    overweight = Max(a, b, c)
    If overweight = a Then
        counter_gross = counter_gross + 1
        fine_gross = fine_gross + Cells(counter, 12)
    ElseIf overweight = b Then
        counter_axle = counter_axle + 1
        fine_axle = fine_axle + Cells(counter, 12)
    ElseIf overweight = c Then
        counter_bridge = counter_bridge + 1
        fine_bridge = fine_bridge + Cells(counter, 12)
    End If

     counter = counter + 1
    Loop


   'Results
```

```
        Cells(2, col) = counter_gross
        Cells(2, col + 1) = Format(fine_gross, "$##0.00")

        Cells(2, col + 2) = counter_axle
        Cells(2, col + 3) = Format(fine_axle, "$##0.00")

        Cells(2, col + 4) = counter_bridge
        Cells(2, col + 5) = Format(fine_bridge, "$##0.00")

        Cells(2, col + 6) = counter_gross + counter_axle + counter_bridge
        Cells(2, col + 7) = Format(fine_gross + fine_axle + fine_bridge, "$##0.00")

End Sub
Private Function Max(ParamArray values() As Variant) As _
    Variant
Dim i As Integer
Dim max_value As Variant

    max_value = values(LBound(values))
    For i = LBound(values) + 1 To UBound(values)
        If max_value < values(i) Then max_value = values(i)
    Next i

    Max = max_value
End Function
Sub runallsheets()


wb = ActiveWorkbook.Name
Dim ws As Worksheet
For Each ws In ActiveWorkbook.Worksheets
  ws.Select
  Application.Run wb & "!violation_types"
Next

End Sub
```