JOINT TRANSPORTATION RESEARCH PROGRAM

INDIANA DEPARTMENT OF TRANSPORTATION
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Overweight Divisible Loads: Permit Administration and Impact on Indiana's Road Infrastructure and Safety

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16. Abstract
Indiana's House Enrolled Act (HEA) 1190-2021 was implemented in January 2022 to address concerns regarding the overweight (OW) loading behavior of the freight transportation industry and OW permitting. The Act required the Indiana Department of Transportation (INDOT) to adopt emergency rules and a fee structure for the interim period. At the start of the interim period, the permit fee was increased from 7 cents/Equivalent Single Axle Load (ESAL)-mile to 25 cents/ESAL-mile. INDOT commissioned the current study to provide specific information about the effects of the Act on OW permit and revenue trends, infrastructure, and safety. The study results suggest that the Act caused an increase in the number of permits issued and revenue; a decline in the average Gross Vehicle Weight (GVW) and ESALs; but no significant impact on pavement and bridge damage or safety at the permitted routes. The Act helped to close the gap between OW-induced infrastructure consumption and tax revenues from OW-induced fuel consumption overall. It also closed the gap between OW-induced infrastructure consumption and permit revenues in the context of non-interstate OW operations. Feedback from freight transportation industry indicated a strong propensity to help protect the infrastructure via axle addition, particularly when incentivized using financial levers. Overall, the Act's evaluation indicated no significant adverse impact on OW permit quantity and revenues, and most importantly, on infrastructure and safety. As such, the study results suggest that there is no need for any further adjustments in the OW divisible load permitting fee structure. In addition, efforts to further encourage responsible loading behavior—such as fee discounts or credits to encourage axle addition and truck load restrictions at specific road classes at certain times of the year—could be pursued.

17. Key Words
overweight, permit fee, ESALs, highway policy, highway legislation

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EXECUTIVE SUMMARY

Introduction

Indiana's House Enrolled Act (HEA) 1190-2021 was implemented on January 1, 2022, to address concerns regarding the overweight (OW) loading behavior of the freight transportation industry and OW permitting. The HEA Act required INDOT to adopt emergency rules and a fee structure for the interim period. At the start of the interim period (which is still ongoing), the permit fee was increased from 7 cents/ESAL-mile to 25 cents/ESAL-mile. INDOT commissioned the current study to provide specific information about the impacts of the Act on OW permit and revenue trends and the effects on infrastructure and safety.

Findings

The study results suggest that, due to HEA, there was an increase in the number of permits issued and revenue gained, a decline in the GVW and ESALs per truck; and no significant impact was made on pavement and bridge damage or safety at most of the permitted routes. The HEA Act helped to close the gap between OW-induced infrastructure consumption and revenues from OW-induced fuel-tax revenue overall; and between OW-induced infrastructure consumption and permitting revenues regarding non-interstate OW operations. Feedback from freight transportation industry representatives indicated a strong propensity to help protect the infrastructure with axle additions, particularly with financial levers. Overall, the impact evaluation of HEA indicated no significant adverse effects on permit volumes and revenues, and most importantly, on infrastructure and safety.

Implementation

Based on the study outcomes, there is no need for any further adjustments in the OW divisible load permitting fee structure, and INDOT should continue to further encourage responsible loading behavior to stimulate ESAL addition.

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LIST OF ACRONYMS

APEW	Average Percent overage of the Extra Weight carried by an OW truck (relative to the maximum allowable weight)
ESAL	Equivalent Single Axle Load
FHWA	Federal Highway Administration
GVW	Gross Vehicle Weight
HCA	Highway Cost Allocation
HCV	Heavy Commercial Vehicle
HEA 1190-2021	House Enrolled Act 1190-2021
HEA 1481-2013	House Enrolled Act 1481-2013
INDOR	Indiana Department of Revenue
INDOT	Indiana Department of Transportation
LCV	Longer Combination Vehicles
MCSD	Motor Carrier Services Division
MPDC	The Marginal Cost of Pavement Damage
MR&R	Maintenance, Reconstruction, and Rehabilitation
NBI	National Bridge Inventory
NHS	National Highway System
NIS-NHS	Non-Interstate road that belongs to the National Highway System
Non-NHS	Non-National Highway System
OW	Overweight
OS	Oversize
PCE	Passenger Car Equivalent
PCR	Pavement Condition Rating
PDC	Pavement Damage Cost
PDO	Property Damage Only (crash)
SNC	Structural Number Coefficient
TIE	Traffic Impairment Effect (of OW operations)
TRE	Trips Reduction Effect (of OW operations)
TS&W	Truck Size and Weight
USDOT	United States Department of Transportation
XHD	Extra Heavy-Duty (highways)

COMMONLY USED TERMS

Average Pavement Damage Cost (APDC)	The total maintenance, rehabilitation, and reconstruction expenditures on a pavement network averaged across the total usage (VMT, AADT, ESALs, etc.).
Chargeable ESALs	ESALs exceeding the ESAL credit threshold, above which an OW truck is responsible to pay a specific fee.
Equivalent Single Axle Load (ESAL)	Damage caused by a given axle load relative to a base axle load (18,000 lbs.).
Equivalent Uniform Annual Cost (EUAC)	The annualized cost associated with M, R, and R of a system over a given analysis period (e.g., the system's remaining life or service life).
HEA 1190-2021	House Enrolled Act 1190-2021
Longer Combination Vehicle (LCV)	Truck tractor combination comprising two or more trailers or semitrailers of total GVW exceeding 80,000 lbs.
Marginal Pavement Damage Cost (MPDC)	The marginal increase in MR&R expenditure associated with a unit additional load on the pavement.
Passenger Car Equivalent (PCE)	The number of passenger vehicles whose impact is equivalent to that of a standard large vehicle on the roadway.

CHAPTER 1. INTRODUCTION

1.1 Study Motivation

The State of Indiana's road network yields benefit to the state by supporting and promoting economic development. Like all engineering systems, the highway systems yield benefits that are accompanied by various costs incident to the stakeholders. These costs, from the road agency's perspective, could be referred to as "consumption" as they are associated with the repair of deteriorated road bridges and pavements, and operationally degraded performance (safety and mobility) at the road segments. The costs are borne by the state's taxpayers and road users through reduced levels of service and increased direct costs of vehicle operations (fuel, tires, engine, and transmission wear, and so on), and the state's residents in general. For this reason, the government of Indiana bears a fiduciary responsibility to identify and implement favorable regulations and policies designed to enhance protection of not only the highway infrastructure (pavements and bridges) from undue deterioration but also traffic safety and overall mobility. Indiana seeks to achieve these objectives without unduly sacrificing the economic development and productivity associated with the state's freight transportation operations.

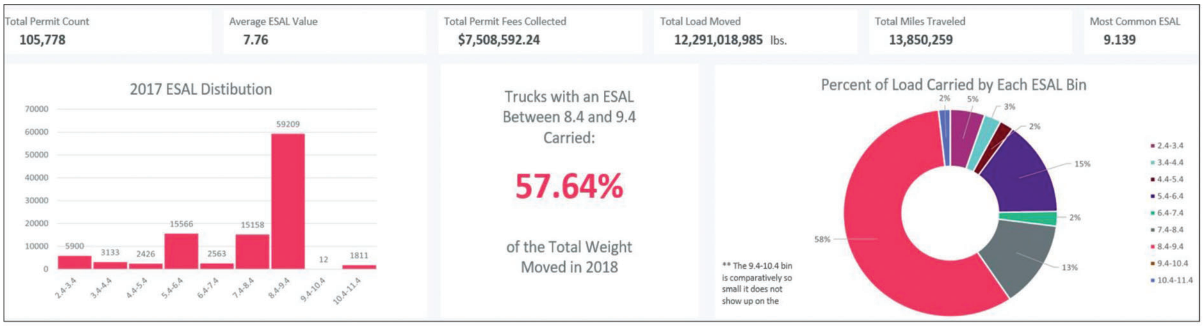
Regarding overweight (OW) road transportation specifically, Indiana, like most states, finds itself in a dilemma: on one hand, the state seeks to recover OW-induced repair/replacement expenditures through permit fees. On the other hand, the state seeks to avoid OW permit fees that do not impair freight transportation productivity and hence, maintain economic efficiency and development. As such, there exists a need to continually monitor the transportation environment and to strike a fair balance between the state's trucking economic competitiveness and adequate recovery of damage-repair expenditures. This is a dynamic challenge because of the vicissitudes that characterize the current socio-economic and technological environment, including: changes in government (and thus policy), fluctuations in agricultural and industrial production, uncertainties in freight shipping demand, changes in infrastructure material quality and structural integrity, inflation-plagued costs of infrastructure replacement and repair, and so on. Due to these trends, the Indiana Department of Transportation (INDOT), as stewards of the state's road infrastructure, has a responsibility to conduct periodic evaluations of its highway OW fee policies and their multi-dimensional impacts.

In this regard, an INDOT sponsored study in 2014 (published as SPR-3757, FHWA/IN/JTRP-2014/14) made recommendations, based on certain assumptions regarding then-prospective freight transportation industry behavior in reaction to HEA 1481-2013 proposed at that time. HEA 1481-2013 was the penultimate OW draft legislation that was passed subsequently circa 2014 as HEA 1481-2013. At the time, the expectation was that the freight transportation industry would respond in ways that would subsequently reduce their permit costs while reducing their equivalent single axle loads (ESALs) (and therefore protecting the road infrastructure). It has been indicated, however, that in the years that followed, those assumptions did not manifest in the manner anticipated, as the industry did not add axles to their trucks to reduce the infrastructure damage to the extent needed (see Figure 1.1). Secondly, there are a few permitting administration issues (including incentives, route selection, and economic analysis) which need to be examined, to further provide the state legislators with the information needed to make more informed decisions.

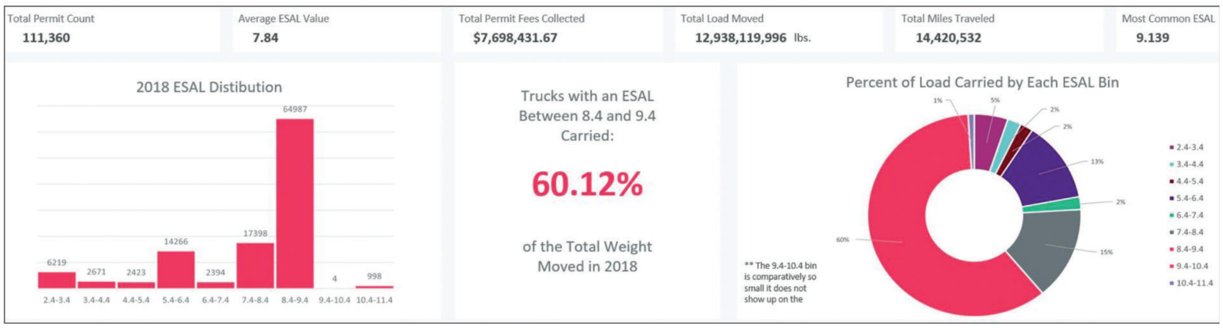
Therefore, in a bid to remain competitive with other states while ensuring the integrity of Indiana's highway infrastructure, the State of Indiana, in January 2022 implemented House Enrolled Act (HEA) 1190-2021, to establish some key revisions to the OW permit fee structure. The key revisions included the removal, from the "overweight divisible load" definition, the commodity list and specified limitations in weights for some commodity types. The highlight of the legislation was the requirement for INDOT to submit a recommended interim OW permit fee structure for OW divisible loads (see Appendix B). Subsequently, INDOT established this interim permit fee as \$0.25 per ESAL-mile, a significant jump from the OW permit fee (\$0.07 per ESAL-mile) that existed since 2014. Also, the legislation expanded the list of commodities that could be counted under this category. Further, the law placed a cap on the total count of single permits issued annually, providing that "not more than 8,500 single trip permits may be issued annually" for applicants with a total ESAL calculation exceeding 2.40 ESAL credit. These imposed limits applied only to permits issued after January 1, 2022. Permits issued before this date were made to be unaffected by this restriction as they were considered as "grandfathered" in. The law also empowered INDOT with the authority to place a limit on the number of OW divisible load permits issued to an individual OW permit-fee applicant. INDOT was also required to adopt rules, recognizing that there existed a lack of transportation alternatives for certain supply chain interruptions, resources, or supply dock backlogs.

HEA 1190-2021 required INDOT to adopt the emergency rules and fee structure for the interim period and report, by July 1, 2023, to Indiana's legislative council and the Interim Study Committee on Roads and Transportation, on the OW divisible load permit fee structure and the impact of OW divisible loads on the road/highway infrastructure. Furthermore, the law required INDOT to report annually to the two legislative offices on the OW divisible load permit market fluctuation. It is anticipated that these reports, along with information provided by other state entities, will help to determine the final "permanent" fee structure. Figure 1.2 illustrates the fee structure timeline.

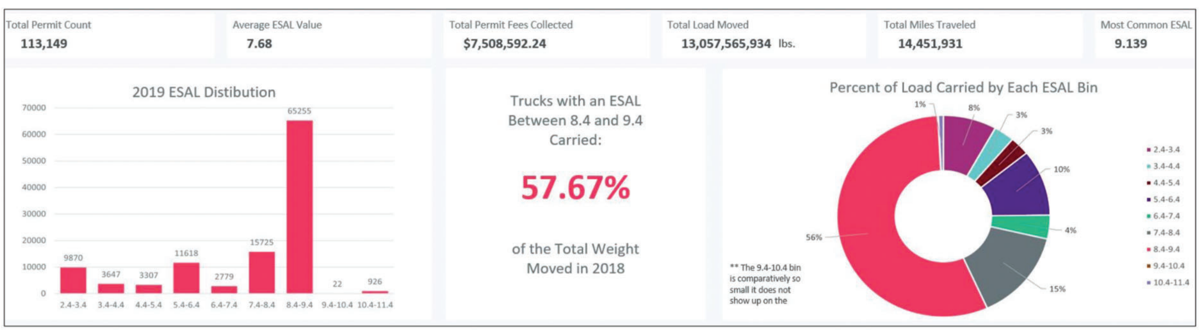
As a post intervention evaluation measure, the state legislators requested INDOT to ascertain the impacts



(a) 2017



(b) 2018



(c) 2019

NOTE: Regarding the period following the HEA 1481-2013 legislation, which was implemented in 2014, the research team used data from the years 2017, 2018 and 2019 to provide a narrative on the extent to which that legislation impacted the loading behavior of freight transportation industry. The data were analyzed to determine the loads carried by the trucks operating on Indiana roads in terms of their ESAL ranges. The network-level aggregate analysis, the results of which are presented in the figure above, suggests that OW operations exceeding 2.4 ESALs were commonplace. For example, trucks with ESAL between 8.4 and 9.4 hauled more than 50% of the total weight moved across Indiana roads in freight in 2017, 2018, and 2019. The most common ESAL observed was 9.139—far above the recommended limit of 2.4 that the 2014 legislation encouraged. This suggests that within that period, at least, OW trucks generally hauled loads with very high ESAL values. This confirms that there was strong motivation for Indiana's decision in 2021 to review the OW fees.

Figure 1.1 Actual OW loading practices in a snapshot period (2017–2019) after the 2013 HEA 1481 legislation.

of HEA 1190-2021 on the number of permits issued, revenues, and infrastructure consumption and operational performance (safety). This is consistent with INDOT's continuing quest to monitor OW operations and associated costs, and to ensure the continuance of reliable and appropriate fee structure for continued OW operations. That way, INDOT will be well equipped to advise the state's legislators appropriately regarding prospective adjustments to the OW fee structure.

1.2 Problem Statement

Against this background, regarding HEA 1190 (see Appendix D and E), INDOT seeks answers to several questions involving several issues. First, there is a need

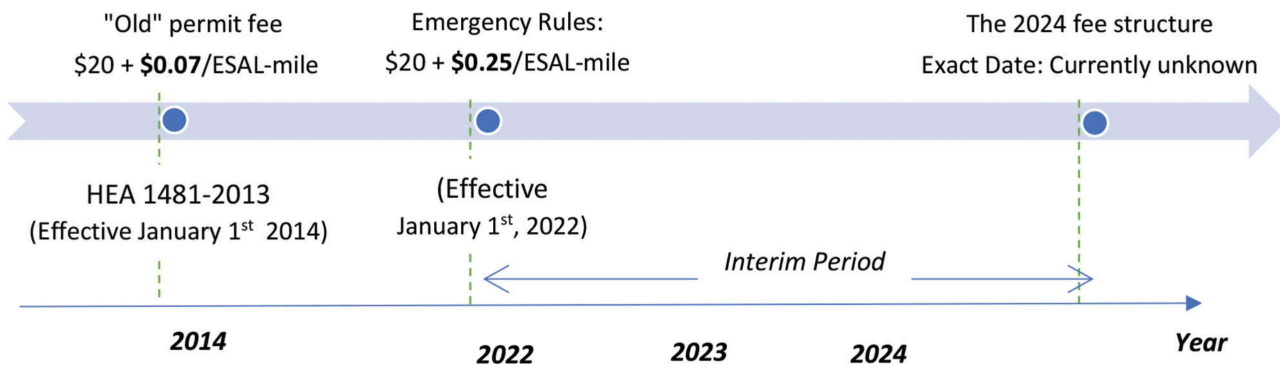


Figure 1.2 Timeline of Indiana's OW permit fee structures.

to understand the impact of permit fees on the number of annual and single trip permits granted relative to the fees based on INDOT's SPR-3757, which was published in 2014 (Everett et al., 2014). It is also necessary to ascertain the extent of actual infrastructure condition, safety, and mobility performance on the permitted routes due to the operations of the OW loads. Next, INDOT seeks to examine if there has been a fluctuation in the count of OW divisible load permitting across the years. Further, in a bid to evaluate a possible need to modify the permit fee structure again to further motivate the freight transportation industry to adopt loading patterns that protect the infrastructure, INDOT seeks to investigate whether there will be any changes in infrastructure damage if there is a change in the OW permit fee structure. It is also in INDOT's interest to measure the effect of the existing OW permit fees on the freight transport industry and their investments (if any) in axle addition and identify and financial and other levers that the agency could use to promote infrastructure-protecting loading behavior of the carriers without compromising the competitive economic position of the state. In 2021, INDOT commissioned Purdue University to undertake a study to investigate these issues, and to provide guidance that will inform INDOT and its recommendations to the legislature.

1.3 Study Objectives and Scope

Based on the problem statement described above, the objective of this study is to generate information that can assist INDOT in making appropriate recommendations to the Indiana General Assembly regarding the permitting of OW divisible loads. Specifically, the study seeks the following.

1. Determine the actual and anticipated impacts of the HEA 1190 legislation on the volume of single-trip and annual permits issued, relative to the volumes that were based on legislation following INDOT Publication No. FHWA/IN/JTRP-2014/14 of the Joint Transportation Research Program (Everett et al., 2014). This part was addressed by INDOT and reported separately to the legislature).
2. Determine the actual infrastructure condition, safety, and mobility performance at the permitted routes.
3. Document the fluctuation in OW divisible load permits granted in 2019 and 2020. This part was addressed by INDOT and reported separately to the legislature.
4. Identify any need to revise the OW fee structure to incentivize user behavior to protect the infrastructure.
5. Assess the expected changes in infrastructure consumption arising from prospective changes to the permit fee structure.
6. Document the impact of the existing fee structure on shippers, carriers including their investments (if any) in axle addition.
7. Explore the financial levers that INDOT could use to make permitting easier, to facilitate competitiveness of freight transportation operations in the state.

Study scope: The study focused on state highways only. The term "overweight vehicles" refers to classes 5 and above that exceed load regulations.

1.4 Organization of the Report

Chapters 2 and 3 present a synopsis of OW permitting state-of-practice in Indiana and other states, and a review of published literature. Chapter 4 addresses the current knowledge on the impacts of OW operations in terms of infrastructure damage (pavements and bridges) and operational degradation in terms of mobility, safety, and OW permitting revenues. Chapter 5 provides a specific look at the infrastructure and safety impacts at specific INDOT OW-permitted routes and Chapter 6 assesses the need to revise fees to incentivize infrastructure-protecting user behavior, through examination of the current fee structure, a review of the aggregate trends, and comparisons of the fuel tax revenues and permit fee revenues with pavement damage costs due to OW operations. Chapter 7 explores a few financial and other levers that INDOT could use to facilitate permitting and to promote competitiveness of freight transportation operations. Chapters 8 and 9 describe the development of an OW permit-fee calculator useful to prospective permit seekers, and a dashboard tool to convert raw permitting data into metrics useful to the Indiana Department of Revenue (INDOR), INDOT, and prospective permit seekers. Chapter 10 discusses the fluctuation in the count of OW divisible load permits granted in 2021, and Chapter 11 presents the perspectives of the carriers (through a questionnaire survey) regarding various aspects of their OW operations and their perspectives on a few prospective initiatives related to OW permitting administration and fee levels. Chapter 12 provides concluding remarks on the study including recommendations. Finally, the report provides some policy recommendations for INDOT. The end of the report contains the references cited in this manuscript, and a few useful OW-related literature and other resources from various Midwest states, and some supporting material related to the study analysis.

CHAPTER 2. OVERWEIGHT PERMITTING: A SYNOPSIS OF NATIONAL AND STATE TRENDS

2.1 Background

Efficient transportation of agricultural or industrial goods (as raw materials, intermediate products, and finished products) across points of extraction/harvesting/manufacture, warehouses, and markets, and across suppliers, distributors, and consumers, can be considered both cause and effect of economic growth. Therefore, freight volumes are not only a critical input to an economy but also represent an outcome of a thriving economy. It has been estimated that in the U.S., over 50 million tons of goods worth $52 billion (2018 dollars) were transported daily in 2018, accounting for approximately 10% of the national Gross Domestic Product (USDOT, 2020).

Of the freight transport modes, truck transportation has dominated shipping under 1,000 miles and, in the United States, carries the largest share of freight by value and weight over the last few decades (USDOT, 2020). For example, in 2018, truck transportation accounted for approximately 11 billion tons (60% of total tonnage) and $12 trillion freight value (61% of total freight value) (USDOT, 2020). The large volume of road freight nationally is evidential of the freight transportation industry's enormous contribution to the socio-economic development of the country. Unfortunately, these benefits are accompanied by costs associated with the damage caused by the OW operations, including deterioration of road infrastructure, and traffic safety and mobility degradation (Ahmed, Agbelie, et al., 2013).

In a bid to address the adversities associated with OW operations (safety and mobility impairment, and pavement and bridge infrastructure deterioration), state DOTs, often required or encouraged by their legislatures, have established weight and size limits, and permitting fees to regulate freight transportation operations. Their goal is to prevent undue damage to the infrastructure and to promote highway traffic mobility and safety without impairing the economic efficiency of freight operations. Without such regulation, the pavements and bridges would deteriorate faster, and the region's freight-related economic productivity and development could be placed in jeopardy (Everett et al., 2014). As such, the Indiana DOT, like other state highway agencies, seeks to identify the delicate balance between reasonable OW-permitting policy (to support the state's economic competitiveness) on one hand, and a reasonable degree of recovery of freight-related highway repair/replacement-related expenditures.

This quest poses a few challenges to the agency. First, there exists several uncertainties associated with analysis inputs. These include variations in infrastructure demand and usage (traffic volumes and loads) that cause variabilities in the unit cost of infrastructure consumption. Also, such consumption costs are affected by technological innovations in bridge and pavement materials science, structural designs, construction processes and project delivery approaches, and maintenance strategies and schedules. These, in turn, influence the maintenance and replacement costs and the service lives of these highway infrastructure assets (Everett et al., 2014). Therefore, to keep abreast of such dynamic trends in the highway administration environment, highway agencies strive to review and update periodically their overall policies and regulations including OW permitting. Such updates require data and information on the potential impacts of prospective changes in policies (such as OW fees) on infrastructure condition, mobility and safety, and economic productivity.

The literature review presented in this chapter addresses the historical evolution of OW permitting and presents a synopsis of national and state trends in this regard.

2.2 Federal Legislation on OW Truck Operations

The 1956 Federal-Aid Highway Act is the first federal regulation associated with truck weight limits. Passed to protect the interstate highway infrastructure, this law placed caps on the weights as follows—combination trucks: 73,280 lbs. GVW; single-axle: 18,000 lbs.; tandem-axle: 32,000 lbs. The truck width was restricted to a maximum of 96 in., and the truck length and height restrictions were left to the states (FHWA, 2015). As explained in subsequent paragraphs, various exceptions to these federal restrictions (collectively known as the "grandfather clause") allowed some flexibility or restrictions regarding the exceedance of truck axle load or GVW limits at interstate highways.

The U.S. Congress, in 1974, legislated an increase in the federal weight limits to 80,000 lbs. maximum GVW; a 20,000 lbs. load limit for any single axle, and 34,000 lbs. for any tandem axle (FHWA, 2015). Unfortunately, such increases did not cover all states, causing hiccups in cross-country freight (USDOT, 2015). The Surface Transportation Assistance Act (STAA) of 1982 addressed these hiccups by setting up a National Highway System (includes all interstate roads, most US roads, a select few state roads, other federal-aid highways deemed to be critical to the nation's freight transportation industry. Regarding this national road system, the federal weight limits served as minimum values and the truck maximum width was increased to 8.5 ft. (FHWA, 2015).

In 1991, the Intermodal Surface Transportation Efficiency Act (ISTEA) was passed. This legislation restricted the weights and routes for long combination vehicles (LCVs). LCVs came to be defined as "a combination of truck-tractor or two or more trailers or semitrailers which operate on the National System of Interstate and Defense Highways with a GVW greater than 80,000 lbs." (FHWA, 2015). As of the time of writing, 17 states allow LCV's operations on their interstates (Figure 2.1). Table 2.1 summarizes federal legislation that influence states' exemptions, their grandfather rights, and restrictions to their truck weights and sizes.

Further, to protect the bridge infrastructure from undue loads, the FHWA established, for trucks crossing bridges, a formula to establish limits on the weight-to-length ratios (FHWA, 2006). This is known as the federal bridge weight relationship (Equation 2.1). The rationale is that specific inter-axle intervals pose different load concentrations, thus causing different stresses on bridges. The overall gross weight, W (to the nearest 500 lbs.) on any set of two (or more) consecutive axles, is given by

$$W = 500\left[\frac{LN}{N-1}\right] + 12N + 36 \qquad \text{(Eq. 2.1)}$$

Where: L = distance (ft.) between the outer axles of any set of two or more consecutive axles; N = the number of axles.

2.3 Indiana State Legislation on OW Truck Operations

Title 9 (Motor Vehicles), Article 20 (Weight and Size Regulations) of Indiana's Code (Indiana General Assembly, 2021) presents the details of the laws that regulate truck weight and size in the state. The state

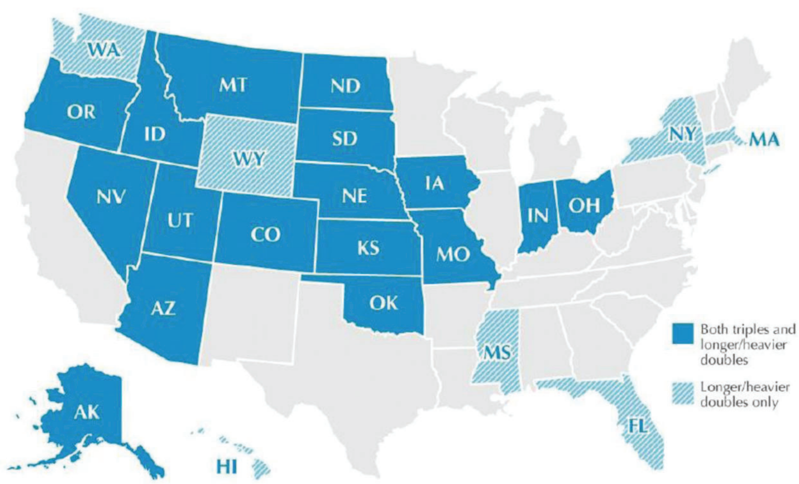


Figure 2.1 States that allow longer combination vehicles on some interstates (USDOT, 2015).

TABLE 2.1
Chronology of federal truck-size and weight legislation from 1956 to 2022

Regulation	Size Limits	Weight Limits
1956: The Federal-Aid Highway Act	Interstate Highways Width: 96 in. max.	Interstate System Single-axle: 18,000 lbs. max. Tandem-axle: 32,000 lbs. max. GVW: 73,280 lbs. max.
1974: Amendments to the Federal-Aid Highway Act	Interstate Highways Width: 96 in. max.	Interstate System Single-axle: 20,000 lbs. max. Tandem-axle: 34,000 lbs. max. GVW: 80,000 lbs. max.
1982: The Surface Transportation Assistance Act (STAA)	Interstate Highways Width: 102 in. max.	Interstate System States were mandated to allow the federal weight limits at their interstate highways
1991: The Intermodal Surface Transportation Efficiency Act (ISTEA)	Freeze on longer combination vehicles (LCVs), imposed by the U.S. Congress	Freeze on longer combination vehicles (LCVs), imposed by the U.S. Congress

law contains provisions that permit trucks on the state's National Highway System (NHS) roads to exceed certain federal limits regarding: (1) GVW exemptions associated with trucks carrying specific commodity types, and (2) truck weight tolerances regarding GVW and/or individual axles. For legal operations on Indiana's roads, a truck must meet the limits on specified weights and dimensions (Table 2.2).

In addition, federal law grandfather provisions allow states to permit the operations of heavy- and extra heavy-duty trucks at certain interstate road sections at a maximum GVW of 134,000 lbs.; single axle weight limit of 22,400 lbs.; and a tandem axle weight limit of 36,000 lbs. The GVW limit depends on whether the highway is designated as a heavy-duty highway or an extra heavy-duty highway. Trucks that exceed the state's legal weight limits need to purchase a permit. Table 2.3 summarizes Indiana's weight limits for truck operations. Also, the state has identified routes where operations by heavy-duty and extra heavy-duty truck are allowed (Figure 2.2 and Figure 2.3).

TABLE 2.2
Size and weight restrictions for legally operating vehicles in Indiana

Attribute	Limits
Length	Two-vehicle combination: 60 ft.[1]; single vehicles: 40 ft.
Width	8 ft. 6 in.
Height	13 ft. 6 in.
Weight	80,000 lbs. GVW
	800 lbs./in. of rim width; subject to axle weight limits
	34,000 lbs. on a tandem axle
	20,000 lbs. on a single axle

[1]No overall length limit for two-vehicle combinations connected by a 5th-wheel hook-up. Nevertheless, total length must not exceed 53 ft.

TABLE 2.3
Summary of Indiana's truck weight limits (lbs.)

Axle(s)	State and Interstate Highways	Heavy-Duty Highways	Extra Heavy-Duty Highways
GVW	80,000 lbs.	80,000 lbs.	134,000 lbs.[1]
			90,000 lbs.[1]
Single Axle	20,000 lbs.	22,400 lbs.	18,000 lbs.
Tandem Axle	34,000 lbs.	36,000 lbs. (18,000 lbs. for each axle)	32,000 lbs.[2]
Other	800 lbs./in. of tire width	800 lbs./in. of tire width	800 lbs./in. width of tire
	1.5% scale tolerance	1.5% scale tolerance	1.5% scale tolerance

[1]State Form 944 (M-233ST) can be found at https://www.in.gov/dor/tax-forms/motor-carrier-forms-and-applications/. It presents the routes where trucks can operate legally with a maximum weight of 134,000 lbs.

[2]Any axle within an axle combination has a maximum weight of 13,000 lbs. (i.e., 26,000 lbs. total for a two-axle group), except in the case of one tandem axle group which may weigh 16,000 lbs. for each axle (i.e., 32,000 lbs. combined).

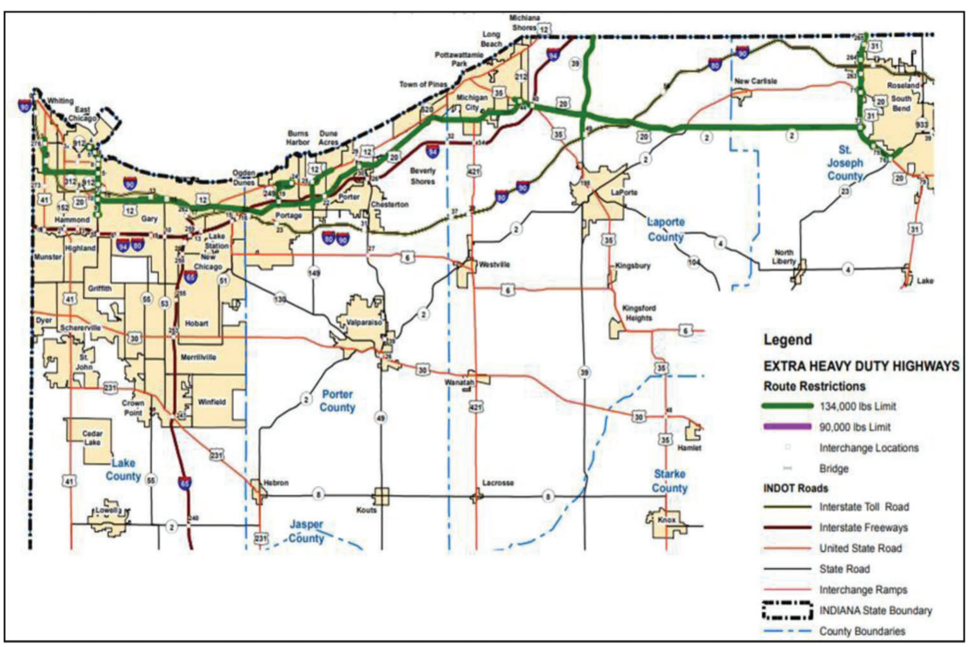


Figure 2.2 Indiana's extra heavy-duty (XHD) roads in northwest Indiana.

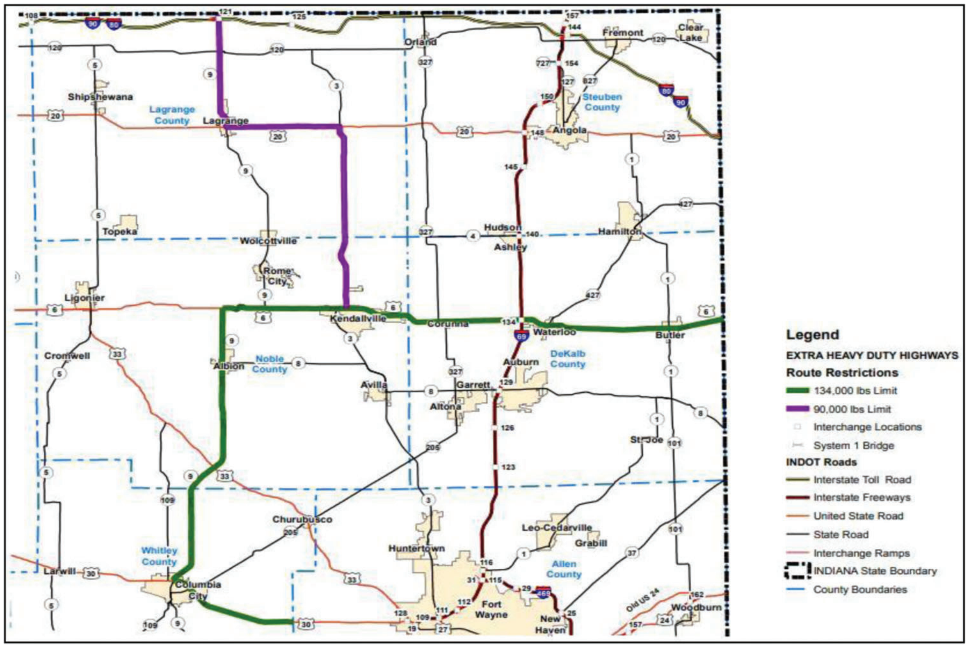


Figure 2.3 Indiana's extra heavy-duty (XHD) roads in northeast Indiana.

CHAPTER 3. LITERATURE REVIEW ON TRUCK PERMITTING: STATE OF PRACTICE IN INDIANA AND OTHER STATES

3.1 Introduction

As mentioned in Chapter 2, public roads in Indiana are designed to support the operations of vehicles of specific size and weight limits. Vehicles whose sizes and weights exceed the legal limits, need to purchase a permit. These operational policies help protect the infrastructure from undue deterioration in physical integrity, longevity, and operational levels of service. The situation is similar to other states in the Midwest and indeed, throughout the U.S. For example, Dehghan-Niri et al. (2020) determined that the differences in permitting practices (types and fees) across the states are generally a reflection of the load type and the OW load levels. The State of Indiana administers permit fees to help ascertain that the OW truck will use the appropriate route, enforce the requisite road safety procedures (INDOR, 2017), and incentivize favorable industry behavior. The revenues associated with these fees are distributed to the State Highway Fund (IC 8-23-9-55). The fund contributes to the funding of the state's highway system and local road system.

This chapter presents the current OW vehicle permitting policies in Indiana and at other Midwest states. The sources of this information are the websites of various agencies. In a subsequent chapter of this report, this literature review is supplemented using information from a questionnaire survey of personnel from various state highway agencies that are responsible for vehicle weight and size permitting.

A vehicle is termed overweight when its gross weight is greater than 80,000 lbs. However, the GVW alone is not enough to capture the full effect of excess weight. The entire weight of a truck is carried on the truck axles. Thus, the weight on each vehicle axle, weight of each set of tandem axles, and the weight on each truck tire are also important criteria of OW status. The stresses on the road pavement and bridge depend on the axle spacings and the number of axles.

The total weight associated with each permit application is determined from the permit application and evaluated based on the federal bridge formula (see Chapter 2), and a comparison is made with the limits that have been established by the state. INDOR (2017) provides further details regarding the federal formula and tables. Therefore, trucks with weight ranging from 80,000 lbs. to 120,000 lbs. are defined as "overweight" and require an OW permit. Trucks of GVW exceeding 120,000 lbs. are referred to as "superloads" in pages 10–11 of the *Indiana Oversize & Overweight Permitting Handbook* (INDOR, 2017) and require a superload permit. Indiana's superload threshold dimensions are 15 ft. height, 16 ft. width, and 110 ft. length.

An exception to the non-divisible loads rule is that for roads designated as "extra heavy-duty highways" in the northern part of the state, permit seekers may carry divisible loads up to a total maximum GVW of 134,000 lbs., subject to legal axle weight specifications (for this, a special permit often referred to as "Michigan Train Permit" is required).

The Indiana Departments of Transportation and Revenue (INDOT and INDOR) collaborate to administer the OSOW permitting process. The departments issue OW permits only after ensuring that the specific truck and loading level will not unduly pose a threat to the road infrastructural or operational integrity.

Applicants that seek OW permits are requested to initially confirm that their intended load is indivisible (defined in Federal Regulations 658.5 Code (INDOR, 2017). In Indiana, permit acquisition platforms include online portals, permitting services, mail, fax, and walk-in. Permit-seeking freight transportation entities that are new to the state are encouraged to visit the INDOR website's Motor Carrier Services portal, to establish an OW account through the link "New to Indiana? Apply for an OW Account." The permit seeker inputs the basic and account information, the truck's USDOT-assigned number, and the applicant's mailing address and other contact information. To facilitate superload permit processing for applicants with severe time constraints, INDOR has established a pre-approval process.

Additionally, for superloads in Indiana, the current permitting process is such that the engineering analysis could be carried out prior to the permit application and the applicant is assigned a pre-approval number for the superload. With the pre-approval number, the applicant, over the following 30 days, can obtain the trip permit using the same permit information (route requested and vehicle configuration) without any further analysis by INDOT analysis or processing delay. INDOT engineers review any loading proposals that fail the overload analysis or exceed 200,000 lbs.; these situations often require additional time for processing.

3.2 OW Permitting Practice: Indiana vs. Midwest States

The literature review highlights the similarities and differences between Indiana's permitting processes for OW freight transportation operations and those of other states. It was observed that Indiana's permitting processes are generally superior in terms of favorability for freight transportation operations (i.e., the ease and convenience of process of acquiring permits). This chapter compared eight (8) Midwest states' practices of OW permitting, special (or extra-legal) weight permitting, and fee levels of structure (per vehicle-mile, per vehicle, per ton-mile, and so on). The states are Wisconsin, Kentucky, Iowa, Michigan, Ohio, Minnesota, Illinois, and Missouri. The review is discussed subsequently in this chapter. The sections present observations regarding states OW permitting processes, permit class weight thresholds, fee levels, and fee structure criteria. The sections also address weight-distance fee concepts, revenue neutrality associated with annual permit fees, and the delineation of special routes for OSOW vehicles. Tables 3.3 and 3.6 provide a synopsis of these discussions.

3.2.1 General Observations

The review of the literature suggests that there still exists significant variability in permitting practices across the Midwest states (as seen earlier in Tables 3.1 and 3.2 of the previous section). This is consistent with the observations of Humphrey (1998) who studied OW permitting differences and uniformities across state DOTs in the nation (published as the NCHRP Synthesis of Practice 143) and Whitford and Moffett (1995) who focused on the Midwest. It is observed in the current study that few or no states have identical permitting policies, notwithstanding some general consistent patterns across some states.

The review of literature showed that regarding weight and size permitting, the state agencies use uniform GVW thresholds that were established by federal legislation. The existing federal maximum (cap) for interstates is GVW 80,000 lbs. Under federal grandfathering provisions, certain states allow the weights of truck combination weights to exceed this limit). The federal cap is referred to as "upper threshold for legal weights." GVWs that exceed this cap are generally termed overloads, or in some cases, "excess loads" or in extreme cases, "superloads." These terms are often used rather loosely, and their exact thresholds and meanings vary across the states. For example, the term "superload" may refer to weights that exceed 100,000 lbs. or more in certain states, 90,000 lbs. in other states, or even 80,000 lbs. in other states. Across the states, there are significantly different upper thresholds for what the state classifies as "excess loads," "superloads," or "extremely OSOW trucks." For clarification, we present Figure 3.1 (reproduced from a 2010 JTRP study (Bilal et al., 2010)). The figure presents the different general schema for OW classification and permitting across the states based on the weight thresholds. The different threshold types of thresholds that define the schema are described as follows.

3.2.1.1 Upper threshold for legal weights (UTLW). UTLW refers to the federal weight threshold (80,000 lbs.). Trucks with weights exceeding this limit are considered extra-legal and require a standard OW permit for their highway operations.

3.2.1.2 Upper threshold for extra-legal weights (UTELW). Regarding trucks whose weights exceed the federally mandated limit of 80,000 lbs., some states may place a further limit, termed UTELW. In some states, this limit applies only to certain OW permitting structures, e.g., a separate UTELWs for multiple-, single-, and blanket (annual) permits, or seasonal restrictions. For example, in Wisconsin, a truck seeking multiple-trip permits cannot, with its load, exceed 170,000 lbs.

3.2.1.3 Upper threshold for extra-legal weights for use at special routes (UTELW-S). Certain states may have a UTELW that does not allow extra-legal truck operations at all the state's highways. Where such restrictions exist for specific highway segments or specific road classes, such threshold could be referred to as UTELW-S. It is typically the case that these road segments or functional classes are roads (or a subset thereof) that had been designed and constructed to relatively superior engineering design and material

TABLE 3.1
Single-trip overweight/oversize permit fees

State	Fee ($)	Remarks
IN	OW: $20 + $1.00/mi. (>150,000 lbs.) OW: $20 + $0.60/mi. (108,001–150,000 lbs.) OW: $20 + $0.35/mi. (≤108,000 lbs.) Special weight permit: $42.50 Mobile home permit: 12 ft. 4 in. = $10; 14 ft. 4 in. = $18	Flat fee and distance based. Separate fee structure for OW only, OS only, OW/OS and Superloads over 120,000 lbs. charged $10 executive fee. Vehicles over 200,000 lbs. charged $10 executive fee + $25 design and review fee + $10 per bridge (bridges fees).
MO	OS/OW permit including pre-issue—$15 plus $20 per each 10,000 lbs. in excess of legal gross weight. OW permits > 160,000 lbs. GVW: $15 + $20 per each 10,000 lbs. more than legal gross wt. Bridge plus roadway analysis fee of: $425 for each permit for moves ≤ 50 mi. distance, and $625 for 51–200 mi; $925 for > 200 mi.	Separate fee structure for OS only, OW only and OS/OW
IA	$10	Flat fee
MI	OS only: $15 OS & OW: $50	Separate flat fee for OS only and OS/OW
OH	*Routine* OS only, 1-way: $65; 2-way: $100 steel coil, 1-way: $65; 2-way: N/A Multi-stage OS/OW, 1-way: $135; 2-way: N/A Multi-stage OS only, 1-way: $65; 2-way: N/A Emergency, 1-way: $250; 2-way: $235 *Super Load* (>120,000 lbs.; 14′ wide; >14′6″ ht.) OS/OW: 1-way: $135 + TM; 2-way: $200 + TM OS only, 1-way: $135 + TM; 2-way: $200 + TM TM = ton-mile = $0.04 *[(GVW-120,000)/2,000]	Separate flat fee structure for routine and super loads and for OS only and OS/OW
WI	Vehicles over length limit = $15 Vehicles over width limit or height limit = $20 vehicles over both width and length limits: $25	Add $10 district fee + $10 bridge fee + $1 online permit order fee + $10 pavement damage fee for vehicles > 16′ width and/or >270 kips GVW
KY	$60	Flat fee
IL	OS only OS and OW (width ≤ 12′) 6 axles, max gross weight 100,000 lbs. = $55 for 181–225 mi. $115 for 451–495 mi. 6 axles, max gross weight 120,000 lbs. = $130 for 181–225 mi. $280 for 451–495 mi. 5 axles, max gross weight 100,000 lbs. = $130 for 181–225 mi. $280 for 451–495 mi.	Flat fee plus distance-based Separate fee structure for OS only and OS/OW Add $40 district fee + $1 online transmission fee

standards, often with the expectation of high-load truck operations.

These schemas are presented based on gross weights only (GVW thresholds); however, similar schema could be developed based on axle loads. For example, a truck weighing less than 80,000 lbs. could nevertheless be considered overweight if the weight of any one of its axles exceeds 20,000 lbs., in which case an "upper threshold axle weight (UTAW)" would be 20,000 lbs. Further, in each state, there could exist different schema or sub-scheme for the different permit types based on permit timespan (single, multiple, and annual blanket permits, for example).

Schema 1: In this schema, there exists an upper threshold for legal weights. This has been set by the federal government (80,000 lbs.) but could change in future. Also, in this schema, there exists a second threshold: UTELW. Trucks whose weights fall between these two thresholds can operate on any highway in the state using an OW permit but trucks with weight exceeding UTELW are not allowed to use the state's highways. Of all the schemas presented in

TABLE 3.2
Annual, multiple-trip, and standard permit fees (flat vs. flat+distance based) across Midwest states

State	Fee ($)	Remarks
IA	$300 (OS/OW)	Flat fee
IN	$405 (OS only)	Flat fee Continuing annual (365 days)
OH	*Annual Blanket Permit* Boat: 1-way = $100 Farm equipment: 1-way = $100 Construction equipment: 1-way = $100 Manufactured building: 1-way = $100 Marina: 1-way = $100 *Continuing Annual Permit* OS/OW: $2,970 (return); $1,970 (1-way) Steel Coil: 2-way = N/A; 1-way = $470 Michigan Legal: 2-way = $470; 1-way = $470	Flat fee
MO	Single commodity: $128 (OS only) Multiple commodity: $400 (OS only)	Flat fee Annual blanket (365 days)
KY	Farm: 14 ft. to 16 ft. wide: $150 Farm: less than 14 ft. wide: $80 Industrial haul: $20 Non-div.14−16 ft. width: $500 Non-div. < 14 ft. width: $250	Flat fee Steel load = $250 (for 35 mi. max.)
MI	OW: $50 + $100 (renewal) = $150 OS only: $15 + $30 (renewal) = $45	Flat fee Annual extended
WI	OW and/or OW & OS: 12 months: $1,050 up to 170 kips GVW	Flat fee Multiple permit (for a 3–12 months period)
MN	Construction supplies: $200 (OS & OW up to 90 K lbs. GVW) Farm machinery: $200 (OS & OW up to 90 K lbs. GVW)	Flat fee

this section, this can be considered the simplest and the most restrictive.

Schema 2: Schema 2, like Schema 1, has an 80,000 lbs. legal weight upper threshold and a second upper threshold (UTELW) for extra-legal trucks (the latter referring to trucks with weights that fall between these two thresholds and are allowed to use all the state's highways if they have a permit). Unlike Schema 1, however, Schema 2 has a third weight threshold, UTELW-S, above UTELW. Trucks with weights between UTELW and UTELW-S are often allowed to operate at specific highway classes (for example, interstates) or specially designated highway segments. These trucks require yet another type of permit. Often, these routes have high design and construction quality standards to support high loads. The northern part of State of Indiana, for example, has routes designated as "extra heavy-duty highways" where maximum (GVW) divisible loads of 134,000 lbs. may be transported, subject to axle weight limits. Weights beyond such UTELW-S limit are prohibited.

Schema 3: Schema 3 is identical to Schema 2 with the exception that the specific designated routes can be used for extra-legal trucks (that is, trucks exceeding 80,000 lbs.).

Schema 4: Of all the schema, Schema 4's only restriction is the 80,000 lbs. for legal operations. There is no limit on truck weights and extra-legal operations (weights exceeding 80,000 lbs.), regardless of weight are allowed if the truck pays the appropriate fee and uses designated routes only. This could be considered the most permissive of all schemas discussed in this section.

This study's literature review showed that most Midwest states have long administered both single-trip permits and annual blanket permits. However, there exist significant variability across their fee structure details and fee levels. It was observed that certain states that have any one of these two fee structure categories also impose an additional charge per mile of travel or per ton-mile (implicitly) of travel. Also, the OW permitting literature suggests that the freight transportation companies that typically undertake several trips annually find it far more economical to purchase annual permit fees. At the same time, it has been long recognized that annual fee permit structures do not yield adequate revenue (Bilal et al., 2010; Chung Li, 2022; Everett et al., 2014; Whitford & Moffett, 1995). As Bilal et al. (2010) observed, state agencies that seek to adopt annual permit fee structures in replacement of single-trip permitting, are interested in the issue of revenue neutrality across these permitting categories. A study by the Texas Transportation Institute (Middleton et al., 1988) suggested that efforts in this

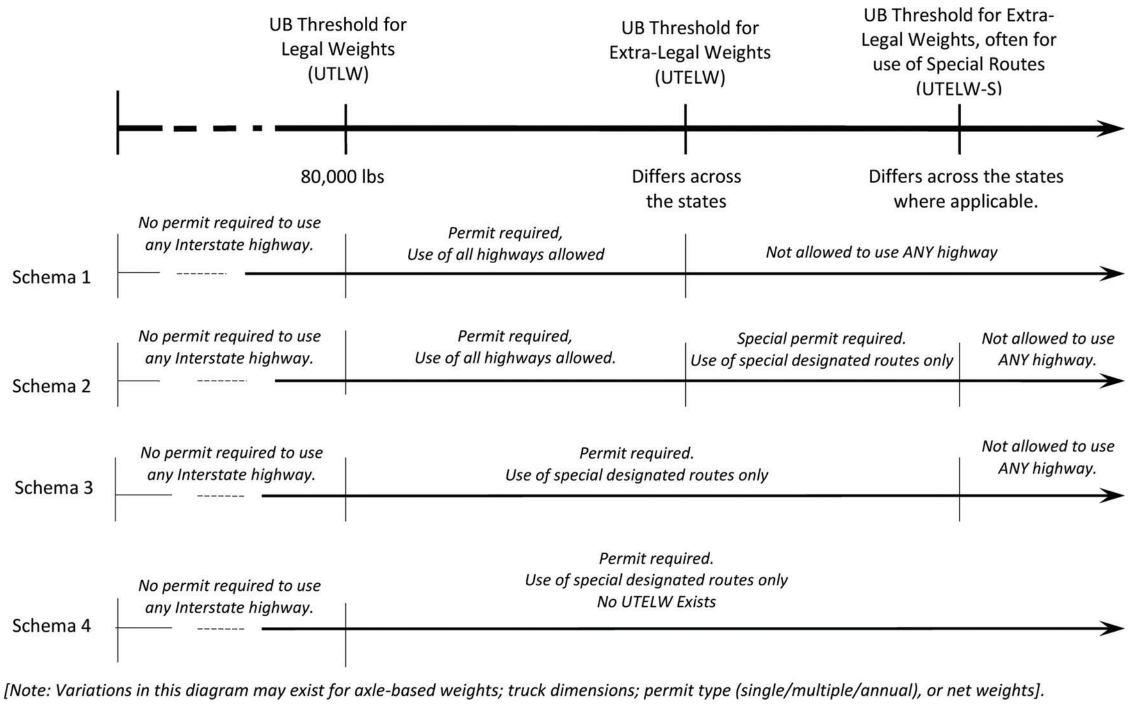


Figure 3.1 Differences across general schema for permitting based on GVW (Bilal et al., 2010).

direction have been generally unsuccessful. The current view in 2023 is not expected to be different. The observations herein regarding the thresholds for legal oversize/overweight permit classification and fee structure criteria, updated from the observations of Bilal et al. (2010), are presented in the next section.

3.2.2 Observations Part I: Legal Overweight/Oversize Permit Threshold Classes

Permits for extra-legal weight and size operations are required in cases where the permit truck exceeds size or weight thresholds. The update showed that the load and dimension thresholds for OW classification and vehicle for oversize classification, respectively, still exhibit marked variations across the various states. Regarding truck weight, the upper threshold across the states is 80,000 lbs. UTLW (Figure 3.1), largely due to federal mandates. This is the limit above which the truck must operate with a permit. Axle weight, unlike GVWs, were found to have upper thresholds that vary across the states. Indiana's maximum weight for each axle is 20,000 lbs. (INDOR, 2017).

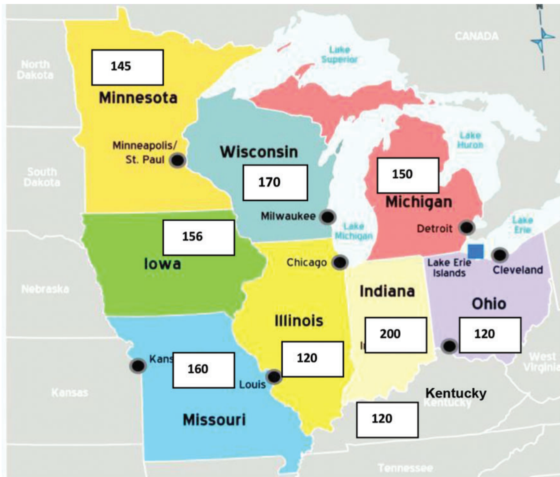
There exists a limit to legal excess weight, as the schema suggest. Beyond the legal weight upper threshold (the point after which excess load beyond 80,000 is imposed a permit fee). This limit, the second threshold (Figure 3.1), is the "threshold for extra-legal weights." Some states refer to the loads between the legal weight upper threshold (UTLW) and the extra-legal weight upper threshold (UTELW) as the "superloads."

Regarding the third category of truck weights (those exceeding the extra-legal weight upper threshold (Figure 3.1)), there exist states that prohibit operations of freight transportation at these weight levels and there also exist others that allow such weight levels only using special permits for use at specific road classes or specific road segments, or in some case during certain seasons of the year (for example, outside the thaw season when the subgrades are at their weakest). As such, there exists a limit, UTELW-S. Beyond this limit, freight transportation operations are proscribed. The literature review indicated that the thresholds (UTELW and UTELW-S) vary significantly across the states.

Some states have no clear demarcation of the thresholds and rather have increments of the permit fee with OW increments above 80,000 lbs. For states that have upper limit weight thresholds for OW trucks (for example, 170,000 lbs. in Wisconsin), it is not certain how the limits were established—expert opinion, optimization, or continuation of historical practices.

Figure 3.2 presents a rough representation of the variation of the upper bound weight (GVW) thresholds for excess-weight OW truck operations at some Midwest states as of 2022. This figure was established based on data on the extant permit fees (Tables 3.1 through 3.6) and published sources online. It can be observed from the figure that Indiana and Wisconsin had the highest thresholds for extra-legal truck weights (over 200,000 lbs. and 170,000 lbs., respectively). They are followed by Missouri (160,000 lbs.); Iowa (156,000 lbs.); Michigan (150,000 lbs.); Minnesota (145,000 lbs.); and Ohio, Illinois, and Kentucky (120,000 lbs.).

It is worth noting that (1) these thresholds are associated with OW permitting fees that vary state-to-state: a few are about annual blanket permits and other, for single trips. Therefore, in comparing OW permitting policies across states, it can considered good practice to



Note: For certain states, this refers to the maximum weights for which a "Superload" Permit is issued. Certain states, such as Indiana, allow weights above these thresholds but duly impose corresponding penalties. See Table 3.4. These thresholds are not comparable since restrictions and conditions exist across the states.

Figure 3.2 Upper thresholds for OW permits across Midwest states.

	Truck is OW Only	Truck is OS Only	Truck is Both OW & OS
Both Flat-Fee and Distance	[4]MO = $15 + $20 per each 10 kips > 80 kips +$425 to $925 based on travel distance. [1]IN: $20 + $0.35/mi. (≤108,000 lbs.) *$20 + $0.60/mi. (108,001–150,000 lbs.) **$20 + $1/mi. (>150,000 lbs.)		[1]IN = Greater of {the OW fee and the OS fee}
Distance-Based Only		[2]IL = $12 to $125 (based on truck size & distance)	[2]IL = $10 to $295; (Depends on the truck size, the number of axles, and the travel distance.
Flat-Fee Only	KY: $60 MI: $50 IA: 10 MO: $15 + $20 per each 10 kips > 80 kips up to 160 kips	[1]IN = $20 to $40 KY = $60 IA = $10 [5]MO = $15 OH = $65–$100 MI = $15 [3]WI = $15 to $25	[6]OH = $135 to $200 IA = 10 KY = $60 MI = $50, MN = $15 + Pavement Damage Fee based on "X number of moves"

Note:

[1] *Refer to the INDOR handbook for details on OSOW permits and their respective fees in Indiana.*

[2] *Plus district fee ($40) and online transmission fee ($1).*

[3] *Plus District fee ($10) and Bridge Fee ($10) and fee for ordering online permit ($1). For vehicles exceeding16 ft. width and/or Exceeding GVW 270,000, add fee for pavement damage ($10).*

[4] *Applied to vehicles exceeding GVW 160,000.*

[5] *For vehicles exceeding 16 ft. width, 16ft. height, or 150 ft. length, add movement feasibility fee ($250).*

[6] *For vehicles exceeding 120,000, add a fee whose amount is = base rate + 0.04[(GVW-120,000)/2,000)]*

* *For vehicles exceeding 120,000 lbs. an additional executive fee of $10 is charged.*

** *For vehicles exceeding 200,000 lbs., additional charges include an executive fee ($10) + a design & review fee ($25) + bridges fees ($10 per bridge on the permit request route).*

Figure 3.3 Single-trip permit fees categorized by fee attribute and truck attribute.

do so with circumspection and on a case-by-case basis; (2) some states still prohibit, implicitly or explicitly, truck operations that exceed some upper threshold listed; others allow this only if such thresholds are not unduly high and if a permit is issued for that load; (3) the use of axle-based thresholds (instead of GVW thresholds) will likely yield a different order of weight thresholds across the states.

Following from (3) in the preceding paragraph, it is worth noting that certain states also consider the weight per axle in establishing the thresholds. The Illinois threshold of 120,000 lbs. is for trucks having six axles or more. Unlike GVWs, the current study could not compare axle-weight thresholds across the states due to inadequate data on such thresholds. Further, for purposes of the state-by-state comparison,

	Truck is OW Only	Truck is OS Only	Truck is Both OW & OS
Both Flat-Fee and Distance	–	–	–
Distance-Based Only	–	–	–
Flat-Fee Only	MO = $300–$624 [3]MI = $100 MN = $60–$850 WI = $65–$1,050 OH = $500–$2,970 [2]IL = $10–$295	[1]*IN = $405* *WI = $30–$90* *MO = $128–$400* [2]*MI = $45, IL = $100–$150* *KY = $80–$500* *MN = $24–$120* OH = $250–$1,170	IA = $25–$300 MI = $100 MN = $60–$850 KY = $20–$500 [2]IL = $10–$295 OH = $500–$2,970

[1]*Refer to the INDOR handbook for details on OSOW permits and their respective fees in Indiana.*
[2]*Add; +$40 district fee +$1 online transmission fee.*
[3]*OS Only: 15 + $30 (renewal/extension fee) = $45, OW: $50 + $100 (renewal/extension fee) = $150*
Note: Please see Appendices 1 through 4(A to K) for more details about Fee/ permit class.

Figure 3.4 Annual/multiple-trip permit fee categorized by fee attribute and truck attribute.

TABLE 3.3
Annual, multiple-trip, and standard permit fees across neighbor states (vehicle weight and/or distance travelled)

State	Fee ($)	Remarks
IA	OS/OW: $300	OW or OS considered; distance not considered
MO	OW well drillers or concrete pump truck permit: $300 Emergency OW permit (round trip): $624	Annual blanket permit distance not considered
OH	*Continuing Annual Permit* OS/OW: $1,970 (1-way), $2,970 (return) *Annual Blanket Permit* Boat: 1-way: $100 Farm equipment: 1-way: $100 Construction equipment: 1-way: $100 Manufactured building: 1-way: $100 Marina: 1-way: $100	Annual blanket permit distance not considered
MI	OW: $50 + $1:0 (renewal fee): $150	Annual extended; distance not considered
MN	Agriculture/6-axle up to 90K lbs. GVW: $300 Construction supplies: $200 (OS & OW ≤ 90K lbs. GVW) Agriculture/7-axle up to 97K lbs. GVW: $500 Farm machinery: $200 (OS & OW up to 90K lbs. GVW)	Distance not considered
IL	OS & OW (Width ≤ 12′) 6 axles, max gross weight 100K lbs. = $55 for 181–225 mi. $115 for 451–495 mi. 6 axles, max gross weight 120,000 lbs. = $130 for 181–225 mi., $280 for 451–495 mi. 5 axles, max gross weight 100,000 lbs. = $130 for 181–225 mi., $280 for 451–495 mi.	Single-trip permit that lasts for 5 days: Add $15 for width > 12′ Add $40 district fee + $1 online transmission fee. Other combinations of weight and distance are also available at https://idot.illinois.gov/doing-business/permits/oversize-and-overweight-permits.html
WI	OW and/or OS & OW 12 month: $1,050 up to 170 kips GVW	Distance not considered
KY	Steel. 35-mi. limit: $250 Steel-statewide: $500 Industrial haul: $20	

there exist other considerations besides weight thresholds, that govern the upper bound limits on superload truck weights (or lack thereof). For example, the fee levels and the perspectives of the freight transportation industry in that state. For example, Wisconsin's high upper threshold is likely viewed favorably by the freight transportation industry, yet its high OW permit fees are likely viewed unfavorably by the industry. Therefore, it is only when all other contexts are considered that a thorough evaluation (of the competitiveness of OW permitting policies) be made confidently.

3.2.3 Observations II: Fee-Structure Criteria

This section addresses observations made from the literature regarding the OW fee levels and the criteria that states have used to establish these levels. This is done for each of eight Midwest states. In Figures 3.3 and 3.4, we present the annual and single-trip permit

TABLE 3.4
Upper thresholds for extra-legal weights (superload permits)

State	GVW	Remarks
MO	160 kips	*For Single-Trip Permit Only* Fees for vehicles > 160 kips = $15 + $20 each; 10 kips more than legal GVW plus bridge and roadway analysis fee of $425 for each permit for moves from 0–50 mi.; $625 for 51–200 mi. $925 for > 200 mi.
OH	120 kips	Additional fees for vehicles over 120 kips based on formula: base rate + 0.04*[(GVW-120,000)/2,000)]
IN	120 kips	*Single-Trip Permit Only* Vehicles over 120K lbs. are allowed but are charged a $10 executive fee. Vehicles over 200K lbs. are allowed on specific routes but are charged a $10 executive fee + $25 design and review fee + bridges fees at the rate of $10 per bridge.
MI	150 kips	Only for extended permits for construction equipment.
IA	156 kips	Single-trip and annual permits.
MN	145 kips	For multiple-trip permit only.
KY	Not specified	–
IL	120 kips	For routine permits. Only for vehicles with 6 or more axles. Lower thresholds for vehicles with 5 or fewer axles. Upper bound threshold for superload permit: 187 kips.
WI	170 kips	For multiple-trip and annual permits only. For single-trip permits, vehicles over 150,000 lbs. are charged $85 + $10 executive fee for each 10,000 lbs. in excess.

TABLE 3.5
OW fees at states with annual blanket OW permits

State	Fee ($)	Remarks
MO	Thirty (30)-day blanket permit: $300 Emergency OW permit (round trip): $624 OS permit (multiple commodity): $400 OS permit (single commodity): $128 OW well drillers or concrete pump truck permit: $300	Permit seekers ***do not*** need to provide accompanying official route map.
OH	Boat: 1-way = $100; 2-way = N/A Construction equipment: 1-way = $100; 2-way = N/A Farm equipment: 1-way = $100; 2-way = N/A Marina: 1-way = $100; 2-way = N/A Manufactured building: 1-way = $100; 2-way = N/A	Permit seekers ***do need*** to provide accompanying official route map.

fees. The latter is presented for each fee attribute. The fee-related criteria are mileage, flat+mileage, and flat, and the truck-related criteria are OW only, OS only, and OS+OW. Tables 3.1 through 3.6 present further details.

Table 3.1 presents details of the *single-trip* OSOW permit fees, for Midwest states that charge OW fees based on truck configuration or dimension (OS permit fees) or weight (OW permit fees) or both. It can be observed that most states in the Midwest provide single-trip permits. In this regard, states that were found to have simple fee structures (that is, flat fees regardless of distance traveled or weight: Iowa: $10/trip; Missouri: $15/trip for OS-only trucks and $50/trip for OW trucks; Kentucky: $60/trip. In Wisconsin, $/trip fees have an added layer of complexity as they are structured to address equity: $/trip fee (with or without a flat base per-trip fee) is applied to OW trucks depending on (1) the degree to which their (excess) weight exceed the threshold, and/or (2) their permitted travel distance.

Table 3.2, like Figure 3.3, details the annual permit fees at Midwest states where OW permit fees are based on vehicle weight (OW) and/or vehicle size. Also, Table 3.3, like Figure 3.4, details the annual fees at Midwest states where fees are charged based on vehicle weight and/or travel distance. It is shown in these tables that most of the Midwest states have also set up annual permits for their OW and OS vehicles. According to Bilal et al. (2010), this represents a change in the state of permitting practice observed by Whitford and Moffett in 1994 when very few states had annual permits. As of the time of reporting (2023), there is no evidence that this situation has changed. Table 3.4 lists the states' upper thresholds for extra-legal weights (in some states, this is referred to as "superload"). Some of the states do not allow freight transportation operations that exceed this upper threshold in an implicit or explicit manner; others allow permitted truck weight operations above this threshold under specific conditions. For example, there exist situations (specific routes) where Indiana allows as much as 200,000 lbs., but only at very specific road corridors.

3.2.4 Observations Part 3: Weight-Distance Fee Concept–The State of Practice

Observations from the literature review threw some light on the state of practice regarding the concept of weight-distance fees. It seems that of the Midwest states studied, only the State of Illinois, and to some extent, Ohio and Indiana, have adopted explicitly the concept of a weight-distance for their OW fees. Over the decades, Oregon, a non-Midwest state, has often blazed the trail in innovative schemes for user charging including OW users. It is worth noting that the freight transportation industry has generally not embraced the weight-distance concept. It is worth repeating here, Bilal et al. (2010) observes from other literature that freight transportation companies that engage in OW operations tend to oppose weight-distance fees to a lower degree compared to those who regularly engage in legal weight trucks; this had been observed earlier by Whitford and Moffett in 1994. It is not uncertain that these stakeholders still hold these views as of the time of reporting (2024).

As the previous paragraph suggests, the concept of weight-distance OW fees has been practiced (at least, implicitly) by some states. Table 3.1 indicates that in Ohio, Indiana, and Illinois, the fees charged for OW vehicles vary by weight group and distance traveled, and their OW fee structure bears some similarity to Oregon's weight-distance system.

TABLE 3.6
Single-trip permits for OS/OW permit carriers by state

State	Validity
IN	OS: 1 trip in 15 days OW: 1 trip in 15 days OS/OW: 1 trip in 15 days Mobile home permit: 12′ 4″: 1 trip in 15 days; 14′ 4″: 1 trip in 5 days
IL	1 trip in 5 days
OH	1 trip in 5 days. Extension/revision can be made thereafter, with extra fee of $10 and $50 for routine and super loads, respectively.
IA	1 trip in 5 days
MI	1 trip in 5 days
MO	1 trip in 7 days
WI	1 trip in 14 days
KY	10 days

3.2.5 Observations Part 4: Revenue Neutrality of Annual Permit Fee Structures

At the turn of the 1980s, several states evolved from single-trip permitting to annual permitting, leading to significant revenue loss (Whitford & Moffett, 1995). The Whitford and Moffett survey of stakeholders in 1994 indicated that highway agencies in states with annual permits expressed concerns about the adequacy of revenue to address the added pavement and bridge damage occasioned by OW trucks; after that study, similar views were expressed in subsequent research reports on OW operations in Indiana (in 2010), Texas (in 2012), and South Carolina (in 2014).

3.2.6 Observations Part 5: Specification of Special Routes for OSOW Vehicles

As Bilal et al. (2010) noted, the highway network of any state contains pavements and bridges built to relatively superior standards of design and construction, structural integrity, and geometry (clearances, lane widths, curve radii, slopes, etc.) and others built to comparatively lower standards. For OW and OS vehicles, plying on lower-class roads could jeopardize the integrity of not only the physical structures but also the operational performance (safety and mobility of

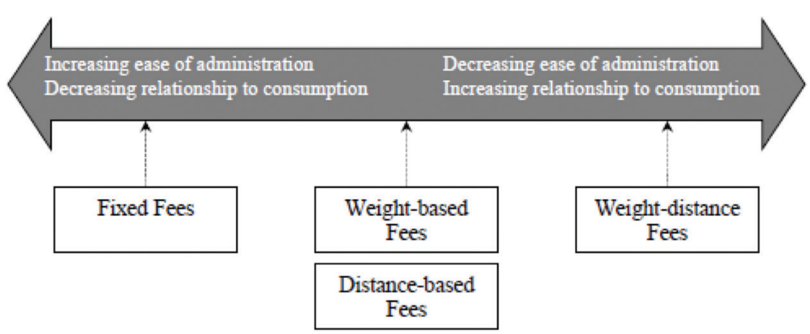


Figure 3.5 A categorization for permit fees structures (Everett, 2015).

other road users). Therefore, such extra-legal vehicles will need to follow specific routes so they operate only at highways that can support their extralegal dimensions or weights. As such, several states have selected such routes.

3.3 A Summary of OW Permit Fee Structures Across the Midwest States

In this discussion, *permit attributes* refer to the permit types, permit fee levels, loads related to the permits, types of goods related to the permit, permit distance, number of trips permitted, permit time horizon, and so on. *OW operations attributes* refer to the characteristics of the overall terrain of OW permitting, including background legislation and regulations, types of goods applicable to OW operations, divisible status of the goods carried, and the infrastructure characteristics (including infrastructure type, age, and design; and structural capacity) that are affected by OW operations.

States in the Midwest region's east-north central division offer single- and multi-trip (and annual permits), as shown in Table 3.7. Yet still, there exist significant variation across the states in the permitted dimensions and weights for each permit type. Obviously, these differences in the levels of permit attributes are due to variations in the states' OW operations attributes.

From the perspective of load divisibility, most of the states' fee structures consider two load types: divisible loads (defined as "a load that requires less than 8 hours to disassemble") and non-divisible load (defined as "loads that cannot be broken into smaller parts or require at least 8 hours for disassembly"). In addition, permits may be different for goods that are in various stages of processing, for example, raw materials, intermediate goods, or finished goods. Further, there are states with permit structures that are designed to be more favorable to specific goods particularly, those considered critical to that state's economy. For example, to promote their state's agricultural and industrial competitiveness and ultimately, to enhance their state's economy, Ohio has OW permits specifically for aluminum/steel coils; Wisconsin has OW permits specifically for its agricultural loads; and Indiana has OW permits for different commodity types (INDOR, 2022; ODOT, 2019; WisDOT, 2021a). Also, it is worth noting that a few states permit the transport of superloads at specific road sections on their highway networks (the definition of superload differs across the states and is often based on weight or size (or both) of the load). For example, in Ohio and Indiana, superload permit upper thresholds are: 120,000 lbs. GVW (both states); and 14 ft. 6 in. height and 14 ft. width (Ohio) and 15 ft. height and 16 ft. width (Indiana).

The desirability of a permit type depends on the perspective of different stakeholders. From the agency's perspective, a permit fee structure must be *efficient.* In other words, it should be related to the infrastructure consumption and therefore make it possible for the agency to use it as a lever to recover the cost of repairing infrastructure damage caused by OW operations, as much as possible. However, from the users (permit applicants) perspective, the fee structures must be *clear and easy* to comprehend with little complexity. From these two perspectives, it is important to observe the four primary types of fee structures across the states: fixed fee, and fees based on mileage, weight, and both mileage and weight. In this respect, it can also be observed that across the states, the fee-structure type varies from simple to detailed, from the perspective of the ease of administration and the fee's relationship to actual consumption (of the infrastructure by OW operations) (see Figure 3.5). On one extreme, Illinois and Indiana's weight-distance based OW permit fees are most reflective of actual consumption but are relatively difficult to administer. On the other extreme, the state of Michigan, with its mostly fixed fees, administers a simple permit fee structure and yet reflects the infrastructure consumption by OW trucks. Midway through this spectrum, Wisconsin and Ohio's weight-based fees have moderate complexity of administration and moderate reflection of OW consumption of infrastructure.

As states strive to accommodate freight-related businesses in a bid to pursue their economic development objectives, they allow exceptions to size/weight limits to allow the transport of OW and OS loads by special permits. This lends complexity to their extant permitting structures. Therefore, it could be argued that the complexity of a state's permitting structure is reflected by the number of permit types administered in that state. For example, in Michigan, the state imposes no additional add-on fees as there exists only two categories for all OW permit fees. On the other hand, Illinois has approximately 17 categories associated with their OS/OW truck operations and administer fees based on several criteria.

3.4 Chapter Summary

In this chapter, the report presented charts and tables that summarize information collected from the literature on Midwest states OW permitting policies. OW permitting was found to be largely based on an administrative fee plus charges per vehicle-mile, vehicle, or ton-mile. The narrative also includes some OW permitting observations at the states, the criteria for fee structures and fee levels, thresholds for legal OW permit classifications, revenue neutrality (or lack thereof) of annual permit fees, applications of the concept of weight-distance fees for OW operations, and the establishment of special routes for OW trucks that far exceeded the federal maximum. A previous JTRP report served as a template on which much of this narrative was developed. In subsequent chapters of this report, some of the issues related to OW permitting are discussed.

TABLE 3.7
Summary of OW permit fee structures at Midwest states

State	Permit Type	Permit Weight Limit	Permit Fee
Indiana (INDOR, 2021a)	Single-trip permit	Non-divisible loads 80,000 lbs. < GVW < 108,000 lbs. 108,000 lbs. < GVW < 150,000 lbs. 150,000 lbs. < GVW < 200,000 lbs. GVW > 200,000 lbs. Divisible loads (all commodities) ESAL > 2.4	$20 + $0.35 per mile + $35 (bridge review fee if required) $20 + $0.60 per mile + $35 (bridge review fee if required) $20 + $1 per mile + $10 per bridge crossed on permitted route $20 + $1 per mile + $35 (required bridge review fee) + $10 per bridge crossed Bridge fee cannot exceed $200 for one-way-trip and $400 for round-trip $20 + $0.25 per mile per ESAL more than 2.4
	Annual permit	Divisible loads ESAL ≤ 2.4	$20
	Special weight permit	GVW: 90,000 lbs. on heavy-duty highways GVW: 134,000 lbs. on extra heavy-duty highways	$42.50 per day + $25 annual registration fee
	Superload permit	120,000 lbs. < GVW ≤ 150,000 lbs. 150,000 lbs. < GVW ≤ 200,000 lbs. GVW > 200,000 lbs.	$20 (base fee) + $10 (executive fee) + $0.60 per mile $20 (base fee) + $10 (executive fee) + $1 per mile $20 (base fee) + $10 (executive fee) + $25 (design review fee) + $1 per mile
Michigan (MDOT, 2019)	Single-trip permit (may include OS)	Non-divisible loads GVW: >80,000 lbs. Single axle: >20,000 lbs. Tandem axle: >34,000 lbs.	$50
	Extended permit/annual permit (May include OS)	Non-divisible loads GVW: >80,000 lbs. Single axle: >20,000 lbs. Tandem axle: >34,000 lbs.	$100
Ohio (ODOT 2019, 2014)	Single-trip permit	Routine load (OS/OW) 80,000 lbs. < GVW < 120,000 lbs. Superload (OS/OW) (width > 14′ or height > 14′ 6″) GVW > 120,000 lbs. Steel/aluminum coil 80,000 lbs. < GVW < 120,000 lbs. Multi-state (OS/OW) 80,000 lbs. < GVW < 120,000 lbs. Emergency 80,000 lbs. < GVW < 120,000 lbs.	$145 (1-way), $210 (1-way and return) $145 (1-way), $210 (1-way and return) $75 (1-way) $145 (1-way) $260 (1-way), $375 (1-way and return)
	Continuing (45-day) permit	International sealed container 80,000 lbs. < GVW < 120,000 lbs.	$260 (1-way)
	Continuing (90-day) permit	Routine load (OS/OW) 80,000 lbs. < GVW < 120,000 lbs. Steel/aluminum coil 80,000 lbs. < GVW < 120,000 lbs. Michigan legal routine load 80,000 lbs. < GVW < 120,000 lbs. Superload GVW > 120,000 lbs. International sealed container 80,000 lbs. < GVW < 120,000 lbs.	$510 (1-way), $760 (1-way and return) $135 (1-way) $125 (1-way and return) $165 (1-way and return) $510 (1-way)
	Continuing annual permit	Routine load (OS/OW) 80,000 lbs. < GVW < 120,000 lbs. Steel/aluminum coil 80,000 lbs. < GVW < 120,000 lbs. Michigan legal routine load 80,000 lbs. < GVW < 120,000 lbs. Superload GVW > 120,000 lbs.	$1,980 (1-way), $2,980 (1-way and return) $480 (1-way) $470 (1-way and return) $630 (1-way and return)
	Blanket permit (365 day)	Routine load 80,000 lbs. < GVW < 120,000 lbs.	$100 (1-way)
Wisconsin (WisDOT 2021a; 2021b)	Single-trip permit (may include OS)	Non-divisible load 80,000 lbs. < GVW ≤ 170,000 lbs. 170,000 lbs. < GVW ≤ 180,000 lbs. 180,000 lbs. < GVW ≤ 190,000 lbs. 190,000 lbs. < GVW ≤ 200,000 lbs. 200,000 lbs. < GVW ≤ 210,000 lbs. 210,000 lbs. < GVW ≤ 220,000 lbs. 220,000 lbs. < GVW ≤ 230,000 lbs. GVW > 230,000 lbs.	$20 $35 $45 $55 $65 $75 $85 $85 + $10 per 10,000 lbs. or fraction thereof

(Continued)

TABLE 3.7
(Continued)

State	Permit Type	Permit Weight Limit	Permit Fee
	Annual multiple- trip permit (may include OS) Note: Permits are available for shorter periods	Non-divisible load	$200
		80,000 lbs. < GVW ≤ 170,000 lbs.	$350
		170,000 lbs. < GVW ≤ 180,000 lbs.	$450
		180,000 lbs. < GVW ≤ 190,000 lbs.	$550
		190,000 lbs. < GVW ≤ 200,000 lbs.	$650
		200,000 lbs. < GVW ≤ 210,000 lbs.	$750
		210,000 lbs. < GVW ≤ 220,000 lbs.	$850
		220,000 lbs. < GVW ≤ 230,000 lbs.	$850 + $10 per 10,000 lbs. or fraction thereof
		GVW > 230,000 lbs.	
		Agricultural products to and from a farm and sealed load in international trade	$300
Illinois (IDOT, 2022)	Single-trip/round trip permit	Category F ≥ 6 axles GVW ≤ 88,000 lbs. Front tandem/axle ≤ 34,000/2 Rear tandem/axle ≤ 48,000/3	$10 (0–45 mi), $12.50 (46–90 mi), $15 (91–135 mi), $17.50 (136–180 mi), $20 (181–225 mi), $22.50 (226–270 mi), $25 (271–315 mi), $27.50 (316–360 mi), $30 (361–405 mi), $32.50 (406–450 mi), $35 (451–495 mi)
		Category G ≥ 6 axles GVW ≤ 100,000 lbs. Front tandem/axle ≤ 44,000/2 Rear tandem/axle ≤ 54,000/3	$15 (0–45 mi), $25 (46–90 mi), $35 (91–135 mi), $45 (136–180 mi), $55 (181–225 mi), $65 (226–270 mi), $75 (271–315 mi), $85 (316–360 mi), $95 (361–405 mi), $105 (406–450 mi), $115 (451–495 mi)
		Category H ≥ 6 axles GVW ≤ 110,000 lbs. Front tandem/axle ≤ 44,000/2 Rear tandem/axle ≤ 54,000/3	$20 (0–45 mi), $32.50 (46–90 mi), $45 (91–135 mi), $57.50 (136–180 mi), $70 (181–225 mi), $82.50 (226–270 mi), $95 (271–315 mi), $107.50 (316–360 mi), $120 (361–405 mi), $132.50 (406–450 mi), $145 (451–495 mi)
		Category I ≥ 6 axles GVW ≤ 120,000 lbs. Front tandem/axle ≤ 48,000/2 Rear tandem/axle ≤ 60,000/3	$30 (0–45 mi), $55 (46–90 mi), $80 (91–135 mi), $105 (136–180 mi), $130 (181–225 mi), $155 (226–270 mi), $180 (271–315 mi), $205 (316–360 mi), $230 (361–405 mi), $255 (406–450 mi), $280 (451–495 mi)
		Category J 5 axles GVW ≤ 88,000 lbs. Front tandem/axle ≤ 44,000/2 Rear tandem/axle ≤ 44,000/2	$20 (0–45 mi), $32.50 (46–90 mi), $45 (91–135 mi), $57.50 (136–180 mi), $70 (181–225 mi), $82.50 (226–270 mi), $95 (271–315 mi), $107.50 (316–360 mi), $120 (361–405 mi), $132.50 (406–450 mi), $145 (451–495 mi)
		Category L 5 axles GVW ≤ 100,000 lbs. Front tandem/axle ≤ 48,000/2 Rear tandem/axle ≤ 48,000/2	$30 (0–45 mi), $55 (46–90 mi), $80 (91–135 mi), $105 (136–180 mi), $130 (181-225 mi), $155 (226–270 mi), $180 (271–315 mi), $205 (316–360 mi), $230 (361–405 mi), $255 (406–450 mi), $280 (451–495 mi)
		Category M ≥ 4 axles GVW ≤ 72,000 lbs. Front tandem/Axle ≤ 34,000/2 Rear tandem/Axle ≤ 40,000/2	$15 (0–45 mi), $25 (46–90 mi), $35 (91–135 mi), $45 (136–180 mi), $55 (181–225 mi), $65 (226–270 mi), $75 (271–315 mi), $85 (316–360 mi), $95 (361–405 mi), $105 (406–450 mi), $115 (451–495 mi)
		Category N ≥ 4 axles GVW ≤ 76,000 lbs. Front tandem/axle ≤ 44,000/2 Rear tandem/axle ≤ 44,000/2	$20 (0–45 mi), $32.50 (46–90 mi), $45 (91–135 mi), $57.50 (136–180 mi), $70 (181–225 mi), $82.50 (226–270 mi), $95 (271–315 mi), $107.50 (316–360 mi), $120 (361–405 mi), $132.50 (406–450 mi), $145 (451–495 mi)
		Category O ≥ 3 axles GVW ≤ 60,000 lbs. Front tandem/axle ≤ 21,000/1 Rear tandem/axle ≤ 40,000/2	$12.50 (0–45 mi), $21.50 (46–90 mi), $30.50 (91–135 mi), $39.50 (136–180 mi), $48.50 (181–225 mi), $57.50 (226–270 mi), $66.50 (271–315 mi), $75.50 (316–360 mi), $84.50 (361–405 mi), $93.50 (406–450 mi), $102.50 (451–495 mi)
		Category P ≥ 3 axles GVW ≤ 68,000 lbs. Front tandem/axle ≤ 21,000/1 Rear tandem/axle ≤ 48,000/2	$20 (0–45 mi), $32.50 (46–90 mi), $45 (91–135 mi), $57.50 (136–180 mi), $70 (181–225 mi), $82.50 (226–270 mi), $95 (271–315 mi), $107.50 (316–360 mi), $120 (361–405 mi), $132.50 (406–450 mi), $145 (451–495 mi)
		Category Q 2 axles GVW ≤ 48,000 lbs. Front tandem/axle ≤ 25,000/1 Rear tandem/axle ≤ 25,000/1	$15 (0–45 mi), $25 (46–90 mi), $35 (91–135 mi), $45 (136-180 mi), $55 (181–225 mi), $65 (226–270 mi), $75 (271–315 mi), $85 (316–360 mi), $95 (361–405 mi), $105 (406–450 mi), $115 (451–495 mi)
		Category R 2 axles GVW ≤ 54,000 lbs. Front tandem/axle ≤ 28,000/1 Rear tandem/axle ≤ 28,000/1	$20 (0–45 mi), $32.50 (46–90 mi), $45 (91–135 mi), $57.50 (136–180 mi), $70 (181–225 mi), $82.50 (226–270 mi), $95 (271–315 mi), $107.50 (316–360 mi), $120 (361–405 mi), $132.50 (406–450 mi), $145 (451–495 mi)
	Limited continuous operation permit (OS-OW)	Non-divisible loads Weight limits are the same as the ones for single-trip permit	$250 (3-month permit) $1,000 (annual permit)

CHAPTER 4. IMPACTS OF OVERWEIGHT VEHICLE OPERATIONS

4.1 Prelude

In the U.S., the volume of road freight has grown consistently in the past decade, except for a blip during the COVID-19 pandemic. In 2020, freight volumes initially increased by approximately 30% because of peri-pandemic panic purchases, then dropped significantly thereafter, and ticked back up again (Bhattacharjee et al., 2020). The increasing loads on the highways generally translate into increased deterioration of the aging infrastructure and lower levels of operational performance. It also translates into increased fee payments for highway usage even though the increased revenue from such fees is not commensurate with the physical and operational damage associated with the traffic growth. In this chapter, the impacts of OW trucks are discussed, supported by findings from published literature. The impact assessments include trends in permit demand and revenues, damage to infrastructure (pavements and bridges), and degradation of operational performance (mobility and safety).

4.2 Overweight Truck Impacts on Pavement Damage

The operations of OW trucks lead to deterioration to road pavements and bridges leading to lowered longevity of the infrastructure (Straus & Semmens, 2006). According to a 2012 Texas study, the damage caused by OW truck operations is 20% greater than (and pavement service life is shorter by 50%) compared to the damage caused by normal-weight truck operations (Banerjee et al., 2012). Also, Salen (2008) carried out research which showed that depending on the pavement asphalt concrete elastic modulus, an axle load that exceeds the legal limit (20,000 lbs.) by 6,000 lbs. causes a reduction in the pavement life by 40%–65%. The acceleration in infrastructure deterioration associated with OW truck load translates into increased frequency and intensity of pavement and bridge rehabilitation and maintenance. The added expenditure related to such damage exacerbates the existing maintenance backlogs at most highway agencies. For this reason, it is important to quantify the infrastructure damage associated with OW vehicles. That way, the agencies can update policies for regulating OW truck operations including establishing appropriate OW permit fees that not only recover all or part of the OW-related damage but also disincentivize excess loading of trucks. Over the past few decades, studies that have addressed the impact of heavy or OW trucks on bridges include the work of Yoder et al. (1979), Reisert and Bowman (2006), Nowak et al. (1993), Lou et al. (2017), Lin et al. (2012), Fu et al. (2003), Ghosn et al. (2015), Dicleli and Bruneau (1995), and Bae and Oliva (2012). Those that addressed pavements include Yoder et al. (1979) and Gibby et al. (1990).

4.2.1 Pavement Damage Cost Due to Heavy or OW Trucks

Several research studies have quantified the specific amount of pavement damage and the associated repair costs due to heavy trucks. Some of these studies went further to compare the costs of pavement damage with the truck license or permit fees that are intended to recover the repair expenditures. An overwhelming majority of these studies stated that the permit or vehicle registration fees currently imposed on heavy trucks recover only a very little percentage of agencies' actual expenditures associated with pavement repair due to heavy loads.

Unfortunately, the existing fee structures (vehicle registration fees or OW permits) at most agencies lack opportunity for agencies to charge fees based on the weight and/or distance traveled by heavy trucks. Most researchers, it seems, agree that the weight-distance fee is the most appropriate way to recover the costs of pavement damage associated with such vehicles. Table 4.1 and Figure 4.1 present the results of selected research studies regarding pavement damage repair costs associated with high class roads, using the most common heavy vehicle on the United States road system: 80 kips, 5-axle, semi-trailers).

Previous studies on heavy truck damage and repair costs have estimated the average or marginal cost of pavement damage (APDC and MPDC, respectively). The former refers to the ratio of the sum of reconstruction rehabilitation, and maintenance (MR&R) costs and the total usage of the pavement measured using, for example, equivalent single axle loads (ESALs). The latter is the increase in MR&R expenditure associated with one additional truck on a given highway segment,

TABLE 4.1
A synopsis of pavement damage cost for high-class road pavements

Study	Cost of Pavement Damage (cents/mi.) (at the year of the original study)	Cost of Pavement Damage in 2010 Dollars (cents/mi.)	Cost of Pavement Damage in 2010 Dollars (cents/ESAL-mi.)
Small et al. (1989)	2	4.1	0.82
FHWA (2000)	12.7–40.9	19.1–61.4	3.82–12.28
Noel et al. (1992)	1	2.1	0.42
Vitaliano & Held (1990)	3	6.2	1.24
USDOT (2000b)	0.003	0.0045	0.0009
Hajek et al. (1998)	0.3	0.5	0.1

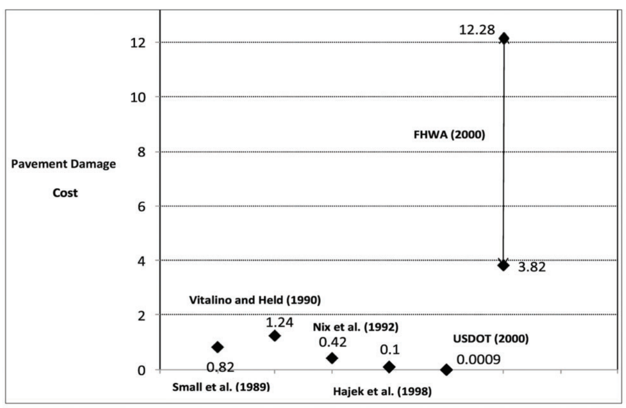
Note: Numbers are shown for a 5-axle, 80,000-lbs. GVW truck (George et al., 1989).

in other words, the ratio of the additional repair costs (reconstruction rehabilitation, and maintenance) and the additional usage of the pavement (Ahmed, Agbelie, et al., 2013).

Many factors affect pavement deterioration, including pavement material types and thicknesses, traffic loading patterns, climate, subgrade quality, and so on (Everett et al., 2014). However, the loading patterns, particularly, vehicle type and weight, are most influential of load-related pavement deterioration (Chowdhury et al., 2013). Luskin and Walton (2001) showed that decrements in the number of axles and increased load magnitude cause significantly increased damage to the road pavement. The unit damage cost has two components: a damage cost due to legal weight; and a damage cost due to the excess (beyond the legal weight limit) weight (Chowdhury et al., 2013).

Figure 4.2 presents a synopsis of pavement damage costs (2022 dollars). Ahmed, Agbelie, et al. (2013) and Ali et al. (2020) identified two approaches for estimating the cost of pavement damage: "engineering" and "empirical." The former identifies (in theory) the relationship between the overall pavement cost over lifecycle (on one hand) and pavement usage (on the other hand). This is done for a unit segment of road pavement which subsequently, can be generalized for the overall road network. Several highway agencies have striven to develop damage traffic load-imposed pavement damage costs. In Arizona, for example, it was determined that OW truck operations on the state highways are associated with uncompensated damage costing $12 million–$53 million annually (Straus & Semmens, 2006). The empirical approach, on the other hand, identifies the statistical correlation between pavement cost (of reconstruction, rehabilitation, and maintenance) on one hand, and pavement usage on the other hand, to generate the unit cost of pavement damage.

In Indiana, a 2012 study developed estimates of the marginal costs of load-related pavement damage cost associated with OW trucks at: non-interstate highways that are not on non-National Highway System (non-NHS); non-interstate highways that are on the National Highway System (NIS-NHS); and interstate highways (IS): $0.218, $0.055, $0.006 per ESAL-mile, respectively. These costs were developed based on pavement expenditures on reconstruction, rehabilitation, and



Note: For high-class roads such as interstates, Nrs are shown for a 5-axle, 80,000-lbs. GVW truck.

Figure 4.1 Pavement damage costs reported by previous studies (cents/ESAL/mile).

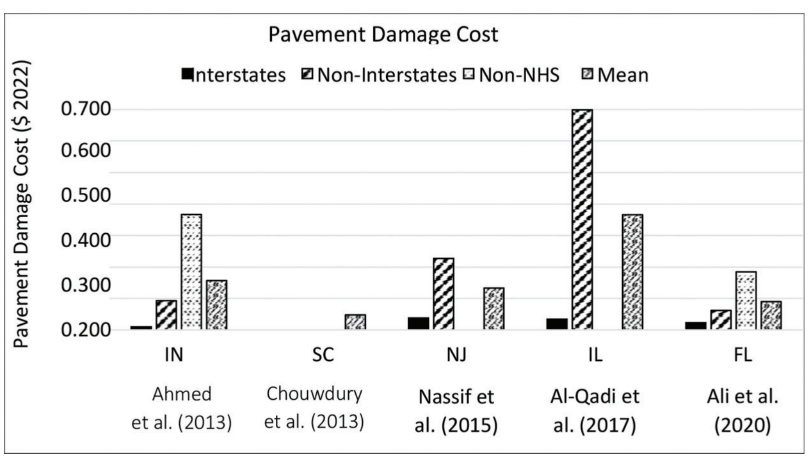


Figure 4.2 A synopsis of pavement damage costs (2022 dollars).

TABLE 4.2
Synthesis of study findings on the cost of pavement damage due to OW loading

Study	State	Analysis Approach	Traffic Usage Variable	Costs Considered	Pavement Damage Cost Estimates
Ahmed, Agbelie, et al. (2013)	IN	Empirical	ESAL	Life cycle cost including the costs of maintenance, rehabilitation, and reconstruction	Rigid Pavement $0.2967/ESAL-mi for non-NHS $0.0756/ ESAL-mi for NIS-NHS $0.0083/ESAL-mi for IS Flexible Pavement $0.2349/ESAL-mi for non-NHS $0.0599/ ESAL-mi for NIS-NHS $0.0066/ESAL-mi for IS
Nassif et al. (2015)	NJ	Empirical	ESAL	Life cycle cost including rehabilitation (milling and resurfacing), and maintenance	60 Years Analysis Period $0.161/ESAL-mi for state roads $0.027/ ESAL-mi for IS; 30 years analysis period; $0.250/ESAL-mi for state roads $0.038/ESAL-mi for IS
Chowdhury et al. (2013)	SC	Theoretical	GVW excess 80 kips ESAL	Costs of pavement replacement	Additional Damage for an OW Truck $0.7565/ESAL-mi for 8-axle, 120–130 kips $0.6773/ESAL-mi for 7-axle, 110–120 kips $0.4160/ESAL-mi for 6-axle, 90–100 kips $0.3801/ESAL-mi for 5-axle, 80–90 kips
Ali et al. (2020)	FL	Theoretical	ESAL	Life cycle cost including maintenance, milling, and resurfacing	$0.147/ESAL-mi for MR $0.049/ESAL-mi for PA $0.018/ESAL-mi for IS
Al-Qadi et al. (2017)	IL	Theoretical	ESAL	Life cycle cost including initial construction, maintenance, and rehabilitation costs	HMA/PCC Pavement $0.5483/ESAL-mi for NIS $0.0270/ESAL-mi for IS Full-depth HMA $1.328/ESAL-mi for NIS $0.0493/ESAL-mi for IS

maintenance over the pavement life cycle (Ahmed, Agbelie, et al., 2013).

In a similar effort in 2013, Chowdhury et al. (2013) developed the costs of pavement deterioration repair (2012 dollars) associated with OW truck operations in the State of South Carolina and determined that the added damage occasioned by a 5-axle 80–90 kip OW truck that has ESALs between the limits of maximum legal weight and maximum OW, is $0.3801/mile.

In the State of New Jersey, Nassif et al. (2015) estimated the unit pavement damage costs associated with OW trucks at state roads and interstate roads based on 60- and 30-year life cycle costs of road damage repairs. The researchers determined that the unit pavement damage costs for the state roads and interstate roads for a 60-year analysis period, $0.161 and $0.027 per ESAL-mile, respectively. For a 30-year analysis period, the damage costs were $0.250 and $0.038 per ESAL-mile, respectively.

In Illinois, Al-Qadi et al. (2017) carried out lifecycle-based costing to develop average costs of pavement damage for different highway classes (interstates and non-interstates) and pavement types (full-depth hot-mix asphalt (HMA); HMA/portland cement concrete (HMA/PCC) overlays). For NIS-NHS, the average cost of pavement damage, for HMA/PCC and HMA pavements were determined as follows: $0.5483/ESAL-mile and $1.328/ESAL-mile, respectively. For interstate highways, the researchers determined that the average costs of pavement damage, for HMA/PCC and HMA pavements are: $0.027/ESAL-mile and $0.0493/ESAL-mile, respectively. In Florida, Ali et al. (2020) estimated the costs of pavement damage for different classes of highways (minor arterials, principal arterials, and interstates), in $/ESAL-mile, as follows: $0.147, $0.049, and $0.018, respectively.

In Table 4.2, a synopsis of the outcomes (pavement damage costs) of the studies discussed above. Considering that these costs were developed at different years; to facilitate comparison, they were updated to 2022 dollars by Chung Li (2022) using the Civil Construction Cost Index (USACE, 2022).

From Figure 4.2, a consistent observation that can be made across the various studies is that the pavement damage costs are lower for higher road classes and higher for lower road classes. First, the pavement damage costs are higher when the usage levels are higher (for example, higher volumes of truck traffic at interstates compared to non-interstates). Second, the damage costs are calculated through a distribution of the lifecycle expenditures on reconstruction, rehabilitation, and maintenance) among the traffic demand such as the total ESALs. It is noteworthy that the lower classes highways tend to receive more frequent repairs and therefore, higher costs over life cycle even though their initial costs are lower. Across the different studies (jurisdictions), there are differences in the analysis parameters including analysis periods (which often represents the pavement life-cycle length), interest rate, and which categories of life cycle costs were considered in the analysis.

4.3 Overweight Truck Impacts on Bridge Damage

Unlike the case for pavements (where ESALs represent an easy and convenient common denominator), bridge damage costs are relatively difficult to calculate. This is due to the consideration of structural moments (which, like ESALs cause damage) that trucks impose at various points of a bridge span; different axle configurations are associated with different moments, even where the load is the same. Also, for the same load and axle configuration, the magnitude of the moments is influenced by the bridge design type including the span lengths. A bridge-crossing OW truck imposes stresses that could cause fatigue or damage to a bridge's structural elements.

Over a bridge life cycle, more frequent loading cycles and larger stresses caused by OW vehicles contribute to accelerated damage due to fatigue (Ali et al., 2020; Dey et al., 2015), leading to more frequent and/or intense bridge maintenance, rehabilitation, and replacement (Everett et al., 2014). As such, bridge damage caused by OW vehicles are a key issue to highway agencies (Babu, 2019).

The longevity of a bridge structure is influenced by factors including age, traffic loading, constituent materials, and so on. In the estimation of bridge damage costs attributable to OW, axle weight, gross weight, and axle configuration are key considerations. OW truck impacts on a bridge depends on the weight of each axle group and the inter-axle distance. The deleterious impact is higher for higher axle group weights and smaller distance between axle groups (USDOT, 2000a; 2000b).

Compared to pavements, very few studies have been conducted to quantify OW damage to bridges. For non-interstate highways in Minnesota, SRF Consulting Group and Cambridge Systematics (2006) estimated that for an 80,000 lbs. tractor-semitrailer, the cost of bridge fatigue damage is $0.0014/mi. In Wisconsin, researchers have assessed the impact of OW loads at bridges (Zhao & Tabatabai, 2009), and indicated a few opportunities in the OW permitting process. In South Carolina, it was shown that OW permit revenues do not cover the infrastructure damage caused by OW operations (Chowdhury et al., 2013).

In Texas, Prozzi et al. (2012) used the concept of structural fatigue to estimate the cost of bridge damage due to OW trucks. The researchers developed an aggregate cost per mile using moment analysis of the bridge structure, and analysis of OW permit records. They determined the bridge damage cost as follows: $0.90 for 200 kips–254 kips GVW; $0.49 for 160 kips–200 kips GVW; $0.38 for 120 kips–160 kips GVW; and $0.23 for 80 kips–120 kips GVW.

In the State of Indiana, Ahmed, Agbelie, et al. (2013) used equivalent uniform annual cost (EUAC) concepts, a disaggregate life cycle model, and incremental cost analysis to estimate the marginal costs of bridge damage. This was done for each of two alternative permit fee options. Option 1 (permit fee structure based on GVW irrespective of the federal legal weight limit) and Option 2 (permit fee to address the difference in the damage triggered by the excess weight beyond the legal vehicle weight limit of 80,000 lbs.). The second option was developed to accommodate the assumption that vehicles weighing up to 80,000 lbs. would not be expected to pay any additional fees. The authors estimated the damage costs by distributing the EUAC across the usage levels, and then for each vehicle, translated into unit costs ($ for every foot-pass) of any specified truck class (see Appendix C).

In South Carolina, researchers determined the costs of bridge damage using a fatigue analysis approach. They used four bridge types and determined the unit bridge damage costs per mile, for each of several truck classes categorized by axle groups (Dey et al., 2014). In New Jersey, Nassif et al. (2015) applied bridge damage functions to assess OW truck impacts on the bridge longevity, estimating that the damage cost associated with transporting 1 ton of OW load for 1 mile, is $0.132 (expressed in 2011 dollars).

In Illinois, Gungor et al. (2019) accounted for truck loads and bridge structural capacity and quantified the bridge impacts of OW trucks. Using condition prediction models, they had developed, the authors estimated the bridge service life reduction associated with traffic load and determined average bridge damage costs ($/mile) as: $0.0182/mi. *Δkip (Δkip = the difference between the bridge average inventory rating and OW truck GVW.

In Florida, researchers estimated the monetary bridge consumption of OW trucks using a representative bridge in the state (Ali et al., 2020). The monetary consumption incurred by an OW truck was estimated using the permit fee structure, and it was determined that the current permit fees generally do not cover the damage caused by OW vehicles to the infrastructure. The authors of the study made proposals for new permit fees to adequately reflect the actual infrastructure consumption

4.4 Safety Degradation Due to OW Truck Operations

With increased levels of road freight transport, highway agencies seek to relax their truck weight and size limits in a bid to help reduce the number of vehicles on the roads without impairing economic development and efficiency associated with the state's freight transportation industries. However, truck weight and size limits continue to represent an issue of great contention, and accidents associated with OSOW truck operations are still of safety concern to transportation agencies and safety advocates (Dong et al., 2017). Approximately a decade ago, AASHTO (2009) had argued that the information contained most existing truck crash datasets is not sufficient to develop confident conclusions on the directional effect of increased truck loads, and therefore, more inquiry is needed. Since then, datasets have been improved and a few studies have thrown light on the issue. However, their individual divergent findings, when taken collectively, suggest a dichotomous nature of the safety impacts of OW operations.

On one hand, it has been argued that OW operations improve road safety when viewed from a systemic perspective because they lead to reduced number of trucks on the roadways. This is because a smaller number of trips is needed to transport the same volume of truck loads, leading to lower truck traffic volumes, reduced exposure, ultimately reduced crashes (Everett et al., 2014; Roshandeh et al., 2016a, b; TRB, 1990).

On the other hand, OW trucks have been associated with reduced safety (in terms of either crash frequency or severity or both), particularly when viewed from the perspective of an individual truck. Crash frequency increases with GVW (TRB, 1990; USDOT, 2015). The safety impacts of large or heavy trucks have been a subject of interest in the literature even though the trucks in those studies were not necessarily those that exceed the legal size and weight limits. Examples include Pigman and Agent's (1999) empirical truck crash study in Kentucky, Gao, Liu, Kong, and Guo's (2004) study that identified truck overloading as a primary culprit of crashes involving heavy and large vehicles (they found that 70%–90% of such crashes were attributable to oversize and overweight trucks), and Prozzi et al. (2012) found that the primary contributing factor of truck-involved crashes was the exceedance of their dimensions and weights above legal limits. Also, the empirical analysis of truck crashes from Dong et al. (2017) asserted that the presence of large trucks in the traffic stream is a major factor of increased crash frequency and severity. There are several reasons for the findings that OW or heavy trucks lead to poor safety. First, an OW truck has lower stability and maneuverability (Luskin & Walton, 2001; Neff & Bai, 2012). The likelihood of truck jackknifing is higher for heavier trucks due to steering difficulty of an OW truck. Second, when a truck is overweight, its ability to maneuver downhill and uphill, or to overtake, is reduced (Luskin & Walton, 2001). Third, overloading could lead to higher tire internal temperature, increasing tire blow-out risk. Fourth, the likelihood that a truck will be involved in a crash with severe consequences is increased for OW truck compared to a truck loaded to the legal load limit (Jacob & Feypell-de La Beaumelle, 2010; Pigman & Agent, 1999). This could be because heavier trucks have higher kinetic energy and thus, greater momentum and impact damage when a collision occurs.

A few researchers have recognized the dichotomous nature of these safety impacts of OW truck operations but argued that both directions of the impacts are valid and not mutually exclusive (Everett et al., 2014; Roshandeh et al., 2016a, b). They stated that there is a net effect, and the direction of the net effect (net increase or a net increase) depends on the relative magnitude of impacts of the two opposing phenomena.

4.5 Mobility Impairment Due to OW Truck Operations

The literature on OW truck operations generally suggest that such operations have significant impacts on overall road traffic conditions including travel time and delay. Yet still, like the safety impacts, there appears to be a dichotomous nature of the mobility impacts of OW operations, as Everett et al. (2014) and Roshandeh et al. (2016a, b) argued. On one hand, OW operations improve road corridor mobility when viewed from a systemic perspective, because they lead to reduced number of trucks on the roadway. This is because fewer trips are needed to transport the same amount of goods, leading to lower volumes of truck traffic, reduced presence of trucks, lower passenger car equivalents (PCEs), and ultimately, higher mobility overall (Everett et al., 2014; Roshandeh et al., 2016a, b).

On the other hand, OW trucks have been associated with reduced mobility when viewed from the perspective of an individual truck. For example, each individual OW truck has a higher PCE compared to a normal weight truck. Also, there exist studies that determined that, compared to "standard" trucks (that is, those loaded to the legal maximum of 80,000 lbs.), OW trucks possess inferior maneuverability and lower capability to decelerate/accelerate which results in their lower running speeds, ultimately reducing traffic throughput in a corridor (Wang et al., 2018). In a Nanjing (China) study, (Zhou et al., 2012) estimated that OW trucks generally travel at speeds lower (by 16%) compared to similarly configured non-OW trucks in similar traffic conditions and road environments. OW impacts on traffic stability and throughput is probably best measured using the PCE. In a 2009 study report, Ohio DOT (Campbell et al., 2009) estimated that the PCE values of heavy vehicles are in the range of 1.5 to 15 (much higher compared to normal trucks). Ahmed, Drakopoulos, and Ng (2013) determined that heavy truck PCE could be as much as 1.76 under certain conditions. The higher PCE of heavy and OW trucks could be attributed to its heavier load and lower operational performance (running and braking): an OW truck in a traffic stream needs more time headway and space headway and has longer reaction time and stopping distance compared to a normally loaded truck (Aghabayk et al., 2012). In addition, other drivers could be intimated or influenced in other ways by the presence of an OW truck, thereby impairing the traffic stream stability (Aghabayk et al., 2012). Some researchers have determined that passenger car drivers tend to maintain larger space and time headways when follow-

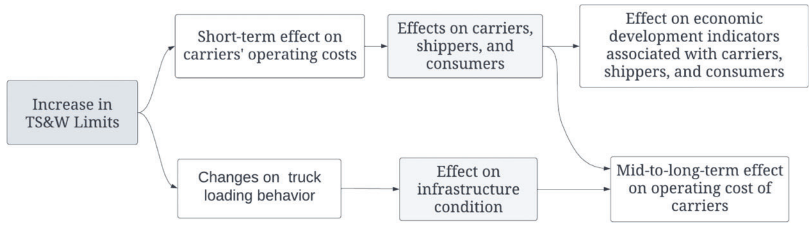


Figure 4.3 Concatenating effects of increased truck weight limits (Everett et al., 2014).

ing a heavy truck compared to other vehicles (Krammes & Crowley, 1986; McDonald et al., 1997; Wang et al., 2018; Yoo & Green, 1999).

Gao et al. (2004) found that at freeways, higher truck weights lead to significantly higher variability in overall operating speeds across the different vehicle classes, and that the presence of heavy trucks leads to reduced traffic mobility and lower highway capacity and throughput. Zhou et al. (2012) evaluated OW truck impacts on traffic conditions at a freeway in Jiangsu, China and confirmed that overloading leads to significant reduced speeds and extended periods of traffic congestion.

4.6 Economic Productivity Impacts of OW Truck Operations

Truck transportation of goods is akin to a mobile warehouse. Like all warehouses, freight transportation economic efficiency is governed by the cost associated with storing (transporting) each product unit. Larger volumes (and hence, generally, weights) of goods stored in the mobile warehouse is associated with greater scale economies, and ultimately, reduced costs of production. As such, OW truck operations significantly impact the economics of freight transportation.

In the nineties, Crockford (1993) determined that freight-related industries earned substantial savings after they were permitted to haul OW goods. Subsequently, researchers confirmed that the transport of heavier loads makes it possible to move the same overall volume of goods in fewer trips; this lowers the costs of labor, vehicle operations (fuel, wear and tear, engine and transmission fluids, and so on), and overhead (Adams et al., 2013; Luskin et al., 2000). These cost reductions, overall, lead to increased savings throughout the production process. For example, carriers may pass the cost savings on to their shippers via reduced haulage rates, and shippers, in turn, may pass the cost savings on to their end customers through reduced prices for raw materials, intermediate products, or finished products (Adams et al., 2013; Dey et al., 2015).

Figure 4.3, which illustrates the concatenating economic development impacts of OW limit increases, underscores the importance of freight transportation economic productivity to economic development (Crockford, 1993; Hewitt et al., 1999) and why it deserves due consideration in prospective legislation on OW permitting.

The freight transportation industry assesses their fleet productivity in terms of the number of ton-miles associated with each truck. Productivity is said to be higher when the commodity shipment ton-miles (the output) increase without an increase in the shipping cost (the input) or when the same or the same amount of goods is transported with reduced shipping costs. According to Everett et al. (2014), OW truck operations lead to increased freight transportation productivity for even small increases in the maximum weight limit. The authors gave an example of a 29,000 lbs. unloaded 5-axle combination truck with allowable payload of 51,000 lbs. (81 kips–29 kips = 51 kips). A 5% increase in the weight limit due to, for example, new legislation, would translate into an additional allowable weight of 4,000 lbs., representing a 7.8% payload increase.

Unfortunately, literature on OW impacts have tended to avoid analysis on the economic development effects. Most have focused on pavement and bridge damage, permitting revenue, and in a few cases, safety impacts. In the paragraphs that follow below, we present and discuss excerpts from this small group of studies. A Texas study (Prozzi et al., 2012) assessed infrastructure damage due to prospective changes in OW legislation and duly acknowledged the importance of studies on economic productivity impacts of OW operations. Crockford (1993) opined that in any quest to maximize truck shipping productivity, it is important to balance policies related to infrastructure protection and those related to vehicle weight. A study in Florida found that higher restrictions in OW permitting lead to higher shipping costs which translate into higher costs of production and retail. The study cautioned that this adverse impact could outweigh the savings associated with infrastructure protection earned from OW permitting (Florida Transportation Commission, 1993). Two decades later, a study in Wisconsin interviewed several state highway agencies and representatives of the freight transportation industry and found that increases in OW permit fee levels significantly influence haulage decisions of carriers. Most carriers in the survey stated that permit fees are closely related to their costs of operations (Adams et al., 2013).

A Montana study in 1999 assessed the impacts of truck OW policy changes on economic development using input-output simulation (Hewitt et al., 1999). The researchers used the following GVW thresholds (lbs.)—80,000, 88,000, 105,000, and 128,000. The analysis used gross state product (GSP) as the metric of economic impact and freight transportation productivity as the input and determined that a higher GVW threshold leads to beneficial impacts on the state's economy and that the changes in the GSP are 2–20 times more than that of infrastructure cost increases, and that such discrepancy increases over time. The outcome of the Hewitt et al. (1999) study is at variance with those of other studies, but certainly provides a valuable perspective that deserves further consideration in terms of the data and the analytical methods used.

A study in Indiana (Everett et al., 2014) assessed the economic development impacts of a proposed OW commodity permit (for transporting divisible loads of metal (120,000 lbs.) and agricultural (97,000 lbs.)) and at a maximum 2.4 ESALs. The researchers carried out a qualitative analysis using results from an industry stakeholders survey and a review of previous research literature. They indicated that the proposed OW permit would reduce the carriers' direct operating costs due to the increased weight limit (and thus, reduction in trip volumes). The study estimated that there will be a direct reduction in the costs of freight transportation due to lower permit fees; and indirect reduction in vehicle operating costs due to better pavement condition (arising, in turn, from reduced loading of the pavements). The researchers stated that the savings from these cost reductions can be expected to reduce the overall operational costs of the freight transportation industry and thereby enhance their net profits (for both shippers and carriers), subsequently (at least, prospectively) benefiting end customers, and ultimately, increasing the state's economic development. Based on their quantitative analysis, the researchers used the concept of elasticity (of demand with respect to travel cost). Overall, the Everett et al. (2014) study results indicated that the prospective OW commodity permits would enhance the economic productivity of agricultural and metal commodity transportation.

4.7 OW Truck Permitting Revenues

The increasing volumes of highway freight transportation has been accompanied by increased maintenance expenditures even when normalized by the inventory size, but highway funding has not kept pace with the funding needs for highway repair (Dehghan-Niri et al., 2020). This is because revenues have been declining due to falling revenues from the gas tax, resulting in repair and replacement backlogs that are growing over time OW permit fees represent one way (albeit often inadequate) to generate funding to help maintain highway pavement and bridge deterioration associated with OW operations. Thus, highway agencies administer OW permit fees for at least two main reasons: (1) to generate revenue for repairing the infrastructure, and (2) to discourage excess loading practices (thereby protecting road safety and mobility for all road users (INDOR, 2017)).

As stated earlier in this chapter, previous studies have found that OW permit revenue does not fully compensate for the marginal damage (and associated expenditures) due to OW operations, thereby exacerbating an extent gap between infrastructure consumption and revenue (Al-Qadi et al., 2017; Crockford, 1993; Dey et al., 2015; Everett et al., 2014; Luskin et al., 2000; Nassif et al., 2015). An FHWA (1997) cost allocation study determined that OW trucks (trucks with GVW exceeding 80 kips) were paying approximately 60% of their share of overall road cost responsibility on average.

A study in Wisconsin (Adams et al., 2013) surveyed highway agencies on the revenues and administrative costs associated with their OSOW permits. The study assessed each agency's expenditures associated with permitting (including infrastructure (road and bridges) engineering reviews, permit processing labor, trip route checks, traffic engineering reviews, and so on) and the sum was compared with OW permit revenues. The researchers found that in many situations particularly where detailed evaluation of each permit (engineering and administrative review for trip routes) is required, the permit fee revenues generally do not recover the costs associated with permit issuance.

In 2009, the ODOT estimated a sum of $144 million as the bridge pavement and damage costs due to OW operations, while $72 million in revenue was collected from various taxes and fees associated with OW operations permitting (Campbell et al., 2009). In 2014, a study in Indiana reported a significant gap between road infrastructure consumption due to OW permitting ($44.15 million) and OW revenues of $12.46 million, with a gap of $32 million for the second half of the 2013 calendar year (Everett et al., 2014).

State highway agencies including INDOT, in a bid for further knowledge on the gap between OW permit revenue and OW-induced costs of road damage (consumption), are increasingly investing efforts in impact evaluation of OW truck operations on their highway system and the state economy. That way, they become better informed to help state legislatures establish reasonable OW permitting fee structures. With appropriate permitting structures in place, the state will be in a better position to generate reasonable levels of permit revenues to contribute towards highway asset expenditures (repair/replacement) without impairing the economic productivity of the state's freight transportation industry.

4.8 Chapter Summary

In this chapter, the impacts of OW trucks, as found in various literature, were assessed. First, the chapter assessed the impact on pavements and presented the pavement damage costs at have been established in the literature, including estimates of highway-class specific OW damage costs developed in recent JTRP studies. The chapter also presented previous literature on the OW-related costs of bridge damage also developed by various researchers worldwide including the authors of JTRP studies. Then the study addressed the safety and mobility degradation associated with OW truck operations. The chapter then presented the economic development impacts of OW legislation and subsequent operations, as evidenced from past studies and states' experiences. Finally, the chapter discussed the revenues that can be expected from OW permits and the efficiency (sufficiency) of those revenues in recovering the damage inflicted to the infrastructure due to OW operations.

CHAPTER 5. INFRASTRUCTURE CONDITION, SAFETY AND MOBILITY PERFORMANCE AT INDOT OW-PERMITTED ROUTES

5.1 Introduction

As stated earlier in this report, OW freight transportation operations cause much higher traffic-related stresses on the highway infrastructure compared with normal-weight operations. Such increased stress on the infrastructure causes accelerated wear and tear, resulting in more frequent maintenance and rehabilitation, which in turn causes higher expenditures. It is the intention of highway agencies to ensure that such an increase in expenditure, as much as possible, are recovered through OW permit fees. As is the case with any engineering system policy change or physical intervention, it is prudent to carry out *ex poste* (or, post-intervention) analysis of the intervention's impacts to ascertain whether the intended goals are being realized. This is consistent with the spirit and intent of HEA 1190-2021. Figure 1.1 in the introduction chapter provides a timeline of the impact evaluation and serves as a basis for the analysis in this chapter. The analysis period is a subset of this timeline and includes the time of the intervention (the starting month of HEA 1190-2021's implementation). This chapter assesses the statewide impacts of HEA 1190-2021 in terms of changes in the following:

- volume of OW operations (represented by the number of permits issued),
- OW shipment weight, on average, and
- OW truck loading on the pavement, on average in terms of ESALs.

In addition, the chapter assesses, for a sample of INDOT OW-permitted routes, the impacts of HEA 1190-2021 in terms of the observed changes in the following:

- pavement condition,
- bridge condition,
- road traffic safety, and
- mobility performance.

The objective of this part of the study is to use such feedback to inform towards any policy changes associated with HEA 1190-2021. Specifically, Section 3 of HEA 1190–2021 had added Indiana Code 9-20-6-2.2, empowering INDOT to, among other things, suspend OW divisible load permitting if the department observes an unusual increase in (1) infrastructure consumption at permitted routes; or (2) the number of accidents associated with OW divisible loads. The analysis period for the impact evaluation is April 2021 to April 2023 (the intervention (HEA 1190-2021) was implemented starting January 2022).

Figure 5.1 presents the trend of number of permits issued monthly prior to and after HEA 1190-2021. As shown by the vertical green broken line at 2022-01 on the horizontal axis, HEA 1190-2021 was implemented on January 1, 2022. From the figure, it can be observed that HEA 1190-2021 caused (or, at least, coincided with) a reversal of the trend of permit counts (from a gently declining trend to a gently increasing one). There were monthly fluctuations of varying magnitude, but the overall trend is clear: a slight downward trajectory in the period leading to HEA 1190-2021 and a slight upward trajectory in the months following the legislation. In fact, if the pre-HEA 1190-2021 trends had continued (assuming linear extrapolation as shown in the thin continuous line) and if there had been no

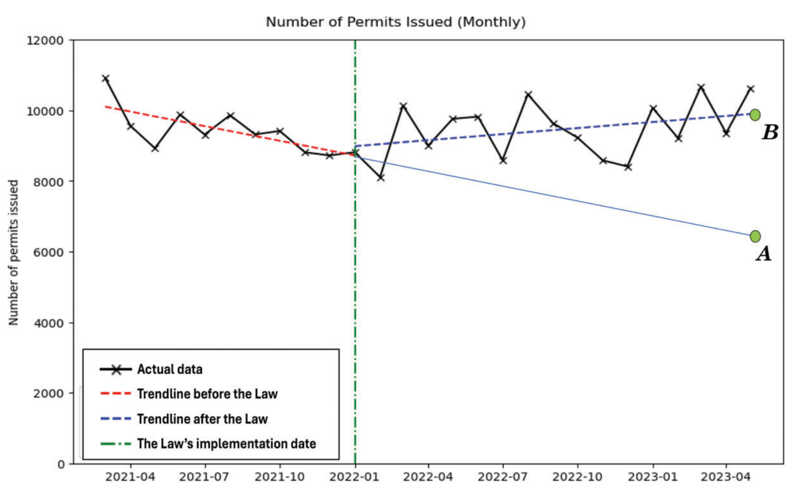


Figure 5.1 Number of permits issued monthly prior to and after HEA 1190-2021.

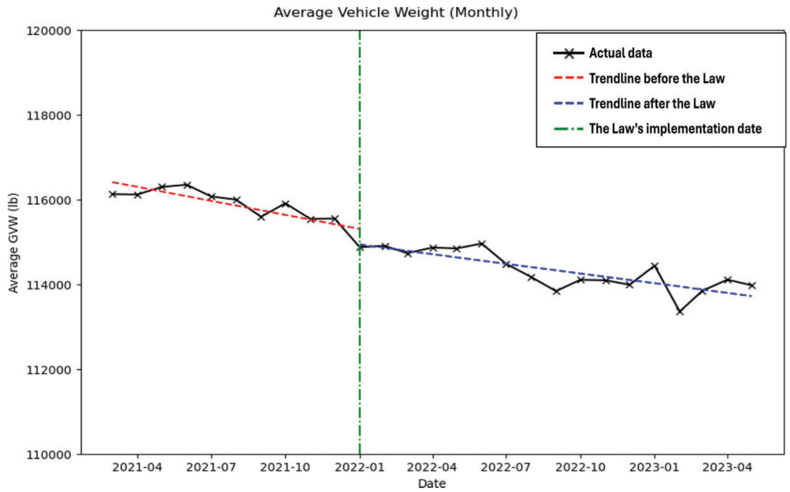


Figure 5.2 Average vehicle weight by month prior to and after HEA 1190-2021.

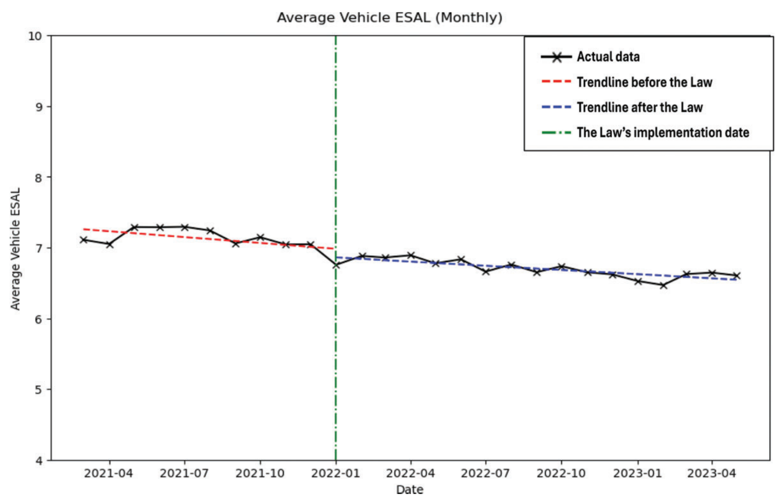


Figure 5.3 Average vehicle ESALs by month prior to and after HEA 1190-2021.

HEA 1190-2021, the number of permits issued in April 2023 would have been approximately 6,500 (Point A). With HEA 1190-2021, the graph shows that the actual count of permits in 2023, was approximately 10,000 (Point B). A plausible explanation for the increase in the permit count after the implementation of HEA 1190-2021, is that the cost of OW became too high for shippers and carriers and sought to load more trucks at little excess weight (thus, more permits) compared to fewer trucks with extreme excess weight (thus, fewer permits), from an economic perspective.

However, it can be observed from Figures 5.2 and 5.3 that the average shipment load and average ESALs were already decreasing prior to January 2022 when HEA 1190-2021 was implemented. It could be argued that the continuance of this trend may have been partly sustained due to the HEA 1190-2021. Another explanation for the reverse trend in the number of permits issued is that HEA 1190-2021 expanded the list of items that could be counted in OW divisible load category. By removing the list of commodities and specific weight limitations for certain commodities from the definition of OW divisible loads, the new legislation expanded the commodities that could be included. As a result, carriers responded by obtaining more OW permits to ship the newly included commodities through OW operations. The next few paragraphs discuss Figures 5.2 and 5.3.

The average GVW (Figure 5.2) exhibits a downward trajectory over the analysis period. It can be observed that even before the legislation was implemented, average vehicle weight for OW divisible loads were declining. This did not change with the law. Therefore, it could be inferred that the law did not significantly change the average vehicle weight for OW divisible loads. A similar conclusion can be drawn regarding the average damage caused by each

OW truck (as shown in the chart for the mean vehicle ESALs (Figure 5.3)).

Taken together, these illustrations indicate that although INDOT has concerns regarding infrastructure consumption at permitted routes, there is no evidence to suggest that there was any significant increase in average OW traffic loading (GVW) or pavement damage (ESALs) caused by each OW truck after the HEA 1190-2021 was implemented. To the contrary, it can be inferred that the downward trajectory for the average weight and average ESAL (which continued after HEA 1190-2021 was implemented) is indicative of the impact of the legislation in terms of its promotion of continued decline in loading and damage. Continuance of the decline in average shipment loads and average damage, even with a higher number of permits, generally bodes well for the road infrastructure. Therefore, it seems reasonable to state that infrastructure consumption is decreasing because of the HEA 1190-2021 legislation. Additional data items from a longer analysis period after the implementation of HEA 1190-2021, will be needed to make such a determination.

5.2 Pavement Damage Due to OW Operations at Permitted Routes During the Interim Period

In this section, a determination was made of the current infrastructure consumption at the permitted routes. The results of this analysis could be used by INDOT not only to adjust the permitting structures and policies to incentivize desired loading behavior but also to recover part of the higher maintenance cost burden attributed to OW loading. It is possible to determine how much should be charged to recover part or all the additional consumption (damage) cost. To do this, the extent of the damage caused by OW operations compared with normal-weight operations, should be determined. To this end, there is need to determine whether the OW operations during the HEA 1190 period caused undue pavement deterioration and if yes, to quantify this effect. As such, this study examined the OW operations at the permitted routes and analyzed their rates of pavement deterioration, to ascertain the difference compared to similar routes not used for OW operations.

To assess such pavement infrastructure damage caused by OW operations, this study analyzed permit data spanning 2021–2023. The data included information on the characteristics of each truck, route information, weights, and category of goods being shipped. The analysis assessed pavement deterioration as a function of the truck loading, measured as ESALs. The metric chosen to represent pavement damage was the Pavement Condition Rating (PCR) (Saraf, 1998). PCR was chosen in part because it is an all-encompassing measure of pavement distress, accounting for a gamut of pavement condition indicators including rutting, roughness, cracking, and general pavement condition. A pavement with a PCR of 100 is pristine, while a pavement with a PCR of zero has failed (in the practice, pavements are not allowed to deteriorate to PCR values of zero as agencies have standards (thresholds) at which pavements must undergo rehabilitation or reconstruction. Functions relating PCR and pavement loading developed for pavements (Equation 5.1) (George et al., 1989):

$$PCR = 90 - [EXP(Age^b) - 1]\log[ESAL/(SNC^c * T)] \quad \text{(Eq. 5.1)}$$

For flexible: $a = 0.8122$, $b = 0.3390$, $c = 0.8082$. For rigid: $a = 1.7661$, $b = 0.2826$.

All other symbols, along with their typical values as established in the original study as presented in Table 5.1. In the present study, average values in the specified ranges were used for the parameters.

TABLE 5.2
U.S. routes used in the pavement damage analysis

Route	Cumulative ESALS	Start/End point
	Northern Indiana	
US-20	72,631	I-69 to US-421
US-6	22,605	I-69 to US-421
US-30	94,739	I-69 to US-31
US-33	9,390	I-69 to US-20
US-35	13,696	Michigan City to Logansport
US-31	43,275	South Bend to Logansport
US-231	53,951	Michigan City to Lafayette
US-421	16,365	Gary to Lafayette
	Southern Indiana	
US-421	16,365	I-465 to Jefferson
US-52	5,280	I-465 to Franklin
US-150	3,455	Shoals to I-65
US-50	25,643	Shoals to I-65
US-41	44,114	I-70 to I-64
US-231	53,951	I-70 to I-64

TABLE 5.1
Typical range of parameter values used in PCR determination (George et al., 1989)

	Range of Each Parameter, Flexible Pavement		
Parameter	**No Overlay**	**Overlay**	**Composite Pavement**
Thickness of AC Surface, Inches (T)	NA	1.0–8.0	2.0–5.0
Modified Structural Number (SNC)	2.5–7.7	1.1–8.2	NA
Age (Years Since Construction or Last Overlay)	1–16	1–10	1–10
Yearly Equivalent Single Axle Load (ESAL)	1,055–104,965	1,191–809,289	4,331–119,696

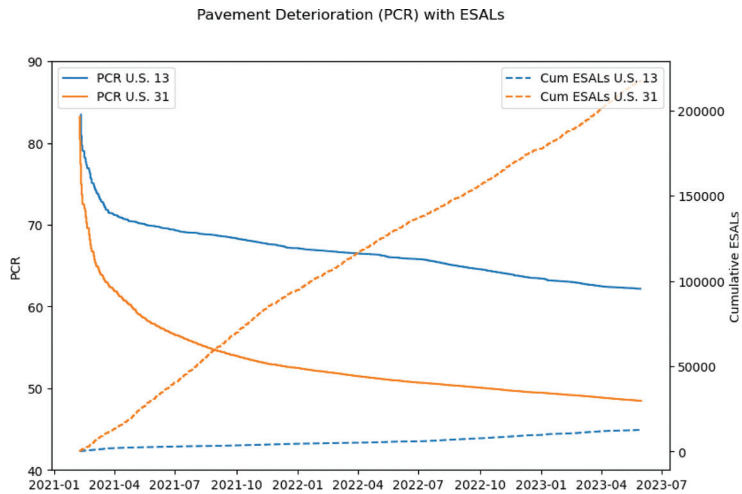


Figure 5.4 Pavement deterioration (PCR) with ESALs.

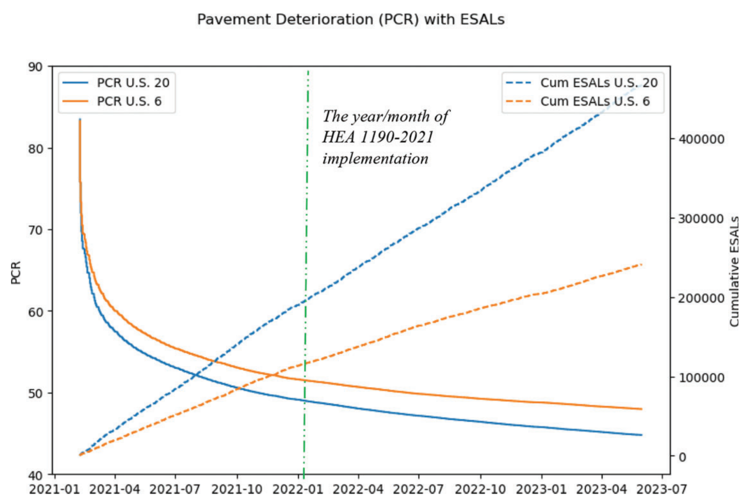


Figure 5.5 Pavement deterioration with ESALs for US-20/US-6.

In determining which routes to evaluate for OW pavement consumption, two important criteria were used. First, the candidate routes were selected such that they exhibited a marked difference in the amount of OW loading experienced yet had as much similarity in all other areas as possible. This was necessary to minimize the contribution of all other factors to the change in pavement conditions. For example, routes were selected in pairs such that candidate routes shared as many characteristics as possible including geographical location, functional class, average traffic loading, and so on. Where possible, candidate routes for the comparative analysis were selected such that they ran parallel to each other. By keeping all other attributes similar, the observed differences in outcome variable (pavement condition) across the comparison pairs could be attributed to the observed difference in OW loading experienced in each comparison pair. Difference in temperatures throughout the year often leads to differences in climatic loading on pavements and consequently on pavement deterioration (Labi & Sinha, 2003). Furthermore, as the northern and southern regions of the state experience different extremes in terms of temperature, with each pair, road sections selected for comparison such that they lie in either the north or south parts of the state.

The routes chosen for comparative analysis need to have a marked difference in their OW loading levels. Without a marked difference in OW loading, it would be hard to ascertain any differences in pavement deterioration due to OW loading. All the interstate sections in the data sample were observed to experience similar levels of OW loading. As such, interstate routes were excluded from comparative analysis, and instead, U.S. routes were selected for the analysis. The U.S. routes met the criteria established earlier for the comparative analysis and exhibit marked differences in OW loading. Table 5.2 summarizes the information at the routes used in the comparative analysis.

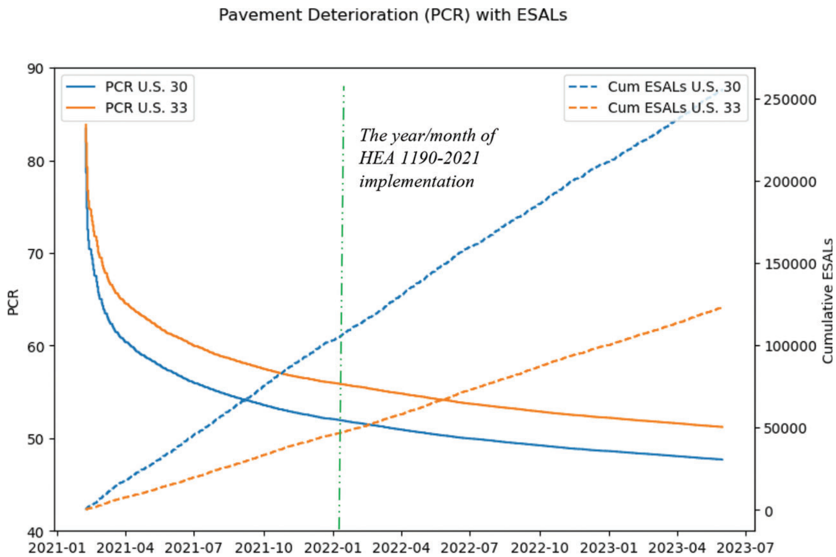


Figure 5.6 Pavement deterioration (PCR) with ESALS for US-30/US-33.

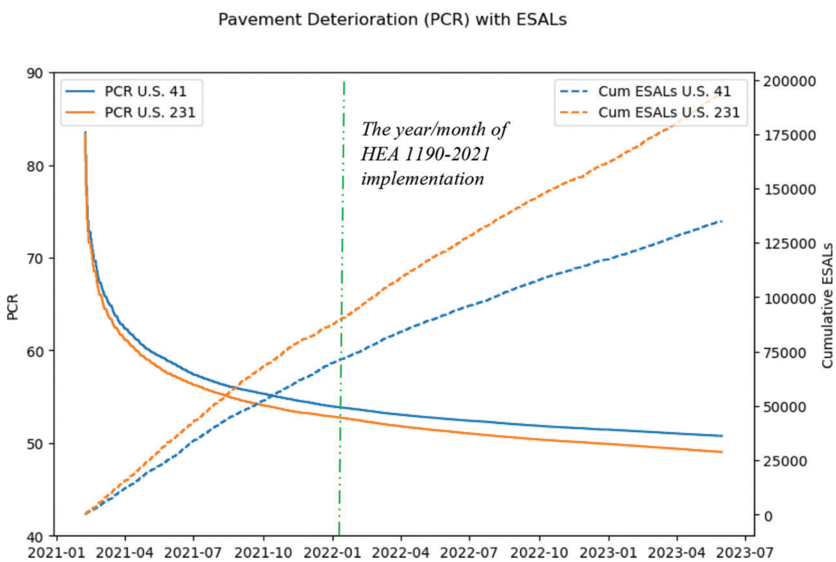


Figure 5.7 Pavement deterioration (PCR) with ESALs for US-41/US-231.

Figures 5.4 through Figure 5.10 present the change in PCR corresponding to cumulative OW loading in ESALs for select U.S. highways. The left vertical axis shows the change in PCR as the pavement is loaded. The horizontal axis shows the date corresponding to the shown loading while the right vertical axis shows the cumulative OW load in ESALs experienced by the pavement in the analysis period. As shown in the figures, routes that experience higher cumulative loads see their PCR decrease faster than their counterparts. The difference in loading, and consequently the change in PCR is more pronounced in some routes than others. For example, Figure 5.4 presents these differences for US-31 and US-13. The cumulative loading on US-31 is nearly ten times that experienced by US-13. Consequently, the PCR on US-31 is on average 15 points lower than that on US-13 for the analysis period. On the other hand, the difference in cumulative loading experienced by US-231 is only approximately 30% higher than that of US-41 (Figure 5.5). As a result, the difference in PCR between US-231 and US-41 is not as pronounced. Similar variations are observed for other figures.

Taken together, the routes with higher cumulative loads experience on average 68,665 more ESALs than their counterparts and see PCR drops of six points on average. This translates into an average deterioration rate of 0.11 PCR points/1,000 ESALs of OW loading. At a marginal PDC of $0.55/ESAL-mile (Ahmed, Agbelie, et al., 2013), this translates into approximately $3,778/mile in pavement damage cost due to OW operations. This implies that OW

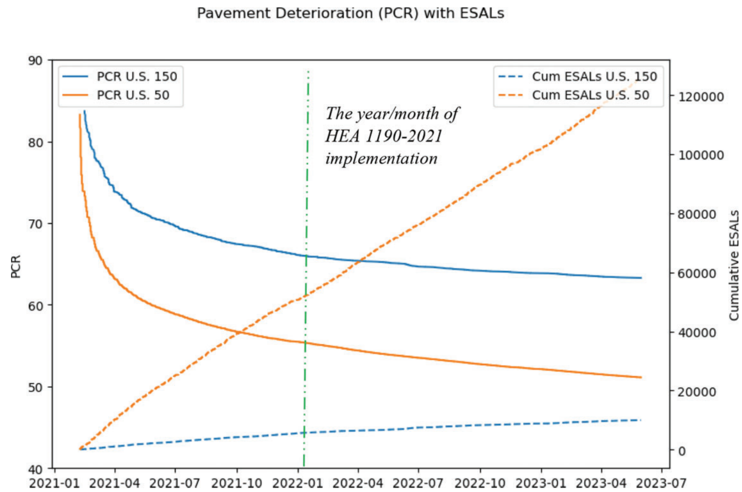


Figure 5.8 Pavement deterioration (PCR) with ESALs for US-50/US-150.

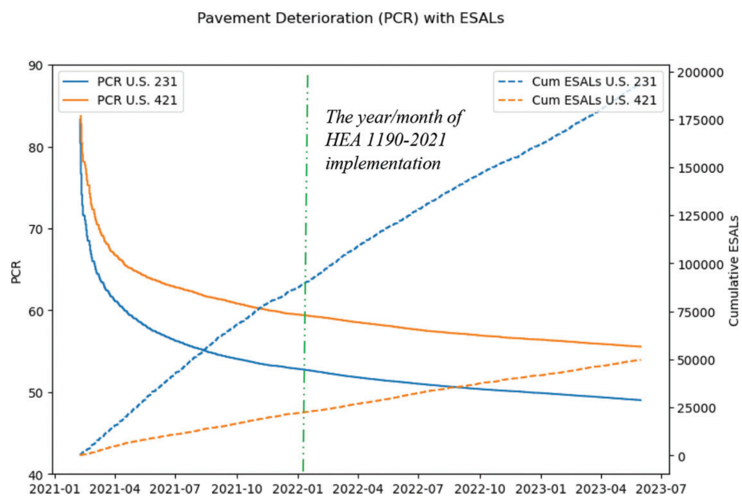


Figure 5.9 Pavement deterioration (PCR) with ESALs for US-231/US-421.

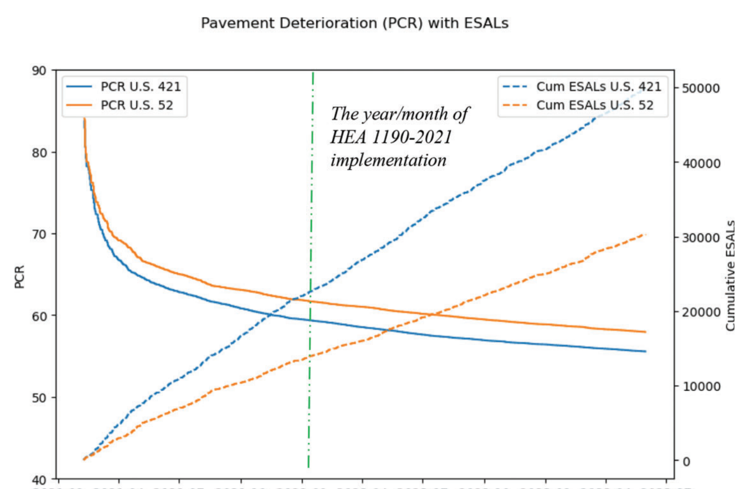


Figure 5.10 Pavement deterioration (PCR) with ESALs for US-52/US-421.

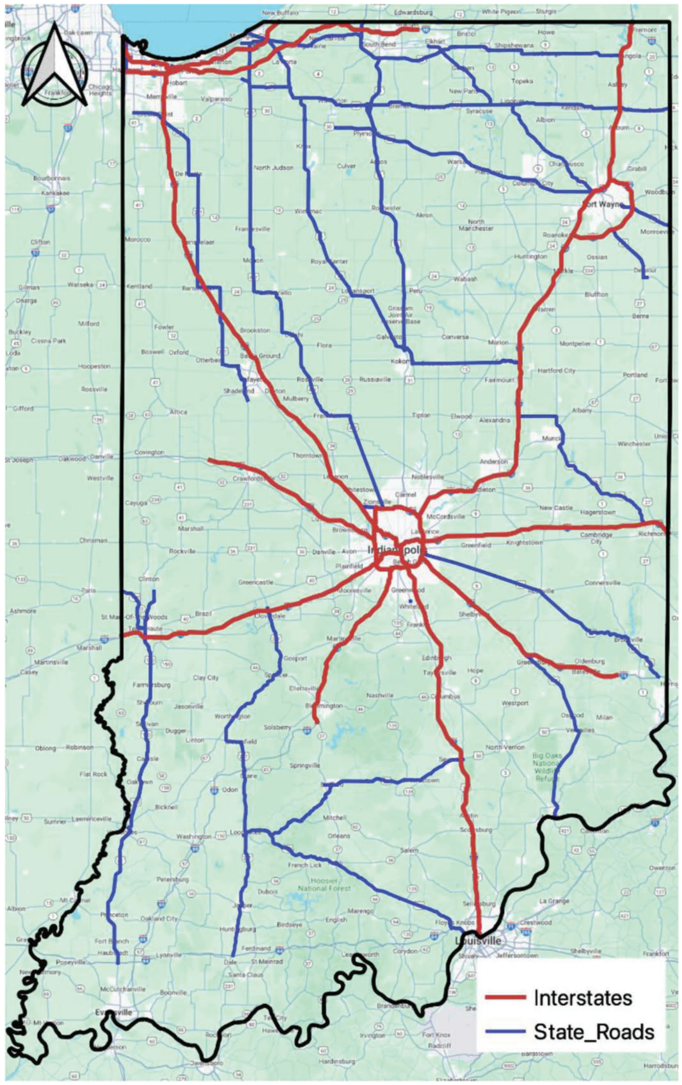


Figure 5.11 Road corridors with the highest permit frequencies.

operations account for an additional $3,778/mile in maintenance and rehabilitation costs at permitted routes compared with normal weight loading.

5.3 Bridge Damage Due to OW Operations at Permitted Routes During the Interim Period

Figure 5.11 presents a map showing the permitted route sections. This study analyzed bridge deterioration rates using data from the NBI database. Condition ratings for bridges on permitted routes were analyzed, and the average ratings were compared for the period before the implementation date of HEA 1190-2021 and after to ascertain the impact of the law. Bridges were categorized by the deck type as well as the superstructure type. To minimize analysis bias, a distinction was also made between older and newer bridges. Older bridges tend to deteriorate faster in response to loading than newer bridges. In this analysis, bridges older than 20 years were classified as "older" while those built or had major rehabilitation work in the last 20 years are considered "newer."

The NBI ratings of bridges on permitted routes were analyzed and bridges whose condition significantly increased over the last 2 years were excluded from the analysis. This is because a significant increase in NBI rating of a bridge corresponds with major maintenance or rehabilitation work. Since the research team did not have maintenance data for these bridges, it was not possible to ascertain the maintenance type or timing applied to each bridge in the past. Therefore, to minimize bias, only bridges whose condition rating declined or stayed steady over the analysis period were included in the analysis.

Tables 5.3 and 5.4 present the results of the bridge OW impacts analysis. The results suggest that with the exception for I-465, the mean NBI bridge showed no statistically significant change because of the law. This result is consistent across all the bridges analyzed, and across the different deck and superstructure type categories.

5.4 Safety and Mobility Impacts of OW Operations at Permitted Routes During the Interim Period

5.4.1 Expected Trends

In addition to exacerbating infrastructure deterioration at permitted routes, OW operations could have adverse effects on safety and mobility performance at these routes. Several factors affect highway safety, as overweight/oversize vehicles might be contributing significantly to the number and severity of crashes (Prozzi et al., 2012). Due to the weight, and thus increased momentum and energy associated with OW trucks, occupants are generally more vulnerable when an OW vehicle experiences a crash than they would be in a similarly sized, normal weight vehicle.

TABLE 5.3
Average bridge damage due to OW operations at permitted routes by deck type

Road Section	Bridge Age	Deck Material Type	Mean NBI Rating		T-Statistic (P-Value)
			Before	After	
I-465	Older	Concrete Cast-in-Place	6.558	6.356	-2.196 (0.0288)
	Newer	Concrete Cast-in-Place	7.379	8.091	4.915 (0.000)
I-70	Older	Concrete Cast-in-Place	6.576	6.51	-1.1935 (0.233)
	Newer	Concrete Cast-in-Place	7.641	7.654	0.0785 (0.937)
US-50	Older	Concrete Cast-in-Place	6.696	6.577	-0.829 (0.408)
		Concrete Precast Panels	7	7	N/A
	Newer	Concrete Cast-in-Place	8.333	8.25	-0.182 (0.858)
US-150	Older	Concrete Cast-in-Place	6.321	6.265	-0.375 (0.708)
		Concrete Precast Panels	7	7	N/A
	Newer	Concrete Cast-in-Place	7.333	7.167	-0.707 (0.493)
US-231	Older	Concrete Cast-in-Place	6.472	6.431	-0.428 (0.669)
	Newer	Concrete Cast-in-Place	7.389	7.167	-1.034 (0.311)

TABLE 5.4
Average bridge damage due to OW operations at permitted routes by superstructure type

Road Section	Bridge Age	Superstructure Material	Mean NBI Rating		T-Statistic(P-Value)
			Before	After	
I-465	Older	Concrete	5.566	5.3	-1.574 (0.122)
		Steel	6.629	6.452	-1.783 (0.0759)
		Prestressed Concrete	7.192	6.937	-1.624 (0.1127)
	Newer	Prestressed Concrete	7.378	8.091	4.915 (0.000)
I-70	Older	Concrete	6.224	6.11	-1.2159 (0.225)
		Steel	6.646	6.565	-1.210 (0.226)
		Prestressed Concrete	7.172	7.208	0.211 (0.833)
	Newer	Steel	7.666	7.571	-0.356 (0.7233)
		Prestressed Concrete	7.611	7.75	0.788 (0.437)
US-50	Older	Concrete	6.277	6.166	-0.711 (0.483)
		Steel	6.833	6.583	-1.042 (0.302)
		Prestressed Concrete	6.833	6.888	0.259 (0.797)
	Newer	Prestressed Concrete	8.333	8.25	-0.182 (0.858)
US-150	Older	Concrete	6.261	6.286	0.1381 (0.891)
		Steel	6.143	6.071	-0.254 (0.801)
		Prestressed Concrete	6.917	6.75	-0.907 (0.384)
	Newer	Prestressed Concrete	7.143	7.167	0.108 (0.915)
US-231	Older	Concrete	6.268	6.115	-1.115 (0.269)
		Steel	6.467	6.6	0.632 (0.534)
		Prestressed Concrete	6.727	6.727	–
	Newer	Prestressed Concrete	7.083	7	-1 (0.338)

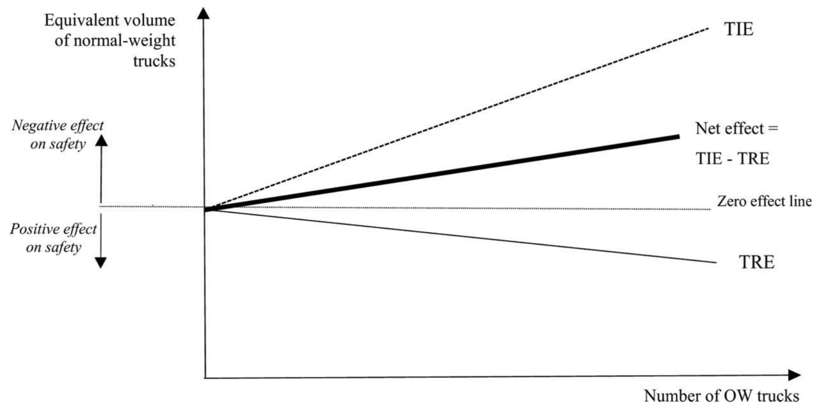


Figure 5.12 Conceptual TRE-TIE relationship and effect on traffic safety and mobility

On aggregate, however, OW trucks' impact on safety and mobility can be a net positive or net negative depending on the prevailing circumstances. This is because OW vehicles can cause traffic impairment due to their limited acceleration, deceleration, and general maneuverability. As a result, other drivers need to keep a larger distance between themselves and the OW vehicle. Consequently, one OW vehicle may have the traffic operational characteristic of several normal weight vehicles. This is called the traffic impairment effect (TIE) and results in a negative impact on safety. On the other hand, because OW vehicles carry the weight equivalent of more than one normal weight vehicle, the aggregate effect is that fewer normal weight vehicles are required to transport the same amount of goods. As a result, an OW vehicle can be thought of as having the traffic volume characteristic of several normal weight vehicles. For example, if OW vehicles are loaded to 30% more than normal weight vehicles, it means 30% fewer vehicles are required to transport the same amount of goods. This is called the trip reduction effect (TRE) and results in a positive impact on safety and mobility. Since TIE and TRE have competing effects on traffic safety and mobility, the net effect is the difference between these two effects. A schematic illustration of these effects is presented in Figure 5.12 (Everett et al., 2014). Appendix G presents calculation details for a case example involving TIE and TRE, and the net effect.

The analysis for baseline safety performance impacts of OW vehicles at permitted routes was conducted and documented in Everett et al. (2014). The present study does not seek to recreate the 2014 analysis, but rather assess the changes in the established safety performance in response to the permit fees implemented under the new law. This assessment is necessary because it is anticipated that the change in permit fees will have an impact on OW traffic demand, and consequently, volume. Although this is not evident from the available data, it can be expected that over a longer analysis horizon, the price elasticity of demand will be negative. This is consistent with established results in literature. The price elasticity of demand for freight transportation has been shown to range from -0.75 to -2.5 (Abdelwahab, 1998). Therefore, it can be expected that over a longer period, the change in permit fees will result in a change in safety and mobility performance on permitted routes. This change can be estimated for a given period by considering the price elasticity of demand function. In Appendix H, we present the elasticity equations for calculating the change in safety performance at a given price elasticity for the change in permit fee implemented in the new law. The results of this analysis are presented in Figure 5.13. Because the exact price elasticity of demand for OW freight transportation operations is determined by several factors including economic outlook, political climate, etc., the present study analyses a range of values for the elasticity. Consequently, we can infer that the safety performance at permitted routes can be expected to improve by between 2%–10% for urban arterials, and between 2%–6% for rural freeways with this change in permit fee.

A similar methodology is employed to assess changes in traffic mobility on the permitted routes because of the changes in permit fees due to the new law. The results are presented in Figures 5.13 and 5.14. Like safety performance, one can observe improvements in mobility for both rural highways and urban arterials. For rural highways, expected mobility improvements range from approximately 2%–30%, while urban arterials improve from 2% to approximately 18%. The exact net improvements in safety and mobility depend on the elasticity value. The elasticity value can be determined as average values from the literature or may be developed by collecting data and applying established methodologies.

5.4.2 Observed Safety Trends Using Crash Data

In addition to the expected trends in safety and mobility performance at permitted routes as presented in Section 5.3.1 of this report, the research team also analyzed crash rate data for the permitted routes to investigate whether the legislation had any impacts on crashes. For each of the permitted

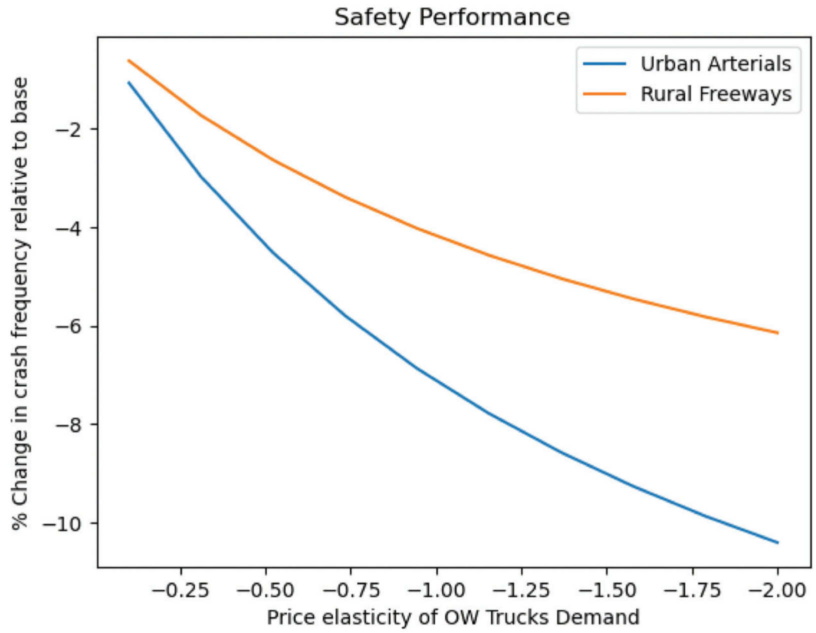


Figure 5.13 Safety performance at permitted routes for a given change in permit fee.

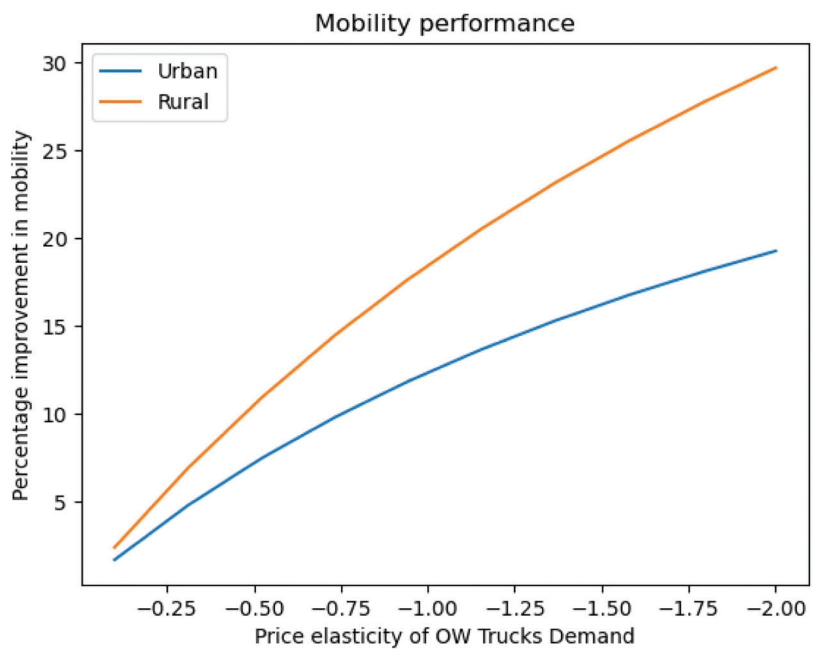


Figure 5.14 Changes in mobility performance at sections of frequent OW permitting.

sections, crash rates were obtained for different types of crashes and the mean crash rates were compared for the period before the implementation date of the law, and after.

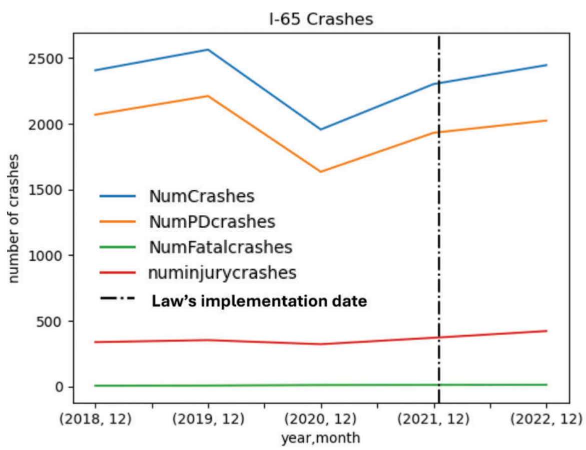
In an earlier part of this section, Figure 5.11 presented the route sections used in the analysis. Figure 5.15 presents the results of the analysis. Throughout the analysis period, the crash charts suggest a consistent trend: there was no significant safety reduction due to the law. There was a general decline in crash numbers in 2020, but this can largely be attributed to the COVID-19 pandemic and the consequent reduction in traffic volumes. Following the waning of the pandemic, the crash counts appear to increase accordingly, reverting to pre-pandemic levels by the end of 2022.

Crash counts are used instead of crash rates because it was assumed that traffic volumes were stable in the years just before and just after the interim period (emergency rules). The results of a statistical *t* test that compared the mean crashes for the period before and after the emergency rules at the permitted routes, suggest that there was no significant increase in the counts of each of the crash categories (PDO crashes, injury crashes, fatal crashes, and total crashes) after the new legislation, at ninety-five percent (95%) confidence level. Therefore, it can be concluded that, based on the available data, there is no evidence of any significant effect of the legislation on safety performance at the permitted routes.

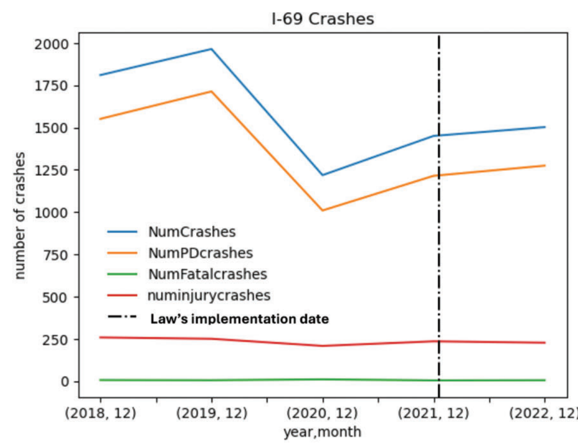
5.5 Chapter Summary

This chapter presented an analysis of the infrastructure condition, safety, and mobility at the most sought OW permit routes, in the interim period. The law was implemented on January 1st, 2022, and the analysis is conducted using permit data from April 2021 through March 2023. The analysis examined trends in OW permitting during this period. The results showed that the total number of permits issued was trending downwards before the implementation of the new law. However, following the law's implementation date, the number of permits issued started to trend upwards. Such reversal of the trend could be attributed to the new law's provision of an expanded list of commodities that could be categorized as divisible OW loads. On the other hand, the trend of the average OW truck weight and average ESALs appear to continue to decline. This bodes well for infrastructure protection because reducing the number of ESALs generated per truck implies a reduction in pavement damage inflicted.

An analysis of the pavement consumption of OW operations is also presented in this chapter. This analysis is done for U.S. routes as these routes displayed a marked difference in the amount of OW loading their experience but were nearly identical in most other aspects. This allowed for the observed differences in pavement condition to be attributed mostly to OW loading. The bridge analysis results suggest that there was generally no significant reduction in bridge deck or superstructure condition due to the OW truck operations within the analysis period. The analysis of safety and mobility yield results that suggest that there was generally no reduction in safety or exacerbation of mobility in the period after the new law.



Permitted sections of I-65



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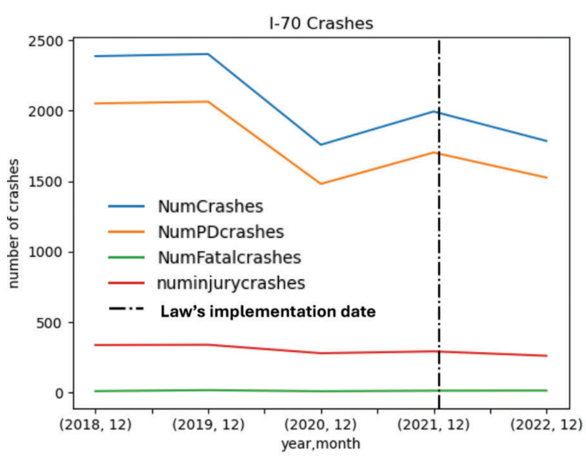

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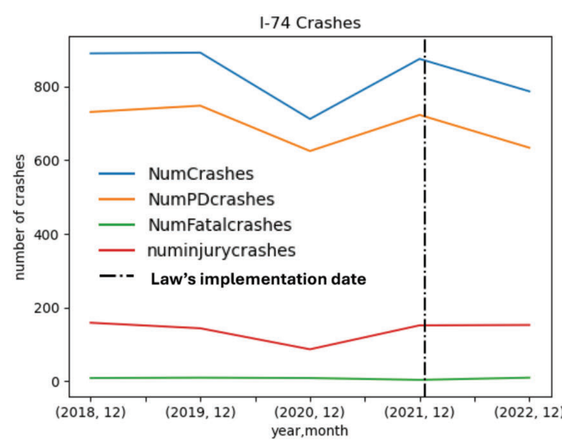
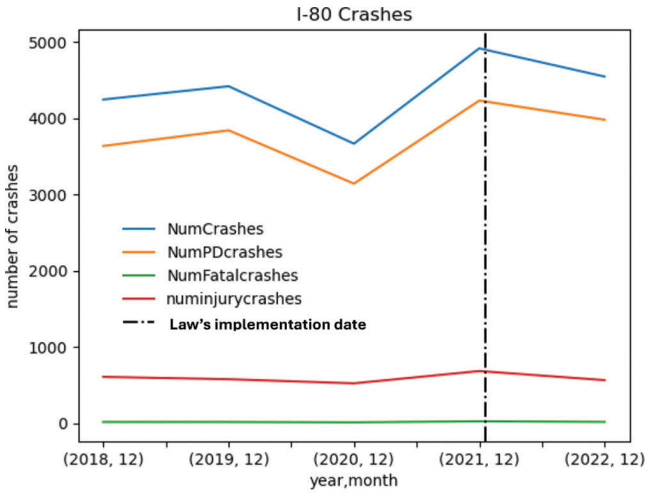


Permitted sections of I-74

Figure 5.15 Continued.



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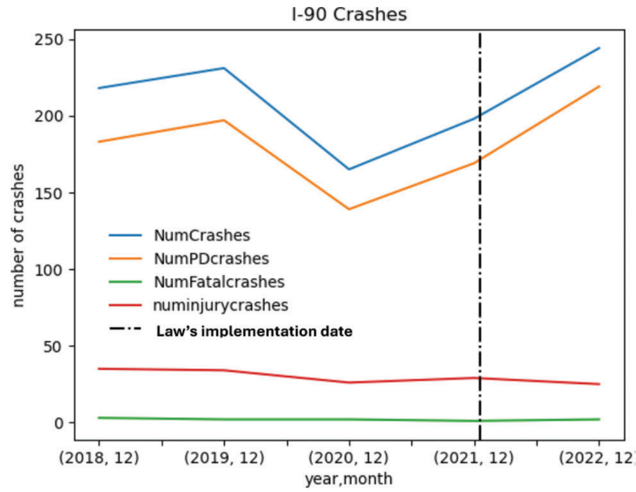

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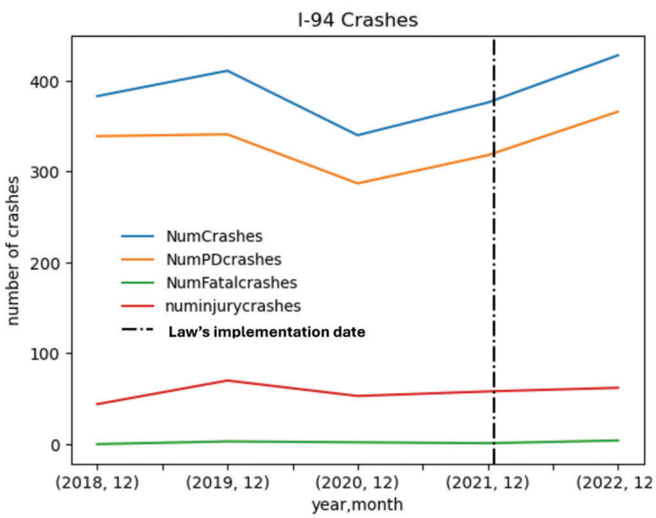

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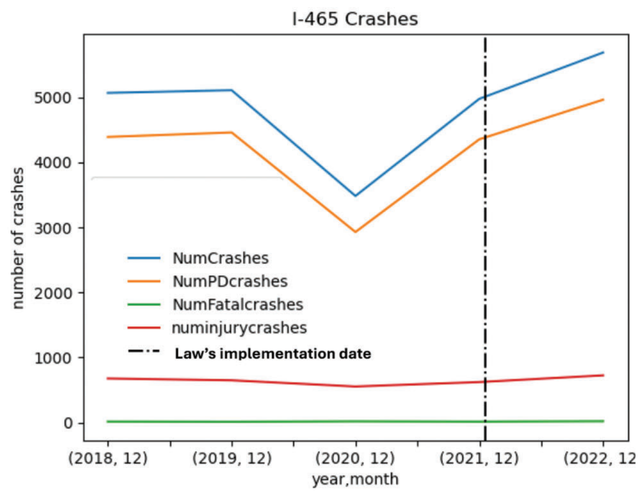

Permitted sections of I-465

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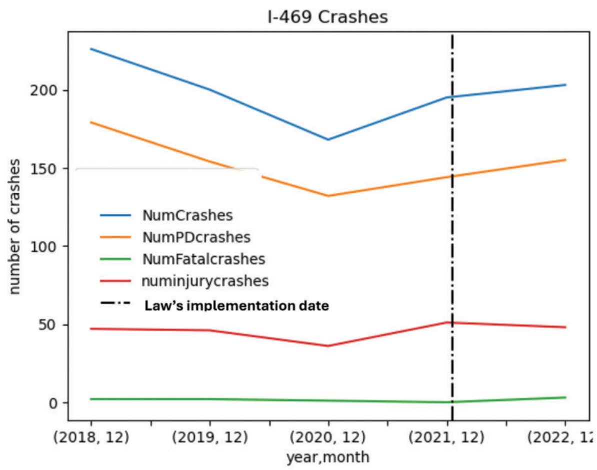
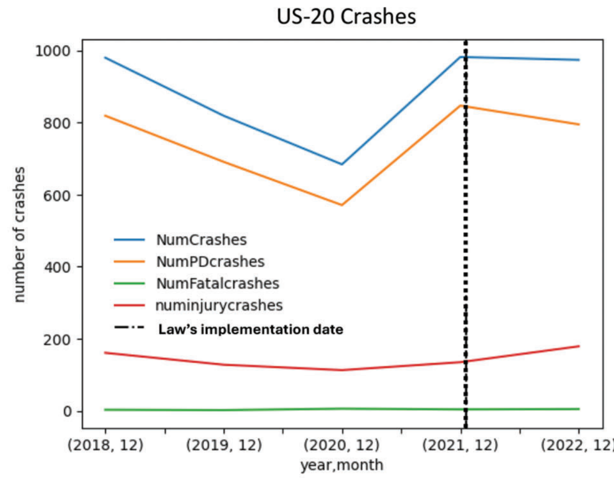
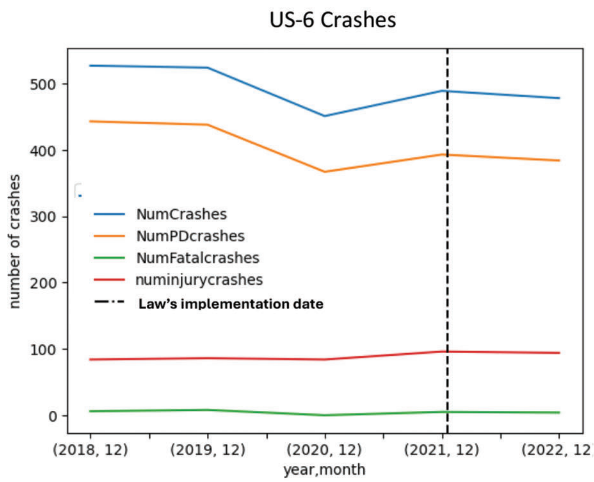


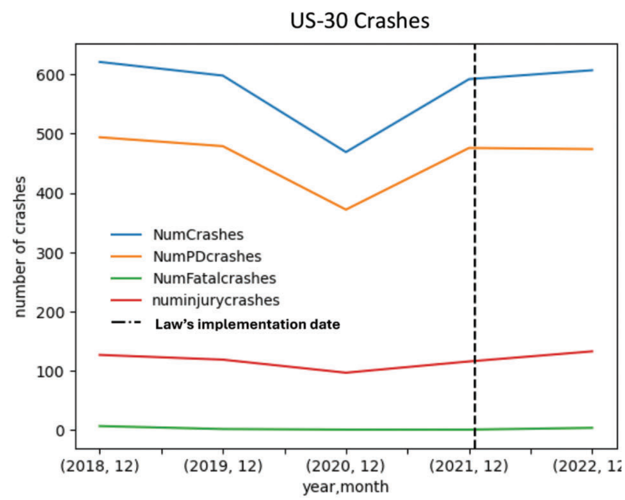
Permitted sections of I-469



Permitted sections of US-20

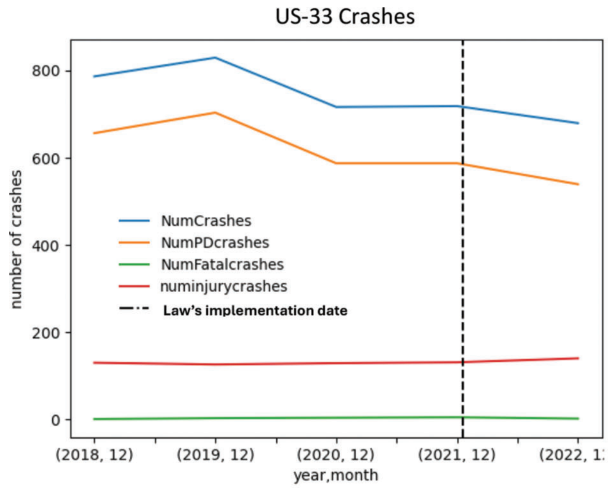


Permitted sections of US-6

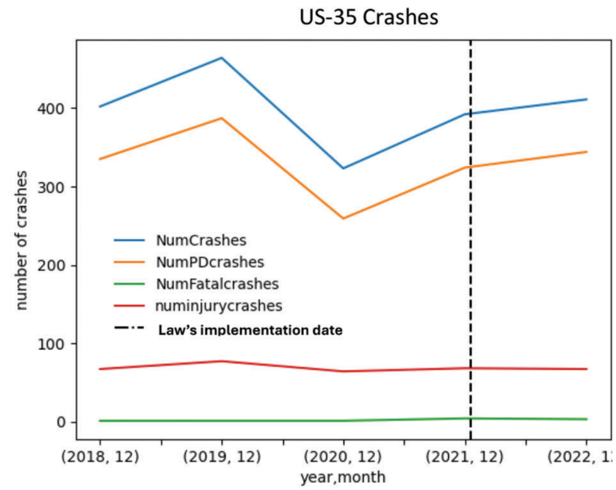


Permitted sections of US-30

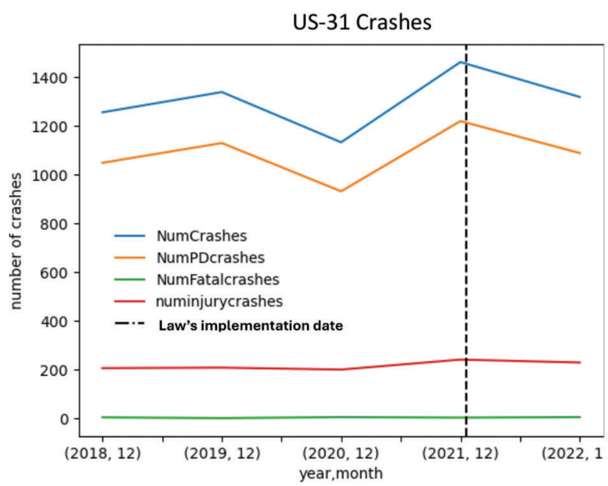
Figure 5.15 Continued.



Permitted sections of US-33



Permitted sections of US-35



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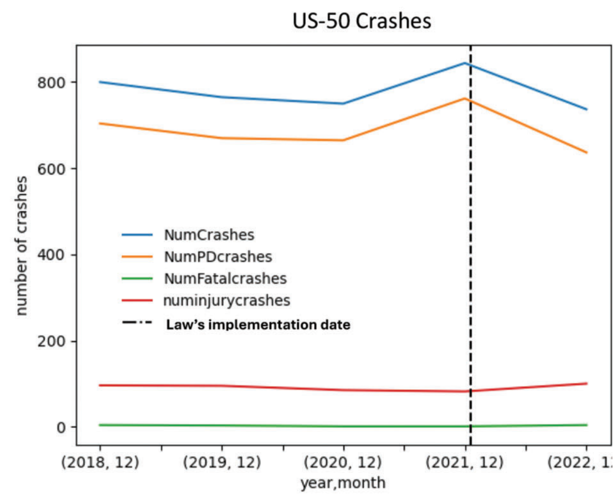
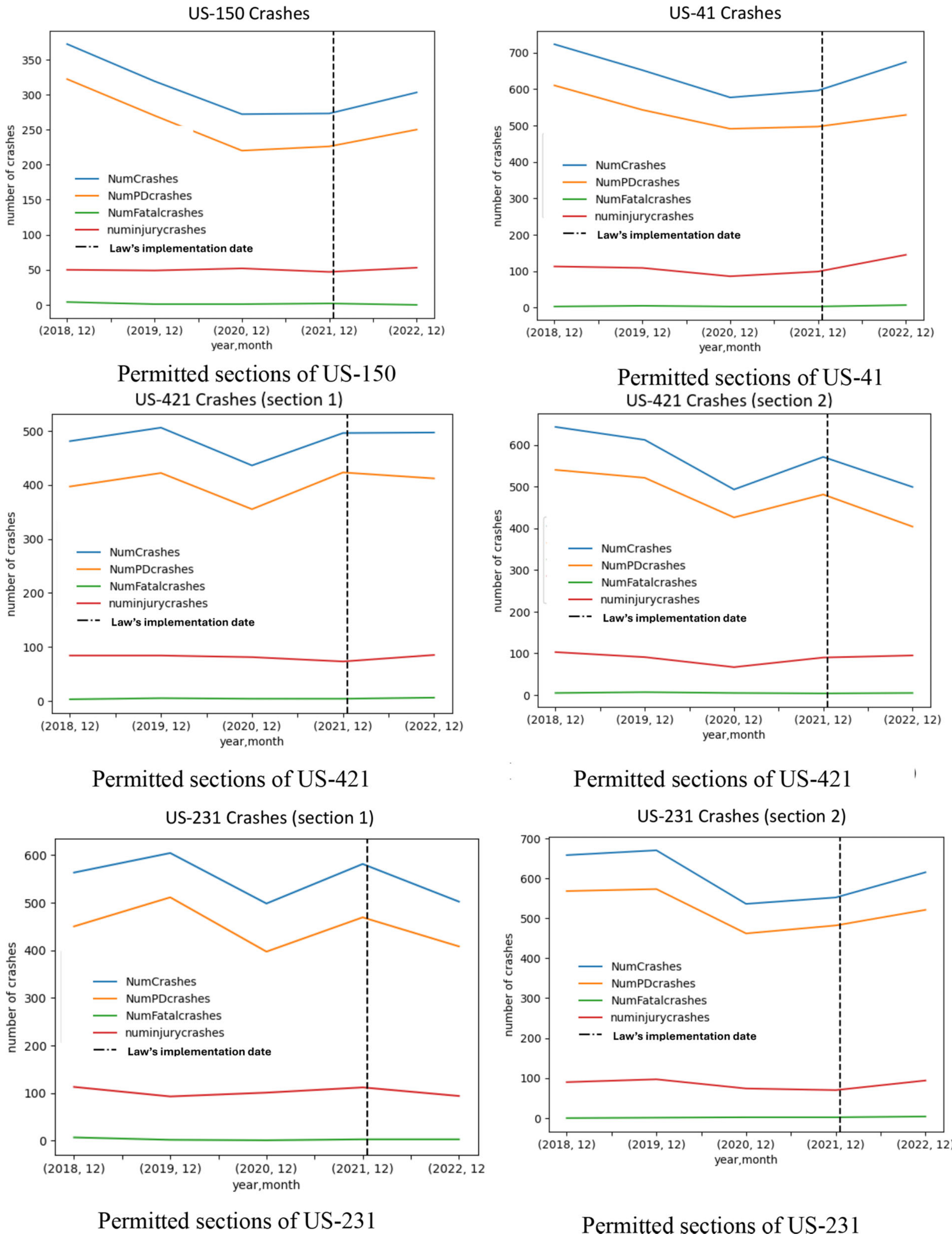


Permitted sections of US-50

Figure 5.15 Continued.



Permitted sections of US-150

Permitted sections of US-41

Permitted sections of US-421

Permitted sections of US-421

Permitted sections of US-231

Permitted sections of US-231

Figure 5.15 Observed crash rates at sections of frequent OW permitting.

CHAPTER 6. ASSESSING THE NEED TO REVISE THE FEE STRUCTURE TO INCENTIVIZE INFRASTRUCTURE-PROTECTING USER BEHAVIOR

6.1 The Current Fee Structure

Federal law, since 1982, requires states to allow GVWs of 80,000 lbs. on interstate highway systems and other designated highways. Each state has its own fee structure, wherein the upper thresholds for loads and other contributing factors are defined in a structure which is more favorable to OW trucks. A vehicle carrying a load over 80,000 lbs. is usually termed as OW in Indiana and charged an OW permit fee. The fee is meant to recover part, or all the excess wear and tear caused to the infrastructure by OW vehicles. The permit fee obtained is mostly transferred to INDOT and only a small portion is retained by DOR. The collected fees are distributed to the State Highway Fund which finances state and local road improvements and maintenance.

Superload, a sub-class of OW loads, has definitions that vary across the states. In Indiana, a superload is a load exceeding 120,000 lbs. Upper thresholds vary with respect to each state and Figure 2.3 shows the variation among Midwestern states. Permit fee structures vary by state, including flat fee structures and progressive structures. Flat fee structures levy a fixed fee per mile, usually stratified into weight brackets. For example, the fee may be $0.20 per mile for OW loads below 100,000 lbs., $0.30 per mile for loads exceeding 100,000 lbs. but below 120,000 lbs., and so on. For progressive structures, the fee is charged per ESAL per mile. This fee structure encourages wider distribution of loads so that the fewest ESALs are generated for each load. Indiana utilizes both flat and progressive fee structures for various contexts. For non-divisible loads, flat fee structures are used while divisible loads are charged on a progressive scheme. This is in part to incentivize carriers to distribute loads whenever possible to generate fewer ESALs and reduce their consumption of the infrastructure. Furthermore, Indiana offers an ESAL credit of 2.40 for each OW load, and therefore carriers are only charged on ESALs generated more than 2.40. An example of a fee structure used by INDOT is presented in Figure 6.1.

In a bid to remain competitive with other states while ensuring the integrity of Indiana's highway infrastructure, HEA 1190-2021 implemented some key revisions to the OW permit fee structure. Among the changes was the removal of the list of commodities and the specific weight limitations for certain commodities from the definition of "overweight divisible load." This expanded the list of commodities that could be counted under this category. Furthermore, the law limited the total number of single permits that can be issued annually, providing that "not more than 8,500 single trip permits may be issued annually for applicants with a total equivalent single axle load calculation of more than 2.40 ESAL credit." These imposed limits would apply only to permits issued after January 1st, 2022. Permits issued before this date would not be affected by this restriction as they are considered as being "grandfathered in." The law also empowered INDOT with the authority to "limit the number of OW divisible load permits issued to an individual applicant." This requires INDOT to adopt rules due to a "lack of transportation options for certain resources, supply chain interruptions, or supply dock backlogs." Additionally, the department is also empowered to "temporarily increase the number of OW divisible load permits issued by order of the commissioner in response to an emergency or changes in market conditions."

HEA 1190-2021 required INDOT to adopt emergency rules and fee structure for the interim period and "issue a report to the legislative council and the interim study committee on roads and transportation regarding the fee structure of OW divisible load permits, and regarding the impact of OW divisible loads on roads and highways by July 1, 2023." Furthermore, the law provided that "[INDOT] shall issue an annual report to the legislative council and the interim study committee on roads and transportation regarding market fluctuation in the number of OW divisible load permits issued during the previous year." These reports, along with information provided by other state entities will help to determine the final "permanent" fee structure. The fee structure timeline is illustrated in Figure 6.2.

This report analyzes trends in permits issued as well as the impacts of the interim fee structure on the demand for OW operations in the state, the infrastructure consumption due to OW operations, and their impacts on safety and mobility at permitted routes. These analyses help to assess the need to revise the permit fee structure, and the recommendations necessary thereof, to adopt a permanent fee structure. Subsequent sections of this chapter present the results of these analyses as it pertains to INDOT's revenues and impacts on carriers.

6.2 Aggregate Trends Using 2017–2019 Data

A brief discussion of the trends in OW permits in the interim period was presented earlier in Chapter 5 of this report (refer to Figures 5.1, 5.2, and 5.3 in Chapter 5, for illustration). Figure 5.1 shows that the number of OW permits issued does not change significantly because of the interim fee, although the trend shows it increasing. The average shipment weight and average ESAL per shipment (Figures 5.2 and 5.3) show a downward trend. While this is positive from an infrastructure consumption standpoint, it cannot be attributed to the change in permit structure. The increased permit fee did not appear to have any significant impact on these metrics. The average weight and ESAL were already trending downward before the interim fee structure was implemented, and this trend did not accelerate following the 2022 fee implementation. To gain further insight on the impacts of the new fee structure, the research team analyzed the variation

Overweight Permit Fees

The cost of a permit can vary depending on many factors. The exact cost is calculated by the permitting system and may be different than the amount shown below.

Type of Vehicle/Permit	Single Trip Permit Fee	Annual Permit Fee	Fees for Bridge Review (If Required)
Overweight, GVW between 80,000 lbs. and 108,000 lbs.	$20 + $0.35 per mile		$35 bridge review fee
Overweight, GVW between 108,000 lbs. and 134,000 lbs.	$20 + $0.60 per mile		$35 bridge review fee
Overweight, GVW between 134,000 lbs. and 150,000 lbs.	$20 + $0.60 per mile		$35 bridge review fee $10 per bridge crossed on permitted route, not to exceed $200 (for round-trip permits, $10 per unique bridge crossed, not to exceed $400)
Overweight, GVW between 150,000 lbs. and 200,000 lbs.	$20 + $1 per mile		$35 bridge review fee $10 per bridge crossed on permitted route, not to exceed $200 (for round-trip permits, $10 per unique bridge crossed, not to exceed $400)
Overweight, GVW greater than 200,000 lbs.	$20 + $1 per mile		***Bridge review required for all vehicles 200,000 lbs. or more GVW.*** $35 bridge review fee $10 per bridge crossed per 30-day preauthorization $10 per bridge crossed per permit, if not ordered from a valid preauthorization
Overweight divisible load (metal, ag, wood), ESAL 2.4 or less		$20	
Overweight divisible load, ESAL greater than 2.4	$20 + $0.07 ($0.25 effective Jan. 1, 2022) per mile per ESAL in excess of 2.4		
Special Weight/Michigan Trail Permit	$42.50 per day + $25 annual registration fee		

10/22/2021

Figure 6.1 A summary of Indiana's OW permit fee structure (INDOT, 2021).

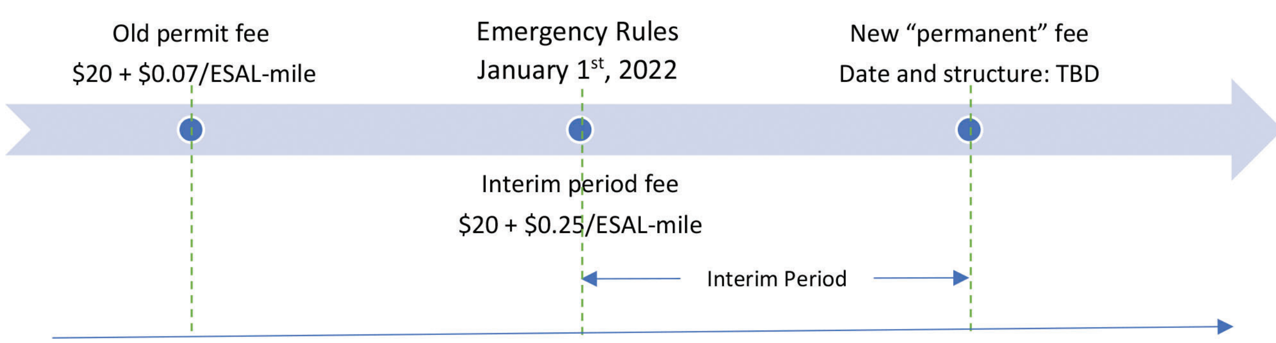


Figure 6.2 A timeline of Indiana's OW permit fee structures.

in the permit fees paid under the various fee structures, and how this would change if carriers added an additional axle to their trucks. This analysis was based on average ESALs and distances and utilized available data for the years 2017 through 2019. These analyses were conducted as part of the dashboard developed during the study, and a few illustrations from the dashboard are presented as figures in this section.

Figure 6.3 presents an illustration from the dashboard showing the variation in the permit fees paid by

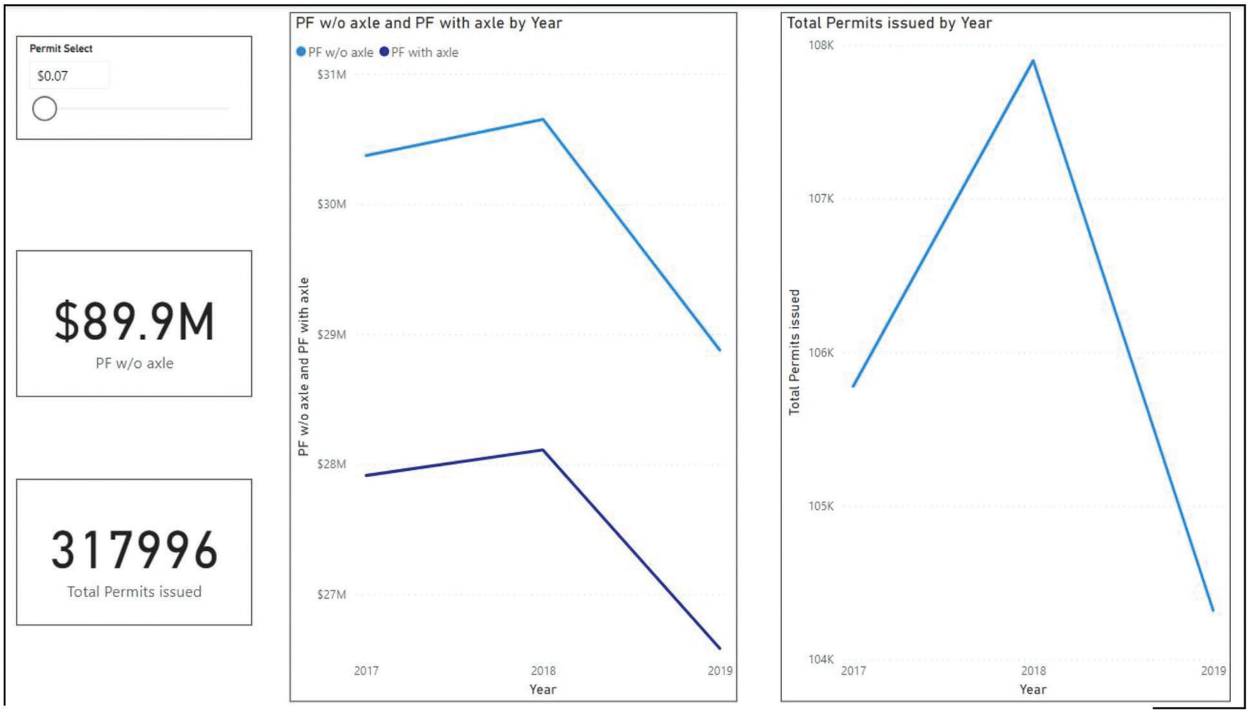


Figure 6.3 Dashboard visuals for permit fee with and without axle and fee issue trend: aggregate network-level analysis.

the carriers in the 3 years analyzed. Because the analysis is based on average ESALs, the total fees paid are proportional to the number of permits issued each year. Since the change in permit fee did not result in a significant change in user behavior as evidenced by the trends in the permits issued (Figures 5.1 through 5.3), the research team considered other ways in which carriers do lower their infrastructure consumption. One such option would be axle addition. Although this option would reduce overall ESALs, and consequently lower infrastructure consumption, it would also lower the permit fees paid and therefore reduce INDOT's revenues. The reduction in permit fees paid is illustrated in Figure 6.3 for the years considered. Results show that if carriers added an additional axle to their trucks, this would on average result in a 7% decline in the permit fees paid. The dashboard submitted as part of this report allows the user to vary the permit fee and the visuals adjust to show the resulting impact of the change. This visual presented here corresponds to a permit fee of $0.07 per ESAL-mile. A different permit fee would likely yield different results on the permit fees paid with and without axle addition. The reader is encouraged to consult the dashboard for more detailed visuals.

For the 2017, 2018, and 2019 years of operation, the load carried by the trucks operating on Indiana roads according to the operating ESAL range were visualized to identify critical ESAL ranges that have the most impact on the bridges and pavements. A network-level analysis, as shown in Figure 6.4, shows the various metrics by ESAL range. Based on the analysis, it can be observed that trucks with ESAL between 8.4 and 9.4 hauled more than 50% of the total weight moved across Indiana roads in freight in 2017, 2018, and 2019. The most common ESAL observed was 9.139. This means that the majority of trucks haul OW operations with a very high ESAL value (raw average, unweighted), which can be associated with high pavement damage. This analysis helps determine the appropriate modifications that would be necessary and helpful to the permit fee structure in terms of increased penalties for these ESAL ranges.

6.3 Comparison of Fuel Tax and Permit Fees with Pavement Damage

It can be argued that the practice inclusion of permit fees penalizes carriers twice for the same operation, given that they already pay for the infrastructure consumption with the additional fuel tax incurred because extra weight means extra fuel consumed and thus, extra fuel tax revenue compared with a normal weight truck. While it is true that OW vehicles consume more fuel than their normal-weight counterparts and thus generate more fuel tax revenues, the reality is that this additional revenue is far from sufficient in covering the OW-induced infrastructure consumption caused by the OW operations.

This section presents a comparison of the additional fuel tax revenue contributed due to OW loading and the infrastructure consumption incurred due to OW loading. The analysis is conducted for a FHWA class 8 semi-truck (the most common truck used for OW operations on Indiana highways). Furthermore, the analysis is carried out separately for interstates and non-interstate highways on the NHS.

Figure 6.4 Examination of OW truck operations (2017–2019) impact using the dashboard.

In this analysis, the fuel tax revenue under consideration is that obtained solely because of OW loading, specifically, only the fuel consumed due to hauling loads over 80,000 lbs. To estimate the fuel tax (and hence, the fuel tax revenue), the fuel efficiency of the OW truck is estimated using the Capps model (Capps et al., 2008) and the British Transport Advisory Committee (BTAC) models (Coyle, 2007). These models are presented as Equations 6.1 and 6.2, respectively.

$$FE(w) = (-4.77 \times 10^{-10})w^2 + (8.0 \times 10^{-6}) + 9.6687 \quad \text{(Eq. 6.1)}$$

$$FE(w) = 6.1 - 0.144\left(\frac{w - 96{,}000}{2{,}204.62}\right) \quad \text{(Eq. 6.2)}$$

The Capps model can be used to reliably estimate the fuel efficiency of a truck having GVW up to 96,000 lbs. while the BTAC model can be used for vehicles having GVW between 96,000 lbs. and 150,000 lbs. For GVW over 150,000 lbs., a minimum fuel efficiency of 2.5 MPG is assumed. The extent of a truck's OW loading is represented as average percentage extra weight (APEW). This refers to the weight excess above the legal limit expressed as a percentage of the legal limit. For example, for a truck with 100,000 lbs. GVW, the excess weight above the legal weight limit is 20,000 lbs., and therefore, its APEW is = 20,000 lbs./80,000 lbs., or 25%.

Using the fuel efficiency estimates obtained using Equations 6.1 and 6.2, and a fuel tax rate of $0.57 per gallon for diesel fuel (Indiana Legislative Services Agency Office of Fiscal and Management Analysis, 2023), the fuel revenues (fuel taxes contributed) at various APEWs is presented in Figure 6.5. As stated earlier in this section, this fuel tax accounts only for the excess or OW portion of the load. Therefore, a truck weighing 80,000 lbs. has an APEW of 0% and therefore does not contribute to the additional OW fuel tax revenue. Figure 6.5 also shows the pavement damage cost resulting from the OW operations. For interstates, the average marginal pavement damage cost is $0.006/ESAL-mile while NIS-NHS routes have a marginal PDC of $0.055/ESAL-mile (Ahmed, Agbelie, et al., 2013).

Figure 6.5 presents the fuel tax revenue contributed, and the pavement damage cost associated with various loading levels (APEW) at interstate highways. Also, Figure 6.6 presents the overall revenue obtained (from fuel tax and permit fee) and the pavement damage cost associated with various loading levels (APEW) at interstate highways. It can be observed that the damage incurred exceeds the revenues obtained from the fuel taxes and the deficit grows with increasing APEW. This result suggests that it is beneficial to furtherevaluate the existing OW permit fee to ascertain whether it covers the additional damage incurred. When the permit fees are applied at the rate proposed in HEA 1190-2021 ($0.25/ESAL-mile with a 2.4 ESAL credit), the results are presented in the figure. At first glance, these results seem to suggest that the revenues obtained from permit fees and fuel taxes exceed the overall infrastructure damage cost. However, this interpretation may be misleading as there are other factors at play. First, the damage cost considered here does not include other assets (bridge damage). As demonstrated in the litera-

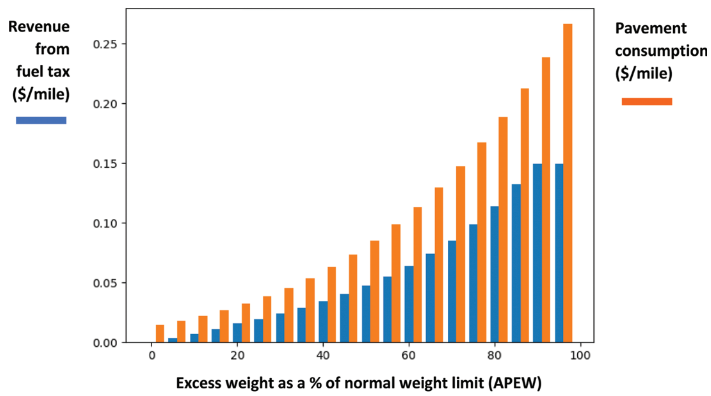


Figure 6.5 Comparison: fuel-tax revenue due to excess load vs. pavement damage consumption due to excess load.

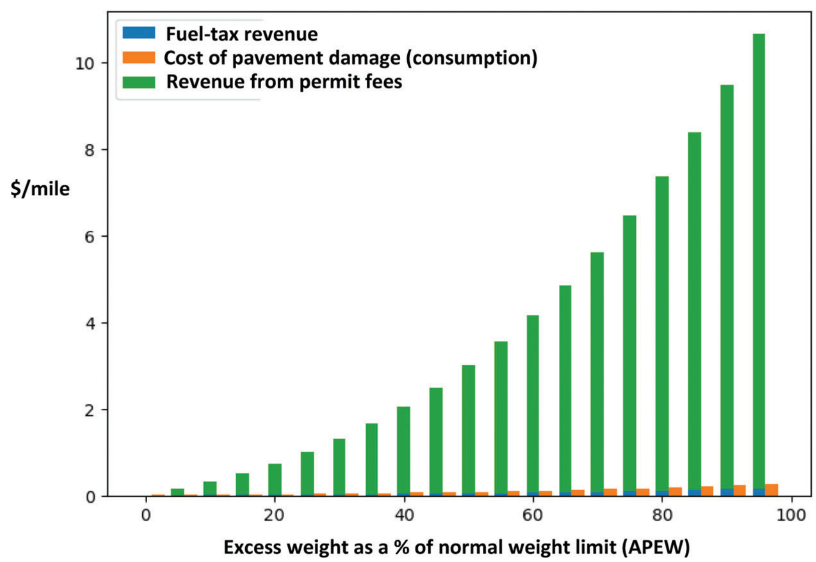


Figure 6.6 Comparison of interstate routes: fuel-tax revenue due to excess load vs. pavement damage consumption due to excess load vs. permit-free revenue due to excess load.

ture, bridges suffer much more damage to OW loads compared to pavements. Second, the interstate routes experience approximately eight times as much traffic as NIS-NHS routes. Due to the higher volume of traffic on interstate routes, the interstate pavement damage cost is spread out over a larger user base. Further, the lower unit cost of interstate pavement consumption could be attributed to the effect of "vertical" scale economies (considering the thicker pavements of interstates and the engineering relationship between loading and pavement thickness). Regarding Figure 6.6, the results show far excess of costs over the fuel-tax revenues.

Similarly, Figure 6.7 compares the pavement damage cost with the fuel-tax revenue at different load levels, and Figure 6.8 compares pavement damage cost with the aggregate of fuel tax revenue and permit fee revenues for non-interstate NHS routes. Without the economies of scale associated with high traffic volumes like those on interstate routes, it becomes evident that the revenues obtained from fuel taxes as result of OW loading, along with the applicable permit fees are not enough to cover the pavement damage incurred by the same.

6.4 Impact of the Existing Fee Structure on Carriers

This section documents the impact of the existing fee structure on carriers. The current fee structure impacts the freight carriers in various ways. The overweight permit fee structure generates revenue for INDOT. The total revenue to INDOT in terms of the OW trucks operating on Indiana roads, consist of the following.

- Direct cost: base permit fee.
- Indirect cost: fee collected via fuel tax.

Here, only the costs incurred to the carriers that would generate revenue for INDOT are considered and explored. There might be other indirect costs that the carriers might incur that are not explored here.

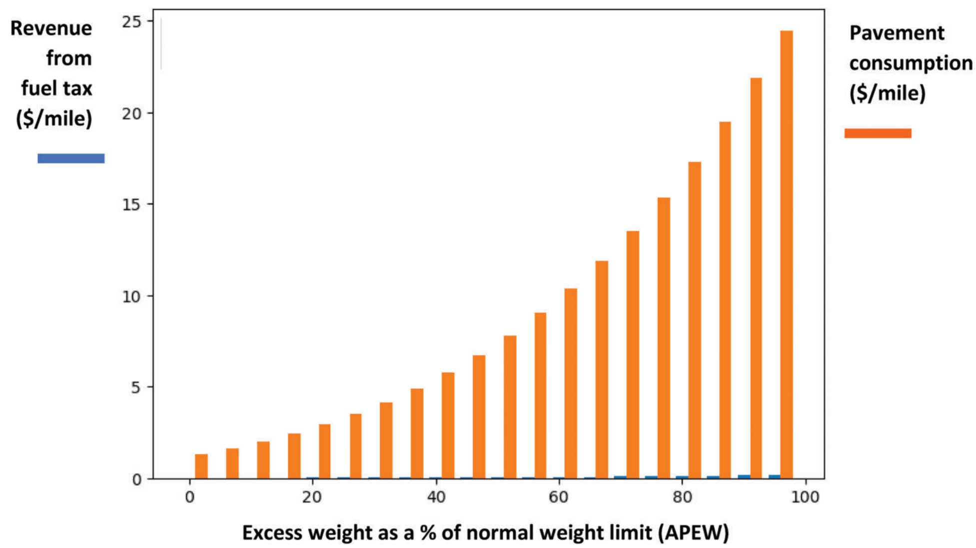


Figure 6.7 Comparison of non-interstate NHS routes: fuel-tax revenue due to excess load vs. pavement damage consumption due to excess load.

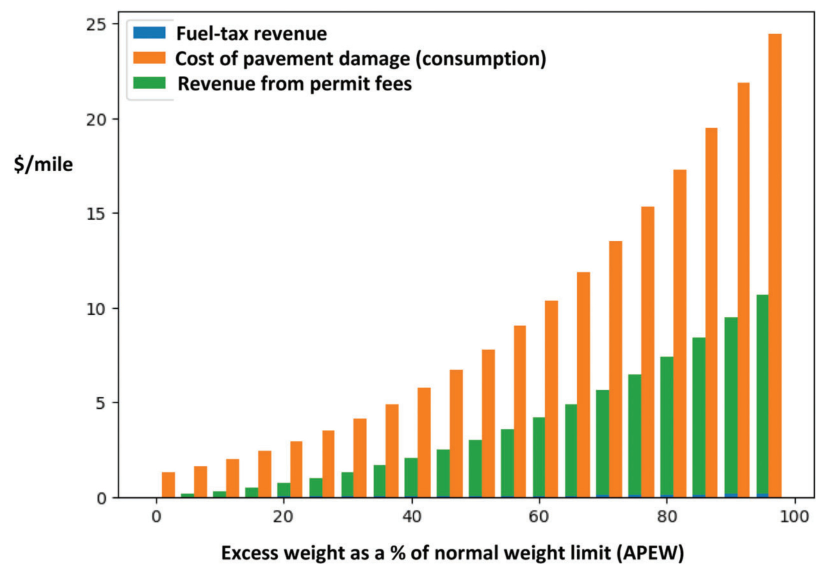


Figure 6.8 Comparison of non-interstate NHS routes: fuel-tax revenue due to excess load vs. pavement damage consumption due to excess load vs. permit-free revenue due to excess load.

6.4.1 Base Permit Fee Based on ESAL Miles

Based on INDOT's current OW permit fee structure, the fees add up when the ESAL value increases more than 2.4, particularly, with multiple trucks in the carrier's fleet. An ESAL value of 2.4 or less can be considered to cause minimal damage to the road infrastructure as that only costs the administrative fee. Based on the analysis, the damage to the road infrastructure increases with ESAL. To incentivize trucks to operate at ESAL values of 2.4 or below, trucks that exceed 2.4 ESALs are charged for every mile ESAL-mile more than 2.4. This extra ESAL is also referred to as "chargeable ESAL."

$$Chargeable\ ESAL = Total\ ESALs - 2.4 \qquad \text{(Eq. 6.3)}$$

Generally, for a permit fee of W per ESAL-mile, and an OW truck of X ESALs that travels Y miles, the permit fee is calculated as:

$$Permit\ fee = Administration\ fee + \$W\ [(Total\ X\ ESALs - 2.4) * Y\ miles] \qquad \text{(Eq. 6.4)}$$

For example:
For an OW truck of 2.9 ESAL that travels 200 miles,

$$Permit\ fee = \$20 + \$0.25\ [(2.9 - 2.4) * 200\ miles] = \$45 \qquad \text{(Eq. 6.5)}$$

To understand the direct impact of existing fee structure on the carriers, a similar calculation was carried out for the 2017, 2018, and 2019 data using old and new permit structures with $0.07 and $0.25 per ESAL mile, respectively. The results are presented in Figure 6.9.

6.4.2 Amount Paid by OW Trucks due to Existing Fuel Taxes

It is important to account for the fact that all carriers, regardless of their vehicle weight or OW status, pay fuel taxes based on the amount of fuel consumed. OW trucks pay an extra amount because they consume more fuel compared to non-OW trucks. The extra fuel they consume can be calculated based on their higher fuel consumption rate (that is, lower fuel efficiency) compared to non-OW trucks. This extra amount, in terms of fuel taxes, paid by OW trucks translate into higher revenue to the agency. For fair accounting, it is important to consider this amount as a contribution that is paid by overweight trucks.

INDOT defines any truck as OW if its total weight exceeds 80,000 lbs. Therefore, the fuel efficiency must be determined for the trucks by first calculating the fuel efficiency for vehicles that weigh from 20,000–80,000 lbs. as a baseline and owing to the

Figure 6.9 Network-level comparative analysis of the average permit fee with the old and new permit structures ($0.07 and $0.25/ESAL-mile, respectively), 2017–2019.

trucks operating at over 80,000 lbs., a different model for fuel efficiency must be used. To calculate the fuel consumption, the fuel efficiency (FE1) of the truck is calculated using an equation adopted from the British Transport Advisory Committee (Dey et al., 2014):

$$Fuel\ efficiency\,(FE1) = 6.1 - 0.144 * (W - 96{,}000)/(2{,}204.62) \quad \text{(Eq. 6.6)}$$

Equation 6.5 estimates the fuel efficiency of trucks weighing greater than 96,000 lbs. Here, w is the total vehicle weight in lbs.

For trucks with an average weight of 80,000 lbs., traveling at an average speed of 65 MPH, the Capps method (Dey et al., 2014) can be used to calculate the fuel efficiency (FE2) as follows:

$$Fuel\ efficiency\,(FE2) = (-4.75 * 10^{-10}) * W^2 + (8 * 10^{-6}) * W + 9.6687 \quad \text{(Eq. 6.7)}$$

Here, w is the total vehicle weight in lbs.

The fuel consumption (FC) due to the entire load of a particular truck (FC1) is calculated and the difference between this value and the fuel consumption for an 80,000 lbs. vehicle (FC2) is calculated to obtain the fuel consumption due to the overweight part of the load.

FC1 = Distance traveled/FE1
FC2 = Distance traveled/FE2

Additional fuel consumed that is fuel due to

$$OW\ part\ of\ the\ load = FC1 - FC2 \quad \text{(Eq. 6.8)}$$

The fuel taxes are comprised of two parts: motor carrier fuel tax and surcharge tax. The following formulae are used to compute the total fuel taxes collected and identifying the proportion of the total fuel taxes that account for the overweight part of the load.

$$Total\ fuel\ tax = FC1 * (Diesel\ rate\ per\ gallon + Motor\ carrier\ surcharge\ fee\ per\ gallon) \quad \text{(Eq. 6.9)}$$

$$Total\ fuel\ tax = FC1 * (0.32 + 0.21)$$

[*Note: *Rates correspond to* 2021]

Due to the OW part of the vehicle,

$$MCFT = (Fuel\ consumed\ by\ overweight\ part\ of\ the\ load) * Diesel\ rate \quad \text{(Eq. 6.10)}$$

$$ST = FC2 * Motor\ carrier\ surcharge\ tax\ per\ gallon\ (= 0.21) \quad \text{(Eq. 6.11)}$$

$$Total\ additional\ fuel\ tax\ revenue = Motor\ carrier\ fuel\ tax + Surcharge\ tax \quad \text{(Eq. 6.12)}$$

6.5 Chapter Summary

This chapter provided details of the impact of existing fee structure on the truck carriers. It is evident that truck carriers pay a higher fee in terms of fuel taxes with OW operations. Despite the costs outlined in this chapter, based on the HCA study discussed in Section 6.3, the fees paid by the heavy weight vehicles is less compared to the consumption or the damage that the vehicles cause to the road infrastructure. This analysis allows INDOT to explore all the factors that impact the carriers, thereby ensuring that the steps taken by INDOT are inclusive and towards a growth driven environment in the state, while also generating enough revenue to maintain the road infrastructure in Indiana.

CHAPTER 7. FINANCIAL AND OTHER LEVERS FOR FACILITATING OW PERMITTING AND PROMOTING FREIGHT TRANSPORT COMPETITIVENESS

7.1 Introduction

The present chapter of the report explores financial and other levers that INDOT could use to facilitate OW permitting and therefore, to promote competitiveness of freight transportation operations in the state. The task focused on how permits and other incentives could be leveraged, using several decision factors, to establish a win-win-win outcome for shippers, carriers, and INDOT, thereby resulting in solutions that balance the goals of the various stakeholders.

Ideally, it is desirable to ensure that the permit fee should cover, as much as practicable, the infrastructure consumption (that is, the expenditures on bridge and pavement maintenance, rehabilitation, and reconstruction that arise because of OW-induced damage). However, such cost recovery efforts must be kept within reasonable limits so that the truck companies are not dissuaded from operating on Indiana roads. From a comprehensive review of the literature and various truck-level and network-level analysis carried out as part of this study, the rest of this chapter discusses three initiatives that could help achieve win-win-win situations.

7.2 Differential Permit Fee Across the Road Classes

In the context of this report, a "differential" permit fee across the road classes means having a surcharge for certain road classes. Here, two road classes are considered: interstates and non-interstates. In an earlier chapter of this report (Chapter 6), the study compared the OW permit-fee revenue with the OW-induced pavement damage (consumption) (Figure 6.6), and it was observed that for the same loading regime, the unit damage cost for interstate routes is significantly lower compared to the that for non-interstate routes.

This is in part because interstate pavements are built to higher quality standards relative to non-interstates pavements. Also, interstate routes generally experience eight times as much traffic, on average, as non-interstate routes. This implies that the pavement damage cost for interstates is spread out over a much larger user base and due to scale economies, is relatively smaller compared to non-interstates. Therefore, a surcharge could be added to the permit fees on OW operations at non-interstate highways, to further protect that class of infrastructure. Any such surcharge could be implemented as an increase in the ESAL-mile fee or as a lump sum to annual permits purchased for non-interstate route operations.

7.3 Differential Permit Fee Across the Seasons

In highway design and construction, highway pavement subgrades and subbases often consist of soils that have lower California Bearing Ratios and therefore reduced structural capacity when they experience high moisture regimes such as inundation or saturation. Such moisture regimes are experienced during the spring thawing season when these layers become saturated because of runoff from melting ice and snow. In addition, ice lenses in the subgrades experience volumetric change due to the change in ambient soil temperatures during the thaw process, and the effect of these volumetric changes translate to the pavement surface as cracks. For this reason, the spring thaw season is generally the time when the subgrades and subbases have the least structural integrity. It was observed from the literature review of this study that at least one Midwest state has imposed restrictions on OW operations during this season.

To address this issue, it may be worthwhile to restrict OW operations during this season, and/or imposing a surcharge on OW operations at this time of year. However, before that is done, it is important to establish the appropriate period of restriction and/or determine the appropriate surcharge amount to cover OW damage to pavements currently. The situation is generally more pertinent at non-interstate highways that are designed to relatively lower standard compared to interstates. Thus, any such surcharge fee could be applied to non-interstates only.

7.4 Permit Fee Credits/Discounts

Implementing permit fee surcharge may be a viable financial lever. However, it may not be popular or well received by all stakeholders. Some carriers already feel that permit fees are high enough as they are, and others yet believe that they are paying twice for OW operations since they already pay fuel taxes. Notwithstanding that this argument is somewhat inadequate, especially because the fuel taxes paid by OW trucks are not enough to compensate for the infrastructure consumption, it is still vital any policies implemented by INDOT are well received by stakeholders.

As such, in place of permit fee surcharges, INDOT may consider providing credits or discounts for behaviors that protect infrastructure. For the reasons outlined earlier, it would be beneficial from an infrastructure preservation standpoint to reduce OW operations during the winter months and on non-interstate roads. Therefore, INDOT can provide these incentives for the appropriate behavior. Like the surcharge, the credits or discounts can be applied to either seasonal operations, or interstate operations, or both.

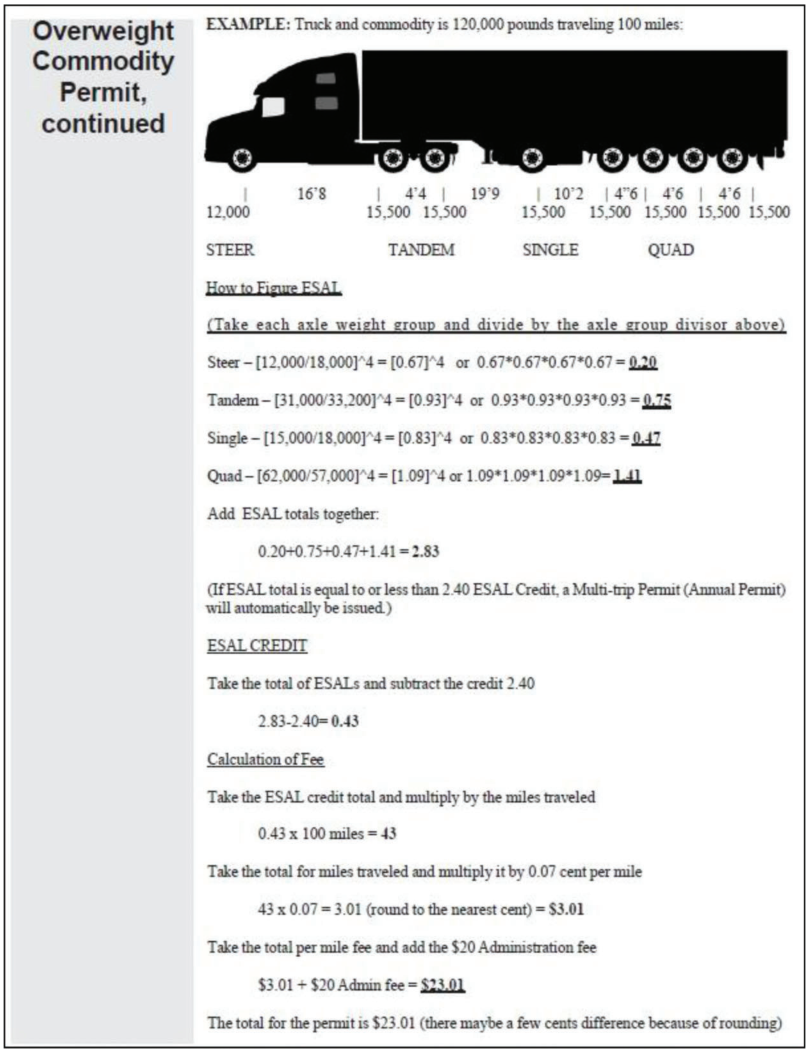
7.5 Permit Fee Discounts for Adding an Axle

The amount of pavement damage resulting from vehicular loading is dependent not only on the gross vehicle weight (GVW) but also on how that weight is distributed. An ESAL is one way of measuring the weight distribution on a vehicle, and consequently the amount of pavement damage caused. For the same GVW, a vehicle with more axles will generate fewer ESALs and therefore cause less severe pavement damage. This is because the weight is being spread out over more axles and therefore exerts less pressure onto the pavement. To incentivize carriers to add extra axles to their trucks, INDOT can provide permit credits or discounts for trucks that add extra axles. Previously, carriers have been reluctant to add axles to their axles, citing cost as the primary factor. However, if INDOT can provide discounts or credits that can help offset this cost, more carriers may be willing to adopt this approach.

Based on the results of the survey conducted for this study (see Chapter 11), most respondents indicated that they would be willing to add an axle to their trucks if financial incentives were provided. Since carriers have indicated a willingness to take this approach, leveraging this gives INDOT a financial lever that is both effective and potentially well received.

CHAPTER 8. DEVELOPMENT OF AN OW PERMIT-FEE CALCULATOR

As part of this project, a permit fee calculator was developed to help prospective seekers of OW permits measure the benefits of adding axles to their trucks, for purposes of OW operations. Indiana uses OW permit fees based on the load carried and the ESAL (see Appendix B). The analysis in previous chapters of this report has shown that the permit fee amount is most sensitive to the ESAL. ESAL computation is carried out based on several considerations including total load, number of axles and axles spacing, and so on. This research study developed a calculator to help stakeholders quickly and easily calculate the ESAL associated with a prospective OW trip.



Overweight Commodity Permit, continued

EXAMPLE: Truck and commodity is 120,000 pounds traveling 100 miles:

| 16'8 | 4'4 | 19'9 | 10'2 | 4"6 | 4'6 | 4'6 |

12,000 15,500 15,500 15,500 15,500 15,500 15,500 15,500

STEER TANDEM SINGLE QUAD

How to Figure ESAL

(Take each axle weight group and divide by the axle group divisor above)

Steer – [12,000/18,000]^4 = [0.67]^4 or 0.67*0.67*0.67*0.67 = 0.20

Tandem – [31,000/33,200]^4 = [0.93]^4 or 0.93*0.93*0.93*0.93 = 0.75

Single – [15,000/18,000]^4 = [0.83]^4 or 0.83*0.83*0.83*0.83 = 0.47

Quad – [62,000/57,000]^4 = [1.09]^4 or 1.09*1.09*1.09*1.09= 1.41

Add ESAL totals together:

0.20+0.75+0.47+1.41 = **2.83**

(If ESAL total is equal to or less than 2.40 ESAL Credit, a Multi-trip Permit (Annual Permit) will automatically be issued.)

ESAL CREDIT

Take the total of ESALs and subtract the credit 2.40

2.83-2.40= **0.43**

Calculation of Fee

Take the ESAL credit total and multiply by the miles traveled

0.43 x 100 miles = **43**

Take the total for miles traveled and multiply it by 0.07 cent per mile

43 x 0.07 = 3.01 (round to the nearest cent) = **$3.01**

Take the total per mile fee and add the $20 Administration fee

$3.01 + $20 Admin fee = **$23.01**

The total for the permit is $23.01 (there maybe a few cents difference because of rounding)

Figure 8.1 Example of calculating ESAL for a sample truck (culled from the INDOT handbook).

8.1 Steps in the ESAL Calculation

This section discusses the steps involved in calculating the ESAL value for trucks based on the formula used by INDOT.

Step 1: Determine the result the first or next single axle weight of the vehicle in pounds (lbs.); divided by 18,000.

Step 2: Determine the result of the Step 1 amount raised to the fourth power.

Step 3: Repeat Step 1 and Step 2 for each additional single axle on the vehicle.

Step 4: Determine the sum of the resulting amounts from Step 2 and Step 3 for all single axles on the vehicle.

Step 5: Determine the result of the first or next tandem axle group weight in pounds (lbs.); divided by 33,200.

Step 6: Determine the result of the Step 5 amount raised to the fourth power.

Step 7: Repeat Step 5 and Step 6 for each additional tandem axle group on the vehicle.

Step 8: Determine the sum of the resulting amounts from Step 6 and Step 7 for all tandem axle groups on the vehicle.

Step 9: Determine the sum of the Step 4 amount and the Step 8 amount.

Axle group divisor is as follows: single axle = 18,000; tandem axle = 33,200; triaxle = 46,000; quad axle = 57,000; quintuple axle = 65,000. (Anything more than a quintuple axle is calculated as a single, tandem or tri.)

The number of equivalent single axle load miles that applies to a trip is the number determined in the following example traveling 100 miles.

8.2 ESAL Calculation Tool

The ESAL calculations for all the trucks were automated using MS Excel. A template was provided to receive raw truck data from INDOT. The ESAL calculator uses a pivot table that is generated from the data. The permit number and fields are used to extract the axle pairs and their classification, and the ESAL is calculated. The axles are classified based on their spacing: single, tandem, tri, quad, and quintuple. If the spacing between any two consecutive axles is less than 60 cm, then the two axles are grouped together (starting from tandem and going up to quintuple based on the number of pairs of consecutive axles having less than 60 cm of spacing between them).

$$= IF\,((D3 > 60),1,0) + IF\,(D3 < 60 \text{ and } E3 = 0,1,0)$$

The template is used for each pair of consecutive axles where D3 refers to the axle spacing and E3 refers to the presence or absence of a subsequent axle. The ESAL ratio for the individual axles is then calculated based on the axle classifications. This dictates the axle group devisor (load denominator) as follows.

$$= IF(AZ3 > 0,0,\ IF(C3 > 0,\ (IF\ (AY3 = 0,\ C3,\ BL3 + C3)/(VLOOKUP(AY3 + 1,' Load\ denominator'!\$A\$1:\ \$B\$6,\ 2,\ FALSE)))^{4,0}))$$

The formula essentially divides the axle load by the load denominator based on the classification of the axle group and raises it to the power of 4. The individual ESAL ratios are then added up to obtain the average ESAL estimate for the truck. With the addition of another axle, the same procedure can be repeated to recalculate the individual ESAL ratios by knowing the position of the new axle. The cell references are based on the contents of the illustration case study provided in the tool.

8.3 Chapter Summary

The automated Excel-based ESAL calculation tool can help stakeholders calculate the OW divisible permit fee for prospective trips. The tool allows INDOT to explore the effects of multiple loading scenarios. INDOT can analyze these trends to make informed decisions to ensure a beneficial permit fee structure. The tool can also help the industry determine how they could optimize load distributions in order to lower their ESAL for a given trip, thereby reducing the permit fee, and reducing the damage caused to the road infrastructure.

CHAPTER 9. DASHBOARD TO CONVERT DATA INTO METRICS

A Power BI dashboard is developed for INDOT to keep track of key performance indicators. The dashboard is developed with the current data shared by INDOT for 2017, 2018, and 2019. The dashboard file can be updated with new data to keep records or with assumed hypothetical data to check results. The dashboard will be provided as a separate file for the INDOT to use, along with a guide. Some of the features of the visual dashboard are presented and described in this section for better understanding.

9.1 Route-Wise Metrics

A custom map visual plugin (IconMapV3) is utilized to visualize the density of truck routes, with the circles indicating the origination and destination (Figure 9.1). The variation in circle diameter is proportional to the density of the corresponding origin and destination. With the visualization, it is possible to identify possible "hotspots" and wherein routes which are more commonly used. Filters can be applied to determine routes undertaken by a singular entity as well as destinations which might have a common origin and vice versa.

The Power BI canvas, in Figure 9.1, presents the visuals indicating the key metrics for 2017. This is similarly replicated for the years 2018 and 2019. The map visual is used to indicate the routes for the trucks with a heatmap style visual. The circle size can be used to identify the number of trucks operated by certain companies in a particular county or locality and track their routes to identify the key routes that the trucks that bring in the highest revenue operate on and are to be focused upon during the revision of the permit fee structure.

The following metrics are visualized and are updated dynamically as any of the particular routes are selected, i.e., the place of origin indicated by the blue circles that when selected show the different destinations and the routes associated with the following.

1. *Average ESAL without Axle*
   The ESAL establishes a relationship for comparing pavement damage to the effects of axles carrying different loads.
   This measure indicates the average value of ESAL for trucks that are operating without the suggested additional axle (that reduces the impact of the vehicle on the roads and recoups the investment for the additional axle by reduced OW permit fee paid over a period) over the truck's current axles.
2. *Average ESAL with Axle*
   This measure indicates the average value of ESAL for trucks that is obtained after adding the additional axle suggested.
3. *Number of Permits Issued*
   It is the number of unique permits issued, i.e., the number of trucks operating on the various routes.
4. *Average Mileage*
   It is the average mileage of the trucks, i.e., the average of the total distance traveled by the trucks on the various routes.
5. *Average Truck Weight*
   This is the average total weight of the trucks (including the OW part of the trucks), i.e., the average load carried by the trucks on the various routes.

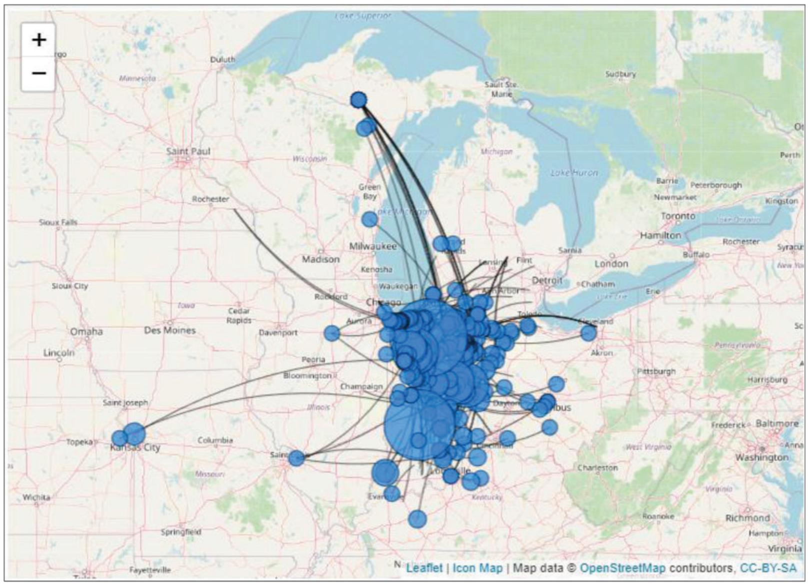


Figure 9.1 Truck route analysis to gauge traffic intensity and high-impact routes.

6. *Distance Travelled*
   It is the aggregate distance travelled by the trucks operating on the various routes.
7. *Fee without Axle: Old Permit Fee*
   It is the total payment by the truck owner if they continue to operate without adding an axle, under the existing permit fee structure with a permit fee of \$0.07 per ESAL-mile. Here, the fees dependent on mileage are discussed. It is calculated as:

$$(0.07 * Mileage * Chargeable\ ESAL) + (Mileage * 1.82) \quad \text{(Eq. 9.1)}$$

   Where, Chargeable ESAL = ESAL – 2.4, this is the chargeable ESAL miles that account for the OW part of the load and (1.82*mileage) refers to the fee charged for the non-OW part of the truck's trip.

8. *Fee with Axle: Old Permit Fee*
   It is the total payment by the truck owners if they operate by adding an axle to their trucks, under the existing permit fee structure with a permit fee of \$0.07 per ESAL-mile. It is calculated as:

$$(0.07 * Mileage * ESAL\ credit\ with\ additional\ axle) + (Mileage * 1.82) \quad \text{(Eq. 9.2)}$$

9. *Fee without Axle: Interim Permit Fee*
   It is the total payment by the truck owners if they continue to operate without adding an axle, under the interim permit fee structure that has a permit fee of \$0.25 per ESAL-mile. It is calculated as:

$$(0.25 * Mileage * ESAL\ credit\ with\ no\ additional\ axle) + (Mileage * 1.82) \quad \text{(Eq. 9.3)}$$

10. *Fee with Axle: Interim Permit Fee*
    It is the total payment by the truck owners if they operate by adding an axle to their trucks, under the interim permit fee structure that has a permit fee of \$0.25 per ESAL-mile. It is calculated as:

$$(0.25 * Mileage * ESAL\ credit\ with\ additional\ axle) + (Mileage * 1.82) \quad \text{(Eq. 9.4)}$$

9.2 Fuel Tax Metrics by Company (Company Names Redacted)

The Power BI canvas, in Figure 9.2, shows the metrics pertinent to the fuel tax breaking down the components of what the total fuel tax consists of. This helps identify how much the companies are paying and what constitutes the total tax paid. The visual depicts the metrics for the 2017 data. This is replicated similarly for the years 2018 and 2019.

The following metrics are measured and displayed in the visual that are updated dynamically as any particular company is selected on the stacked chart visual that identifies the top companies paying the highest amount of total fuel tax and how much is the proportion of additional fuel tax they pay, of the total fuel tax paid.

1. *Total Indiana Miles*
   This is the amount of distance travelled by the truck on Indiana roads as the fuel taxes charged by the State of Indiana can only account for the distance travelled by the trucks on Indiana roads.
2. *Permits Issued*
   This is the number of unique permits issued for trucks operating in Indiana.
3. *Fuel Consumption (gallons)*
   It is the average amount of fuel consumed (*FC*) due to the OW load of the truck (>80,000 lbs.) during its journey through Indiana roads. This is calculated as the difference between fuel consumption (*FC1*) due to the entire load of a truck and fuel consumption (*FC2*) by a truck carrying 80,000 lbs. load.

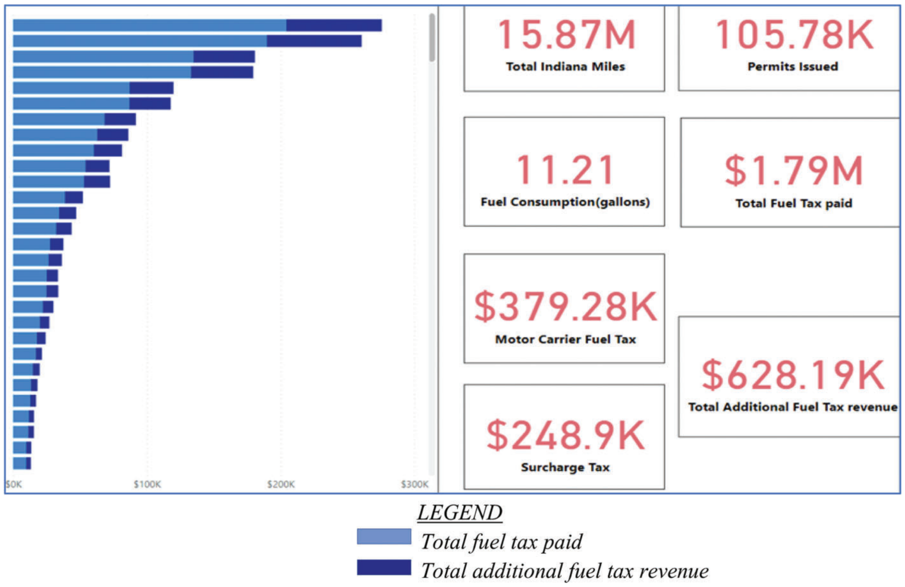


Figure 9.2 Top contributors to fuel tax revenue and associated metrics (each bar represents a different freight transportation company).

4. *Total Fuel Tax Paid*
   It is the total fuel tax paid for the full load carried by the truck.
5. *Motor Carrier Fuel Tax*
   It is the motor carrier fuel tax (MCFT) incurred by the company owing to the OW part of the load.
6. *Surcharge Tax*
   It is the amount of motor carrier surcharge tax (MCST) that is incurred by the company associated with the OW part of the load.
7. *Total Additional Fuel Tax Revenue (AFTR)*
   It is the total fuel tax incurred due to the OW load carried by the company to operate the truck with an OW load (>80,000 lbs.).

9.3 Permit Fee Sensitivity

The Power BI canvas in Figure 9.3 presents visuals indicating the metrics annually over the period 2017–2019. The "year" slider and the "permit select" slider could be adjusted to measure and visualize the following metrics at any selected year or a range of years and for different permit fees (from $0.07 to $0.50 per ESAL-mile) interactively.

1. *Permit Fee without Axle*
   This is the aggregate permit fee paid by the truck owners that are operating without the suggested additional axle which is calculated as:

$$(Selected\ permit\ fee * Mileage * ESAL\ credit\ with\ no\ additional\ axle) + (1.82 * Mileage) \quad \text{(Eq. 9.5)}$$

2. *Permit Fee with Axle*
   This is the aggregate permit fee paid by the truck owners that are operating with the additional axle suggested for better weight distribution which is calculated as:

$$(Selected\ permit\ fee * Mileage * ESAL\ credit\ with\ additional\ axle) + (1.82 * Mileage))$$

3. *Total Permits Issued*
   This is the aggregate number of trucks with unique permit numbers, or essentially the number of trips.
4. *The Variation of Average Permit Fees with and without Axle According to ESAL Range of the Trucks*
   The tooltips in the graph update all the measures including the number of permits in the range when hovered over them or clicked upon. Figure 9.4 shows the visuals and metrics for trucks having an ESAL of 6.4–7.4 as an example.
5. *Variation of Total Permit Fees with and Without Axle Across the Various Companies*
   The tooltips in the graph update all the measures including the number of trucks operated by the company when hovered over them or clicked upon. The example in Figure 9.5 shows the visuals and metrics for the company that brings in the highest permit fee revenue across all 3 years.

9.4 Fuel Tax Sensitivity

The Power BI canvas in Figure 9.6 shows all visuals indicating measures for the 3 years from 2017–2019. The "diesel rate," "surcharge tax," and "year" sliders can be adjusted to measure and visualize the following metrics on any particular year or a range of years dynamically for the different years and values of diesel tax per mile ranging from $0.16 to $0.50 and fuel surcharge tax per mile ranging from $0.11 to $0.50.

1. *Motor Carrier Fuel Tax (MCFT)*
   This is the motor carrier fuel tax (MCFT) incurred by the company owing to the OW part of the load.
2. *Fuel Surcharge Tax (ST)*
   This is the amount of motor carrier surcharge tax (MCST) that is incurred by the company associated with the OW part of the load.

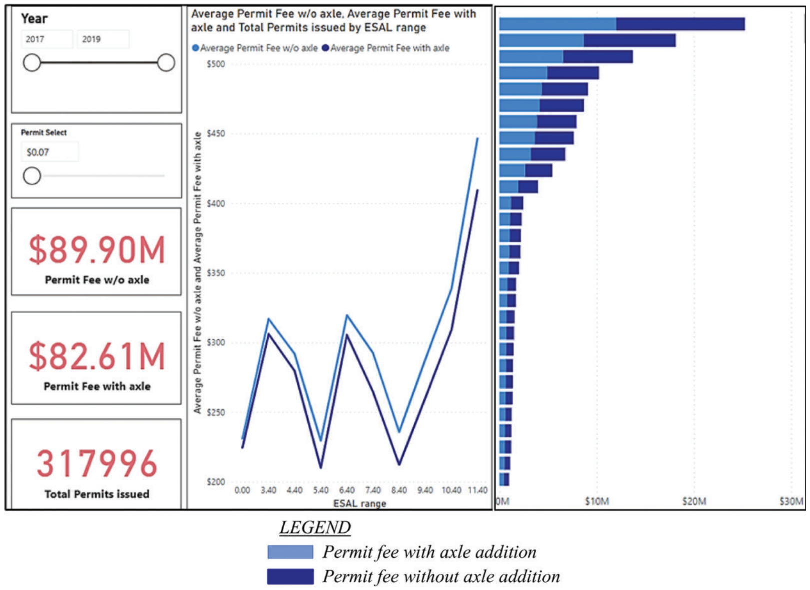


Figure 9.3 Permit fee sensitivity to permit fee increase per ESAL-mile (each bar represents a different freight transportation company).

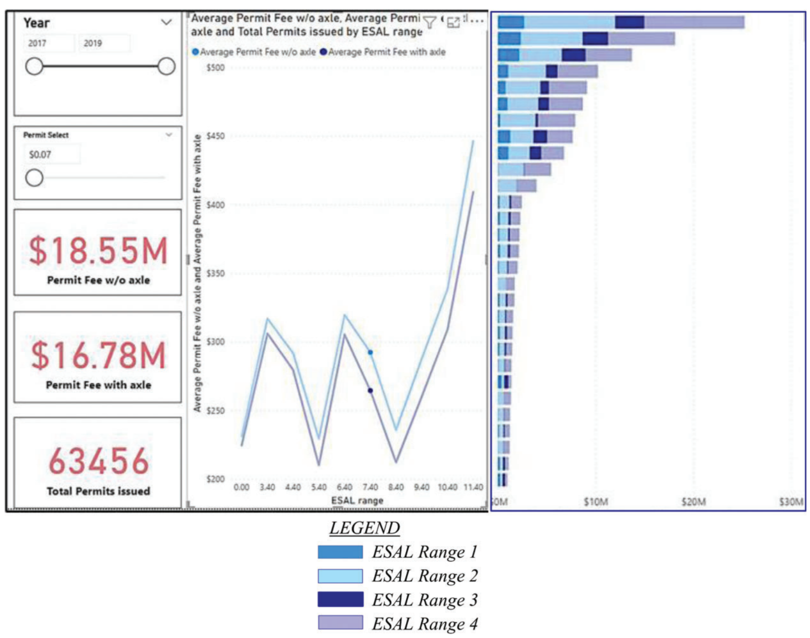
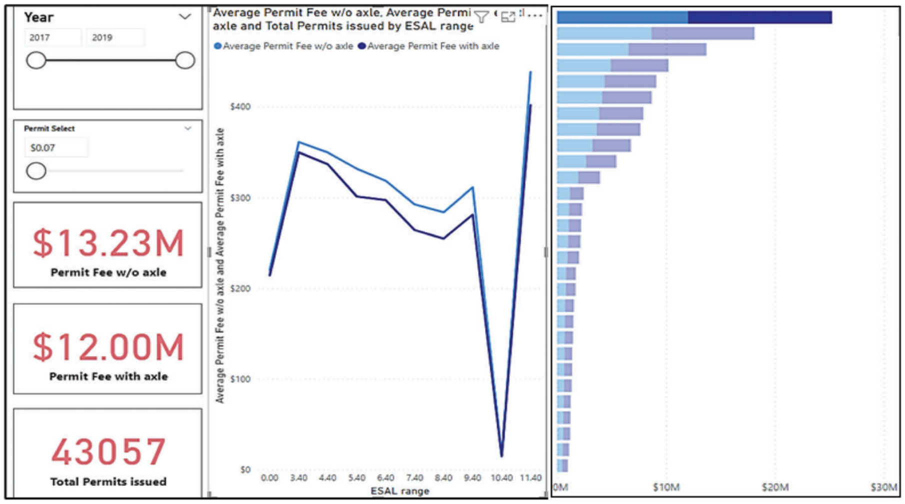


Figure 9.4 Observation of permit fee metrics for a specific ESAL range.

3. *Additional Fuel Tax Revenue*
   This is the total additional fuel tax revenue obtained due to the OW portion of the load carrying truck.
4. *Total Permits Issued*
   This is the aggregate number of trucks with unique permit numbers, or essentially the number of trips.
5. *Total Fuel Tax Paid*
   This is the total fuel tax paid for the full load carried by the truck.
6. *The Variation of Average MCFT and ST According to ESAL Range of the Trucks*
   The tooltips in the graph update all the measures including the number of trucks in the range when hovered over them or clicked upon. The example in Figure 9.6 shows the visuals and metrics for trucks having an ESAL of 6.4–7.4.
7. *Fuel Tax Metric for a Specific Company*
   The tooltips in the graph update all the measures including the number of trucks operated by the particular company when hovered over them or clicked upon. The example in Figure 9.7 shows the visuals and metrics for the company that brought in the highest fuel tax revenue across all 3 years.

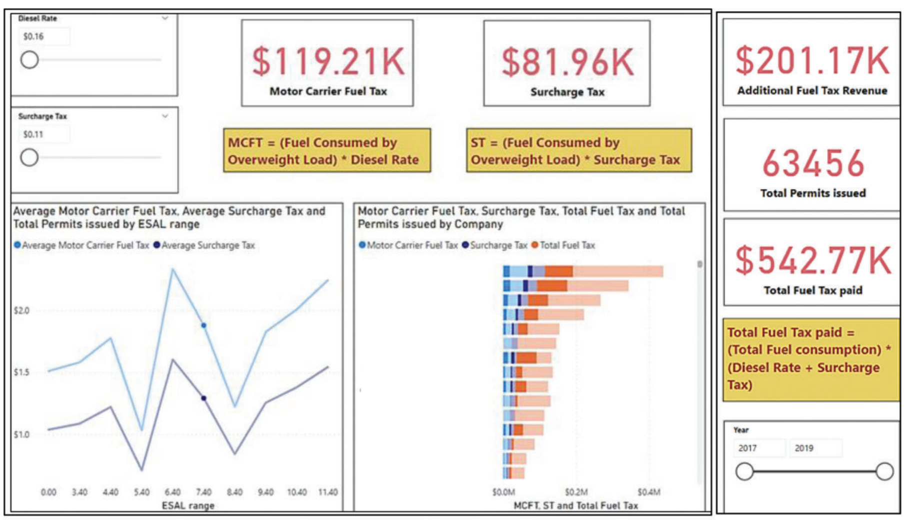


LEGEND

Permit fee with axle addition

Permit fee without axle addition

Figure 9.5 Observation of permit fee metrics for a specific company.



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Different bar colors represent different types of fuel tax,
For example, Motor Carrier Fuel Tax, Surcharge Tax, etc.

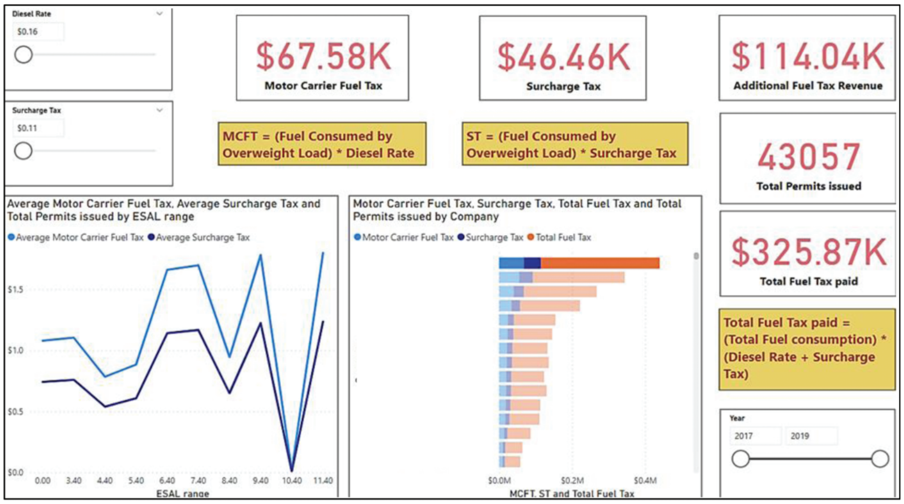
Figure 9.6 Observation of fuel tax metrics for a specific ESAL range.

9.5 Effect of Modified Permit Fee Structure

The Power BI canvas in Figure 9.8 shows the comparative permit fees paid assuming the previous legislation (HEA 1481-2013) and interim legislation (HEA 1190-2021), using the 3-year data (2017–2019).

9.6 Chapter Summary

This chapter provides details of the Power BI dashboard that is developed to help INDOT keep track of the key performance indicators. This would enable INDOT to continuously monitor the OW operations in the state and the factors that impact the permit fee structure. It would assist INDOT in making informed changes to the permit fee structure such that it provides a competitive environment for OW operations in the state.



LEGEND

Different bar colors represent different types of fuel tax,
For example, Motor Carrier Fuel Tax, Surcharge Tax, etc.

Figure 9.7 Observation of fuel tax metrics for a specific carrier.

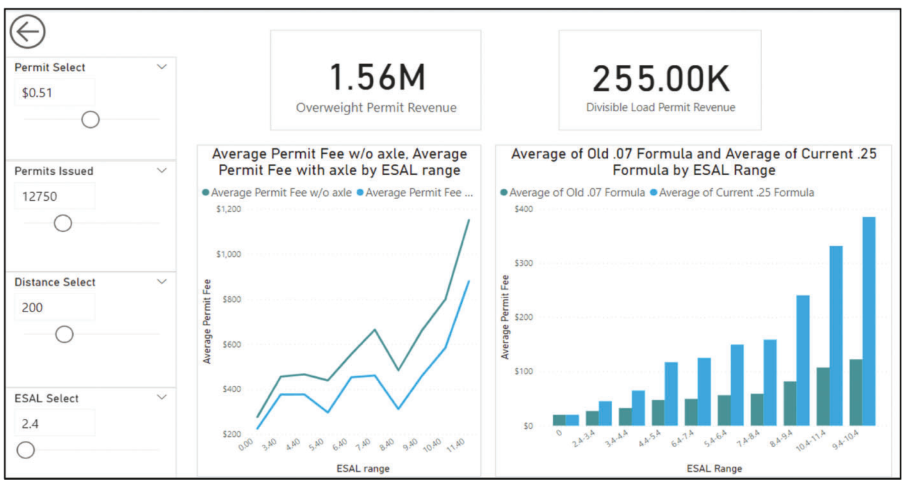


Figure 9.8 Permit fee sensitivity associated with the OW part of the load.

CHAPTER 10. FLUCTUATION IN THE NUMBER OF OW DIVISIBLE LOAD PERMITS ISSUED IN 2021

10.1 Introduction

The previous JTRP study assessed permit fees and OW operations in Indiana (Everett et al., 2014) and concluded that increasing OWOS permit fees would incentivize carriers to add axles to their vehicles, and thereby reduce infrastructure consumption. However, it has since been shown that those conclusions did not manifest to the extent expected. Carriers did not add the requisite axles to their trucks to the extent needed to effect a significant change in highway infrastructure consumption. Following the changes in permit fees proposed in HEA 1190-2021, this study seeks to explore the changes, if any, in the number of OW permits issued under various categories as a direct result of the revised permit fees. The trends in the permits issued can help inform the state about the effect of the fee revision on OW operations via-a-vis infrastructure consumption, operational performance, and economic competitiveness.

The analysis presented in this chapter examines fluctuations in OW divisible load (ODL) permits issued between the years 2021 through 2023 (inclusive). ODLs, as defined in the HEA 1190-2021, means a tractor–semitrailer and load that (1) can be traditionally separated or reduced to meet the specified regulatory limits for weight, (2) meet other requirements for height, length, and width; and (3) have a GVW of more than 80,000 lbs. but a GVW of not more than 120,000 lbs. The analysis period is divided into the period before the implementation date of HEA 1190-2021 (the "before" period), and the period after the implementation date (the "after" period). HEA 1190-2021 was implemented on January 1st, 2022. Therefore, before this date, the OW permit fees was \$20 + \$0.07 per ESAL-mile for ESALs more than 2.4. The new structure increased the fee to \$20 + \$0.25 per ESAL-mile for ESALs more than 2.4. The remainder of this chapter presents fluctuations in various characteristics of permits issued during the analysis period including the number of permits issued, type of permits, the shipment weight, ESALs generated, etc.

10.2 Trends by Permit Issue Type: Grandfathered vs. Yearly Total

1. *Number of Permits Issued*
   Figure 10.1 shows the monthly trends in the number of permits issued by issue type, i.e., grandfathered, or yearly total. For grandfathered permits, the general trend in the before period is a downward trend, showing a 15% decline in the number of permits issued between January 2021 and January 2022. The period following the bill's implementation date still trends downwards, albeit slower than before. The decline rate in the after period is on average 4%, much lower than the 15% in the before period. The yearly total category shows an upward trend in both the before and after periods. In the period from January 2022 through March 2023, the permits issued as yearly total increased from approximately 300 to well over 1,200, a four-fold increase, while the before period saw a two-fold increase.
2. *Number of ESALs*
   Figure 10.2 and Figure 10.3 show the variation in average trip and total monthly ESALs by permit issue type, respectively. The average trip ESALs for grandfathered permits show a reversal in the trend from an increase in the before period to a decrease in the after period. The yearly total, on the other hand, appears to show the opposite trend, moving from a decreasing trend in the before period to an increase in the after period. The total monthly trip ESALs show a more consistent trend for both yearly total and grandfathered permits. Grandfathered permits show a decline in both periods while yearly total permits show an increase in both the before and after periods.
3. *Trip Weight*
   Figure 10.4 and Figure 10.5 show variations in the total monthly and average trip weight by issue type. Permits issued as grandfathered show a consistent downward trend in both the before and after periods, although the exact rate is lower in the after period than the before period. Permits issued as yearly total show an upward trend in both the before and after periods. The before period saw a two-fold increase while the after period saw a four-fold increase in the total monthly trip distance. For the average trip distance, the average trip distance remained approximately constant for permits issued as grandfather in the before period, but sharply declined in the after period. The permits issued as yearly total display an almost opposite trend, showing an increase in the before period and remaining almost constant, with a very slight downward trend in the after period. Overall, the permits issued as yearly total exhibit greater variation in their average trip distance when compared to the permits issued as grandfathered, or when comparing the before and after periods.
4. *Trip Distance*
   Trends in the average trip distance as well as the total monthly trip distance for permits issued as grandfathered or yearly total are illustrated in Figure 10.6 and Figure 10.7. The average trip distance showed a declining trend across the board, although the exact value of the rate of decline varies from period (or issue type) to the next. The total monthly trip distance is illustrated in Figure 10.7 and shows a declining trend for both the yearly total and grandfathered permits.

10.3 Trends by Commodity Type

10.3.1 General

There exist significant variations in the trends of the number of permits issued when examined by commodity type, as presented in Figure 10.8. For agriculture permits, the trend was upward in the period before the law's implementation, leading to an increase in the number of permits from approximately 35 in July 2021 to approximately 65 by January 2022. However, the period following the enactment of HEA 1190-2021 saw these permits decrease steadily, with only approximately

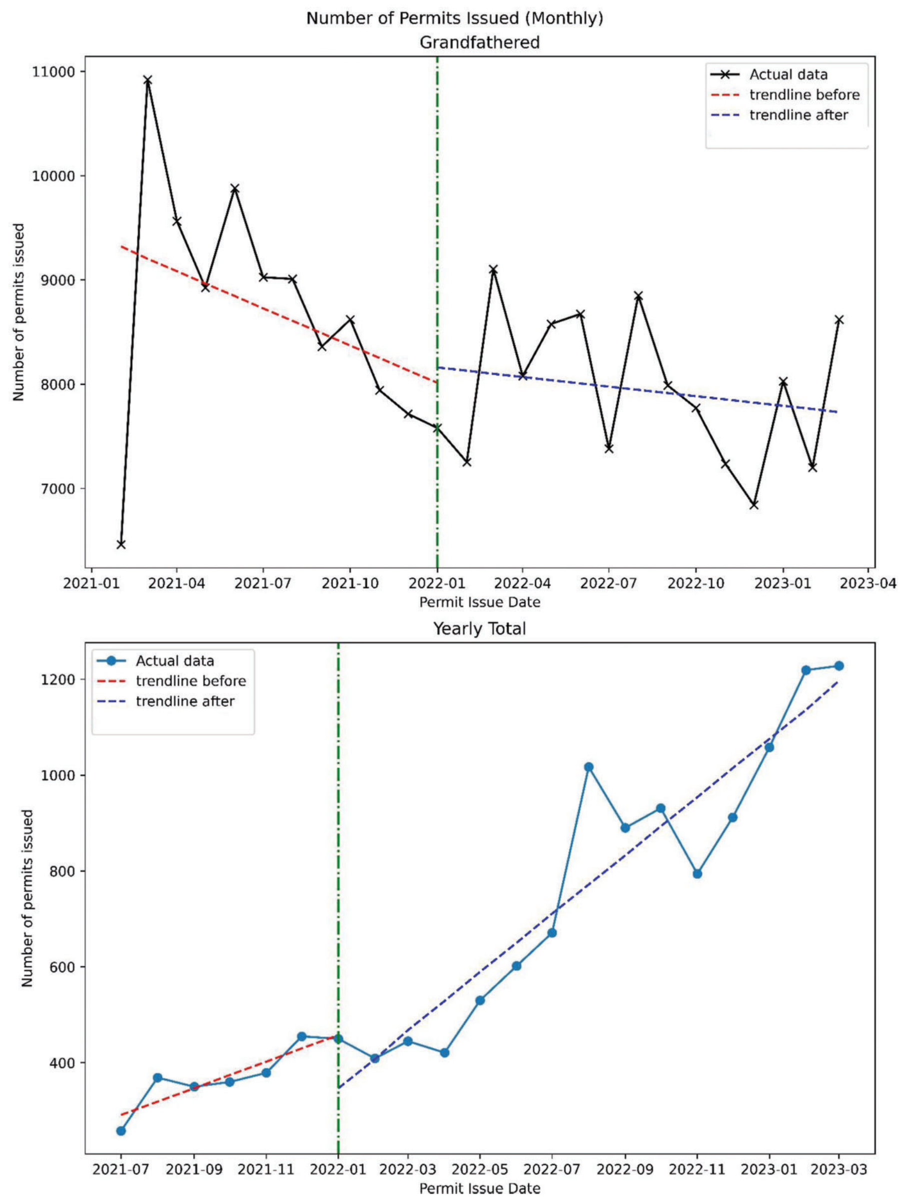


Figure 10.1 Number of permits by issue type.

30 permits being issued by April 2023. Permits issued under the metals category remained largely consistent over the analysis period. Although the trendlines appear to show a downward trend for both the before and after periods, the actual permit data appears to fluctuate between 8,000 and 10,000 permits per month throughout the analysis period, with April 2023 appearing to be an outlier. Permits issued as "other" show a consistent upward trend, increasing in both the before and after periods. The number of permits in this category increases steadily, from around 300 permits issued in July 2021 to a peak of approximately 1,400 permits in January 2023. The April 2023 observations could be considered as outliers in this dataset. In the figures, the HEA 1190-2021 implementation date is shown as a vertical green dotted line.

10.3.2 Trends of the Average Trip Distance

For commodities classified as metals and "other," the average trip distance for permitted OW trips trends downwards in both the before and after periods (see Figure 10.9). In both cases, the decline is steeper in the before period than the after period. Consistent with the number of permits issued, OW shipments for goods classified as metal seem to be on the decline. The same trend can be seen in all other analysis categories such as GVW (Figure 10.13) and ESALs (Figure 10.11). Not only are fewer permits issued for metals, but the average distance for the permits issued also decreases with time. Reasons for this decrease are not clear, but it may be attributed in part to supply chain disruptions due to the pandemic. The average trip distance for permits issued

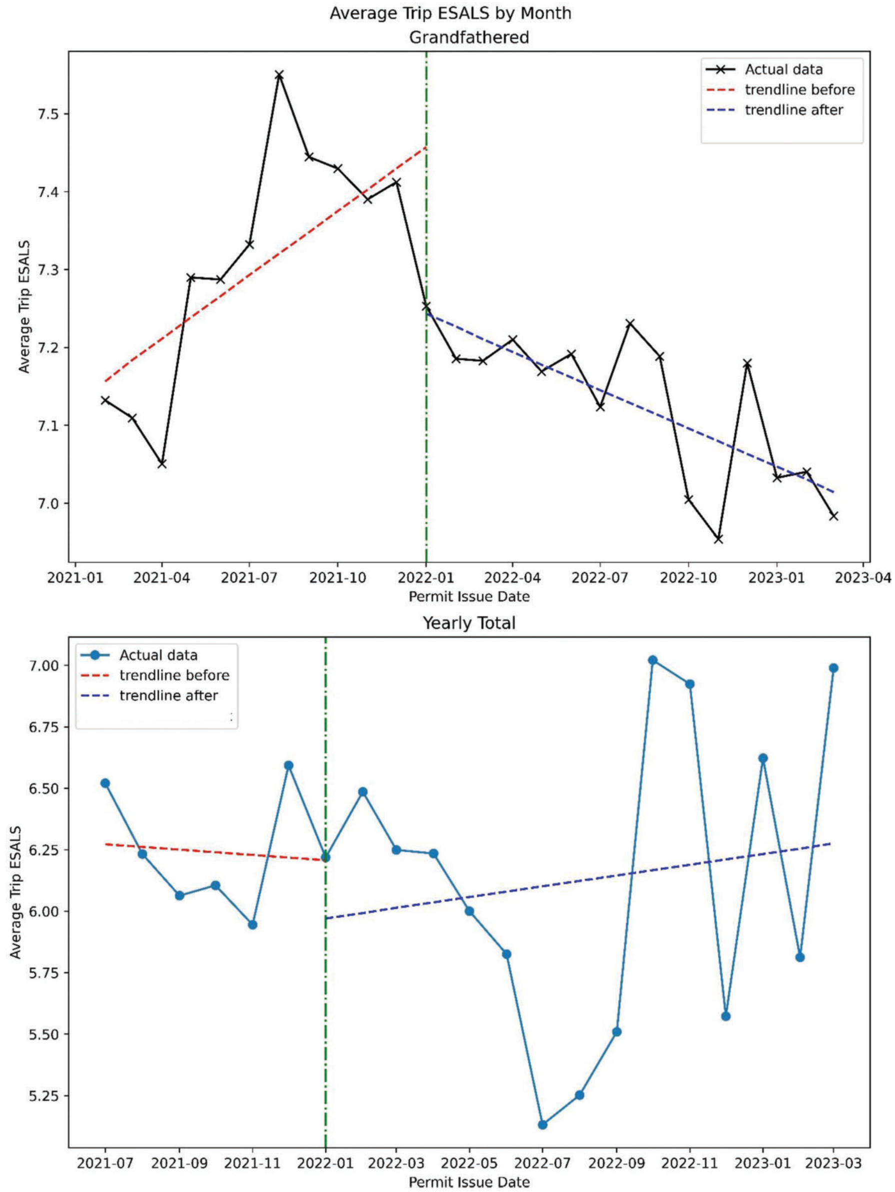


Figure 10.2 Average ESALs (monthly) by issue type (HEA 1190-2021 implementation date is shown as green dotted line).

for agricultural goods trends down in the before period but the trend reverses after HEA 1190-2021 was implemented. Although significant variations occur from month to month, the trend average is upward, from an average of 60 miles per trip in January 2022, to approximately 100 miles per trip by April 2023. This contrasts with the number of permits issued under the same category, which trends downwards in the same period. We can conclude therefore that while fewer permits are issued in this category, the carriers are traveling longer distances.

10.3.3 Trends of the Total Trip Distance

Figure 10.10 shows the cumulative trip distance of permitted trips per month for each commodity. Shipments for permits issued as agriculture remained consistent throughout the analysis period, while those of metals showed a decline, consistent with the trends seen in other metrics. Shipments categorized as "other" showed an upward trend throughout the analysis period. The growth accelerated following the enactment of the bill, going from a cumulative monthly distance of just over 60,000 miles in January 2022 to over 160,000 miles by March 2023.

10.3.4 Trends of the Trip ESALs

Figure 10.11 presents the total monthly ESALs for OW trips by commodity type, while the average trip ESALs are presented in Figure 10.12. Total monthly ESALs for agriculture permits trend upwards in the period before the law was implemented, while the

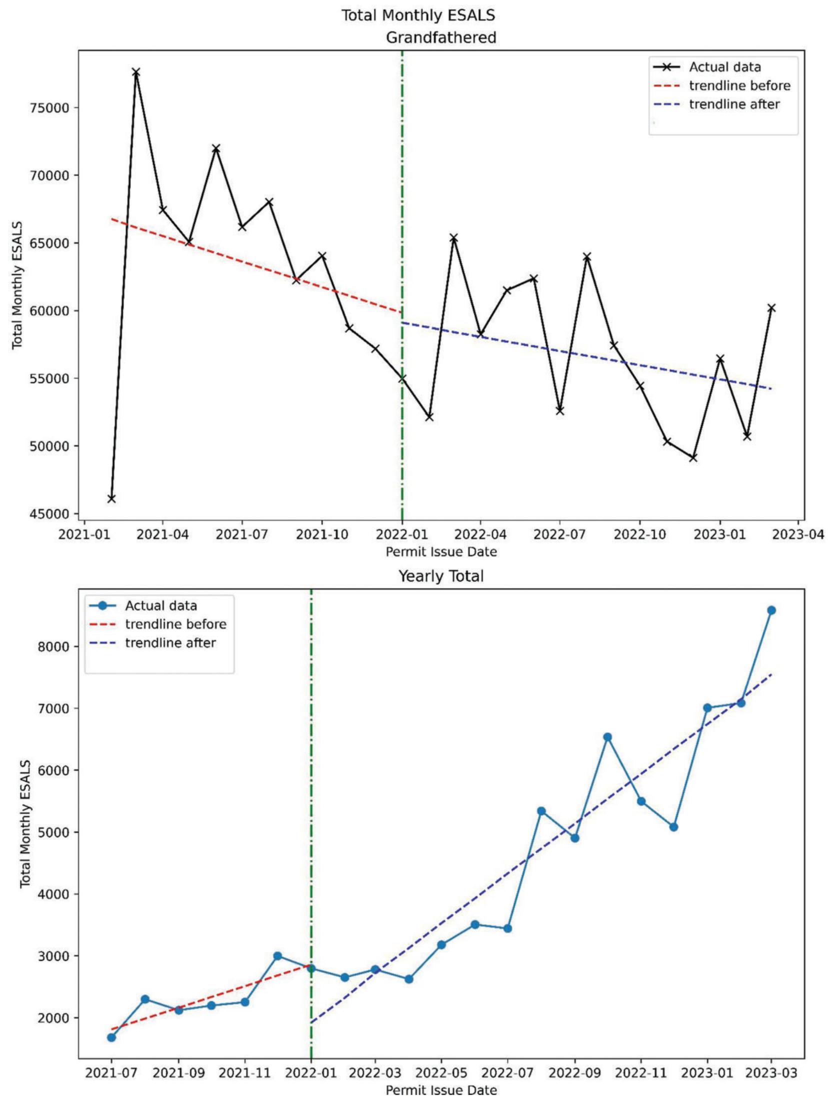


Figure 10.3 Total monthly ESALs by issue type (HEA 1190-2021 implementation date is shown as green dotted line).

period after seeing higher monthly fluctuations, even though on average the trend shows a downward movement. The average trip ESALs for agriculture commodities remained constant throughout the analysis period. Permits for metals saw a downward movement in the total monthly ESALs for both periods, while the average remained mostly consistent, with a slight downward movement in the after period. Commodities classified as "other" saw an upward trend in monthly total ESALs for both periods, with greater variation in the after period. The average monthly ESALs decreased after the law. This suggests that after the law's implementation, carriers loaded their trucks at lower payloads but undertook more trips.

10.3.5 Trends of the Shipment Weight

Figure 10.13 and Figure 10.14 present trends in trip shipment weights for OW permits by commodity type. Figure 10.13 shows the total monthly trip shipment weights while Figure 10.14 shows the average trip shipment weight. With minor fluctuations from month to month, the shipment weights for commodities issued as metals remained constant over the analysis period, both in terms of total and average weight. Commodities classified as "other," on the other hand, saw an upward trend in the shipment weight over the analysis period. While the total monthly shipment weight under this category increased steadily, the average weight did not increase in the same way. This implies that during the analysis period, the number of permits issued for commodities classified as "other" increased. This is confirmed by the trends shown in Figure 10.8, which shows the number of permits issued as "other" increasing in both the before and after periods. The law, therefore, does not appear to have had a significant influence on the permits for commodities issued as "other."

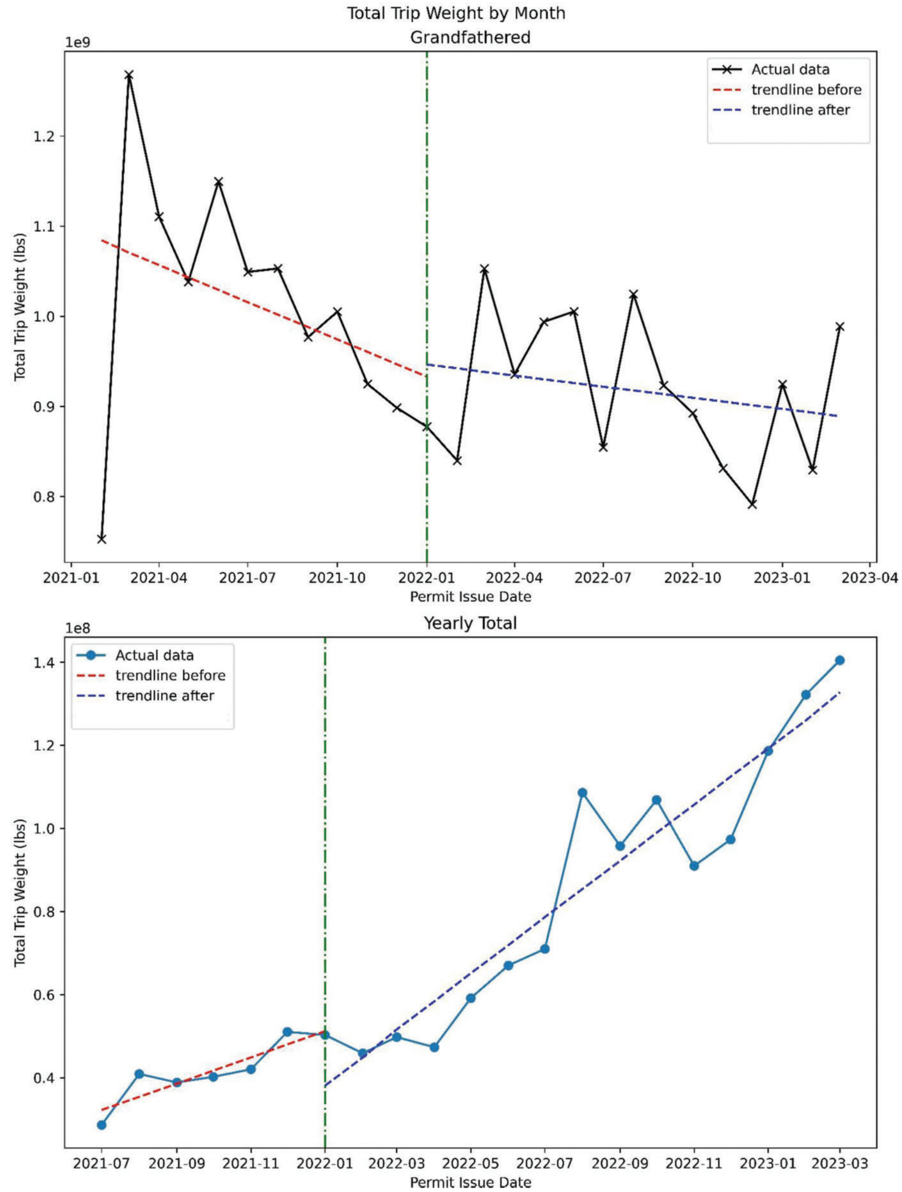


Figure 10.4 Total monthly weight by issue type (HEA 1190-2021 implementation date is shown as green dotted line).

10.3.6 Trends of the Shipment Weight by Commodity Type

Permits for commodities issued as agriculture, on the other hand, did see a change in the trend as it relates to the periods before and after the law was implemented. In the before period, the total monthly shipment weight for permits under this category was increasing, while the average for the same period remained fairly constant, with a very slight uptick. The after period, however, saw a reversal of this trend, with the number total shipment weight declining from an average of 5.5 million lbs. in January 2022 to approximately 3.5 million lbs. by March 2023. At the same time, the average shipment weight increased, from approx. 96,000 lbs. per trip in January 2022 to well over 110,000 lbs. per trip by March 2023. This would imply that fewer trips were taken under this category after the law was implemented, however, the trucks were loaded heavier than before. This is also confirmed by the trends shown in Figure 10.8, where the number of permits issued under this category decreased once the law was implemented, along with the total monthly ESALs (Figure 10.11). However, the average ESALs remained constant over the same period, signifying that the trucks did not change their axle configurations in response to the law, but instead took fewer trips.

10.4 Chapter Summary

This chapter presented an analysis of the trends in the number of permits OW permits in the periods prior

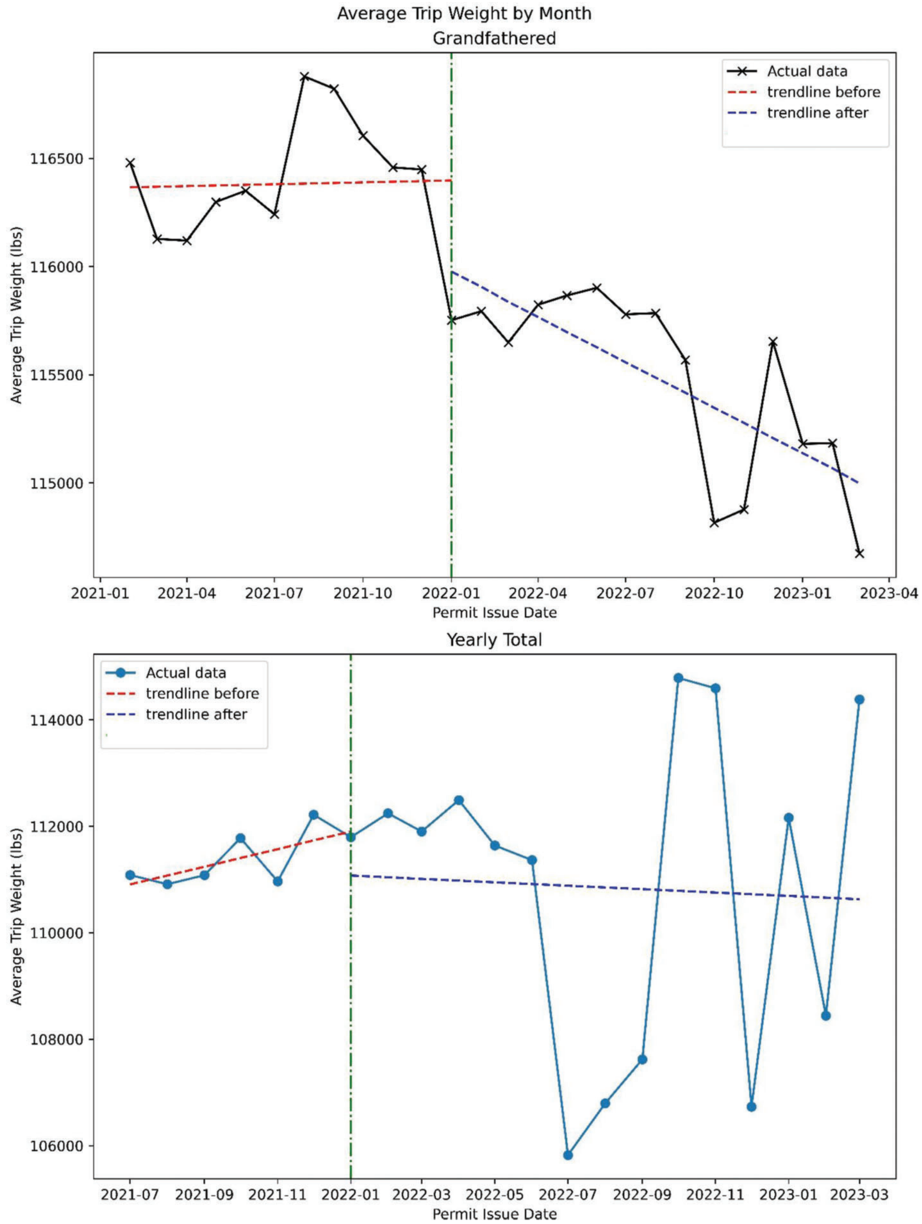


Figure 10.5 Average trip weight by issue type (HEA 1190-2021 implementation date is shown as green dotted line).

to and after the implementation date of HEA 1190-2021. The analyses were presented for the number of permits, total and average weight, distance, and vehicle ESALs. These trends were categorized by permit issue type (yearly or grandfathered) as well as by commodity type.

The number of permits issued saw a continued decline in the trend for grandfathered permits, showing a 15% decline in the number of permits issued in the before period, while the after period saw a more modest 4% decline. The period following the bill's implementation date still trends downwards, albeit slower than before. The yearly total category shows an upward trend in both the before and after periods. The average trip ESALs for grandfathered permits show a reversal in the trend from an increase in the before period to a decrease in the after period. The yearly total, on the other hand, appears to show the opposite trend, moving from a decreasing trend in the before period to an increase in the after period. The total monthly trip ESALs show a more consistent trend for both yearly total and grandfathered permits. Grandfathered permits show a decline in both periods while yearly total permits show an increase in both the before and after periods.

When viewed by commodity type, there exist significant variations in the trends of the number of permits issued, as presented in Figure 10.8. For agriculture permits, the trend was upward in the period before the law was implemented, observing that the number of issued permits increased from approximately

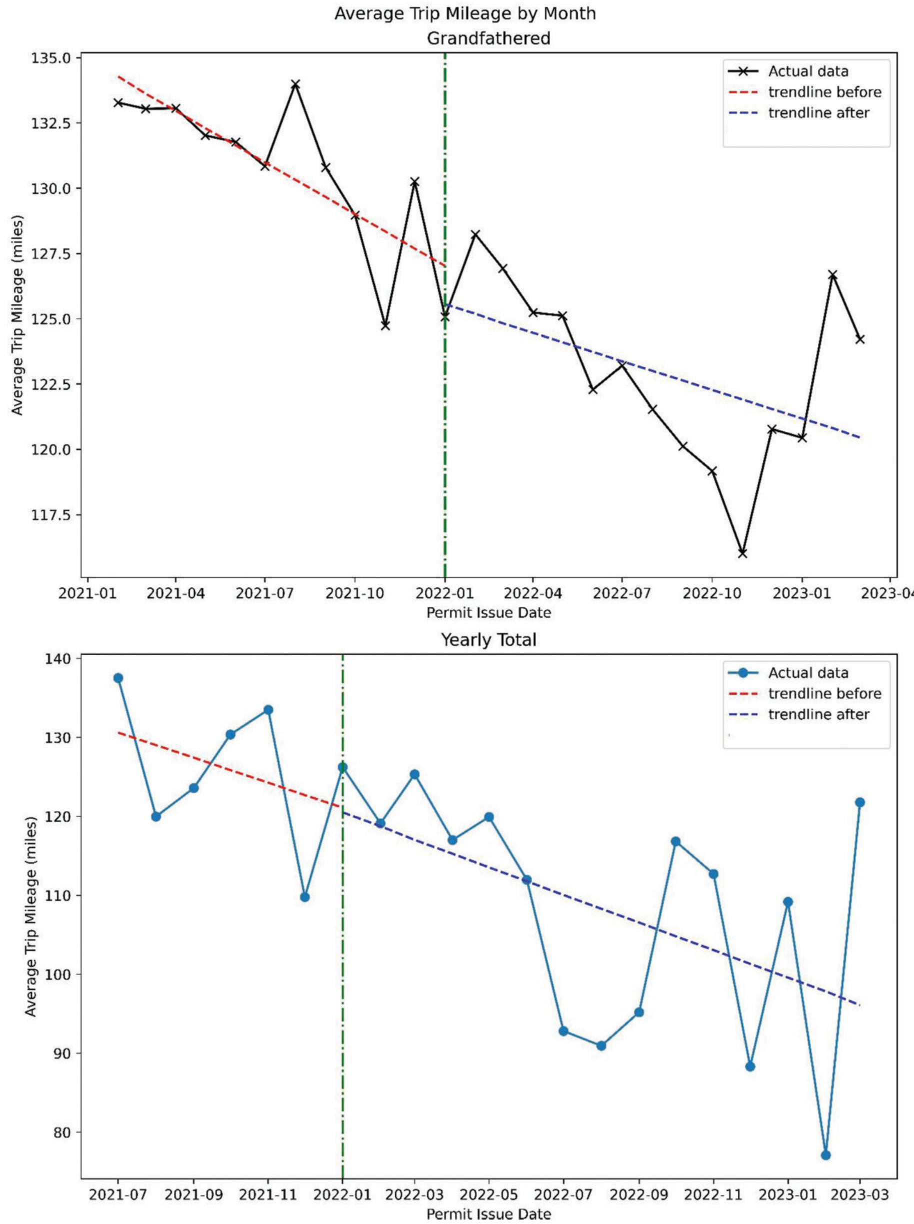


Figure 10.6 Average trip mileage by permit issue type (HEA 1190-2021 implementation date is shown as green dotted line).

35 in July 2021 to approximately 65 by January 2022. However, the period following the enactment of HEA 1190-2021 saw these permits decrease steadily, with only approximately 30 permits being issued by April 2023. Permits issued under the metals category remained largely consistent over the analysis period.

Shipments for permits issued as agriculture remained consistent throughout the analysis period, while those of metals showed a decline, consistent with the trends seen in other metrics. Shipments categorized as "Other" showed an upward trend throughout the analysis period.

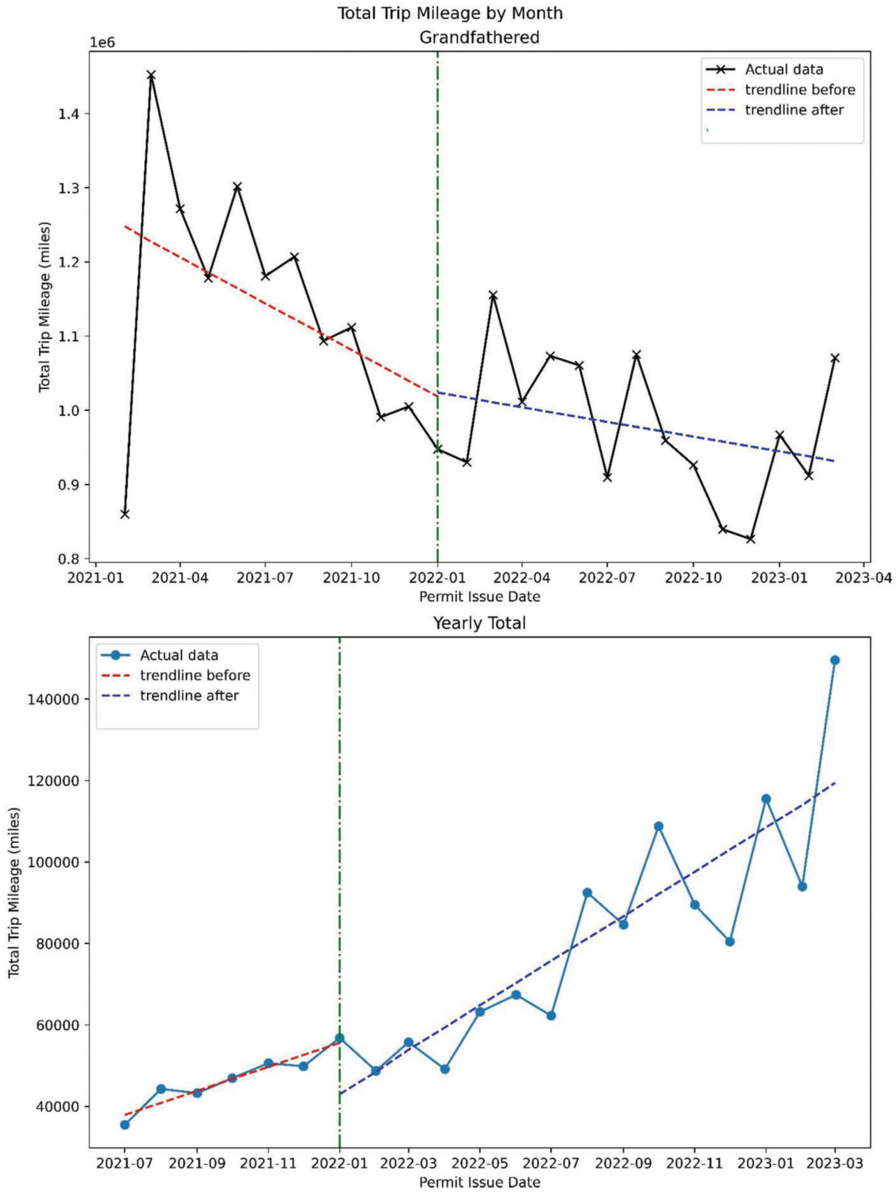


Figure 10.7 Total monthly trip distance by permit issue type (HEA 1190-2021 implementation date is shown as green dotted line).

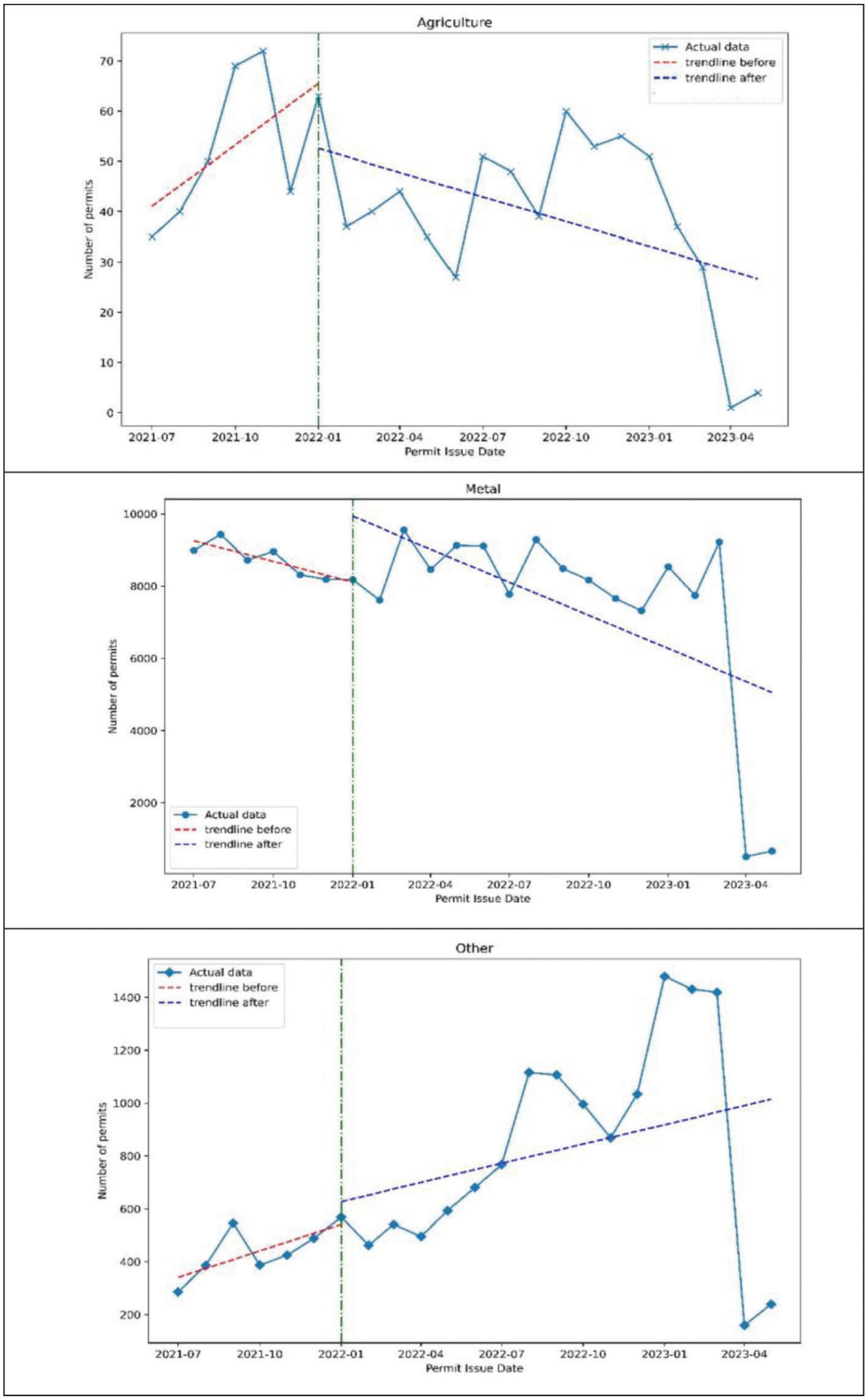


Figure 10.8 Number of permits issued by commodity type.

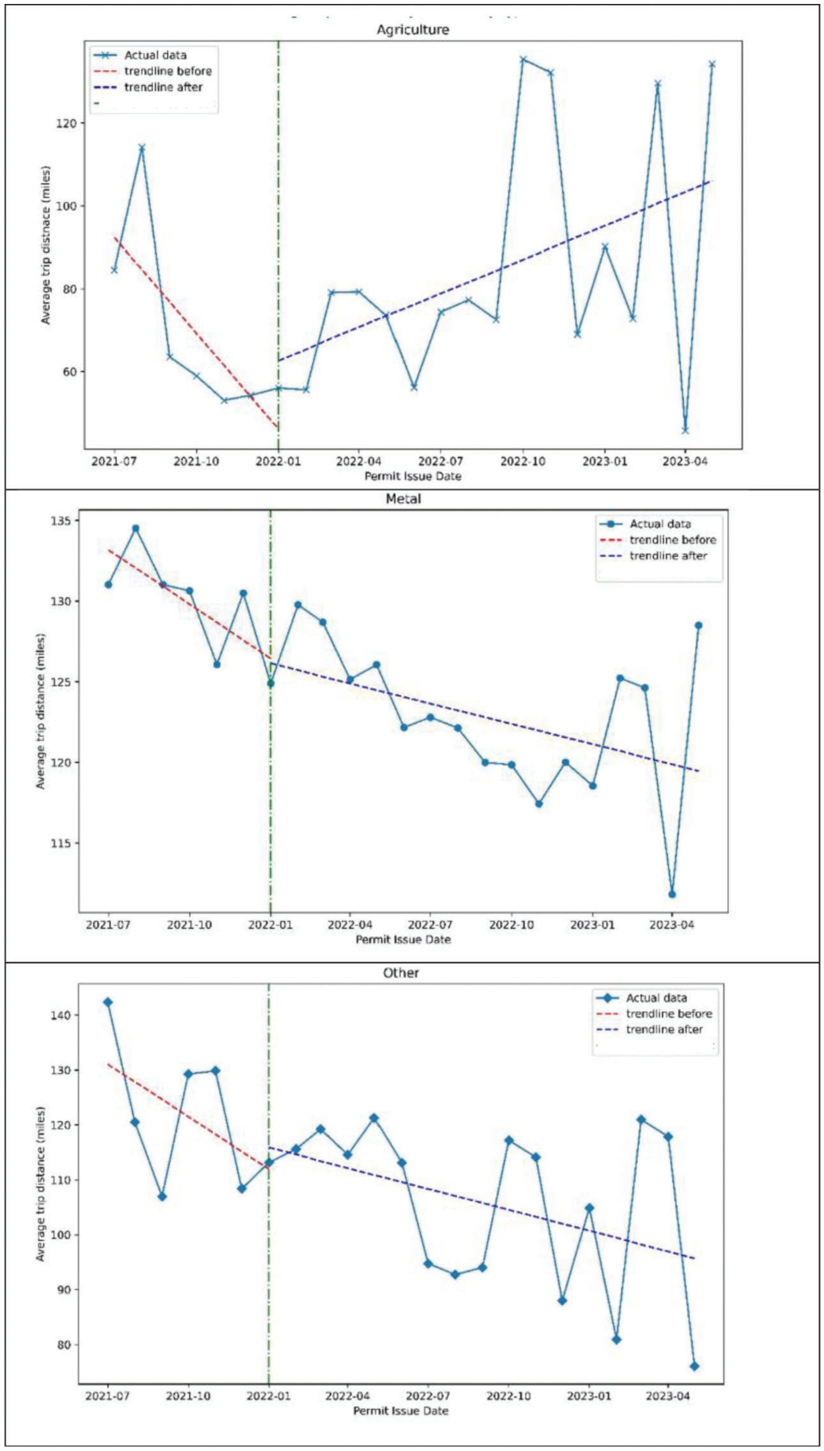


Figure 10.9 Average trip distance by commodity type.

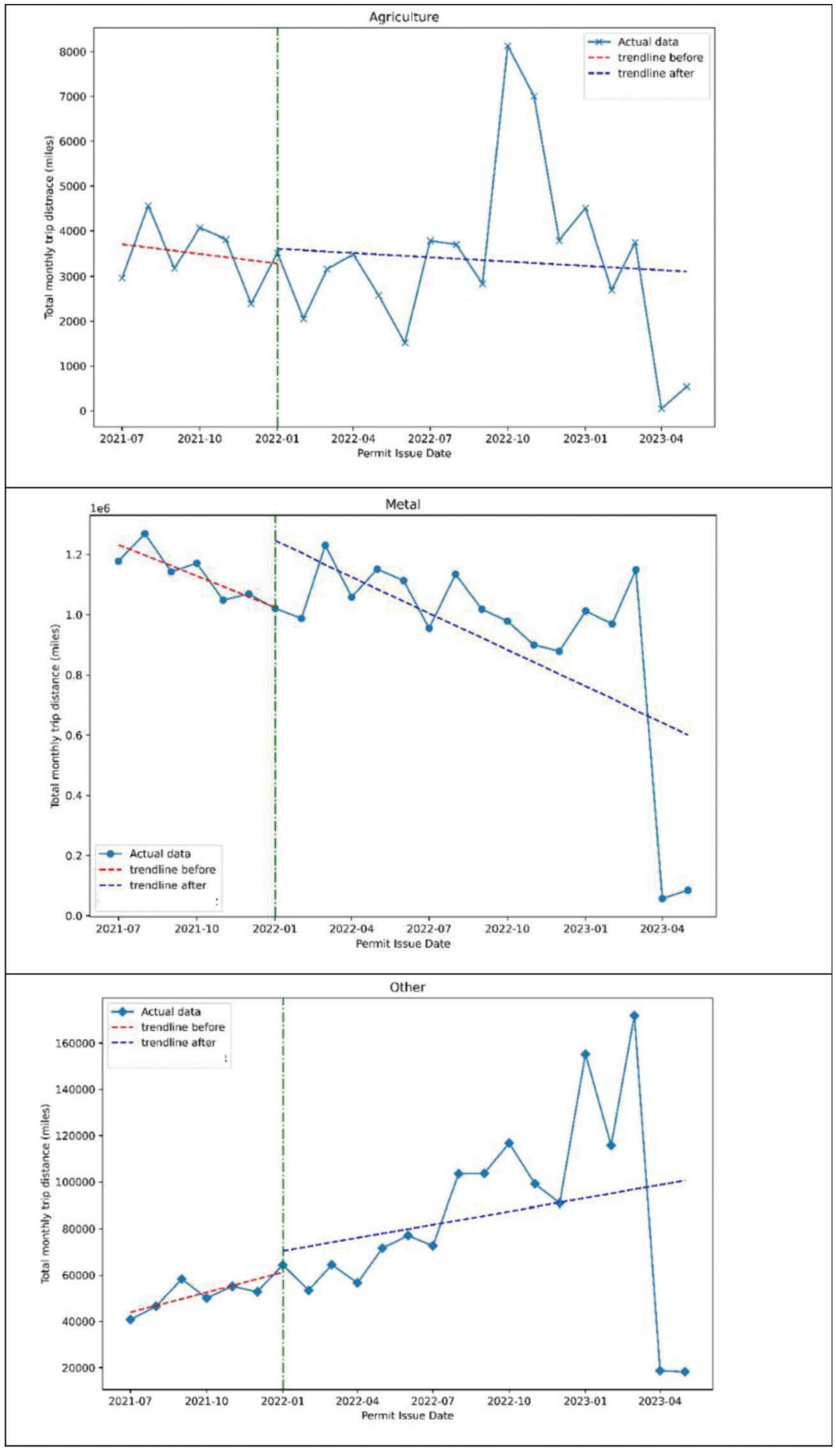


Figure 10.10 Total trip distance by commodity type.

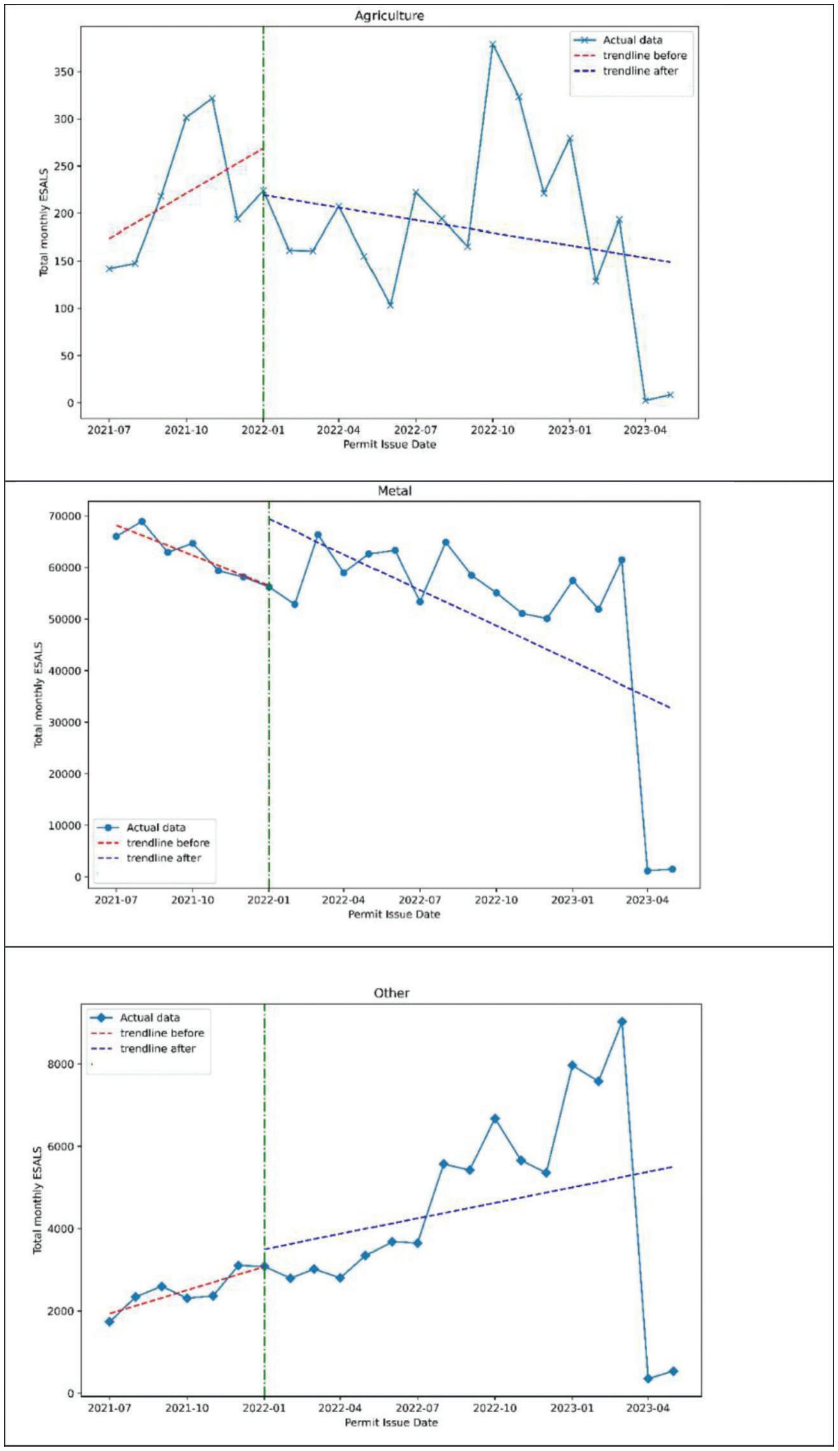


Figure 10.11 Cumulative monthly ESALs for OW trips by commodity type.

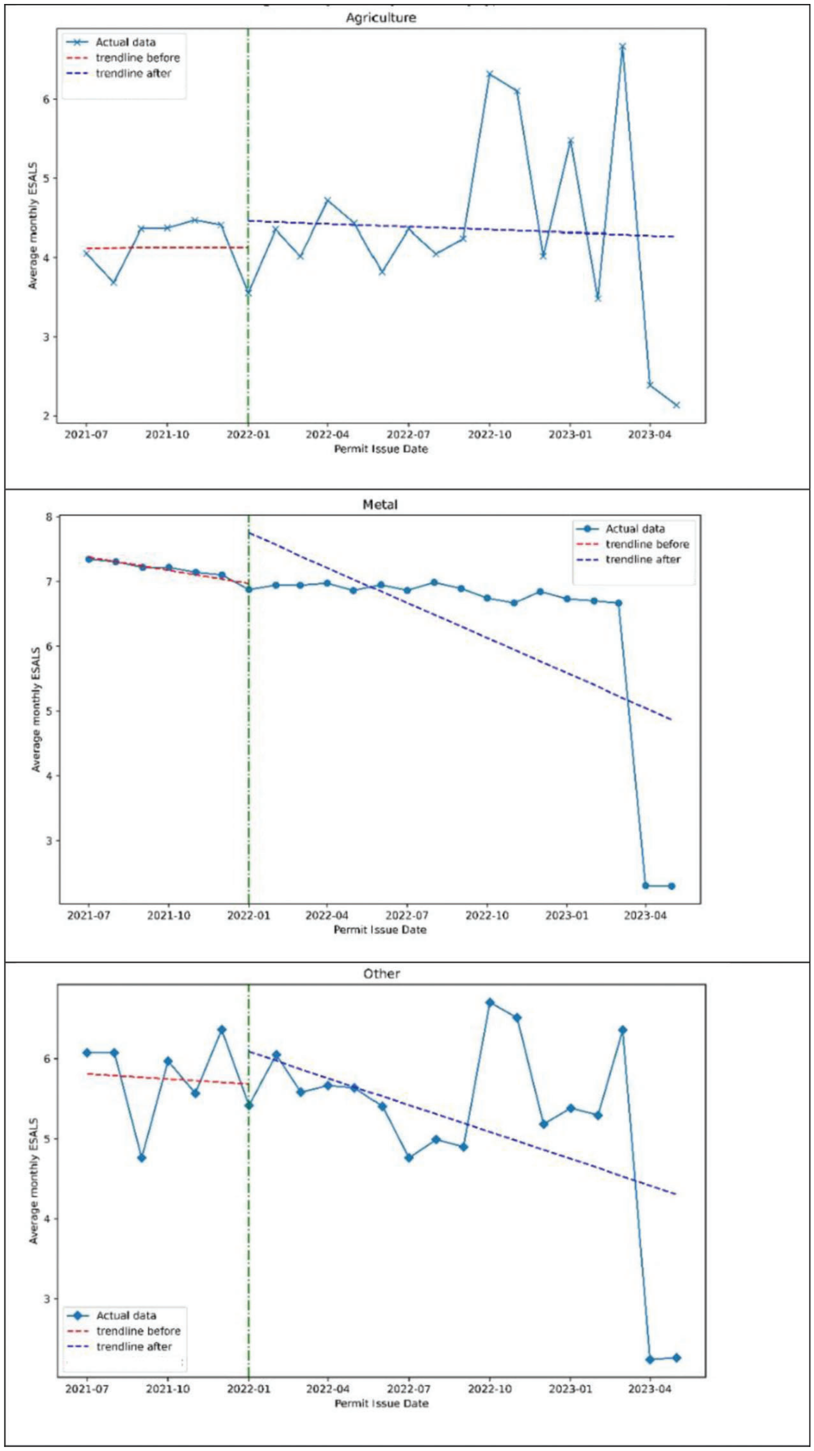


Figure 10.12 Average trip ESALS for OW trips by commodity type

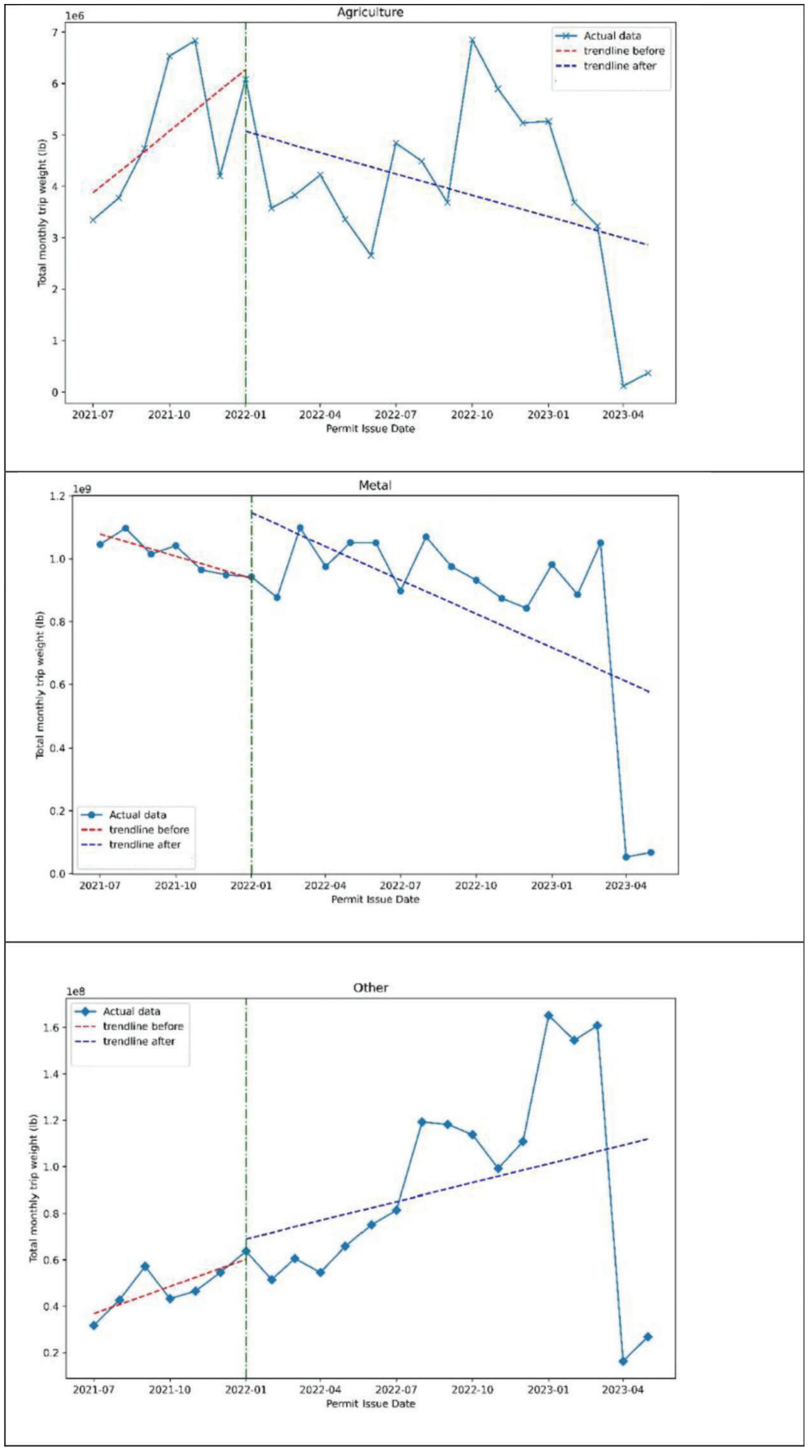


Figure 10.13 Total OW monthly shipment weights by commodity type.

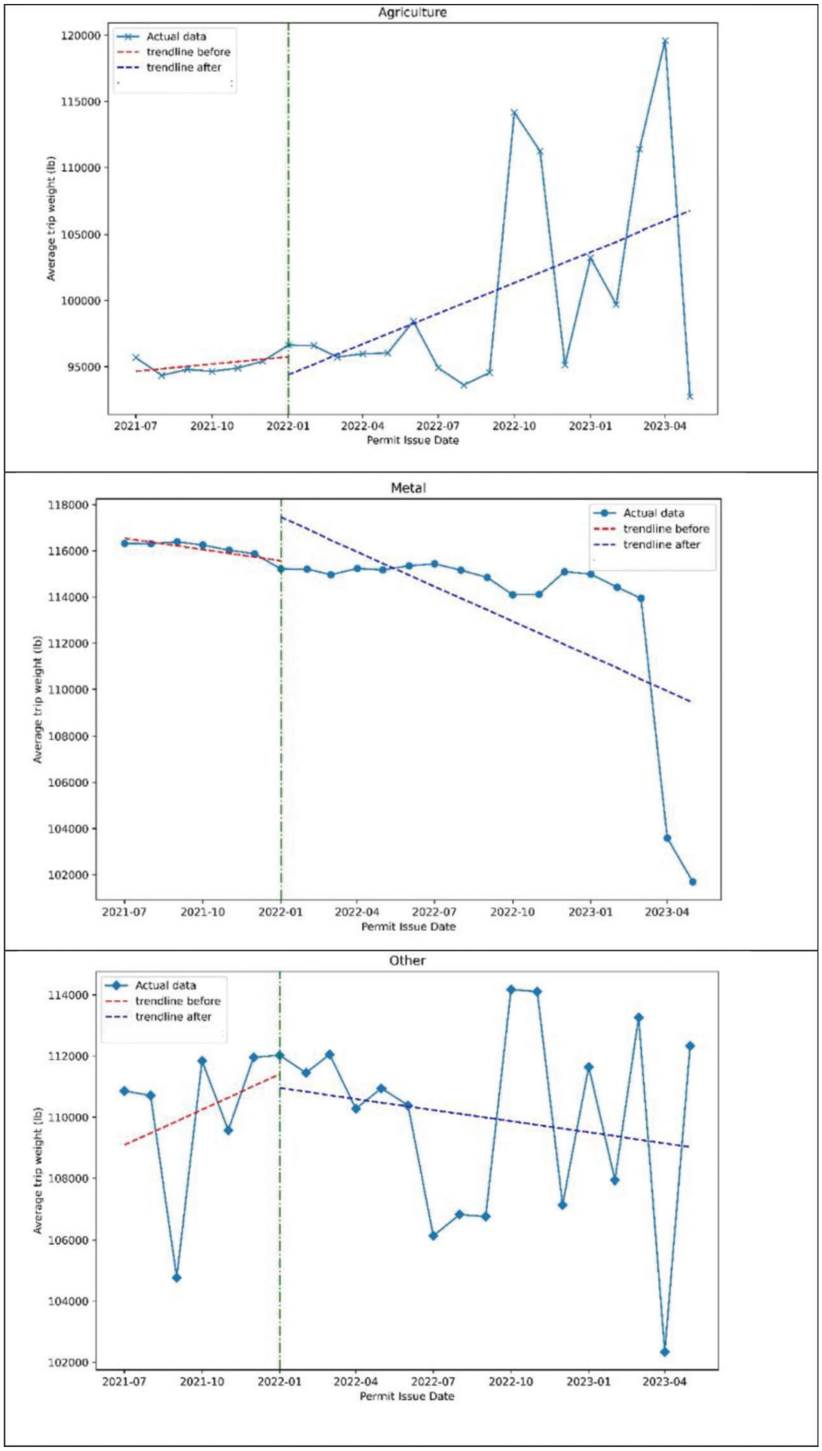


Figure 10.14 Average shipment weight for OW permits by commodity type.

CHAPTER 11. A SURVEY OF THE CARRIERS

In addition to the analyses discussed earlier in this report, the research team conducted a survey among carriers in the state to gauge their sentiments and perspectives on issues related to oversize and overweight (OW) operations and permitting. The survey comprised 20 questions, covering two primary areas: (1) the condition of infrastructure and its impact on OW operations, and (2) carrier opinions on the existing permit fee structure and load limits. Responses were received from sixteen participants, and a summary of the questions and their corresponding answers has been compiled. To facilitate a clearer understanding of the results, this section is organized into six themes, each accompanied by graphs to facilitate visualization of the survey outcomes.

11.1 Vehicle Operations and Road Maintenance

Survey question 1 sought respondents' opinions on the extent to which they agreed with the assertion that traffic loading primarily contributes to pavement deterioration, leading to heightened vehicle operating costs due to poorly maintained pavements. As illustrated in Figure 11.1, the findings reveal that 40% of respondents either strongly agreed or somewhat agreed with the statement, while 35% expressed a neutral stance. The remaining 25% of participants disagreed with the given statement. Figure 11.1 provides a concise overview of the survey responses to question 1.

Question 2 of the survey inquired about respondents' levels of concern regarding pavement damage resulting from OW vehicles. Figure 11.2 summarizes the results pertaining to this question.

The survey results indicate a notable consensus among respondents regarding concerns related to pavement damage caused by OW vehicles. Nearly half of the participants expressed a high level of concern, with 35% indicating a moderate level of concern, and slightly over 5% stating extreme concern. The remaining 12% reported no concern at all. Among those who expressed no concern, some attributed their stance to the belief that pavement deterioration was primarily caused by general traffic loading, and OW operations, constituting a small portion of total traffic, were perceived to contribute minimally to pavement damage compared to other traffic. It is crucial to highlight, however, that despite representing a small fraction of traffic volume, OW vehicles significantly contribute to load-related pavement deterioration. This is attributed to the fact that pavement deterioration is influenced by ESAL, and OW vehicles generate far more ESALs compared to normal weight vehicles.

When questioned about their likelihood of adding an additional axle to their vehicles to mitigate pavement deterioration and consequently reduce their permit fees, 35% of respondents expressed a strong inclination to do so. Approximately 12% stated they would be somewhat likely, while 12% remained neutral. Conversely, nearly

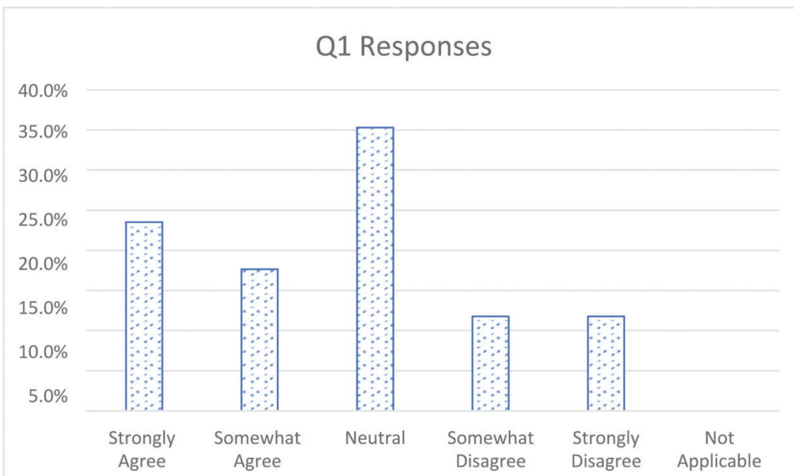


Figure 11.1 Survey responses to question 1.

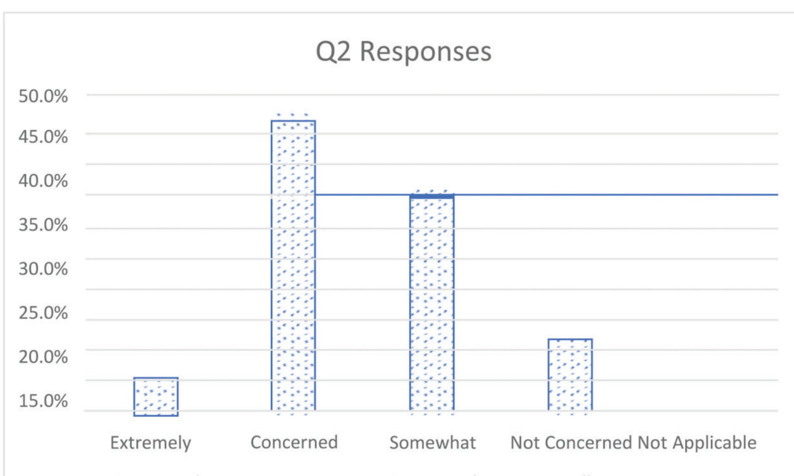


Figure 11.2 Survey responses to question 2.

40% of participants indicated that they would be unlikely or somewhat unlikely to add more axles for this purpose, and 6% deemed the question not applicable (refer to Figure 11.3). Among those disinclined or somewhat disinclined, some cited the existing policies in other states, like Michigan, mandating additional axles for OW vehicles, yet not significantly improving road conditions compared to Indiana or Ohio, which currently lack such policies. Others highlighted the prohibitive costs associated with adding an axle, pointing to expenses such as tires, increased maintenance, and elevated tare weight due to the extra axle. This additional weight raised concerns for some, as it could impact payload capacity in areas where OW loading is restricted. Furthermore, respondents engaged in specific operations, such as dump trucks operating in urban environments, emphasized that adding more axles could diminish maneuverability, thereby hindering their operational efficiency.

Survey question 5 inquired whether respondents would contemplate reducing the maximum weight of their trucks or adding an axle if the state offered a financial incentive. The responses are illustrated in Figure 11.4. The findings reveal that 56% of participants answered affirmatively, while 38% responded negatively. Among those who responded negatively, some cited concerns about increased maintenance costs and ongoing expenses for tires, even if the state provided financial incentives to cover the initial cost of axle installation. Regarding the idea of reducing the maximum weight of their trucks, respondents expressed reluctance, asserting that it was not in their business interest to lower the maximum weight as it would diminish their payload capacity.

Among the respondents willing to consider a state incentive for adding an axle or reducing the maximum weight of their trucks, when asked about the preferred type of incentive, a significant majority—over half—

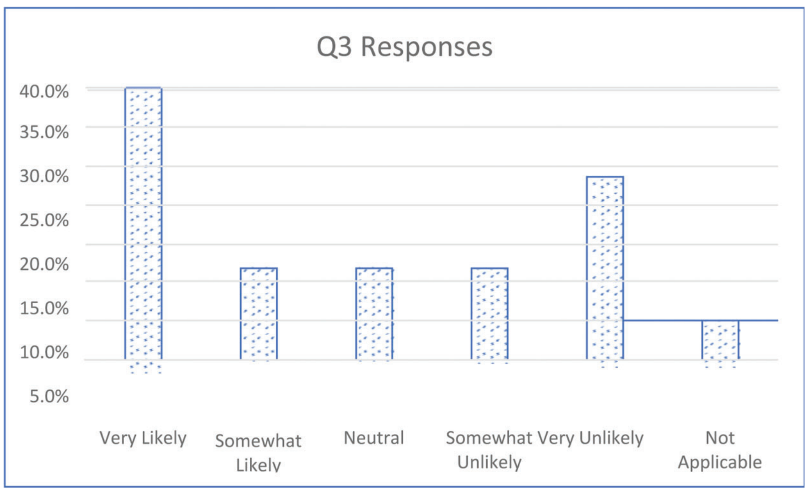


Figure 11.3 Survey responses to question 3.

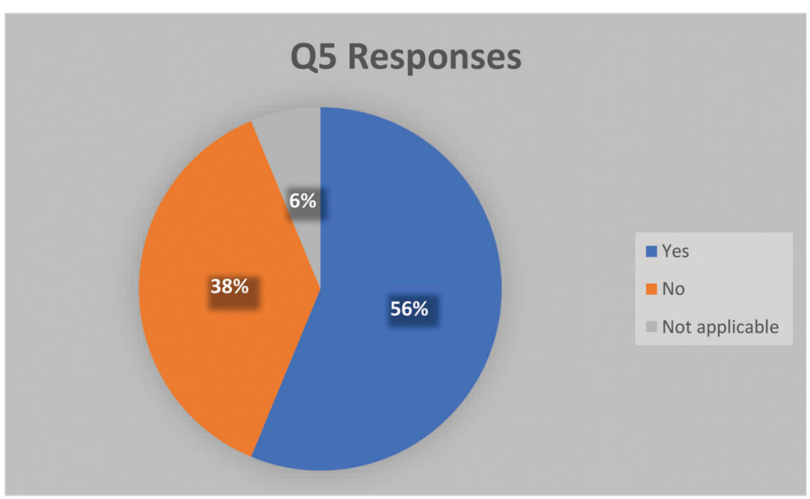


Figure 11.4 Survey responses to question 5.

expressed a preference for a blanket fee (annual fee or annual permit). Only 11% favored a fee for each oversize/overweight (OSOW) trip, and an even smaller percentage opted for a fee per ESAL per mile. Nearly 25% stated that this option was not applicable to their specific situation. Figure 11.5 provides a visual representation of these responses.

When asked to specify the average cost range of adding an axle to a single truck, 41% of respondents indicated an average cost falling between $12,500 and $15,000, as depicted in Figure 11.6. Approximately 18% of respondents stated the average cost to be in the range of $10,000 to $12,500, with an equal percentage indicating a range of $7,500 to $10,000. It is evident from the responses that the actual direct cost of axle addition varies significantly, influenced by factors such as location, vehicle type, and other considerations. Notably, several respondents commented on the use of the term "truck" in the question, pointing out that there is a distinction between the "truck" and the "trailer." In the context of the question, axle addition was envisioned for the trailer, not the "truck" itself. Consequently, some respondents chose not to provide an average cost estimate, instead selecting "not applicable." They clarified that adding an axle to a "truck" would entail replacing the entire vehicle, as trucks are not easily modified in the same way as trailers. Consequently, such a modification would be deemed almost impractical, particularly for businesses operating entire fleets.

Survey question 8 inquired about the threshold at which respondents would consider adding an axle rather than paying the permit fee, comparing it to the cost of axle addition. Approximately 18% of respondents stated a preference for adding an axle if the permit fee slightly exceeded 5% of the cost of axle addition. Six percent (6%) of participants indicated they would consider

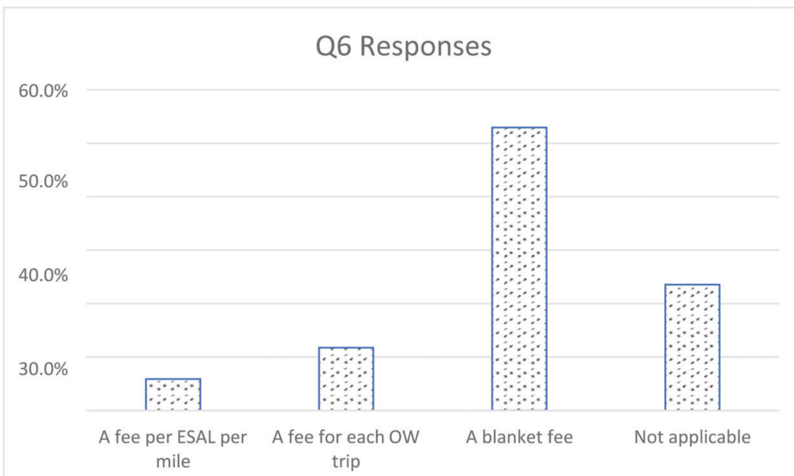


Figure 11.5 Survey responses to question 6.

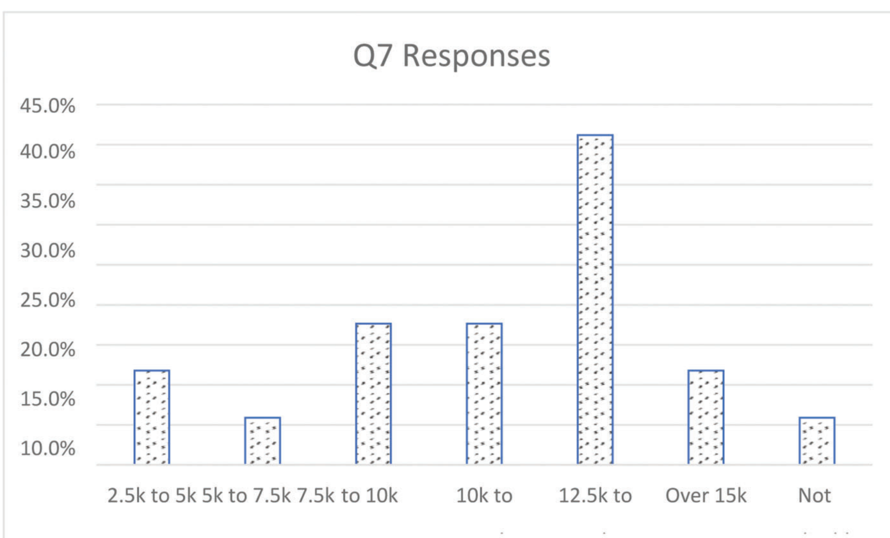


Figure 11.6 Survey responses to question 7.

adding an axle if the permit fee just exceeded 10% of the axle addition cost. An equal percentage set their threshold at 20% and 25% of the axle addition cost, respectively. Notably, nearly half of all respondents opted for the "not applicable" option, indicating that they did not establish a specific threshold at which they would consider adding an axle instead of paying the fee. Figure 11.7 provides a summary of these responses.

11.2 Overweight Trips

Nearly 50% of the respondents indicated that less than 50% of their truck trips were OW, while 31% reported that 50%–100% of their truck trips fell into the OW category. However, as depicted in Figure 11.8, the majority (approximately 38) stated that 0%–10% of their truck trips were OW. Most respondents (6 out of 16, acknowledging the limited sample size) mentioned that their company's trucks undertake more than 100 OW trips monthly. It is important to note that drawing conclusive insights from this small number of responses may be challenging. One respondent noted a significant decline in their operations using OW permits following the last permit fee increase. The majority (56%) of respondents reported transporting OW loads to other states, with the most common destinations being Ohio (38%), Michigan (29%), and Kentucky (24%).

11.3 Trailers and Axles

Most respondents (approximately 81%) reported that a typical tractor in their company was attached to one trailer. However, opinions on adding at least one additional axle were varied, as illustrated in Figure 11.9. Approximately 75% of respondents stated that it would cost them between $7,500 and $15,000 to add an

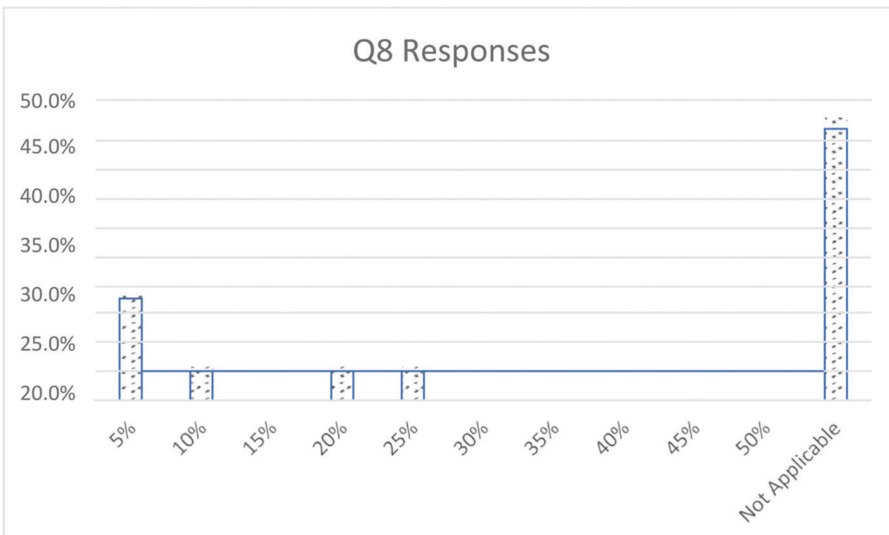


Figure 11.7 Survey responses to question 8.

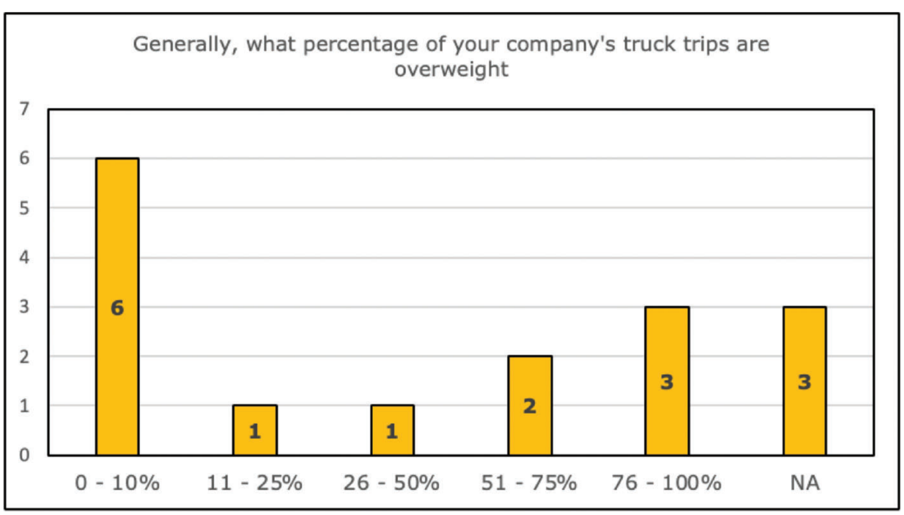


Figure 11.8 OW truck trips: granular.

axle (Figure 11.10). One notable concern expressed by respondents was the indirect costs associated with axle addition, including downtime, expenses for tires, and the logistical challenge of adding axles to a large fleet. Other concerns raised included trucks already operating at the maximum number of axles (seven) and the necessity of having a smaller base to maneuver around job sites.

11.4 Financial Incentives from the State and Permit Fees

A significant majority of respondents (62.5%) believed that Indiana's OW permit fees were either comparable to or higher than those in other states. A substantial portion, approximately 44% (refer to Figure 11.11), expressed an extreme opinion that these fees were very high. The remaining respondents (32.5%, as indicated in Figure 11.11) either did not provide an answer or did not find it relevant to decide on adding an axle based on the permit fee.

Few respondents indicated a willingness to consider adding an axle if the permit fee increased to approximately 5% of the cost of an additional axle (see Figure 11.12). Even fewer would contemplate this option if the permit fee reached as high as 20%–25% of the additional axle cost. Most respondents did not provide an answer to this question.

Approximately 38% of respondents indicated that financial levers would motivate them to add axles, while a nearly equal number, around 31%, stated that financial incentives or levers would not

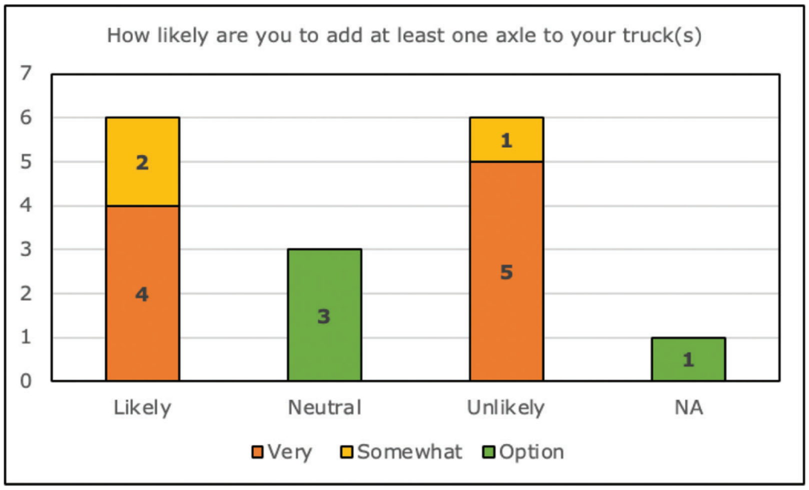
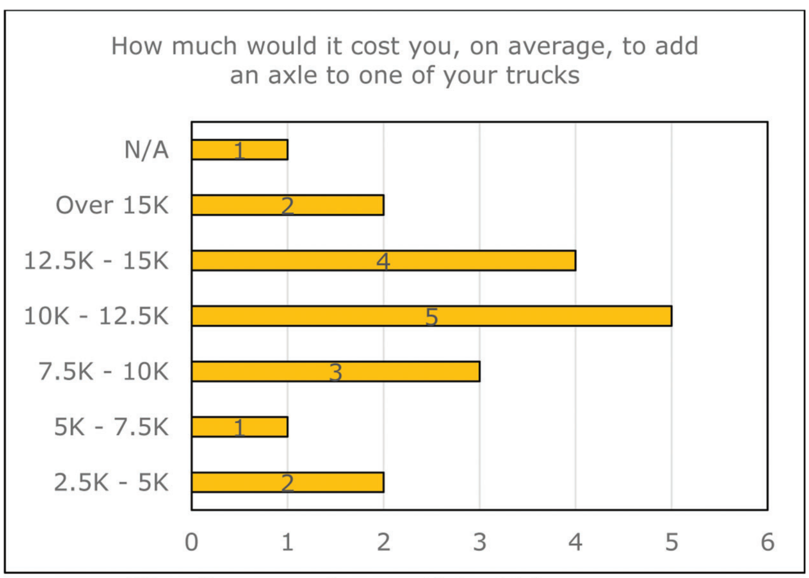


Figure 11.9 Propensity to add an extra axle.



**Note: Some respondents provided multiple answers.*

Figure 11.10 Cost of adding an extra axle.

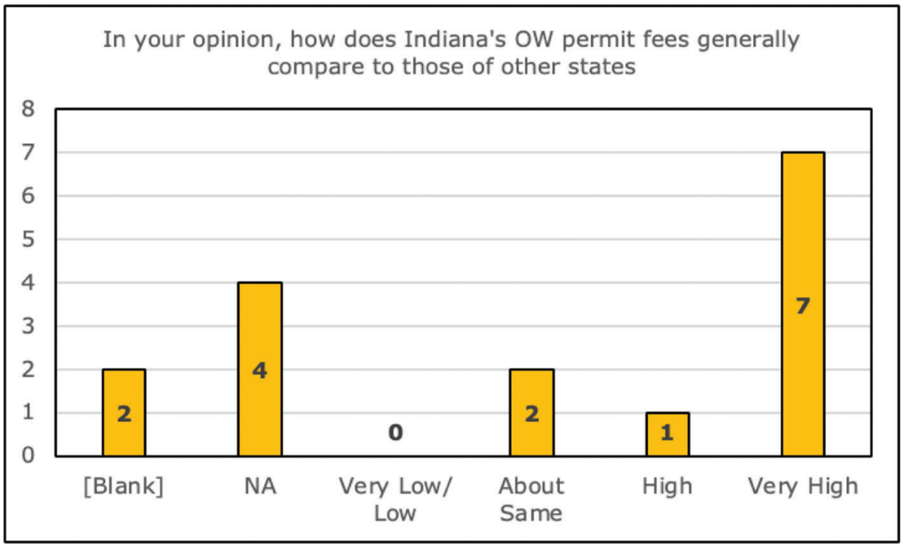
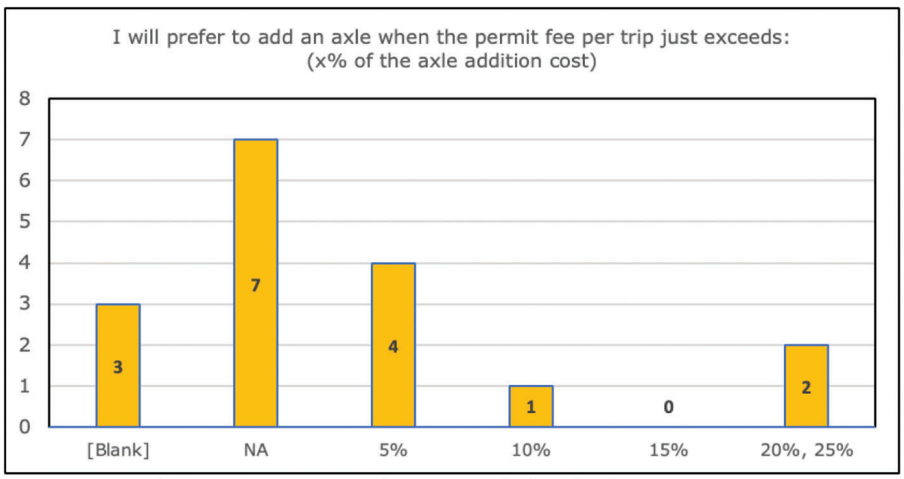


Figure 11.11 Benchmarking Indiana's OW permit fees.



**Note: Some respondents provided multiple answers.*

Figure 11.12 Axle cost and permit fee.

be a motivating factor for them. However, the majority (50%, as illustrated in Figure 11.13) considered a blanket fee, such as an annual permit, as the most favorable option in terms of providing incentives.

11.5 Indiana Roads

Respondents reported that almost all the listed highways (I-64, I-65, I-69, I-70, I-74, I-80, I-90, and I-94) were used to a similar extent for transporting OW loads. Approximately 69% of respondents indicated that the pavement conditions on Indiana highways where they conducted OW operations were either fair or good. Only three of the respondents felt that the pavement condition of Indiana highways was generally relatively poor.

Most responses in Figure 11.14 indicated that Indiana's pavements were either superior to or at par with those of the states considered in the survey, including Ohio, Michigan, Illinois, Wisconsin, and Kentucky. When comparing Indiana's pavements to those of each specific state, as few as 62.5% of respondents rated Indiana's pavements as superior to or at par with Illinois, while as many as 90% rated Indiana's pavements as superior to or at par with Michigan.

11.6 Dashboards

Most respondents, comprising approximately 56%, expressed a willingness to utilize an online dashboard provided by the state. This online dashboard would facilitate the input of various metrics (such as payload, axle configuration, trip distance, and other

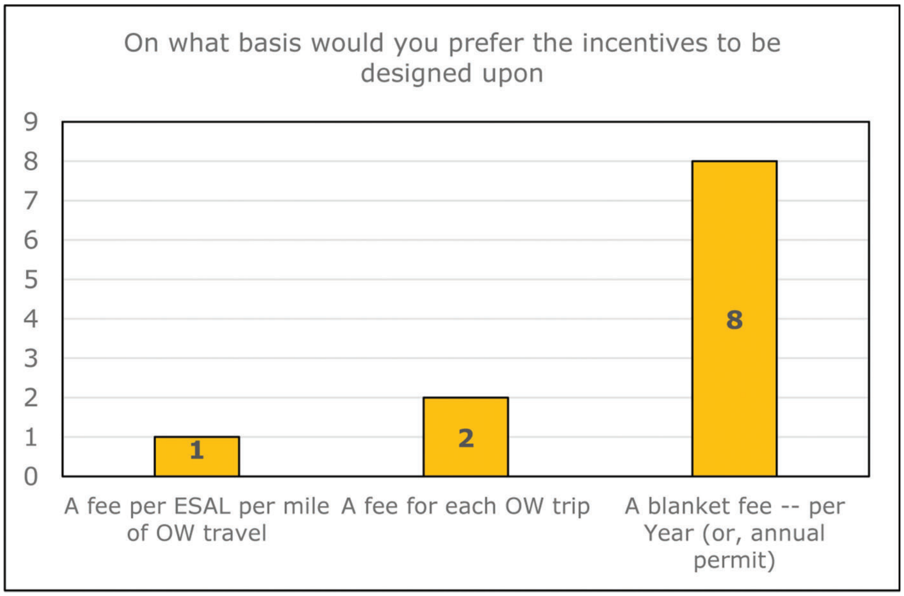


Figure 11.13 State financial incentives.

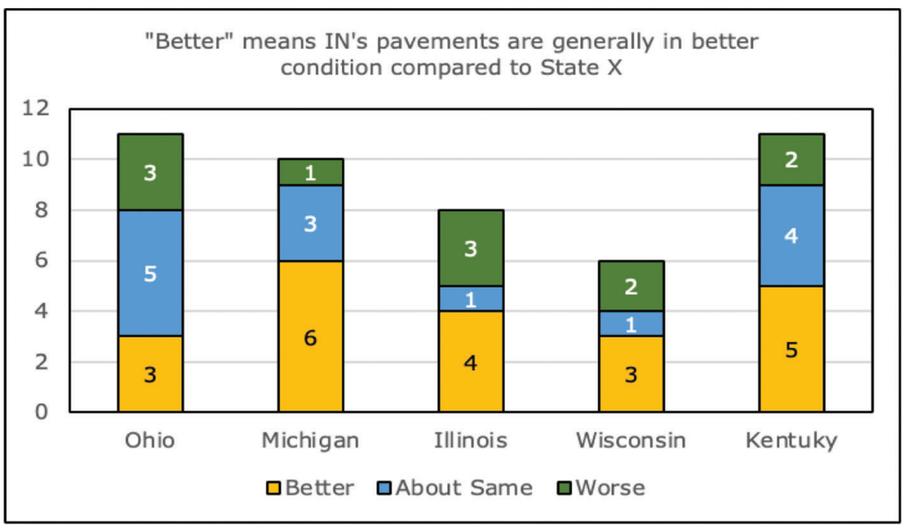


Figure 11.14 Freight transport industry perceptions of Indiana pavement quality compared to other states.

relevant factors) for a given OW trip, generating an estimate of the associated permit fee. Respondents highlighted the importance of specific functionalities for the dashboard, including the following.

- *Integration Capability:* The ability to integrate with freight transportation management systems, streamlining the process and automating the issuance of permits, particularly if on a per-load basis.
- *Confirmation and Timely Updates:* Confirmation of permit receipt and an estimate of when the permit would be distributed, providing transparency and clarity in the process.
- *Dashboard Elements:* Desire for relevant dashboard elements, such as a permit history feature, information on trip duration, and map views for enhanced visibility and tracking.

While a significant portion of respondents saw merit in the proposed online dashboard, one respondent held a different perspective, suggesting that the primary focus should be on addressing the fundamental issue of adding an additional axle and increasing the legal weight capacity.

11.7 Chapter Summary

The survey results indicate that fewer respondents run trips with more than 50% being OW, and the number of OW trips has decreased after the increase in permit fees. Many respondents noted a reluctance to add an additional axle to their trucks, citing a projected cost of nearly ten thousand dollars and expressing a preference to avoid this modification. Apart from direct costs, respondents highlighted indirect costs and other concerns associated with adding axles. Most respondents indicated that Indiana pavements are in better or similar condition compared to pavements in other states where they haul trucks. The survey suggested that companies would be interested in using online dashboards to estimate permit fees, with respondents suggesting specific features. However, there was a common sentiment among respondents that the dashboard might have little impact on the primary issue of OW permit fees. A recurring theme in the responses was the desire for Indiana to align its policies consistently with those of neighboring states to facilitate smoother operations for companies. Such consistency with neighboring states was identified as a key consideration by survey participants.

CHAPTER 12. SUMMARY AND CONCLUSIONS

12.1 Actual and Anticipated Impacts of HEA 1190-2021 on the Volume of Single-Trip and Annual Permits Issued

The analysis of the trend of number of permits issued monthly prior to and after HEA 1190-2021 implementation suggests that HEA 1190-2021 caused (or, at least, coincided with) a reversal of the trend of permit counts (from a gently declining trend to a gently increasing one). There were monthly fluctuations of varying magnitude, but the overall trend is clear: a slight downward trajectory in the period leading to HEA 1190-2021 and a slight upward trajectory in the months following the legislation. A plausible explanation for the increase in the permit count after the implementation of HEA 1190-2021, is that HEA 1190-2021 expanded the list of items that could be counted in the OW divisible load category. By removing the list of commodities and specific weight limitations for certain commodities from the definition of "overweight divisible loads," the bill expanded the commodities that could be included. As a result, carriers responded by obtaining more OW permits to ship the now included commodities as OW.

12.2 Actual Infrastructure Conditions and Safety Performance at the Permitted Routes

Chapter 5 of this report presented the analysis of the impacts of OW loading on infrastructure consumption and safety performance at permitted routes. The results showed that routes that experience higher cumulative loads see their PCR decrease faster than their counterparts. The difference in loading, and consequently the change in PCR is more pronounced in some routes than others. For example, Figure 5.4 presents these differences for US-31 and US-13. The cumulative loading on US-31 is nearly ten times that experienced by US-13. Consequently, the PCR on US-31 is on average 15 points lower than that on US-13 for the analysis period. On the other hand, the difference in cumulative loading experienced by US-231 is only approximately 30% higher than that of US-41 (Figure 5.5). As a result, the difference in PCR between US-231 and US-41 is not as pronounced. Similar variations are observed for other figures.

Taken together, the routes with higher cumulative loads experience on average approximately 70,000 more ESALs than their counterparts and see PCR drops of six points on average. This translates into an average deterioration rate of 0.11 PCR points/1,000 ESALs of OW loading. At a marginal PDC of $0.55/ESAL-mile (Ahmed, Agbelie, et al., 2013), this translates into approximately $3,778/mile in pavement damage cost due to OW operations. This implies that OW operations account for an additional $3,778/mile in maintenance and rehabilitation costs at permitted routes compared with normal weight loading.

The results of the safety analysis showed that throughout the analysis period, the crash rates show a consistent trend, with no impact from the law. A decline in crash rates is noted across the board in 2020, but this can largely be attributed to the COVID 19 pandemic and reduced traffic it caused. Following the waning of the pandemic, the crash rates appear to increase accordingly and getting back to pre-pandemic levels by the end of 2022. A statistical test comparing the mean crash rates at the permitted routes for the period before and after the implementation date of the law showed that across all the categories, no statistically significant difference was found between the mean number of crashes for the periods before and after at 95% level of confidence (5% level of significance). We can conclude therefore, that based on the available data, there is no evidence of any significant effect of the interim policy on safety performance at the permitted routes.

12.3 Prospects for OW Fee Revision to Incentivize User Behavior to Protect Infrastructure

The analyses presented in Section 5.1 and Chapter 11 show that the average GVW exhibits a downward trajectory over the analysis period (see Figure 5.2). It can be observed that even before the legislation was implemented, the average vehicle weight for OW divisible loads was declining. This did not change with the interim permit fees. Therefore, it could be inferred that the new fee structure did not significantly change the average vehicle weight for OW divisible loads. A similar conclusion can be drawn regarding the average damage caused by each OW truck (as shown in the chart for the mean vehicle ESALs (Figure 5.3)).

These illustrations indicate that although INDOT has concerns regarding infrastructure consumption at permitted routes, there is no evidence to suggest that there was any significant increase in average OW traffic loading (GVW) or pavement damage (ESALs) caused by each OW truck after the HEA 1190-2021 was implemented. On the contrary, it can be inferred that the downward trajectory for the average weight and average ESAL (which continued after HEA 1190-2021 was implemented) is indicative of the impact of the legislation in terms of its promotion of continued decline in loading and damage.

Continuance of the decline in average shipment loads and average damage, even with a higher number of permits, generally bodes well for the road infrastructure. Therefore, it seems reasonable to state that infrastructure consumption is decreasing because of the HEA 1190-2021 legislation. Additional data items spanning a longer analysis period after the implementation of HEA 1190-2021, will be needed to make such a determination.

12.4 Impact of the Existing Fee Structure on Shippers and Carriers, Including Their Investments (if any) in Axle Addition

The addition of an axle is associated with significant cost (estimates are approximately $7,500, https://www.heavyequipmentforums.com/). This will also lead to costs of preventive and remedial maintenance, estimated at approximately 10% of the purchase cost per year, in tire replacement, and maintenance of other parts on the added axle. With an added axle, shippers and carriers can load more and will enjoy the 2.4 ESAL credit to a larger extent and frequency. A rough estimation of the payback period is approximately 8–14 months, for an OW truck that has an average OW load and travels over distances equal to the average of all OW trips.

12.5 Financial Levers INDOT Can Use to Facilitate Permitting and Freight Transportation Competitiveness of the State

To incentivize user behavior that will reduce infrastructure consumption, INDOT could implement a permit fee surcharge for OW operations on certain routes such as non-interstate routes or during certain times of the year such the winter periods. This is essential because pavement construction standards vary by functional class. Interstates have the highest construction standards, followed by NIS-NHS roads. As such, interstate routes can handle more loading than their NIS-NHS counterparts. Therefore, operating the same OW truck on both routes results in greater damage on the non-interstate route than the interstate. To compensate for this disparity, INDOT could implement a surcharge fee for each permit that includes non-interstate routes. The surcharge fee can be a fixed added to the permit fee or can be prorated per mile calculated based on the non-interstate route distance covered. Implementing this surcharge for the winter periods, or for non-interstate routes, or both accounts for the disparities in infrastructure construction due to these varying factors. Similarly, in place of, or in addition to a surcharge, INDOT could provide credits for behaviors that preserve infrastructure such as primarily using interstates for OW operations and avoiding or reducing OW operations during the winter months.

Another lever that can be considered is the provision of incentives for carriers to add additional axles to their trucks. Previously, carriers have been reluctant to add axles to their axles, citing cost as the primary factor. However, if INDOT can provide discounts or credits that can help offset this cost, more carriers may be willing to adopt this approach. Based on the results of the survey conducted for this study (see Chapter 10), most respondents indicated that they would be willing to add an axle to their trucks if financial incentives were provided. Since carriers have indicated a willingness to take this approach, leveraging this gives INDOT a financial lever that is both effective and potentially well received. It is worth noting that such a lever would constitute a financial lever, not a subsidy.

CHAPTER 13. RECOMMENDATIONS

13.1 Continuance of the Current Permit Fee Structure

The analysis presented in this report shows that the change in permit fee from $0.07 per ESAL-mile to $0.25 per ESAL-mile will significantly increase the expected revenue from OW permitting. This is because the trends have shown that the new law does not significantly impact the demand for OW operations. In fact, the study found that the number of OW permits issued is increasing despite the increased permit fee (Figure 5.1). Although the average shipment weight is declining, the increased number of permits compensates for this decline, from the revenue adequacy perspective. Clearly, the permit fee increase did not cause a reduced demand for OW operations. More importantly, it is observed that the new fees incentivized favorable loading behavior by the freight industry. Therefore, this report recommends that the current (interim) permit fee of $0.25 per ESAL-mile should be maintained and made permanent after the interim period expires.

13.2 Differential Permit Fee Across the Road Classes

A differential permit fee across the road classes means having a surcharge for certain road classes. In Chapter 6 of this report, the OW permit-fee revenue was compared with the OW-induced pavement consumption (Figure 6.6), and it was observed that the unit damage cost for interstate routes is much lower than the corresponding unit damage cost for non-interstate routes for the same loading. This is in part because interstate pavements are generally built to a higher standard compared to non-interstates. Also, interstate routes generally experience eight times as much traffic, on average, as non-interstate routes. This implies that the pavement damage cost for interstates is spread out over a much larger user base and due to scale economies, is relatively smaller compared to non-interstates. Therefore, this report recommends that INDOT add a surcharge to permit fees on OW operations at non-interstate routes, to further protect that class of infrastructure. Such a surcharge could be implemented as an increased ESAL-mile fee or as a lump sum to annual permits requested for non-interstate routes.

13.3 Differential Permit Fee Across the Seasons

Highway pavement subgrades and subbases often consist of soils that have lower bearing strength in high moisture regimes. Such moisture regimes are experienced during the spring thaw season when these layers become saturated because of runoff from melting ice and snow. In addition, ice lenses in the subgrades experience volumetric changes due to the change in ambient soil temperatures during the thawing process, and the effect of these volumetric changes translate to the pavement surface as cracks. Thus, generally, the spring thaw season is the time when the subgrades and subbases have the least structural integrity. For this reason, at least one Midwest state has imposed restrictions on OW operations during this season. This report recommends that Indiana should consider either restricting OW operations during this season, and/or imposing a surcharge on OW operations at this time of year. This report recommends that INDOT should commission a JTRP study to investigate this issue, and to establish the appropriate period of restriction and/or the surcharge amount to cover OW damage to pavements at this time. The situation is generally more pertinent at non-interstate highways, and thus, any such surcharge fee could be applied to non-interstates only.

13.4 Incentivizing Good User Behavior Through Permit Fees: Surcharging vs. Crediting

From a public relations perspective, crediting could be more acceptable tool to reward good road-user behavior instead of surcharging to penalize poor behavior, to achieve the same goal. Therefore, instead of permit fee surcharging as suggested above for OW operations at non-interstate highways or during the spring thaw season, a more astute policy to protect the infrastructure could be to provide credits or discounts for OW operations at interstate highways or during periods other than the spring thaw season.

13.5 Permit Fee Credits or Discounts for Adding an Axle

The previous experience in Indiana has been characterized by the freight industry's reluctance to add axles to their trucks, citing cost as the primary factor. Based on the survey feedback from the freight transportation industry representatives in this study, the industry is willing to add axles to their trucks, particularly if financial incentives are provided. As direct subsidies may be a violation of government policy at the current time, this report suggests that INDOT and INDOR could provide permit discounts or credits to help recover some of this cost. Such a financial lever could be not only acceptable but also potentially effective and efficient to both stakeholders.

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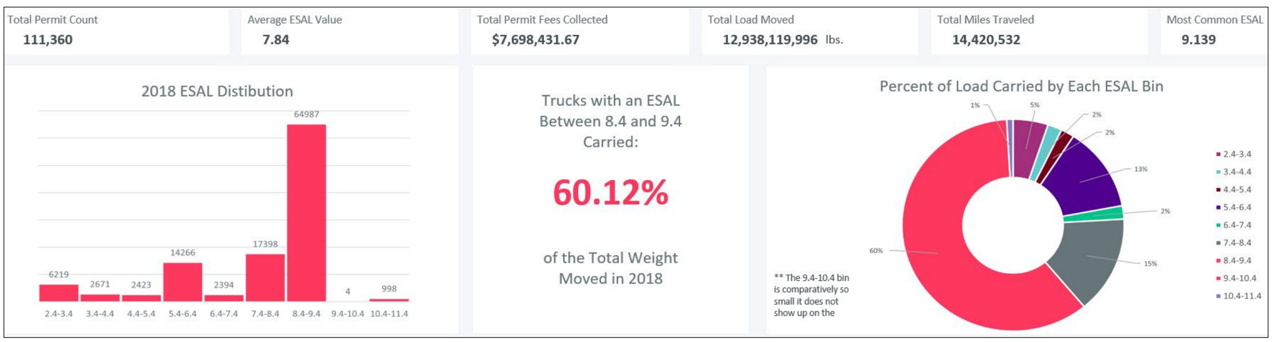
APPENDICES

APPENDIX A. OBSERVED AGGREGATE OW LOADING PRACTICES 2017–2019

(a) 2017



(b) 2018

(c) 2019

APPENDIX B. SUMMARY OF INDOT'S RECOMMENDED OW PERMIT FEE STRUCTURE DURING THE INTERIM PERIOD

Overweight Permit Fees

The cost of a permit can vary depending on many factors. The exact cost is calculated by the permitting system and may be different than the amount shown below.

Type of Vehicle/Permit	Single Trip Permit Fee	Annual Permit Fee	Fees for Bridge Review (If Required)
Overweight, GVW between 80,000 lbs. and 108,000 lbs.	$20 + $0.35 per mile		$35 bridge review fee
Overweight, GVW between 108,000 lbs. and 134,000 lbs.	$20 + $0.60 per mile		$35 bridge review fee
Overweight, GVW between 134,000 lbs. and 150,000 lbs.	$20 + $0.60 per mile		$35 bridge review fee $10 per bridge crossed on permitted route, not to exceed $200 (for round-trip permits, $10 per unique bridge crossed, not to exceed $400)
Overweight, GVW between 150,000 lbs. and 200,000 lbs.	$20 + $1 per mile		$35 bridge review fee $10 per bridge crossed on permitted route, not to exceed $200 (for round-trip permits, $10 per unique bridge crossed, not to exceed $400)
Overweight, GVW greater than 200,000 lbs.	$20 + $1 per mile		***Bridge review required for all vehicles 200,000 lbs. or more GVW.*** $35 bridge review fee $10 per bridge crossed per 30-day preauthorization $10 per bridge crossed per permit, if not ordered from a valid preauthorization
Overweight divisible load (metal, ag, wood), ESAL 2.4 or less		$20	
Overweight divisible load, ESAL greater than 2.4	$20 + $0.07 ($0.25 effective Jan. 1, 2022) per mile per ESAL in excess of 2.4		
Special Weight/Michigan Trail Permit	$42.50 per day + $25 annual registration fee		

10/22/2021

Source: INDOR, 2021a

APPENDIX C. UNIT COSTS OF OW DAMAGE TO BRIDGES

Table C.1 Estimates of bridge damage cost by road class, bridge material type, age, for truck class HS20–HS31 (Ahmed et al., 2012)

Highway Type	Bridge Type	Age Group (yrs)	Number	EUA Overweight Truck Volume	EUAC/Length (2010$ x 10^3/ft) for all Vehicles	EUAC/Length (2010$ x 10^3/ft) for Overweight Trucks	Cost per Length per pass for AASHTO Loadings (HS)(2010$ /ft)											
							20	21	22	23	24	25	26	27	28	29	30	31
Interstate	Steel	0 to 20	569	517,564	850.8	342.6	0.000	0.006	0.007	0.032	0.061	0.091	0.123	0.155	0.197	0.261	0.333	0.415
		21 to 35	374		892.0	359.2	0.000	0.006	0.007	0.033	0.064	0.096	0.128	0.162	0.207	0.273	0.349	0.435
		36 to 55	2		892.2	359.3	0.000	0.006	0.007	0.033	0.064	0.096	0.128	0.162	0.207	0.273	0.349	0.435
		56 to 70	0		961.3	387.1	0.000	0.006	0.007	0.035	0.068	0.102	0.138	0.174	0.222	0.294	0.375	0.468
	Prestressed Concrete	0 to 20	102		873.4	351.7	0.000	0.006	0.007	0.033	0.062	0.094	0.126	0.159	0.202	0.268	0.342	0.426
		21 to 35	53		910.2	366.5	0.000	0.006	0.007	0.034	0.065	0.097	0.131	0.165	0.211	0.279	0.356	0.443
		36 to 55	2		937.4	377.5	0.000	0.006	0.007	0.035	0.066	0.100	0.135	0.170	0.217	0.287	0.366	0.456
		56 to 70	0		1,017.5	409.7	0.000	0.006	0.007	0.037	0.072	0.108	0.145	0.184	0.235	0.311	0.397	0.495
	Reinforced Concrete	0 to 20	255		842.7	339.4	0.000	0.006	0.007	0.032	0.060	0.091	0.122	0.153	0.196	0.259	0.330	0.411
		21 to 35	65		874.7	352.2	0.000	0.006	0.007	0.033	0.062	0.094	0.126	0.159	0.203	0.268	0.342	0.426
		36 to 55	9		905.0	364.4	0.000	0.006	0.007	0.034	0.064	0.097	0.130	0.164	0.209	0.277	0.354	0.441
		56 to 70	0		979.2	394.3	0.000	0.006	0.007	0.036	0.069	0.104	0.140	0.177	0.226	0.299	0.382	0.477
NHS Non-Interstate	Steel	0 to 20	188	193,354	850.8	342.6	0.000	0.007	0.013	0.081	0.158	0.240	0.324	0.409	0.523	0.694	0.887	1.106
		21 to 35	175		892.0	359.2	0.000	0.007	0.013	0.084	0.165	0.251	0.339	0.428	0.548	0.726	0.929	1.159
		36 to 55	14		892.2	359.3	0.000	0.007	0.013	0.084	0.165	0.251	0.339	0.428	0.548	0.727	0.929	1.159
		56 to 70	0		961.3	387.1	0.000	0.007	0.013	0.090	0.177	0.269	0.364	0.461	0.589	0.782	1.000	1.248
	Prestressed Concrete	0 to 20	129		873.4	351.7	0.000	0.007	0.013	0.083	0.162	0.246	0.332	0.420	0.537	0.712	0.910	1.135
		21 to 35	84		910.2	366.5	0.000	0.007	0.013	0.086	0.168	0.256	0.345	0.437	0.559	0.741	0.947	1.182
		36 to 55	10		937.4	377.5	0.000	0.007	0.013	0.088	0.173	0.263	0.355	0.450	0.575	0.763	0.975	1.217
		56 to 70	0		1,017.5	409.7	0.000	0.007	0.013	0.094	0.187	0.284	0.384	0.487	0.623	0.827	1.058	1.320
	Reinforced Concrete	0 to 20	151		842.7	339.4	0.000	0.007	0.013	0.080	0.157	0.238	0.321	0.405	0.518	0.687	0.878	1.095
		21 to 35	108		874.7	352.2	0.000	0.007	0.013	0.083	0.162	0.246	0.332	0.420	0.538	0.713	0.911	1.136
		36 to 55	23		905.0	364.4	0.000	0.007	0.013	0.085	0.167	0.254	0.343	0.434	0.556	0.737	0.942	1.175
		56 to 70	13		979.2	394.3	0.000	0.007	0.013	0.091	0.180	0.274	0.370	0.469	0.600	0.796	1.018	1.271
Non-NHS Roads	Steel	0 to 20	72	55,174	850.8	342.6	0.000	0.028	0.055	0.292	0.562	0.849	1.142	1.442	1.842	2.438	3.115	3.883
		21 to 35	107		892.0	359.2	0.000	0.028	0.055	0.304	0.587	0.887	1.195	1.509	1.928	2.554	3.263	4.068
		36 to 55	10		892.2	359.3	0.000	0.028	0.055	0.304	0.587	0.887	1.195	1.509	1.928	2.554	3.263	4.069
		56 to 70	2		961.3	387.1	0.000	0.028	0.055	0.323	0.628	0.952	1.283	1.622	2.074	2.748	3.512	4.380
	Prestressed Concrete	0 to 20	111		873.4	351.7	0.000	0.028	0.055	0.298	0.576	0.870	1.171	1.479	1.889	2.502	3.196	3.985
		21 to 35	89		910.2	366.5	0.000	0.028	0.055	0.309	0.598	0.904	1.218	1.539	1.966	2.605	3.328	4.150
		36 to 55	6		937.4	377.5	0.000	0.028	0.055	0.316	0.614	0.929	1.253	1.583	2.023	2.681	3.426	4.273
		56 to 70	0		1,017.5	409.7	0.000	0.028	0.055	0.339	0.661	1.004	1.355	1.714	2.192	2.905	3.714	4.633
	Reinforced Concrete	0 to 20	118		842.7	339.4	0.000	0.028	0.055	0.290	0.557	0.841	1.132	1.429	1.825	2.416	3.086	3.847
		21 to 35	182		874.7	352.2	0.000	0.028	0.055	0.299	0.576	0.871	1.173	1.481	1.892	2.505	3.201	3.990
		36 to 55	45		905.0	364.4	0.000	0.028	0.055	0.307	0.594	0.899	1.211	1.530	1.955	2.590	3.310	4.127
		56 to 70	17		979.2	394.3	0.000	0.028	0.055	0.328	0.639	0.968	1.306	1.651	2.111	2.798	3.576	4.460

Table C.2 Estimates of bridge damage cost by road class, bridge material type, age, for truck class HS31–HS40 (Ahmed et al., 2012)

Highway Type	Bridge Type	Age Group (yrs)	Number	EUA Overweight Truck Volume	EUAC/Length (2010$ x 10^3/ft) for all Vehicles	EUAC/Length (2010$ x 10^3/ft) for Overweight Trucks	Cost per Length per pass for AASHTO Loadings (HS)(2010$ /ft)									
							31	32	33	34	35	36	37	38	39	40
Interstate	Steel	0 to 20	569	517,564	850.8	342.6	0.415	0.501	0.603	0.723	0.864	1.027	1.263	1.700	2.330	3.369
		21 to 35	374		892.0	359.2	0.435	0.525	0.632	0.758	0.906	1.077	1.324	1.782	2.442	3.532
		36 to 55	2		892.2	359.3	0.435	0.525	0.632	0.758	0.906	1.077	1.324	1.782	2.443	3.532
		56 to 70	0		961.3	387.1	0.468	0.566	0.681	0.816	0.976	1.160	1.426	1.920	2.632	3.806
	Prestressed Concrete	0 to 20	102		873.4	351.7	0.426	0.514	0.619	0.742	0.887	1.054	1.296	1.745	2.392	3.458
		21 to 35	53		910.2	366.5	0.443	0.536	0.645	0.773	0.924	1.098	1.351	1.818	2.492	3.604
		36 to 55	2		937.4	377.5	0.456	0.552	0.664	0.796	0.951	1.131	1.391	1.872	2.566	3.711
		56 to 70	0		1,017.5	409.7	0.495	0.598	0.720	0.863	1.032	1.227	1.509	2.032	2.785	4.028
	Reinforced Concrete	0 to 20	255		842.7	339.4	0.411	0.497	0.598	0.716	0.856	1.017	1.251	1.684	2.308	3.337
		21 to 35	65		874.7	352.2	0.426	0.515	0.620	0.743	0.888	1.056	1.298	1.748	2.395	3.463
		36 to 55	9		905.0	364.4	0.441	0.533	0.641	0.769	0.919	1.092	1.343	1.808	2.478	3.583
		56 to 70	0		979.2	394.3	0.477	0.576	0.693	0.831	0.994	1.181	1.452	1.956	2.681	3.876
NHS Non-Interstate	Steel	0 to 20	188	193,354	850.8	342.6	1.106	1.337	1.610	1.930	2.308	2.745	3.376	4.546	6.232	9.013
		21 to 35	175		892.0	359.2	1.159	1.401	1.687	2.023	2.419	2.877	3.539	4.765	6.533	9.448
		36 to 55	14		892.2	359.3	1.159	1.401	1.688	2.023	2.420	2.877	3.539	4.766	6.534	9.450
		56 to 70	0		961.3	387.1	1.248	1.509	1.817	2.179	2.606	3.099	3.812	5.134	7.040	10.182
	Prestressed Concrete	0 to 20	129		873.4	351.7	1.135	1.372	1.653	1.981	2.369	2.817	3.465	4.666	6.397	9.252
		21 to 35	84		910.2	366.5	1.182	1.429	1.721	2.064	2.468	2.935	3.610	4.862	6.666	9.641
		36 to 55	10		937.4	377.5	1.217	1.472	1.773	2.125	2.542	3.022	3.718	5.007	6.865	9.929
		56 to 70	0		1,017.5	409.7	1.320	1.596	1.923	2.306	2.758	3.279	4.035	5.434	7.450	10.776
	Reinforced Concrete	0 to 20	151		842.7	339.4	1.095	1.324	1.595	1.912	2.286	2.718	3.344	4.503	6.173	8.927
		21 to 35	108		874.7	352.2	1.136	1.374	1.655	1.984	2.373	2.821	3.470	4.673	6.406	9.265
		36 to 55	23		905.0	364.4	1.175	1.421	1.712	2.052	2.454	2.918	3.590	4.835	6.628	9.586
		56 to 70	13		979.2	394.3	1.271	1.537	1.851	2.219	2.655	3.156	3.883	5.230	7.170	10.371
Non-NHS Roads	Steel	0 to 20	72	55,174	850.8	342.6	3.883	4.693	5.650	6.772	8.097	9.626	11.838	15.939	21.848	31.594
		21 to 35	107		892.0	359.2	4.068	4.918	5.921	7.097	8.486	10.089	12.408	16.707	22.902	33.119
		36 to 55	10		892.2	359.3	4.069	4.919	5.922	7.098	8.488	10.091	12.411	16.710	22.906	33.126
		56 to 70	2		961.3	387.1	4.380	5.296	6.377	7.644	9.141	10.868	13.368	18.001	24.677	35.688
	Prestressed Concrete	0 to 20	111		873.4	351.7	3.985	4.817	5.799	6.950	8.311	9.880	12.151	16.361	22.426	32.431
		21 to 35	89		910.2	366.5	4.150	5.017	6.041	7.241	8.658	10.293	12.660	17.047	23.368	33.793
		36 to 55	6		937.4	377.5	4.273	5.165	6.220	7.456	8.916	10.600	13.037	17.555	24.065	34.802
		56 to 70	0		1,017.5	409.7	4.633	5.602	6.746	8.088	9.673	11.501	14.146	19.050	26.117	37.772
	Reinforced Concrete	0 to 20	118		842.7	339.4	3.847	4.649	5.597	6.708	8.021	9.535	11.726	15.787	21.640	31.293
		21 to 35	182		874.7	352.2	3.990	4.823	5.807	6.960	8.323	9.894	12.169	16.384	22.459	32.478
		36 to 55	45		905.0	364.4	4.127	4.989	6.007	7.200	8.609	10.235	12.589	16.950	23.236	33.602
		56 to 70	17		979.2	394.3	4.460	5.393	6.494	7.785	9.310	11.069	13.616	18.335	25.135	36.351

Table C.3 Estimates of bridge damage cost by road class, bridge material type, age, for truck class HS41–HS50 (Ahmed et al., 2012)

Highway Type	Bridge Type	Age Group (yrs)	Number	EUA Overweight Truck Volume	EUAC/Length (2010$ x 10^3/ft) for all Vehicles	EUAC/Length (2010$ x 10^3/ft) for Overweight Trucks	Cost	Cost per Length per pass for AASHTO Loadings (HS)(2010$ /ft)								
							41	42	43	44	45	46	47	48	49	50
Interstate	Steel	0 to 20	569	517,564	850.8	342.6	5.382	5.652	5.922	6.192	6.462	7.616	8.945	10.469	12.212	14.201
		21 to 35	374		892.0	359.2	5.642	5.848	6.054	6.260	6.466	7.622	8.952	10.478	12.224	14.217
		36 to 55	2		892.2	359.3	5.643	5.849	6.055	6.260	6.466	7.622	8.952	10.478	12.225	14.217
		56 to 70	0		961.3	387.1	6.079	6.178	6.276	6.375	6.473	7.632	8.964	10.493	12.245	14.244
	Prestressed Concrete	0 to 20	102		873.4	351.7	5.524	5.759	5.994	6.229	6.465	7.620	8.949	10.474	12.219	14.210
		21 to 35	53		910.2	366.5	5.756	5.934	6.112	6.290	6.468	7.625	8.955	10.482	12.230	14.224
		36 to 55	2		937.4	377.5	5.928	6.064	6.200	6.335	6.471	7.628	8.960	10.488	12.238	14.235
		56 to 70	0		1,017.5	409.7	6.434	6.446	6.457	6.468	6.479	7.639	8.974	10.506	12.262	14.265
	Reinforced Concrete	0 to 20	255		842.7	339.4	5.330	5.614	5.897	6.181	6.464	7.619	8.948	10.473	12.217	14.207
		21 to 35	65		874.7	352.2	5.532	5.766	6.000	6.234	6.467	7.623	8.953	10.480	12.227	14.220
		36 to 55	9		905.0	364.4	5.724	5.910	6.097	6.284	6.470	7.628	8.959	10.486	12.236	14.231
		56 to 70	0		979.2	394.3	6.192	6.264	6.335	6.406	6.478	7.638	8.972	10.503	12.258	14.260
NHS Non-Interstate	Steel	0 to 20	188	193,354	850.8	342.6	14.401	15.647	16.894	18.140	19.387	22.849	26.834	31.406	36.637	42.604
		21 to 35	175		892.0	359.2	15.096	16.172	17.247	18.322	19.398	22.864	26.853	31.431	36.669	42.646
		36 to 55	14		892.2	359.3	15.099	16.174	17.248	18.323	19.398	22.865	26.853	31.431	36.670	42.646
		56 to 70	0		961.3	387.1	16.268	17.055	17.842	18.629	19.416	22.890	26.886	31.472	36.725	42.717
	Prestressed Concrete	0 to 20	129		873.4	351.7	14.782	15.935	17.088	18.240	19.393	22.858	26.845	31.420	36.655	42.627
		21 to 35	84		910.2	366.5	15.404	16.404	17.403	18.403	19.403	22.871	26.862	31.442	36.684	42.665
		36 to 55	10		937.4	377.5	15.864	16.750	17.637	18.523	19.410	22.881	26.875	31.458	36.706	42.693
		56 to 70	0		1,017.5	409.7	17.218	17.772	18.325	18.878	19.431	22.910	26.912	31.506	36.770	42.775
	Reinforced Concrete	0 to 20	151		842.7	339.4	14.263	15.545	16.828	18.110	19.392	22.856	26.843	31.416	36.650	42.620
		21 to 35	108		874.7	352.2	14.804	15.953	17.102	18.251	19.401	22.868	26.857	31.435	36.675	42.653
		36 to 55	23		905.0	364.4	15.316	16.340	17.363	18.386	19.409	22.879	26.872	31.454	36.699	42.684
		56 to 70	13		979.2	394.3	16.570	17.285	17.999	18.714	19.429	22.906	26.906	31.498	36.759	42.761
Non-NHS Roads	Steel	0 to 20	72	55,174	850.8	342.6	50.473	54.011	57.548	61.085	64.623	76.165	89.447	104.687	122.122	142.014
		21 to 35	107		892.0	359.2	52.912	55.849	58.786	61.724	64.661	76.218	89.515	104.773	122.237	142.162
		36 to 55	10		892.2	359.3	52.922	55.857	58.791	61.726	64.661	76.218	89.515	104.774	122.238	142.162
		56 to 70	2		961.3	387.1	57.019	58.945	60.872	62.799	64.726	76.306	89.628	104.919	122.431	142.411
	Prestressed Concrete	0 to 20	111		873.4	351.7	51.811	55.019	58.227	61.436	64.644	76.194	89.484	104.734	122.185	142.095
		21 to 35	89		910.2	366.5	53.989	56.662	59.334	62.006	64.678	76.241	89.544	104.812	122.288	142.227
		36 to 55	6		937.4	377.5	55.602	57.878	60.153	62.428	64.703	76.276	89.589	104.869	122.364	142.325
		56 to 70	0		1,017.5	409.7	60.349	61.456	62.563	63.671	64.778	76.378	89.719	105.037	122.589	142.613
	Reinforced Concrete	0 to 20	118		842.7	339.4	49.992	53.654	57.317	60.979	64.642	76.189	89.477	104.723	122.168	142.071
		21 to 35	182		874.7	352.2	51.886	55.082	58.279	61.475	64.671	76.230	89.529	104.790	122.257	142.186
		36 to 55	45		905.0	364.4	53.683	56.437	59.191	61.946	64.700	76.269	89.578	104.854	122.342	142.295
		56 to 70	17		979.2	394.3	58.078	59.750	61.423	63.096	64.769	76.363	89.699	105.009	122.550	142.562

APPENDIX D. INDIANA'S HEA 1190-2021 OVERWEIGHT TRUCK PERMITS (SUMMARY)

Bill Summary

Overweight truck permits. Makes certain changes to the maximum gross vehicle weight limit. Provides that the Indiana department of transportation (department) may issue an overweight permit for transporting overweight vehicles and loads carrying resources on certain highways in the state highway system. Provides a civil penalty for deviation from an approved route. Provides that the department shall recalculate and apply permit fees for annual and trip permits based on the 2014 Purdue Study, and shall consider the impact of overweight divisible loads on roads and highways. Provides that not more than 8,500 trip permits may be issued annually for applicants with a total equivalent single axle load calculation more than 2.40 equivalent single axle load credit. Provides that the trip permit limit does not include overweight divisible load permits obtained by shippers and carriers that obtained permits before January 1, 2021. Provides that the department may temporarily increase the number of overweight divisible load permits issued by order of the commissioner in response to an emergency or changes in market conditions. Provides that the department may limit the number of overweight divisible load permits issued to an individual applicant. Allows the department to suspend the overweight divisible load permitting program under certain conditions. Requires the department to adopt rules due to lack of transportation options for certain resources, supply chain interruptions, or supply dock backlogs. Provides that the department shall issue a report to the legislative council and the interim study committee on roads and transportation regarding the fee structure of overweight divisible load permits, and regarding the impact of overweight divisible loads on roads and highways by July 1, 2023. Requires, beginning July 1, 2022, annual reports from the department to the legislative council and the interim study committee on roads and transportation regarding market fluctuation in the number of overweight divisible load permits issued during the previous year. Requires, beginning July 1, 2022, the Indiana state police department and the Indiana department of transportation to submit annual reports to the legislative council and the interim study committee on roads and transportation regarding the number of accidents involving applicants permitted for overweight divisible loads which should include the number of accidents resulting in property damage, and the number of accidents resulting in personal injury. Requires the department to provide a report on July 1, 2026, and July 1, 2030, to the legislative council and the interim study committee on roads and transportation regarding the impact of overweight divisible loads on roads, highways, and accidents resulting in property damage or personal injury. Requires the interim study committee on roads and transportation to provide a final report on October 31, 2026, that recommends or opposes an overweight divisible load maximum weight increase to 110,000 pounds. Requires the interim study committee on roads and transportation to provide a final report on October 31, 2030, that recommends or opposes an overweight divisible load maximum weight increase to 120,000 pounds. Provides that a local authority may apply for and grant permits for transporting overweight divisible loads on local streets under the control of the local authority. Provides a civil penalty for deviation from an approved local route. Makes conforming changes.

Subject

No subjects listed

Sponsors (7)

Mike Bohacek (R)*, Jon Ford (R)*, Ron Grooms (R)*, David Niezgodski (D)*, Jim Pressel (R)*, Bob Heaton (R), Edmond Soliday (R),

Last Action

Public Law 179 (on 04/29/2021)

Official Document

http://proxy.legiscan.com/iga.php

Source: BillTrack50. (n.d.). IN HB1190, Overweight truck permits. *https://www.billtrack50.com/billdetail/1258789*

APPENDIX E. INDIANA'S HEA 1190-2921 OVERWEIGHT TRUCK PERMITS (DETAILS)

First Regular Session of the 122nd General Assembly (2021)

PRINTING CODE. Amendments: Whenever an existing statute (or a section of the Indiana Constitution) is being amended, the text of the existing provision will appear in this style type, additions will appear in **this style type**, and deletions will appear in ~~this style type.~~

Additions: Whenever a new statutory provision is being enacted (or a new constitutional provision adopted), the text of the new provision will appear in **this style type**. Also, the word **NEW** will appear in that style type in the introductory clause of each SECTION that adds a new provision to the Indiana Code or the Indiana Constitution.

Conflict reconciliation: Text in a statute in *this style type* or ~~*this style type*~~ reconciles conflicts between statutes enacted by the 2020 Regular Session of the General Assembly.

HOUSE ENROLLED ACT No. 1190

AN ACT to amend the Indiana Code concerning motor vehicles.

Be it enacted by the General Assembly of the State of Indiana:

SECTION 1. IC 9-13-2-120.7, AS AMENDED BY P.L.54-2018, SECTION 1, IS AMENDED TO READ AS FOLLOWS [EFFECTIVE JULY 1, 2021]: Sec. 120.7. "Overweight divisible load" means a tractor-semitrailer and load that:

(1) can be traditionally separated or reduced to meet the specified regulatory limits for weight;

~~(2) are involved in hauling, delivering, or otherwise carrying metal, bark, logs, sawdust, wood chips, or agricultural commodities, not including bulk milk;~~

~~(3)~~ **(2)** meet other requirements for height, length, and width; and

~~(4)~~ **(3)** have a gross vehicle weight of more than eighty thousand (80,000) pounds but a gross vehicle weight of not more than **one hundred twenty thousand (120,000) pounds.**

~~(A) one hundred twenty thousand (120,000) pounds if hauling metal commodities; and~~

~~(B) ninety-seven thousand (97,000) pounds if hauling from the point of harvest to the point of first destination bark, logs, sawdust, wood chips, or agricultural commodities, not including bulk milk.~~

SECTION 2. IC 9-20-6-1, AS AMENDED BY P.L.196-2017, SECTION 2, IS AMENDED TO READ AS FOLLOWS [EFFECTIVE JULY 1, 2021]: Sec. 1. (a) This chapter applies to the issuance of the

HEA 1190 — CC 1

Source: LegiScan. (n.d.). Indiana House Bill 1190. https://legiscan.com/IN/text/HB1190/id/2378280 following permits:

(1) A permit for the transportation of oversized or overweight vehicles and loads under section 2 **or 2.2** of this chapter.

(2) A toll road gate permit under section 3 of this chapter.

(3) An emergency permit issued under section 4 of this chapter.

(4) A permit for oversized semitrailers or trailers used with semitrailers under section 6 of this chapter.

(b) IC 9-20-2-1 applies to the issuance of a permit to operate machinery or equipment for the construction of highways.

(c) IC 9-20-9 applies to the issuance of a special towing permit for the operation of a combination of vehicles on a highway.

(d) IC 9-20-14 applies to the issuance of the following permits:

(1) A general permit for the operation of a tractor-mobile home rig.

(2) A special permit for the operation of a tractor-mobile home rig.

(e) IC 9-20-15 applies to the issuance of the following permits:

(1) A general permit for the operation of a special tractor-mobile home rig.

(2) A special permit for the operation of a special tractor-mobile home rig.

SECTION 3. IC 9-20-6-2.2 IS ADDED TO THE INDIANA CODE AS A **NEW** SECTION TO READ AS FOLLOWS [EFFECTIVE JULY 1, 2021]: **Sec. 2.2. (a) This section applies to overweight divisible loads (as defined in IC 9-13-2-120.7).**

(b) As used in this section, "equivalent single axle load" means the known quantifiable and standardized amount of damage to highway pavement structures equivalent to one (1) pass of a single eighteen thousand (18,000) pound dual tire axle, with all four (4) tires on the axle inflated to one hundred ten (110) pounds per square inch.

(c) A permit issued under this section does not apply to a highway under a local authority's jurisdiction.

(d) Subject to subsection (e), the Indiana department of transportation may, upon proper application in writing, grant a permit for transporting overweight vehicles and overweight divisible loads carrying resources on a highway in the state highway system, including state maintained routes through cities and towns.

(e) A permit granted under this section may be used only on designated highways within the state highway system, avoiding highways under a local authority's jurisdiction.

(f) A permit issued under this section may designate the route to be traversed and may contain any other restrictions or conditions required for the safe movement of the vehicle. If the department designates a route, a deviation from that route constitutes a violation subject to a civil penalty under IC 9-20-18-14.5.

(g) A permit issued under this section is limited to a gross vehicle weight of more than eighty thousand (80,000) pounds, but not more than one hundred twenty thousand (120,000) pounds.

(h) Not later than October 1, 2021, the Indiana department of transportation shall recalculate and apply permit fees for annual and trip permits granted under this section based on the Joint Transportation Research Program publication No. FHWA/IN/JTRP-2014/14. The Indiana department of transportation shall consider the impact of overweight divisible loads on roads and highways in recalculating permit fees under this subsection.

(i) Except as provided in subsection (k), the Indiana department of transportation may not issue more than eight thousand five hundred (8,500) single trip permits annually for applicants with a total equivalent single axle load calculation of more than 2.40 equivalent single axle load credit.

(j) A trip permit limit set under subsection (i) and a permit weight limit set under subsection (g) do not include overweight divisible load permits obtained by shippers and carriers that obtained permits before January 1, 2021.

(k) The Indiana department of transportation may temporarily increase the number of permits issued under subsection (i) by order of the commissioner in response to an emergency or changes in market conditions as defined by rules adopted under subsection (m).

(l) The Indiana department of transportation may limit the number of permits issued under subsection (i) to an individual applicant.

(m) The Indiana department of transportation shall adopt rules under IC 4-22-2, including emergency rules in the manner provided under IC 4-22-2-37.1, for the issuance, administration, fee structure, calculation of equivalent single axle load values, and enforcement of a permit under this section due to lack of transportation options for certain resources, supply chain interruptions, or supply dock backlogs.

(n) The Indiana department of transportation may suspend

overweight divisible load permitting if the department observes an unusual increase in:

(1) infrastructure damage on a permitted route; or

(2) the number of accidents associated with overweight divisible loads.

(o) Not later than July 1, 2023, the Indiana department of transportation shall submit a report to the legislative council and to the interim study committee on roads and transportation established by IC 2-5-1.3-4 in an electronic format under IC 5-14-6 regarding:

(1) the fee structure and recommended changes to the fee structure for permits issued under this section; and

(2) the impact of overweight divisible loads on roads and highways.

(p) Beginning July 1, 2022, the Indiana department of transportation shall, before July 1 of each year, submit a report to the legislative council and to the interim study committee on roads and transportation established by IC 2-5-1.3-4 in an electronic format under IC 5-14-6 regarding the market fluctuation in the number of overweight divisible load permits issued during the previous year.

(q) Beginning July 1, 2022, the Indiana state police department shall, before July 1 of each year, submit a report to the legislative council and to the interim study committee on roads and transportation established by IC 2-5-1.3-4 in an electronic format under IC 5-14-6 regarding the number of accidents involving applicants permitted for overweight divisible loads. The report must include at least the following:

(1) The number of accidents that resulted in property damage.

(2) The number of accidents that resulted in personal injury.

SECTION 4. IC 9-20-6-2.5, AS ADDED BY P.L.135-2013, SECTION 5, IS AMENDED TO READ AS FOLLOWS [EFFECTIVE JULY 1, 2021]: Sec. 2.5. ~~The Indiana department of transportation or~~ **(a) A** local authority that:

(1) has jurisdiction over a state highway, an interstate highway, or a local street; and

(2) is responsible for the repair and maintenance of the state highway, interstate highway, or local street;

may, upon proper application in writing and upon good cause shown, grant a permit for transporting overweight divisible loads **on or over roads or streets under the control of a local authority.**

(b) If a local authority grants a permit under subsection (a), the

local authority may designate a route for the permit. A deviation from that route constitutes a violation subject to a civil penalty under IC 9-20-18-14.5.

SECTION 5. IC 9-20-18-14.5, AS AMENDED BY HEA 1150-2021, SECTION 4, IS AMENDED TO READ AS FOLLOWS [EFFECTIVE JULY 1, 2021]: Sec. 14.5. (a) The civil penalties imposed under this section are in addition to the other civil penalties that may be imposed under IC 8 and IC 9. Notwithstanding section 12 of this chapter, a civil penalty imposed under this section:

(1) is imposed on the carrier transporting the vehicle or load;
(2) shall be deposited in the motor carrier regulation fund established by IC 8-2.1-23-1;
(3) is in addition to any fees or fines imposed by a court; and
(4) is assessed and determined by the department of state revenue in accordance with the procedures in IC 6-8.1-5-1.

(b) A carrier transporting vehicles or loads under a permit issued under this article that is violated with respect to this article subjects the carrier to a civil penalty of not more than ~~five hundred~~ **one thousand** dollars ~~($500)~~ **($1,000)** for the first violation and not more than one thousand **five hundred** dollars ~~($1,000)~~ **($1,500)** for each subsequent violation.

(c) A carrier that transports vehicles or loads subject to this article and fails to obtain a permit required under this article is subject to a civil penalty of not more than five thousand dollars ($5,000) for each violation described in an Indiana state police vehicle examination report.

(d) A carrier that transports vehicles or loads subject to this article in excess of the legal weight or dimensional limits and for which no permit is available to allow for such excess weight or dimension is subject to a civil penalty of not more than ten thousand dollars ($10,000) for each issued Indiana state police vehicle examination report.

(e) The department of state revenue may not assess a penalty under this section after more than one (1) year has passed from the date the department is notified of a violation described under subsection (b), (c), or (d).

(f) A carrier against whom a civil penalty is imposed under this section may protest the civil penalty and request an administrative hearing. If a carrier protests a civil penalty, the department of state revenue shall allow the carrier an opportunity to present information as to why the civil penalty should not be assessed or reduced pursuant to a defense provided under section 7 of this chapter.

(g) The department of state revenue's notice of proposed assessment under IC 6-8.1-5-1 is presumptively valid.

APPENDIX F. CONCEPTUAL RELATIONSHIP BETWEEN PAVEMENT DAMAGE COST AND TRUCK GVW

Figure F.1 presents the conceptual relationship between the units cost of pavement damage and the GVW. The figure indicates that the unit damage cost has two components: a damage cost due to legal weight; and a damage cost due to the excess (beyond the legal weight limit) weight (Chowdhury et al., 2013).

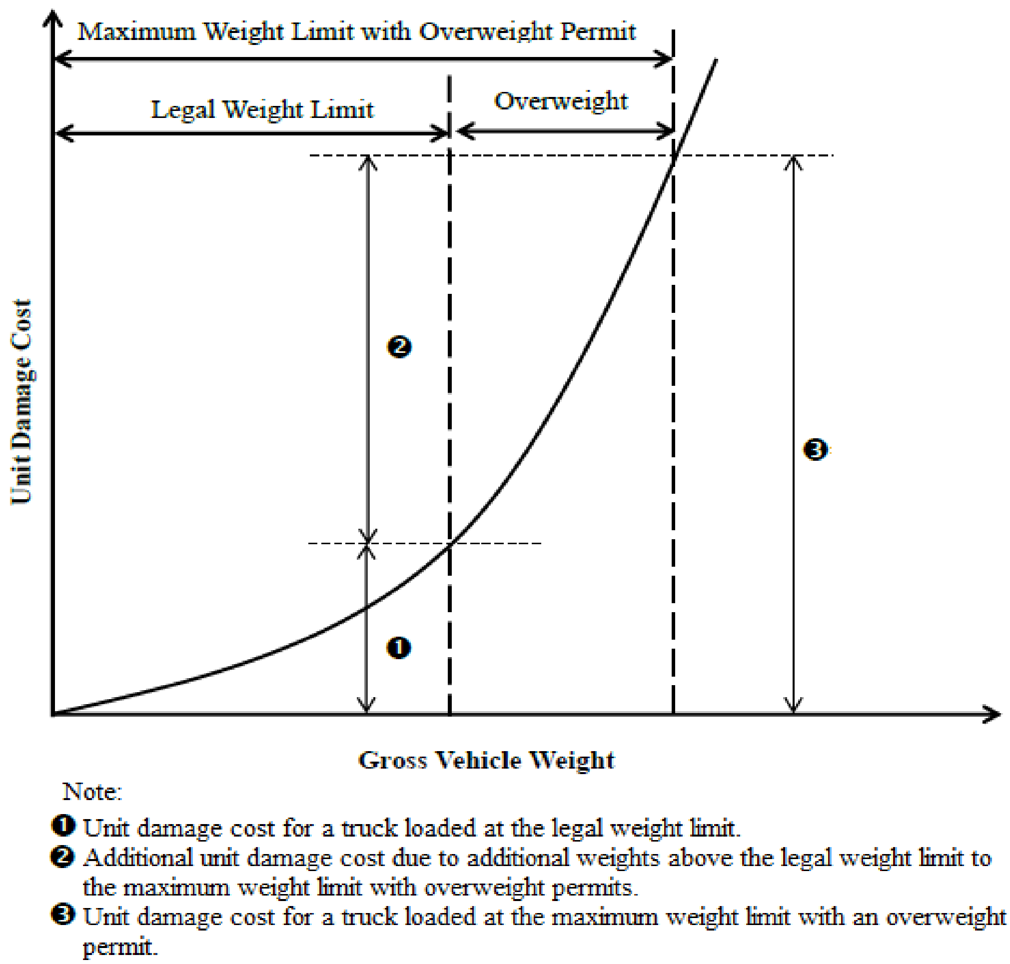


Figure F.1 The unit cost of truck damage corresponding to different truck weights (adapted from Chowdhury et al., 2013).

APPENDIX G. OVERWEIGHT OPERATIONS: THE POSITIVE IMPACTS (TRIPS REDUCTION) AND THE NEGATIVE (TRAFFIC IMPAIRMENT) IMPACTS ON SAFETY AND MOBILITY

This appendix presents a detailed description for calculating the trips-reduction (TIE) and the traffic impairment effect (TRE) of OW operations on safety. The net effect of these opposing effects may be positive or negative. A previous JTRP project report (Everett et al., 2014) is the only resource worldwide that brought attention to this issue, with a theory-based discussion on the conditions under which the net effect is positive and those under which the net effect is negative.
TRE is computed according to the equation below:

$$TRE = APEW \times N_{TT} \times P_{OW} \quad \text{(G.1)}$$

Where:
$APEW$ = average percent of extra weight compared to the maximum allowable weight for all trucks. For example, if the maximum allowable weight is 80,000 lb., and OW trucks are loaded on average to 120,000 lb., then APEW = 50%.
P_{OW} = percent of OW trucks in entire traffic stream.
N_{TT} = total number of legal weights + OW trucks (trucks per day).

See Figure 5.12 in the main text, which presents a conceptual graph of the relationship between TRE and TIE on traffic safety and mobility.

Sample computation: Consider a traffic stream with $APEW$ = 20%, N_{TT} = 1,200 trucks/day and P_{OW} = 10%, then:
$TRE = 0.20 \times 1{,}200 \times 0.10 = 24$ trucks/day
This implies that under these circumstances, by allowing OW operations, 24 legal weight trucks will be excluded from the traffic stream. In consequence, the traffic volume for the purpose of safety and mobility, would be 1,176, not 1,200.

The traffic impairment effect (TIE) is calculated according to equation below:

$$TIE = T_{TT} \times P_{OW} \times [(PCE_{OW} - P_{CEN}) / P_{CEN}] \quad \text{(G.2)}$$

Where:
PCE is the passenger car equivalent.
PCE_{OW} = PCE of OW trucks
P_{CEN} = PCE of legal weight trucks and all other symbols are as previously defined.
Sample computation: For a traffic stream with N_{TT} = 1,200 trucks/day, P_{OW} = 10%, PCE_{OW} = 2.5, and P_{CEN} = 1.5, then:
$TIE = 1{,}200 \times 0.10 \times (2.5-1.5)/1.5 = 240$ trucks/day

This means that in the prevailing circumstances, OW trucks will represent an equivalent additional 240 normal weight trucks. For the purposes of safety and mobility, therefore, an effective volume of 1,440 (not 1,200) should be used in the analysis.

The net effect, therefore, is the sum of the two effects, is:

$$NET = N_{TT} - TRE + TIE \qquad \text{(G.3)}$$

Where: *NET* = net total equivalent nr. of legal weight trucks.

Sample computation: For the example presented above, the net total equivalent number of legal weight trucks, *NET* = 1,200 + 240 – 24 = 1,416 trucks/day.

This net volume of truck traffic can then be used to compute the safety and mobility performance as applicable. For safety performance, the function employed in the current study is presented in the equation below (AASHTO, 2010).

$$CF = exp[a+bln(AADT)+\ln(L)] \qquad \text{(G.4)}$$

Where: *CF* is the severe crash frequency,

L is the road segment length

AADT is the average annual daily traffic

For urban roads, *a* is 16.22, *b* is 1.66.

For rural roads, *a* is –8.837, *b* is 0.958.

APPENDIX H. USING THE "PRICE-ELASTICITY OF DEMAND" CONCEPT TO ESTIMATE SAFETY PERFORMANCE CHANGES

This appendix discusses the "price-elasticity of demand" concept, as part of an effort to estimate the change in safety performance in response to demand changes which in turn are caused by the change in permit fee. The price elasticity of demand for freight transportation has been shown to range from –0.75 to –2.5 (Abdelwahab, 1998). Therefore, it can be expected that over a longer period, the change in permit fees will result in a change in safety and mobility performance on permitted routes. This change can be estimated for a given period by considering the price elasticity of demand function.

Given OW shipment demand (volume) qi at permit fee pi, and price elasticity e, we can determine the demand qf for a price change from pi to pf through a simple algebraic manipulation of the elasticity equation as:

$$e = \frac{\partial q}{q} \bigg/ \frac{\partial p}{p} = \frac{q_f - q_i}{q_f + q_i} \bigg/ \frac{p_f - p_i}{p_f + p_i} \qquad \text{(H.1)}$$

Knowing the initial demand (q_i), the initial and final prices (p_i, p_f), and the elasticity e, we can, by simple algebraic manipulation obtain an expression for the new demand (q_f). This is presented in the following equation.

$$q_f = q_i \frac{(1+\gamma)}{(1-\gamma)} \qquad \text{(H.2)}$$

Where:

$$\gamma = e \frac{(p_f - p_i)}{(p_f + p_i)} \qquad \text{(H.3)}$$

And all other symbols are as previously defined.

Using the equation above and the procedure established in Everett et al. (2014), the change in safety and mobility performance at permitted routes for a given change in permit fee, was calculated in this study (see Figure 5.13 and Figure 5.14, respectively, in the main text) in Chapter 5.

About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1—evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at http://docs.lib.purdue.edu/jtrp.

Further information about JTRP and its current research program is available at http://www.purdue.edu/jtrp.

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