OREGON COMMERCE AND COMPLIANCE DIVISION SAFETY ACTION PLAN

Final Report

by

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

Historically, transportation-related fatalities in Oregon have had downward trends. However, these transportation-related fatalities have been increasing since 2013. This increase is consistent across the United States. In addition, fatality numbers can fluctuate due to a variety of economic, demographic, and transportation system factors. Nevertheless, increases in fatalities reinforce the importance of continued focus and investment on multidisciplinary transportation safety programs.

Of particular focus are truck crashes. Due to the nature of truck crashes, they can have substantial societal costs associated with them. For example, truck crashes can cause significant congestion, which in turn results in delays, added fuel usage, and negative environmental impacts. It has been estimated that these factors alone can total up to $28 billion (Blincoe et al., 2015). This value increases significantly when considering crashes in which an injury or fatality has occurred.

In Oregon, truck crashes have increased 29% from 2013 to 2017. In each of these years it was determined that the truck was at fault for approximately 50% of the crashes considering the yearly crash totals. Note that the driver was determined to be the cause of about 95% of the truck-at-fault crashes. Reported crash causation statistics are unique to Oregon, as few states or federal agencies report the cause of the crash. Oregon, specifically, reports the driver-level crash cause as well. A summary of truck-involved crashes is provided in Table 1

Table 1.1: Truck-Involved Crash History

	2013	2014	2015	2016	2017
Truck Driver-at-Fault Crashes	676	715	684	739	904
Truck Mechanical-at-Fault Crashes	24	42	28	32	42
Other Driver-at-Fault	522	579	237	652	639
Non Driver-at-Fault	87	82	87	85	108
Total Number of Truck Crashes	1,309	1,418	1,036	1,508	1,693
Percentage of Mechanical-at-Fault Crashes*	3%	6%	4%	4%	4%
Percentage of Driver-at-Fault Crashes*	97%	94%	96%	96%	96%

Table 1 from the Summary of Oregon Truck Safety and Guide to the 2018 Oregon Commercial Motor Vehicle Safety Plan.
*Percentages are based only on truck at-fault crashes

In 2017, truck drivers in Oregon were found to have been at-fault for 904 crashes. Of those 904 crashes, 34 were cases in which the driver of the truck and the driver of the other vehicle were both at-fault. Considering these cases, incidents where the truck driver was at-fault accounted for 870 crashes, about 50% of the total number of truck-involved crashes. The actions of other drivers causes 639 of the crashes.

Still considering 2017, just 42 of the 946 truck at-fault crashes were attributed to mechanical issues (i.e., tire failure, brake failure, etc.). This, too, is consistent with previous years and supports the Commerce and Compliance Transportation Division (CCD) Commercial Vehicle Safety Plan's focus on assessing the behavior and fitness of truck drivers as the most effective method to reduce truck driver-at-fault crashes.

Based on Oregon crash data, the largest contributing driver behavior associated with truck at-fault crashes is speeding. Other factors that account for a larger proportion of truck at-fault crashes include following too close, failure to remain in the lane of travel, improper lane changing, improper turns, inattention/distraction, failure to yield, and fatigue. A review of this crash data exhibits the need for law enforcement agencies to increase traffic-related enforcement efforts. With increased enforcement efforts, unsafe driving behaviors can be identified and addressed in an attempt to mitigate truck driver-at-fault crashes.

In light of these statistics, the Oregon CCD publishes an annual Oregon Commercial Motor Vehicle Safety Plan (CVSP). The goal of this plan is to reduce crashes involving commercial motor vehicles and, if crashes occur, reduce the number of injuries and fatalities resulting from these crashes. Therefore, a primary objective of CVSP is to address unsafe driver behavior that statistics show to be the cause of greater than 90% of truck at-fault crashes.

With that in mind, the Oregon CCD implemented a pilot program to assess behavior and fitness. Details of the program are outlined in the following section.

2.0 OREGON COMMERCE AND COMPLIANCE SAFETY ACTION PLAN

In support of Oregon's CCD safety goal of reducing truck and bus fatalities, and the CVSP, the Oregon CCD began a pilot program: Oregon Commerce and Compliance Safety Action Plan (OCCSAP). The pilot program began in July, 2016 and will continue through the 2019-21 biennium.

The goal of OCCSAP is to reduce truck driver-at-fault crashes in Oregon. This is accomplished by focusing on and addressing unsafe truck driver behavior, as the drivers are shown to be at-fault for greater than 90% of truck at-fault crashes. For program implementation, the Oregon CCD provided state funds to increase North American Standard Level 2 (Level 2) truck inspections by partnering with local law enforcement agencies. The result of enhanced level of roadside inspection activity by law enforcement agencies stemmed from identifying unsafe driving behaviors (e.g., speeding, following too close, etc.), which proceeded to the Level 2 safety inspection. Essentially, when a truck driver exhibited unsafe driver behavior in the presence of law enforcement, the officer performed a traffic enforcement stop followed by a Level 2 inspection.

Partnership with local law enforcement agencies was done through Inter Governmental Agreements allowing Level 2 inspection to take place upon observation of unsafe driving behaviors. Law enforcement agencies who partnered for the program are summarized in Table 2 and locations can be viewed via Figure . As observed, all law enforcement agency partners with the exception of Salem Police Department, Scappoose Police Department, and Stanfield Police Department, are located in the Portland Metropolitan area.

Table 2.1: Participating Law Enforcement Agencies

Agency	Location
Clackamas County Sheriff's Office	Clackamas County, OR
West Linn Police Department	Clackamas County, OR
Oregon City Police Department	Clackamas County, OR
Scappoose Police Department	Columbia County, OR
Marion County Sheriff's Office	Marion County, OR
Salem Police Department	Marion County, OR
Multnomah County Sheriff's Office	Multnomah County, OR
Portland Police Bureau	Multnomah County, OR
Stanfield Police Department	Umatilla County, OR
Washington County Sheriff's Office	Washington County, OR
Tigard Police Department	Washington County, OR

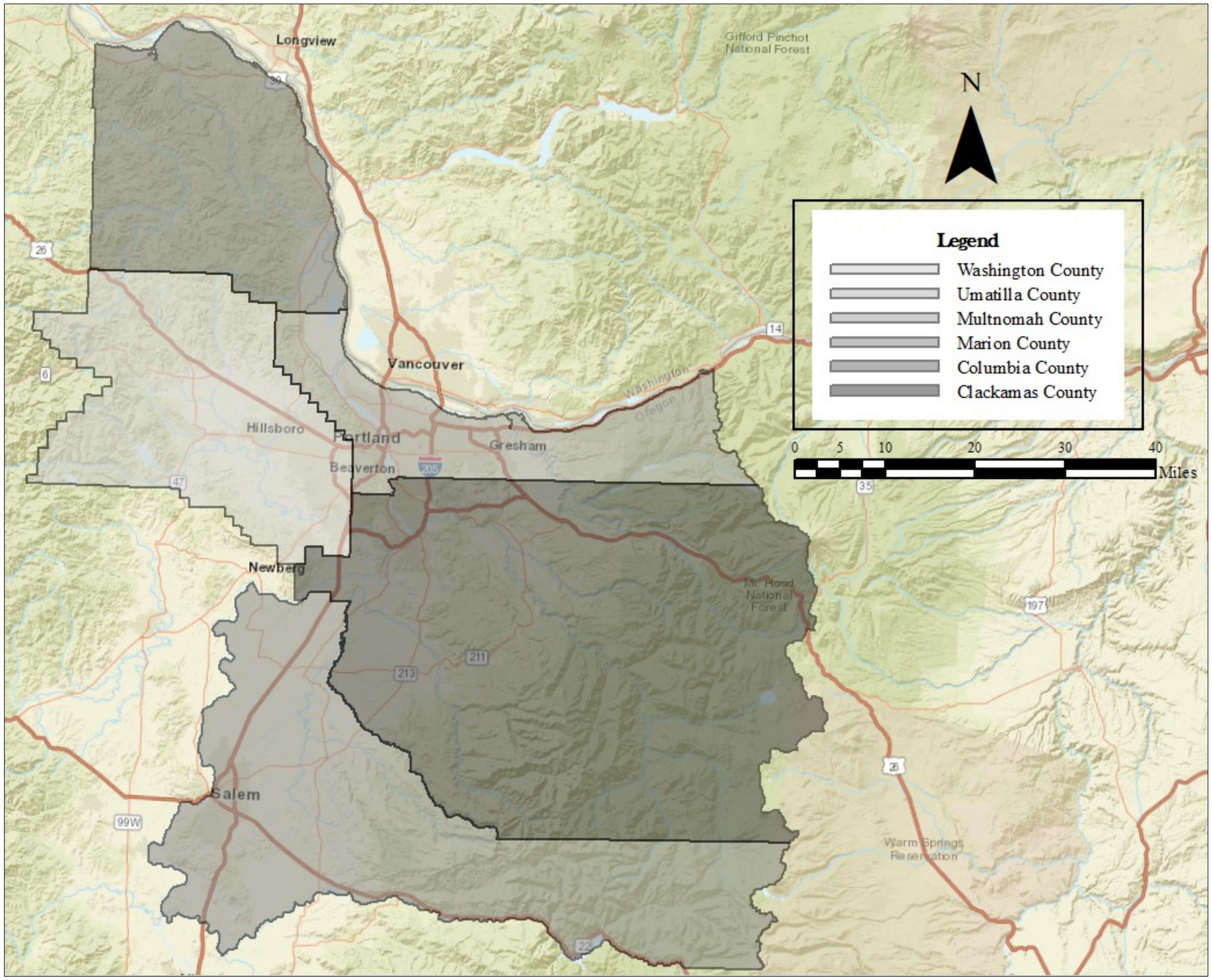

Figure 2.1: Locations of participating law enforcement agencies

3.0 DATA

As part of the pilot program, various data have been collected and analyzed. This section will describe the data used for analysis. Data considered includes unsafe driving behavior leading to inspections, number and locations of inspections, and truck at-fault crash data.

3.1 INSPECTION DATA

As stated previously, if a truck driver exhibits unsafe driving behavior (e.g., speeding, following too close, unsafe lane change, etc.), in the presence of a law enforcement officer, the officer performs a traffic enforcement stop followed by a Level 2 inspection. From the start of the program (July, 2016) through December, 2018, there were a total of 4,210 Level 2 inspections resulting from unsafe driving behavior. The unsafe driving behavior that led to the inspection is recorded in the data, as shown in Figure .[1] Of the unsafe driving behaviors, two account for the majority: speeding and lane restriction violation. Nearly 66% of all inspections resulted from drivers who were speeding and about 19% of inspections resulted from lane restriction violations.

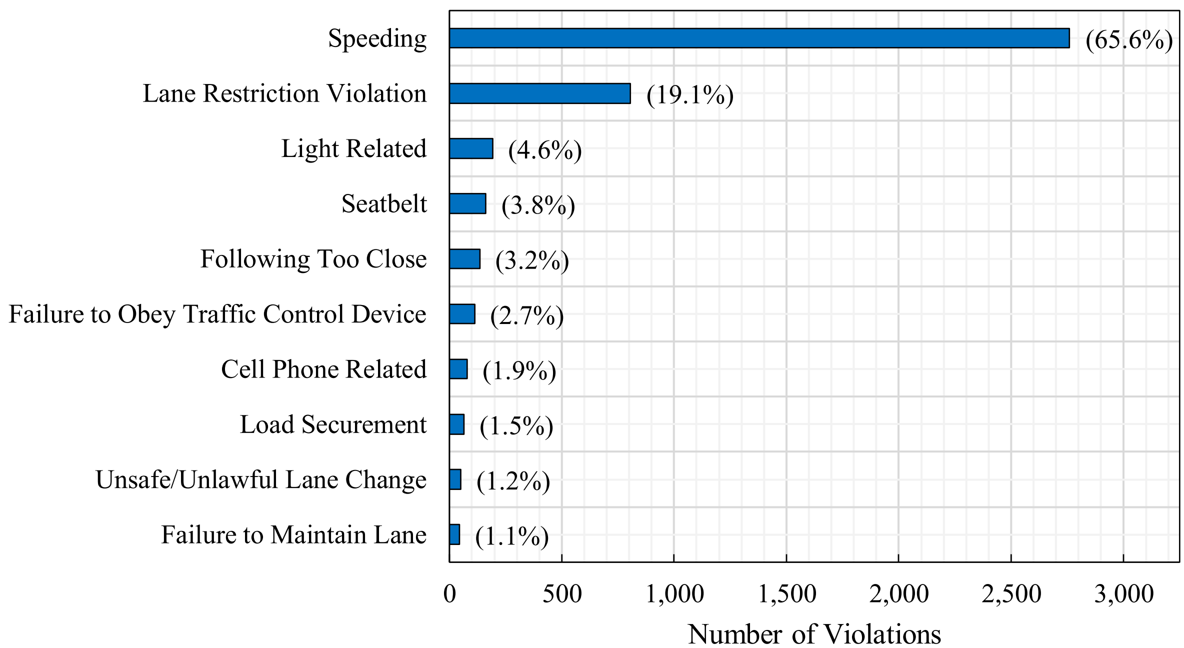

Figure 3.1: Frequency of most occurring unsafe driving behaviors

[1] In some instances, multiple unsafe driving behaviors were recorded. Therefore, the percentages in Figure do not necessarily sum to 100%. If speeding and following to close were recorded as the unsafe driving behavior, it goes to the counts for speeding and to the counts for following too close.

Vehicle lighting-related violations refer to any violation related to lighting attributes of the truck, ranging from no headlights or taillights to prohibited lighting.

The locations of the 4,210 Level 2 inspections are shown in Figure 1 and the frequency of inspections by highway are shown in Figure .[2] Referring to Figure 1, the majority of inspections took place on I-205, I-84, and I-5. As discussed later, this is likely due to resources and roadway geometry (i.e., is there sufficient shoulder space for a truck to safely park). Specifically, referring to Figure , approximately 61% of inspections occurred on I-205, 10% on I-84, and 10% on I-5.

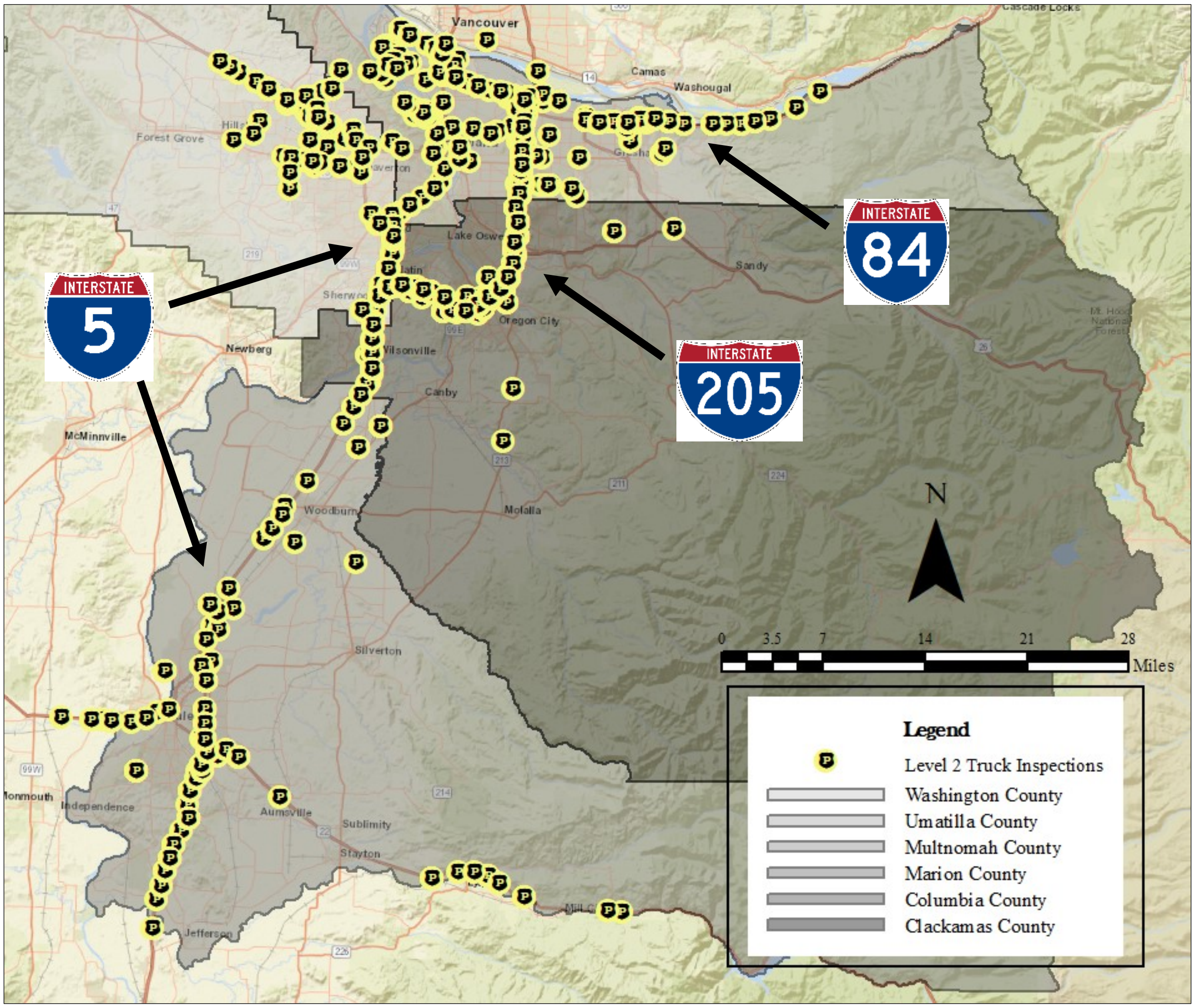

Figure 1.2: Locations of Level 2 truck inspections

[2] Violations resulting in inspections occurred on various roadways; however, only the highways where inspections were overrepresented are shown in Figure .

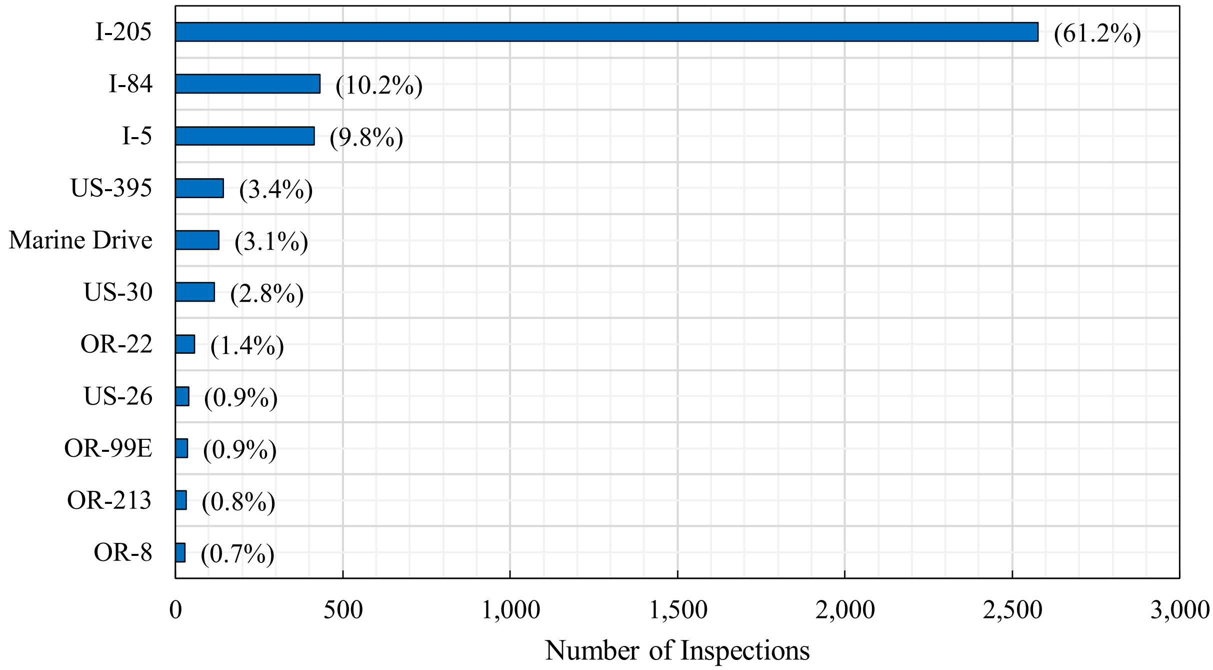

Figure 3.3: Frequency of inspections by highway

Temporal trends of inspections are shown in Figure . As observed, there are fluctuations in the number of inspections during the duration of the program. The outlier is July, 2017, where the number of inspections substantially decreases as a result of Inter-Governmental Agreement renewals. In the following year, however, no substantial decrease is observed during this process. In general, the fall, winter, and spring months account for the most inspections, while summer months the least.

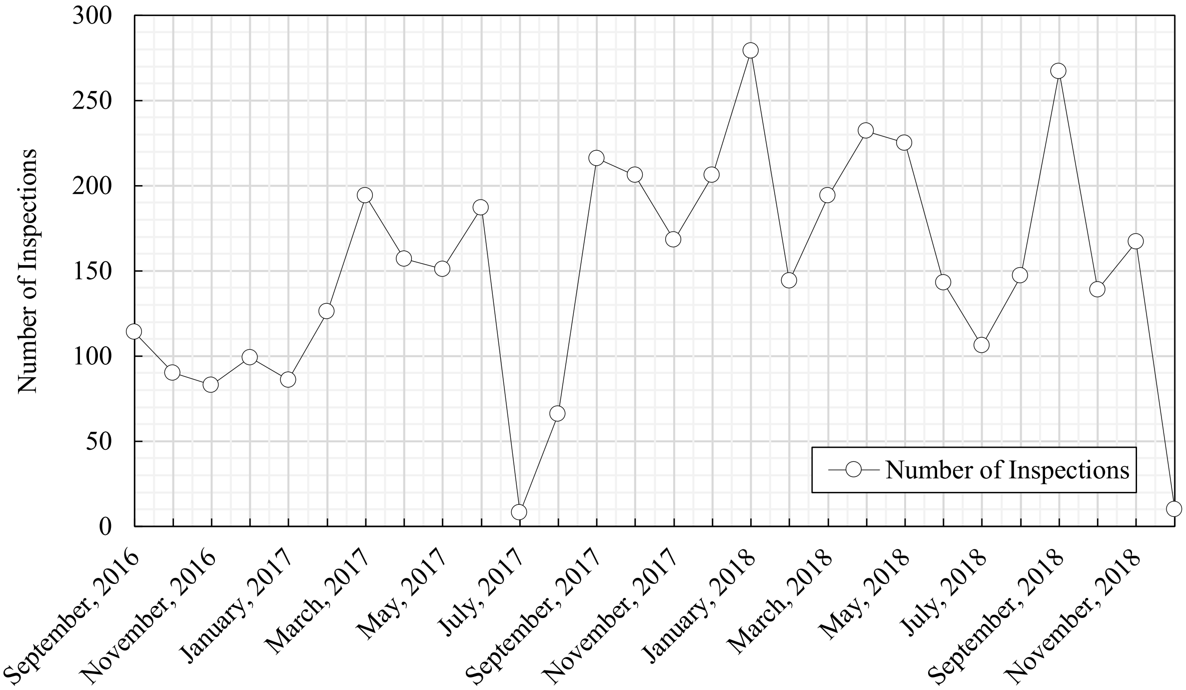

Figure 3.4: Number of inspections by month

3.2 TRUCK AT-FAULT CRASH DATA

To assess the effectiveness of the pilot program, crash data from the ODOT Transportation Development Division (TDD) was obtained. The crash data was compiled to consist of truck at-fault crashes, including driver-at-fault and mechanical-at-fault. Crash data for each of the highways in Figure were provided.[3] Although the primary analysis focuses on I-205 due to the majority of inspections occurring along this corridor, the other highways are summarized.

Crash data of the highways shown in Figure consisted of the years 2015 to 2018. As stated previously, the crash data was obtained via ODOT TDD. Using the data, the frequency of crash causes along these highways, holistically, is assessed. In the crash data provided, there were a total of 391 truck at-fault crashes. For crash cause frequencies that occurred most often, refer to Figure , while Table 3 summarizes all reported crash causes regardless of how often they occurred. As shown, mechanical-at-fault truck crashes account for approximately 5.4% of truck at-fault crashes. In other words, the driver was reported to be at-fault for 94.6% of truck at-fault crashes on the highways and years considered.

[3] Based on Figure 1, specific segments of I-5, and I-84 were selected based on locations of inspections. For I-5, the defined segment is from Salem, OR to the Oregon-Washington border. On I-84, the defined segment runs from milepost marker 11 to milepost marker 30.

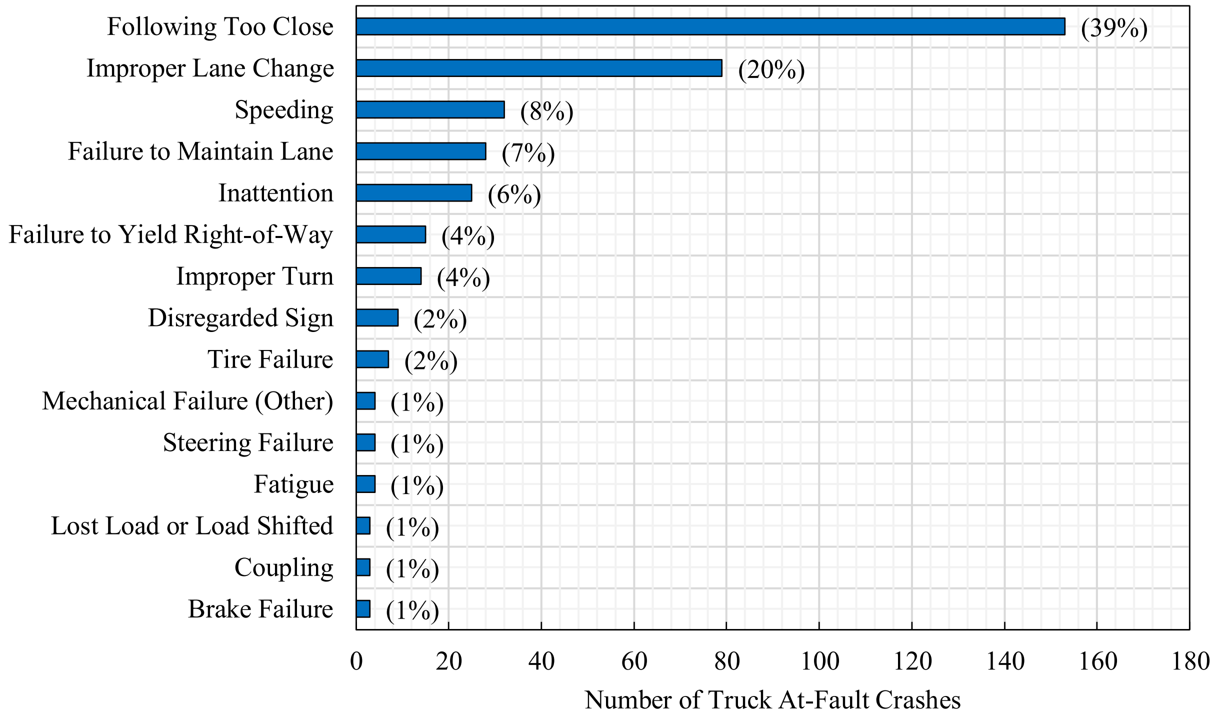

Figure 3.5: Reported crash cause for truck at-fault crashes

Table 3.1: Frequency of Reported Crash Causes for Truck At-Fault Crashes

Reported Crash Cause	Number of Crashes	Percent of Total
Following Too Close	153	39.1%
Improper Lane Change	79	20.2%
Speeding	32	8.2%
Failure to Maintain Lane	28	7.2%
Inattention	25	6.4%
Failure to Yield Right-of-Way	15	3.8%
Improper Turn	14	3.6%
Disregarded Sign	9	2.3%
Tire Failure	7	1.8%
Fatigue	4	1.0%
Steering Failure	4	1.0%
Mechanical Failure (Other)	4	1.0%
Brake Failure	3	0.8%
Coupling	3	0.8%
Lost Load or Load Shifted	3	0.8%
Failure to Maintain Control	2	0.5%
Improper Backing	2	0.5%
Vision Obscured	1	0.3%
Improper Pass	1	0.3%
Driving Under the Influence	1	0.3%
Failed to Avoid Vehicle Ahead	1	0.3%
Total	**391**	**100%**

To further assess truck at-fault crashes, the number of crashes and their associated reported crash causes by highway are evaluated. Based on Figure and Table , greater than 50% of the crashes occurred on the segment of I-5, 20% took place on I-205, and 5% happened on US-30.

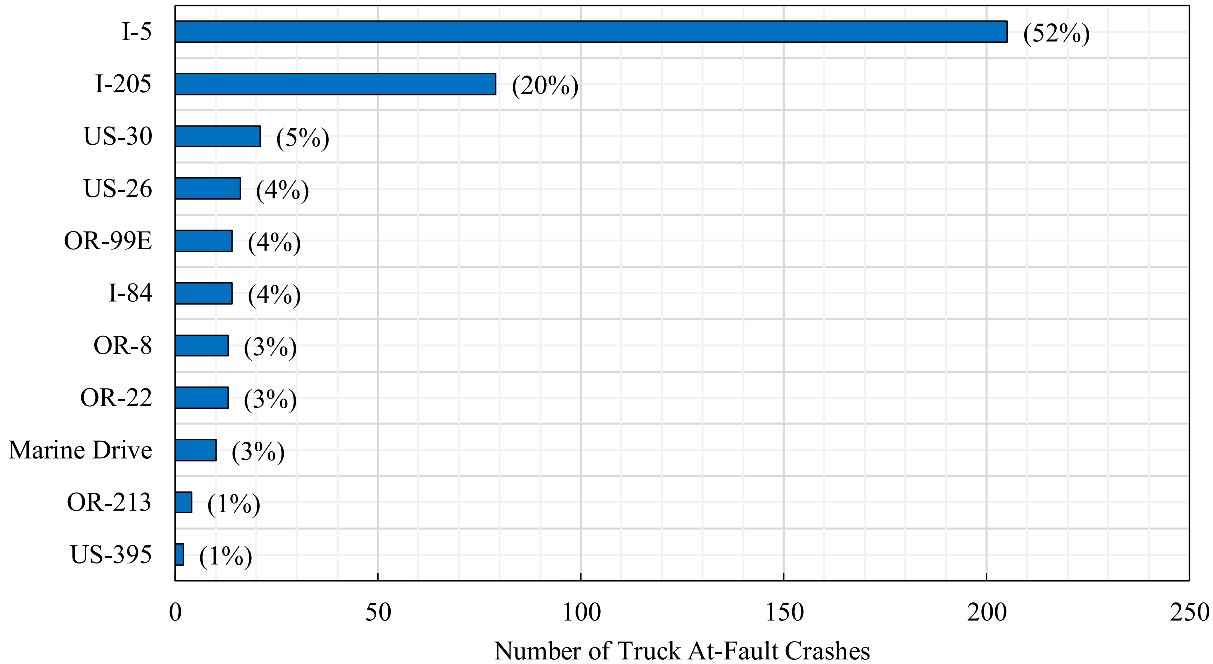

Figure 3.6: Frequency of truck at-fault crashes by highway

Table 3.2: Frequency of Truck At-Fault Crashes by Highway

Highway/Road	Number of Crashes	Percent of Total
I-5	205	52.4%
I-205	79	20.2%
US-30	21	5.4%
US-26	16	4.1%
I-84	14	3.6%
OR-99E	14	3.6%
OR-22	13	3.3%
OR-8	13	3.3%
Marine Drive	10	2.6%
OR-213	4	1.0%
US-395	2	0.5%
Total	**391**	**100%**

4.0 INSPECTION AND CRASH ANALYSIS

Using inspection data and Oregon crash data, relationships are identified. Summary of crash frequency and inspections are provided for each of the aforementioned highways. However, as stated previously, due to the large number of inspections on I-205, I-205 is the only corridor considered for further analysis and is the focal point of this report. To begin, summaries will be provided for the other highways.

4.1 INSPECTIONS AND CRASH FREQUENCIES

As stated above, all highways (excluding I-205) will be summarized in terms of crash frequencies and number of inspections. This section will summarize these corridors. Summaries begin on the following page.

4.1.1 Interstate 5

I-5 from Salem to the Oregon-Washington border, as shown in Figure , experienced the highest volume of crashes from 2015 to 2018. Although this segment experienced a large number of crashes, the relative number of inspections was low. Based on the limited number of participating law enforcement agencies, and the roadway geometries of I-5 through the Portland Metro area, the conditions for a truck to park on the shoulder are unfavorable. Referring to Figure , no significant change in crash frequency is observed in relation to the number of inspections. For instance, the number of inspections substantially increased from 2016 to 2017, with essentially no change in the number of truck at-fault crashes. These results are likely explained by the number of inspections, which are limited based on law enforcement resources along the corridor, corridor geometrics, etc.

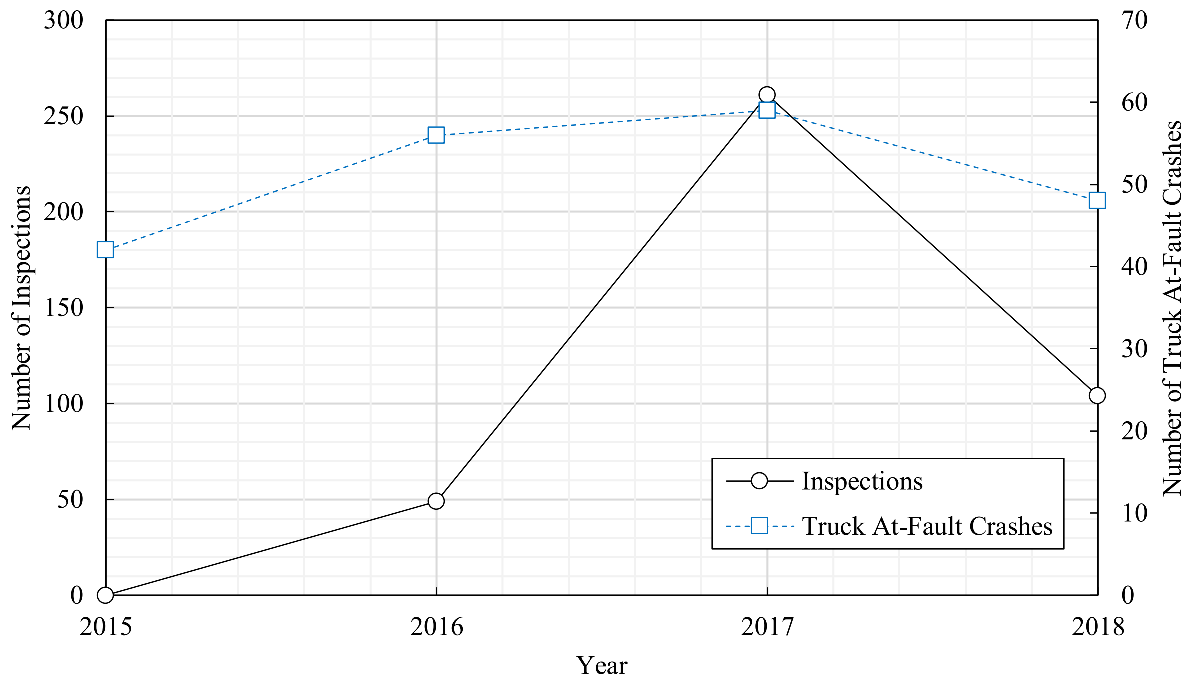

Figure 4.1: Number of inspections and truck at-fault crashes on I-5

4.1.2 US-30

Of the considered highways, US-30 accounts for approximately 5% of the truck at-fault crashes and 3% of the total number of inspections. For a comparison of inspections and crash frequency on US-30, refer to Figure . Although a small number of both inspections and at-fault crashes took place on US-30, the anticipated trend is observed. That is, as inspections increase, the number of truck at-fault crashes decrease. This suggests that around 48 inspections per year is adequate. However, this requires further analysis and observation to validate.

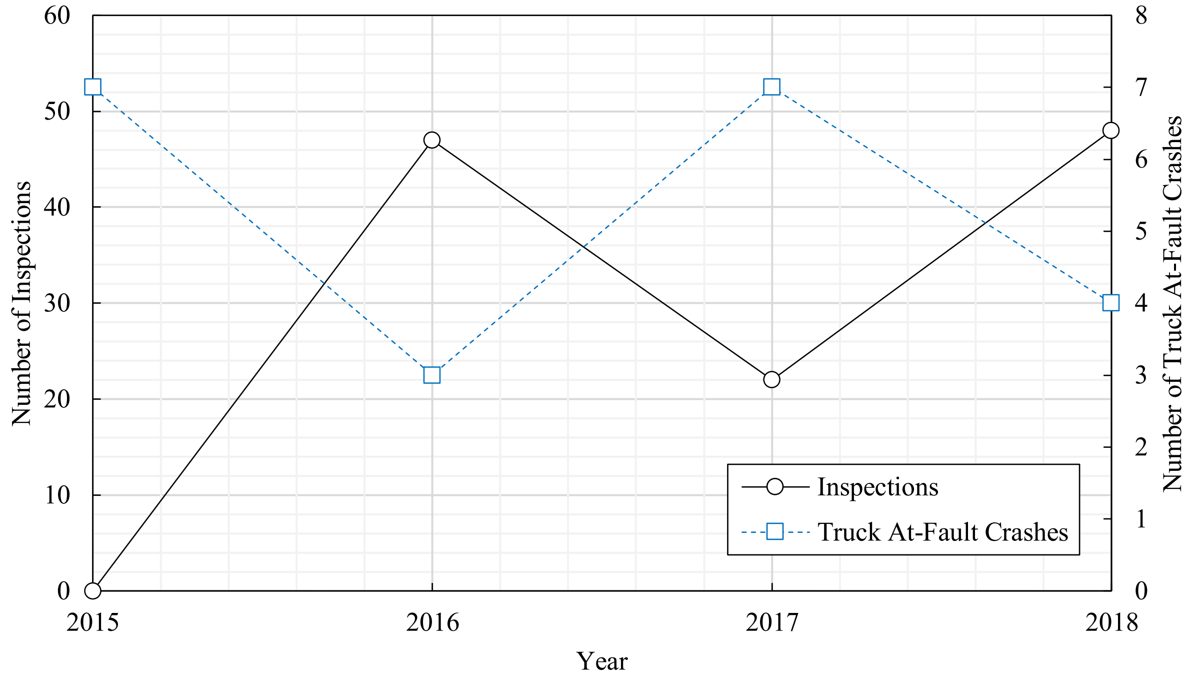

Figure 4.2: Number of inspections and truck at-fault crashes on US-30

4.1.3 US-26

US-26 accounts for approximately 4% of the truck at-fault crashes and 1% of the total number of inspections. For a comparison of inspections and crash frequency on US-26, refer to Figure 4.32. Similar results, in terms of few observations, are observed for US-26. As inspections decreased, the number of truck at-fault crashes increased.

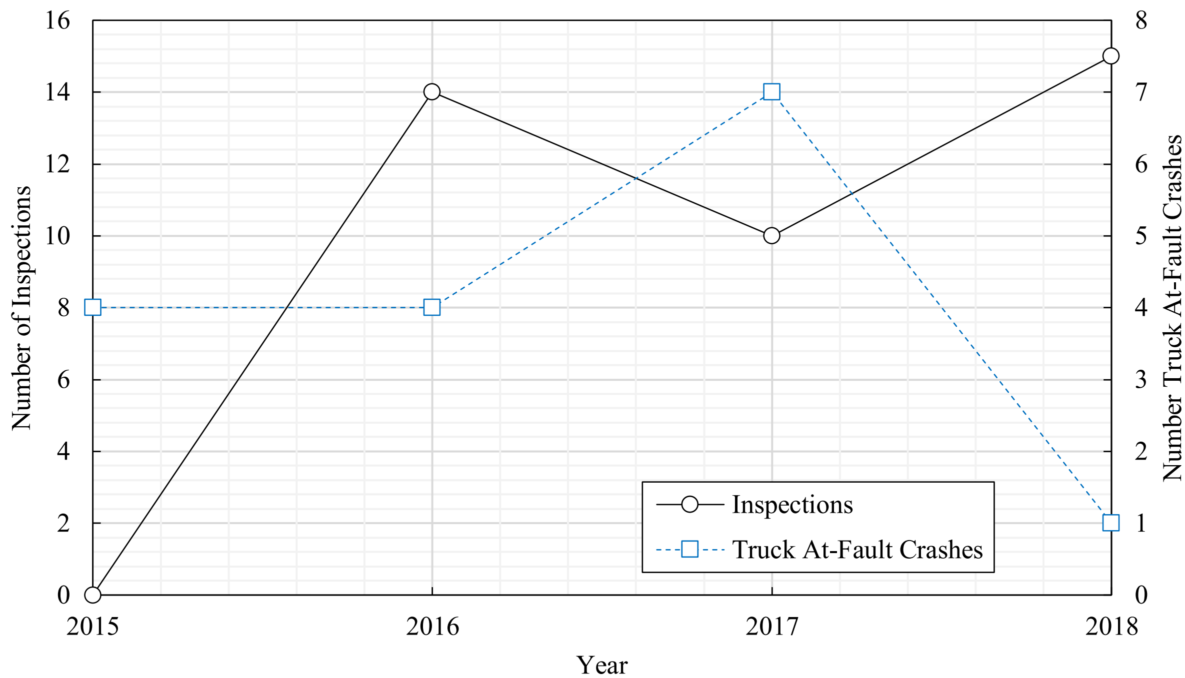

Figure 4.32: Number of inspections and truck at-fault crashes on US-26

4.1.4 OR-99E

OR-99E accounts for approximately 4% of the truck at-fault crashes and 1% of the total number of inspections. For a comparison of inspections and crash frequency on OR-99E, refer to Figure . Due to the small number of both inspections and crashes, no anticipated results are observed. Being that this segment is not prone to a high number of truck at-fault crashes, it may be not be a viable option for the program.

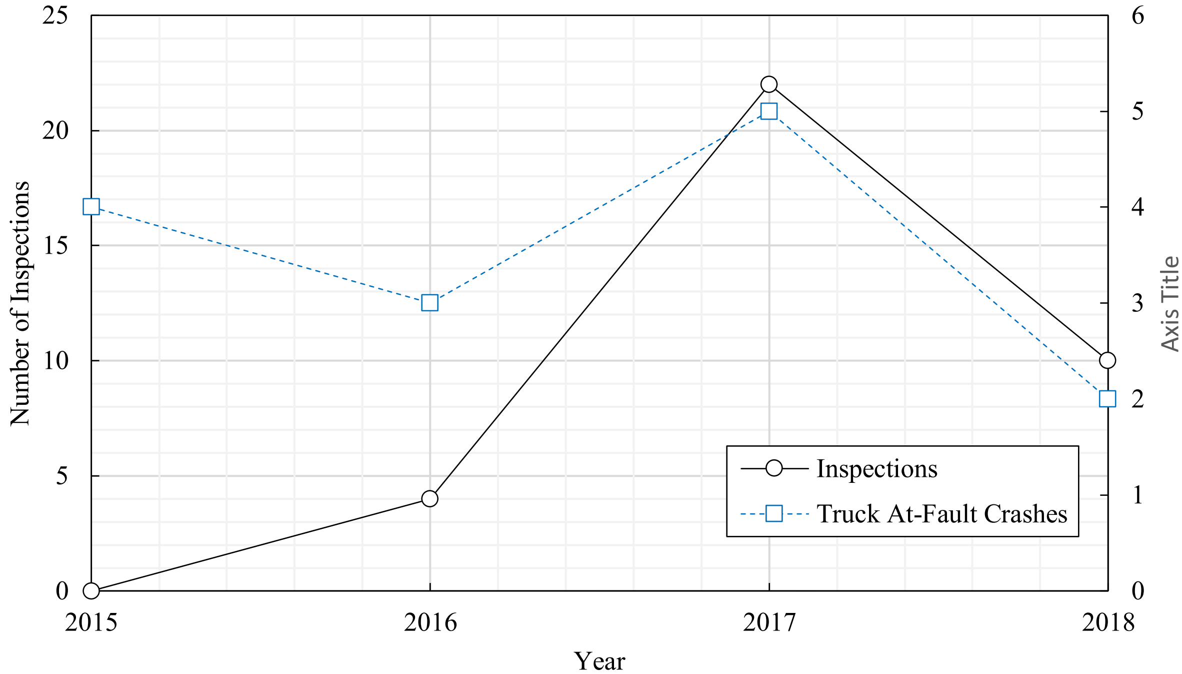

Figure 4.4: Number of inspections and truck at-fault crashes on OR-99E

4.1.5 Interstate 84

I-84 accounts for approximately 4% of the truck at-fault crashes and 10% of the total number of inspections. For a comparison of inspections and crash frequency on I-84, refer to Figure . Although the number of inspections is relatively large compared to other highways, the number of truck at-fault crashes along this segment of I-84 are not. When inspections increased, truck at-fault crashes decreased or remained the same. Due to the small number of truck at-fault crashes along this segment of I-84, it may not be a viable candidate for the program.

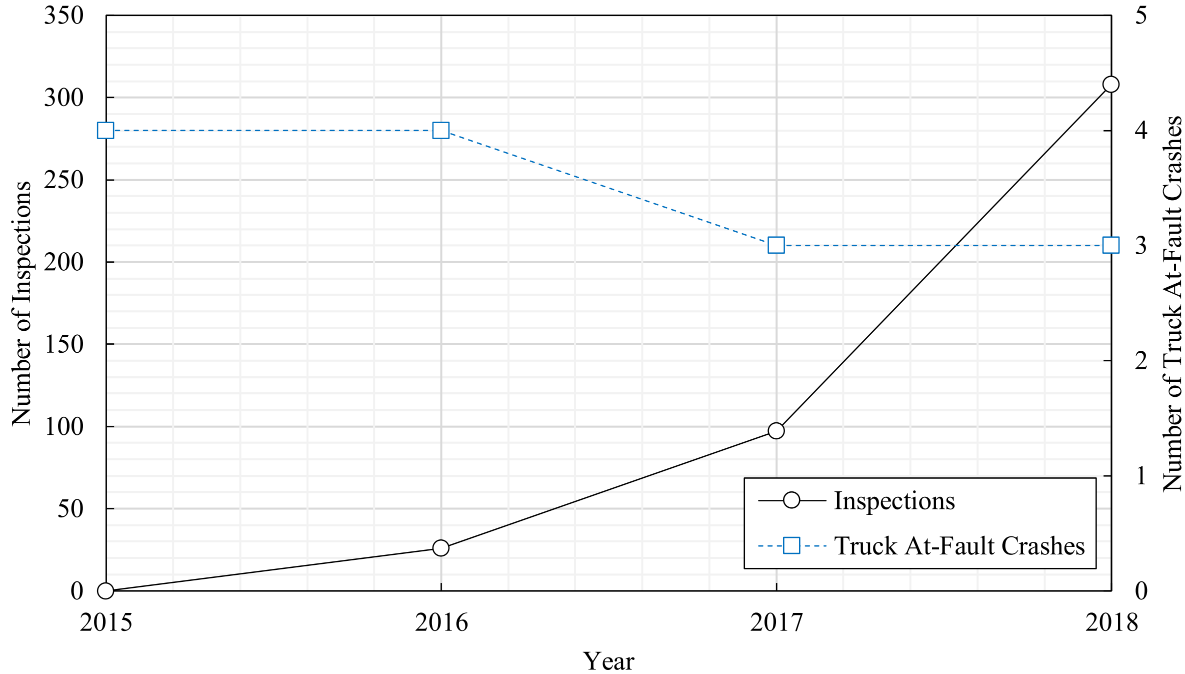

Figure 4.5: Number of inspections and truck at-fault crashes on I-84

4.1.6 OR-8

OR-8 accounts for approximately 3% of the truck at-fault crashes and 0.7% of the total number of inspections. For a comparison of inspections and crash frequency on OR-8, refer to Figure . The anticipated trends are observed from 2016 to 2017, but crashes remain the same thereafter with decreasing inspections. Due to the small number of truck at-fault crashes along this corridor, OR-8 may not be a viable corridor. In addition, many portions of OR-8 are in an urban environment with stop and go traffic and many signalized intersections. This section, in the main, is not a free-flowing corridor like most of the other corridors studied.

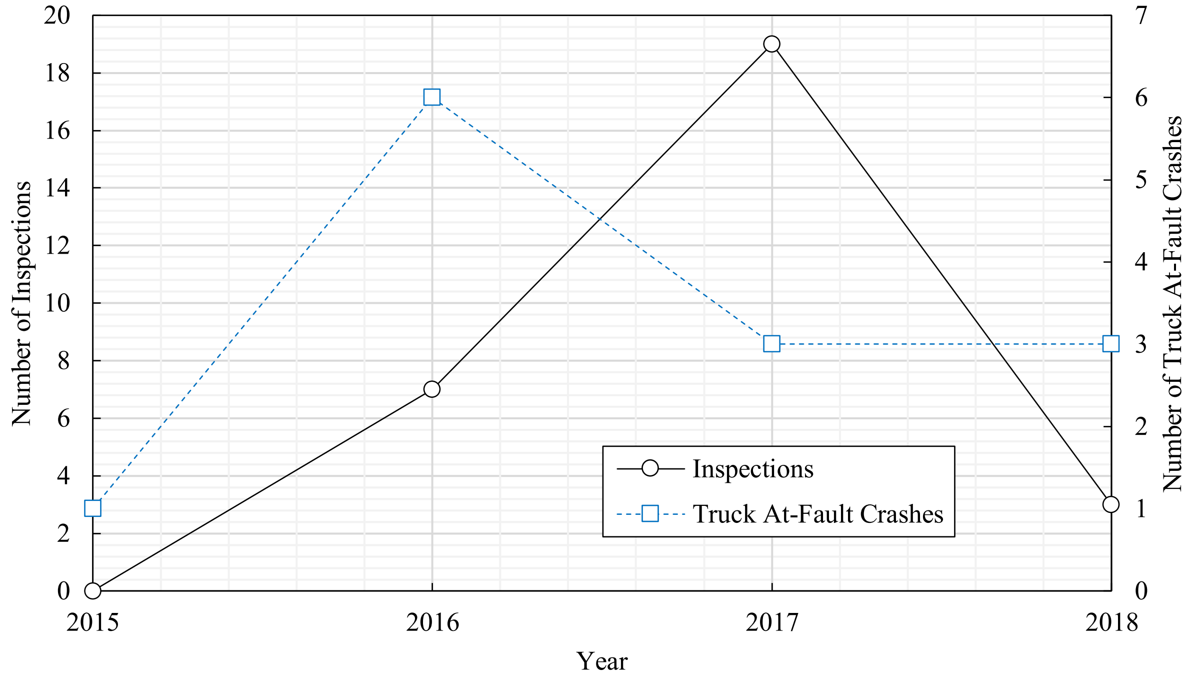

Figure 4.6: Number of inspections and truck at-fault crashes on OR-8

4.1.7 OR-22

OR-22 accounts for approximately 3% of the truck at-fault crashes and 1.4% of the total number of inspections. For a comparison of inspections and crash frequency on OR-22, refer to Figure . On OR-22, the anticipated results are observed (i.e., increasing inspections and decreasing truck at-fault crashes). However, the sample size is small, as are the crash numbers.

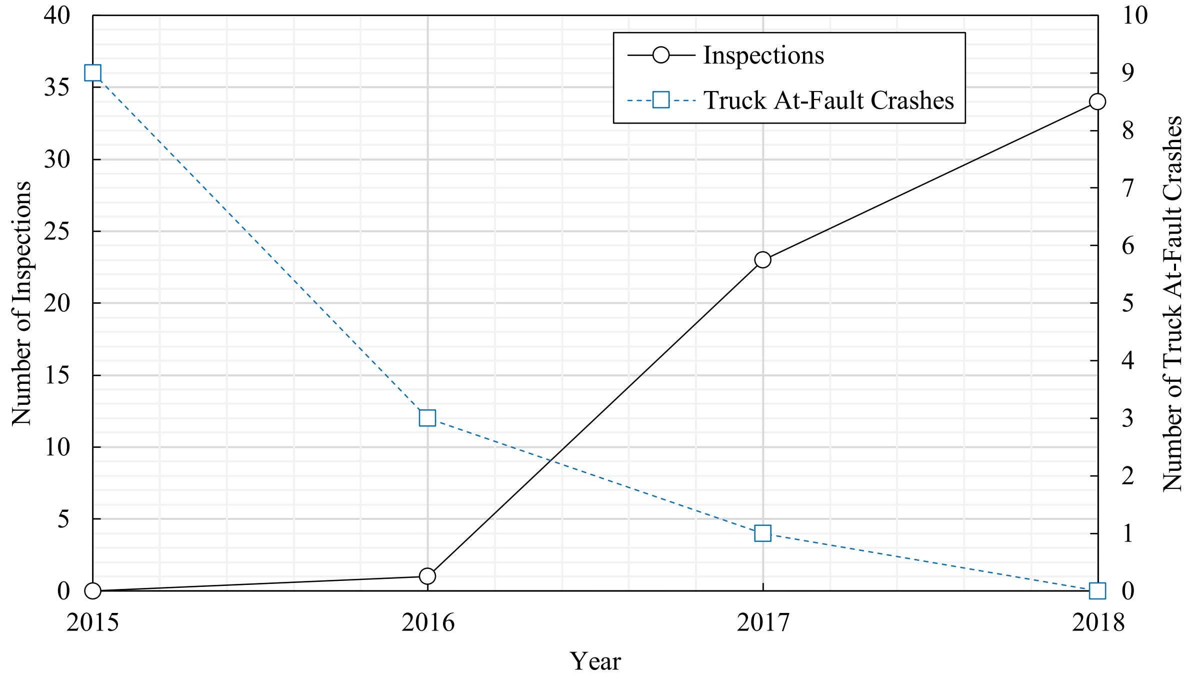

Figure 4.7: Number of inspections and truck at-fault crashes on OR-22

4.1.8 Marine Drive

Marine Drive accounts for approximately 3% of the truck at-fault crashes and 3% of the total number of inspections. For a comparison of inspections and crash frequency on Marine Drive, refer to Figure . On Marine Drive, the anticipated results are again observed (i.e., increasing inspections and decreasing truck at-fault crashes). However, the crash numbers along this corridor are already low.

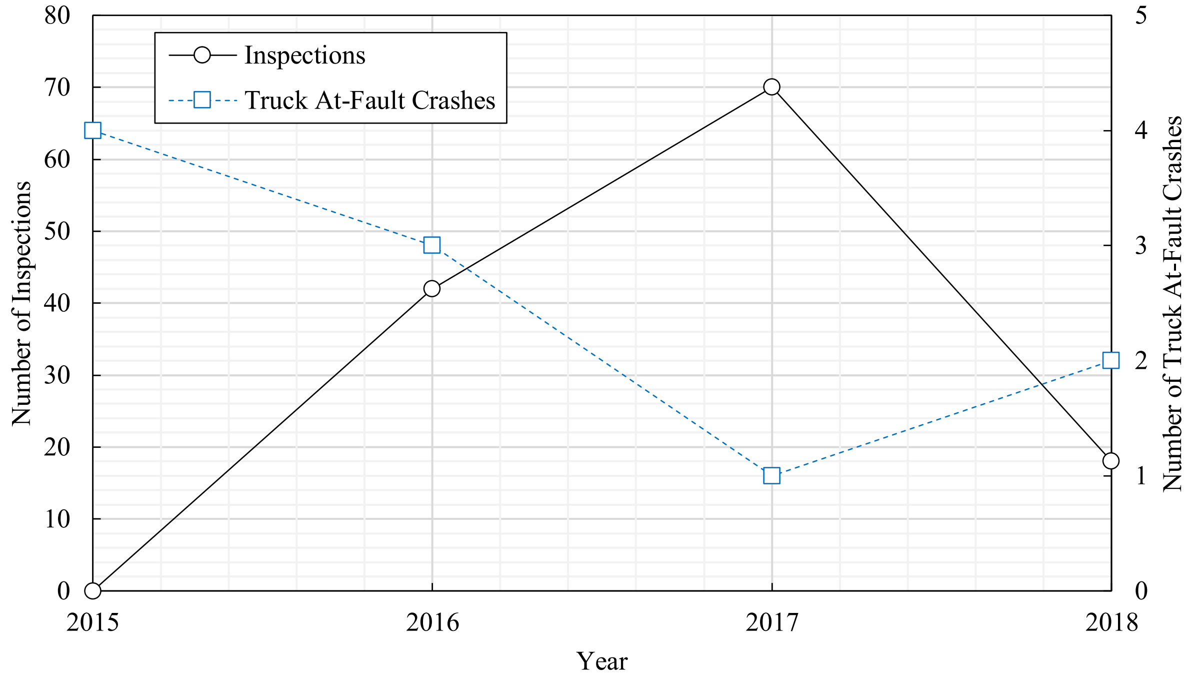

Figure 4.8: Number of inspections and truck at-fault crashes on Marine Drive

4.1.9 OR-213

OR-213 accounts for approximately 1% of the truck at-fault crashes and 0.8% of the total number of inspections. For a comparison of inspections and crash frequency on OR-213, refer to Figure . Once more, on a corridor with small sample sizes, anticipated results are observed; that is, increasing inspections and decreasing truck at-fault crashes.

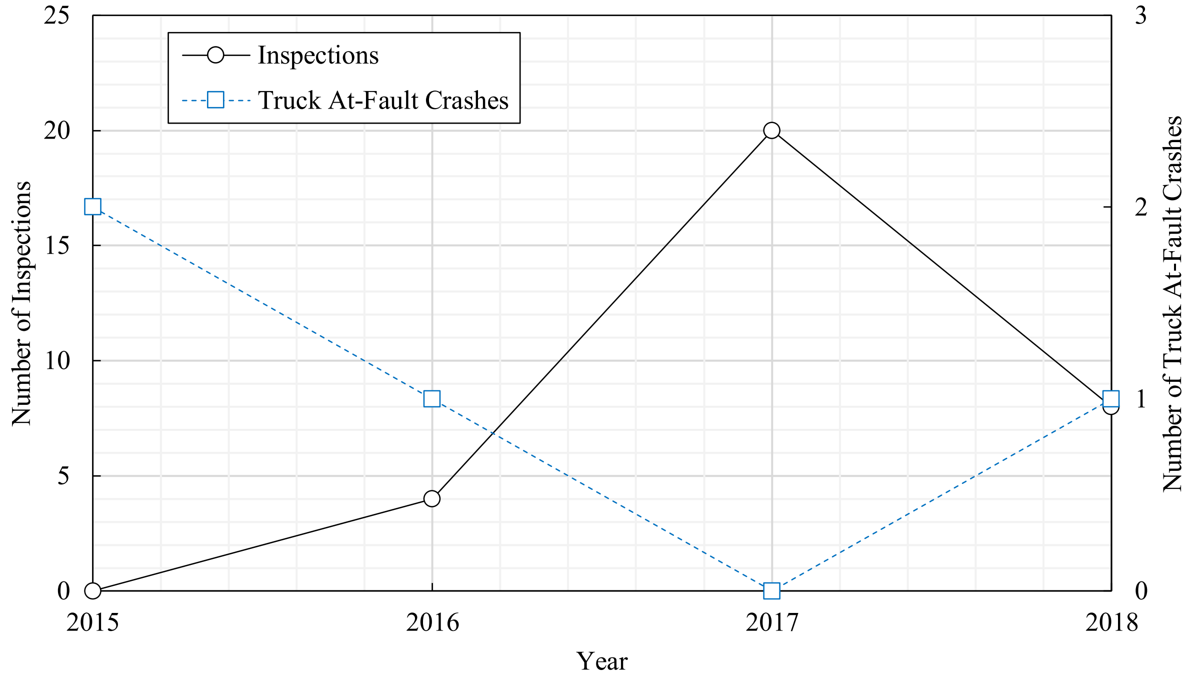

Figure 4.9: Number of inspections and truck at-fault crashes on OR-213

4.1.10 US-395

US-395 accounts for approximately 1% of the truck at-fault crashes and 3.4% of the total number of inspections. For a comparison of inspections and crash frequency on US-395, refer to Figure . The anticipated results on US-395 are observed. But, once more, the total number crashes along this corridor is low.

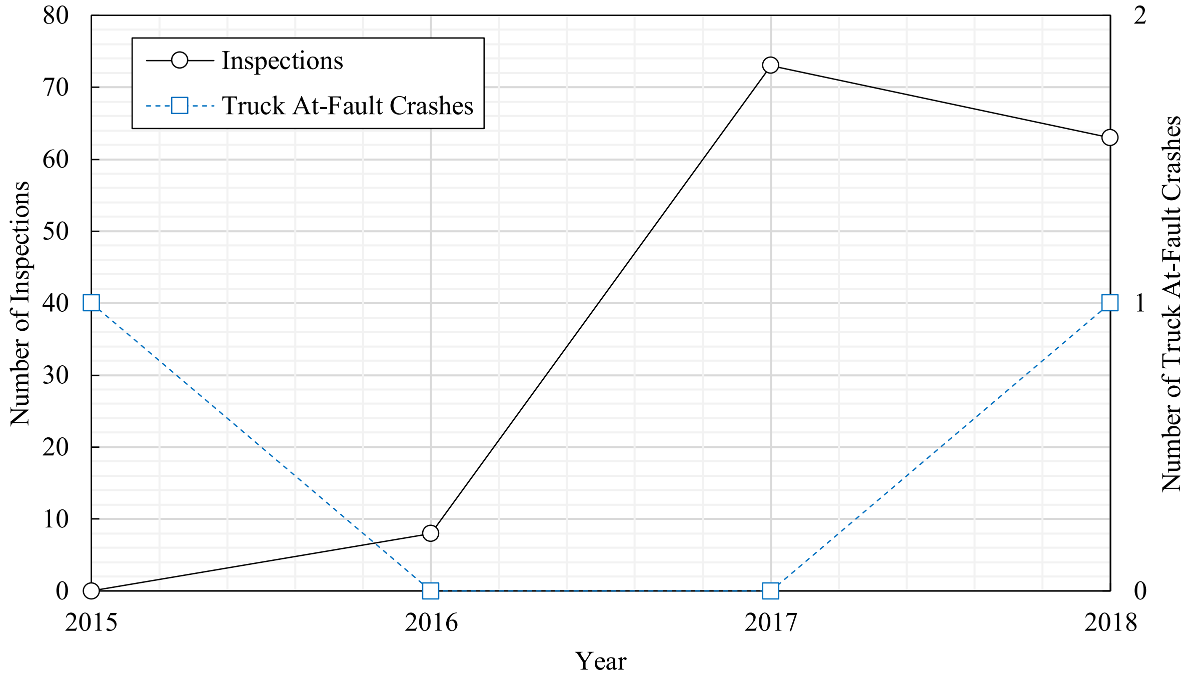

Figure 4.10: Number of inspections and truck at-fault crashes on US-395

4.2 INTERSTATE 205

With I-205 having the most inspections over the period of the program, I-205 will be the primary focus for a more in-depth analysis. In addition to analyzing inspections and crash frequency, crash rate (to account for traffic volumes) and a cost-benefit (or cost-effectiveness) analysis will be discussed.

Over the duration of the program, there have been 2,576 inspections on I-205. Also during this time period, there have been 79 truck at-fault crashes. Locations of inspections and truck at-fault crashes on I-205 can be seen in Figure . Based on records from ODOT Commerce and Compliance, the most occurring unsafe driving behaviors leading to inspections are shown in Figure and the most occurring reported causes of truck at-fault crashes are shown in Figure . Lastly, the total number of inspections by year and truck at-fault crashes by year are shown in Figure and Figure , respectively.

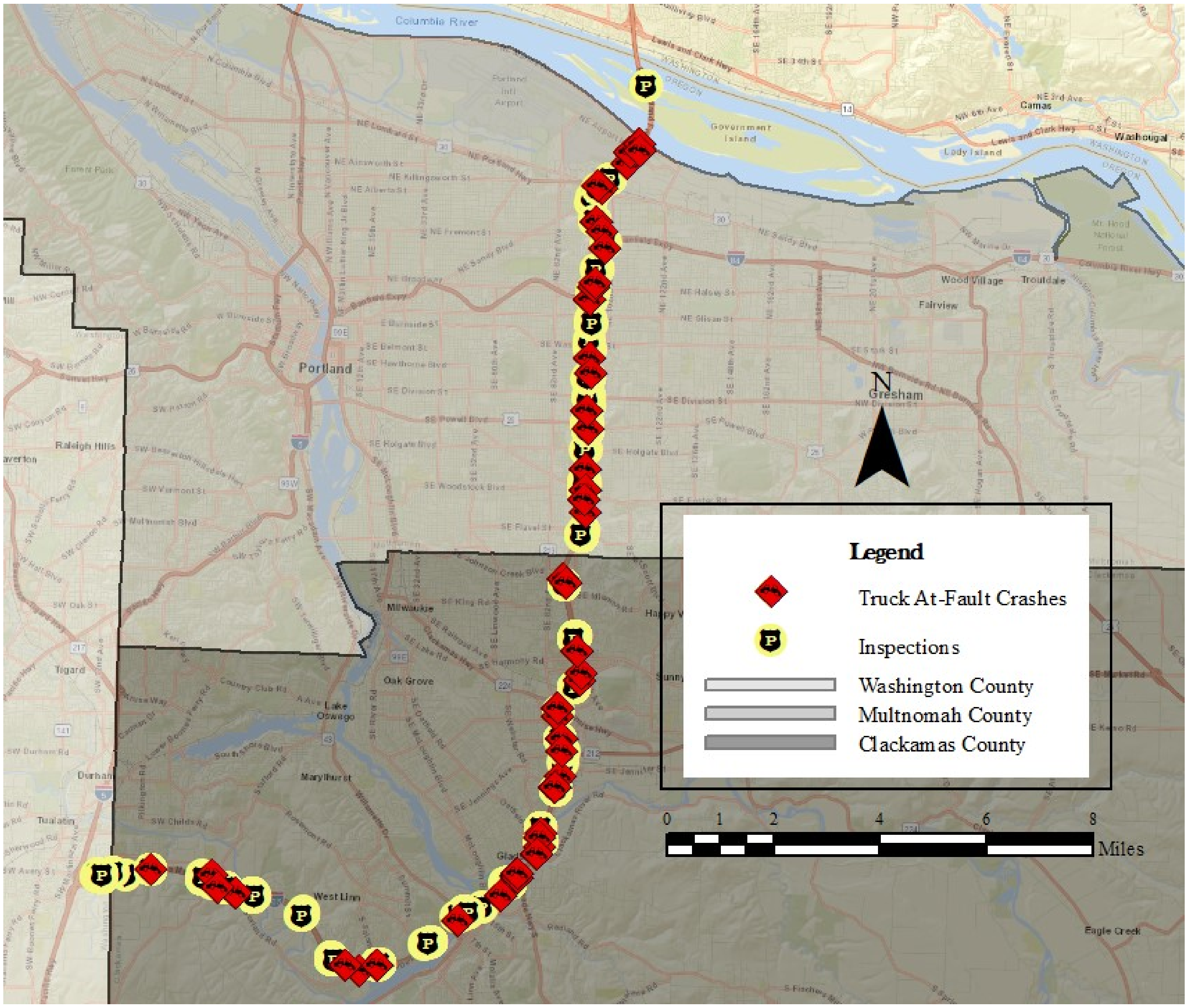

Figure 4.11: Inspections and truck at-fault crashes on I-205

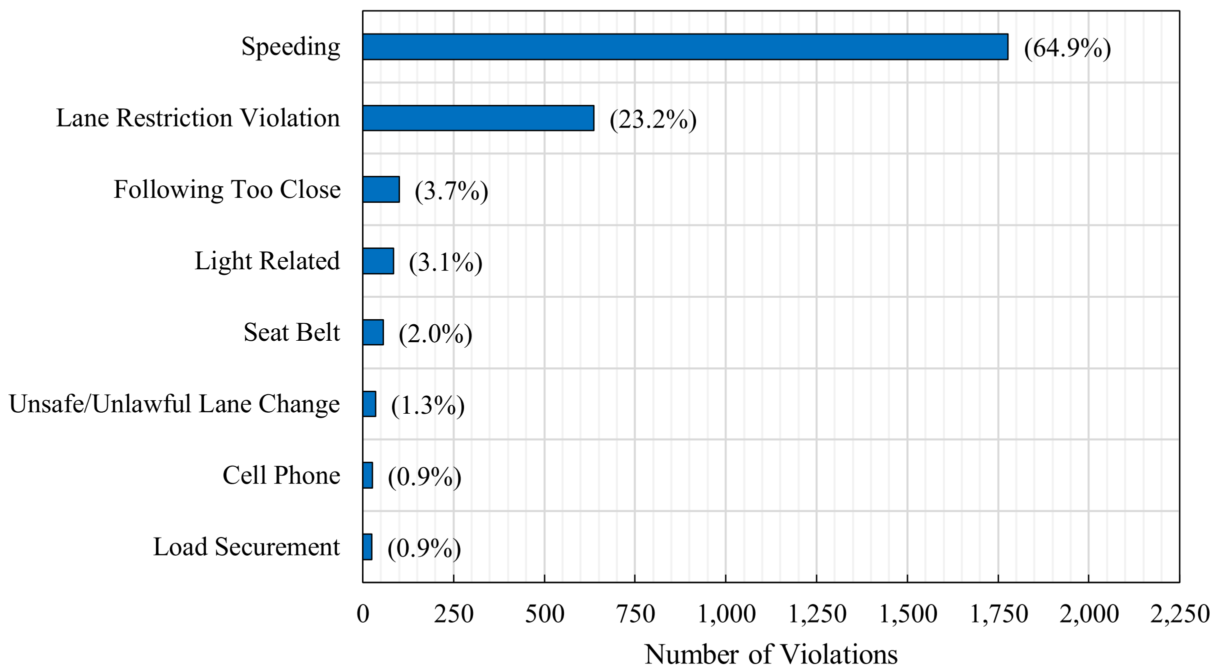

Figure 4.12: Most occurring unsafe driving behaviors leading to inspections

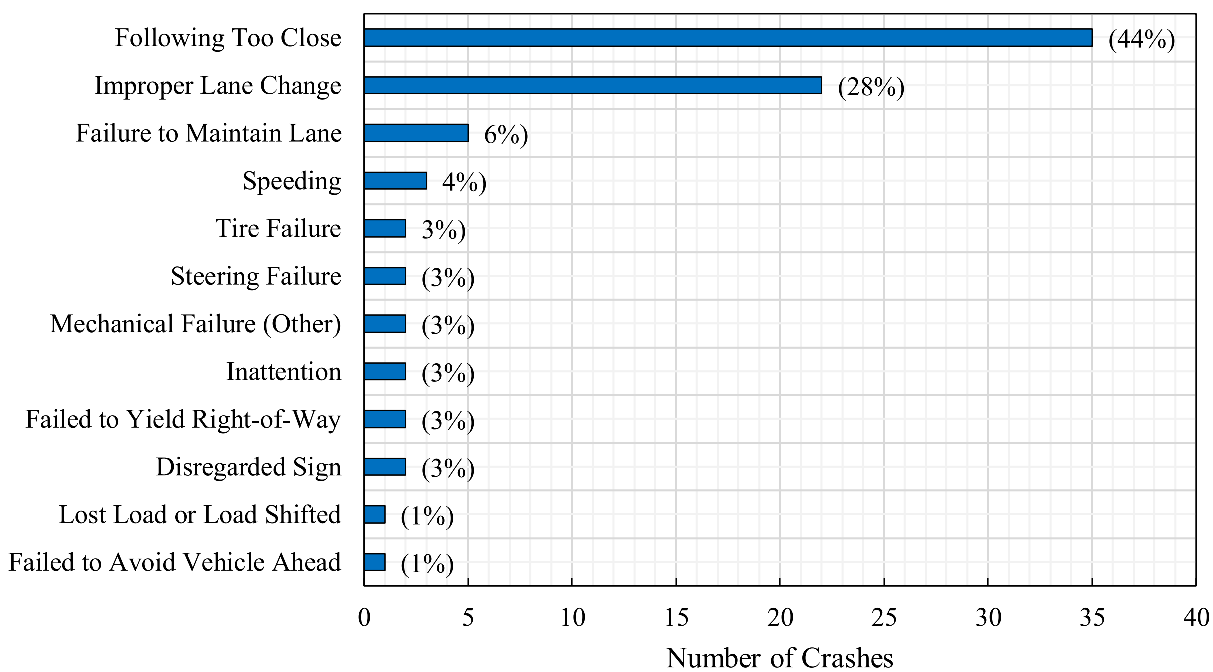

Figure 4.13: Frequency of reported causes for truck at-fault crashes on I-205

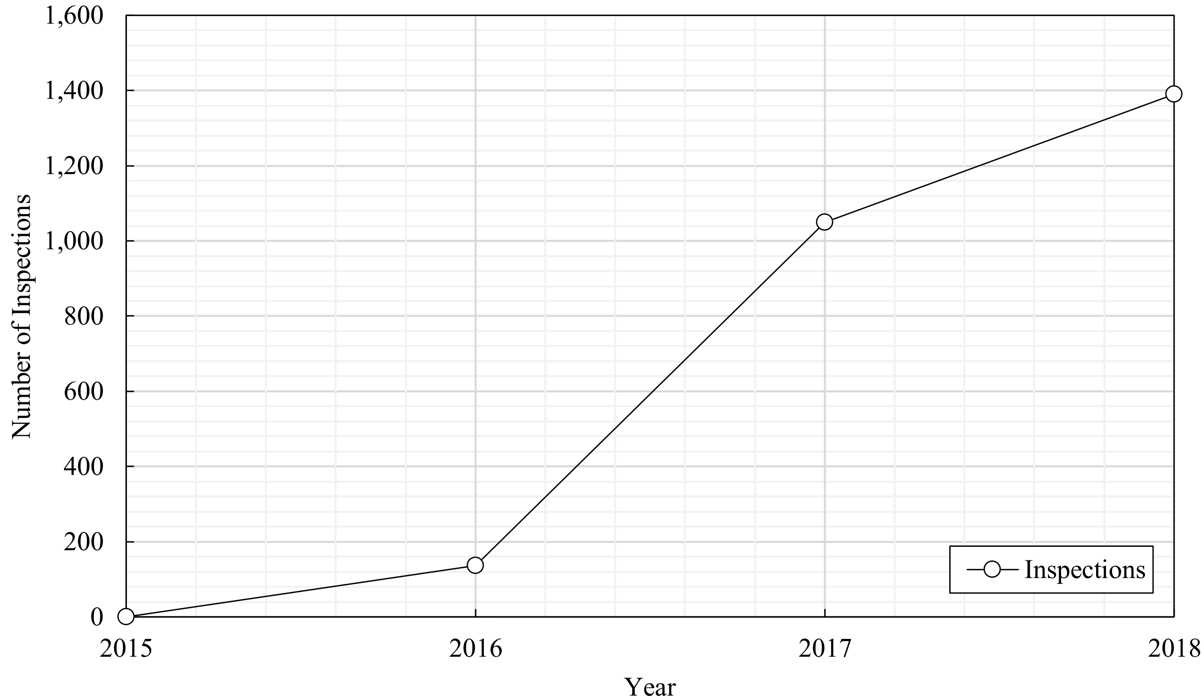

Figure 4.14: Number of inspections by year on I-205

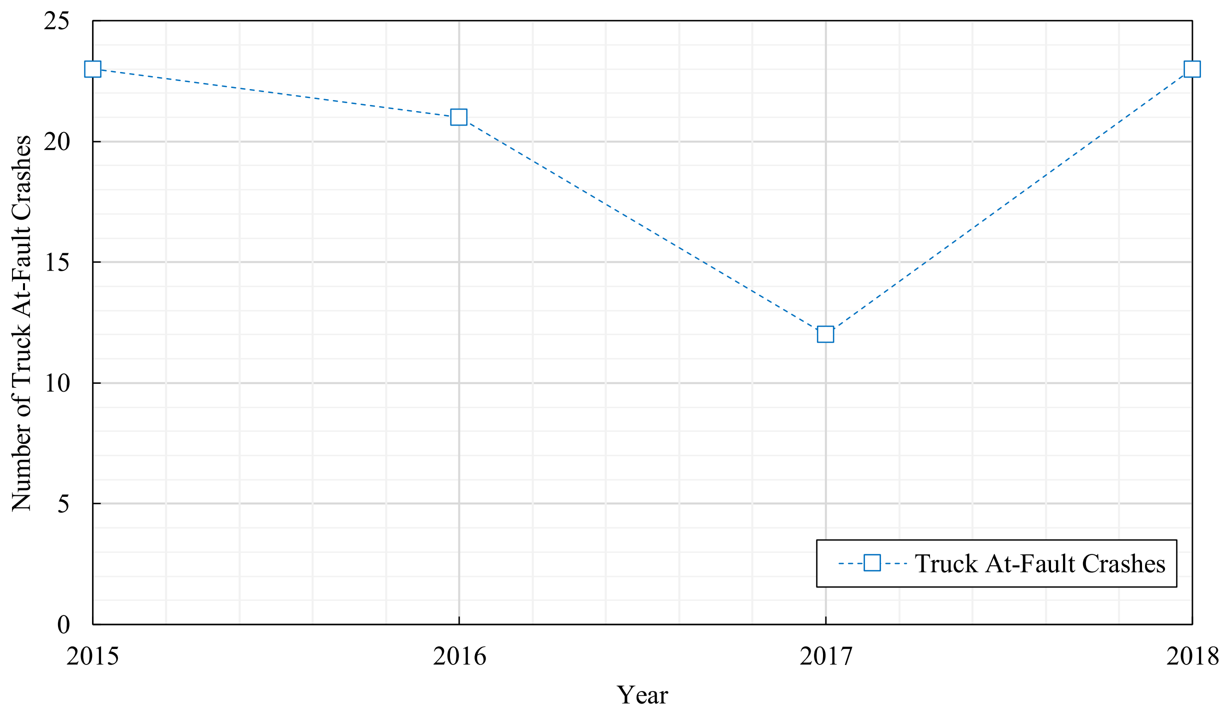

Figure 4.15: Number of truck at-fault crashes by year on I-205

Before any further analysis, any crash that occurred under congested conditions, or was caused by a mechanical failure, was omitted. This was done to account for crashes that increased law enforcement are unable to potentially mitigate. In other words, crashes that occur in extreme congestion (i.e., stop-and-go conditions) and crashes that occur due to mechanical failures have a low likelihood of being reduced as a result of increased law enforcement. Removal of these crashes are based on the crash reports as provided by ODOT Commerce and Compliance and the reported crash cause. As such, the new crash trends and the difference in crash totals are shown in Figure and Table , respectively.

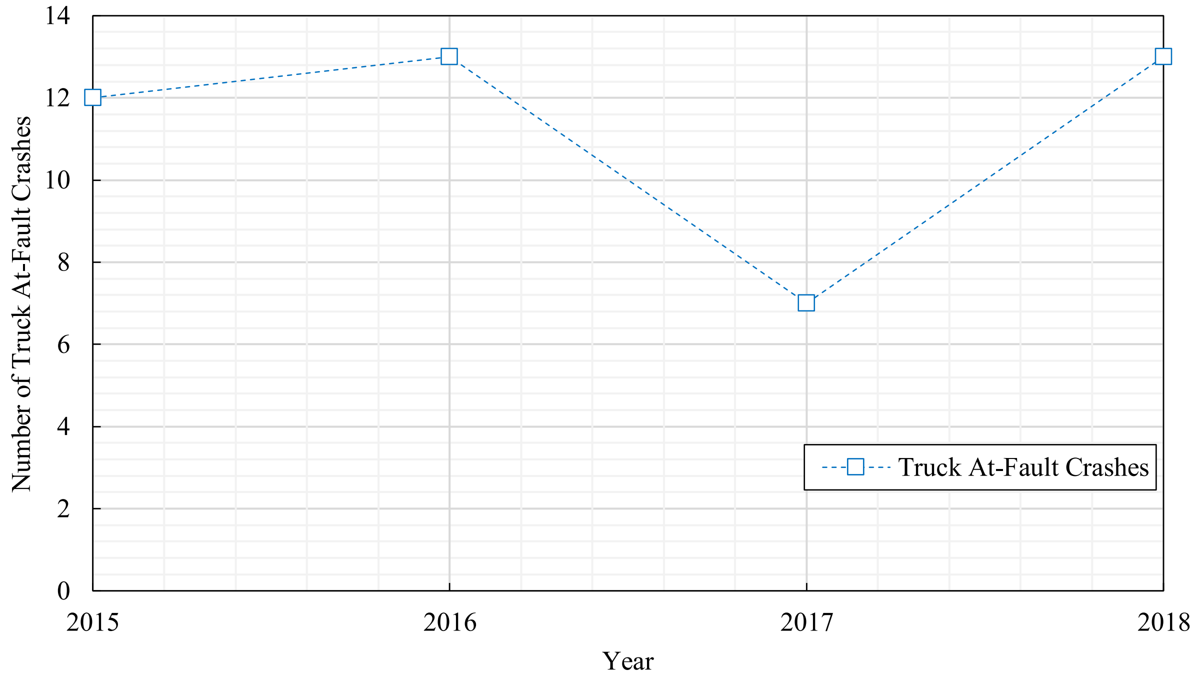

Figure 4.16: Number of driver-at-fault truck cashes in uncongested conditions on I-205

Table 4.1: Comparison of Crashes Based on Driver-at-Fault and Congestion

All Crashes		Driver-at-Fault Without Congestion	Percent Difference
Year	**Number of Crashes**	**Number of Crashes**	
2015	23	12	-48%
2016	21	13	-38%
2017	12	7	-42%
2018	23	13	-44%

In addition to reported crashes, maximum crash severities were provided for I-205. Maximum crash severities are used to assess the average cost of the truck at-fault crash.[4] The frequency of

[4] Maximum crash severity refers to the most extreme injury sustained during the crash. For example, if both a non-fatal injury and a fatal injury occurred, the maximum crash severity would be recorded as fatal.

crashes by maximum crash severity are shown in Figure . As observed, no fatal crashes occurred along I-205 during this time period, 24% of the crashes involved a non-fatal injury, and 76% resulted in no injury.

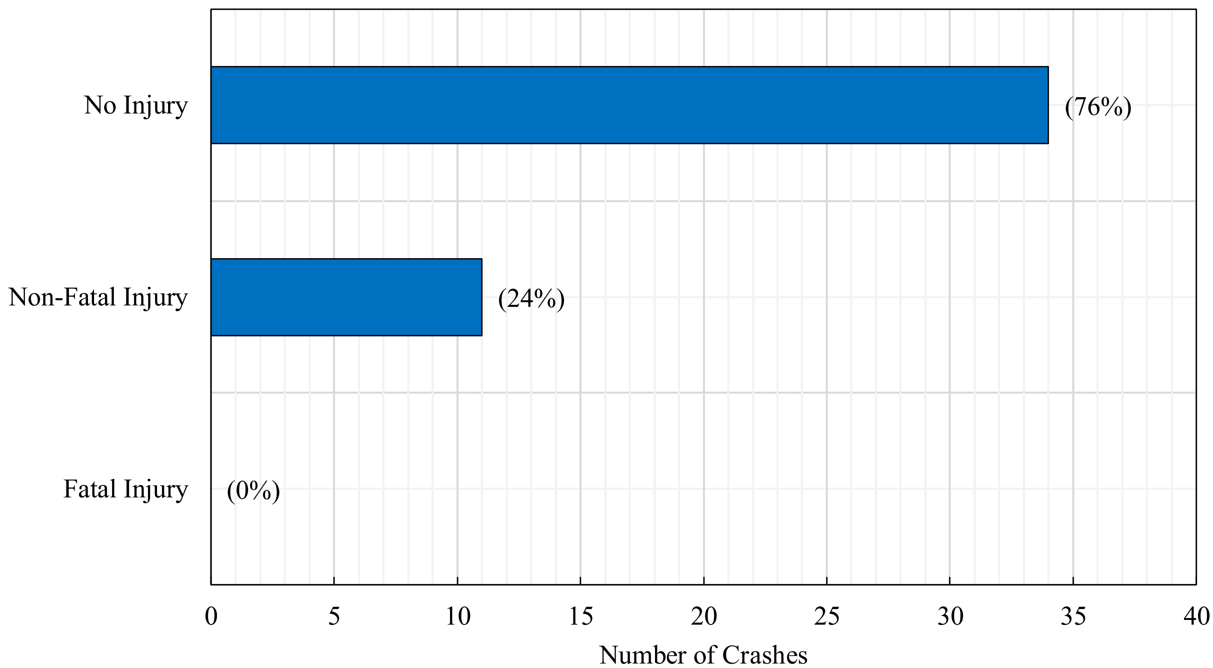

Figure 4.17: Number of crashes by maximum crash severity on I-205

The trend in no injury and non-fatal injury crashes along I-205 are shown in Figure . The number of injury crashes are decreasing, while the number of no injury crashes have increased over the last year.

To account for traffic volumes, the remaining plots are in terms of crash rate; specifically, the number of truck at-fault crashes per 100-million vehicle-miles-traveled (VMT). VMT is measured for trucks only. Figure shows the trend in truck at-fault crashes in 2015. This is the year before the program started; therefore, the plot shows no inspections. Figure shows the number of inspections and truck at-fault crashes by month for the first year of the program. The program started late in the year, which is depicted in the figure. Near the end of the year, a slight increasing/decreasing relationship between inspections and truck at-fault crashes is observed. In 2017, the first full year of the program, the relationship between inspections and truck at-fault crashes is anticipated for parts of the year (see Figure). This relationship is primarily observed in the late winter months and the summer months. Lastly, Figure 3 shows the relationship between inspections and truck at-fault crashes in 2018, the second year of the program. In 2018, the anticipated trends are observed throughout the year. In each case where inspections are increasing or decreasing, truck at-fault crashes are doing the opposite. In addition, as shown in Figure , if a crash does occur, they are resulting in more no injury crashes (i.e., injury crashes and fatal crashes are being reduced).

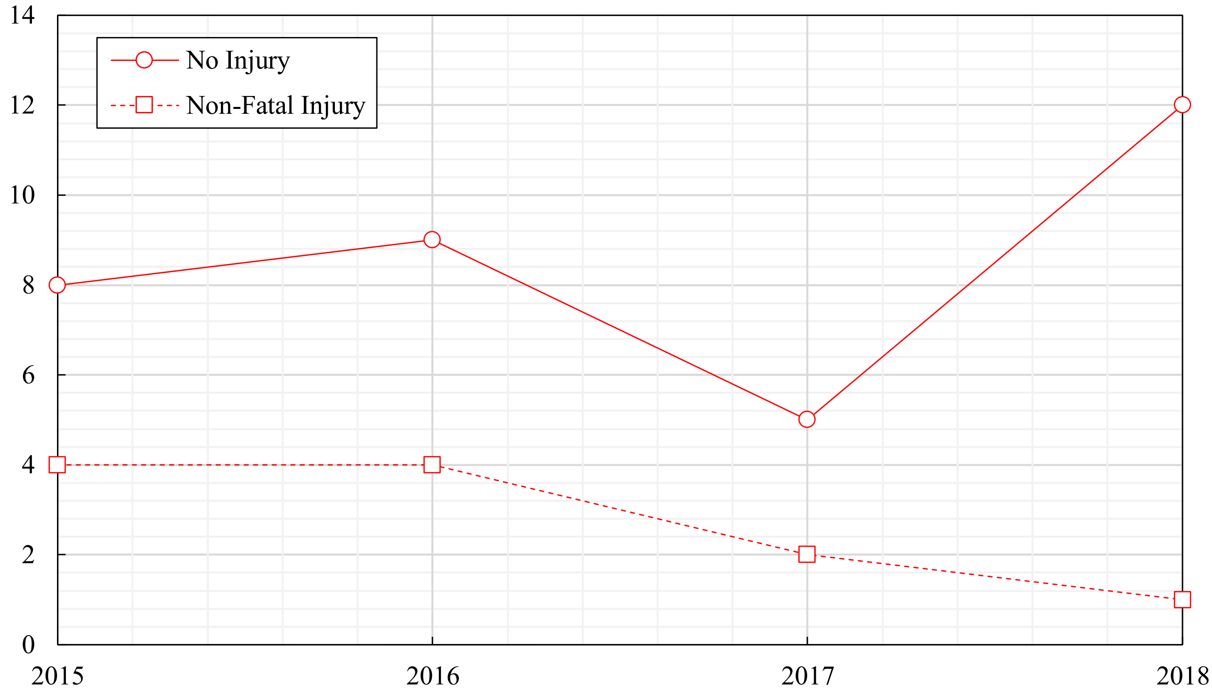

Figure 4.18: I-205 crashes by maximum crash severity on I-205

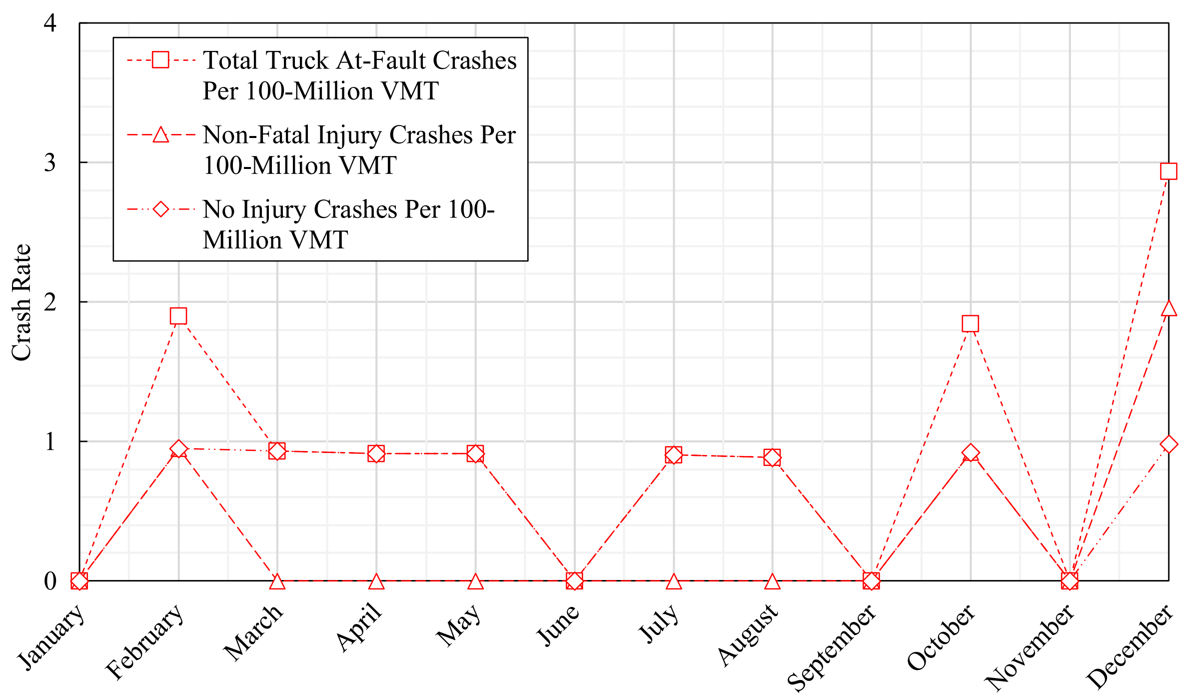

Figure 4.19: Truck at-fault crash rate in 2015 on I-205

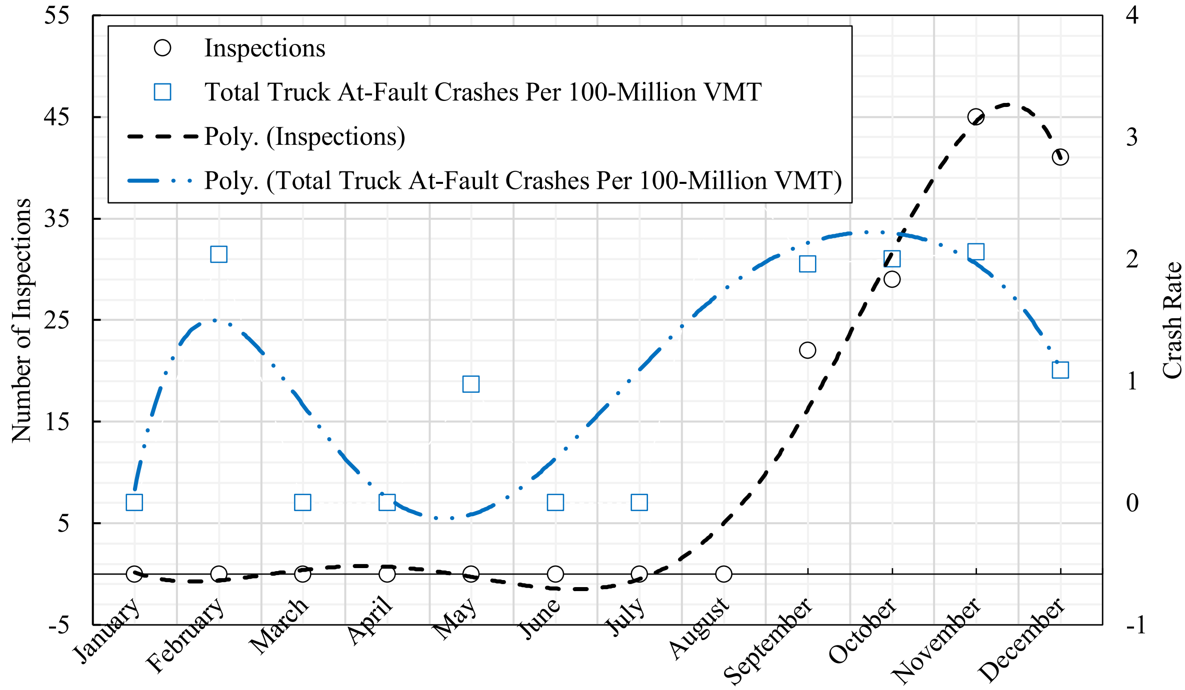

Figure 4.20: Number of inspections and truck at-fault crash rate in 2016 on I-205

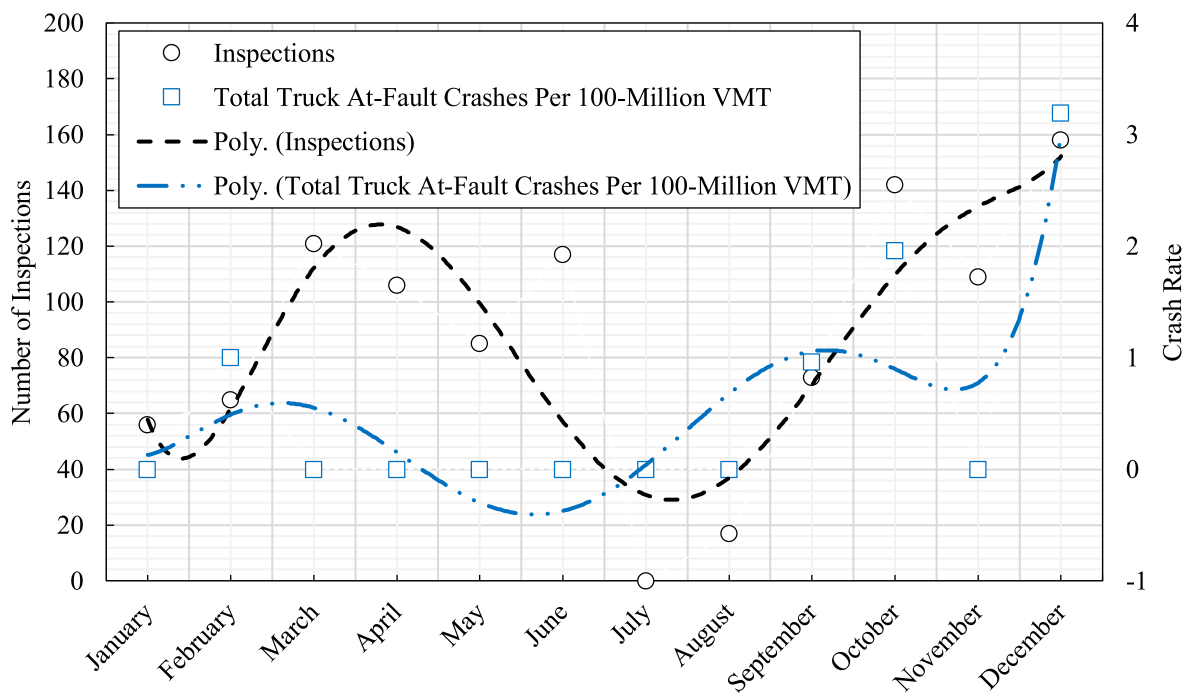

Figure 4.21: Number of inspections and truck at-fault crash rate in 2017 on I-205

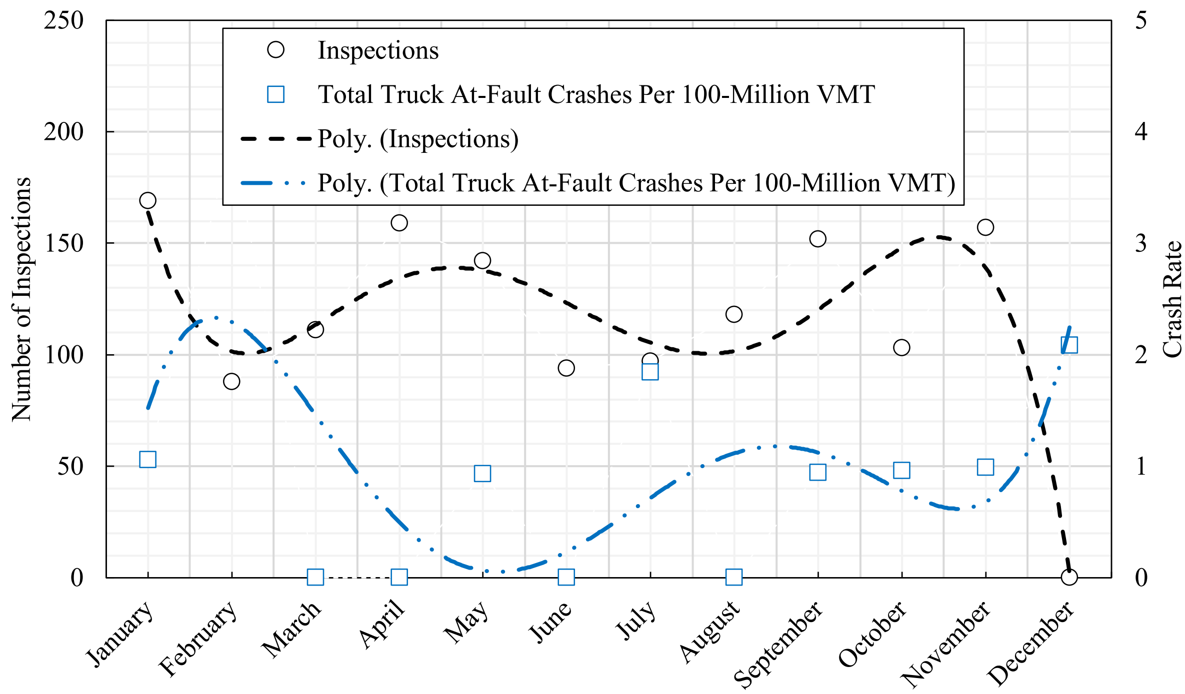

Figure 3: Number of inspections and truck at-fault crash rate in 2018 on I-205

4.3 INSPECTIONS COSTS AND CRASH COSTS

To assess the cost of inspections and crash costs, crash harm is used. Crash harm is a "*quantitative measure of the combined human and material losses from traffic crashes based on economic valuation*" (Knipling, 2009). These costs, or crash harm, are based on the maximum crash severity (i.e., the most severe injury sustained in the crash).

The most recent crash harm metrics are presented by Zaloshnja and Miller (2007). Included in the crash harm metric are monetary values related to the following:

- Medical costs.
- Emergency services costs.
- Property damage costs.
- Costs due to lost productivity.
- Value of pain and suffering.
- Value of quality of life that family loses due to death or injury.

Due to the crash harm metrics being presented in 2005 dollars, they are converted to 2018 dollars using consumer price index (CPI) inflation conversion factors (US Bureau of Labor Statistics, 2019; Sahr, 2019):

$$C_{2018_s} = \frac{C_s}{CF}$$

(4-1)

Where:

C_{2018_s} is the average co2st per crash for severity s in 2018 dollars, C_s is the average cost per crash for severity s in 2005 dollars, and CF is a conversion factor used to convert 2005 dollars to 2018 dollars.

In this case, the conversion factors is based on the final annual average CPI for 2018, resulting in a conversion factor of 0.746. Table summarizes average truck-involved crash costs by severity.

Table 4.2: Summary of Truck-Involved Crash Costs

Crash Severity	Average Cost in 2005	Average Cost in 2018	Percent Change
No Injury	$15,114	$19,352	+28.04%
Non-Fatal Injury	$195,258	$250,010	
Fatal	$3,604,518	$4,615,260	

In terms of inspections, each inspection costs $113.75. Based on 2018 crash costs by maximum crash severity and inspection costs of $113.75 per inspection, Figure shows a linear trend over the duration of the program. As more money is spent on inspections, costs due to truck at-fault crashes are decreasing. To quantify, see Table .

As observed in Table , there is a steady reduction in crash harm. Although the number of crashes is slightly up in 2018 compared to the previous year, the crash harm has decreased as a result of less severe crashes. Table shows that since the beginning of the program, total crash cost has reduced by nearly 68%. This is due to a substantial decrease in the total number of crashes in 2017, as well as crashes that did occur in 2018 being primarily no injury crashes. In addition, the trend of inspections and crashes in 2018 is the anticipated result. The overall numbers may be a result of specific months in which crashes increased due to too few inspections (refer to Figure 3). As such, this particular month can inflate the year's crash numbers. Once more, refer to Figure 3 to observe the desired trend in truck at-fault crashes and the number of inspections. Ultimately, the data shows that the program is working, both in terms of reducing driver-at-fault crashes and associated severities. Figure shows the trend in the relationship between crash cost and inspection cost. The first full year of the program has a steep slope, but following the first year of the program, the slope begins to flatten. It is anticipated that at some inspection cost, the line no longer decreases. The point of this behavior is expected to be obtained with the data still being collected. Therefore, the additional data from 2019, being that the program has been extended, can further substantiate these findings.

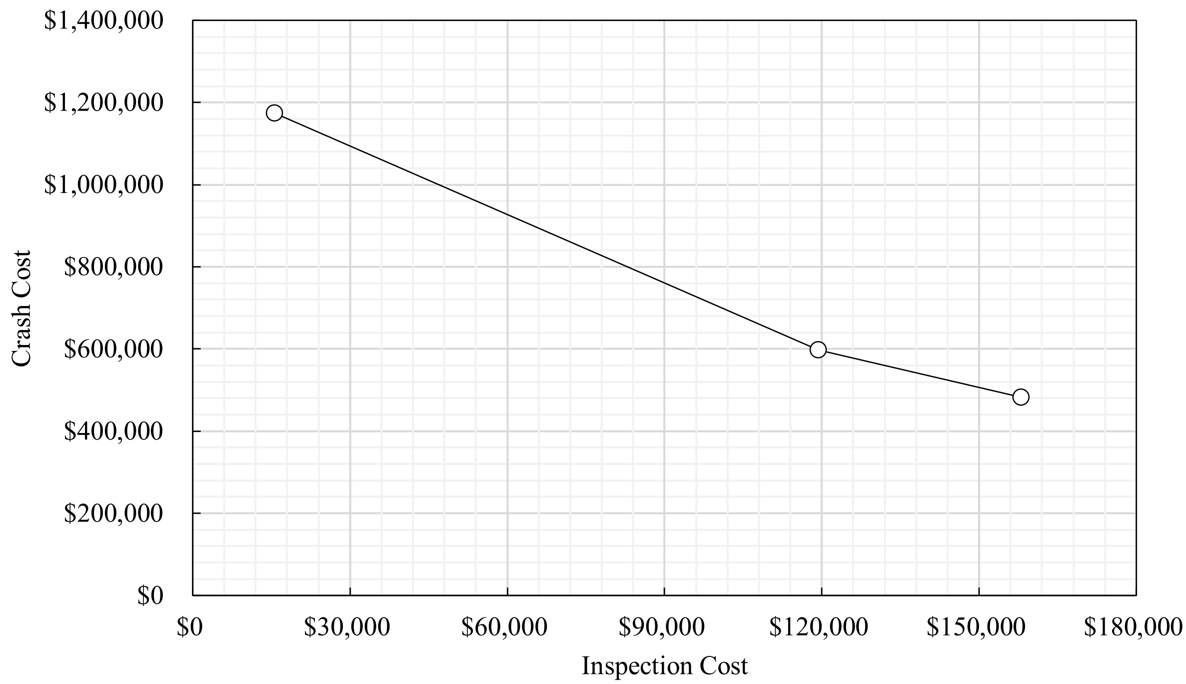

Figure 4.23: Crash cost and inspection cost

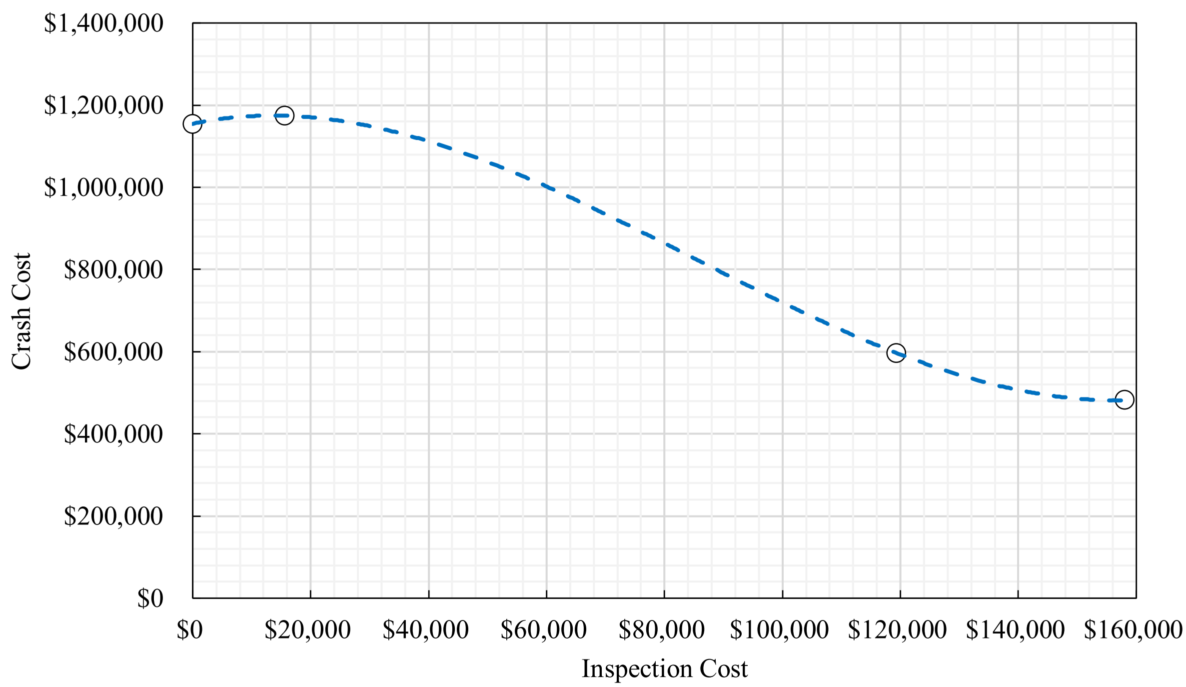

Figure 4.24: Trend in crash cost versus inspection cost

Table 4.3: Changes in Crash Cost and Inspection Costs

Year	Crash Cost	Inspection Cost	Change in Crash Cost	Change in Inspection Cost	Accumulated Percent Change in Crash Cost
2015	$1,154,858	$0	-	-	-
2016	$1,174,210	$15,584	↑ 1.7%	-	↑ 1.7%
2017	$596,781	$119,324	↓ 49.2%	↑ 665.68%	↓ 47.5%
2018	$482,236	$158,113	↓ 19.2%	↑ 32.51%	↓ 66.7%

Table 4.4: Changes in Truck VMT and Number of Crashes

Year	Truck VMT	Crashes	Injury Crashes	No Injury Crashes	Percent Change			
					VMT	Total	Injury	No Injury
2015	107,471,648	12	4	8	-	-	-	-
2016	100,091,285	13	4	9	-6.9%	8.3%	0.0%	12.5%
2017	102,093,111	7	2	5	2.0%	-46.2%	-50.0%	-44.4%
2018	104,134,973	13	1	12	2.0%	85.7%	-50.0%	140.0%

4.4 NEXT STEPS

Although this report provides evidence of the program's effectiveness, there is still work to be done. In terms of steps to be taken, there are three primary aspects:

1. Continue data collection through the program's extension.
2. Cost-benefit/cost-effectiveness analysis.
3. Program expansion and development of a state budget model.

The following subsections will detail each of the avenues moving forward.

4.4.1 Continued Data Collection

With the program being extended, data is still being collected. At the point of this report, only data through 2018 has been used. Data will continue to be collected through 2020, resulting in two years of additional data to be analyzed. It is anticipated, as discussed previously, that a plateau in the crash cost and inspection cost relationship will be observed. In addition, the spike of crashes observed in 2018 can be assessed. Along with continued data collection, other data sources will be fused to generate a picture with a higher resolution. For example, information on work zones, weather, roadway geometries, etc., can be included in the analysis.

4.4.2 Cost-Benefit/Cost-Effectiveness Analysis

Of particular interest from this program is the cost-benefit, or cost-effectiveness, of having increased law enforcement to mitigate truck driver-at-fault crashes. Due to data constraints for the current report, the two proposed analyses were not conducted. However, as part of a current ODOT research project, *SPR-810: A Framework to Evaluate Causes and Effects of Truck Driver At-Fault Crashes*, these cost-related analyses are being explored. To explain these analyses, refer to the following subsections.

4.4.2.1 Cost-Benefit/Cost-Effectiveness Analysis

Of particular interest to determine the effects of the treatment (i.e., increased law enforcement) on truck at-fault crashes are three analyses. As stated previously, these analyses are being explored in *SPR-810: A Framework to Evaluate Causes and Effects of Truck Driver At-Fault Crashes*, using both the inspection data presented in the current report and additional years of crash data. The first of these analyses is a Bayesian-based cost-effectiveness analysis. This methodology will be implemented in R, where the resulting scripts can be made available to ODOT. The premise behind this methodology is to post-process the results of a specific evaluation, in this case, increased law enforcement. This consists of estimating various parameters to generate estimations for costs and benefits as it pertains to inspections. This method has been applied to health science and social science, but has yet to be applied in this context.

The second methodology is also a process to be completed in R: Cost-effectiveness analysis using a multi-state survival (duration, hazard, etc.) modeling framework. This methodology allows the analyst to build a Markov decision model, where explanatory variables in the model will be observed characteristics in the data. This results in model predictions and model fits. Using the generated model, the cost-effectiveness can be analyzed by performing deterministic and probabilistic sensitivity analyses. Unlike the previous Bayesian-based analysis, this is a parametric approach. Outputs from both cost-effectiveness analyses include graphical figures to help visualize the effectiveness of a specific treatment, such as the cost-effectiveness plane, acceptability curve, and expected value of information curve.

The third method is a regression-based technique that is rarely applied to transportation-related applications due to limitations in data. It is anticipated that with the additional years of crash data being used in SPR-*810: A Framework to Evaluate Causes and Effects of Truck Driver At-Fault Crashes*, this method can be applied successfully. The proposed regression technique is regression discontinuity. This method is based on using knowledge of precise rules determining a treatment. In the case of the current work, this would be the start of the program. In addition, regression discontinuity includes a parameter to be estimated where endogeneity is not a concern, which in turn allows the analyst to make inference on causal effects (i.e., the reduction in crash harm was/is ***caused*** by increased inspections). This particular parameter also ensures there is no reverse causality and no omitted variable bias in the model estimations. The type of regression discontinuity being applied in this context is Sharp Regression Discontinuity, as the treatment status is deterministic and is a continuous function of the proposed explanatory variables (observed characteristics in the data). The model estimations will provide quantified causal effects of inspections on crashes in terms of cost.

4.4.2.2 Program Expansion and Budget Model

These future tasks will begin in September, 2019, when *SPR-832: Motor Carrier Safety Action Plan Expansion* begins. All tasks in the referenced research project will be conducted using data generated from this program. The objectives of this work include development of a marginal enforcement cost vs. marginal benefit site scoring model, allowing for ODOT to rank viable locations based on their cost-benefit ratio. This work will also include the application of the aforementioned model to identify other candidate corridors in Oregon for this program to be implemented. Included will be a spatial-based statistical analysis so candidate corridors can be chosen with a high level of confidence. The project will conclude by developing an implementation plan for the program, permitting other jurisdictions to adopt the program. The implementation plan will also consist of an optimal cost allocation algorithm.

5.0 SUMMARY

Due to drivers being at-fault for approximately 95% of truck at-fault crashes in Oregon, a Safety Action Plan was developed. The program consisted of Inter-Governmental Agreements to partner with local law enforcement agencies. When truck drivers exhibited unsafe driver behaviors in the presence of law enforcement, the officers performed traffic enforcement stops followed by a Level 2 inspection. The premise behind the program is to decrease truck at-fault crashes, their severities, and associated social costs (referred to as crash harm in this report). The program resulted in data which was used to assess these factors.

The program collected data for about three and one-half years, including information on the unsafe driving behavior that lead to the inspection and the location of the inspection. In addition, truck at-fault crash data was provided, where the reported crash cause was also assessed. The data indicated that over 4,000 inspections took place with the most occurring unsafe driving behaviors being speeding and lane restriction violations. Of the thousands of inspections, more than one-half were conducted on I-205, which is the corridor of focus for the current report. As for leading truck at-fault causes, following too close, improper lane change, and failure to maintain lane were the most occurring. Of these leading causes, all are driver-at-fault causes.

With I-205 being the corridor of focus due to the high number of inspections, a further analysis was conducted to identify the relationship between inspections and driver-at-fault crashes. Also included in the analysis was a crash harm assessment, where the social costs of truck at-fault crashes were compared to the costs attributed to inspections. Results show that there is a benefit of having increased law enforcement on I-205, as crash costs have decreased greater than 60% since the start of the program. In addition, the crashes that are happening are less severe (i.e., no injury crashes). Although other highways in this report also showed promise, the sample sizes of both inspections and crashes are too small to make any inference with a high level of confidence. This suggests that there are specific characteristics about a corridor which lend itself to be a viable candidate for the program, two of which are the presence of law enforcement and the presence of truck at-fault crashes. With other known programs to mitigate specific types of crashes (e.g., distracted driving initiatives, D.U.I. initiatives, seat belt initiatives, work zone initiatives, etc.), the current report shows that this type of initiative has its success tantamount to its counterparts.

Although a formal cost-benefit/cost-effectiveness analysis could not be done for the current report, these analyses have been detailed and are presently part of SPR-*810: A Framework to Evaluate Causes and Effects of Truck Driver At-Fault Crashes*. In addition, program-related analyses are being extended further at the start of *SPR-832: Motor Carrier Safety Action Plan Expansion*.

6.0 REFERENCES

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