



Memorandum

To: Tony Brindisi, P.E.

From: Josh Sender, P.E.

Date: November 6, 2019

Re: I-25 North Metro Managed Lanes RSA Report – November 2019 Update

INTRODUCTION

The Road Safety Audit (RSA) report for the I-25 North Metro Managed Lanes was completed in December of 2017. This report included a crash data review for the I-25 mainline from milepost (MP) 217.04 (US 36 / I-270) to MP 222.18 (Community Center Dr) using crash data from January 1, 2012 through December 31, 2016. A memo dated June 13, 2019 provided an update to the report with an analysis of crash data from January 1, 2017 to June 30, 2018. This memo intends to conduct a similar crash data review on the same project limits; however, this memo will also utilize crash data from July 1, 2018 through December 31, 2018.

This memo frequently references the following documents:

- *I-25 North Metro Managed Lanes Road Safety Audit (RSA) Report, December 2017*
- *I-25 North Metro Managed Lanes RSA Report – 2019 Update Memo, June 13, 2019*

This memo contains the following sections and supporting attachments:

- Safety Enhancements
- Crash Data Review
- Next Steps

SAFETY ENHANCEMENTS

Since the completion and distribution of the RSA report, CDOT has continued to implement many of the safety enhancements mentioned in the report. These safety enhancements have included educational outreach efforts (Table 1), enhanced law enforcement visibility, and several roadway maintenance and engineering enhancements (Table 2).

Table 1 - Educational Outreach Efforts

Educational Outreach Efforts
<ul style="list-style-type: none">• Traditional Media Press release with resulting TV, radio, and print coverage
<ul style="list-style-type: none">• Variable Message Signs Safety messages on permanent and portable VMS, periodically changed
<ul style="list-style-type: none">• Social Media CDOT, State Patrol, Commuter Group, Corridor Government social media posts

Educational Outreach Efforts
<ul style="list-style-type: none"> • CDOT Public Information Office and Partners Leverage partner social media, newsletters, websites, and billboard access to spread messages
<ul style="list-style-type: none"> • E-470 / Express Toll Include information in billing statements and e-newsletters

Table 2 - Completed Safety Enhancements

Completed Safety Enhancement	Category
<ul style="list-style-type: none"> • "EXPRESS" word markings Reduce confusion approaching I-270 left exit 	Pavement Markings
<ul style="list-style-type: none"> • On-ramp striping improvements Merge traffic to one lane before entering mainline 	Pavement Markings
<ul style="list-style-type: none"> • "MOVE ACCIDENTS FROM TRAFFIC" signs Clear minor incidents from travel lanes quickly 	Signing
<ul style="list-style-type: none"> • Improve Express Lane dynamic sign messages Reduce confusion approaching I-270 left exit 	Signing
<ul style="list-style-type: none"> • Rumble Strips Improve compliance with managed lane entry point restrictions 	Roadway
<ul style="list-style-type: none"> • Evaluate and Implement Corridor Signing Improvements Improved signing for lane violation regulations, reduction of sign clutter, and improved guide signing 	Signing
<ul style="list-style-type: none"> • 88th Avenue Park-n-Ride Bus Operations Prevent unexpected bus maneuvers adjacent to freeway traffic. Communications with RTD appear to have resolved this issue. 	Operations / Incident Management
<ul style="list-style-type: none"> • Enhanced Law Enforcement Visibility Pilot program for rolling patrols during peak periods conducted Fall 2018. 	Enforcement
<ul style="list-style-type: none"> • Advanced Traffic Management Queue warning system implementation 	ITS
<ul style="list-style-type: none"> • Shoulder Widening (pull-out areas) Implemented in select locations. Intended to be used by law enforcement 	Incident Management / Enforcement

Furthermore, Table 3 shows the safety enhancements which are ongoing and currently underway.

Table 3 - Ongoing Safety Enhancements

Potential Safety Enhancement	Category	Schedule
<ul style="list-style-type: none"> • Traffic Incident Management Plan Multi-agency coordinated incident response and detour planning 	Operations / Incident Management	In progress: Draft completed November 2019
<ul style="list-style-type: none"> • Enhanced Law Enforcement Visibility Effort is continuing after aforementioned pilot program and is being funded by HPTE. Effort is continually evaluated for renewal every six months. 	Enforcement	In progress
<ul style="list-style-type: none"> • Advanced Traffic Management Investigate variable speed limits and speed harmonization 	ITS	Late 2020
<ul style="list-style-type: none"> • Managed Lane Ingress/Egress Zone Modifications Evaluate type, frequency, and delineation options (double dashed striping) of zones 	Signing and Pavement Markings	In progress
<ul style="list-style-type: none"> • Reconstruct Roadway to Full Template Provide standard shoulders, improve lane balance at I-270 / US 36 	Roadway	Post 2020
<ul style="list-style-type: none"> • Buffer Zone Delineation Enhancements Continue to explore various delineation strategies such as physical devices, seasonal applications, and selective location applications. 	Delineation	In progress

CRASH DATA REVIEW

The crash history for the period of January 1, 2012 through December 31, 2016 was examined in the RSA report. Additionally, the crash history for the period of January 1, 2017 to June 30, 2018 was examined in the June 2019 RSA update memo. Within this collective study period, 3,976 crashes were reported along I-25 between MP 217.04 and MP 222.18. Of these, there were 778 injury collisions and 4 fatal collisions; 1,052 injured and 4 killed overall. Table 4 summarizes the crash totals for mainline I-25 over the six-and-a-half-year study period.

Table 4 - Crash Totals from January 1, 2012 to June 30, 2018

Year	Property Damage Only (PDO) Crashes	Injury (INJ) Crashes	Injuries	Fatal (FAT) Crashes	Fatalities	Total Crashes
2012	253	67	95	0	0	320
2013	335	60	70	0	0	395
2014*	507	125	176	0	0	632
2015*	517	123	175	1	1	641
2016	592	153	203	3	3	748
2017	691	157	208	0	0	848
Jan-Jun 2018	299	93	125	0	0	392
Total	3,194	778	1,052	4	4	3,976
Average/Yr	491.4	119.7	161.8	0.6	0.6	611.7

*Primary construction period

Note: Crash totals for these time periods may not exactly match the crash totals seen in the RSA report or June 2019 RSA update memo. This is due to data refinements and post processing occurring since the documents were published. Changes in crash totals are minor and do not affect overall conclusions.

The RSA report also examined cumulative crash totals for 2016 to determine if the managed lane tolling operation affected crash frequency. Figure 1 (next page) displays the cumulative crash total plot with the tolling timeline from the RSA report. Figure 2 (next page) displays a similar cumulative crash total plot with the addition of the available crash data from the June 2019 RSA update memo.

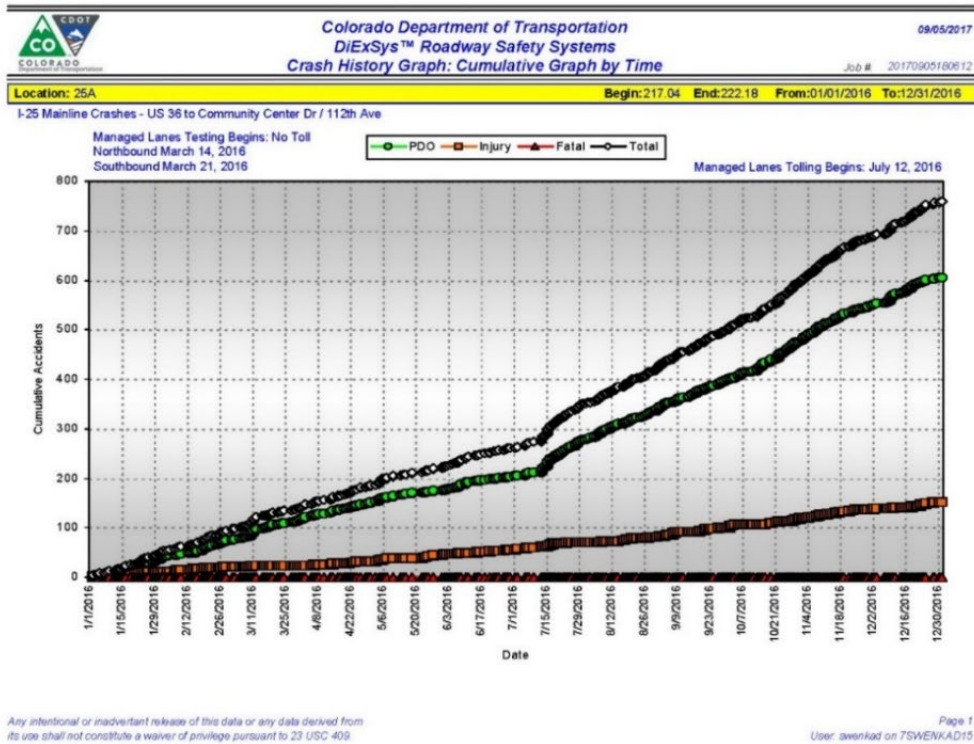


Figure 1 – January 1, 2016 to December 31, 2016 Crash Data with Tolling Timeline

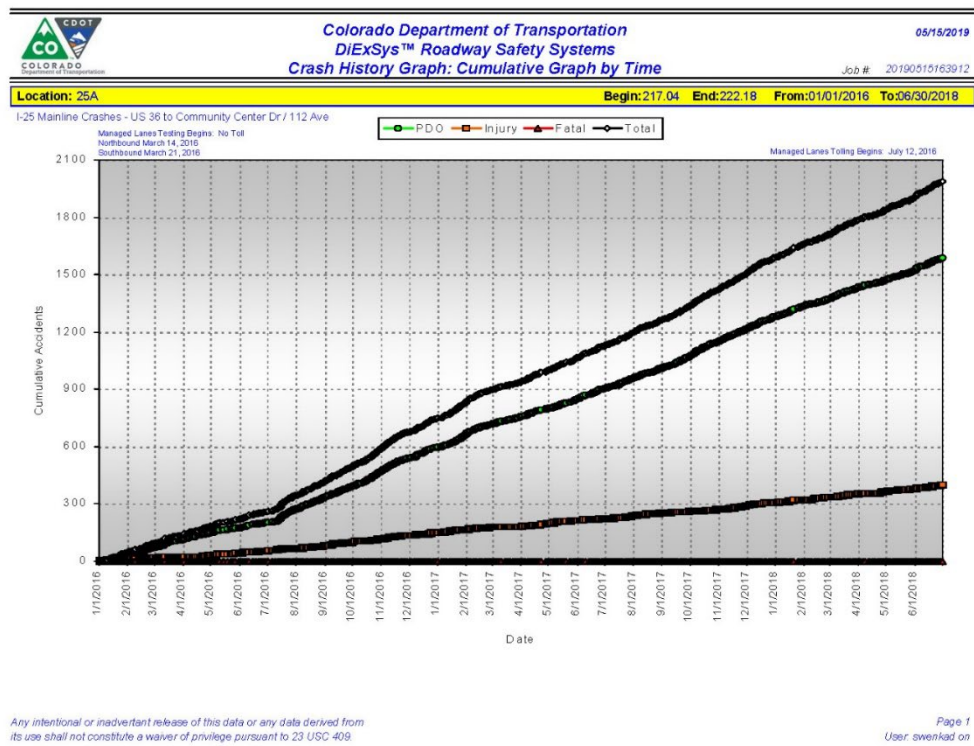


Figure 2 - January 1, 2016 to June 30, 2018 Crash Data with Tolling Timeline

Crash data from July 1, 2018 to December 31, 2018 is presented in Table 5. During this time, 394 crashes were reported in the study area. Of these, there were 89 injury collisions with 120 injured overall and 0 fatal collisions.

Table 5 - Crash Totals from July 1, 2018 to December 31, 2018

Year	Property Damage Only (PDO) Crashes	Injury (INJ) Crashes	Injuries	Fatal (FAT) Crashes	Fatalities	Total Crashes
Jul-Dec 2018	305	89	120	0	0	394
Total	305	89	120	0	0	394
Average/Yr	610.0	178.0	240.0	0.0	0.0	788.0

The June 2019 RSA update memo analyzed comparable five-year study periods comparing the crash data available at two timeframes. A similar analysis was conducted with the addition of the latest July 1, 2018 to December 31, 2018 crash data. Overall, proportions in crash severities and types remained relatively consistent, as seen in Figure 3 and Figure 4.

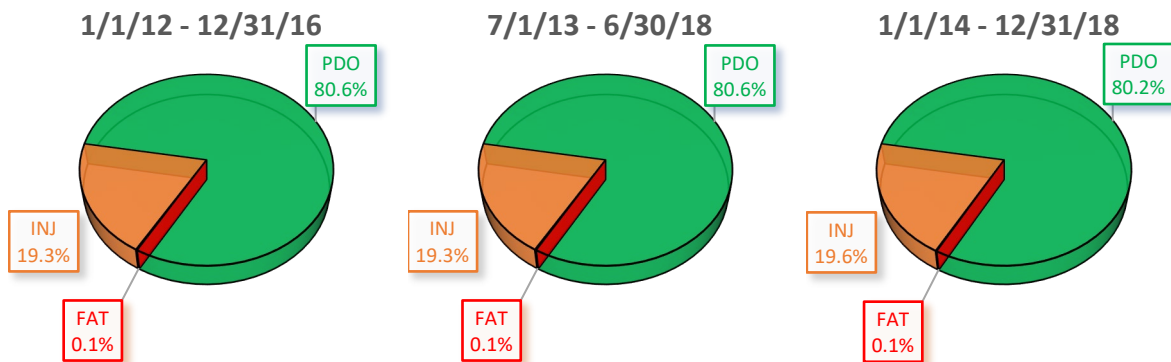


Figure 3 - Crash Distribution by Five-Year Period and Severity

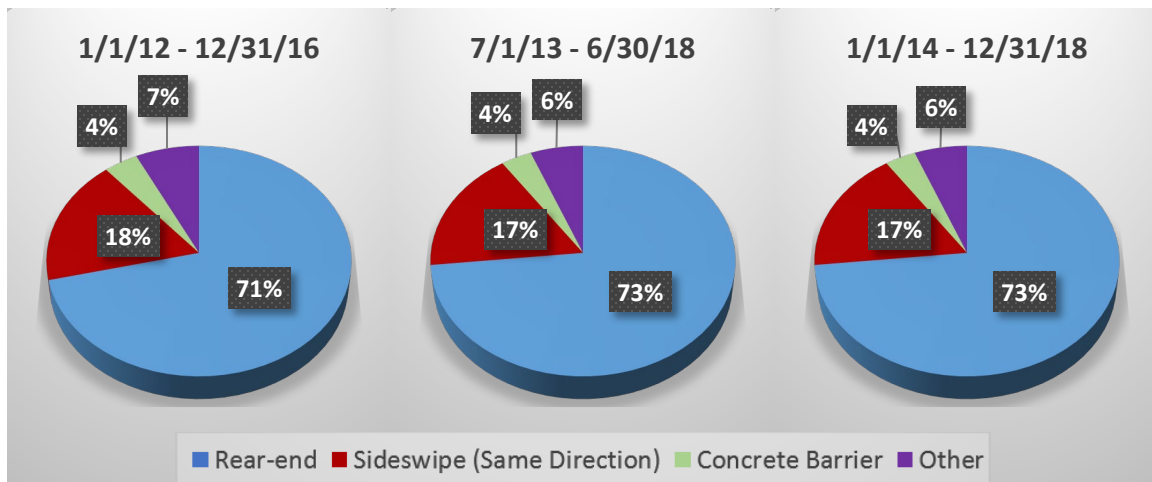


Figure 4 - Crash Distribution by Five-Year Period and Crash Type

The RSA report and June 2019 update memo also analyzed crash data by specific sections of the I-25 corridor as seen in Table 6.

Table 6 - I-25 Sections

Section	Begin Mile Post	Begin Reference	End Mile Post	End Reference	Length (miles)
1	217.036	I-270 and US-36 Junction	218.463	84 th Avenue	1.451
2	218.463	84 th Avenue	219.859	Thornton Parkway	1.318
3	219.859	Thornton Parkway	221.027	104 th Avenue	1.182
4	221.027	104 th Avenue	222.177	Community Center Drive	1.135

Figure 5 shows the distribution of the at fault vehicle (Vehicle 1) direction while comparing the three five-year study periods. In each study period, a greater proportion of crashes occur in the southbound direction in Sections 2, 3, and 4 while the reverse is true in Section 1. In comparing the most recent five-year period with the previous five-year periods presented in the RSA Report and June 2019 update memo, there is an increase in the proportion of southbound crashes in Section 1 and 2, while the proportions remain relatively unchanged in Sections 3 and 4. In each case, however, the directional prevailing majority remains unchanged.

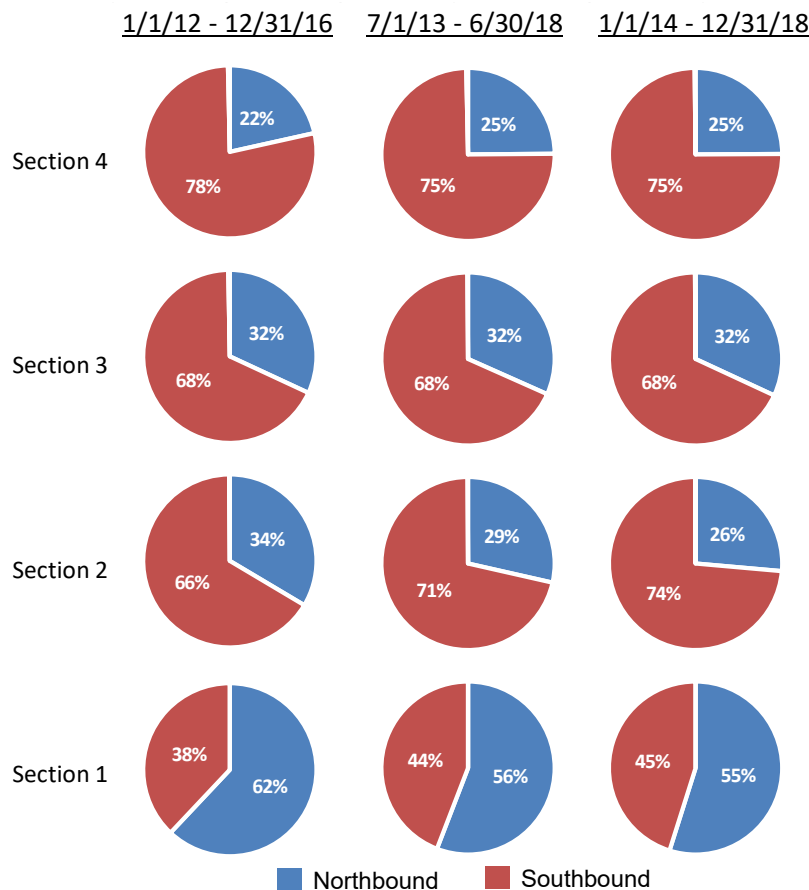


Figure 5 - Crash Distribution by Section and Direction

Figure 6 compares the crash totals in each section of I-25 using the three aforementioned five-year study periods. Consistent with the findings in the previous two analyses, Section 2 still appears to stand out as the largest contributor to total crashes in this corridor of I-25. However, the most recent five-year study period shows a decrease in total crashes regardless of crash severity or section when compared to the July 1, 2013 to June 2018 study period. In fact, PDO and injury crash totals in Section 4 decreased when compared to the initial January 1, 2012 to December 31, 2016 study period.

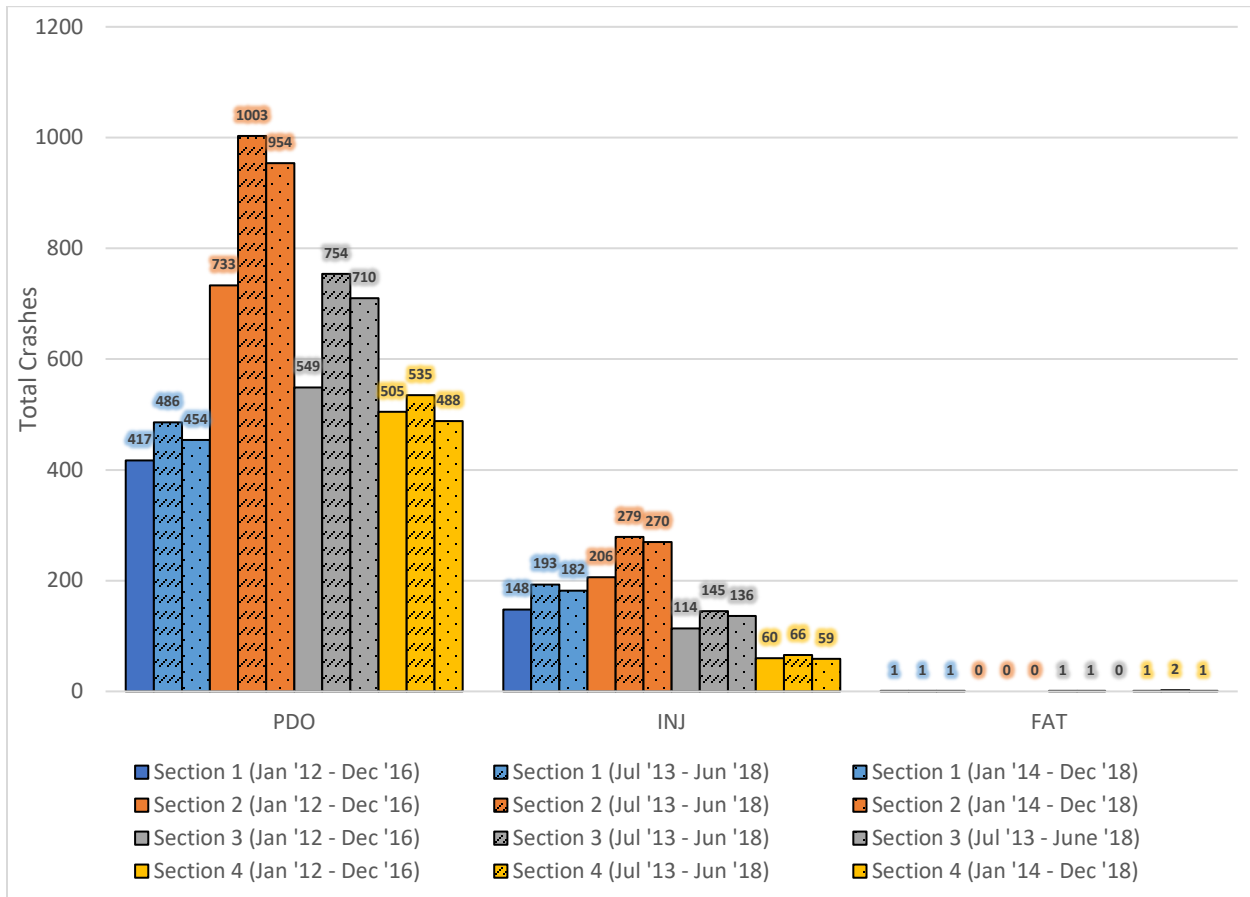


Figure 6 - Total Crashes by Section and Severity

The RSA report noted that there was a distinct increase in annual crash rate from 2012 to 2016. This observation was examined by plotting the cumulative number of each crash type for each year. As mentioned in the RSA report, the plot line for each year generally trends on a linear path, indicating a consistent trend in monthly crash totals within that year. However, the RSA report notes that March to April of 2015 and June to July of 2016 both indicate a sharp increase in slope. Similarly, the June 2019 RSA update memo noted an increase in the PDO slope from 2016 to 2017, while also noting a slight decrease in INJ slope from 2016 to 2017. Figure 7 displays this plot along with additional lines reflecting the new July 1, 2018 through December 31, 2018 cumulative crash totals (new lines highlighted in yellow).

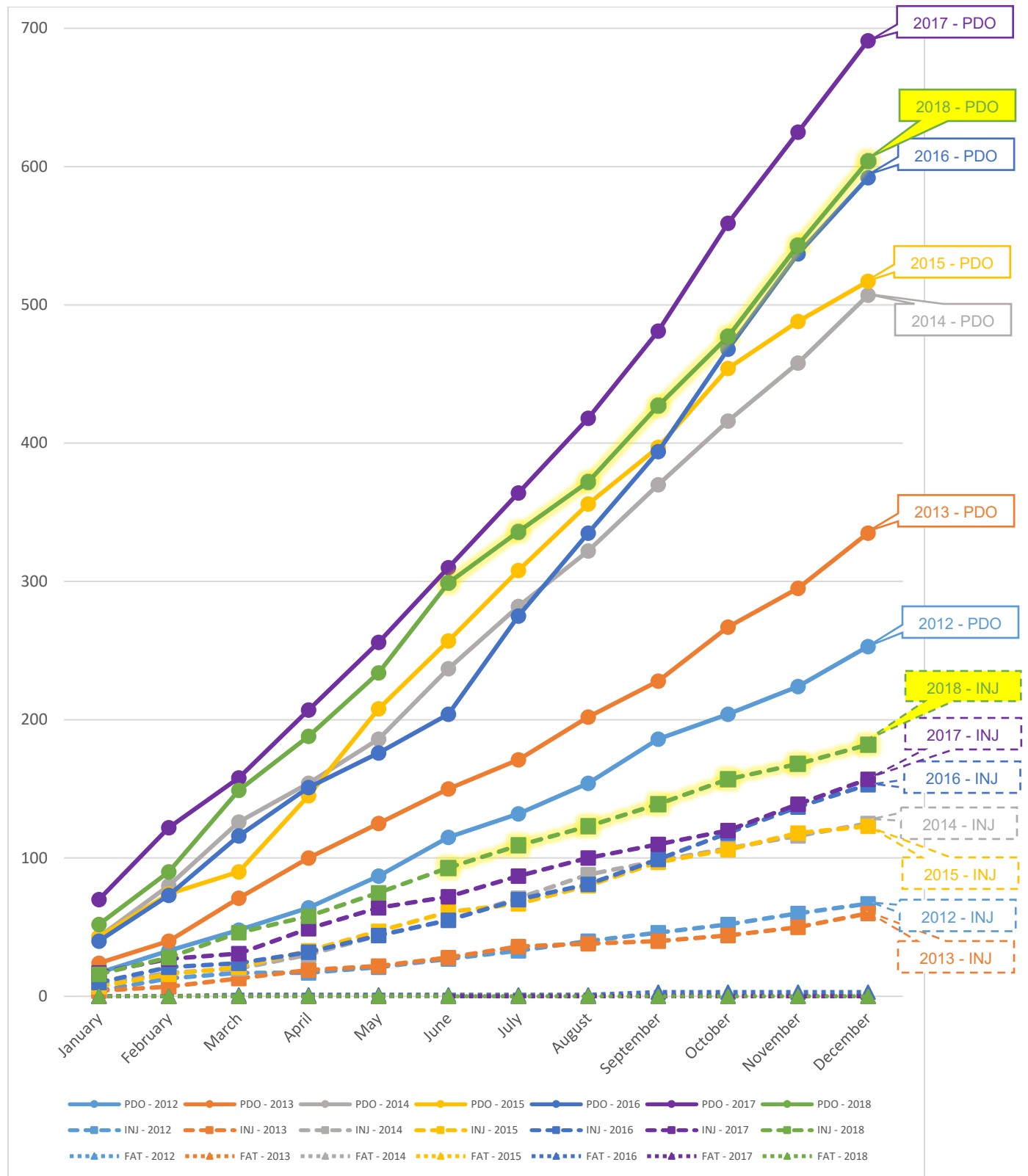


Figure 7 - Cumulative Crash Totals

A more detailed examination of the slope of each plot line displayed in Figure 7 on the preceding page is shown in Table 7 below. These slopes correspond to the trend in the cumulative monthly crash totals for each crash type during each year. These data indicate that the PDO slope in 2018 decreased by approximately 12% from 2017. Meanwhile, the INJ slope in 2018 increased by approximately 23% from 2017.

Table 7 - Cumulative Crash Total Plot Line Slopes

	2012	2013	2014	2015	2016	2017	2018
PDO Slope	21.8	27.9	42.2	46.1	50.6	56.2	49.3
INJ Slope	5.5	4.8	11.4	11.2	13.1	12.6	15.5
FAT Slope	0.0	0.0	0.0	0.1	0.3	0.0	0.0

The RSA report further investigated these trends by examining the total crash rate per million vehicle miles traveled (MVMT) for this I-25 corridor for each year. Figure 8 displays these crash rates and is appended with the most recent crash data, highlighted in yellow.

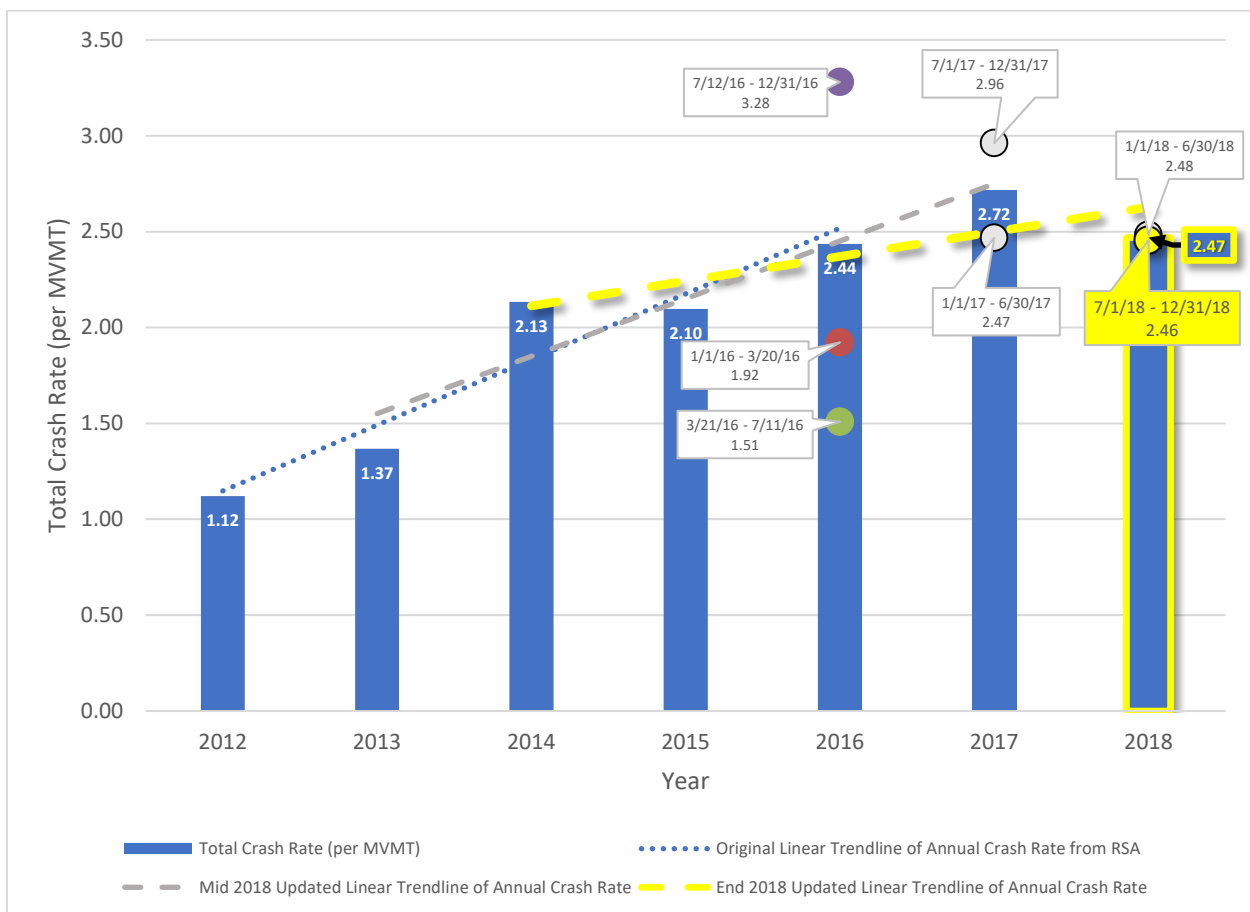


Figure 8 - Total Crash Rates by Year

The total crash rate for 2018 was 2.47 crashes per MVMT, a decrease of approximately 9% from the previous year. Figure 8 also displays three linear trendlines. The blue dotted linear trendline was the previous trendline drawn in the RSA report which used crash data from 2012 to 2016. The gray dashed linear trendline represents the trend seen in total annual crash rate from 2013 to 2017. Lastly, the yellow

dashed trendline represents the trend seen in total annual crash rate from 2014 to 2018. Notably, the trendlines all have a positive slope, however the slope of the yellow trendline is less than the slope of the gray and blue trendline. In practical terms, this means that on this corridor of I-25, the increase in total crash rate is beginning to show signs of slowing. In fact, the crash rate from 2018 shows a decrease from 2017 and is only slightly above 2016.

Meanwhile, the average annual daily traffic (AADT) on this corridor of I-25 has continued to show a modest increase from 2012 to 2018. Crash frequency has continued to outpace volume increases as displayed in Figure 9 (newly available data appended and highlighted in yellow). However, the 2014 to 2018 disparity between the five-year percent increases of total crashes and AADT has considerably decreased from that of 2012 to 2016 and 2013 to 2017.

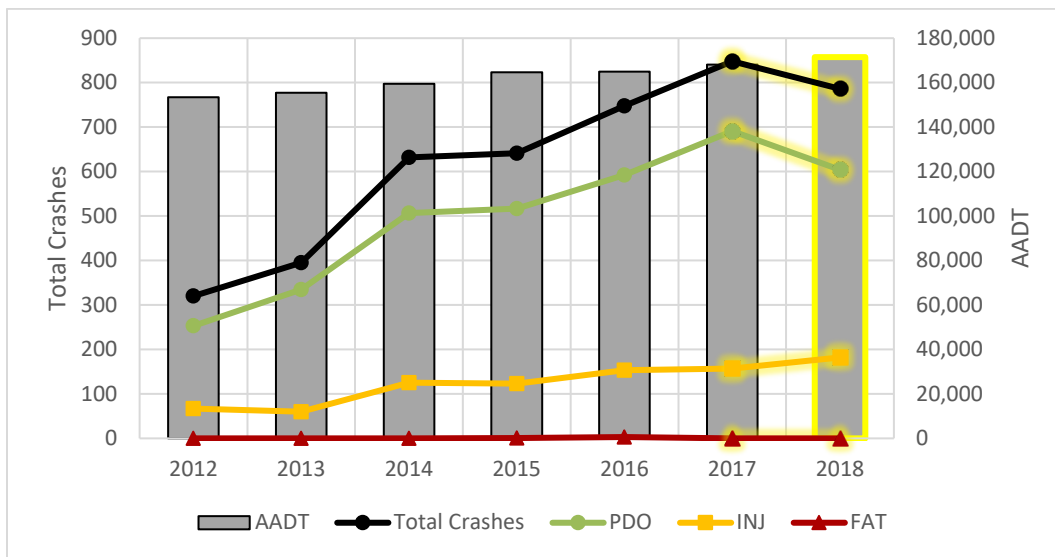


Figure 9 - Total Crash Distribution Compared to AADT

The crash total from 2018 showed a marked decrease from 2017, which in turn drove the latest aforementioned five-year trends downward (fewer crashes). Rear-end, concrete barrier, and other crash totals decreased while sideswipe same direction crashes increased from 2017 to 2018, as seen in Figure 10.

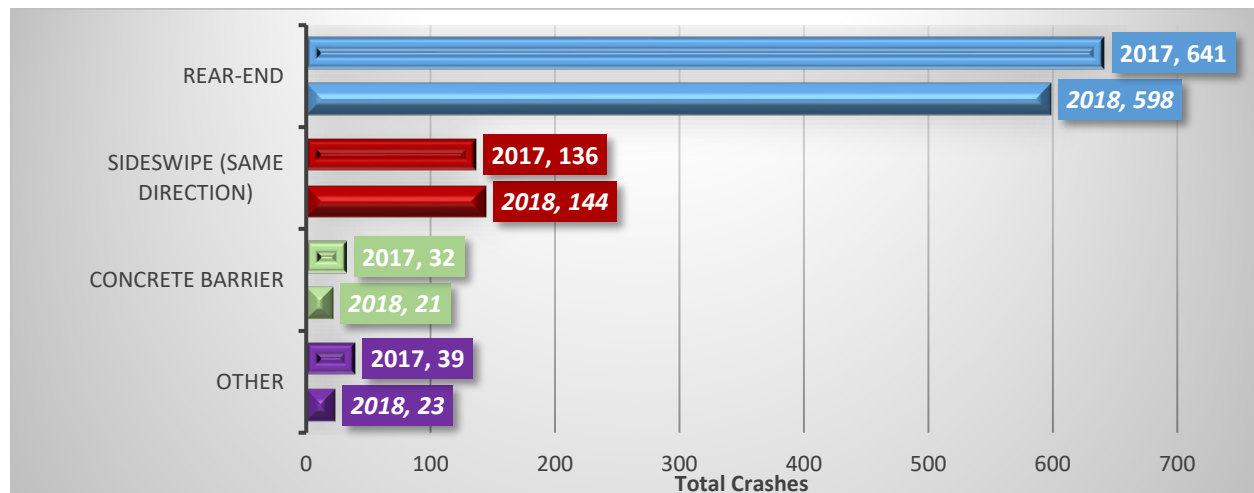


Figure 10 - Comparison of 2017 and 2018 Crash Totals by Type

More specifically, Figure 11 shows PDO and INJ crashes from 2017 and 2018 broken down by Section of I-25 (no fatal crashes occurred during this time period). There is a decrease in PDO crash totals in Sections 2, 3, and 4 and the Section 4 INJ crash total. Meanwhile, Section 1 PDO and Section 1, 2, and 3 INJ crash totals increased.

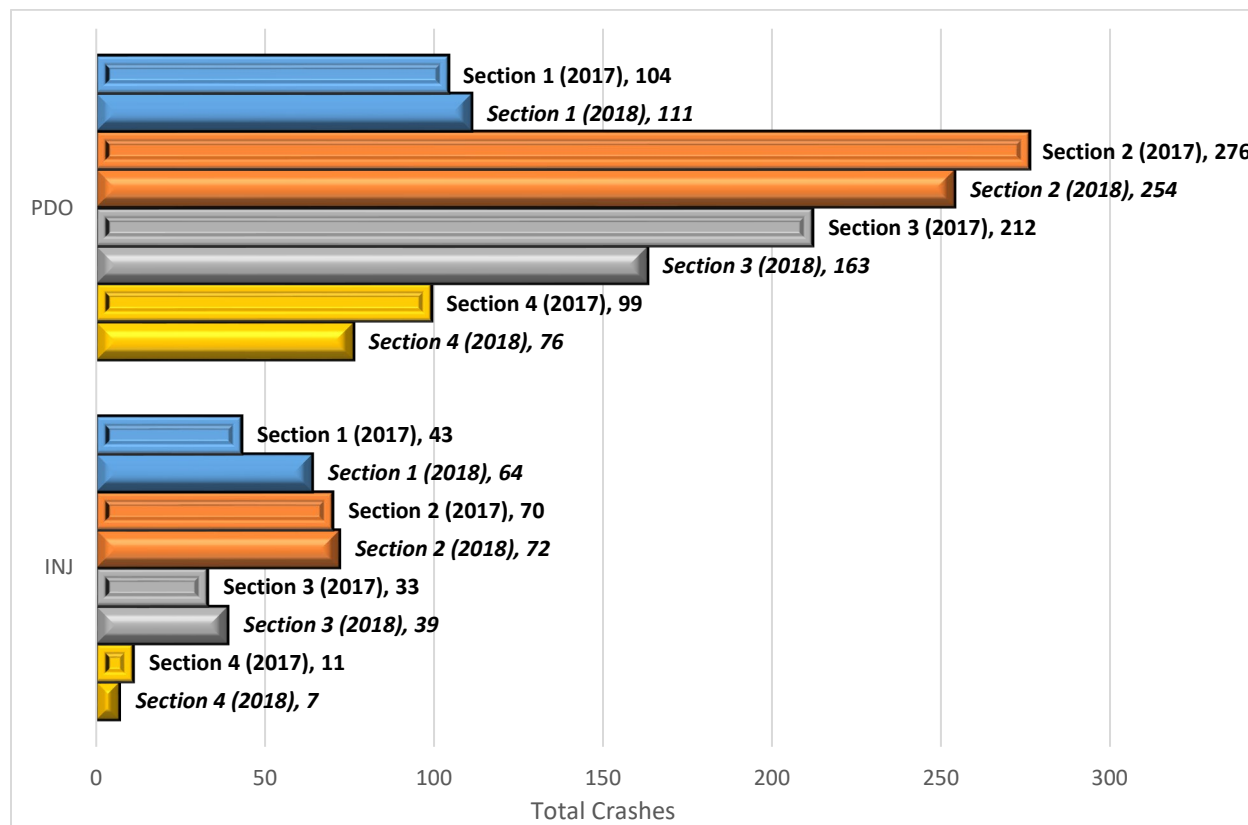


Figure 11 - Comparison of 2017 and 2018 Crash Totals by Severity and Section

The greatest decrease in PDO crashes from 2017 to 2018 occurred from rear-end crashes in Sections 3 and 4, with a decrease of 44 and 21 total crashes respectively. Meanwhile, rear-end crashes in Sections 1 and 2 accounted for the greatest increase in INJ crashes from 2017 to 2018. Sideswipe same direction crashes also moderately contributed to the increase in INJ crashes in Section 1, increasing by 7 total crashes.

NEXT STEPS

The safety enhancements on this corridor of I-25 which are either completed, in progress, or planned may affect the trend in crash totals. The level of effectiveness of these safety enhancements will be seen by continuing to monitor and summarize the crash data on a regular basis.