I-270 Existing Safety Conditions Report

I-270 Corridor Improvements

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CDOT Region 1
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Acronyms and Abbreviations

Acronym	Definition
AADT	annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
CDOT	Colorado Department of Transportation
HMVMT	hundred million vehicle miles traveled
HSM	*Highway Safety Manual*
I-25	Interstate 25
I-270	Interstate 270
I-70	Interstate 70
LOSS	Level of Service of Safety
PDO	property damage only
PSI	potential for safety improvement
ROR	run-off-the-road
SPF	safety performance functions

1.0 Introduction

The Colorado Department of Transportation (CDOT) and the Federal Highway Administration, in conjunction with local partners Adams County and Commerce City, are proposing improvements to 6 miles of Interstate 270 (I-270) in Adams County, Commerce City, and the City and County of Denver, Colorado, primarily between Interstate 25 (I-25) and Interstate 70 (I-70). This undertaking is referred to as the I-270 Corridor Improvements Project (project). This document describes the safety study of the existing conditions of the I-270 corridor.

Refer to Appendix A of the Environmental Assessment for the project setting, description of the Proposed Action, and description of no action.

I-270 is a 6-mile-long controlled-access interstate highway with two through-lanes in each direction, providing a direct connection from I-25 to I-70 between northern and eastern Denver metro communities and traveling through a primarily industrial setting (Figure 1). I-270 is a key link to the Denver International Airport and large energy, manufacturing, and freight distribution centers, and is a major truck corridor, providing access to adjacent industrial areas. Between I-25 and I-70, partial interchanges occur on I-270 at Interstate 76 (I-76), York Street, Vasquez Boulevard, and Quebec Street. The posted speed limit on the I-270 is 55 miles per hour (mph), lane width is 12 feet, the median type is mostly concrete barrier (44 percent), cable barrier (30 percent), and guardrail (20 percent). The highway crosses over both the Union Pacific Railroad and BNSF railroads, as well as the South Platte River, Clear Creek, and Burlington Ditch, and parallels Sand Creek. I-270 also travels through and near many known hazardous materials sites.

Based on review of I-270 historical crash data from 2014 to 2019, several key transportation safety findings for the corridor are listed as follows:

1. A greater than average fatal crash rate, and total and fatal/injury crash frequency, compared to average crash rates and frequencies for urban four-lane freeways in Colorado, when applying statistical safety models for comparison
2. Increasing crash trends over the most recent 6-year period of available data
3. An overrepresentation of truck-related crashes due to large truck volumes, which has resulted in an increased need for road design features to accommodate these vehicles
4. Five eastbound and two westbound locations, totaling 4.23 miles (32 percent of the total miles with both directions added together), are classified as Level of Service of Safety (LOSS) III and IV, which are defined as safety hotspots that experience higher than average crashes, indicating a high potential need for safety improvement
5. An external issue to the corridor itself relates to the impact from the Central 70 project. This neighboring project was started in 2017 and is likely diverting some traffic from I-70 to I-270. This diversion of traffic may contribute increased crashes to the I-270 corridor.

While speeding, following too closely, careless driving, and improper lane change are some of the main driver-related contributing factors and may require enforcement or educational treatments, many of the safety findings are related to traffic congestion, speed differentials between vehicles, and geometric design features, such as the need for an additional traffic lane, short weaving distances, short ramp merge areas, narrow shoulders, limited highway lighting, and small radius loop ramps. Based on 2014 to 2019 crash data (CDOT 2020), an average of 344 crashes per year occurred from 2014 to 2019 along the I-270 mainline, including an average of 1 fatal and 81 injury crashes per year. Rear-end crashes are the most frequent crash types, which account for about 60 percent of both injury and property damage crashes. The second and third highest crash types are same-direction-sideswipe and run-off-the-road (ROR) crashes, with 22 and 15 percent of all crashes, respectively. Rear-end and same-direction-sideswipe crashes often occur during congested conditions when speed differentials exist between high-speed and slower-moving vehicles. These conditions require drivers to react more quickly, and in many cases, drivers when not attentive, may not be able to perceive and react quickly enough to avoid crashes. Over 29 percent of the mainline crashes were speed related. As stated in the available crash reports from 2014 to 2019 (CDOT 2020), the officers responding to these incidents indicated the speed-related crashes resulted from reckless driving, speeding – speed not specified, too fast for conditions, or following too close. These crash types also tended to occur in locations with high volumes, short weaving sections, and short merge areas. Appendix A, Detailed Summary of Crashes, lists all reported crashes for the project study period from 2014 to 2019.

2.0 Crash History

The KABCO scale is used for reporting and assessing levels of crash severity in Colorado. The KABCO scale was originally developed by the National Safety Council to measure the observed injury severity for any person involved in a crash as determined by law enforcement (National Safety Council 1962; AASHTO 2010). The KABCO scale is used in Colorado and most other states by law enforcement officials, planners, and engineers, for classifying crashes according to the most severe outcome of a crash and is included in the current American Association of State Highway and Transportation Officials (AASHTO) *Highway Safety Manual* (HSM). The severity levels and KABCO acronym is defined as follows:

- "K" is a fatal injury that results in death
- "A" is an incapacitating injury (also referred to as evident incapacitating injury)
- "B" is a non-incapacitating injury
- "C" is a possible injury
- "O" is a no injury or property damage only (PDO)

Crashes are coded in the KABCO scale based on the most severe outcome in the crash. In this report, "total crashes" includes all five of these outcomes. Injury crashes include all reported injuries (A, B, and C) excluding fatal injuries. Table 1 shows the frequency of reported crashes for the I-270 mainline and ramps by severity during the 2014 to 2019 analysis period. Ramp crashes are identified using the "ramp" field in the crash data, which includes collector-distributor roads as well.

Table 1. 2014 to 2019 Reported Crashes by Severity

	Mainline						Ramps				Total	
	Crashes				Persons		Crashes			Persons	Crashes	
Year	Fatal	Injury[a]	PDO	Total	Fatalities	Injuries[a]	Injury[a]	PDO	Total	Injuries[a]	Fatal/Injury[a]	Total
2014	1	77	209	287	1	102	6	24	30	8	84	317
2015	1	88	256	345	1	121	11	37	48	17	100	393
2016	2	75	241	318	2	92	12	50	62	12	89	380
2017	1	67	261	329	1	96	9	33	42	12	77	371
2018	1	84	284	369	1	118	9	37	46	12	94	415
2019	0	96	322	418	0	129	15	42	57	16	111	475
Total	6	487	1,573	2,066	6	658	62	223	285	77	555	2,351
Average/Year	1.0	81.2	262.2	344.3	1.0	109.7	10.3	37.2	47.5	12.8	92.5	391.8

Source: CDOT 2020

[a] ABC severities on the KABCO scale are included.

As shown in Table 1, there are an average of 344 crashes per year on the I-270 mainline (88 percent of all corridor crashes) and, on average, 48 crashes or 12 percent per year on the ramps. Additionally, on average, 24 percent of mainline crashes are fatal/injury crashes. All six fatal crashes were mainline crashes.

Figure 1 shows the trend of the I-270 mainline and ramp crashes for total and for fatal/injury crashes. As shown on Figure 1, both total and fatal/injury crashes have been increasing in recent years.

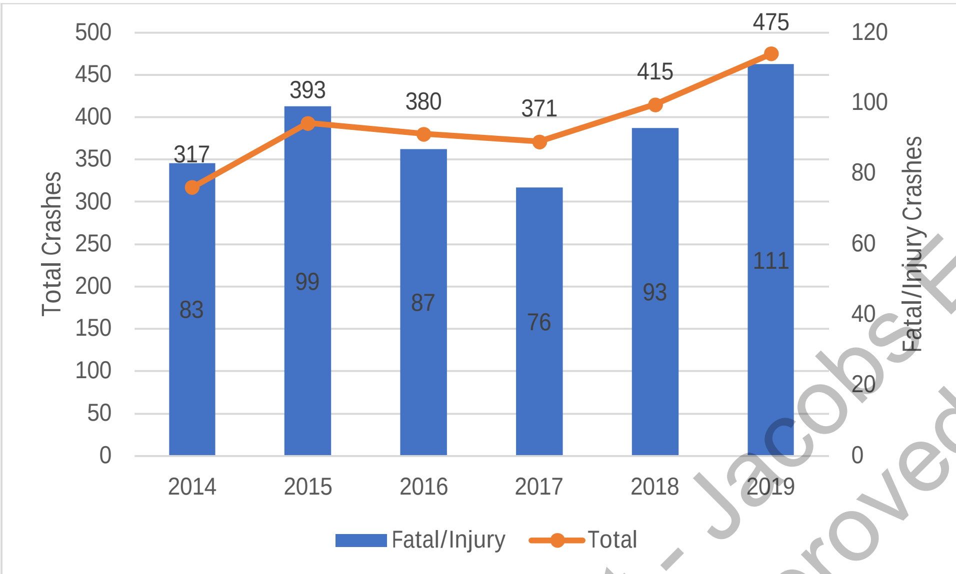
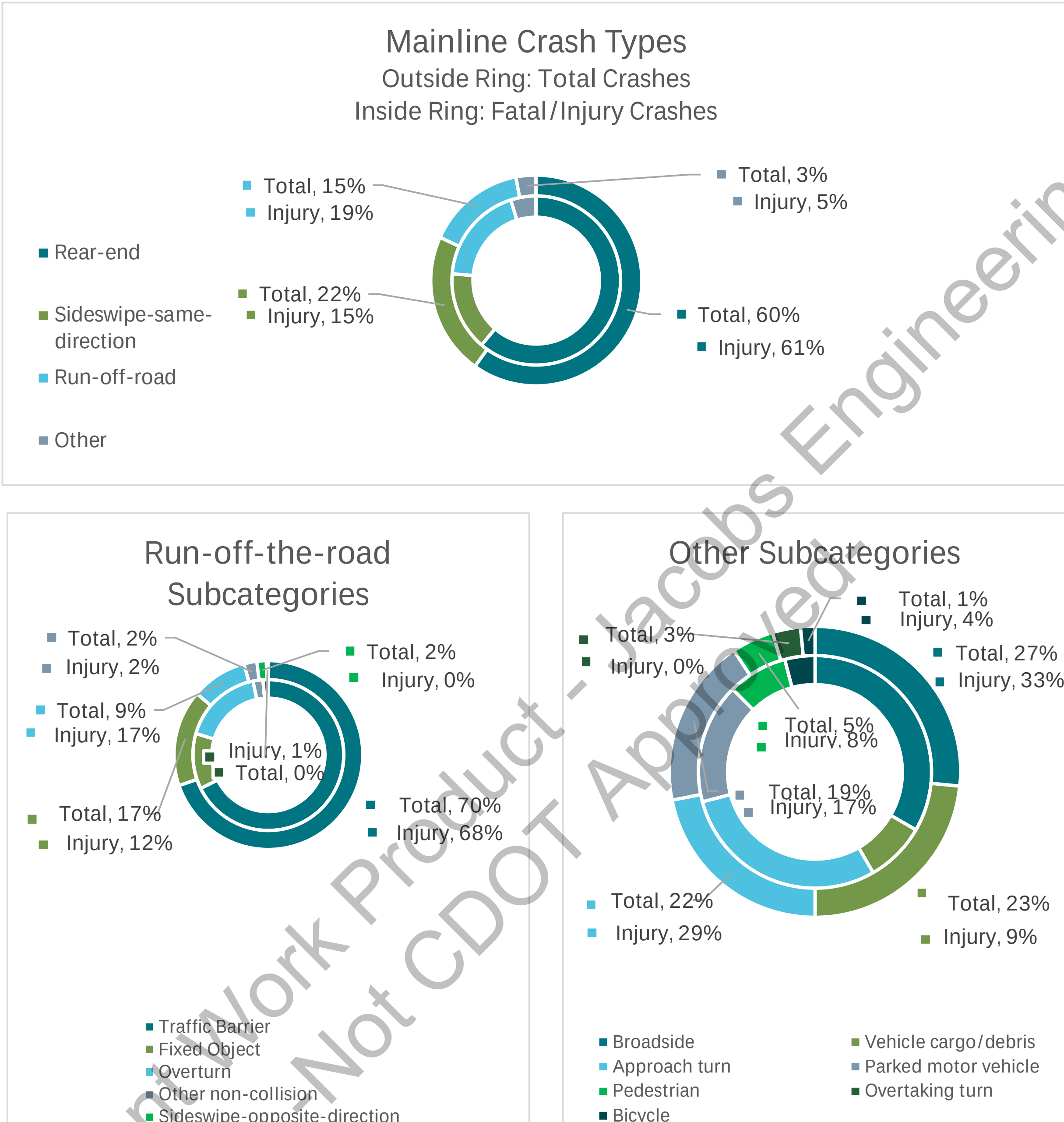


Figure 1. Total and Fatal/Injury Crash Trends (Mainline and Ramps)
Source: CDOT 2020

Crash type for both total crashes and fatal/injury crashes for mainline I-270 is shown on Figure 2. The outside ring shows crash types for total crashes, and the inside ring shows the crash types for fatal/injury crashes. Detailed crash types of the crash data for mainline I-270 are shown for the three most frequent categories (rear-end, ROR, sideswipe-same-direction) and all other crash types are provided as other. Whereas the rear-end and sideswipe-same-direction categories do not have any subcategories, the ROR category includes crashes with a traffic barrier (guardrail, concrete barrier, cable rail, crash cushion, bridge rail, and barricade), fixed object (utility pole, sign, embankment, tree, and similar), overturn, head-on, and sideswipe-opposite-direction. Additionally, the other category includes broadside, turning, vehicle cargo/debris, parked motor-vehicle, pedestrian, and bicycle.



In all three graphics, the outside ring represents all crash severities and the inside ring represents fatal/injury crashes. The number in each label shows the proportion of crashes in percentage.

Figure 2. I-270 Mainline Crash Type/Severity
Source: CDOT 2020

Based on Figure 2, about 60 percent of total and fatal/injury crashes are rear-end. ROR crashes are 19 percent of fatal/injury and 15 percent of total crashes, whereas sideswipe-same-direction crashes account for 22 percent of total and 15 percent of injury crashes. The other crash types account for less than 5 percent of crashes. Within ROR crashes (15 percent total and 19 percent of fatal/injury), about 70 percent are related to traffic barriers and 17 percent of fatal/injury crashes are overturn crashes. For more detail related to identified crash patterns, refer to Sections 4.0 and 5.0.

Similar to Figure 2 for the mainline, Figure 3 shows the crash types for both total crashes and injury crashes for I-270 ramps.

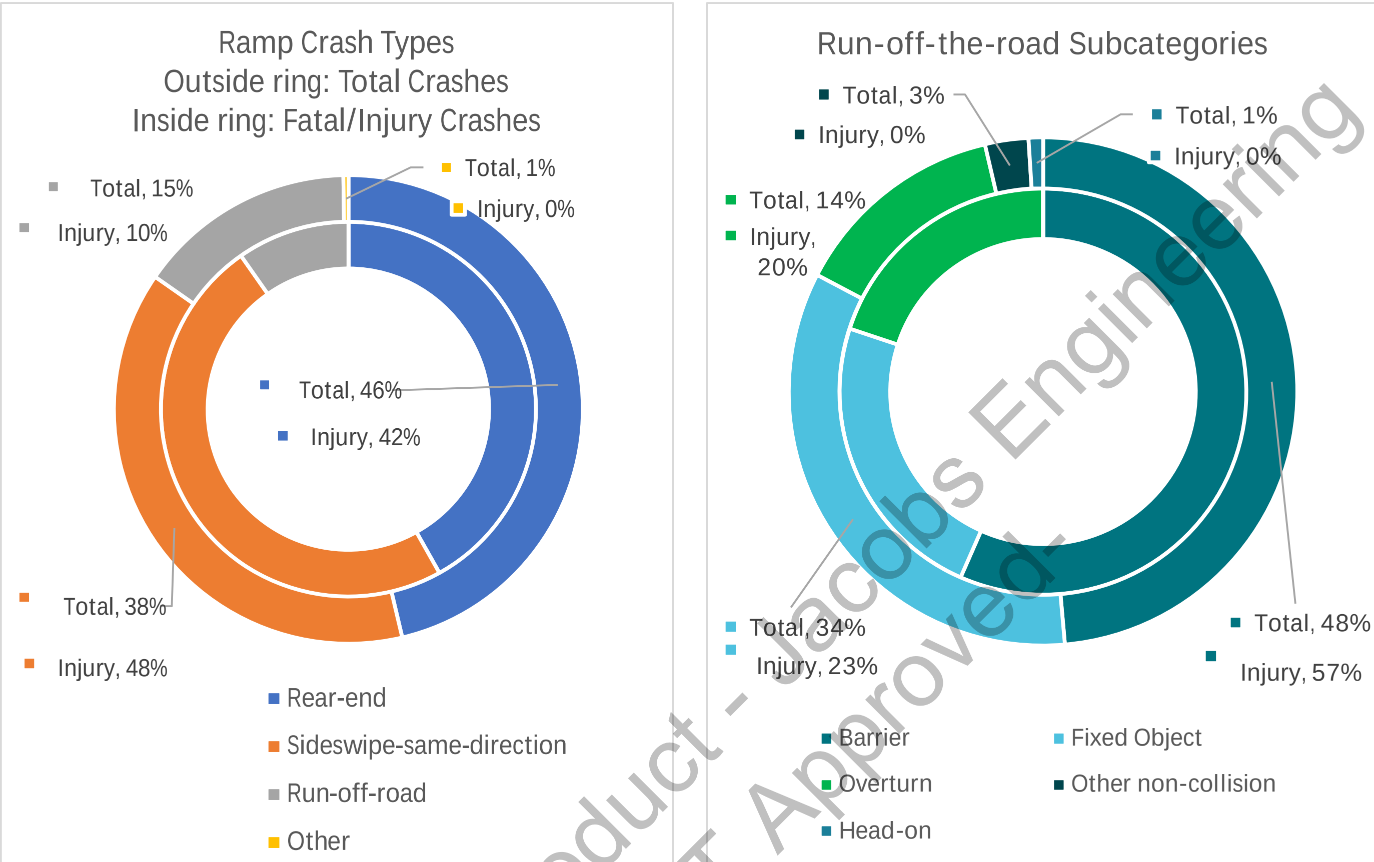


Figure 3. I-270 Ramps Crash Type/Severity
Source: CDOT 2020

As shown on Figure 3, 48 percent of injury crashes on I-270 ramps are sideswipe-same-direction crashes and 42 percent are rear-end crashes. On ROR subcategories, barrier crashes account for 48 percent of total and 57 percent of injury crashes. Overturn crashes account for 14 percent of total crashes but only 20 percent of injury crashes.

Figure 4 shows the total number of I-270 mainline annual crashes per mile for the corridor from 2014 through 2019. The annual total number of crashes per mile ranges from less than 9 annual crashes per mile (shown in yellow) up to 98 (shown in red).

Figure 4 shows a high number of crashes primarily concentrated at interchange areas, such as the following:

- Eastbound and westbound I-270 near Vasquez Boulevard
- Eastbound I-270 east of I-25
- Eastbound I-270 between I-76 and east of York Street
- Eastbound and westbound I-270 at Quebec Street
- Eastbound I-270 in the vicinity of the Burlington Ditch structure

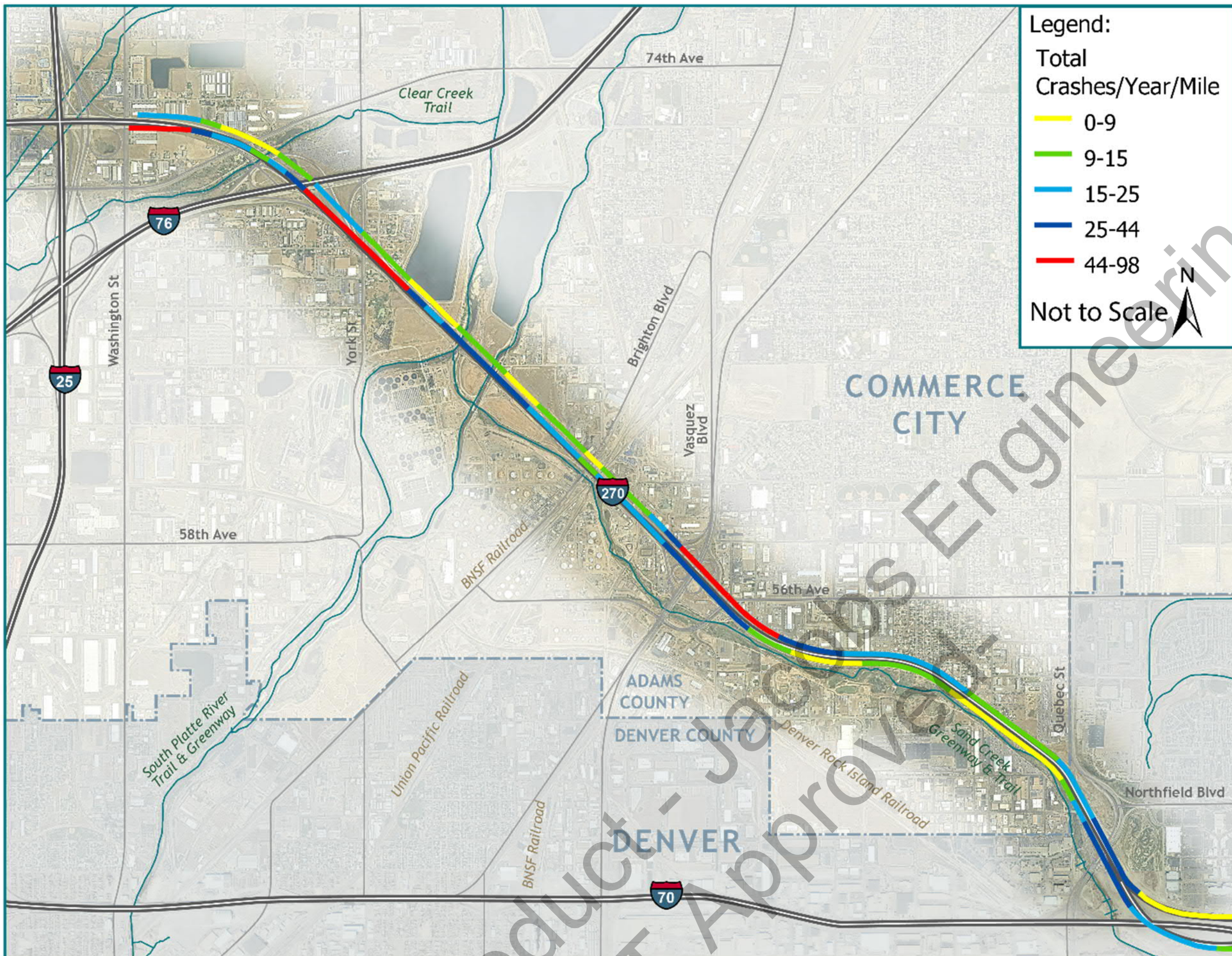


Figure 4. I-270 Mainline Crashes Per Year Per Mile (2014 to 2019) – Total Crashes
Source: Jacobs

Figure 5 indicates the level of fatal/injury crashes for the I-270 corridor, which is the annual number of fatal and injury crashes per mile per year. Considering crash severity is important, because the reduction of fatalities and injuries is emphasized as a goal in the *Colorado Strategic Highway Safety Plan* (CDOT 2014) and in the national Fixing America's Surface Transportation Act legislation.

Figure 5 shows a high number of annual fatal/injury crashes that are primarily concentrated at the following interchange areas:

- Westbound I-270 near Vasquez Boulevard (16.6 KABC crashes per year per mile)
- Eastbound I-270 east of I-25 (14.2 KABC crashes per year per mile)
- Eastbound I-270 between I-76 and York Street (19.6 KABC Crashes per Year per Mile)

These locations are similar in size compared for the high-crash areas shown on Figure 4. Areas highlighted in red experience between 15 and 20 injury crashes per year per mile, and areas highlighted in dark blue experience between 10 and 15 injury crashes per year per mile. The symbology on Figure 4 and Figure 5 is based on five different classes, and each class is defined to ensure maximum variation between classes and minimum variation inside each class (Jenks 1967). This helps to provide a relatively easy way to visualize the crash frequency data. Color coding shows the magnitude of the observed crashes, which is an interim step to the safety analysis.

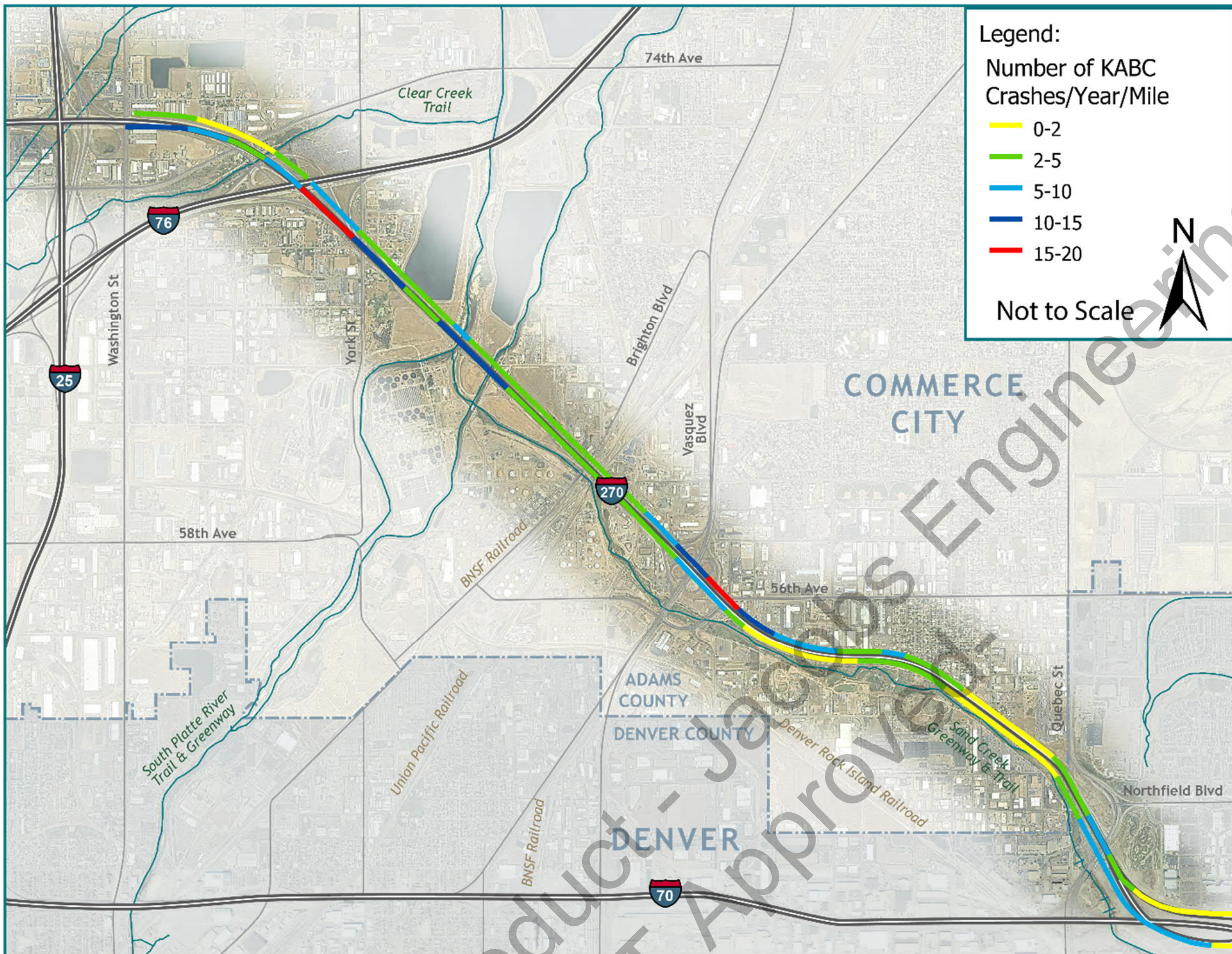


Figure 5. Fatal and Injury I-270 Mainline Crashes Per Year Per Mile (2014 to 2019)
Source: Jacobs

2.1 Fatal Crash History

Six fatal crashes occurred from 2014 to 2019 on the I-270 mainline but none on the I-270 ramps. These fatal crashes are explained in more detail in Table 2 and are shown on the map on Figure 6. The index number is used to link Table 2 and Figure 6. For each fatal crash, the location, date, roadway, light, and weather condition information are provided in addition to crash type. Information about the driver (or pedestrian) and possible contributing factors (if any were recorded) are provided.

Based on Table 2, there were two pedestrian fatalities on I-270 mainline from 2014 to 2019 (index 1 and index 4). While pedestrians are usually not expected on access-controlled freeway facilities, nationally 19 percent, and in Colorado 15 percent of urban freeway fatal crashes involve a pedestrian (NHTSA n.d.). Darkness, driver expectancy, higher speeds, and lack of pedestrian facilities could all be considered as contributing factors to the pedestrian crashes.

There were three ROR fatal crashes from 2014 to 2019. One out of five injury crashes on I-270 were ROR crashes, and these ROR fatal crashes seemed to follow the overall proportion. There was one fatal sideswipe crash involving a heavy truck in which the passenger car driver departed the lane into a truck in an adjacent lane. Relative to other crash types, sideswipe-same-direction crashes can be less severe, but other contributing factors such as impaired and an unrestrained driver along with the size differential between passenger cars and heavy trucks could potentially increase the severity of these crashes.

Table 2. Overview of Fatal Crashes from 2014 to 2019 on I-270 Mainline

Index	Location and Date	Crash Type	Contributing Factors, and Violation	Conditions
1	Westbound I-270 at Vasquez Interchange Thursday, October 04, 2018 - 04:16 a.m.	Pedestrian hit by passenger car	Pedestrian walks into path of vehicle	Dark, unlighted, straight, dry
2	Eastbound I-270 at Vasquez eastbound on-ramp Sunday, March 06, 2016 - 03:44 a.m.	Passenger car sideswiped a truck	Impaired, unrestrained	Dark, lighted, dry
3	Westbound I-270 0.41-mile east of Vasquez Friday, April 21, 2017 - 07:18 p.m.	Passenger car ROR right while changing lanes	Unrestrained, preoccupied (distracted)	Daylight, rain
4	Eastbound I-270, milepost 3 Wednesday, September 10, 2014 - 10:37 p.m.	Pedestrian hit by sport utility vehicle	Impaired	Dark, unlighted, dry, curve
5	Westbound I-270 0.21-mile east of Quebec Monday, July 18, 2016 - 08:20 p.m.	Motorcycle ROR left and overturn		Dusk, dry, curve
6 [a]	Eastbound I-270 at Central Park eastbound on-ramp entrance point Saturday, May 02, 2015 - 04:27 p.m.	Passenger car ROR right and hit guardrail	Physical disability [b] Older driver (note CDOT 2014 calls this "aging road user")	Daylight, dry

Source: CDOT 2020

[a] This crash is on the edge of the study area

[b] This factor noted on CDOT crash report (CDOT 2020)

Figure 6. Location of the I-270 Mainline Fatal Crashes
Refer to Table 2 for more information by index
Source: CDOT 2020

2.2 Heavy-vehicle Crashes

I-270 is a critical truck route that has had higher than statewide average truck crash rates for 5 consecutive years (between 2008 and 2014, according to the *Colorado Freight Plan* [CDOT 2019]). As a major truck route, I-270 carries an average of 11.7 percent trucks, while other urban interstates in Colorado carry an average of 10.2 percent (CDOT n.d.a).[1] Trucks require additional interchange ramp lengths to accelerate and decelerate due to the lower weight to horsepower capability. Trucks require additional distance to change lanes to enter or exit the freeway. For these reasons, cloverleaf interchanges with smaller radius loop ramps, such as at Vasquez Boulevard, may be particularly challenging for heavy vehicles. Depending on the curve radius, grade change, speed, and truck loadings, trucks may experience more rollover crashes than passenger cars. This is particularly apparent on smaller radius loop entrance/exit ramps that may not provide sufficient acceleration/deceleration distance to achieve the operating speed of the freeway mainline needed for maneuvering to and from the freeway.

Table 3 shows the frequency of heavy vehicle-involved crashes for the I-270 mainline and ramps by severity and the number of heavy vehicles involved crashes on the I-270 mainline and ramps by severity

[1] 270A data from https://dtdapps.coloradodot.info/otis/HighwayData#/ui/2/0/criteria/270A/0/5.986; 270B data from https://dtdapps.coloradodot.info/otis/HighwayData#/ui/2/0/criteria/270B/0.177/1.1

from 2014 to 2019. From Table 3, there are, on the average, about 54 heavy-vehicle crashes per year on the I-270 mainline (93 percent) and an average of four heavy-vehicle crashes per year on the ramps (7 percent). Additionally, 18 percent of heavy-vehicle crashes involve a fatality or injury. This is a lower proportion of fatality/injury crashes than the 23 percent for all vehicles. Similar to Figure 1, Figure 7 shows the recent upward trend from 2016 to 2019 of the I-270 mainline and ramp heavy-vehicle total crashes.

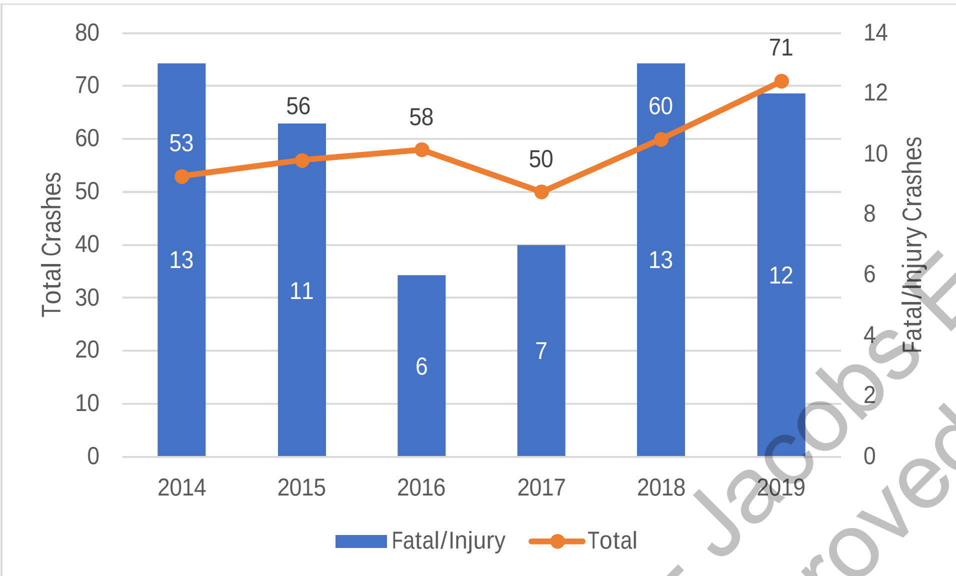


Figure 7. Heavy Vehicle-involved Crash Trends
Source: CDOT 2020

Table 3. 2014 to 2019 Reported Heavy-vehicle Crashes by Severity

	Mainline						Ramps				Total	
	Crashes				Persons		Crashes			Persons	Crashes	
Year	Fatal	Injury[a]	PDO	Total	Fatalities	Injuries[a]	Injury[a]	PDO	Total	Injuries[a]	Fatal/Injury[a]	Total
2014	0	13	35	48	0	15	0	5	5	0	13	53
2015	0	10	42	52	0	10	1	3	4	1	11	56
2016	1	6	47	54	1	7	0	4	4	0	7	58
2017	0	7	41	48	0	8	0	2	2	0	7	50
2018	0	12	42	54	0	15	1	5	6	2	13	60
2019	0	12	55	67	0	15	0	4	4	0	12	71
Total	1	60	262	323	1	70	2	23	25	3	63	348
Average/Year	0.2	10.0	43.7	53.8	0.2	11.7	0.3	3.8	4.2	0.5	10.5	58.0

Source: CDOT 2020

[a] ABC severities on the KABCO scale are included.

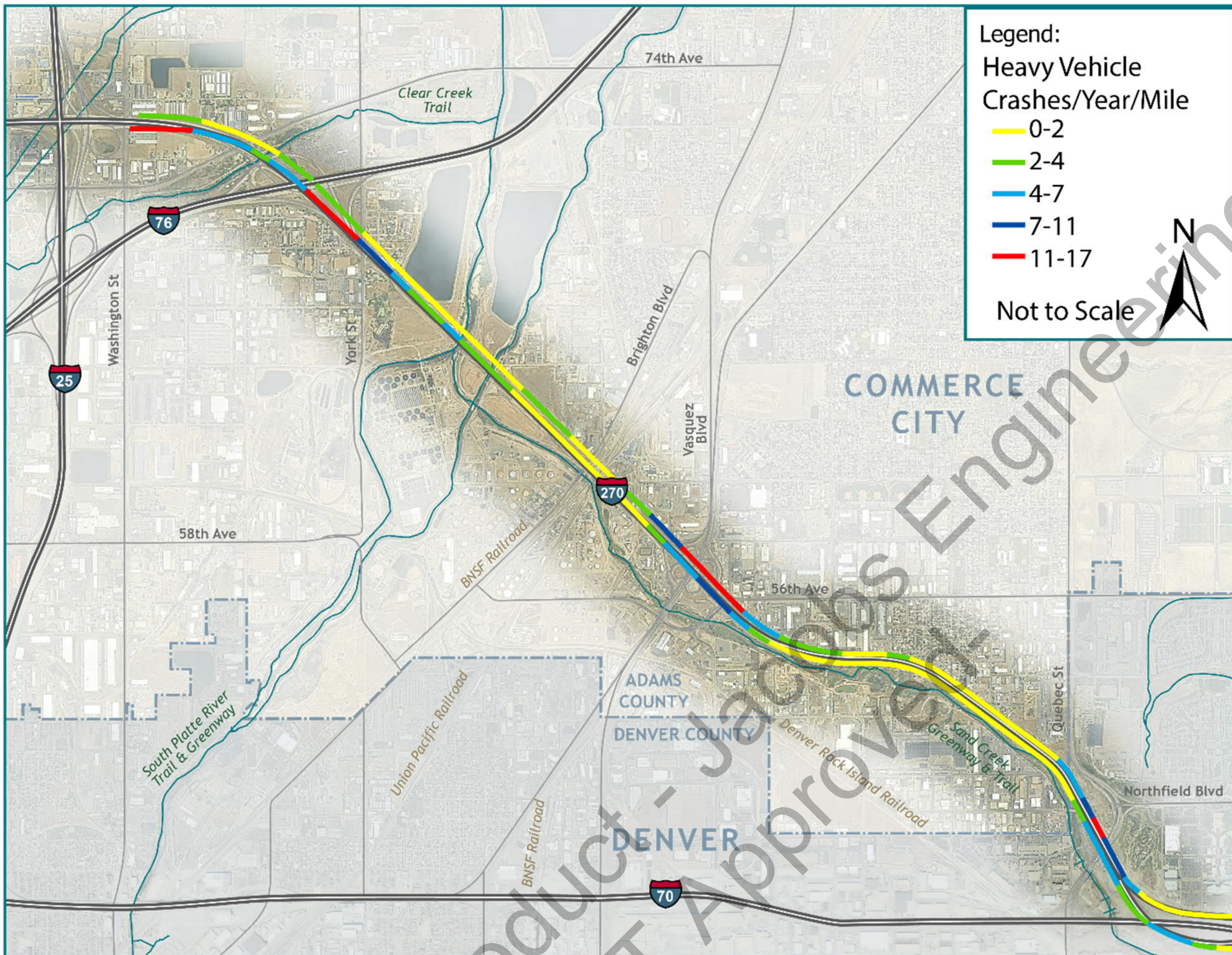


Figure 8. Heavy-vehicle (Truck) Total I-270 Mainline Crashes Per Year Per Mile (2014 to 2019)
Source: CDOT 2020

Figure 8 shows the map of heavy-vehicle crashes along the I-270 mainline. As shown, truck crashes occur throughout the corridor but are concentrated at interchange locations on the mainline of I-270. As discussed previously, this concentration of crashes at interchanges confirms there are operational issues related to insufficient distances for acceleration, merge, and weaving areas that heavy vehicles or trucks encounter.

3.0 Study Analysis Method

The AASHTO HSM (2010) offers several performance measures to quantify the safety performance of a roadway facility including crash rate, LOSS, and potential for safety improvement (PSI). Crash rate is a traditional descriptive measure, whereas the LOSS is considered a quantitative predictive measure. Quantitative predictive measures (like LOSS and PSI) are considered more advanced and more reliable and are recommended for detailed safety analysis, whereas the traditional descriptive measures (like crash rate) are more general and focused on providing overall summaries of the safety performance and do not account for potential statistical biases.

The LOSS was initially developed by CDOT (Kononov and Allery 2003). The initial version was presented in the HSM (AASHTO 2010). The LOSS was revisited by the same authors and others in 2015 to address two main limitations of the initial LOSS, not addressing regression to mean bias and difficulty with interpretation when data are skewed (Kononov et al. 2015). In the revised LOSS method, the LOSS boundaries were defined based on the percentile of the crash frequency distribution rather than offsets based on a fixed multiplier of the standard deviation of the crash frequency. The revised LOSS method, which is presented in the CDOT interactive Excel sheets, is used in this study (CDOT 2016).

The PSI value is the excess expected crash frequency with adjustments to account for regression to mean bias. Addressing the regression to mean bias is essential in safety analysis given the short-term observations (4 to 5 years of crash data) and the longer-term return period of crashes (Hauer 1997). Addressing the regression to mean bias is performed by using the Empirical Bayes method explained in HSM (AASHTO 2010). The expected crash frequency is obtained from the safety performance functions (SPF). The SPF is a numerical model that predicts the crash frequency based on traffic volume and other related attributes such as roadway or intersection characteristics. The SPF used in this study is from the Colorado-specific SPF (expected mean curve) for urban four-lane freeways (CDOT 2016) as shown on Figure 9. This SPF provides the statewide average predicted crash frequency for urban four-lane freeways as a function of the annual average daily traffic (AADT).

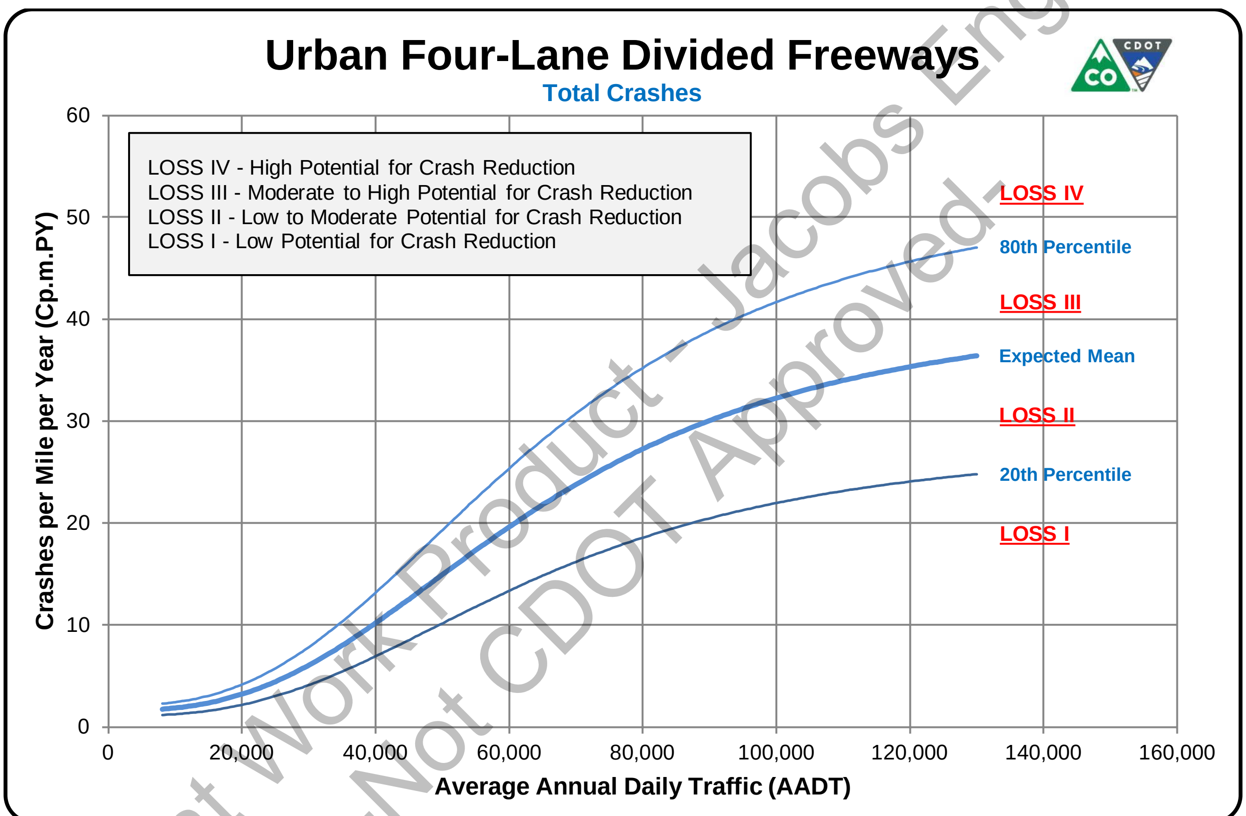


Figure 9. The Urban Four-Lane Divided Freeway Safety Performance Functions and Level of Service of Safety Mean and Boundary Curves
Source: CDOT 2016

The PSI value is the difference between the observed crashes (adjusted for regression to mean) and the predicted crashes from the SPF. To calculate the PSI values on the I-270 mainline, the sliding window network screening method, as described in the HSM (AASHTO 2010), is used. The purpose of screening is to identify the segments with the most potential for safety improvement. For this study, a 0.4-mile window with an increment of 0.1 mile is slid over the I-270 mainline for each direction, and the PSI value is calculated for each window.

Traffic data in the form of AADTs are used to calculate the SPFs, as shown on Figure 10. The AADT used for SPF calculation is based on 2016 data and is adjusted as needed by comparison of link volumes to attain improved consistency and accuracy.

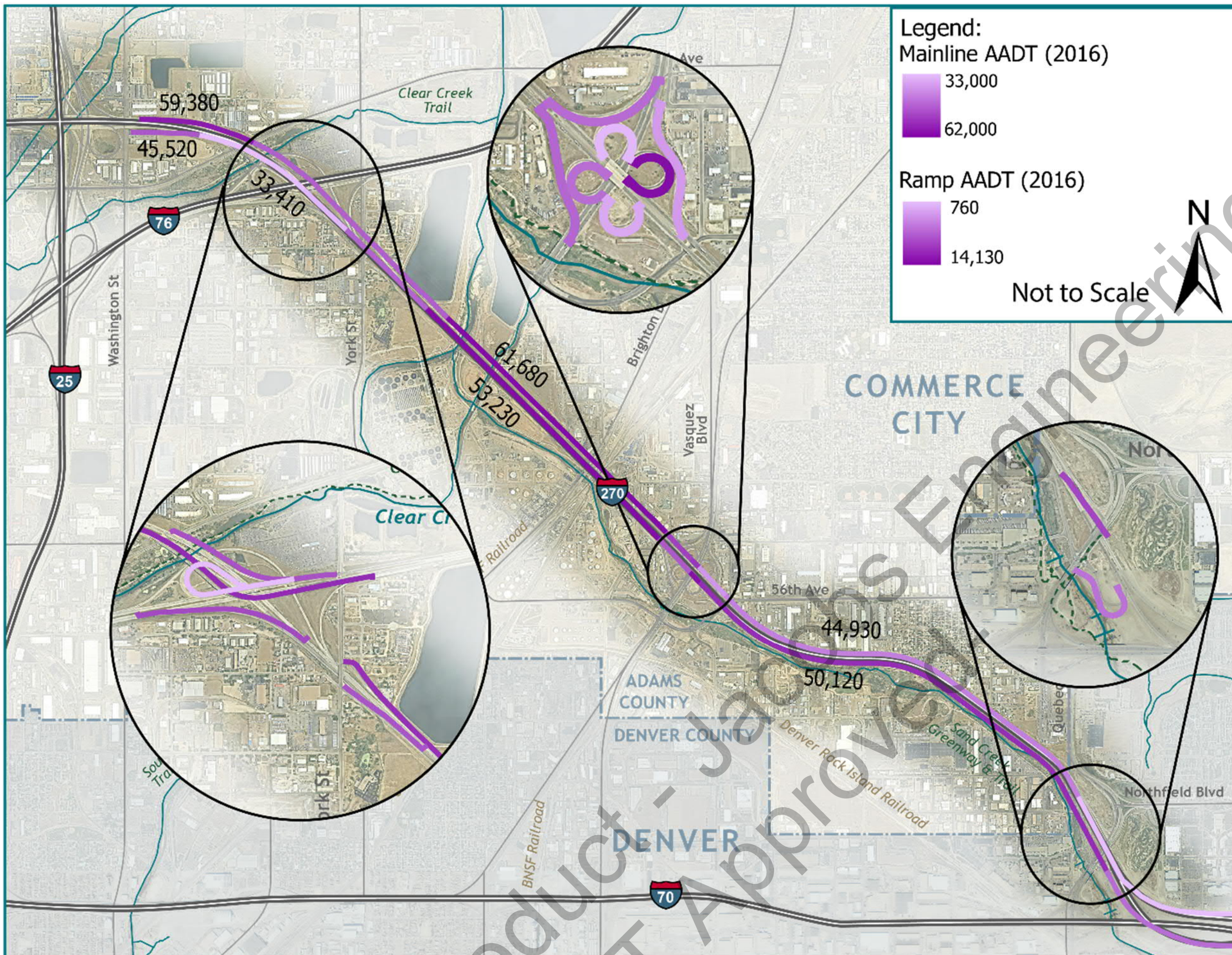


Figure 10. 2016 Annual Average Daily Traffic
Source: CDOT n.d.a

Locations with LOSS III or LOSS IV are those that are experiencing crashes at a higher than average frequency (expected mean curve) and are identified as hotspots. In addition to LOSS, which is used for network screening, crash type/characteristics overrepresentation analysis (based on the HSM [AASHTO 2010]), is performed for diagnostic purposes using the same sliding window approach. The distribution of each crash type/characteristic for each sliding window is compared with the distribution of that crash type/characteristic for the whole study area to identify if a crash type/characteristic is overrepresented using a statistical hypothesis testing (explained in HSM Chapter 4 [AASHTO 2010]). Statistical hypothesis testing is a method of statistical inference to identify if random observed data support or reject a hypothesis (which is overrepresentation in this case). The results of this analysis are provided in Sections 4.0 and 5.0 for mainline and ramps.

4.0 Analysis of Mainline Study Segments

The results of the I-270 mainline detailed safety analysis is provided in this section under two subsections: Screening Results and Diagnostic Results.

Additionally, fatal crash rates are also provided for all urban interstates and are compared with I-270 fatal crash rates. Crash rates are calculated as the ratio of the number of fatal crashes divided by hundred million vehicle miles traveled (HMVMT). HMVMT is calculated by multiplying AADT by length by 365 (days per year) and divided by 100 million. AADT is obtained from the Traffic Database, and fatal crashes are obtained from the Fatality Analysis Reporting System website.

Table 4. Fatal Crash Rate Comparison

Year	All Urban Interstates in Colorado			I-270		
	HMVMT[a]	Fatal Crashes[b]	Fatal Crash Rate[c]	HMVMT[a]	Fatal Crashes	Fatal Crash Rate[c]
2014	86.58	32	0.37	2.28	1	0.44
2015	90.3	45	0.50	2.36	1	0.42
2016	93.75	39	0.42	2.41	2	0.83
2017	96.01	51	0.53	2.40	1	0.42
2018	98.12	50	0.51	2.40	1	0.42
Total	464.76	217	0.47	11.85	6	0.51

[a] Source: Traffic Database (https://dtdapps.coloradodot.info/staticdata/Downloads/TrafficDataBase/)

[b] Source: NHTSA n.d. (https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars)

[c] Fatal crashes per HMVMT

As shown in Table 4, the overall fatal crash rate for I-270 is slightly higher than the average fatal crash rate of other urban interstates in Colorado. The average fatal crash rate for all urban interstates in Colorado is 0.47 crashes per HMVMT compared to the higher rate for the study corridor of 0.51 fatal crashes per HMVMT. While I-270 is experiencing a slightly higher fatal crash rate than the average for all urban interstates in Colorado, the study team is not able to comment on whether this difference is statistically significant because of data limitations. To perform a significance test, it is necessary to have access to the raw crash data for all urban interstates in Colorado to make a comparison.

4.1 Screening Results

As described previously, the I-270 mainline screening is performed using a sliding window approach of 0.4-mile windows with 0.1-mile increments using the PSI value as the safety performance measure that is used to identify the potential number of crashes that can be reduced. The LOSS is obtained using the interactive Excel sheets provided by CDOT (2016). The results of the safety analysis using LOSS for all crash severities included is shown on Figure 11. The safety hotspots are defined by direction based on these total crash results as locations with LOSS III or IV.

Figure 11. Level of Service of Safety Based on Total Crashes
Source: Jacobs

As shown on Figure 11, there are seven hotspots (LOSS III or IV) along the I-270 mainline. Analysis of each of these locations is presented in this section. In addition to the LOSS based on all crashes, the LOSS is also calculated based on fatal/injury crashes shown on Figure 12. Even though the hotspots are identified based on total crashes (Figure 11), the LOSS based on fatal/injury crashes can provide an overview of the severity of the crashes for each hotspot. Also, consideration of the severity of crashes and the sites that have a higher magnitude of severe crashes, for example fatal/injury related, is important because this addresses the objective of the *Colorado Strategic Highway Safety Plan* (2014), which is to reduce severe crashes.

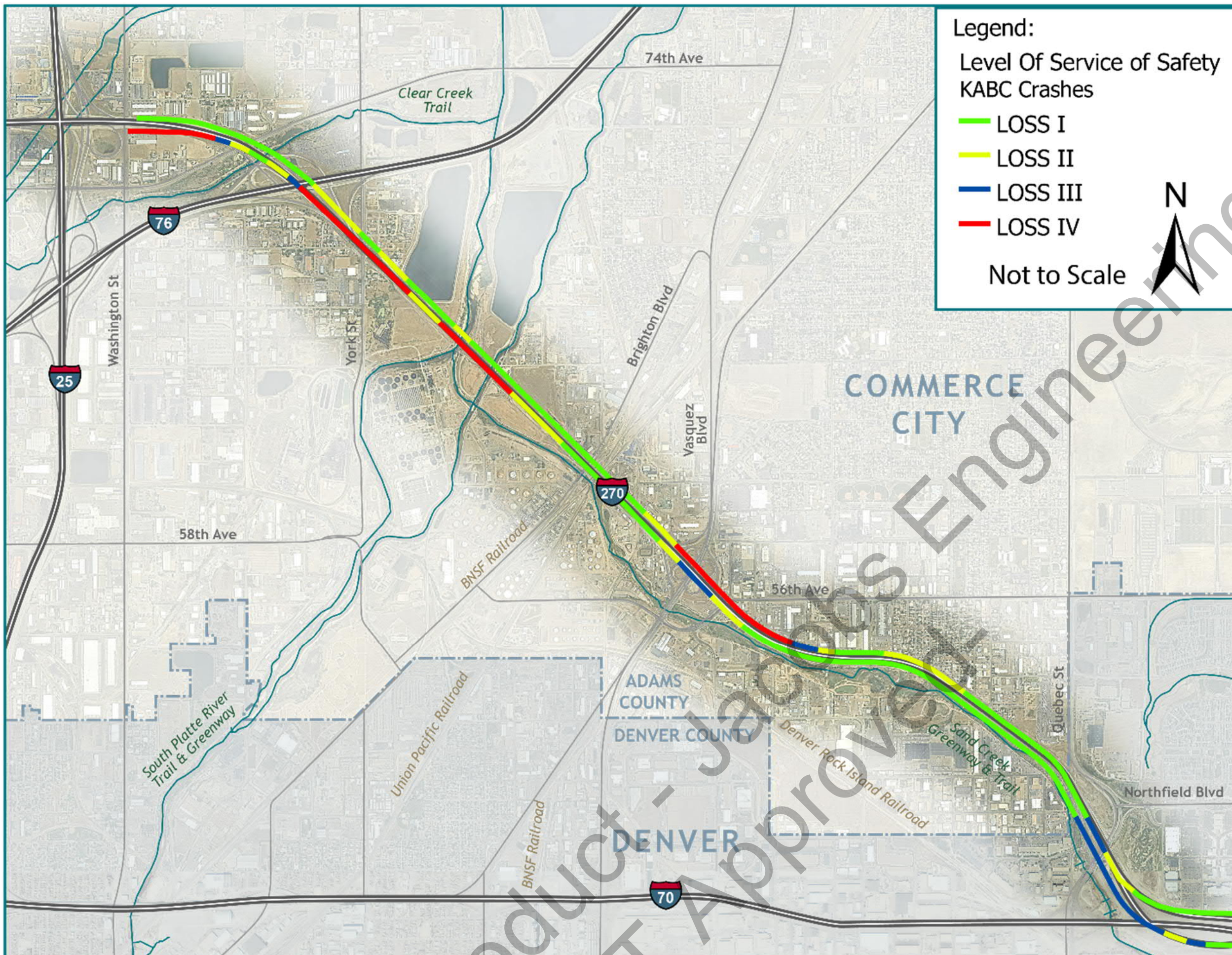


Figure 12. Level of Service of Safety Based on Fatal and Injury Crashes (KABC)
Source: Jacobs

Comparing Figure 12 and Figure 11 provides an overview of the severity extent of each hotspot. Whereas some hotspots may have similar LOSS in both figures, there might be locations that have a higher LOSS based on fatal/injury LOSS or vice versa. For example, hotspots at Quebec Street interchange (both directions) are identified as LOSS IV for all crashes but are identified as LOSS III for fatal/injury crashes, which means crashes are less severe at this location. However, the eastbound hotspot over the South Platte River and the Burlington Ditch is mostly LOSS III for all crashes but is identified as LOSS IV for fatal/injury crashes, which means crashes at this location are more severe.

Additionally, the PSI value is calculated for each hotspot for both total crashes and fatal/injury crashes. Hotspots are ranked from 1 to 7 based on their Total PSI value using total crashes in Table 5. In addition to PSI, observed crashes, predicted crashes, and expected crashes (adjusted observed crashes to address regression to the mean bias) for both total and fatal/injury crashes are provided.

In summary, the seven hotspots, cover 32 percent of total mileage, 58 percent of all crashes, and 54 percent of fatal/injury crashes.

Table 5. I-270 Safety Hotspots (LOSS III or IV) Ranked by Total PSI

Hotspot Name ID (Route and Milepost)	Rank	Mileage	Observed Crashes (2014 to 2019)		Predicted Crashes (based on 2016 AADT)		Expected Crashes		Total PSI	Fatal-Injury PSI
			Total	Fatal Injury (KABC)	Total	Fatal Injury (KABC)	Total	Fatal Injury (KABC)		
Westbound Vasquez Interchange (270 A 2.2-3.2)	1	1.0	369	71	91.21	24.18	348.55	59.28	257.35	35.10
Eastbound I-76 to York (270 B 0.87 to 1.1, 270A 0.0 to 0.7)	2	0.93	311	73	73.55	20.40	289.70	58.09	216.15	37.69
Eastbound I-25 to I-76 (270 B 0.17-0.67)	3	0.5	143	39	40.86	11.22	127.61	26.21	86.76	14.99
Westbound Quebec Interchange (270 A 4.5-5.0)	4	0.5	101	16	35.52	10.26	89.90	13.47	54.39	3.21
Eastbound Vasquez Interchange (270 A 2.1-2.5)	5	0.4	98	17	37.57	9.85	88.23	13.78	50.66	3.93
Eastbound York to Vasquez (270 A 0.8-1.2)	6	0.4	92	27	40.14	10.22	84.07	19.60	43.93	9.38
Eastbound Quebec Interchange (270 A 4.3-4.8)	7	0.5	85	21	46.60	12.25	79.83	17.52	33.24	5.28

Source: CDOT 2020

The hotspots are shown on Figure 13.

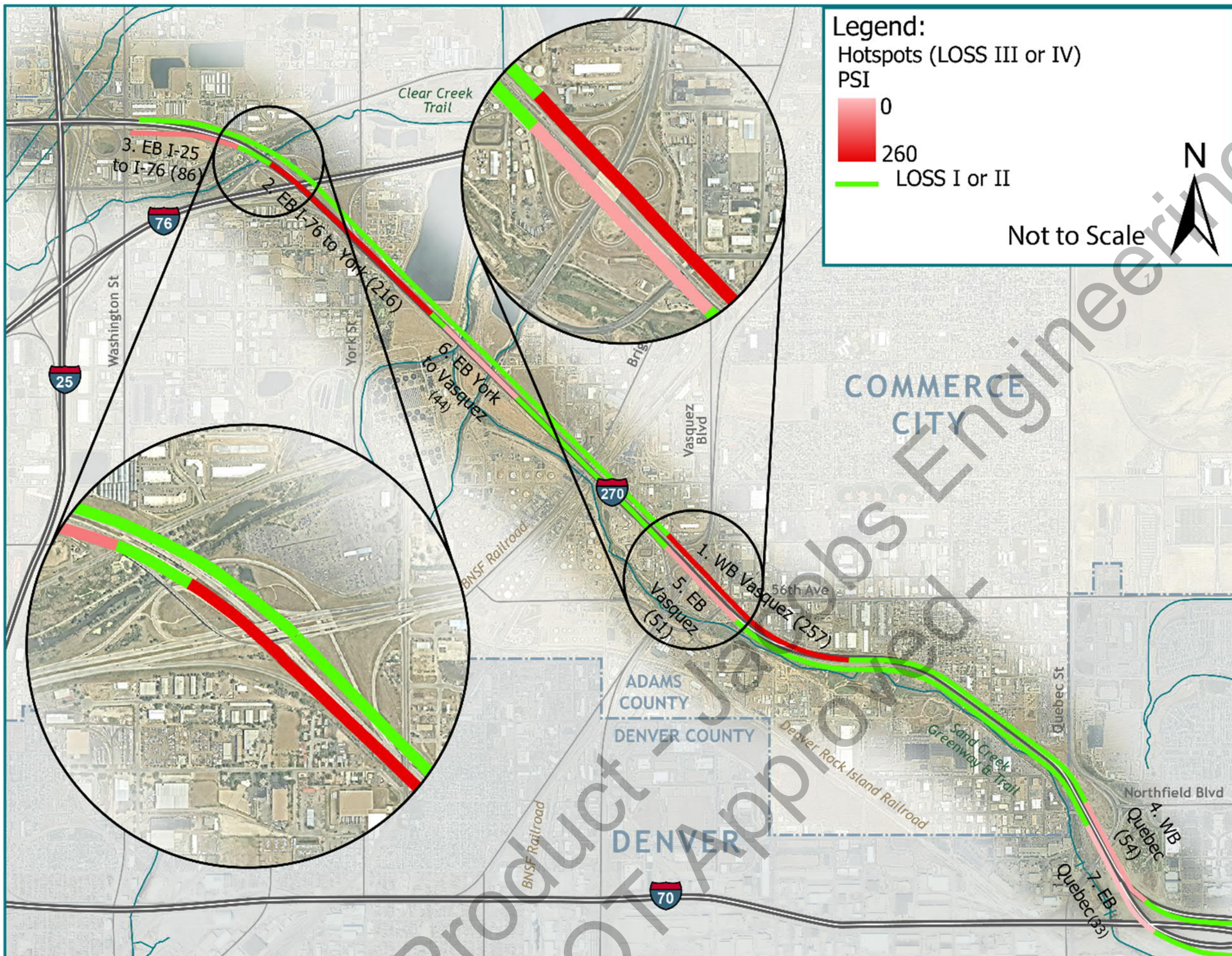


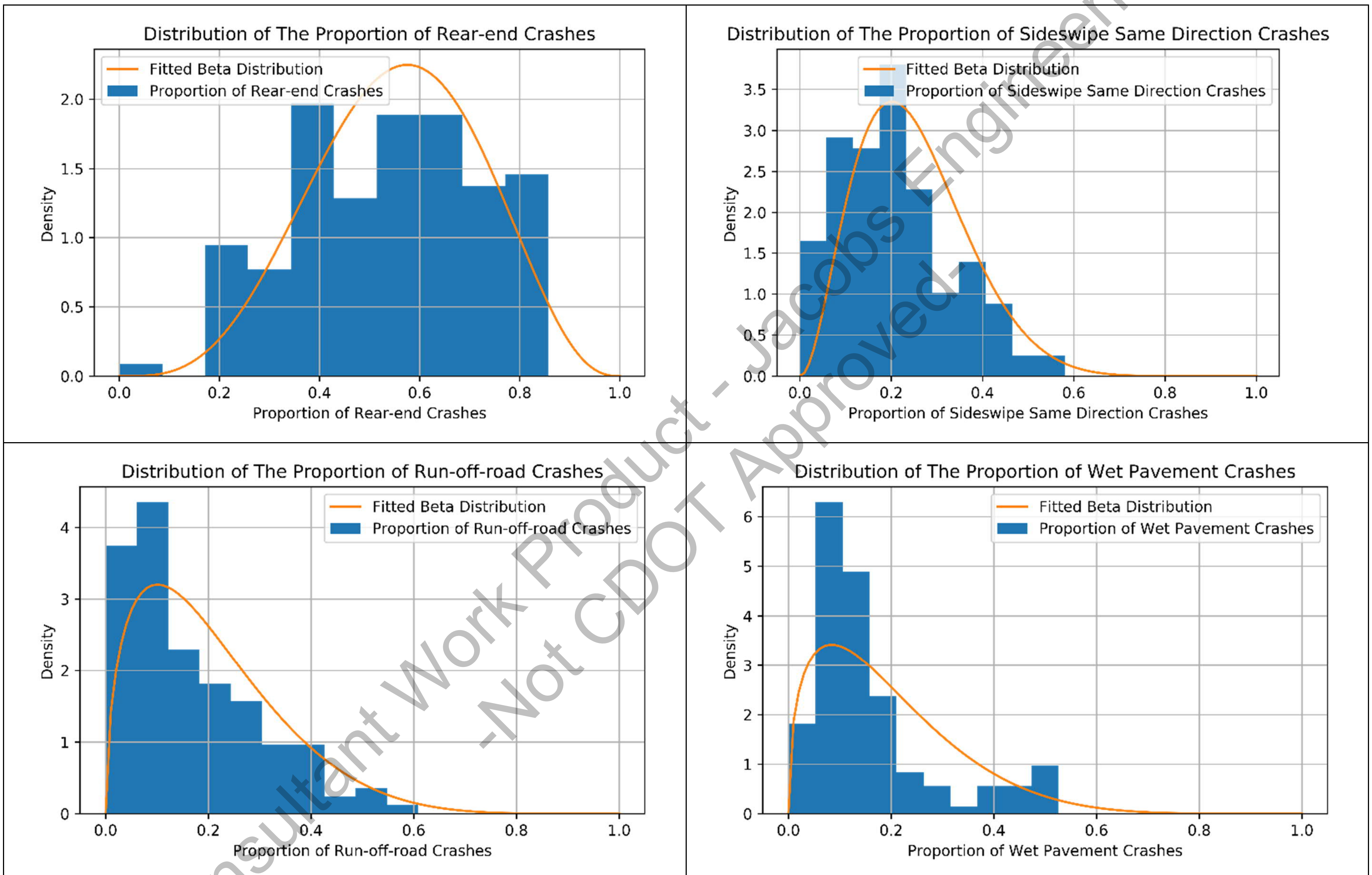
Figure 13. I-270 Safety Hotspots (LOSS III or IV) Locations with Rank, Name ID, and PSI Value
Source: Jacobs

4.2 Diagnostic Results

While LOSS is effective in identifying locations with more than expected crashes, it does not replace a thorough diagnostic examination of crashes and correctable crash patterns may exist in lower categories of LOSS (Kononov et al. 2015). Screening and diagnostics analysis complement each other and are key steps in the safety management process. These two steps, as outlined in the HSM (AASHTO 2010), quantify the magnitude of the potential for crash reduction (screening) and overrepresentation of crash patterns to help the planners and engineers have a comprehensive understanding of the safety conditions to develop countermeasures that are efficiently applied at optimal locations in a targeted manner.

To provide a comprehensive diagnosis of safety data, it is important to conduct a review of key crash types to identify crash patterns, crash severity, vehicle size, and roadway environmental patterns; the overrepresentation of crash characteristic are calculated for prominent crash descriptive statistics. Based on a review of the data for I-270, the following were selected: rear-end, ROR, sideswipe, heavy-vehicle, night-time, wet pavement, and speeding. The objective is to identify which crash types are statistically higher than what might be expected. Locations with overrepresented crash types are candidates for more detailed study.

For this purpose, the confidence level of each crash characteristic proportion exceeding the average proportion for that crash characteristic is calculated. This process is explained in the HSM (AASHTO 2010) page 4-52 under 4.4.2.9, which includes fitting a beta distribution to the crash proportions and performing statistical hypothesis testing to compare each segment with the average proportion and reporting the test results. The histogram and the fitted beta distributions are shown on Figure 14 for the five selected crash characteristics. Density, which is the vertical axis on Figure 14, is defined as the relative frequency divided by the width of the histogram bars, which makes the total area under the density curve to sum to 1.



Distribution of The Proportion of Rear-end Crashes
Fitted Beta Distribution
Proportion of Rear-end Crashes
Density
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
Proportion of Rear-end Crashes
Distribution of The Proportion of Sideswipe Same Direction Crashes
Fitted Beta Distribution
Proportion of Sideswipe Same Direction Crashes
Density
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
0.0
0.2
0.4
0.6
0.8
1.0
Proportion of Sideswipe Same Direction Crashes
Distribution of The Proportion of Run-off-road Crashes
Fitted Beta Distribution
Proportion of Run-off-road Crashes
Density
0
1
2
3
4
0.0
0.2
0.4
0.6
0.8
1.0
Proportion of Run-off-road Crashes
Distribution of The Proportion of Wet Pavement Crashes
Fitted Beta Distribution
Proportion of Wet Pavement Crashes
Density
0
1
2
3
4
5
6
0.0
0.2
0.4
0.6
0.8
1.0
Proportion of Wet Pavement Crashes

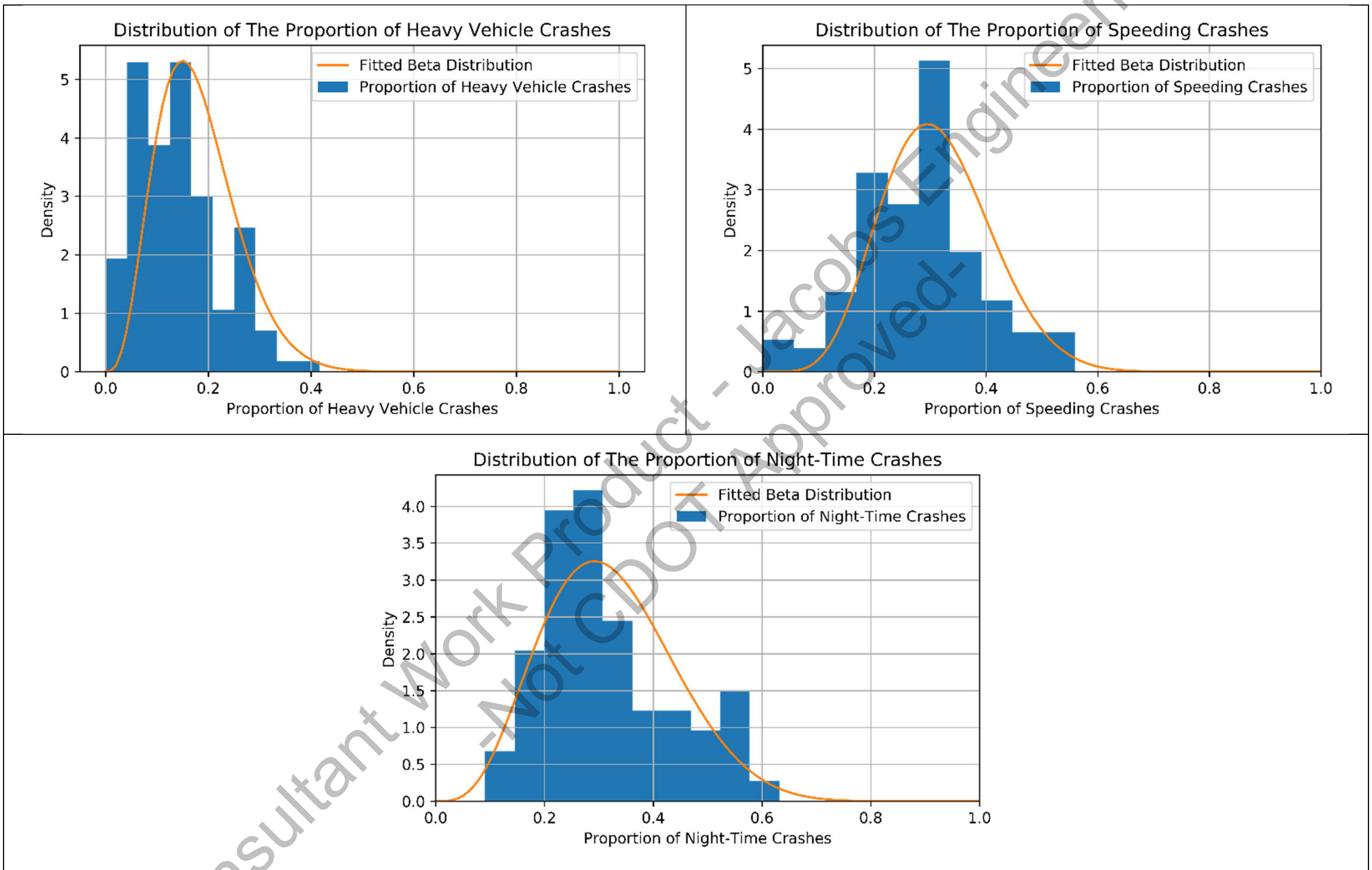


Figure 14. Histogram and Fitted Beta Distribution for Crash Type/Characteristics of I-270 Mainline
Source: Jacobs

The results of the diagnostic analysis are shown on Figure 15, Figure 16, Figure 17, Figure 18, and Figure 19. In these figures, the map shows the level of confidence related to the degree of overrepresentation for each crash type/characteristic for each direction. Segments are considered and coded as not being overrepresented if the confidence level is less than 85 percent. Also, locations with 85 percent and 95 percent confidence levels are shown in different colors.

Segments with a crash type/characteristic overrepresented at 95 percent or higher indicate a pattern of crashes that is unlikely to be explained by the randomness in the crash data and usually is an indication of a location-specific factor causing those crashes, which could be correctable. These segments with a specific crash pattern may or may not overlap with a hotspot based on LOSS. Segments that are not safety hotspots and are not identified with any specific crash pattern may not benefit as much from specific safety treatments as crashes may just follow a random pattern.

On the other hand, segments with a high PSI value (hotspots) that have a specific crash pattern identified would likely benefit the most from appropriate safety treatments based on the specific patterns identified. Locations with specific crash pattern that are not safety hotspots based on LOSS could still benefit from an appropriate safety treatment; however, the number of crashes reduced may be less, depending on the PSI value and the crash proportions. Hotspot locations without any overrepresented crash patterns should be studied to identify the appropriate treatment based on most frequent crash types/characteristics.

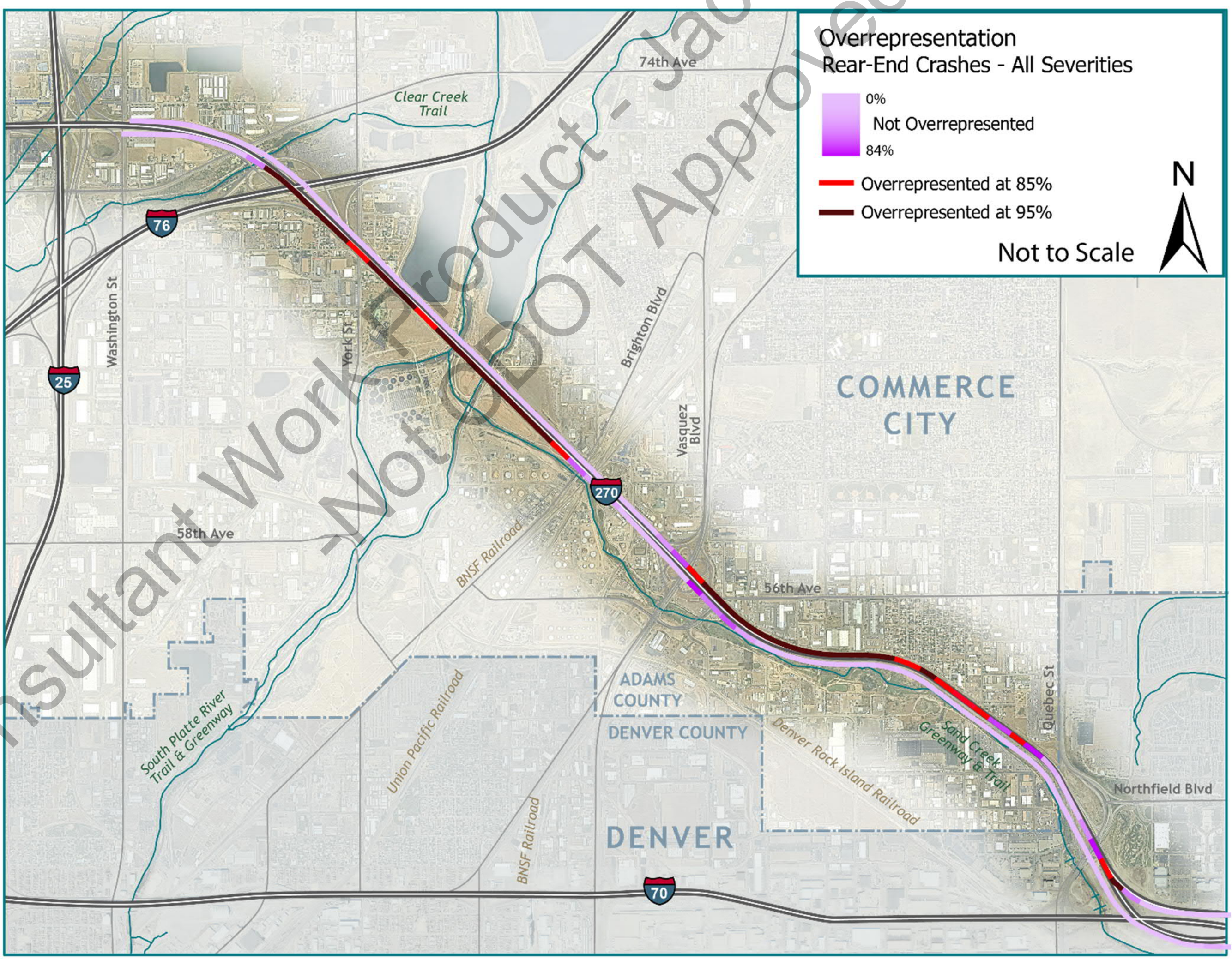


Figure 15. Overrepresentation of Rear-end Crashes – All Severities
Source: Jacobs

Rear-end crashes, as discussed previously, have the highest proportion of mainline total crashes (60 percent) and injury crashes (61 percent) for the I-270 corridor. Identifying locations where these crashes are overrepresented is a key factor in identifying locations of greatest need and is a starting point for the diagnosis of crash countermeasures to mitigate these crashes. Figure 15 shows large areas of high rear-end crash patterns occurring at 95 and 85 percent levels of significance. A pattern of rear-end crashes is associated with high levels of traffic congestion and a need to look at the adequacy of merge and diverge areas at interchange ramp areas in addition to the need to add an interstate lane that can reduce congestion.

As shown on Figure 15, overrepresented rear-end crash patterns occur in a high proportion of the I-270 mainline corridor mileage. Specifically, high segments of overrepresentation are identified in the eastbound direction from I-76 to 0.5 mile west of the Vasquez interchange. This segment overlaps hotspots 2 and 6 identified in Table 5 and on Figure 13. Additionally, in the westbound direction, there are rear-end patterns at the Quebec interchange (hotspot 4 in Table 5 and on Figure 13) and immediately east of the Vasquez interchange (hotspot 1 in Table 5 and on Figure 13). The Vasquez interchange rear-end pattern extends to about 2 miles east of the interchange, which is related to the queuing of traffic due to congestion. A review of traffic heat maps for the corridor indicates that both the a.m. and p.m. peak periods experience low traffic speeds from 10 to 30 mph from the Vasquez Boulevard on-ramp east to the Quebec Street on-ramp. Speeds in this range indicate traffic congestion.

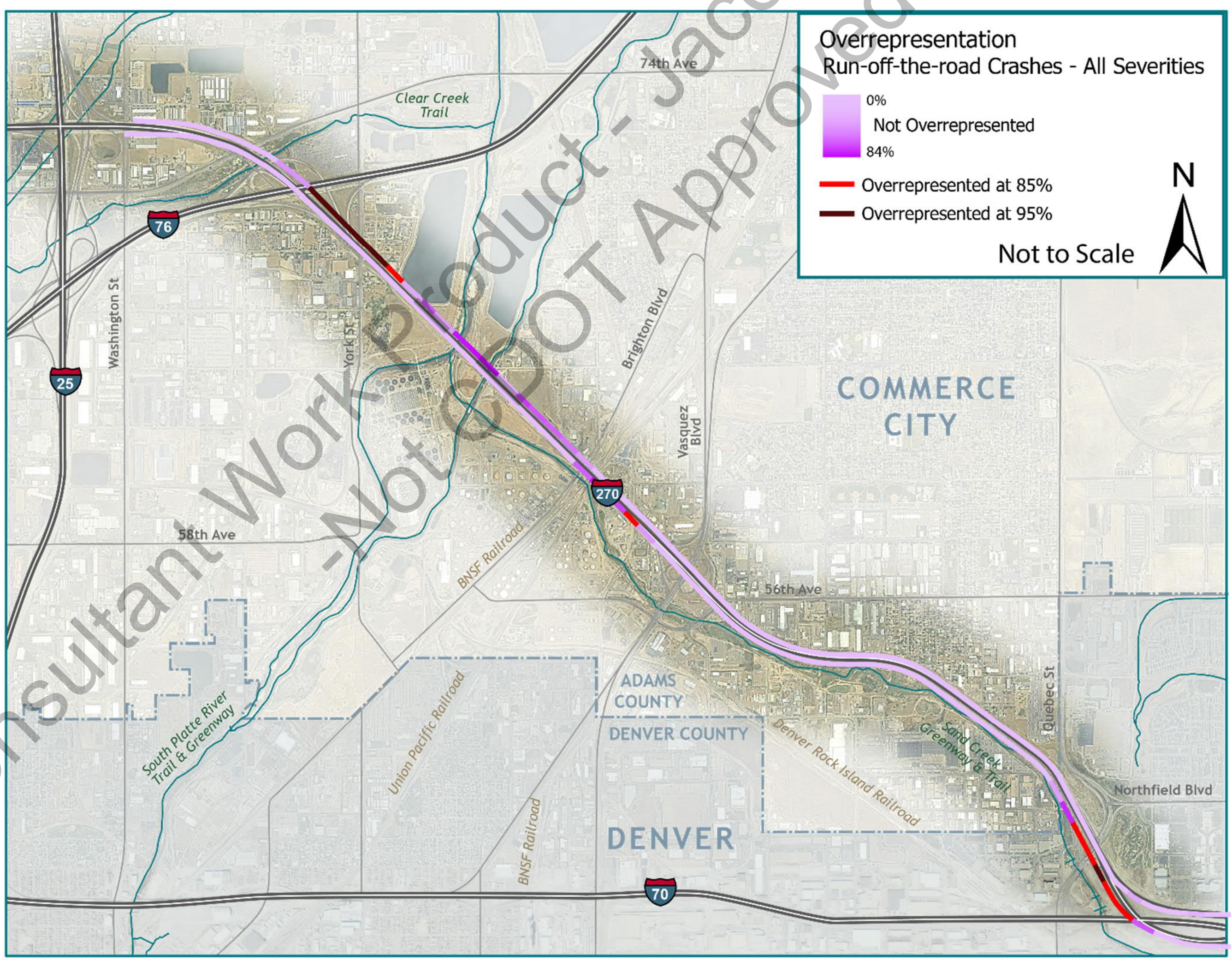


Figure 16. Overrepresentation of Run-off-the-road Crashes – All Severities
Source: Jacobs

As discussed previously, ROR crashes have the second highest proportion of mainline injury crashes (19 percent) and third highest proportion of total crashes (15 percent) for the I-270 corridor. Figure 16 shows areas of high ROR crash patterns occurring at 95 and 85 percent levels of significance. A pattern of rear-end crashes is associated with speeding, distracted driving, lighting condition, adverse weather conditions, and the lack of a shoulder area to provide recovery for vehicles. Figure 2 identifies ROR crash types that can potentially be mitigated, such as collisions with traffic barriers and other fixed objects.

As shown on Figure 16, overrepresentations of ROR crash (refer to Figure 2 for sub categories) patterns are identified at two primary locations: in the eastbound Quebec interchange area (hotspot 7 on Figure 13) and westbound 0.7 mile before I-76 to I-76, which is not a hotspot based on LOSS. The ROR pattern in the westbound direction is longer and more severe compared to eastbound. As mentioned previously, even though the westbound ROR pattern is not a safety hotspot, it could still benefit from appropriate safety treatments specifically given the extent and the confidence in the crash pattern. However, it should be noted that some of the crashes in this area near I-70 could have been related to construction activities and possibly the temporary moving of I-270 in that time period.

Figure 18 shows that wet-pavement crashes are also overrepresented at the same location, which helps to identify the appropriate safety treatment (possible drainage issues). Other countermeasures include improved shoulders, relocation and removal fixed objects, improved highway lighting and intelligent transportation system improvements to advise users of roadway conditions and incidents. For some sections in the westbound direction from Burlington Ditch to approximately I-76, the inside shoulder width is about 4 feet. It widens to 8 feet about 850 feet west of the York Street bridge and continues to widen out to about 10 feet beyond I-76

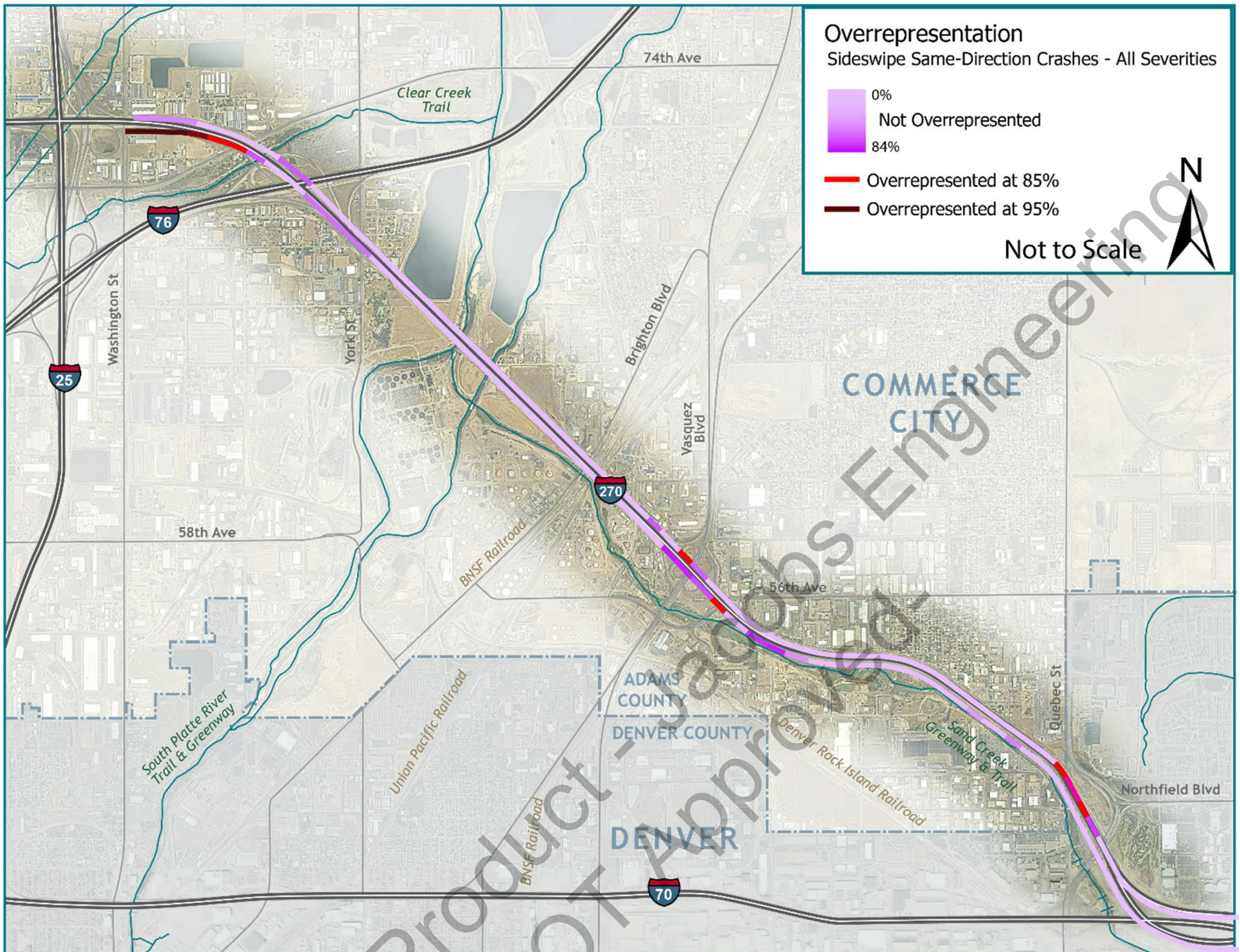


Figure 17. Overrepresentation of Sideswipe-Same-Direction Crashes – All Severities
Source: Jacobs

Sideswipe-same-direction crashes, as discussed previously, have the second highest proportion of total crashes (22 percent) and third highest injury crashes (15 percent) for the I-270 mainline corridor.

Figure 17 shows that sideswipe-same-direction crashes are overrepresented between I-25 and I-76 in the eastbound direction, which suggests weaving and lane change issues area (hotspot 3, Figure 13). It is recommended that example countermeasures be considered to mitigate this crash type, such as geometric improvements to facilitate a more defined lane merge operation (including an added auxiliary lane), would improve lane change maneuvers. Increased merge lengths should be considered to improve weaving operations.

A related potential crash issue for this section is the presence of the left-hand entrance ramp from I-25, which is challenging and conflicts with higher-speed mainline traffic in the outside shoulder lane. Mitigation options may include added signing, lighting, and a review of lane balance. Refer to Section 4.3.1 for additional discussion.

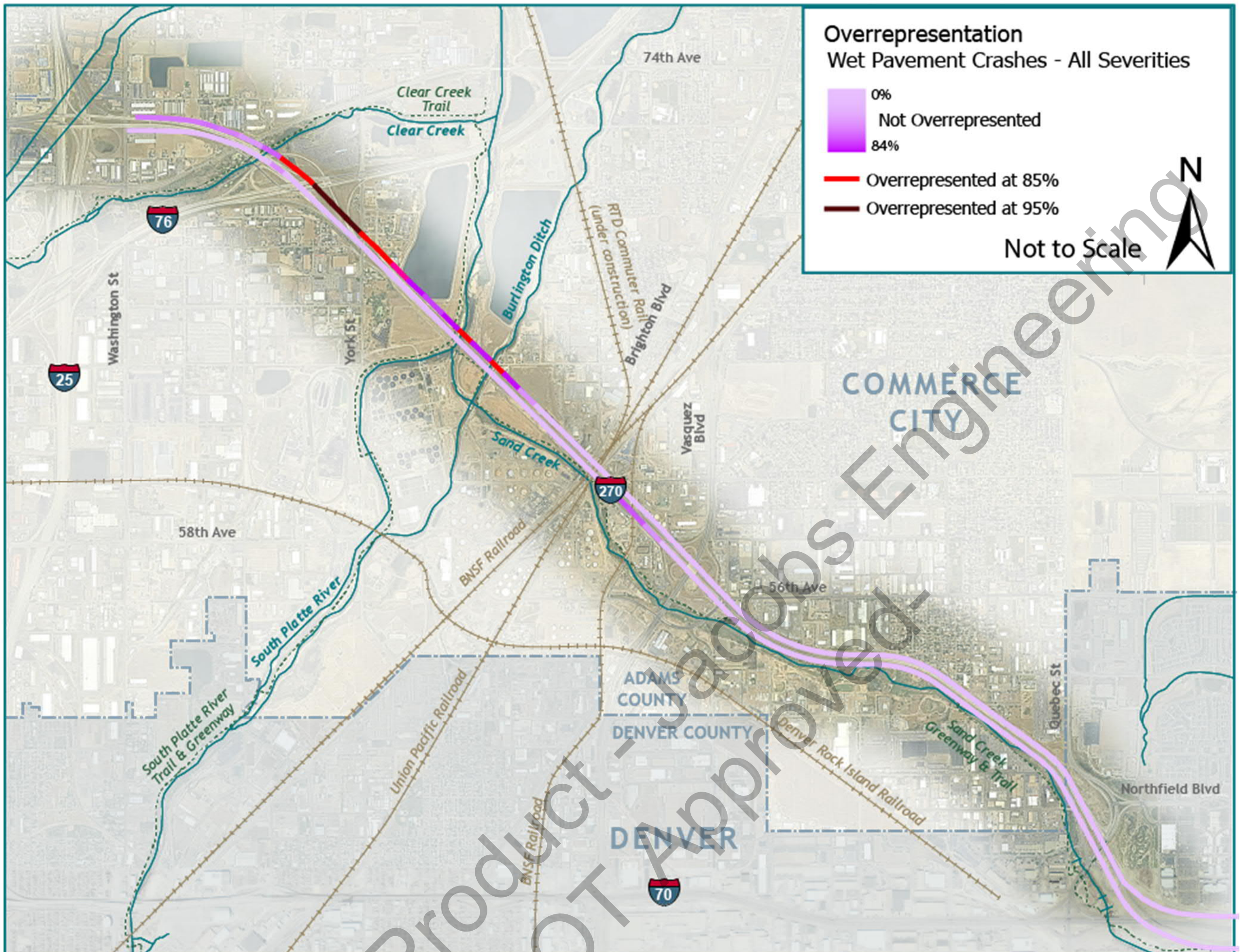


Figure 18. Overrepresentation of Wet Pavement Crashes – All Severities
Source: Jacobs

As shown on Figure 18, wet-pavement crash patterns exist westbound at and prior to I-76, which also has an overrepresentation of ROR crashes and was discussed after Figure 16. For this section, the combination of these two crash types are of interest because a wet-pavement environment may be a contributing factor to ROR crashes. Thus, mitigation of wet-pavement crashes may reduce ROR crashes. This issue should be studied in more detail in the design phase because the wet-pavement crash overrepresentation may be related to such factors as drainage issues and/or reduced pavement friction.

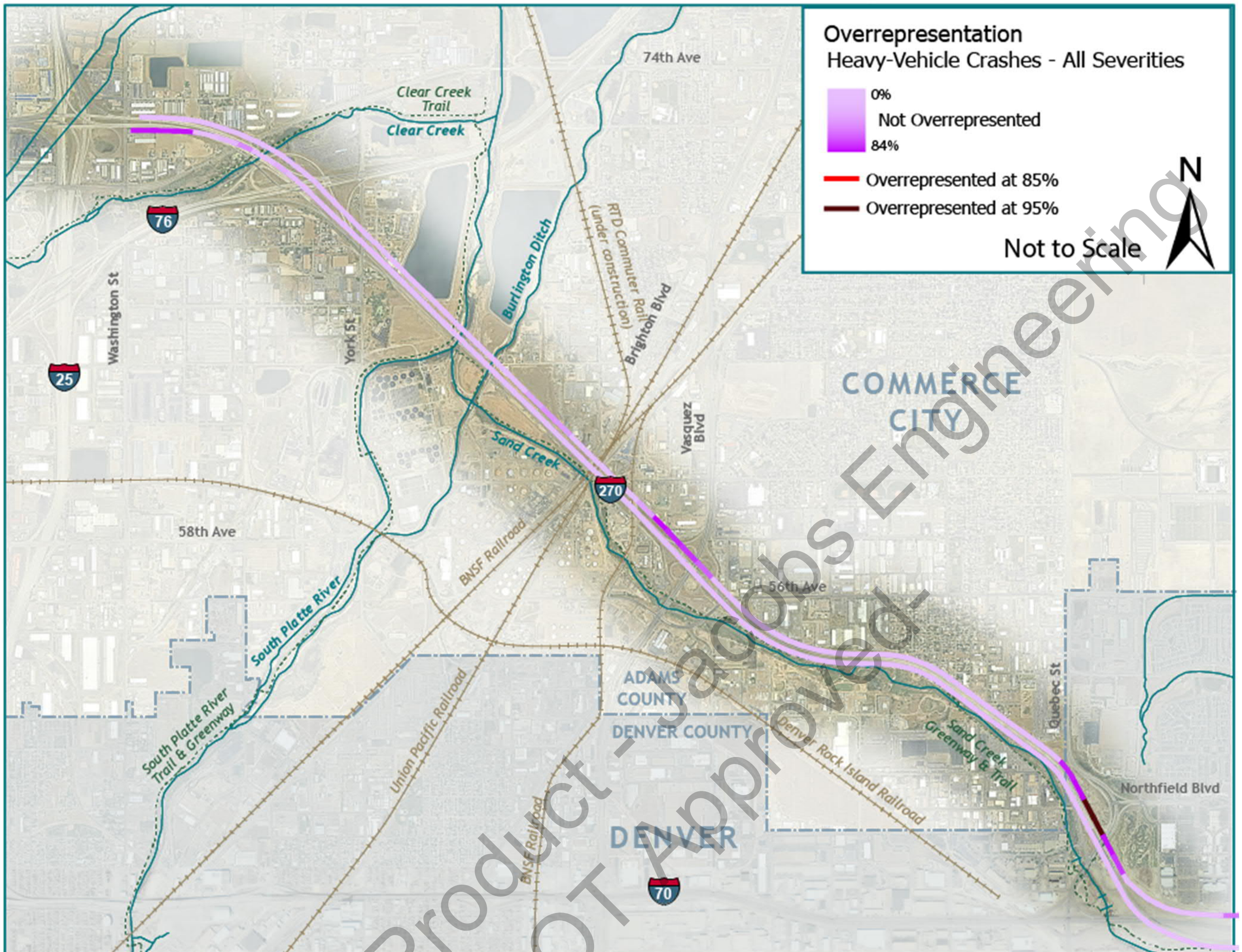


Figure 19. Overrepresentation of Heavy-Vehicle Crashes – All Severities
Source: Jacobs

Figure 19 shows that for the mainline of I-270, the primary segment with a 95 percent overrepresented heavy-vehicle crash pattern is on the westbound direction of the Quebec interchange, which also has a slight overrepresentation of heavy-vehicle crashes (below but close to 85 percent) on the westbound Vasquez interchange and eastbound between I-25 and I-76. Part of the overrepresentation of truck crashes in the Quebec interchange area may be due to the presence of two major truck service facilities that are located on each side of I-270 near the interchange, which add heavy-vehicle traffic. In addition, the ramps of Vasquez interchange have an overrepresentation of heavy-vehicle crashes, which is discussed in Section 5.0.

A review of the frequency of heavy-vehicle crashes at this location by year indicates that heavy-vehicle crashes increased significantly in 2018 and 2019 compared with 2014 to 2017.

While it appears that heavy-vehicle crashes at this location increased in 2018 and 2019, it is not clear whether this relates to I-70 or I-270 traffic patterns or to increased traffic due to truck service facilities. If there is a need to investigate crash patterns for heavy vehicles more, it is possible to develop a breakdown of crash types for heavy-vehicle crashes at this location by using reported crash data.

Virtually all overrepresentations relate to the need to provide improvements to the operating characteristics of heavy vehicles, which are discussed in this report in addition to the higher proportion of heavy vehicles in the mainline corridor and interchanges. Additional discussion of heavy-vehicle needs follows.

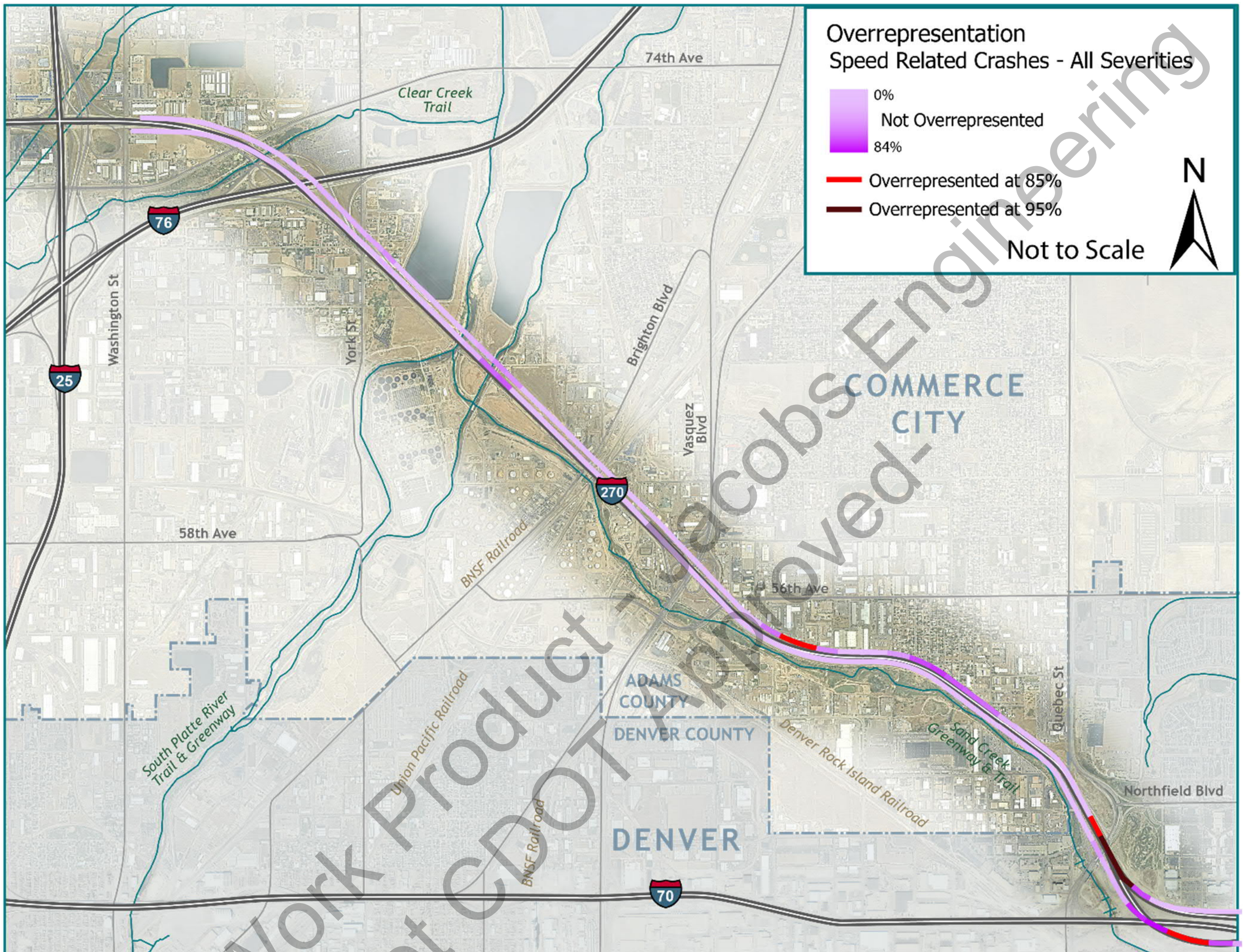


Figure 20. Overrepresentation of Speed-related Crashes – All Severities
Source: Jacobs

Overrepresentation of speed-related crashes are shown on Figure 20. A speed-related crash is identified by violation codes including following too close, too fast for condition, reckless driving, and speeding – speed not specified. The only identified hotspot at a 95 percent confidence level is at the westbound Quebec interchange area, where the potentially higher-speed traffic from I-70 meets the slower traffic at Quebec interchange right after the horizontal curve.

In addition to violation codes noted above that are speed related and primarily a function of driver behavior or misinterpretation of roadway conditions, limited or inadequate stopping sight distance can be a roadway-related deficiency, which is speed related in that motorists could be exceeding the safe speed that exists for a given section of roadway. The westbound horizontal curve section described above coming from I-70 onto I-270 was studied to assess any limitation of stopping sight distance. The findings and a design countermeasure to address the situation are discussed below.

There is a chain-link fence approximately 29 feet off the shoulder of the proposed roadway and 47 feet from the centerline of the inside lane. The radius of the centerline of the inside lane is 2,063 feet. Data contained on Figure 3-2 of the *2018 Roadway Design Guide* (CDOT 2018) indicate a stopping sight distance that equates to 910 feet and a design speed of 80 mph, which is sufficient for this condition.

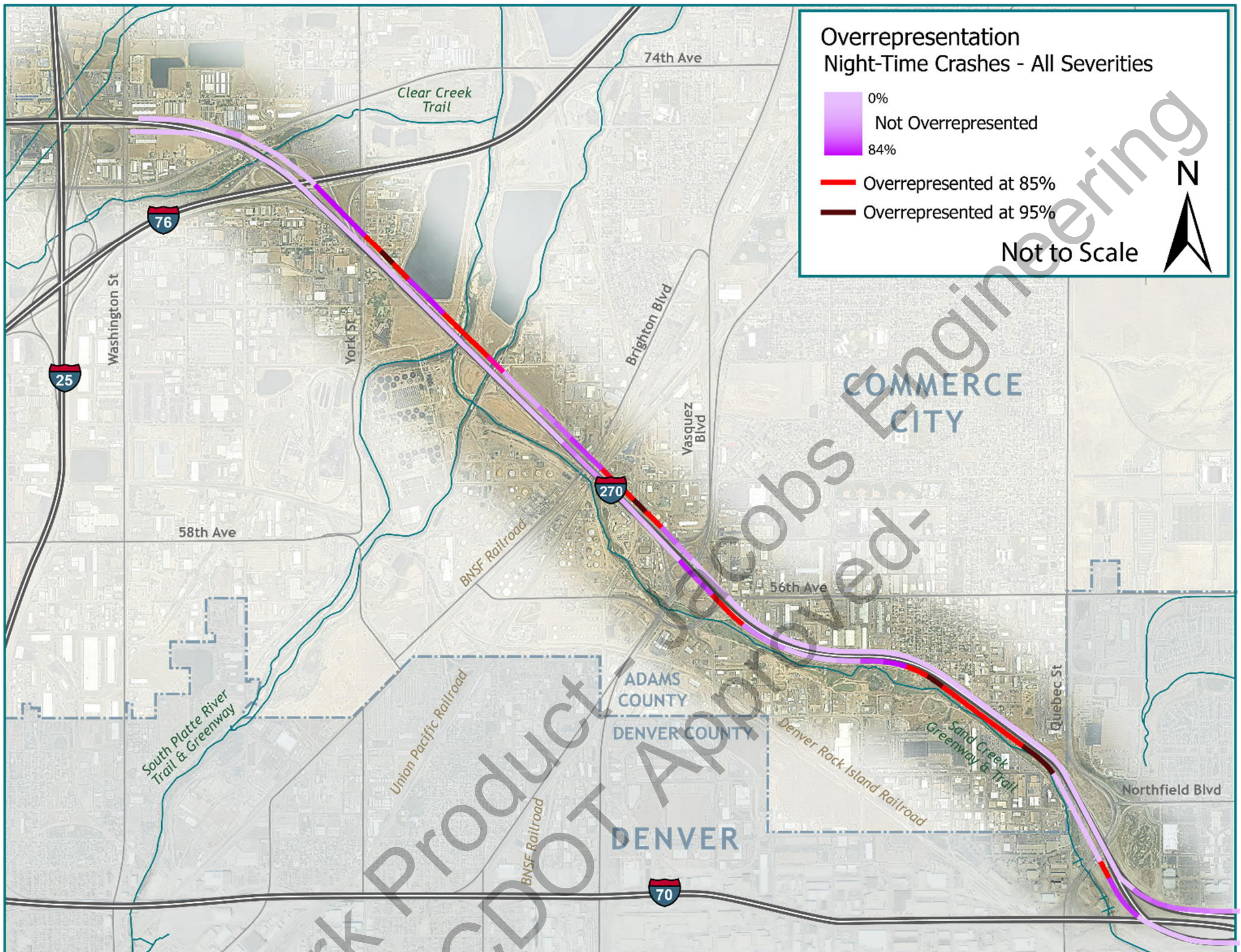


Figure 21. Overrepresentation of Night-Time Crashes – All Severities
Source: Jacobs

Figure 21 shows the overrepresentation of night-time crashes for I-270 and locations with high overrepresentation that would be candidates for improving the lighting. Night-time crashes are defined as crashes coded by the reporting police officer as dark-lighted, dark-unlighted, and dawn or dusk. Specifically, the eastbound direction from milepost 3.3 to 4.1 (between Vasquez Boulevard and Quebec Street) has a long continuous segment with night-time crashes overrepresented at either 85 or 95 percent.

As discussed previously, several crash patterns such as ROR, speeding, and wet-pavement can be related to night-time crash patterns and implementing a countermeasure such as highway lighting can provide a cost-effective means to address multiple crash types.

4.3 Summary

In this section, hotspots and segments with overrepresentation are discussed in more detail, and the results are summarized. A snapshot of the aerial view of each segment is also provided.

4.3.1 Eastbound from I-25 to I-76 (270B 0.17-0.67)

Figure 22. Summary Section - Eastbound from I-25 to I-76 (270B 0.17-0.67)
Source: Jacobs

This location is a safety hotspot (ranked third) with a high potential for safety improvement and an overrepresented sideswipe-same-direction crash pattern (Figure 23). Responding officers coded the top two contributing factors as careless driving and unsafe lane change (Figure 23b).

These crashes, the greatest proportion of which occur during the a.m. peak (Figure 23c), likely result mostly from southbound I-25 traffic from the left-side entering ramp weaving over to the right-side exit ramp for northbound I-76. The ramp spacing between the two is approximately 2000 feet, which does meet CDOT and AASHTO guidance for spacing of successive entrance/exit ramps on the same side of the freeway (for example, two right-side ramps). However, the left-side entrance requires three or four lane changes (weaving maneuvers) to reach the right-side exit, depending on if the driver navigates from the southbound I-25 ramp in the right or left lane. Although no specific guidance for this situation is provided by AASHTO or CDOT for the recommended weaving length for this scenario, this safety analysis compares the existing 2000-foot distance between these two ramps to the 1200-foot-per-lane weave distance selected for the South I-25 Gap design for a similar scenario, which had a right-side ramp entrance followed by the left-side introduction of an express (managed) lane. Using this criterion, a distance of 3600 feet (3 times 1200) is estimated to provide the needed weaving distance between these two ramps (for a driver in the right lane of the southbound I-25 ramp).

Given the congested conditions during the a.m. and p.m. peak periods and the shorter weaving distance provided, there can be limited gaps in traffic for motorists to weave across the three I-270 mainline lanes to reach the downstream right-side exit. This maneuver may be particularly challenging for heavy-vehicle drivers that would need to make lane changes. A study conducted by CDOT indicated that this weaving maneuver volume from I-25 to I-76 may be relatively light; the average frequency of weaving vehicles was 66 vehicles in the a.m. peak (6 to 8 a.m.) and 36 vehicles in the p.m. peak (3 to 6 p.m.).

Overall, under current conditions, a statistically high overrepresentation of sideswipe crashes occurs (Figure 17). There is a 25 percent proportion of truck crashes, which translates to an 81 percent probability of overrepresentation at this section (Figure 19).

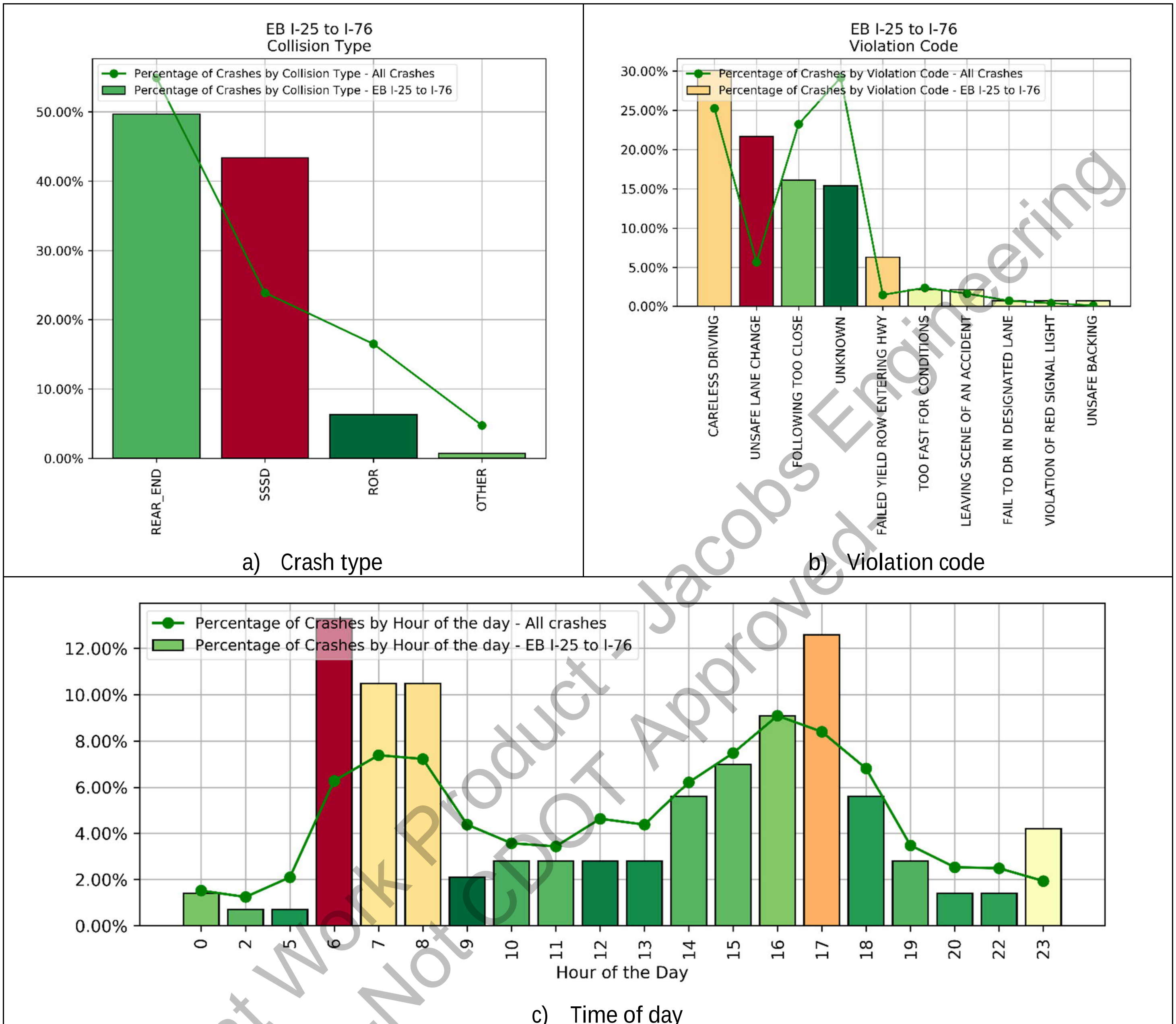


Figure 23. I-270 Mainline Eastbound from I-25 to I-76 Crash Characteristics
Source: Jacobs

Bar charts on Figure 23 show distribution of crashes for this location (color-coded bars) compared to the distribution of crashes for the entire I-270 mainline (green dots). Bars are color coded based on their deviation from the average mainline proportion. Proportions with highest deviation from average are color coded in red and proportions with lowest deviation are color coded in green. Each set of proportions (bars or dots) sum to 100 percent.

The crash data indicates that the a.m. peak hours from 6 to 9 a.m. have a greater proportion of crashes compared to the corridor.

4.3.2 Eastbound from I-76 to Vasquez Boulevard (270B 0.877 to 270A 1.6)

Figure 24. Summary Section - Eastbound from I-76 to Vasquez Boulevard (270B 0.877 to 270A 1.6)
Source: Jacobs

I-270 from I-76 to 0.8 mile west of Vasquez Boulevard contains two safety hotspots (rank 2 and 6) with similar crash characteristics. This section has a very high potential for safety improvement and experiences about 70 percent rear-end crashes (Figure 12), which is above the I-270 average (approximately 55 percent) (Figure 25a). These crashes are mostly coded as careless driving and following too closely.

The elevated rear-end crash frequency is likely caused, at least in part, by the close proximity of the I-76 and York Street successive on-ramps in the eastbound direction, which is a site of regular traffic congestion. The largest proportion of crashes happen during the a.m. peak (Figure 25c). It is important to note this section also has a higher frequency of heavy-vehicle crashes (Figure 8) but is not considered to be overrepresented at the 85 or 95 percent levels (Figure 19).

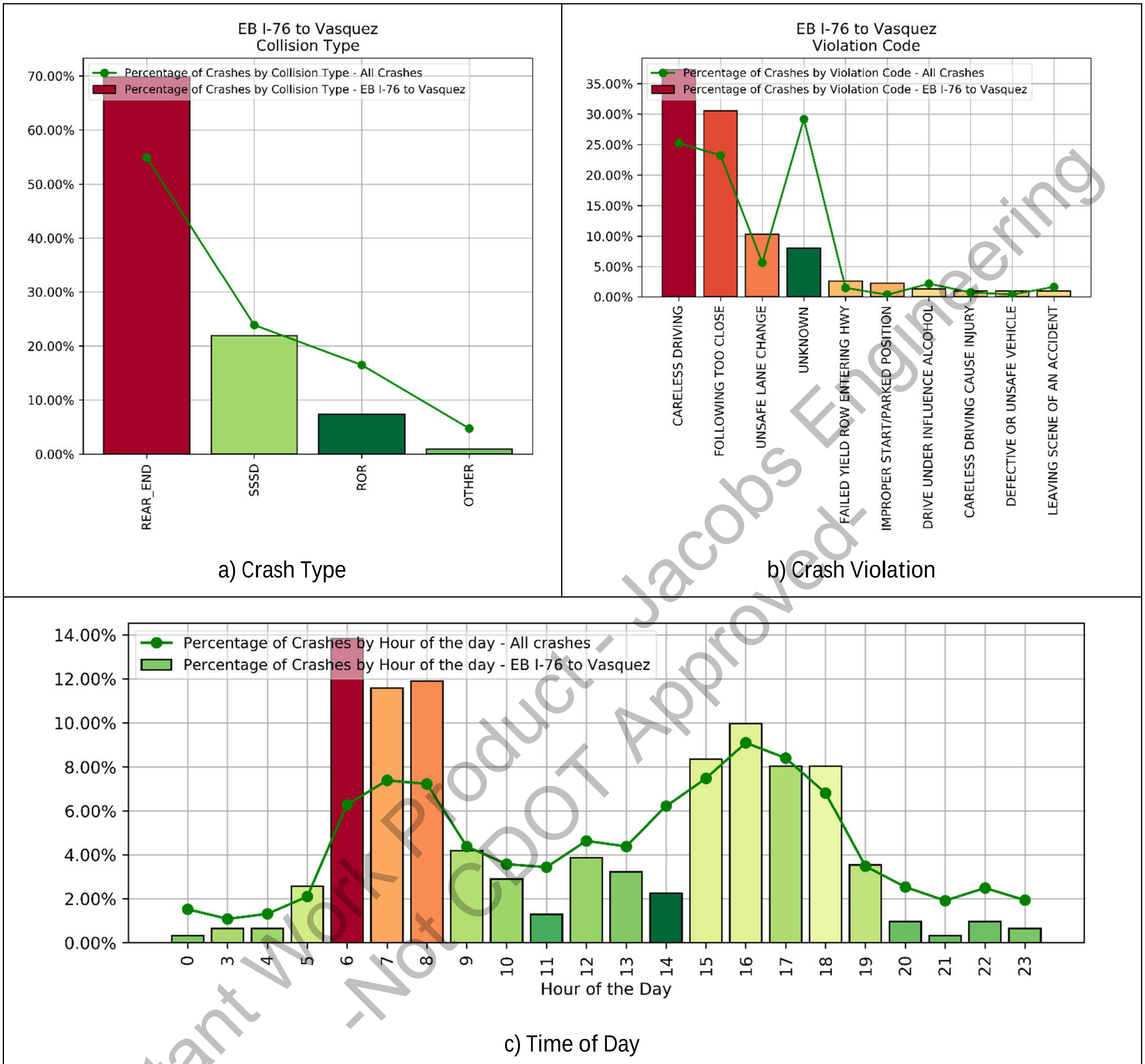


Figure 25. I-270 Mainline Eastbound from I-76 to Vasquez Boulevard Crash Characteristics
Source: Jacobs

One issue that was raised was the effect of sun glare, particularly in areas with higher representations of same-direction-sideswipe crashes. Essentially, there is an overrepresentation of same-direction-sideswipe crashes on I-270 from I-25 to Vasquez Boulevard in the eastbound direction from 6 to 7 a.m. and a higher frequency of crashes from 7 to 9 a.m. (Figures *23 and 25).*

To the gauge the potential impact of sun glare, reported crashes were studied in this section. For example, from I-25 eastbound to Vasquez in the eastbound direction from 6 to 8 a.m., there were 57 crashes from 2014 to 2018. The highest number of crashes by month were January (9), April (9), and December (7). Given the small sample size of crash frequency, the extent of our study was limited in scope, and other related contributing factors were not considered. If this pattern is deemed to be an issue, it is recommended to study it in more detail. It is noted that CDOT did issue a safety alert relating to sun glare safety that offered safety tips for motorists (CDOT n.d.b). A number of strategies for motorists to use to help mitigate the risk of this contributing factor are cited in the alert.

4.3.3 Eastbound Vasquez Interchange (270A 2.1-2.5)

Figure 26. Summary Section - Eastbound Vasquez Interchange (270A 2.1-2.5)
Source: Jacobs

I-270 eastbound near Vasquez Boulevard is a safety hotspot (rank 5) with potential for safety improvement. Both rear-end and sideswipe-same-direction identified crash patterns are likely resulting from slower traffic merging with high-speed mainline traffic and diverging traffic associated with the cloverleaf interchange design. No specific pattern regarding time of day was observed at this location.

When the interchange was constructed decades ago, lower volume and congestion levels were likely present to enable appropriate accelerating and decelerating to occur in the auxiliary lane between the ramps. The approximately 450-foot weaving distance between the successive eastbound on- and off-ramps is likely not sufficient based on current needs for merging and diverging maneuvers given the current through and weaving volumes. The rear-end crashes may be happening because heavy volumes of accelerating/decelerating vehicles, particularly heavy vehicles, are occurring to and from the mainline lanes, resulting in a speed differential with through traffic.

4.3.4 Eastbound Quebec Interchange (270A 4.3-4.8)

Figure 27. Summary Section - Eastbound Quebec Interchange (270A 4.3-4.8)
Source: Jacobs

This location is a safety hotspot rank 7 out of 7, with the lowest potential for safety improvement for hotspots but a strong ROR crash pattern. Driver inexperience is coded as one of the main contributing factors, along with overrepresentation of night-time, overturn, guardrail, and utility pole crashes. However, these crash data are based primarily on the previous design for eastbound I-270 with a flyover geometry (sharper curve and narrow shoulders) that was replaced in 2019 with a new flyover structure that included wider shoulders and a flatter horizontal curve. In addition, either post reflectors or barrier reflectors should be added as needed to enhance guidance.

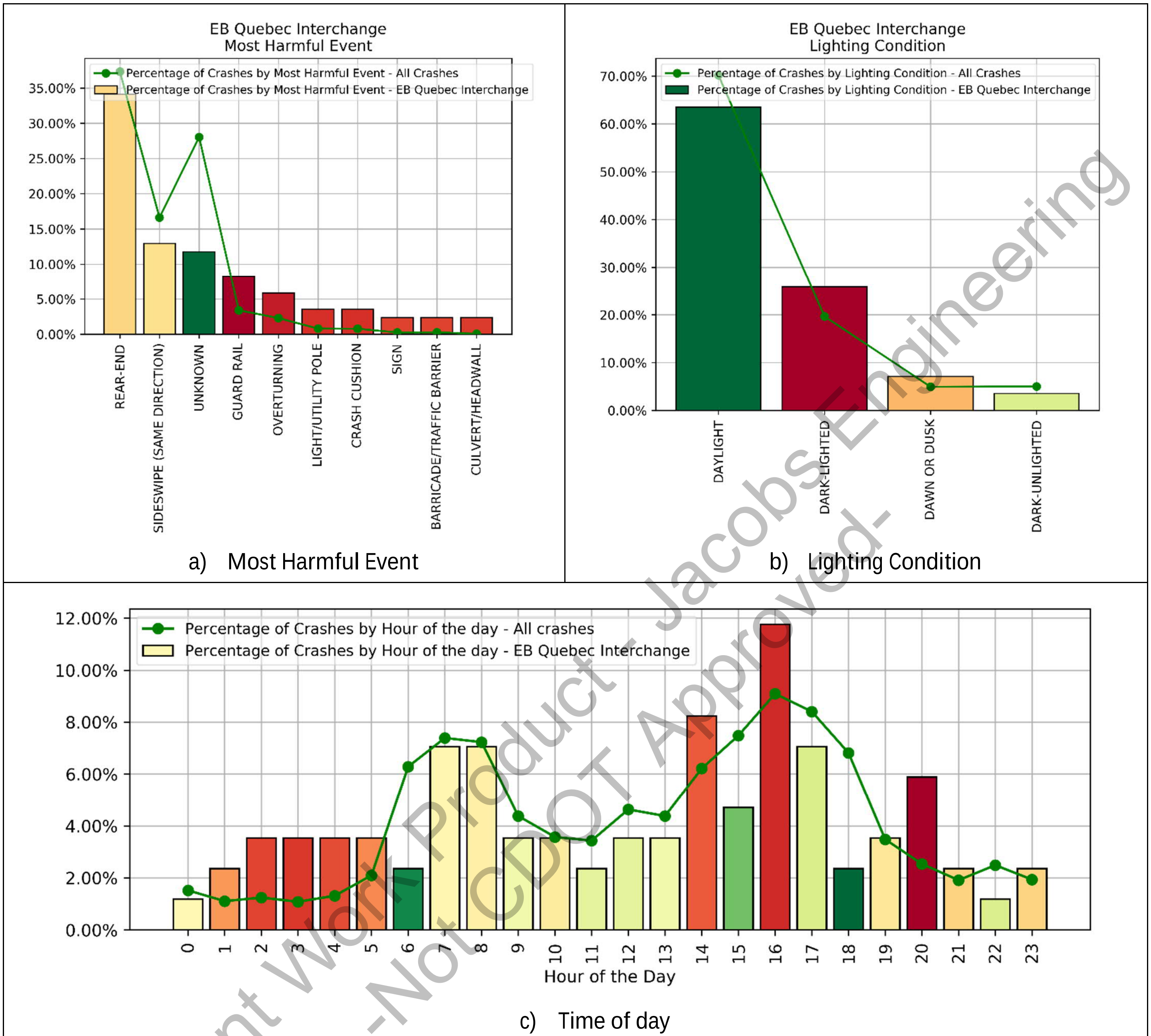


Figure 28. I-270 Mainline Eastbound Quebec Interchange Crash Characteristics
Source: Jacobs

4.3.5 Westbound Quebec Interchange (270A 4.5-5)

Figure 29. Summary Section - Westbound Quebec Interchange (270A 4.5-5)
Source: Jacobs

This location is a safety hotspot (rank 4) with a potential for safety improvement and a pattern of rear-end and sideswipe crashes likely mostly due to following too closely and traffic congestion during p.m. peaks. There is also an overrepresentation of heavy-vehicle crashes at this location with the same crash pattern. As shown on Figure 30a and Figure 30b, the overrepresentation of rear-end and following too closely crash patterns is confirmed compared to the overall I-270 corridor. Figure 30c shows that a higher proportion of crashes occurs in the peak hours.

With the identified crash patterns and apparent relationship of congestion, the addition of a travel lane should be considered as a potential countermeasure, particularly given all vehicles are similarly affected. Another countermeasure could be dynamic signage to alert drivers about stopped traffic ahead or other traffic incidents.

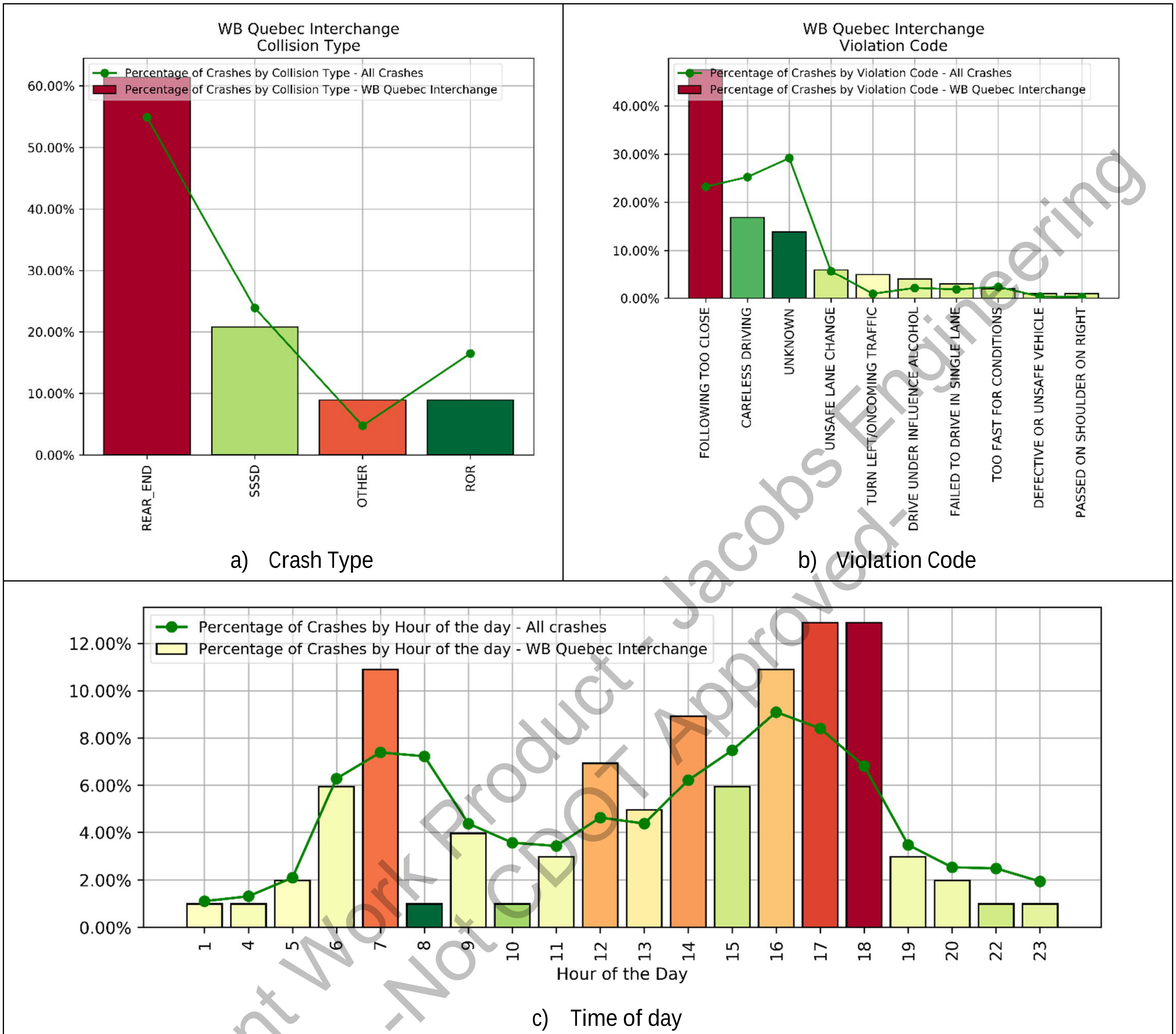


Figure 30. I-270 Mainline Westbound Quebec Interchange Crash Characteristics
Source: Jacobs

4.3.6 Westbound Vasquez Interchange (270A 2.2-4.2)

Figure 31. Summary Section - Westbound Vasquez Interchange (270A 2.2-4.2)
Source: Jacobs

The location shown on Figure 31 contains the safety hotspot with the highest rank and potential for safety improvement. It has a strong pattern of rear-end crashes particularly in advance of the interchange (Figure 15). This section of I-270 has a high mainline traffic volume as well as high traffic volume exiting the freeway onto northbound Vasquez Boulevard. In addition, high ramp volumes use the cloverleaf interchange traveling from northbound Vasquez Boulevard to westbound I-270 and westbound I-270 to southbound (southbound) Vasquez Boulevard. Vehicles operate at different speeds in this section and have multiple conflict points due to weaving traffic in the short distance between entrance to exit to and from ramps accessing I-270 at the cloverleaf. Also, the westbound I-270 off-ramp to northbound Vasquez Boulevard is short. In this area, through traffic in the right lane operates at mainline operating speeds, while exiting traffic slows on the mainline due to short deceleration lengths.

Traffic congestion, speed differentials, short weaving distance, and limited deceleration lane result in a higher risk and statistically high overrepresentation of rear-end crashes. In this section, more than half of the crashes recorded by the responding officer as a contributing factor were vehicles following too closely. Figure 32 compares percentage of crashes occurring by hour of day near westbound Vasquez interchange to overall corridor crash percentages.

In addition, sideswipe-same-direction crashes are overrepresented in the vicinity of the interchange, likely due to conflicting merge and diverge maneuvers. There is a slight overrepresentation (75 percent) of heavy-vehicle crashes at the interchange. About 50 percent of the reported heavy-vehicle crashes are sideswipe-same-direction crashes.

Crash patterns suggest that improved weave and merge lengths should be added, considering redesign of the existing loop ramps to facilitate this. The high proportion of rear-end crashes and congestion suggests adding an additional travel lane would reduce congestion and the probability of rear-end crashes.

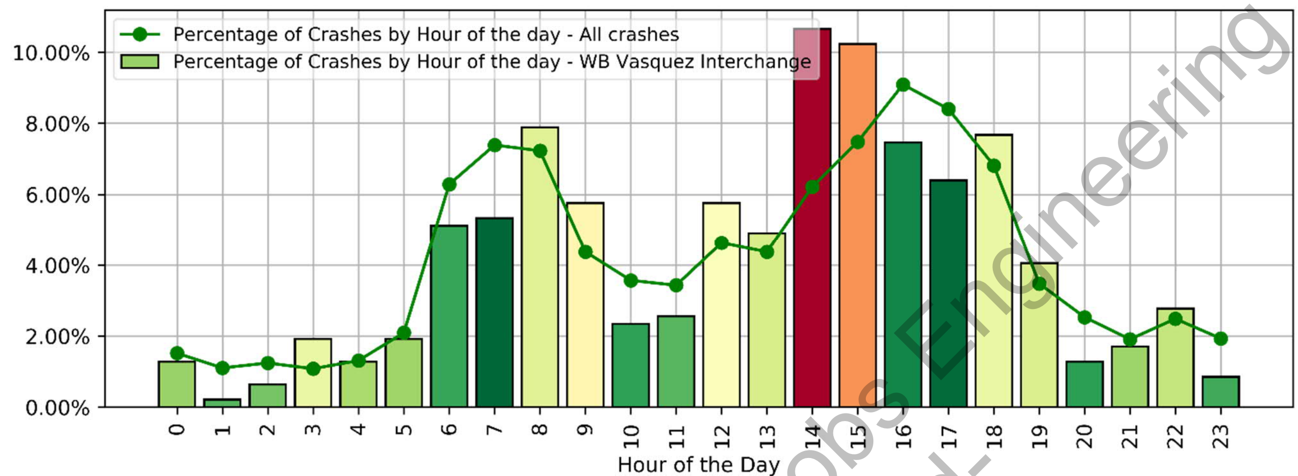


Figure 32. I-270 Mainline Westbound Vasquez Interchange Crashes by Time of Day
Source: Jacobs

4.3.7 Westbound York Street to I-76 (270A 0-0.7)

Figure 33. Summary Section - Westbound York Street to I-76 (270A 0-0.7)
Source: Jacobs

This location is not a safety hotspot but shows a strong pattern of ROR (Figure 16) and wet-pavement crashes (Figure 18) happening in off-peak hours (Figure 34d). Concrete barrier crashes (Figure 34c) during snow or rain (Figure 34a) and driving too fast for conditions (Figure 34b) are identified at this location. Installing a high-friction surface and/or check for possible drainage issues could help to address safety issues at this location.

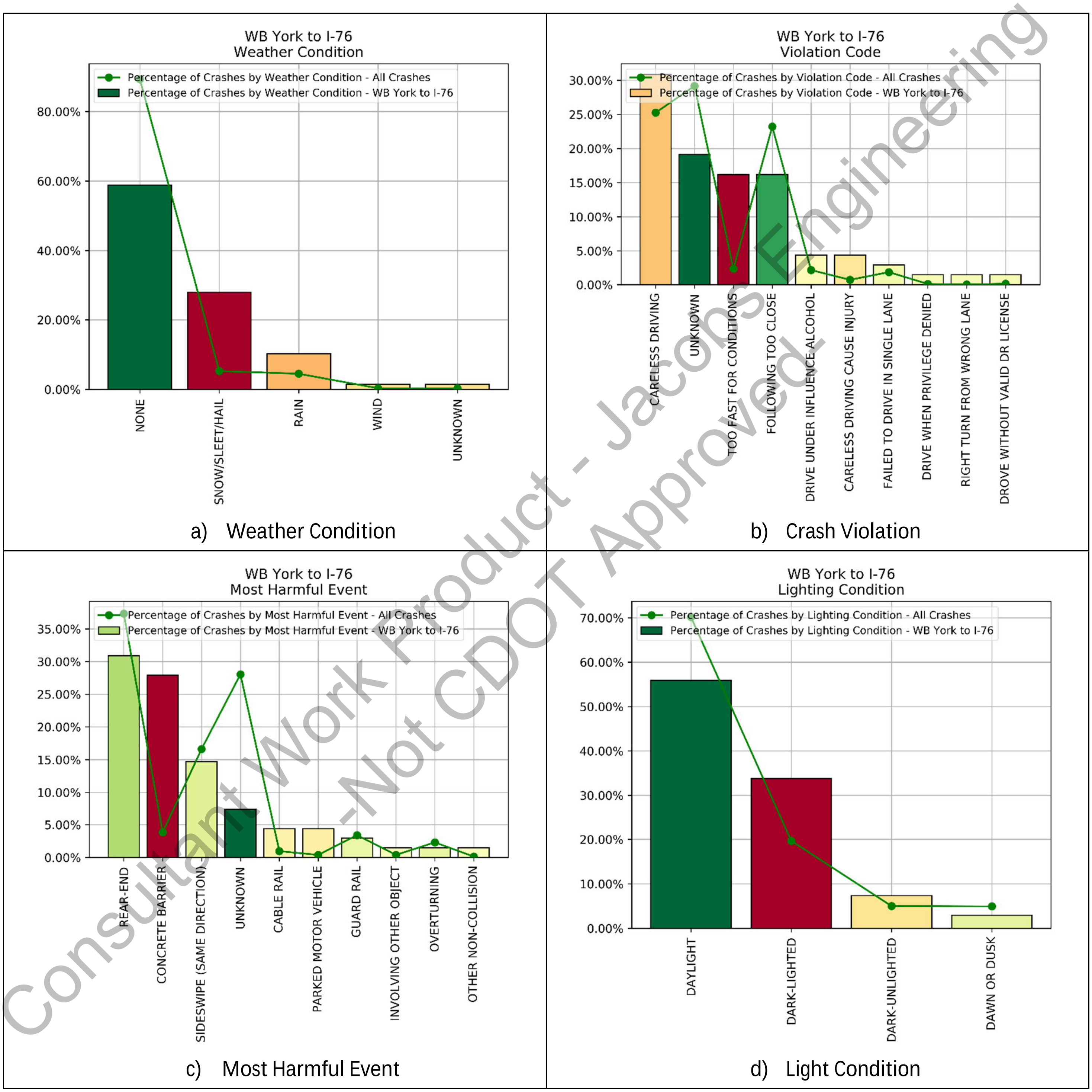


Figure 34. I-270 Mainline Westbound York Street to I-76 Crash Characteristics
Source: Jacobs

5.0 Ramp Analysis

A summary overview of ramp crashes is shown in Table 1, which lists crashes by severity and year. Figure 3 shows that, for all ramps in the study corridor, there is a 51 percent ROR and 33 percent rear-end crashes for all severities. Additionally, there is an overrepresentation of total crashes at ramp during off-peak hours (7 p.m. to midnight mostly weekends and Wednesdays) (Figure 35) and adverse weather crashes. Among violations and contributing factors, driver unfamiliar with area, driver inexperience, careless driving, impaired driving, and too fast for condition are identified as issues.

Figure 35 a) summarizes total crashes for ramps by day of week, and Figure 3 indicates for ramp situations that same-direction-sideswipe crashes account for 48 percent and rear-end crashes account for 42 percent of all ramp injury crashes. Impaired ramp crashes are a contributing factor related to 6.3 percent of ramp crashes, which compares to 3.5 percent for the I-270 mainline.

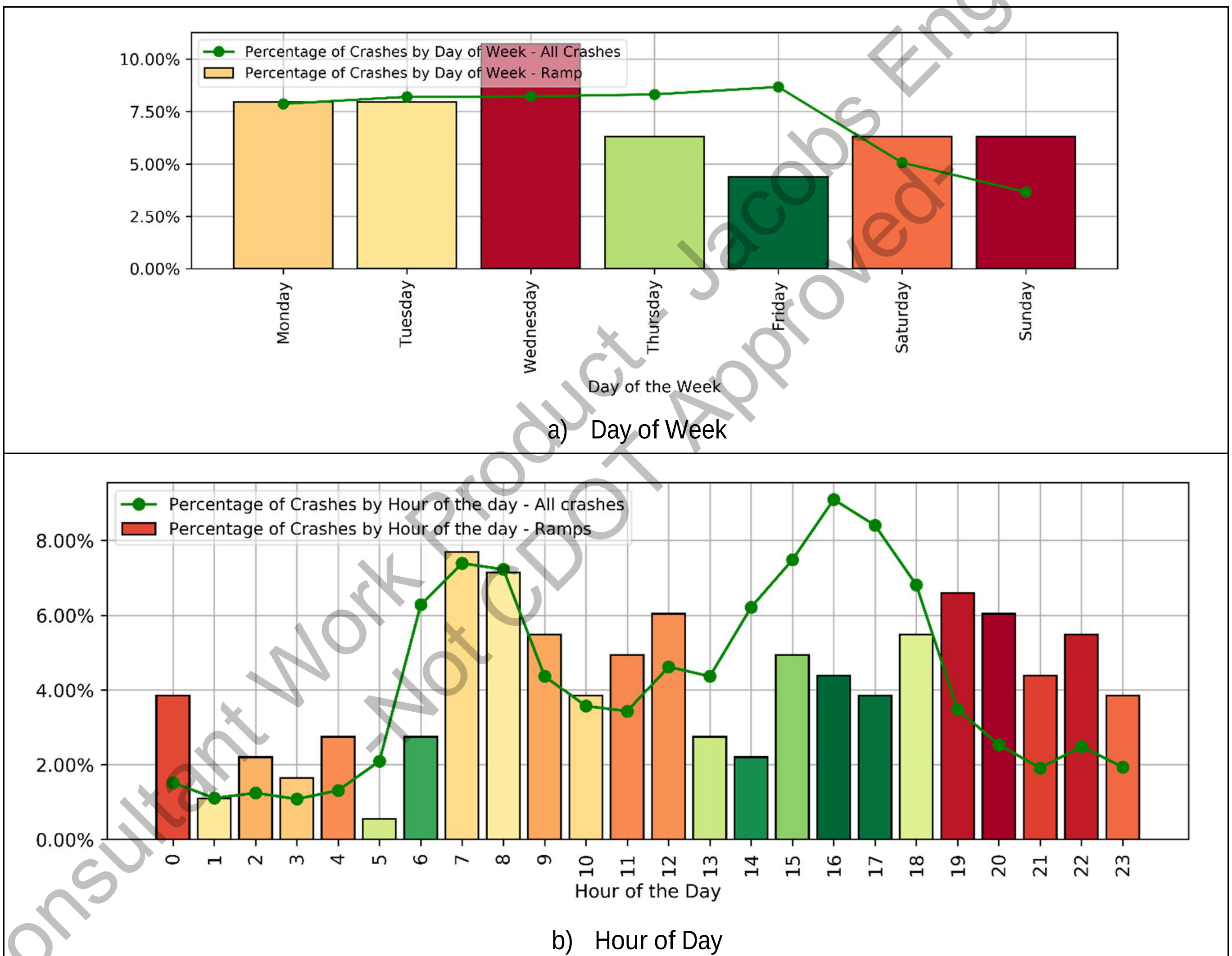


Figure 35. I-270 Ramp Crash Characteristics
Source: Jacobs

The safety performance of each individual ramp is also measured and compared. Number of crashes per million vehicles traveling per year is considered as the performance measure in absence of state-specific SPFs for ramps. Length of the ramp is not considered in calculating the performance measure, due to lack of explicit data relating to length, and normalization to compare ramps is performed only based on AADT to reduce potential bias. Ramps for I-270 and I-76 in addition to the I-270 interchanges at York

Street, Vasquez Boulevard, and Quebec Street are analyzed. For each ramp, the calculated number of crashes per million vehicles per year ranges from 0.04 to 13.8 per million vehicles of travel and is shown on Figure 36. Results are visualized in four different colors, and the legend shows the range for each color.

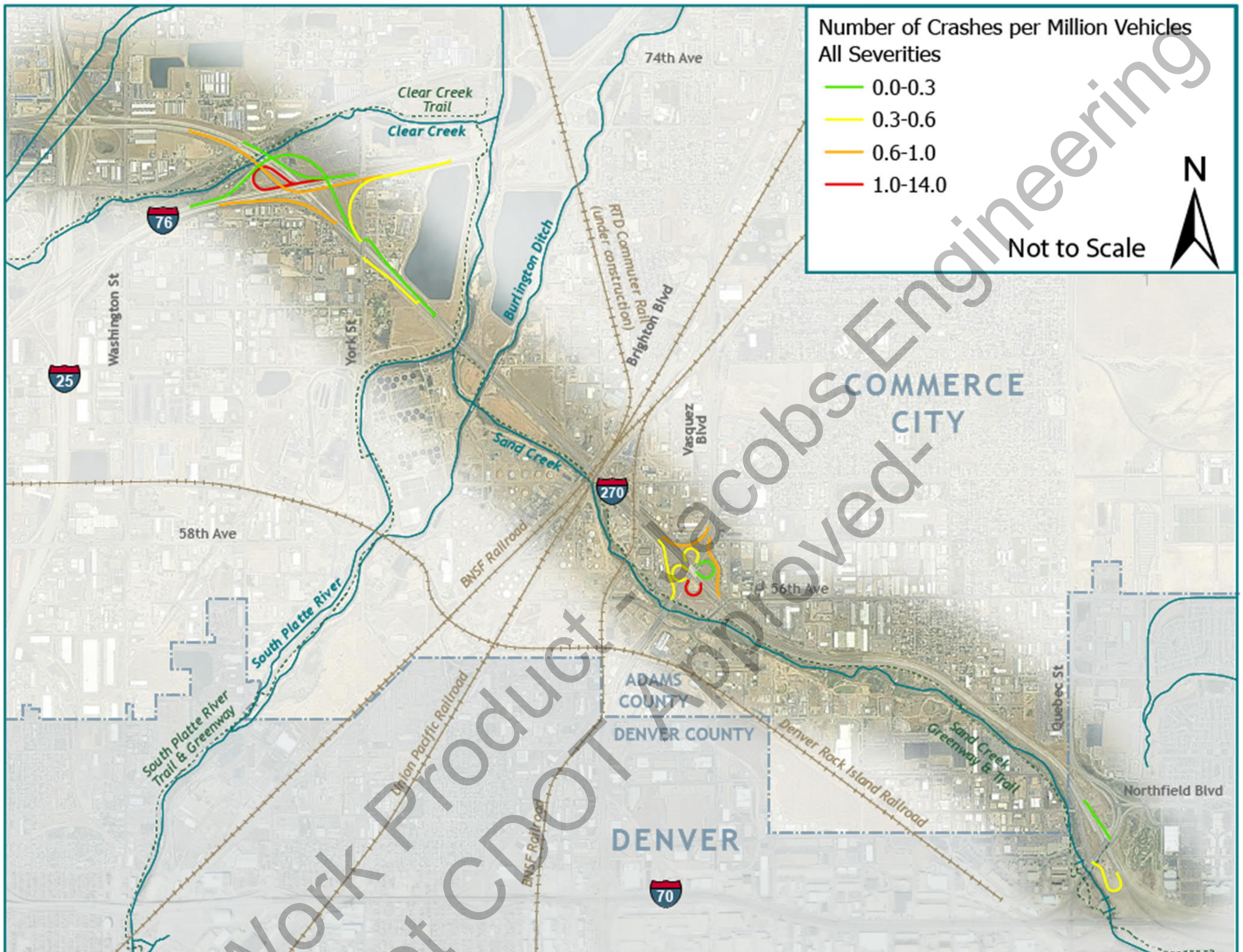


Figure 36. Results of Ramp Screening
Source: Jacobs

The highest crash rate on ramps is related to the I-76 westbound to I-270 eastbound interchange, with a value of 13.8 crashes per million vehicles. The second highest rate is related to the loop ramp on I-270 eastbound to Vasquez Boulevard northbound, with the value of 1.09 crashes per million vehicles. These two ramps are shown in red on Figure 36.

In addition to Figure 36, a diagnostic analysis was performed on ramps (similar to what was done for mainline) to provide insights on crash characteristics overrepresentation. The results are shown on Figure 39 to Figure 48.

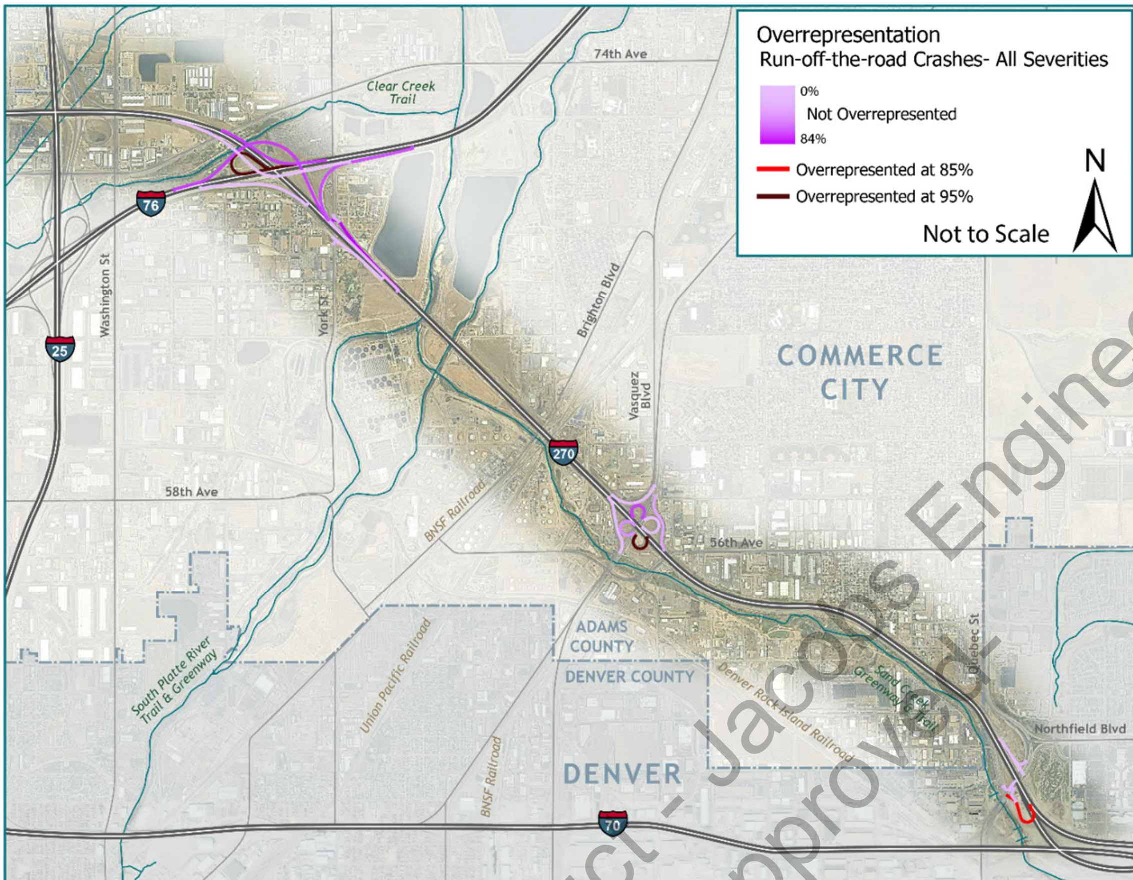


Figure 37. Overrepresentation of Run-off-the-road Crashes for Ramps – All Severities
Source: Jacobs

Figure 37 shows ramps that have overrepresentations of ROR crashes. As indicated, the I-76 westbound to I-270 eastbound and I-270 eastbound to Vasquez Boulevard northbound are identified with an overrepresentation of ROR crashes with more than 95 percent confidence, and the I-270 eastbound to Quebec ramps are identified with an overrepresentation of more than 85 percent confidence. (Figure 38 shows photos of three of these situations having crash overrepresentations of ROR crashes.) It is shown later on Figure 48 that the I-76 westbound to I-270 eastbound and the I-270 eastbound to Quebec ramps are also overrepresented for night-time crashes and likely for ROR crashes.

Recommended countermeasures include providing increased deceleration length, improving visibility of curves, and adding signage could help improve the safety performance of these ramps. Note that I-270 eastbound to Vasquez Boulevard northbound has improved signage that may contribute to a reduced crash experience for night-time crashes (Figure 38b).

a) I-76 westbound to I-270 eastbound ramp	b) I-270 eastbound to Vasquez Boulevard northbound	c) I-270 eastbound to Quebec Street

Figure 38. Horizontal Curves with Overrepresentation of Run-off-the-road Crashes
Ramps a and c are also overrepresented for night-time crashes
Source: Jacobs

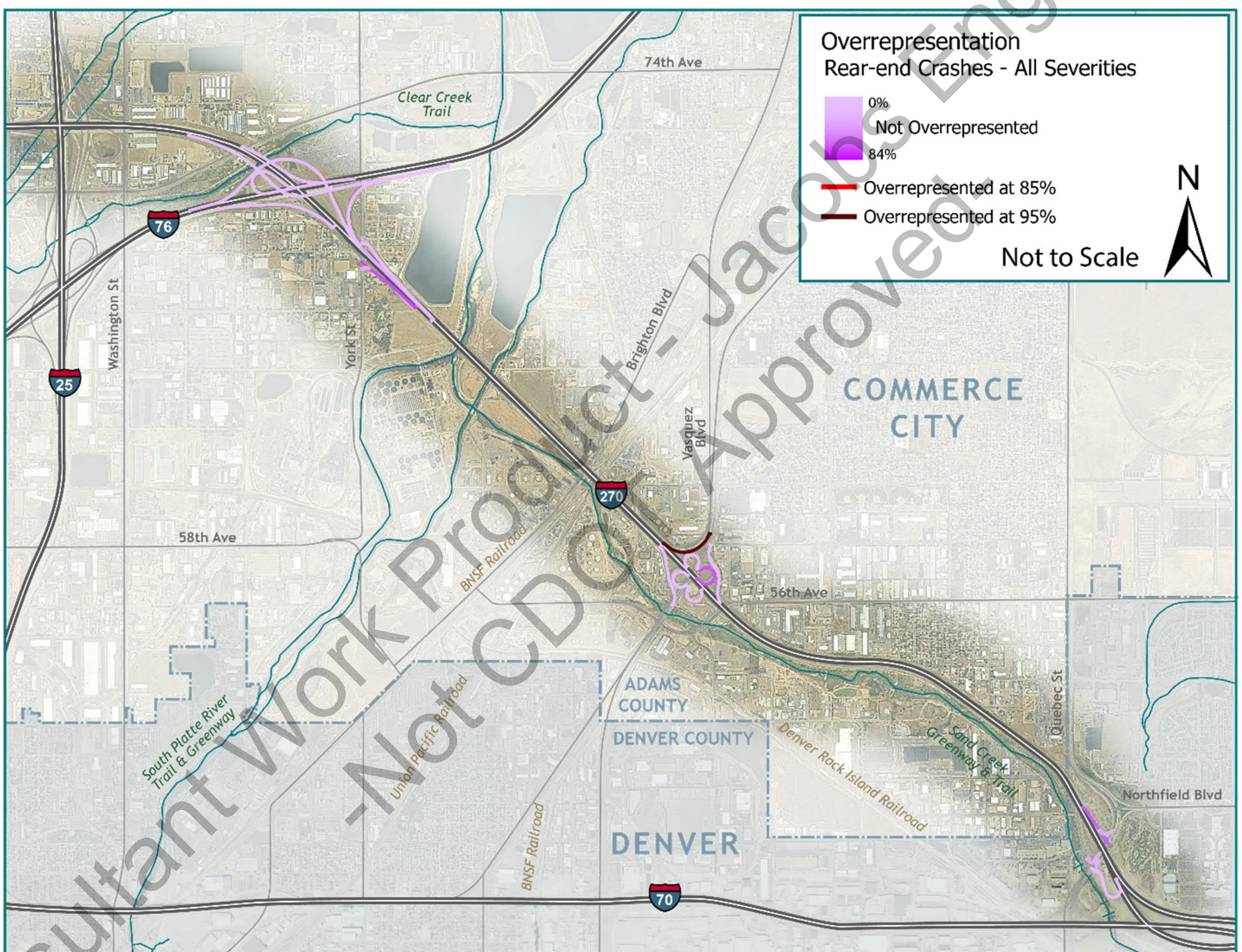


Figure 39. Overrepresentation of Rear-end Crashes for Ramps – All Severities
Source: Jacobs

Figure 39 shows the overrepresentation of rear-end crashes, and the Vasquez Boulevard southbound to I-270 westbound ramp, shown on Figure 40, has an overrepresentation of 95 percent for rear-end crashes. The overrepresentation could be related to drivers not expecting stopping/slower traffic and possible traffic queuing on the ramp.

Figure 40. Vasquez Southbound to I-270 Westbound Ramp – Overrepresented for Rear-end Crashes
Source: Jacobs

In addition to the Vasquez Boulevard southbound to I-270 westbound ramp, the Quebec southbound to I-270 westbound, Vasquez Boulevard northbound to I-270 westbound, and York Street to I-270 eastbound ramps also have a smaller (67 to 71 percent confidence) overrepresentation of rear-end crashes, which could be related to traffic congestion or sudden stops of vehicles in the traffic stream.

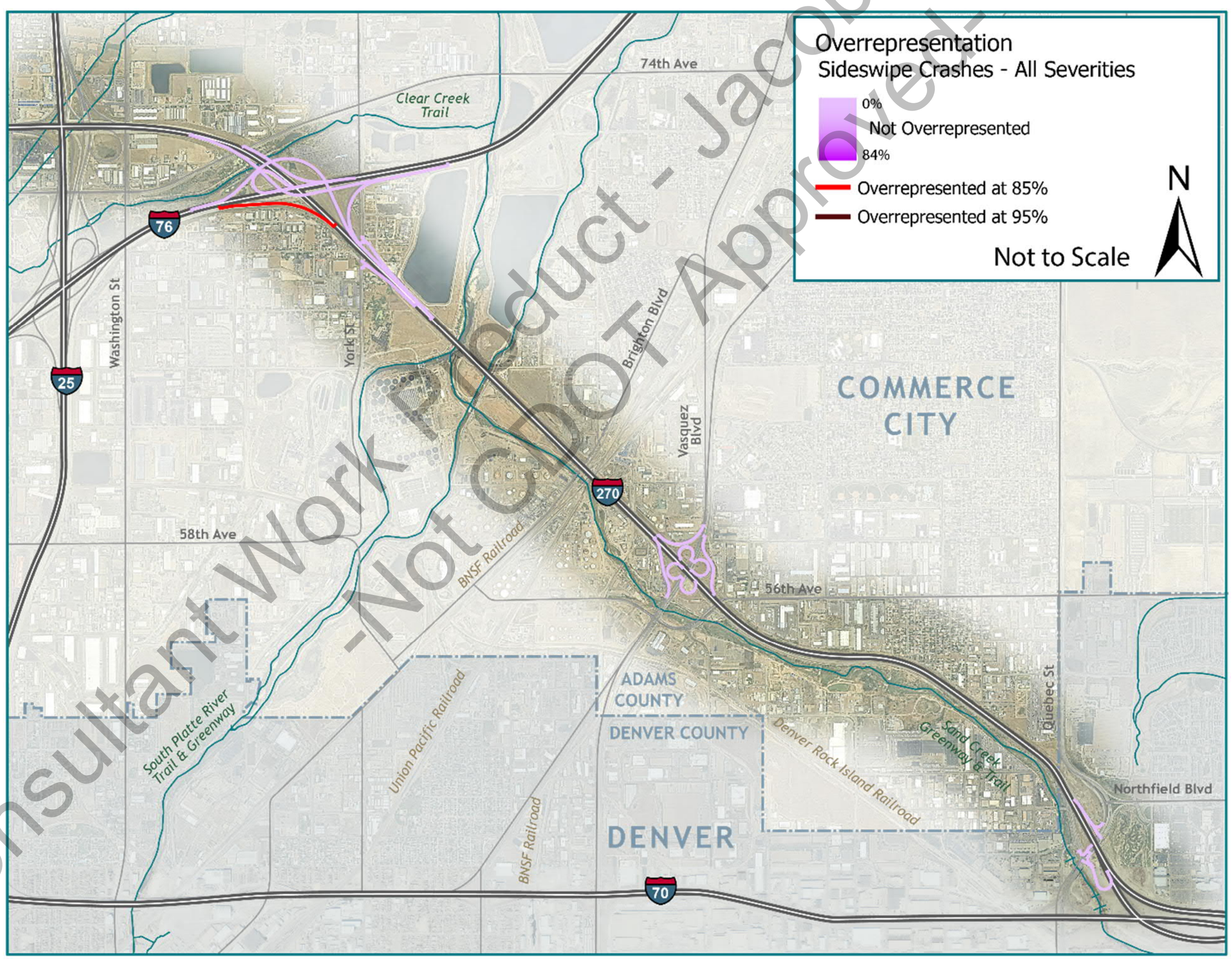


Figure 41. Overrepresentation of Sideswipe Crashes for Ramps – All Severities
Source: Jacobs

As shown on Figure 41, the only ramp with an overrepresentation of sideswipe crashes is the I-76 northbound to I-270 eastbound, which is a two-lane ramp dropping to a one-lane ramp prior to merging with I-270, as shown on Figure 42. It is shown on Figure 47 that there is an overrepresentation of speed-related crashes and a slight (65 percent) overrepresentation of heavy-vehicle crashes on this ramp.

Figure 42. I-76 Northbound to I-270 Eastbound Ramp – Overrepresentation of Sideswipe Crashes and Speeding
Source: Jacobs

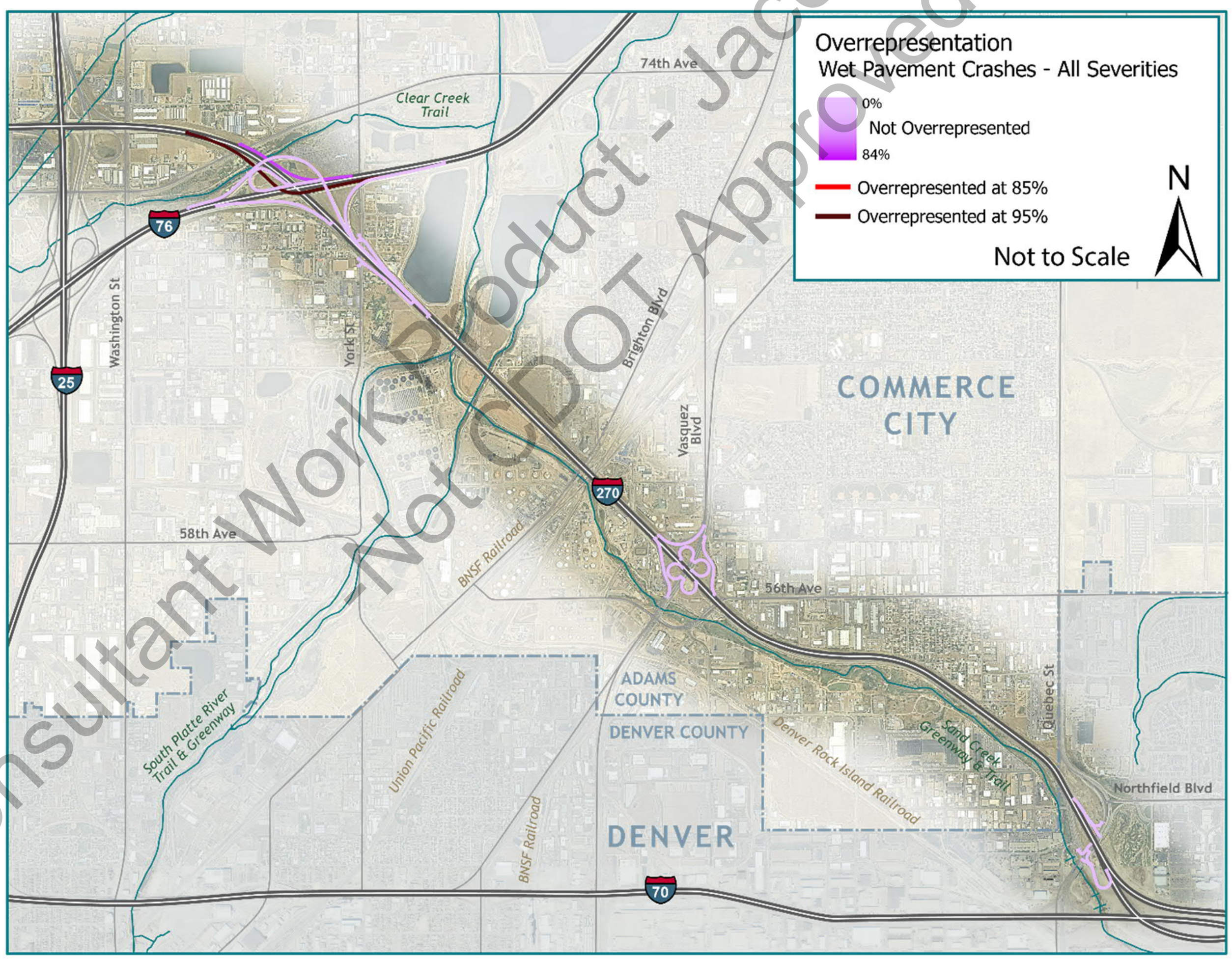


Figure 43. Overrepresentation of Wet-pavement Crashes for Ramps – All Severities
Source: Jacobs

As shown on Figure 43, wet-pavement crashes are overrepresented at the flyover ramp of I-270 eastbound to I-76 northbound (Figure 44). High-friction surface treatment could help to enhance the safety of this ramp. In addition, other potential countermeasures my include a review of the superelevation characteristics and drainage and the installation of active advisory speed warning devices.

Figure 44. I-270 Eastbound to I-76 Northbound Ramp – Overrepresentation of Wet-pavement Crashes
Source: Jacobs

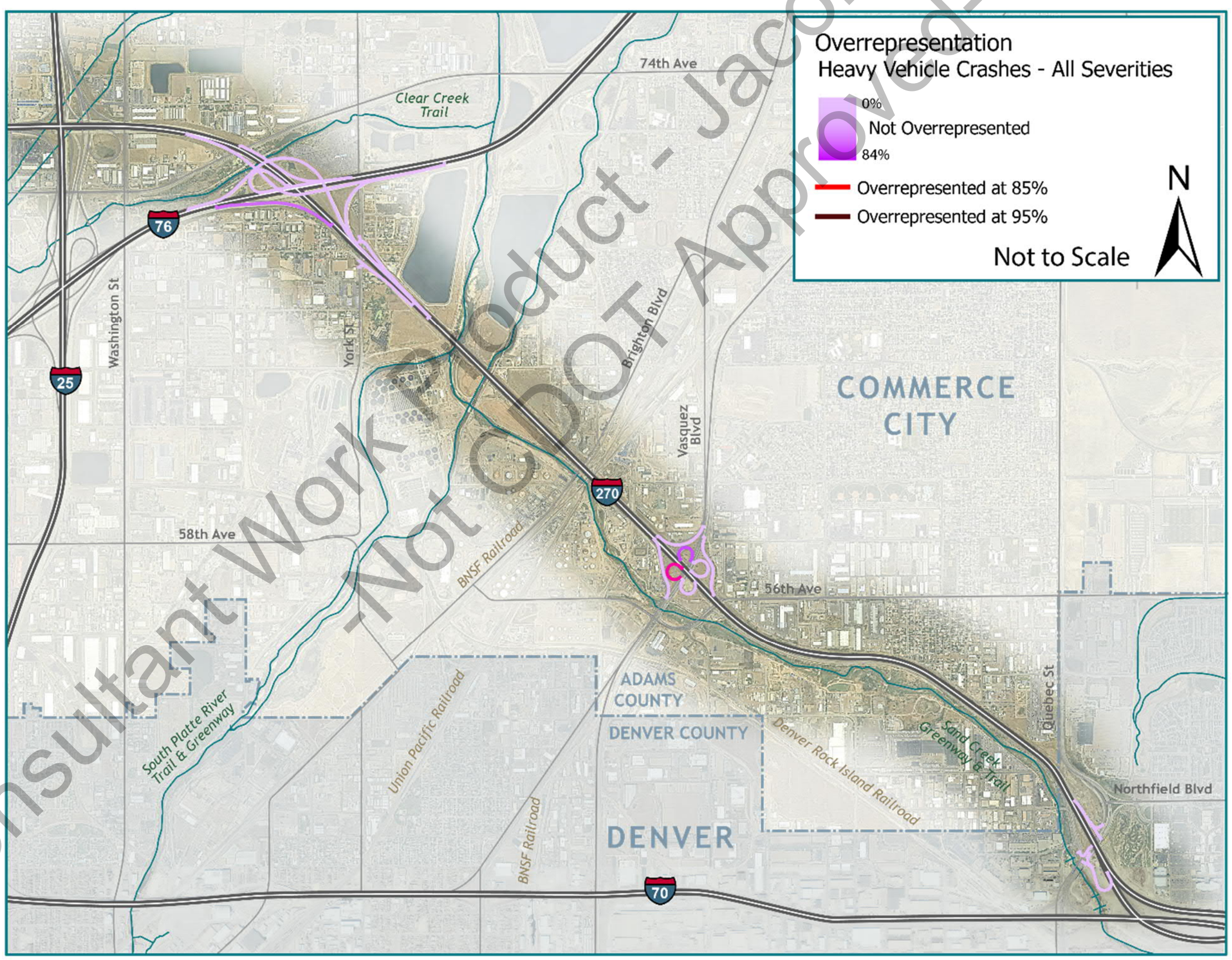


Figure 45. Overrepresentation of Heavy-vehicle Crashes for Ramps – All Severities
Source: Jacobs

As shown on Figure 45, there is an overrepresentation of heavy-vehicle crashes on the loop ramp of Vasquez Boulevard southbound to I-270 eastbound, with a confidence level of 85 percent. Additionally, the loop ramp of I-270 westbound to Vasquez Boulevard southbound also has an overrepresentation of heavy-vehicle crashes at a 71 percent confidence level. The smaller radii of the loop ramps might be more challenging for heavy vehicles to navigate and may contribute to more crashes. Crash issues may also be related to a higher volume of trucks on these ramps.

Figure 46. Vasquez Boulevard Southbound to I-270 Eastbound Loop Ramp – Overrepresentation of Heavy-vehicle Crashes
Source: Google Street View

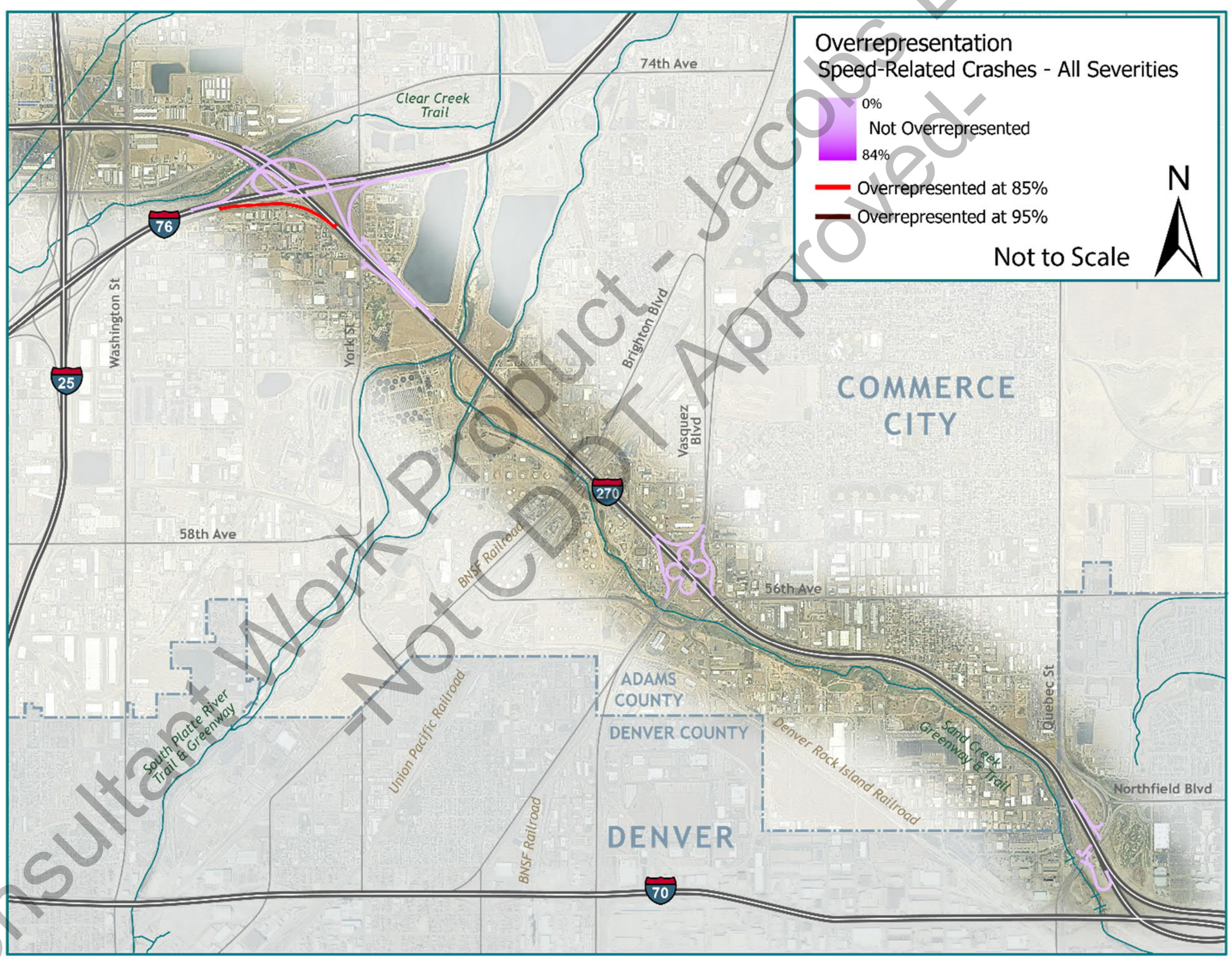


Figure 47. Overrepresentation of Speed-related Crashes for Ramps – All Severities
Source: Jacobs

As shown on Figure 47, the only ramp with an overrepresentation of speed-related crashes is the I-76 northbound to I-270 eastbound ramp. This ramp also has overrepresentation of sideswipe crashes and slight overrepresentation of heavy-vehicle crashes. This ramp is discussed related to sideswipe crashes and is shown on Figure 41.

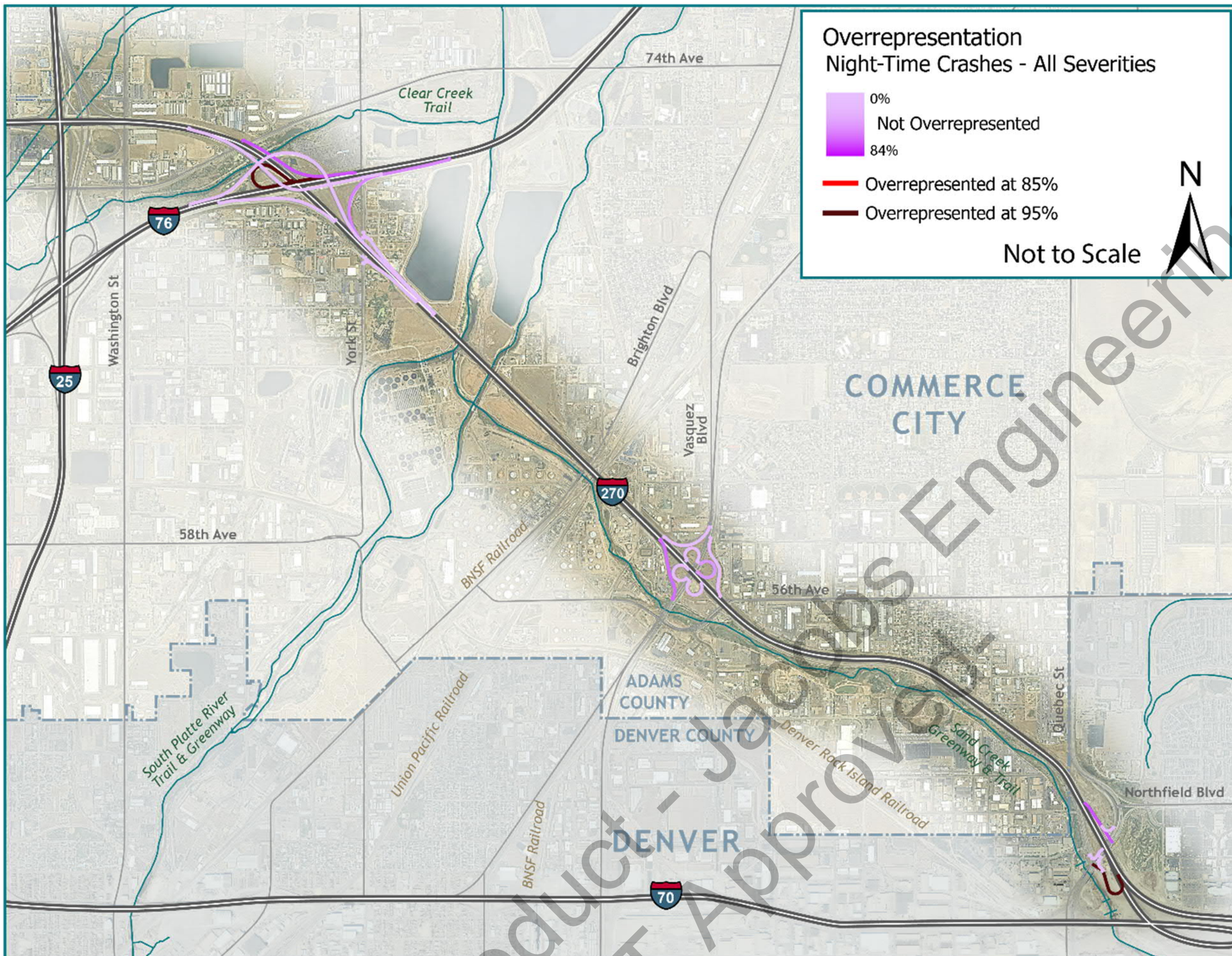


Figure 48. Overrepresentation of Night-Time Crashes for Ramps – All Severities
Source: Jacobs

As shown on Figure 48, the I-76 westbound to I-270 eastbound and I-270 eastbound to Quebec ramps are identified with overrepresentation of night-time crashes. These ramps also are identified with overrepresentation of ROR crashes and are discussed after Figure 37.

6.0 References

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Appendix A

Detailed Summary of Crashes

Colorado Department of Transportation
DiExSys™ Roadway Safety Systems
General Summary of Crashes Report

09/15/2020

Job #: 20200915123421

Location: 270A **Begin:** 0.00 **End:** 5.99 **From:** 01/01/2019 **To:** 12/31/2019

Severity

PDO:	301	
INJ:	80	99 :Injured
FAT:	0	0 :Killed
Total:	**381**	

Number of Vehicles

One Vehicle:	69
Two Vehicles:	256
Three or More:	56
Unknown:	0
Total:	**381**

Location

On Road:	313
Off Road:	68
Unknown:	0
Total:	**381**

Mainline/Ramps/Frontage Rds

Mainline:	345
Ramps:	23
Frontage/Ramp Intsx:	4
Frontage Roads:	13
HOV Lanes:	0
Unknown:	0
Total:	**381**

Lighting Conditions

Daylight:	258
Dawn or Dusk:	19
Dark - Lighted:	72
Dark - Unlighted:	31
Unknown:	1
Total:	**381**

Crash Rates

PDO:	1.46 *
INJ:	0.39 *
FAT:	0.00 **
Total:	**1.85** *

* Per MVMT
** Per 100 MVMT

Crash Type

Overturning:	6
Other Non Collision:	1
Pedestrians:	0
Broadside:	5
Head On:	1
Rear End:	213
Sideswipe Same:	77
Sideswipe Opposite:	1
Approach Turn:	4
Overtaking Turn:	0
Parked Motor Vehicle:	2
Railway Vehicle:	0
Bicycles:	1
Domestic Animal:	0
Wild Animal:	0
Fixed Objects:	62
Other Objects:	8
Unknown:	0
Total:	**381**

Weather Conditions

None:	350
Rain:	14
Snow/Sleet/Hail:	15
Fog:	0
Dust:	0
Wind:	2
Unknown:	0
Total:	**381**

Road Conditions

Dry:	337
Wet:	20
Muddy:	0
Snowy:	2
Icy:	8
Slushy:	4
Foreign Material:	0
With Road Treatment:	10
Unknown:	0
Total:	**381**

Vehicle Types

	Vehicle 1	Vehicle 2	Vehicle 3
Passenger Car/Van:	159	128	22
Passenger Car/Van w/Trailer:	0	0	0
Pickup Truck/Utility Van:	88	63	8
Pickup Truck/Utility Van w/Trailer:	2	1	0
SUV:	72	77	22
SUV w/Trailer:	0	0	0
Truck 10k lbs or Less:	0	0	0
Trucks > 10k lbs/Busses > 15 People:	31	35	1
School Bus < 15 People:	0	0	0
Non School Bus < 15 People:	0	1	0
Motorhome:	0	0	0
Motorcycle:	6	2	0
Bicycle:	0	1	0
Motorized Bicycle:	0	0	0
Farm Equipment:	0	0	0
Hit and Run - Unknown:	23	4	2
Other:	0	0	0
Unknown:	0	0	1
Total:	**381**	**312**	**56**

ADT: 97,948 **Length:** 5.77

Location: 270B **Begin:** 0.18 **End:** 1.10 **From:** 01/01/2019 **To:** 12/31/2019

Severity

PDO:	37		
INJ:	17	31	:Injured
FAT:	0	0	:Killed
Total:	**54**		

Number of Vehicles

One Vehicle:	6
Two Vehicles:	41
Three or More:	7
Unknown:	0
Total:	**54**

Location

On Road:	48
Off Road:	6
Unknown:	0
Total:	**54**

Mainline/Ramps/Frontage Rds

Mainline:	53
Ramps:	1
Frontage/Ramp Intsx:	0
Frontage Roads:	0
HOV Lanes:	0
Unknown:	0
Total:	**54**

Lighting Conditions

Daylight:	40
Dawn or Dusk:	2
Dark - Lighted:	8
Dark - Unlighted:	4
Unknown:	0
Total:	**54**

Crash Rates

PDO:	1.54 *
INJ:	0.71 *
FAT:	0.00 **
Total:	**2.25** *

* Per MVMT
** Per 100 MVMT

Crash Type

Overturning:	0
Other Non Collision:	0
Pedestrians:	0
Broadside:	0
Head On:	0
Rear End:	37
Sideswipe Same:	9
Sideswipe Opposite:	0
Approach Turn:	0
Overtaking Turn:	0
Parked Motor Vehicle:	1
Railway Vehicle:	0
Bicycles:	0
Domestic Animal:	0
Wild Animal:	0
Fixed Objects:	6
Other Objects:	1
Unknown:	0
Total:	**54**

Weather Conditions

None:	49
Rain:	2
Snow/Sleet/Hail:	2
Fog:	1
Dust:	0
Wind:	0
Unknown:	0
Total:	**54**

Road Conditions

Dry:	48
Wet:	2
Muddy:	0
Snowy:	1
Icy:	1
Slushy:	0
Foreign Material:	0
With Road Treatment:	2
Unknown:	0
Total:	**54**

Vehicle Types

Vehicle Types	Vehicle 1	Vehicle 2	Vehicle 3
Passenger Car/Van:	27	18	2
Passenger Car/Van w/Trailer:	0	0	0
Pickup Truck/Utility Van:	11	7	2
Pickup Truck/Utility Van w/Trailer:	0	1	0
SUV:	9	18	3
SUV w/Trailer:	0	0	0
Truck 10k lbs or Less:	0	0	0
Trucks > 10k lbs/Busses > 15 People:	2	4	0
School Bus < 15 People:	0	0	0
Non School Bus < 15 People:	0	0	0
Motorhome:	0	0	0
Motorcycle:	0	0	0
Bicycle:	0	0	0
Motorized Bicycle:	0	0	0
Farm Equipment:	0	0	0
Hit and Run - Unknown:	5	0	0
Other:	0	0	0
Unknown:	0	0	0
Total:	**54**	**48**	**7**

ADT: 79,000 **Length:** 0.83

Location: 270A | Begin: 0.00 | End: 5.99 | From:01/01/2014 | To:12/31/2018

Severity

PDO:	1113		
INJ:	320	437	:Injured
FAT:	6	6	:Killed
Total:	**1439**		

Number of Vehicles

One Vehicle:	214
Two Vehicles:	1012
Three or More:	213
Unknown:	0
Total:	**1439**

Location

On Road:	1224
Off Road:	215
Unknown:	0
Total:	**1439**

Mainline/Ramps/Frontage Rds

Mainline:	1293
Ramps:	119
Frontage/Ramp Intsx:	4
Frontage Roads:	27
HOV Lanes:	0
Unknown:	0
Total:	**1439**

Lighting Conditions

Daylight:	1048
Dawn or Dusk:	70
Dark - Lighted:	227
Dark - Unlighted:	93
Unknown:	1
Total:	**1439**

Crash Rates

PDO:	1.10 *
INJ:	0.32 *
FAT:	0.60 **
Total:	**1.43** *

* Per MVMT
** Per 100 MVMT

Crash Type

Overturning:	26
Other Non Collision:	7
Pedestrians:	3
Broadside:	8
Head On:	0
Rear End:	880
Sideswipe Same:	278
Sideswipe Opposite:	4
Approach Turn:	8
Overtaking Turn:	2
Parked Motor Vehicle:	8
Railway Vehicle:	0
Bicycles:	0
Domestic Animal:	0
Wild Animal:	0
Fixed Objects:	195
Other Objects:	20
Unknown:	0
Total:	**1439**

Weather Conditions

None:	1288
Rain:	54
Snow/Sleet/Hail:	82
Fog:	3
Dust:	1
Wind:	4
Unknown:	7
Total:	**1439**

Road Conditions

Dry:	1262
Wet:	84
Muddy:	1
Snowy:	36
Icy:	39
Slushy:	4
Foreign Material:	0
With Road Treatment:	10
Unknown:	3
Total:	**1439**

Vehicle Types

	Vehicle 1	Vehicle 2	Vehicle 3
Passenger Car/Van:	707	597	112
Passenger Car/Van w/Trailer:	1	0	0
Pickup Truck/Utility Van:	221	231	39
Pickup Truck/Utility Van w/Trailer:	7	2	1
SUV:	299	267	47
SUV w/Trailer:	4	0	0
Truck 10k lbs or Less:	0	0	0
Trucks > 10k lbs/Busses > 15 People:	95	108	7
School Bus < 15 People:	0	0	0
Non School Bus < 15 People:	0	5	0
Motorhome:	0	0	0
Motorcycle:	9	2	0
Bicycle:	0	0	0
Motorized Bicycle:	0	0	0
Farm Equipment:	0	0	0
Hit and Run - Unknown:	91	8	3
Other:	5	5	0
Unknown:	0	0	4
Total:	**1439**	**1225**	**213**

ADT: 95,625 Length: 5.77

Location: 270A **Begin:** 0.00 **End:** 5.99 **From:** 01/01/2014 **To:** 12/31/2018

Severity

PDO:	1113	
INJ:	320	437 :Injured
FAT:	6	6 :Killed
Total:	**1439**	

Number of Vehicles

One Vehicle:	214
Two Vehicles:	1012
Three or More:	213
Unknown:	0
Total:	**1439**

Location

On Road:	1224
Off Road:	215
Unknown:	0
Total:	**1439**

Mainline/Ramps/Frontage Rds

Mainline:	1293
Ramps:	119
Frontage/Ramp Intsx:	4
Frontage Roads:	27
HOV Lanes:	0
Unknown:	0
Total:	**1439**

Lighting Conditions

Daylight:	1048
Dawn or Dusk:	70
Dark - Lighted:	227
Dark - Unlighted:	93
Unknown:	1
Total:	**1439**

Crash Rates

PDO:	1.10 *
INJ:	0.32 *
FAT:	0.60 **
Total:	**1.43** *

* Per MVMT
** Per 100 MVMT

Crash Type

Overturning:	26
Other Non Collision:	7
Pedestrians:	3
Broadside:	8
Head On:	0
Rear End:	880
Sideswipe Same:	278
Sideswipe Opposite:	4
Approach Turn:	8
Overtaking Turn:	2
Parked Motor Vehicle:	8
Railway Vehicle:	0
Bicycles:	0
Domestic Animal:	0
Wild Animal:	0
Fixed Objects:	195
Other Objects:	20
Unknown:	0
Total:	**1439**

Weather Conditions

None:	1288
Rain:	54
Snow/Sleet/Hail:	82
Fog:	3
Dust:	1
Wind:	4
Unknown:	7
Total:	**1439**

Road Conditions

Dry:	1262
Wet:	84
Muddy:	1
Snowy:	36
Icy:	39
Slushy:	4
Foreign Material:	0
With Road Treatment:	10
Unknown:	3
Total:	**1439**

Vehicle Types

	Vehicle 1	Vehicle 2	Vehicle 3
Passenger Car/Van:	707	597	112
Passenger Car/Van w/Trailer:	1	0	0
Pickup Truck/Utility Van:	221	231	39
Pickup Truck/Utility Van w/Trailer:	7	2	1
SUV:	299	267	47
SUV w/Trailer:	4	0	0
Truck 10k lbs or Less:	0	0	0
Trucks > 10k lbs/Busses > 15 People:	95	108	7
School Bus < 15 People:	0	0	0
Non School Bus < 15 People:	0	5	0
Motorhome:	0	0	0
Motorcycle:	9	2	0
Bicycle:	0	0	0
Motorized Bicycle:	0	0	0
Farm Equipment:	0	0	0
Hit and Run - Unknown:	91	8	3
Other:	5	5	0
Unknown:	0	0	4
Total:	**1439**	**1225**	**213**

ADT: 95,625 **Length:** 5.77

Location: 270B **Begin:** 0.18 **End:** 1.10 **From:** 01/01/2014 **To:** 12/31/2018

Severity

PDO:	209		
INJ:	76	113	:Injured
FAT:	0	0	:Killed
Total:	**285**		

Number of Vehicles

One Vehicle:	23
Two Vehicles:	228
Three or More:	34
Unknown:	0
Total:	**285**

Location

On Road:	262
Off Road:	23
Unknown:	0
Total:	**285**

Mainline/Ramps/Frontage Rds

Mainline:	276
Ramps:	9
Frontage/Ramp Intsx:	0
Frontage Roads:	0
HOV Lanes:	0
Unknown:	0
Total:	**285**

Lighting Conditions

Daylight:	213
Dawn or Dusk:	12
Dark - Lighted:	50
Dark - Unlighted:	10
Unknown:	0
Total:	**285**

Crash Rates

PDO:	1.86 *
INJ:	0.68 *
FAT:	0.00 **
Total:	**2.53** *

* Per MVMT
** Per 100 MVMT

Crash Type

Overturning:	3
Other Non Collision:	1
Pedestrians:	0
Broadside:	1
Head On:	0
Rear End:	151
Sideswipe Same:	102
Sideswipe Opposite:	0
Approach Turn:	0
Overtaking Turn:	0
Parked Motor Vehicle:	1
Railway Vehicle:	0
Bicycles:	0
Domestic Animal:	0
Wild Animal:	0
Fixed Objects:	22
Other Objects:	4
Unknown:	0
Total:	**285**

Weather Conditions

None:	254
Rain:	9
Snow/Sleet/Hail:	21
Fog:	0
Dust:	0
Wind:	1
Unknown:	0
Total:	**285**

Road Conditions

Dry:	234
Wet:	26
Muddy:	0
Snowy:	4
Icy:	16
Slushy:	5
Foreign Material:	0
With Road Treatment:	0
Unknown:	0
Total:	**285**

Vehicle Types

	Vehicle 1	Vehicle 2	Vehicle 3
Passenger Car/Van:	108	123	10
Passenger Car/Van w/Trailer:	2	0	0
Pickup Truck/Utility Van:	52	38	7
Pickup Truck/Utility Van w/Trailer:	6	3	1
SUV:	57	72	15
SUV w/Trailer:	0	0	0
Truck 10k lbs or Less:	0	0	0
Trucks > 10k lbs/Busses > 15 People:	41	22	0
School Bus < 15 People:	0	0	0
Non School Bus < 15 People:	0	0	0
Motorhome:	0	0	0
Motorcycle:	2	1	0
Bicycle:	0	0	0
Motorized Bicycle:	0	0	0
Farm Equipment:	0	0	0
Hit and Run - Unknown:	17	1	0
Other:	0	0	0
Unknown:	0	2	1
Total:	**285**	**262**	**34**

ADT: 74,000 **Length:** 0.83

COLORADO Department of Transportation

Location: 270B **Begin:** 0.18 **End:** 1.10 **From:**01/01/2014 **To:**12/31/2018

Severity

PDO:	209		
INJ:	76	113	:Injured
FAT:	0	0	:Killed
Total:	**285**		

Number of Vehicles

One Vehicle:	23
Two Vehicles:	228
Three or More:	34
Unknown:	0
Total:	**285**

Location

On Road:	262
Off Road:	23
Unknown:	0
Total:	**285**

Mainline/Ramps/Frontage Rds

Mainline:	276
Ramps:	9
Frontage/Ramp Intsx:	0
Frontage Roads:	0
HOV Lanes:	0
Unknown:	0
Total:	**285**

Lighting Conditions

Daylight:	213
Dawn or Dusk:	12
Dark - Lighted:	50
Dark - Unlighted:	10
Unknown:	0
Total:	**285**

Crash Rates

PDO:	1.86 *
INJ:	0.68 *
FAT:	0.00 **
Total:	**2.53** *

* Per MVMT
** Per 100 MVMT

Crash Type

Overturning:	3
Other Non Collision:	1
Pedestrians:	0
Broadside:	1
Head On:	0
Rear End:	151
Sideswipe Same:	102
Sideswipe Opposite:	0
Approach Turn:	0
Overtaking Turn:	0
Parked Motor Vehicle:	1
Railway Vehicle:	0
Bicycles:	0
Domestic Animal:	0
Wild Animal:	0
Fixed Objects:	22
Other Objects:	4
Unknown:	0
Total:	**285**

Weather Conditions

None:	254
Rain:	9
Snow/Sleet/Hail:	21
Fog:	0
Dust:	0
Wind:	1
Unknown:	0
Total:	**285**

Road Conditions

Dry:	234
Wet:	26
Muddy:	0
Snowy:	4
Icy:	16
Slushy:	5
Foreign Material:	0
With Road Treatment:	0
Unknown:	0
Total:	**285**

Vehicle Types

	Vehicle 1	Vehicle 2	Vehicle 3
Passenger Car/Van:	108	123	10
Passenger Car/Van w/Trailer:	2	0	0
Pickup Truck/Utility Van:	52	38	7
Pickup Truck/Utility Van w/Trailer:	6	3	1
SUV:	57	72	15
SUV w/Trailer:	0	0	0
Truck 10k lbs or Less:	0	0	0
Trucks > 10k lbs/Busses > 15 People:	41	22	0
School Bus < 15 People:	0	0	0
Non School Bus < 15 People:	0	0	0
Motorhome:	0	0	0
Motorcycle:	2	1	0
Bicycle:	0	0	0
Motorized Bicycle:	0	0	0
Farm Equipment:	0	0	0
Hit and Run - Unknown:	17	1	0
Other:	0	0	0
Unknown:	0	2	1
Total:	**285**	**262**	**34**

ADT: 74,000 **Length:** 0.83