

Appendix H.

SAFETY ANALYSIS AND RECOMMENDATIONS REPORT



PROVIDING VALUE FIRST

Colorado Department of Transportation Planning and Environmental Linkages (PEL) Study Santa Fe Drive, I-25 to C-470

Safety Analysis and Recommendations Report Project No. STU 08 52-117

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INTRODUCTION

US Highway 85 (Santa Fe Drive) between State Highway 470 (C-470) and Interstate 25 (I-25) has high traffic volumes, which results in frequent congestion. Regional growth in the surrounding area is anticipated to continue to increase traffic demand on the corridor. The objective of the Santa Fe Drive Planning and Environmental Linkages (PEL) Study is to develop both short-term and long-term alternatives to address congestion, serve existing and future needs, improve traffic operations, travel time, multi-modal person-trip capacity, and safety.

The purpose of this Safety Analysis is to review recent crash analyses conducted by the Colorado Department of Transportation (CDOT) and further investigate segment and intersection crash trends to provide safety recommendations for inclusion in the PEL Study. The study period of CDOT safety assessment reports is typically three years. This safety analysis is intended to build off the CDOT safety assessment report for this corridor which was completed in March 2020. As such, the same crash data was used for analysis. The crash data for this report is from January 1, 2016 through December 31, 2018 on Santa Fe Drive, from MP 200.30 (C-470) to MP 210.86 (Alameda Ave).

STUDY AREA AND CORRIDOR CHARACTERISTICS

This safety analysis evaluates historical crashes on Santa Fe Drive (US 85) between MP 200.30 to MP 210.86. The study corridor is approximately 10.56 miles in length, and spans between Douglas, Arapahoe, and Denver Counties and includes the cities of Denver, Englewood, Sheridan, and Littleton. The functional classification of Santa Fe Drive is a Principal Arterial for the entire length with two access categories. From C-470 to Florida Avenue Santa Drive has an access category of Expressway, and north of Florida Avenue is has an access category of Non-Rural Principal Highway. Both are considered rolling terrain. Within the limits of the study, Santa Fe Drive ranges from a 4-lane to 8-lane roadway. Santa Fe Drive serves as a major north-south bypass route for traffic into and out of the Downtown Denver Area. The 2018 average daily traffic (ADT) on Santa Fe Drive ranges from 41,000 to 112,000 vehicles per day (VPD), with traffic volumes increasing from the south to north end. Truck traffic accounts for 5.9 to 9.3 percent of total traffic vehicles, and the posted speed limit on the corridor ranges from 45 to 55 mph. The Santa Fe Drive study corridor was divided into four segments for analysis, based on traffic volumes and roadway conditions. The segments are listed in **Table 1**. A map of the Santa Fe Drive Corridor is shown in **Figure 1**.

Table 1: Roadway Segment Characteristics

Segment	MP Start	Roadway Start	MP End	Roadway End	Number of Lanes	2018 ADT (vehicles per day)
1	210.68	North Limit	207.94	Yale Avenue	6-8*	88,000 - 112,000
2	207.94	Yale Avenue	204.60	S of Belleview Ave	6-8*	65,000 - 88,000
3	204.60	S of Belleview Ave	202.90	S of Weaver Avenue	4-6*	50,000 - 65,000
4	202.90	S of Weaver Avenue	200.30	South Limit	4	41,000 - 50,000

*Indicates a portion or all of the segment has HOV express lanes and are included in total number of lanes

Santa Fe Drive is an expressway, consisting of primarily at-grade intersections and several access-controlled interchanges. The roadway network in the vicinity of the study corridor was largely developed around the adjacent Union Pacific Railroad tracks and South Platte River. The Santa Fe Drive study corridor includes 4 grade-separated traffic interchanges and 31 at-grade intersections. Of the at-grade intersections, 14 are controlled by traffic signals and 17 operate under minor-street stop or yield control. A summary of the

intersecting roadways and traffic control at each intersection is provided in **Table 2**. In addition to the 35 intersections and interchanges, there are approximately 30 driveway access points along the corridor. The access density of each segment is summarized in **Table 3**. The greatest density of intersection and driveways exists along Segment 3.

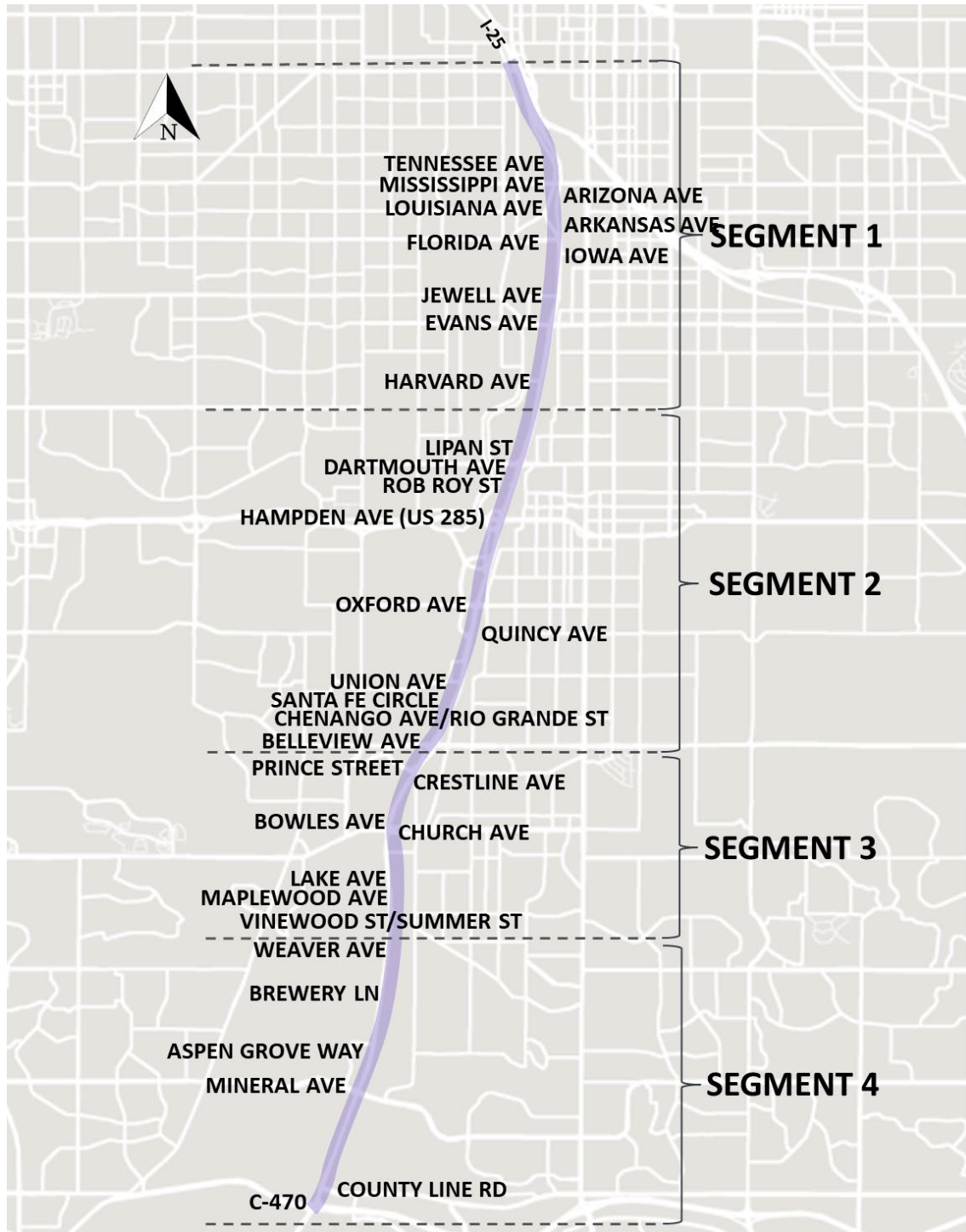


Figure 1: Study Corridor Map

Table 2: Intersecting Roadways and Traffic Interchanges

Intersecting Roadway	Access Control	Intersection Geometry
I-25 Interchange	Traffic Interchange	N/A
Tennessee Avenue	Minor-Street Stop	Three-Leg (West Leg)
Mississippi Avenue	Divided Traffic Signals	Four-Leg
Arizona Avenue	Minor-Street Stop	Three-Leg (East Leg)
Louisiana Ave	Minor-Street Stop	Three-Leg (East Leg)
South Platte River Drive	Minor-Street Stop	Three-Leg (West Leg)
Arkansas Avenue	Minor-Street Stop	Three-Leg (East Leg)
Florida Avenue	Traffic Signal	Four-Leg
Iowa Avenue	Traffic Signal	Three-Leg (East Leg)
Cherokee Street	Minor-Street Stop	Three-Leg (East Leg)
Jewell Avenue	Minor-Street Stop	Three-Leg (West Leg)
Evans Avenue	Traffic Interchange	N/A
Harvard Avenue	Minor-Street Stop	Three-Leg (West Leg)
Lipan Street	Minor-Street Yield	Three-Leg (West Leg)
Dartmouth Avenue	Traffic Signal	Four-Leg
Rob Roy Street	Minor-Street Yield	Three-Leg (West Leg)
Hampden Avenue (US 285)	Traffic Interchange (Traffic Signals on Santa Fe)	Three-leg (West Legs)
Oxford Avenue	Traffic Signal	Four-Leg
Quincy Avenue	Minor-Street Stop	Three-Leg (West Leg)
Union Avenue	Traffic Signal	Three-Leg (West Leg)
Santa Fe Circle	Minor-Street Stop	Three-Leg (West Leg)
Chenango Avenue/Rio Grande Street	Minor-Street Stop/Merge	Four-Leg
Bellevue Avenue (SH-88)	Traffic Interchange	N/A
Prince Street	Traffic Signal	Four-Leg
Crestline Avenue	Minor-Street Yield	Three-Leg (East Leg)
Bowles Avenue	Traffic Signal	Four-Leg
Church Avenue	Traffic Signal	Four-Leg
Lake Avenue	Minor-Street Stop	Three-Leg (West Leg)
Maplewood Avenue	Minor-Street Stop	Three-Leg (West Leg)
Vinewood Street/Sumner Street	Traffic Signal	Four-Leg
Weaver Avenue	Minor-Street Yield	Three-Leg (West Leg)
Brewery Lane	Traffic Signal	Three-Leg (West Leg)
Aspen Grove Way	Traffic Signal	Three-Leg (West Leg)
Mineral Avenue	Traffic Signal	Four-Leg
County Line Road	Traffic Signal	Four-Leg
C-470	Traffic Interchange	N/A

Table 3: Roadway Segment Access Density

Segment	Length (mi)	Intersection Count	Driveway Count	Intersections per Mile	Intersections and Driveways per Mile
1	2.74	11	6	4.0	6.2
2	3.34	10	2	3.0	3.6
3	1.70	8	9	4.7	10.0
4	2.60	5	13	1.9	6.9

REVIEW OF CDOT SAFETY ASSESSMENT REPORT

The CDOT Safety Assessment Report (2020) summarizes the 2,282 crashes that occurred on the study corridor from January 1, 2016 to December 31, 2018. Results of the corridor analysis were summarized by crash severity, crash type, and by intersection. The number of crashes per year were generally consistent through the three-year period. As shown in **Figure 2**, 80% of crashes resulted in property damage only, 20% were injury crashes, and less than 1% were fatal crashes.

Year	PDO	Injury	Fatal	Total
2016	646	143	4	793
2017	582	150	1	733
2018	592	159	5	756
Total	1,820	452	10	2,282

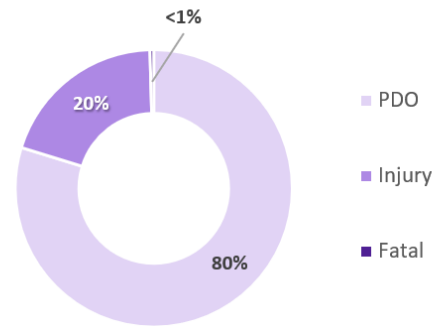


Figure 2: Crash Injury Severity, 2016 to 2018

The CDOT Safety Assessment Report identified rear end collisions as the most common crash type, accounting for 56.5% of all crashes reported during the study period. Other common crash types include same direction sideswipe crashes (19.5%) and fixed object crashes (7.5%). The reported crash types are shown in **Figure 3**.

Both rear end crashes and sideswipe crashes on Santa Fe Drive are above the published CDOT 2016 Baseline Normatives which are 48.9% and 9.5%, respectively.

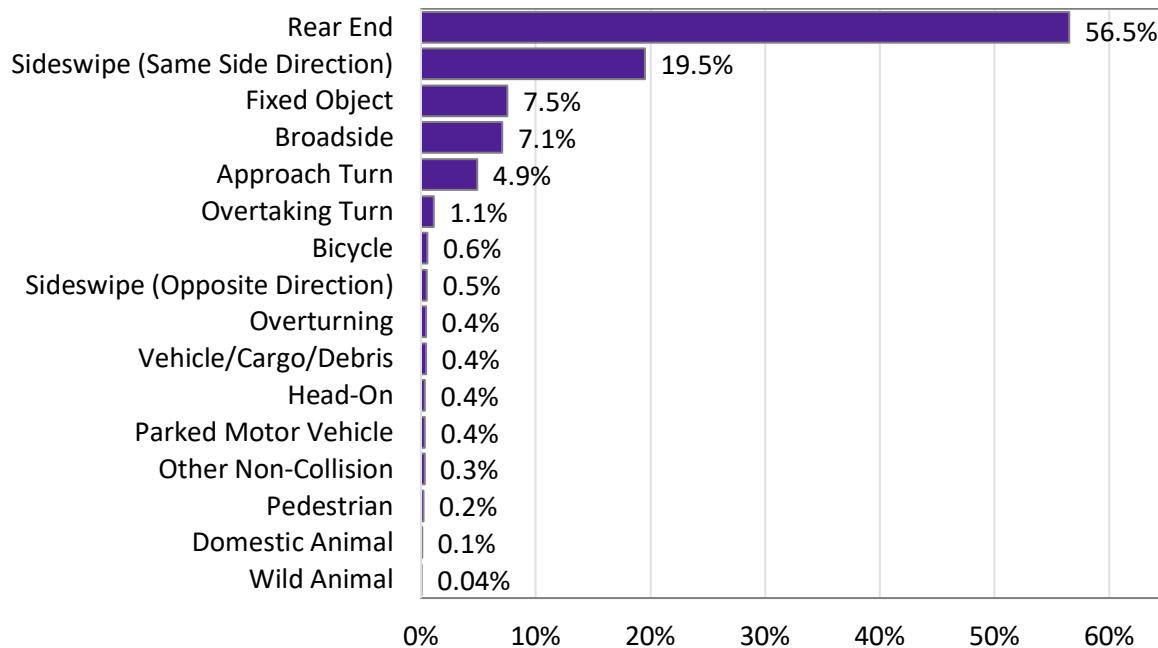


Figure 3: Crashes by Crash Type, 2016 to 2018

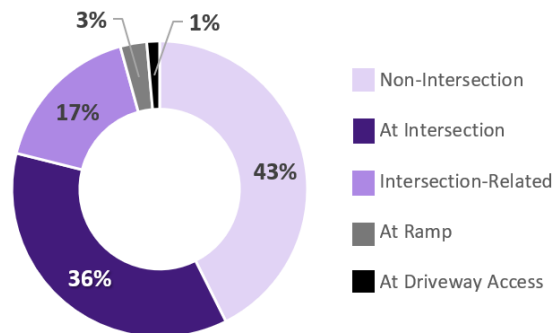
There were 172 fixed-object crashes during the three-year analysis period. Of the fixed object crashes, the most common objects struck include curbs/raised medians, guardrail, light/utility poles, concrete barriers, and signs. The CDOT Safety Assessment Report categorized crashes by location, in terms of non-intersection crashes, intersection crashes, and driveway crashes. The number of crashes associated with each intersection were identified, and the Level of Service of Safety (LOSS) was determined where intersecting roadway traffic volumes were available. Safety recommendations were provided at the intersections with LOSS III or IV, which indicate a greater potential for safety improvements.

SAFETY ANALYSIS

This report is intended to build on the 2020 CDOT Safety Assessment Report to further identify crash trends, spatial clustering, and additional safety recommendations for consideration in the Santa Fe Drive Planning and Environmental Linkages Study. Of the 2,282 crashes that were reported during the three-year period, 43% of crashes occurred at non-intersection locations, 53% of crashes occurred at or near intersections, 3% of crashes occurred at interchange ramps, and 1% of crashes occurred at driveway access points (Table 4). This study evaluates crashes from a corridor perspective and analyzes intersection crashes in greater detail to identify localized crash patterns and trends. The following crash analysis findings were used in the development of improvement recommendations.

Table 4: Corridor Crashes by Location

Crash Location	Crashes	
Non-Intersection	972	42.6%
At Intersection	829	36.3%
Intersection-Related	384	16.8%
At Ramp	66	2.9%
At Driveway Access	31	1.4%
Total	2,282	100.0%



CDOT SAFETY PERFORMANCE FUNCTIONS

CDOT has developed Safety Performance Function (SPF) models, which serve as a predictive tool for the frequency, severity, and manner of collision for various roadway and intersection types. The models are based on historical crash data collected on Colorado roadways. The following SPF models have been developed by CDOT:

Roadway Segments:

- Rural Flat & Rolling 2-Lane Highway
- Rural Mountainous 2-Lane Highway
- Rural Flat & Rolling 3-Lane Highway
- Rural Mountainous 3-Lane Highway
- Rural Flat & Rolling 4-Lane Divided Freeway
- Rural Flat & Rolling 4-Lane Divided Highway
- Rural Mountainous 4-Lane Divided Freeway
- Rural Mountainous 4-Lane Divided Highway
- Rural Mountainous 6-Lane Divided Highway
- Urban 4-Lane Divided Freeway
- Urban 6-Lane Divided Freeway
- Urban 8-Lane Divided Freeway

Intersections:

- Urban 2-Lane Divided Unsignalized 3-Leg Intersection
- Urban 2-Lane Undivided Unsignalized 3-Leg Intersection
- Urban 2-Lane Undivided Unsignalized 4-Leg Intersection
- Urban 4-Lane Divided Signalized 3-Leg Intersection
- Urban 4-Lane Divided Signalized 4-Leg Intersection
- Urban 4-Lane Divided Unsignalized 3-Leg Intersection
- Urban 4-Lane Divided Unsignalized 4-Leg Intersection
- Urban 4-Lane Undivided Unsignalized 4-Leg Intersection
- Urban 6-Lane Divided Signalized 4-Leg Intersection

The SPF models supported the development of Normative Baselines and LOSS scores for each of the roadway segment/intersection types. The LOSS score is calculated based on the daily vehicle exposure (traffic volumes), intersection/roadway configuration, traffic control, and crash history. The resulting LOSS score is based on the average crash conditions on other facilities that have been classified by CDOT under the same intersection or roadway segment type. The four LOSS groups include:

- LOSS I – Below 20th Percentile (low potential for crash reduction)
- LOSS II – 20th Percentile to Mean (low to moderate potential for crash reduction)
- LOSS III – Mean to 80th Percentile (moderate to high potential for crash reduction)
- LOSS IV – Above 80th Percentile – (high potential for crash reduction)

Two LOSS scores can be calculated for each intersection or roadway facility evaluated; one based on the overall number of crashes and a second based on the frequency of injury and fatal crashes. A score of LOSS I or II indicates a lower potential for crash reduction (less frequent/less severe crashes than the average for the facility classification), and LOSS III or LOSS IV indicates a greater potential for crash reduction (more frequent/more severe crashes than the average for the facility classification). The relative safety of various intersection and roadway types can be compared using the LOSS concept, as it normalizes the factor variations of traffic volume, traffic control, intersection/roadway configuration, and crash history.

Normative Baselines were developed to provide typical crash attributes for each intersection and roadway segment model type. Historical crashes on each facility type were reviewed to develop the typical attributes. The Normative Baselines summarize the crashes by severity, number of vehicles involved, the crash location, crash type, lighting condition, weather condition, road surface condition, and the contributing factors of the driver.

LOSS and Normative Baselines are both valuable tools in identifying crash patterns that are occurring more frequently than typical, comparable facilities. These tools are discussed subsequently in this report in the segment and intersection analyses.

SEGMENT CRASH ANALYSIS

Crashes were analyzed based on the segments identified in **Table 1**. Crashes are clustered along intersecting roadways and interchanges along the corridor. A spatial heat map of the crashes is shown in **Figure 4**. The spatial heat map displays high frequency crash areas along the corridor using color variations. The line graph below the heat map mirrors the corridor alignment and charts crash frequencies by mile marker. Spikes along the graph correlate with crashes that occurred at intersections. The heat map was used to identify high frequency segments along the corridor. Heat mapping is an effective tool to identify segments based on natural breaks in crash frequency. High frequency intersections are identified in future sections of this report. Based on analysis from the heat map, high frequency segments along the corridor include Mississippi Avenue to Iowa Avenue, Harvard Avenue to Hampden Avenue, Union Avenue to Prince Street, and Bowles Avenue to Vinewood Street. These segments exhibit a higher concentration of crashes when compared to the rest of the corridor.

Congestion maps were analyzed to determine if a relationship can be established between congestion along the corridor and crash frequency. A comparison between congestion maps and the crash frequency map is shown in **Figure 5**. Congestion scans indicate that congestion primarily occurs at the northern and southern ends of the corridor. Of the four identified high frequency segments, the crash frequency from Mississippi Avenue to Iowa Avenue and Bowles Avenue to Vinewood Street may be related to congestion. The high crash frequency from Harvard Avenue to Hampden Avenue and Union Avenue to Prince Street appears to be unrelated to congestion along the corridor.

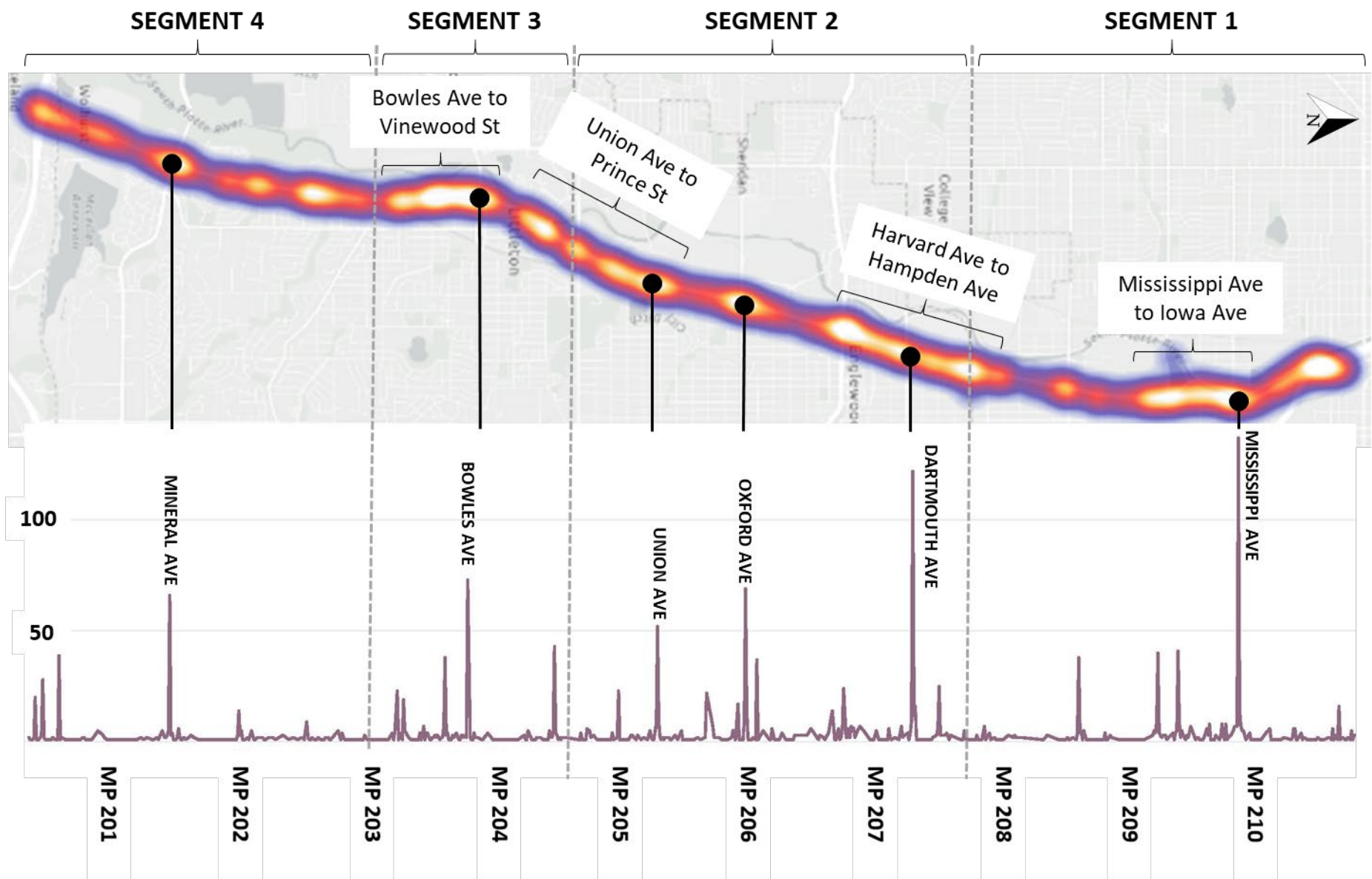


Figure 4: Corridor Crash Frequency Map

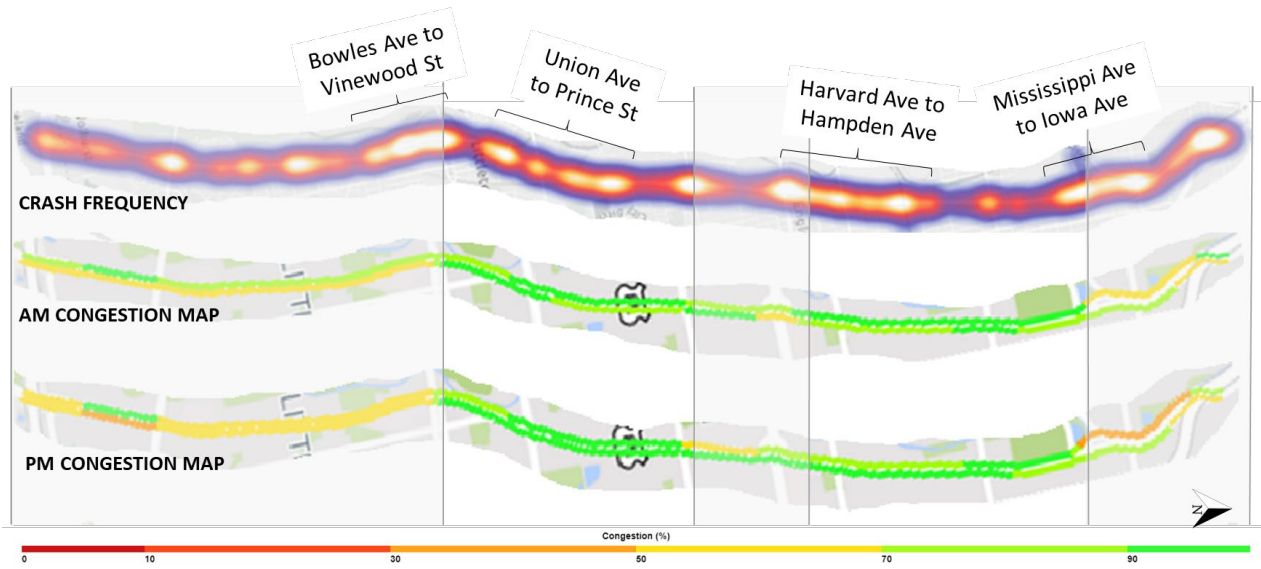


Figure 5: Crash Frequency Compared to Congestion

A spatial heat map of crashes along the corridor that resulted in an injury or fatality is shown in **Figure 6**. High injury hot spots are identified on the figure and concentrated around major intersections.



Figure 6: Corridor Injury Crash Frequency Map

SEGMENT CRASH RATES

Segment crash rates were determined using the historical traffic volumes retrieved from the CDOT Online Transportation Information System. The segment crash rates were calculated using the following FHWA Methodology:

$$R = \frac{1,000,000 \times C}{365 \times N \times V \times L}$$

Where:

R = Crash rate for the roadway segment expressed as crashes per million vehicle-miles of travel (MVMT)

C = Total number of crashes within the study period

N = Number of years of data

V = Number of vehicles per day (both directions)

L = Length of the roadway segment in miles

Crash rates were developed for each segment of the corridor, which include crashes that occurred at intersections and driveways along the segment. Crash rates were calculated as a weighted average of the three-year study period, as well as for each individual year (**Table 5**). After normalizing the data based on the frequency of crashes using traffic volume and segment length, it was determined that Segment 3 has the highest crash rate, with 3.65 crashes per MVMT. The higher crash rate on Segment 3 is attributed to the higher frequency of intersection and driveway density, as documented in **Table 3**. The lowest crash rate was observed in Segment 1, with 2.27 crashes per MVMT. The lower crash rates on Segment 1 are attributed to the low frequency of median openings and one-way pair traffic operation north of Florida Avenue, where northbound and southbound lanes are separated by the South Platte River.

Table 5: Segment Crash Rates, 2016 to 2018

Segment	Length (mi)	Crashes				AADT ¹			Crash Rate ²			
		2016	2017	2018	Total	2016	2017	2018	2016	2017	2018	3-Year Average
1	2.74	248	202	207	657	95,500	96,500	97,000	2.60	2.09	2.13	2.27
2	3.34	296	270	281	847	78,000	80,000	78,000	3.11	2.77	2.96	2.94
3	1.70	143	126	127	396	59,000	59,000	57,000	3.91	3.44	3.59	3.65
4	2.60	106	135	141	382	47,000	49,000	46,500	2.38	2.90	3.20	2.82
Total	10.38	793	733	756	2,282							

¹ The AADT represents the average daily traffic volumes recorded on multiple subsegments from the CDOT traffic database.

² The crash rates were calculated in terms of million vehicle-miles of travel (MVM).

Santa Fe Drive is classified as a Principal Arterial. In previous years, CDOT has published average crash rate information for various roadway types. The most recent publication was in 2012. The crash rates calculated on the Santa Fe Drive segments are compared to the average segment crash rates for Expressways and Principal Arterials in **Table 6**. In general, there are higher segment crash rates on arterials compared to expressway facilities, due to the greater density of access points.

The overall crash rates on the Santa Fe Drive segments are more closely related to the CDOT crash rates for Principal Arterials. All segments had a crash rate greater than that of a typical expressway facility. All segments had a greater crash rate than the typical Principal Arterial as well, except for Segment 1. Other findings in terms of crash severity include:

- PDO crashes occurred more frequently on Segment 3 compared to typical Principal Arterials,
- Injury crashes were more frequent on all segments compared to typical Principal Arterials, and
- Fatal crashes occurred more frequently on Segment 1 compared to typical Principal Arterials.

Table 6: Santa Fe Drive Crash Rate Comparison to CDOT Expressways and Principal Arterials

Segment	Miles	ADT	MVMT	PDO		Injury		Fatal		Total	
				#	Rate	#	Rate	#	Rate	#	Rate
CDOT Expressways	332	36,524	4,426	6,518	1.47	632	0.14	32	0.007	7,182	1.62
CDOT Principal Arterials	2,883	7,978	8,395	20,752	2.47	2,302	0.27	116	0.014	23,170	2.76
Santa Fe Dr Segment #1	2.74	96,333	289	519	1.80	131	0.45	7	0.024	657	2.27
Santa Fe Dr Segment #2	3.34	78,667	288	689	2.39	156	0.54	2	0.007	847	2.94
Santa Fe Dr Segment #3	1.70	58,333	109	322	2.97	74	0.68	0	0.000	396	3.65
Santa Fe Dr Segment #4	2.60	47,500	135	290	2.14	91	0.67	1	0.007	382	2.82

Note: The CDOT Expressway and Principal Arterial average crash rates are based on reported crashes in 2012.

Note: The Santa Fe Drive segment crash rates are based on reported crashes during the three-year analysis period from 2016 to 2018.

ANNUAL COST OF CRASHES BY SEGMENT

Crash costs are used to quantify the economic impact of crashes and can provide justification for safety improvement projects. Costs are developed based on crash severity and crash frequency. Higher severity crashes are associated with higher costs. Crash costs and calculation methodologies have been adopted on a state-by-state basis; the crash costs adopted by the Colorado Department of Transportation are shown in **Table 7**.

Table 7: Colorado Crash Costs

Crash Severity	Economic Crash Unit Cost
Fatal	\$1,766,400
Injury	\$98,900
Property Damage Only	\$10,700

Colorado uses economic person-injury unit costs from the National Safety Council’s (NSC) report on *Estimating the Costs of Unintentional Injuries*. These costs include wage and productivity losses, medical expenses, administrative expenses, motor vehicle damage, and employers’ uninsured costs. These costs are adopted in the Colorado Highway Safety Improvement Program and are used in benefit to cost ratio assessments for improvement projects. The annual cost of segment crashes on the study corridor are listed in **Table 8**. Although Segment 3 was identified to have the highest crash rate (**Table 5**), a greater proportion of injury and fatal crashes per mile occurred in Segment 1.

Table 8: Annual Crash Costs by Segment

Segment	Length (mi)	Crash Severity, 2016 to 2018				Annual Cost of Crashes	
		PDO	Injury	Fatal	Total	Entire Segment	Per Mile
1	2.74	519	131	7	657	\$ 10,291,333	\$ 3,755,961
2	3.34	689	156	2	847	\$ 8,777,833	\$ 2,628,094
3	1.70	322	74	0	396	\$ 3,588,000	\$ 2,110,588
4	2.60	290	91	1	382	\$ 4,623,100	\$ 1,778,115
Total	10.38	1,820	452	10	2,282		

FATAL CRASHES

Ten fatal crashes were reported along the Santa Fe Drive Corridor during the three-year analysis period from 2016 to 2018. Of the 10 fatal crashes, 7 occurred in Segment 1, 2 occurred in Segment 2, and 1 occurred in Segment 4. The locations of the fatal crashes are shown in **Figure 5**, and the characteristics of the crashes are provided in **Table 9**. Four crashes involved two motor vehicles, four were single-vehicle crashes, and two crashes involved a pedestrian or bicyclist.



Figure 7: Map of Fatal Crash Locations

Table 9: Fatal Crash Characteristics, 2016 to 2018

	Date	Time	Nearest Intersection	Crash Type	Notes
1	3/9/2018	7:00 PM	Santa Fe Drive/ Tennessee Drive	Rear End	The crash involved two southbound vehicles. The following vehicle was preoccupied at the time of the crash.
2	2/21/2016	2:31 AM	Santa Fe Drive/ Mississippi Avenue	Overtuning	The crash involved one southbound vehicle, which resulted in overturning. The cause of the overturning is unknown.
3	10/25/2016	1:48 AM	Santa Fe Drive/ Mississippi Avenue	Fixed Object	The crash involved one northbound vehicle that struck a traffic signal pole at Mississippi Avenue.
4	10/6/2018	9:02 PM	Santa Fe Drive/ Iowa Avenue	Pedestrian	This crash was a hit-and-run collision involving a southbound through vehicle and a pedestrian. The pedestrian was indicated to have been intoxicated at the time of the collision, and the specific pedestrian action is unknown.
5	6/9/2018	11:34 AM	Santa Fe Drive/ Evans Avenue	Bicycle	This crash involved a southbound vehicle and a bicycle crossing Santa Fe Drive from west to east.
6	9/4/2018	12:06 PM	Santa Fe Drive/ Evans Avenue	Fixed Object	This crash involved one northbound vehicle that struck a light/utility pole.
7	11/24/2018	2:46 AM	Santa Fe Drive/ Harvard Avenue	Opposite Direction Sideswipe	This crash involved a wrong way driver colliding with a northbound vehicle. The wrong way driver was intoxicated at the time of the crash.
8	5/9/2016	1:55 PM	Santa Fe Drive/ Dartmouth Avenue	Same Direction Sideswipe	This crash involved two southbound motorists; a motorcycle collided with a bus as it attempted to pass.
9	3/29/2017	8:11 AM	Santa Fe Drive/ Dartmouth Avenue	Same Direction Sideswipe	This crash involved two northbound vehicles, one of which was changing lanes.
10	3/12/2016	12:18 PM	Santa Fe Drive/ Mineral Avenue	Overtuning	This crash involved a single vehicle (motorcycle), that was making a northbound to westbound left-turn.

CRASHES INVOLVING VULNERABLE USERS

During the three-year analysis period, 5 pedestrian-related, 13 bicycle-related crashes, and 28 motorcycle related crashes were reported along the study corridor. The majority of crashes occurred at intersections or interchange ramps. Although vulnerable user crash data does not capture “near misses”, the location of these crashes provides insight into where mitigation measures should be implemented to reduce pedestrian, bicycle and motorcycle related conflicts. Crash locations are summarized in **Table 10**. There were a total of 4 fatal injury crashes, 25 injury crashes, and 17 crashes resulting in property damage only (**Table 11**). The fatal pedestrian-related crash occurred at near Iowa Avenue in October 2018, and the fatal bicycle-related crash occurred at Evans Avenue in June 2018. The two fatal motorcycle crashes occurred at Mineral Avenue in March 2016 and Dartmouth Avenue in May 2016.

Table 10: Pedestrian and Bicycle Crash Locations, 2016 to 2018

Location	Pedestrian-Related Crashes	Bicycle-Related Crashes	Motorcycle Crashes	Total
Mississippi Avenue	2	3	1	6
Evans Avenue	1	2	1	4
Dartmouth Avenue	0	2	2	4
Mineral Avenue	0	0	3	3
Hampden Avenue	0	1	1	2
Iowa Avenue	1	1	0	2
Union Avenue	0	0	2	2
Prince Street	0	0	2	2
Florida Avenue	0	1	1	2
Lipan Street	0	0	1	1
Bates Avenue	0	0	1	1
Church Avenue	0	0	1	1
Platte River Drive	0	0	1	1
Aspen Grove Way	0	0	1	1
Belleview Avenue	0	0	1	1
Brewery Lane	0	0	1	1
Bowles Avenue	0	1	0	1
Other Non-Intersection Locations	1	2	8	11
Total	5	13	28	46

Table 11: Pedestrian and Bicycle Crash Severity, 2016-2018

Crash Severity	Pedestrian-Related Crashes	Bicycle-Related Crashes	Motorcycle Crashes	Total
Property Damage Only	1	8	8	17
Injury	3	4	18	25
Fatal	1	1	2	4
Total	5	13	28	46

SEGMENT ANALYSIS BASED ON CDOT SAFETY PERFORMANCE FUNCTIONS

Santa Fe Drive is classified as a Principal Arterial, with primarily at-grade intersections and several grade-separated traffic interchanges. The most closely related SPF for the Santa Fe Corridor are the Urban 4/6/8-Lane Divided Freeway models; however, these models are not considered to be comparable for evaluation. The crash patterns vary between freeways and expressways, due to the differences in access control. The LOSS and Normative Baseline evaluations were not performed because a comparable SPF is not available.

INTERSECTION CRASH ANALYSIS

Crashes that occurred near intersections were further evaluated to identify closer crash trends. **Table 12** summarizes the number of crashes and crash severity at each intersection or interchange. The data shown in the table represents crashes that were coded as “At Intersection”, “Intersection-Related” and “Ramp”. The crashes not depicted in the table are located at non-intersection locations or driveway access points.

Table 12: Crashes by Intersection, 2016 to 2018

Intersecting Roadway	Access Control	PDO	Injury	Fatal	Total
I-25 Interchange	Traffic Interchange	41	14		55
Tennessee Avenue	Minor-Street Stop	2	1		3
Mississippi Avenue	Traffic Signal	112	28	1	141
Arizona Avenue	Minor-Street Stop	6	1		7
Louisiana Ave	Minor-Street Stop	3			3
Arkansas Avenue	Minor-Street Stop	1			1
Florida Avenue	Traffic Signal	38	10		48
Iowa Avenue	Traffic Signal	32	16		48
Jewell Avenue	Minor-Street Stop	2			2
Evans Avenue	Traffic Interchange	35	4	1	40
Harvard Avenue	Minor-Street Stop	2			2
Lipan Street	Minor-Street Yield	20	1		21
Dartmouth Avenue	Traffic Signal	121	22	1	144
Rob Roy Street	Minor-Street Yield	2	1		3
Hampden Avenue (US 285)	Traffic Interchange	50	15		65
Oxford Avenue	Traffic Signal	62	17		79
Quincy Avenue	Minor-Street Stop	9	5		14
Union Avenue	Traffic Signal	48	13		61
Santa Fe Circle	Minor-Street Stop	13	9		22
Chenango Avenue/Rio Grande Street	Minor-Street Stop/Merge	13	9		22
Bellevue Avenue (SH-88)	Traffic Interchange	22	5		27
Prince Street	Traffic Signal	44	10		54
Crestline Avenue	Minor-Street Yield	5	2		7
Bowles Avenue	Traffic Signal	66	14		80
Church Avenue	Traffic Signal	46	4		50
Lake Avenue	Minor-Street Stop	4	4		8
Maplewood Avenue	Minor-Street Stop	14	6		20
Vinewood Street/Sumner Street	Traffic Signal	26	3		29
Weaver Avenue	Minor-Street Yield	1	3		4
Brewery Lane	Traffic Signal	13	2		15
Aspen Grove Way	Traffic Signal	18	4		22
Mineral Avenue	Traffic Signal	68	10	1	79
County Line Road	Traffic Signal	32	10		42
C-470	Traffic Interchange	38	22		60
Total		1,009	265	4	1,278

The intersections with the greatest number reported crashes are Santa Fe Drive and Dartmouth Avenue (144 crashes), Mississippi Avenue (141 crashes), Bowles Avenue (80 crashes), Mineral Avenue (79 crashes), and Oxford Avenue (79 crashes).

ANNUAL COST OF CRASHES BY INTERSECTION

The annual cost of crashes was calculated based on the crash severity and frequency at each intersection. The methodology described previously in the report for segments and the crash costs provided in **Table 7** were applied. The annual cost of crashes by intersection is shown in **Table 13**.

Table 13: Annual Cost of Crashes by Intersection, 2016 to 2018

Intersecting Roadway	PDO	Injury	Fatal	Total	Annual Cost of Crashes
Mississippi Avenue	112	28	1	141	\$ 1,911,333
Dartmouth Avenue	121	22	1	144	\$ 1,745,633
Mineral Avenue	68	10	1	79	\$ 1,161,000
C-470	38	22		60	\$ 860,800
Evans Avenue	35	4	1	40	\$ 845,500
Oxford Avenue	62	17		79	\$ 781,567
Bowles Avenue	66	14		80	\$ 696,933
Hampden Avenue (US 285)	50	15		65	\$ 672,833
Iowa Avenue	32	16		48	\$ 641,600
I-25 Interchange	41	14		55	\$ 607,767
Union Avenue	48	13		61	\$ 599,767
Prince Street	44	10		54	\$ 486,600
Florida Avenue	38	10		48	\$ 465,200
County Line Road	32	10		42	\$ 443,800
Chenango Avenue/Rio Grande Street	13	9		22	\$ 343,067
Santa Fe Circle	13	9		22	\$ 343,067
Church Avenue	46	4		50	\$ 295,933
Maplewood Avenue	14	6		20	\$ 247,733
Bellevue Avenue (SH-88)	22	5		27	\$ 243,300
Quincy Avenue	9	5		14	\$ 196,933
Aspen Grove Way	18	4		22	\$ 196,067
Vinewood Street/Sumner Street	26	3		29	\$ 191,633
Lake Avenue	4	4		8	\$ 146,133
Brewery Lane	13	2		15	\$ 112,300
Lipan Street	20	1		21	\$ 104,300
Weaver Avenue	1	3		4	\$ 102,467
Crestline Avenue	5	2		7	\$ 83,767
Arizona Avenue	6	1		7	\$ 54,367
Rob Roy Street	2	1		3	\$ 40,100
Tennessee Avenue	2	1		3	\$ 40,100
Louisiana Ave	3			3	\$ 10,700
Harvard Avenue	2			2	\$ 7,133
Jewell Avenue	2			2	\$ 7,133
Arkansas Avenue	1			1	\$ 3,567
Total	1,009	265	4	1,278	\$ 14,690,133

INTERSECTION CRASH RATES

Incorporating vehicle exposure data provides a valuable comparison of crash characteristics between intersections. This process is used to identify locations with a high ratio of crashes to traffic exposure, which can occur at intersections of any size. The intersection crash rates were calculated using the following FHWA Methodology:

$$R = \frac{1,000,000 \times C}{365 \times N \times V}$$

Where:

R = Crash rate for the intersection expressed as crashes per million entering vehicles (MEV)

C = Total number of crashes within the study period

N = Number of years of data

V = Traffic volume entering the intersection daily

Crash rates were calculated for 18 of the study intersections, as traffic volumes are not available for all intersecting roadways. The calculated crash rates for signalized and unsignalized intersections are provided in **Table 15** and **Table 16**, respectively.

LEVEL OF SERVICE OF SAFETY ANALYSIS

The LOSS was calculated for all intersections along the study corridor with known traffic volumes and a comparable CDOT SPF. The intersections evaluated are listed in **Table 14**.

Table 14: Intersection for Level of Service of Safety Analysis

Intersection	Comparable CDOT SPF
Santa Fe Drive/Dartmouth Avenue	Urban 6-Lane Divided Signalized 4-Leg Intersection
Santa Fe Drive/Oxford Avenue	Urban 6-Lane Divided Signalized 4-Leg Intersection
Santa Fe Drive/Prince Avenue	Urban 6-Lane Divided Signalized 4-Leg Intersection
Santa Fe Drive/Bowles Avenue	Urban 4-Lane Divided Signalized 4-Leg Intersection
Santa Fe Drive/Church Avenue	Urban 4-Lane Divided Signalized 4-Leg Intersection
Santa Fe Drive/Lake Avenue	Urban 4-Lane Divided Unsignalized 3-Leg Intersection
Santa Fe Drive/Maplewood Avenue	Urban 4-Lane Divided Unsignalized 3-Leg Intersection
Santa Fe Drive/Aspen Grove Way	Urban 4-Lane Divided Signalized 3-Leg Intersection
Santa Fe Drive/Mineral Avenue	Urban 4-Lane Divided Signalized 4-Leg Intersection
Santa Fe Drive/County Line Road	Urban 4-Lane Divided Signalized 4-Leg Intersection

The resulting LOSS scores are shown in **Table 15** and **Table 16**, respectively. Based on the level of traffic exposure and crash history, only one intersection, Maple Avenue, resulted in a LOSS score greater than LOS II. The expected crash rates were calculated based on CDOT SPFs. Table values of N/A indicate that a SPF model was not available for the respective intersection geometry.

Maplewood Avenue is a three-leg, full-access, unsignalized intersection within Segment 3 of the corridor. Maplewood Avenue provides access to a gas station and car wash center, the Hudson Gardens and Event Center, and several residential properties. Maplewood Avenue has an average traffic volume of approximately 5,600 vehicles per day (based on recent counts included in the CDOT Safety Assessment Report). The most common crash types at Santa Fe Drive/Maplewood Avenue are approach turn crashes (55%) and broadside crashes (30%). Nearly all crashes involve a northbound left-turn and southbound through vehicle.

Table 15: Crash Rates of Signalized Intersections, 2016 to 2018

Intersecting Roadway	Average Daily Traffic		PDO Injury Fatal Total				Observed Crash Rate	Expected Crash Rate	LOSS	
	Santa Fe Drive	Intersecting Roadway							All	Fat + Inj
Dartmouth Avenue	85,000	21,000	121	22	1	144	1.24	1.26	II	I
Mississippi Avenue	100,000	21,600	112	28	1	141	1.06	N/A	N/A	
Evans Avenue	6,100*	31,000	35	4	1	40	0.98	N/A	N/A	
Mineral Avenue	49,963	26,000	68	10	1	79	0.95	0.96	II	I
Bowles Avenue	56,025	36,700	66	14	0	80	0.79	0.81	II	I
Oxford Avenue	76,334	17,346	62	17	0	79	0.77	0.81	II	II
Union Avenue	70,900	7,090	48	13	0	61	0.71	N/A	N/A	
Church Avenue	56,025	9,838	46	4	0	50	0.69	0.71	II	I
County Line Road	40,828	14,500	32	10	0	42	0.69	0.73	II	II
Prince Street	65,472	9,000	44	10	0	54	0.66	0.69	II	I
Florida Avenue	105,000	9,000	38	10	0	48	0.38	N/A	N/A	
Iowa Avenue	111,700	7,700	32	16	0	48	0.37	N/A	N/A	
Aspen Grove Way	54,000	8,000	18	4	0	22	0.32	0.34	II	II

*Note: The Santa Fe Drive average daily traffic volumes at Evans Avenue represent the total northbound and southbound ramp volumes.

Table 16: Crash Rates of Unsignalized Intersections, 2016 to 2018

Intersecting Roadway	Average Daily Traffic		PDO Injury Fatal Total				Observed Crash Rate	Expected Crash Rate	LOSS	
	Santa Fe Drive	Intersecting Roadway							All	Fat + Inj
Lipan Street	41,200	4,120	20	1	0	21	0.42	N/A	N/A	
Quincy Avenue	36,080	3,600	9	5	0	14	0.32	N/A	N/A	
Maplewood Avenue	56,025	5,600	14	6	0	20	0.30	0.29	III	III
Chenango Avenue/ Rio Grande Street	70,911	3,000	13	9	0	22	0.27	N/A	N/A	
Lake Avenue	56,025	5,600	4	4	0	8	0.12	0.13	II	II

NORMATIVE BASELINE ANALYSIS

Intersections were included in the Normative Baseline analysis if a comparative SPF model was available and if there was an adequate sample size of crashes. An intersection was considered to have an adequate sample size if 45 crashes had occurred during the three-year period (15 crashes per year). Applying a sample size threshold avoids regression to the mean bias of small samples. The intersections evaluated are listed in **Table 17**.

Table 17: Intersections for Normative Baseline Analysis

Intersection	Comparable CDOT SPF Model
Santa Fe Drive/Dartmouth Avenue	Urban 6-Lane Signalized 4-Leg Intersection
Santa Fe Drive/Oxford Avenue	Urban 6-Lane Signalized 4-Leg Intersection
Santa Fe Drive/Union Avenue	Urban 6-Lane Divided Signalized 3-Leg Intersection
Santa Fe Drive/Prince Avenue	Urban 6-Lane Signalized 4-Leg Intersection
Santa Fe Drive/Bowles Avenue	Urban 4-Lane Signalized 4-Leg Intersection
Santa Fe Drive/Church Avenue	Urban 4-Lane Signalized 4-Leg Intersection
Santa Fe Drive/Mineral Avenue	Urban 4-Lane Signalized 4-Leg Intersection

Each intersection was compared to the associated Normative Baseline; the analysis is detailed in **Attachment A**. Instances where the study intersection has a greater proportion of a particular crash type than the normative baseline are shown in red, and instances with a smaller proportion of a particular crash type are shown in green. A gradient scale was used to emphasize occurrences of greater variation.

In general, there were fewer injury crashes and more PDO crashes at the study intersection compared to the Normative Baselines. Rear end crashes were more frequent in the study intersections, and crash trends involving weather and road conditions issues were not frequent compared to the Normative Baselines. Key findings at each intersection are listed below.

Santa Fe Drive/Dartmouth Avenue

- There was a higher occurrence of rear end crashes, accounting for 75% of all intersection crashes.
- Approach turn crashes occurred less frequently.
- There was a slightly higher occurrence of crashes during snowy conditions.

Santa Fe Drive/Oxford Avenue

- There was a higher occurrence of rear end and fewer approach turn crashes.
- There was a slightly higher occurrence of fixed object collisions. Struck objects include a sign, concrete barrier, and a wall/building.
- Fewer crashes occurred during dark hours.
- There was a higher occurrence of crashes during snowy and wet roadway conditions.
- Drivers were identified as preoccupied more frequently than typical, accounting for the contributing factor in over 25% of all crashes.

Santa Fe Drive/Union Avenue

- There was a higher occurrence of rear end and fewer approach turn crashes.
- There was a slightly higher occurrence of fixed object collisions. Struck objects include a concrete barrier, curb, and large boulders.
- There was a slightly higher occurrence of crashes during snowy conditions.

Santa Fe Drive/Prince Street

- There was a higher occurrence of rear end and fewer approach turn crashes.
- Fewer crashes occurred during dark hours.
- Drivers were identified as preoccupied more frequently than typical.

Santa Fe Drive/Bowles Avenue

- Single vehicle crashes occurred more frequently, and fixed object collisions were more common. Struck objects include a light/utility pole, traffic signal pole, guard rail, and curb.

- There was a higher occurrence of rear end and same direction sideswipe crashes. Approach turn and broadside crashes were not as common.

Santa Fe Drive/Church Avenue

- Single vehicle crashes occurred less frequently.
- There was a higher occurrence of rear end and same direction sideswipe crashes. Approach turn and broadside crashes were not as common.
- Fewer crashes occurred during dark hours.
- Drivers were identified as preoccupied more frequently than typical.

Santa Fe Drive/Mineral Avenue

- There was a higher than typical occurrence of crashes involving three or more vehicles.
- There was a higher occurrence of rear end and same direction sideswipe crashes. Approach turn and broadside crashes were not as common.

CRASH TYPE ANALYSIS

The LOSS and Normative Baseline analyses are valuable tools in identifying crash patterns; however, due to limited traffic volume data and comparable Normative Baselines, not all intersections could be analyzed. Instead, the crash types at each intersection were evaluated further, and compared to other intersections along the corridor. The signalized and unsignalized intersections were evaluated separately. Specific countermeasures were developed based on crash patterns at each intersection.

The overall crash type trends at the signalized intersections are shown in **Figure 8**; the most common crash types that occurred from 2016 to 2018 were rear end (54%), sideswipe (16%), and broadside (12%) crashes. The crash type totals and the respective crash type percentages are provided in **Table 18**. A gradient scale was applied to the crash type, with darker red colors indicating a higher percentage of a particular crash type.

The signalized intersections with the greatest proportion of rear end crashes are Brewery Avenue, Church Avenue, Vinewood Street, and Dartmouth Avenue; where rear end crashes are attributed to over 75% of all crashes at each intersection. The Belleview Avenue traffic interchange and Dartmouth Avenue intersection have the highest proportion of sideswipe crashes, and the C-470 traffic interchange and Mississippi Avenue intersection has the highest proportion of broadside crashes. The crash patterns shown in **Table 18** were used as the basis for further evaluation of vehicular direction of travel and manner of collision.

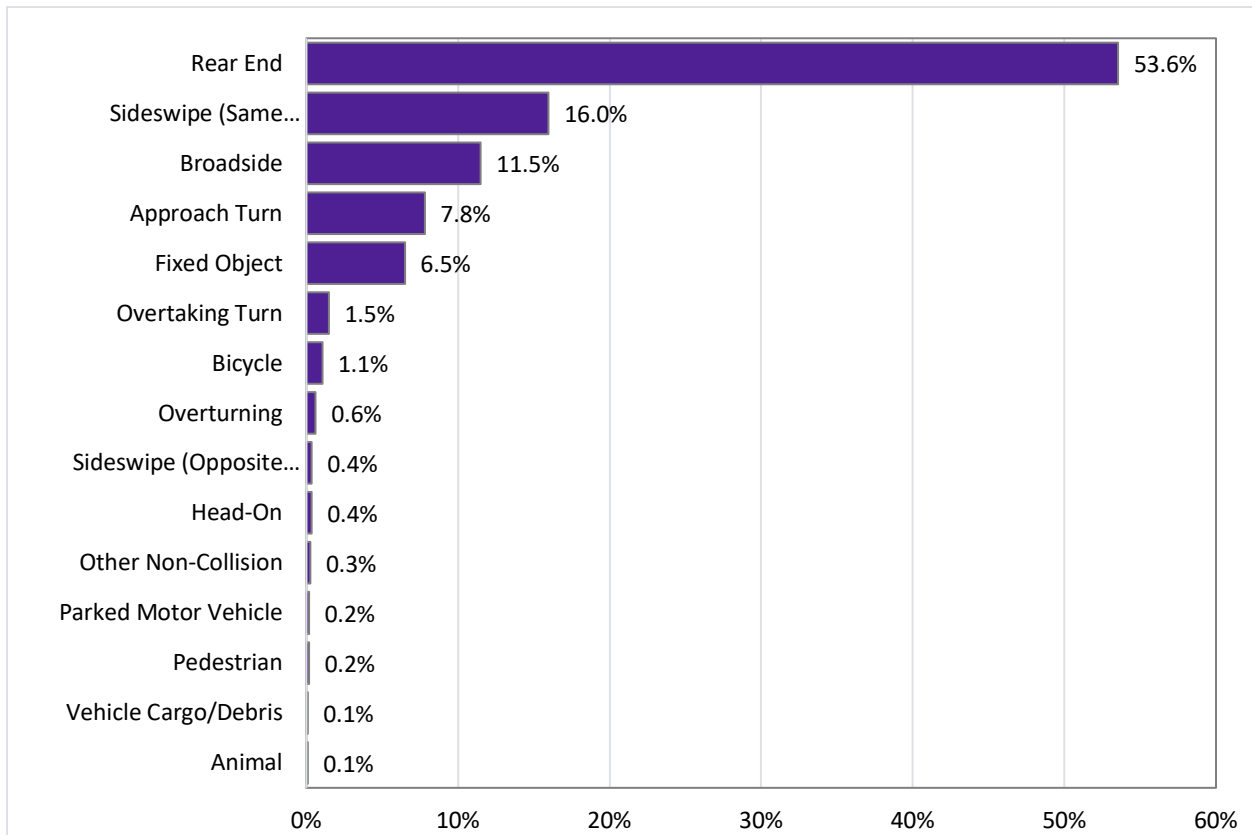


Figure 8: Signalized Intersection Crash Type Summary, 2016 to 2018

The overall crash type trends at the unsignalized intersections are shown in **Figure 9**; the most common crash types that occurred from 2016 to 2018 were rear end (51%), approach turn (14%), and broadside (13%) crashes. The crash type totals of each intersection are listed in **Table 19**.

At most unsignalized intersections, rear end crashes are the most common collision type. **Table 19** also indicates that at Maplewood Avenue, broadside and approach turn crashes make up over 80% of crashes at the intersection. It was also concluded that sideswipe crashes were more common at Chenango Avenue than at other intersections.

Intersection	Rear End		Sideswipe (Same Direction)		Sideswipe (Opposite Direction)		Broadside		Approach Turn		Fixed Object		Overtaking Turn		Overturning		Head-On		Parked Motor Vehicle		Bicycle		Pedestrian		Vehicle Cargo/Debris		Animal		Other Non-Collision		Total
	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	Total	%	
I-25	26	47%	20	36%	0	0%	2	4%	0	0%	7	13%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	55
Mississippi Avenue	31	22%	35	25%	0	0%	37	26%	18	13%	3	2%	12	9%	1	1%	0	0%	0	0%	3	2%	1	1%	0	0%	0	0%	0	0%	141
Florida Avenue	26	54%	7	15%	1	2%	5	10%	2	4%	3	6%	1	2%	0	0%	2	4%	0	0%	1	2%	0	0%	0	0%	0	0%	0	0%	48
Iowa Avenue	18	38%	6	13%	0	0%	6	13%	15	31%	0	0%	2	4%	0	0%	0	0%	0	0%	1	2%	0	0%	0	0%	0	0%	0	0%	48
Evans Avenue	20	50%	8	20%	0	0%	5	13%	2	5%	1	3%	0	0%	0	0%	0	0%	0	0%	2	5%	1	3%	0	0%	0	0%	1	3%	40
Dartmouth Avenue	108	75%	11	8%	1	1%	12	8%	4	3%	5	3%	0	0%	0	0%	0	0%	0	0%	1	1%	2	1%	0	0%	0	0%	0	0%	144
Hampden Avenue	27	42%	9	14%	0	0%	9	14%	2	3%	13	20%	0	0%	3	5%	0	0%	1	2%	1	2%	0	0%	0	0%	0	0%	0	0%	65
Oxford Avenue	54	68%	6	8%	0	0%	5	6%	5	6%	7	9%	1	1%	0	0%	1	1%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	79
Union Avenue	40	66%	9	15%	0	0%	4	7%	2	3%	5	8%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	1	2%	61
Belleview Avenue	10	37%	8	30%	0	0%	0	0%	0	0%	7	26%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	1	4%	1	4%	0	0%	25
Prince Avenue	31	57%	4	7%	1	2%	8	15%	6	11%	3	6%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	1	2%	54
Bowles Avenue	48	60%	14	18%	0	0%	3	4%	5	6%	9	11%	0	0%	0	0%	0	0%	0	0%	1	1%	0	0%	0	0%	0	0%	0	0%	80
Church Avenue	41	82%	7	14%	0	0%	1	2%	0	0%	0	0%	0	0%	0	0%	1	2%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	50
Vinewood Street	22	76%	2	7%	0	0%	2	7%	1	3%	2	7%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	29
Brewery Lane	14	93%	0	0%	0	0%	1	7%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	15
Aspen Grove Way	14	64%	3	14%	0	0%	3	14%	0	0%	1	5%	0	0%	0	0%	0	0%	0	0%	1	5%	0	0%	0	0%	0	0%	0	0%	22
Mineral Avenue	49	62%	15	19%	1	1%	7	9%	1	1%	4	5%	0	0%	2	3%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	79
County Line	15	36%	3	7%	0	0%	2	5%	18	43%	2	5%	1	2%	1	2%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	42
C-470	16	27%	15	25%	0	0%	19	32%	8	13%	2	3%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	60

Table 18: Crash Type Totals by Signalized Intersection, 2016 to 2018

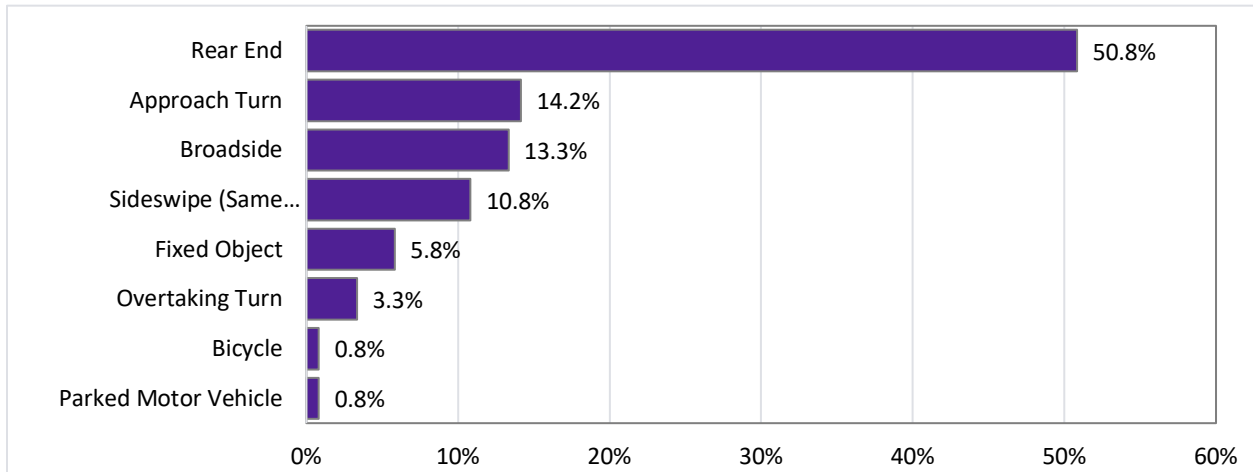


Figure 9: Unsignalized Intersection Crash Type Summary, 2016 to 2018

Table 19: Crash Type Totals by Unsignalized Intersections, 2016 to 2018

Intersection	Rear End	Sideswipe (Same Direction)	Sideswipe (Opposite Direction)	Broadside	Approach Turn	Fixed Object	Overtaking Turn	Overtaking	Head-On	Parked Motor Vehicle	Bicycle	Pedestrian	Vehicle Cargo/Debris	Animal	Other Non-Collision	Total
Weaver Avenue	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	4
Maplewood Avenue	2	0	0	6	11	1	0	0	0	0	0	0	0	0	0	20
Lake Avenue	5	1	0	2	0	0	0	0	0	0	0	0	0	0	0	8
Crestline Avenue	4	0	0	1	1	1	0	0	0	0	0	0	0	0	0	7
Chenango Avenue	6	6	0	3	4	2	1	0	0	0	0	0	0	0	0	22
Santa Fe Circle	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3
Quincy Avenue	10	1	0	1	1	0	0	0	0	0	1	0	0	0	0	14
Rob Roy Street	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Lipan Street	19	1	0	0	0	0	1	0	0	0	0	0	0	0	0	21
Harvard Avenue	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Jewell Avenue	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	2
Arkansas Avenue	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Louisiana Avenue	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	3
Arizona Avenue	3	1	0	0	0	1	2	0	0	0	0	0	0	0	0	7
Tennessee Avenue	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3

RECOMMENDATIONS

SUMMARY OF CONCLUSIONS FROM THE SAFETY ASSESSMENT REPORT

The CDOT Safety Assessment provided the following general recommendations to be implemented along the study corridor:

- Good skid resistance and drainage of the roadway surface,
- Adjustment, repair, and upgrade of existing guardrail to meet current standards,
- Implementation of safety edge applications (pavement edge drop-offs),
- Roadway crown correction (where appropriate),
- Replacement of all button reflectors and guardrail reflectors to ensure good visibility during nighttime and inclement weather conditions,
- Upgraded pedestrian signal equipment,
- Review of traffic signal timing plans to ensure appropriate signal change period, and
- Mitigation measures to reduce congestion along corridor.

SYSTEMIC CORRIDOR IMPROVEMENTS

Recommendations were developed based on identification of areas with greater frequency and severity. Rear ends were the most common crash type along Santa Fe Drive, followed by same direction sideswipe crashes. The following systemic safety improvements, and their associated crash modification factor (CMF) and crash reduction factor (CRF) where available, are based on a review of the entire corridor and all intersecting roadways:

SIGNAL TIMING IMPROVEMENTS

1. **Traffic signal retiming and coordination** – Signal coordination can significantly affect crash likelihood and severity. With an associated CMF of $e^{-0.0444(Y-X)}$ where X and Y are a change in signal cycles per hour, improving coordination so platoons of vehicles are arriving in the second half of the green interval is associated with significantly lower crash likelihood and severity.
2. **Left-turn mode and sequence modifications** – In areas that have a high rate of angle crashes such as County Line Road, Iowa Avenue, and Mississippi Avenue, changing left-turn movements from protected/permitted to protected only has an associated CMF of 0.45 (CRF 55%). Additionally, retiming coordination along the corridor may require changing left-turn sequences from leading to lagging to reduce queueing thereby reducing rear end crashes.

SIGNING AND STRIPING IMPROVEMENTS

3. **Signing and pavement marking improvements for lane merging and lane drop sections** – Installing profiled thermoplastic pavement markings has a CMF of 0.968 (CRF 3.2%). By installing signing and pavement markings for lane merging and lane drop sections, drivers will be more aware of weaving sections and there may be a reduction in rear end and sideswipe crashes.
4. **Pedestrian crossing enhancements for yield-controlled crossings on channelized right-turn lanes** – Pedestrian crossing enhancements, such as installing or refreshing high-visibility crosswalks or installing raised pedestrian crossings, can provide better visibility to pedestrians and potentially reduce rear end crashes associated with last minute braking.
5. **Installation/reapplication of stop lines, signing, and visibility improvements at signalized approaches** – Implementing systemic signing and marking improvements at signalized intersections including retroreflective backplates, re-stripping stop lines, and installing overhead

signs has an associated CMF of 0.955 (CRF 4.5%). Most of the signals along the corridor do not have backplates or have backplates that are not retroreflective. Refreshing existing signing and striping should be considered as part of a maintenance program and non-MUTCD compliant infrastructure should be upgraded.

6. **Advance lane designation signs at intersections** – Advance lane designation signs at intersections potentially reduces last minute weaving near the intersection and corresponding sideswipe and rear end crashes.

GEOMETRY IMPROVEMENTS

7. **Modification of long transitional right-turn lanes to provide distinct right turn lane** – Modifications including sharpening flat approach angles, reducing radii, and adjusting the stop bar position have an associated CMF of 0.558 (44.2%). This will also provide more storage and reduce rear end crashes by reducing spillback queues from the through lanes.

INFRASTRUCTURE AND ITS IMPROVEMENTS

8. **Install Advance Dilemma Zone Detection** – Advance vehicle detection with dilemma zone protection continuously monitors an upstream detector and can extend the vehicle green or yellow phase to eliminate a driver's decision from accelerating or braking when in the dilemma zone of an intersection approach. Advance dilemma zone detection for rural high-speed approaches have a CMF of 0.61 (CRF 39%). Note that no CMF for urban high-speed approaches has been published.
9. **Advance intersection flashing beacons in select locations** – Installing advance intersection flashing beacons at intersections where there is frequent queuing has an associated CMF of 0.27 (CRF 73%). Flashing beacons can communicate with traffic signals and display an advance warning sign if the vehicle will arrive in a red signal phase.

SYSTEMIC IMPROVEMENTS

10. **Corridor speed limit harmonization/variable speed limits** – Throughout the corridor the speed limit varies. Creating harmonization and installing variable speed limits based on real-time traffic conditions has an associated CMF of 0.71 (CRF 29%).
11. **Develop access management plans for segments with a high frequency of driveways and minor street intersections** – At unsignalized intersections with high rear end crash volumes associated with ingress movements and angle crashes associated with egress movements such as Maplewood Avenue, Quincy Avenue and Lipan Street, access control, including closure or complete relocation of all driveways from functional areas of an intersection, has an associated CMF of 0.93 (CRF 7%).
12. **Additional pedestrian and bicyclist facilities and crossing enhancements at intersections** – Crossing enhancements such as high-visibility crosswalks (CMF 0.6, CRF 40%), raised pedestrian crosswalks (CMF 0.64, CRF 36%), and rectangular rapid flashing beacons (RRFB) (CMF 0.526, 48%), will reduce pedestrian and bicycle related crashes. High-visibility crosswalks should be implemented at every intersection and raised pedestrian crosswalks and RRFB should be implemented at channelized right-turn locations that have a high pedestrian volume.

ATTACHMENT A: INTERSECTION COMPARISONS TO CDOT NORMATIVE BASELINES

Normative Baseline Comparison of 4-Lane, 4-Leg Signalized Study Intersections, Table 1 of 2

	2002 CDOT Normative Baseline: Urban 4-Lane Signalized 4-Leg Intersection Percentage of Total Crashes	Mineral Avenue		Church Avenue		Bowles Avenue	
		Percentage of Total Crashes	Algebraic Difference	Percentage of Total Crashes	Algebraic Difference	Percentage of Total Crashes	Algebraic Difference
Crash Severity							
Property Damage Only	68.8%	86.1%	17.3	92.0%	23.2	82.5%	13.7
Injury	31.0%	12.7%	-18.3	8.0%	-23.0	17.5%	-13.5
Fatal	0.3%	1.3%	1.0	0.0%	-0.3	0.0%	-0.3
Vehicles Involved							
Single Vehicle Involved	6.7%	6.3%	-0.3	0.0%	-6.7	10.0%	3.3
Two Vehicles Involved	81.2%	78.5%	-2.7	84.0%	2.8	81.3%	0.1
Three or More Vehicles Involved	11.9%	15.2%	3.3	16.0%	4.1	8.8%	-3.1
Unknown Number of Vehicles	0.3%	0.0%	-0.3	0.0%	-0.3	0.0%	-0.3
Crash Type							
Overtaking	0.4%	2.5%	2.1	0.0%	-0.4	0.0%	-0.4
Other Non-Collision	0.4%	0.0%	-0.4	0.0%	-0.4	0.0%	-0.4
Cargo or Debris	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Pedestrian	1.8%	0.0%	-1.8	0.0%	-1.8	0.0%	-1.8
Broadside	15.4%	8.9%	-6.6	2.0%	-13.4	3.8%	-11.7
Head On	0.6%	0.0%	-0.6	2.0%	1.4	0.0%	-0.6
Rear End	45.2%	62.0%	16.8	82.0%	36.8	60.0%	14.8
Sideswipe Same Direction	7.7%	19.0%	11.3	14.0%	6.3	17.5%	9.8
Sideswipe Opposite Direction	0.6%	1.3%	0.7	0.0%	-0.6	0.0%	-0.6
Approach Turn	19.4%	1.3%	-18.1	0.0%	-19.4	6.3%	-13.1
Overtaking Turn	1.1%	0.0%	-1.1	0.0%	-1.1	0.0%	-1.1
Parked Motor Vehicle	1.5%	0.0%	-1.5	0.0%	-1.5	0.0%	-1.5
Railway Vehicle	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Bicycle	1.3%	0.0%	-1.3	0.0%	-1.3	1.3%	0.0
Motorized Bicycle	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Domestic Animal	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Wild Animal	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2
Fixed Object	4.3%	5.1%	0.7	0.0%	-4.3	11.3%	6.9
Fixed Object Crash Type (Subcategory)							
Light or Utility Pole	0.6%	1.3%	0.7	0.0%	-0.6	2.5%	1.9
Traffic Signal Pole	0.7%	0.0%	-0.7	0.0%	-0.7	2.5%	1.8
Sign	0.5%	0.0%	-0.5	0.0%	-0.5	0.0%	-0.5
Bridge Rail	0.0%	1.3%	1.2	0.0%	0.0	0.0%	0.0
Guard Rail	0.1%	0.0%	-0.1	0.0%	-0.1	1.3%	1.2
Cable Rail	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Concrete Barrier	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Bridge Abutment	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Column or Pier	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Culvert or Headwall	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Embankment	0.1%	1.3%	1.2	0.0%	-0.1	0.0%	-0.1
Curb	1.0%	1.3%	0.2	0.0%	-1.0	2.5%	1.5
Delineator Post	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Fence	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Tree	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Large Boulders	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Rocks in Roadway	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Barricade	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Wall or Building	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Crash Cushion	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Mailbox	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Other Fixed Object	0.3%	0.0%	-0.3	0.0%	-0.3	2.5%	2.2
Involving Other Object	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2
Road Maintenance Equipment	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Unknown Crash Type	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2

Normative Baseline Comparison of 4-Lane, 4-Leg Signalized Study Intersections, Table 2 of 2

	2002 CDOT Normative Baseline: Urban 4-Lane Signalized 4-Leg Intersection Percentage of Total Crashes	Mineral Avenue		Church Avenue		Bowles Avenue	
		Percentage of Total Crashes	Algebraic Difference	Percentage of Total Crashes	Algebraic Difference	Percentage of Total Crashes	Algebraic Difference
Lighting Condition							
Daylight	71.7%	73.4%	1.7	78.0%	6.3	72.5%	0.8
Dawn or Dusk	3.4%	6.3%	3.0	2.0%	-1.4	7.5%	4.1
Dark - Lighted	21.7%	20.3%	-1.5	20.0%	-1.7	17.5%	-4.2
Dark - Unlighted	1.4%	0.0%	-1.4	0.0%	-1.4	2.5%	1.1
Unknown Lighting	1.8%	0.0%	-1.8	0.0%	-1.8	0.0%	-1.8
Atmospheric Conditions							
No Adverse Weather	88.5%	92.4%	3.9	92.0%	3.5	95.0%	6.5
Rain	4.9%	6.3%	1.4	6.0%	1.1	5.0%	0.1
Snow or Sleet or Hail	4.1%	1.3%	-2.8	2.0%	-2.1	0.0%	-4.1
Fog	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Dust	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Wind	0.4%	0.0%	-0.4	0.0%	-0.4	0.0%	-0.4
Unknown Weather	2.0%	0.0%	-2.0	0.0%	-2.0	0.0%	-2.0
Road Condition							
Dry Road	84.5%	93.7%	9.1	92.0%	7.5	93.8%	9.2
Wet Road	8.6%	5.1%	-3.6	4.0%	-4.6	6.3%	-2.4
Muddy Road	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Snowy Road	1.5%	0.0%	-1.5	2.0%	0.5	0.0%	-1.5
Icy Road	1.9%	0.0%	-1.9	2.0%	0.1	0.0%	-1.9
Slushy Road	0.3%	0.0%	-0.3	0.0%	-0.3	0.0%	-0.3
Foreign Material on Road	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2
With Road Treatment	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2
Dry with Icy Road Treatment	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2
Wet with Icy Road Treatment	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Snowy with Icy Road Treatment	0.1%	1.3%	1.2	0.0%	-0.1	0.0%	-0.1
Icy with Icy Road Treatment	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Slushy with Icy Road Treatment	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Unknown Road Condition	2.3%	0.0%	-2.3	0.0%	-2.3	0.0%	-2.3
Driver 1 Contributing Factor							
No Apparent Contributing Factor	65.6%	43.0%	-22.5	44.0%	-21.6	32.5%	-33.1
Asleep at the Wheel	0.4%	1.3%	0.8	0.0%	-0.4	0.0%	-0.4
Illness	0.3%	0.0%	-0.3	0.0%	-0.3	0.0%	-0.3
Distracted by Passenger	1.0%	0.0%	-1.0	2.0%	1.0	0.0%	-1.0
Driver Inexperience	4.6%	5.1%	0.5	2.0%	-2.6	6.3%	1.7
Driver Fatigue	0.4%	2.5%	2.2	0.0%	-0.4	0.0%	-0.4
Driver Preoccupied	14.1%	13.9%	-0.2	22.0%	7.9	18.8%	4.6
Driver Unfamiliar with Area	1.6%	2.5%	0.9	0.0%	-1.6	0.0%	-1.6
Driver Emotionally Upset	0.3%	0.0%	-0.3	0.0%	-0.3	0.0%	-0.3
Evading Law Enforcement	0.2%	1.3%	1.1	0.0%	-0.2	0.0%	-0.2
Physical Disability	0.3%	0.0%	-0.3	0.0%	-0.3	0.0%	-0.3
Unknown Contributing Factor	11.2%	30.4%	19.2	30.0%	18.8	42.5%	31.3
Driver 1 Impairment Condition							
No Impairment Suspected	79.7%	97.5%	17.7	96.0%	16.3	92.5%	12.8
Alcohol Involved	5.1%	2.5%	-2.6	2.0%	-3.1	5.0%	-0.1
RX/Medication/Drugs Involved	0.2%	0.0%	-0.2	2.0%	1.8	0.0%	-0.2
Illegal Drugs Involved	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Alcohol & Drugs Involved	0.3%	0.0%	-0.3	0.0%	-0.3	2.5%	2.2
Driver Not Observed	4.5%	0.0%	-4.5	0.0%	-4.5	0.0%	-4.5
Unknown Condition of Driver	10.1%	0.0%	-10.1	0.0%	-10.1	0.0%	-10.1

Normative Baseline Comparison of 6-Lane, 4-Leg Signalized Study Intersections, Table 1 of 2

	2002 CDOT Normative Baseline: Urban 6-Lane Signalized 4-Leg Intersection Percentage of Total Crashes	Prince Street		Oxford Avenue		Dartmouth Avenue	
		Percentage of Total Crashes	Algebraic Difference	Percentage of Total Crashes	Algebraic Difference	Percentage of Total Crashes	Algebraic Difference
Crash Severity							
Property Damage Only	70.5%	81.5%	11.0	78.5%	8.0	84.0%	13.5
Injury	29.3%	18.5%	-10.8	21.5%	-7.8	15.3%	-14.0
Fatal	0.2%	0.0%	-0.2	0.0%	-0.2	0.7%	0.5
Vehicles Involved							
Single Vehicle Involved	5.2%	7.4%	2.2	6.3%	1.2	2.8%	-2.4
Two Vehicles Involved	80.3%	75.9%	-4.4	83.5%	3.2	86.1%	5.8
Three or More Vehicles Involved	14.3%	16.7%	2.4	10.1%	-4.2	11.1%	-3.2
Unknown Number of Vehicles	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2
Crash Type							
Overturning	0.4%	0.0%	-0.4	0.0%	-0.4	0.0%	-0.4
Other Non-Collision	0.3%	1.9%	1.6	0.0%	-0.3	0.0%	-0.3
Cargo or Debris	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Pedestrian	1.5%	0.0%	-1.5	0.0%	-1.5	0.0%	-1.5
Broadside	12.6%	14.8%	2.2	6.3%	-6.3	8.3%	-4.3
Head On	0.4%	0.0%	-0.4	1.3%	0.8	0.0%	-0.4
Rear End	48.9%	57.4%	8.5	68.4%	19.5	75.0%	26.1
Sideswipe Same Direction	9.2%	7.4%	-1.8	7.6%	-1.6	7.6%	-1.6
Sideswipe Opposite Direction	0.4%	1.9%	1.5	0.0%	-0.4	0.7%	0.3
Approach Turn	20.1%	11.1%	-9.0	6.3%	-13.8	2.8%	-17.3
Overtaking Turn	1.3%	0.0%	-1.3	1.3%	0.0	0.0%	-1.3
Parked Motor Vehicle	0.4%	0.0%	-0.4	0.0%	-0.4	0.7%	0.3
Railway Vehicle	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Bicycle	0.9%	0.0%	-0.9	0.0%	-0.9	1.4%	0.5
Motorized Bicycle	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Domestic Animal	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Wild Animal	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Fixed Object	3.6%	5.6%	1.9	8.9%	5.2	3.5%	-0.2
Fixed Object Crash Type (Subcategory)							
Light or Utility Pole	0.5%	1.9%	1.4	1.3%	0.8	0.0%	-0.5
Traffic Signal Pole	0.4%	0.0%	-0.4	0.0%	-0.4	0.0%	-0.4
Sign	0.4%	1.9%	1.5	2.5%	2.1	1.4%	1.0
Bridge Rail	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Guard Rail	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Cable Rail	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Concrete Barrier	0.1%	0.0%	-0.1	1.3%	1.1	1.4%	1.3
Bridge Abutment	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Column or Pier	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Culvert or Headwall	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Embankment	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Curb	1.4%	0.0%	-1.4	1.3%	-0.1	0.7%	-0.7
Delineator Post	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Fence	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Tree	0.1%	1.9%	1.8	0.0%	-0.1	0.0%	-0.1
Large Boulders	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Rocks in Roadway	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Barricade	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Wall or Building	0.1%	0.0%	-0.1	1.3%	1.2	0.0%	-0.1
Crash Cushion	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Mailbox	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Other Fixed Object	0.1%	0.0%	-0.1	1.3%	1.1	0.0%	-0.1
Involving Other Object	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2
Road Maintenance Equipment	0.0%	0.0%	0.0	0.0%	0.0	0.0%	0.0
Unknown Crash Type	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2

Normative Baseline Comparison of 6-Lane, 4-Leg Signalized Study Intersections, Table 2 of 2

	2002 CDOT Normative Baseline: Urban 6-Lane Signalized 4-Leg Intersection Percentage of Total Crashes	Prince Street		Oxford Avenue		Dartmouth Avenue	
		Percentage of Total Crashes	Algebraic Difference	Percentage of Total Crashes	Algebraic Difference	Percentage of Total Crashes	Algebraic Difference
Lighting Condition							
Daylight	73.2%	77.8%	4.6	67.1%	-6.1	77.1%	3.9
Dawn or Dusk	3.0%	5.6%	2.6	7.6%	4.6	4.2%	1.2
Dark - Lighted	21.6%	16.7%	-5.0	25.3%	3.7	16.7%	-5.0
Dark - Unlighted	0.9%	0.0%	-0.9	0.0%	-0.9	2.1%	1.2
Unknown Lighting	1.2%	0.0%	-1.2	0.0%	-1.2	0.0%	-1.2
Atmospheric Conditions							
No Adverse Weather	90.0%	85.2%	-4.8	87.3%	-2.6	88.9%	-1.1
Rain	4.5%	7.4%	2.9	3.8%	-0.7	2.8%	-1.7
Snow or Sleet or Hail	3.8%	5.6%	1.7	8.9%	5.0	6.9%	3.1
Fog	0.1%	0.0%	-0.1	0.0%	-0.1	0.7%	0.6
Dust	0.0%	1.9%	1.8	0.0%	0.0	0.0%	0.0
Wind	0.3%	0.0%	-0.3	0.0%	-0.3	0.7%	0.4
Unknown Weather	1.4%	0.0%	-1.4	0.0%	-1.4	0.0%	-1.4
Road Condition							
Dry Road	86.1%	85.2%	-1.0	79.7%	-6.4	84.0%	-2.1
Wet Road	8.2%	7.4%	-0.8	12.7%	4.4	6.3%	-2.0
Muddy Road	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Snowy Road	1.3%	1.9%	0.6	1.3%	0.0	4.9%	3.6
Icy Road	1.6%	1.9%	0.2	2.5%	0.9	2.8%	1.1
Slushy Road	0.3%	1.9%	1.5	2.5%	2.2	2.1%	1.7
Foreign Material on Road	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
With Road Treatment	0.2%	0.0%	-0.2	0.0%	-0.2	0.0%	-0.2
Dry with Icy Road Treatment	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Wet with Icy Road Treatment	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Snowy with Icy Road Treatment	0.0%	1.9%	1.8	0.0%	0.0	0.0%	0.0
Icy with Icy Road Treatment	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Slushy with Icy Road Treatment	0.0%	0.0%	0.0	1.3%	1.3	0.0%	0.0
Unknown Road Condition	1.7%	0.0%	-1.7	0.0%	-1.7	0.0%	-1.7
Driver 1 Contributing Factor							
No Apparent Contributing Factor	68.5%	37.0%	-31.5	36.7%	-31.8	56.3%	-12.3
Asleep at the Wheel	0.3%	0.0%	-0.3	2.5%	2.2	0.0%	-0.3
Illness	0.3%	0.0%	-0.3	0.0%	-0.3	0.0%	-0.3
Distracted by Passenger	0.7%	0.0%	-0.7	0.0%	-0.7	0.0%	-0.7
Driver Inexperience	3.9%	3.7%	-0.2	7.6%	3.7	6.9%	3.0
Driver Fatigue	0.2%	0.0%	-0.2	1.3%	1.0	1.4%	1.2
Driver Preoccupied	13.7%	20.4%	6.6	27.8%	14.1	10.4%	-3.3
Driver Unfamiliar with Area	1.7%	1.9%	0.1	0.0%	-1.7	3.5%	1.7
Driver Emotionally Upset	0.2%	1.9%	1.6	0.0%	-0.2	1.4%	1.1
Evading Law Enforcement Officer	0.1%	0.0%	-0.1	2.5%	2.4	0.7%	0.6
Physical Disability	0.2%	0.0%	-0.2	1.3%	1.0	0.0%	-0.2
Unknown Contributing Factor	10.0%	35.2%	25.2	20.3%	10.3	19.4%	9.5
Driver 1 Impairment Condition							
No Impairment Suspected	81.8%	98.1%	16.3	98.7%	16.9	97.2%	15.4
Alcohol Involved	4.4%	1.9%	-2.5	1.3%	-3.1	2.1%	-2.3
RX/Medication/Drugs Involved	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Illegal Drugs Involved	0.1%	0.0%	-0.1	0.0%	-0.1	0.0%	-0.1
Alcohol & Drugs Involved	0.2%	0.0%	-0.2	0.0%	-0.2	0.7%	0.5
Driver Not Observed	4.4%	0.0%	-4.4	0.0%	-4.4	0.0%	-4.4
Unknown Condition of Driver	8.9%	0.0%	-8.9	0.0%	-8.9	0.0%	-8.9

Normative Baseline Comparison of 6-Lane, 3-Leg Signalized Study Intersection

	2002 CDOT Normative Baseline: Urban 6-Lane Signalized 3-Leg Intersection Percentage of Total Crashes	Union Avenue	
		Percentage of Total Crashes	Algebraic Difference
Crash Severity			
Property Damage Only	68.9%	78.7%	9.8
Injury	30.9%	21.3%	-9.6
Fatal	0.2%	0.0%	-0.2
Vehicles Involved			
Single Vehicle Involved	5.4%	8.2%	2.8
Two Vehicles Involved	78.3%	77.0%	-1.3
Three or More Vehicles Inv.	16.0%	14.8%	-1.3
Unknown Number of Vehicles	0.3%	0.0%	-0.3
Crash Type			
Overtaking	0.5%	0.0%	-0.5
Other Non-Collision	0.3%	1.6%	1.3
Cargo or Debris	0.0%	0.0%	0.0
Pedestrian	1.4%	0.0%	-1.4
Broadside	11.5%	6.6%	-4.9
Head On	0.5%	0.0%	-0.5
Rear End	51.2%	65.6%	14.4
Sideswipe Same Direction	8.3%	14.8%	6.5
Sideswipe Opposite Direction	0.4%	0.0%	-0.4
Approach Turn	19.8%	3.3%	-16.6
Overtaking Turn	1.1%	0.0%	-1.1
Parked Motor Vehicle	0.3%	0.0%	-0.3
Railway Vehicle	0.0%	0.0%	0.0
Bicycle	1.0%	0.0%	-1.0
Motorized Bicycle	0.0%	0.0%	0.0
Domestic Animal	0.0%	0.0%	0.0
Wild Animal	0.2%	0.0%	-0.2
Fixed Object	3.6%	8.2%	4.6
Fixed Object Crash Type (Subcategory)			
Light or Utility Pole	0.4%	0.0%	-0.4
Traffic Signal Pole	0.4%	0.0%	-0.4
Sign	0.4%	0.0%	-0.4
Bridge Rail	0.0%	0.0%	0.0
Guard Rail	0.0%	0.0%	0.0
Cable Rail	0.0%	0.0%	0.0
Concrete Barrier	0.1%	1.6%	1.6
Bridge Abutment	0.0%	0.0%	0.0
Column or Pier	0.0%	0.0%	0.0
Culvert or Headwall	0.0%	0.0%	0.0
Embankment	0.0%	0.0%	0.0
Curb	1.1%	4.9%	3.9
Delineator Post	0.0%	0.0%	0.0
Fence	0.1%	0.0%	-0.1
Tree	0.1%	0.0%	-0.1
Large Boulders	0.0%	1.6%	1.6
Rocks in Roadway	0.0%	0.0%	0.0
Barricade	0.1%	0.0%	-0.1
Wall or Building	0.0%	0.0%	0.0
Crash Cushion	0.0%	0.0%	0.0
Mailbox	0.0%	0.0%	0.0
Other Fixed Object	0.2%	0.0%	-0.2
Involving Other Object	0.3%	0.0%	-0.3
Road Maintenance Equipment	0.1%	0.0%	-0.1
Unknown Crash Type	0.4%	0.0%	-0.4

	2002 CDOT Normative Baseline: Urban 6-Lane Signalized 3-Leg Intersection Percentage of Total Crashes	Union Avenue	
		Percentage of Total Crashes	Algebraic Difference
Lighting Condition			
Daylight	75.7%	83.6%	7.9
Dawn or Dusk	3.2%	6.6%	3.3
Dark - Lighted	17.2%	9.8%	-7.4
Dark - Unlighted	1.8%	0.0%	-1.8
Unknown Lighting	2.0%	0.0%	-2.0
Atmospheric Conditions	0		
No Adverse Weather	89.5%	85.2%	-4.2
Rain	4.3%	4.9%	0.6
Snow or Sleet or Hail	3.6%	9.8%	6.2
Fog	0.1%	0.0%	-0.1
Dust	0.0%	0.0%	0.0
Wind	0.3%	0.0%	-0.3
Unknown Weather	2.2%	0.0%	-2.2
Road Condition			
Dry Road	85.3%	85.2%	0.0
Wet Road	8.2%	8.2%	0.0
Muddy Road	0.1%	0.0%	-0.1
Snowy Road	1.3%	3.3%	2.0
Icy Road	1.6%	1.6%	0.0
Slushy Road	0.4%	0.0%	-0.4
Foreign Material on Road	0.1%	1.6%	1.5
With Road Treatment	0.2%	0.0%	-0.2
Dry with Icy Road Treatment	0.2%	0.0%	-0.2
Wet with Icy Road Treatment	0.0%	0.0%	0.0
Snowy with Icy Road Treat.	0.0%	0.0%	0.0
Icy with Icy Road Treatment	0.0%	0.0%	0.0
Slushy with Icy Road Treat.	0.1%	0.0%	-0.1
Unknown Road Condition	2.6%	0.0%	-2.6
Driver 1 Contributing Factor			
No Apparent Contr. Factor	64.8%	65.6%	0.8
Asleep at the Wheel	0.2%	0.0%	-0.2
Illness	0.3%	0.0%	-0.3
Distracted by Passenger	0.7%	0.0%	-0.7
Driver Inexperience	4.3%	1.6%	-2.7
Driver Fatigue	0.2%	0.0%	-0.2
Driver Preoccupied	16.8%	6.6%	-10.2
Driver Unfamiliar with Area	1.8%	6.6%	4.7
Driver Emotionally Upset	0.2%	0.0%	-0.2
Evading Law Enforcement	0.1%	0.0%	-0.1
Physical Disability	0.3%	0.0%	-0.3
Unknown Contributing Factor	10.2%	19.7%	9.5
Driver 1 Impairment Condition			
No Impairment Suspected	83.9%	95.1%	11.2
Alcohol Involved	3.8%	4.9%	1.1
RX/Medication/Drugs	0.2%	0.0%	-0.2
Illegal Drugs Involved	0.1%	0.0%	-0.1
Alcohol & Drugs Involved	0.2%	0.0%	-0.2
Driver Not Observed	3.6%	0.0%	-3.6
Unknown Condition of Driver	8.3%	0.0%	-8.3