Urban Safety Performance

FINAL REPORT

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The objective of this study was to explore the historic crash frequency, crash severity and crash rate on urban 2-lane undivided (2U), urban 3-lane (3L), urban 4-lane undivided (4U), and urban 4-lane divided (4D) roads across Minnesota. The analysis was conducted on all crash types combined. Pedestrian and bicycle fatalities and serious injuries were not analyzed separately due to sample size constraints. Additionally, the study compared safety performance of 2U and 4D roads and 4U and 3L roads. The analysis focused in urban areas and data was compiled and organized to allow evaluation for Statewide, Greater Minnesota and Metro area conditions. The principal research question was to understand average crash rates on the different facility types statewide, in Greater Minnesota and the Metro areas. A project specific database was developed to support the analysis. The database was developed by identifying urban areas, creating evaluation segments within each urban area and assigning crashes and traffic volumes to each segment. Data used in the project analysis included information from the Minnesota Geospatial Commons (e.g., urban areas, roadway details, traffic volumes) and crash records. Because identifying urban location and facility types using the available information was unreliable, counties and cities from each MnDOT District were contacted to confirm the segment attributes (especially the facility type and features). Overall, there were 1,550 miles of roads in the database; approximately two-thirds of the data were 2U roads. Between 2016 and 2020 there were 51,595 crashes on these roads – on average 10,320 crashes per year, and 204 fatal and serious injury crashes per year. More details about the data are included in Chapter 4: Data Summary.

The project also included a brief literature review to identify other findings related to safety performance on these facility types. At the time of the research three studies were identified. The material showed that converting roads from a 4U to 3L or 2U to 4D will reduce crashes. One study showed that converting a road from 4U to 3L will reduce non-junction and all crashes.

The project analyses were conducted by comparing crash rates (by years and VMT) and crash frequencies and severities. The project did not include any statistical assessment to compare conditions across groupings of facilities with and without various features. Throughout this study, the crash rate for all crashes is measured in Million Vehicle Miles Travelled (MVMT) and the crash rate for fatal (K) and serious injury (A) crashes is measured in Hundred Million Vehicle Miles Travelled (HMVMT). Table 1 summarizes the results of the statewide evaluation for all crashes (junction plus non-junction):

- For all crash severities:
  - 2U roads had the ***lowest*** crash rate;
  - 2U roads had a crash rate ***lower*** than 4D roads;
  - 3L roads had a crash rate ***lower*** than 4U roads; and
  - 4U roads had the ***highest*** crash rates.
- For Fatal (K) and Serious Injury (A) crashes:
  - 4D roads had the ***lowest*** crash rate
  - 4D roads had a crash rate ***lower*** than 2U roads;
  - 3L roads had a crash rate ***lower*** than 4U roads; and
  - 4U roads had the ***highest*** crash rate.

Table 1: Crash Rates by Facility Type, Statewide, All Crashes

Facility Type	Crashes per year	Mileage (MVMT)	Crash Rate (crashes per MVMT)	K+A Crashes per Year	K+A Crash Rate (crashes per HMVMT)
2U	4,117	1056.6 (2038.5)	2.02	90	4.42
3L	490	80.4 (208.2)	2.35	13	6.44
4U	2,359	135.6 (654.0)	3.61	45	6.82
4D	3,354	275.2 (1421.3)	2.36	56	3.93
Total	10,320	1547.7 (4322.0)		204	

The research also evaluated crash trends for non-junction crashes. As shown in Table 2, there were 2,648 non-junction all-severity crashes per year and 61 K+A crashes per year in the data set. For non-junction crashes:

- For all crash severities:
  - 4D roads had the ***lowest*** crash rate;
  - 2U roads had a crash rate ***higher*** than 4D roads;
  - 3L roads had a crash rate ***lower*** than 4U roads; and
  - 4U roads had the ***highest*** crash rates.
- For Fatal (K) and Serious Injury (A) crashes:
  - 4D roads had the ***lowest*** crash rate;
  - 2U roads had a crash rate ***higher*** than 4D roads;
  - 3L roads had a crash rate ***higher*** than 4U roads; and
  - 3L roads had the ***highest*** crash rate

Table 2: Crash Rates by Facility Type, Statewide, Non-Junction Crashes

Facility Type	Crashes per year	Mileage (MVMT)	Crash Rate (crashes per MVMT)	K+A Crashes per Year	K+A Crash Rate (crashes per HMVMT)
2U	1,266	1056.6 (2038.5)	0.62	33	1.62
3L	153	80.4 (208.2)	0.73	5	2.31
4U	600	135.6 (654.0)	0.92	12	1.84
4D	629	275.2 (1421.3)	0.44	11	0.80
Total	2,648	1547.7 (4321.9)	-	61	

It is typically expected that K+A crash severity is lower on 3L roads as compared to 4U. The findings for the K+A non-junction crashes (i.e., 3L K+A crash rates are higher than 4L crash rates) are not consistent with this expectation; however, it is noted that the sample size for K+A crashes on 3L roads was small compared to other facility types. Two anomalies were identified:

- As will be shown in Section 5.2.1, when the data are further disaggregated by region of the state (i.e., Statewide, Greater Minnesota, and Metro) for all crashes (i.e., junction and non-junction crashes) the higher K+A crash rate on 3L roads is driven by data from the Metro area.
- When the data are limited to non-junction crashes and disaggregated by region of the state (Section 5.2.2) the K+A crash rate for 3L roads is higher than the K+A crash rate for 4U roads statewide and when separated into Greater Minnesota and the Metro Area.

Recognizing the anomalous results based only a descriptive assessment (no statistical analysis), several additional analyses were conducted (e.g., linear regression analysis considering crashes against volumes, linear regression analysis considering crashes against intersection density, organizing the data into a variety of traffic volume bins) to understand how/why the 3L roads had a higher K+A crash rate in the Metro area and for all non-junction crashes. No conclusions were made from these analyses. Additional research is needed to understand these results. It is recommended the additional research be conducted using a cross-sectional analysis with regression models. Further, the findings presented herein should be used cautiously given the variation of results and decreasing sample size as data is disaggregated.

CHAPTER 1: INTRODUCTION

OBJECTIVE

The objective of this study was to explore the historic crash frequency, severity and rate on urban 2-lane undivided (2U), urban 3-lane (3L), urban 4-lane undivided (4U), and urban 4-lane divided (4D) roads across Minnesota. Additionally, the study compared safety performance of 2U and 4D roads and 4U and 3L roads. The analysis focused in urban areas and data was compiled and organized to allow evaluation for Statewide, Greater Minnesota and Metro area conditions. The principal research question was to understand average crash rates on the different facility types statewide, in Greater Minnesota and the Metro areas.

Two crash rates were tabulated and evaluated: total (i.e., all severity) crash rates, and fatal and A-injury (FAR) crashes rates. The analysis was conducted as a comparative crash rate analysis, with a goal of understanding historic crash rates on various urban facilities. The evaluation can be used to inform current roadway planning and design and inform decisions about optional cross sections. The investigation did not include any before-after statistical analyses.

A small case study was also performed to compare crash rates on two roads that were converted from two-lane undivided to a four-lane divided road and two roads that were converted from a four-lane undivided to a three-lane road.

METHODOLOGY

In order to conduct the analysis, a database was developed with an inventory of existing roadway characteristics such as: facility type, traffic volume, segment length, lane configurations, presence of pedestrian facilities (e.g., sidewalks on one or both sides, paved shoulder), presence of bicycle facilities (e.g., paved shoulders, bike lane, or separated trail), posted speed limits, documented years of lane expansions or changes in facility type, and crash data.

The data were also organized into categories to support for analysis. The categories related to geography (statewide, Greater Minnesota, Metro Area), traffic volume ranges, posted speed limits, presence of pedestrian facilities and presence of bicycle facilities. Total crash rates and FAR crash rates for each urban facility type were then calculated and summarized.

Chapter 2 summarizes a brief literature review about relative crash rates on different roadway types. Chapter 3 summarizes how the project data set was developed. Chapter 4 provides a summary of the information in the data set. Chapter 5 presents the results of the comparative analysis of the crash rates and Chapter 6 presents the case studies.

CHAPTER 2: LITERATURE REVIEW

A brief literature review (Table 3) seeking to understand relative safety performance of these different facilities was conducted using:

- AASHTO Highway Safety Manual
- FHWA Crash Modification Factor Clearinghouse
- NCHRP 500: Guidance for Implementation of the AASHTO Strategic Highway Safety Plan

Studies discussing CMFs related to converting two lane undivided roads to four lane undivided roads and converting four lane undivided roads to two lanes were not available.

Sun and Rahman (2019) evaluated the change in crashes when a four-lane undivided roadway was converted to a three-lane road. The CMF for the lane conversion was found to be 0.69 for all crash types and all severities based on the Empirical-Bayes methodology. In comparison, the CMF for non-junction only crashes of all severities was 0.61 based on the Empirical-Bayes method.

Pawlovich (2006) assessed crash history reduction due to converting four-lane undivided roadways to three-lane roadways with center turn lane in Iowa. This study was completed by the Iowa State University Department of Statistics in cooperation with the Iowa Department of Transportation's Office of Traffic and Safety (TAS). The study consisted of both monthly crash data and estimated volumes from TAS for 30 sites, with half of the sites as treatment and the other half control. The data used spanned 23 years (1982 to 2004) and during this period the sites had volumes ranging from 2,030 to 15,350 vehicles per day and were largely located in smaller urbanized areas. The crash data was analyzed at each site before and after the conversions were completed. The study found that there was a 25.2% reduction in crash frequency per mile and an 18.8% reduction in crash rate; which corresponds to CMF values 0.748 and 0.812 respectively for all crash types and all severities.

Ahmed et al. (2015) evaluated the safety effectiveness of widening urban and rural two-lane to four-lane divided roadways. This study was completed using various observational before-after analyses which ranged from simple, using a comparison group, Empirical Bayes (EB) and Bayesian approach. The study indicated that converting two-lane roadways to four-lane divided roadways resulted in a notable reduction of more than 63% (CMF 0.367) on urban roadways and 45% reduction (CMF 0.549) on rural roadways for fatal and injury (F+I) crashes. This roadway conversion also yielded a higher reduction in total and property damage only crashes in urban areas than in rural areas. Additionally, the safety effects of the conversion appear to be more effective on roadway segments with high AADT in urban areas.

Table 3: Summary of Literature Review

Conversion	Study Author	CMF	Notes from Study
4U to 3L	Sun and Rahman (2019)	0.61 all non-junction crashes (EB) 0.69 all crashes (EB)	
4U to 3L	Pawlovich (2006)	0.812 all crashes [crash rate] 0.748 as crashes [crashes per mile]	
2U to 4D	Ahmed (2015)	0.367 urban areas, fatal and injury 0.549 rural areas, fatal and injury	• Conversion tends to be more effective for high volume urban roads • Urban areas tend to have greater reductions for total and PDO crashes.

CHAPTER 3: DATA PREPARATION PROCESS

There were three major steps to organizing the data for this analysis:

- Identifying urban areas
- Creating segments within the urban areas
- Assigning crashes and AADT

IDENTIFYING URBAN AREAS

Identifying the urban areas was a challenging effort. Initially, the analysis considered any road within a municipal boundary as an urban area (hosted feature layer where CTU_CLASS = 'CITY'). However, there are many areas that fall within a municipal boundary that are not urban. For example, Hibbing, MN has a population of approximately 16,000 people but covers an area of approximately 186 square miles. In comparison, Minneapolis has a population exceeding 400,000 living in an area of 58 square miles. Hibbing, and many other cities in Minnesota, have areas within the city limits that are rural. Another approach considered was to select roads that had a typical urban design (such as curb and gutter instead of open ditches) regardless of whether the corridor is within a municipal boundary. Again, this approach proved insufficient. For example, Trunk Highway (TH) 120 through the Twin Cities metro area is an urban road that still has ditches instead of curb and gutter. By scanning county roads in the Twin Cities metro, other examples were quickly found where this approach omitted urban roads.

From the Minnesota Geospatial Commons, the GIS layer "Urban Areas" was ultimately selected as the means to differentiate between urban and rural areas. These urban polygons in the GIS layer were cut into individual cities and assigned a city name and population using the GIS layer "City, Township, and Unorganized Territory in Minnesota", also available on the Minnesota Geospatial Commons. The urban areas layer does include small rural communities that in most cases the streets don't fit the criteria of an urban road, or the urban road section is very short. Therefore, a population threshold of 600 residents was used to screen out the smallest towns.

CREATING SEGMENTS

Using MnDOT's information in the GIS layer "Roadway Details in Minnesota" (2019 was the latest available on the Minnesota Geospatial Commons), roads were eligible to be study segments if they were within the selected urban boundaries. Alternatively, road segments were eliminated if they were identified as fully access controlled (i.e., freeway), or the functional class was 'Local' or the facility type was 'Ramp' for the Increasing direction.

To confirm the segment attributes (especially the facility type), 5 MnDOT Districts, 18 counties and 21 cities participated in the survey to validate road features. Counties and cities from each MnDOT District were contacted to increase geographic diversity. Note that the counties and cities requested to participate tended to have more urban miles.

A succinct list of segments was developed for survey takers to review by concatenating shorter segments within the same urban area into larger segments where the following field values matched:

- Number of Thru Lanes
- Divided/Undivided
- Facility Type
- End Mile/Begin Mile

Segments were split if they intersected with more than one urban area so that the corridor was directed to the correct city, county, or district survey taker.

Table 4 summarizes the information sent to each agency and the source used to populate the initial values. Agency staff were asked to validate the information for urban roads under their jurisdiction. Survey takers could manually change any information for any segment.

Table 4 Survey Attributes

Field	Source
ID	Auto generated in SQL database
Route	2019_HPMS_data.txt (ROUTE_ID)
Begin	2019_HPMS_data.txt (BEGPT)
End	2019_HPMS_data.txt (ENDPT)
City	2019_HPMS_data.txt (CITYNAME)
Facility Type	2019_HPMS_data.txt (FAC)
Posted Speed Limit	ClearGuide – provided by MnDOT for this study use only
# Signalized Intersections	Open Street Map – gis_osm_traffic_free_1 shapefile where Feature Class like '%Signal%'
# Roundabouts	GeoCommons (shp_trans_roads_structure) in addition to Kittelson database

ASSIGNING CRASHES AND AADT

Crash records were associated with each survey segment if the crash points were within 250 feet of the segment and where the crash record route ID matched the segment route ID or the crash is indicated as a junction crash. Furthermore, crashes were identified as Junction or Non-Junction depending on whether the crash location was within 250 feet of an intersection.

Annual average daily traffic (AADT) volumes were associated spatially with each segment using data provided by MnDOT in the GIS layer "Annual Average Daily Traffic Segments in Minnesota" (available on the Minnesota Geospatial Commons). Assigning volumes to each segment was essential for calculating crash rates.

CHAPTER 4: DATA SUMMARY

Overall, there were approximately 1,550 miles of roads in the data; approximately two-thirds of the data were 2U roads. Between 2016 and 2020 there were 51,600 crashes on these roads – on average 10,320 crashes per year. Table 5 shows the distribution of miles of roads, crashes per year, and crash severity in the database. Considering crash severity, 3L roads in the database had a slightly higher proportion of K and A crashes and smaller proportion of B crashes as compared to other roads in the database.

In total, there were 1,020 fatalities and serious injuries; of these 276 were pedestrians or bicyclists. As the data was disaggregated by facility and region the sample sizes were relatively small and no specific analysis was conducted on the pedestrian and bicycle fatalities or serious injuries.

Table 5 - Summary of Database

			Crash Severity Distribution (%)				
	Miles (MVMT)	Crashes Per Year	K	A	B	C	O
Two-Lane Undivided (2U)	1,056.6 (2038.5)	4,117	0.29	1.87	11.02	15.59	71.23
Three-Lane (3L)	80.4 (208.2)	490	0.47	2.07	10.30	15.57	71.62
Four-Lane Undivided (4U)	135.6 (654.0)	2,359	0.20	1.67	10.46	17.17	70.51
Four-Lane Divided (4D)	275.2 (1421.3)	3,354	0.25	1.38	10.21	17.25	70.92
Total	1,547.7 (4321.9)	10,320					

Figure 1 shows the comparison of miles, vehicle miles traveled (VMT), distribution of all crashes per year, and distribution of K+A crashes per year in the database by facility type. As shown, 2U roads in the data set tended to have a lower proportion of crashes than VMT and 4U roads in the data set tended to have a higher proportion of crashes than VMT.

Figure 1: Comparison of Number of Miles, VMT and Crashes by Facility

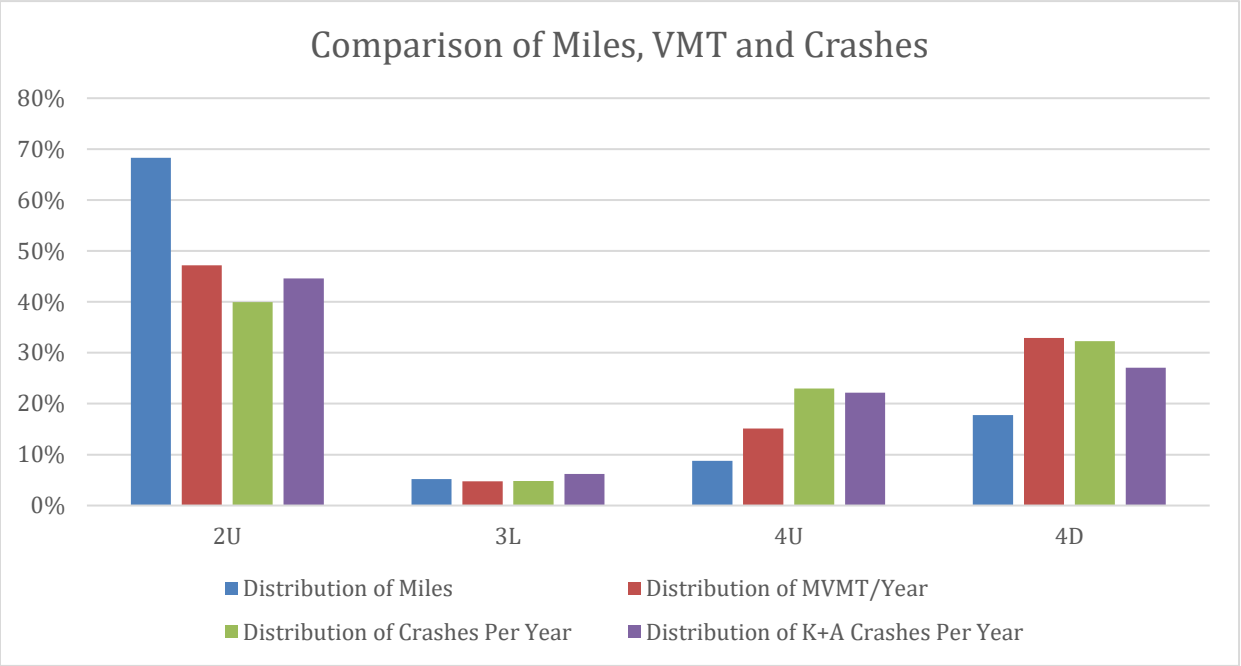


Figure 2 shows the number of miles of facilities by three AADT volume bins: less than 5,000 vehicles per day (vpd), between 5,000 and 10,000 vpd and greater than 10,000 vpd. Most of the roads in the roadway database had less than 5,000 vpd and most of this traffic was on 2U roads.

Figure 2: Summary of Vehicles per Day by Facility Type

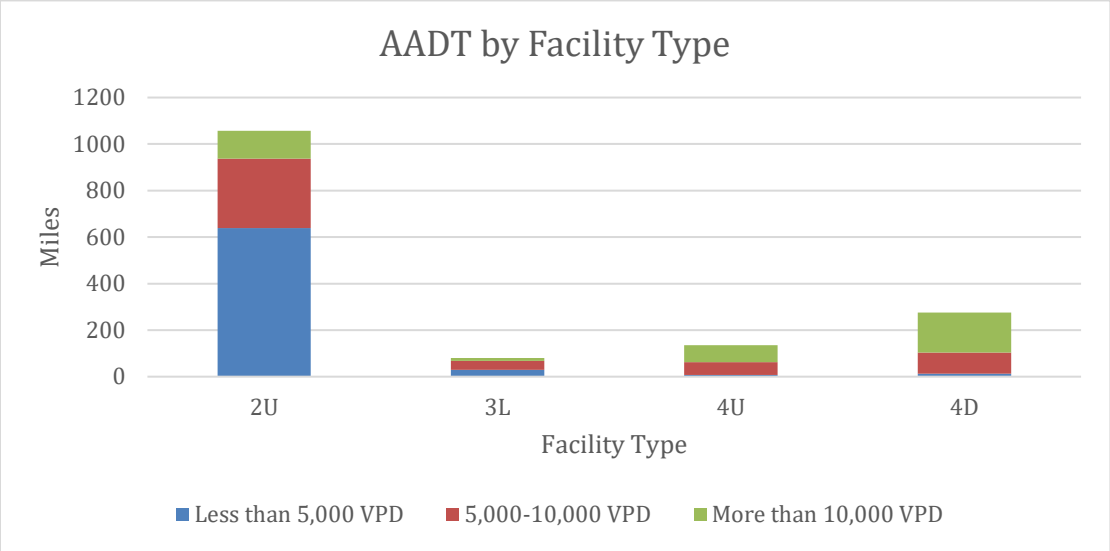


Figure 3 shows the distribution of miles in the database by two posted speed limit categories: 35 mph or less, and 40 mph or higher. Approximately, 45% of the roads in the database had a posted speed of 35 miles per hour or less and the rest of the roads had a posted speed limit of 40 mph or higher.

Figure 3: Distribution of Roadways by Posted Speed

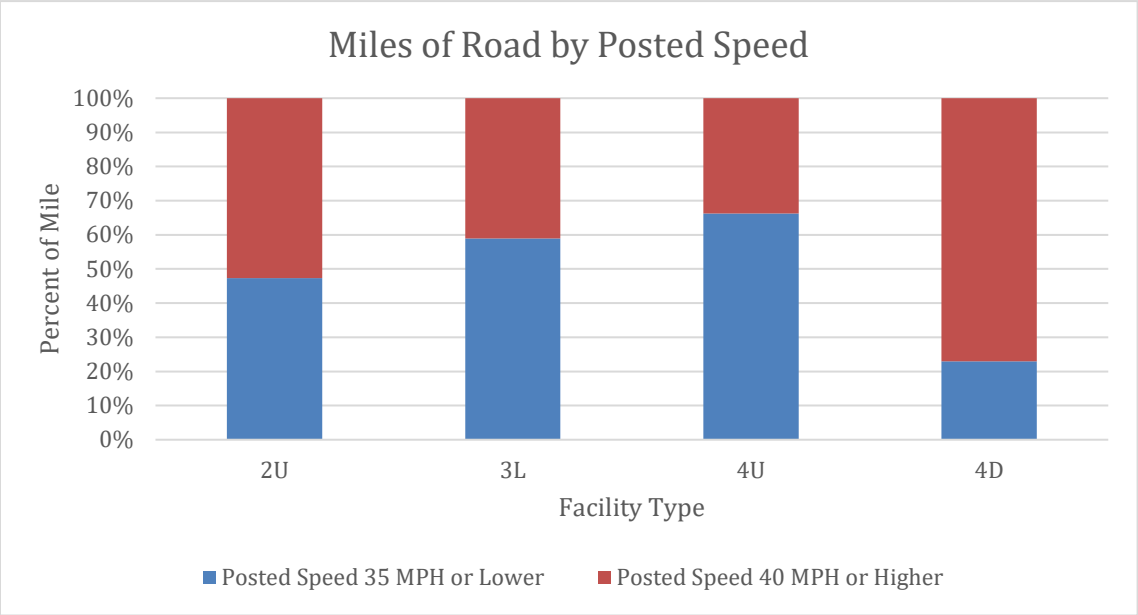


Figure 4 and Figure 5 summarize the types and number of miles of bicycle and pedestrian facilities in the dataset, respectively. Almost 40% of roads in the data had no bike facilities (approximately 620 miles) followed second and third by paved shoulders (approximately 430 miles) and a trail on one side, respectively (approximately 370 miles). Approximately 43% of the roads had a sidewalk on one or both sides of the road (approximately 665 miles).

Figure 4: Summary of Bicycle Facilities in Data

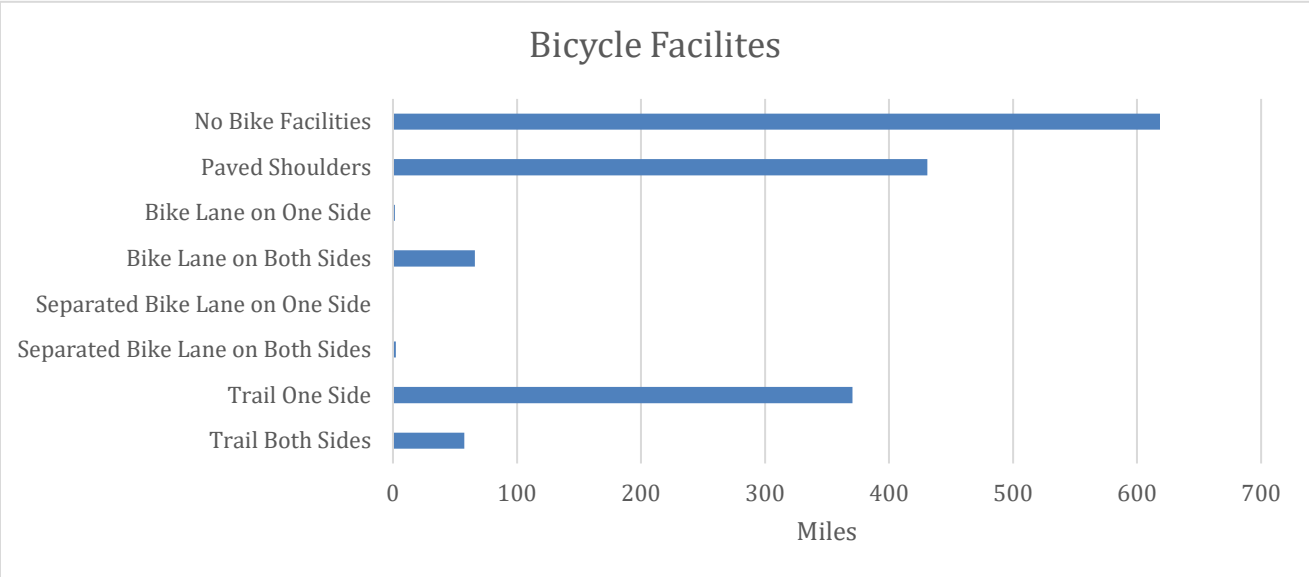
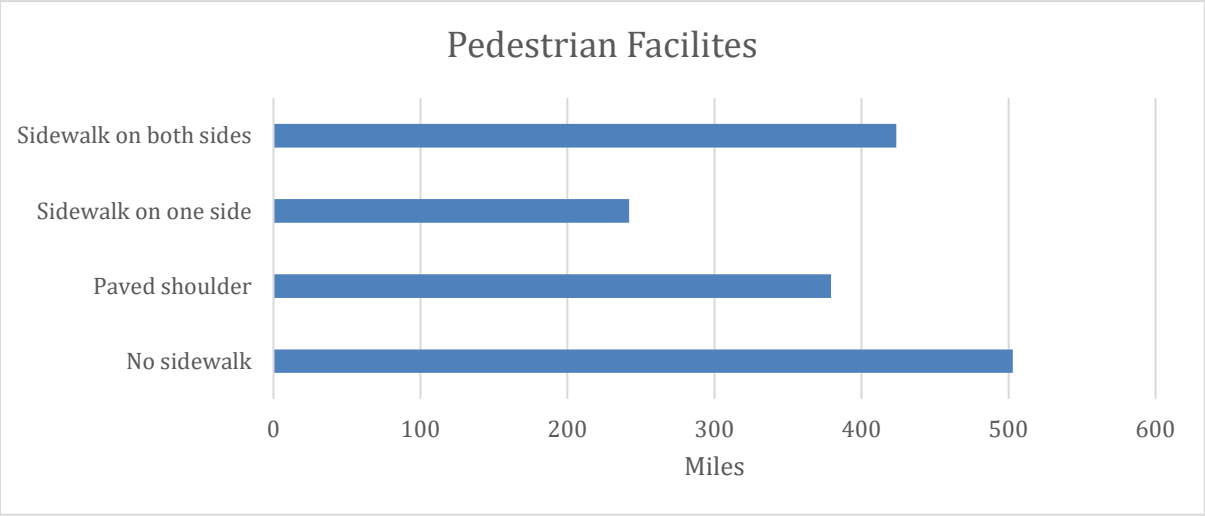


Figure 5: Summary of Pedestrian Facilities in Data



CHAPTER 5: DATA ANALYSIS

STATEWIDE CRASH RATES – TOTAL AND NON-JUNCTION

The database was used to calculate all severity crash rates (crashes per million VMT [MVMT]) and a fatal (K) plus serious injury (A) crash rate (crashes per hundred million VMT [HMVMT]). The project analyses were conducted by comparing crash rates (by years and VMT) and crash frequencies and severities. The project did not include any statistical assessment to compare conditions across groupings of facilities with and without various features. As will be shown there is extensive variation in the results that may be resolved with more statistical analysis. The findings presented herein should be used cautiously given the variation of results as data is disaggregated.

As shown in Table 6, on a statewide basis for 2U and 4D roads:

- All crashes, 2U facilities had a ***lower*** crash rate than 4D facilities.
- K+A crashes, 2U facilities had a higher crash rate than 4D facilities.

Table 7 shows statewide crash rates for non-junction crashes. In this case:

- All crashes, 2U facilities had a ***higher*** crash rate than 4D facilities.
- K+A crashes, 2U facilities had a ***higher*** crash rate than 4D facilities.

The K+A analysis results for 2U and 4D roads for all crashes and non-junction crashes are largely consistent with the literature review findings in this project (Table 3). One exception is that for all crash severities and for all crash types (junction and non-junction), 2U roads had a lower crash rate than 4D roads. This may be due to intersection crashes, as the non-junction crash rates were consistent with the literature review.

Comparing 3L and 4U roads as shown in Table 6, on a statewide basis considering:

- All crashes, 3L roads had a ***lower*** crash rate than 4U roads.
- K+A crashes, 3L roads had a ***lower*** crash rate than 4U facilities.

These findings are consistent with the literature review findings in this project (Table 3).

Table 7 shows overall crash rates for non-junction crashes. In this case:

- All crashes, 3L facilities had a ***lower*** rate than 4U facilities.
- K+A crashes, 3L facilities had a ***higher*** crash rate than 4U facilities.

Based on the literature review, it is expected that 3L roads will have fewer crashes (all severities) than 4U roads. The literature review did not provide any information about K+A crash frequency on 3L roads as compared to 4U roads; however, it is typically expected that K+A crash severity is lower on 3L roads as compared to 4U. Noting again, the relatively small sample size of K+A crashes on 3L roads (Table 7),

the findings for the K+A non-junction crashes (i.e., 3L K+A crash rates are higher than 4L crash rates) are not consistent with this expectation. Two anomalies were identified:

- As will be shown in Section 5.2.1, when the data are further disaggregated by region of the state (i.e., Statewide, Greater Minnesota, and Metro) for all crashes (i.e., junction and non-junction crashes) the ***higher*** K+A crash rate on 3L roads is driven by data from the Metro area.
- When the data are disaggregated into non-junction crashes and by region of the state (Section 5.2.2) the K+A crash rate for 3L roads is ***higher*** than the K+A crash rate for 4U roads statewide and when separated into Greater Minnesota and the Metro Area.

Several additional analyses were conducted (e.g., linear regression analysis considering crashes against volumes, linear regression analysis considering crashes against intersection density, organizing the data into a variety of traffic volume bins) to understand how/why the 3L roads had a higher K+A crash rate in the Metro area and for all non-junction crashes. No conclusions were made from these analyses. Additional research is needed to understand these results. It is recommended the additional research utilize more rigorous statistical methods such as before-after using comparison group with a safety performance function or a cross-sectional analysis with regression models.

Table 6: Overall Crash Rates, All Crashes

Facility Type	Miles (MVMT)	Crashes per year	Crash Rate (crashes per MVMT)	K+A Crashes per Year	K+A Crash Rate (crashes per HMVMT)
2U	1056.6 (2038.5)	4,117	2.02	90	4.41
3L	80.4 (208.2)	490	2.35	13	6.44
4U	135.6 (654.0)	2,359	3.61	45	6.82
4D	275.2 (1421.3)	3,354	2.36	56	3.93

Table 7: Overall Crash Rates, Non-Junction

Facility Type	Miles (MVMT)	Crashes per year	Crash Rate (crashes per MVMT)	K+A Crashes per Year	K+A Crash Rate (crashes per HMVMT)
2U	1056.6 (2038.5)	1,266	0.62	33	1.62
3L	80.4 (208.2)	153	0.73	5	2.31
4U	135.6 (654.0)	600	0.92	12	1.84
4D	275.2 (1421.3)	629	0.44	11	0.80

As shown in Table 8, bicycle and pedestrian crash rates are lowest on 4D roads. 4U have the highest crash rates for all crash severities.

Table 8: Bicycle and Pedestrian Involved Crash Rates, All Crashes

Facility Type	Bicycle Involved Crash Rate (crashes per HMVMT)	Pedestrian Involved Crash Rate (crashes per HMVMT)
2U	4.06	5.51
3L	3.31	7.41
4U	8.9	13.61
4D	3.08	2.56

CRASH RATES BY CATEGORY

Crash rates for all crashes and non-junction crashes for all severity and K+A severity are summarized in the following pages. The observed crash rates were evaluated in the following categories:

- Statewide, greater Minnesota and Metro
- Traffic Volume
    - AADT less than 5,000 VPD
    - AADT 5,000-10,000 VPD
    - AADT greater than 10,000 VPD
- Posted Speed Limit
    - 35 MPH or less
    - 40 MPH or more
- Pedestrian Facilities
    - No pedestrian or bicycle facilities
    - Sidewalk on one or both sides of the street, no bicycle facilities
    - Sidewalk on one or both sides of the street and bicycle facilities on one or both sides of the street
- Bicycle Facilities
    - No pedestrian or bicycle facilities
    - Bicycle facilities on one or both sides of the street, no sidewalks
    - Bicycle facilities on one or both sides of the street, sidewalks on one or both sides of the street

A searchable Excel file has also been provided to MnDOT.

5.2.1 Statewide, Greater Minnesota, and Metro – All Crashes

Statewide Crash Rates

All Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	4,116.8	90.2	1,056.6	2.02	4.42
3L	489.8	13.4	80.4	2.35	6.44
4U	2,359.0	44.6	135.6	3.61	6.82
4D	3,353.6	55.8	275.2	2.36	3.93

Greater Minnesota Crash Rates

All Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	1,221.2	20.4	571.8	1.62	2.70
3L	190.4	4.0	48.5	1.79	3.77
4U	574.0	8.2	42.7	3.39	4.85
4D	1,284.2	13.8	81.7	3.06	3.28

Metro Crash Rates

All Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	2895.6	69.8	484.8	2.26	5.44
3L	299.4	9.4	31.9	2.93	9.21
4U	1,785.0	36.4	92.9	3.68	7.51
4D	2,069.4	42.0	193.6	2.07	4.20

Statewide for all crashes, two lane roads have the lowest all severity crash rate and 4D roads have the lowest K+A crash rate. 4U roads have the highest all severity crash rate and K+A crash rate.

In Greater Minnesota, two lane roads have the lowest all severity and K+A crash rate. 4U roads have the highest all severity and K+A crash rate.

In the Metro area 4D roads, closely followed by 2U roads, have the lowest all severity and K+A crash rates. 3L roads have the highest K+A crash rates and 4U roads have the highest all severity crash rate.

5.2.2 Statewide, Greater Minnesota, and Metro – Non-Junction Crashes

Statewide Crash Rates

Non-Junction Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	1,266.0	33.0	1056.6	0.62	1.62
3L	152.8	4.8	80.4	0.73	2.31
4U	600.0	12.0	135.6	0.92	1.84
4D	628.8	11.4	275.2	0.44	0.80

Greater Minnesota Crash Rates

Non-Junction Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	426.8	11.2	571.8	0.57	1.51
3L	76.2	2.2	48.5	0.72	1.88
4U	174.6	3.0	42.7	1.03	1.77
4D	268.0	3.6	81.7	0.64	0.86

Metro Crash Rates

Non-Junction Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	839.2	21.8	484.8	0.65	1.70
3L	76.6	2.6	31.9	0.75	2.55
4U	425.4	9.0	92.9	0.88	1.86
4D	360.8	7.8	193.6	0.36	0.78

Statewide for non-junction crashes, 4D roads have the lowest all severity and K+A crash rates. 4U roads have the highest all severity crash rate and 3L roads have the highest K+A crash rate.

In Greater Minnesota, 2U roads have the lowest all severity crash rate, and 4D roads have the lowest K+A Crash rate. 4U roads have the highest all severity and 3L roads have the highest K+A crash rate.

In the Metro area, 4D roads have the lowest all severity and K+A crash rates. 4U roads have the highest all severity and 3L roads have the highest K+A crash rate.

In all three geographies, the difference in K+A crash rates on 3L roads are higher than 4U roads; and 2U roads have K+A crashes rates higher than 4D roads.

5.2.3 Traffic Volume Categories – All Crashes

AADT Less than 5,000 vpd

Statewide Crash Rates

All Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	1,091.0	25.8	636.5	1.90	4.48
3L	88.2	2.4	29.7	2.15	5.85
4U	49.4	0.8	7.7	4.05	6.56
4D	88.0	1.4	13.2	4.76	7.57

AADT 5,000 to 10,000 vpd

Statewide Crash Rates

All Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	1,953.2	44.4	302.4	2.50	5.68
3L	234.2	7.8	37.7	2.54	8.47
4U	856.4	17.8	56.0	5.52	11.47
4D	775.6	16.8	91.5	2.93	6.35

AADT Greater than 10,000 vpd

Statewide Crash Rates

All Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	1,072.6	20.0	117.6	1.57	2.94
3L	167.4	3.2	13.0	2.23	4.26
4U	1,453.2	26.0	71.9	2.99	5.34
4D	2,490.0	37.6	170.6	2.19	3.30

For all crashes all volume categories, two-lane undivided roads have the lowest all severity and K+A crash rate in each volume range.

For all traffic volume categories, the all severity crash rate and the K+A crash rates in the 3L category is lower than the 4U crashes.

Comparing 2U to 4D roads, K+A crash rates are lower on 2U roads in all traffic volume categories. This is not consistent with the research conducted for this project. This is for all crashes; the junction crashes included in this may be skewing the results.

5.2.4 Traffic Volume Categories – Non-Junction Crashes

AADT Less than 5,000 vpd

Statewide Crash Rates

Non-Junction Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	356.0	11.2	636.5	0.62	1.95
3L	30.0	0.2	29.7	0.73	0.49
4U	10.4	0.0	7.7	0.85	-
4D	11.4	0.2	13.2	0.62	1.08

AADT 5,000 to 10,000 vpd

Statewide Crash Rates

Non-Junction Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	566.8	16.6	302.4	0.72	2.12
3L	88.4	3.6	37.7	0.96	3.91
4U	197.4	3.8	56.0	1.27	2.45
4D	162.6	4.2	91.5	0.61	1.59

AADT Greater than 10,000 vpd

Statewide Crash Rates

Non-Junction Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	343.2	5.2	117.6	0.50	0.76
3L	34.4	1.0	13.0	0.46	1.33
4U	392.2	8.2	71.9	0.81	1.69
4D	454.8	7.0	170.6	0.40	0.62

Considering non-junction crashes, 4U roads have the highest all severity crash rate independent of the volume category.

In the mid-volume category, the all severity crash rates are higher on 4U roads compared to 3L roads and lower for K+A severity crash rates. This is not consistent with the research for this project.

K+A crash rates on 2U and 4D roads follow the trends of the research for this project.

5.2.5 Posted Speed Limit – All Crashes

Posted Speed 35 MPH or Lower

Statewide Crash Rates

All Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	3,189.2	61.8	499.9	2.95	5.72
3L	369.8	10.8	47.4	3.08	9.00
4U	2,066.2	37.8	89.8	4.29	7.85
4D	1,125.8	19.0	63.1	3.33	5.61

Posted Speed 40 MPH or Higher

Statewide Crash Rates

All Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	927.6	28.4	556.6	0.97	2.96
3L	120.0	2.6	33.0	1.36	2.95
4U	292.8	6.8	45.8	1.70	3.94
4D	2,227.8	36.8	212.1	2.06	3.40

Roads with higher posted speed limits tend to have lower crash rates for both all severity and K+A crash rates.

4U roads have the highest all severity crash rates for lower posted speeds and 4D for highest posted speeds. 3L roads have the highest K+A crash rates on roads with lower posted speed limits.

Project research shows 4D roads should have lower K+A crash rates than 2U roads. In Minnesota in the 40 MPH or higher posted speed category, 2U roads have slightly lower K+A crash rates than 4D roads.

5.2.6 Posted Speed Limit – Non-Junction Crashes

Posted Speed 35 MPH or Lower

Statewide Crash Rates

Non-Junction Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	877.4	18.6	499.9	0.81	1.72
3L	102.0	3.2	47.3	0.85	2.67
4U	500.2	10.4	89.8	1.04	2.16
4D	202.6	3.0	63.1	0.60	0.89

Posted Speed 40 MPH or Higher

Statewide Crash Rates

Non-Junction Crashes, All Pedestrian and Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	388.6	14.4	556.6	0.41	1.50
3L	50.8	1.6	33.0	0.58	1.81
4U	99.8	1.6	45.8	0.58	0.93
4D	426.2	8.4	212.1	0.39	0.78

Disaggregating by speeds and eliminating junction crashes, roads with higher posted speed limits tend to have lower crash rates for both all severity and K+A crash rates.

3L roads have the highest K+A crash rates in both speed groupings.

K+A crash severity rate for 2U to 4D roads follow the trends of project research in both speed categories. However, 4U to 3L roads in the data set do not follow the same trends as identified in the project research.

5.2.7 Pedestrian Facilities – All Crashes

Statewide

All Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	237.8	8.6	261.8	0.87	3.15
3L	17.8	1.0	5.0	1.35	7.59
4U	52.6	1.6	6.4	1.52	4.63
4D	141.4	3.0	12.4	1.60	3.39

All Crashes, Sidewalk on One or Both Sides and No Bicycle Facilities

2U	1,490.6	27.8	189.5	3.44	6.42
3L	73.8	1.0	13.0	2.18	2.96
4U	1,855.6	33.6	80.2	4.53	8.21
4D	880.6	12.6	50.5	2.71	3.88

All Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	2,060.2	44.6	469.1	2.01	4.35
3L	350.6	10.2	48.1	2.81	8.18
4U	348.2	7.6	27.6	2.46	5.37
4D	1,250.6	23.4	115.9	2.26	4.23

Greater Minnesota

All Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	111.2	3.6	183.7	0.77	2.50
3L	14.2	0.8	4.7	1.54	8.67
4U	7.2	0.2	1.2	1.75	4.86
4D	37.4	0.4	3.9	1.11	1.19

All Crashes, Sidewalk on One or Both Sides and No Bicycle Facilities

2U	447.6	4.8	107.9	2.99	3.21
3L	37.2	0.4	10.1	1.46	1.57
4U	493.6	6.2	30.2	3.56	4.47
4D	335.6	1.4	13.4	3.50	1.46

All Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	499.8	8.8	217.1	1.42	2.51
3L	101.4	2.2	24.4	1.95	4.24
4U	42.4	1.2	7.2	2.51	7.11
4D	448.2	6.4	28.2	3.50	5.00

Metro

All Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	126.6	5.0	78.0	0.98	3.87
3L	3.6	0.2	0.3	0.91	5.07
4U	45.4	1.4	5.2	1.49	4.60
4D	104.0	2.6	8.5	1.89	4.73

All Crashes, Sidewalk on One or Both Sides and No Bicycle Facilities

2U	1,043.0	23.0	81.7	3.68	8.11
3L	36.6	0.6	2.9	4.37	7.16
4U	1,362.0	27.4	50.1	5.03	10.12
4D	545.0	11.2	37.1	2.38	4.88

All Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	1,560.4	35.8	252.0	2.31	5.30
3L	249.2	8.0	23.7	3.42	10.98
4U	305.8	6.4	20.4	2.45	5.13
4D	802.4	17.0	87.7	1.89	4.01

No Pedestrian or Bicycle Facilities

Statewide - Roads without pedestrian or bicycle features have the lowest crash rates. This may be due to the surrounding contexts more than whether the pedestrian or bicycle facilities exist. This is also true in Greater Minnesota and the Metro Area.

Without pedestrian and bicycle facilities, considering total crashes, on a statewide basis, the three-lane, four-lane undivided and four-lane divided facilities have similar performance all severity crash rates.

Greater Minnesota - In Greater Minnesota, 2U and 4D roads without pedestrian and bicycle facilities have the lowest all severity and K+A crash rates.

Metro – In Metro Minnesota, 4D roads have the highest crash rates for roads without pedestrian and bicycle facilities.

Sidewalks on One or Both Sides No Bike Facilities

Statewide – Statewide roadways with sidewalks on one or both sides of the street but no bicycle facilities, 4D and 3L facilities have the lowest all severity and K+A severity crash rates.

Sidewalks on One or Both Sides with Bike Facilities

In the case where there are sidewalks on one or both sides of the street, and bicycle facilities, 4D roads have the lowest all severity and K+A crash rates, and 3L roads have the highest crash rates.

5.2.8 Pedestrian Facilities – Non-Junction Crashes

Statewide

Non-Junction Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	97.8	5.8	261.8	0.36	2.12
3L	7.8	0.8	5.0	0.59	6.07
4U	13.4	0.8	6.4	0.39	2.32
4D	30.0	0.4	12.4	0.34	0.45

Non-Junction Crashes, Sidewalk on One or Both Sides and No Bicycle Facilities

2U	413.6	7.2	189.5	0.95	1.66
3L	30.4	0.2	13.0	0.90	0.59
4U	477.2	9.6	80.2	1.17	2.34
4D	157.8	2.6	50.5	0.49	0.80

Non-Junction Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	648.6	16.4	469.1	0.63	1.60
3L	98.8	2.8	48.1	0.79	2.24
4U	74.8	1.4	27.6	0.53	0.99
4D	223.4	4.2	115.9	0.40	0.76

Greater Minnesota

Non-Junction Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	50.6	3.0	183.7	0.35	2.08
3L	7.4	0.6	4.7	0.80	6.50
4U	1.2	0.2	1.2	0.29	4.86
4D	13.0	0.0	3.9	0.39	0.00

Non-Junction Crashes, Sidewalk on One or Both Sides and No Bicycle Facilities

2U	116.8	1.4	107.9	0.78	0.94
3L	21.6	0.2	10.1	0.85	0.79
4U	150.4	2.8	30.2	1.09	2.02
4D	63.4	0.2	13.4	0.66	0.21

Non-Junction Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	210.2	5.2	217.1	0.60	1.48
3L	36.0	0.8	24.4	0.69	1.54
4U	15.8	0.0	7.2	0.94	-
4D	78.4	1.6	28.2	0.61	1.25

Metro

Non-Junction Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	47.2	2.8	78.0	0.37	2.17
3L	0.4	0.2	0.3	0.10	5.07
4U	12.2	0.6	5.2	0.40	1.97
4D	17.0	0.4	8.5	0.31	0.73

Non-Junction Crashes, Sidewalk on One or Both Sides and No Bicycle Facilities

2U	296.8	5.8	81.7	1.05	2.04
3L	8.8	0.0	2.9	1.05	-
4U	326.8	6.8	50.1	1.21	2.51
4D	94.4	2.4	37.1	0.41	1.05

Non-Junction Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	438.4	11.2	252.0	0.65	1.66
3L	62.8	2.0	23.7	0.86	2.75
4U	59.0	1.4	20.4	0.47	1.12
4D	145.0	2.6	87.7	0.34	0.61

No Pedestrian or Bicycle Facilities

Statewide - Considering, non-junction crashes only, roads without pedestrian or bicycle features have the lowest crash rates. This may be due to the surrounding contexts more than whether the pedestrian or bicycle facilities exist.

Without pedestrian and bicycle facilities, considering non-junction crashes, on a statewide basis, the two-lane and 4D roads have similar all severity crash rates. For non-junction crashes on roads without pedestrian or bicycle facilities, 4D roads have the lowest K+A crash rate.

Greater Minnesota – In Greater Minnesota, 3L roads have the highest all severity and K+A crash rates.

Metro – In Metro Minnesota, 3L roads have the lowest crash rates for roads without pedestrian and bicycle facilities.

Sidewalks on One or Both Sides, No Bike Facilities

Statewide - On a Statewide basis, 4D and 3L roads with sidewalks on one or both sides of the street but no bicycle facilities have the lowest all severity and K+A severity crash rates.

Greater Minnesota and the Metro Area - 4D roads with sidewalks on one or both sides of the street but no bicycle facilities have the lowest all severity crash rates and K+A crash rates.

Sidewalks on One or Both Sides, With Bike Facilities

Statewide - On a statewide basis, in the case where there are sidewalks on one or both sides of the street, and bicycle facilities, 4D roads have the lowest crash rates and 3L roads have the highest crash rates.

Metro Area - In the Metro area, 4D roads with sidewalks on one or both sides of the street and bicycle facilities have the lowest all severity and K+A crash rate.

5.2.9 Bicycle Facilities – All Crashes

Statewide

All Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	237.8	8.6	261.8	0.87	3.15
3L	17.8	1.0	5.0	1.35	7.59
4U	52.6	1.6	6.4	1.52	4.63
4D	141.4	3.0	12.4	1.60	3.39

All Crashes, No Pedestrian Facilities and Bicycle Facilities on One or Both Sides

2U	328.2	9.2	136.2	1.07	3.00
3L	47.6	1.2	14.3	1.31	3.29
4U	102.6	1.8	21.4	1.50	2.63
4D	1,081.0	16.8	96.5	2.38	3.69

All Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	2,060.2	44.6	469.1	2.01	4.35
3L	350.6	10.2	48.1	2.81	8.18
4U	348.2	7.6	27.6	2.46	5.37
4D	1250.6	23.4	115.9	2.26	4.23

Greater Minnesota

All Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	111.2	3.6	183.7	0.77	2.50
3L	14.2	0.8	4.7	1.54	8.67
4U	7.2	0.2	1.2	1.75	4.86
4D	37.4	0.4	3.9	1.11	1.19

All Crashes, No Pedestrian Facilities and Bicycle Facilities on One or Both Sides

2U	162.6	3.2	63.1	1.47	2.89
3L	37.6	0.6	9.3	1.92	3.07
4U	30.8	0.6	4.2	3.19	6.22
4D	463.0	5.6	36.3	2.84	3.44

All Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	499.8	8.8	217.1	1.42	2.51
3L	101.4	2.2	24.4	1.95	4.24
4U	42.4	1.2	7.2	2.51	7.11
4D	448.2	6.4	28.2	3.50	5.00

Metro

All Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	126.6	5.0	78.0	0.98	3.87
3L	3.6	0.2	0.3	0.91	5.07
4U	45.4	1.4	5.2	1.49	4.60
4D	104.0	2.6	8.5	1.89	4.73

All Crashes, No Pedestrian Facilities and Bicycle Facilities on One or Both Sides

2U	165.6	6.0	73.1	0.85	3.07
3L	10.0	0.6	5.0	0.59	3.55
4U	71.8	1.2	17.2	1.22	2.04
4D	618.0	11.2	60.2	2.11	3.83

All Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	1,560.4	35.8	252.0	2.31	5.30
3L	249.2	8.0	23.7	3.42	10.98
4U	305.8	6.4	20.4	2.45	5.13
4D	802.4	17.0	87.7	1.89	4.01

No Pedestrian Facilities, Bicycle Facilities on One or Both Sides

In all three geographies, 2U roadways had a lower all severity and K+ A crash rate than 4D roads with no pedestrian facilities but bike facilities on one or both sides of the road.

In all three geographies, 3L roadways had lower all severity crash rates than 4U roads with no pedestrian facilities but bike facilities on one or both sides of the road. However, the K+A crash rates were higher for statewide and Metro.

5.2.10 Bicycle Facilities- Non-Junction Crashes

Statewide

Non-Junction Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	97.8	5.8	261.8	0.36	2.12
3L	7.8	0.8	5.0	0.59	6.07
4U	13.4	0.8	6.4	0.39	2.32
4D	30.0	0.4	12.4	0.34	0.45

Non-Junction Crashes, No Pedestrian Facilities and Bicycle Facilities on One or Both Sides

2U	106.0	3.6	136.2	0.35	1.17
3L	15.8	1.0	14.3	0.43	2.74
4U	34.6	0.2	21.4	0.51	0.29
4D	217.6	4.2	96.5	0.48	0.92

Non-Junction Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	648.6	16.4	469.1	0.63	1.60
3L	98.8	2.8	48.1	0.79	2.24
4U	74.8	1.4	27.6	0.53	0.99
4D	223.4	4.2	115.9	0.40	0.76

Greater Minnesota

Non-Junction Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	50.6	3.0	183.7	0.35	2.08
3L	7.4	0.6	4.7	0.80	6.50
4U	1.2	0.2	1.2	0.29	4.86
4D	13.0	0.0	3.9	0.39	-

Non-Junction Crashes, No Pedestrian Facilities and Bicycle Facilities on One or Both Sides

2U	49.2	1.6	63.1	0.44	1.44
3L	11.2	0.6	9.3	0.57	3.07
4U	7.2	0.0	4.2	0.75	-
4D	113.2	1.8	36.3	0.70	1.11

Non-Junction Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	210.2	5.2	217.1	0.60	1.48
3L	36.0	0.8	24.4	0.69	1.54
4U	15.8	0.0	7.2	0.94	-
4D	78.4	1.6	28.2	0.61	1.25

Metro

Non-Junction Crashes, No Pedestrian and No Bicycle Facilities

Facility	Average Total Crashes Per Year	Average K+A Crashes Per Year	Total Miles	All Severity Crash Rate (MVMT)	K+A Severity Crash Rate (HMVMT)
2U	47.2	2.8	78.0	0.37	2.17
3L	0.4	0.2	0.3	0.10	5.07
4U	12.2	0.6	5.2	0.40	1.97
4D	17.0	0.4	8.5	0.31	0.73

Non-Junction Crashes, No Pedestrian Facilities and Bicycle Facilities on One or Both Sides

2U	56.8	2.0	73.1	0.29	1.02
3L	4.6	0.4	5.0	0.27	2.37
4U	27.4	0.2	17.2	0.47	0.34
4D	104.4	2.4	60.2	0.36	0.82

Non-Junction Crashes, Sidewalk on One or Both Sides, Bike Facilities on One or Both Sides

2U	438.4	11.2	252.0	0.65	1.66
3L	62.8	2.0	23.7	0.86	2.75
4U	59.0	1.4	20.4	0.47	1.12
4D	145.0	2.6	87.7	0.34	0.61

No Pedestrian or Bicycle Facilities

Statewide, both 3L crash rates were higher than the 4U roads with no pedestrian or bicycle facilities.

In Greater Minnesota, on roads with no pedestrian or bicycle facilities, 3L roads have a higher all severity and K+A crash rates than 4U roads.

In the Metro area, 2U roads have higher all severity and K+A crash rates than 4D roads. 3L roads have lower All severity crash rate and higher K+A crash rates than 4U roads.

No Pedestrian Facilities, Bicycle Facilities on One or Both Sides

Statewide, all severity crash rates are higher on 4D roads than 2U roads. The K+A crash rates are lower on 4D roads.

CHAPTER 6: SUMMARY OF FINDINGS AND RECOMMENDATIONS

The objective of this research study was to understand Statewide, Greater Minnesota and Metro area crash frequency, crash rate, and crash severity on 2U, 3L, 4U and 4D roads; and to compare safety performance between 2U and 4D roads as well as 4U and 3L roads. A database containing urban area road segments of various facility types was compiled and crash data linked to the roadway segments. Between 2016 and 2020, there were 51,595 crashes on these roads (i.e., junction plus non-junction crashes). On average there were 10,320 crashes (all severities) per year and 204 K+A crashes per year.

Overall, there were approximately 1,550 miles of roads in the data set. Approximately two-thirds of the mileage in the data set were 2U roads, and about one-third of the miles in dataset had less than 5,000 vehicles per day. Approximately 45% of the roads in the database had a posted speed of 35 miles per hour or less and the rest of the roads had a posted speed limit of 40 mph or higher. Finally, most of the roadways had no bike facilities and no pedestrian facilities.

On a statewide basis considering all K+A crashes (junction and non-junction) the crash rates were consistent with the literature: 4D K+A crash rates were lower than 2U crash rates, and 3L K+A crash rates were lower than 4U crash rates. However, anomalies emerged as the data were disaggregated: in the Metro area, the K+A crash rates on 3L roads are ***higher*** than K+A crash rates on 4U roads; and throughout the state the non-junction K+A crash rates on 3L roads are ***higher*** than 4U roads.

Recognizing the anomalous results based only a descriptive assessment (no statistical analysis), several additional analyses were conducted in an attempt to understand these differences from expectations; however, no findings were evident. Therefore, the findings presented herein should be used cautiously given the variation of results and decreasing sample size as data is disaggregated. Additional research is needed to understand these results.

It is recommended the additional research be conducted using a cross-sectional analysis with regression models. The generalized workflow for this effort would be:

- Re-evaluate database for sufficiency for cross-sectional analysis (e.g., minimums, maximums, or missing data); consider updating data to current period.
    - It is likely that additional data will be needed for 3L and 4U roads as the sample size for this work was relatively small.
- Segment matching to pair similar facilities for evaluation.
- Develop safety performance functions to predict crash experience on the facilities and estimate the CMFs based on the models.

An important part of conducting this type of analysis will be acquiring and integrating information into the data set about roadway features for a given segment each year. The cross-sectional analysis will span multiple years and it will be important to know features on the segment for each year. Given current characteristics of current MnDOT databases, acquiring this information may require significant effort.

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