LOUISIANA

Vulnerable Road User Safety Assessment

NOVEMBER 15, 2023 | FINAL

DESTINATION ZERO DEATHS

A Letter from Secretary Kalivoda

As the ultimate traffic safety goal for the State, **Destination Zero Deaths**—where no one is killed or seriously injured in a traffic-related crash on Louisiana public roads—is the long-term vision of the Louisiana Department of Transportation and Development (DOTD). The DOTD remains steadfast in its mission to reduce fatalities and serious injuries on Louisiana roadways, especially among the most vulnerable users such as pedestrians and cyclists.

The Louisiana Vulnerable Road User (VRU) Safety Assessment addendum to the State's 2022 Strategic Highway Safety Plan (SHSP) meets federal requirements to use a data-driven process to assess the safety performance of Louisiana roadways with respect to vulnerable road users. This report is a tool for the DOTD, Louisiana State Police (LSP), the Louisiana Highway Safety Commission (LHSC), and other state agencies, as well as the State of Louisiana's partners—including local governments, non-profit organizations, academia, advocacy groups, law enforcement, and private sector partners—to engage in supporting the Safe System Approach for the safety of all road users, including those who walk, bike, drive, ride transit, and travel by other modes.

The goal of the Louisiana VRU Safety Assessment is to develop a State plan to improve the safety of VRUs with a long-term vision of achieving zero deaths and serious injuries on Louisiana roads. VRU safety must be considered in transportation investment decisions, including planning, programming, environmental analyses, design, construction, and operations and maintenance.

Disadvantaged communities are disproportionately affected by adverse safety impacts, including high rates of VRU fatalities. DOTD recognizes equity impacts such as socioeconomic disparities and uses a data driven approach to identifying potential safety improvements. The Louisiana VRU Safety Assessment addresses equity by considering the impacts to these underserved communities.

Development of the Louisiana VRU Safety Assessment included consultations with local stakeholders to develop VRU concepts, countermeasures, and strategies. Like the 2022 SHSP, the Louisiana VRU Safety Assessment is a planning-level document and additional effort will be needed to further develop the strategies identified in the Louisiana VRU Safety Assessment and to identify and develop projects as part of the transportation planning process. Partnerships with stakeholders will help guide implementation over the next four years into development of the next SHSP and associated Louisiana VRU Safety Assessment updates.

Remember, **Destination Zero Deaths** is not just a statewide goal. It is a goal that starts with your family, your friends, and your community. Just like any goal, it requires effort. Join me in this effort; we need each driver to do their part. Zero is the only acceptable number of deaths on Louisiana's roads.

Eric Kalivoda
Secretary

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This document and the information contained herein, is prepared for the purpose of identifying, evaluating, and planning safety improvements on public roads, which may be implemented utilizing federal aid highway funds. This information shall not be subject to discovery or admitted into evidence in Federal or State court pursuant to 23 U.S.C. 407.

Abbreviations and Acronyms

AIC	Akaike's Information Criterion
CMF	Crash Modification Factor
CRF	Crash Reduction Factor
DOTD	Louisiana Department of Transportation and Development
FHWA	Federal Highway Administration
HDC	Historically Disadvantaged Community
HSIP	Highway Safety Improvement Program
LEHD	Longitudinal-Employer Household Dynamics
LHSC	Louisiana Highway Safety Commission
LSP	Louisiana State Police
LSU CARTS	Louisiana State University Center for Analytics & Research in Transportation Safety
LTAP	Louisiana Local Technical Assistance Program
MPO	Metropolitan Planning Organization
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
PHB	Pedestrian Hybrid Beacon
RSC	Regional Safety Coalition
SHSP	Strategic Highway Safety Plan
SSA	Safe System Approach
SPF	Safety Performance Function
USDOT	United States Department of Transportation
VMT	Vehicle Miles Traveled
VRU	Vulnerable Road User

Introduction

1

Why Address Vulnerable Road Users?

In the United States, a growing number of roadway fatalities and injuries are occurring between vulnerable road users (VRUs) and motor vehicles.[1] The Federal Highway Administration (FHWA) defines a VRU as a non-motorist such as a person walking, biking, or using a personal conveyance device. It also includes highway workers on foot in a work zone. Nationally, 2021 experienced the highest number of traffic fatalities since 2005.[2] From 2020 to 2021, bicyclist fatalities were up 1.9% and pedestrian fatalities were up 13%.[3] FHWA's vision is achieving zero deaths on the Nation's roads. Therefore, FHWA is encouraging States to prioritize VRU safety in all federal highway investments and in all projects.

Between 2016 and 2020 in Louisiana, the total percent of VRU fatalities was 21% of the total roadway fatalities. Louisiana's 2022 Strategic Highway Safety Plan (SHSP) identifies a Destination Zero Deaths Initiative to eliminate traffic-related deaths in Louisiana. The first goal is to reduce fatalities and serious injuries by 50% between 2010 and 2030.

Development of the Louisiana VRU Safety Assessment supports two strategies in the 2022 SHSP under the Infrastructure and Operations Emphasis Area. The first is to identify or develop sources of information that assist with the selection of safety projects and provide outreach and training to all SHSP/Highway Safety Improvement Program (HSIP) stakeholders. The second is to improve data collection, quality, analysis, mapping, and reporting for all public roads and educate users on how to access the information for evaluation, project selection, and prioritization.

Addressing the safety of VRUs through a multifaceted, collaborative, and comprehensive approach will allow people that walk, bike, and roll safe and comfortable access to the transportation system.

What is a Vulnerable Road User (VRU) Safety Assessment?

This initial Louisiana VRU Safety Assessment is an addendum to the state's 2022 SHSP and will be updated with subsequent updates of the 2022 SHSP. The assessment consists of an overview of the state's safety performance as it relates to VRUs, including crash and demographic trends related to crashes involving fatalities and serious injuries. Using a systemic, data-driven approach, the assessment identifies target areas in the state for VRU improvements. The assessment presents potential improvement strategies such as infrastructure countermeasures, education and outreach, and programs or policies. Finally, the assessment summarizes the consultation process with targeted communities.

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[1] FARS Encyclopedia (dot.gov) and Fatality and Injury Reporting System Tool (FIRST) (dot.gov)
[2] Overview of Motor Vehicle Traffic Crashes in 2021 (dot.gov)
[3] Ibid.

How was the Assessment Completed?

The Louisiana VRU Safety Assessment started with an analysis of statewide VRU crash trends. Then an area-based network screening evaluation was performed to identify pedestrian and bicycle Target Analysis Areas. Upon identifying the Target Analysis Areas in this assessment, the project team consulted with those communities to evaluate strategies to improve the safety of VRUs. The findings from the data analysis and consultation with local agencies informed the program of strategies to improve safety conditions.

The Louisiana VRU Safety Assessment adheres to the principles and objectives of the Safe System Approach (SSA), which addresses the safety of all road users. The SSA is a holistic and comprehensive approach that provides a guiding framework to make transportation safer for people. Fundamentally, the SSA works by anticipating human mistakes and lessening impact forces to reduce crash severity and save lives. **Figure 1** outlines the six SSA principles that explain how the overall goal of the approach is to prioritize eliminating crashes that result in death and serious injuries. **Figure 2** identifies the SSA objectives which include infrastructure strategies such as safe speeds and safe roads, which slow motorized traffic and physically separate VRUs from motorized traffic in time and in space. The SSA deals with safety from multiple perspectives, ranging from the variety of road users, to the vehicles we drive, to the speeds we travel at, to the design of the roads, and post-crash care in the event of a crash.

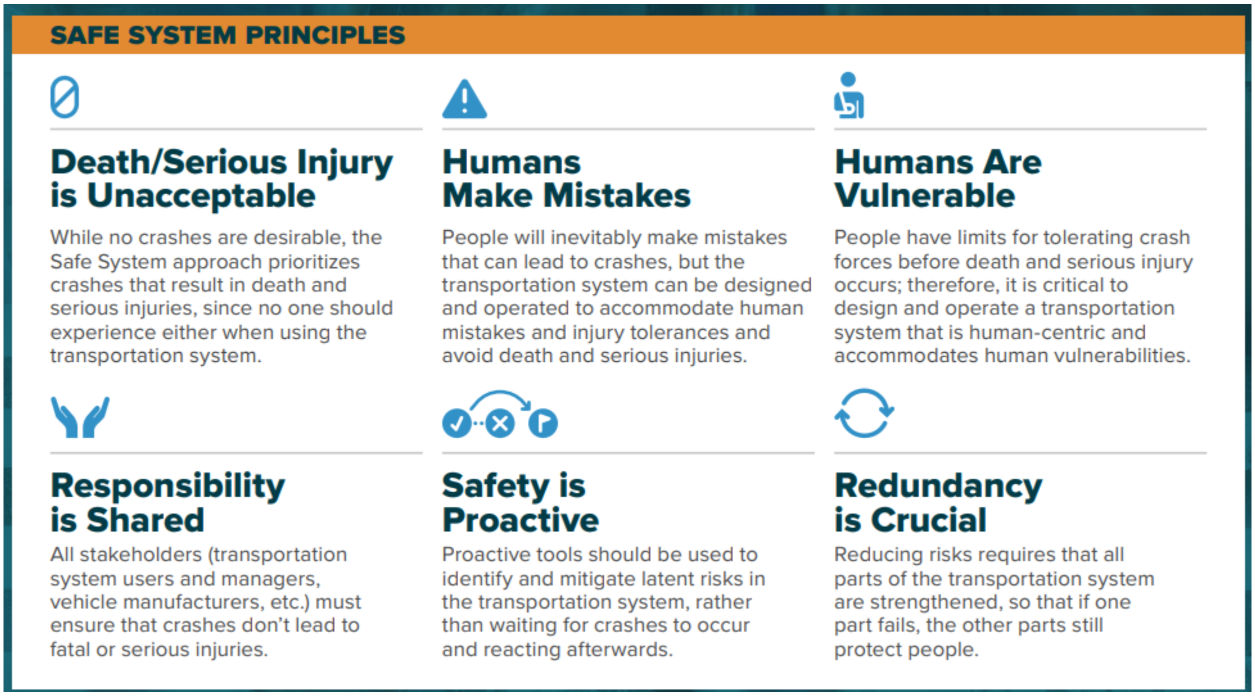

Figure 1. Safe System Principles. Source: U.S. DOT, Safe System Approach Flyer

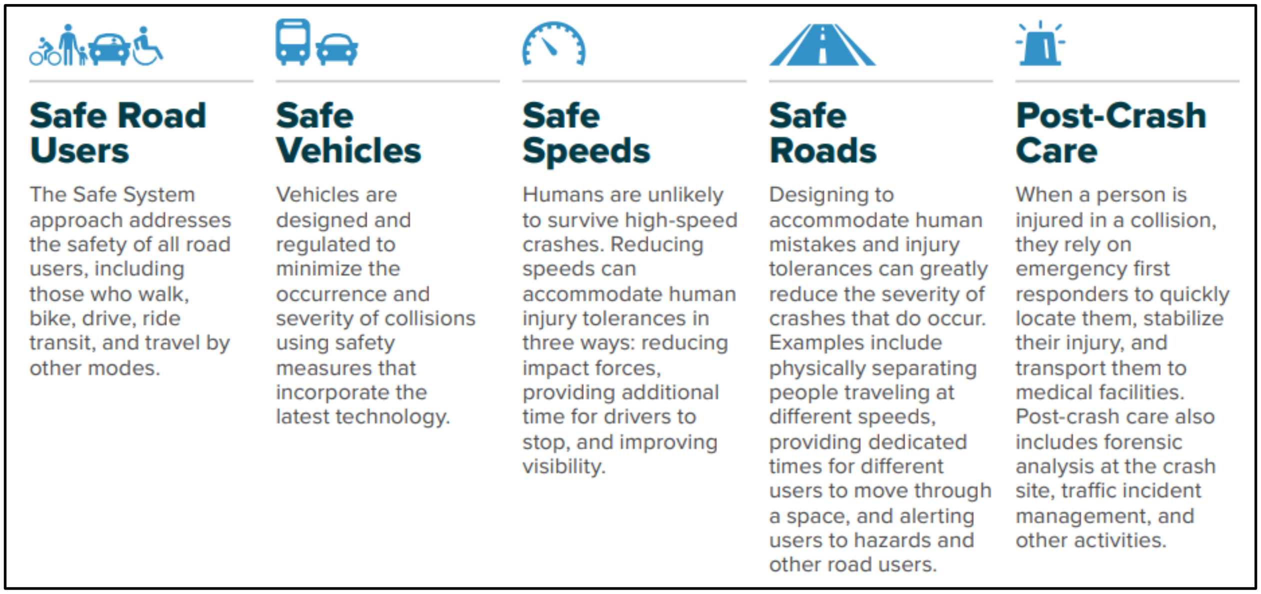

Figure 2. Safe System Approach Objectives. Source: U.S. DOT, Safe System Approach Flyer

The Louisiana VRU Safety Assessment also considers equity impacts such as racial disparities, access for elderly and those with disabilities, workforce development, economic development, and automobile dependence. Nationally, underserved communities, including American Indian/Alaskan Native and Black populations and those living in poverty, are disproportionately affected by adverse safety impacts, including high rates of pedestrian fatalities.[4] The Louisiana VRU Safety Assessment will address equity by considering the impacts to these underserved communities. Populations that share a particular characteristic, as well as geographic communities, and have been systematically denied a full opportunity to participate in aspects of economic, social, and civic life are considered underserved communities.

FHWA guidance for VRU safety assessments encourages projects that address climate change and sustainability. Throughout the planning and project development process, projects should consider how they can address greenhouse gas reduction, climate resilience, and environmental justice commitments. This process can be done by providing facilities that encourage walking, biking, and rolling along with supporting fiscally responsible land use and efficient transportation design.

[4] National Roadway Safety Strategy (transportation.gov)

Overview of VRU Safety Performance

2

Chapter 2 of the Louisiana VRU Safety Assessment summarizes initial crash data exploration and analysis. This chapter discusses the data that were compiled, presents historical trends for VRU fatalities and serious injuries over a 10-year period, and summarizes the results of the crash disaggregation analysis.

Data Compilation

Statewide data, comprehensive of all roadway types, was collected and assembled into a geodatabase for use in the Louisiana VRU Safety Assessment. Data included statewide coverage of roadways, location of parks and schools, crash location and attributes, 2020 US Census data, location of transit stops, volume data for vehicles, pedestrians, bicyclists and transit, employment, signalized intersection location, and census tracts classified as Historically Disadvantaged Communities as defined per the USDOT.[5] Appendix A provides more detail on data collected, sources, and descriptions.

VRU Fatal and Serious Injury Trends

Crash data for 2012-2021, and other statewide data mentioned above, were analyzed for trends in VRU fatalities and serious injuries. Louisiana's initial target goal is to reduce fatalities and serious injuries by 50% between 2010 and 2030; however, as shown in **Figure 3,** non-motorist fatalities and serious injuries have increased by almost 50% over the last 10 years from 302 serious injuries or fatalities in 2012 to 451 serious injuries or fatalities in 2021. **Figure 3** shows the 2018 through 2024 5-year rolling average targets for non-motorist fatal and serious injuries. As the 5-year rolling averages have continued to increase, the targets have continued to not be met. In order for the 2023 target to be met, statewide non-motorist fatal and serious injuries will need to average less than 360 for 2022 and 2023. For the calendar year 2024 performance target to be met, Louisiana will need the 2022 through 2024 non-motorist fatal and serious injury total to average less than 444 for these three years.

[5] Transportation Disadvantaged Census Tracts (Historically Disadvantaged Communities) Interim Definition Methodology | US Department of Transportation

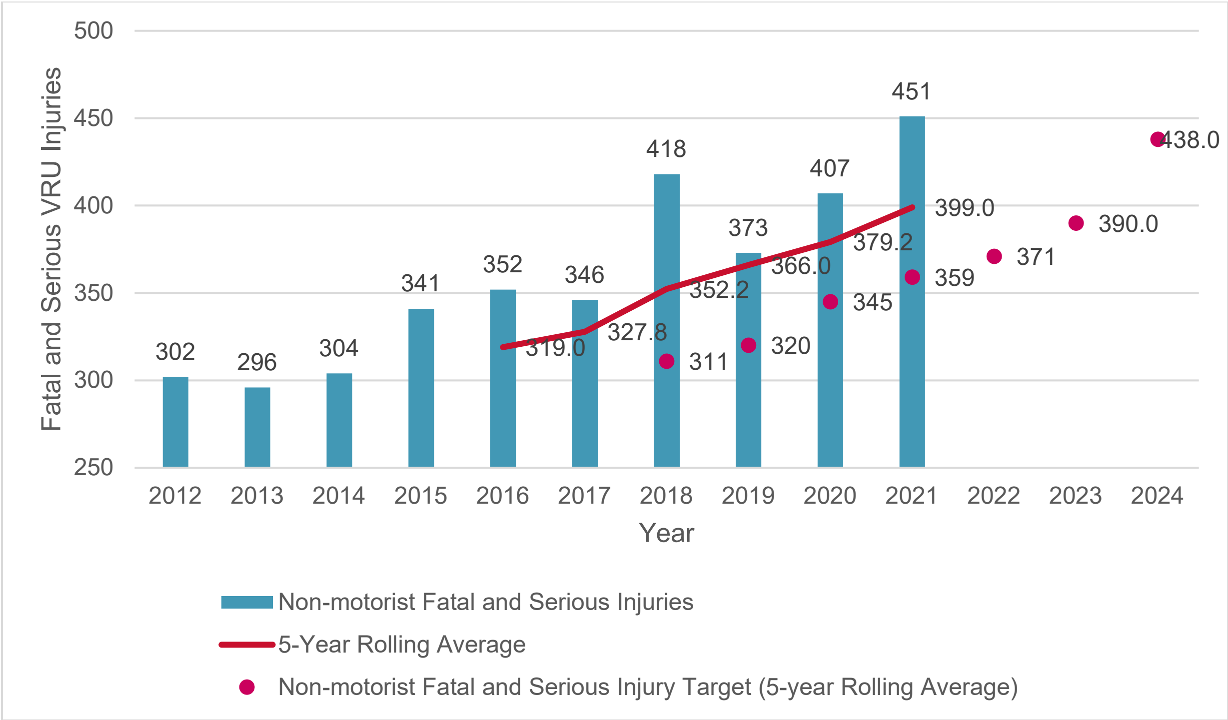

Figure 3. Non-motorist Fatal and Serious Injuries by Year

Figure 4 highlights VRU crash trends (2012-2021) that were found in Louisiana. Appendix A presents a full narrative of the crash trend analysis. Review of the crash data also revealed that Friday and Saturday have the highest frequencies of VRU fatal and suspected serious injuries. Of the VRU fatal and suspected serious injuries that occur at night or in low light conditions, 39% occur where street lighting is not present. For pedestrian fatal and serious injuries when comparing age and race, the younger age groups tend to be more predominantly Black while the older age groups skew white. Bicyclist fatal and serious injuries have a higher concentration of injuries in the "35-65" age groups.

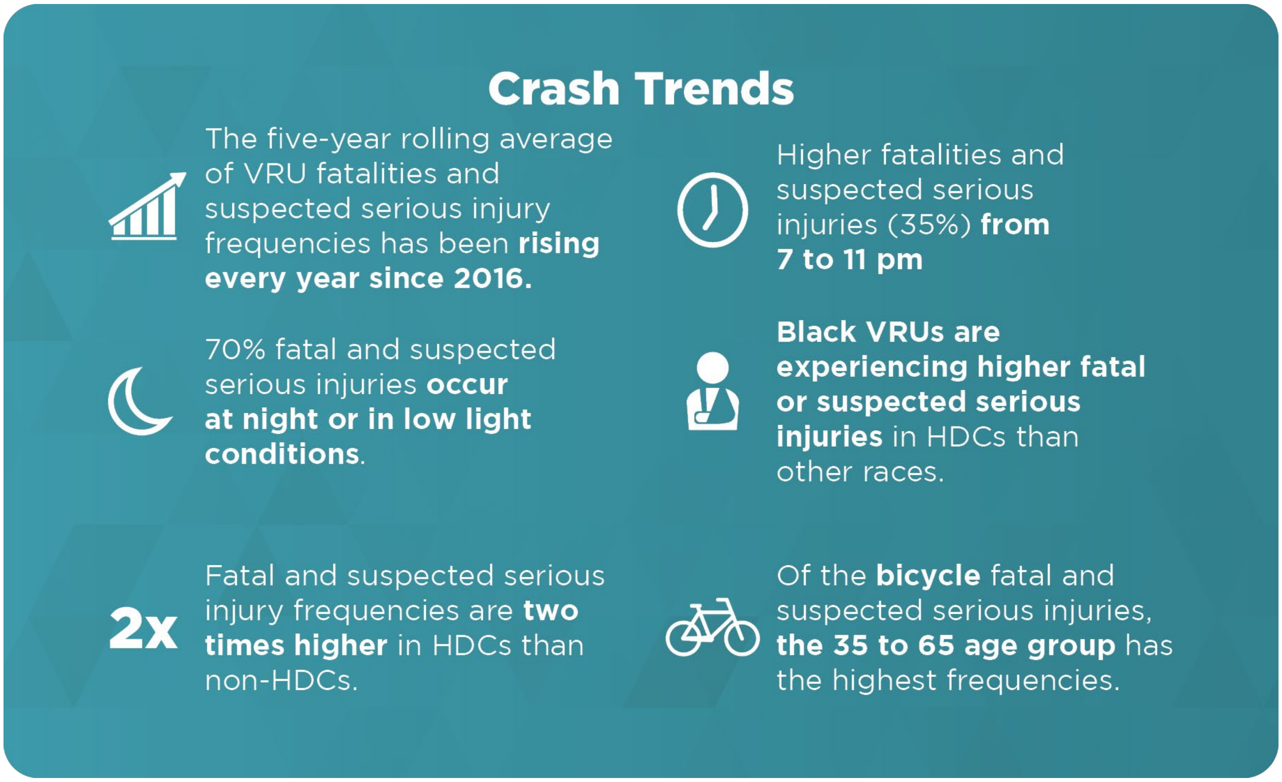

Figure 4. VRU Involved Crash Trends (2012-2021)

Crash Disaggregation Analysis

The objective of the crash disaggregation analysis was to identify target facility types for pedestrians and bicyclists. Crash injury outcomes were spatially matched with Louisiana's Highway Class layer. A crash tree tool was used to perform the crash disaggregation analysis. The output of the tool is shown in Appendix A.

A three-layered tree was developed. The first layer split pedestrians and bicyclists with fatal or suspected serious injuries statewide, 2012-2021. Of the 3,590 VRU fatalities or suspected serious injuries over that period, 2,924 (81%) were pedestrians and 666 (19%) were bicyclists.

The second layer split pedestrians and bicyclists by whether the crash they were involved with was intersection related, as indicated by the crash data. Most pedestrians and bicyclists were injured or killed at locations not involving intersections. Only 29% of pedestrian injuries or fatalities (36% for bicyclists) were at intersections.

Lastly, the highway classification of the roadway where the crash was located was used to further refine the crash tree. The goal of the crash tree was to determine roadway facility types that represent where most of the pedestrian and bicycle crashes occur. The crash tree indicates that most intersection and non-intersection crashes involving fatally or seriously injured pedestrians and bicyclists occur on urban two-lane roadways. Urban two-lane roadways account for approximately 19% of all roadway centerline mileage in Louisiana. However, the crash tree does not account for the length of highway class categories in Louisiana and the density of fatalities and serious injuries by highway class. To supplement the crash tree and determine other high priority roadway types, **Table 1** presents total centerline mileage, number of pedestrian fatalities and serious injuries, and the number of pedestrian fatalities and serious injuries per mile by highway class. The last column represents a density measurement which may be a better measure of identifying target facility types than just using the facility types with the highest pedestrian-involvement frequency. The facility types with the highest pedestrian fatality-and-serious injury densities were urban roadways with six or more lanes and a continuous two-way left-turn lane, followed by urban divided roadways with six or more lanes, urban four-lane roadways with a continuous two-way left-turn lane, urban three-lane roadways, rural two-lane roadways with a continuous two-way left-turn lane, and urban four-lane undivided roadways. Some of these facility types have relatively low statewide centerline mileage. For the purposes of this study, no statistical tests were conducted to check for regression-to-the-mean errors associated with comparing the facility types.

Table 1. Pedestrian Fatalities and Serious Injuries (2012-2021) and Pedestrian Fatality-and-Serious-Injury Density by Highway Class

Highway Class	Total Centerline Mileage	Pedestrian Fatalities and Serious Injuries (2012-2021)	Pedestrian Fatalities and Serious Injuries per Mile
Urban >=6-lane Cont Turn	4.8	16	3.36
Urban >=6-lane Divided	99.7	124	1.24
Urban 4-lane Cont Turn	158.0	129	0.82
Urban 3-lane	14.7	11	0.75
Rural 2-lane Cont Turn	8.2	6	0.73
Urban 4-lane	408.8	262	0.64
Urban 2-lane Cont Turn	53.7	29	0.54
Urban 6-lane Interstate	196.0	88	0.45
Urban 8-lane Interstate	10.9	4	0.37
Urban 2-lane Interstate	7.6	2	0.26
Urban 4-lane Divided	1,438.5	342	0.24
Urban 3-lane Interstate	20.8	4	0.19
Rural 6-lane Interstate	55.7	9	0.16
Urban 4-lane Interstate	596.9	79	0.13
Urban 4-lane Freeway	166.8	22	0.13
Urban 2-lane Divided	1,138.4	138	0.12
Urban 1-way varied	1,006.8	114	0.11
Rural 4-lane Cont Turn	27.5	3	0.11
Rural 3-lane Divided	9.7	1	0.10
Rural 4-lane	55.8	5	0.09
Urban 2-lane	20,085.1	1,090	0.05
Rural 4-lane Interstate	999.1	43	0.04
Rural 4-lane Divided	1,463.8	47	0.03
Rural 2-lane Divided	106.4	1	0.01
Other Urban Roads	4,931.9	44	0.01
No Class Name Given	8,245.8	53	0.01
Rural 2-lane	41,081.5	255	0.01

Highway Class	Total Centerline Mileage	Pedestrian Fatalities and Serious Injuries (2012-2021)	Pedestrian Fatalities and Serious Injuries per Mile
Other Rural Roads	24,536.5	3	0.00
Rural 1-way 1-lane	138.3	0	0.00
Urban 5-lane Interstate	4.7	0	0.00
Rural 1-way 2-lane	59.2	0	0.00
Urban 3-lane Divided	2.1	0	0.00
Urban 6-lane	1.4	0	0.00

Table 2 presents total centerline mileage, number of bicyclist fatalities and serious injuries, and the number of bicyclist fatalities and serious injuries per mile by highway class. Like Table 1, the last column represents the density measurement. The facility type with the highest bicyclist fatality-and-serious-injury density was urban divided roadways with six or more lanes, followed by urban three-lane roadways, urban roadways with six or more lanes and a continuous two-way left-turn lane, urban four-lane roadways with a continuous two-way left-turn lane, urban four-lane undivided roadways, and urban four-lane divided roadways.

Table 2. Bicyclist Fatalities and Serious Injuries (2012-2021) and Bicyclist Fatality-and-Serious-Injury Density by Highway Class

Highway Class	Total Centerline Mileage	Bicyclist Fatalities and Serious Injuries (2012-2021)	Bicyclist Fatalities and Serious Injuries per Mile
Urban >=6-lane Divided	99.7	37	0.37
Urban 3-lane	14.7	4	0.27
Urban >=6-lane Cont Turn	4.8	1	0.21
Urban 4-lane Cont Turn	158.0	31	0.20
Urban 4-lane	408.8	53	0.13
Urban 4-lane Divided	1,438.5	84	0.06
Urban 2-lane Cont Turn	53.7	3	0.06
Urban 1-way varied	1,006.8	40	0.04
Urban 2-lane Divided	1,138.4	43	0.04
Rural 4-lane	55.8	1	0.02
Urban 6-lane Interstate	196.0	3	0.02
Urban 2-lane	20,085.1	273	0.01
Rural 4-lane Divided	1,463.8	13	0.01
Urban 4-lane Interstate	596.9	2	0.00
Other Urban Roads	4,931.9	15	0.00
Rural 2-lane	41,081.5	56	0.00
No Class Name Given	8,245.8	6	0.00
Other Rural Roads	24,536.5	1	0.00
Rural 2-lane Cont Turn	8.2	0	0.00
Urban 8-lane Interstate	10.9	0	0.00
Urban 2-lane Interstate	7.6	0	0.00
Urban 3-lane Interstate	20.8	0	0.00

Highway Class	Total Centerline Mileage	Bicyclist Fatalities and Serious Injuries (2012-2021)	Bicyclist Fatalities and Serious Injuries per Mile
Rural 6-lane Interstate	55.7	0	0.00
Urban 4-lane Freeway	166.8	0	0.00
Rural 4-lane Cont Turn	27.5	0	0.00
Rural 3-lane Divided	9.7	0	0.00
Rural 4-lane Interstate	999.1	0	0.00
Rural 2-lane Divided	106.4	0	0.00
Rural 1-way 1-lane	138.3	0	0.00
Urban 5-lane Interstate	4.7	0	0.00
Rural 1-way 2-lane	59.2	0	0.00
Urban 3-lane Divided	2.1	0	0.00
Urban 6-lane	1.4	0	0.00

Conclusions

The objective of the crash disaggregation analysis was to identify target facility types for pedestrians and bicyclists in Louisiana. Using the crash tree alone, urban two-lane roadways are shown to have the most pedestrian-and-bicyclist fatalities and serious injuries (both intersection- and non-intersection-related crashes) during 2012-2021. When systemwide centerline mileage of highway classifications is considered, the facility types that have the highest number of pedestrian-and-bicyclist fatalities and serious injuries per mile are typically urban roadways with large cross sections. Five of the six facility types with the highest pedestrian fatality-and-serious-injury density are also five of the six facility types with the highest bicyclist fatality-and-serious-injury density. Vehicle miles traveled (VMT) of these target facility types were considered in developing the predictive models of the Louisiana VRU Safety Assessment, which is discussed in the following chapter.

The crash disaggregation analysis could be enhanced in the future by introducing additional roadway elements, such as posted speed limit, land use characteristics, access point density, and context classification. Additionally, performing the crash disaggregation analysis for intersections using intersection characteristics will greatly inform the analysis. Statewide data limitations prevented the Louisiana VRU Safety Assessment from performing the crash disaggregation analysis with these additional data.

In addition, given the high number of fatalities and serious injuries that occur on urban two-lane roadways, DOTD could explore additional analysis and programming to identify systematic approaches to reducing crashes (e.g., conversion of standard crosswalks to highly reflective crosswalks) on these roads.

Summary of Quantitative Analysis and Findings

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The objective of the quantitative analysis was to identify Target Analysis Areas to focus on developing strategies to reduce pedestrian and bicycle crash frequency. Area-based safety performance functions (SPFs) were developed to predict pedestrian crashes and bicycle crashes separately. The National Cooperative Highway Research Program (NCHRP) Project 17-81 is an example of a past study that has created area-based SPFs. The SPFs along with observed crash data were used to calculate pedestrian and bicycle excess expected crash frequency for defined areas in Louisiana. This resulted in the identification of 20 Target Analysis Areas for pedestrian crashes and 20 Target Analysis Areas for bicycle crashes.

Data Collection

Datasets were collected for the purposes of SPF development. The Louisiana VRU Safety Assessment was a statewide assessment, including all roadways. Any dataset that was used to develop SPFs was required to be statewide and not just partial to state-owned roadways or regional in nature. Also, given the short timeframe of this assessment, the data were used "as-is" and no manual data collection was performed. The following are the data that were compiled for SPF development. Appendix A discusses the data collected in more detail.

- Highway classification
- Crash data
- Traffic volume
- Historically disadvantaged community locations
- Locations of parks and schools
- US Census data: household income, race, age, and mode choice of work commuters
- Bike miles traveled, walk miles traveled, and transit miles traveled
- Employment data
- Transit stop locations
- Signalized intersection locations

FHWA's guidance for VRU safety assessments suggested using speed-related data for the quantitative analysis. However, no statewide comprehensive databases of either design speed, operating speed, or speed limits were available that could be used in this quantitative analysis. Additionally, including more information about intersections would have been ideal for developing SPFs. Unfortunately, a statewide database of all intersections that includes intersections of non-state-owned roadways was not available. Future analyses may benefit from having these data.

H3 polygons were used to divide the state of Louisiana into areas for model development and application. H3 is an open-source hierarchical geospatial indexing scheme originally developed to manage global geospatial data. H3 divides the earth's surface into a grid of hexagonal cells. At resolution "zero" of the framework, 122 cells cover the earth. At each subsequent resolution, each hexagonal cell is further subdivided into 7 smaller hexagons. At resolution 7, the resolution used in this study, the average hexagon area is approximately 5 km^2, and approximately 24,500 hexagons cover the state of Louisiana. H3 was chosen for this study because it allows for efficiently combining disparate spatial data into a common spatial framework to support subsequent analysis. The Google Cloud Platform was used to assign the data to the polygons and for data management.

Pedestrian and Bicycle Safety Performance Functions (SPFs)

SPFs were developed to predict crashes separately for pedestrian and bicycle crashes within the polygons, using the general form shown in Equation (1).

$$N_p = e^{\ln t + \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i} \quad \textbf{(1)}$$

where:

N_p = predicted average crash frequency of particular crash type

t = offset variable

β_i = model coefficients

X_i = independent variables

Appendix B contains details about the SPF development process. The pedestrian-crash-frequency SPF is presented in Equation (2). The bicycle-crash-frequency SPF is shown in Equation (3). All variables pertain to the polygon for which the model is predicting crash frequency.

Table 3 presents the effect that each of the SPF variables have on predicting pedestrian and bicycle crashes. An “up” arrow signifies that the variable has an increasing effect on predicting crashes, while a “down” arrow represents a decreasing effect on predicting crashes. The coefficients and their standard errors are shown in **Table 4** and **Table 5** for the pedestrian-crash-frequency SPF and bicycle-crash-frequency SPF, respectively. Definitions of the variables for both pedestrian and bicycle models are in **Table 6**. The models were developed based on areas with the following characteristics and thus are applicable to areas with the following characteristics:

- Total daily VMT greater than or equal to 64,000
- Population greater than zero
- Percent of VMT that is on freeways is less than 90%

In general, areas that do not meet these three criteria have very few VRU crashes relative to areas that do meet these criteria. In these models, variables with positive coefficients are directly correlated with increasing predicted crash frequency, while variables with negative coefficients are correlated with decreasing predicted crash frequency.

Table 3. Effect of SPF Independent Variables on Crash Prediction

Variable	Pedestrian SPF	Bicycle SPF
Percent of VMT that is on a freeway	↓	↓
Percent of VMT that is urban	↑	--
Percent of VMT that is on urban target facility type	--	↑
Percent of polygon in historically disadvantaged community	↑	↑
Percent of white/non-Hispanic population	↓	↑
Median household income	↓	--
Number of households with zero vehicles	↑	↑
Count of jobs	--	↑
Ratio of pedestrian miles walked over VMT	↑	--
Ratio of bicycle miles traveled over VMT	--	↑
Number of signalized intersections	↑	--
Number of transit stations	↑	↑
Number of schools	--	↑

NOTE: The following factors were not statistically significant in both the pedestrian and bicycle SPFs: number of parks, mode choice by work commuters, and transit miles traveled.

$$N_{pedi} = e^{\ln VMT + a + b\times VMT_{fwy1} + c\times VMT_{fwy2} + d\times VMT_{urb} + e\times \ln(1000\times WVMT) + f\times HDC + g\times \ln SIG + h\times \ln HHZ + j\times \ln HHI + k\times WNH + l\times \ln TS} \quad \textbf{(2)}$$

where:

N_{pedi}	= number of predicted pedestrian crashes in polygon *I* for a 10-yr period
VMT	= total daily vehicle miles traveled (VMT)
VMT_{fwy1}	= 1 if the freeway VMT is greater than 60% of total VMT, otherwise equals 0
VMT_{fwy2}	= 1 if the freeway VMT is greater than 0% and less than or equal to 60% of total VMT, otherwise equals 0
VMT_{urb}	= percent of VMT that is on urban roadways
WVMT	= ratio of pedestrian miles walked to total VMT
HDC	= percent of polygon that is in a historically disadvantaged community
SIG	= number of signalized intersections
HHZ	= number of households with zero vehicles
HHI	= median household income
WNH	= percent of population that is white and non-Hispanic
TS	= number of transit stops

$$N_{bikei} = e^{\ln VMT + a + b\times VMT_{fwy1} + c\times VMT_{fwy2} + d\times HR_1 + e\times HR_2 + f\times HR_3 + g\times \ln(1000\times BVMT) + h\times \ln HHZ + j\times HDC + k\times WNH + l\times \ln TS + m\times \ln SCH + n\times \ln JOB} \quad \textbf{(3)}$$

where:

N_{bikei}	= number of predicted bicycle crashes in polygon *i* for a 10-yr period
HR_1	= 1 if target facility type VMT is greater than 40% of total VMT, otherwise equals 0
HR_2	= 1 if target facility type VMT is greater than 20% and less than or equal to 40% of total VMT, otherwise equals 0
HR_3	= 1 if target facility type VMT is greater than 0% and less than or equal to 20% of total VMT, otherwise equals 0
BVMT	= ratio of bicycle miles traveled to total VMT
TS	= number of transit stops
SCH	= number of schools
JOB	= number of jobs

Table 4. Pedestrian SPF Parameter Estimates

Parameter	Model Coefficient	Standard Error
a	-9.429	0.5090
b	-0.208	0.0729
c	-0.149	0.0630
d	0.504	0.1376
e	0.603	0.0344
f	0.233	0.0680
g	0.024	0.0096
h	0.114	0.0178
j	-0.204	0.0479
k	-0.339	0.1243
l	0.107	0.0191
Overdispersion	0.216	0.0188

Table 5. Bicycle SPF Parameter Estimates

Parameter	Model Coefficient	Standard Error
a	-13.074	0.3424
b	-0.858	0.1226
c	-0.490	0.1000
d	0.021	0.2035
e	0.317	0.1706
f	0.243	0.1049
g	0.360	0.0422
h	0.224	0.0353
j	0.414	0.1346
k	0.511	0.2231
l	0.080	0.0329
m	0.174	0.0724
n	0.131	0.0384
Overdispersion	0.408	0.0415

Table 6. Variable Definitions

Variable	Definition
Freeway VMT Percentage	Percentage of total VMT in polygon that is on a freeway. A freeway is defined as any highway class with “Interstate” or “Freeway” in the name.
Urban VMT Percentage	Percentage of total VMT in polygon that is on a highway class that is classified as being urban.
Ratio of pedestrian miles walked to VMT	Total pedestrian miles walked within polygon divided by total VMT in polygon.
Percent of polygon in historically disadvantaged community	Percentage of polygon that is in a historically disadvantaged community using criteria set by the USDOT consistent with the Justice40 Initiative.
Number of signalized intersections	Number of signalized intersections in polygon.
Number of households with zero vehicles	Number of households with zero vehicles in polygon.
Median household income	Median household income in polygon based on 2020 US Dollars.
Percent of population that is white/non-Hispanic	Percentage of population within polygon that is white and non-Hispanic.
Number of transit stops	Number of fixed bus/transit stops in polygon.
Urban target facility type VMT Percentage	Percentage of total VMT in polygon that is on an urban target facility type for bicyclists. An urban target facility type is defined as any of the following highway classes: • Urban divided roadways with 6 or more lanes • Urban 3-lane roadways • Urban roadways with 6 or more lanes and a continuous two-way left-turn lane • Urban 4-lane roadways with a continuous two-way left-turn lane • Urban 4-lane undivided roadways • Urban 6-lane undivided roadways
Ratio of bicycle miles travelled to VMT	Total bicycle miles travelled within polygon divided by total VMT in polygon.
Number of schools	Total number of schools in polygon.
Number of jobs	Total number of jobs in polygon.

Use of Excess Expected Crash Frequencies to Rank Polygons

The excess expected crash frequency performance measure was used to rank polygons to assist in determining Target Analysis Areas for pedestrian and bicycle crashes. Excess expected crash frequency is the difference between the expected average crash frequency and the predicted average crash frequency. When the excess expected crash frequency value is greater than zero, a site experiences more crashes than predicted for similar locations with similar characteristics.

The following steps were used to calculate excess expected crash frequency for each polygon. Note that this process was performed twice for each polygon, once to calculate pedestrian excess expected crash frequency and once to calculate bicycle excess expected crash frequency.

STEP 1: CALCULATE PREDICTED AVERAGE CRASH FREQUENCY FROM SPF

The pedestrian and bicycle SPFs developed and discussed in this report were used to calculate the predicted average crash frequency for each polygon that was within the applicable range of VMT and population for the SPFs. In total, SPFs were applied to 864 polygons.

STEP 2: CALCULATE THE WEIGHTED ADJUSTMENT FACTOR

The weighted adjustment factor was calculated for each polygon, which accounts for the reliability of the SPF, as shown below:

$$w = \frac{1}{1 + k \times \sum_{n=1}^{Y} N_{\text{predicted},n}} \quad \textbf{(4)}$$

where:

w = weighted adjustment factor for the site

k = overdispersion parameter of the SPF

Y = number of years of crash data

$N_{predicted,n}$ = predicted average crash frequency from SPF for year n (however, since the pedestrian and bicycle SPFs predicted number of crashes for a 10-yr period, the whole summation term is just the output of the SPF

STEP 3: CALCULATE THE EXPECTED AVERAGE CRASH FREQUENCY

The expected average crash frequency was calculated for the polygon, as shown below:

$$N_{\text{expected}} = w \times N_{\text{predicted}} + (1 - w) \times \sum_{n=1}^{Y} N_{\text{observed},n} \quad \textbf{(5)}$$

where:

$N_{expected}$ = expected average crash frequency for the site

w = weighted adjustment factor for the site

$N_{predicted}$ = predicted average crash frequency (output from SPF)

SumTerm = total number of observed crashes for the site

Figure 5 shows a histogram of pedestrian 10-yr expected crash frequency. Most polygons have a pedestrian expected crash frequency between zero and 20 crashes over the 10-year period.

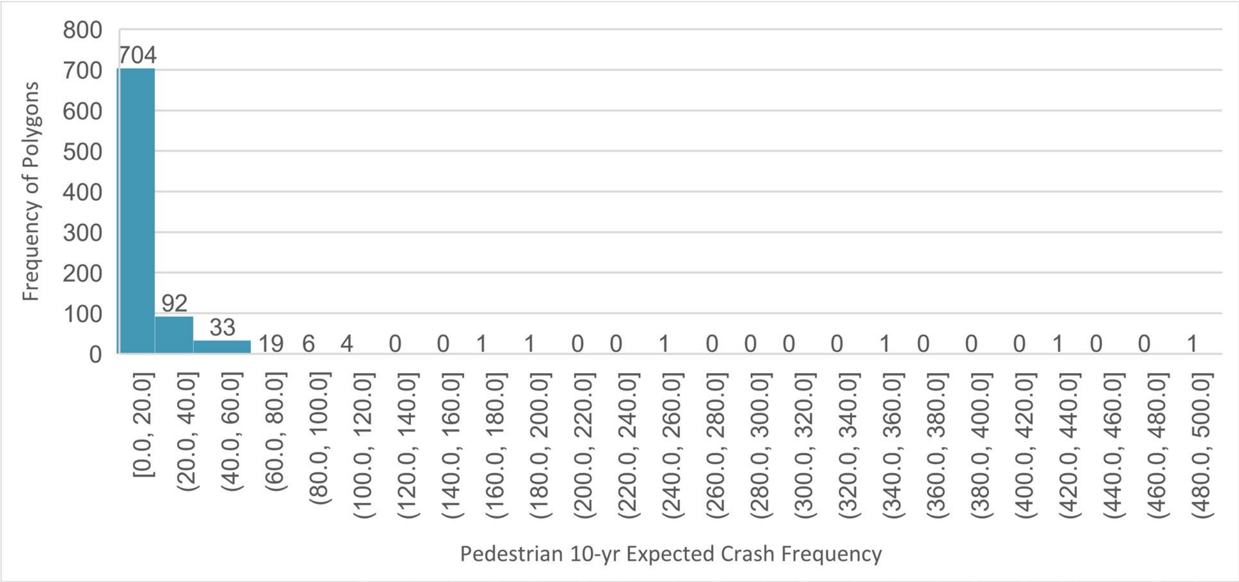

Figure 5. Pedestrian Expected Crash Frequency Histogram

Figure 6 presents a histogram of bicycle 10-yr expected crash frequency. Most polygons have a bicycle expected crash frequency between zero and 20.

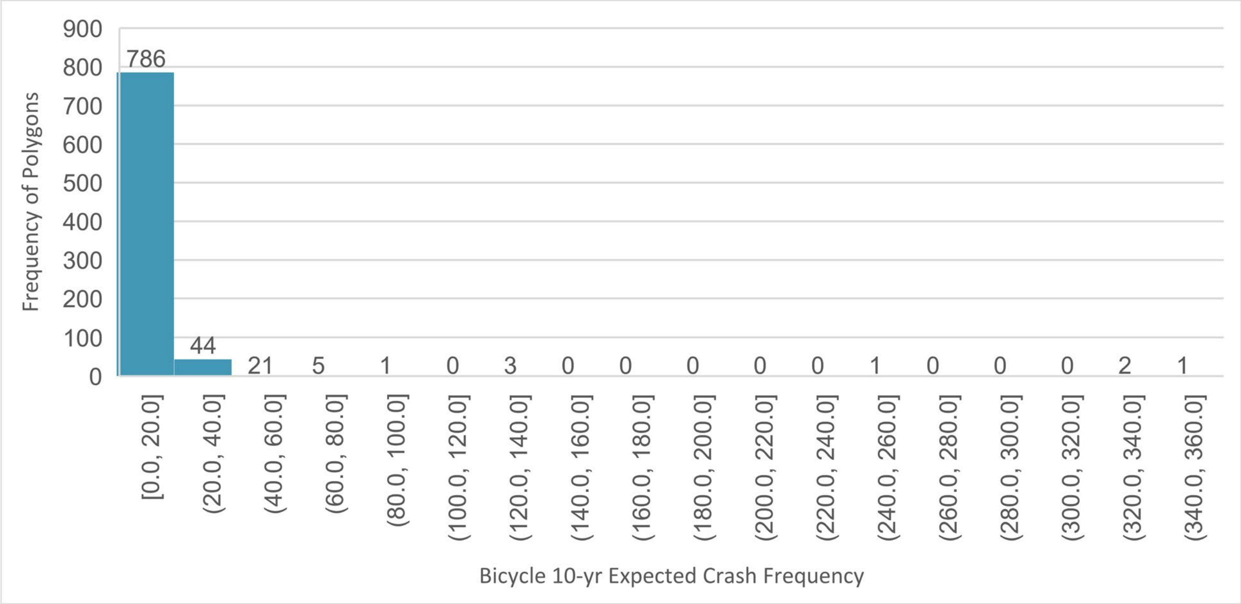

Figure 6. Bicycle Expected Crash Frequency Histogram

STEP 4: CALCULATE THE EXCESS EXPECTED AVERAGE CRASH FREQUENCY

The difference between the expected and predicted average crash frequencies is the excess expected average crash frequency:

$$Excess = N_{expected} - N_{predicted} \tag{6}$$

Figure 7 shows a histogram of pedestrian 10-yr excess expected crash frequency. The first, second, and third quartile values are -1.2, 0.0, and 0.6, respectively. The top 20 pedestrian excess expected crash frequencies range from 20.4 to 422.8.

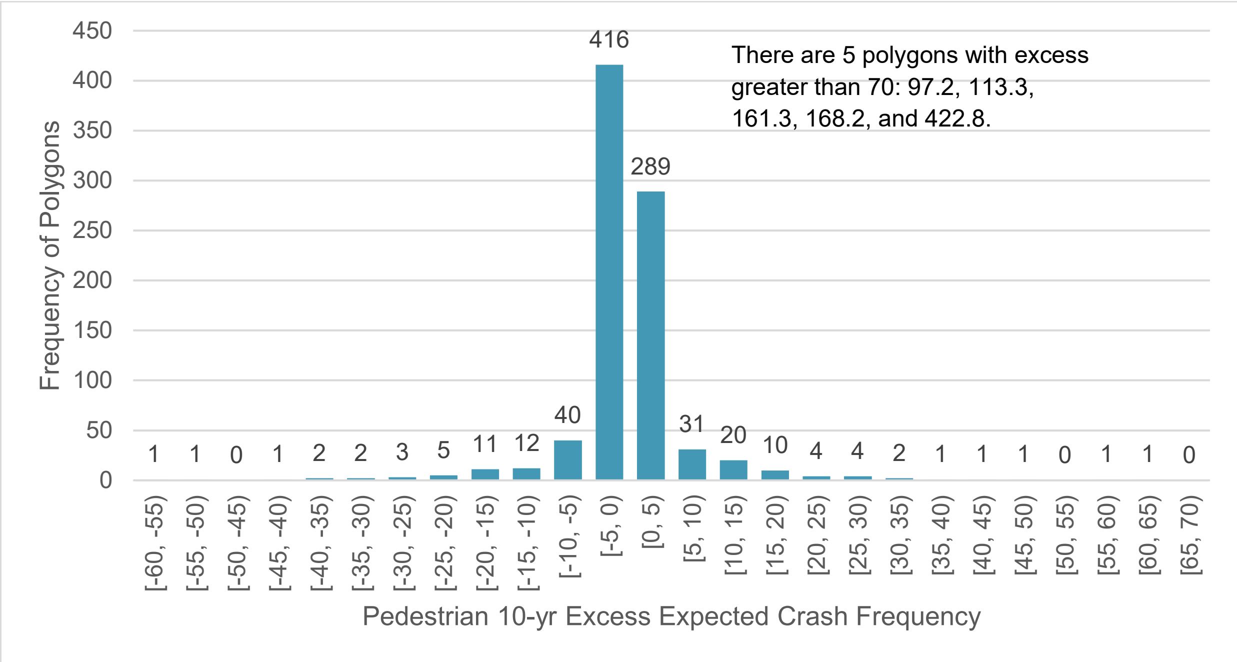

Figure 7. Histogram of Pedestrian Excess Expected Crash Frequency

Figure 8 presents a histogram of bicycle 10-yr excess expected crash frequency. The first, second, and third quartile values are -0.7, 0.0, and 0.3, respectively. The top 20 bicycle excess expected crash frequencies range from 17.6 to 242.7.

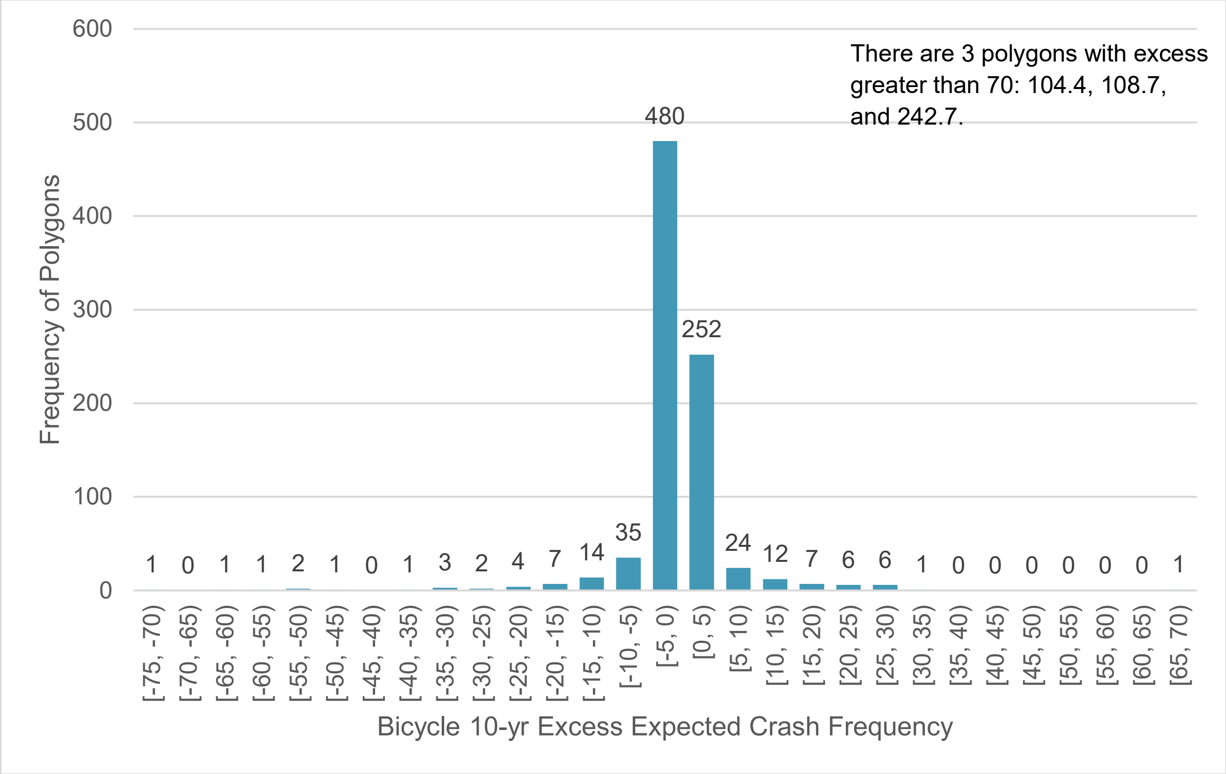

Figure 8. Histogram of Bicycle Excess Expected Crash Frequency

Identification of Target Analysis Areas

The 864 polygons in which excess expected crash frequencies were calculated were ranked in descending order based on excess expected crash frequency. Each polygon was assigned a rank for pedestrian excess expected crash frequency and a rank for bicycle excess expected crash frequency. Polygons with the highest excess expected average crash frequency are those in which pedestrian or bicycle safety improvements have the highest potential for effectiveness. For purposes of this report, only the top 20 locations are shown and discussed. By ranking the top 20 pedestrian and top 20 bicycle polygons, a total of 32 unique Target Analysis Areas were identified (**Figure 9**). **Table 7** presents the 20 polygons with the highest pedestrian excess expected crash frequency. **Table 8** shows the 20 polygons with the highest bicycle excess expected crash frequency.

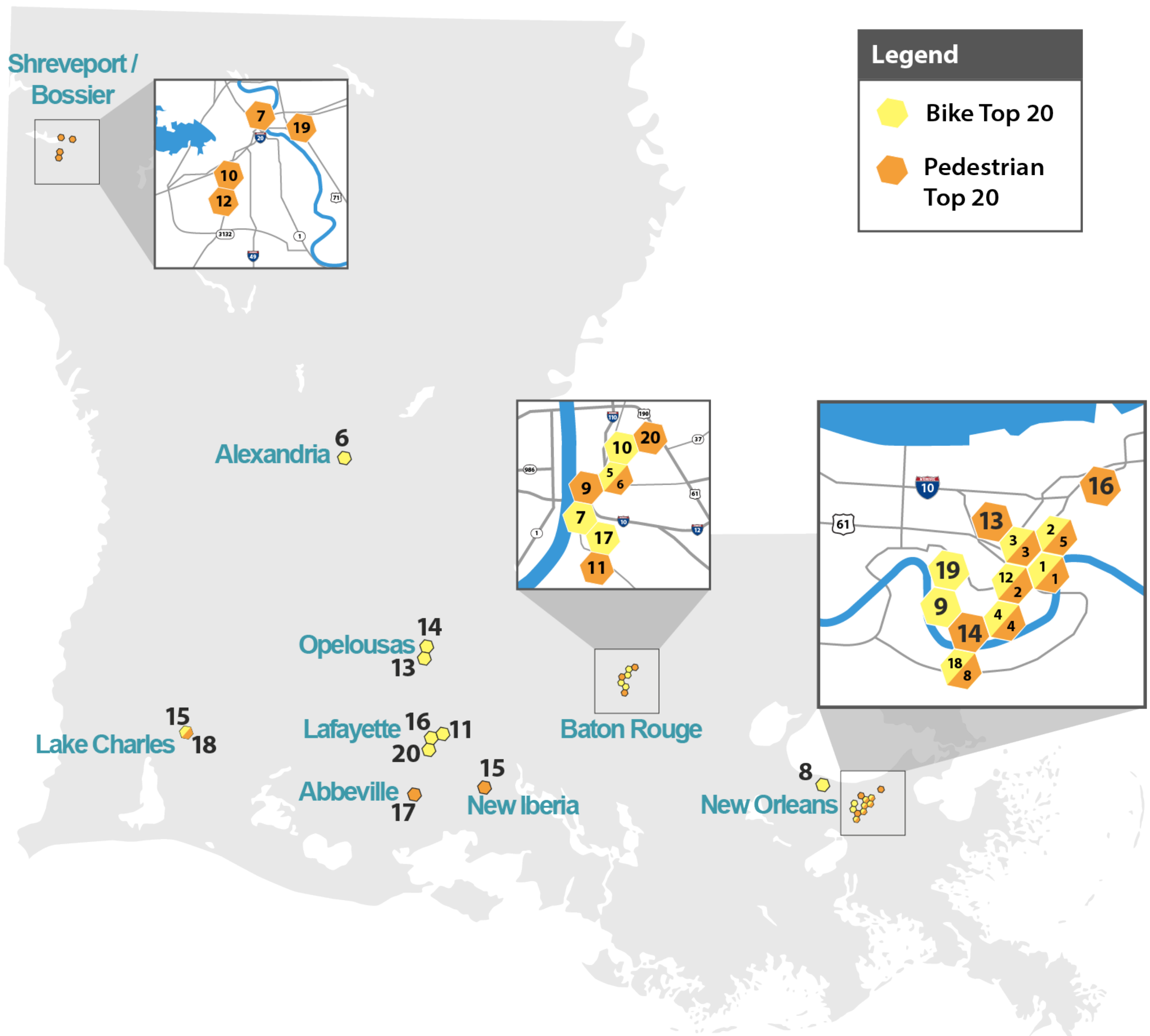

Figure 9. Top 20 Pedestrian and Bike Excess Expected Crash Frequency Polygons

Table 7. Top 20 Pedestrian Excess Expected Crash Frequency

Pedestrian Excess Expected Crash Frequency Statewide Rank	Pedestrian Excess Expected Crash Frequency (per 10 years)	Pedestrian Expected Crash Frequency (per 10 years)	Pedestrian Predicted Crash Frequency (per 10 years)	Pedestrian Observed Crash Frequency (per 10 years)	General Location
1	422.8	484.0	61.1	516	New Orleans
2	168.2	437.1	268.9	440	New Orleans
3	161.3	356.2	194.8	360	New Orleans
4	113.3	169.7	56.4	179	New Orleans
5	97.2	258.2	161.0	261	New Orleans
6	62.4	117.8	55.4	123	Baton Rouge
7	59.2	83.9	24.7	95	Shreveport/Bossier
8	45.9	91.3	45.4	96	New Orleans
9	44.7	103.5	58.8	107	Baton Rouge
10	39.7	77.1	37.4	82	Shreveport/Bossier
11	32.6	61.9	29.3	67	Baton Rouge
12	31.0	62.4	31.4	67	Shreveport/Bossier
13	29.5	81.4	51.9	84	New Orleans
14	28.1	58.8	30.7	63	New Orleans
15	27.2	51.9	24.7	57	New Iberia
16	26.6	74.4	47.8	77	New Orleans
17	23.2	48.8	25.6	53	Abbeville
18	22.7	46.6	24.0	51	Lake Charles
19	22.1	58.2	36.0	61	Shreveport/Bossier
20	20.4	68.0	47.7	70	Baton Rouge

Table 8. Top 20 Bicycle Excess Expected Crash Frequency

Bicycle Excess Expected Crash Frequency Statewide Rank	Bicycle Excess Expected Crash Frequency (per 10 years)	Bicycle Expected Crash Frequency (per 10 years)	Bicycle Predicted Crash Frequency (per 10 years)	Bicycle Observed Crash Frequency (per 10 years)	General Location
1	242.7	340.9	98.3	347	New Orleans
2	108.7	259.2	150.5	261	New Orleans
3	104.4	332.9	228.5	334	New Orleans
4	65.6	128.4	62.8	131	New Orleans
5	33.9	65.4	31.5	68	Baton Rouge
6	29.4	46.9	17.4	51	Alexandria
7	29.0	45.8	16.8	50	Baton Rouge
8	28.7	43.1	14.4	48	New Orleans
9	28.4	46.0	17.6	50	New Orleans
10	27.3	50.1	22.8	53	Baton Rouge
11	26.3	53.6	27.3	56	Lafayette
12	24.2	335.8	311.6	336	New Orleans
13	22.9	33.9	11.1	39	Opelousas
14	22.6	34.2	11.6	39	Opelousas
15	22.0	33.2	11.3	38	Lake Charles
16	21.7	50.1	28.4	52	Lafayette
17	20.4	42.8	22.4	45	Baton Rouge
18	19.2	54.7	35.5	56	New Orleans
19	19.0	90.3	71.3	91	New Orleans
20	17.6	35.6	18.1	38	Lafayette

Program of VRU Improvement Strategies

4

This chapter presents a menu of infrastructure countermeasures, educational and outreach ideas, and programmatic and policy approaches that can improve conditions for VRUs, especially for the target analysis areas identified in Chapter 3. These strategies and countermeasures are applicable to common crash characteristics in Louisiana and consistent with the strategies previously identified in the state's 2022 SHSP which analyzed crash trends from 2016 to 2020.

Common Crash Characteristics

The 2022 SHSP identified four emphasis areas to reduce traffic fatalities and serious injuries. These emphasis areas included: distracted driving, impaired driving, occupant protection, and infrastructure and operations. Except for "occupant protection," which refers to seatbelt usage and child car seats, the emphasis areas also relate to VRU crashes. The 2022 SHSP also summarized characteristics for crashes involving people biking and walking as shown in **Figure 10**.

This information is supplemented by the findings in Chapter 2, which analyzed trends related to VRU crashes causing fatalities and serious injuries. The summary of VRU fatal and serious injury crash characteristics includes:

Time of Day/Lighting: The most common time of day for a VRU-related crash was between 7 pm and 11 pm. Lighting conditions were either lit by streetlights or dark, not lighted.

Day of Week: Most pedestrian crashes occurred on Fridays or weekends. Most bicyclist crashes were Thursday and Saturday.

Pedestrian and bicycle crash summary for crashes between 2016 and 2020:

- Pedestrian crashes involving young drivers occurred more commonly later in the night between 9 PM and midnight, while pedestrian crashes involving older drivers were found to occur earlier in the day between noon and 3 PM.
- Male drivers between 45 to 54 years old were more likely to be involved in pedestrian-related crashes than any other demographic. Pedestrian crashes showed the most overlap with intersections and alcohol-related crashes.
- Bicycle-involved crashes contributed to 3.5% of all fatalities and serious injuries between 2016 and 2020.
- Bicycle crashes most commonly involved angle and rear-end collisions and males between 55 and 64 years old.
- Pedestrian-involved crashes contributed to 14.2% of all fatalities and serious injuries between 2016 and 2020.

Figure 10. VRU Crash Characteristics from the 2022 SHSP

VRU Action Prior to Crash: The most common, known action for a pedestrian was crossing a roadway. About one-third of fatal and serious pedestrian injuries occurred at intersections. For bicyclists, most crash reports did not identify the bicyclist's action. The most common, known action for a bicyclist was failure to yield right-of-way. Most pedestrian and bicycle crashes occurred at non-intersections rather than intersections.

Motorist/VRU Condition Prior to Crash: Most driver conditions and VRU conditions prior to a crash were either labeled as apparently normal, unknown, or other. The highest known problematic condition for motorists and VRU was under the influence of medication, alcohol, or drugs.

VRU Demographics and Historically Disadvantaged Communities: VRU fatal-and-serious-VRU injury frequencies were two times higher in Historically Disadvantaged Communities than non-Historically Disadvantaged Communities. Pedestrian fatal and serious injuries affecting those aged 1 to 14 correlated with people who identify as Black, while those aged 65 and older correlated with people who identify as white. Bicyclist fatal and serious injuries were highest in the 35 to 65 age group.

Target Facility Types: Most fatal and serious VRU injuries occurred on urban two-lane roadways. However, other facility types have higher numbers of VRU fatal and serious injuries per mile than urban two-lane roadways. The resulting target facility types are typically urban roadways with a wide cross section. For pedestrians and bicyclists, the following facility types had the highest number of fatal and serious injuries per mile: urban divided roadways with six or more lanes, urban three-lane roadways, urban five-lane roadways with a continuous two-way left-turn lane, urban four-lane undivided roadways, and urban roadways with six or more lanes and a continuous two-way left-turn lane. Urban four-lane divided roadways also had a high number of bicycle fatal and serious injuries per mile, and rural three-lane roadways with a continuous two-way left-turn lane have a high number of pedestrian fatal and serious injuries per mile. Refer to Table 1. Pedestrian Fatalities and Serious Injuries (2012-2021) and Pedestrian Fatality-and-Serious-Injury Density by Highway Class and Table 2. Bicyclist Fatalities and Serious Injuries (2012-2021) and Bicyclist Fatality-and-Serious-Injury Density by Highway Class in Chapter 2 for more detail.

Best Practice Resources

Louisiana DOTD subscribes to the U.S. DOT's Safe System Approach to achieve the state's Destination Zero Deaths initiative. This approach identifies six principles and five objectives that influence the choice of strategies and countermeasures selected to improve conditions for VRUs in Louisiana, which is described in the Introduction.

While the Safe System Approach provides the objectives and principles to achieve zero deaths and serious injuries, it does not provide design guidance. Several national and state guidance documents provide tested countermeasures and strategies, consistent with the SSA, to reduce traffic crashes and improve conditions for VRUs. Design guides also incorporate best practices for bicycle and pedestrian facility design – which is critical to the safe road users and safe roads objectives. Resources used in this chapter are listed in Appendix D.

For each of the four emphasis areas identified in the 2022 SHSP, the plan also identifies strategies related to each emphasis area and tactics to support each strategy. The strategies and tactics from the 2022 SHSP that are relevant to VRU crashes are supported by the countermeasures and strategies described in the next sections and in Appendix C.

Pedestrian and Bicycle Infrastructure Countermeasures

Consistent with best practice resources and the Safe System Approach, the Louisiana VRU Safety Assessment identifies bicycle and pedestrian infrastructure countermeasures that support the 2022 SHSP strategies and associated tactics. Any traffic control devices, such as traffic signals, signs, and striping, must comply with the Manual on Uniform Traffic Control Devices (MUTCD) along with other state and local specifications, policies, and procedures. Refer to Appendix C for more details on the 2022 SHSP strategies and tactics and the following VRU countermeasures.

Examples of potential countermeasures for pedestrians include:

Sidewalks, walkways, and paved shoulders to provide pedestrians space that is separated from roadway vehicles so they can safely travel within the public right-of-way.

Curb extensions (bulb-outs or neckdowns) to shorten the distance of a crosswalk by extending the sidewalk or curb line out into the parking lane (**Figure 11**).[6] This feature reduces the effective street width and reduces the time that pedestrians are in the street.

Figure 11. Curb Extension Example

Raised pedestrian crossings (raised crosswalk or raised intersection) to make pedestrians more prominent in a driver's field of vision by having them cross the road at the same level as the sidewalk (**Figure 12**).[7] It also reduces vehicle speeds and improves vehicle yielding.

Figure 12. Raised Crosswalk Example

[6] Curb extension image source: File:Curb extensions at midblock crosswalk.jpg - Wikimedia Commons
[7] Raised crosswalk image source: HDR Engineering, Inc.

Crossing islands (pedestrian refuge islands) to protect pedestrians crossing multilane roads by including a refuge area in the median (**Figure 13**).[8] This feature allows pedestrians to focus on one direction of traffic at a time as they cross the road.

Figure 13. Pedestrian Refuge Island Example

Leading pedestrian intervals (LPI) to provide pedestrians the WALK signal three to seven seconds before the motorists are allowed to proceed through the intersection. This measure positions pedestrians in the crosswalk by the time the traffic signal turns green and allows them to establish their presence in the crosswalk before motorists can start turning.

PUFFIN (Pedestrian User Friendly Intelligent Intersection) use active detection and passive presence of pedestrians in crosswalks to determine whether the pedestrian phase of a traffic signal or beacon should be extended or canceled (**Figure 14**).[9] DOTD would need to develop an equipment specification for this countermeasure.

Figure 14. PUFFIN Example

Rectangular Rapid Flashing Beacons are located under the crosswalk signs and flash when activated to alert motorists to the presence of a pedestrian in the crosswalk (**Figure 15**).[10] Activation can be either passive or active detection. DOTD currently uses active detection (i.e., pedestrian pushbuttons) and would need to update their specification to use passive detection (i.e., systems that automatically detect the presence of a pedestrian in the crosswalk).

Figure 15. Rectangular Rapid Flashing Beacon Example

8 Pedestrian refuge island image source: https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/pedestrian-safety-islands/
9 PUFFIN image source: What is a Puffin crossing? | Auto Express
10 Rectangular rapid flashing beacon image source: HDR Engineering, Inc.

Examples of potential countermeasures for bicyclists include:

Standard bicycle lanes provide an exclusive space for bicycles that is distinct from roadway vehicles through pavement markings and signage.

Buffered bike lanes add a painted buffer to the bike lane, typically between the motorized travel lane and the bike lane (**Figure 16**).[11] If on-street parking is present, a buffer may be added between the bike lane and the parking lane to provide separation between bicyclists and motorists opening vehicle doors.

Figure 16. Buffered Bicycle Lanes Example

Separated bicycle lanes (protected bicycle lanes or cycle tracks) provide an exclusive space for bicycles that is distinct from roadway vehicles through pavement markings and signage, a buffer, and a vertical element (**Figure 17**).[12]

Figure 17. Separated Bicycle Lanes Example

Bicycle signals at an intersection may be used to separate bicycle through movements from vehicle right turning movements. They can also be used to facilitate complex bicycle movements or help people on bicycles navigate complex intersections. A leading bicycle interval, which uses a bicycle signal lens to provide three to five seconds of green time before the corresponding vehicle green indication, can be used to increase the visibility of bicyclists to motorists. DOTD would need to develop an equipment specification or standard for this countermeasure.

[11] Buffered bike lane image source: HDR Engineering, Inc.
[12] Separated bike lane image source: City of Minneapolis, 3.4E In-street curb-protected bike lanes: Minneapolis Street Guide (minneapolismn.gov)

Bike boxes are designated areas at a signalized intersection that provides bicyclists a way to get ahead of queuing traffic during the red signal phase (**Figure 18**).[13] Placed between the stop line and the pedestrian crosswalk, bike boxes increase the visibility of queued bicyclists and provide them with the ability to start up and enter the intersection in front of motor vehicles when the signal turns green.

Figure 18. Bike Box Example

Two-stage turn queue boxes allow bicyclists to make left turns at multilane intersections from a right-side separated bike lane, or right turns from a left-side separated bike lane (**Figure 19**).[14] Cyclists who arrive on a green light travel into the intersection and pull out into the two-stage turn queue box away from through-moving bicycles and in front of cross-street traffic.

Figure 19. Two-Stage Turn Queue Box Example

Examples of potential countermeasures for both pedestrians and bicyclists include:

Shared use paths are physically separated from motorized travel lanes and designed for bi-directional travel by both bicyclists and pedestrians (**Figure 20**).[15]

Figure 20. Shared Use Path Example

[13] Bike box image source: Streetsblog 1292433696FRDQ.jpg (1800×1282) (streetsblog.org) Engineering Establishment Poised to Endorse Bike Boxes and Bike Signals — Streetsblog USA
[14] Two-stage turn queue box image source: New Left Turn for Bicycles Introduced (cambridgema.gov)
[15] Shared use path image source: HDR Engineering, Inc.

A **road diet** typically converts an existing four-lane undivided roadway to a three-lane roadway with a two-way left-turn lane (**Figure 21**).[16] This measure improves safety by providing fewer lanes for pedestrians and bicycles to cross. It can also better accommodate the needs of all road users by providing the space to install additional features such as refuge islands, bicycle lanes, wider sidewalks, etc.

Figure 21. Road Diet Example

Pedestrian Hybrid Beacons (PHBs) remain dark until activated by a pedestrian wishing to cross the street (**Figure 22**).[17] The signal will turn to yellow flashing, then yellow steady to slow traffic. The next phase is red steady then red flashing while the pedestrian is crossing. The signal will then return to the dark phase allowing motorized traffic to resume.

Figure 22. Pedestrian Hybrid Beacon Example

Roundabouts are circular intersections designed to eliminate left-turns and reduce the number of conflict points for all users (**Figure 23**).[18] They are designed for slow speeds and geometry which better facilitates motor vehicles yielding to pedestrians and bicyclists.

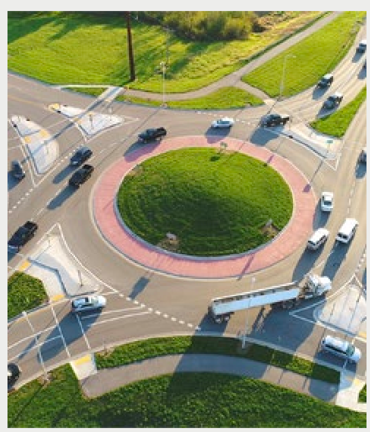

Figure 23. Roundabout Example

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[16] Road diet image source: Leidos, [Road Diets (Roadway Configuration) | FHWA (dot.gov)]
[17] Pedestrian hybrid beacon image source: HDR Engineering, Inc.
[18] Roundabout image source: https://highways.dot.gov/safety/intersection-safety/intersection-types/roundabouts

Lighting and illumination improvements can increase comfort and safety by illuminating pedestrians and bicycles for approaching motorists (**Figure 24**).[19]

Figure 24. Lighting Example

Tighter curb radii (curb radius reduction) can improve sight lines between driver and pedestrian, shorten the crossing distance, bring crosswalks closer to the intersection, and reduce speeds of right-turning vehicles (**Figure 25**).[20]

Figure 25. Curb Radius Reduction Example

Traffic calming techniques can be implemented to create horizontal or vertical deflection forcing motorists to slow down. Examples include speed tables/humps, speed cushions, chicanes (**Figure 26**),[21] mid-block medians, pinch point/choker, neighborhood traffic circles, and narrowed lanes.

Figure 26. Traffic Calming Chicane Example

[19] Lighting image source: https://highways.dot.gov/public-roads/novemberdecember-2015/future-roadway-lighting
[20] Curb radius image source: Pedestrian Safety Guide and Countermeasure Selection System (pedbikesafe.org)
[21] Traffic calming chicane image source: Why Traffic Chicanes are Better than Speed Humps — Sidewalking Victoria

Education and Outreach Strategies

The DOTD has nine Regional Safety Coalitions (RSCs), with a role for a RSC Coordinator in each, to help address traffic safety concerns at the regional, parish and city levels. These Coordinators lead several outreach and education strategies that support the 2022 SHSP. Additionally, the DOTD partners with the Louisiana Highway Safety Commission (LHSC) on educational and outreach efforts. Refer to Appendix C for more details on VRU education and outreach strategies.

Education and outreach strategies for pedestrians, bicyclists, and other non-motorists include:

- **Elementary-Age Child Pedestrian Training** includes in-school curriculum that equips children with knowledge and practice to enable them to walk safely in environments with traffic and other safety hazards.
- **Bike Safety Rodeo/Safety Town** and similar events like cycling skills clinics and bicycle safety fairs are local events often run by law enforcement, school personnel, or other civic and volunteer organizations. Their purpose is to teach children on-bicycle skills and how to ride defensively in traffic conditions.
- **Bicycle safety education for adult bicyclists** aims to improve knowledge of laws and cycling best practices to lead to safer cycling behaviors, including riding predictably and using safety materials such as reflective clothing and helmets.
- **Bicycle helmet promotions** aim to increase bicycle helmet use and thereby reduce the number of severe and fatal head injuries. This countermeasure involves conducting single events or extended campaigns to promote helmet distribution and use among all ages. Current Louisiana law requires anyone under 12 to wear a helmet as a rider or passenger on a bicycle.
- **Media campaigns** may be designed to target any demographic and focus on any traffic safety issue, such as distracted driving, impaired driving, or sharing the road with VRUs.
- **Drivers' Education** including pedestrian and bicycle safety-related training is intended to increase the sensitivity of drivers to the presence of pedestrians and bicyclists and their shared responsibility to prevent crashes and enhance the safety of all road users.
- **Operation Bright Light** promotes bicycle and pedestrian visibility and safety. This outreach strategy involves handing out materials like drawstring reflective backpacks, bike lights, reflective bracelet, etc. It is usually aimed at homeless populations.
- **Walking School Buses** is an outreach program that uses volunteer adults, usually parents, to walk a group of students on a specific route to and from school, collecting or dropping off children on the way.

Laws and Enforcement Strategies

Laws and enforcement policies can reduce non-motorized user fatalities and serious injuries on public roads through targeted investments and outreach. The DOTD partners with the Louisiana Highway Safety Commission, Louisiana State Police (LSP), and local law enforcement agencies on enforcement strategies. Refer to Appendix C for more details on VRU laws and enforcement strategies.

Laws and enforcement strategies for pedestrians, bicyclists, and other non-motorists include:

- **Bicycle Helmet Laws** can require both adults and children to wear bicycle helmets. Current Louisiana law requires anyone under 12 to wear a helmet as a rider or passenger on a bicycle.
- **Motorist Passing Bicyclist Laws** require motor vehicle drivers to leave at least a legally defined amount of clearance space between the vehicle and the cyclist when overtaking the cyclist. This law helps to minimize the likelihood of a sideswipe, and to reduce the chance of a close encounter that could potentially destabilize or divert the course of a cyclist and cause a crash. In Louisiana, existing law requires a safe passing distance of not less than three feet.
- **Hands Free Laws** restrict mobile phone usage while driving. For Louisiana, a handheld ban is in place for drivers with a learner or intermediate license, regardless of age and for drivers in school zones. An all-cell phone ban is also applicable to drivers under the age of 18 and to all school bus drivers.
- **Speed Safety Cameras** are addressed in an existing DOTD policy (**Figure 27**).[22] Agencies should conduct an analysis of speeding-related crashes to identify locations to implement speed safety cameras and submit a permit request to the DOTD.[23]

Figure 27. Speed Camera Example

[22] **Speed camera image source:** New Jersey may shield drivers from other states' red light, speed cameras - Autoblog

[23] A - Traffic Enforcement Systems Policy.pdf (la.gov)

Programmatic or Policy Strategies

Refer to Appendix C for more details on VRU programmatic or policy strategies.

Programs and policies for pedestrians, bicyclists, and other non-motorists include:

- **Complete Streets** policies are designed and operated to enable safe use and support mobility for all users. The concept of complete streets encompasses many approaches to planning, designing, and operating roadways and rights of way with all users in mind to make the transportation network safer and more efficient. These approaches may include sidewalks, bicycle lanes, bus lanes, public transportation stops, crossing opportunities, median islands, accessible pedestrian signals, curb extensions, modified vehicle travel lanes, streetscape, and landscape treatments. DOTD maintains a Complete Streets policy for the state and encourages local public agencies to develop their own complete streets policies for their jurisdictions.
- **Pedestrian Safety Zones** are programs that increase cost-effectiveness of interventions by targeting education, enforcement, and engineering measures to geographic areas and audiences where significant portions of the pedestrian crash problem exist.
- **Safe Routes to School** are community-based programs that educate about safe walking and bicycling behavior and safe driving behavior around pedestrians and bicyclists. The programs also include enforcement and engineering activities to improve traffic safety around schools.
- **Safe Routes to Public Places Program (SRTPPP):** The SRTPPP allows public agencies to compete for funding for SRTPPP projects for the purpose of facilitating the planning, development, and implementation of projects that will improve safety for pedestrians, bicyclists, and transit users of all ages and abilities. Eligible projects include improving pedestrian and bicycle facilities to schools, libraries, governmental buildings, hospitals, transit facilities, public parks, other public places, and other types of pedestrian traffic generators. All public roads, state and locally owned, are eligible under the SRTPPP.[24]
- **Highway Safety Corridor Program:** Louisiana Revised Statute 32:267 establishes a Highway Safety Corridor Program in which a portion of highways may be designated as "highway safety corridors" to address highway safety problems through law enforcement, education, and safety enhancements. A highway safety corridor is a special segment of a highway that has been identified by data analysts and approved by a majority vote of the Safety Corridor Advisory Group as a location with a high potential for safety improvement, especially for fatal and serious injury crashes. The primary cause of these crashes is driver behavior such as speeding, aggressive driving, impairment, and distracted driving. The Advisory Group shall establish objective criteria for safety enhancements, engineering improvements, infrastructure investments, queue detection

[24] Louisiana DOTD, Safe Routes to Public Places Program Guidelines.docx, May 2021

systems, extended Motorist Assistance Patrols, or instant tow dispatch and public outreach.[25] Implementation procedures have yet to be developed for this program.

Data Collection Strategies

Gathering data related to VRU crashes can help the State better understand the circumstances that lead to the crashes and therefore mitigate those circumstances. As the State continues to develop data collection, compilation and distribution, the following statewide data should be considered:

- Roadway design speed, operating speed, and/or speed limits
- Locations of intersections and intersection characteristics such as type of intersection control, number of lanes, presence of turn lanes, presence of crosswalks
- Presence and type of bicycle facilities along roadways
- Presence and type of pedestrian facilities along roadways
- Presence and level of lighting along facilities
- Non-motorist exposure data may include:
    - Population and number of hours traveled by mode
    - Distance by non-motorized mode
    - Number of trips by non-motorized mode
    - Percentage of population that commutes by non-motorized mode

On a project-scale, the following additional data would also be useful:

- Widths for motorized and non-motorized facilities
- Intersection geometrics such as turning radii, leg approach angle, etc.
- Presence of on-street parking
- Condition of facilities for all modes
- Obstacles that may be blocking clear lines of sight
- Additional non-motorist exposure data may include:
    - Annual, weekly, and/or daily crossing volumes (considering seasonal variations)
    - Annual, weekly, and/or daily trip volumes along the facility (considering seasonal variations)
    - Location of non-motorist in the right-of-way
    - Number of conflict points at intersections and crossings
    - Length of crosswalks
    - Number of intersections and driveways needing to be crossed along a facility between two specified points
    - Direction of travel

[25] Louisiana Laws - Louisiana State Legislature

Summary of Consultation and Outcomes

5

As part of the Louisiana VRU Safety Assessment, FHWA requires states to consult with local governments, Metropolitan Planning Organizations (MPOs), and regional transportation planning organizations that represent Target Analysis Areas. The purpose of the consultation requirement for the Louisiana VRU Safety Assessment is to gain local knowledge and perspective on the factors contributing to the safety concerns at the Target Analysis Areas and to identify potential projects or strategies to improve the safety of vulnerable road users in these areas. This chapter describes the process DOTD used to consult with local stakeholders about Target Analysis Areas and provides a summary of the outcomes, including safety concerns and potential solutions. DOTD first conducted consultations with the Regional Safety Coalition Coordinators and then conducted consultations with local stakeholders in the Target Analysis Areas. In parallel with the Louisiana VRU Safety Assessment, additional VRU trainings and workshops were held throughout the State, which are also described in this chapter.

Regional Safety Coalition Coordinators Meeting

On July 12, 2023, the Regional Safety Coalition Coordinators met to discuss potential education, outreach, program, and policy strategies for the Louisiana VRU Safety Assessment. The coordinators described the current efforts occurring throughout Louisiana as well as brainstormed potential improvements and identified areas where additional support would be beneficial. One suggestion was to develop new outreach platforms that would do a better job of reaching targeted audiences, such as people who are older than 65. Funding, accessibility, and available resources should be considered when identifying new outreach platforms. These platforms should provide a spark that grabs the attention of the target audience. Another recommendation was for Louisiana's Destination Zero Deaths initiative to have its own educational posters for coordinators to use. Currently, coordinators borrow material from other states to make outreach packets, handouts, and posters. Having material specifically made for the state of Louisiana that applies to the diverse areas of the state as well as a wide range of age groups would be a significant benefit. Lastly, the importance of motorist education was also discussed. Media campaigns that include humor or are developed on social media apps such as Tik-Tok could help reach a wider audience. Crash simulations were another example of how motorists can be educated on the importance of safe driving.

The Regional Safety Coalition Coordinators may be able to use the results of the Louisiana VRU Safety Assessment to focus their outreach efforts. For example, they may be able to focus on the top-ranked Target Analysis Areas for biking and walking for implementation of educational and outreach programs or tailor their programs to better suit the demographics with the highest rate of biking and pedestrian crashes. Overall, the Regional Safety Coalition Coordinators' meeting resulted in several ideas for improvement to outreach and education strategies as well as identified a couple of potential locations that could benefit from infrastructure improvements or educational efforts. Additional outreach with Regional Safety Coalition Coordinators will take place as part of SHSP outreach.

Local Consultation Meetings

In August/September 2023, DOTD and DOTD's consultant for the Louisiana VRU Safety Assessment, HDR Engineering, Inc. (HDR), facilitated five consultation meetings to discuss the Louisiana VRU Safety Assessment with local entities within the top 20 Target Analysis Areas. DOTD invited FHWA, the Regional Safety Coalition Coordinators, the Louisiana Local Technical Assistance Program (LTAP), MPOs, cities, parishes, and other state and local agencies and stakeholders to discuss and prioritize candidate locations for potential infrastructure improvements and consider non-infrastructure strategies to improve conditions for VRUs. Jurisdictions within the top 20 Target Analysis Areas included Baton Rouge, New Orleans, Lake Charles, Shreveport/Bossier, and the Acadiana region (Lafayette, Abbeville, New Iberia, and Opelousas). The consultations included a discussion on the background of the Louisiana VRU Safety Assessment as well as a review of the area-based VRU Network Screening that was completed to identify the Target Analysis Areas. The top Target Analysis Areas, both bicycle and pedestrian, in each city/region were shown along with any target facility types. After a review of local programs, policies, and existing and future projects, the groups discussed potential candidate locations within Target Analysis Areas.

Baton Rouge Consultation

The Baton Rouge consultation on August 30, 2023, included attendees from the City of Baton Rouge, Capital Region Planning Commission, FHWA, DOTD, and HDR. As shown in Chapter 3, Baton Rouge has a total of seven Target Analysis Areas, including three pedestrian, three bicycle, and one pedestrian/bicycle areas in the top 20. The City of Baton Rouge mentioned that they have proposed VRU improvements as part of their MOVEBR program.[26] The local agencies identified the following safety concerns and potential solutions:

- *Safety concerns:* midblock crossings; lack of places for pedestrians and cyclists to safely cross the street; poor visibility
- *Potential solutions:* road diets; improved lighting; traffic calming measures to help slow vehicles down

New Orleans Consultation

The New Orleans consultation on August 31, 2023, included attendees from the City of New Orleans, New Orleans Regional Planning Commission, University of New Orleans Transportation Institute, LTAP, Regional Safety Coalition, FHWA, DOTD, and HDR. As shown in Chapter 3, New Orleans has a total of 12 Target Analysis Areas, including three pedestrian, three bicycle, and six pedestrian/bicycle areas in the top 20. The local agencies identified the following safety concerns and potential solutions:

- *Safety concerns:* filling in bike lanes to connect existing bike lanes; gaps in the sidewalk forces users, especially wheelchair users, to travel in the street in the opposite direction of vehicles; pedestrian traffic near shops and restaurants; six-lane highway serving a minority and low-income area with a significant number of transit users

[26] MOVEBR (brla.gov)

- *Potential solutions:* road diets; bike lanes; pedestrian hybrid beacons; signal enhancements; medians; refuge islands; sidewalk improvements

Acadiana Region Consultation

The Acadiana consultation on September 6, 2023, included attendees from the City of Abbeville, City of New Iberia, Acadiana Planning Commission, Lafayette Consolidated Government, LTAP, Regional Safety Coalition, LSU CARTS, FHWA, DOTD, and HDR. As shown in Chapter 3, the Acadiana Region has a total of seven Target Analysis Areas, including one pedestrian Target Analysis Area in Abbeville, one pedestrian Target Analysis Area in New Iberia, two bicycle Target Analysis Areas in Opelousas, and three bicycle Target Analysis Areas in Lafayette. The local agencies identified the following safety concerns and potential solutions:

- *Safety concerns:* general concerns for safety and accommodation of vulnerable road users; challenges improving sidewalks in areas with utility and driveway conflicts and without available right-of-way; pedestrian traffic near hospitals, schools, and universities; corridors with significant vehicle congestion; weaving and wrong-way crossings by bicycles on an existing shared use path
- *Potential solutions:* sidewalks and other pedestrian/transit infrastructure improvements; improved safety measures along corridors into historic downtown; separated bike facilities; improved access management; new or improved pedestrian and bicycle crossings; additional signage

Lake Charles Consultation

The Lake Charles consultation on September 6, 2023, included attendees from the City of Lake Charles, Regional Safety Coalition, FHWA, DOTD, and HDR. As shown in Chapter 3, Lake Charles has one pedestrian/bicycle Target Analysis Area. The local agencies identified the following safety concerns and potential solutions:

- *Safety concerns:* pedestrians on constrained roadways without sidewalks or viable alternative routes
- *Potential solutions:* road diets; bike lanes; improved sidewalks or other pedestrian facilities

Shreveport/Bossier Consultation

The Shreveport/Bossier consultation on September 7, 2023, included attendees from the City of Shreveport, the City of Bossier City, Northwest Louisiana Council of Governments, Regional Safety Coalition, FHWA, DOTD, and HDR. As shown in Chapter 3, Shreveport/Bossier has four pedestrian Target Analysis Areas but no bicycle Target Analysis Areas. After presenting these Target Analysis Areas, the local agencies identified the following safety concerns and potential solutions:

- *Safety concerns:* pedestrian safety
- *Potential solutions:* pedestrian infrastructure improvements

Additional Trainings/Workshops

Additional VRU activities were conducted for local agencies and stakeholders throughout the months of August and September 2023. From August 9, 2023, through September 14, 2023, LTAP, in partnership with others, conducted nine VRU safety workshops at locations Statewide titled *LTAP in Partnership with FHWA Resource Center, FHWA Louisiana Division Office and Destination Zero Deaths presents: Vulnerable Road Users Safety Workshop*. Each workshop discussed how safety stakeholders and local agencies can help reduce VRU deaths and serious injuries in Louisiana. Some of the topics included operating characteristics and safety concerns related to VRUs; available data sources and tools that can be used in VRU safety analysis; and relating Proven Safety Countermeasures and the Safe System Approach to VRUs. These workshops were attended by transportation professionals and safety stakeholders representing local, state, and federal government throughout Louisiana.

FHWA and DOTD conducted two two-day workshops on September 18-21, 2023, in Baton Rouge and Alexandria titled *Local Agency Working Sessions for Improving Safety of Pedestrians on Louisiana's Roads and Streets*. The purpose of these working sessions was to help identify solutions to address non-motorized user safety and mobility issues as well as determine next steps and other considerations for project development. The target audience was local entities and roadway owners. Attendance included representatives from MPOs and city, parish, state, and federal agencies. Each attendee was encouraged to bring a candidate location from their community or jurisdiction where they were interested in improving pedestrian safety. A team of FHWA technical experts from across the country facilitated the workshop and helped attendees develop potential solutions. The workshop was structured around these candidate locations and featured exercises and working groups where attendees considered the context their location played within the greater community, and then developed concept corridor and intersection designs. Areas where additional analysis or information could benefit each location was discussed. Each attendee left the workshop with potential pedestrian safety solutions for a real-world location, next steps to pursue, and a framework to apply these concepts through their entire network.

Outcomes

After the five local consultation meetings were completed, a follow up email was sent to representatives from each jurisdiction that included a copy of the presentation. Access to the ArcGIS map with the Target Analysis Areas was also granted to local representatives. This follow-up allowed jurisdictions more time to review the Target Analysis Areas and identify additional locations for potential infrastructure improvements. Representatives were also encouraged to consider educational and enforcement strategies that could be applied systemically to encourage safer behaviors of individuals using the transportation system.

Next steps beyond the publication of the Louisiana VRU Safety Assessment include identifying candidate locations in each jurisdiction for developing concepts for potential infrastructure improvements and non-infrastructure strategies. In identifying locations for potential infrastructure improvements within the Target Analysis Areas, consideration may include if the location is also on a pedestrian or bicycle target facility type, has been identified in a previous safety plan, and/or whether it is in a Historically Disadvantaged Community. Another factor to consider is whether the location has an existing or future project that would mitigate the issue. Follow-up with each region through the SHSP Infrastructure and Operations emphasis area teams is also anticipated as part of this process.

Conclusion

6

The Louisiana VRU Safety Assessment is consistent with Louisiana's commitment to the Destination Zero Deaths Initiative and is compliant with FHWA's guidance for VRU safety assessments. After introducing the Safe System Approach in Chapter 1, which is the underlying theme of the Louisiana VRU Safety Assessment, this report covers the following components based on the FHWA template for VRU safety assessments:

- Overview of VRU Safety Performance (Chapter 2)
- Summary of Quantitative Analysis (Chapter 3)
- Program of VRU Improvement Strategies (Chapter 4)
- Summary of Consultation and Outcomes (Chapter 5)

The DOTD, along with SHSP partners and local and regional stakeholders, will advance safety for non-motorists through the strategies outlined in this assessment. The DOTD is continuing to work with the jurisdictions identified as having top-ranked Target Analysis Areas for biking and walking to develop strategies that can address the issues within those Target Analysis Areas. These strategies may include policy changes, coordination with the Regional Safety Coalition Coordinators, or infrastructure safety countermeasure projects. The DOTD also plans to continue investigating the high frequency of pedestrian fatalities and serious injuries on urban two-lane roads. By collaborating and continuing to leverage resources, Louisiana is creating a safer, more sustainable transportation network for all users – particularly for those who walk, bike, or roll.

APPENDIX A

Data Collection and VRU Crash Trend Analysis

Data Collection and Sources

The data presented in **Table A-1** were used for the VRU crash trend analysis and developing the pedestrian and bicycle SPFs.

Table A-1. Summary of Collected Data

Data	Source	Description
Highway Class Segments	LSU CARTS	This geodatabase represents all roads statewide and includes highway classification, and annual average daily traffic.
Parks and Schools	National Center for Education Statistics / ParkServe	These geodatabases include location of all schools and parks in Louisiana.
Crash Data	LSU CARTS	This database contains crash-level and person-level data on all crashes involving a VRU 2012-2021. The database contains necessary information to geolocate and spatially relate with other geodatabases.
Household Income	Replica population synthesis of US Census data	These data are from the 2020 US Census.
Number of Vehicles per Household	Replica population synthesis of US Census data	These data are from the 2020 US Census.
Race, age of population	Replica population synthesis of US Census data	These data are from the 2020 US Census.
Mode Choice for Work Commuters	Replica population synthesis of US Census data	These data are from the 2020 US Census.
Bike Miles Traveled	Replica	Replica activity generation model and travel assignment results. Daily miles for an average weekday in the Fall of 2021.
Walk Miles Traveled	Replica	Replica activity generation model and travel assignment results. Daily miles for an average weekday in the Fall of 2021.
Transit Miles Traveled	Replica	Replica activity generation model and travel assignment results. Daily miles for an average weekday in the Fall of 2021.
Transit Stop Data	Replica, Rapides Area Planning Commission, Calcasieu Parish Police Jury, Transitland, Monroe Transit System	This is a statewide comprehensive geodatabase of all transit and bus stops. Specific regions/jurisdictions were contacted, as shown to the left, to complete the statewide database of transit stops.
Employment	LEHD, Workplace Area Characteristics	This was the count of total jobs from LEHD workplace area characteristics file for Louisiana, reported at the census block level.
Historically Disadvantaged Communities	LSU CARTS	This geodatabase identifies all areas in Louisiana that are considered Historically Disadvantaged Communities.
Signalized Intersections	Open Street Map	Geodatabase of all signalized intersection locations in Louisiana.

VRU Fatality and Serious Injury Trends Analysis

Chapter 2 presented the VRU fatality and serious injury trends that were found in examining the data. This section presents data summaries in more detail. The crash data presented in this section originate from the crash data obtained through LSU CARTS and have not been manipulated or aggregated into broader categories than those reported by LSU CARTS. All crash data presented in this section are 2012-2021 crash data.

Table A-2 and **Table A-3** show the change in VRU injury levels for each year. Injury levels are categorized using the KABCO scale: "K" refers to fatal injury, "A" refers to suspected serious injury, "B" refers to suspected minor injury, "C" refers to possible injury, and "O" refers to no apparent injury. **Table A-2** shows that the count of "BCO" injury levels is decreasing over time while the "KA" (fatal and suspected serious) injuries are increasing over time. **Table A-3** shows that the percentage, or proportion, of "BCO" injuries per year is decreasing while the percentage of "KA" injuries is increasing. Overall, the total number of VRUs involved in crashes has been decreasing each year since 2016; however, the number of VRU fatal and serious injuries reached annual highs in 2021.

Table A-2. VRU Injury Levels by Year (Frequency)

	Crash Year										
Injury Level	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	**Grand Total**
(K) FATAL INJURY	146	111	123	142	150	140	195	144	180	220	1,551
(A) SUSPECTED SERIOUS INJURY	156	185	181	199	202	206	223	229	227	231	2,039
(B) SUSPECTED MINOR INJURY	879	877	806	892	945	953	930	918	702	726	8,628
(C) POSSIBLE INJURY	1001	959	965	957	1034	1033	956	958	734	693	9,290
(O) NO APPARENT INJURY	268	259	281	297	278	258	258	250	203	163	2,515
NOT REPORTED	189	185	167	161	163	144	125	160	112	113	1,519
Grand Total	2,639	2,576	2,523	2,648	2,772	2,734	2,687	2,659	2,158	2,146	25,542

Table A-3. VRU Injury Levels by Year (Percentage)

	Crash Year										
Injury Level	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	**Grand Total**
(K) FATAL INJURY	5.5%	4.3%	4.9%	5.4%	5.4%	5.1%	7.3%	5.4%	8.3%	10.3%	6.1%
(A) SUSPECTED SERIOUS INJURY	5.9%	7.2%	7.2%	7.5%	7.3%	7.5%	8.3%	8.6%	10.5%	10.8%	8.0%
(B) SUSPECTED MINOR INJURY	33.3%	34.0%	31.9%	33.7%	34.1%	34.9%	34.6%	34.5%	32.5%	33.8%	33.8%
(C) POSSIBLE INJURY	37.9%	37.2%	38.2%	36.1%	37.3%	37.8%	35.6%	36.0%	34.0%	32.3%	36.4%
(O) NO APPARENT INJURY	10.2%	10.1%	11.1%	11.2%	10.0%	9.4%	9.6%	9.4%	9.4%	7.6%	9.8%
NOT REPORTED	7.2%	7.2%	6.6%	6.1%	5.9%	5.3%	4.7%	6.0%	5.2%	5.3%	5.9%

Intersection Relation

Table A-4 provides a breakdown of injury levels by VRU type and whether the crash occurred at the intersection or along a segment (i.e., not at intersection). Intersection relation is a derived field in the crash data based on police officer judgement and post-processing of the crash data. Both pedestrians and bicyclists experience a high frequency of "B" and "C" injury severity crashes at both intersections and not at intersections. Pedestrians crashes not at intersections skew slightly more towards the fatal and serious injury categories.

Table A-4. VRU Injury Level by Intersection Relation

	Person Type / Intersection Related				
	PEDESTRIAN		BICYCLIST		**Grand Total**
Injury Status	At Intersection	Not At Intersection	At Intersection	Not At Intersection	
(K) FATAL INJURY	300	1,000	64	187	1,551
(A) SUSPECTED SERIOUS INJURY	560	1,064	182	233	2,039
(B) SUSPECTED MINOR INJURY	2,009	3,993	1,063	1,563	8,628
(C) POSSIBLE INJURY	1,935	3,856	1,346	2,153	9,290
(O) NO APPARENT INJURY	396	819	490	810	2,515
NOT REPORTED	275	526	293	425	1,519
Grand Total	5,475	11,257	3,438	5,371	25,542

Age and Race

Pedestrian fatal and serious injuries are spread out across the age groups, with the “1-14” age group having a higher frequency relative to other young age groups, particularly for Black persons. When comparing race, the younger age groups tend to be more predominantly Black while the older age groups skew white (**Figure A-1**).

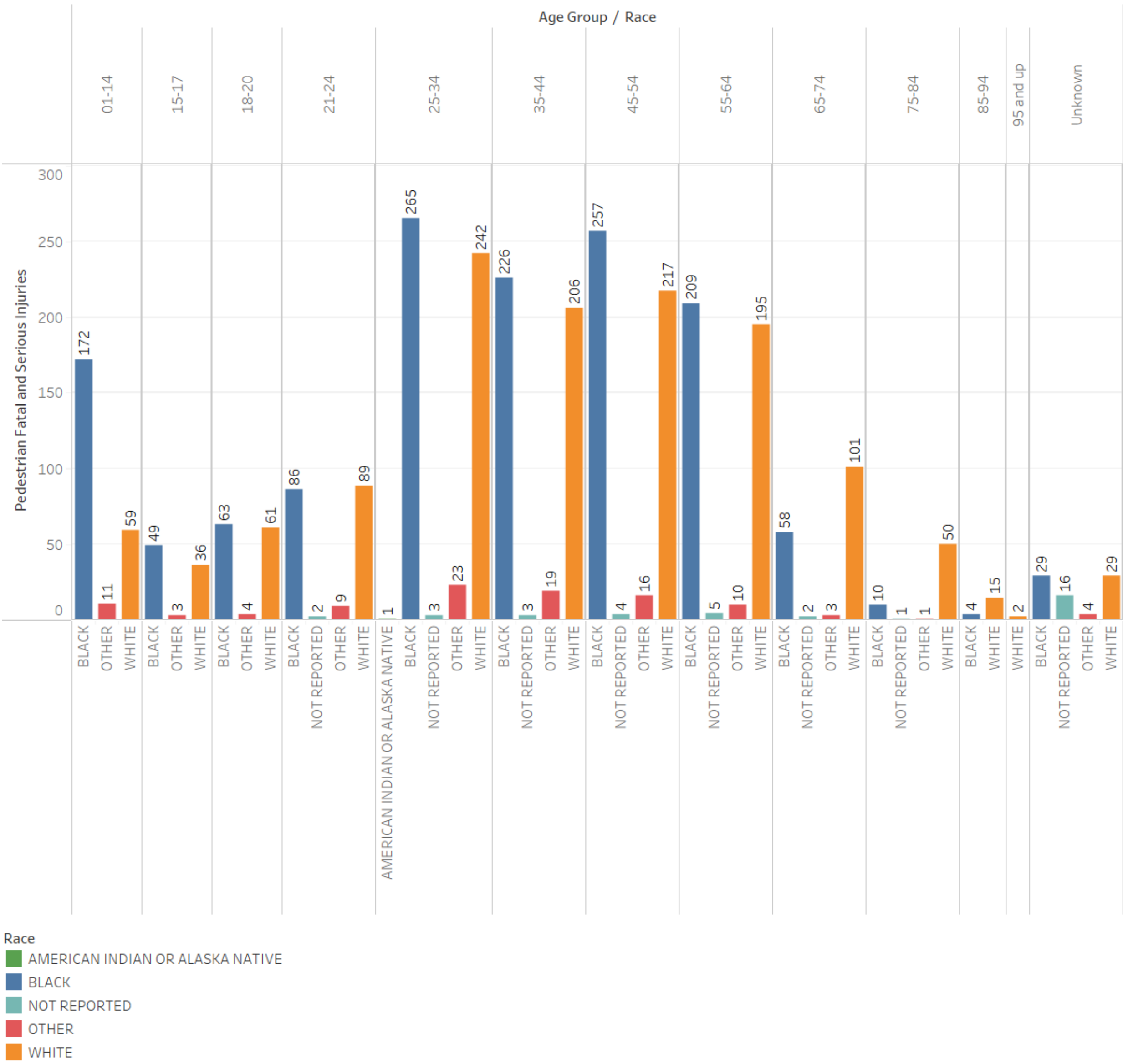

Figure A-1. Pedestrian Fatal and Serious Injuries, Age by Race

Bicyclist fatal and serious injuries have a higher concentration of injuries in the "35-65" age groups. The "25-64" age group tends to skew to more fatal and serious injuries for white persons, while the other age groups tend to be similar (**Figure A-2**).

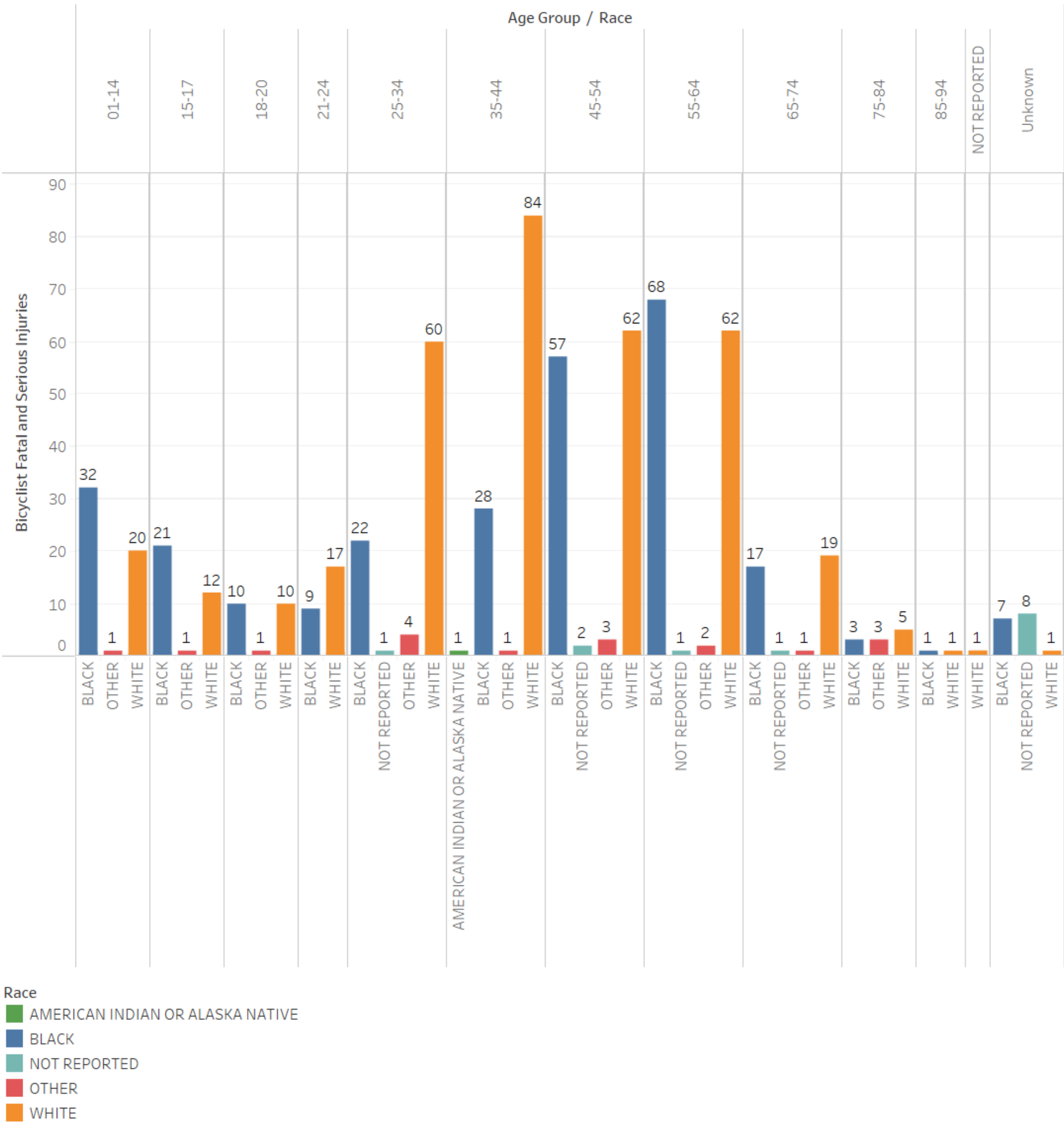

Figure A-2. Bicyclist Fatal and Serious Injuries, Age by Race

Drivers involved in a crash resulting in a VRU fatal and serious injury have a bell curve distribution in terms of age groups, with “25-34” being the peak frequency and trailing out towards the younger and older years. The distribution across the race categories is even between Black and white (**Figure A-3**). It is important to note the 497 drivers of unknown race and age, which makes up almost 20% of all drivers involved in VRU fatal and serious injury crashes. Around 75% of these drivers (372 drivers) were involved in hit-and-run crashes, thus the driver in most of these crashes is unknown.

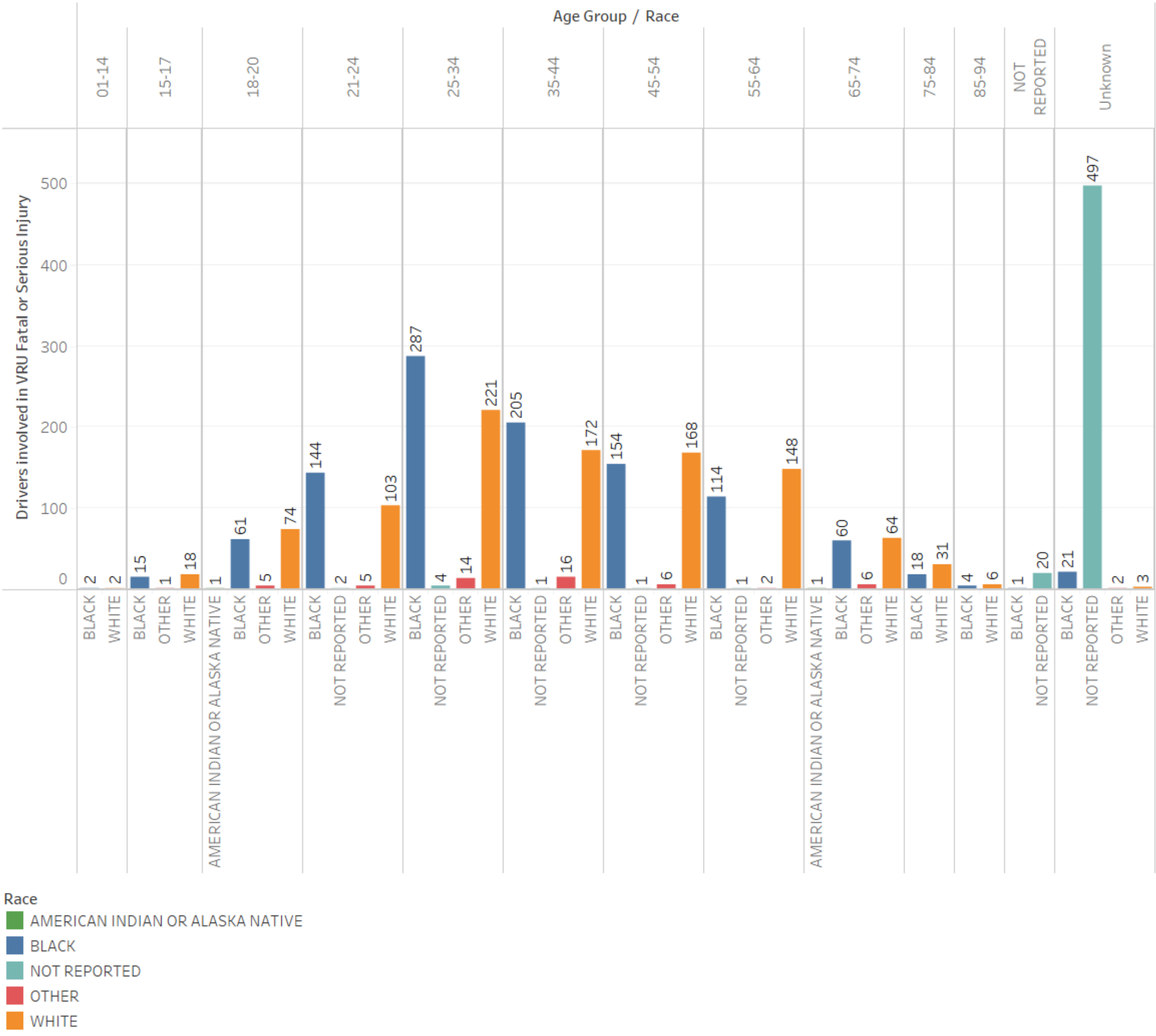

Figure A-3. Drivers involved in a VRU Fatal or Serious Injury, Age by Race

Hit and Run Crashes

Figure A-4 shows the number of fatally and seriously injured pedestrians and bicyclists involved in hit-and-run crashes. Around 25% of pedestrian fatal and serious injuries are related to hit-and-run crashes, and about 21% of bicyclists fatal and serious injuries are related to hit-and-run crashes.

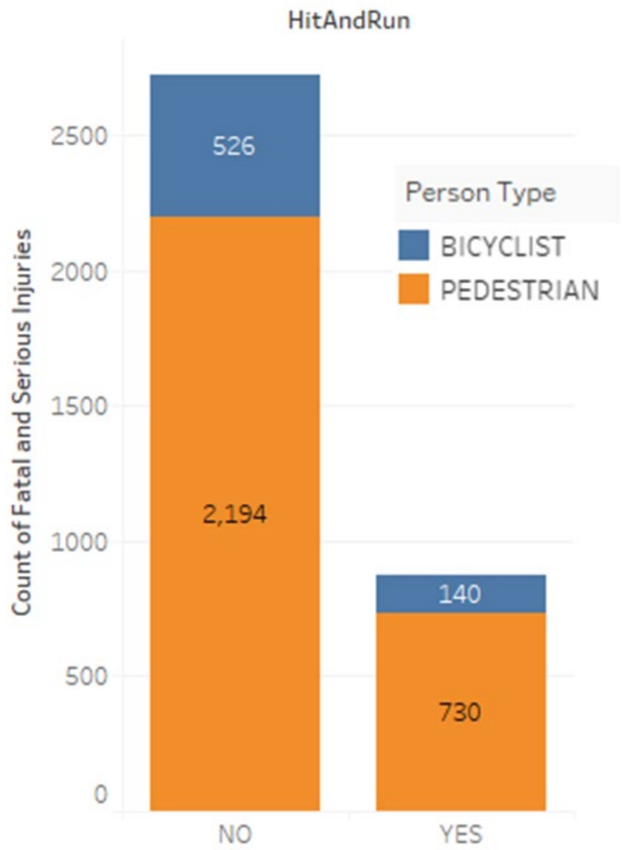

Figure A-4. Hit-and-run VRU Injuries

VRU Action Prior to Crash

Figure A-5 (pedestrians) and **Figure A-6** (bicyclists) display the VRU action prior to fatal and serious injuries. Most pedestrians are crossing the roadway when they are involved in a crash with a vehicle. Around one-third of pedestrians crossing actions prior to crashes occur at intersections (428 pedestrians). The next highest categories are traveling along the roadway with traffic or in the roadway. For bicyclists, there is not much to be gleaned from the data. The most common actions prior to the crash are marked in the database as other contributing action, no contributing action, or failure to yield right of way.

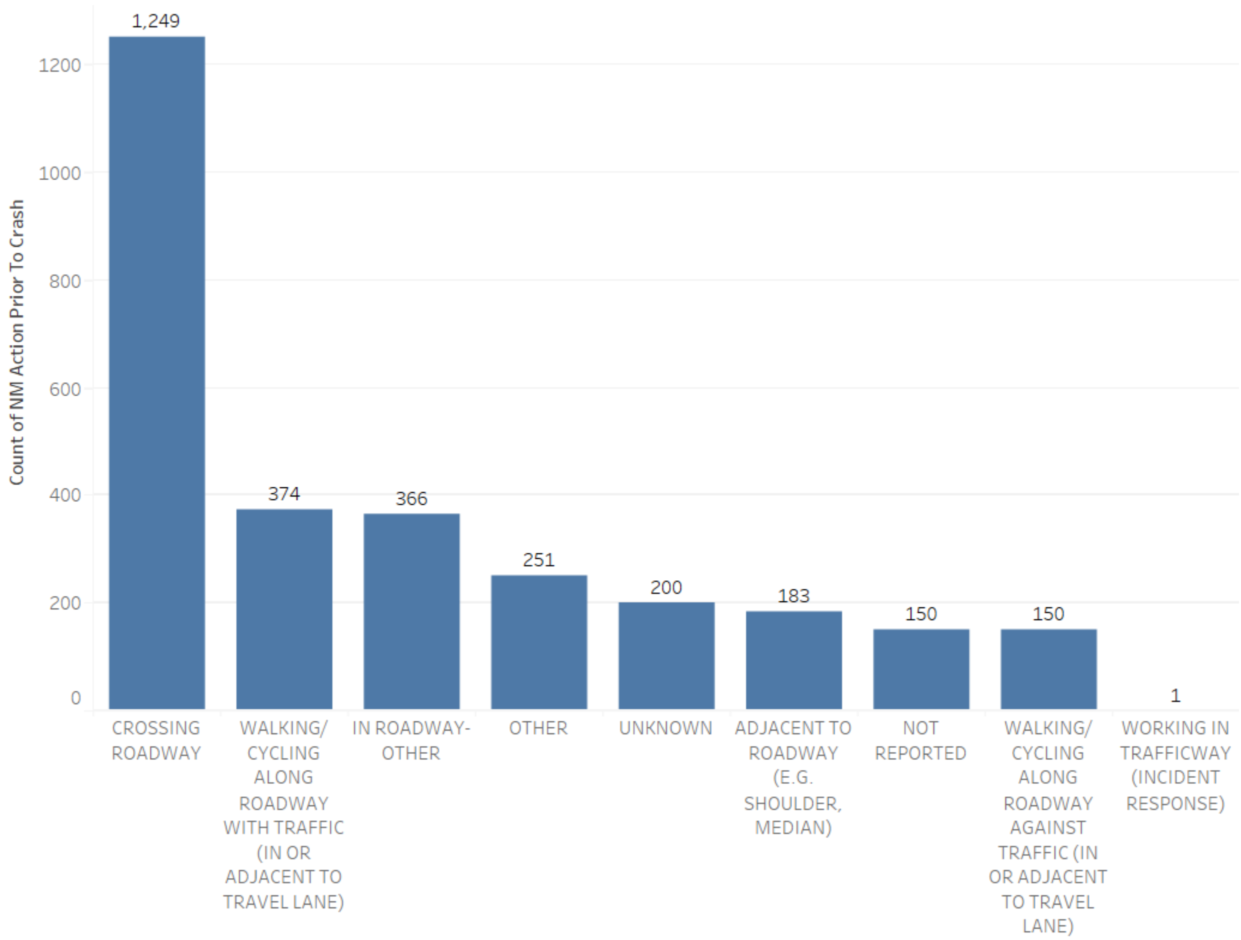

Figure A-5. Pedestrian Fatal and Serious Injury Action Prior to Crash

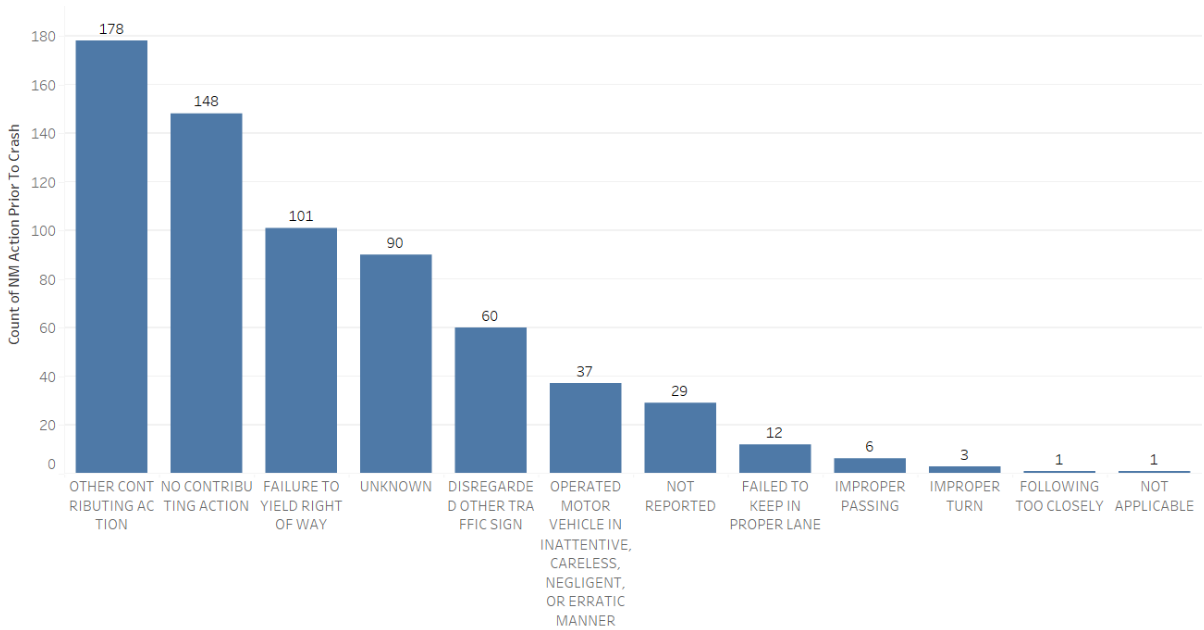

Figure A-6. Bicyclist Fatal and Serious Injury Action Prior to Crash

Time of Day and Day of Week Trends

Table A-5 and **Table A-6** show fatal and serious injuries by year across the hours of the day. The hours with the highest pedestrian fatal and serious injuries tend to happen in the evening, particularly at around 8 pm or the “20 Hour”. In recent years, the frequency of crashes in this time period have increased with more than 45 fatal and serious injuries occurring in the 8 pm hour in 2020 and 2021 compared to 27 fatal and serious injuries occurring in the 8 pm hour in 2012-2013. The early morning hours also have moderate frequencies of fatal and serious injuries, albeit not as frequent as the evening counts. Bicyclist fatal and serious injuries are almost predominantly occurring in the evening hours, 5 to 9 pm in particular.

Table A-5. Pedestrian Fatal and Serious Injuries Time of Day by Year

	Hour of Day																								
Crash Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	**Grand Total**
2012	6	15	13	4	6	14	9	5	5	3	3	4	7	3	4	6	7	15	18	12	27	27	23	14	250
2013	14	8	13	7	11	4	8	5	2	3	1	2	6	5	7	6	6	17	20	18	27	24	22	14	250
2014	10	21	6	6	7	9	12	12	7	4	1	4	3	9	6	15	12	10	14	18	18	16	21	14	255
2015	13	9	15	11	7	15	8	7	4	4	4	2	7	4	7	8	3	14	18	21	22	33	22	17	275
2016	8	22	13	5	10	8	7	4	3	4	4	0	6	5	9	12	8	18	17	22	39	17	26	16	283
2017	5	4	11	8	4	7	10	6	5	6	8	4	7	10	7	10	16	16	32	16	31	21	24	9	277
2018	12	11	12	10	16	10	20	5	8	4	1	4	7	3	10	9	4	23	31	32	41	35	19	14	341
2019	12	11	8	3	9	11	14	7	5	8	9	9	6	6	5	9	7	26	24	26	26	30	19	11	301
2020	18	1	8	9	10	21	9	4	2	3	1	3	6	10	6	7	9	21	19	26	46	34	30	19	322
2021	18	9	14	9	7	11	22	6	3	8	3	7	2	16	10	10	9	13	32	31	45	35	28	22	370
Grand Total	116	111	113	72	87	110	119	61	44	47	35	39	57	71	71	92	81	173	225	222	322	272	234	150	2,924

Table A-6. Bicyclist Fatal and Serious Injuries Time of Day by Year

	Hour of Day																								
Crash Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	**Grand Total**
2012	2	0	0	1	0	2	2	1	3	0	0	1	1	1	1	5	2	2	9	1	9	2	4	3	52
2013	0	1	0	0	0	0	0	0	0	1	1	2	0	2	1	4	5	6	2	6	6	7	1	1	46
2014	1	0	0	1	1	1	1	1	0	1	1	2	2	2	6	5	5	5	3	2	4	1	4	0	49
2015	3	3	1	1	1	0	0	1	2	3	4	3	2	2	3	2	5	6	0	5	7	4	5	3	66
2016	1	2	1	0	0	3	4	2	0	0	3	3	3	7	5	4	3	4	7	4	9	3	1	0	69
2017	1	2	2	3	1	5	3	3	1	1	0	2	2	4	2	1	7	6	5	7	4	3	2	2	69
2018	0	2	0	0	0	4	3	1	6	5	4	2	2	4	3	4	2	5	5	9	3	5	5	3	77
2019	2	2	2	1	0	1	2	3	2	3	3	1	4	1	4	6	6	2	2	3	11	7	2	2	72
2020	4	1	1	1	1	1	6	2	3	3	1	1	1	8	4	3	3	5	5	11	8	9	2	1	85
2021	5	1	1	1	1	4	0	2	1	1	6	2	1	2	4	1	2	9	7	9	9	5	2	5	81
Grand Total	19	14	8	9	5	21	21	16	18	18	23	19	18	33	33	35	40	50	45	57	70	46	28	20	666

Figure A-7 displays the frequency of pedestrian fatal and serious injuries by the day of the week. Days with the highest frequency of pedestrian fatal and serious injuries occur on Friday and the weekend, with Friday being the most frequent for fatal and serious injuries. The mid-week (Tuesday and Wednesday) experienced the lowest frequency of injuries. **Table A-7** displays pedestrian crashes by hour of the day by the day of the week. As noted, pedestrian fatal and serious injuries are predominantly occurring in the evening hours with weekends, and Friday in particular, having a higher frequency of injuries. Saturday and Sunday early morning hours also have moderate frequency of fatal and serious injuries.

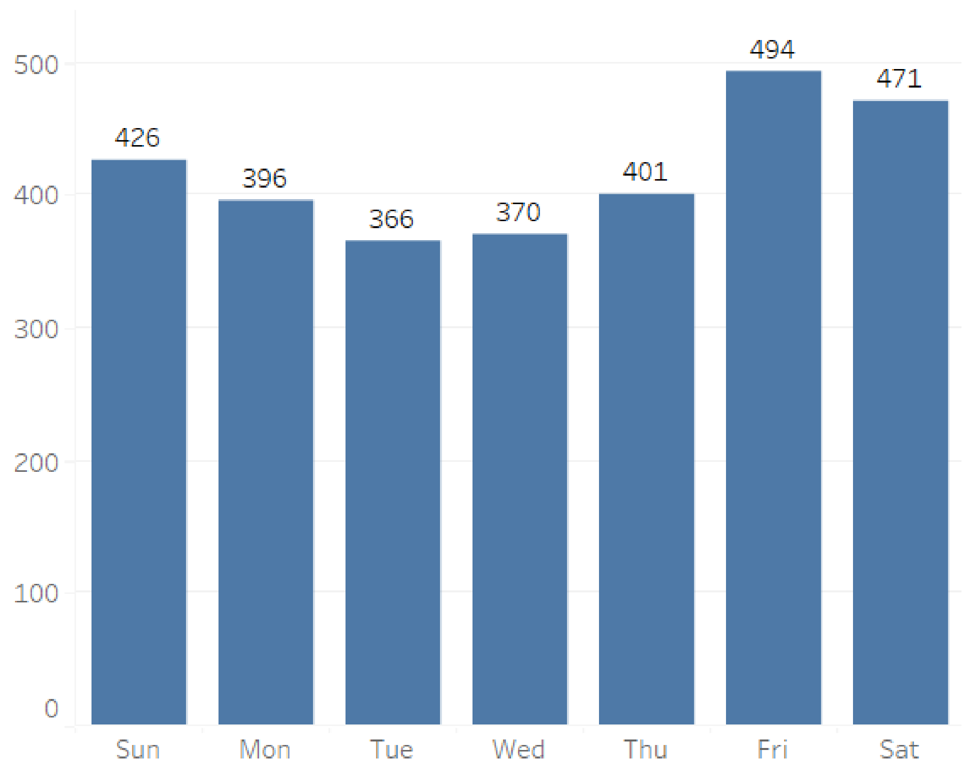

Figure A-7. Pedestrian Fatal and Serious Injuries by Day of Week

Table A-7. Pedestrian Fatal and Serious Injuries Time of Day by Day of Week

	Weekday							
Hour of Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	**Grand Total**
0	24	10	10	14	14	16	28	116
1	36	11	12	11	8	12	21	111
2	31	10	9	9	10	14	30	113
3	14	7	12	6	5	14	14	72
4	12	6	10	13	14	15	17	87
5	14	21	13	17	13	9	23	110
6	9	15	13	16	22	26	18	119
7	3	12	14	3	13	10	6	61
8	0	6	4	14	9	7	4	44
9	11	9	8	6	3	8	2	47
10	4	6	5	4	6	6	4	35
11	5	8	3	4	5	6	8	39
12	7	7	7	8	7	5	16	57
13	8	5	10	12	12	17	7	71
14	6	11	14	11	11	9	9	71
15	12	20	21	8	8	11	12	92
16	10	17	12	13	13	11	5	81
17	27	21	29	23	23	31	19	173
18	23	33	35	29	27	38	40	225
19	37	36	23	24	38	40	24	222
20	44	44	32	42	46	58	56	322
21	42	37	32	37	42	48	34	272
22	31	27	25	31	30	50	40	234
23	16	17	13	15	22	33	34	150
Grand Total	426	396	366	370	401	494	471	2,924

Figure A-8 displays the frequency of bicyclists fatal and serious injuries by the day of the week. The highest frequency of bicyclist fatal and serious injuries occurs on Thursday and Saturday. The lowest frequency of fatal and serious injuries is Sunday while the other weekdays are consistent. **Table A-8** provides the frequency of bicyclist fatal and serious injuries by the hour of the day across the day of the week. Most fatal and serious injuries occur between 5 to 9 pm.

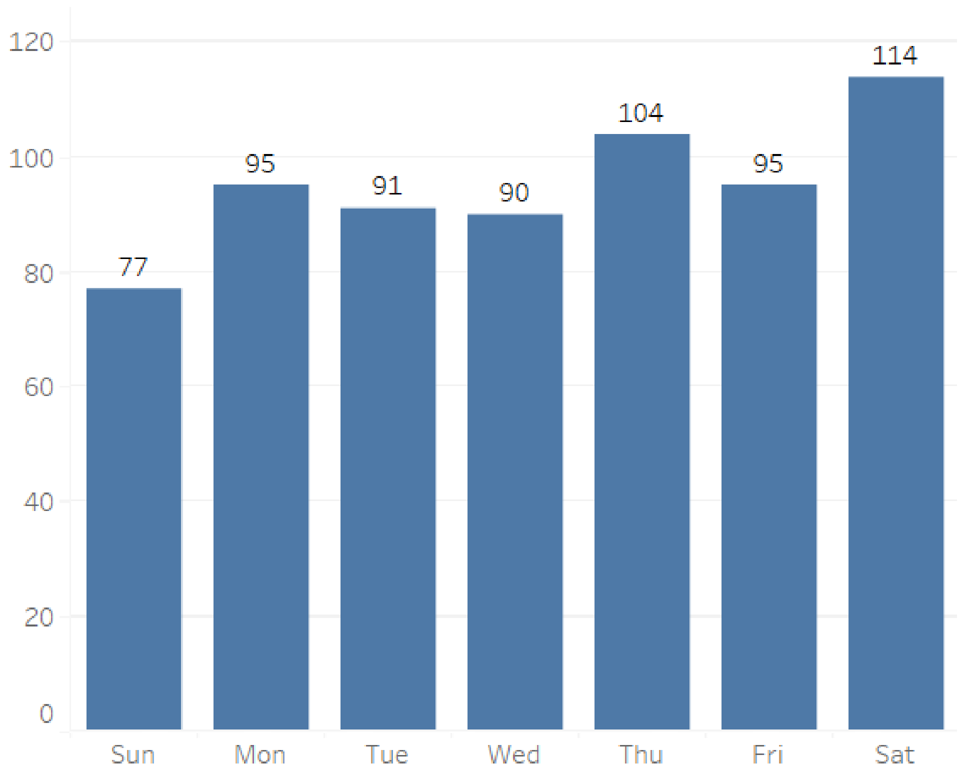

Figure A-8. Bicyclist Fatal and Serious Injuries by Day of Week

Table A-8. Bicyclist Fatal and Serious Injuries Time of Day by Day of Week

	Weekday							
Hour of Day	Sun	Mon	Tue	Wed	Thu	Fri	Sat	**Grand Total**
0	2	3	1	0	3	3	7	19
1	2	1	2	1	2	2	4	14
2	4	0	0	0	0	3	1	8
3	3	1	1	1	1	0	2	9
4	1	1	0	1	0	0	2	5
5	0	3	5	4	5	2	2	21
6	0	3	4	4	6	3	1	21
7	0	3	3	2	2	3	3	16
8	2	3	2	3	0	6	2	18
9	0	3	3	2	4	3	3	18
10	1	3	4	4	3	4	4	23
11	3	1	0	4	2	4	5	19
12	3	4	1	6	2	1	1	18
13	3	5	1	5	8	7	4	33
14	6	5	3	7	3	5	4	33
15	6	4	8	2	7	3	5	35
16	3	6	7	7	5	11	1	40
17	5	7	10	6	6	6	10	50
18	3	8	8	5	7	4	10	45
19	7	8	9	7	10	7	9	57
20	10	10	8	8	14	5	15	70
21	5	6	7	5	6	7	10	46
22	3	7	2	5	4	2	5	28
23	5	0	2	1	4	4	4	20
Grand Total	77	95	91	90	104	95	114	666

VRU Injuries in Historically Disadvantaged Communities

Historically Disadvantaged Communities (HDC) are defined using criteria set by the USDOT consistent with the Justice40 Initiative.[27] For a Census Tract to be considered an HDC, it must meet four of the following six transportation disadvantaged indicators: transportation access, health, environmental, economic, resilience, and equity.

Table A-9 displays the VRU type by HDC by year for fatal and serious injuries. Overall, approximately 68% of pedestrian and bicycle fatal and serious injuries occur in HDCs. Bicyclist injuries in HDCs grew from 2012-2015 and have maintained the frequency of injuries. The non-HDC injuries for bicyclists have varied over time with peak frequencies in 2015-2016 and 2020-2021. Generally, VRU fatal and serious injury frequencies are two times higher in HDCs than non-HDCs.

Table A-10 exhibits the pedestrian fatal and serious injuries for HDCs by age group and race while **Table A-11** displays the bicyclist fatal and serious injuries for HDCs by age group and race. Overall, Black VRUs are experiencing higher fatal or serious injuries in HDCs than other races. The 1-14 age group of Black pedestrians in HDCs has a higher frequency of fatal and serious injuries than other races. For bicyclists in HDCs, the middle age group, ages 25-44, white bicyclists have a higher frequency of fatal and serious injuries than other races while the younger Black bicyclists tend to experience higher fatal and serious injuries. Younger bicyclists and bicyclists over age 45 that are fatally or seriously injured are more frequently Black than other races.

27 Transportation Disadvantaged Census Tracts (Historically Disadvantaged Communities) Interim Definition Methodology | US Department of Transportation

Table A-9. Bicyclist and Pedestrian Fatal and Serious Injuries Present in Historically Disadvantaged Communities

		Crash Year										
Person Type	**Location**	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	**Grand Total**
BICYCLIST	HDC	32	31	27	44	49	54	60	53	55	53	458
	Non-HDC	18	15	19	21	20	15	17	19	30	28	202
PEDESTRIAN	HDC	162	175	167	187	170	182	232	203	237	246	1,961
	Non-HDC	74	71	80	81	106	88	109	96	83	121	909
Grand Total		286	292	293	333	345	339	418	371	405	448	3,530

Table A-10. Pedestrian Fatal and Serious Injuries in Historically Disadvantaged Communities by Race

	Race				
Age Group	BLACK	NOT REPORTED	OTHER	WHITE	**Grand Total**
01-14	135	0	11	39	185
15-17	34	0	1	22	57
18-20	48	0	3	38	89
21-24	62	0	6	63	131
25-34	183	3	13	148	347
35-44	159	3	14	132	308
45-54	191	3	12	146	352
55-64	147	3	6	110	266
65-74	40	2	3	63	108
75-84	9	1	1	35	46
85-94	4	0	0	11	15
95 and up	0	0	0	1	1
Unknown	21	10	3	22	56
Grand Total	1,033	25	73	830	1,961

Table A-11. Bicyclist Fatal and Serious Injuries in Historically Disadvantaged Communities by Race

	Race					
Age Group	AMERICAN INDIAN OR ALASKA NATIVE	BLACK	NOT REPORTED	OTHER	WHITE	**Grand Total**
01-14	0	26	0	0	11	37
15-17	0	16	0	0	10	26
18-20	0	9	0	1	6	16
21-24	0	7	0	0	10	17
25-34	0	18	0	4	41	63
35-44	1	21	0	1	49	72
45-54	0	45	0	3	39	87
55-64	0	59	1	2	35	97
65-74	0	11	0	0	13	24
75-84	0	2	0	2	1	5
85-94	0	1	0	0	1	2
Unknown	0	5	6	0	1	12
Grand Total	1	220	7	13	217	458

Light Condition

Figure A-9 contains a bar chart of fatal and serious injuries for all VRUs by the light conditions at the time of the crash. The most frequent condition is “Daylight” with “Dark – continuous streetlights” being a close second. “Dark – not lighted” is also a frequent light condition. Overall, 2,455 fatal and serious VRU injuries occurred at night or low light conditions, which makes up 68% of all VRU fatal and serious injuries.

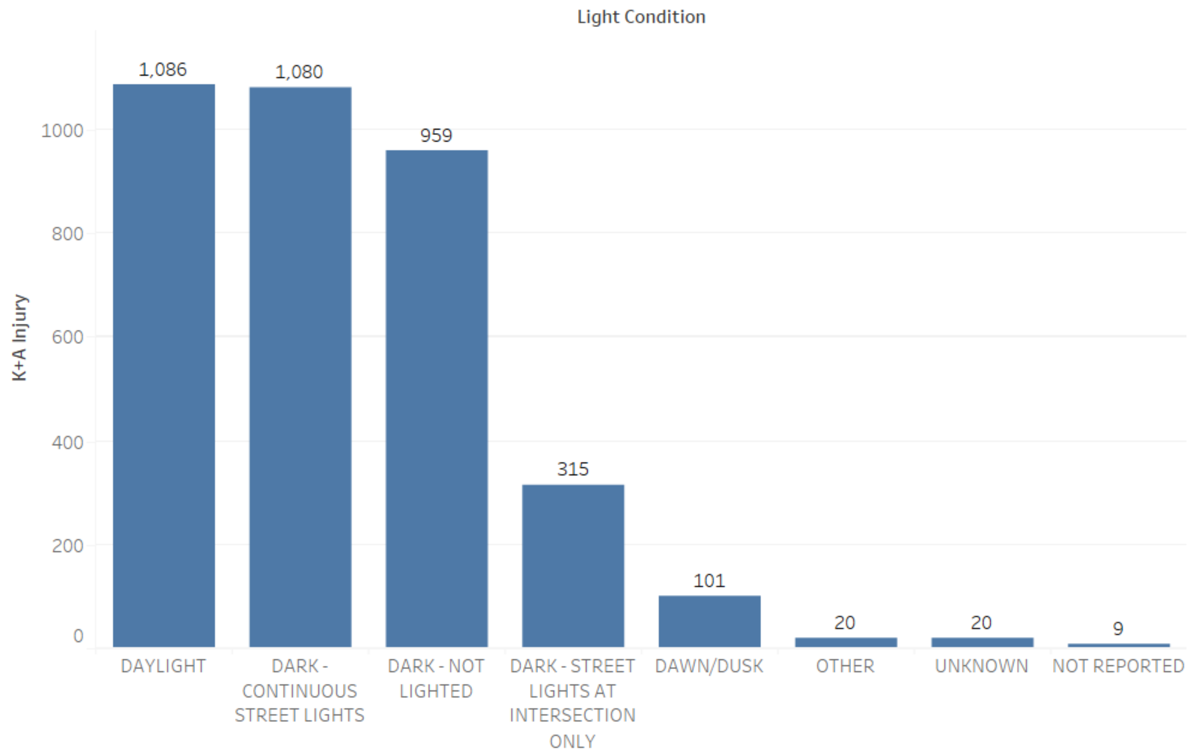

Figure A-9. VRU Fatal and Serious Injuries by Light Condition

Speeding Related

The crash form provides a field for the reporting officer to indicate whether the driver of the vehicle involved in the crash was exceeding the posted speed limit, which was defined as speeding-related in this project. **Figure A-10** plots the speeding-related fatal and serious injuries by year for pedestrians and bicyclists. Very few fatal or serious injuries from speeding-related crashes were recorded, which may indicate that occurrence of speeding was unknown rather than absence of speeding.

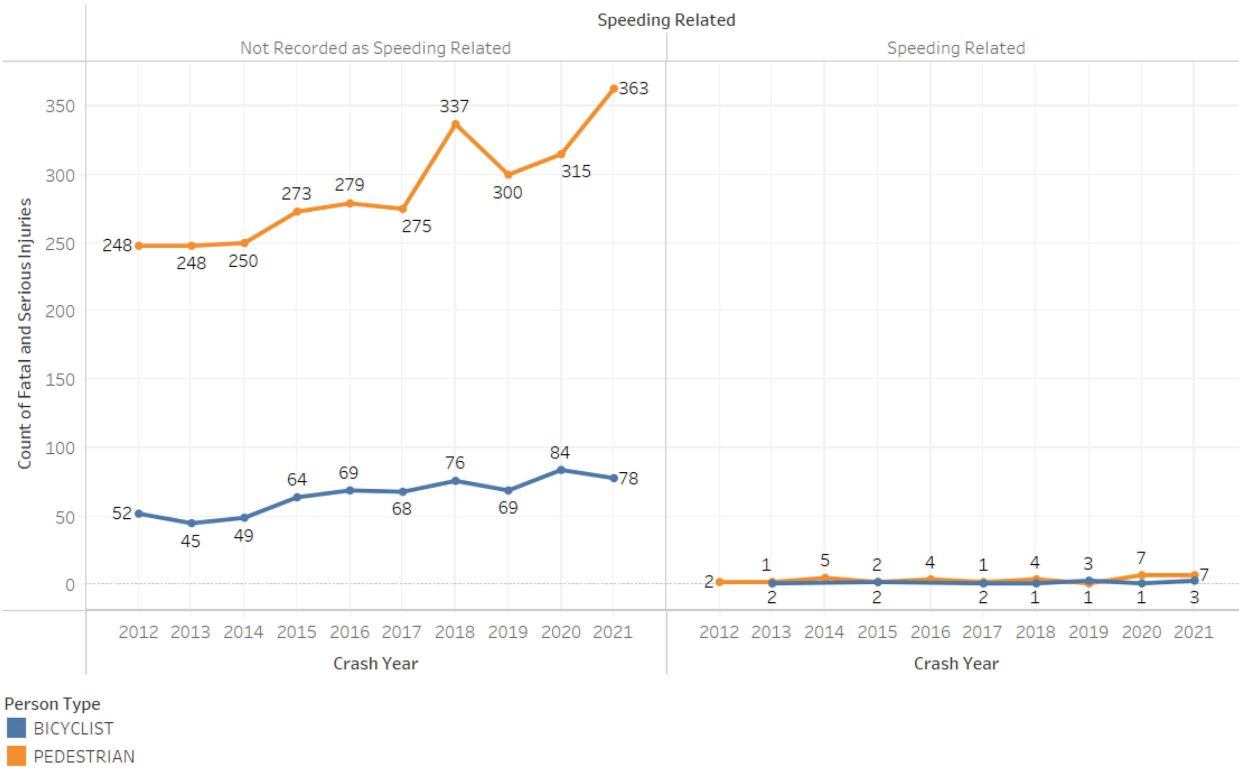

Figure A-10. Speeding Related VRU Fatal and Serious Injuries by Year

Driver and VRU Condition Prior to Crash

Table A-12 shows the driver condition prior to the crash by the VRU injury level. The condition of the driver is being reported as normal or other/unknown most frequently for both fatal and serious VRU injury crashes, and non-fatal and non-serious VRU injury crashes. **Table A-13** displays the VRU condition prior to the crash by injury severity and by VRU type. Both pedestrians and bicyclists are reporting as normal most frequently for non-fatal and serious injuries. For the fatal and serious injuries, both pedestrians and bicyclists are reporting as unknown most frequently.

Table A-12. Driver Condition by VRU Injury Outcome

	Non-Fatal and Non-Serious VRU Injury	Fatal or Serious VRU Injury	Grand Total
Driver Condition	DRIVER	DRIVER	
APPARENTLY NORMAL	12,298	2,269	14,567
UNKNOWN	4,942	776	5,718
OTHER	3,942	562	4,504
UNDER THE INFLUENCE OF MEDICATION/ALCOHOL/DRUGS	352	260	612
NOT REPORTED	453	96	549
ASLEEP/BLACKOUT	34	16	50
FATIGUED	25	6	31
PHYSICAL IMPAIRED	28	3	31
ILL (SICK), FAINTED	16	7	23
Grant Total	22,090	3,995	26,085

Table A-13. VRU Condition by VRU Type

	Non-Fatal and Non-Serious VRU Injury		Fatal or Serious VRU Injury		Grand Total
VRU Condition	PEDESTRIAN	BICYCLIST	PEDESTRIAN	BICYCLIST	
APPARENTLY NORMAL	6,019	3,985	670	192	10,866
OTHER	3,543	2,749	640	178	7,110
UNKNOWN	1,248	907	1,104	272	3,531
NOT REPORTED	1,820	259	340	10	2,429
UNDER THE INFLUENCE OF MEDICATION/ALCOHOL/DRUGS	873	204	315	25	1,417
PHYSICAL IMPAIRED	67	10	10	3	90
ILL (SICK), FAINTED	25	2	16	2	45
FATIGUED	22	7	0	1	30
ASLEEP/BLACKOUT	5	3	16	0	24
Grand Total	13,622	8,126	3,111	683	25,542

Comparison of Trends to Safety Performance Targets

Louisiana developed safety performance targets for calendar year 2024. One of the performance measures was for the five-year rolling average of non-motorist fatal and serious injuries. The target set for this performance measure was 438.0 non-motorist fatal and serious injuries. **Figure A-11** shows the annual total of non-motorist fatal and serious injuries for 2012-2021 along with the five-year rolling average of these annual numbers. Overall, the annual non-motorist fatal and serious injuries are increasing, with a slight decrease in 2019 and 2020 as compared to 2018. The five-year rolling average has been steadily increasing. For the calendar year 2024 performance target to be met, Louisiana will need the 2022 through 2024 non-motorist fatal and serious injury total to average less than 444 for these three years. Unless non-motorist fatal and serious injury totals start decreasing from the high in 2021, it seems unlikely this target will be met.

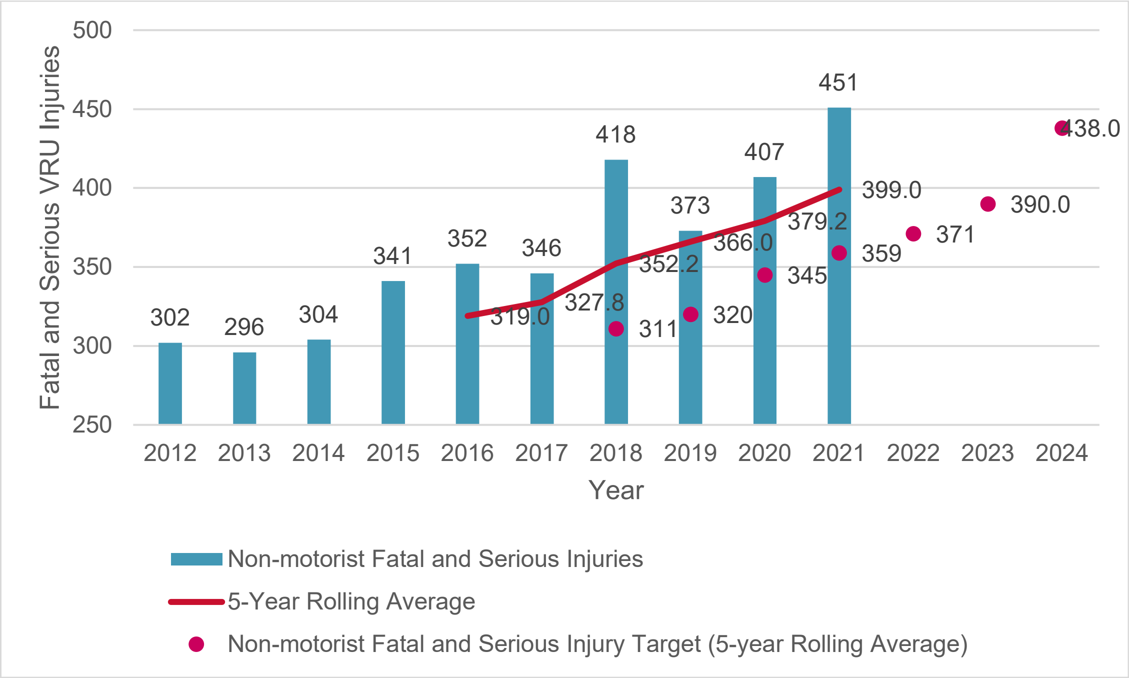

Figure A-11. Non-motorist Fatal and Serious Injuries by Year

Conclusions

The following is a summary of conclusions from reviewing the 2012-2021 VRU crash data:

- Overall, the total number of VRUs involved in crashes have been decreasing each year since 2016; however, the number of VRU fatal and serious injuries reached annual highs in 2021.
- VRU crashes occur at non-intersection locations more frequently than intersections.
- For pedestrian fatal and serious injuries when comparing age and race, the younger age groups tend to be more predominantly Black while the older age groups skew white.
- Bicyclists in the 35 to 65 age group have the highest concentration of fatal and suspected serious injuries.
- 24% of VRU fatal and serious injuries are related to hit-and-run crashes.
- Most fatally or seriously injured pedestrians are crossing the roadway when they are involved in a crash with a vehicle.
- The hours with the highest pedestrian fatal and serious injuries tend to happen in the evening, particularly around 8 pm.
- Bicyclist fatal and serious injuries are almost predominantly occurring in the evening hours, 5 to 9 pm in particular.
- Days with the highest frequency of pedestrian fatal and serious injuries occur on Friday and the weekend, with Friday being the most frequent for fatal and serious injuries.
- The highest frequency of bicyclist fatal and serious injuries occurs on Thursday and Saturday.
- VRU fatal and serious injury frequencies are generally two times higher in Historically Disadvantaged Communities than non-Historically Disadvantaged Communities.
- Overall, Black VRUs are experiencing higher fatal or serious injuries in Historically Disadvantaged Communities than other races.
- Almost 70% of all VRU fatal and serious injuries occur at night or in low light conditions.
- Very few crashes involving VRU fatal and serious injuries were marked as speeding related.
- Most driver conditions and VRU conditions prior to a crash are either labeled as apparently normal, unknown, or other.
- Given the recent trends, it seems unlikely Louisiana will meet its calendar year 2023 and 2024 targets for non-motorist fatal and serious injuries.

Crash Tree

Chapter 2 discusses the conclusions made from the crash tree tool. The output of the tool is shown in **Figure A-12**.

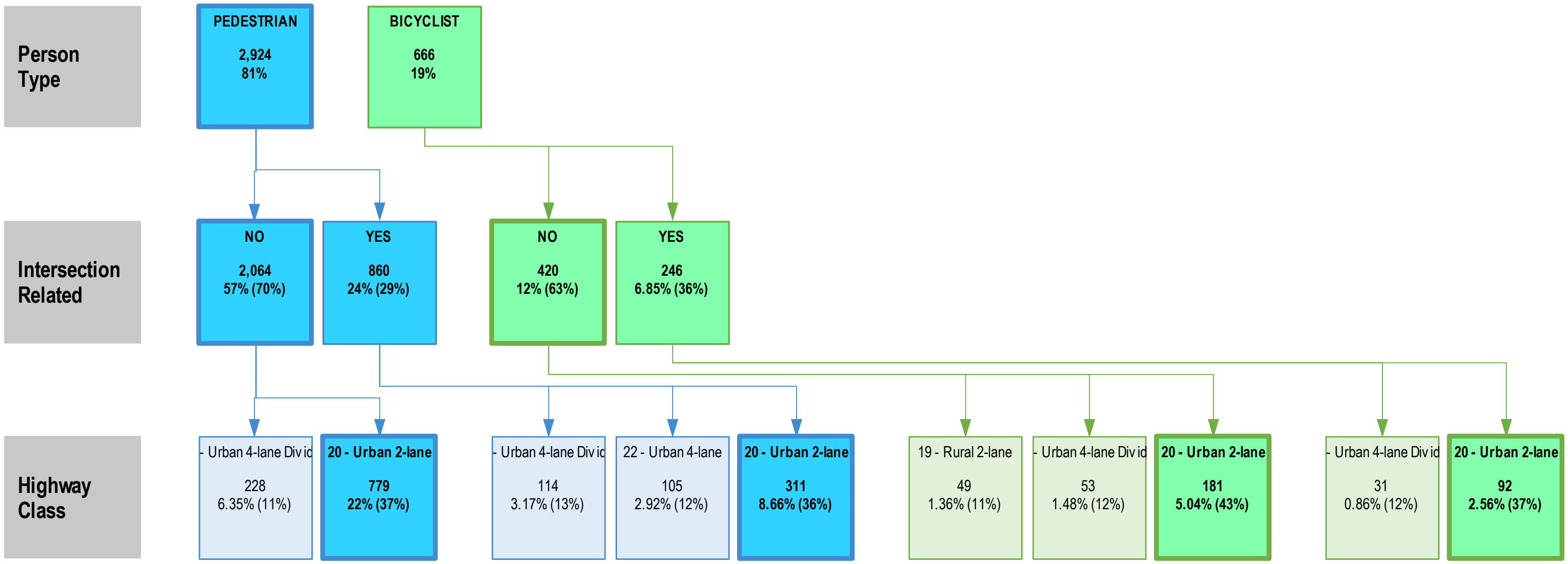

Figure A-12. Crash Tree Tool Output

APPENDIX B

SPF Model Development

The negative binomial regression model was used to model the crash counts of pedestrians and bicyclists for all eligible H3 polygons as described in Chapter 3 Summary of Quantitative Analysis and Findings. The negative binomial regression model is a generalization of the Poisson regression model since it has the same functional form other than an extra parameter to model the over-dispersion. Both the Poisson and negative binomial distributions model count data such as crashes. However, if the variance of the crashes is greater than the mean of the crashes, or in other words, the data is over-dispersed, the negative binomial distribution is the appropriate distribution to use. It accommodates the over-dispersion by estimating and adjusting the variance by this parameter.

The safety performance functions (SPFs) developed for the Louisiana VRU Safety Assessment are based on the negative binomial distribution and specified separately for pedestrian and bicycle crashes. The models related 10-year total crashes observed within the polygon to its average road network, mode choice preferences and population attributes as of 2020. The research team collated the full set of crash type variables and attributes of interest per polygon into one analytical dataset (see Chapter 2 for the complete set of variables and development of the analytical dataset). The functional form of the negative binomial regression model used in this study is:

$$\mu_i = \exp\left(\ln(VMT_i) + \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_1 x_{ki} + e_i\right)$$

Where μ_i represents the total number of crashes observed over a 10-year period from 2012 to 2021 for the ith polygon. The variable VMT_i represents the daily vehicle miles traveled for all road facilities within the ith polygon as of 2020. The variables $x_{1i},\ x_{2i},\ \ldots,\ x_{ki}$ indicate different explanatory or independent variables that when weighted by the parameters $\beta_1,\ \beta_2,\ \ldots,\ \beta_k$ can reasonably predict the values for μ_i. The parameter β_0, called the intercept, represents the average number of crashes when all values of the independent variables are zero.

The independent variables were a mix of continuous variables such as the natural logarithm (LN) of the number of households with zero vehicles or the LN of the number of transit stations and categorical variables such as different freeway daily VMT categories (e.g., none, moderate percentage, high percentage). Each level of a categorical variable is represented by an indicator variable with two values, 0 if the polygon does not match that level's attribute, 1 if it does. An important distinction when using categorical variables is that there is always one level that does not have its own indicator variable. This is because its effect is explained by the intercept parameter and is equivalent to a baseline or zero condition.

Finally, e_i is the error term in the model. Since it is not possible to develop a regression model that perfectly predicts an outcome, the error in the model is represented by this term.

The independent variables of interest were included in the analytical dataset in the models to determine the best possible SPFs for predicting crash rates and crashes based on the characteristics of the polygons. Only the independent variables that were found to be statistically significant were included in the final two models. Since the patterns of pedestrian and bicycle patterns were highly correlated (i.e., 95% correlation), five of the statistically significant independent variables used in the two models were identical.

The following independent variables were found to be statistically significant from the various area-based models that were evaluated:

- Area-Based Variables Significant to Both Pedestrian and Bicycle Crashes
    - Whether or not the percentage of freeway VMT was greater than 0% and 60% or less
    - Whether or not the percentage of freeway VMT was greater than 60%
    - Number of transit stops
    - Number of households with zero vehicles
    - Percent of polygon that is in a historically disadvantaged community
    - Percent of population that is white and non-Hispanic
- Area-Based Variables Significant to Pedestrian Only Cras–es - variables identified for both, plus:
    - Percent of daily walk miles traveled by daily VMT
    - Percent of daily urban road facilities VMT by daily VMT
    - Number of signalized intersections
    - Median household income
- Area-Based Variables Significant to Bicycle Only Crashes- variables identified for both, plus:
    - Whether or not the percentage of VMT of target facility types was greater than 0% and 20% or less
    - Whether or not the percentage of VMT of target facility types was greater than 40% and 60% or less
    - Whether or not the percentage of VMT of target facility types was greater 60%)
    - Percent of daily bike miles traveled by daily VMT
    - Number of public and private K-12 school locations
    - Number of jobs
- Area-Based Variables not Significant to either Pedestrian or Bicycle Crashes:
    - Number of parks

- Mode choice by work commuters
- Transit miles traveled

To avoid over-fitting the models with too many independent variables, the Akaike Information Criterion (AIC) was used. The smaller the AIC, the better the model fit. Hence, the independent variables based on the model with the smallest AIC were selected.

Preliminary Data Analysis

The analytical file consisted of 24,546 polygons representing the total land and water acreage of Louisiana. The research team studied the incidence of total pedestrian and bicycle polygon crashes to understand how prevalent crashes were over the 10-year study period. At the state level, only 8% of polygons had any pedestrian crashes while only 4% had any bicycle crashes.

Selection criteria were established for filtering polygons that had meaningful data from which to form crash prediction models. Logically, sufficient daily VMT and population were necessary since both vehicles and a population must both occur to have a chance of either a pedestrian or bicycle crash involving at least one vehicle.

To that extent, a percentile analysis of daily VMT as a function of total crashes was conducted to determine a threshold for minimum daily VMT. Results of our analysis are in **Table B-1**.

Table B-1. Percentile analysis of Pedestrian Crashes by Daily VMT Range

Daily VMT Range	Number of Polygons	Percentiles						
		5	10	25	50	75	90	95
<= .00	8,701	0	0	0	0	0	0	0
.01 - 130.68	647	0	0	0	0	0	0	0
130.69 - 383.69	1,167	0	0	0	0	0	0	0
383.70 - 652.59	1,169	0	0	0	0	0	0	0
652.60 - 949.71	1,168	0	0	0	0	0	0	0
949.72 - 1288.10	1,169	0	0	0	0	0	0	0
1288.11 - 1714.38	1,169	0	0	0	0	0	0	0
1714.39 - 2302.01	1,168	0	0	0	0	0	0	0
2302.02 - 3140.55	1,167	0	0	0	0	0	0	0
3140.56 - 4450.71	1,170	0	0	0	0	0	0	1
4450.72 - 6602.16	1,168	0	0	0	0	0	0	1
6602.17 - 11233.25	1,169	0	0	0	0	0	1	1
11233.26 - 23235.51	1,168	0	0	0	0	1	1	2
23235.52 - 64163.98	1,168	0	0	0	0	2	4	7
64163.99+	1,178	0	0	0	2	9	27	44
Total	**24,546**	**0**	**0**	**0**	**0**	**0**	**0**	**1**

Results show that polygons had to have at least 64,000 daily VMT to produce a distribution where the median number of total crashes in 10 years was one. Approximately 1,200 polygons met that criterion. With respect to 10-year total bicycle crashes, at least 120,000 daily VMT was required to achieve a similar distribution. This cut-off for the bicycle crash analysis represented approximately 600 polygons.

In addition to filtering on daily VMT, polygons were filtered to identify those with a population count greater than zero and having 90% or less of daily VMT attributed to vehicle freeway miles traveled. If a polygon had more than 90% of its total daily VMT traveled on freeways, the research team decided that the chances of pedestrians or bicyclists traveling in those polygons would be extremely low.

After filtering on the three criteria (i.e., daily VMT, population, percent freeway VMT of daily VMT), 864 polygons remained for modeling pedestrian crashes and 486 remained for modeling bicycle crashes. The research team removed a further four polygons with the four highest crashes for both pedestrians and bicyclists based on the initial results of the regression models. The goodness of fit based on the AIC for the models improved after removing the polygons with the four highest crashes. The histograms **Figure B-1** and **Figure B-2** show how the four highest crashes for pedestrian and bicycle crashes, respectively, right-skew the distribution of crashes.

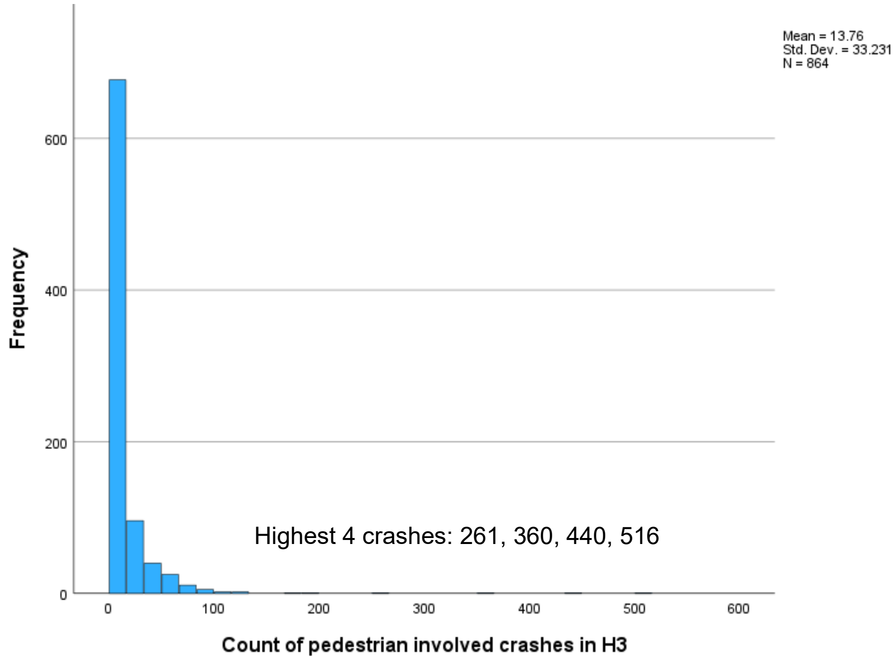

Figure B-1. Histogram of Pedestrian Crash Frequencies

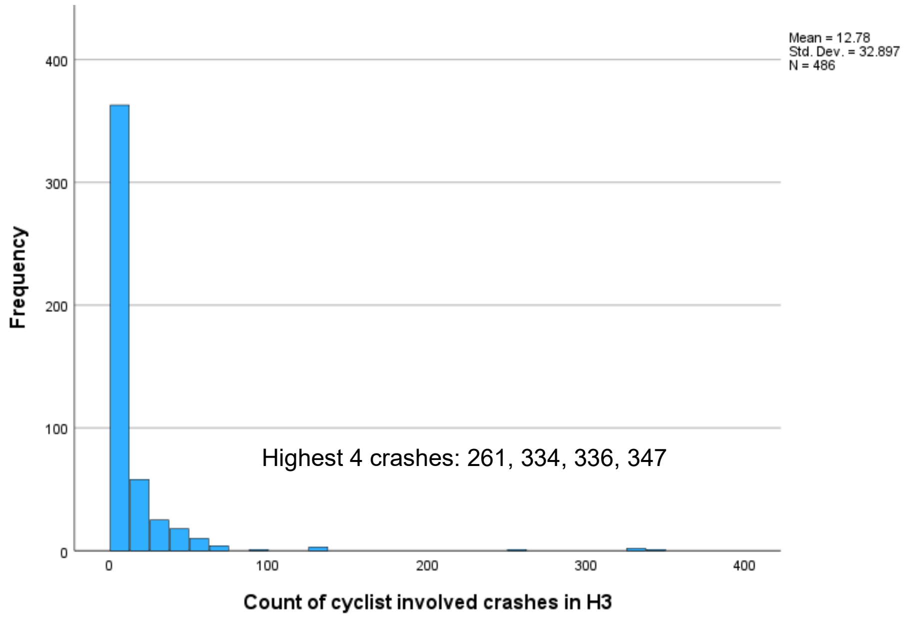

Figure B-2. Histogram of Bicycle Crash Frequencies

The total number of potential independent variables was large as many variables represented discrete values of road attributes by highway classes. Given that less than 4% of the polygons had sufficient pedestrian and bicycle crash data, VMT data by road classes were aggregated. The aggregated VMT road class data are as follows:

- Daily VMT for all road classes
- Daily Freeway VMT
- Daily Urban VMT
- Daily Rural VMT
- Daily VMT on Target Facility Types

Where daily VMT on Target Facility Types was the total of daily VMT observed for the following road classes:

- Urban 4-lane
- Urban 3-lane
- Urban 6-lane
- Urban >=6-lane Divided
- Urban 4-lane Cont Turn
- Urban >=6-lane Cont Turn

The research team had access to total miles by road class; however, as these variables were correlated with the equivalent set of VMT variables, and to avoid multi-collinearity issues, only VMT variables were used. In addition, the set of variables of daily commuter by mode and daily miles traveled by mode were also correlated. Of the two sets, daily miles traveled by mode was the focus when testing if these variables were statistically significant.

Results

Based on the results of this evaluation, regression models were derived that related patterns in pedestrian and bicycle crashes as function of road attributes and socio-economic indicators.

Pedestrian Crashes

Table B-2 has the results from the modelling exercise for pedestrian crashes. The independent variables that are in the model were statistically significant at the 5% or 0.05 level of significance. The significance is expressed as a p-value. A p-value less than 5% indicates that the variable is statistically significant at our selected test threshold. This means that there is confidence at a probability of at least 95% that the variable contributes to explaining the observed crashes and that its respective weight as represented by its coefficient is not zero.

Table B-2. Pedestrian Crash Regression Model Output

Dependent Variable	Total Pedestrian Crashes from 2012 to 2021				
Offset Variable	Daily VMT				
Independent Variable (x)	Coefficient	Std. Error of Coefficient	Lower 95% Confidence Interval	Upper 95% Confidence Interval	P-value
(Intercept)	-9.429	0.5090	-10.427	-8.432	< 0.001
Percent Freeway VMT					
60% < % Freeway Daily VMT <= 90%	-0.208	0.0729	-0.351	-0.065	0.004
0 < % Freeway Daily VMT <= 60%	-0.149	0.0630	-0.273	-0.026	0.018
Percent Urban VMT	0.504	0.1376	0.234	0.773	< 0.001
LN(Daily walk miles traveled/Daily VMT*1000)	0.603	0.0344	0.535	0.670	< 0.001
LN(Number of Signalized Intersections)	0.024	0.0096	0.005	0.043	0.012
LN(Number of Transit Stops)	0.107	0.0191	0.070	0.144	< 0.001
LN(Number of Households with Zero Vehicles)	0.114	0.0178	0.079	0.149	< 0.001
LN(Median Household Income)	-0.204	0.0479	-0.298	-0.110	< 0.001
% in Historically Disadvantaged Community	0.233	0.0680	0.099	0.366	0.001
% of Population White or Non-Hispanic	-0.339	0.1243	-0.583	-0.096	0.006
(Negative Binomial Dispersion Parameter)	0.216	0.0188	0.182	0.256	

Overall, the fit from the set of independent variables is statistically different from having a model without any of the variables (that is, the null model). The team based this finding on the output from the omnibus test. This test uses a likelihood ratio chi-square statistic. If the p-value is less than 5% or 0.05, the model is a significant improvement compared to a null model. The omnibus test statistic from the pedestrian crash regression model is 1114 with 10 degrees of freedom, resulting in a p-value significantly lower than 0.001.

The negative binomial regression model's dispersion parameter and its 95% confidence interval was included in **Table B-2**. A negative binomial's dispersion parameter captures the higher variability in count data relative to the average crash rate. Provided the parameter's confidence interval does not include the value 0, the negative binomial regression is appropriate to model the crash data. If the confidence interval would have contained a 0, meaning that there was no over-dispersion, a Poisson model would be appropriate.

The independent variables listed in **Table B-2** are statistically significant as each variable's p-value is less than 0.05. The dispersion parameter is 0.216 with a 95% confidence interval of (0.182,0.256). Since 0 is not included in the interval, it can be said that it is statistically significant and that the negative binomial model is an appropriate distribution to model data rather than the Poisson distribution.

Interpreting the effect of the variable on changes in crashes is based on the direction of the coefficient (e.g., positive, or negative value) and its magnitude. Since the dependent variable or crashes is on the LN scale, and a sub-set of the independent variables are also LN transformed, additional transformations on the coefficients are required to bring interpretation back to the original scale.

If a coefficient has a negative value for an independent variable of interest, as that variable's value increases, crashes decrease. If the coefficient is positive, then as the independent variable increases, so do the number of crashes, holding all other independent variables constant.

Also, interpreting the magnitude of the coefficient depends if the independent variable is on the level scale (raw data) or transformed using natural logarithms. For example, consider the indicator variable representing if a polygon has over 60% freeway daily VMT. The indicator is on the level scale. It has a coefficient of -0.208. Holding all other independent variables constant, based on this coefficient, crashes are less likely to occur compared to a polygon with no freeway daily VMT by 19% ([1-exp(-0.208)=0.19]).

Continuous variables on the level scale are also exponentiated before interpreting the magnitude of its influence on crashes. The coefficient for percent of urban road class daily VMT is 0.504. For every 1% increase in percent VMT, crashes increase by 66% ([1-exp(0.504)= 0.66]).

Five of the continuous variables are on the natural log scale. Their impact is quantified by the coefficient's value. The coefficient for the LN of number of households with zero vehicles is 0.114. This means that for every 1% increase in such households, crashes increase by 0.1%. However, if one wants to assess how a higher percentage 'p' increase in households affects crashes, a power transform is required, that is, ($1.p^{coeff}$ – 1). For example, a 20% increase in households with zero vehicles translates to 1.20.114 – 1 = 0.02 or 2%.

Of interest is the variable LN(Daily walk miles traveled/Daily VMT*1000). (A multiplier of 1,000 was used to keep the coefficient within the same magnitude of the other coefficients since walk miles traveled is an exceedingly small fraction of VMT.) Its coefficient is 0.603. For every 1%

increase in the ratio of walk to vehicle miles traveled, crashes increase by 0.603/1000 or 0.000603%, or for every doubling of the ratio, crashes increase by $2^{0.000603} - 1 = 0.00035$ or 0.035%.

To better understand the scale of the independent variables and the relationship with the crash variable, a profile snapshot using summary statistics has been provided. **Table B-3** and **Table B-4** show basic descriptive statistics for each of the independent variables measured on a continuous scale and categorical scale, respectively.

Table B-3. Pedestrian Continuous Independent Variable Descriptive Statistics

Independent Variable (x)	n	min	max	median	mean	Std. deviation
Pedestrian Crashes	860	0	191	4	12.0	19.8
% Urban Road Class Daily VMT	860	0	1	1	0.86	0.33
Daily Miles Walked/Daily VMT*1000	860	0	46	3.3	4.8	4.9
Number of Signalized Intersections	860	0	51	0.0	2.1	3.9
Number of Transit Stops	860	0	151	0.0	7.9	17.6
Number of Households with Zero Vehicles	860	0	1809	35	107	185
Median Household Income	860	0	$292,668	$48,825	$52,657	$23,761
% in Historically Disadvantaged Community	860	0	1	0.72	0.60	0.40
% of Population White or Non-Hispanic	860	0	1	0.61	0.57	0.25

Table B-4. Pedestrian Categorical Independent Variable Frequency Statistics

Categorical Variable	Levels	n	Percent
Percent Freeway Daily VMT	60% < % Freeway Daily VMT <= 90%	238	28%
	0 < % Freeway Daily VMT <= 60%	158	18%
	0% Freeway Daily VMT	464	54%
	Total	**860**	**100%**

Bicycle Crashes

Table B-5 has the results from the modelling exercise for bicycle crashes. The independent variables that are in the model were statistically significant at the 5% or 0.05 level of significance and are in the p-value column. Similarly, as was observed for the pedestrian crashes model, the fit from the bicycle crashes model's set of independent variables is statistically different from having a model without any of the variables (that is, the null model). The team based this finding on the output from the omnibus test. The omnibus test statistic for evaluating if the fit of the bicycle crash model is significantly better than having no variables is 602 with 12 degrees of freedom, resulting in a p-value significantly lower than 0.001. The result shows that the model is an improvement over a model without the variables in capturing the variance of crashes over the set of eligible polygons.

Table B-5. Bicycle Crash Regression Model Output

Dependent Variable	Total Bicycle Crashes from 2012 to 2021				
Offset Variable	Daily VMT				
Independent Variable (x)	Coefficient	Std. Error of Coefficient	Lower 95% Confidence Interval	Upper 95% Confidence Interval	P-value
(Intercept)	-13.074	0.3424	-13.745	-12.402	< 0.001
Percent Freeway VMT					
60% < % Freeway Daily VMT <= 90%	-0.858	0.1226	-1.098	-0.617	< 0.001
0 < % Freeway Daily VMT <= 60%	-0.490	0.1000	-0.685	-0.294	< 0.001
Percent Target Facility Type Daily VMT					
% Target Facility Type Daily VMTs > 40%	0.021	0.2035	-0.378	0.420	0.917
20 < % Target Facility Type Daily VMT <= 40%	0.317	0.1706	-0.017	0.652	0.063
0 < % Target Facility Type Daily VMT <= 20%	0.243	0.1049	0.038	0.449	0.020
LN(Daily bicycle miles traveled/Daily VMT*1000)	0.360	0.0422	0.278	0.443	< 0.001
LN(Number of Transit Stops)	0.080	0.0329	0.015	0.145	0.015
LN(Number of Households with Zero Vehicles)	0.224	0.0353	0.155	0.293	< 0.001
LN(Number of public and private K-12 schools)	0.174	0.0724	0.032	0.316	0.016
LN(Number of Jobs)	0.131	0.0384	0.056	0.207	0.001
% in Historically Disadvantaged Community	0.414	0.1346	0.150	0.678	0.002
% of Population White or Non-Hispanic	0.511	0.2231	0.074	0.949	0.022
(Negative Binomial Dispersion Parameter)	0.408	0.0415	0.334	0.498	

The dispersion parameter is 0.408 with a 95% confidence interval of (0.334,0.498). Since 0 is not included in the interval, it can be stated that it is statistically significant and that the negative binomial model is an appropriate distribution to model data rather than the Poisson distribution.

To aid in understanding the influence of the independent variables, examples are provided using the calculations as demonstrated for the pedestrian crash model. Note that for each example, all other independent variables are held constant.

For example, the coefficient for the indicator variable representing if a polygon has between 0 and 20% of daily VMT attributed to traffic on target facility types is 0.243. Holding all other independent variables constant, based on this coefficient, crashes are more likely to occur compared to a polygon with no target facility types by 28% ([1-exp(0.243)=0.28]). With respect to the variable that measures the percent of a polygon's area in a historically disadvantaged community, with a coefficient of 0.414, for every 1% increase, crashes increase 51% ([1-exp(0.414)=0.51]).

The coefficient for the variable LN(Daily bicycle miles traveled/Daily VMT*1000) is 0.360. For every 1% increase in the ratio of bicycle to vehicle miles traveled, crashes increase by 0.360/1000 or 0.000360%, or for every doubling of the ratio, crashes increase by $2^{0.000360} - 1 =$ 0.00025 or 0.025%.

To better understand the scale of the independent variables and the relationship with the crash variable, a profile snapshot using summary statistics has been provided. **Table B-6** and **Table B-7** show basic descriptive statistics for each of the independent variables measured on a continuous scale and categorical scale, respectively.

Table B-6. Bicycle Continuous Independent Variable Descriptive Statistics

Independent Variable (x)	n	min	max	median	mean	Std. deviation
Bicycle Crashes	482	0	135	4.0	10.2	17.1
Daily Miles Bicycled/Daily VMT*1000	482	0	27	1.0	2.3	3.6
Number of Transit Stops	482	0	151	0.0	12.6	21.8
Number of Households with Zero Vehicles	482	0	1,809	65.5	154.5	228.4
Number of public and private K-12 schools	482	0	9	1.0	1.5	1.8
Number of Jobs	482	0	25,049	1,176	2,325	3,247
% in Historically Disadvantaged Community	482	0	1	0.67	0.59	0.38
% of Population White or Non-Hispanic	482	0	1	0.57	0.53	0.25

Table B-7: Bicycle Categorical Independent Variable Frequency Statistics

Categorical Variable	Levels	n	Percent
Percent Freeway Daily VMT	60% < % Freeway Daily VMT <= 90%	164	34%
	0 < % Freeway Daily VMT <= 60%	132	27%
	0% Freeway Daily VMT	186	39%
	Total	**482**	**100%**
% Target Facility Type Daily VMT	% Target Facility Type Daily VMTs > 40%	18	4%
	20 < % Target Facility Type Daily VMT <= 40%	29	6%
	0 < % Target Facility Type Daily VMT <= 20%	252	52%
	0% Target Facility Type Daily VMT	183	38%
	Total	**482**	**100%**

Model Performance

Goodness of Fit

The two negative binomial regression models for pedestrian and bicycle crashes use numerical estimation methods based on maximizing a likelihood function. A likelihood function is the joint probability that the collected data was observed as a function of the parameters of a statistical model. The estimated coefficients from the regression model when combined with the data produce a joint probability that is maximized. This process is different from ordinary least squares (OLS) regression models that use minimum least squares methodology whereby the process selects the coefficients to minimize errors between the model's prediction and the actual observations. A measure of goodness of fit using OLS regression is the R^2 or adjusted R^2. Its value ranges from 0 to 1. The closer the value is to 1, the better is the model at predicting actual values. A model that perfectly predicts outcomes would have a value of 1.

However, an equivalent absolute goodness of fit measure is not available for the negative binomial regression model. The goodness of fit measures for negative binomial models such as Akaike's Information Criterion (AIC) or Log Likelihood function are relative means of performance and not actual deviations between predictions and observed values. If using the AIC, the smaller the AIC, the better the fit. If using the log likelihood function, the larger function, the better the fit.

A measurement called the pseudo R^2 is available as an approximate measure of how well a model's estimates approaches the true or observed values for regression models whose coefficients are output based on maximizing the likelihood of the joint probabilities. However, it does not have the same interpretation as the R^2. A rule of thumb based on work done by Daniel McFadden is that a pseudo R^2 between 0.2 to 0.4 is a very good fit.[28]

The pseudo R^2 for both the pedestrian and bicycle models were calculated, and the pseudo R^2 for each was 0.2. Since the pedestrian and bicycle crash patterns are highly correlated at a rate of 95% and reference similar independent variables, the similar regression fits based on the pseudo R^2 are an expected outcome.

Prediction Performance

A practical approach to assessing model performance is to gauge if the model can distinguish polygons with lower-than-average count of crashes versus those with higher-than-average count of crashes. If the model can predict and follow the trend in crashes from the polygons with the lowest count of crashes to the polygons with the highest count of crashes in close approximation, and in a monotonic fashion, the model, for practical purposes is a reasonable tool to model excess crashes.

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[28] Louviere JJ, Hensher AD, Swait DJ. Stated choice methods. New York: Cambridge University Press, 2000 as cited in Dukjae Lee. A Comparison of Choice-based Landscape Preference Models between British and Korean Visitors to National Parks. Life Sci J 2013; 10(2): 2028-2036]. (ISSN: 1097-8135).

Table B-8 shows a comparison of predicted polygon pedestrian crashes to the actual pedestrian crashes where the polygons have been binned into 10 groups of equal sizes, that is, deciles. For this assessment, the pedestrian crash regression model rule was applied on all polygons used as input for the regression model and included the polygons with the highest four crashes for a total of 864 polygons.

Decile 1 captures the 10% of polygons with the lowest ranked predicted crashes, decile 2 captures the next 10% of polygons based on their crash rankings. The equally sized groupings of the ranked polygons continue in the same fashion until decile 10 which captures the 10% of polygons with the highest ranked predicted crashes.

Comparing the total predicted crashes from decile 1 to decile 10 with the polygons' total actual crashes, the model's total predictions per decile bin are reasonably close to actual total crashes. In addition, the trend in total predicted crashes from decile 1 to decile 10 mirrors that of the actual total crash trend. The correlation measure between the two trends is 99.9%.

Table B-8. Crash Decile Analysis of Predicted Pedestrian Crashes

Crash Decile (1-lowest crashes, 10-highest crashes)	Number of Polygons	Minimum Predicted Crashes	Maximum Predicted Crashes	Total Predicted Crashes	Total Actual Crashes
1	86	0	3	22	36
2	86	0	6	87	112
3	86	0	10	180	155
4	86	0	10	259	263
5	86	0	21	381	349
6	87	0	27	545	539
7	85	0	23	761	646
8	88	2	39	1,261	1,257
9	86	6	95	2,194	2,384
10	86	20	516	5,312	6,146
Total				**11,001**	**11,887**

In a similar fashion, **Table B-9** has the results from the bicycle crash regression model. The model was applied to the same 864 polygons used to assess the pedestrian crash model. The model's predicted crashes from polygons with the lowest count of crashes to the polygons with the highest count of crashes, closely reflects the trends observed from actual total crashes. The correlation between the two trends is a nearly perfect of 99.9%.

Overall, the models developed for this project provide reasonable predictions given the nature of the information collected to date for each eligible polygon.

Table B-9. Crash Decile Analysis of Bicycle Pedestrian Crashes

Crash Decile (1-lowest crashes, 10-highest crashes)	Number of Polygons	Minimum Predicted Crashes	Maximum Predicted Crashes	Total Predicted Crashes	Total Actual Crashes
1	87	0	1	6	5
2	86	0	3	21	30
3	87	0	6	50	61
4	86	0	8	90	115
5	86	0	9	146	144
6	86	0	10	227	238
7	87	0	17	375	373
8	87	0	22	641	621
9	86	2	51	1,205	1,336
10	86	3	347	4,190	4,119
Total				**6,951**	**7,042**

Program of VRU Improvement Strategies

Pedestrian and Bicycle Infrastructure Countermeasures

#	2022 SHSP Strategy Reference[1]	Countermeasure	Bike/Ped/ Both	Description	Targeted Crash Characteristics	Where to Use	Reference Documents	Potential Percentage Reduction in Crashes[2]
1	4.5.G	Sidewalks, Walkways	Pedestrian	Sidewalks and walkways provide pedestrians space that is separated from roadway vehicles so they can safely travel within the public right-of-way.	Walking along roadway (adjacent to travel lane)	New and renovated road facilities	PedSafe Pedestrian Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Install Sidewalk (CMF ID: 11246)** % reduction in crashes = 40% • Crash Type = Vehicle/Ped • Crash Severity = All • Area = N/A • Intersection = None – roadway • Star Quality = 4/5
2	4.5.F 4.6.D	Curb extensions (bulb-outs or neckdowns)	Pedestrian	Curb extensions shorten the distance of a crosswalk by extending the sidewalk or curb line out into the parking lane. This feature reduces the effective street width and reduces the time that pedestrians are in the street.	Crossing roadway Failure to yield	Intersections with on-street parking lanes	PedSafe Pedestrian Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Curb Extensions (ODOT ID: I33)** % reduction in crashes = 30% • Crash Type = All • Crash Severity = All • Area = Urban • Intersection = Signalized or unsignalized
3	4.5.D 4.6.D	Raised Pedestrian Crossings (Raised Crosswalk or Raised Intersection)	Pedestrian	Raised pedestrian crossings make pedestrians more prominent in a driver's field of vision by having them cross the road at the same level as the sidewalk. It also reduces vehicle speeds and improves vehicle yielding.	Crossing roadway Failure to yield	Midblock crossings Intersections Local and collector roads where traffic calming is desired	PedSafe Pedestrian Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Install Raised Pedestrian Crosswalks (CMF ID: 136)** % reduction in crashes = 46% • Crash Type = Vehicle/Ped • Crash Severity = All injury • Area = Urban or suburban • Intersection = None – roadway • Number of lanes = 2 • Star Quality = 3/6
4	4.5.F 4.6.D	Crossing Island (Pedestrian Refuge Island)	Pedestrian	Crossing islands protect pedestrians crossing multilane roads by including a refuge area in the median. This feature allows pedestrians to focus on one direction of traffic at a time as they cross the road.	Crossing roadway Failure to yield	Multi-lane controlled intersections Midblock crossings on roads with three or more travel lanes, speed limits 35 mph or greater and/or AADT of 9,000 or higher	PedSafe Pedestrian Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Install Raised Median with or without Marked Crosswalk (CMF ID: 8799)** % reduction in crashes = 32% • Crash Type = Vehicle/Ped • Crash Severity = All • Area = Urban or suburban • Intersection = None – roadway • Number of lanes = 2-8 • Star Quality = 4/5
5	4.5.G 4.6.D	Leading Pedestrian Interval (LPI)	Pedestrian	LPIs provide pedestrians the WALK signal three to seven seconds before the motorists are allowed to proceed through the intersection. This measure positions pedestrians in the crosswalk by the time the traffic signal turns	Crossing roadway Failure to yield	Signalized intersections	PedSafe Pedestrian Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Modify Signal Phasing (Implement a Leading Pedestrian Interval) (CMF ID: 9903)** % reduction in crashes = 19%

#	2022 SHSP Strategy Reference[1]	Countermeasure	Bike/Ped/ Both	Description	Targeted Crash Characteristics	Where to Use	Reference Documents	Potential Percentage Reduction in Crashes[2]
				green and allows them to establish their presence in the crosswalk before motorists can start turning.				• Crash Type = Vehicle/Ped • Crash Severity = All • Area = Urban or suburban • Intersection = Signalized • Star Quality = 5/5
6	4.6.D	PUFFIN signal crossing	Pedestrian	PUFFIN stands for Pedestrian User Friendly Intelligent Intersection. It uses active detection and passive presence of pedestrians in crosswalks to determine whether the pedestrian phase of a traffic signal or beacon should be extended or canceled.	Crossing roadway	Signalized crossings with a high frequency of pedestrians aged 65 and above and/or pedestrians with disabilities Traditional traffic signals with pedestrian signals Pedestrian Hybrid Beacons	PedSafe Pedestrian Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Convert Pelican Crossing or Farside Pedestrian Signal to Puffin Crossing (CMF ID: 3889)** % reduction in crashes = 24% • Crash Type = Vehicle/Ped • Crash Severity = Fatal and all injury • Area = Not specified • Intersection = Signalized • Star Quality = 3/5
7	4.5.G	Rectangular Rapid Flashing Beacon (RRFB)	Pedestrian	The RRFBs, located under the crosswalk signs, flash when activated to alert motorists to the presence of a pedestrian in the crosswalk. Activation can be either passive or active detection.	Crossing roadway Failure to yield	Multilane crossings with speed limits less than 40 mph Uncontrolled marked crosswalks	FHWA Rectangular Rapid Flashing Beacons (RRFB)	**Install Enhanced RRFB Pedestrian Crossing at Mid-Block Crossing Location (CMF ID: 9124)** % reduction in crashes = 36% • Crash Type = Vehicle/Ped • Crash Severity = All • Area = All • Intersection = None – roadway • Number of lanes = 2-5 • Star Quality = 1/5 **Install Rectangular Rapid Flashing Beacon (RRFB) (CMF ID: 11158)** % reduction in crashes = 69% • Crash Type = Vehicle/Ped • Crash Severity = All • Area = All • Intersection = Roadway/pedestrian crossing (e.g., midblock crossing) • Star Quality = 4/5

#	2022 SHSP Strategy Reference[1]	Countermeasure	Bike/Ped/ Both	Description	Targeted Crash Characteristics	Where to Use	Reference Documents	Potential Percentage Reduction in Crashes[2]
8	4.5.G	Standard Bicycle Lanes	Bicyclist	Bicycle lanes provide an exclusive space for bicycles that is distinct from roadway vehicles through pavement markings and signage.	Biking along roadway (in or adjacent to travel lane)	Most appropriate for roads with speeds up to 25 mph and volumes up to 3,000 ADT	BikeSafe Bicycle Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Install Bicycle Lanes on a Four Lane Roadway (CMF ID: 10738)** % reduction in crashes = 49% • Crash Type = All • Crash Severity = All • Area = Urban • Intersection = None – roadway • Number of lanes = 4 • Star Quality = 4/5 **Install Bicycle Lanes on a Two Lane Roadway (CMF ID: 10742)** % reduction in crashes = 31% • Crash Type = All • Crash Severity = All • Area = Urban • Intersection = None – roadway • Number of lanes = 2 • Star Quality = 4/5
9	4.5.G	Buffered Bicycle Lanes	Bicyclist	A buffered bike lane adds a painted buffer to the bike lane, typically between the motorized travel lane and the bike lane. If on-street parking is present, a buffer may be added between the bike lane and the parking lane to provide separation between bicyclists and motorists opening vehicle doors.	Biking along roadway (in or adjacent to travel lane)	Any road where a standard bicycle lane is being considered Most appropriate for roads with speeds up to 25 mph and volumes between 3,000 and 6,000 ADT	BikeSafe Bicycle Safety Guide and Countermeasure Selection System (pedbikesafe.org)	N/A
10	4.5.G	Separated Bicycle Lanes (aka Protected Bicycle Lanes or Cycle Tracks)	Bicyclist	A separated bike lane is an exclusive facility for bicyclists that is located within or directly adjacent to the roadway and that is physically separated from motor vehicle traffic with a vertical element.	Biking along roadway (in or adjacent to travel lane)	Any road where a bicycle lane is being considered Most appropriate for roads with speeds greater than 25 mph and volumes greater than 6,000 ADT	Bike Safe Bicycle Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Install Cycle Tracks, Bike Lanes, or On-Street Cycling (CMF ID: 4102 & 4097)** % reduction in crashes = 59% - 74% • Crash Type = Vehicle/Bike • Crash Severity = All Injury • Area = Urban • Intersection = None – roadway • Number of lanes = 1-3 • Star Quality = 2/5

#	2022 SHSP Strategy Reference[1]	Countermeasure	Bike/Ped/ Both	Description	Targeted Crash Characteristics	Where to Use	Reference Documents	Potential Percentage Reduction in Crashes[2]
11	4.6.D	Bicycle Signals	Bicyclist	Bicycle signals may be used to separate bicycle through movements from vehicle right turning movements. They can also be used to facilitate complex bicycle movements or help people on bicycles navigate complex intersections. A leading bicycle interval, which uses a bicycle signal lens to provide three to five seconds of green time before the corresponding vehicle green indication, can be used to increase the visibility of bicyclists to motorists.	Failure to yield Turning conflicts	Signalized intersections	FHWA Separated Bike Lane Design Guide NACTO Bicycle Signal Heads	**Install Bike Signal (ODOT ID: BP21)** % reduction in crashes = 45% • Crash Type = Bike • Crash Severity = All • Area = Urban or rural • Intersection = Signalized
12	4.6.D	Bike Boxes	Bicyclist	Bike boxes are designated areas at the head of a traffic lane at a signalized intersection that provides bicyclists a way to get ahead of queuing traffic during the red signal phase. Placed between the stop line and the pedestrian crosswalk, bike boxes increase the visibility of queued bicyclists and provide them with the ability to start up and enter the intersection in front of motor vehicles when the signal turns green. In the past, bike boxes also facilitated left turns for bicyclists; however, recent best practices recommended Two-stage Turn Queue Boxes for left turns.	Crossing roadway Failure to yield Turning conflicts	Signalized intersections	NACTO Bike Boxes FHWA Separated Bike Lane Design Guide	**Install Bike Box at Conflict Points (ODOT ID: BP7)** % reduction in crashes = 35% • Crash Type = Bicycle • Crash Severity = All • Area = Urban or Rural • Intersection = Signalized
13	4.6.D	Two-stage Turn Queue Boxes	Bicyclist	Two-stage turn queue boxes allow bicyclists to make left turns at multilane intersections from a right-side separated bike lane, or right turns from a left-side separated bike lane. Cyclists who arrive on a green light travel into the intersection and pull out into the two-stage turn queue box away from through-moving bicycles and in front of cross-street traffic.	Turning conflicts	Signalized and unsignalized intersections	NACTO Two-Stage Turn Queue Boxes FHWA Separated Bike Lane Design Guide	**Install Bike Box at Conflict Points (ODOT ID: BP7)** % reduction in crashes = 35% • Crash Type = Bicycle • Crash Severity = All • Area = Urban or rural • Intersection = Signalized
14	4.5.G	Shared Use Paths	Both	Shared use paths are physically separated from motorized travel lanes and designed for bi-directional travel by both bicyclists and pedestrians.	Biking or walking along roadway (in or adjacent to travel lane)	Roadways with few intersections or driveways	Bike Safe Bicycle Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Install Shared Path (CMF ID: 9250)** % reduction in crashes = 25% • Crash Type = Vehicle/Bike • Crash Severity = Fatal, all injury, and property damage only (PDO) • Area = Urban • Intersection = None – roadway • Star Quality = 2/5

#	2022 SHSP Strategy Reference[1]	Countermeasure	Bike/Ped/ Both	Description	Targeted Crash Characteristics	Where to Use	Reference Documents	Potential Percentage Reduction in Crashes[2]
15	4.5.F 4.6.D	Road Diet (Roadway Configuration)	Both	A road diet typically converts an existing four-lane undivided roadway to a three-lane roadway with a two-way left-turn lane. This measure improves safety by providing fewer lanes for pedestrians and bicycles to cross. It can also better accommodate the needs of all road users by providing the space to install additional features such as refuge islands, bicycle lanes, wider sidewalks, etc.	Crossing roadway Failure to yield Biking along roadway (in or adjacent to travel lane) Walking along roadway (adjacent to travel lane)	Existing four-lane undivided roadways	FHWA Road Diets (Roadway Configuration) NCHRP Research Report 1036 Roadway Cross-Section Reallocation: A Guide	**Converting 4-Lane Roadways to 3-Lane Roadways with Center Turn Lane (Road Diet) (CMF ID: 2841)** % reduction in crashes = 47% • Crash Type = All • Crash Severity = All • Area = Urban or suburban • Intersection = None – roadway • Number of lanes = 4 • Star Quality = 5/5
16	4.5.G	Pedestrian Hybrid Beacon (PHB)	Both	PHBs remain dark until activated by a pedestrian or bicyclist wishing to cross the street. The signal will turn to yellow flashing, then yellow steady to slow traffic. The next phase is red steady then red flashing while the person is crossing. The signal will then return to the dark phase allowing motorized traffic to resume.	Crossing roadway Failure to yield	Uncontrolled intersections Midblock Crossings Locations where gaps in traffic are not sufficient, or speed limits exceed 35 miles per hour Locations where pedestrians and bicyclists are crossing three or more lanes, or traffic volumes are above 9,000 AADT	FHWA Pedestrian Hybrid Beacons	**Install a Pedestrian Hybrid Beacon (PHB or HAWK) (CMF ID: 10591)** % reduction in crashes = 43% • Crash Type = Vehicle/Ped • Crash Severity = All • Area = Urban or suburban • Intersection = Not specified • Star Quality = 5/5
17	4.5.D 4.6.D	Roundabout	Both	Roundabouts are circular intersections designed to eliminate left turns. They are designed for slow speeds and geometry which better facilitates motor vehicles yielding to pedestrians and bicyclists.	Crossing roadway Failure to yield Speed-related	Intersections Contexts with fewer lanes on the major and minor road are better suited for enhancing the safety of bike and pedestrian users. Roundabouts should be avoided near active, at-grade railroad crossings.	PedSafe Pedestrian Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Convert Intersection to Roundabout (CMF ID: 9156)** % reduction in crashes = 72% • Crash Type = All • Crash Severity = Fatal • Area = Not specified • Intersection = Not specified • Star Quality = 5/5 **Convert Intersection to Roundabout (CMF ID: 9157)** % reduction in crashes = 44% • Crash Type = All • Crash Severity = All injury • Area = Not specified • Intersection = Not specified • Star Quality = 5/5

#	2022 SHSP Strategy Reference[1]	Countermeasure	Bike/Ped/ Both	Description	Targeted Crash Characteristics	Where to Use	Reference Documents	Potential Percentage Reduction in Crashes[2]
18	1.4.D	Lighting and Illumination	Both	Appropriate quality and placement of lighting can increase comfort and safety by illuminating pedestrians and bicycles for approaching motorists.	Dark (not lighted)	Along both sides of streets At intersections At midblock crossings	PedSafe Pedestrian Safety Guide and Countermeasure Selection System (pedbikesafe.org)	**Install Intersection Lighting (CMF ID: 10993)** % reduction in crashes = 21% • Crash Type = All • Crash Severity = All • Area = Rural • Intersection = Not specified • Time of Day = All • Star Quality = 4/5 **Install Lighting (CMF ID: 7776)** % reduction in crashes = 32% • Crash Type = All • Crash Severity = All • Area = All • Intersection = None – roadway • Time of Day = Night • Star Quality = 4/5
19	4.5.D 4.6.D	Tighter Turning Radii	Both	Tighter curb radii can improve sight lines between driver and pedestrian or bicyclist, shorten the crossing distance, bring crosswalks closer to the intersection, and reduce speeds of right-turning vehicles. Consider accommodating larger vehicles instead of designing for them.	Speed-related Failure to yield Turning conflicts	Intersections	WSDOT STEP - Action Plan	N/A
20	4.5.D	Traffic Calming	Both	A variety of techniques can be implemented to create horizontal or vertical deflection forcing motorists to slow down. Examples include speed tables/humps, speed cushions, chicanes, mid-block medians, pinch point/choker, neighborhood traffic circles, and narrowed lanes.	Speed-related	Any location where traffic speeds are higher than desired Locations where green infrastructure or sewer improvements are desired	NACTO Speed Management	**Area-Wide or Corridor-Specific Traffic Calming (CMF ID: 586)** % reduction in crashes = 11% • Crash Type = All • Crash Severity = Injury • Area = Urban • Intersection = None – roadway • Star Quality = 3/5 **Traffic Calming (CMF ID: 128)** % reduction in crashes = 32% • Crash Type = All • Crash Severity = Fatal, all injury, and PDO • Area = Urban • Intersection = None – roadway • Star Quality = 3/5

[1] The pedestrian and bicycle infrastructure countermeasures in this table support the 2022 SHSP strategies. The numbers and letters in this column (X.X.X) refer to the associated 2022 SHSP emphasis area number, strategy number, and tactic letter. For reference, the applicable EAs, strategies, and tactics from the 2022 SHSP associated with VRUs are extracted from the 2022 SHSP below.

[2] Potential percentage reduction in crashes was obtained from the Crash Modification Factors (CMF) Clearinghouse website where available. Where data was not available from the CMF Clearinghouse, a crash reduction factor (CRF) was used from the Oregon Department of Transportation (ODOT) which publishes a list of CRFs. Both references are provided in Appendix D.

Emphasis Area 1 – Distracted Driving

Strategy 4 – Reduce distracted driving through infrastructure/operational improvements and utilizing technology.

Tactic D. Identify high-risk locations for severe crashes though systemic network screening related to distracted driving. Target these locations for developing Safety Performance Functions (SPFs) and implementing systemic mitigation countermeasures such as edge line, center line and transverse rumble strips, wider and higher visibility striping, dynamic curve warning systems, wrong way driving systems, and lighting.

Emphasis Area 4 – Infrastructure and Operations

Strategy 5 – Reduce non-motorized user fatalities and serious injuries on all public roads through targeted investments and outreach.

Tactic D. Advocate for motorist speed management techniques and consideration for engineering judgement beyond the 85th percentile, as well as new proven speed countermeasures, where pedestrians or bicyclists are expected.

Tactic F. Improve access management in corridors with high levels of access through a systemic approach for predefined countermeasures with favorable Crash Modification Factors, including closing or restricting access locations, implementing a road diet, and pedestrian refuge and curb extensions.

Tactic G. Implement and encourage pedestrian facility safety improvements through a systemic approach (e.g., facilities, including Leading Pedestrian Interval, Rectangular Rapid Flashing Beacon, etc.).

Strategy 6 – Reduce crashes at intersection for drivers, pedestrians, and bicyclists.

Tactic D. Identify best practices to improve intersection design components to improve the safety of non-motorized users at intersections. Countermeasures include:

- Verify sight triangles and eliminate obstructions.
- Systemically improve intersection signing, markings, or street lighting at rural intersections to increase intersection conspicuity.
- Develop and implement a comprehensive plan to address angle, left-turn, bicycle, and pedestrian crashes at intersections by improving pedestrian and bike facilities at intersections near pedestrian and bike crashes.
- Design for appropriate road capacity to reduce crosswalk length and crosswalk conflicts. Utilize road diets (4-lane to 3-lane conversions) and curb extensions where appropriate.

Education and Outreach Strategies

#	2022 SHSP Strategy Reference[1]	Strategy	Bike/Ped/Both	Description	Target Demographic	Reference Documents
1	1.1.C	Elementary-Age Child Pedestrian Training	Pedestrian	In-school curriculum that equips children with knowledge and practice to enable them to walk safely in environments with traffic and other safety hazards.	Elementary school-age children	NHTSA 2.1 Elementary-Age Child Pedestrian Training
2	4.5.H	Bike Safety Rodeo/Safety Town	Bicyclist	Cycling Skills Clinics, bicycle safety fairs, and rodeos are local events often run by law enforcement, school personnel, or other civic and volunteer organizations. Their purpose is to teach children on-bicycle skills and how to ride defensively in traffic conditions.	Elementary school-age children	NHTSA 1.4 Cycling Skills Clinics, Bike Fairs, Bike Rodeos
3	4.4.B 4.4.D	Bike Safety for Adults	Bicyclist	Bicycle safety education for adult bicyclists aims to improve knowledge of laws, risks, and cycling best practices, and to lead to safer cycling behaviors, including riding predictably and use of safety materials such as reflective clothing and helmets.	Adults	NHTSA 2.2 Bicycle Safety Education for Adult Cyclists
4	4.5.H	Bike Helmet Use	Bicyclist	Bicycle helmet promotions aim to increase bicycle helmet use and thereby reduce the number of severe and fatal head injuries. This countermeasure involves conducting single events or extended campaigns to promote helmet distribution and use among all ages. Current Louisiana law requires anyone under 12 to wear a helmet as a rider or passenger on a bicycle.	All Ages	NHTSA 3.2 Promote Bicycle Helmet Use With Education
5	1.1.A - H 2.2.A - D 4.4.A - E	Media Campaigns	Both	Media campaigns may be designed to target any demographic and focus on any traffic safety issue, such as distracted driving, impaired driving, or sharing the road with VRUs.	Adults – or as designed	NHTSA 4.2 Share the Road Awareness Programs Louisiana Highway Safety Commission Bicycle & Pedestrian Safety Marketing & Advertising
6	4.4.B	Drivers' Education	Both	Pedestrian and bicycle safety-related training is intended to increase the sensitivity of drivers to the presence of pedestrians and bicyclists and their shared responsibility to prevent crashes and enhance the safety of all road users.	Motorists - Teens and older	NHTSA 4.5 Driver Training 4.1 Driver Training
7	N/A	Operation Bright Light (Existing program)	Both	Promotes bicycle and pedestrian visibility and safety. This outreach strategy involves handing out materials like drawstring reflective backpacks, bike lights, reflective bracelet, etc.	Typically aimed at homeless populations but could be expanded	N/A
8	N/A	Walking School Buses	Pedestrian	A program that uses volunteer adults, usually parents, to walk a group of students on a specific route to and from school, collecting or dropping off children on the way.	Elementary school-age children	NHTSA 2.3 Walking School Buses

[1] The education and outreach strategies in this table support the 2022 SHSP strategies. The numbers and letters in this column (X.X.X) refer to the associated 2022 SHSP emphasis area number, strategy number, and tactic letter. For reference, the applicable EAs, strategies, and tactics from the 2022 SHSP associated with VRUs are extracted from the 2022 SHSP below.

Emphasis Area 1 – Distracted Driving

Strategy 1 – Increase public information, engagement, and education efforts regionally and statewide.

Tactic A. Support and promote participation in one distracted driving Public Service Announcement (PSA) contest in each region, hosted at the state level, to increase awareness of the effects of distracted driving.

Tactic B. Support Regional Safety Coalition Coordinators in educating local organizations and companies on the effects of distracted driving and on the importance and benefits of a cell phone policy by providing a standardized presentation.

Tactic C. Regional Safety Coalition Coordinators collaboratively create traffic education materials for schools (K-12) and higher education facilities through the development of a Destination Zero Deaths lesson plan template. Implement the Destination Zero Deaths Distracted Driving lesson plan to a minimum of one high school and/or driving school in all nine regions.

Tactic D. Develop and distribute statewide safety-related data to promote awareness using social media platforms on the effects and statistics of distracted driving.

Tactic E. Support training, educational resources, and engagement targeted at underserved populations. Contact relevant organizations to increase understanding of distracted driving dangers.

Tactic H. Conduct an observation/education compliance event related to seat belt or distracted driving on high school and/or college campuses followed by a re-observation one-week post-young driver education messaging.

Emphasis Area 2 – Impaired Driving

Strategy 2 – Conduct education and community outreach programs.

Tactic A. Develop and distribute standardized annual impaired driving media campaign scheduler to Regional Safety Coalition Coordinators. Include targeted awareness messages regarding prescription drug use (including medical cannabis).

Tactic B. Create safer communities by promoting transportation choices that encourage alternatives to driving when impaired by alcohol or other drugs.

Tactic C. Use data analysis to identify locations and demographic groups with high instances of impaired driving to support the national “Drive Sober or Get Pulled Over” campaign with targeted overtime enforcement and paid media outreach.

Tactic D. Produce and distribute public information and education materials to combat impaired driving and underage drinking and provide paid media outreach for state-planned impaired driving education. Include messaging related to alcohol and all other drug use.

Emphasis Area 4 – Infrastructure and Operations

Strategy 4 – Increase statewide education and awareness via social media and other forms of communication.

Tactic A. Increase statewide awareness of Infrastructure and Operations (I/O) via social media by developing and distributing a standardized annual I/O media campaign schedule to Regional Safety Coalition Coordinators. Provide training on how to use social media effectively.

Tactic B. Support and enhance driver education and awareness programs. Create an inventory of existing driver education programs and determine the extent to which curriculum and behind-the-wheel training address crashes that are over-represented by young drivers. Examples include, but are not limited to, red light running, failure to yield, roadway departure, etc.

Tactic C. Coordinate the facilitation of Operation Lifesaver presentations by authorized volunteers and safety partners in the Regional Safety Coalition Coordinators.

Tactic D. Support educational outreach activities that educate all road users on state statutes and best practices for relatively newer safety countermeasures as they are implemented (i.e., flashing yellow arrows, queue detection systems, pedestrian hybrid beacon, rectangular rapid flashing beacon, sequential lighting in work zones, etc.).

Tactic E. Fund a paid media campaign focused on non-motorized safety-related state laws.

Strategy 5 – Reduce non-motorized user fatalities and serious injuries on all public roads through targeted investments and outreach.

Tactic H. Partner with Emergency Medical Services (EMS), bike advocacy groups, community groups, and fire departments to teach pedestrian and bicycle safety to children by conducting safety rodeos and safety towns.

Laws and Enforcement Strategies

#	2022 SHSP Strategy Reference[1]	Enforcement	Bike/Ped/Both	Description	Target Demographic	Reference Documents
1	N/A	Bicycle Helmet Laws (Existing Louisiana State Law)	Bicyclist	Laws that would require both adults and children to wear bicycle helmets. Current Louisiana law requires anyone under 12 to wear a helmet as a rider or passenger on a bicycle.	All bicyclists	NHTSA 1.1 Bicycle Helmet Laws for Children 2.1 Bicycle Helmet Laws for Adults
2	4.6.E	Motorist Passing Bicyclist Laws (Existing Louisiana State Law)	Bicyclist	Requires motor vehicle drivers to leave at least a legally defined amount of clearance space between the vehicle and the cyclist when overtaking the cyclist. This law helps to minimize the likelihood of a sideswipe, and to reduce the chance of a close encounter that could potentially destabilize or divert the course of a cyclist and cause a crash. In Louisiana, state law requires motorists to leave a safe passing distance of at least three feet when passing a bicyclist.	Motorists	NHTSA 3.4 Motorist Passing Bicyclist Laws Louisiana State Legislature Louisiana Laws - Louisiana State Legislature
3	1.2.A	Hands Free Law (Existing Louisiana State Law)	Both	For Louisiana, a handheld ban is in place for drivers with a learner or intermediate license, regardless of age and for drivers in school zones. An all-cell phone ban is also applicable to drivers under the age of 18 and to all school bus drivers.	Motorists	GHSA Louisiana Highway Safety Commission Traffic Safety Laws
4	4.6.E	Speed Safety Cameras (Existing DOTD Policy)	Both	Agencies should conduct an analysis of speeding-related crashes to identify locations to implement speed safety cameras and submit a permit request to the DOTD.	All VRUs	FHWA Speed Safety Cameras | FHWA (dot.gov) DOTD Policy A - Traffic Enforcement Systems Policy.pdf

[1] The enforcement approaches in this table support the 2022 SHSP strategies. The numbers and letters in this column (X.X.X) refer to the associated 2022 SHSP emphasis area number, strategy number, and tactic letter. For reference, the applicable EAs, strategies, and tactics from the 2022 SHSP associated with VRUs are extracted from the 2022 SHSP below.

Emphasis Area 1 – Distracted Driving

Strategy 2 – Strengthen laws and public policies to prohibit distracted driving.

Tactic A. Promote a “hands-free” cell phone law to legislators to strengthen cell phone laws. Steps to garner support and pass the law and include:

- Conduct public education campaigns to inform the public about the benefits of a hands-free law.
- Administer public opinion surveys to assess current levels of support for a hands-free law.
- Develop summary briefing and talking points on the benefits of a hands-free law and distribute to elected and appointed officials and the media.

Emphasis Area 4 – Infrastructure and Operations

Strategy 6 - Reduce crashes at intersections for drivers, pedestrians, and bicyclists.

Tactic E. Promote adoption or usage of best practices, laws, or policies at regional levels to streamline the process of state passing laws and regional local parish level implementation.

Programmatic or Policy Approaches

#	2022 SHSP Strategy Reference[1]	Program/Policy	Bike/Ped/Both	Description	Target Demographic	Reference Documents
1	4.3.C	Pedestrian Safety Zones	Pedestrian	Programs that increase cost-effectiveness of interventions by targeting education, enforcement, and engineering measures to geographic areas and audiences where significant portions of the pedestrian crash problem exist.	All pedestrians	NHTSA and FHWA 4.1 Pedestrian Safety Zones
2	4.3.A 4.6.E 4.6.G	Complete Streets Policies (Existing DOTD Policy)	Both	Complete streets are designed and operated to enable safe use and support mobility for all users. The concept of complete streets encompasses many approaches to planning, designing, and operating roadways and rights of way with all users in mind to make the transportation network safer and more efficient. These approaches may include sidewalks, bicycle lanes, bus lanes, public transportation stops, crossing opportunities, median islands, accessible pedestrian signals, curb extensions, modified vehicle travel lanes, streetscape, and landscape treatments. Louisiana DOTD maintains a Complete Streets Policy and Complete Streets Advisory Council.	All users (drivers, pedestrians, bicyclists, public transportation users, etc.)	US Department of Transportation Complete Streets Louisiana DOTD Complete Streets Policy
3	4.3.C	Safe Routes to School	Both	Community-based programs that educate about safe walking and bicycling behavior and safe driving behavior around pedestrians and bicyclists. The programs also include enforcement and engineering activities to improve traffic safety around schools.	Elementary school-age children	NHTSA 2.2 Safe Routes to School | NHTSA
4	4.3.C	Safe Routes to Public Places Program (SRTPPP) (Existing DOTD Program)	Both	The SRTPPP allows public agencies to compete for funding for SRTPPP projects for the purpose of facilitating the planning, development, and implementation of projects that will improve safety for pedestrians, bicyclists, and transit users of all ages and abilities. Eligible projects include improving pedestrian and bicycle facilities to schools, libraries, governmental buildings, hospitals, transit facilities, public parks, other public places, and other types of pedestrian traffic generators. All public roads, state and locally owned, are eligible under the SRTPPP.	All users	Louisiana DOTD Safe Routes to Public Places Program
5	4.3.C	Highway Safety Corridor Program (Existing DOTD Program)	Both	DOTD currently operates a Highway Safety Corridor Program in which a portion of highways may be designated as "highway safety corridors" to address highway safety problems through law enforcement, education, and safety enhancements. A highway safety corridor is a special segment of a highway that has been identified by data analysts and approved by a majority vote of the Safety Corridor Advisory Group as a location with a high potential for safety improvement, especially for fatal and serious injury crashes. The primary cause of these crashes is driver behavior such as speeding, aggressive driving, impairment, and distracted driving. The Advisory Group shall establish objective criteria for safety enhancements, engineering improvements, infrastructure investments, queue detection systems, extended Motorist Assistance Patrols, or instant tow dispatch and public outreach.	Motorists	Louisiana State Legislature Louisiana Laws - Louisiana State Legislature

[1] The programmatic and policy approaches in this table support the 2022 SHSP strategies. The numbers and letters in this column (X.X.X) refer to the associated 2022 SHSP emphasis area number, strategy number, and tactic letter. For reference, the applicable EAs, strategies, and tactics from the 2022 SHSP associated with VRUs are extracted from the 2022 SHSP below.

Emphasis Area 4 – Infrastructure and Operations

Strategy 3 – Standardize the consideration of substantive safety of non-motorized users within the project development process for all projects.

Tactic A. Develop an approach to each project that incorporates consideration for complete streets concepts, multimodal facilities where applicable, and opportunities for other safety improvements in efforts to maximize the impact of available funds during the planning stage, prior to final design.

Tactic C. Identify high-risk locations through a systemic process and identify contributing factors for pedestrian, bicyclist, and personal mobility crashes.

Strategy 6 – Reduce crashes at intersections for drivers, pedestrians, and bicyclists.

Tactic E. Promote adoption or usage of best practices, laws, or policies at regional levels to streamline the process of state passing laws and regional local parish level implementation.

Tactic G. Encourage leaders to require taking safety into consideration as a requirement during all project development phases rather than just HSIP projects and others where safety is a known problem.

APPENDIX D

Best Practice Resources

National Countermeasure Resources

- Federal Highway Administration (FHWA)
  - PEDBIKESAFE: Safety Guides and Countermeasure Selection Systems
  - Proven Safety Countermeasures | FHWA (dot.gov)
- National Highway Traffic Safety Administration (NHTSA)
  - Countermeasures That Work

Crash Modification/Reduction Factors

- FHWA
  - CMF Clearinghouse
- Oregon Department of Transportation
  - Crash Reduction Factors

National Design Resources

- American Association of State Highway Transportation Officials (AASHTO)
  - Guide for the Development of Bicycle Facilities
  - Guide for the Planning, Design, and Operation of Pedestrian Facilities
- FHWA
  - Separated Bike Lane Planning and Design Guide
- National Association of City Transportation Officials (NACTO)
  - Designing for All Ages & Abilities
  - Urban Bikeway Design Guide
- U.S. Department of Transportation
  - Complete Streets | US Department of Transportation

State-Specific Active Transportation Plans and Design Guidance

- Louisiana Department of Transportation and Development
  - Bicycle Planning Tool (arcgis.com)
- Washington State Department of Transportation
  - State Active Transportation Plan, 2020 and Beyond
  - Action Plan for Implementing Pedestrian Crossing Countermeasures at Uncontrolled Intersections
- Minnesota Department of Transportation
  - Statewide Bicycle System Plan
  - Bicycle Facility Design Manual
- Ohio Department of Transportation
  - Statewide Bike and Pedestrian Plan
  - Walk. Bike. Ohio. User Types and Facilities
- Oregon Department of Transportation
  - Oregon Bicycle and Pedestrian Plan
  - Bicycle and Pedestrian Design Guide
  - Oregon Transportation Safety Action Plan