ADOT Bicycle Safety ACTION PLAN

FINAL REPORT

Kimley-Horn and Associates, Inc.

ADOT

SEPTEMBER 2012

PREPARED FOR: ADOT

Bicycle Safety Action Plan

ADOT MPD Task Assignment 18-10
PGTD 0440
Contract # T08-49-U0001

Final Report

Prepared by:

Kimley-Horn
and Associates, Inc.

Prepared for:

ARIZONA DEPARTMENT OF TRANSPORTATION
September 2012
091374036

Cover photo credits: (left) Kimley-Horn and Associates, (right) Kevin Davidson, (top) Randy Victory

TABLE OF CONTENTS

INDEX OF TABLES

INDEX OF FIGURES

1 INTRODUCTION

1.1 Study Overview

The Arizona Department of Transportation (ADOT) Bicycle Safety Action Plan (BSAP) identifies improvements, programs, and strategies that, upon their implementation, will reduce the frequency of bicyclist fatalities and injury crashes that occur on the State Highway System (SHS) in Arizona.

Although no single countermeasure or strategy will unilaterally reduce bicyclist crashes, injuries, and/or fatalities, a comprehensive program of countermeasures can lead to a reduction in bicycle crashes.

Potential improvements, programs, and strategies will consist of a combination of:

- Engineering solutions
- Education of bicyclists and motorists
- Improving enforcement of laws and regulations
- Evaluation guidelines to determine the effectiveness of the BSAP

1.2 Study Area

The study area for the ADOT BSAP consists of all ADOT-maintained highway rights-of-way. However, the study team recognizes that bicyclist crashes, fatalities, and injuries in Arizona are not limited to state highway rights-of-way and occur on all Arizona roadways including those operated and maintained by county, tribal, and local jurisdictions. Education programs recommended in the ADOT BSAP will extend beyond the SHS to non-SHS roadways including those in local cities, counties, and tribal lands.

Photo courtesy of Kevin Davidson

County, tribal, and local agencies and jurisdictions are also encouraged to develop Bicycle Safety Action Plans for roadways within their jurisdictions.

1.3 Overview of Final Report

The BSAP, *Final Report,* provides an overview of information documented in previous working papers[1].

- *Working Paper No. 1* presented a profile of bicycle safety on Arizona's state highways
- *Working Paper No. 2* introduced the ADOT BSAP goal and emphasis areas
- *Working Paper No. 3* identified priority crash locations on state highways, summarized crash analyses at these locations, and identified a menu of potential safety countermeasures that may be considered for implementation at each priority location to reduce bicycle crashes
- *Working Paper No. 4* provided recommendations to achieve the BSAP safety goal, including policies, analysis tools, procedural and best-practices references, and programmatic considerations needed to improve bicycle safety on the SHS.

The Bicycle Safety Action Plan, *Final Report*, includes the following chapters:

- Chapter 1 – Introduction
- Chapter 2 – Profile of Bicycle Safety in Arizona
- Chapter 3 – BSAP Goal and Emphasis Areas
- Chapter 4 – Countermeasures to Improve Bicycle Safety
- Chapter 5 – Action Plan to Improve Bicyclist Safety
- Chapter 6 – Summary

[1] http://www.azdot.gov/mpd/systems_planning/bicycle_safety_study.asp

2 PROFILE OF BICYCLE SAFETY IN ARIZONA

Chapter 2 describes the current state of bicycle safety in Arizona, as previously documented in Working Paper No. 1. The profile draws from public input as obtained through a statewide survey, statewide motor vehicle-bicycle crash statistics, and SHS motor vehicle-bicycle crash statistics.

Photo courtesy of Randy Victory

2.1 Stakeholder Survey

Public stakeholders represent a valuable resource and partner in learning more about bicycle usage in Arizona and identifying specific bicycle safety concerns on the SHS.

In the spring of 2010, a web-based survey was distributed to bicycling stakeholders statewide to solicit input and perspectives about bicycle usage patterns and bicycling conditions at specific locations on the SHS. A link to the public survey was posted on the ADOT Bicycle and Pedestrian Program website homepage.[2]

The survey was disseminated to the ADOT Bicycle and Pedestrian Program e-mail notification/distribution list. Copies of the survey were also provided to tribal communities, and a press release was issued inviting the public to participate in the survey.

2.1.1 Survey Responses

There were 1,076 respondents to the on-line survey, which was posted for approximately a six-week period. The survey's findings are summarized below.

Question 1: Voluntary information including name, email address, and city/town/zip code

- Respondents represented 74 cities and towns in Arizona. Three respondents identified themselves as being from out of state.

[2] http://www.azbikeped.org/index.html

Question 2: Please describe your bicycling level of experience.

- 70 percent of respondents self-identified as 'advanced' bicyclists. The study team recognizes that survey respondents are self-selected, and that experienced bicyclists are more likely to be engaged in bicycling advocacy and to respond to a survey. The study team also recognizes that people who seldom ride on the SHS are under-represented in the survey respondents. In addition, populations of disadvantaged groups are underrepresented.

Question 3: Do you bicycle on any state highways?

- 75 percent stated that they ride on state highways.

Question 4: If you answered yes to question #3, how often do you bicycle on the state highway (please count each round trip as one trip)?

- Of those who ride on state highways, approximately 39 percent of respondents bicycle at least once per week; an additional 38 percent of the respondents bicycle at least once or more per month.

Question 5: If you answered yes to question #3, on average, approximately how far do you bicycle?

- The majority of respondents use the state highways for bicycle rides that are more than 10 miles.

Question 6: If you answered yes to question #3, what is the purpose of your bicycling trips on the state highway? Please check all boxes that are applicable.

- Most survey respondents identified bicycling for recreation or exercise as the purpose for their bicycle trips, comprising 95 percent of those responding to this question.

Question 7: If you answered NO in question #3, (you don't bicycle on state highways) identify the reasons that you don't bicycle or don't bicycle more often to reach your destination.

- Over 77 percent of respondents listed safety concerns as a reason that they do not bicycle more often; a lack of bicycle lanes or wide shoulders was also listed by nearly 70 percent of respondents,

demonstrating that most bicyclists perceive that bicycle lanes and wide shoulders are requisite facilities.

Question 8: Are you aware of any general or specific bicycling safety issues, concerns, or obstacles on the state highways within or near your community, town, or city?

- There were 587 responses to Question 8; a summary of responses to Question 8 is provided in **Appendix C**.

Question 9: What steps can be taken to improve bicycle safety and to reduce the crashes involving bicyclists? These could include educational programs, road improvements, and increased enforcement.

- Stakeholders identified action items related to improved shoulder maintenance, public awareness and education, law enforcement, pavement markings and signage, roadway and shoulder construction and maintenance (e.g., rumble strips), improved bicycle network (wide, paved, striped shoulders), roadway and shoulder construction practices, and improved connectivity; suggestions included:

- Perform regular maintenance of shoulders and bicycle lanes (maintain the surface and sweep debris)
- Develop an educational program (including for law enforcement) to raise awareness and to teach drivers and bicyclists the rules of the road and how to be observant and considerate; include education of three-foot law
- Increase enforcement and penalties for both motorists and bicyclists
- Provide more wide shoulders and/or bicycle lanes, and pathways where feasible

Question 10: The ADOT State Highway Bicycle Safety Action Plan may result in recommendations for improvement projects on state highways. Understanding that funding is limited, projects will require prioritization. Please rate the importance of each of the listed prioritization criteria.

Multiple criteria were rated as very important by survey respondents, including project impact on safety, the cost and benefit of the project, comfort level of bicyclists, project attracts the most users, and project establishes connectivity.

Project impact on safety was identified as the most important criteria. The top three criteria identified by survey respondents were:

- Project impact on safety
- Project establishes or improves connectivity
- Cost/benefit of the project

Question 11: Please list any bicycle clubs, groups, or advocacy organizations that you belong to, or with which you participate.

811 persons responded to this question, identifying 210 clubs. A list is provided in Working Paper No. 1.[3]

2.2 National and Arizona Bicyclist Crash Trends and Statistics

2.2.1 Data Sources

This section summarizes fatal motor vehicle-bicycle crashes on a nationwide and statewide basis, drawing from information contained in the following sources:

- Fatality Analysis Reporting System (FARS) 2010:[4] The FARS contains data on fatal traffic crashes within the 50 states, the District of Columbia, and Puerto Rico. To be included in FARS, a crash must involve a motor vehicle travelling on a road customarily open to the public and resulting in the death of a person (occupant of a vehicle or a non-occupant) within 30 days of the crash.
- The Arizona Motor Vehicle Crash Facts, 2010:[5] This document, prepared by ADOT, reports motor vehicle-bicycle crash statistics in Arizona.
- Arizona Strategic Highway Safety Plan (SHSP):[6] The SHSP identifies emphasis areas related to motor vehicle crashes based on an analysis of 2001 to 2005 crash data. Several of the identified emphasis areas are related to motor vehicle-bicycle crashes, namely speeding, impaired driving, lane departure, and intersection crashes.

2.2.2 Crash Statistics

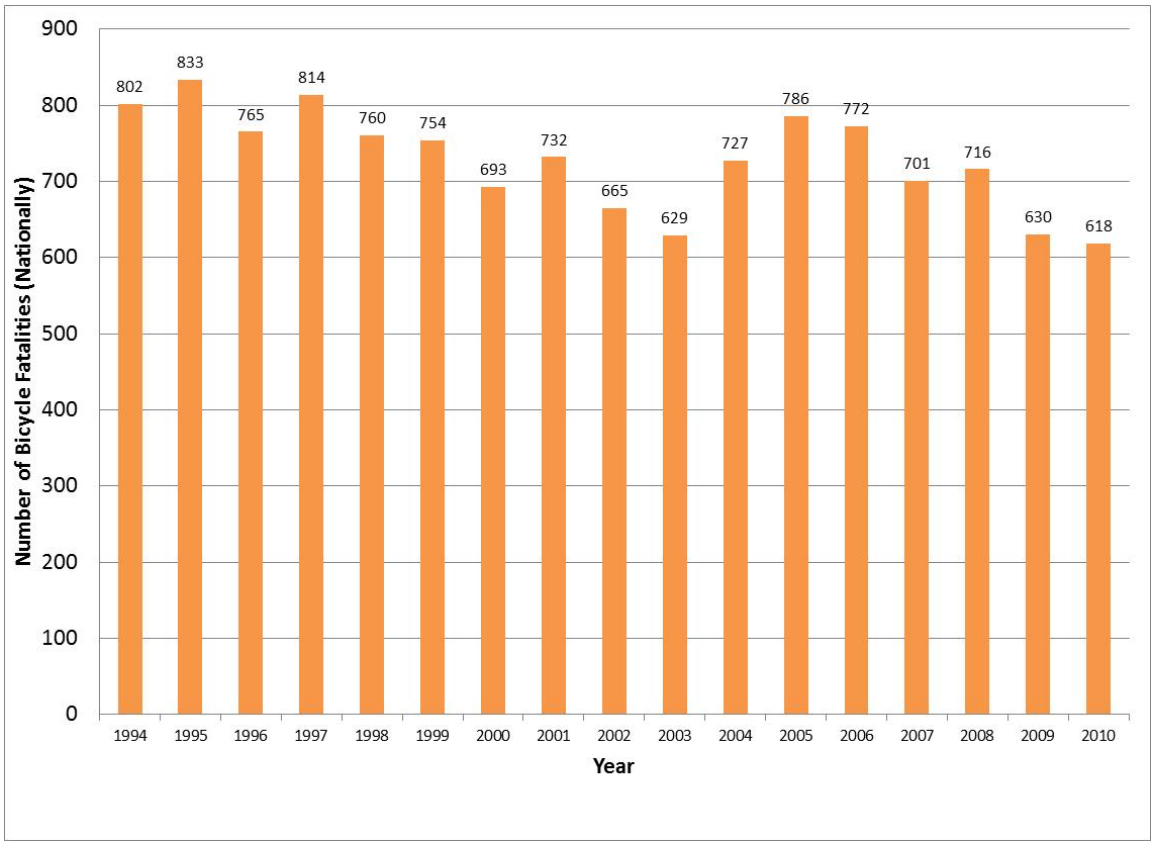
Nationally in the United States in 2010, 618 bicyclists were killed in motor vehicle-bicycle crashes, representing 1.7 percent of total traffic crash fatalities (FARS).

In Arizona in 2010, 19 bicyclists were killed in motor vehicle-bicycle crashes, representing 2.72 percent of all motor vehicle crash fatalities (698) in the state. This represents a 28 percent decrease from 2009, when 25 bicyclists were killed in Arizona, representing 2.5 percent of all motor vehicle crash fatalities. In 2009, Arizona ranked 5th highest in bicyclist fatalities per million population. In 2010, Arizona ranks 7th highest in bicyclist fatalities per million population.

[3] http://www.azdot.gov/mpd/systems_planning/bicycle_safety_study.asp
[4] http://www-nrd.nhtsa.dot.gov/Pubs/811624.pdf
[5] http://www.azdot.gov/mvd/statistics/crash/index.asp
[6] http://www.azdot.gov/highways/traffic/TSS/SHSP/AZ_Strategic_Highway_Safety_Plan.pdf

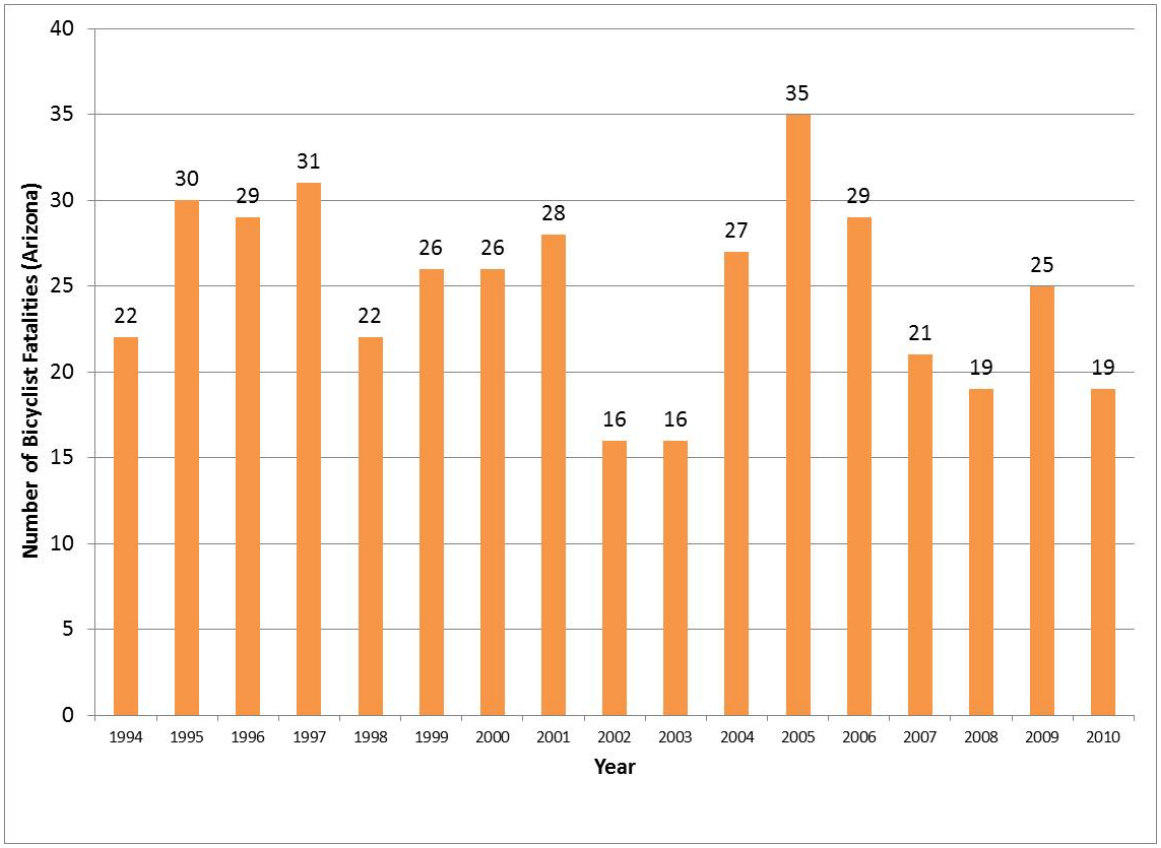
Figure 1 depicts the number of bicyclist fatalities reported nationwide from 1994 to 2010 (FARS).

Figure 2 depicts bicyclist fatalities reported in Arizona from 1994 to 2010. **Figure 3** shows the locations of statewide fatal bicycle crashes from 2004 to 2008.



Source: Fatality Accident Reporting System

Figure 1 – Nationwide Bicyclist Fatality Trends from 1994 to 2010



Source: Fatality Accident Reporting System, Arizona Motor Vehicle Crash Facts 2010

Figure 2 – Bicyclist Fatality Trends in Arizona, 1994 to 2010

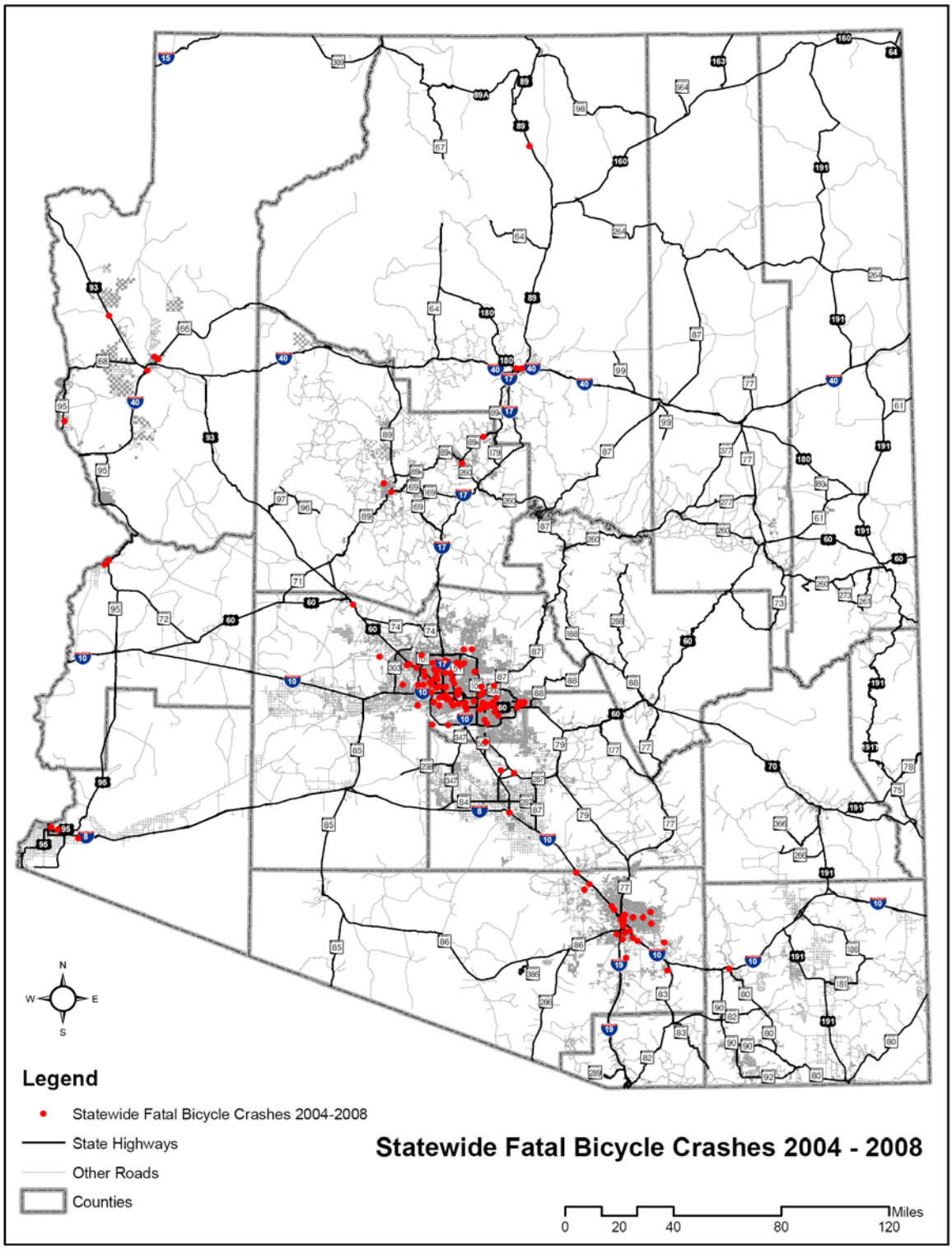


Figure 3 – Statewide Fatal Bicycle Crashes, 2004 – 2008

2.3 Statewide and SHS Motor Vehicle-Bicycle Crashes

The study team recognizes that a majority of bicyclist crashes in Arizona (approximately 90 percent) occur on local city and county roadways that are outside the jurisdiction of ADOT. However, although the BSAP is focused on the SHS, many of the recommendations from the BSAP will benefit bicyclist safety on both the SHS and all public roadways in Arizona.

This section summarizes statewide (all public roads in Arizona) motor vehicle-bicycle crashes and those that occurred on the SHS, based on crash data provided by ADOT for the period from January 1, 2004 to December 31, 2008.

The data shows that:

- A total of 9,867 motor vehicle-bicycle crashes were reported statewide (all public roads in Arizona), 2004 to 2008
- Of the 9,867 statewide crashes, 1,089 motor vehicle-bicycle crashes were reported on the SHS

Figure 4 illustrates the injury severity of the crashes that were reported for both statewide (all public roads) and SHS motor vehicle-bicycle crashes. While SHS crash statistics are similar to crashes that occurred on all roads in Arizona, SHS crashes are generally more severe, as demonstrated in **Figure 4**.

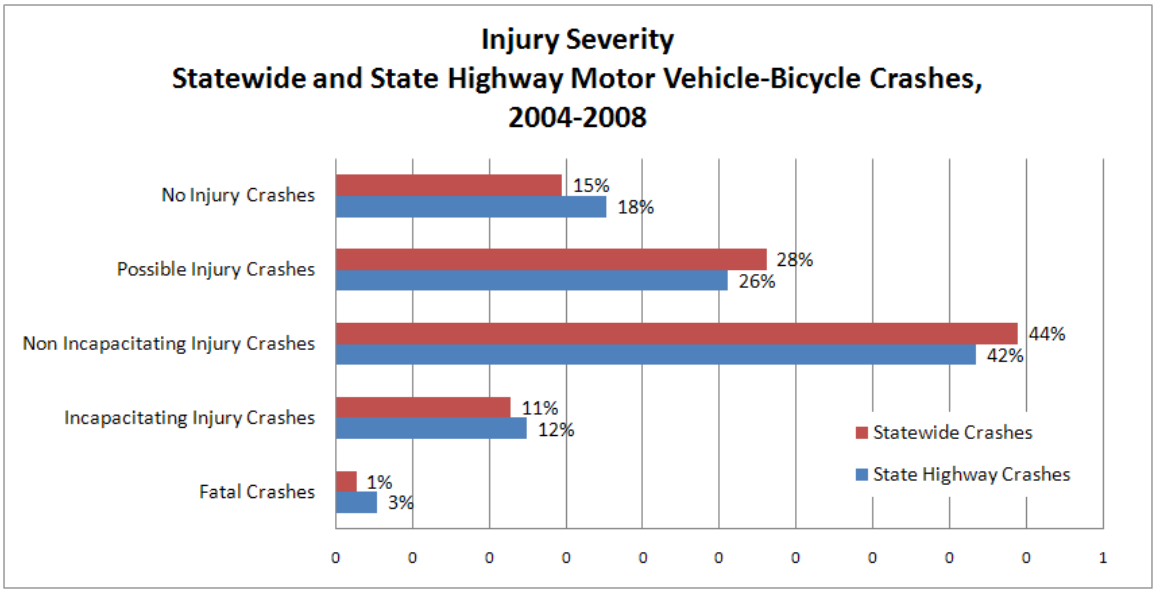


Figure 4 – Injury Severity, Statewide and SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008

Table 1 shows contributing factors for statewide (all public roadways) and SHS motor vehicle-bicycle crashes. A review of the ADOT crash data illustrates the following:

- 77 percent of motor vehicle-bicycle crashes on state highways and statewide (all public roads) occurred in daylight
- 23 percent (SHS) and 22 percent (statewide) of motor vehicle-bicycle crashes included a report that the motorist failed to yield the right-of-way
- 12 percent (SHS) and 11 percent (statewide) of motor vehicle-bicycle crashes were attributed to the bicyclist not yielding the right-of-way
- 47 percent (SHS) and 41 percent (statewide) of bicyclists were aged 25 to 54
- 83 percent (SHS) and 79 percent (statewide) of bicyclists involved in crashes were male

A more detailed review of SHS crashes, utilizing the Pedestrian-Bicycle Crash Analysis Tool, is reported in **Section 2.4**.

Table 1 – Contributing Factors, Statewide and SHS Motor Vehicle-Bicycle Crashes in Arizona, 2004 – 2008

Contributing Factor	Condition	Statewide Motor Vehicle-Bicycle Crashes		SHS Motor Vehicle-Bicycle Crashes	
		Number of crashes	Percentage	Number of crashes	Percentage
Total Crashes	-	9,867	-	1,089	-
Lighting Conditions	Not Reported	30	< 1%	3	< 1%
	Daylight	**7620**	**77%**	**837**	**77%**
	Dawn or Dusk	625	6%	64	6%
	Darkness	1592	16%	185	17%
Weather	**Clear**	**8820**	**89%**	**958**	**88%**
	Cloudy	831	8%	106	10%
	Sleet/Hail	5	< 1%	1	< 1%
	Rain	153	2%	17	2%
	Snow	7	< 1%	1	< 1%
	Severe Crosswinds	5	< 1%	1	< 1%
	Blowing Sand, Soil, Dirt, Snow	3	< 1%	2	< 1%
	Fog, Smog, Smoke	2	< 1%	-	-
	Unknown	41	< 1%	3	< 1%

Table 1 – Contributing Factors, Statewide and SHS Motor Vehicle-Bicycle Crashes in Arizona, 2004 – 2008

Contributing Factor	Condition	Statewide Motor Vehicle-Bicycle Crashes		SHS Motor Vehicle-Bicycle Crashes	
		Number of crashes	Percentage	Number of crashes	Percentage
Surface Condition	**Dry**	**9394**	**95%**	**1024**	**94%**
	Wet	245	2%	31	3%
	Snow	4	< 1%		
	Slush	1	< 1%	1	< 1%
	Ice	6	< 1%		
	Other	19	< 1%	1	< 1%
	Unknown	198	2%	32	3%
Physical Condition (Motorist)	**No Apparent Influence**	**8231**	**82%**	**909**	**83%**
	Had Been Drinking	122	1%	15	1%
	Appeared to be Under Influence of Drugs	19	< 1%	2	< 1%
	Ill-Ability Influenced	3	< 1%	1	< 1%
	Sleepy-Fatigued	8	< 1%		< 1%
	Physical Impairment	7	< 1%	1	< 1%
	Prescription Drugs	27	< 1%	3	< 1%
	Other	51	1%	6	16%
	Unknown	1560	16%	164	15%
Physical Condition (Bicyclist)	**No Apparent Influence**	**8497**	**85%**	**888**	**81%**
	Had Been Drinking	320	3%	56	5%
	Appeared to be Under Influence of Drugs	25	< 1%	1	< 1%
	Ill-Ability Influenced	3	< 1%	-	-
	Sleepy-Fatigued	2	< 1%	-	-
	Physical Impairment	9	< 1%	2	< 1%
	Prescription Drugs	12	< 1%	2	< 1%
	Other	94	1%	13	1%
	Unknown	1003	10%	139	13%

Table 1 – Contributing Factors, Statewide and SHS Motor Vehicle-Bicycle Crashes in Arizona, 2004 – 2008

Contributing Factor	Condition	Statewide Motor Vehicle-Bicycle Crashes		SHS Motor Vehicle-Bicycle Crashes	
		Number of crashes	Percentage	Number of crashes	Percentage
Violation (Motorist) (continued)	**No Improper Driving**	**4888**	**49%**	**515**	**47%**
	Speed Too Fast for Conditions	167	2%	15	1%
	Exceeded Lawful Speed	29	< 1%	-	-
	Failed to Yield Right-of-Way	**2192**	**22%**	**257**	**23%**
	Followed Too Closely	16	< 1%	1	< 1%
	Ran Stop Sign	76	1%	7	1%
	Disregarded Traffic Signal	122	1%	11	1%
	Made Improper Turn	95	1%	4	< 1%
	Drove in Opposing Traffic Lane	53	1%	2	< 1%
	Knowingly Operated with Faulty or Missing Equipment	2	< 1%	-	-
	Pass in No-Passing Zone	3	< 1%	2	< 1%
	Unsafe Lane Change	27	< 1%	3	< 1%
	Other Unsafe Passing	46	< 1%	9	1%
	Inattention	**1131**	**11%**	**146**	**13%**
	Other	438	4%	49	4%
	Unknown	733	7%	78	7%
Violation (Bicyclist)	**No Improper Driving**	**2901**	**29%**	**305**	**28%**
	Speed Too Fast for Conditions	75	1%	7	1%
	Exceeded Lawful Speed	3	< 1%	-	-
	Failed to Yield Right-Of-Way	**1225**	**12%**	**124**	**11%**

Table 1 – Contributing Factors, Statewide and SHS Motor Vehicle-Bicycle Crashes in Arizona, 2004 – 2008

Contributing Factor	Condition	Statewide Motor Vehicle-Bicycle Crashes		SHS Motor Vehicle-Bicycle Crashes	
		Number of crashes	Percentage	Number of crashes	Percentage
Violation (Bicyclist) Continued	Followed Too Closely	5	< 1%	-	-
	Ran Stop Sign	173	2%	5	< 1%
	Disregarded Traffic Signal	422	4%	101	9%
	Made Improper Turn	56	1%	5	< 1%
	Drove in Opposing Traffic Lane	901	9%	86	8%
	Knowingly Operated with Faulty or Missing Equipment	141	1%	13	1%
	Inattention	971	10%	108	10%
	Other	**2435**	**24%**	**277**	**25%**
	Unknown	647	6%	69	6%
Age (Motorist)	0 to 5	1	< 1%	0	< 1%
	6 to 15	27	< 1%	1	< 1%
	16 to 19	745	7%	60	5%
	20 to 24	1102	11%	117	11%
	25 to 54	**4938**	**49%**	**532**	**48%**
	55 to 80	1688	17%	224	20%
	>80	164	2%	19	2%
	Unknown	1353	14%	146	13%
Age (Bicyclist)	0 to 5	64	1%	2	< 1%
	6 to 15	2236	22%	138	13%
	16 to 19	1098	11%	119	11%
	20 to 24	1105	11%	132	12%
	25 to 54	**4072**	**41%**	**522**	**47%**
	55 to 80	848	9%	114	10%
	>80	36	< 1%	5	< 1%
	Unknown	496	5%	68	6%

Table 1 – Contributing Factors, Statewide and SHS Motor Vehicle-Bicycle Crashes in Arizona, 2004 – 2008

Contributing Factor	Condition	Statewide Motor Vehicle-Bicycle Crashes		SHS Motor Vehicle-Bicycle Crashes	
		Number of crashes	Percentage	Number of crashes	Percentage
Gender (Motorist)	**Male**	**5182**	**52%**	**593**	**54%**
	Female	4048	40%	415	38%
	Unknown	788	8%	91	8%
Gender (Bicyclist)	**Male**	**7884**	**79%**	**909**	**83%**
	Female	1980	20%	178	16%
	Unknown	91	1%	13	1%

2.4 Analysis of SHS Motor Vehicle-Bicycle Crashes Using Pedestrian-Bicycle Crash Analysis Tool (PBCAT)

This section presents a detailed summary of motor vehicle-bicycle crashes that occurred on the SHS. The analysis was conducted using the Federal Highway Administration (FHWA) Pedestrian-Bicycle Crash Analysis Tool (PBCAT).

2.4.1 Focus Area Crashes

Statewide (all public roadways) motor vehicle-bicycle crash data was obtained from ADOT for the years 2004 – 2008, during which there were 9,867 motor vehicle-bicycle crashes. 1,089 of these motor vehicle-bicycle crashes occurred on Arizona's SHS.

Utilizing geographic information system (GIS) tools, areas of the SHS with higher numbers of motor vehicle-bicycle crashes were identified. The 746 focus area crashes occurred at both intersections and along segments. Each focus area crash was categorized as an 'intersection/interchange' crash or as a 'segment' crash:

- **Intersection/interchange** crashes are focused on specific intersections/interchanges, and adjacent roadways did not exhibit a pattern of crashes. The analysis identified 91 intersection / interchange locations comprising 266 crashes (**Table 2**).
- **Segment crashes** are those for which crash pattern extends along the length of a corridor. Note that segment crashes include all of the crashes within the segment, including those at intersections within the segment. The analysis identified 33 segments comprising 480 crashes (**Table 3**).

The next step was to identify priority locations from among the interchanges/intersections and segments consistent with criteria as explained below.

2.4.2 Priority Interchange/Intersection Crashes

Priority intersection/interchanges are those that met the following criteria:

- Intersection experienced five (5) or more crashes in the analysis period (2004 – 2008)

Fifteen (15) intersection/interchange locations met the prioritization criteria. These are identified in **Table 2**. These 15 intersections experienced 85 motor vehicle- bicycle crashes during the analysis period.

Mapping of each priority intersection/interchange is provided in Appendix A.

2.4.3 Priority Segment Crashes

Priority segments are those that met the following criteria:

- Segment experienced five (5) or more crashes in the analysis period (2004 – 2008)
- Crashes per mile per year on the segment are greater than 1

Nineteen (19) segments met the prioritization criteria (**Table 3**). These 19 segments experienced 441 motor vehicle-bicycle crashes during the analysis period.

Mapping of each priority segment is provided in Appendix A.

2.4.4 PBCAT Database

The development of effective countermeasures to help prevent motor vehicle-bicycle crashes is often hindered by insufficient detail in the crash reports and database, which lack sufficient level of detail regarding the sequence of actions leading to each crash. To address this shortcoming, the study team utilized the FHWA PBCAT to develop a database of the 746 focus area crashes. PBCAT is a software application designed to assist in the analysis of bicycle and pedestrian crashes. The tool aids the analyst in determining important pre-crash details and identifying a crash type.

Arizona Crash Reports were obtained for each of the 746 SHS focus area crashes. The narrative of each crash report was reviewed and information regarding each crash was input into the PBCAT database. **Table 4** lists data items that were entered for each crash in the PBCAT database.

Table 2 – Focus Area Intersection/Interchange Bicycle-Motor Vehicle Crashes

Location ID	City/Town	Type	On Street	Intersecting Street	Number of Crashes	Priority Location
39b	Tempe	Intersection	Scottsdale Road	SR 202 Ramp	8	√
18c	Mesa	Intersection	SR 87	SR 202 Ramp	6	√
26b	Phoenix	Intersection	Indian School Road	SR 51 Ramp	6	√
28c	Phoenix	Intersection	Northern Avenue	I-17 Frontage Road/Ramp	6	√
28e	Phoenix	Intersection	Bethany Home Road	I-17 Frontage Road/Ramp	6	√
30a	Phoenix	Intersection	Indian School Road	I-17 Frontage Road/Ramp	6	√
39a	Tempe	Intersection	Priest Drive	SR 202 Ramp	6	√
39e	Tempe	Intersection	Baseline Road	I-10 Ramp	6	√
6a	Chandler	Intersection	Elliot Road	SR 101 Ramp/Frontage Road	5	√
6d	Chandler	Intersection	SR 87	SR 202 Ramp	5	√
18e	Mesa	Intersection	SR 87	McKellips Road	5	√
26f	Phoenix	Intersection	7th Street	I-10 Ramp	5	√
26h	Phoenix	Intersection	24th Street	SR 202 Ramp	5	√
27b	Phoenix	Intersection	27th Avenue	SR-101 Frontage Road (Beardsley Road)	5	√
39f	Tempe	Intersection	Priest Drive	US 60	5	√
22d	Oro Valley	Intersection	SR 77	Orange Grove Road	4	-
25e	Peoria and Glendale	Intersection	US 60	Bethany Home Road	4	-
26d	Phoenix	Intersection	McDowell Road	SR 51 Ramp	4	-
26i	Phoenix	Intersection	32nd Street	SR 202 Ramp	4	-
27c	Phoenix	Intersection	Union Hills Drive	I-17 Frontage Road/Ramp	4	-
28b	Phoenix	Intersection	Dunlap Avenue	I-17 Ramp	4	-
39g	Tempe	Intersection	Mill Avenue	US 60 Ramp	4	-
41a	Tucson	Intersection	SR 86	Kostka Avenue/Valley Road	4	-

Table 2 – Focus Area Intersection/Interchange Bicycle-Motor Vehicle Crashes (continued)

Location ID	City/Town	Type	On Street	Intersecting Street	Number of Crashes	Priority Location
41c	Tucson	Intersection	6th Avenue	I-10 Ramp	4	-
2c	Apache Junction	Intersection	SR 88	US 60	3	-
3a	Avondale	Intersection	Dysart Road	I-10 Ramp	3	-
6b	Chandler	Intersection	Warner Road	SR 101 Ramp/Frontage Road	3	-
6c	Chandler	Intersection	Chandler Boulevard	SR 101 Ramp	3	-
25c	Peoria and Glendale	Intersection	Olive Avenue	SR 101 Ramp	3	-
25d	Peoria and Glendale	Intersection	US 60	Peoria Avenue	3	-
26c	Phoenix	Intersection	Thomas Road	SR 51 Frontage Road/Ramp	3	-
26g	Phoenix	Intersection	16th Street	I-10 Ramp	3	-
27d	Phoenix	Intersection	Bell Road	I-17 Frontage Road	3	-
27e	Phoenix	Intersection	Greenway Road	I-17 Ramp	3	-
27f	Phoenix	Intersection	Thunderbird Road	I-17 Frontage Road/Ramp	3	-
28a	Phoenix	Intersection	Peoria Avenue	I-17 Frontage Road/Ramp	3	-
29a	Phoenix	Intersection	Bell Road	SR 51 Ramp	3	-
39c	Tempe	Intersection	McClintock Drive	SR 202 Ramp	3	-
40c	Tucson	Intersection	Grant Road	I-10 Frontage Road/Ramp	3	-
40d	Tucson	Intersection	Speedway Boulevard	I-10 Frontage Road/Ramp	3	-
41d	Tucson	Intersection	SR 210	Richey Boulevard	3	-
42	Tucson	Intersection	Kolb Road	I-10 Frontage Road	3	-
1	Aguila	Intersection	US 60	1st Street	2	-
2a	Apache Junction	Intersection	SR 88	Superstition Boulevard/Scenic Street	2	-
3b	Avondale	Intersection	McDowell Road	SR 101 Ramp	2	-

Table 2 – Focus Area Intersection/Interchange Bicycle-Motor Vehicle Crashes (continued)

Location ID	City/Town	Type	On Street	Intersecting Street	Number of Crashes	Priority Location
11f	Flagstaff	Intersection	Butler Avenue	I-40 Ramp	2	-
*11g	Flagstaff	Intersection	US 89	Snowflake Drive	2	-
13	Glendale	Intersection	67th Avenue	SR 101 Ramp	2	-
14a	Kingman	Intersection	Stockton Hill Road	I-40	2	-
16	Marana	Intersection	Burlingame Rd/Cortaro Rd	I-10 Ramp/Frontage Road	2	-
17a	Mesa	Intersection	University Drive	SR 202 Ramp	2	-
17c	Mesa	Intersection	Guadalupe Road	SR 202 Ramp	2	-
18b	Mesa	Intersection	McKellips Road	SR 202 Ramp	2	-
19b	Mesa	Intersection	Stapley Drive	US 60 Ramp	2	-
20	Mesa	Intersection	Greenfield Road	US 60 Ramp	2	-
22b	Oro Valley	Intersection	SR 77	Calle Concordia	2	-
23a	Oro Valley	Intersection	SR 77	Rancho Vistoso Boulevard	2	-
23b	Oro Valley	Intersection	SR 77	Tangerine Road	2	-
23c	Oro Valley	Intersection	SR 77	Rams Field Pass	2	-
24b	Payson	Intersection	SR 260	SR 87	2	-
25a	Peoria and Glendale	Intersection	Thunderbird Road	SR 101 Ramp	2	-
26j	Phoenix	Intersection	40th Street	SR 202 Ramp	2	-
26k	Phoenix	Intersection	7th Street	I-17 Frontage/Access Road	2	-
27a	Phoenix	Intersection	Deer Valley Road	I-17 Frontage Road/Ramp	2	-
28d	Phoenix	Intersection	Glendale Avenue	I-17 Frontage Road/Ramp	2	-
28f	Phoenix	Intersection	Camelback Road	I-17 Frontage Road/Ramp	2	-
28g	Phoenix	Intersection	Camelback Road	US 60 Ramp	2	-

*Note: Segment 11g (US 89/Snowflake Drive) has been transferred to the City of Flagstaff.

Table 2 – Focus Area Intersection/Interchange Bicycle-Motor Vehicle Crashes (continued)

Location ID	City/Town	Type	On Street	Intersecting Street	Number of Crashes	Priority Location
30b	Phoenix	Intersection	Thomas Road	I-17 Ramp	2	-
30c	Phoenix	Intersection	67th Avenue	I-10 Ramp	2	-
33	Prescott Valley	Intersection	SR 69	Robert Road	2	-
34	San Luis	Intersection	US 95	B Street/C Street	2	-
39h	Tempe	Intersection	Rural Road	US 60 Ramp	2	-
39i	Tempe	Intersection	Southern Avenue	SR 101 Ramp	2	-
39k	Tempe	Intersection	Guadalupe Road	SR 101 Ramp	2	-
40e	Tucson	Intersection	St. Mary's Road	I-10 Frontage Road/Ramp	2	-
40f	Tucson	Intersection	Congress Street	I-10 Frontage Road/Ramp	2	-
40h	Tucson	Intersection	Broadway Boulevard	SR 210	2	-
41b	Tucson	Intersection	Irvington Road	I-19 Ramp	2	-
44a	Yuma	Intersection	US 95	32nd Street	2	-
43a	Wickenburg	Intersection	US 60/US 93	Adams Street/Apache Street	2	-
43b	Wickenburg	Intersection	US 60	295th Avenue to Cookes Road	2	-
12	Florence	Intersection	SR 79B	San Carlos Street	1	-
19c	Mesa	Intersection	Gilbert Road	Inverness Avenue	1	-
25b	Peoria and Glendale	Intersection	Peoria Avenue	SR 101 Ramp	1	-
26a	Phoenix	Intersection	Camelback Road	SR 51 Frontage Road	1	-
26e	Phoenix	Intersection	7th Avenue	I-10 Ramp	1	-
27g	Phoenix	Intersection	Cactus Road	I-17 Ramp	1	-
29b	Phoenix	Intersection	Cactus Road	SR 51 Ramp	1	-
36	Show Low	Intersection	US 60	5th Street	1	-
39d	Tempe	Intersection	Broadway Road	I-10 Ramp	1	-
40g	Tucson	Intersection	Starr Pass Boulevard	I-10 Ramp	1	-

Table 3 – Focus Area Segment Bicycle-Motor Vehicle Crashes

Location ID	City/Town	Type	On Street	Limits	Number Through Lanes	Length (Miles)	Number of Crashes	Crashes/ Mile / Year	Priority Location
11c	Flagstaff	Segment	SR 40B	SR 89A to Elden Street	4	1	56	11.2	√
11a	Flagstaff	Segment	SR 89A (Milton Road)	I-17 to SR 40B	4	1.3	33	5.1	√
15	Lake Havasu City	Segment	SR 95	Swanson Avenue to Mesquite Avenue	4	0.22	4	3.6	-
18a	Mesa	Segment	SR 101 Frontage Road/Ramp	University Drive to Broadway Road	2	1.01	15	3.0	√
11d	Flagstaff	Segment	Route 66	Switzer Canyon Drive to Lockett Road	4	3.1	45	2.9	√
22c	Oro Valley	Segment	SR 77	Mountain Vista Drive to Ina Road	6	1.33	19	2.9	√
40a	Tucson	Segment	SR 77 (Oracle Road)	River Road to Miracle Mile	6	2.5	32	2.6	√
8	Cottonwood	Segment	SR 89A	Cottonwood Street to Grosetta Road	4	0.63	8	2.5	√
*44b	Yuma	Segment	SR 8B	7th Street to Catalina Drive	4 or 6	3.05	35	2.3	√
24a	Payson	Segment	SR 87	Forest Drive to Ridge Lane	4	1.95	22	2.3	√
5	Casa Grande	Segment	SR 287/SR 387	Cottonwood Lane to Arizona Road	4	3.5	37	2.1	√
14b	Kingman	Segment	SR 66	I-40 to Armour Avenue	4	0.5	5	2.0	√

*Note: Segment 44b SR 8B has been transferred to City of Yuma.

Table 3 – Focus Area Segment Bicycle-Motor Vehicle Crashes (continued)

Location ID	City/Town	Type	On Street	Limits	Number Through Lanes	Length (Miles)	Number of Crashes	Crashes/ Mile / Year	Priority Location
25e	Peoria and Glendale	Segment	US 60	Northern Avenue to Bethany Home Road	6	0.5	5	2.0	√
44a	Yuma	Segment	US 95	Arizona Avenue to 24th Street	4	3.02	26	1.9	√
40b	Tucson	Segment	SR 77 (Miracle Mile)	Fairview Avenue to Romero Road	4	0.67	6	1.8	√
35	Sedona	Segment	SR 89A	Dry Creek Road to Soldier Pass Road	4	1.88	15	1.6	√
11e	Flagstaff	Segment	US 180	SR 40B to Meade Lane	2	1.4	11	1.6	√
38	Somerton	Segment	US 95	State Street to Somerton Avenue	4	0.27	2	1.5	-
2b	Apache Junction	Segment	SR 88	Broadway Avenue to 14th Avenue	4	0.42	3	1.4	-
11b	Flagstaff	Segment	SR 40B	Blackbird Roost Street to Riordan Road	4	0.29	2	1.4	-
17b	Mesa	Segment	US 60X	Sossaman Road to Meridian Drive	6	5.02	34	1.4	√
32	Prescott	Segment	SR 69/SR 89	Bradshaw Drive to Heather Heights	4	0.61	4	1.3	-
37a	Sierra Vista	Segment	SR 92/SR 90	MLK Parkway/Tree Top Ave to Calle Mercancia	4	2.49	15	1.2	√
19a	Mesa/ Gilbert	Segment	SR 87	Guadalupe Road to Baseline Road	6	1.02	6	1.2	√

Table 3 – Focus Area Segment Bicycle-Motor Vehicle Crashes (continued)

Location ID	City/Town	Type	On Street	Limits	Number Through Lanes	Length (Miles)	Number of Crashes	Crashes/ Mile / Year	Priority Location
9	Douglas	Segment	US 191B	1st Street to 7th Street	4	0.6	3	1.0	-
10a	El Mirage	Segment	US 60	Thompson Ranch Road to Poppy Street	4	0.43	2	0.9	-
7	Chino Valley	Segment	SR 89	Road 1 North to Perkinsville Road	4	1.3	5	0.8	-
21a, 21b	Nogales	Segment	SR 19B	SR 82 to International Street	4	1.47	5	0.7	-
39j	Tempe	Segment	SR 101 Front. Road/Ramp	Baseline Road to US 60	2	1.02	3	0.6	-
4	Bullhead City	Segment	SR 95	Marina Boulevard to Seventh Street	4	4.4	11	0.5	-
24c	Payson	Segment	SR 260	Tyler Parkway to Chaparral Pines Road	4	0.84	2	0.5	-
31	Pinetop Lakeside	Segment	SR 260	Woodland Lake Road to Rainbow Lake Dr.	4	4.58	9	0.4	-

Table 4 – PBCAT Data Items

Principal Information
- 1 Report Number
- 2 Date of Crash (mmddyyyy)
- 3 Time of Day (military - hhmm)
- 4 No of Bicyclists
- 5 Hit and Run

Driver Information
- 6 Driver Age
- 7 Driver Gender
- 8 Driver Injury Severity
- 9 Conditions Influencing Driver
- 10 Driver Action
- 11 Motor Vehicle Type
- 12 Motor Vehicle Defects
- 13 Motor Vehicle Estimated Speed
- 14 Driver Location Before Crash

Area Characteristics
- 15 Type of Area
- 16 Development Type

Environmental Conditions
- 17 Light Conditions
- 18 Weather Conditions
- 19 Surface Conditions

Violations/Citations
- 20 Driver Violation 1
- 21 Driver Violation 2
- 22 Bicyclist Violation 1
- 23 Bicyclist Violation 2
- 24 Citation Issued To

Location
- 25 Type of Location
- 26 Location of Crash
- 27 Orientation of Crash
- 28 City/Town
- 29 On Road
- 30 Intersecting Road
- 31 Near Milepost
- 32 On Road AADT

Bicyclist Information
- 33 Bicyclist Age
- 34 Bicyclist Gender
- 35 Bicyclist Injury Severity
- 36 Conditions Influencing Bicyclist
- 37 Bicyclist Action
- 38 Bicyclist Helmet
- 39 Bicyclist Lights
- 40 Bicycle Defects
- 41 Bicycle Estimated Speed
- 42 Bicyclist Location Before Crash

Roadway and Facility Features
- 43 No of Through Lanes
- 44 Roadway Type
- 45 Roadway Configuration
- 46 Roadway Grade
- 47 Roadway Alignment
- 48 Roadway Surface
- 49 Special Location
- 50 Traffic Control
- 51 Speed Limit
- 52 Bicycle Facility Presence
- 53 Bike Lane / Paved Shoulder Width
- 54 Marked Crosswalk Presence
- 55 Sidewalk Presence

Crash Typing Information
- 56 Crash Type Number
- 57 Crash Type Description
- 58 Crash Group Number
- 59 Crash Group Description
- 60 Crash Location
- 61 Crash Location Description
- 62 Bicyclist Position
- 63 Bicyclist Position Description
- 64 Bicyclist Direction
- 65 Bicyclist Direction Description

2.4.5 Crash Typing

The PBCAT database was utilized to "crash type" each of the 746 focus area crashes. Crash typing was developed in the 1970s by the National Highway Traffic Safety Administration to better define the sequence of actions leading to bicycle and pedestrian crashes. PBCAT includes the latest evolution of crash types and includes more than 70 specific bicyclist crash types.

Each of the 746 focus area crashes was assigned a crash type**. Table 5** lists the top five crash types that comprise more than 50 percent of focus area crashes.

The crash types may be collapsed into 20 crash-typing groups. **Table 6** lists the three most frequent crash groups that comprise more than 50 percent of focus area crashes.

Table 5 – SHS Crash Types

Number of SHS Focus Area Crashes	Percentage of SHS Focus Area Crashes	Crash Type Description
103	13.8 %	Bicyclist Ride Through - Signalized Intersection
83	11.1 %	Motorist Drive Out - Sign-Controlled Intersection
76	10.1 %	Motorist Drive Out - Right-Turn-on-Red
71	9.51 %	Motorist Drive Out - Commercial Driveway / Alley
61	8.17 %	Motorist Drive Out - Signalized Intersection
746		Total SHS Motor Vehicle-Bicycle Crashes

Table 6 – SHS Crash Groups

Number of SHS Focus Area Crashes	Percentage of SHS Focus Area Crashes	Crash Group Description
148	19.8%	*Motorist Failed to Yield - Signalized Intersection*: The motorist enters an intersection and fails to stop at a traffic signal, striking a bicyclist who is traveling through the intersection on a perpendicular path. Typically, no turning movements are made by either party, except for a possible right turn on red. **Many of these crashes involve bicyclists who are riding the wrong-way against traffic**, either in the roadway or on the sidewalk approaching the intersection.
122	16.3%	*Bicyclist Failed to Yield - Signalized Intersection:* The bicyclist enters an intersection on a red signal or is caught in the intersection by a signal change, colliding with a motorist. **This group of crashes could involve a lack of understanding of the signal or inexperience of a young bicyclist or flagrant disregard for the signal by an older bicyclist. In many of these crashes, the bicyclist is likely to be riding on the sidewalk or riding the wrong-way**, against traffic, and failed to notice the signal indication.

Table 6 – SHS Crash Groups (continued)

Number of SHS Focus Area Crashes	Percentage of SHS Focus Area Crashes	Crash Group Description
108	14.4%	*Motorist Drove / Motorist Failed to Yield Midblock:* The motorist typically **pulls out of a driveway** or alleyway and fails to yield to a bicyclist riding along the roadway or a parallel path or sidewalk. **Two-thirds of these types** of crashes typically involve a bicyclist who **is riding the wrong-way against traffic**, either on the sidewalk or on the roadway.
746		Total SHS Motor Vehicle-Bicycle Crashes

2.4.6 Focus Area Crash Summary

Figure 5 through Figure 23 present analysis of the 746 focus area crashes. Table 7 lists key observations for each figure.

It should be emphasized that the percentages presented in **Figure 5** through **Figure 23** are based on the 746 focus area crashes, and not all SHS crashes that occurred within the analysis period.

Table 7 – Key Observations from the PBCAT Analysis of SHS Focus Area Crashes

Figure	Key Observations
Figure 5	▪ 1 percent of crashes resulted in a fatality. ▪ 10 percent of crashes resulted in an incapacitating injury.
Figure 6	▪ 47 percent of bicyclists are between the ages of 25-54.
Figure 7	▪ The vast majority of bicyclists (82 percent) are male.
Figure 8	▪ Most crashes (99 percent) occurred in urbanized and developed areas, even though most bicycling in Arizona is recreational (as determined by survey responses); even on the SHS, most crashes occurred in urbanized and developed areas.
Figure 9	▪ The Flagstaff urban area represents 20 percent of all SHS motor vehicle-bicycle crashes. Flagstaff has numerous state highways including US 180 and US 89.
Figure 10	▪ The most common crash groups are "motorist failed to yield – at signalized intersections" (20 percent) and "bicyclist failed to yield at signalized intersections" (16 percent).
Figure 11	▪ The most common crash types are "bicyclist ride through-signalized intersection" (14 percent) and "motorist drive out-sign controlled intersection" (11 percent). Another frequent crash type is "motorist drive-out – right turn on red" (10 percent).
Figure 12	▪ The majority of crashes (51 percent) occurred while a vehicle was making a right turn.
Figure 13	▪ 37 percent of crashes occurred while the motorist was making a right turn and the bicyclist was facing traffic (as opposed to riding with traffic).
Figure 14	▪ 84 percent of crashes occurred in locations with no bicycle facilities (shoulder, bicycle lane, etc.).
Figure 15	▪ 9 percent of crashes on Non-Interstate State Highways were crash typed as "motorist drive-out – sign-controlled intersection.
Figure 16	▪ 8 percent of crashes on Local/Municipal roads were crash typed as "bicyclist ride through – signalized intersection.
Figure 17	▪ 0.27 percent of crashes on interstate frontage roads and ramps were crash typed as "crossing paths – uncontrolled intersections."
Figure 18	▪ 46 percent of crashes occurred near commercial or industrial development while a vehicle was making a right turn.
Figure 19	▪ 21 percent of crashes occurred while the motorist was making a right turn, and the bicyclist was riding on the sidewalk.
Figure 20	▪ The most common crash type in large urbanized areas (200,000 or more) is "motorist failed to yield – signalized intersection" (11 percent).
Figure 21	▪ The most common crash type in rural areas is "motorist overtaking bicyclist" (0.4 percent).
Figure 22	▪ The most common crash type in small urban areas (5,000 – 49,999) is "motorist failed to yield – midblock" (5 percent).
Figure 23	▪ The most common crash type in small urban areas (50,000 – 199,999) is "motorist failed to yield – signalized intersection" (6 percent).

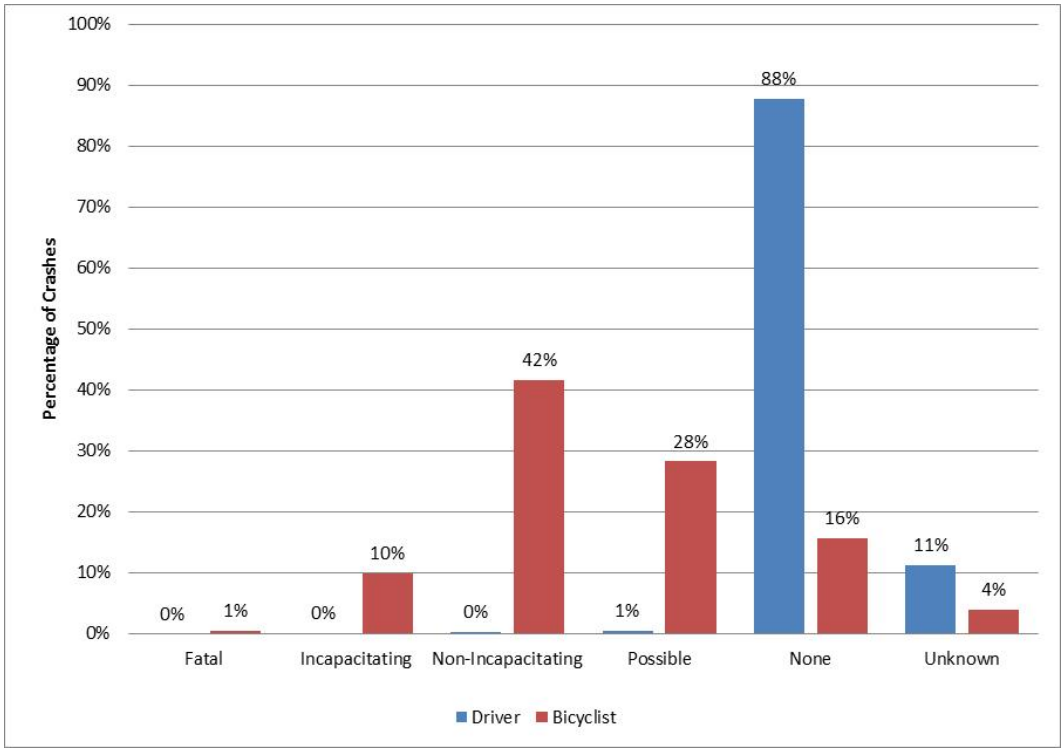


Figure 5 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Injury Severity

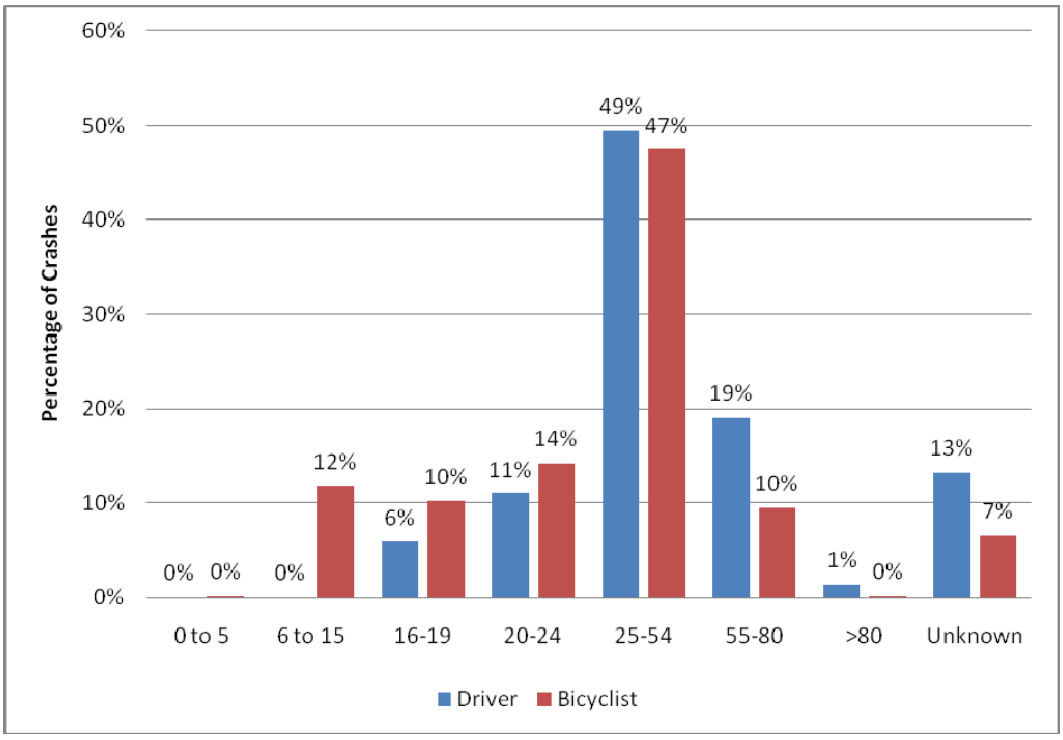


Figure 6 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Age

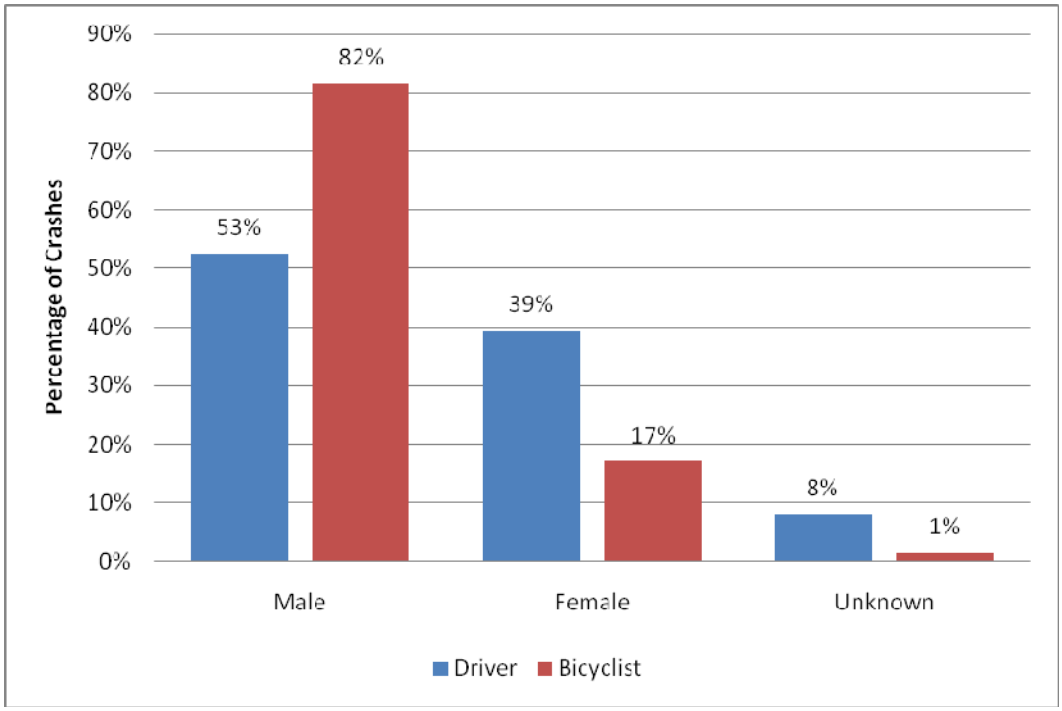


Figure 7 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Gender

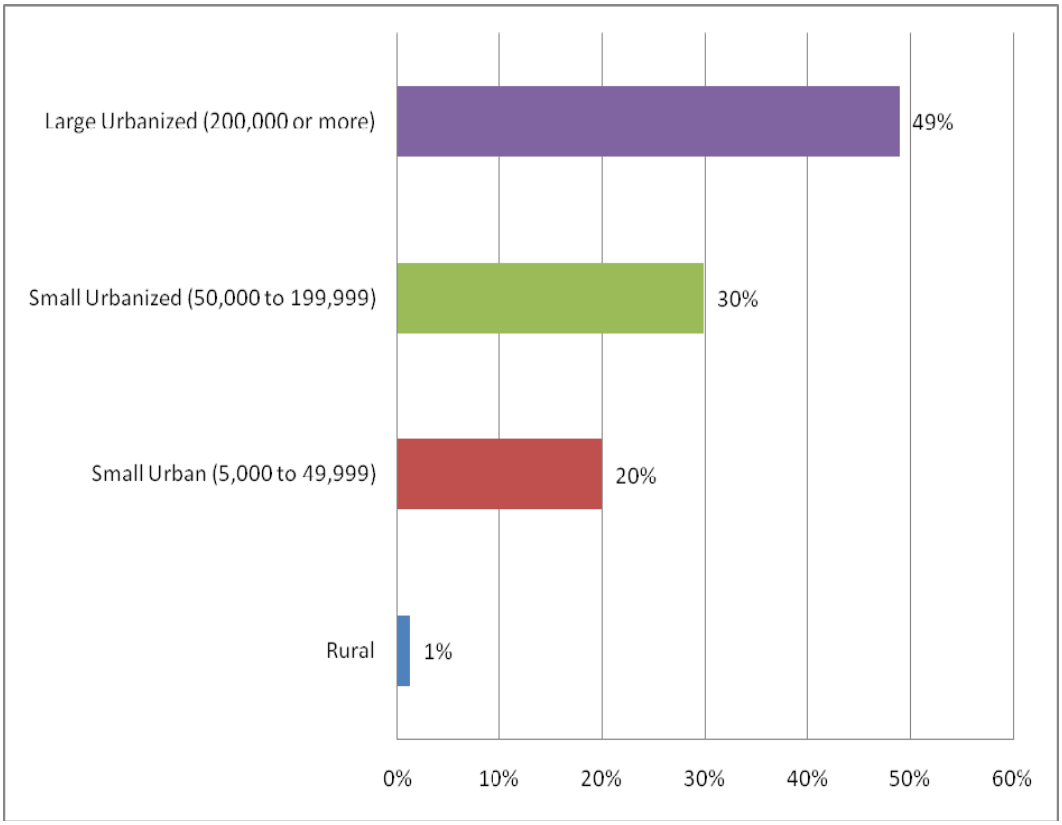
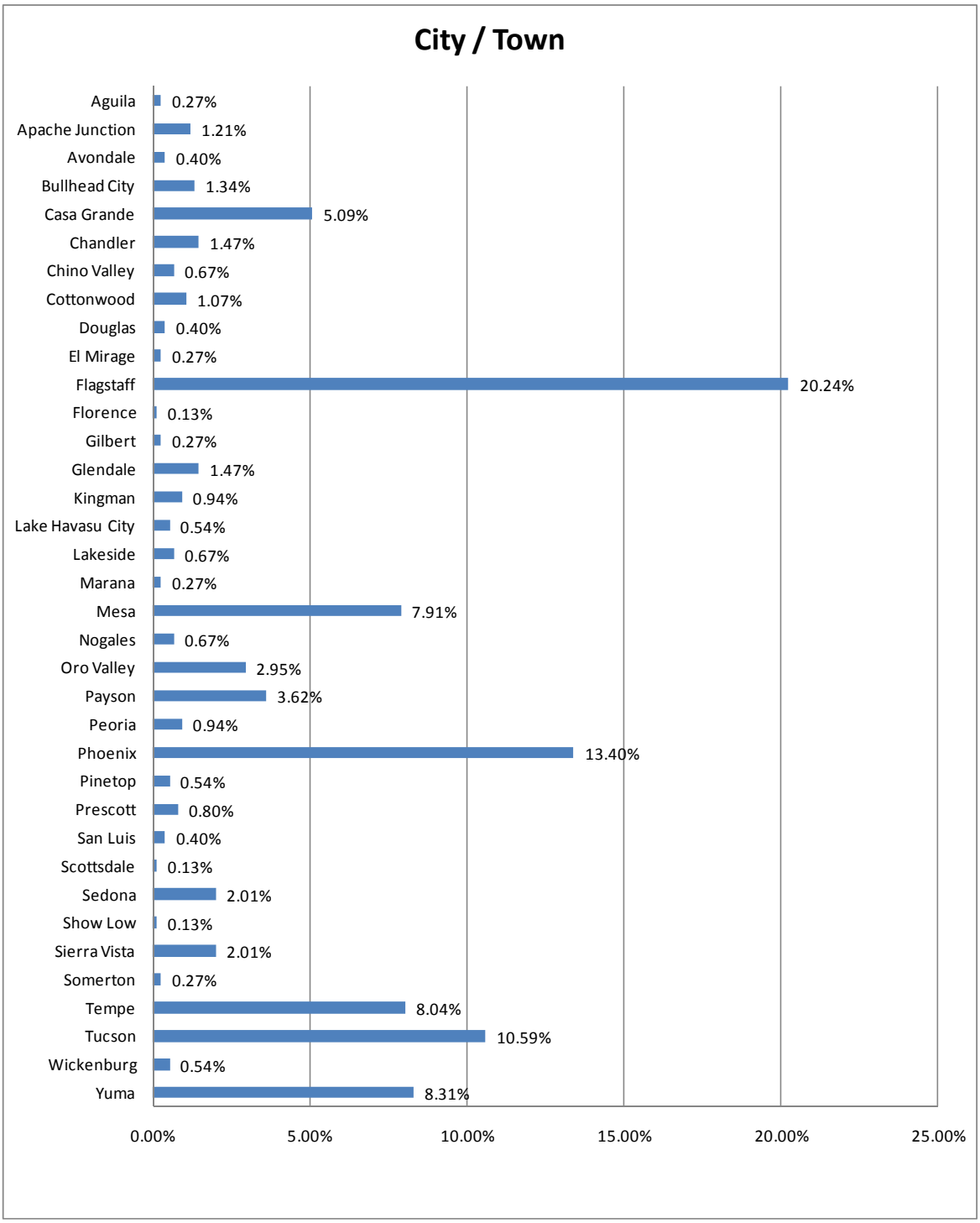


Figure 8 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Area Type



Note: Many Flagstaff and Yuma area crashes may have occurred on segments that have either been turned back to City of Flagstaff or to the City of Yuma, respectively, or on shared-use paths within ADOT right-of-way.

Figure 9 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Cities and Towns

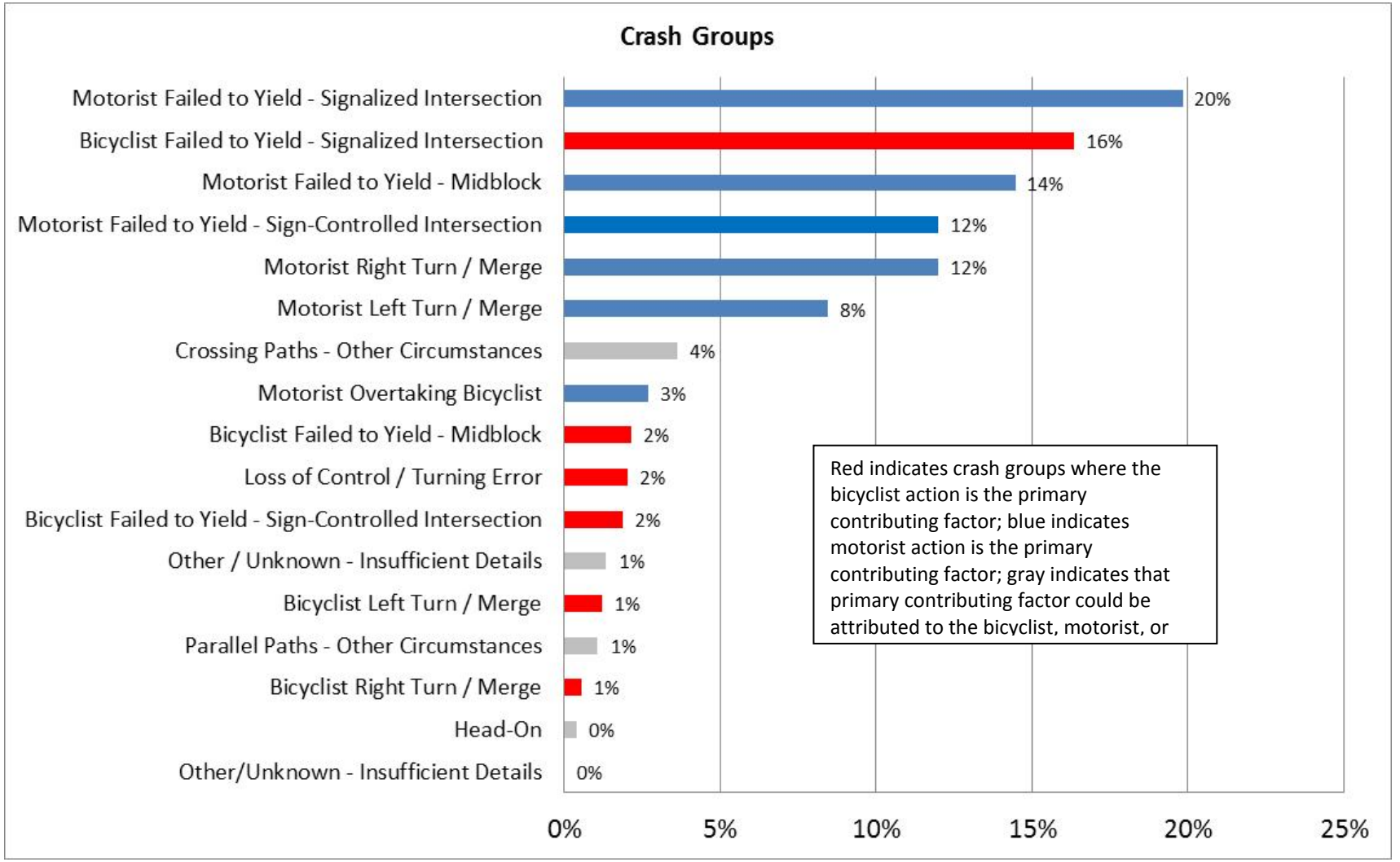


Figure 10 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Crash Group

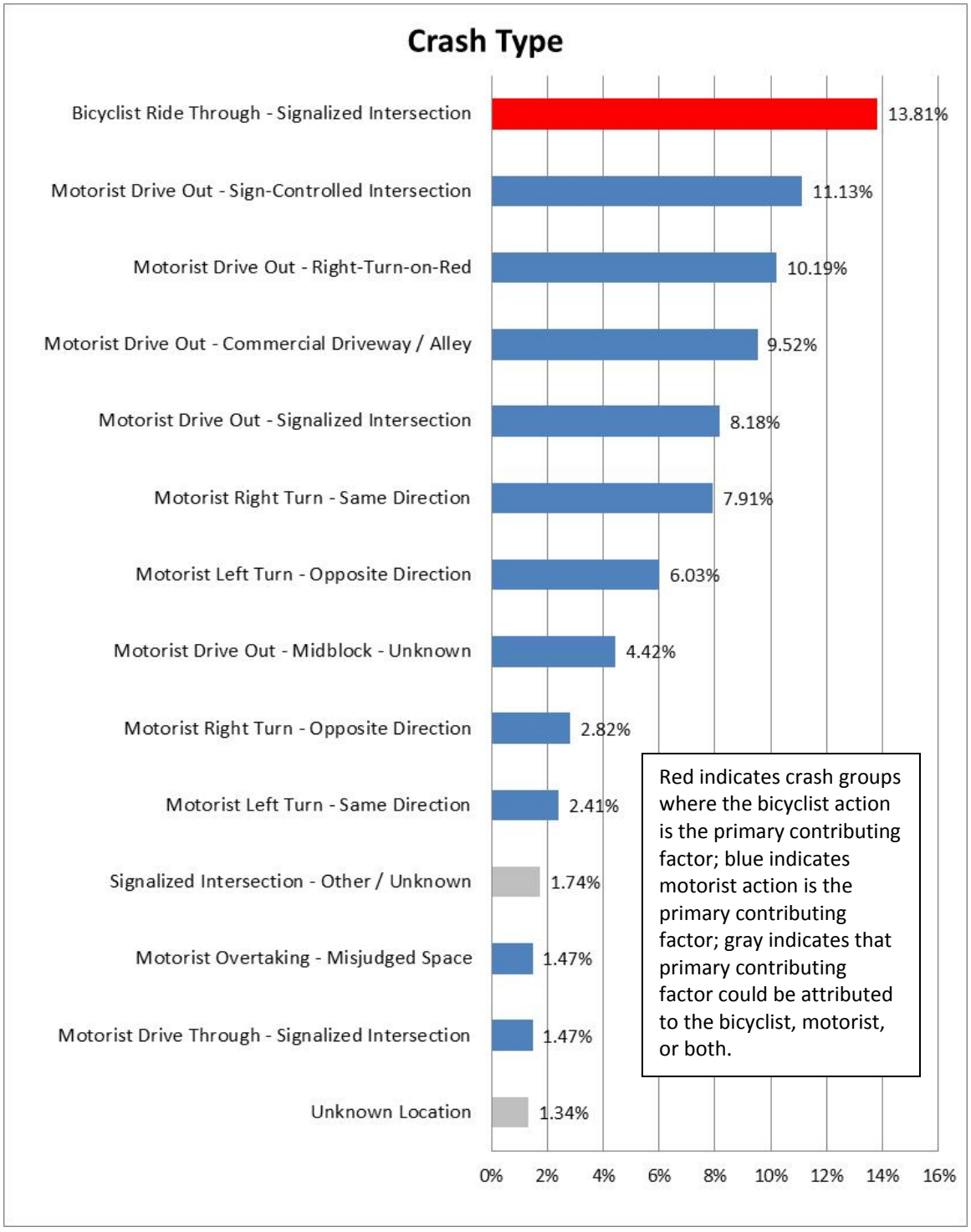


Figure 11 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Crash Type

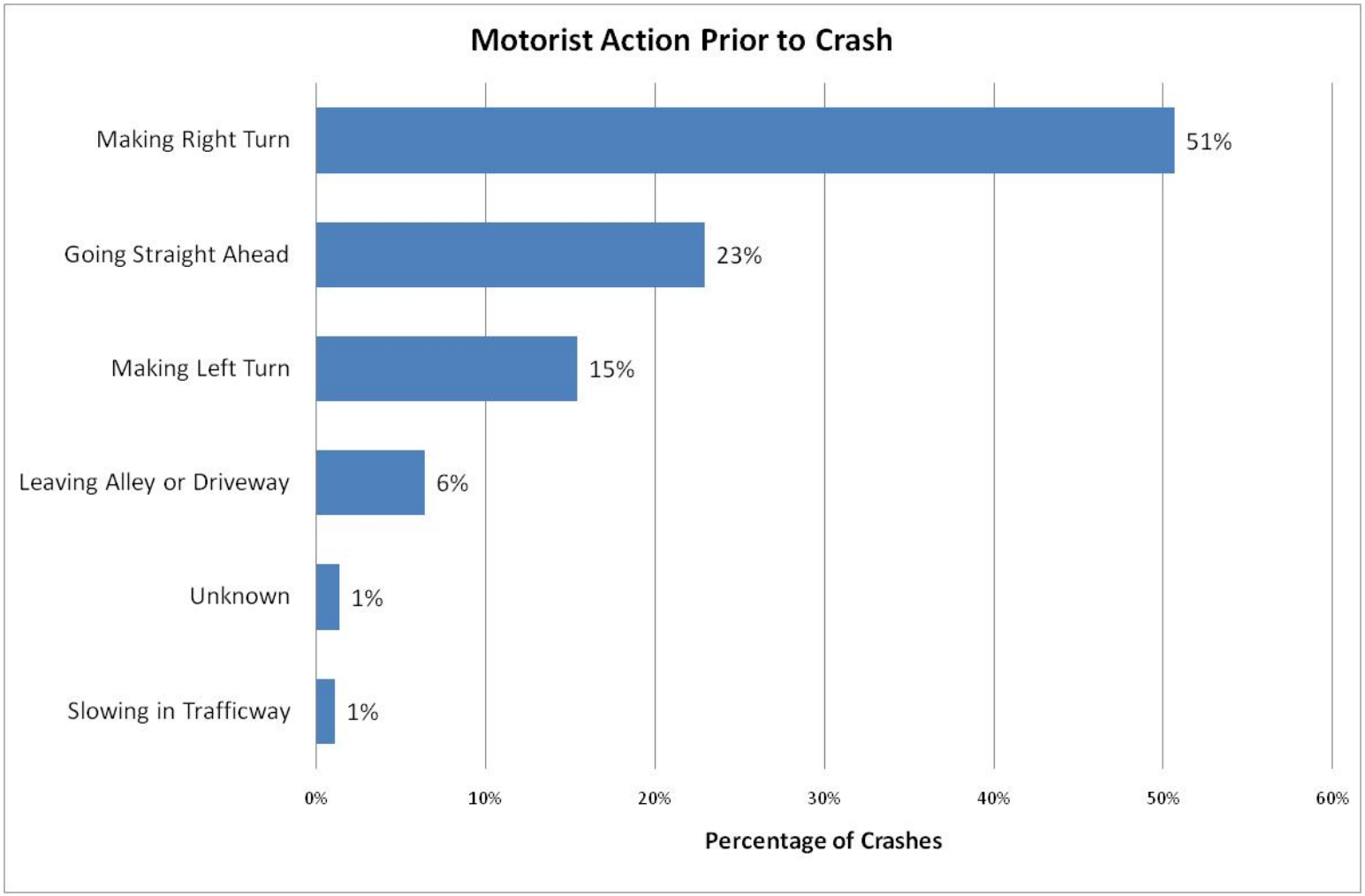


Figure 12 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Motorist Action

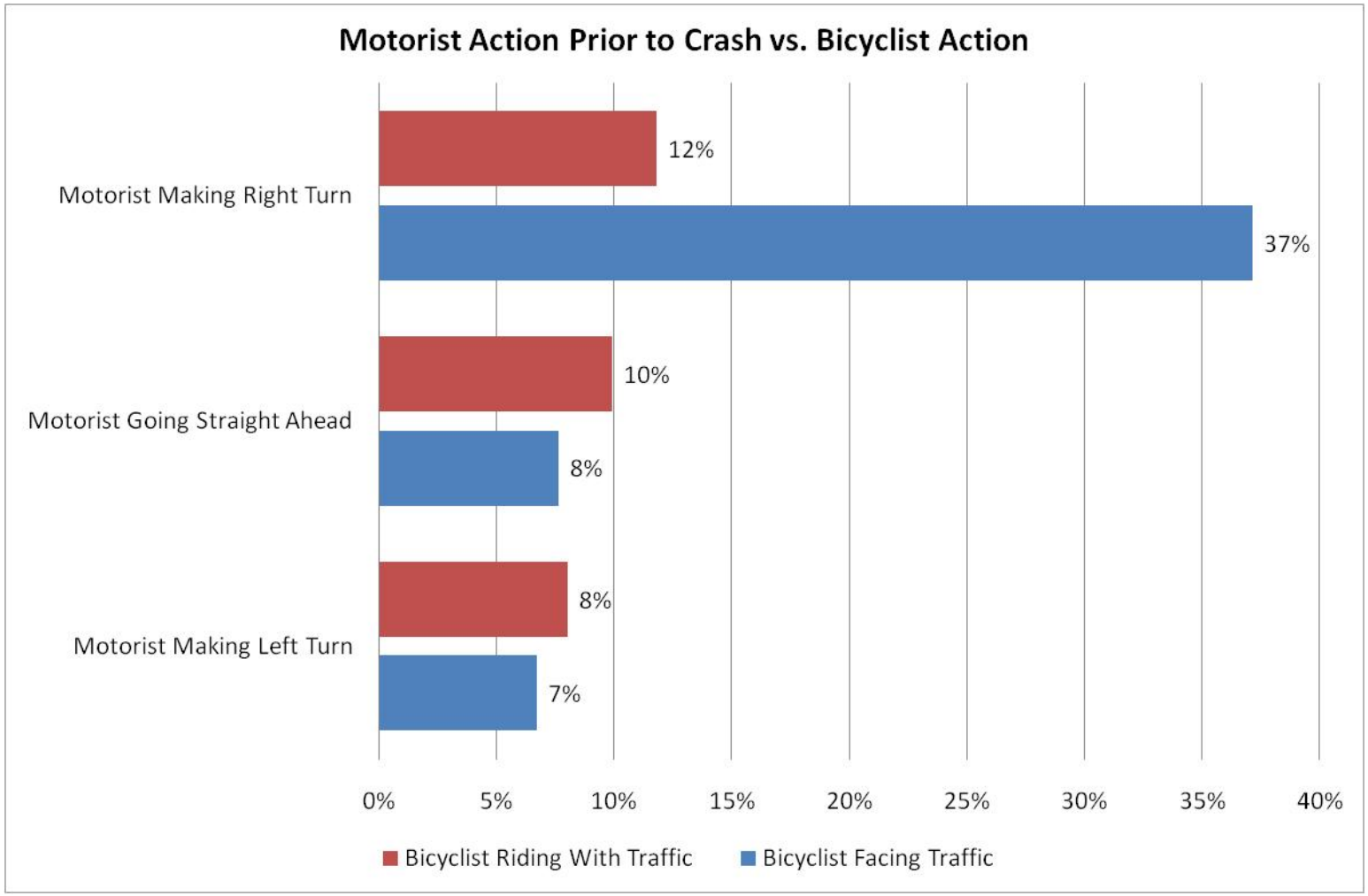


Figure 13 – SHS Motor Vehicle-Bicycle Crashes, 2004 –- 2008, Motorist/Bicyclist Action

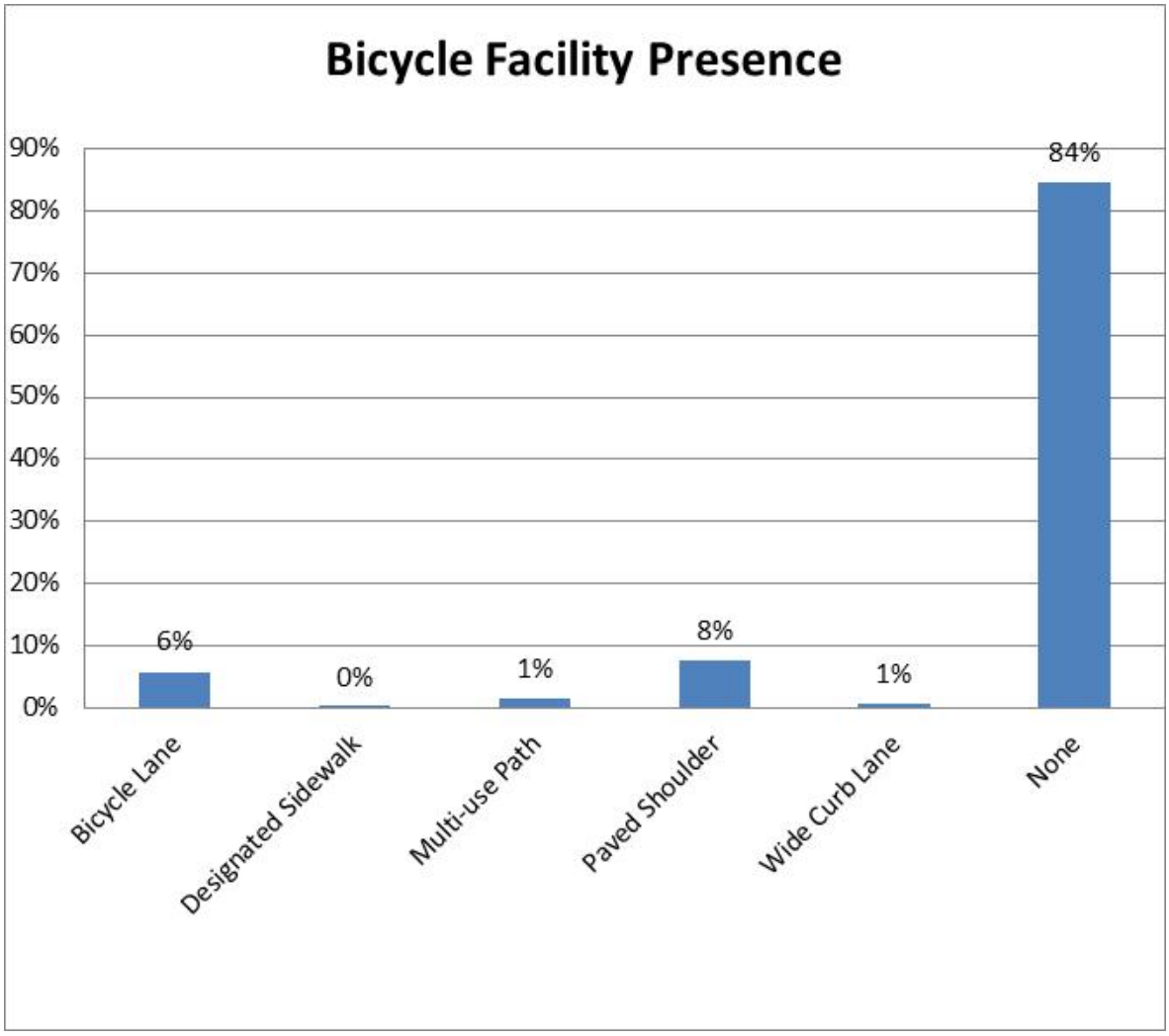


Figure 14 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Bicycle Facility Presence

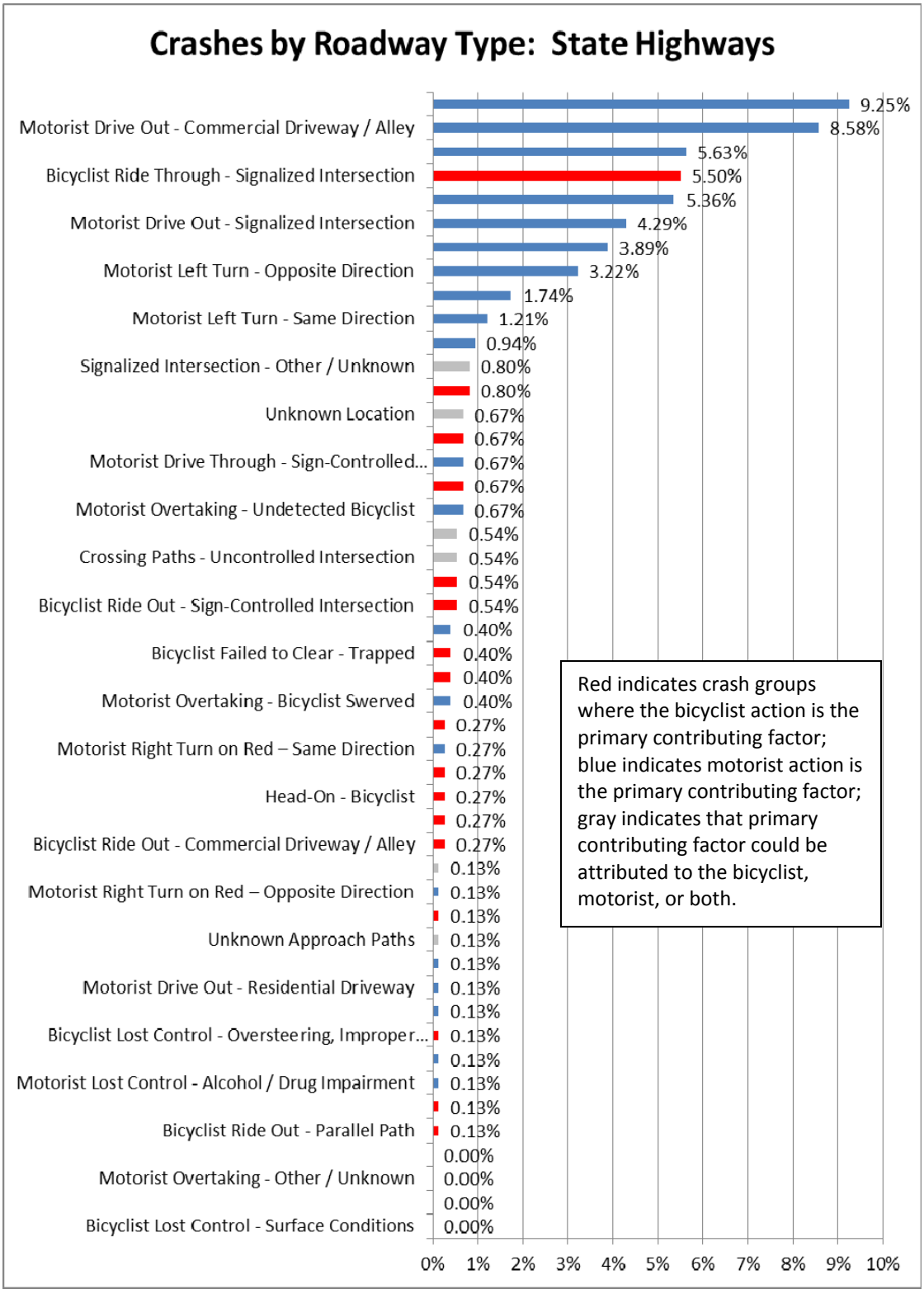
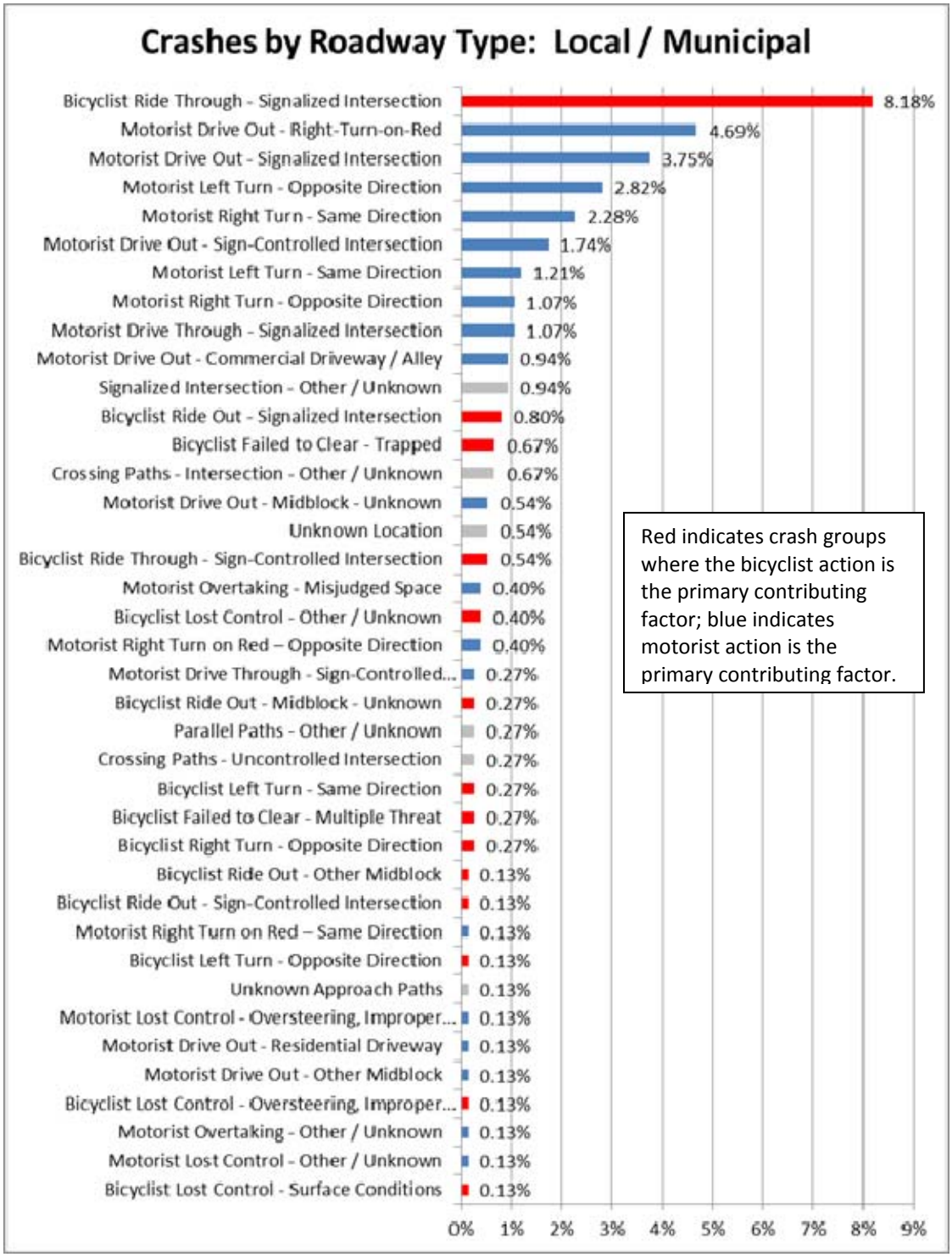


Figure 15 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Crashes by Roadway Type (Non-Interstate State Highways)



Note: Represents crashes that occurred on local streets within ADOT right-of-way. An example is a crash that occurred on an arterial street within an interchange area.

Figure 16 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Crashes by Roadway Type (Local Roadways)

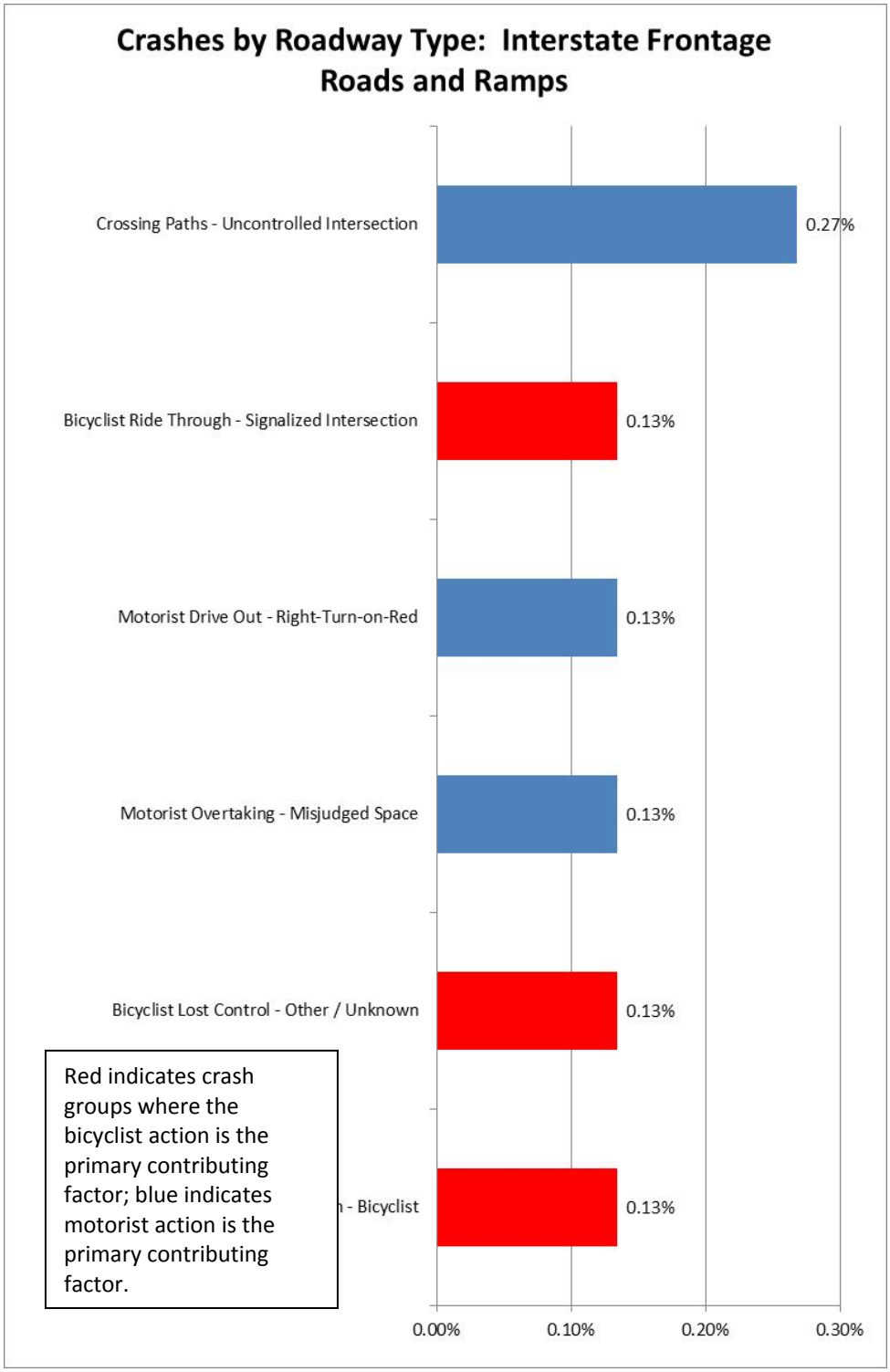


Figure 17 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Crashes by Roadway Type (Interstate Frontage Roads and Ramps)

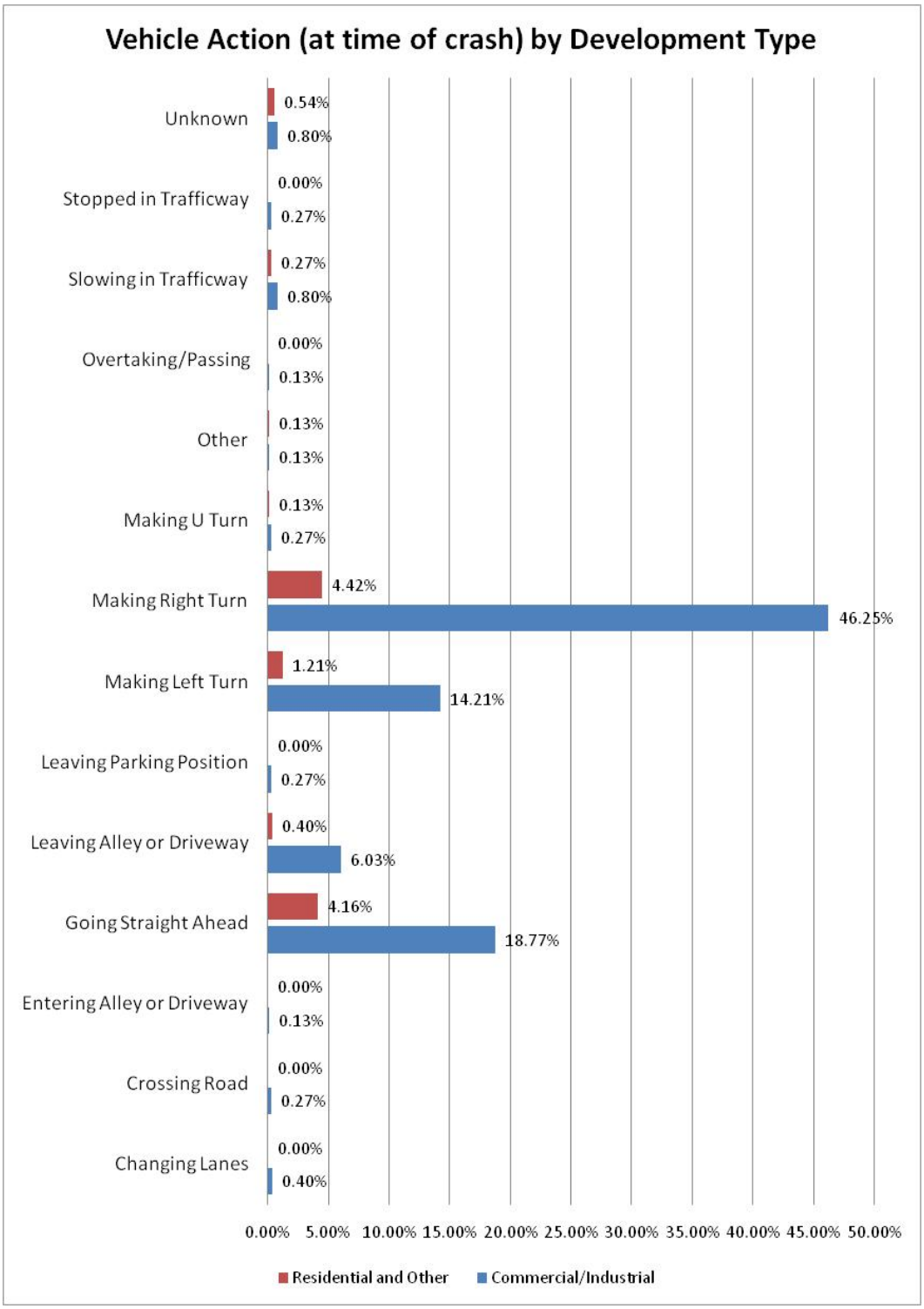


Figure 18 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Motorist Action by Surrounding Area Development Type

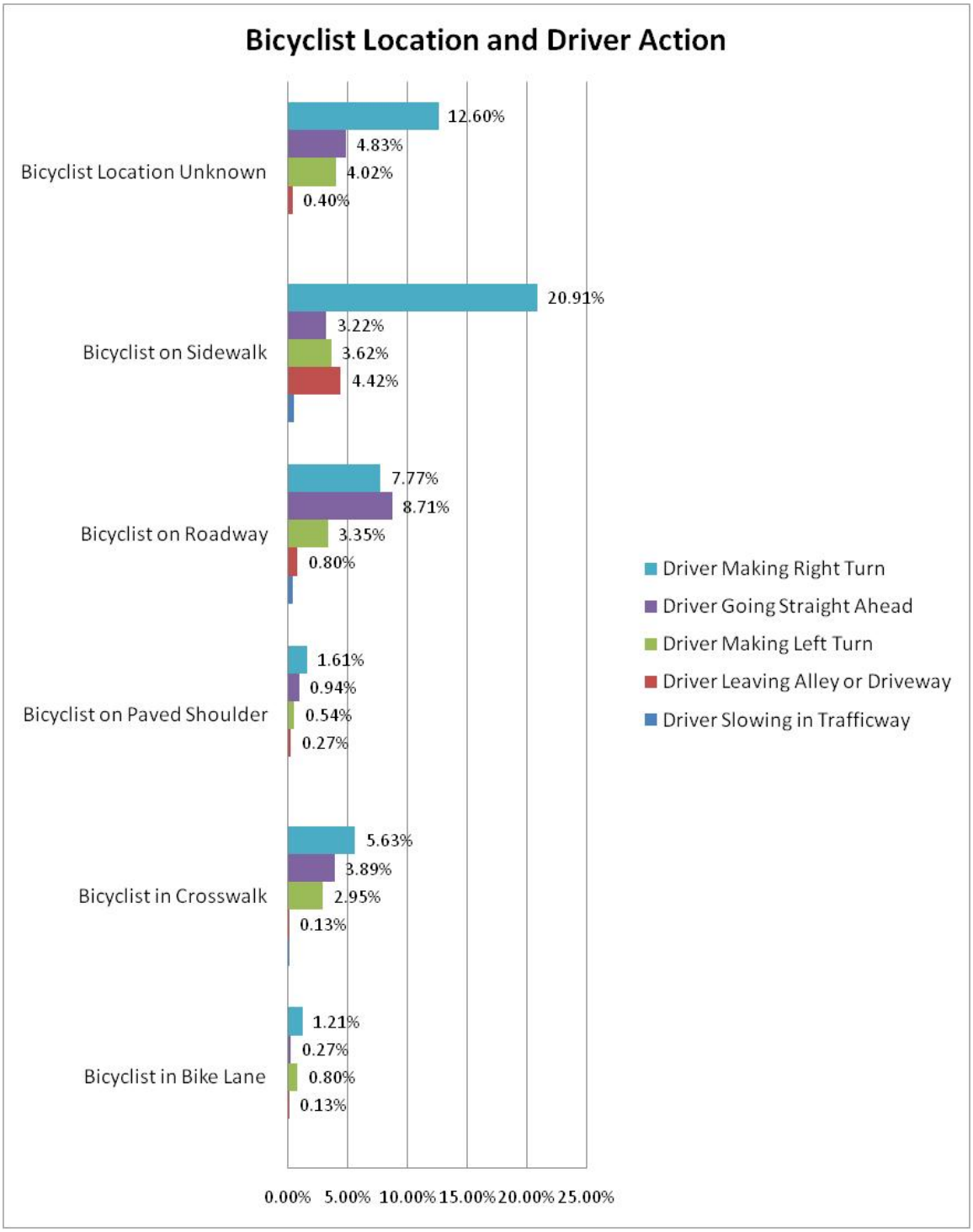


Figure 19 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Bicyclist Location and Motorist Action

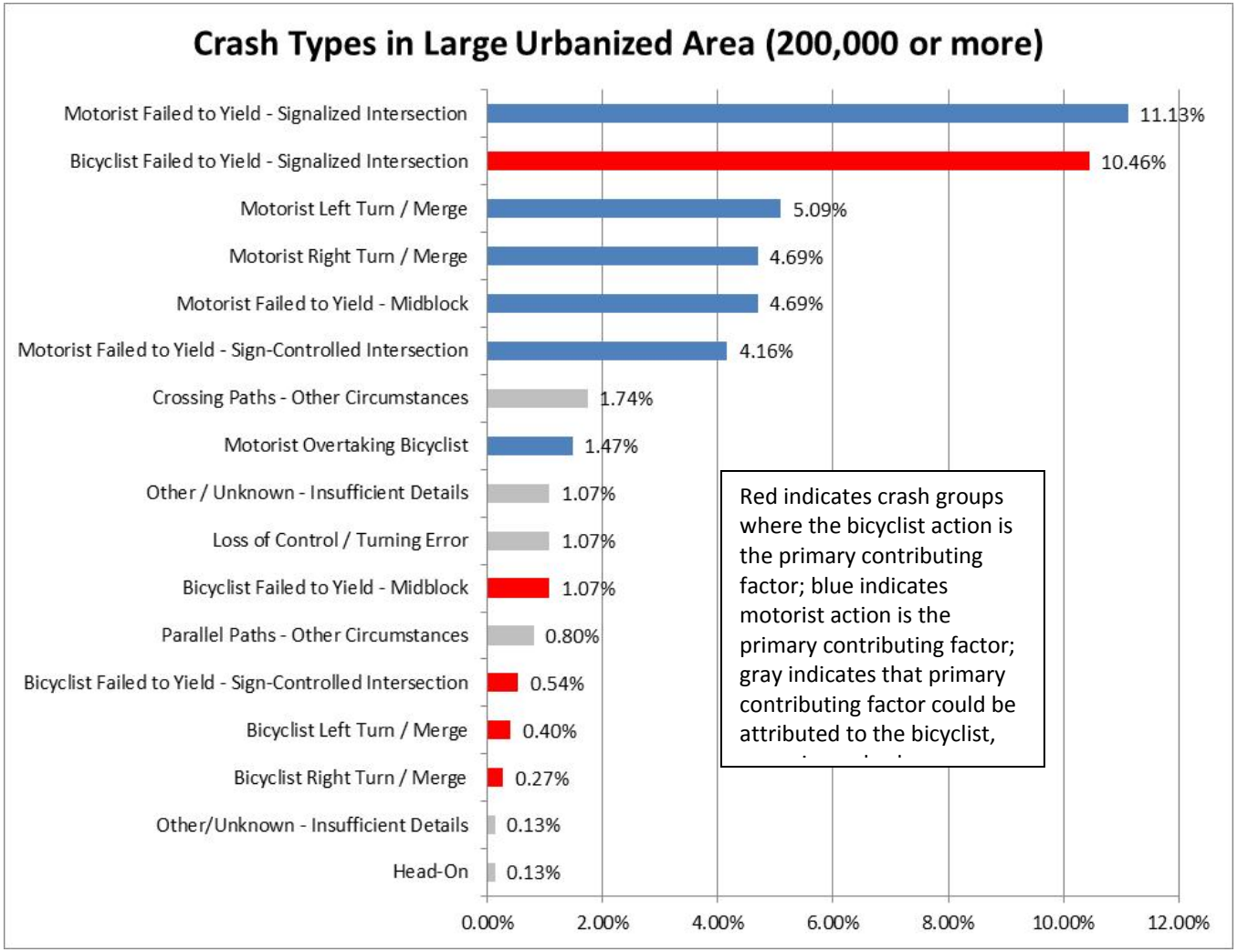


Figure 20 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Crash Types in Large Urbanized Areas

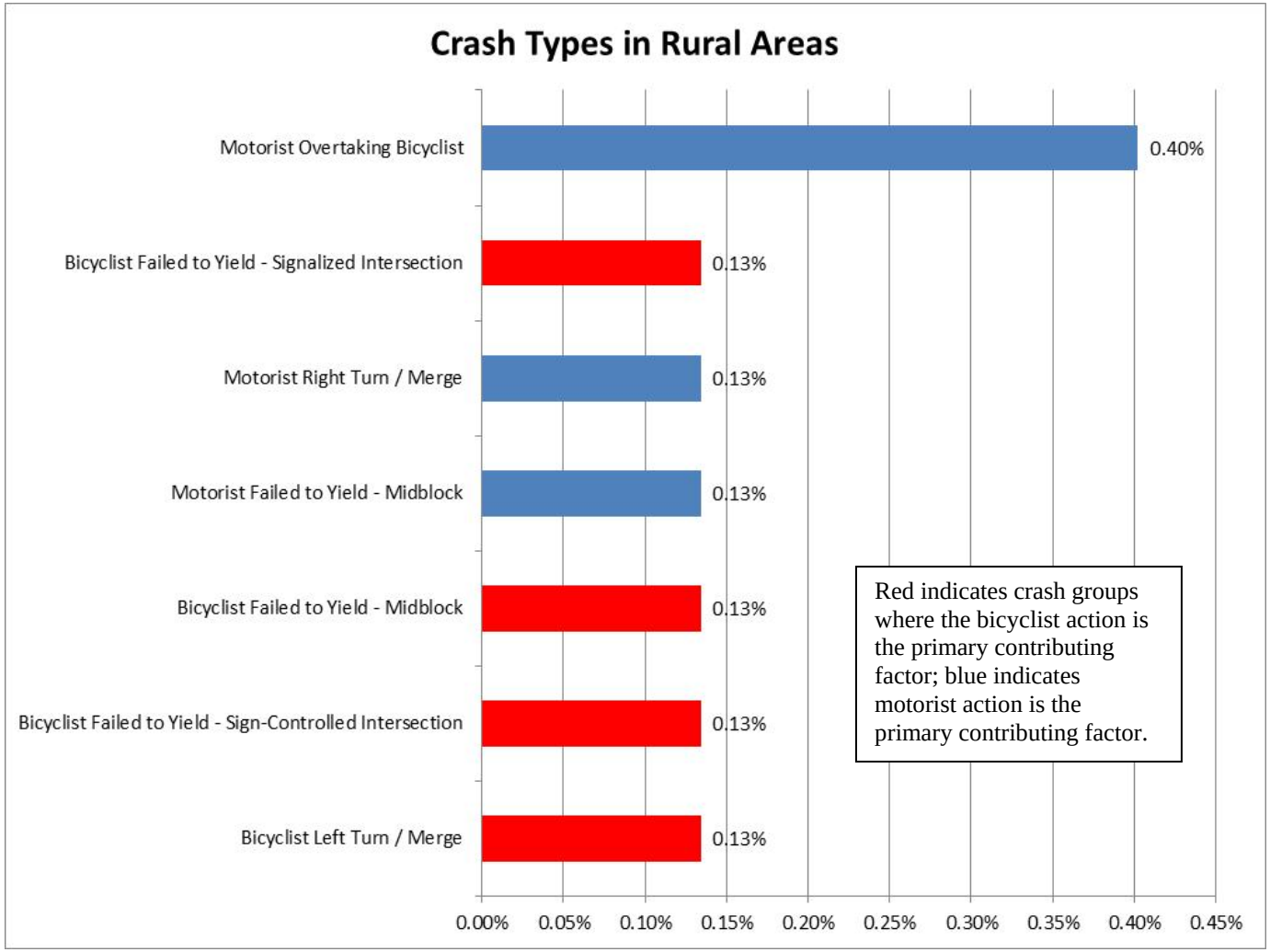


Figure 21 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Crash Types in Rural Areas

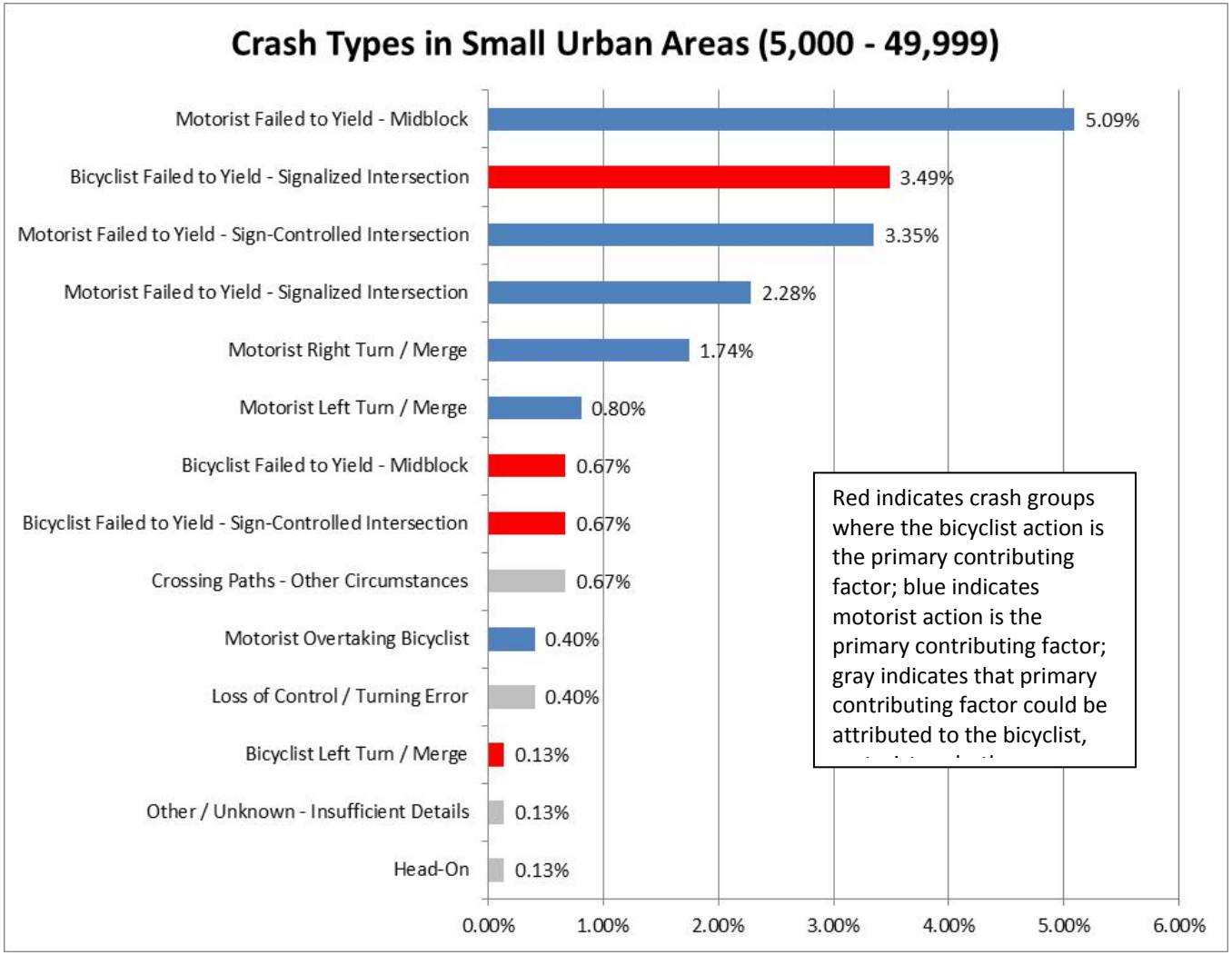


Figure 22 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Crash Types in Small Urban Areas (5,000 – 49,999)

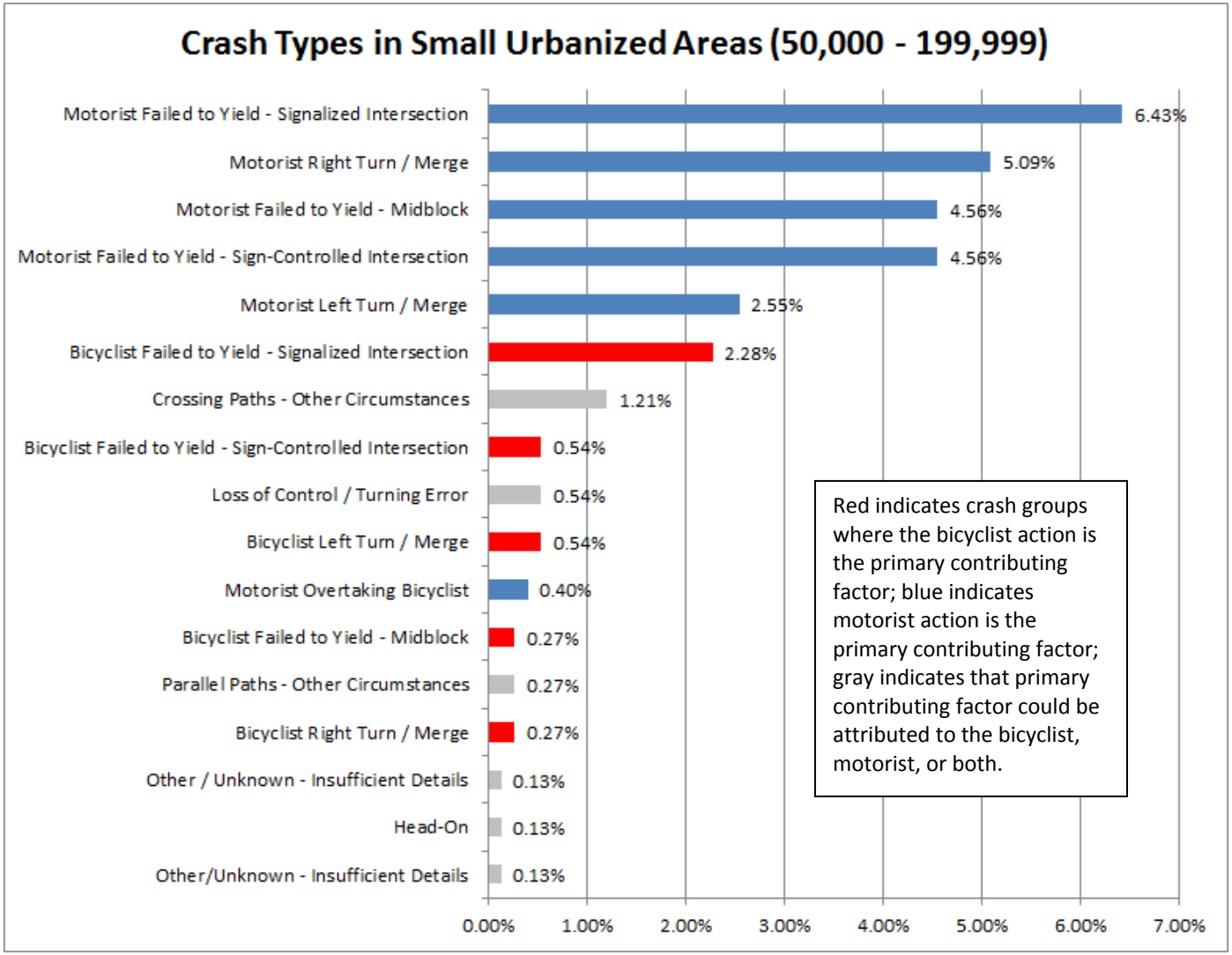


Figure 23 – SHS Motor Vehicle-Bicycle Crashes, 2004 – 2008, Crash Types in Small Urbanized Areas (50,000 – 199,999)

2.5 Fatal SHS Motor Vehicle-Bicycle Crashes

Arizona Traffic Accident Reports were obtained for all fatal bicycle crashes that occurred on the SHS, 2004 – 2008. Twenty-four (24) fatal crash reports obtained from ADOT were then entered into PBCAT for analysis. **Figure 24** through **Figure 28** show crash statistics for the 24 fatal motor vehicle-bicycle crashes on state highways in Arizona that occurred during the analysis period. Key observations are identified in **Table 8.**

Table 8 – Key Observations from the PBCAT Analysis of Fatal Crashes on the SHS

Figure	Key Observations
Figure 24	▪ Bicyclists between the ages of 25 – 54 represent 58% of fatal crashes, and 47% of all crashes.
Figure 25	▪ Male bicyclists represent 96% of fatal crashes, and just 82% of all crashes.
Figure 26	▪ 46% of fatal crashes occurred in rural areas; in contrast, just 1% of all crashes occurred in rural areas. ▪ Rural crashes, when they occur, tend to be more severe as higher speeds are generally a contributing factor.
Figure 27	▪ Motorist overtaking the bicyclist is the dominating crash type.
Figure 28	▪ Bicyclist direction is not as significant a factor in fatal crashes, as a large percentage of fatal crashes are overtaking crashes.

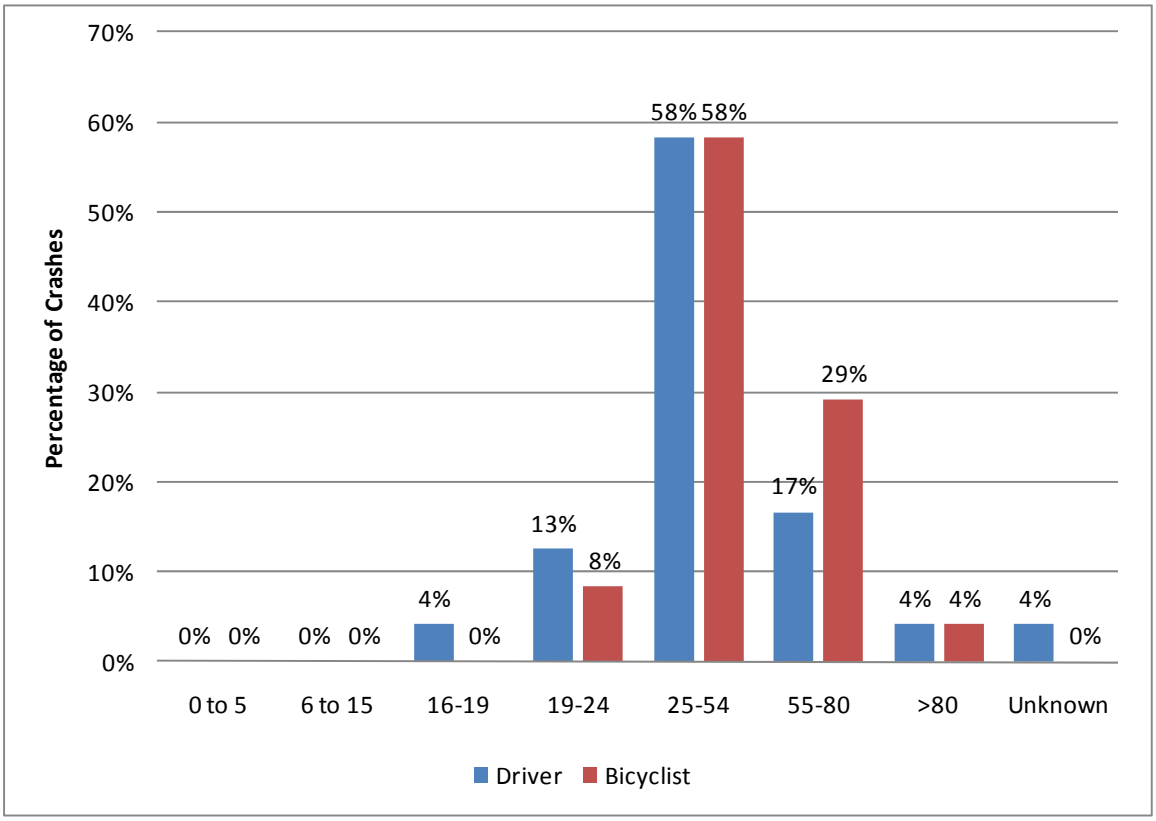


Figure 24 – Fatal SHS Bicyclist Crashes, 2004 – 2008, Age

Observation:

Bicyclists between the ages of 25 – 54 represent 58% of fatal crashes, and 47% of all crashes.

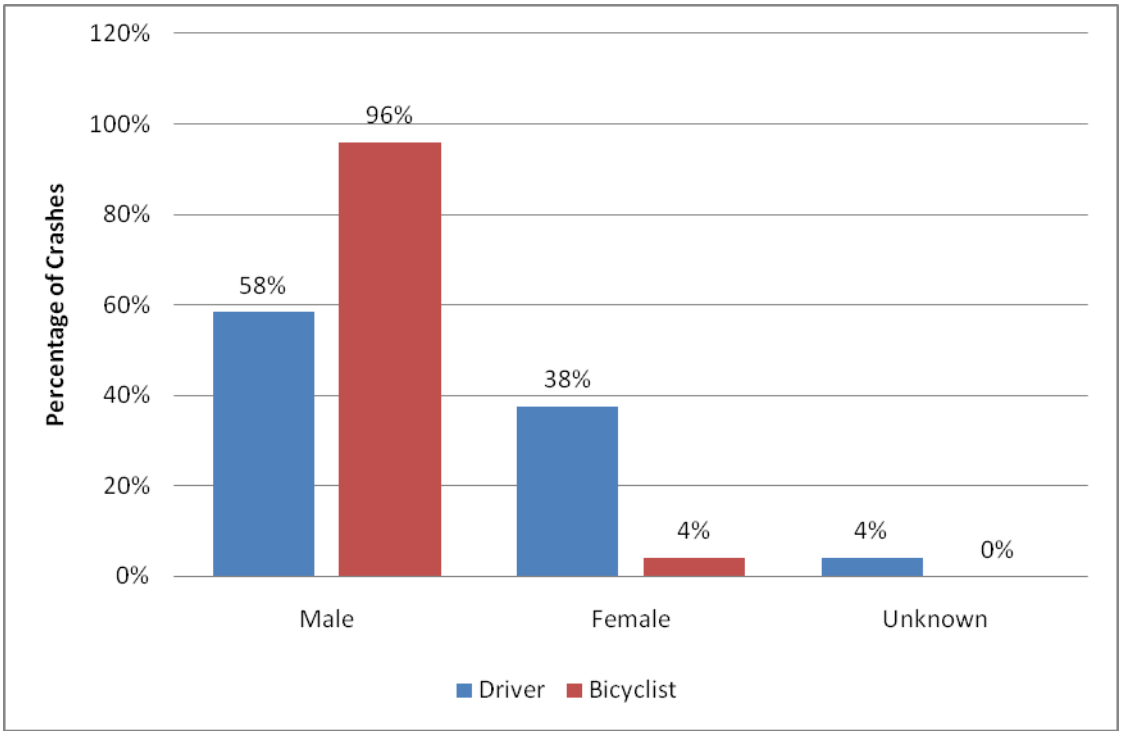


Figure 25 – Fatal SHS Bicyclist Crashes, 2004 – 2008, Gender

Observation:

Male bicyclists represent 96% of fatal crashes, and just 82% of all crashes.

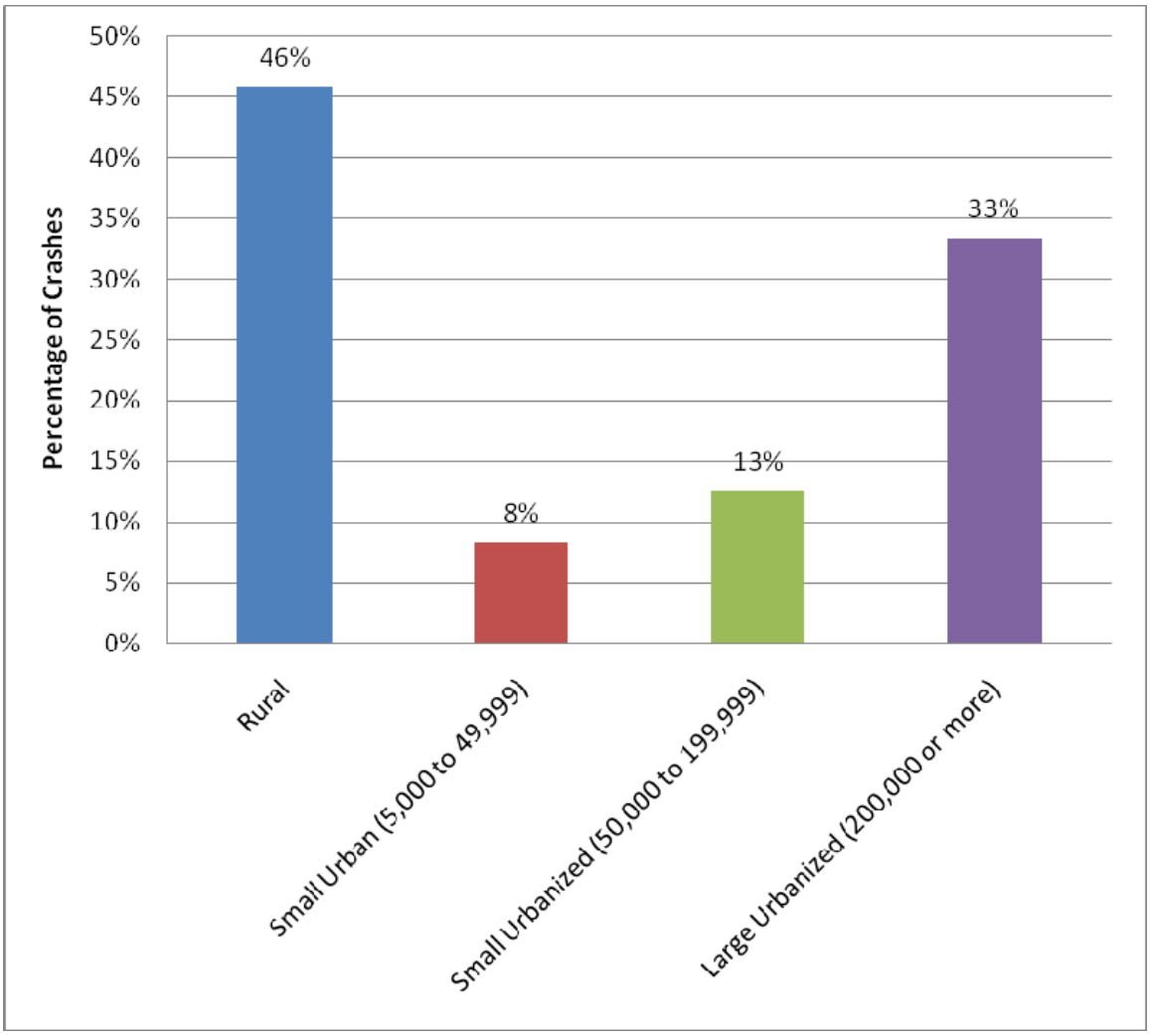


Figure 26 – Fatal SHS Crashes, 2004 – 2008, Type of Area

Observations:

46% of fatal crashes occurred in rural areas; in contrast, just 1% of all crashes occurred in rural areas.

Rural crashes, when they occur, tend to be more severe, as higher speeds are generally a contributing factor.

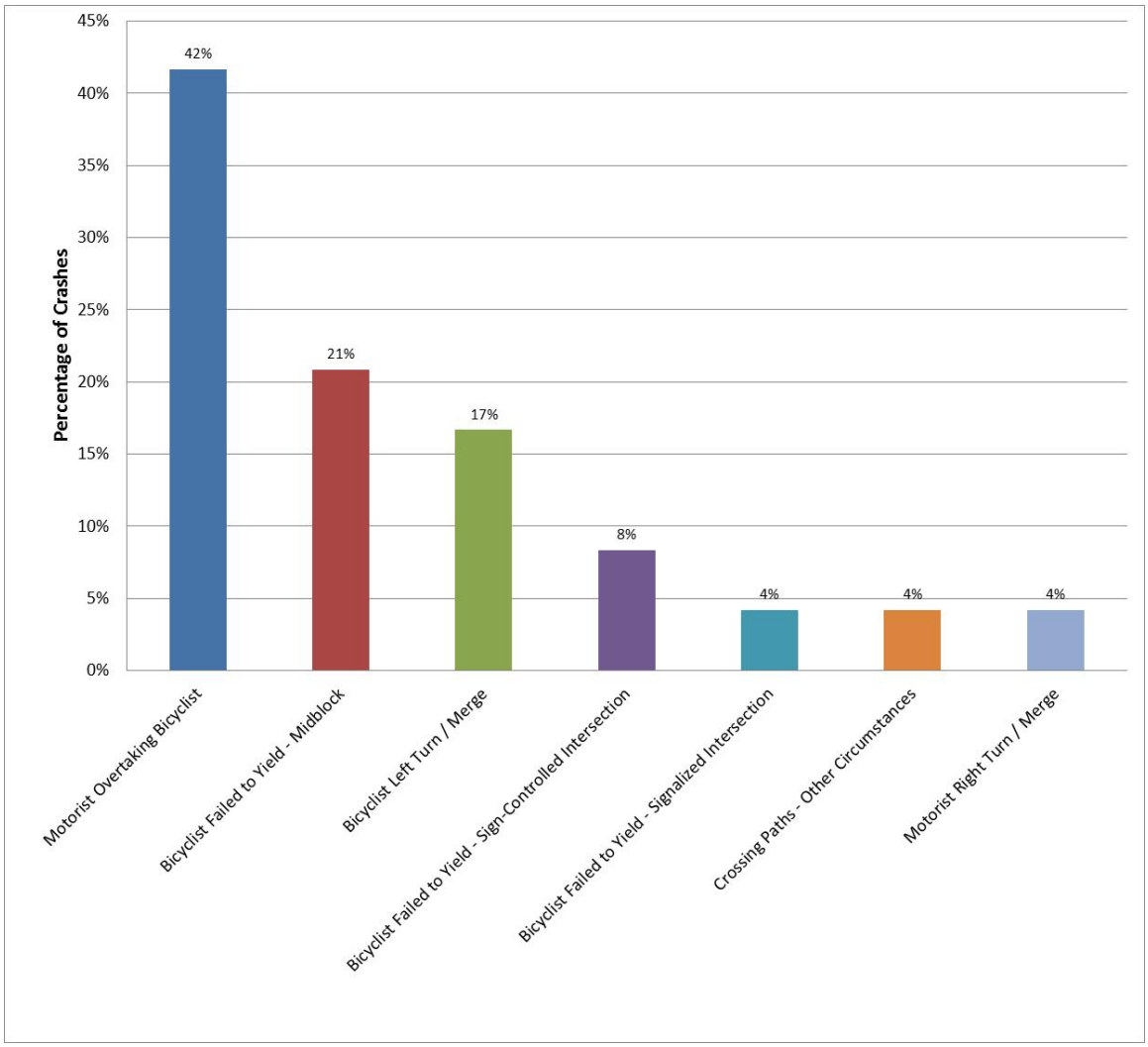


Figure 27 – Fatal SHS Bicyclist Crashes, 2004 – 2008, Crash Type

Observation:

Motorist overtaking the bicyclist is the dominating crash type.

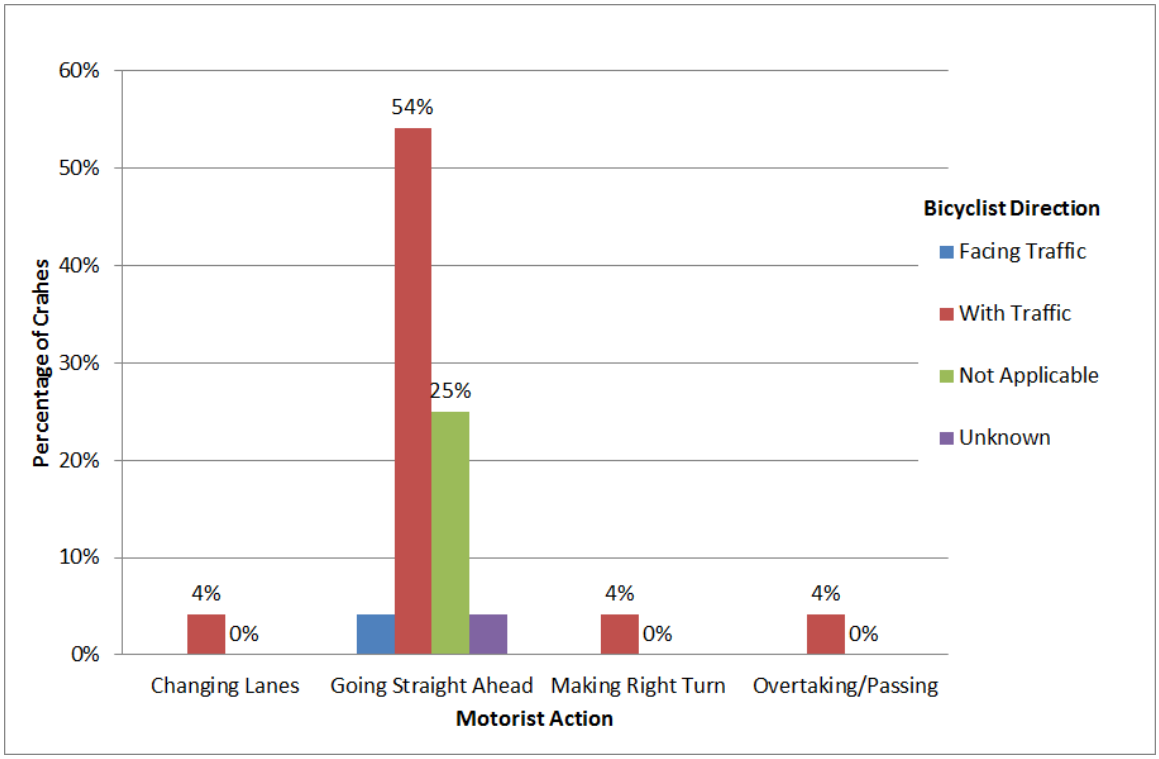


Figure 28 – Fatal SHS Bicyclist Crashes, 2004 – 2008, Motorist Action vs. Bicyclist Direction

Observation:

Bicyclist direction is not as significant a factor in fatal crashes, as a large percentage of fatal crashes are overtaking crashes.

3 BSAP GOAL AND EMPHASIS AREAS

The purpose of this chapter is to propose a BSAP Plan safety goal and emphasis areas.

The chapter begins with a review of bicycle safety goals included in other federal and state plans. A BSAP Goal is subsequently presented. This goal is designed to support goals identified in other plans and studies.

The chapter concludes with identification of Bicycle Safety Emphasis Areas. Emphasis Areas are based on the crash analysis presented in Chapter 2.

Photo courtesy of Kimley-Horn and Associates, Inc.

3.1 Existing Bicycle Safety Goals and Policies of Federal and State Plans

United States Department of Transportation (DOT)

On March 11, 2010, the United States DOT signed the Policy Statement on "Bicycle and Pedestrian Accommodation Regulations and Recommendations." The purpose of this Policy Statement is to support interconnected bicycling and walking networks to increase bicycle and pedestrian safety. To accomplish this goal, every transportation agency is responsible for integrating bicycle and pedestrian facilities into transportation systems. The Policy Statement recommends the following actions:

- Consider walking and bicycling as equals with other transportation modes

- Ensure that people of all abilities and ages are considered when planning and designing facilities
- Go beyond minimum standards
- Integrate bicycle and pedestrian accommodation on new, rehabilitated, and limited-access bridges
- Collect data on bicycling and walking trips
- Set mode share targets for bicycling and walking and track them over time
- Remove snow from sidewalks, bike lanes, and shared-use paths
- Improve non-motorized facilities during maintenance projects

Federal Highway Administration (FHWA)

The safety mission for the Federal Highway Administration (FHWA) is to improve bicycle and pedestrian safety by integrating the "4Es" of safety: engineering, education, enforcement, and emergency services. The FHWA plans to incorporate these "4Es" into bicycle and pedestrian plans by using a systematic, data-driven approach.

FHWA documented the following goals in 1994 National Bicycling and Walking Study (page 2):[7]

> "to double the percentage of total trips made by bicycling and walking in the United States from 7.9 to 15.8 percent of all travel trips; and to simultaneously reduce by 10 percent the number of bicyclists and pedestrians killed or injured in traffic crashes."

Most recently, the 2010 National Bicycling and Walking Study 15-Year Status Report stated:[8]

> "Though the reductions in pedestrian and bicyclist fatalities have met the goals set forth in the original study, there is always room for improvement in the area of safety (but) Creating environments that are safe for bicyclists and pedestrians of all abilities should continue to be a top priority. Though challenging in the short term, it is also important to improve the process for reporting and documenting pedestrian and bicyclist crashes and injuries."

Arizona Department of Transportation (ADOT)

In 2007, the Arizona Governor's Traffic Safety Advisory Council developed the Arizona Strategic Highway Safety Plan (SHSP), which identifies a vision and associated goals for

[7] http://www.hsrc.unc.edu/research_library/PDFs/The%20National%20Bicycling%20and%20Walking%20Study%20Title%20Page.pdf

[8] http://katana.hsrc.unc.edu/cms/downloads/15-year_report.pdf

reducing crashes in Arizona. The vision of the Arizona SHSP is "zero fatalities on Arizona roads, your life depends on it" (the Every One Counts vision).

The Every One Counts vision is supported by a state "stretch" goal designed to achieve clear progress towards the Every One Counts vision. The goal is to reduce the number of fatalities on Arizona's roadways by approximately 12 percent by the year 2012. The base year of comparison is 2007.

The SHSP selected a number of emphasis areas, and sub-goals and strategies were developed for each emphasis area.

1. Restraint Usage
2. Speeding
3. Young Drivers
4. Impaired Driving
5. Roadway/Roadside (lane departure and intersections)
6. Data Improvement

Although the SHSP emphasis areas did not focus explicitly on bicycle emphasis areas, the report stated that all areas of safety will have to be addressed to support a zero fatality vision. As each emphasis area involves many aspects of crashes, it is likely that addressing the selected emphasis areas will provide benefits in other areas of traffic safety, including bicyclists.

3.2 Bicycle Safety Action Plan Goal

Consistent with the safety goals established by the USDOT, FHWA, and Arizona, a BSAP goal is proposed:

Goal: Reduce the total number of bicycle crashes (fatalities and non-fatalities) on Arizona state highways by 12 percent by the year 2018.

Between 2004 and 2008, there were 1,086 bicycle crashes on state highways, equating to an average of 217 bicycle crashes on Arizona state highways each year. The reduction in bicycle crashes will be measured by a five-year average (2014 to 2018), with the years 2004 through 2008 acting as the base years. With a baseline of 217 crashes per year and a goal of 12-percent reduction, the target is a five-year average of 191 crashes per year, a decrease of 26 crashes per year.

3.3 Bicycle Safety Emphasis Areas

Bicycle Safety Action Plan Emphasis Areas are presented in **Table 9**. Selection of emphasis areas was data driven based on the analysis of motor vehicle-bicycle crash data and consideration of public input. The emphasis areas support the goal of reducing bicycle crashes by 12 percent by the year 2018.

Table 9 – Emphasis Areas to Improve Bicyclist Safety on the SHS

Emphasis Areas/Goal	Justification
Urban Areas: Reduce the number of bicycle crashes in urbanized and developed areas (large urbanized, small urbanized, and small urban).	The vast majority of focus area crashes occurred in urbanized areas. Crashes in rural areas represent a small percentage of crashes.
Signalized Intersections: Reduce crashes in which bicyclists or motorists failed to yield at signalized intersections.	20 percent of focus area crashes are attributable to bicyclists or motorists failing to yield at signalized intersections.
Unsignalized Intersections: Reduce crashes in which bicyclists or motorists failed to yield at unsignalized intersections.	14 percent of focus area crashes are attributable to bicyclists or motorists failing to yield at unsignalized (sign-controlled) intersections.
Right Turn Hook Crashes: Reduce bicycle crashes involving vehicles making a right turn.	51 percent of focus area crashes occurred while the motor vehicle was making a right turn. The vast majority of these crashes occurred in commercial areas.
Wrong Way Bicyclists: Reduce crashes in which bicyclists were riding facing traffic.	52 percent of focus area crashes occurred when bicyclists were facing traffic. Of these, 37 percent of crashes occurred while the motor vehicle was making a right turn.
Sidewalk Riding: Reduce crashes in which bicyclists were riding on the sidewalk.	32 percent of focus area crashes involved a bicyclist riding on the sidewalk. Of these, 21 percent of the crashes involved the driver making a right turn.
Dark Conditions: Reduce bicycle crashes that occurred in dawn, dusk, or dark conditions.	22 percent of focus area bicycle crashes occurred in dawn, dusk, or dark conditions.

4 COUNTERMEASURES TO IMPROVE BICYCLE SAFETY

SHS priority locations, presented in Section 2.4.2 and 2.4.3, were analyzed in more detail to identify potential countermeasures that could be considered at each location. The FHWA BIKESAFE Bicycle Crash Countermeasure Selection System was used to assist in the identification of potential countermeasures.

Potential countermeasures for each priority location are listed in Appendix B1. For each priority location, the following information is provided:

- Location ID
- Leading crash type descriptions (defined in Appendix B2)
- Probable contributing causes
- Menu of potential engineering countermeasures
- Education, enforcement, and encouragement countermeasures (EEE) recommended for further consideration

An example of the information presented in Appendix B1 is provided below.

Sample of SHS Priority Crash Locations Menu of Potential Countermeasures (as presented in Appendix B1)

Location No. ###

PRIORITY INTERSECTION Location No. 39b Tempe	**On Road**	**Intersecting Road**	**Total Crashes**
	Road A	Road B	##
Leading Crash Type Descriptions	1. Crash Type No. 1 2. Crash Type No. 2 3. Crash Type No. 3		
Probable Contributing Causes	1. Contributing Cause No. 1 2. Contributing Cause No. 2 3. Contributing Cause No. 3		
Potential Countermeasures	1. Potential Countermeasure No. 1 2. Potential Countermeasure No. 2 3. Potential Countermeasure No. 3		
Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**		
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
1.				
2.				

5 ACTION PLAN TO IMPROVE BICYCLIST SAFETY

This chapter proposes an action plan that may be undertaken by ADOT and partner agencies to improve bicyclist safety on Arizona's highways. The action plan consists of the following:

1. **Conduct road safety assessments (RSAs) for priority crash locations**
2. **Modify ADOT plans, policies, and guidelines**
3. **Install pavement markings or signage to discourage wrong-way bicycle riding**
4. **Develop and adopt an Arizona complete streets policy**
5. **Consider bicycles at single point urban interchanges (SPUIs)**
6. **Recommend modifications to Arizona crash report forms**
7. **Develop and implement a bicycle counting program for the SHS**
8. **Recommend enhancements to Arizona Driver License Manual and Customer Service Guide**
9. **Establish connectivity/alternative routes to SHS through local jurisdictions**
10. **Develop and implement bicyclist and motorist education campaigns**
11. **Collaborate with law enforcement**
12. **Recommend changes to Arizona Revised Statutes**
13. **Implement ADOT Access Management Plan**
14. **Implement a BSAP evaluation program**

5.1 Conduct Road Safety Assessments for Priority Crash Locations

A menu of potential countermeasures that may be considered at priority locations is presented in Appendix B1. The potential countermeasures were identified from among 50 engineering, education, and enforcement countermeasures contained in the FHWA BIKESAFE Bicycle Countermeasure Selection System.[9]

The menu of countermeasures is presented at a planning level, and is based on countermeasures that are proven to effectively reduce the crash types most frequently

[9] http://www.bicyclinginfo.org/bikesafe/

exhibited at the priority crash location. Examples of potential countermeasures to be considered at high crash locations include the following:

1. Curb radii reduction (to slow the speed of right-turning vehicles)
2. Sight distance improvement
3. Intersection signing and marking improvement
4. Bike lane or paved shoulder
5. Driveway improvement/access management
6. Intersection warning treatments (side path/roadway intersection)

A field review of each priority location was not conducted. The next step in countermeasure development and implementation is to assemble a multidisciplinary team of traffic engineers, roadway designers, and bicycle professionals to collaboratively review each location, discuss, and select those countermeasures most appropriate considering engineering opportunities and constraints.

The ADOT Road Safety Assessment (RSA) program may provide an appropriate forum to review priority crash locations and develop appropriate recommendations. The RSA program conducts Road Safety Assessments on state, local, and tribal road facilities. The ADOT RSA team accepts applications from interested agencies.

It is recommended that the ADOT Bicycle and Pedestrian Program collaborate with the ADOT RSA team to conduct RSAs for each priority location (19 segments and 15 intersections/interchanges). More information about the ADOT RSA program is available through the ADOT Traffic Safety Section.[10] The RSA team may employ RSA materials that are specific to bicycle infrastructure such as the Bicycle Road Safety Audit Guidelines and Prompt list, published by FHWA.[11]

Summary of Roles of Proposed Countermeasure: Conduct Road Safety Assessments for Priority Crash Locations
Bicyclists: • Not applicable
Motorists: • Not applicable
Engineers and Planners: • Conduct a Road Safety Assessment (RSA) for each priority crash location • Develop a program of improvements

[10] http://www.azdot.gov/highways/traffic/9620.asp
[11] http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa12018/

• Identify opportunities and funding for implementation
Law Enforcement: • Participate in RSA team

5.2 Modify ADOT Plans, Policies, and Guidelines

The US Department of Transportation (USDOT) reaffirmed their support for bicycle and pedestrian accommodation on March 15, 2010 (*United States Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations, March 15, 2010* (**emphasis added**).[12]

> "Transportation agencies should plan, fund, and implement improvements to their walking and bicycling networks, including linkages to transit. In addition, DOT encourages transportation agencies **to go beyond the minimum requirements**, and proactively provide convenient, safe, and context-sensitive facilities that **foster increased use by bicyclists** and pedestrians of all ages and abilities, and utilize universal design characteristics when appropriate. Transportation programs and facilities should accommodate people of all ages and abilities, including people too young to drive, people who cannot drive, and people who choose not to drive.

The USDOT/FHWA Policy Statement directs agencies to develop policy statements that affirm their commitment to improving conditions for bicycling and walking, and to go beyond minimum design standards in doing so.

> "The DOT encourages States, local governments, professional associations, community organizations, public transportation agencies, and other government agencies, **to adopt similar policy statements** on bicycle and pedestrian accommodation as an indication of their commitment to accommodating bicyclists and pedestrians as an integral element of the transportation system. In support of this commitment, transportation agencies and local **communities should go beyond minimum design standards** and requirements to create safe, attractive, sustainable, accessible, and convenient bicycling and walking networks. Such actions include:
>
> 1. Considering walking and bicycling **as equals with other transportation modes**: The primary goal of a transportation system is to safely and efficiently move people and goods. Walking and bicycling are efficient transportation modes for most short trips and, where convenient intermodal systems exist, these nonmotorized trips can easily be linked with transit to significantly increase trip distance. **Because of the benefits they provide,**

[12] http://www.dot.gov/affairs/2010/bicycle-ped.html

transportation agencies should give the same priority to walking and bicycling as is given to other transportation modes. Walking and bicycling should not be an afterthought in roadway design.

Arizona State Transportation Board Policies (revised January 4, 2011) also emphasize ADOT's commitment to accommodation of bicycles on the SHS.[13]

4: Multimodal Facilities Policy

2. It is the policy of the Board to facilitate and encourage the development and use of alternate transportation modes by (emphasis added):

   a) Reflecting the **integration** of all modes of transportation (e.g. motor vehicles, rail, air, **bicycle, pedestrian,** and other modes) in all phases of project planning and development.

   c) Directing ADOT to accommodate other modes where possible whenever constructing, revising, and/or improving a highway **by evaluating how pedestrian, bicycle**, transit improvements and inter-modal transfer facilities **can be incorporated in the design**.

7: Bicycle and Pedestrian Facilities Policy

1. It is the policy of the Board to **encourage bicycling and walking** as viable transportation modes, and actively work toward improving the transportation network so that these modes are accommodated, by:

   a) **Promoting increased use of bicycling and walking**, and accommodating bicycle and pedestrian needs in the planning, design and construction of transportation facilities alongside state highways.

   b) Developing design guidelines and measures that give the roadway designer flexibility in **accommodating the needs of all users** of the transportation facility.

   c) Developing design guideline implementation policies that **balance** the needs of **motorists, bicyclists and pedestrians**.

Potential modifications to ADOT policies, consistent with the above directives, are proposed in the following sections.

[13] http://www.azdot.gov/Board/PDF/Board_Policies_010411.pdf

5.2.1 ADOT Bicycle Policy

The ADOT Bicycle Policy, MGT 02-01[14] establishes uniform guidelines for accommodating bicycle travel on the SHS. The policy was updated in 2007, and specified a review date of 2010. The review has not been completed. The ADOT Bicycle Policy has provided significant benefits to bicyclists on the SHS; however, crash analysis conducted for the BSAP demonstrates that improvements to bicycling safety on the SHS are needed. Strengthening the ADOT Bicycle Policy can contribute to improved bicyclist safety on state highways.

It is suggested that an internal ADOT Work Group be established to review the ADOT Bicycle Policy, and to propose changes that reflect both ADOT State Transportation Board policies and recent FHWA policy statements as described above. In addition, the ADOT Bicycle Policy should be consistent with recommendations in the 2012 AASHTO Guide for the Development of Bicycle Facilities, 4th Edition.

Potential revisions to the ADOT Bicycle Policy, for consideration by the internal ADOT Work Group, are identified below. Potential additions to the Policy are in *italics;* deletions are in ~~strikethrough.~~

POLICY

1. It is ADOT's goal to develop a transportation infrastructure that provides safe and convenient bicycle access *that fosters increased usage by bicyclists*. ADOT further advocates that bicyclists have the right to operate in a legal manner on all roadways open to public travel, with the exception of fully controlled-access highways. Bicyclists may use fully controlled-access highways in Arizona except where specifically excluded by regulation and where posted signs give notice of a prohibition. In support of, and in accord with the foregoing, it is ADOT's policy to:

    a. *Go beyond minimum requirements to* include provisions for bicycle travel in all new major construction and major reconstruction projects on the state highway system. New bridge and roadway widening projects are normally considered as being within the scope of major construction or major reconstruction. *Bicycle accommodation will be considered in* pavement preservation, utility, and minor and spot improvement projects ~~are not included~~ *if the cost of accommodations is reasonable and feasible; at a minimum,* existing widths for bicycles will be maintained. The scoping documents for new construction and reconstruction will define the parameters for inclusion of bicycle travel.

    b. Utilize the AASHTO Guide for the Development of Bicycle Facilities as the design guide for roadway features to accommodate bicycles.

[14] http://www.azbikeped.org/images/MGT01-2%20Bike%20Policy.pdf

c. Utilize the Manual on Uniform Traffic Control Devices, Part 9 as adopted in accordance with ARS 28-641 for design of traffic controls for bicycle facilities.

~~d. Provide shared roadway cross section templates as a minimum condition with new major construction and major reconstruction projects, regardless of the presence of a shared use path.~~ [*Note: this paragraph is deleted because it is now addressed by bullet point 'e'*].

e. ~~Consider,~~ *Provide* as a part of major new construction and major reconstruction in urban areas, *a minimum 4-ft paved shoulder* ~~wide curb lanes up to 15' in width~~ (exclusive of gutter pan) and placement of a stripe at the vehicle lane edge where appropriate, *regardless of the presence of a shared use path*. ~~This decision will be made on a project basis weighing such factors as location, vehicular traffic, grades, anticipated bicycle usage, and right of way availability.~~

f. ~~Consider,~~ *Provide* bicycle lanes for inclusion with major new construction or major reconstruction when~~:1) incremental costs for construction and maintenance are funded by a local agency AND 2)~~ the bicycle lane is included as a part of a bicycle facilities plan adopted by a local agency, *regardless of the presence of a shared use path*.

g. As a part of major new construction and major reconstruction, ADOT will fund and construct at-grade or grade separated (including bridges) street or roadway crossings of state highway system roadways to meet cross section templates accommodating bicyclists that have been adopted as standard by the local agency. The limits of construction are determined on a project-by-project basis, are normally within the ADOT right of way, and may include appropriate transitions to existing roadways outside of ADOT right of way.

h. Accommodate shared use paths within the ADOT right of way when the facilities are: 1) designed and located in accordance with accepted criteria for a proper and safe facility AND 2) funded and properly maintained by the local agency.

i. Utilize the ADOT Traffic Engineering PGP # 1030 to designate route sections where bicycle traffic is prohibited on fully access-controlled State Highways.

j. Utilize the ADOT Traffic Engineering PGP # 480 for placement of longitudinal rumble strips on State Highways.

k. Use pavement surfacing materials that provide reasonably smooth surfaces on travel lanes and shoulders in conjunction with paving projects.

l. ~~Evaluate and consider the impacts of~~ *Accommodate* bicyclists when restriping roadways in conjunction with new construction, reconstruction, pavement preservation and minor spot improvement projects [*Note: Consider moving bullet point 'l' to immediately follow bullet point 'a' to emphasize bicycle improvements as part of minor project*].

m. Utilize Intergovernmental Agreements to define funding and maintenance responsibilities with local governments for bicycle facilities within State highway right-of-way.

2. It is ADOT's Policy not to: [*Note: as policy content is approved, consider rephrasing so that it contains positive statements, followed by a list of exceptions*]

   a. Reduce existing travel lane widths *on higher speed, free flowing, principal arterials* to accommodate bicycle traffic unless the *need is justified to allow provision for bicyclists, and* supported by a traffic study. *Travel lane widths may be considered for reduction to accommodate bicycles under interrupted-flow operating conditions at lower posted speeds (45 mph or less). Narrower lane widths on lower speed (45 mph or less) facilities are normally adequate and have some advantages.*[15] Concurrence by the State Traffic Engineer and the Assistant Engineer, Roadway Engineering Group are required.

   b. Sign or designate bikeways on any roadways on the State Highway System or roads on State owned right of way without concurrence of the District Engineer and State Bicycle Coordinator.

   c. Sign or designate sidewalks as bicycle routes or bikeways.

   d. Use ~~t~~*T*ransportation ~~enhancement~~ *Alternative* funds for maintenance of bicycle facilities.

   e. Mark or sign sidewalks or shared-use paths on State right of way parallel and adjacent to roadways for the preferential or exclusive use of bicyclists per ADOT Traffic Engineering PGP # 1031.

3. It is ADOT's policy to require written approval from the State Traffic Engineer and the Assistant State Engineer, Roadway Engineering Group in consultation with the State Bicycle Coordinator for any variations or exceptions to this policy.

5.2.2 ADOT Roadway Design Guidelines

Modifications to ADOT, Roadway Engineering Group,[16] Roadway Design Guidelines may be considered to improve the routine accommodation of bicycles on the State Highway System. Potential modifications are listed below. Additions are indicated in *italics*; deletions are shown in ~~strikethrough~~.

[15] The Florida Department of Transportation allows travel lanes to be narrowed to 11 feet on the state highway system regardless of speed if the purpose is to accommodate a bicycle facility. Travel lanes can be narrowed to 10 feet if the design speed is 35 miles per hour. Refer to FDOT Plans Preparation Manual, Volume I, Chapter 25.4.5; accessible at: http://www.dot.state.fl.us/rddesign/PPMManual/2012/Volume1/Chap25.pdf.

[16] http://www.azdot.gov/Highways/Roadway_Engineering/Roadway_Design/index.asp

209.1 – Climbing Lanes, paragraph 7

Also see the design memorandum entitled "A Policy on the Design of Passing Lanes and Climbing Lanes" on the Roadway Design website~~. If bicyclists are utilizing the facility, a~~ *A* minimum shoulder width of 4 ft *or more* should be provided *to accommodate bicyclists*.

209.2 – Passing Lanes, paragraph 8

For adding passing lanes to existing roadways, see the design memorandum entitled "A Policy on the Design of Passing Lanes and Climbing Lanes" on the Roadway Design website. ~~If bicyclists are utilizing the facility, a~~ *A* minimum shoulder width of 4 ft *or more* should be provided *to accommodate bicyclists.*

302.4 – Shoulder Width

The shoulder width given in Table 302.4 shall be the minimum continuous usable width of paved shoulder.

Within Table 302.4, Paved Shoulder Width, Paved Shoulder Width (ft) (In Direction of Travel), Right, change widths specified for Urban multi-lane divided, Urban multi-lane undivided, Acceleration lanes, and Frontage roads (2-lane) from 4-ft to 6-ft.

306.4 – Urban Cross Sections, paragraph 3:

A) Urban Section UA*:* This section should be used on highways for the initial construction to four lanes. This section is normally used as the urban extension of a divided rural or fringe-urban highway. Use of this section should be based, in part, on a consideration of the access requirements of adjacent properties. The section may not be appropriate for areas of heavy strip development. ~~On a project-by-project basis,~~ *Provide a minimum 4-ft paved shoulder,* exclusive of curb and gutter, ~~may be considered~~ *and place a stripe at the vehicle edge line.* to accommodate bicycle usage. ~~Factors to be considered include location, vehicular traffic, grades, anticipated bicycle usage, and right of way availability.~~

B) Urban Section UB: This section should be used where an existing four-lane undivided highway is being widened or where existing strip development requires the continuous two-way left-turn lane. ~~On a project-by-~~project basis, *Provide a minimum 4-ft paved shoulder* ~~a 15 ft outside lane~~, exclusive of curb and gutter, ~~may be considered~~ to accommodate bicycle usage ~~when weighing the factors listed in Section UA~~.

E) Non-Standard Sections: The following sections can be utilized on a very limited and restricted basis, subject to specific prior approval of the Assistant State Engineer, Roadway Engineering Group. The approval is required prior to development of the Final Project Assessment or Final Design Concept Report.

Included are:

- Three lanes. Use of a three-lane section is restricted to local traffic or non-through routes; i.e., routes with little or no external through traffic, which have

very restrictive existing right-of-way. Further, the section is limited to application in small urban areas, and where implementation will constitute final, ultimate construction. The roadway will be 44 ft wide with two 12-ft through lanes, a 12-ft turn lane, and 4-ft non-curbed shoulders on each side. With curb and gutter, a 4-ft paved shoulder ~~14-ft wide outside lane~~ exclusive of curb and gutter is acceptable to accommodate bicycle traffic.

408.11 – Right Turn Channelization**,** paragraph 13
D) Bicycle Buffer: ~~Where bicycles are expected to be prevalent, a~~ *A* buffer area between the through lane and the right-turn lane should be provided. Figure 408.11A shows the bicycle buffer with a wide curb lane. The buffer area is formed by the extension of the through lane and the face of curb line. Figure 408.11B shows the bicycle buffer for non-curb and gutter sections. ~~The buffer may be omitted where bicycle traffic or right-turn traffic is expected to be infrequent.~~

5.2.3 ADOT Safety Action Plan, Arizona Strategic Highway Safety Plan, and FHWA Oversight Agreement

ADOT Safety Action Plan (ASAP)

The ASAP (2009) provides suggestions to enhance ADOT's focus on its road safety goals and to empower the agency to take a leadership role in addressing safety issues throughout the state of Arizona. The ASAP was developed based on more than 30 interviews with ADOT staff in the Intermodal Transportation Division, Multimodal Planning Division, Motor Vehicle Division, and other divisions, as well as safety staff from related agencies.

The ASAP identified bicycles as an important safety consideration in the following recommendation (ASAP, page 2-9):

Progress would be maximized by encouraging staff to go "above and beyond" traditional engineering practices. Crashes have many factors, which must be considered in developing safety countermeasures, including:

- Demographic factors: e.g., young, old, ethnic groups
- Behaviors: e.g., impairment, fatigue, use of occupant protection
- Crash types: e.g., roadway departure, intersection, multi-vehicle, single vehicle, vehicle type
- Modes: e.g., passenger car, pedestrian, bicycle, heavy truck, motorcycle

It is recommended that future updates to the ASAP be coordinated with findings of the ADOT BSAP. Bicyclist safety can be incorporated throughout the ASAP. Potential considerations include:

- Incorporate bicycle fatalities and injuries into the "Safety Dash Board"

- Include bicycle representation in the proposed ADOT Safety Management Team
- Include bicycle safety considerations in the project scoping of all projects

Arizona Strategic Highway Safety Plan (SHSP)

The Arizona Strategic Highway Safety Plan[17] was completed in 2007. While bicycles are not specifically identified as an emphasis area of the SHSP, the SHSP addresses bicycling through the following:

- Bicycle safety is addressed through multiple emphasis areas, including:

- Selection of lane departure fatalities and intersection fatalities would also address 46 percent of Arizona's bicycle fatalities and serious injuries (page 19).
  - An Intersection Strategy and Countermeasure is to improve the operation of pedestrian and bicycle facilities and promote the implementation of the Statewide Pedestrian Safety Action Plan (pages 93-94). The SHSP recommends that bicycle and pedestrian facilities be improved at intersections with high numbers of pedestrian and bicycle fatalities.

Findings of the BSAP may be considered during the next update of the SHSP.

FHWA and ADOT Stewardship and Oversight Agreement for Arizona

The FHWA and ADOT Stewardship and Oversight Agreement for Arizona (March 2010)[18] includes performance measures associated with the performance of the Federal Aid Highway Program in Arizona. These performance measures are developed, reassessed, and/or revised as necessary on an annual basis. The Agreement currently includes performance measures for pedestrian safety, including the number of pedestrian fatalities (current year + four-year history), and the number of SHS pedestrian fatalities (current year + four-year history).

It is recommended that bicycle safety performance measures be considered for inclusion in the Oversight Agreement:

- Number of statewide bicyclist fatalities (current year + 4 year history).
- Number of SHS bicyclist fatalities (current year + 4 year history).

Inclusion of bicycle safety data in the Oversight Agreement will demonstrate bicycle safety trends both statewide and on the SHS.

[17] http://www.azdot.gov/highways/traffic/9620.asp
[18] http://www.fhwa.dot.gov/azdiv/stewtoc.htm

Summary of Roles of Proposed Countermeasure: Modify ADOT Plans, Policies, and Guidelines
Bicyclists: • Not applicable
Motorists: • Not applicable
Engineers and Planners: • Review ADOT Bicycle Policy and Roadway Design Guidelines • Incorporate language into ADOT Bicycle Policy and Roadway Design Guidelines to strengthen the accommodation of bicycling on state highways, consistent with USDOT Policy Statement • Consider bicycles in updates to the ASAP, SHSP, and FHWA and ADOT Stewardship and Oversight Agreement
Law Enforcement: • Not applicable

5.3 Install Pavement Markings or Signage to Discourage Wrong-Way Bicycle Riding

Wrong-way bicycle riding was identified as a common contributing factor to motor vehicle-bicycle crashes.

Potential countermeasures to reduce wrong-way bicycle riding, during which the bicyclist is riding while facing traffic, include pavement markings and signage.

Currently, ADOT Bicycle Policy is not to mark shoulders as bicycle lanes unless funded by the local agency and with concurrence of the District Engineer. It is suggested that ADOT allow pavement markings and/or signage in or adjacent to shoulders that meet minimum widths for bike lanes (based on AASHTO's *Guide for the Development of Bicycle Facilities*), particularly those located at BSAP priority locations. These pavement markings and/or signage would help indicate the appropriate direction of travel for bicyclists.

Potential signing and marking alternatives include:

- Install a bicycle lane symbol with a directional arrow. Ideally, a directional arrow would be placed at the beginning and end of each block. Currently, ADOT policy does not allow for the signing and marking of shoulders as bicycle lanes unless funded and maintained by local agencies. This option would require modification of ADOT Bicycle Policy, ADOT Roadway Design Guidelines, and ADOT Traffic Engineering Policies, Guidelines and Procedures (PGP), to allow pavement markings to be placed in wide shoulders.
- Install "Bicycle Wrong Way" (Section 9B.07, R5-1b) and 'Ride with Traffic" (R9-3cP) signs, consistent with the MUTCD.

Summary of Roles of Proposed Countermeasure: Install Pavement Markings or Signage to Discourage Wrong-Way Bicycle Riding
Bicyclists: • Follow laws and safe practices by riding with traffic
Motorists: • Not applicable
Engineers and Planners: • Review ADOT Bicycle Policy, Roadway Design Guidelines, and Traffic Engineering PGP • Install "Bicycle Wrong Way, Ride With Traffic" signs on state highway segments that exhibit a high degree of wrong-way bicycle riding crash types • Develop a plan to obtain ADOT approval to install bicycle lane pavement markings on wide shoulders
Law Enforcement: • Enforce wrong-way bicycling riding on the roadway

5.4 Develop and Adopt Arizona Complete Streets Policy

State highways often serve as a "Main Street" in many of Arizona's urbanized rural communities. These state highways serve multiple users, including vehicles, pedestrians, and bicyclists; however, many state highways through rural urbanized areas are designed primarily for motor vehicles. Improving state highways to accommodate all users is essential to improving bicyclist safety. Roadways that serve all users are often referred to as "Complete Streets."

It is recommended that ADOT develop and implement a Complete Streets Policy that addresses accommodation of all roadway users on state highways, particularly through urbanized rural communities and the crossing of relatively wide state highways including interchanges and large intersections.

An ADOT Complete Streets Policy may include language similar to the following:

The State Department of Transportation shall provide for the needs of drivers, public transportation vehicles and patrons, bicyclists, and pedestrians of all ages and abilities in all planning, programming, design, construction, reconstruction, retrofit, operations, and maintenance activities and products. The Department shall view all transportation improvements as opportunities to improve safety, access, and mobility for all travelers in Arizona and recognizes bicycle, pedestrian, and transit modes as integral elements of the transportation system.[19]

It is recommended that an ADOT Complete Streets Policy consider the following:[20]

- Direct roadways to be designed and operated to be safe and accessible for all users, including: bicyclists, pedestrians, transit users, and motorists of all ages and abilities, including children, youth, families, older adults, and individuals with disabilities.
- Apply to all state highways, recognizing that roadway design should be appropriate to the function and context of the facility, and should be sensitive to the surrounding land use and community character (e.g., rural, suburban, or urban context). The policy should recognize that complete streets elements will differ in rural and urban areas.
- Recognize the local context and that the needs vary in urban, suburban, and rural settings. The policy could specifically define applicability limits (e.g., within one mile of an urban area).
- Be applicable in almost all transportation projects and phases, including any construction, reconstruction, retrofit, maintenance, alteration, or repair of streets, bridges, or other portions of the transportation network.
- Recognize that there is no requirement to immediately retrofit (this serves to alleviate concerns that a policy would mandate immediate retrofits on all existing roads).
- Include minimal number of exceptions. Example exceptions are where non-motorized users are prohibited, or there is an irrefutable absence of present and future need, or the project places “excessive” or “disproportionate” costs compared to need or probable use.

[19] www.completestreets.org
[20] http://www.completestreets.org/changing-policy/model-policy/

> Exceptions should be rare, documented and publicly available, and approved at a high level.

According to the National Complete Streets Coalition, as of May 2012, 26 states have adopted some form of state-level Complete Streets policy (legislation, design guidelines, executive order, and/or internal policy) aimed at converting street networks into complete streets. "Complete Streets Policy Analysis 2010: A Story of Growing Strength," stated:

> "States have a leadership role to play in providing guidance on Complete Streets. Localities look to the state to provide examples of policy language, but also how to effectively create Complete Streets. Outreach from the New Jersey and Wisconsin DOTs [has] helped not only their district departments, but also locals, understand the more technical and process details to Complete Streets."

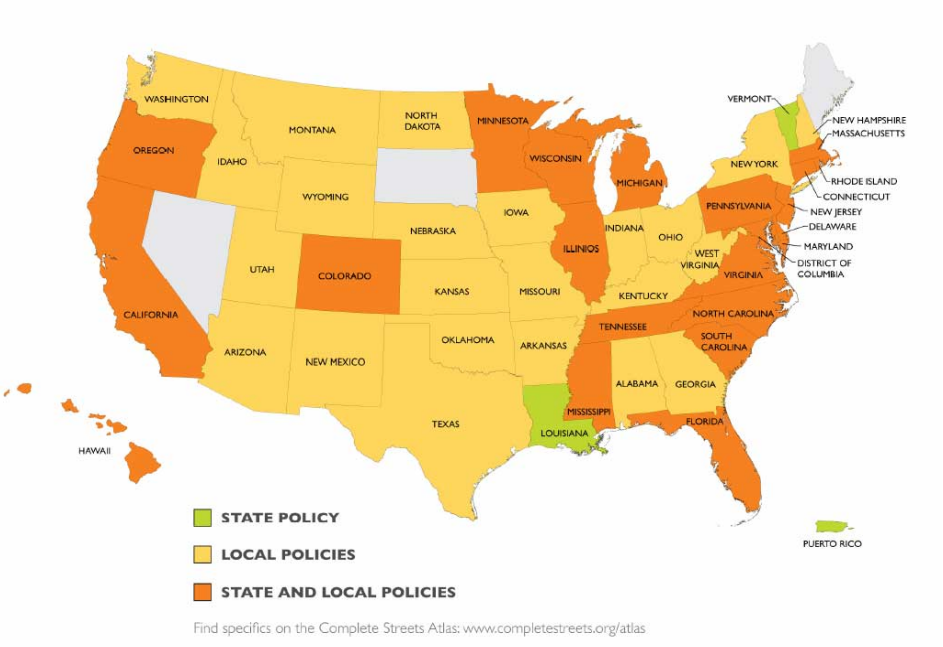
The status of Complete Streets adoption throughout the United States is shown in **Figure 29**. In total, 352 regional and local jurisdictions, 26 states, the Commonwealth of Puerto Rico, and the District of Columbia have adopted policies or have made written commitment to do so.

The State of California adopted state legislation and developed an internal DOT policy through California Department of Transportation (Caltrans) Deputy Directive Number DD-64-R1, entitled "Complete Streets - Integrating the Transportation System." [21] The internal policy provides a policy statement, definitions/background, responsibilities regarding implementing complete streets, and an applicability statement. Caltrans followed up by developing a guide for Complete Intersections.[22]

Within Arizona, the Maricopa Association of Governments recently developed the MAG Complete Streets Design Guide. The City of Scottsdale is the only Arizona jurisdiction with a Complete Streets policy.

[21] http://www.dot.ca.gov/hq/tpp/offices/ocp/complete_streets.html

[22] http://www.dot.ca.gov/hq/traffops/survey/pedestrian/



Source: http://www.completestreets.org/webdocs/resources/cs-policyanalysis.pdf

Figure 29 – Nationwide Status of Complete Streets Policy Development

Summary of Roles of Proposed Countermeasure: Develop and Adopt a Complete Streets Policy
Bicyclists: Not applicable
Motorists: Not applicable
Engineers and Planners: • Develop an internal DOT policy that would be approved/signed by ADOT State Engineer
Law Enforcement: Not applicable

5.5 Consider Bicycles at Single Point Urban Interchanges (SPUIs)

The BSAP identified that a significant number of motor vehicle-bicycle crashes occur at interchanges.

Interchanges can present many challenges for bicyclists. Ramp angles and design speeds encourage drivers to primarily focus on vehicular traffic and provide insufficient attention to bicyclists and pedestrians. Turning roadways for on-ramps and off-ramps require roadway markings and signage for bicyclists and pedestrians to be frequently discontinuous through interchange areas. As stated in the AASHTO Guide for the Development of Bicycle Facilities (1999):

"Turning roadways provided for interchange ramp ingress and egress often require bicyclists on the cross street to perform merging, weaving, or crossing maneuvers with ramp vehicles. These conflict points are made challenging when a wide disparity exists between traffic on the ramp and cross street bicycle traffic crossing the ramp…. If a bike lane or route must traverse an interchange area, these intersections or conflict points should be designed to limit the conflict areas or to eliminate unnecessary uncontrolled ramp connections to urban roadways."

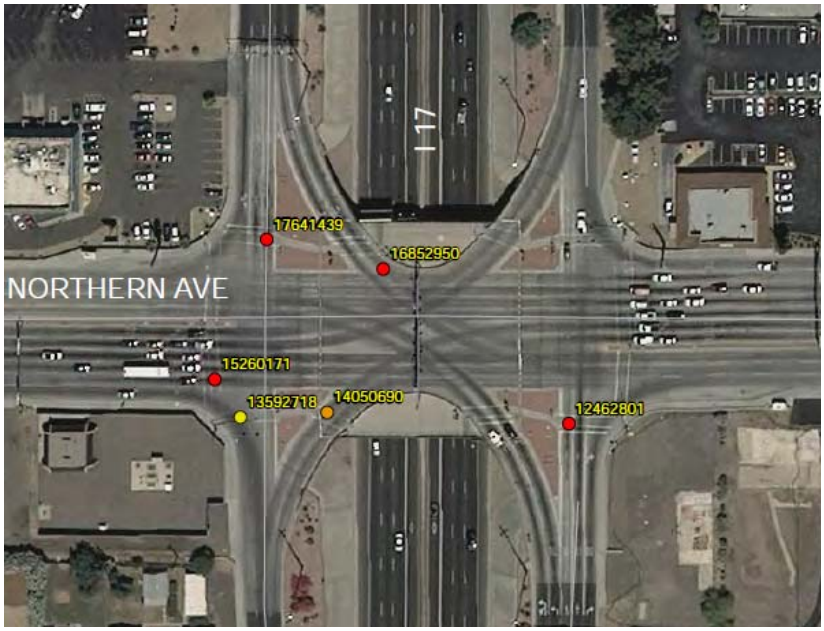


Figure 30 – Example of SPUI Design on I-17 at Northern Avenue

Interchanges can better accommodate bicycles by constructing ramp angles at 90 degree/right angles, designing exit ramps for low-speed ramp-cross street intersections, limiting free flow right-turn lanes to one lane, and continuing cross-street shoulder widths through the interchange area.

Six of the 16 high priority intersection/interchange locations are single point urban interchanges (SPUI). An example of a SPUI (I-17 and Northern Avenue) is shown in **Figure 30**. SPUIs are similar to diamond interchanges except that in a SPUI, the two intersections of a diamond interchange are combined into a single intersection, allowing opposing left-turn movements. SPUIs can provide improved operations and reduced right-of-way requirements compared to other interchange forms; however, their design can be challenging for bicyclists due to a number of considerations, including:

- Due to the large intersection area, bicyclists may need more green and all-red clearance time before opposing traffic proceeds
- The presence of bicycles, due to their slower speeds, may reduce the capacity of the SPUI, thereby negating the benefits of the SPUI over other design alternatives

A number of states have adopted SPUI guidelines that consider bicyclists. For example, Caltrans has developed guidelines to better accommodate bicyclists, as described in a Memorandum dated June 15, 2001, entitled, "Single Point Interchange Planning, Design, and Operations Guidelines." Caltrans refers to SPUIs as Single Point Interchanges (SPI).

An example of a bicycle-friendly SPUI design is shown in **Figure 31**, which is from the Oregon Department of Transportation, Statewide Bicycle and Pedestrian Plan Update. ODOT provides the following guidance regarding SPUI designs to make them more accessible for bicyclists and pedestrians:[23]

> "The Single Point Urban Interchange…can be made accessible to pedestrians and bicyclists by following these principles:
>
> - Each vehicular movement should be clearly defined and controlled
> - Exit and entry ramps should be designed at close to right angles
> - Pedestrian crossings should be visible and easily identifiable
> - Pedestrians should not be required to cross more than one or two lanes at a time
> - Bicyclists should be able to proceed through the intersection in a straight line
> - Motor vehicles merging to and from freeway on/off ramps should be required to yield to through cyclists

The SPUI works reasonably well for pedestrians and bicyclists if the intersection is that of a local thoroughfare and a freeway; pedestrian and bicyclists need to be accommodated only on the cross-street, not the freeway. If a SPUI is used for the grade-separated intersection of two surface streets, which accommodate pedestrians and cyclists, then the SPUI design is not effective, as pedestrians and cyclists on one of the streets will be in a freeway-like environment, with free-flowing exiting and merging ramps."

[23] http://cms.oregon.gov/ODOT/HWY/BIKEPED/pages/planproc.aspx

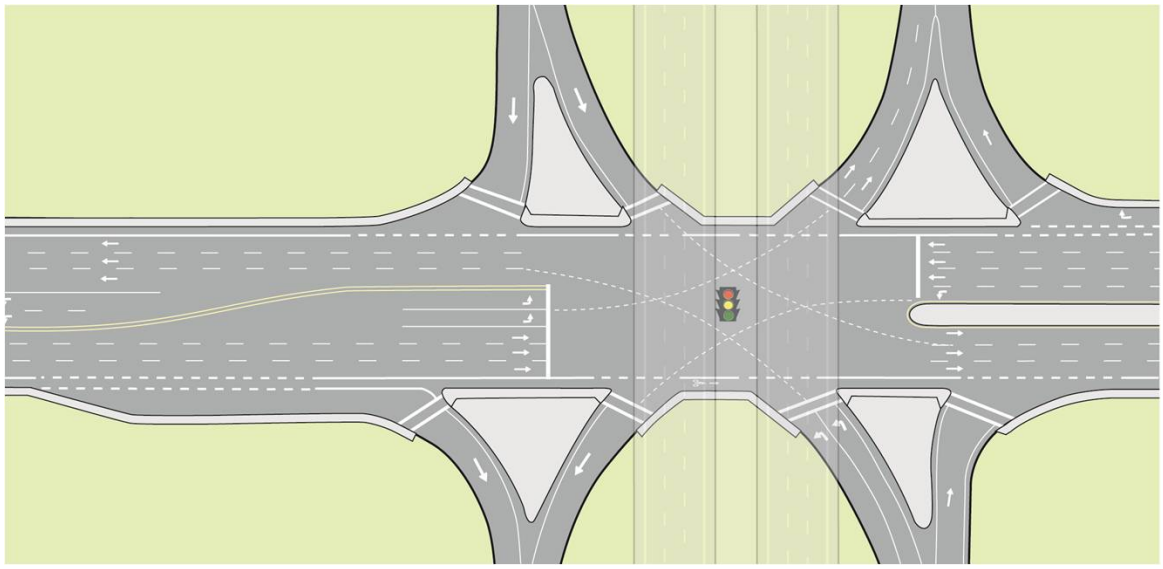


Figure 31 – State of Oregon Bicycle-Friendly SPUI Design

Source: Oregon Department of Transportation

Summary of Roles of Proposed Countermeasure: Consider Bicycle Accommodation at Interchanges
Bicyclists: • Be particularly alert when crossing through interchanges
Motorists: • Be alert for bicycles at interchanges and intersections
Engineers and Planners: • Design interchanges to accommodate bicycles
Law Enforcement: • Not applicable

5.6 Recommend Modifications to Arizona Crash Report Form

The analysis of bicycle crashes, as documented in Chapter 2, employed the Pedestrian Bicycle Crash Analysis Tool (PBCAT). The use of PBCAT enabled the study team to identify a crash type for each motor vehicle-bicycle crash. However, the PBCAT analysis required compilation of data beyond that available in the Arizona Crash Report. In many cases, the data was readily available through roadway inventory databases. In

other cases, the data was not readily available and ideally would have been provided by the police officer at the time of the crash.

The Arizona Crash Report form was updated in 2009; however, the new format was not in use during the BSAP analysis period, which analyzed crashes that occurred between 2004 and 2008. While the 2009 Arizona Crash Report form represents a significant improvement over its predecessor, additional enhancements to the form with respect to bicycle crashes would allow improved analysis of bicycle crashes.

It is suggested that the Arizona Crash Report form be thoroughly reviewed to identify modifications and enhancements to improve data collection regarding bicycles. Our review of the Arizona Crash Report form identifies that the data items described in **Table 10** could be included or enhanced in the Arizona Crash Report form.

Perhaps as important as new data items is emphasizing the importance of comprehensively completing the existing data fields in the Arizona Crash Report form. The BSAP crash analysis demonstrated that many of the data fields were left incomplete, particularly as they related to the bicyclist.

Summary of Roles of Proposed Countermeasure: Recommend Modifications to the Arizona Crash Report Form
Bicyclists: • Not applicable
Motorists: • Not applicable
Engineers and Planners: • Develop a process to modify the Arizona Crash Report Form to include additional modifications and enhancements when reporting crashes involving bicycles.
Law Enforcement: • Comprehensively complete the existing data fields in the Arizona Crash Report form. When bicyclists are involved, include additional details as appropriate in the narrative.

Table 10 – Potential Modifications to Arizona Crash Report Form

Arizona Crash Report Data Item	Data Description	Discussion	Recommendation for Arizona Crash Report
4dd	Safety Devices	The current definition in the Crash Report form states that "helmet used…is not used for non-motorists such as bicycle and other pedal cycle riders and vehicle occupants other than motorized cycles." The Model Minimum Uniform Crash Criteria, Third Edition (2008) (MMUCC) recommends including a non-motorist Safety Equipment (e.g., helmets, lighting, etc.) data field to evaluate the effectiveness of non-motorist safety equipment, and to calculate usage statistics to inform development and evaluation of educational countermeasures.	• Include a new data item representing non-motorized safety equipment (helmet, lighting, reflective clothing, etc.) • Alternatively, a pedalcycle / bicycle supplement could be developed similar to supplements for fatal crash, truck/bus, and occupants (10 or more)
23	Traffic Unit Maneuver/Action • 17: Crossing Road	Data item title does not emphasize to the reporting police officer that this data item also applies to bicyclists	Change data item title to: 17: Crossing Road: Pedestrian Only
	Traffic Unit Maneuver/Action • 18: Walking With Traffic	Data item title does not emphasize to the reporting police officer that this data item also applies to bicyclists	Change data item title to "Non-Motorist Walking/Riding With Traffic"
	Traffic Unit Maneuver/Action • 19: Walking Against Traffic	Data item title does not emphasize to the reporting police officer that this data item also applies to bicyclists	Change data item title to "Non-Motorist Walking/Riding Against Traffic"
-	Presence/Type of Bicycle Facility	This data is currently not collected in the Arizona Crash Report Form. This data item is recommended in the MMUCC, which states that this data is needed to: • Determine usage and safety of bicycle facilities.	Add data field for presence/type of bicycle facility. MMUCC defines this data item as: Any road, path, or way which is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

Table 10 – Potential Modifications to Arizona Crash Report Form (continued)

Arizona Crash Report Data Item	Data Description	Discussion	Recommendation for Arizona Crash Report
-	Presence/Type of Bicycle Facility (continued)	• Determine the location of bicycle crashes in relation to a bicycle facility. This data is important for ascertaining the relative safety performance of various types/classes of bike paths to guide future design/operation decisions (MMUCC)	Subfields include: 1) Facility: None, Wide Curb Lane, Marked Bicycle Lane, Unmarked Paved Shoulder, Separate Bicycle Path/Trail, Unknown 2) Signed Bicycle Route: Yes, No, Unknown, Not Applicable
-	Widths of Lane(s) and Shoulder(s)	This data is currently not collected in the Arizona Crash Report Form. This data item is recommended in the MMUCC, which states that it is important to monitor the association of lane/shoulder widths and the frequency of crashes.	Add data field for widths of the lane(s) and shoulder(s). MMUCC defines this data item as: Widths (in feet) of the lane(s) and of the shoulder(s) where crash occurred. Data attributes would include the width of the lane(s) and of the shoulder(s) at the location of the crash. Suggested data fields are: • Lane Width • Right Shoulder Width • Left Shoulder Width
-	Adjacent development type	Functional class of the roadway is recommended in the MMUCC, to be added through linking of the crash data with the roadway inventory data. The MMUCC states that "knowledge of land use is needed in analyzing crashes as part of a network analysis."	Add data field to describe adjacent land uses. Suggested data fields are: Residential, commercial, industrial, retail, recreational, mixed use, other, unknown.
-	Mainline number of lanes at intersection	This data item is recommended in the MMUCC in order to accurately describe the intersection, and to identify associations of crashes with roadway/intersection width.	The MMUCC defines this data field as: Number of through lanes on the mainline approaches of an intersection, including all lanes with through movement (through and left-turn, or through and right-turn) but not exclusive turn lanes.

5.7 Develop and Implement a Bicycle Counting Program

The USDOT Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations, March 15, 2010 [24] includes the following:

"Recommended Actions…should include (emphasis added):

- **Collecting data on walking and biking trips**: The best way to improve transportation networks for any mode is to collect and analyze trip data to optimize investments.…This data gap can be overcome by establishing routine collection of nonmotorized trip information. Communities that routinely collect walking and bicycling data are able to track trends and prioritize investments to ensure the success of new facilities.
- **Setting mode share targets for walking and bicycling and tracking them over time**: A byproduct of improved data collection is that communities can establish targets for increasing the percentage of trips made by walking and bicycling"

Similar to most states, agencies, and jurisdictions, ADOT lacks a program to routinely collect bicycle and pedestrian count data. Development of a bicycle counting program can provide meaningful data to ADOT to be used to track trends and to prioritize investments on state highways. A bicycle counting program may utilize automatic bicycle counters. Automatic bicycle counters can provide counts of bicyclists in high crash segment locations and can provide support for expenditures on new bicycle facilities and bicycle policies. Bicycle counters at high crash locations will provide information to compute an exposure rate. Currently, an automatic bicycle counter is being tested on SR 179 near Sedona, Arizona. Consideration should be given to expanding the bicycle counters to BSAP high-priority segments to assist in determining exposure rates for bicyclists. A bicycle count program could include a data collection schedule, prioritization of locations, evaluation of information, and how the information can be used.

[24] http://www.dot.gov/affairs/2010/bicycle-ped.html

Summary of Roles of Proposed Countermeasure: Develop and Implement a Bicycle Counting Program for the SHS
Bicyclists: • Not applicable
Motorists: • Not applicable
Engineers and Planners: • Develop a bicycle counting program to measure ridership on the SHS, and in particular on BSAP high-priority segments.
Law Enforcement: • Not applicable

5.8 Recommend Enhancements to Arizona Driver License Manual and Customer Service Guide

In the web-based survey conducted for the BSAP, multiple survey respondents cited a need for increased public knowledge regarding bicycle laws in Arizona and bicyclists' rights on state highways. This is confirmed through the crash analysis, which demonstrated that both motorists and bicyclists frequently exhibit unsafe behaviors that are correctable through education.

Two actions are recommended:

1. Collaborate with Motor Vehicle Division (MVD) to include additional mandatory questions on the Arizona Driver License test regarding bicyclist laws and bicyclist rights. The driver's license test should include a question on the minimum safe distance when passing a bicycle traveling in the same direction. A limitation in using the driver's license test as an education mechanism is that Arizona drivers' licenses expire on the 65th birthday; as such, drivers rarely are required to take a test. Other mechanisms, such as defensive driver training or traffic safety diversion programs should be utilized.
2. Collaborate with MVD to revise the *Arizona Driver License Manual and Customer Service Guide* to emphasize bicycle safety.

Table 11 shows suggested revisions or enhancements to the *Arizona Driver License Manual and Customer Service Guide* published by the ADOT MVD.

Table 11 – Potential Modifications to Arizona Driver License Manual (March 2012)

MVD License Manual (March 2012)	Current Text	Suggested Revision or Enhancement
Page 25 – Positioning Vehicle-Cushion of Space Around Your Vehicle	When sharing a lane with a bicycle, allow at least 3 feet for clearance between you and the bicycle. Moderate your speed. At high speeds, your vehicle may cause a gust of wind that could knock the bicyclist to the ground. Be alert for the bicycle swerving.	Add illustration of three foot clearance to emphasize.
Page 28 – Roundabouts	Always yield to pedestrians and bicyclists that are crossing the road. Bicyclists – Be aware of traffic rules or walk your bike and use the crosswalks.	Add depictions of cars yielding for bicyclists and pedestrians in the roundabout.
Page 44 – Right Turns- Right on red	Always yield the right-of-way to pedestrians, bicyclists and of course, oncoming traffic. Unless signs direct you otherwise, turn into the right lane of the road you enter.	Provide an illustration showing potential conflicts regarding bicyclists.
Page 46 – Sharing the Road with a Bike	Bicyclists must obey the same traffic laws as drivers of vehicles, and they have the right-of-way under the same conditions as motorists. Motorists should be alert for bicyclists along the roadway because cyclists are often difficult to see. Extra caution is necessary. Motorists are required to allow a minimum safe distance of 3 feet when passing a bicycle traveling in the same direction. At night, you should dim your headlights for bicyclists. Drivers should be prepared for a bicyclist swerving. Although bicyclists must ride with the flow of traffic and stay near the right side of the road, they can legally move left for several reasons, such as: • Turning left. • Avoiding hazards. • Passing pedestrians or vehicles. • If the lane in which the person is operating a bicycle is too narrow for a bicycle and motor vehicle to travel safely side-by-side.	Add a graphic depicting the 3-foot rule to emphasize it. Highlight the 3-foot rule in text, and place it in a separate paragraph. Add text to fourth bullet to read: • If the lane in which the person is operating a bicycle is too narrow for a bicycle and motor vehicle to travel safely side-by-side. In this case, the bicyclist may use as much of the lane as needed to discourage unsafe passing.

Table 11 – Potential Modifications to Arizona Driver License Manual (March 2012) (continued)

MVD License Manual (March 2012)	Current Text	Suggested Revision or Enhancement
Page 46 – Sharing the Road with a Bike (continued)	Important rules for bicyclists: • Do not carry more persons than the design of the bicycle permits. • Do not ride more than two side-by side. • Ride as near to the right side of the road as possible. • Use proper hand signals. • Do not bicycle under the influence of drugs or alcohol — it is illegal. • When riding at night, have a white head lamp visible from 500 feet, and a rear reflector.	• Ride ~~as near to the right side of the road as possible~~ Ride on the right side of the roadway in the same direction as other traffic. (Note: This is a much more important safety message and directly addresses the #1 safety risk - wrong-way bicycling. This also avoids having to list the exceptions noted above, which would be needed if the text refers to "as far to the right as practical" {NEVER "as far as possible"!}) For more information and tips on bicycling on Arizona roads and streets, see "Arizona Bicycling Street Smarts", at http://www.azbikeped.org/azbss.htm
Page 65 –Test Questions	11. What are the rights of a person riding a bicycle in the street?	Add questions – Question: When passing a bicycle traveling in the same direction, what is the minimum legal passing distance between the motorist and the bicyclist? Answer: not less than 3 feet Question: Although bicyclists must ride with the flow of traffic and as close as practicable to the right-hand curb or edge of the roadway, in which situations can they legally move left? Answers: a. When turning left b. To avoid a hazard c. If the lane in which the person is operating a bicycle is too narrow for a bicycle and a vehicle to travel safety side by side within the lane. d. All of the above.

Summary of Roles of Proposed Countermeasure: Recommend Enhancements and Revisions to Arizona Driver License Manual and Exam
Bicyclists: • Not applicable
Motorists: • Not applicable
Engineers and Planners: • Collaborate with MVD to modify the Driver License Manual and Exam, to particularly reflect Arizona's 3-foot law.
Law Enforcement: • Collaborate with MVD to modify the Driver License Manual and Exam to reflect Arizona's 3-foot law.

5.9 Establish Connectivity and Alternative Routes to State Highways through Local Jurisdictions

Bicyclists do not stop riding at jurisdictional boundaries, nor when ownership of a road changes from a city to ADOT. However, in many cases on Arizona's highways, discontinuities exist in the bicycling network as a result of roadway ownership boundaries, including discontinuation of bicycle lanes or narrowing of wide shoulders upon entering ADOT right-of-way. Furthermore, many Arizona state highways, as they are designed for high-speed motor vehicle traffic, are uncomfortable facilities for bicyclists, even when the state highway passes through the center of town and serves more of a "main street" role than a state highway role.

While it is recommended that ADOT continue to improve accommodation of bicyclists on state highways, it is suggested that local cities and towns also develop bicycle alternatives to the state highway; for example:

- A local street that runs parallel to a state highway could be marked and improved as a bicycle route. Signs directing the bicyclists to the local parallel bicycle route would lessen the dependency of bicyclists on the SHS. Alternative routes may have fewer driveways and lower traffic volumes that are more conducive to bicycling.
- Additional mid-mile crossings of interstates and freeways would separate bicyclists from the traffic interchange area. In the Phoenix area, mid-mile collector and arterial streets could be constructed to cross I-17 to provide an

alternative to the traffic interchanges located at the mile arterials. Currently, particularly north of I-10, bicyclists who desire to cross I-17 are limited to opportunities at the traffic interchanges and a pedestrian overpass at Maryland Avenue. It is noteworthy that three of 15 high-priority intersection/interchange locations are along I-17. Twelve other locations on I-17 were also identified as experiencing a high number of motor vehicle-bicycle crashes.

Summary of Roles of Proposed Countermeasure: Establish Alternative Parallel Bicycling Routes
Bicyclists: • Coordinate with local agencies to identify alternative parallel routes to the SHS that are more comfortable and conducive to bicycling
Motorists: • Not applicable
Engineers and Planners: • Identify alternative parallel routes to the SHS that are more comfortable and conducive to bicycling; do not neglect bicycle accommodation on the SHS. • Identify opportunities to construct additional crossings of freeways and interstates to provide bicyclists with alternatives to traffic interchanges.
Law Enforcement: • Not applicable

5.10 Develop and Implement Bicyclist and Motorist Education Campaigns

Education of motorists and bicyclists is an essential element to reducing motor vehicle-bicycle crashes on state highways. Recommendations to educate bicyclists and motorist are listed below.

Integrate BSAP into ADOT Bicycle and Pedestrian Safety Education Materials

The BSAP emphasis areas can be incorporated into educational programs for motorists and bicyclists, such as the ADOT "Be a Roll Model" campaign.[25]

[25] http://www.azbikeped.org/education.html#campaigneducation

Three BSAP emphasis areas in which education can play a significant role are listed in **Table 12.** Potential safety campaign messages that can be incorporated into educational campaigns are provided in **Table 12**.

Table 12 – BSAP Emphasis Areas and Safety Campaign Messages

BSAP Emphasis Areas	Safety Campaign Messages/Strategy
Wrong Way Bicyclists: Reduce crashes in which the bicyclist was riding facing traffic.	Campaign can explain the danger of wrong-way bicycling riding.
Sidewalk Riding: Reduce crashes where the bicyclist was riding on the sidewalk.	Campaign can show potential issues and hazards of bicyclists riding on the sidewalk.
Dark Conditions: Reduce bicycle crashes that occurred in dawn, dusk, or dark conditions.	Campaign can emphasize use of lights while riding at night and low-light conditions.

While motorists' education is important, improving bicyclist skill level may be the most critical element of an education program. As evidenced in the BSAP, a large number of crashes occurred while bicyclists were riding improperly. Some of the most important bicycling behaviors that should be addressed in a bicycle safety education campaign include the following:

Bicyclist Wrong-Way Riding

Campaign and educational programs can include messages about the dangers of wrong-way riding, such as:[26]

- Cars which pull out of driveways, parking lots, and cross streets (ahead of you and to the left), which are making a right onto your street, aren't expecting traffic to be coming at them from the wrong-way
- It is difficult to make a right turn when you are riding in the wrong direction
- Cars will approach you at a much higher relative speed
- Riding the wrong-way is illegal and you can get ticketed for it

Bicyclist Riding on Sidewalks

Key considerations are:[27]

[26] http://bicyclesafe.com/
[27] http://www.commutebybike.com/2008/07/09/top-5-rules-for-riding-on-the-sidewalk/

- The law in most areas of the country requires bicycles to follow the same rules of the road as other motor vehicles
- Riding on the sidewalk has its own dangers such as cars pulling out of driveways, turning conflicts, and potential for pedestrian/bicyclist crashes
- The sidewalk is designed for pedestrians, so bicyclists should not be going faster than them. Pedaling fast down the sidewalk raises the potential for a serious bicyclist/pedestrian crash

Bicyclists' Education Emphasizing that Bicyclists have the Same Responsibilities as Motorists

Examples of messages could include:

- Bicyclists must obey all traffic control signs and signals, just like motorists
- Motorists and bicyclists must respect the right-of-way of others, especially pedestrians. Never assume other road users will give you the right-of-way
- Bicyclists must signal their turns and should ride in a predictable manner
- Bicyclists must use a headlight and rear reflectors when it is dark. To increase visibility, add a rear lamp that emits a red light visible from a distance of five hundred feet to the rear in addition to the red reflector

Bicyclist Riding in Dark Conditions

Key considerations are:

- When riding at night, bicyclists are required by law to use a white front lamp and a red rear reflector. A red rear lamp is also recommended.

Nighttime bicycle crashes represent a significant percentage of motor vehicle-bicycle crashes. While no single crash type is overly dominant in nighttime crashes, over 50% of crashes were typed as "motorist drive-out" or "motorist-turning." Increasing the visibility of bicyclists riding at night is critical to reducing motor vehicle-bicycle crashes.

ARS 28-817 requires bicyclists to utilize a white front lamp and a red rear reflector when riding at night. However, reflectors require several conditions to be met in order to be effective. Potential situations where reflectors may not be effective, or work at all, include:[28]

[28] http://www.sheldonbrown.com/reflectors.html

- Bicyclist (and the reflector) is outside the beam of a driver's headlights
- The reflector is tilted at an angle ("entrance angle") that severely degrades its optical performance
- The driver's eye may be outside the narrow cone of light that the reflector sends back to the light source
- Fog can completely block the reflector when other lights remain visible
- The driver may have a burned-out headlight
- The headlights may be mis-aimed or covered with dirt
- The reflector surface can be abraded, covered with moisture or dust, or otherwise altered in a way that diminishes its optical performance

It is unclear from the available ADOT crash data what percentage of crashes involved a bicyclist utilizing a front lamp and a rear reflector. However, it is intuitive that increased visibility of bicyclists is essential to reducing nighttime crashes. This requires increased compliance to existing Arizona law through enforcement and education.

Safety education campaign messsages should emphasize the importance of utilizing front and rear lamps, in addition to reflectors, to increase visibility in dark conditions. Bicyclists should be taught that the use of a rear red-lamp provides an additional layer of security to improve the safety of the bicyclist.

Motorist Education Emphasizing that Bicyclists Have the Same Rights as Motorists

Examples of messages could include:[29]

- Reduce your speed when passing bicyclists, especially if the roadway is narrow
- When a road is too narrow for cars and bikes to travel safely side by side, bicycles should "take the lane," which means riding in or near the center of the travel lane
- Recognize situations and obstacles which may be hazardous to cyclists, such as potholes, debris, and drain grates. Give bicyclists adequate space to maneuver
- Do NOT pass bicyclists if oncoming traffic is near. Wait as you would with any slow-moving vehicle
- When turning left at an intersection, yield to oncoming bicyclists just as you would yield to oncoming motorists
- Give at least three feet of passing space between the right side of your vehicle and a bicyclist just as you would with a slow-moving vehicle (The “Be a Roll Model” Campaign recommends five feet)

[29] http://www.sfbike.org/download/resources/Motorists-STR.pdf

- Do not pass bicyclists if you will be making a right turn immediately afterward. Always assume bicyclists are traveling through unless they signal otherwise
- Educational campaigns should recognize, and reach out to, demographic groups with restricted transportation choices that may more often ride bicycles, especially in urban areas, and need reaffirmation of "rules-of-the-road."

Inform Local Bicycling Safety Campaigns and Events

The BSAP can inform other bicycle safety campaigns and bicycling events that are held throughout the state. The findings of this study can be used to provide input to safety campaigns, seminars, and events, such as the statewide bicycle safety campaign being developed by Valley Metro.

Photo courtesy of www.pedbikeimages.org / Mike Cynecki

Continue Distribution of Educational Materials

The ADOT Bicycle and Pedestrian Program distributes educational materials to regional, local, advocacy organizations, and individuals throughout the state. Multimedia materials developed by ADOT to inform and educate bicyclists, pedestrians, and motorists about the rules of the road, laws, and safety can be found on ADOT's website.[30] Arizona Bicycling Street Smarts[31] is an example of an ADOT-sponsored publication that seeks to educate and increase the skill level of bicyclists as they operate on streets with motor vehicles. It is recommended that ADOT continue to distribute this resource, and make this resource available to other agencies and advocacy groups.

Draw Upon National Educational Resources

ADOT can continue to educate bicyclists utilizing resources developed nationally. The League of American Bicyclists "Smart Cycling" program is a set of curricula for adults and children taught by certified instructors. It is recommended that ADOT encourage and

[30] http://www.azbikeped.org/education.html
[31] http://www.azbikeped.org/azbss.htm

partner with local agencies and bicycle advocacy organizations to offer the LAB courses to as many bicyclists as possible, including children in elementary and middle schools. In fact, the MAG Strategic Transportation Safety Plan includes a goal to reduce the number of crashes that involve bicyclists or pedestrians through utilizing LAB materials. Stated goals of the Plan include the following:[32]

- Promote bicyclist training programs for youth and adults. Utilize programs such as those provided by the League of American Bicyclists and Pedestrian & Bicycle Information Center
- Co-sponsor safety and training programs with Coalition of Arizona Bicyclists and/or other agencies

Summary of Roles of Proposed Countermeasure: Develop and Implement Bicyclist and Motorist Education Campaigns
Bicyclists: Practice safe bicycling behavior, including the following: • Travel with flow of traffic • Drive on the roadway • Position properly within lane • Adhere to signs and signals • Yield properly when entering a roadway • Use an effective left-turn strategy • Increase bicyclist conspicuity (use headlamps, reflectors, etc. to increase visibility to motorists) • Plan for emergency maneuvers • Maintain bicycle • Maintain sobriety when bicycling • Utilize front and rear lights in low-light conditions
Motorists: Practice safe motorist behavior, including the following: • Pass safely and legally – maintain three-foot rule • Yield when entering the roadway from driveways • Yield when required at intersections • Maintain sobriety when driving

[32] http://www.azmag.gov/Documents/pdf/cms.resource/strategic_safety_plan226438.pdf

Engineers and Planners: • Develop and implement bicyclist and motorist education campaigns and programs, with particular emphasis on key contributing factors identified in the BSAP
Law Enforcement: • Enforce motorist laws (and as applicable to bicyclists); utilize enforcement activities to educate bicyclists and motorists of proper and safe bicycling practices

5.11 Collaborate with Law Enforcement

Bicycle education of public safety and law enforcement officers that leads to better enforcement of traffic laws can have a trickle-down effect of educating the general public. Examples of training resources are provided at the website Bicyclinginfo.org.[33]

- Bicycle Traffic Enforcement Video - This is an internal training video for the Portland Police Bureau available through the PBIC Video Library.[34]
- Traffic Enforcement for Bicyclist Safety - A training video for Chicago Police Officers created in partnership between the Chicago Police Department and The Chicago Department of Transportation available through the PBIC Video Library.
- Law Enforcement's Roll Call Video: "Enforcing Law for Bicyclists" - This short video was developed by National Highway Traffic Safety Administration (NHTSA)
- Enhancing Bicycle Safety: Law Enforcement's Role - This two-hour self-paced training for law enforcement officers was developed by the U.S. Department of Transportation, NHTSA
- NHTSA Community Oriented Bicycle Safety for Law Enforcement (2002)
- Wisconsin Pedestrian and Bicycle Law Enforcement Training Course (2007)
- Law Officers Guide to Bicycle Safety (2002)
- NHTSA Resource Guide on Laws Related to Pedestrian and Bicycle Safety
- Florida Bicycle Law Enforcement Guide (2003)
- North Carolina Department of Transportation Bicycle Law Enforcement Manual (1981)

[33] http://www.bicyclinginfo.org/enforcement/training.cfm

[34] http://www.walkinginfo.org/videos/

Summary of Roles of Proposed Countermeasure: Collaborate with Law Enforcement
Bicyclists: • Obey all traffic laws
Motorists: • Obey all traffic laws
Engineers and Planners: • Facilitate education programs targeted toward public safety and law enforcement; enhance working relationships with public safety and law enforcement to establish a 'team' approach to reducing bicycle crashes
Law Enforcement: Enforce bicyclist behaviors: • Enforce correct direction of travel on roadways • Enforce adherence to signs and signals • Enforce yielding when entering roadway • Enforce use of required lighting • Enforce proper behavior of group rides Enforce motorist behaviors • Enforce vehicle speed limits • Enforce red-light running violations • Enforce required safe-passing distance (at least 3 feet) • Enforce yielding when entering the roadway from driveways • Enforce yielding when required at intersections • Enforce yielding when turning right or left • Enforcing sobriety

5.12 Recommend Changes to Arizona Revised Statutes

Arizona recently received a "B" grade in legislation as applicable to bicyclists by the League of American Bicyclists, indicating that while Arizona law, as it relates to bicycles, is above average, opportunities for improvement exist.

Central to Arizona Revised Statues (ARS) as they apply to bicycles is ARS 28-812, which states that an individual riding a bicycle on a roadway or shoulder is granted all of the rights of a driver of a vehicle, and is also subject to the responsibilities and duties also applicable to a vehicle driver. However, there are opportunities to improve ARS as they relate to bicycle riding on sidewalks.

Bicycle Riding on Sidewalks

Bicyclists riding on the sidewalk and riding while facing traffic were identified as contributing factors to bicycle crashes. A typical crash scenario is when a bicyclist enters a roadway immediately after riding on the sidewalk while facing traffic. In such a scenario, the motorist may not see a bicyclist approaching from the right-hand side of the roadway.

When riding in the roadway or shoulder, Arizona law requires bicycles to ride with traffic. ARS 28-721 states that vehicles (and bicyclists) operating on the roadway should drive on the right half of the roadway. ARS 28-812 states that a person riding a bicycle on a roadway or on a shoulder adjoining a roadway is granted all of the rights and is subject to all of the duties applicable to the driver of a vehicle. The definition (ARS 28-601) of a roadway excludes the shoulder and sidewalk.

ARS 28-627 specifically grants the power to local authorities to regulate the operation of bicycles. Cities and towns have legal authority to develop local regulations regarding the use of sidewalks by bicyclists.

ARS 28-904 prohibits motor vehicles from riding on sidewalks. Arizona law does not prohibit bicycles from operating on sidewalks or from facing traffic while riding on the sidewalk.

When riding on a sidewalk, it is important for bicyclists to function as pedestrians – at a slow rate of speed; yielding to other pedestrians; carefully scanning cross streets before proceeding across the intersection, cross street, or driveway; and being willing to walk the bicycle when conditions dictate.

It is recommended that ARS be revised to govern the activities of bicycles on sidewalks. Potential revisions to ARS include the following (proposed modifications are *italicized*):

28-904. Driving on Sidewalk [35]

A. A person shall not drive a vehicle on a sidewalk area except on a permanent or duly authorized temporary driveway.

B. This section does not apply to a motorized wheelchair, electric personal assistive mobility device, authorized emergency vehicle, security vehicle owned by this state or small service vehicle owned by this state or a political subdivision of this state.

[35] http://www.azleg.state.az.us/ars/28/00904.htm

C. A person propelling a bicycle upon and along a sidewalk, or across a roadway upon and along a crosswalk, shall have all the rights and duties applicable to a pedestrian under the same circumstances as provided in Chapter 3, Article 10, shall travel no faster than a speed appropriate for pedestrian travel, shall yield the right of way to any pedestrian, and shall not ride in locations where prohibited by ordinance or by the posting of official traffic control devices"

D. Subsection C does not apply on paths on independent alignments which are not parallel and adjacent to highways or roadways

Summary of Roles of Proposed Countermeasure: Recommend Modifications to Arizona Revised Statutes
Bicyclists: • Not applicable
Motorists: • Not applicable
Engineers and Planners: • Review ARS; provide recommendations to ARS to department legislative liaisons for consideration; partner with advocacy organizations to revise ARS
Law Enforcement: • Not applicable

5.13 Implement ADOT Access Management Plan

Every driveway and street connection represents a potential conflict point for bicyclists and motorists. A review of state highway focus area bicycle-motor vehicle crash statistics shows that many crashes are symptomatic of numerous driveway openings and a lack of adequate access management on many state highways through urban areas. Examples include:

- Most crashes (99 percent) occurred in urbanized and developed areas
- 46 percent of crashes occurred near commercial or industrial development while a vehicle was making a right turn
- The majority of crashes (51 percent) occurred while a vehicle was making a right turn

Managing access, including the number, locations, and spacing of driveways, can have a significant benefit to both the bicyclist and the motorist. As stated in BIKESAFE[36] access management strategies such as providing raised/non-traversable medians and limiting driveway access may be useful in promoting safe bicycle travel, particularly on arterial or major collector streets, since they help reduce the number of potential conflict points.

Access management strategies that would improve bicyclist safety include:

- Limiting the number of or establishing minimum spacing between driveways
- Providing for right-in, right-out only movements
- Restricting turns to certain intersections
- Reducing curb radii to slow vehicular traffic making a right turn
- Using non-traversable medians to manage left- and U-turn movements

In accordance with the policy of the State Transportation Board, ADOT is developing a statewide Access Management Program[37], to preserve the functional integrity of the State Highway System.

This program includes the development of an access management classification system for state highways, design guidelines, a comprehensive manual, and a web-based application to guide the uniform application of access management throughout the State.

Included within the Program will be the establishment of Administrative Rules. Once ADOT begins the formal rulemaking process, the public and stakeholders will have an opportunity to comment on the proposed rules.

The ADOT Bicycle and Pedestrian Program supports implementation of the ADOT Access Management Program to improve conditions for bicyclists on state highways.

[36] http://www.bicyclinginfo.org/bikesafe/countermeasure.cfm?CM_NUM=8
[37] http://www.azaccessmanagement.com/

Summary of Roles of Proposed Countermeasure: Implement ADOT Access Management Plan
Bicyclists: • Not applicable
Motorists: • Not applicable
Engineers and Planners: • Support implementation of the ADOT Access Management Plan. • Educate other disciplines on the benefits of access management that can be realized for bicycle safety.
Law Enforcement: • Not applicable

5.14 Develop a BSAP Evaluation Program

The ADOT Bicycle and Pedestrian Coordinator conducts an annual review of bicyclist crashes and fatalities based on data published in Arizona Motor Vehicle Crash Facts. To chart progress toward the BSAP goal (reduce the total number of bicycle crashes (fatalities and non-fatalities) on the Arizona SHS by 12 percent by the year 2018), it is recommended that a detailed review and analysis of crash data occur a minimum of once every three years. The crash analysis documented in Chapter 2 analyzes data for 2004 to 2008. An updated analysis would include 2009, 2010, and 2011 crash data. In addition, the review could include an annual review of strategies and recommendations to ensure that progress is being made towards their implementation.

Summary of Roles of Proposed Countermeasure: Develop BSAP Evaluation Program
Bicyclists: • Not applicable
Motorists: • Not applicable
Engineers and Planners: • Develop an evaluation program to review progress toward the BSAP goal. The BSAP Evaluation Program should include a review of motor vehicle-bicycle crashes and a review of strategies and recommendations to ensure that progress is being made toward their implementation.
Law Enforcement: • Not applicable

6 SUMMARY

Table 13 summarizes action items as presented in Chapter 5, to improve bicycle safety on Arizona state highways. The action plan consists of action items to address needed revisions to policies and programs, or new tools to improve bicyclists' safety on the SHS.

For each action item, the role of engineers, planners, law enforcement, and motorists/bicyclists is identified.

Photo courtesy of Brent Crowther

Table 13 – Summary of ADOT Bicycle Safety Action Plan

BSAP Final Report Section	Action Item	Action Plan for Bicyclists	Action Plan for Motorists	Action Plan for Engineers and Planners	Action Plan for Law Enforcement
5.1	Conduct Road Safety Assessments for Priority Crash Locations Lead Agency: ADOT	-	-	• Conduct a Road Safety Assessment (RSA) for each priority crash location • Develop a program of improvements • Identify opportunities and funding for implementation	• Participate in RSA team.
5.2	Modify ADOT Plans, Policies, and Guidelines Lead Agency: ADOT	-	-	• Review ADOT Bicycle Policy and Roadway Design Guidelines • Incorporate language into ADOT Bicycle Policy and Roadway Design Guidelines to strengthen the accommodation of bicycling on state highways, consistent with USDOT Policy Statement and 2012 AASHTO Guide for the Development of Bicycle Facilities, 4th Edition. • Consider bicycles in updates to the ASAP, Strategic Highway Safety Plan, and FHWA and ADOT Stewardship and Oversight Agreement	-

Table 13 – Summary of ADOT Bicycle Safety Action Plan (continued)

BSAP Final Report Section	Action Item	Action Plan for Bicyclists	Action Plan for Motorists	Action Plan for Engineers and Planners	Action Plan for Law Enforcement
5.3	Install Pavement Markings or Signage to Discourage Wrong-way Bicycle Riding Lead Agency: ADOT	Follow laws and safe practices by riding with traffic	-	• Review ADOT Bicycle Policy, Roadway Design Guidelines, and Traffic Engineering PGP • Install "Bicycle Wrong Way, Ride With Traffic" signs on state highway segments that exhibit a high degree of wrong-way bicycle riding crash types • Develop a plan to obtain ADOT approval to install bicycle lane pavement markings on wide shoulders	• Enforce wrong-way bicycle riding on the roadway.
5.4	Develop and Adopt an Arizona Complete Streets Policy Lead Agency: ADOT	-	-	• Develop an internal DOT policy that would be approved/signed by ADOT State Engineer	
5.5	Consider Bicycles at Single Point Urban Interchanges (SPUIs) Lead Agency: ADOT	Be particularly alert when crossing through interchanges	Be alert for bicycles at interchanges and intersections	• Design interchanges to accommodate bicycles	

Table 13 – Summary of ADOT Bicycle Safety Action Plan (continued)

BSAP Final Report Section	Action Item	Action Plan for Bicyclists	Action Plan for Motorists	Action Plan for Engineers and Planners	Action Plan for Law Enforcement
5.6	Recommend Modifications to Arizona Crash Report Forms Lead Agency: ADOT	-	-	• Develop a process to modify the Arizona Crash Report Form to include additional modifications and enhancements when reporting crashes involving bicycles.	• Comprehensively complete existing data fields in the Arizona Crash Report form. When bicyclists are involved, include additional details as appropriate in narrative.
5.7	Develop and implement a Bicycle Counting Program Lead Agency: ADOT	-	-	• Develop a bicycle counting program to measure ridership on state highways, and in particular on BSAP high-priority segments.	-
5.8	Recommend Enhancements to Arizona Driver License Manual and Customer Service Guide Lead Agency: Arizona Motor Vehicle Division	-	-	• Collaborate with MVD to modify the Driver License Manual and Exam, to particularly reflect Arizona's 3-foot law.	• Collaborate with MVD to modify the Driver License Manual and Exam, to particularly reflect Arizona's 3-foot law.

Table 13 – Summary of ADOT Bicycle Safety Action Plan (continued)

BSAP Final Report Section	Action Item	Action Plan for Bicyclists	Action Plan for Motorists	Action Plan for Engineers and Planners	Action Plan for Law Enforcement
5.9	Establish Connectivity / Alternative Routes to State Highways through Local Jurisdictions Lead Agency: ADOT, in collaboration with local agencies and jurisdictions	Coordinate with local agencies to identify alternative parallel routes to the SHS that are more comfortable and conducive to bicycling	-	• Identify alternative parallel routes to the SHS that are more comfortable and conducive to bicycling; do not neglect bicycle accommodation on the SHS. • Identify opportunities to construct additional crossings of freeways and interstates to provide bicyclists with alternatives to traffic interchanges.	-

Table 13 – Summary of ADOT Bicycle Safety Action Plan (continued)

BSAP Final Report Section	Action Item	Action Plan for Bicyclists	Action Plan for Motorists	Action Plan for Engineers and Planners	Action Plan for Law Enforcement
5.10	Develop and Implement Bicyclist and Motorist Education Campaigns Lead Agency: ADOT	Practice safe bicycling behavior, including the following: • Travel with flow of traffic • Drive on the roadway • Position properly within lane • Adhere to signs and signals • Yield properly when entering a roadway • Use an effective left-turn strategy • Increase bicyclist conspicuity (use headlamps, reflectors, etc. to increase visibility to motorists) • Plan for emergency maneuvers • Maintain bicycle • Maintain sobriety when bicycling • Utilize front and rear lights in low-light conditions	Practice safe motorist behavior, including the following: • Pass safely and legally – maintain three-foot rule • Yield when entering the roadway from driveways • Yield when required at intersections • Maintain sobriety when driving	• Develop and implement bicyclist and motorist education campaigns and programs, with particular emphasis on key contributing factors identified in the BSAP	• Enforce motorist laws (and as applicable to bicyclists); utilize enforcement activities to educate bicyclists and motorists of proper and safe bicycling practices

Table 13 – Summary of ADOT Bicycle Safety Action Plan (continued)

BSAP Final Report Section	Action Item	Action Plan for Bicyclists	Action Plan for Motorists	Action Plan for Engineers and Planners	Action Plan for Law Enforcement
5.11	Collaborate with Law Enforcement Lead Agency: ADOT and Arizona Department of Public Safety	Obey all traffic laws	Obey all traffic laws	• Facilitate education programs targeted toward public safety and law enforcement; enhance working relationships with public safety and law enforcement to establish a 'team' approach to reducing bicycle crashes	Enforce bicyclist behaviors: • Enforce correct direction of travel on roadways • Enforce adherence to signs and signals • Enforce yielding when entering roadway • Enforce use of required lighting • Enforce proper behavior of group rides Enforce motorist behaviors • Enforce vehicle speed limits • Enforce red-light running violations • Enforce required safe-passing distance (at least 3 feet) • Enforce yielding when entering the roadway from driveways • Enforce yielding when required at intersections • Enforce yielding when turning right or left • Enforce sobriety

Table 13 – Summary of ADOT Bicycle Safety Action Plan (continued)

	Action Item	Action Plan for Bicyclists	Action Plan for Motorists	Action Plan for Engineers and Planners	Action Plan for Law Enforcement
5.12	Recommend Changes to Arizona Revised Statutes Lead Agency: ADOT, in collaboration with advocacy organizations	-	-	• Review ARS and make recommendations to department legislative liaisons for consideration; partner with advocacy organizations to revise ARS	-
5.13	Develop and implement ADOT Access Management Plan Lead Agency: ADOT	-	-	• Support implementation of the ADOT Access Management Plan. • Educate other disciplines on benefits of access management that can be realized for bicycle safety.	-
5.14	Develop BSAP Evaluation Program Lead Agency: ADOT	-	-	• Develop an evaluation program to review progress toward BSAP goal. The BSAP Evaluation Program should include a review of motor vehicle-bicycle crashes and strategies and recommendations to ensure progress is being made toward their implementation.	-

APPENDIX A

Appendix A1 and A2 are provided under separate cover. Refer to Final Report, Appendix A

Appendix A1 – High Priority Crash Segments Microfilm Numbers
Appendix A2 – High Priority Crash Segments Mapping

APPENDIX B

Appendix B1 – SHS Priority Crash Locations Menu of Potential Countermeasures

Appendix B2 – Crash Type Descriptions and Diagrams

Appendix B1

SHS Priority Crash Locations Menu of Potential Countermeasures

Location 5: Casa Grande

PRIORITY SEGMENT Location No. 5 Casa Grande	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crashes per Mile per Year
	SR 287/SR387	Cottonwood Lane	Arizona Road	3.5	37	4	2.1
Leading Crash Type Descriptions	1. Motorist Drive Out – Sign-Controlled Intersection (18.9%) 2. Bicyclist Ride Through – Signalized Intersection (18.9%) 3. Motorist Drive Out – Commercial Driveway (10.8%) 4. Motorist Drive Out – Right-Turn-on-Red (10.8%) 5. Motorist Drive Out – Signalized Intersection (10.8%) 6. Motorist Left Turn – Same Direction (5.4%) 7. Motorist Right Turn – Same Direction (5.4%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal 4. Bicyclist fails to yield 5. Too many driveways						
Potential Countermeasures	7. Curb radii reduction (to slow the speed of right turning vehicles) 8. Sight distance improvement 9. Intersection signing and marking improvement 10. Bike lane or paved shoulder 11. Driveway improvement/access management						
Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**						
	Bicyclists	**Motorists**	**Engineers and Planners**		**Law Enforcement**		
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows		Enforcement of proper bicyclist behavior		
Adhere to signs and signals	Education campaign	N/A	N/A		Enforcement of obeisance of signs and signals		
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane		Enforcement of proper motorist behavior		
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane		Enforcement of proper motorist behavior		
Yield when entering the roadway from driveway	N/A	Education campaign	1. Bike lane 2. Access management		Enforcement of proper motorist behavior		

Location No. 6a Chandler

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 6a Chandler	Elliot Road	SR 101 Frontage Road/Ramp	5
Leading Crash Type Descriptions	1. Motorist Right Turn – Same Direction (40.0%) 2. Motorist Drive Out – Signalized Intersection (20.0%) 3. Motorist Right Turn – Opposite Direction (20.0%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal 4. Bicyclist fails to yield		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 6d Chandler

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 6d Chandler	SR 87	SR 202 Ramp	5
Leading Crash Type Descriptions	1. Motorist Drive Out – Signalized Intersection (60.0%) 2. Bicyclist Ride Through – Signalized Intersection (20.0%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist fails to yield		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement		

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement	Enforcement of proper motorist behavior

Location No. 8 Cottonwood

PRIORITY SEGMENT Location No. 8 Cottonwood	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 89A	Cottonwood St	Grosetta Rd	0.71	8	4	2.25
Leading Crash Type Descriptions	1. Motorist Drive Out – Commercial Driveway (62.5%) 2. Motorist Right Turn – Same Direction (25.0%) 3. Bicyclist Ride Out – Commercial Driveway (12.5%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist fails to yield 4. Too many driveways						
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement* 4. Bike lane or paved shoulder 5. Driveway improvement/access management						

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Yield when entering roadway from driveway	Education campaign	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist and bicyclist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

*Consider wayfinding signage and connecting bike lanes to connect with Cove Parkway

Location 11a: Flagstaff

PRIORITY SEGMENT Location No. 11a Flagstaff	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 89A (Milton Road)	I 17	SR 40B	1.3	33	4	5.1

Leading Crash Type Descriptions	1. Motorist Drive Out – Signalized Intersection (15.2%) 2. Motorist Drive Out – Midblock (15.2%) 3. Motorist Drive Out – Commercial Driveway (12.1%) 4. Motorist Left Turn – Opposite Direction (12.1%) 5. Motorist Drive Out – Sign Controlled Intersection (9.1%) 6. Motorist Right Turn – Same Direction (6.1%) 7. Motorist Drive Out – Right-Turn-on-Red (6.1%) 8. Motorist Drive Through – Signalized Intersection (6.1%)
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Too many driveways
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder 5. Driveway improvement/access management

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior
Yield when entering the roadway from driveway	N/A	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location 11c: Flagstaff

PRIORITY SEGMENT Location No. 11c Flagstaff	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 40B	SR 89A	Elden Street	1	56	4	11.2
Leading Crash Type Descriptions	1. Motorist Right Turn – Same Direction (19.6%) 2. Motorist Drive Out – Right-Turn-on-Red (12.5%) 3. Motorist Drive Out – Sign-Controlled Intersection (8.9%) 4. Motorist Right Turn – Opposite Direction (8.9%) 5. Motorist Drive Out – Midblock (8.9%) 6. Motorist Left Turn – Opposite Direction (8.9%) 7. Bicyclist Ride Through – Signalized Intersection (7.1%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal						
Potential Engineering Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder						

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane and stencils	Enforcement of proper motorist behavior
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane and stencils to indicate the correct direction of travel for bicyclists.	Enforcement of proper motorist behavior
Yield when entering the roadway	Education campaign	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist and bicyclist behavior

Location 11d: Flagstaff

PRIORITY SEGMENT Location No. 11d Flagstaff	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR-40B/ Route 66	Switzer Canyon Drive	Lockett Road	3.1	45	4	2.9
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (17.8%) 2. Motorist Right Turn – Opposite Direction (11.1%) 3. Motorist Drive Out – Signalized Intersection (8.9%) 4. Motorist Drive Out – Midblock (8.9%) 5. Motorist Drive Out – Right-Turn-on-Red (6.7%) 6. Motorist Drive Out – Sign-Controlled Intersection (6.7%) 7. Motorist Left Turn – Opposite Direction (6.7%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal 4. Bicyclist fails to yield						
Potential Engineering Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Intersection warning treatments (Side path/ Roadway Intersection) 5. Bike lane or paved shoulder 6. Driveway improvement/access management						

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Intersection warning treatments (Side path/ Roadway Intersection) 3. Bike lane	Enforcement of proper motorist behavior
Yield when entering the roadway	Education campaign	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist and bicyclist behavior

Location 11d: Flagstaff (continued)

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Intersection warning treatments (Side path/ Roadway Intersection) 3. Bike lane	Enforcement of proper motorist behavior

Location 11e: Flagstaff

PRIORITY SEGMENT Location No. 11e Flagstaff	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	US 180	SR 40B	Meade Lane	1.4	11	2	1.6
Leading Crash Type Descriptions	1. Motorist Drive Out – Sign-Controlled Intersection (36.4%) 2. Motorist Right Turn – Same Direction (36.4%) 3. Motorist Drive Out – Right-Turn-on-Red (9.1%) 4. Motorist Left Turn – Opposite Direction (9.1%) 5. Motorist Drive Through – Sign-Controlled Intersection (9.1%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic						
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Intersection warning treatments (Side path / Roadway Intersection)Bike lane or paved shoulder						
Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**						
	Bicyclists	**Motorists**	**Engineers and Planners**		**Law Enforcement**		
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows		Enforcement of proper bicyclist behavior		
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Intersection warning treatments (Side path/ Roadway Intersection) 3. Bike lane		Enforcement of proper motorist behavior		
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Intersection warning treatments (Side path/ Roadway Intersection) 3. Bike lane		Enforcement of proper motorist behavior		

Location No. 14b Kingman

PRIORITY SEGMENT Location No. 14b Kingman	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 66	I-40	Armour Avenue	0.5	5	4	2
Leading Crash Type Descriptions	1. Motorist Drive Out – Commercial Driveway (20.0%) 2. Bicyclist Ride Through – Signalized Intersection (20.0%) 3. Motorist Drive Out – Right-Turn-on-Red (20.0%) 4. Motorist Drive Out – Midblock (20.0%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal 4. Too many driveways						
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder 5. Driveway improvement/access management						
Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**						
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**			
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior			
Yield when entering roadway from driveway	N/A	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist behavior			
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals			
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior			

Location 17b: Mesa

PRIORITY SEGMENT Location No. 17b Mesa	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	US 60X	Sossaman Road	Meridian Drive	5.02	34	6	1.4

Leading Crash Type Descriptions	1. Motorist Drive Out – Sign Controlled Intersection (29.4%) 2. Motorist Drive Out – Midblock (8.8%) 3. Motorist Overtaking – Undetected Bicyclist (8.8%) 4. Parallel Paths – Other / Unknown (8.8%) 5. Motorist Drive Out – Commercial Driveway (5.9%) 6. Motorist Drive Out – Signalized Intersection (5.9%) 7. Bicyclist Ride Out – Other Midblock (5.9%)
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist fails to yield 4. Too many driveways
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder 5. Driveway improvement/access management

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior
Yield when entering the roadway from driveway	N/A	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Intersection warning treatments 3. Bike lane	Enforcement of proper motorist behavior

Location 18a: Mesa

PRIORITY SEGMENT Location No. 18a Mesa	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 101 Frontage Road	University Drive	Broadway Road	1.01	15	2	3
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (26.7%) 2. Motorist Drive Out – Sign-Controlled Intersection (20.0%) 3. Motorist Left Turn – Opposite Direction (20.0%) 4. Motorist Drive Out – Commercial Driveway (13.3%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal 4. Too many driveways						
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder 5. Driveway improvement/access management						
Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**						
	Bicyclists	**Motorists**	**Engineers and Planners**		**Law Enforcement**		
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows		Enforcement of proper bicyclist behavior		
Adhere to signs and signals	Education campaign	N/A	N/A		Enforcement of obeisance of signs and signals		
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane		Enforcement of proper motorist behavior		
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane		Enforcement of proper motorist behavior		
Yield when entering roadway from driveway	N/A	Education campaign	1. Bike lane 2. Access management		Enforcement of proper motorist behavior		

Location No. 18c Mesa

PRIORITY INTERSECTION Location No. 18c Mesa	On Road	Intersecting Road	Total Crashes
	SR 87	SR 202 Ramp	6
Leading Crash Type Descriptions	1. Motorist Drive Out – Signalized Intersection (50.0%) 2. Bicyclist Ride Through – Signalized Intersection (16.7%) 3. Motorist Drive Out – Right-Turn-on-Red (16.7%) 4. Motorist Overtaking – Misjudged Space (16.7%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal 4. Lack of bicycle facility 5. Bicyclist improper lane position		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Recommended Countermeasures			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Proper lane position/Safe passing	Education campaign	Education campaign	1. Signage and pavement markings with directional arrows 2. Bike lane	Enforcement of proper motorist and bicyclist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 18e Mesa

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 18e Mesa	SR 87	McKellips Road	5
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (60.0%) 2. Bicyclist Failed to Clear - Trapped (20.0%) 3. Bicyclist Ride Out – Midblock (20.0%)		
Probable Contributing Causes	1. Bicyclist travels facing traffic 2. Bicyclist disregards signal 3. Bicyclist fails to yield		
Potential Countermeasures	1. Sight distance improvement 2. Intersection signing and marking improvement 3. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals

Location No. 19a Mesa

PRIORITY SEGMENT Location No. 19a Mesa/Gilbert	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 87	Guadalupe Road	Baseline Road	1.02	6	6	1.2
Leading Crash Type Descriptions	1. Motorist Drive Out – Right-Turn-on-Red (33.3%) 2. Motorist Right Turn – Same Direction (16.7%) 3. Motorist Left Turn – Opposite Direction (16.7%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic						
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder						
Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**						
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**			
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior			
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior			

Location 22c: Oro Valley

PRIORITY SEGMENT Location No. 22c Oro Valley	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 77	Mountain Vista Drive	Ina Road	1.33	19	6	2.9
Leading Crash Type Descriptions	1. Motorist Drive Out – Commercial Driveway (26.3%) 2. Motorist Right Turn – Same Direction (26.3%) 3. Motorist Left Turn – Opposite Direction (15.8%) 4. Motorist Drive Out – Midblock (10.5%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist fails to yield 4. Too many driveways						
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Driveway improvement/access management						
Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**						
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**			
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior			
Yield when entering roadway from driveway	Education campaign	Education campaign	Access management	Enforcement of proper motorist and bicyclist behavior			
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement	Enforcement of proper motorist behavior			

Location 24a: Payson

PRIORITY SEGMENT Location No. 24a Payson	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 87	Forest Drive	Ridge Lane	1.95	22	4	2.3

Leading Crash Type Descriptions	1. Motorist Drive Out – Commercial Driveway (22.7%) 2. Motorist Drive Out – Sign-Controlled Intersection (13.6%) 3. Bicyclist Ride Through – Signalized Intersection (13.6%) 4. Motorist Right Turn – Opposite Direction (9.1%)
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal 4. Bicyclist fails to yield 5. Too many driveways
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder 5. Driveway improvement/access management

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Yield when entering roadway from driveway	Education campaign	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist and bicyclist behavior
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 25e Peoria/Glendale

PRIORITY SEGMENT Location No. 25e Peoria/Glendale	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	US 60	Northern Avenue	Bethany Home Road	0.5	5	6	2
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (40.0%) 2. Motorist Drive Out – Sign-Controlled Intersection (20.0%) 3. Motorist Drive Out – Signalized Intersection (20.0%)						
Probable Contributing Causes	1. Bicyclist disregards signal 2. Motorist fails to yield 3. Bicyclist travels facing traffic						
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder						
Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**						
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**			
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior			
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals			
Yield when entering intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior			

Location No. 26b Phoenix

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 26b Phoenix	Indian School Road	SR 51 Ramp	6
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (66.7%) 2. Motorist Left Turn – Opposite Direction (16.7%) 3. Motorist Drive Out – Signalized Intersection (16.7%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist disregards signal 3. Bicyclist fails to yield 4. Motorist speeds too fast for conditions		
Potential Countermeasures	1. Sight distance improvement 2. Intersection signing and marking improvement 3. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 26f Phoenix

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 26f Phoenix	7th Street	I-10 Ramp	5
Leading Crash Type Descriptions	1. Motorist Drive Out – Sign-Controlled Intersection (40.0%) 2. Motorist Drive Out – Signalized Intersection (20.0%) 3. Crossing Paths - Uncontrolled Intersection (20.0%) 4. Bicyclist Left Turn – Opposite Direction (20.0%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 26h Phoenix

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 26h Phoenix	24th Street	SR 202 Ramp	5
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (40.0%) 2. Motorist Drive Out – Sign-Controlled Intersection (20.0%) 3. Motorist Drive Out – Right-Turn-on-Red (20.0%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 27b Phoenix

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 27b Phoenix	27th Avenue	SR-101 Frontage Road (Beardsley Road)	5
Leading Crash Type Descriptions	1. Motorist Drive Out – Right-Turn-on-Red (40.0%) 2. Motorist Right Turn – Same Direction (20.0%) 3. Bicyclist Failed to Clear – Trapped (20.0%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 28c Phoenix

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 28c Phoenix	Northern Avenue	I-17 Frontage Road/Ramp	6
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (66.7%) 2. Motorist Left Turn – Opposite Direction (16.7%) 3. Motorist Right Turn – Same Direction (16.7%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist disregards signal 3. Bicyclist fails to yield		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 28e Phoenix

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 28e Phoenix	Bethany Home Road	I-17 Frontage Road/Ramp	6
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (83.3%) 2. Head-On - Bicyclist (16.7%)		
Probable Contributing Causes	1. Bicyclist disregards signal 2. Bicyclist travels facing traffic		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals

Location No. 30a Phoenix

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 30a Phoenix	Indian School Road	I-17 Frontage Road/Ramp	6
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (33.3%) 2. Motorist Drive Out – Right-Turn-on-Red (16.7%) 3. Motorist Drive Out – Signalized Intersection (16.7%) 4. Motorist Right Turn on Red – Opposite Direction (16.7%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location 35: Sedona

PRIORITY SEGMENT Location No. 35 Sedona	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 89A	Dry Creek Road	Soldier Pass Road	1.88	15	4	1.6

Leading Crash Type Descriptions	1. Motorist Drive Out – Midblock (20.0%) 2. Motorist Drive Out – Sign-Controlled Intersection (13.3%) 3. Motorist Drive Out – Commercial Driveway (13.3%) 4. Motorist Right Turn – Same Direction (13.3%)
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Too many driveways
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder 5. Driveway improvement/access management

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior
Yield when entering roadway from driveway	N/A	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location 37a: Sierra Vista

PRIORITY SEGMENT Location No. 37a Sierra Vista	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 92/90	Martin Luther King Parkway/Tree Top Avenue	Calle Mercancia	2.49	15	4	1.2
Leading Crash Type Descriptions	1. Bicyclist Ride Through – Signalized Intersection (40.0%) 2. Motorist Drive Out – Sign-Controlled Intersection (13.3%) 3. Motorist Drive Out – Commercial Driveway (13.3%) 4. Motorist Drive Out – Right-Turn-on-Red (13.3%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal 4. Too many driveways						
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Intersection warning treatments (Side path / Roadway Intersection) 5. Bike lane or paved shoulder 6. Driveway improvement/access management						

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Intersection warning treatments (Side path / Roadway Intersection) 3. Bike lane	Enforcement of proper motorist behavior
Yield when entering roadway from driveway	N/A	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 39a Tempe

PRIORITY INTERSECTION Location No. 39a Tempe	On Road	Intersecting Road	Total Crashes
	Priest Drive	SR 202 Ramp	6
Leading Crash Type Descriptions	1. Motorist Drive Out – Right-Turn-on-Red (33.3%) 2. Motorist Drive Out – Signalized Intersection (16.7%) 3. Bicyclist Lost Control – Surface Conditions (16.7%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Motorist speeds too fast for conditions		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior
Adhere to speed limit	N/A	Education campaign	Curb radii reduction (to slow the speed of right turning vehicles)	Enforcement of proper motorist behavior

Location No. 39b Tempe

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 39b Tempe	Scottsdale Road	SR 202 Ramp	8

Leading Crash Type Descriptions	4. Motorist Drive Out – Sign-Controlled Intersection (25.0%) 5. Bicyclist Ride Through – Signalized Intersection (12.5%) 6. Motorist Drive Out – Right-Turn-on-Red (12.5%) 7. Motorist Left Turn – Same Direction (12.5%) 8. Motorist Drive Out – Signalized Intersection (12.5%)
Probable Contributing Causes	4. Motorist fails to yield 5. Bicyclist travels facing traffic 6. Bicyclist disregards signal
Potential Countermeasures	4. Curb radii reduction (to slow the speed of right turning vehicles) 5. Sight distance improvement 6. Intersection signing and marking improvement 7. Bike lane or paved shoulder

Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when entering the intersection from crossing street	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 39e Tempe

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 39e Tempe	Baseline Road	I-10 Ramp	6
Leading Crash Type Descriptions	1. Motorist Drive Out – Signalized Intersection (33.3%) 2. Motorist Right Turn – Same Direction (16.7%) 3. Bicyclist Ride Through – Signalized Intersection (16.7%) 4. Motorist Left Turn – Opposite Direction (16.7%) 5. Motorist Right Turn – Opposite Direction (16.7%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 39f Tempe

PRIORITY INTERSECTION	On Road	Intersecting Road	Total Crashes
Location No. 39f Tempe	Priest Drive	US 60	5
Leading Crash Type Descriptions	1. Motorist Drive Out – Signalized Intersection (40.0%) 2. Bicyclist Ride Through – Signalized Intersection (20.0%) 3. Motorist Drive Through – Signalized Intersection (20.0%)		
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal		
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder		

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	N/A	N/A	Enforcement of obeisance of signs and signals
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location 40a: Tucson

PRIORITY SEGMENT Location No. 40a Tucson	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 77 (Oracle Road)	River Road	Miracle Mile	2.5	32	6	2.6
Leading Crash Type Descriptions	1. Motorist Drive Out – Commercial Driveway (25%) 2. Motorist Left Turn – Opposite Direction (18.8%) 3. Motorist Drive Out – Right-Turn-on-Red (12.5%) 4. Motorist Right Turn – Same Direction (9.4%) 5. Bicyclist Ride Through – Signalized Intersection (6.3%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Bicyclist disregards signal 4. Too many driveways						
Potential Countermeasures	1. Driveway improvement/access management 2. Curb radii reduction (to slow the speed of right turning vehicles) 3. Sight distance improvement 4. Intersection signing and marking improvement 5. Bike lane or paved shoulder						

Desired Outcomes	Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration			
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior
Adhere to signs and signals	Education campaign	Education campaign	N/A	Enforcement of obeisance of signs and signals
Yield when entering the roadway from driveway	N/A	Education campaign	1. Bike lane 2. Access management	Enforcement of proper motorist behavior
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior

Location No. 40b Tucson

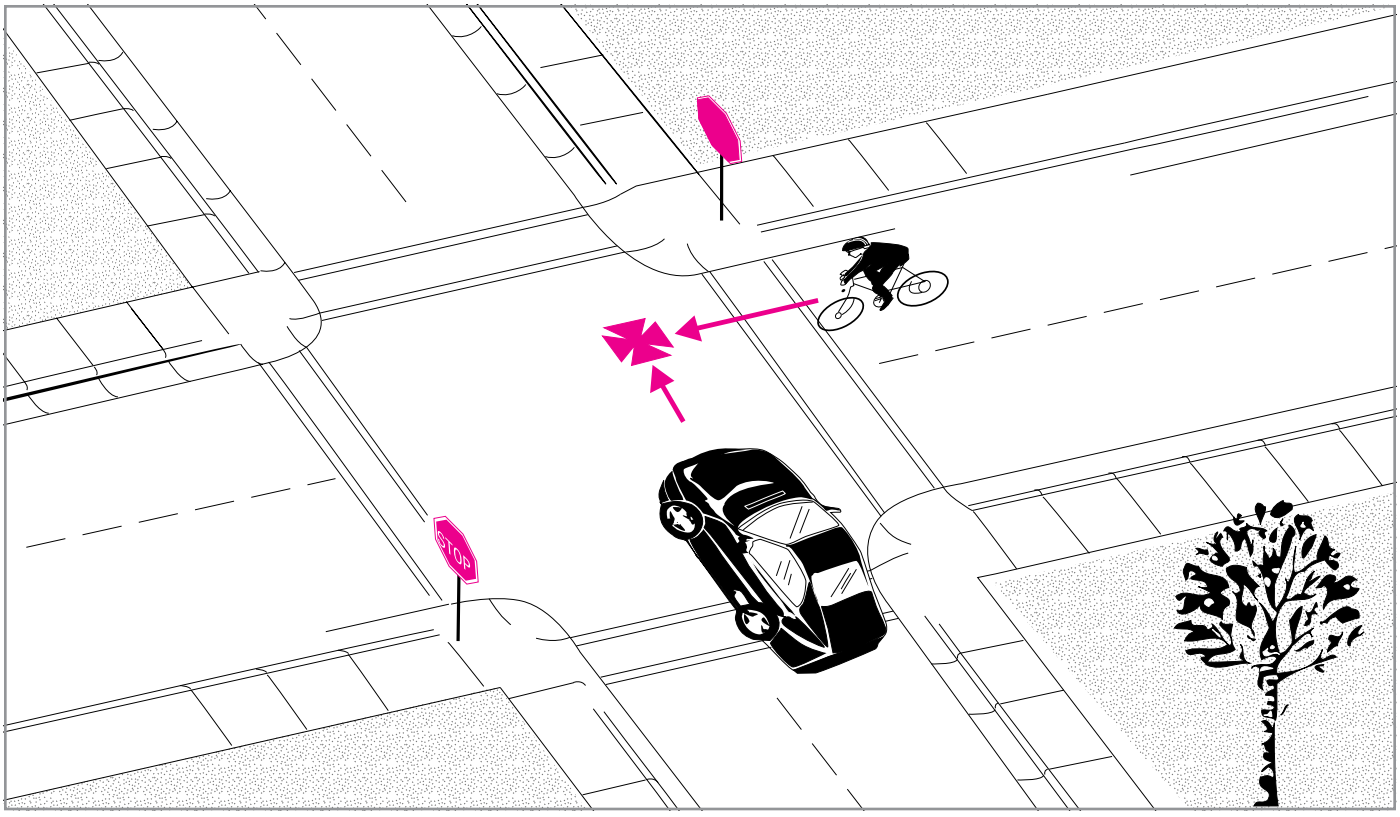
PRIORITY SEGMENT Location No. 40b Tucson	Roadway	From	To	Length (mile)	Total Crashes	Lanes	Crash per Mile per Year
	SR 77 (Miracle Mile)	Fairview Avenue	Romero Road	0.67	6	4	1.8
Leading Crash Type Descriptions	1. Motorist Right Turn – Same Direction (16.7%) 2. Motorist Left Turn – Opposite Direction (16.7%) 3. Bicyclist Ride Out – Commercial Driveway (16.7%) 4. Crossing Paths – Uncontrolled Intersection (16.7%) 5. Motorist Drive Through – Signalized Intersection (16.7%)						
Probable Contributing Causes	1. Motorist fails to yield 2. Bicyclist travels facing traffic 3. Motorist disregards signal 4. Bicyclist fails to yield 5. Too many driveways						
Potential Countermeasures	1. Curb radii reduction (to slow the speed of right turning vehicles) 2. Sight distance improvement 3. Intersection signing and marking improvement 4. Bike lane or paved shoulder 5. Driveway improvement/access management						
Desired Outcomes	**Engineering, Education, and Enforcement (EEE) Countermeasures for Further Consideration**						
	Bicyclists	**Motorists**	**Engineers and Planners**	**Law Enforcement**			
Travel with the flow of traffic	Education campaign	N/A	Signage and pavement markings with directional arrows	Enforcement of proper bicyclist behavior			
Yield when turning right or left	N/A	Education campaign	1. Intersection signing and marking improvement 2. Bike lane	Enforcement of proper motorist behavior			
Yield when entering roadway from driveway	Education campaign	N/A	1. Bike lane 2. Access management	Enforcement of proper bicyclist behavior			
Adhere to signs and signals	N/A	Education campaign	N/A	Enforcement of obeisance of signs and signals			

APPENDIX B2

Crash Type Descriptions and Diagrams

Source: Bicycle Safety Guide and Countermeasure Selection System, Chapter 3: Selecting Improvements for Bicyclists

Chapter 3 – Selecting Improvements for Bicyclists



Identification of High-Crash Locations

Bicycle Crash Typing

Definitions of Bicycle Crash Types

Crash-Related Countermeasures

Performance Objectives

Program of Improvements

Deciding on a set of treatments that will provide the greatest safety and mobility benefits for bicyclists requires transportation and land-use planners, engineers, law enforcement officials, and community leaders to engage in problem-solving. In most cases, a two-pronged approach is required. The first prong involves an examination of the bicycling crash problem through a review of historical crash data. Two specific types of crash analyses that are detailed in this chapter include:

- The identification of high-crash or hazardous locations
- The detailed examination of pre-crash maneuvers that lead to bicycle-motor vehicle collisions

However, many of the problems faced by bicyclists either do not involve crashes or the crashes are not reported. Thus, the second prong is more broad-based and focuses on performance objectives that will lead to changes in behavior that, in turn, will result in a safer and more accessible environment for bicyclists.

IDENTIFICATION OF HIGH-CRASH LOCATIONS

A first step in the problem-solving process of improving bicycle safety and mobility is to identify locations or areas where bicycle crash problems exist and where engineering, education, and enforcement measures will be most beneficial. Mapping the locations of reported bicycle crashes in a neighborhood, campus, or city is a simple method of identifying sites for potential bicycle safety improvements. One method of analyzing crash locations is through computerized Geographic Information Systems (GIS) software. This type of map can help transportation engineers and planners focus safety improvements on intersections, corridors, or neighborhoods where bicycle crashes have occurred.

Several issues should be considered when creating GIS maps of reported crash locations. First, the volumes of bicycle and motor vehicle traffic that use each location will affect reported crash density. Second, bicycle crashes may not be reported frequently enough to establish a pattern of unsafe bicycling locations. In either case, other steps may improve the identification of unsafe locations for bicycling. These include:

- Using bikeability checklists.[1]
- Noting bicycle and driver behavior and examining roadway and bicycling characteristics at specific sites.
- Observing and recording the number of bicycle-motor vehicle conflicts at specific sites.[2]
- Mapping locations known to have a high potential for bicycle crashes in an area.
- Calculating a bicycle level of service.[3]

In regard to conflicts, a number of studies have been performed using bicycle-motor vehicle conflicts as a study variable in lieu of crash data.[2] A conflict is usually defined as a sudden change in speed or direction by either party to avoid the other. In regard to bicycle level of service, one popular tool is the Bicycle Compatibility Index, where a user inserts values for several easily obtained variables to determine the comfort level (level of service) for bicyclists on a midbock section of a street or roadway.[3] An intersection level of service for the bicycle through movement has also been developed.[4] Another intersection rating tool is under development for the Federal Highway Administration (FHWA) for both bicyclists and pedestrians. The bicyclist portion considers the through movement, right turns, and left turns.[5]

BICYCLE CRASH TYPING

The development of effective roadway design and operation, education, and enforcement measures to accommodate bicyclists and prevent crashes is hindered by insufficient detail in computerized state and local crash files. Analysis of these databases can provide information on where bicycle crashes occur (city, street, intersection, two-lane road, etc.), when they occur (time of day, day of week, etc.), and characteristics of the victims involved (age, gender, injury severity, etc.). Current crash files cannot provide a sufficient level of detail regarding the sequence of events leading to the crash.

In the 1970s, methods for typing pedestrian and bicycle crashes with motor vehicles were developed by the National Highway Traffic Safety Administration (NHTSA) to better define the sequence of events and precipitating actions leading to pedestrian- and bicycle-motor vehicle crashes.[6,7,8] These methodologies were applied by Hunter et al. in a 1996 study to more than 8,000 pedestrian and bicycle crashes from six states.[9] The results provided a representative summary of the distribution of crash types experienced by pedestrians and bicyclists. Some of the most frequently occurring bicycle crash types include:

- A motorist failing to yield (21.7 percent of crashes)
- A bicyclist failing to yield at an intersection (16.8 percent of crashes)
- A motorist turning or merging into the path of the bicyclist (12.1 percent of crashes)

- A bicyclist failing to yield at a midblock location (11.7 percent of crashes)
- A motorist overtaking a bicyclist (8.6 percent of crashes)
- A bicyclist turning or merging into the path of the motorist (7.3 percent of crashes)

The crash-typing methodology described above has evolved over time and has been refined as part of a software package known as the Pedestrian and Bicycle Crash Analysis Tool (PBCAT).[10] The development of PBCAT was sponsored by FHWA and NHTSA. Those interested may register for the PBCAT software and user's manual from the Pedestrian and Bicycle Information Center Web site at http://www.bicyclinginfo.org/bc/pbcat.htm. An update of this software will soon be available on the Web site.

PBCAT is a software product intended to assist state and local pedestrian and bicycle coordinators, planners, and engineers with the problem of lack of data regarding the sequence of events leading to a crash. PBCAT accomplishes this goal through the development and analysis of a database containing details associated with crashes between motor vehicles and pedestrians or bicyclists. One of these details is the crash type, which describes the pre-crash actions of the parties involved. The more than 70 specific bicyclist crash types used in PBCAT may be collapsed into 20 crash-typing groups. Several of these groups (including rarer or unusual crash types) have been further combined into 14 BIKESAFE groups for purposes of selecting treatments. A few PBCAT types that include rarer or difficult to remedy crashes that cannot be very specifically defined are not treated in the Crash Matrix. Some of these types of crashes are discussed in group 14 in the text that follows. Examining the closely-related crash groups for countermeasures could be helpful, as well as using the Performance Objectives Matrix to identify appropriate countermeasures. (See Chapter 4 for more information on the Crash and Performance Objectives matrices.)

DEFINITIONS OF BICYCLE CRASH TYPES

Provided below are the definitions of the 14 crash groups included in the BIKESAFE application (13 are included in the interactive crash matrix). These definitions are adapted from the PBCAT software.[10] For any crash group, there are multiple problems or possible causes that may have led to the crash. The following section provides examples of a few possible causes and problems for each group and some of the countermeasures within BIKESAFE that may be applicable. At the end of each potential solution is the countermeasure number in parentheses, which can be used to quickly locate the countermeasure description in Chapter 5.

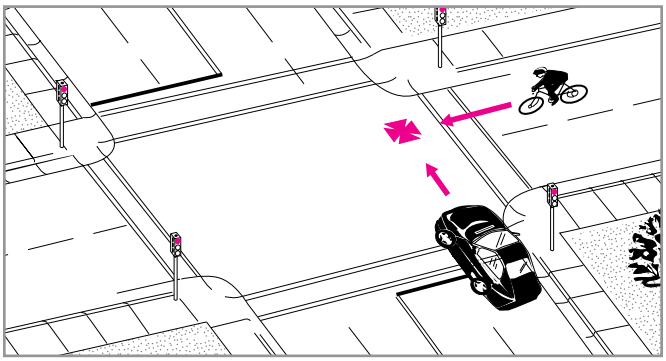
Neither the list of problems and possible causes nor the suggested countermeasures are to be considered comprehensive. Practitioners will still be required to supplement the analysis and recommendations with their own investigations and knowledge of local policies and practices. A number of potential countermeasures have, however, been identified for each group of crashes. The user is intended to think broadly initially, and develop their own narrower list of suitable options based on particular crash problems, detailed site conditions and other local circumstances. The countermeasures selection tool in the BIKESAFE software application (described in Chapter 4) is intended to aid in this process.

1. MOTORIST FAILED TO YIELD—SIGNALIZED INTERSECTION

The motorist enters an intersection and fails to stop at a traffic signal, striking a bicyclist who is traveling through the intersection on a perpendicular path. Typically, no turning movements are made by either party, except for a possible right turn on red. Many of these crashes involve bicyclists who are riding the wrong way against traffic, either in the roadway or on the sidewalk approaching the intersection.

Possible Cause/Problem #1

Motorist drives through a red signal without stopping. The motorist could be speeding and unable to stop in time, trying to get through the intersection on a yellow or amber signal indication, disregarding the signal, or failing to see the red signal.



General Countermeasures

a. Add/improve roadway lighting (4).

b. Reduce number of lanes (9).

c. Reduce lane width (10).

d. Install roundabouts (17).

e. Add/improve intersection markings (18).

f. Improve sight distance at intersection (19).

g. Install mini traffic circles (25).

h. Add chicanes or other traffic calming to slow motor vehicle speeds (26, 27).

i. Provide raised intersection (30).

j. Provide trail intersection treatments for shared-use paths crossing the roadway at the intersection (32).

k. Provide trail intersection warnings/advance treatments for shared-use paths crossing the roadway (33).

l. Optimize signal timing or improve signal visibility (35).

m. Make sign improvements (37).

n. Improve pavement markings (38).

o. Make school zone improvements (39).

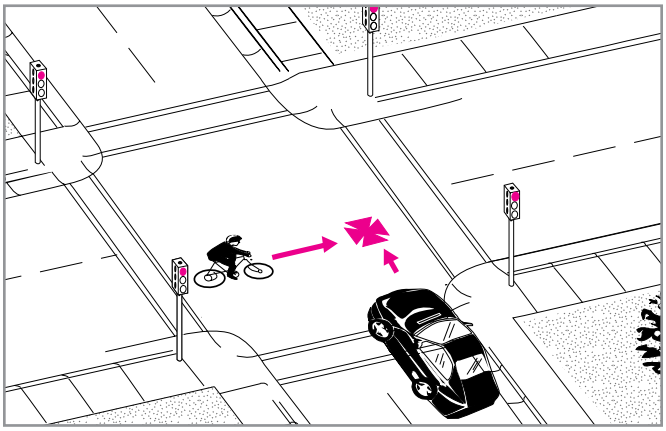
p. Provide law enforcement (40).

q. Provide bicyclist education on wrong-way riding and riding on the sidewalk (41).

r. Provide motorist education (42).

Possible Cause/Problem #2

The motorist drives out after stopping for a red signal, into the path of an oncoming bicyclist. The motorist may be making a right turn on red and fails to look to the right to see an approaching bicyclist. The bicyclist could be riding the wrong way in either the roadway or on the sidewalk.



General Countermeasures

a. Add/improve roadway lighting (4).

b. Reduce curb radii to slow motor vehicle speeds (16).

c. Install roundabouts (17).

d. Add/improve intersection markings (18).

e. Provide intersection sight distance improvements (19).

f. Restrict right-turn-on-red (20).

g. Provide trail-roadway intersection treatments for shared-use paths adjacent to the roadway (32).

h. Provide trail intersection advance warning treatments for shared-use paths adjacent to the roadway (33).

i. Make sign improvements (37).

j. Provide bicyclist education (41).

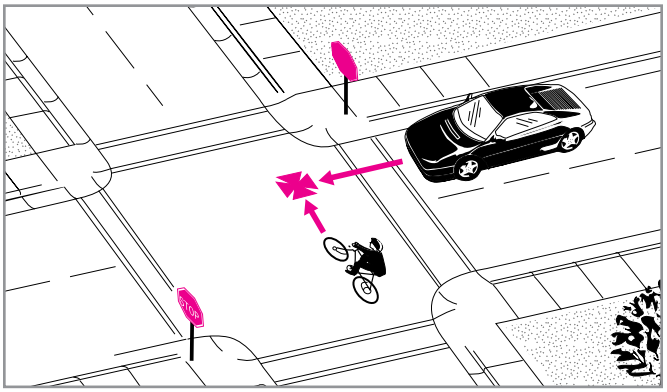
k. Provide motorist education (42).

2. MOTORIST FAILED TO YIELD—NON-SIGNALIZED INTERSECTION

The motorist enters an intersection without properly stopping or yielding at a stop sign, yield sign, or uncontrolled location, striking a bicyclist who is traveling through the intersection on an initial perpendicular path. Many of these crashes also involve bicyclists who are riding the wrong way against traffic, either in the roadway or on the sidewalk approaching the intersection.

Possible Cause/Problem #1

Motorist fails to stop at a stop sign or yield at a yield sign or uncontrolled intersection. The motorist could be speeding or otherwise fail to observe correct right-of-way, including flagrantly violating sign control.



General Countermeasures

a. Add/improve roadway lighting (4).

b. Reduce number of lanes (9).

c. Reduce lane width (10).

d. Reduce curb radii to slow motor vehicle turning speeds (16).

e. Install roundabout (17).

f. Add/improve intersection markings (18).

g. Improve intersection sight distance (19).

h. Redesign merge area (21).

i. Install mini traffic circle at intersection (25).

j. Add chicanes or other traffic calming to reduce vehicle speeds (26, 27).

k. Provide raised intersection and other traffic calming treatments (30).

l. Provide path intersection treatments for shared-use paths crossing the roadway (32).

m. Provide path intersection warnings/advance treatments for shared-use paths crossing the roadway (33).

n. Install traffic signal (35). If signal is installed, add bike detection/activation (36).

o. Make sign improvements (37).

p. Improve pavement markings (38).

q. Make school zone improvements (39).

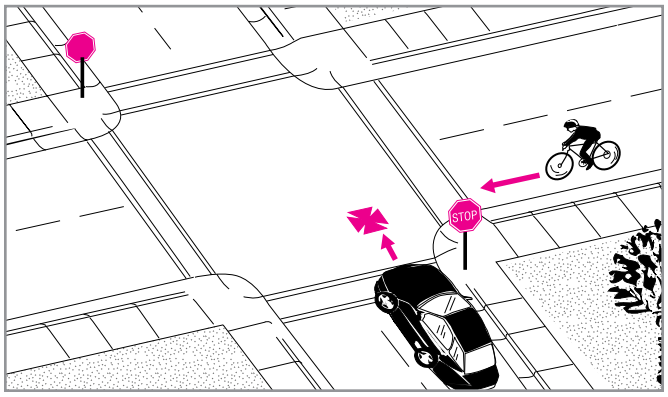
r. Provide law enforcement (40).

s. Provide bicyclist education on wrong-way riding and riding on the sidewalk (41).

t. Provide motorist education (42).

Possible Cause/Problem #2

The motorist pulls out into the path of a bicyclist traveling through the intersection after first stopping (or slowing). The bicyclist could be riding the wrong way or on the sidewalk or both and ride into the intersection in the pedestrian crosswalk area. The motorist may pull out and fail to check or notice the bicyclist approaching (particularly from the right). The motorist may be turning right.



General Countermeasures

a. Add/improve roadway lighting (4).

b. Reduce curb radii to slow turning speeds (16).

c. Install roundabout (17).

d. Add/improve intersection markings (18).

e. Improve sight distance (19).

f. Install mini traffic circle (25).

g. Provide raised intersection (30).

h. Provide path intersection treatments for shared-use paths crossing the roadway (32).

i. Provide trail intersection warnings/advance treatments for shared-use paths adjacent to the roadway (33).

j. Make school zone improvements (39).

k. Provide bicyclist education (41).

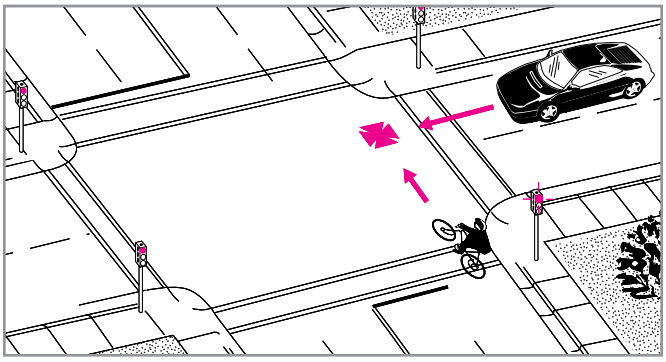
l. Provide motorist education (42).

3. BICYCLIST FAILED TO YIELD—SIGNALIZED INTERSECTION

The bicyclist enters an intersection on a red signal or is caught in the intersection by a signal change, colliding with a motorist who is traveling through the intersection. This group of crashes could involve a lack of understanding of the signal or inexperience for a young bicyclist or flagrant disregard for the signal by an older bicyclist. In many of these crashes, the bicyclist is likely to be riding on the sidewalk or riding the wrong way, against traffic, and fail to notice the signal indication.

Possible Cause/Problem #1

The bicyclist rides into the intersection through a red signal without stopping. The bicyclist may be trying to rush through on an amber signal indication, fail to see the red signal, or choose to disregard the signal. The bicyclist may not want to interrupt momentum or stop for a signal with an excessively long delay or that does not detect bicyclists' presence. Inexperience could also contribute to this type of crash. The signal may be more difficult to observe if the bicyclist is traveling wrong-way or riding on the sidewalk.



General Countermeasures

a. Add/improve roadway lighting (4).

b. Install roundabout (17).

c. Add/improve intersection markings (18).

d. Improve sight distance (19).

e. Provide path intersection treatments for shared-use paths crossing the roadway (32).

f. Provide path intersection advance warning treatments for shared-use paths crossing the roadway (33).

g. Install/optimize signal timing (35).

h. Install bike-activated signals (36).

i. Make sign improvements (37).

j. Improve pavement markings (38).

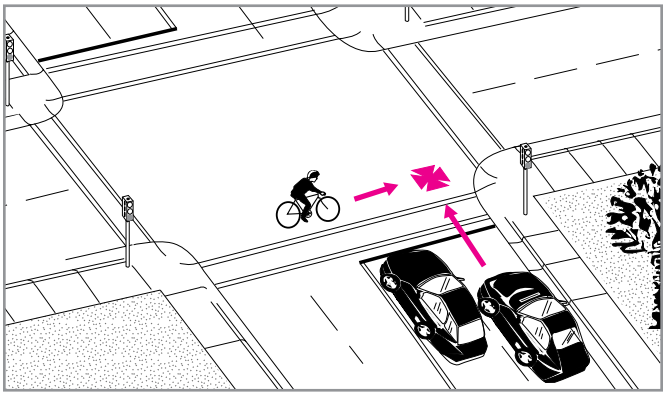
k. Make school zone improvements (39).

l. Provide law enforcement (40).

m. Provide bicyclist education (41).

Possible Cause/Problem #2

The bicyclist enters the intersection on a green or amber traffic signal indication but fails to clear the intersection when the traffic signal changes to green for the cross-street traffic. A multiple threat crash can also occur when the signal changes to green for the cross-street traffic and the bicyclist is struck by a motor vehicle whose view was obstructed by standing or stopped traffic in an adjacent lane.



General Countermeasures

a. Add/improve roadway lighting (4).

b. Reduce the number of traffic lanes (9).

c. Reduce the width of traffic lanes (10).

d. Install roundabout (17).

e. Add/improve intersection markings (18).

f. Improve sight distance at the intersection (19).

g. Add traffic calming treatments to slow motor vehicle speed (25, 26, 27, and 30).

h. Provide path intersection treatments for shared-use paths crossing the roadway (32).

i. Provide path intersection warnings/advance treatments for shared-use paths crossing the roadway (33).

j. Optimize signal timing (35).

k. Install bike-activated signal (36).

l. Make school zone improvements (39).

m. Provide bicyclist education (41).

n. Provide motorist education about multiple threat (42).

Possible Cause/Problem #3

The bicyclist rides into the intersection after stopping for a red signal and into the path of a motorist. The bicyclist may ride out after waiting for a green indication if there is no provision for bicycle detection or the delay is excessive.

General Countermeasures

a. Install a modern roundabout (17) or mini traffic circle (25) (depending on street function and volumes).

b. Improve signal timing (35).

c. Add bike-activation to the traffic signal (36).

d. Enforce traffic laws (40).

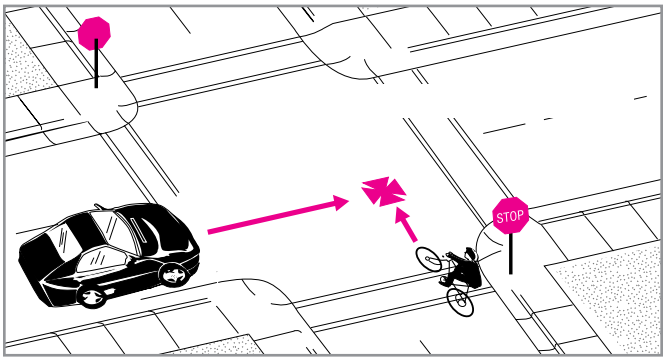
e. Provide bicyclist education (41).

4. BICYCLIST FAILED TO YIELD—NON-SIGNALIZED INTERSECTION

The bicyclist enters an intersection and fails to stop or yield at a non-signalized intersection (typically controlled by a stop sign), colliding with a motorist who is traveling through the intersection. This group of crashes could involve a lack of understanding of the sign control or inexperience for a young bicyclist, or flagrant disregard for the sign by an older bicyclist.

Possible Cause/Problem #1

Bicyclist fails to yield at a stop sign, yield sign or uncontrolled intersection. Sidewalk or wrong-way riding may exacerbate



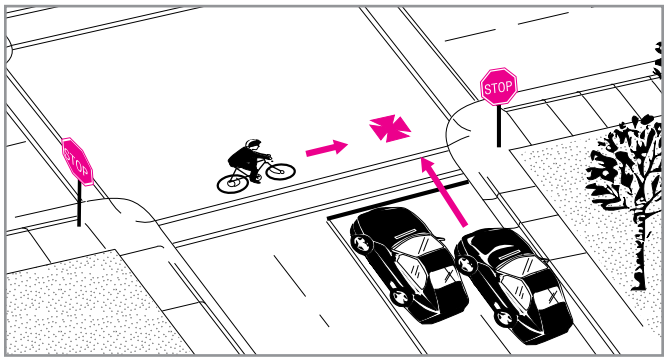
the problem by increasing the chances the bicyclist will not notice and obey sign control. Younger bicyclists tend to be disproportionately involved in this crash type.

General Countermeasures

a. Add/improve lighting (4).
b. Install roundabouts (17).
c. Improve sight distance at intersection (19).
d. Install mini traffic circle (25).
e. Provide path intersection treatments (32).
f. Provide path intersection warnings/advance treatments (33).
g. Install traffic signal (35) and bike-activated signal (36).
h. Make sign improvements (37).
i. Improve pavement markings (38).
j. Make school zone improvements (39).
k. Provide law enforcement (40).
l. Provide bicyclist education (41).

Possible Cause/Problem #2

The bicyclist rides out after stopping (or slowing). At a yield or two-way stop, the motorist could be speeding, the bicyclist may underestimate the time needed to start-up and get through the intersection, or the bicyclist may not detect an approaching motorist. At a four-way stop, the bicyclist may not understand right-of-way rules. A multiple threat situation can also occur at a non-signalized location.



General Countermeasures

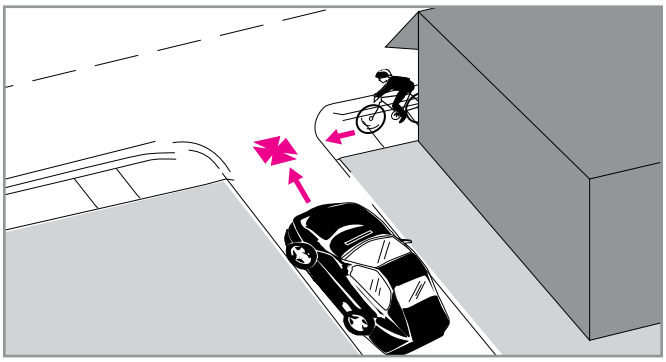
a. Add/improve lighting (4).
b. Reduce the number of traffic lanes (9).
c. Recuce the width of traffic areas (10).
d. Install roundabout (17).
e. Implement special intersection markings (18).
f. Improve sight distance at the intersection (19).
g. Redesign merge area (21).
h. Install mini traffic circle (25).
i. Install chicanes or other traffic calming measures to slow motorist speeds (26, 27, 30).
j. Install speed tables, humps, or cushions (27).
k. Install raised intersection (30).
l. Install traffic signal (35) and bike-activated signal (36).
m. Provide bicyclist education (41).
n. Provide motorists education about multiple threat and child bicyclists (42).

5. MOTORIST DROVE OUT—MIDBLOCK

The motorist typically pulls out of a driveway or alleyway and fails to yield to a bicyclist riding along the roadway or on a parallel path or sidewalk. Two-thirds of these types of crashes typically involve a bicyclist who is riding the wrong way against traffic, either on the sidewalk or on the roadway.

Possible Cause/Problem

The motorist pulls out of a residential or commercial driveway or alleyway and fails to yield to a bicyclist riding along the roadway, on the sidewalk, or on a parallel shared-use path. Visibility may be obscured by buildings, parked cars, trees and shrubs, signal control boxes, sign posts and a host of other things that can be found along the sidewalk or edge of the roadway. The motorist may also fail to look right before pulling out or fail to detect higher-speed bicyclists or those traveling wrong-way on the roadway or sidewalk.



General Countermeasures

a. Make parking improvements to increase sight distance (5).
b. Make driveway improvements (7).

c. Improve access management (8).

d. Provide path intersection treatments for shared-use paths adjacent to the roadway (32).

e. Provide path intersection warning treatments for shared-use paths adjacent to the roadway.

f. Optimize signal timing to create gaps mid-block (35).

g. Make sign improvements (37).

h. Improve pavement markings (38).

i. Provide law enforcement (40).

j. Provide bicyclist education (41).

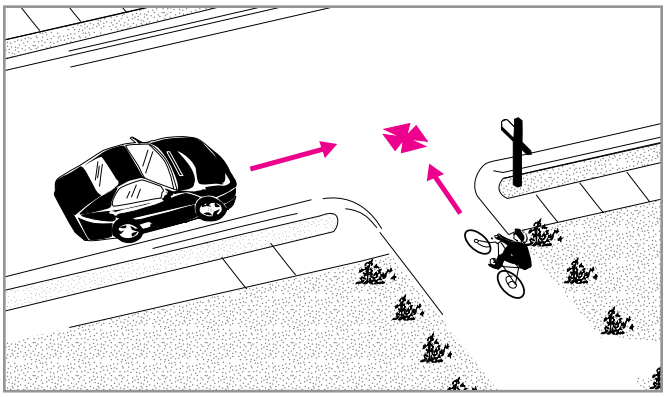
k. Provide motorist education (42).

6. BICYCLIST RODE OUT—MIDBLOCK

The bicyclist rides out from a residential driveway, commercial driveway, sidewalk, or other midblock location into the road and is struck by or collides with a motorist.

Possible Cause/Problem

The bicyclist rides out from a residential driveway, commercial driveway, sidewalk, or other midblock location into the road without stopping or yielding and is struck by a motorist. This crash type is a common one for young children who fail to stop and scan for vehicles before crossing the road or pulling out into traffic. Motorists speeding through neighborhood streets increase the risk of being unable to avoid this type of crash, so traffic calming measures may be appropriate.



General Countermeasures

a. Make parking improvements to increase visibility (5).

b. Install medians or crossing islands (6).

c. Make driveway improvements (7).

d. Improve access management (8).

e. Reduce number of lanes (9).

f. Reduce lane width (10).

g. Install traffic calming measures (26, 27, 28, 29).

h. Provide path intersection treatments for midblock roadway crossings (32).

i. Provide path intersection advance warnings treatments (33).

j. Optimize signal timing to create gaps mid-block (35).

k. If midblock signal is installed, add bike detection or activated signal (36).

l. Provide school zone improvements (39).

m. Provide law enforcement (40).

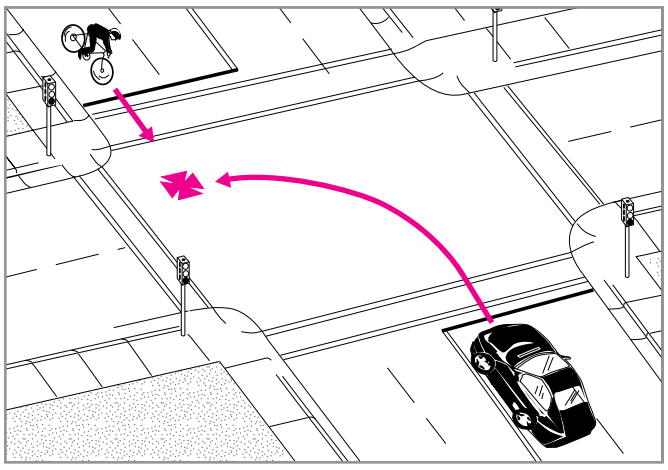
n. Provide bicyclist education (41).

7. MOTORIST TURNED OR MERGED LEFT INTO PATH OF BICYCLIST

The motorist turns left into the path of an oncoming bicyclist or turns or merges left across the path of a bicyclist who is traveling straight in the same direction as the motorist. This crash can also involve motorists or bus or delivery vehicles pulling out of parking spaces or stops.

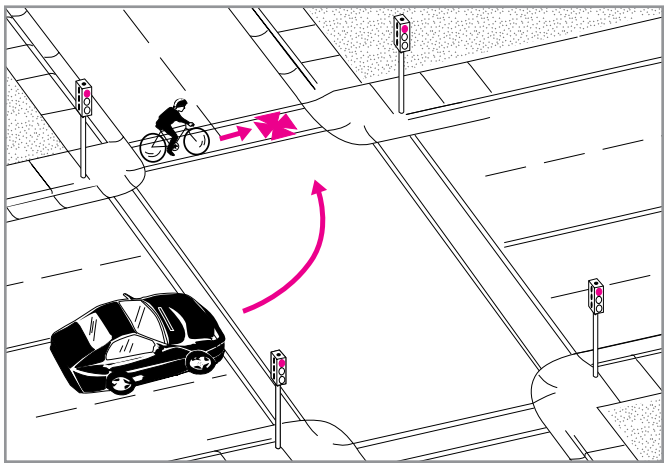
Possible Cause/Problem #1

The motorist turns left into the path of an oncoming bicyclist. The problem frequently occurs at signalized intersections on roads with four or more lanes, but may occur at driveways and other non-signalized junctions. The left-turning motorist is waiting for a gap in oncoming traffic and fails to look for, see, or yield to the oncoming bicyclist.



Possible Cause/Problem #2

A motorist turns or merges left across the path of a bicyclist who is traveling straight ahead in the same direction as the motorist. Many times this crash occurs at an intersection or driveway where the bicyclist is riding the wrong way against traffic or is riding the wrong way against traffic on the sidewalk. Reducing wrong-way riding would be a goal of bicyclist education and other countermeasures. Most general countermeasures are the same for these first two types of crashes.



General Countermeasures

a. Add/improve roadway lighting (4).
b. Install medians or crossing islands (6).
c. Make driveway improvements (7).
d. Improve access management (8).
e. Provide bike lanes (11).
f. Provide paved shoulders (13).
g. Reduce curb radii or redesign skewed intersections (16).
h. Install roundabout (17).
i. Enhance intersection markings (18).
j. Make sight distance improvements at intersection (19).
k. Restrict left turns (20).
l. Implement mini traffic circle (25).
m. Install traffic diversion (29).
n. Install raised intersection (30).
o. Provide path intersection treatments for shared-use paths adjacent to the roadway (32).
p. Provide path intersection warnings/advance treatments for shared-use paths adjacent to the roadway (33).
q. Install or optimize signal timing (dedicated left turn) (35).
r. Add sign improvements (37).
s. Provide bicyclist education (41).
t. Provide motorist education (42).

Possible Cause/Problem #3

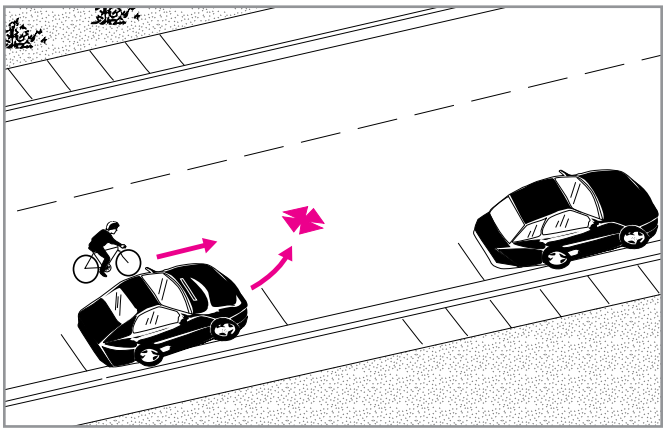
A motorist merges left across the path of a bicyclist traveling straight ahead at an on/off ramp or other merge or weave area.

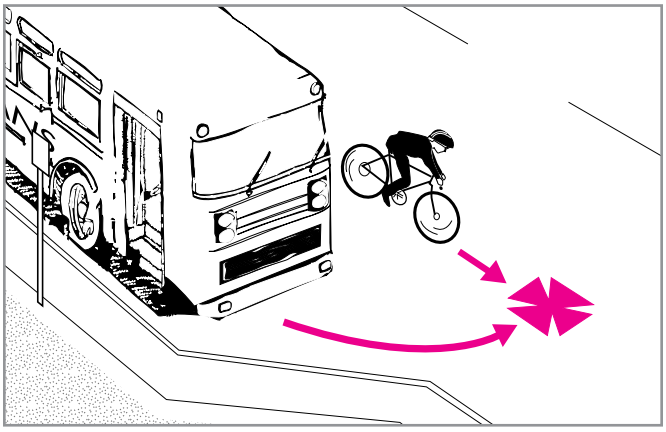
General Countermeasures

a. Improve roadway lighting (4).
b. Enhance intersection markings (18) or make pavement marking improvements (38).
c. Add sign improvements (37).
d. Redesign merge area (21).

Possible Cause/Problem #4

A motorist, bus, or delivery vehicle strikes a bicyclist when pulling out of a parking space or stop.





General Countermeasures

a. Add/improve roadway lighting (4).
b. Provide parking treatments (5).

c. Provide transit stop treatments (covered under bike lanes) (11).

d. Provide combination lanes (14).

e. Provide bicyclist education (41).

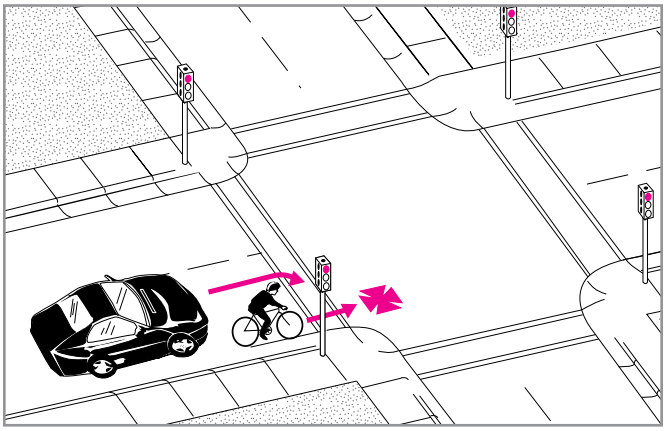
f. Provide motorist education (42).

8. MOTORIST TURNED OR MERGED RIGHT INTO PATH OF BICYCLIST

The motorist turns right into the path of a bicyclist traveling in the same direction or a motorist turning right strikes an oncoming bicyclist who is riding against traffic. This crash can also involve motorists pulling into parking spaces, bus or delivery vehicle pull-overs, or motorists making right turns on red.

Possible Cause/Problem #1

At an intersection, merge area, or driveway, the motorist turns or merges right across the path of a bicyclist who is traveling straight ahead in the same direction. The motorist may misjudge the speed of the bicyclist or believe (mistakenly) that the bicyclist should wait for them.



General Countermeasures

a. Add/improve roadway lighting (4).

b. Provide parking treatments (5).

c. Make driveway improvements (7).

d. Improve access management (8).

e. Reduce number of travel lanes to slow motor vehicle speeds (9).

f. Reduce lane width to encourage bicyclists to take the lane (in low-speed areas) (10).

g. Provide bike lanes (11).

h. Provide paved shoulders (13).

i. Reduce curb radii (16).

j. Improve intersection markings (18).

k. Implement turning restrictions (20).

l. Redesign merge areas (21).

m. Install traffic diversion (29).

n. Add raised intersection (30).

o. Provide path intersection treatments for shared-use paths adjacent to the roadway (32).

p. Provide path intersection warnings/advance treatments for shared-use paths adjacent to the roadway (33).

q. Make sign improvements (37).

r. Improve pavement markings (38).

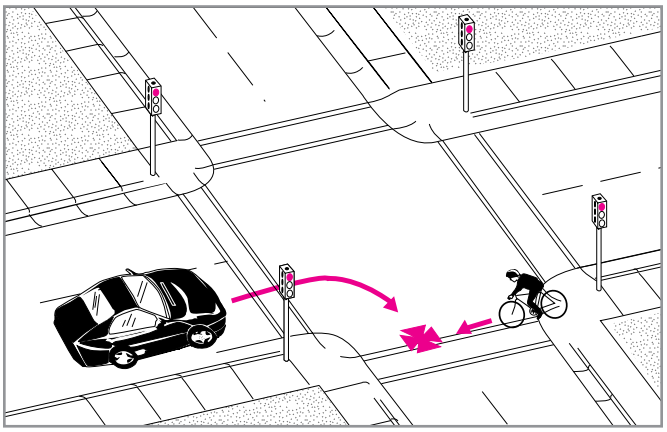
s. Provide law enforcement (40).

t. Provide bicyclist education (41).

u. Provide motorist education (42).

Possible Cause/Problem #2

A motorist turns right, striking a bicyclist approaching from the opposite direction. The bicyclist is most likely riding the wrong way, against traffic, but could be legally riding on the sidewalk or an adjacent shared-use path. This crash may involve a right-turn-on-red, with the bicyclist possibly violating a red signal since the crash type involves traveling on a parallel path to the motorist.



General Countermeasures

a. Add/improve roadway lighting (4).

b. Make driveway improvements (7).

c. Implement turning restrictions (20).

d. Install traffic diversion (29).

e. Provide path intersection treatments for shared-use paths adjacent to the roadway (32).

f. Provide path advance of intersection warning treatments for shared-use paths adjacent to the roadway (33).

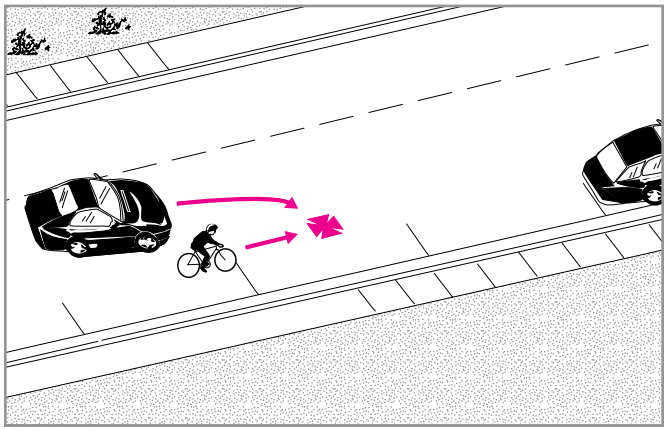
g. Make sign improvements (37).

h. Provide bicyclist education (41).

i. Provide motorist education (42).

Possible Cause/Problem #3

A motorist, bus, or delivery vehicle strikes a bicyclist when pulling into a parking space or stop.



General Countermeasures

a. Add/improve roadway lighting (4).

b. Provide parking treatments (5).

c. Provide transit stop treatments (covered under bike lanes) (11).

d. Provide combination lanes (14).

e. Provide bicyclist education (41).

f. Provide motorist education (42).

Possible Cause/Problem #4

A motorist merges right across the path of a bicyclist traveling straight ahead at an on/off ramp or other merge/weave area..

General Countermeasures

a. Improve roadway lighting (4).

b. Enhance intersection markings (18) or make pavement marking improvements (38).

c. Add sign improvements (37).

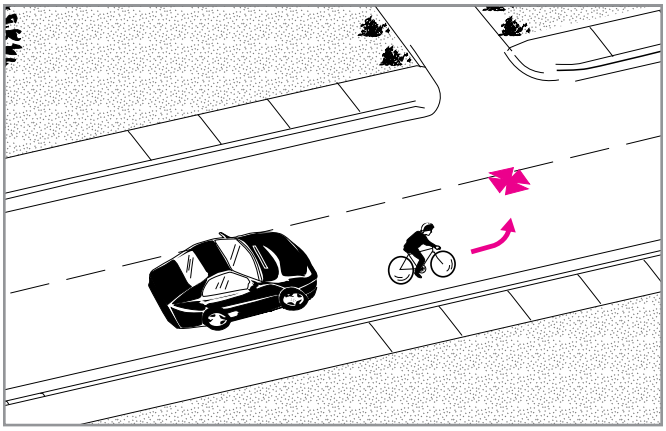
d. Redesign merge area (21).

9. BICYCLIST TURNED OR MERGED LEFT INTO PATH OF MOTORIST

The bicyclist turns or merges left into the path of an overtaking motorist who is traveling straight ahead in the same direction as the bicyclist, or a bicyclist turning left strikes an oncoming motorist. This crash can also involve a bicyclist riding out from a sidewalk or path beside the road. The bicycle and the motor vehicle are initially on parallel paths.

Possible Cause/Problem #1

The bicyclist turns or merges left from the right side of the roadway. The rider fails to see or yield to a motorist coming from behind and is hit by the overtaking motorist. The crash also could involve a bicyclist riding out from a sidewalk or path beside the road. Speed of overtaking vehicles may be a factor in this group of crashes. The motorist also may not see the bicyclist, or may not suspect that the bicyclist will turn in front in time to react.



General Countermeasures

a. Make roadway surface hazard improvements (1).

b. Add/improve roadway lighting (4).

c. Provide parking improvements (5).

d. Reduce number of lanes/road diet (9).

e. Reduce lane width in low-speed areas to encourage shared-lane use (10).

f. Install roundabout (17).

g. Improve intersection markings (18).

h. Perform repetitive and short-term maintenance to reduce surface hazards (22).

i. Perform major maintenance (23).

j. Institute a hazard identification program (24).

k. Install mini traffic circle (25).

l. Provide traffic calming treatments (26, 27, 28) to slow motor vehicle speeds.

m. Divert traffic (29).

n. Install raised intersection (30).

o. Provide path intersection treatments (parallel paths adjacent to the roadway) (32).

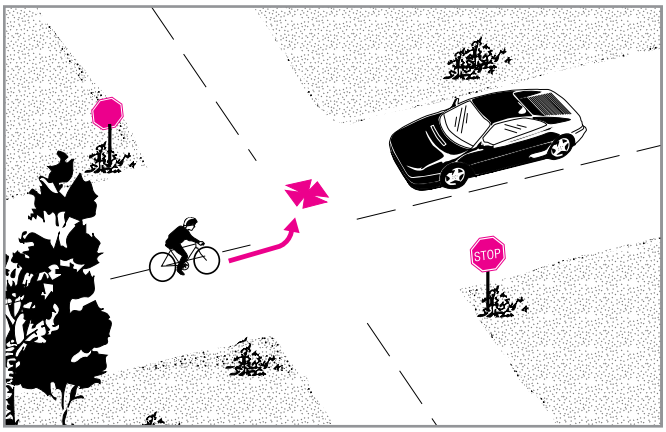
p. Provide path intersection warnings/advance treatments (33).

q. Make pavement marking improvements (38).

r. Provide bicyclist education (41).

Possible Cause/Problem #2

The bicyclist attempts to make a left turn and rides into the path of an oncoming motorist. The crash could occur at an intersection, a midblock driveway, or a shared-use path.



General Countermeasures

a. Install medians or crossing islands (6).

b. Improve driveways (7).

c. Improve access management (8).

d. Reduce number of lanes/road diet (9).

e. Reduce lane width (10).

f. Install roundabout (17).

g. Improve intersection markings (18).

h. Improve sight distance (19).

i. Install mini traffic circle (25).

j. Provide trail intersection treatments (32).

k. Provide trail intersection warnings/advance treatments (33).

l. Install/optimize signal timing (35).

m. Add bike activated signals (36).

n. Make pavement marking improvements (38).

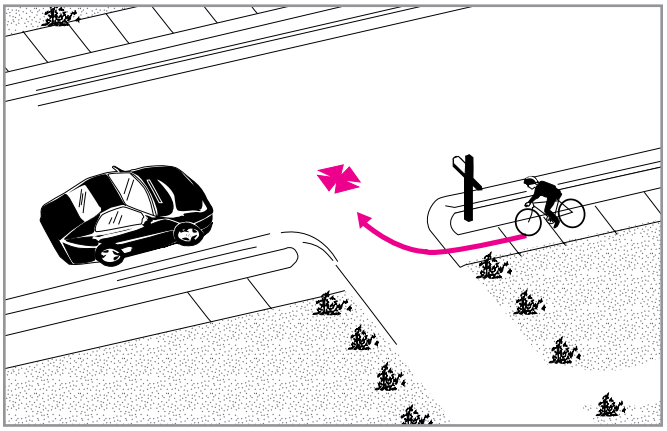
o. Provide bicyclist education (41).

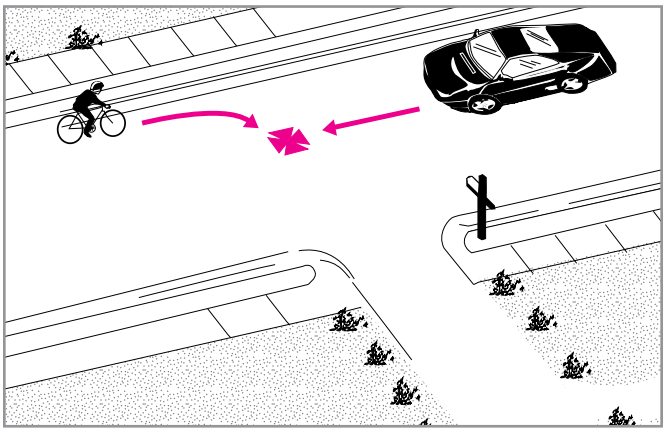
10. BICYCLIST TURNED OR MERGED RIGHT INTO PATH OF MOTORIST

The bicyclist turns or merges right into the path of an oncoming motorist, or a bicyclist turns right across the path of a motorist traveling in the same direction as the bicyclist. This crash can also involve a bicyclist riding out from a sidewalk or shared-use path beside the road. The bicycle and the motor vehicle are initially on parallel paths.

Possible Cause/Problem #1

The bicyclist turns or merges right into the path of an oncoming motorist. The crash could occur at an intersection or mid-block. The bicyclist may be riding out from an adjacent sidewalk or shared-use path or attempting to make a right turn from the wrong side of the roadway.





General Countermeasures

a. Reduce number of lanes/road diet to gain space for bike lanes (9).

b. Reduce lane width (10).

c. Install bike lanes on both sides of the street (11).

d. Provide/improve intersection markings (18).

e. Perform repetitive and short-term maintenance (22).

f. Perform major maintenance (23).

g. Institute a hazard identification program (24).

h. Add traffic calming treatments to slow motorist speeds (25, 26, 27, 28, 29, 30).

i. Provide path intersection treatments for shared-use paths adjacent to the roadway (32).

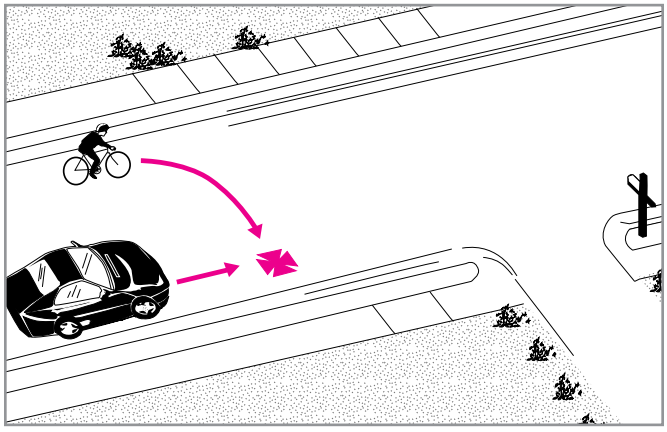
j. Provide path intersection warnings/advance treatments for shared-use paths adjacent to the roadway (33).

k. Make pavement marking improvements (38).

l. Provide bicyclist education on wrong-way riding (41).

Possible Cause/Problem #2

The bicyclist turns or merges right into the path of a motorist who is traveling straight ahead in the same original direction as the bicyclist. The bicyclist may be attempting to change lanes to make a right turn. This crash can also involve a bicyclist riding out from a sidewalk or shared-use path beside the road or changing from traveling facing traffic (wrong side of the street) to the correct side of the street.



General Countermeasures

a. Reduce number of lanes/road diet to gain space for bike lanes (9).

b. Reduce lane width to slow motor vehicle speeds (10).

c. Install bike lanes on both sides of the street (11).

d. Provide or improve intersection markings (18).

e. Institute good maintenance practices to reduce surface and other hazards (22, 23, 24).

f. Add traffic calming treatments (25, 26, 27, 28, 29, 30).

g. Provide trail intersection treatments for shared-use paths adjacent to the roadway (32).

h. Provide trail intersection warnings/advance treatments for shared-use paths adjacent to the roadway (33).

i. Make pavement marking improvements (38).

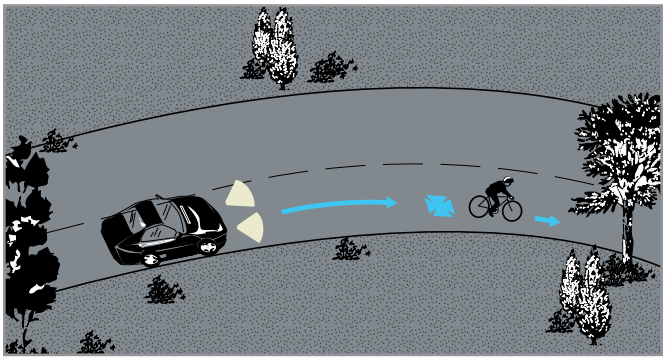
j. Provide bicyclist education on wrong-way riding and scanning behind (41).

11. MOTORIST OVERTAKING BICYCLIST

The motorist is overtaking a bicyclist and strikes the bicyclist from behind. These crashes tend to occur because the motorist fails to detect the bicyclist, the bicyclist swerves to the left to avoid an object or surface irregularity, or the motorist misjudges the space necessary to pass the bicyclist.

Possible Cause/Problem #1

The motorist is overtaking and fails to detect a bicyclist, striking the bicyclist from behind. These crashes often occur at night, and one or both parties may have been drinking. The bicyclist may have inadequate lights or reflectors, or may not be using lights.



General Countermeasures

a. Provide space on bridges/overpasses (2).

b. Provide space and other measures in tunnels/underpasses (3).

c. Add/improve roadway lighting (4).

e. Provide space on roadway for bicyclists with bike lanes (11), wide curb lanes (12), paved shoulders (13), or combination lanes (14).

f. Provide chicanes or serpentine for low-speed, shared-lane situations (26).

g. Provide other traffic calming measures (27, 28, 29).

h. Provide a separate path or trail (31).

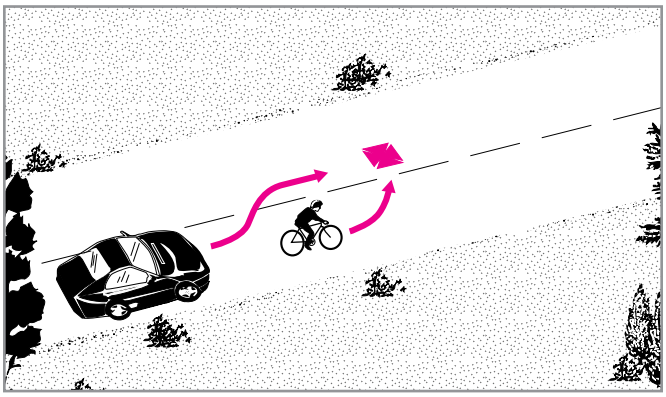
i. Make sign improvements (37).

j. Improve pavement markings (38).

k. Provide bicyclist education about conspicuity and riding at night (41).

l. Provide motorist education (42).

Possible Cause/Problem #2
The overtaking motorist strikes a bicyclist suddenly swerving to the left, possibly to avoid an object or surface irregularity, extended door of a parked car, or other obstacle.



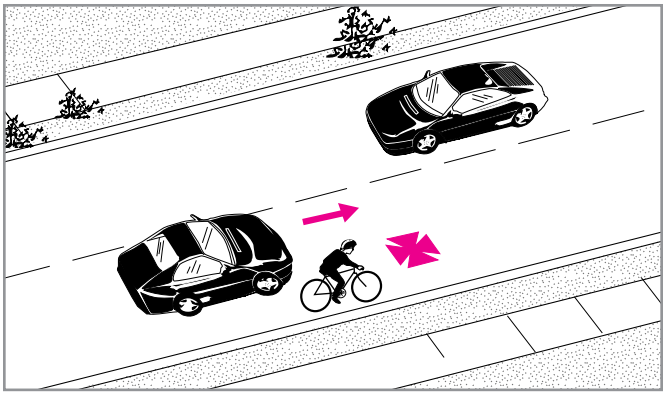
General Countermeasures

a. Make roadway surface hazard improvements (1).
b. Add/improve roadway lighting (4).
c. Provide parking improvements (5).
d. Make driveway improvements (7).
e. Provide bike lanes (11).
f. Provide wide curb lanes (12).
g. Provide paved shoulders (13).
h. Perform repetitive and short-term maintenance (22), major maintenance (23), and institute a hazard identification program (24).
i. Provide chicanes or serpentine design or other traffic calming measures (26, 27, 28, 29).
j. Provide a separate path or trail (31).
k. Make sign improvements (37).
l. Improve pavement markings (38).
m. Provide bicyclist education about avoiding objects and correct spacing from parked motor vehicles (41).
n. Provide motorist education (42).

Possible Cause/Problem #3
The overtaking motorist detects the bicyclist ahead but fails to allow enough space to safely pass the bicyclist.

General Countermeasures

a. Make roadway surface hazard improvements (1).
b. Provide space on bridges and overpasses (2).
c. Provide space and other measures in tunnels and underpasses (3).

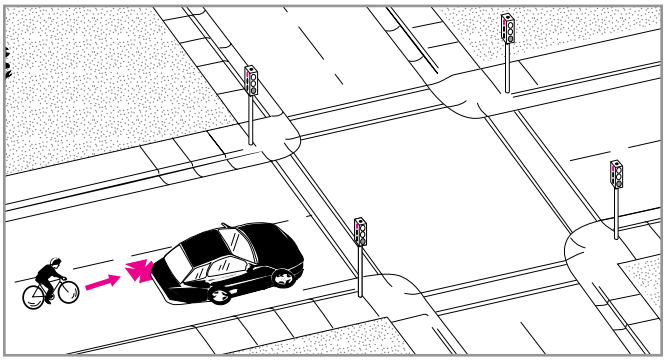


d. Add/improve roadway lighting (4).
e. Reduce lane width (on low speed roads) to encourage bicyclist to "take the lane" (10).
f. Provide space for bicyclists on high speed roadways with bike lanes (11), wide curb lanes (12), or paved shoulders (13).
g. Identify maintenance needs and perform routine and major maintenance (22, 23, 24).
h. Provide chicanes or chicane-like parking (26).
i. Provide a separate shared-use path (31).
j. Make sign improvements (37).
k. Improve pavement markings (38).
l. Provide bicyclist education (41).
m. Provide motorist education (42).

12. BICYCLIST OVERTAKING MOTORIST

The bicyclist is overtaking and strikes the motor vehicle from behind. These crashes tend to occur because the bicyclist tries to pass on the right or left, the bicyclist strikes a parked vehicle while passing, or the bicyclist strikes an extended door on a parked vehicle while passing.

Possible Cause/Problem #1
The overtaking bicyclist strikes a motor vehicle while attempting to pass on either the right or the left.



General Countermeasures

a Provide space for bicyclists with bike lanes (11), wide curb lanes (12), paved shoulders (13), or combination lanes (14).

b. Perform repetitive and short-term maintenance (22).

c. Perform major maintenance (23).

d. Institute a hazard identification program (24).

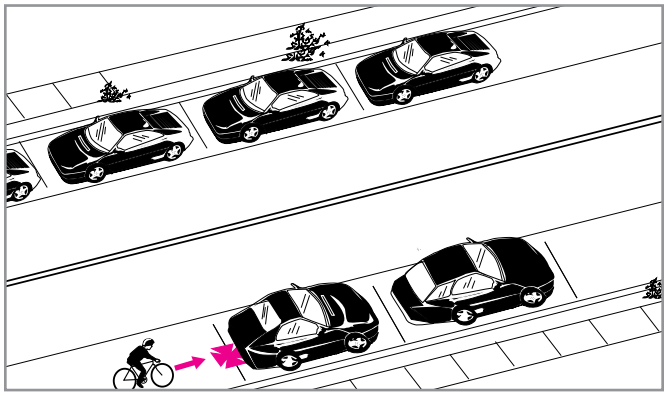
e. Provide a separate shared-use path (31).

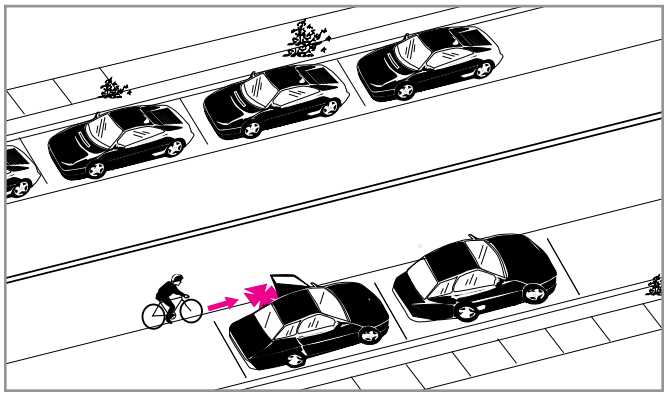
f. Improve pavement markings (38).

g. Provide bicyclist education (41).

Possible Cause/Problem #2

The overtaking bicyclist strikes a parked motor vehicle or extended door of a parked motor vehicle while attempting to pass on either the right or the left.





General Countermeasures

a. Implement parking treatments (5).

b. Provide bike lanes (11).

c. Provide wide outside lanes (12).

d. Provide paved shoulders (13).

e. Provide a separate shared-use path (31).

f. Improve pavement markings (38).

g. Provide bicyclist education (41).

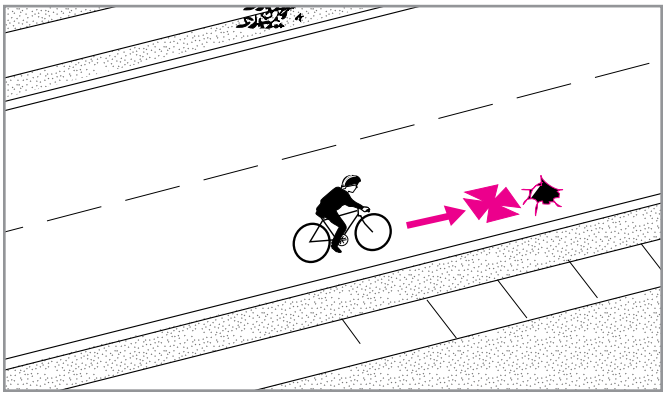
h. Provide motorist education (42).

13. NON-MOTOR VEHICLE CRASHES

These crashes do not involve a motor vehicle and can occur in a variety of ways, including falls from a bike, a collision between two bicycles, a collision between a bike and a pedestrian, or a bicyclist striking an object.

Possible Cause/Problem #1

The bicyclist loses control due to a pavement surface irregularity, debris, or other hazard.



General Countermeasures

a. Make roadway surface hazard improvements (1).

b. Improve bridge access and surfaces (2).

c. Improve tunnel access and surfaces (3).

d. Add/improve roadway lighting (4).

e. Make driveway improvements (5).

f. Perform repetitive and short-term maintenance (22).

g. Perform major maintenance (23).

h. Institute a hazard identification program (24).

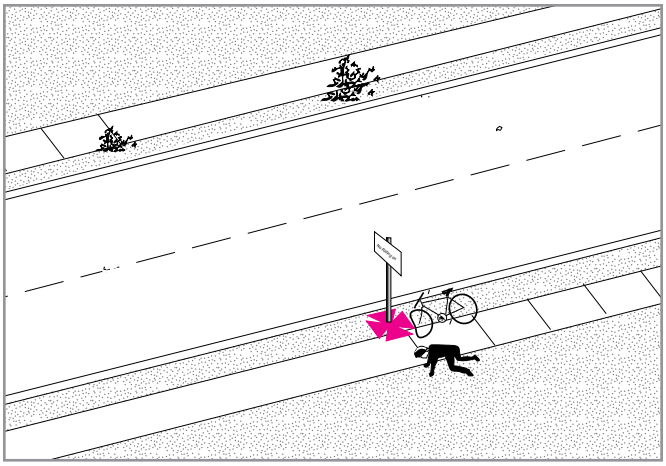
i. Implement "share the path" measures (34).

j. Improve pavement markings (38).

k. Provide bicyclist education (41).

Possible Cause/Problem #2

The bicyclist strikes a pedestrian, object or other bicyclist on a shared-use path, sidewalk, or roadway.

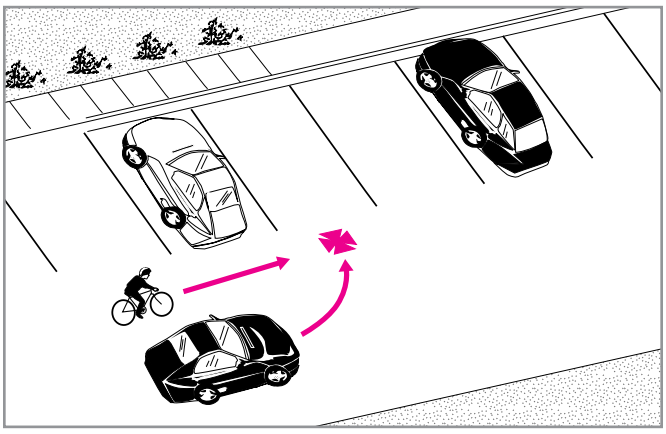


General Countermeasures

a. Make roadway surface hazard improvements (1).
b. Add/improve lighting (4).
c. Make parking improvements (5).
d. Implement maintenance countermeasures (22, 23, 24).
e. Provide path intersection treatments (32).
f. Provide path intersection advance warning treatments (33).
g. Implement "share the path" measures (34).
h. Improve pavement markings (38).
i. Provide school zone improvements (39).
j. Provide bicyclist education (41).

14. NON-ROADWAY AND OTHER CRASHES

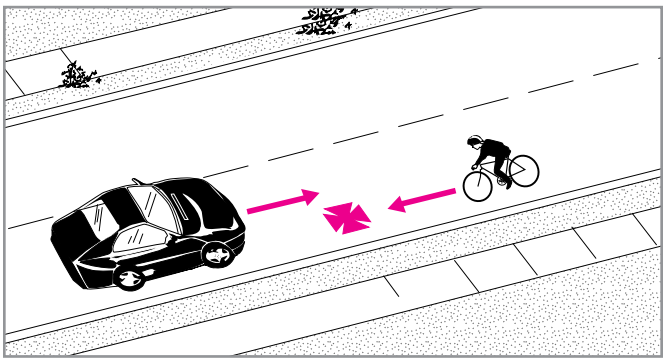
Possible Cause/Problem #1 (Non-Roadway)
A motorist and bicyclist collide in a parking lot or driveway. The motor vehicle may be backing at the time of the crash.



General Countermeasures

a. Add/improve lighting (4).
b. Redesign parking (5).
c. Make driveway improvements (7).
d. Perform repetitive and short-term maintenance (22).
e. Perform major maintenance (23).
f. Institute a hazard identification program (24).
g. Provide speed tables, humps, or cushions (27).
h. Make sign improvements (37).
i. Improve pavement markings (38).
j. Provide bicyclist education (41).
k. Provide motorist education (42).

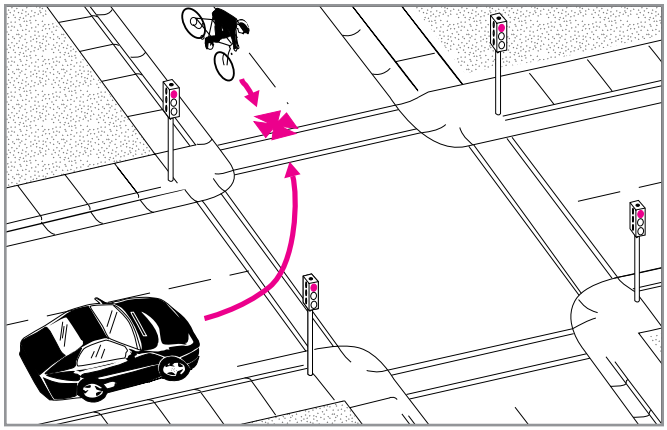
Possible Cause/Problem #2 (Other)
Either the bicyclist or the motorist was traveling in the wrong lane or direction and collided head-on with the other. The bicyclist could have been riding on the wrong side of the roadway or the motorist could have been passing another vehicle when the crash occurred.

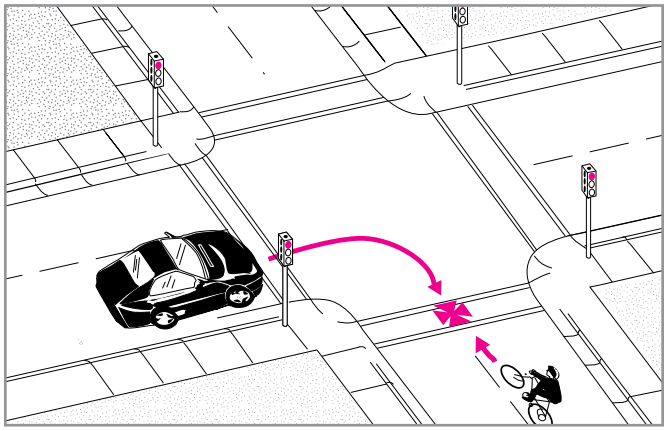


General Countermeasures

a. Add or improve roadway lighting (4).
b. Provide bike lanes (11).
c. Provide paved shoulders (13).
d. Complete repetitive and short-term maintenance (general sight distance maintenance) (22, 24).
e. Provide law enforcement (40).
f. Provide bicyclist education about wrong-way riding and conspicuity and using lights at night (41).
g. Provide motorist education on safe passing (42).

Possible Cause/Problem #3 (Other)
Either the bicyclist or motorist made a turning error (swung too wide on a right turn or cut the corner on a left turn) and turned into the opposing lane or path of the other.





General Countermeasures

a. Install median divider (6).

b. Make driveway improvements (7).

c. Revise curb radii or re-align skewed intersections (16).

d. Install roundabout (17) or mini traffic circle (25) at intersection.

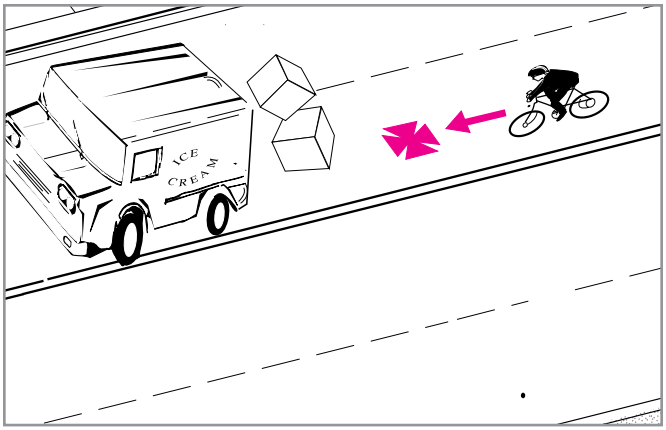
e. Add or improve intersection markings (18).

f. Impose turning restrictions (20).

g. Install raised intersection (30).

Possible Cause/Problem #4 (Other)

The bicyclist or motorist intentionally caused the crash, one or the other lost control due to impairment, mechanical problems, or other causes, or there were other unusual circumstances such as the bicyclist being struck by falling cargo. Few specific countermeasures can be identified for unusual or non-specific types of crashes other than educational and enforcement measures. To view general performance objectives and corresponding countermeasures to reduce crashes and encourage safer bicycling, go to the Performance Objectives section.



CRASH-RELATED COUNTERMEASURES

A total of 50 different bicyclist countermeasures are presented in Chapter 5 of this guide. To assist engineers and planners who may want further guidance on which measures are appropriate to address certain types of bicycle crashes, a matrix is provided on pages 32–33. The applicable treatments within the nine categories of countermeasures are shown for each of the 13 crash type groups.

To illustrate how to use the table, consider the sixth crash type group in the table ("Bicyclist Ride Out—Midblock"). This is a crash involving a bicyclist riding out into the roadway from a location in the middle of the block, such as a residential driveway. This tends to be a right-angle crash and often involves younger bicyclists.

The chart shows that there are 17 potential countermeasures that may reduce the probability of this type of crash, depending on the site conditions. These countermeasures include shared roadway improvements, such as removal of parking to increase sight distance, traffic calming measures such as speed humps that could slow motor vehicle speeds and decrease the braking distance, and other possible countermeasures.

In Chapter 5, details are provided on each of the countermeasures listed. The quick reference index at the start of Chapter 5 can be used to easily locate the page containing the detailed description. The Web/CD-ROM application allows the list of countermeasures to be refined on the basis of site characteristics (see Chapter 4).

These charts are intended to give general information on candidate solutions that should be considered when trying to reduce a pattern of bicycle crashes at a specific location or roadway section. Many bicyclist crashes are the direct result of careless or illegal motorist behavior or unsafe bicyclist behavior. Many of these crashes can-

not necessarily be prevented by roadway improvements alone. In such cases, bicyclist and motorist education and enforcement activities may be helpful.

PERFORMANCE OBJECTIVES

Bicyclists face a variety of challenges when they ride along and across streets with motor vehicles. Communities are asking for help to "slow traffic down," and "make the street more inviting to bicyclists."

The following is a list of requests (objectives) that transportation professionals are likely to face when working to provide bicycle safety and mobility:

- Provide safe on-street facilities/space for bicyclists.
- Provide off-road paths or trails for bicyclists.
- Provide and maintain quality surfaces for bicyclists.
- Provide safe intersections for bicyclists.
- Improve motorist behavior/compliance with traffic laws.
- Improve bicyclist behavior/compliance with traffic laws.
- Encourage and promote bicycling.

Each of these objectives can be accomplished through a variety of the individual treatments presented in this chapter. Yet, most treatments will work best when used at multiple locations and in combination with other treatments.

In addition, many of the treatments will accomplish two or more objectives. The key is to make sure that the right treatments are chosen to accomplish the desired effect.

The matrix located on pages 34–35 shows which countermeasures are appropriate to consider for the seven performance objectives. In using the chart, it is important to remember that it is simply a guide. In all cases, good engineering judgment should be applied when making decisions about what treatment will be best for a specific location.

PROGRAM OF IMPROVEMENTS

While some bicycle crashes are associated with deficient roadway designs, bicyclists and motorists often contribute to crashes through a disregard or lack of understanding of laws and safe driving or riding behavior.[9] Because most crashes are a result of human error, crashes will not be completely eliminated as long as bicyclists and motor vehicles share the same space. The consequences of these crashes are exacerbated by speeding, failing to yield, or failing to check both directions for traffic, so new education, enforcement, and engineering tools are needed to manage the conflicts between bicyclists and drivers.

A complete program of bicyclist safety improvements includes:

- Shared roadway accommodations, such as provision of roadway surface improvements or lighting where needed.
- Provision of bicyclist facilities, such as bike lanes, wide curb lanes and separate trails.
- Provision of intersection treatments, such as curb radii revisions and sight distance improvements.
- Maintenance of roadways and trails.
- Use of traffic calming treatments, such as mini circles and speed control measures.
- Adequate signs, signals, and markings, particularly as pertains to intersections and share-the-road philosophies.
- Programs to enforce existing traffic laws and ordinances for motorists (e.g., obeying speed limits, yielding to approaching bicyclists when turning, traffic signal compliance, obeying drunk-driving laws) and bicyclists (e.g., riding in the same direction with traffic, obeying traffic signals and signs).
- Encouraging bicyclists to use reflective clothing and appropriate lighting when riding at night.
- Encouraging and educating bicyclists in proper helmet use.
- Education programs provided to motorists and bicyclists.
- Providing support facilities, such as bicycle parking and events, such as ride-to-work days or fundraisers to support bicycling.

Roadway improvements can often reduce the likelihood of a bicycle-motor vehicle crash. Physical improvements are most effective when tailored to an individual location and traffic problem. Factors to consider when choosing an improvement include: location characteristics, bicycle and motor vehicle volume and types, motor vehicle speed, design of a given location, city laws and ordinances, and financial constraints. Many of these factors are included for consideration in the BIKESAFE Selection Tool (see Chapter 4).

It is important to remember that overuse or unjustified use of any traffic control measure is not recommended, since this may breed disrespect for such devices. While facilities and shared roadway accommodations for bicyclists can, in many cases, reduce the risk of collisions, crash reduction is not the only reason for providing such accommodations. Other benefits include improved access to destinations by riding, better air quality due to less dependence on driving, and improved personal health. Traffic and transportation engineers have the responsibility

for providing facilities for all modes of travel, including bicycling (and walking).

COUNTERMEASURES ASSOCIATED WITH SPECIFIC CRASH GROUPS

Crash Type	Shared Roadway	On-Road Bike Facilities	Intersection Treatments	Maintenance
1) Motorist failed to yield – signalized intersection	· Lighting Improvements · Reduce Lane Number · Reduce Lane Width		· Curb Radii Revisions · Roundabouts · Intersection Markings · Sight Distance Improvements · Turning Restrictions	·
2) Motorist failed to yield – non-signalized intersection	· Lighting Improvements · Reduce Lane Number · Reduce Lane Width		· Curb Radii Revisions · Roundabouts · Intersection Markings · Sight Distance Improvements · Merge and Weave Area Redesign	
3) Bicyclist failed to yield – signalized intersection	· Lighting Improvements · Median/Crossing Island · Reduce Lane Number · Reduce Lane Width		· Roundabouts · Intersection Markings · Sight Distance Improvements	
4) Bicyclist failed to yield – non-signalized intersection	· Lighting Improvements · Reduce Lane Number · Reduce Lane Width		· Roundabouts · Intersection Markings · Sight Distance Improvements · Merge and Weave Area Redesign	
5) Motorist drive out – midblock	· Parking Treatments · Driveway Improvements · Access Management			
6) Bicyclist ride out – midblock	· Parking Treatments · Median/Crossing Island · Driveway Improvements · Access Management · Reduce Lane Number · Reduce Lane Width			
7) Motorist turned or merged left into path of bicyclist	· Lighting Improvements · Parking Treatments · Median/Crossing Island · Driveway Improvements · Access Management · Reduce Lane Number	· Bike Lanes · Paved Shoulders · Combination Lanes	· Curb Radii Revisions · Roundabouts · Intersection Markings · Sight Distance Improvements · Turning Restrictions · Merge and Weave Area Redesign	
8) Motorist turned or merged right into path of bicyclist	· Lighting Improvements · Parking Treatments · Driveway Improvements · Access Management · Reduce Lane Number · Reduce Lane Width	· Bike Lanes · Paved Shoulders · Combination Lanes	· Curb Radii Revisions · Intersection Markings · Turning Restrictions · Merge and Weave Area Redesign	
9) Bicyclist turned or merged left into path of motorist	· Roadway Surface Improvements · Lighting Improvements · Parking Treatments · Median/Crossing Island · Driveway Improvements · Access Management · Reduce Lane Number · Reduce Lane Width		· Roundabouts · Intersection Markings · Sight Distance Improvements	· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program
10) Bicyclist turned or merged right into path of motorist	· Reduce Lane Number · Reduce Lane Width	· Bike Lanes	· Intersection Markings	· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program
11) Motorist overtaking bicyclist	· Roadway Surface Improvements · Bridge and Overpass Access · Tunnel and Underpass Access · Lighting Improvements · Parking Treatments · Reduce Lane Width	· Bike Lanes · Wide Curb Lanes · Paved Shoulders · Combination Lanes		· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program
12) Bicyclist overtaking motorist	· Parking Treatments	· Bike Lanes · Wide Curb Lanes · Paved Shoulders · Combination Lanes		· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program
13) Non-motor vehicle crashes	· Roadway Surface Improvements · Bridge and Overpass Access · Tunnel and Underpass Access · Lighting Improvements · Parking Treatments · Driveway Improvements			· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program

Traffic Calming	Trails/Shared-Use Paths	Markings, Signs, Signals	Education and Enforcement
· Mini Traffic Circles · Chicanes · Speed Tables/Humps/Cushions · Raised Intersection	· Path Intersection Treatments · Intersection Warning Treatments	· Install Signal/Optimize Timing · Sign Improvements · Pavement Marking Improvements · School Zone Improvements	· Law Enforcement · Bicyclist Education · Motorist Education
· Mini Traffic Circles · Chicanes · Visual Narrowing · Speed Tables/Humps/Cushions · Raised Intersection	· Path Intersection Treatments · Intersection Warning Treatments	· Install Signal/Optimize Timing · Sign Improvements · Pavement Marking Improvements · School Zone Improvements	· Law Enforcement · Bicyclist Education · Motorist Education
· Mini Traffic Circles	· Path Intersection Treatments · Intersection Warning Treatments	· Install Signal/Optimize Timing · Bike-Activated Signal · Sign Improvements · Pavement Marking Improvements · School Zone Improvements	· Law Enforcement · Bicyclist Education · Motorist Education
· Mini Traffic Circles · Chicanes · Speed Tables/Humps/Cushions · Raised Intersection	· Path Intersection Treatments · Intersection Warning Treatments	· Install Signal/Optimize Timing · Bike-Activated Signal · Sign Improvements · Pavement Marking Improvements · School Zone Improvements	· Law Enforcement · Bicyclist Education · Motorist Education
	· Path Intersection Treatments · Intersection Warning Treatments	· Install Signal/Optimize Timing · Sign Improvements · Pavement Marking Improvements	· Law Enforcement · Bicyclist Education · Motorist Education
· Chicanes · Speed Tables/Humps/Cushions · Visual Narrowing · Traffic Diversion	· Path Intersection Treatments · Intersection Warning Treatments	· Install Signal/Optimize Timing · Bike-Activated Signal · School Zone Improvements	· Law Enforcement · Bicyclist Education
· Mini Traffic Circles · Traffic Diversion · Raised Intersection	· Path Intersection Treatments · Intersection Warning Treatments	· Install Signal/Optimize Timing · Sign Improvements · Pavement Marking Improvements	· Bicyclist Education · Motorist Education
· Traffic Diversion · Raised Intersection	· Path Intersection Treatments · Intersection Warning Treatments	· Sign Improvements · Pavement Marking Improvements	· Bicyclist Education · Motorist Education
· Mini Traffic Circles · Chicanes · Speed Tables/Humps/Cushions · Visual Narrowing · Traffic Diversion · Raised Intersection	· Path Intersection Treatments · Intersection Warning Treatments	· Install Signal/Optimize Timing · Bike-Activated Signal · Pavement Marking Improvements	· Bicyclist Education
· Mini Traffic Circles · Chicanes · Speed Tables/Humps/Cushions · Visual Narrowing · Traffic Diversion · Raised Intersection	· Path Intersection Treatments · Intersection Warning Treatments	· Pavement Marking Improvements	· Bicyclist Education
· Chicanes · Speed Tables/Humps/Cushions · Visual Narrowing · Traffic Diversion	· Separate Shared-Use Path	· Sign Improvements · Pavement Marking Improvements	· Bicyclist Education · Motorist Education
	· Separate Shared-Use Path	· Pavement Marking Improvements	· Bicyclist Education · Motorist Education
	· Path Intersection Treatments · Intersection Warning Treatments · Share the Path Treatments	· Pavement Marking Improvements · School Zone Improvements	· Bicyclist Education

COUNTERMEASURES ASSOCIATED WITH SPECIFIC OBJECTIVES

Objectives	Shared Roadway	On-Road Bike Facilities	Intersection Treatments	Maintenance
1) Provide safe on-street facilities/space for bicyclists.	· Roadway Surface Improvements · Bridge and Overpass Access · Tunnel and Underpass Access · Lighting Improvements · Parking Treatments · Median/Crossing Island · Driveway Improvements · Access Management · Reduce Lane Number · Reduce Lane Width	· Bike Lanes · Wide Curb Lanes · Paved Shoulders · Combination Lanes · Contraflow Bike Lanes		· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program
2) Provide off-road paths or trails for bicyclists.				· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program
3) Provide and maintain quality surfaces for bicyclists.	· Roadway Surface Improvements · Bridge and Overpass Access · Tunnel and Underpass Access			· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program
4) Provide safe intersections for bicyclists.	· Lighting Improvements · Parking Treatments · Reduce Lane Number · Reduce Lane Width		· Curb Radii Revisions · Roundabouts · Intersection Markings · Sight Distance Improvements · Turning Restrictions · Merge and Weave Area Redesign	
5) Improve motorist behavior/compliance with traffic laws.	· Lighting Improvements · Parking Treatments · Driveway Improvements · Reduce Lane Width		· Curb Radii Revisions · Roundabouts · Intersection Markings · Sight Distance Improvements · Merge and Weave Area Redesign	· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program
6) Improve bicyclist behavior/compliance with traffic laws.	· Roadway Surface Improvements · Bridge and Overpass Access · Tunnel and Underpass Access · Parking Treatments	· Bike Lanes	· Intersection Markings · Sight Distance Improvements · Merge and Weave Area Redesign	· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program
7) Encourage and promote bicycling.	· Roadway Surface Improvements · Bridge and Overpass Access · Tunnel and Underpass Access · Lighting Improvements · Median/Crossing Island	· Bike Lanes · Paved Shoulders		· Repetitive/Short-Term Maintenance · Major Maintenance · Hazard Identification Program

Traffic Calming	Trails/Shared-Use Paths	Markings, Signs, Signals	Education and Enforcement	Support Facilities and Programs
· Mini Traffic Circles · Chicanes · Speed Tables/Humps/ Cushions · Visual Narrowing · Traffic Diversion · Raised Intersection		· Sign Improvements · Pavement Marking Improvements · School Zone Improvements	· Practitioner Education	· Wayfinding · Aesthetics/Landscaping
	· Separate Shared-Use Path · Path Intersection Treatments · Intersection Warning Treatments · Share the Path Treatments	· Sign Improvements · Pavement Marking Improvements	· Bicyclist Education · Practitioner Education	· Wayfinding · Aesthetics/Landscaping
		· Pavement Marking Improvements	· Practitioner Education	
· Mini Traffic Circles · Chicanes · Speed Tables/Humps/ Cushions · Raised Intersection	· Path Intersection Treatments · Intersection Warning Treatments	· Install Signal/Optimize Timing · Bike-Activated Signal · Sign Improvements · Pavement Marking Improvements · School Zone Improvements	· Practitioner Education	
· Mini Traffic Circles · Chicanes · Speed Tables/Humps/ Cushions · Visual Narrowing · Traffic Diversion · Raised Intersection		· Install Signal/Optimize Timing · Sign Improvements · Pavement Marking Improvements · School Zone Improvements	· Law Enforcement · Motorist Education	· Bike Maps · Events/Activities
· Mini Traffic Circles	· Path Intersection Treatments · Intersection Warning Treatments · Share the Path Treatments	· Install Signal/Optimize Timing · Bike-Activated Signal · Sign Improvements · Pavement Marking Improvements · School Zone Improvements	· Law Enforcement · Bicyclist Education	· Bike Maps · Events/Activities
	· Separate Shared-Use Path	· Bike-Activated Signal · School Zone Improvements	· Bicyclist Education · Motorist Education · Practitioner Education	· Bike Parking · Transit Access · Bicyclist Personal Facilitie · Bike Maps · Wayfinding · Events/Activities · Aesthetics/Landscaping

APPENDIX C

Web-based Survey Input (May 2010)

Bicycle Facility Issues, Concerns and Obstacles Reported through Web-based Public Survey (Survey Question 8)

Road Name	Segment	Concerns
I-10	Crossing from Baseline to 48th St.	Dangerous for cyclists
I-17	Pinnacle Peak overpass	Needs a wider shoulder
	Happy Valley roundabout	Dangerous for bicyclists
	Near Flagstaff	Debris in the shoulders
I-19	Green Valley to Nogales	Paved shoulders are too rough and dirty to ride on
Business I-19	Generally on Business I-19	Poorly maintained and narrow shoulders
I-40	Around Flagstaff	Debris in shoulders
US-60	Springerville to Show Low	Lack of shoulder in most areas
	Gold Canyon to Apache Junction	No signage letting drivers know bicyclists are present, rough pavement in shoulders, rumble strips located where a bicyclist would ride, no shoulder
	I-17 to Wickenburg	Worn out paving
	Goldfield to Florence Junction	Poorly maintained shoulders
	Approximately between Milepost 10 and 20	Debris in the shoulder
	Between the Pinto Valley and the Top of the World	Narrow shoulder
SR-61	Approximately 5 miles west of Saint John's Post Office	Narrow shoulders
	Whole roadway	No shoulder
SR-64	Generally on SR-64	Sides of the road are crumbling, forcing cyclists into the road or they risk falling or getting a flat tire
SR-66	Milton Rd to I-40	Presence of bike lanes is inconsistent
	South Mall Way to I-40 interchange	Rough pavement in shoulders

Bicycle Facility Issues, Concerns and Obstacles Reported through Web-based Public Survey (Survey Question 8) (continued)

Road Name	Segment	Concerns
SR-66 (continued)	US-66 / Switzer Canyon Rd intersection and US-66 / Enterprise intersection	Dangerous for riders because riders cannot be seen by vehicular traffic
	Kingman to Oatman	Bike lane disappears, rough pavement
	Milepost 50 to Milepost 75	Need bike lanes
	Milepost 80 to Milepost 81	Narrow shoulders
	Milepost 86 to Milepost 90	Narrow shoulders
	Milepost 54 to Milepost 58	Need a designated bike lane
SR-69	Dewy to Cordes Junction	Debris in the shoulders
	Frontier Village Mall and Costco	Lack of shoulders
	Prescott to Humboldt	Lack of bike lanes
SR-74	Bridges	Rumble strips reduce the rideable space of the shoulder
SR-77	Milepost 86 to Milepost 88 (north and south)	Narrow or nonexistent shoulder or bicycle lanes
	Milepost 99 to Milepost 101 (north)	Narrow or nonexistent shoulder or bicycle lanes
	Milepost 123 to Milepost 135	Narrow or nonexistent shoulder or bicycle lanes
	Rancho Vistoso Blvd. to Tangerine Ave.	Rough pavement on shoulder
	Mammoth to Oracle	Lack of shoulders
	1st Ave. to Tangerine Rd.	Newly resurfaced roads made conditions worse for cyclists (inch deep grooves in the bike lanes, forcing cyclists into the vehicle travel lanes)
	Through Catalina	Disappearing and narrow shoulders, rough pavement
SR-79	Between junction with SR 77 and Florence	Needs wider shoulders
SR-80	SR-90 to Bisbee	Poorly maintained shoulders
	Bisbee to Benson	Presence of rumble strips in the shoulder where cyclists ride

Bicycle Facility Issues, Concerns and Obstacles Reported through Web-based Public Survey (Survey Question 8) (continued)

Road Name	Segment	Concerns
SR-80	Border Patrol to Milepost 300	Presence of rumble strips in the shoulder where cyclists ride
SR-82	Patagonia to SR-90	Poorly maintained shoulder
	Bridge over San Pedro River	Narrow shoulder
SR-83	I-10 to Sonoita	Shoulders are too narrow or nonexistent
	Parker Canyon to SR-82	Northernmost section
SR-84	Murphy Rd. to Montgomery Rd.	Little or no shoulder, rough pavement in the shoulders
SR-86	Three Points to AZ-386	Lack of shoulder
	Generally on SR-86	Debris in shoulders
	West of Kinney Rd	Narrow shoulders and debris and rumble strip in shoulders;
SR-87	South of Baseline *Note: location not specified; may not be ADOT jurisdiction*	There are sections of SR87 that I will not ride due to the high auto traffic volume and lack of bike lanes in those areas
	Gilbert Rd to Saguaro Lake turn off; and Salt River to Saguaro Lake	Lots of debris and the speed of traffic too high
	City of Mesa *Note: location not specified; may not be ADOT jurisdiction*	Debris on the road and poorly maintained shoulders
	Loop 202 to Shea turn off	Both sides of the road have debris
	Gila River Indian Community	Presence of debris
	Mountain sections	Need shoulders
	Bridge over Salt River, from Mesa/Country Club to SR-87	No bicycle lanes over the bridge; high traffic volumes and lack of bicycle lanes
	Coolidge to Picacho	Has rumble strips which are okay, but when near a bridge or guard rail it is impossible to ride from far shoulder back onto main road to cross the bridge without riding over rumble strips.

Bicycle Facility Issues, Concerns and Obstacles Reported through Web-based Public Survey (Survey Question 8) (continued)

Road Name	Segment	Concerns
SR-87 (continued)	Payson area	High traffic volumes and lack of bicycle lanes
	Sunflower to Sycamore Creek (southbound)	Lack of shoulders
	Bush Hwy intersection	Shoulder ends
	Payson to SR 260 turn off	Lack of bike lanes
	Approximately 5 miles prior to Sunflower Rd. (northbound)	Lack of bike lanes
	Beeline Hwy – Gilbert Rd. to the turnoff towards Fountain Hills	Full of debris and flat tires are common there
	Milepost 217 to Milepost 221	Pavement is cracked and decaying, loose gravel, and debris
	Bush Highway north to Payson	Loose debris, requires sweeping
SR-88	Apache Junction to Canyon Lake and at Milepost 215	Disrepair from water damage over the bridge at Tortilla Flat
SR-89A	Milepost 320 to Milepost 360	Needs to be widened to include a wide, shared shoulder on the uphill side
	Ft. Tuthill Park to Sedona	No shoulders. Would see more commuters from Kachina Village and Mountainaire if improved
	Through Sedona	Lack of bike lanes or paved shoulder; lack of bike lanes in the new traffic circles
	Sedona to Flagstaff	Narrow or nonexistent shoulders; high traffic volumes
	Mingus Mt.	Lack of shoulder
	Milepost 326	Lack of shoulder
	Prescott to Wilhoit	Loose and breaking pavement in shoulders
	Generally on 89A	Lack of bike lanes in areas, harassment from drivers; vehicles fail to yield right-of-way in traffic circles; debris; stopped vehicles in the bike lane; slick concrete when hot on newly paved areas

Bicycle Facility Issues, Concerns and Obstacles Reported through Web-based Public Survey (Survey Question 8) (continued)

Road Name	Segment	Concerns
SR-90	Generally on SR-90	Narrow or lack of shoulder, poorly maintained shoulder when present
SR-92	Coronado Memorial Rd to east end of S. Hereford Rd.	Poorly maintained shoulders
SR-93	North of Chloride; west of Wickenburg	Speeding of vehicles, narrow shoulders due to rumble strips
US 89	Flagstaff Mall to Townsend - Winona Rd	No safe route for bicyclists
	Tuba City to Cameron, US 160 to SR 64	Lack of shoulder
US-95	East of Ave. 9E to Fortuna Rd	Poorly maintained shoulder
SR-163	Generally on SR-163	Lack of shoulders or bike lanes
SR-169	Generally on SR-169	Rumble strip and shoulder are rough for bicyclists
SR-177	Generally on SR-177	No shoulder and is very rough
SR-179	South of the Village of Oak Creek	Bike lanes disappear, and the shoulder is too narrow because of the rumble strips
	Milepost 304 to Milepost 299	rumble strips reduce the width of the shoulder and leaves the rider between the road and a drop off;
	Village of Oak Creek to I-17	Poorly maintained shoulders and rumble strips make the shoulder too narrow
	Generally on SR-179	Vehicles fail to yield right-of-way in new traffic circles;
SR-180	Section near Snowbowl Road (1-mile east of Snowbowl)	Shoulders are very rough or nonexistent, road is bumpy and full of gravel
	Section through Baderville area	Has limited shoulder
	Between Northern Arizona Museum north approximately 1-2 miles	Shoulders are very rough or nonexistent
	Intersection with Forest Rd.	No available crossings and narrow shoulders

Bicycle Facility Issues, Concerns and Obstacles Reported through Web-based Public Survey (Survey Question 8) (continued)

Road Name	Segment	Concerns
SR-180 (continued)	Milton Road (within Flagstaff city limits)	Needs a bicycle lane. There is no safe route on this road.
	Before Hidden Hollow Rd.	Narrow, blind corner west of Cheshire. Bad pavement, no shoulder; the rumble strips leave only 2-3 feet of shoulder, grooves are too wide, and it isn't straight;
	Forest Ave intersection	Speed limit is too high (35mph). A slower speed limit of 25 mph is necessary from Humphries Street north to at least Sechrist School to make this area safer for cyclists
	Section north of Flagstaff City limits	Section is in frequent bad repair and has no shoulder
SR-186	Generally on SR-186	Lack of shoulders
SR-187	Milepost 185	Little or no shoulder
SR-188	Generally on SR-188	Debris in the shoulders
SR-191	Between Springerville and St. Johns	Wide rumble strip takes up the shoulder, cracks in the shoulders
SR-195	In Yuma area	Provide signs that bicyclists may be present
SR-202	University to Country Club –	Separate trail needed along 202 for safe access to the college
SR-238	Maricopa to Gila Bend Note: not all of this road is ADOT jurisdiction	Lack of a shoulder
SR-260	Mileposts 205-220	Shoulder width varies widely, rough surfaces, and difficult to cross the bridge; rumble strips occupy the only smooth part of the shoulder;
	Camp Verde to Cottonwood	Poorly maintained shoulders with lots of debris;

Bicycle Facility Issues, Concerns and Obstacles Reported through Web-based Public Survey (Survey Question 8) (continued)

Road Name	Segment	Concerns
SR-260 (continued)	Payson to Strawberry	Lack of shoulder; poorly maintained shoulders, rumble strips reduce rideable area
SR-260 (continued)	Cottonwood to Camp Verde	Narrow or no shoulder, lack of understanding or awareness of bicycle laws in Arizona; presence of debris in the shoulders
	Payson to Wood's Canyon Lake	Non-existent shoulders
	Show Low to Springerville	Rumble strip reduces rideable area in shoulder
SR-277	Generally on SR-277	No bicycle lanes
SR-287	I-10 to Pinal Ave	No bike lanes
	Milepost 140 to Milepost150	Lack of bike lanes
SR-289	Generally on SR-289	Lacking share the road signage
SR-303	between Bell and Grand	Shoulder improvements
	Near the Happy Valley intersection	Lack of a bike lane in the construction zone
SR-347	I-10 toward Maricopa	Debris in shoulders
General Issues	**Concern**	
Roadway and shoulder construction practices	Rubberized crack seals can be slippery when hot	
	Rumble strips are improperly placed so as to reduce the rideable width of the shoulder	
	There is a lack of consistent paved shoulders	
	A minimum shoulder suitable for bicyclists should be maintained during construction	
	Potholes and uneven joints on bridges can also be of concern	
Shoulder maintenance	There is a need for frequent cleaning to clear debris from shoulders	
	Trucks routinely park in shoulders when other options are available	
	Construction or temporary signage (e.g. Border Patrol signs) is often placed in the shoulder; clean-up is needed when the sandbags break	
Public awareness and education	There is a lack of public knowledge regarding bicycle laws and bicyclists rights on state highways (most motorists are not aware of the 3-foot rule)	

Bicycle Facility Issues, Concerns and Obstacles Reported through Web-based Public Survey (Survey Question 8) (continued)

General Issues	Concern
Laws, Regulations, and Law Enforcement	Need enforcement for drivers who do not respect bicyclists' rights
Roadway pavement markings and signage	At traffic circles, signing and education is needed to instruct bicyclists how to enter and to use the traffic circles
	Need "share the road" signs alerting motorists of the presence of bicyclists and to share the road
	Education or signage at freeway exit/on-ramps is needed
Coordination with Other Agencies and Jurisdictions	Coordination between municipalities is needed to ensure that bike lanes and shoulders that cross jurisdiction boundaries are consistent

APPENDIX D

Summary of Referenced Resources Web Links

1. ADOT Bicycle Safety Action Plan, project website:
http://www.azdot.gov/mpd/systems_planning/bicycle_safety_study.asp

2. ADOT Bicycle and Pedestrian Program
http://www.azbikeped.org/index.html

3. ADOT Bicycle Safety Action Plan, project website:
http://www.azdot.gov/mpd/systems_planning/bicycle_safety_study.asp

4. National Highway Traffic Safety Administration, Traffic Safety Facts 2010,
http://www-nrd.nhtsa.dot.gov/Pubs/811624.pdf

5. The Arizona Motor Vehicle Crash Facts, 2010
http://www.azdot.gov/mvd/statistics/crash/index.asp

6. Arizona Strategic Highway Safety Plan
http://www.azdot.gov/highways/traffic/9620.asp

7. 1994 National Bicycling and Walking Study, Federal Highway Administration
http://katana.hsrc.unc.edu/cms/downloads/NatlBicycleWalk94.pdf

8 2010 National Bicycling and Walking Study 15-Year Status Report
http://katana.hsrc.unc.edu/cms/downloads/15-year_report.pdf

9. FHWA BIKESAFE Bicycle Countermeasure Selection System
http://www.bicyclinginfo.org/bikesafe/

10. ADOT Traffic Safety Section
http://www.azdot.gov/highways/traffic/9620.asp

11. FHWA Bicycle Road Safety Audit Guidelines and Prompt List
http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa12018/

12. United States Department of Transportation Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations, March 15, 2010
http://www.dot.gov/affairs/2010/bicycle-ped.html

13. Arizona State Transportation Board Policies
http://www.azdot.gov/Board/PDF/Board_Policies_010411.pdf

14. ADOT Bicycle Policy, MGT 02-01
http://www.azbikeped.org/images/MGT01-2%20Bike%20Policy.pdf

15. FDOT Plans Preparation Manual, Volume I, Chapter 25.4.5; accessible at:
http://www.dot.state.fl.us/rddesign/PPMManual/2012/Volume1/Chap25.pdf.

16. ADOT Roadway Engineering Group
http://www.azdot.gov/Highways/Roadway_Engineering/Roadway_Design/index.asp

17. Arizona Strategic Highway Safety Plan, 2007
http://www.azdot.gov/highways/traffic/9620.asp

18. FHWA and ADOT Stewardship and Oversight Agreement for Arizona
http://www.fhwa.dot.gov/azdiv/stewtoc.htm

19. Complete Streets Coalition
www.completestreets.org

20. Complete Streets Coalition, Model Complete Streets Policy
http://www.completestreets.org/changing-policy/model-policy/

21. California Department of Transportation, Complete Streets Program
http://www.dot.ca.gov/hq/tpp/offices/ocp/complete_streets.html

22. California Department of Transportation, Pedestrian Safety Resources
http://www.dot.ca.gov/hq/traffops/survey/pedestrian/

23. Oregon Department of Transportation, Bicycle and Pedestrian Design Guide
http://cms.oregon.gov/ODOT/HWY/BIKEPED/pages/planproc.aspx

24. USDOT Policy Statement on Bicycle and Pedestrian Accommodation Regulations and Recommendations, March 15, 2010
http://www.dot.gov/affairs/2010/bicycle-ped.html

25. ADOT Bicycle and Pedestrian Program, Safety Awareness Campaign
http://www.azbikeped.org/education.html#campaigneducation

26. How to Not Get Hit by Cars, Important Lessons in Bicycle Safety
http://bicyclesafe.com/

27. Commute by Bike. Tips, news reviews, and safety for bike commuters.
http://www.commutebybike.com/2008/07/09/top-5-rules-for-riding-on-the-sidewalk/

28. Cycle Sense: Why Reflectors Don't Work
http://www.sheldonbrown.com/reflectors.html

29. Share the Road. Rules for Motorists
http://www.sfbike.org/download/resources/Motorists-STR.pdf

30. ADOT Bicycle and Pedestrian Program, Education Plan
http://www.azbikeped.org/education.html

31. Arizona Bicycling Street Smarts
http://www.azbikeped.org/azbss.htm

32. MAG Strategic Transportation Safety Plan
http://www.azmag.gov/Documents/pdf/cms.resource/strategic_safety_plan226438.pdf

33. Pedestrian and Bicycle Information Center, Training Law Enforcement
http://www.bicyclinginfo.org/enforcement/training.cfm

34. Pedestrian and Bicycle Information Center, Video Library
http://www.walkinginfo.org/videos/

35. Arizona Revised Statute, 28-904 Driving on sidewalk
http://www.azleg.state.az.us/ars/28/00904.htm

36. BIKESAFE Bicycle Countermeasure Selection System
http://www.bicyclinginfo.org/bikesafe/countermeasure.cfm?CM_NUM=8

37. ADOT Access Management Program
http://www.azaccessmanagement.com/