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DRAFT TASK 1 MEMORANDUM

Date:	December 15, 2014	Project #: 18028
To:	Joshua Naramore Northeast Ohio Areawide Coordinating Agency	
From:	Matt Braughton; Nick Foster, AICP; and Brian L. Ray, PE	
Project:	Safety Planning Analysis	
Subject:	State of Safety in the Cleveland Metropolitan Region - Data Analysis Support	

The Northeast Ohio Areawide Coordinating Agency (NOACA) is preparing the first transportation safety action plan (TSAP) in the region. Understanding existing crash conditions is an initial part of this effort. To accomplish this, NOACA is preparing a report documenting existing crash conditions and safety planning efforts. This report will be titled *State of Safety in the Cleveland Metropolitan Region*.

Kittelson & Associates, Inc. (KAI) is providing data analysis support for this report by analyzing the most recent five years of crash data, 2008 – 2013, according to a number of specific categories. This memorandum summarizes the results of this analysis. It also contains additional analysis KAI staff determined would be beneficial, based on national and Ohio Department of Transportation (ODOT) practices. The results of this analysis describe existing crash conditions and identify factors contributing to severe crashes in the region. These findings can be used to help identify and prioritize safety-focused countermeasures and projects.

DATA ANALYSIS

The following sections describe the results of the crash data analysis within the following categories defined by NOACA:

- Non-Freeway Crashes
- Pedestrians (non-freeway crashes only)
- Bicyclists (non-freeway crashes only)
- Crash Type Detail
- Freeway Crashes
- Transit and Rail Related Crashes

In addition to the specific analyses NOACA requested, we have analyzed the extent to which several factors contribute to fatal and severe injury crashes in the region. The factors includes in this analysis are cited in national and other regional efforts, as well as ODOT's strategic highway safety plan (SHSP). The additional analysis will help NOACA identify crash types that could be targeted to achieve the greatest benefit, in terms of reduced fatalities and serious injuries resulting from transportation crashes. It also provides the potential for coordination with ongoing national and Ohio-wide efforts.

KAI linked the region's state and non-state roadway data with the crash data by linearly referencing the crash data to the state and non-state roadway networks in ArcGIS using the crash data's roadway identification field (NFL_ID) and mile post field (LOGPOINT_S). KAI then joined the roadway network data to the crash data by roadway and mile point. We combined the two linked crash datasets (state and non-state) into one dataset.

One of two approaches was taken with crash data that could not be directly linearly referenced to the roadway network. About 15% of the crash dataset included default roadway identifications or mile post information (e.g., mile post "99.99" or roadway identification "MCUY9999999**C"), instead of specific locational information. We have assumed that these crashes occurred on local two-lane roadways, given that these roadways are sometimes excluded from regional datasets, and added them to our crash database as such. Other crash data, about 4% of the provided database, contained incorrect roadway identifiers or mile post information, indicating a possible recording error. These data represented were excluded from our analysis database because of the uncertainty surrounding where the crash actually occurred.

We have summarized analysis results in graphic and/or tabular format to allow NOACA staff to easily insert the findings of this analysis into their final report. Where appropriate, bullet point text provides further insights into the analysis results and how they might be interpreted.

Non-Freeway Crashes

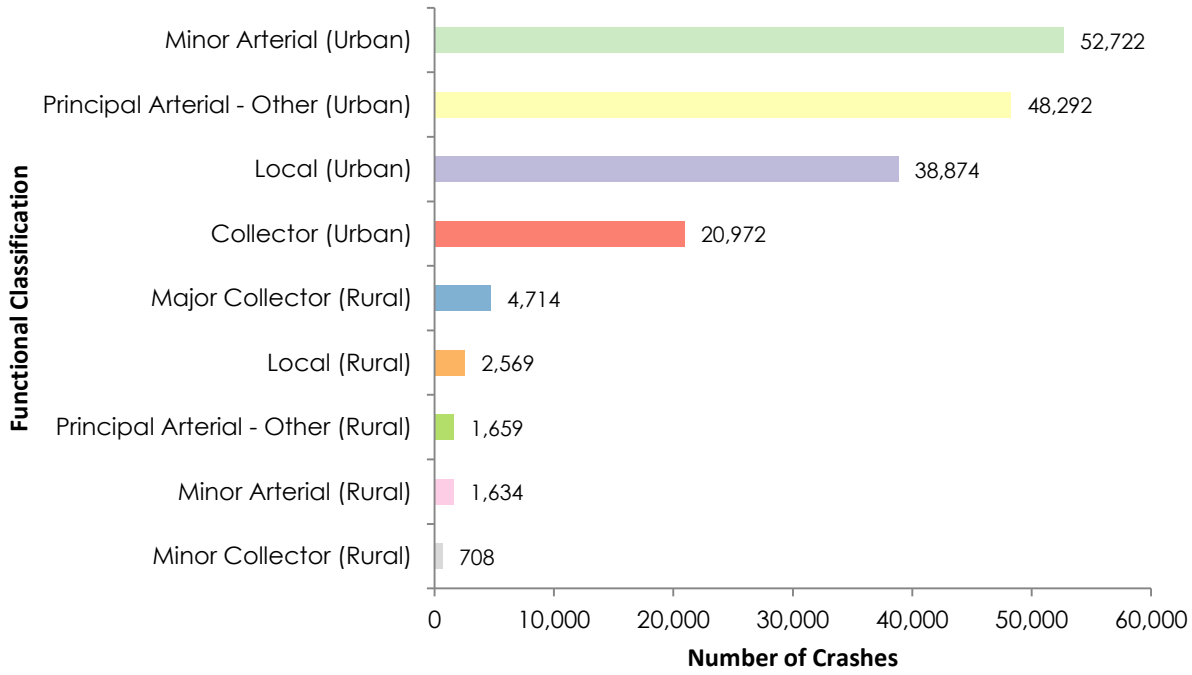
Per direction from NOACA staff, all crashes that occurred on non-freeway roadways are summarized according to the following categories:

- Roadway classification
- Number of lanes
- Crash type
- Contributing factor

Roadway Classification

Figure 1 summarizes non-freeway crashes by functional classification.

Figure 1. Non-Freeway Crashes by Functional Classification (2009 – 2013)



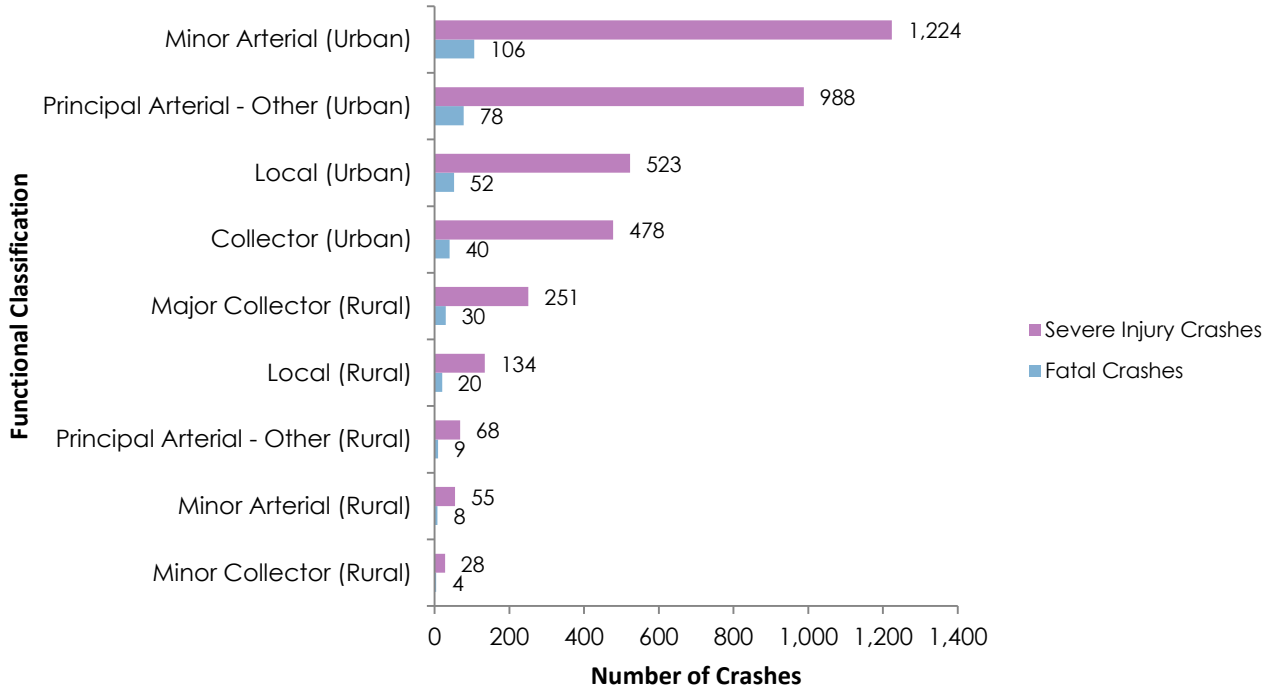
- The majority of non-freeway crashes occur on urban roadways (93%). This is higher than the approximately 87% of non-freeway daily vehicle miles traveled (VMT)[1] that occurs on urban roadways.
- The proportion of crashes for each individual functional classification is generally consistent with the proportion of VMT carried by each classification (i.e. roadways with higher volumes tend to have higher crash frequencies). This is consistent with national research showing a direct relationship between traffic volumes and crash frequencies[2].

Figure 2 summarizes fatal and severe injury non-freeway crashes by functional classification.

[1] VMT percentages were calculated from the Ohio Department of Transportation Division of Planning's *2013 Daily Vehicle Miles Traveled Report* by summing all non-freeway functional classifications for rural and urban roadways for the five counties within NOACA. The DMVT reports can be found at the following address: http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/DVMT.aspx

[2] *Highway Safety Manual, 1st Edition*. American Association of State Highway and Transportation Officials. 2010.

Figure 2. Fatal and Severe Injury Non-Freeway Crashes by Functional Classification (2009 – 2013)

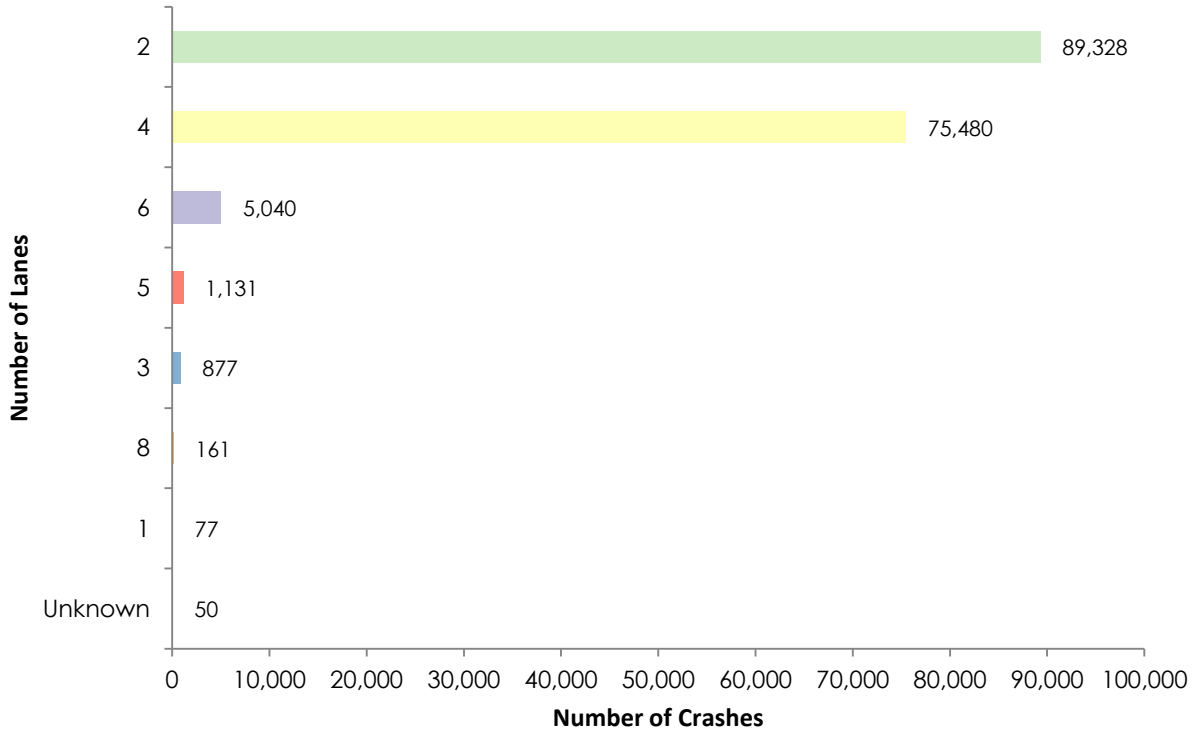


- The distribution of fatal and severe injury crashes across functional classifications generally follows the distribution of total crashes.
    - However, rural roadways tend to account for a higher proportion of fatal and severe injury crashes than they do of total crashes.

Number of Lanes

Figure 3 summarizes non-freeway crashes by number of lanes.

Figure 3. Non-Freeway Crashes by Number of Lanes (2009 – 2013)

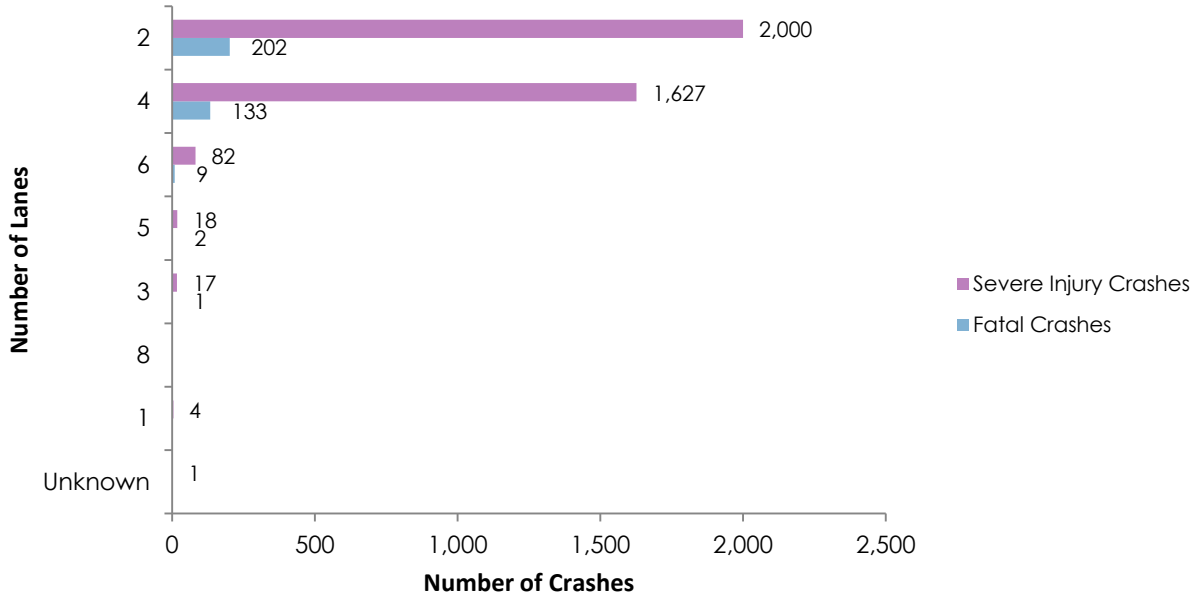


- Most non-freeway crashes (96%) occur on two-lane or four-lane roadways, which is consistent with existing traffic volumes[3]. Over 93% of VMT is on these facilities.
- Over half (52%) of reported non-freeway crashes occurred on two-lane roadways, while nearly 44% of non-freeway crashes occurred on four-lane roadways. These proportions are in line with the proportion of VMT (approximately 55% and 38%) accounted for by these two roadway types.

Figure 4 summarizes fatal and severe injury non-freeway crashes by number of lanes.

[3] VMT by number of lanes was calculated using two different methods. For collectors and arterials, VMT was calculated using the segment length and average daily traffic (ADT) data from the state and local roadway GIS networks provided by NOACA. The VMT for local facilities, all of which were assumed to be two lanes, is taken from the Ohio Department of Transportation's *2013 Daily Vehicle Miles Traveled Report* and added to the GIS calculations of collector and arterial VMT to arrive at the total VMT by number of lanes.

Figure 4. Fatal and Severe Injury Non-Freeway Crashes by Number of Lanes (2009 – 2013)

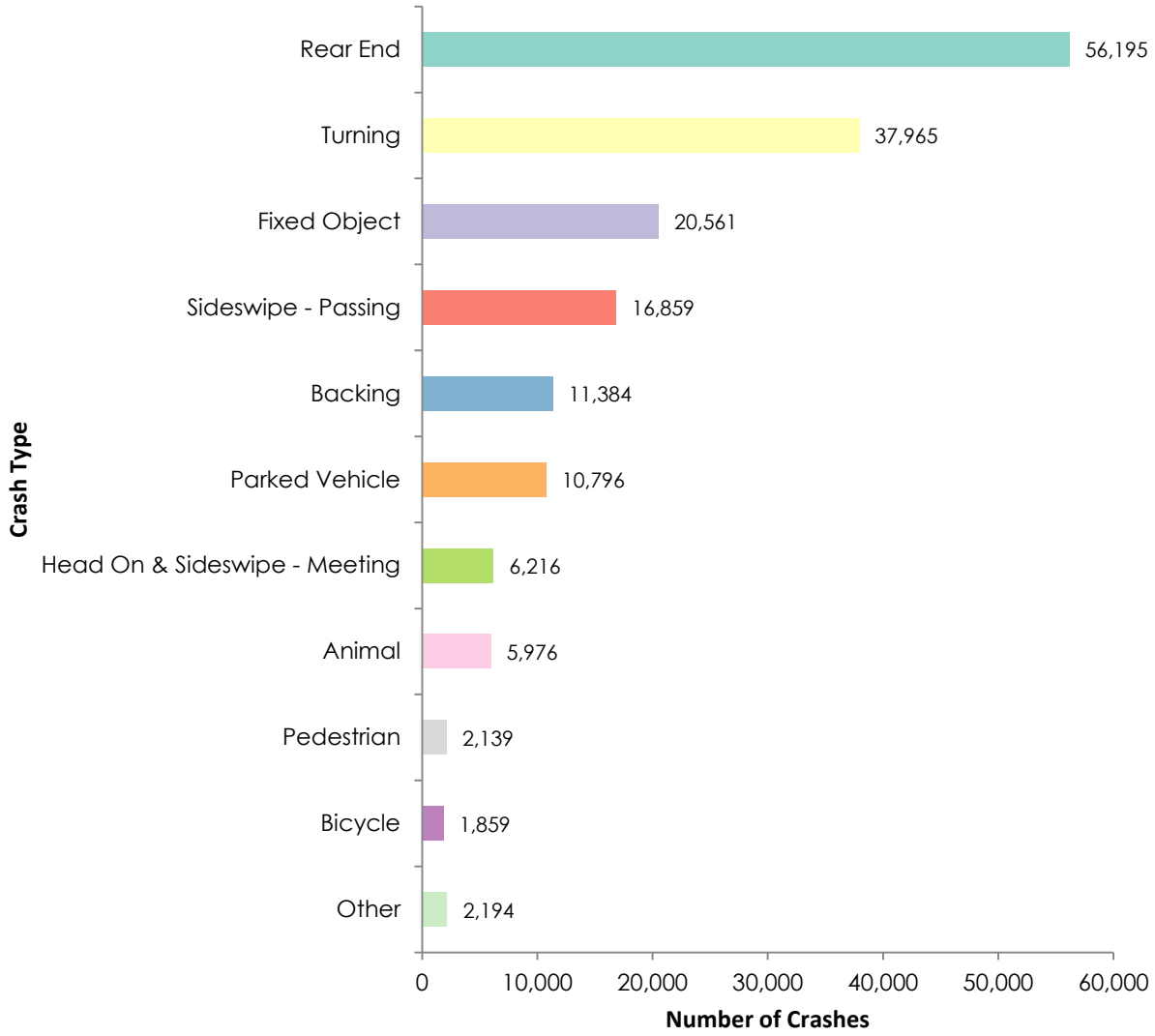


- The distribution of fatal and severe injury crashes follows the pattern of total crashes with most fatal and severe injury crashes occurring on two- and four-lane roadways.

Crash Type

Figure 5 summarizes non-freeway crashes by crash type. KAI simplified crash types from the original crash dataset by combining similar crash types (e.g., "Angle" and "Left Turn" were combined into the "Turning" crash type). The top ten most frequent simplified crash types are displayed with remaining crash types combined into the "Other" crash type. Tables showing the detail types that make up these simplified types are included in Attachment "A."

Figure 5. Non-Freeway Crashes by Crash Type (2009– 2013)



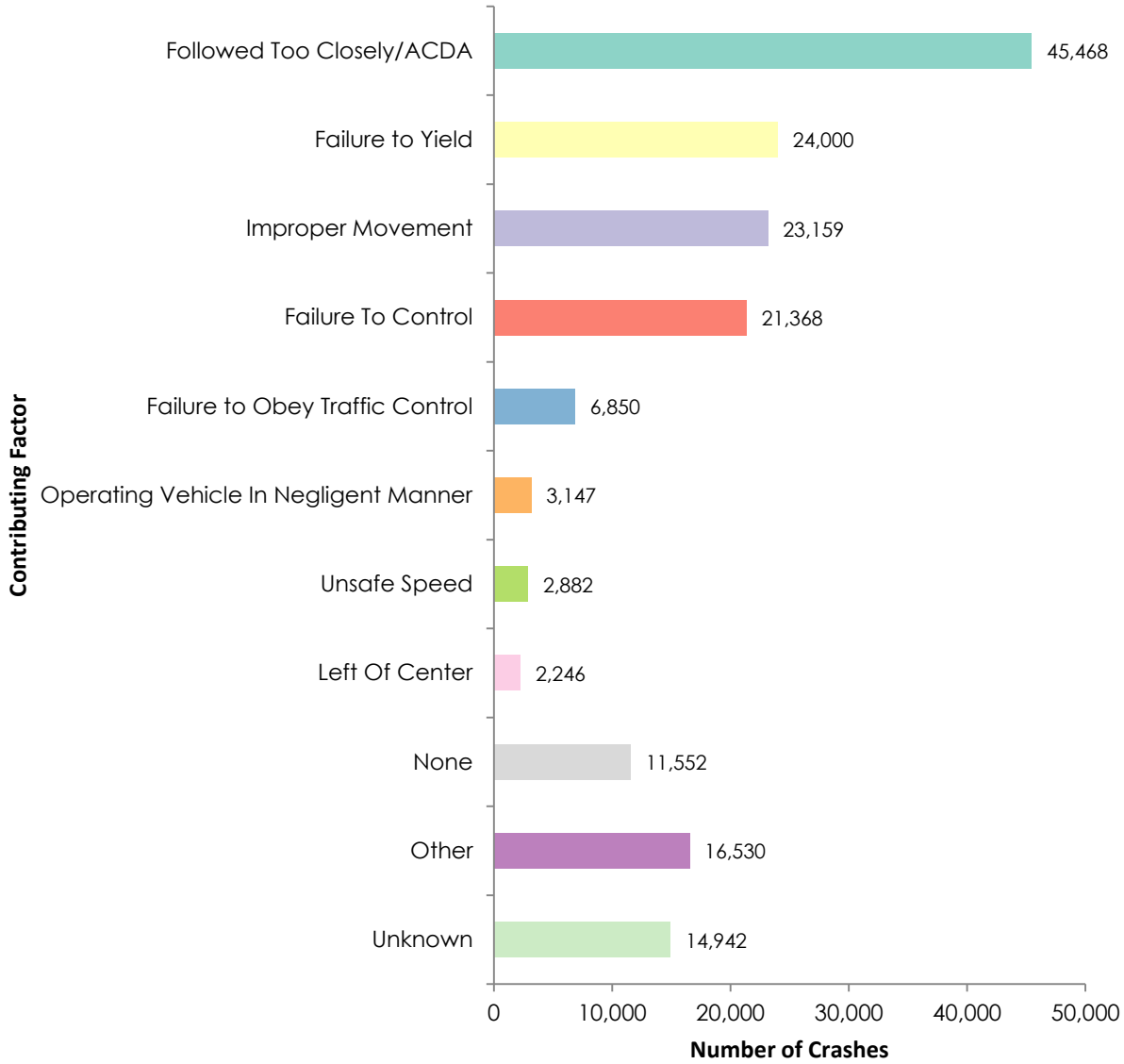
- Rear end (33%) and turning (22%) crashes represent the two largest proportions of non-freeway crashes. These two crash types were followed by fixed object (12%) and sideswipe - passing (10%) crashes. This rank ordering and proportions are roughly similar to crash trends in the Portland, Oregon metropolitan area[4].

[4] *Metro State of Safety Report*. Metro. April 2012.

Contributing Factor

Figure 6 summarizes non-freeway crashes by contributing factor. KAI simplified contributing factors by combining similar factors. The eight most frequent contributing factors as well as crashes with no contributing factor or an unknown contributing factor are displayed. We combined remaining contributing factors into the "Other" category. Tables summarizing what contributing factors were simplified into these factors are included in Attachment "A."

Figure 6. Non-Freeway Crashes by Contributing Factor (2009 – 2013)



- The followed too closely/assured clear distance ahead (ACDA) contributing factor (26%), failure to yield (14%), improper movement (14%), and failure to control (12%) represent the four highest proportions of contributing factors to non-freeway crashes. This finding appears consistent with the frequency of rear end, turning, and fixed object crash types shown in Figure 3.

Pedestrians (non-freeway crashes)

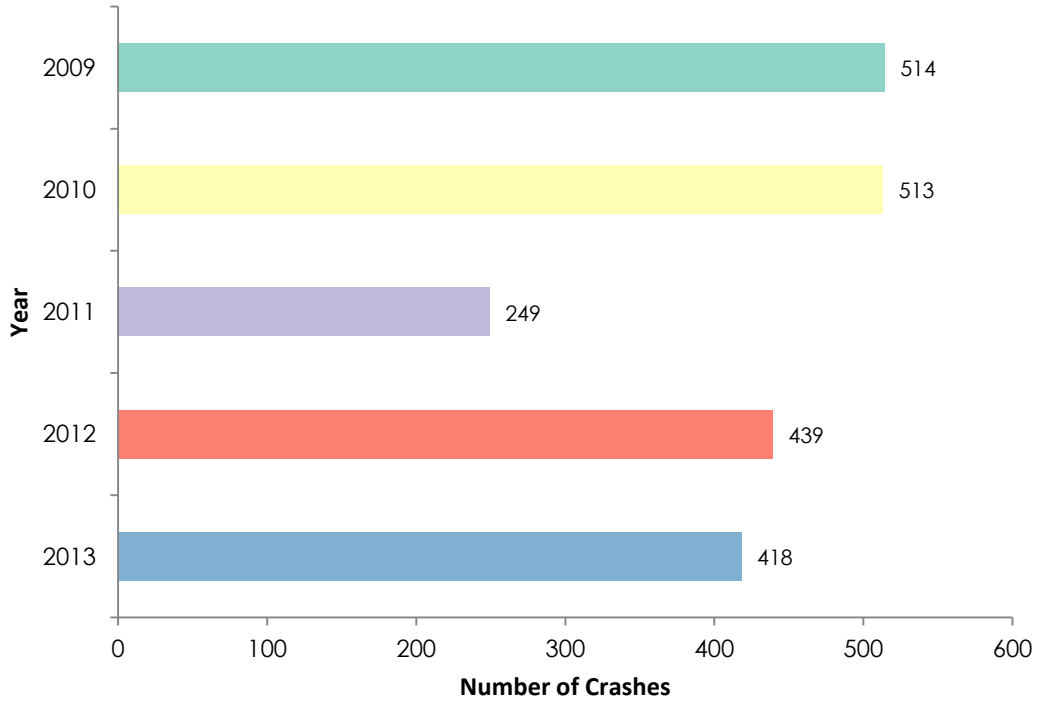
Per direction from NOACA staff, KAI summarized pedestrian crashes that occurred on non-freeway roadways according to the following categories:

- Year
- County
- City
- Month
- Time of day
- Weather
- Road surface condition
- Roadway classification
- Number of lanes
- Contributing factor
- Pedestrian age and gender

Year

Figure 7 summarizes non-freeway pedestrian crashes by year.

Figure 7. Non-Freeway Pedestrian Crashes by Year

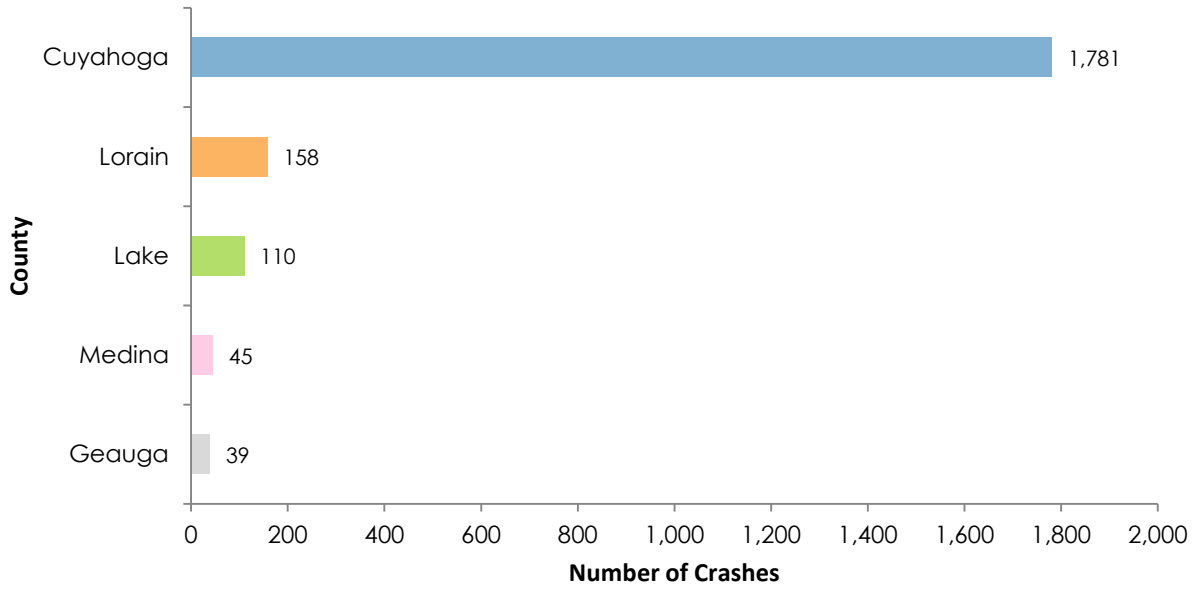


- Pedestrian-involved, non-freeway crashes in 2011 were lower than the rest of the years, while pedestrian-involved, non-freeway crashes in 2009 and 2010 were higher than 2012 or 2013. This is consistent with overall crash trends, which were lower in 2011 than the other years analyzed. These trends are also consistent with bicyclist collision trends (see Figure 15).

County

Figure 8 summarizes non-freeway pedestrian crashes by county.

Figure 8. Non-Freeway Pedestrian Crashes by County (2009 – 2013)



- Over four-fifths (84%) of the pedestrian involved, non-freeway crashes occurred in Cuyahoga County. Approximately 61% of the region's population lives in Cuyahoga County[5] and Cleveland is the urban center of the region with a major downtown area. .
- Lorain County and Lake County had the second and third highest proportions of regional pedestrian crashes (7% and 5%, respectively), which are roughly consistent with the two counties' proportion of the population (15% and 11%).

City

Table 1 summarizes non-freeway pedestrian crashes by city.

[5] U.S. Bureau of the Census, Population Estimates Program (PEP), http://www.census.gov/popest/index.html, 2013.

Table 1. Non-Freeway Pedestrian Crashes by City (2009 – 2013)

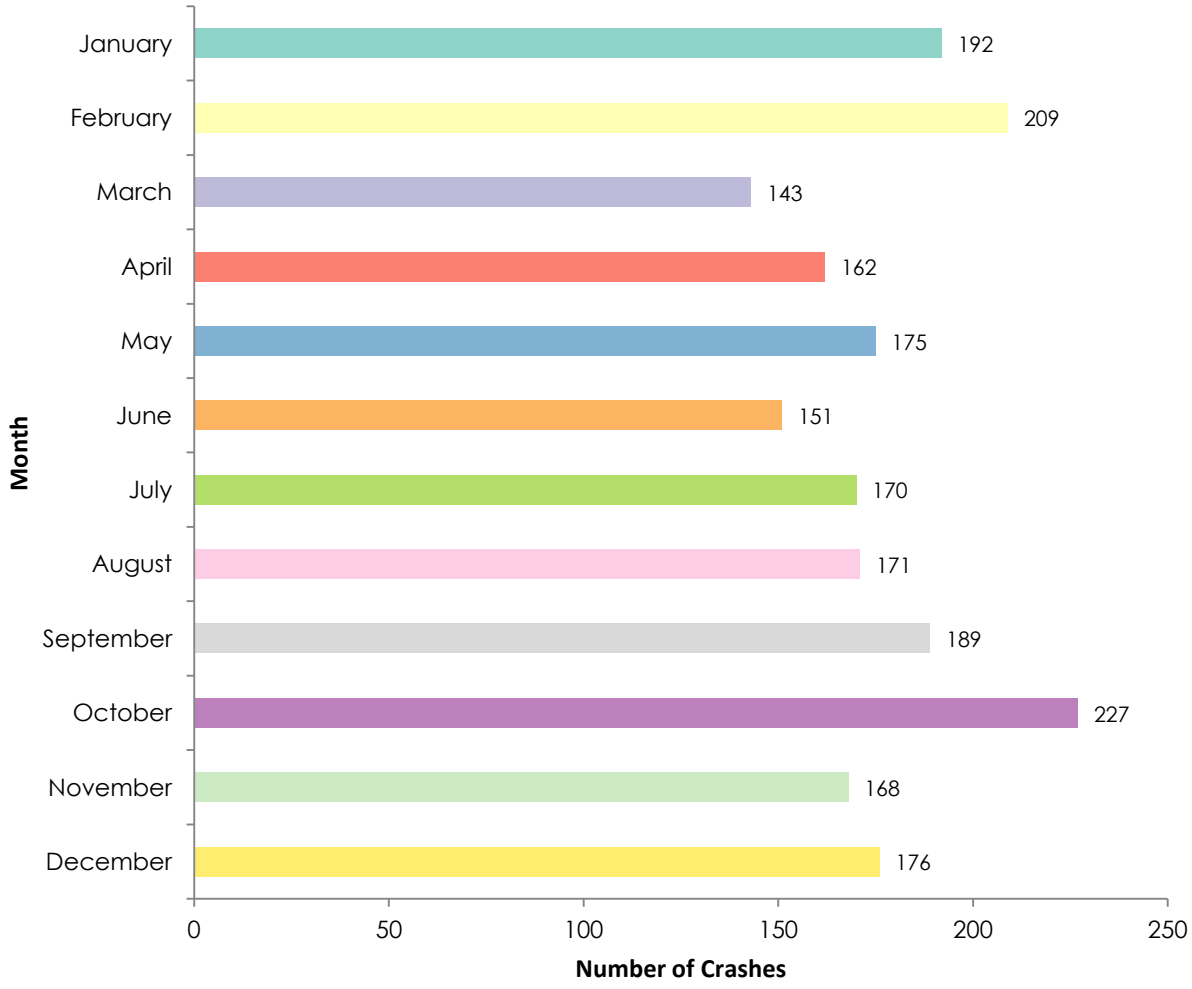
City	Pedestrian Crashes	City (cont.)	Pedestrian Crashes (cont.)	City (cont. 2)	Pedestrian Crashes (cont. 2)
Cleveland	1052	Wadsworth	10	Carlisle	2
Cleveland Heights	76	Broadview Heights	9	Grafton	2
Euclid	68	Brunswick	9	Kirtland Hills	2
Parma	61	University Heights	9	Leroy (Township Of)	2
Lakewood	54	Wickliffe	9	Medina (Township Of)	2
Lorain	53	Richmond Heights	8	Moreland Hills	2
Elyria	45	Bainbridge	6	Pepper Pike	2
Garfield Heights	44	Eaton	6	Seven Hills	2
Maple Heights	38	Fairview Park	6	Sharon	2
East Cleveland	37	Mayfield	6	Willoughby Hills	2
Painesville	24	Oakwood	6	Brooklyn Heights	1
South Euclid	24	Sheffield	6	Columbia	1
Shaker Heights	20	Amherst	5	Columbia (Township Of)	1
North Olmsted	19	Avon Lake	5	Eaton (Township Of)	1
Mentor	17	Chester	5	Fairview Park (Fairview)	1
Berea	16	Concord	5	Harrisville (Township Of)	1
Bedford	15	Middlefield	5	Highland Hills	1
Mayfield Heights	15	Avon	4	Hinckley	1
Rocky River	15	Brecksville	4	Kirtland	1
Westlake	15	Cleveland Metroparks	4	Lafayette	1
Willoughby	15	Oberlin	4	Lafayette (Township Of)	1
Chardon	13	Perry	4	Liverpool	1
Medina	13	South Euclid (Bluestone)	4	Mentor-On-The-Lake	1
Beachwood	12	Bay Village	3	Milton	1
Brooklyn	12	Bedford Heights	3	Montville (Township Of)	1
Chagrin Falls	12	Claridon	3	New Russia	1
Lyndhurst	12	Gates Mills	3	Newbury	1
Middleburg Heights	12	Independence	3	North Randall	1
Parma Heights	12	Lagrange	3	Olmsted	1
Solon	12	Madison (Township Of)	3	Olmsted (Township Of)	1
Brook Park	11	Olmsted Falls	3	Sheffield (Township Of)	1
Madison	11	Wellington	3	Sheffield Lake	1
North Ridgeville	11	Willowick	3	Spencer	1
Strongsville	11	Woodmere	3	Troy	1
Warrensville Heights	11	Auburn	2	Waite Hill	1
Eastlake	10	Burton	2	Walton Hills	1
North Royalton	10	Camden	2	Westfield	1

- Pedestrian crashes are concentrated in Cleveland, with 49% of reported pedestrian crashes occurring within the City.
- The cities of Cleveland Heights, Euclid, Parma, Lakewood, and Lorain each have over 50 pedestrian crashes over the 5-year period. These cities are all among the most populous cities for the region.

Month

Figure 9 summarizes non-freeway pedestrian crashes by month.

Figure 9. Non-Freeway Pedestrian Crashes by Month (2009 – 2013)

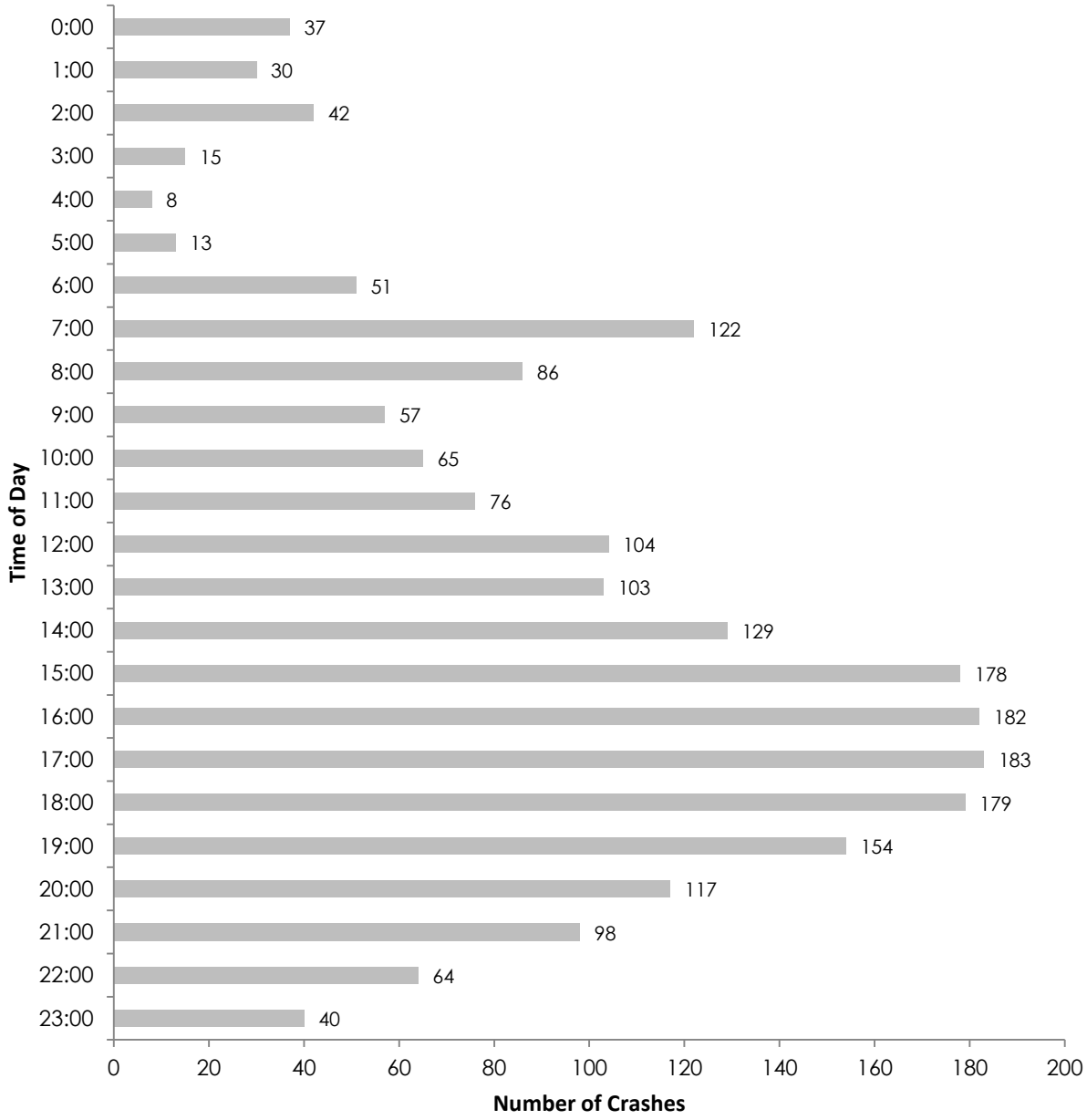


- Pedestrian crashes are highest in October (11% of crashes) and February (10% of crashes), while they are lowest in March and June (7% of crashes, each).

Time of Day

Figure 10 summarizes non-freeway pedestrian crashes by time of day.

Figure 10. Non-Freeway Pedestrian Crashes by Time of Day (2009 – 2013)

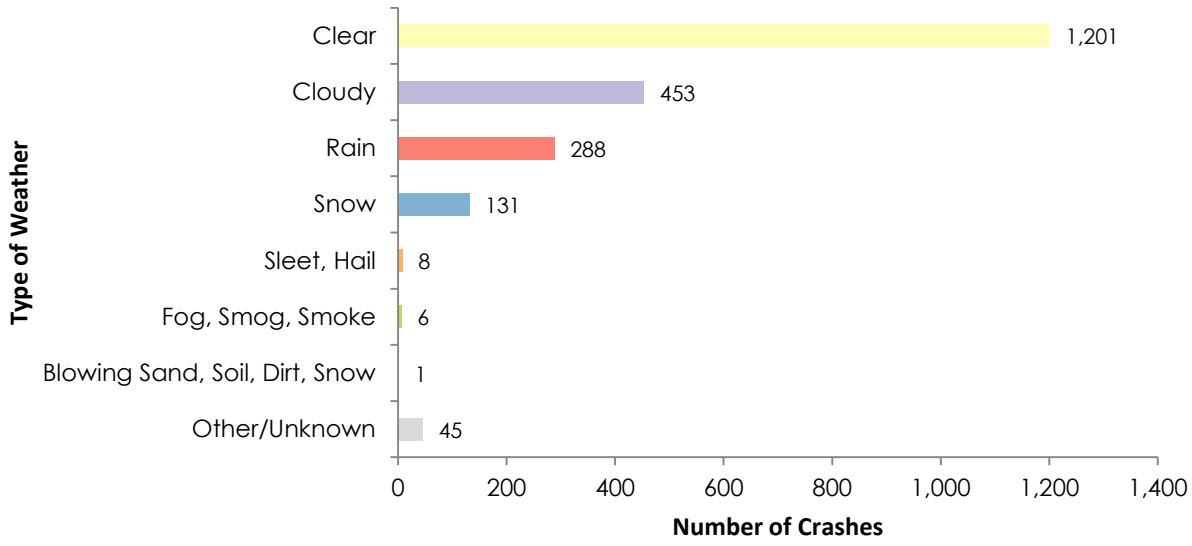


- Non-freeway pedestrian crashes peak in the afternoon/early evening hours between 2:00 p.m. and 8:00 p.m. Approximately 47% of non-freeway pedestrian-involved crashes occur during these six hours.
- There is a smaller peak in non-freeway, pedestrian crashes during the 7:00 a.m. to 8:00 a.m. hour representing nearly 6% of crashes.
- These peak periods are generally in line with typical motor vehicle volume patterns.

Weather

Figure 11 summarizes non-freeway pedestrian crashes by weather conditions.

Figure 11. Non-Freeway Pedestrian Crashes by Weather (2009 – 2013)

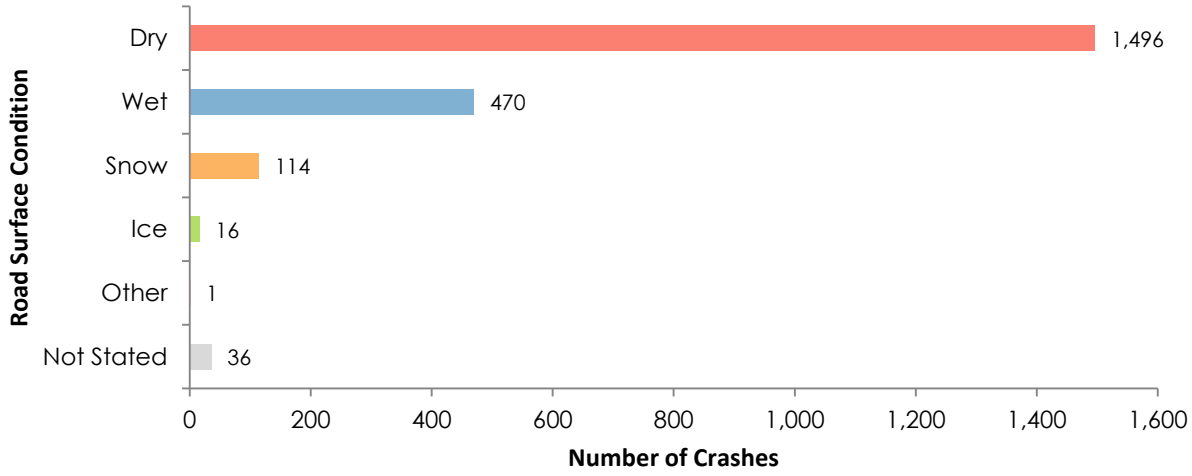


- 58% of all pedestrian-involved crashes occurred under clear weather, while approximately 22% and 14% of pedestrian-involved non-freeway crashes occurred during cloudy or rainy weather, respectively.

Road Surface Condition

Figure 12 summarizes non-freeway pedestrian crashes by road surface condition.

Figure 12. Non-Freeway Pedestrian Crashes by Road Surface Condition (2009 – 2013)



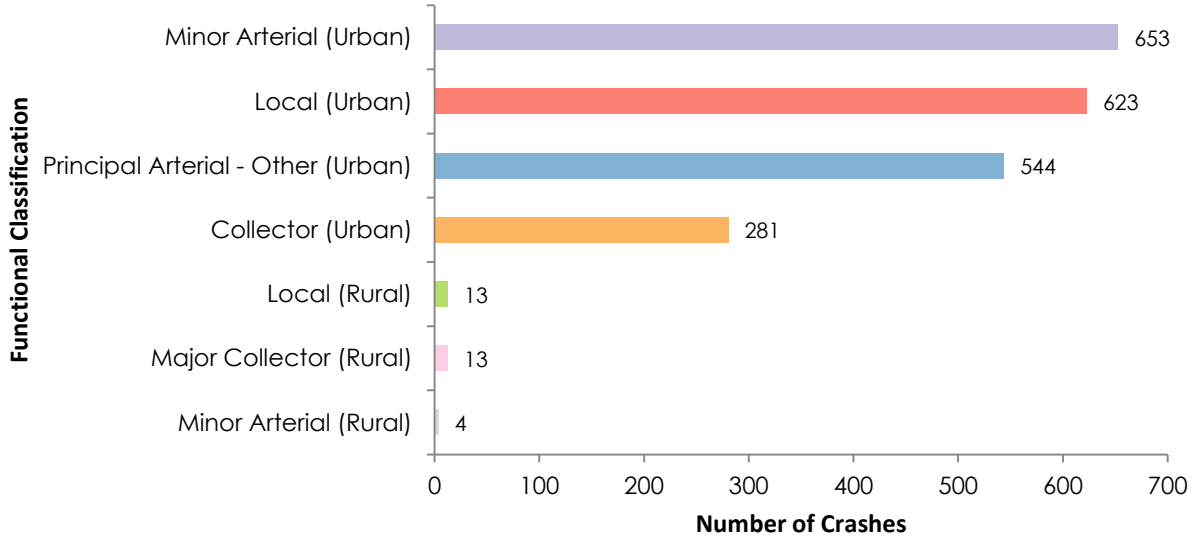
- 70% of pedestrian-involved crashes occurred during dry roadway conditions, while wet roadway surface conditions represent 22% of pedestrian-involved non-freeway crashes. These

findings are consistent with the weather results shown in Figure 11.

Roadway Classification

Figure 13 summarizes non-freeway pedestrian crashes by roadway functional classification.

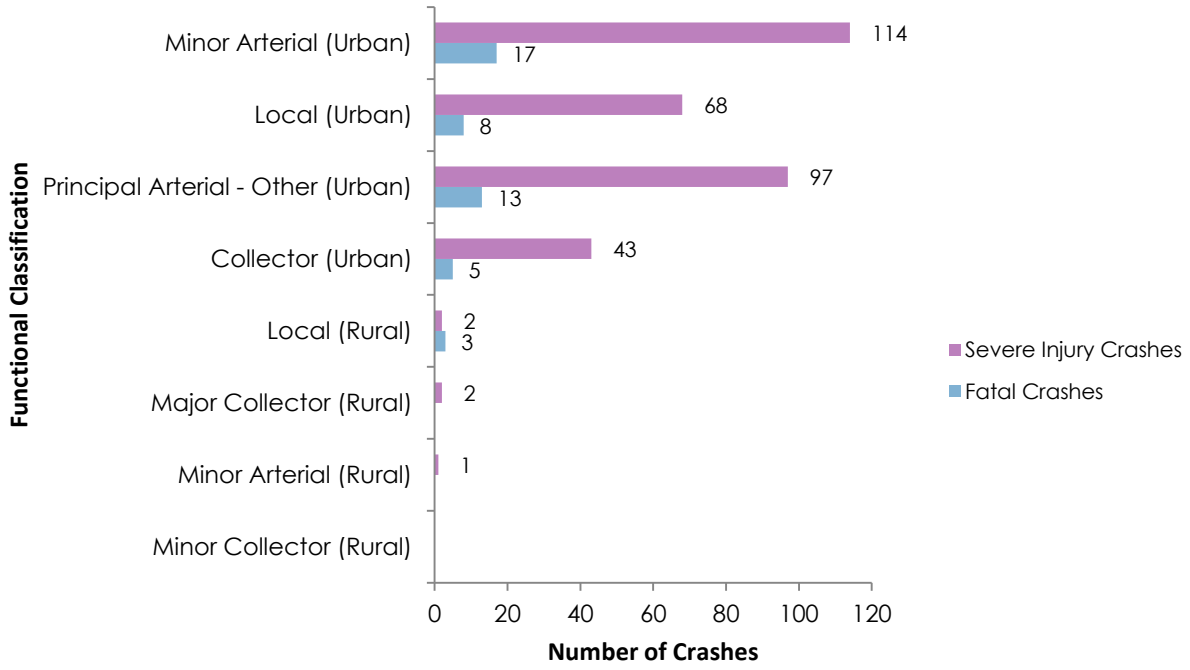
Figure 13. Non-Freeway Pedestrian Crashes by Functional Classification (2009 – 2013)



- 99% of pedestrian-involved crashes occur in urban areas, with the majority occurring on higher-volume urban roadways including Minor Arterials (31%), Locals (29%), Principal Arterials (26%), and Collectors (13%). Like non-freeway motor vehicle crashes, most non-freeway pedestrian crashes occur in urban areas. However, Local roadways account for the second highest proportion of pedestrian crashes, whereas Principal Arterials account for the second highest proportion of motor vehicle crashes (Local roadways are third).

Figure 14 summarizes fatal and severe injury non-freeway pedestrian crashes by roadway functional classification.

Figure 14. Fatal and Severe Injury Non-Freeway Pedestrian Crashes by Functional Classification (2009 – 2013)

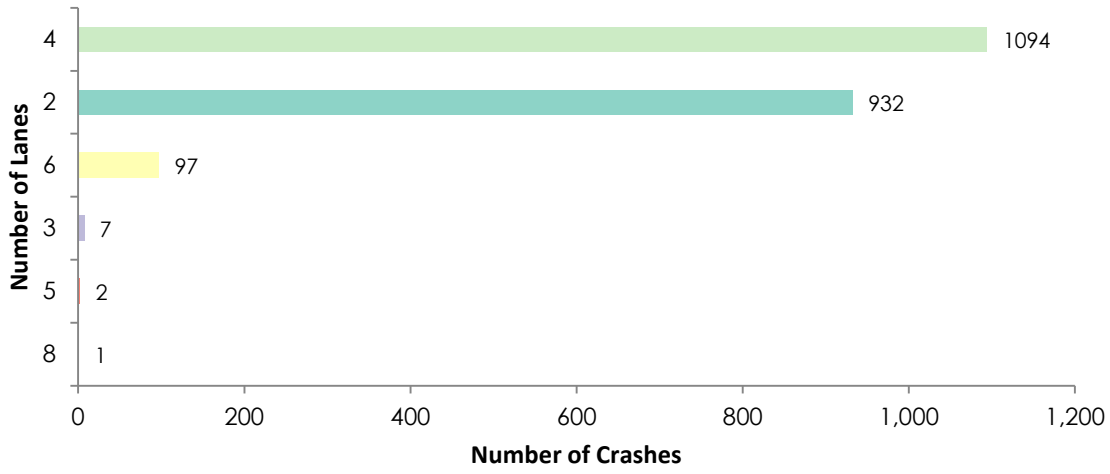


- Fatal and severe injury non-freeway pedestrian crashes generally follow the trends of total non-freeway pedestrian crashes.
- Urban Local roads account for lower proportions of fatality (17%) and severe injury (21%) crashes than they do total non-freeway pedestrian crashes (29%). This is not surprising given the typically lower speeds of these roads.
- Urban Minor Arterials and Rural Local roads notably account for higher percentages of fatal crashes (37% and 7%, respectively) than they do total non-freeway pedestrian crashes (31% and <1%, respectively).

Number of Lanes

Figure 15 summarizes non-freeway pedestrian crashes by number of lanes.

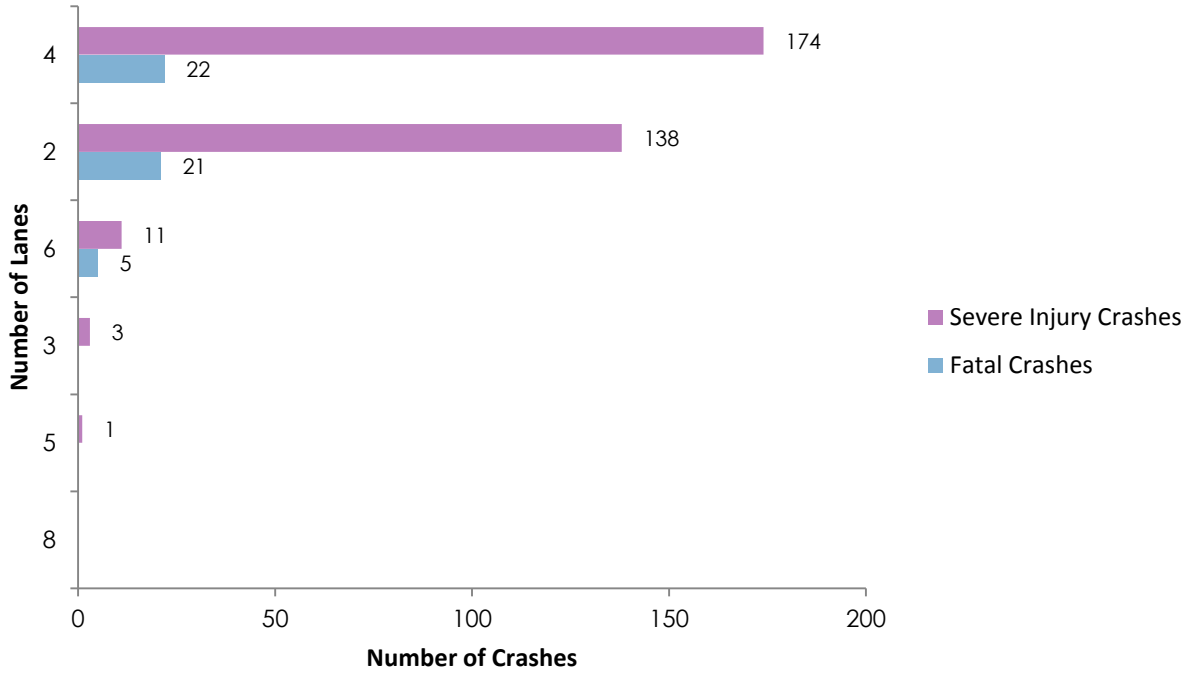
Figure 15. Non-Freeway Pedestrian Crashes by Number of Lanes (2009 – 2013)



- Similar to motor vehicle crashes, most pedestrian-involved non-freeway crashes occurred on four-lane or two-lane facilities (95%). Just over half, about 51%, occurred on four-lane roadways, while approximately 44% occurred on two-lane roads. The trend of more crashes involving pedestrians on four-lane than two-lane facilities is the opposite of what is seen for motor vehicle crashes (see Figure 2).
- Multi-lane roadways generally carry higher risk factors for pedestrians, including higher motor vehicle volumes, greater motor vehicle speeds, and increased crossing distances than two-lane roadways.

Figure 16 summarizes non-freeway pedestrian crashes by number of lanes.

Figure 16. Fatal and Severe Injury Non-Freeway Pedestrian Crashes by Number of Lanes (2009 – 2013)

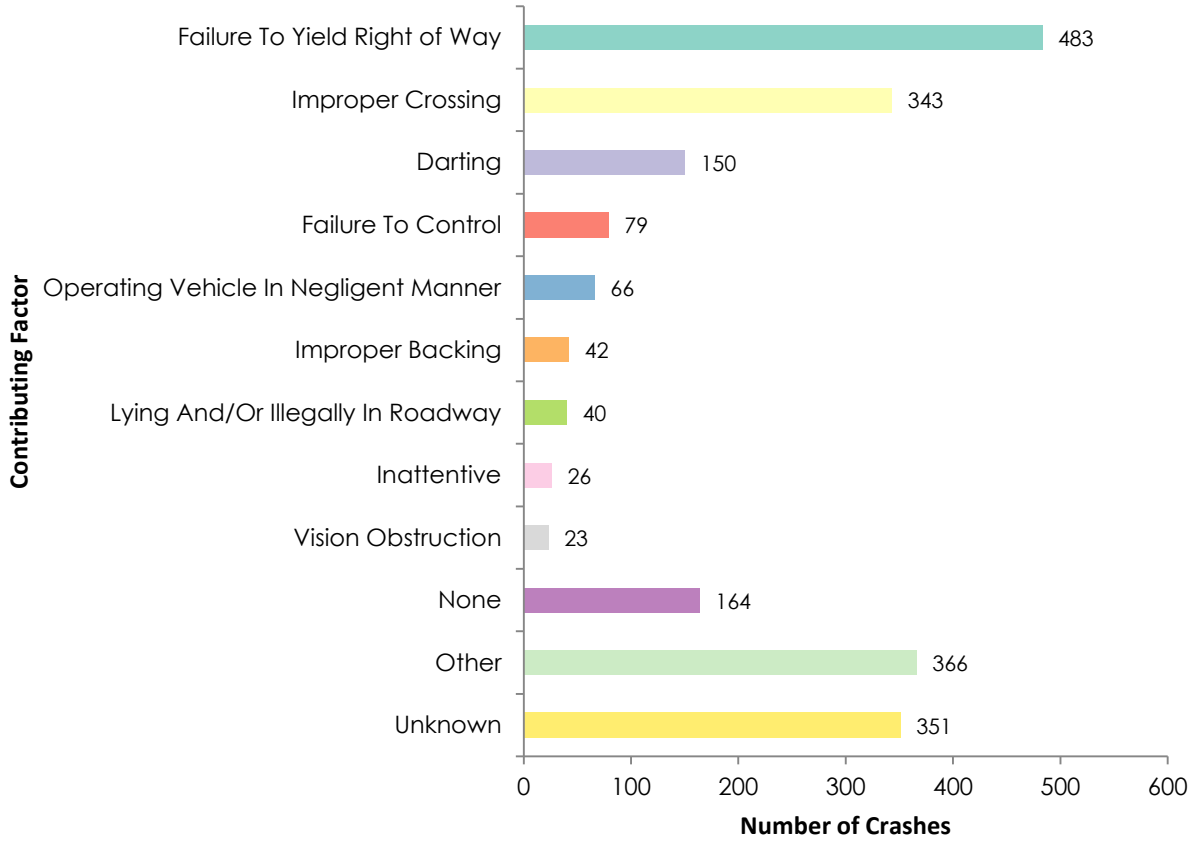


- The distribution of fatal and severe injury non-freeway pedestrian crashes is generally similar to the distribution of total non-freeway pedestrian crashes, based on the number of lanes on the roadway.
    - Six-lane roadways do account for a larger proportion of non-freeway pedestrian fatalities (10%) than they do total non-freeway pedestrian crashes (5%).

Contributing Factor

Figure 17 summarizes non-freeway pedestrian crashes by contributing factor. Similar to vehicle contributing factors, KAI simplified non-freeway pedestrian crash contributing factors and the nine most frequent contributing factors are displayed along with crashes with unknown or no contributing factors. Other contributing factors were combined into the "Other" contributing factor. Tables summarizing what contributing factors were simplified into these factors are included in Attachment "A."

Figure 17. Non-Freeway Pedestrian Crashes by Contributing Factor (2009 – 2013)

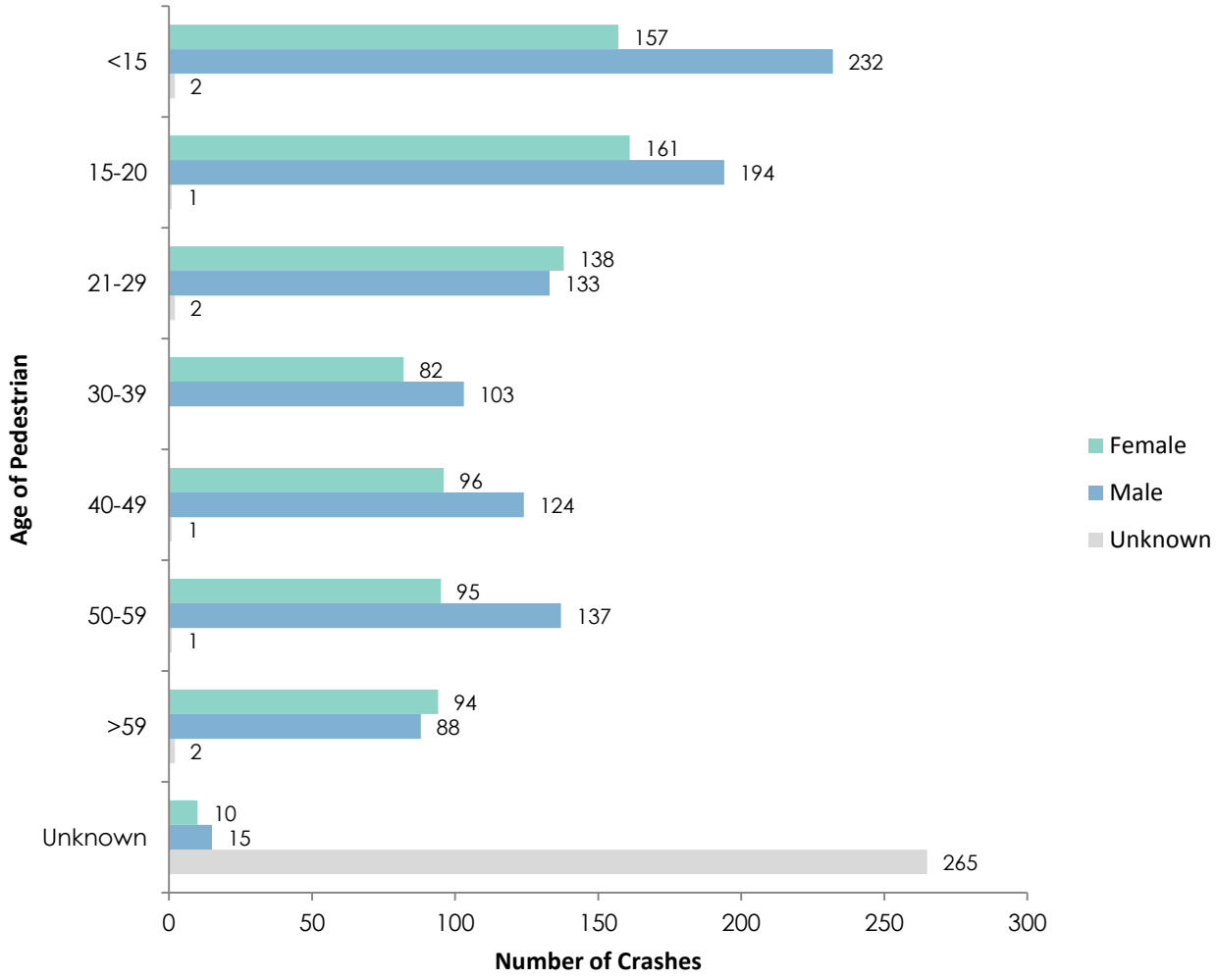


- Failure to Yield Right of Way is the most common contributing factor. It is the reported factor in nearly 23% of non-freeway, pedestrian-involved crashes. The second most common contributing factor is improper crossing, representing 16% of non-freeway, pedestrian crashes.
- The graph above shows significant proportions of the pedestrian-involved crashes are attributed to actions by pedestrians (e.g. improper crossing, darting) and motor vehicle drivers (e.g. failure to yield right of way, failure to control). Strategies addressing both users groups could be effective at reducing crashes involving pedestrians.
- High proportions of pedestrian crashes either had an unknown contributing factor (17%) or no contributing factor (17%) associated with them. Improving crash reporting practices for pedestrian-involved crashes could be an action item to consider when developing the TSAP.

Pedestrian's Age and Gender

Figure 18 summarizes non-freeway pedestrian crashes by the pedestrian's age and gender.

Figure 18. Non-Freeway Pedestrian Crashes by Age and Gender (2009 – 2013)



- Crashes involving the two youngest age groups (under age 15, and ages 15-20) represented the highest proportion of crashes for male (20%) and female (15%) pedestrians.
- Comparatively high proportions of pedestrian crashes had either an unknown age or gender recorded in the crash data (14%). This again suggests that there may be an opportunity to improve reporting practices for pedestrian-involved crashes.

Bicyclists (non-freeway crashes)

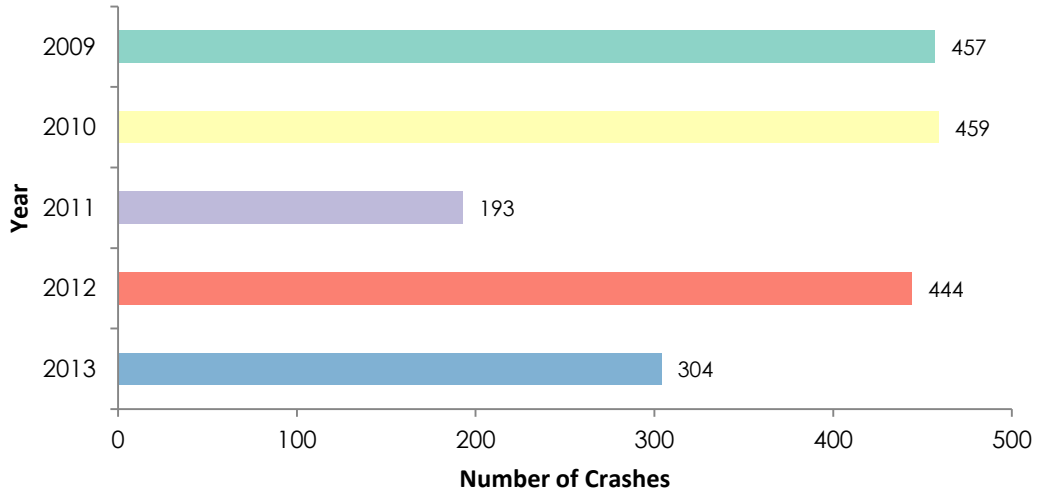
Per direction from NOACA staff, KAI summarized bicycle crashes that occurred on non-freeway roadways according to the following categories:

- Year
- County
- City
- Month
- Time of day
- Weather
- Road surface condition
- Roadway classification
- Number of lanes
- Contributing factor
- Bicyclist age and gender

Year

Figure 19 summarizes non-freeway bicyclist crashes by year.

Figure 19. Non-Freeway Bicyclist Crashes by Year (2009 – 2013)

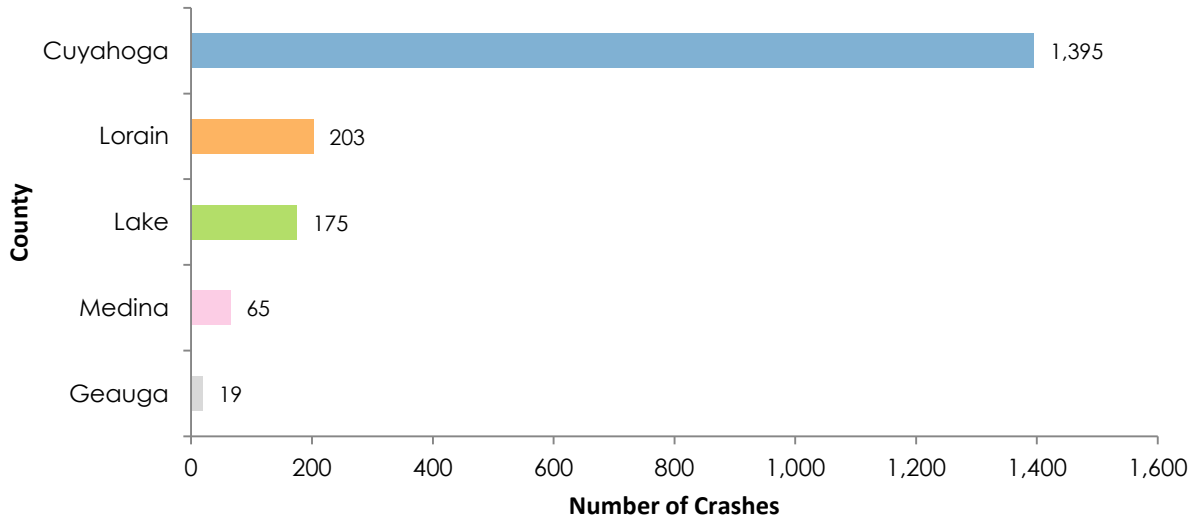


- Bicyclist-involved, non-freeway crashes in 2011 and 2013 were lower than the rest of the years. This trend is similar to vehicle and pedestrian trends for 2011; however, the drop in non-freeway bicyclist-involved crashes in 2013 is lower than the trend in total non-freeway crashes.

County

Figure 20 summarizes non-freeway bicyclist crashes by county.

Figure 20. Non-Freeway Bicyclist Crashes by County (2009 – 2013)



- Three-quarters of reported non-freeway bicyclist crashes occurred in Cuyahoga County (75%). Approximately 61% of the region's population lives in Cuyahoga County[6] and Cleveland is the urban center of the region with a major downtown area.
- Lorain County and Lake County had the second and third highest proportions of bicyclist crashes (11% and 9%, respectively), which are roughly consistent with the two counties' proportions of the population (15% and 11%).

City

Table 2 summarizes non-freeway bicyclist crashes by city.

[6] U.S. Bureau of the Census, Population Estimates Program (PEP), http://www.census.gov/popest/index.html, 2013.

Table 2. Non-Freeway Bicyclist Crashes by City (2009 – 2013)

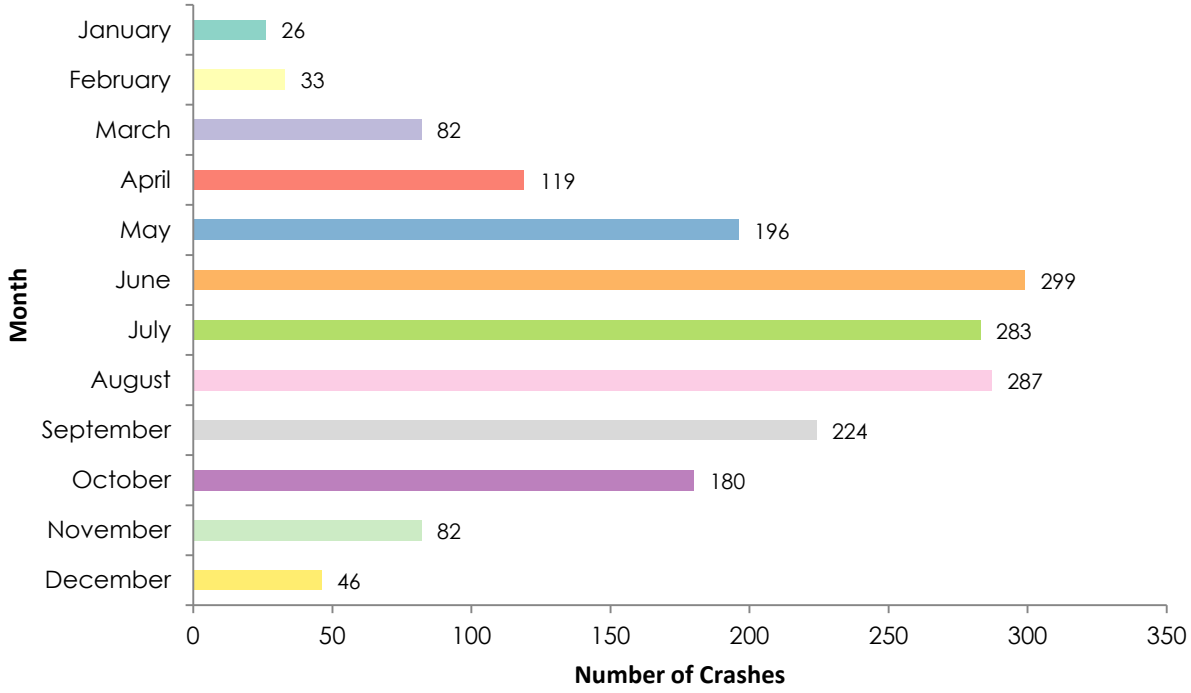
City	Bicyclist Crashes	City (cont.)	Bicyclist Crashes (cont.)	City (cont. 2)	Bicyclist Crashes (cont. 2)
Cleveland	688	Oberlin	9	Newburgh Heights	2
Lakewood	106	Bay Village	8	Oakwood	2
Lorain	69	Highland Heights	8	Olmsted (Township Of)	2
Mentor	60	Olmsted	7	Perry (Township Of)	2
Parma	60	Seven Hills	7	Valley View	2
Cleveland Heights	56	Shaker Heights	7	Vermilion	2
Elyria	52	Wickliffe	7	Westfield	2
Westlake	38	Amherst	6	Willoughby Hills	2
North Olmsted	32	Avon	6	Auburn	1
Garfield Heights	28	Mentor-On-The-Lake	6	Bay Village (Corporate Name Fo	1
Painesville	28	Perry	6	Bedford Heights	1
Euclid	25	Willowick	6	Brooklyn Heights	1
Medina	25	Brecksville	5	Brownhelm	1
Rocky River	23	Warrensville Heights	5	Chesterland	1
Avon Lake	22	Bedford	4	Cleveland Metro Parks	1
Fairview Park	21	Brunswick Hills	4	Columbia	1
Solon	21	Chagrin Falls	4	Columbia (Township Of)	1
Mayfield Heights	19	Eaton	4	Fairport Harbor	1
Willoughby	19	Independence	4	Hunting Valley	1
Berea	18	Middlefield	4	Huntington (Township Of)	1
Madison	17	Olmsted Falls	4	Kirtland	1
Parma Heights	17	Pepper Pike	4	Lafayette	1
Brooklyn	16	Bainbridge	3	Lagrange	1
Cleveland Metroparks	15	Concord	3	Liverpool	1
East Cleveland	15	Madison (Township Of)	3	Liverpool (Township Of)	1
Maple Heights	14	Mayfield	3	Montville	1
Strongsville	14	Medina (Township Of)	3	Moreland Hills	1
Brunswick	12	Newbury	3	Munson	1
Middleburg Heights	12	Bentleyville	2	New Russia	1
Beachwood	11	Broadview Heights	2	Orange	1
Brook Park	11	Burton	2	Parkman	1
Eastlake	11	Carlisle	2	Pittsfield	1
North Ridgeville	11	Chardon	2	Richmond Heights	1
South Euclid	11	Gates Mills	2	Russell	1
University Heights	11	Grafton	2	South Euclid (Bluestone)	1
Lyndhurst	10	Leroy	2	Waite Hill	1
Sheffield	10	Linndale	2	Wellington	1
Wadsworth	10	Litchfield	2		
North Royalton	9	Montville (Township Of)	2		

- Bicyclist crashes are concentrated in Cleveland with 37% of bicyclist crashes occurring within the City.
- The cities of Lakewood, Lorain, Mentor, Parma, Cleveland Heights, and Elyria have over 50 bicyclist crashes over the 5-year period. These cities are among the largest in the region.

Month

Figure 21 summarizes non-freeway bicyclist crashes by month.

Figure 21. Non-Freeway Bicyclist Crashes by Month (2009 – 2013)

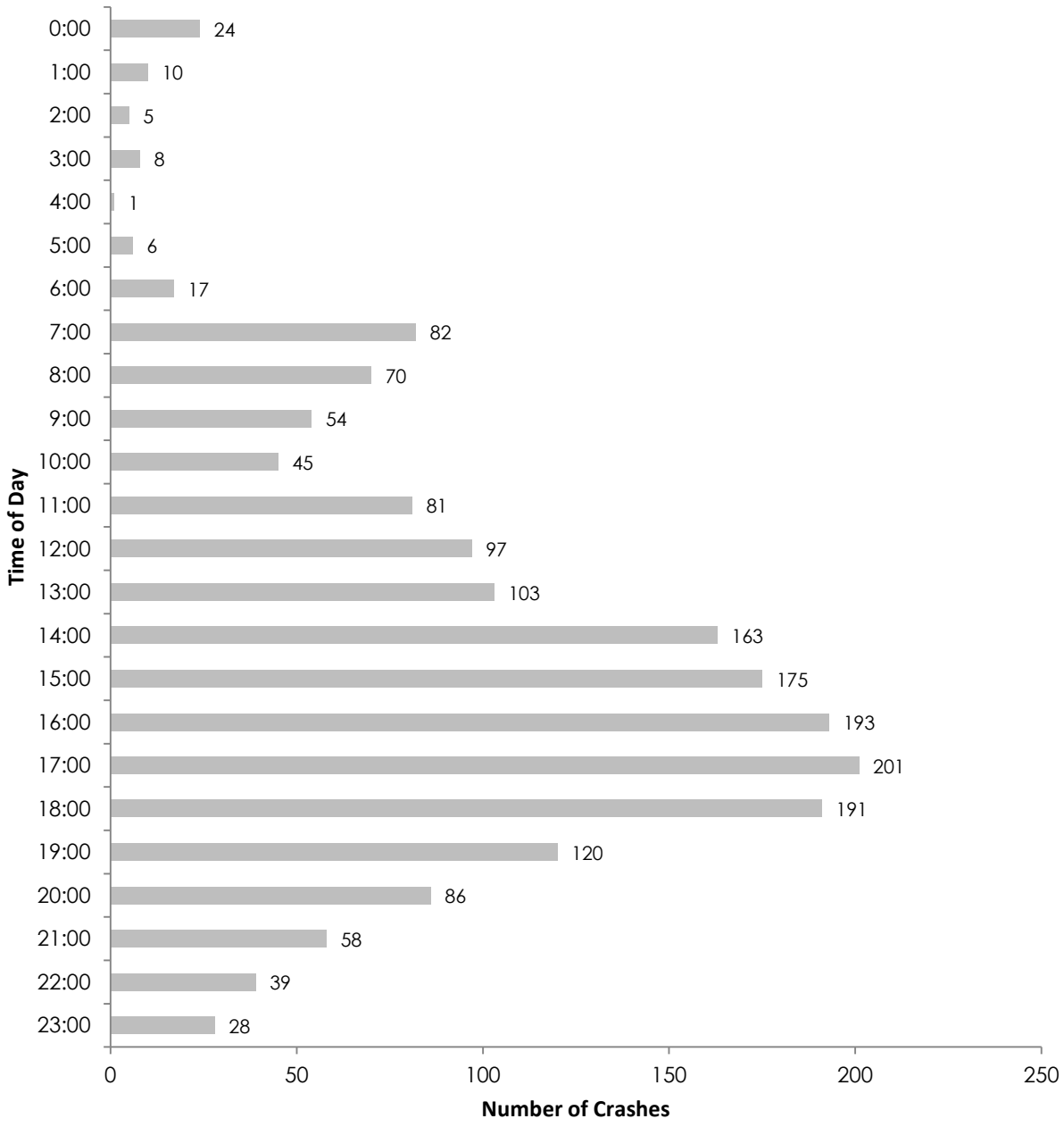


- Non-freeway, bicyclist-involved crashes are more prevalent in the summer, with 46.8% of non-freeway, bicyclist-involved crashes occurring during June, July, and August. The winter months between December and February represent only 6% of all non-freeway, bicyclist-involved crashes. These patterns match expectations, as fewer people bicycle during the colder winter months than during the summer months.

Time of Day

Figure 22 summarizes non-freeway bicyclist crashes by time of day.

Figure 22. Non-Freeway Bicyclist Crashes by Time of Day (2009 – 2013)

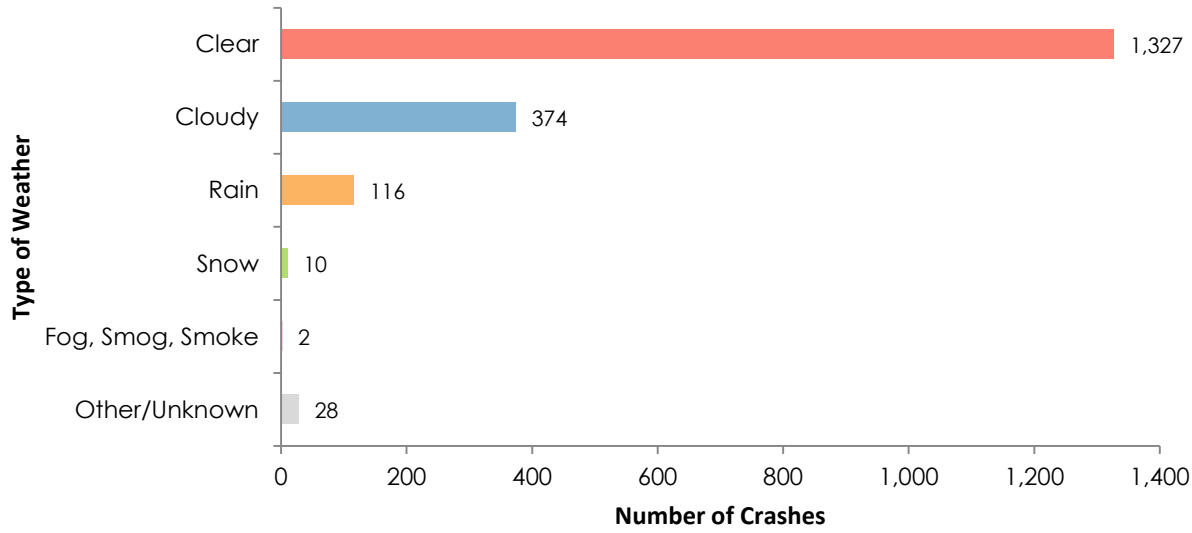


- Non-freeway bicyclist crashes peak in the afternoon/early evening hours between the hours of 2:00 p.m. and 7:00 p.m. Approximately 50% of non-freeway bicyclist crashes occur during these 5 hours.
- There is a smaller peak in non-freeway bicyclist crashes between the hours of 7:00 a.m. and 9:00 a.m. hour representing nearly 8% of all crashes.
- These peak periods are generally consistent with typical motor vehicle volume patterns.

Weather

Figure 23 summarizes non-freeway bicyclist crashes by weather condition.

Figure 23. Non-Freeway Bicyclist Crashes by Weather (2009 – 2013)

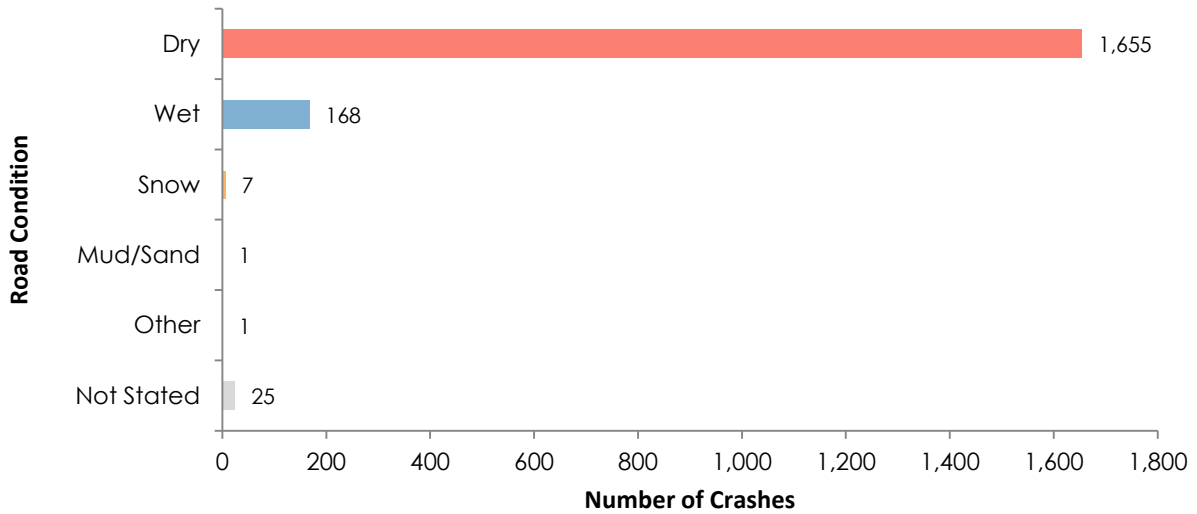


- 76% of bicyclist-involved crashes occur under clear weather, while cloudy weather and rain represented 20% and 6% of bicyclist-involved crashes, respectively.

Road Surface Condition

Figure 24 summarizes non-freeway bicyclist crashes by year.

Figure 24. Non-Freeway Bicyclist Crashes by Road Condition (2009 – 2013)

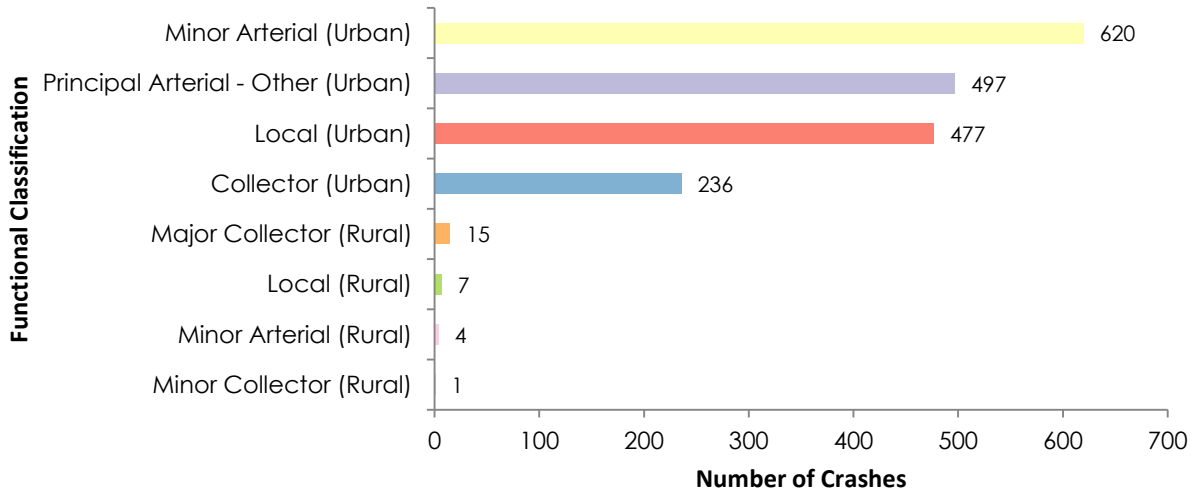


- 89% of bicyclist-involved crashes occur under dry roadway conditions, while wet roadway surface conditions represent 9% of bicyclist-involved crashes.

Roadway Classification

Figure 25 summarizes non-freeway bicyclist crashes by roadway functional classification.

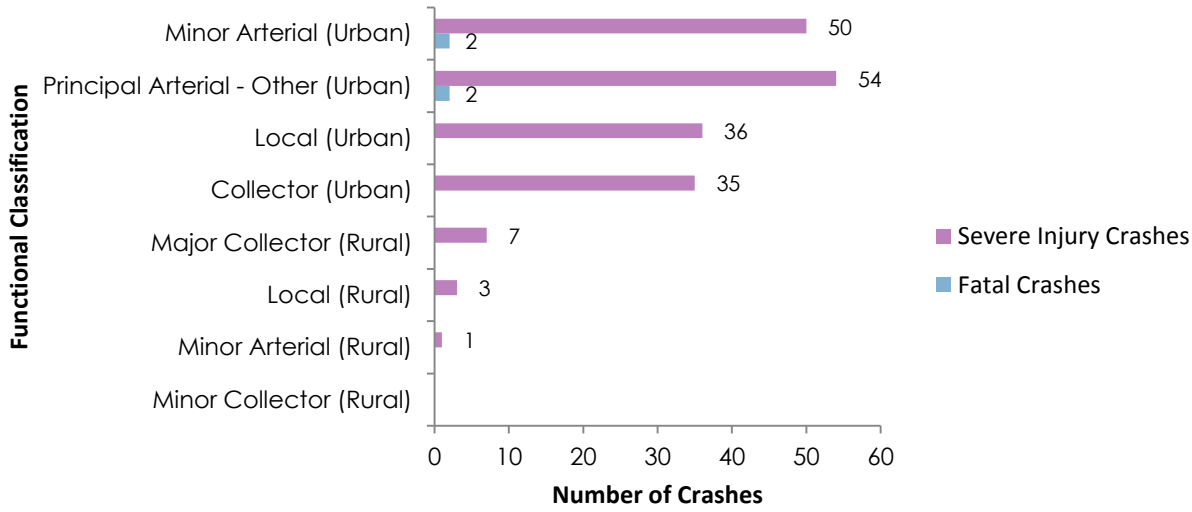
Figure 25. Non-Freeway Bicyclist Crashes by Functional Classification (2009 – 2013)



- Over 98% of bicyclist-involved crashes occur in urban areas, with the majority occurring on higher-volume urban roadways including Minor Arterials (33%), Principal Arterials (27%), Locals (26%), and Collectors (13%).

Figure 26 summarizes fatal and severe injury non-freeway bicyclist crashes by roadway functional classification.

Figure 26. Fatal and Severe Injury Bicyclist Crashes by Functional Classification (2009 - 2013)



- There were only four fatal bicyclist non-freeway crashes over the five-year period so it is not possible to define any trends.
- The distribution of bicyclist crashes resulting in a severe injury is mostly similar to the

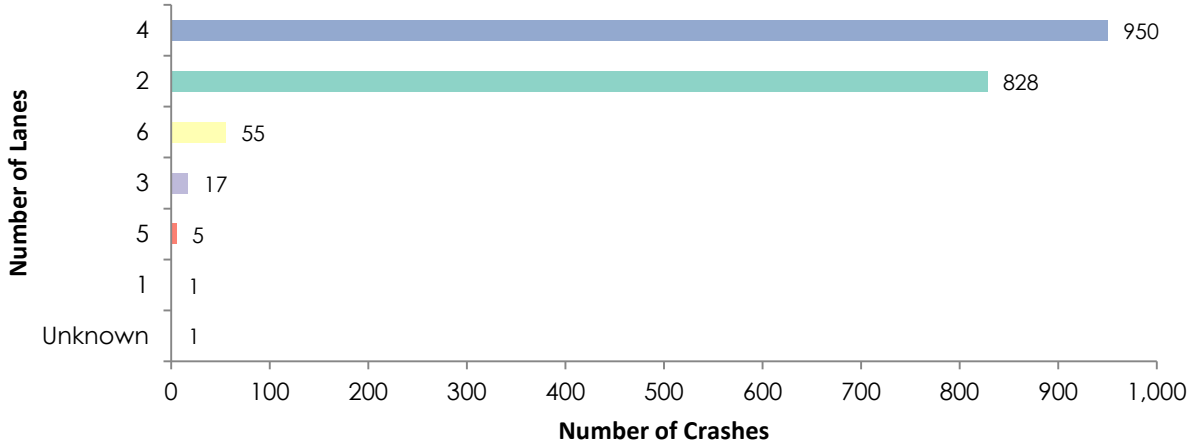
distribution of total non-freeway bicyclist crashes across road functional classifications, with the following exceptions (note that the relatively small sample size of bicyclist severe injury crashes makes it difficult to draw conclusions from these trends).

- The proportions of bicyclist severe injury crashes on Urban Minor Arterial and Urban Local roads (27% and 19%, respectively) are lower than the proportions of total non-freeway bicyclist crashes occurring on those facilities (33% and 26%, respectively).
- The percentage of bicyclist severe injury crashes that occurred on Urban Collector roads (19%) is higher than the proportion of total non-freeway bicyclist crashes reported on those roads (13%).

Number of Lanes

Figure 27 summarizes non-freeway bicyclist crashes by number of lanes.

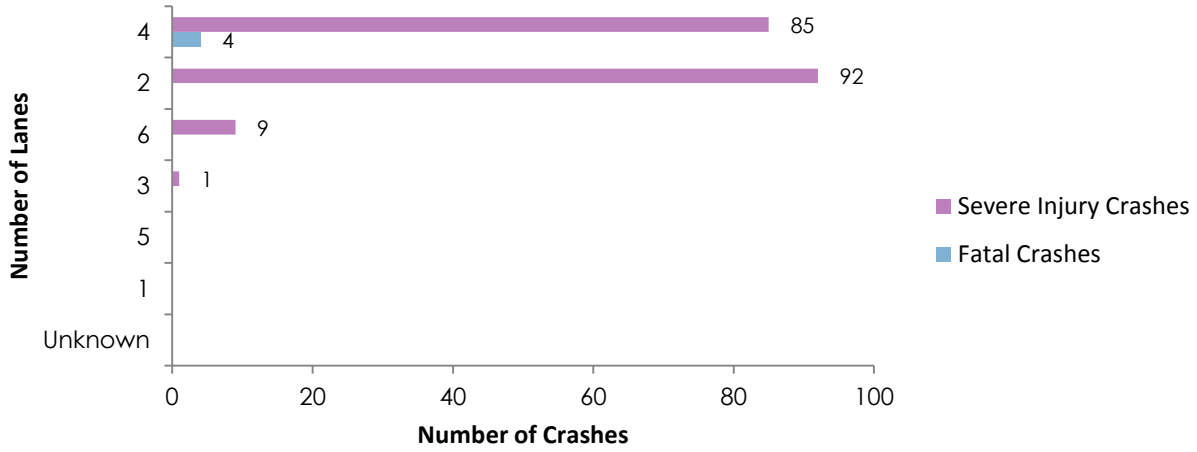
Figure 27. Non-Freeway Bicyclist Crashes by Number of Lanes (2009 – 2013)



- Similar to motor vehicle crashes, most bicyclist-involved non-freeway crashes occurred on four-lane or two-lane facilities (96%). Just over half, about 51%, occurred on four-lane roadways, followed by approximately 45% occurred on two-lane roads. The trend of more crashes involving bicyclists on four-lane than two-lane facilities is the opposite of what is seen for motor vehicle crashes (see Figure 2).
- Multi-lane roadways generally carry higher risk factors for bicyclists, including higher motor vehicle volumes, greater motor vehicle speeds, and increased intersection crossing distances than two-lane roadways.

Figure 28 summarizes fatal and severe injury non-freeway bicyclist crashes by number of lanes.

Figure 28. Fatal and Severe Injury Non-Freeway Bicyclist Crashes by Number of Lanes (2009 – 2013)

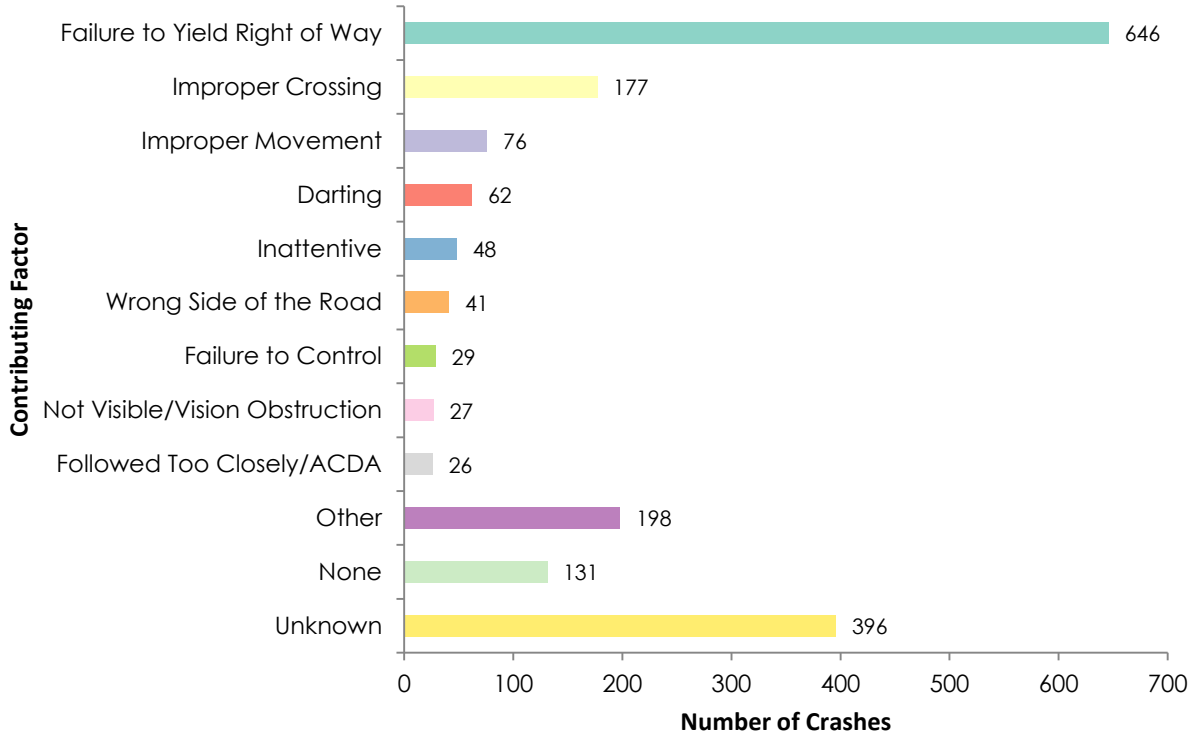


- There were only four fatal bicyclist non-freeway crashes over the five-year period so it is not possible to define any trends.
- Similar to total non-freeway bicyclist crashes proportions, most non-freeway bicyclist-involved severe injury crashes occurred on two- or four-lane roadways (95%). A slightly higher proportion of non-freeway bicyclist-involved crashes resulted in severe injuries on two-lane facilities (49%) and a lower proportion of severe injuries on four-lane facilities (46%) than would be expected based on overall crash proportions for two-lane facilities (45%) and four-lane facilities (51%).

Contributing Factor

Figure 29 summarizes non-freeway bicyclist crashes by contributing factor. Similar to pedestrian contributing factors, KAI simplified non-freeway bicyclist crash contributing factors and the nine most frequent contributing factors are displayed along with crashes with unknown or no contributing factors. Other contributing factors were combined into the "Other" contributing factor. Tables summarizing what contributing factors were simplified into these factors are included in Attachment "A."

Figure 29. Non-Freeway Bicyclist Crashes by Contributing Factor (2009 – 2013)

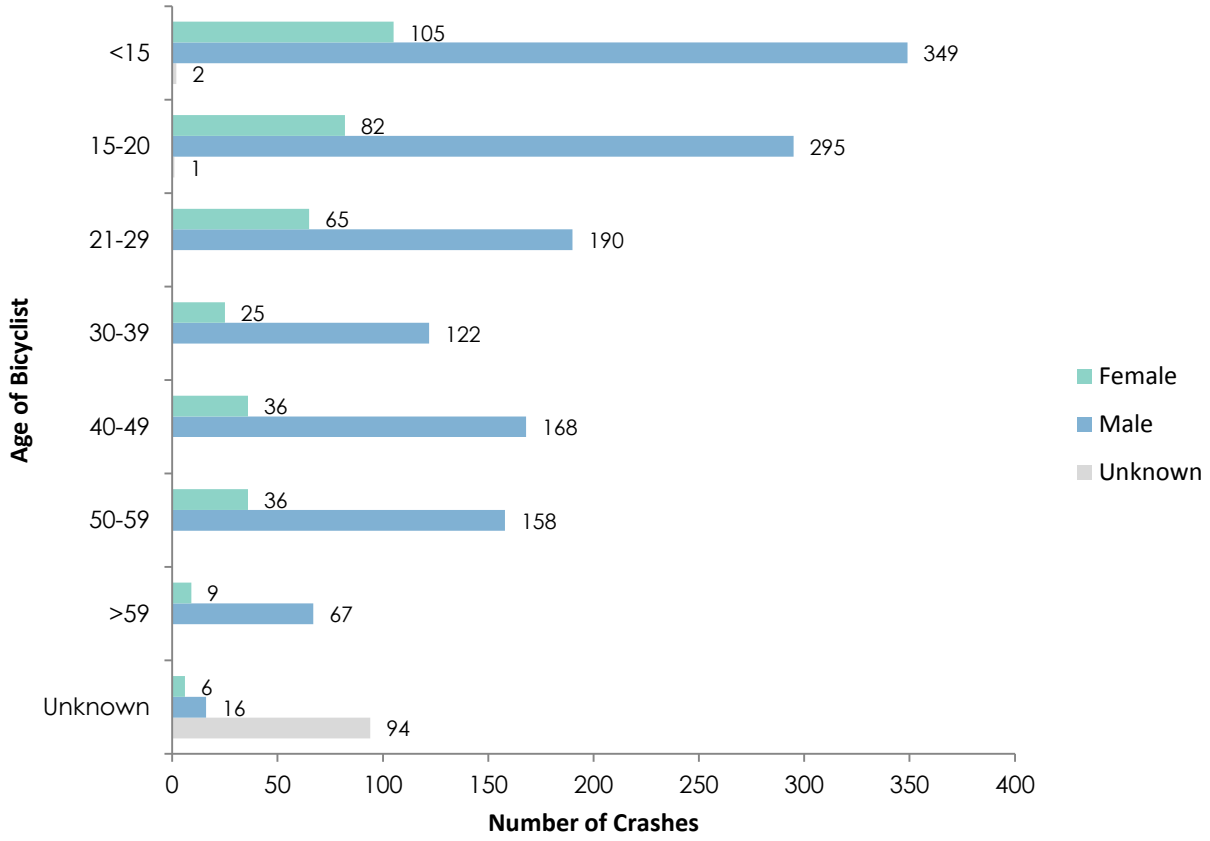


- Failture to yield right of way was the most common contributing cause of non-freeway bicyclist crashes, representing 35% of non-freeway bicyclist crashes.
- Improper crossing (10%), improper movements (4%), and darting (3%) were relatively common contributing causes to non-freeway bicyclist crashes.
- The graph above shows significant proportions of the bicyclist-involved crashes are attributed to actions by bicyclists and motor vehicle drivers. Efforts to reduce crashes involving bicyclists could include strategies for both user groups.
- About 28% of non-freeway bicyclist crashes had either no contributing cause (7%) or an unknown contributing cause (21%),. Improving crash reporting practices for pedestrian-involved crashes could be an action item to consider in developing the TSAP.

Bicyclist's Age and Gender

Figure 30 summarizes non-freeway bicyclist crashes by bicyclist age and gender.

Figure 30. Non-Freeway Bicyclist Crashes by Gender and Age (2009 – 2013)



- Nearly three-quarters of non-freeway bicyclist crashes involved a male bicyclist (74%). This is consistent with the national gender distribution with men accounting for approximately 76% of bicycle trips nationally[7].
- The two youngest age groups, under age 15 and ages 15 to 20, represent the highest proportions of bicyclist crashes for both genders (a combined 45% of reported bicyclist crashes).

Crash Type Detail

Per direction from NOACA staff, KAI summarized the entire crash dataset by contributing factor and severity according to the following categories:

- All crash types
- Rear-end crashes

[7] Alliance for Biking and Walking, *Bicycling and Walking in the United States: 2014 Benchmarking Report* (2014). This report uses data from the 2009 National Household Travel Survey and 2011 American Community Survey.

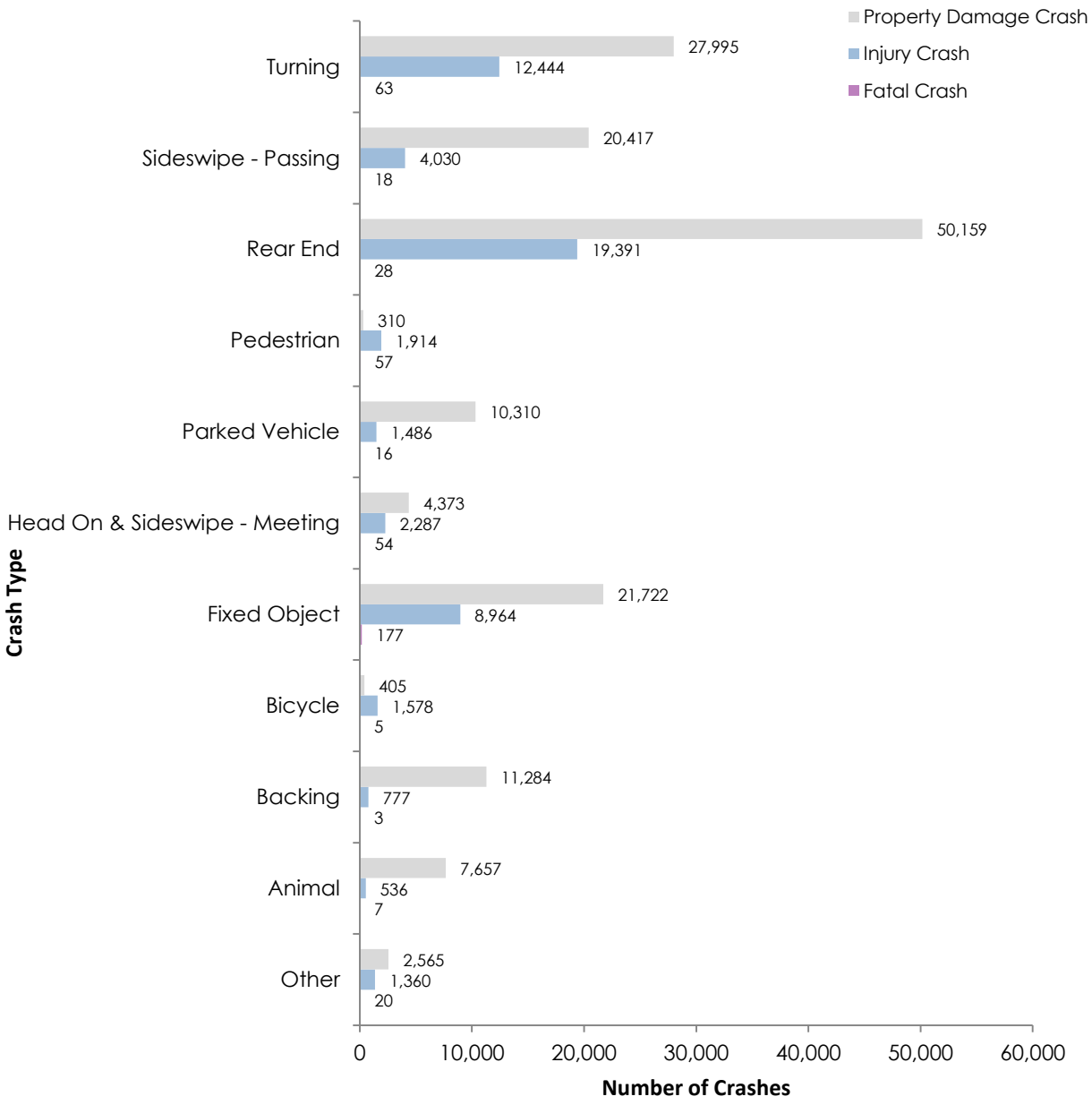
- Turning crashes
- Fixed object crashes
- Pedestrian crashes

As mentioned previously, KAI also analyzed contributing factors for fatal and severe injury crashes in the region. Our analysis used contributing factors cited in national and other regional efforts, as well as the factors identified in ODOT's strategic highway safety plan (SHSP). This analysis is included in this section prior to the discussion of the individual crash types (e.g. Rear-end crashes).

All Crash Types

Figure 31 summarizes crashes by type and severity.

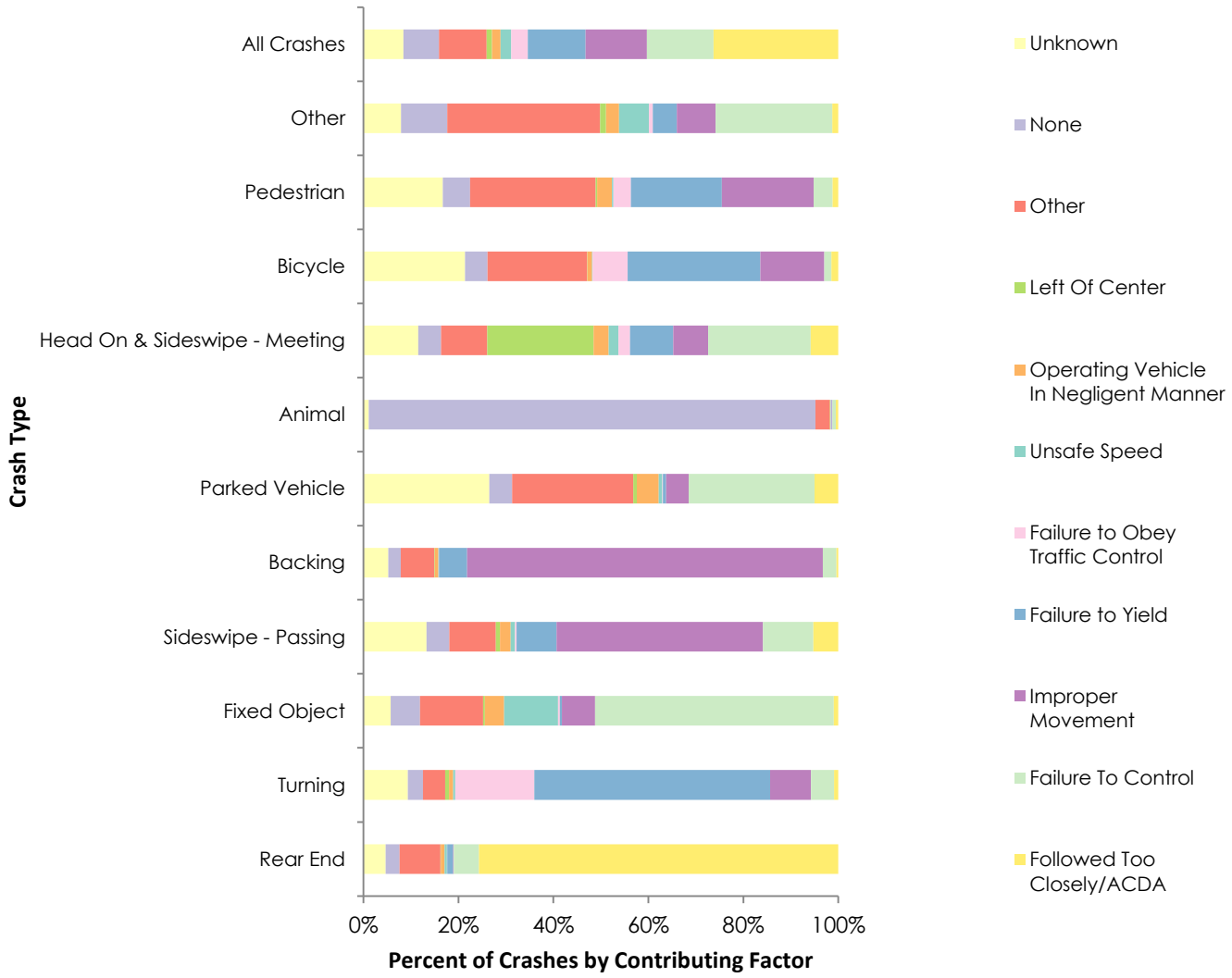
Figure 31. Crashes by Type and Severity (2009 – 2013)



- The proportions of fixed object (0.6%), head on and sideswipe – meeting (0.8%), and pedestrian (3%) crashes resulting in a fatality were larger than the proportion for total crashes (0.2%) that resulted in a fatality.
- The proportion of bicycle (79%) and pedestrian (84%) crashes resulting in an injury were higher than the proportion for total crashes (26%), while head on and sideswipe – meeting (34%), and turning (31%) injury crashes were also higher than the proportion for total crashes.

Figure 32 summarizes crashes by type and contributing factor.

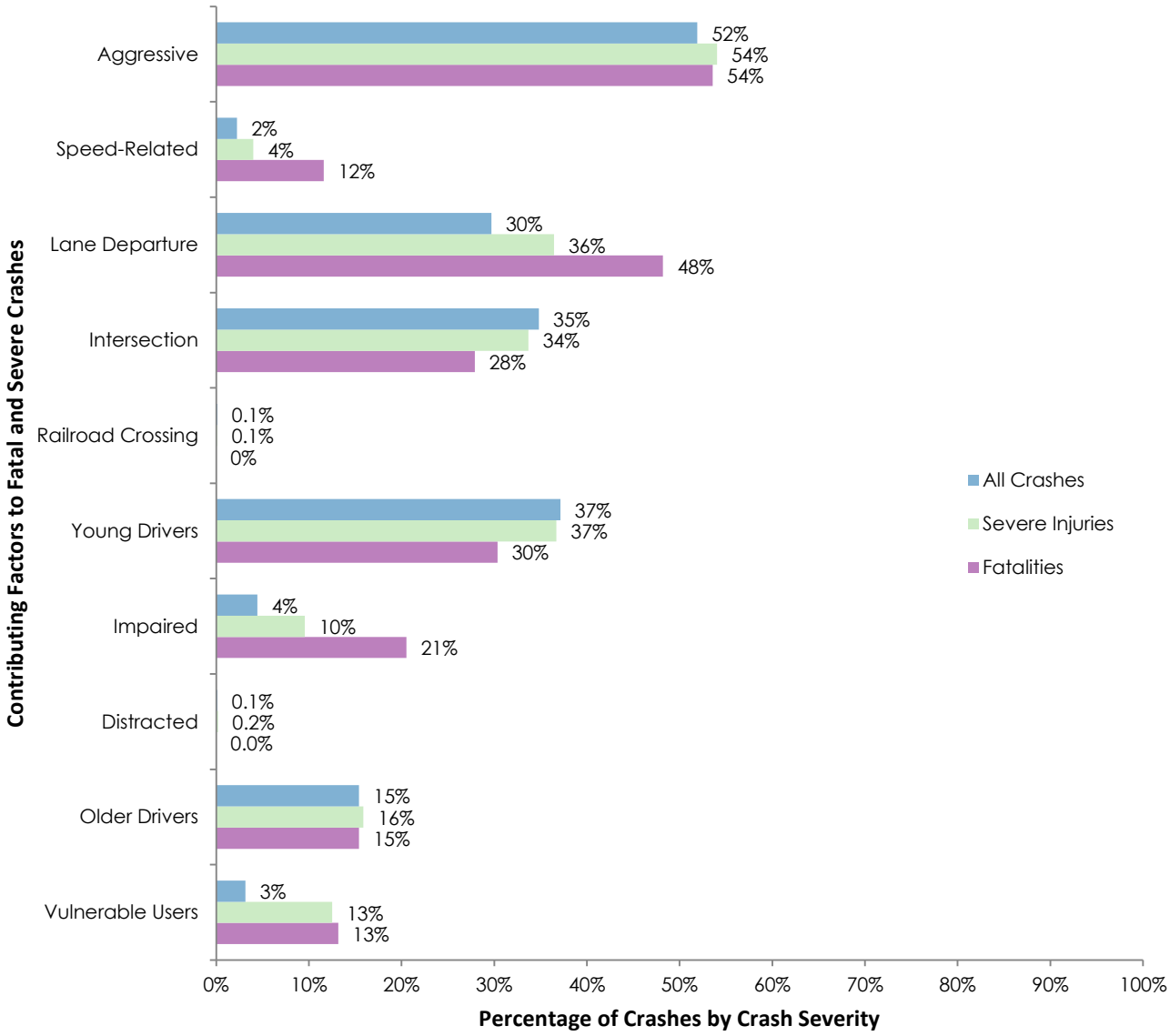
Figure 32. Crash Type by Contributing Factor (2009 – 2013)



- Contributing causes vary significantly by crash type. The following are the primary contributing factors for each crash type shown:
    - All crashes – Followed too closely/ACDA (26%)
    - Other Crashes – Other (32%)
    - Pedestrian crashes – Other (26%)
    - Bicycle crashes – Failure to Yield (28%)
    - Head On & Sideswipe – Meeting – Left of center and failure to control (22% each)
    - Animal – None (94%)
    - Parked Vehicle – Failure to control and unknown (27% each)
    - Backing – Improper movement (75%)
    - Sideswipe – Passing – Improper movement (43%)
    - Fixed object crashes – Failure to control (50%)
    - Turning crashes – Failure to yield (50%)
    - Rear-end crashes – Followed too closely/ACDA (76%)

A number of factors have been identified under the national *Towards Zero Deaths*[8] initiative and the ODOT Strategic Highway Safety Plan as contributing to fatal and severe crashes. We analyzed the overall crash dataset to identify the extent to which these factors contribute to fatal, severe injury, and total crashes. The results of this analysis are shown in Figure 33. Note that the factors may overlap with each other (e.g. a crash may involve both aggressive driving and lane departure), so the total percentages do not sum to 100%.

Figure 33. Factors Contributing to Fatal and Severe Crashes as a Percentage of Crashes by Severity (2009 – 2013)



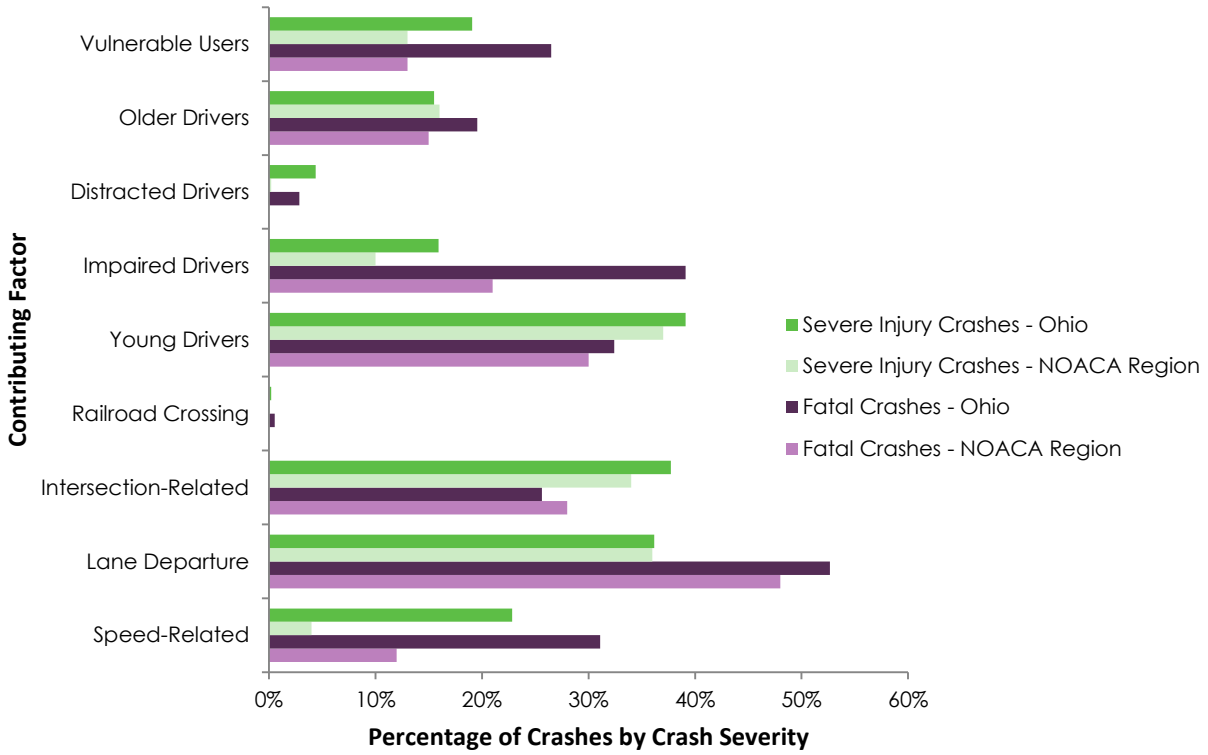
- Aggressive driving (e.g. speeding, red light running, following too close, etc.) contributes to

[8] *Toward Zero Deaths: A National Strategy on Highway Safety*. www.towardzerodeaths.org.

the highest proportion of fatalities and severe injuries, followed by lane departure (e.g. run-off-the-road, head-on, sideswipe), young drivers (25 years old and younger), and intersection-related crashes.
    - These could be good focus areas for countermeasures as they may offer the greatest opportunity for reducing fatalities and serious injuries.
- Impaired driving, vulnerable user, and speed-related factors each contribute to a proportion of fatal crashes that is four times higher than the proportion of total crashes they contribute to.

Figure 34 compares trends in the NOACA region to statewide trends in Ohio[9] across the contributing factors for which data is available at both levels.

Figure 34. Fatal and Severe Injury Crash Contributing Factor Trends, Ohio Compared to NOACA region



- Trends are generally similar across the two datasets for most factors. Three exceptions to this are:
    - Speed-related factors, impaired drivers, and vulnerable users (i.e. motorcyclists, bicyclists, and pedestrians) are cited in a smaller proportion of severe crashes in the NOACA region than across Ohio.
    - The difference in vulnerable users is mostly due to differences in crashes involving motorcycles, which are reported as being involved in a smaller proportion of severe crashes in the NOACA region than statewide.

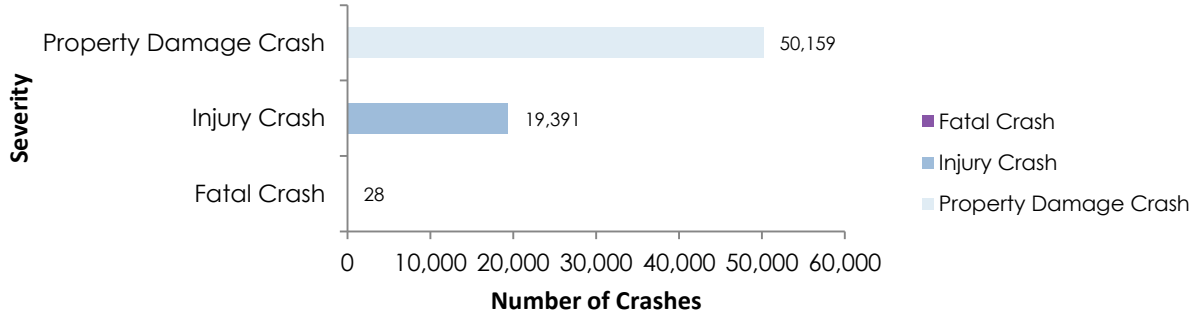
[9] *Ohio SHSP Emphasis Areas*. Ohio Department of Transportation. http://www.dot.state.oh.us/Divisions/Planning/ProgramManagement/HighwaySafety/SHSP/SHSP%20Emphasis%20Areas/2002-2012%20SHSP%20Annual%20Emphasis%20Area%20Tracker.pdf.

- Similarities in trends between the regional, state, and national data may facilitate coordination between NOACA, ODOT, Federal Highway Administration (FHWA), and other agencies in deploying countermeasures aimed at contributing factors that are a priority for multiple agencies.

Rear-End Crashes

Figure 35 summarizes rear-end crashes by severity.

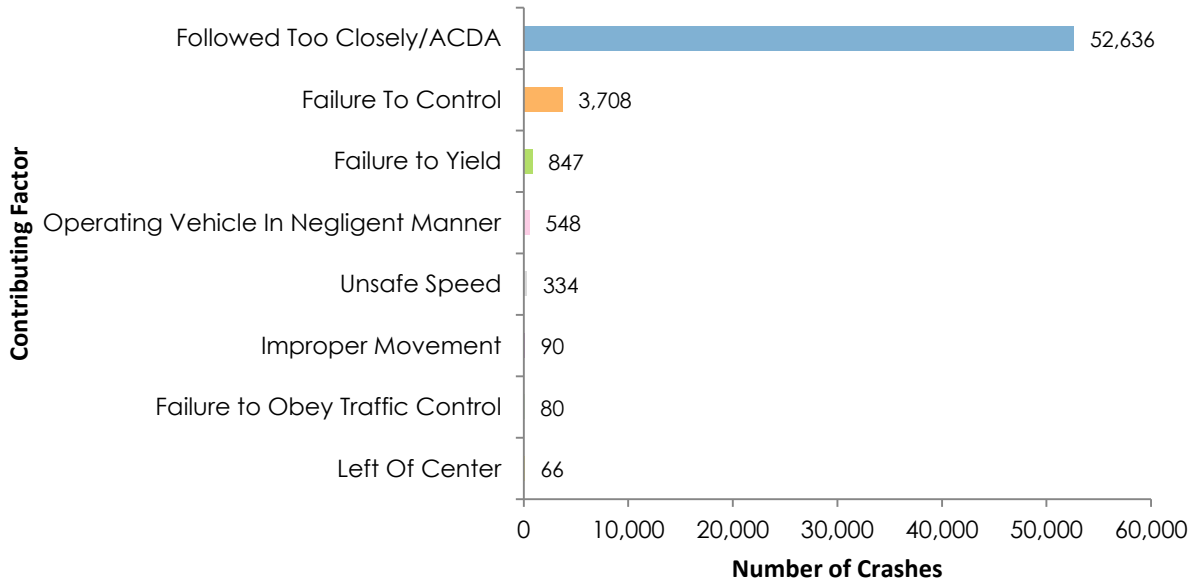
Figure 35. Rear-End Crashes by Severity (2009 – 2013)



- Rear-end crashes result in a fatality less than 0.1% of the time, which is below the average for reported crashes.
- Injury crashes are slightly over represented for rear end crashes (28%). However, these injuries are less likely to be severe than all reported crashes (1.7% versus 2.1%, respectively).

Figure 36 summarizes rear-end crashes by contributing factor.

Figure 36. Rear-End Crashes by Contributing Factor (2009 – 2013)



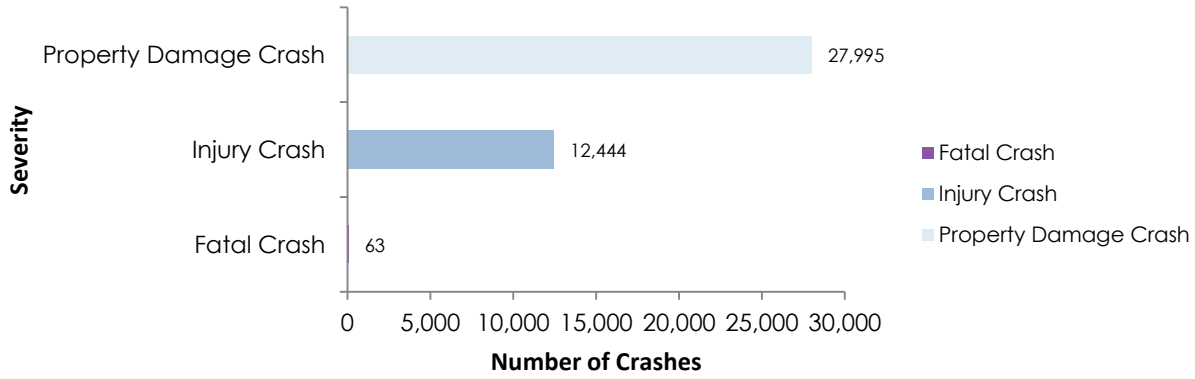
- Over three-quarters of rear end crashes (76%) had followed too closely/ACDA reported as

their contributing factor.

Turning Crashes

Figure 37 summarizes turning crashes by severity.

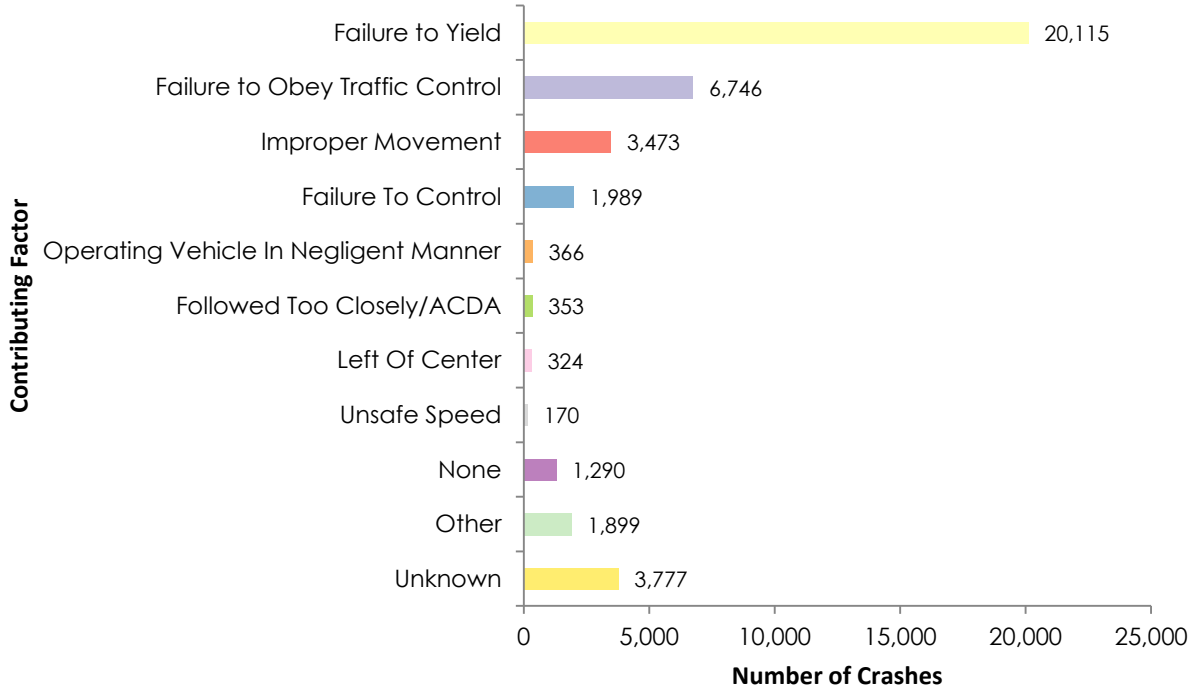
Figure 37. Turning Crashes by Severity (2009 – 2013)



- The proportion of turning crashes resulting in a fatality (0.5%) or injury (31%) are overrepresented.

Figure 38 summarizes turning crashes by contributing factor.

Figure 38. Turning Crashes by Contributing Factor (2009 – 2013)

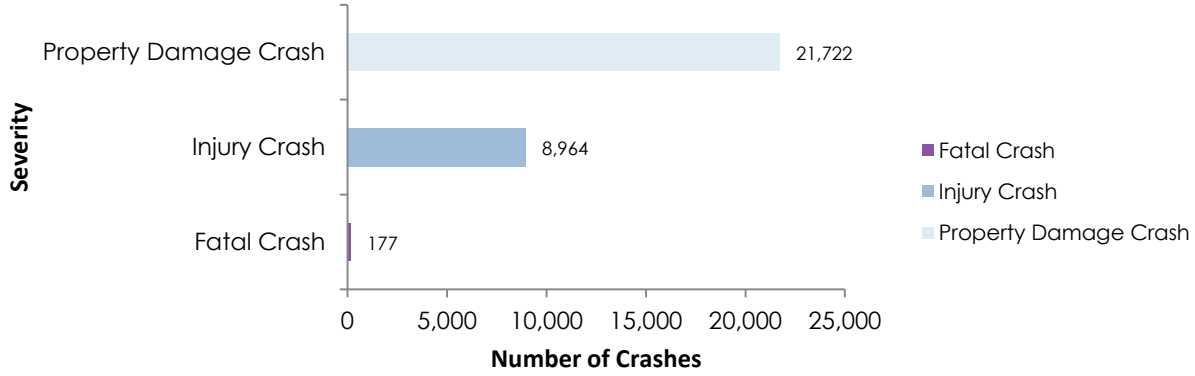


- Failure to yield was the most common contributing factor, reportedly contributing to nearly half (50%) of the turning crashes. Failure to obey traffic control (17%) and improper movement (9%) were also leading reported contributors.

Fixed Object Crashes

Figure 39 summarizes fixed object crashes by severity.

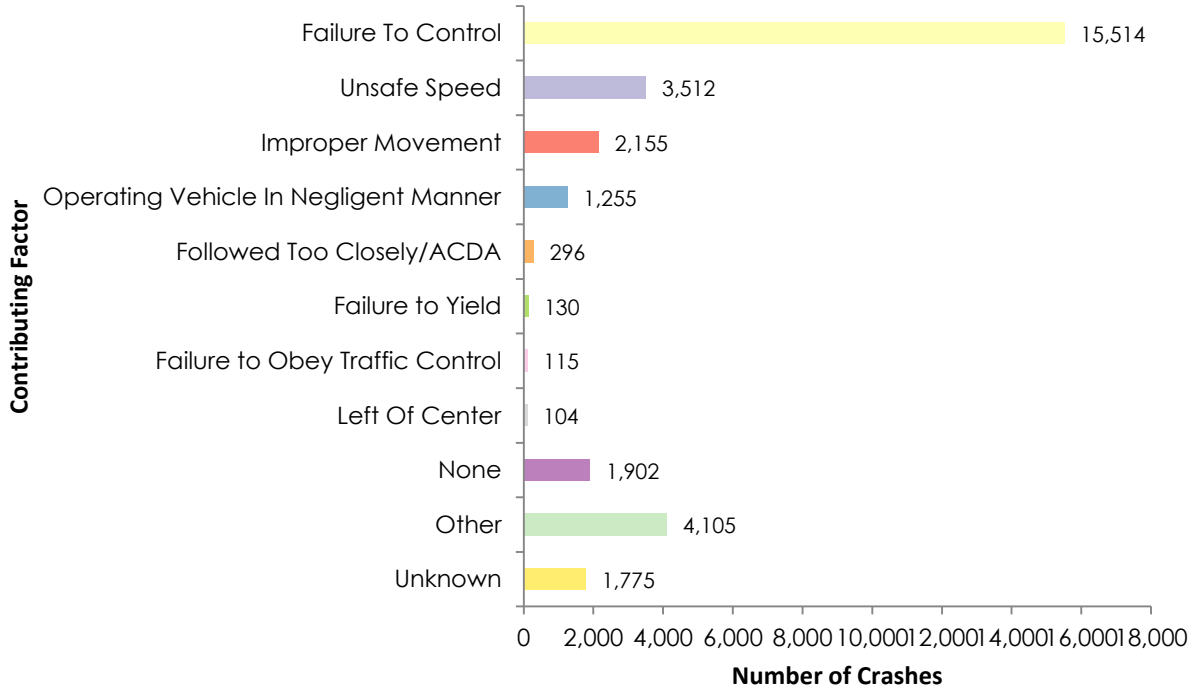
Figure 39. Fixed Object Crashes by Severity (2009 -2013)



- The proportions of fixed object crashes resulting in a fatality (2%) or injury (41%) are over represented.

Figure 40 summarizes fixed object crashes by contributing factor.

Figure 40. Fixed Object Crashes by Contributing Factor (2009 – 2013)

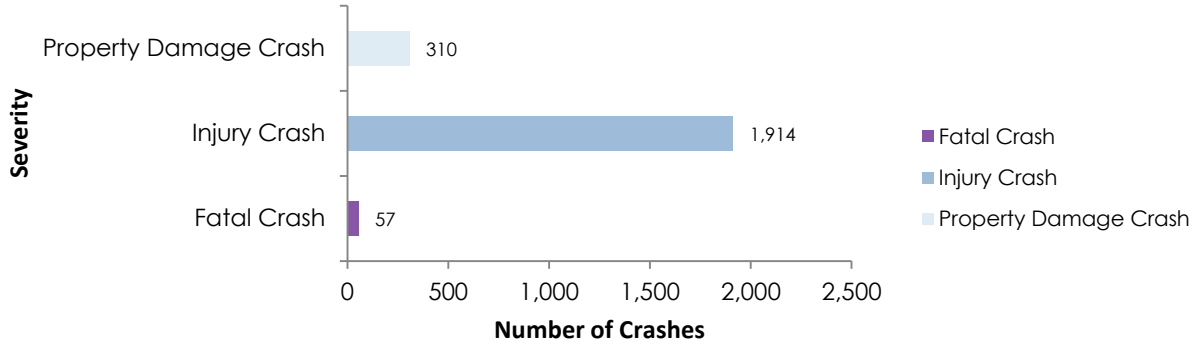


- The reported contributing factor for half of the fixed object crashes (50%) is failure to control.
- Unsafe speed (11%) is the second most frequently reported contributing factor to fixed object crashes.

Pedestrian Crashes

Figure 41 summarizes pedestrian crashes by severity including freeway pedestrian crashes. Freeway pedestrian crashes accounted for 6% of the reported pedestrian crashes.

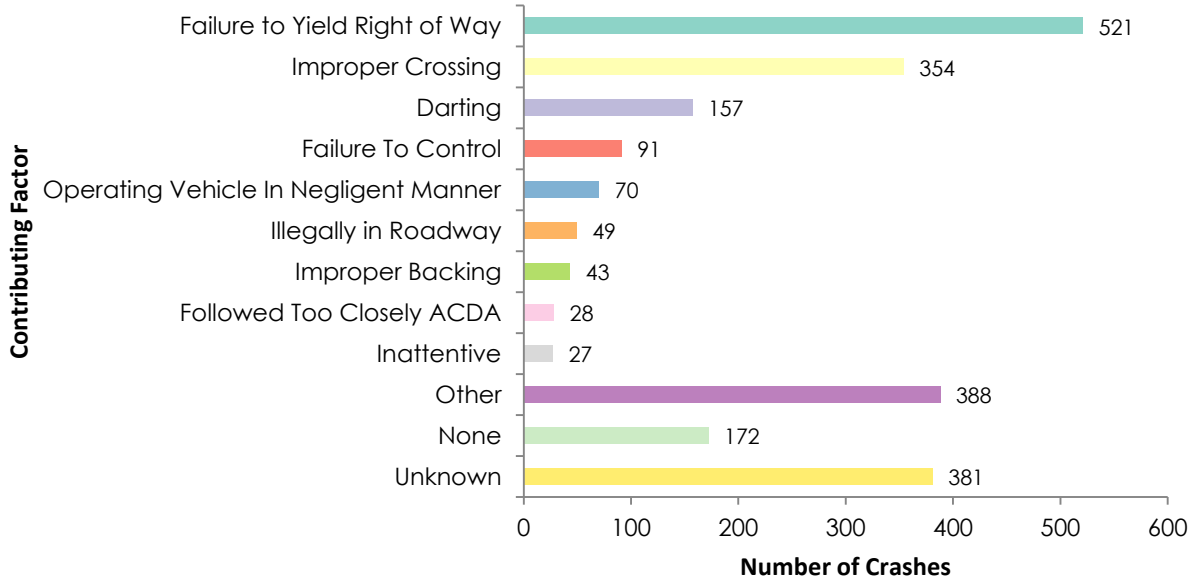
Figure 41. Pedestrian Crashes by Severity (2009 – 2013)



- The proportions of pedestrian crashes resulting in a fatality (2%) or injury (84%) are overrepresented.

Figure 42 summarizes pedestrian crashes by contributing factor.

Figure 42. Pedestrian Crashes by Contributing Factor (2009 – 2013)



- The failure to yield right of way contributing cause represented the largest proportion of pedestrian crashes (23%), following by improper crossing (16%) and darting (7%).
- Approximately one-quarter of pedestrian crashes had no reported contributing cause (8%) or a reportedly unknown contributing cause (17%).

Freeway Crashes

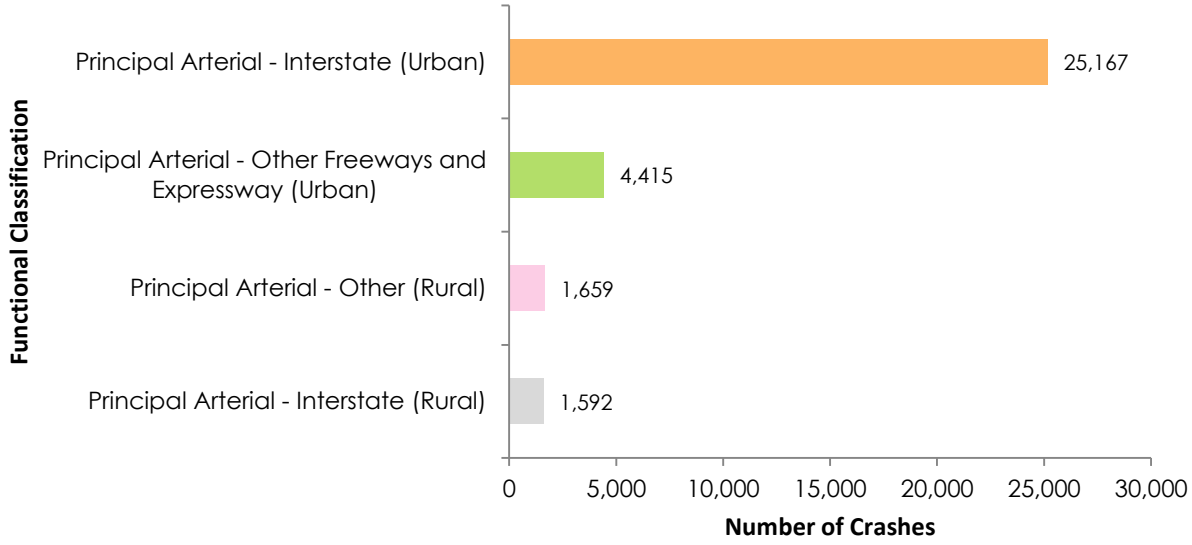
Per direction from NOACA staff, KAI summarized crashes that occurred on freeway roadways according to the following categories:

- Roadway classification
- Number of lanes
- Crash type
- Contributing factor

Roadway Classification

Figure 43 summarizes freeway crashes by roadway functional classification.

Figure 43. Freeway Crashes by Functional Classification (2009 – 2013)

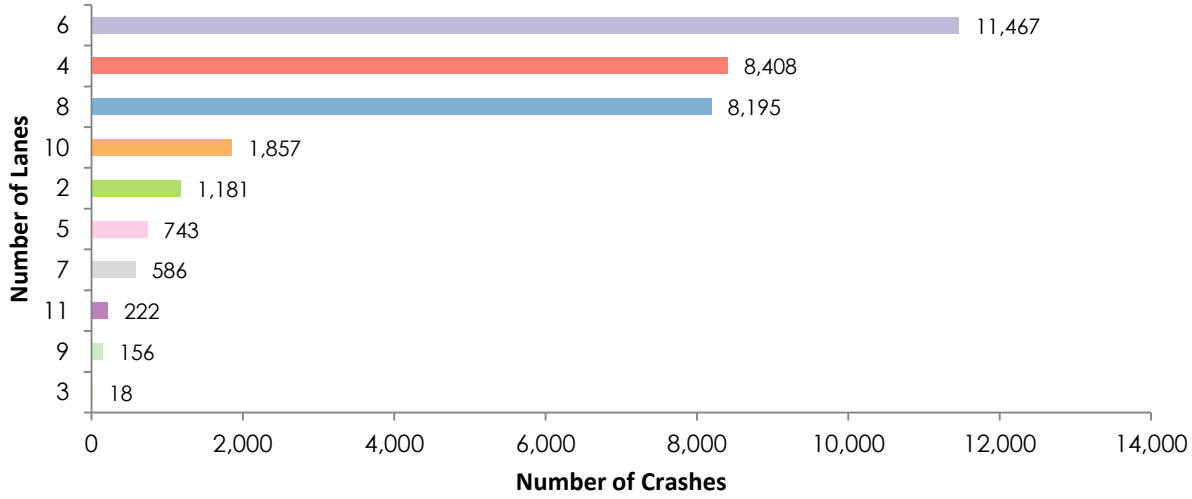


- Over 90% of freeway crashes occur on urban freeways, with 77% occurring on urban interstates.
- Rural freeway crashes are nearly evenly split between interstate and other freeway facilities.

Number of Lanes

Figure 44 summarizes freeway crashes by number of lanes.

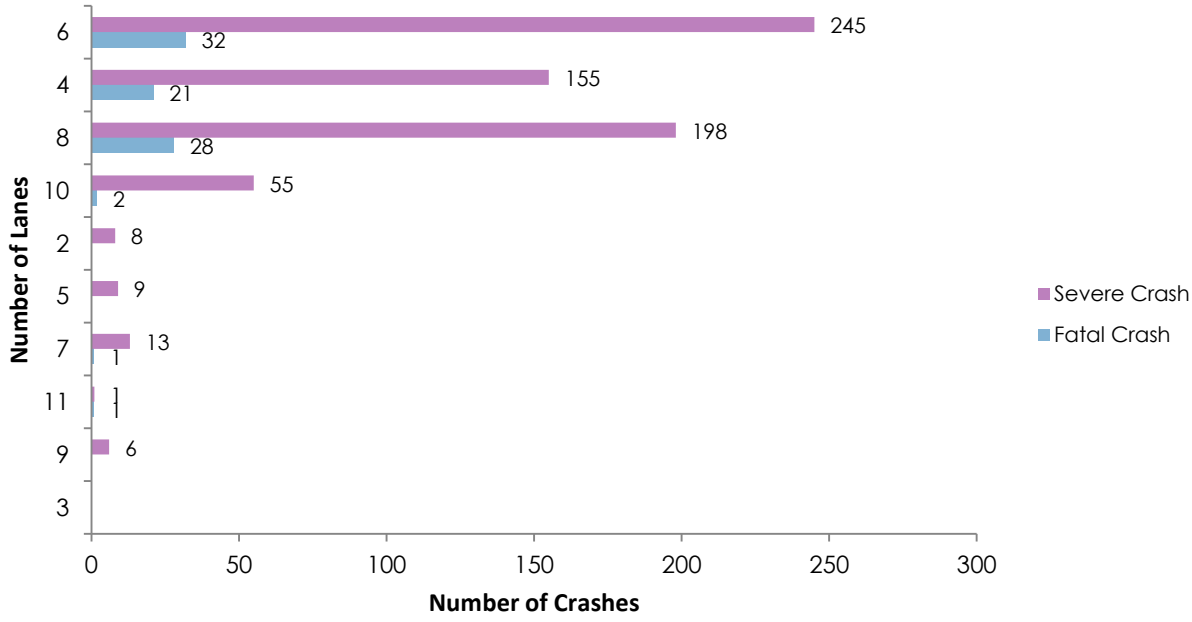
Figure 44. Freeway Crashes by Number of Lanes (2009 – 2013)



- Over 85% of freeway crashes occur on 6-lane (35%), 4-lane (26%), or 8-lane (25%) facilities. These are the most common lane configurations on the freeway system.

Figure 45 summarizes fatal and severe injury freeway crashes by number of lanes.

Figure 45. Fatal and Severe Injury Freeway Crashes by Number of Lanes (2009 - 2013)



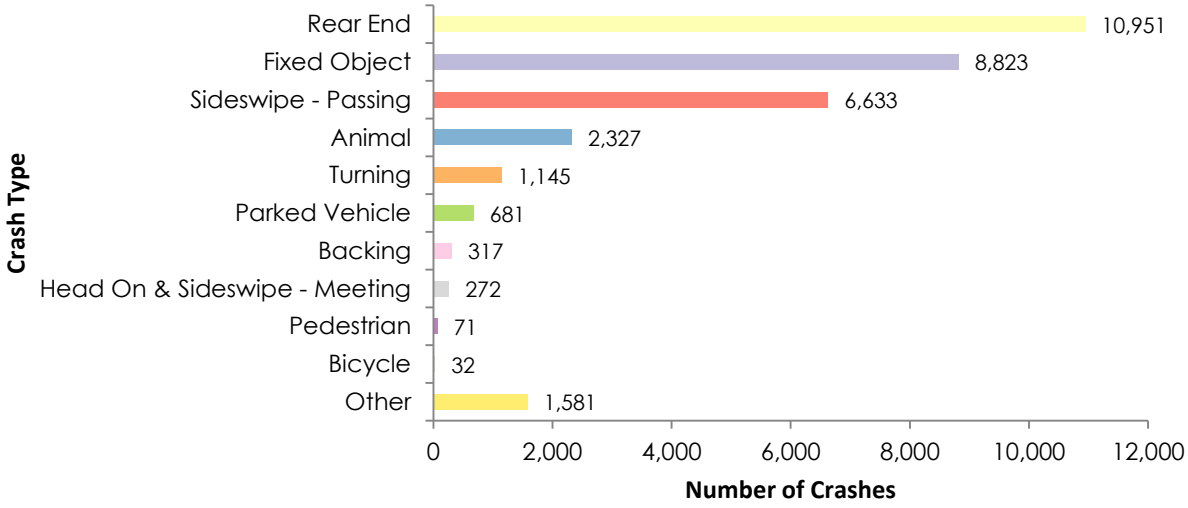
- The proportions of fatal and severe injury freeway crashes by number of lanes are generally within 2-3% of the proportions of total freeway crashes by number of lanes. However, eight-lane facilities have a higher proportion of fatalities (33%) and severe injuries (29%) than

expected based on total crash proportions by number of lanes (25%).

Crash Type

Figure 39 summarizes freeway crashes by crash type.

Figure 46. Freeway Crashes by Crash Type (2009 – 2013)

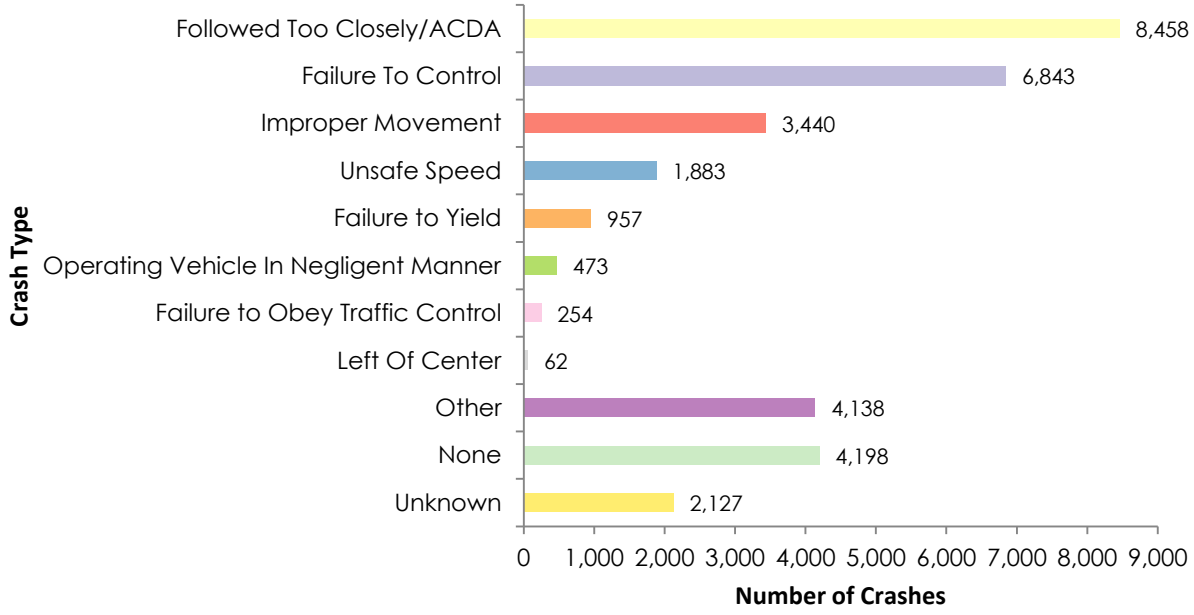


- One-third of all freeway crashes were rear end collisions (33%).
- The fixed object (27%) and sideswipe - passing (20%) crash types also represent notable proportions of freeway crashes.

Contributing Factor

Figure 40 summarizes freeway crashes by contributing factor.

Figure 47. Freeway Crashes by Contributing Factor (2009 – 2013)



- The largest contributing factor to freeway crashes was following too closely/ACDA, which accounted for 26% of freeway crashes. This is consistent with data trends showing one-third of freeway crashes were rear end crashes (see Figure 39).
- Failure to control (21%) and improper movement (11%) also represent notable proportions of freeway crashes consistent with data showing the second and third most common crash types of fixed object and sideswipe - passing crashes.

Transit and Rail Related Crashes

Per direction from NOACA staff, KAI summarized crashes that involved transit vehicles or facilities according to the following categories:

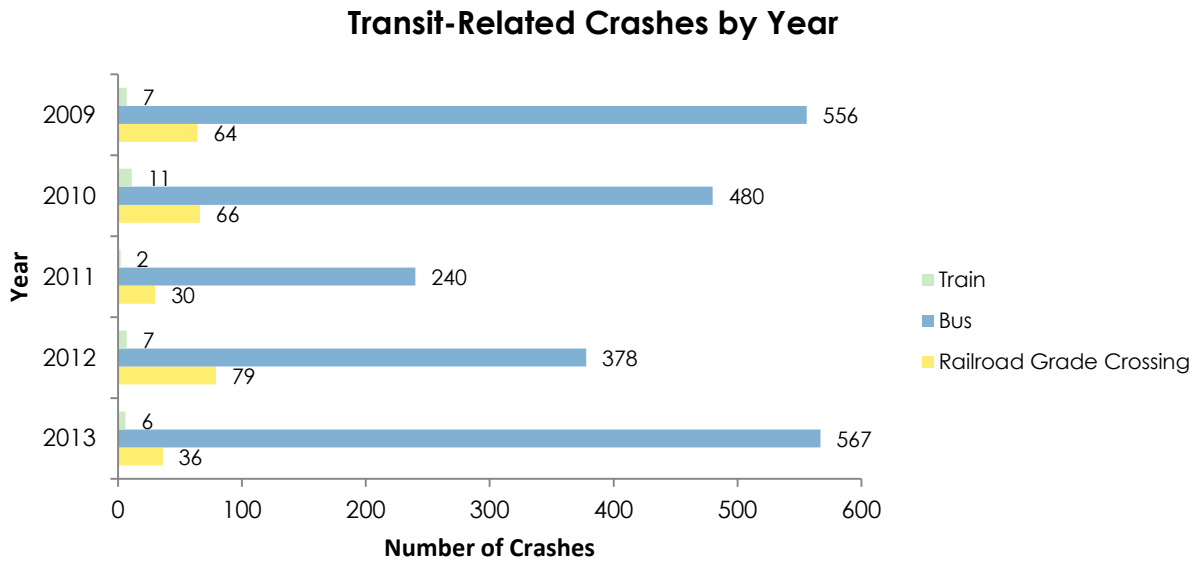
- Year
- Severity

These summaries include all railroad crossing related crashes because countermeasures for crossing-related crashes are likely to be similar regardless of whether it is a heavy rail or light rail vehicle crossing.

Year

Figure 48 summarizes transit and rail related crashes by year.

Figure 48. Transit and Rail Related Crashes by Year

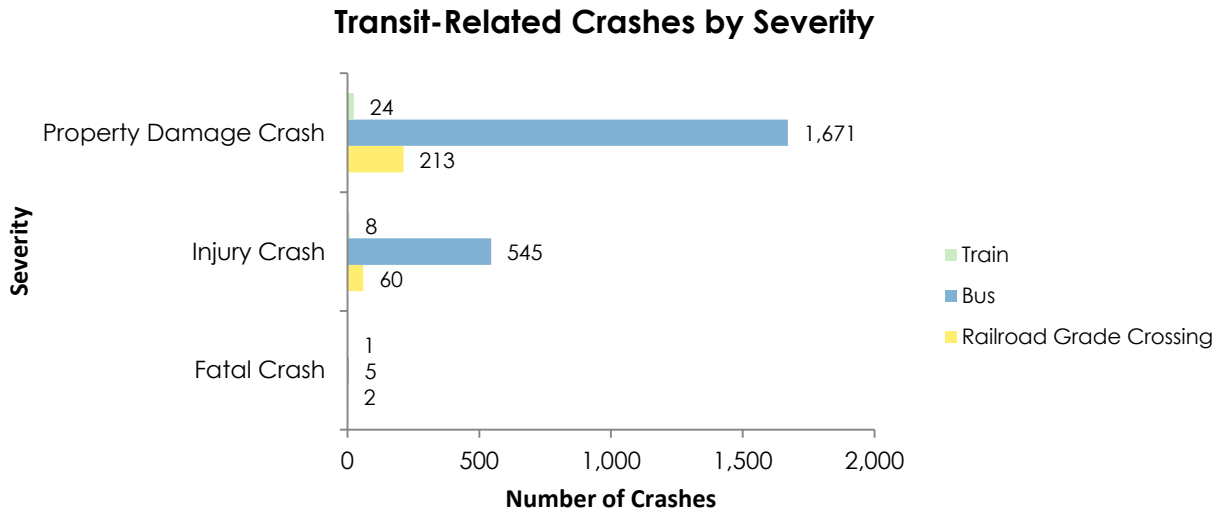


Transit and rail related crashes were lowest in 2011 for all types of transit and rail related crashes, mirroring trends for total vehicle crashes and crashes involving bicyclists and pedestrians. Bus-involved crashes were highest in 2009 and 2013. There were relatively few train-related crashes in any individual year. Finally, railroad grade crossing crashes were highest in 2012 with approximately half as many railroad grade crossing crashes in 2011 and 2013.

Severity

Figure 49 summarizes transit-related crashes by severity.

Figure 49. Transit-Related Crashes by Severity



- Severity trends are generally similar across the three types of transit and rail related crashes,

with about 72-78% of the crashes resulting in property damage only and approximately 22-25% of the crashes resulting in an injury.
    - The proportion of transit and rail-related crashes resulting in an injury is slightly lower than the average for total vehicle crashes (22-25% compared to 26%).
- The proportion of all transit and rail-related crashes resulting in a fatality is similar to the proportion of total vehicle crashes resulting in a fatality (about 0.3%).

CONCLUSION

This memorandum summarizes data analysis conducted by KAI in support of NOACA's TSAP. KAI analyzed the most recent five years of crash data, 2009 – 2013, according to a number of specific categories to help NOACA identify priority areas. KAI staff also carried out additional analysis of severe crash contributing factors based on national and Ohio Department of Transportation (ODOT) efforts. The results of this analysis describe existing crash conditions and identify trends contributing to crashes in the region including:

- crashes generally happen on roads, in areas, and during times of the day with the most activity;
- multi-lane roads tend to have more crashes per mile than two-lane roads;
- in some instances, fatal and severe injury crashes tend to make up a higher proportion of total crashes on roads that are likely to have higher speeds (e.g., rural and higher classified roads);
- rear-end, turning (including angle), sideswipe-passing, and fixed object are the most common crash types; and
- Aggressive driving, lane departure, young driver, and intersections are the most common contributing factors to severe crashes in the NOACA region, with each of these factors being reported in more than one-quarter of fatal and serious injury crashes.

Additionally, the analysis found that reported bicycle and pedestrian crashes had contributing factors of "none" or "unknown" at a higher rate than for the overall crash dataset

These findings can be used to help identify and prioritize safety-focused countermeasures and projects. Action items we have identified that NOACA could consider as it develops its TSAP include:

- Reviewing crash reporting practices for bicycle and pedestrian crashes
- Identifying and focusing on crash emphasis areas based on those factors that contribute to the greatest proportions of fatal and serious injury crashes or are the most overrepresented in fatal and severe injury crashes
- Coordinating efforts with FHWA, ODOT, and other agencies on crash reduction efforts based on shared priorities

Attachment A Crash Type and Contributing Factor Simplification Tables

Crash Type Simplification

Crash Type	Simplified Crash Type
Angle	Turning
Animal	Animal
Backing	Backing
Fixed Object	Fixed Object
Head On	Head On & Sideswipe - Meeting
Left Turn	Turning
Other Non-Collision	Other
Other Non-Vehicle	Fixed Object
Other Object	Fixed Object
Overturning	Other
Parked Vehicle	Parked Vehicle
Pedalcycles	Bicycle
Pedestrian	Pedestrian
Rear End	Rear End
Sideswipe - Meeting	Head On & Sideswipe - Meeting
Sideswipe - Passing	Sideswipe - Passing
Train	Other
Unknown	Other

Contributing Factor Simplification (Total Crashes)

Contributing Factor	Simplified Contributing Factor
(blank)	Unknown
Darting	Other
Exceeded Speed Limit	Unsafe Speed
Failure To Control	Failure To Control
Failure To Obey Signs/Signals/Officer	Failure to Obey Traffic Control
Failure To Yield	Failure to Yield
Failure To Yield Right Of Way	Failure to Yield
Followed Too Closely/ACDA	Followed Too Closely/ACDA
Improper Backing	Improper Movement
Improper Crossing	Improper Movement
Improper Lane Change/Passing/Offroad	Improper Movement
Improper Start From Parked Position	Other
Improper Turn	Improper Movement
Inattentive	Other
Left Of Center	Left Of Center
Load Shifting/Falling/Spilling	Other
Lying And/Or Illegally In Roadway	Other
None	None
None Non-Motorist	Other
Not Visible (Dark Clothing)	Other
Operating Defective Equipment	Other
Operating Vehicle In Negligent Manner	Operating Vehicle In Negligent Manner
Other Improper Action	Other
Other Non-Motorist	Other
Ran Red Light	Failure to Obey Traffic Control
Ran Stop Sign	Failure to Obey Traffic Control
Stopped Or Parked Illegally	Other
Swerving To Avoid	Other
Unknown	Unknown
Unsafe Speed	Unsafe Speed
Vision Obstruction	Other
Wrong Side Of The Road	Other
Wrong Side/Wrong Way	Other

Contributing Factor Simplification (Pedestrian Crashes)

Pedestrian Contributing Factor	Simplification
Darting	Darting
Failure To Control	Failure To Control
Failure To Yield	Failure To Yield Right of Way
Ran Red Light	Failure To Yield Right of Way
Failure To Yield Right Of Way	Failure To Yield Right of Way
Failure To Obey Signs/Signals/Officer	Failure To Yield Right of Way
Improper Backing	Improper Backing
Improper Crossing	Improper Crossing
Improper Lane Change/Passing/Offroad	Improper Lane Change/Passing/Offroad
Inattentive	Inattentive
Lying And/Or Illegally In Roadway	Lying And/Or Illegally In Roadway
None	None
None Non-Motorist	None
Operating Vehicle In Negligent Manner	Operating Vehicle In Negligent Manner
Load Shifting/Falling/Spilling	Other Improper Action
Operating Defective Equipment	Other Improper Action
Exceeded Speed Limit	Other Improper Action
Wrong Side/Wrong Way	Other Improper Action
Improper Start From Parked Position	Other Improper Action
Stopped Or Parked Illegally	Other Improper Action
Unsafe Speed	Other Improper Action
Left Of Center	Other Improper Action
Not Visible (Dark Clothing)	Other Improper Action
Ran Stop Sign	Other Improper Action
Swerving To Avoid	Other Improper Action
Wrong Side Of The Road	Other Improper Action
Improper Turn	Other Improper Action
Followed Too Closely/ACDA	Other Improper Action
Other Non-Motorist	Other Improper Action
Other Improper Action	Other Improper Action
Unknown	Unknown
Vision Obstruction	Vision Obstruction

Contributing Factor Simplification (Bicyclist Crashes)

Bicyclist Contributing Factor	Simplified
Wrong Side Of The Road	Wrong Side of the Road
Wrong Side/Wrong Way	Wrong Side of the Road
Unknown	Unknown
Other Improper Action	Other
Other Non-Motorist	Other
Exceeded Speed Limit	Other
Left Of Center	Other
Operating Defective Equipment	Other
Stopped Or Parked Illegally	Other
Swerving To Avoid	Other
Load Shifting/Falling/Spilling	Other
Lying And/Or Illegally In Roadway	Other
Unsafe Speed	Other
Operating Vehicle In Negligent Manner	Operating Vehicle In Negligent Manner
Vision Obstruction	Not Visible/Vision Obstruction
Not Visible (Dark Clothing)	Not Visible/Vision Obstruction
None	None
None Non-Motorist	None
Inattentive	Inattentive
Improper Turn	Improper Turn
Improper Lane Change/Passing/Offroad	Improper Lane Change/Passing
Improper Crossing	Improper Crossing
Improper Backing	Improper Backing
Followed Too Closely/ACDA	Followed Too Closely/ACDA
Failure To Yield	Failure to Yield Right of Way
Failure To Yield Right Of Way	Failure to Yield Right of Way
Failure To Obey Signs/Signals/Officer	Failure to Yield Right of Way
Ran Red Light	Failure to Yield Right of Way
Ran Stop Sign	Failure to Yield Right of Way
Failure To Control	Failure to Control
Darting	Darting