Baltimore City Strategic Highway Safety Plan

2022 - 2026

BALTIMORE CITY DEPARTMENT OF TRANSPORTATION | MAYOR BRANDON SCOTT

Contents

Tables

Figures

Acknowledgments

Project Manager: Shayna Rose, City Planner II, DOT

with special thanks to:

- Clea Baumhofer, Engineer Supervisor, DOT
- Cindy Burch, Transportation Safety Planner, Baltimore Metropolitan Council
- Luciano Diaz, Community Aid, DOT
- William Haynes, Traffic Chief, DOT
- Corren Johnson, Complete Streets Deputy Director, DOT
- Allysha Lorber, Capital Planning Chief, DOT
- John Malinowski, Engineer II, DOT
- Brian Seel, Data Analyst, DOT
- Adrea Turner, Chief of Staff, DOT
- Graham Young, Complete Streets Manager, DOT
- Meg Young, Shared Mobility Coordinator, DOT
- Mikah Zaslow, City Planner II, BCDOP

Introduction

Federal transportation bills have required Strategic Highway Safety Plans (SHSP) within each state for over a decade; State leadership in Maryland further acknowledged the need for strategic planning at the local level and began to encourage the development and implementation of local SHSPs in 2017. This coincided with the development of the Toward Zero Baltimore (TZB) strategic plan.

Toward Zero Baltimore is a long-term approach that aims to achieve zero traffic fatalities and serious injuries. The core goals of Toward Zero Baltimore are:

- Prevent dangerous roadway behaviors
- Prioritize safety as the primary determinant of city-wide decision-making
- Improve all City streets to be safer for all, with emphasis on the most vulnerable users (pedestrians and cyclists)
- Reduce and ultimately eliminate fatalities and injuries caused by traffic-related crashes on City streets
- Prevent dangerous roadway user behaviors, encouraging respect for other users and safe use of the City's shared streets

Building upon the work that Toward Zero Baltimore began, the Baltimore City SHSP strives to prevent crashes that result in severe injury or death occurring on the roadway every year, siting Zero Deaths and Serious Injuries by 2030 as its guiding vision. The SHSP will use the Safe System Approach, which emphasizes using engineering as the primary mechanism to solve systemic roadway safety problems\. In 2018, Baltimore City adopted a Complete Streets Ordinance and a subsequent Complete Streets Manual. The Complete Streets approach, which elevates the priority of pedestrians, bicyclists, transit users, and other vulnerable roadway users, will be used as the lens through which all safety countermeasures will be designed and implemented. The implementation of a Safe System Approach of complete streets is essential to the vision of this plan.

This effort is being led by the Baltimore City Department of Transportation (DOT) and utilizes crash data collected by the Baltimore City BPD Department (BPD). These agencies will be the primary data resources for this plan and effort, while also building partnerships with the Departments of Health, Fire and Emergency Medical Services (EMS), Planning, Public Works, and Baltimore City Public Schools. This plan is a means to bring together several agencies and departments to coordinate safety planning into one City-wide strategic plan.

In addition to TZB, relevant prior plans include the Baltimore City Crash Reduction Plan (2021) and the Baltimore City Bicycle Master Plan (2015, 2017 Separated Bike Lane Network addendum), and multiple small area plans throughout the city. DOT also has ongoing efforts to improve safety with traffic calming, ADA accessibility, and roadway improvement programs. These plans and programs guide the SHSP in identifying high-impact projects that address known safety issues and protect vulnerable roadway users. Projects will target noted crash hot spots as well as system-wide safety issues, incorporating strategies such as implementing the Separated Bike Network, reconfiguring traffic signals to reduce motorist speeds, reducing the lanes of oversized roads, and tackling traffic safety in neighborhoods holistically. DOT currently

has several programs that specifically target traffic safety; the SHSP will reinforce the importance of those efforts and recommend to expand them.

The efforts identified in this plan will be evaluated annually as well as at the end of this plan's life cycle. The action plan is a living document; during the life cycle of the SHSP, adjustments may be made based on acute changes or unforeseen occurrences, such as the effects of the COVID-19 pandemic. Iterative evaluation will empower this team to modify strategies as needed to continue the effort of reaching and maintaining zero fatalities and serious injuries.

Mission, Vision, and Goals

Mission: To reduce traffic-related fatalities and serious injuries to zero on the Baltimore City transportation network by 2030.

Vision: To implement a location-based program for improving safety at intersections and along corridors in Baltimore City under the guidance of Complete Streets, utilizing evidence-based, proven effective countermeasures.

The core tenants of the Baltimore City Strategic Highway Safety Plan Vision are:

- Reduce and ultimately eliminate all fatalities and serious injuries caused by traffic crashes on city streets;
- Using data, reinforce and prioritize safety as the primary determinant of decision-making within the city;
- Improve city streets to be safer for all, with emphasis on the most vulnerable users, such as pedestrians and bicyclists;
- Identify specific locations where risky motorist behavior is likely to interact with vulnerable users and implement countermeasures;
- Implement the Es of Safety: Engineering, Enforcement, Evaluation, Equity, Empowerment, and Enactment.

The Baltimore City SHSP is based on the "Safe System" approach. A Safe System recognizes that humans are subject to errors in judgment, distraction, and cultural pressures. Rather than placing the onus on individuals to safely negotiate with a system, the focus of Safe Systems is to design roadways such that severe crashes do not occur. Roads in a Safe System are retrofitted to keep travelers alert, reduce the design speeds of motorists, and prevent interaction between motorists and non-motorists. In the event of a crash, a Safe System ensures that impact forces are within the boundary of human tolerance. Policies in a Safe System are developed to complement road design in encouraging safe travel. When infrastructure and policymakers bear the brunt of the burden in engineering a Safe System, individuals can be better partners in upholding safe conditions on the road. This Action Plan will build on information gathered from interagency workgroups, prior safety reports and plans, existing transportation programs in the City of Baltimore, and DOT Transportation goals.

Source: UC Berkeley Safety Transportation Research and Education Center

Key Partners

Multiple agencies and partners play important roles in the selection and funding of projects related to transportation safety, enforcement and data collection, and grassroots community action. While DOT is the agency lead, the following partners are identified as having unique perspectives in multi-modal safety issues and equity. These partners will have a chance to provide comments on plans developed by DOT and will be invited to sit on subject-specific working groups and committees. The following lists are preliminary and not meant to preclude any additional groups that may have valuable insight.

Lead Agency - Baltimore City Department of Transportation (DOT)

- Director's Office
- Planning Division
- Traffic Division
- Traffic Safety Division
- Transportation Engineering and Construction Division
- Communications
- Data Team
- GIS Team
- Automated Traffic Violation Enforcement System (ATVES)

Identified Baltimore City and Quasi-City Government Partners

- Baltimore City BPD Department (BPD)
- Baltimore City Sherriff's Office
- Maryland Department of Transportation State Highway Administration (MDOT SHA)
- Maryland Department of Transportation Maryland Transit Administration (MDOT MTA)
- Baltimore City Health Department
- Baltimore City Public Schools
- Baltimore City Department of Public Works
- Baltimore City Department of Planning
- Baltimore City Department of Finance
- Baltimore City Department of Human Resources
- Baltimore City Housing and Community Development
- Baltimore City Fire and Emergency Management Department
- Baltimore Development Corporation
- Baltimore City Recreation and Parks
- Baltimore City Mayor's Office

Identified Community Partners

- Bikemore
- Black People Ride Bikes
- Maryland Institute College of Art (MICA) School for Social Design
- ReBUILD Metro
- The Neighborhood Design Center
- Baltimore City Community Development Corporations
- Baltimore City Waterfront Partnership
- Baltimore City Downtown Partnership
- Johns Hopkins University
- Morgan State University
- Rails to Trails

Steering Committees

The Steering Committees are the means to accomplishing the goals set forth in this document. Each has a role in evaluating plans and progress towards safety goals, as well as tracking crashes, selecting and evaluating interventions, and pursuing partnerships and funding. Partners are invited to sit on one or multiple steering committees, all of which are mutually influential.

Existing:

- Zero Stat Meeting (Monthly, hosted by DOT)
- Pedestrian and Bicycle Fatality Review (Quarterly, hosted by DOT)
- Sustainable Transportation Subcabinet (Monthly, hosted by Department of Planning)
- Neighborhood Traffic Calming Review (Monthly, hosted by DOT)

- Impact Investment Area Subcabinets (Quarterly, hosted by DOT)
- Mayor's Advisory Committee on Complete Streets (Quarterly, hosted by DOT)
- Mayor's Bicycle Advisory Committee (Monthly, hosted by DOT)
- Traffic Stat (Monthly, hosted by DOT)
- Traffic Impact Study Panel (Hosted by Department of Planning)
- INSPIRE meeting (Monthly, hosted by Baltimore City Public Schools)

Recommended New Committees:

- *CIP Project Review (Annual)* – to ensure projects put forward by DOT to the CIP reflect commitment to safety goals and Complete Streets
- *Mayor's Advisory Commission on Traffic Safety (Quarterly)* – to review projects and policies and hold the City accountable to the public on safety goals
- *Safe Routes to School Working Group (Quarterly)* – to plan infrastructure and educational projects that specifically target the most vulnerable users; pedestrians and bicyclists under the age of 12
- *Resurfacing Project Review (Monthly)* – to ensure all annual resurfacing projects are incorporating safety and Complete Streets
- *Communications and Programs Working Group (Quarterly)* – to develop safety messaging and Complete Streets safety training. Also, build out programs and corresponding messaging that empower community action around road safety

Problem Identification

Data Trends

Crash data can help identify some of the root causes of crashes, and this data is collected by the Baltimore BPD Department (BPD). BPD analysts use information ascertained by BPD reports to geocode crashes with their respective details. The following sections use this data to identify patterns and trends. It should be noted that not all crashes receive BPD reports; BPD reports are typically filed if a vehicle is towed or an ambulance is called. The following tables and figures are therefore likely incomplete. Sometimes BPD reports can be unreliable because they may be missing important factors or incorporate some subjectivity into the narrative of a crash. Speed is an example of this; crashes are only recorded as speeding-related if an officer or witness observes speeding. The following sections will take this into account and attempt to only report the metrics that are most likely to be objective. This report will also call out the sections in which metrics may fall subject to inconsistent or incomplete reporting. The Baltimore Crash Reduction Report has more details on the specific issues with crash data reporting.

Overall Trends

Over the last five years for which crash data is available (2016-2020), Baltimore City has experienced a significant number of crash-related fatalities and injuries. While crashes have steadily decreased, fatalities have not decreased and injury crashes continue to make up about 30% of all crashes.

Table 1: Total Crashes 2016 - 2020

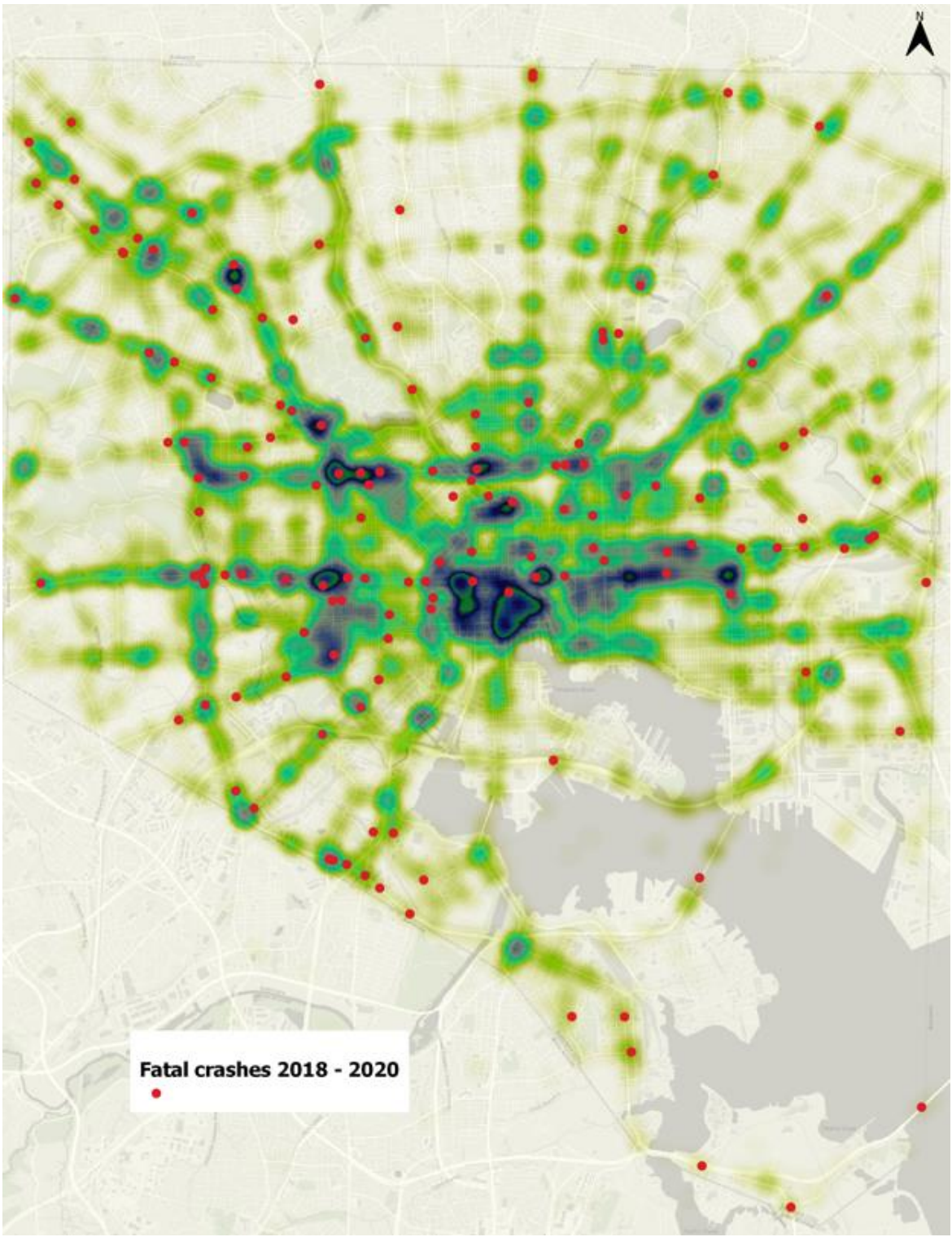
Year	2016	2017	2018	2019	2020	5-YR AVG.
Fatal Crashes	52	41	37	48	70	50
Total Injury Crashes	5,993	6,063	5,808	5,710	4,865	5,688
Serious Injury Crashes	1,323	1,007	1,030	1,081	1,044	1,097
Property Damage Crashes	20,487	13,808	12,563	12,230	11,063	14,030
Total Crashes	26,526	19,914	18,404	17,985	15,991	19,764
Total of All Fatalities	53	44	36	49	68	50
Total Number Injured	9,664	10,062	9,544	9,550	8,057	9,375
Total Serious Injuries	4,816	3,031	2,896	3,120	2,748	3,322

In 2020, which saw the beginning of COVID-19 pandemic, fewer people commuted to their jobs and traveled to other destinations causing fewer cars on the road. While this may have contributed to fewer crashes overall, fatalities saw an uncharacteristic rise. According to the National Highway Traffic Safety Administration, this trend was observed nationally and may be attributed to people driving at higher speeds when traffic congestion was reduced.

This report is primarily concerned with crashes that result in severe outcomes. As such, DOT mapped injury crashes and fatalities for the years 2018 – 2020 to represent the most up-to-date context for location-based crashes. Crashes were primarily concentrated in and around Downtown. Of particular concern are the entirety of the North Ave corridor, Edmondson Ave

around Monroe St and Fulton St, Edmondson at Hilton, and the eastern portions of Fayette Street and Orleans Street. Most fatalities occurred outside of the main Downtown area.

Figure 1: Injury and fatal crashes heat map 2018 - 2020



Pedestrian Crashes

While the number of total pedestrian crashes has declined by about 40% between 2016 and 2020, the number of pedestrian fatalities has remained close to 20 each year. While pedestrians only make up about 4% of all crashes, they make up anywhere from 30% – 47% of all fatal crashes, making protecting pedestrians a crucial element of this action plan. All pedestrian crashes are injury crashes. The number of injury crashes that involved pedestrians declined from 20% in 2016 to 14% in 2020, but continue to represent an outsized proportion of injury crashes. Note that crashes involving pedestrians are often unreported, making this data likely an underestimation of crashes involving pedestrians.

Table 2: Total Pedestrian Crashes 2016 - 2020

Year	2016	2017	2018	2019	2020	5-YR AVG.
Total Crashes	1,228	1,190	1,019	916	682	1,007
% of total crashes	*5%*	*6%*	*6%*	*5%*	*4%*	*5%*
Total of All Fatalities	18	20	10	19	19	17
% of total fatalities	*34%*	*45%*	*28%*	*39%*	*28%*	*35%*
Total Number Injured	1,254	1,276	1,134	959	759	1,076
% of total injuries	*13%*	*13%*	*12%*	*10%*	*9%*	*11%*

Bicycle Crashes

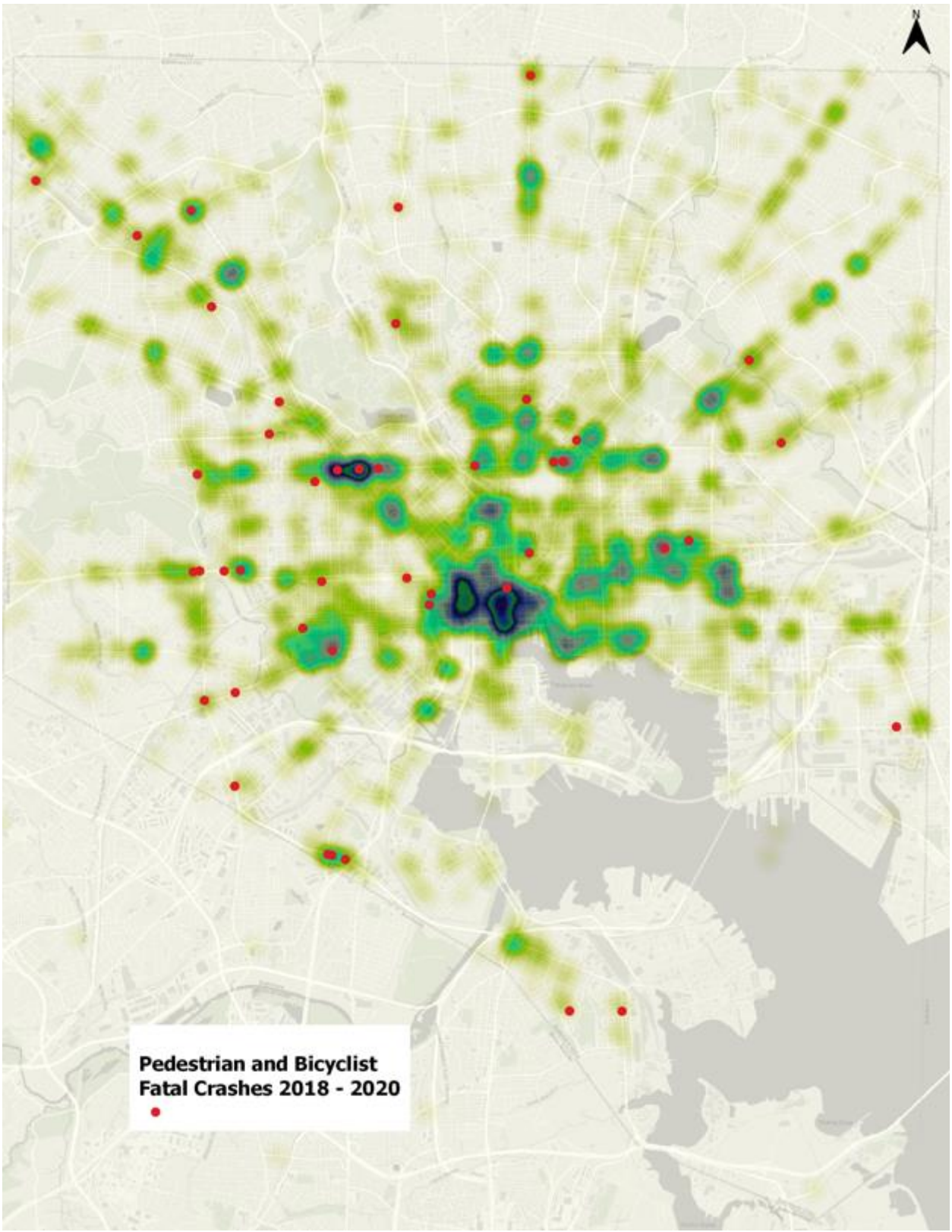
Between 2016 and 2019, bicycle crashes showed little sign of decline but starkly dropped in 2020. Fatalities have hovered at approximately one per year for the past five years. Similar to pedestrians, bicyclists make up an outsized proportion of injuries and fatalities. Though bicyclists are involved in under 1% of all crashes, they represent 2% of all injuries and fatalities. Note that crashes involving bicyclists are often unreported, making this data likely an underestimation of crashes involving bicyclists.

Table 3: Total Bicycle Crashes 2016 – 2020

	2016	2017	2018	2019	2020	5-YR AVG.
Total Crashes	238	209	199	217	156	204
Total of All Fatalities	1	1	0	2	1	1
Total Number Injured	200	179	172	198	155	181

DOT also mapped pedestrian and bicycle crashes for 2018 – 2020, as seen in the figure below. Crashes are predominantly concentrated in the Downtown core. There is also a high concentration of crashes along the entire North Ave corridor, along the eastern segments of Fayette and Orleans, and in and around the intersection of Wilkens and Monroe. Fatalities mostly occurred outside of Downtown, particularly on North Ave, MLK Blvd, and Edmondson Ave and Wilkens Ave to the west, the McElderry Park neighborhood to the east, and Patapsco Ave to the south.

Figure 2: Pedestrian and Bicycle crashes heat map 2018 - 2020



Intersection-related Crashes

Between 2016 and 2020, the number of intersection-related crashes declined by 31% and intersection-related injuries declined by 22%. Prior to 2020, fatalities at intersections seemed to be on the decline, but they rose sharply in 2020. In 2020, 46% of all fatal crashes occurred at intersections. While intersections make up about 40% of total crashes that occurred in 2020, intersections account for over 50% of all injuries.

Table 4: Intersection-related crashes 2016 - 2020

	2016	2017	2018	2019	2020	5-YR AVG.
Total Crashes	9,433	8,205	7,461	7,328	6,469	7,779
Total of All Fatalities	24	28	12	22	31	23
% of total fatalities	*45%*	*64%*	*33%*	*45%*	*46%*	*47%*
Total Number Injured	5,442	5,595	5,205	5,268	4,272	5,156
% of total injuries	*56%*	*56%*	*55%*	*55%*	*53%*	*55%*

Serious Injury and Non-Motorist Trends

This action plan is focused on crashes that are likely to cause serious injuries and fatalities. The following sections investigate severe injury crashes, fatal crashes, and non-motorist crashes under a variety of circumstances and contexts, including road type, speed limit, vehicle movement type, vehicle type, drugs or alcohol involved, and time of day. These factors were chosen to be further analyzed for their relevance and reporting reliability.

Road Type

Crash reports include a designation of the kind of road where the crash occurred. The types are:

- Not applicable: includes non-road crashes such as parking lots or parking garages
- Two-way, not divided: traditional two-way road with a painted line down the middle
- One-way: one-way road
- Two-way (divided, unprotected): two-way road with a painted buffer in the middle of at least 4 feet)
- Two way (divided with positive median barrier): road that has a divider that is more than paint, such as a built median or a barrier
- Two way, undivided with left turn lane
- Other
- Unknown, which are typically sidewalks, parking lots, or other areas not within a roadway

The following table breaks down all crashes into four categories over each road type:

- Severe injuries: crashes where the most severe injury was marked as either ‘possible incapacitating injury’ or ‘incapacitating injury’
- Fatal injuries: crashes where at least one person was fatally injured

- Pedestrian involved crashes
- Bike/Scooter involved crashes

The following table shows the break-down of crash types that occur on each road by percentage. The rows do not add up to 100% because this table does not include all crash types, and has overlapping types.

Table 5: Severe crashes by road type 2016 - 2020

	Severe Injury	Fatal	All Ped	All Bike/Scooter
Not Applicable	15.06%	0.00%	5.70%	0.78%
Two-Way, Not Divided	29.44%	0.37%	6.93%	1.34%
One-Way	24.77%	0.21%	6.42%	1.29%
Two-Way, Divided, Unprotected	34.91%	0.55%	6.90%	1.21%
Two-Way, Divided, Positive Median Barrier	37.89%	1.03%	4.52%	0.68%
Two-Way, Not Divided W/Left Turn	42.72%	3.54%	7.65%	0.75%
Other	27.38%	0.13%	4.88%	1.22%
Unknown	17.57%	0.43%	10.71%	1.86%

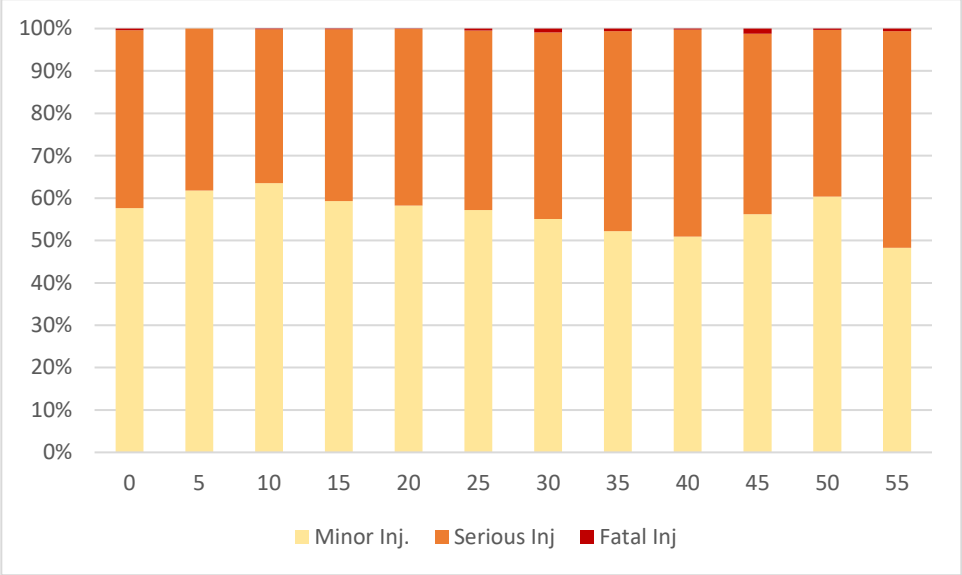
Two-way, undivided roads with left turn lanes have the highest severe injury rate, the highest fatality rate, and the highest pedestrian crash rate (apart from the 'unknown' category). However, without the number of lanes, speed limit, and land use contexts, this data is incomplete. The table might lead one to believe that two-way roads with left-turn lanes are more dangerous than two-way roads without left-turn lanes. The reality is that roads in Baltimore with left-turn lanes are more likely to be major arterials with multiple travel lanes, higher speed limits, signals spaced far apart allowing for free-flow movement, and high conflict points. For pedestrians, the most common category was 'unknown', which generally is attributed to crashes that happened on sidewalks, crosswalks, or parking lots, according to BPD report narratives. Beyond the 'unknown' category, pedestrian crashes most commonly occur on roads without a median. In future analysis, road type categories should be broken down by lane numbers, speed limits, and analyzed in terms of their proximity to pedestrian generators in order to better understand trends.

Speed Limit

Speed plays a major role in the outcome of a crash, with higher speed crashes resulting in worse outcomes. While speed limits are set based on the design of the road, Baltimore City is an urban environment meaning that roads with high speed limits can be close to pedestrian generators and other conflict points. Showing the catastrophic outcomes of higher speed roads in Baltimore demonstrates a need for higher protection for vulnerable users on those roads and for road retrofitting. Baltimore City does not have jurisdiction over setting its own speed limits, but it can also retime traffic signals to promote slower speeds.

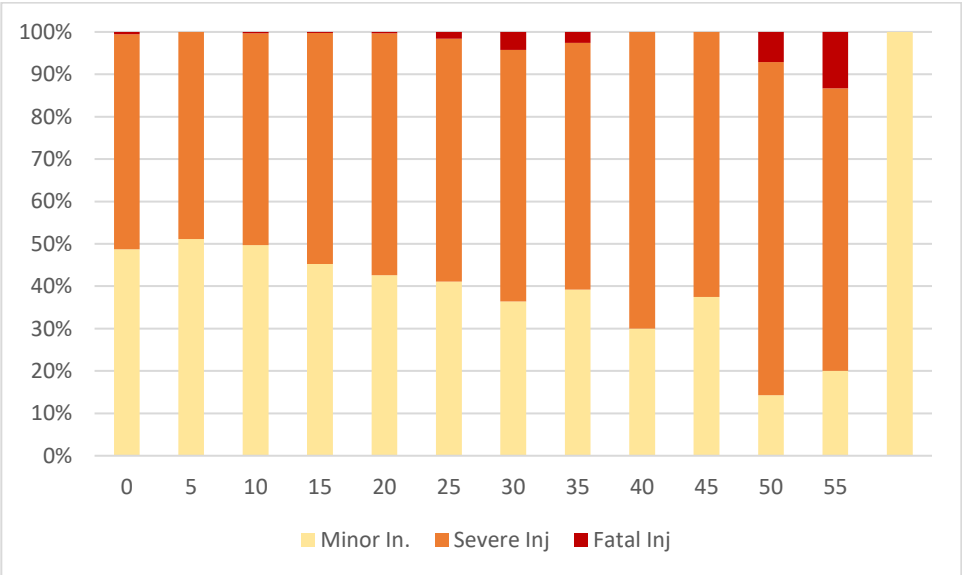
The following graph looks at the breakdown of crash severity by the road speed limit for crashes that resulted in injury (although, this does not mean that this was the speed that the vehicles were traveling).

Figure 3: Crash Severity by Speed Limit 2016 - 2020



When looking only at crashes that involve a vulnerable road user, the outcomes are more severe. In crashes that do not involve vulnerable road users, about 50% of crashes result in injury, with a slight correlation when speed limit increases. Between 75 – 80% of all crashes involving a vulnerable road user result in injury. The likelihood of severe injury increases significantly by speed limit, beginning at 10 mph. Vulnerable road user fatalities increase at speed limits of 25 mph and greater. Pedestrians who were hit on roads with speeds of 50 mph or higher tend to be construction workers or people with broken-down vehicles.

Figure 4: Pedestrian and Bicycle Crashes by Speed Limit 2016 - 2020



Vehicle Movement Type

Crash records typically contain information around the context of a crash. Cross referencing vehicle movement type by the crash severities of interest (severe injury, fatal injury, pedestrian crash, and bike/scooter crash) allows us to predict the relationship between vehicle behaviors and severe crashes, and ultimately control for them with infrastructure countermeasures and policies.

Table 6: Severe crashes by vehicle movement type 2016 - 2020

	Severe Inj.	Fatal	All Ped	All Bike/Scooter
Not Applicable	6.32%	0.02%	2.19%	0.45%
Moving Constant Speed	12.82%	0.18%	2.49%	0.46%
Accelerating	13.51%	0.14%	3.25%	0.55%
Slowing or Stopping	11.03%	0.36%	2.15%	0.44%
Starting from Lane	12.87%	0.03%	3.40%	0.93%
Starting from Parked	7.93%	0.10%	5.28%	0.29%
Stopped in Traffic Lane	10.32%	0.07%	0.46%	0.15%
Changing Lanes	7.94%	0.10%	0.71%	0.31%
Passing	7.01%	0.15%	1.71%	0.33%
Parking	3.59%	0.00%	3.06%	0.26%
Parked	5.78%	0.13%	0.75%	0.12%
Backing	4.16%	0.00%	5.70%	0.17%
Making Left Turn	15.74%	0.24%	5.17%	0.79%
Making Right Turn	9.76%	0.07%	4.92%	1.38%
Right Turn On Red	15.43%	0.00%	11.43%	0.57%
Making U Turn	14.17%	0.06%	1.22%	0.17%
Skidding	12.38%	0.76%	1.19%	0.33%
Driverless Moving Vehicle	6.94%	0.46%	4.17%	0.00%
Leaving Traffic Lane	17.70%	0.82%	1.65%	0.00%
Entering Traffic Lane	14.49%	0.00%	0.93%	0.52%
Negotiating a Curve	16.40%	0.53%	1.32%	0.26%
Other	8.74%	0.51%	2.10%	0.62%
Unknown	7.42%	0.14%	2.29%	0.32%

When looking at injury crashes, a few trends stand out:

- Fatal crashes tend to involve vehicles that are out of control, such as ‘leaving traffic lane’, ‘skidding’, ‘negotiating a turn’, or vehicles without a driver at the wheel.
- Unsurprisingly, incapacitating injury crashes have some of the same trends as fatal crashes. 'Making a left turn’ crashes are over represented in injury crashes, which can happen either when someone gets hit in the process of turning on a permissive green, or when a pedestrian/cyclist is hit by a driver that does not look for them in the process of a turn. We see similar issues on ‘right turn on red’.

- Pedestrian involved crashes by volume are usually low speed crashes, such as 'backing', 'starting from parked', and 'parking'. However, that does not represent the most severe crashes. Pedestrians have an outsized representation in crashes involving a right turn on red.
- The most common crash for bike and scooters is a vehicle making a right turn. Bicycles and scooters also commonly get hit as cars turn left or by cars 'starting from lane', which means while accelerating after being stopped at a traffic signal or stop sign.

Looking at the movements vehicles made in severe and fatal crashes that involved a pedestrian/cyclist/scooter helps to identify more common causes of crashes. However, the challenge is that single events can have a much greater impact on the data because these collisions have fewer data points. The following shows the number of serious/fatal crashes that involved a pedestrian where a driver made one of the following movements.

Table 7: Incapacitating and fatal vehicle movements involving a pedestrian, cyclist, or scooter rider 2016 - 2020

	Severe/Fatal
Not Applicable	36.73%
Moving Constant Speed	47.75%
Accelerating	48.15%
Slowing or Stopping	40.21%
Starting from Lane	36.88%
Starting from Parked	39.13%
Stopped in Traffic Lane	26.72%
Changing Lanes	34.69%
Passing	45.45%
Parking	39.68%
Parked	39.34%
Backing	39.58%
Making Left Turn	44.10%
Making Right Turn	43.46%
Unknown	49.86%

Particularly in the case of pedestrian and cyclist crashes, reported movement may be hard to capture in the BPD report. Regardless, some trends emerge from the data captured. Crashes that result in serious injury or fatality typically involve a moving vehicle and often one that is negotiating a turning or passing movement.

Vehicle Type

This chart looks at the breakdown of injury severity and vulnerable user-involved crash by type of vehicle involved. This is data from 2016-2020 for vehicles types that were involved in a minimum of 20 crashes. Note that these crashes do not indicate that they were caused by these types of vehicles, but rather the associated injury rate with vehicles involved in crashes. For instance, a moped operator is not protected by the encasing of a vehicle meaning that injury severity would be higher for mopeds involved in crashes. Dirt bikes are commonly used in

Baltimore and fall into the category of Moped. Low-speed vehicles are typically street-legal golf carts.

Table 8: Crash Severity by Vehicle Type 2016 - 2020

	Severe Inj.	Fatal	Ped	Bike/Scooter
Not Applicable	7.61%	0.06%	2.40%	0.54%
Motorcycle	38.11%	2.56%	1.86%	0.88%
Passenger Car	11.04%	0.14%	2.06%	0.39%
Station Wagon	11.92%	0.00%	2.49%	0.09%
Cargo Van/Light Truck 2 Axles (10,000lbs (4,536 Kg) Or Less)	10.04%	0.46%	1.47%	0.58%
Medium/Heavy Trucks 3 Axles (More Than 10,000lbs (4,536kg)	9.09%	0.40%	1.19%	0.27%
Truck Tractor	10.21%	1.60%	1.32%	0.00%
Recreational Vehicle	8.70%	0.00%	2.82%	0.31%
Transit Bus	20.79%	0.30%	3.10%	0.51%
School Bus	2.34%	0.11%	0.22%	0.33%
Ambulance/Emergency	5.00%	0.00%	0.69%	0.43%
Ambulance/Non Emergency	2.36%	0.00%	0.47%	0.47%
Fire Vehicle/Emergency	2.68%	0.13%	1.34%	0.00%
Fire Vehicle/Non Emergency	1.91%	0.00%	1.44%	0.48%
BPD Vehicle/Emergency	10.74%	0.07%	1.52%	0.42%
BPD Vehicle/Non Emergency	5.50%	0.03%	1.74%	0.71%
Moped (including “Dirt Bikes”)	41.74%	1.56%	2.01%	2.23%
Pickup Truck	10.94%	0.19%	2.42%	0.47%
Van	11.68%	0.19%	2.65%	0.33%
Other Light Trucks (10,000lbs (4,536kg))	7.62%	0.08%	1.60%	0.42%
(Sport) Utility Vehicle	11.90%	0.21%	2.60%	0.41%
Low Speed Vehicle	7.24%	0.00%	3.82%	0.53%
Other Bus	15.38%	0.12%	2.93%	0.12%
All-Terrain Vehicle (ATV)	13.53%	0.00%	2.35%	0.00%
Other	9.61%	0.17%	1.75%	0.44%
Unknown	3.56%	0.03%	2.32%	0.36%

Crashes involving motorcycles and mopeds/dirt bikes tend to result in the most serious injuries and fatalities. This is consistent with national trends; motorcycles and mopeds/dirt bikes are more likely to be in crashes, due to a variety of factors including operator behavior, lack of helmet, and vehicular blind spots. They are also more likely to be injured or killed; motorcyclists and moped/dirt bike drivers travel at the same speeds as motor vehicles but without the protection of a metal encasing or may be driving recklessly.

The vehicles with the worst outcomes in crashes involving pedestrians are larger vehicles including medium/heavy trucks, tractor trailers, buses, pickup trucks, and sport utility vehicles (SUV). Cyclists and scooter riders have a disproportionately high crash rate with motorcycles and mopeds, possibly due to these vehicle operators often improperly use bike lanes.

Drugs or Alcohol Involved

Drugs and alcohol also have a significant impact on the severity of injuries from crashes. The following data looks only at the maximum injury from crashes in which a driver has a 'substance use code' of one of the following. The first two lines of the table are crashes for which the officer either did not test the driver, or where there was a drug/alcohol test that came back negative. These two categories will serve as the baseline from which to compare the alcohol and drug categories. Officers select "Alcohol Present" (or drugs, medication) when they believe there is no indication that the presence of alcohol, drugs, or medication contributed to the crash. There is likely subjectivity in the distinction between "present" and "contributed", which may lead to inconsistency in trends.

Table 9: Crash severity by crashes involving drugs and alcohol 2016 - 2020

	Severe Inj.	Fatal	Ped	Bike/Scooter
Not Applicable	16.42%	0.20%	3.80%	0.68%
None Detected	18.21%	0.38%	5.84%	1.04%
Alcohol Present	21.92%	4.59%	14.30%	0.43%
Illegal Drug Present	19.02%	6.83%	10.73%	0.98%
Medication Present	14.41%	4.24%	11.02%	0.85%
Combined Substance Present	12.90%	14.52%	17.74%	0.00%
Alcohol Contributed	21.00%	0.58%	10.60%	0.19%
Illegal Drug Contributed	30.00%	1.43%	11.43%	0.95%
Medication Contributed	23.75%	0.00%	11.25%	0.00%
Combination Contributed	18.92%	13.51%	13.51%	0.00%
Other	15.33%	6.57%	13.87%	0.73%
Unknown	9.68%	0.33%	5.70%	0.82%

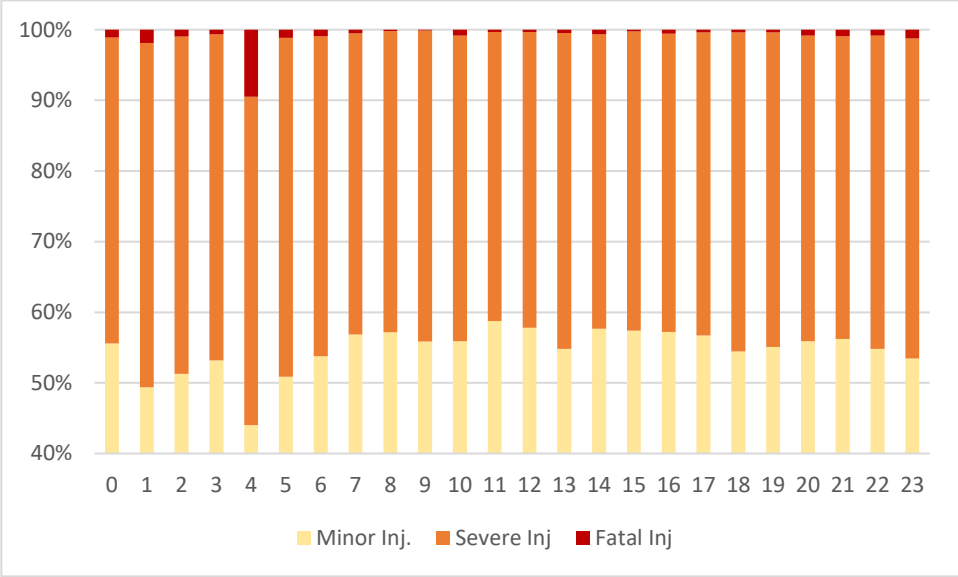
The following trends can be discerned from this data:

- Generally, a higher percentage of crashes that involved a driver under the influence of a substance resulted in fatalities and pedestrians being hit compared with crashes involving drivers who were not under the influence.
- Crashes involving alcohol (whether "present" or contributed") were more likely to result in severe injuries, fatalities, and pedestrians being hit.
- Crashes in which officers determined that illegal drugs or medications contributed were more likely to result in severe injury.
- Drivers in which multiple substances were detected had the highest rates of fatal and pedestrian crashes, though seemingly no impact on crashes involving severe injuries.
- There are no discernable patterns with crashes involving bicyclists; this however may be due to a lack of data.

Time of Day

The time of day can have an impact on the crash severity. High severity and fatal crashes have an uptick at night, particularly between 10pm and 6am. This may be attributed to reduced night-time visibility or drivers being more distracted at night.

Figure 5: Injury and fatal crashes by time of day 2016 - 2020



While the data represented on the above graph may not seem particularly stark, the trends become more prominent when considering the amount of vehicles on the road throughout the day. Generally, more vehicles are on the road during the day than at night, making the seemingly slight uptick at night represented above more pronounced in reality. Additionally, during the day, more vehicles are on the road during peak hours (7 – 9am, 4 – 7pm) than during off-peak hours. Further investigation into road volumes and the role of street lighting may be necessary to glean insight into time of day crashes.

Additionally, the following facts are important to consider when accounting for Baltimore's challenges:

- Commercial trucks and transit buses account for about 4% of crashes. Standard automobiles are the most frequently involved vehicles.
- Nearly 40% of crashes occur in or near an intersection.

A 2021 study by Basil Labs tracked crash-related 911 calls compared to crash reports in Washington, DC.[1] The study found that about 10% of vehicle-only crashes and 30% of crashes that involved a person outside of a vehicle did not end up in official crash reports. This pattern was especially pronounced in majority-Black communities. A similar evaluation can be done in Baltimore to determine if there are similar issues. Having complete crash data is vitally important in order to identify issues; crash reports may need to be supplemented with 911 data and hospital case data. Data gathering will be further explored in the strategies section.

[1] https://www.bloomberg.com/news/articles/2021-07-15/how-many-traffic-crashes-are-going-unreported

Outside Research

Outside of DOT, several academic institutions have conducted their own traffic safety studies in Baltimore. In 2017, an "Analysis of Intersection Related Pedestrian Crashes in the City of Baltimore" was completed by students of University of California, Los Angeles[2]. Major takeaways from this research project included:

- Intersections that have a higher number of crashes or higher severity of crashes are highly concentrated in the downtown area, or along major arterials characterized by commercial and mixed-use land uses.
- There is a statistically significant difference in the average number of lanes at high crash intersections versus low crash intersections. The average number of lanes at high crash intersections is 7, versus 5 lanes at lower crash intersections.

Additionally, "Moving Toward Zero in the City of Baltimore" research was conducted by students from Duke University's Sanford School of Public Policy in 2017. The research recommended implementing a "20 is Plenty" campaign, which would establish a default speed of 20 MPH in the downtown area, supplemented by expanded enforcement and education.

Baltimore City Crash Reduction Plan

In 2021, the Baltimore City Department of Transportation entered into an agreement with Mead & Hunt, Inc. to conduct an analysis of traffic crash patterns in Baltimore City and identify locations for improvement. Three years of crash data were utilized (2017-2019) to identify hot spots at the intersection and segment levels. Interstates were excluded from the study and crash rates were not used due to lack of data availability.

Once the hot spots were identified, a weighting system that incorporated crash frequency, severity, and crash rate was applied. Frequency is the total count of crashes at that location, the higher the number the higher the rank. Severity rank was calculated by applying weights according to the level of injury experienced in the crash, the more injurious the crash the higher the rank. Crash rate was calculated using vehicular exposure metrics: vehicle miles traveled (MVMT) on roadway segments and million entering vehicles (MVE) for intersections. A composite crash index (CCI) rank was calculated as 25% frequency rank, 25% crash rate rank, and 50% severity rank. Ranks are highest at the lowest score (e.g. 1 is the highest rank). Equity ranks were applied to hot spots as well, using DOT's Transit Equity Score (Wallace Montgomery, 2021). Baltimore City's "Transit Equity Score" highlights census blocks with poor transportation access as relates to age, poverty, race, no-car households, income, education, Hispanic/Latinx, public transit commuters, and disability status.

The study also incorporated the Safe System Approach by noting common denominators in roadway characteristics data at identified road segments and intersections. This information can be used to identify countermeasures and as a predictive model for other potential high crash locations.

The study resulted in four lists of high crash hot spots, including High Crash Intersections, High Crash Road Segments, High Pedestrian and Bicycle Crash Intersections, and High Pedestrian and

[2] https://www.researchgate.net/publication/277152058_An_Analysis_of_Pedestrian-Vehicular_Crashes_Near_Public_Schools_in_the_City_of_Baltimore_Maryland

Bicycle Crash Segments. Tables 10, 11, 12, and 13 show each list in order of their overall composite score ranking with associated discrete subject scores. As this Action Plan is primarily concerned with severe and fatal crashes, Figures 6 and 7 map overall crash hot spots and ped/bike hot spots, respectively, in order of their Severity Rank.

Overall High Crash Intersections and Road Segments

Figure 6: Baltimore City Crash Reduction Plan High Crash Corridors and Intersections 2017 - 2019 with Transit Equity Score

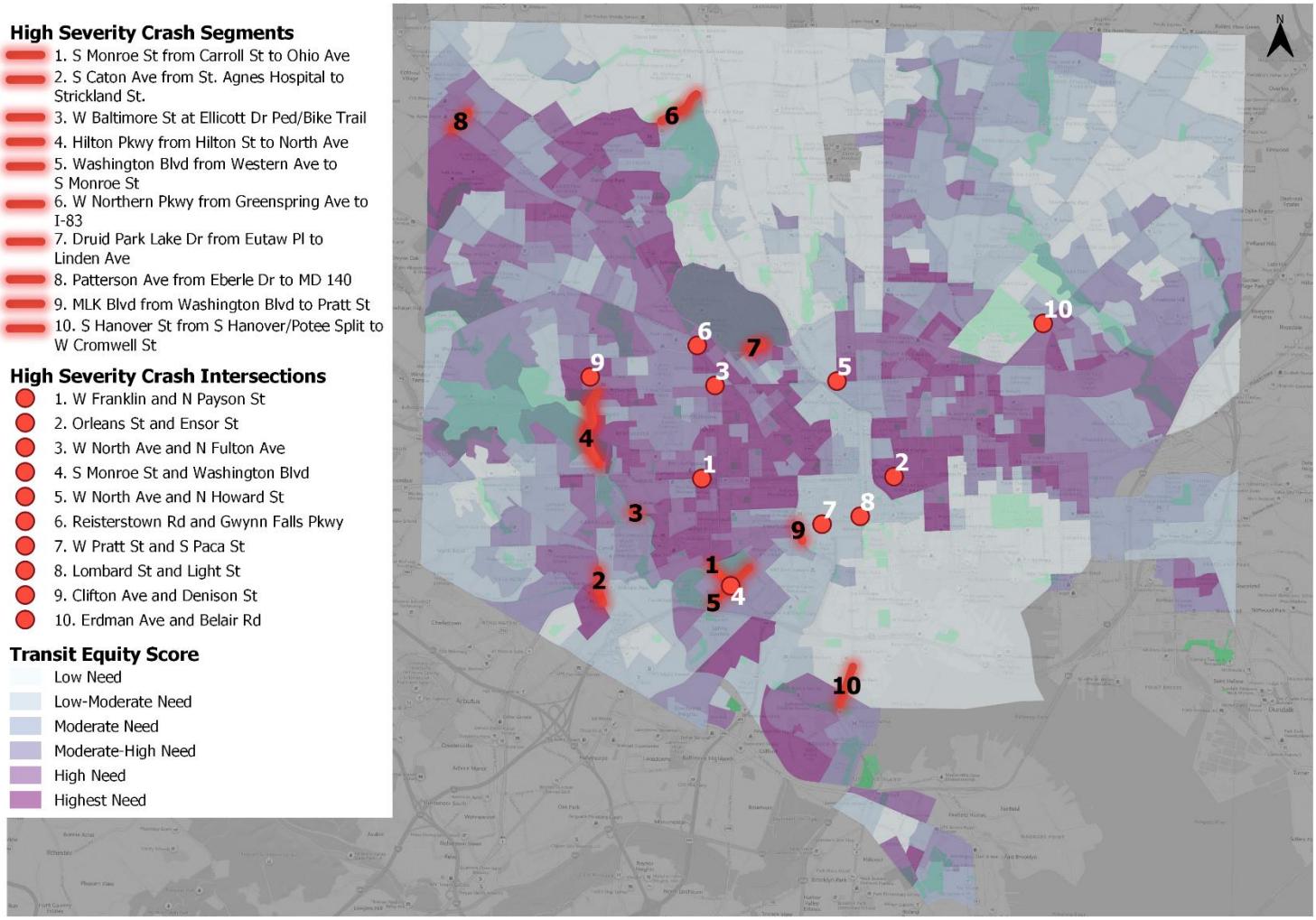


Table 10: Intersection Crash Hot Spots 2017 - 2019

Intersection	Frequency Rank	Rate Rank	Severity Rank	Equity Rank
1. W Franklin St and N Payson St	2	2	1	3
2. Orleans St and Ensor St	1	3	2	2
3. W North Ave and N Fulton Ave	4	5	3	6
4. S Monroe St and Washington Blvd	3	4	4	7
5. W North Ave and N Howard St	5	7	5	1
6. Clifton Ave and Denison St	8	1	9	5
7. Lombard St and Light St	6	6	8	T9
8. Reisterstown Rd and Gwynns Falls Pkwy	9	8	6	8
9. W Pratt St and S Paca St	7	9	7	T9
10. Erdman Ave and Belair Rd	10	10	10	4

The following key points can be discerned from this data:

- 70% of intersections had at least 4 lanes on both the major and minor road
- 60% of intersections had a left turn lane from at least one approach, four of which had a protected left turn phase
- The posted speed was 30 MPH on 90% of the intersecting roads
- Right turns on red were allowed at 50% of the intersections
- All major roads have an AADT greater than 10,000, and 90% have an AADT greater than 20,000
- 60% of intersections were of principal arterials on both the major and minor road
- Roadway functional classes breakdown as:
    - Principal arterial: 75%
    - Minor arterial: 15%
    - Local: 10%
- One intersection (S Monroe St at Washington Blvd) had a cycle length of 150s, all other signalized intersections had a cycle length between 110-120s
- 70% of intersections had crosswalks across all four legs, 20% had crosswalks across three legs, and 10% did not have any crosswalks
- Most intersections were near major pedestrian generators, including: West Baltimore MARC Station, bus stops, grocery/drug stores, convenience stores, Mondawmin Mall

Table 11: Road Segment Crash Hot Spots 2017 - 2019

Segment	Frequency Rank	Rate Rank	Severity Rank	Equity Rank
1. S MONROE ST	2	5	1	T4
2. W BALTIMORE ST	4	1	3	6
3. S CATON AVE	3	6	2	7
4. WASHINGTON BLVD	5	2	5	T4
5. HILTON PKWY	1	10	4	3
6. DRUID PARK LAKE DR	9	3	7	1
7. W NORTHERN PKWY	6	8	6	8
8. PATTERSON AVE	7	4	8	2
9. S MARTIN LUTHER KING JR BLVD	8	7	9	9
10. S HANOVER ST	10	9	10	10

The following key points can be discerned from this data:

- 90% of segments were 4 or greater lane roadways
- The posted speeds break down as:
  - 20 MPH: 10% (Advisory speed, typical speed is 30 MPH)
  - 25 MPH: 10%
  - 30 MPH: 40%
  - 35 MPH: 40%
- 40% of segments had an AADT greater than 32,000
- One segment had an AADT less than 10,000 (W Baltimore St, 8,900)
- All segments were two-way roads
- 50% of segments had median, either concrete or concrete and grass, one of which had a partial two way left turn lane
- All segments were classified as arterials
- Lane widths break down as:
  - 9.5 ft: 10%
  - 10 ft: 40%
  - 11 ft: 40%
  - 12 ft: 10%
- Curb-to-curb road width break down as:
  - 40-45 ft: 2
  - 46-50 ft: 1
  - 51-55 ft: 0
  - 56-60 ft: 5
  - 61-65 ft: 0
  - 66-70 ft: 1
  - >70 ft: 1

- Two segments had no sidewalks or pedestrian trails present
- 8 segments had no cycling facilities present
- 70% had no pedestrian crossings within the segment (excluding crossings at segment limits)
- 80% of segments had a distance greater than 2 blocks between pedestrian crossings

Pedestrian and Bicycle High Crash Intersections and Road Segments

Figure 7: Baltimore City Crash Reduction Plan High Crash Pedestrian and Bicycle Intersections and Corridors with Transit Equity Score

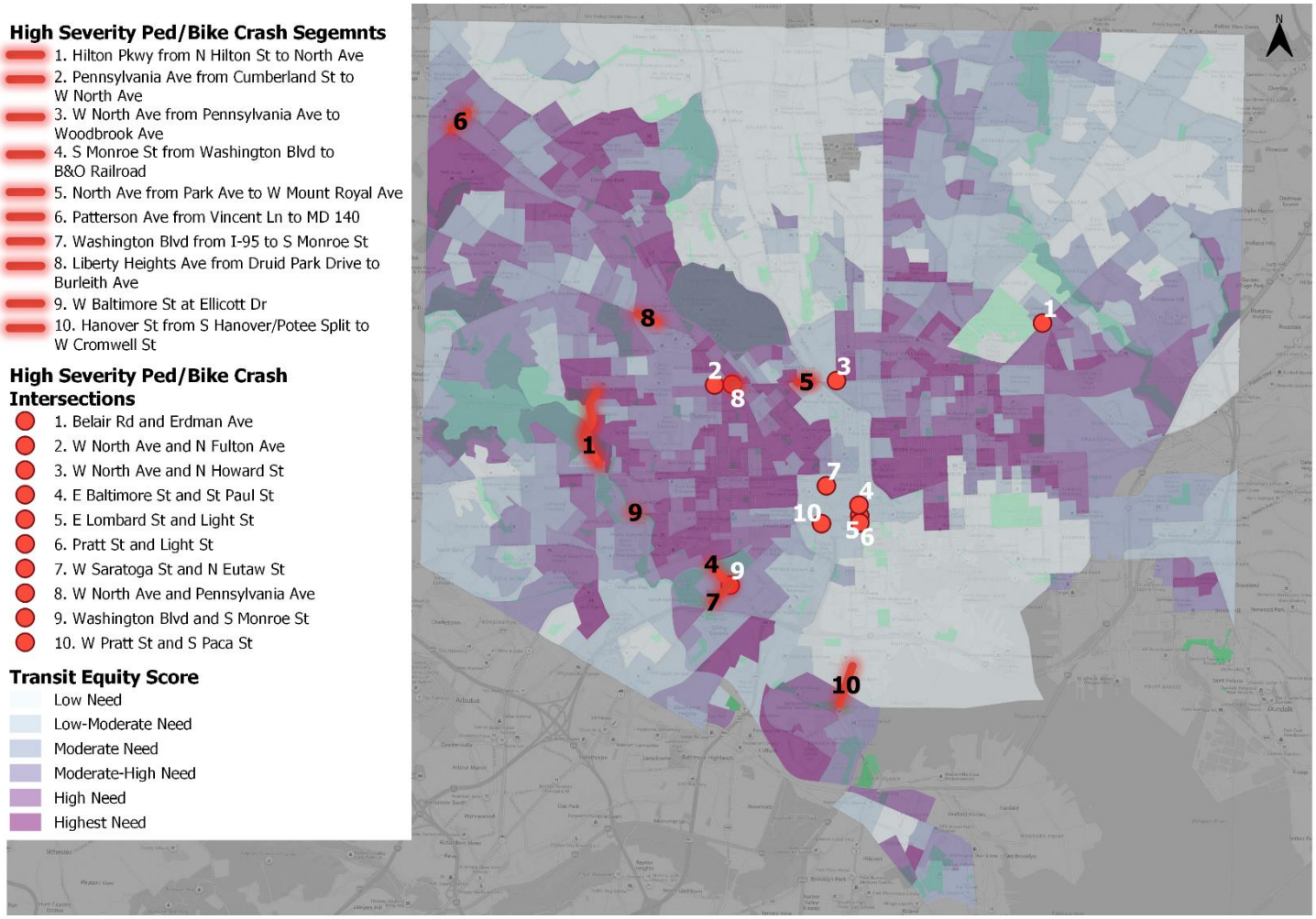


Table 12: Pedestrian and Bicycle Intersection Crash Hot Spots 2017 - 2019

Intersection	Frequency Rank	Rate Rank	Severity Rank	Equity Rank
1. Belair Rd and Erdman Ave	1	3	T1	3
2. W North Ave and N Fulton Ave	2	4	T1	4
3. E Baltimore St and St Paul St	4	2	4	T7
4. E Lombard St and Light St	3	5	T5	T7
5. W North Ave and N Howard St	6	8	3	1
6. Pratt St and Light St	5	9	T5	T7
7. W Saratoga St and N Eutaw St	9	1	7	6
8. W North Ave and Pennsylvania Ave	7	7	8	2
9. Washington Blvd and S Monroe St	8	6	T9	5
10. W Pratt and S Paca St	10	10	T9	T7

The following key points can be discerned from this data:

- 70% of intersections had a left turn lane from at least one approach, only 1 had a protected left turn phase
- All intersections had crosswalks across all legs
- Intersection lighting was good at all intersections
- Right turns on red were prohibited at 90% of intersections
- The posted speed was 30 MPH on 90% of the intersecting roads
- 90% of intersections had at least 4 lanes on both the major and minor road
- 90% of major roads had an AADT greater than 10,000, 70% of major roads had an AADT greater than 20,000
- 60% of intersections were of principal arterials on both the major and minor road
- Roadway functional classes breakdown as:
    - Principal arterial: 75%
    - Minor arterial: 25%
- 60% had right turn lanes, all of which had permissive phases and prohibited right on red
- One intersection (S Monroe St at Washington Blvd) had a cycle length of 150s, all other intersections had a cycle length between 110-120s
- Most intersections were near major pedestrian generators, including: grocery/drug stores, the Inner Harbor, Camden Yards, the Lexington Market, Penn-North Metro Station, bus stops, office buildings

Table 13: Pedestrian and Bicycle Segment Crash Hot Spots 2017 - 2019

Segment	Frequency Rank	Rate Rank	Severity Rank	Equity Rank
1. PENNSYLVANIA AVE	4	1	2	1
2. W NORTH AVE (Pennsylvania Ave)	2	3	3	2
3. HILTON PKWY	1	9	1	5
4. S MONROE ST	3	6	4	T6
5. W NORTH AVE (Park Ave)	5	7	5	9
6. PATTERSON AVE	6	5	6	3
7. WASHINGTON BLVD	7	4	7	T6
8. W BALTIMORE AVE	8	2	9	8
9. LIBERTY HEIGHTS AVE	9	8	8	4
10. S HANOVER ST	10	10	10	10

The following key points can be discerned from this data:

- 90% of segments were 4 or greater lane roadways
- The posted speeds break down as:
  - 20 MPH: 10% (Advisory speed, typical speed is 30 MPH)
  - 25 MPH: 40%
  - 30 MPH: 30%
  - 35 MPH: 20%
- Sidewalks were present at all segments
- Only one segment had cycling facilities on the segment
- Pedestrian generators in the vicinity of the segments include schools (e.g., MICA, BCCC, The Mount Royal School), parks, grocery stores/shopping centers, Penn-North Metro Station, bus stops
- Some segments were inter-neighborhood connectors or bypasses which were one of if not the only road to other areas, thus channeling pedestrians (e.g., Hanover St Bridge, Hilton Pkwy, Patterson Ave to Reisterstown Plaza Metro under the RR crossing)
- 60% of segments had an AADT greater than 20,000
- All segments were two-way roads
- 40% of segments had median, either concrete or concrete and grass, one of which had a partial two way left turn lane
- All segments were classified as arterials
- Lane widths break down as:
  - 9.5 ft: 20%
  - 10 ft: 20%
  - 11 ft: 50%
  - 18 ft: 10%
- Curb-to-curb road width break down as:

  - 39-45 ft: 3
  - 46-50 ft: 1
  - 51-55 ft: 0
  - 56-60 ft: 3
  - 61-65 ft: 0
  - 66-70 ft: 0
  - >70 ft: 3
- 60% had no crosswalk within the segment
- 60% of segments had a distance greater than 0.25 mi between pedestrian crossings

Overarching Findings

- Findings highlighted unsurprising characteristics of hot spot roadways and intersections, such as high AADT and more lanes at hot spot locations.
- For pedestrian and bicycle intersection crashes, all hot spots had crosswalks at all intersection legs. Additionally, right turns were prohibited at 90% of these intersections. This suggests that presence of pedestrian amenities is not the primary safety factor for bicyclist and pedestrians at intersections, but rather, other operational characteristics of the roadway / intersection (e.g., phasing, speeds,) factor in the safety of bicyclists and pedestrians.
- Conversely, bike facilities were found along only 1 of the top 10 bicycle/pedestrian hot spot road segments, suggesting that bike facilities may help reduce bike crashes along road segments.

Other Identified Issues

The Baltimore City Crash Reduction Plan notes several issues with crash data and reporting:

- The crash location XY coordinates are not validated by the MSP before being incorporated into SHA's crash database (TANG).
- MDOT SHA is moving towards a new database structure that is based on the ACRS data structure. This is called MSCAN
- Washington College processes the final crash data product (Sanitized Shapefiles) annually for DOT. This data is derived from MDOT SHA's TANG database. They use the ACRS manual to resolve data conflicts. However, because there are parallel crash data QC efforts among different contractors, it is unclear whether all the QC is captured in the final, sanitized shapefile provided to DOT by Washington College.
- Near misses are a critical factor in road safety, however this data is difficult to capture
- Many crashes go unreported, either because they are minor, or due to other interests of the parties involved. This is particularly the case for crashes involving a pedestrian or bicyclist, which can underrepresent actual pedestrian and bicycle crash statistics.
- Although there are standard reporting forms for crash incidents, consistent documentation and interpretation among dozens of municipal, county, and state law enforcement agencies is challenging, which can result in skewed data.
- Not all crashes are reportable to the ACRS system, including incidents involving public transit vehicles and minor speeding and traffic violations.

- Often, the responding officer is able to determine causation based on prevailing site and driver conditions. Other times, however, critical causation data is not offered by the driver (e.g. distracted, texting), which can underrepresent actual risky behaviors.

Data Recommendations

The following is a list of data recommendations to improve crash data accuracy. The recommendations are categorized by whether the solution is on the scene at the crash location (source) or during post processing (PP). Additionally, location accuracy improvements (Location) are distinguished from (Attribute) accuracy improvements.

Source, Location Recommendation

- Require responding officer to collect the coordinates of the crash location with a GPS-enabled application and provide training.

PP, Location Recommendations

- Compare GIS points to the Road name and Reference Road name attributes. The Road name is the crash on street and the Reference Road name is the nearest intersection to the crash. Using a centerline GIS file, an analyst can check the location for the proper on street and nearest cross street.
- Compare the GIS point location to the information provided in the Narrative data attribute. The Narrative data attribute is often the most valuable piece of information in the attribute table because it provides the officer the opportunity to list details of the crash such as the distance that it occurred from the intersection or the lane in which the crash occurred.

Source, Attribute Recommendations

- Investigate the ACRS system and see where improvements can be made for standardization of data attribute entry. This could include the following:
    - Refining the domains (possible input values) that are given as options in ACRS
    - ACRS not accepting blank or null values
    - Ensuring all officer's vehicles are equipped with standardized ACRS systems.
- Officer training on data input.

PP, Attribute Recommendations

- Cross reference data attributes, checking for consistency. For example, if the Weather attribute is rainy, the Surface Condition Attribute should be wet or slippery. The following data attributes are easy to cross reference:
    - Accident Time / Light Code
    - Weather / Surface Condition
    - Junction / Intersection Type
- When there are blank or null values for Weather or Surface Condition, historical weather reports can be researched.
- Compare the Narrative attribute to other data attributes.