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A

Appendix 1: Systemic Safety Analysis

VISION ZERO
SAFE STREETS IN NASHVILLE

NDOT

Executive Summary

This systemic safety analysis assesses the characteristics of collisions that occurred between January 2014 and August 2021 to identify locations within Nashville that have an increased risk for specific crash types. As part of the Nashville Vision Zero program, this analysis specifically focuses on traffic collisions that resulted in a person being injured to some degree, whether that injury be minor, serious, or fatal. Particular attention was paid to serious and fatal collisions, otherwise known as killed and severely injured collisions (KSIs). The analysis did not include collisions that resulted in property damage only. By investigating factors associated with each injury collision (e.g., lighting conditions, demographics) and the characteristics of the roadway on which the collision occurred (e.g., number of lanes, surrounding land use context, presence of sidewalks), this analysis identifies some of the most pertinent trends in Nashville's injury collisions.

Collisions used in this analysis were accessed via the Tennessee Department of Transportation's E-Trims digital platform. Only collisions that occurred along state and locally controlled roadways were included. The high rates of traffic on federally controlled interstates would obscure trends from state and local roads. The crash factors involved in interstate collisions tend to differ substantially relative to other facility types. Additionally, local authorities have less control over these roads.

Key Findings

Who is impacted?

BY MODE

- One in four people hit by a car while walking in Nashville are killed or seriously injured.
- Pedestrians in Nashville are disproportionately involved in fatal and serious injury collisions. Though only 3% of typical commuters, pedestrians are involved in 17% of fatal and serious injury collisions.
- Pedestrians account for 9% of minor injury hit-and-runs but 35% of fatal and serious injury hit-and-runs.
- Although bicyclists make up less than 0.3% of Nashville commuters, they represent 2% of all fatal and serious injury collisions.

BY DEMOGRAPHICS

- Across all modes, Vulnerable and Highly Vulnerable Areas, as determined by the prior Equity Analysis, have collision rates 2-4 times greater than non-vulnerable areas when normalized by square mile.
- A person walking in a highly vulnerable area is 9 times more likely to be killed or severely injured on a high-speed road.

When are collisions occurring?

- Pedestrians and Motorists are most often killed or seriously injured in a traffic collision between 5pm and 9pm.
- 67% of collisions where a pedestrian was fatally or seriously injured occurred after dark. Dark-lighted conditions means that the collision occurred after daylight hours on a roadway with lighting. The high percentage of pedestrian collisions occurring in dark-lighted conditions could indicate lighting along these roadways is not sufficient for people to walk them after dark.
- Collisions involving pedestrians are rising. If the current trend continues, the number of annual fatal and serious injury crashes involving a pedestrian will increase from 81 in 2019 to a projected 96 by 2026.

Where are collisions happening, and what roadway facility characteristics are associated with collisions?

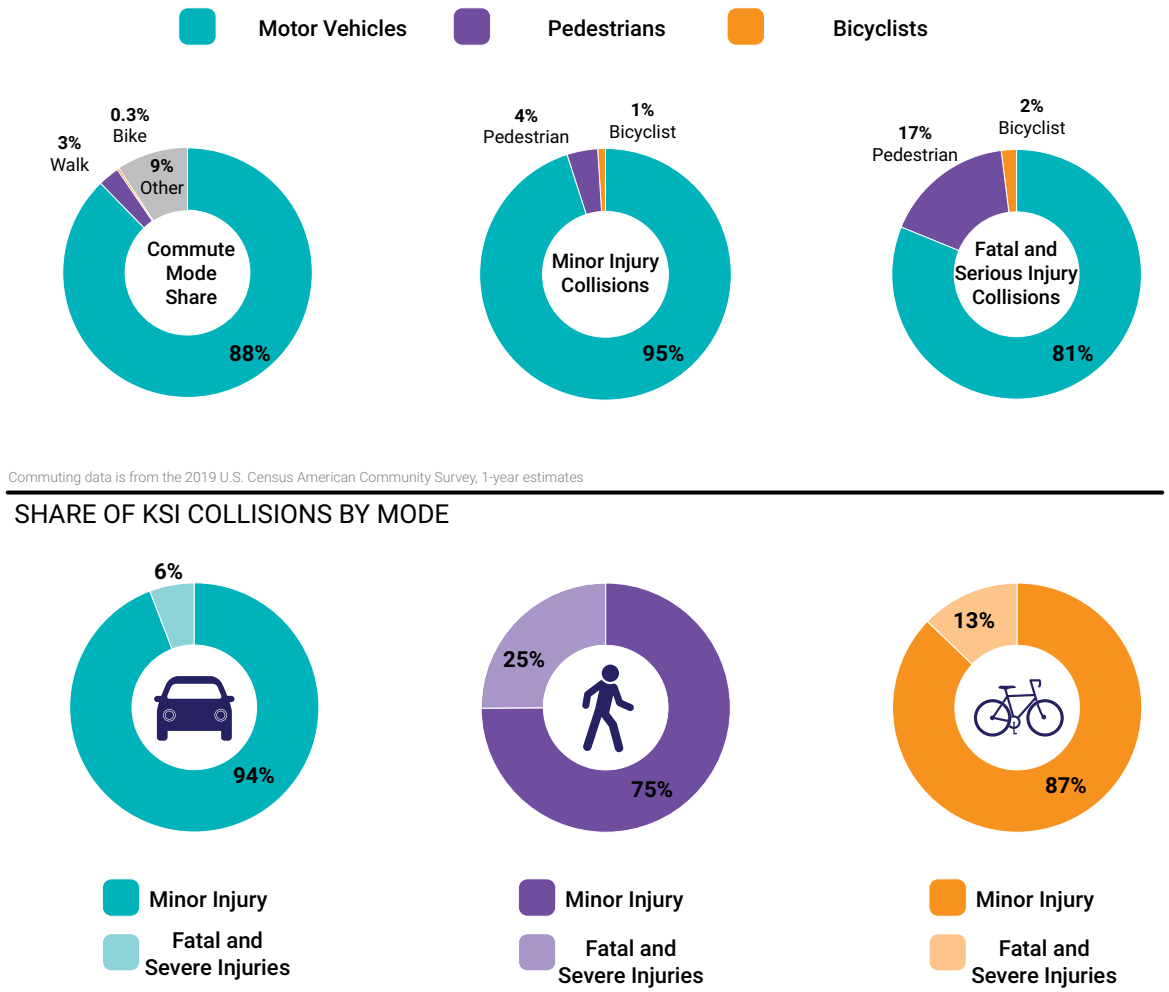
- An increase in the posted speed limit from 30 to 35 mph results in a three- to six-fold increase in collision rates for all modes and all severities.
- 60% of pedestrian and 52% of bicyclist fatal and serious injury collisions occur within 500 feet of a high frequency transit stop (defined as having 15-minute or shorter headway from 6 – 9 AM).
- Commercial areas account for just 4% of the county's total land use but an average of 22% of the parcel area within 500' of all collisions.

Safety Overview

When examining overall patterns in modes and temporal trends, the analysis determined that pedestrians and bicyclists are more at risk for fatal and serious injury collisions than motorists. **While pedestrians account for just 3% of commuters and 4% of minor injury collisions, they account for 17% of collisions where a person was killed or seriously injured.** Overall, one in four (25%) of people hit by a vehicle while walking was killed or seriously injured, which is nearly double the percentage of cyclists (13%) and four times that of motorists (6%). Temporal trends indicate that pedestrians are most at risk during the evening hours, between 5:00pm and 9:00pm. Furthermore, the slight increase in pedestrian-involved collisions during the winter months could suggest a greater need for adequate pedestrian lighting during twilight and dark conditions as there is less daylight during that time of year.

Crashes by Mode

Figure 1 - Collisions by Mode



Crash Hotspots

While 91% of collisions occur on Metro controlled roadways, TDOT roadways have more collisions per mile. Further, state-owned roadways feature the highest density of collisions that result in injury, regardless of severity, meaning state-owned roads have the most minor injury, serious injury, and fatal collisions per mile. This is likely due to the fact that state-controlled roadways comprise just a small portion of the total road network in Nashville, but make up many of the higher-speed arterial roads whereas Metro owns the majority of the local road network.

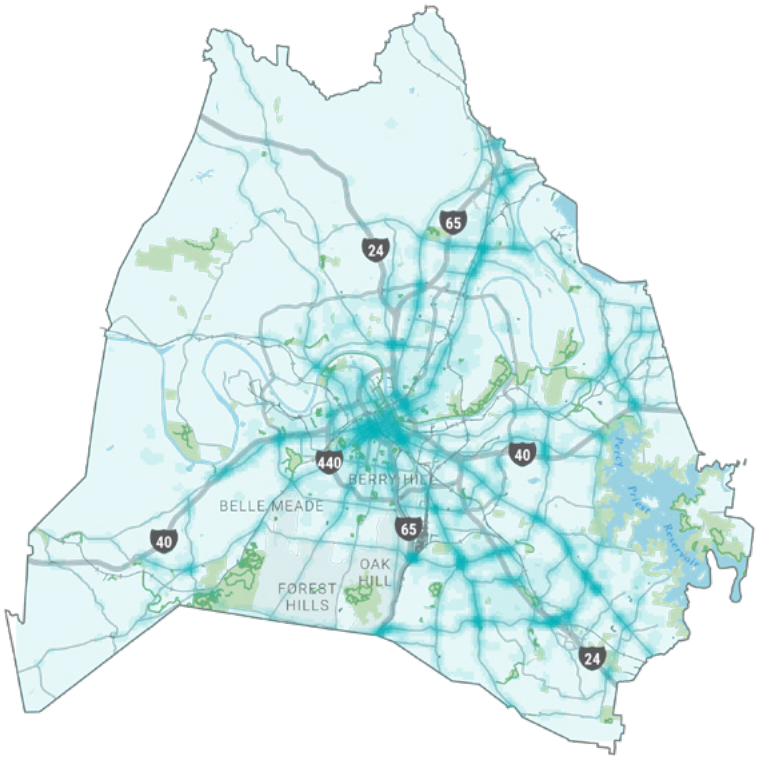
Figure 2 - Roadway Ownership of Collisions, by Severity and Mode



Among state-owned roads, Nolensville Pike and Gallatin Pike are the roadways with the greatest collision frequency for all modes of travel. Murfreesboro Pike and Dickerson Pike also feature a high number of collisions for pedestrians and motorists. Regardless of roadway ownership, collisions are concentrated along arterial connectors and in the downtown areas which underscore the roles of speed and roadway width in influencing collisions.

Map 1 - Motorist-Involved Collisions

MOTORIST COLLISION HEAT MAP



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Table 1 - Greatest Frequency of Motorist-Involved Collisions within 50 Feet of the Roadway

ROADWAY	COLLISIONS
Murfreesboro Pike	2755
Nolensville Pike	2087
Bell Rd	1847
Old Hickory Blvd	1765
Gallatin Pike	1453
Dickerson Pike	1280
Harding Pl	1259
Lebanon Pike	806
Charlotte Pike	800
Charlotte Ave	726

Map 2 - Pedestrian-Involved Collisions

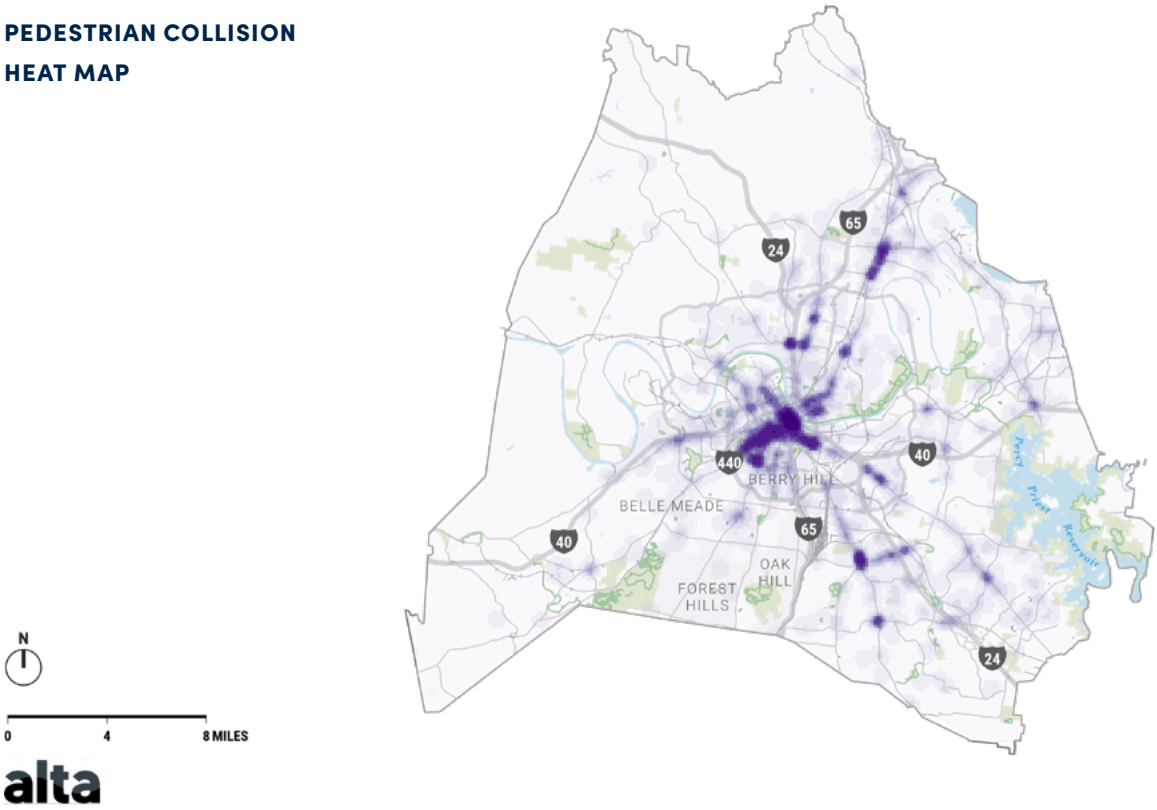


Table 2 - Greatest Frequency of Pedestrian-Involved Collisions within 50 Feet of the Roadway

ROADWAY	COLLISIONS
Gallatin Pike	107
Murfreesboro Pike	106
Nolensville Pike	104
Broadway	90
Dickerson Pike	69
West End Ave	67
Church St	64
Lafayette St	60
12th Ave S	47
21st Ave S	45

Map 3 - Bicyclist-Involved Collisions

BICYCLIST COLLISION HEAT MAP

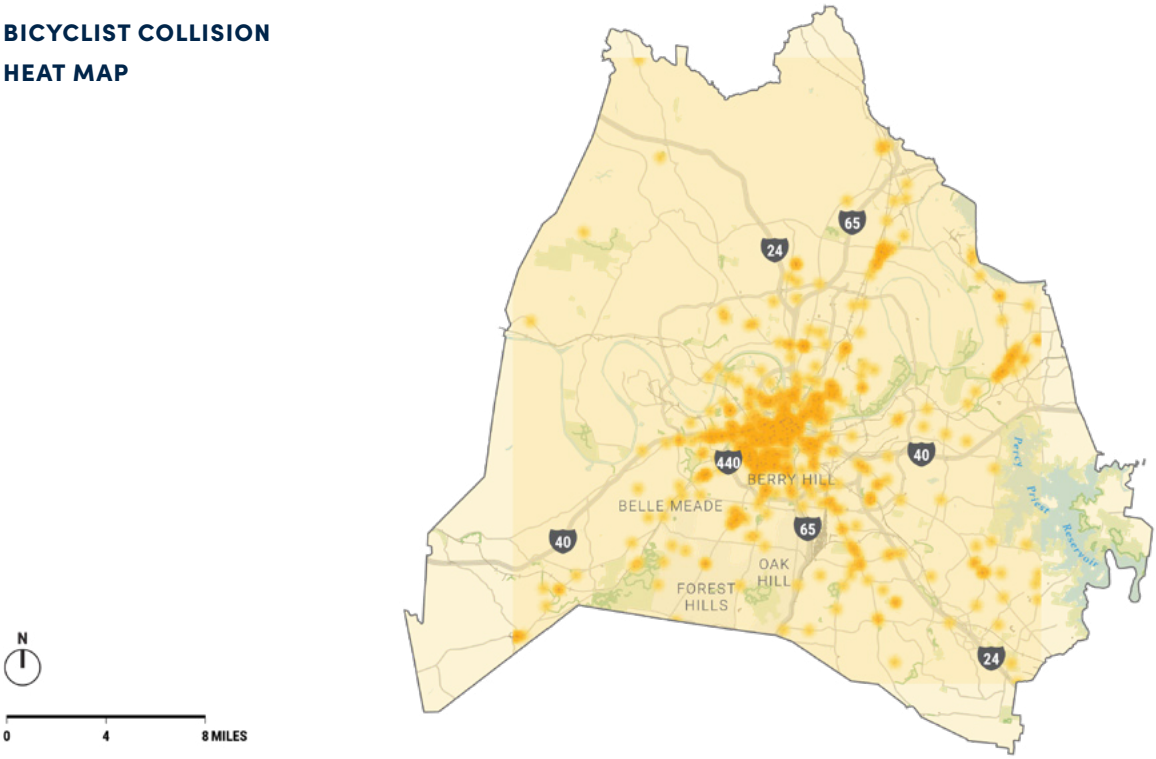


Table 3 - Greatest Frequency of Bicyclist-Involved Collisions within 50 Feet of the Roadway

ROADWAY	COLLISIONS
Charlotte Ave	24
Church St	18
Nolensville Pike	16
Gallatin Pike	13
8th Ave S	12
Lebanon Pike	12
21st Ave S	11
West End Ave	11
Demonbreun St	10
Jefferson St	10

Crash Rates per 100,000 People

The National Highway Traffic Safety Administration documents and reports yearly traffic fatality rates per 100,000 population for cities and counties across the nation. In 2019, **Nashville had the 24th highest fatality rate and 21st highest pedestrian fatality rate per 100,000 population amongst the**

Table 4 - Top 25 Metro Areas by Crash Rates per 100,000 People, All Modes

CITY	FATALITY RATE PER 100,000 POPULATION (2019)
Chattanooga, TN	24.07
Knoxville, TN	23.99
Jackson, MS	23.66
Fort Lauderdale, FL	22.47
Macon-Bibb County, GA	22.2
Memphis, TN	19.97
St. Louis, MO	19.96
Tucson, AZ	19.52
Lubbock, TX	19.32
Baton Rouge, LA	18.62
Albuquerque, NM	18.02
Birmingham, AL	17.67
Detroit, MI	17.16
Atlanta, GA	16.97
Mobile, AL	16.96
Little Rock, AR	16.72
Jacksonville, FL	16.35
Kansas City, MO	15.95
San Bernardino, CA	15.76
Tampa, FL	15.76
Louisville/Jefferson County, KY	15.22
Lakewood, CO	15.2
Nashville-Davidson County, TN	14.46
Palmdale, CA	14.19
Lancaster, CA	13.96

Source: NHTSA Annual Tables, "People Killed, Population, and Fatality Rates in Cities With Populations of 150,000 or Greater, 2019"

174 cities and counties with populations over 150,000 residents. Generally, cities and counties with the highest fatality rates were concentrated in the southeastern United States, and four of the top 25 cities and counties are located in Tennessee.

Table 5 - Top 25 Metro Areas by Crash Rates per 100,000 People, Pedestrians Only

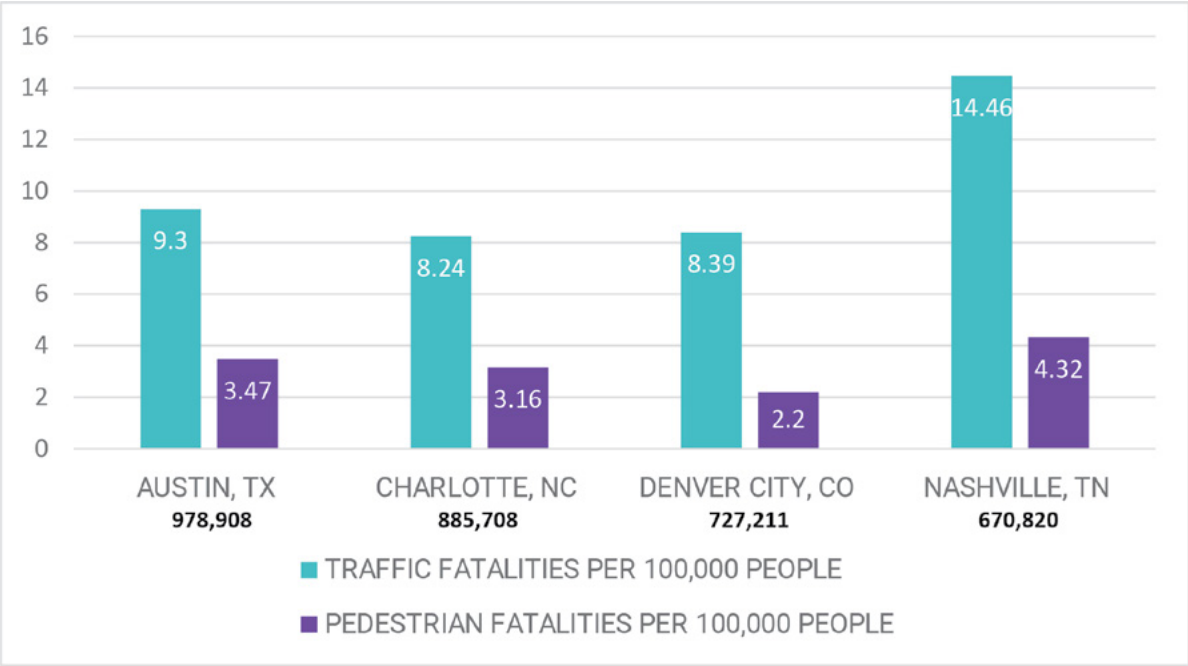
CITY	PEDESTRIAN FATALITY RATE PER 100,000 POPULATION (2019)
Fort Lauderdale, FL	10.96
Albuquerque, NM	7.49
Tucson, AZ	7.48
Macon-Bibb County, GA	7.18
Orlando, FL	6.61
Jackson, MS	6.23
Little Rock, AR	6.08
San Bernardino, CA	6.02
Miami, FL	5.77
Memphis, TN	5.53
St. Louis, MO	5.32
St. Petersburg, FL	5.28
Stockton, CA	5.12
Lakewood, CO	5.07
Tampa, FL	5
Phoenix, AZ	4.82
Columbus, GA	4.6
Atlanta, GA	4.54
Jacksonville, FL	4.5
Dallas, TX	4.39
Nashville-Davidson, TN	4.32
Knoxville, TN	4.26
Newark, NJ	4.26
El Paso, TX	4.25
Detroit, MI	4.18

Source: NHTSA Annual Tables, "People Killed, Population, and Fatality Rates in Cities With Populations of 150,000 or Greater, 2019"

Vision Zero Cities - Peer Comparisons

Compared to identified peer cities Austin, Charlotte, and Denver, Nashville has a significantly higher rate of fatal crashes per 100,000 population. Nashville also has the highest rate of fatal pedestrian-involved crashes among peer cities. However, Nashville features a slightly lower proportion of pedestrians among the total fatalities reported in 2019.

Figure 3 - Fatal Crash Rates Among Peer Cities, by All Modes and Pedestrian-Only



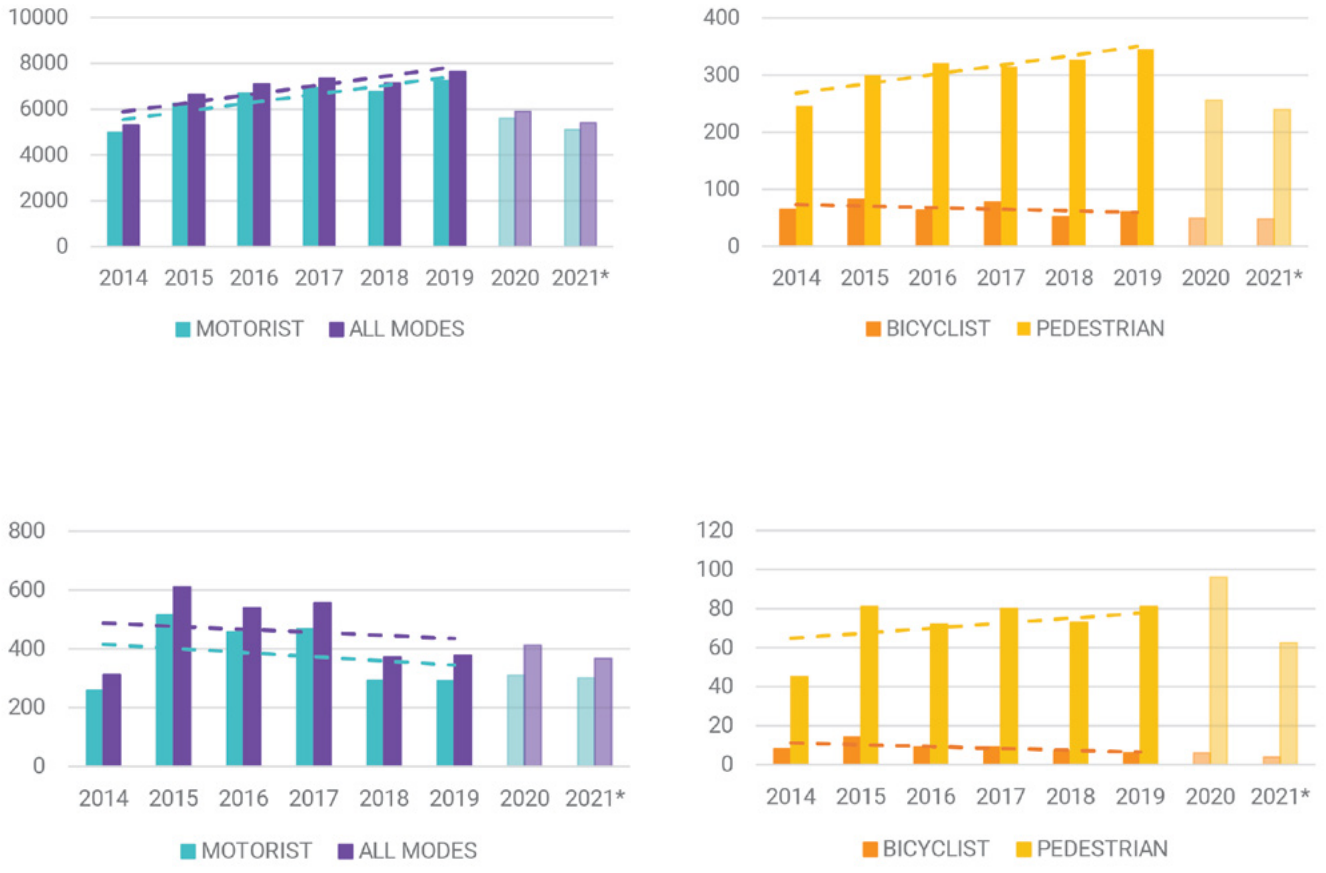
Source: NHTSA Annual Tables, "People Killed, Population, and Fatality Rates in Cities With Populations of 150,000 or Greater, 2019"

Collisions by Year

On average, the number of collisions per year have increased since 2014 in Nashville. Separating collisions by mode also reveals that pedestrian- and motorist-involved collisions have increased. Furthermore, there is a slight upward trend in collisions where a person walking has been killed or seriously injured. Conversely, collisions where a motorist was killed or severely injured trended downward. While bicyclist-involved collisions show a downward trend, the smaller sample of bike collisions included in the analysis compared to pedestrian and motorist collisions limits confidence in the trendline.

The COVID-19 pandemic has significantly impacted travel patterns and as such, It is difficult to accurately forcast future travel demand. The year 2020 was removed from the trend analysis due to the sharp decline in vehicle miles traveled that year. 2021 data was also not included in the trend line as the data analyzed only captures collisions through August.

Figure 4 - Collisions, by Year and Injury

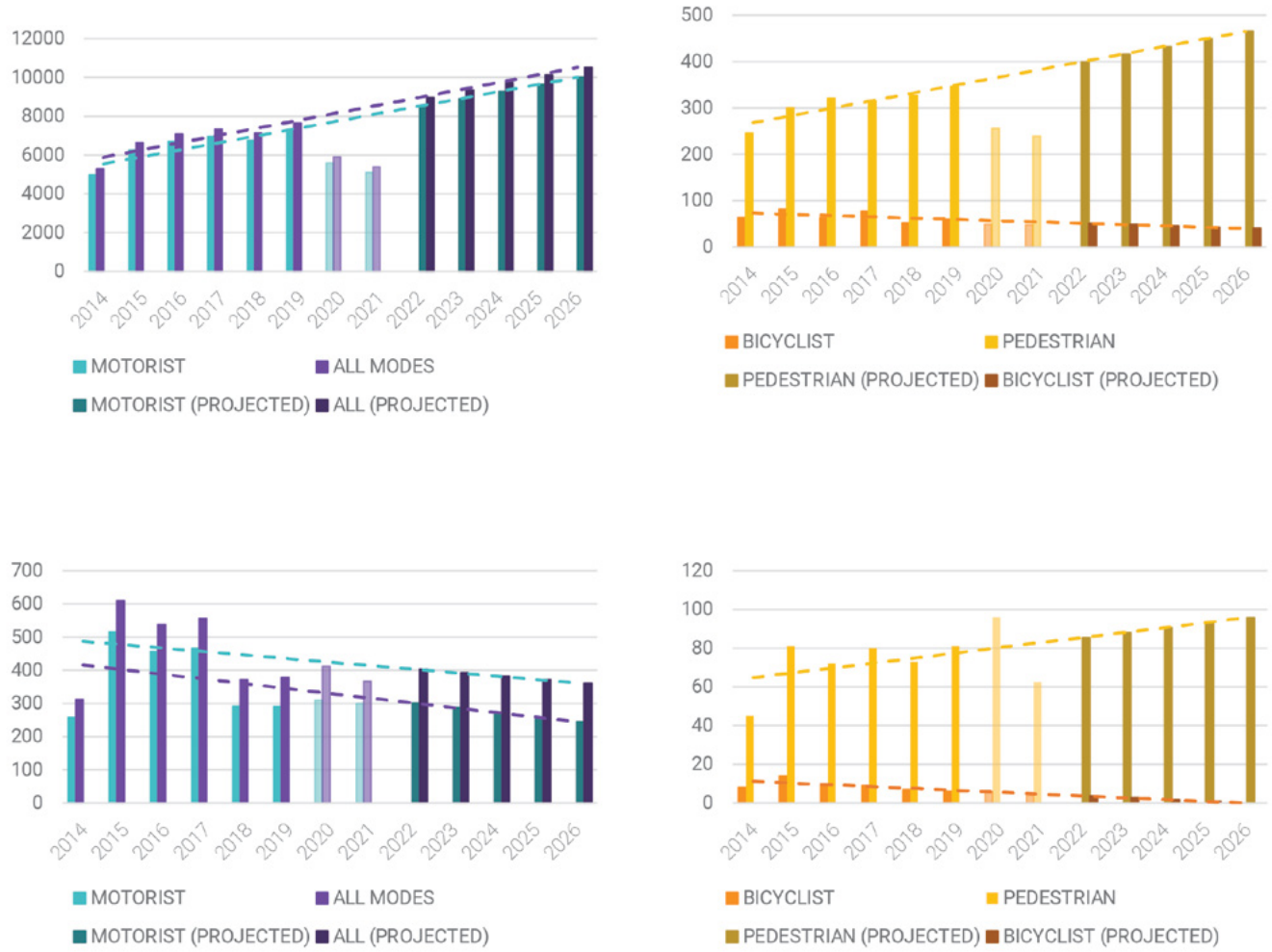


**2021 Data only includes crashes recorded through August, 2021.*

Projected Collisions by Year

Collisions for the next five years (up to 2026) were projected, excluding 2020 and 2021, based on the calculated trendlines described above. Though the ongoing impacts of the COVID-19 pandemic make projecting future travel difficult to confidently predict, if the current trend continues, **we can expect an increase from 81 crashes resulting in the death or serious injury of a person walking in 2019 to a projected 96 by 2026.**

Figure 5 - Projected Collisions, by Year and Injury



Collisions by Month

When examining collisions by month, there is a slight trend towards pedestrian and bicyclist collisions occurring more during the fall and winter months. Although people typically walk and bike more during the warmer months, the reduced daylight hours during the fall and winter can present more dangerous walking and biking conditions that can result in an increased number of collisions.

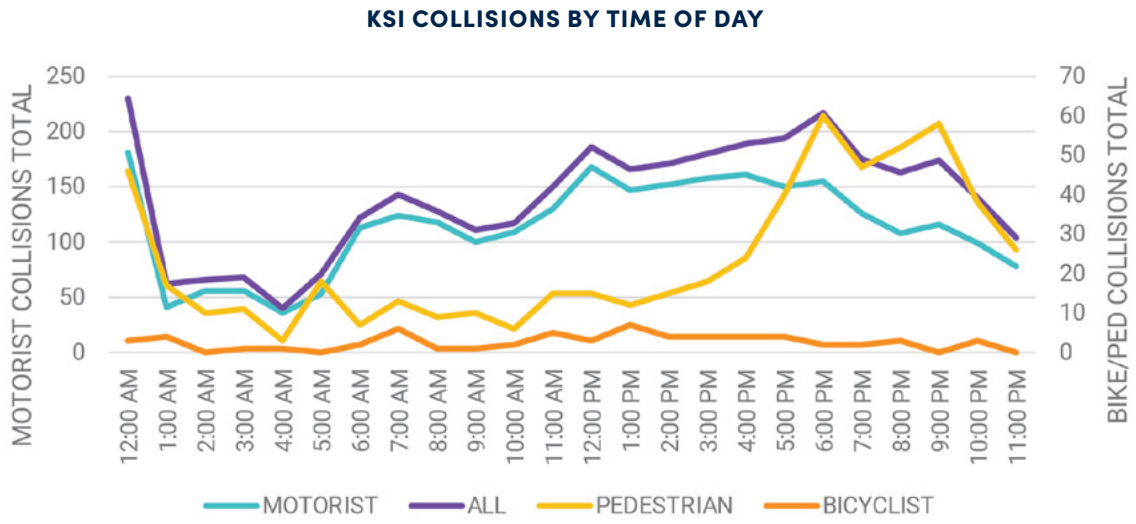
Figure 6 - Collisions, by Month and Injury



Collisions by Time of Day

The top crash times of day for minor injury collisions for all modes occurred between 4:00pm and 7:0 pm, which is consistent with evening commuting peaks. **There is a significant spike in collisions for pedestrians who were killed or seriously injured between 5:00pm and 9:00pm.** These evening hours may represent times with peak traffic volumes due to evening commuting and low-light conditions, making it more dangerous for pedestrians to walk during these hours.

Figure 7 - Fatal and Serious Injury Collisions, by Time of Day



Collisions by Presence of Street Lighting

The majority of collisions for all modes of travel occur during daylight hours, which are the hours when most people are traveling. **Notably, 67% of crashes where a pedestrian struck by a vehicle is killed or severely injured happen after dark. 51% of collisions where a pedestrian struck by a vehicle was killed or seriously injured occurred during Dark-lighted conditions.** Dark-lighted conditions refer to collisions that occur at night but with some source of lighting nearby, usually street lighting. The high percentage of fatal and serious injury pedestrian collisions that occur in dark-lighted conditions may potentially indicate that while lighting is present on the roadways where these crashes are occurring, it is not sufficient for safe pedestrian use.

Table 6 - Collisions, by Illumination and Injury

	MINOR INJURY			FATAL OR SERIOUS INJURY		
	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST
Dark - Unknown Lighting	0%	1%	1%	0%	1%	0%
Dark - Lighted	23%	35%	14%	24%	51%	24%
Dark - Not Lighted	5%	8%	3%	10%	15%	3%
Dawn	1%	2%	1%	1%	1%	2%
Daylight	68%	51%	79%	62%	30%	68%
Dusk	2%	2%	2%	2%	2%	3%
Other/unknown	0%	1%	1%	0%	0%	0%

Note: Reported percentages are rounded and may not total to 100%.

High Risk Users

Collisions in Vulnerable Area

Collision rates were examined among areas with vulnerable populations identified in a transportation vulnerability analysis. The areas with the highest vulnerably scores were determined through a degree of vulnerability analysis adapted from the Greater Nashville Regional Council's methodology. For the analysis, thirteen indicators were assessed to identify vulnerable communities with high transportation need. Indicators used in the analysis include:

- Active transportation users
- Carless households
- People with disabilities
- Educational Attainment
- Females
- Cost-burdened households
- Limited English proficiency
- People of color
- Households below the federal poverty line
- Unemployment rate
- Homeownership
- Older adults
- Youth

Areas with the highest rates of people living in poverty, and places with the highest rates of renters bear 37% of all crashes, despite these areas accounting for only 20% of the total Nashville population. Areas with high rates of housing cost burden and areas with the largest share of people of color also disproportionately experience traffic collisions. **Residents in Vulnerable or Highly Vulnerable Areas, as determined by the degree of vulnerability analysis, face collision rates 2-4x greater than non-vulnerable areas when normalized by square mile.**

The following map represent the 20% most vulnerable populations and Table 7 highlights the collisions for each indicator used in the vulnerability analysis.

Map 4 – Highly Vulnerable Areas

VULNERABLE AND HIGHLY VULNERABLE AREAS

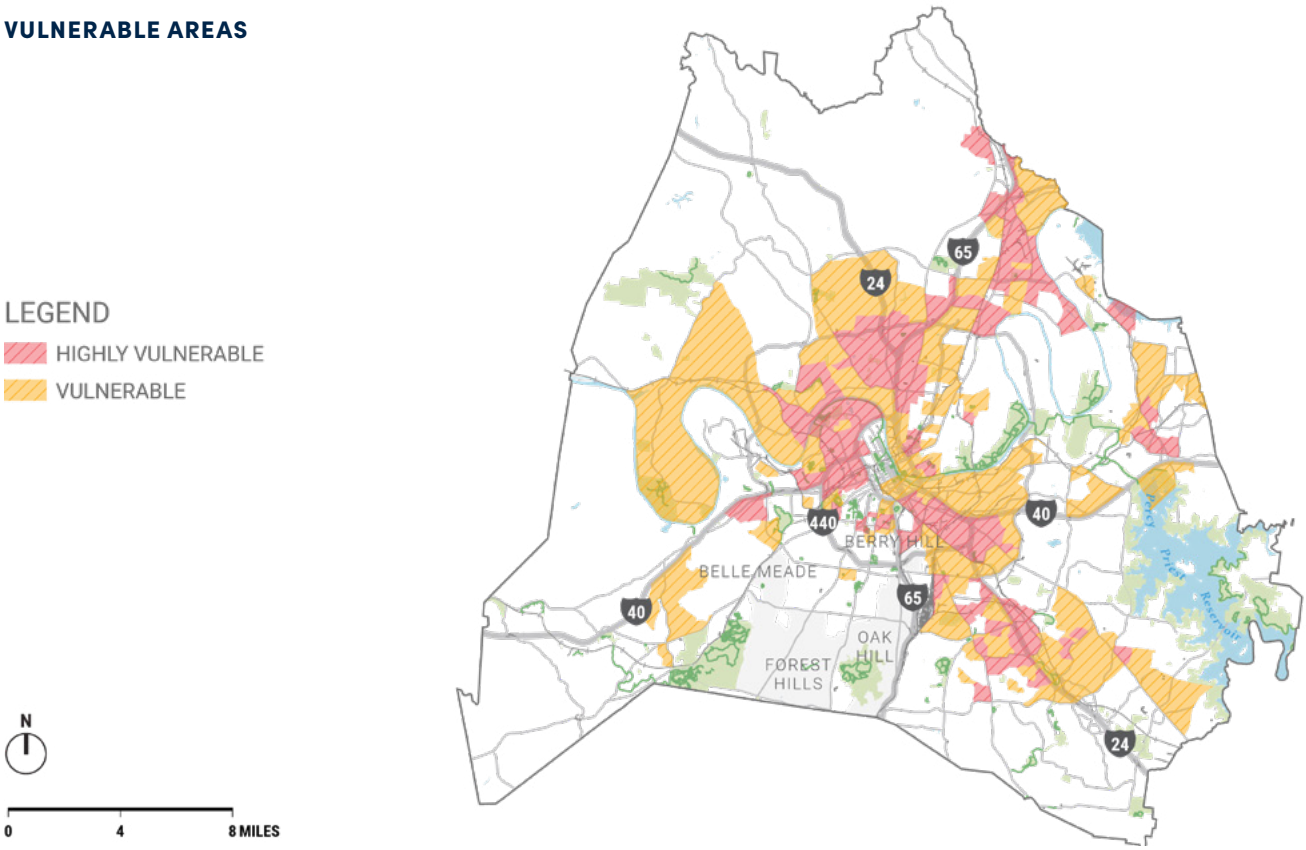


Table 7 - Demographic Inputs and Collisions of the Highly Vulnerable Areas (Top 20% of all Block Groups)

PERCENT OF COLLISIONS BY DEMOGRAPHIC GROUP

BLOCK GROUPS INCLUDING THE TOP 20% OF EACH DEMOGRAPHIC GROUP	NON-KSI	KSI
Active transportation users (workers that use transit, walk, or bike to work)	25%	21%
Carless households (no vehicles available)	20%	20%
Disabled population	20%	24%
Educational level (less than High School)	27%	29%
Females	26%	24%
Housing cost-burdened households (spending 30% or more of income on housing/rent)	30%	29%
Limited English households	20%	18%
People of Color (non-white and/or Hispanic/Latinx)	29%	28%
Poverty	37%	35%
Renters vs. owners	37%	33%
Seniors (65+)	23%	22%
Unemployment rate	21%	23%
Youth (under 18)	19%	20%

Note: Reported percentages represent overlapping census block groups and do not add up to 100%.

Table 8 - Collision Rates in Vulnerable Areas, by Mode and Injury

		MINOR INJURY			FATAL OR SERIOUS INJURY			
	TOTAL AREA (SQ. MI)	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST	ALL COLLISIONS
Non-Vulnerable Area	396.1	62.6	2.1	0.6	4.0	0.6	0.1	69.9
Vulnerable Area	88.1	127.7	6.0	1.5	7.8	1.6	0.2	144.7
Highly Vulnerable Area	41.8	225.8	8.7	1.6	13.6	4.6	0.3	254.6
All	525.9	86.4	3.3	0.8	5.4	1.1	0.1	97.1

Trip Destinations by Income

Data from Replica Places contains information on trip endpoints for users by household income. This data provides an estimate of not only where low-income populations live, but also where they travel to in order to understand if there are any significant collision patterns. **53% of pedestrian collisions occurred in the highest percentile of low-income trip-ends per square mile.**

Table 9 - Low-Income Trip Destinations, by Mode and Injury

	MINOR INJURY			FATAL OR SERIOUS INJURY			
TRIPS PER SQUARE MILE	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST	ALL COLLISIONS
Low (least low-income trips)	15%	4%	9%	22%	4%	16%	15%
Low-Moderate	16%	8%	6%	19%	9%	10%	16%
Moderate	21%	15%	13%	19%	20%	19%	21%
High-Moderate	24%	20%	23%	22%	27%	23%	24%
High (most low-income trips)	24%	53%	49%	18%	41%	32%	24%

Notes:

- *Reported percentages are rounded and may not total to 100%.*
- *The breakpoints for each of the categories is based on quantile splits.*
- *This chart is based on Replica Places data that is filtered to trips made by households with an annual income less than $25,000; the data shows where low-income people are traveling to at the block group level.*
- *Replica Places is a data product provided by Sidewalk Labs spin-off Replica. Replica Places is an activity-based model developed off a combination of mobile, land use, census, and transaction data to generate census-block level OD estimates that can be used to estimate trip distances and understand common origins-destinations. Their data also provides estimates of mode split and trip purpose based on their synthetic populations that are created as part of their estimation process.*

Collisions by Driver Behavior

Examining the reported crash types revealed that the majority of collisions were considered angled collisions. Bicyclist and pedestrian collisions are all reported under the "No collision with vehicle" category, limiting further analysis on possible collision types for these modes.

Table 10 - Manner of Collision of Motorist-only Collisions, by Mode and Severity

MANNER OF COLLISION	MINOR INJURY	FATAL OR SERIOUS INJURY	ALL COLLISIONS
Angle	35%	34%	35%
Head-on	5%	14%	5%
No Collision with Vehicle	14%	29%	15%
Rear to Rear	0%	0%	0%
Rear to Side	0%	0%	0%
Rear-end	38%	17%	36%
Sideswipe, Opposite Direction	2%	2%	2%
Sideswipe, Same Direction	5%	3%	5%
Other	1%	1%	1%
Unknown	0%	1%	0%

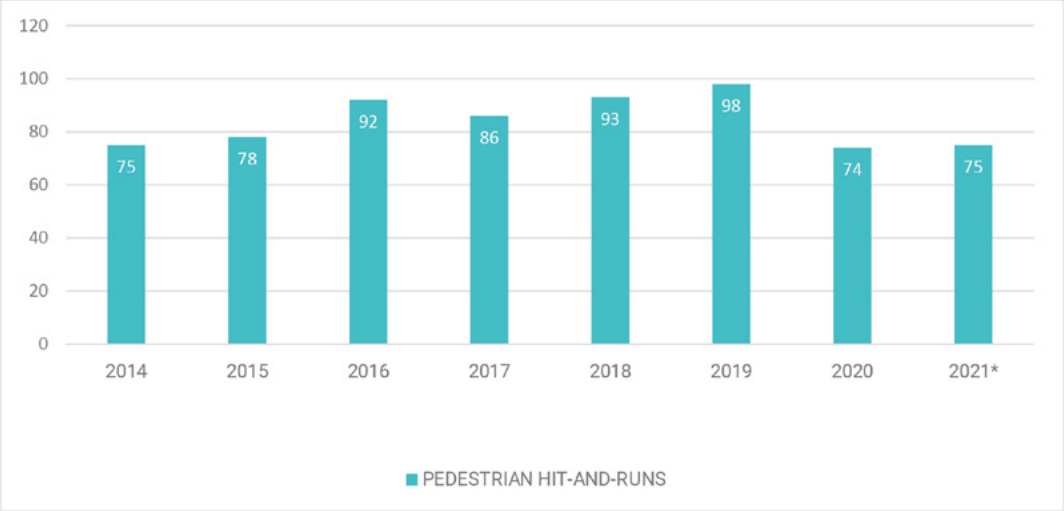
Note: Reported percentages are rounded and may not total to 100%. All Bicycle and Pedestrian Collisions are listed as 'No collision with vehicle' in E-Trims.

Hit-and-Run Collisions

HIT-AND-RUN COLLISIONS BY YEAR, SEVERITY, AND MODE

In comparison to previous years, the number of pedestrian-involved hit-and-run collisions is up significantly in 2021. 2021 has seen 74 pedestrian-involved hit-and-runs as of the end of August. In just 8 months, this is already higher than the total pedestrian hit-and-runs in 2020. **39% of pedestrian hit-and-run collisions occur within the most highly vulnerable areas.**

Figure 8 - Hit-and-Runs Involving Pedestrians Yearly Trends



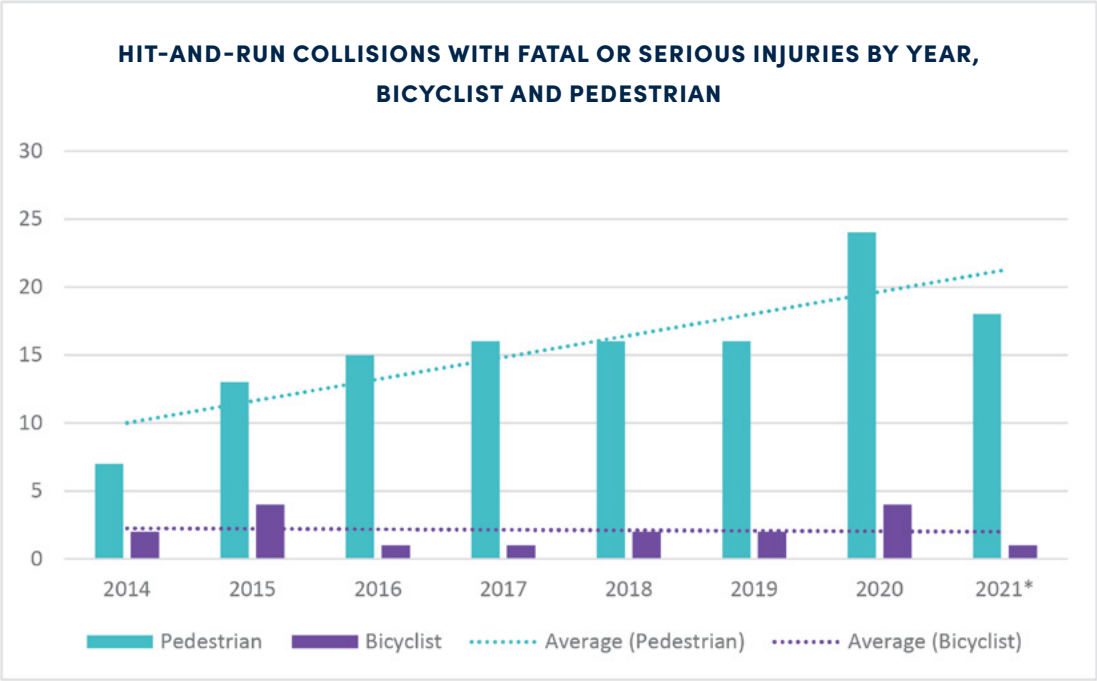
**2021 data includes data through August, 2021*

Table 11 - Share of Hit-and-Run Collisions, by Mode

YEAR	PERCENT OF ALL COLLISIONS THAT WERE HIT AND RUN	PERCENT OF TOTAL PEDESTRIAN COLLISIONS THAT WERE A HIT AND RUN	PERCENT OF TOTAL BICYCLIST COLLISIONS THAT WERE A HIT AND RUN
2014	9%	30%	14%
2015	10%	26%	26%
2016	11%	29%	17%
2017	10%	27%	14%
2018	12%	28%	17%
2019	11%	28%	28%
2020	15%	29%	16%
2021*	11%	31%	19%

**2021 data includes data through August, 2021*
Note: Reported percentages are rounded and may not total to 100%.

Figure 9 – Pedestrian Hit-and-Run Collisions that Result in a Fatal or Serious Injury

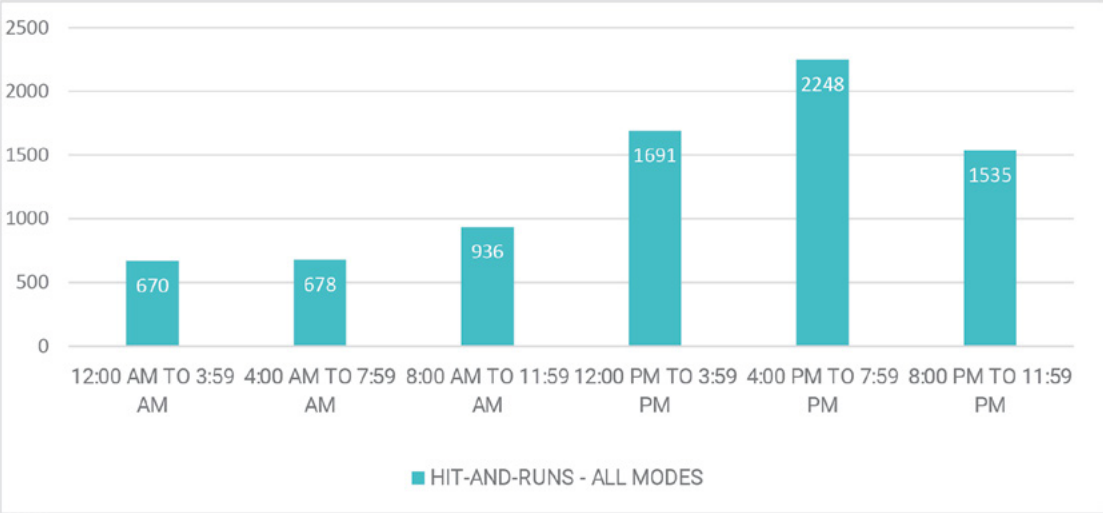


**2021 data includes data through August, 2021*

PEDESTRIAN HIT-AND-RUN COLLISIONS, BY DAYLIGHT VS. DARK CONDITIONS

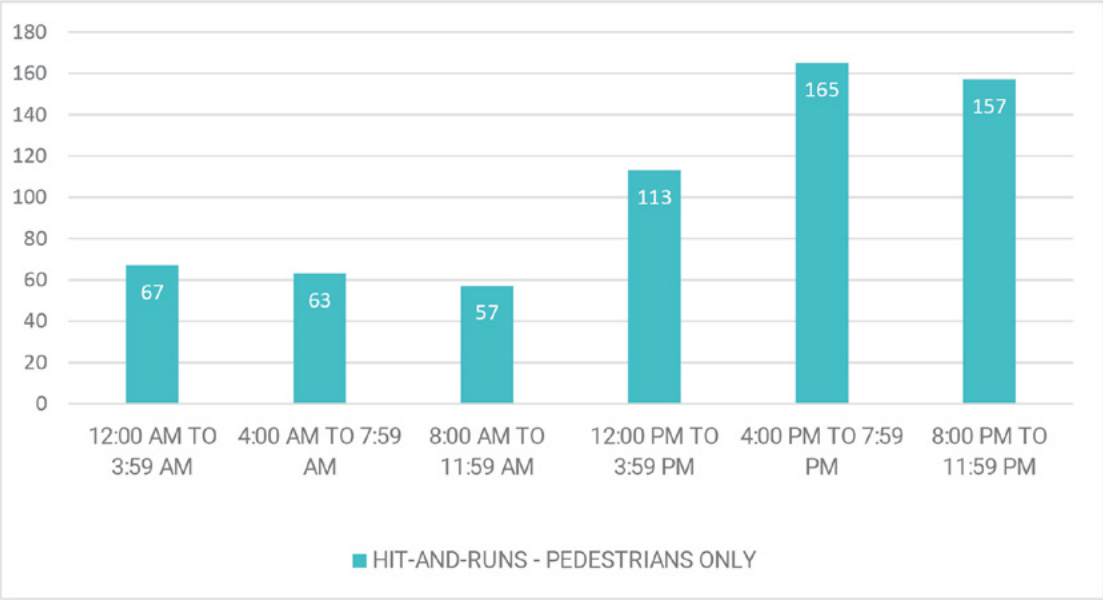
52% of pedestrian hit-and-run collisions occur during dark conditions. The majority of pedestrian collisions occurred during dark-lighted conditions, which refer to collisions that occur at night but with some source of lighting nearby, usually street lighting.

Figure 10 – Hit-and-Runs by Time of Day: All Modes



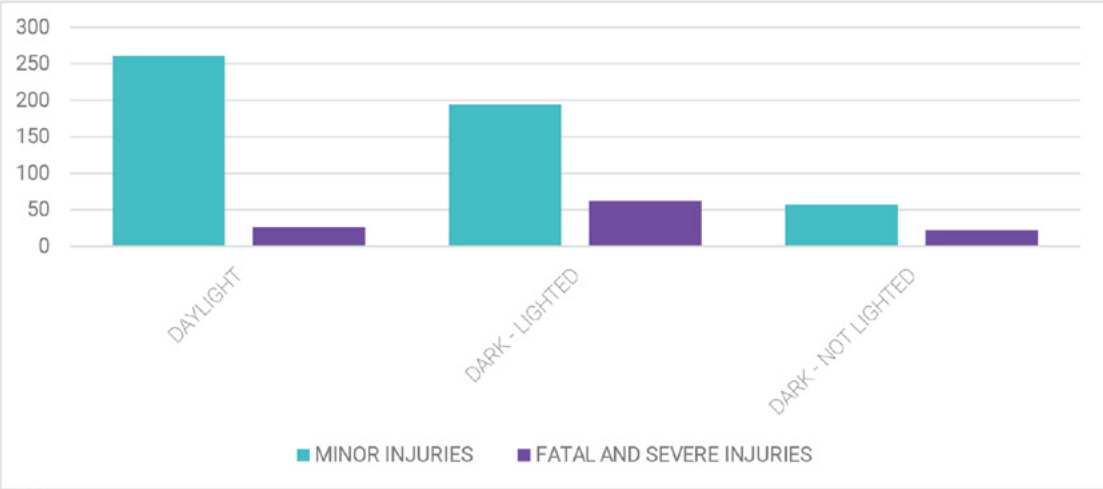
Note: 484 of 8,242 collisions were missing time information.

Figure 11 – Hit-and-Runs by Time of Day: Pedestrian Only



Note: 66 out of 688 collisions were missing time information

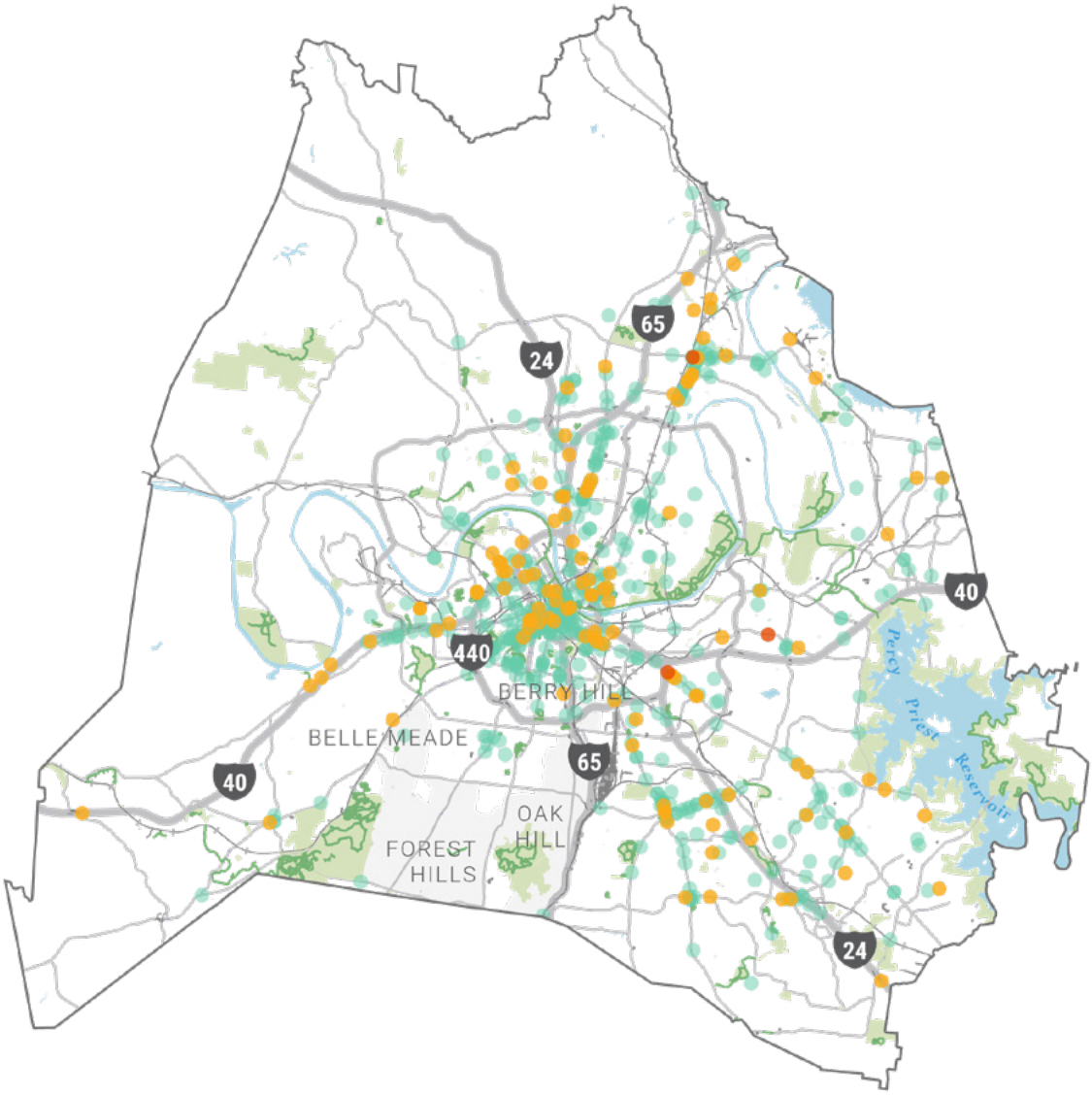
Figure 12 - Lighting Conditions of Pedestrian Hit-and-Run Collisions by Severity



Note:

- *66 out of 688 collisions were missing time information*
- *Dark-Lighted is when either street lights or pedestrian scale lighting is present along the roadway. Dark-Not Lighted is when there is no illumination present along the roadway.*

Map 5 - Pedestrian-Involved Hit-and-Run Collisions



PEDESTRIAN INVOLVED HIT-AND-RUNS

High Risk Facilities

The characteristics of roadways and land use that correlate with high-crash rates are roadways with the highest speeds and highest traffic volumes. The most dangerous roads in Nashville are arterial roadways, and roadways with posted speed limits of 40 miles per hour or greater when looking by roadway mile. 27% of all collisions occur at an intersection, and **41% of bicyclist-involved collisions are associated with an intersection.** Land use also plays a role: as compared to the overall county land use mix, collisions happen at disproportionately high rates in commercial areas.

Collisions in Commercial Corridors

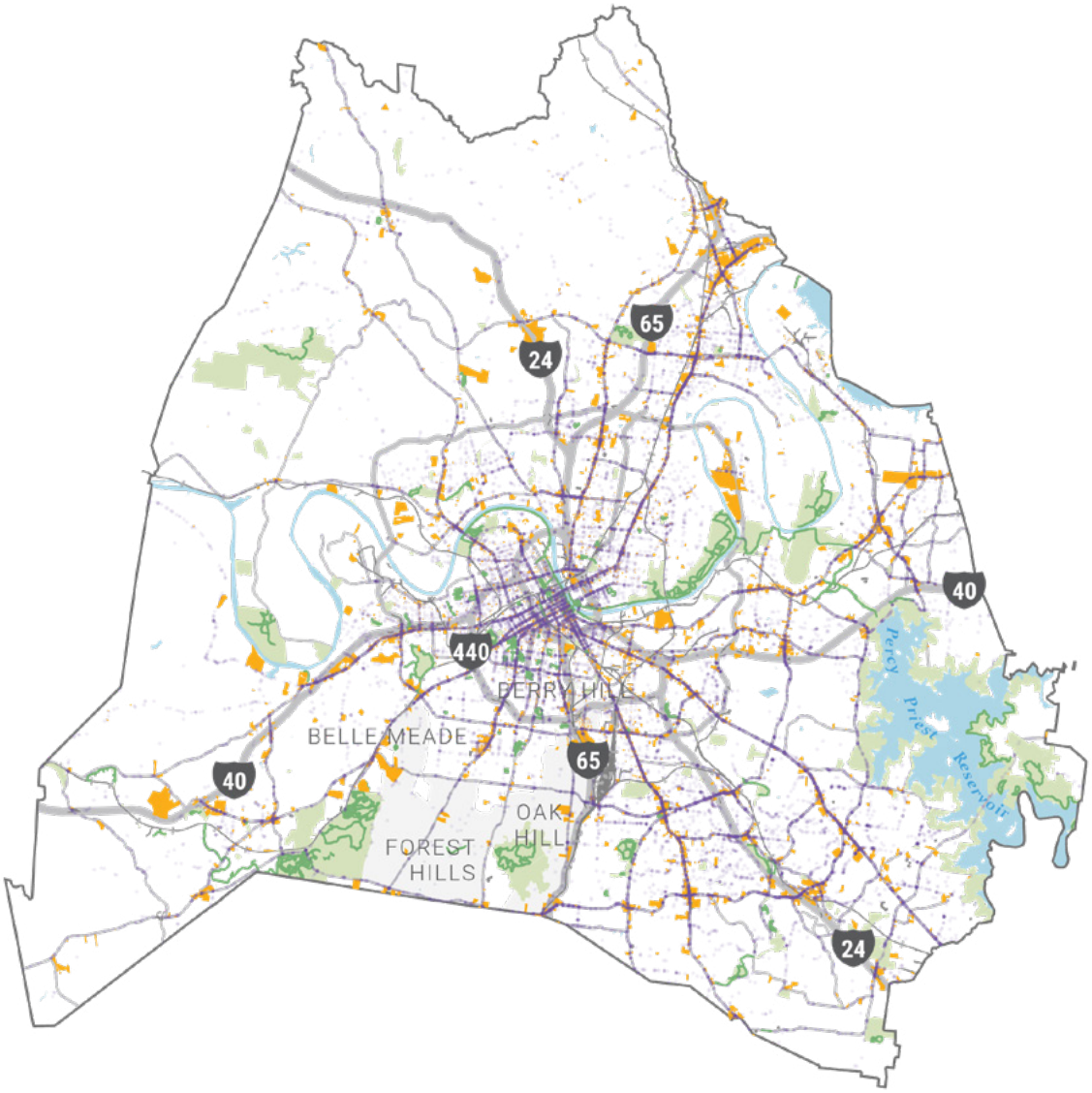
The analysis revealed a connection between land use and collision frequency. **Parcels with commercial land uses represent just 4% of the total land use type, but make up, on average, 22% of all parcels within 500' of all collisions.**

Table 12 - Land Use Mix Within 500' of Collisions, by Injury and Mode

	MINOR INJURY			FATAL OR SERIOUS INJURY				
LAND USE TYPE	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST	ALL COLLISIONS	PERCENT OF TOTAL LAND USE TYPE
Commercial	22%	23%	18%	20%	28%	18%	22%	4%
Single Family	20%	13%	19%	23%	14%	29%	20%	47%
Multifamily	13%	16%	13%	12%	16%	14%	14%	6%
Office	12%	19%	17%	9%	12%	15%	12%	4%
Industrial	10%	10%	10%	9%	11%	8%	10%	5%
Parks and Open Space	18%	14%	18%	20%	15%	13%	18%	30%
Other/ Unknown	5%	6%	5%	6%	4%	3%	5%	4%

Note: Reported percentages are rounded and may not total to 100%.

Map 6 – All Collisions in Nashville, Shown with Commercial Land Use Highlighted.



COLLISIONS AND COMMERCIAL CORRIDORS

Collisions Near High-Frequency Transit

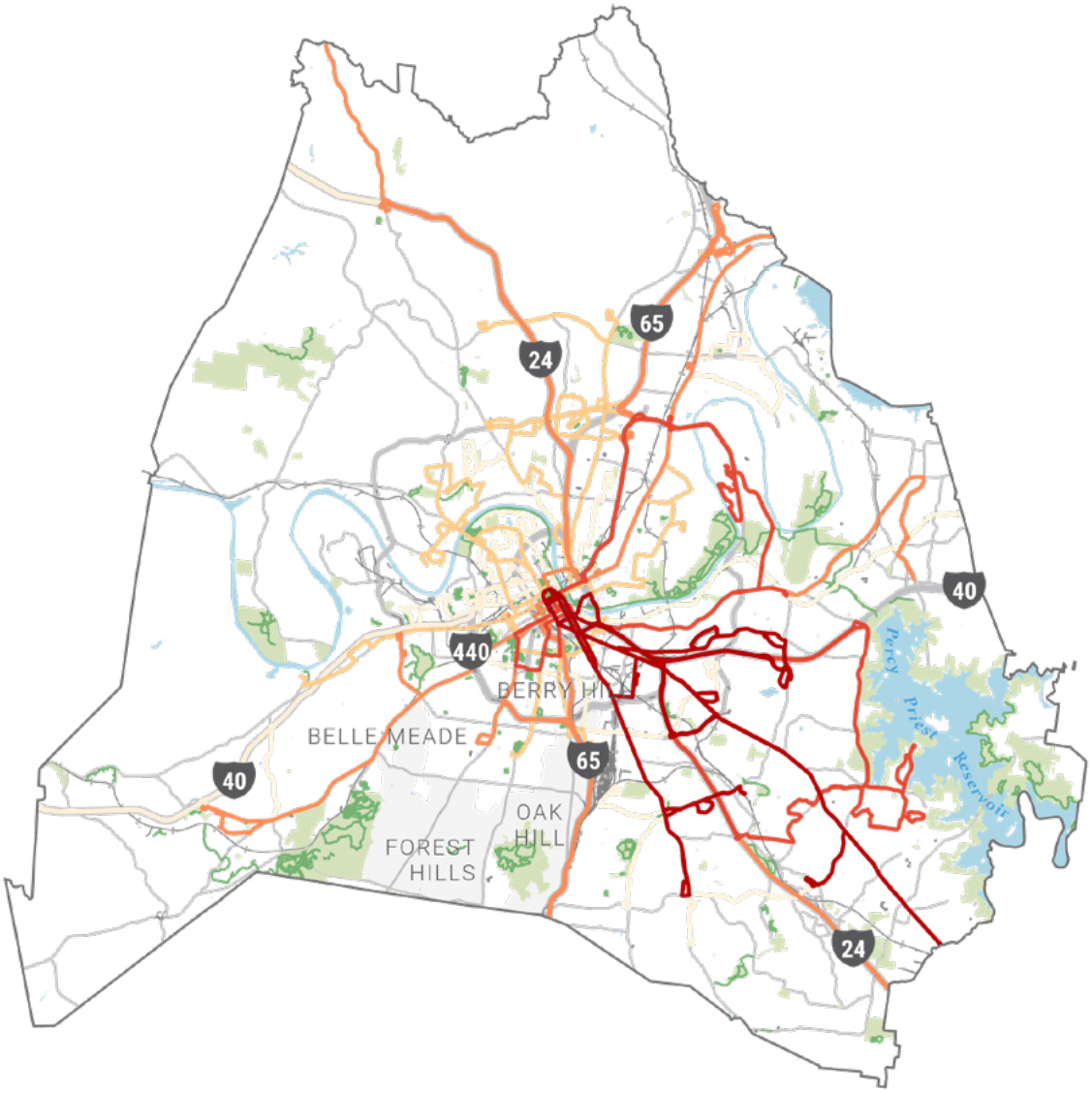
Nearly half of all collisions in Nashville occur within 500 feet of a high-frequency transit stop. **For fatal and serious injury pedestrian collisions, 60% occur within 500 feet of a high-frequency stop compared to just 33% for vehicle-only fatal and serious injury collisions.** High frequency transit stops are defined as stops with a 15-minute headway during peak morning commuting hours (6:00 am – 9:00 am).

Table 13 - Distance to Frequent Transit Stop from Each Collision, by Injury and Mode

	MINOR INJURY			FATAL OR SERIOUS INJURY			
DISTANCE	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST	ALL COLLISIONS
Less than 500'	40%	65%	53%	33%	60%	52%	48%
500' to 1000'	15%	16%	20%	14%	17%	18%	17%
Greater than 1000'	45%	20%	27%	54%	23%	31%	35%

Note: Reported percentages are rounded and may not total to 100%.

Map 7 – Pedestrian-Involved Collisions Less Than 500' From a High Frequency Transit Route



TRANSIT ROUTES WITH THE MOST PEDESTRIAN COLLISIONS

(WITHIN 500 FEET)

Table 14 – Transit Routes with the Highest Frequency of Pedestrian Collisions within 500 Feet

ROUTE NAME	ORGANIZATION	PEDESTRIAN COLLISIONS
Nolensville Pike	MTA	403
Murfreesboro Pike	MTA	388
Nashville-Murfreesboro	MTA/RTA	360
Airport	MTA	333
Star West End Shuttle	MTA/RTA	290
Antioch	MTA	288
Opry Mills	MTA	251
Gallatin Pike	MTA	249
Springfield	RTA	242
Franklin Express	RTA	240

Collisions by Roadway Classification

Collisions across modes were significantly more likely to occur on arterial roadways. This is likely due to the greater traffic volumes and higher speeds associated with these roadways. Arterial roadways make up 12% of Nashville's road network (excluding federally controlled freeways), demonstrating that these roads are more dangerous to travel on.

Table 15 – Road Classification of Collisions, by Injury and Mode

	MINOR INJURY			FATAL OR SERIOUS INJURY			
ROAD CONTEXT	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST	ALL COLLISIONS
Arterial	54%	59%	52%	50%	65%	61%	65%
Major Collector	15%	11%	19%	16%	11%	13%	14%
Minor Collector	31%	29%	28%	33%	22%	26%	20%
Local	1%	1%	0%	1%	1%	0%	0%

Note: Reported percentages are rounded and may not total to 100%.

Collisions by Roadway Context

Many collisions are occurring at intersections, and the trend is particularly strong for bicyclists. **41% of bicyclist involved collisions resulting in a minor injury happen at an intersection.** Yet, for pedestrians, the majority of fatal and serious injury collisions are occurring at midblock locations.

Table 16 - Road context of Collisions, by Injury and Mode

	MINOR INJURY			FATAL OR SERIOUS INJURY			
ROAD CONTEXT	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST	ALL COLLISIONS
Accel/deceleration Lane	0%	0%	0%	0%	0%	0%	0%
Crossover related	0%	0%	0%	0%	0%	2%	0%
Driveway, alley access, etc.	2%	1%	6%	1%	2%	2%	2%
Entrance/exit ramp related	3%	1%	0%	3%	1%	3%	3%
Intersection	27%	32%	41%	28%	22%	35%	27%
Intersection related	9%	10%	11%	5%	5%	5%	9%
Non-junction	58%	53%	41%	62%	70%	52%	58%
Rail grade crossing	0%	0%	0%	0%	0%	0%	0%
Shared use path or trail	0%	0%	0%	0%	0%	0%	0%
Other/unknown	1%	3%	1%	1%	1%	2%	1%

Note: Reported percentages are rounded and may not total to 100%.

Collisions On High-Speed Roads

When analyzing collision rates per mile, roads with higher posted speed limits have higher collision frequencies. **Focusing on the 5 mph increase in speed from 30 to 35 mph, all modes and all severities show three- to six-fold increases in collision rates.** Though Nashville recently decreased residential speed limits from 30 mph to 25 mph, this analysis assumed residential speed limits of 30 mph because the majority of collision data was collected prior to the policy change went into effect.

Table 17 - Collisions per Mile by Posted Speed Limit, by Injury and Mode

		MINOR INJURY			FATAL OR SERIOUS INJURY			
TOTAL LENGTH	SPEED LIMIT	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST	ALL COLLISIONS
4.0	15 mph	22.3	0	0	0.8	0	0	23.0
4.2	20 mph	6.2	1.19	0.2	0.7	0.5	0	8.8
6.9	25 mph	2.5	0	0	0.1	0	0	2.6
2,993.3	30 mph	4.6	0.3	0.07	0.3	0.1	0.01	5.4
224.0	35 mph	28.2	1.07	0.3	1.5	0.3	0.1	31.4
489.9	40+ mph	47.6	1.1	0.3	3.2	0.6	0.1	52.8
3,722.3	All	11.7	0.5	0.1	0.7	0.2	0.1	13.2

Collisions by Traffic Control Device

Breaking down the collisions that occurred within 50 feet of an intersection found that there is a nearly equal share of collisions at non-signalized intersections as there are signalized intersections.

Table 18 - Traffic Control Device at Collisions, by Injury and Mode

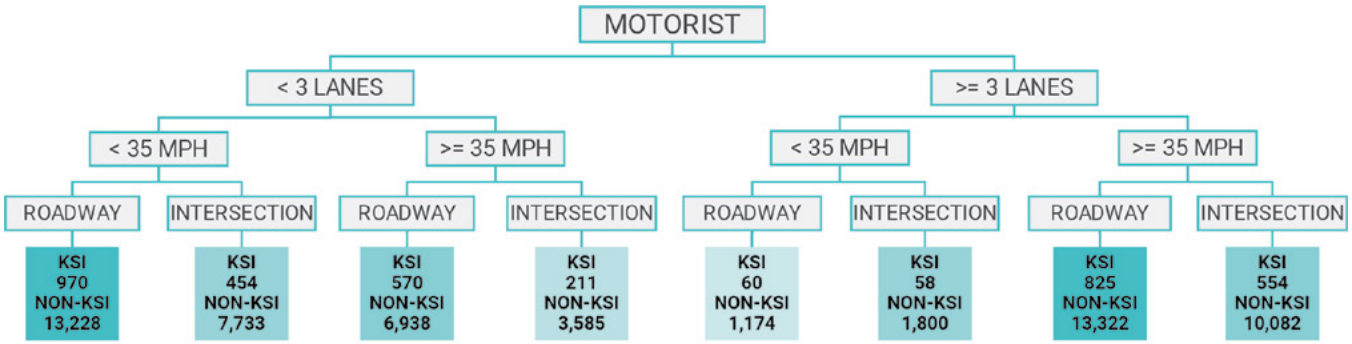
		MINOR INJURY			FATAL OR SERIOUS INJURY			
TRAFFIC CONTROL	INTER SECTION TYPE	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST	ALL COLLISIONS
Not at Intersection	N/A	50%	42%	33%	57%	58%	45%	50%
Within 50' of Intersection	Non-signalized	23%	25%	35%	22%	20%	29%	23%
	Signalized	26%	34%	31%	21%	22%	26%	26%

Predictive Roadway Characteristics

Crash Trees by Mode

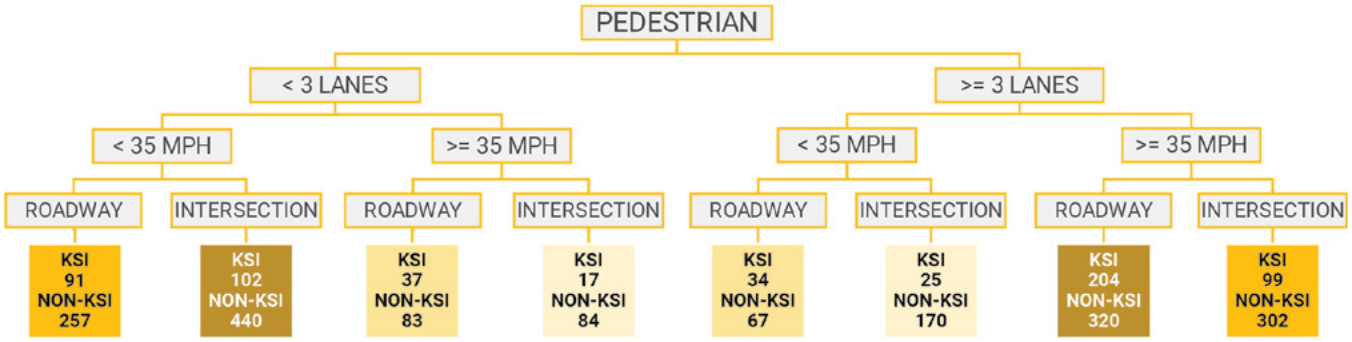
The crash trees below categorize collisions based on the shared characteristics of the roadways they occurred on. Roadway characteristic collisions were categorized by number of lanes, posted speed limit, and whether the collision occurred along a roadway segment or at an intersection. While factors identified in the executive summary above, such as land use and proximity to high-frequency transit stops, were found to be associated with collisions, this predictive model focuses solely on roadway characteristics. **The crash trees utilize the abbreviation KSI to represent collisions where a person was killed or seriously injured.** "Non-KSI" refers to collisions that resulted in minor injury.

Figure 13 - Crash Tree of Motorist-Involved Collisions



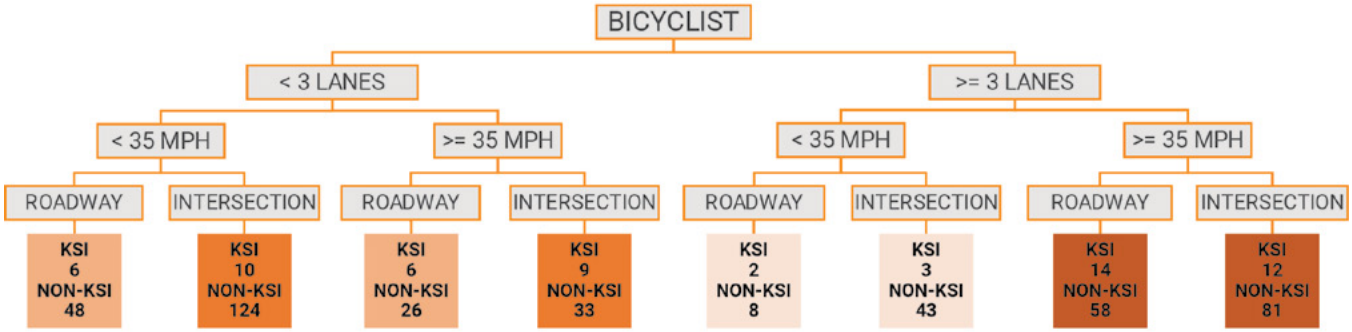
Roads with three or more lanes and speed limits of 35 mph or greater are among the most unsafe for pedestrians. Furthermore, many of Nashville's high-frequency transit stops are along such roadways, which can create conflicts between motorists and the transit riders who board and disembark at these stops, contributing to the 60% of fatal and serious injury pedestrian collisions that occur within 500 feet of a high-frequency transit stop.

Figure 14 - Crash Tree of Pedestrian-Involved Collisions



For all speed and lane configurations, most bicyclist collisions occur at intersections. Roads with three or more lanes and 35 mph or greater speed limits are the most dangerous for bicyclists

Figure 15 - Crash Tree of Bicyclist-Involved Collisions



Fatal + Serious Injury Predictive Indicators

As transportation safety practice has progressed, more emphasis is being placed on proactive approaches to identifying safety improvements based on the identification of facilities that have similar characteristics to high collision locations. Often, predictive models called safety performance functions, are developed that use information about roadway geometry and operations (volumes) to estimate the frequency of crashes per year. While safety performance functions were not created as part of this systemic safety analysis, an exploratory analysis using random forest regression modeling was used to identify potential characteristics that are "predictive" of fatal or severe injury collisions per road segment[1]. The following highlight the key findings of the predictive model:

- When considering all fatal or severe injury collisions, AADT, number of lanes, and speed limit were the most important variables.
- Filtered to just predict motorist involved fatal or severe injury collisions, the posted speed limit increases in importance, while AADT decreases, and number of lanes remains about the same.
- When considering only pedestrian fatal or severe injury collisions, traffic volume is the most important variable, followed by the number of lanes, and the fraction of commercial land use within 500' of the collision location.

Due to sample size limitations, random forest regression is not suitable for predicting bicyclist fatal or severe injury collisions.

Table 19 – Predictive Indicators of Fatal or Severe Injury Collisions per segment for All Modes

VARIABLE	IMPORTANCE
Traffic Volume (AADT)	0.39
Speed Limit	0.33
Number of Travel Lanes	0.14
Local Commercial Land Use Density	0.08
Shoulder Width	0.05
Local Job Density	0.01
Lane Width	0.01
Local Population Density	0.01

[1] *Alta developed multiple models looking at predictions of collisions per segment and collisions per mile. The example here focuses on collisions per segment as models looking at collision per mile seemed to be sensitive to outliers and produced non-intuitive results. Earlier work on the study network was done to normalize segmentation so that segments were roughly one mile long, but not all segments were that length. These model results illustrated the importance of road geometry and speeds consistent with our tabulations and analysis of collision trends.*

Appendix 1

Methodology

The data used in the collision analysis was provided by the Tennessee Department of Transportation, through their E-Trims digital platform, queried to include all collisions resulting in injury that occurred in Davidson County between January 2014 and August 2021. Special queries identified hit-and-run collisions and collisions involving alcohol during the same time period. Alta combined street centerline data from Nashville Metro and Greater Nashville Regional Council (GNRC) to produce a single, consolidated street network identifying local road characteristics for each collision.

IDENTIFYING COLLISION ATTRIBUTES

Collision data pulled directly from E-Trims contains several useful attributes for crash analysis, which Alta supplemented with other provided data sources. A summary of crash-level attributes and their sources is provided in Table 1.

Table 20 - Crash Attributes and their Data Sources

CRASH ATTRIBUTE	SOURCE	EXAMPLE VALUE(S)
Location on Road	Collision report pulled from E-Trims	Acceleration/Deceleration lane, driveway, intersection related
Time of Day	Collision report pulled from E-Trims	1400 (2:00 pm)
First Harmful Event	Collision report pulled from E-Trims	Vehicle in transport, pedestrian, other object
Manner of Collision	Collision report pulled from E-Trims	Rear-end, head-on, sideswipe
Weather Conditions	Collision report pulled from E-Trims	Rain, cloudy, clear
Lighting Conditions	Collision report pulled from E-Trims	Daylight, dark – not lighted, dark – lighted
Proximity to Frequent Transit Stop	Near analysis in ArcGIS to find closest high frequency transit stop*	1000 feet
Proximity to any Transit Stop	Near analysis in ArcGIS to find closest transit stop	1000 feet
At Intersection	Near analysis to provided intersection points, limited to 50' search radius	1 (collision within 50' of an intersection), 0 (not within 50' of an intersection)
Intersection Type	Near analysis to provided signalized intersection points, limited to 50' search radius	1 (signalized), 0 (non-signalized)
Council District	Spatial join to provided council district boundaries	District 25
Vulnerable Area Status	Spatial join to Davidson County vulnerability index	Non-vulnerable area, vulnerable area, highly vulnerable area

IDENTIFYING ROADWAY ATTRIBUTES

A centerline file data provided by GNRC included several road characteristics like posted speed limit, number of lanes, and traffic volumes. However, this road network did not include most local and residential roads, which were merged from the Nashville Metro provided centerline data set. The inclusion of local roads from another dataset meant that the residential streets had fewer attributes relative to the GNRC data. In cases where residential were missing important road attributes their missing values were filled with the following assumptions, informed by road design standards and expert judgment. All road attributes are summarized in Table 2.

Table 21 - Road Attributes and their Data Sources

CRASH ATTRIBUTE	SOURCE	EXAMPLE VALUE(S)
One-Way	GNRC, local roads assumed to be two-way	1 (one-way street), 0 (two-way street)
Bikeway Status	Spatial join of provided bike network data	No facility, current facility, future facility
Bikeway Type	Spatial join of provided bike network data	PBL, BL, SSR
Sidewalk Presence	Spatial join of provided sidewalk data	0 (no sidewalk), 1 (sidewalk on one side), 2 (sidewalk on both sides)
Number of Travel Lanes	GNRC, local roads assumed to be two lanes	4 lanes
Speed Limit	GNRC, local roads assumed to be 30 mph*	35 mph
Lane Width	GNRC, local roads assumed to have 12' lanes	10 feet
Shoulder Width	GNRC, local roads assumed to have 8' parking lane shoulders	2 feet
Traffic Volume (AADT)	GNRC, local roads assumed to have AADT of 2400 vehicles/day	2400 vehicles/day
Surrounding Land Use	Fraction of land use types in area within 500' of each road segment, from provided property data	25% commercial, 10% multifamily, 10% office
Median Income	Maximum median income of all Census tracts within 500' of each road segment**	$60,000
Percent White	Maximum fraction of population that identifies as white in all Census tracts within 500' of each road segment**	35%
Population Density	Maximum population density of all Census tracts within 500' of each road segment**	4000 people/square mile
Job Density	Maximum job density of all Census blocks within 500' of each road segment***	1000 jobs/square mile

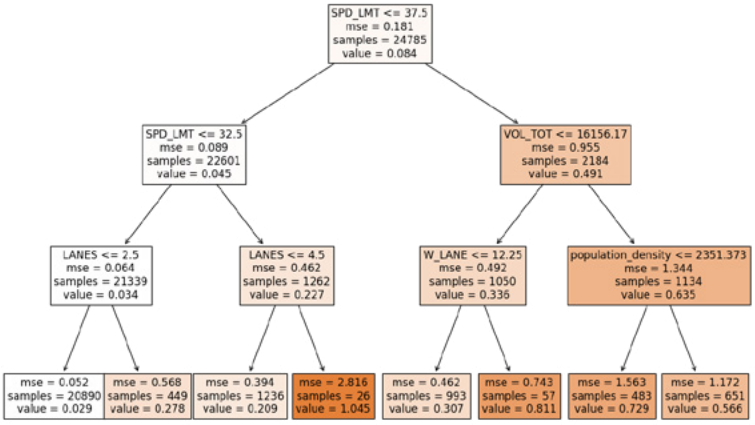
**Nashville residential speed limits were lowered to 25 mph beginning in March 2021, but because the majority of collision data is from before that policy change, we assumed the speed limit to be 30 mph.*
***Census data from 2019 ACS, reported at the Census block group level.*
****Jobs data from 2018 LEHD LODES, reported at the Census tract level.*

Random Forest Road Attribute Selection

Using the populated roadway characteristics table, Alta staff created a random forest regression model to investigate which variables are most important in predicting the number of KSI collisions per road segment. The regression included eight total variables and after a grid search model parameter optimization process, three variables rose to the top as the most important predictors of KSI collisions of all modes: (1) number of lanes, (2) posted speed limit, and (3) AADT. These variables remained important when considering motorist involved KSI collisions. AADT and number of lanes also stand out as important variables in the case of pedestrian involved KSI collisions, along with the fraction of commercial land use within 500' of the road segment.

Random forest regression builds many decision trees with a subset of the input variables, all trained on historic KSI collision data with the goal of identifying combinations of underlying roadway characteristics that are common to these dangerous crashes. This ensemble method relies on strength in numbers by averaging predictions across 100 models rather than relying on a single model.

Figure 16 – Sample of a Decision Tree Underlying the Random Forest Regression Model



Data Limitations

The following limitations were identified in the collision data:

- The systematic safety analysis is derived from collision data collected on the scene of an incident. Collisions are hand-recorded by law-enforcement officers at the scene of the incident. Factors related to human error may yield incomplete or inaccurate results.
- All of the data recorded on the police report at the scene of the incident isn't available within the E-Trims data platform maintained by TDOT. Once a police report is filed, it's then collected and entered into the TITAN data platform, managed by the Department of Safety. E-Trims pulls data directly from TITAN but in a different format, resulting in some loss of data – such as victim age, race, gender, etc.
- Collision data is recorded by incident only, not by the number of people involved. Because of this, there's limited data available for every person involved in the collision.
- There is no "cause of collision" field within the E-TRIMS data. In addition, the "crash type" field contains limited types and only relate to motorist-involved collisions.
- The low reported alcohol involved figures, 3% of motorist collisions and 1% of pedestrian collisions, indicate that there may be an issue in the incident reporting.
- While bicycle and pedestrian involved collisions featured other attributes associated with the collision, all pedestrian and bicyclist collisions examined did not have a listed "crash type" attribute. Rather, bicycle and pedestrian crash types were characterized as "not a collision with a motor vehicle". This is an unfortunate omission as it limits our ability to understand potential contributing behavior to a bicycle or pedestrian collision (such as a left turn, rear-end, or head-on collisions).
- AADT data provides the ability to measure collision rates (the number of collisions per average traffic volume). Bicyclist and Pedestrian volumes are not captured by AADT, meaning there is limited ability to determine the number of collisions by pedestrian or bicyclist traffic volume.
- If the driver of a hit-and-run collisions is identified after time of the incident, the original police report is often not updated – limiting the amount of data available as to the cause or conviction of the hit-and-run collision.

In addition, the collision data collected does not count for unreported incidents and near misses. A 2021 public survey conducted by Alta in support of the Nashville Vision Zero Action Plan found that 19% of respondents (318 respondents) stated they were involved in an unreported crash or near miss involving a bicyclist or pedestrian, much higher than the percentage that stated they were involved in a reported crash. Gathering traffic collision data through medical reports, 911 dispatch logs, or the original police reports could shed light on unreported incidents involving a pedestrian or bicyclist.

BICYCLIST KILLED AND SERIOUSLY INJURED COLLISIONS

Over the study period from 2014-2021, there were 483 bicyclist collisions involving a minor injury. Among these collisions, 61 were serious injuries and 1 was fatal. With such a small sample size, it is difficult to identify data trends.

PEOPLE EXPERIENCING HOMELESSNESS

People experience homelessness in a multitude of ways. Unsheltered homelessness is typically only a small percentage of the total unhoused population. It is very challenging for municipalities to collect location data on people experiencing unsheltered homelessness. Furthermore, the public use of this data could be used to target, profile, or harass unhoused individuals. As a result of missing geospatial data, Alta was unable to incorporate the effect of traffic collisions on people experiencing homelessness.

Additional research could be conducted using medical records from area hospitals or the Davidson County medical examiner. Journalists in Austin, Texas examined the cause of death where an individual was marked as "transient" in the medical death report, finding 14% of all fatalities among this population were connected to traffic collisions.

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Appendix 2: High Injury Network

Executive Summary

Vision Zero asserts that traffic injuries and fatalities are preventable. High injury networks illustrate that often a small number of improvable roadways can address the majority of injury-causing collisions. This approach moves beyond typical crash history, and allows for a better understanding of the types of roadways in Davidson County where users are most at risk. High injury networks focus primarily on roadways and intersections with the highest potential for harm. Therefore, a greater emphasis is placed on collisions that result in a severe injury or fatality than collisions that involve a minor injury or no injury. Collisions involving a fatality or severe injury are commonly referred to as KSI (killed or severely injured) collisions.

- The roadways identified in the composite HIN comprise **59% of collisions** where a person is killed or severely injured and **61% of total collisions** on just **6% of the roadway miles.**
- The pedestrian only HIN captures **60% of collisions** where a person walking is killed or severely injured in traffic on just **2% of the roadway miles.**
- The bicyclist only HIN captures **50% of collisions** where a person biking is killed or severely injured in traffic on less than **1% of the roadway miles.**
- The motorist only HIN captures **40% of collisions** where a person driving is killed or severely injured on **3.5% of the roadway miles.**

Collecting and analyzing this data also illuminates the disproportionate impacts of traffic violence on certain populations. **53% of the total high injury network miles fall within identified highly vulnerable areas.** This sobering statistic points to a larger problem of inequity in the built environment.

Addressing road facilities and characteristics also can have an impact in reducing collisions. The majority of collisions along the high injury network have a speed limit of 40 miles per hour or higher. Additionally, protecting transit users, particularly those who rely on transit to access essential services such as work or healthcare is vitally important. **For pedestrian-involved collisions, 81% of minor injuries and 73% of serious and fatal injuries occurred within 500 feet of a transit stop.**

Finally, Vision Zero requires a multi-agency approach and strong collaboration and leadership. **This is particularly important when considering that 46% of the high injury network is located on TDOT-controlled roadways.**

Methodology

Collision Preparation

This collision analysis examines data from January 2014 through August 2021 for collisions that involved an injury or fatality. The data is inclusive of motor vehicle, bicyclist, pedestrian, and motorcycle collisions within Davidson County. The data used in the collision analysis was provided by the Tennessee Department of Transportation, through their E-Trims digital platform. Collision data was summarized along the roadway network. Alta removed federally-managed freeways, and on and off ramps, as well as any crashes associated with these facilities. Including freeways would significantly alter the HIN, given the high volume of vehicle miles traveled on these roads. In cases where collisions were within 50 ft. of another segment (intersections), the collisions were snapped to the facility with the highest functional classification for the purposes of HIN collision accumulation. Ultimately, this resulted in 48,460 total collisions considered in the analysis.

Collision Weighting

Collision points were weighted accounting for severity, vulnerable users, and equity. Following precedents from previous Vision Zero plans, weights were determined that were high enough to generate network prioritization metrics to emphasize fatal or severe collisions, but not ignore the risks implied by minor injury collisions patterns. A severity index is created when these collision weights are aggregated to segments and intersections to inform HIN generation and network screening. The following summarizes the methodology used to determine the scoring of each collision:

- **Severity Index**[1] - The severity weighting scheme is as follows:
  - Fatality = 15
  - Serious Injury = 5
  - Minor Injury = 0.5
- **Vulnerable Users** - Collisions involving pedestrians and bicyclists were weighted more than collisions only involving a motorist. Collisions involving bicyclists or pedestrians had their severity index multiplied by 1.5.
- **Equity** - Finally, collisions within a highly vulnerable area were multiplied by 2. Vulnerable areas were defined using the Greater Nashville Regional Council (GNRC) equity methodology (refer to Nashville Vision Zero Equity Analysis Technical Memo).

The final weighting index is determined by multiplying the severity index, the vulnerable users index, and the equity index. The highest possible score an individual collision can receive is 45 (15 multiplied by 1.5 multiplied by 2).

[1] *Severity weighting was informed by the FHWA safety manual (page 14) safety.fhwa.dot.gov/hsip/docs/fhwasa17071.pdf.*

Centerline Network Preparation

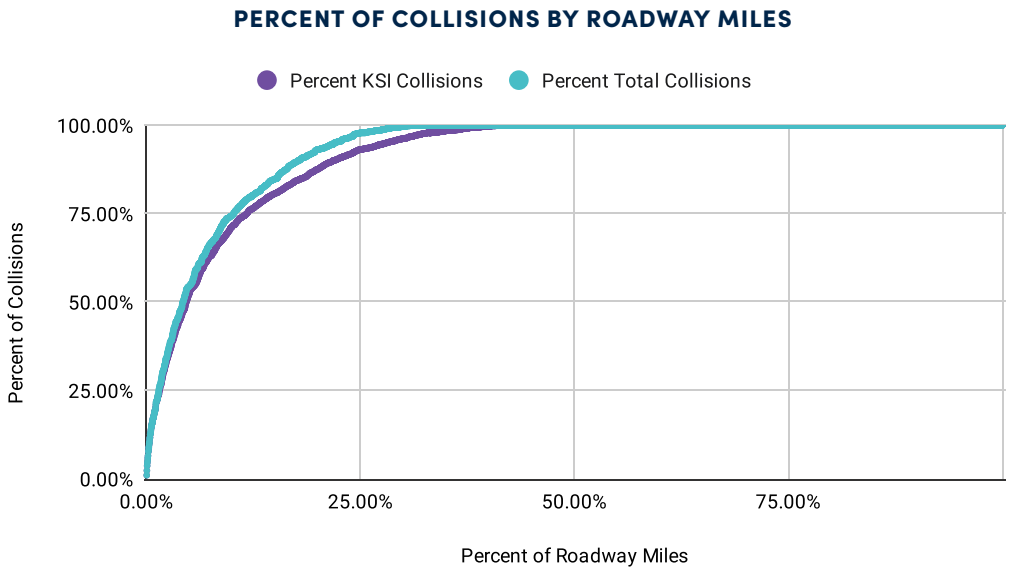
Alta prepared a centerline file for analysis by ensuring that dual-carriage ways were consolidated. Additionally, Alta removed federally-managed freeways and on/off ramps. Contextual attributes such as speed limits, lane width, road ownership, council district, and the presence of bikeways and sidewalks were added to the centerline network to aid in analysis of characteristics of identified high injury network segments. To capture segments that more closely conform to the general understanding of a street, the centerline segments were dissolved into non-multipart segments containing the same "Full Name" attribute. The segment lengths were normalized to be approximately the same length, at 1-mile segments.

High Injury Network Determinations

Alta conducted two spatial joins of the weighted collision points to the centerline network. The first join associated all collisions within 50 ft. of prepared network segments so that the segment based weighted severity index could be determined for every segment. This index would reflect not only collisions directly on segments, but those within its sphere of influence at intersections. The second join associated all collisions directly on the network to the centerline network. These collisions were used for the purposes of accumulating KSI collisions associated with the draft HIN, (i.e. how many collisions are captured by high injury network streets). These "accumulation collisions" were checked to ensure no collision points were double counted. The length in miles for each segment was calculated and added to the network, but to mitigate the influence of sliver segments, the minimum length of each segment was assumed to be 0.25 miles. The final HIN severity index was determined by dividing the weighted collisions by the calculated length in miles.

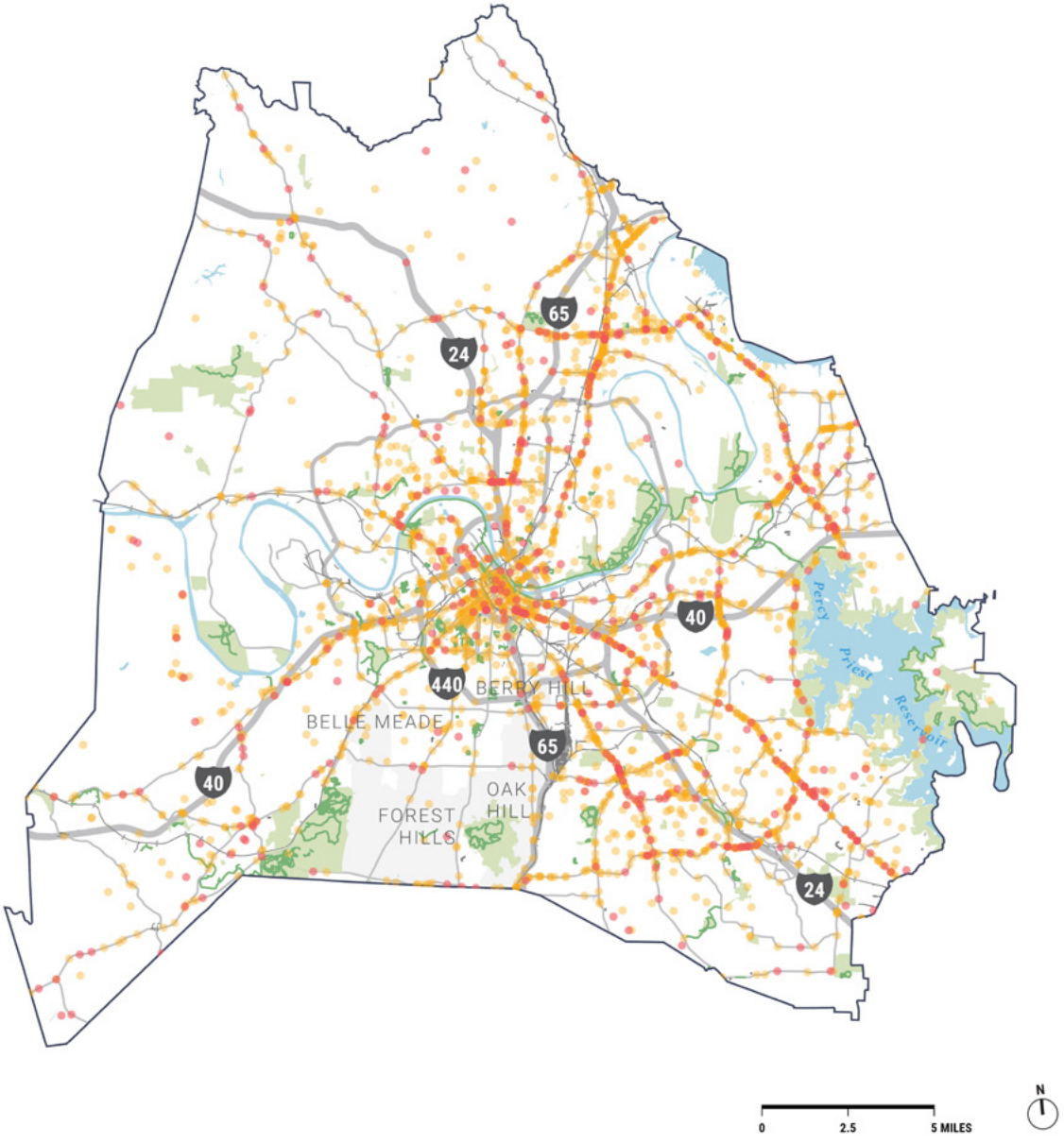
The threshold for what qualifies a segment as part of the high injury network was determined using Microsoft Excel. The table with the final HIN score was converted into an Excel file and sorted in descending order by the HIN score. The percentage of total road network, percentage of total fatal and serious collisions, and percentage of all injury-causing collisions were calculated. Using these percentages, and examining the rate of the percent of collisions by percent of roadway, an HIN threshold of 59% of KSI collisions was identified.

Figure 1 – Accumulated Collisions by Roadway Miles



In order to reduce segments being disproportionately weighted based on length and enable a logical network, segments with only 1 collision and segments shorter than 0.25 miles were removed from the HIN. **The final HIN comprises of 6% of total Davidson County roadway miles, 59% of killed or severely injured collisions (1,955), and 61% of all collisions (29,530).**

Map 1 – All Collisions, by Severity



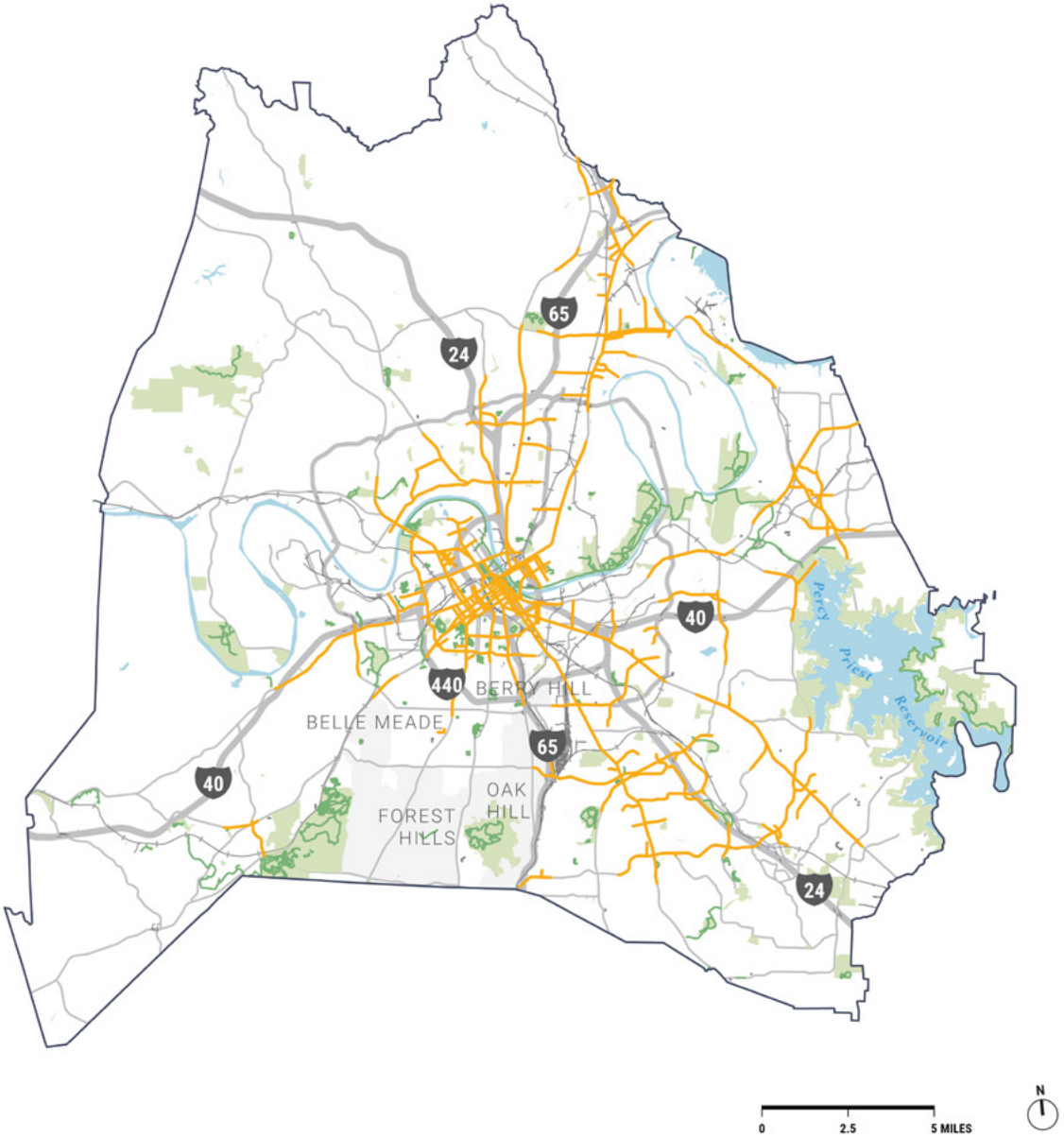
NASHVILLE COLLISIONS RESULTING IN A FATAL OR SERIOUS INJURY

LEGEND

KSI COLLISIONS

- FATAL
- SUSPECTED SERIOUS INJURY

Map 2 - Nashville High Injury Network, All Modes



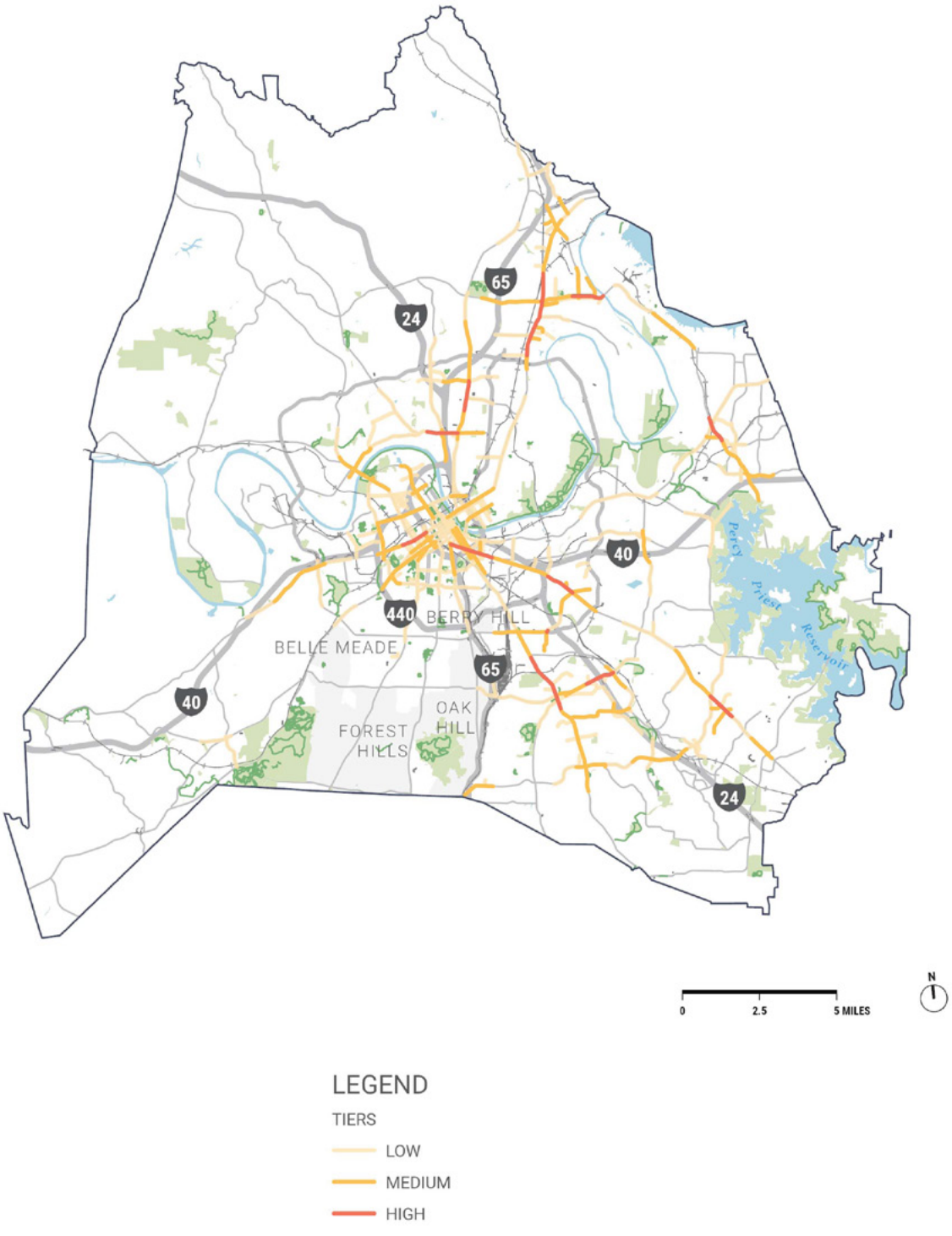
NASHVILLE
HIGH INJURY NETWORK

LEGEND

HIGH INJURY NETWORK

Map 3 - Nashville High Injury Network Severity Index

The high injury network was symbolized with a graduated color ramp to identify the roads along the high injury network in the highest tier, in terms of where the most serious crashes are occurring. The symbology was determined using ESRI's natural breaks algorithm, which identifies natural groupings in the data.



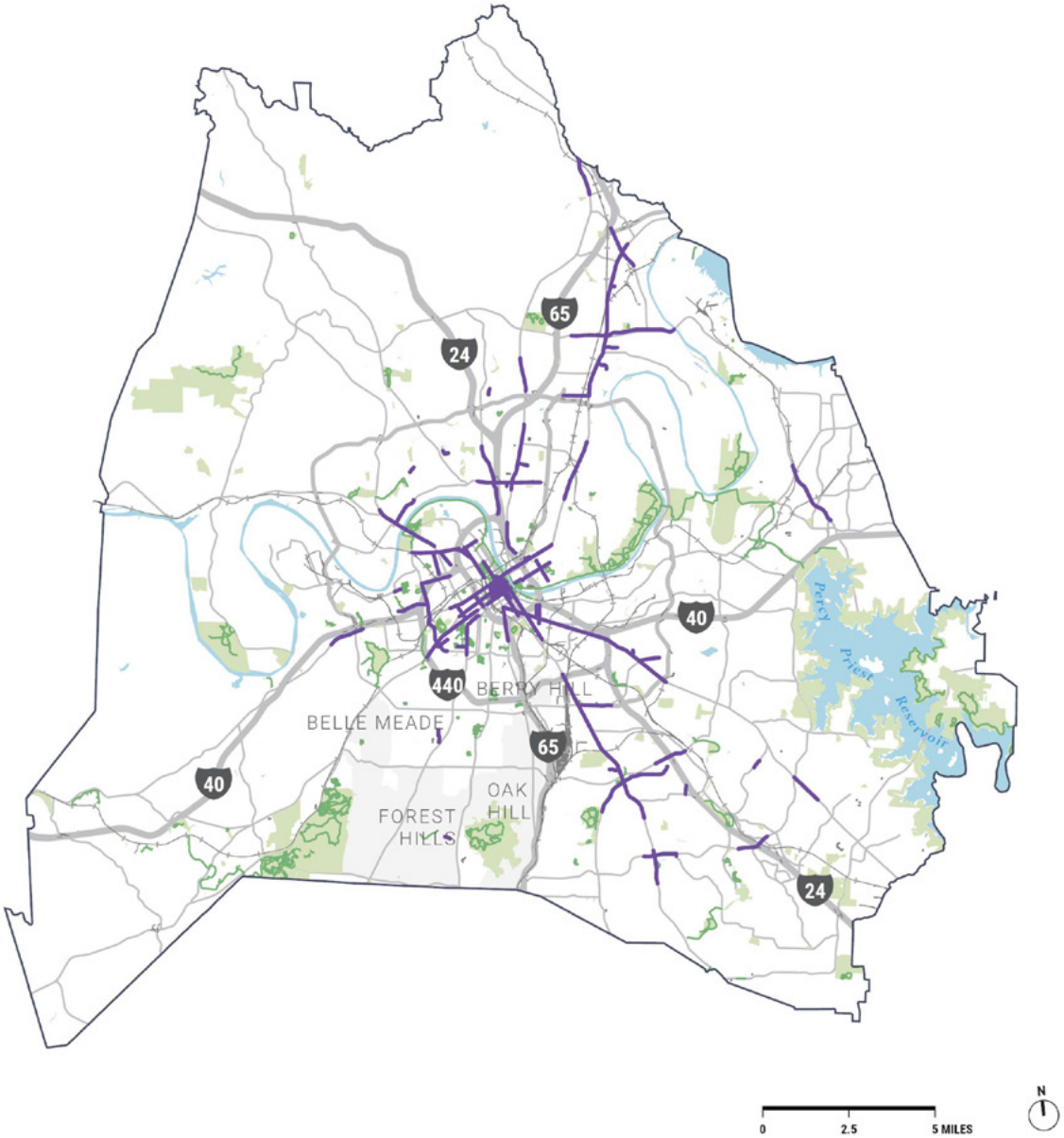
Modal High Injury Networks

In addition to the high injury network that takes into account all modes of transportation, three additional high injury networks were developed for motorist collisions, bicyclist collisions, and pedestrian collisions. The collision points were prepared in the same manner as the composite high injury network, minus the vulnerable road users weighting. While bicyclists were considered, the data is less reliable as the other modes given the small sample size.

The results of the high injury networks are the following:

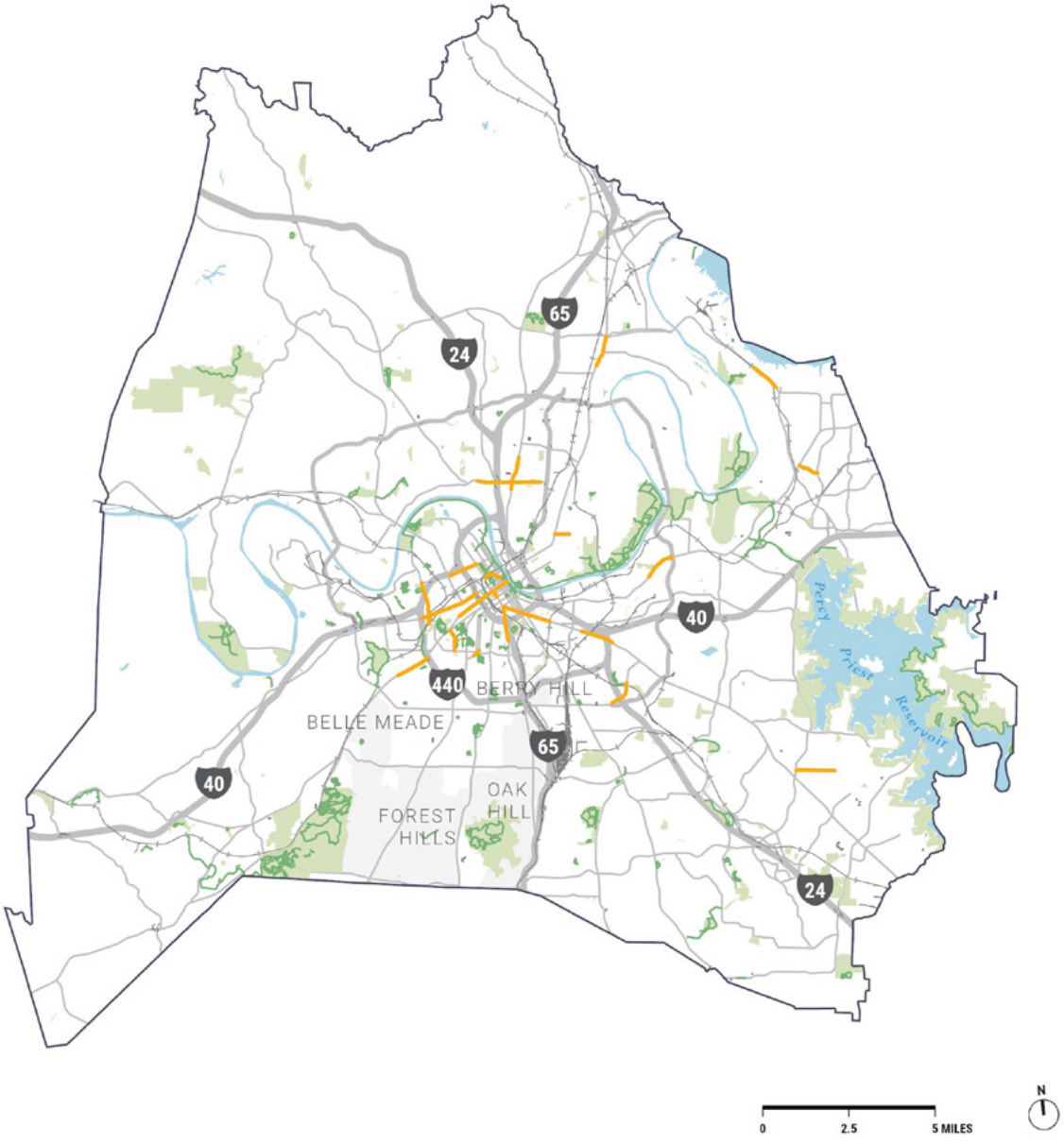
- The motorist high injury network captures 40% of collisions where a motorist is killed or severely injured on 3.5% of the network.
- The bicyclist high injury network captures 50% of collisions where a bicyclist is killed or severely injured on <1% of the network.
- The pedestrian high injury network captures 60% of collisions where a pedestrian is killed or severely injured on 2% of the road network.

Map 4 - Pedestrian High Injury Network



NASHVILLE PEDESTRIAN HIGH INJURY NETWORK

Map 5 - Bicyclist High Injury Network

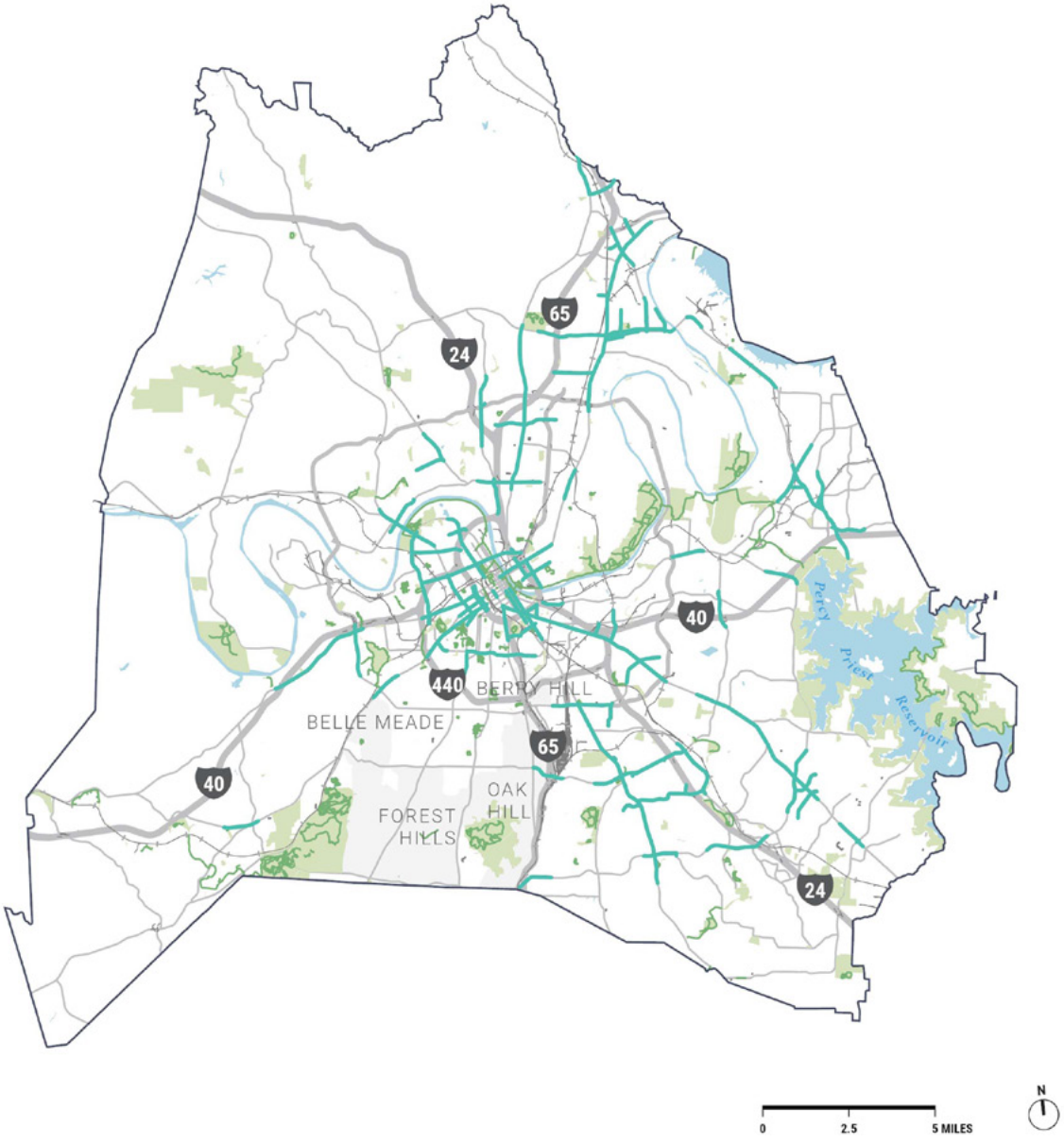


NASHVILLE BICYCLIST HIGH INJURY NETWORK

LEGEND

BICYCLIST HIN

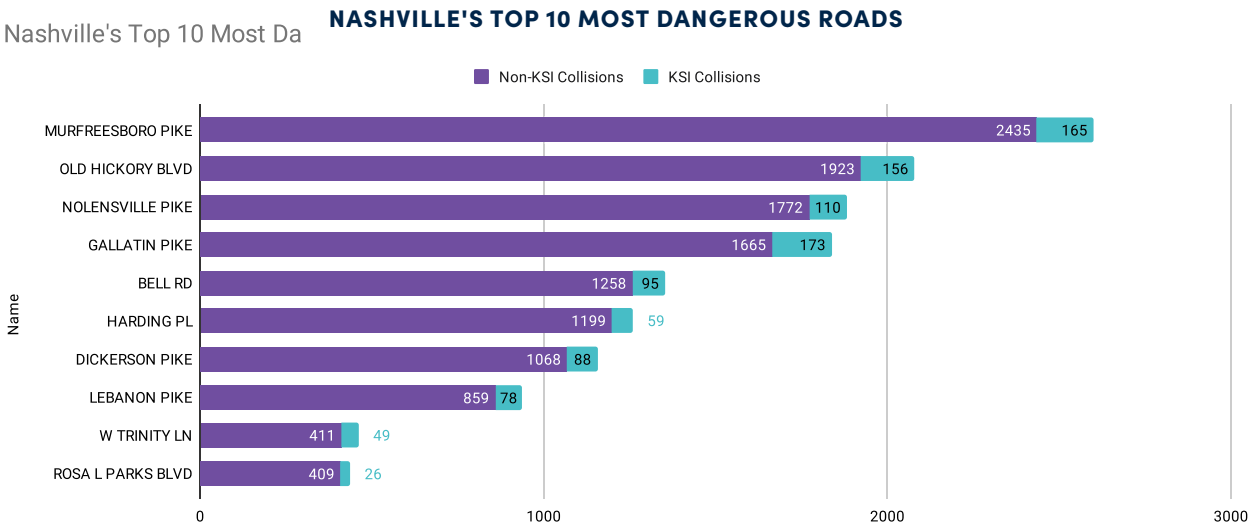
Map 6 - Motorist High Injury Network



NASHVILLE MOTORIST HIGH INJURY NETWORK

Nashville's Top 10 Most Dangerous Roads

Figure 2 - Nashville Roads with the Highest Severity Score



High Injury Network Crash Types

Table 1 - Collision Types along the High Injury Network

CRASH TYPE	MINOR INJURIES	FATAL OR SERIOUS INJURIES
Angle/Sideswipe	39%	42%
No collision w/ vehicle *(includes all collisions with a bicyclist, pedestrian, or single vehicle)*	7%	20%
Rear-end	40%	19%
Head-on	5%	13%
Sideswipe, same direction	5%	3%
Sideswipe, opposite direction	2%	2%
Other	1%	1%

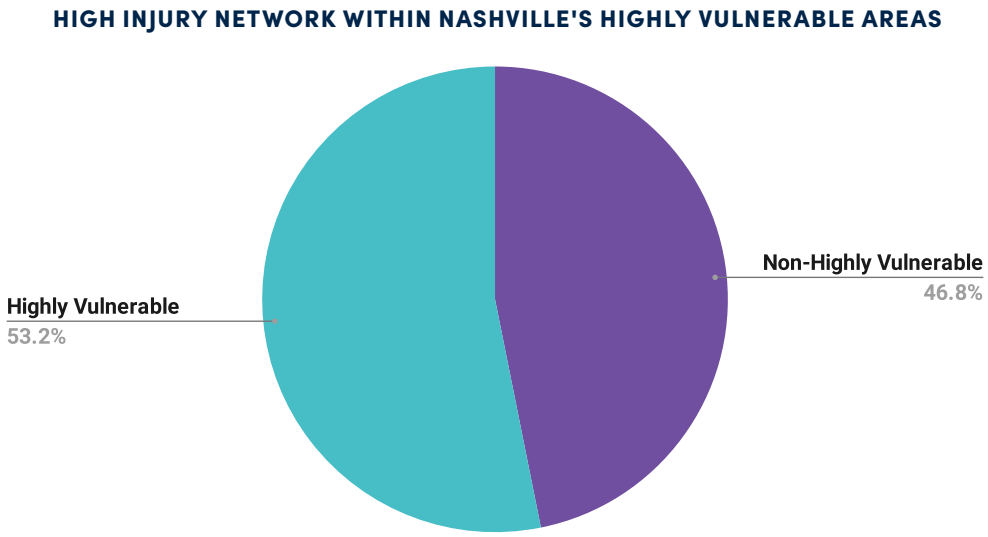
Note:

- *Reported percentages are rounded and may not total to 100%.*
- *Bicyclist and pedestrian collisions are all listed as 'No Collision with Vehicle'.*

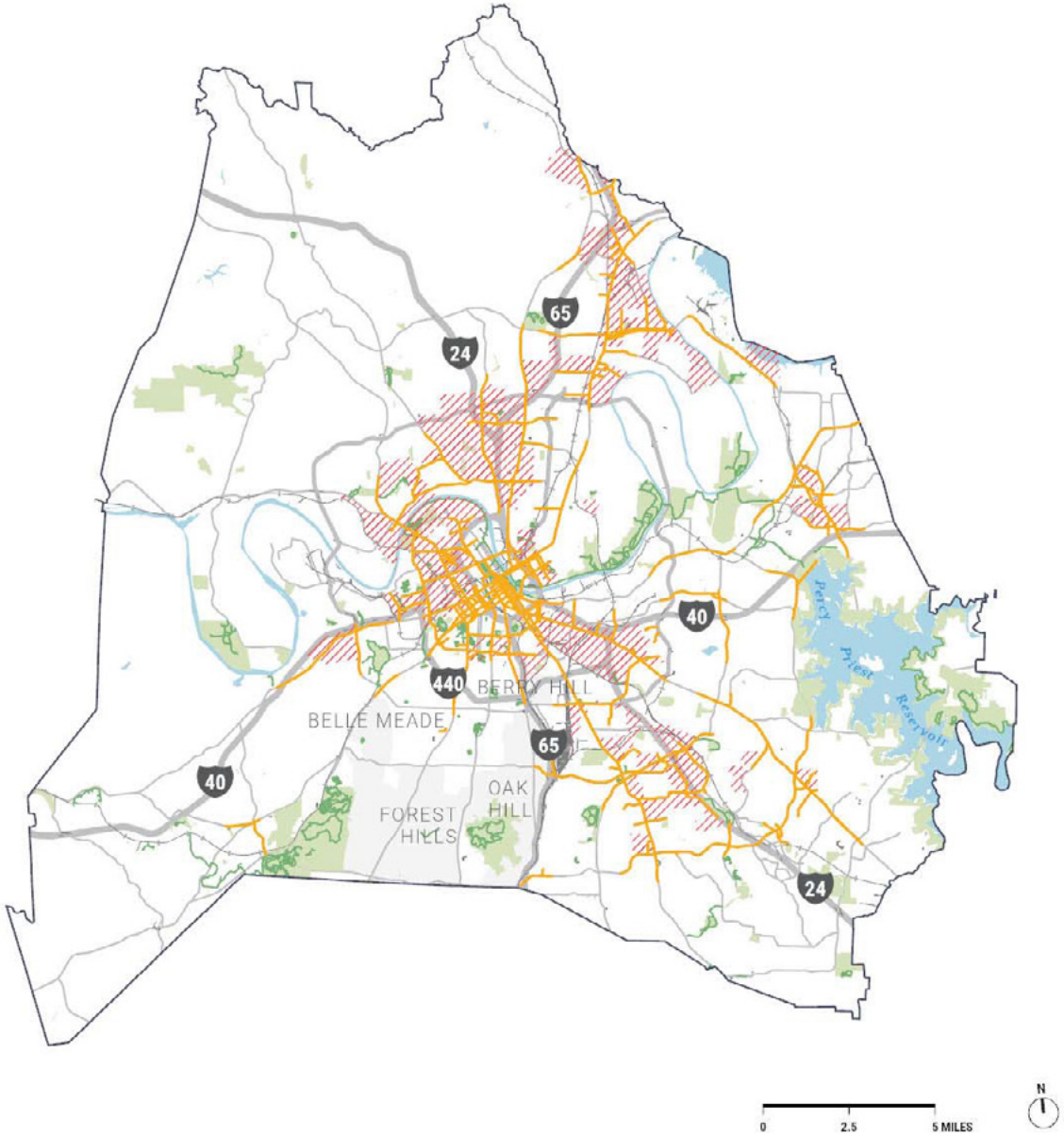
Equity

Consistent with national trends, those who live in highly vulnerable communities are more likely to be impacted by traffic violence. Highly vulnerable communities were determined using methods adapted from the Greater Nashville Regional Council's (GNRC) 2019 degree of vulnerability analysis (refer to Nashville Vision Zero Equity Analysis Technical Memo for more detail on methodology). **Though the highly vulnerable areas comprise just 20% of Davidson County's census block groups, 53% of the HIN occurs within these areas.**

Figure 3 – High Injury Network within Highly Vulnerable Areas



Map 7 - Nashville High Injury Network & Highly Vulnerable Areas



NASHVILLE HIGH INJURY NETWORK AND HIGHLY VULNERABLE AREAS

Highly vulnerable areas were determined through a tabulation involving 13 demographic inputs. The following table represents the 20% most vulnerable population, by block group, and the percentage of the High Injury Network that falls within each area. Block groups with the highest percentage of people living in poverty feature 47% of the High Injury Network miles, and block groups with the highest proportion of renters had 44% of the High Injury Network within its boundaries.

Table 2 – Nashville Vulnerable Demographics and HIN

MOST VULNERABLE 20% OF NASHVILLE BLOCK GROUPS	PERCENT OF HIGH INJURY NETWORK
Active transportation users (workers that use transit, walk, or bike to work)	32%
Carless households (no vehicles available)	28%
Disabled population	25%
Educational level (less than High School)	33%
Females	25%
Housing cost-burdened households (spending 30% or more of income on housing/rent)	37%
Limited English proficiency households	20%
Minorities (non-white and/or Hispanic/Latinx)	35%
Poverty	47%
Renters vs. owners	44%
Seniors (65+)	20%
Unemployment rate	28%
Youth (under 18)	21%

Note: Reported percentages represent overlapping census block groups and do not add up to 100%.

Facilities

Crashes that occurred along the High Injury Network were tabulated by roadway characteristics and roadway facilities:

- 41% of all motorist fatal and severe injury collisions, 27% of all pedestrian collisions where somebody is fatally or severely injured, and 38% of all bicyclist fatal and severe injury collisions were related to an intersection.
- The majority of pedestrian collisions occurred at midblock locations.
- Speed was also a major factor in HIN collisions, with 61% of pedestrian involved fatal and severe injury collisions and 50% of bicyclist involved fatal and severe injury collisions occurring on roadways with a 40 mph or greater speed limit.
- Transit stops also were associated with HIN collisions, with 81% of minor injury pedestrian collisions and 73% of pedestrian collisions where somebody was fatally or severely injured occurred within 500 feet of a transit stop.

Percent of HIN Crashes by Roadway Type

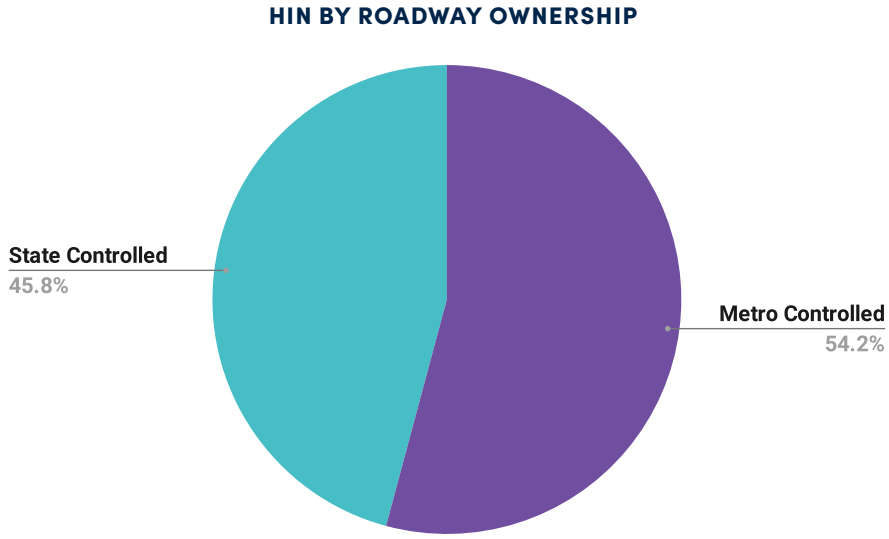
Table 3 - Roadway Characteristics for High Injury Network Collisions

	MINOR INJURY			FATAL OR SEVERE INJURY		
	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST
	0%	0%	0%	0%	0%	0%
Crossover Related	0%	0%	0%	0%	0%	0%
	2%	1%	6%	2%	2%	3%
Entrance/Exit Ramp Related	4%	1%	0%	3%	1%	6%
	31%	35%	44%	34%	23%	32%
	11%	10%	13%	7%	5%	6%
	51%	50%	36%	53%	68%	50%
Rail Grade Crossing	0%	0%	0%	0%	0%	0%
	0%	0%	0%	0%	0%	0%
Other/Unknown	1%	2%	1%	2%	1%	3%

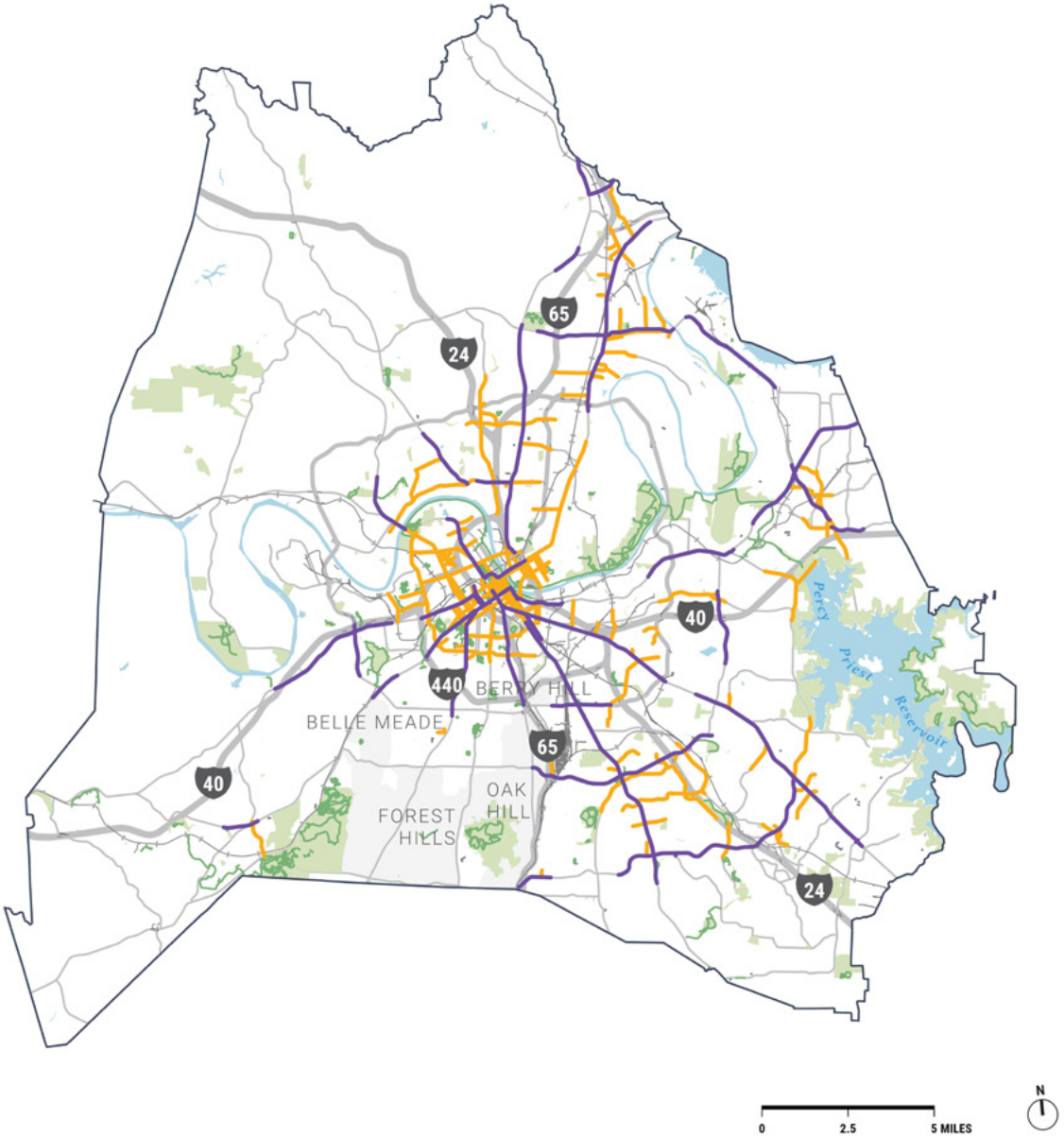
Note: Reported percentages are rounded and may not total to 100%.

HIN Collisions by Roadway Ownership

Figure 4 - Share of HIN by Ownership



Map 8 - Nashville High Injury Network by Roadway Ownership



NASHVILLE
HIGH INJURY NETWORK
BY ROAD OWNERSHIP

LEGEND

HIGH INJURY NETWORK - STATE ROADS

HIGH INJURY NETWORK - LOCAL ROADS

HIN Collisions by Speed Limit

Table 4 - Speed Limit in Collisions on the High Injury Network

	MINOR INJURY			FATAL OR SEVERE INJURY		
25 mph	0%	0%	0%	0%	0%	0%
35 mph	14%	18%	19%	12%	15%	26%

Note: Reported percentages are rounded and may not total to 100%. Local roadways without speed limit attributes were assigned a 30-mph speed limit, as the majority of the data was collected prior to the reduction in residential speed limits.

HIN Collisions by Sidewalk Presence

Table 5 - Sidewalk Presence in Collisions on the High Injury Network

	MINOR INJURY			FATAL OR SEVERE INJURY		
	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST
No sidewalks	27%	13%	11%	31%	18%	15%
Sidewalks on one side	32%	26%	21%	31%	27%	44%
Sidewalks on both sides	41%	62%	68%	38%	56%	41%

Note: Reported percentages are rounded and may not total to 100%.

HIN Collisions by Bikeway Presence

Table 6 - Bikeway Presence in Collisions on the High Injury Network

	MINOR INJURY			FATAL OR SEVERE INJURY		
	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST
Complete	43%	43%	52%	40%	47%	35%
Future	34%	36%	29%	34%	32%	38%
No Facility	23%	21%	18%	25%	21%	26%

Note: Reported percentages are rounded and may not total to 100%.

HIN Collisions by Bikeway Type

Table 7 - High Injury Collisions by Bikeway Type

	MINOR INJURY			FATAL OR SEVERE INJURY		
	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST
Future Facility	34%	36%	29%	34%	32%	38%
No Facility	23%	21%	18%	25%	21%	26%
Buffered Bike Lane	9%	8%	11%	9%	13%	3%
Bike Lane	17%	13%	21%	16%	16%	12%
Protected Buffered Bike Lane	1%	1%	1%	0%	1%	3%
Protected Bike Lane	0%	0%	1%	0%	0%	0%
Signed Shared Route	14%	18%	15%	13%	15%	18%
Wide Outside Lane	2%	3%	3%	2%	3%	0%

Note: Reported percentages are rounded and may not total to 100%.

HIN Collisions by Transit Stop Presence

The following chart represents the presence of collisions near transit on the high injury network.

Table 8 - High Injury Network Collisions by Transit Stop Presence

	MINOR INJURY			FATAL OR SEVERE INJURY		
	MOTORIST	PEDESTRIAN	BICYCLIST	MOTORIST	PEDESTRIAN	BICYCLIST
Less than 500'	64%	81%	76%	59%	73%	62%
500' to 1000'	19%	12%	17%	18%	16%	24%
Greater than 1000'	18%	7%	7%	23%	10%	15%

Note: Reported percentages are rounded and may not total to 100%.

High Injury Intersections

Introduction

High injury intersections identify junctions in the network that have the largest concentrations of collisions where victims are killed or injured. Intersections are considered within the high injury network. However, intersections are summarized separately to the network as there are many collision types that are specific to where streets meet, and their unique characteristics warrant a separate review and summary.

Methodology

This collision analysis examines data from January 2014 through August 2021 for collisions that involved an injury or fatality. The data is inclusive of motor vehicle, bicyclist, pedestrian, and motorcycle collisions within Davidson County. The data used in the collision analysis was provided by the Tennessee Department of Transportation, through their E-Trims digital platform. Collisions were prepared for analysis in the same manner they were prepared for the High Injury Network, and collisions occurring on an interstate were removed. Additionally, the same weighting scheme was applied.

Intersection points were provided to Alta by Metro. A total of 18,620 intersection points were considered. A Near analysis was completed to determine intersection distances from collision data marked as "occurring at an intersection" to determine the optimal buffer distance. 95% of collisions labeled as occurring at an intersection were located less than 49.5 feet from an intersection. Using this information, intersection points occurring at a major or minor arterial roadway were assigned a 50-foot buffer. Intersections occurring on a local or residential roadway were assigned a 25-foot buffer. The buffer sizes varied to account for the larger intersection area and queuing area present in arterial roads. A spatial join with the intersection buffer and prepared collision points was conducted, with the total collisions, total fatal and severe injury collisions, and total weighted collisions summed in the resulting intersection features. This resulted in 25,878 collisions associated with an intersection.

High Injury Intersections were determined by examining the table in Microsoft Excel, sorting the highest weighted intersections and examining the percent of total fatal and severe injury collisions associated with the intersections. For all modes, the top 50 high injury intersections were identified. These intersections account for 10% of fatal and severe injury collisions associated with an intersection, but comprise just 0.27% of total intersections in Davidson County. The same process was used to examine vulnerable user collisions separately. A total of 321 bicyclist collisions and 1,264 pedestrian collisions were associated with an intersection. The top 44 pedestrian and top 34 bicyclist high injury intersections were identified.

Highest Crash Density Intersections

Table 9 - Dangerous Intersections: All Modes

INTERSECTION	ALL COLLISIONS	FATAL OR SEVERE INJURY	BICYCLIST OR PEDESTRIAN INVOLVED
TN 255 & Sidco Drive	146	2	0
Murfreesboro Pike & Hamilton Church Road	102	6	2
W. Trinity Lane & Brick Church Pike	92	8	6
Nolensville Pike & Harding Place	84	6	3
Murfreesboro Pike & Hobson Pike	74	7	0
Old Hickory Blvd & Gallatin Pike S.	72	5	6

Table 10 - Dangerous Intersections: Pedestrians Only

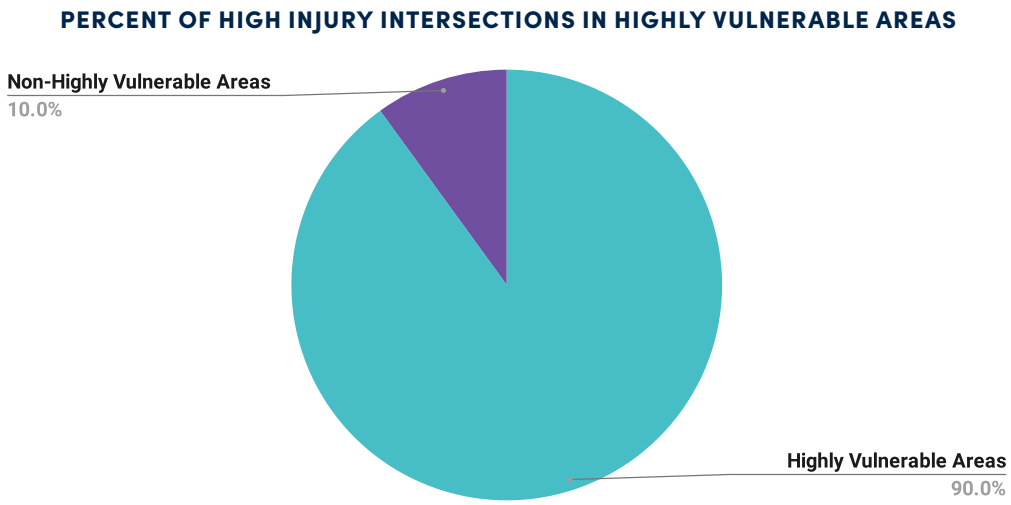
INTERSECTION	ALL COLLISIONS	FATAL OR SEVERE INJURY
Lafayette Street & Charles E. Davis Blvd.	7	1
Gallatin Pike S. & Neelys Bend Road	7	3
Gallatin Pike S. & Berkley Drive	7	2
Dr. Martin Luther King Jr. Blvd & Rep. John Lewis Way	6	2
Gallatin Pike S. & Madison Street	6	2
Nolensville Pike & Welshwood Drive	6	2
Murfreesboro Pike & Millwood Drive	6	2

Table 11 - Dangerous Intersections: Bicyclists Only

INTERSECTION	ALL COLLISIONS	FATAL OR SEVERE INJURY
Division Street & 12th Avenue S.	2	1
Lebanon Pike & Bonnabrook Drive	2	1
Clifton Avenue & 28th Avenue N.	2	1
Gallatin Pike S. & Emmit Avenue	2	1
Highland Avenue & 25th Avenue S.	2	1
E. Thompson Lane & Old Glenrose Avenue	2	1

Percent of High Injury Intersections in Highly Vulnerable Areas

Figure 5 - Percent of High Injury Intersections in Highly Vulnerable Areas



High Injury Intersection Collisions by Collision Type

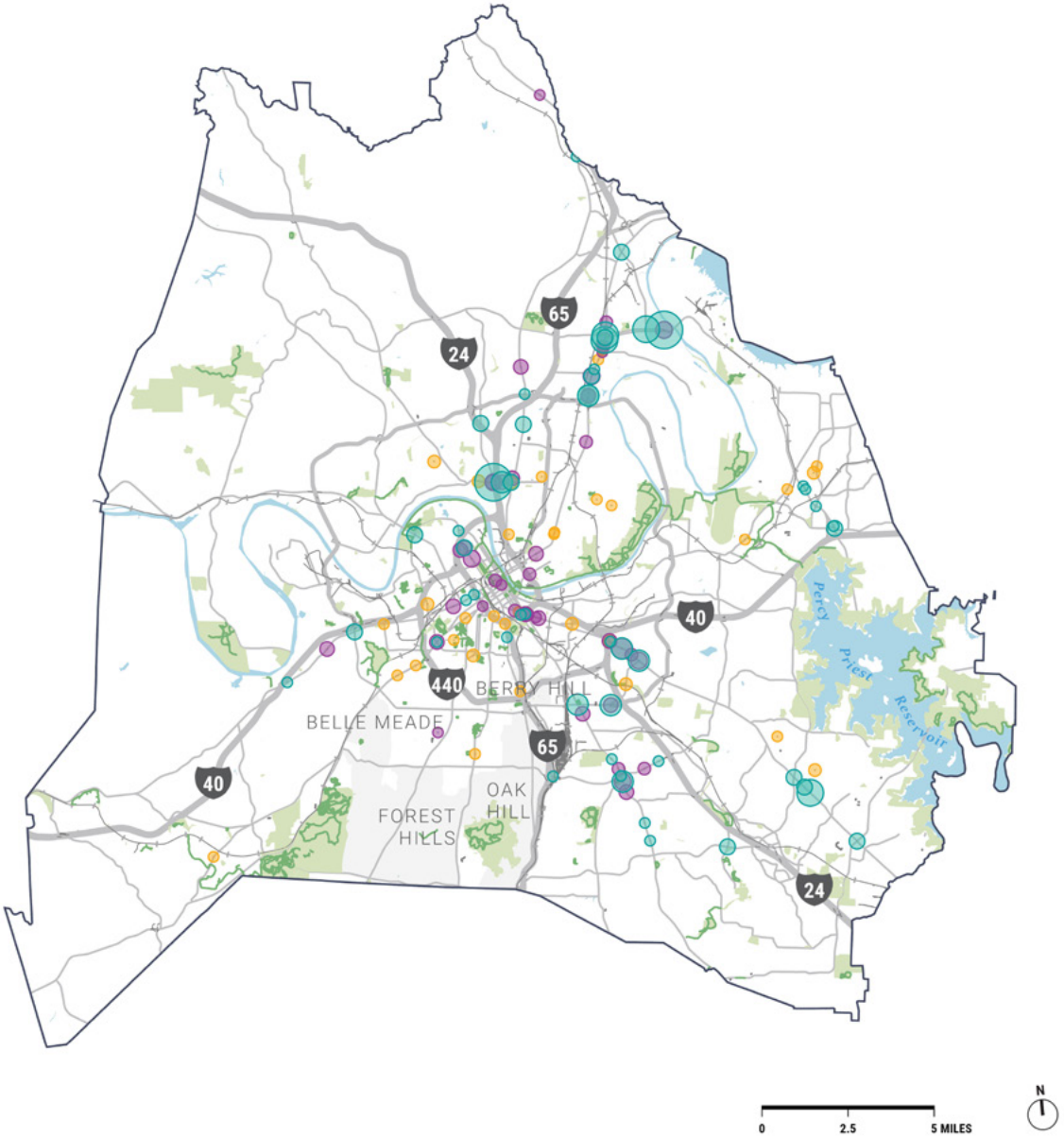
The majority of crash types along the High Injury Network were angled/sideswipe collisions or rear-end collisions. Bicyclist and pedestrian collisions are all reported under the "No collision with vehicle" category, limiting further analysis on possible collision types for these modes.

Table 12 – Predictive Indicators of Fatal or Severe Injury Collisions per segment for All Modes

COLLISION TYPE	PERCENT OF ALL COLLISIONS
Angle/Sideswipe	48%
Rear-end	32%
No collision w/ vehicle (Includes all collisions with a bicyclist, pedestrian, or single vehicle)	7%
Head-on	7%
Sideswipe, same direction	3%
Sideswipe, opposite direction	1%
Other	1%

Note: Reported percentages are rounded and may not total to 100%.

Map 9 – Nashville High Injury Intersections by Mode



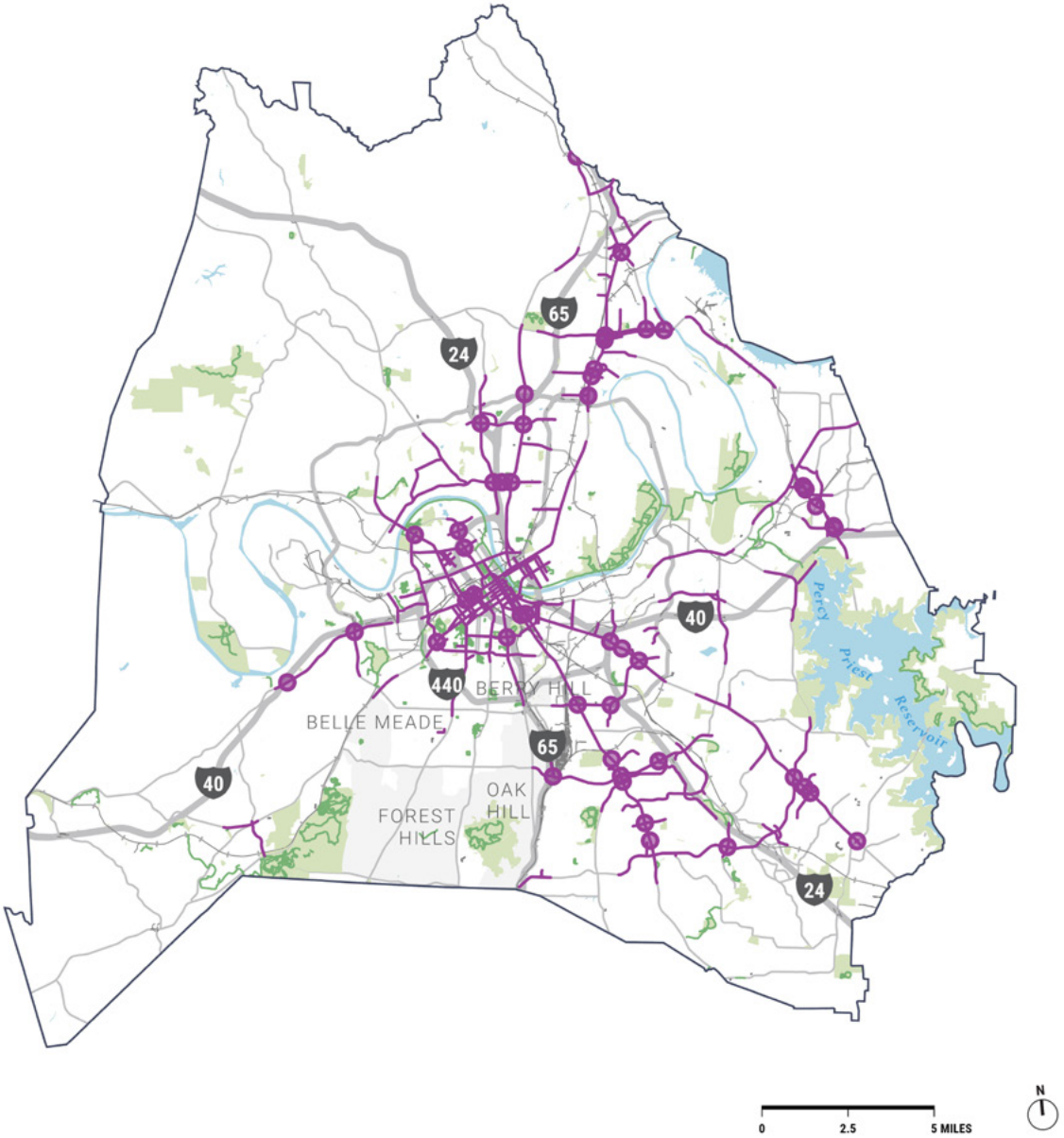
NASHVILLE HIGH INJURY NETWORK BY MODE

LEGEND

- All Modes
- Bicyclist
- Pedestrian

Higher Weighted Score

Map 10 – Nashville High Injury Network and High Injury Intersections



NASHVILLE
HIGH INJURY NETWORK
BY MODE

LEGEND

HIGH INJURY NETWORK

HIGH INJURY INTERSECTIONS

Higher Weighted Score

Conclusion

High injury networks identify streets and intersections with the largest concentrations of collisions where victims are killed or injured. The high injury network identifies corridors that have the potential for the most significant interventions to decrease traffic-related injuries and fatalities. The high injury network works in conjunction with the comprehensive systematic safety analysis to identify locations, contributing factors, and countermeasures to traffic deaths and injuries in Nashville.

High injury networks are derived from collision data collected on the scene of an incident. Factors related to human error may yield incomplete or inaccurate results. Additionally, high injury networks are constrained by their ability to measure exposure to a crash (taking into account traffic rates); this is particularly true when considering bicyclist and pedestrian collisions, where data related to pedestrian and bicycle volumes are not included with average daily traffic counts.

Data limitations

High Injury networks vary greatly among Vision Zero cities in their assumptions and weighting schemes. Additionally, data can suffer from human error in its collection and processing. The collision data collected does not count for unreported incidents and near misses. A public survey conducted by Alta in support of Vision Zero in Nashville found that 19% of respondents (318 respondents) stated they were involved in an unreported crash or near miss involving a bicyclist or pedestrian, nearly ten times the percentage that stated they were involved in a reported crash.

Collisions are often associated with intersections, causing potential problems when joined to individual street segments. Determining when a collision occurs on a roadway segment versus an intersection and determining which street segment an intersection crash is associated with are not clear-cut decisions. Furthermore, collisions only involving motorists far outnumber collisions involving pedestrians or bicyclists, though both these groups experience greater rates of traffic collisions. As there were less available data for both modes, there is less certainty about the associations between collision characteristics among these groups.

Appendix 3: Executed Transportation System Safety Policy Resolution No. RS2021-1236

SUBSTITUTE RESOLUTION NO. RS2021-1236

A resolution recommending implementation of certain transportation system safety policies in furtherance of Vision Zero.

WHEREAS, Vision Zero is a strategy to eliminate all traffic fatalities and severe injuries while increasing safe, healthy, and equitable mobility for all; and,

~~WHEREAS, on January 18, 2020, Mayor Cooper announced his administration's commitment to Vision Zero to help eliminate traffic fatalities and severe injuries in Nashville and Davidson County; and,~~

~~WHEREAS, Vision Zero is a strategy to eliminate all traffic fatalities and severe injuries while increasing safe, healthy and equitable mobility for all; and,~~

WHEREAS, the Metro Nashville WalknBike Strategic Plan of 2017 recommended the completion of a Vision Zero plan, and in January, 2020, Mayor Cooper announced his administration's commitment to Vision Zero in Nashville and Davidson County, and the Metro Council is represented on the Vision Zero Task Force Steering Committee;

WHEREAS, committing to Vision Zero requires implementing policies that require the Metropolitan Government of Nashville and Davidson County ("Metro") ~~strategies and transportation safety policies, allowing the Metropolitan Government of Nashville and Davidson County ("Metro") to shape~~ to engineer its transportation and mobility infrastructure ~~around~~ for the safety and well-being of all residents and all modes of travel; and,

WHEREAS, implementation of a quick-build policy by the Metropolitan Department of Finance, Procurement Division, would enable Metro to deliver quick-build projects in a more efficient and expedited manner by streamlining project delivery; and,

WHEREAS, implementation of a crosswalk policy would provide a framework with procedures for installation, enhancement, removal and relocation of crosswalks throughout Nashville and Davidson County, with specific guidance on crosswalks near bus stops; and,

~~WHEREAS, implementation of a fatal crash investigative team led by the Nashville Department of Transportation and Multimodal Infrastructure ("NDOT") in connection with Metro Nashville Police Department ("MNPD") would enable Metro to evaluate the engineering, environmental, vehicle, and behavioral factors for deadly crashes; and,~~

~~WHEREAS, advancing these polices and ensuring the success of Vision Zero is in the best interest of the citizens of the Metropolitan Government and Davidson County.~~

WHEREAS, implementation of a multi-disciplinary working group led by the Nashville Department of Transportation & Multimodal Infrastructure ("NDOT"), working in concert with the fatal crash investigative team of the Metropolitan Nashville Police Department Traffic Division, would enable NDOT to consistently evaluate and address engineering factors in deadly and severe-injury crashes; and

WHEREAS the draft Vision Zero Plan will be released for public comment on December 15, 2020 and advancing complimentary policies now will be compatible with that work and lay the foundation for Vision Zero efforts; and

WHEREAS, implementing and reporting on these and other Vision Zero policies and goals, and organizing staff and work flow to manage processes that deliver timely infrastructure improvement and safety results is in the best interest of the citizens of the Metropolitan Government of Nashville & Davidson County.

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE METROPOLITAN GOVERNMENT OF NASHVILLE AND DAVIDSON COUNTY:

Section 1. That the Metropolitan Council hereby goes on record as recommending that the Finance Department, Division of Procurement, examine current law, in consultation with the Metro Legal Department, to determine the legality of a quick-build policy and if feasible, implement the same.

Section 2. That the Metropolitan Council hereby goes on record as recommending that the Nashville Department of Transportation and Multimodal Infrastructure implement a cross-walk policy ~~with~~ framework with procedures for installation, enhancement, removal and relocation of crosswalks throughout Nashville and Davidson County.

Section 3. That the Metropolitan Council hereby goes on record as recommending that the Nashville Department of Transportation and Multimodal Infrastructure, in connection with the Metro Nashville Police Department, formalize a multi-disciplinary work group and referral process in concert with the fatal crash investigative team of the Metropolitan Nashville Police Department Traffic Division to ~~evaluate the~~ enable NDOT to address engineering~~, environmental, vehicle, and behavioral~~ factors for all deadly and severe-injury crashes.

Section 4. That the Metropolitan Clerk is authorized to send a copy of this resolution to Department of Finance, Procurement Division Director, the Metropolitan Nashville Police Department, Traffic Division, the Metropolitan Legal Department Director and the Nashville Department of Transportation and Multimodal Infrastructure.

Section 5. That NDOT will report to the Metropolitan Council on the recommendations of this resolution on or before March 1, 2022.

Section ~~5~~6. That this resolution shall take effect from and after its final passage, the welfare of The Metropolitan Government of Nashville & Davidson County requiring it.

Mayor John Cooper **Date** DEC 08 2021

John Cooper

Metropolitan Nashville and Davidson County, TN

Legislative History

File Number: RS2021-1236

File ID:	RS2021-1236	**Type:**	Resolution	**Status:**	Passed
Version:	2	**Agenda Section:**		**In Control:**	Metropolitan Council
				File Created:	11/05/2021
Subject:				**Final Action:**	

Caption: A resolution recommending implementation of certain transportation system safety policies in furtherance of Vision Zero.

Sponsors:	Young, OConnell, Allen, Henderson, Benedict, Porterfield, Welsch and Hancock	**Enactment Date:**	
Attachments:	Substitute RS2021-1236	**Enactment Number:**	
LS:		**Hearing Date:**	
Entered by:	Danielle.Godin@nashville.gov	**Effective Date:**	
Related Files:			

History of Legislative File

Version:	Acting Body:	Date:	Action:	Sent To:	Due Date:	Return Date:	Result:
1	Metropolitan Council	11/09/2021	filed				
1	Budget and Finance Committee	11/15/2021	approved				
1	Metropolitan Council	11/16/2021	deferred				
1	Transportation and Infrastructure Committee	12/07/2021	approved with amendments				
1	Metropolitan Council	12/07/2021	substituted				
1	Metropolitan Council	12/07/2021	adopted				
2	Mayor	12/08/2021	approved				