To: Multnomah County

From: Mike Sellinger, Bianca Popescu, Kelly Dunn, Rohan Oprisko, and David Wasserman, Alta Planning + Design

Date: June 2025

Re: East Multnomah County Systemic Safety Analysis Technical Memo

Introduction

This systemic safety analysis examined the locations where there are crashes and the severity of the crashes, as well as contributing factors and crash types by relevant road users. The analysis investigated the traits of the parties involved, crash types (e.g., rear-end, broadside), preceding movements, unsafe behaviors, and other contributing factors like time of day, weather, or alcohol influence. In addition, the analysis investigated trends in contextual characteristics such as roadway speeds and volumes, intersection traffic controls, the presence of pedestrian and bicycle facilities, and the types of nearby land uses.

Focusing on severe injury and fatal crashes, these variables tell the story of the safety of roadway users and help to identify locations, contextual characteristics, and contributing factors that will influence project prioritization and countermeasure recommendations. The systemic safety analysis deliverables are summarized in the following sections:

1. Summary of Key Crash Trends
2. Crash Locations and the High Injury Corridors (HIC)
3. Equity Analysis
4. Spatial-Temporal Analysis
5. Crash Profiles and Crash Trees
6. Additional Safety Analysis

The study area includes the urban area East Multnomah County, to the City of Portland border.

Data Inputs

This analysis pulled data from the following sources:

- Crash data and reporting (including from ODOT and Multnomah County, 2013-2022),
- Roadway data (e.g., traffic volumes, posted speeds, number of lanes, bicycle and pedestrian facilities, etc.)
- Socioeconomic data
- Transit routes and ridership
- High Injury Corridors provided by Metro using ODOT crash data, 2017-2021
- Breakdown of crashes and fatalities by severity, mode, time of day, and other factors
- Regional and jurisdictional trends

Executive Summary

All Mode Crashes

- The most severe crashes in the study area occur on the arterial network.
- While roads with a 35 MPH speed limit account for 11% of centerline miles overall, they account for 66% of all fatal and serious injury crashes.
- Serious injuries and fatalities spike in the winter months for all modes, with a larger spike in November possibly attributed to Daylight Savings Time change. This trend is especially stark for pedestrians and bicyclists at dusk and dawn.
- Most fatal crashes happen after dark, and of those after-dark fatalities, drug or alcohol impairment is involved in 83% of crashes. Alcohol and drug involved crashes appear disproportionately among fatal and serious injury crashes.
- Fixed object crashes on 35 MPH roads accounted for 9% of all fatal and serious injury crashes, and 3% of all injury crashes.
- A disproportionate number of fatal and serious injury motorcycle crashes occurred at intersections with a turning vehicle.
- For vehicle-only crashes, there is a significant number of crashes on every arterial in the study area, particularly in the central and western parts of the study area.
- Fatalities are distributed throughout the study area but concentrated on Burnside Road and 181st Avenue and are largely at intersections.
- Crashes have increased over time in the communities of Wood Village and Fairview.
- Crashes have increased over time at the intersections of NE Burnside Road & NE Division Street and SE 181st Avenue & Stark Street. They are also located in equity priority areas.
- Crashes have decreased over time in the community of Troutdale and along Division Street.
- For all crashes in the study area, vulnerable road users (people walking, biking, and using a motorcycle) were more likely to be involved in a serious injury or fatal crash.

Pedestrian Crashes

- In pedestrian-involved injury crashes, the most common cause is failure to yield the right of way, accounting for 217 crashes (52%). Of these 217 crashes, it was deemed that the driver had failed to yield the right of way in 166 crashes (76%).
- The second-most common cause of pedestrian-involved crashes is a pedestrian being illegally in the roadway, with 115 crashes (28%). Of these crashes, 91 were near a transit stop (79%), and 88 were near commercial or mixed-use zoning, which correlates highly with transit stop locations. 24 of the crashes (21%) were at intersections, but very few were near a signalized intersection (8%).
- Darkness on roads with a full or partial sidewalk was found to be a risk factor for pedestrian fatal and serious injury crashes.
- Fatal and serious injury pedestrian crashes were found to occur disproportionately at intersections with an improper maneuver by the driver.

- The highest concentrations of all pedestrian crashes are surrounding the intersections at NE Division & NE Kane Drive, NE Burnside Rd & NE Division, SE 182nd Avenue & W Powell Boulevard, and E. Burnside Road and SE 181st Avenue.
- High pedestrian crash injury corridors include Stark Street, Burnside Road, 181st, 182nd, and NE 162nd Avenues.

Bicycle Crashes

- Fatal and serious injury bicycle crashes were found to occur disproportionately at intersections with a turning vehicle, on roads with a dedicated bicycle facility.
- Bike crashes are concentrated in a few corridors particularly along 181st Avenue, Burnside Road, Powell Boulevard, NE Glisan Street, and segments of Powell Blvd, Kane Drive, and NE Halsey Street.

Summary of Key Crash Trends

Alta examined cross-tabulations of crash data prepared by Metro and observed the following trends:

Crash Injuries by Mode

There were 8,474 injury crashes that occurred in the study area from 2013 to 2022. Compared to occupants in vehicles, vulnerable road users (people walking, biking, and using a motorcycle) were more likely to die or be seriously injured if involved in a crash, as shown in **Figure 1**. Of the 417 pedestrian injury crashes, 22% were fatal or serious injury crashes, with 39 fatalities during this period. Of the 248 bicycle injury crashes, 10% were fatal or serious injury crashes, with 4 fatalities during this period. Of the 229 motorcycle injury crashes, 27% were fatal or serious injury crashes, with one fatality during this period. Of the 7,580 vehicle injury crashes, only 5% were fatal or serious injury crashes.

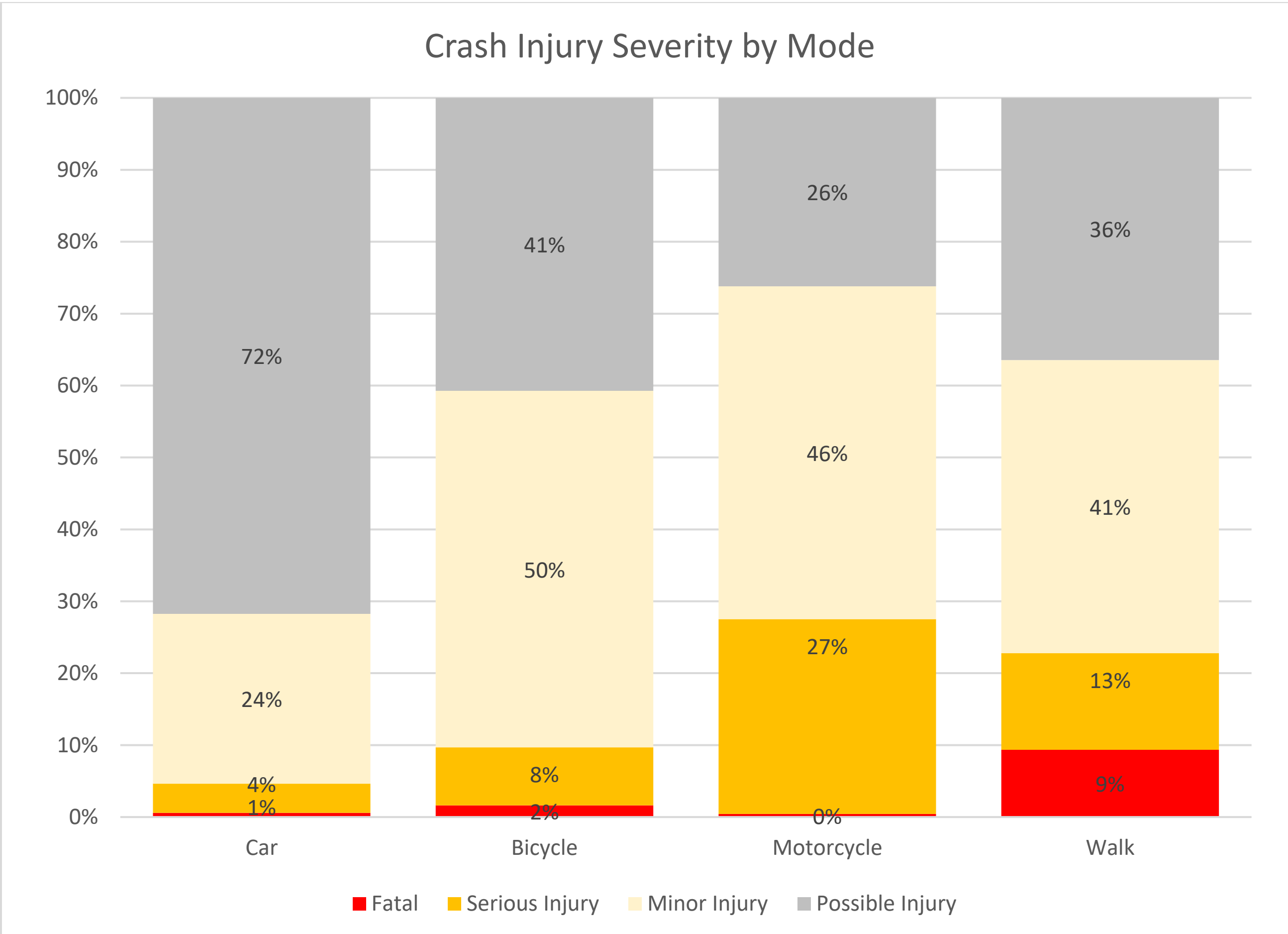


Figure 1: Crash Injury Severity by Mode

Crash Trends by Month

Serious injuries and deaths spike in November and the winter months for both vulnerable road users and motorist-involved crashes, as shown in **Figure 2.**

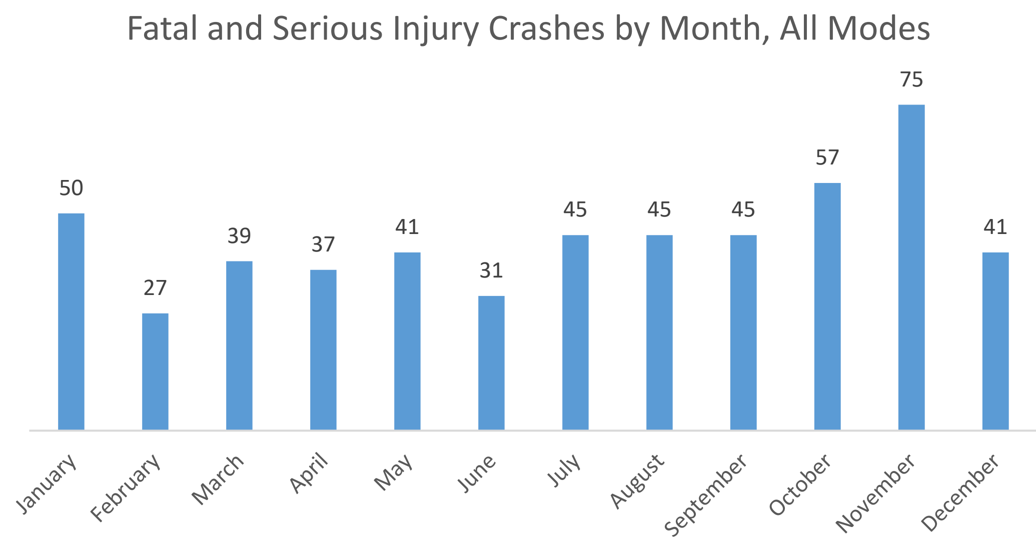


Figure 2: Fatal and serious injury Crashes by month for all modes

This trend cannot be explained by longer dark hours alone, since darkness peaks in December. In fact, the trend toward November is accentuated when examining all injury crashes occurring at dusk and dawn, as shown in **Figure 3,** despite the fact that all months have approximately the same number of hours of twilight.

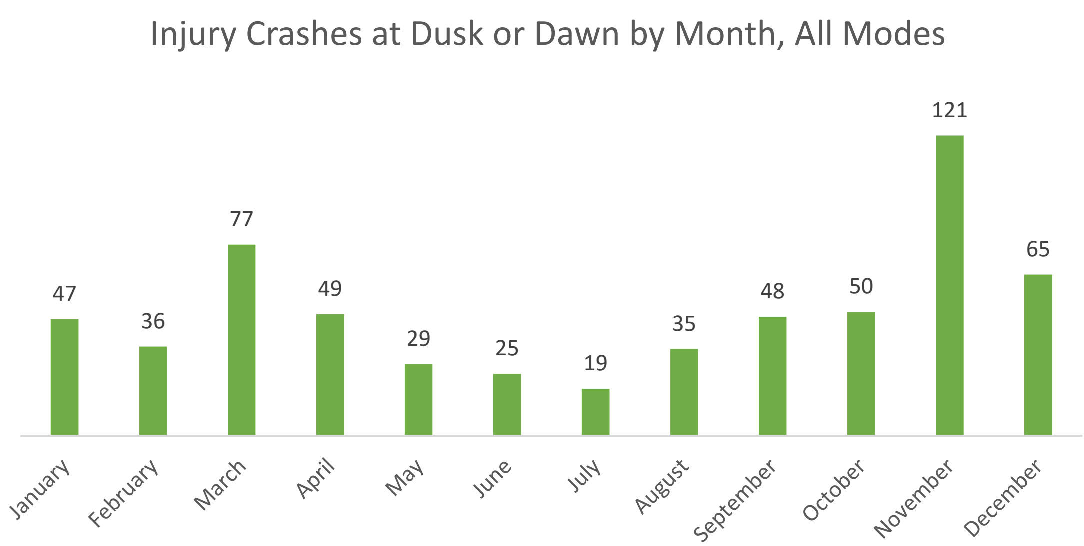


Figure 3: Crashes at dusk and dawn for all modes

Notably, there is another small spike in March. The trend coincides with the months of Daylight Savings Time beginning and ending, when the dusk and dawn hours suddenly shift into peak commuting times: In November, sunset shifts earlier from about 6pm to 5pm, whereas in March, sunrise shifts later from about 6:30 am to 7:30 am. The trend is particularly stark for bicyclists and pedestrians, as shown in **Figure 4.**

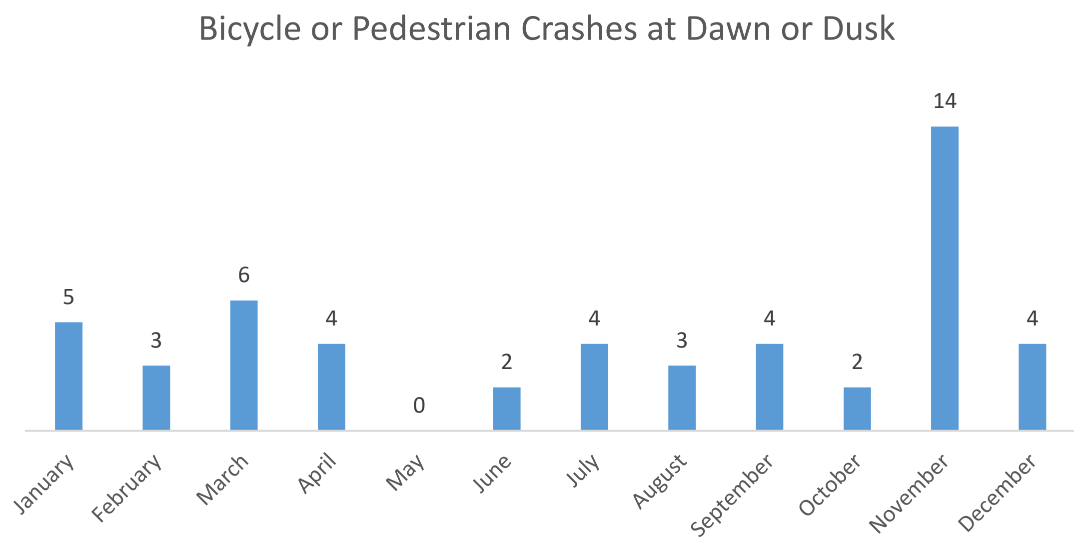


Figure 4: Bicycle or pedestrian crashes at dusk or dawn

Pedestrian Crash Trends

In pedestrian-involved injury crashes, the most common cause is failure to yield the right of way and the second-most common cause is a pedestrian being illegally in the roadway, such as crossing outside of a marked crosswalk. Of these crashes, 91 were near a transit stop (79%), and 88 were near commercial or mixed-use zoning, which correlates highly with transit stop locations. Pedestrian-involved injury crashes involving a failure to yield the right of way account for 217 crashes. Of these 217 crashes, it was deemed that the driver had failed to yield the right of way in 166 crashes (76%). Of the 29 of these crashes that involved a KSI, it was the driver who failed to yield the right of way in 17 crashes (58%).

Of the 115 crashes involving a pedestrian illegally in the roadway, 24 (21%) were at intersections. In eleven of these crashes, data indicated that no pedestrian signal was present at the intersection; in six cases a signal was present, so we assume that the pedestrian was crossing against the signal in this case. The crashes at intersections with no signal all occurred at different intersections. Three occurred on SE Division Street in Gresham close to Centennial Middle School, three occurred on NE 181st Avenue between SE Stark Street and NE Halsey St, and two on East Powell Blvd. near downtown Gresham.

The remaining 91 crashes involving a pedestrian illegally in the roadway occurred outside an intersection (79%). In 69 of these (76%), the pedestrian was crossing in between intersections; nine involved someone standing or lying in the roadway. These crashes were more clustered: eight occurred near the intersection of SE 182nd Avenue and W Powell Blvd; six occurred on NE Burnside Rd just south of Division Street; and four occurred near the intersection of SE Division Street & SE 182nd Avenue. The cluster on Burnside is notable because six crashes were in very close proximity and, unlike the other clusters, were more than 300 feet from the nearest intersection. This point of the roadway has a McDonald's and a dispensary on the east side, and a Motel 6 and fitness center on the west side. The road also curves just north of that point, which may make southbound traffic difficult for pedestrians to see and vice versa.

Bicycle Crash Trends

In the 248 bicycle-involved crashes, the most common cause was also failure to yield right of way, accounting for 155 crashes (63%). This share changed little whether the crash occurred at an intersection (64%) or mid-block (60%).

In bike-involved crashes due to a failure to yield, it was the driver who failed to yield 74% of the time; for the remainder, it was the cyclist. This share of failure to yield crashes where the driver bore responsibility changed little whether the crash occurred at an intersection (76%) or mid-block (70%).

Lighting

While most injury crashes happen during daylight hours, most fatal crashes happen after dark. In 84% of after-dark fatal crashes, drug or alcohol impairment is involved (see **Figure 5**). This is much higher than severe or minor injury crashes after-dark without drug or alcohol impairment. In contrast, in 29% of after-dark severe injury crashes and 14% of after-dark minor injury crashes, drug or alcohol impairment is involved.

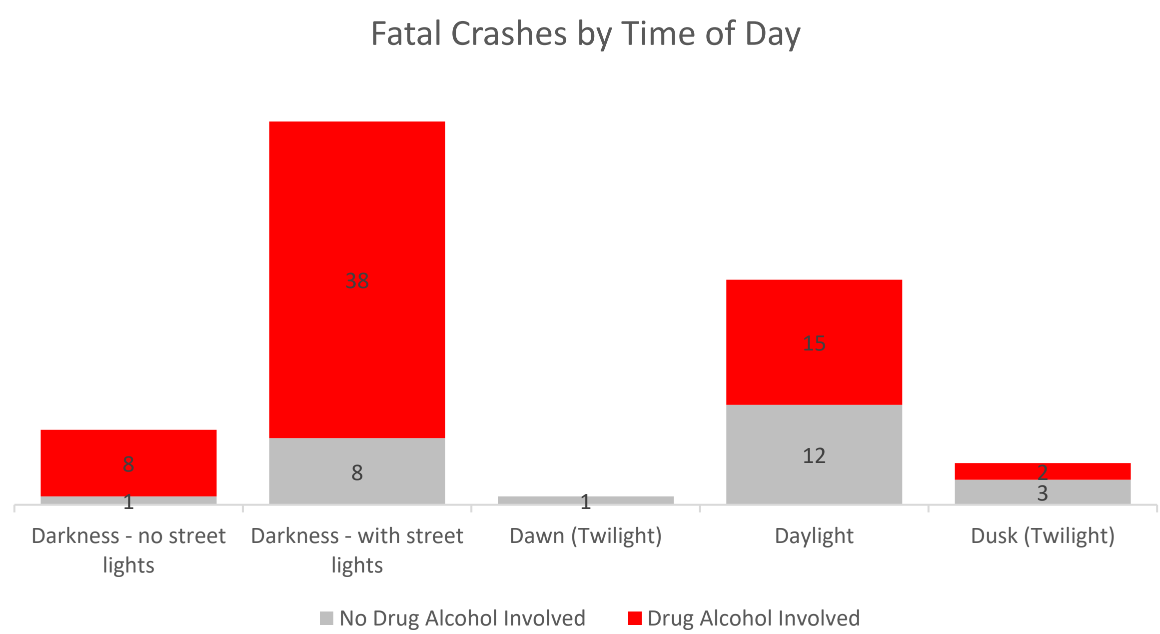


Figure 5: Fatal Crashes by Time of Day

Crash Locations and High Injury Corridors

The following section summarized the key findings from the initial data review (Task 3.3) and includes a crash analysis by mode, using 10-year crash data from 2013-2022, and the regional High Injury Corridors (HIC) developed by Metro using 5-year crash data from 2017-2021.

Crash Locations

The crashes in the study area were mapped by mode of travel and symbolized by injury and crash type. Additionally, a crash concentration index was developed for each mode that summarizes crash frequency and severity within a 0.2-mile-wide hexagon grid[1]. Each hexagon's score is the sum of crash scores weighted by severity. Crashes were weighted on a simple downwards scale from five to one according to the KABCO[2] crash classification:

- Fatal Injury (K) = 5
- Suspected Serious Injury (A) = 4
- Suspected Minor injury Crash (B) = 3
- Possibly Injury Crash (C) = 2
- No Apparent injury/Property Damage Only (PDO) Crash (O) = 1

The key trends were summarized for each map.

Pedestrian Crash Analysis

Pedestrian crash points are mapped in **Figure 6** and pedestrian crash concentrations are shown in **Figure 7**. The highest concentrations of pedestrian crashes are at intersections distributed across the study area including NE Division & NE Kane Drive, NE Burnside Rd & NE Division, SE 182nd Avenue & W Powell Boulevard, and E. Burnside Street and SE 181st Avenue.

High pedestrian crash corridors include Stark Street, Burnside Road, 181st, 182nd, and NE 162nd Avenues; pedestrian fatalities are concentrated on major arterials, especially along the SE 181st and 182nd Avenues.

Some pedestrian fatalities are also identified directly along I-84 or on highway ramps, with the crash cause due to improper driving or pedestrian being illegally in roadway.

In the study area, the northwest portions have particularly high concentrations of severe crashes. This includes segments of E Burnside Road, SE 181st Avenue, and NE Glisan Street.

[1] Hexagons were chosen for this analysis, as they reduce sampling bias, better represent curved data outputs, and are better suited for analyzing connectivity or movement paths, among other aspects. https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-statistics/h-whyhexagons.htm

[2] The KABCO Scale is a tool used to classify crashes by injury severity (source: FHWA).

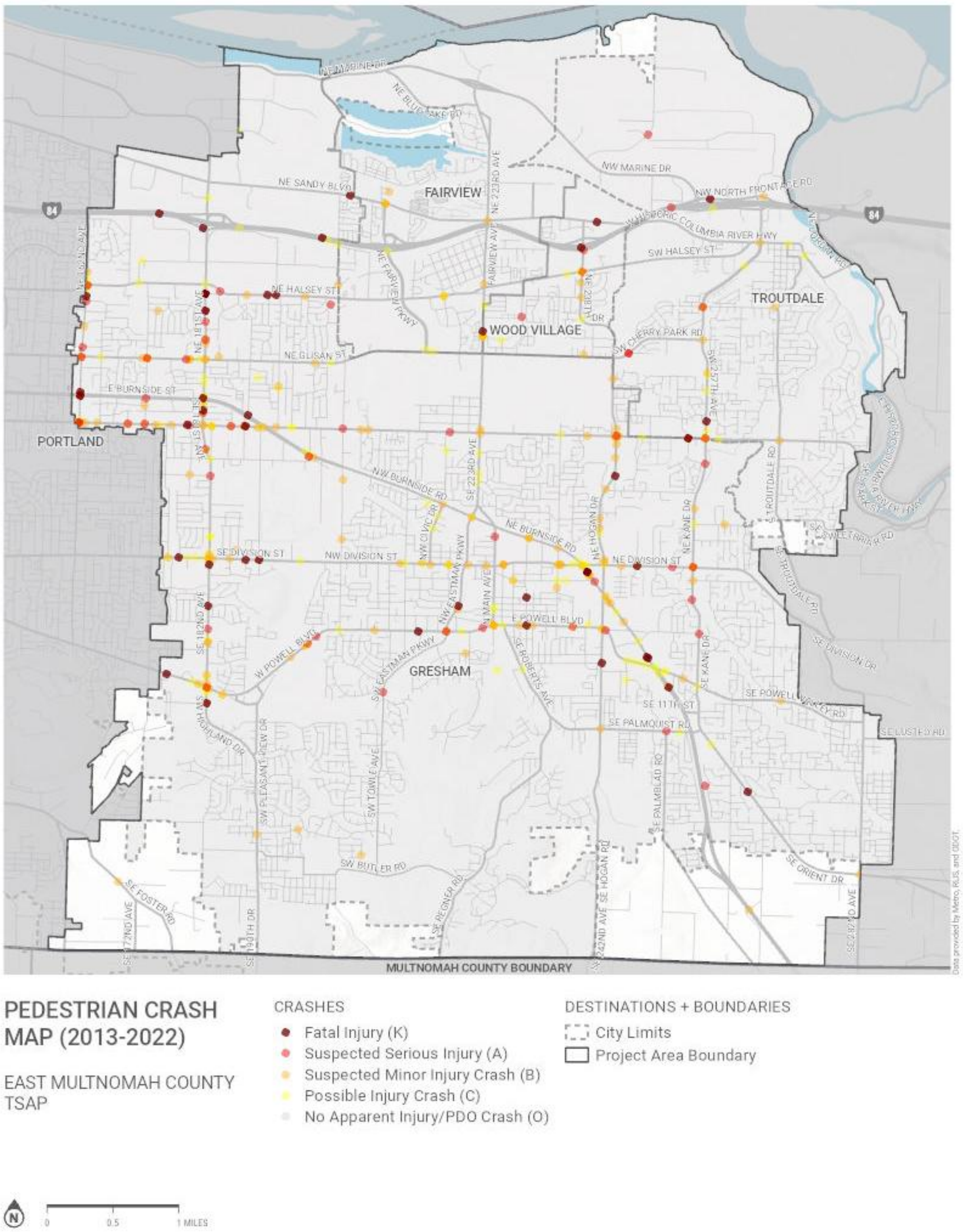
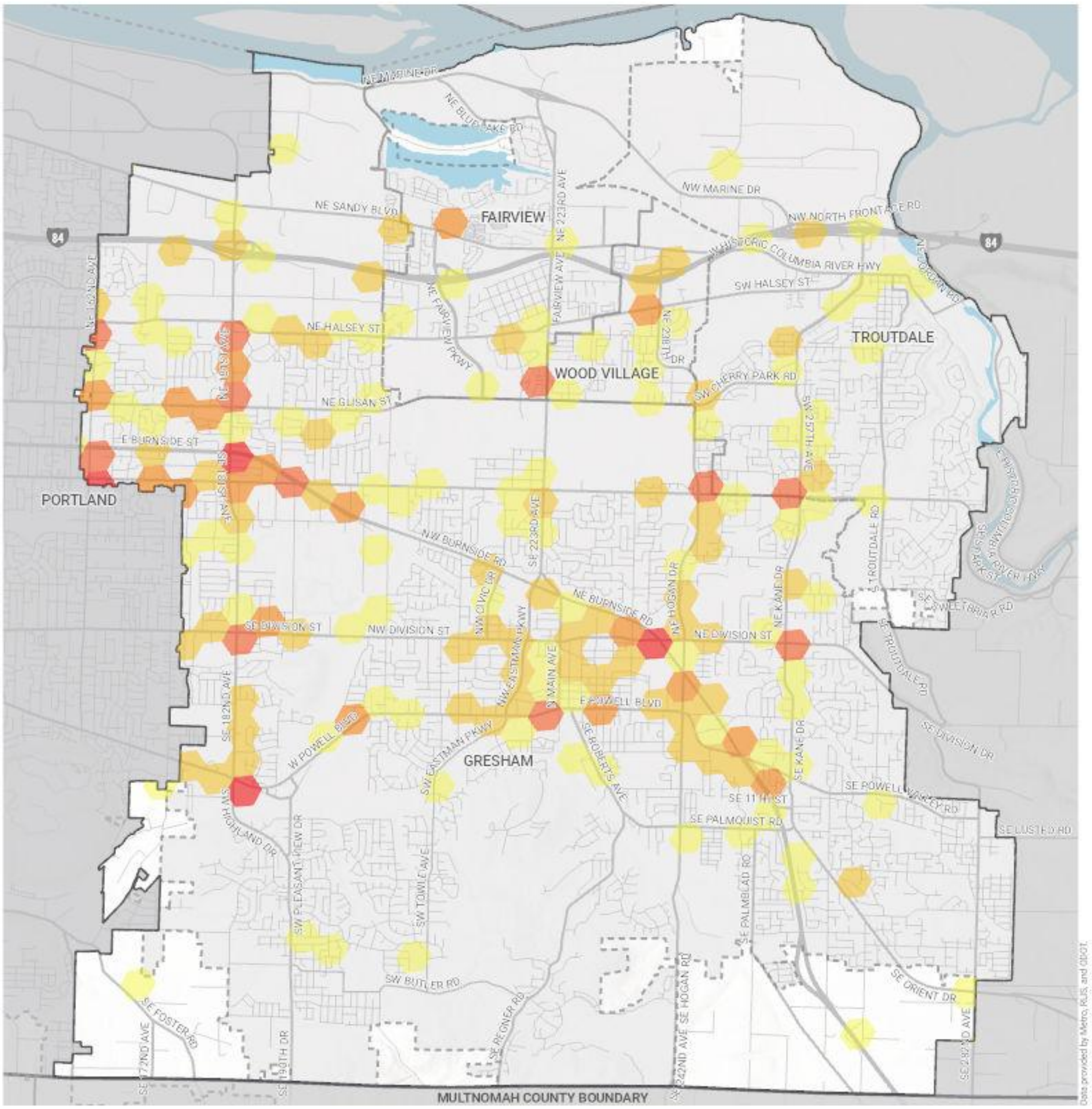


Figure 6: Pedestrian-involved Crash Points by Severity



PEDESTRIAN CRASH DENSITY MAP (2013-2022)

EAST MULTNOMAH COUNTY TSAP

CRASH CONCENTRATION INDEX*

High

Low

* The Crash Concentration Index was developed by summing up crash scores weighted by severity inside a respective hexagon.

DESTINATIONS + BOUNDARIES

City Limits

Project Area Boundary

0 0.5 1 MILES

Figure 7: Pedestrian Crash Density, Weighted by Severity

Bicycle Crash Analysis

Figure 8 shows bicycle-involved crash points, while **Figure 9** shows weighted crash concentrations by hexagon. Bicycle crashes are concentrated in a few corridors particularly along 181st Avenue, Burnside Road, Powell Boulevard, and NE Glisan Street. The intersection of Burnside Road and Division Street has a particularly high concentration. Some other corridors with high concentrations of bicycle crashes include segments on Powell Blvd, Kane Drive, NE Glisan Street and NE Halsey Street.

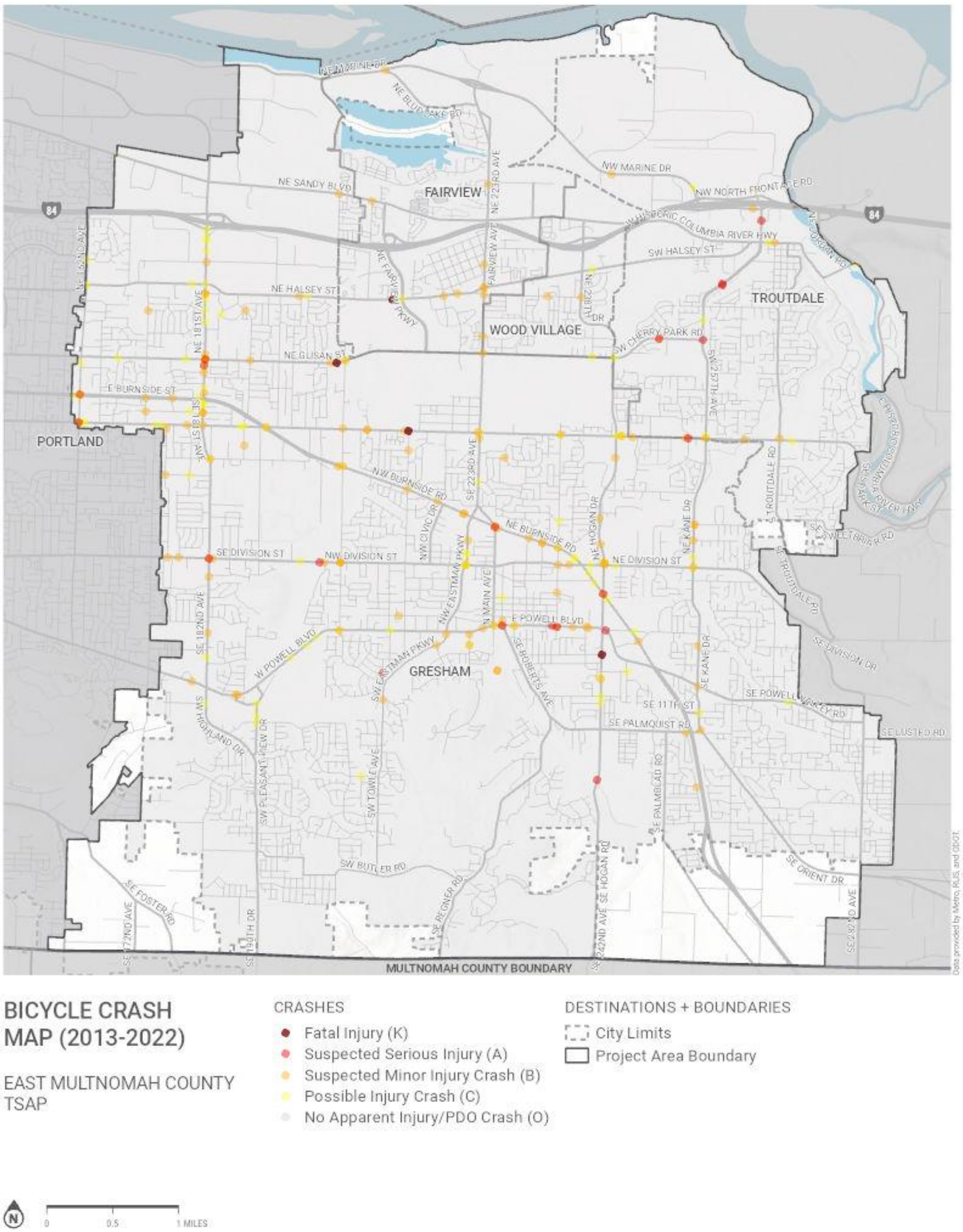


Figure 8: Bicycle-Involved Crash Points by Severity

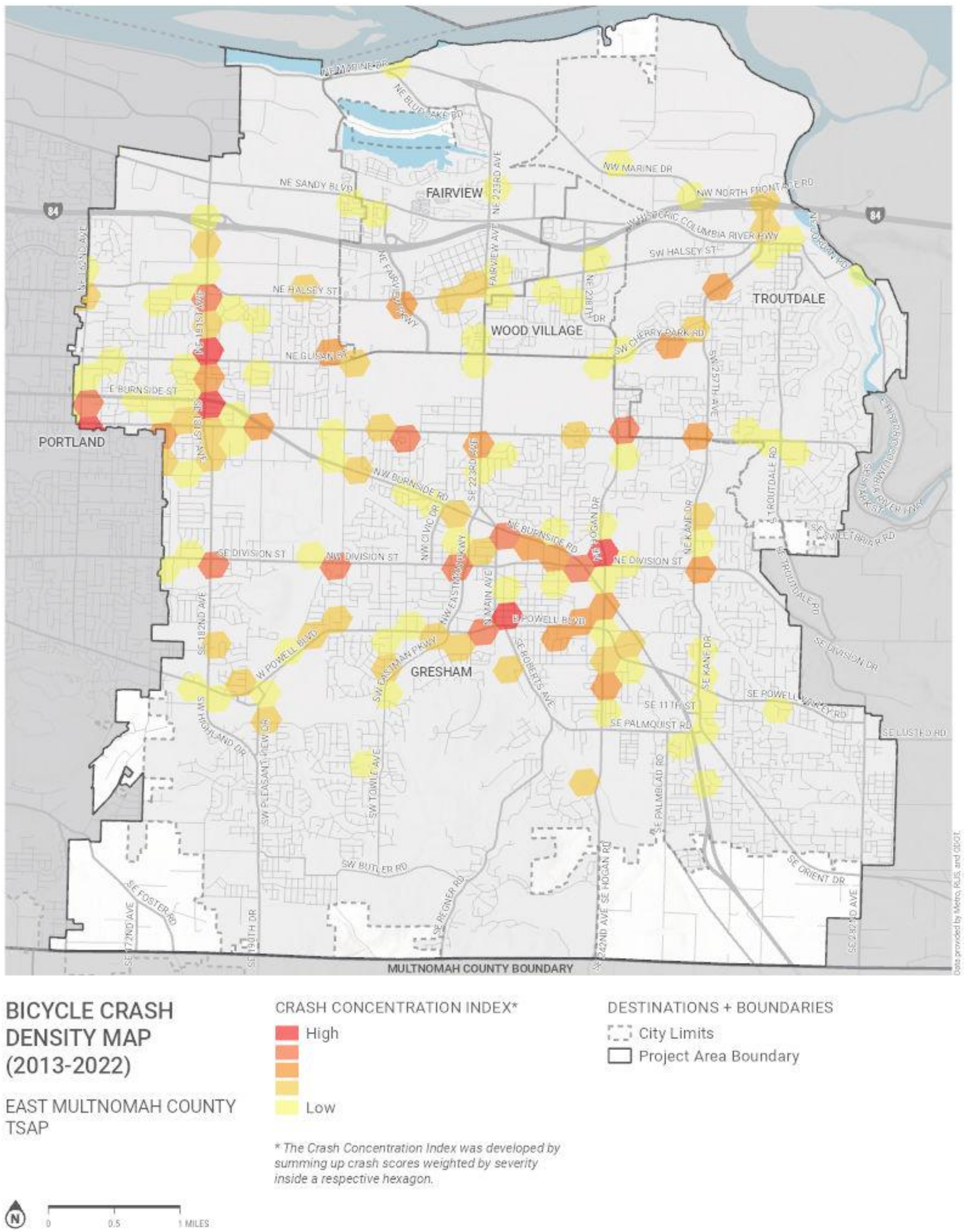


Figure 9: Bicycle Crash Density, Weighted by Severity

Vehicle Crash Analysis

Figure 10 shows vehicle-only crash points, while **Figure 11** shows weighted crash concentrations by hexagon.

There are a significant number of crashes on every major arterial in the study area, particularly in the central and western areas. Fatalities are distributed throughout the study area and are especially concentrated on Burnside Road and 181st Avenue. Fatalities throughout the county are largely at intersections. Minor injury crashes are distributed throughout the study area.

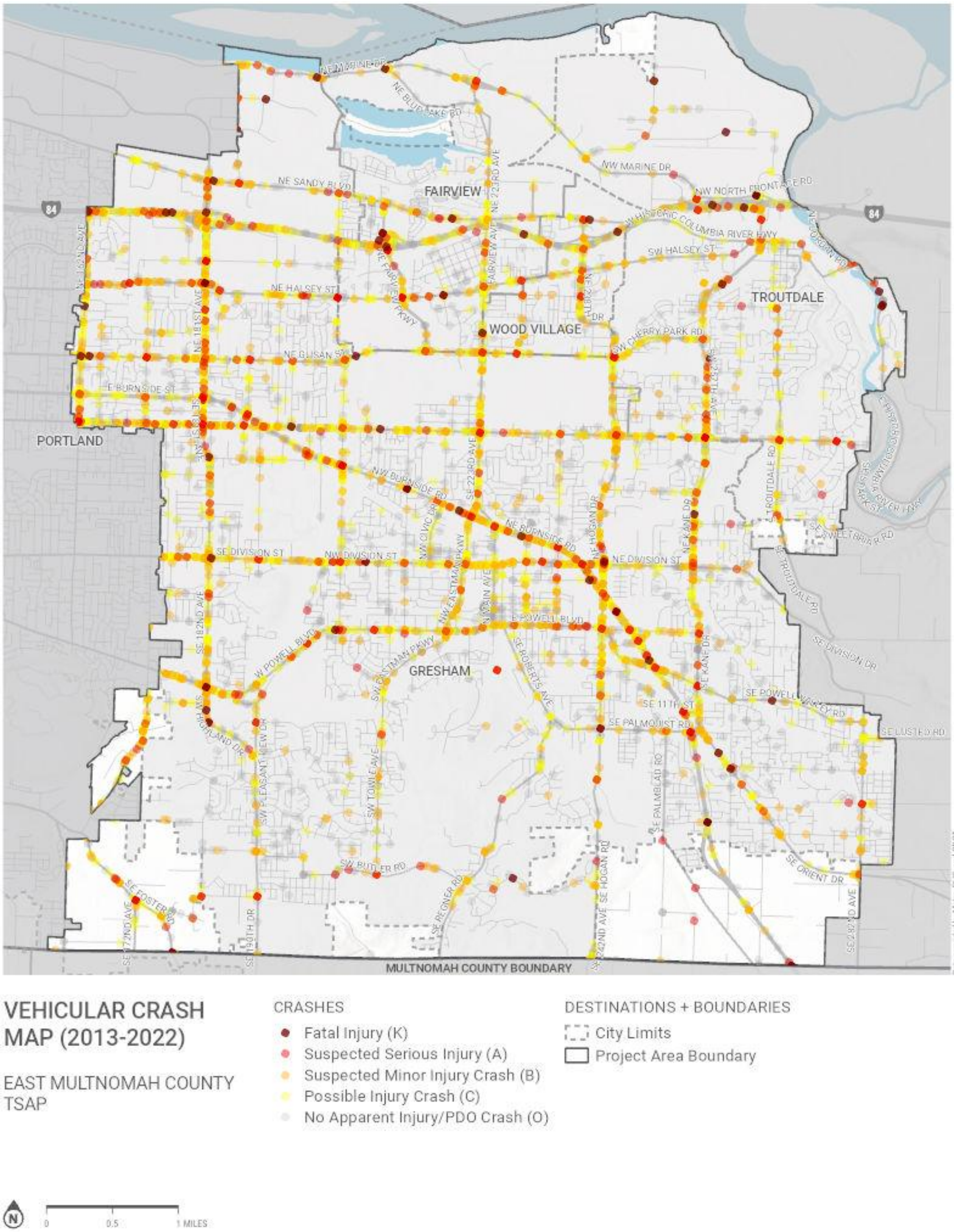


Figure 10: Vehicle Crash Points by Severity

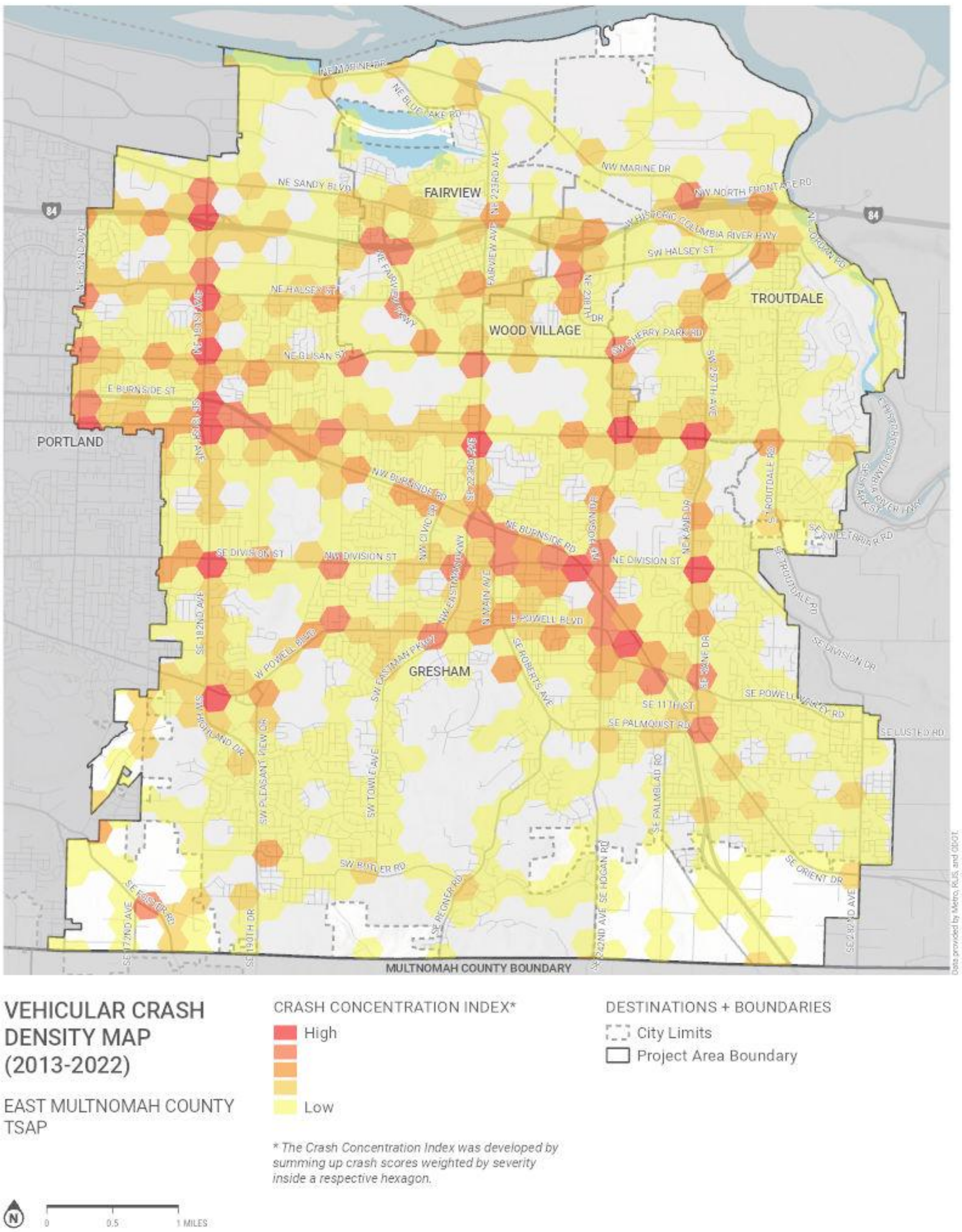


Figure 11: Vehicle Crash Density

All Modes Crash Concentration Analysis

The map featuring crashes of all modes together, shown in **Figure 12**, largely mirrors the motor vehicle-only crash map because vehicle-only crashes represent 89% of all crashes. Again, the highest concentration of any type of injury crash is found at the intersection of Burnside Road and 181st Avenue. This is an intersection of two five- to six-lane arterials and a MAX station.

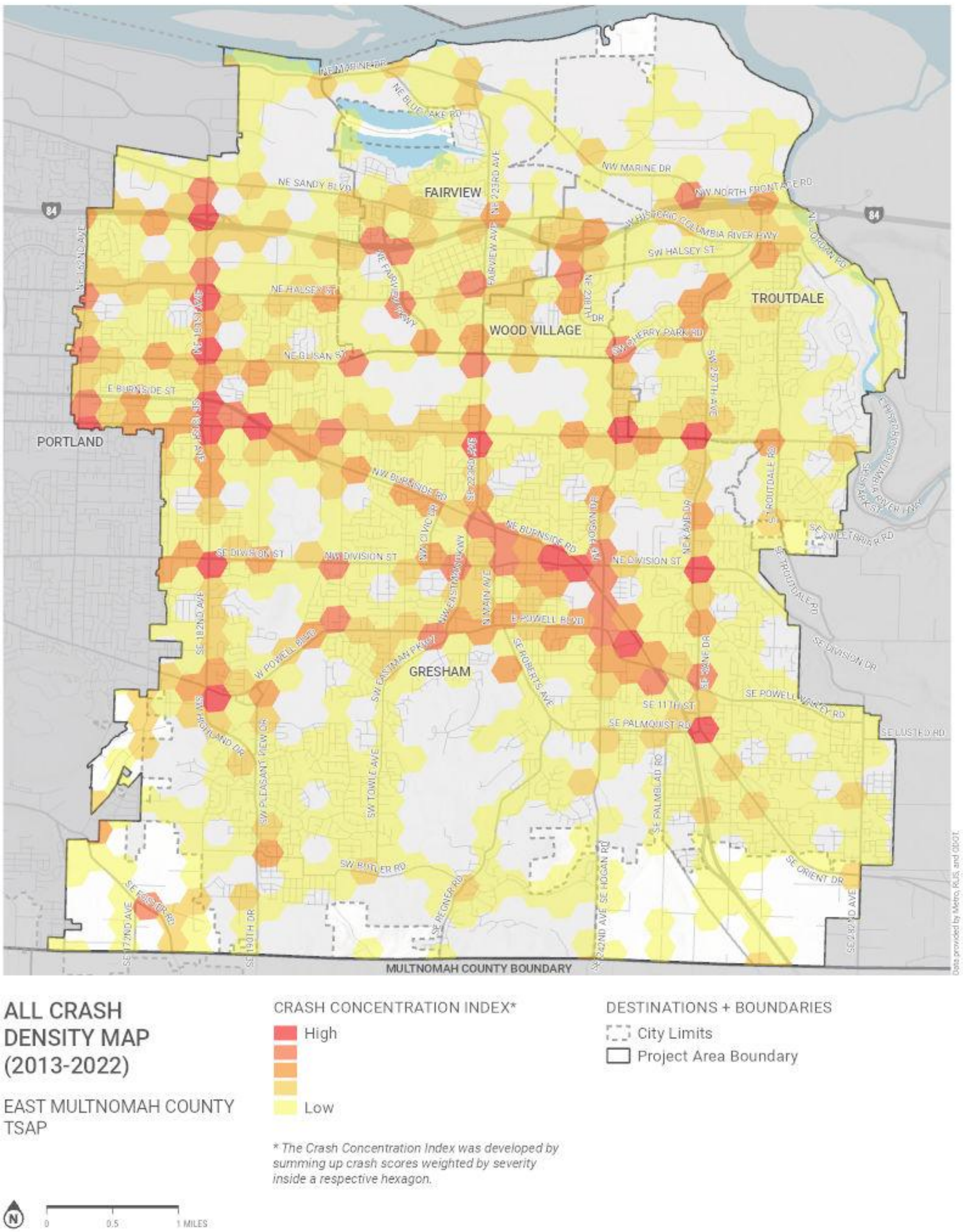


Figure 12: Crash Density, Severity-Weighted, All Modes

High Injury Corridors (HIC)

Regional High Injury Corridors (2017-2021)

Figure 13 displays three mode-specific High Injury Corridor analyses completed at the regional scale by Metro: Bicycle, Pedestrian, and All Modes. The analyses identify the corridors with the highest concentration of serious injury crashes throughout the greater Portland area, comparing all roads over a mile long in the region. Roadways are scored based on the number of fatal and serious injury crashes per mile (or all injury crashes to identify bike and pedestrian high injury corridors) using ODOT crash data from 2017-2021. A roadway qualifies as a high injury corridor if the number of serious crashes per mile places it within the top 20 percent worst scores.[3] This map highlights only the portion of the analysis in urban East Multnomah County.

As shown, the regional HIC corridors are largely in the northern portions of the study area. Burnside Road, W Powell Blvd., and 181st/182nd, highlighted as areas of serious crash concentrations, appear as HICs for each of the three modes. Burnside Road and 181st have over eight serious crashes per mile.

The regional HICs highlight some different patterns than the crash analyses that are specific to East Multnomah County. Roads that do not rise to the top high injury corridors for East Multnomah are still, when compared to the region, relatively high-risk.

[3] Metro High Injury Corridor Metadata

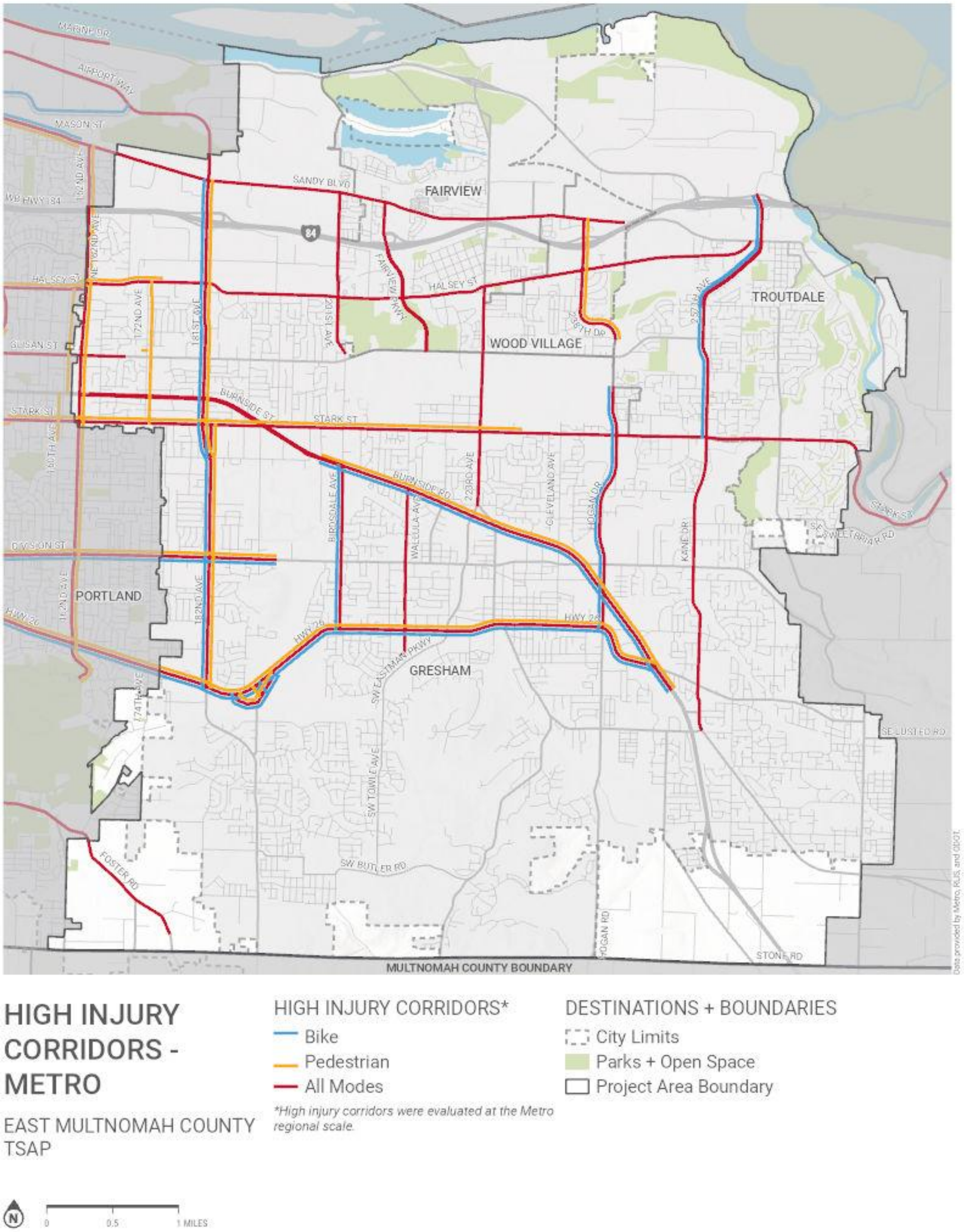


Figure 13: HIC analysis (2017-2021). Source: Metro

Equity Analysis

Justice 40 and Metro Equity Focus Areas

At the census tract level, Alta identified equity areas present in the U.S. Council on Environmental Quality Justice 40 and Metro datasets. This is shown in **Figure 14**.

Most of the census tracts in the East Multnomah County study area were identified as equity focus areas in either the Metro or Justice 40 datasets, with many being identified in both. Due to this, Alta developed a composite equity score to better prioritize census tracts, as described in the next section.

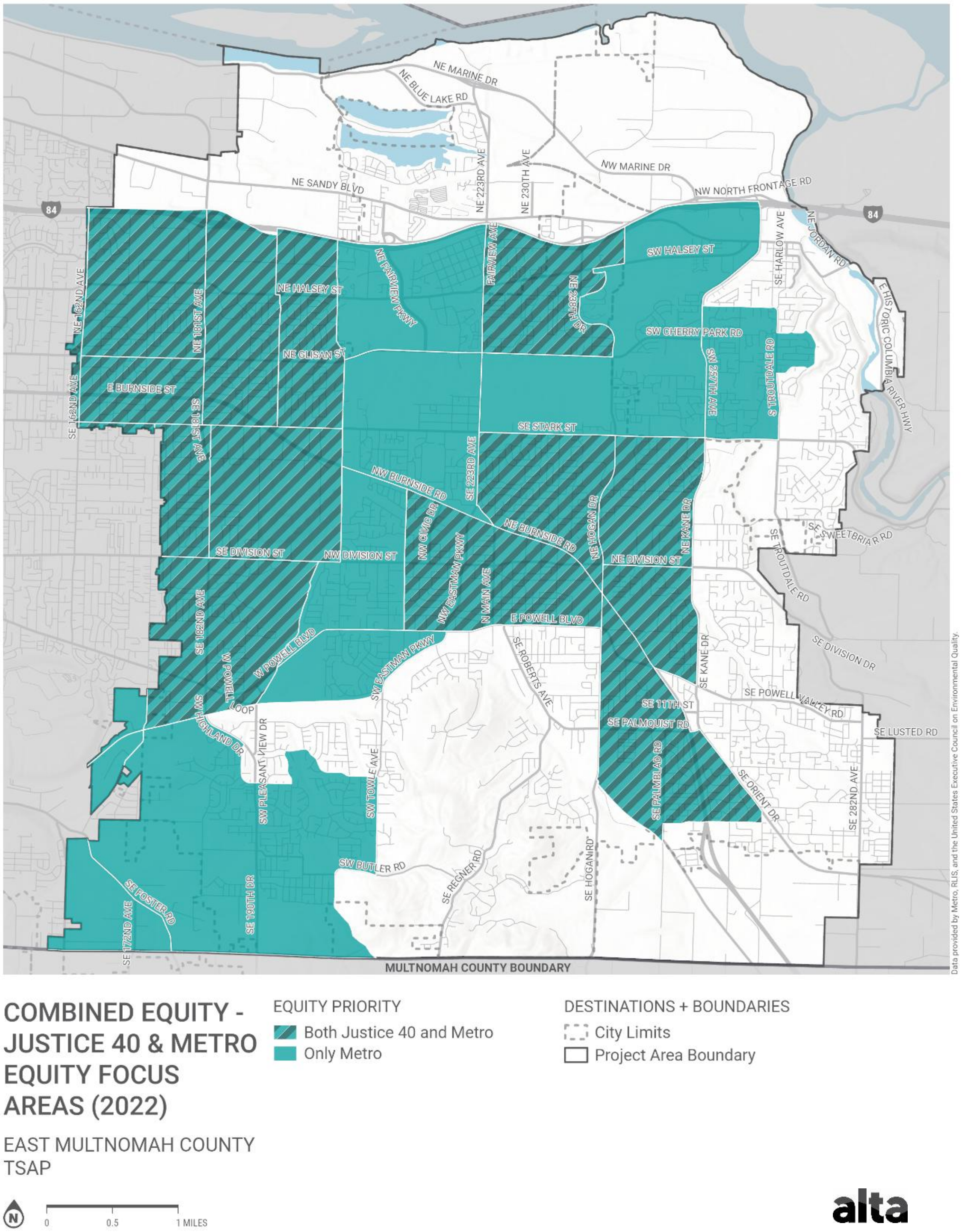


Figure 14: Combined Equity Focus Areas

Composite Equity Priority Map

Alta completed an equity analysis to identify areas of high equity priority in East Multnomah County. A composite equity score was generated using ten weighted variables as shown in **Table 1.**

Table 1: Equity analysis variables

Variable	Weight	Data Source
Percent low-income households	25%	American Community Survey, 2022
Percent people of color or Hispanic	20%	American Community Survey, 2022
Percent youth or senior (Under 19 or over 65)	5%	American Community Survey, 2022
Percent of households with no vehicle	10%	American Community Survey, 2022
Housing Cost Burden	5%	American Community Survey, 2022
Percent with no High School Diploma or GED	10%	American Community Survey, 2022
PM 2.5 levels of air pollution	5%	EJScreen
Lack of Tree canopy	5%	Tree Equity Score
Economic Opportunity	10%	Opportunity Atlas
Coronary Heart Disease	5%	CDC Places

Higher equity priority areas are in the western portions of the study area with pockets alongside Burnside Road in southeast portions of the study area, as shown in **Figure 15**. Equity priority areas align somewhat with the areas with higher number of crashes, highlighting a need for focused safety measures in these areas. Central portions of the study area are areas of median equity priority. The tracts with the top 20% of equity scores in the study area were extracted and used for comparison in the safety analysis.

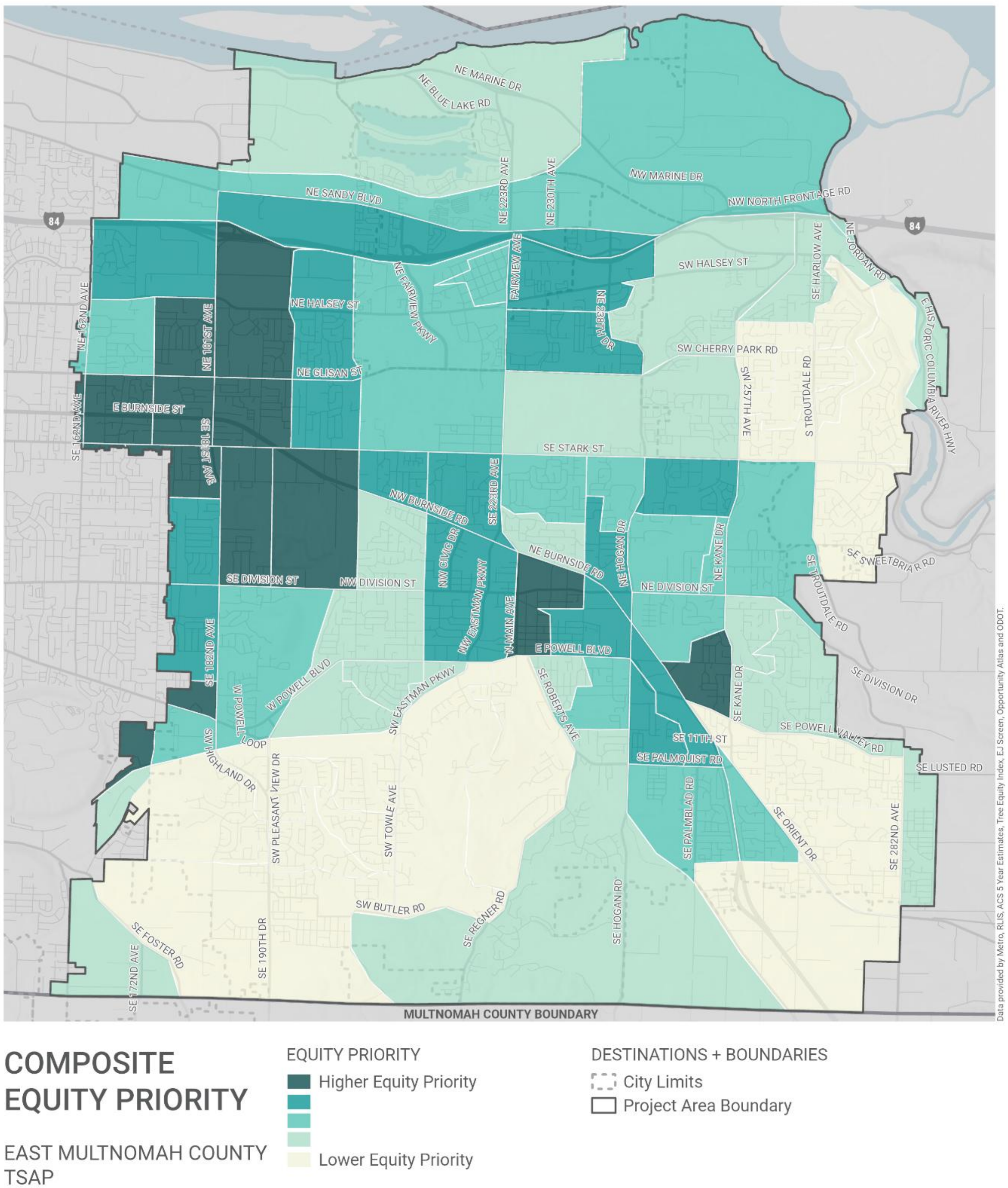


Figure 15: Composite Equity Priority Areas

Person-Trip Assignment Equity Index

Alta used the activity-based model from Replica Places (2023)[4] to study the travel habits of low-income populations in East Multnomah County. This approach moves beyond merely understanding where low-income populations live and examines how they use the transportation system and which locations they frequent. Findings are important for understanding which facilities are most used by these populations, so that improvements can be concentrated where they will have the most benefit.

This analysis first examined the number of bike, walk, or transit trips ("sustainable transportation") by corridor for the population earning less than 80% of Area Median Income. Results, shown in **Figure 16**, show that the highest volumes of sustainable transportation trips occur along the MAX Blue Line corridor on East Burnside/NW Burnside Road in Gresham, which is also served by TriMet Route 287 and has a bike lane along some of it, in addition to adequate sidewalks. High volumes of sustainable trips are also shown on NW Division St, W Powell Blvd, NE Glisan St, SE Stark St, NE Halsey St, and SE 182nd Avenue. Most of these corridors have bike facilities as well as sidewalks and bus service. Most also run through commercial areas with a variety of retail and recreational destinations.

These findings suggest that robust infrastructure as well as a mix of destinations support active trips. They also demonstrate that low-income residents travel about the region for a variety of reasons; their trips are not limited to low-income neighborhoods. Maintaining and improving bike, pedestrian, and transit infrastructure on these corridors will support the many people already using these systems, making their trips even safer and more comfortable, which is of critical importance especially for people without access to a vehicle. Adding infrastructure to similar corridors with lower volumes may induce more sustainable trips in those areas as well.

Next, this analysis examined the percentage of trips made by low-income people where the primary mode was biking or walking ("active transportation"). The hot spots here, shown in **Figure 17**, were more sporadic, but high shares were found along SW Halsey St, NE Sandy Blvd, and NE 201st Avenue in Fairview. There are several apartment buildings and mobile home parks in this area, as well as a small commercial area and Reynolds Middle School. Infrastructure in these areas is mixed: While Halsey Street and NE 233rd Avenue have bike lanes and sidewalks, Sandy Blvd. and NE 201st Avenue do not. Some other more isolated hot spots occurred mainly on blocks adjacent to schools: N Main Ave, in front of Gresham High School, SE 217th Ave, in front of North Gresham Elementary, and SW 257th Ave, in front of Reynolds High School. Children and youth are likely to be a larger share of people walking or biking in these areas.

These results highlight areas where low income people, by choice or necessity, are most likely to choose active transportation. Adding or improving facilities in these areas will improve safety and comfort as people navigate to work, school, errands, and social opportunities.

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[4] Replica Places is an activity-based travel demand model based on a synthetic population. Trips by low-income populations are modeled based on the demographics of the census tracts where trip-makers live. More details are available at https://documentation.replicahq.com/docs/demographics-employment.

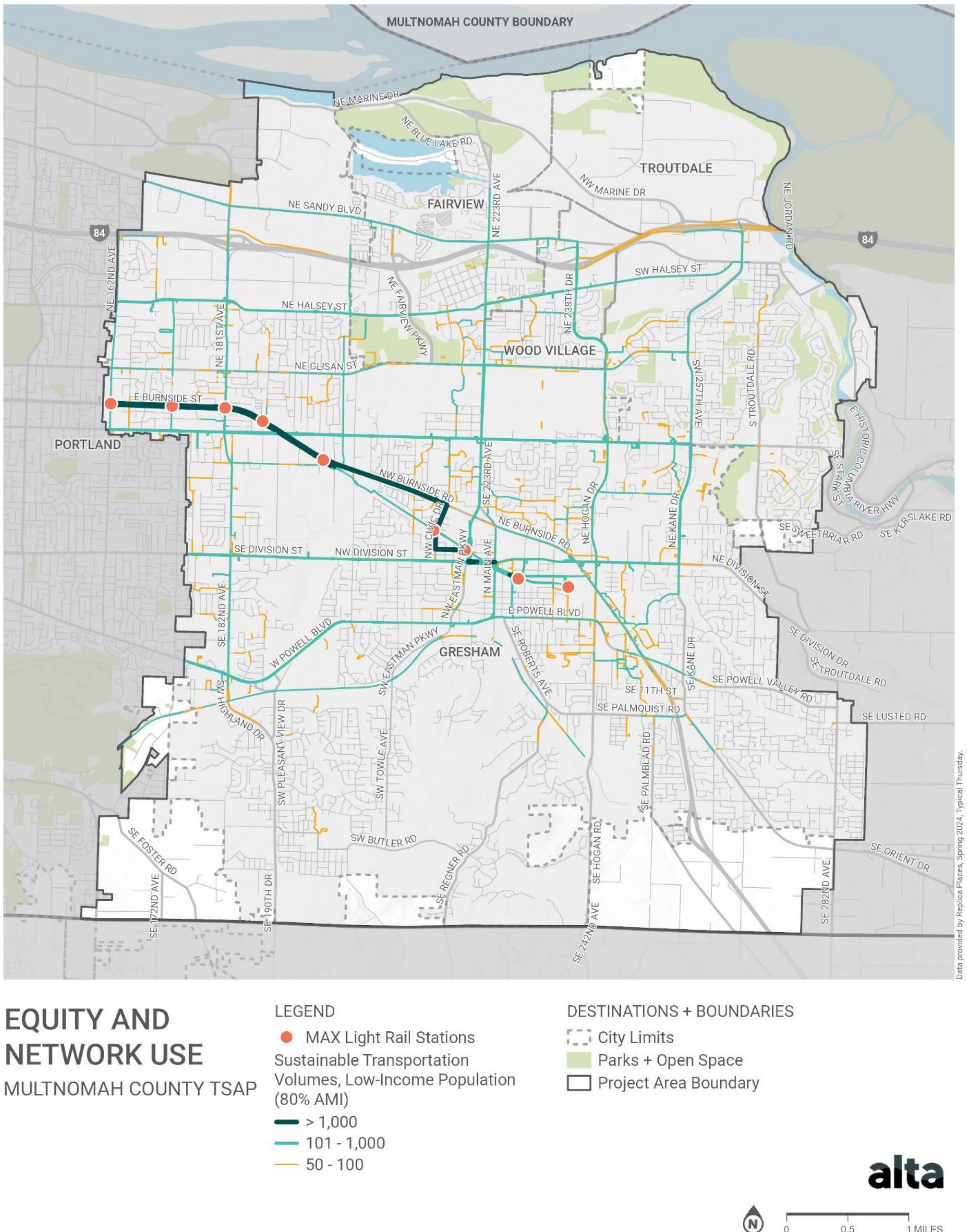

Figure 16: Sustainable transportation trip volumes made by low income people

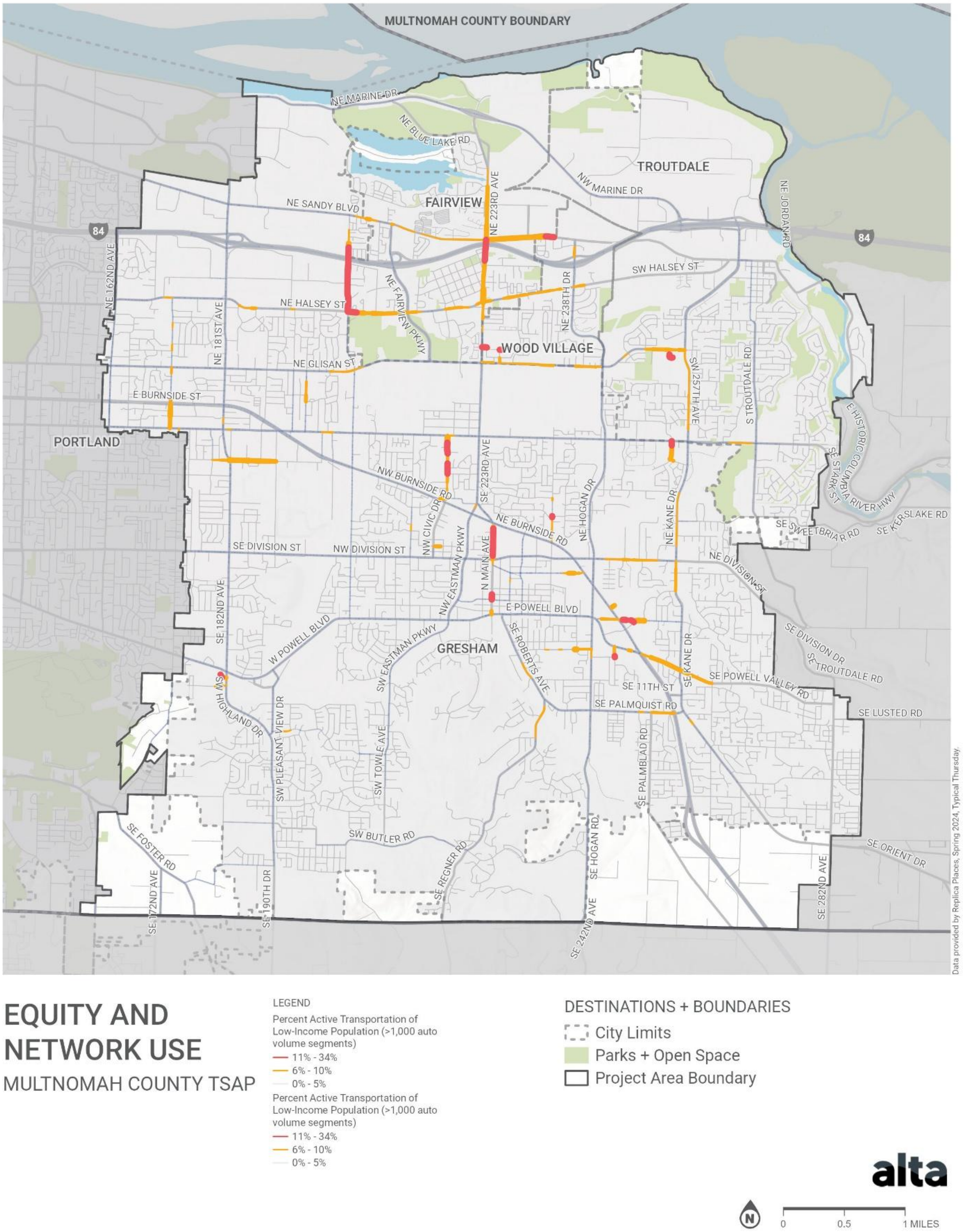

Figure 17: Percentage of low-income trips made by active modes

Spatial-Temporal Analysis

The Alta team conducted a spatial-temporal analysis of crashes (2013-2022) in the study area, identifying specific crash hotspot locations, and trends of crashes in hexagon areas. The crashes analyzed in the spatial-temporal analysis included all crashes in the study area, including along the highways. These results were then compared with hexagons from the crash concentration analysis and top 20% equity areas. This section is divided into the following parts:

1. Introduction to Spatial-Temporal Analyses and Space Time Cubes.
2. Maps resulting from the Spatial Temporal Analysis and discussion.
3. Maps and relation of Equity Analysis to Spatial-Temporal Analysis.

Introduction to Spatial-Temporal Analyses and Space Time Cubes

Typically, crash analyses focus on the spatial nature of crashes that occurred over a set window of time, such as five or ten years. These analyses consider *where* a crash occurred, but do not specifically consider *when* in the window it occurred. By considering the role of time in addition to location, trends can emerge that help distinguish between areas with short-term or seasonal crash spikes and areas with consistent crash patterns. Using crash data from 2013 – 2022, Alta performed a spatial-temporal analysis to analyze injury-causing crashes over time.

The concept of temporal analysis can be best illustrated with an example. Consider two hypothetical intersections over a period of five years. Location A has five injury-causing crashes and location B has three injury-causing crashes in that five-year window.

Location A	Location B
5 crashes	3 crashes

A traditional crash analysis would identify Location A as a higher priority for safety investments based solely from crash count. However, by considering time, it might become apparent that all the crashes at Location A occurred in year one, while Location B's crashes were distributed evenly across the five-year window.

Year	Location A	Location B
1	5 crashes	1 crash
2		
3		1 crash
4		
5		1 crash

This addition of the time component paints a different picture than a spatial analysis alone. Year one may have been an anomaly that caused five crashes in an intersection that usually has no crashes: perhaps an ice storm or major event that brought many visitors to the city, for example. It could also indicate where safety improvements during the study period have been effective in reducing crashes, so the area does not need to be flagged for further improvements. On the other hand, data at Location B suggests a steady pattern of crashes that may require attention.

The Alta team conducted the spatial-temporal analysis of crashes (2013-2022), through employing a geospatial space time cube. The space time cube agglomerated crash points in hexagons with a radius of 200 feet, at a timeframe of two-month periods. A visual depiction of the process is displayed in **Figure 18** and **Figure 19**.

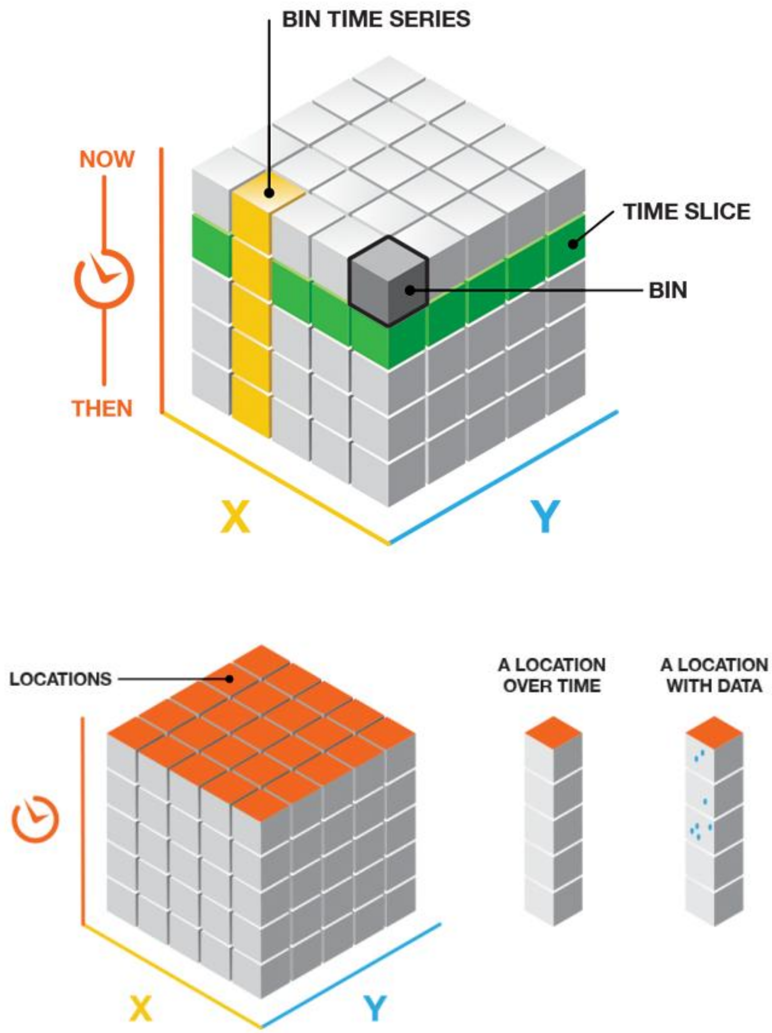

Figure 18: Space-time cubes show trends in data over time rather than analyzing only one slice of time (such as 10 years). Source: ESRI

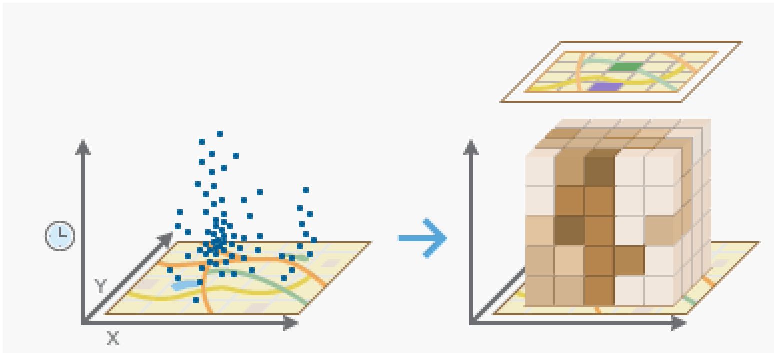

Figure 19: Space-time cubes can be thought of as adding a third dimension, time, to two-dimensional spatial data. Source: ESRI

The Alta team ran an emerging hot spot analysis on the newly created space time cube. This analysis functions by identifying trends in the spatial clustering of crash points, comparing these clusters to a global density value in a defined time period[5]. Temporal patterns are then identified to create a joint conceptualization of clusters across space and time by comparing local neighborhood patterns being statistically different from global patterns.

For this analysis, the Alta team analyzed data in two-month periods. Crashes were clustered within 800-foot-wide neighborhoods, which allows for the identification of relatively small hotspots and generates different outputs than when larger neighborhood sizes are used. The Alta team ran a sensitivity analysis of the results, determining the following parameters, including the impacts of fluctuations of the neighborhood time step, neighborhood extent and defined global window. A detailed definition of parameters used in the analysis is provided in **Additional Safety** Analysis

Alta performed additional in-depth safety analyses of key issues that arose from stakeholder and community engagement, as well as the results of the initial systemic safety analysis. The topics chosen for additional safety analysis included the following:

- A mid-block crossing analysis to identify locations in E Multnomah County where there may be mid-block crossing needs;
- A lighting analysis to identify locations where lighting conditions are unsafe for pedestrians;
- A speed data analysis to identify locations in E Multnomah County where observed speeds exceed posted speed limits; and,
- A detailed review of the contextual and safety data at two locations where crashes are increasing over time based on the temporal map data shown in **Figure 23.**

[5] Esri. (2023). Emerging Hot Spot Analysis (Space Time Pattern Mining)—ArcGIS Pro. https://pro.arcgis.com/en/pro-app/latest/tool-reference/space-time-pattern-mining/emerginghotspots.htm

Crossing Safety Analysis

The crossing safety analysis aimed to identify areas in which pedestrians were struck in the roadway while not at an intersection or crosswalk. Alta used an intersection type attribute in the crash data to identify 68 pedestrian-involved crashes that were not at an intersection. In examining the data spatially, Alta noticed that in 40% of crashes, a pedestrian was within 200 feet of an intersection or crosswalk but nonetheless was not at the intersection. In the other 60% of crashes, a pedestrian was farther away. For the purposes of this analysis, all crossings not at crossings are referred to as “mid-block.” Alta assumed that all signalized intersections had crosswalks, and unsignalized crossings did not, because comprehensive crosswalk data was not available. A brief desktop review of aerial and street-level imagery was performed to validate this assumption. We also used a spot check of aerial imagery to verify the accuracy of the intersection tags in the crash data and to confirm that crashes marked as not at an intersection were also not at a mid-block crossing.

As shown in **Figure 33**, many mid-block crashes occurred along SE 182nd Ave/NE 181st Avenue. The largest cluster of pedestrian mid-block crashes occurred near the intersection of NE Burnside Road and NE Division Street in Gresham. Four crashes, including one fatality and one involving a person in a wheelchair, occurred in close proximity here about 350 feet south of Division Street, between a Motel 6 and a McDonald’s. Three of these four crashes were in the dark, and visibility was cited as an issue in addition to the pedestrian being outside of a crossing. This stretch of roadway has four travel lanes in addition to a two-way center left turn lane. For people wanting to get between two mid-block destinations, it may feel worth the risk to cross mid-block rather than walking 700 feet out of their way, in addition to waiting for a signal. Although mid-block pedestrian signals are not feasible on all roads, they may be warranted in areas with many mid-block crashes and popular destinations on both sides of the street.

Another large cluster of crashes occurred W Powell Blvd. & SW Highland Drive, where four crashes occurred near, but not at, the signal. Three of these four occurred in the dark. Although the distance to the signal was between 110 and 200 feet for these crashes, the time required to wait for the signal may have been enough of a deterrent to incentivize the pedestrian to cross mid-block.

Forty-nine of the 68 mid-block crashes (72%) occurred at dusk, dawn, or after dark, mostly in areas with at least some streetlights, suggesting that pedestrians are especially difficult to see in the dark when drivers are not expecting them, and streetlights alone are not enough to ensure visibility.

Lighting Safety Analysis

The lighting analysis evaluated 160 pedestrian-involved crashes that occurred after dark on roads with sidewalks (crash profile 3) and compared them to lighting quality at intersections of major roads where lighting data was available. Roads with sidewalks were chosen as the focus for this analysis to focus on areas where pedestrians are most likely to walk. Of these crashes, 137 (86%) were recorded as being in areas with streetlights.

Figure 34 shows that crashes after dark are highly clustered in a few areas, including NE Burnside Rd & NE Division St, and along SE 182nd Ave/NE 181st Avenue at West Powell, SE Division, E Burnside, and NE Halsey Street. It is notable that many of these areas were also hot spots for pedestrian mid-block crashes.

Alta evaluated the number of streetlights at each of these locations, a proxy for the quality of illumination in the area. While most clusters were in moderately lit areas, with 1-3 light fixtures, the intersection at E Burnside & NE 181st Ave was heavily lit (defined as having at least four light fixtures). Of 32 after-dark crashes at this intersection, 16 (50%) were rear-end crashes and five involved a pedestrian. This is a major intersection with 4-5 lane roads, a MAX station, and significant commercial activity nearby. The lighting may simply not be sufficient to overcome drivers' distractions, high vehicle volumes, and significant pedestrian activity that contributes to these crash rates, particularly if signal phasing allows for vehicle-pedestrian conflicts and depends on drivers seeing pedestrians crossing before turning.

Only two intersections of major roads did not have any roadway-scale lighting, and these were not hot spots for pedestrian crashes after dark. These intersections were in more rural areas of Southeast Multnomah County, where there are few land uses that generate pedestrian trips.

Crashes occurring after dark were more likely to be mid-block. Overall, 52% of pedestrian crashes after dark were not at an intersection or crossing. The interaction between mid-block and after dark crashes suggests that both factors combine to create more dangerous conditions for pedestrians than either one on its own.

Speed Analysis

Alta's speed analysis identifies areas where uninhibited traffic flows exceed the speed limit, which may highlight corridors where the design speed does not match the speed limit. This analysis compared free-flow speeds on major roads from Replica Places (2023) with posted speed limits on the same roads, as provided by the City of Gresham and Multnomah County. Where posted speeds were not available, Alta assumed 25 mph on residential roads, 55 mph on trunk roads, and 35 mph on frontage roads after a desktop review. Alta also manually validated speed limits on roads with surprising results and made corrections to speed limit data on NW Graham Road, NE Glisan Street, and the Historic Columbia River Highway to ensure accuracy.

The speed analysis, shown in **Figure 35**, showed that most roads have free-flow speeds approximately at or below the speed limit. This does not mean that speeding by individual vehicles does not occur, but the regular flow of most traffic is not exceeding the speed limit.

The amount of traffic traveling below the posted speed indicates that lowering the posted speeds of these roads could be an appropriate measure for arterials with free-flow speeds below the speed limit, such as for example East Burnside Street (west of NE 202nd Avenue), NE 201st Avenue, and NE 233rd Avenue.

Several roads in southern Gresham and Troutdale have free flow speeds up to 5 mph over the speed limit, including W Powell Blvd, SW Towle Ave, SW Pleasant View Drive, and most of the Columbia River Highway. The only major road with free-flow speeds exceeding the speed limit by more than 5 mph is the southernmost portion of Mount Hood Highway in Multnomah County. Two other very small segments in Troutdale were also identified as having excessive free flow speeds. This suggests that the design speed of those roads, the speed which feels safe for most drivers, exceeds the posted speed limit. If reducing speeds on those roads is desired, it may be necessary to implement design changes rather than merely lower the speed limit.

There appears to be some relationship between the 244 crashes cited as being caused by excessive speed and the areas where free flow speeds exceed the speed limit. On the higher-speed portion of Columbia River Highway, four crashes were said to be speed-related, while two were speed related on the highlighted segment of Mount Hood Highway. However, 83% of speed-related crashes occurred on roads where the free-flow speed was equal to or under the speed limit. This suggests that an individual vehicle exceeding the speed limit can occur on any roadway, even when the majority of traffic there is traveling under the speed limit. More detail on how crashes are coded could also illuminate this trend; it could be that officials are more likely to classify crashes related to speed if the vehicle speed exceeded that of other traffic, rather than exceeding the speed limit.

There is not a strong correlation between areas with excessive speed and those with high mid-block or after-dark crashes. An exception is a section of West Powell Boulevard, where free-flow speeds exceed the speed limit by up to 5 mph, and where a cluster of after-dark crashes occurs west of Birdsdale Avenue.

Appendix A. Through this sensitivity analysis, the Alta team determined that these parameters were the most suitable for the analysis.

Results

As there are still challenges in communicating the results of a space time cube in a three-dimensional format, the Alta team concluded the best way to visualize the results would be in a two-dimensional format. The list below outlines the maps included in this section. Descriptions of results are included under each map.

1. Crash Trend Analysis: All Modes
2. Temporal Crash Hotspot & Concentrations
3. Temporal Crash Hotspot & Trend Bin Analysis

Crash Hotspot Analysis: All Modes

Figure 20 displays the hotspots of crashes (2013-2022), comparing each hexagon repeatedly over yearly periods to a global hexagon average in terms of crash count. The hot spots show the locations with a continuous trend of a high number of crashes. A takeaway from this map is that hotspot locations are distributed throughout urban East Multnomah County. Concentrations are found in the communities of Wood Village and Fairview, along Burnside Road and Division Street and the 181st Ave/182nd Ave/Highland Drive corridor. Furthermore, there are smaller concentrations found in the Northwest and the Southeast of the maps. It is important to note however, that the relative distribution of the hotspots is highly dependent on the specific parameters used in the emerging hot spot analysis, described above and in Appendix A. With a neighborhood search distance of 800 feet, the focus of this analysis was primarily on identifying small geographic areas of crash clusters that providing a similar neighborhood search scale to our larger hexagons used for our previous summaries.

Temporal Map Hot Spot Trends

Temporal hot spots, defined as locations where there was an upward trend in crashes and a hotspot showing that the frequency of crashes at a location was consistently high during the time under study (2013 – 2022), were apparent in a review of **Figure 23.** The two highest hot spot locations were chosen for a qualitative review of crash and contextual trends: NE Glisan Street and NE 223rd Avenue, and E Burnside Street and SE Stark Street/SE 190th Avenue.

NE Glisan Street and NE 223rd Avenue

There were 51 crashes at NE Glisan Street and NE 223rd Avenue in the past ten years, with two serious injury crashes, one bicycle crash and no pedestrian crashes. Most crashes (45%) occurred in the dark with streetlights on. Over half (53%) of the crashes at this intersection were rear-end crashes, 25% were turning movement crashes and 10% were angle crashes. The top four contributing circumstances were failure to avoid vehicle ahead (31%), did not yield right-of-way (16%), followed too closely (12%) and disregarded traffic signal (10%).

Over the past ten years, rear-end crashes have increased at this intersection, with 10 out of the total 27 rear-end crashes occurring in 2021 and 2022. During the study time period, there has not been any significant new development or infrastructure changes at NE Glisan Street and NE 223rd Avenue.

The intersection of NE Glisan Street and NE 223rd Avenue has sidewalks, narrow bike lanes, and transit stops, and yet it is not designed for the comfort and safety of pedestrians and bicyclists. The intersection has speed limits of 40 MPH, no physical separation of vulnerable roads users, no pedestrian scale streetlights, and a right turn slip lane for vehicles turning right southeast. The protected left turns at this intersection do minimize the risk of left turning movement crashes. However, the high number of rear-end crashes are likely caused by drivers exceeding safe speeds, drivers following too closely and driver inattention. Based on the crash data and a brief desktop review of the roadway context, some countermeasures at NE Glisan Street and NE 223rd Avenue could include longer yellow and all-red signal phase time, reducing speed limits and narrowing travel lanes to encourage lower travel speeds, curb extensions to slow down right turns and improve safety for pedestrians crossing, removing the right-turn slip lane, and widening and separating the bike lane

E Burnside Street and SE Stark Street/SE 190th Avenue

There were 52 crashes at E Burnside Street and SE Stark Street/SE 190th Avenue in the past ten years, with one serious injury crash, two bicycle crashes and two pedestrian crashes. Most crashes (45%) occurred in the dark with streetlights on. Forty-two percent of the crashes at this intersection were rear-end crashes, 33% were turning movement crashes and 10% were angle crashes. The top four contributing circumstances were failed to avoid vehicle ahead (25%), did not yield right-of-way (17%), disregarded traffic signal (13%) and too fast for conditions (12%).

There has not been an observed increase of a specific crash type or contributing circumstance trend at this intersection in the past ten years. However, some new development has recently been constructed just west of the intersection (from 2019 – 2022), potentially increasing the number of people traveling through this intersection.

The intersection of E Burnside Street and SE Stark Street/SE 190th Avenue has a skew, a third T-intersection 50 feet west of the main intersection, sidewalks, narrow bike lanes along SE Stark Street, and at-grade light rail, creating a complex scenario for all road users. Skewed intersections have longer crossing distances for pedestrians, higher than typical speed turning movement for vehicles, and lower visibility for drivers making acute turns. Based on the crash data and a brief desktop review of the roadway context, some countermeasures at E Burnside Street and SE Stark Street/SE 190th Avenue could include improving pedestrian scale lighting, not allowing right turns on red, curb extensions to slow down right turns and improve safety for pedestrians crossing, and widening, separating and extending the bike lane to the intersection.

Additional Safety Analysis

alta

Alta performed additional in-depth safety analyses of key issues that arose from stakeholder and community engagement, as well as the results of the initial systemic safety analysis. The topics chosen for additional safety analysis included the following:

- A mid-block crossing analysis to identify locations in E Multnomah County where there may be mid-block crossing needs;
- A lighting analysis to identify locations where lighting conditions are unsafe for pedestrians;
- A speed data analysis to identify locations in E Multnomah County where observed speeds exceed posted speed limits; and,
- A detailed review of the contextual and safety data at two locations where crashes are increasing over time based on the temporal map data shown in **Figure 23.**

Crossing Safety Analysis

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Appendix A

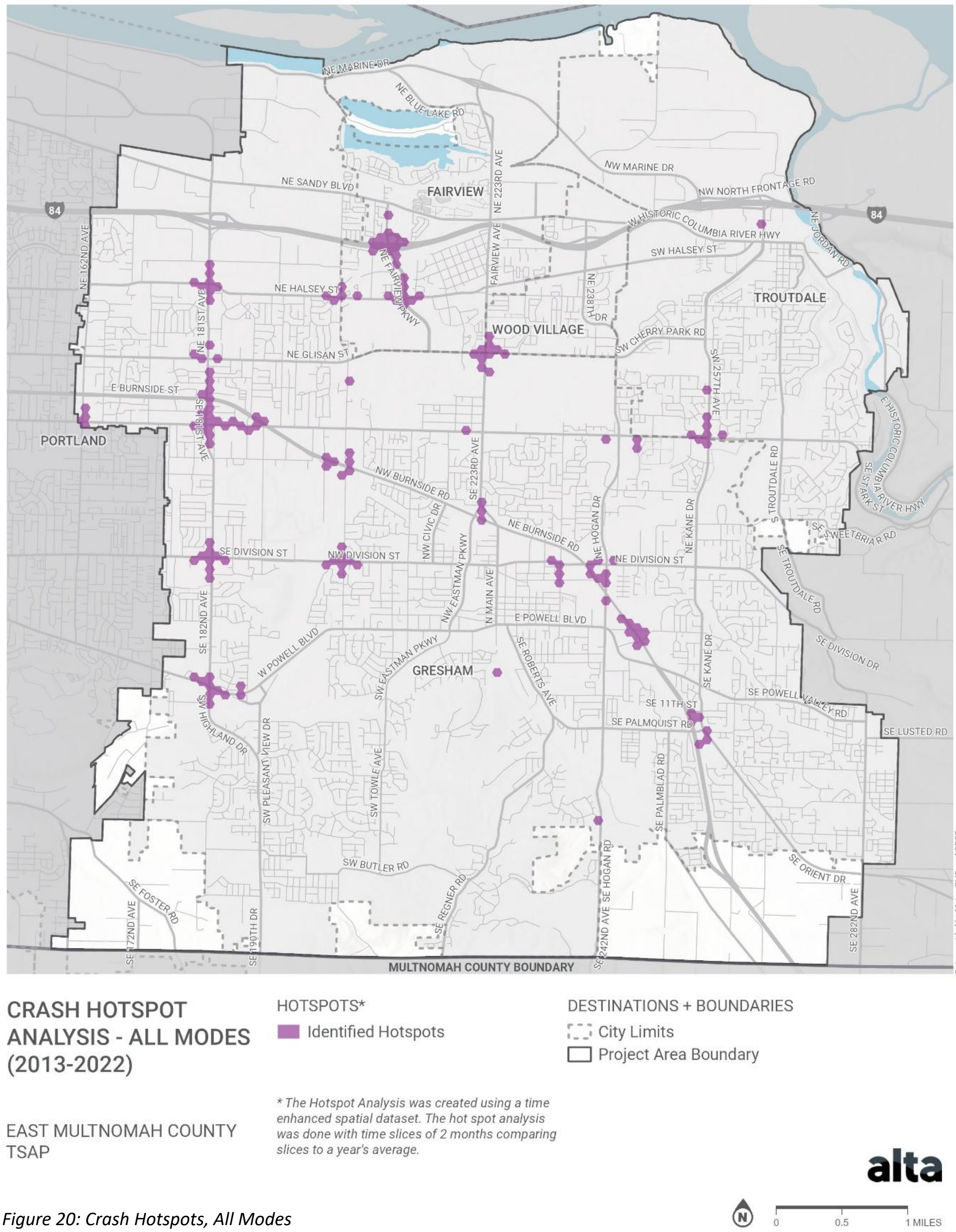

Figure 20: Crash Hotspots, All Modes

Crash Trend Analysis: All Modes

Figure 21 demonstrates the results of a crash trend analysis at the hexagon level. This analysis evaluates a location and deduces whether there is statistically significant[6] upward or downward trend in the number of injury crashes at that location over time. The trend analysis complements the crash concentration analysis by highlighting how crash numbers are changing in an area, rather than the absolute number of crashes there. The lack of an upward trend does not mean the location does not have a high number of crashes; rather it may indicate persistent crashes. Similarly, a downward trend indicates an area where crash rates have improved, but this does not say how many crashes are still occurring there.

The map shows that the communities of Wood Village and Fairview have high concentrations of hexagons which are trending upwards, while having a lower number of hexagons trending downwards. This could potentially be correlated with an increase in activity in the area. Furthermore, 181st Street and NE Burnside Road have a mix of upward and downward trend bins. As this analysis was done on a micro scale, this could potentially be attributed to treatments that have had an effect over time. However, it should be noted that NE Burnside Road appears to have an upward trend throughout the study area and is a major arterial through the region.

This map also demonstrates a substantial number of areas where there are downward trends in crashes. These concentrations are primarily located in Troutdale and along Kane Drive and Division Street.

[6] Statistical significance, shown in terms of confidence levels on the map, states how confidently we can say that the apparent trend is due to an actual change in crash rates rather than random chance.

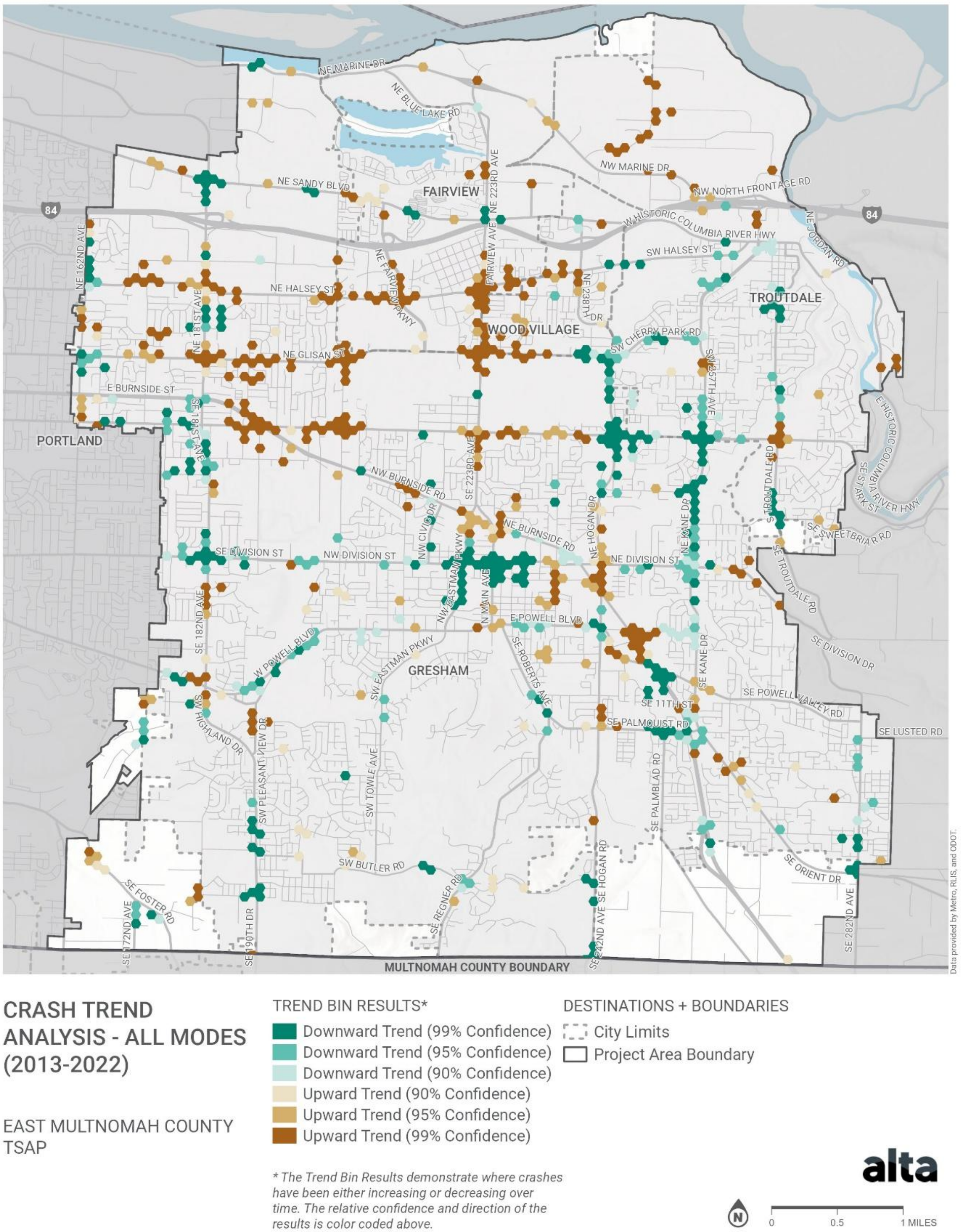

Figure 21: Crash Trend Analysis - All Modes

Temporal Crash Hotspot & Concentrations

Figure 22 overlays the hotspots where there are persistent crashes over time from **Figure 20** on top of the crash concentrations from **Figure 12**. The resulting map compares the crash concentration areas with the temporal crash hotspots that have a constantly high number of crashes over time. As is to be expected, there is high overlap, but there are locations that have high crash concentration values, but no hotspots. This could indicate that in these areas, total crash numbers were influenced by a specific year or otherwise isolated events and not evenly distributed throughout the ten year time period. It is important to note that the emerging hot spot analysis does not give weight by severity, so it could also indicate that the location had fewer total crashes, but they were more severe.

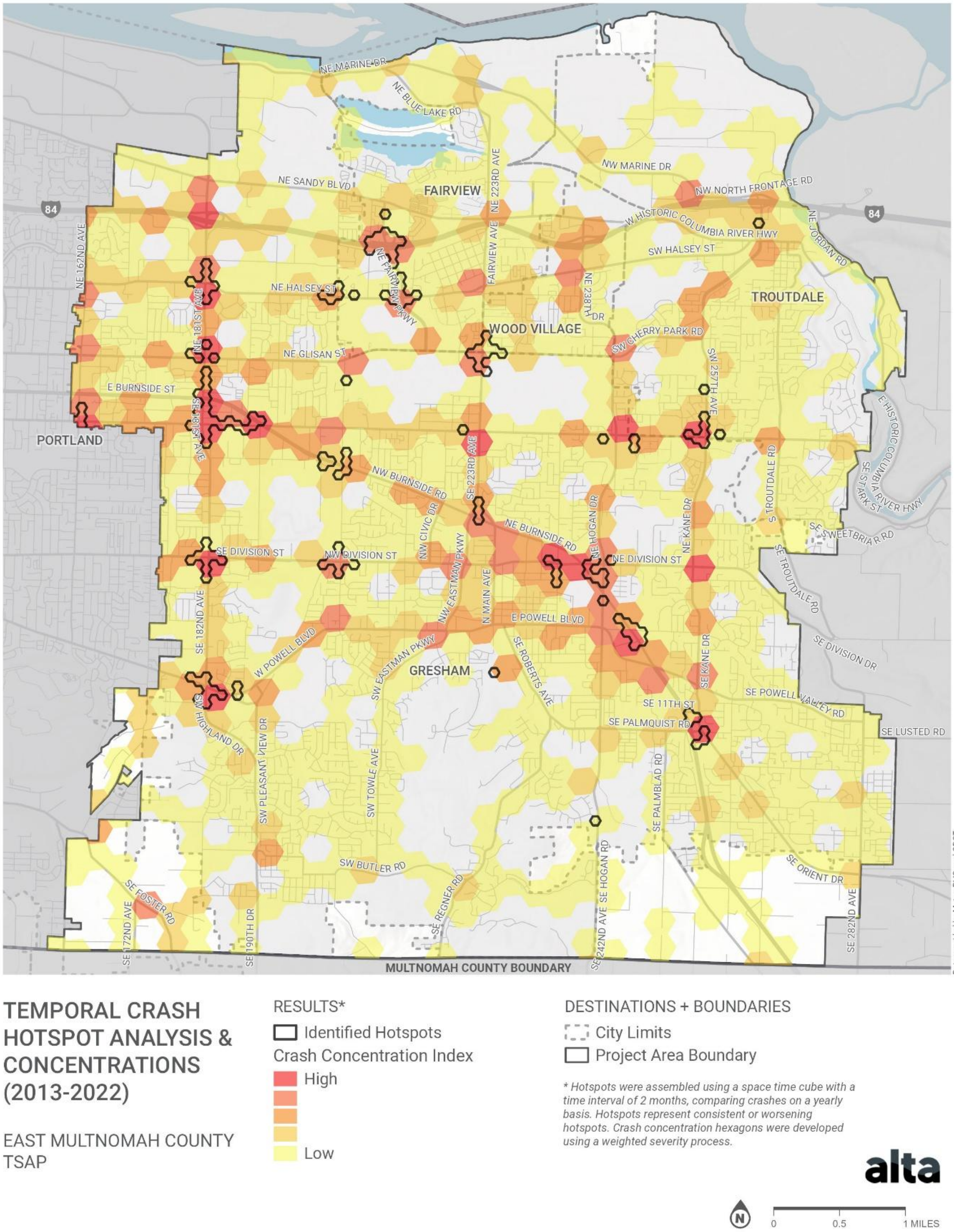

Figure 22: Crash Hotspots and Crash Concentrations

Temporal Crash Hotspot & Trend Bin Analysis

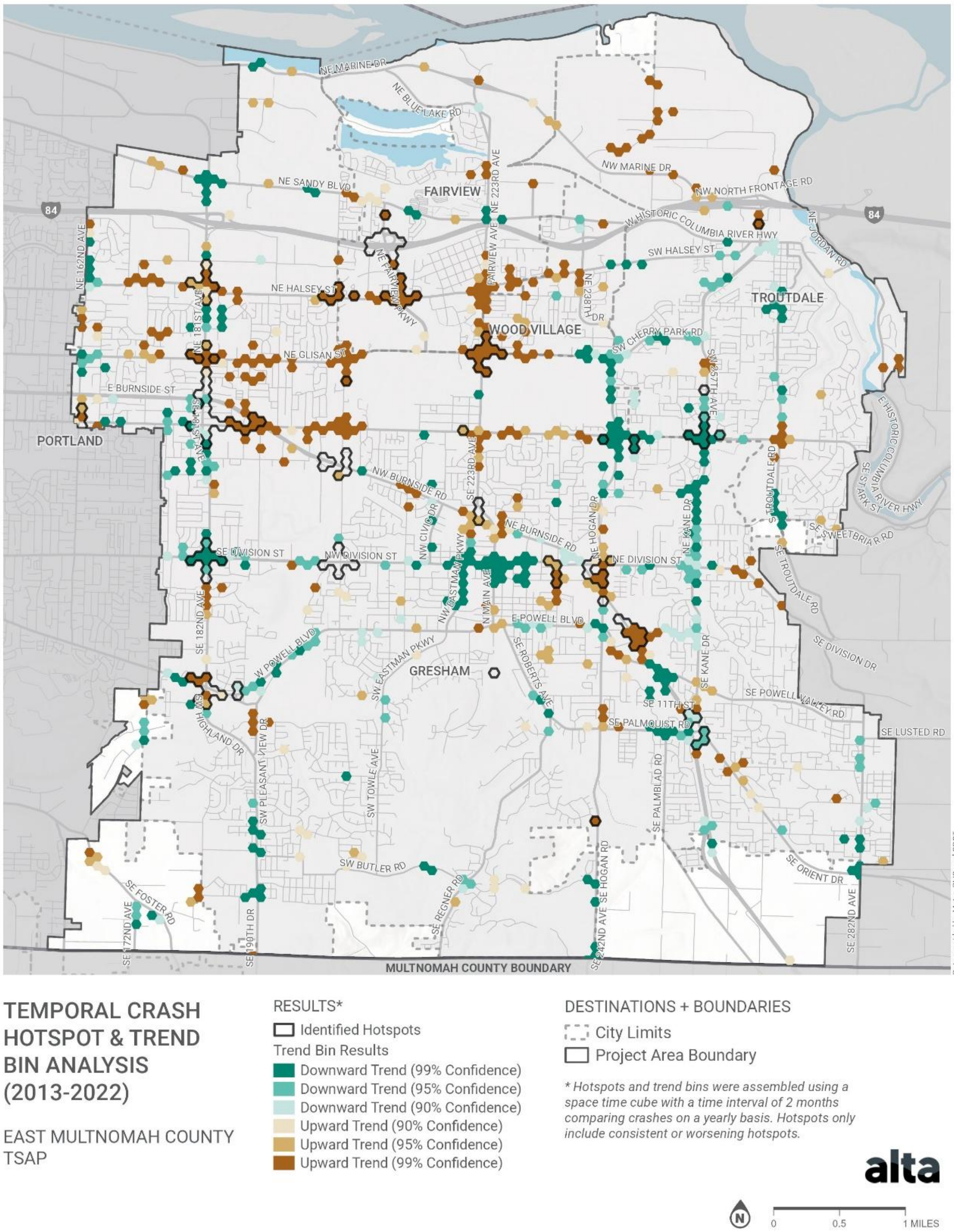

Figure 23: Crash Hot Spots and Trends

Figure 23 compares the trend bin analysis from **Figure 19** and the hotspot analysis from **Figure 18**, presenting a complete picture of how trends are interacting with hotspot locations.

The most important locations highlighted on this map are those with both hotspots and an upward trend. These locations should be studied individually in more detail and prioritized in terms of safety features, because they have high crash rates that are getting worse. However, this should not detract from the hotspot locations where there is no detected trend. No trend hotspot locations indicate that the frequency of crashes in that location is consistently high. If that location is a hotspot, that is also a cause for concern. A specific example of this occurrence is on the 181st corridor. This location has a fair amount of no trend hexagons. However, all analyses point to this area being high-risk.

When reviewing this map, it is also critical to understand why a hotspot location could have a decreasing trend. This generally indicates that in early years of the time period under study (2013-2022), this location was a source of more crashes, but the crash rate has decreased since then. This could be due to safety treatments or loss of an activity center leading to lower volumes, for example. However, the magnitude of crashes occurring are still high compared to the rest of E Multnomah County such that the area still is regarded as a hotspot.

It should be noted that hotspot locations with decreasing trends should be continued to be analyzed into the future, but they perhaps do not need to be prioritized as heavily as other locations. While saying this, it is crucial to recognize that the emerging hot spot analysis does not take crash severity into consideration, so while total crashes may be decreasing in an area, the analysis does not weigh crashes based on severity.

Temporal Analysis Summary

These analyses demonstrate that the highest crash concentrations overall are along NE 181st Avenue and NE Burnside Road. Since our analysis is at a small scale, it also points to many smaller clusters of crashes, some of which are not visible on a large scale. Depending on the time period or size of hexagon used, different areas may be highlighted.

Comparing Spatial-Temporal Analysis with Equity Results

Disadvantaged and underserved communities have historically faced the brunt of unsafe roadways, lack of transportation options, and crash concentration areas. As such, the Alta team explicitly looked at equity in the context of the results of the spatial-temporal analyses. The two maps in this section overlay the top 20% of equity communities, identified through the equity analysis conducted by this study. Although these communities represent 20% of census tracts in the study area, they had more than 20% of the share of hot spots, increasing crash trends, and high-crash areas. In particular, equity priority tracts account for:

- 47% of all hotspots
- 30% of all increasing trend bins (hexagons)
- 33% of the top crash concentration hexagons.

Top 20% Equity Priority Areas Crash Maps

Figure 24 shows the top 20% of equity areas overlaid with the combined crash concentration and hotspot analyses. This map visualizes the overrepresentation of both the crash concentration corridors and hotspot locations in equity areas. This furthers the call for prioritization of the 181st and NE Burnside Road corridors in terms of safety treatments, as they are the most prominent locations in the equity areas.

Figure 25 shows the top equity areas overlaid with the hot spot and trend analyses. This map visualizes how equity priority areas are overrepresented among locations with increasing trends in crash numbers. The most notable takeaway is that while there are some downward trends along the 181st corridor, analysis locations in equity areas typically see upward trends in crashes. This is primarily seen in the hotspot location areas.

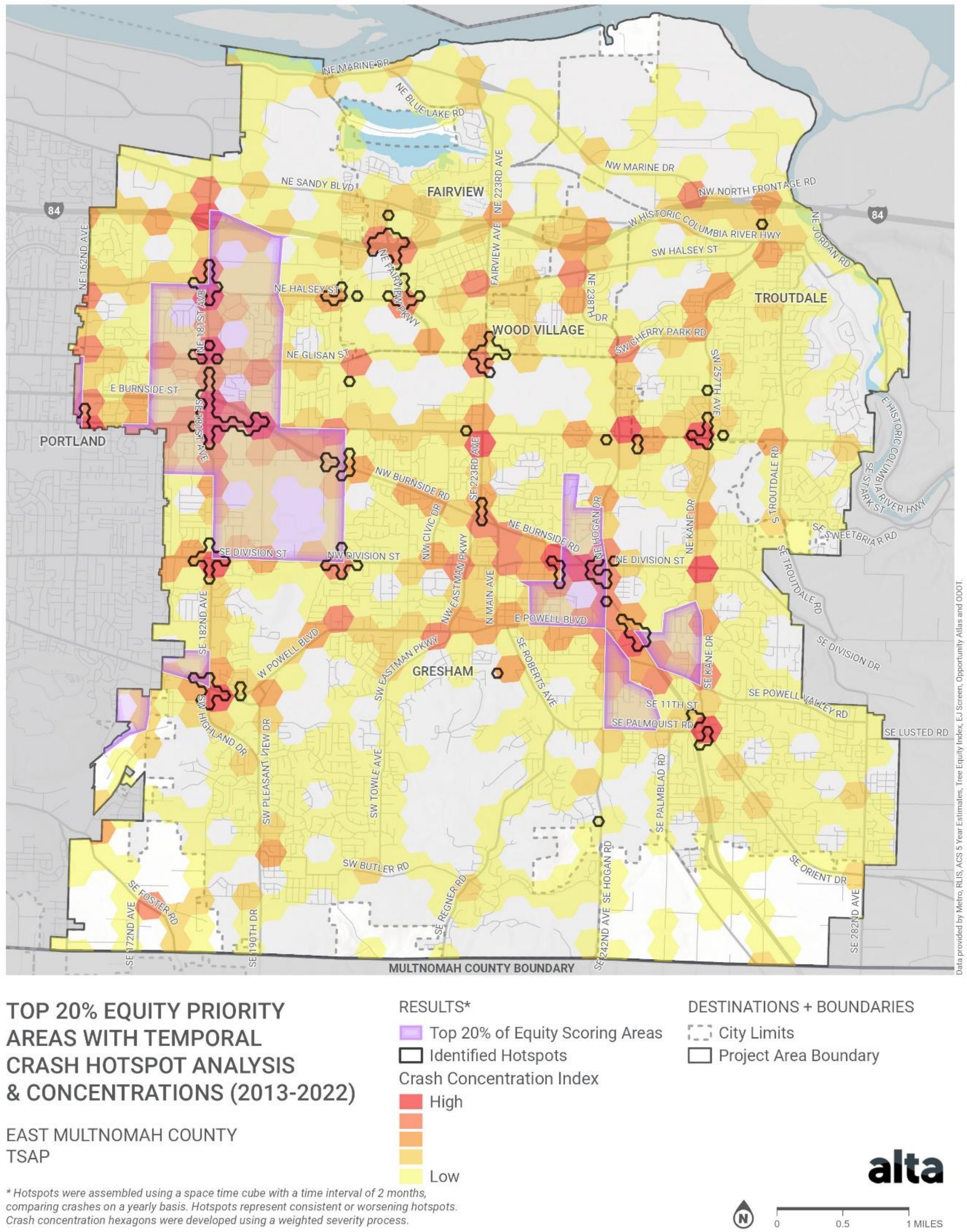

Figure 24: Equity areas, crash hot spots, and crash concentrations (all modes)

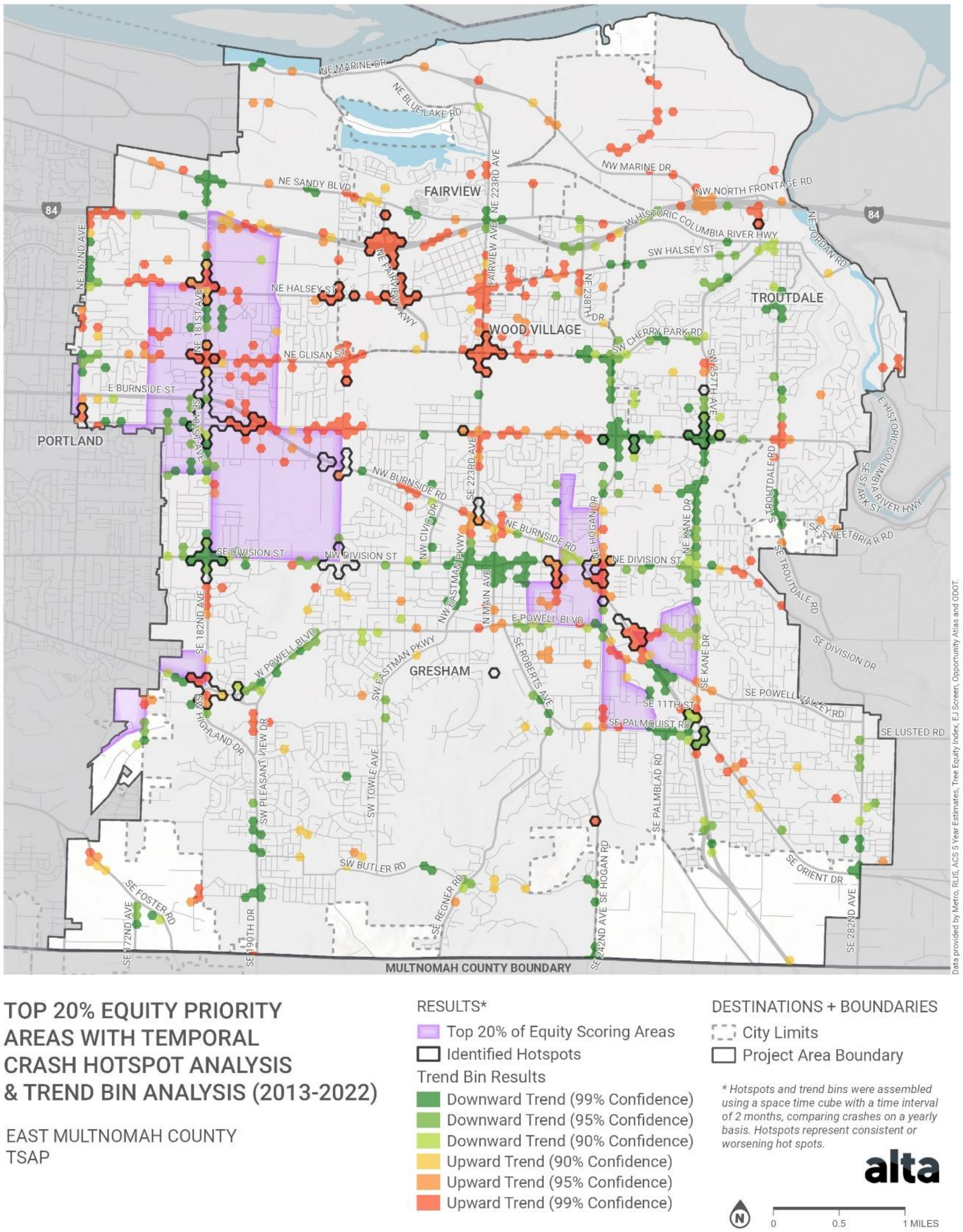

Figure 25: Equity areas, crash hot spots, and trends (all modes)

Crash Profiles and Crash Trees

Methodology

Alta performed an exploratory crash pattern analysis of crash factors using crosstabulations. This analysis identified characteristics that many crashes tended to have in common, in particular those that were disproportionately associated with fatal and serious injury crashes. Using this exploratory analysis as a starting point, Alta further developed these crash profiles by looking for additional variables that would describe crashes more specifically. Crash trees, as shown in **Figure 26,** helped to identify combinations of variables that accounted for large shares of crashes.

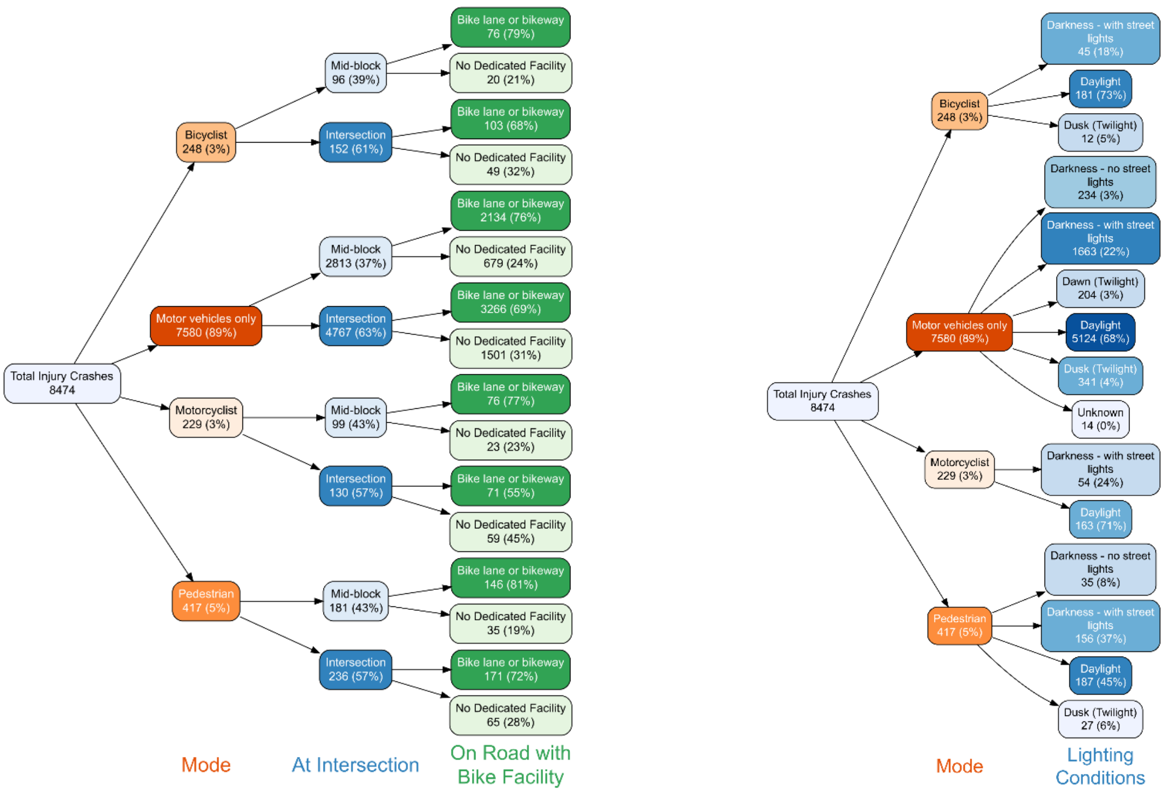

Figure 26 Crash Trees were used as an exploratory data analysis tool to identify and visualize the trends highlighted in crash profiles. The crash trees can be viewed in and in an HTML, file provided alongside this memo.

Crash Profiles Summary

Alta has identified six crash profiles, groups of crashes with similar characteristics. Profiles were chosen based on the number of crashes represented and the factors that appeared disproportionately among fatal and serious injury crashes. Profiles are summarized in **Table 2** and described in more detail below. Maps of the crashes in each profile follow.

Table 2: Crash Profile Summary

Profile Number	Mode	Crash Factor	Contextual Factor	Number of Crashes	Share of injury crashes for this mode	Share of fatal and serious injury crashes for this mode
1	All	Alcohol or drugs involved		568	7%	24.0%
2	All	Fixed object	35 mph road	286	3%	8.6%
3	Pedestrian	Dark	Road with full or partial sidewalk	160	38%	46.3%
4	Pedestrian	Improper maneuver by driver	At intersection	160	38%	25.3%
5	Bicyclist	Vehicle turning movement	At intersection, on road with dedicated bike lane or trail	73	29%	33.3%
6	Motorcyclist	Vehicle turning movement	At intersection	68	30%	31.7%

Note: Profiles are not mutually exclusive. Some crashes may belong to more than one profile while others do not belong to any.

Profile 1: Crashes with Alcohol or Drugs Involved (568 crashes)

Alcohol- or drug-involved crashes can involve impairment on the part of a driver, a vulnerable road user, or both. These crashes were four times as likely as injury crashes overall to result in a fatal and serious injury crash. When the crash results in a fatality, about half the time the crash is with a pedestrian. When the crash results in a serious injury, it is usually because an impaired driver collides with a fixed object.

The highest number of injury crashes in this profile occurred between 7 pm and midnight, with 38% of crashes. In comparison, only 17% of non-substance involved crashes occurred between those hours. These trends are highlighted in the crash trees.

This profile is mapped in **Figure 27**. As with crashes overall, high concentrations are found along Burnside Road and NE 181st Avenue, with significant numbers along SE Stark Street as well.

Profile 2: Fixed Object Crashes on 35 MPH roads (286 crashes)

This profile accounts for 9% of all fatal and serious injury crashes, and 3% of all injury crashes. Roads with a 35 MPH speed limit are disproportionately involved in injury crashes. Though they account for 11% of centerline miles overall, they account for 66% of fatal and serious injury crashes. This is a reflection both of higher traffic volumes on these streets and of the role of high speeds in commercial areas.

In equity areas, these roads account for an even higher share of fatal and serious injury crashes, at 89%. This is partly because a higher share of centerline miles in these areas are also 35 mph roads. Equity areas, for this analysis, included the top 20% of census tracts by the Alta-derived equity score, which is derived from demographic variables associated with marginalized populations and described in more detail in the Equity analysis section.

This profile is mapped in **Figure 28,** which shows particularly high numbers along NE 181st Avenue.

Profile 3: Pedestrian Crash, After Dark, On Road with Full or Partial Sidewalk (160 crashes)

Crashes in this profile account for 46% of pedestrian fatal and serious injury crashes and 38% of all pedestrian injury crashes.

The crash trees show that of all modes, crashes involving pedestrians were the most likely to occur after dark. This suggests that pedestrians are particularly vulnerable to poor visibility. Interestingly, crashes occurred in spite of streetlights; 85% of crashes in this profile were on lit streets. Furthermore, about half of the crashes in this profile were at an intersection. Lighting at intersections may not be sufficient to make pedestrians visible to drivers due to sometimes being only on one side of the street and not at pedestrian scale, and the risk is exacerbated when speeds are high and vehicles are large.

This profile is mapped in **Figure 29.** These crashes are more concentrated than crashes overall, with clusters near the intersection of Burnside Rd and Division Street and along 181st Avenue NE between NE Halsey Street and NE Stark Street. In particular, there are six crashes just south of the intersection of Burnside & Division. Of these, the majority were noted as having a pedestrian illegally in the roadway. This location is in a busy commercial corridor, with a Motel 6 on one side of the street and McDonald's on another, and there is nearly a quarter mile in between marked crossings. It appears that pedestrians are attempting to save time by crossing where no crosswalk exists.

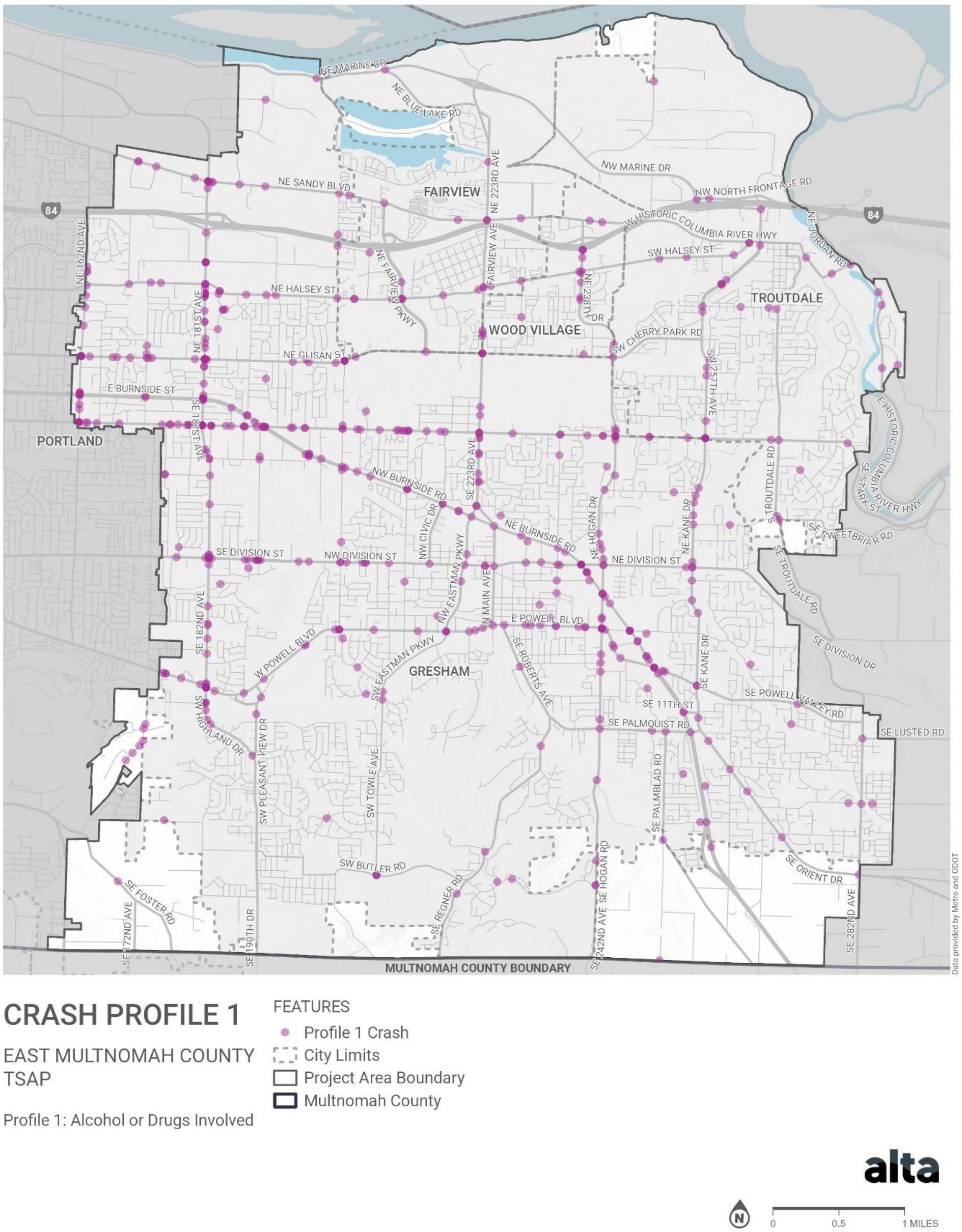

Figure 27: Crash Profile 1: Crashes with Alcohol or Drugs Involved

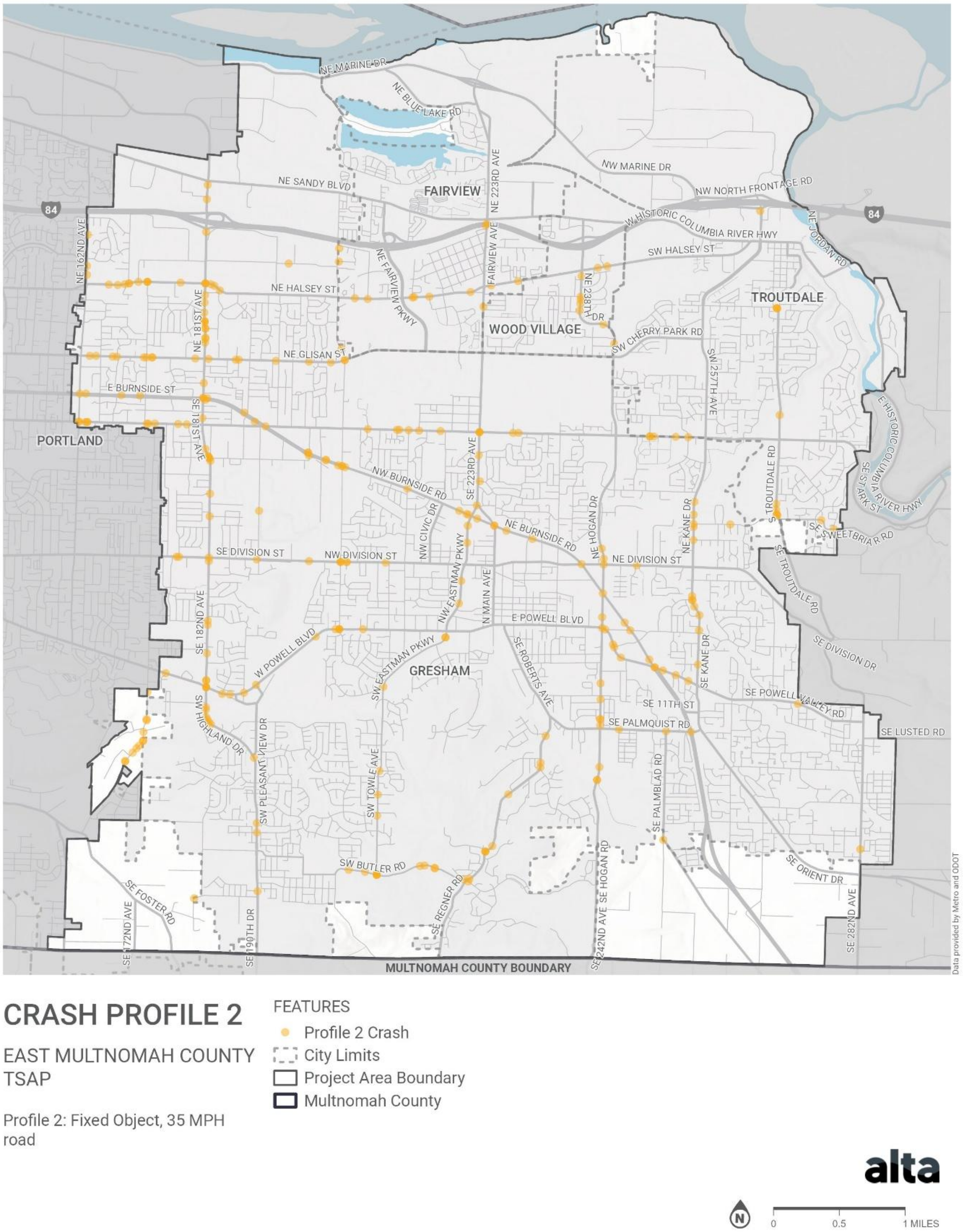

Figure 28: Crash Profile 2: Fixed Object Crashes on 35 MPH roads

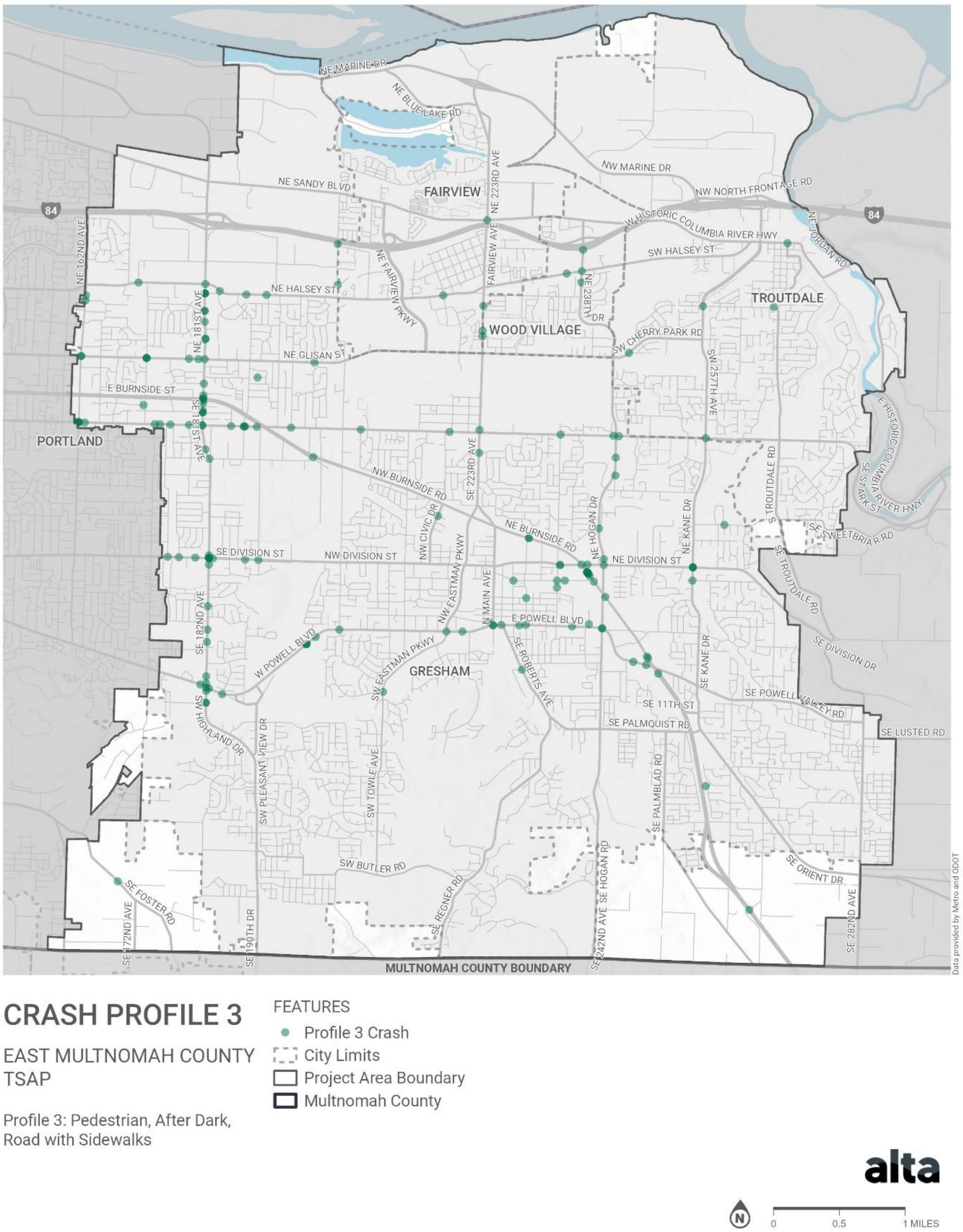

Figure 29: Crash Profile 3: Pedestrian Crash, After Dark, On Road with Full or Partial Sidewalk

Profile 4: Pedestrian Crash, At intersection, with Improper Maneuver by Driver (160 crashes)

Crashes in this profile account for 25% of pedestrian fatal and serious injury crashes and 38% of pedestrian injury crashes. About half occurred at signalized intersections, and half at unsignalized. In all but three crashes, the improper maneuver was failure to yield the right-of way. The driver was responsible for failing to yield in 128 of these failure to yield crashes (82%).

This profile is mapped in **Figure 30** and crashes are fairly distributed throughout the study area.

Profile 5: Bicycle Crash, At Intersection, with a Turning Vehicle, On Road with Dedicated Bike Facility (73 crashes)

This profile accounts for 33% of bicycle-involved fatal and serious injury crashes and 29% of bicycle injury crashes. For this analysis, bike facilities are bike lanes (protected or unprotected) or shared-use paths. Crashes on roads with sharrows or signage but no dedicated infrastructure are not included. These numbers indicate that even on a facility with some level of separation or protection from traffic, cyclists are still vulnerable to turning vehicles at intersections.

In 70% of these crashes (52 crashes), the cause was failure to yield right-of-way. The driver was responsible for failing to yield in 45 of these crashes (86%), while the cyclist was responsible in the remainder.

Half of crashes in this profile were at unsignalized intersections, where right-of-way may be ambiguous.

This profile is mapped in **Figure 31.** As with the pedestrian crashes in profile 3, these crashes are concentrated on a segment of 181st Avenue NE. This corridor is a major connecting street in the area with a bike lane, but it lacks physical separation or protection. There are also many commercial uses and driveways along this corridor, presenting safety risks to cyclists.

Profile 6: Motorcyclist Crash, At Intersection, with a Turning Vehicle (68 crashes)

This profile accounts for 32% of motorcyclist fatal and serious injury crashes and 30% of motorcyclist injury crashes. In half of the fatal and serious injury crashes in this profile, one vehicle was making a left turn. As with many other profiles, the leading cause was a failure to yield right-of-way. Responsibility for failure to yield right-of-way could not be determined from the crash data. The majority (59%) of these crashes were at unsignalized intersections, particularly at stop-controlled intersections between local streets and arterials in commercial areas, where one party was making a turn and failed to yield. Six of these occurred along NE 181st Avenue north of SE Yamhill St, and another three along SE Stark. This profile is mapped in **Figure 32** and shows that other than those clusters, these crashes are fairly distributed through the region.

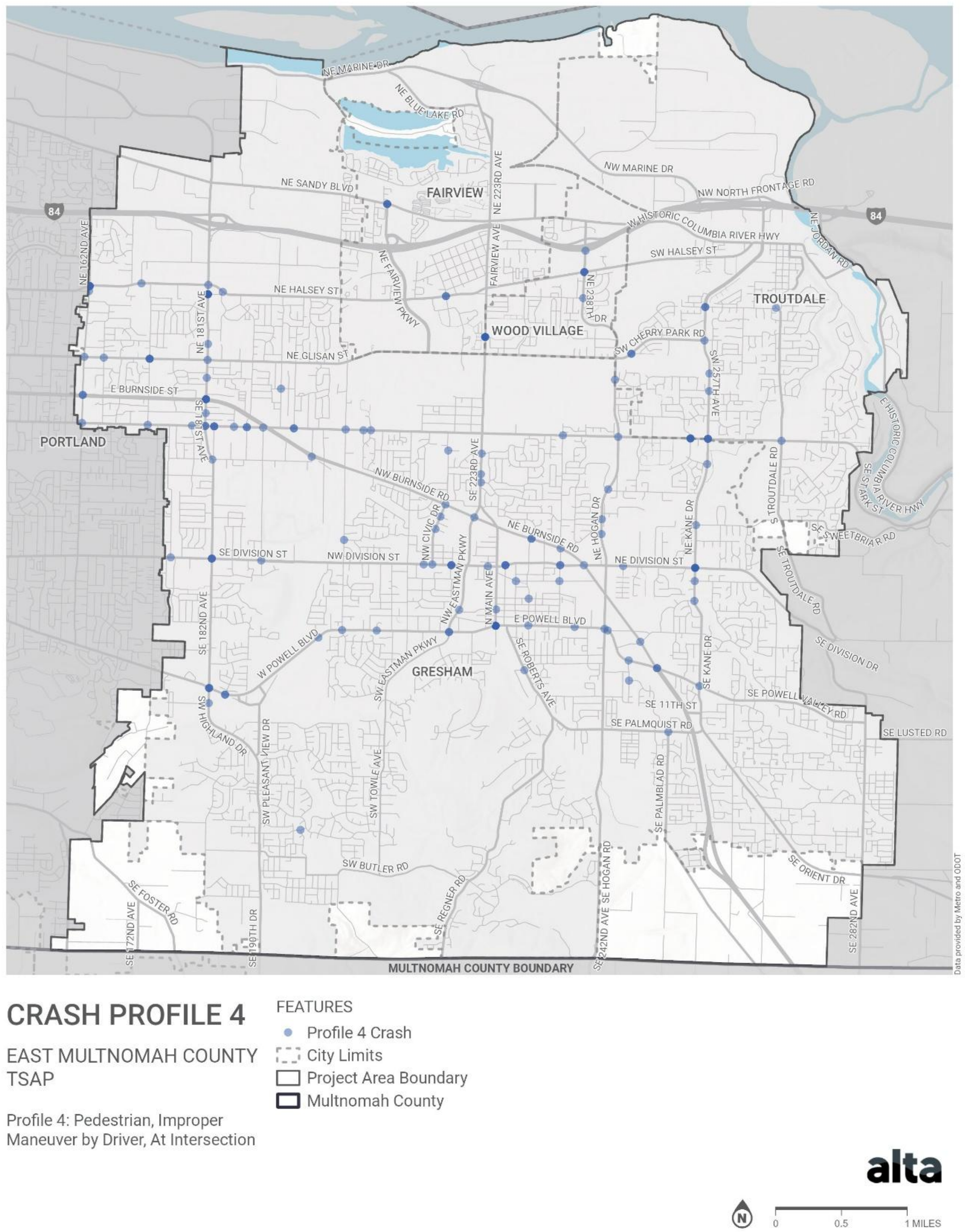

Figure 30: Crash Profile 4: Pedestrian Crash, At intersection, with Improper Maneuver by Driver

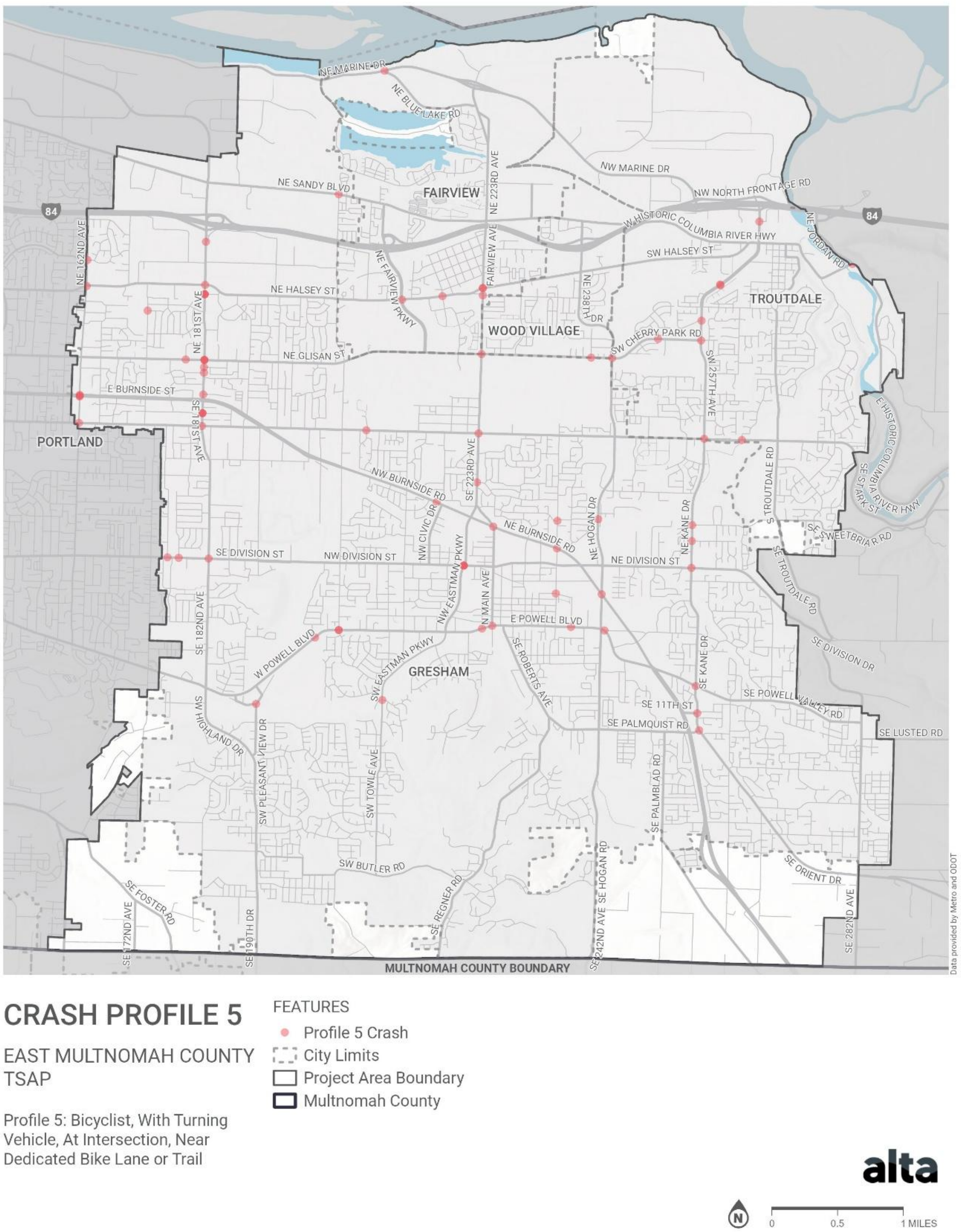

Figure 31: Crash Profile 5: Bicycle Crash, At Intersection, with a Turning Vehicle, On Road with Dedicated Bike Facility

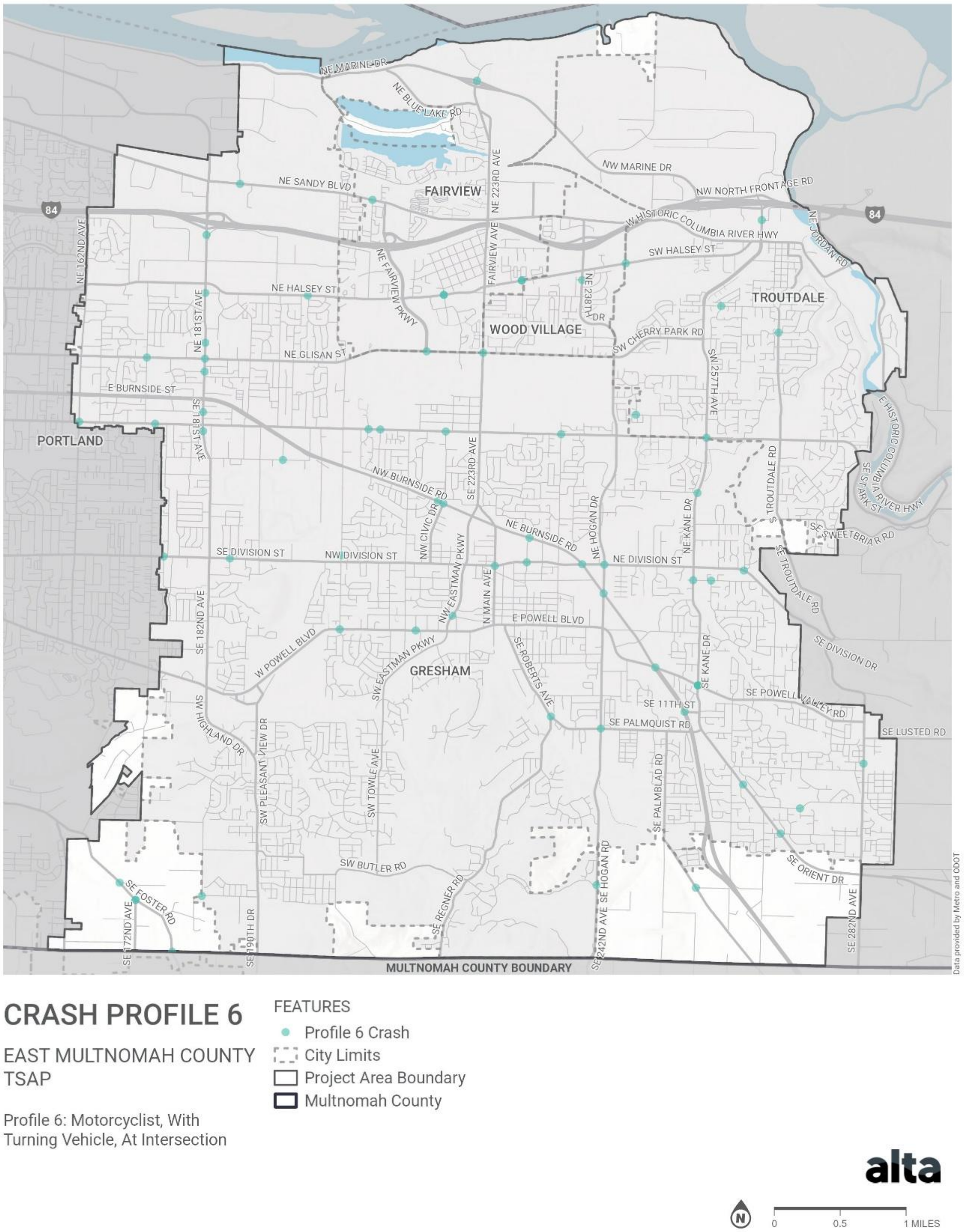

Figure 32: Crash Profile 6: Motorcyclist Crash, At Intersection, with a Turning Vehicle

Additional Safety Analysis

Alta performed additional in-depth safety analyses of key issues that arose from stakeholder and community engagement, as well as the results of the initial systemic safety analysis. The topics chosen for additional safety analysis included the following:

- A mid-block crossing analysis to identify locations in E Multnomah County where there may be mid-block crossing needs;
- A lighting analysis to identify locations where lighting conditions are unsafe for pedestrians;
- A speed data analysis to identify locations in E Multnomah County where observed speeds exceed posted speed limits; and,
- A detailed review of the contextual and safety data at two locations where crashes are increasing over time based on the temporal map data shown in **Figure 23.**

Crossing Safety Analysis

The crossing safety analysis aimed to identify areas in which pedestrians were struck in the roadway while not at an intersection or crosswalk. Alta used an intersection type attribute in the crash data to identify 68 pedestrian-involved crashes that were not at an intersection. In examining the data spatially, Alta noticed that in 40% of crashes, a pedestrian was within 200 feet of an intersection or crosswalk but nonetheless was not at the intersection. In the other 60% of crashes, a pedestrian was farther away.[7] For the purposes of this analysis, all crossings not at crossings are referred to as "mid-block." Alta assumed that all signalized intersections had crosswalks, and unsignalized crossings did not, because comprehensive crosswalk data was not available. A brief desktop review of aerial and street-level imagery was performed to validate this assumption. We also used a spot check of aerial imagery to verify the accuracy of the intersection tags in the crash data and to confirm that crashes marked as not at an intersection were also not at a mid-block crossing.

As shown in **Figure 33**, many mid-block crashes occurred along SE 182nd Ave/NE 181st Avenue. The largest cluster of pedestrian mid-block crashes occurred near the intersection of NE Burnside Road and NE Division Street in Gresham. Four crashes, including one fatality and one involving a person in a wheelchair, occurred in close proximity here about 350 feet south of Division Street, between a Motel 6 and a McDonald's. Three of these four crashes were in the dark, and visibility was cited as an issue in addition to the pedestrian being outside of a crossing. This stretch of roadway has four travel lanes in addition to a two-way center left turn lane. For people wanting to get between two mid-block destinations, it may feel worth the risk to cross mid-block rather than walking 700 feet out of their way, in addition to waiting for a signal. Although mid-block pedestrian signals are not feasible on all roads, they may be warranted in areas with many mid-block crashes and popular destinations on both sides of the street.

Another large cluster of crashes occurred W Powell Blvd. & SW Highland Drive, where four crashes occurred near, but not at, the signal. Three of these four occurred in the dark. Although the distance to the signal was between 110 and 200 feet for these crashes, the time required to wait for the signal may have been enough of a deterrent to incentivize the pedestrian to cross mid-block.

[7] Two-hundred feet was chosen as a threshold because the National Association of City Transportation Officials (NACTO) states that signalized crosswalks can be permitted up to every 200 feet. https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/crosswalks/

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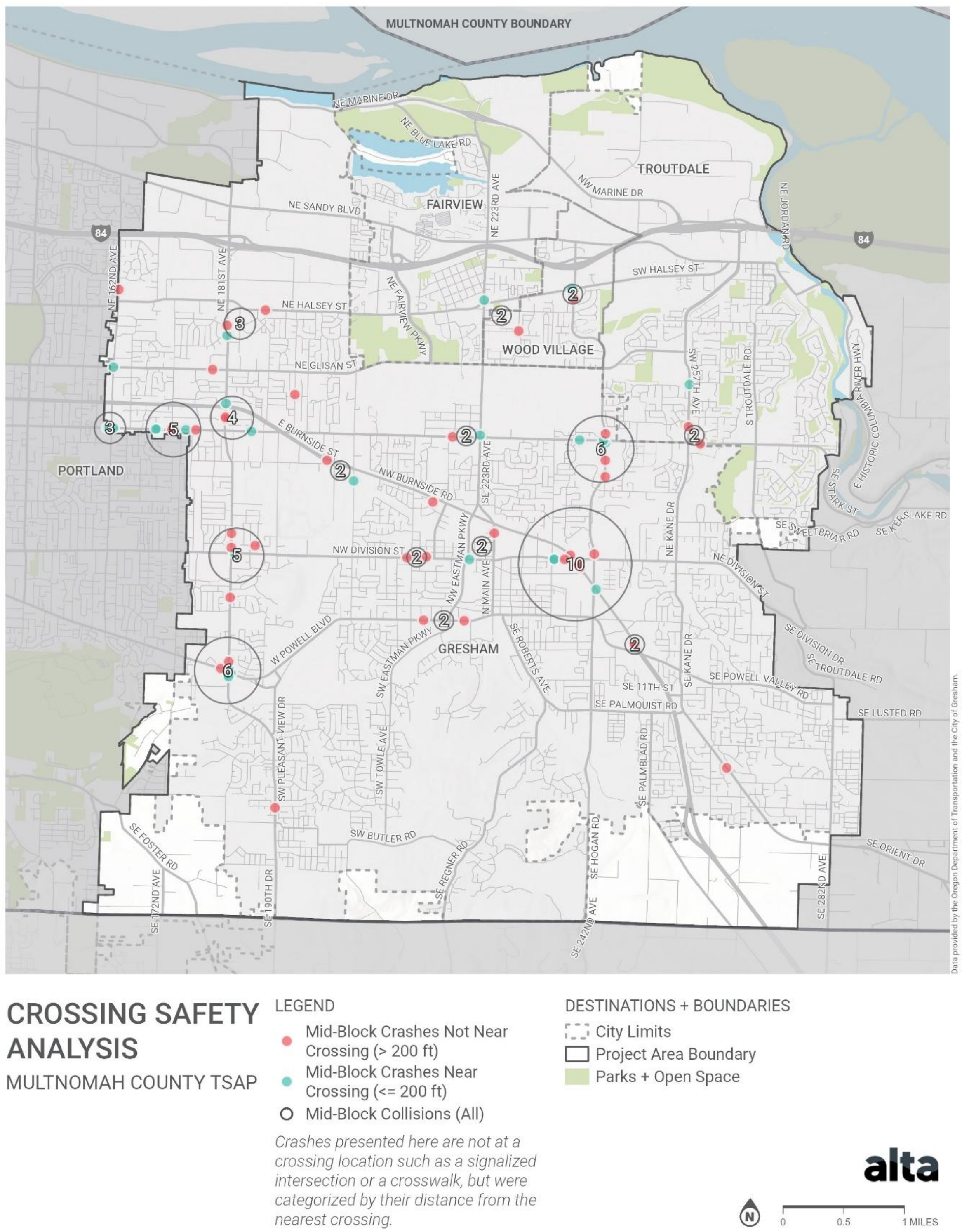

Figure 33: The crossing analysis highlights clusters of mid-block crashes, distinguishing those near a crossing opportunity (green) from those that were not (red).

Forty-nine of the 68 mid-block crashes (72%) occurred at dusk, dawn, or after dark, mostly in areas with at least some streetlights, suggesting that pedestrians are especially difficult to see in the dark when drivers are not expecting them, and streetlights alone are not enough to ensure visibility.

Lighting Safety Analysis

The lighting analysis evaluated 160 pedestrian-involved crashes that occurred after dark on roads with sidewalks (crash profile 3) and compared them to lighting quality at intersections of major roads where lighting data was available[8]. Roads with sidewalks were chosen as the focus for this analysis to focus on areas where pedestrians are most likely to walk. Of these crashes, 137 (86%) were recorded as being in areas with streetlights.

Figure 34 shows that crashes after dark are highly clustered in a few areas, including NE Burnside Rd & NE Division St, and along SE 182nd Ave/NE 181st Avenue at West Powell, SE Division, E Burnside, and NE Halsey Street. It is notable that many of these areas were also hot spots for pedestrian mid-block crashes.

Alta evaluated the number of streetlights at each of these locations, a proxy for the quality of illumination in the area. While most clusters were in moderately lit areas, with 1-3 light fixtures, the intersection at E Burnside & NE 181st Ave was heavily lit (defined as having at least four light fixtures). Of 32 after-dark crashes at this intersection, 16 (50%) were rear-end crashes and five involved a pedestrian. This is a major intersection with 4-5 lane roads, a MAX station, and significant commercial activity nearby. The lighting may simply not be sufficient to overcome drivers' distractions, high vehicle volumes, and significant pedestrian activity that contributes to these crash rates, particularly if signal phasing allows for vehicle-pedestrian conflicts and depends on drivers seeing pedestrians crossing before turning.

Only two intersections of major roads did not have any roadway-scale lighting, and these were not hot spots for pedestrian crashes after dark. These intersections were in more rural areas of Southeast Multnomah County, where there are few land uses that generate pedestrian trips.

Crashes occurring after dark were more likely to be mid-block. Overall, 52% of pedestrian crashes after dark were not at an intersection or crossing. The interaction between mid-block and after dark crashes suggests that both factors combine to create more dangerous conditions for pedestrians than either one on its own.

Speed Analysis

Alta's speed analysis identifies areas where uninhibited traffic flows exceed the speed limit, which may highlight corridors where the design speed does not match the speed limit. This analysis compared free-flow speeds[9] on major roads from Replica Places (2023) with posted speed limits on the same roads, as provided by the City of Gresham and Multnomah County. Where posted speeds were not available, Alta assumed 25 mph on residential roads, 55 mph on trunk roads, and 35 mph on frontage roads after a desktop review. Alta also manually validated speed limits on roads with surprising results and made corrections to speed limit data on NW Graham Road, NE Glisan Street, and the Historic Columbia River Highway to ensure accuracy.

[8] This was not a photometric analysis of lighting because no data on illumination was available; instead, Alta used the number of light fixtures at the intersection as a proxy for lighting quality. Street view imagery was used to verify accuracy in select locations.

[9] Replica defines free-flow speeds as 66th percentile vehicle speeds between the hours of midnight and 6 am. This represents the time when congestion is typically lightest.

The speed analysis, shown in **Figure 35**, showed that most roads have free-flow speeds approximately at or below the speed limit. This does not mean that speeding by individual vehicles does not occur, but the regular flow of most traffic is not exceeding the speed limit. [10]

The amount of traffic traveling below the posted speed indicates that lowering the posted speeds of these roads could be an appropriate measure for arterials with free-flow speeds below the speed limit, such as for example East Burnside Street (west of NE 202nd Avenue), NE 201st Avenue, and NE 233rd Avenue.

Several roads in southern Gresham and Troutdale have free flow speeds up to 5 mph over the speed limit, including W Powell Blvd, SW Towle Ave, SW Pleasant View Drive, and most of the Columbia River Highway. The only major road with free-flow speeds exceeding the speed limit by more than 5 mph is the southernmost portion of Mount Hood Highway in Multnomah County. Two other very small segments in Troutdale were also identified as having excessive free flow speeds. This suggests that the design speed of those roads, the speed which feels safe for most drivers, exceeds the posted speed limit. If reducing speeds on those roads is desired, it may be necessary to implement design changes rather than merely lower the speed limit.

There appears to be some relationship between the 244 crashes cited as being caused by excessive speed and the areas where free flow speeds exceed the speed limit. On the higher-speed portion of Columbia River Highway, four crashes were said to be speed-related, while two were speed related on the highlighted segment of Mount Hood Highway. However, 83% of speed-related crashes occurred on roads where the free-flow speed was equal to or under the speed limit. This suggests that an individual vehicle exceeding the speed limit can occur on any roadway, even when the majority of traffic there is traveling under the speed limit. More detail on how crashes are coded could also illuminate this trend; it could be that officials are more likely to classify crashes related to speed if the vehicle speed exceeded that of other traffic, rather than exceeding the speed limit.

There is not a strong correlation between areas with excessive speed and those with high mid-block or after-dark crashes. An exception is a section of West Powell Boulevard, where free-flow speeds exceed the speed limit by up to 5 mph, and where a cluster of after-dark crashes occurs west of Birdsdale Avenue.

[10] While this may be surprising, it is likely partly due to congestion from peak hours spilling over into non-peak hour times, lowering average speeds. There may be times of day with very light congestion when free-flow speeds are higher. Post-pandemic travel patterns indicate that the afternoon peak is now longer than the AM peak.

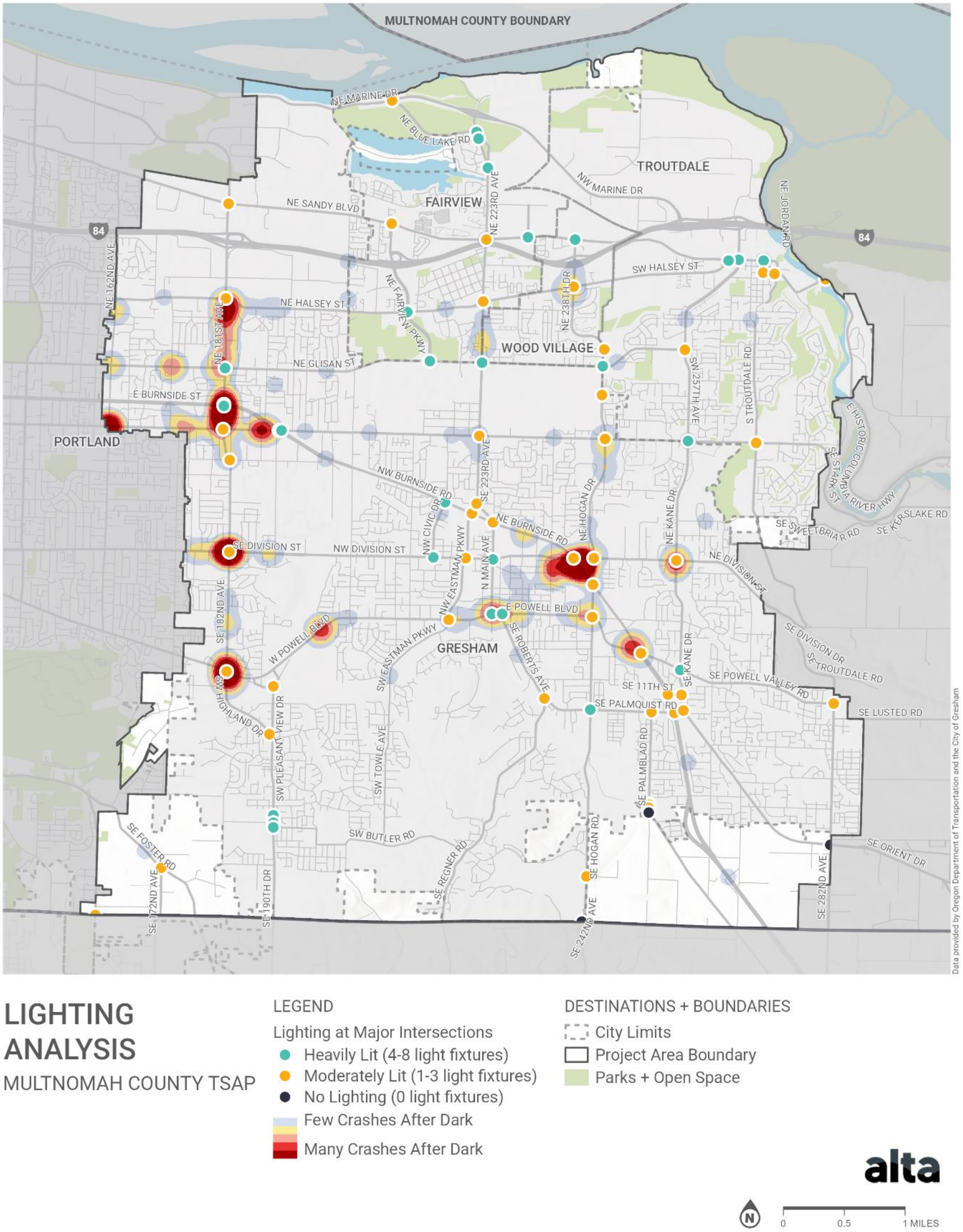

Figure 34: The lighting analysis compares hot spots of after-dark crashes with the lighting quality at major intersections.

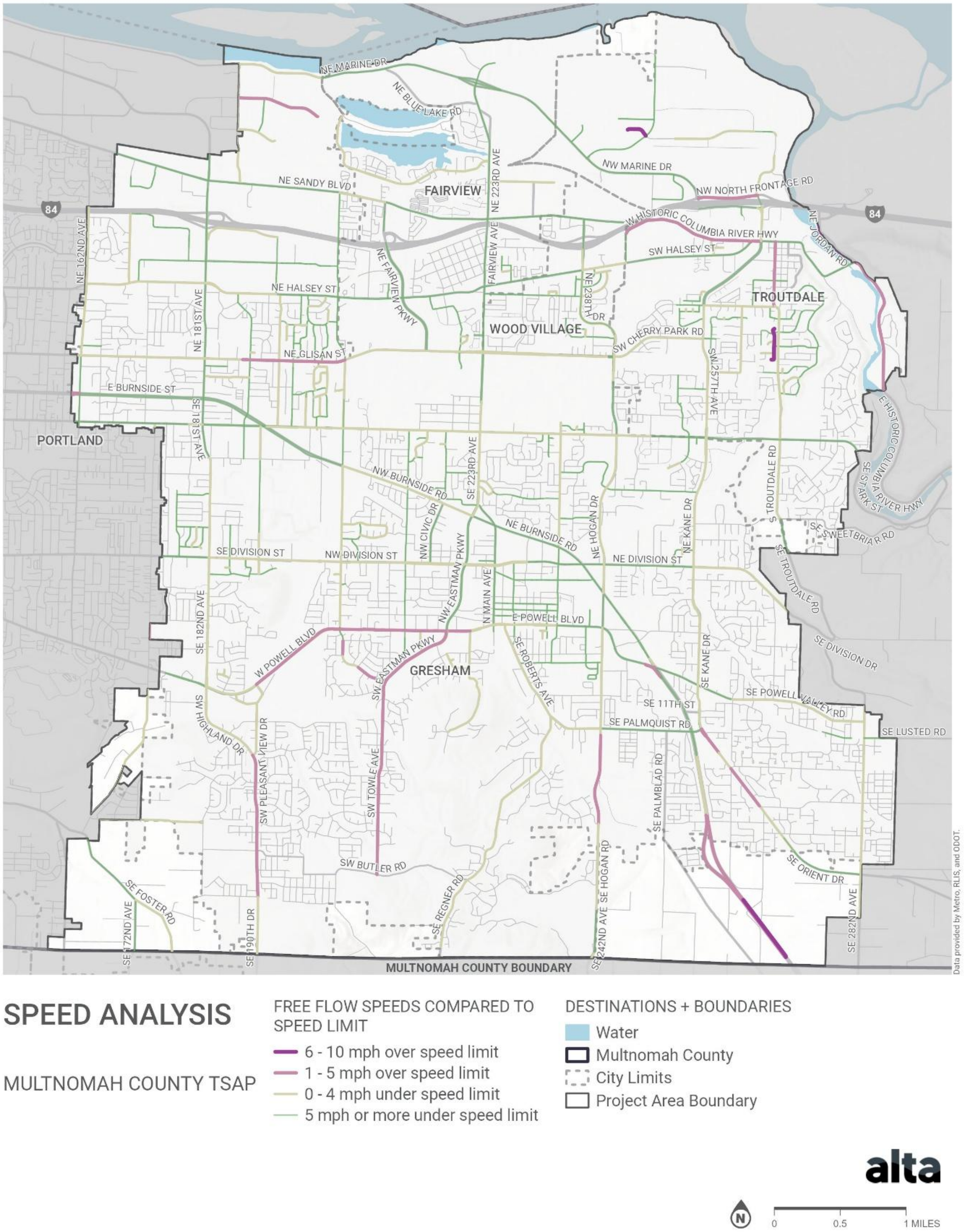

Figure 35: The speed analysis highlights areas in purple where typical free-flow speeds exceed the posted speed limit.

Appendix A

Parameters used for Space-Time Cube Tool

The Alta team ran an emerging hot spot analysis on the newly created space time cube. This analysis functions by identifying trends in the clustering of values, comparing these clusters to a global value in a defined time period[11]. These values are clustered based off specific factors. For this analysis, the Alta team specified the following factors:

- **Spatially determined neighborhood extents:** The determining factor of what values are analyzed together to assess local space-time clustering. A neighborhood extent of **800 feet** was used for the analysis. This was chosen to replicate the crash concentration hexagons.
- **Neighborhood time steps:** The number of time-step intervals to include in the analysis neighborhood. A neighborhood time step of six was used for this analysis. As points were agglomerated in **two-month** intervals, this would in turn represent a comparison time step of a year.
- **Conceptualization of spatial relationships:** The specification on how spatial relationships among bins are defined. A **fixed distance approach** was selected. This approach specifies that bins inside the defined neighborhood extent distance of 800 feet receive a weight of one and exert influence on computations from the target bin. Those that fall outside of the 800 feet do not influence a target bin's computations.
- **A defined global window:** The parameter by which bins are used to calculate the global value. The neighborhood time step was selected.

[11] ESRI definition of ArcGIS Tool: https://pro.arcgis.com/en/pro-app/latest/tool-reference/space-time-pattern-mining/emerginghotspots.html

Appendix B

Crash Trees Developed for Profiles

Below are crash trees developed to help identify and visualize trends in the crash profiles developed as part of Alta's systemic safety analysis. The trees can be further inspected in an HTML file provided alongside this memo.

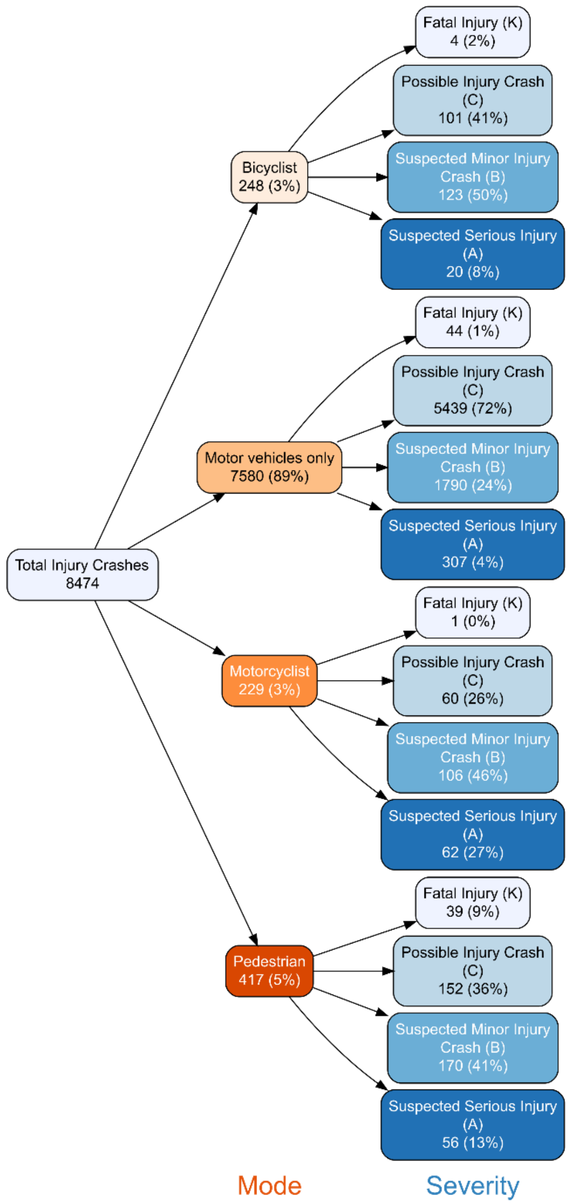

Figure 36: All Injury-Causing Crashes by Mode and Severity

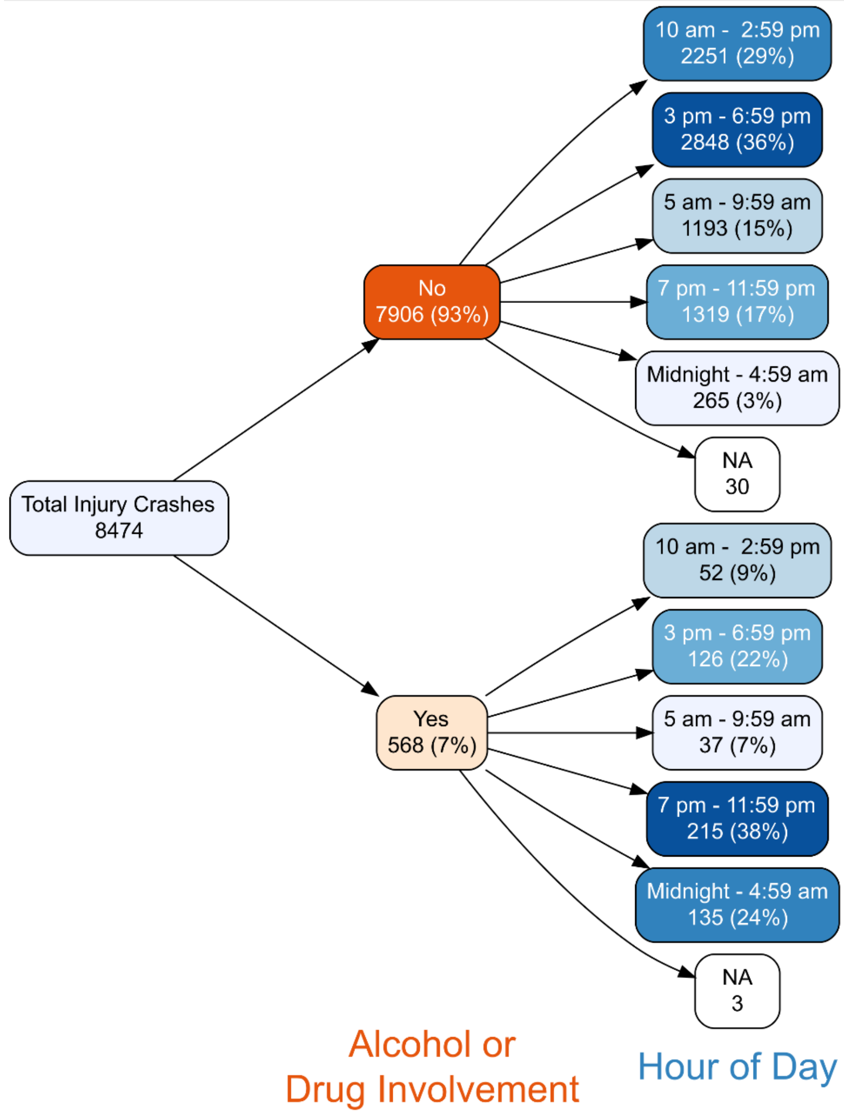

Figure 37: Profile 1 - Alcohol or Drug Involvement, with Time of Day

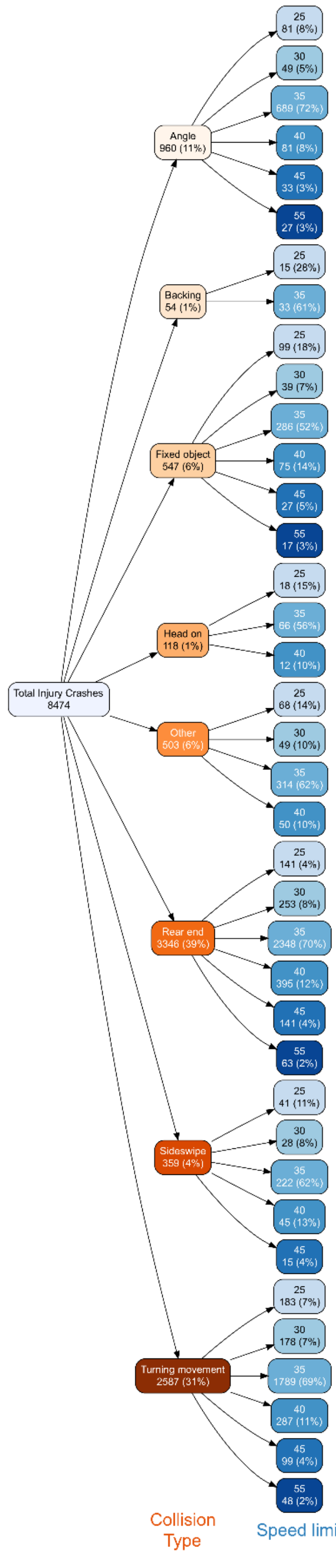

Figure 38: Profile 2 – Crash Type and Speed Limit

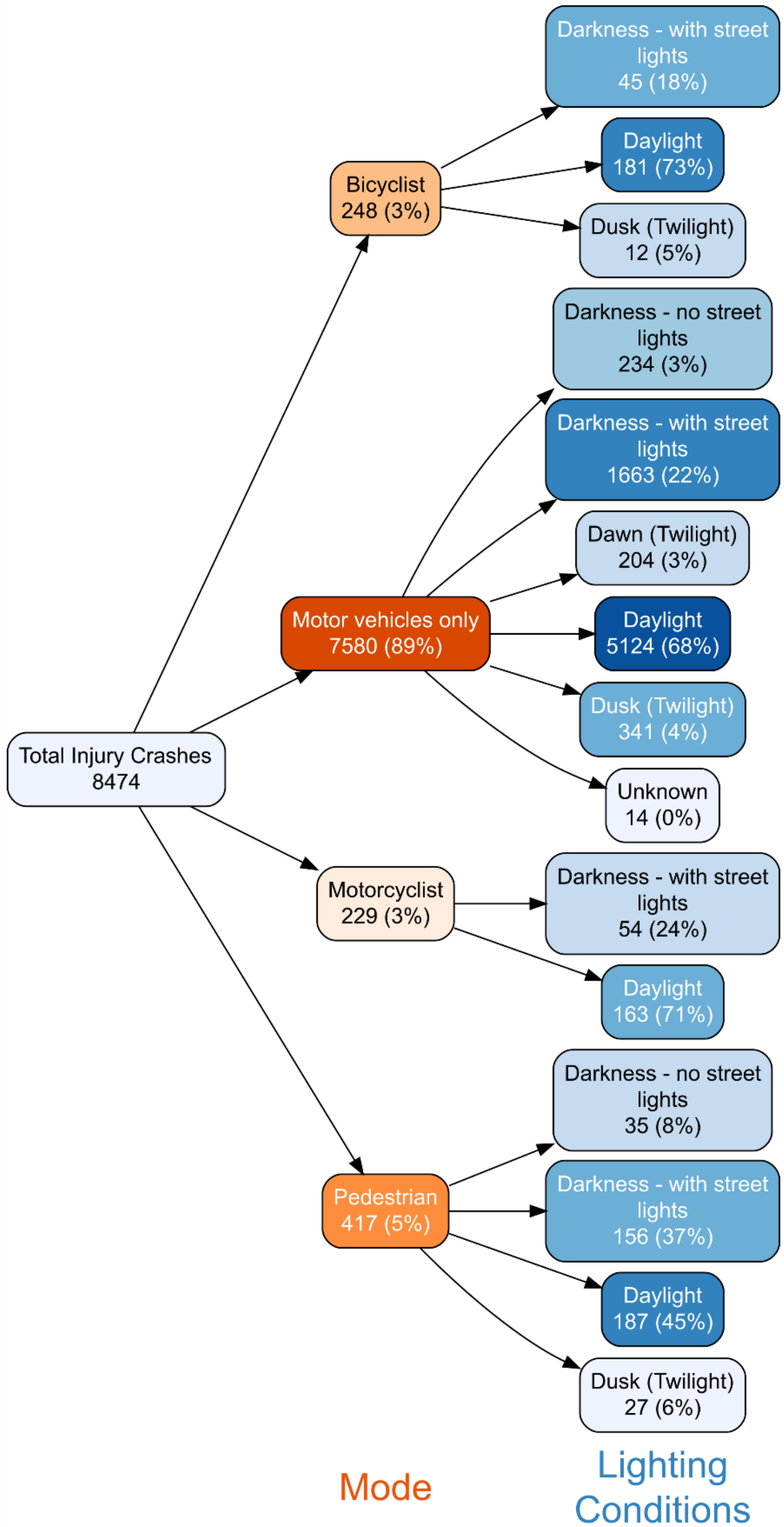

Figure 39: Profile 3 – Mode and Lighting Conditions

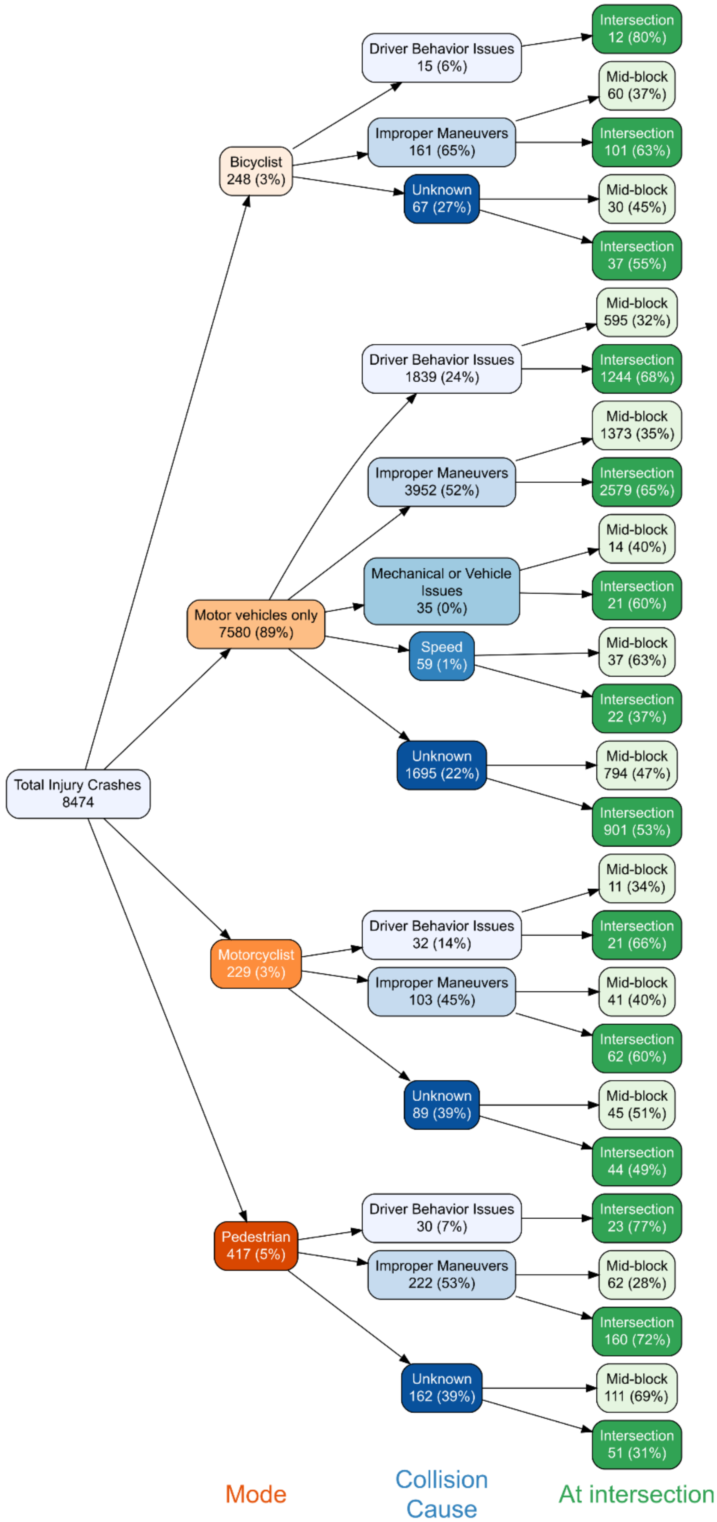

Figure 40: Profile 4 - Mode, Crash Cause, and Intersection Status

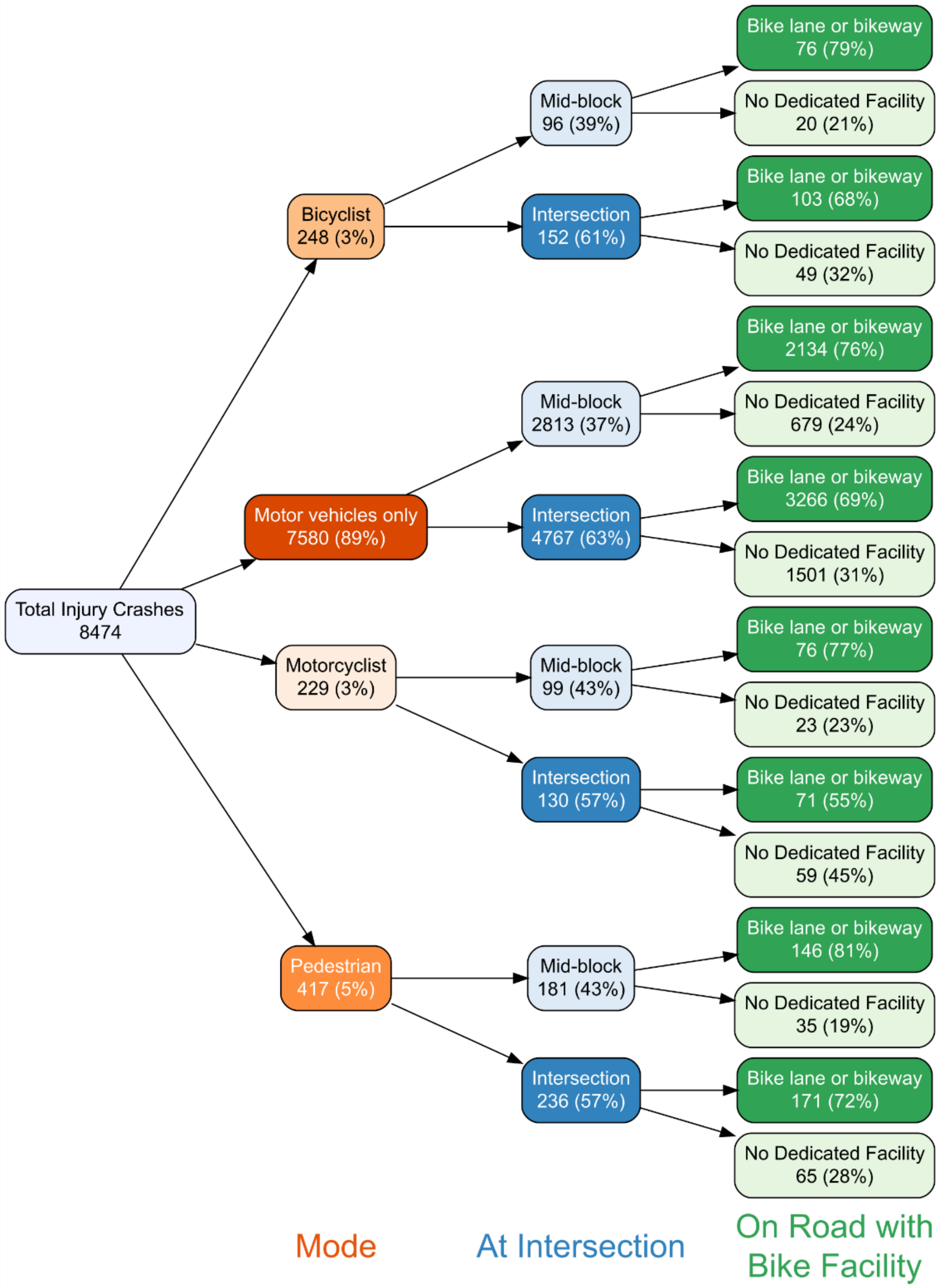

Figure 41: Profile 5 - Mode, Intersection Status, Bike Facility Presence

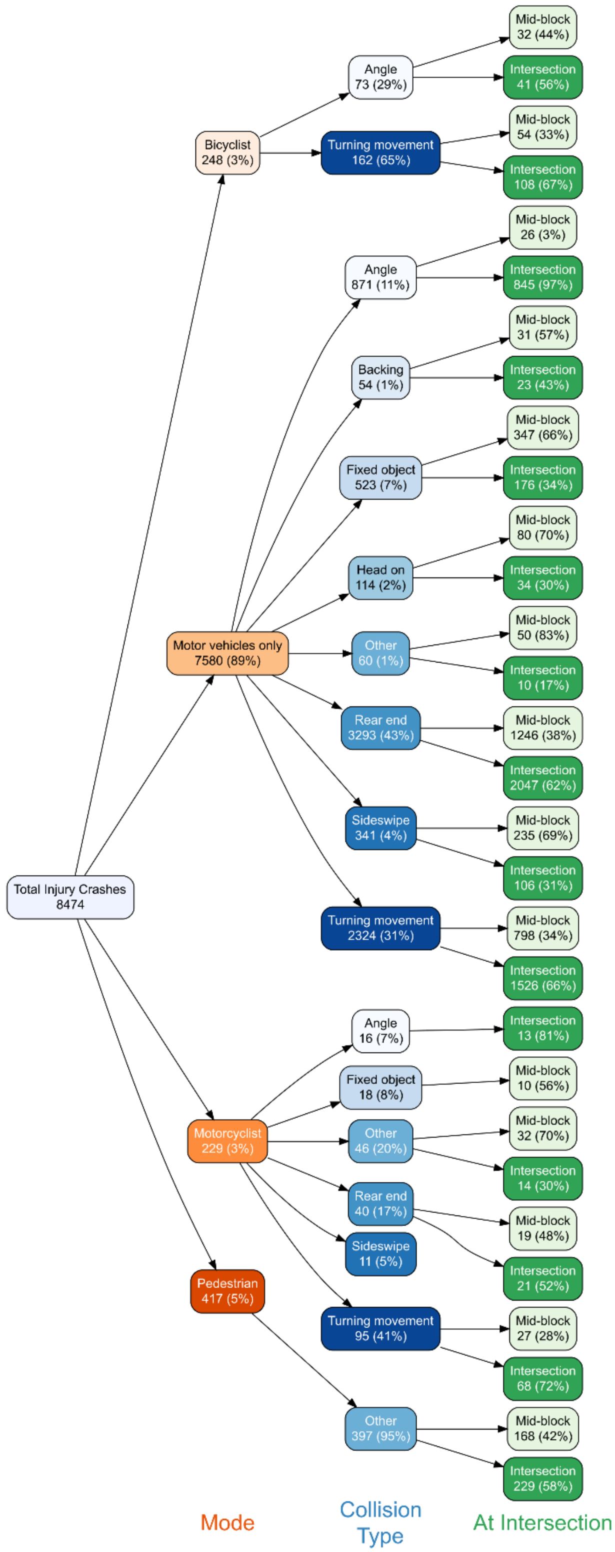

Figure 42: Profile 6 - Mode, Crash Type, and Intersection Status