APPENDIX A
SAFETY ANALYSIS METHODOLOGY

This appendix includes the methodologies for the following:

- High Injury Network (HIN) and High Injury Intersections (HII)
- Risk Analysis
- Corridor and Intersection Prioritization

HIGH INJURY NETWORK METHODOLOGY

Introduction

The purpose of this memorandum is to document the process for a November 2024 update of the regional Durham-Chapel Hill-Carrboro (DCHC) Metropolitan Planning Organization (MPO) High Injury Network (HIN), as well as 7 local HINs for the following jurisdictions:

1. Town of Carrboro
2. Town of Chapel Hill
3. Chatham County
4. City of Durham
5. Durham County
6. Town of Hillsborough
7. Orange County

Note that the July 2024 bicycle/pedestrian HIN, as well as the High Injury Intersections (HIIs; regional and local) remain unchanged.

Data

The project team obtained two sets of crash data from the North Carolina Department of Transportation (NCDOT):

- All crash data from the NCDOT enterprise crash database (2016-2023)
- Bicycle and pedestrian-specific crash data available via NCDOT's Open Data Portal (2013-2022)[1]

These data sources included characteristics such as location, roadway characteristics, and crash severity. There are several considerations for the inclusion of both data sources:

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[1] https://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=b4fcdc266d054a1ca075b60715f88aef

- Crash data from NCDOT's enterprise database have limited crash location data. **Generally, crashes are much more likely to be locatable on NCDOT-maintained roads, and therefore able to be used to generate a network of high crash locations.**
- By contrast, the crashes in NCDOT's curated Bicycle and Pedestrian dataset are manually located and therefore can be located on all parts of the network with greater confidence.
- Furthermore, NCDOT reviews all potential bicycle and pedestrian crashes for accurate reporting. NCDOT:
    - removes crashes that may be labeled as bicycle or pedestrian that did not actually involve a bicyclist or a pedestrian, as well as
    - removes any crash that did not occur in the public right of way (i.e., excluding parking lots or private driveways).
- Differences in crash frequency and timeliness account for the differences in the year ranges associated with each dataset (i.e., 7 years of total crashes and 10 years of bicycle and pedestrian crashes). Although all bicycle and pedestrian crashes are locatable, they are less frequent than total crashes and more observations are required for meaningful insights.

The project team also obtained NCDOT's route characteristics file and intersection inventory in a geographic information systems (GIS) format. The project team used a spatial join to link crashes with roadway segments based on a common route classification (for the all-crash HIN); this helped reduce the likelihood of erroneous joins between crashes and roadway segments. Crashes were designated intersection-related for the HII if they occurred within 150-foot buffer standard in the NCDOT inventory.

Methodology

For this analysis, a Python-based tool was developed that uses a sliding window approach to generate an equivalent property damage only (EPDO) score for each roadway segment. The tool is customizable to different settings that dictate how the tool scans the network. The tool iterates along a centerline one-tenth of a mile at a time and creates a 1-mile segment with an associated EPDO value; note that this creates overlaps, as each one-tenth mile segment is incorporated in several 1-mile segments.

For the purposes of this HIN version, access-controlled roads (I-40, I-885, I-85, NC 147, and the US 15-501 Bypass in Durham County), ramps, and crashes were excluded from local HINs; this left only non-access-controlled roads (except for US 15-501 in Orange County) in the analysis. US 15-501 remained in the Chapel Hill and Carrboro HINs due to the high proportion of local fatal and serious injury crashes. At the end of the analysis, the access-controlled roads identified in the July 2024 HIN were reincorporated into the DCHC regional HIN to create the complete final version of the regional network.

The following steps summarize the process by which data were processed and HIN segments were synthesized:

- After excluding crashes with a route number flagged as access-controlled, crash points are clipped to the boundaries of each subregion.
- EPDO values are assigned to crashes based on crash severity, and this value is summed during the aggregation process. Table 1 provides the EPDO weights for each severity type.

Table 1. EPDO Weights for High Injury Locations

Crash Severity	Crash Cost ($2022)	EPDO Weight
Fatal (K) or Suspected Serious Injury (A)	$3,865,000	268
Suspected Minor Injury (B)	$230,000	16
Possible Injury (C)	$136,000	9
Property Damage Only (PDO)	$14,400	1

- A one-tenth mile sliding window captures crashes on segments.
- A spatial join is performed to calculate total EPDO score for each segment.
- To generate final HIN corridors, the top 5 percent of segments region-wide, and top 10 percent of segments for each locality were extracted for final processing.
- Since this produces overlaps, segments are aggregated so that each individual segment is a single feature; more than one HIN segment may be on a single route, but unique segment features are generated if these are not spatially contiguous.
- As noted previously, access-controlled segments identified in July 2024 were re-integrated into DCHC regional HIN.

High Injury Intersection Network (HII)

To ensure consistency between which crashes are associated with which networks, the HII is created first. Then, any crashes associated with the HII are excluded from the creation of the HIN and the bike-ped HIN. The following steps provide a summary for the development of the HII.

- **Step 1**: Clip intersection polygons and spatially locatable crashes to the DCHC planning area using the Pairwise Clip geoprocessing tool.
- **Step 2**: Spatial join intersection polygons to crash points with the parameters Join One to Many, Closest, Keep ALL, and a search radius of 25 feet.
- **Step 3**: Run Summary Statistics on the spatial join layer. Sum the EPDO field by KeyIntersectionID.

  This provides a sum of EPDO scores by unique intersection An example of this calculation is shown in Figure 3.
- **Step 4**: Use the join field geoprocessing tool to tie the Sum EPDO column to the original intersection layer using fields KeyIntersectionID and KeyIntersectionID.
- **Step 5**: For any locations with a *null* value in the summed EPDO field, calculate a "0."
- **Step 6**: Calculate the percentile rank of all locations.

  This step normalizes the location scores between 0 and 100, where the highest intersection based on EPDO is closest to 100 and the lowest is 0. The script for this analysis is shown in Figure 4. To determine the top 1 percent of scores/locations, for instance, one would select all rows with a value of 99 and above.
- **Step 7**: Create a non-intersection crash layer based on crashes that were not located within the 150-ft influence area of an intersection polygon.

```
In [1]: import arcpy
        from scipy import stats

In [2]: # Define geodatabase path(s)
        gdb = r'\\vhb.com\gis\proj\Raleigh\39600.01 NCDOT_NC SHSP 2024\Project\NC Safety Plans\DCHC_HIN\DCHC_Geodatabase\temp_outputs.gdb'

        # Define geodatabase content(s)
        fc = gdb + r'\\' + r'DCHC_Intersections'

In [3]: # Field containing values to rank
        value_field = 'Pct_Total'

        # Field to which to write the rankings
        rank_field = 'PercentileRank_total'

        # SQL query to limit rankings to certain rows in the table
        # If no query is needed (if performing ranking on all rows of the table) set the clause variable like: clause = None
        clause = None

In [4]: ScoreArray = []
        with arcpy.da.SearchCursor(fc, [value_field]) as sCur:
            for row in sCur:
                if row[0] is not None:
                    ScoreArray.append(row[0])

        print(len(ScoreArray))
        with arcpy.da.UpdateCursor(fc, [value_field, rank_field]) as uCur:
            for row in uCur:
                row[1] = stats.percentileofscore(ScoreArray, row[0], kind='weak')
                uCur.updateRow(row)

        print("Finished.")
```

Figure 1. ArcPy Script for Calculating Percentile Rank.

It is important to consider the HII in relationship to a HIN. Assessing the HII and the HIN separately is a safety planning practice that allows a more nuanced view of the safety problems on the road network. Intersection crashes and non-intersection crashes can tell different stories about the safety issues on the road network and create opportunity for more context-specific countermeasure development. By examining intersection crashes and non-intersection crashes in their own layers, we are able to see a network of roadways, as well as a network of intersections that contribute to the High Crash Network in the DCHC region.

Regional High Injury Network (HIN) – All Crashes

The following steps provide a summary for the development of the HIN for all crashes in the DCHC planning area. Steps 1 through 6 generate individual high injury segments, and Step 7 generates the HIN from these segments. **Based on conversations with DCHC, the project team can adjust the thresholds for identifying HIN segments and corridors for the final HIN. The proposed and recommended threshold for the regional HIN is the top 1%.**

- **Step 1**: Clip road centerlines and remaining non-intersection crashes to the DCHC planning area using the pairwise clip geoprocessing tool.
- **Step 2**: Segment roadway centerlines to generate segments between intersections using the intersection inventory and generate a unique ID for each road segment in the study area.
- **Step 3**: Using route class as a common attribute, join roadway segments to crashes with the parameters Join One to Many, Closest, Keep ALL, and a search radius of 150 ft.

- **Step 4**: Run the Merge and Summarize Script with appropriate inputs and outputs to get final route segments with sum EPDO for each segment.
- **Step 5**: For any locations with a null value in the summed EPDO field, calculate a "0"
- **Step 6**: Calculate the percentile rank of all locations.
- **Step 7**: Using the 99th percentile segments (top 1% of EPDO scores), connect any HIN segments that share the same RouteID (i.e. are objectively the same roadway) and are within 0.5 miles of each other, and delete any HIN segments that are not within 0.5 miles of another HIN segment. Minimum length for HIN segments included in the final map are 1.0 miles.

  This step is sometimes referred to as "smoothing". This smoothing process takes a disconnected network of short segments and smooths it into a legible road network. This process serves a number of benefits: 1) Improves data interpretability by removing segments between HIN segments that may not show up on the analysis because several severe crashes may not have occurred on that block specifically , but it is representative of the same safety concern, 2) enhances countermeasure application by removing isolated one-block segments and considering the relationship between high injury segments and corridors

Localized High Injury Network (HIN) – All Crashes

The following steps provide a summary for the development of a localized HIN for all crashes in the DCHC planning area. Based on conversations with DCHC, the project team has identified the need to develop a localized HIN for all crashes in the following communities within the DCHC planning area: City and County of Durham, Town of Chapel Hill/Town of Carrboro, Town of Hillsborough, Orange County/Chatham County. The development of these localized HINs starts with clipping the crashes and road centerlines to the identified community boundaries and then follows the same steps 2 through 7 outlined in the Region HIN. An objective of the localized HINs would be to create more detailed networks for local agencies; however, any locations identified on the regional network should also be present in the local network. **Based on conversations with the individual communities, the project team can adjust the thresholds for identifying HIN segments and corridors for the final localized HINs. The proposed thresholds for the localized HINs will vary between 1% and 5% based on local contexts.**

Through this curated approach, each community identified in this step will have the regional HIN and a localized HIN, which provides greater opportunity to identify nuances safety issues, foster local support for safety countermeasures, and identify funding opportunities (local, state, federal) for safety countermeasure implementation.

High Injury Network (HIN) – Bicycle and Pedestrian Crashes

The following steps provide a summary for the development of the HIN for bicycle and pedestrian crashes only in the DCHC planning area. The primary difference between the "All Crashes" version and the "Bicycle and Pedestrian Crash" version is the segmentation of the roadway. Since bicycle and pedestrian crashes are much less frequent than other crash types, road segments are developed using dynamic segmentation[2]; this creates longer contiguous segments than the intersection-to-intersection approach. This process creates homogenous segments based on

[2] https://pro.arcgis.com/en/pro-app/latest/help/production/roads-highways/apply-dynamic-segmentation.htm

selected attributes. For the DCHC analysis, the project team used RouteID, functional class, and number of lanes to create homogenous segments of similar characteristics.

- **Step 1:** Clip road centerlines and remaining, non-intersection crashes to the DCHC planning area using the pairwise clip geoprocessing tool.
- **Step 2:** Segment roadway using RouteID, functional class, and number of lanes fields with no multi-part features and generate a unique ID for each road segment in the study area.
- **Step 3:** Exclude road segments and crashes with the "Interstate" route class (road segments layer) or road class (crashes layer).
- **Step 4:** Use Spatial Join (join setting Closest, search radius 150 feet) on study area crashes and study area segments.
- **Step 5:** Use Summary Statistics geoprocessing tool on the crash layer to get EPDO and Frequency (i.e., total number of crashes) by SegmentID.
- **Step 6:** Use Join Field to join crash frequency and sum of EPDO back to original segments using join fields SegmentID.
- **Step 7:** Calculate the percentile rank of all locations based on EPDO score.

Key Distinctions from the Previous Methodology & Conclusions

There are important distinctions between the November 2024 version of the analysis and the July 2024 version. Previous HIN versions separated midblock and intersection-related crashes to avoid redundancy between these two networks. However, this creates a more segmented, block-by-block visualization to the HIN. There is no appreciable difference in "coverage" of historic fatal and serious injury crashes or mileage between either approach; however, the more continuous corridors may be more intuitive for presentation or discussion with stakeholders. Furthermore, as a result of combining midblock and intersection-related crashes, most HIIs are also on corridors identified in the regional and/or local HINs. Only 2 intersections are uniquely (i.e., not on an HIN) regional or local HIIs after this update.

RISK ANALYSIS

Introduction

This memorandum summarizes the data analysis conducted to support the Durham-Chapel Hill-Carrboro Metropolitan Planning Organization (DCHC) Vision Zero Safety Action Plan. This includes a review of historic crashes to identify high crash locations (reactive analysis), as well as a systemic, risk-based analysis to identify locations that share factors that contribute to certain crash types even if a crash has not occurred in recent history at all locations that share these characteristics (proactive analysis).

High Injury Network (HIN) and Intersections (HII)

Analysis

The project team submitted a draft summary of the High Injury Network and High Injury Intersections to DCHC in summer 2024. The Results section in this memorandum provide the coverage statistics for the following networks:

- Regionwide HIN and HII for all modes (Total Crash)
- Regionwide HIN and HII for bicyclist- and pedestrian-involved crashes (Bike/Ped Crash)
- Local HINs and HIIs for:
    - Chatham County (unincorporated, within DCHC)
    - Durham City and County
    - Orange County (unincorporated, within DCHC)
    - Town of Carrboro
    - Town of Chapel Hill
    - Town of Hillsborough

Regional HIN and HII

Figure 1 displays the coverage statistics for Regional HIN and HII. These statics cover the total percentage of public road miles and intersections included in their respective high injury analysis, contrasted with the total percentage of fatal (also referred to as “K” injuries) and serious injury (also referred to as “A” injuries) crashes during the study period that are included on the network.

The DCHC Total Crash HIN covers 63.5% of fatal and serious injury crashes between 2016 and 2023 and 9.1% of road mileage. The Bike/Ped Crash HIN covers 48.6% of fatal and serious injury bike/ped crashes between 2013 and 2022 while only consisting of 3.8% of road mileage. The Bike/Ped Crash HIN and HII combined cover 100% of fatal, non-interstate highway, bike/ped crashes between 2013 and 2022.

The DCHC Total Crash HII (the top 1% of intersections) covers 29% of intersection-related fatal and serious injury crashes, as well as 100% of all bike/ped intersection-related fatal and serious injury crashes.

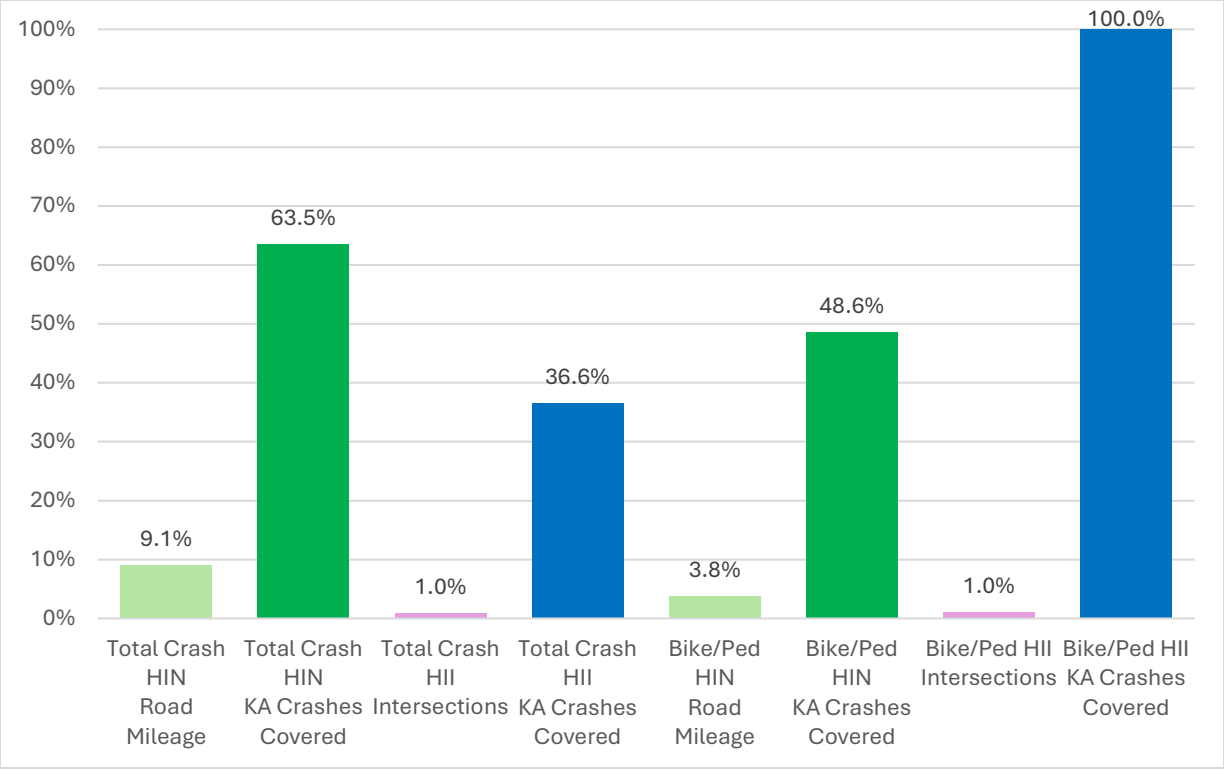


Figure 2. Regional HIN Coverage Statistics.

Figure 2 displays the coverage statistics for the HIN when routes signed as interstates (e.g., I-40, I-885, and I-85) are excluded. The DCHC non-interstate HIN covers 58% of fatal and serious injury (KA) crashes and 7.5% of road mileage.

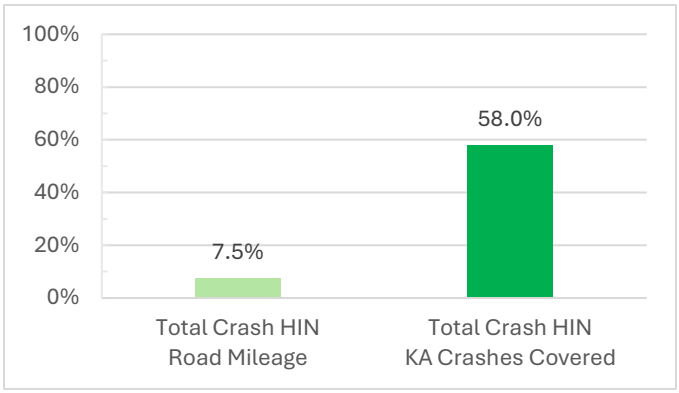
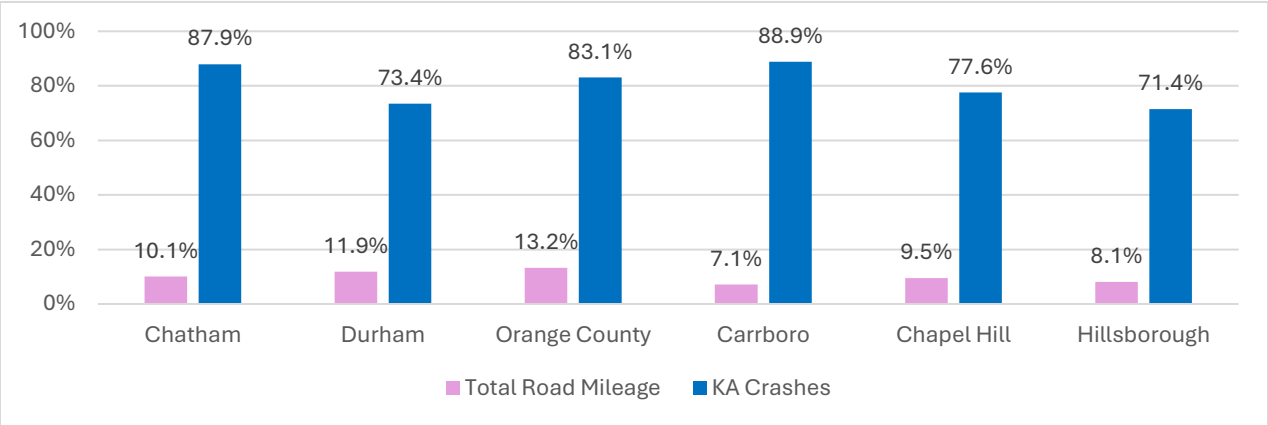


Figure 3. Regional HIN Coverage Statistics Excluding Interstate Highways.

Local HIN and HII

Figure 3 provides coverage statistics for local HINs in the DCHC region. Mileages for each HIN vary between 7.1% and 13.2% of the locality's roads, while fatal and serious injury crash coverage varies between 71.4% and 88.9%. These thresholds were used to capture the greatest share of



historic fatal and serious injury crashes, while keeping the amount of road mileage around 10% for any single jurisdiction.

Figure 4. Local HIN Coverage Statistics.

Figure 4 provides a summary of the fatal and serious crash coverage for the top 1% of intersections in each locality. There are roughly 11,600 intersections in the MPO boundary, and this threshold was set at 1% across the region to focus attention on the highest severe crash locations.

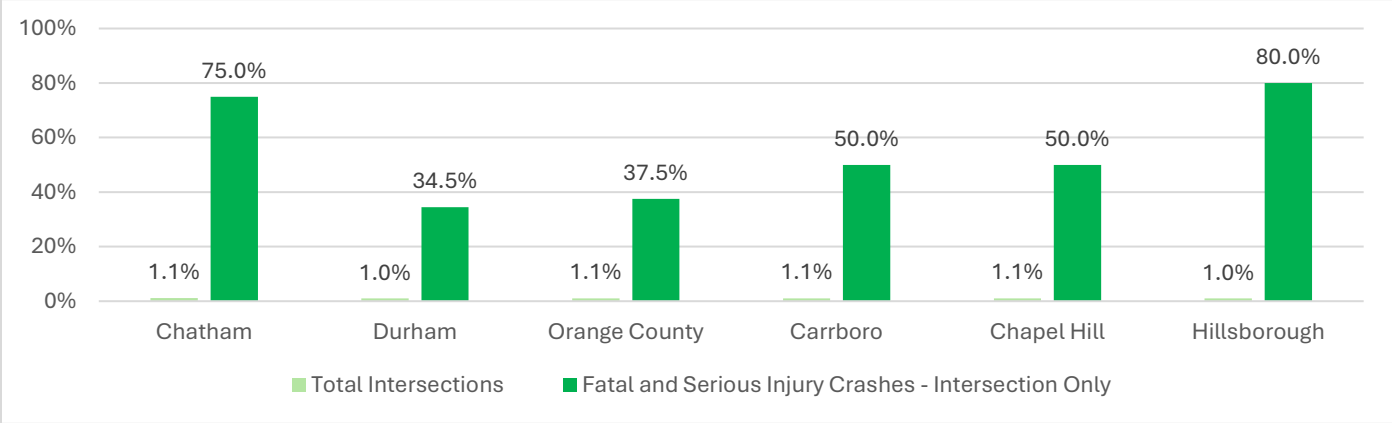


Figure 5. Local HII Coverage Statistics.

Risk-Based Networks

Analysis

The objective of the risk-based analysis is to enhance road safety through the identification of specific roadway characteristics where fatal (K), suspected serious injury (A), and suspected minor injury (B) crashes are most likely to occur. This analysis identifies common roadway characteristics at high severity crash locations and identifies a network of road segments and intersections with those same characteristics. This approach identifies segment- and intersection-level risk factors and is a tool used to inform transportation policies and infrastructure improvements that can proactively target these specific high injury crash types.

The following crash types represent a greater share of KA injury crashes than total crashes. Focusing on these crash types as the highest priority for treatment – due to their comparative higher severity than other crashes – supports the Vision Zero goals of this action plan.

- **Lane Departure:** Crash/Collision type recorded as running off the road, rollover/overturn, striking fixed object, sideswipe in opposite directions, or head on.
- **Speed-Related:** Contributing circumstances related to the driver are recorded as exceeding the posted speed limit or driving too fast for conditions.
- **Bike:** Crash/Collision type, "vehicle" type, or person type recorded as a bicycle.
- **Pedestrian:** Crash/Collision type, "vehicle" type, or person type recorded as a pedestrian.
- **Motorcycle:** Vehicle type involved in crash is recorded as a motorcycle.
- **Intersection-Related:** Roadway feature at the crash location is an at-grade intersection.
    - All crash modes
    - Bicycle/Pedestrian crashes

Methodology

Risk network identification starts by identifying the roadways and intersections where more severe KAB focus crashes (i.e., the seven identified above) have occurred during the study period. This framework then assesses common characteristics among these roadways using a binary logistic model for each of the seven crash types. This model produces a probability that a crash will occur at a segment or intersection based on the associated characteristics of each site. This produces a set of risk factors – characteristics that are correlated with KAB crashes. The characteristics are then used to generate a "probability" or score for each segment and intersection in the inventory that indicates the likelihood that a KAB crash will occur based on the characteristics of that location.

This "probability" is not associated with a site's specific crash history, but rather an indication of crash likelihood based on the known characteristics. Furthermore, there may be site-specific characteristics that are not captured as part of the model that can influence safety. For instance, although the presence of a traffic signal, approach AADT, and intersection skew angle are all risk factors for intersections, sites that have these similar characteristics might be differentiated by sight distance limitations associated with vegetation or other obstructions or driveway curb cuts

near the intersection that may impact safety at the individual site-level. This reflects the importance of site-level diagnosis and review before implementing countermeasures.

Results

Figure 5 provides the coverage statistics for the seven high risk networks developed for the DCHC area. This includes five segment-based networks and two intersection networks. The following notes provide more context for the high-risk network:

- Whether or not a crash has occurred at a segment or intersection does not factor into whether the location is "high risk" or not; only the probability produced by the model indicates high risk.
- The risk networks in Figure 5 reflect the highest probability locations for each crash type; each risk network is distinct and may include overlapping or unique segments to the other risk networks. These networks are distinct from the HINs and may include overlapping or unique segments to those.
- The coverage statistics in Figure 5 reflect crashes that have an NCDOT flag associated with that crash type; there are a different number of crashes in each crash type across the DCHC region; some individual crashes may be identified in multiple crash types.
- All road segments and intersections in the region have a risk probability, or score, associated with them. The road mileage or number of intersections included in Figure 5 are not necessarily meant to be used as clear cutoff points for a standalone high-risk network(s). Rather, this is a comparable amount of road mileage to the HIN statistics in

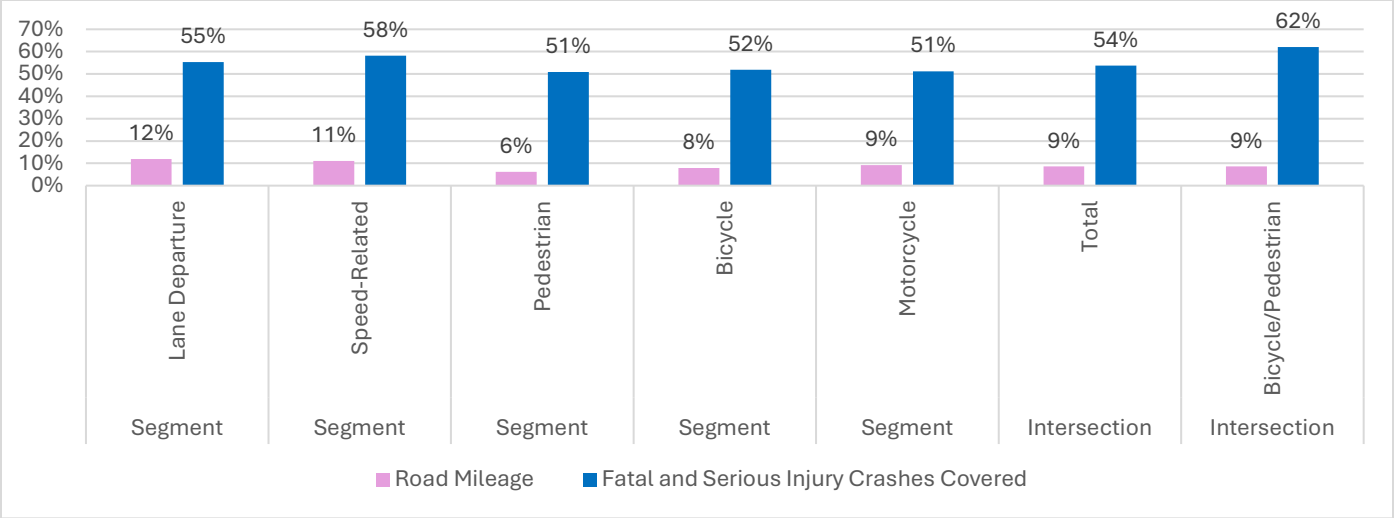


Figure 3.

Figure 6. Risk Network Coverage Statistics.

Risk-Factors

The logistic model considered many potential factors that could contribute to a higher likelihood of a certain crash type. Table 1 provides an overview of risk factors by crash type. This does not reflect any specific statistical significance threshold – the results are meant to only be used as a general

guide for illustrating contributing factors correlated with increased risk. A green cell indicates a risk factor is correlated with higher risk for that crash type. A black cell indicates a potential risk factor that was not considered; this can be because the factor is not necessarily appliable to a crash type (i.e., transit stops and lane departure). A blank square indicates a potential risk factor that was not significantly correlated with risk for that crash type.

Table 2 Risk-Factors by Crash Type

Risk Factor	Lane Departure	Speed-Related	Pedestrian	Bicycle	Motorcycle	Total Intersection	Bike/Ped Intersection
School or University Nearby							
Transit Stop Present							
Fewer Travel Lanes							
More Travel Lanes							
Higher AADT							
US Route							
NC Route							
SR Route							
Rural Context Classification							
Suburban Context Classification							
Urban Context Classification							
Higher CDC Social Vulnerability Index							
Higher Proportion of Zero Vehicle Households							
Higher Population and Employment Density							
Four Legs							
Signalized							
Greater Intersection Skew							

Comparison of 2023 Bike/Ped Crashes

NCDOT produces a curated dataset of bicycle and pedestrian crashes separate from the primary NC crash database.[3] Due to the timing of the analysis for this plan, crashes for the 2023 calendar year were not available for the HIN/HII or high-risk analysis. This provided an opportunity to test the HIN and high-risk networks to see how networks developed using 2013-2022 data compare to the crash locations in 2023.

Table 2 shows that both networks do a relatively good job of capturing 2023 crashes. However, the high-risk network appears to slightly outperform the crash frequency-based HIN analysis. This underscores the importance of considering risk in the DCHC region along with locations that have experienced severe crashes recently.

Table 3. Comparison of the DCHC Bike/Ped HIN and Pedestrian High-Risk Network.

	DCHC Regional Bike/Ped High Injury Network		DCHC High Risk Network (Top 500 Segments)	
	Total	**Percent**	**Total**	**Percent**
Total Mileage	119.18	3.8%	127.23	4.1%
Total KA Crashes	11	44.0%	13	52.0%
Total KAB Crashes	35	30.2%	47	40.5%
Total Crashes (All Severities)	62	29.8%	86	41.3%

[3] https://www.arcgis.com/home/item.html?id=b4fcdc266d054a1ca075b60715f88aef

PRIORITIZATION FRAMEWORK

Understanding and Assumptions

- The purpose of this analysis is to identify locations that could be suitable for project development by Triangle West and its member jurisdictions.
- This is not meant to scope or review project feasibility; however, the data analysis can help suggest to Triangle West the type of safety issues they might want to address.
- We can provide CMFs and countermeasures for the region to consider, but we will not attempt to do any specific project scoping or diagnosis.
- This framework will not consider access-controlled roads/highways in the screening.
- The output of this work will be lists of priority areas (corridors and intersections) for each part of the network:
    - A regional list that includes DOT-maintained roads
    - Agency-specific lists that will focus on areas where local agencies can affect change
- Next step may be to screen priority lists for locations that have already received a project or treatment in recent years.

Framework

Prioritize locations that have the potential to affect one or more of the following dimensions of safety:

- **Severity – Reduce the kinetic energy associated with collisions:** Projects that reduce the kinetic energy of collisions will be prioritized. Crashes that occur at higher speeds and at more severe angles are more likely to result in a fatality or serious injury. The most effective proven safety countermeasures, such as roundabouts and all-way stops, are effective because they can either 1) reduce the speed at which a potential collision occurs or, 2) reduce the angle (i.e., sideswipes instead of head on or angle crashes) at which crashes occur.
- **Likelihood – Reduce the likelihood of a collision occurring:** Proactive projects that prevent a collision from occurring will be prioritized. The Action Plan may include projects that remove or reduce potential conflicts that tend to result in more severe outcomes. Example strategies include intersection designs that reduce conflicts points between left-turning vehicles and on-coming traffic and median barriers that reduce or prevent cross-centerline collisions.
- **Exposure – Reduce the exposure to potential collisions:** Reducing exposure to collisions is another method of reducing severe crashes. This can take many forms, but a simple example may be the presence of bicycle and pedestrian traffic generators near major traffic thoroughfares. For example, this could be applicable to reviewing existing transit stops that may be incurring unsafe and unexpected crossings or reviewing planned development for proximity to high-speed, high-volume crossings. Projects that provide refuge and visible crossings in the former example and reconsideration of traffic patterns in the latter example are examples of projects that should be prioritized.

Practical Application

- Separate paths for corridors and intersections
- **Corridor path**
    - Severity: Flag segments that are above the average 50th percentile speed. If no reliable speed data are available, severity will be assumed to be low, and likelihood and exposure will be used to rank
    - Likelihood: Flag segments that are in the top 20% of bike or ped risk or on the bike/ped HIN, as well as a separate flag for being in the top 20% of lane departure or speed risk or on the "all mode" HIN
    - Exposure: Flag segments above 9,000 and 15,000 AADT, as well as segments in suburban, urban, urban core, and rural town contexts. Below is the order of priority in terms of highest to lowest priority

AADT[4]	Context[5]
1. >15,000 2. 9,000 – 15,000 3. <9,000	1. Urban Core 2. Urban 3. Rural Town 4. Suburban

    - According to this framework, priority will be given to corridors that:
        - Are an above average speed for the functional class
        - Have a high likelihood of either a VRU or motor vehicle collision
        - Are in neighborhoods where multiple modes are more likely to be present
    - Separate lists will be developed for vehicular and VRU priority
    - Example:
        - Road One is identified as a high priority location because it exhibits high speeds (85th percentile +), high Bicycle Risk, Moderate High Lane Departure Risk, Moderate Volumes, is in an Urban area, and is on the Bike/Ped HIN,
        - Road Two is not identified as a high priority location because it has the same indicators, except speeds are more moderate, and it is Moderate Bicycle Risk and is not on the Bike/Ped HIN.
- **Intersection path**
    - Severity: Flag Intersections that are on corridors that have above average 50th percentile speeds on an approach (corridor analysis). If no reliable speed data are available for any approach, severity will be assumed to be low, and likelihood and exposure will be used to rank
        - Roundabouts and all way stops receive lowest "Severity" priority by default
    - Likelihood: Flag intersections that are in the top 20% of bike or ped risk or on the bike/ped HII, as well as a separate flag for being in the top 20% of total crash risk or on the "all mode" HII.

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[4] Thresholds noted in FHWA's Unsignalized crossing guidance https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/docs/STEP-guide-improving-ped-safety.pdf

[5] In order of areas where multiple modes are likely to mix and be present

- Exposure: Flag intersections with approaches above 9,000 and 15,000 AADT, as well as intersections in suburban, urban, urban core, and rural town contexts. For AADT, all approaches will be considered so intersections with multiple approaches >15k will be highest priority. Below is the order of priority in terms of highest to lowest priority:

AADT	Context
1. >15,000 2. 9,000 – 15,000 3. <9,000	1. Urban Core 2. Urban 3. Rural Town 4. Suburban

- According to this framework, priority will be given to intersections that:
  - Have an approach that has an above average speed for the functional class
  - Have a high likelihood of either a VRU or motor vehicle collision
  - Are in neighborhoods where multiple modes are more likely to be present
- Separate lists will be developed for vehicular and VRU priority

Tiers for Prioritization

- High priority locations will be those that meet the highest criteria in each category, Severity, Likelihood, and Exposure
- Based on the top tier of locations, those that meet all the criteria, we will find top locations for the region and each agency (Orange County, Durham County, Chatham County, Chapel Hill, Hillsborough, City of Durham, and Carrboro) for inclusion in the final action plan

APPENDIX B
EQUITY MAPPING AND ANALYSIS

INTRODUCTION

This memo presents the framework for the Durham-Chapel Hill-Hillsborough Metropolitan Planning Organization (DCHC MPO) Vision Zero Action Plan equity analysis. The framework defines equity, describes methods used for the equity analysis, and lays out the historical housing and infrastructure context that influence current outcomes related to transportation safety. This memo also includes the results of the equity analysis and an assessment of comparative transportation safety outcomes. Finally, it shares conclusions and recommendations to help guide and create an implementable DCHC MPO Vision Zero Action Plan that is grounded in the region's history and centers transportation equity.

EQUITY DEFINITION

Equity can be defined in many different ways depending on the context. The transportation planning field defines "equitable transportation" as planning that:

- Accounts for current and past inequality;
- Provides for current needs;
- Produces an overall improvement in the system; and
- Ensures that everyone has transportation access and options that allow them to participate fully in society.

Environmental Justice

In accordance with federal statues, DCHC MPO incorporates environmental justice principles into all relevant areas of the transportation process that they oversee. These principles are:

- Avoid, minimize, or mitigate disproportionately high and adverse human health or environmental effects, including social and economic efforts, on minority populations and low-income populations.
- Ensure the full and fair participation by all potentially affected communities in the transportation decision-making process.
- Prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority populations and low-income populations.

Source: Environmental Justice. DCHC MPO website. https://www.dchcmpo.org/work-with-us/environmental-justice-ej

Achieving an equitable transportation system requires understanding of how both positive and negative impacts are distributed throughout a region and across different demographic groups. Communities that have experienced historic marginalization – such as Black, Indigenous, and People of Color (BIPOC), people with disabilities, low-income individuals, or English language learners – are more likely to shoulder the burdens of the transportation system or have benefits of the system withheld due to the ongoing effects of past policies and investment patterns. This results in disparate transportation experiences and an inequitable transportation system.

EQUITY ANALYSIS APPROACH

A Vison Zero equity analysis can be used to identify people that experience both sociodemographic vulnerability (due to systemic discrimination and marginalization) and transportation disadvantage. It can help improve understanding of the disproportionate outcomes related to transportation safety and access.

It can then examine how these communities are impacted and provide insights on how future transportation investments can remove sociodemographic disparities and redress past harms. The knowledge gained through the equity analysis will be used in the DCHC Vision Zero Action Plan as a component of project prioritization and the plan implementation to monitor, reduce, and, ideally, eliminate disparities.

The equity analysis for the DCHC Vision Zero Action Plan will follow the approach in Figure 1. The following sections of this memo will walk through each component of the approach and present findings.

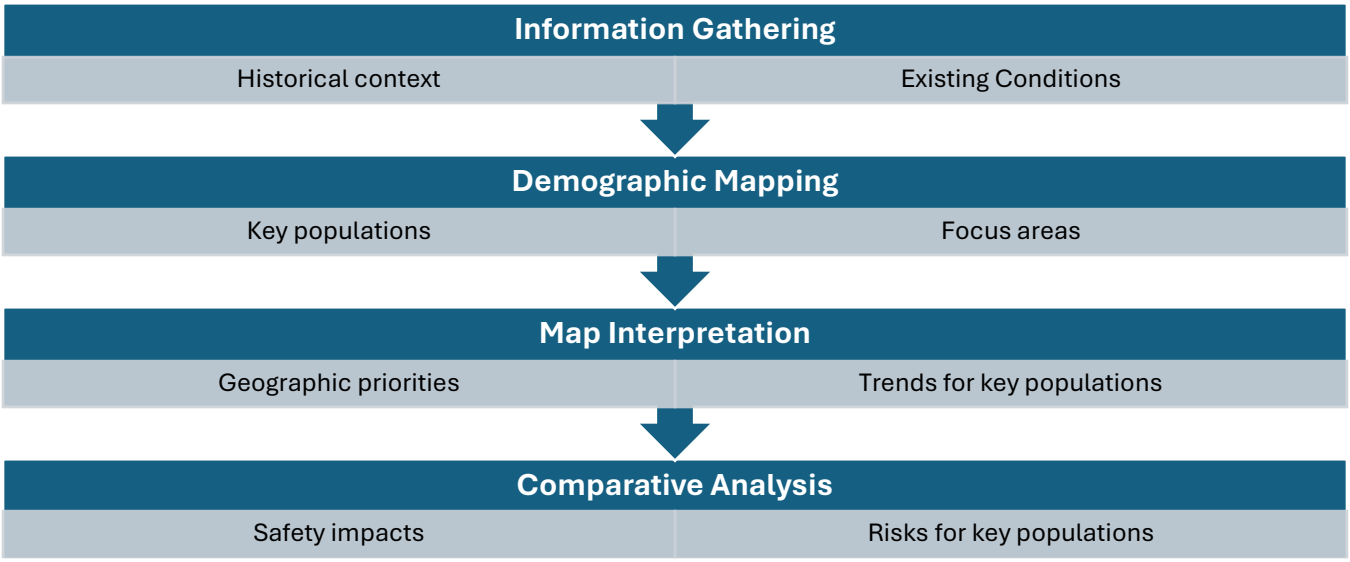

Figure 7. Equity Analysis Approach

INFORMATION GATHERING

Transportation is a key element of all people's daily lives. Nearly everyone must use the transportation network to access jobs, healthcare, grocery shopping, entertainment, and recreation opportunities. In the DCHC MPO region, historic and current policies and practices surrounding housing, infrastructure, and law enforcement contribute to inequitable transportation safety outcomes for BIPOC, people in low-income households, people without vehicles, people who walk and bike, and other marginalized groups.

The following section provides and overview of historical context and current policies and practices impacting transportation safety outcomes for marginalized people within the DCHC region.

Historical Context – Overview of Policies and Outcomes

This equity framework recognizes that current conditions are a product of historical investments and policy decisions. Understanding historical context is critical to understanding who is currently underserved by the transportation network. By looking into where disadvantages began for communities, we can trace the impacts back to present day as historical actions leave a legacy of effects.

Transportation policies and practices across the United States have long failed to serve BIPOC communities. The region that encompasses Durham, Chapel Hill, Carrboro, Hillsborough, and parts of Chatham County is no different as policies with racist origins enabled the perpetration of disinvestment in certain communities. This disinvestment negatively impacted these communities in numerous aspects through direct and indirect effects, but directly in infrastructure and capital investments, including the lack of paved roads and sidewalks.[6] In the words of former Congressman John Lewis:

"The legacy of Jim Crow transportation is still with us. Even today, some of our transportation policies and practices destroy stable neighborhoods, isolate and segregate our citizens in deteriorating neighborhoods, and fail to provide access to jobs and economic growth centers.[7]"

Investments in safe, accessible, and reliable transportation infrastructure are disproportionately allocated in white neighborhoods, often to the detriment of BIPOC communities that have experienced disinvestment and underinvestment. Since the mid-twentieth century, the United States has prioritized highways and suburban commuter transit, chronically underfunding public transportation systems that serve many BIPOC communities and creating unsafe roadways in these communities, with higher speeds and an absence of safe, connected facilities for walking

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[6] Ernst, S. (2024, May 7). *Hooligan Heights: Redlining*. Retrieved from Hooligan Heights: Mishawaka's Wild West: https://hooliganheights.com/redlining/

[7] Lewis, John. (2004). Foreword to *Highway Robbery: Transportation Racism & New Routes to Equity* by Robert Bullard, G. Johnson, & A. Torres. South End Press.

and bicycling.[8] The impact of this disinvestment is visible along racial lines across areas such as access to employment,[9] traffic death and injury rates,[10] and exposure to other public health risks.[11]

Households with low incomes and people with disabilities have also been marginalized and excluded from transportation system benefits and overly burdened by negative outcomes of the system. Both these demographic groups experience inequitable transportation outcomes, including longer work commutes and the increased likelihood of being killed while biking or walking.

The existing conditions for the groups mentioned above are a result of historical policies and practices, some that are clearly related to transportation and others that, while on the surface are not transportation-related, often impact transportation access. To establish this context, the following sections discuss policies and practices in infrastructure, housing, and law enforcement that have led to and continue to exacerbate the transportation conditions for vulnerable groups in the DCHC region. Acknowledging and understanding these policies equips present-day transportation planners and plans – like the DCHC Vision Zero Action Plan – with the knowledge to abate further harm, rebuild trust with the community, increase positive outcomes of the system, and redress past harms.

The postwar history of infrastructure planning across the country and in the Durham region has led to inequitable transportation outcomes in terms of access, connectivity, and traffic safety. The Vision Zero Action Plan acknowledges these disparities and will create policy, program, and infrastructure strategies that aim to address pressing harms, eliminate disparities, and achieve zero deaths and serious injuries on the region's roadways.

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[8] Archer, Deborah. (2021). Transportation Policy and the Underdevelopment of Black Communities. 106 *Iowa Law Review* 2125, NYU School of Law, Public Law Research Paper No. 21-12.

[9] Golub, A., Martens, K. (2014). Using principles of justice to assess the modal equity of regional transportation plans. *Journal of Transport Geography*, 41, 10-20.

[10] Governors Highway Safety Association. (2021). An Analysis of Traffic Fatalities by Race and Ethnicity.

[11] Rosenbaum, A., Hartley, S., Holder, C. (2011). Analysis of diesel particulate matter health risk disparities in selected US harbor areas. American Journal of Public Health, Suppl, 101, S217-223.

Starting by reflecting on the history of modern transportation planning allows us to examine how past policy and practice has perpetual impacts. These past policies and practices not only influence our current circumstances, but often form the foundation for existing policies and practices. It is important that the Vision Zero Action Plan acknowledges this history so that the strategies included serve people who have disproportionately shouldered the burdens of transportation "progress" in the past.

Highway Construction and Urban Renewal

In 1956, the first Federal-Aid Highway Act was passed to create the Dwight D. Eisenhower National System of Interstate and Defense Highways, commonly known as the Interstate Highway System. This law, in concert with the 1949 Housing Act, led to widescale construction of highways through urban, Black communities which facilitated and supported white flight from cities to the suburbs over the next two decades.

In the wake of desegregation and Supreme Court rulings that upended Jim Crow laws, many cities used highway development to bulldoze "blighted" communities designated by inherently racist methodologies, including many vibrant and successful Black communities.[12] The DCHC region had many thriving African American communities that suffered large-scale demolition and intentional marginalization through transportation and housing policy.

Figure 8. Aerial imagery of Hayti in 1950 and 1972, before and after re-routing of Fayetteville St and construction of Durham Freeway. Source: Bull City 150

This included neighborhoods such as:

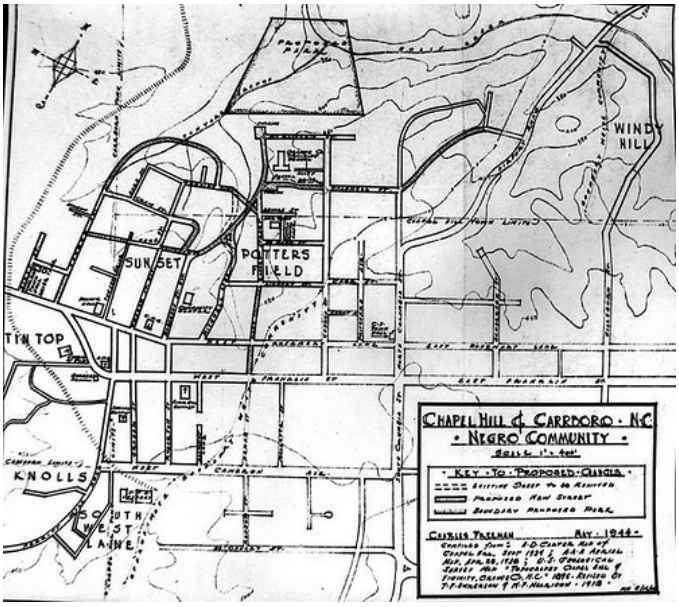
Hayti in Durham – Hayti was founded after the Civil War by formerly enslaved African Americans, many of whom came to work in tobacco factories. The establishment of African American-owned North Carolina Mutual Life Insurance Company in 1898 led to significant growth and investment into the community. By the early 1900s, Hayti was one of the most successful [of] all Black communities in the country.[13] Throughout the 1920s and 1930s, businesses and civic assets thrived while simultaneously, Black families in the neighborhood still dealt with the realities of redlining, segregation, and racial discrimination. Vibrant and impressive buildings were constructed along Fayetteville Street as the community established schools, churches,

[12] Dickerson, A. Mechele. (2020). Systemic Racism and Housing, 70 *Emory Law Journal* 1535.

[13] Rhodes, Brianna (2020). 9 Historic Black Neighborhoods That Celebrate Black Excellence. National Trust for Historic Preservation.

restaurants, renowned theaters, hotels, a library, and hospital. Neighborhood decline began in the early 1960s as highway development and urban renewal planning began by both conservative and progressive decision-makers in Durham. The construction of the Durham Freeway in 1970 – supported by white business owners who wanted to relieve vehicle congestion downtown and connect to the Research Triangle Park – included rerouting Fayetteville Street and demolishing dozens of homes and businesses.[14] Nearly all structures on the corridor were demolished aside from St. Joseph AME Church. By the end of urban renewal practices in Durham, over 4,000 families and 500 businesses were displaced from Hayti.[15]

Pottersfield and Sunset in Chapel Hill and Carrboro – The area that is now commonly referred to as Northside is a historically Black community originally established over 100 years ago for Black workers at the University of North Carolina, including stone masons that built the university's walls and workers who carried water to student dorms.[16] Despite the importance of the Black residents and workers to the university, the community was segregated and did not have access to Town services – such as roadway paving – until 1950.[17] These closeknit neighborhoods included thriving businesses and were mostly comprised of homeowners and families.[18] Urban renewal planning began in the 1960s and in 1975, Chapel Hill received its first Community Development Block Grant from the federal government. Despite residents organizing to fight urban renewal planners' efforts, the demand for student rental housing continued to grow. As many Black residents took relocation offers or passed away, the community faced destabilization and housing prices increased, furthering displacement for low-income residents who could no longer afford rising rents. By 1980 the population and homeownership rates of Black residents began to rapidly decline.[19]



A removed community in Hillsborough near what is now Margaret Lane – After the Civil War, African American families began settling near the Eno River and established a robust community of self-sustaining businesses including a funeral home, boarding house, cobbler, historic church, and parsonage.[20] In 1964, the homes, businesses, and buildings were forcibly destroyed, and citizens

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[14] Bull City 150. Dismantling Hayti: Who Caused All This?. Bullcity150.org
[15] Bull City 150. Dismantling Hayti.Bullcity150.org
[16] Moss, Gary. (2016). Building on history. Unc.edu
[17] Fanning, Sophia. (2023). We really had a community: A 100-year look at housing in Chapel Hill's Northside. Dailytarheel.com
[18] Pottersfield (or Potter's Field). Fromtherockwall.org.
[19] Fanning, Sophia. (2023). We really had a community: A 100-year look at housing in Chapel Hill's Northside. Dailytarheel.com
[20] (2023). Hillsborough's Black History; A Self-Guided Walking Tour. Visithillsboroughnc.com.

displaced to build the Churton Street Bridge to connect outlying areas to the Hillsborough town center area. The bridge was planned and built using both local and federal funding.[21] Today, where this vibrant community once stood there is now a park with commemorative plaques.

These communities were not the only ones impacted by highway development and urban renewal practices in the region. Other predominately Black neighborhoods like Tin Top and Rogers Road in Carrboro, Pine Knolls in Chapel Hill, and West End/Lyon Park, Brookstown, Hickstown, Walltown, and the East End in Durham were similarly impacted and marginalized.

> In Durham, over 90% of Black residents voted in support of a 1963 Urban Renewal-related bond referendum. This is because residents and community leaders were misled about how the major infrastructure investment would impact their homes, businesses, neighborhood and lives. They were promised new housing, new commercial development, and other physical infrastructure improvements.
>
> ***"Urban renewal failed on every level to make good on its promises for a renewed Hayti and adequate replacement for lost housing and businesses. Black leaders and the Hayti community were left stung by a sense of betrayal. 'The so-called Urban Renewal program in Durham is not only the biggest farce ever concocted in the mind of mortal man… but just another scheme to relieve Negroes of property.' – Louis Alson, Carolina Times Editor, 1965"***
>
> This exemplifies how equitably addressing transportation safety in historically marginalized neighborhoods goes beyond physical infrastructure. Incorporating transportation equity in both process and outcome will require transportation agencies to intentionally and thoughtfully rebuild trust with communities that have experienced targeted harm and deception from the government. This takes time.
>
> Source: Bull City 150, Dismantling Hayti: Empty Promises

Highways and other transportation infrastructure like railroads used to create lasting physical barriers between white and predominantly Black neighborhoods still influence demographic trends long after the end of urban renewal practices in the region. The impact of this is not only felt by Black residents – these infrastructures planned and built in the past present current barriers that disproportionately impact people who are low-income, female, elderly, children, immigrants, disabled, do not drive, or do not have regular access to a vehicle. [22]

Highway development and urban renewal supported rapid suburbanization of American metropolitan areas, with much of the growth happening through auto-oriented development patterns. To this day, the DCHC area is highly car dependent, meaning residents of the area are experiencing increased household transportation costs related to car ownership and maintenance.

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[21] Eno River Bridge (1964). Openorangenc.org.

[22] Wang, W., Espeland, S., Barajas, J.M. et al. (2023). Rural–nonrural divide in car access and unmet travel need in the United States, *Transportation*.

It also results in barriers to transportation for people who cannot drive or do not have regular access to a vehicle, as well as disproportionate impacts on people who are female, low-income, elderly, and/or disabled.

Highway and arterial construction also inflicted (and continues to inflict) harm on historically marginalized communities because of the air, water, and noise pollution that comes with high traffic volumes. People of Color and people with lower incomes are more likely to live within a mile of major roads and highways and, as a result, have higher risk of asthma, lung disease, heart disease, and reproductive health issues.[23,24]

[23] Boehmer, Tegan, et al. (2010). Residential Proximity to Major Highways – United States. *MMWR Morbidity and Mortality Weekly Report*, 62(3).

[24] Melton, Courtnee. (2017). How Transportation Impacts Public Health. The Sycamore Institute.

Transportation and housing policies have been historically linked, both intentionally and unintentionally. Traffic issues and parking provisions strongly influence the types of development that can occur, which in turn affects the provision of affordable housing and surrounding transportation network. Across the United States, and in North Carolina, this linkage has created inequitable outcomes and often places affordable housing near the most dangerous roadways, especially for people walking, biking, or taking transit.

After the Civil War, federal, state, and regional policymakers enacted Jim Crow laws and other racist policies to marginalize African Americans in terms of access to public space, transportation, housing, economic opportunity (amongst other realms of public life). Restrictive covenants were used in the 1920s through 1960s to keep Black and other People of Color confined in certain neighborhoods, where schools received less funding and transportation infrastructure was less developed or non-existent. Redlining, which began in the 1930s, codified racial segregation by favoring white-only neighborhoods and making it impossible for residents of majority Black or racially mixed neighborhoods to secure loans from banks based on "risk." These legacy policies continue to affect people today. A study from the National Community Reinvestment Coalition found that economic inequality and segregation persist in areas that were historically redlined

During the highway construction boom between the 1950s and 1970s, displaced populations were often relocated to massive public housing projects, notorious for their inhumane living conditions and poor construction. Public housing and highway construction were the twin cornerstones of the racially motivated urban renewal that swept the country in the mid-twentieth century, resulting in an extensive loss of urban housing stock and the creation of segregated communities.

"Created in 1958, the Durham Redevelopment Commission oversaw seven projects of urban renewal aimed at combating "urban blight," one in Durham's downtown and the other six in historically black neighborhoods including Hayti and Northeast Central Durham. These six neighborhood projects affected a primarily residential area of some 9,100 people, or 11.7% of Durham's population at the time. Beginning in 1961 and initially scheduled for completion within ten years, the full slate of projects was never finished."

Community and tenant-led organization through organizations like United Organizations for Community Improvement, Operation Breakthrough, and ACT were an important part of ending harmful public housing development strategies in Durham. Low-income residents from Black and white communities began organizing around housing issues in the 1960s and advocated for fair and improved conditions.

Although the scope of the DCHC Vision Zero Action Plan does not include housing-specific strategies, the inextricable relationship between transportation, housing, and land use development is an important factor that contributes to transportation planning, transportation equity, and traffic safety outcomes. The demographic geography of race and income did not happen by chance – it is the result of government policy and investment and important to understand for developing strategies to eliminate roadway deaths in the region. This process should engage with grassroots advocates, members of the public, relevant government departments, and relevant agencies to pursue a collaborative approach to equitable and coordinated strategies for growth and development.

Source: Digital NC, Durham Urban Renewal Records; Bull City 150, Tenants Mobilize: The Power of Grassroots Organizing; and Bruce Mitchell and Juan Franco HOLC "Redlining" Maps: The persistent structure of segregation and economic inequality

EXISTING CONDITIONS

Transit

Public transportation that is fast, convenient, and easy to use is associated with increased access to healthcare services and healthy food.[25] Conversely, when people depend on public transportation that is inadequate or irregular, inconvenient, or requires multiple transfers, they are more likely to forego accessing necessary destinations, including health services.[26] Historically, the shift in focus toward developing automobile infrastructure, most notably the interstate highway system, came at the expense of funding for public transportation, creating wider access disparities between those that had access to private vehicles and those that did not.[27]

There are multiple local agencies that work in coordination to provide public transportation services to residents in the DCHC region, as shown in Table 1. This includes traditional fixed route bus service and demand-response paratransit service for eligible riders such as people with disabilities, elders, and people in low-income households. Notably, Chapel Hill Transit is one of the largest bus systems in the country that is fare free.[28]

Amtrak provides daily passenger rail service through the Durham station with direct service to 24 cities. In 2022, there were 83,173 passengers that arrived or departed at the station.[29]

Table 4. Public transit operators in the DCHC region

Agency	Types of Service	Service Areas	Annual Ridership (2023)[30]
Chapel Hill Transit	Fixed route bus service	Town of Chapel Hill, Town of Carrboro, and University of North Carolina	3,798,800
E-Z Rider	Demand-response paratransit service for eligible riders	Town of Chapel Hill and Town of Carrboro	56,600
GoDurham	Fixed route bus service	Durham County	5,267,800
GoDurham ACCESS	Demand-response ADA paratransit service for eligible riders	City of Durham and Durham County	149,200
GoTriangle	Fixed route bus service	Wake County, Durham County, Orange County	1,663,700
GoTriangle ACCESS	Demand-response ADA paratransit service for eligible riders	Wake County, Durham County, Orange County	39,000
Orange County Transportation Services	Fixed route service and demand response service for eligible riders	Town of Hillsborough and Orange County	21,000* **Approximate 2022 ridership*[31]

[25] Litman, Todd. (2022). Evaluating Public Transit Benefits and Costs. Victoria Transport Policy Institute.
[26] Farhang, Lili and R. Bhatia. (2005). Transportation for Health. *Race Poverty, & the Environment*.
[27] Sheller, Mimi. (2018). *Mobility Justice: The Politics of Movement in an Age of Extremes*. Verso.
[28] Morris, DL Gregory. (2023). Ridership rebounds for Chapel Hill Transit. *The Local Reporter*.
[29] Rail Passengers Association. (2023). Amtrak service in Durham, NC.
[30] American Public Transportation Association. (2024). Public Transportation Ridership Report Fourth Quarter 2023.
[31] Orange County Transportation Services. (2024). Draft Orange County Short Range Transit Plan.

Multimodal Investment Strategies

Historic transportation planning has led to an overwhelming focus on automobile-oriented transportation investments, which is a significant contributor to inequitable transportation outcomes. In addition to the focus on vehicle-related projects over other modes, contemporary planning frameworks that evaluate system performance are often based on vehicle travel speeds – the faster the better. Vehicular level-of-service standards reinforce the focus on automobile-oriented transportation investments. These frameworks justify road expansions that aim to reduce vehicular congestion delays but often fail to consider how less congestion and higher speeds

> Approximately $700 is spent on roads and $1,000-$3,000 on parking subsidies annually per capita [in the United States], compared with $100-200 for transit subsidies and $20-50 for pedestrian and cycling facilities. This is unfair to non-drivers and since driving tends to increase with income, it is regressive, resulting in lower-income households subsidizing the costs of their wealthier neighbors.
>
> Source: Litman, T. (April 22, 2021). Evaluating Transportation Diversity. Victoria Transport Policy Institute; Victoria Transport Policy Institute.

impact other roadway users as well as safety for all roadway users.

DCHC MPO and municipalities throughout the region are working to implement more multimodal planning frameworks to meet the needs of nondrivers.

Active Transportation

Active transportation investments enable safer and more comfortable experiences for people walking, biking, or taking transit. However, active transportation planning has also contributed to racial disparities through a traditional focus on recreational users over those who rely on these modes for mobility. Research shows that the result is a disproportionate lack of infrastructure for walking and bicycling in Black and Latino neighborhoods,[32,33]. In the United States today, majority Black and Latinx neighborhoods have lower quality sidewalks with more obstructions and accessibility issues, even though residents of these neighborhoods are less likely to own or rely on vehicles for transportation.[34,35]

That said, proposed bikeways and sidewalks are sometimes seen as harbingers of gentrification in these same neighborhoods and are met with opposition because, often, there are other needs that

[32] Barajas, Jesus. (2021). Biking where Black: Connecting transportation planning and infrastructure to disproportionate policing. *Transportation Research Part D: Transport and Environment*, 99, DOI: 10.1016/j.trd.2021.103027.

[33] Lee, Richard. I. N. Sener & S. N. Jones. (2017). Understanding the role of equity in active transportation planning in the United States, *Transport Reviews*, 37:2, 211-226, DOI: 10.1080/01441647.2016.1239660.

[34] Kelly, C. M., Schootman, M., Baker, E. A., Barnidge, E. K., & Lemes, A. (2007). The association of sidewalk walkability and physical disorder with area-level race and poverty. *Journal of Epidemiology and Community Health*, 61(11), 978–983. DOI: 10.1136/jech.2006.054775

[35] Rajaee, M, et al. (2021). Socioeconomic and racial disparities of sidewalk quality in a traditional rust belt city. *SSM Popul Health*, 16:100975. DOI: 10.1016/j.ssmph.2021.100975.

residents have continually asked for and feel should be addressed first (e.g., violence, education, health outcomes, etc.).[36] Decades of disinvestment in BIPOC neighborhoods have bred distrust in communities where cities have failed to respond to the concerns and needs of residents. Contention can occur when historic requests by the community appear to be overlooked in lieu of an investment in active transportation that was not requested.

Where bicycle facilities have been built, many are standard bicycle lanes that end at intersections or shared lane markings that place bicycle riders in the same lane as motor vehicles. These facilities are designed for riders who are confident riding in traffic, failing to serve the majority of potential riders who are "interested but concerned."[37] Furthermore, the disproportionate effects of traffic crashes on Indigenous, Black, and Latinx individuals emphasizes a need for safer active transportation facilities for vulnerable road users.

Neighborhoods with a higher proportion of Black residents are also less likely to have access to shared micromobility services, including both bikes and scooters.[38] This is partially due to shared micromobility vendors prioritizing areas that already have active transportation infrastructure like bike lanes and paths, rather than those with the greatest need. This lack of geographic coverage contributes to racial disparities in the access and use of micromobility services.

Traffic Crashes and Fatalities

Nationwide, crash analyses have found that American Indian and Alaska Native, Black, and Latinx Americans face higher rates of traffic injuries and fatalities.[39,40] These disparities are particularly pronounced for pedestrians[41,42] (see Figure 3). Across the US, the number of people killed while walking reached a new high in 2022, with an estimated 7,500 pedestrians struck and killed, up 19 percent since 2019.[43] Between

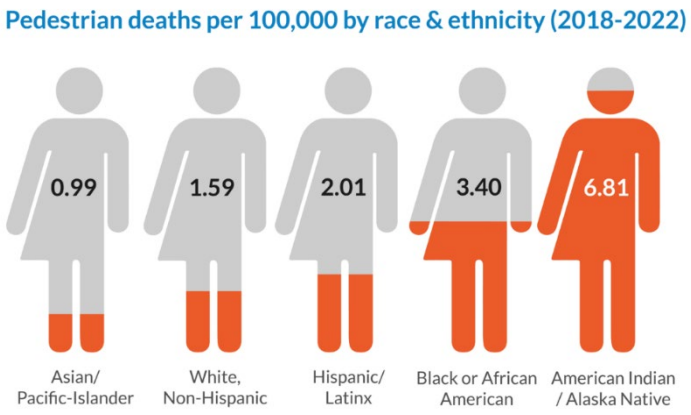

Figure 9: Pedestrian deaths in the United States by race and ethnicity. (Fatality Analysis Reporting System (FARS) data, 2024).[35]

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[36] Flanagan, Elizabeth, U. Lachapelle, & A. El-Geneidy. (2016). Riding tandem: Does cycling infrastructure investment mirror
gentrification and privilege in Portland, OR and Chicago, IL? Research in Transportation Economics, 60: 14-24, DOI: 10.1016/j.retrec.2016.07.027.

[37] Dill, Jennifer & N. McNeil. (2012). Four Types of Cyclists? Testing a Typology to Better Understand Bicycling Behavior and Potential. OTREC Working Paper.

[38] Aman, J.J.C., Zakhem, M., Smith-Colin, J. (2021). Towards Equity in Micromobility: Spatial Analysis of Access to Bikes and Scooters amongst Disadvantaged Populations. *Sustainability*, 13, 11856. DOI: 10.3390/su132111856

[39] Governors Highway Safety Association. (2021). An Analysis of Traffic Fatalities by Race and Ethnicity.

[40] Nauman, Rebecca B. and Laurie F. (2013). Motor Vehicle Traffic-Related Pedestrian Deaths — United States, 2001–2010. *MMWR Morbidity and Mortality Weekly Report*, 62(15):277-282.

[41] Lucas, K. (2012). Transport and social exclusion: Where are we now? *Transport Policy*, 20, 105–113.

[42] Roll, Josh. (January 19, 2021). Analysis of Pedestrian Injury, Built Environment, Travel Activity, and Social Equity: Pedestrian and Social Equity in Oregon.

[43] Governors Highway Safety Association. (2023). Pedestrian Traffic Fatalities by State: 2022 Preliminary Data.

2015-2019, the annual average bicycle and pedestrian fatality rate in the DCHC region was 1.9 per 100,000 people overall. Within the DCHC region, in geographic areas with a relatively higher population of nonwhite residents, the rate was 3.7 per 100,000.[44] People of Color, particularly Native Americans and Black Americans, are substantially more likely to die while walking than any other race or ethnic group.[45]

In addition, people walking in lower income areas are killed at higher rates than people walking in higher income areas (see Figure 4).[46] The bicycle and pedestrian fatality rate in low-income areas of the DCHC region was 3.0 per 100,000 from 2015-2019; in areas with more zero-car households the rate was 2.8 per 100,000 .[47]

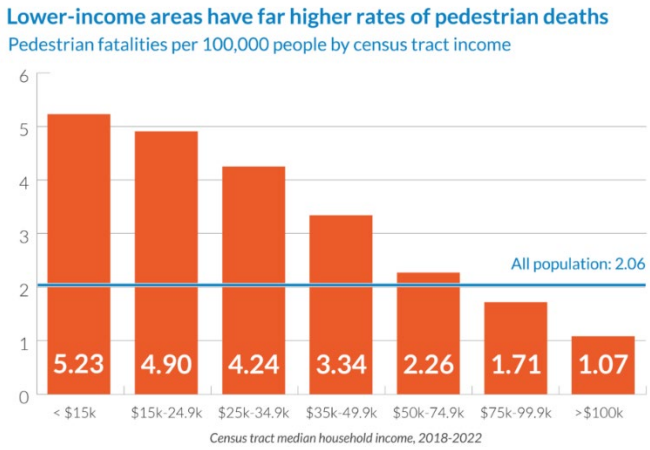

Figure 10: Pedestrian deaths in the United States by census tract income. (FARS data, 2024).[36]

Disparities in transportation safety are closely tied to the road infrastructure present in low-income and BIPOC neighborhoods. Three-quarters of the United States' sixty most dangerous roads for pedestrians are in low-income neighborhoods, and more than half are in predominantly Black or Latinx neighborhoods. The majority of these roads match a particular profile of arterials that were constructed through BIPOC neighborhoods, with five or more travel lanes, speed limits of 30 miles per hour or higher, and a lack of facilities for people walking or riding bikes.[48]

Nationwide trends also show that rural pedestrians are killed at a similar rate to pedestrians in urban areas. From 2010-2019 when controlling for population, there were 1.7 deaths for every 100,000 people in rural areas compared to 1.6 pedestrian deaths for every 100,000 people in urban areas.[49] In many rural areas – such as northern parts of Durham County and northern and southern areas in Orange County – pedestrians must navigate high-speed state roads with minimal shoulders. Overlap between low-income and rural areas can exasperate transportation safety disparities, especially as it relates to pedestrians.

Law Enforcement

Enforcement has historically been viewed as a key component of achieving transportation safety and compliance. However, enforcement-based approaches to traffic safety have resulted in racially

[44] DCHC MPO. 2050 Metropolitan Transportation Plan (MTP): Biking and Walking Safety in Communities of Concern.
[45] Smart Growth America & National Complete Streets Coalition. (2022). *Dangerous by Design*.
[46] Smart Growth America. (2022). Dangerous by Design. https://smartgrowthamerica.org/dangerous-by-design/#custom-tab-0-3b878279a04dc47d60932cb294d96259
[47] DCHC MPO. 2050 Metropolitan Transportation Plan (MTP): Biking and Walking Safety in Communities of Concern.
[48] NACTO. (2022). Breaking the Cycle: Reevaluating the Laws that Prevent Safe & Inclusive Biking.
[49] Smart Growth America, (2021). Dangerous by Design 2021 Update.

disparate impacts to mobility and safety. Police officers stop Black drivers at higher rates than white drivers, and both Black and Latinx drivers are searched more often than their white counterparts. [50] As a result of this discrimination, transportation safety strategies that prioritize increasing traffic enforcement by officers are likely to result in racially disparate outcomes.

Racial disparities are even higher for investigatory stops and non-moving violations, such as equipment and registration violations, although research indicates that enforcement of non-moving violations does not have a discernable effect on crime rates.[51] Research has shown that traffic stops are not related to a reduction in deaths from vehicular crashes, [52] although these stops can become a safety risk for Black drivers and Latinx drive who are more likely to be met with the use of force during these stops.[53]

In 2023, 59 percent of drivers stopped by Durham Police Department were Black and 15 percent were Hispanic – this is in contrast to 36 percent of the population that is Black and 13 percent that is Hispanic or Latino. When looking just at the stops conducted by the City's Traffic Services officers, the data shows that 51 percent of those subset of stops were of Black people. Although still a clear disparity, it is notable to review the data from this unit because they conduct the most traffic stops in the department and the stops are distributed geographically across Durham.[54]

The report notes that based on a statistical test examining if racial disproportionality in traffic stops existed within the 2023 data, "there was no evidence of unexplainable disparities regarding traffic stops among the officers. Rather, officers are stopping vehicles consistent with the demographics and crime statistics of their assigned areas." The report does not include consideration for variation in roadway characteristics that contribute to traffic behavior, however it does note that officers with the highest rates of traffic stops involving minorities, "worked in geographical areas with higher minority populations, including District 1 and District 4, which also have the highest per capita violent crime figures."

Despite the report's framing, this does not necessary dispel concerns about biases - research shows that traffic stops are not an effective strategy for reducing crime.[55] Additionally, these stops have lasting impacts on law abiding residents using transportation system for daily needs and activities. As shared by Anthony McLendon, member of the McDougald Terrace public housing resident council (located in Police District 4),

"...he has been stopped by police multiple times in recent weeks. One time an officer said the tint on his license plate was too dark. Another time, it was the tint on his windows. The third time, an officer pulled up to him after he had run back and forth to the store a few times. The officer warned McLendon, he said, that if he came and left again, he was going to pull him over. McLendon asked why. Suspicion, the cop told him, McLendon said. "Suspicion of

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[50] Stanford Open Policing Project. (2021). Findings.

[51] Policing Project. (2018). Reevaluating Traffic Stops in Nashville. NYU School of Law.

[52] Sarode, Anuja L. MPH et al. (2021). Traffic stops do not prevent traffic deaths. *Journal of Trauma and Acute Care Surgery*, 91(1), DOI: 10.1097/TA.0000000000003163.

[53] Emily Weisburst and Felipe Goncalves. (2020). Economics Research on Racial Disparities in Policing.

[54] City of Durham. (2023). Executive Summary- Traffic Stop Data.

[55] Policing Project. (2018). Reevaluating Traffic Stops in Nashville. NYU School of Law.

what….We live over here." Another time McLendon was pulled over, and the cop jumped out of his car with his hand on his gun. "He made me real nervous," McLendon said. The officer said McLendon's car looked similar to a suspect that he was looking for, before soon taking off in response to some chatter on the officer's radio, the resident said. McLendon hasn't been arrested or cited, but the interactions have left him feeling targeted and even more skeptical of police."[56]

In line with statewide and regional trends, Carrboro Police Department and Chapel Hill Police Department data also shows that Black and Hispanic drivers are disproportionately impacted by traffic stops and non-moving violations. In 2021, the rate of citations to warnings for Black drivers in Chapel Hill as 23 percent higher than white drivers; for Hispanic drivers the rate was 20 percent higher. In Carrboro, Black people comprise about 16 percent of the population but accounted for 29 percent of traffic stops; Hispanic drivers accounted for 12 percent of stops even though only 7 percent of the population is Hispanic or Latino.[57]

Police departments across the DCHC region have made public statements condemning racial discrimination in policing, committed to data transparency that is disaggregated by race, participated in internal reviews and reforms related to racial disparities, and developed and elevated community-oriented task forces and committees.[58],[59]

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[56] Bridges, Virginia. (2023). Durham residents chafe at more aggressive policing after community unit disappears. The News and Observer.

[57] Adams, Jospeh. (2022). Chapel Hill and Carrboro policing data shows racial disparities in traffic stops. Daily Tar Heel.

[58] Adams, Jospeh. (2022). Chapel Hill and Carrboro policing data shows racial disparities in traffic stops. Daily Tar Heel.

[59] McConnell, Brighton. (2020). Chapel Hill, Carrboro and Hillsborough Police Share Statements on Racial Injustice. Chapelboro.com

EQUITY ANALYSIS

This section discusses mapping to distinguish demographic populations that reflect communities who have been systemically oppressed and marginalized through historical policies and practices. Using available Census and American Community Survey (ACS) data, we can identify and map these populations. We will use the equity analysis results in the planning process to compare transportation safety outcomes in areas experiencing greatest socioeconomic vulnerability, guide an inclusive community outreach approach, and develop strategies for the DCHC Vision Zero Action Plan that do not further contribute to disparate transportation outcomes.

Through this equity analysis, we identify key populations that are vulnerable to transportation disadvantage based on socioeconomic factors. For example, children and youth are often not independently mobile and rely on guardians to accompany them as they travel. Households in poverty may spend an outsized portion of their income on travel expenses. People in households without a vehicle – or even people who have limited access to the vehicle within their household – may be dependent on the availability of safe multimodal facilities to access their daily needs. Once key populations are defined, we delineate areas throughout the region where we see the highest proportions of these populations and assume that these areas have greater socioeconomic vulnerability.

Methodology

Defining Key Populations

This equity analyses uses eight key demographic populations that face transportation and socioeconomic disparities. The identification of these populations was informed by the DCHC 2020 Environmental Justice Report, NCDOT Transportation Disadvantage Index, and the Indicators of Potential Disadvantage methodology, discussed in the following section. The key populations in the DCHC Vision Zero Action Plan equity analysis are:

- Black, Indigenous, and other People of Color, specifically the ACS race and ethnicity categories:
    - Black or African American
    - American Indian and Alaska Native
    - Asian
    - Two or More Races
    - Hispanic or Latino
- Households in poverty
- Carless households
- Youth under 18 years old
- Older adults over 64 years old
- People with disabilities
- People with limited English proficiency
- People with limited educational attainment

- Note, this indicator was added due to empirical research that shows people with lower education attainment are more likely to be vulnerable roadway users that walk or bike for transportation.[60] Research has also found that as education levels increase, so does access to reliable transportation.[61]

Regional - Indicators of Potential Disadvantage Methodology

The regional equity analysis uses the Indicators of Potential Disadvantage (IPD) methodology, originally developed by Delaware Valley Regional Planning Commission (DVRPC). The IPD methodology uses ACS, 5-year estimates (2018-2022) to delineate areas where key populations are more prevalent. Although identified at the block group level, the data is gathered at the regional level so that regional averages for each population group can be determined.

Each block group's population percentage is calculated from the standard deviations relative to each indicator's regional average. The calculations range from "well below average" to "well above average." An example of this is shown in Figure 2.

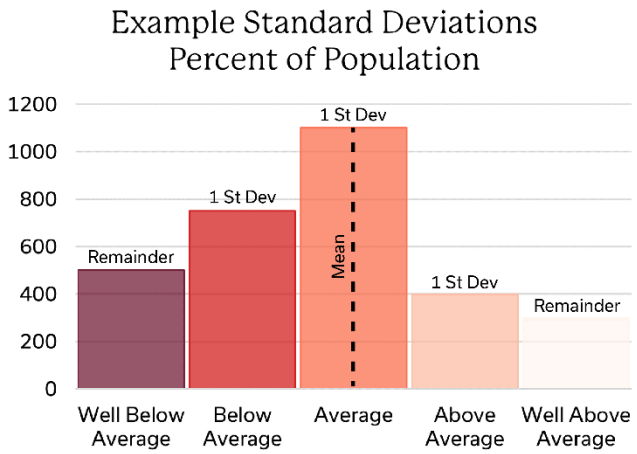


Figure 11 Example Standard Deviations and Corresponding Scores (Source: DVRPC)

For each indicator, block groups receive a score of 0 to 4 as follows:

- Well below average – score of 0
- Below average – score of 1
- Average – score of 2
- Above average – score of 3
- Well above average – score of 4

60

61 Ng AE, Adjaye-Gbewonyo D, Dahlhamer J. Lack of reliable transportation for daily living among adults: United States, 2022. NCHS Data Brief, no 490. Hyattsville, MD: National Center for Health Statistics. 2024. DOI: https://dx.doi.org/10.15620/ cdc:135611. Retrieved from https://www.cdc.gov/nchs/data/databriefs/db490.pdf

The Overall IPD is a summary of the indicator scores, ranging from 0 – 32. For the purposes of the DCHC Vision Zero Action Plan, the regional Overall IPD is used as the basis for identifying Vision Zero Focus Areas to guide plan engagement, strategies, and implementation. This is discussed further in Section 3.3 of this document.

Localized Equity Analyses

In addition to the regional equity analysis, this equity framework presents localized equity analyses for the following communities in the DCHC planning area:

- City of Durham
- Town of Chapel Hill
- Town of Carrboro
- Town of Hillsborough
- Durham County
- Orange County
- Chatham County

The localized analyses use the same indicators for the analyses and a similar methodology. Still at the block group scale, ACS, 5-year estimates (2018-2022) data is collected at the community level and the community average is determined for each population group. Each block group's population percentage is calculated from the standard deviations relative to each indicator's community-level average. A community-level Overall IPD is available for each of the communities above to allow for a contextualized approach to safety action planning, engagement, and strategy implementation.

Map Interpretation

Race

The IPD analysis for racial minorities assesses where there are prevalent populations of Black, Native American, Alaska Native, Asian, Native Hawaiian, Pacific Islander, Hispanic or Latino, and multiracial residents. Results for the regional analysis are shown in Figure 6.

In Orange County, there are above average concentrations of nonwhite residents in the northwest areas of Hillsborough and the surrounding areas that are part of Orange County. Most of Chapel Hill has an average concentration of nonwhite residents, however there are a few census blocks with above average concentrations of People of Color in the Northside area and in the southwest corner of the Town, north of NC-54.

Durham County has the highest concentrations of People of Color, most notably on the south and east sides of the City which range from above to well above average. There are additional areas with above average or well above average concentrations of nonwhite residents, including the Duke University campus area, and communities along Durham-Chapel Hill Boulevard between the two municipalities.

Most of the unincorporated areas of Orange, Durham, and Chatham County range from average to well below average concentrations of this demographic group.

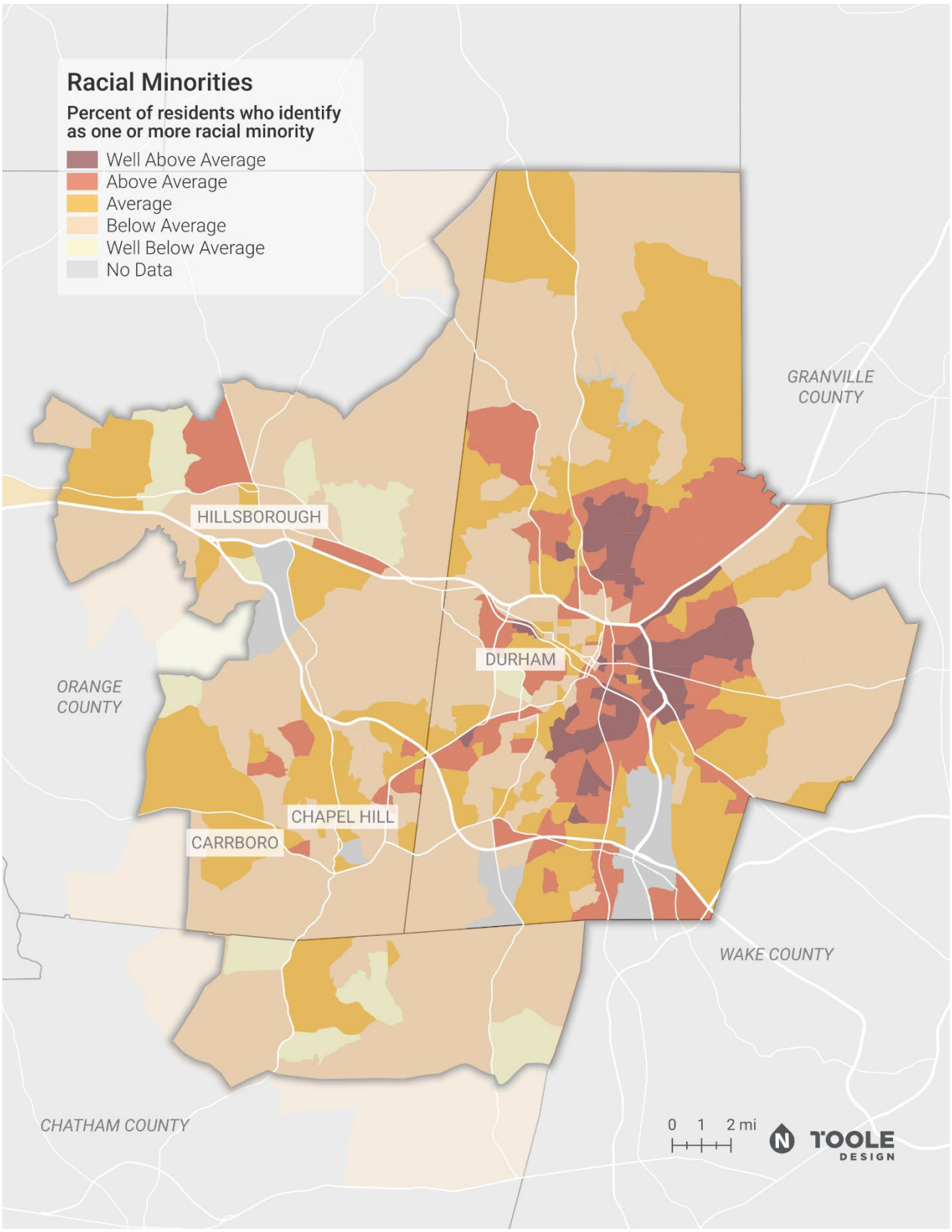


Figure 12. DCHC MPO Indicators of Potential Disadvantage: Racial Minority Population

APPENDIX C
ENGAGEMENT SUMMARY

In Process

APPENDIX D
MEMBER AGENCY MAPS AND ACTIONS

This appendix includes information that that is detailed for specific TWTPO member agencies. The following agencies are included:

- Town of Carrboro
- Town of Chapel Hill
- City of Durham
- Town of Hillsborough
- Durham County
- Orange County
- Chatham County

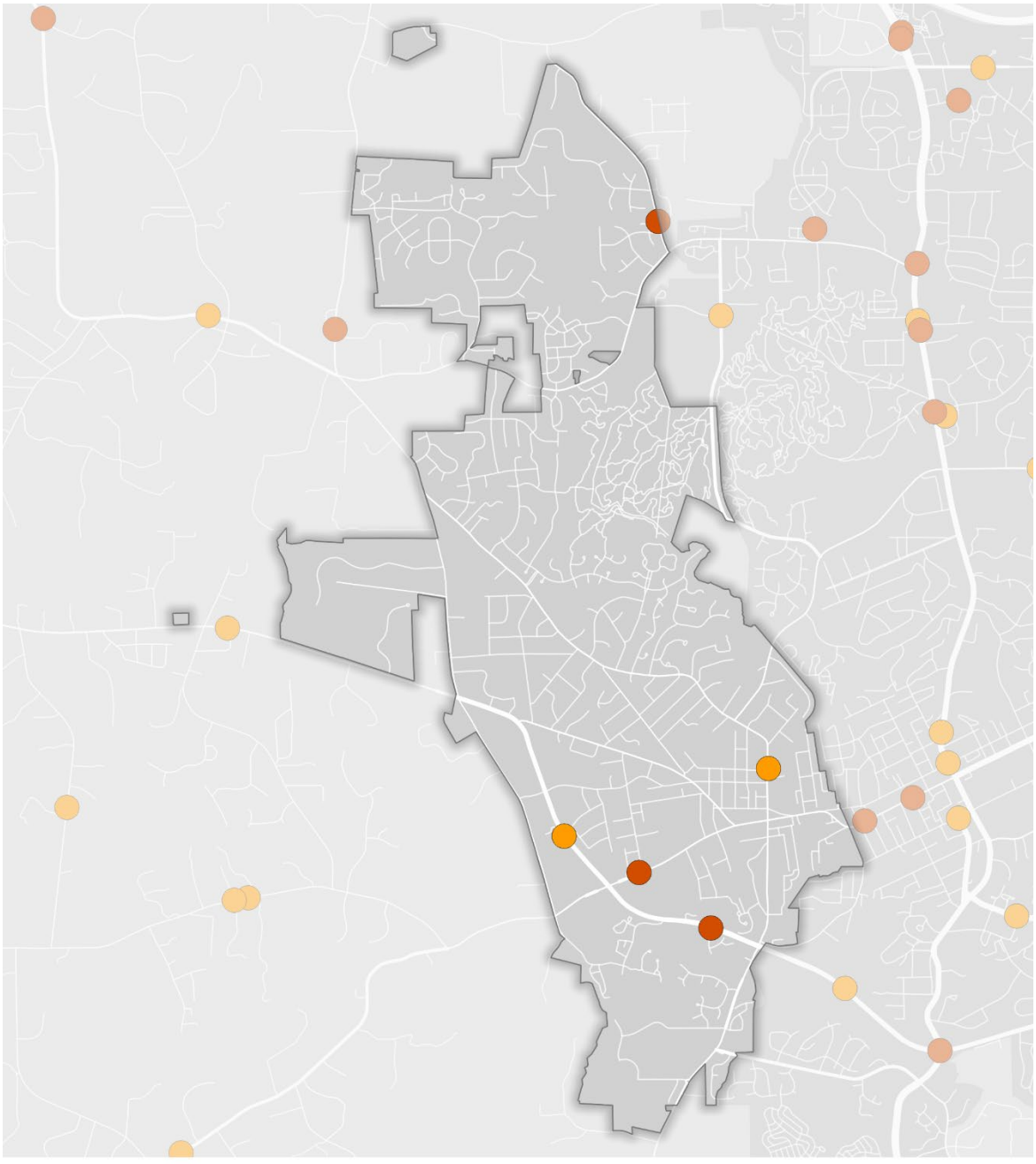
For each of these agencies, results from data analysis have been mapped to the respective jurisdiction. Additionally, some action items have been updated based upon comments from the Technical Advisory Committee (TAC) to include details that are specific to the member agency. This may include a change in wording or an update to the recommended timeframe for the action. Only the modified actions are included in this appendix. If no table is included, the proposed actions in the Vision Zero Plan should be used by the jurisdiction.

A series of maps are included for each member agency followed by the updated action table (if applicable). The maps included in this appendix for each member agency are the following:

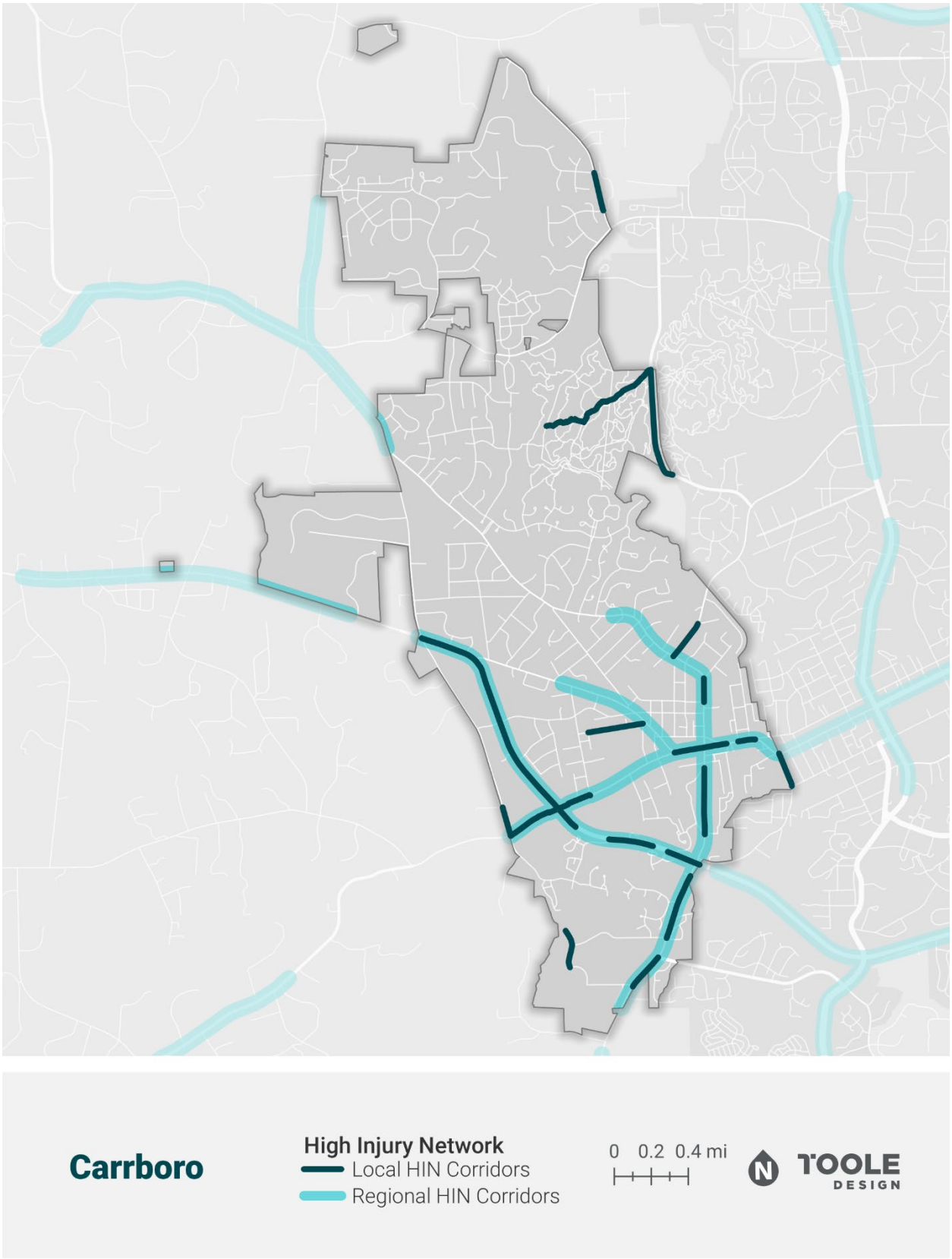
- Crash Map: illustrating fatal and serious injury crashes
- High Injury Network
- High Injury Intersections
- VRU High Injury corridors and intersections
- High Risk Corridors
- High Risk Intersections
- Indicators of Potential Disadvantage and HIN
- Priority Corridors
- Priority Intersections
-

TOWN OF CARRBORO

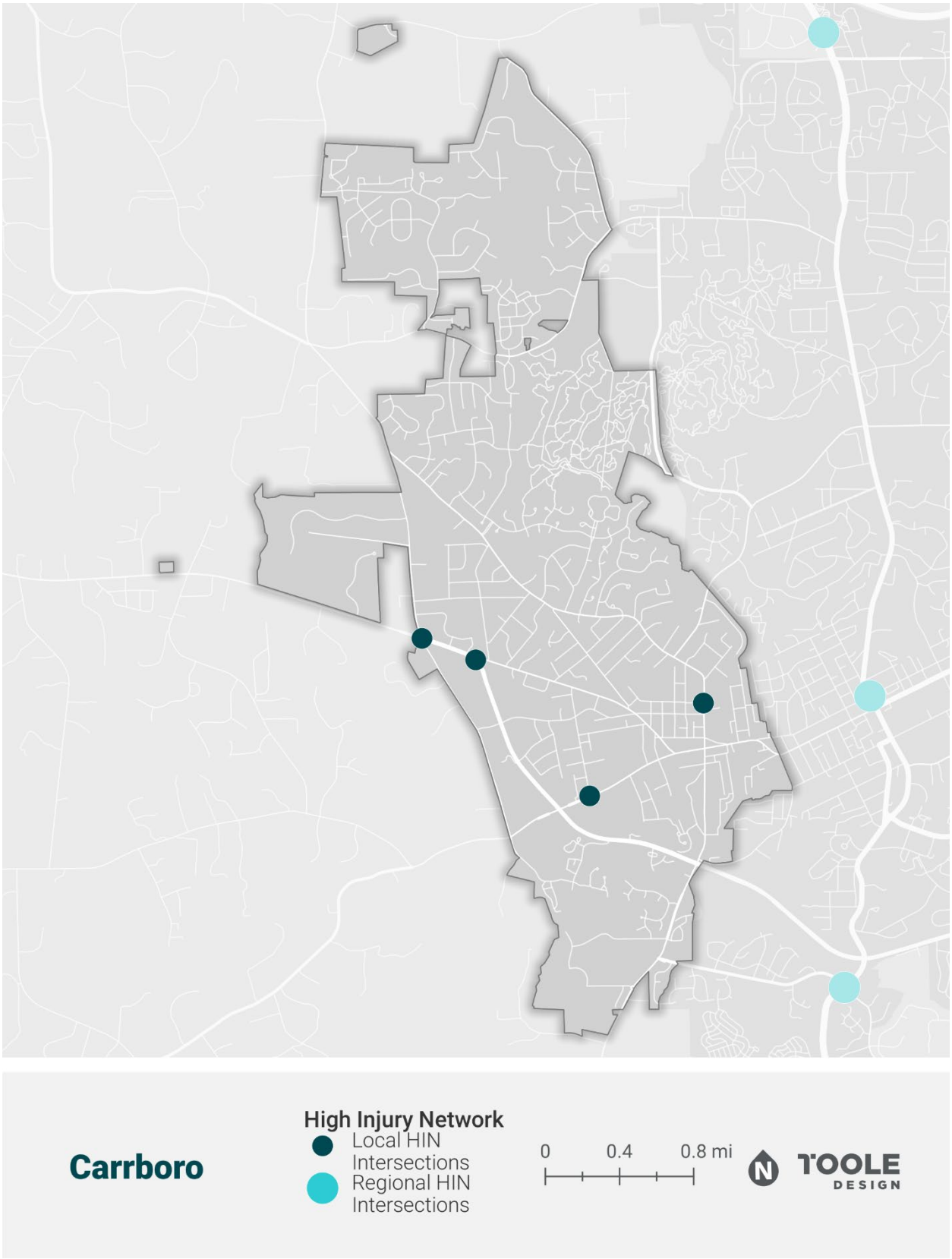
Crash Map



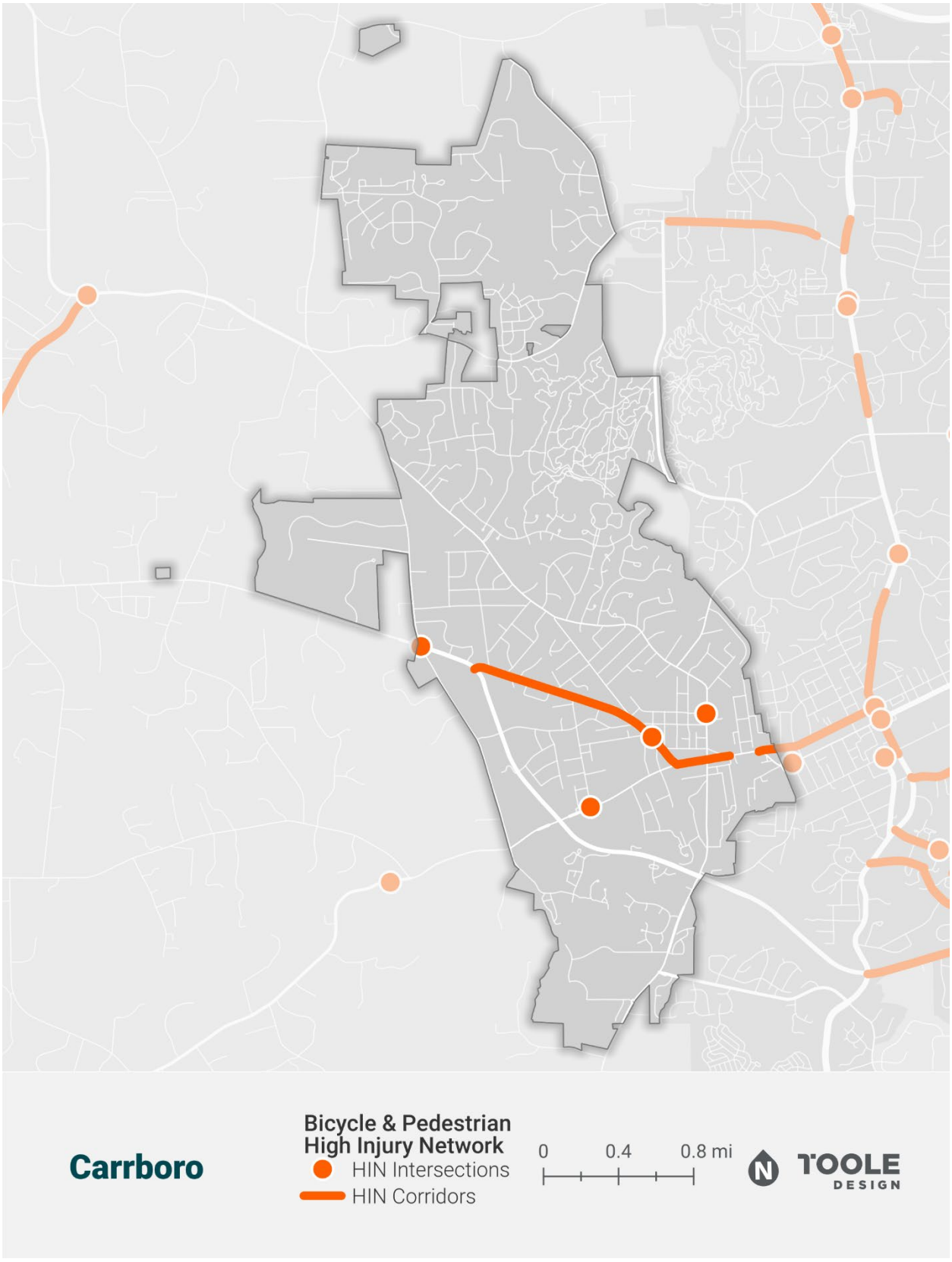
High Injury Network



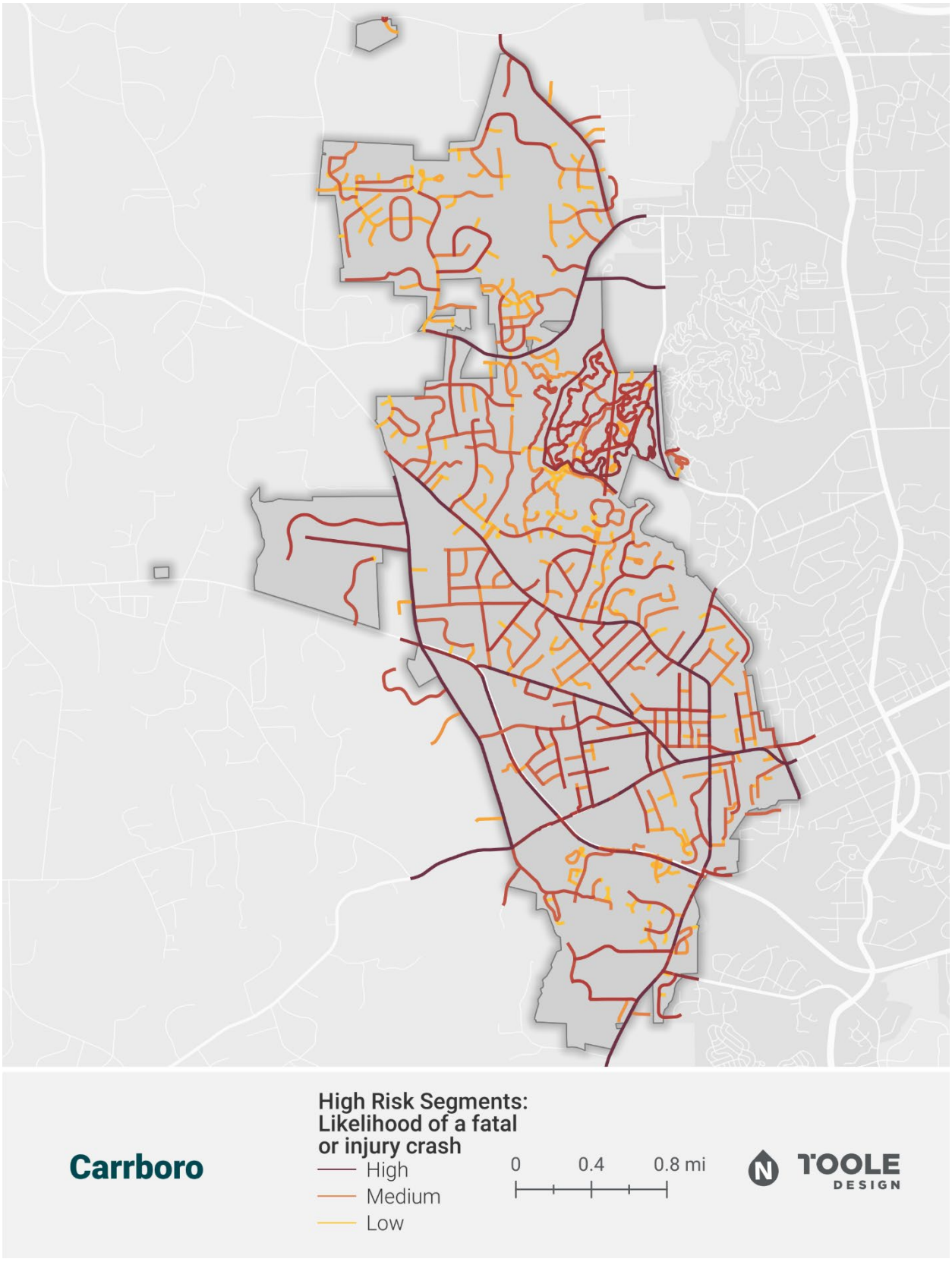
High Injury Intersections



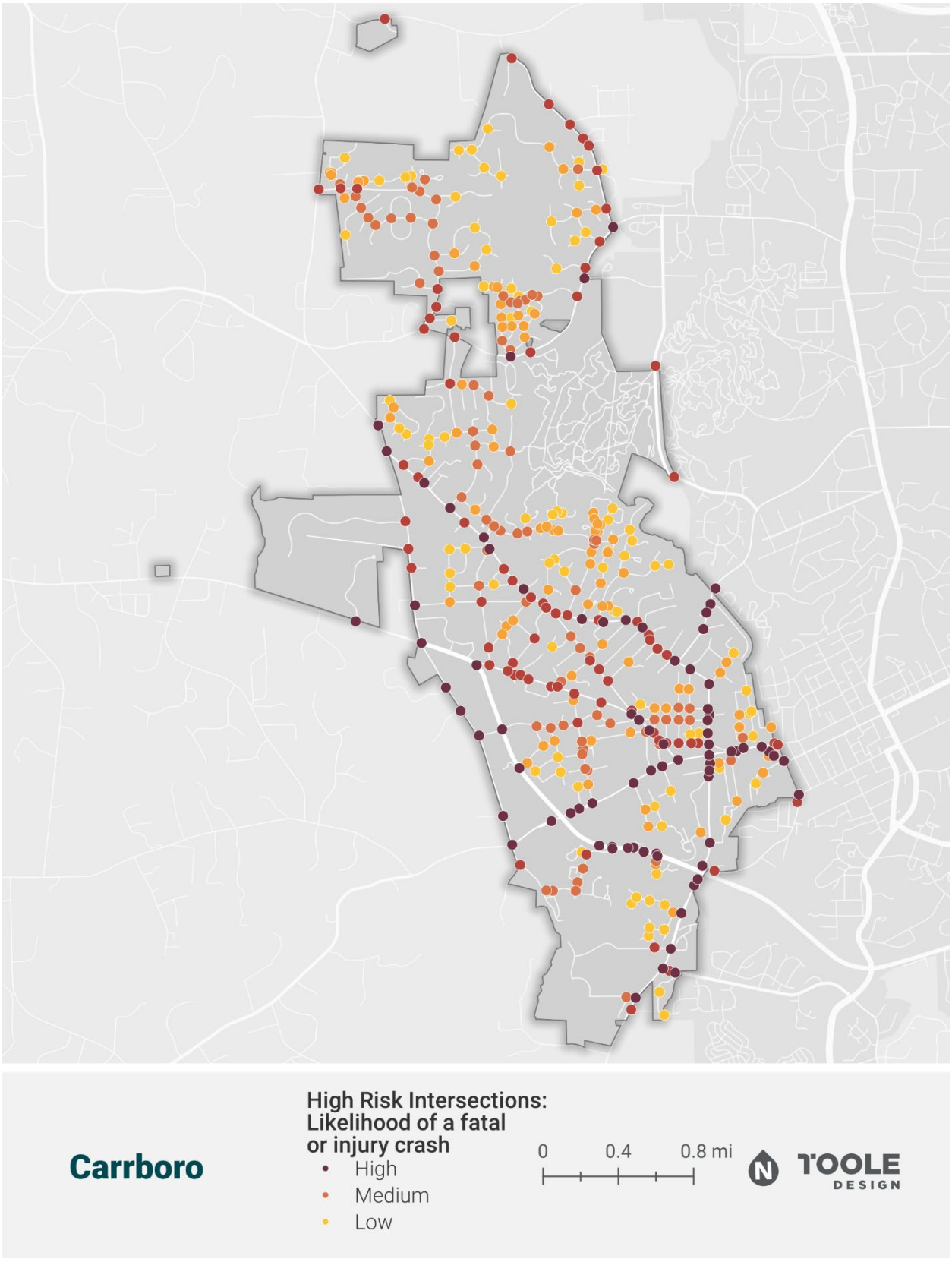
VRU High Injury corridors and intersections



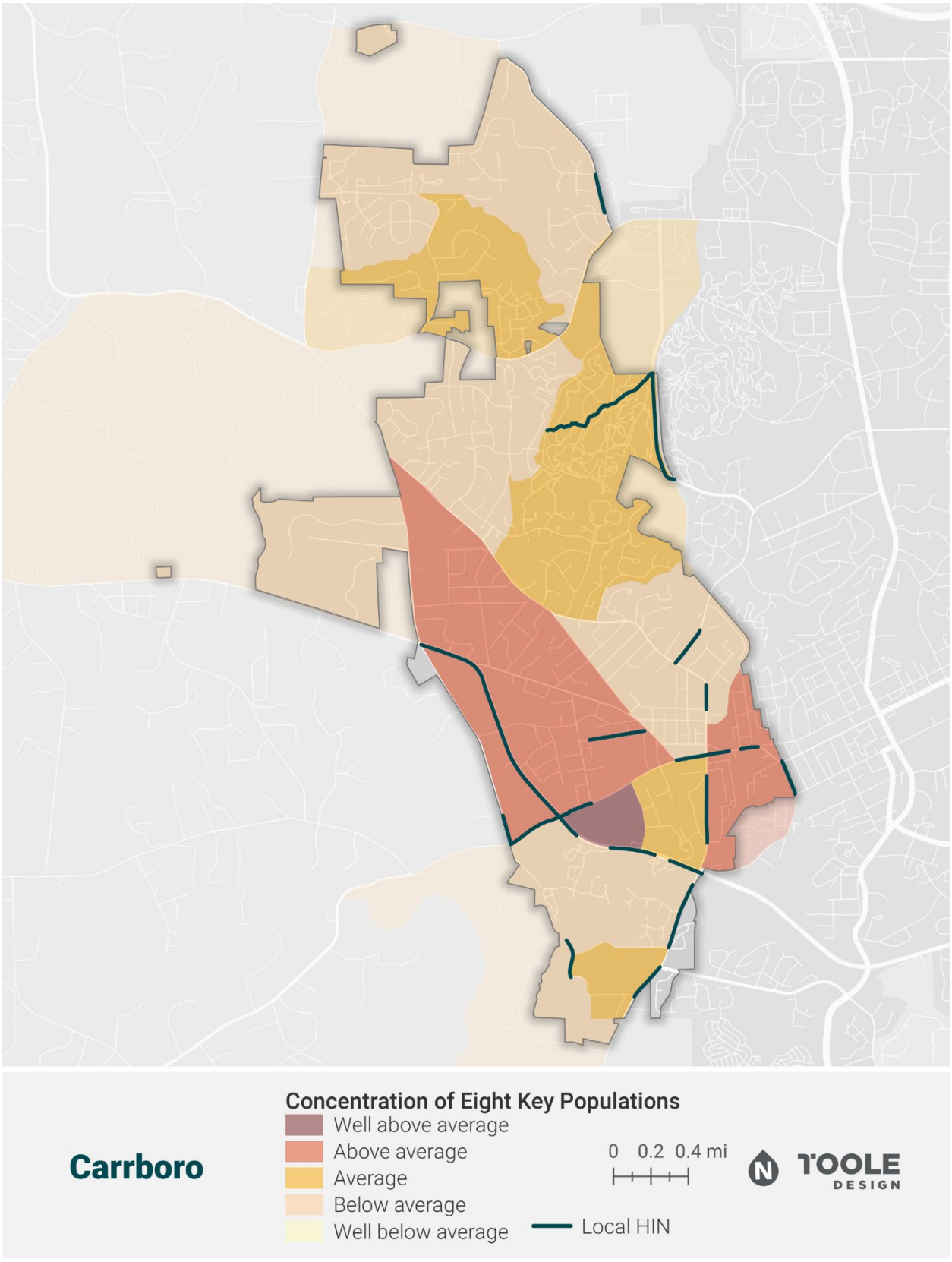
High Risk Corridors



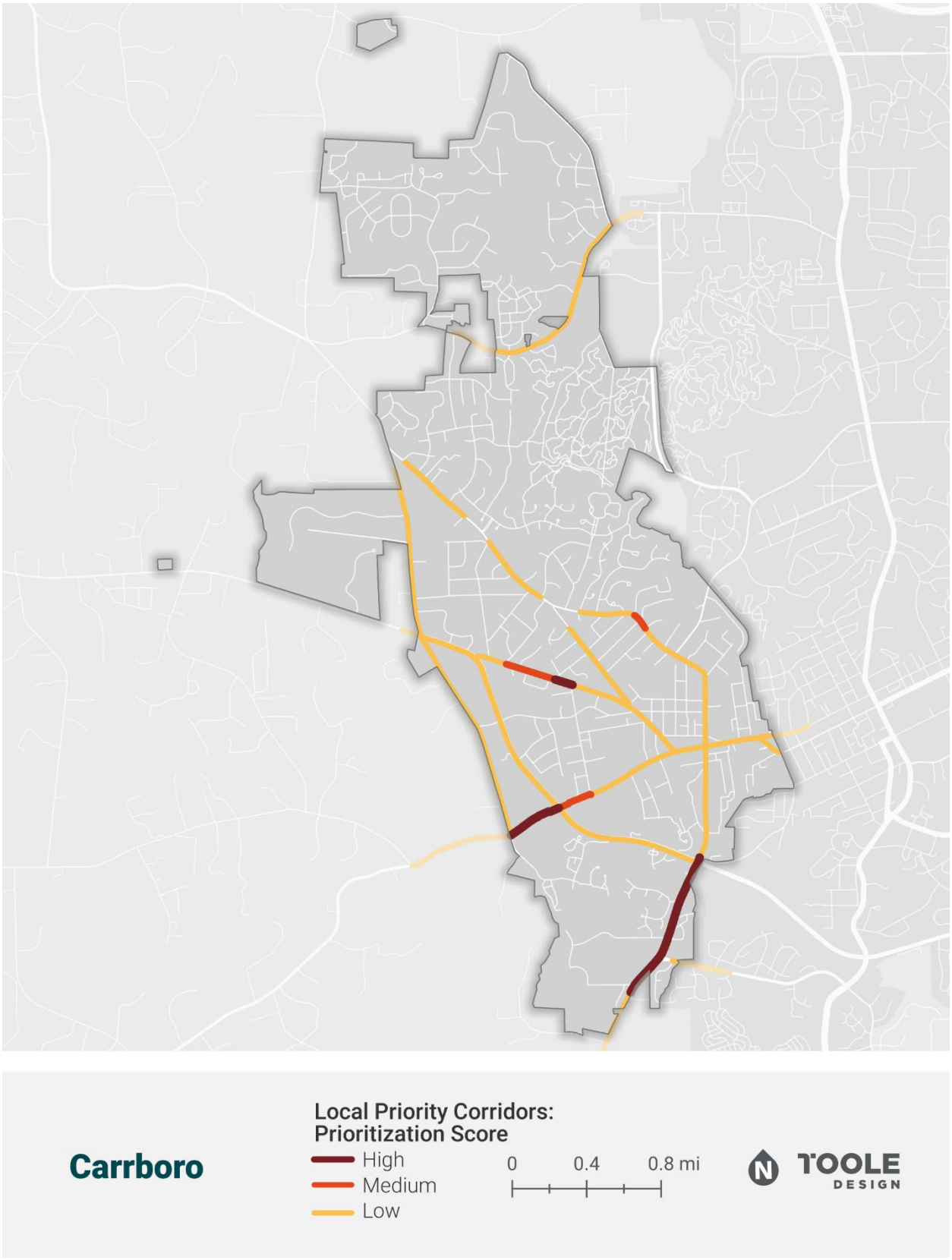
High Risk Intersections



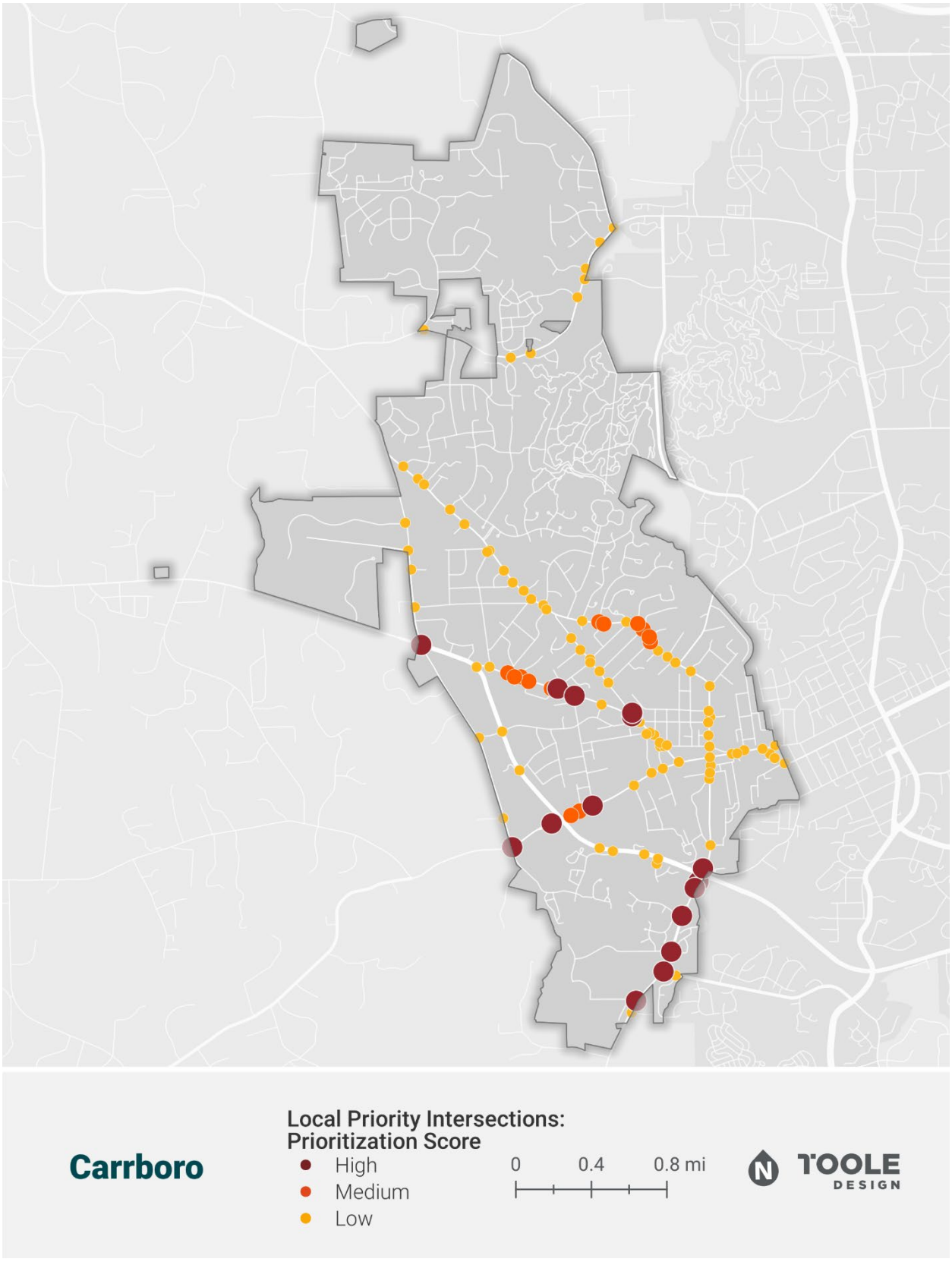
Indicators of Potential Disadvantage and HIN



Priority Corridors

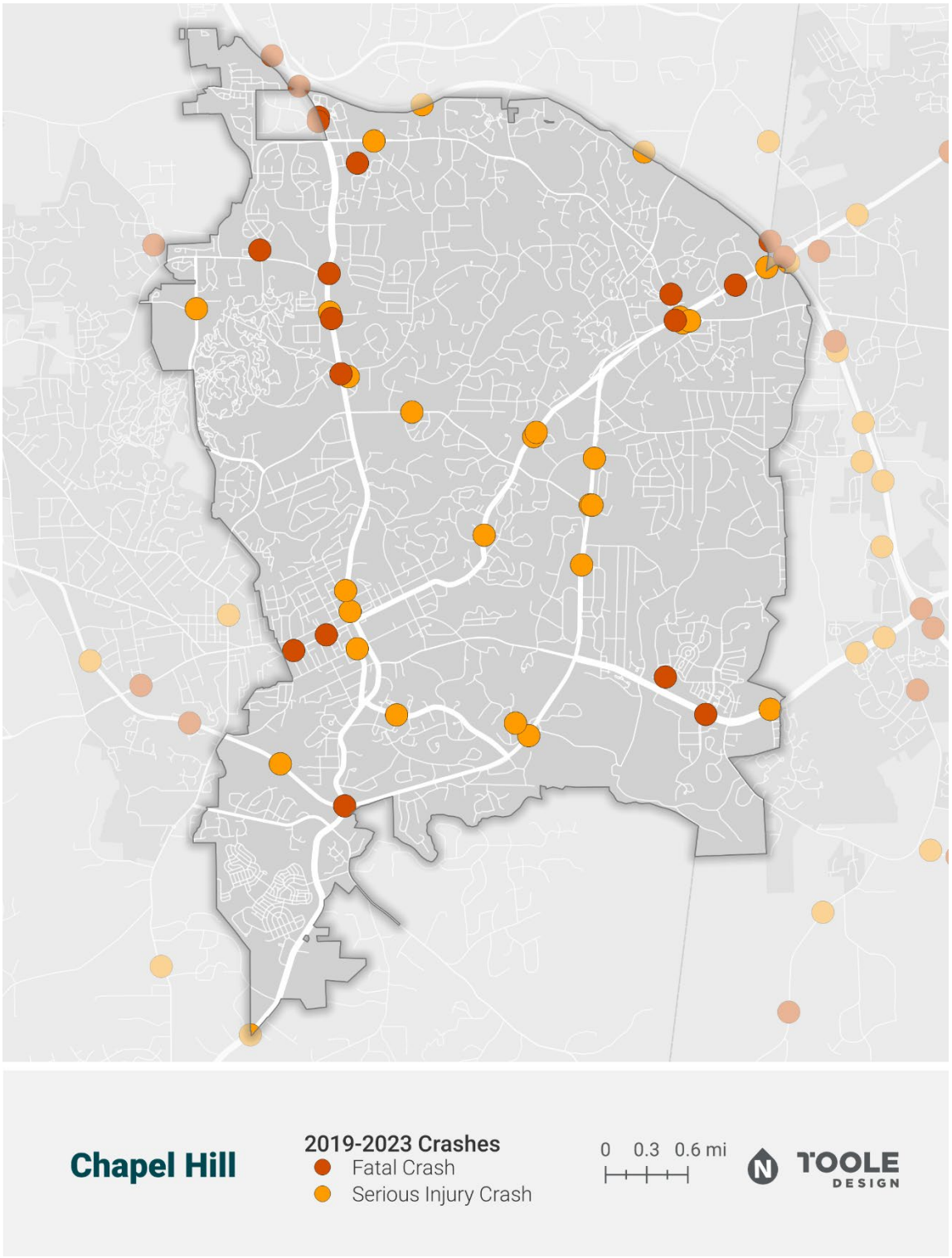


Priority Intersections

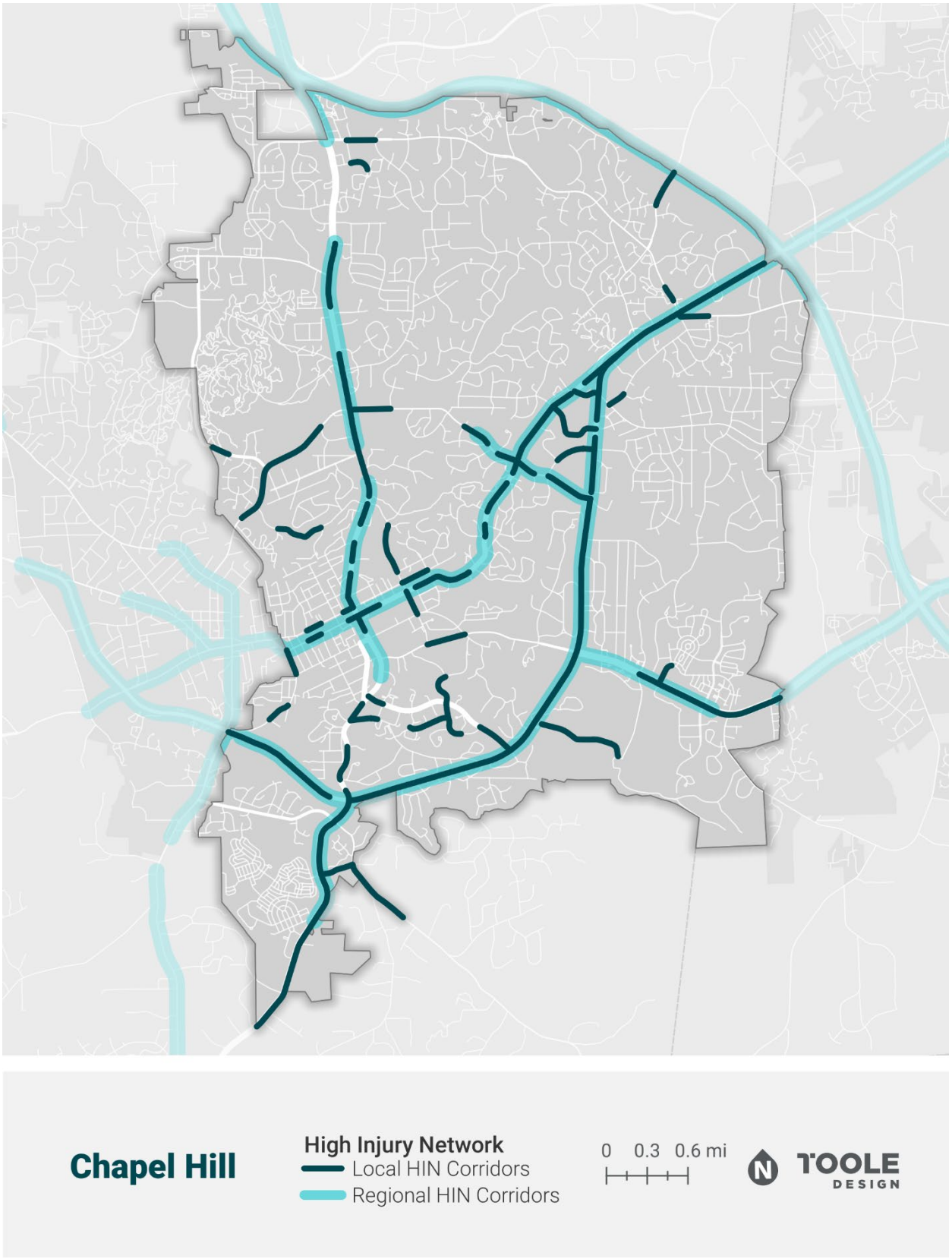


TOWN OF CHAPEL HILL

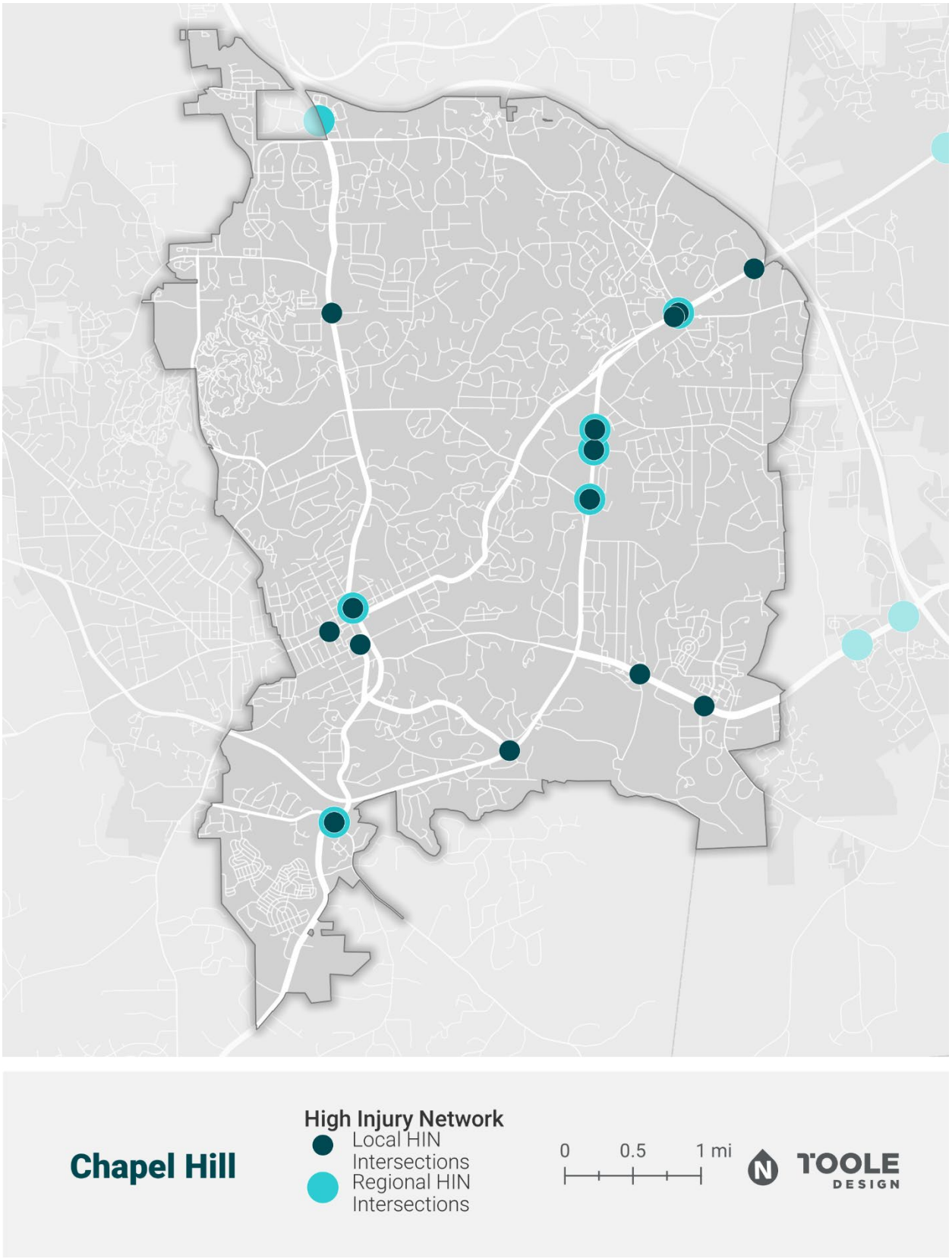
Crash Map



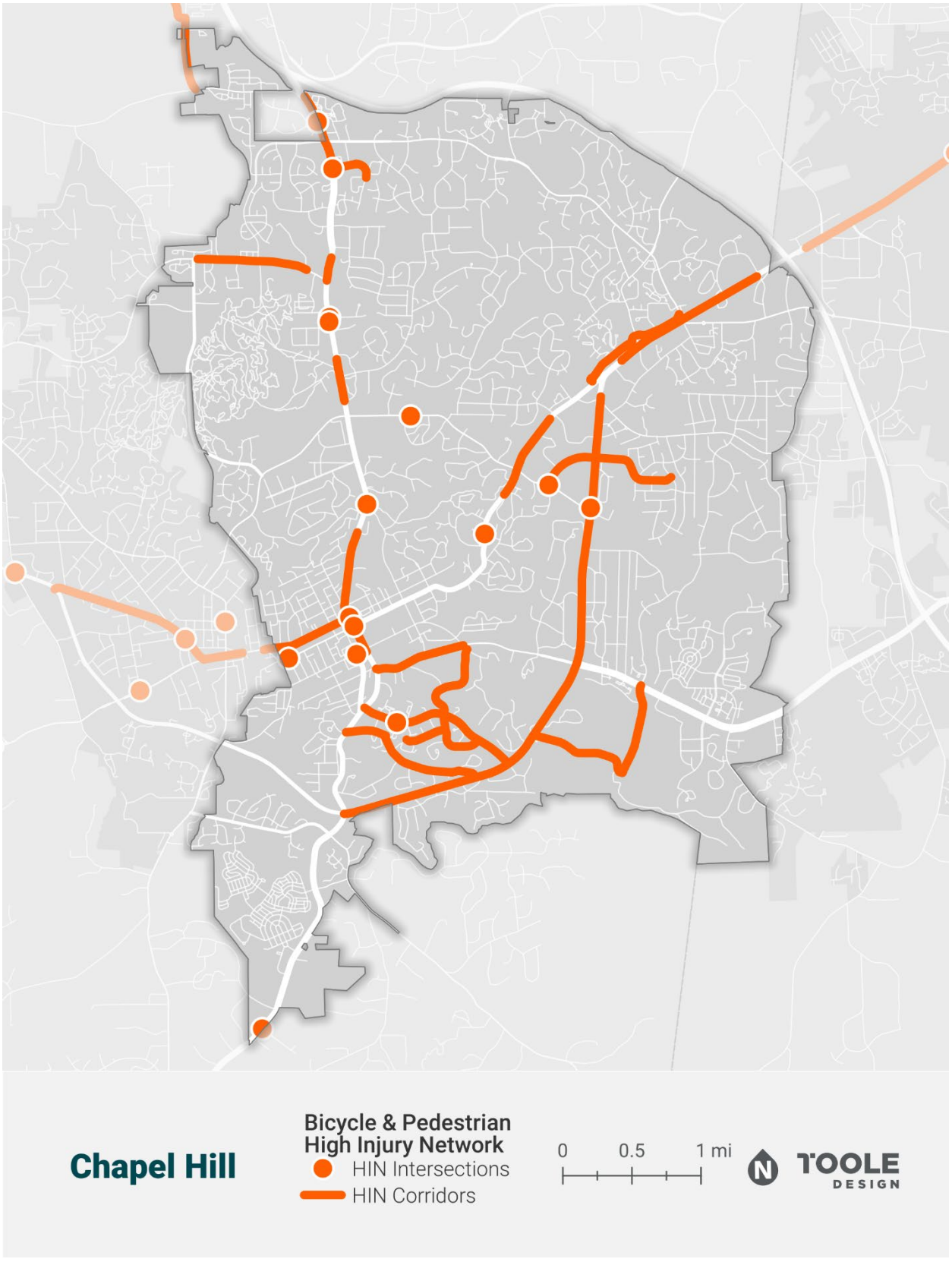
High Injury Network



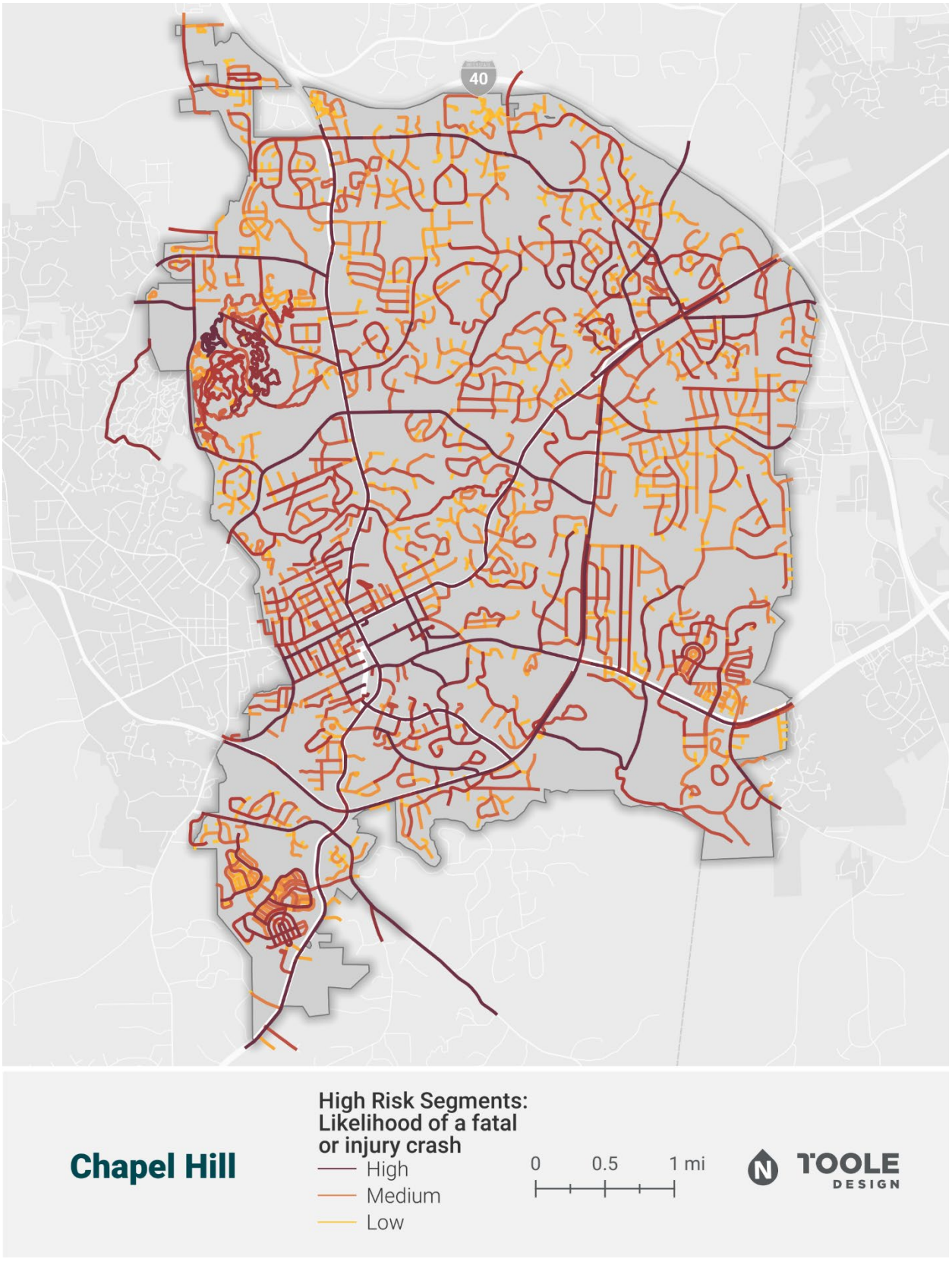
High Injury Intersections



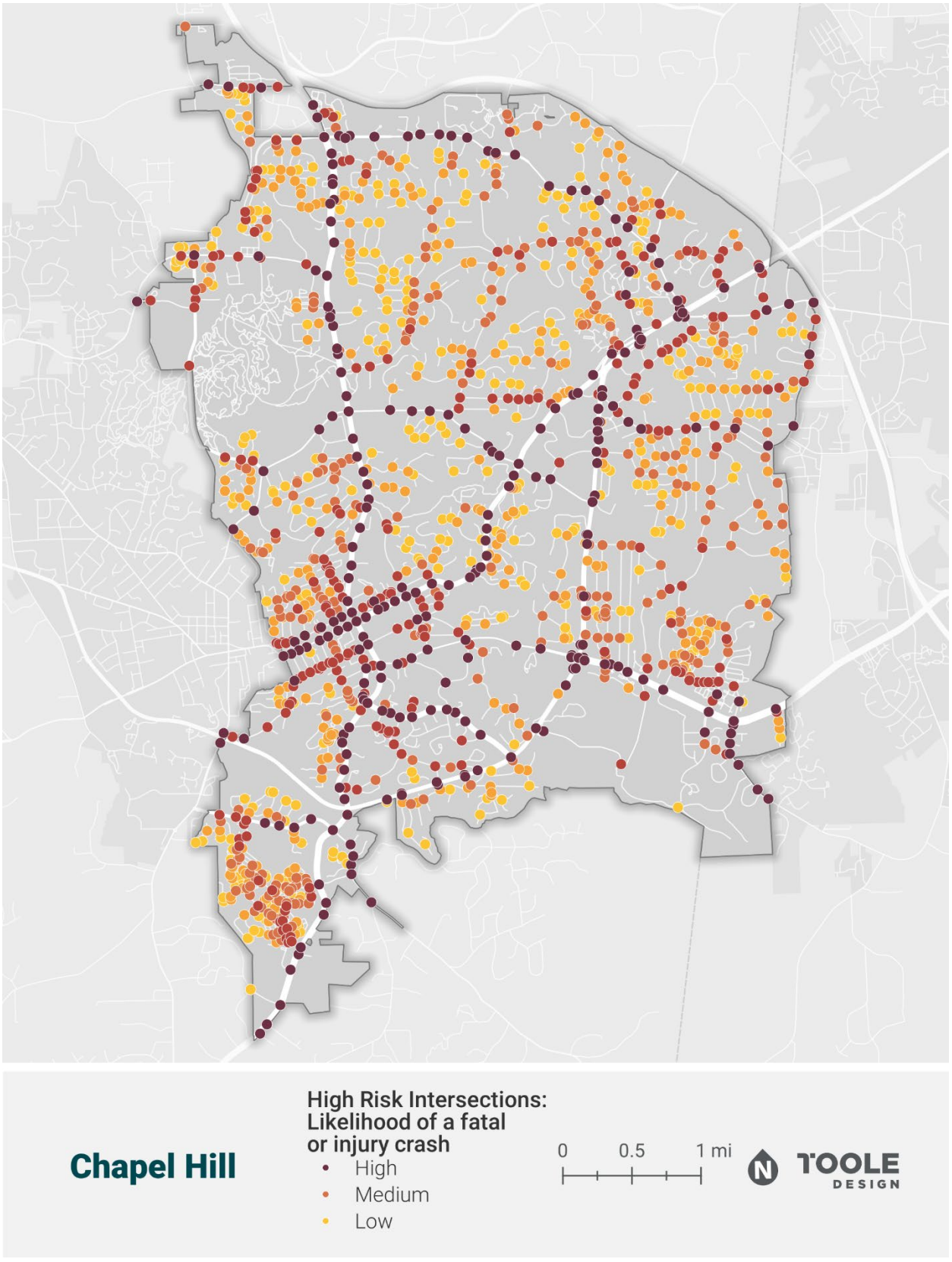
VRU High Injury corridors and intersections



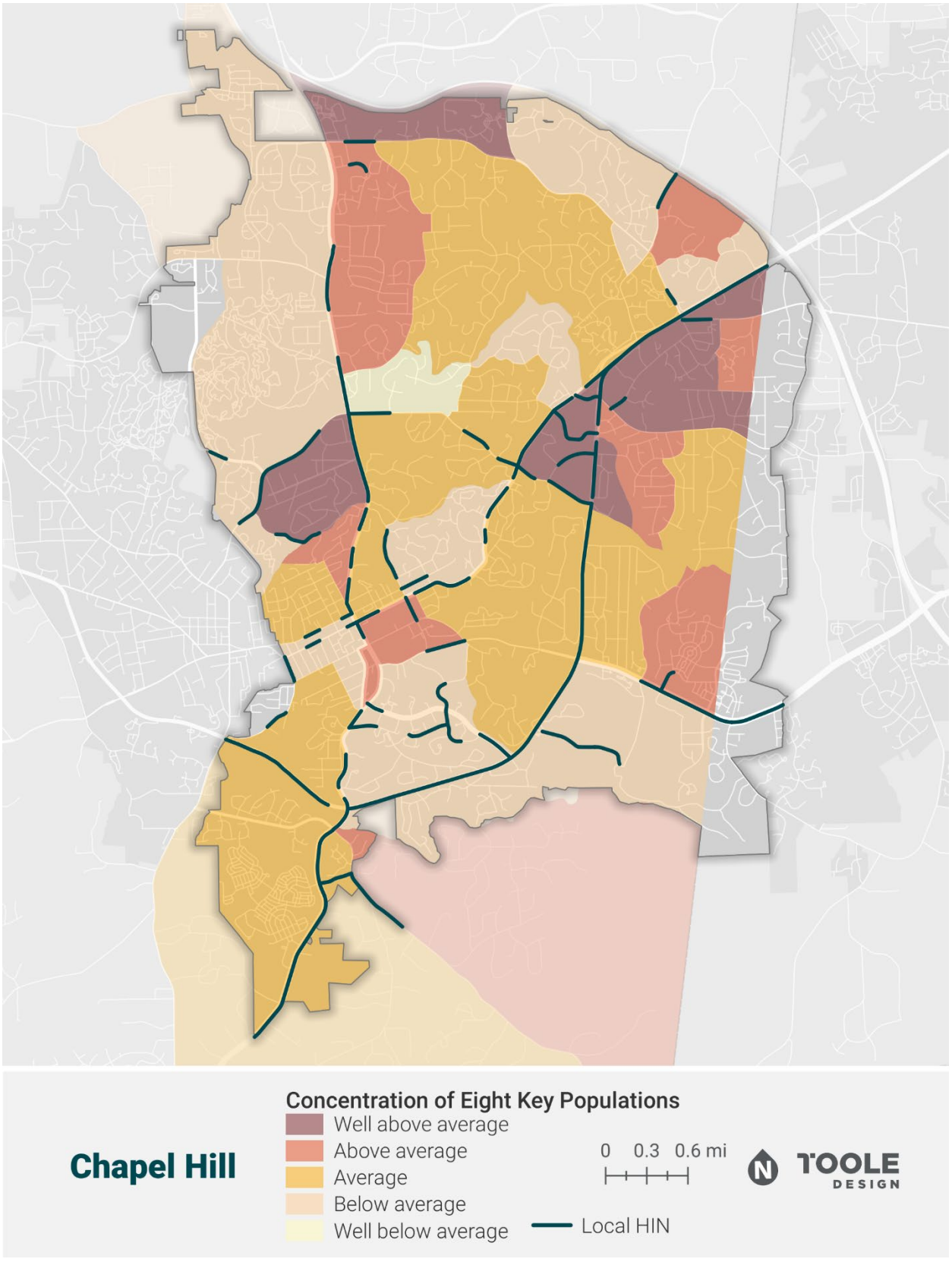
High Risk Corridors



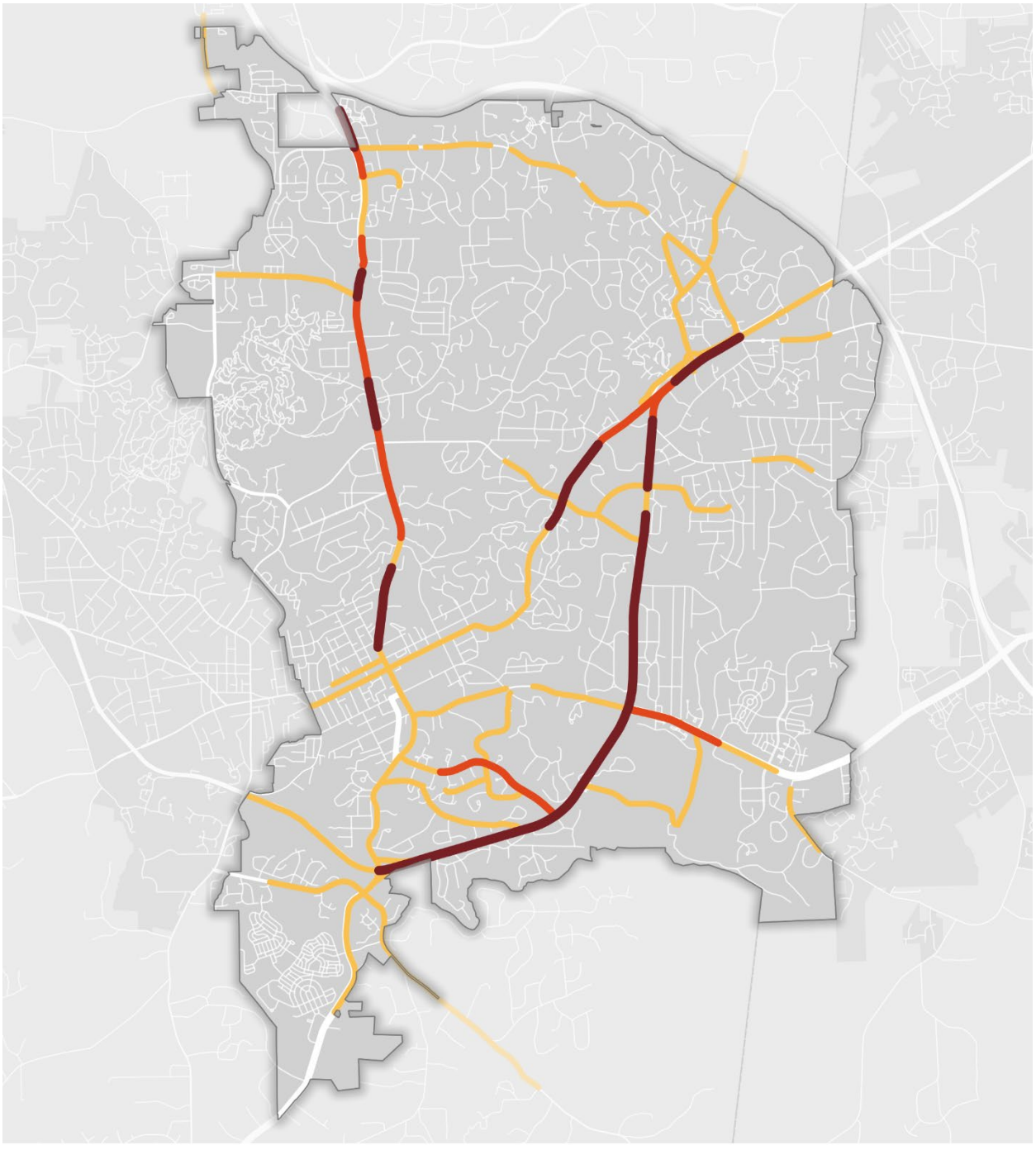
High Risk Intersections



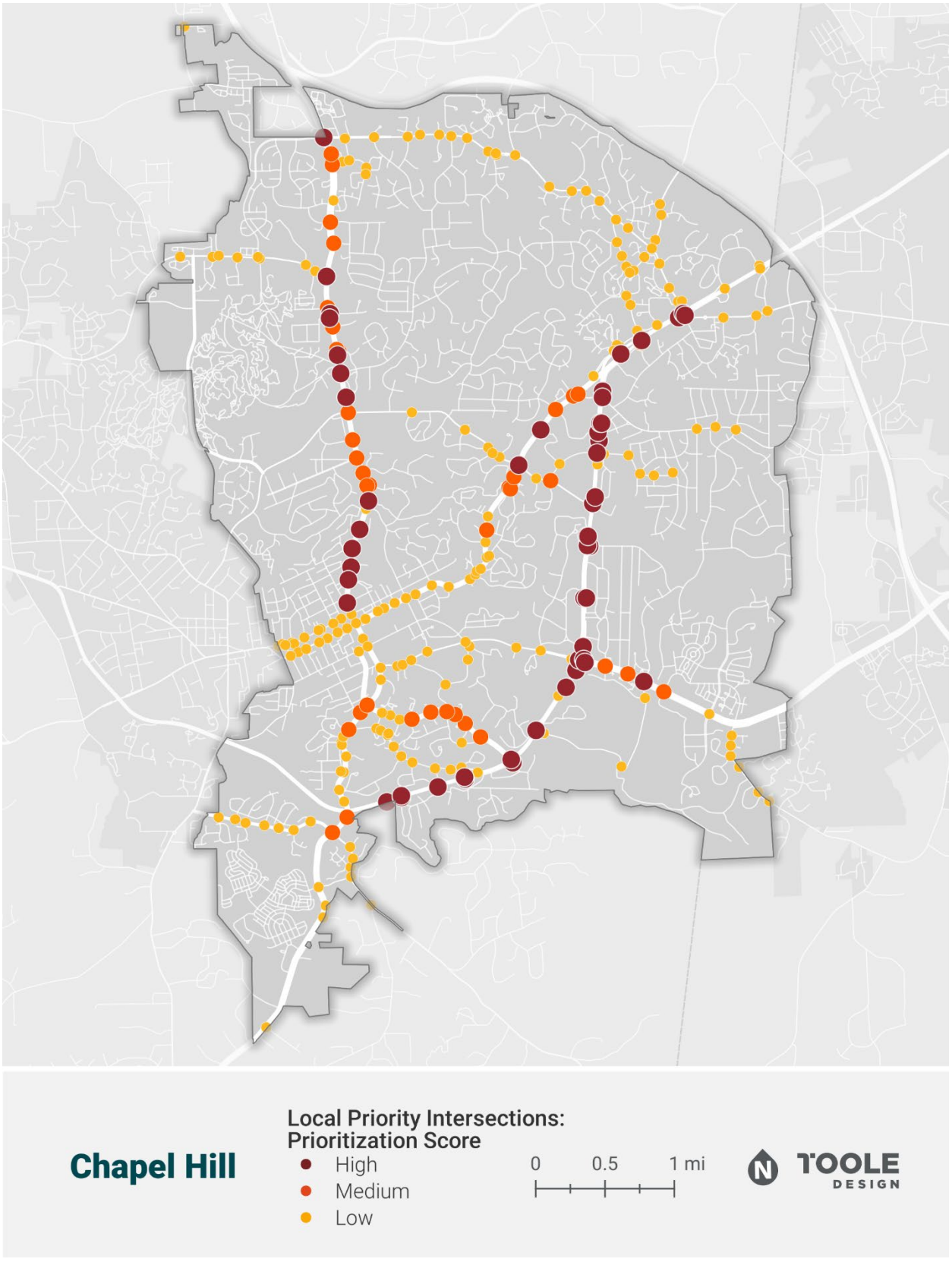
Indicators of Potential Disadvantage and HIN



Priority Corridors

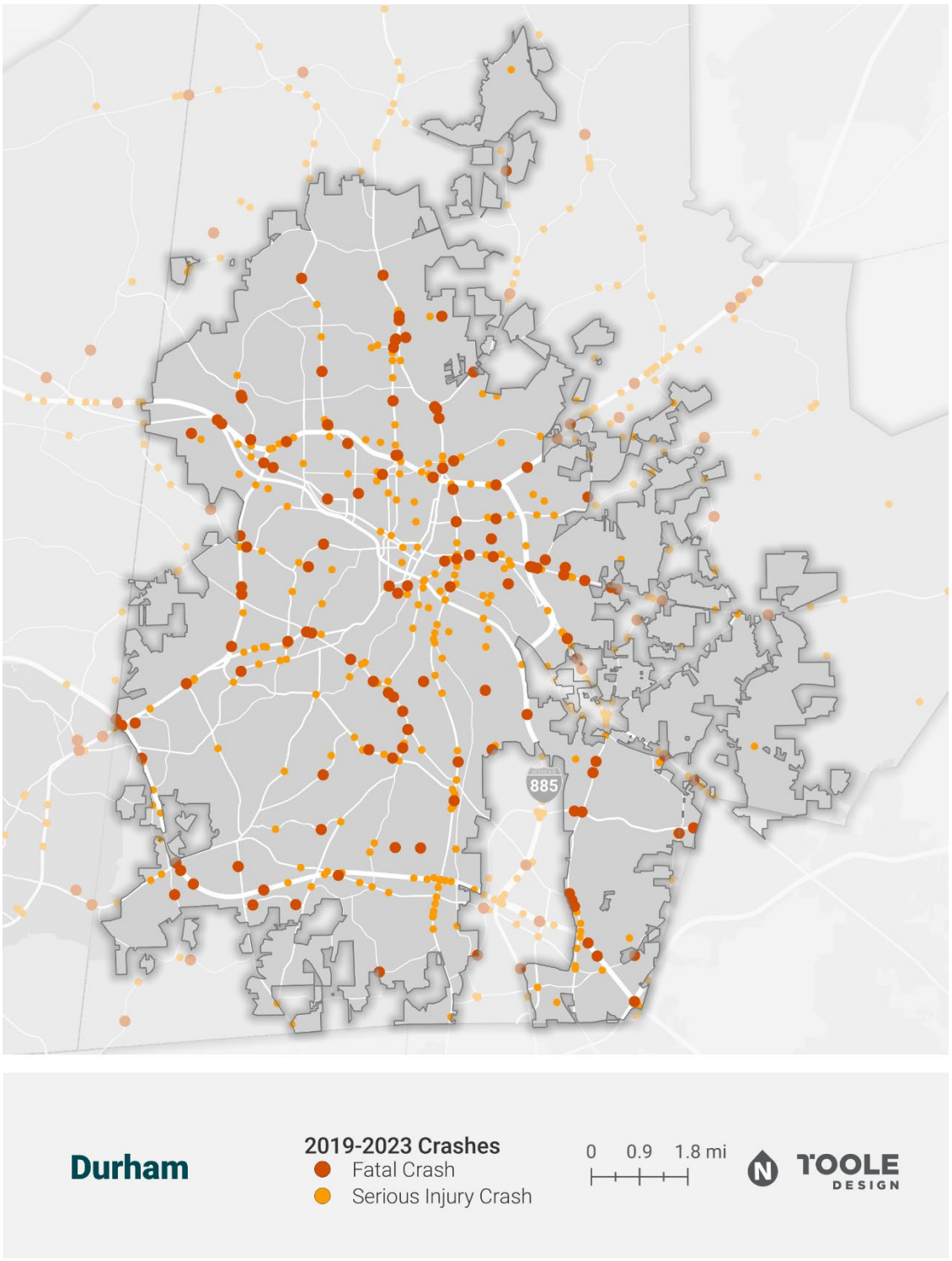


Priority Intersections

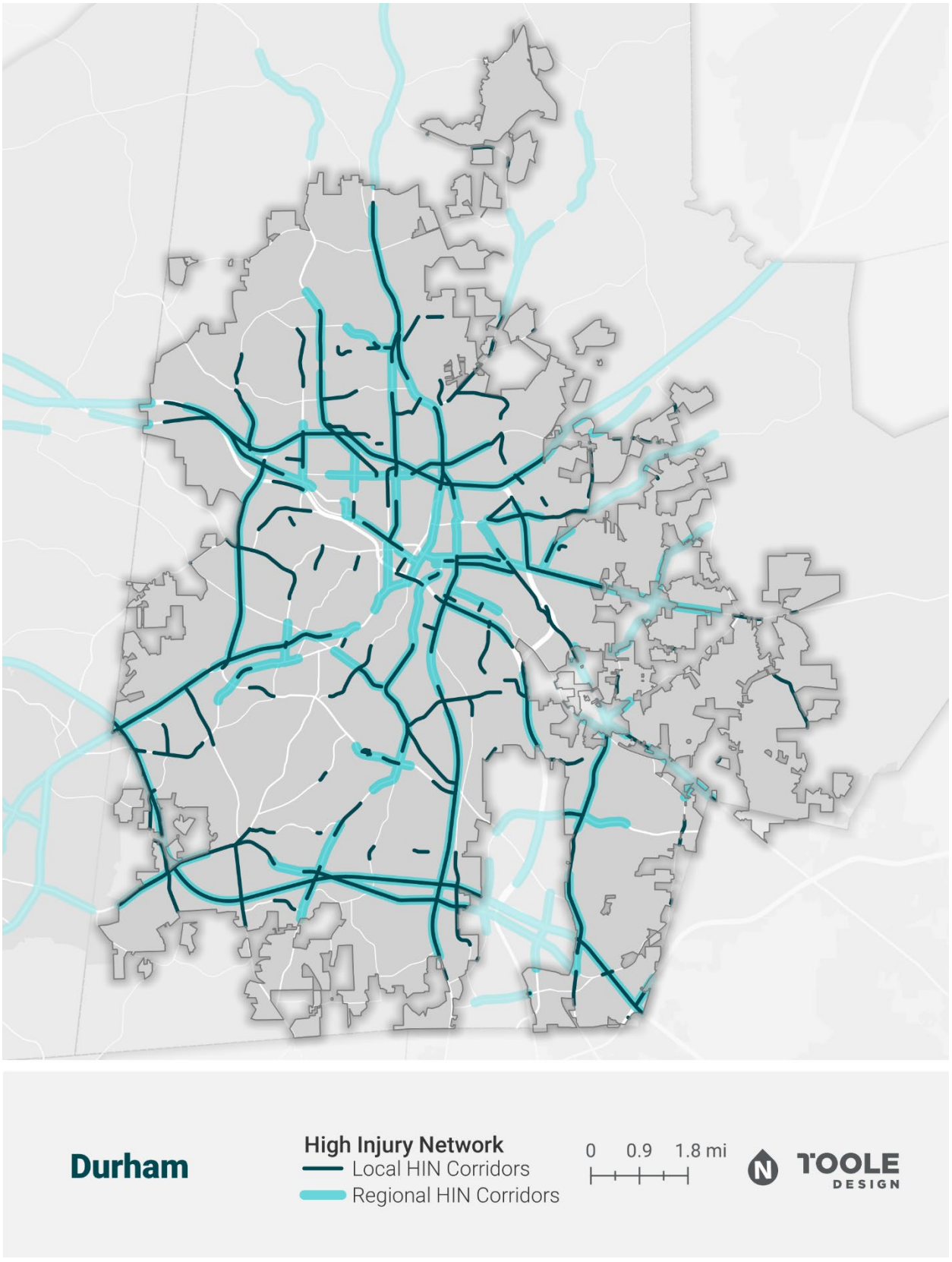


CITY OF DURHAM

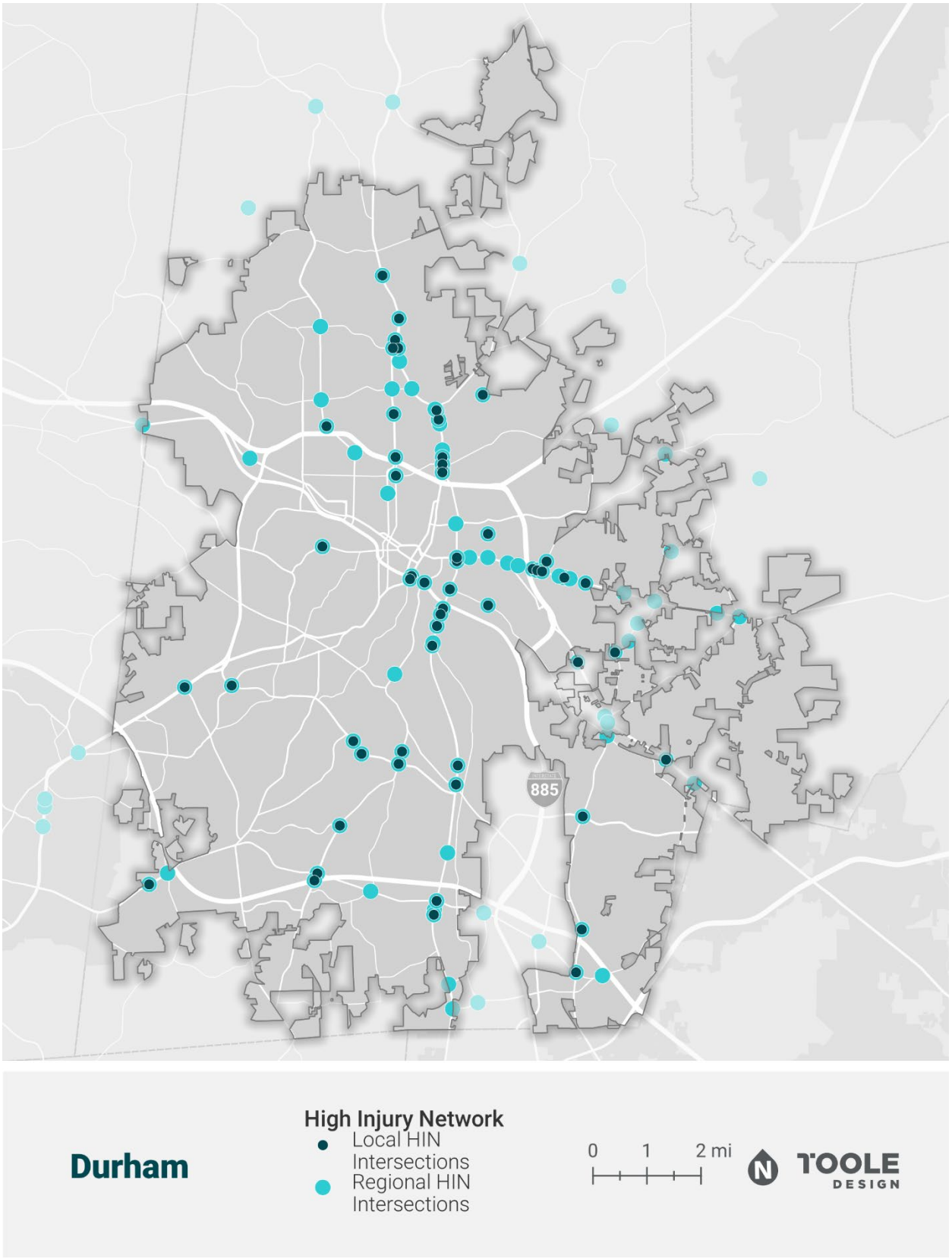
Crash Map



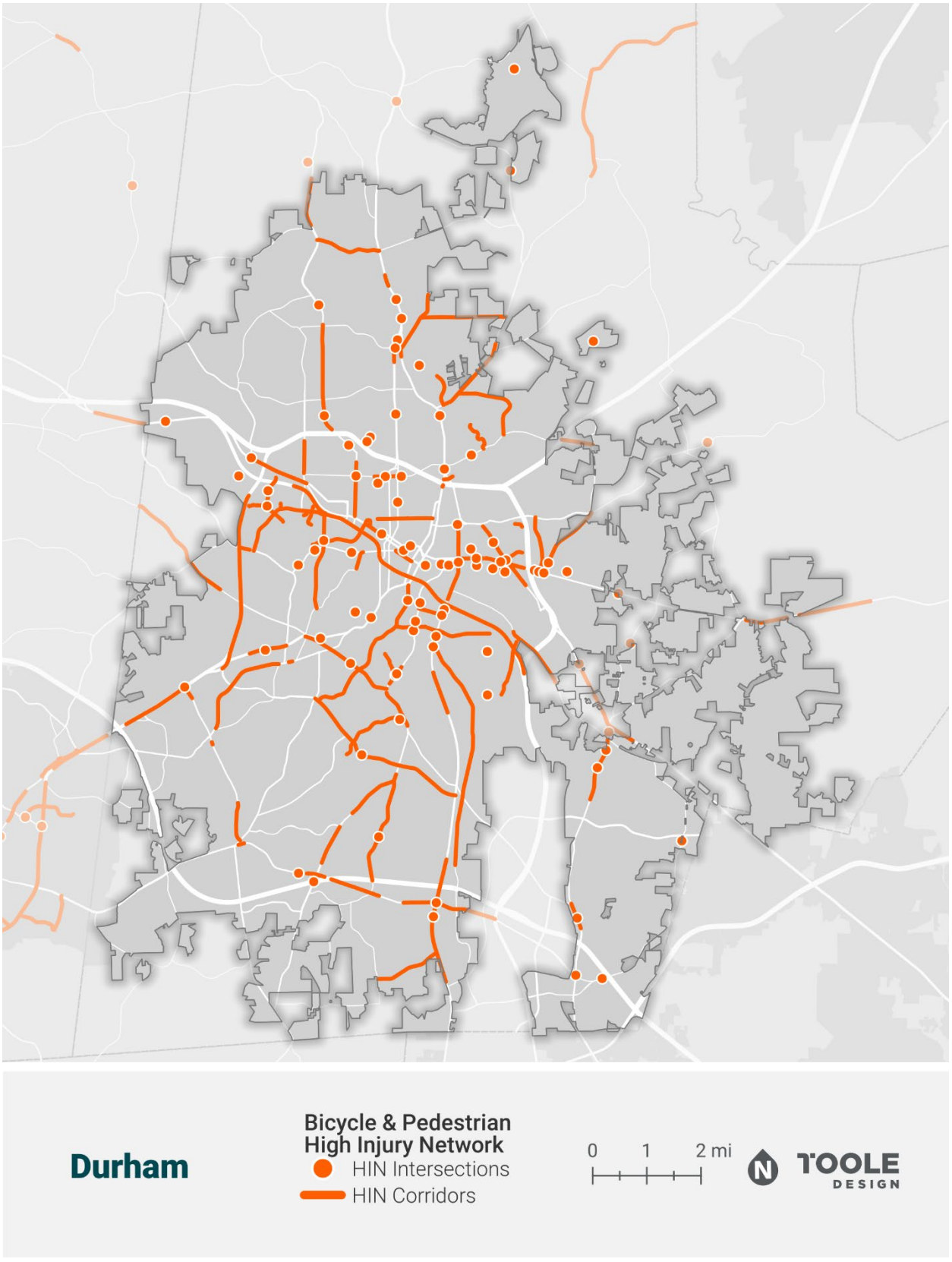
High Injury Network



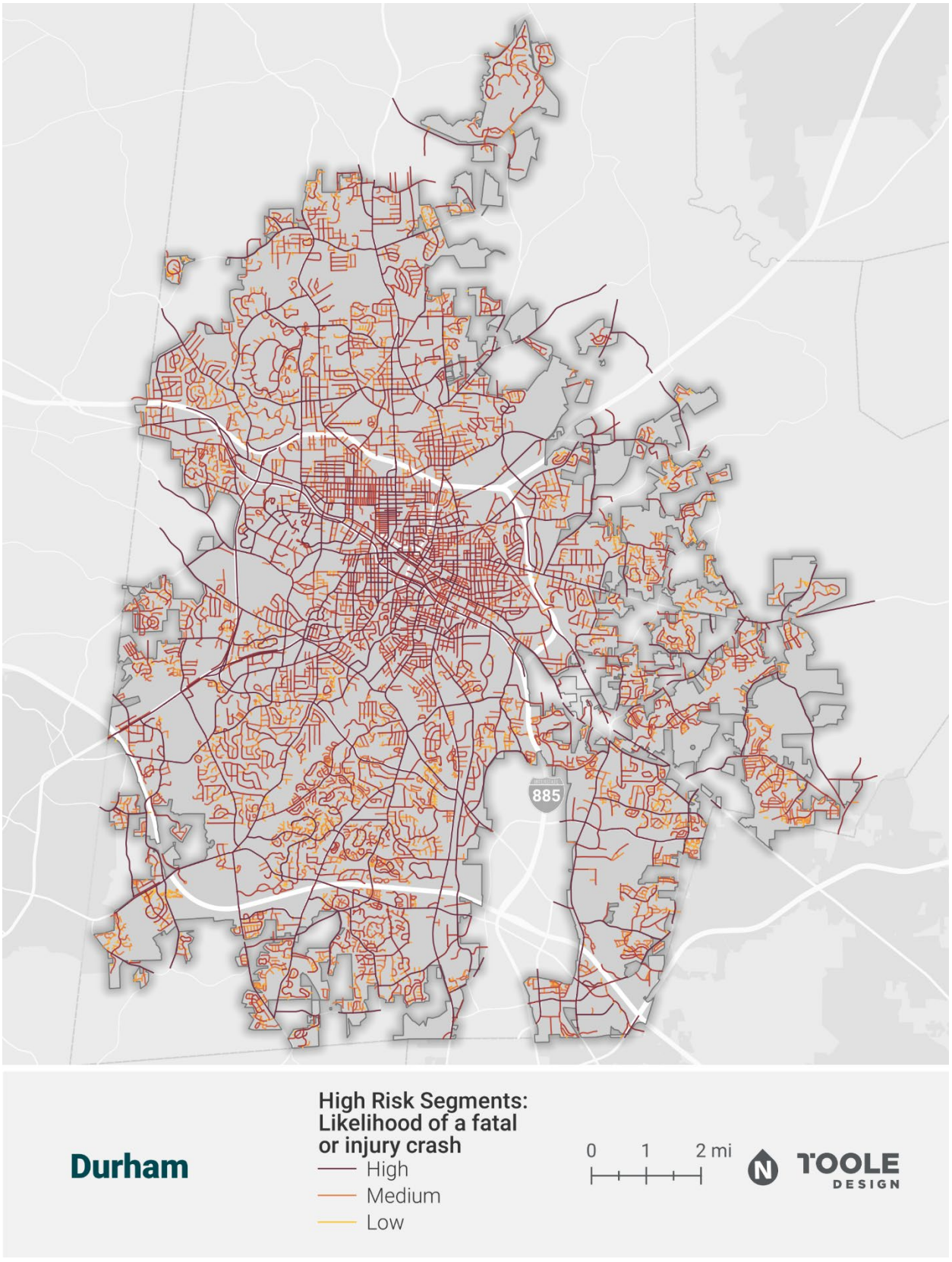
High Injury Intersections



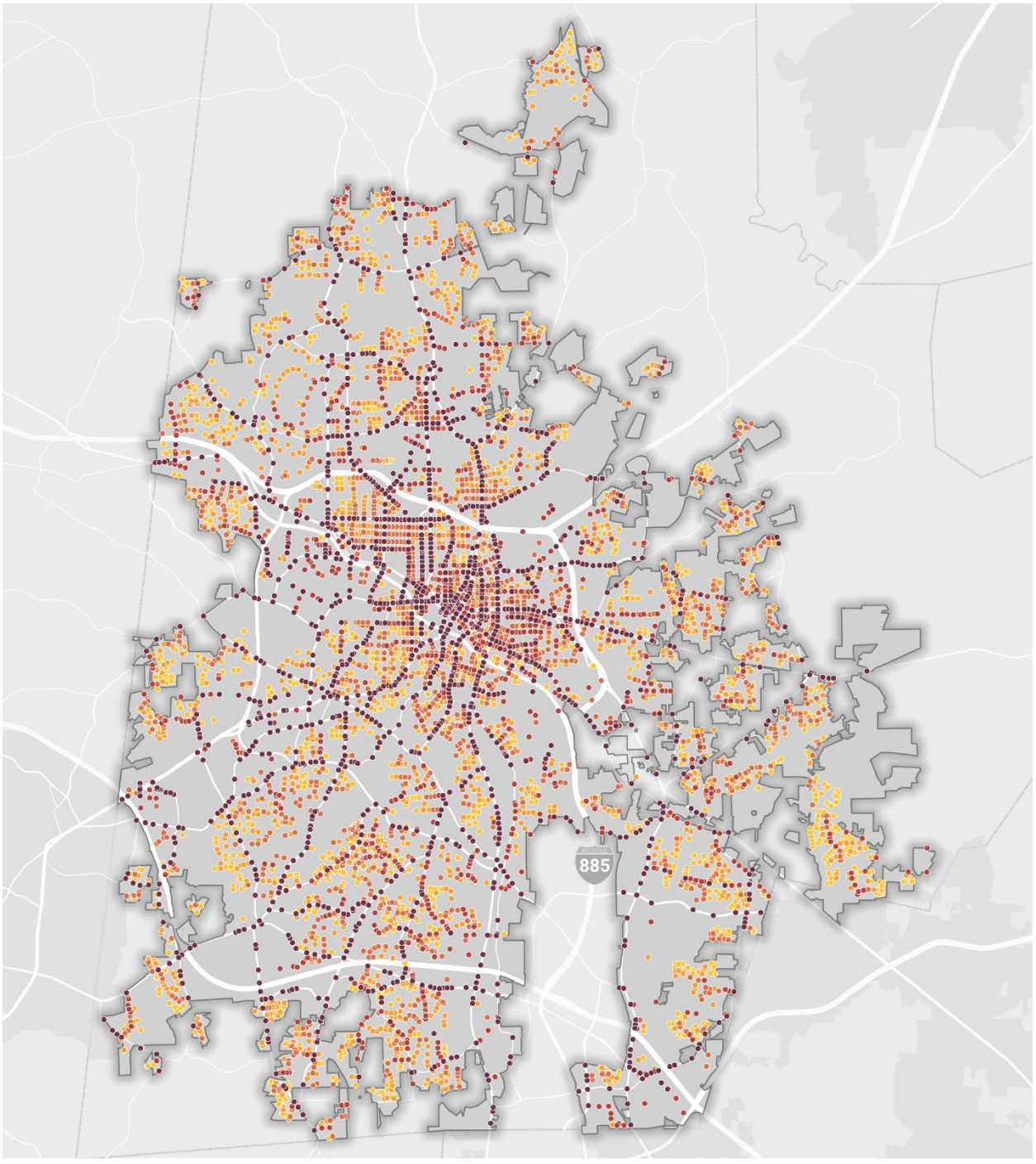
VRU High Injury corridors and intersections



High Risk Corridors



High Risk Intersections



Durham

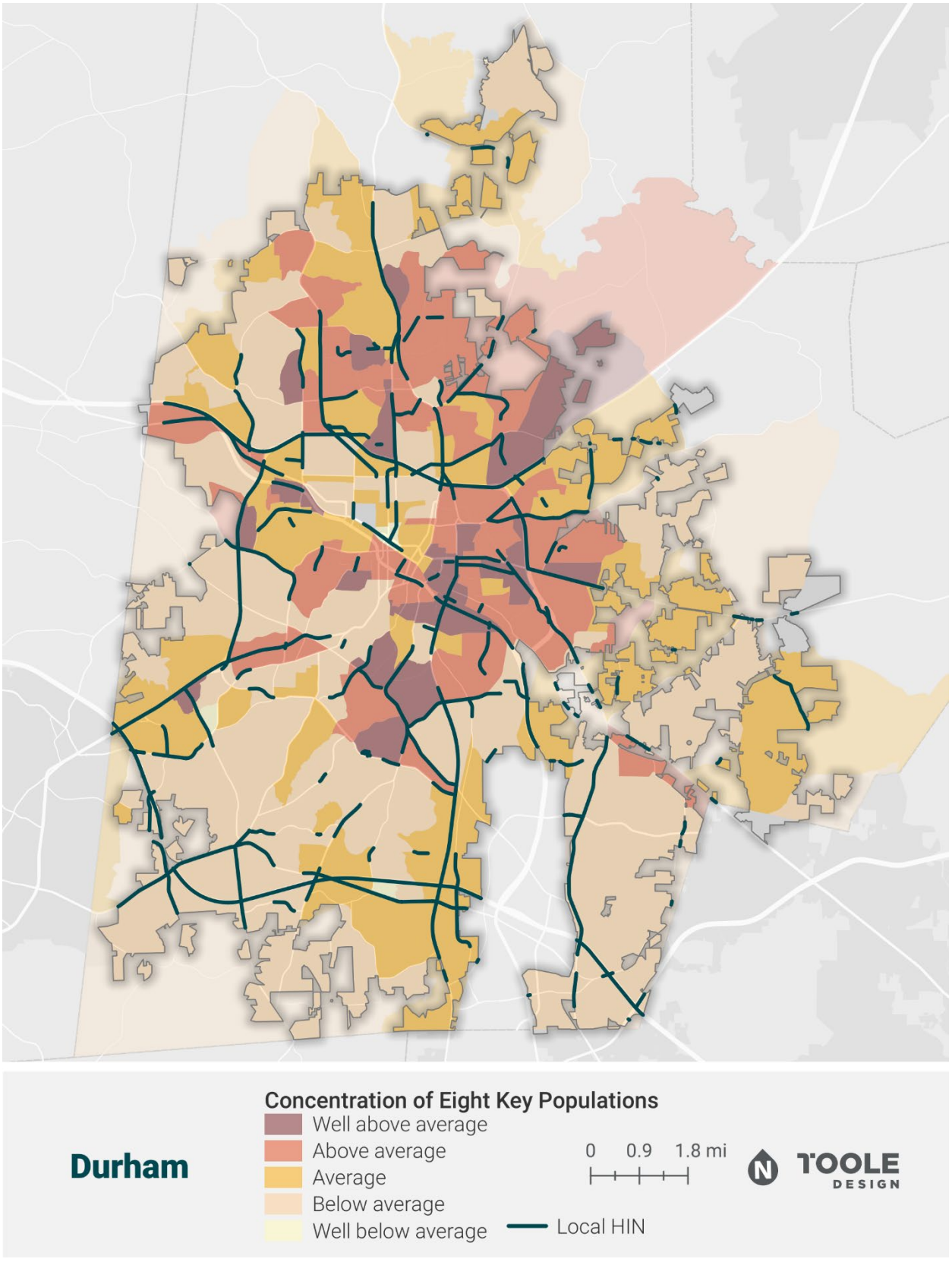
High Risk Intersections:
Likelihood of a fatal
or injury crash

- High
- Medium
- Low

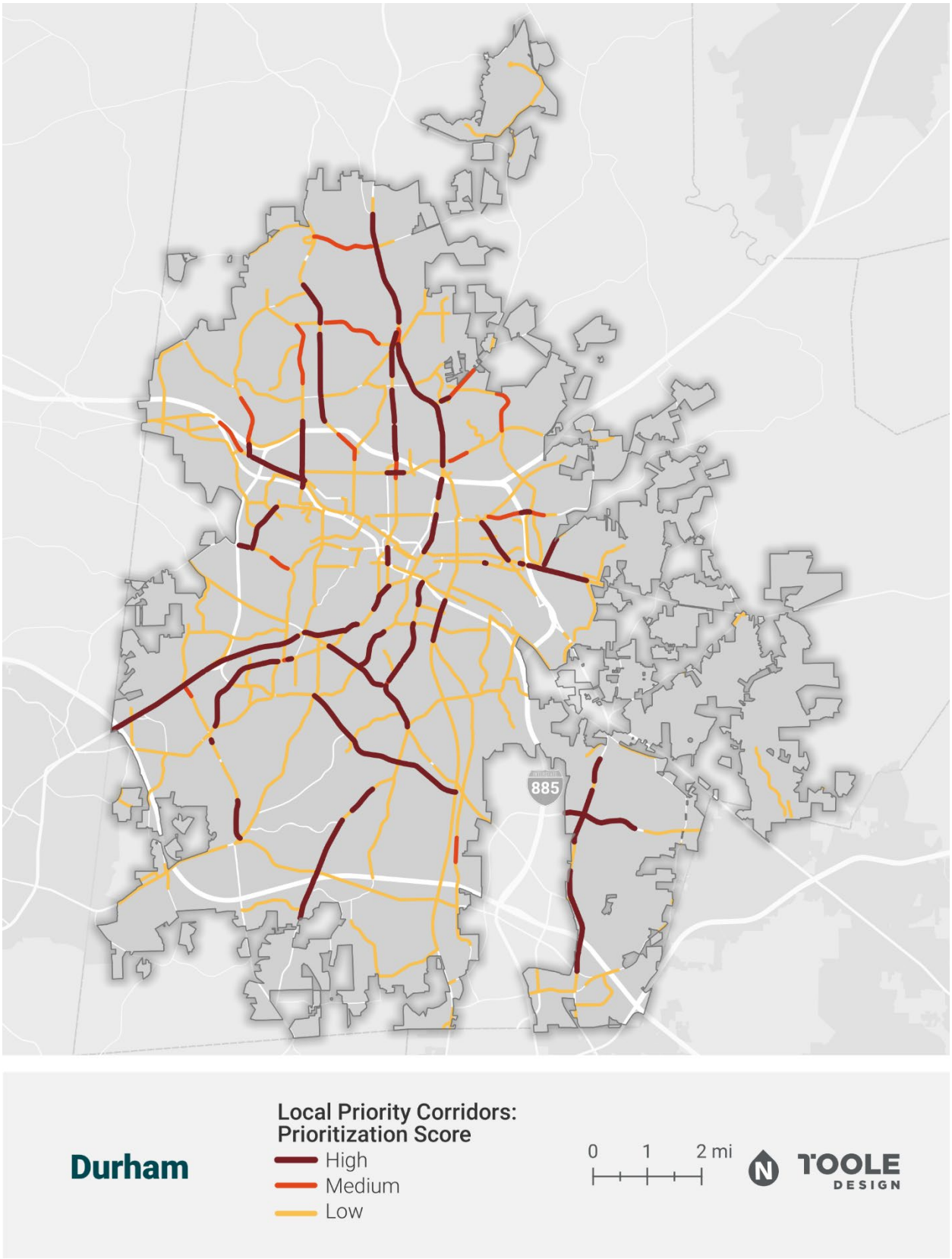
0 1 2 mi

TOOLE DESIGN

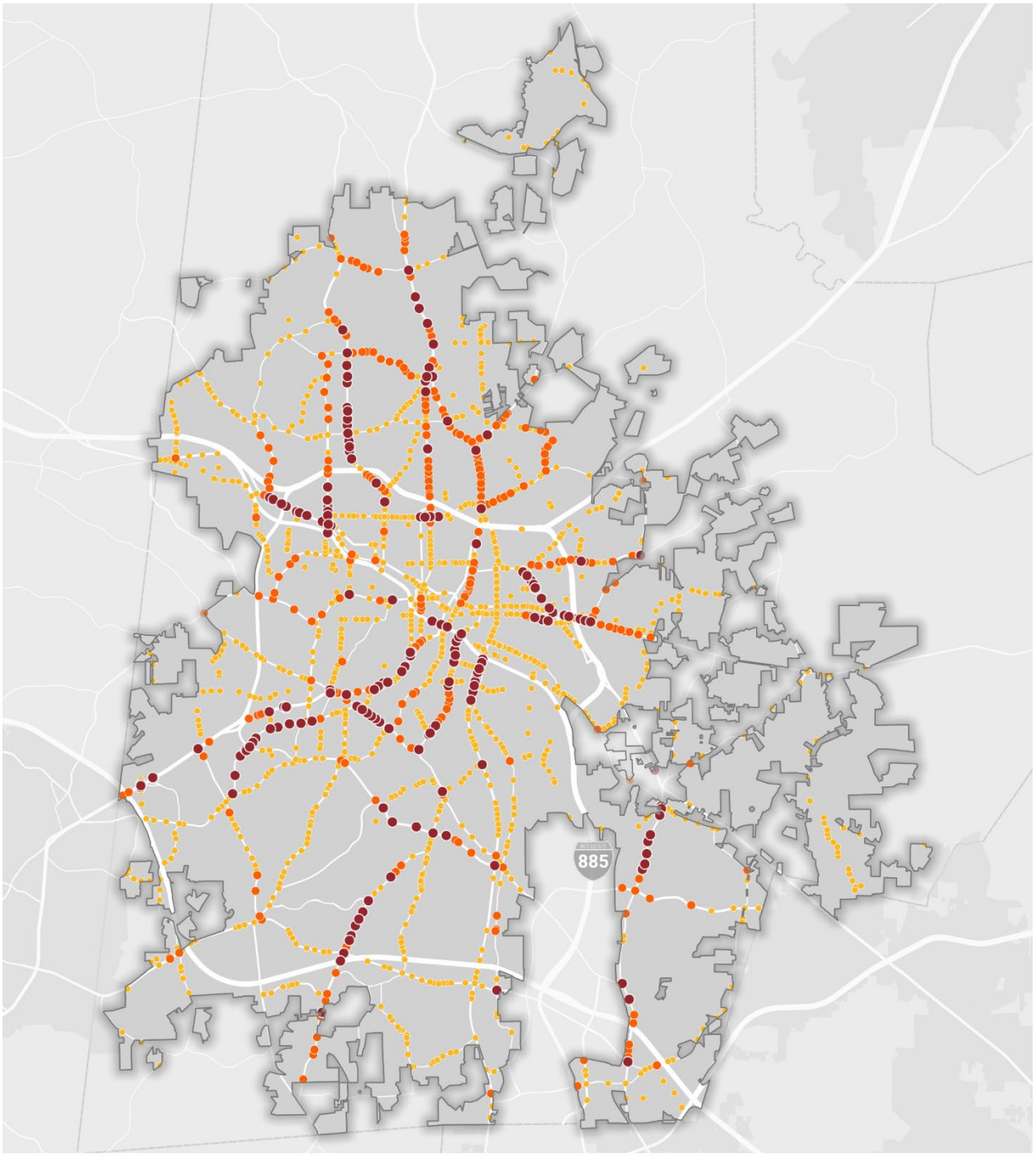
Indicators of Potential Disadvantage and HIN



Priority Corridors



Priority Intersections



Durham

Local Priority Intersections:
Prioritization Score

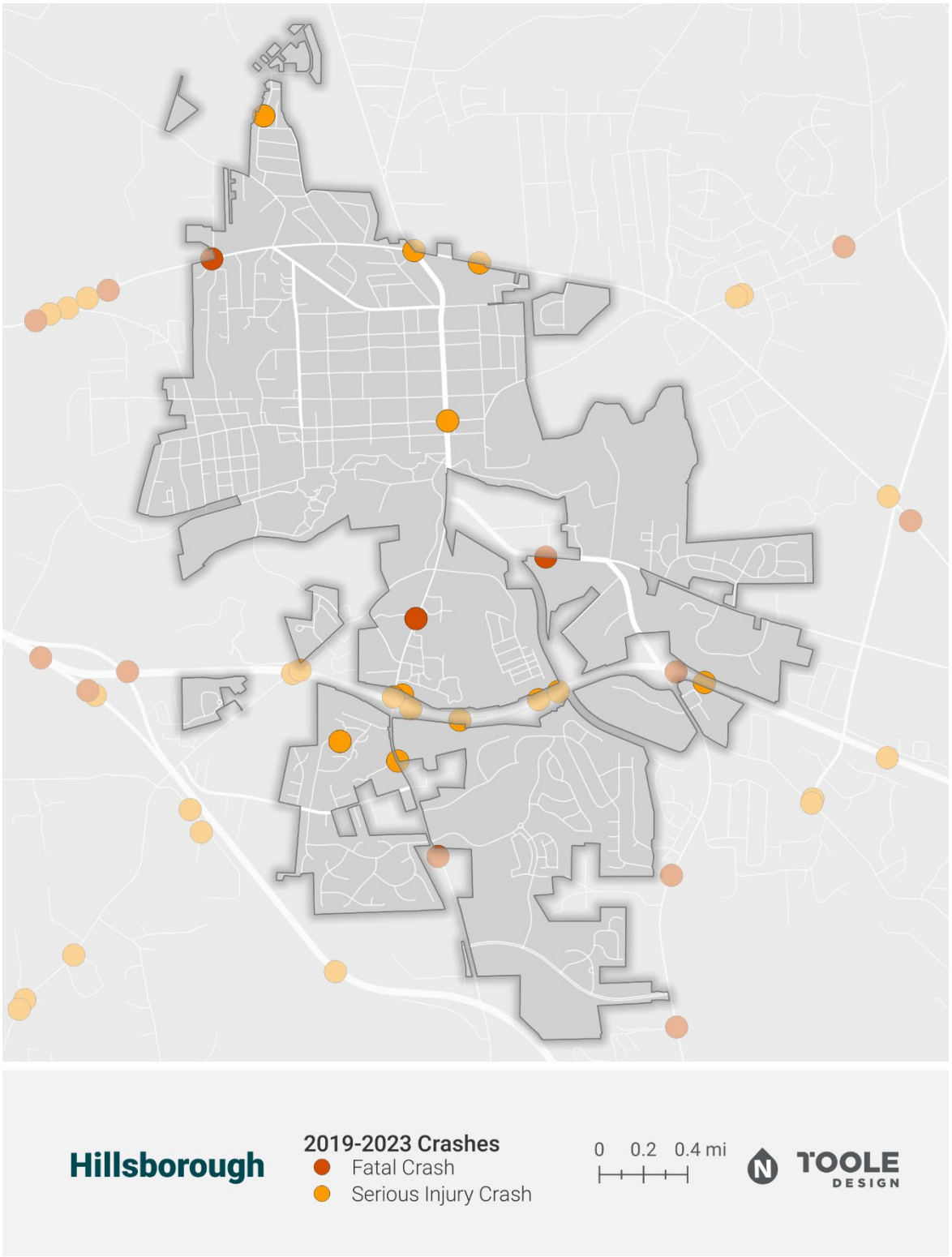
- High
- Medium
- Low

0 1 2 mi

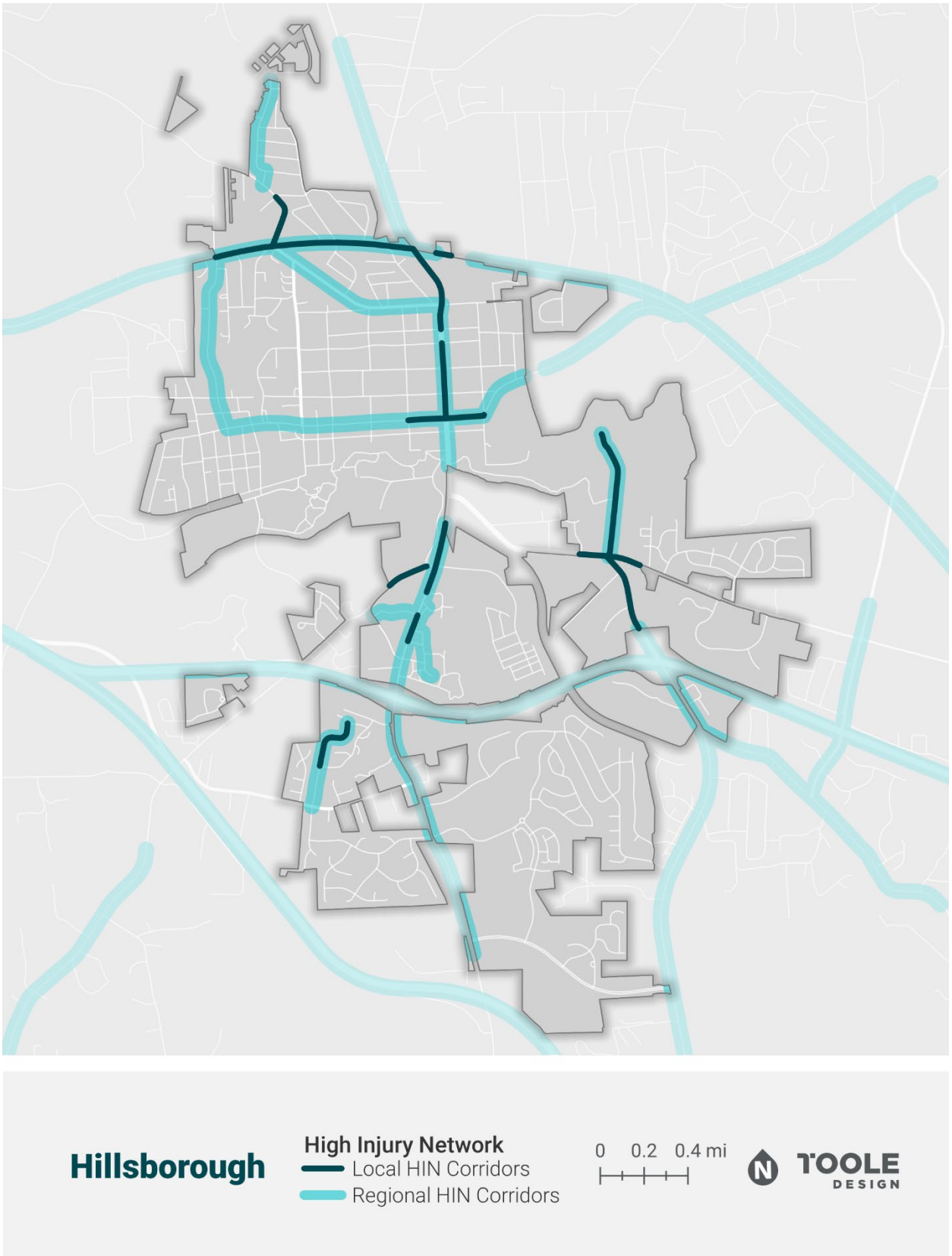
TOOLE DESIGN

TOWN OF HILLSBOROUGH

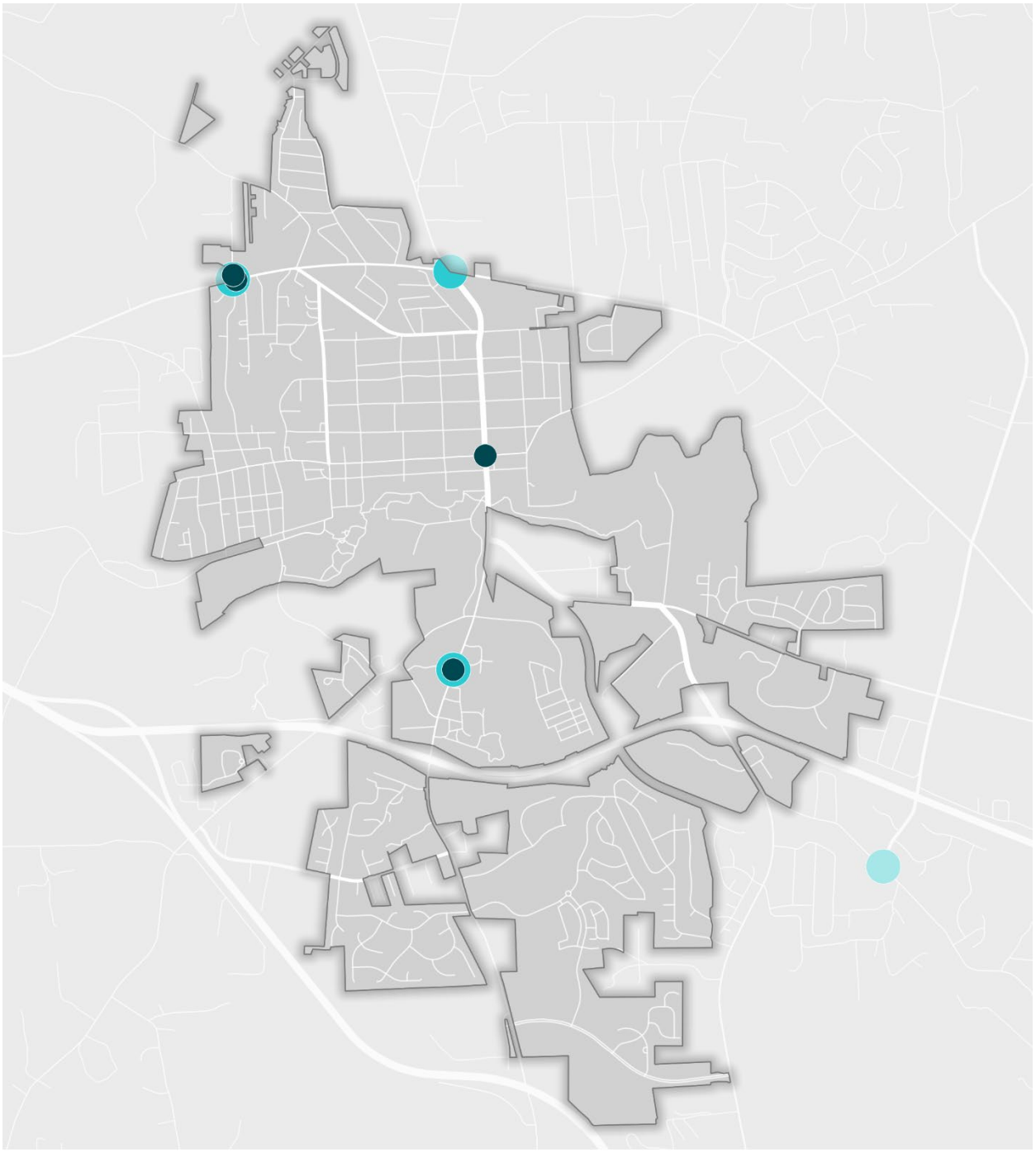
Crash Map



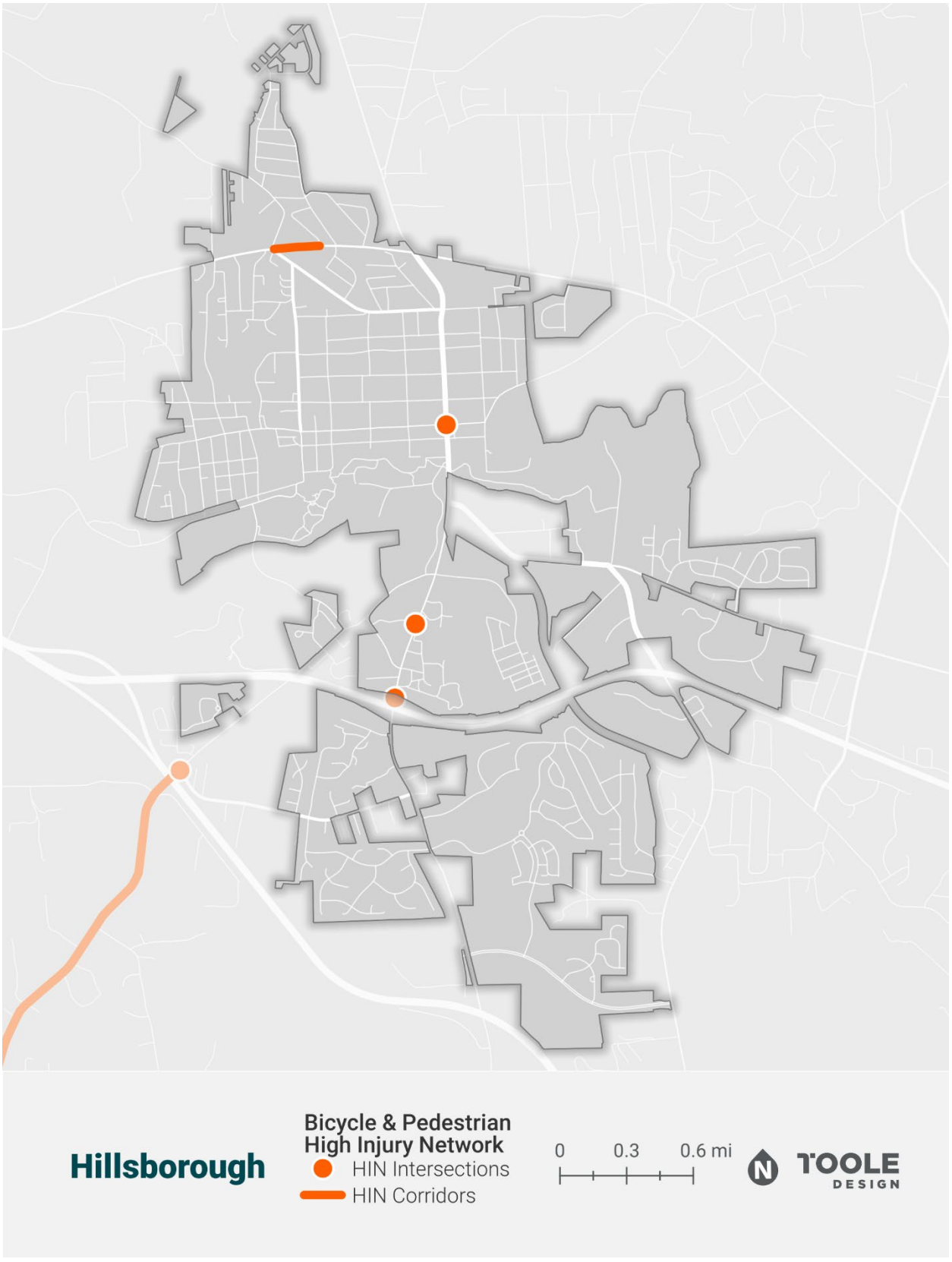
High Injury Network



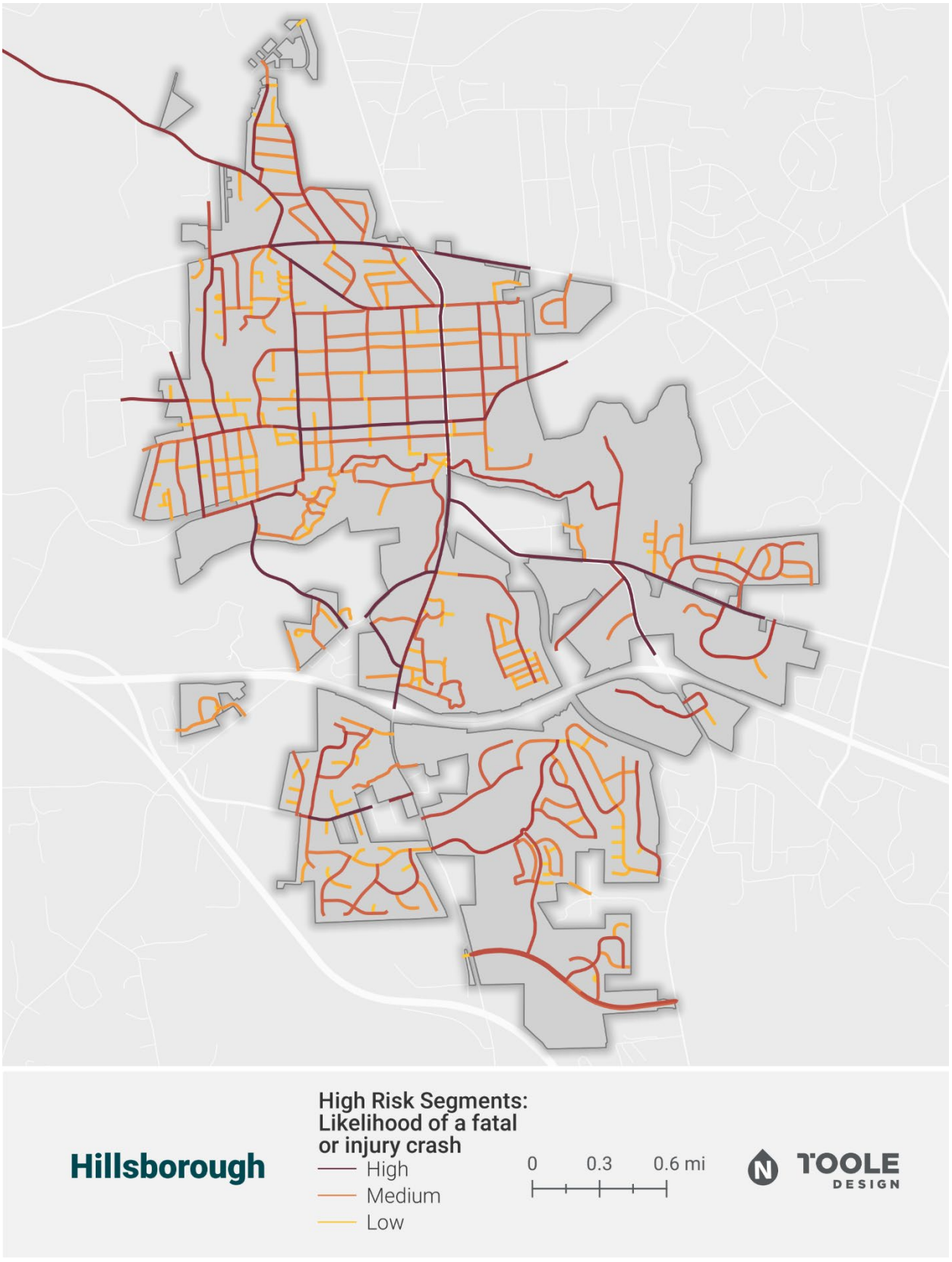
High Injury Intersections



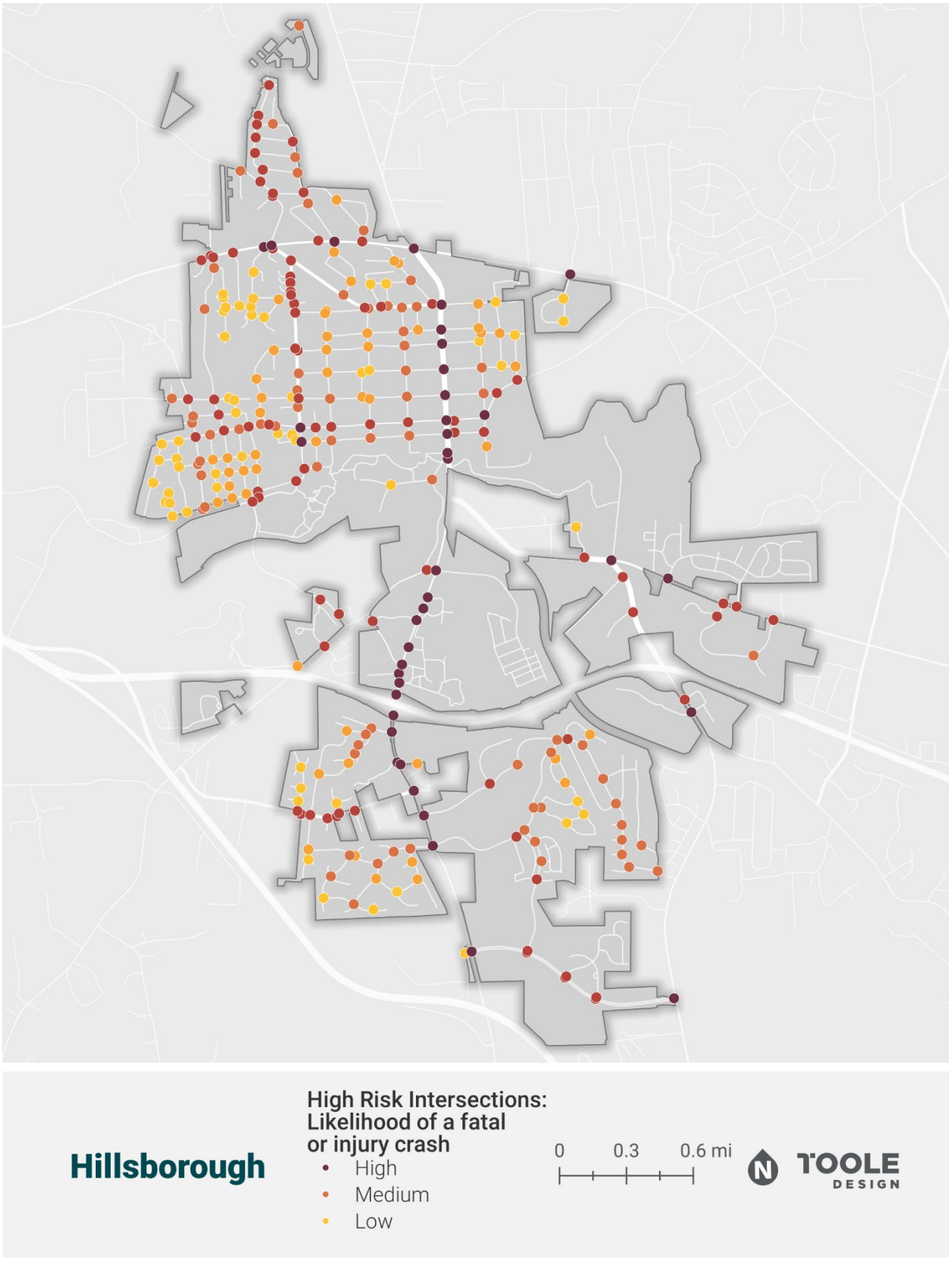
VRU High Injury corridors and intersections



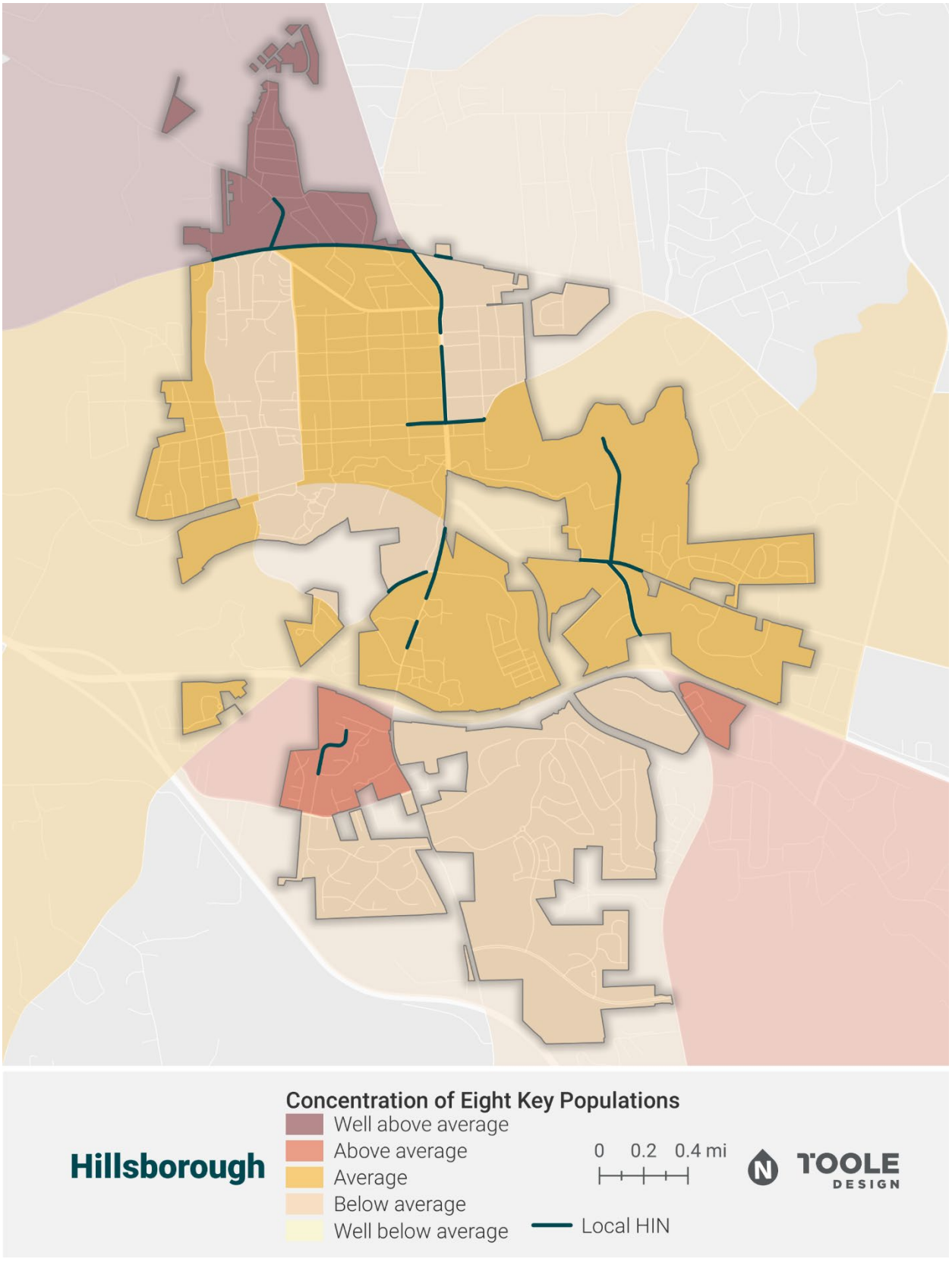
High Risk Corridors



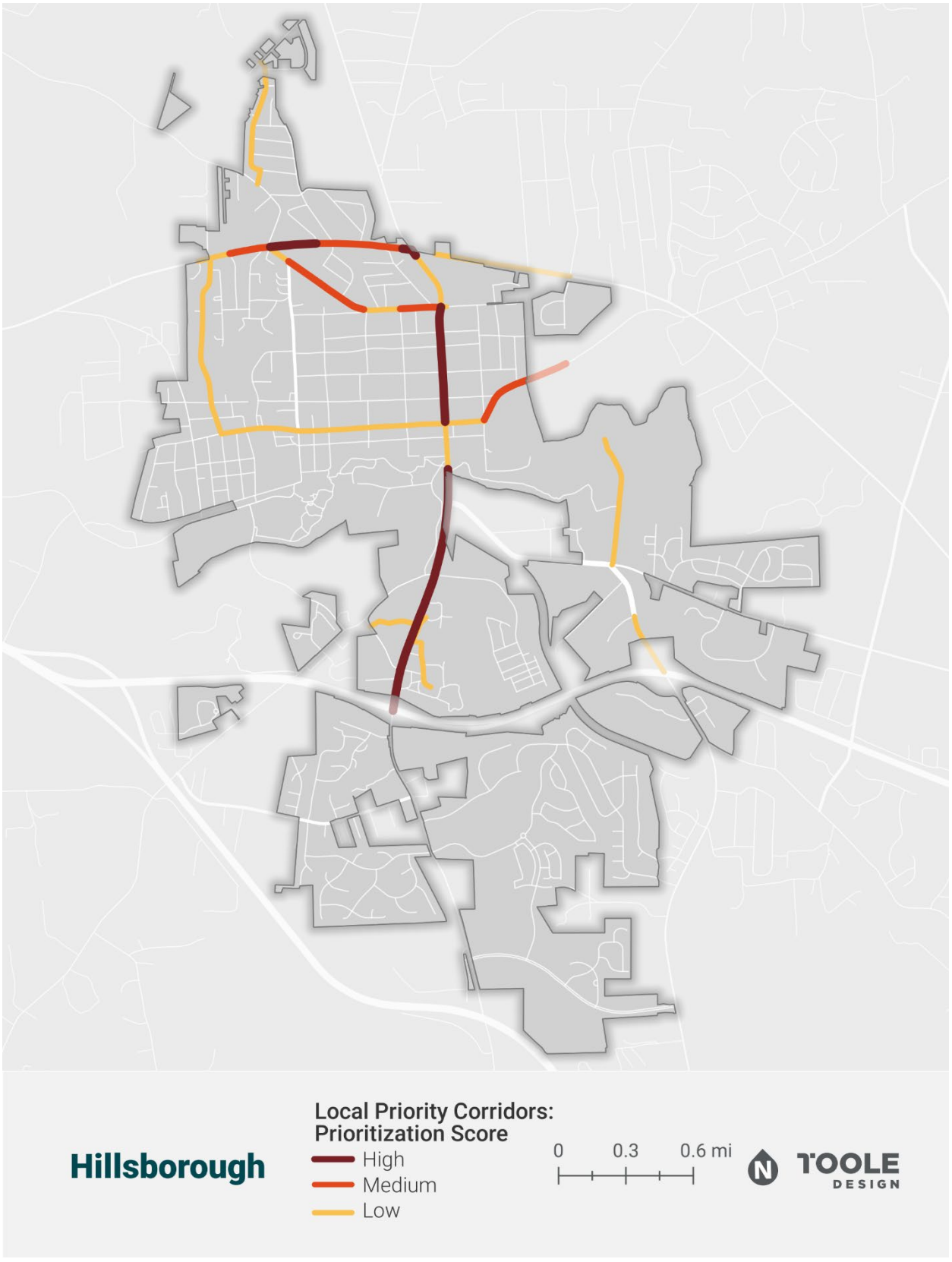
High Risk Intersections



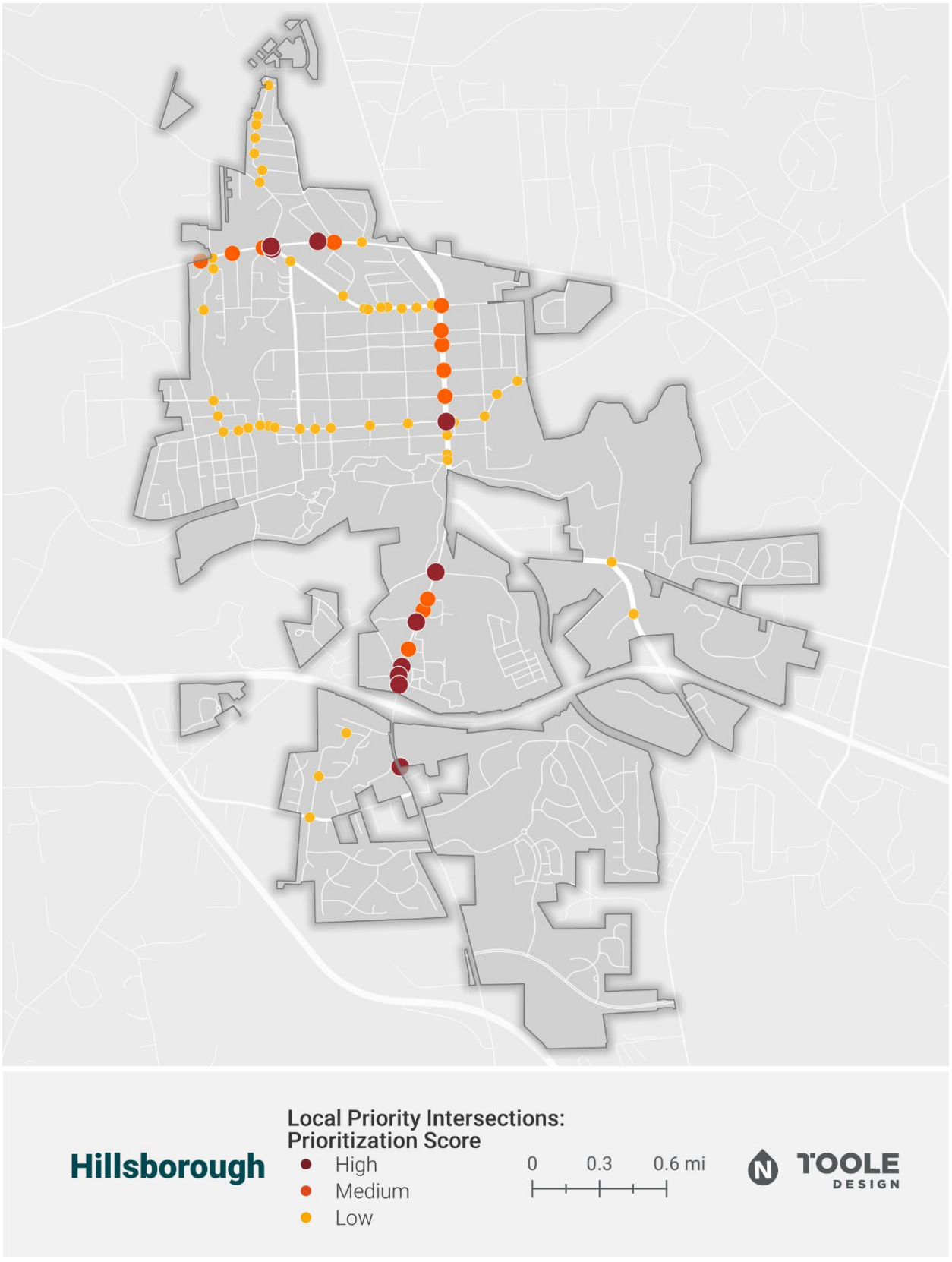
Indicators of Potential Disadvantage and HIN



Priority Corridors

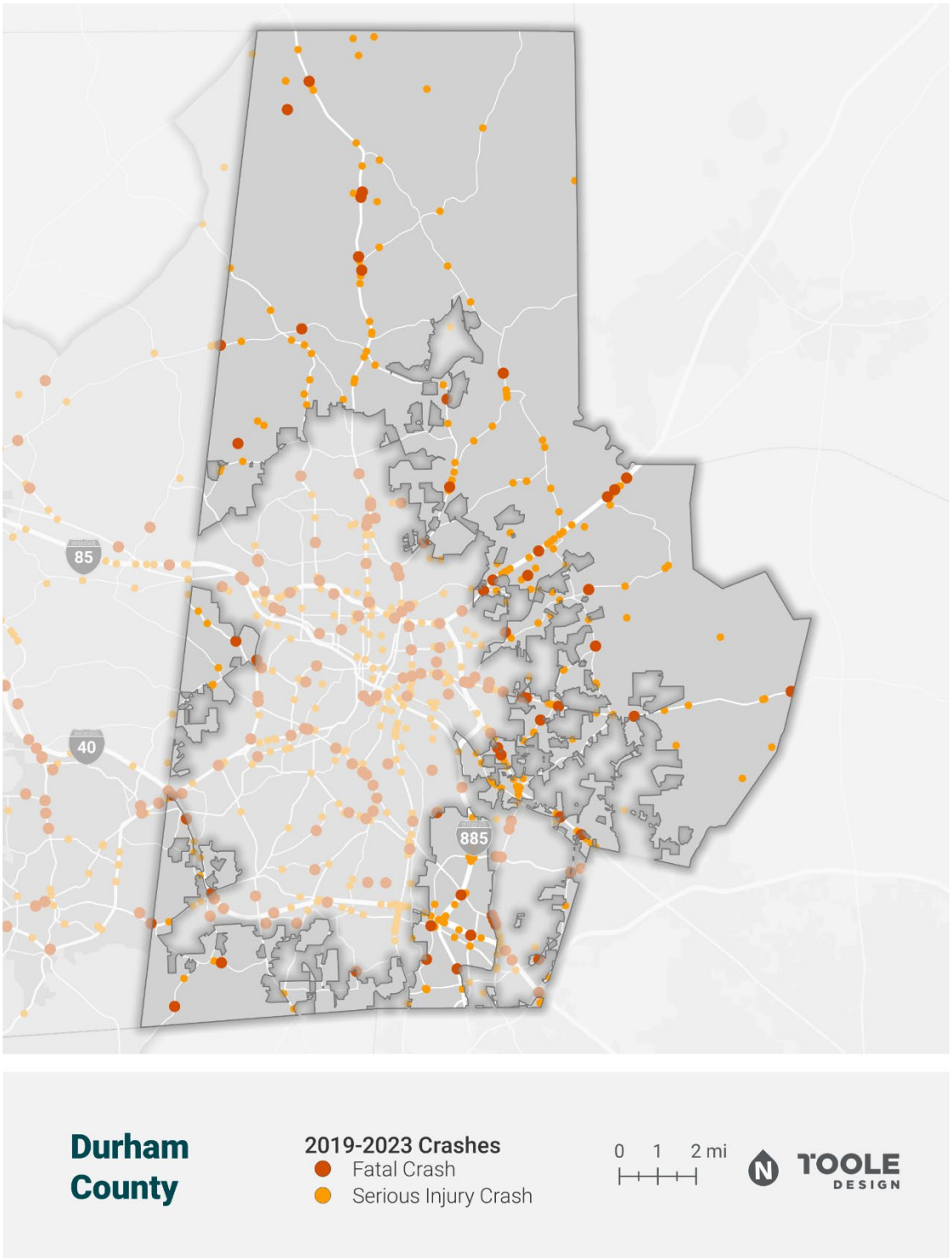


Priority Intersections

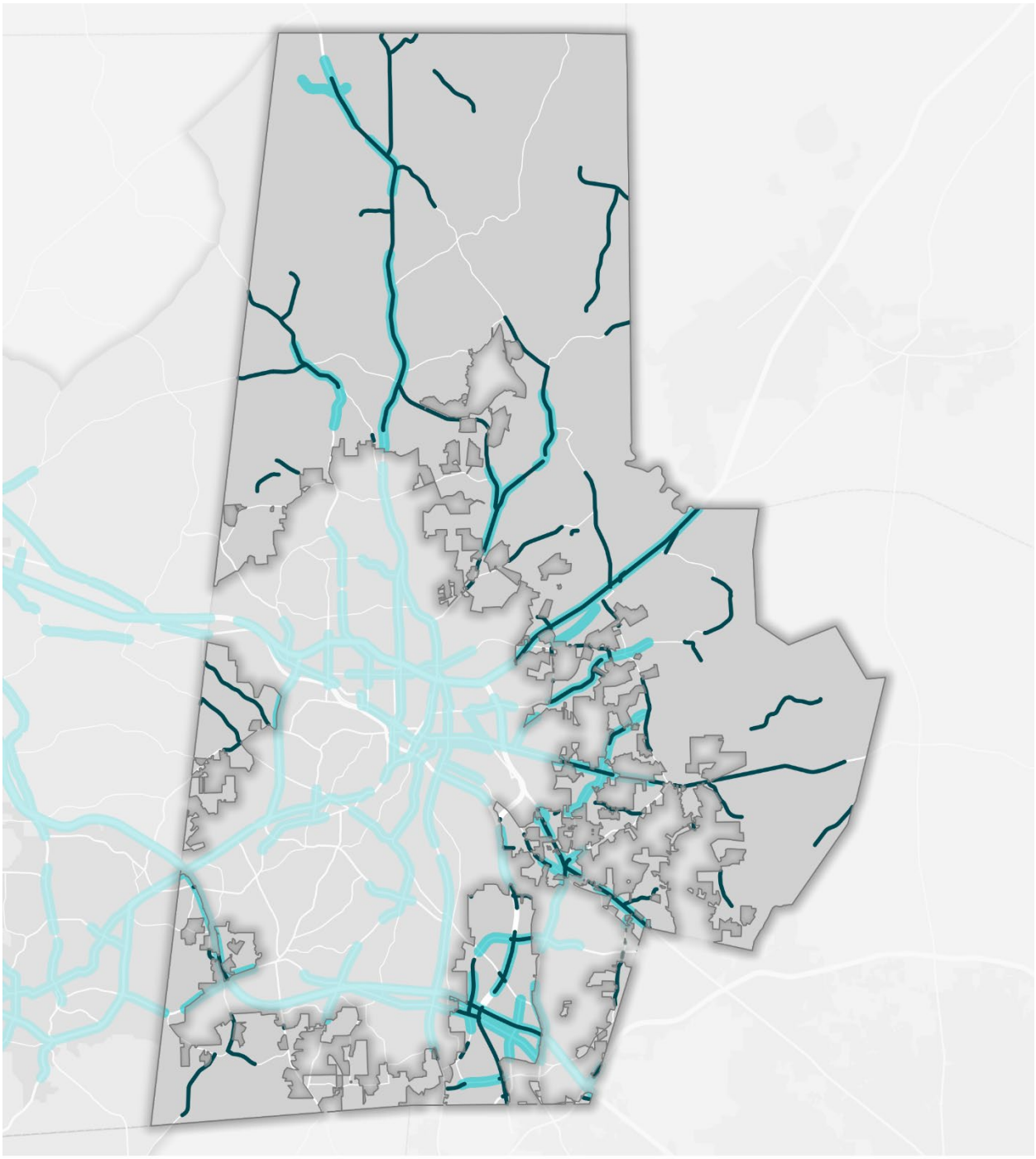


DURHAM COUNTY

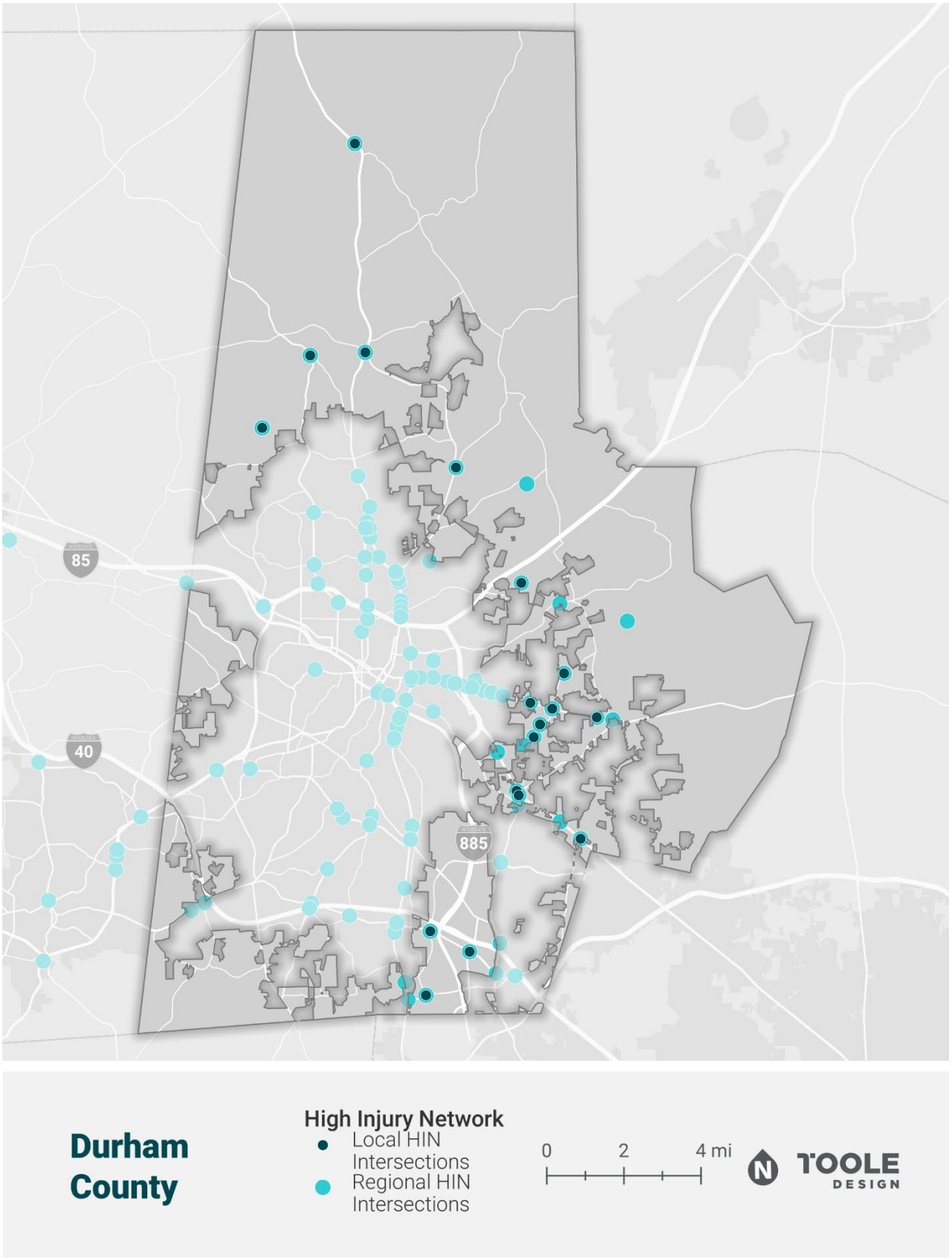
Crash Map



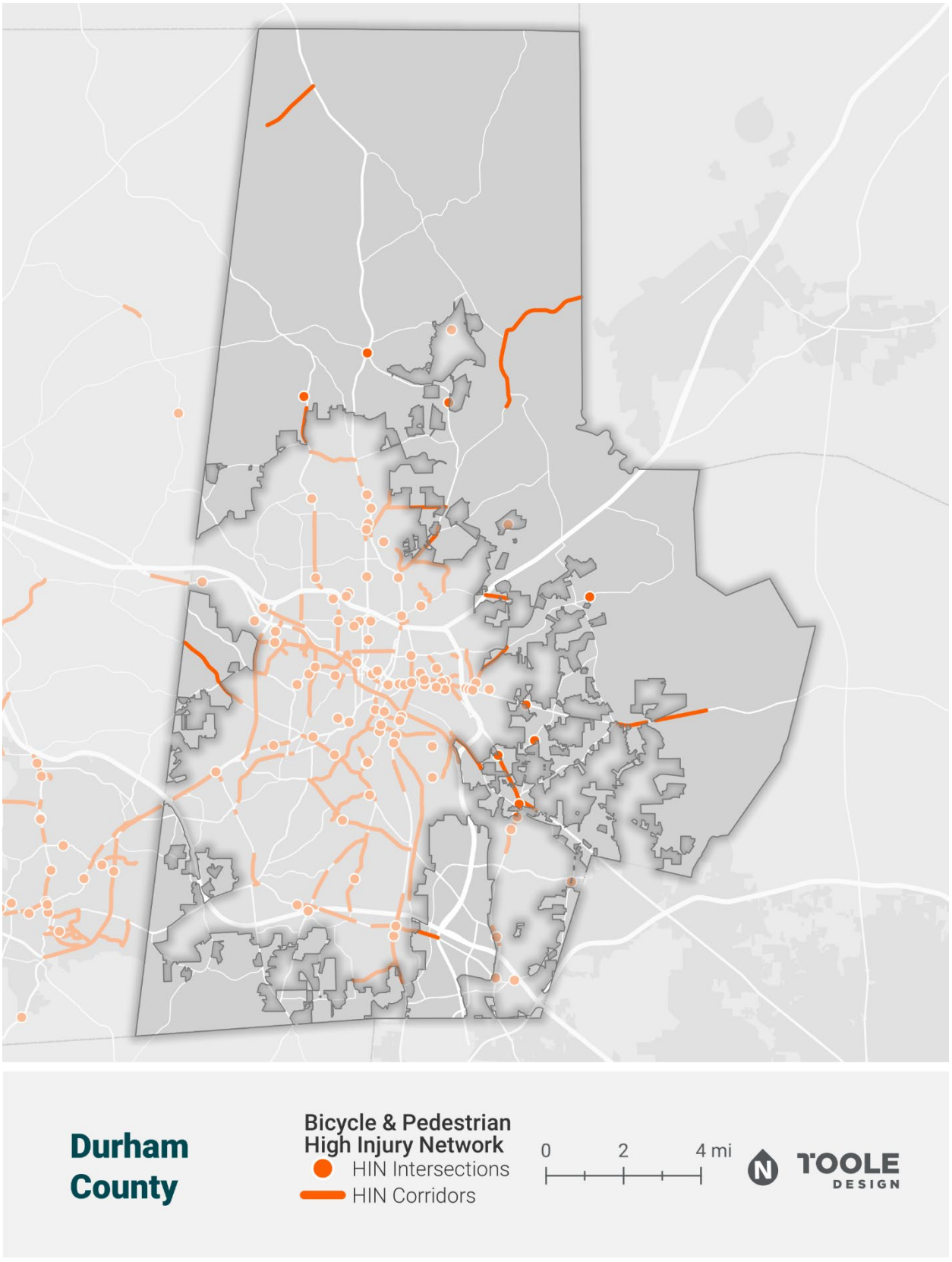
High Injury Network



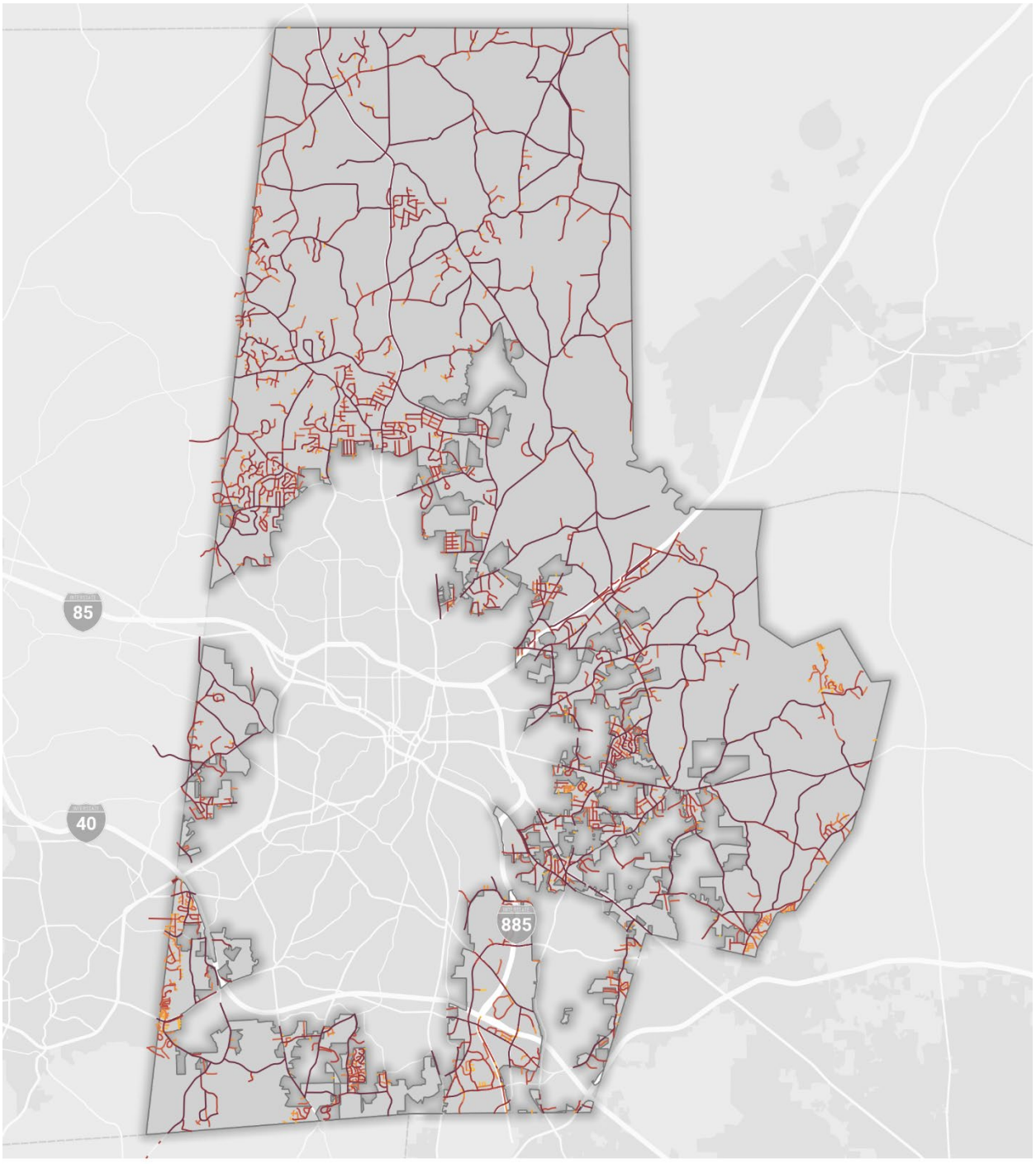
High Injury Intersections



VRU High Injury corridors and intersections



High Risk Corridors



Durham County

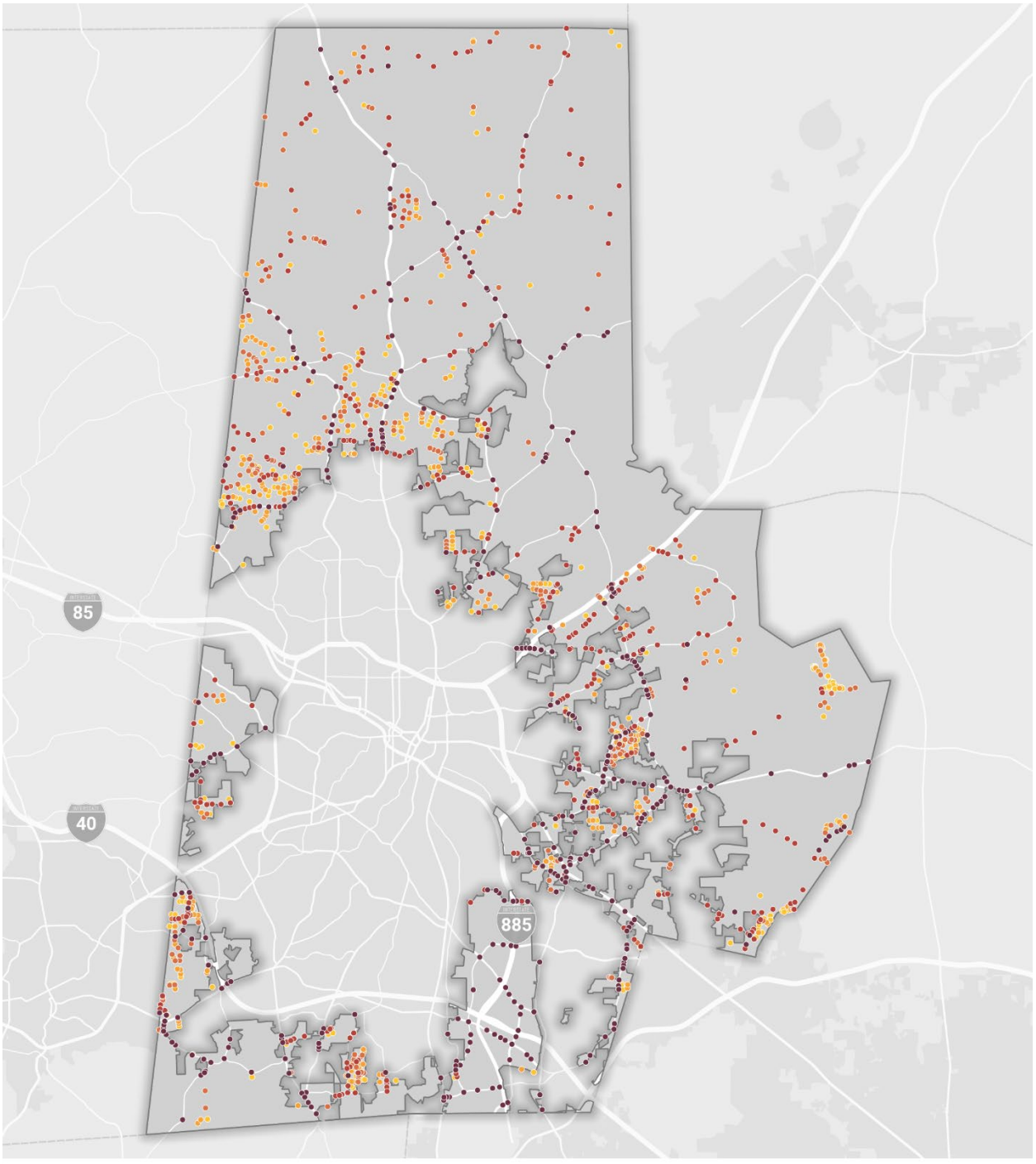
High Risk Segments: Likelihood of a fatal or injury crash

- High
- Medium
- Low

0 2 4 mi

TOOLE DESIGN

High Risk Intersections



Durham County

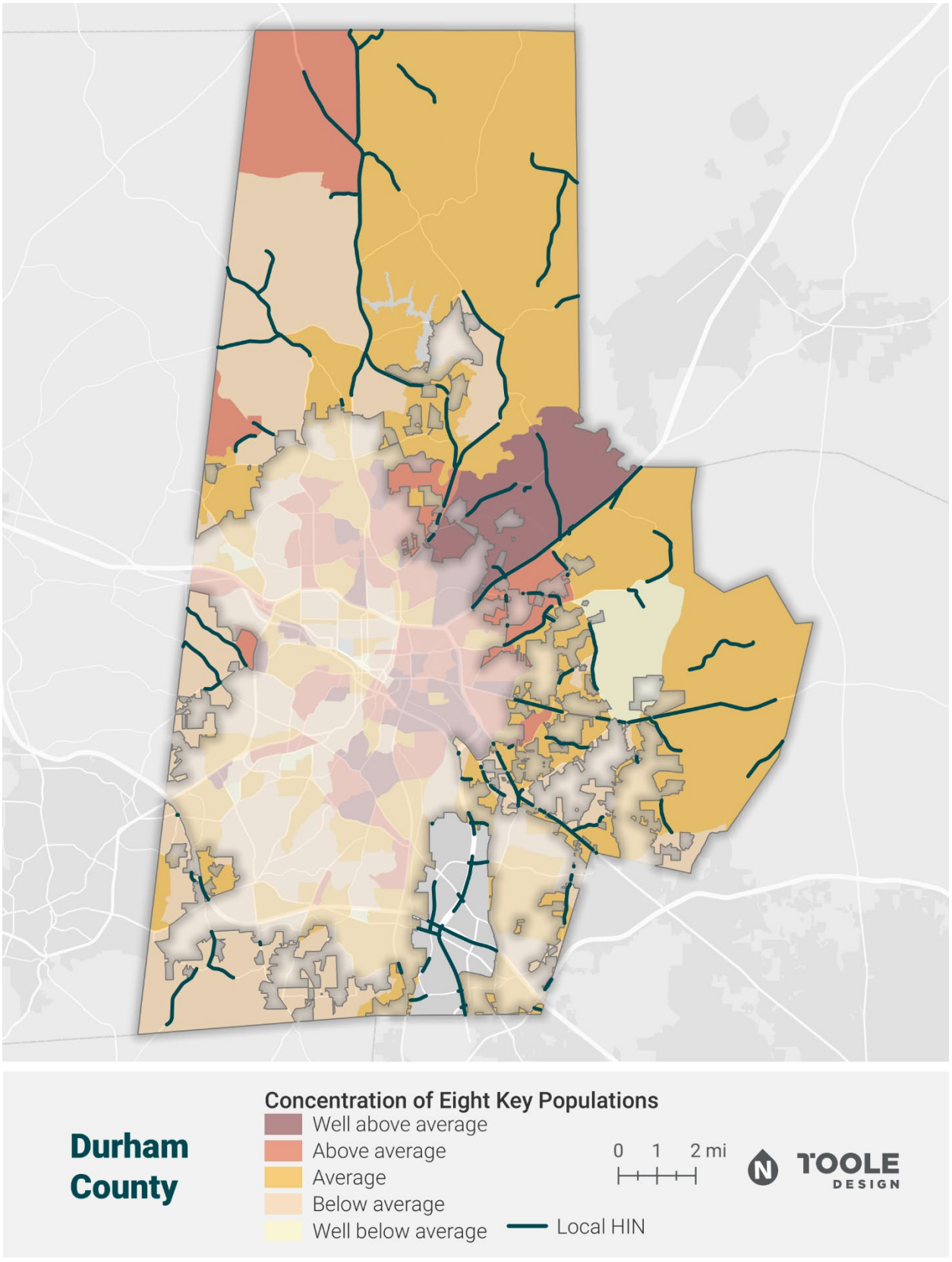
High Risk Intersections: Likelihood of a fatal or injury crash

- High
- Medium
- Low

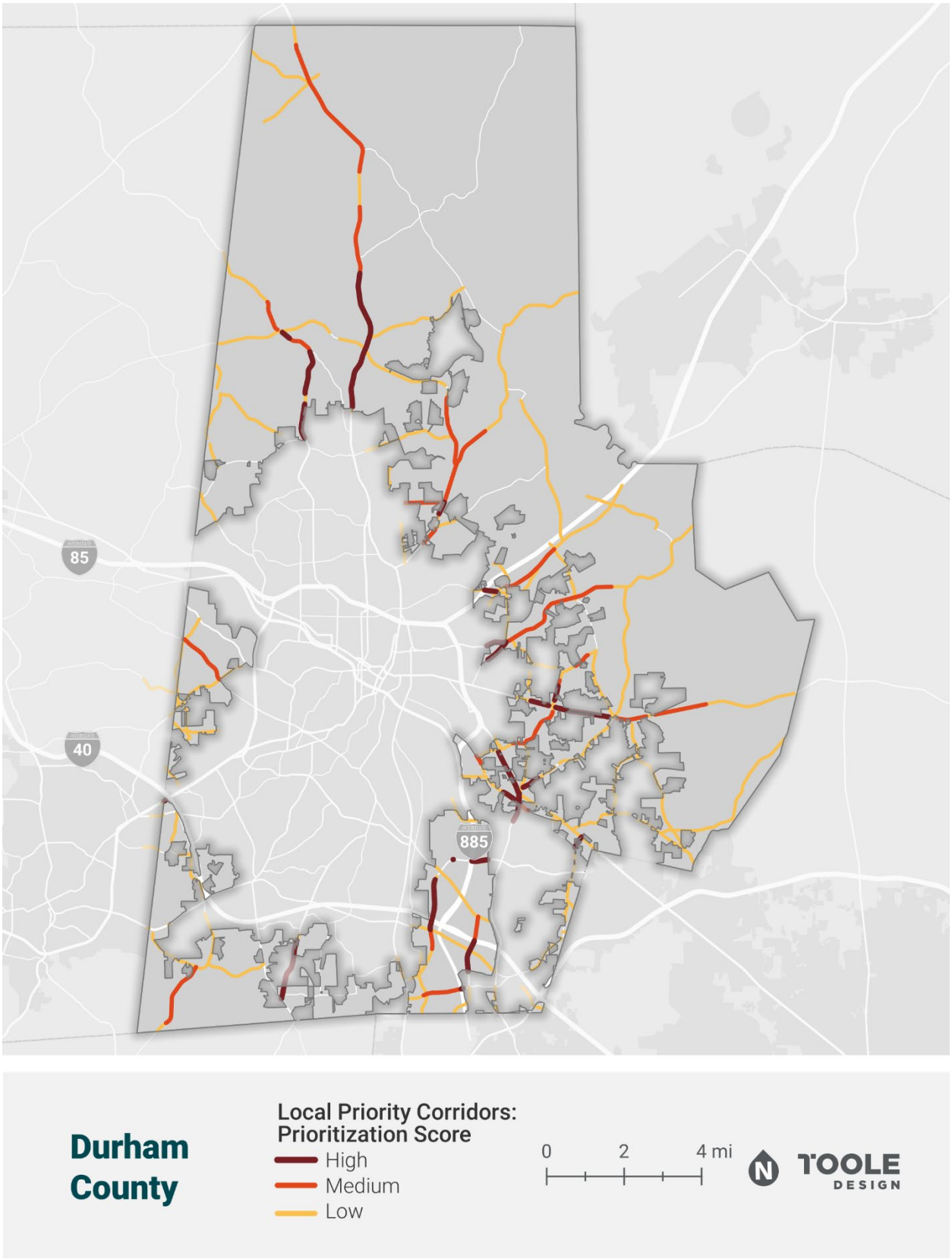
0 2 4 mi

TOOLE DESIGN

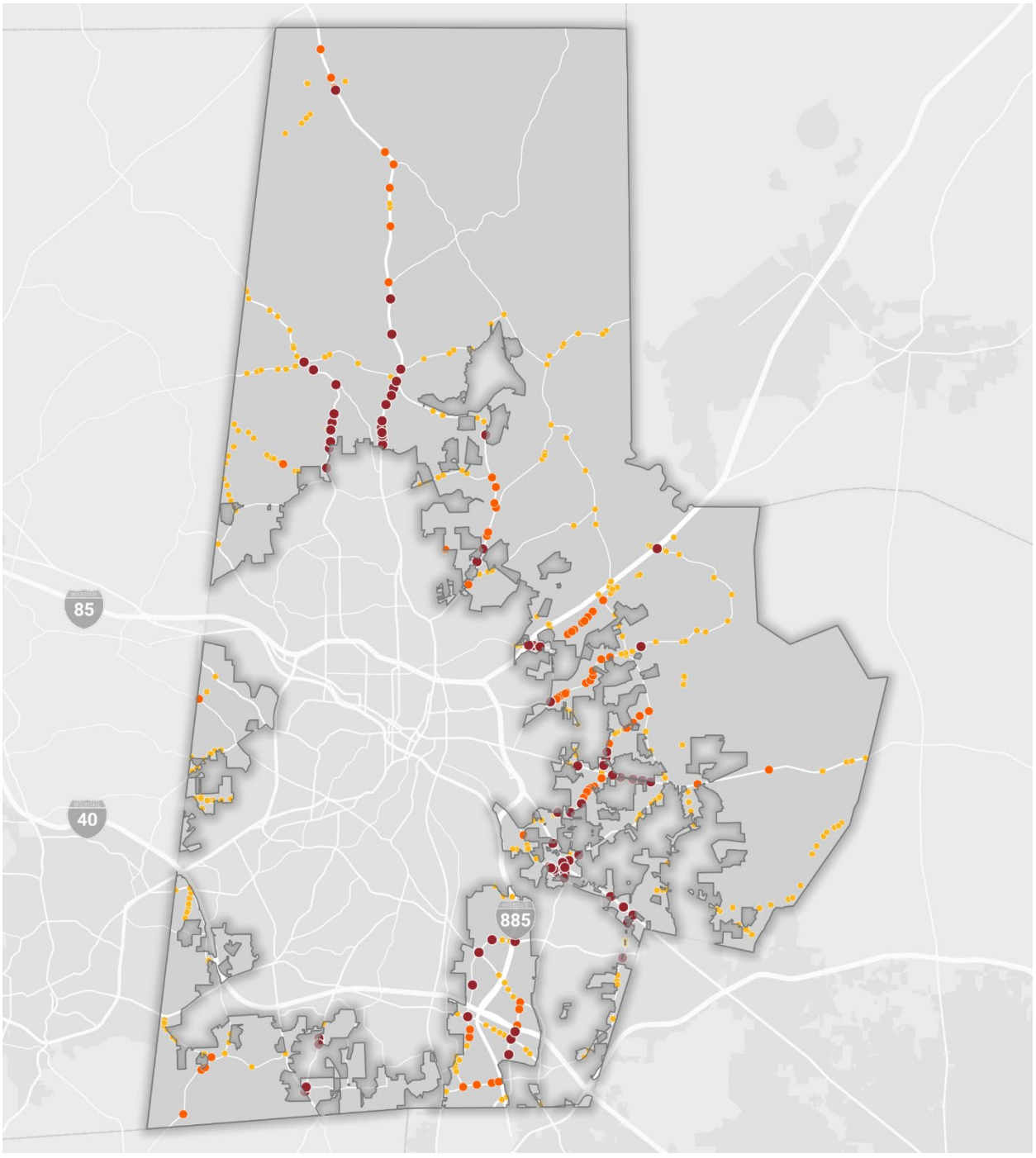
Indicators of Potential Disadvantage and HIN



Priority Corridors



Priority Intersections



Durham County

Local Priority Intersections:
Prioritization Score

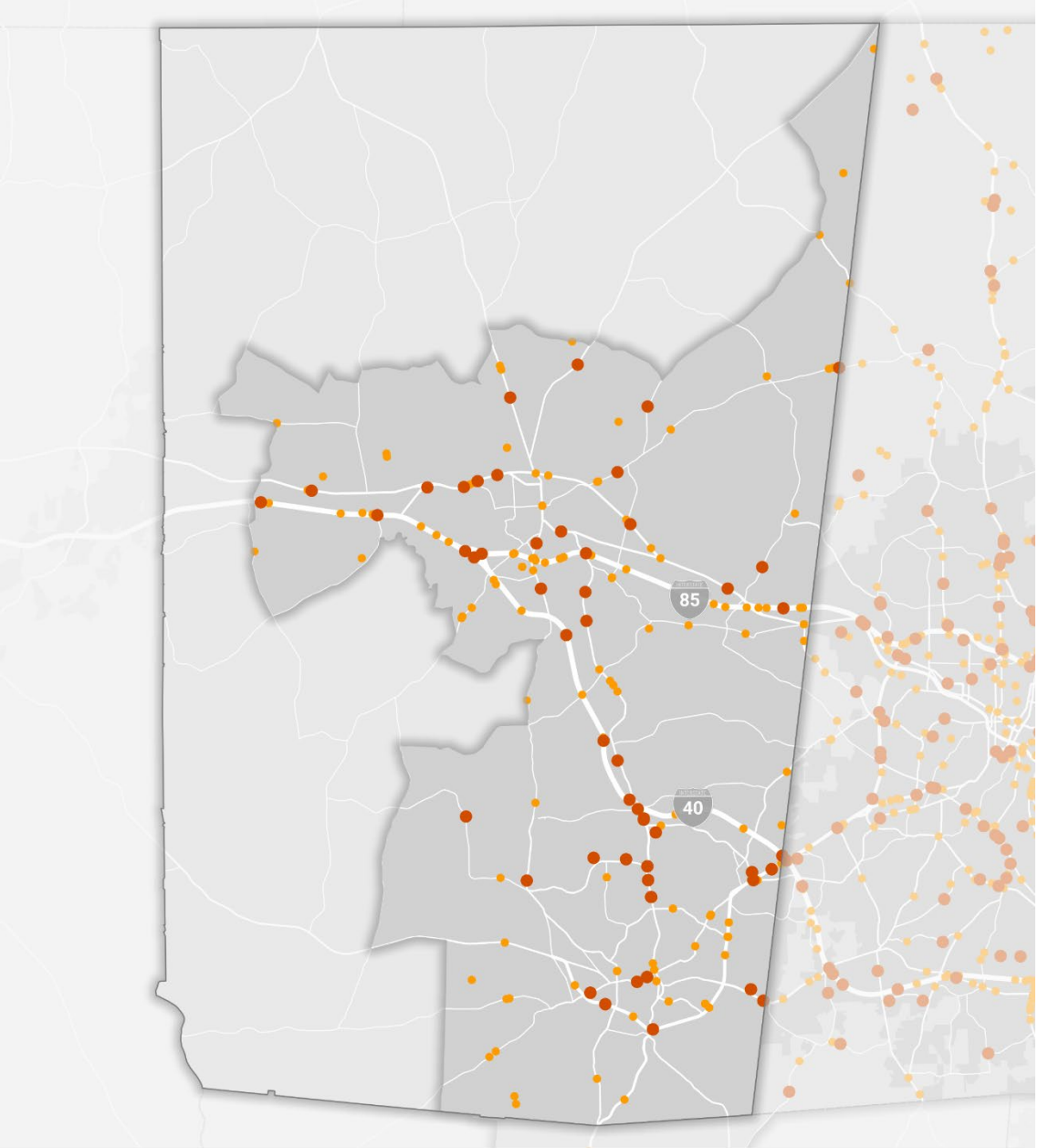
- High
- Medium
- Low

0 2 4 mi

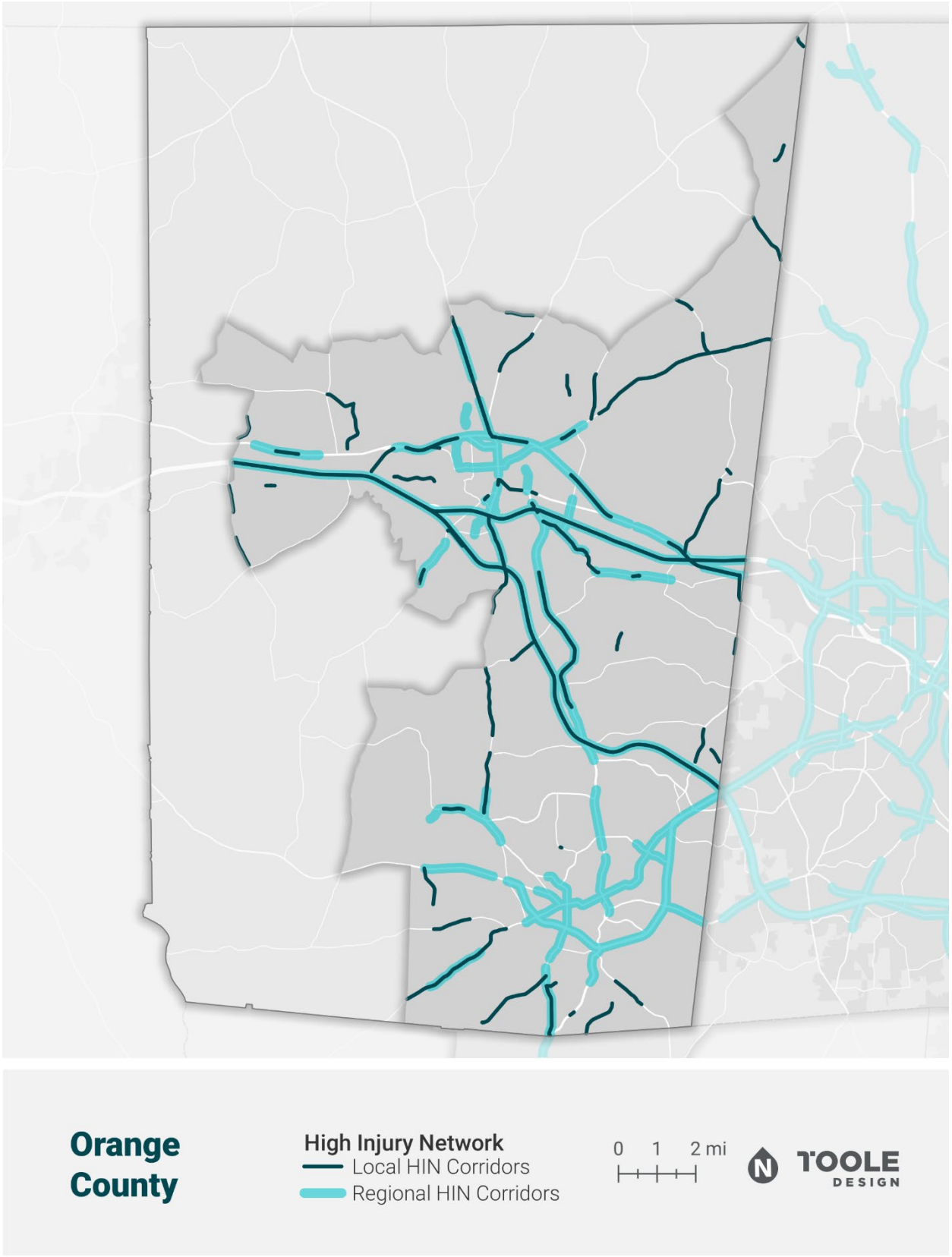
TOOLE DESIGN

ORANGE COUNTY

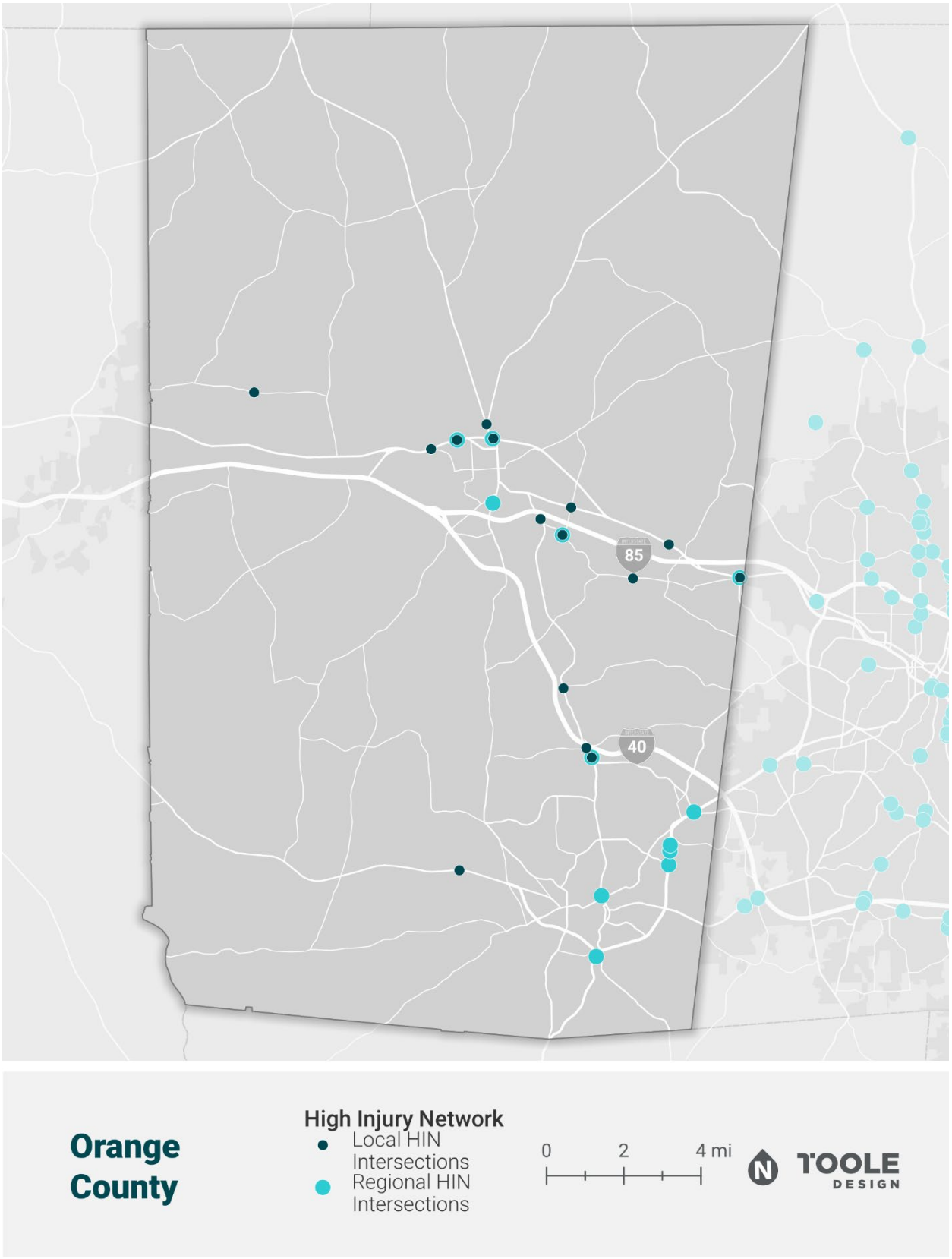
Crash Map



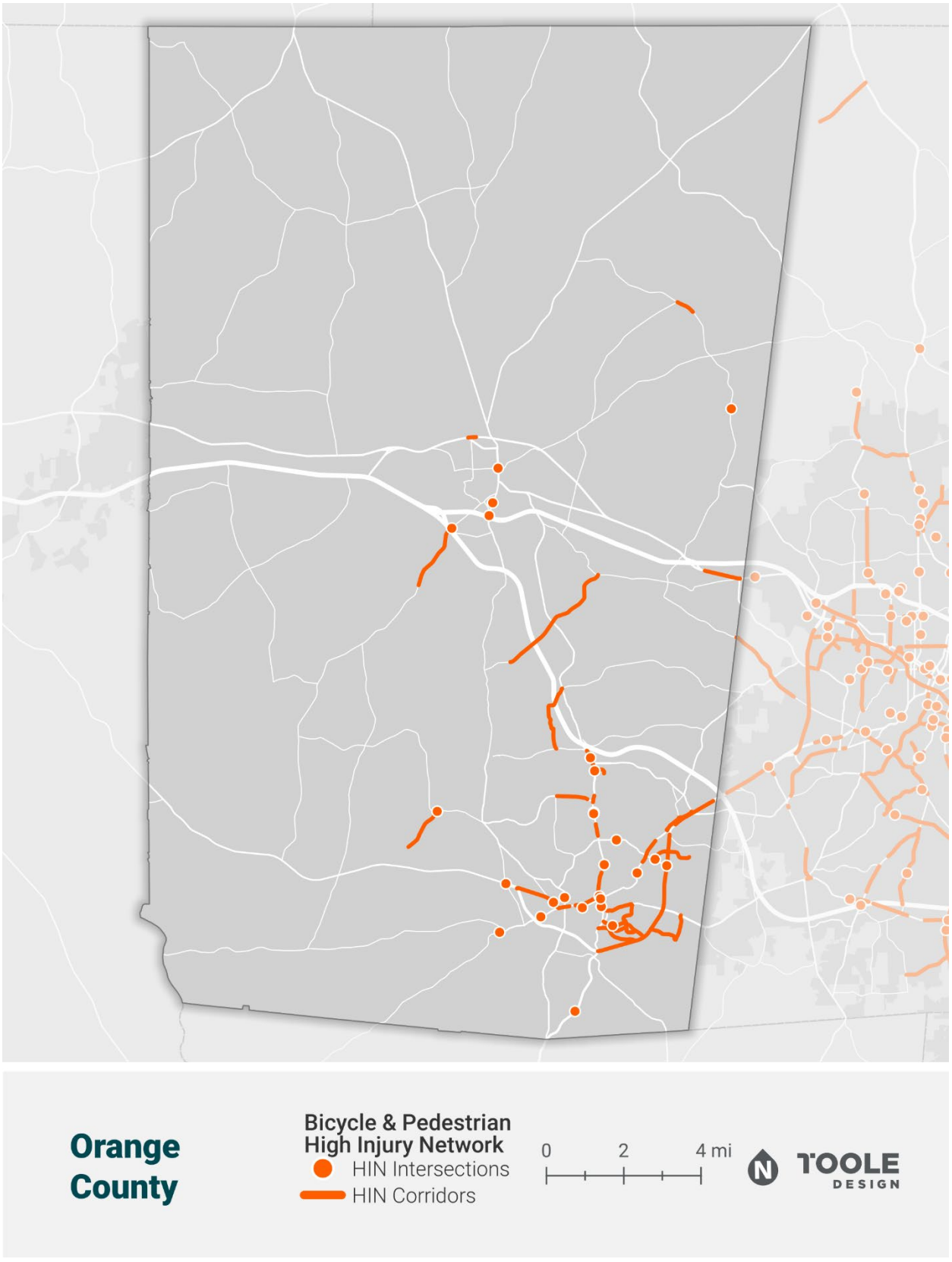
High Injury Network



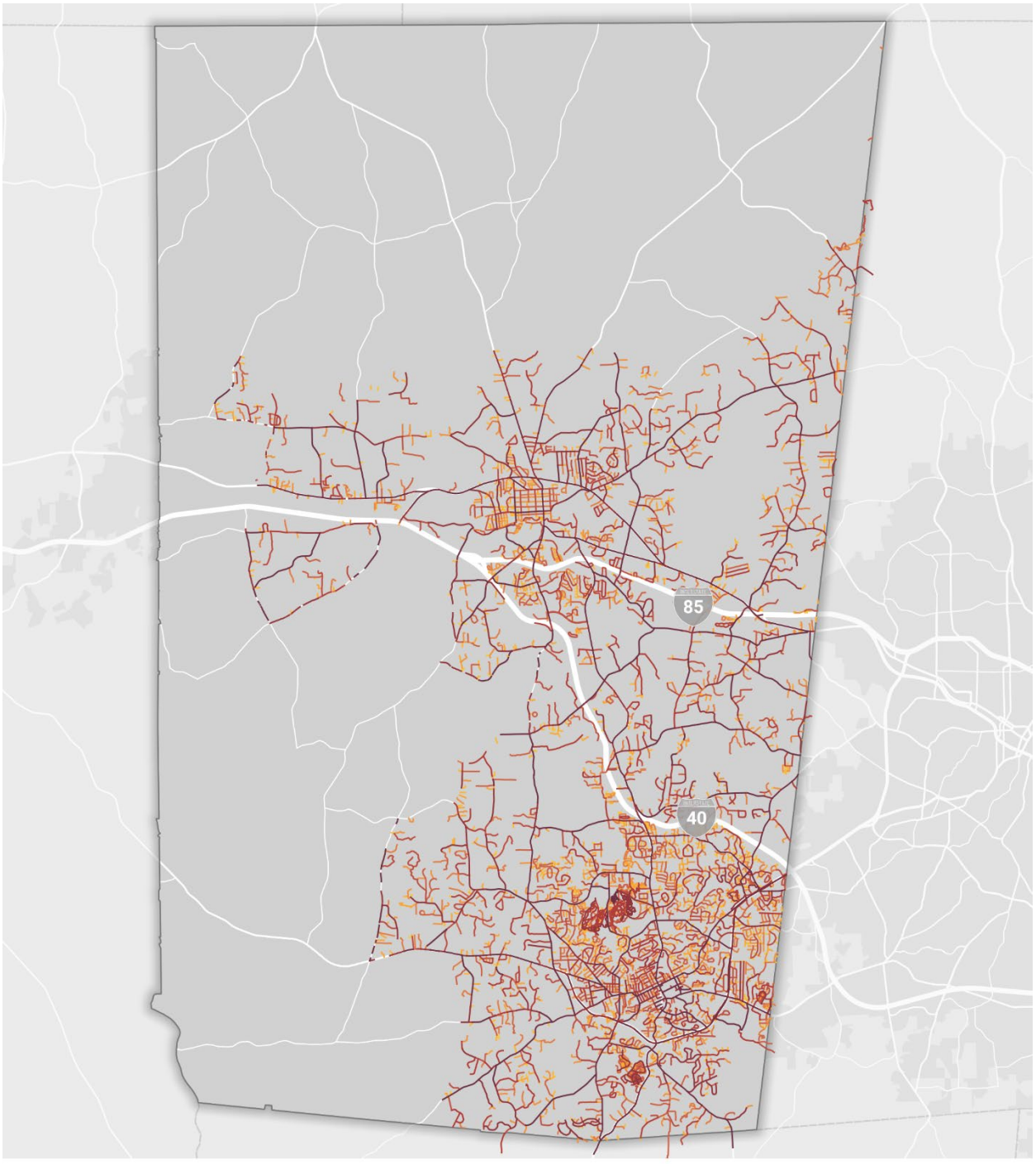
High Injury Intersections



VRU High Injury corridors and intersections



High Risk Corridors



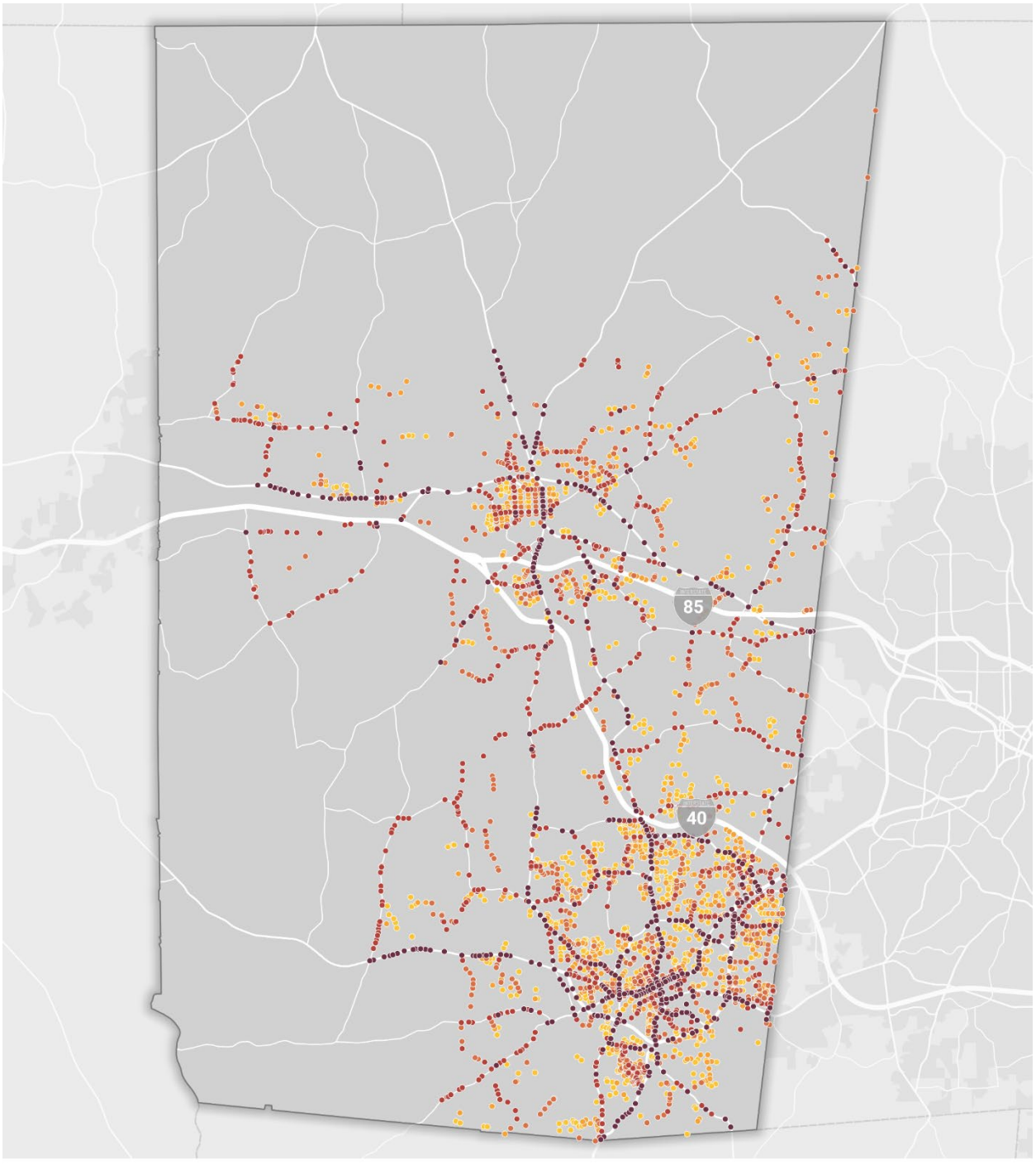
Orange County

High Risk Segments: Likelihood of a fatal or injury crash
- High
- Medium
- Low

0 2 4 mi

TOOLE DESIGN

High Risk Intersections



Orange County

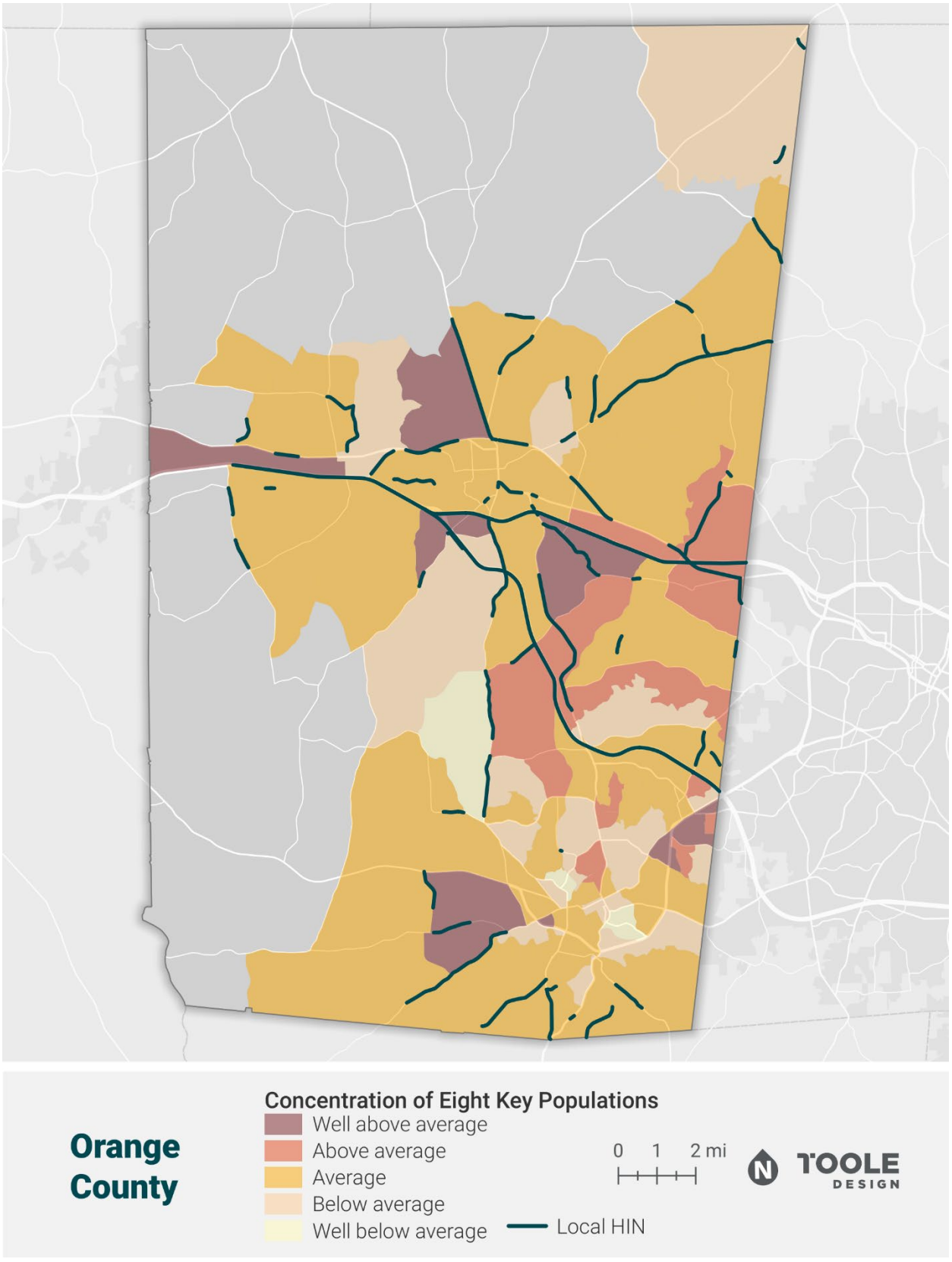
High Risk Intersections: Likelihood of a fatal or injury crash

- High
- Medium
- Low

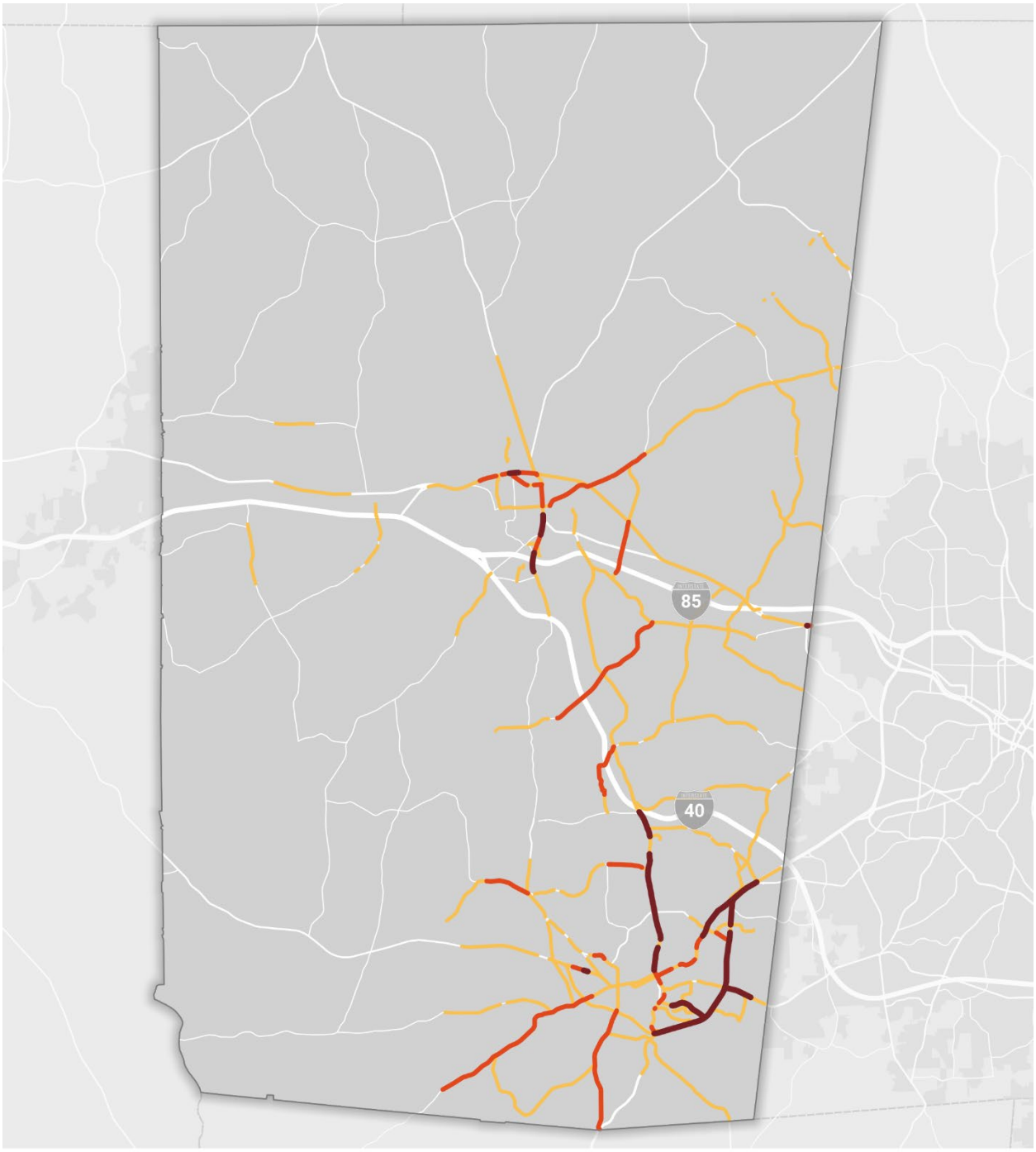
0 2 4 mi

TOOLE DESIGN

Indicators of Potential Disadvantage and HIN



Priority Corridors



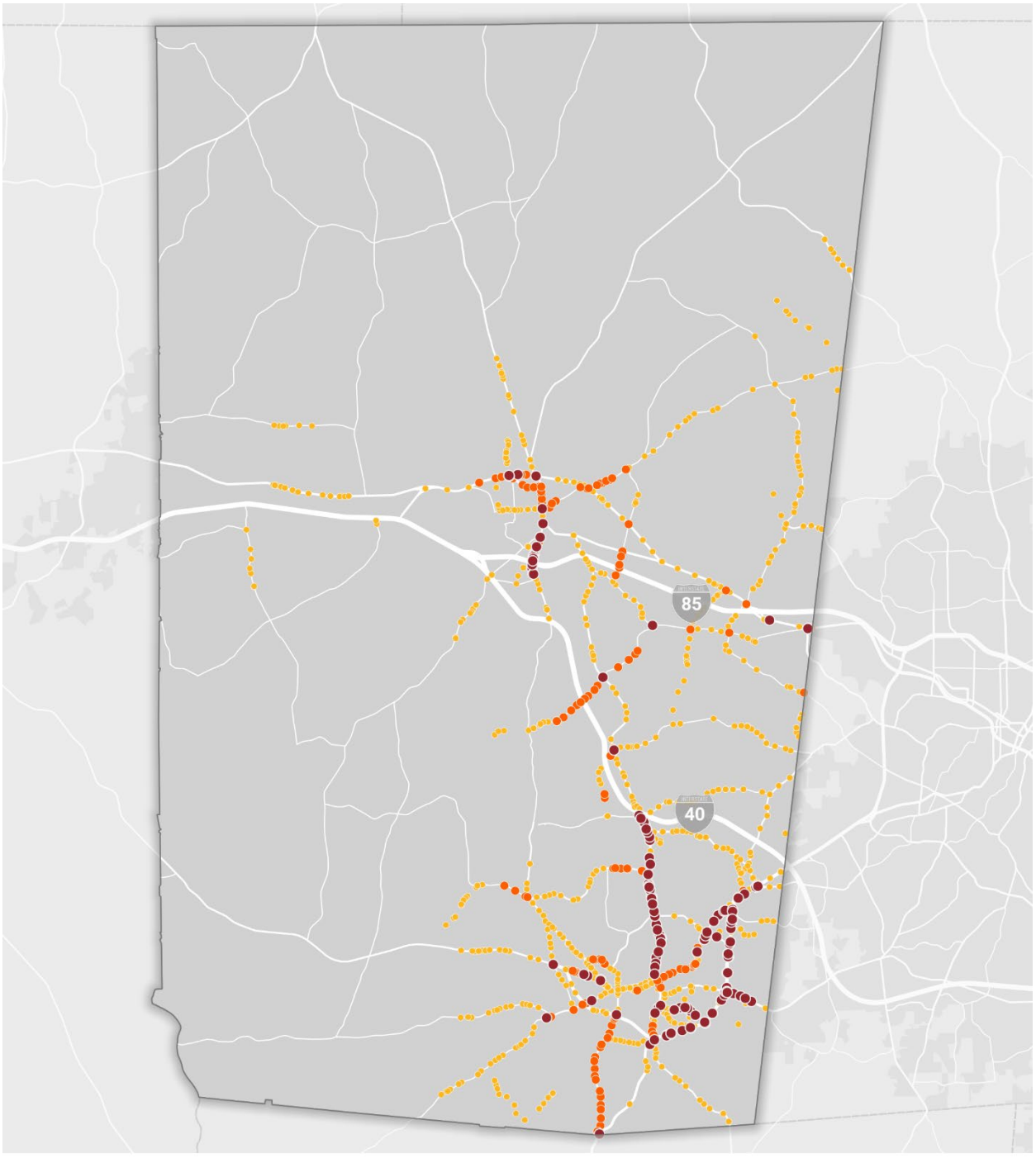
Orange County

Local Priority Corridors:
Prioritization Score
- High
- Medium
- Low

0 2 4 mi

TOOLE DESIGN

Priority Intersections



Orange County

Local Priority Intersections:
Prioritization Score

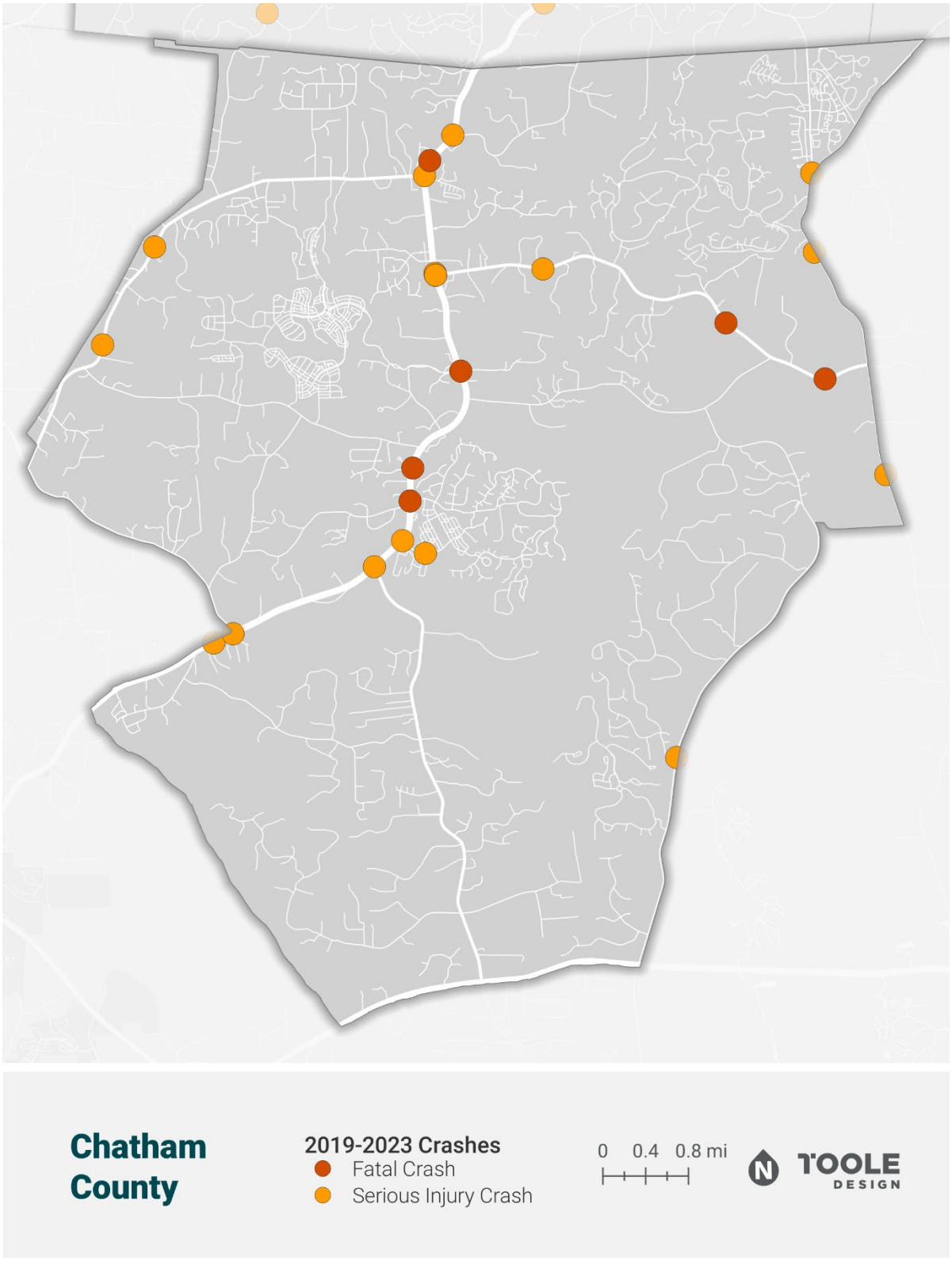
- High
- Medium
- Low

0 2 4 mi

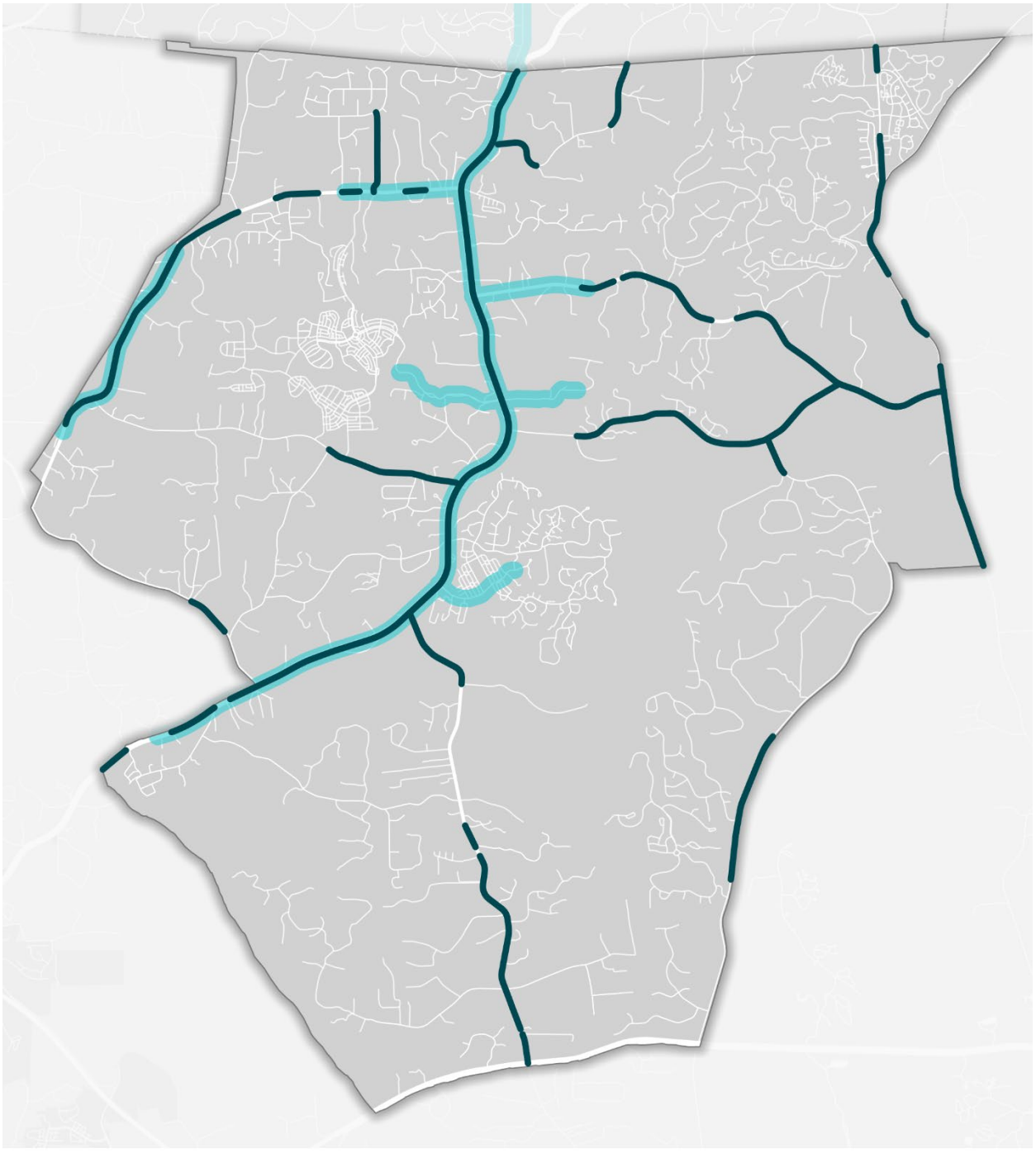
TOOLE DESIGN

CHATHAM COUNTY

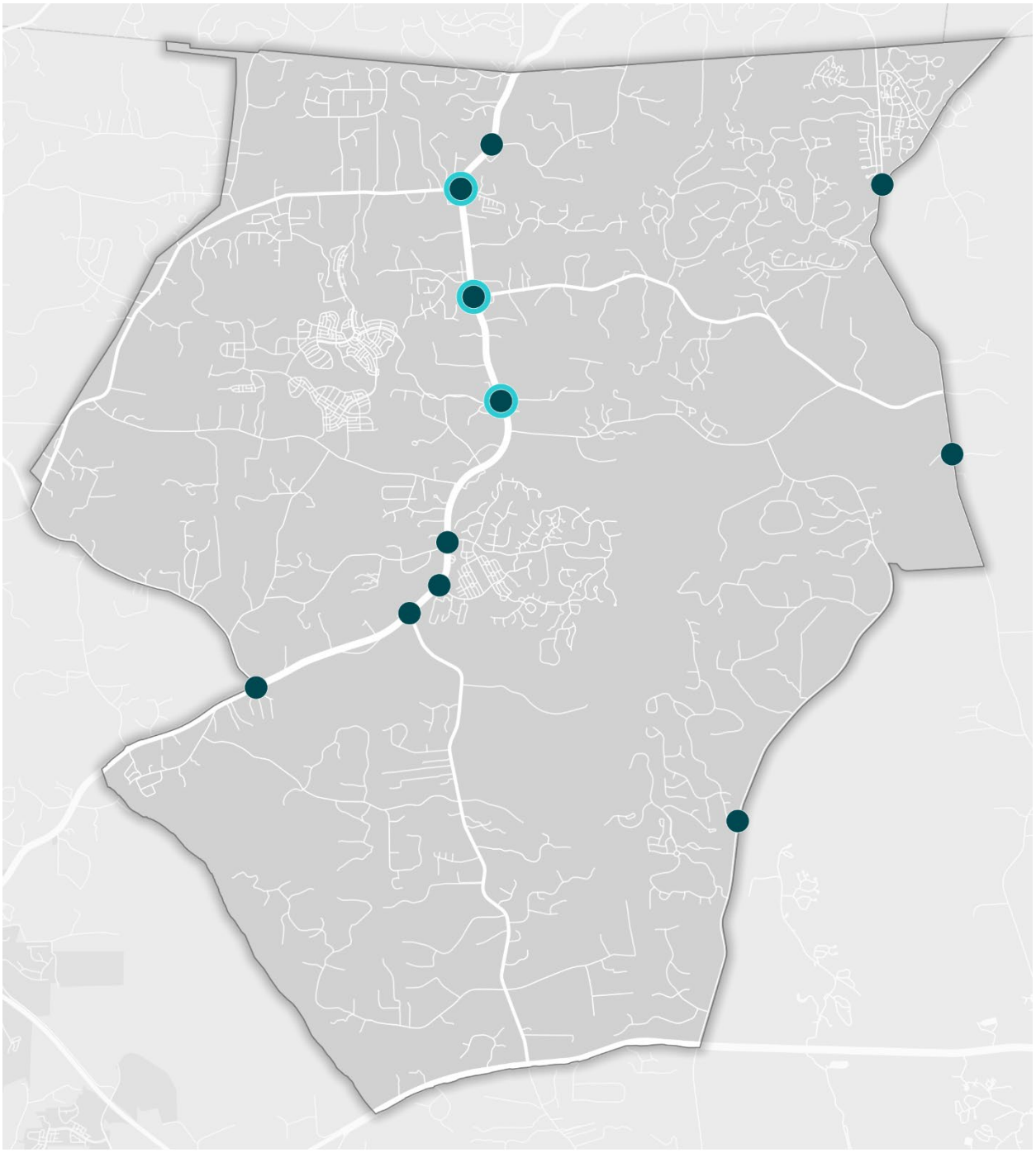
Crash Map



High Injury Network



High Injury Intersections



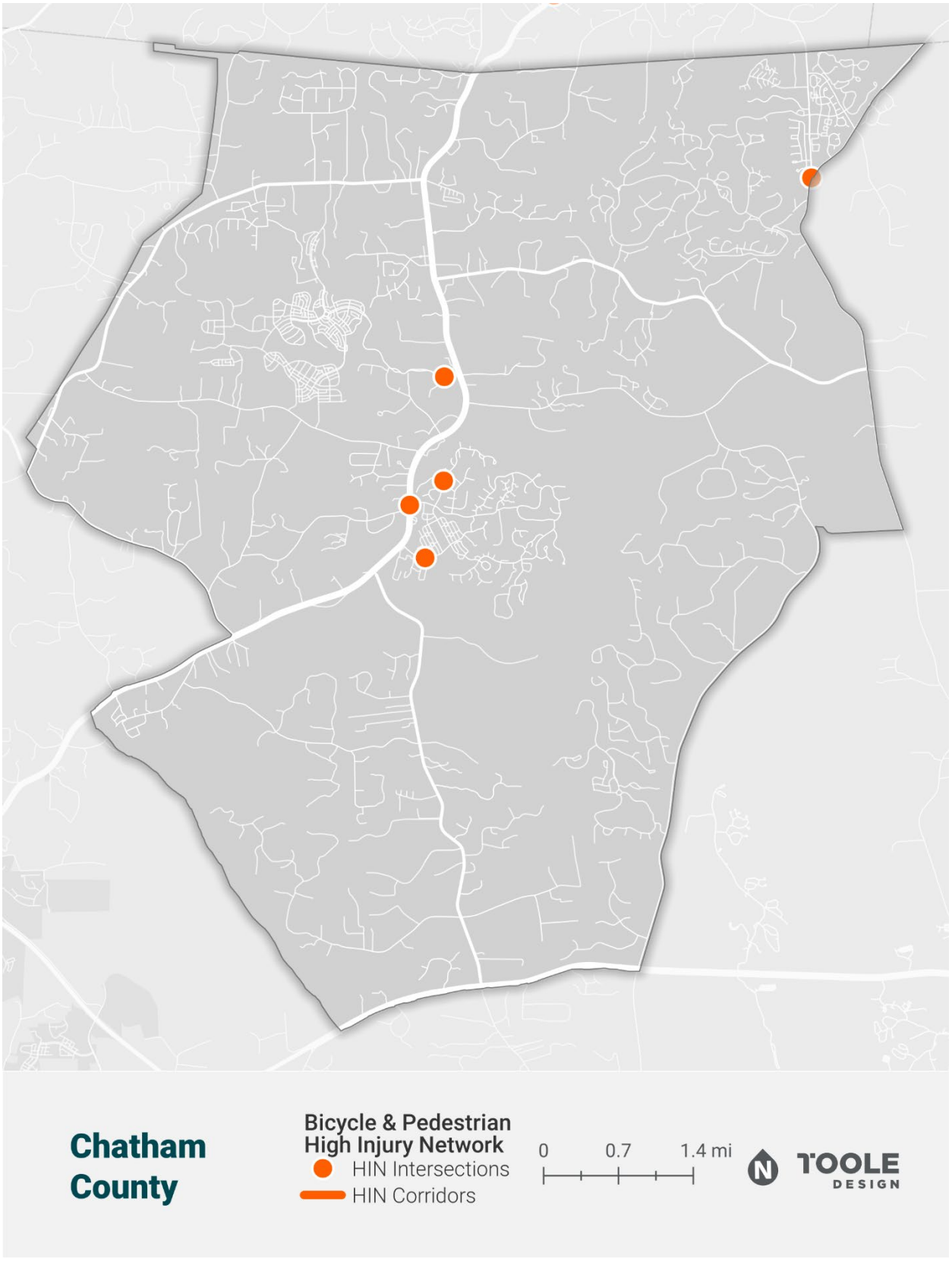
Chatham County

High Injury Network
- Local HIN Intersections
- Regional HIN Intersections

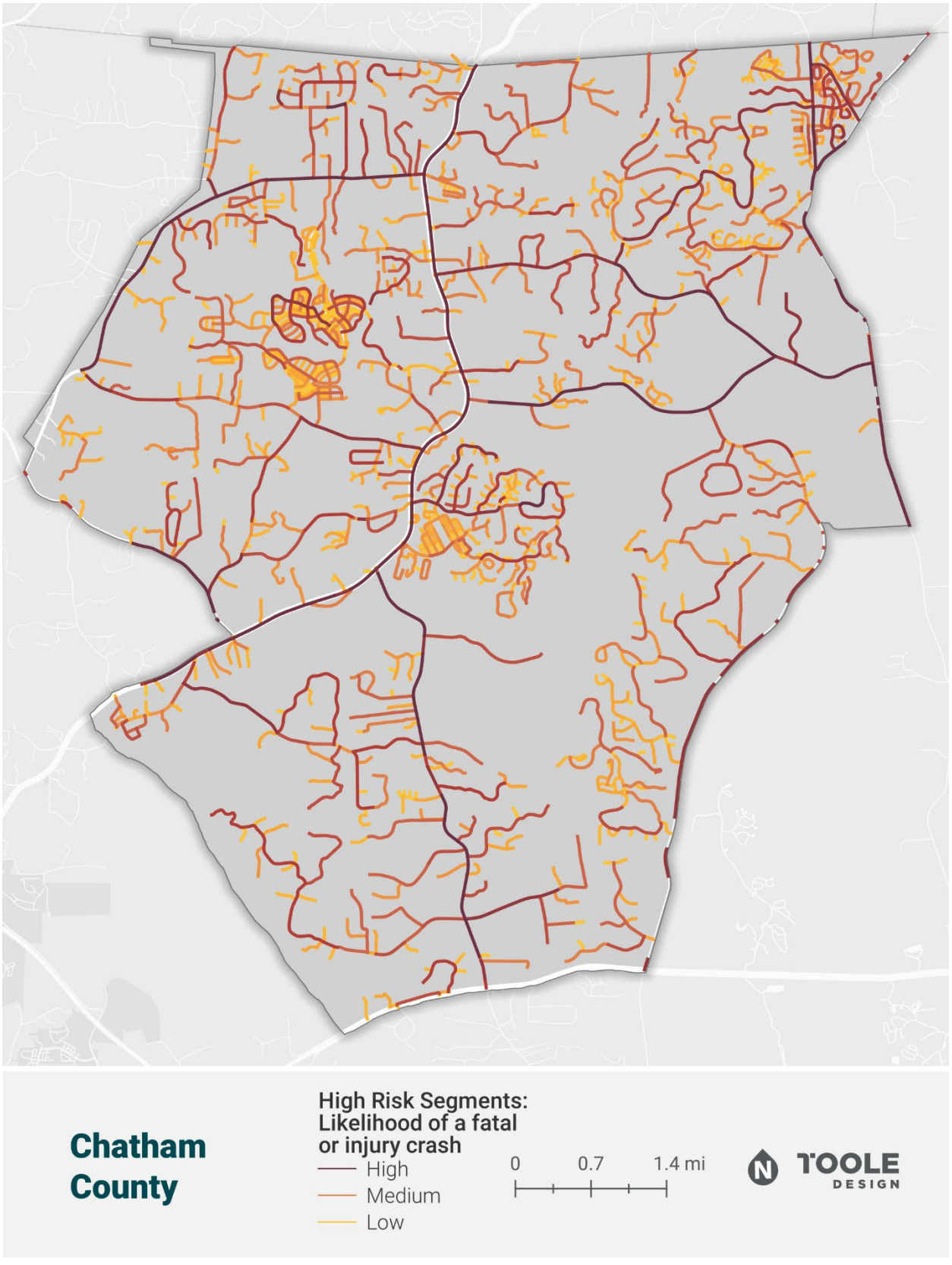
0 0.7 1.4 mi

TOOLE DESIGN

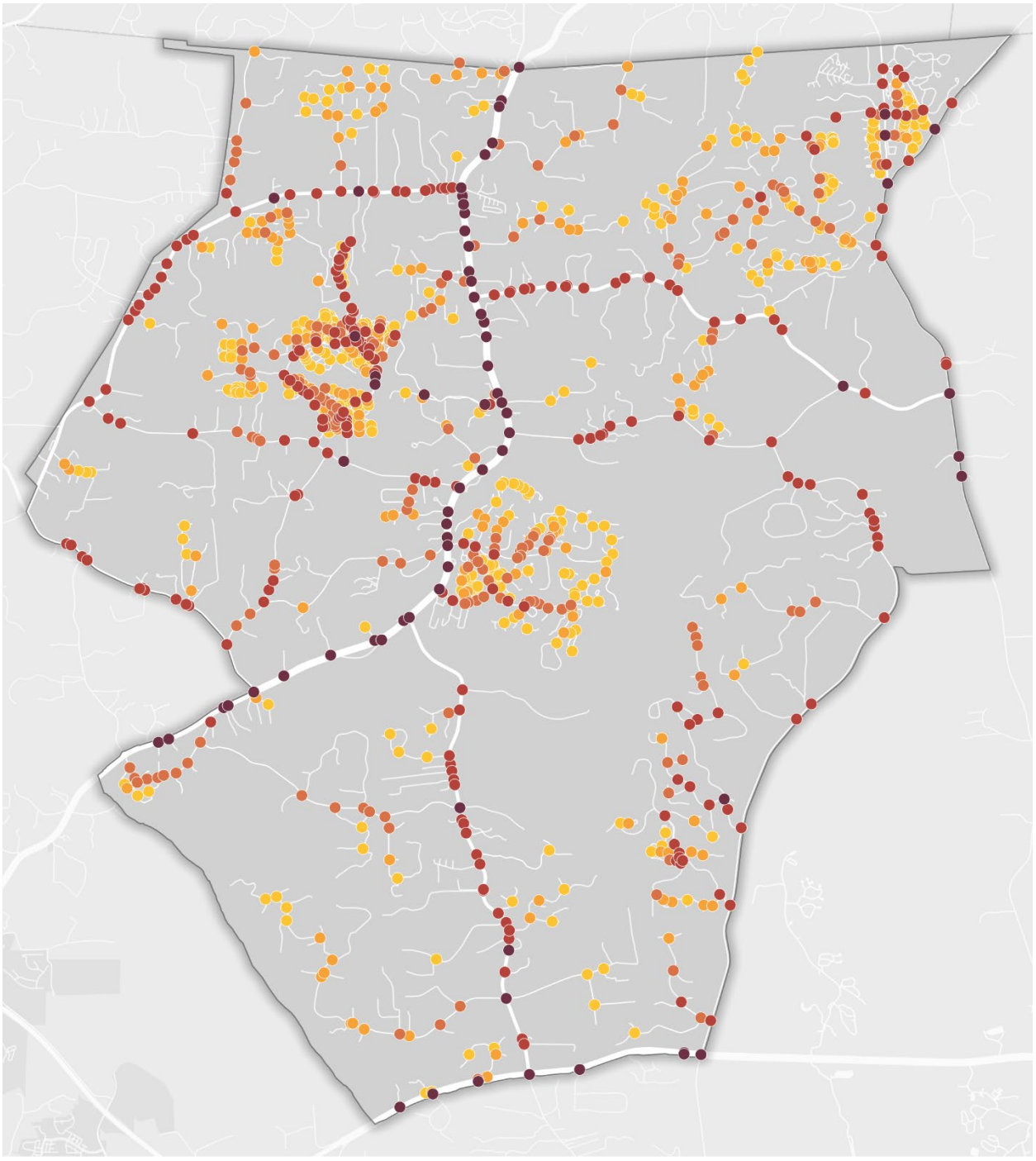
VRU High Injury corridors and intersections



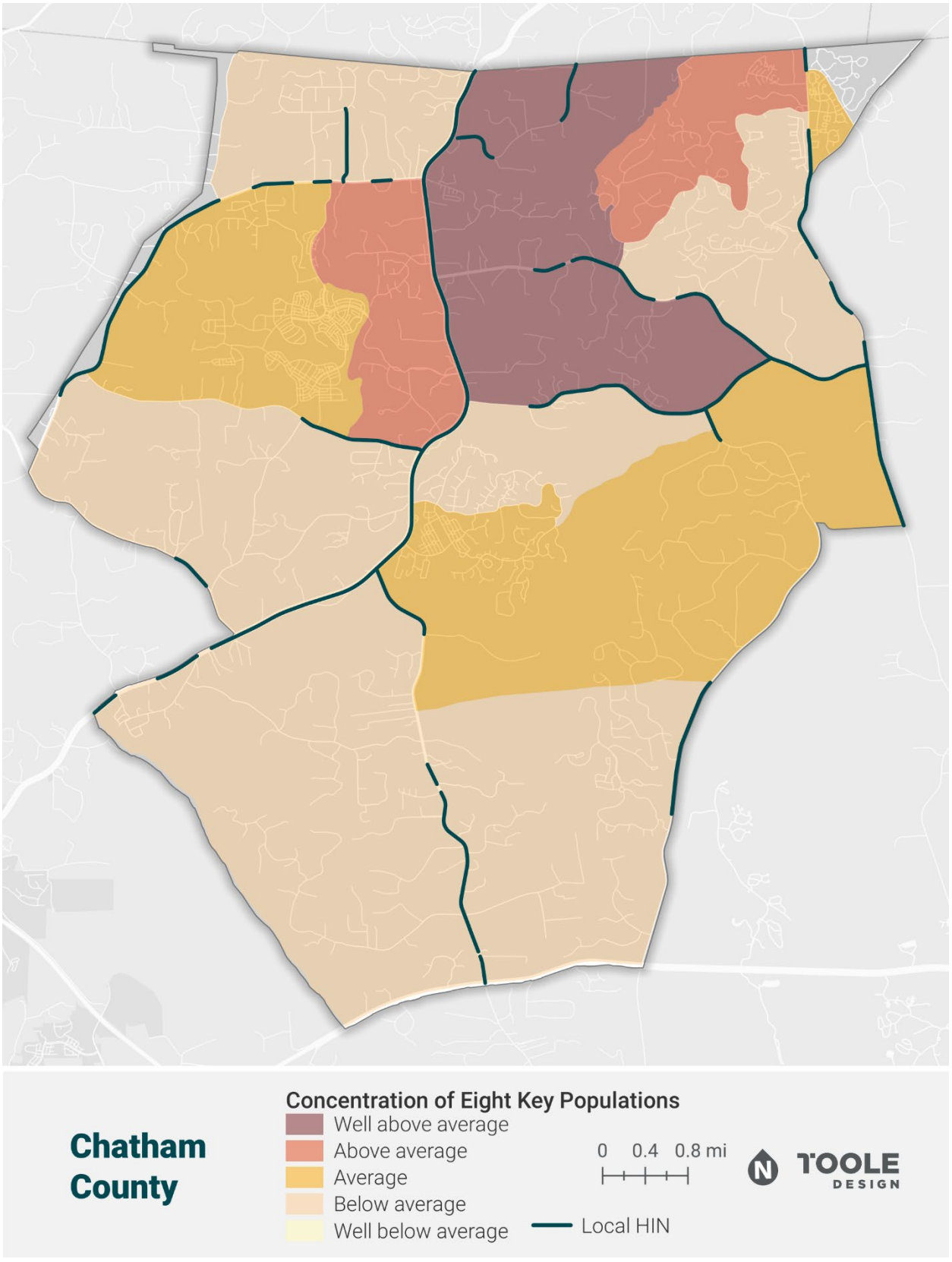
High Risk Corridors



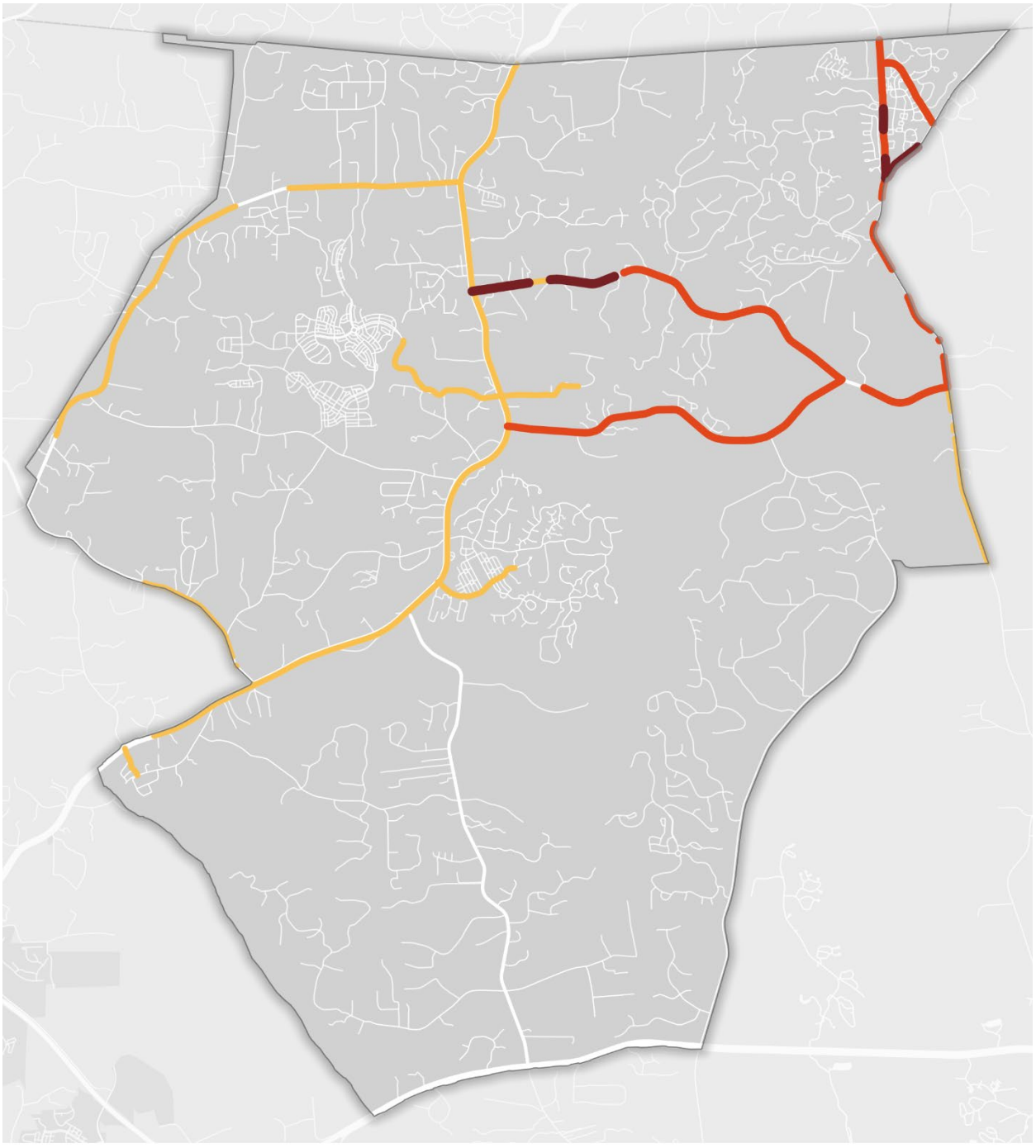
High Risk Intersections



Indicators of Potential Disadvantage and HIN



Priority Corridors



Chatham County

Local Priority Corridors:
Prioritization Score

- High
- Medium
- Low

0 0.7 1.4 mi

TOOLE DESIGN

Priority Intersections