Memorandum

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Date: June 05, 2024

From: Ian Hamilton, VHB
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Re: High Injury Network Methodology

Introduction

The purpose of this memorandum is to provide an overall summary of the methodology for creating high injury network (HIN) locations for the French Broad River Metropolitan Planning Organization (FBRMPO) and Land of Sky Rural Planning Organization (LOSRPO) region. The purpose of this network is to identify locations that have a high frequency of recent severe crashes that could be reviewed in detail for potential countermeasures, projects, and policy interventions.

Data

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

- All crash data from the NCDOT enterprise crash database (2016-2023)

This data included several characteristics such as location, roadway characteristics, and crash severity. There are two primary considerations for the inclusion of this data source:

- Crash data from NCDOT's enterprise database have limited crash location data. **Generally, only crashes on NCDOT-maintained roads can be located and therefore generate a network of high crash locations**.
- 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).

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; this helped reduce the likelihood of erroneous joins between crashes and roadway segments.

Methodology

The scope of work for the Safe Streets for WNC includes analysis of crashes occurring on the entire system of roads in the five-county region, with a purpose of understanding historic trends in the region. The following sections discuss the methodology for developing a high crash layer:

High Injury Network – All crashes, regardless of crash type

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Severity Weighting

The project team used an equivalent property damage only (EPDO) approach to determine a severity weighting for crashes. This approach is consistent with a Safe System Approach by emphasizing fatal and serious injury crashes over other severities.[1] Locations with a higher EPDO score tend to have more severe crashes than those with a lower score.

Figure 1 from NCDOT's 2022 Standardized Crash Cost Estimates for North Carolina[2] provides the typical cost associated with crashes by severity.

Crash Type	Cost Per Crash 2022 Dollars
Fatal Crash	$11,983,000
A Injury Crash	$694,000
B Injury Crash	$230,000
C Injury Crash	$136,000
Property Damage Only Crash	$14,400
Average Crash	$135,000
Injury Crash (F+A+B+C)	$462,000
Non-Fatal Injury Crash (A+B+C)	$199,000
Severe Injury Crash (F+A)	$3,865,000
Moderate Injury Crash (B+C)	$168,000

Figure 1. Cost per Crash by Severity in North Carolina – Total Crashes

The EPDO methodology weights crashes based on the severity of the crash, using the KABCO scale[3], relative to a property damage only (PDO) crash. Figure 2 provides an example of how to calculate the EPDO crash weight for a "B Injury" crash.

$$\frac{B\ Injury\ Crash\ Cost}{PDO\ Crash\ Cost} = EPDO\ Severity\ Weight$$

$$\frac{\$230{,}000}{\$14{,}400} = 16$$

Figure 2. Example EPDO Weighting of a "B Injury" Crash

Table 1 provides the weights used for all crashes in the EPDO analysis for the HIN

Table 1. EPDO Weights for the Safe Streets for WNC High Injury Locations

Crash Severity	Crash Cost ($2022)	EPDO Weight
Fatal (K)	$11,983,000	832

[1] https://www.transportation.gov/NRSS/SafeSystem

[2] https://connect.ncdot.gov/resources/safety/Documents/Crash%20Data%20and%20Information/2022%20Crash%20Costs.pdf

[3] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813525

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Serious Injury Crash (A)	$694,000	48
Suspected Minor Injury (B)	$230,000	16
Possible Injury (C)	$136,000	9
Property Damage Only (PDO)	$14,400	1

Figure 3 provides the method to calculate the total EPDO score for a segment.

$$Total\ EPDO\ Score = Total\ \text{Fatal (K)} * 832 +$$

$$Total\ Suspected\ Serious\ Injury\ (A) * 48$$

$$Total\ Suspected\ Minor\ Injury\ (B) * 16 +$$

$$Total\ Possible\ Injury\ (C)\ \text{Crashes}\ *\ 9\ +$$

$$Total\ Property\ Damage\ Only\ (PDO)\ Crashes * 1$$

Figure 3. Example EPDO Calculation

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High Injury Network – All Crashes

The following steps provide a summary for the development of the HIN for all crashes in the five-county planning area. Steps 1 through 5 generate individual segments for the HIN. **Based on conversations with FBRMPO and LOSRPO, the project team will determine thresholds for merging and retaining high injury segments in the final HIN.**

- **Step 1:** Clip road centerlines and remaining, non-intersection crashes to the five-county 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, join method as Closest, Keep ALL target features, and a search within a radius of 50 ft.
- **Step 4:** Run the Merge and Summarize Script with appropriate inputs and outputs to get final route segments with a summed EPDO for each segment.
- **Step 5:** Calculate the percentile rank of scored segments. This produces an ordered list, between 0 and 100, where the highest segment based on EPDO is closest to 100 and the lowest is 0. For instance, to determine the top 5 percent of locations, select all rows with a value of 95 and above. This process can also be performed in Excel by exporting the resulting EPDO summed segments to .xlsx format and using the PERCENTILE() formula.