Introduction

This memorandum provides a comprehensive analysis aimed at identifying segment risk factors associated with the following crash types: Lane Departure, Speed, Bike, Pedestrian, and Motorcycle within the five-county region of Buncombe, Haywood, Henderson, Madison, and Transylvania. It also aims to identify intersection risk factors for all crashes and Bike/Ped crashes. The objective is to enhance road safety through the identification and analysis of specific roadway characteristics where fatal (K), serious injury (A), and injury (B) crashes are most likely to occur. Combined with the reactive safety approach, utilizing High Injury Network and High Injury Intersections, this proactive approach serves to inform effective transportation policies and infrastructure improvements, guiding the allocation of resources to mitigate these types of crashes.

Data

The project team obtained crash data from the North Carolina Department of Transportation (NCDOT) for the years 2016 to 2023. This included several characteristics such as location, roadway facility type, crash type, and crash severity. Route data was also pulled from NCDOT. This data contained information on functional classification, route classification, Annual Average Daily Traffic (AADT), Number of lanes, Route Identification, Presence of a Transit Stop, Proximity to Schools or Universities, and block group level information such as context classification, Social Vulnerability Index (SVI) Overall Score, Population and Employment Density and Percentage of Zero Vehicle Households.

Methodology

The scope of work involves analyzing the roadway types where serious injury and fatal crashes are most prevalent across the five-county region. The methodological framework is built on three key components:

1. Identifying focus crash types.
2. Identifying focus facility types for these crash types.
3. Identifying risk factors associated with crashes on these facilities.

This memo emphasizes the third component, applying logistic regression models to determine risk factors for each crash type. VHB has strategically decided to separate the risk analysis for crash severity into routes and intersections. This approach acknowledges the distinct characteristics and contributing factors of both routes and intersections, thereby enhancing the precision and effectiveness of the analysis.

Layers Produced for Risk Analysis:

Table 1: Layers Produced for Risk Analysis

Layer Name	Description	Score Range	Median Value
FBR Routes Severity	This layer indicates roadways 85th percentile speeds for a 24-hour period for weekdays. The focus of this layer is to identify routes that have high speeds.	0 to 55+	32
FBR Routes Exposure	The exposure layer indicates where traffic volumes are the highest. This can help answer questions such as are you expecting more road users or a greater mix of road users.	<500 to 40000+	2200
FBR Likelihood Ped	This layer indicates the likelihood that a pedestrian K, A, or B crash will happen on that roadway.	0 – 0.82	0
FBR Likelihood Bike	This layer indicates the likelihood that a bicycle K, A, or B crash will happen on that roadway.	0 – 0.39	0
FBR Likelihood Speed	This layer indicates the likelihood that a speed related K, A, or B crash will happen on that roadway.	0 - 0.66	0.01
FBR Likelihood Motorcycle	This layer indicates the likelihood that a motorcycle K, A, or B crash will happen on that roadway.	0 - 0.70	0.01
FBR Likelihood LD	This layer indicates the likelihood that lane departure K, A, or B crash will happen on that roadway.	0 – 0.92	0.04
FBR Intersections Likelihood BikePed	This layer indicates which intersections have a greater likelihood of having a bike or pedestrian K, A, or B crash.	0 – 0.86	0.01
FBR Intersections Likelihood All Crashes	This layer indicates which intersections have a greater likelihood of having a K, A, or B crash.	0 – 0.93	0.04

Context Classification

Utilizing NCHRP Research Report 1022: *Context Classification Application: A Guide* assisted VHB in determining appropriate context classifications for an area. Context classifications were determined at the block group level. The five classifications include: Rural Town, Rural, Suburban, Urban, and Urban Core. The classifications for French Broad River were identified using the block group fields: urban flags, municipal flags, intersection density, and building area density. If the urban flag was 0, and the municipality flag is 1, it was classified as a Rural Town. If it was not urban and the municipality flag is 0, it was classified as Rural. For Suburban, Urban, and Urban Core, if the urban flag is 1 and the building area density is greater than 4500000, square feet it was Urban Core, if the intersection density was greater than 110 than it was Urban, the remaining segments were classified as Suburban (Figure 1)

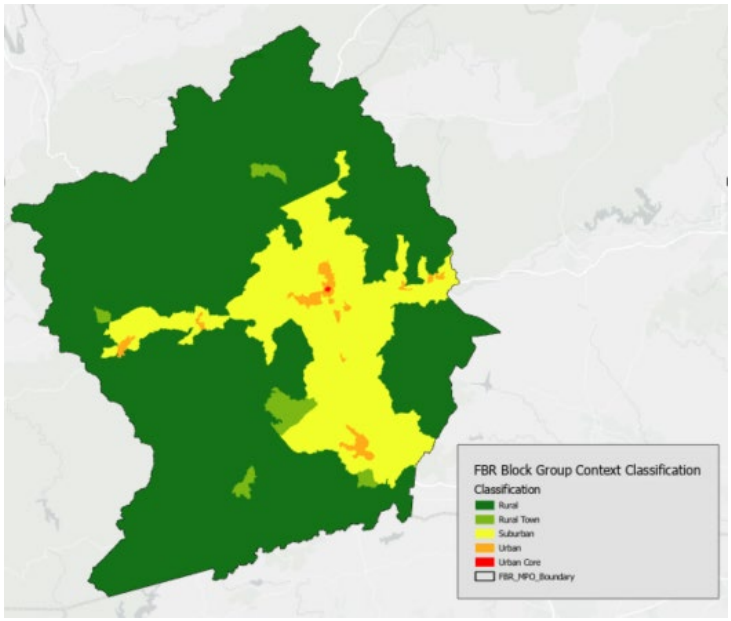

Figure 1: French Broad River MPO Context Classifications

Identifying Risk Factors Segments Likelihood

Using the focus crash types identified in the previous analysis as well as the focus facility types, risk factors were identified for these segment crashes over the five-county region (Buncombe, Haywood, Henderson, Madison, and Transylvania) using logistic regression. These risk factors include:

*Table 2: Risk factors for segments based on focus crash types *indicates not statistically significant at p<0.3, **only includes statistically significant categories.*

Factor	Lane Departure	Speed	Bike	Ped	Motorcycle
AADT	Higher	Higher	Higher	Higher	Higher
Number of Lanes	Fewer	Fewer	More*	More	More*
Presence of Transit Stop (within 100 ft of a transit stop)	--	--	Present	Present	--
School or University Proximity (within 0.25 miles of a school or university)	Not Present	Not Present	Present	Present	Present*
Zero Vehicle Households	--	--	More	More	
Context Classification**	Rural, suburban or urban	Rural or suburban	Urban	--	--
SVI Overall Score	Higher	Higher	Higher	Higher	Higher
Population + Employment Density	Higher	Higher	Higher	Higher	Higher
Route Class	US Route NC Route Secondary Route	US Route NC Route Secondary Route	US Route NC Route Secondary Route	US Route NC Route Secondary Route	US Route NC Route Secondary Route
County**	Buncombe, Henderson, Haywood, Transylvania	Buncombe, Henderson, Haywood	Buncombe, Transylvania	Buncombe, Henderson, Haywood, Transylvania	Buncombe, Haywood

Once these factors were identified, the data team created probabilities for each roadway segment in the five-county area based on these factors. For example, if a roadway had higher AADT, fewer lanes, was rural, had a high SVI and high employment and population density, was a US Route, and in Buncombe County, this segment would have a high

probability of a K, A, or B Lane departure crash happening on that segment (Table 2. The probabilities for each crash type on each segment and intersection were calculated using p = 1 / (1 + EXP(-logit)) (logit = coefficients*variables + constant)

Identifying Risk Factors Intersections Likelihood

Using the focus crash types identified in the previous analysis as well as the focus facility types, risk factors were identified for these intersection crashes over the five-county region using logistic regression. These risk factors include:

*Table 3: Risk factors for intersections based on focus crash types*indicates not statistically significant at p<0.3, **only includes statistically significant categories.*

Factor	Intersection – All Crashes	Intersection – Ped/Bike Crashes
Intersection AADT	Higher	Higher
Number of Legs	4+	4+
Signalized	Yes	Yes
Intersection Angle <70 Degrees	Yes	
School or University Proximity	--	Present
Transit Stop Proximity	Present	Present
Zero Vehicle Households		--
Context Classification	Rural, Suburban or Urban Core	Urban*
Population + Employment Density	Lower	Higher
SVI Overall Score	Higher	--
County**	--	Buncombe, Transylvania

Once these factors were identified, the data team created probabilities for each intersection in the five-county area based on these factors. For example, if an intersection had higher AADT, four or more legs, was signalized, had an intersection angle <70 degrees, close to a transit stop, in a suburban area, in an area with low population and employment density, and a high SVI score has a high probability of a K, A, or B crash happening on that intersection (Table 2).

Exposure

In addition to addressing likelihood, VHB developed an exposure map to offer a comprehensive understanding of road usage patterns and potential risks (Figure 1). The exposure map is instrumental in answering the crucial question of whether there is an expectation of an increase in the number of road users or a greater diversity in types of road users. By analyzing the AADT, the exposure map helps identify high risk areas that may require additional safety measures due to increase of traffic volume. This map, in conjunction with the likelihood maps, ensure that planning and resources can be strategically allocated to enhance road safety before critical issues arise.

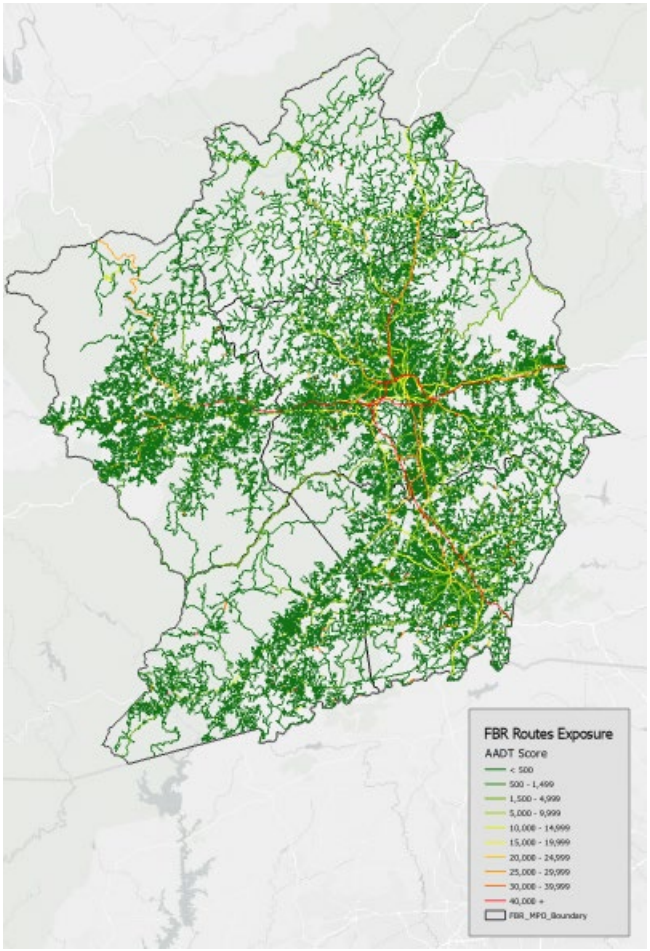

Figure 2: French Broad River Exposure

Severity

To round out the risk assessment, a severity layer based on the 85th percentile of speed during workdays for a 24-hour period was created (Figure 2). This layer is aimed at answering the question where is speed the highest? This information is essential for planners and safety officials because it highlights zones where targeted interventions like engineering improvements, speed limit adjustments, or traffic calming designs could reduce the potential for fatal and serious injury crashes. Thus, contributing to a more resilient and adaptive road system.

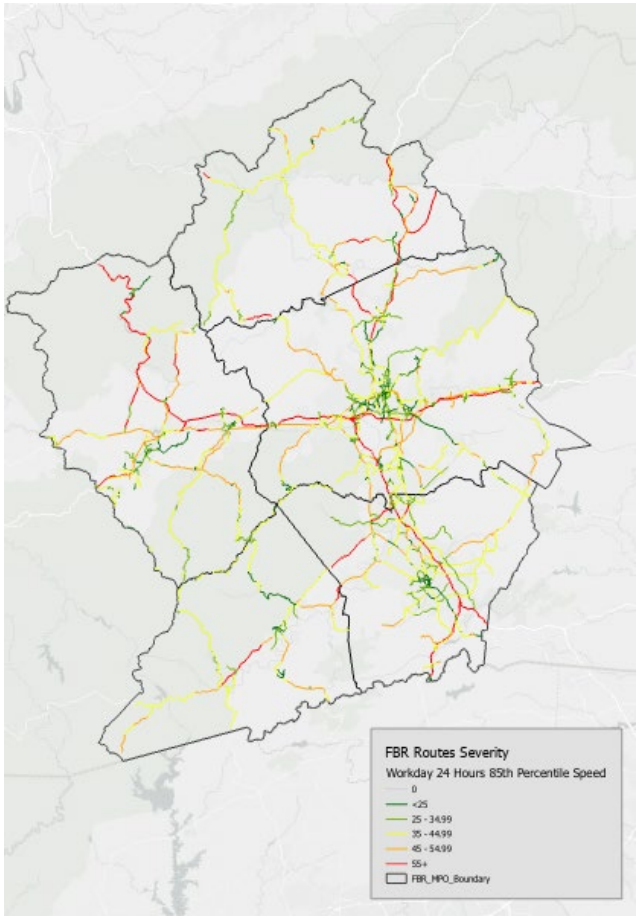

Figure 3: French Broad River Severity Conclusion

This memo provides a detailed analysis of roadway and intersection risk factors that contribute to fatal, serious injury, and injury crashes across Buncombe, Haywood, Henderson, Madison, and Transylvania. Using findings from previous analyses and logistic regression models, segment risk factors were found for Lane Departure, Speed, Bike, Pedestrian, and Motorcycle crashes. For intersections, risk factors for All and Bike/Ped crashes were identified. The analysis reveals correlations between specific roadway characteristics and the likelihood of sever crashes to occur on those segments. For road segments, factors like high AADT and increased SVI significantly increase the risk of a severe crash. While the intersection analysis uncovered a correlation between increased number of intersection legs as well as signalization with increased crash risk.

In conjunction with the exposure and severity maps, this memo provides a comprehensive framework that not only highlights high-risk areas but also prioritizes them for targeted safety intervention. The combined approach allows for

strategic allocation of resources ensuring proactive measures are in place to mitigate crash risks and improve overall road safety in the region.

Data Sources

85th Percentile Speed Data: NCDOT
North Carolina Intersections: NCDOT
North Carolina Routes with Systemic Analysis Characteristics: NC One Map, NCDOT, USGS, VHB

- Contains data from: NC Transit Stops, PBIN-Existing sidewalks, Trail crossings, Urban Areas, City Boundaries, Parcels, and Educational Structures

North Carolina Block Groups: Census