2021

Operational Risk Assessment Handbook

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"An Operational Risk Analysis will identify the comprehensive impacts to the road network with relation to other construction projects, limitations or constraints to the network, and outline the risks to the regional and statewide systems. This Operational Risk Analysis will stay with the project throughout its lifecycle and assist in the development of programming and letting strategies."

-Draft Traffic Operations Policy for Significant Projects, Rev. 30 July 2019

Introduction

Operational Risk Assessments (ORA) should be completed along with Planning Documents early in the project process. This will allow for proper planning, analysis, coordination, and design of suggested mitigations within the report. It is expected that the Operational Risk Assessment will be used to inform cost estimates for the preliminary engineering and construction phases, project schedules, and the design of the project.

This document is intended to provide guidance as well as a template for performing an Operational Risk Assessment. Transportation Improvement Program (TIP) project I-5987 is used as the example project for this proof of concept.

Purpose

This handbook provides guidance and general requirements for the uniform development of ORAs. The techniques and procedures for assessing risks to traffic mobility and safety during major construction projects are documented in this handbook. Additionally, the handbook guides practitioners, reviewers, and decision-makers through development of documentation and deliverables necessary to complete, interpret, and amend an ORA.

The guidance provided in this handbook relies on documents and information previously published elsewhere such as technical reports, research reports, manuals, and geographic information systems (GIS) platforms.

Intended Use

The primary intended users of this handbook are transportation practitioners preparing ORAs which are to be accepted or approved by the NCDOT and reviewers of such efforts. ORAs are an integral part of the project planning process.

The handbook guides the reviewer to the items that need to be checked and verified before accepting the work performed by the analyst. This handbook does not address the details of every aspect of traffic mobility and safety but rather provides guidance the analyst should use when conducting ORAs in North Carolina.

This handbook does not constitute a training manual. Rather, it assumes the user has sufficient knowledge, experience and expertise in traffic mobility and safety concepts and is familiar with relevant tools and resources available in the industry. Additionally, when the standards, methods or procedures are documented elsewhere, the handbook refers to those publications.

When to Conduct an ORA

Operations Risk Assessments should be requested as part of the Integrated Project Delivery (IPD) process for the following STIP projects:

- Interstate (I-####) projects >$14M
- Rural (R-####, A-####, and X-####) projects >$100M
- Urban (U-####) projects >$100M
- Highway Safety (W-####, SI-####, and SF-####) projects >$70M

The estimate project costs are based on estimated construction costs before being assigned sub-TIP numbers.

The decision to develop an ORA should be made shortly after the Start of Study Letter is received. Just because an ORA is requested and meets the thresholds above, does not mean that one is necessary. Projects that do not present impacts or risks to the road network, do not require an ORA. For example, construction of a new ring freeway with relatively small impacts to existing traffic may not need an ORA.

Handbook Organization

The chapters of the handbook give guidance on conducting ORAs as follows:

- **Introduction** – contain an overview of the handbook including purpose, goals and intended use.
- **Project Background** – provides guidelines to prepare project background information and limits for the assessment.
- **User-Specific Considerations** – provides guidance on establishing the existing conditions for all road users who may be impacted by the construction project.
- **Safety** – provides guidance and resources for assessing potential safety issues.
- **Mobility and Traffic Operations** – provides guidance and resources for assessing potential mobility and traffic operations issues.

Key Elements

There are several key elements that an ORA should discuss and address. This handbook will provide guidance, resources, and considerations for each element, immediately followed by a specific project example.

The key elements that ORAs should include are:

- Project Background
- Preliminary Incident Management (IM) Routes
- User-Specific Considerations
- Safety
- Mobility and Traffic Operations
- Vulnerable Locations
- Safety Project Opportunities
- SPOT Mobility Project Opportunities
- Project-Wide Solutions

User Guide

The sections below are presented with guidance accompanied by examples. The guidance is indicated by *grey italic text*, and the example is shown in normal black font. The information provided in this guide is written as if the ORA was developed in the feasibility study stage of the project.

If a practitioner discovers a potential risk to the road network or its users that is not necessarily discussed in this handbook, they should provide a high-level assessment of the risk and provide practicable solutions that limit the negative impacts to safety and mobility during construction.

Project Background

Each ORA should include background information about the project being assessed. Because the ORA reaches a broad audience, the background information should include available information regarding:

- *Project limits*
- *Final design*
- *Funding sources*
- *Construction years*
- *Letting type and date*

The ORA is first developed early in the project process, so there may not be a great amount of detail available.

TIP Project I-5987 widens I-95 between Lumberton (Exit 22) and Fayetteville (Exit 40) to 8-lanes. The future typical section is shown below in Figure 1. The latest STIP (dated September 2020) shows construction years of FY 2021, 2022, and 2023. Project funding includes “Build NC” support.

The project was recently changed from Design-Build to Design-Bid-Build with a scheduled let date of late July 19, 2022.

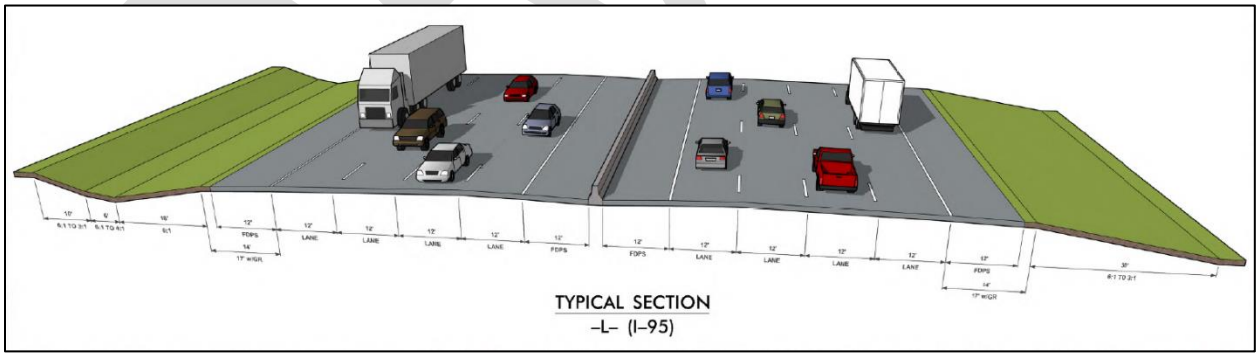

Figure 1 TIP I-5987 - I-95 8-Lane Typical Section

Preliminary Incident Management (IM) Routes

Work zones can create additional conflict points and motorist distractions. It follows that crashes typically increase in work zones. IM routes are intended to be used as detour or alternate routes during unplanned traffic incidents. By identifying and vetting the routes at the beginning of the project, issues are avoided during an actual incident.

Preliminary IM routes are typically developed by NCDOT personnel at both the Division and Statewide level. At the time of the ORA, the preliminary IM routes typically have not been field verified.

These routes may have been used in the past by the Division, the Regional Transportation Management Center (TMC), and/or the Statewide Transportation Operations Center (STOC). When new IM routes are developed for a project, it is typically a collaborative effort between the relevant parties. Routes should be field verified and adjusted as necessary prior to the start of construction. Additionally, the Construction Contractor is generally expected to adjust routes when construction activities interrupt the IM routes.

The ORA should provide a basic description of the IM routes and accompanying maps. The maps should show locations of existing intelligent transportation system (ITS) devices, desired permanent ITS devices and desired portable ITS devices. In addition to supporting IM planning, this will help inform the estimate and scope writing.

Preliminary incident management routes are described below. The descriptions generally follow the northbound direction.

- MM 20-22 IM Route (Figure 2) - Lumberton
    - NC 211
    - Fayetteville Road
- MM 22-25 IM Route (Figure 2)
    - US 301
- MM 25-33 IM Route (Figure 3) – St. Paul
    - US 301
    - NC 20 (Broad Street)
- MM 33-41 IM Route (Figure 4)
    - US 301
    - NC 59 (Chicken Foot Road)
- Long-Distance IM Route (Figure 5) – Laurinburg, Raeford, Fayetteville
    - US-74 / I-74
    - US-15/US-401
    - Cliffdale Road
    - I-295

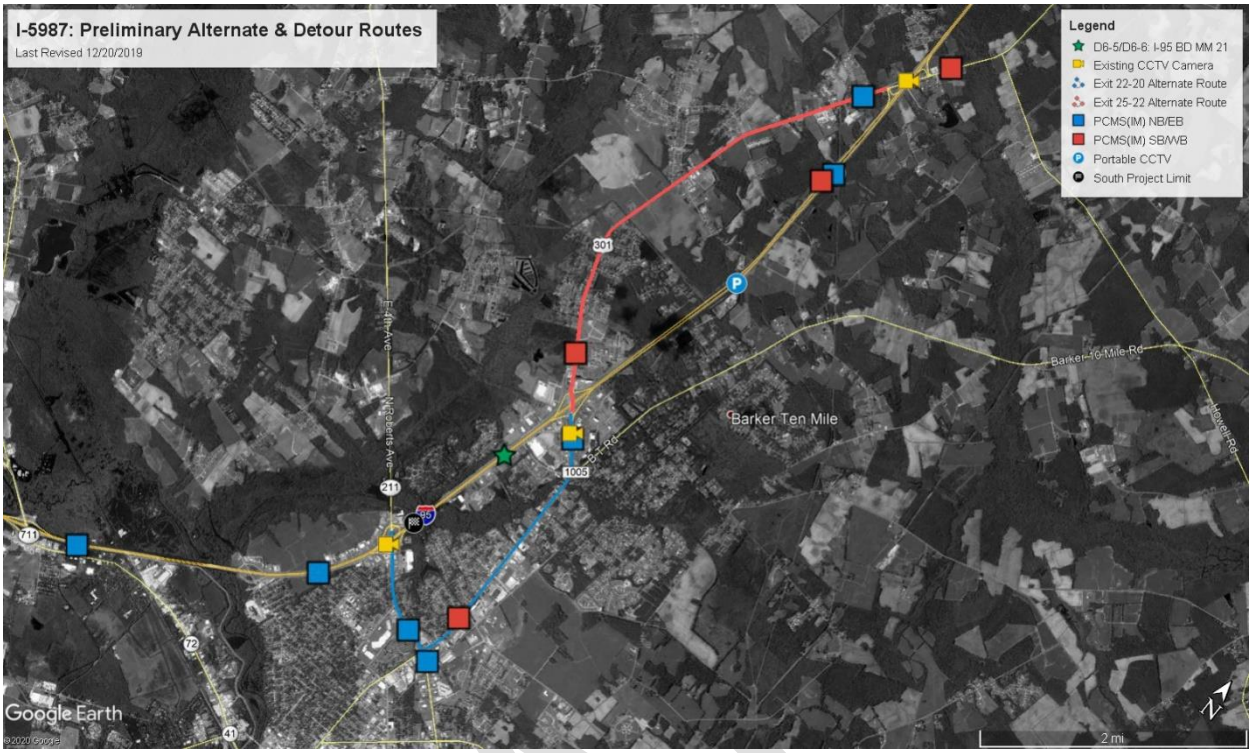

Figure 2 MM 20-22 and MM 22-25 IM Routes

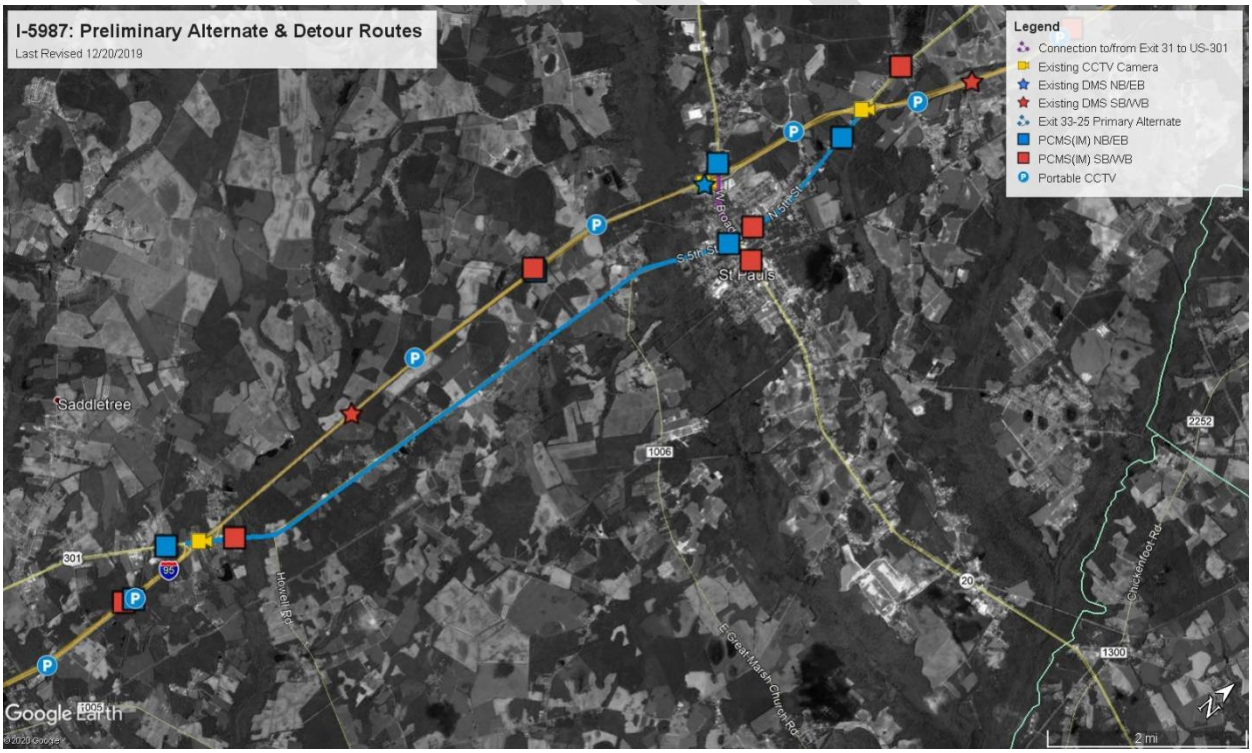

Figure 3 MM 25-33 IM Route

Figure 4 MM 33-41 IM Route

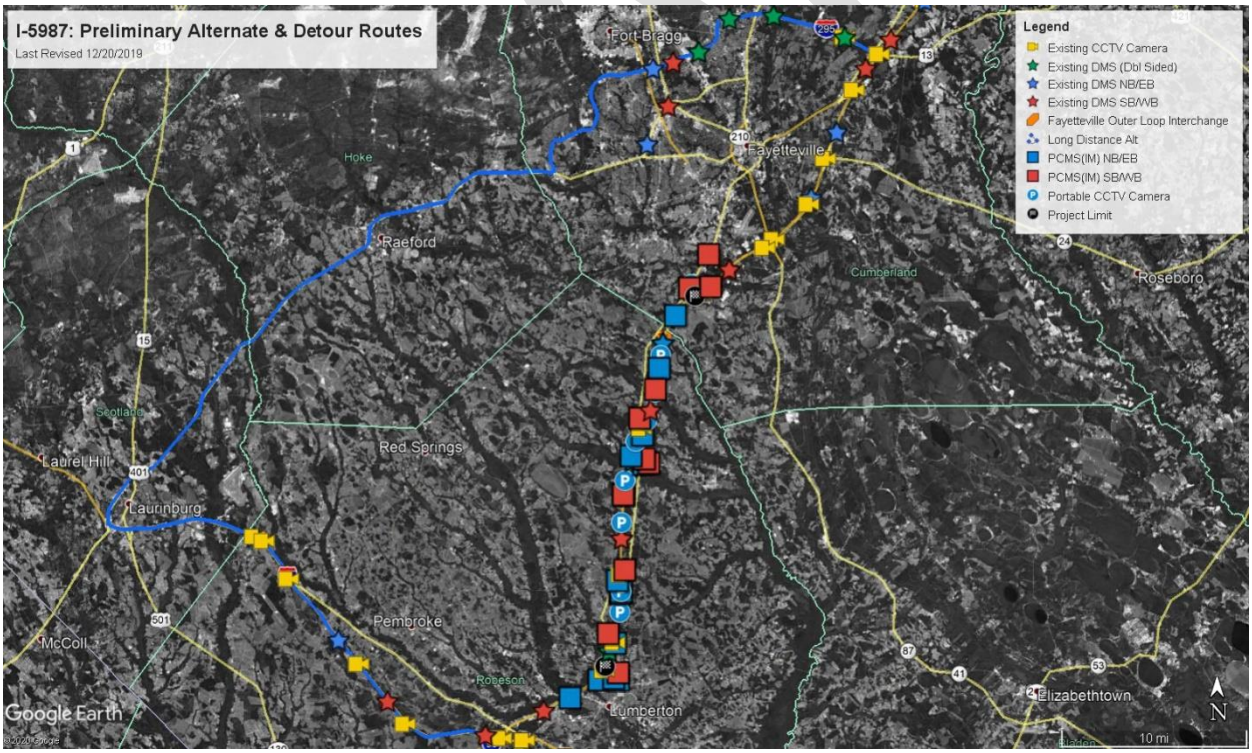

Figure 5 Long-Distance IM Route

The portable ITS device quantities required to support these routes are shown in Table 1.

Table 1 Summary of Portable ITS Devices by IM Route

Route	Portable Changeable Message Sign (CMS)	Portable Closed-Circuit Television (CCTV) Camera	Total Portable ITS Devices
MM 20-22	7	0	7
MM 22-25	3	2	5
MM 25-33	7	3	10
MM 33-41	8	5	11
Long Distance	0	0	0
Totals	25	10	35

User-Specific Considerations

It is important that the impacts to all users be considered during construction. In the following sub-sections a variety of users and how they could be impacted are assessed. This ranges from the most dominant road-user to the most vulnerable. Assessing the impacts for many users provides a thorough assessment of potential risks.

Tractor Trailers

Information related to trucks is very helpful when determining the availability of alternate and detour routes. Ideally, all alternate and detour routes are available to all trucks; however, this is not common. Long-distance alternate routes typically are available to all trucks, with short-distance alternate and detour routes available to trucks with single trailers less than or equal to 53 feet.

Using routes that are available to trucks with single trailers less than or equal to 53 feet could mean that overweight/oversized trucks are not able to travel on the alternate/detour route. Routes with truck restrictions should be avoided when selecting alternate and detour routes, especially when managing traffic from a route that is available to all trucks (e.g. Interstates, many U.S. Highways).

NCDOT resources include:

- *North Carolina Truck Network Map*
  - *https://ncdot.maps.arcgis.com/home/item.html?id=a8f091b8fadc4c5d8bb905bf44556a5d*
- *Truck Access and Route Designation information and resources*
  - *https://connect.ncdot.gov/business/trucking/Pages/Truck-Access-Designation.aspx*

North Carolina Truck Network (NCTN)

The NCTN indicates routes that are available to all trucks, are available to trucks with single trailers less than or equal to 53 feet (e.g. AASHTO WB-67), and have truck restrictions.

The NCTN in the area of the I-5987 project is shown in Figure 6.

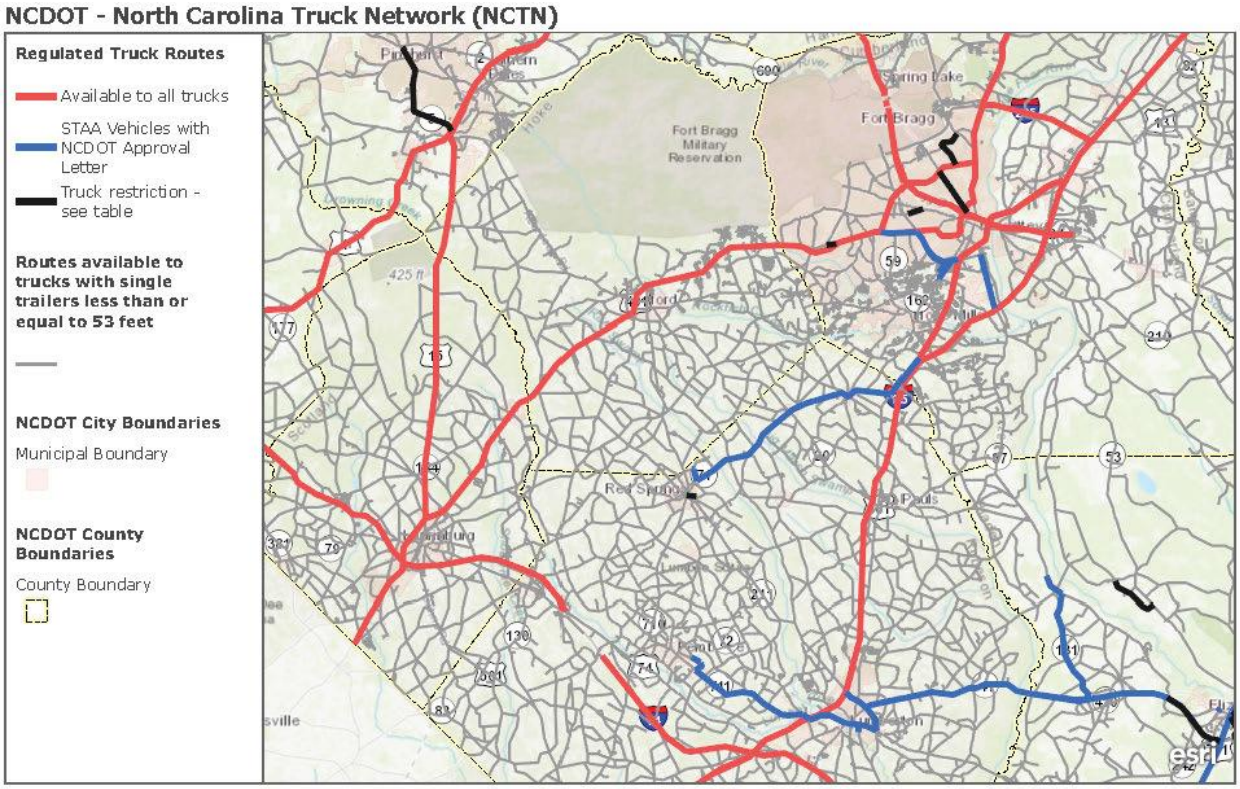

Figure 6 NCTN for I-5987 Area

Green Line Routes for Overweight Loads

The Green Line Routes are developed by the NCDOT's Oversize/Overweight Permit Unit. The map is for NCDOT internal-use only. The map identifies routes suitable for tractor trailers with a gross weight up to 160,000 pounds that have a wheelbase greater than 51 ft. The map used for this ORA was updated 1/5/2017.

Pink routes are specifically not approved as "Green Line Routes".

The only preliminary route not identified as a "Green Line Route" is MM 20-22.

The excerpted area of the Green Line Routes map is shown in Figure 7.

Assessment

In this section, the information presented above is assessed for potential risks and potential mitigations are discussed. The length will depend on the complexity of the risks identified.

Based on the NCTN and the Green Line Routes, the long-distance alternate route of I-74/US-74, US-401, and I-295 appears to be mostly available to all trucks. The sections not designated as "available to all trucks" in the NCTN are part of the US-74 (future I-74) corridor and the future I-295 Fayetteville Outer Loop. These sections are shown as "Green Line Routes" and therefore should be usable by trucks. Although there are sections of US-401, between Laurinburg and Raeford, that are 2-lane highway with

little-to-no paved shoulder, that entire length is shown on both resources as available to all trucks. However, vehicles that are extra wide may not be able to use the routes relying on US-401.

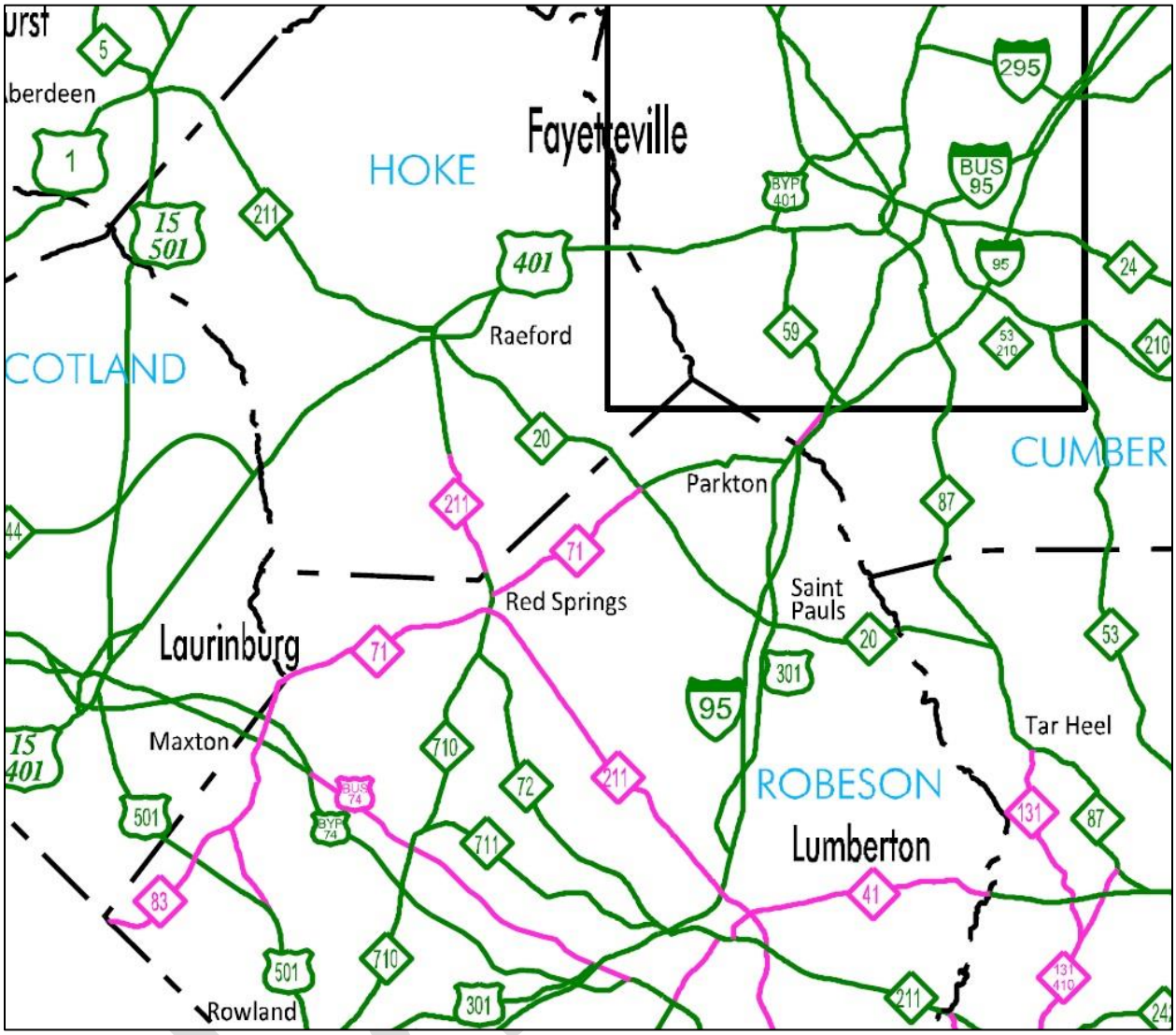

Figure 7 Green Line Routes for I-5987 Area

The local alternate/detour routes of US-301, parallel to the I-95 corridor, are all available to trucks with single trailers less than or equal to 53 feet based on the NCTN. The Green Line Route map shows that most of US 301 is approved for use by tractor trailers.

Many sections of US-301 are 2-lane roads with little-to-no paved shoulder. Oversize/overweight permitted vehicles may not be able to use the routes relying on US-301.

The preliminary route for MM 20-22 is shown on the NCTN as being available to trucks with single trailers less than or equal to 53 feet but is not a “Green Line Route”. This route has several commercial properties, so it is reasonable to expect that most tractor trailers that do not require special permits are able to use this route.

During complete closures of I-95, oversize/overweight vehicles will typically be directed to a location to wait until part of the roadway can be opened up for the vehicle to pass or traffic control can allow for a U-turn. There are several national chain truck stops (e.g. TA, Pilot, Love's) north of the work zone (e.g. Dunn) and south of the South Carolina border; however, there are none in the immediate vicinity. There may be local stops or travel centers that heavy vehicles can wait out any extended-duration incidents. There is a weigh station near MM 24 that may be an option for holding oversize/overweight vehicles.

Summary

At the end of each section, a summary of the assessment and potential mitigations should be included. After all considerations are presented and assessed, they are compiled together to create a complete picture of potential issues, highlighting areas with several identified risks, later in the report.

The assessment did not identify any additional or uncommon risks to managing truck traffic during an incident within the I-5987 work area. No adjustments to alternate and detour routes were necessary due to truck restrictions.

No mitigations specifically related to truck restrictions on alternate and detour routes are suggested.

Vulnerable Users – School Zones, Pedestrians, and Bicycles

Public Transit

When an IM plan is activated, the additional traffic on the IM route can negatively impact public transit and its ability to stay on schedule. Additionally, there is generally a higher level of pedestrian activity near transit stops. From a safety standpoint, in-lane public transit stops can create unexpected temporary lane blockages, especially to unfamiliar motorists.

The ORA should identify transit routes and their schedules that may impact IM route planning. It is possible that a route with transit may only be activated outside of transit service hours or during complete closures of the primary construction route.

If special signal timing plans are being considered for a particular route (i.e. Integrated Corridor Management) with bus service, it should be explored if transit signal priority (TSP) is in place or scheduled for implementation. When signal timing plans are being developed on routes with TSP, coordination with the transit agency should occur.

The Fayetteville Area System of Transit (FAST) bus route 17 serves Cliffdale Road between US 401 and I-295 in Fayetteville.

The bus runs every 90 minutes on the following schedule:

- MONDAY-FRIDAY: 5:45am - 8:28 pm (every 90 minutes)
- SATURDAY: 7:10am - 6:40 pm (every 90 minutes)
- SUNDAY: 9:30am - 7:13 pm (every 90 minutes)

Several stops are in the lane on Cliffdale Road, meaning that during hours of bus service, there is possibility of temporary bottlenecks on the long-distance route. This could create operational and safety issues, especially for unfamiliar motorists who are not expecting to approach a queue.

Schools Zones

Similar to public transit routes, school zones can create time-specific risks. During the morning and afternoon school zone periods, activity of many modes will likely significantly increase. Identifying school zones in the ORA will help inform the Integrated Corridor Management (ICM) decision matrix.

Using aerial imagery (e.g. Google Maps) and NConemap.com, the following Schools and School Zones have been identified on or around the IM routes:

- MM 20-22: Lumberton Senior High School – Fayetteville Road
- MM 22 -25
    - Robeson Community College (RCC) – U.S. 301 (no school zone)
    - Magnolia Elementary School – U.S. 301
- MM 25-33 - St. Pauls Middle & High Schools – U.S. 301
- MM 33-41 – No Schools or School Zones
- Long-Distance Route
    - Wagram Primary School – U.S. 401
    - Hoke County High School – U.S. 401
    - East Hoke Middle School – U.S. 401

The schedules and users around schools should be considered when developing the rule sets and/or decision matrix.

Bicyclists

To identify locations where bicycle activity is expected, the ORA should research the local bicycle network maps as well as safety maps that show locations of bicycle crashes.

Aerial imagery and maps can be used to identify bicycle facilities and mixed use-paths. Additionally, the NCDOT maintains a library of municipal, county, and metropolitan area Comprehensive Transportation Plans (CTPs).

Crash histories can help identify locations of bicycle activity and potential safety issues. NCDOT publishes and maintains a bicycle and pedestrian crash map that can be accessed at: https://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=b4fcdc266d054a1ca075b60715f88aef#. The crash data goes back to 2007 and the map is maintained by the NCDOT Traffic Safety Unit.

In the below example, there are no existing crossings or designated on-road facilities (e.g. bike lanes or sharrows) on any of the proposed routes; however, historic crash data shows a relatively high number of bicycle crashes on one of the routes. This indicates that interstate traffic diverted onto the route may be mixed with cyclists on that route and special consideration may be appropriate.

The 2016 Lumberton Comprehensive Transportation Plan (CTP) 2006 Robeson County CTP, and 2011 Fayetteville Urban Area CTP provide maps of existing and recommended bicycle routes, as well as those needing improvement. There are no existing conflicts of bicycle facilities crossing or being on-road with the preliminary IM routes.

The following paragraphs discuss the number of bicycle crashes broken down by the preliminary IM routes.

MM 20-22 – There were nine (9) reported bicycle v. motorized vehicle crashes on this route from 2007-2018, three (3) of which were in the school zone associated with Lumberton Senior High School.

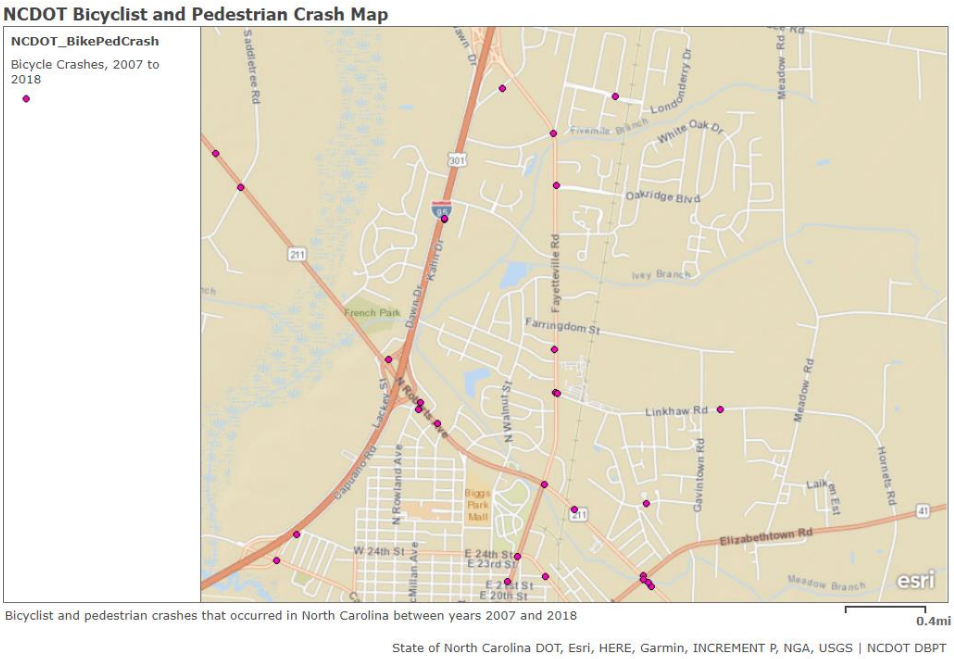

Figure 8 Bicycle Crashes 2007-2018 for MM 20-22 Route

MM 22-25 – There were three (3) reported bicycle v. motorized vehicle crashes on this route from 2007-2018. In all three crashes, the bicyclist was riding in the direction with traffic.

MM 25-33 – There were no reported bicycle crashes on this route.

MM 33-41 – There was one (1) reported bicycle v. motorized vehicle crashes on this route from 2007-2018. In this fatal crash, the bicyclist was riding in the direction with traffic.

Long-Distance Route – There were seven (7) reported bicycle v. motorized vehicle crashes on this route from 2007-2018. All of them occurred on US 401 or Cliffdale Road, and all north of Raeford.

Pedestrians

To identify locations where pedestrian activity is expected, the ORA should research the local facilities as well as safety maps that show locations of pedestrian crashes. Sidewalks and signalized crossings carry a relative lower level of risk. Unsignalized crosswalks and pedestrian crashes near locations without a stop- or signal- controlled crosswalk should be given special attention.

Aerial imagery and maps can be used to identify pedestrian facilities and mixed use-paths. Additionally, the NCDOT maintains a library of municipal, county, and metropolitan area Comprehensive Transportation Plans (CTPs).

NCDOT publishes and maintains a bicycle and pedestrian crash map that can be accessed at: https://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=b4fcdc266d054a1ca075b60715f88aef#. The crash data goes back to 2007 and the map is maintained by the NCDOT Traffic Safety Unit.

In the below example, historic crash data shows a cluster at an intersection with pedestrian signals on the long-distance route. In this case where controlled and separated facilities already exist, pedestrian crossing times should be given special attention if and when special signal timing plans are developed.

This could include leading pedestrian intervals or pedestrian minimum recall during certain times of the day (e.g. during hours of transit operation).

The following paragraphs discuss the number of pedestrian crashes broken down by the preliminary IM routes.

MM 20-22 – There were two (2) reported pedestrian crashes on this route from 2007-2018.

MM 22-25 - There were two (2) reported pedestrian crashes on this route from 2007-2018.

MM 25-33 – There were five (5) reported pedestrian crashes on this route from 2007-2018.

MM 33-41 – There were eight (8) reported pedestrian crashes on this route from 2007-2018. Seven of those crashes were on the route north of Parkton Tobermory Road.

Long-Distance Route – There were thirty-six (36) reported pedestrian crashes on this route from 2007-2018. Please note, the long-distance route is greater than 80 miles in length.

There is a cluster of six (6) pedestrian crashes at the intersection of Cliffdale Road (NC 1400) and Rim Road (SR 1402) in Fayetteville, shown in Figure 9. This intersection includes bus stops for FAST route 17. The intersection is already equipped with push-button activated signalized pedestrian crosswalks on all four approaches.

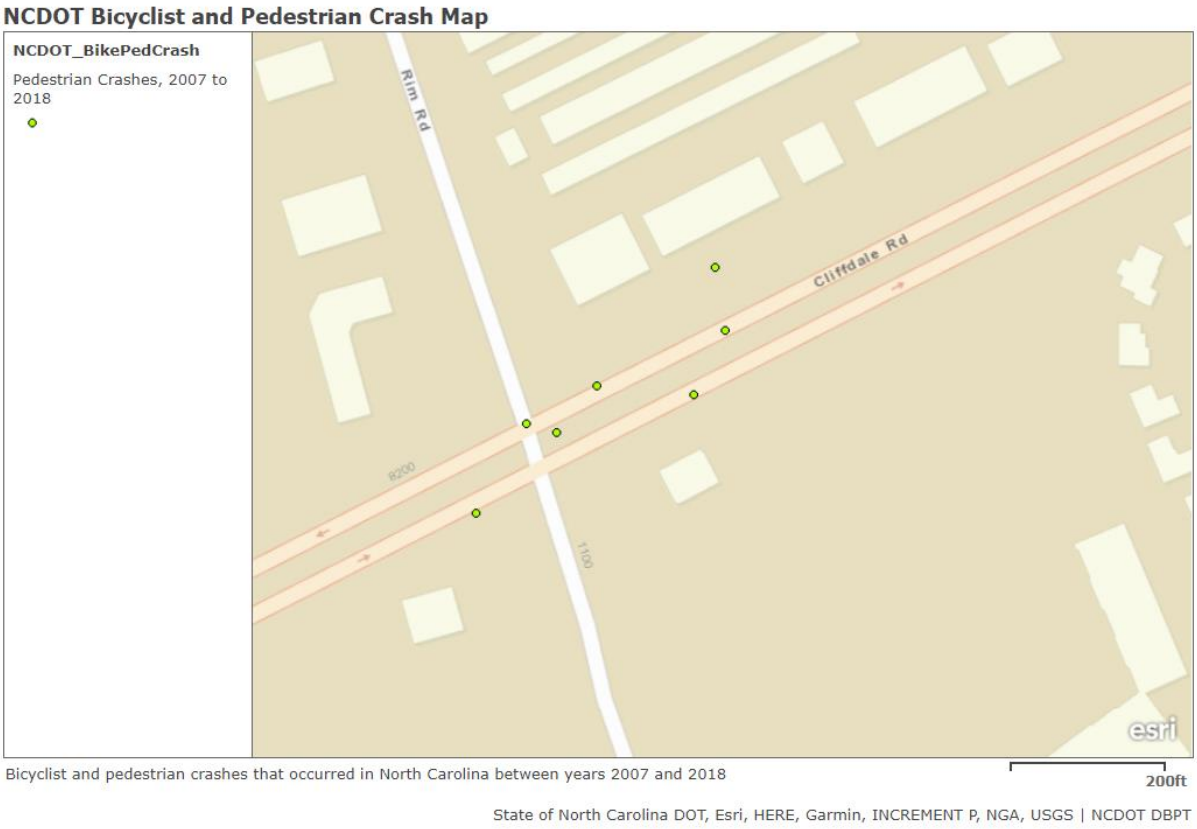

Figure 9 Pedestrian Crashes 2007-2018 at Intersection of Rim Rd and Cliffdale Rd

Assessment

Although the long-distance route has three school zones, long distance routes are typically only used during the most severe incidents (e.g. several hours of complete closure of I-95). Increased exposure to the school zones would therefore be relatively limited.

The route for MM 20-22 includes both a school zone and a relatively high number of bicycle crashes. If traffic is detoured onto the route, current safety issues could be exacerbated and maintaining mobility could be challenging. Unfortunately, no improvements to bicycle accommodations are planned or programmed for this route. These issues and this route may require further investigation and additional consideration when developing the decision matrix.

Route MM 33-41 has a relatively high number of pedestrian crashes between Parkton Tobermory Road and NC 59 (Chicken Foot Rd). Although this is a 2-lane road in a relatively rural area, the amount of pedestrian crashes indicates a decent amount of pedestrian activity in the area. As would be expected, there are no pedestrian facilities on this section of US 301. Additionally, the Fayetteville Urban Area CTP does not have any pedestrian, bicycle, or multi-use related improvements in this area. These issues and this route may require further investigation.

The long-distance route showed a cluster of pedestrian crashes at the intersection Cliffdale Road (NC 1400) and Rim Road (SR 1402). Future work along I-295 may allow the long-distance route to avoid use of this intersection. If that is not possible, pedestrian crossing times should be given special attention when special signal timing plans are developed. This could include leading pedestrian intervals or pedestrian minimum recall during certain times of the day (e.g. during hours of transit operation).

Overall, there are no planned projects identified to improve or enhance existing pedestrian and bicycle facilities.

Summary

Although information regarding vulnerable users do not indicate a need to adjust any of the preliminary routes, the MM 20-22 route and MM 33-41 is recommended for further investigation to better identify any trends. The “Robeson County Vision Zero Task Force” should be used as a resource for developing mitigations.

Special attention should be paid to the intersection of Cliffdale Road (NC 1400) and Rim Road (SR 1402) on the long-distance route. If the future I-295 loop will be complete before the start of the I-5987 project, consider altering the long-distance route. Alternatively, further investigation into the safety issues at this intersection should be carried out to identify possible mitigations at the intersection during route activations.

Safety

Work zones typically increase crash frequency within and approaching the work zone. Therefore, it is important to keep potential alternate and detour routes clear and moving. One potential risk is locations that show a relatively high crash frequency or safety issues. Routing detoured interstate traffic would increase exposure to risks, and potentially exacerbate network mobility if a crash occurs on an alternate or detour route.

The below paragraphs discuss the information available in the following resources:

- *Total Crash Frequency by Intersection*
  - *http://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=dc944f1c834f49a18479c17df1f783b9*
  - *This data set provides planning level crash data grouped by intersection. Only locations on State Maintained Roads are shown on this map. This data should not be used for detailed analysis. The NCDOT Traffic Safety Unit can provide detailed numbers.*
- *Severe Injury and Fatal Crash Locations*
  - *http://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=9a25021dbe91427a92f2eca57bd71ee2*
  - *This map shows fatal and serious injury crashes on that occurred on public roadways in North Carolina for that past 10 years.*
  - *The NCDOT Traffic Safety Unit maintains this map.*
- *Historic Highway Safety Improvement Program (HSIP) Locations Map*
  - *http://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=bb6dd277ce6247438fc096200141949a*
  - *This map, maintained by the NCDOT Traffic Safety Unit, shows locations that met HSIP warrants for that past 5 years.*
  - *Note that the locations are the results of the HSIP screening process, and not necessarily project locations.*
- *Planning Level Safety Score*
  - *https://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=7415a4df4df1468585225bc74a77369b*
  - *This map shows planning level crash data for State maintained roadway segments.*
  - *This data should be viewed as planning level data only. If detailed crash data is needed for a specific location for decision making purposes, it should be requested from the NCDOT Traffic Safety Unit.*
  - *The project areas with the higher scores are considered to have the poorer highway safety performance.*

Total Crash Frequency by Intersection

The bin for the highest volume of crashes is 50 or more between 2014-2018. The discussion below will focus on intersection locations where a relatively high number of crashes have been reported, or where other trends of vulnerability have been identified.

- MM 20-22
  - This route has 8 intersections with 50 or more crashes from 2014-2018
  - This route has already been identified as having a relatively high number of bicycle crashes.
  - This route includes a school zone for Lumberton Senior High School
  - The IM route includes a turning movement (outside of interchanges with I-95) at NC 211 and Lafayette Rd (94 crashes)
    - NB Route – protected left turn
    - SB Route – protected-permitted right turn

- MM 22-25 - Entrance to RCC – 57 Crashes
- MM 25-33 – No intersections with 50 or more crashes from 2014-2018
- MM 33-41 – No intersections with 50 or more crashes from 2014-2018
- Long Distance Route
    - Cliffdale Road and Rim Road, Fayetteville – 66 Crashes
        - This intersection also had a relatively high number of pedestrian crashes
    - US 401 and Club Pond Road, Raeford – 74 Crashes
        - A high number of crashes would not necessarily be expected here
        - The intersection is in a School Zone
        - East Hoke Middle School sits in the SE quadrant of the intersection

Severe Injury and Fatal Crash Locations

The numbers below exclude crashes at I-95 interchange intersections.

- MM 20-22 – 9 Severe Injury Crashes
- MM 22-25 – 2 Severe Injury Crashes. 4 Fatal Crashes.
- MM 25-33 – 5 Severe Injury Crashes. 3 Fatal Crashes.
- MM 33-41 – 13 Severe Injury Crashes. 9 Fatal Crashes.
- Long-Distance Route – 72 Severe Injury Crashes. 32 Fatal Crashes.

Historic HSIP Locations Map

- MM 20-22
    - Intersection of NC 211 (Roberts Ave) and Rowland Ave - 2016, 2017, and 2018
- MM 22-25
    - Intersection of US 301 and SR 1529 (Powersville Rd) - 2016, 2017, 2018, and 2019
        - Plans to be addressed with future 4-way stop control.
- MM 25-33
    - Intersection of NC 20 (Broad St) and Sanford St – 2019
    - Intersection of NC 20 (Broad St) and Old Stage Rd – 2019
    - Intersection of NC 20 (Broad St) and US 301 (5th St) – 2017, 2018, and 2019
- MM 33-41
    - Intersection of US 301 and Parkton Tobermory Rd (SR 1723) – 2016, 2017, 2018 and 2019
        - Has been addressed with new 4-way stop control.
        - Planned for construction of roundabout starting in 2022.
    - Intersection of US 301 and Roslin Farm Rd (SR 1121) –2017, 2018 and 2019
    - Intersection of Chickenfoot Rd (NC 59) and Marracco Dr (SR 2274) – 2017 and 2019
- Long-Distance Route – 4 Sections and 19 Intersections met HSIP warrants at some point during the last 5 years. The list below identifies those of note.
    - Intersection of US 15/501 and Highland Rd (SR 1323) – 2017, 2018, and 2019
    - Intersection of US 401 and Club Pond Road (SR 1508) – 2015 and 2018
    - Intersection of US 401 (Raeford Road) and Cliffdale Road – 2017

Planning Level Safety Scoring Data

The bin for the highest Planning Level Safety Score is for combined scores between 66 and 100. Combined scores of 66 or higher will be identified in the sections below.

- MM 20-22 – The entire route has a combined score of 66 or higher.
- MM 22-25 – Most of the route has a combined score of 66 or higher.
- MM 25-33 – Most of the route has a combined score of 66 or higher.
- MM 33-41 – Most of the route has a combined score of 66 or higher.
- Long-Distance Route – Approximately half of the route has a combined score of 66 or higher.

Assessment

In this assessment, the four sets of crash and safety data should be discussed. Of most interest will be the locations that appear most frequently in the information presented. Because it is summarizing and discussing the combined findings of 4 data sets, this assessment will likely be greater in length than other sections.

The route between MM 20-22 is highlighted by all of the four data sources as having potential safety issues. Similar to the "Vulnerable Users" section, these issues and this route may require further investigation. It is possible that this route is only activated during the most severe incidents on I-95 or only during periods of low activity (e.g. between 10 PM and 5 AM).

The intersection of US 301 and SR 1529 (Powersville Rd) will receive a targeted safety treatment prior to construction. Therefore, the location of most concern on the route between MM 22-25 is near the entrance to RCC. This signalized intersection has a relatively high number of crashes and the roadway section has a combined safety score of 88.9. Investigation is needed to see if IM route activations should consider hours of the school, traffic demand patterns, or if the ICM signal timing plans require additional attention beyond vehicular capacity.

The area of greatest note along the routes for MM 25-33 is the "spur" section along NC 20 between I-95 and US 301, including the intersection of NC 20 (Broad St.) and US 301. The intersection of NC 20 (Broad St.) and US 301 is ≤0.5 miles of St. Pauls Middle School and St. Pauls High School. Similar to the above, additional investigation is needed to see if IM route activations should consider hours of the school, traffic demand patterns, or if the ICM signal timing plans require special attention. It is possible that the NC 20 "spur" have more restrictive activation criteria than the rest of the route.

The route between MM 33 and 41 had 22 reported serious injury and fatal crashes for 2010-2019, which is relatively high compared to the other routes. Additionally, this route has 3 intersections that were on the HSIP Locations Map for multiple years. A cursory review does not indicate any obvious patterns or reasons for the safety issues. The land uses along the corridor are mostly low-density residential and traffic volumes are relatively low. It is possible, given the route is relatively flat and straight, that speeding is an issue.

The routes for MM 22-25 and MM 33-41 will have 4-way stops before construction begins on I-95. These may create mobility issues if interstate traffic is detoured onto US 301. Requiring all large trucks to stop and start may offset any positive benefits of using the route during an incident, other than when under complete closure. Possible options to mitigate this include: adjusting the construction schedule of the roundabout along route MM 33-41 to occur before construction on I-95, limiting non-closure route

activations to low-volume periods, and working with Division maintenance and law enforcement for traffic control options (e.g. manual control or temporary two-way-stop control).

The long-distance route presents several safety-related issues that will require a wide range of considerations. Identified trends in the safety planning data include:

- US 15/501 and Highland Rd (SR 1323), Laurinburg – Met HSIP warrants in 2017, 2018, and 2019
- US 401 and Club Pond Road, Raeford
    - A relatively high number of crashes
    - The intersection is in a School Zone
    - Met HSIP warrants in 2015 and 2018
- US 401 (Raeford Road) and Cliffdale Road, Fayetteville – Met HSIP warrants in 2017
- Cliffdale Road and Rim Road, Fayetteville
    - Relatively high number of crashes
    - Relatively high number of pedestrian crashes
    - FAST Route 17 bus stop

Summary

Similar to the assessment, this summary will be one of the longer ones in the document due to the amount of information presented above. The objective is to tie all of the information presented above into meaningful actionable items.

Each of the routes should be investigated further for special considerations of when and how to activate the route. This should include identifying any trends in the crash data that could provide some insight, such as time of day or ages (e.g. if any individuals are school-aged). These investigations and outcomes will help inform the decision matrix for route activations.

The schedule of the I-295 construction project should also be explored further. If the interchange with US 401 (Raeford Rd) will be complete and open to traffic, this may be an opportunity to avoid some identified issues on the long-distance route.

In this instance, in addition to the preliminary IM route, several planned detours by the construction contractor were also planning to use the intersection of US 301 & Parkton-Tobermory Road, a 4-way stop. With the support of the Congestion Management Unit, discussions with the Division Project Development Unit led to agreement for completing the roundabout (TIP W-5706H) at this intersection prior to the start of TIP I-5987.

The possibility of rescheduling TIP W-5706H should be discussed with the Division Project Engineers. Completing the roundabout prior to the start of TIP I-5987 would eliminate the need for any special traffic control at the intersection of US 301 and Parkton-Tobermory Road (currently a 4-way stop).

Finally, special traffic control plans should be explored and discussed with Division maintenance, the Assistant Division Traffic Engineer, and local law enforcement at the 4-way stop intersections (e.g. at the intersection of US 301 and SR 1529 (Powersville Road)).

Mobility and Operations

The above sections have explored potential issues related to mixing interstate traffic with a variety of users and safety. In this section, potential risks to mobility and traffic operations will be explored. This includes geometric bottlenecks, other work zones, and temporary bottlenecks, such as railroad crossings and in-lane bus stops.

Resources for this section include:

- *State Transportation Improvement Program (STIP) Map [(1) NCDOT 2020-2029 STIP Map (arcgis.com)]*
- *RITIS Congestion Scans and Bottleneck Rankings*
- *Aerial imagery (e.g. Google Maps)*
- *Federal Rail Administration (FRA) Track usage and crash histories https://fragis.fra.dot.gov/GISFRASafety/.*

State Transportation Improvement Program (STIP) Map

The purposes for researching STIP projects are to:

- *Identify adjacent work zones along the primary and IM routes;*
- *Identify work zones that could conflict with IM route activations; and*
- *Identify opportunities for efficiencies in improvements on adjacent routes and IM routes.*

The investigation should cover projects in the STIP with construction start between two years prior and two years after the construction years of the subject project. In this example, STIP projects with the construction phase between 2019 and 2025 are investigated.

The latest STIP (July 2020) shows construction years of FY 2021, 2022, and 2023 for TIP project I-5987. The list below identifies other STIP projects that have the potential to conflict with the surrounding network of this project, focusing on anticipated alternate and detour routes.

The projects below highlight those with the construction phase starting between 2 years prior and 2 years after the I-5987 project.

- MM 20-22
    - U-5797 – Widen Fayetteville Rd in Lumberton
        - Construction begins FY 2024, after I-5987 is complete.
        - This is part of the planned alternate/detour routes.
        - Scheduling concern should I-5987 be delayed or U-5797 be moved forward.
- MM 22-25 - None
- MM 25-33 - None
- MM 33 – 41
    - U-2519AA - Fayetteville Loop Southern connection to I-95
        - Construction continues into FY 2020 and 2021
        - Seek information regarding impacts to US 301 during construction, as that will most likely be a detour route for construction related closures and during large traffic incidents on I-95.
    - W-5706H – Roundabout at US 301 and Parkton Tobermory Rd

        - Letting 11/16/2022 Project in TIP but not STIP map
        - Replaces 4-way stop with roundabout
        - If constructed as scheduled, would conflict with construction.
        - Acceleration or pre-work would be beneficial to the I-5987 project
- B-4491 – Replace NC 59 Bridge over I-95 BUS/US 301
    - STIP shows final CON year of FY 2020
    - Project alters interchange configuration to a traditional Parclo-A
- Long Distance Detour
    - W-5808A – I-74 /US-74 exits 183 and 184
        - Upgrade Signing and Pavement Markings
        - Construction FY 2021
        - Work would likely be at night, possible with lane closures. Potential conflict if major nighttime incident closes I-95 for several hours and long-distance route is activated.

RITIS Congestion Scans and Bottleneck Rankings

Congestion scans and bottleneck rankings were used to develop Table 2 below. The table below summarizes locations with the greatest amount of vehicle delay for the year 2019. The rank is based on all locations in Robeson County. The congestion scans were used to provide the general time of day of the congestion.

Not all bottleneck locations show on the congestion scans. Bottlenecks where the time of day could be cross-referenced in the congestion scans are highlighted in yellow.

What is seen is regular congestion at the following locations and times:

- I-95 NB near MM 33 - 8:45 AM to 9:00 AM
- US 401 SB near Lindsey Road
    - 6:45 AM to 7:15 AM
    - 3:00 PM to 5:15 PM
- US 401 NB near Cliffdale Road
    - 3:45PM to 4:45 PM

Table 2 Robeson County Congestion Scan 2019

Rank	Head Location	Average max length (mi)	Average daily duration	Total duration	All events/ incidents	Volume Estimate (AADT)	TOTAL DELAY (vhd)	Congestion Scan Time of Day
3	I-95 S @ US-301/EXIT 33	6.98	9 m	2 d 12 h 48 m	62	20,844	22,829,447	
4	I-95 N @ NC-20/EXIT 31	7.06	8 m	2 d 44 m	91	20,467	20,757,894	
5	I-95 N @ US-301/EXIT 25	3.65	17 m	4 d 7 h 57 m	52	21,922	17,526,310	
6	I-95 S @ US-301/EXIT 25	7.13	6 m	1 d 14 h 17 m	94	21,397	17,518,419	
8	I-95 N @ US-301/EXIT 33	2.82	8 m	2 d 3 h 23 m	93	19,650	14,169,765	845-900
9	I-95 N @ I-95-BR N/US-301	10.4	3 m	22 h 56 m	106	20,431	13,635,726	
10	I-95 S @ NC-20/EXIT 31	3.29	6 m	1 d 13 h 34 m	72	20,042	12,808,777	
11	I-95 S @ US-301/FAYETTEVILLE RD/EXIT 22	4.16	4 m	1 d 5 h 20 m	105	21,235	10,147,220	
16	I-95 N @ US-301/FAYETTEVILLE RD/EXIT 22	3.43	3 m	18 h 23 m	38	22,517	4,168,114	
18	I-95 S @ NC-211/EXIT 20	4.28	3 m	20 h 48 m	104	22,633	3,639,092	
21	US-401 S @ LINDSEY RD	1.88	13 m	3 d 8 h 3 m	2	11,836	3,180,887	645-715; 1500-1715
24	US-401 S @ CLIFFDALE RD/NC-1400	3.06	6 m	1 d 13 h 12 m	1	13,631	3,039,970	
25	US-301 N @ I-95/DAWN DR/KAHN DR	0.09	3 h 37 m	55 d 2 h 54 m	0	8,145	2,781,799	
26	I-95 N @ NC-211/EXIT 20	3.03	3 m	21 h 32 m	32	23,189	2,235,975	
30	US-401 N @ CLIFFDALE RD/NC-1400	1.75	6 m	1 d 12 h 58 m	6	11,922	840,752	1545-1645
31	US-301 S @ NC-20/W BROAD ST	1.67	3 m	19 h 9 m	4	8,946	838,806	
32	US-401 N @ LINDSEY RD	5.42	1 m	6 h 12 m	6	12,264	781,711	
34	US-301 N @ NC-20/W BROAD ST	6.32	1 m	8 h 31 m	1	8,404	752,238	

Known Interstate Bottlenecks Report

Bottlenecks are likely to be exacerbated by a work zone. Identifying historic bottlenecks ahead of time helps to inform the development of Traffic Management Plans (e.g. where to place smart work zone devices) and locations of portable ITS devices during construction.

This list reports top ten rankings from monthly interstate bottleneck reports from July 2019 – June 2020. The data comes from RITIS. Only one location relevant to this project is identified on the list.

- I-95 NB MM 32-40 – Rank #8 – Feb 2020

Potential Bottlenecks and Capacity Drops

The purpose of identifying potential bottleneck locations on the IM routes is to help inform the development of special signal timing plans and any supporting decision matrix. In most cases, there will not be opportunity to increase capacity through additional lanes or altered lane configurations prior to the start of construction. However, by identifying the possible constrained locations early on, a comprehensive view of the available network is developed.

This section identifies locations where capacity of the ICM route is reduced due to a lane drop or turning lanes. It excludes ramps and their intersections associated with the primary route, I-95, and focuses on those on the ICM routes. Areas where a TWLT terminates are not noted.

- MM 20-22
  - Northbound Route
    - NC 211 and Lafayette Rd – Single-Lane Protected Left Turn
  - Southbound Route
    - NC 211 and Lafayette Rd – Single-Lane Protected-Permitted Right Turn
- MM 22-25
  - Both Directions
    - US 301 and Powersville Road - 4-Way Stop (future, Aug. 2020 Letting)
  - Northbound Route
    - North Entrance to RCC – Lane Drop (Right-Turn Trap)
- MM 25-33 – None (excluding use of NC 20 / Broad Street)
- MM 33-41
  - Both Directions
    - US 301 and Parkton Tobermory Road – 4-Way Stop (future roundabout, Nov. 2022 letting)
  - Northbound Route
    - I-95 Business to US 301 Service Rd to Chicken Foot Rd – Single -Lane Yield-Controlled Left Turn into Single-Lane Signal-Controlled Right Turn.
    - This issue is scheduled to be resolved by TIP B-4491 prior to the start of I-5987.
  - Southbound Route
    - Chickenfoot Rd/Main St to Southern Blvd – Single-Lane Yield-Controlled Right Turn. This issue is scheduled to be resolved by TIP B-4491 prior to the start of I-5987.
    - I-95 Business to US 301 – Single-Lane Ramp
- Long Distance Route

- Northbound Route
  - Ramp from I-74/US-74 to McColl Rd (US 501) – Single-Lane Permitted Left Turn
  - McColl Rd (US 401) at Highland Rd (SR 1323), N of Laurinburg – Lane Drop
  - Raeford Rd (US 401) to Cliffdale Road in Fayetteville – Dual-Lane Protected Left Turn
  - Cliffdale Rd to I-295 in Fayetteville – Single-Lane Free-Flow Loop Ramp
- Southbound Route
  - I-295 to Cliffdale Rd in Fayetteville – Single-Lane Signal-Controlled Right Turn
  - Cliffdale Rd to Raeford Rd (US 401) – Single-Lane Protected-Permitted Right Turn
  - Raeford Rd (US 401) in Raeford – Lane Drop (Left-Turn Trap)
  - McColl Rd (US 501) to I-74/US-74 – Single-Lane Yield-Controlled Left Turn.

Other

At-Grade Railroad Crossings

At-grade railroad crossings have the potential for significant impacts to the operations of an incident management route, especially in the case of a crossing train. Additionally, under NC general statute §20-142.3, school busses are required to stop when approaching at-grade railroad crossings (2). Because these can create a temporary operational bottleneck, the location of the railroad crossing relative to the schools should be noted.

Track usage and crash histories are available through the Federal Rail Administration (FRA) at https://fragis.fra.dot.gov/GISFRASafety/.

It is also important to identify at-grade rail crossings on adjacent routes that could impact IM route operations. Signalized intersections within 200 feet of a railroad crossing are typically connected and will have some type of rail preemption or limited service plans for when a train is crossing (1). The limited service plans could impact any special signal timing plans that would be created to be activated during incidents, to the point that the detoured traffic is not served by the traffic signal while the train signal is active.

The connection between signalized intersections and a nearby railroad crossing are less likely once the distance separating them is greater than 200 feet (1). Therefore, signalized intersections with a railroad crossing within 500 feet should be investigated for existing interconnect, pre-emption, and rail-activated signal timing plans. Any signal timing plan development should account for disruptions caused by rail preemption and limited-service plans, as well as queue lengths extending into the rail crossing.

Where appropriate, improvements related to interconnect, queue detection, pre-emption, and rail-activated signal timing plans should be considered as possible mitigations.

US 15/401 in Laurinburg has an angled single-track at-grade crossing (Crossing 852558H), just south of Aberdeen Road. Based on the inventory report (2017), there are two (2) train crossings per week with an average crossing speed of 5-10 mph. The inventory report shows an average of 35 school buses cross the tracks per day. No historic accident reports were found for this location.

US 401 in Wagram has a single-track at-grade crossing (Crossing 852673P) between Wagram Primary School and Riverton Road (SR 1403). The latest inventory report (2017) shows zero (0) train crossing per

week and no accident reports were found for this location. The inventory report shows an average of 10 school buses cross the tracks per day.

Based on the relatively low train activity at these crossings and lack of reasonable alternative, any risk of additional vehicle delay due to trains on the incident management routes is considered manageable.

School busses are required to stop when approaching at-grade railroad crossings. This can create a temporary operational bottleneck. Both identified crossings show multiple busses crossing the tracks daily. Therefore, outreach to the schools regarding bus routes and schedules should be considered.

No at-grade rail crossings were identified on adjacent routes within 500 feet of the preliminary IM routes.

Assessment

Potential mobility and operations issues were identified as follows:

- MM 20-22
    - U-5797 construction could conflict with I-5987 if I-5987 is delayed or U-5797 is accelerated. This situation can likely be avoided through discussion with the Division.
    - The signalized intersection of NC 211 (Roberts Ave) and Fayetteville Road is a potential bottleneck due to the IM route using the turn lanes.
        - The greatest constraint would most likely be the EB NC 211 (Roberts Ave) left-turn.
        - Consider upgrading to a 4-head flashing yellow arrow configuration for the movement.
- MM 22-25
    - The intersection of US 301 and Powersville Road is under 4-way stop control.
        - This is likely the greatest constraint on this route.
        - Consider working with law enforcement and Division maintenance to develop a IM route activation strategy.
    - For the northbound direction of this route, there is a lane drop (right turn trap) near the north entrance to RCC.
        - This is a geometric constraint that may be unavoidable.
        - To limit queuing into the intersection of US 301 and Dawn Drive, special signal timing plans for a northbound activation should consider the capacity of the downstream merge.
- MM 25-33
    - I-95 NB at Exit 33 was a top 10 bottleneck for Robeson County in 2019. Similarly, I-95 NB between MM 32 and 40 was the eighth highest bottleneck in February 2020 in the state.
        - Any incident will likely exacerbate what would be typical congestion.
        - Activation of this IM route could occur more frequently than others due to increased crash frequency and greater likelihood of significant queuing.
        - Consider working with WZTC to include speed sensors and queue warning system south of this area.
        - Locating PCMS and CCTV cameras should plan for expected queuing and be adjusted as needed throughout the life of the project.

  - The EBT and WBT, Phase 2 and 6 respectively, are set to "min recall" at the intersection of US 301 and NC 20 (Broad Street). Consider adjusting the "min recall" settings at the intersection of US 301 and NC 20 (Broad Street) during activations.
- MM 33-41
  - The construction of the Fayetteville Outer Loop (TIP U-2519) should have limited, if any, conflicts or overlap with I-5987. Its progress should be monitored as it may provide an improved long-distance IM route.
  - The intersection of US 301 and Parkton Tobermory Road is currently a 4-way stop.
    - Upgrading the intersection to a roundabout is already scheduled.
    - Construction of a roundabout at US 301 and Parkton Tobermory Rd (W-5706H) will disrupt the preliminary IM route if construction occurs as scheduled.
    - The desired solution is to adjust schedules so that the roundabout is open to traffic before I-5987 impacts traffic on I-95.
  - I-95 NB between MM 32 and 40 was the eighth highest bottleneck in February 2020 in the state.
    - Any incident will likely exacerbate what would be typical congestion.
    - Activation of this IM route could occur more frequently than others due to increased crash frequency and greater likelihood of significant queuing.
    - Consider working with WZTC to include speed sensors and queue warning system south of this area.
    - Locating PCMS and CCTV cameras should plan for expected queuing and be adjusted as needed throughout the life of the project.
- Long-Distance Route
  - Signing and pavement marking work (W-5808A) at I-74/US-74 Exits 183 and 184
    - Could create conflicts during nighttime IM route activations.
    - Suggested mitigations:
      - Coordination with WZTC and Division
      - Include contractor into the contact matrix
  - The movement from WB I-74/US-74 to NB US-501 (McColl Rd) is served by a shared through-left permitted left turn signal.
    - This is most likely the greatest constraint for the NB long-distance route.
    - Consider upgrading to a 4-head FYA signal configuration for this movement to accommodate split-phasing operations.
  - The movement from SB US 501 (McColl Rd) to EB I-74/US-74 is served by a single-lane yield controlled left turn.
    - This is most likely the greatest constraint for the NB long-distance route.
    - If signalization of this intersection is not warranted and feasible, work with the Division and local law enforcement to develop plan for implementing manual traffic control.
  - The following geometric and control constraints should be considered when developing the signal timing plans:
    - Northbound
      - US-401 (McColl Rd) at Highland Rd (SR 1323), N of Laurinburg – Lane Drop

- US 401 (Raeford Rd) to Cliffdale Road in Fayetteville – Dual-Lane Protected Left Turn
- Cliffdale Rd to I-95 in Fayetteville – Single-Lane Free-Flow Loop Ramp

▪ Southbound

- I-295 to Cliffdale Rd in Fayetteville – Single-Lane Signal-Controlled Right Turn
- Cliffdale Rd to Raeford Rd (US 401) – Single-Lane Protected-Permitted Right Turn
- Raeford Rd (US 401) in Raeford – Lane Drop (Left-Turn Trap)
- McColl Rd (US 501) to I-74/US-74 – Single-Lane Yield-Controlled Left Turn.

o The following regular congestion locations and periods should be considered when developing the route activation matrix:

▪ US 401 SB near Lindsey Road N of Raeford – AM and PM peak periods
▪ US 401 NB near Cliffdale Road – PM peak period
▪ School bus operations at railroad crossings.

- US 15/401 RR crossing in Laurinburg experiences approximately 35 school bus crossings per day
- US 15/401 RR crossing in Wagram experiences approximately 10 school bus crossings per day
- Coordinate with area schools to determine bus schedules

Summary

MM 20-22

The greatest operational constraint for this route is most likely the EB left turn from NC 211 (Roberts Ave) to Fayetteville Rd. A practical solution would be to upgrade the signal head controlling the movement from a 3-aspect to a 4-aspect with FYA capabilities, as shown in Figure 10. This will provide greater programming flexibility by allowing the movement to be served by both protected and permitted operations. Additionally, during IM route activations, adjusting which phases are set to “min recall” should be considered.

Figure 10 Typical Arrangement of Separate Signal Faces with FYA for Protected/Permissive Mode and Protected Only Mode Left Turns (Source MUTCD, Dated May 2012)

MM 22-25

There are two operational constraints on this route that will most likely require manual or temporary traffic control to mitigate during IM route activations. The first is the 4-way stop at US 301 and Powersville Road. Placing the intersection under police control or temporarily converting the intersection to a 2-way stop should are possible solutions to explore.

The second is the northbound lane drop near RCC. In addition to considering capacity of the lane-drop merge when preparing signal timing plans, installing a temporary taper in the right-turn lane to reinforce the merge may also be desirable.

MM 25-33

This route has a consistent 2-lane bi-directional capacity for the length of the IM route. However, congestion routinely occurs on the relevant section of I-95, so it is reasonable to expect this route to be activated more frequently than other. This would be due to additional incident on I-95, and in the event of an incident quickly building queues. To account for this, it is suggested that the transportation management plan include speed sensors and a queue warning system approaching this section. Additionally, PCMS and CCTV cameras should be located based on expected queuing and regularly reviewed for adjustment.

Additionally, the default timing chart is not set up to accommodate additional demand on the NBT or SBT movements during an activation at the intersection of US 301 and NC 20 (Broad Street) in St. Pauls. This intersection may require several unique signal timing plans to support NB, SB, bi-directional, and spur route activations.

MM 33-41

Although the Fayetteville Outer Loop crosses over this section of US 301, its construction (TIP U-2519) should not impact this IM route during the I-5987 project. The progress of the Fayetteville Outer Loop should be monitored as it may introduce additional IM route opportunities for both short- and long-distance detours.

The upgrade of the intersection of US 301 and Parkton Tobermory Road to a roundabout (W-5706H) will disrupt this IM route if constructed as currently scheduled. Ideally, the roundabout would be open to traffic before I-95 traffic is impacted by I-5987. This will require coordination with the Division. This would remove the capacity issue related to the 4-way stop.

Finally, congestion is shown to occur on I-95 NB between MM 32 and 40. Therefore, it's reasonable to expect that activation of this IM route could occur more frequently than others due to increased crash frequency and greater likelihood of significant queuing. Similar to the route for MM 25-33, it is suggested that the transportation management plan include speed sensors and a queue warning system approaching this section. Additionally, PCMS and CCTV cameras should be located based on expected queuing and regularly reviewed for adjustment.

Long-Distance Route

Incident Management Plan Recommendations

Project Coordination

Signing and pavement marking work (W-5808A) at I-74/US-74 Exits 183 and 184 is scheduled for construction in FY 2021. This could potentially overlap with construction work on I-95, which is scheduled for FY 2021, 2022, and 2023. Assuming that work related to W-5808A would occur under nighttime lane closures, the greatest chance for conflict would be during nighttime IM route activations.

Prior to construction, the WZTC section, Division personnel, and STOC representatives should discuss and agree upon the process for activating the long-distance IM route as it relates to the W-5808A work zone. As part of the Incident Management Plan for I-5987, the contractor and Division PM should be included in the contact matrix, as well as the agreed procedure for notifications.

Manual Traffic Control

The movement from SB US-15/401/501 (McColl Rd) to WB I-74/US-74 to NB US-15/401/501 (McColl Rd) is served by a single-lane yield-controlled left turn. The opposing through traffic is free-flowing. This is most likely the greatest capacity constraint for the SB long-distance route, especially during peak periods.

To mitigate the issue, assuming signalization of this intersection is not warranted and feasible, it is recommended the contractor, STOC, Division, and local law enforcement work together to develop a plan for implementing manual traffic control as part of the Incident Management Plan for I-5987.

Intersection Improvements

The movement from WB I-74/US-74 to NB US-15/401/501 (McColl Rd) is served by a shared through-left permitted left turn signal. This lane is served by a 3-aspect permissive only mode signal head. This is most likely the greatest capacity constraint for the NB long-distance route. Excessive queuing at this location could lead to spill back onto I-74/US-74 creating potential safety issues.

To mitigate capacity issues during IM route activations, a 4-aspect FYA signal configuration as seen in Figure 10 should be considered for this movement. This would accommodate split-phasing operations during IM route activations and provide greater flexibility in signal operations.

Signal Timing Development

The following geometric and control constraints should be considered when developing the signal timing plans:

- Northbound Route
  - US-401 (McColl Rd) at Highland Rd (SR 1323), N of Laurinburg
    - The capacity of the NB lane drop should be considered when developing the capacity and coordination of the upstream signal timing plans.
  - US 401 (Raeford Rd) to SR 1400 (Cliffdale Road) in Fayetteville
    - The left turn from US 401 (Raeford Rd) to SR 1400 (Cliffdale Road) is served by a Dual-Lane Protected Left Turn.
    - When traffic conditions allow, consider adjusting “min recall” settings to optimize timing for this movement.
  - SR 1400 (Cliffdale Road) to NB I-295 in Fayetteville
    - The capacity of the single-lane free-flow loop ramp should be considered when developing the capacity and coordination of the upstream signal timing plans.
- Southbound Route
  - I-295 to SR 1400 (Cliffdale Road) in Fayetteville
    - The right turn from the I-295 SB off-ramp to WB SR 1400 (Cliffdale Road) is served by a single signal-controlled lane.
    - When traffic conditions allow, consider adjusting “min recall” settings to optimize timing for this movement.
  - Cliffdale Rd to Raeford Rd (US 401)
    - The right turn from the I-295 SB off-ramp to WB SR 1400 (Cliffdale Road) is served by a single signal-controlled lane.

        - When traffic conditions allow, consider adjusting "min recall" settings to optimize timing for this movement.
    - Raeford Rd (US 401) in Raeford
        - The capacity of the SB left-turn trap, downstream of Club Pond Road, should be considered when developing the capacity and coordination of the upstream signal timing plans.
    - McColl Rd (US 501) to I-74/US-74
        - For additional discussion on this movement, see the above "Manual Traffic Control" section.
        - The capacity of this left-turn movement, which may be under manual traffic control during an activation, should be considered when developing the capacity and coordination of the upstream signal timing plans.

Decision Matrix Development

The following locations on the long-distance route show regular congestion. To better understand impacts at railroad crossings, further investigation is needed to determine the school bus schedules and routes.

Background congestion can impact when the long-distance detour is activated. When developing the decision matrix, they should receive consideration.

- US 401 SB near Lindsey Road N of Raeford – AM and PM peak period congestion
- US 401 NB near Cliffdale Road – PM peak period congestion
- US 15/401 RR crossing in Laurinburg – Averages 35 school bus crossing per day
- US 15/401 RR crossing in Wagram – Averages 10 school bus crossings per day

Safety Project Opportunities

Spot Safety Projects can provide opportunities to address some of the previously identified issues. On occasion, they can also present new operational risks. When future projects are identified, coordination with the Division, Congestion Management, and the Traffic Safety Unit should occur to minimize negative impacts to the routes.

This map contains the Spot Safety projects that were completed in 2019 or 2020 or are still in a stage of pre-completion: on hold (project submitted but not yet funded), in design, or design complete but not yet in construction. The map shows lines (section projects) and points (intersection projects). Safety projects conducted across a wide area (e.g., countywide, divisionwide) are not shown on the map.

https://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=3f8b32844ad04673b391033a86496852

In this example, the only identified project was the introduction of a 4-way stop on an IM route.

These projects may identify potential resource-sharing opportunities. Alternatively, they may identify potential future operational issues.

- MM 22-25
    - Install 4-way stop at intersection of US 310 and SR 1529 (Powersville Road / Mt Olive Church Road)

This project has been addressed in the "Potential Bottlenecks and Capacity Drops" section.

SPOT Mobility Project Opportunities

SPOT Mobility Projects can provide opportunities to address some of the previously identified issues. On occasion, they can also present new operational risks. When future projects are identified, coordination with the Division and Congestion Management.

http://ncdot.maps.arcgis.com/home/webmap/viewer.html?webmap=683e22735d324c89abe812d4db9d6838

The P5.0 Projects Viewer provides a visualization of the submitted and scored P5 projects for all transportation modes throughout North Carolina. The viewer highlights projects draft funded at the Statewide Mobility category for the 2020-2029 STIP. The viewer also includes projects considered committed in the current STIP.

The viewer provides access to the following data:

- *Highway Projects - Layer depicting the location of highway projects.*
- *Bike/Ped Projects - Layer depicting the location of bicycle and pedestrian projects.*
- *Aviation - Layer depicting the location of aviation projects.*
- *Rail - Layer depicting the location of rail projects.*
- *Transit - Layer depicting the location of transit projects.*
- *Ferry - Layer depicting the location of ferry projects.*

In this example, no SPOT Mobility Projects are identified.

No projects identified that conflict with the I-5987 project or its preliminary incident management routes.

Vulnerable Locations and Solutions

This section represents a culmination of the above sections, summarizing the identified issues and the possible mitigations for consideration.

The issues and mitigations discussed below assume no changes to identified IM routes.

MM 20-22

Identified Issues

The below issues were identified on this IM route:

- School Zone related to Lumberton Senior High School
- Relatively high number of bicycle crashes
- High number of intersections with a relatively high number of crashes
- Relatively high number of severe injury crashes
- The intersection of NC 211 (Roberts Ave) and Rowland Ave met HSIP warrants in 2016, 2017, and 2018
- The entire route has a relatively high combined Planning Level Safety Score
- Potential conflicting construction if I-5987 completion delayed – U-5797 (let May 2024)

- Capacity issues due to turn movements at intersection of NC 211 (Roberts Ave) and Lafayette Rd.

Mitigations

Suggested mitigation tools to address some or all of the above issues include:

- Investigate crash trends.
- Additional signal timing plans when IM response plans active accounting for:
  - School Zone times
  - Pedestrian service at intersections
  - Turning movement service at intersection of NC 211 (Roberts Ave) and Lafayette Rd
- At intersection of NC 211 (Roberts Ave) and Lafayette Rd, change eastbound left-turn signal heads to allow for FYA operations.
  - Analysis into the safety and operations of a FYA for this movement should be performed prior to decision
  - FYA operations may only be available during off-peak periods for safety reasons
- NCDOT-administered towing contract to:
  - Reduce clearance times on I-95, and therefore limit additional risk exposure on IM route
  - Available to respond to and clear incidents on IM route
- Regular communication with Division 6 Project Development Unit regarding potential schedule conflicts with other projects (i.e. U-5797)

MM 22-25

Identified Issues

The below issues were identified on this IM route:

- Schools
  - School Zone for Magnolia Elementary School
  - RCC (no School Zone)
- High crash frequency at signalized entrance to RCC
  - The section in front of the college has a relatively high combined Planning Level Safety Score of 88.9
  - A serious injury crash and fatal crash occurred in front of the neighboring cemetery (2010-2019)
- The intersection of US 301 and SR 1529 (Powersville Rd) met HSIP warrants in 2016, 2017, 2018, and 2019
- Congestion
  - There is an expected bottleneck in the northbound direction due to a lane drop (right turn trap) at the north entrance to RCC.
  - Future 4-way stop at intersection of US 301 and SR 1529 (Powersville Rd) – Aug. 2020 letting

Mitigations

Suggested mitigation tools to address some or all above issues include:

- Additional signal timing plans when IM response plans active, especially NB or bi-direction, accounting for:
    - School Zone times
    - Pedestrian service at intersection in front of RCC.
- Alternative traffic control during IM route activation, especially during high-volume periods
    - Law enforcement
    - Eliminate left-turns with delineators in CL of US 301 (may include bagging N-S stop signs)
    - Temporary taper for NB US 301 right-turn trap at RCC entrance
- NCDOT-administered towing contract to:
    - Reduce clearance times on I-95, and therefore limit additional risk exposure on IM route

MM 25-33

Identified Issues

The below issues were identified on this IM route:

- School Zones related to St. Pauls Middle and High Schools on U.S. 301
- Three intersections meeting HSIP warrants
    - Intersection of NC 20 (Broad St) and Sanford St – 2019
    - Intersection of NC 20 (Broad St) and Old Stage Rd – 2019
    - Intersection of NC 20 (Broad St) and US 301 (5th St) – 2017, 2018, and 2019
- The IM route "spur" on NC 20 (Broad St) has a combined planning level safety score >90
- I-95 NB at Exit 33 was a top 10 bottleneck for Robeson County in 2019. Similarly, I-95 NB between MM 32 and 40 was the eighth highest bottleneck in February 2020 in the state.
- Default timing settings at intersection of US 301 and NC 20 (Broad St) not conducive to support additional traffic on most of the IM routes for this section.

Mitigations

Suggested mitigation tools to address some or all above issues include:

- I-95 congestion mitigation
    - Consider working with WZTC to include speed sensors and queue warning system on I-95 NB
    - Locate PCMS and CCTV cameras for expected queuing and adjust as needed throughout the life of the project.
- Investigate crash trends
- Additional signal timing plans when IM response plans active accounting for:
    - School Zone times
    - Expected congestion and accelerated queuing on NB I-95
    - Several unique signal timing plans to support NB, SB, bi-directional, and spur route activations likely required
- NCDOT-administered towing contract to:
    - Reduce clearance times on I-95, and therefore limit additional risk exposure on IM route
    - Available to respond to and clear incidents on IM route

MM 33-41

Identified Issues

The below issues were identified on this IM route:

- 8 pedestrian crashes from 2007-2018
- 13 severe injury and 9 fatal crashes from 2010-2019
- Unmitigated HSIP intersections
    - Intersection of US 301 and Roslin Farm Rd (SR 1121) –2017, 2018 and 2019
    - Intersection of Chickenfoot Rd (NC 59) and Marracco Dr (SR 2274) – 2017 and 2019
- 4-way stop at US 301 and SR 1723 (Parkton Tobermory Rd)
- Potential Construction conflicts
    - U-2519AA - Fayetteville Loop Southern connection to I-95
    - W-5706H – Roundabout at US 301 and Parkton Tobermory Rd
- Background congestion on I-95 NB between MM 21 and 40

Mitigations

Suggested mitigation tools to address some or all above issues include:

- Investigate crash trends
- Coordinate with Division on construction schedules related to U-2519AA and W-5706H.
    - Preferably, both are complete before I-5987 begins to affect traffic on I-95.
    - This address potential construction conflicts and the 4-way stop at SR 1723 (Parkton Tobermory Rd)

Long-Distance Route

Route Capacity

Identified Issue

The below possible capacity issues were identified on this route:

- Scheduled signing and pavement marking (W-5808A) on I-74/US-74
- Northbound
    - Ramp from I-74/US-74 to McColl Rd (US 501) – Single-Lane Permitted Left Turn
    - McColl Rd (US 401) at Highland Rd (SR 1323), N of Laurinburg – Lane Drop
    - Raeford Rd (US 401) to Cliffdale Road in Fayetteville
        - Dual-Lane Protected Left Turn
        - Recurring PM peak congestion
    - Cliffdale Rd to I-295 in Fayetteville – Single-Lane Free-Flow Loop Ramp
- Southbound
    - I-295 to Cliffdale Rd in Fayetteville – Single-Lane Signal-Controlled Right Turn
    - Cliffdale Rd to Raeford Rd (US 401) – Single-Lane Protected-Permitted Right Turn
    - US 401 SB near Lindsey Road N of Raeford – AM and PM peak periods
    - Raeford Rd (US 401) in Raeford – Lane Drop (Left-Turn Trap)
    - McColl Rd (US 501) to I-74/US-74 – Single-Lane Yield-Controlled Left Turn
- RR Crossings
    - US 15/401/501 in Laurinburg

- US 401 in Wagram

Mitigations

Suggested mitigation tools to address some or all the above issues include:

- Additional signal timing plans when IM response plans active accounting for:
  - School Zone times
  - Downstream capacity constraints
  - Further investigate school bus schedules in relation to school bus crossings
- NCDOT-administered towing contract to:
  - Reduce clearance times on I-95, and therefore limit additional risk exposure on IM route
- Coordinate with Division and contractor regarding W-5808A on I-74/US-74 and include contractor in contact matrix
- Consider upgrading to a 4-head FYA signal configuration for the left turn from WB I-74/US-74 to NB US-15/401/501 (McColl Rd)
- Develop plan, in coordination with the Division and local law enforcement, for implementing manual traffic control at US 15/401/501 (McColl Rd) and EB I-74/US-74

US 401 and Club Pond Road, Raeford

Identified Issues

The below issues were identified at the intersection of US 401 and Club Pond Road on Long-Distance IM route:

- School Zone for East Hoke Middle School
- HSIP warrants met in 2015 and 2018
- High crash frequency at the signalized intersection
  - 74 Crashes between 2014-2018
  - This intersection had a serious injury and fatal crash between 2010-2019
  - A single pedestrian crash was reported at/near the intersection between 2007-2018
- This section of U.S. 401 has a combined safety score of 88.9

Mitigations

Suggested mitigation tools to address some or all the above issues include:

- Investigate crash trends that could provide some insight, such as time of day or ages of individuals
- Additional signal timing plans when IM response plans active accounting for:
  - School Zone times
- NCDOT-administered towing contract to:
  - Reduce clearance times on I-95, and therefore limit additional risk exposure on IM route
  - Respond to and clear incidents on IM routes

Intersection of Cliffdale Road and Rim Road, Fayetteville

Identified Issues

The below issues were identified at the intersection of Cliffdale Road and Rim Road on the Long-Distance IM route:

- Met HSIP warrants in 2017
- High crash frequency at the signalized intersection
    - 66 Total crashes at the intersection between 2014-2018.
    - 6 Pedestrian crashes at the intersection between 2007-2018.
    - This intersection had a serious injury and fatal crash between 2010-2019.
- This section of Cliffdale Road has a combined safety score of 100 (worst possible).
- FAST in-lane bus stops in both directions of Cliffdale Road on the eastern leg of the intersection.

Mitigations

Suggested mitigation tools to address some or all of the above issues include:

- Additional signal timing plans when IM response plans active accounting for:
    - School Zone times
- NCDOT-administered towing contract to:
    - Reduce clearance times on I-95, and therefore limit additional risk exposure on IM route
    - Respond to and clear incidents on IM routes
- Coordination with FAST
    - Confirm schedule and frequency
    - Develop alerting process when IM route is activated

Project-Wide Solutions

Smart Work Zone Tools (SWZT)

Through use of the Smart Work Zone Decision Matrix and accompanying support guide, the following Smart Work Zone Tools have been preliminarily identified for use during the construction phase of TIP I-5987.

The only identified SWZT appropriate for TIP I-5987 are STOC-Controlled IM CMS and CCTV Cameras

STOC-Controlled portable CMS are used to display alternate route information ahead of detour points for incidents on the project. These alternate and detour routes are planned so that activation is quick. The positioning of these IM CMSs and CCTV Cameras are coordinated with the TMC/STOC and the Engineer.

These ITS devices provide additional resources to the TMCs for monitoring and managing traffic in and around the work zone especially during unplanned incidents.

Locations and quantities are previously identified in Preliminary Incident Management (IM) Routes section.

HAWKS

The Helping All Work Zones Keep Safe (HAWKS) program dedicates funding for additional NCSHP patrol shifts on high priority work zones. The patrol shifts are used for speed enforcement in critical areas to provide an additional measure of safety for on-site construction workers and queue management. The patrols are assigned on a volunteer basis based on the staffing levels of the troop. Work zone prioritization is based on four (4) scoring categories:

- Tier (e.g. Functional Class)
- Crash Rate

- Average Speed
- Congestion

The ORA identifies categories that this project is likely to score high using the following available planning-level data:

- Functional Class of I-95
- Average Planning Level Safety Score of I-95
- Average Speed of I-95 based on previous 12-months of HERE data (24/7/365)
- Average Congestion (% of FFS) on I-95 based on previous 12-months of HERE data (24/7/365)

The table below summarizes the HAWKS score for I-95.

Table 3 Preliminary HAWKS Scoring Summary

	Tier	Crash Rate	Avg. Speed Score	Congestion Score
Source	Functional Class	Avg. Planning Level Safety Score	RITIS – I-95 Robeson Co.	RITIS – I-95 Robeson Co.
Result	Interstate	64.2 (out of 100)	1-9% Higher than Posted	0-9% below FFS
HAWKS Score	3	3	2	0

The preliminary combined HAWKs score of 8 is high enough to recommend placing this project on the HAWKS Project List. The data used in this ORA is different than that used to calculate the final HAWKs score; therefore, the scoring should be revisited prior to adding to the HAWKS Project List.

Towing Considerations

Fayetteville has several light- and heavy-duty towing companies. Two tow operators are already prequalified for light-duty only and one is prequalified for both light- and heavy-duty operations. There are no prequalified towers in Lumberton or Robeson County. Feedback from NCSHP is that most tow operators in the Lumberton area are not equipped to handle multiple incidents or those with large vehicles.

Based on the various characteristics of the work zone and surrounding area, a NCDOT-administered towing contract is likely the best option. See *Towing Considerations* on page 40.

Due to vulnerabilities on the identified incident management routes, towing along those routes is also suggested.

A NCDOT-Administered Towing Contract is recommended for this construction project for the following reasons:

- The Fayetteville area is expected to provide adequate competition and ample resources.
- A towing contract will augment existing IMAP patrols and potentially allow IMAP to expand patrol areas during construction.
- A towing contractor can be required to operate to support evacuation activities until weather conditions are no longer safe.
- A NCDOT-administered contract will reduce the burden on alternate/detour routes by clearing I-95 faster and can include key alternate routes to keep clear.
- The work zone has existing safety issues and NCDOT-administered towing contracts with prequalified towers are shown improve response and clearance times.

Additionally, Chief Michael McNeill of the Lumberton Police Department is supportive of a towing contract in this area for this construction project.

Additional consideration details are shown in the Towing Considerations Matrix.

Citations

1. National Academies of Sciences, Engineering, and Medicine 2017. *Traffic Signal Preemption at Intersections Near Highway Rail Grade Crossings*. Washington, DC: The National Academies Press. https://doi.org/10.17226/24769.
2. North Carolina General Assembly. *North Carolina General Statutes*. July 13, 2020. Raleigh, NC.

Risk Mitigation Strategy and Tactic Matrix

Identified Risks	Primary Strategy	Secondary Strategy	Tactics (for Consideration)											
			Contract Towing (WZ only)	DOT Towing (may incl. alt routes)	Enhanced IMAP in WZ	Add'l TMC Resource(s)	Queue Mgmt / Dynamic Zip	Median Crossovers / Gates	Alt Route Signal Systems	Dynamic Trailblazers	IMAP on Alt Rtes	Schedule	HAWKS	Ramp Gates
Safety in WZ	QC and IM in WZ	ICM / Enhanced Alt Route	P	S		P		P	S	S	S			
Safety on Alt Routes	QC on Alt Rtes	QC in WZ		P		P					P			
Lack of Alt Routes	QC and IM in WZ	ICM / Enhanced Alt Route	P	S	P	P		P	S	S	S			
Infrequent Access	QC and IM in WZ	Contra-Flow Planning	P		P	P & S		P						
Construction on Alt Routes	Schedule Change	QC and IM in WZ		P		P		P				P – Project Order		
Construction during Hurricane Season (on Evac Route)				P	P							P – Hold Points		
Recurring Congestion in WZ	Keep Alt Route Moving								P	P	P			
High Speeds in WZ (unexpected queuing)	Queue Mgmt	LE Presence					P						S	
High Speeds on Alt Route	LE Presence												P	
Recurring Congestion on Alt Route	QC and IM in WZ		P		P	P								
Truck Restrictions in surrounding network	QC and IM in WZ	ICM / Enhanced Alt Route	P		P	P		P	S	S	S			
NC Truck Network														
School, Bike, Ped on Alt Routes	QC and IM in WZ	ICM / Enhanced Alt Route	P		P	P		P	S	S	S			
Contract Towing not Possible					P – Snatch Truck	P								
Strategic Highway Corridor														

P – Tactic for Primary strategy; S – Tactic for Secondary strategy.

Towing Considerations Matrix

Project Characteristics	Keep As-Is (i.e. Local Rotation)	Enhanced IMAP	NCDOT Administered Towing	Note
New Alignment w/ connections to freeway/interstate ***N/A***	X			Contractor Towing unable to go outside of footprint
High Availability of Towing Companies ***Fayetteville***			X	High competition and ample resources for multiple contracts
Low Availability of Towing Companies ***Lumberton***		X		Low competition. Sticking with one and/or locals provides local knowledge and experience. Using rotation may result in long response times.
Complete Closure (e.g. Bus 40) ***N/A***				Contractor Towing unable to go outside of footprint. Keeps remaining network clear.
No IMAP ***N/A***				Adds resource for Quick Clearance
IMAP Presence ***Yes, on entire stretch of I-95***		X	X	Frees up IMAP for responding elsewhere
No Regional TMC Coverage ***No Regional TMC Coverage***	X			NCDOT Administered Contract requires additional resources (e.g. TIMC, TMC Staffing, ATS, etc.).
Regional TMC Coverage ***N/A***				Resourced to handle additional load caused by NCDOT led contract.
CON cost <$20M ***N/A. Cost > $400M***	X	X		Cost of NCDOT Administered towing likely cost prohibitive.
Hurricane Evac Route ***I-95 serves in-state and out-of-state evacuation traffic***		X	X	Can require NCDOT Administered towing to operate during evacuation until wind speeds exceed safe threshold.
Alt Route Vulnerability (e.g. lack of alt routes, other projects, safety issues) ***Alt routes are 2-lane rural highways. Some have 4-way stops.***		X	X	NCDOT led contract can include key alternate routes to keep clear.
Work area has pre-existing safety issues. ***Most sections of I-95 have a Planning Level Safety Score >66 (e.g. High)***		X	X	Contracts with pre-qualified towers shows improved response and clearance times.
Long Length (miles) of work zone ***18 miles***			X	Towing contracts show more benefit/value the longer the freeway/interstate zones.
Inter-state travel ***Yes***		X	X	Disruptions to routes serving interstate travel/commerce are expected to have broader impacts than disruptions on commuter routes. Local/commuter traffic are generally more knowledgeable about available alternatives, and delays or disruptions have narrower impacts