

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

**Monroe Connector/Bypass
(R-3329/R-2559)**

**Technical Report on Direct,
Indirect and Cumulative Impacts
to Federally Listed Species**

Response to FWS Letter dated December 20, 2012

DRAFT

Prepared for the North Carolina Turnpike Authority



A Division of North Carolina Department of Transportation



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TABLE OF CONTENTS

Table of Contents	iii
Table of Tables	iv
Table of Figures	iv
Table of Maps	v
Table of Appendices	vi
1.0 Introduction	1
1.1 What Is the Proposed Project?	1
1.2 What is the Purpose of this Document?	1
1.3 Why Is this Update Needed?.....	1
2.0 Updates to Direct Impacts to protected species	2
2.1 Updated Carolina Heelsplitter (<i>Lasmigona decorata</i>) Surveys	2
2.2 Updated Endangered Plant Surveys	3
3.0 Update to Indirect Impacts	4
3.1 Why Is an Updated Quantitative Indirect and Cumulative Effects Analysis Needed?	4
3.2 How Is an ICE Analysis Done?	4
3.3 What Is the Study Area for the ICE Analysis?	5
3.4 What Are the Land Use Conditions and Trends in the Study Area?.....	6
3.5 Existing Land Use	17
4.0 Review of Socioeconomic Projections	20
4.1 What Is an MPO?.....	20
4.2 How Did the MPO and CDOT Develop the Projections?.....	24
4.3 How Have Other Studies Used the MRM Socioeconomic Projections	44
4.4 How Do the MRM Socioeconomic Projections Compare to Other Projections?	51
4.5 How Accurate are the MPO Projections?	54
4.6 Conclusions.....	54
5.0 Induced Growth Assessment and Future Land Use Scenarios	57
5.1 How Did the ICE Analysis Project Land Use without the Proposed Project?.....	57
5.2 How Was Project-Induced Growth Estimated?	59
6.0 Updated Land Use Results	67
6.1 What Are the Land Use Results for the Entire Study Area?.....	67
6.2 What are the Land Use Results for Goose and Sixmile Creek Watersheds?	68
6.3 What Are the Indirect Land Use Impacts for Goose and Sixmile Creek Watersheds?.....	69
6.4 How Was Impervious Surface Estimated?.....	69
6.5 What Are the Indirect Impervious Surface and Cumulative Water Quality Impacts?.....	71
6.6 What are the Indirect and Cumulative Impacts to Plant Species?.....	72
6.7 Changes in Traffic Patterns.....	75
6.8 What Are the Indirect and Cumulative Impacts to the Carolina Heelsplitter	78
6.9 Conclusions.....	78
7.0 References	82

TABLE OF TABLES

Table 1: Study Area Watersheds.....	6
Table 2: List of Interviews Completed in 2012 ^a	7
Table 3: Zoning or Other Local Data Collected During Interviews*	9
Table 4: MRM Socioeconomic Projection Versions	25
Table 5: Roles, Factors and Accessibility Considerations of the MRM Socioeconomic Projection Process Components	33
Table 6: Capacity of Allocation Model to Capture Growth Influences	35
Table 7: Dr. Hammer’s Population Projection for the Charlotte Region.....	36
Table 8: Union County Land Development Factors	39
Table 9: Household and Population Projections for the Corridor Study Area (132,436 acres).....	47
Table 10: Change in Household and Population Projections within the Corridor Study Area.....	49
Table 11: Comparison of Population Projections	53
Table 12: Non-Residential Land Use by Employment	59
Table 13: Updated Land Use Scenario Results.....	67
Table 14: Updated Land Use Scenario Results, Sixmile Creek Watershed.....	68
Table 15: Updated Land Use Scenario Results, Goose Creek Watershed	69
Table 16: Percent Impervious Surface for Each Land Use Category	70
Table 17: Updated 2010 Baseline Imperviousness Compared to Previous 2007 Baseline Imperviousness	70
Table 18: Updated 2030 No-Build Imperviousness Compared to Previous No-Build Imperviousness	70
Table 19: Updated 2030 Build Imperviousness Compared to Previous 2030 Build Imperviousness	71
Table 20: Percent Impervious Surface by Watershed and Alternative	71
Table 21: Percent Impervious Cover Results from 2010 Report Compared to 2013 Report.....	71
Table 22: 2012 Clean Water Act §303(d) Impaired Streams by Watershed.....	72
Table 23: Total Conversion of Pasture/ Hay Natural Herbaceous and Barren Land Cover to Developed Land	73
Table 24: County and Regional Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT)	76

TABLE OF FIGURES

Figure 1: Average Annualized Growth Rates Comparison.....	12
Figure 2: Lawyers Road and I-485 Small Area Plan, Land Use.....	15
Figure 3: Union County Future Land Use Plan	16
Figure 4: Land Use Categorization Process.....	19
Figure 5: Four-Step Travel Demand Model and Inputs.....	23
Figure 6: Timeline of MRM Projection Development.....	25
Figure 7: Visualization of LUSAM Workbook Process	28
Figure 8: LUSAM Example, Fairview, 2009 and 2008 Interim Projections, 2015 Horizon Year.....	32

TABLE OF MAPS

- Map 1: Project Location
- Map 2: Study Area Watersheds
- Map 3: Updated Baseline 2010 Land Use Scenario
- Map 4: Charlotte Region MPOs and RPOs
- Map 5: Metrolina Model TAZs by Planning Organization
- Map 6: Travel Time to Employment Center Analysis – Employment Center Locations and Travel Time Results
- Map 7: Difference in Travel Time to Employment Centers Factor from Bottom Up Allocation
- Map 8: Difference in Land Development Factor Composite Score from Bottom Up Allocation
- Map 9: Household Density, 2030 Horizon Year, 2009 Projections
- Map 10: Employee Density, 2030 Horizon Year, 2009 Projections
- Map 11: Kenan Institute Study Zones and ICE FLUSAs
- Map 12: Household Growth by TAZ, 2005 to 2030, 2009 Projections
- Map 13: Employment Growth by TAZ, 2005 to 2030, 2009 Projections
- Map 14: Comparison of Accessibility No-Build vs. Build
- Map 15: Comparison of Accessibility No-Build vs. Build Goose and Sixmile Creek Watersheds
- Map 16: Sanitary Sewer Availability
- Map 17: Updated 2030 No-Build Land Use Scenario
- Map 18: Land Use Change Baseline (Existing) to No-Build, Goose and Sixmile Creek Watersheds
- Map 19: Updated 2030 Build Land Use Scenario
- Map 20: Change in Land Use from No-Build to Build, Goose and Sixmile Creek Watersheds
- Map 21: Land Use Change Baseline to No-Build Effects to Sunflower Populations
- Map 22: Land Use Change No-Build to Build Effects to Sunflower Populations
- Map 23: Raw Model Volumes for No-Build and Build Scenarios, US 601 from Monroe Bypass/Connector to Cabarrus County

TABLE OF APPENDICES

Appendix A	Interview Summaries
Appendix B	Growth Trends and Factors Analysis Memorandum
Appendix C	Kenan Institute Report
Appendix D	Hartgen Analysis
Appendix E	MRM Raw Model Volume Traffic Comparison

1.0 INTRODUCTION

1.1 What Is the Proposed Project?

The North Carolina Turnpike Authority (NCTA), a division of the North Carolina Department of Transportation (NCDOT), in cooperation with the Federal Highway Administration (FHWA), proposes to construct a project known as the Monroe Connector/Bypass. A project which would be a controlled-access toll road extending from US 74 near I-485 in Mecklenburg County to US 74 between the towns of Wingate and Marshville in Union County, a distance of approximately 20 miles. Map 1 shows the proposed project and surrounding area. The proposed action is included in the NCDOT 2009–2015 State Transportation Improvement Program (STIP) as Project R-3329 (Monroe Connector) and Project R-2559 (Monroe Bypass) as a toll facility.

1.2 What is the Purpose of this Document?

NCTA, through this document, is responding to the USFWS December 20, 2012 Letter sent to NCTA which among other items, recommended a re-initiation of consultation under Section 7 of the Endangered Species Act (ESA). Previous coordination on this issue is summarized in the May 25, 2010 Biological Assessment (BA).

This document evaluates previous conclusions regarding direct as well as indirect and cumulative effects (ICE) to federally listed species (threatened and endangered species) associated with the Monroe Bypass/Connector. The following species are listed for Union and/or Mecklenburg Counties: Carolina heelsplitter, Schweinitz's sunflower, Michaux's sumac, and smooth coneflower. The report summarizes updated surveys for these species within the project area as well as the conclusions reached in the evaluation of ICE and describes the data collected, methodologies used and analyses conducted for the ICE for the project. The document also re-evaluates and considers data, analytical research relevant to the project area, and new information relevant to the analysis of the indirect and cumulative effect on land use, water quality, and federally designated threatened and endangered species and their critical habitat. Since the Carolina heelsplitter lives in two watersheds in the study area, water quality is a major focus area of this analysis. Thus, results for the watershed level are provided in this update. As the listed plant species are generally found in opened habitats, ICE analysis for these species focuses on potential land use changes associated with the project.

1.3 Why Is this Update Needed?

As stated previously, Section 7 consultation for the Monroe Connector/Bypass was summarized in the May 2010 Biological Assessment. NCTA previously analyzed indirect and cumulative effects of the Detailed Study Alternatives for the proposed action through a Qualitative Indirect and Cumulative Effects Assessment (Qualitative ICE) completed for the Draft Environmental Impact Statement (DEIS Chapter 7) and incorporated into the Final Environmental Impact Statement (FEIS Appendix G). This analysis was expanded and extended for the Preferred Alternative through a Quantitative Indirect and Cumulative Effects Analysis for Land Use (Quantitative ICE) and Quantitative Indirect and Cumulative Effects Water Quality Analysis (WQA) completed for the Final Environmental Impact Statement (FEIS Appendices H & I). These reports were summarized in Section 2.5.5 of the FEIS and together these reports comprise the FEIS ICE analysis and conclusions. In August 2010, FHWA issued a Record of Decision (ROD) selecting Detailed Study Alternative D (DSA D) as the Selected Alternative for the proposed action based on the

analysis of the DEIS and FEIS showing that this alternative had lower overall impacts to the natural environment and residential areas compared to other alternatives.

In November 2010, The North Carolina Wildlife Federation, Clean Air Carolina and Yadkin Riverkeepers (Plaintiffs) filed suit to overturn the ROD. The U.S. District Court for the Eastern District of North Carolina decided the case in October 2011, finding for FHWA and NCTA that the FEIS was sufficient. Plaintiffs appealed the decision to the U.S. Court of Appeals for the Fourth Circuit and the appellate court vacated the District Court decision on May 3, 2012. The FHWA rescinded its ROD for the project on July 3, 2012 in response to the appeals court decision.

The primary purpose of this report is to provide an update to the US Fish and Wildlife Service (USFWS) on the direct, indirect and cumulative impacts to federally listed species. This includes a substantial update to the FEIS summary of the quantitative ICE effects documented in the FEIS Appendix H. This document will:

1. Review the direct impacts to species and updates surveys of the corridor (Section 2.0)
2. Review the scope of the ICE analysis and conditions and trends in the study area, including the existing land use scenario (Section 3.0)
3. Review the Metrolina Regional Model socioeconomic projections, including how other studies have used the projections, and evaluate the most appropriate use of those projections within the framework of the ICE analysis (Section 4.0)
4. Explain the methods used to estimate induced growth and develop the future land use scenarios (Section 5.0)
5. Report revised induced growth results and conclusions based on the updated land use scenarios (Section 6.0)
6. Review measures that localities and others could adopt to minimize any impacts of future development, whether induced or not, on sensitive environmental resources (Section 7.0).

This report summarizes the conclusions reached in the evaluation of direct, indirect and cumulative effects to species and describes the data collected, methodologies used and analysis. This document also re-evaluates and considers data, analytical research relevant to the project area, and new information relevant to the analysis of the indirect and cumulative effect on land use, water quality, and federally designated threatened and endangered species and their critical habitat in the surrounding area.

2.0 UPDATES TO DIRECT IMPACTS TO PROTECTED SPECIES

2.1 Updated Carolina Heelsplitter (*Lasmigona decorata*) Surveys

Carolina heelsplitter surveys were conducted in 2012.¹ The locations for the 2012 mussel surveys were determined by overlaying the location of potential effects and/or impacts within the Future Land Use Study Area (FLUSA) with streams identified during the 2009 surveys that contain a robust freshwater mussel population that could potentially support the Carolina heelsplitter. Accordingly, South Fork Crooked Creek and Stewarts Creek in the vicinity of the project alignment, and portions of Crooked Creek and Richardson Creek within the FLUSA were surveyed.

¹ *Freshwater Mussel Survey Report Update* (October 26, 2012), prepared by The Catena Group.

Overall the results of the 2012 survey efforts are very similar to the 2009 surveys, and as was the case in 2009, the Carolina heelsplitter was not found in any of the surveyed streams. Differences between the two survey efforts are more likely a result of differences in time of year and survey conditions, rather than an indication of changes in mussel abundances. For example, while the Savannah lilliput was found in low numbers (3 individuals) in Richardson Creek in 2009, it was not located in 2012, but is likely still present. There was a large amount of leaf pack covering the substrate of Richardson Creek in 2012 generally making surveying difficult. This coupled with the very small size of the Savannah lilliput (< 2 inches) is likely the reason it was not detected. The fact that most of the other species occurring in Richardson Creek were found in similar numbers further supports this assumption. Furthermore, the difficulty of detecting a species that is present in low numbers during a one-time survey is highlighted by the fact that the Paper pondshell was found (one individual) in Richardson Creek in 2012, but not in 2009, although it was known from the stream prior to 2009 (North Carolina Wildlife Resources Commission [NCWRC] Unpublished Aquatic Species Database).

2.2 Updated Endangered Plant Surveys

Surveys were performed 2012 for Schweinitz's sunflower (*Helianthus schweinitzii*) and Michaux sumac (*Rhus michauxii*).² The survey area was the final proposed design footprint for the Monroe Connector/Bypass, including all utility relocations. No previously unknown populations of any of the species were found.

² *Updated T&E Plant Species Field Review* (October 9, 2012), prepared by Atkins

3.0 UPDATE TO INDIRECT IMPACTS

3.1 Why Is an Updated Quantitative Indirect and Cumulative Effects Analysis Needed?

This report summarizes the conclusions reached in the evaluation of ICE and describes the data collected, methodologies used and analysis conducted for the ICE for the project. This document also re-evaluates and considers data, analytical research relevant to the project area, and new information relevant to the analysis of the indirect and cumulative effect on land use, water quality, and federally designated threatened and endangered species and their critical habitat in the surrounding area.

3.2 How Is an ICE Analysis Done?

The National Environmental Policy Act of 1969, as amended (NEPA), the North Carolina State Environmental Policy Act (SEPA), and the United States Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] Parts 1500-1508) identify assessment of indirect and cumulative effects as a necessary component of environmental impact assessment for major Federal actions. The ICE analysis to evaluate potential land use changes and environmental effects associated with the Monroe Connector/Bypass project followed a process contained in guidance released in 2001 by the North Carolina Department of Transportation (NCDOT), in consultation with the North Carolina Department of the Environment and Natural Resources (NCDENR), the North Carolina State Attorney General's Office and the Association of Municipalities entitled *Guidance for Assessing Indirect and Cumulative Impacts for Transportation Projects in North Carolina, Volume I: Guidance Policy Report and Volume II: Practitioners' Handbook*.³ In this guidance document, the agencies agreed to the following steps that should be taken to thoroughly assess indirect and cumulative impacts.

- Step 1: Definition of the Future Land Use Study Area
- Step 2: Identification of the FLUSA's Direction and Goals
- Step 3: Inventory of Notable Features
- Step 4: Identification of Important Impact Causing Activities
- Step 5: Identification and Analysis of Potential Indirect/Cumulative Effects
- Step 6: Analyze Indirect/Cumulative Effects
- Step 7: Evaluate Analysis Results
- Step 8: Assess the Consequences and Develop Appropriate Mitigation and Enhancement Strategies.

The first five steps are undertaken for a qualitative ICE study. The last three steps are undertaken if a quantitative study is required. The ICE analysis previously conducted for the Monroe Connector/Bypass project included a qualitative analysis for inclusion and publication in the DEIS and a quantitative analysis for inclusion and publication in the FEIS.

FHWA and NCTA presented the results of the analysis of the first five steps in a Qualitative ICE, which was included in the DEIS and the FEIS as Appendix G. Based on a review of data and information available since that report was completed, the results and conclusions in the FEIS Appendix G would not

³ NCDOT and NCDENR. *Guidance for Assessing Indirect and Cumulative Impacts for Transportation Projects in North Carolina, Volume I: Guidance Policy Report and Volume II: Practitioners' Handbook*. November 2001.

be significantly different or introduce new significant impacts or information, which were not previously considered.

Subsequently, a Quantitative ICE was developed following steps six through eight and was presented in FEIS Appendix H. Because of new data, information and the results of the Fourth Circuit of the United States Court of Appeals, FHWA and NCTA have reanalyzed steps six through eight in this updated Quantitative ICE. The scope of this Quantitative ICE includes analysis of the potential of increased indirect and cumulative effects on water resources, threatened and endangered species, and in response to agency and public comment on the DEIS. The decision to use watersheds as boundaries to quantitatively analyze effects, instead of the zones presented in the Qualitative ICE, was made due to the water quality concerns expressed by resource agencies. Watershed boundaries were also used for analysis for compliance with Section 7 of the ESA. Land use changes within watersheds were analyzed first and those results were used to estimate changes in water quality and impacts on the federally protected species. Because the Carolina heelsplitter mussel is an aquatic species, this report includes an evaluation of potential ICEs to water quality in Goose Creek and Sixmile Creek. Map 2 shows each watershed within the project study area.

The Quantitative ICE analysis addresses the potential land use changes associated with the proposed project by developing three land use scenarios associated with the following conditions:

- **Existing (or Baseline) Land Use Scenario:** A scenario that reflects the land use conditions as they existed in 2010 to provide a basis for comparison for cumulative impacts assessment.
- **No-Build Land Use Scenario:** A scenario that reflects the best estimate of land use development conditions in 2030 if the proposed project is not built based on the assumptions and methods used in this report.
- **Build Land Use Scenario:** A scenario that reflects the best estimate of land use development conditions in 2030 if the proposed project is built based on the assumptions and methods used in this report.

3.3 What Is the Study Area for the ICE Analysis?

The NCDOT ICE Guidance indicates that the development effects of a new or improved roadway facility are most often found within one mile of an interchange, and approximately two to five miles along major intersecting roadways to the interchange. Using the ICE Guidance, it was determined for the purposes of the Draft EIS that the potential for ICE exists within about five miles of the various project alignments, which for the purpose of the study were evaluated as a single Build Alternative. This approximate five-mile radius is depicted in the Draft EIS, Figure 7-1, and is referred to in the Draft EIS and the Qualitative ICE Assessment as the FLUSA.

Based on coordination with USFWS and other agencies, the DEIS FLUSA was expanded to include all of the Goose Creek watershed (14-digit Hydrologic Unit 03040105030020) as well as the headwaters of some of the area streams in the FLUSA. The Goose Creek watershed is located at its closest point approximately one mile north of the proposed project in northwestern Union County. Although some of the FLUSA watersheds overlap Anson County, the FLUSA was not expanded into Anson County because it lies outside the five-mile radius and does not contain special resources noted in comments on the Draft EIS. This expanded FLUSA is the area within which the Build Alternatives have the potential to affect the

resources that are the subject of this report (water quality, threatened and endangered species, and land use). The expanded FLUSA is depicted in Map 1. The watersheds within the Study Area that are the subjects of this report are shown in Map 2 and area of each watershed within the study area is listed in Table 1; the Goose Creek watershed is the relatively large watershed along the northern border.

Table 1: Study Area Watersheds

Watershed Name	Area (Square Miles)
Sixmile Creek	2.6
Goose Creek	42.3

3.4 What Are the Land Use Conditions and Trends in the Study Area?

To understand existing land use conditions and estimate future land use conditions, a review and assessment of land use conditions, land use regulations, growth trends, growth factors and other factors was completed. Much of this analysis was already completed in the original Quantitative ICE analysis. Additional background research for this Quantitative ICE updated included:

- Updated interviews with local planners
- The 2010 Census and growth trends and conditions in the study area
- Additional development activity
- New planning documents (such as new land use plans and new capital improvement plans).

Interviews

In 2008, the study team interviewed planners with local jurisdictions within the FLUSA, such as the Council of Governments (COG) and city, county and town planning department representatives, as part of the Qualitative ICE Assessment. In August 2009, the study team interviewed with the same organizations as part of the FEIS Quantitative ICE, with follow-up questions as necessary. In September 2012, the study team interviewed representatives of the same organizations again to determine if any new information was available to inform the update of the ICE analysis. Table 2 lists the organization that was the focus of these recent interviews, the individual respondents, and the dates of contact. Those contacts whose jurisdictions include portions of Goose Creek or Sixmile Creek are italicized. The study team was unable to schedule an interview with the mayor of Hemby Bridge. Additionally, the project team was unable to meet with staff from Lake Park, but their most recent Unified Development Ordinance for the Village of Lake Park was obtained.

Each interview began with an introduction of the study and its purpose. A map of the study area was provided to facilitate communication, as were past interview summaries as applicable. The purpose of the interviews was to identify changes to future land use scenarios since the 2009 interviews for the Quantitative ICE and gather any new or updated databases or GIS data that would be useful to the analysis. The following data was requested:

- Approved developments
- Updated zoning
- Information on current stream buffer or other environmental protection areas
- Water and sewer utility information
- Water and sewer priority areas
- Future land use projections

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

- Existing land use
- Approved population and employment projections and anticipated variations from projections with each land use scenario.

Table 2: List of Interviews Completed in 2012^a

Organization	Respondent	Date of Interview
Town of Wingate	Patrick Niland – Town Manager	September 6, 2012
<i>Centralina COG</i>	<i>Diane Dil – Centralina Planner I</i>	<i>September 12, 2012</i>
<i>Town of Matthews</i>	<i>Kathi Ingrish – Planning Director</i>	<i>September 10, 2012</i>
<i>Town of Unionville</i>	<i>Sonya Gaddy – Land Use Administrator</i>	<i>September 11, 2012</i>
<i>Union County Planning</i>	<i>Amy Helms – Water and Land Resources Division Manager</i> <i>Scott Huneycutt – Engineering Division Manager</i> <i>Richard “Dick” Black – Planning Director</i>	<i>September 12 & 19, 2012</i>
Town of Marshville	Amanda Reid – Town Manager	September 12, 2012
<i>Town of Indian Trail</i>	<i>Shelley DeHart – Director of Planning and Neighborhood Services</i> <i>Adam McLamb, Civil Engineer</i>	<i>September 14, 2012</i>
<i>Town of Mint Hill</i>	<i>John Hoard - Planner</i>	<i>September 14, 2012</i>
<i>Town of Weddington</i>	<i>Jordan Cook - Town Planner and Zoning Administrator</i>	<i>September 25, 2012</i>
Town of Wesley Chapel	Josh Langen – Planning and Zoning Administrator	September 12, 2012
<i>Charlotte – Mecklenburg Planning</i>	<i>Debra Campbell – Director, Charlotte-Mecklenburg Planning Department</i>	<i>September 14, 2012</i>
City of Monroe	Doug Britt – Senior Planner	September 11, 2012
<i>Town of Fairview</i>	<i>Ed Humphries – Land Use Administrator</i>	<i>September 11, 2012</i>
<i>Town of Stallings</i>	<i>Brian Matthews – Town Manager</i> <i>Lynne Hair – Town Planner</i>	<i>September 14, 2012</i>
Union County Partnership for Progress*	Gretchen Carson – Planner Melanie O’Connell Underwood – Interim Director	September 27, 2012
Union County Planning*	Richard “Dick” Black – Planning Director	January 21, 2013
CSX Corporation*	Vance E. Bennett Jim Van Derzee	November 29-30, 2012

^a - Italics indicates contacts representing portions of the Goose Creek or Sixmile Creek watersheds

* Contacted after the initial round of interviews to obtain information on the Proposed Legacy Park Development

Prior to the discussion, staff provided a list of the questions to the respondents. Appendix A contains complete minutes from all of the interviews. The following 11 questions were asked during interviews with local planners:

1. *The August 2009 interview covered land use and economic development trends, growth management and natural resource protection – in general, have any of these dynamics affecting future land use changed since the previous interview?*

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

2. *Have any changes to future land use plans, transportation plans or other plans, policies or projections been made that incorporate information from the 2010 Census?*
3. *Have new or amended land use regulations been developed since August of 2009? Please see the list we have provided of documents we collected and reviewed during the previous environmental documentation effort. Are there any updates to those plans or regulations? If there have been any changes, please provide specific web link or a copy of the document.*
4. *Has the local regulation of natural resources (including stream buffers) changed since August 2009? If so, how?*
5. *What can you tell us about any proposed or approved developments that have come to light since the August 2009 interviews? What information is available about any of these planned or approved developments that are not built yet? Can you provide any details and locations for these projects?*
6. *Have long-term growth expectations changed since the previous interview and if so how?*
7. *Has the city/town/county updated its Comprehensive Plan or Land Use plan since August 2009?*
 - o *If so, does this updated plan reflect conditions in the future with or without the Monroe Connector/Bypass?*
8. *We are reviewing and considering the predictions of future growth (2030 forecast year) included in the previous EIS. Are there any other factors that have changed since August 2009 that might affect the level of future growth and the location of that growth in your community?*
 - o *Do these changes reflect the future with the Monroe Connector/Bypass, without the Monroe Connector/Bypass, or is there no difference on that basis?*
9. *Have there been any changes in capacity of utility infrastructure or expectations about the future capacity since the last round of interviews? Do any of those changes affect growth expectations?*
10. *Are you or other planners or development review staff familiar with the North Carolina Wildlife Resources Commission “Green Growth Toolbox”? (<http://216.27.39.101/greengrowth/>)*
 - o *Have you attempted to implement any of the practices, ordinances or other policies recommended by the toolbox?*
 - o *Have you attempted to incorporate any other low-impact design type policies into zoning, subdivision or other land development ordinances?*
 - o *How would you rate the likelihood of incorporating any low-impact design principles in future regulations or plans?*

Supplemental questions were asked pertaining to the specific interviewee’s location or expertise. Face-to-face interviews were conducted to the extent practical. The interviews generally took between 30 and 60 minutes to complete. Notable information included:

- Often, zoning maps provided the best representation of current land use, while land use plans provided the best representation of future land use. Much of this information was available as geographic information systems (GIS) data.
- Some land use plans were in the process of being updated and were not yet available for this study. For example, Indian Trail was in the process of updating their Comprehensive Land Use Plan. Marshville indicated that the next update of their land use plan would include the Monroe Bypass/Connector. The City of Monroe was developing the US 74 Corridor revitalization Plan, which included the Monroe Bypass/Connector in its assumptions. Older land use plans tended not to include the Monroe Connector/Bypass, while the updated plans usually included the project.

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

- Based on the 2010 Census, the Mecklenburg-Union Metropolitan Planning Organization (MUMPO) Urbanized Area is expanding to include Marshville.
- Mecklenburg County now administers the Goose Creek Management Plan⁴
- Goose Creek Water Quality Recovery Program Plan for the Fecal Coliform Total Maximum Daily Load TMDL was revised in 2010. This is a plan to reduce fecal coliform impairments based on the TMDL report completed in 2005.
- Areas in the eastern portion of the study area were more likely to indicate that their future plans included the Monroe Connector/Bypass and that the implementation of certain aspects of their plans was contingent on the development of the facility.
- Water and Sewer moratoria were rescinded in Union County in 2012.⁵

Plans and Ordinances

Specific documents or information obtained during the interview process are summarized in Table 3.

In addition, Charlotte Department of Transportation (CDOT) staff were interviewed on June 19, 2012 to discuss the Traffic Analysis Zone (TAZ) projections and any updates to their data since they were developed in 2008. Further communications were conducted with CDOT staff as this report was prepared. Summaries of that interview and follow up communications are provided in Appendix A along with the interviews listed in Table 3.

Table 3: Zoning or Other Local Data Collected During Interviews*

Jurisdiction/Area	Document	Year
<i>Goose Creek Watershed</i>	<i>Goose Creek Water Quality Recovery Program Plan for the Fecal Coliform TMDL</i>	<i>2010</i>
City of Monroe	Zoning Ordinance	Modified 2010
	List of Current Developments	Modified 2009
Village of Lake Park	Unified Development Ordinance	Draft 2012
Town of Unionville	<i>Zoning Map</i>	<i>Updated 2011</i>
	<i>Future Land Use Map</i>	<i>2005</i>
	<i>Zoning Amendments</i>	<i>Modified 2012</i>
Town of Fairview	<i>Future Land Use Map</i>	<i>Modified 2010</i>
	<i>Land Use Ordinance</i>	<i>Updated 2009</i>
Town of Stallings	<i>Unified Development Ordinance</i>	<i>Adopted 2012</i>
	<i>Post Construction Ordinance</i>	<i>Adopted 2010</i>

⁴ This is a plan to guide restoration, retrofit and preservation efforts aimed at achieving specific goals for improving water quality conditions in the Goose Creek Watershed in Mecklenburg County such that these waters meet or exceed their State designated uses and are no longer rated as impaired on 303(d) lists. *Goose Creek Watershed Management Plan*. Charlotte-Mecklenburg Storm Water Services. October 31, 2009.

<http://charmeck.org/stormwater/Projects/Documents/GooseCreekWatershedManagementPlan.pdf>

⁵ Rescinding the moratorium may increase the short-term development activity within the study area, however, long-term growth is more dependent on long planned capital facilities expansions for water and sewer capacity, which have already been analyzed and considered in the Indirect and Cumulative Effects Analysis. Therefore, this change in policy does not affect long-term growth trends in the study area.

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

Jurisdiction/Area	Document	Year
<i>Town of Mint Hill</i>	<i>Unified Development Ordinance</i>	<i>Adopted 2011</i>
	<i>Lawyers Road & I-485 Small Area Plan</i>	<i>Adopted 2011</i>
	<i>Pedestrian Master Plan</i>	<i>Adopted 2011</i>
<i>Town of Marshville</i>	<i>Urbanized Area Expansion</i>	<i>Updated 2010</i>
	Comprehensive Pedestrian Plan	<i>Adopted 2010</i>
	Comprehensive Transportation Plan	<i>Updated 2010</i>
<i>Town of Wingate</i>	<i>Land Use Ordinance</i>	<i>Updated 2010</i>
	Wingate 2020 Plan (Comprehensive Plan and Concept Plan)	<i>Adopted 2010</i>
	<i>Wingate Mixed Use Center Plan</i>	<i>Draft 2012</i>
<i>Town of Weddington</i>	<i>Local Area Regional Transportation Plan</i>	<i>Updated 2009</i>
	<i>Land Use Map</i>	<i>Modified 2012</i>
	<i>Zoning Map</i>	<i>Modified 2011</i>
	<i>Land Use Plan</i>	<i>Modified 2011</i>
<i>Village of Wesley Chapel</i>	<i>Flood Damage Prevention Ordinance</i>	<i>Updated 2009</i>
	<i>Subdivision Ordinance</i>	<i>Updated 2011</i>
	<i>Western Union County Local Area Regional Transportation Plan</i>	<i>Prepared 2009</i>
	<i>Zoning Ordinance</i>	<i>Updated 2012</i>
<i>Town of Matthews</i>	<i>Zoning Code</i>	<i>Modified 2010</i>
	<i>Unified Development Ordinance</i>	<i>Draft 2012</i>
	<i>Downtown Master Plan</i>	<i>Draft 2012</i>
	Town of Matthews Land Use Plan	<i>Draft 2012</i>
	<i>Demographic/Economic Update</i>	<i>Prepared 2012</i>
<i>Charlotte-Mecklenburg</i>	<i>Growth Framework</i>	<i>Adopted 2010</i>
	<i>FY 2013-2017 Capital Improvements, including 10-Year Needs for Water and Sewer Projects</i>	<i>Updated 2012</i>
	<i>Water Quality Buffer Implementation Guidelines</i>	<i>Updated October 2011</i>
	<i>Floodplain Ordinance</i>	<i>Adopted 2012</i>
<i>Union County</i>	<i>Water Allocation Policy</i>	<i>Updated 2012</i>
	<i>Sewer Policy</i>	<i>Updated 2012</i>
	<i>Union County Water and Sewer Extension Ordinance</i>	<i>Updated 2012</i>
	<i>Carolina Thread Trail Master Plan</i>	<i>Adopted 2011</i>
	<i>Union County Land Use Ordinance</i>	<i>Adopted 2008</i>
	<i>Union County Thoroughfare Plan</i>	<i>Updated 2008</i>

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and Cumulative Impacts to Federally Listed Species*

Jurisdiction/Area	Document	Year
	<i>Union County 2025 Comprehensive Plan</i>	<i>Adopted October 2010</i>
	<i>Comprehensive Water and Wastewater Master Plan</i>	<i>December 2011</i>
	<i>US 74 Corridor Revitalization Study</i>	<i>Underway</i>

*Bolded documents include the Monroe Connector/Bypass

Growth Trends and Factors

A review of critical growth factors and trends indicates that Union County maintains a number of advantages relative to other suburban jurisdictions in the region. These growth trends and factors are discussed in detail in Appendix B. First, Union County has more land available for development than Mecklenburg, Gaston or Cabarrus counties. Union County has the highest median income of all surrounding counties, it has affordable housing relative to its median income level, and it has one of the best school districts in the region based on SAT scores and graduation rates. In terms of commute times, the interesting trend is that despite having one of the highest average commute times over the last decade, Union County has grown faster than any other county in the region. This finding suggests that factors other than accessibility to jobs are encouraging households to choose to locate in Union County. For the past decade, Union County has exhibited strong growth, and the factors driving those trends are poised to continue attracting growth to Union County regardless of whether the Monroe Connector/Bypass is constructed.

These findings are further supported by the analysis of the Operations Research and Education Laboratory of the Institute for Transportation Research and Education at North Carolina State University’s February 28, 2007 *Land Use Study Final Report 2006-2007*. In its research on behalf of the Union County Public Schools, it described the leading factor of growth in Union County as its location within the Charlotte-Mecklenburg region. The Operations Research and Education Laboratory of the Institute for Transportation Research and Education determined the western area of Union County continues to experience a substantial population increase as a result of its desirable location. Marvin, Waxhaw, Weddington, Wesley Chapel and other western Union County suburbs continue to experience high demand for single-family homes. The report also listed the following other factors contributing to growth in Union County:

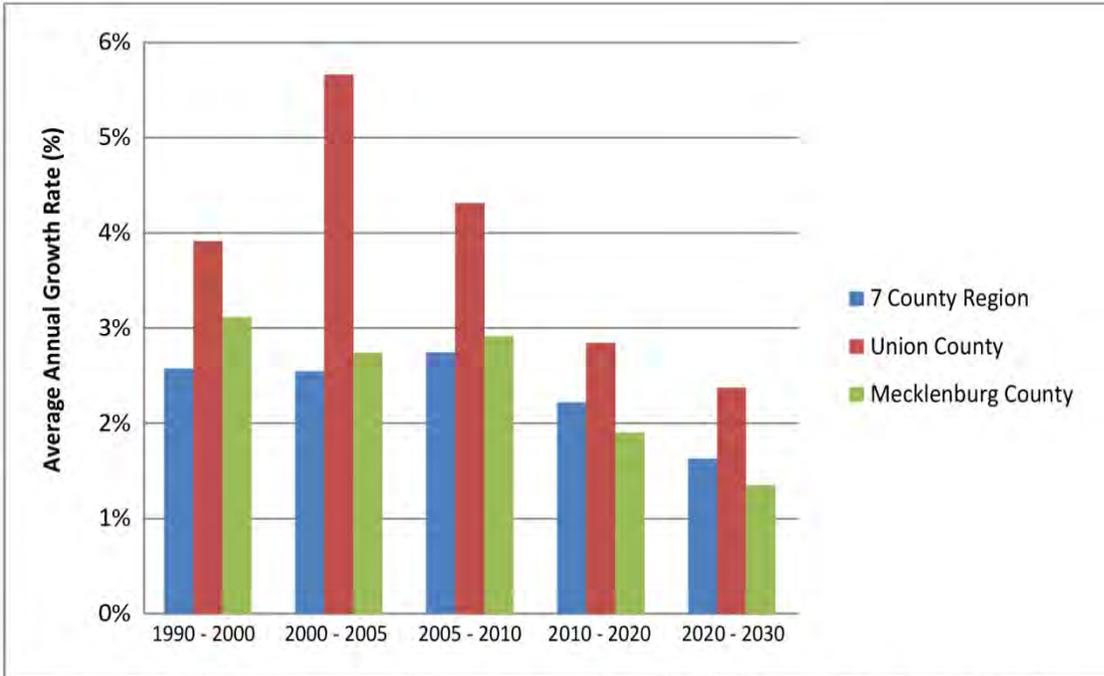
- Low taxes
- Good quality schools
- Comparatively reasonable land prices.

The report described the availability and cost of undeveloped land as a factor of future growth in the western part of the county. It concluded that a reduction in raw land would lead development in the eastern part of the county. The report described the eastern expansion of growth towards Monroe as constrained by a lack of easy access to Charlotte and Mecklenburg County.

Lastly, a review of current growth trends and projected growth trends suggests that while growth has slowed in Union County since 2005, it has still grown at a pace above the regional average. While the MPO projections still foresees a growth rate above the regional average into the future, the projected

growth rate is expected to decline dramatically. To reach the projected 337,317 estimate of population by 2030, growth in Union County would have to slow to an average annualized growth rate of 2.6 percent, based on the 2010 Census count. Figure 1⁶ shows the differences in average annual growth rates across the five different periods (1990 to 2000, 2000 to 2005, 2005 to 2010, 2010 to projected 2020 and projected 2020 to projected 2030). The difference between 2000-2005, 2005-2010, 2010-2020 and 2020-2030 average annual growth rates reflects a typical “s-curve” of decreasing growth rates over time as a population base expands.

Figure 1: Average Annualized Growth Rates Comparison



Note: The adopted MUMPO forecasts for whole counties are only available for Cabarrus, Gaston, Lincoln, Mecklenburg, Rowan, Union and York Counties.

Sources: US Census 2000 and 2010, MUMPO 2009 Socioeconomic Forecasts

Specific Updates from Prior Quantitative ICE Analysis

Jurisdictions within Portions of Goose and Sixmile Creek Watersheds

Based on the interviews and review of documents provided by local jurisdictions, this section outlines the new information that prompted modifications to the future land use scenarios compared to the prior Quantitative ICE analysis.

Charlotte/Mecklenburg County: There were no major changes to growth expectations or land use plans. Local planners did note one subdivision and zoning update of a 24-acre parcel on land that previously was identified as Industrial or Undeveloped in the future scenarios of the last Quantitative ICE analysis. The area is now expected to develop as High Density Residential in the future under any scenario.

⁶ Figure 1 compares growth rates to a 7 county region as the TAZ level forecasts for whole counties are only available for Cabarrus, Gaston, Lincoln, Mecklenburg, Rowan, Union and York Counties.

Matthews: There were no major changes in growth expectations or land use plans. Local planners did note one zoning change and one planned land use change affecting about 275 acres of land. These changes affected land that was previously identified as Low Density Residential Development or Undeveloped in the future scenarios of the last Quantitative ICE analysis. These areas were now expected to develop as Commercial, High Density Residential or Low Density Residential Development in the future under any scenario.

Mint Hill: There were no major changes in growth expectations but some changes to land use plans as a small area plan has been developed for the area around Lawyers Road and I-485 (see Figure 2).⁷ The entire small area plan covers over 1,200 acres of land. In the prior Quantitative ICE analysis, most of this area was already designated as developed, as either Commercial or Low Density Residential. With the new information, some of the land previously identified as Low Density Residential is now identified as Medium Density Residential, Commercial, Institutional or Undeveloped (in the case of those areas identified as Open Space in the Small Area Plan). Mint Hill staff indicated in their interview that the developer will use best management practices to minimize stormwater impacts to Goose Creek.

Stallings: There were no major changes in growth expectations, land use plans or zoning that would necessitate adjustments to the ICE land use scenarios.

Indian Trail: There were no major changes in growth expectations or land use plans. One zoning change involves a 28-acre development. In the prior Quantitative ICE analysis, this area had been identified as a Low Density Residential Area. This area is now being zoned as Commercial and is expected to develop as Commercial under any scenario.

Fairview: The town has adopted a new land use plan with some important changes. Specifically the town has added some commercial nodes at major intersections and is working with the County on expanding water and sewer availability at the US 601 and NC 218 intersection. The new land use plan calls for a commercial district at this intersection as well as at NC 218 and Mill Grove Road (SR-1525) and at US 601 and Lawyers Road (SR-1612). The new land use plan also calls for a new Industrial node along Price Tucker Road (SR-1603) and at NC 218 and Old Dutch Road (SR-1542). All of these new nodes are expected to develop with or without the Monroe Connector/Bypass. In the prior Quantitative ICE analysis, these areas were expected to be Low Density Residential and Undeveloped areas. These areas are now expected to develop as Commercial and Industrial areas under any scenario.

Union County: The County has adopted a new land use plan that provides more detailed information on growth expectations in the eastern end of the county if the proposed project is built (see Figure 3).⁸ Growth expectations are not changing in the Goose and Sixmile Creek watersheds, thus there were no changes to the land use conditions in the watersheds due to this new information.

Jurisdictions outside of Goose Creek and Sixmile Creek Watersheds

Wesley Chapel: There were no major changes in growth expectations, land use plans or zoning that would necessitate adjustments to the ICE land use scenarios.

Stallings: There were no major changes in growth expectations, land use plans or zoning that would necessitate adjustments to the ICE land use scenarios.

⁷ *Lawyers Road & I-485 Small Area Plan*, Future Land Use Map

⁸ *Union County 2025 Comprehensive Plan*, p 33

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

Monroe: There were no major changes in growth expectations or land use plans that would necessitate adjustments to the ICE. Local planners noted that there were zoning changes affecting parcels totaling about 80 acres that were previously identified as Low Density Residential in the previous Quantitative ICE analysis but that would now be expected to develop as Institutional and Commercial under any scenario.

Wingate: There were no major changes in expectations, land use or zoning requiring adjustments to the ICE. The previously Quantitative ICE analysis used the town zoning to determine the most appropriate allocation and density of development under a No-Build Scenario. For the Build Scenario in the prior Quantitative ICE analysis, the study team incorporated many of the proposed zoning changes noted in the Strategic Plan for Economic Development, Town of Marshville, Town of Wingate (2008) as this plan assumes construction of the Monroe Connector/Bypass. These assumptions appear to remain reasonable and valid based on discussions with local planners.

Marshville: There were no major changes in growth expectations, land use plans or zoning that would necessitate adjustments to the ICE land use scenarios (see Wingate discussion above).

Figure 2: Lawyers Road and I-485 Small Area Plan, Land Use

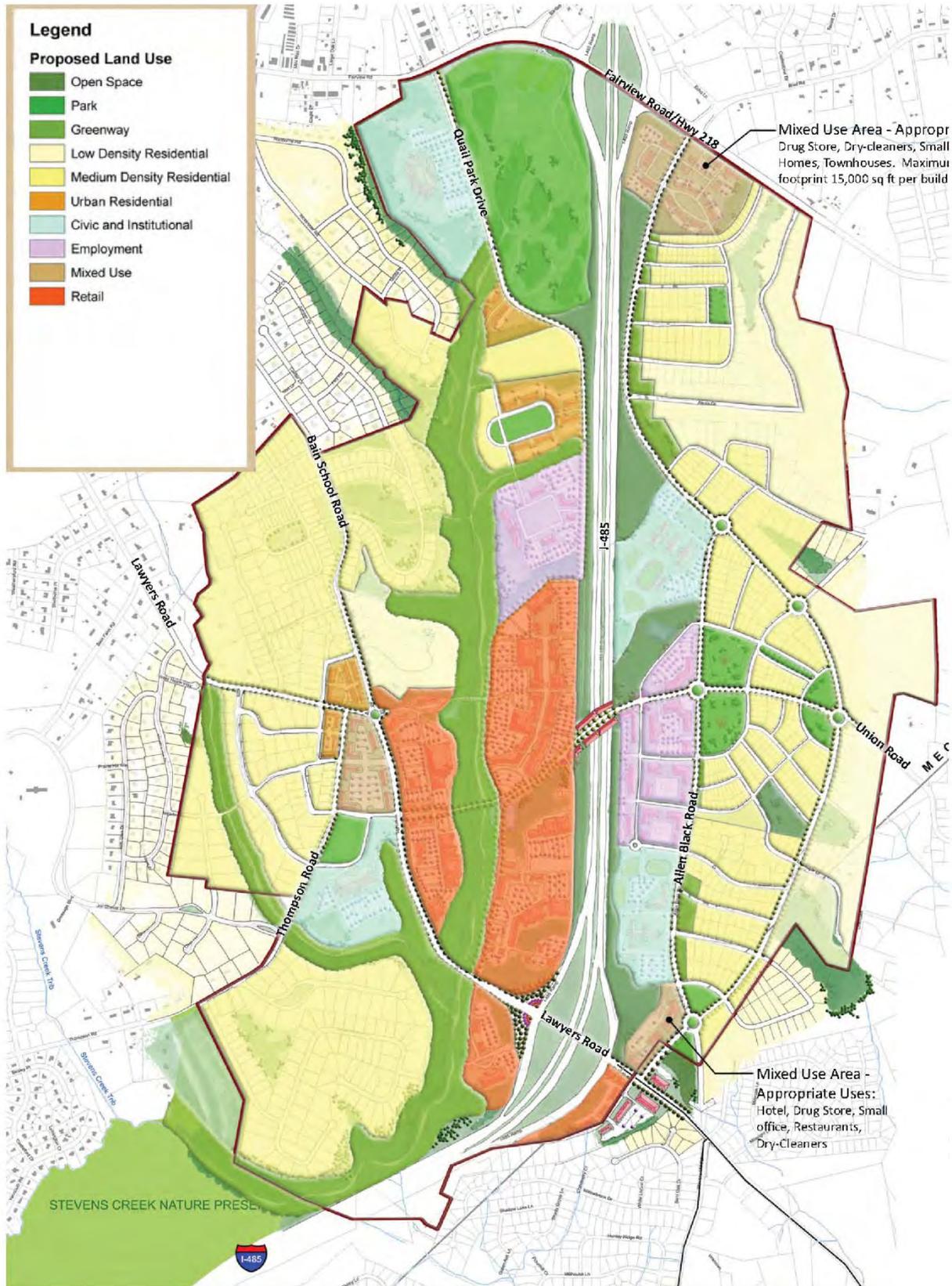
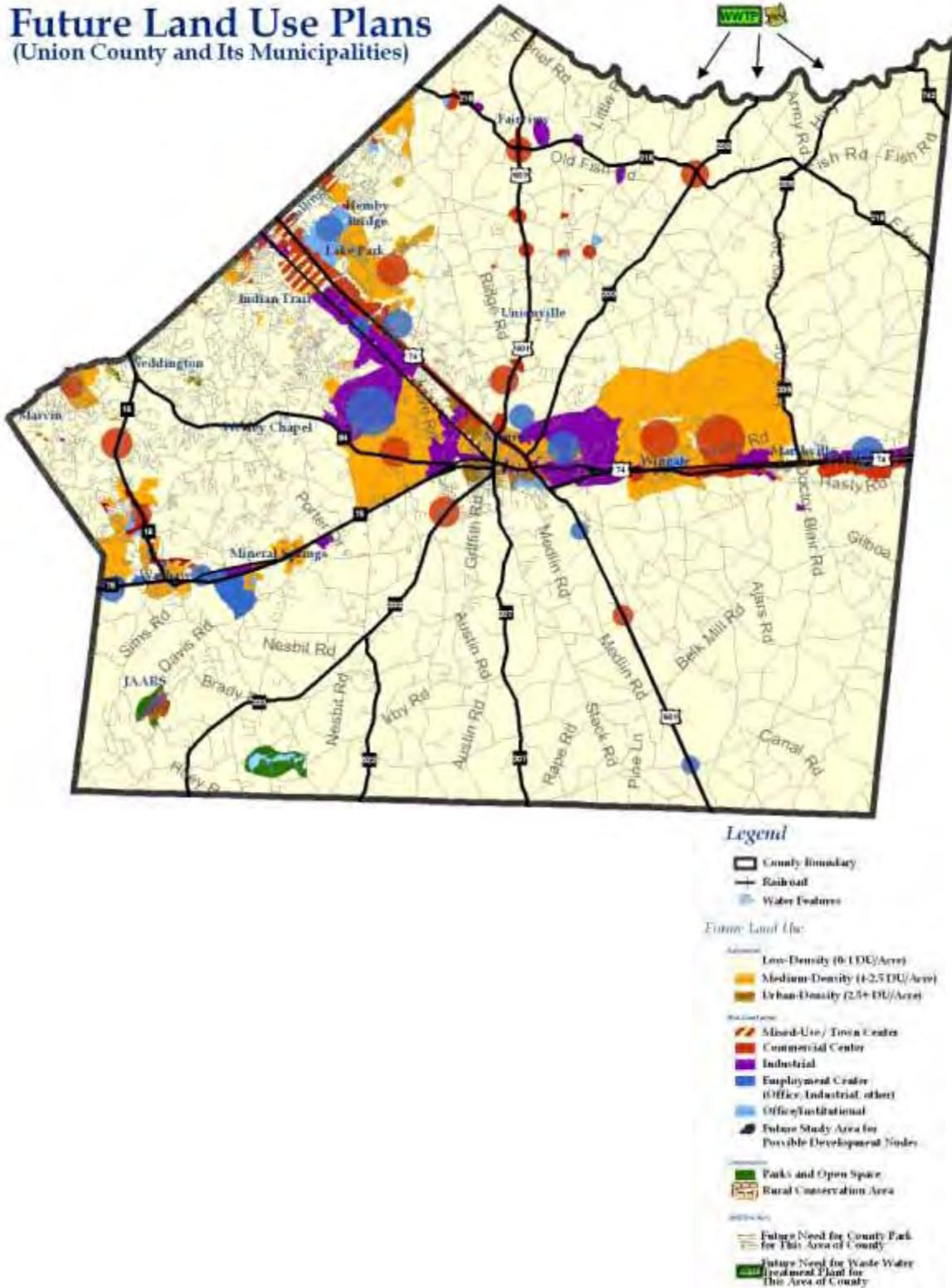


Figure 3: Union County Future Land Use Plan



3.5 Existing Land Use

How Was Existing Land Use Modeled?

Existing land use was developed using parcel-based data from both Mecklenburg and Union counties combined with zoning layers from all the local jurisdictions and the NCGAP⁹ land cover dataset, which is based on 1992 aerial photography. The existing land cover is largely a combination of these three data sets, with developed land based on current parcel data and the North Carolina Gap Analysis Project (NC-GAP) data filling in the land cover types where parcels are undeveloped. Each parcel was classified as developed or undeveloped. Undeveloped properties included vacant land and farms. For parcels in the developed category, each was assigned one of five land use categories based on its zoning category and land use attributes from the parcel assessment records. The five categories were:

1. Low Density Residential
2. Medium Density Residential
3. High Density Residential
4. Commercial
5. Industrial/Office/Institutional.

Spot checks for the assessment were conducted by comparing recent aerial photography (2010) of the Study Area with the assessed land use. In addition to the zoning and parcel land use attributes, Union County provided a list of parcels that had applied for tax deferral based on agricultural use. This list was used to categorize farm properties as undeveloped. Aerial photography was used to identify farm properties in Mecklenburg County and also to check for other farms in Union County that were not included in the farm deferral list provided by the County.

Once each parcel was assigned to one of these five development categories or the undeveloped category, the parcel polygon feature class was converted to a raster image. A raster is a rectangular grid where each cell or pixel within the grid represents one unit of area and contains a value (which in this analysis represents land use). For this analysis, all rasters were formatted with a 30x30 meter cell size to match the NCGAP land cover dataset. Each raster cell is a 30x30 meter square, or about one quarter of an acre. For undeveloped properties, the NCGAP raster dataset was used to fill in the natural and farm land covers within those areas. Since parcels do not cover all land in the Study Area, a provision had to be made to account for areas outside parcel boundaries. Since nearly all land not included within a parcel boundary is a road right-of-way, these areas were categorized as transportation uses. Figure 4 illustrates how the existing land use raster was developed. It shows for an example area how the parcels were categorized and converted to a raster and then the undeveloped areas were filled in with the NC-GAP land cover.

The resulting land cover is a raster image consisting of over 900,000 individual cells, each cell categorized into one of 26 land use categories. The 26 land cover categories consist of: 5 developed

⁹ The Gap Analysis Program is a national program with the mission of developing key datasets needed to assess biological diversity across the nation. The North Carolina Gap Analysis Project (NCGAP) was a state affiliate based at the North Carolina Cooperative Fish and Wildlife Research Unit and charged with developing those data for the state. A map of North Carolina's land cover was developed using Landsat TM satellite imagery acquired in 1991 and 1992.

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and Cumulative Impacts to Federally Listed Species*

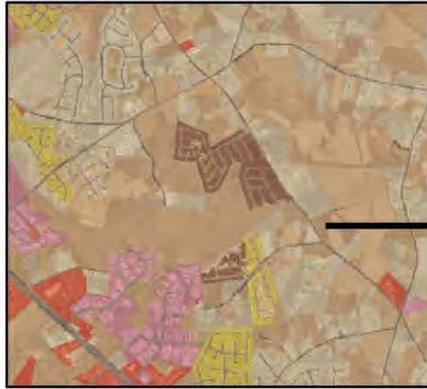
categories, 1 transportation category, 2 farm categories, 16 vegetation categories from the NCGAP land cover, and 2 barren categories from the NC-GAP land cover. Existing land use, or Baseline condition, is presented in Map 3. To simplify the display of the land cover, many categories have been aggregated into larger categories in Maps 3, 17 and 19. These aggregated categories are:

- Agricultural Fields: includes both the Agricultural Fields and the Agricultural Pasture/Hay and Natural Herbaceous.
- Barren: includes both Barren (bare rock and sand) and Barren (quarries, strip mines, and gravel pits).
- Forested: includes Coniferous Cultivated Plantation (natural / planted), Successional Deciduous Forests, Piedmont Xeric Pine Forests, Piedmont Dry-Mesic Pine Forests, Piedmont Xeric Woodlands, Piedmont/ Mountains Dry-Mesic Oak and Hardwood Forests, Piedmont Mesic Forest, Xeric Pine-Hardwood Woodlands and Forests.
- Other Natural: includes Piedmont/Mountain Submerged Aquatic Vegetation, Piedmont/Mountain Emergent Vegetation, Riverbank Shrublands, Floodplain Wet Shrublands.

Figure 4: Land Use Categorization Process

Parcel Categorization

Parcels categorized based on zoning and land use attributes from assessment database. Aerial Photography used to spot check for accuracy. 5 Developed categories.



Land Use Category

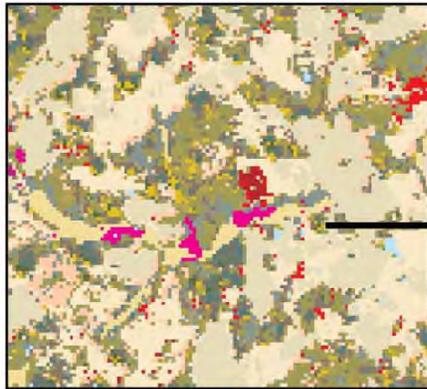
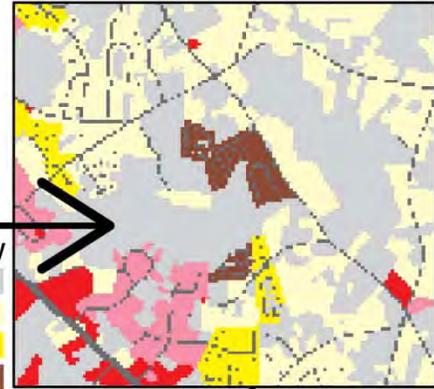
- Undeveloped
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Commercial
- Industrial/Office/Institutional

Land Use Category

- Undeveloped
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Commercial
- Industrial/Office/Institutional
- Transportation

Parcel to Raster Conversion

Parcels converted to raster layer and transportation use is added to the empty spaces between the parcels. 6 Developed categories.



Natural Background Land Cover Categories

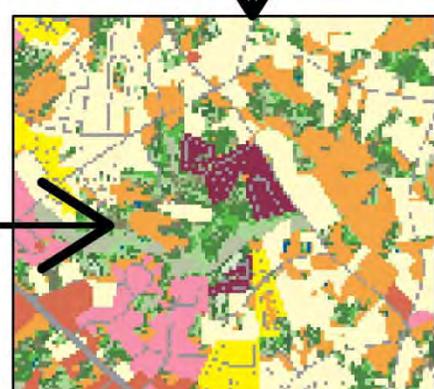
NCGAP Landcover developed in 1992 serves as the "background" land cover for natural areas. The 3 developed categories (Residential Urban, Urban Low and Urban High) were removed prior to merging with the developed land cover. 20 Natural categories.

Final Existing Land Use Categories From Parcel Categorization

- Low Density Residential
- Medium Density Residential
- High Density Residential
- Commercial
- Industrial/Office/Institutional
- Transportation

From NCGAP

- Open Water
- Agricultural Fields
- Barren (bare rock and sand)
- Barren (quarries, strip mines, and gravel pits)
- Coniferous Cultivated Plantation
- Dry Mesic Oak Pine Forests
- Floodplain Wet Shrublands
- Piedmont Deciduous Mesic Forest
- Piedmont Dry-Mesic Oak and Hardwood Forests
- Piedmont Dry-Mesic Pine Forests
- Piedmont Emergent Vegetation
- Piedmont Mixed Bottomland Forests



Merged Land Cover

Rasterized Parcel Land Cover and NCGAP Land Cover are merged to produce a complete land cover including developed and natural categories. Parcel Land Cover takes precedence. NCGAP is only included in the areas categorized as "Undeveloped" in the Parcel Land Cover.

26 Total Land Cover categories
6 Developed
20 Natural

- Piedmont Oak Bottomland and Swamp Forests
- Piedmont Submerged Aquatic Vegetation
- Piedmont Xeric Pine Forests
- Piedmont Xeric Woodlands
- Riverbank Shrublands
- Successional Deciduous Forest
- Xeric Pine-Hardwood Woodlands and Forests

4.0 REVIEW OF SOCIOECONOMIC PROJECTIONS

To assess potential impacts from induced development, two future land use scenarios are needed: a No-Build that reflects the future without the proposed project and a Build that reflects the future with the proposed project. Research on induced growth impacts of transportation investments indicates that typically induced development impacts fully arise within eight years of the opening of new roads or new capacity.¹⁰ Therefore, if the proposed project is expected to be open to traffic before 2020, a 2030 horizon year would be an appropriate and reasonable analysis year. Since the prior Quantitative ICE analyzed 2030 conditions, it would also be appropriate to maintain that analysis year to make comparisons easier.

Since the Quantitative ICE analysis is looking at land use changes at the watershed level, the next question is how to estimate future growth under either scenario at that level of detail. Many entities, such as state level demographic agencies, private forecasters such as Woods and Poole, and even universities, produce projections of population and employment at the county, regional or state level, and these projections could be used to estimate growth in the study area. However, none of these sources provide detail on where that growth may occur below the level of individual counties. Metropolitan Planning Organizations (MPOs) develop similar projections of population and employment and, due to their federally mandated planning efforts, their projections typically include much smaller geographic divisions. MPO projections, therefore, represent the only best available resource for population and employment projections at the necessary geographic and temporal scales to reasonably estimate quantitative land use impacts of transportation projects.

4.1 What Is an MPO?

MPOs have been required under federal law since the early 1970s. Federal regulations requires any Census Bureau defined urbanized area (UZA) of at least 50,000 people to have an MPO to develop regional transportation plans and programs through a continuing, cooperative and comprehensive (3-C) transportation planning process. An MPO is required to develop a number of planning documents to guide the planning and funding of transportation improvements across the metropolitan region. To address the long-range transportation needs of a region, MPOs are required under federal regulations to estimate and accommodate the mobility needs for persons and goods in their Metropolitan Transportation Plans (MTP). This requirement, therefore, necessitates estimating the long-range travel needs of their respective regions. As such, most MPOs use some form of travel demand modeling to estimate the long-range travel needs for their regions and help in addressing other policy concerns such as transportation conformity (through emissions estimates), estimation of freight movement and of non-motorized trips. Most MPOs, including those in the Charlotte region, use a standard four-step travel demand model while a few MPOs have begun using more advanced modeling techniques such as activity-based models.

What Is the Metrolina Regional Travel Demand Model and How Does It Relate to the MPO Projections?

The main reason that MPOs prepare regional socioeconomic projections is to operate a regional travel demand model (TDM). The TDM is used to project future travel demand for use in transportation planning activities. In the Metrolina region, the TDM is called the Metrolina Regional Model (MRM).

¹⁰ Cervero, Robert. "Road Expansion, Urban Growth and Induced Travel: A Path Analysis." *Journal of the American Planning Association*. Vol. 69, No. 2. Spring 2003, p 158.

This model is used for the four major tasks that MPOs must complete as part of their federally mandated planning responsibilities:

1. Identifying existing transportation conditions and deficiencies on the major segments of the transportation network within the region
2. Identifying future transportation conditions and deficiencies on the major segments of the transportation network within the region
3. Prioritizing projects for inclusion in LRTPs and a plan of implementation for inclusion in the Transportation Improvement Plan
4. Demonstrating conformity to the National Ambient Air Quality Standards established by the U.S. Environmental Protection Agency (EPA), under the Clean Air Act, for the EPA designated non-attainment area(s) within the region (also known as the air conformity process).

Based on the *Metrolina Regional Travel Demand Model Memorandum of Agreement*, CDOT is the custodian for the MRM and all its constituent parts (network files, socioeconomic data and projections, programming scripts, trip tables and any other files necessary to run the model). The MRM is the main tool used by state, regional and local planning agencies to assess regional travel patterns. The MRM covers the following areas, also shown in Map 4:

- Cabarrus-Rowan Metropolitan Planning Organization (CRMPO): Cabarrus and Rowan Counties
- Gaston Urban Area Metropolitan Planning Organization (GUAMPO): Most of Gaston County
- Mecklenburg-Union Metropolitan Planning Organization (MUMPO): All of Mecklenburg and most of Union County
- Part of the Lake Norman Rural Planning Organization (LNRPO): Iredell, Lincoln and Cleveland Counties and the remainder of Gaston County
- Part of the Rocky River Rural Planning Organization (RRRPO): Stanly and Anson Counties and the remainder of Union County
- All of York County and part of Lancaster County, South Carolina, including all areas within the Rock Hill-Fort Mill Area Transportation Study (RFATS, the MPO for eastern York County).

As custodian of the model, CDOT leads the model team and leads the model development and maintenance process, including all its constituent parts such as socioeconomic projections. Most CDOT staff members who oversee the model are also staff to MUMPO.

In addition to the above tasks, the MPO and others may use the travel demand model or its component parts to complete other planning or analytical tasks related to land use, transportation or environmental planning within the region. Often, in completing the necessary environmental studies, DOTs or others will use MPO socioeconomic projections and travel demand models for traffic forecasting or land use analysis as the MPO projections and travel demand models are often the only readily available source or tools available to complete the necessary analyses. As shown in Figure 5, the regional travel demand model is a “Four-Step Model” that uses the projections of population, households and employment as one key input file.

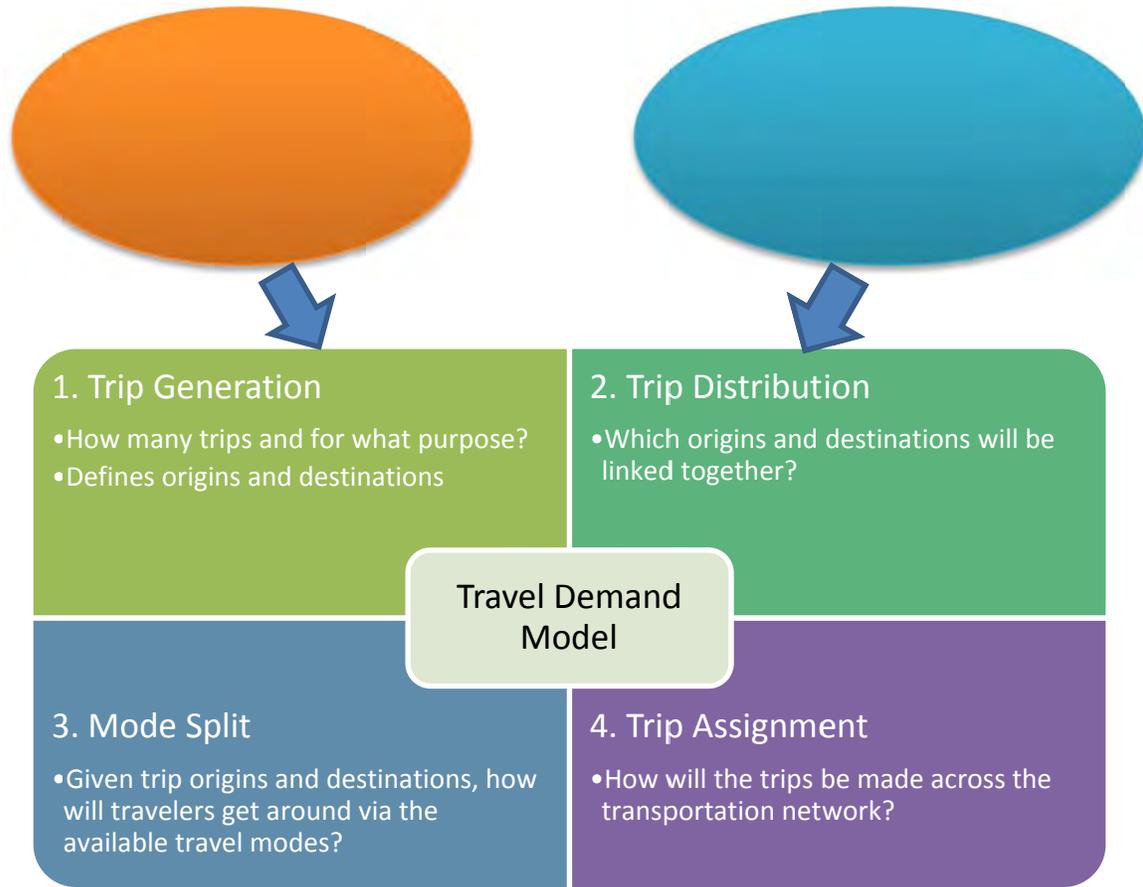
In most MPOs that use a Four-Step Model, the MPO develops the socioeconomic projections through some combination of projecting of historical trends, build-out capacity and other methods as appropriate for the specific region. To properly develop traffic forecasts, these socioeconomic projections must be provided at small geographic scales, thus the projections are allocated from a regional level, to a county

level and finally to smaller geographic areas called Traffic Analysis Zones (TAZs). The TAZ projections typically include data for a base year (with data based on Census counts and other survey resources) and future horizon years based on the MPO forecasting process. The data for each year typically includes, for each TAZ,

- the number of households
- number of persons within households
- number of persons within group quarters (i.e. dorms, prisons or other non-household living arrangements)
- median income for households
- the number of students (sometime divided into sub-categories by age group)
- number of employees (typically divided into multiple sub-categories by type of employment).

The regional travel model uses this data in Step 1 of 4 to predict how many trips and what type of trips are generated in each TAZ. The MRM TAZs for the Future Land Use Study Area (or FLUSA, the study area defined for the purposes of the ICE report) are shown in Map 5 to provide a sense of scale for these important geographic subdivisions. Also shown in Map 5 is the distinction between TAZs within the jurisdiction of MUMPO and those TAZs under the jurisdiction of another MPO or RPO. Of the 383 TAZs partially or fully within the FLUSA, 349 are within the jurisdiction of MUMPO, while the remaining 34 are under the jurisdiction of the RRRPO. Each planning organization is the final authority of the socioeconomic projections at the TAZ level for the TAZs under its jurisdictions. As discussed in Section 3.2, the socioeconomic projections developed for the Metrolina region have been developed through an extensive and highly cooperative regional projection process.

Figure 5: Four-Step Travel Demand Model and Inputs



TAZs are delineated by the MPO working from Census data on population and employment and criteria set by the FHWA. These criteria recommend minimum populations of 600 persons or workers but they generally recommend approximately 1,200 persons or workers per TAZ. Additionally, FHWA recommends or requires that TAZs meet the following criteria¹¹:

- Compactness: TAZs should be compact in nature.
- Nesting and boundaries: TAZs must nest within a county and must not cross county or state boundaries. Where possible, TAZs should follow city or town boundaries.
- Maximize contiguity: TAZs should be contiguous across each county without any missing slivers.
- Include all water and land: TAZs must include all area within the territory of a county; water bodies must be part of a TAZ.
- Unique and identifiable: TAZs must have unique identifiers and each MPO must have a unique identifier.

A TDM generates trip “productions” based on household location and characteristics, and trip “attractions” based on the employment data, which represent not only job destinations but also shopping

¹¹ FHWA CTPP Data Products. March 2010. “TAZ Delineation Business Rules.” http://www.fhwa.dot.gov/planning/census_issues/ctpp/data_products/tazddbules.cfm

and other activities that attract household trips. The overall number of productions and attractions are balanced, providing a set of trip origins and destinations, which is then taken into Step 2 of the Travel Demand Model for Trip Distribution – the linking of the origins and destinations into trips. At this point, the model begins to use a separate input file that represents the network of available roadways in the region, including data about the capacity, speeds, and other characteristics of each road or highway.

Other modes of transportation such as public transit are also taken into account in Step 3 of the model, which estimates the division of all trips across the available travel modes. The final “loading” of trips onto the network happens in an iterative process in Step 4 of the model, in which trips are distributed across all of the roads in the network and the impacts of congestion on travel patterns are incorporated.

What is both important and relevant to the ICE analysis process is the fact that the socioeconomic projections (the projection of where population and employment will be in the future) are a distinct input to the travel demand model from the transportation network. Consequently, the extent to which the socioeconomic projections represent the land use impacts of any given project cannot be answered by solely looking at the transportation network used in the travel demand model or its outputs. Instead, it requires examining the process and data used by the MPO in developing the population and employment projections. The assumptions behind the MRM socioeconomic projections are discussed below.

4.2 How Did the MPO and CDOT Develop the Projections?

It is important to note that regional socioeconomic models and projections are somewhat fluid in their development. Factors and variables may be created in the development stage that are either applied narrowly or omitted due to data limitations or other aspects of the extremely complex process of creating future land use projections at regional, county, and TAZ levels. This is one factor that caused confusion in the past quantitative ICE analysis and which could persist in spite of the additional information provided here. As such, it is necessary not only to conduct a very careful review of how the models were designed, but more importantly, how they were ultimately used in developing socioeconomic projections. This is necessary in order to understand fundamental questions regarding the role of the Monroe Connector/Bypass in the ultimate socioeconomic projections. For this reason, the following discussion reviews not just the model processes, but also reviews the model results and includes information from CDOT, who created and applied the many of these models. These reviews are needed to understand the true meaning and bases of the regional projections and to develop a full understanding of the projections and their appropriate use in other analyses.

Review of Projection Versions

As custodian of the MRM, CDOT and MUMPO staff oversaw the various regional socioeconomic projection processes and updates that have occurred over the last decade. As the discussions below shows, the projection process is a continuous and evolving process, so it is important to document exactly which datasets are used for any different purposes and different planning efforts.

The current MRM 2011 v 1.1 uses projections finalized in 2009 and is used as the basis for air conformity approvals for the 2035 Long-Range Transportation Plan (LRTP) adopted May 3, 2010. These current projections (hereafter called the 2009 Projections) were the latest update to projections that were first developed beginning in 2003. Table 4 summarizes the various socioeconomic projections, the associated file naming conventions, the month and year the projections were completed, associated MRM versions and the base and horizon years for each socioeconomic projection dataset. Figure 6 shows the timeline of

when the projections were developed relative to the adoption of each MUMPO LRTP. The Projection Names shown in the table and figure are not an official name but are used in this document for ease of reference. Each socioeconomic projection dataset includes projections for ten-year increments, with five-year increments interpolated between horizon years. Thus for the 2009 Projections (which were used in the 2035 LRTP), the horizon years were 2015, 2025 and 2035, but interpolated projections were also available for 2020 and 2030. Similarly, for the 2005 Projections (which were used in the 2030 LRTP), the horizon years were 2010, 2020 and 2030, but interpolated projections were also available for 2015 and 2025.

In the 2003-2004 timeframe, MUMPO and its regional partners at other MPOs and Rural Planning Organizations (RPOs) prepared the TAZ-level 2030 projections of population, households and employment in support of the development of the 2030 LRTP. The projections originally developed for this purpose were completed in 2005 and became the projections used in the official Metrolina Travel Demand Model 2005 version 1 (MRM05v1) and all versions of the model through MRM06v1.1.

Table 4: MRM Socioeconomic Projection Versions

Projection Name	TAZ File Name	Projections Completed	Use for LRTP Conformity Determination	Associated Model Version	Base and Horizon Years
2009 Projections	SE_Year_091028	October 2009	MUMPO 2035 LRTP	MRM 09 v1.0 MRM 11 v1.0 MRM 11 v1.1	Base: 2005 Horizon: 2015, 2025, 2035
2008 Interim Projections	SE_Year_081119_MUMPO_interim	November 2008	None	None	Base: 2005 Horizon: 2015, 2025, 2035
2008 Projections	SE_Year_081024	October 2008	RFATS 2035 LRTP	MRM 08 v1.0	Base: 2005 Horizon: 2015, 2025, 2035
2005 Projections	SE_Year_taz2934	May 2005	MUMPO 2030 LRTP	MRM 05 v1.0 MRM 06 v1.0 MRM 06 v1.1	Base: 2000 Horizon: 2010, 2020, 2030

Figure 6: Timeline of MRM Projection Development

Development Timeline: Metrolina Regional Model Socioeconomic Projections



Subsequent to the adoption of the 2030 LRTP, MUMPO conducted an update process for their projections in 2008-2009 and extended their projections to 2035. These updates used the 2005 Projections as a critical input as described below. All of these updates used a spreadsheet model system called a Land Use Allocation Model (LUSAM) to develop the 2008 and 2009 Projections. The details of this process are described in later sections.

The first of these updates was completed and incorporated into MRM 08 v1.0, which was the official model used to support the 2035 LRTP for the Rock Hill-Fort Mill Transportation Study Area. CDOT continued to update the regional projections based on new information and developed interim projections in 2008 for use in the Northeast Transit Corridor planning process. These projections are known as the 2008 Interim Projections. These projections were further updated and finalized in 2009 and eventually incorporated into the 2035 LRTP adopted May 3, 2010 and modeled using Metrolina Travel Demand Model 2009 version 1 (MRM09v1). Subsequent Metrolina Travel Demand Model versions (MRM11v1, MRM11v1.1) also use these same projections.

The FEIS Quantitative ICE (developed in 2009 and completed in 2010) used the 2008 Interim Projections, as they were the most up-to-date projections available at the time of that analysis. Given that CDOT has updated its projections since that report, it would be most appropriate to use the 2009 Projections. The following sections describe the 2009 Projections and the various inputs and processes used to develop those projections, as well as describing the prior process for developing projections. The purpose of this review is to fully disclose and explain what, if any, impact the Monroe Connector/Bypass had on the 2009 Projections to determine the most appropriate way to use those projections in the update of the ICE analysis.

2008 and 2009 Projections (LUSAM Process)

In 2008, CDOT, MUMPO and other regional MPOs began development of their 2035 LRTPs and in doing so, needed to update population and employment projections for 2015 and 2025 and develop a TAZ level projection for 2035. The initial step was to develop the socioeconomic base year of 2005 by reviewing recent development activity and updating TAZ level data on households, population and employment estimates as of 2005. Next, CDOT staff developed a spreadsheet model system called a Land Use Allocation Model (LUSAM) to consider multiple factors as part of the projection process. CDOT documented how the model worked in an internal draft document titled *Metrolina Regional Travel Demand Model LUSAM: Land Use Allocation Model Technical Documentation* dated December 4, 2007.

The LUSAM model uses a number of inputs to generate the future projections of households and employment for each TAZ and uses a district level approach to determining the factors considered in the distribution of the households and employment to each TAZ. The LUSAM model requires TAZs to be grouped into districts with up to 32 districts defined in the model. This simplifies the process of entering model weights, targets and factors. The model outputs its horizon year projections in an iterative process, such that each horizon year projection builds upon the next. Each iteration requires the input of base year values. For the first iteration, which produced the 2015 projections, the 2005 base year was used as the base year in all LUSAM model runs. For later LUSAM model iterations, the prior model output was used. Thus, for the 2025 horizon year, the 2015 output would be input as the base year and for the 2035 horizon year, the 2025 output would be input as the base year. The LUSAM model uses a district level targeting approach, where target household, population and employment values are set for each horizon year and the model attempts to adjust the projections such that the totals for the TAZs within each district would

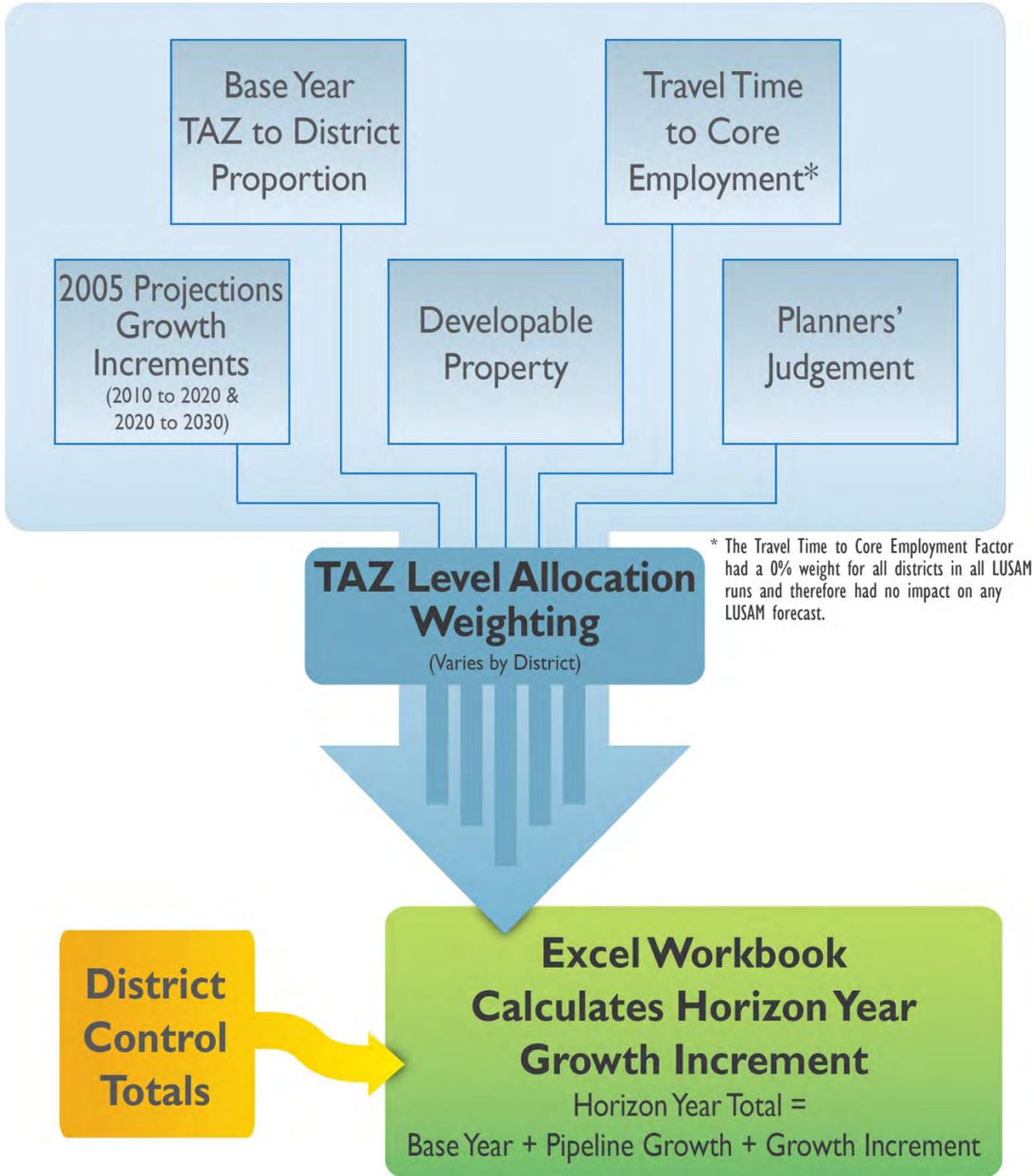
equal the district target. LUSAM aggregates the base TAZ data into the same districts as the targets. The difference between the target and base is allocated by percentages to the TAZs within the district and a new TAZ land use dataset is created. These targets were developed independent of the LUSAM model and the inputs to those are discussed later.

Figure 7 provides a visual representation of the LUSAM model process. The model would use up to five weighted factors to determine how to allocate the district level target of growth to each TAZ within the district. The growth increment would then be added to the base year plus the pipeline growth (the number of households or jobs under construction or approved for construction) to yield to total for the horizon year. The five factors available in the LUSAM workbook are described below; however, as applied in the projection process, not all factors were used:

- **2005 Projections Growth Increment:** The change (growth) over time from an earlier projection (e.g. – projections for a new 2015 dataset would use the same growth allocation as an earlier projection between 2010 and 2020). In practice, the 2005 Projections growth increments for 2010 to 2020 and 2020 to 2030 were used as the input for this factor. Thus, the 2008 Interim and 2009 Projections relied on the growth increments in the 2005 Projections.
- **Base Year Proportion:** The same proportion of TAZ to District as in the base TAZ file (e.g. if TAZ “1” has 100 retail employees of the 1000 retail employees in the district – it would receive 10 percent of all new retail employees)
- **Developable Property:** This is based on an estimate of households or jobs per acre (and total acres). Relative development density is a primary input to this category. It differs across categories and across geographies, for example, employment density by acre is considerably higher in the center city than in suburbs.
- **Travel Time to Core Employment:** The estimated travel time to downtown Charlotte under peak highway congestion conditions. This factor was inverted as shorter travel times are preferred over longer. In the LUSAM Models for the 2008 Interim and 2009 Projections the weight applied to this factor was zero. Therefore, this factor was never used.
- **Planners’ Judgment:** A direct 1-5 scale rating that could be applied to specific TAZs to reflect highly popular or unpopular TAZs for residential or non-residential development.

Figure 7: Visualization of LUSAM Workbook Process

Land Use Allocation Model (LUSAM) for 2008 and 2009 Projections



*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

The LUSAM model also incorporated “Pipeline” data by TAZ. The number of households or jobs under construction or planned could be added to a specific TAZ. Similarly, known decreases, such as that for a factory being closed, could be subtracted from a particular TAZ. Pipeline data would be added or subtracted to the base prior to allocation from districts.

The LUSAM model allowed for a weighting of the factors by each district. Thus, one district could have its entire weight based on the previous projections while another could have its entire allocation weight based on planners’ judgment. The basic allocation equation is essentially the same for all categories and households are used in the example below.

$$\begin{aligned}
 & HH_future_{taaz} \\
 &= HH_base_{taaz} + HH_pipeline_{taaz} \\
 &+ (HH_target_{dist} - (HHbase_{dist} - HH_pipeline_{dist})) * \\
 &(Wgt1 * (\Delta HH_y2 - y1_{taaz} / \sum \Delta HH_y2 - y1) \\
 &+ Wgt2 * (HH_base_{taaz} / \sum HH_base) \\
 &+ Wgt3 * (Vacant_res_{taaz} / \sum Vacant_res) \\
 &+ Wgt4 * (TravTime_{taaz} / \sum TravTime) \\
 &+ Wgt5 * (PlannersJudgment / \sum PlannersJudgment))
 \end{aligned}$$

Where:

HH_future_{taaz}	Future (projection) year TAZ households
HH_base_{taaz}	base year TAZ households
$HH_pipeline_{taaz}$	Pipeline households added to TAZ between base year & future year
$\Delta HH_y2 - y1_{taaz}$	Change in no. of HH in TAZ between y1 and y2 in “old” projection set
$\sum \Delta HH_y2 - y1$	Change in no. of HH in district (sum of all TAZ) between y1 and y2 in old projection set
HH_base_{taaz}	No. of base households in district
$\sum HH_base$	Sum of base households for district
$Vacant_res_{taaz}$	Vacant residential acres for TAZ
$\sum Vacant_res$	Sum of vacant residential acres for district
$TravTime_{taaz}$	Reciprocal of travel time to core employment for TAZ
$\sum TravTime$	Sum of reciprocal of travel time to core employment for district
$PlannersJudgment_{taaz}$	Planners Judgment value (1-5) for taz
$\sum PlannersJudgment$	Sum of Planners Judgment values for district
$Wgt1 \dots Wgt5$	Weights (0 – 1 for each factor, weights must sum to 1.0)

The 2008 Projections were the first projections developed using the LUSAM methodology. These projections were developed and used for the Rock Hill-Fort Mill Area Transportation Study 2035 LRTP air quality conformity analysis. The 2008 Projections were not used for any planning purposes within the MUMPO or RRRPO regions. Also, these projections were not used in development of the 2008 Interim or 2009 Projections, either. Therefore, they were not analyzed as part of this report.

The 2008 Interim Projections were the projections provided to NCTA for use in the FEIS Quantitative ICE analysis. The model inputs show that for the 2008 Interim Projections the major focus of adjustment was on Mecklenburg County, with the remainder of the region largely relying on the growth projections from the 2005 Projections to guide the LUSAM adjustments. Of the factors in the model, the Travel Time

to Core Employment is not used at all for any district for any horizon year. For all areas outside Mecklenburg County, the previous projections (2005 Projections, which were used in the 2030 LRTP) were the main factor in the household and population projections. For employment projections outside Mecklenburg County, the previous projections had the highest weighting but some weight (10-25 percent) was placed on the estimate of available land and densities. Within Mecklenburg County, projections of households and population were based on a mixture of the previous projections, available land and density and planners' judgment, with the exact weighting varying from district to district within the county.

The 2009 Projections are the most recently completed projections that have been fully adopted and used in regional air conformity analysis. These projections are very similar to the 2008 Interim Projections and, in fact, LUSAM runs were only used in Mecklenburg County to adjust between the 2008 Interim Projections and the 2009 Projections. Only minor adjustments were made in Union County and only to employment. Within Mecklenburg County, projections of households and population were based on a mixture of the previous projections, available land and density and planners' judgment, with the exact weighting varying from district to district within the county.

To illustrate how the LUSAM workbook produces the projections, Figure 8 shows the LUSAM process with district targets and changes for household projections for all TAZs in the Fairview District for the 2015 horizon year from the 2009 and 2008 Interim Projections LUSAM Model run. Fairview was chosen because it is partially located within the Goose Creek watershed and provides information on how population projections within the watershed were developed. The example is somewhat simplified as there are no pipeline household adjustments and 100 percent of the weight is on the Old Projection factor. Pipeline households would be any planned or under construction households in a TAZ. The process begins with the base year households, which are the number of households in each TAZ in 2005. The model then adds the pipeline households to the base year households. Next, the model works to distribute the households from the district level targets to the TAZ level using the weighted factors. In the example of Marshville, the full weight is placed on the distribution from the Old Projections (the 2005 Projections used in the 2030 LRTP). Thus, in the example shown below, TAZ 9032 captures 5.4 percent of the district household growth in the Old Projections. Thus, it receives that same percentage of the district household growth from the new, targeted growth ($5.4\% \times 688 = 37$ households). Thus, the household projection for 2015 for TAZ 9032 is 164 households.

Based on these inputs and the LUSAM process, the Monroe Connector/Bypass could only have affected the LUSAM model through four possible inputs:

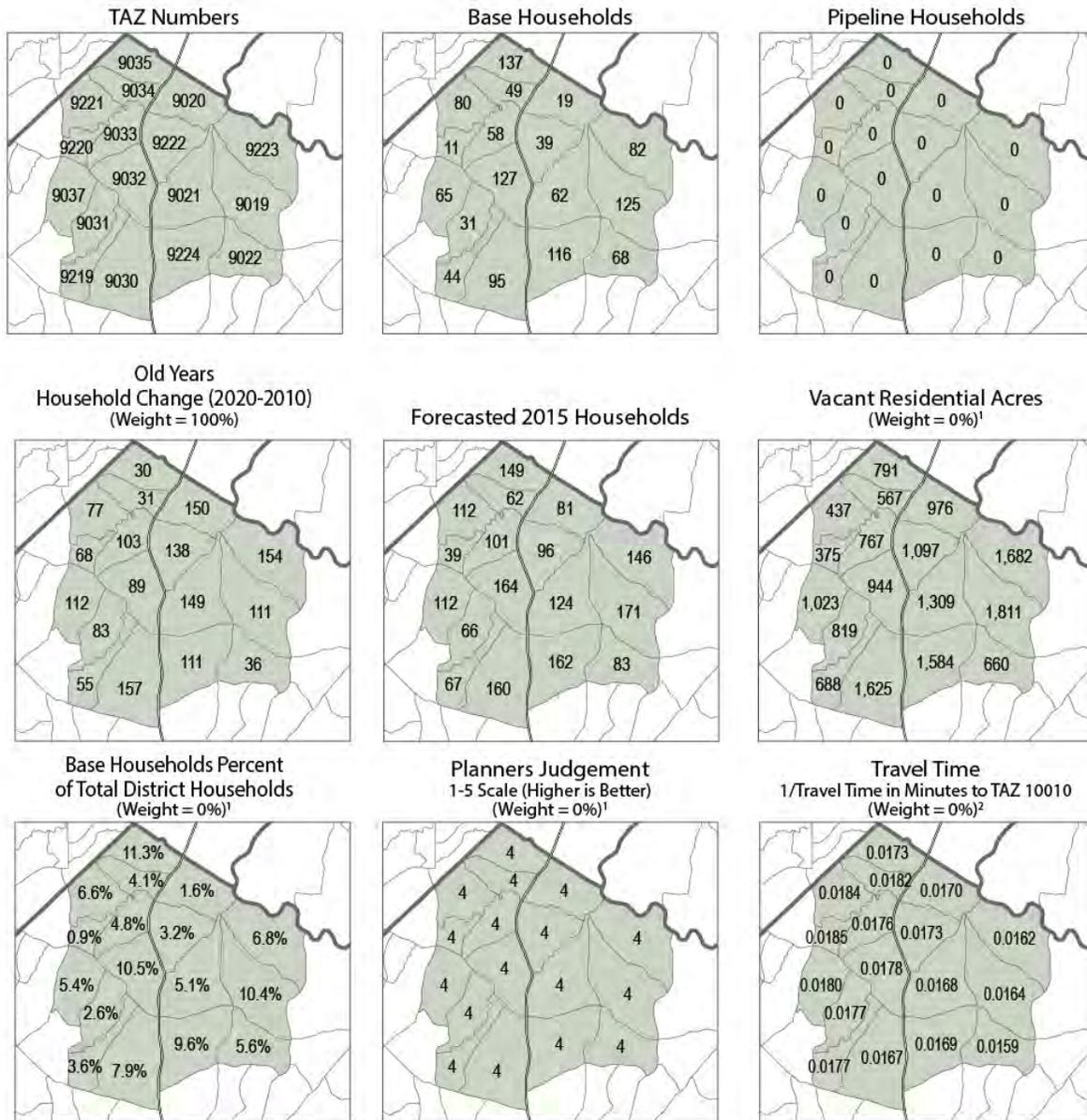
- The Planners' Judgment Factor
- The Travel Time to Core Employment Factor
- The Old Projections Growth Increments Factor (2005 Projections)
- District Level Targets.

As discussed above, however, the Travel Time to Core Employment Factor was not used (its weight was zero percent) for any LUSAM runs. Furthermore, the Planners' Judgment Factor was not used at all in Union County for any LUSAM run. Thus, based on the weighting of factors, the Monroe Connector/Bypass could not have influenced the projections through these two factors.

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

Thus, to fully assess whether the 2008 Interim or 2009 Projections were affected by the Monroe Connector/Bypass, one must fully understand the 2005 Projections (since the allocation of those projections guided the allocation of the newer projections) and the District Level Targets.

Figure 8: LUSAM Example, Fairview, 2009 and 2008 Interim Projections, 2015 Horizon Year



Fairview District		Fairview District Old Forecasts	
2005 Base HHs	1,208	2010 Forecasted HHs	1,845
2015 Target HHs	1,896	2020 Forecasted HHs	3,499
Difference	688	Difference	1,654

TAZ 9032 Example Calculation

$$2005 \text{ Base HHs} + \text{Pipeline HHs} + ((\text{Old Years}_{\text{TAZ}} / \text{Old Years}_{\text{Dist}}) \times \text{HH_Target}_{\text{Dist}}) = 2015 \text{ HH Forecast}$$

$$127 + 0 + ((89 / 1,654) \times 688) = 164 \text{ HHs}$$

¹These factors were not used at all in Union County for the 2008 Interim or 2009 Forecasts. These variables were used in Mecklenburg County forecasts with the weights varied by district.

²While the LUSAM includes values for the Travel Time to Core Employment factor, the factor was not used for any forecast. The weight applied to it in all cases was 0%. It is shown here for the purposes of full transparency.

Development of the 2005 Projections (Used in the 2030 LRTP)

The 2005 Projections (which were used in the 2030 LRTP) were developed through a process with three main components, a Top-Down projection, a Bottom-Up projection and input from an advisory group on the final projections. Each component in the process had a key role, as shown in Table 5. The development of the TAZ-level projections relied first on the Top-Down process to project future growth at the regional level and then allocate the regional growth to the county level. A subsequent Bottom-Up process allocated the county-level growth to the TAZ level within each county. Different parts of the Metrolina region used different approaches to the Bottom-Up process, but for the MUMPO area, which included most of Union County, a process prepared by Paul Smith of UNC-Charlotte provided the initial allocation. As was the case with the Top-Down projections, the Bottom-Up steps used input from local planners and jurisdictional representatives to review and refine the projections prior to adoption.

Table 5: Roles, Factors and Accessibility Considerations of the MRM Socioeconomic Projection Process Components

	Roles	Projection Factors	Accessibility Considerations
Macroeconomic (Top-Down) Projections Completed by Dr. Thomas Hammer	Projects regional household, population and employment totals and sets county level control totals	Regional Projection National population and employment trends linked by economic sector to regional trends	None
		County Level Allocation Past economic and demographic trends Economic and demographic conditions (as of 2003) Influence of income on growth Proximity Land availability Past land use and infrastructure policies	Explicitly includes two major road projects: <ul style="list-style-type: none"> • NC 16 Freeway to Lincoln County • Garden Parkway Only considers proximity in linear terms (county centroid to county centroid); no use of roadway networks
Household and Employment Allocation: (Bottom-Up) Process Completed by Paul Smith, UNC-Charlotte	Distributes growth from county-level to the Traffic Area Zones level	Developable Residential Land Redevelopable Residential Land Recent Population Change Travel Time to nearest Employment Center Water Availability Sewer Availability Expert Panel (High Growth Areas) Growth Policy Factor	Considers travel time from each TAZ to the NEAREST employment center, NOT regional employment centers Uses the TDM network, including the Monroe Connector/Bypass, but only in travel time to nearest employment calculations for final period (2020-2030).
Advisory/ Expert Input	County representatives agree on final county totals based on Top-Down process Local planners refine the Bottom-Up allocation based on adopted plans and local land use expertise; serves as a reality check on the allocation	Discretionary	Reflects local advisors' expectations (in 2003-2004) of whether new roads would be built Reflects the assumptions in adopted land use plans at the time regarding the anticipated road network

Regional Socioeconomic Projection and County Level Allocation (Top-Down Process)

The process to develop regional socioeconomic projections and allocate them to the county level (known as the Top-Down process) was a rigorous, research-based approach to developing a regional and county level projection of households and employment. Led by Dr. Thomas Hammer and documented in his report to the region titled *Demographic and Economic Forecasts for the Charlotte Region* (hereafter referred to as the “Hammer Report”), Dr. Hammer developed a long-range regional growth projection based on economic factors in the Charlotte region.

Dr. Hammer described his model as a demand-side model where the model determined economic employment (earnings) from a breakdown of different employment groups based on their link to national employment trends. The model also assumed by 2030, population demographic changes would constrain regional earnings. His report described large transportation projects and public policy land use or development controls as supply-side factors that do not necessarily contribute to the growth demand, but act as limits or constraints to where growth might occur at smaller scale projections.¹² Therefore, Dr. Hammer’s projections were not sensitive to large transportation projects such as the construction of the Monroe Connector/Bypass.

Dr. Hammer’s process started with descriptions of the national economy and regional economy to quantitatively link the economies based on worker earnings, referred to as employment. His modeling broke the regional economy into a 42-industry classification scheme to quantitatively link to the national economy. The procedure separated employment in each regional industry into a “basic” component and a “population-serving” component to quantitatively link the regional industry employment trends to national industry employment trends. Separate quantitative analysis was performed to create a linkage between the basic component of employment between the regional and national trends and the “population-serving” component of employment between the regional and national trends. The two separate quantitative linkages were combined to develop overall industry profiles for the region. Demographic projections were obtained by finding a regional population profile for each future year that yielded a labor force consistent with expected employment level.¹³ The process yielded region-wide employment and demographic totals that became control totals to help determine where in the region the overall growth would occur.

The region-wide employment and household totals were allocated among the counties and districts with the aid of 35 equations to identify factors used in the determination of county level growth shares of the regional industry growth total. These equations included three for demographic variables of upper, middle and low-income housing, and 32 equations for employment by sector. These equations were calibrated on the experience of 227 counties in 29 separate U.S. metropolitan areas chosen for their comparability to the Charlotte region. The modeling allocation process also included factors such as available land in each county and location proximity between employment and households. The location proximity was incorporated by weighting an inverse function of distance to the county for which a variable was being measured to another county. However, the model omitted such supply side factors of large-scale transportation projects, new land use policies and provision of infrastructure, and natural land constraints

¹² Hammer Report, p 10

¹³ Hammer Report, p 7

on development. Table 6 summarizes Dr. Hammer’s description of the capacity of his projection and allocation model to capture growth influences.

Table 6: Capacity of Allocation Model to Capture Growth Influences

	Demand Side	Supply Side
Growth Factors Covered	<ul style="list-style-type: none"> • Past economic & demographic trends • Existing economic & demographic conditions • Economic-demographic linkages • Influence of income on growth patterns • Location 	<ul style="list-style-type: none"> • Land area and land availability (as estimated on the basis of development magnitudes) • Past land use and infrastructure policies (to the extent they register in past growth)
Growth Factors Omitted	<ul style="list-style-type: none"> • Refinements <ul style="list-style-type: none"> ○ Some measures could be improved such as distance and area descriptors 	<ul style="list-style-type: none"> • New or altered public policies governing land use and the provision of infrastructure • Large-scale transportation projects • Natural land constraints on development (if not strongly reflected in past growth)

Hammer Report, p 14

Dr. Hammer provided ranges of population and employment projections to account for variability and error in the model. He specifically noted, “. . . the upper and lower limits that express the ranges are specifically intended to express 90 percent or 95 percent confidence intervals. They cover only the year 2030, but could be extended to other years using the same proportions of past 2002 growth involved in their derivation”¹⁴. He obtained the upper and lower limits of growth by adding and subtracting amounts from the “most-likely” projection shown in Table 7.

*The additions or subtractions at each geographic level equal a common percentage times the difference between the most likely values for 2030 and the actual values for 2002. Thus, the greater the expected growth, the wider the error margin, on the logic that unforeseen supply-side influences will operate mainly by reallocating growth rather than affecting urban development already present.*¹⁵

Dr. Hammer noted that different percentage margins are appropriate at different geographic levels, since the potential for error increases as area size decreases. He stated that “[s]mall margins are appropriate for the region as a whole because supply-side factors exert little influence at that scale.” He calculated regional margins for population and employment by adding and subtracting 10 percent of the most likely 2002-2030 growth. He further noted that “[a]t the county level and district levels, the calculations involve larger downside margins than upside margins, on the argument that land use policies and environmental factors can have larger effect in diverting growth than in attracting development over and above location based demands.” He obtained the county ranges from the 2030 most-likely projection, by applying a 25 percent deduction of the 2002-2030 most-likely growth and a 15 percent addition to the 2002-2030 most-likely growth.¹⁶ Table 7 shows Dr. Hammer’s 2030 population projection ranges.

¹⁴ Hammer Report, p 66

¹⁵ Hammer Report, p 66

¹⁶ Hammer Report, p 66

Table 7: Dr. Hammer’s Population Projection for the Charlotte Region

County	2030 Population		
	Lower	Most-Likely	Upper Limit
Anson County	36,967	40,847	43,175
Cabarrus County	247,142	283,115	304,699
Cleveland County	125,373	134,563	140,077
Gaston County	235,228	249,261	295,071
Iredell County	227,287	259,906	279,477
Lincoln County	113,206	128,857	138,247
Mecklenburg County	1,051,400	1,157,311	1,220,858
Rowan County	183,747	200,639	210,774
Stanly County	80,171	87,366	91,682
Union County	268,543	312,147	338,309
Cherokee County	83,228	93,168	99,132
Chester County, SC	52,278	58,306	61,923
Lancaster County, SC	91,781	101,680	107,619
Union County, SC	38,480	41,466	43,258
York County, SC	272,096	305,228	334,080

Hammer Report, p 67

*Regional Projection and County Allocation (Top-Down Process) and the Monroe
Connector/Bypass*

Correspondence from interested parties suggests that Dr. Hammer’s regional projections implicitly included the Monroe Connector/Bypass and therefore the regional projections should be used as the basis for a Build scenario or should be recalculated for the purposes of the Quantitative ICE.¹⁷ Specifically, one comment suggests that Dr. Hammer’s analysis assumed that there would be sufficient infrastructure available to accommodate any future growth and that this assumption implies that the Monroe Connector/Bypass is therefore assumed in the socioeconomic projections. As detailed above, supply side constraints were not a factor in Dr. Hammer’s projections.¹⁸ The following quotes from Dr. Hammer’s report show that his process did not assume construction of the Monroe Bypass/Connector in projecting socioeconomic projections for the region or in allocation to the county level.

The strengths of the model approach include its objectivity and ability to capture a wide variety of relationships and spatial interactions. Its weaknesses derive from the severe limits on types of variables that can be feasibly collected for large sample model calibration. Because whole classes of variables must be omitted, the factors driving the model (other than regional totals) are limited to earlier values of the target variables themselves – i.e. to demographic and economic descriptors – plus functions of distance,

¹⁷ Letter from Southern Environmental Law Center to Jennifer Harris, NCTA, November 30, 2012, p 19.

¹⁸ Hammer Report, p 11

land area and density. The most important omissions are factors that typically must be measured at a fine-grain level of detail (and often are hard to quantify in a relevant fashion) such as land use controls, natural land characteristics and availability of infrastructure. Since these factors mostly affect the supply of land suitable for development, and since the factors that allocation models do cover are most predictors of development demand, the limitations of such constructs can be summarized by calling them demand-side models¹⁹.

Two circumstances allow demand-side models to capture some supply-side influences. First such models can express the general role of land availability using crude measures that consider total land area (minus large-scale deductions like the military installations, wetlands and parks) and existing development density. Second because the model equations operate partly by extrapolation and are pegged to replicate past conditions in the subject areas, they implicitly cover all supply-side factors to the extent that future impacts of these factors equal past impacts.²⁰

But what models of the given type cannot do is capture the influence of exceptionally large infrastructure projects or shifts to more or less stringent development controls. They basically assume that the tendency of public actions to restrict or encourage growth will resemble the conditions prevailing in the calibration period (at the present meaning the 1990s).²¹

Other comments from correspondence suggest that the “proximity factor” used by Dr. Hammer implicitly assumes an improved transportation network.²² Dr. Hammer’s proximity factor cannot include the transportation network. Since Dr. Hammer used the growth rates that occurred in the county between 1990 and 2000 to calibrate his model equations and there has been no controlled access freeway built in Union County in the last two decades, his projections, therefore, could not have assumed construction of a limited access roadway like the Monroe Connector/Bypass. Further, 2000-2010 growth that occurred in the region moved Union County’s population rank among regional counties from sixth in 2000 to fourth in 2010. This growth occurred without a freeway. Thus, a freeway (even less so a toll-road), is not a factor contributing to the extremely high growth occurring in Union County. Rather Dr. Hammer describes major infrastructure projects as an influence that will operate by mainly reallocating growth rather than affecting the urban development that is already present.²³ As discussed in Section 3.3, this conclusion is not exclusive to the analytical work performed by Dr. Hammer.

Correspondence from interested parties also suggests that the county level population projections and employment projections should be re-calculated to exclude the Monroe Connector/Bypass.²⁴ Again, Dr. Hammer’s model to allocate the region growth to County population and employment projections was not

¹⁹ Hammer Report, p 10

²⁰ Hammer Report, p 10-11

²¹ Hammer Report, p 11

²² Letter from Southern Environmental Law Center to Jennifer Harris, NCTA, November 30, 2012, p 19.

²³ Hammer Report, p 66

²⁴ Letter from Southern Environmental Law Center to Jennifer Harris, NCTA, November 30, 2012, p 19.

sensitive to a large-scale transportation project like the Monroe Connector/Bypass as he described in his report.²⁵

In North Carolina, county-level forecasts from a calibrated allocation model should ordinarily be reliable – to the extent any forecast is reliable – with little or no adjustment for omitted supply-side influences. But supply-side factors gain potential importance at progressively smaller geographic scales, so the question is how far below the county level a model application should extend.

Later in the report, Dr. Hammer notes how he adjusted outputs from the model to account for a particular major highway project that he believed would influence growth in a particular county.

The present approach is designed to avoid any need for ad hoc adjustment of results (other than systematic reconciliation with bottom-up, supply-side forecasts, if these are available). However, one after the fact adjustment has occurred here to improve the validity of the numbers in an area relevant for a particular planning project. The failure of the top-down forecasting procedure to acknowledge the impacts of special infrastructure development was judged a critical weakness in eastern Lincoln County, where the upgrading of Route 16 to a freeway will clearly yield growth increments over and above those predicted by demand-side model. This situation has been addressed by advancing the population forecast for one sub-district of Lincoln County from 2035 to 2025 and advancing the forecasts for two other Lincoln sub-districts from 2029 to 2025²⁶.

Finally, explaining the ranges of population and employment projections shown in his tables, Dr. Hammer noted how he adjusted model results for the upper limit of the projections for East Gaston, Southwest Gaston, North York districts for the proposed toll road over the Catawba River.

The second factor is the possibility that a toll expressway will be constructed across the Catawba River to link southern Gaston County with western Mecklenburg. Such a facility would have substantial development impacts on East Gaston, Southwest Gaston, North York and the two counties in aggregate. These potential impacts are incorporated into the upper-limit population and employment values as explained in the footnotes to tables 11 and 12. Adjustments of this nature are not provided for the Route 16 freeway in Lincoln County because the impacts of this facility have already been incorporated into the forecasts, as discussed near the end of Section I. There are also not adjustments for completion of the I-485 beltway around Charlotte because it is not clear whether or how the beltway will alter district-level development patterns relative to what has already been predicted.²⁷

In summary, Dr. Hammer's analytical approach estimated regional and county growth within the Metrolina Regional Travel Demand model area. This projection was designed to establish regional and county level household, population and employment control totals and as such was not influenced by

²⁵ Hammer Report, p 11

²⁶ Hammer Report, p 12-13

²⁷ Hammer Report, p 69

projects that primarily impact accessibility within one county such as the Monroe Connector/Bypass. This means Dr. Hammer’s regional and county projections would not have changed with or without the construction of the project.

***MUMPO 2030 LRTP Household, Population and Employment Allocation Process
(Bottom-Up Process)***

In 2004, CDOT hired Paul Smith and his team from the UNC-Charlotte Center for Applied GIS to create a model to allocate households, population and employment from the county level to the TAZ level. The methodology of the process is described in Mr. Smith’s report *Mecklenburg-Union Metropolitan Planning Organization Population Projections and Employment Allocations, 2000-2030*. Mr. Smith’s process focused on the household (and by default population) allocation and the allocation of population-chasing employment. Population-chasing employment is that employment associated with retail and services that tend to follow population growth. Non-population-chasing employment was distributed solely based on the input of staff and expert panel participants. Mr. Smith’s allocation process started with the county-level control totals developed in the Top-Down process, existing baseline data (2000), and the influence of the of land development factors chosen and ranked by expert panels. Within Union County there were eight land development factors used to assess the attractiveness and capacity of each TAZ in the county to draw future growth. These variables are listed in Table 8.

Table 8: Union County Land Development Factors

Factor	Weight by Year of Allocation		
	2010	2020	2030
Developable Land	3	3	3
Travel Time to Employment	3	3	3
Water	2	2	2
Sewer	2	2	2
Redevelopable Land	2	3	3
Population Change	3	1	Not used
Expert Panel	2	2	2
Growth Policy	1	1	1

Mr. Smith used a raster cell based analysis system where Union County was split into a set of 500 feet by 500 feet grid cells and the value for each land development factor was calculated for each grid cell. Each land development factor would also be normalized to a 0 to 1 scale and weighted so that all scores could be combined into a composite score. The composite grid scores were calculated for each cell and then averaged across each TAZ to calculate land attractiveness scores for each TAZ. The TAZ land attractiveness scores were used to derive the available residential acreage to be consumed during each allocation period. The 2005 Projections (which were used in the 2030 LRTP) were developed for 2010, 2020 and 2030. Thus for each allocation period (2000-2010, 2010-2020, 2020-2030) land development factors were calculated and normalized then weighted and the composite score calculated for each cell. Finally, for each TAZ, an average of the composite scores for all cells within each TAZ was calculated. Higher scores reflected higher attractiveness and would result in higher acreage consumed, until a TAZ reached its calculated maximum capacity. Allowable development densities per TAZ multiplied by the derived residential acres to be consumed were used to calculate the number of households in each TAZ.

Historical household size was used to generate TAZ population at each allocation period. Existing development and available land acted as limits on further growth. Thus, while the available developable land served as a land development factor, it also served as a constraint in the model to ensure that growth in a TAZ was predicted within its capacity to accept development. Once the developable land within a TAZ was consumed, future development would be assigned to TAZs with lower composite scores in subsequent iterations. The land development factors and corresponding weights that were used in the Union County portion of the model are shown in Table 8.

The modeled predictions were subject to feedback and adjustment from the panel of experts. These experts reviewed and adjusted projections as documented in *Land Use and Socioeconomic Data and Projections for the Greater Charlotte Region*. No specific changes to household, population or employment projections are documented in the report but the overall process of expert panel input is reviewed. Expert panel review is a common and recommended method in long-range projection to improve the acceptance of projections by political entities and data users.²⁸ Within Union County, however, no changes were made to the household and population projections as developed by Paul Smith at the TAZ level for the horizon years of 2010, 2020 and 2030. These projections were included as the socioeconomic projections for the adopted MUMPO 2030 LRTP.

Consultation with CDOT staff indicates that there was no influence from the Monroe Connector/Bypass on growth expectations associated with these projections (Appendix A). The travel time to employment factor did include the Monroe Connector/Bypass in the road network used to calculate travel times for the final period, but the assessment of CDOT staff was that the methodology used to calculate that factor would have minimized any impact of the Monroe Connector/Bypass on the 2005 Projections (which were used in the 2030 LRTP). Furthermore, a review of Mr. Smith's results shows no indications of population or employment growth clusters along the project corridor. If the 2005 Projections had included growth expectations associated with the Monroe Connector/Bypass, one would expect to see higher than average population and employment growth and density in TAZs along the project corridor. There are no indications of such clusters of growth along the project corridor in Mr. Smith's results.

Review of the Travel Time to Employment Factor within the Bottom-Up Process

Since May 2012, NCTA has worked with CDOT staff and Paul Smith to reanalyze the travel time factor to determine if the factor affected the 2005 Projections (which were used in the 2030 LRTP) in a way that would indicate those projections include the induced growth effects of the proposed project. Specifically, NCTA engaged Paul Smith and CDOT staff in a reevaluation of the factor beginning in June 2012 and Paul Smith completed his analysis and reported his results to NCTA in September 2012.

The travel time to employment factor for Mr. Smith's model used an estimate of travel time to the nearest employment center. Mr. Smith defined an employment center as any location with 5,000 jobs within a ½-mile area. Travel time was calculated using a composite approach, combining travel speed information from the Metrolina Region Travel Demand Model (MRM), a GIS shapefile of existing roads and assumed walking speed of 2.5 miles per hour.²⁹ The MRM was used to estimate travel speeds for all roads within

²⁸ Smith, Stanley K., Tayman, Jeff, Swanson, David A. *State and Local Population Projections: Methodology and Analysis*. Kluwer Academic/Plenum Publishers, New York, 2001. p 358

²⁹ FHWA guidance on signal design recommends using 3 to 5 feet per second (2 to 2.7 mph) walking speeds in developing pedestrian clearance times for signal timings. FHWA. Traffic Signal Timing Manual. Chapter 5, Section 5.3.3. <http://ops.fhwa.dot.gov/publications/fhwahop08024/chapter5.htm>

the MRM network. For the 2010 and 2020 horizon years, the 2010 model network was used and for the 2030 horizon year the 2025 model network was used. Using the speed assumptions above, travel times to the nearest employment center were then calculated for each horizon year (2010, 2020 and 2030). These travel times were then normalized to a 0 to 1 scale and averaged across each TAZ to determine the score for each TAZ.

The Monroe Connector/Bypass was included in the 2025 MRM network and thus the speed of that facility influenced the travel time to employment factor for the 2020 to 2030 period. Map 6 shows the original travel times calculated using this methodology. These travel times formed the basis of the original Travel Time to Employment Factor used in the Bottom-Up allocation process. As illustrated in the map and detailed in the discussion that follows, the Monroe Connector/Bypass does have a minor influence on the travel time used as an input to the Bottom-Up allocation process as indicated by the area of travel times of less than 10 minutes around the proposed project from Unionville-Indian Trail Road to Rocky River Road. The map also shows that many employment centers were used as destination points for the analysis in Mecklenburg and Union Counties. Notably, none of these employment centers are in the Goose or Sixmile Creek watersheds. The closest employment centers within the FLUSA are at the following locations:

- US 74 and Rama Road in Charlotte
- Monroe Road and Sardis Road in Matthews
- US 74 at NC 51 in Matthews
- US 74 just west of Seacrest Short Cut Road in Monroe
- Downtown Monroe
- US 74 at Sutherland Ave in Monroe
- Along Seacrest Avenue, north of US 74 in Monroe.

The methodology to calculate the travel time to employment for the Bottom-Up allocation calculated travel times to the *nearest* employment center, not to major destinations such as downtown Charlotte. The average distance from an employment center for the MUMPO study area Mr. Smith analyzed was only 3.8 miles, while the greatest distance was 14 miles. Thus, the methodology was a relatively localized analysis of travel time. Freeway type facilities, such as the proposed 20-mile long Monroe Connector/Bypass, tend to serve longer trip lengths. As such, the travel time to employment center analysis methodology would largely miss the travel time savings that would accrue to longer trips like those most likely to occur on the Monroe Connector/Bypass. Lastly, the location of the employment centers Mr. Smith used relative to the Monroe Bypass/Connector would tend to minimize the travel time savings the project could provide. A number of employment centers are located in and around downtown Monroe, as seen in Map 6, and since the proposed project bypasses the downtown Monroe area, Mr. Smith's travel time analysis would largely not account for travel time savings associated with the project in central and eastern Union County.

Revising the Travel Time to Employment Factor without the Monroe Connector/Bypass

Since May 2012, NCTA worked with CDOT staff and Paul Smith to rerun the MRM model and the Bottom-Up allocation process with a revised MRM network that did not include the Monroe Connector/Bypass. NCTA requested the analysis to compare the results to the original 2005 Projections to determine whether removal of the proposed project would affect the results. CDOT staff obtained the 2025 MRM model used to calculate the travel speeds for the original travel time to employment factor analysis and revised the network by removing the Monroe Connector/Bypass. They subsequently reran

the travel demand model with the revised network to get new speed data for the transportation network that did not include the Monroe Connector/Bypass. Mr. Smith then incorporated this new speed data into his other speed assumptions and recalculated the travel times used to develop the travel time to employment factor score for each TAZ. He then recalculated the composite attractiveness scores and subsequently reapplied his allocation model with the new composite attractiveness scores to determine if there would be any differences in population or employment allocations with the new travel time results.

When Mr. Smith removed the Monroe Connector/Bypass from his analysis, it resulted in minor changes to the travel times and composite attractiveness index. Out of 256 TAZs in the MUMPO analysis area of Union County, most had little to no change in travel time to employment centers when the Monroe Connector/Bypass was removed from the network:

- 150 TAZs (59 percent) had no change in their travel time
- 85 TAZs (33 percent) had a travel time increase of less than 1 minute
- 21 TAZs (8 percent) experienced a travel time increase of 1 minute or more
- The maximum change for a TAZ was 5.7 minutes, and the average change throughout Union County was 16 seconds.

The areas with increased travel time are shown in Map 7. The areas with the greatest increase in travel time are in western Union County, centered around the proposed corridor between Stallings and Monroe. The impact of this travel time change is highly localized around the western end of the Monroe Connector/Bypass.

As seen in Map 7, there are no changes in the travel time factor for any TAZ in the Sixmile Creek watershed. For Goose Creek watershed, most TAZs see less than a 30-second increase in travel time, while three TAZs see between a 30-second and 3-minute increase in travel time.

As described above, the model uses travel time to employment as one of several weighted factors in the calculation of composite grid attractiveness scores, which are averaged across a TAZ to derive the percentage of available acreage to be consumed by TAZ for each period. Mr. Smith used the recalculated travel time to employment factor to recalculate the grid attractive scores and TAZ scores for the 2020 to 2030 period. When the composite attractiveness scores were recalculated to include the revised travel time results above and then further averaged for each TAZ, the results showed that most TAZs had little to no change in attractiveness score. Of those that did change, the result was a reduction in attractiveness scores, as increased travel time would result in lower attractiveness to development. Out of 256 TAZs in the MUMPO portion of the study area:

- 150 TAZs (59 percent) had no change in composite attractiveness score
- 92 TAZs (36 percent) had a reduction of less than 1 percent
- 14 TAZs (5 percent) had a reduction of 1 percent or more change in composite score
- The greatest Composite Score reduction is 3.9 percent, and the average Composite Score reduction is 0.21 percent.

Changes in composite attractiveness scores by TAZ, calculated by Mr. Smith, are shown in Map 8. The geographic distribution of the changes roughly parallels those in the travel time map.

As seen in Map 8, there are no changes in composite land development factor for any TAZ in the Sixmile Creek watershed. For Goose Creek watershed, most TAZs see less than a 0.5 percent decrease in their

composite factor, while three TAZs see between a 0.5 and 2 percent decrease in their composite land development factor.

Next, Mr. Smith reapplied the allocation model to determine specifically if the change in travel times and composite scores would result in a different allocation of households and employment. The allocation model uses the composite scores to determine the percentage of available land in each TAZ that would be consumed by growth. The higher the composite score the higher the percentage of available land that would be consumed. The model would then multiply the percentage consumed by the actual available land in each TAZ to determine the acreage of land consumed within each TAZ. Then the acreage would be multiplied by the development density for each TAZ (calculated from tax and zoning records) to determine the actual number of households to be added to each TAZ for each period. Thus any change in composite score could potentially change the percentage of land consumed and thus the number of households added to any given TAZ.

When Mr. Smith reran the allocation model with the new composite scores, the results showed that the land use projections were identical to those produced in his original report; in other words the results did not change. For the 106 TAZs where the change in travel time led to a reduction in their composite attractiveness index, the allocation model in the original allocation (i.e. before the Monroe Connector/Bypass was removed) had calculated that those TAZs would use 100 percent of available land by 2030. For those same TAZs, when the new allocation model was run (i.e. after the Monroe Connector/Bypass was removed) the lower attractiveness scores did not reduce their attractiveness in the allocation model enough to cause the allocation model to request less than 100 percent of the developable land within each of those TAZs by 2030. These 106 TAZs already had relatively high composite scores as they were in areas with sewer and water availability, where growth policy was favorable and where Expert Panel members expected growth already. The relatively small reduction in composite attractiveness that resulted from the changes in travel time did not reduce the score for these TAZs enough to reduce the percentage of land the model would consume. In addition, many of these TAZs had little available land to fill in the 2020 to 2030 period. This result is logical given that the areas where travel time and composite scores changed have experienced extensive growth since 1990 and thus are likely to reach build out sooner than most other areas of the County.

These results show clearly that removal of the Monroe Connector/Bypass from the travel time to employment factor had no effect on the results of the 2005 Projections. Therefore, it is clear that the Bottom-Up portion of the 2005 Projections was insensitive to the presence or absence of the proposed project. Since this factor was the only factor that explicitly included the project in either the Top Down or Bottom Up, it is clear that the 2005 Projections are insensitive to the presence or absence of the proposed project. As such, it is reasonable to conclude, that the proposed project had no influence on the “Old Projections” factor used in the LUSAM process for the 2008 and 2009 Projections.

Relevance to Goose and Sixmile Creek Watersheds

As noted above and seen in Maps 7 and 8, the re-evaluation of the Travel Time to Employment Center factor resulted in minimal changes to that factor for Goose Creek watershed and no changes to that factor for Sixmile Creek watershed. Similarly, the re-evaluation of that factor resulted in minimal changes to that the composite land development factor for Goose Creek watershed and no changes to the composite factor for Sixmile Creek watershed. Most important, though, is that the re-evaluation of the results of the 2005 Projections using the revised Travel Time to Employment Factor showed absolutely no change in

the final results for any TAZ in Goose Creek or Sixmile Creek watersheds. Since this factor was the only factor that explicitly included the project in either the Top Down or Bottom Up, it is clear that the 2005 Projections are insensitive to the presence or absence of the proposed project. As such, it is reasonable to conclude, that the proposed project had no influence on the “Old Projections” factor used in the LUSAM process for the 2008 and 2009 Projections for Goose and Sixmile Creek watersheds.

District Level Targets

The only remaining area that the Monroe Connector/Bypass could have influenced the LUSAM process would be through the district level targets. The household, population and employment targets used in the LUSAM models were developed based on the following inputs:

- Interpolation and extrapolation of the previous projections (2005 Projections, which were used in the 2030 LRTP)
- NC State Data Center Demographic Projections (Summer 2007)
- Hammer Report Five-Year Projections.

As previously documented, neither the Hammer Report nor the 2005 Projections (which were used in the 2030 LRTP) were influenced by the Monroe Connector/Bypass growth expectations. The NC State Data Center develops its projections based on trend growth over the previous two decades drawing from both Census counts and estimates. The projections are then developed using the most appropriate smoothing model that best fits the trend line data.³⁰ Since these projections rely entirely on trend data, there is no influence in these projections from proposed transportation improvements. Therefore, it is reasonable to conclude that the district level targets were unaffected by any influence from growth associated with the Monroe Connector/Bypass.

Review of Projection Results

An examination of density levels along the project corridor is illustrative regarding the relationship (or lack thereof) between the proposed project and the MPO projections of households, population and employment. Map 9 shows the household density by TAZ in 2030 from the 2009 Interim Projections. The household density levels in TAZs along the proposed project corridor in the 2030 projections are similar to the household densities of surrounding TAZs. If the projections were representative of a Build Scenario then one would expect to see higher household density levels along the project corridor, particularly at interchange locations. Map 10 shows the employment density by TAZ in 2030 from the 2009 Interim Projections. The employment density levels in TAZs along the proposed project corridor in the 2030 projections are similar to the densities of surrounding TAZs. If the projections were representative of a Build Scenario then one would expect to see higher employment density levels along the project corridor, particularly at interchange locations. Overall, the density pattern in the 2009 Projections shows no signs of influence from the Monroe Connector/Bypass. Furthermore, CDOT staff indicated that growth impacts of the proposed road were not a consideration in the projection process.

4.3 How Have Other Studies Used the MRM Socioeconomic Projections

The NCTA hired other consultants and researchers to perform work on traffic and revenue studies to obtain investment ratings for Toll Revenue Bonds. The work performed consisted of a Preliminary Traffic

³⁰ Smoothing models use historical data on past population or employment conditions and apply exponential functions that best fit those past trends to then forecast future conditions.

and Revenue Study, an Independent Economist Evaluation of the Socio-economic Estimates Underlying the Study of the Feasibility of the Proposed Monroe Connector/Bypass, and a Comprehensive Traffic and Revenue Study. This section will provide a summary of the work and the relevance to the research performed and used in the Quantitative ICE analyses.

WSA, Proposed Monroe Connector Preliminary Traffic and Revenue Study, Final Report,
October 11, 2006

The NCTA hired Wilbur Smith Associates (WSA) to conduct a preliminary traffic and revenue study for the proposed Monroe Connector. The purpose of the study was to determine the feasibility of pursuing toll financing for construction of the Monroe Connector and/or Monroe Bypass. WSA assumed that the proposed project would provide significant time savings for travelers moving between I-485 south of Charlotte and Monroe or points south and east based on their analysis of travel conditions on US 74 in 2006 and travel demand model analysis of travel speeds in their study area. It should be noted that WSA completed this preliminary study in 2006 before analysis for the EIS had begun. WSA used the 2005 Projections socioeconomic data set (which were used in the 2030 LRTP) as it was the most recent projection available at the time of their study.

WSA collected traffic counts in the project corridor and used the information to re-calibrate the Metrolina Regional TDM model and provide traffic scenarios for No-Build, Build (Toll Free) and Build (Tolled) scenarios. They also updated the network within the model to account for proposed transportation improvements. WSA also collected information regarding regional and corridor income characteristics to aid in the development of estimated values of time for potential users of the toll facility. WSA stated that this is a critical parameter used to assess a motorist's willingness to pay for tolls and use the facility.

WSA concluded that the Monroe Connector/Bypass would help reduce congestion in the study area even with the planned widening of US 74. Its preliminary traffic and revenue study concluded that pursuing project financing with tolling was feasible and would be best served by combining the Monroe Connector and Bypass in a proposed toll financed project.

WSA's analysis relied upon the socioeconomic projections incorporated in the Metrolina Regional TDM. They concluded that the population projections contained in the Metrolina Regional TDM at that time were directly related to the growth rate of traffic predicated by the model. They indicated that the Monroe Connector/Bypass is included in the model and influences the growth projections therein. However, WSA did not perform a Build versus No-Build analysis for purposes of determining the project influence on the socioeconomic conditions in its study area. Furthermore, WSA provided no basis for the assumption that the Monroe Connector/Bypass influenced the growth projections in the model nor did they provide any documentation to justify the assumption. WSA's report clarified that its work was performed without the benefit of an independent economic review of the socioeconomic projections. WSA also acknowledged that such work would typically be required to support project financing.

In summary, this report was a preliminary traffic and revenue study and conducted prior to the DEIS Qualitative ICE and FEIS Quantitative ICE analyses. Furthermore, as shown through the analysis by Mr. Paul Smith discussed in section 4.4, the Monroe Connector/Bypass did not influence the 2005 Projections (which were used in the 2030 LRTP).

**Kenan Institute of Private Enterprise, Technical Memorandum, Proposed Monroe
Connector/Bypass Comprehensive Traffic and Revenue Study, Initial Report of
Independent Economist, September 28, 2009**

In subsequent work on the traffic and revenue studies, the WSA team, in consultation with NCTA, hired the Kenan Institute of Private Enterprise at the University of North Carolina's Kenan-Flagler Business School (Kenan Institute) in 2009 to develop a set of TAZ projections specifically for the Monroe Connector/Bypass Traffic and Revenue Study. The Kenan Institute developed their projections based on Dr. Hammer's 2003 projections for regional and county growth, a review of the MUMPO Bottom-Up process to allocate county and district growth from Dr. Hammer's projections to TAZs; a review of recent economic, employment and population trends and estimates produced by other organizations; a regional scan of the project area; and, interviews with planners, developers and business/economic experts within the region. The Kenan Institute Report, entitled *Initial Report of Independent Economist* (Appendix C), was used in the development of WSA's *Comprehensive Traffic and Revenue Study*, October 22, 2010.

The main objective of the Kenan Institute Report was to determine the socioeconomic conditions that would be prevalent in its project study area with the construction of the Monroe Connector/Bypass toll road. As part of its work, the Kenan Institute conducted an independent economic review of the 2008 Interim Projections, which were the most up to date TAZ level projections available at the time of their study. The Kenan Institute's corridor study area for evaluation and analysis is shown in Map 11.

Map 11 also includes the Qualitative and Quantitative ICE analysis areas. One key observation is the Kenan Institute's study area is much smaller than either the Qualitative or Quantitative ICE study areas. The Quantitative ICE study boundary was established to evaluate effects on the natural environment in consultation with resource agencies and is focused on impacts to watersheds and protected species. The Kenan Institute's study area appears to have been established based on the project's travel time savings during peak travel times. The Kenan Institute study area is 132,436 acres compared to the Quantitative ICE study area of 202,000 acres or 66 percent of the Quantitative ICE study area. This observation also highlights that the area of influence of change in socioeconomic projections is much less than the project area, the county and the region as a whole. In other words, the Kenan Institute analysis and resulting study area provide further evidence that the Monroe Connector/Bypass would have little to no effect on regional or county level growth. As seen in Map 11, the Kenan Institute study area included only very small portions of either Sixmile or Goose Creek watersheds. The report notes that the corridor was "an analyst's construct approximating the area where travel behavior is most likely to be influenced by the new roadway."³¹ This would suggest that their conclusion was that there would be little to no effect on travel behavior or growth in the Goose Creek or Sixmile Creek watersheds.

The Kenan Institute reviewed the 2008 Interim Projections and determined that for the purposes of forecasting traffic for Toll Revenue Bond issuance, adjustments would be required to develop socioeconomic projections that were reasonable but did not overestimate traffic forecasts. The Kenan Institute made two adjustments to the socioeconomic estimates. "The first was to make region-wide adjustments consistent with the national growth expectations. The second was to reallocate growth in Union County in line with development factors and constraints."³²

³¹ Appendix C, p 2, Footnote 3

³² Appendix C, p 29

The Kenan Institute’s analysis determined that the growth in the 2008 Interim Projections needed to be adjusted to account for the extended recession, which it determined was not accounted for in the projections. Based on its research, the Kenan Institute lowered the TAZ level projections by 8.7 percent to account for the national economic correction, which suggests that as growth resumes, the gross domestic product is expected to be 91.3 percent as high as it would have been at the same time in the absence of the national crisis.³³ Table 9 shows the original 2008 Interim Projections of household and population, the Kenan Institute adjustments for the national economic correction, and their project specific adjustments.

Table 9: Household and Population Projections for the Corridor Study Area (132,436 acres)

Year	MRM 2008 Interim Projections		Kenan Adjustments for “National Correction”		Kenan Adjustments due to Project	
	Households	Population	Households	Population	Households	Population
2005	42,595	120,054	42,595	120,054	42,595	120,054
2010	49,393	140,267	45,164	128,258	45,346	128,732
2015	56,454	161,371	51,556	147,364	51,968	148,486
2020	62,479	178,152	57,056	162,689	57,974	165,207
2025	68,407	194,812	62,469	177,902	63,869	181,775
2030	74,497	211,973	68,029	193,573	69,843	198,613

Looking within the project corridor, the Kenan Institute accepted the allocation of growth by the MPO in Mecklenburg County. However, it reallocated the projected population growth within Union County away from the line of high growth in the southwest quadrant of the county to the Connector/Bypass corridor because of the project. A portion of the expansion in several high growth TAZs in the northeastern quadrant of the county was also reallocated towards the corridor. The Kenan Institute made these adjustments based on results of interviews with local planners, analysis of growth trends in the area, and analysis of water and sewer demand and capacity in the area. The Kenan Institute report notes that many of the regional planners could not recall critical details of the regional and TAZ level socioeconomic projection and allocation modeling and reasoning behind specific projections. They also concluded from the interviews that a few biases may have entered into the Union County small area projections. Dr. Appold specifically noted the line of growth in southwest Union County along and south of NC 75 that did not appear to be appropriate given limitations on growth in that area.³⁴ However, that the Kenan Institute found it necessary to reallocate growth to account for the influence of the Monroe Connector/Bypass is consistent with the contention that the existing projections did not represent a Build Condition for the Monroe Connector/Bypass.

Table 10 provides a comparison between the MRM 2008 Interim Projections in the corridor to the overall adjustments made by the Kenan Institute.

The set of projections in the second column of Table 10, shown under the heading Kenan National Correction Adjusted, was calculated by multiplying the MPO projection for 2030 by 8.68 percent (the same reduction that the Kenan Institute used to adjust the projection for all TAZs). This calculation allowed a comparison of the Kenan Institute adjustments within the corridor due to the project (third

³³ Appendix C, p 24

³⁴ Appendix C, p 24-25

column set of projections) with projections adjusted due to the national correction. Thus, the last column set in the table shows how the project would increase growth by zones in the corridor of the Kenan Institute study area. It is important to note that the Kenan Institute did not conduct a “Build versus No-Build” analysis, but only created a scenario of a 2030 projections of population and households with the project.

Although the growth rate difference in the entire corridor is rather small (3 percent), the tables show the substantial difference in the allocation of growth between the western corridor zones to the eastern corridor zones. This re-allocation of growth by zone is very similar to the growth patterns in the DEIS Qualitative ICE and FEIS Quantitative ICE. Therefore, the Kenan Institute reallocation of adjusted regional growth in Union County supports the Quantitative ICE conclusions regarding the project’s influence on accelerated growth in central and eastern Union County.

For the Sixmile Creek watershed, only a small portion falls within Zone 1 of the Kenan study area. As noted in Table 10, this zone saw limited adjustment from the Kenan analysis, suggesting that this zone would have little to no change associated with the proposed project. A small portion of Zones 1 and 2 fall within the Goose Creek watershed. As noted in Table 10, these zones saw limited adjustment from the Kenan analysis, suggesting that these zones would have little to no change associated with the proposed project. Thus, the Kenan Institute adjustments and choice of study area, strongly suggest that there would be little to no indirect land use changes in either Goose or Sixmile Creek watersheds associated with the proposed project.

Table 10: Change in Household and Population Projections within the Corridor Study Area

Year	MRM 2008 Interim Projections ¹		Kenan “National Correction” Adjusted		Kenan Project Adjusted ¹		Change in Kenan Projection due to project in 2030 (%)	
	Households	Population	Households	Population	Households	Population	Households	Population
Corridor								
2005	42,595	120,054	42,595	120,054	42,595	120,054		
2030	74,497	211,973	68,029	193,573	69,843	198,613	3%	3%
Zone 1								
2005	14,118	38,774	14,118	38,774	14,118	38,774		
2030	19,307	55,413	17,631	50,603	17,730	50,871	1%	1%
Zone 2								
2005	11,017	30,859	11,017	30,859	11,017	30,859		
2030	16,676	47,280	15,228	43,176	15,474	43,842	2%	2%
Zone 3								
2005	7,617	20,404	7,617	20,404	7,617	20,404		
2030	11,369	30,980	10,382	28,291	11,074	30,225	7%	7%
Zone 4								
2005	6,164	19,084	6,164	19,084	6,164	19,084		
2030	17,827	51,435	16,279	46,970	16,455	47,580	1%	1%
Zone 5								
2005	3,679	10,933	3,679	10,933	3,679	10,933		
2030	9,318	26,865	8,509	24,533	9,110	26,095	7%	6%

¹ Appendix C Table 11

One may argue that the Kenan Institute concluded that the growth in the corridor area would reallocate outside Union County without the project. However, the Kenan Institute acknowledged that it did not conduct a no-build versus build analysis. It also acknowledged that its analysis relied upon the regional growth allocation to the counties, which did not consider supply-side factors such as large infrastructure projects. Lastly, the Kenan Institute’s study area of 132,436 acres is much smaller than the area of Union County. Therefore, any conclusion the Kenan Institute report made regarding a No-Build Scenario was not reached with the same degree of analytical work performed in developing the adjusted projections.

A final point regarding the reports prepared by the Kenan Institute for the project is the complimentary narratives regarding Dr. Hammer’s methodologies, models and projections of region and county

population and employment described in his report, *Demographic and Economic Forecasts for the Charlotte Region*, 2003.

*Our basic assessment of the MPO socio-economic projections is twofold. First, although the region-wide projections were prepared with an unusual degree of competency and care, they may have been over-adapted to new information during the boom years which followed.*³⁵

*The large area projections performed by Thomas Hammer and summarized above appear to be thoughtfully and carefully constructed.*³⁶

*Recognizing that no projection is completely accurate (error bounds are discussed in the full report), our judgment is that Thomas Hammer, the consultant hired by MUMPO to estimate county and sub-county population and employment for selected years, has the most credible methodology of any known population and employment projection. His estimation process relies on Census data, the quantified detailed experiences of similar metropolitan regions, and extensive feedback from knowledgeable regional (Charlotte) informants. We feel that his estimates, modified with the best available information about development subsequent to his work, form the best possible basis for NCTA decision-making.*³⁷

WSAs, Final Report, Proposed Monroe Connector/Bypass Comprehensive Traffic and Revenue Study, October 22, 2010

WSA's Comprehensive Traffic and Revenue Study (T&R Study), begun in 2009, was a follow up to the preliminary study performed in 2006. This research was conducted parallel to but separate from the NEPA analyses conducted for the FEIS and ROD. The report was not completed until after issuance of the ROD. The T&R Study used the Kenan Institute's socioeconomic projections of population, household and employment described above as inputs to the Metrolina Regional TDM. WSA also conducted an Origin-Destination Study in the project study area to identify current travel patterns and trip characteristics. They also supplemented NCDOT traffic counts with further counts during March 2009. WSA also updated the proposed transportation projects into the transportation network. Finally, based on traffic counts, WSA adjusted the model during a calibration process to achieve model predictions better aligned with current traffic observations.

WSA's T&R Study Report also compared population projections from the 2005 Projections (which were used in the 2030 LRTP), the 2008 Interim Projections, and the projections developed by the Kenan Institute in 2009 within the corridor. WSA found that the three different population projections for the corridor in the year 2030 closely correlate. For example, in 2009, the Kenan Institute estimated the 2030 population in their study area to be 198,613. This projection clearly included the effects of the project. However, the information WSA extracted from the 2005 Projections estimated the 2030 population in their study area to be 210,900. The information WSA extracted from the 2008 Interim Projections estimated the 2030 population in their study area to be 211,973. As previously discussed, none of the

³⁵ Appendix C, p 4

³⁶ Appendix C, p 23

³⁷ Appendix C, p 3

MRM socioeconomic projection versions included growth effects from the project. All of these projection results are within seven percent and suggest a strong correlation between different projection versions. Since the Kenan Institute's charge in developing their projections was to err on the side of not overestimating traffic so as to provide a conservative estimate for financing purposes, it would not necessarily be appropriate to use those adjusted projections as a basis for environmental impacts analysis. Finally, WSA's T&R Study did not construct a No-Build versus Build scenario to analyze the effects of the project on the study area. However, they did break down the project zones to more precisely describe where increased growth was likely to occur. This work is similar to the work conducted in the FEIS Quantitative ICE analysis and the implications from their analyses regarding the areas most likely to see additional growth due to the project are similar to the conclusions of the DEIS Qualitative ICE and FEIS Quantitative ICE.

4.4 How Do the MRM Socioeconomic Projections Compare to Other Projections?

The ICE Guidance recommends using adopted regional projections authored by MPOs where available.³⁸ Yet it would be best to compare those projections to others before using them. Therefore, it is instructive to compare the MPO projections to other population projections for the area. Projections from other sources show a wide range of future growth trends for Union County. Two of the most commonly cited privately developed projections are from Woods & Poole and Global Insights. Both firms use cohort-component projections, a demographic projection method that focuses on fertility, mortality and net migration to estimate total population by year. The Global Insight model incorporates the predictions of a regional macroeconomic model, thereby incorporating some economically driven assumptions of jobs growth into the process. The North Carolina State Data Center also generates population projections using a time series trends projection process. Table 11 summarizes five different projections of population to 2030 from four different sources:

1. MRM 2009 Projections (developed between 2004 and 2009)
2. Global Insights Projections (developed in 2009)
3. Woods & Poole Projections (developed in 2009)
4. NC State Data Center Projections (developed in 2009)
5. NC State Data Center Projections (developed May 2011).

As all of the projections operate from either demographic trend projection or economic modeling projections; they do not incorporate expectations of transportation infrastructure development except to the extent that past infrastructure development has affected past trends. One key to understanding the differences in these projections is to compare the actual change in each five-year increment. The demographically driven approaches used by Woods & Poole and the NC State Data Center produce very similar changes in each five-year increment of their projections, whereas the Global Insights and MPO projections, which are more economically driven models, show significant differences in each five-year increment of changes.

As to the actual projection of future population in Union County, the highest projection is from the NC Data Center in 2009, which projected a 2030 population of 400,683. The NC Data Center's projection

³⁸ NCDOT & NCDENR, 2001a, p III-16

from 2011, however, predicts a 2030 population of 271,289, the lowest of all the projections. The Global Insights projection from 2009 predicts a 2030 population of 393,407, while Woods & Poole from 2009 predicts a 2030 population of 283,433. The MRM 2009 Projections fall generally in the middle of all these projections, predicting a 2030 population of 337,314 for Union County. Most interesting is how closely the MPO projections predicted the 2010 populations (based on actual 2010 Census counts) of Mecklenburg and Union Counties. In the case of Mecklenburg County, the MPO projection for 2010 population of 931,666 (Table 11) is only 1.3 percent higher than the actual 2010 Census count of 919,628. In the case of Union County, the projected population in 2010 of 200,450 is only 0.4 percent lower than the actual 2010 Census count of 201,292. This compares favorably to other projections completed prior to 2010. The Global Insights projections from 2009 overestimated population in Mecklenburg and Union Counties by four percent and nine percent respectively. The Woods & Poole projection from 2009 underestimated population for Mecklenburg and Union Counties by 0.3 percent and two percent respectively. The NC State Data Center projections from 2009 underestimated Mecklenburg County population by one percent and overestimated Union County population by four percent. Given that these other projections were all completed about one year prior to the horizon year in question (the 2010 Census counts) whereas the MRM Socioeconomic projections were largely completed two years prior (and the underlying work dates back to 2004), the MRM socioeconomic projections for Mecklenburg and Union Counties compare favorably.

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

Table 11: Comparison of Population Projections

Global Insights (2009)									
	Mecklenburg	Change	Annualized % Change	Union	Change	Annualized % Change	Region*	Change	Annualized % Change
2005	806,834			161,765			1,314,553		
2010	956,823	149,989	3.5%	219,690	57,925	6.3%	1,570,976	256,423	3.6%
2015	1,065,308	108,485	2.2%	263,298	43,608	3.7%	1,749,656	178,680	2.2%
2020	1,171,442	106,134	1.9%	303,978	40,680	2.9%	1,920,865	171,209	1.9%
2025	1,275,768	104,326	1.7%	349,186	45,208	2.8%	2,097,412	176,547	1.8%
2030	1,382,406	106,638	1.6%	393,407	44,221	2.4%	2,280,808	183,396	1.7%
Woods & Poole (2009)									
	Mecklenburg	Change	Annualized % Change	Union	Change	Annualized % Change	Region*	Change	Annualized % Change
2005	802,400			160,876			1,307,329		
2010	916,747	114,347	2.7%	197,554	36,678	4.2%	1,497,063	189,734	2.8%
2015	1,000,055	83,308	1.8%	218,988	21,434	2.1%	1,630,535	133,472	1.7%
2020	1,084,264	84,209	1.6%	240,490	21,502	1.9%	1,765,570	135,035	1.6%
2025	1,168,900	84,636	1.5%	261,995	21,505	1.7%	1,901,371	135,801	1.5%
2030	1,253,544	84,644	1.4%	283,433	21,438	1.6%	2,037,236	135,865	1.4%
MRM 2009 Projections									
	Mecklenburg	Change	Annualized % Change	Union	Change	Annualized % Change	Region*	Change	Annualized % Change
2005	837,862			168,728			1,369,445		
2010	931,666	93,804	2.15%	200,450	31,722	3.51%	1,544,779	175,334	2.44%
2015	1,025,004	93,338	1.93%	231,986	31,536	2.97%	1,719,218	174,439	2.16%
2020	1,111,254	86,250	1.63%	266,612	34,626	2.82%	1,891,996	172,778	1.93%
2025	1,196,999	85,745	1.50%	301,053	34,441	2.46%	2,063,849	171,853	1.75%
2030	1,271,300	74,301	1.21%	337,314	36,261	2.30%	2,221,345	157,496	1.48%
NC State Data Center (2009)									
	Mecklenburg	Change	Annualized % Change	Union	Change	Annualized % Change	Region*	Change	Annualized % Change
2005	796,529			159,726			1,298,879		
2010	911,252	114,723	2.7%	210,069	50,343	5.6%	1,518,920	220,041	3.2%
2015	996,414	85,162	1.8%	257,378	47,309	4.2%	1,706,871	187,951	2.4%
2020	1,081,577	85,163	1.7%	304,688	47,310	3.4%	1,894,854	187,983	2.1%
2025	1,166,740	85,163	1.5%	351,996	47,308	2.9%	2,082,842	187,988	1.9%
2030	1,253,198	86,458	1.4%	400,683	48,687	2.6%	2,274,700	191,858	1.8%

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

NC State Data Center (2011)									
	Mecklenburg	Change	Annualized % Change	Union	Change	Annualized % Change	Region*	Change	Annualized % Change
2005	802,998			160,260			1,305,092		
2010	923,144	120,146	2.8%	202,200	41,940	4.8%	1,510,094	205,002	3.0%
2015	1,009,658	86,514	1.8%	219,522	17,322	1.7%	1,634,793	124,699	1.6%
2020	1,095,857	86,199	1.7%	236,778	17,256	1.5%	1,758,306	123,513	1.5%
2025	1,182,056	86,199	1.5%	254,034	17,256	1.4%	1,881,818	123,512	1.4%
2030	1,268,257	86,201	1.4%	271,289	17,255	1.3%	2,005,336	123,518	1.3%

* The Regional projections here are for a four county region of Cabarrus, Gaston, Mecklenburg and Union Counties. This is due to data limitations from the various sources.

4.5 How Accurate are the MPO Projections?

Projecting socioeconomic conditions, and any projection of the future, is an uncertain process fraught with the potential for error. Available evidence on socioeconomic projection indicates that “forecast errors are generally larger for small places [such as an individual TAZ] than for large places; are generally larger for places that have very high [such as Union County] or negative growth rates than they are for places that have moderate, positive growth rates; generally increase with the length of the projection horizon; and vary from one launch year to another.”³⁹ Errors for long-range socioeconomic projection can also be quite high, especially for smaller geographies. For county level projections of 25 years, the typical mean algebraic percentage errors are about 30 percent while for census tracts (which are typically larger than TAZs) errors are typically 45 percent for the same period.⁴⁰ Thus, despite the best efforts of researchers and forecasters, the error rates for long-range projections are still quite high and thus any projection or estimate of induced and cumulative effects must be considered the best estimate within a wide range of error. The accuracy of projected growth under any future scenario could be affected by many variables. These include individual owner or developer actions, the timing of or changes in utility provision, changes in local or state regulations on land use and, most importantly, changes in national or regional economic conditions. While the potential for error is high, the techniques used by the MPO are the best available and provide the best available data for projecting population and employment conditions in the future.

4.6 Conclusions

What Influence Did the Monroe Connector/Bypass Have on the MPO Projections?

As discussed above, an assessment of the MRM socioeconomic projections reveals the following regarding the influence of the Monroe Connector/Bypass on the projections:

- The proposed project did not affect the Travel Time to Core Employment factor in the LUSAM process as this factor had zero weight for all districts for all LUSAM runs.

³⁹ Smith, Stanely K., Tayman, Jeff, Swanson, David A. *State and Local Population Projections: Methodology and Analysis*. Kluwer Academic/Plenum Publishers, New York, 2001. p 292

⁴⁰ Smith, Tayman, Swanson, p 340

- The proposed project did not affect the Planners' Judgment factor in the LUSAM process as this factor had zero weight for all districts in Union County for all LUSAM runs.
- The proposed project was included in the Travel Time to Employment factor used by Paul Smith in developing the 2005 Projections, but a reassessment of that factor without the proposed project shows that the project had no influence on the projection results.
- The proposed project did not affect Dr. Hammer's projections of households and employment that were used in the 2005 Projections for county level control totals and were used in the 2008 Interim and 2009 Projections for developing the district level targets.
- There is no evidence or indication that any other factor in the LUSAM process or the other projection processes was influenced by the proposed project and communications with CDOT staff indicate that the proposed project was not a consideration in development of the projections.
- A review of the results of the projections shows no signs that the proposed project influenced the projections.

Based on this review, the overall evidence suggests that the MRM socioeconomic projections are insensitive to the presence or absence of the proposed project in the land use models used to develop the projections. The methodology used by CDOT and MUMPO to develop the projections is effectively insensitive to the Monroe Bypass/Connector and other large transportation projects. In the methodology used by Dr. Hammer, specific adjustment had to be made to account for the expected growth induced by large roadway projects in the Top-Down process. As the sensitivity analysis of Paul Smith's Travel Time to Employment Factor showed, the proposed project made no difference in the Bottom-Up allocation process. Thus, the methodology used does not incorporate the full accessibility impacts of major roadway projects. Consequently, if the ICE analysis were to follow the exact same methodology as the MRM socioeconomic projections to calculate induced growth impacts of the Monroe Connector/Bypass, then the result would be to find no induced growth. However, the qualitative ICE analysis and all other studies point to localized land use impacts occurring with the Build Alternative, particularly in eastern Union County. Therefore, it would be inappropriate to use the MPO socioeconomic projection and allocation methods to attempt to estimate induced growth or induced land use changes associated with the Monroe Bypass/Connector. As described in Section 5, the study team has chosen other methodologies to estimate induced growth and induced land use changes associated with the proposed project.

How Did the Quantitative ICE Use the MPO Projections?

Based on the above review of the assumptions and variables used in the Top-Down and Bottom-Up processes, the inputs and variables used in the LUSAM models, a review of the actual results of the various projection versions, and a re-evaluation of the 2005 Projections without the project, we concluded that the MUMPO models did not incorporate the induced land use effects of the Monroe Connector/Bypass. Furthermore, in comparison to other projections for Union County, the MPO projections appear to be reasonable and in the middle of the range of available projections. Since the MPO projections are also the only source that provides growth projections at a small geographic scale, which is critical to a Quantitative ICE analysis, the MPO projections appear to be the best resource to developing a starting point for future land use conditions in the study area.

*Monroe Connector/Bypass Draft Technical Report on Direct, Indirect
and Cumulative Impacts to Federally Listed Species*

A review of the actual distribution of growth in the projections indicates that there is no pattern of development along the proposed project corridor that would suggest that the proposed project was considered in the projection development. Furthermore, a review of how other entities have used the MRM Projections for Traffic and Revenue analyses shows that minor adjustments were made to the MRM socioeconomic projections to account for the presence of the Monroe Connector/Bypass. These adjustments generally consisted of increases in household and employment in eastern portions of the study area. These conclusions suggest that additional analysis is needed to estimate the induced land use effects of the project. As described in Section 4, this Quantitative ICE analysis used the MPO projections as control totals, along with various other information, to develop a scenario without the project or its growth inducing impacts (i.e., the No-Build Scenario). The study team then estimated the induced growth potential of the project and added that estimated induced growth to the No-Build land use scenario to create a new scenario that represents future conditions with the project and its growth inducing impacts (i.e. the Build Scenario).

5.0 INDUCED GROWTH ASSESSMENT AND FUTURE LAND USE SCENARIOS

To assess the induced growth potential of the proposed project and compare, quantitatively, the land use conditions with and without the proposed project, two land use scenarios were developed. The Build Scenario would represent the best estimate of land development conditions with the proposed project and its growth inducing impacts. The No-Build Scenario would represent the best estimate of land use conditions without the proposed project or its growth inducing impacts. As noted above, a reference point for the future growth of the study area was needed from which to base the two scenarios and that reference point was the MPO socioeconomic projections. The sections below describe specifically how each scenario was created and how the projections were used in the development of those scenarios.

5.1 How Did the ICE Analysis Project Land Use without the Proposed Project?

To estimate the land use conditions in 2030 without the proposed project or its growth-inducing impacts, the study team used three main inputs:

- Stream buffer regulations
- Land use plans or zoning ordinances (as appropriate per the research phase)
- MPO socioeconomic projections of growth.

All undeveloped parcels were isolated from the process to develop the Existing Land Use Scenario and these parcels were considered available for development unless specifically excluded by regulations. These parcels were then compared to the areas designated for stream buffers and the zoning and land use plans for the various communities to determine the potential use and density for each parcel. Then, based on the growth estimates in the TAZ level projection, the total amount of development was estimated for 2030. The specific steps and methods are detailed below.

Lands Excluded from Development

Prior to allocating growth, stream buffers were excluded from the subset of developable parcels because development within these areas is prohibited by local and/or state regulations. Buffers were developed based on the Post Construction Ordinance regulations and NCDENR's *Site Specific Water Quality Management Plan for the Goose Creek Watershed* (NCDENR, 2009). These regulations vary somewhat between jurisdictions but generally require the following buffers: 30 feet on streams draining areas less than 50 acres; 35 feet on streams draining more than 50 acres and less than 300 acres; 50 feet on streams draining areas more than 300 acres less than 640 acres; and 100 feet plus the floodplain on streams draining more than 640 acres. Special rules apply in the Goose Creek watershed where undisturbed riparian buffers within 200 feet of waterbodies within the 100-year floodplain and within 100 feet of waterbodies that are not within the 100-year floodplain are now required.⁴¹ Buffers were developed on all streams in the National Hydrographic Dataset available for the area.⁴² While it is possible to obtain an exemption to these restrictions, it is assumed that mitigation requirements would offset any impacts.

⁴¹ North Carolina Department of Environment and Natural Resources (NCDENR). 2009. Site Specific Water Quality Management Plan for the Goose Creek Watershed.

⁴² U.S. Geological Survey Water Resources Division and U.S. Department of Agricultural Natural Resources Conservation Service (USGS & USDA). 1999. National Hydrography Dataset, Watershed Boundaries Dataset.

Residential Development Allocation

Once the total land available for development was determined, the next step was to estimate the level of development needed to accommodate future household growth. The study team used the projected household growth from the MPO 2009 Projections. For each TAZ, the total undeveloped (vacant or agricultural) area was determined based on the parcel categorization completed for the Existing Land Use Scenario (see Section 2.1). For the future scenario, each undeveloped parcel was re-categorized into one of the five development categories (low density residential, medium density residential, high density residential, commercial, or industrial/office/institutional) based on the future land use plans and zoning of the local jurisdictions. For residential properties, the land use categories equated to the following densities:

- Low Density Residential – two dwelling units (DU) per acre or fewer
- Medium Density Residential – greater than two DU per acre but fewer than five
- High Density Residential – five or more DU per acre.

Household growth by TAZ based on the MUMPO’s projections is depicted in Map 12. The allocation for residential growth followed a four-step process, as detailed below.

Step 1 - Identification of TAZ Build-Out Capacity: The total acreage of currently undeveloped land that is zoned or planned for future residential development based on local land use plans was calculated for each TAZ to determine the total build-out capacity of that TAZ. Based on local future land use plans, each parcel was assigned a residential land use category, and the total number of possible dwelling units was determined.

Step 2: - Identification of Projections by TAZ: The build-out capacity values calculated in Step 1 were then compared to the household growth in the MUMPO TAZ projections.

Step 3 - Density Adjustments for Over-Capacity TAZs: Where projected growth based on MUMPO’s TAZ projection exceeded capacity (determined in Step 1 above), spot checking was done to determine where infill development could be expected to increase density, and parcels were reclassified to a higher residential density appropriately to allow the projected growth to “fit” within the TAZ area.

Step 4 - Distribution of Growth for Under-Capacity TAZs: Where projected growth was equal to or less than capacity, a “percentage of capacity factor” was calculated by dividing the projected growth by the capacity. This factor was used to determine the reduction of the potential build-out area necessary to represent the projected level of growth.

Rather than selecting some parcels to build-out and others to remain undeveloped, the methodology spreads the growth across a proportionate amount of every potential parcel. This provides a more fragmented land use projection than that which might actually occur; therefore, it is a conservative estimate (i.e., overestimate), in terms of coverage, of the areas that may have future development. Given that TAZ boundaries are smaller than watershed boundaries, distributing growth to control totals within the TAZs does not appear to potentially skew the indirect or cumulative effects results for watersheds.

It should be noted that only a portion of each developable parcel was converted to development for the future land use scenario, as described below, so that the total acres of development in each TAZ was maintained according to the projections. For example, if a TAZ had 1,000 acres of currently undeveloped parcels categorized for low density residential growth in the future (two DU per acre), the TAZ would have capacity for 2,000 households. If the TAZ was expected, based on the MPO projections, to add

1,000 households in the future, the TAZ would be filling only 50 percent of its capacity. Thus, a 50 percent reduction factor would be applied to all currently undeveloped parcels in that TAZ categorized for future low density residential development. Therefore, each of those parcels in that TAZ would be reduced in size by 50 percent to reflect the expectation that growth under the 2030 No-Build scenario will only fill 50 percent of the total capacity of low density residential development in that TAZ, and the remaining 50 percent was classified as undeveloped. These undeveloped areas retained the previously assigned NCGAP land cover category (as listed in Section 2.1).

Non-Residential Development Allocation

A similar process was completed for future non-residential development. All currently undeveloped parcels with non-residential zoning or future land use designations were summarized at the TAZ level to calculate the difference between projected growth and capacity.

The MPO TAZ projections include projections for the number of new employees by economic sector for each TAZ. Those sectors were aggregated into Office, Retail or Industrial/Warehouse/Distribution employment growth. Total employment growth by TAZ is depicted in Map 13. Projected new employees were used to calculate new acres of employment-related development using the Social Cost of Alternative Land Development Scenarios (SCALDS) model values provided in the NCDOT’s ICE Guidance for assessing future land use (NCDOT & NCDENR, 2001b, p. A-14). These model values are presented in Table 12.

Table 12: Non-Residential Land Use by Employment

Employment Type	Employees/Acre
Office	52.32
Retail	21.78
Industrial/Warehousing/ Distribution	16.33

As with the residential land use analysis, the resulting values from the conversion of employees to acres of land developed were compared to the total capacity for each land use in each TAZ. Reduction factors were calculated in similar fashion to the residential process. These reduction factors were then applied to the non-residential parcels. As with residential development, the growth was spread across a portion of all developable parcels rather than selecting which parcels would develop and which would not within each TAZ.

Once both residential and non-residential development had been accounted for in the parcel and TAZ analysis, the “reduced” parcels categorized by land use were converted to 30x30-meter raster and overlaid on the existing land cover raster to create a new 2030 No-Build scenario raster image.

5.2 How Was Project-Induced Growth Estimated?

As National Cooperative Highway Research Program (NCHRP) Report 423A notes:

When a transportation project or policy makes it easier to access certain locations, these places can become attractive to more or different types of development. However, improving accessibility does not guarantee that land use changes will follow. The type, amount, and timing of land use changes will also depend upon the state of the regional economy, the current levels of accessibility, the types of development permitted by land

*use regulations, the availability of services such as sewer and water, the desirability of the area for development, and other factors.*⁴³

This statement suggests that induced growth impacts of major road projects will be dependent upon five major factors:

- The state of the regional economy
- Current levels of accessibility
- The types of development permitted by land use regulation
- The availability of sewer and water
- The desirability of an area for development.

Thus, in some cases, induced growth impacts of specific projects may be negligible. The Monroe Connector/Bypass would certainly improve travel times to eastern Union County; however, most of the county is already highly accessible with a well-connected roadway network and no major barriers limiting access from Union County to the major employment centers in Mecklenburg County. Various studies have shown that accessibility improvements of highway projects have had diminishing impacts on land values since the 1950s. This is logical—as the national and regional highway systems have been more fully built out, the addition of any single additional link in the network provides a diminishing return to the overall accessibility of any given area. Boarnet and Haughwout note that:

As more highways are built, and the metropolitan highway network matures, the incremental effect on accessibility from new or improved highways decreases, thus accounting for a smaller change in land prices due to any access premium.

*New evidence suggests that metropolitan highway projects still influence land use in the way that theory predicts. The important difference between the new evidence and earlier studies is that the geographic scale of the land use effect appears to be somewhat smaller. A new highway or improvement might importantly reduce travel times in the immediate vicinity of a project, even if the resulting changes in metropolitan-wide transportation accessibility are small. Hence the land use effects of modern highway projects likely operate over a very fine geographic scale, rather close to the project.*⁴⁴

Therefore, other factors that might affect land use change, such as utility availability and planned and zoned land uses were also analyzed to estimate the potential induced impacts of the project. The methods used to estimate the induced growth potential of the proposed project can be summarized as a combination of the following analytical techniques:

- a scenario writing approach to identify areas most likely to see induced growth based on planning information and interviews
- a build-out analysis to see which areas had the most capacity for induced growth

⁴³ NCHRP Report 423A. *Land Use Impacts of Transportation: A Guidebook*. Washington DC: National Academy Press, 1999.

⁴⁴ Boarnet, Marlon G. and Haughwout, Andrew F. *Do Highways Matter? Evidence and Policy Implications of Highways' Influence on Metropolitan Development*. The University of California Transportation Center, Berkeley, CA. August 2000. <http://escholarship.org/uc/item/5rn9w6bz>. p. 9

- an accessibility analysis to see which areas would most benefit from the proposed project and thus most likely to see induced growth
- a Hartgen Analysis to estimate potential commercial growth at interchange areas.

This combination of approaches was deemed most appropriate as the local land use regulatory restrictions varied dramatically across the FLUSA and a more direct gravity model approach would likely overstate growth in some areas and understate it in others by missing the regulatory restrictions. The accessibility analysis did not consider that the cost of a toll would offset the value of the time saved using the road and therefore that portion of the analysis may actually overstate the potential for induced growth.

Build Land Use Scenario

This Quantitative ICE examines potential effects of the alternative DSA D, which was the Recommended, Preferred Alternative (RPA) for the Monroe Connector/Bypass in the Final Environmental Impact Statement (FEIS). NCTA found no reason to change the conclusions previously reached by NCTA and its agency partners as to the RPA when evaluating changes in the study area since the publication of the ROD and therefore this ICE report analyzes only the RPA in the Build Land Use Scenario.

Improvements in Accessibility/Travel Time

An analysis of accessibility was completed to determine the areas most likely to see development increases attributable to the Monroe Connector/Bypass. The main areas of employment in the region are in Mecklenburg County; therefore, improving accessibility (as measured by travel time) to I-485 and the major employment centers in Mecklenburg County would be the main reason for changes in development patterns. This assertion is supported by the Qualitative ICE Assessment and the ICE discussion in the Draft EIS. To identify the areas with substantially improved accessibility, an estimate of the improvement in travel time to the US 74/I-485 interchange attributable to the proposed project was calculated for the FLUSA.

Map 14 shows the changes in driving time under the Build scenario compared to the No-Build scenario. This analysis was completed using the Network Analyst extension of ArcGIS and a general roadway network with posted speed limit attributes. The travel time from all intersections within the Study Area to the I-485/US 74 interchange was calculated in both the No-Build and Build scenarios. The scenarios are compared on the basis of traffic operating at posted speed limits. The difference in travel time to each intersection was calculated, and the result was converted to a raster surface using the Inverse Distance Weighted method. The resulting map shows the estimated travel time improvement that the Monroe Connector/Bypass will provide to the study area, given the assumptions noted above. The results are not intended to represent the exact travel time savings that the project would provide to the study area. It is mostly an illustrative tool for determining which areas will see the greatest and least accessibility improvements because of the proposed project. The analysis shows improvement in accessibility, especially east of Monroe and around Wingate due to the proposed project. There are also improvements for some sections of Unionville along NC 200 (Morgan Mill Road). Notably, neither Goose Creek nor Sixmile Creek watersheds see sizeable travel time savings from the proposed project, which would strongly suggest that these watersheds would be highly unlikely to see project-induced growth.

Map 15 shows the changes in driving time for the Goose and Sixmile Creek watersheds in more details. As seen in the map, Sixmile Creek sees little to no travel time benefit from the proposed project. The southern portions of Goose Creek appear to reap some travel time benefits based on this drive time analysis. The southern portions of the watershed show potential improvements in travel time of between

one and three minutes. The methodology used in this analysis may overestimate the benefits to these portions of the study area. The analysis estimated travel time benefits to the I-485/US 74 Interchange since access to I-485 was regularly noted as a key benefit of the proposed project. These portions of the Goose Creek watershed have more direct access to I-485 via Idlewild Road, Lawyers Road and NC 218 and drivers originating from the southern portions of the Goose Creek watershed would likely find shorter travel times to I-485 via these roads than via the proposed project.

Scenario Writing and Build Out Analyses

Other factors considered in the allocation of growth in the project area with the Monroe Connector/Bypass included the availability of water and sewer, and the inclination of local jurisdictions to new development. Availability of sewer service in the future was determined by using Future Public Sewer System coverage from the NC Center for Geographic Analysis. Map 16 shows the estimates of existing and future availability of sewer service in the FLUSA. Existing sewer service is relatively limited north of the proposed project, particularly east of Rocky River Road. In the future, sewer service is expected to be extended into Fairview and northern parts of Unionville, but these areas are relatively far from the proposed project and do not coincide with areas that see travel time savings from the proposed project. East of Morgan Mill Road, sewer service exists around each interchange and in the future sewer service is expected to be expanded especially north and south of Wingate. These areas coincide with areas that would benefit substantially from the travel time savings of the proposed project. These areas would logically be the most likely to see some induced land use changes associated with the proposed project.

The inclination of local jurisdictions toward new development is also critical to the likelihood of induced land use changes and induced growth. Based on the interviews and review of planning documents, the localities in the western portions of the study area, particularly Indian Trail and Stallings, are less interested in fostering significant growth within their jurisdictions. Unionville, while not opposed to new development, is not interested in increasing densities and would prefer to maintain its rural character, though they are planning for a commercial node at the US 601 interchange with the proposed project.

Other jurisdictions, however, are more interested in fostering growth and development associated with the proposed project. Union County, as noted above, has a new land use plan that specifically recommends residential development north of Wingate and east of Monroe that is expected to occur with the proposed project. Additionally, Wingate and Marshville have plans to encourage development around the interchange areas within their jurisdictions. These observations were suggested in the Qualitative ICE Assessment and Draft EIS, and are supported by the GIS analysis and interviews conducted for the quantitative ICE analysis. Based on this improved accessibility, as well as the availability of sewer service, the areas east of Monroe and north of Wingate, in the eastern portions of the Study Area, are most likely to see increased growth as a result of the project.

As for the Sixmile Creek watershed, most of the watershed is already served by sewer and water service it is nearly built out already. Furthermore, the watershed is already well served by I-485, so the addition of a new freeway far from the watershed would be unlikely to spur additional development.

For Goose Creek, about half of the watershed has sewer and water service currently. The remainder of the watershed is expected to get sewer and water service in the future, which would be expected to spur additional development. The town of Fairview, which covers the majority of the undeveloped property in the watershed currently, does not plan to encourage moderate to high density residential development nor does it plan to encourage substantial commercial or industrial development. As the watershed is already

served by a well-connected roadway system that connects it easily to I-485, the addition of a freeway that is largely farther from the watershed than I-485 would be unlikely to spur additional development.

Hartgen Analysis of Interchanges

In addition to the accessibility analysis described above, a “Hartgen analysis” was completed for each interchange area to gauge potential for development, using methods researched by Dr. David Hartgen.⁴⁵ A Hartgen analysis reviews the traffic volumes, distance to nearest towns, and access to sewer and water services to gauge the potential for induced development at interchanges in rural areas. The results of that analysis indicated that all interchanges except the Forest Hills School Road interchange have at least moderate potential for commercial development. Thus, the Build scenario analysis indicates that more dense growth would be expected where accessibility will improve and other needed infrastructure will be available in the future. Results of this analysis are shown in Appendix D.

As none of the interchange areas are within the Sixmile Creek or Goose Creek watersheds, the Hartgen Analysis is not applicable to the analysis of project-induced development in those watersheds.

Project-Induced Growth Allocation

The preceding analysis identified the general locations and types of development that the proposed project would induce in a Build Scenario. The amount of additional development was determined based on the availability of land in the vicinity of proposed interchanges, the density allowed by zoning and land use plans for the jurisdictions and the capacity for additional development. Capacity for additional development is limited primarily by the access to sewer services. Thus, those areas around the interchanges that are not expected to receive sewer service in the future were not considered for higher density uses. Most new commercial development was allocated in the immediate vicinity of interchanges or at major crossroads nearby. Additional residential development or increases in residential density were allocated in areas near (within roughly two to three miles) but not immediately adjacent to interchanges. The resulting adjustments in parcel level land use from the 2030 No-Build scenario was then converted to a 30x30 meter raster land cover and overlaid on the 2030 No-Build raster.

Finally, one method often considered in induced growth analysis is the possible reallocation of growth within a study area. As accessibility improves in the eastern parts of Union County, the expanded opportunities for development may result in less development in the western portions of the FLUSA in a Build Scenario, relative to a No-Build Scenario, as new development may prefer less costly land and more growth friendly jurisdictions. Other ICE analyses have sometimes taken a reallocation approach to the issue of induced growth. In this case, the study team has specifically chosen not to reallocate growth, but instead to add the estimated induced growth over and above that growth expected under a No-Build Scenario. With this assumption, the ICE analysis is taking a more conservative approach to assuming higher possible cumulative effects across the entire study area.

Induced land use changes in the area of US 74 at the western terminus of the project were expected to be limited. Under the No-Build Scenario, 84 percent of the land within one mile of the interchange is already developed and many of the remaining undeveloped areas are within or near regulated riparian buffers and would therefore be more difficult to develop. Thus, most of the land in the vicinity of this interchange is already developed or planned for development and there would be little opportunity for additional

⁴⁵ NCDOT & NCDENR, 2001a, p. IV-27

development under the Build Scenario. Additionally, the proposed project does not provide substantial time savings to major regional employment centers from this area and would therefore be unlikely to spur development in this area.

At Indian Trail-Fairview Road, approximately 50 acres of additional industrial development was expected with the Build scenario. This is consistent with the Indian Trail's zoning and land use plans for the interchange area to become a major industrial park.

At Unionville-Indian Trail Road, Indian Trail land use plans projected a village center as the focal point of the interchange area. Land use plans called for additional commercial space to take advantage of the interchange and medium density residential using Traditional Neighborhood Design (TND) principles. TND principles include building developments with a range of housing types, a well-connected street system, integrated public spaces and some mix of uses. Land use changes under the Build scenario were a shift from residential to commercial for about 50 acres and increases in residential density affecting about 100 acres.

At Rocky River Road, an addition of approximately 50 acres of commercial land use was expected, with about half being converted from a different use compared to the No-Build, consistent with City of Monroe's Rocky River Land Use Corridor Plans (November 2008) for additional commercial development in this area should the proposed project be built.

At US 601, an additional 100 acres of commercial development, with about half being converted from residential use compared to the No-Build, was expected and was consistent with the City of Monroe zoning and plans for areas near this interchange. About 100 acres of residential land use were expected to increase in density. While this was not consistent with existing zoning for the area, it was projected that additional residential density would follow commercial development in the vicinity of this interchange.

At Morgan Mill Road, additional commercial development of less than 50 acres was expected just south of the interchange, mostly converted from residential compared to the No-Build scenario. In addition, about 50 acres of increased residential density was expected in the Build scenario. Also, less than 50 acres of industrial land use, converted from residential as compared to the No-Build, was expected, which was consistent with existing land use and zoning.

At Austin Chaney Road, additional industrial/office development of about 100 acres, plus additional commercial development of about 50 acres was expected. Most of these additions would replace residential development as compared to the No-Build scenario. Additional or increased residential density of about 150 acres was also expected. These were generally consistent with the *Strategic Plan for Economic Development, Town of Marshville, Town of Wingate* (2008) indicating that this interchange area should be a focal point for non-residential development in eastern Union County. In addition, approximately 1,000 additional acres of Low Density Residential development is expected in the areas north of Wingate and east of Monroe. This is generally consistent with the expected land use changes identified in the updated Union County Comprehensive Plan.

At Forest Hills School Road, only new residential development was expected as the results of Hartgen Analysis indicated poor conditions for commercial development. About 100 acres of additional or higher density residential development was expected around this interchange.

Project-Induced Growth Estimates for Goose and Sixmile Creek

Using the analytical tools above, project-induced growth was estimated for the entire study area and allocated to different parts of the study area. The results of that analysis indicated that there would not be any project-induced growth within the Goose or Sixmile Creek watersheds. These results are due to the fact that these two watersheds are in the western portion of the study area and travel times from those watersheds to major regional employment centers see little to no change from the proposed project. Therefore, there are no project-induced growth estimated to occur within these two watersheds.

Legacy Park Proposal

The resource agencies and others have questioned whether the Quantitative ICE should consider the effects associated with the proposed Legacy Park development in eastern Union County and include them in one or both of the future land use scenarios. The proposed Legacy Park is a potential industrial park and intermodal shipment terminal advocated by the former economic development agency for Union County (Union County Partnership for Progress) and mentioned in several regional reports, including the NCDOT Seven Portals Study. The potential development was proposed to be sited north and east of Marshville, along and north of the CSX railroad. Estimates from the Union County Partnership for Progress of the full build-out of the proposed industrial park and rail terminal included up to 5,000 acres of development and up to 20,000 jobs on site.

The Qualitative ICE and the previous Quantitative ICE addressed this development as not being reasonably foreseeable as there were no definite project plans or financing behind the project. Research by the Kenan Institute at the same time as the Quantitative ICE indicated that the proposal did not have any funding commitment and needed to surmount a significant number of hurdles before becoming a reality.⁴⁶

Further research by the study team since the FEIS has reinforced the conclusion that Legacy Park is currently not a reasonably foreseeable development, particularly in the timeframe of the ICE analysis (see interview summaries in Appendix A). There are a few factors that do indicate planning for the project is continuing. For example, the most recent Union County Water and Wastewater Master Plan (2011) does include provisions for ensuring sufficient capacity to provide service if Legacy Park is built, but the plan includes no actions items or financing recommendations for providing the specific water or sewer lines to directly serve the site. Three localities (Anson County, Marshville and Wingate) have adopted resolutions supporting the proposal, but these localities do not have jurisdiction over most of the proposed site.

The vast majority of evidence at this time suggests the proposal is highly speculative and unlikely to develop in a foreseeable timeframe, if ever. In an interview with the project's main sponsor, staff from the Union County Partnership for Progress indicated that planning for the project is "dead" and that they felt the project was highly speculative and unlikely to develop. Their most optimistic estimate was that if the Monroe Connector/Bypass were built there might be a 25 percent chance of some industrial development at the proposed site.

In an interview with Richard Black, the Planning Director for Union County, it was noted that the site of the proposed development was marked for rural residential development in the most recent Union County Land Use Plan. The first draft of that plan did include industrial planned land use at the site of the

⁴⁶ Appendix C, p 34-35

proposal, but the planned land use was changed as Planning Commissioners and others felt the Legacy Park proposal was too speculative and highly unlikely to occur. Furthermore, the current zoning for most of the site is rural residential. Mr. Black also noted that his impression was that the proposal hinged on the participation of CSX Transportation and, in particular, the development of an intermodal (rail-truck) terminal at the site to spur connected industrial development.

The project team corresponded with CSX staff who noted that the site was topographically well suited to development and situated in a manner that would make it easy to develop rail-served industrial development or an intermodal terminal. They noted that they have previously marketed the site to a number of customers but that none had showed interest. As to the development of an intermodal terminal, CSX staff noted that they did not see the level of market demand necessary to proceed with a feasibility study at this time.

Finally, the project team communicated with Dr. Stephen J. Appold, Assistant Professor at the Kenan Institute at UNC-Chapel Hill. Dr. Appold has been involved with CDOT and the Metrolina Region on new Top-Down projections and has worked on logistics studies for the State Logistics Task Force. Dr. Appold noted that the anchor tenant for Legacy Park has expressed interest but made no commitment. He noted that the location of Legacy Park is distant from the main traffic flows in the region and that even if the Monroe Connector/Bypass were constructed as a non-toll facility, it would not be clear that Legacy Park would develop as a logistics node. Additionally, Dr. Appold noted that while many proposed developments may cite large potential “build out” projections, such projections are often inflated and that many proposals never reach their build out and some may never attract any tenants or users at all.⁴⁷

In August 2013, officials with the Monroe-Union County Economic Development Department indicated they were revamping the Legacy Park proposal to pursue a smaller development in the range of 200-300 acres. NCTA will contact Chris Platé of Monroe-Union County Economic Development to discuss this issue and to assess the level of planning that has occurred.

The totality of information points toward the likelihood that Legacy Park is a highly speculative proposal that is unlikely to see development within the time horizon of the ICE analysis (2030) with or without the Monroe Connector/Bypass. Therefore, no development associated with Legacy Park has been incorporated into any future land use scenarios for this analysis. However, NCDOT and FHWA will continue to monitor the Legacy Park proposal and other proposed development projects throughout the NEPA process.

US 74 Revitalization Study

Beginning in 2011, Union County, and the Towns of Stallings, Indian Trail and Monroe worked together to begin development of the US 74 Revitalization Study. The study completed a draft plan in 2013 and those draft recommendations are currently under review and consideration. The study team reviewed the draft US 74 Revitalization Study and its recommendations for their potential impact to future land use scenarios. Since the study is still draft and has not been adopted and since the land use and other recommendations would result in minimal changes to the land use scenario results, the study team determined it was not reasonably foreseeable to incorporate the draft plan recommendations into any future land use scenario.

⁴⁷ Letter from Dr. Stephen J. Appold to Jamal Alavi, NCDOT, May 29, 2013, p 3-4.

6.0 UPDATED LAND USE RESULTS

6.1 What Are the Land Use Results for the Entire Study Area?

The following section outlines the updated results from the three updated scenarios, the 2010 Existing (Baseline), the 2030 No-Build, and the 2030 Build scenario.

Table 13: Updated Land Use Scenario Results

Land Use	Updated Baseline (2010)		Updated 2030 No-Build			Updated 2030 Build		
	Total Area (acres)	% of Total Area	Total Area (acres)	% of Total Area	Change in % from Baseline	Total Area (acres)	% of Total Area	Change in % from No-Build
Total Residential	71,500	35%	97,900	48%	13%	99,700	49%	1%
<i>Low Density</i>	55,600	28%	79,500	40%	12%	80,600	40%	0%
<i>Medium Density</i>	12,900	6%	14,900	7%	1%	15,600	8%	1%
<i>High Density</i>	3,100	2%	3,500	2%	0%	3,500	2%	0%
Commercial	3,900	2%	5,600	3%	1%	5,900	3%	0%
Industrial/Office/Institutional	7,100	4%	8,700	4%	1%	8,800	4%	0%
Transportation	12,700	6%	12,800	6%	0%	13,900	7%	1%
Total Developed	95,200	47%	125,000	62%	15%	128,200	63%	2%
Total Agricultural	52,900	26%	37,500	19%	-8%	35,500	18%	-1%
Total Forested	51,900	26%	37,700	19%	-7%	36,500	18%	-1%
Total Other	1,900	1%	1,800	1%	0%	1,800	1%	0%
TOTAL	202,000	100%	202,000	100%	0%	202,000	100%	0%

Notes: Results have been rounded to the nearest 100 acres and whole percent. Differences were calculated prior to rounding. Totals may appear not to equal the sum of the parts because of rounding.

6.2 What are the Land Use Results for Goose and Sixmile Creek Watersheds?

The results of all three scenarios for the Sixmile Creek watershed are shown in Table 14.

Table 14: Updated Land Use Scenario Results, Sixmile Creek Watershed

Land Use	Updated Baseline (2010)		Updated 2030 No-Build			Updated 2030 Build		
	Total Area (acres)	% of Total Area	Total Area (acres)	% of Total Area	Change in % from Baseline	Total Area (acres)	% of Total Area	Change in % from No-Build
Total Residential	900	52%	1,100	69%	17%	1,100	69%	0%
<i>Low Density</i>	200	13%	300	16%	3%	300	16%	0%
<i>Medium Density</i>	600	37%	700	44%	8%	700	44%	0%
<i>High Density</i>	0	3%	100	9%	6%	100	9%	0%
Commercial	0	0%	0	1%	1%	0	1%	0%
Industrial/Office/Institutional	0	2%	0	2%	0%	0	2%	0%
Transportation	200	12%	200	12%	0%	200	12%	0%
Total Developed	1,100	66%	1,400	83%	17%	1,400	83%	0%
Total Agricultural	100	7%	100	4%	-3%	100	4%	0%
Total Forested	400	27%	200	13%	-14%	200	13%	0%
Total Other	0	0%	0	0%	0%	0	0%	0%
TOTAL	1,600	100%	1,600	100%	0%	1,600	100%	0%

Notes: Results have been rounded to the nearest 100 acres and whole percent. Differences were calculated prior to rounding. Totals may appear not to equal the sum of the parts because of rounding.

The results of all three scenarios for the Goose Creek watershed are shown in Table 15. The Update 2010 Baseline Land Use is illustrated in Map 3. Map 17 illustrates the No-Build Scenario land use conditions and Map 18 shows the raw land use changes in the Goose and Sixmile Creek watersheds and surrounding areas.

Map 19 shows the Build Scenario land use conditions and Map 20 shows the raw land use change in the Goose and Sixmile Creek watersheds and surrounding areas. These results are analyzed in the indirect and cumulative impacts review below.

Table 15: Updated Land Use Scenario Results, Goose Creek Watershed

Land Use	Updated Baseline (2010)		Updated 2030 No-Build			Updated 2030 Build		
	Total Area (acres)	% of Total Area	Total Area (acres)	% of Total Area	Change in % from Baseline	Total Area (acres)	% of Total Area	Change in % from No-Build
Total Residential	10,600	39%	13,900	51%	12%	13,900	51%	0%
<i>Low Density</i>	10,400	39%	13,100	48%	10%	13,100	48%	0%
<i>Medium Density</i>	100	1%	800	3%	2%	800	3%	0%
<i>High Density</i>	0	0%	0	0%	0%	0	0%	0%
Commercial	0	0%	600	2%	2%	600	2%	0%
Industrial/Office/Institutional	100	0%	100	1%	0%	100	1%	0%
Transportation	1,400	5%	1,400	5%	0%	1,400	5%	0%
Total Developed	12,100	45%	16,100	59%	15%	16,100	59%	0%
Total Agricultural	5,800	21%	4,400	16%	-5%	4,400	16%	0%
Total Forested	9,100	34%	6,500	24%	-9%	6,500	24%	0%
Total Other	100	0%	100	0%	0%	100	0%	0%
TOTAL	27,000	100%	27,000	100%	0%	27,000	100%	0%

Notes: Results have been rounded to the nearest 100 acres and whole percent. Differences were calculated prior to rounding. Totals may appear not to equal the sum of the parts because of rounding.

6.3 What Are the Indirect Land Use Impacts for Goose and Sixmile Creek Watersheds?

Table 14 shows the indirect land use differences between the Updated No-Build and Updated Build scenarios for Sixmile Creek watershed. Table 15 shows the indirect land use differences between the Updated No-Build and Updated Build scenarios for Goose Creek watershed. The Build Scenario has no measurable difference in effect on the amount of developed land in the Goose Creek or Sixmile Creek watersheds, which are known to support the endangered Carolina heelsplitter. The comparisons between the 2030 No-Build and Build finds no difference for Goose Creek and Sixmile Creek for any land use.

6.4 How Was Impervious Surface Estimated?

In order to determine the amount of impervious surface in the FLUSA and by watershed under all the land use scenarios, each land use category was assigned an assumed level of impervious surface. This step of the analysis followed guidance in the Soil Conservation Service (SCS) TR-55 Manual. The SCS TR-55 Manual is widely used for drainage studies and runoff calculations. Land use categories with their associated percentage of impervious coverage applied in this quantitative ICE analysis are presented in Table 16.

Table 16: Percent Impervious Surface for Each Land Use Category

Land Use Category	% Impervious using SCS TR-55 Manual
Commercial	85%
Industrial/Office/Institutional	70%
High Density Residential	38%
Medium Density Residential	25%
Low Density Residential	20%
Transportation	100%
Agricultural and Natural	0%

Source: SCS, 1986

These percentages were applied to the land use acreages, and results are summarized here. The 2010 Quantitative ICE analyses included a Water Quality Analysis based on the results of the 2010 Quantitative ICE for Land Use. To determine the need for additional water quality modeling, the results of the impervious surface analysis from the 2013 Quantitative ICE are compared to the results from the 2010 Quantitative ICE to determine if the changes are substantial enough to necessitate rerunning the water quality modeling. Table 17 shows the changes in impervious surface between the original 2007 Baseline (from the 2010 report) and the updated 2010 Baseline results (from the 2013 report). The updated Existing 2010 Land Use shows that Goose and Sixmile Creek watersheds have seen little to no change in impervious surface percentage since 2007.

Table 17: Updated 2010 Baseline Imperviousness Compared to Previous 2007 Baseline Imperviousness

Watershed Name	Original Impervious Cover	Updated Impervious Cover	Difference in Percentages
Sixmile Creek	25%	26%	1% ↑
Goose Creek	13%	13%	No Change

Notes: Results have been rounded to the nearest one whole percent. Differences were calculated prior to rounding. Totals may appear not to equal the sum of the parts because of rounding.

Table 18 shows the changes in impervious surface between the original No-Build (from the 2010 report) and the updated No-Build results (from the 2013 report). Sixmile Creek and Goose Creek show an increase of one full percentage point. These shifts are due to factors noted in Section 1.7, such as the changes in expected development at the Lawyers Road interchange with I-485. Overall, the updated results are similar to the previous results.

Table 18: Updated 2030 No-Build Imperviousness Compared to Previous No-Build Imperviousness

Watershed Name	Original Impervious Cover	Updated Impervious Cover	Difference in Percentages
Sixmile Creek	30%	31%	1% ↑
Goose Creek	17%	18%	1% ↑

Notes: Results have been rounded to the nearest one whole percent. Differences were calculated prior to rounding. Totals may appear not to equal the sum of the parts because of rounding.

Table 19 shows the changes in impervious surface between the original Build (from the 2010 report) and the Updated Build results (from the 2013 report). Both Sixmile Creek and Goose Creek show an increase of one percent over the previous results. Therefore, the results are similar to the previous results. This suggests that additional water quality modeling would find the same results as the prior water quality modeling, given the standard errors associated with both land use projections and water quality modeling. The indirect and cumulative effects of these impervious surface results are discussed further in Section 6.6.

Table 19: Updated 2030 Build Imperviousness Compared to Previous 2030 Build Imperviousness

Watershed Name	Original Impervious Cover	Updated Impervious Cover	Difference in Percentages
Sixmile Creek	30%	31%	1% ↑
Goose Creek	17%	18%	1% ↑

Notes: Results have been rounded to the nearest whole percent. Differences were calculated prior to rounding. Totals may appear not to equal the sum of the parts because of rounding.

6.5 What Are the Indirect Impervious Surface and Cumulative Water Quality Impacts?

Indirect Impervious Surface Impacts

Impervious surface was calculated as described above. The changes in impervious surface from Baseline to No-Build and No-Build to Build in the updated analysis are show in Table 20. In all cases, the total impervious area was calculated from the raw land use results and then rounded to the nearest percent.

Table 20: Percent Impervious Surface by Watershed and Alternative

Watershed Name	2010 Baseline Impervious Cover	2030 No-Build Impervious Cover	Change from Baseline to 2030 No-Build ¹	2030 Build Impervious Cover	Change from 2030 No-Build to 2030 Build ¹
Sixmile Creek	26%	31%	5%	31%	No Change
Goose Creek	13%	18%	5%	18%	No Change

¹ Changes were calculated prior to rounding and therefore do not match exactly the difference shown in the table results.

Table 21: Percent Impervious Cover Results from 2010 Report Compared to 2013 Report

Watershed Name	Impervious Cover Results from 2010 Report				Impervious Cover Results from 2013 Report				Difference in Change in Build from No-Build between 2010 Report and 2013 Report
	2007 Baseline	2030 No-Build	2030 Build	Change in Build from No-Build	2010 Baseline Updated	2030 No-Build Updated	2030 Build Updated	Change in Build from No-Build	
Sixmile Creek	25%	30%	30%	0%	26%	31%	31%	0%	0%
Goose Creek	13%	17%	17%	0%	13%	18%	18%	0%	0%

Notes: Results have been rounded to the nearest one whole percent. Differences were calculated prior to rounding. Totals may appear not to equal the sum of the parts because of rounding.

As shown in Table 21, the change in percent impervious surface has no change from 2030 No-Build to 2030 Build. In addition, the percent impervious cover results from the 2010 Report to the 2013 Report also shows no change.

Cumulative Water Quality Impacts

Sixmile Creek and Goose Creek watersheds include three streams that are impaired in some capacity according to water quality ratings established by the NCDENR, Division of Water Quality (DWQ). These watersheds and their impaired waters are documented in Table 22. The impervious surface level for these watersheds is not expected to change from the Build to the No-Build condition. Given that there is no difference in induced impact, no induced water quality impacts are expected in these watersheds.

Table 22: 2012 Clean Water Act §303(d) Impaired Streams by Watershed

Watershed Name	Impaired Stream or Water Body	Impaired Reasons (Year)
Sixmile Creek	Sixmile Creek (Source to NC/SC Line)	Category 5 Fair Bioclassification (2006)
Goose Creek	Duck Creek (Source to Goose Creek)	Category 4b Fair Bioclassification (2008)
	Goose Creek (Source to SR 1524)	Category 4b Turbidity
	Goose Creek (SR 1524 to Rocky River)	Category 4b Fair Bioclassification (1998)
		Category 4t Fecal Coliform Violation

Source: 2012 NCDENR 2012 North Carolina 303(d) Integrated Report

These results are the same as the results of the original Quantitative ICE. The model calibration completed for the Quantitative ICE Water Quality Analysis (FEIS Appendix I) used the Nash-Sutcliffe coefficient, as recommended by the American Society of Civil Engineers, to estimate how well the hydrological model fit observed stream flows. The analysis at the calibration stage and at the validation stage both returned a 0.78, which indicated a very good fit. Since the land use results have changed very little, and are well within the typical variability of hydrological modeling, then new water quality modeling would be highly unlikely to show any differences from the prior results.

6.6 What are the Indirect and Cumulative Impacts to Plant Species?

Michaux’s sumac, Schweinitz’s sunflower, and the smooth coneflower are federally listed as endangered plant species. The sumac and sunflower are listed for both Mecklenburg and Union counties, but the coneflower is listed only for Mecklenburg County.⁴⁸ There are known populations of Schweinitz’s sunflower in the FLUSA, and populations of the species have been found in the vicinity of the proposed alignment for the Monroe Connector/Bypass. An evaluation of potential indirect and cumulative effects to the species is summarized below.

Michaux’s sumac grows in sandy or rocky open woods on sandy or sandy loam soils with low cation-exchange capacities and appears to depend upon some form of disturbance to maintain the open quality of

⁴⁸ NC Natural Heritage Program. “Data Services.” Updated January 9, 2009.

its habitat.^{49,50} Most extant populations can be found on open disturbed areas, such as railroad, road, and utility rights-of-way that are periodically maintained and/or managed for the species. The only known occurrence of Michaux’s sumac in the FLUSA was last observed in 1794 and no populations were found in surveys of suitable habitat in the FLUSA. The survey methodology is discussed in the Biological Assessment.⁵¹ As no populations of the species have been found in the FLUSA, it is not anticipated that the Monroe Connector/Bypass project will have any indirect or cumulative effects on the species.

There are no know populations of smooth coneflower in the FLUSA. Based on the ICE analysis, indirect effects are not anticipated in the Mecklenburg County portion of the FLUSA, therefore no ICEs are anticipated for this species.

Historically, it is believed that Schweinitz’s sunflower occupied open prairie and Post Oak-Blackjack Oak Savannas that were maintained by relatively frequent fire.⁵² FLUSA-wide, physical investigation of all suitable habitat within forest gaps was beyond the scope of this ICE analysis. In addition, the sunflower is an opportunistic species that can colonize even disturbed areas. Therefore, indirect effects to Schweinitz’s sunflower are addressed through examining the conversion of land exhibiting habitat characteristics that would support the species. The NCGAP land cover categories included in the analysis were:

- Agricultural Pasture/Hay and Natural Herbaceous
- Barren (subcategory quarries, strip mines, and gravel pits)
- and Barren (subcategory bare rock and sand).

Utilizing these entire categories as potential habitat is a conservative assessment (overestimates potential impacts), since only the ecotonal edges of these land covers could provide potential habitat for the species. Although this species could eventually inhabit some of the lands converted to developed land use⁵³, such land use categories were not included in the analysis to present a more conservative estimate of the amount of suitable habitat loss. Table 23 presents the results of this analysis.

Table 23: Total Conversion of Pasture/ Hay Natural Herbaceous and Barren Land Cover to Developed Land

	Baseline (acres)	2030 No- Build (acres)	2030 Build (acres)	Change in 2030 with No-Build (acres)	Change in 2030 with Build (acres)
Acres	33,000	23,000	21,700	-10,000	-11,300
% of Baseline	-	-	-	-30%	-34%

Notes: Results have been rounded to the nearest 100 and whole percent. Differences were calculated prior to rounding. Totals may appear not to equal the sum of the parts because of rounding.

With the 2030 No-Build, there is an estimated 30 percent decrease in land cover types presumed to

⁴⁹ USFWS. *Michaux’s Sumac Recovery Plan*. 1993. Atlanta, GA: p 30.

⁵⁰ Suiter, D. Endangered Species Biologist, USFWS. Raleigh, NC. Personal Communication regarding Draft 5-year status review of Michaux’s sumac. Telephone: Feb. 2 and 18, 2010.

⁵¹ The Catena Group for NCTA, *Biological Assessment of Carolina Heelsplitter (Lasmigona decorata) and Designated Critical Habitat, Schweinitz’s Sunflower (Helianthus schweinitzii), Michaux’s Sumac (Rhus michauxii), and Smooth Coneflower (Echinacea laevigata)*, Monroe Connector/Bypass, May 25, 2010.

⁵² USFWS. *Schweinitz’s Sunflower Recovery Plan*. 1994. Atlanta, GA: p 28.

⁵³ For example, utility rights of way, which are periodically maintained could provide habitat for the Schweinitz’s sunflower, whereas frequently maintained lawns and landscape areas would not provide suitable habitat.

provide potential suitable habitat for the Schweinitz's sunflower. The incremental effect with the 2030 Build scenario is approximately a four percent decrease in potential suitable habitat (34 percent versus 30 percent). This decrease in habitat combined with changes in land use resulting from reasonably foreseeable infrastructure projects may potentially result in effects to Schweinitz's Sunflower.

The land use analysis indicates a significant increase in development and residential growth throughout the FLUSA regardless of construction of the proposed project. Figure 21 depicts changes in land use projected to occur under the No-Build scenario as compared to the current Baseline condition in relationship to known Sunflower populations. Figure 22 illustrates changes in land use from the No-Build to Build scenarios, such as from Residential to Non-Residential (commercial, industrial, etc.) relative to known populations of the Sunflower. Land use around EO# 31, EO# 78, and EO# 18 is not anticipated to change as a result of the project. Land use near EO# 5 is expected to change generally from Undeveloped and Residential to Non-Residential, but since this population is believed to be extirpated, no indirect impacts are anticipated.

There are also several categories of land use change near EO# 77 and EO# 230. While the specific locations of these EO are not anticipated to incur changes in land use, due to their proximity to areas that are projected to experience induced changes in land use, EO# 230 and EO# 77 could potentially be indirectly affected, as they have an increased risk of degradation due to the projected increase in density of nearby development. However, water and sewer service is currently available throughout this area (Cockerhan 2010, Union County Engineering, pers. comm.); therefore, installation of potential additional infrastructure for these services is not expected. In addition, Union Power does not plan to relocate their utility lines near these populations for the Monroe Connector/Bypass. Power line relocation is not typically necessary in response to residential, commercial, or light industrial / office development. NCDOT Division 10 also recently resurfaced and widened the shoulders of Secrest Shortcut Road and does not foresee a need for further road widening to accommodate future development (Thompson 2010a, pers. comm.). Furthermore, these populations are within NCDOT and Union Power ROW and both agencies have agreed to preserve these populations in place. As such, no indirect effects are anticipated to the known populations.

The Build scenario is anticipated to result of in a maximum loss of four percent of potentially suitable habitat within the FLUSA compared to the No Build. A large portion of the four percent estimate includes fringe ecotones, primarily along the edges of agricultural fields that are generally maintained. Such areas are typically not where Schweinitz's Sunflower is found in the FLUSA; they are typically found within NCDOT ROW and utility easements. As such, the 4 percent loss of habitat is not "high-quality" habitat per se. Further, overall there is, and will continue to be, sufficient suitable habitat in the form of NCDOT ROW and utility easements throughout the FLUSA for Schweinitz's Sunflower to colonize. Therefore, it is not anticipated that the project will have indirect effects on the species.

6.7 Changes in Traffic Patterns

The ICE shows that some limited growth would take place (mostly in the eastern part of the FLUSA) if the Monroe Connector/Bypass is built. For this reason, it was necessary to evaluate how growth caused by the project would influence traffic patterns in the FLUSA.

The evaluation used the Metrolina Regional Model (MRM). The model was used to calculate raw traffic volumes under three scenarios:

- The No-Build Scenario
- A Build Scenario using MUMPO's 2009 projected traffic (original socioeconomic data)
- A Build Scenario that adds the effects of the growth projected in the ICE (additions made to the original socioeconomic data based on results of the ICE analysis).

The details of the evaluation are summarized below. The basic conclusions reached were that the added traffic caused by induced growth in the project area had little effect on the overall function of the area road network (on average, traffic increased by about 1,400 vehicles per day on roads intersecting the proposed Monroe Connector/Bypass (Y-line roads).

The volumes reported are raw model volumes that have not been fully calibrated or adjusted per standard traffic engineering principles. These volumes therefore do not represent a fully calibrated forecast of No-Build and Build traffic conditions, but because they were developed the same way from the same MRM version, the difference between them can help reveal the induced traffic impacts of the project. For the No-Build Scenario, the MRM 11 v1.1 was revised to remove the Monroe Connector/Bypass from the model network and the model was run using the 2009 Projections for the socioeconomic input. As documented in Section 4, the 2009 Projections were used to develop the No-Build scenario and therefore were used in this analysis to represent the No-Build Scenario.

For the Build Scenario, two scenarios were run to compare the differences with and without the estimated growth impacts of the proposed project. In the first scenario, the MRM 11 v1.1 was used with the Monroe Connector/Bypass in the model network and the model was run using the 2009 Projections for the socioeconomic input. For the second Build Scenario the MRM 11 v1.1 was used with the Connector/Bypass in the model network and the model was run using an adjusted version of the 2009 Projections for the socioeconomic input. The land use differences identified in the Build Scenario ICE analysis were reviewed at the TAZ level and, based on the localized density assumptions, estimates of the additional household and employment attributable to the additional development anticipated under a Build Scenario were developed at the TAZ level. These estimates of additional households and employment were then added to the 2009 Projections to create a 2009 ICE Projections version. These adjustments added, on net, approximately 4,900 households and 3,800 employees to TAZs within the FLUSA. The raw model volumes from the MRM are shown in Appendix E. Table 24 shows a comparison of the regional vehicle miles traveled (VMT) and vehicle hours traveled (VHT) under the same three scenarios.

The segment level volumes in Appendix E show that when comparing the two Build scenarios run in the model, the project's induced growth does add to the volume level on the Monroe Connector/Bypass, US 74 and intersecting roadways. The highest percent change is along the Y-Line corridors, where there would be some road segments that would see sizeable percentage increase relative to a Build Scenario without the project-induced growth. Yet, the volume increase for any given road segment is less than

3,500 AADT. On average, each roadway segment only sees an additional 1,400 vehicles per day. Along the US 74 and Monroe Connector/Bypass corridors, the percent increase is much lower, less than five percent in most cases. The eastern end of US 74 sees the greatest percentage increases, but again, most of these segments see relatively modest AADT increases of less than 5,000 vehicles per day. Also of note, is the comparison between the Build (2009 Projections) and the Build (Adjusted Projections) volume along the US 74 corridor. Under both scenarios, volume on the US 74 corridor drops by between 8 and 36 percent, depending on the segment, meaning that under the Build Scenario, with or without project-induced growth, US 74 would see substantially less traffic than under a No-Build Scenario.

With respect to total vehicle miles traveled within Union County, the Build Scenario with project-induced growth shows total VMT three percent higher than the Build Scenario without project-induced growth and eight percent higher than the No-Build Scenario. At the regional level, however, the difference is only one percent relative to the No-Build. For vehicle hours traveled, within Union County, the Build Scenario with project-induced growth is three percent higher than the No-Build and four percent higher than the Build without project-induced growth.

Table 24: County and Regional Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT)

County		Union	Mecklenburg	All Others	Regional Total
No-Build	VMT	9,253,669	44,616,030	51,580,950	105,450,650
	VHT	307,176	1,659,686	1,533,217	
Build (2009 Projections)	VMT	9,612,887	44,747,461	51,525,166	105,885,514
	VHT	302,260	1,664,994	1,529,494	
Build (Adj. Projections)	VMT	9,948,279	44,745,210	51,543,589	106,237,079
	VHT	315,582	1,665,283	1,529,690	
No-Build vs Build (2009 Projections)	% Change VMT	4%	0%	0%	0%
	% Change VHT	-2%	0%	0%	
No-Build vs Build (Adj. Projections)	% Change VMT	8%	0%	0%	1%
	% Change VHT	3%	0%	0%	
Build (2009 Projections) vs Build (Adj. Projections)	% Change VMT	3%	0%	0%	0%
	% Change VHT	4%	0%	0%	

With respect to total vehicle miles traveled within Union County, the Build Scenario with project-induced growth shows total VMT three percent higher than the Build Scenario without project-induced growth and eight percent higher than the No-Build Scenario. At the regional level, however, the difference is only one percent relative to the No-Build. For VHT, within Union County, the Build Scenario with project-induced growth is three percent higher than the No-Build and four percent higher than the Build without project-induced growth.

Overall, these forecasted traffic levels indicate that the induced growth impacts of the proposed project will add to the total volume of traffic in Union County and to the total vehicle miles traveled and vehicle hours traveled. Roads that connect to the Monroe Connector/Bypass will likely see some increases in traffic. Overall, however, the increases in traffic are modest and would not likely create substantial congestion issues within the design year of the project, particularly given that the impacts will be spread across the many miles of transportation facilities throughout Union County. Since most of the additional

development in a Build Scenario is expected in the eastern portions of the study area, the additional volumes mostly fall on roadways east of US 601. Therefore, there are little to no increases in traffic volumes associated with induced development in the Goose Creek and Sixmile Creek watersheds.

US 601 North of Monroe Connector/Bypass

Questions had been raised on how the Monroe Connector/Bypass would affect traffic on US 601 north of the project area. This is of special concern as US 601 passes through portions of the Goose Creek Watershed.

There are plans to widen US-601 south of the Monroe Connector/Bypass. While traffic throughout Union County is projected to increase through the design year of the project, widening of the sections of US 601 north of Ridge Road are not included in the constrained long-range transportation plan for MUMPO. The proposal to widen the section between Ridge Road and Lawyers Road was considered in the 2035 MUMPO Long Range Transportation Plan, but the project is ranked 261 out of 307 projects considered and was left unfunded. The widening south of the bypass has been incorporated into the ICE analysis. US 601 north of the Monroe Bypass to the Union/Cabarrus Line includes the area that crosses Stewarts Creek, Crooked Creek and Goose Creek watersheds. Since the indirect and cumulative land use results show no increase in development along US 601 north of Stewarts Creek, one would not expect to see any substantial increase in traffic volume along the US 601 corridor north of Stewarts Creek. It is more likely that for the segments of US 601 north of Stewarts Creek, traffic volumes would probably decrease in a Build Scenario relative to a No-Build Scenario due to through trips diverting off of NC 218 and US 601 to the Monroe Connector/Bypass for longer distance travel between counties or across the region.

To evaluate any potential traffic impacts to US 601, raw traffic model data was analyzed under No-Build and Build Scenarios to determine whether the proposed project might affect the likelihood that US 601 might require widening in the future. Map 23 shows a comparison of the traffic volumes on US 601 north of the Ridge Road, with and without the proposed project. In the Build Scenario with the induced development included, traffic volumes are expected to mostly decrease to between 5,300 and 13,000 vehicles per day (VPD). The only segment that increases compared to the No-Build Scenario north of Ridge Road is the segment between Ridge Road and Sykes Mill road, where volumes would increase by approximately 2 percent or 300 VPD. All other segments decrease in volume between 3 to 13 percent (300 to 1,200 VPD). Since the Build Scenario is likely to see a reduction, overall, in volumes north of Ridge Road, the proposed project would be unlikely to increase the need to widen US 601 north of Ridge Road. Furthermore, for a rural two-lane road, the projected traffic volumes are below the Annual Average Daily Traffic (AADT) threshold of 15,000 (+/- 5,000) at which widening might be recommended. Therefore, there is no expectation that the traffic impacts associated with induced development from the Monroe Connector/Bypass would necessitate any improvements to US-601 north of Ridge Road.

Do the Indirect and Cumulative Impacts to Traffic Affect Endangered Species

Based on the analysis above, there are no indications that any increases in traffic associated with the project would cause indirect or cumulative effects to federally listed species. Since traffic increases are expected to be limited to the eastern portions of the study area, away from Goose and Sixmile Creek watersheds, it is unlikely that any increases in traffic would affect the Carolina heelsplitter Critical Habitat. Traffic increases noted above would be unlikely to affect federally listed plant species as there is no clear channel through which those increases would impact the plant species in the study area.

6.8 What Are the Indirect and Cumulative Impacts to the Carolina Heelsplitter

Within the FLUSA, the Carolina heelsplitter is found only in the Goose Creek and Sixmile Creek watersheds. As shown in previous sections of direct and indirect effects, no measureable differences in impervious surface were found between the 2030 No-Build and 2030 Build within the Goose Creek or Sixmile Creek watersheds. Therefore, there are no indirect effects on the species associated with the Monroe Connector/Bypass project. As there are no indirect effects, the project does not contribute an incremental effect that would yield potential cumulative effects. Therefore, there would be no cumulative effect to the Carolina heelsplitter or Critical Habitat Unit 1 associated with project-induced changes to land use or impervious surface because of the proposed project.

6.9 Conclusions

As with any attempt to project future growth or development, there are limitations to the accuracy and certainty of the results of these analyses. Most of these analyses rely on the land use projections developed using recommended methods as described in the NCDOT ICE Guidance⁵⁴. Specifically, the land use projections rely on the socioeconomic projections developed by CDOT, and therefore the results are only as accurate as those projections. Projection of socioeconomic conditions, and any projection of the future, is an uncertain process fraught with the potential for error. Despite the best efforts of researchers and forecasters, the error rates for long-range projections are still quite high and thus any projection or estimate of induced and cumulative effects must be considered the best estimate within a wide range of error. The accuracy of growth projections under any future scenario could be affected by many variables. These include individual owner or developer actions, the timing of or changes in utility provision, changes in local or state regulations on land use and, most importantly, changes in national or regional economic conditions. While the potential for error is high, the techniques used by the MPO are the best available and provide the best available data for trying to project population and employment conditions in the future.

As discussed above, the MRM socioeconomic projections appear to be robust in light of their basis in empirical research and the accuracy of the 2009 Projections in comparison to 2010 Census data, and while the potential for error is still large, these projections are the best resource available to estimate future growth in the study area. The methods used to distribute land use effects are based on reasonable assumptions to produce a valid comparative analysis, but these methods also result in high, conservative estimates of effects.

Carolina Heelsplitter

Direct Impacts

- Updated field surveys within the project area found no new populations, thus there is no change in the anticipated direct effects of the project, which were minimal based on the analysis of the BA.

⁵⁴ NCDOT & NCDENR, 2001a

Indirect Impacts

- There are no changes in land use within the Sixmile Creek and Goose Creek watersheds from the No-Build to the Build scenarios, thus there are no indirect land use impacts attributable specifically to the projects.
- Since there are no differences in land use between the No-Build and Build scenarios, there are also no differences in the impervious surface levels between the No-Build and Build scenarios in both watersheds.
- With regard to percent impervious cover as an indicator for water quality effects and effects to aquatic species, findings show no difference in percent impervious cover between the 2030 Build and 2030 No-Build for the two watersheds. Thus there are no changes in the indirect water quality impacts.

Cumulative Impacts

- There are substantial increases in development from the Baseline condition to both the No-Build and Build conditions, but these changes would occur with or without the proposed project. Therefore, there are no indirect impacts from the proposed project in the two watersheds and thus there are no cumulative land use impacts from the proposed projects in the two watersheds.
- There are substantial increases in development from the Baseline condition to both the No-Build and Build conditions leading to substantial increases in impervious surface levels, but these changes would occur with or without the proposed project. Therefore, there are no indirect impacts from the proposed project in the two watersheds and thus there are no cumulative impervious surface impacts from the proposed projects in the two watersheds.
- There are substantial increases in development from the Baseline condition to both the No-Build and Build conditions leading to substantial increases in impervious surface levels and possibly reductions in water quality, but these changes would occur with or without the proposed project. Therefore, there are no indirect impacts from the proposed project in the two watersheds and thus there are no cumulative water quality impacts from the proposed projects in the two watersheds.
- Mecklenburg and Union Counties, and communities in the Goose Creek and Sixmile Creek watershed, have developed regulations to reduce the cumulative effect of development on water quality in these sensitive watersheds. These regulations include the Site Specific Water Quality Management Plan for the Goose Creek Watershed, the Goose Creek Water Quality Recovery Program Plan for the Fecal Coliform TMDL, and Charlotte-Mecklenburg Water Quality Buffer Implementation Guidelines.
- Overall, as the land use and impervious surface results are only slightly different from the results of the original Quantitative ICE, additional water quality modeling is not necessary, as these differences are not large enough to see substantial differences compared to the prior water quality results.

Carolina Heelsplitter Critical Habitat

Direct Impacts

- Since the project footprint has not changed and the Critical Habitat definition has not changed, there are no changes in the anticipated direct effects of the project to Critical Habitat Area 1, which were minimal based on the analysis of the BA.

Indirect Impacts

- There are no changes in land use within the Sixmile Creek and Goose Creek watersheds from the No-Build to the Build scenarios, thus there are no indirect land use impacts attributable specifically to the projects.
- Since there are no differences in land use between the No-Build and Build scenarios, there are also no differences in the impervious surface levels between the No-Build and Build scenarios in both watersheds.
- With regard to percent impervious cover as an indicator for water quality effects and effects to aquatic species, findings show no difference in percent impervious cover between the 2030 Build and 2030 No-Build for the two watersheds. Thus, there are no changes in the indirect water quality impacts.

Cumulative Impacts

- There are substantial increases in development from the Baseline condition to both the No-Build and Build conditions, but these changes would occur with or without the proposed project. Therefore, there are no indirect impacts from the proposed project in the Goose Creek watershed and thus there are no cumulative land use impacts from the proposed projects in the watershed.
- There are substantial increases in development from the Baseline condition to both the No-Build and Build conditions leading to substantial increases in impervious surface levels, but these changes would occur with or without the proposed project. Therefore, there are no indirect impacts from the proposed project in the Goose Creek watershed and thus there are no cumulative impervious surface impacts from the proposed projects in the watershed.
- There are substantial increases in development from the Baseline condition to both the No-Build and Build conditions leading to substantial increases in impervious surface levels and possibly reductions in water quality, but these changes would occur with or without the proposed project. Therefore, there are no indirect impacts from the proposed project in the Goose Creek watershed and thus there are no cumulative water quality impacts from the proposed projects in the watershed.
- Mecklenburg and Union Counties, and communities in the Goose Creek watershed, have developed regulations to reduce the cumulative effect of development on water quality in these sensitive watersheds. These regulations include the Site Specific Water Quality Management Plan for the Goose Creek Watershed, the Goose Creek Water Quality Recovery Program Plan for the Fecal Coliform TMDL, and Charlotte-Mecklenburg Water Quality Buffer Implementation Guidelines.
- Overall, as the land use and impervious surface results are only slightly different from the results of the original Quantitative ICE, additional water quality modeling is not necessary, as these differences are not large enough to see substantial differences compared to the prior water quality results.

Schwinetzer's Sunflower

Direct Impacts

- Updated field surveys within the project area found no new populations, thus there is no change in the anticipated direct effects of the project.

Indirect Impacts

- For the 2030 Build, findings indicate a four percent greater decrease of land exhibiting habitat characteristics that might support the Schweinitz's sunflower as compared to the change predicted for the 2030 No-Build based on results of this study.
- These indirect effects are the same as previously reported in the BA.
- Therefore there are no changes in the previously conclusions regarding indirect impacts to the sunflower.

Cumulative Impacts

- Since the direct and indirect effects are the same as previously reported in the BA, there are no changes in the previously conclusions regarding cumulative impacts to the sunflower.

Michaux's Sumac

Direct Impacts

- Updated field surveys within the project area found no new populations, thus there is no change in the anticipated direct effects of the project.

Indirect Impacts

- Since no populations of this species have been found in the FLUSA, no indirect impacts are expected to occur as a result of the proposed project.

Cumulative Impacts

- Since no populations of this species have been found in the FLUSA, no cumulative impacts are expected to occur as a result of the proposed project.

Smooth Coneflower

Direct Impacts

- Field surveys within the project area found no new populations, thus there is no change in the anticipated direct effects of the project.

Indirect Impacts

- Since no populations of this species have been found in the FLUSA, no indirect impacts are expected to occur as a result of the proposed project.

Cumulative Impacts

- Since no populations of this species have been found in the FLUSA, no cumulative impacts are expected to occur as a result of the proposed project.

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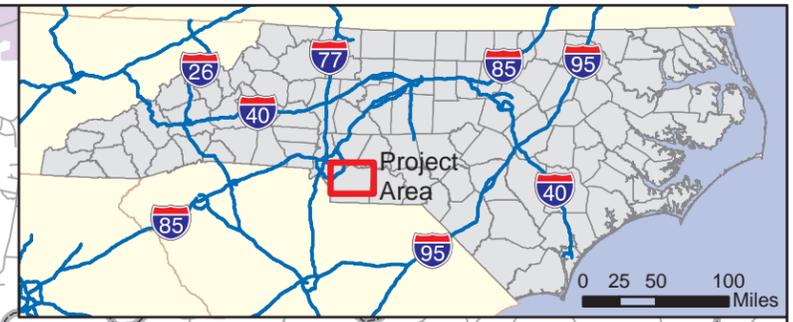
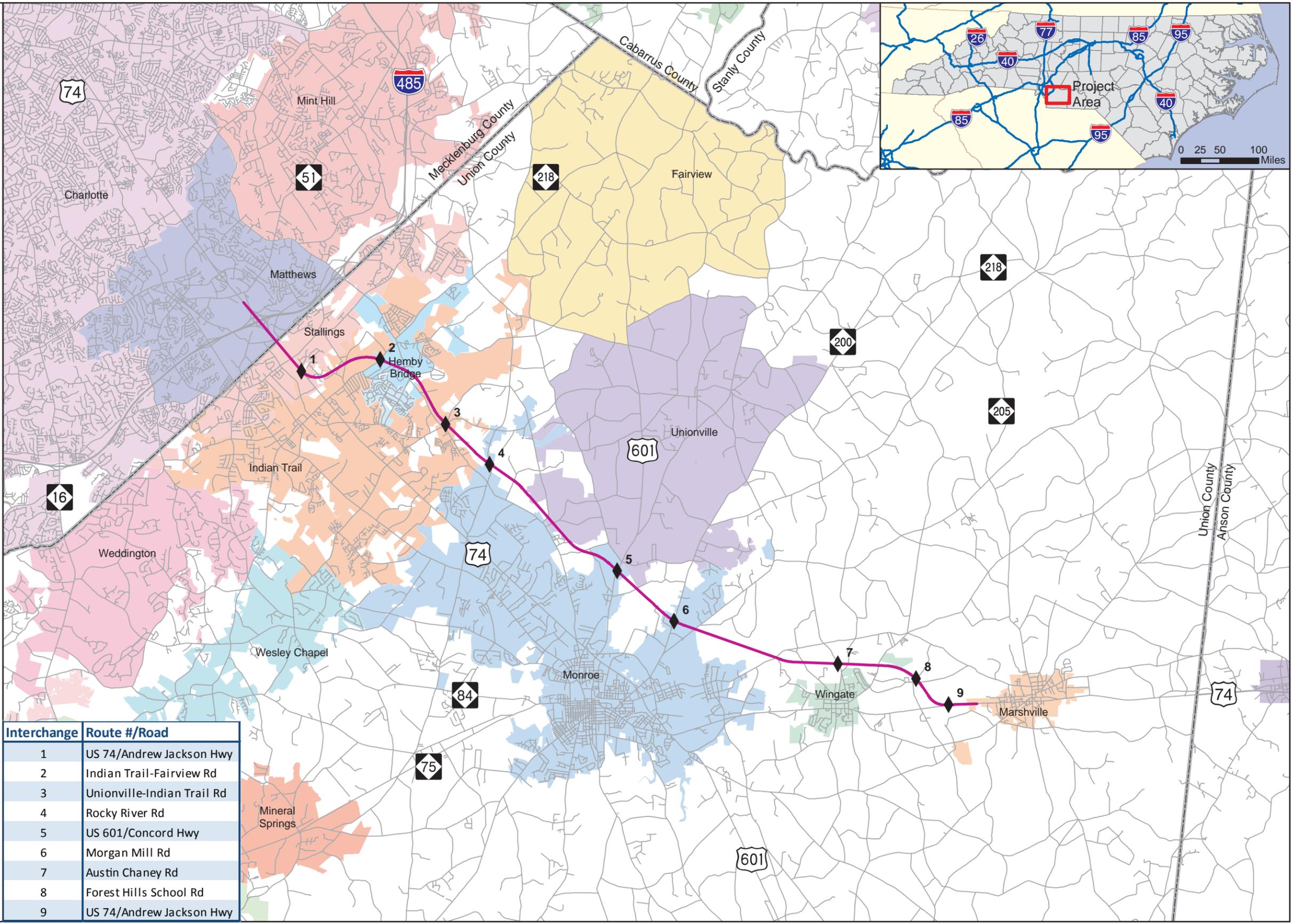
Maps

Map 1: Project Location

- ◆ Interchanges
- RPA Centerline
- Existing Roads



Interchange	Route #/Road
1	US 74/Andrew Jackson Hwy
2	Indian Trail-Fairview Rd
3	Unionville-Indian Trail Rd
4	Rocky River Rd
5	US 601/Concord Hwy
6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy

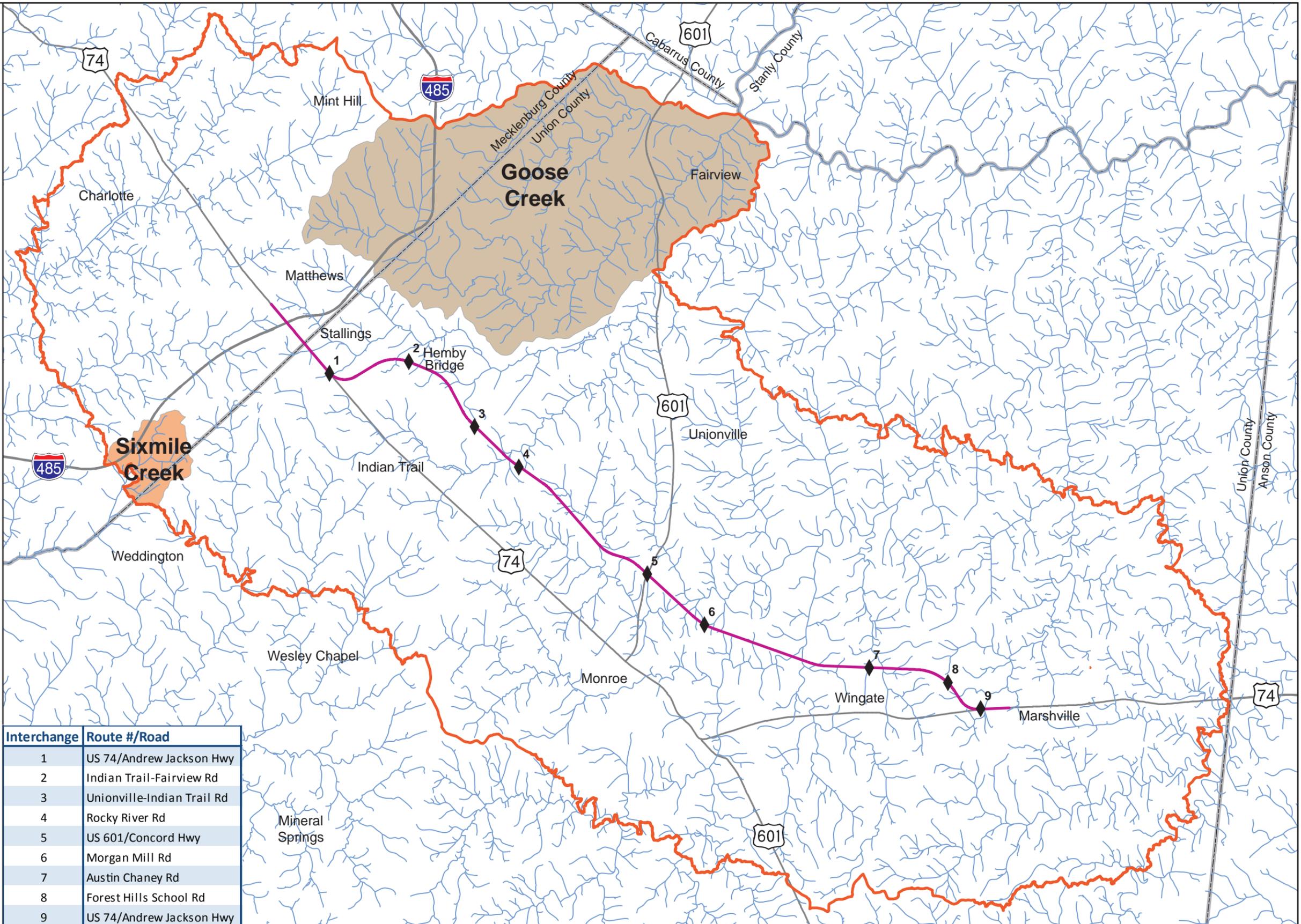


Map 2: Study Area Watersheds

- ◆ Interchanges
- Recommended Preferred Alternative Centerline
- ~ River or Stream
- FLUSA Boundary



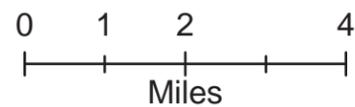
Interchange	Route #/Road
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7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy



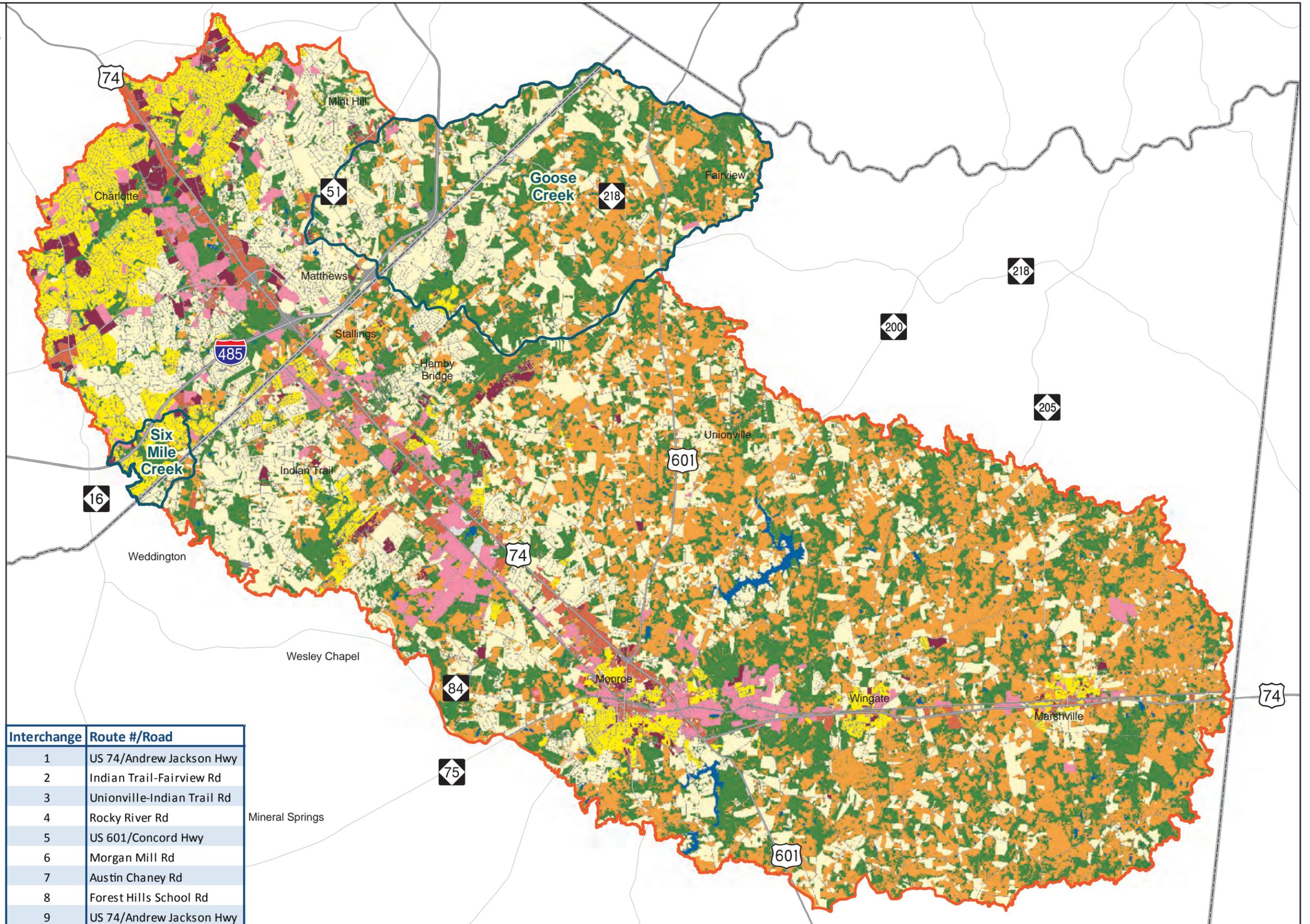
Map 3: Updated 2010 Baseline Land Use Scenario

Existing Land Use

- Agricultural Fields
- Barren
- Commercial
- Forested
- Other Natural
- High Density Residential
- Industrial/Office/Institutional
- Low Density Residential
- Medium Density Residential
- Open Water
- Transportation
- FLUSA Boundary
- Watersheds

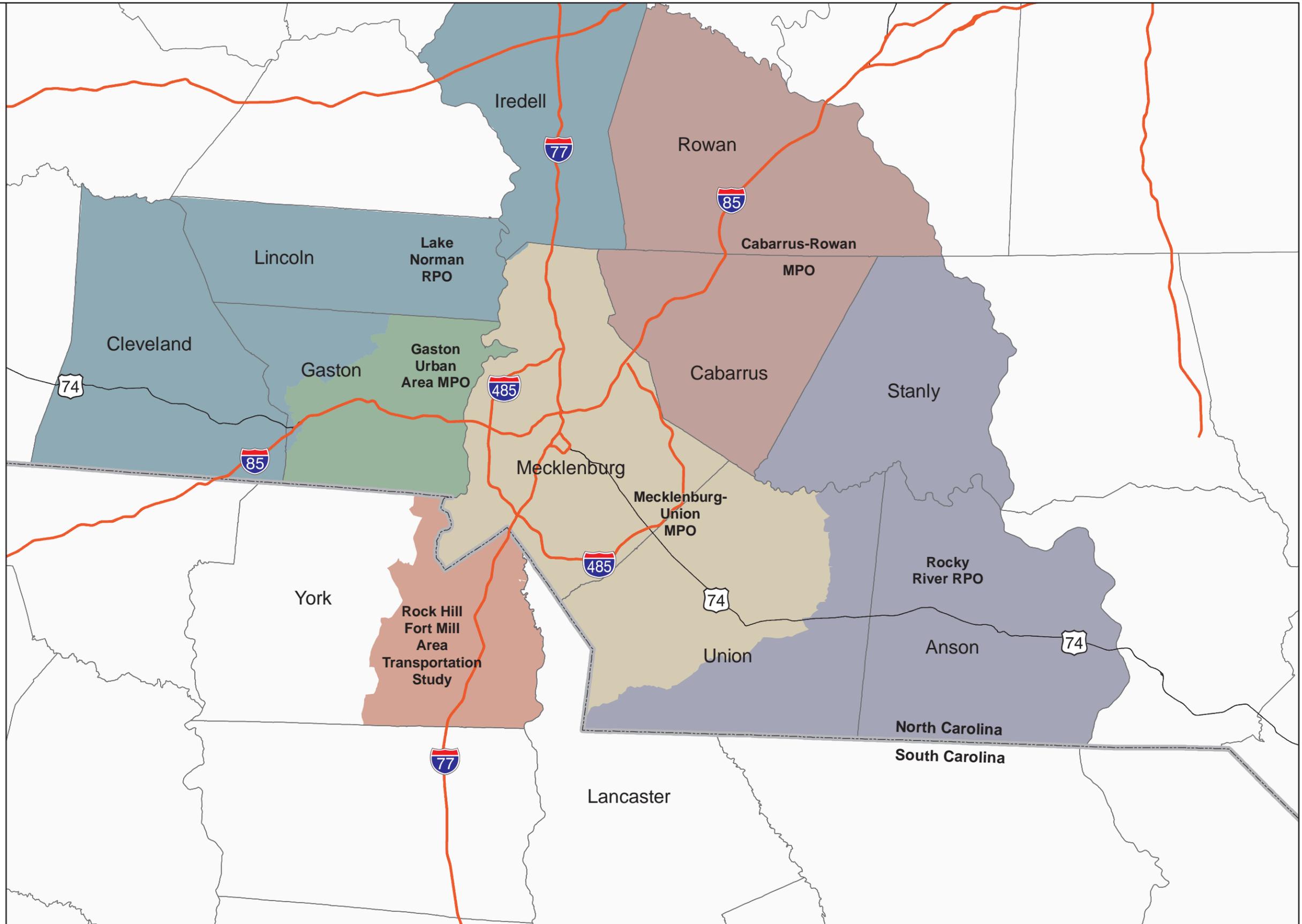
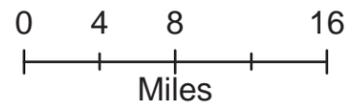


Interchange	Route #/Road
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5	US 601/Concord Hwy
6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy



Map 4 Charlotte Region MPOs and RPOs

- Interstates
- Major Roads
- Counties

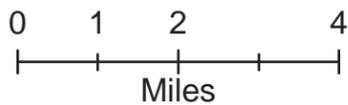


Map 5: Metrolina Model TAZs by Planning Organization

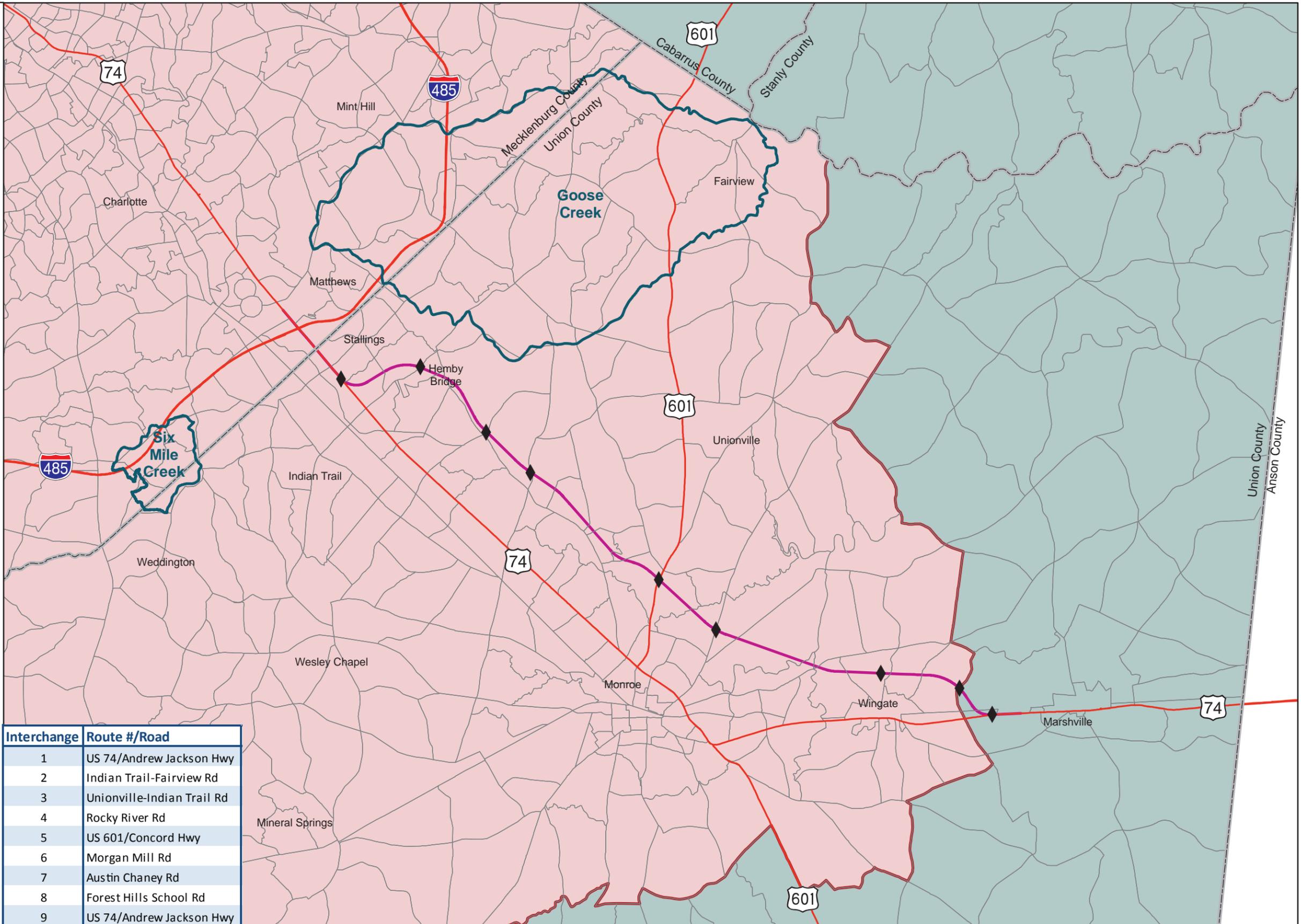
- ◆ Interchanges
- Recommended Preferred Alternative Centerline
- ▭ MUMPO Analysis Area
- ▭ Watersheds

Metrolina Model TAZs

- ▭ MUMPO
- ▭ Other MPO or RPO



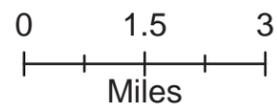
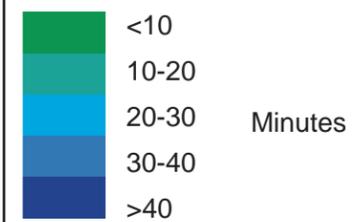
Interchange	Route #/Road
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5	US 601/Concord Hwy
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7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy



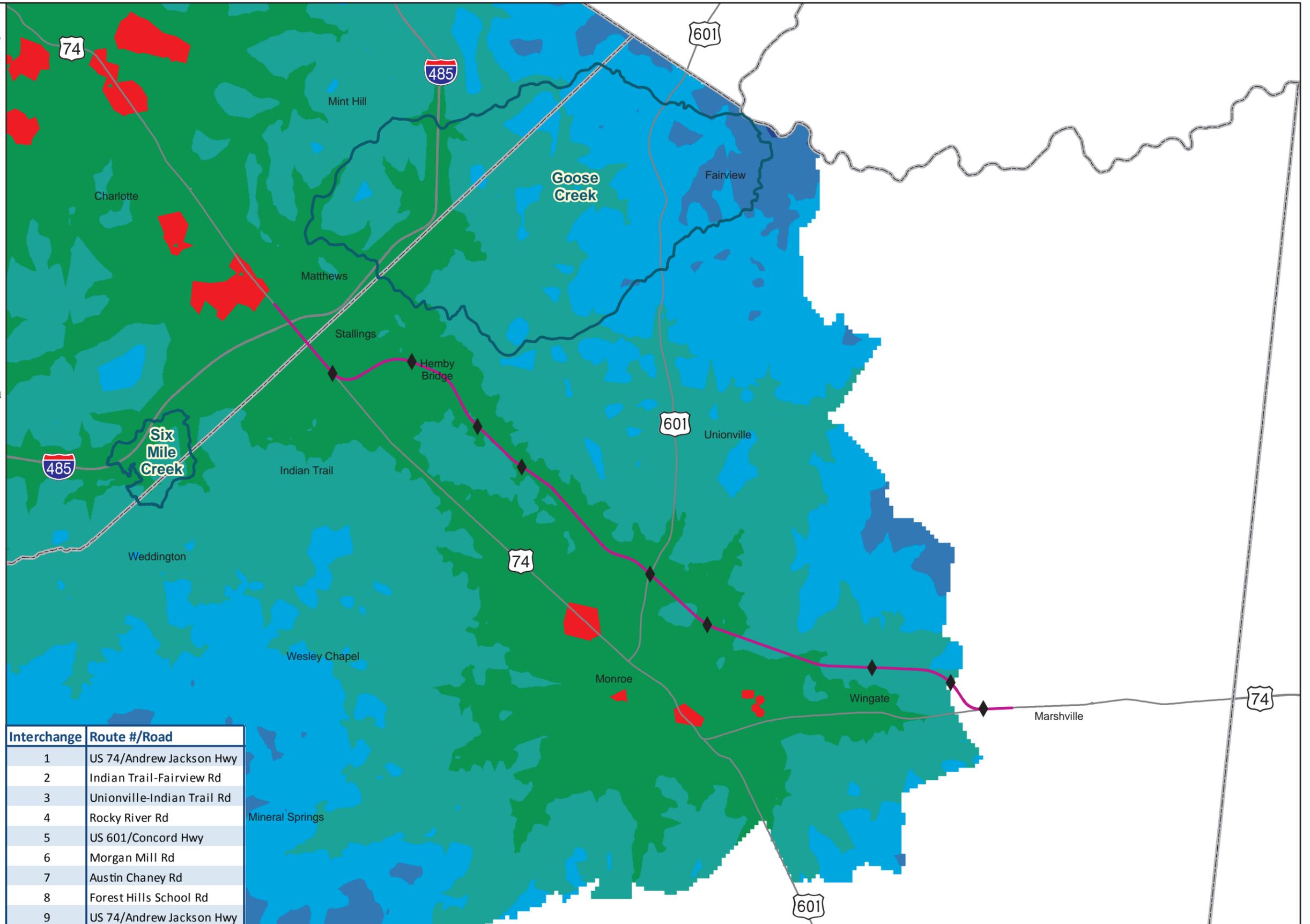
Map 6: Travel Time to Employment Center Analysis - Employment Center Location and Travel Time Results

-  RPA Centerline
-  Interchanges
-  Watersheds
-  MUMPO Analysis Area
-  Employment Centers

Travel Time to Employment Center



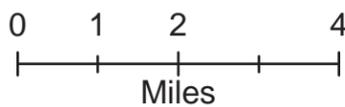
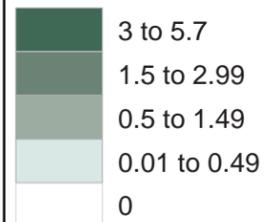
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7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy



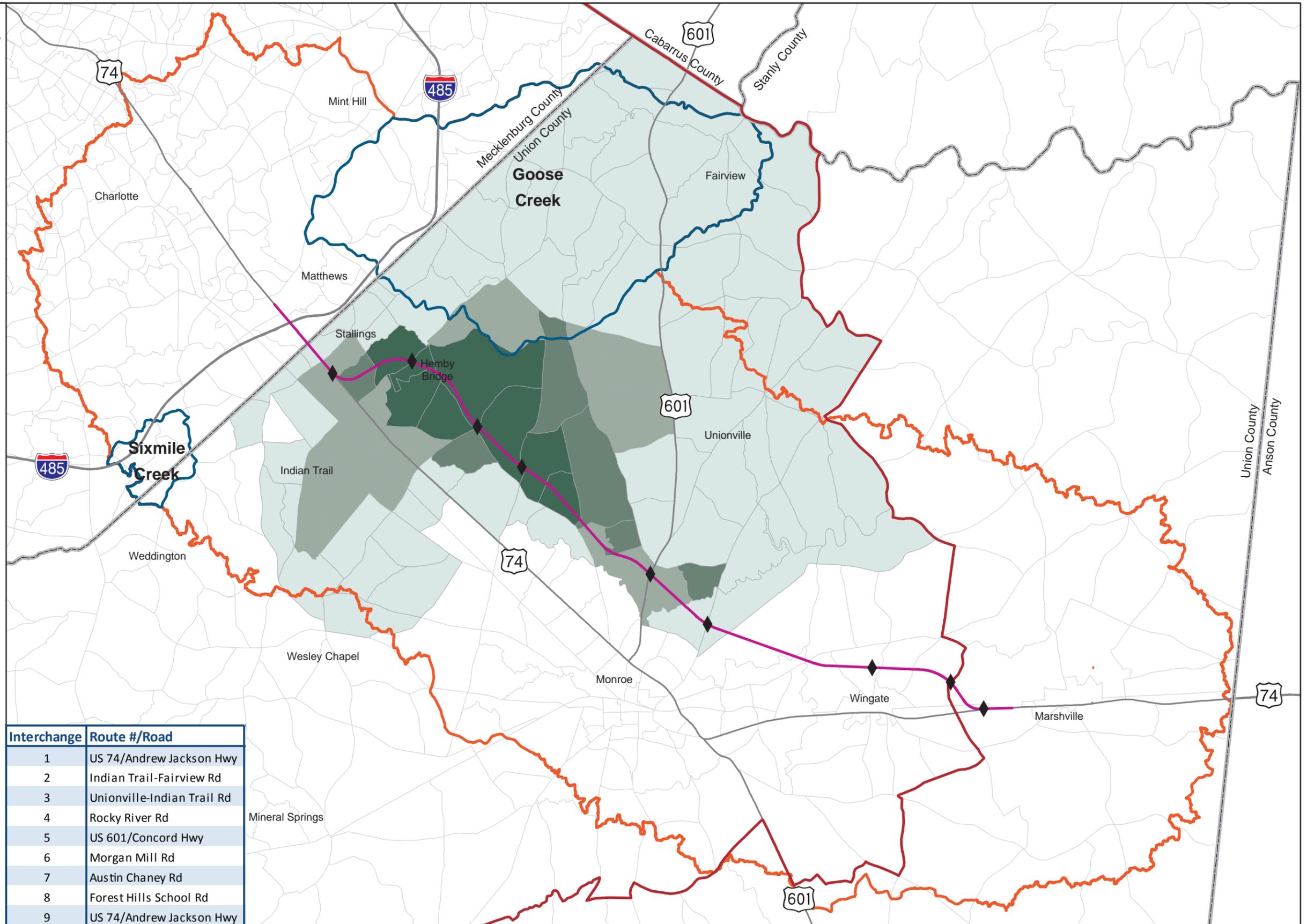
Map 7:
 Difference in Travel
 Time to Employment
 Centers Factor from
 Bottom Up Allocation

- ◆ Interchanges
- RPA Centerline
- ▭ Watersheds
- ▭ FLUSA Boundary
- ▭ MUMPO Analysis Area
- ▭ Watersheds

**Travel Time to
 Employment Centers**
 Time Difference
 (Minutes)



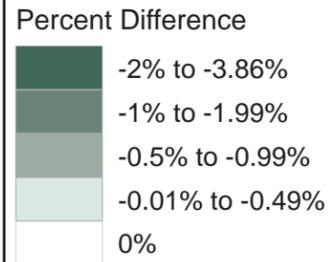
Interchange	Route #/Road
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6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy



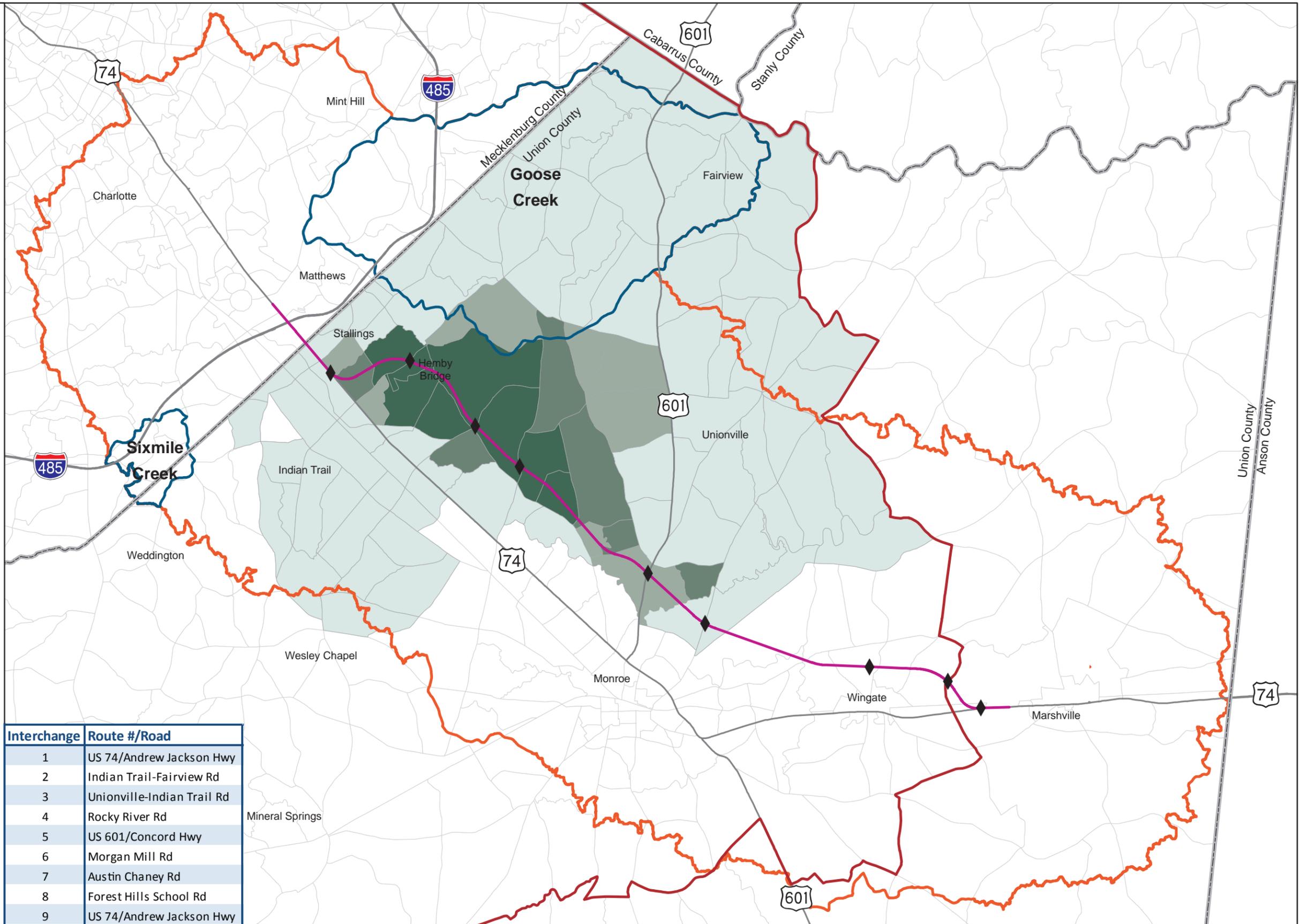
Map 8:
 Difference in Land
 Development Factor
 Composite Score
 from Bottom Up
 Allocation

- ◆ Interchanges
- RPA Centerline
- Watersheds
- FLUSA Boundary
- MUMPO Analysis Area
- Watersheds

**Land Development Factor
 Composite Score**



Interchange	Route #/Road
1	US 74/Andrew Jackson Hwy
2	Indian Trail-Fairview Rd
3	Unionville-Indian Trail Rd
4	Rocky River Rd
5	US 601/Concord Hwy
6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy

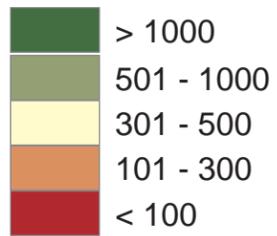


**Map 9:
 Household Density
 2030 Horizon
 Year**

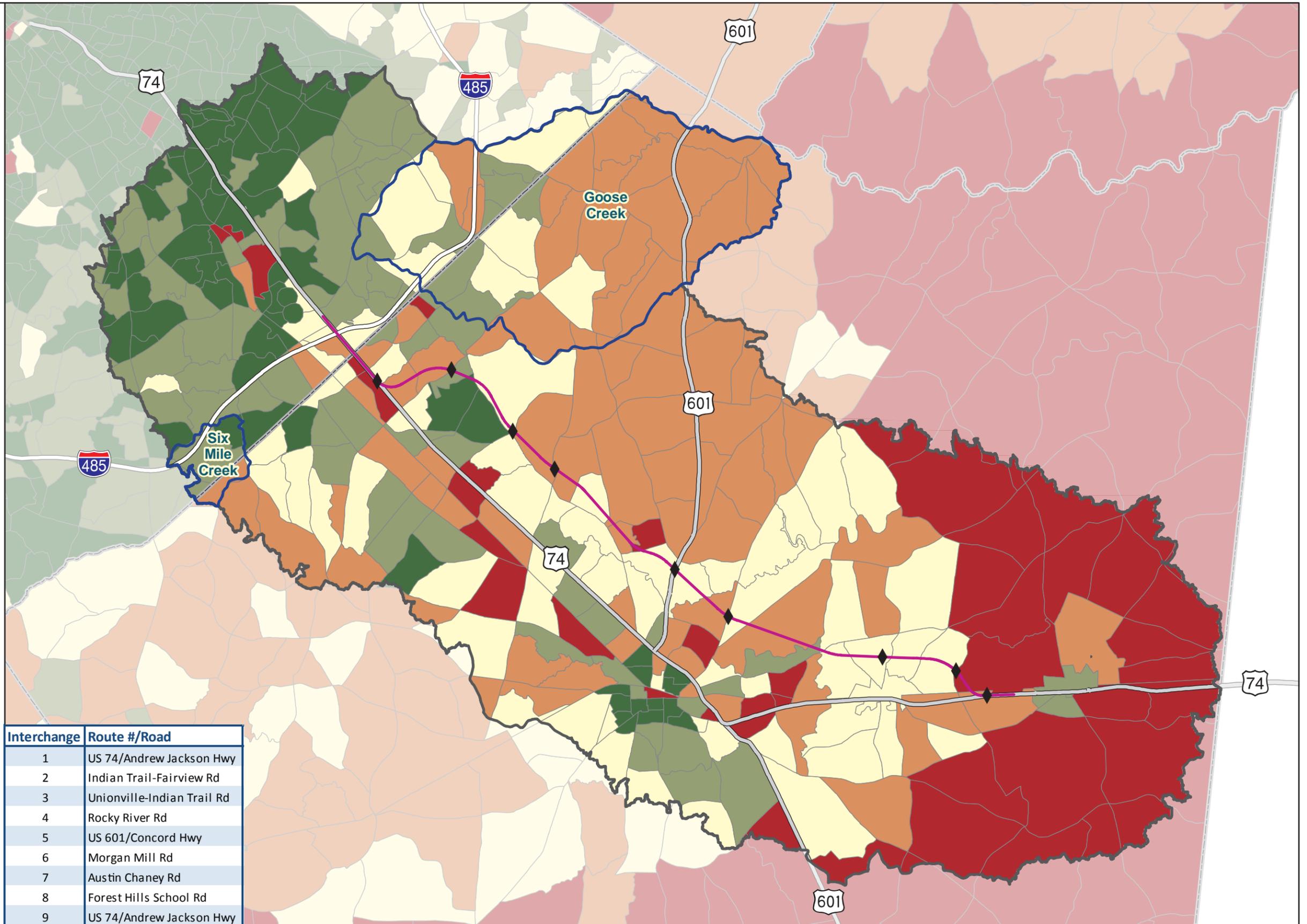
2009 Projections

-  Watersheds
-  FLUSA Boundary
-  Interchanges
-  RPA Centerline

**Household Density
 per Sq. Mile**



Interchange	Route #/Road
1	US 74/Andrew Jackson Hwy
2	Indian Trail-Fairview Rd
3	Unionville-Indian Trail Rd
4	Rocky River Rd
5	US 601/Concord Hwy
6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy

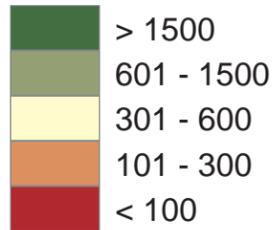


Map 10:
Employee Density
2030 Horizon
Year

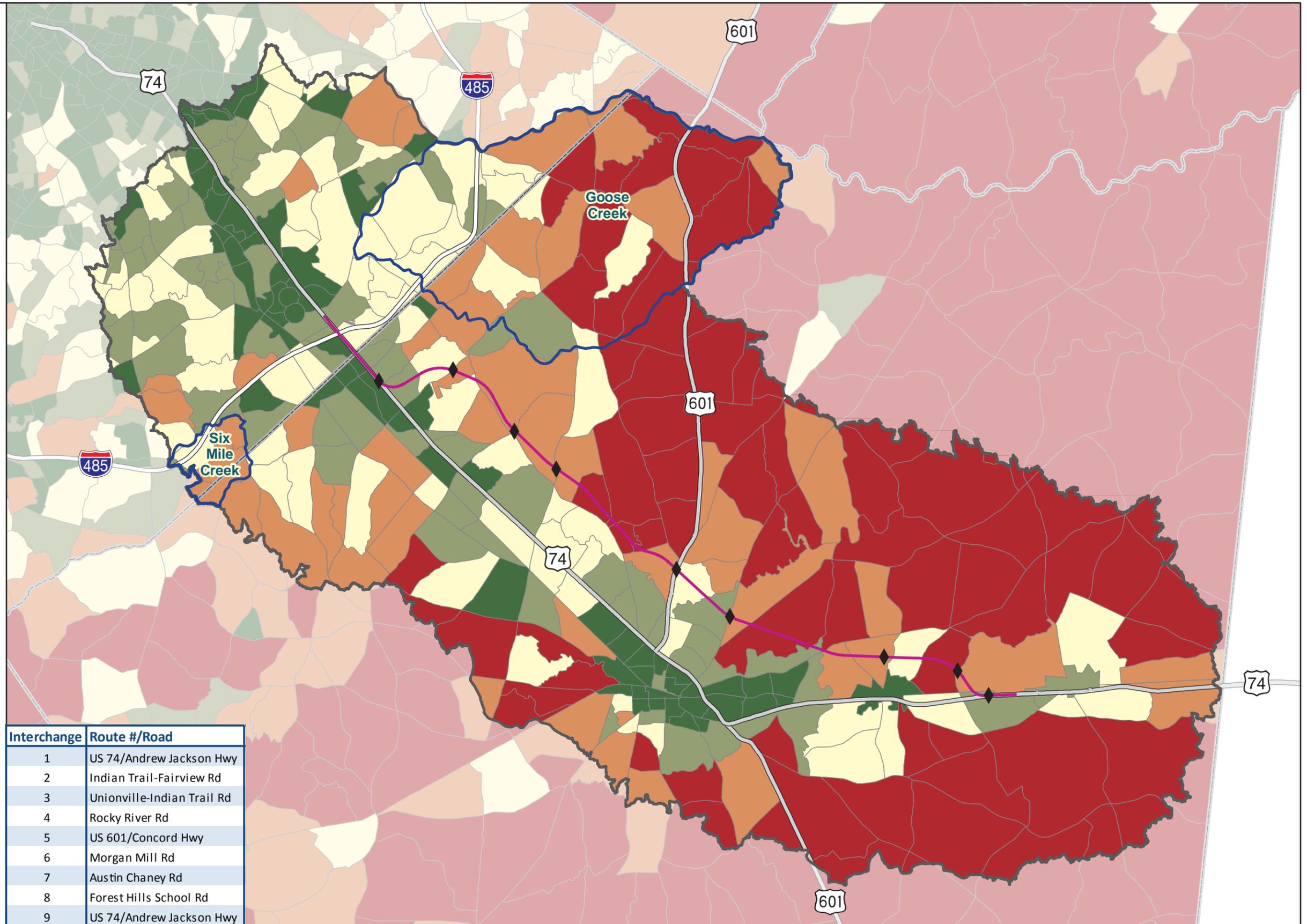
2009 Projections

-  Watersheds
-  FLUSA Boundary
-  Interchanges
-  RPA Centerline

Employee Density
per Sq. Mile

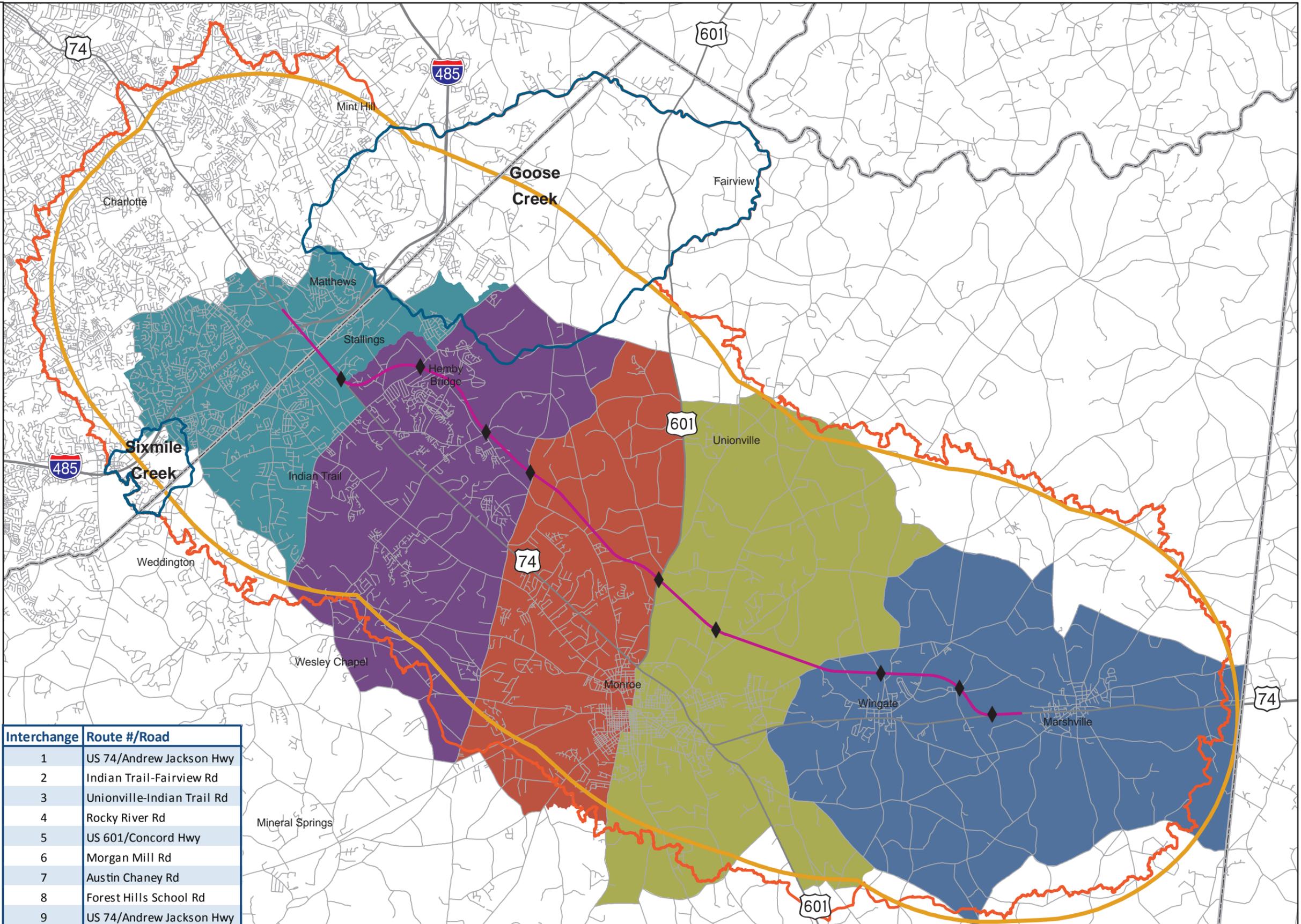


Interchange	Route #/Road
1	US 74/Andrew Jackson Hwy
2	Indian Trail-Fairview Rd
3	Unionville-Indian Trail Rd
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5	US 601/Concord Hwy
6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy



Map 11: Kenan Institute Study Zones and ICE FLUSAs

- ◆ Interchanges
 - RPA Centerline
 - ▭ Watersheds
 - ▭ FLUSA (Qualitative ICE)
 - ▭ FLUSA (Quantitative ICE)
- Kenan Study Zones**
- 1
 - 2
 - 3
 - 4
 - 5



Interchange	Route #/Road
1	US 74/Andrew Jackson Hwy
2	Indian Trail-Fairview Rd
3	Unionville-Indian Trail Rd
4	Rocky River Rd
5	US 601/Concord Hwy
6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy

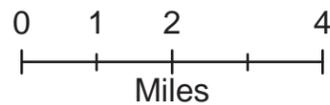
Map 12: Household Growth by TAZ

2009 Projections

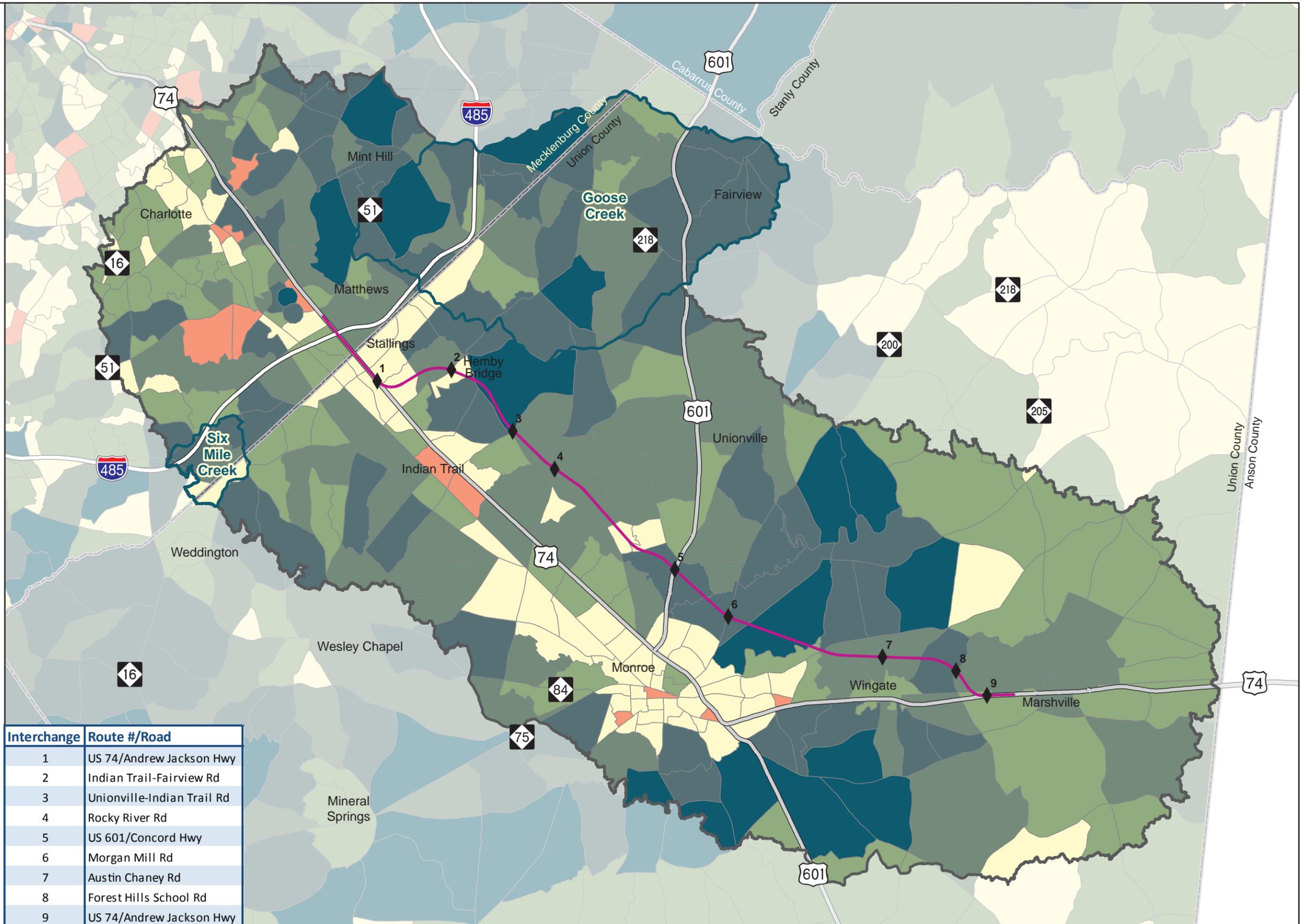
-  Watersheds
-  FLUSA Boundary
-  Interchanges
-  RPA Centerline

Household Growth 2005-2030

-  < 0
-  1 - 50
-  51 - 100
-  101 - 200
-  201 - 500
-  >500



Interchange	Route #/Road
1	US 74/Andrew Jackson Hwy
2	Indian Trail-Fairview Rd
3	Unionville-Indian Trail Rd
4	Rocky River Rd
5	US 601/Concord Hwy
6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy



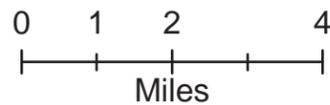
Map 13: Employment Growth by TAZ

2009 Projections

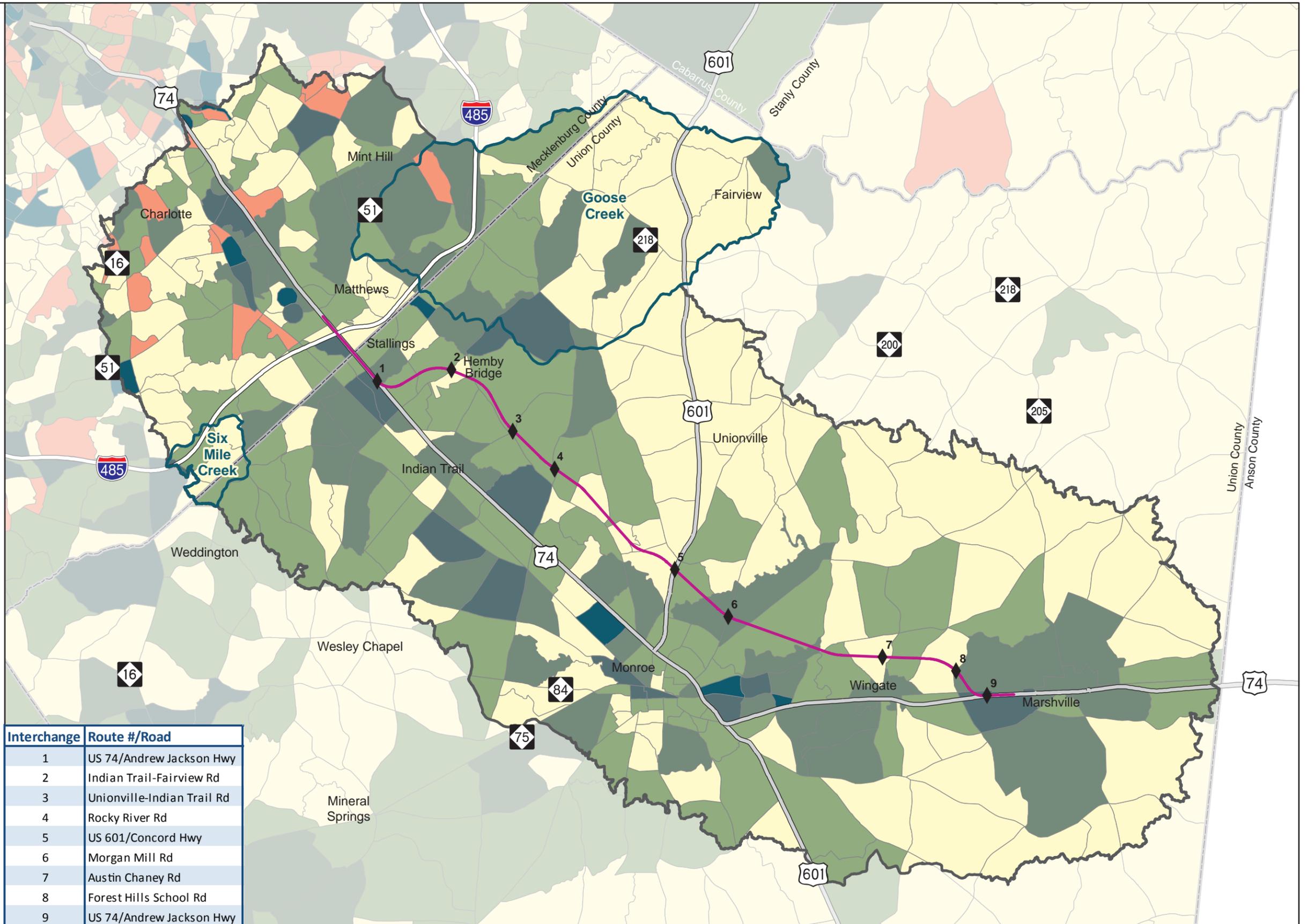
-  Watersheds
-  Study Area
-  Interchanges
-  RPA Centerline

Employment Growth 2005-2030

-  < 0
-  1 - 150
-  151 - 350
-  351 - 700
-  701 - 1200
-  > 1200



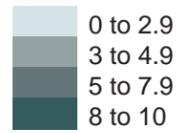
Interchange	Route #/Road
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7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy



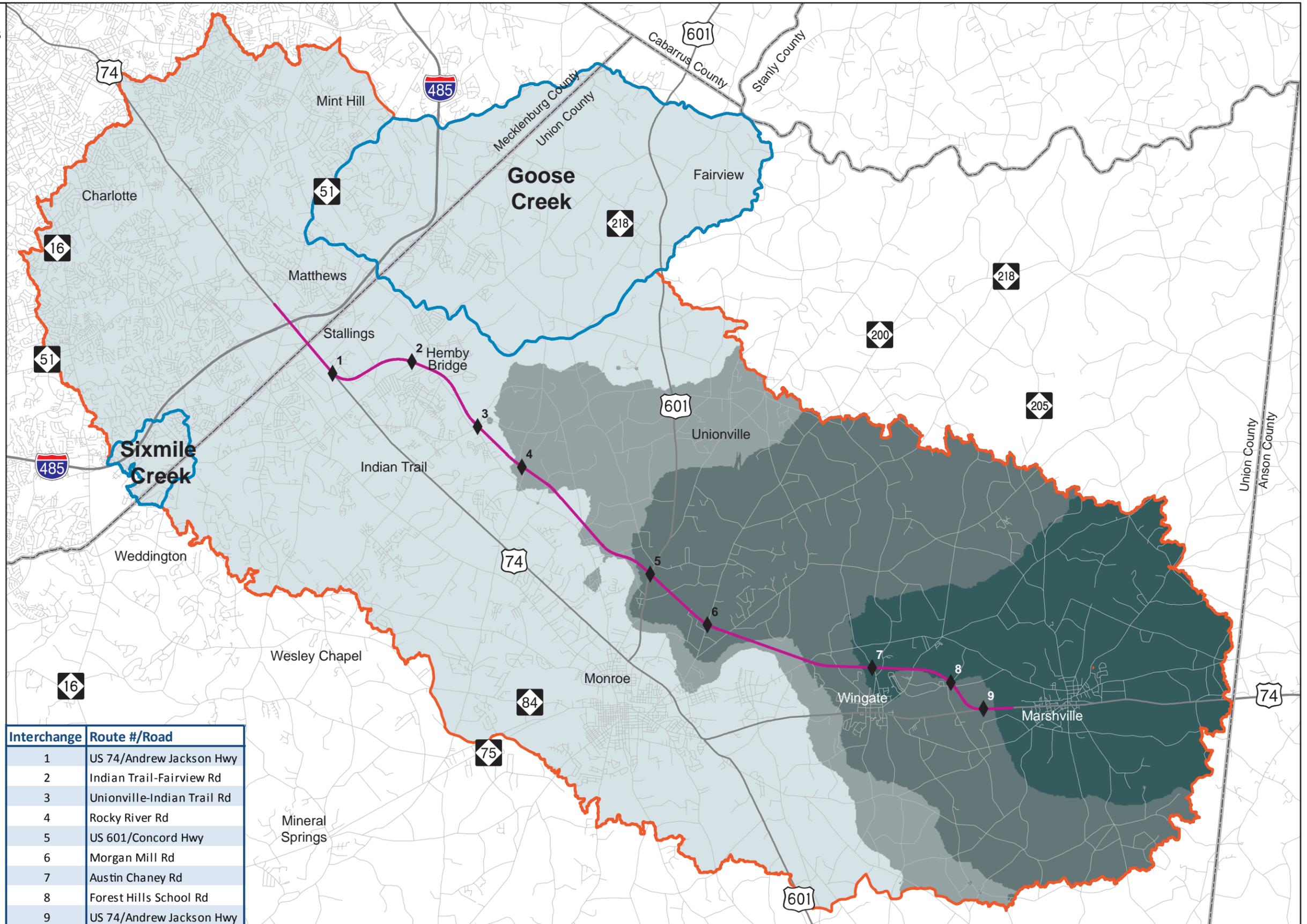
Map 14: Comparison of Accessibility No-Build vs Build

- ◆ Interchanges
- Recommended Preferred Alternative Centerline
- ▭ FLUSA Boundary
- ▭ Watershed Boundary

Change in Travel Time
 Decrease from
 No Build to Build (Min)

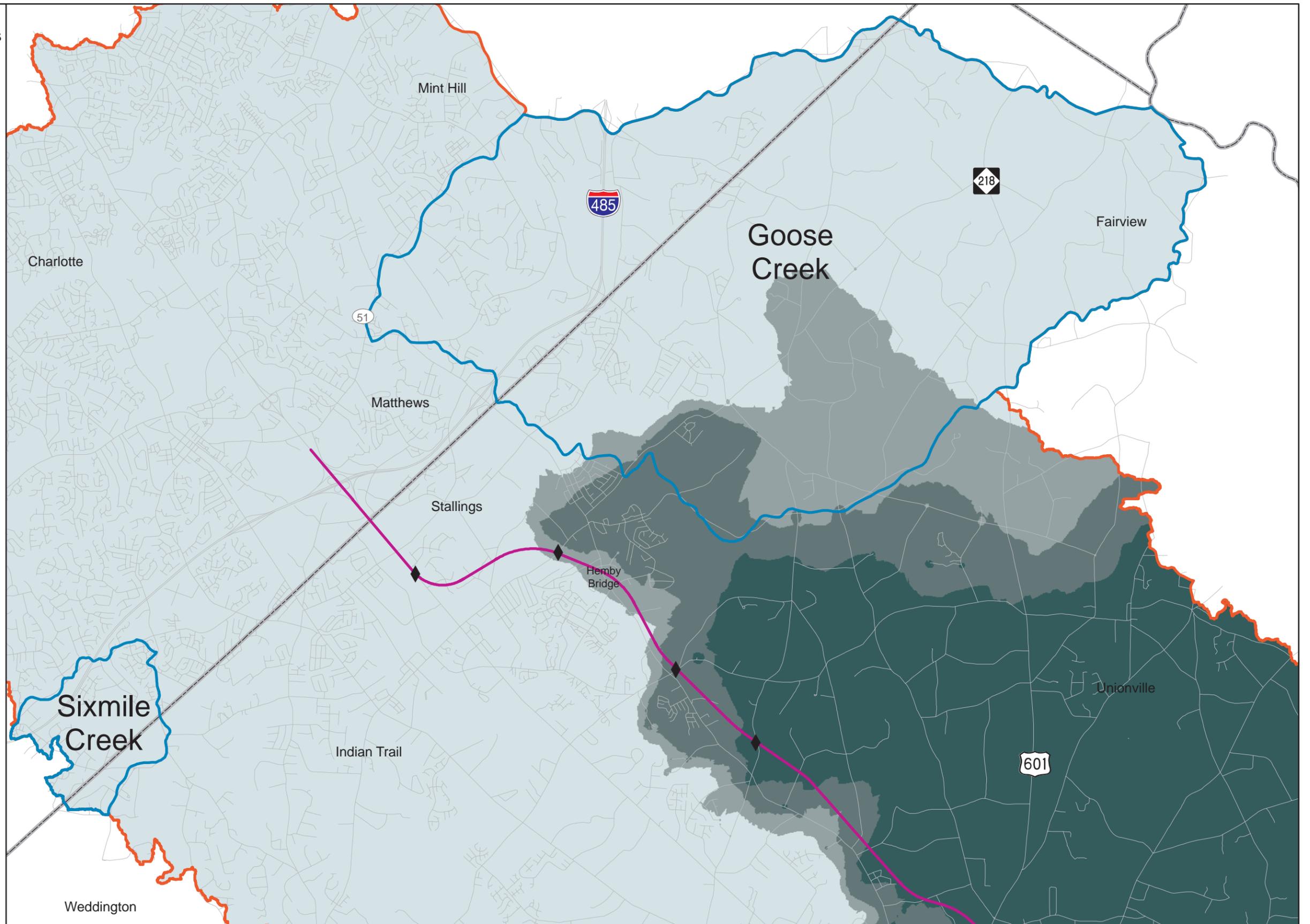
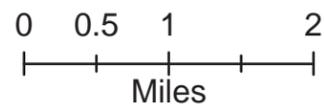


Interchange	Route #/Road
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5	US 601/Concord Hwy
6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy



Map 15: Comparison of Accessibility No Build vs Build

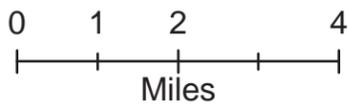
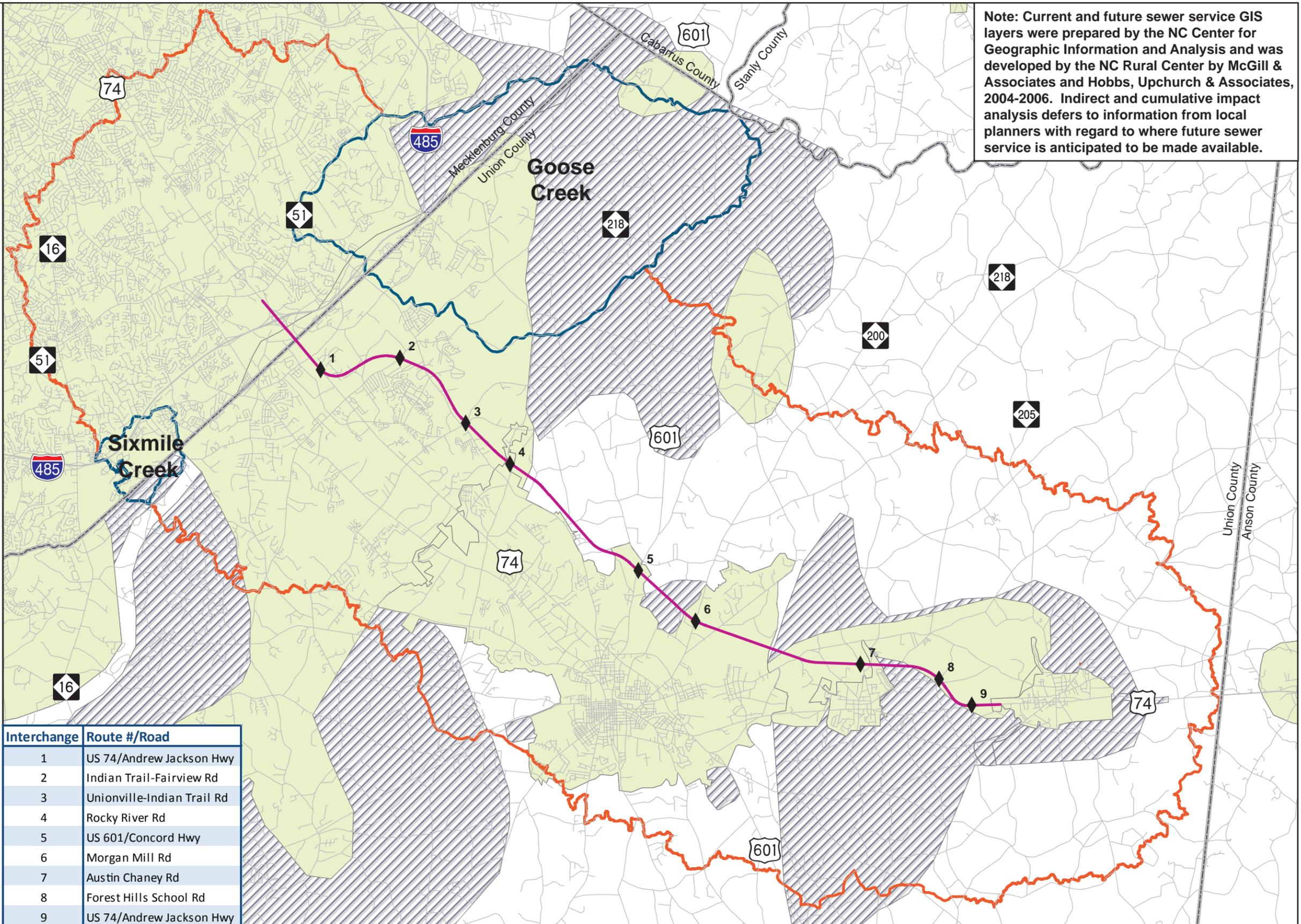
- ◆ Interchanges
- Recommended Preferred Alternative Centerline
- ▭ FLUSA Boundary
- ▭ Watersheds
- Change in Travel Time
Decrease from
No Build to Build
- 0 to 0.9
- 1 to 1.9
- 2 to 2.9
- 3 to 10



Map 16: Sanitary Sewer Availability

Note: Current and future sewer service GIS layers were prepared by the NC Center for Geographic Information and Analysis and was developed by the NC Rural Center by McGill & Associates and Hobbs, Upchurch & Associates, 2004-2006. Indirect and cumulative impact analysis defers to information from local planners with regard to where future sewer service is anticipated to be made available.

- ◆ Interchanges
- Recommended Preferred Alternative Centerline
- Existing Roads
- ▭ Watersheds
- ▭ Future Land Use
- ▭ Study Area Boundary
- ▭ Current Sewer Service
- ▭ Future Sewer Service

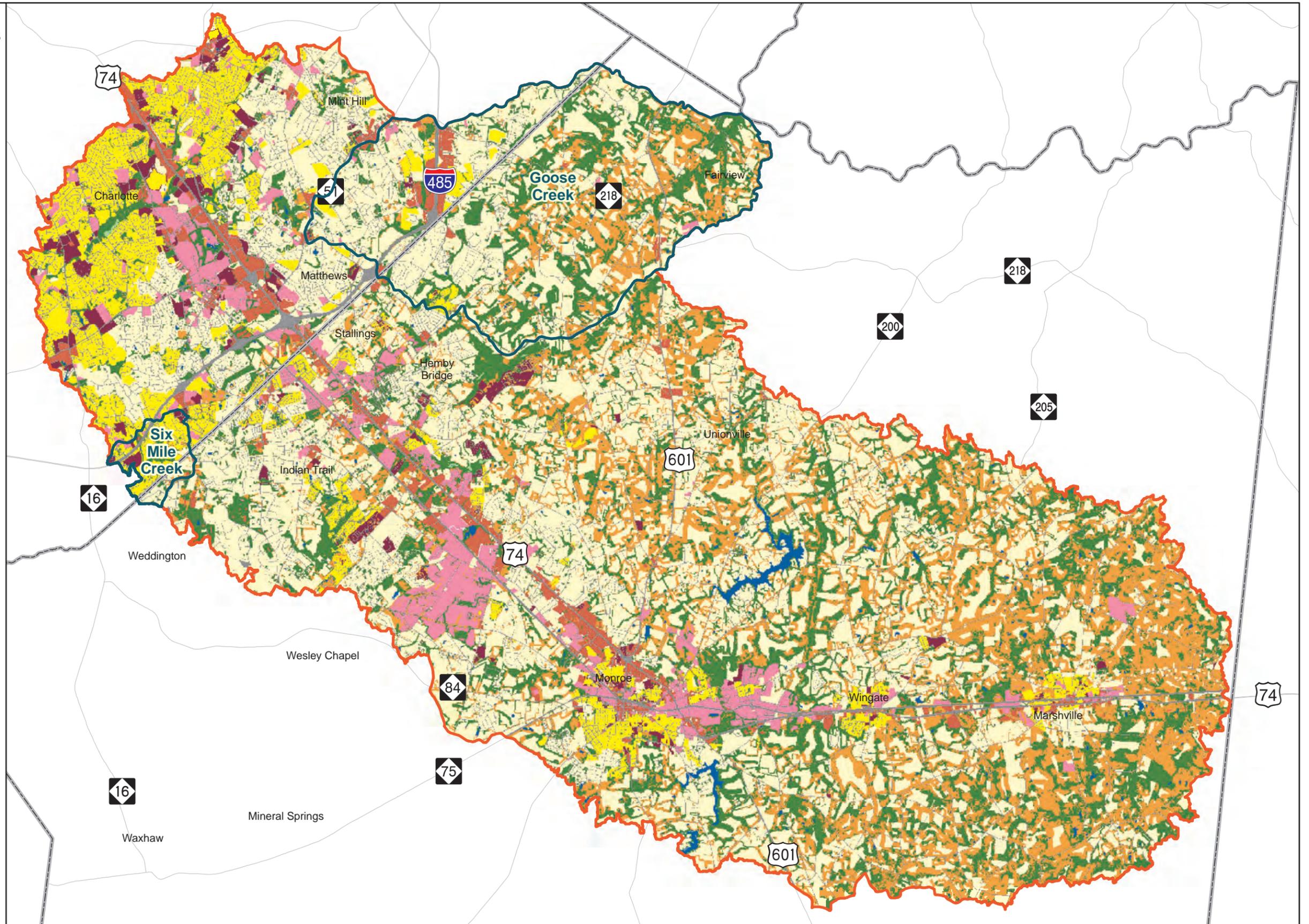
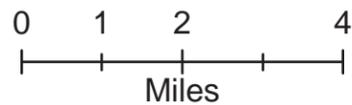


Interchange	Route #/Road
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5	US 601/Concord Hwy
6	Morgan Mill Rd
7	Austin Chaney Rd
8	Forest Hills School Rd
9	US 74/Andrew Jackson Hwy

Map 17: Updated 2030 No-Build Land Use Scenario

No Build Land Use

-  Agricultural Fields
-  Barren
-  Commercial
-  Forested
-  Other Natural
-  High Density Residential
-  Industrial/Office/Institutional
-  Low Density Residential
-  Medium Density Residential
-  Open Water
-  Transportation
-  FLUSA Boundary
-  Watersheds



Map 18: Land Use Change

Baseline (Existing)
to No-Build

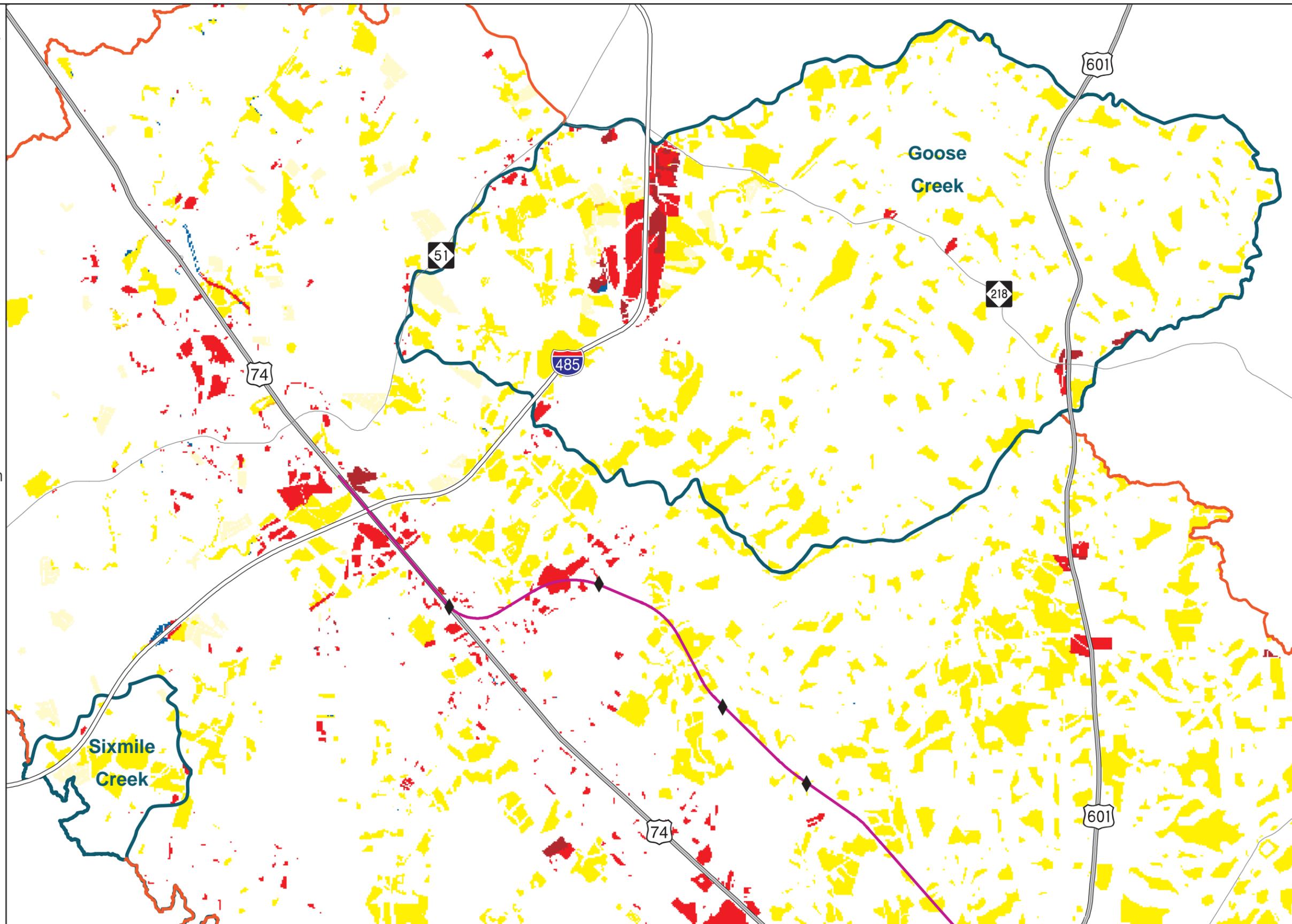
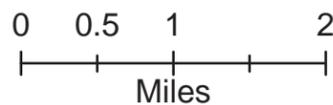
Change in Land Use

-  From Undeveloped to Residential
-  From Lower to Higher Density Residential
-  From Non-Residential to Residential
-  From Residential to Non-Residential
-  From Undeveloped to Non-Residential
-  Other Change between Developed Land Uses

 RPA Centerline

 FLUSA Boundary

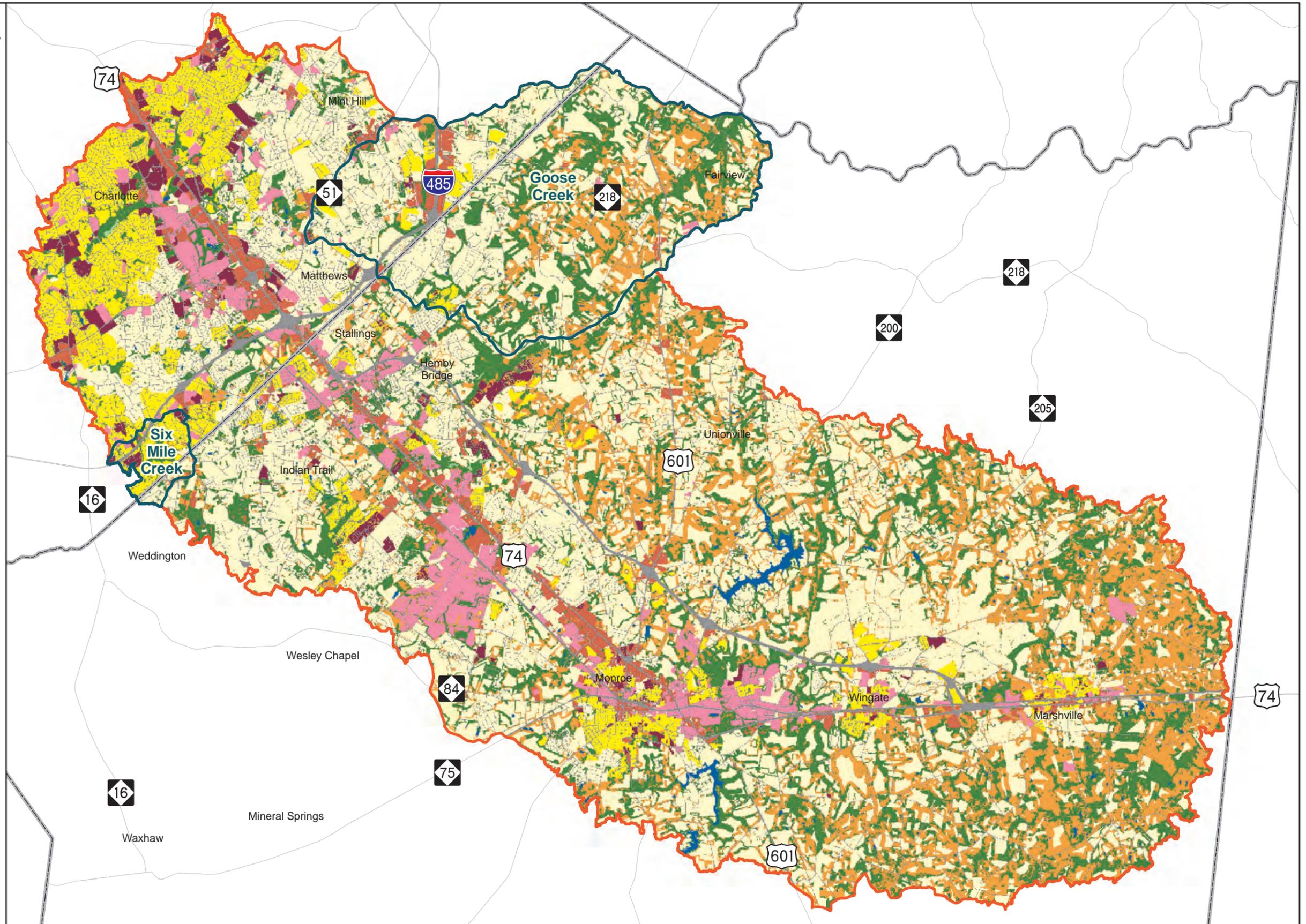
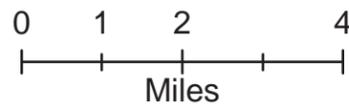
 Watersheds



Map 19: Updated 2030 Build Land Use Scenario

Build Land Use

-  Agricultural Fields
-  Barren
-  Commercial
-  Forested
-  Other Natural
-  High Density Residential
-  Industrial/Office/Institutional
-  Low Density Residential
-  Medium Density Residential
-  Open Water
-  Transportation
-  FLUSA Boundary
-  Watersheds



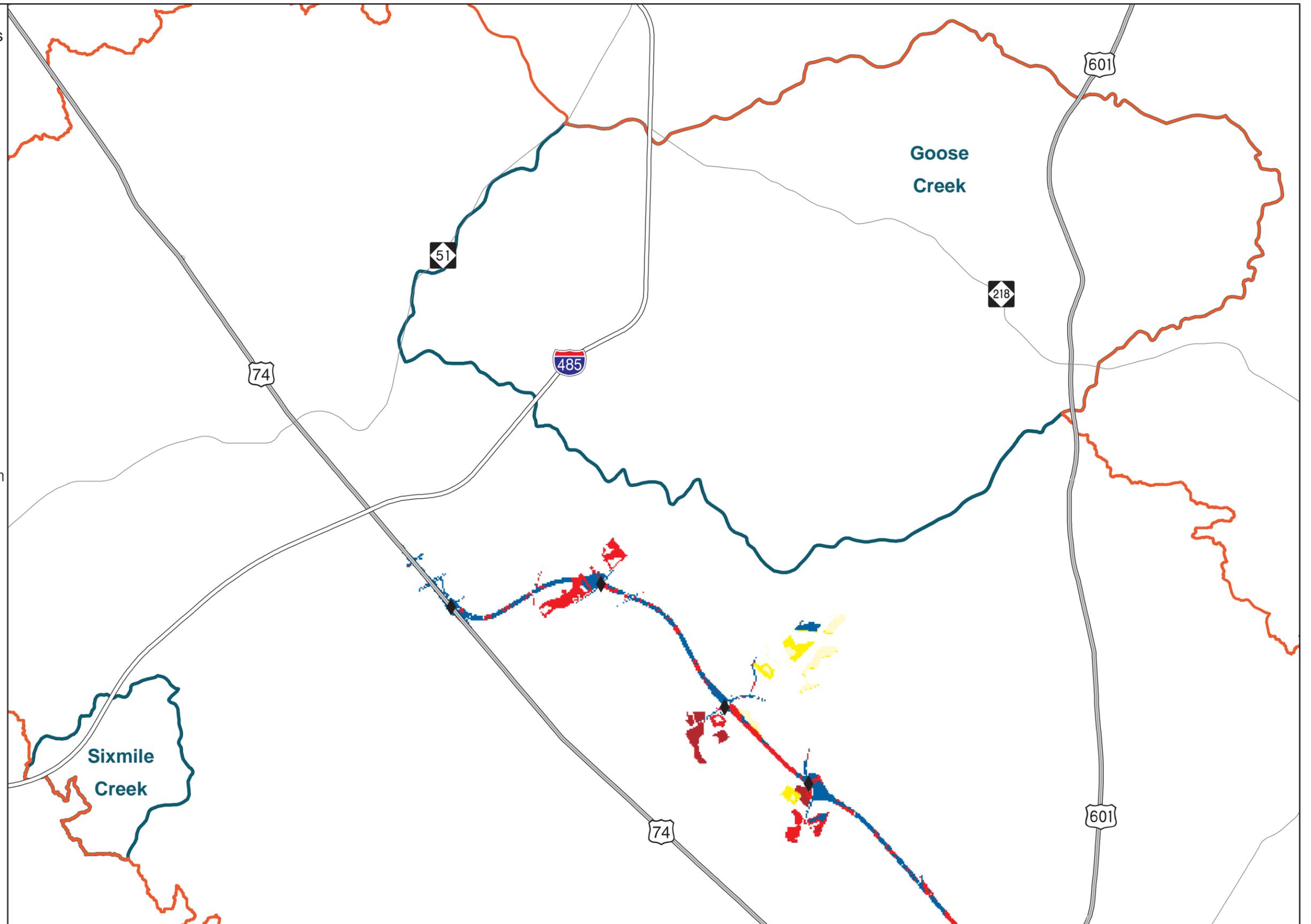
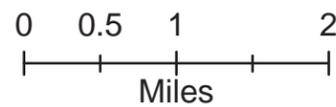
Map 20: Land Use Change

No-Build
to Build

Change in Land Use

- From Undeveloped to Residential
- From Lower to Higher Density Residential
- From Non-Residential to Residential
- From Residential to Non-Residential
- From Undeveloped to Non-Residential
- Other Change between Developed Land Uses

- FLUSA Boundary
- Watersheds

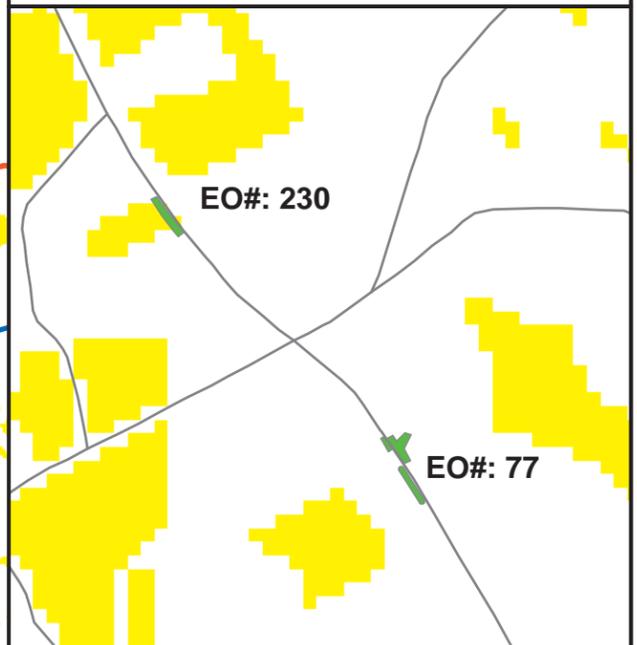
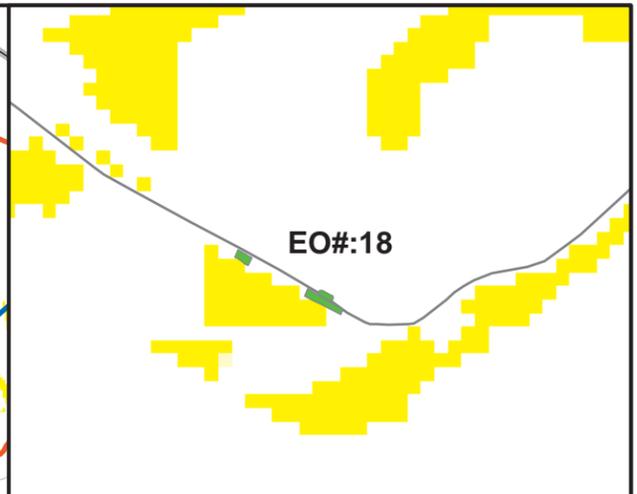
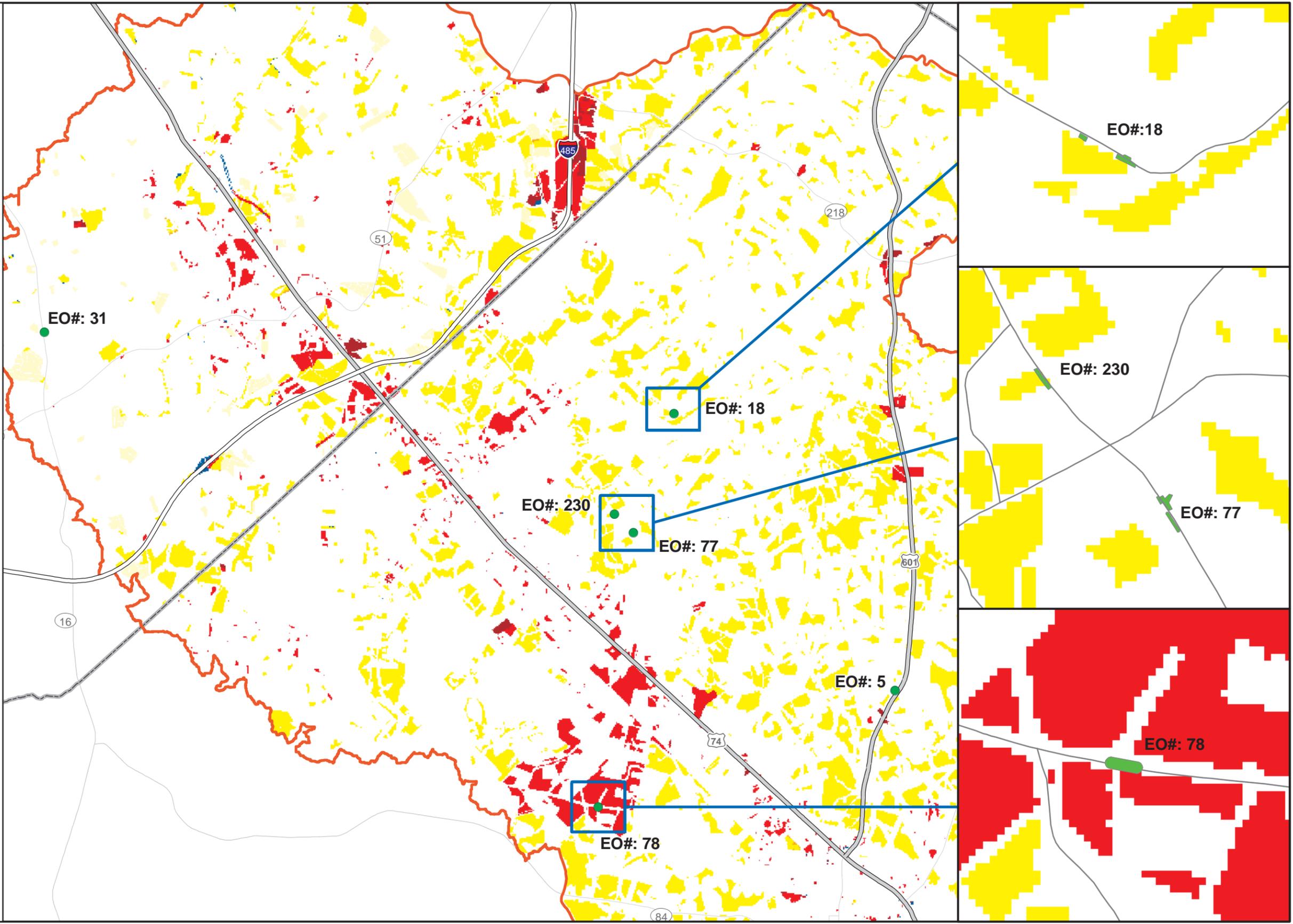
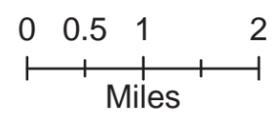


Map 21: Land Use Change Baseline (Existing) to No-Build Effects to Sunflower Populations

● Schweinitz's
Sunflower
Population

- Change in Land Use**
- From Undeveloped to Residential
 - From Lower to Higher Density Residential
 - From Non-Residential to Residential
 - From Residential to Non-Residential
 - From Undeveloped to Non-Residential
 - Other Change between Developed Land Uses

FLUSA Boundary

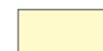


Map 22: Land Use Change

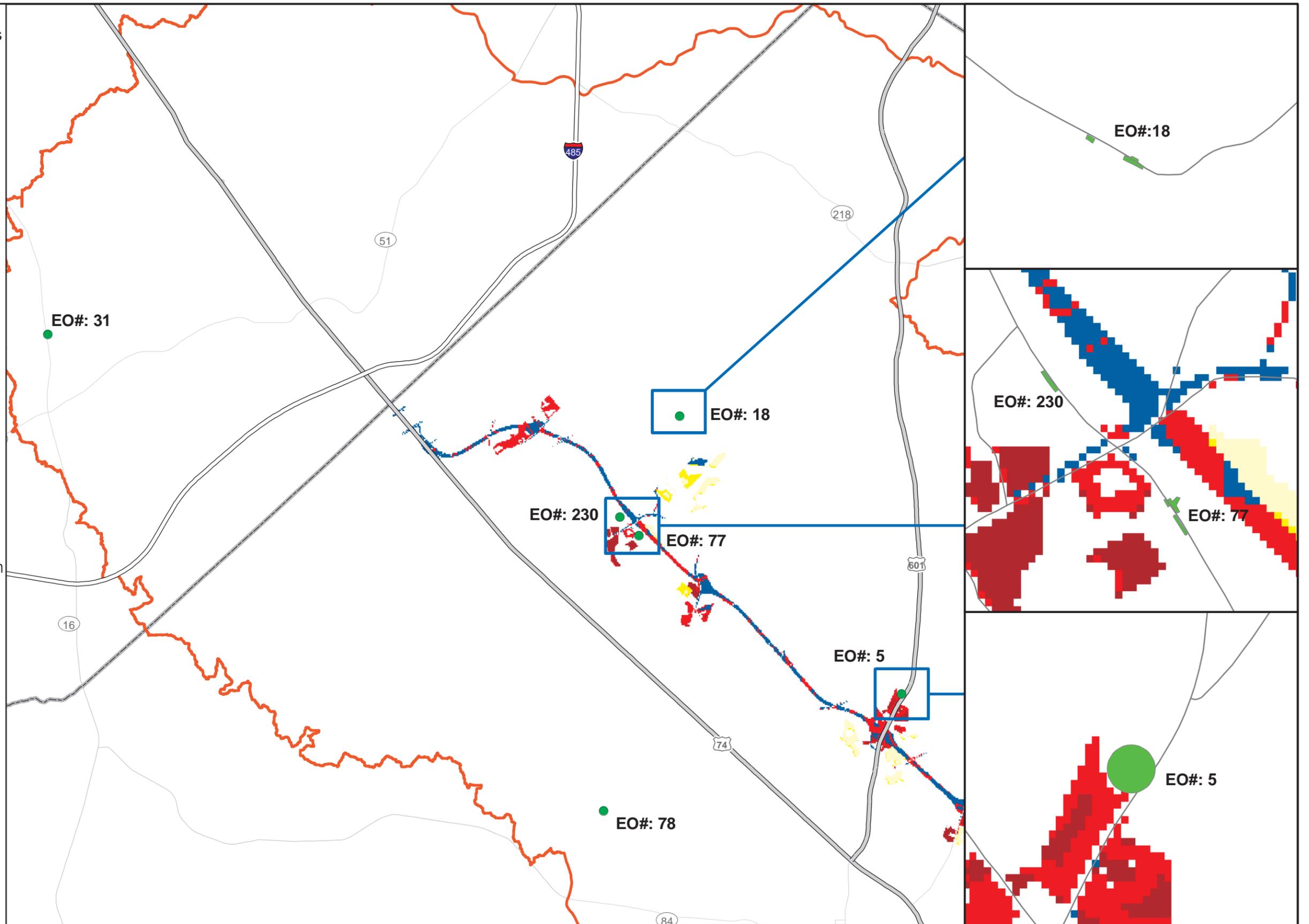
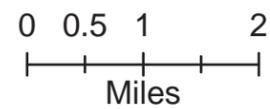
No-Build
to Build
Effects to
Sunflower
Populations

 Schweinitz's
Sunflower
Population

Change in Land Use

-  From Undeveloped to Residential
-  From Lower to Higher Density Residential
-  From Non-Residential to Residential
-  From Residential to Non-Residential
-  From Undeveloped to Non-Residential
-  Other Change between Developed Land Uses

 FLUSA Boundary



Monroe Connector/Bypass
 Supplement to the
 Biological Assessment

Map 23: Raw Model Volumes No-Build and Build Scenarios

US 601 from
 Monroe Connector/Bypass
 to Cabarrus County

-  Volume **decrease**
from No-Build to
Build
-  Volume **increase**
from No-Build to
Build

Raw Model Volumes

No-Build	1,000
Build	(1,000)

-  RPA Centerline
-  FLUSA Boundary
-  Watersheds

