Owensboro Outer Loop Study

FINAL
Owensboro Outer Loop Feasibility Study
Daviess County, Kentucky

Kentucky Transportation Cabinet

In Partnership with:

Owensboro-Daviess County MPO
Green River Area Development District
HMB Professional Engineers, Inc.
AECOM

December 2021

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FINAL EXECUTIVE SUMMARY

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Introduction and Study Area

The Owensboro Outer Loop Feasibility Study was initiated in April 2020 by the Kentucky Transportation Cabinet (KYTC) to evaluate the feasibility of an "outer loop" around Owensboro in Daviess County, Kentucky. **Figure ES-1** shows the study area which encompasses the surrounding area of Owensboro in Daviess County, Kentucky. This includes US 60 from the intersection with US 231 in the east to the intersection with KY 1554 in the west. It extends into the county south to the area where I-165 intersects with KY 142. All state-maintained routes within this boundary were included for consideration of this study. The study was conducted in coordination with KYTC, the Owensboro-Daviess County Metropolitan Planning Organization (MPO), and the Green River Area Development District (GRADD).

The initial study goals were as follows:

- Quantify Existing Needs in the Study Area
- Develop / Evaluate Feasibility of a Range of Connectivity Options
- Consider Independent Utility of Segments from a Benefit-Cost Analysis

To accomplish the objective and goals, the Project Team (consisting of organizations listed above and consultant personnel) worked collaboratively with the public, local officials, and stakeholders to accomplish the following tasks:

- Conduct a comprehensive review of the existing conditions
- Identify existing and potential new corridors / segments for "outer loop" connectivity
- Model and forecast current and future traffic for proposed segments to help with comparative analysis
- Develop a comparative analysis method for quantifying pros and cons of each segment and the corridors as a whole
- Conduct a benefit-cost analysis for identified corridors and / or segments

Existing Conditions

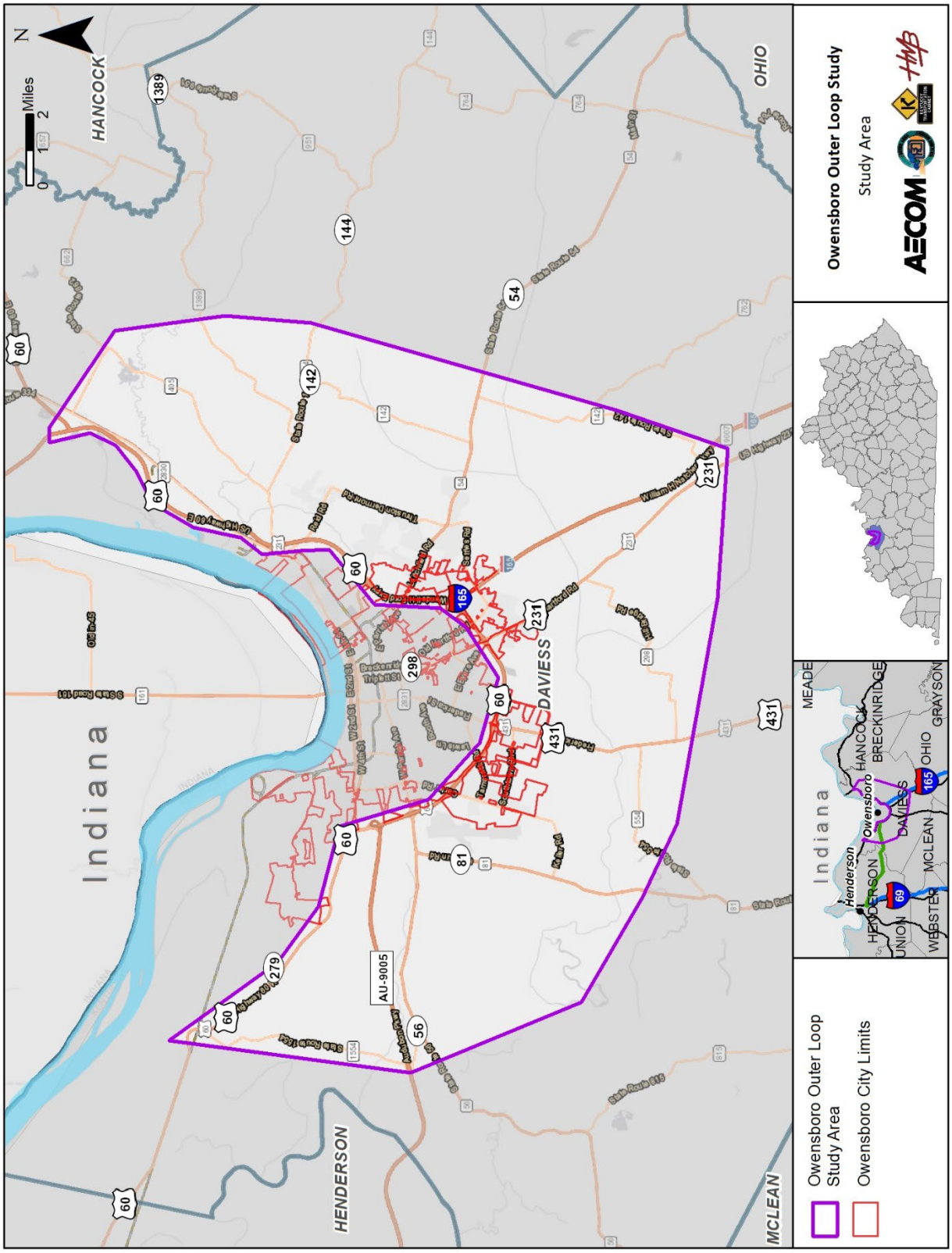
Information on elements of the existing transportation network were collected including roadway facility types and geometrics, structures, traffic volumes and operations, crash history and analysis, and bicycle and pedestrian accommodations.

Functional Class and Roadway Systems – The study area has a wide range of functional classifications from local roads to interstates. Portions of the Audubon Parkway and I-165 are included in the study area.

National Highway System – US 60, Audubon Parkway, and I-165 are included in the National Highway System (NHS) and therefore fall under the monitoring and performance for the Federal Highway Administration (FHWA) Practices for Performance-Based Planning and Programming.

Typical Section – The typical section of roadways varies throughout the study area, ranging from one to five lanes, with lane widths ranging from eight to fourteen feet. In the rural portions of the study area, traffic volumes tend to be lower and there is less pavement width. As traffic volumes increase in the urban areas, number of lanes and lane widths tend to increase in size.

Figure ES-1. Study Area



Speed Limit – The posted speed limit on roadways varies from 25 mph on the local routes to 70 mph on I-165.

Horizontal and Vertical Curves – Significant instances of higher degree horizontal curves occur on KY 298 (Old Hartford Road), KY 1456 (Thurston Dermont Road), KY 142, and KY 1554. Vertical grades are especially high on KY 1456 (Thurston Dermont Road) and KY 3143.

Structures – There are 125 structures in the study area identified through KYTC's Bridge Data Miner service, three of which have a Poor rating in the most recent inspection report. These include one on US 60 over Katie Meadow Slough. The other two are in the eastern portion of the study area with one on Graves Lane over Allgood Ditch and the other on South Hampton Road over Burnett Fork.

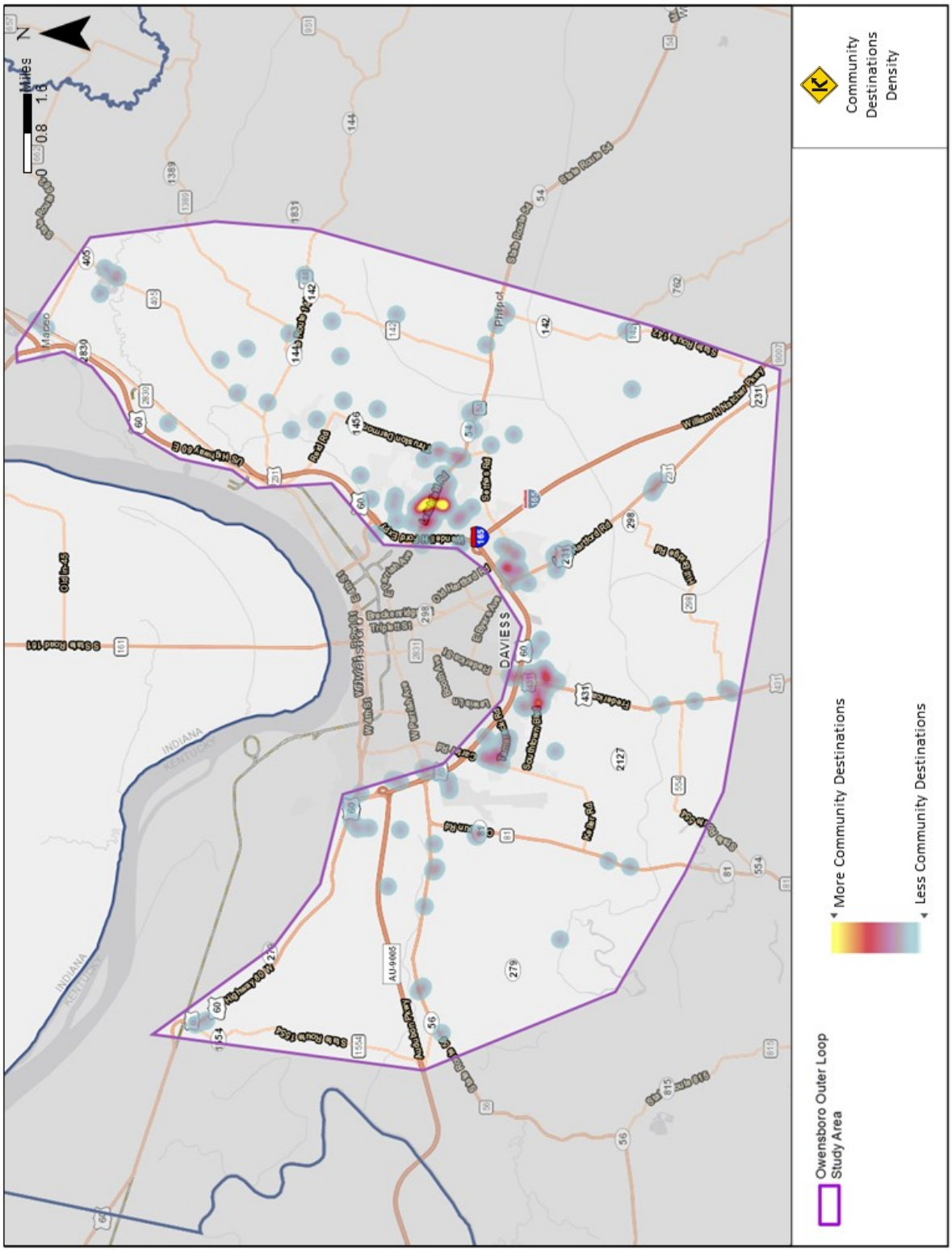
Traffic Volumes and Operational Analysis – Existing year (2020) average annual daily traffic (AADT) is highest along US 60 around Owensboro at 24,400 to 38,100 vehicles. These volumes are based on traffic counts from 2014 – 2020. A level of service (LOS) analysis was performed to determine a qualitative measure of operational characteristics of the roadways in the study area. LOS ranges from A (best operating conditions) to F (worst operating conditions). Two sections were identified with a LOS E or F rating. US 60 from US 431 (Frederica Street) to KY 54 (Leitchfield Road) is calculated to operate at a LOS F, with a small portion of KY 54 (Leitchfield Road) near US 60 at LOS E.

Crash Analysis – Historical crash data was evaluated across a three-year period from September 2017 to August 2020 to help identify locations and trends along roadways that could be considered high crash locations. Two types of statistical crash analysis were performed – evaluation of Excess Expected Crashes (EEC) and Critical Crash Rate Factor (CRF) analysis. The highest EEC values occurred on US 60, east of US 431, and ranged from 3.3 to 5.0. Typically, an EEC over 3.0 is considered a high value. For the CRF analysis, there were 31 segments that could be deemed high crash segments, with 24 between 1.0 and 2.0 and seven over 2.0. For reference, a CRF over 1.0 indicates crashes may be occurring more often than can be attributed to random occurrence.

Pedestrian and Bicycle Facilities – Pedestrian facilities are located primarily near the city center and major development areas. The Adkisson Greenbelt is a multi-use path and there are two US bicycle identified corridors – the Ramblin' River and the Underground Railroad tours.

Environmental Overview – An Environmental Overview was conducted to identify resources and potential issues for consideration during the development of potential connectivity options. This included identification of natural environment resources such as rivers and streams, wetlands and ponds, groundwater, floodplain / floodway, prime farmland, and protected species. From the overview, it was found that prime farmland comprises almost 80 percent of the study area. The human environment resources include land use, community features, historic districts, and properties. A heat map was generated of community destinations consisting of neighborhoods, businesses and industries with at least 100 employees, schools, parks, campgrounds, golf courses, medical facilities, churches, fire stations, and law enforcement, and other critical government facilities (refer to **Figure ES-2**).

Figure ES-2. Community Destinations Density



Collaboration

During the study process, multiple collaborative meetings were held including three Project Team meetings, two local official / stakeholder (LO/S) meetings, and one public meeting. All meetings were held virtually due to the COVID-19 pandemic. After each LO/S meeting, an online survey was sent out to collect input on the study. The public meeting was held after the second LO/S meeting to inform the public about the study and collect feedback both at the meeting and through an online survey.

Potential Connectivity Development and Analysis

Improving connectivity was the basis for developing initial segments which were combined to form preliminary corridors. The process for development and analysis is summarized in **Figure ES-3** and in the text below.

Segment Development

- Reviewed existing road network to determine potential segment options that connect to and utilize existing roadways to minimize right of way need.
- Reviewed existing and proposed bicycle facilities for potential connections and / or overlap.
- Reviewed community destinations to connect points of interest.
- Analyzed input from local officials and stakeholders collected early in the study process.

Segment Analysis

Segment characteristics were evaluated by the following categories:

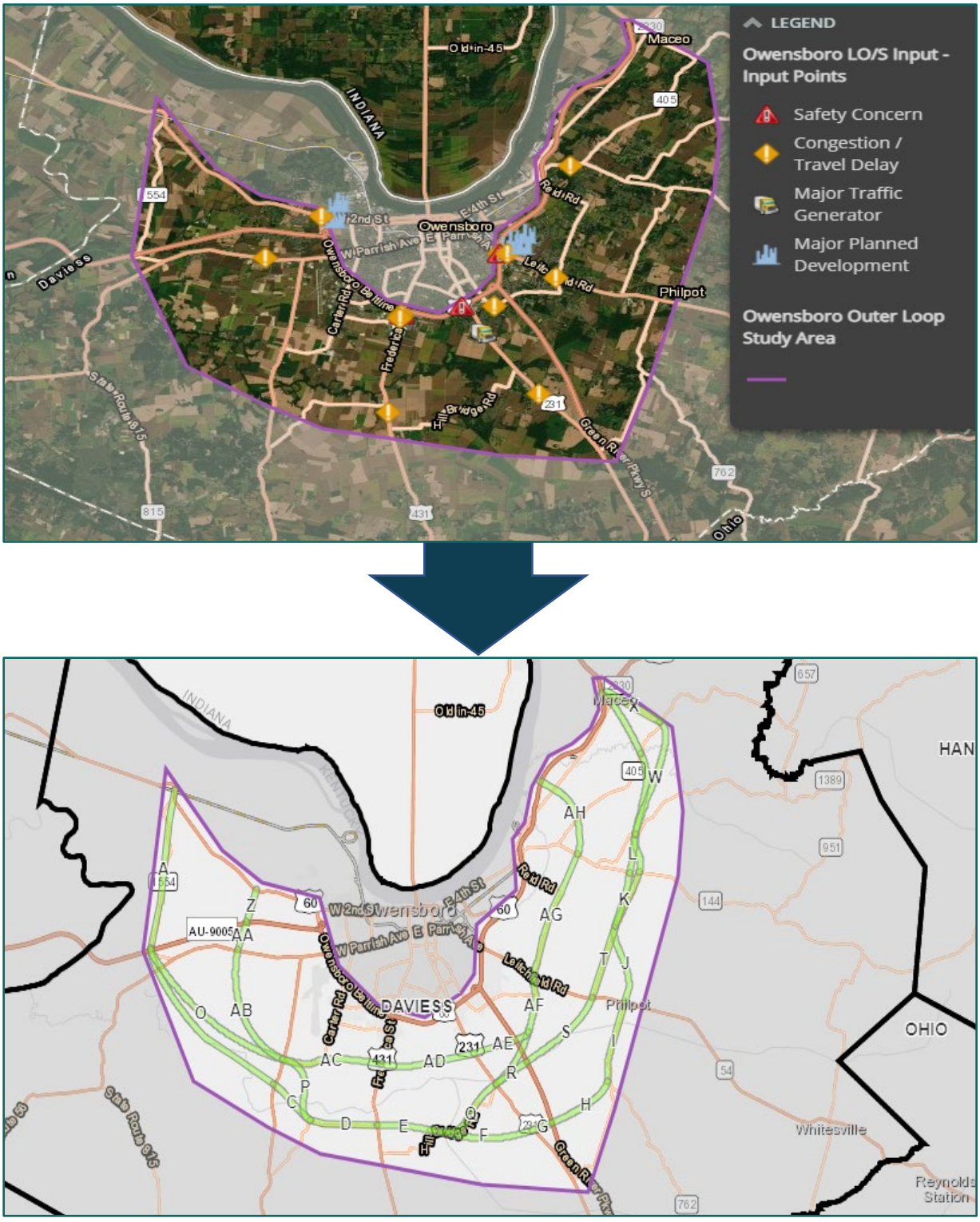
- Impacts to Natural Environment
- Impacts to Built Environment
- Effect on Safety
- Existing/Future Traffic Demand
- Utilization / Impact to Existing Roadways

Preliminary Corridor Analysis

Individual segments were evaluated through technical assessment and combined to provide a collection of segments that had the least impacts and most benefits to connectivity. The combined segments are shown as preliminary corridors for planning purposes only and should not be used as an indication of final alignments. The following preliminary corridors were analyzed as part of this study.

- No Build – no “Outer Loop” construction; routine maintenance and rehabilitation of existing infrastructure in study area.
- Green – At an approximate length of 35 miles, this is the longest of all corridors that provides full connectivity between US 60 east and west of Owensboro. It is the farthest option from / outside the city and is comprised of Segments A, B, C, D, E, F, G, H, I, J, K, L, W, and X. From the scoring perspective, this option is the lowest ranked outer corridor based on the comparative technical analysis.
- Red – At an approximate length of 22 miles, this is the shortest of all corridors that provides full connectivity between US 60 east and west of Owensboro. It is the closest option to the city and is comprised of Segments Z, AA, AB, AC, AD, AE, AF, AG, AH.

Figure ES-3. Segment Development and Analysis



- Blue – This corridor is a hybrid option of the Red and Green corridors and has an approximate length of 31 miles. It is comprised of Segments Z, AA, AB, P, D, E, F, G, H, I, J, K, L, W, and X. This corridor ranked the highest meaning it would have less impacts and more benefits compared to the other routes.

Figure ES-4 shows the preliminary corridors in the context of the study area. **Table ES-1** provides information about the corridors

Figure ES-4. Preliminary Corridors

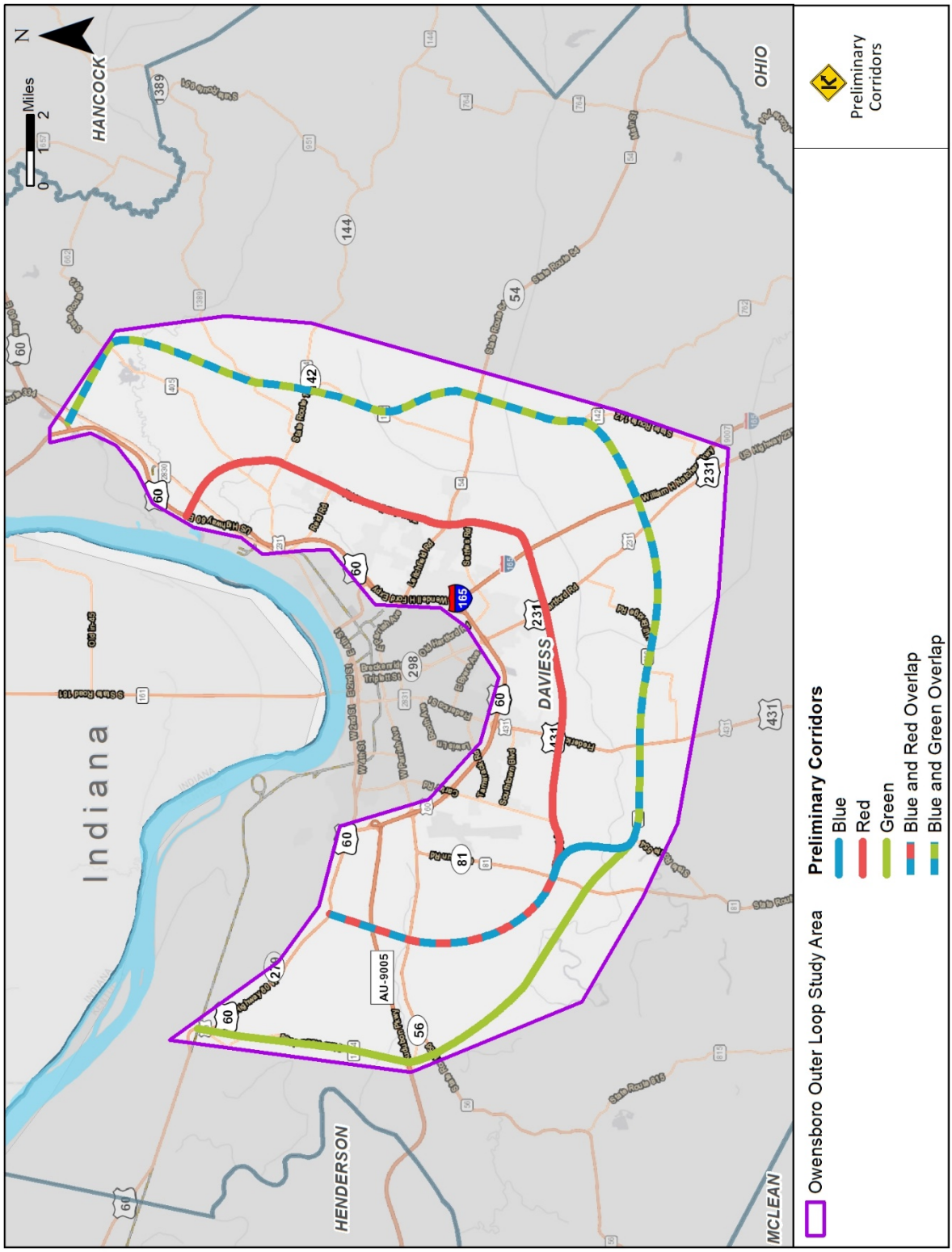


Table ES-1. Preliminary Corridor Summary

Summary Categories	No-Build	Red	Blue	Green
Length (Miles)	N/A	21.9	30.9	35.0
Traffic Volume Average (2045 AADT)	N/A	8,490	2,240	2,370
Public Input (Survey Only)*	1,532	380	136	190
Cost (Design, ROW, Utilities, and Construction)**	N/A	$227,800,000	$330,800,000	$365,000,000
Benefit-Cost Analysis***	N/A	0.35	0.09	0.04

Notes:

**These are DRAFT 2021 planning level costs subject to further review assuming an access-controlled facility with four 12' Lanes; two 10' Shoulders, 12' Ditches, 40'Median, and 34' Clear Zone. Costs will decrease as the typical section footprint decreases.

Study Outcomes

The Project Team met on July 20, 2021, to review the input received during the public comment period that closed on July 2, 2021. The response from the public was considerable, with 2,439 surveys completed, numerous Facebook and Twitter comments, and several emails received – all of which were considered by the Project Team. The benefit-cost analysis for the preliminary corridors was found to be less than one for all potential corridors. **The Project Team concluded that based on the current conditions, traffic projections, engineering analysis, and public feedback - an outer loop connection is not feasible at this time.**

The Project Team also further evaluated three short segments and one combination of segments that could potentially be independent projects with consideration to go into the CHAF Database. The benefit-cost analysis prepared for these segments showed Segment G (US 231 to I-165) to have a significantly higher benefit-cost value (9.3) compared to the other segments (all less than or equal to one). As a result, Segment G could potentially be considered as part of a future potential interchange along I-165 and an associated new connection to US 231.

Table of Contents

List of Figures

List of Tables

Appendices

Chapter 1 – Introduction

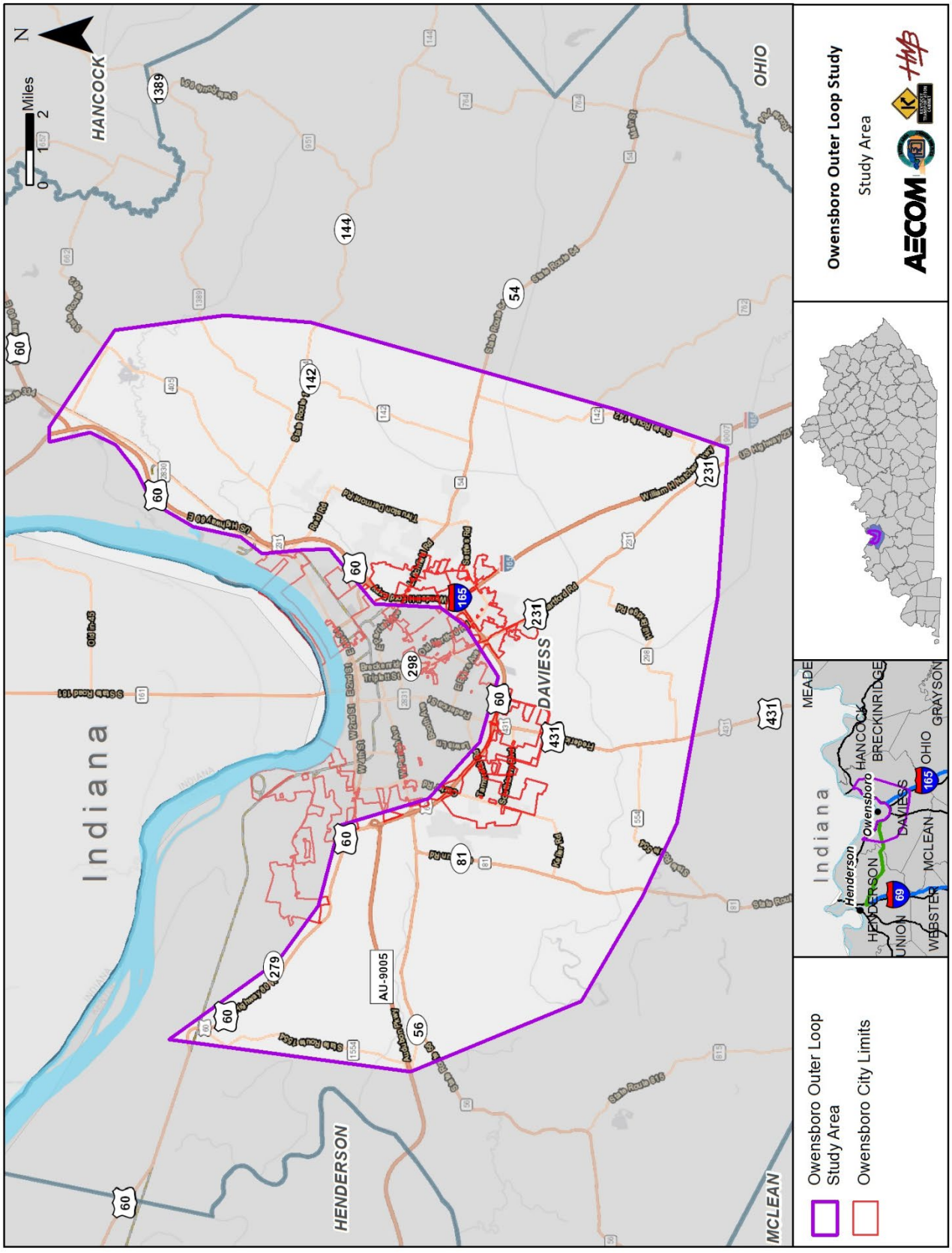
The Owensboro Outer Loop Feasibility Study was initiated in April 2020 by the Kentucky Transportation Cabinet (KYTC) to evaluate the feasibility of an "outer loop" around Owensboro in Daviess County, Kentucky. As part of the study, options for connectivity were identified and evaluated in terms of benefit versus cost to determine what connections, if any, would enhance the transportation network around Owensboro.

The study was conducted in coordination with KYTC, the Owensboro-Daviess County Metropolitan Planning Organization (MPO) and the Green River Area Development District (GRADD). These entities along with the consultant team made up the Project Team for this study.

1.1 Study Area

Illustrated in **Figure 1**, the study area encompasses the surrounding area of Owensboro in Daviess County, Kentucky. This includes US 60 from the intersection with US 231 in the east to the intersection with KY 1554 in the west. It extends into the county south to the area where I-165 intersects with KY 142. All state-maintained routes within this boundary were included for consideration of this study.

Figure 1. Study Area



1.2 Study Process

The process of this study is described in detail in the following nine chapters and generally follows a chronological order of activities. Additional resource / reference materials are included in the appendices.

Chapter 1 - Introduction

The first chapter provides background introductory information about the study and provides the framework for the remainder of the report.

Chapter 2 - Existing Conditions

The second chapter encompasses collected data including geometrics, structures, bicycle and pedestrian accommodations, transit, existing traffic volumes and operations, and safety analysis.

Chapter 3 – Environmental Overview

This chapter is devoted to a summary of the natural, human, and socioeconomic impacts within the study area.

Chapter 4 - Initial Engagement Efforts

This chapter is devoted to a summary of initial outreach efforts which includes coordination with the Project Team and a meeting with local officials / stakeholders.

Chapter 5 – Potential Connectivity Development and Analysis

Chapter five presents the process by which potential segments and preliminary corridors were developed. It also includes a discussion on analysis procedures, using the No Build as a baseline for comparison.

Chapter 6 – Potential Connectivity Refinement

In this chapter, additional information is presented to help further examine potential segments / corridors for connectivity to help determine what (if anything) is warranted. This includes more in-depth traffic and safety analysis and the development of planning-level cost estimates.

Chapter 7 - Additional Engagement Efforts

Chapter seven focuses on input from the Project Team, local officials / stakeholders and the public on the range of potential segments / corridors.

Chapter 8 – Benefit-Cost Analysis

To help with comparisons between potential segments and corridors and determine relative (if any) benefits associated with them, this chapter presents a planning-level Benefit-Cost Analysis.

Chapter 9 - Study Outcomes

The final chapter presents the outcomes of the study. This includes discussion of any feasible segments / corridors as determined by the technical information, public outreach efforts, and benefit-cost analysis compared to the No Build scenario.

1.3 Study Objective and Goals

The objective of the Owensboro Outer Loop Study is to evaluate the need for and feasibility of an "outer loop" around Owensboro in Daviess County, Kentucky. As part of the study, options for connectivity were identified and evaluated with a benefit-cost analysis completed for the most feasible corridors. To help accomplish this objective, study goals included the following:

- Quantify Existing Needs in the Study Area
- Develop / Evaluate Feasibility of a Range of Connectivity Options
- Consider Independent Utility of Segments from a Benefit-Cost Analysis

The timeline of key tasks and milestones for achieving these objectives and goals is as follows in **Figure 2**. Dates on a blue background indicate technical study tasks. Dates on a gold / yellow background indicate coordination study tasks.

Figure 2. Study Schedule

April 2020	Study Initialized
May – Oct. 2020	Scoping / Data Gathering / Existing Conditions Analysis
August 2020	Travel Demand Model Meeting
November 2020	Project Team Meeting No. 1 / Traffic Forecasting
December 2020	LO/S Meeting No. 1 / Segment Development
February 2021	Environmental Analysis / Segment Analysis
March 2021	Project Team Meeting No. 2
April 2021	Develop Feasible Corridors / Refine Corridors
May 2021	LO/S Meeting No. 2 / Public Outreach
June 2021	Project Team Meeting No. 3
August 2021	Prepare Draft Report
Sept. - Nov. 2021	Address Comments / Finalize Report

1.4 Previous Studies, and Identified and Highway Plan Projects

Previously completed studies, locally identified projects, and projects listed in *Kentucky's Highway Plan* were identified in the study area that could impact future new or upgraded transportation connections.

Previous Studies

There are several planning studies that have been performed recently that overlap the study area including the following:

- *2012 Master Plan, City of Owensboro and Daviess County Combined Parks and Recreation*[1] – This study was commissioned by the city of Owensboro. The master plan examined and evaluated park operations and assets. Identification of existing and future needs related to recreation is useful to the Owensboro Outer Loop Feasibility Study for context on community assets and transportation linkages.

- *2018 Owensboro-Daviess County Metropolitan Planning Organization Bike/Pedestrian Master Plan*[2] – Commissioned by Owensboro and Daviess County, due to the recent trends of national bicycle sales. The objective of the study was to examine the potential for creating a bicycle network throughout the county. ArcGIS files for existing and proposed additions were obtained and incorporated into the Owensboro Outer Loop Feasibility Study as a resource for evaluating future transportation connections.

- *2018 Comprehensive Plan for Owensboro, Whitesville, Daviess County*[3] – Commissioned by the Owensboro Metropolitan Planning Office, this plan is a requirement for local government by Kentucky Revised Statutes, Chapter 100, to apply land use regulations. It encourages a local community to devise a vision of its future and apply land use regulations as tools to implement that vision. Within the document is a section devoted to the existing transportation system and plans for improving the function of major roadways. Projects are referenced back to the 2015 Transportation Improvement Program (TIP). Other recommendations from this document include:
  - *Reservation of right-of-way to facilitate the implementation of planned roadway improvements.*
  - *Controls on the spacing of street intersections and driveway entrances as the primary way of maintaining the highest possible levels of transportation service and safety.*

- *2019-2024 Owensboro-Daviess County Metropolitan Planning Organization Transportation Improvement Program (TIP)*[4] – Prepared by the Owensboro-Daviess County MPO, this transportation process plan is required by the Federal Highway Act of 1962 for all urbanized areas of 50,000 people or more. The TIP is generated in coordination with KYTC's data-driven process to prioritize projects called Strategic Highway Investment Formula for Tomorrow (SHIFT). Projects identified in the TIP were compared with those identified in the Continuous Highway Analysis Framework (CHAF) database and the Kentucky Highway Plan.

[1] ParksMasterPlan-2002-02-Entire.pdf (iompc.org)
[2] 2018_bike_ped_plan.pdf (gradd.com)
[3] Manual (iompc.org)
[4] FY-2019-2024-TIP-FINAL.pdf (daviessky.org)

Identified and Highway Plan Projects

Identified projects are transportation projects that have been identified from a variety of sources and have been entered in the CHAF database. The database provides a means to track and analyze projects as well as a way to sponsor, score, and rank projects as part of the SHIFT prioritization process. Other sources for identified projects can come from regional transportation plans such as the 2019 – 2024 Owensboro-Daviess County MPO TIP.

Highway Plan projects are those that have been prioritized through SHIFT and have been included in Kentucky's Highway Plan. During this study, a new highway plan was proposed and enacted. Therefore, Highway Plan projects were identified from both *Kentucky's FY 2018 – 2024* and *FY 2020 – 2026 Highway Plan*. **Figure 3** and **Figure 4** summarize color-coded identified and Highway Plan projects. Due to the size of the study area and number of identified projects, only the sponsored projects are shown on the map. A sponsored project is a project that has been selected by the ADD or Highway District to be scored in SHIFT. **Tables 1** and **2** contain all sponsored and unsponsored identified projects in the study area.

Figure 3. 2020 Sponsored Identified Projects

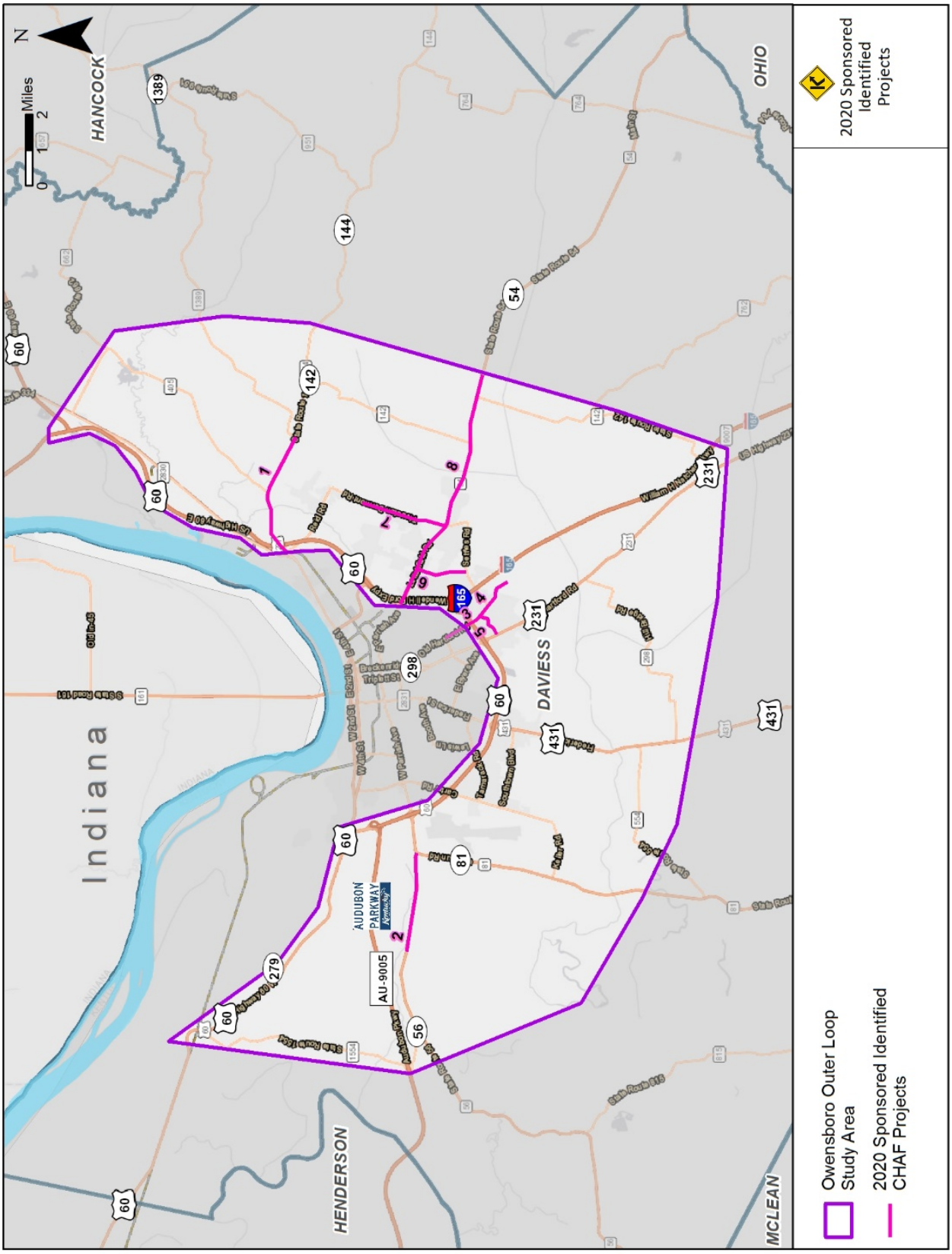


Figure 4. Highway Plan Projects

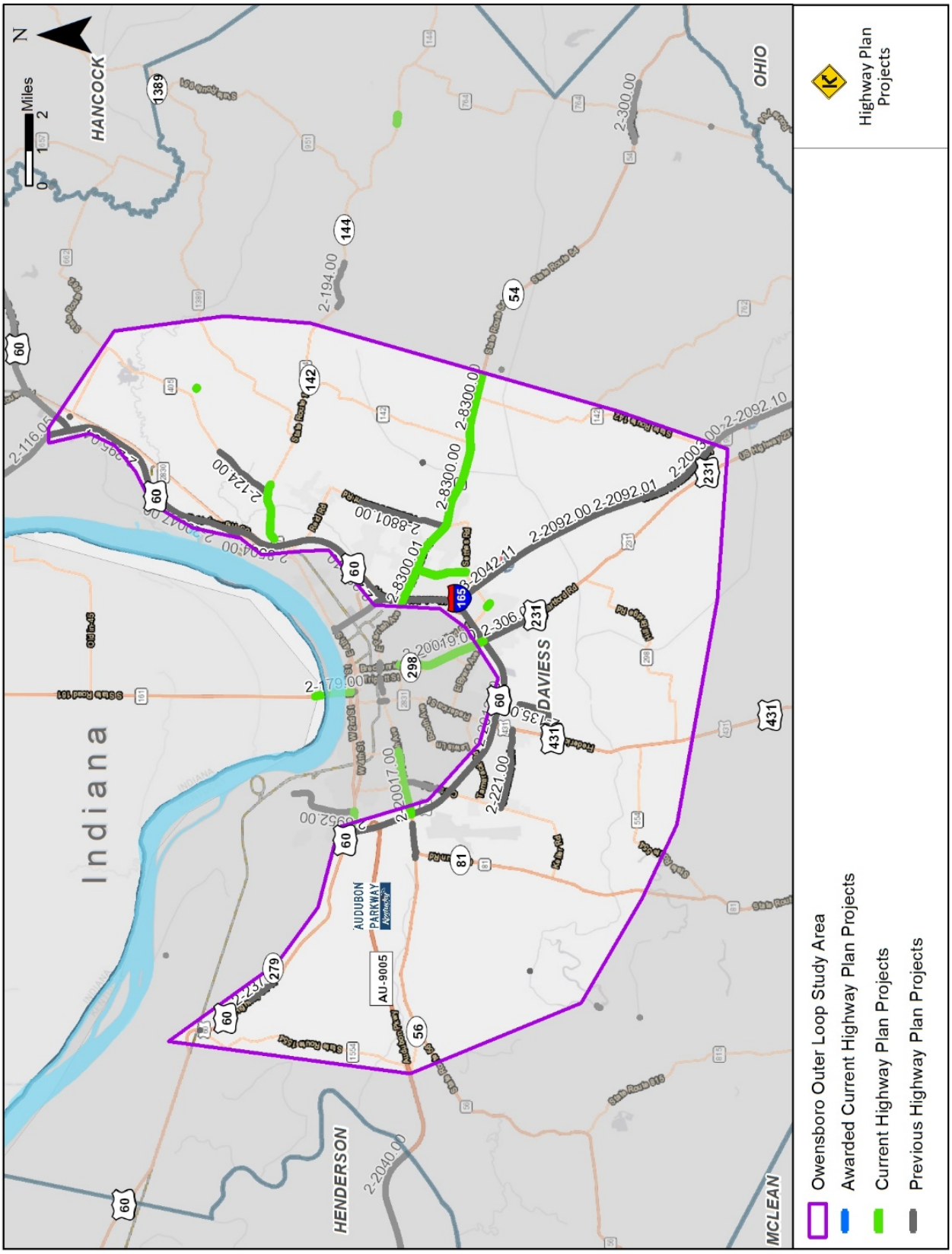


Table 1. 2020 Sponsored Identified Projects

Map ID	ADD/MPO	Project Type	CHAF ID	Item #	Sponsor	Description	Main Route	Begin Mile Point	End Mile Point	Length	Work Type	Improvement Type	2020 SHIFT Score	Total / Estimate
1	Owensboro	CHAF	IP20050032	-	2	KY 144 - Reconstruct to provide 12 foot driving lanes and turn lanes where needed. Project begins near US 60 interchange at Reid Rd (KY 1456) and ends at Jones Rd (KY 1389).	KY 144	2.090	4.966	2.876	Reconstruction	Modernize Roadway - Rural	36.5	$18,125,000
2	Owensboro	CHAF	IP20080056	-	2	KY 56 - Improve traffic flow and safety. Projects begins at KY 279 South and ends at KY 81.	KY 56	11.863	14.088	2.225	Reconstruction	Other Improvement Types	38.0	$12,058,000
3	Owensboro	CHAF	IP20080063	-	Owensboro MPO	Old Hartford Rd - Widen to improve traffic flow and safety. Project begins at Harriet Ln (CR 1120H) and ends at Burlew Blvd (KY 1432).	KY 298	7.042	8.986	1.944	Minor Widening	Modernize Roadway - Rural	34.7	$20,579,000
4	Owensboro	CHAF	IP20080064	2-229	2	Reconstruct Intersection at Fairview Drive (KY 3143) and KY 298. (12CCR) (16CCR) (18CCN)	KY 298	7.700	7.800	0.100	Reconstruction	Improve Intersection	17.0	$3,930,000
5	Owensboro	CHAF	IP20080068	-	Owensboro MPO	Southeastern Pkwy - Reconstruct to address safety, add curb/gutter, install sidewalks, realign the curves, and install turn lanes where needed. Project begins at New Hartford Rd (US 231) and ends at Old Hartford Rd (KY 298).	KY 2117	0.000	0.610	0.610	Minor Widening	Modernize Roadway – Rural	37.0	$5,623,000
6	Owensboro	CHAF	IP20150271	2-8854	2	Improve KY 3143 from KY 3335 to KY 54 (14CCN)	KY 3143	1.829	2.958	1.129	Major Widening	Install Two-way Left Turn Lane	64.5	$16,625,000
7	Owensboro	CHAF	IP20150313	2-8801	2	Address Substandard Roadway Geometrics and Safety Concerns on KY 1456 from KY 54 to Hayden Road. MP 2.778 to 4.714 (See 2-8709.00)(14CCN)(16CCR)	KY 1456	2.778	4.714	1.936	Reconstruction	Modernize Roadway - Rural	29.6	$15,950,000
8	Owensboro	CHAF	IP20150444	2-8300 / 2-8300.01	2	Improve KY 54 from west of the US 60 Bypass to CR 1021 (Jack Hinton Road) (06CCN)(10CCR)(14CCR)(16CCR)	KY 54	2.470	8.003	5.533	Major Widening	Arterial to Partial Control	85.5	$60,350,000

Table 2. Unsponsored Identified Projects

ADD/MPO	Project Type	CHAF ID	Item #	Description	Main Route	Begin Mile Point	End Mile Point	Length	Work Type	Improvement Type	2020 SHIFT Score	Total / Estimate
Owensboro	CHAF	IP20050033	-	Fairview Drive - Extend from existing section to Pleasant Valley Road near Hayden Road. Project begins at Calumet Trace (CR 1507A) and ends at Pleasant Valley Road (CR 1013).	CR 1507L	0.506	0.582	0.076	New Route	Local Roadway Improvements	Not Scored	$6,500,000
Owensboro	CHAF	IP20070054	-	US 231 - Address safety by widening and increasing the width of the shoulders. Project begins at South Burton Rd (CR 1188) and ends near the Owensboro Community College.	US 231	7.807	9.985	2.178	Reconstruction	Modernize Roadway-Rural	Not Scored	$16,600,000
Owensboro	CHAF	IP20070056	-	US 431 - Reconstruct to provide better traffic flow, provide better access, and improve safety. Project begins at Marksberry Rd (CR 1225) and ends near the Panther Creek Bridge.	US 431	5.798	8.588	2.790	Reconstruction	Modernize Roadway-Rural	Not Scored	$22,500,000
Owensboro	CHAF	IP20080053	-	US 60 - Improve traffic flow and safety. Project begins at KY 279 South and ends at KY 331.	US 60	6.580	10.179	3.599	Major Widening	Modernize Roadway-Rural	Not Scored	$18,400,000
Owensboro	CHAF	IP20080054	-	US 431 - Improve to provide better traffic flow, provide better access, and improve safety. Project begins near the Panther Creek Bridge and ends near Martin Luther King Jr. Blvd.	US 431	8.543	10.143	1.600	Major Widening	Other Improvement Types	Not Scored	$12,000,000
Owensboro	CHAF	IP20080058	-	KY 81 - Improve KY 81 leading toward Owensboro to enhance development and better accommodate future traffic growth. Project begins at Keller Rd (CR 1301) and ends at KY 56.	KY 81	7.959	11.036	3.077	Major Widening	Modernize Roadway-Rural	Not Scored	$14,600,000
Owensboro	CHAF	IP20080060	-	KY 144 - Reconstruct to improve traffic flow and safety. Project begins at Jones Rd (KY 1389) and ends at Knottsville-Mt. Zion Rd (KY 1831).	KY 144	4.966	7.624	2.658	Reconstruction	Modernize Roadway-Rural	Not Scored	$12,100,000
Owensboro	CHAF	IP20080066	-	KY 405 - Reconstruct to include shoulders and 12 foot driving lanes. Project begins at KY 144 and ends at KY 2830.	KY 405	0.000	6.729	6.729	Reconstruction	Modernize Roadway-Rural	Not Scored	$30,500,000
Owensboro	CHAF	IP20080067	-	Address substandard roadway geometrics and safety concerns on KY 1456 near Hayden Rd (MP 4.71) to KY 144 (MP 7.30).	KY 1456	4.714	7.301	2.587	Reconstruction	Modernize Roadway-Rural	Not Scored	$11,300,000
Owensboro	CHAF	IP20080069	-	Goetz Drive - Extend to Martin Luther King Loop West and provide 12 foot lanes and turn lanes were needed. Project begins at Southtown Blvd (KY 2121) and ends at Martin Luther King Jr Loop (CS 1783).	PR 1072	0.000	0.133	0.133	New Route	Modernize Roadway-Rural	Not Scored	$3,400,000

Chapter 2 – Existing Conditions

In this chapter, the existing transportation network conditions are presented. This includes information on roadway facility types and geometrics, structures, traffic volumes and operations, crash history and analysis, and bicycle and pedestrian accommodations. Data for this chapter was collected from KYTC's Highway Information System (HIS) database, City of Owensboro Geographic Information System (GIS) mapping, bridge inspection reports, National Bridge Inventory forms, the KYTC Traffic Count Reporting System, and site visits.

Consideration of transit systems and opportunities is another area of consideration for studies. Most of the study area does not have designated or fixed transit routes currently. The majority of the study area is designated as rural with low potential of transit usage. In the downtown area, the Owensboro Transit System operates.

2.1 Functional Class and Roadway Systems

Functional Class

Functional classification[5] is the process of grouping streets and highways by character of travel service and access to adjacent land uses. All public roadways, including those maintained by non-state agencies, are assigned one of the following functional classifications:

Interstates – Roadways that comprise the Dwight D. Eisenhower National System of Interstate and Defense Highways and other Interstates as designated by the Secretary of Transportation.

Other Freeways and Expressways – Non-Interstate roadways with access points limited to on-ramp and off-ramp locations and directional travel lanes usually separated by a physical barrier.

Other Principal Arterials – Roadways that provide a high level of traffic mobility for substantial statewide travel and / or serve major activity centers and the longest trip demands within urban areas.

Minor Arterials – Roadways that serve trips of moderate length to smaller geographic areas and at a slightly lower level of traffic mobility than Principal Arterials.

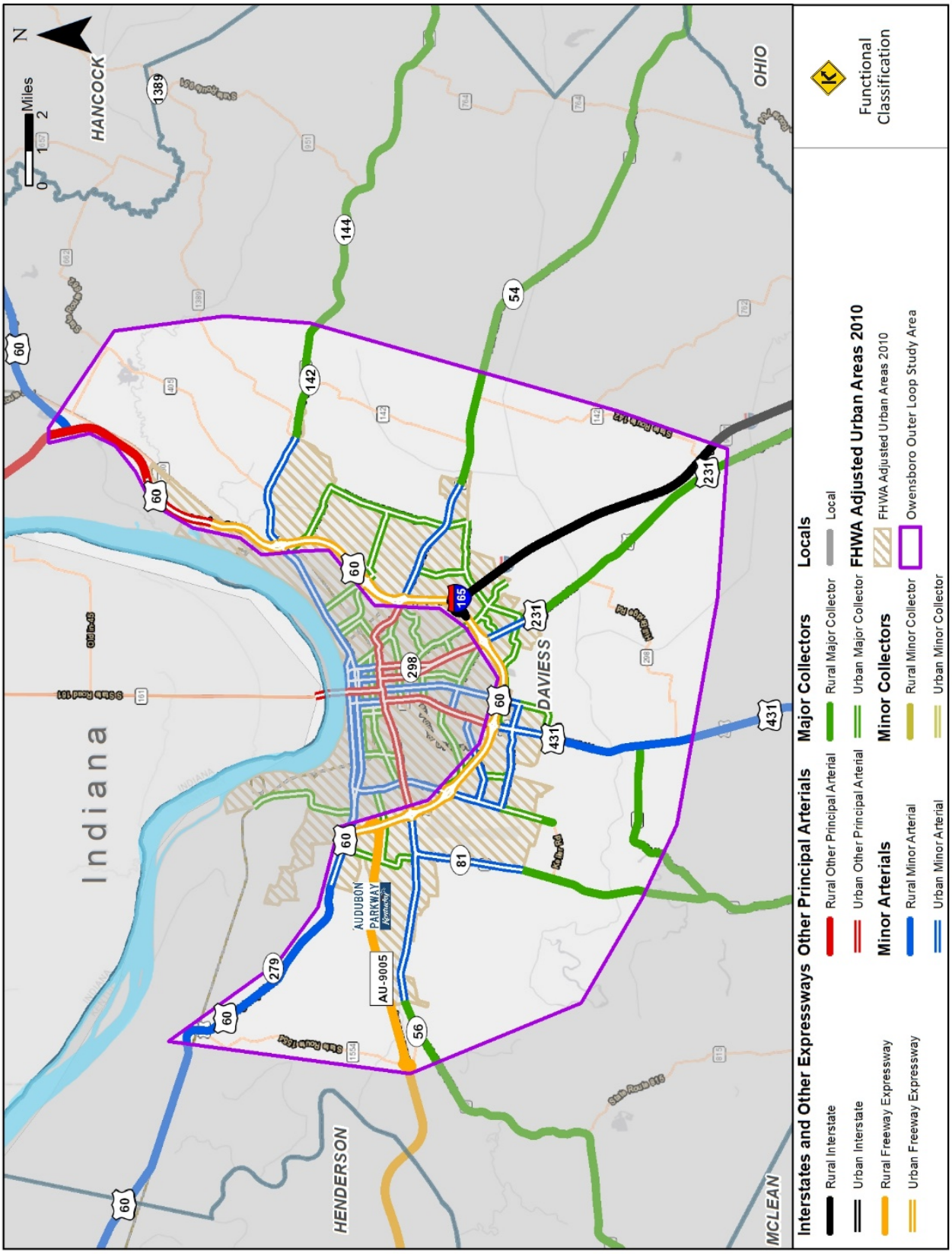
Major Collectors – Roadways that distribute and channel trips between the lower roadway classifications and the arterial systems.

Minor Collectors – Roadways that distribute and channel trips between Local Roads and the higher classifications at a lower level of traffic mobility.

Local Roads – Roadways that primarily provide direct access to adjacent land and are not intended for use in long distance travel.

[5] https://transportation.ky.gov/Planning/Pages/Functional-Classification.aspx

Figure 5. Functional Classification



National Highway System

The National Highway System (NHS) is a network of strategic highways within the United States including the Interstate Highway System and other roads serving major airports, ports, military bases, rail or truck terminals, railway stations, pipeline terminals and other strategic transport facilities. Within the study area, US 60, the Audubon Parkway, and I-165 are included in the NHS as depicted in **Figure 6**. As such, they fall under the monitoring and performance for the Federal Highway System (FHWA) Practices for Performance-Based Planning and Programming. Improvement concepts that are identified as part of this study should consider the impact on Kentucky's performance measures as these are reported to FHWA.

Freight

There are multiple important links in the Kentucky Highway Freight Network (KHFH). The freight network (as shown in **Figure 7**) includes three Tier 2 routes (US 60 east from the intersection with KY 331, the Audubon Parkway and I-165). This designation means it is part of the Kentucky Primary Highway Freight Network (PHFN) and has a truck AADT (AADTT) > 7,000. US 60, the Audubon Parkway and I-165 are also federal authorized route on the National Truck Network (NN). The NN was created by the federal Surface Transportation Assistance Act of 1982 (STAA) to require states to allow conventional combination trucks on the designated system serving to support interstate commerce connecting principal cities and densely developed areas.

Major Employers

The locations of major employers (those with over 100 employees) were identified since they usually contribute to this truck traffic. These are displayed along with the freight network on **Figure 7**.

Figure 6. National Highway System

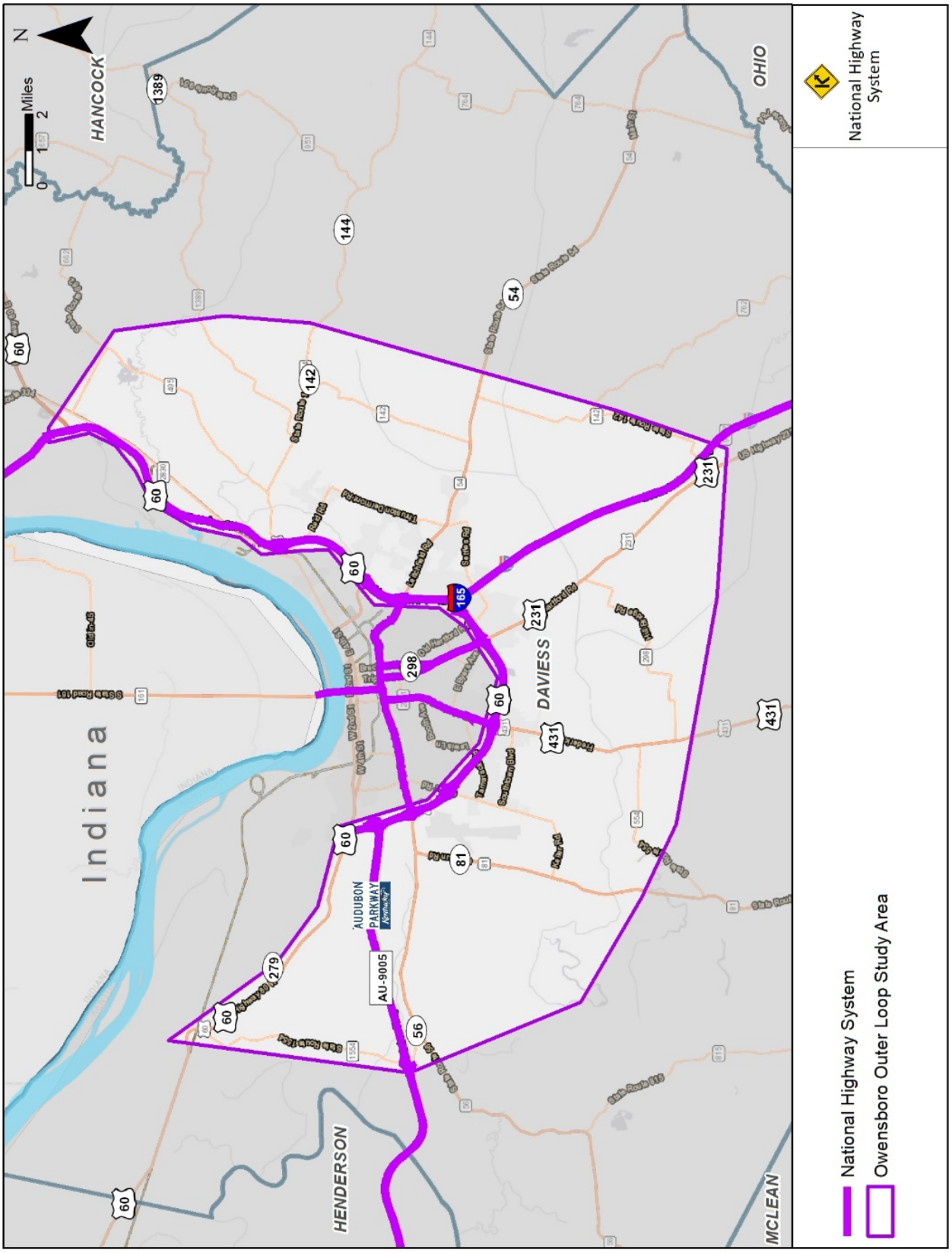
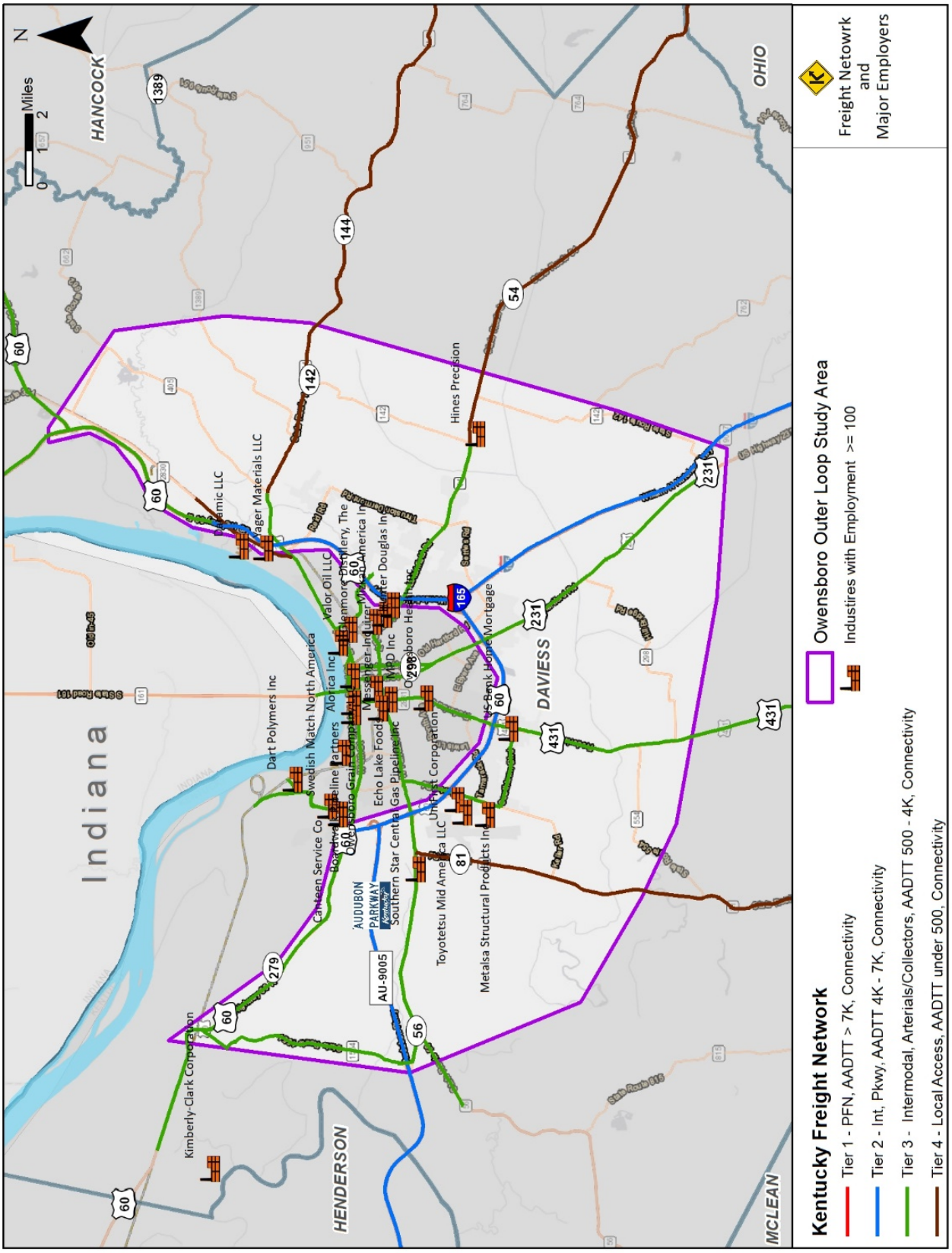


Figure 7. Freight Network and Major Employers



2.2 Roadway Geometric Characteristics

Current geometric characteristics of roadways within the study area were identified through HIS queries and compared with roadway design standards and common practices as set forth in AASHTO's *A Policy on Geometric Design of Highways and Streets, 7th Edition (2018).* Highway data assembled from HIS for use in this study included typical sections, speed limits, and horizontal and vertical curves.

Typical Sections

The typical section of roadways varies throughout the study area. The study area includes roadways ranging from one to five lanes, and lane widths ranging from eight to fourteen feet. Similarly, shoulder types and widths, median types and widths, and presence of auxiliary lanes such as left and right turn lanes vary throughout the study area. In the rural portions of the study area, traffic volumes tend to be lower and there is less pavement width. As traffic volumes increase in the urban areas, number of lanes and lane widths tend to increase in size. Connections to downtown such as US 431 (Frederica Street), KY 54, and US 231 (Old Hartford Road), and other regional connectors such as the Audubon Parkway and I-165 have larger footprint typical sections due to their higher traffic usage. Number of lanes and lane widths are shown on **Figure 8** and roadway shoulder widths are shown on **Figure 9.**

Speed Limits

The posted speed limit on roadways in the study area varies from 25 mph on the local routes to 70 mph on the interstate. Most of the major roadways in the study area are signed 55 mph, reducing to lower speed limits as they get closer to the city center of Owensboro. **Figure 10** depicts the range of speed limits within the study area for state-maintained routes.

Horizontal and Vertical Curves

KYTC HIS information was utilized to obtain the horizontal and vertical curve classes of roadways in the study area. As shown in **Figure 11**, significant instances of higher degree horizontal curves occur on KY 298 (Old Hartford Road), KY 1456 (Thurston Dermont Road), KY 142, and KY 1554. **Figure 12** shows vertical curve grade classes. Due to the terrain, the mostly flat western portion of the study area contains relatively flat vertical roadway grades that increase as the roadways move towards the eastern portion of the study area. The vertical grades are especially high on KY 1456 (Thurston Dermont Road) and KY 3143.

Figure 8. Number of Lanes and Lane Widths

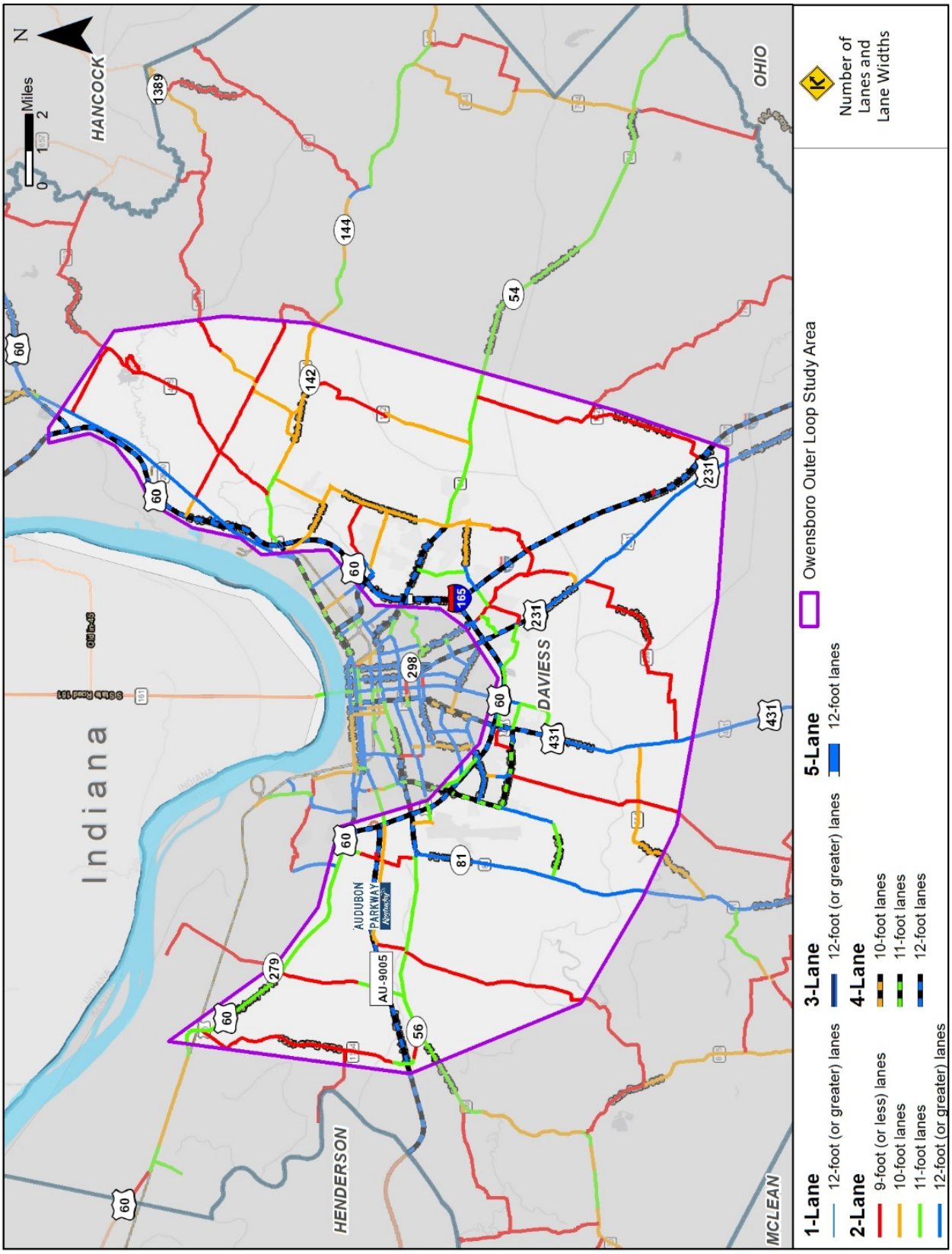


Figure 9. Shoulder Widths

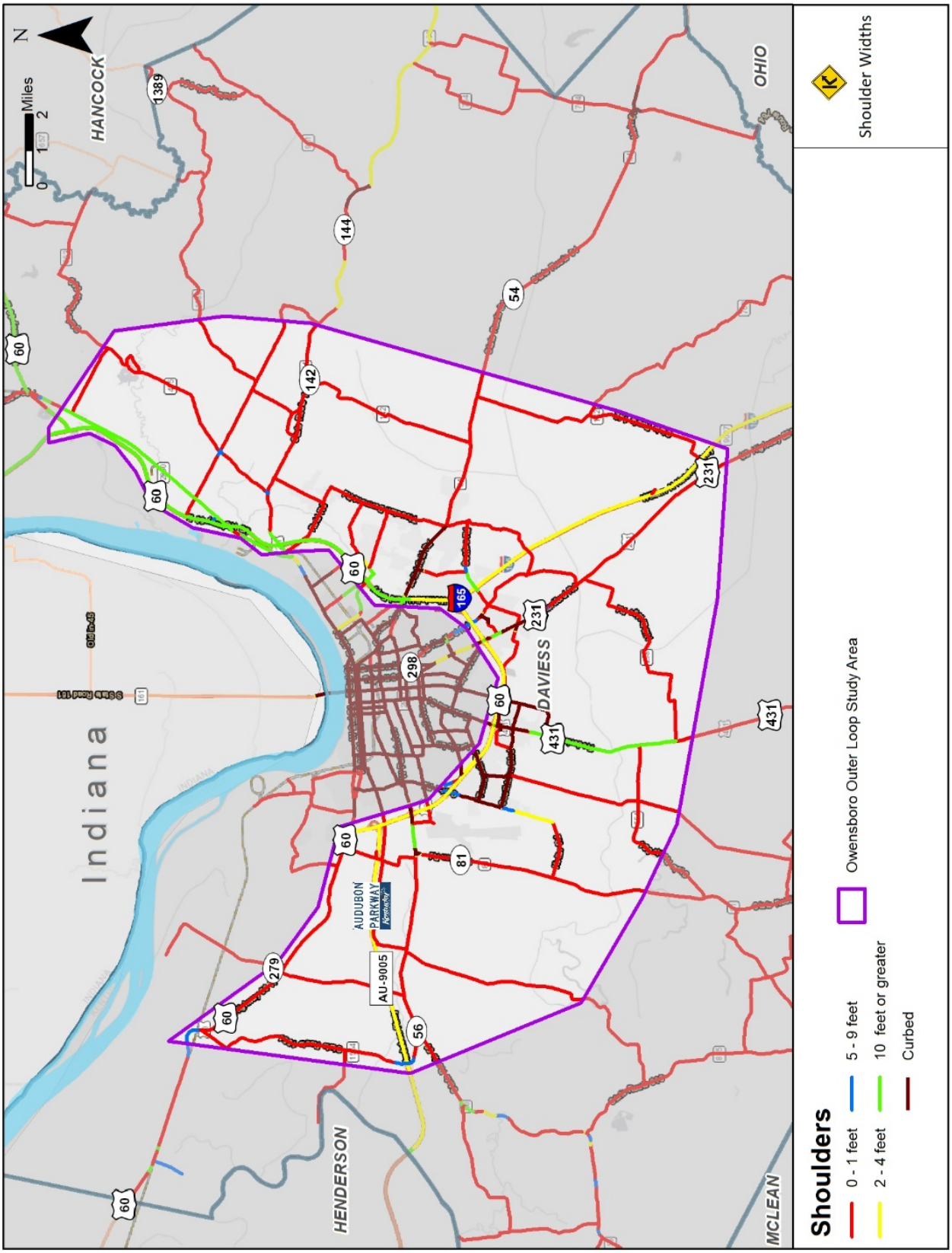


Figure 10. Study Route Speed Limits

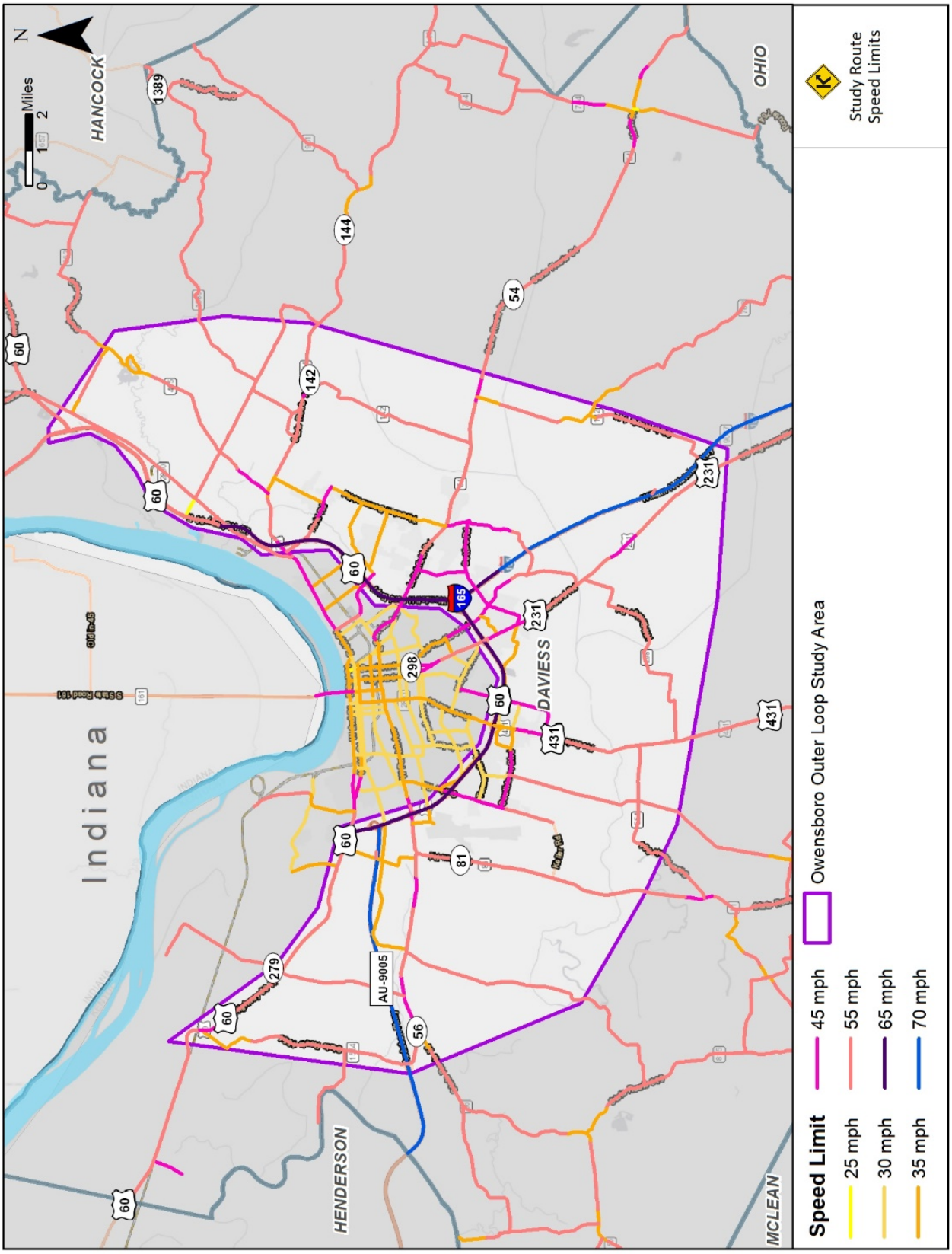


Figure 11. Horizontal Alignment Elements

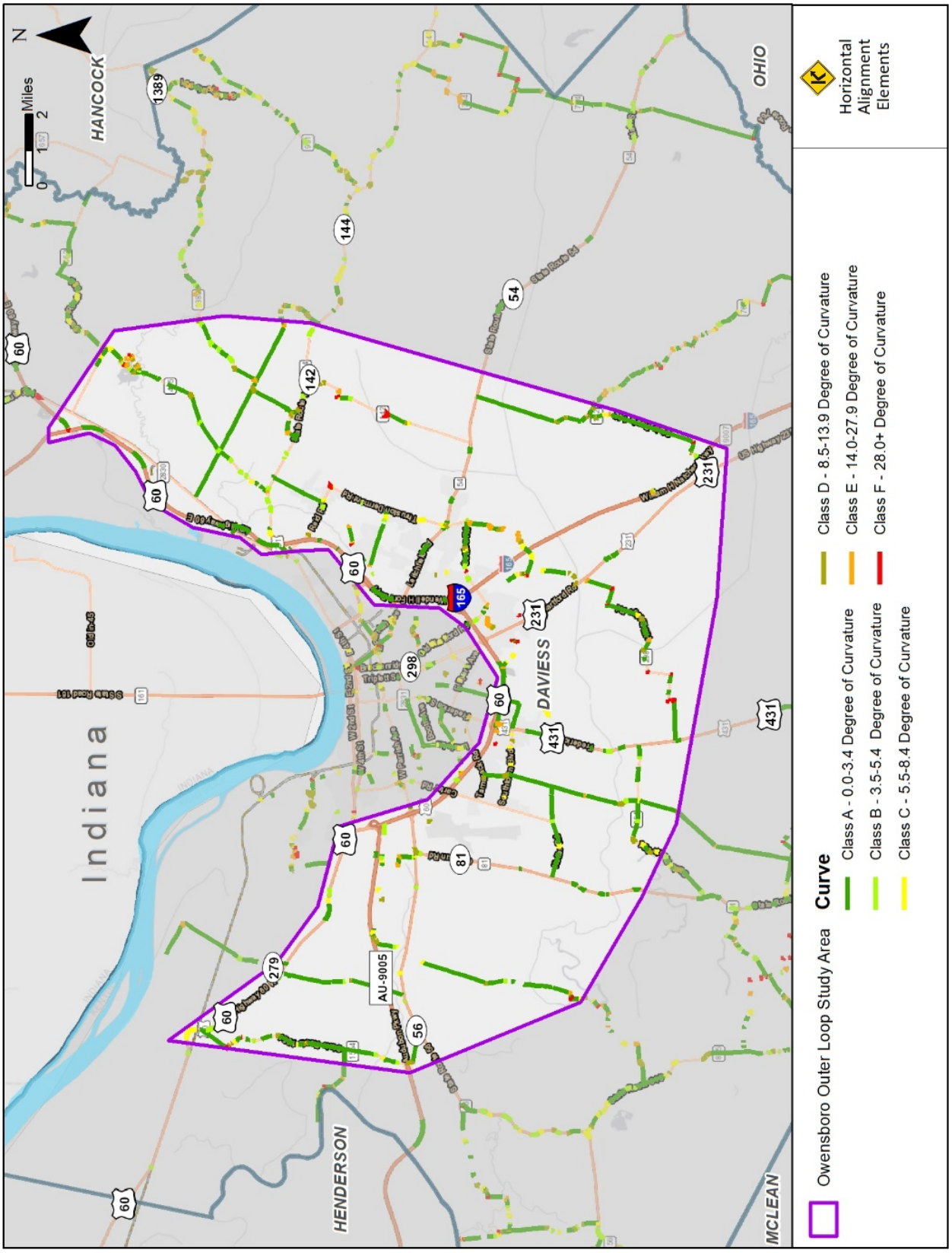
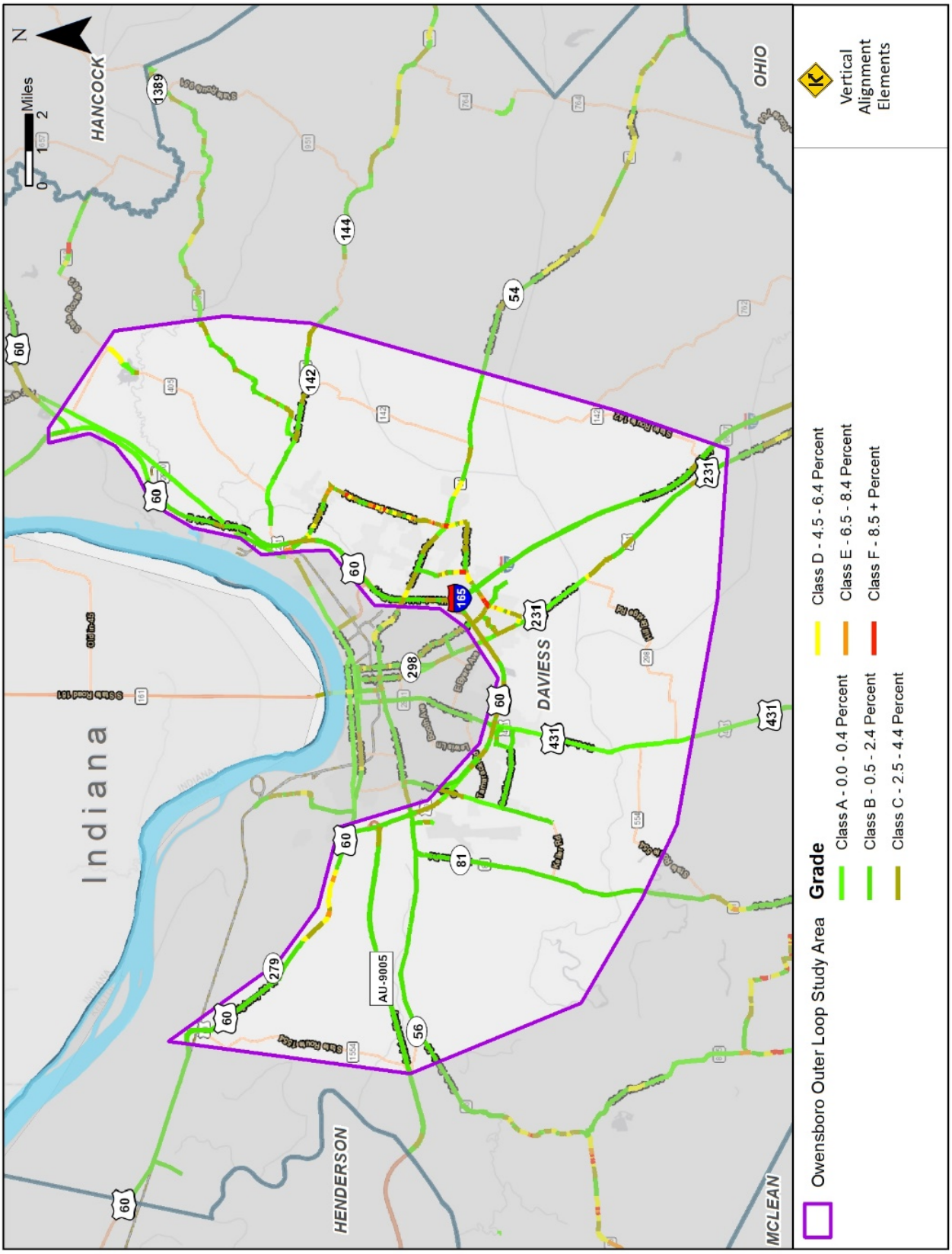


Figure 12. Vertical Alignment Elements



2.3 Structures

There were 125 structures identified through KYTC's Bridge Data Miner service that can be seen in **Figure 13** with more detailed information in **Appendix A.** KYTC uses the FHWA National Bridge Inventory (NBI) condition rating scale which includes classifications of Good, Fair, and Poor. These terms are defined in accordance with the FHWA's Pavement and Bridge Condition Performance Measures final rule, published in January of 2017. Bridge Condition is determined by the lowest rating of NBI condition ratings for Item 58 (Deck), Item 59 (Superstructure), Item 60 (Substructure), or Item 62 (Culvert). If the lowest rating is greater than or equal to 7, the bridge is classified as Good; if it is less than or equal to 4, the classification is Poor. Bridges rated 5 or 6 are classified as Fair.

There were three structures identified with a Poor rating within the study area. One is along US 60 in the western portion of the study area over Katie Meadow Slough. The other two are in the eastern portion of the study area with one being along Graves Lane over Allgood Ditch, and the other being along South Hampton Road over Burnett Fork. It should be noted that there are numerous additional structures as identified through mapping provided by the Owensboro Daviess County GIS Consortium, however, they are not NBI rated and have no rating assigned. Therefore, for this high-level study area review, only the rated structures are identified.

2.4 Existing Traffic Volumes and Operational Analysis

Existing year (2020) traffic volumes for KYTC maintained roadways are based on the most recent KYTC count stations. The count years range from 2014 – 2020. Year 2020 volumes were calculated from these counts, applying a growth factor based on historic trends and the Owensboro MPO Regional Travel Demand Model. The range of average annual daily traffic (AADT) for 2020 is shown on **Figure 14**. Additional information is provided in the Traffic Forecast Report (**Appendix B**).

A level of service (LOS) analysis was performed for the study area roadways by using a large-scale operations analysis. LOS is a qualitative measure of determining the operational characteristics of a roadway facility. It is used to define the quality of traffic operations based on measures such as vehicle speed, travel time, comfort and convenience, maneuverability, congestion, and delay. There are six levels of service for each type of facility. The levels are designated by letters, from A to F, with LOS A representing the best operating conditions and LOS F the worst. Acceptable operations for roadways in rural areas are LOS C or better, and in urban areas LOS D or better. **Figure 15** presents a graphical depiction of LOS for reference.

A methodology previously applied to KYTC studies was employed based on a combination of methods from the Highway Capacity Manual - Sixth Edition (HCM6) and a spreadsheet-based method developed by the Florida Department of Transportation in 2018 that relies upon average daily traffic, functional classification, number of lanes, and median type to determine an estimated level of service. Two sections were identified with a LOS E or F rating. The portion of US 60 from US 431 (Frederica Street) to KY 54 (Leitchfield Road) is calculated to operate below the acceptable threshold at LOS F, along with a small portion of KY 54 (Leitchfield Road) near US 60 at LOS E. The existing (2020) LOS results are presented in **Figure 16.**

Figure 13. Existing Structures

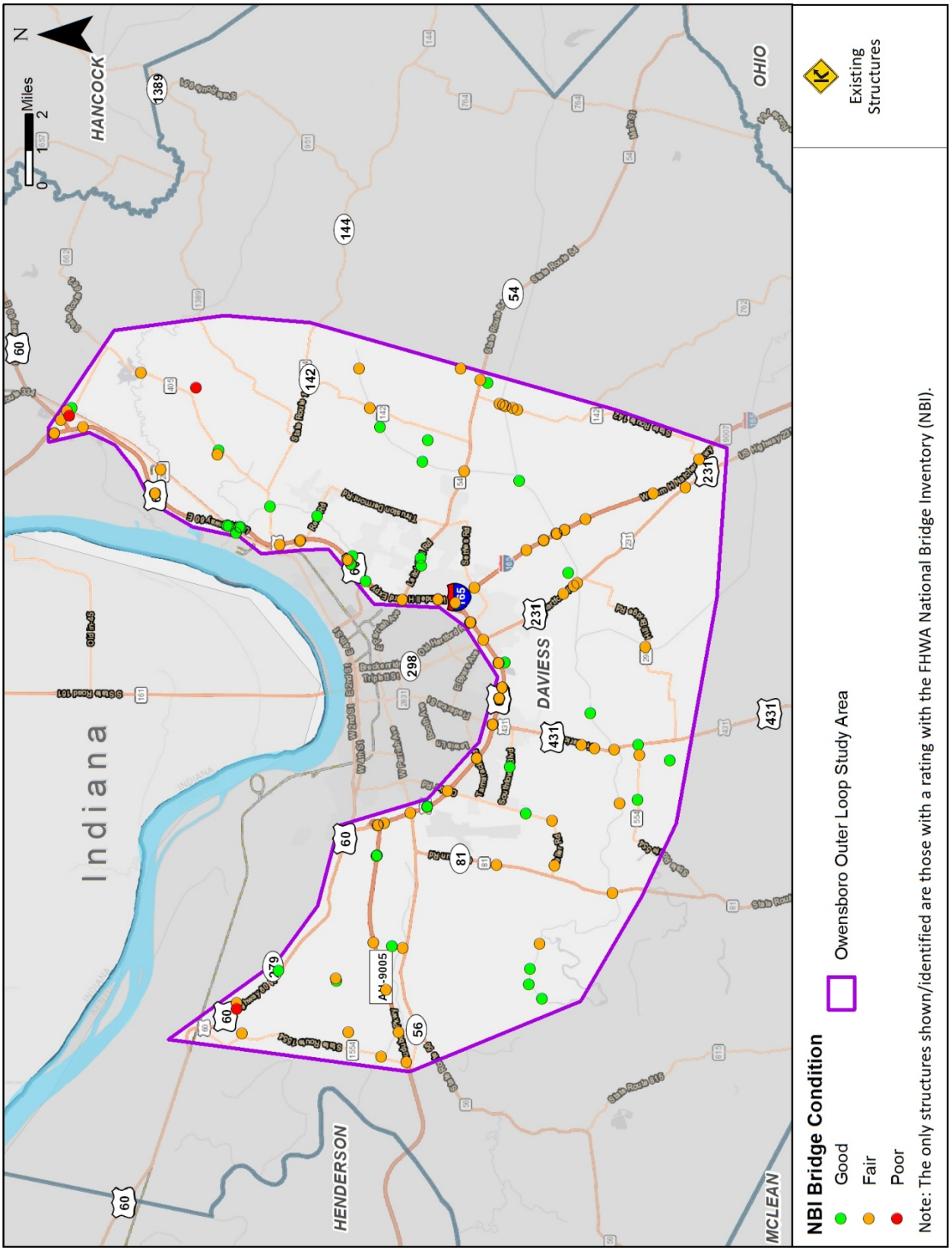


Figure 14. 2020 AADT Range

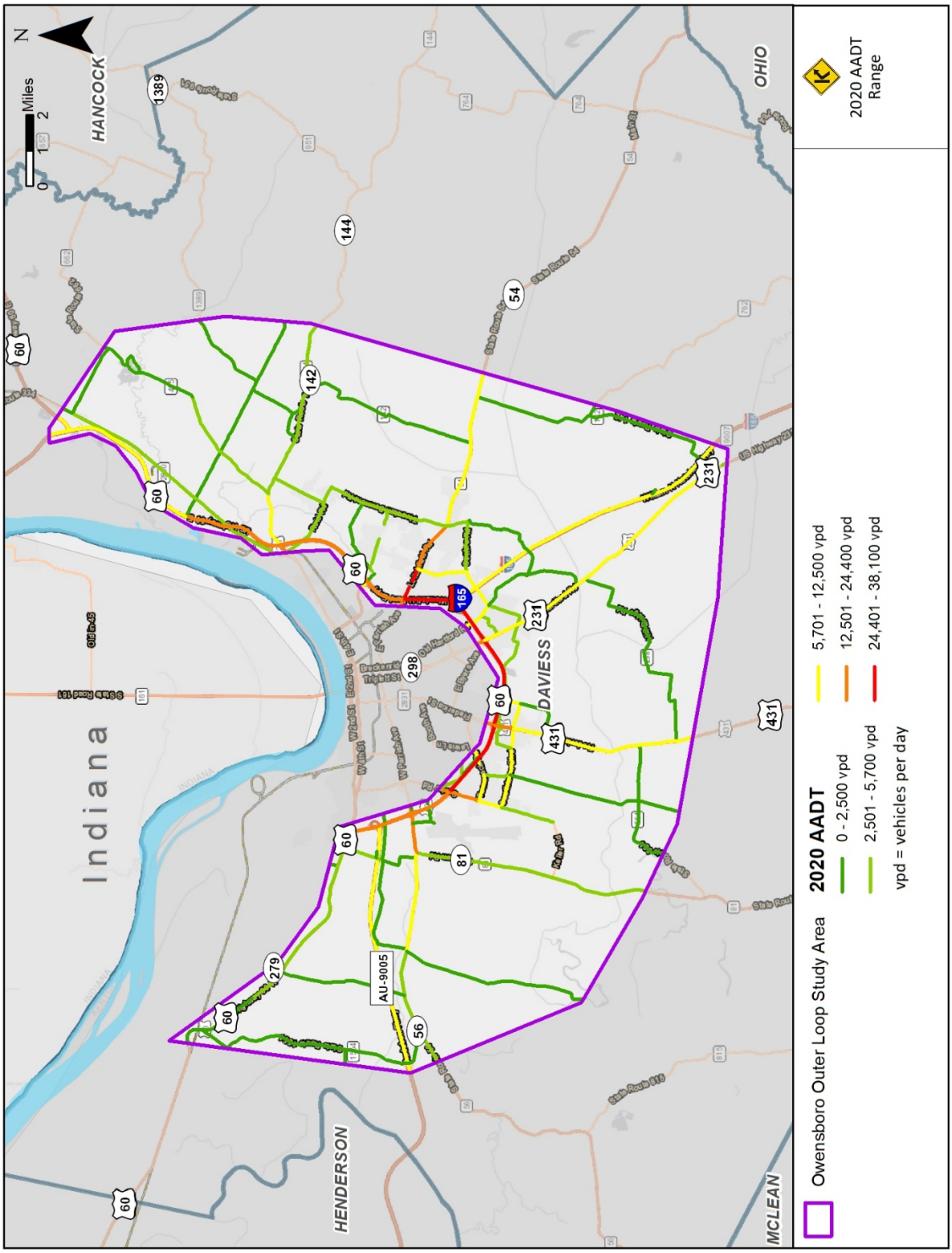


Figure 15. Level of Service (LOS) Designations

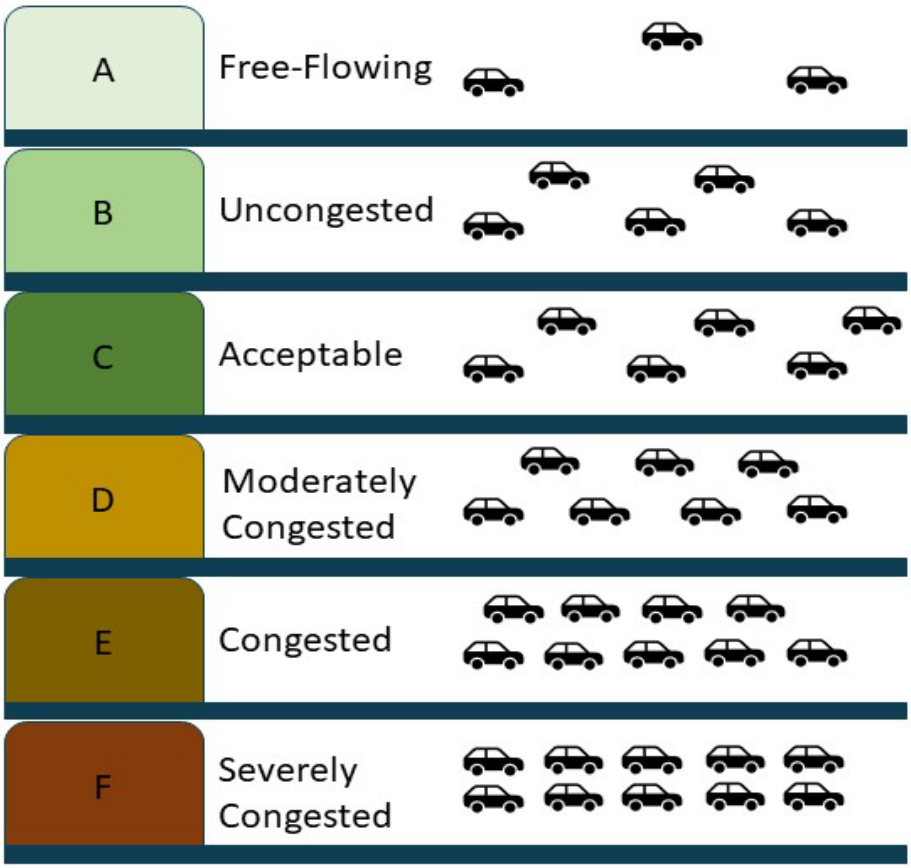
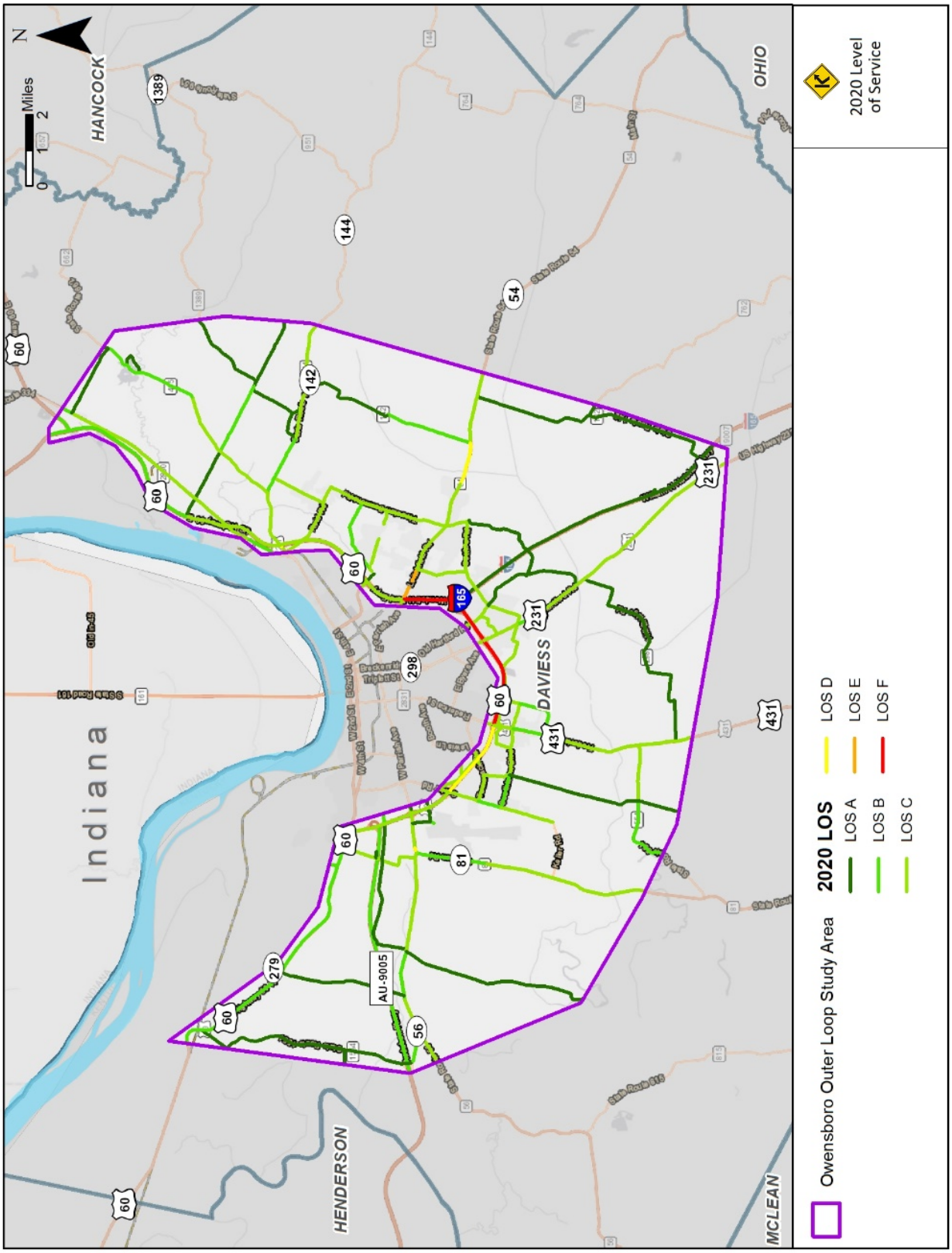


Figure 16. 2020 Level of Service



2.5 Crash Analysis

Historical crash data for the study area was analyzed to identify locations and trends along roadways that could be considered high crash locations. Historical crash records were extracted from the Kentucky State Police's (KSP) *Collision Analysis* for a three-year period (September 2017 – August 2020).

Crash Analysis Methods

The statistical crash analysis was performed based on methods that compare existing crash rates with crash rates of similar types of facilities. These methods included the Critical Crash Rate Factor (CRF) method and the Excess Expected Crashes (EEC) method. Historical crash rates for the study area were provided by the City of Owensboro. Detailed crash reports were analyzed for specific locations as needed.

1. Excess Expected Crashes - KYTC crash analysis methodology has been evolving, transitioning from the Critical Crash Rate method and progressing toward the EEC methodology based on the AASHTO Highway Safety Manual (HSM) procedures. HSM methods allow for the ability to estimate potential crash frequency on roadways, and the potential effects that differences in roadway characteristics have on crashes (e.g. a 3-foot shoulder versus a 10-foot shoulder). If the EEC is positive, it indicates more crashes have occurred than expected in the segment. If the EEC is negative, it indicates that there are fewer crashes than expected. EEC mapping showing the EEC data for every KYTC maintained roadway in the study area was used. It is based on crash data from 2013 to 2017.

   EEC analysis uses historical observed crash data for a specified time period and segment length. The segments are based on KYTC's traffic count segments, and those typically change when there is a change in roadway characteristic or breakpoint such as an intersecting road.

   The EECs are classified by severity as KAB (K, A, and B crashes), or CO (C, O crashes). Crash severities are classified based on the 4th Edition of the Model Minimum Uniform Crash Criteria (MMUCC 4th Edition) KABCO Injury Classification Scale which Kentucky adopted in 2017 and was required to be adopted by all states on or before April 15, 2019. KABCO is defined in accordance with the MMUCC as follows:

   - **Fatal Injury (K):** A fatal injury is any injury that results in death within 30 days after the motor vehicle crash in which the injury occurred.
   - **Suspected Serious Injury (A):** A suspected serious injury is any injury other than fatal which results in one or more of the following:
     - Severe laceration resulting in exposure of underlying tissues/muscle/organs or resulting in significant loss of blood
     - Broken or distorted extremity (arm or leg)
     - Crush injuries
     - Suspected skull, chest or abdominal injury other than bruises or minor lacerations
     - Significant burns (second and third degree burns over 10% or more of the body)
     - Unconsciousness when taken from the crash scene
     - Paralysis

- **Suspected Minor Injury (B):** A minor injury is any injury that is evident at the scene of the crash, other than fatal or serious injuries. Examples include lump on the head, abrasions, bruises, minor lacerations (cuts on the skin surface with minimal bleeding and no exposure of deeper tissue/muscle).
- **Possible Injury (C):** A possible injury is any injury reported or claimed which is not a fatal, suspected serious or suspected minor injury. Examples include momentary loss of consciousness, claim of injury, limping, or complaint of pain or nausea. Possible injuries are those which are reported by the person or are indicated by his/her behavior, but no wounds or injuries are readily evident.
- **No Apparent Injury (O):** Also known as Property Damage Only, No Apparent Injury is a situation where there is no reason to believe that the person received any bodily harm from the motor vehicle crash. There is no physical evidence of injury and the person does not report any change in normal function.

An overview of segments with an EEC greater than zero for KAB crashes is presented in **Figure 17.**

2. Critical Crash Rate Factor - KYTC also uses a systematic procedure to identify locations having high crash rates. The actual number of crashes occurring within a roadway segment are used to calculate the Actual Crash Rate using the number of crashes, roadway length, AADT, and the number of years for which crash data is being examined. Using an analysis procedure from KTC and referenced in *The Analysis of Traffic Crash Data in Kentucky (2014-2018)*, Actual Crash Rates are compared to the Critical Crash Rates for similar types of Kentucky roadways. The Critical Crash Rate is the rate which is statistically greater than the Average Crash Rate for similar roadways, and it represents a rate which crashes may be occurring in a non-random fashion. This ratio of Actual Crash Rate to the Critical Crash Rate is the Critical Crash Rate Factor (CRF). Thus, a CRF greater than 1.0 indicates crashes may be occurring more often than can be attributed to random occurrence. This procedure is used as a screening technique indicating locations where further analysis may be needed. It is not a definitive statement of a crash problem, nor a measurement of a crash problem.

   Critical Crash Rate data for the study area roadways was provided by the City of Owensboro. Segments were broken down by major break points such as intersections or changes in typical section. Based on this analysis, there were 31 segments that could be deemed high crash segments within the study area which include 24 with CRFs between 1.0 and 2.0, and 7 with CRFs over 2.0. An overview of the high CRF segments is presented in **Figure 18**.

Figure 17. Excess Expected KAB Crashes by Segment Greater Than Zero (2013-2017)

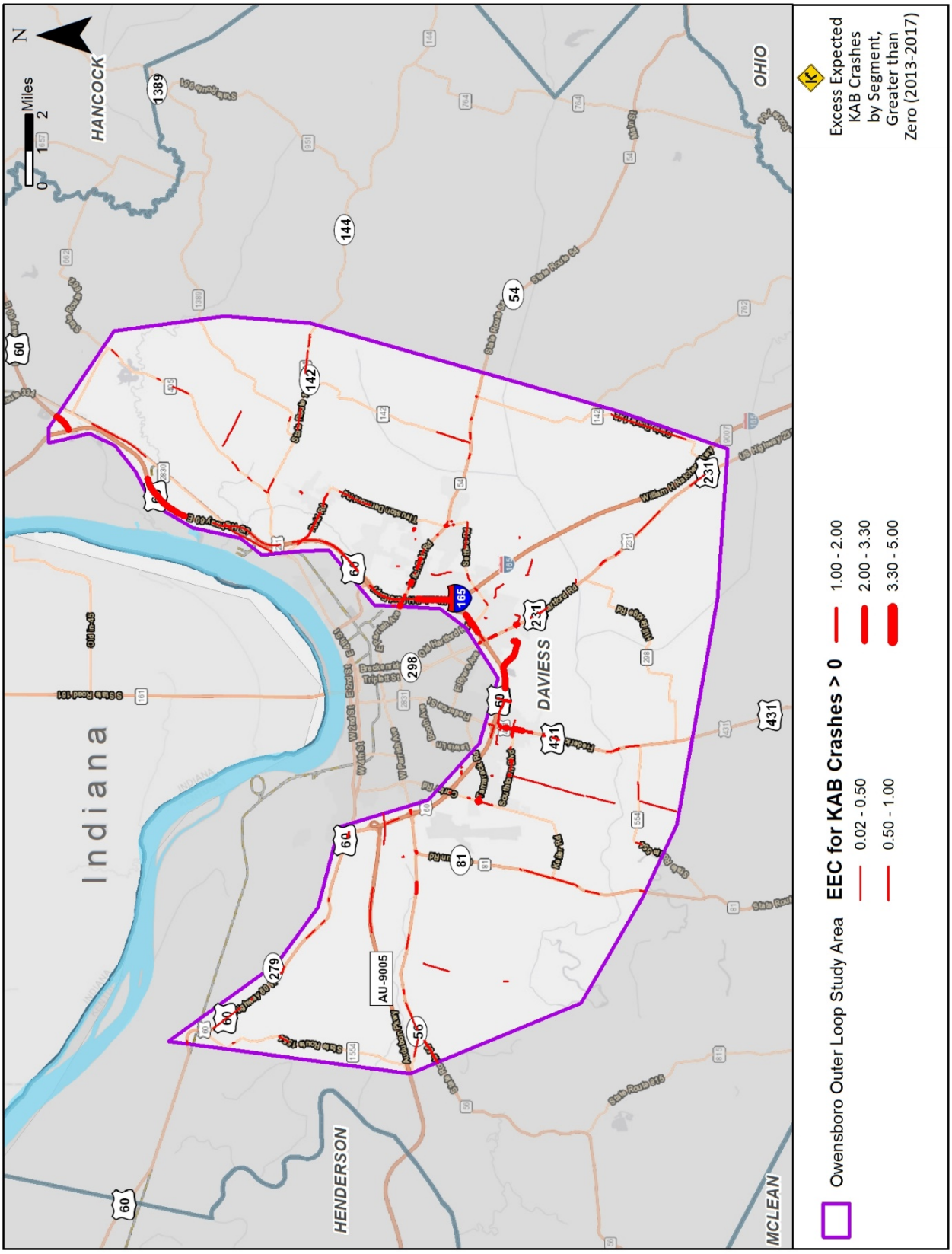
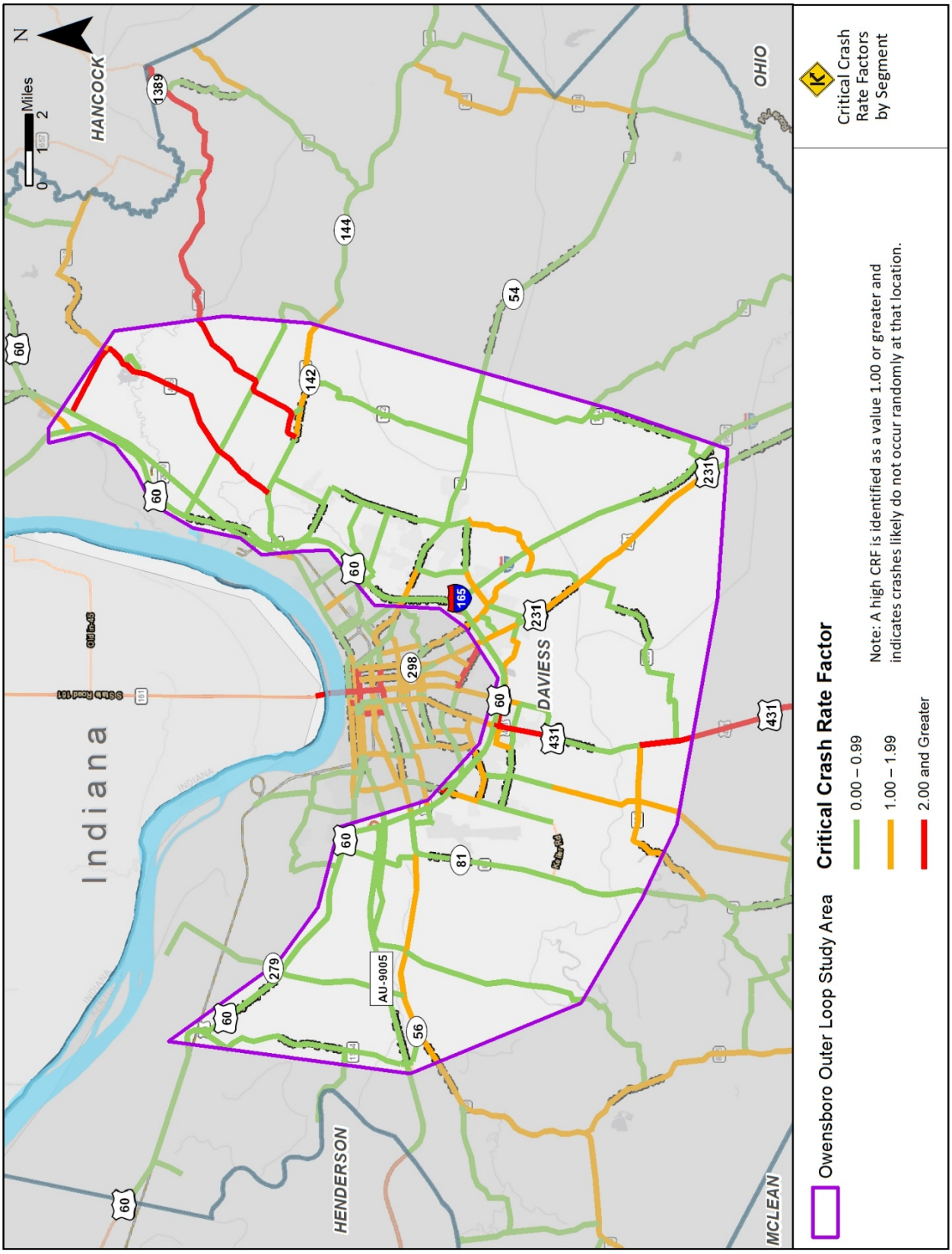


Figure 18. Critical Crash Rate Factors by Segment

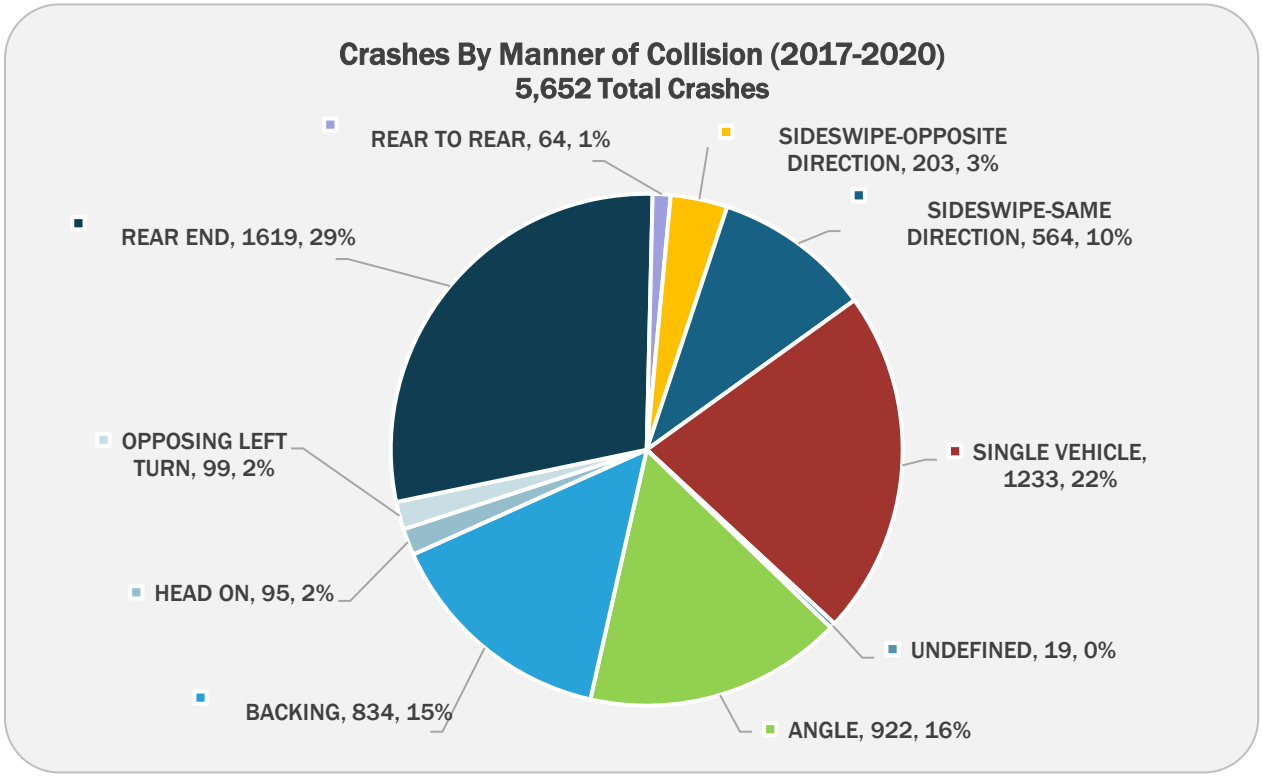


High-Level Crash Analysis

Aside from these two crash analysis methods, a high-level crash analysis was performed by analyzing the historical crash information provided by the KSP Collision Database and plotting all crashes along the corridor during the 3-year time period by their geographic coordinates. This involved analyzing statistics such as manner of collision, collision severity, daylight versus dark conditions, weather conditions, directional analysis, and others to find trends and help determine what could be contributing to crashes along the corridor.

Overall, there were 5,652 crashes within the 3-year timeframe in the study area. Summary statistics are provided in **Figure 19**. An overview map of the crash distribution density is presented in **Figure 20**. Manner of Collision is illustrated by crash clusters on **Figure 21**. A more in-depth list of all crashes can be found in **Appendix C.**

Figure 19. Crash Statistics Infographic



Total Crashes by Severity (2017-2020):

15 Fatal Crashes (K)
– 15 Fatalities

700 Injury (ABC) Crashes (12%)
– 1,020 Injuries
- 36 A (4%)
- 403 B (40%)
- 513 C (54%)

4,937 Property Damage Only (O) Crashes (87%)

Other Statistics to Note:

4303 Non-Dry Condition Crashes (24%)
Wet – 1101 (19%)
Snow/Slush – 80 (1%)
Ice – 117 (2%)
Water – Standing or Moving – 31 (0.6%)
Flooded – 6 (0.1%)
Other – 2 (0%)

4922 Straight Segment Crashes (87%)
Straight & Level (4358, 77%)
Straight & Grade (402, 7%)
Straight & Hillcrest (162, 3%)

1525 Non-Daylight Condition Crashes (27%)
1271 Dark & Not Lighted Or Lights Off (23%)

2026 Non-Clear Weather Condition Crashes (36%)
Cloudy – 1173 (21%)
Raining – 704 (12%)
Snowing – 64 (1%)
Fog – 11 (0%)
Fog with Rain – 9 (0%)
Sleet, Hail, or Freezing Rain – 30 (1%)
Blowing Sand/Soil/Dirt/Snow – 16 (0%)

Figure 20. Crash Density – All Crashes

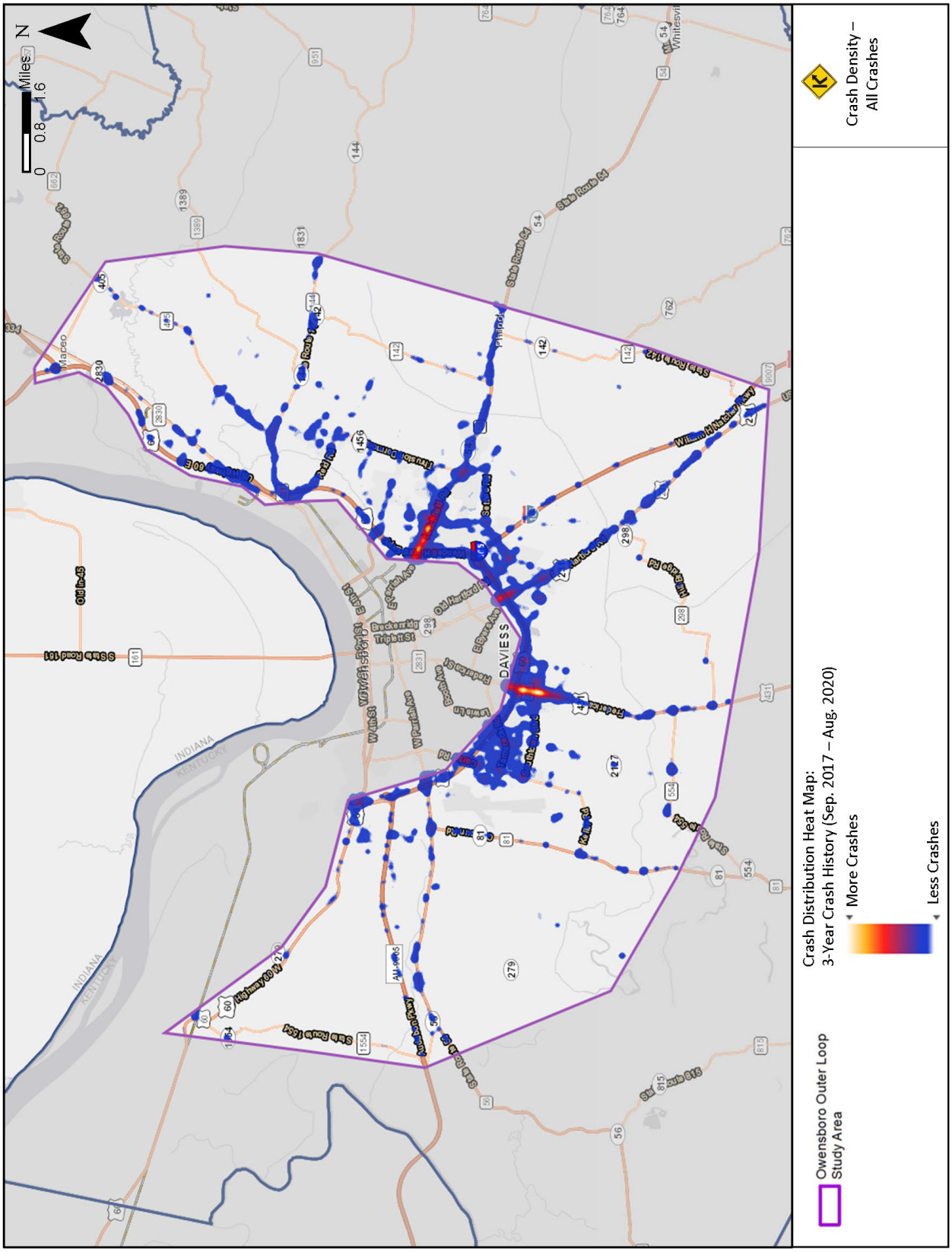
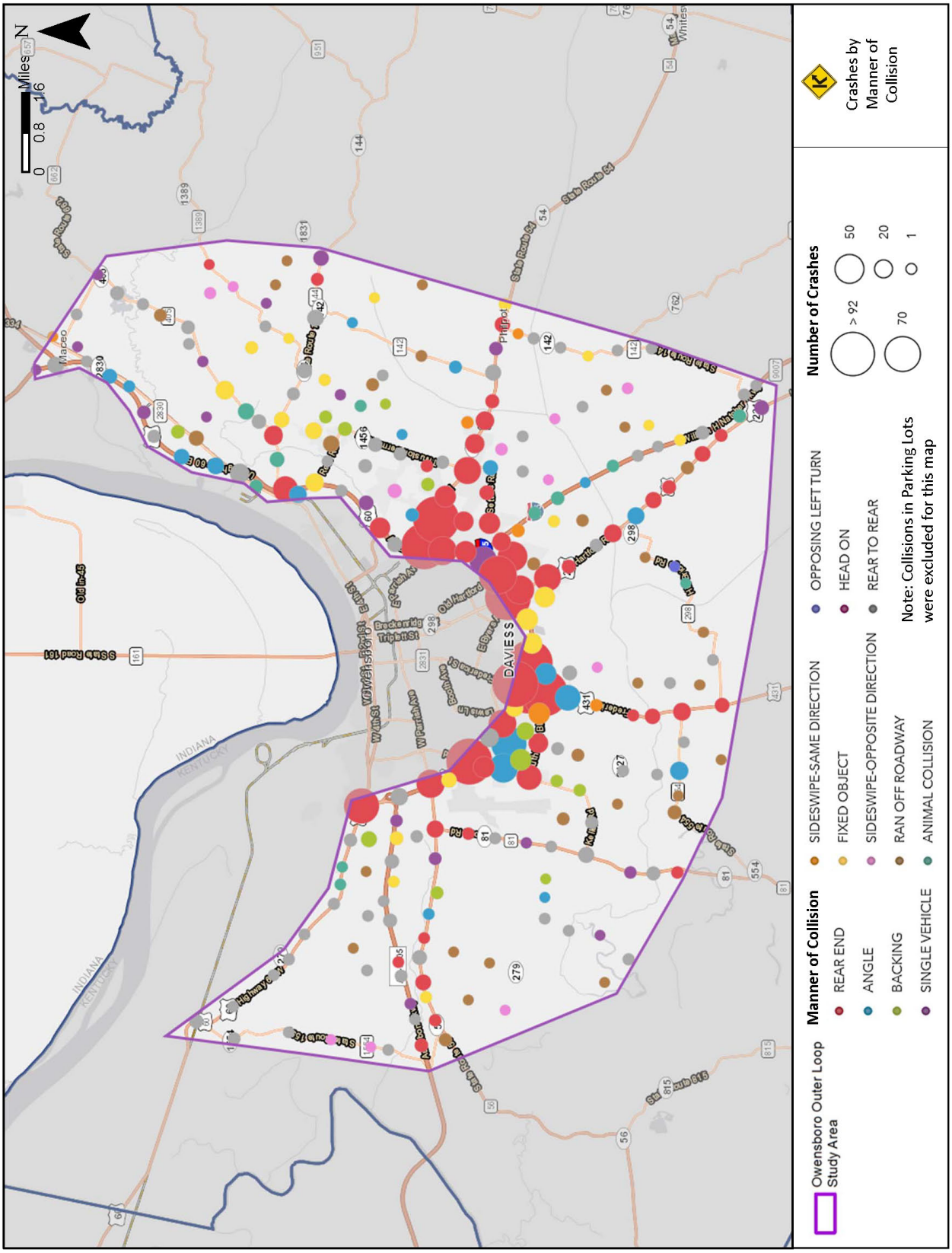


Figure 21. Crashes by Manner of Collision



2.6 Pedestrian and Bicycle Facilities

The city of Owensboro and Daviess County have a variety of accommodations for pedestrians and bicyclists, primarily near the city center and major development areas. These include bike lanes, multi-use paths such as the Adkisson Greenbelt, shared lanes, and sidewalks. Two U.S. bicycle identified corridors, the Ramblin' River and the Underground Railroad bike tours, provide a bicycle network for connectivity to outside the study area. Existing bicycle and pedestrian facilities can be seen on **Figure 22.** Bicycle and pedestrian accommodations that have been proposed by GRADD as route additions or projects are located on **Figure 23.**

Figure 22. Existing Pedestrian and Bicycle Facilities

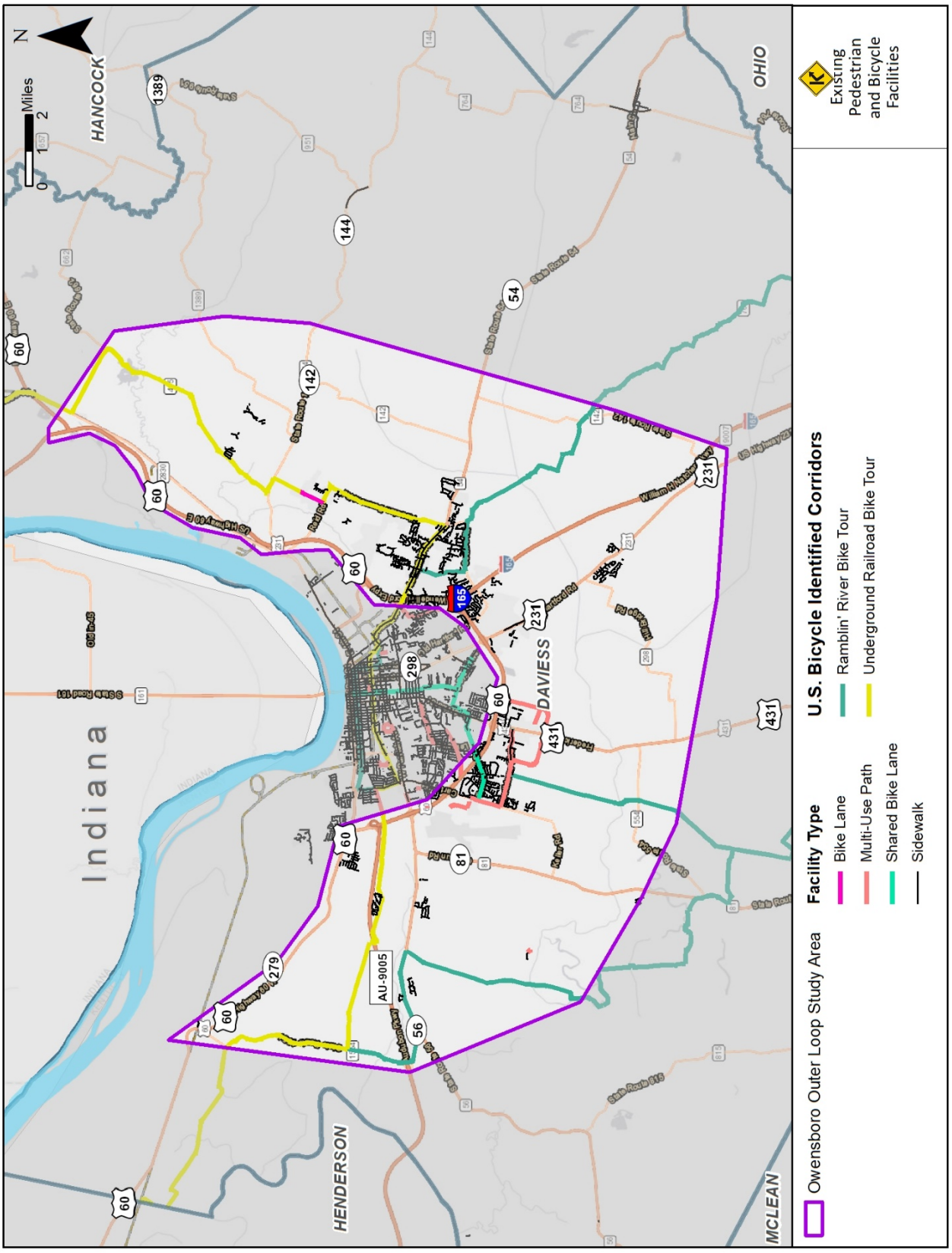
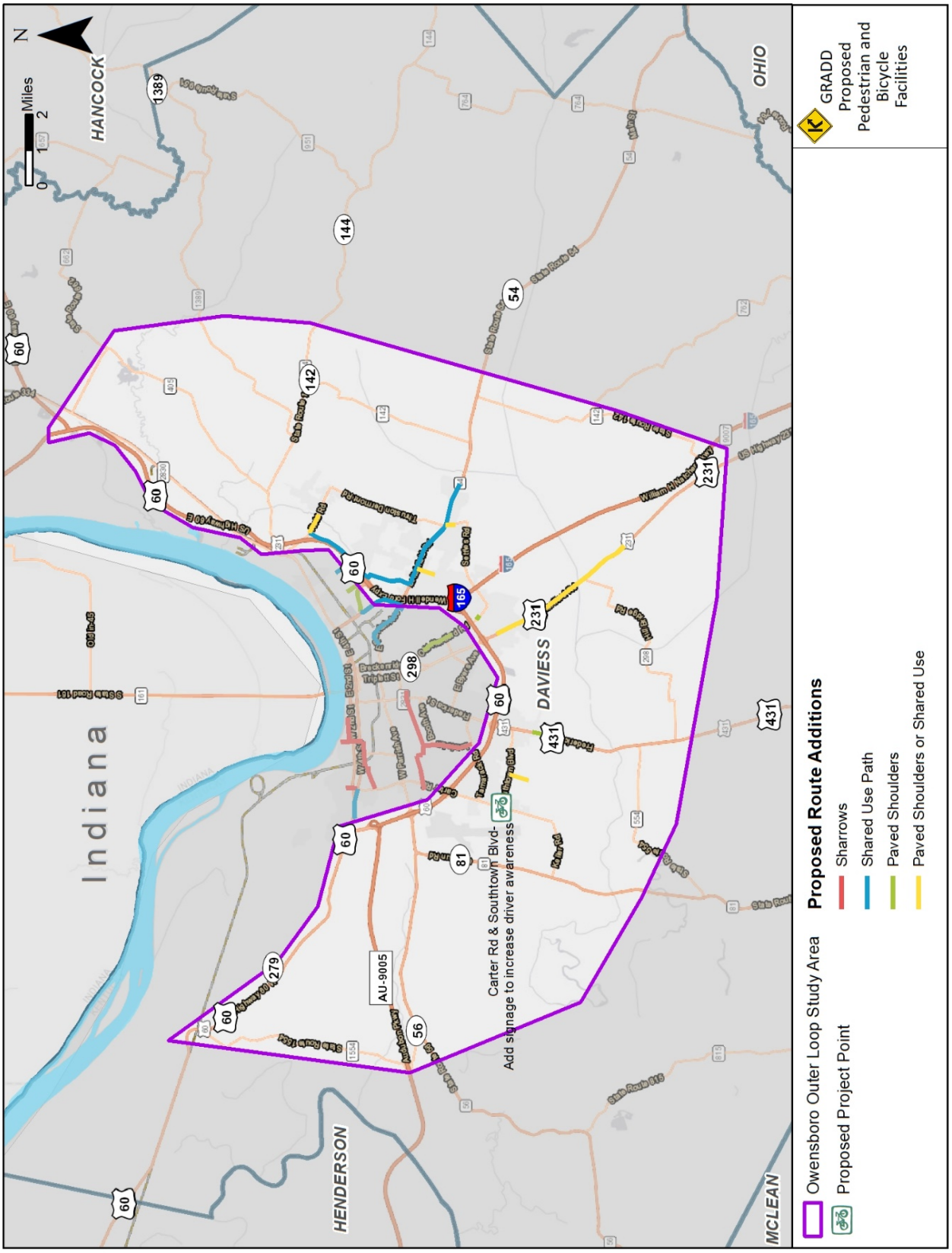


Figure 23. GRADD Proposed Pedestrian and Bicycle Facilities



Chapter 3 – Environmental Overview

An Environmental Overview was conducted to identify resources and potential issues for consideration during the development of improvement concepts. Natural and human environmental resources were identified from a literature/database review. Study area environmental resources are summarized in the following sections with supplemental mapping and resources included in **Appendix D**.

3.1 Natural Environment

The natural environment typically refers to all living and non-living things found to occur in nature. It includes aquatic ecology such as rivers, streams, and wetlands; threatened and endangered species; and prime and unique farmland. An assessment of geotechnical potential impacts is included in this study for potential identified segments / corridors and is presented later in the report during the evaluation section.

Rivers and Streams

The Ohio River is the most notable water resource adjacent to the study area. Daviess County has approximately 29 miles of river front, with potential for commerce and recreation. There are nine major watersheds within the project study area. They are Cowhide Slough (Ohio River), Green River (near Spottsville), Panther Creek (near Rome), Rhodes Creek, South Fork Panther Creek, North Fork Panther Creek, Van Burren Creek, Ohio River tributaries (near Maceo), and Pup Creek. None of the streams in the study area are on the Kentucky Division of Water (KDOW) 303(d) list of streams failing to meet designated uses. None of the streams in the potential study area are on the KDOW Exceptional Water or Outstanding State Resource Water list.

There are 71 named creeks located within the study area. These are displayed on a series of maps in **Appendix D**.

Wetlands and Ponds

The National Wetlands Inventory (NWI) has documented 993 wetlands throughout the study area, with the majority (964) palustrine wetlands (4,700 acres). Most of the palustrine wetlands are small ponds or are associated with streams. The remaining wetlands include seventeen upland wetlands (1,710 acres), seven riverine wetlands (340 acres), and five lacustrine wetland (150) acres. The wetlands are shown on a series of maps in **Appendix D**.

Groundwater

Approximately 223 wells were identified, 87 of which are plugged and decommissioned, 61 are active single-family domestic-use wells, and 60 are active groundwater monitoring wells. There are also 15 active groundwater remediation wells. In addition, there are records for 11 underground storage tank sites within the study area. Six of these sites are still active, while the other five sites have been closed. There is one groundwater spring listed for the study area. These are displayed on a series of maps in **Appendix D**.

Floodplain/Floodway

Federal Emergency Management Agency (FEMA) 100-year floodplain exists primarily along Panther Creek that flows east to west across the central part of the study area. There are also 100-year floodplains in the northwestern section of the study area associated with Rhodes Creek and Katie Meadow Slough as well as the northeastern section of the study area associated with Van Buren Creek, Yellow Creek, and Pup Creek and these are shown in a series of maps in **Appendix D**.

Prime Farmland

The Natural Resources Conservation Service (NRCS) soil survey shows 63,643 acres of prime farmland in the study area which comprises 76.7% of the approximately 83,000 acre study area. Most areas along US 60 and some of the eastern parts of the study area are not considered prime farmland (approximately 19,372 acres). Farmland of statewide importance (2,588 acres) is mostly in the eastern section of the study area. Farmland classification data is shown in **Appendix D**.

Protected Species

There are 3 bats and 12 mussels listed as Threatened or Endangered by United States Fish and Wildlife Service (USFWS) with potential to occur within the study area. The tip of the northeastern section of the study area and the northwestern section of the study area are within areas designated by USFWS as "Known Summer" habitat for the Indiana bat. No critical habitats were identified through the USFWS Threatened and Endangered Species Active Critical Habitat database search.

3.2 Human Environment

The human environment typically refers to the built environment or the communities where we live. It includes elements such as land use, community features, historic districts and properties, and hazardous materials considerations.

Land Use

The land use and zoning within the study area is primarily rural agricultural. There are pockets of light industrial, coal mining, and residential zoning areas scattered within the study area. Individual businesses such as gas stations, auto dealers and repair, storage, restaurants, and dollar stores are interspersed throughout the study area.

Community Features

Several community features are located within the study area and include schools (20), churches (23), cemeteries (45), medical facilities, fire stations, parks (11) and golf courses (3). Six of the parks are also considered 6(f) resources for having received money from the Land and Water Conservation Fund (LWCF). Most parks tend to be near the northern border of the study area. There are no state or national parks in the study area. Additional large-scale features include the Owensboro-Daviess County Regional Airport and the Daviess County Landfill. These community features are shown in a series of maps in **Appendix D**.

Historic Districts and Properties

Much of the land use in the study area is classified as undeveloped, commercial, or residential. There are few properties / structures that are of historical significance. There is only one property listed on the National Register of Historic Places (NHRP), Willow Hill, and it shown **Appendix D**. Other properties within the study area with historic significance but not on the NRHP noted during the review include:

- Husk Family House
- Sutherland School
- J W Edmond Fields Farm
- Ashby/Fuqua House
- Throckmorton House
- Senator Thomas C. McCreery House
- John McFarland House
- Lynch Gray House

3.3 Socioeconomic Study

The Owensboro Outer Loop Study Environmental Justice Review was completed by the Green River Area Development District (GRADD). The intent of the review at this stage is to assist the Project Team and subsequent users of the study in making informed and prudent transportation decisions in the study area with regard to the requirements of Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (signed February 11, 1994). Statistics are provided on minority, elderly, disabled, low income, and limited English proficiency populations. Data was obtained from the 2014-2018 American Community Survey (ACS) statistics. Due to the size of the study area which encompasses most of Daviess County, the county numbers were selected as the reference threshold. The county numbers provide a better snapshot of the overall population characteristics in the study area as opposed to the United States or state percentages. **Table 3** provides a summary of the data by population group, identifying the number of Block Groups higher than the county threshold. The full report completed by the GRADD is included in **Appendix E**.

Table 3. Summary of Socioeconomic Data

Population Group	No. of Block Groups Higher than County Threshold
Racial Minority Population	4
Population by Persons Age 65 and Older	13
Population by Disability Status	14
Population by Persons below Poverty Level	10
Population with Limited English Proficiency Age 18 Years and Older	6

Chapter 4 – Initial Engagement Efforts

During the course of the study, multiple collaborative meetings were held. These include three meetings with the Project Team, two with local officials / stakeholders (LO/S), and one with the general public. As noted at the beginning of this report, the Project Team consists of KYTC, the Owensboro MPO /GRADD, and the consultant team. The meetings with the Project Team were conducted to discuss study progress, next steps, and key decisions. Local officials / stakeholders (LO/S) were identified by the Project Team and included the following representatives for a planning study:

- County Judge/Executive
- Mayor
- Planning Commission
- City / County Engineer
- Emergency Medical Services (EMS)
- Fire / Police / Sheriff's Offices
- Schools
- Bicycle / Pedestrian Advocacy Groups
- Regional Multimodal Transportation Agencies (i.e. airport and riverports)
- State and Federal Senators and Representatives

The meetings with local officials / stakeholders (LO/S) were an opportunity to share study information and gather input from various perspectives on identifying areas of concern, developing potential improvements, and providing input on prioritization. One public meeting was agreed upon by the Project Team during the scoping of this study to provide information to the public about the existing transportation network and discuss potential transportation network connections / collect information about the feasibility of identified improvement options. Therefore, this meeting was held later in the study once potential connectivity options were identified and initially evaluated. More information about this meeting is provided later in this report.

The initial meetings with the Project Team and LO/S provided an opportunity to review objectives and goals of the study, present and discuss the existing conditions information, and collect initial input for the improvement concept development process.

4.1 Project Team Meeting No.1

The first Project Team meeting was held virtually on Wednesday, November 18, 2020. Representatives included KYTC Divisions of Planning and Highway Design staff, KYTC District 2, GRADD staff, and the consultant team. Study background information including the study area, objective and goals, tasks, and schedule were shared with the attendees. The meeting also included a review of collected existing conditions information such as typical sections, traffic conditions, freight network and major industries, crash analysis, committed and identified projects, and field review notes. Key action items included discussion of the improvement concept development process and preparation for the first local official / stakeholder meeting outreach and materials. Key notes from this meeting included:

- Identification of pavement management schedule and years of expenditure for preventative maintenance funds to consider potential overlap in projects identified along existing routes.
- Only one project in the 2020 Highway Plan would impact capacity in the future and should be considered in future year traffic forecasts – improvements to KY 54 (item No. 2-8300.00).

- A local project, Fairview Drive extension, will provide connectivity on the eastern portion of the study area and should be taken into consideration.
- Regionally, conversion of the Audubon Parkway to an interstate as well as I-69 connectivity should be considered as part of the future network in the Owensboro Regional Travel Demand Model.

For additional detail regarding information presented and discussed at the meeting, refer to the meeting minutes found in **Appendix F**.

4.2 Local Officials / Stakeholder Meeting No. 1

Local officials / stakeholders (LO/S) meetings were held to provide a more targeted approach to help inform the process and encourage participation. The first meeting was held virtually on Thursday, December 10, 2020. A presentation was given by the consultant that provided information on the study background and existing conditions. An online survey link was provided to all invited LO/S via email (38 invitees total) to collect input on study issues, general connectivity needs, and existing transportation issues. A total of thirteen (13) responses were received. The consensus from the responses included the following:

- Safety identified as top issue compared to natural resources, multimodal opportunities, freight movements, travel time, and economic development.
- Connectivity around Owensboro should facilitate mobility mostly locally with some regional (6/13 responses)
- Connectivity around Owensboro should emphasize a balanced mix of fixing existing issues and planning for future growth (7/13 responses)
- Connectivity around Owensboro should improve access with a balanced mix of downtown destinations and regional travel (6/13 responses)
- Connectivity around Owensboro should prioritize mostly constructing new routes with some improvements to existing connections (5/13 responses)
- Connectivity around Owensboro should focus on a balanced mix of short-term and long-term improvements (8/13 responses)

Additionally, respondents were asked to provide input on safety concerns, congestion / travel delay, major traffic generators and major planned development locations via a location-based Geographic Information Systems (GIS) database. A demonstration of how to provide input was given during the presentation.

A full summary of the meeting and the input is included in **Appendix F**.

Chapter 5 – Potential Connectivity Development and Analysis

In this chapter, the process is summarized for the identification and analysis of initial segments and how those segments were reduced to a set of preliminary corridors for further evaluation. The existing conditions, environmental analysis and coordination with the LO/S informed and guided this process.

5.1 Segment Development

Improving connectivity was the basis for developing initial segments. This included looking at connectivity in the following ways:

- Reviewed existing road network to determine potential segment options that connect to and utilize existing roadways to minimize right of way need.
- Reviewed existing and proposed bicycle facilities for potential connections and / or overlap.
- Reviewed community destinations to connect points of interest.
- Analyzed input from local officials and stakeholders collected early in the study process.

Existing Routes

The City of Owensboro is situated along the Ohio River with numerous routes radiating from the city center (US 60, Audubon Parkway, KY 56, KY 2698, KY 2127, US 431, US 231, I-165, KY 144, and KY 54). As these routes extend into the county, distance between them expands, with less opportunity in some areas for travel between these links. The consideration to upgrade connectors between these routes is one way to reduce impacts and costs while providing increased mobility through the study area. The following figure (**Figure 24**) displays the contrast between the routes leading to / from the city center and the existing state-maintained connections between the routes. All routes highlighted in blue (KY 1554, KY 279, KY 81, KY 554, KY 298, KY 1456, KY 142, and KY 405) are considered as potential connections between the red routes leading to / from the city.

Bicycle Connectivity

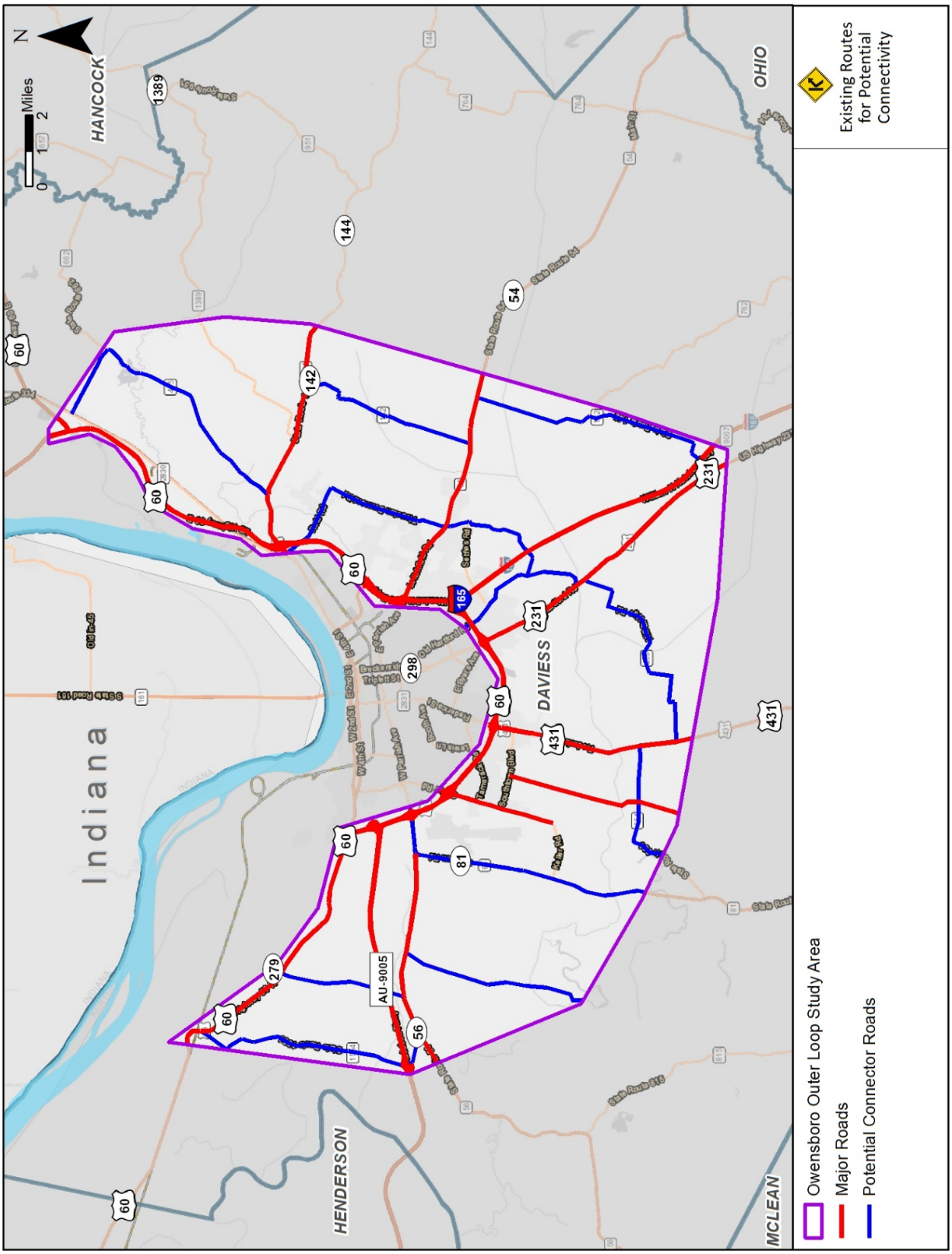
Using resources identified in the existing conditions analysis, particularly the *2018 Owensboro-Daviess County Metropolitan Planning Organization Bike/Pedestrian Master Plan*, opportunities were examined to connect to or provide accommodations for facilities through a new / upgraded connection.

Community Destinations

Input from the LO/S Meeting No.1 in conjunction with community features identified as part of the environmental overview informed the determination of points of interest within the study area which included:

- Neighborhoods
- Businesses and industries with at least 100 employees
- Existing and potential development
- Schools
- Parks, campgrounds and golf courses
- Medical facilities
- Churches
- Fire stations and law enforcement offices
- Other critical government facilities (KYTC facilities, other recreation areas, humane society, federal buildings, judicial buildings, public works, landfill and more).

Figure 24. Existing Routes for Potential Connectivity



Combining these features enables concentrations or clusters of interest points to be identified. From this, gaps in the transportation network are identified that could possibly provide mobility between higher density feature areas. Refer to **Figure 25** for the community destinations density map.

Initial Segments

From this process of evaluating connectivity, 34 individual potential segments were identified. Each segment was assigned a letter. A 1,000 foot buffer – 500 feet on either side of the centerline was used for each segment in order to ensure potential impacts were fully realized in the evaluation phase and allow for flexibility for potential future design phases (if applicable). **Figure 26** displays the location of these initial segments.

Figure 25. Community Destinations Density

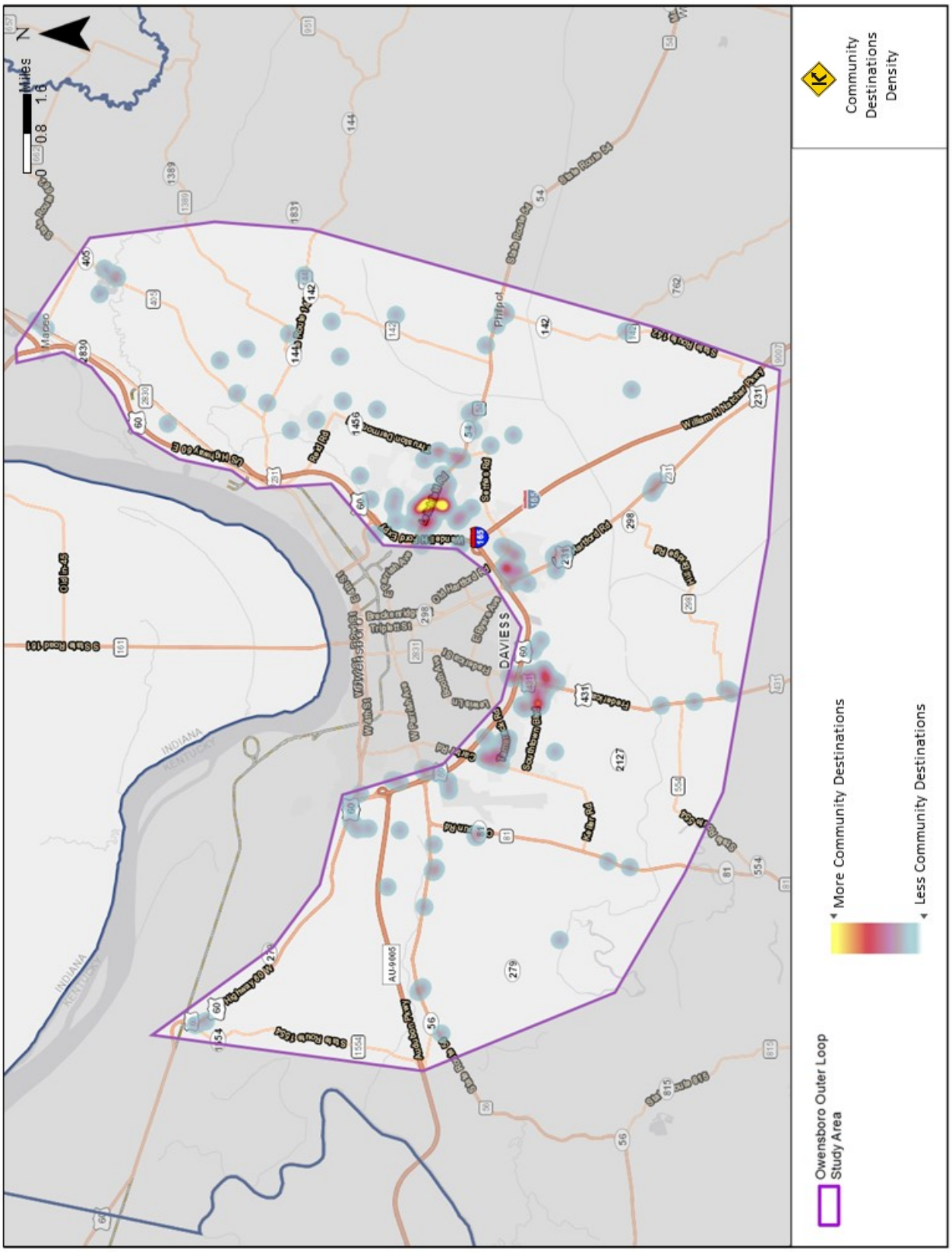
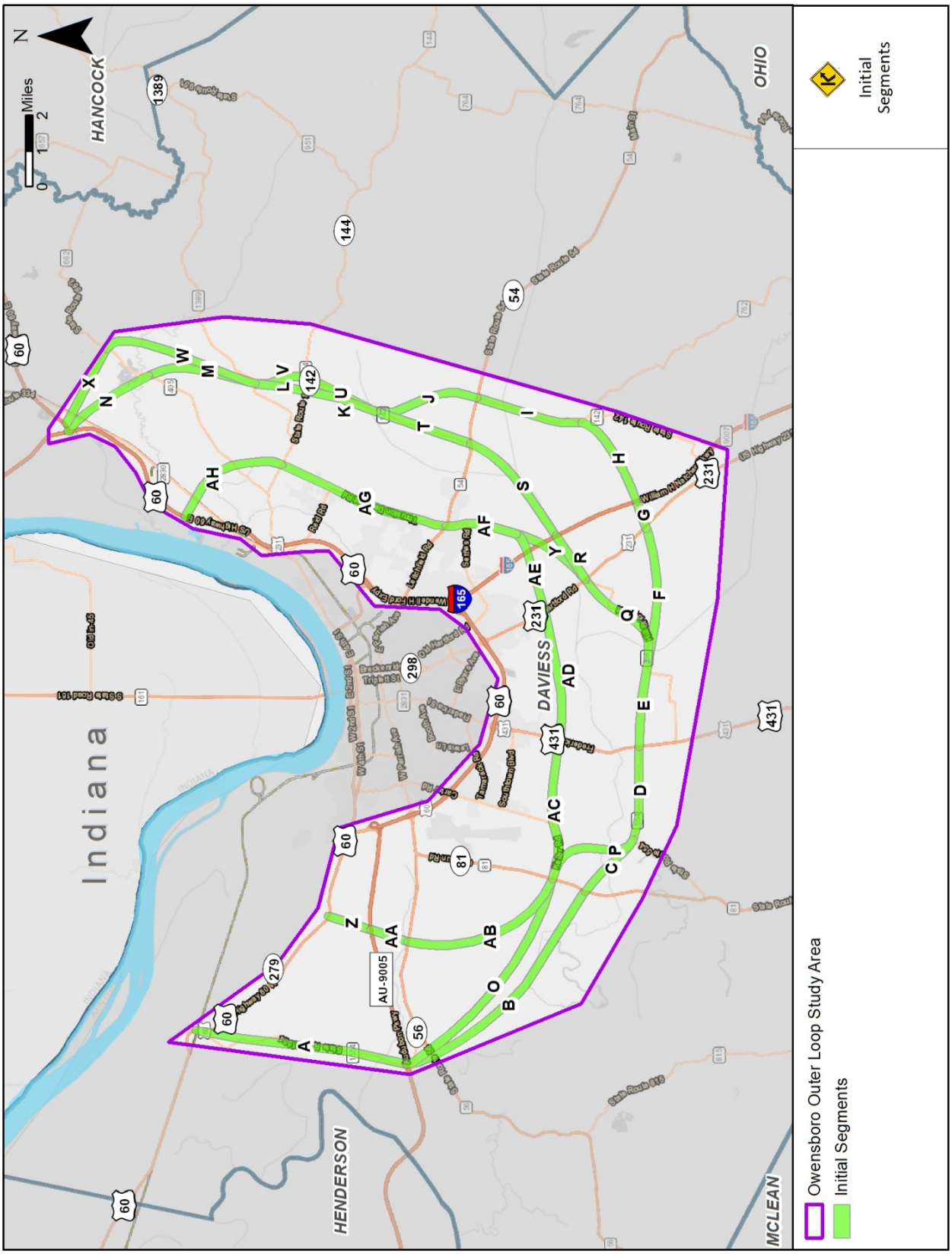


Figure 26. Initial Potential Segments



5.2 Analysis of Initial Segments

Segment characteristics were evaluated by the following categories:

- Impacts to Natural Environment
- Impacts to Built Environment
- Effect on Safety
- Existing / Future Traffic Demand
- Utilization / Impact to Existing Roadways

These impacts and benefits were quantified where features intersected with the buffers mentioned previously. Based on the outcome of this analysis, segments were scored in each impact and benefit category and ranked against the remaining segments. A brief description of each evaluation category is provided.

Natural Environment Assessment
Existing natural resources were analyzed for each segment, including wetlands, streams, ponds, lakes, floodplains, and prime farmland. **Table 4** lists the specific impacts and **Table 5** provides a comparative ranking.

Built Environment Assessment
The existing built environment resources presented earlier were analyzed by comparing potential impacts to historic structures, historic neighborhoods, environmental justice areas, neighborhood / land parcels, major employers, and other community interests such as schools, parks and hospitals. **Table 6** lists the specific impacts / benefits and **Table 7** provides a comparative ranking. Archaeological impacts were assessed but are not presented in this table due to the sensitivity of this information.

Safety Assessment
The safety evaluation by segment consisted of identifying the following for existing segments: number of crashes, fatal crashes, injury crashes, intersection EEC KAB, and Segment EEC KAB. For new segments, crash data was collected for any routes that intersected the segment. **Table 8** lists the specific values and **Table 9** provides a comparative ranking.

Traffic Assessment
The traffic evaluation included an assessment of functional class, speed, AADT, LOS, truck percentage, and proximity of bicycle facilities. For new segments, AADT was estimated based on surrounding or intersecting routes. **Table 10** lists the specific values and **Table 11** provides a comparative ranking.

Roadway Features Assessment
The final category used for initial assessment of potential segments is roadway features. For existing segments, this included the percentage of existing roadway within the segment, degree of curvature, roadway grade, pavement condition, number of structures and structural rating. For all segments, consideration was given to whether it was in the Highway Plan or coincided with a CHAF. **Table 12** lists the specific values and **Table 13** provides a comparative ranking.

Table 4. Natural Environmental Assessment by Segment

Segment ID	Segment Length (miles)	Wetland Area (acres)	Length of Streams Impacted (LF)	Ponds / Lakes Impacted (acres)	Floodplain Area (acres)	Prime Farmland Impacted (acres)
A	4.85	1.11	21,453	0.90	449.67	507.17
AA	0.98	3.24	14,090	0.22	20.02	121.20
AB	3.95	1.04	19,182	0.48	31.11	455.43
AC	3.25	0.60	38,001	0.15	231.04	410.84
AD	3.05	32.44	45,171	21.55	340.29	371.75
AE	1.95	1.44	28,809	1.17	71.37	215.92
AF	1.70	0.00	19,960	0.61	0.00	127.20
AG	4.03	4.71	32,803	3.99	31.77	206.69
AH	2.84	4.55	22,483	3.42	99.82	228.94
B	5.82	140.59	41,793	3.57	108.44	599.95
C	1.68	35.76	9,997	6.52	79.77	190.10
D	2.21	14.57	10,338	9.01	220.36	281.78
E	1.94	0.00	44,591	0.00	215.47	234.55
F	3.25	24.34	27,483	10.83	59.29	270.56
G	0.76	0.00	5,350	0.00	0.00	86.59
H	2.30	2.78	10,032	4.56	0.00	97.69
I	2.52	5.93	18,311	7.16	121.59	218.12
J	2.45	2.00	16,305	2.32	5.48	151.16
K	1.72	6.28	13,125	7.50	36.29	126.24
L	1.27	3.62	10,478	5.46	0.00	107.54
M	2.54	3.72	9,761	3.02	16.49	185.59
N	2.30	15.41	26,137	90.50	180.28	239.14
O	5.51	24.05	34,472	4.21	75.34	584.48
P	2.37	61.99	27,604	3.57	171.64	256.72
Q	2.80	28.39	31,170	21.71	164.79	251.49
R	1.27	77.64	25,815	12.70	148.14	160.60
S	2.95	139.91	43,140	5.34	279.72	310.40
T	2.41	2.12	16,635	4.81	14.74	147.20
U	1.77	1.76	15,506	4.95	40.75	131.68
V	1.25	5.10	11,068	8.77	0.00	101.50
W	3.63	33.59	11,590	1.71	12.95	291.04
X	2.00	1.06	30,351	1.26	66.91	192.97
Y	1.97	68.62	28,277	17.12	165.43	212.86
Z	1.10	1.64	3,691	3.30	0.00	92.75

Table 5. Natural Environmental Assessment by Segment Ranking

Segment ID	Wetland (acres)	Length of Streams Impacted (LF)	Ponds / Lakes (acres)	Floodplain (acres)	Prime Farmland (acres)	Overall Rank Sum	Overall Average Rank	Overall Rank
G	1	2	1	1	1	6	1	1
Z	9	1	13	1	2	26	5	2
AF	1	17	6	1	8	33	7	3
H	13	5	19	1	3	41	8	4
AA	14	11	4	11	6	46	9	5
L	15	7	23	1	5	51	10	6
J	11	13	11	7	11	53	11	7
M	16	3	12	10	13	54	11	8
V	19	8	27	1	4	59	12	9
T	12	14	20	9	10	65	13	10
U	10	12	21	15	9	67	13	11
AB	5	16	5	12	31	69	14	12
X	6	26	9	17	15	73	15	13
AE	8	25	8	18	18	77	15	14
K	21	10	26	14	7	78	16	15
W	28	9	10	8	27	82	16	16
E	1	33	1	29	21	85	17	17
AH	17	19	14	21	20	91	18	18
C	29	4	24	20	14	91	18	18
AG	18	28	17	13	16	92	18	20
A	7	18	7	34	32	98	20	21
AC	4	30	3	31	30	98	20	21
I	20	15	25	23	19	102	20	23
D	22	6	28	30	26	112	22	24
F	25	22	29	16	25	117	23	25
R	32	20	30	24	12	118	24	26
P	30	23	15	27	24	119	24	27
O	24	29	18	19	33	123	25	28
N	23	21	34	28	22	128	26	29
Y	31	24	31	26	17	129	26	30
Q	26	27	33	25	23	134	27	31
B	34	31	16	22	34	137	27	32
S	33	32	22	32	28	147	29	33
AD	27	34	32	33	29	155	31	34

Note: Smaller number rankings signify better performance.

Table 6. Built Environment Assessment by Segment

Segment ID	Segment Length (miles)	Potential 50+ Year Old Structures Impacted	Neighborhood(s) Impacted	Environmental Justice Area Impacted (acres)	Major Employers Within Corridor (# Employees)	Community Interests
A	4.85	9	0	9	N/A	2
AA	0.98	0	1	114	N/A	0
AB	3.95	1	0	484	N/A	0
AC	3.25	1	1	399	N/A	0
AD	3.05	0	0	375	N/A	0
AE	1.95	0	1	175	N/A	1
AF	1.70	0	4	0	N/A	1
AG	4.03	0	10	77	N/A	2
AH	2.84	2	1	210	N/A	1
B	5.82	0	2	700	N/A	1
C	1.68	0	1	209	N/A	0
D	2.21	0	1	264	N/A	0
E	1.94	0	0	9	N/A	0
F	3.25	0	1	348	N/A	0
G	0.76	0	0	88	N/A	0
H	2.30	0	0	9	N/A	0
I	2.52	12	2	0	N/A	0
J	2.45	10	2	0	N/A	0
K	1.72	0	2	0	N/A	0
L	1.27	1	0	10	N/A	0
M	2.54	1	0	305	N/A	0
N	2.30	2	1	284	N/A	0
O	5.51	0	0	663	N/A	1
P	2.37	0	0	293	N/A	0
Q	2.80	0	1	276	N/A	0
R	1.27	0	0	150	N/A	0
S	2.95	0	1	9	Potentially 1 (170)	1
T	2.41	0	3	0	N/A	0
U	1.77	0	2	0	N/A	0
V	1.25	1	1	10	N/A	0
W	3.63	0	0	409	N/A	0
X	2.00	5	3	247	N/A	0
Y	1.97	0	1	163	N/A	0
Z	1.10	0	1	9	N/A	0

Table 7. Built Environment Assessment by Segment Ranking

Segment ID	Potential 50+ Year Old Structures Impacted	Neighborhoods Impacted	EJ Impact	Community Interests	Overall Rank Sum	Overall Average Rank	Overall Rank
E	1	1	7	9	19	4	1
H	1	1	7	9	19	4	1
G	1	1	15	9	27	5	3
R	1	1	17	9	29	6	4
AE	1	13	19	3	37	7	5
AD	1	1	29	9	41	8	6
Y	1	13	18	9	42	8	7
T	1	31	1	9	43	9	8
C	1	13	20	9	44	9	9
Z	1	13	7	9	45	9	10
Q	1	13	24	9	48	10	11
S	1	13	7	3	51	10	12
F	1	13	28	9	52	10	13
K	1	26	1	9	52	10	13
P	1	1	26	9	52	10	13
U	1	26	1	9	52	10	13
O	1	1	33	3	53	11	17
AA	1	13	16	9	54	11	18
W	1	1	31	9	57	11	19
D	1	13	23	9	61	12	20
L	24	1	12	9	61	12	20
AH	29	13	21	3	67	13	22
A	32	1	7	1	68	14	23
AF	1	33	1	3	70	14	24
V	24	13	12	9	73	15	25
M	24	1	27	9	76	15	26
AC	24	13	30	9	77	15	27
N	29	13	25	9	77	15	27
B	1	26	34	3	79	16	29
AG	1	34	14	1	82	16	30
AB	24	1	32	9	93	19	31
J	33	26	1	9	96	19	32
I	34	26	1	9	97	19	33
X	31	31	22	9	127	25	34

Note: Smaller number rankings signify better performance.

Table 8. Safety Assessment by Segment

Segment ID	Segment Length (miles)	No. of Crashes	No. Fatal Crashes	No. of Injury Crashes	Intersection EEC KAB > 0	Segment EEC KAB > 0
A	4.85	12	0	1	0	1
AA	0.98	5	0	0	0	2
AB	3.95	9	0	3	1	2
AC	3.25	23	0	8	1	5
AD	3.05	8	0	1	0	3
AE	1.95	12	0	3	0	4
AF	1.70	62	0	9	2	4
AG	4.03	86	0	19	1	4
AH	2.84	31	0	9	1	4
B	5.82	4	0	2	0	1
C	1.68	9	0	8	0	1
D	2.21	44	0	19	1	3
E	1.94	13	0	3	0	1
F	3.25	6	0	2	0	1
G	0.76	9	0	2	0	1
H	2.30	3	0	0	0	0
I	2.52	11	0	3	1	0
J	2.45	2	0	3	2	1
K	1.72	12	0	8	0	0
L	1.27	11	0	4	0	0
M	2.54	3	1	0	0	0
N	2.30	20	2	9	1	6
O	5.51	11	0	3	1	4
P	2.37	16	0	9	0	1
Q	2.80	13	0	5	0	0
R	1.27	8	0	2	0	0
S	2.95	7	0	0	0	1
T	2.41	17	0	1	4	2
U	1.77	4	0	4	0	1
V	1.25	1	0	0	0	1
W	3.63	6	0	0	0	0
X	2.00	0	0	1	0	1
Y	1.97	7	0	2	0	0
Z	1.10	5	0	0	0	1

Table 9. Safety Assessment by Segment Ranking

Segment ID	No. of Crashes	Fatal Crashes	Injury Crashes	Intersection EEC KAB > 0	Segment EEC KAB > 0	Overall Rank Sum	Overall Average Rank	Overall Rank
H	4	1	1	1	1	1	2	1
K	22	1	26	1	1	1	9	1
L	19	1	23	1	1	1	8	1
M	4	33	1	1	1	1	7	1
Q	25	1	25	1	1	1	9	1
R	14	1	12	1	1	1	5	1
W	10	1	1	1	1	1	3	1
Y	12	1	12	1	1	1	5	1
A	22	1	8	1	10	9	9	9
B	6	1	12	1	10	9	7	9
C	16	1	26	1	10	9	11	9
E	25	1	17	1	10	9	11	9
F	10	1	12	1	10	9	7	9
G	16	1	12	1	10	9	8	9
I	19	1	17	24	1	9	12	9
P	27	1	29	1	10	9	13	9
S	12	1	1	1	10	9	6	9
U	6	1	23	1	10	9	8	9
V	2	1	1	1	10	9	4	9
X	1	1	8	1	10	9	5	9
Z	8	1	1	1	10	9	5	9
AA	8	1	1	1	23	22	9	22
AB	16	1	17	24	23	23	17	23
AD	14	1	8	1	26	23	12	23
J	3	1	17	32	10	23	14	23
AE	22	1	17	1	28	26	16	26
D	32	1	33	24	26	26	24	26
AG	34	1	33	24	28	28	25	28
AH	31	1	29	24	28	28	24	28
O	19	1	17	24	28	28	20	28
AC	30	1	26	24	33	31	24	31
AF	33	1	29	32	28	31	26	31
T	28	1	8	34	23	31	21	31
N	29	34	29	24	34	34	31	34

Note: Smaller number rankings signify better performance.

Table 10. Traffic Assessment by Segment

Segment ID	Segment Length (miles)	Functional Class	Speed Limit (mph)	2020 Traffic (vpd)	Truck %	LOS	Bicycle Facilities	2045 Projected Traffic (vpd)
A	4.85	Principal Arterial - Other Freeways and Expressway	55	550	0.00	B	YES	581
AA	0.98	Principal Arterial - Other Freeways and Expressway	55	7630	3.29	C	NO	2802
AB	3.95	Major Collector	55	5190	4.21	C	NO	1100
AC	3.25	Major Collector	55	3100	4.21	C	NO	6848
AD	3.05	Major Collector	55	9210	2.06	C	NO	7193
AE	1.95	Minor Collector	55	9210	1.97	C	NO	7050
AF	1.70	Major Collector	45	5030	1.97	C	YES	10680
AG	4.03	Minor Arterial	55	4980	1.97	C	YES	12858
AH	2.84	Minor Collector	55	2880	0.00	C	NO	4400
B	5.82	Principal Arterial - Other Freeways and Expressway	55	1540	0.00	B	NO	1748
C	1.68	Major Collector	55	1850	4.21	C	NO	1186
D	2.21	Major Collector	55	2300	1.21	C	YES	5238
E	1.94	Minor Collector	55	430	0.00	A	YES	2046
F	3.25	Minor Collector	55	430	0.00	A	NO	1824
G	0.76	Major Collector	55	6740	23.78	C	NO	2656
H	2.30	Minor Collector	35	630	23.78	A	NO	2656
I	2.52	Minor Collector	35	630	0.00	A	NO	2322
J	2.45	Minor Collector	55	580	0.00	B	NO	2618
K	1.72	Minor Collector	55	580	0.00	A	NO	2603
L	1.27	Minor Collector	55	1330	0.00	A	NO	3409
M	2.54	Minor Collector	55	910	0.00	B	NO	1576
N	2.30	Minor Arterial	35	1740	17.40	B	NO	1489
O	5.51	Principal Arterial - Other Freeways and Expressway	55	1540	4.21	B	NO	1688
P	2.37	Major Collector	55	1850	4.21	B	NO	5771
Q	2.80	Minor Collector	55	430	0.00	A	NO	1824
R	1.27	Major Collector	55	6740	0.00	C	NO	7050
S	2.95	Major Collector	55	1590	3.74	B	NO	2322
T	2.41	Minor Collector	55	1590	0.00	B	NO	2618
U	1.77	Minor Collector	55	580	0.00	A	NO	2603
V	1.25	Minor Collector	55	370	0.00	A	NO	3409
W	3.63	Rural Minor Collector	55	1660	0.00	C	NO	1576
X	2.00	Minor Arterial	55	730	0.00	A	NO	1489
Y	1.97	Major Collector	55	6740	0.00	C	NO	7050
Z	1.10	Principal Arterial - Other Freeways and Expressway	35	190	15.11	A	NO	923

Table 11. Traffic Assessment by Segment Ranking

Segment ID	Speed Limit (mph)	2020 Traffic (vpd)	Truck %	LOS	Bicycle Facilities	2045 Projected Traffic (vpd)	Overall Rank Sum	Overall Rank
Z	31	34	4	3	6	33	39	1
AB	1	7	5	1	6	32	38	2
C	1	13	5	1	6	31	37	2
N	31	15	3	2	6	29	35	2
X	1	23	17	3	6	29	35	2
Y	1	4	17	1	6	4	10	2
W	1	16	17	1	6	27	33	3
A	1	29	17	2	1	34	35	4
M	1	22	17	2	6	27	33	4
O	1	19	5	2	6	26	32	4
Q	1	30	17	3	6	23	29	4
S	1	17	10	2	6	20	26	4
U	1	26	17	3	6	18	24	4
V	1	33	17	3	6	11	17	4
T	1	17	17	2	6	16	22	5
F	1	30	17	3	6	23	29	7
B	1	19	17	2	6	25	31	8
I	31	24	17	3	6	20	26	8
R	1	4	17	1	6	4	10	8
K	1	26	17	3	6	18	24	9
P	1	13	5	2	6	8	14	9
J	1	26	17	2	6	16	22	11
L	1	21	17	3	6	11	17	11
E	1	30	17	3	1	22	23	13
G	1	4	1	1	6	14	20	14
H	31	24	1	3	6	14	20	14
AA	1	3	11	1	6	13	19	21
D	1	12	16	1	1	9	10	21
AH	1	11	17	1	6	10	16	22
AC	1	10	5	1	6	7	13	24
AE	1	1	13	1	6	4	10	24
AF	30	8	13	1	1	2	3	27
AG	1	9	13	1	1	1	2	27
AD	1	1	12	1	6	3	9	28

Note: Smaller number rankings signify better performance.

Table 12. Roadway Features Assessment by Segment

Segment ID	Segment Length (miles)	Sponsored CHAF?	CHAF?	Length of Existing Road Used Per Mile (% Used)	Degree of Curvature	Roadway Grade	Pavement Condition	No. of Structures
A	4.85	Inactive	1	95%	28.1	0.0	Poor	3
AA	0.98	Identified	2	0%	0.0	0.0	N/A	0
AB	3.95	Identified	8	0%	0.0	0.0	N/A	0
AC	3.25	Identified	8	63%	8.4	0.0	Poor	2
AD	3.05	Identified	4	0%	0.0	0.0	N/A	0
AE	1.95	Identified	6	45%	27.9	0.0	Fair	1
AF	1.70	Identified	4	96%	27.9	0.0	Fair	0
AG	4.03	Identified	7	67%	13.9	8.5	Fair	0
AH	2.84	Identified	6	42%	0.0	0.0	Poor	0
B	5.82	Identified	1	0%	13.9	0.0	N/A	2
C	1.68	-	-	0%	13.9	0.0	N/A	0
D	2.21	Identified	2	96%	5.4	0.0	Poor	3
E	1.94	Identified	2	12%	28.1	0.0	Poor	0
F	3.25	-	-	17%	0.0	0.0	N/A	1
G	0.76	Identified	8	0%	0.0	0.0	N/A	0
H	2.30	Identified	8	11%	0.0	0.0	N/A	0
I	2.52	Identified	2	97%	13.9	0.0	Poor	4
J	2.45	Identified	2	19%	28.1	0.0	Good	0
K	1.72	Identified	1	49%	28.1	0.0	Fair	1
L	1.27	Identified	2	0%	0.0	0.0	Fair	0
M	2.54	Identified	2	0%	0.0	0.0	N/A	1
N	2.30	Identified	7	0%	0.0	0.0	N/A	0
O	5.51	Identified	4	0%	13.9	0.0	N/A	1
P	2.37	Identified	6	0%	13.9	0.0	Poor	1
Q	2.80	Identified	3	30%	28.1	2.5	Poor	1
R	1.27	Identified	11	0%	0.0	2.5	N/A	1
S	2.95	Identified	10	12%	0.0	0.0	Fair	1
T	2.41	Identified	2	92%	28.1	0.0	Poor	0
U	1.77	Identified	2	48%	28.1	0.0	Fair	1
V	1.25	Identified	2	0%	0.0	0.0	N/A	0
W	3.63	Identified	4	0%	0.0	0.0	N/A	0
X	2.00	-	-	94%	8.4	0.0	Good	4
Y	1.97	Identified	7	0%	0.0	0.0	N/A	2
Z	1.10	Identified	2	0%	0.0	0.0	N/A	0

Table 13. Roadway Features Assessment by Segment Ranking

Segment ID	Percentage of Existing Road in Segment Used (%)	Pavement Condition	No. of Structures	Degree of Curvature	Road Grade	Overall Rank Sum	Overall Average Rank	Overall Rank
AF	3	2	1	26	4	4	8	1
T	6	3	1	28	4	7	9	2
AG	7	2	1	20	4	8	7	3
AH	12	3	1	1	4	13	4	4
J	14	1	1	28	4	15	11	5
E	16	3	1	28	4	17	11	6
H	18	4	1	1	1	19	5	7
AA	19	4	1	1	4	20	5	8
AB	19	4	1	1	4	20	5	8
AD	19	4	1	1	4	20	5	8
C	19	4	1	20	4	20	10	8
G	19	4	1	1	4	20	5	8
L	19	2	1	1	4	20	5	8
N	19	4	1	1	4	20	5	8
V	19	4	1	1	4	20	5	8
W	19	4	1	1	4	20	5	8
Z	19	4	1	1	2	20	5	8
K	9	2	18	28	4	27	14	18
U	10	2	18	28	4	28	14	19
AE	11	2	18	26	4	29	14	20
Q	13	3	18	28	4	31	15	21
D	2	3	31	17	4	33	13	22
F	15	4	18	1	4	33	9	22
I	1	3	33	20	4	34	14	24
A	4	3	31	28	4	35	16	25
S	17	2	18	1	4	35	9	25
AC	8	3	28	18	4	36	14	27
M	19	4	18	1	4	37	10	28
O	19	4	18	20	4	37	14	28
P	19	3	18	20	4	37	14	28
R	19	4	18	1	4	37	10	28
X	5	1	33	18	4	38	14	32
B	19	4	28	20	4	47	17	33
Y	19	4	28	1	2	47	12	33

Note: Smaller number rankings signify better performance.

Summary of Highest Scoring Segments
After performing the initial evaluations for each category, segment scores were averaged to provide a combined overall ranking. The ranking allowed for direct comparison between segments and facilitated refinement of these segments to full corridors. **Table 14** lists the summary of rankings and **Figure 27** depicts the segment rankings in tiers; 1-10, 11-20, and 21-34. **Smaller number rankings signify better performance according to the comparative analysis.**

Preliminary Corridors
Individual segments were evaluated through the technical assessment and combined to provide a collection of segments that had the least impacts and most benefits to connectivity. The following preliminary corridors were analyzed as part of the study:

- No Build – No "Outer Loop" construction; routine maintenance and rehabilitation of existing infrastructure in study area.
- Green – At an estimated length of 35 miles, this is the longest of all corridors that provides full connectivity between US 60 east and west of Owensboro. It is the farthest option from / outside the city and is comprised of Segments A, B, C, D, E, F, G, H, I, J, K, L, W, and X. From the scoring perspective, this option is the lowest ranked outer corridor based on the comparative technical analysis.
- Red – At an estimated length of 22 miles, this is the shortest of all corridors that provides full connectivity between US 60 east and west of Owensboro. It is the closest option to the city and is comprised of Segments Z, AA, AB, AC, AD, AE, AF, AG, AH.
- Blue – This corridor is a hybrid option of the Red and Green corridors and has an approximate length of 31 miles. It is comprised of Segments Z, AA, AB, P, D, E, F, G, H, I, J, K, L, W, and X. This corridor ranked the best meaning it would have less impacts and more benefits compared to the other routes.

Table 15 shows the rankings for the combined segments. **Figure 28** shows the preliminary corridors in the context of the study area.

5.3 Project Team Meeting No. 2

The second Project Team meeting was held on Wednesday, March 3, 2021. Attendees included KYTC Division of Planning staff, KYTC District 2 staff, Owensboro MPO / GRADD staff, and the consultant team. The materials presented and discussed at the meeting included a review of the study, data compiled from the LO/S Meeting No. 1, the initial segments, analysis of the segments, and development of preliminary corridors. Discussion focused on the process of the initial segment development and analysis along with the presentation of preliminary corridors to the LO/S and public. For additional detail regarding information presented and discussed at the meeting, refer to the meeting minutes found in **Appendix F**.

Table 14. Summary Ranking of Segments

Segment ID	Beg. MP	End MP	Segment Length (miles)	Overall Rank	Natural Environment Impacts Ranking	Built Environment Impacts Ranking	Safety Impacts Ranking	Traffic Impacts Ranking	Geometrics Ranking
H	I-165	KY 142	2.30	1	4	1	1	14	7
Z	US 60 W	Audubon Parkway	1.10	2	2	10	22	1	8
G	US 231	I-165	0.76	3	1	3	26	14	8
C	KY 81	KY 554	1.68	4	18	9	18	2	8
E	US 431	KY 298	1.94	4	17	1	16	13	6
L	KY 144	KY 1389	1.27	4	6	20	1	11	8
W	KY 1389	KY 405 / KY 662	3.63	7	16	19	1	3	8
V	KY 144	KY 1389	1.25	8	9	25	20	4	8
K	KY 142	KY 144	1.72	9	15	13	1	9	18
T	KY 54	KY 142	2.41	9	10	8	32	5	2
U	KY 142	KY 144	1.77	9	11	13	17	4	19
M	KY 1389	KY 405	2.54	12	8	26	1	4	28
R	US 231	I-165	1.27	12	26	4	1	8	28
Q	KY 298	US 231	2.80	14	31	11	1	4	21
Y	US 231	I-165 / Newbolt Rd	1.97	15	30	7	1	2	33
AA	Audubon Parkway	KY 56	0.98	16	5	18	30	21	8
AB	KY 56	KY 81	3.95	17	12	31	19	2	8
F	KY 298	US 231	3.25	17	25	13	11	7	22
J	KY 54	KY 142	2.45	19	7	32	24	11	5
A	US 60 W	Audubon Parkway	4.85	20	21	23	10	4	25
S	I-165	KY 54	2.95	21	33	12	12	4	25
AF	I-165 / Newbolt Rd	Millers Mill Rd / KY 54	1.70	22	3	24	34	27	1
P	KY 81	KY 554	2.37	22	27	13	14	9	28
AE	US 231	I-165 / Newbolt Rd	1.95	24	14	5	31	24	20
X	KY 405 / KY 662	US 60	2.00	25	13	34	15	2	32
AH	KY 144	KY 1831 / US 60	2.84	26	18	22	27	22	4
I	KY 142	KY 54	2.52	27	23	33	13	8	24
AD	US 431	KY 231	3.05	28	34	6	23	28	8
N	KY 405	US 231 / US 60	2.30	29	29	27	33	2	8
O	Audubon Parkway	KY 81	5.51	30	28	17	21	4	28
AG	KY 54	KY 144	4.03	31	20	30	25	27	3
B	Audubon Parkway	KY 81	5.82	32	32	29	9	8	33
D	KY 554	US 431	2.21	33	24	20	28	21	22
AC	KY 81	US 431	3.25	34	21	27	29	24	27

Note: Smaller number rankings signify better performance.

Figure 27. Ranking of Segments by Tier

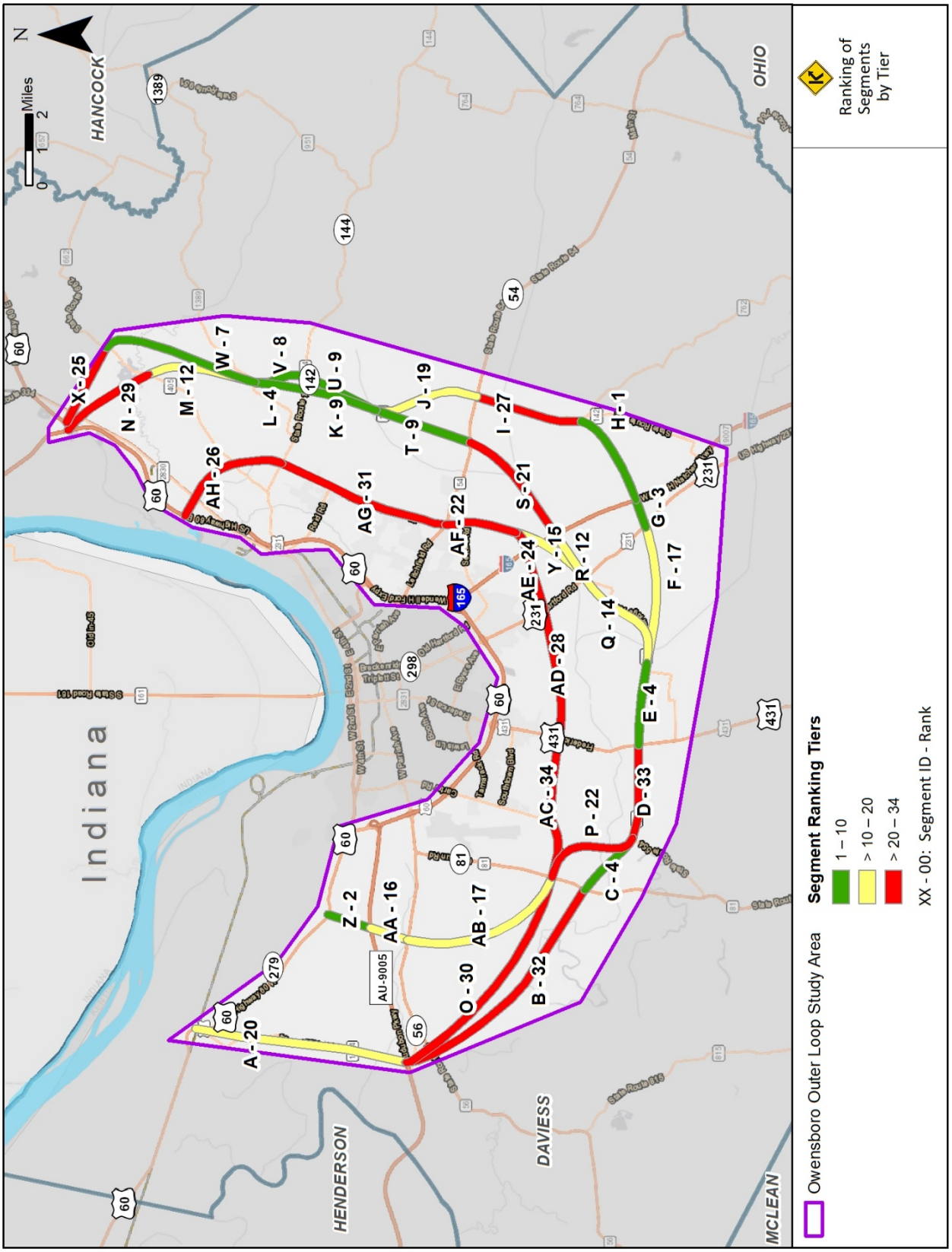
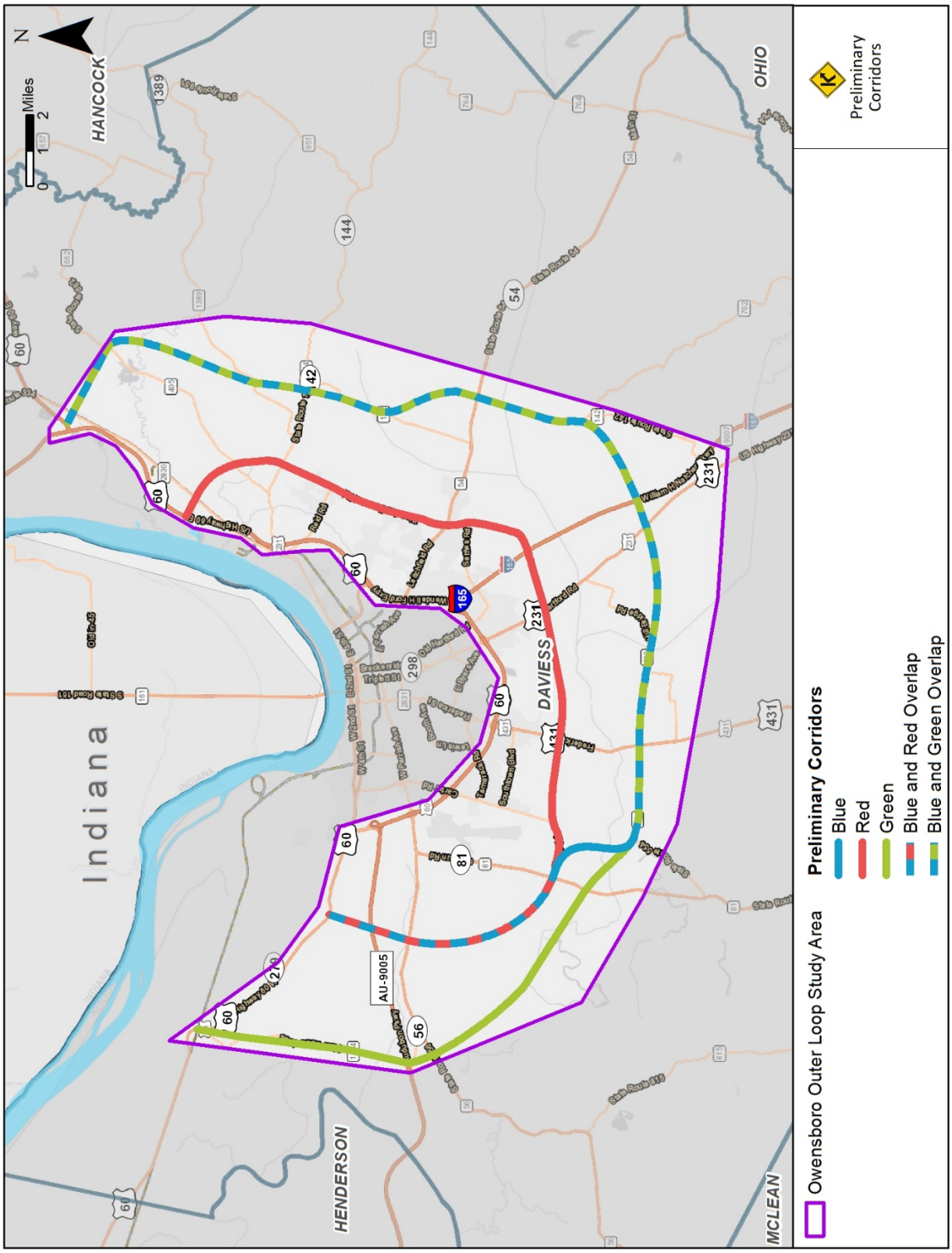


Table 15. Preliminary Corridor Rankings

Preliminary Corridor ID	Total Distance (Miles)	# of Segments	Overall Rank	Segment ID														
21	30.9	15	1	Z	AA	AB	P	D	E	F	G	H	I	J	K	L	W	X
23	32.48	15	2	Z	AA	AB	P	D	E	F	G	H	I	J	U	V	W	X
20	31.67	15	3	Z	AA	AB	P	D	E	F	G	H	I	J	K	L	M	N
22	31.70	15	4	Z	AA	AB	P	D	E	F	G	H	I	J	U	V	M	N
25	30.61	14	5	Z	AA	AB	P	D	E	Q	R	S	T	K	L	W	X	
27	30.64	14	6	Z	AA	AB	P	D	E	Q	R	S	T	U	V	W	X	
24	29.82	14	7	Z	AA	AB	P	D	E	Q	R	S	T	K	L	M	N	
2	35.0	14	8	A	B	C	D	E	F	G	H	I	J	K	L	W	X	
26	29.86	14	9	Z	AA	AB	P	D	E	Q	R	S	T	U	V	M	N	
6	34.56	13	10	A	B	C	D	E	Q	R	S	T	K	L	W	X		
4	36.43	14	11	A	B	C	D	E	F	G	H	I	J	U	V	W	X	
8	34.59	13	12	A	B	C	D	E	Q	R	S	T	U	V	W	X		
1	35.62	14	13	A	B	C	D	E	F	G	H	I	J	K	L	M	N	
3	35.65	14	14	A	B	C	D	E	F	G	H	I	J	U	V	M	N	
5	33.78	13	15	A	B	C	D	E	Q	R	S	T	K	L	M	N		
11	36.77	14	16	A	O	P	D	E	F	G	H	I	J	K	L	W	X	
7	33.81	13	17	A	B	C	D	E	Q	R	S	T	U	V	M	N		
13	36.81	14	18	A	O	P	D	E	F	G	H	I	J	U	V	W	X	
15	34.93	13	19	A	O	P	D	E	Q	R	S	T	K	L	W	X		
10	35.99	14	20	A	O	P	D	E	F	G	H	I	J	K	L	M	N	
17	34.97	13	21	A	O	P	D	E	Q	R	S	T	U	V	W	X		
12	36.03	14	22	A	O	P	D	E	F	G	H	I	J	U	V	M	N	
14	34.15	13	23	A	O	P	D	E	Q	R	S	T	K	L	M	N		
16	34.19	13	24	A	O	P	D	E	Q	R	S	T	U	V	M	N		
29	25.90	11	25	Z	AA	AB	P	D	E	Q	Y	AF	AG	AH				
9	29.85	10	26	A	B	C	D	E	Q	Y	AF	AG	AH					
18	30.22	10	27	A	O	P	D	E	Q	Y	AF	AG	AH					
28	21.9	9	28	Z	AA	AB	AC	AD	AE	AF	AG	AH						
19	27.18	8	29	A	O	AC	AD	AE	AF	AG	AH							

Note: Smaller number rankings signify better performance.

Figure 28. Preliminary Corridors



Chapter 6 – Potential Connectivity Refinement

For the preliminary corridors, additional information was collected to help in consideration of determining feasibility. Traffic forecasts were prepared for the future year 2045, planning-level cost estimates were developed, a geotechnical overview was performed, and information was solicited for input and comments on the study area / preliminary corridors. The following sections describe these activities in more detail.

All analyses was predicated on an ultimate footprint that would consist of:

- Four twelve-foot travel lanes
- Two 10-foot paved shoulders
- Twelve-foot ditches
- Forty-foot median

These elements resulted in a 132-foot typical section plus 34 feet on each side for a clear zone. The larger footprint was considered to ensure adequate capacity for future transportation demand. Additional analysis would be necessary to determine the most appropriate typical section for a new connection, if recommended.

6.1 2045 Traffic Forecasts and Operations

Year 2045 forecasts for all state-maintained routes in the study area were generated using output from the updated Owensboro MPO Regional Travel Demand Model. The model update was completed early 2021 and has a base year of 2018 and a future year of 2045. For this study, **Table 16** includes the projects from CHAFs and the Highway Plan that may affect capacity in the future. Annual growth rates were provided from the model and applied to previously adjusted 2020 volumes. Forecasts for the study area roadways are shown on **Figure 29** as a summary of the 2045 AADT range. For additional details regarding the traffic forecasting process, refer to the Traffic Forecast Report in **Appendix B**. The spreadsheet-based method was used in a similar manner as the 2020 LOS operations analysis to determine 2045 LOS. The resulting 2045 LOS values are shown on **Figure 30**.

Table 16. Identified and Committed Projects Included in Owensboro MPO Regional Travel Demand Model

County	Item No.	Route	Type	Description
Daviess	2-8300	KY 54	Major Widening	Convert section to 5 lanes
Daviess	2-8854	KY 3143	Minor Widening	Convert section to 3 lanes
Daviess	N/A	Fairview Dr.	Extension	Extend Fairview Dr. to Pleasant Valley Rd.
Daviess/ Henderson	N/A	Audubon Pkwy.	Conversion	Convert to interstate facility
Henderson	N/A	I-69	New River Crossing	New route across the Ohio River

Figure 29. 2045 AADT Range

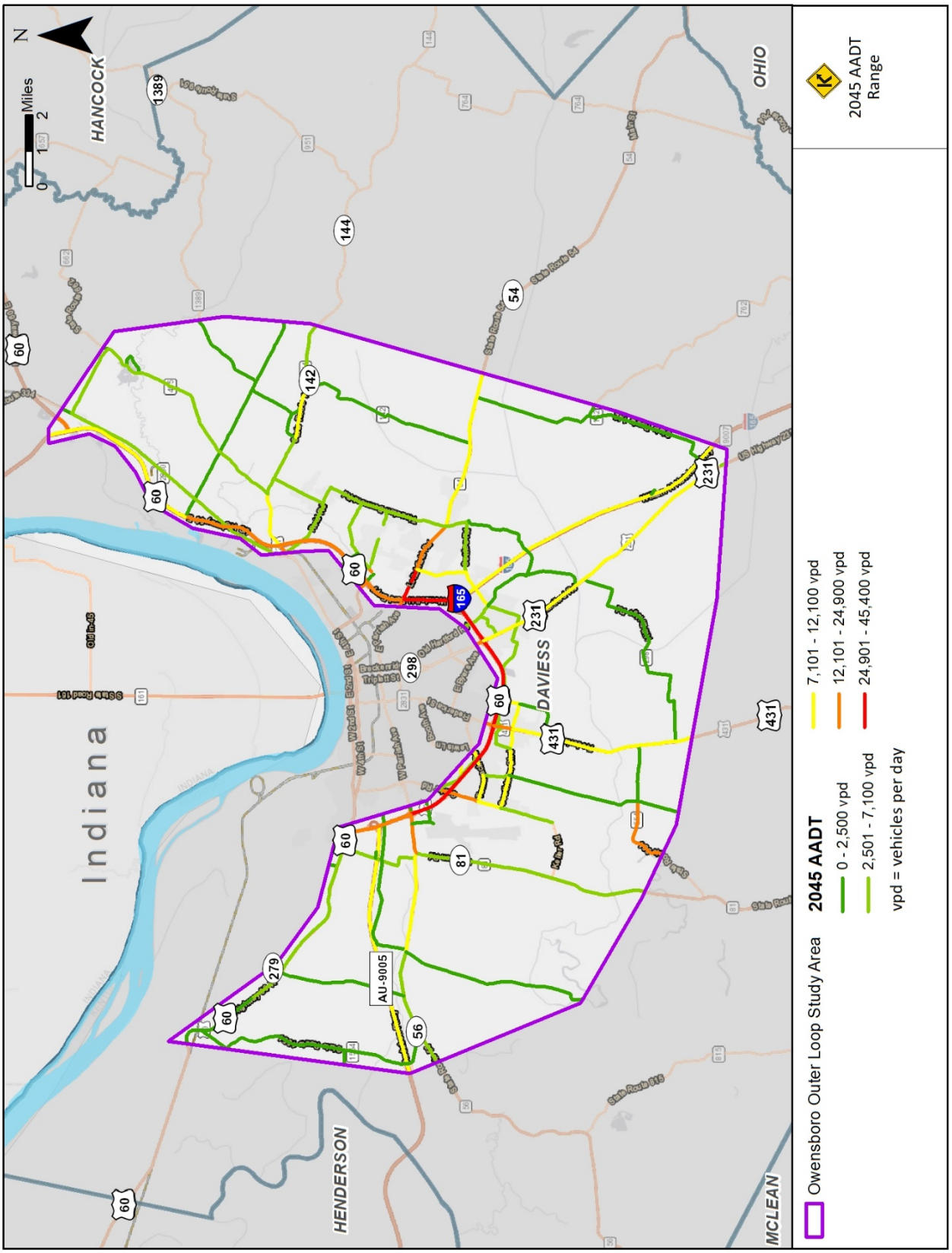
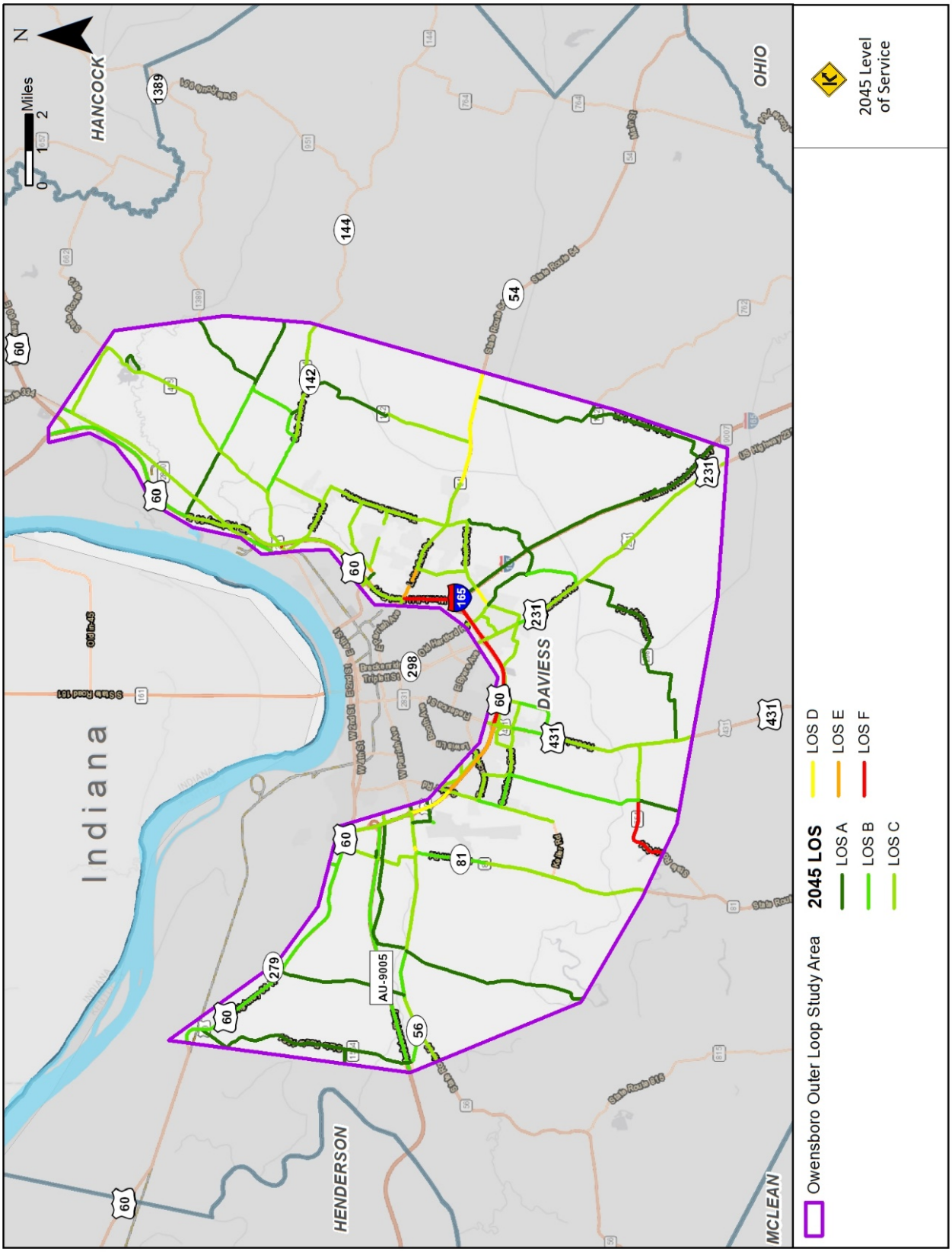


Figure 30. 2045 Level of Service



The Owensboro MPO Regional Travel Demand Model was also used to help determine traffic volumes / usage of the preliminary corridors. Assuming the 4-lane typical section, the resulting traffic volumes for 2045 are shown in **Table 17**. Furthermore, all corridors are assumed to connect to major intersecting roadways including new interchanges with I-165.

Table 17. Preliminary Corridors 2045 AADT

Corridor	Lowest Volume AADT (vpd)		Highest Volume AADT (vpd)		Corridor Weighted Average AADT (vpd)
Green	340	Audubon Pky and US 60	11,670	US 231 to I-165	2,370
Blue	790	Near KY 81 / KY 2698	11,770	US 231 to I-165	2,240
Red	790	US 60 to W 5th St Rd	16,220	KY 144 to KY 1456	8,490

For a breakdown of volumes by segment and changes from the No Build, please refer to the Traffic Forecast Report in **Appendix B**. All segments would operate at an acceptable LOS given the available capacity.

6.2 Planning-Level Cost Estimates

Planning-level (high-level) cost estimates were produced for each of the segments and preliminary corridors by estimating the 2021 costs of Design, Right-of-way acquisition, Utilities, and Construction. No surveying or detailed design was performed. Construction quantities such as pavement, earthwork, traffic items, etc. were estimated for each item determined to be necessary to construct the conceptual improvements. Factors were applied to increase this amount to account for contingencies and miscellaneous items not estimated. This cost was then multiplied by a factor to estimate the design cost. High-level utility location and identification was performed to determine estimates of relocation based on any potential impacts. For new segments or segments along the existing routes that potentially impact areas outside of right-of-way, the area was sent to KYTC to obtain a cost estimate for potential right-of-way acquisition. All costs are based on the typical section noted at the beginning of this section. If a smaller footprint were to be considered such as a two-lane facility, costs would reduce accordingly. **Table 18** displays the costs determined for each preliminary corridor. Costs by segment within each corridor are displayed in **Table 19**. For calculation purposes, all segment costs do not equal the same amount as the corridor costs. The independent segments have higher costs for smaller projects and some overlap between segments.

Table 18. Preliminary Corridor Costs (2021 dollars)

Corridor	Design	ROW (Per Acre)	Utilities (Per Mile)	Construction	Total
Green	$23,600,000	$37,800,000	$21,000,000	$282,600,000	$365,000,000
Blue	$21,300,000	$35,400,000	$18,600,000	$255,500,000	$330,800,000
Red	$14,500,000	$26,200,000	$13,100,000	$174,000,000	$227,800,000

Table 19. Preliminary Corridor Costs by Segment (2021 dollars)

Corridor	Segment	Segment Length	Overall Cost
Green	A	4.85	$ 44,240,800
	B	5.82	$ 62,574,400
	C	1.68	$ 16,452,100
	D	2.21	$ 23,629,800
	E	1.94	$ 18,433,700
	F	3.25	$ 31,911,400
	G	0.76	$ 10,561,400
	H	2.30	$ 24,533,400
	I	2.52	$ 27,774,400
	J	2.45	$ 23,299,800
	K	1.72	$ 17,620,000
	L	1.27	$ 12,517,700
	W	3.63	$ 34,522,000
	X	2.00	$ 24,853,700
Blue	Z	1.10	$ 19,489,500
	AA	0.98	$ 18,028,000
	AB	3.95	$ 37,571,500
	P	2.37	$ 24,534,600
	D	2.21	$ 23,409,900
	E	1.94	$ 18,252,600
	F	3.25	$ 31,678,200
	G	0.76	$ 17,168,800
	H	2.30	$ 31,036,700
	I	2.52	$ 27,542,200
	J	2.45	$ 23,258,700
	K	1.72	$ 17,442,900
	L	1.27	$ 12,382,900
	W	3.63	$ 34,250,700
	X	2.00	$ 24,779,600
Red	Z	1.10	$ 19,489,500
	AA	0.98	$ 18,808,700
	AB	3.95	$ 37,874,600
	AC	3.25	$ 31,736,400
	AD	3.05	$ 29,193,800
	AE	1.95	$ 30,974,200
	AF	1.70	$ 14,670,500
	AG	4.03	$ 38,036,800
	AH	2.84	$ 26,421,900

6.3 Geotechnical Assessment

A preliminary geotechnical assessment was conducted to provide general geotechnical concerns in the area focused on the preliminary corridors. Findings include:

- The study area is in the Western Coal Field Physiographic Region.
- Several faults are located within the west and northeast ends of the study area as well as just south of the study area. Additional information may be needed for structures, but the faults are not expected to have a detrimental effect on any future project.
- An inactive coal mine is in the west end of the study area. It has been mined extensively with most of the coal removed.
- There are numerous oil and gas wells within the study area with the majority being dry and abandoned.
- Based on a site review and collected information, the subgrade for new roadways will consist of clay and silt with some sand. Stabilization will likely be required. The existing embankment fills are constructed at 2H:1V or flatter inclinations. Fill embankments over 20 feet will be required at new bridge approaches.

For additional information and graphics depicting these features, please refer to **Appendix G**.

6.4 Resource Agency Coordination

To help with early identification of potential construction impacts or mitigation needs, the KYTC Division of Planning requested input and comments from several agencies by email. Study information provided along with the email includes forecasted traffic volumes, crash data, and general environmental overview characteristics. The preliminary conceptual corridors were also provided for reference. Nine responses were received from the following agencies and are presented in the order as they were received:

- Kentucky Airport Zoning Commission: Their response noted they did not observe anything in the study area regulated by the Airport Zoning Commission.
- Kentucky Heritage Council: Response noted to consider obtaining preliminary or full records reviews for above ground cultural resources and archaeological resources.
- Kentucky State Nature Preserves Commission: Wetlands within the Panther Creek watershed, particularly those within the Jackson Flats should be avoided. These areas include a variety of high-quality natural communities that are critical habitat.
- Kentucky Department of Fish and Wildlife Resources: Identified federally (3) and state (17) listed species within the study area.
- Kentucky Department for Natural Resources: Two certified agricultural districts are located within the study area. There is the potential that the Green Corridor could affect existing agricultural district 030-01 along KY 54. The response noted that both prime farmland and farmland of statewide importance is vital to our state's agricultural economy.
- Kentucky Division of Forestry: Any selected improvements should follow Owensboro's Code of Ordinances as it pertains to trees.
- Kentucky Department for Public Health: A summary report of Active Living (Non-motorized travel) Health Impact Assessment was provided. In the report, pedestrian activity was noted as low to mid-range within the study area. Bicycle activity shows a low range within the study area. Requests consideration that non-motorized facilities be incorporated with any improvement projects and not adversely affect at risk populations or minority or low-income residential areas.
- US Army Corps of Engineers, Louisville District: The response noted it appears a Department of the Army (DA) Permit may be required as work may be in or near what appears to be "waters of the US".

- Kentucky Department for Environmental Protection: The response included several notations regarding permitting and identified environmental concerns.
    - The Water Quality Branch requests best management practices should be utilized to reduce runoff from project construction activities into nearby waters.
    - The Water Resources Branch noted a Clean Water Act Section 401 Water Quality Certification from the DOW is required for this project as there are three mitigation sites, several streams that are impaired, and several streams that are full support for aquatic life.
    - The Goundwater Section of the Watershed Management Branch notes there are domestic groundwater well users in the vicinity of the study and a Groundwater Protection Plan (GPP) would need to be developed to protect groundwater resources.
    - The Surface Water Permits Branch notes that if the construction area disturbed is equal to or greater than 1 acre, a Kentucky Pollutant Discharge Elimination System (KPDES) stormwater discharge permit should be obtained.
    - The Division of Waste Management noted underground storage tank sites (UST), superfund sites, active / historic landfill sites, solid waste sites, hazardous waste sites, and RLA tracked open dumps within the study area.
    - The Division for Air Quality provided suggestions on how to stay in compliance with NAAQS during construction.
    - Finally, the Kentucky Nature Preserves noted that there is the potential of impacting federally or state listed species and natural communities.

All responses are included in **Appendix H** for more information.

6.5 Summary of Refinement

Compiling the additional information, a high-level summary sheet was developed for each preliminary corridor. **Figures 31 –33** display information about each corridor from a relative comparative point. These figures helped display information to be conveyed to the LO/S and public as discussed in the next section.

Figure 31. Green Preliminary Corridor Summary

GREEN

This 35.0-mile corridor is the outermost connection and extends from US 60 / US 231 in the east to US 60 in the west. A new interchange would be constructed at I-165.

Evaluation Criteria

Usage	✓
Safety	✓ ✓ ✓
Environmental Impacts	✓
Access to Community Facilities	✓ ✓
Cost	✓
Bicycle Connectivity	✓

✓ Good ✓ ✓ Better ✓ ✓ ✓ Best

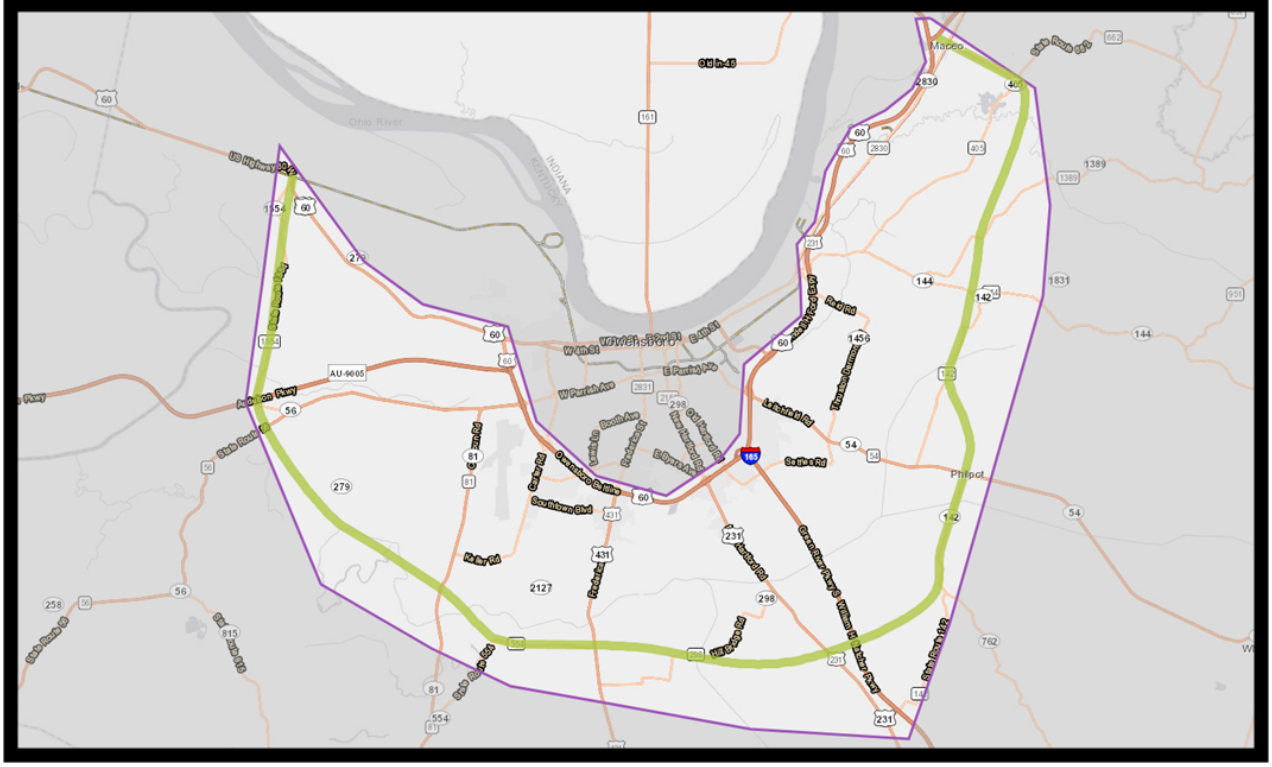


Figure 32. Blue Preliminary Corridor Summary

BLUE

This 30.9-mile corridor is a hybrid inner / outer connection and goes from US 60 / US 231 in the east to US 60 in the west. A new interchange would be constructed at I-165 and the Audubon Parkway.

Evaluation Criteria

Usage	✓
Safety	✓✓
Environmental Impacts	✓✓
Access to Community Facilities	✓
Cost	✓
Bicycle Connectivity	✓

✓ Good ✓✓ Better ✓✓✓ Best

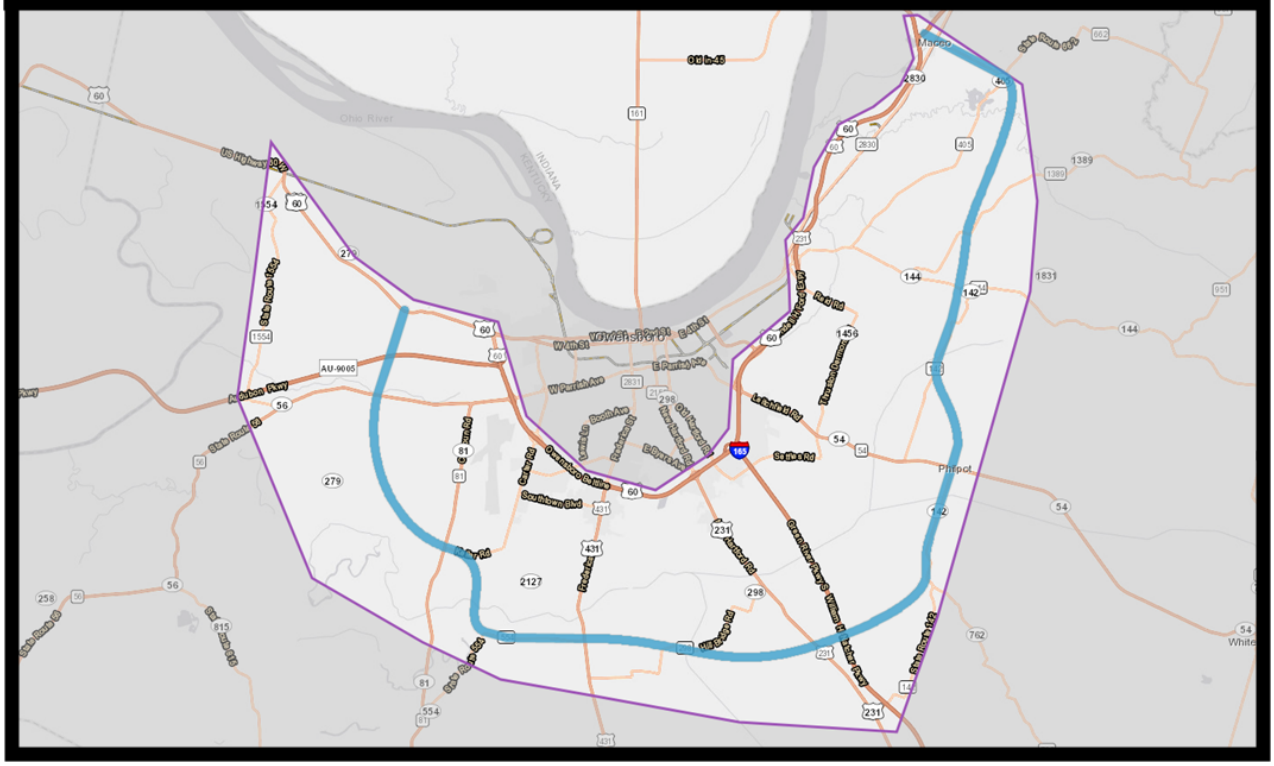


Figure 33. Red Preliminary Corridor Summary

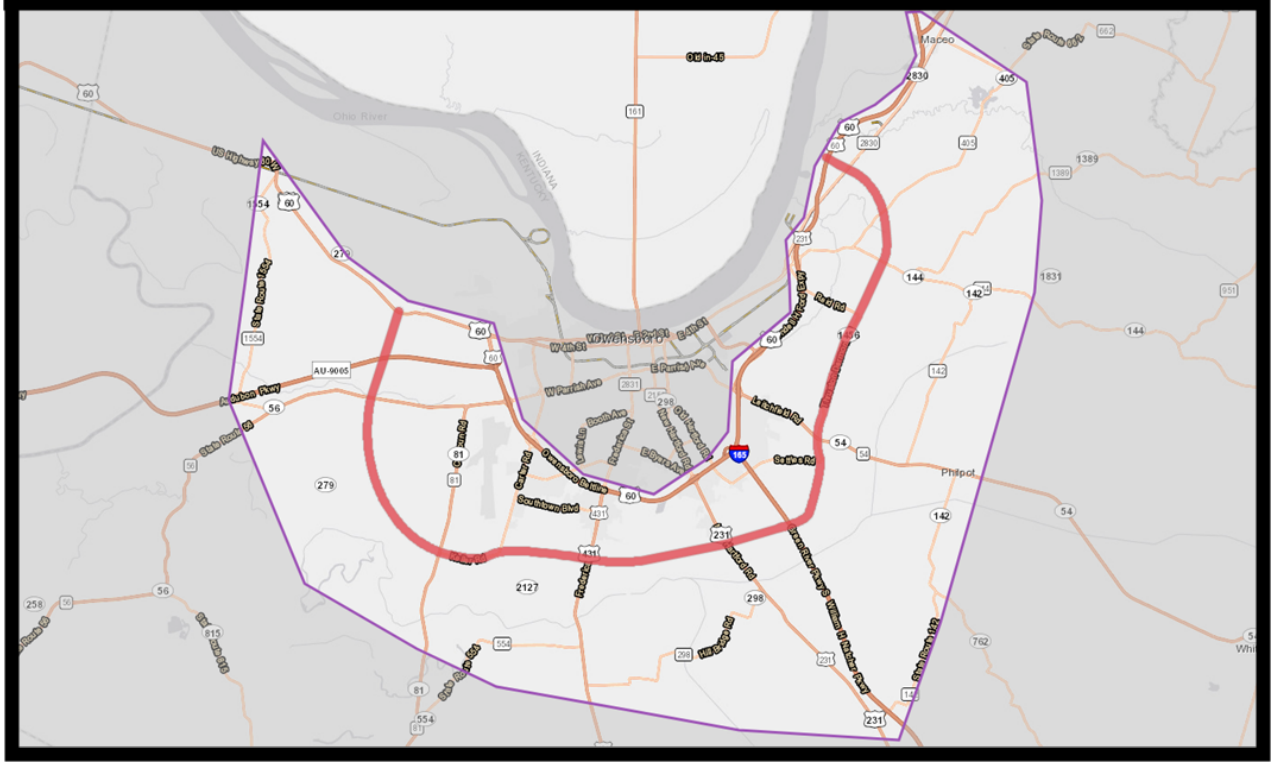
RED

This 21.9-mile corridor is the innermost connection and extends from US 60 in the east to US 60 in the west. A new interchange would be constructed at I-165 and the Audubon Parkway.

Evaluation Criteria

Usage	✓✓✓
Safety	✓
Environmental Impacts	✓
Access to Community Facilities	✓✓✓
Cost	✓✓
Bicycle Connectivity	✓✓✓

✓ Good ✓✓ Better ✓✓✓ Best



Chapter 7 – Additional Engagement Efforts

7.1 Local Officials / Stakeholder Meeting No. 2

The second LO/S meeting was held virtually on Friday, May 7, 2021. Its purpose was to update the LO/S on the status of the study, present the preliminary corridors and analysis compared to the No Build, and gather feedback prior to public engagement. A presentation was given by the consultant that provided information on study background, a review of the first LO/S Meeting, initial segment development and analysis, and preliminary corridors. An online survey link was provided to all invited LO/S via email (45 invitees total) to collect input on study issues, general connectivity needs, and existing transportation issues. A total of thirteen (13) responses were received. The majority response for input collected includes:

- Most respondents attended the first LO/S Meeting and completed the first survey (11/12 responses)
- Most respondents live and work in / or adjacent to the study area (8/12 responses)
- Safety was identified as the most important issue (number one selection by 61.5% response)
- Of the preliminary corridors, Red was selected as the preferred option (4 responses) followed by Green and Blue (3 responses each). None of the above was selected by one respondent.
- When asked to select preferred segments within the corridors to evaluate priority, the top three selected segments included a tie between: G (3 responses), K (responses), and AC (3 responses) and AE (3 responses).
- No other connections were identified that are not currently being considered.
- Relative to other Identified and Committed projects, most responses ranked the need for an outer loop around Owensboro as "Medium" (8/13 responses)

A full summary of the meeting and the input is included in **Appendix F**.

7.2 Public Meeting Summary

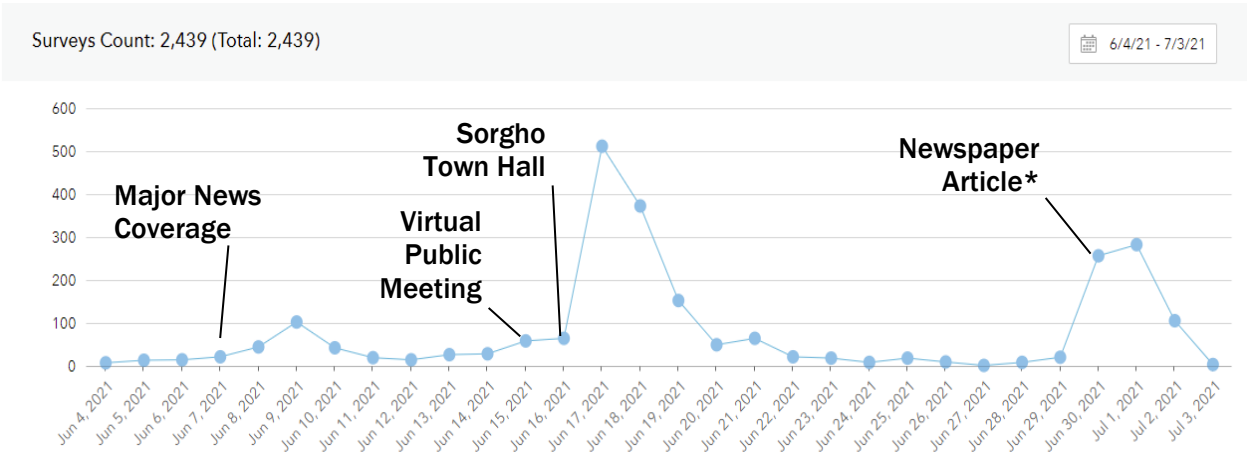
Virtual public engagement for this study consisted of hosting a virtual meeting using the Zoom platform as well as an informational survey open for four weeks to collect input on the study information and feasibility of an outer loop around Owensboro.

The survey was available on the study Story Map as well as an individual link shared by KYTC (website, Facebook, Twitter), news agencies, and other outlets. For reference, a Story Map is a web-based application in ArcGIS that enables the user to share maps in the context of narrative text and other multimedia content. To further enhance the Facebook views, a tool called Facebook Boost was employed on June 10th and June 25th. These dates correspond with just prior to the virtual meeting and right before the closure of the survey. The survey was open from June 4, 2021 to July 3, 2021. There were 2,439 surveys submitted.

The virtual public meeting was held on June 15, 2021 using the Zoom platform. The meeting date was advertised through a number of traditional means (i.e. virtual message boards and local media) and used resources through social media to spread the message. During the course of the two-hour meeting, there were 182 maximum participants. In the chat box, 235 questions were entered requesting more study information. All were answered either during the meeting or in a separate post to the KYTC District 2 website following the meeting. The presentation of material was performed twice during the meeting; once each hour.

Figure 34 shows the timeline for the virtual public engagement with key milestones; where meetings were held; or advertising was enhanced. For reference, the Sorgho Town Hall was a meeting initiated by local citizens to discuss the study.

Figure 34. Public Engagement Timeline



*An article was published in the Messenger-Inquirer titled "Deadline for outer loop survey approaching". The June 30 spike could be attributed to this notification. [Deadline for "outer loop" survey approaching | Local News | messenger-inquirer.com]

The following serves as an overview of the results obtained from the Survey123 software. Questions included in the survey yielded the following response:

- The majority of people found out about the survey through KYTC District 2 Facebook / Twitter (989 or 40.55%) or by other means such as by word of mouth and news media (993 or 40.71%).
- The majority of respondents live and work in the study area (1,091 or 41.73%).
- Environmental Impact is the most important issue (871 responses or 36.49% or the total responses) identified relative to cost, safety, economic development, travel time or bicycle / pedestrian opportunities.
- Other issues that were noted as important included: homes, family, farm, and land impacts.
- In comparing the preliminary corridors to the No Build, the majority of respondents selected "None of the above" or "No Build" (1,532 or 62.81%).
- When asked to select preferred segments within the corridors to evaluate priority (related to independent utility), the top three selected segments included AF (283 responses), AE (245 responses), and A (215 responses).
- Relative to other Identified and Committed projects, most responses ranked the need for an outer loop around Owensboro as "Low" (2,035 or 83.44%)

Following the virtual public meeting, additional public responses was collected in the following forms:

- News Articles
- KYTD District 2 Facebook Comments Page
- Website – https://stoptheouterloop.com
- Petition – [Petition · Stop the Owensboro Outer Loop · Change.org]

(5,982 signatures)
- Written Petition – 1,779 Signatures
- Email Responses

The majority of these efforts were to express concern that farmland and homes were more important than new transportation connections.

7.3 Project Team Meeting No. 3

The third (and final) Project Team Meeting was held on Tuesday, July 20, 2021. Attendees included KYTC Division of Planning staff, KYTC District 2 staff, Owensboro MPO / GRADD staff, and the consultant team. The materials presented and discussed at the meeting included:

- Review of the study background
- Data compiled from the LO/S Meeting No. 2
- Input from the public meeting / information meeting and survey
- A summary of preliminary corridors (comparative information provided in **Table 20**)
- Discussion of additional analysis on high-ranking segments

Segments G, K, AC and AE were the top segments identified by local officials / stakeholders. Segments A, AD, AE, and AF received more than 200 positive responses from the survey. The Project Team determined there was merit in evaluating three short segments and one combination of segments that have the potential to be independent projects with consideration to go into the CHAF Database. The discussion yielded the following segments for additional analysis: AE, AF, G, and a combination of AE and AF.

Table 20. Preliminary Corridor Summary

Summary Categories	No-Build	Red	Blue	Green
Length (Miles)	N/A	21.9	30.9	35.0
Traffic Volume Average (2045 AADT)	N/A	8,490	2,240	2,370
Public Input (Survey Only)*	1,532	380	136	190
Cost (Design, ROW, Utilities, and Construction)**	N/A	$227,800,000	$330,800,000	$365,000,000

Notes:
*Question requested input on preference of No-Build, Red, Blue or Green option. 201 survey participants did not answer this question.
**These are DRAFT 2021 planning level costs subject to further review assuming an access-controlled facility with four 12' Lanes; two 10' Shoulders, 12' Ditches, 40'Median, and 34' Clear Zone. Costs will decrease as the typical section footprint decreases.

For additional detail regarding information presented and discussed at the meeting, refer to the meeting minutes found in **Appendix F.**

Chapter 8 – Benefit-Cost Analysis

Benefits of a transportation investment measure the direct and positive effects of that project over a specified period of time. A benefit-cost analysis (BCA) can be leveraged as one of the many tools to consider improvements and support decisions for infrastructure investment. Relying upon guidance from the U.S. Department of Transportation Benefit-Cost Analysis Guidance for Discretionary Grant Programs (2021), there are four primary areas of project benefit that can be translated into monetary values. These include:

- Travel Time Savings (vehicle-hours traveled or VHT)
- Vehicle Operating Costs (vehicle-miles traveled or VMT, which is the most common variable that affects vehicle operating costs)
- Safety Benefits (reduction in the likelihood of fatalities, injuries, and property damage resulting from crashes on the investment)
- Emissions Reduction Benefits

Benefits for BCA for KYTC Division of Planning studies typically consider travel time savings based on VHT and crash cost savings. This is also consistent with evaluation processes used for the Strategic Highway Investment Formula for Tomorrow (SHIFT), the Cabinet's data-driven, objective approach to compare capital improvement projects and prioritize limited transportation funds.

Costs for this planning stage focused on capital costs – the total investment required to prepare a highway improvement for service. Maintenance costs were not included as the initial benefit-cost time period focuses on the initial benefit of construction. All monetary values are in constant (2021) dollars. Discounting (the process of converting the costs and benefits that take place in different years into a common year) is not included for this high-level analysis.

VMT can be monetized as an operating cost. Though KYTC does not typically consider this cost in planning studies, this information is included as an additional factor and a supplemental BCA.

8.1 Preliminary Corridors Benefit-Cost Analysis

The focus for BCA for the preliminary corridors is VHT savings provided by the updated Owensboro MPO Regional Travel Demand Model. Safety benefits were not considered at this high-level of analysis and likely would be minimal compared to the VHT savings. **Table 21** provides output from the model for VMT and VHT. **Table 22** presents the high-level BCA for the preliminary corridors and the resulting ratio of Benefit versus Cost. Values of 0.48 cents per mile and $32.05 user cost per hour were used to apply dollar values to the VMT and VHT changes respectively. These values were based on recommendations from the US Department of Transportation's (USDOT) *Benefit-Cost Analysis Guidance for Discretionary Grant Programs (2021)*[6].

[6] https://www.transportation.gov/sites/dot.gov/files/2021-02/Benefit%20Cost%20Analysis%20Guidance%202021.pdf#:~:text=1%E2%80%9Cenefit-cost%20analysis%E2%80%9D%20and%20%E2%80%9Ccost-benefit%20analysis%E2%80%9D%20are%20interchangeable%20names,method%20for%20ranking%20projects%20is%20the%20benefit-cost%20ratio.

Table 21. Preliminary Corridor VMT and VHT

Scenario	VMT	VMT delta	VHT	VHT delta
No-Build	4,754,013	N/A	119,500	N/A
Red Corridor	4,773,972	19,959	118,862	-638
Green Corridor	4,782,084	28,071	119,016	-484
Blue Corridor	4,776,987	22,974	119,025	-475

Table 22. High Level Benefit Cost Analysis

Scenario	Operating Cost/yr	Travel Time Savings/yr	Travel Time minus Operating Cost/yr	Benefit over 20 yrs	Capital Cost (DRUC)	B/C
No-Build	N/A	N/A	N/A	N/A	N/A	N/A
Red Corridor	$3,496,817	$7,462,855	$3,966,038	$79,300,000	$227,800,000	0.35
Green Corridor	$4,918,039	$5,661,476	$743,437	$14,900,000	$365,000,000	0.04
Blue Corridor	$4,025,045	$5,556,201	$1,531,156	$30,600,000	$330,800,000	0.09

As shown in the table, benefit-costs (B/C) presented for the preliminary corridors are all less than 1.0.

8.1 Segments Benefit-Cost Analysis

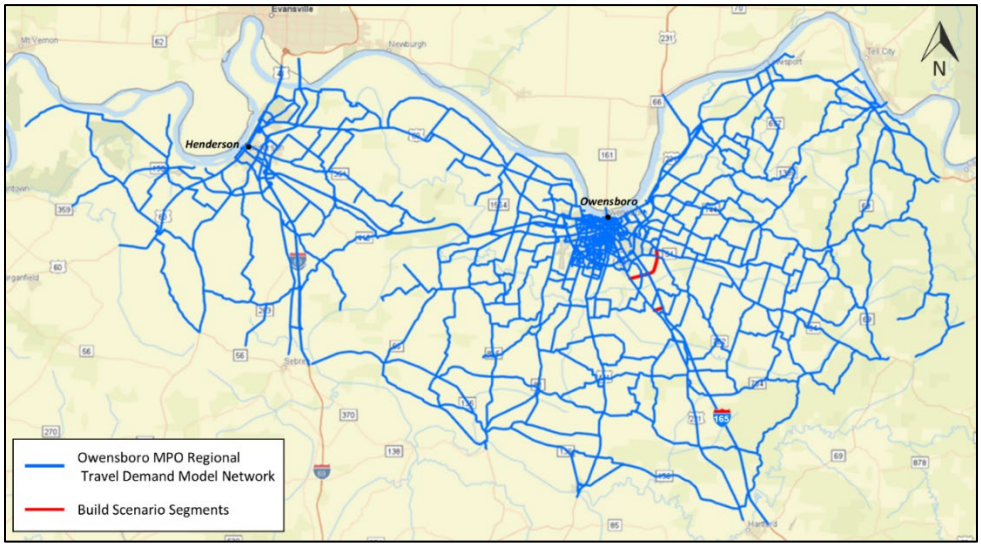
Segments for Analysis
At the third Project Team Meeting, it was determined there was merit in evaluating three segments that have the potential to be independent projects with consideration to go into the CHAF Database. Therefore, a benefit-cost analysis was performed for the following build scenarios:

- Scenario G – Segment G
- Scenario AE – Segment AE
- Scenario AF – Segment AF
- Scenario AE-AF – Segments AE + AF

Each build scenario was compared to the No Build or Base Scenario.

Travel Time Savings – VHT
The study used the updated Owensboro MPO Regional Travel Demand to forecast traffic volumes and miles traveled for the study horizon year of 2045. This model provided forecasts for the entire region as depicted in **Figure 35**.

Figure 35. Owensboro MPO Regional Travel Demand Model Links



Though this road network expands greatly beyond the study area, it should be noted that each model run (or each forecast) is based on the same No Build or base model run. The only variable in each scenario is the addition of the added segments, G, AE, AF, and AE + AF. The area of influence of changes in traffic volumes for each Build Scenario likely does not extend outside the study area, so there is no negative or risk in using the larger model area for the VHT and VMT forecasts.
In the table that follows (**Table 23**), the traffic volume data is summarized as daily maximum volumes for the Build Scenario segments and VHT for each scenario. The VHT delta indicates the change between the No Build and each Build scenario.

Table 23. Segment VHT

Scenario	Max Volume	VHT	VHT delta
No Build	N/A	119,500	N/A
G	12,580	119,209	-291
AE	5,580	119,389	-111
AF	10,680	119,373	-127
AE + AF	12,130	119,230	-270

Based solely on a consideration of reduction in the forecast daily VHT for 2045, Scenario G shows the greatest improvement, in a daily reduction of 291 VHT. The benefit associated with travel time savings for the BCA is $32.05. This is based on Recommended Hourly Values of Travel Time Savings (2019 U.S. $ per person-hour) from the US Department of Transportation's (USDOT) *Benefit-Cost Analysis Guidance for Discretionary Grant Programs (2021).* The analysis assumes 10% trucks across the study area for calculation purposes.

The cost of an hour in traffic is derived as follows per the guidance cited above:

Auto Cost of Time/hr	$17.90
Truck Cost of Time/hr	$30.80
Overall Vehicle Cost of Time/hr	$19.19
Occupancy Rate	1.67

Overall Occupant Cost of Time/hr $32.05

With the cost of time of $32.05 and the VHT considered over a 20-year BCA period, the following benefits in **Table 24** are associated with the various Build Scenarios:

Table 24. Travel Time Savings (Benefit) for Additional Segment Analysis

Scenario	VHT Reduction/Year	VHT Yearly Benefit	VHT 20yr Benefit
No Build	N/A	N/A	N/A
AE	40,515	$ 1,298,500	$ 25,970,000
AF	46,355	$ 1,485,700	$ 29,714,000
G	106,215	$ 3,404,200	$ 68,084,000
AE + AF	98,550	$ 3,158,500	$ 63,170,000

Over a 20-year BCA period, there is a benefit of less time on the road (VHT) that can be monetized from a low of $25,970,000 for Scenario AE, to a high of $68,084,000 in benefit for Scenario G. This BCA should be used for comparison of scenarios and is not meant to present an actual Return on Investment (ROI) value.

Crash Cost Savings

The methodology for examining the potential reduction in crashes was developed in coordination with KYTC Division of Planning and Division of Traffic Operation's Highway Safety Improvement Program (HSIP) staff. Unlike the travel time savings, the area analyzed was confined to the study area and considered the major road segments for which KYTC had evaluated Excess Expected Crashes (EEC). This was to align the BCA crash savings analysis with the study's earlier crash analysis. Information regarding roadway type used for EEC analysis was provided for the study and was used as the basis for this portion of the BCA.

The map that follows (**Figure 36**) depicts the road segments considered.

Figure 36. Segments Included in Crash Cost Savings Analysis

For all roadway segments included in the EEC data set above, information was readily available regarding the roadway type used in KYTC's Safety Performance Function (SPF) Predictive Crash calculations. This SPF Predictive Crash methodology is documented in the Kentucky Transportation Center's (KTC) report[7].

The team discussed with KYTC if considering historical crash data for the road network in the study area to determine an Empirical Bayes Expected Crash estimate was appropriate. The conclusion was to only use the SPF Predictive Crash calculation. When forecasting for a future year, over 20 years from the present, the use of historical crash data for the most recent year was not recommended.

The SPF Predictive Crash calculation, per the KTC report, is as follows:

$$\textbf{SPF Predicted Crashes} = L * e^{a} * AADT^{b} * AF$$

Where,

L = Length of Segment
AADT = Annual Average Daily Traffic
a = regression parameter for intercept
b = regression parameter for AADT
AF = adjustment factor (if needed)

Also note that "e" is Euler's Number.

The SPF Predicted Crash formula above considers these variables:

- Length of the roadway segment
- AADT – Volumes used are from the traffic model forecasts for 2045 for the No Build and each Build Scenario
- Roadway Type determines the regression parameters ("a" and "b") for the formula
- Adjustment Factors are not currently used in SHIFT analysis and were not used in this BCA

For a study of an entire road network, looking only at road segments was determined to be appropriate. It is acknowledged that considering predicted crash reductions associated with intersections would provide an additional data point, but the road segment analysis alone provides sufficient BCA information to evaluate differences in improvement concepts. When both analysis (road segments and intersections) are used in the SHIFT process, they are not consolidated, but stand as two separate measures to identify potential project locations. There is not an established methodology for determining what to consider a road segment as opposed to an intersection so that these data points or calculations could be combined into one metric. Additionally, the methodology and associated formulas for intersections, used by KTC in their EEC analysis for KYTC, has not been published.

This BCA for crash reduction uses comprehensive cost for overall crashes calibrated for the study area. That cost applied to each crash is $50,676. SHIFT breaks EEC analysis by severity, into KAB

[7] Safety Analysis for SHIFT Implementation
Report Number: KTC-19-23/PL31-1F
https://doi.org/10.13023/ktc.rr.2019.23

and CO. The table that follows (**Table 25**), describes the KABCO model and associated cost used by KYTC in the HSIP. The highlighted value is the cost applied to each crash.

Table 25. Values of Crash Costs

Crash Costs based on Recent Research by VHB[8]		
Description	**Code**	**Comprehensive Cost**
Fatality	K	$9,281,571
Suspected Serious Injury	A	$537,913
Suspected Minor Injury	B	$162,885
Possible Injury	C	$102,957
No Apparent Injury	O	$9,689

Owensboro Outer Loop Severity Distribution (2017-2020)		
Code	**# of Crashes**	**Total Cost**
K	15	$139,223,565
A	25	$13,447,825
B	274	$44,630,490
C	401	$41,285,757
O	4937	$47,834,593

Weighted Average Costs	
KA	$3,816,785
KAB	$628,350
KABC	$333,689
KABCO	$50,676
AB	$194,242
ABC	$141,949
ABCO	$26,113
CO	$16,695

Since SHIFT analyzes KAB and CO crashes as separate EEC calculations, the team gave this consideration. Presently, KTC has not published the Regression Parameters and Over Dispersion Parameter tables developed for KAB and for CO. The only table published and available for use is that for all crashes (KABCO). That table (Table 26), from the KTC report referenced earlier follows:

[8] VHB stands for the engineering firm of Vanasse Hagan Brustlin, Inc. The costs determined as part of the research were developed for FHWA Office of Safety Programs and adopted by the KYTC Highway Safety Improvement Program for use in countermeasure development and evaluation.

Table 26. KTC Values for Parameters

Appendix B Regression Parameters and Over-Dispersion Parameters for SPFs

The following table represents the regression parameters for eight roadway types.

Roadway Type	a	b	θ
Rural two Lane	-4.492	0.844	1.532
Urban two Lane	-3.65	0.78	1.126
Rural Multilane (Divided)	-5.337	0.768	1.951
Rural Multilane (Undivided)	-6.962	1.045	0.649
Urban Multilane (Divided)	-4.171	0.761	0.814
Urban Multilane (Undivided)	-6.894	1.15	0.882
Rural Interstate and Parkways	-6.358	0.869	2.448
Urban Interstate and Parkways	-10.595	1.305	1.642

The methodology applied for the BCA crash cost savings is summarized as follows:

- All road segments in the study area which had a previous EEC calculation were analyzed
- SPF Predicted Crashes were calculated for each roadway segment
- These segments included the proposed Build Segments, G, AE, AF, and AE + AF
- The SPF Predicted Crashes were based on traffic volume forecasts for 2045
- An overall crash cost of $50,676 was used
- No Adjustment Factor (AF) was applied for any road segment

The actual process was as follows:

Traffic volume forecasts for the No Build and each Build Scenario were spatially joined to the EEC shapefile in an ESRI ArcGIS platform. This included adding line segments for each of the Build Scenario segments, G, AE, AF, and AE + AF. This data was then exported to Microsoft Excel. In the spreadsheet, an SPF Predicted Crash estimate was calculated for each roadway segment, for the No Build and each Build Scenario. The change in Predicted Crashes from the No Build compared to each Build Scenario was calculated. The change in Predicated Crashes was then multiplied by the crash cost of $50,676 and this value was multiplied by 20 to provide a 20-year BCA value.

Results of the BCA crash cost savings are shown in **Table 27**.

The table that follows indicates that Scenario G reduces crashes by 123 annually. This relates to a benefit over 20 years of $124,348,400. The data also shows that Scenario AE and AE + AF actually increase crashes in a given year by 15 and 10 respectively, so rather than there being a benefit related to crash reduction associated with Scenarios AE and AE + AF, there is actually a cost due to increased crashes associated with each.

Table 27. 20-Year Crash Cost Savings

Build Scenario	Crashes Reduced/yr	20yr Crash Cost Savings
G	123	$ 124,348,400
AE	-15	$ (15,372,000)
AF	7	$ 7,019,000
AE + AF	-10	$ (10,216,500)

As can be seen in the table above, Scenario G provides a significant crash cost savings. Most of this can be attribute to Scenario G providing access to I-165 and allowing traffic to divert to I-165 rather than travel on the rural two-lane US 231. On US 231, from MP 6.400 to MP 8.865, the construction of Scenario G (Segment G) would reduce traffic volumes on US 231 by 80% to only 20% of that forecast for the 2045 No Build Scenario. This is a reduction in forecast volume on US 231 from a range of 12,768 - 14,918 AADT to a range of 1,950 - 2,742 AADT. This reduction in volume of this nearly 2 ½ mile stretch of US 231 suggests a reduction in predicted crashes of 58 each year. This accounts for a significant portion of the 123 crashes per year reduction reflected in the earlier table for Scenario G.

BCA Results

When considering capital cost, travel time savings, and crash cost savings, with no other factors or discounting, the results show a significant B/C value for Scenario G compared to the other scenarios. The following table (**Table 28**) summarizes the BCA and provides the B/C for each Build Scenario:

Table 28. BCA Results for Additional Segment Analysis

Build Scenario	Capital Cost	20yr Travel Time Savings VHT	20yr Crash Cost Savings	B/C
G	$ 16,620,700	$ 68,084,000	$ 124,348,400	11.6
AE	$ 26,519,700	$ 25,970,000	$ (15,372,000)	0.4
AF	$ 31,132,500	$ 29,714,000	$ 7,019,000	1.2
AE + AF	$ 48,652,200	$ 63,170,000	$ (10,216,500)	1.1

Supplemental BCA Results

Vehicle Miles Traveled (VMT) is a routine output from traffic modeling efforts and was readily available to the team. The methodology for VMT is similar to that detailed earlier for VHT, which again, assumes 10% trucks across the study area for calculation purposes. The cost associated

with operating a vehicle are estimated in the same guidance referenced for VHT, the US Department of Transportation's (USDOT) *Benefit-Cost Analysis Guidance for Discretionary Grant Programs (2021).*

In this report, the value suggested is derived as follows:

Auto VMT Cost	$0.43
Truck VMT Cost	$0.93
Overall VMT Cost	$0.48

Using the Overall VMT cost of $0.48, we get slightly different B/C values for the Build Scenarios. These supplemental BCA results are reflected in the following table (**Table 29**)

Table 29. BCA Results with Operating Costs for Additional Segment Analysis

Build Scenario	Capital Cost	20yr Travel Time Savings VHT	20yr Safety Cost Savings Crash	20yr Vehicle Operating Cost	B/C including VMT
G	$ 16,620,700	$ 68,084,000	$ 124,348,400	$ 37,502,000	9.3
AE	$ 26,519,700	$ 25,970,000	$ (15,372,000)	$ 2,298,000	0.3
AF	$ 31,132,500	$ 29,714,000	$ 7,019,000	$ 2,420,000	1.1
AE + AF	$ 48,652,200	$ 63,170,000	$ (10,216,500)	$ 8,704,000	0.9

As shown in this table, Scenario G still has a significantly higher B/C value compared to the other segments.

Chapter 9 – Study Outcomes

The Project Team met on July 20, 2021, to review the input received during the public comment period that closed on July 2, 2021. The response from the public was considerable, with 2,439 surveys completed, numerous Facebook and Twitter comments, and several emails received – all of which were considered by the Project Team. The benefit-cost analysis for the preliminary corridors was found to be less than one for all potential corridors. **The Project Team concluded that based on the current conditions, traffic projections, engineering analysis, and public feedback - an outer loop connection is not feasible at this time.**

The Project Team also further evaluated three short segments and one combination of segments that could potentially be independent projects with consideration to go into the CHAF Database. The benefit-cost analysis prepared for these segments showed Segment G (US 231 to I-165) to have a significantly higher benefit-cost value (9.3) compared to the other segments (all less than or equal to one). As a result, Segment G could potentially be considered as part of a future potential interchange along I-165 and an associated new connection to US 231.

9.1 Next Steps

This document serves as an initial look / feasibility assessment of connectivity around Owensboro, Kentucky. As determined through this study, at this time an outer loop connection is not feasible. Therefore, no further action is required based upon the conclusions from this study for any large-scale connectivity project. If desired, further development of Segment G may be pursued, though no funds are identified nor is it included in *Kentucky's FY 2020 – 2026 Highway Plan*. If Segment G is desired and determined to be of merit compared to other transportation needs, Daviess County and the Owensboro MPO / GRADD should collaborate with KYTC on future development. This standalone project would require a separate Interchange Justification Study and environmental document before it could be advanced into further project development phases.

9.2 Additional Information

Written requests for additional information should be sent to KYTC Division of Planning Director, 200 Mero Street, Frankfort, Kentucky 40622. Additional information regarding this study can be obtained from the District 2 Project Manager at (270) 824-7080 or by mail at 1840 North Main Street, Madisonville, Kentucky 42431.