FINAL REPORT
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Prepared for and with the assistance of

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The entire KY 536 Scoping Study is located online at www.oki.org/536.
# Table of Contents

Table of Contents................................................................................................................................. i
Glossary of Terms.................................................................................................................................. iii
Executive Summary ....................................................................................................................................... 1
Overview.................................................................................................................................................. 1
Introduction............................................................................................................................................... 1
Study Area................................................................................................................................................ 2
Review of Other Transportation Projects and Studies........................................................................... 4
Summary of Existing Conditions and Environmental Overview......................................................... 8
Alternatives Development ........................................................................................................................ 13
Typical Section Characteristics.............................................................................................................. 13
Alternatives Concepts............................................................................................................................. 15
Alternatives............................................................................................................................................... 16
On-Alignment and Off-Alignment Alternatives..................................................................................... 19
Final Recommendations ....................................................................................................................... 23
Future Considerations........................................................................................................................... 24
Re-Evaluation of Design Assumptions .................................................................................................... 24
Corridor Project Packages..................................................................................................................... 24
List of Figures

Figure 1. KY 536 Study Area ................................................................. 3
Figure 2. KY 536 Community Facilities ..................................................... 8
Figure 3. KY 536 Prime Farmland .............................................................. 9
Figure 4. KY 536 Environmental Constraints ............................................. 9
Figure 5. KY 536 Horizontal and Vertical Deficiency Locations ............... 10
Figure 6. KY 536 Crash Rate Analysis ...................................................... 11
Figure 7. KY 536 Proposed Typical Sections .............................................. 14
Figure 8. Revised Evaluation Matrix for Initial Alternatives ....................... 19
Figure 9. Evaluation Matrix for Off-Alignment and On-Alignment Alternatives 20
Figure 10. Revised Rural Typical Sections .................................................. 21
Figure 11. Separate Multi-Use Path Option ............................................... 22

List of Tables

Table 1. KY 536 Existing Traffic Operations ............................................. 12
Table 2. Existing Travel Times ................................................................. 12
Table 3. KY 536 Projected Average Daily Traffic ...................................... 13
Table 4. KY 536 Alternatives’ Traffic Operations ...................................... 17

Appendices

Appendix A. Project Development Team (PDT) Members
Appendix B. Existing Conditions Report
Appendix C. Environmental Overview/Red Flag Summary
Appendix D. Purpose and Need Statement
Appendix E. Eight Initial Alternatives
Appendix F. Alternative 9
Appendix G. On-Alignment and Off-Alignment Alternatives
Appendix H. Final Public Comments
Glossary of Terms

**AM/PM Peak Period** – The part of the day during which traffic congestion on roads and crowding on public transit is at its highest. Normally, this happens twice a day—once in the morning and once in the evening, the times when the most people commute. For this study, peak periods were determined to be the following times based on traffic counts performed for this study: 7:00am to 9:00am and 4:00pm to 6:00pm.

**Average Daily Traffic (ADT)** – The total volume of traffic passing a point or segment of a highway facility in both directions divided by the number of days in the year.¹

**Design speed** – A speed used to design the horizontal and vertical alignments of a highway.¹

**Functional class** – The process by which streets and highways are grouped into classes, or systems, according to the character of traffic service that they are intended to provide. There are three highway functional classifications: arterial, collector, and local roads. All streets and highways are grouped into one of these classes, depending on the character of the traffic (i.e., local or long distance) and the degree of land access that they allow.²

**Horizontal curvature (HC)** – A transition between two tangent roadway sections. The minimum radius for a horizontal curve varies depending on the design speed.

**K-Factor** – The proportion of traffic volume that occurs during the peak hour.¹

**Level of Service (LOS)** – A quantitative stratification of a performance measure or measures that represent quality of service, measured on an A-F scale, with LOS A representing the best operating conditions from the traveler’s perspective and LOS F the worst.¹

**Minimum radius** – A limiting value of curvature for a given design speed, determined from the maximum rate of super-elevation and the maximum side friction factor selected for design.³

**Sight distance** – The length of the roadway ahead that is visible to the driver. The selected design speed of a roadway establishes the minimum sight distance that should be used in design.³

¹ Highway Capacity Manual 2010

² Federal Highway Administration
(http://www.fhwa.dot.gov/environment/publications/flexibility/ch03.cfm)

Stopping Sight Distance (SSD) – The sum of two distances: (1) the distance traversed by the vehicle from the instant the driver sights an object necessitating a stop to the instant the brakes are applied, and (2) the distance needed to stop the vehicle from the instant brake application begins.\(^3\)

Truck – AASHTO vehicle classifications 4-13.

Vertical curvature (VC) – A transition between two sloped roadway sections. The required Stopping Sight Distance for a vertical curve varies depending on the design speed.

Volume to capacity (v/c) ratio – The ratio of flow rate to capacity for a system element.\(^1\)
Executive Summary

In fall of 2014, the Ohio-Kentucky-Indiana Regional Council of Governments (OKI) initiated a Scoping Study for the KY 536 corridor between KY 17 and the Campbell County line. This segment of KY 536 is part of a regional plan to upgrade KY 536 in Boone, Kenton, and Campbell counties to improve east-west connectivity in northern Kentucky. The segment pertaining to this study, between KY 17 and the Campbell County line, is the only piece of the KY 536 corridor in Boone, Kenton, and Campbell counties slated for upgrades that has not initiated design. The goal of the scoping study is to reach consensus on a recommended alternative that satisfies the purpose and need of the improvements to the corridor.

To provide the study with local leadership and input, a Project Development Team (PDT) was created from a vast cross section of community organizations, business leaders, and political representatives. The members are listed in Appendix A. Six PDT meetings were held throughout the duration of the study to set goals, provide feedback, gain information from the engineering team and disseminate the information to their constituents. Ultimately, the PDT recommended an alternative for KY 536 to advance to a future Kentucky Transportation Cabinet (KYTC) project development phase.

The study team accumulated data on existing roadway, utility, and traffic conditions, as well as environmental resources to identify potential red flags. These were developed into separate reports titled “Existing Conditions Report”, the “Environmental Overview/Red Flag Summary”, and the “Purpose and Need Statement”, all of which are included as appendices B, C and D, respectively, to this report.

The acquired data was used to catalog existing geometric deficiencies along the route and high crash rate locations. Existing traffic operations were studied to determine how the corridor functions, including the time needed to travel the length of the corridor. The entire corridor suffers from narrow lanes; insufficient shoulders; and horizontal and vertical curves that are deficient based upon current roadway standards. These deficiencies lead to crash rates that are multitudes higher in several locations in comparison to similar roadways in Kentucky. These safety concerns cause traffic to operate at slower speeds, increasing the time needed to travel the corridor, or avoid the corridor entirely, increasing the traffic volumes on I-275. Traffic analysis shows Level of Service (LOS) “D” in several segments.

The review of environmental data helped shape alternative locations for KY 536. There are several streams that were taken into consideration when developing the alternatives. White’s Tower Elementary School is an important community facility located at the intersection of KY 536 and KY 16. Care was taken to maximize the safety of students, teachers, staff, and the general public when developing alternatives. All community facilities; cemeteries; churches; utilities; potential historic properties; and other environmental constraints were mapped to minimize potential impacts. Particular attention was paid to farmland, given the agricultural classification of the area east of KY 16 and the residents’ desire to keep the area rural in nature.
Based upon the data collected in the first phase of the study, a Purpose and Need Statement was developed that outlined the current conditions of the corridor and defined the need for action. Using the information obtained from data collection efforts, the study team developed eight potential alternatives for upgrading KY 536 (Appendix E). These alternatives included both On-Alignment segments (keeping KY 536 exactly where it is currently located) and Off-Alignment segments. The section between KY 17 and KY 16 is classified by KYTC as urban, meaning curb/gutter and multi-use paths for pedestrians and bicyclists were included in the alternatives. Since KYTC classifies the section east of KY 16 as rural, no curb/gutter and multi-use paths were included. The roadway in this area would have wide shoulders and ditches. Pedestrians and bicyclists could use the wide shoulders to travel the area, as is normal KYTC policy for rural roadways. Alternative 1 was developed for consideration as the No Build. This alternative would only upgrade three curves that have high crash rates. No improvements to the remainder of the corridor would be considered as a part of Alternative 1. Alternative 2 upgraded the entire corridor to current roadway standards, keeping KY 536 in its current location throughout the length of the segment. This alternative did not eliminate the disjointed nature of the existing roadway (six right/left turns needed to travel from KY 17 to the Campbell County line). Alternatives 3-8 upgraded KY 536 to current standards for the entire length of the corridor and eliminated the six turns needed to travel the corridor.

The alternatives were presented to the PDT on June 30, 2015 and the general public via a Public Open House on July 6, 2015. The information presented included conceptual drawings of each alternative and an Evaluation Matrix that illustrated how each alternative met the goals established for the study. In addition to upgrading the roadway to current standards, Alternatives 3-8 reduced the travel time needed to go from KY 17 to the Campbell County line by approximately six minutes.

Feedback received from KYTC indicated that because of cost considerations for future maintenance, they were concerned about having to maintain two roadways (existing KY 536 and a potential new route). Feedback from the public was captured at the Public Open House. The majority of feedback received centered on three themes:

1) Move the intersection of KY 536/KY 16 away from White’s Tower Elementary School for safety of the students;
2) Minimize the amount of existing KY 536 that would need to be maintained in addition to the new KY 536; and
3) Prioritize saving farmland utilization over residences, with the belief that many affected homes could be rebuilt on their property.

Based upon feedback from both PDT and the general public, a ninth alternative was developed that reused more of the existing roadway corridor before deviating to an off-alignment route (Appendix F).

On July 31, 2015 the PDT discussed the alternatives and narrowed the nine alternatives to two, an On-Alignment alternative and an Off-Alignment alternative (Appendix G). Because KY 536 is part of the regional bicycle plan, they requested that in addition to
multi-use paths in the urban section between KY 17 and KY 16, the study team should include a separate multi-use path in the rural section from KY 16 to the Campbell County line. The PDT was not comfortable using the roadway shoulders for pedestrians and bicyclists.

The study team refined these two alternatives and developed more quantitative impact information, including conceptual cost information for Design, Right-of-Way, Utility, and Construction costs. These two alternatives were presented to the PDT on September 25, 2015. After discussion regarding the multi-use path in the rural section, the PDT recommended that the Off-Alignment alternative be advanced to a future KYTC design phase. This was presented to the public at a Public Open House on October 5, 2015, where comment sheets were provided, as well as links to the KY 536 Scoping Study website and online comment form. After a 30 day comment period, the survey results were tabulated. The public agreed by a 61.44% margin with the PDT recommendation of the Off-Alignment Alternative. As such, the study goal of reaching consensus on a recommended alternative was achieved.
Overview

Introduction

KY 536 in Northern Kentucky is a major east-west transportation corridor through Boone, Kenton, and Campbell counties. Regional leaders, transportation officials, Northern Kentucky businesses and residents recognize KY 536 as critical to east-west connectivity in the region. Other than I-275 and KY 536, there are limited direct route options for east-west travel in Northern Kentucky. Efforts are underway by the Kentucky Transportation Cabinet (KYTC) to upgrade KY 536 as a modern corridor that will improve access, mobility and safe travel while enhancing the economic vitality of the region. The Ohio-Kentucky-Indiana Regional Council of Governments (OKI) established this KY 536 Scoping Study in 2014 to identified improvements for the 6.5 mile segment from KY 17 to the Campbell County line. The purpose of the KY 536 Scoping Study is to:

- Improve safety
- Correct existing geometric roadway deficiencies and bring to current standards
- Improve travel time, reliability and traffic flow
- Develop consistency with, state, regional, county and local city planning initiatives
- Enhance the transport of goods and people to improve economic vitality

The Project Development Team (PDT) included engineering consultants, public officials, business and community leaders, and representatives from the general public (Appendix A). The PDT developed the following goals for the study:

The current KY 536 Scoping Study will identify a preferred alternative for improvements to KY 536, between KY 17 (Madison Pike) and the Kenton/Campbell County line to meet the purpose and needs established for the project. It will also identify and evaluate possible alternatives that will:

- Consider community input gathered through an open and transparent communications process
- Address local and regional needs for travel safety and reduce accident rates
- Update this section of KY 536 as part of a modern, continuous transportation corridor that connects to a regional, multi-county roadway system and can support multiple travel modes (car, truck, bus/transit, bike, farm equipment, foot)
- Provide infrastructure that can support economic prosperity in the region through efficient transportation connectivity
- Be consistent with current plans that address existing and future land uses to efficiently accommodate growth in urban and suburban sections while maintaining the rural, agricultural character of the eastern portion of study area
- Maintain/enhance the quality of life for residents, business owners and other stakeholders located within the study area
- Preserve and protect natural resources and hillsides and improve or maintain air and water quality in the study area while providing for mobility needs
Demonstrate public support

Study Area
The study area for the KY 536 Scoping Study consists of the 6.5-mile segment of KY 536 between KY 17 (Madison Pike) and the Kenton/Campbell County Line (Figure 1). KY 536 within this Scoping Study comprises various local roadways including Harris Pike; Taylor Mill Road (KY 16); Maverick Road; Staffordsburg Road; Visalia Road; Decoursey Pike (KY 177); and Creektrace Road. This section of KY 536 is characterized by fragmented connections, drastic elevation changes, poor sight lines and high crash rates.

The study area extended one-mile on either side of the existing KY 536 roadway in order to provide for a range of potential alternative solutions. The study area has a hilly terrain from KY 17 (Madison Pike) and KY 16 (Taylor Mill Road), but a significant elevation change from west of Steep Creek Road to KY 177 (Decoursey Pike). Between KY 177 (Decoursey Pike) and the Licking River, the terrain is relatively flat.

In addition to the existing roadway system, one Class I rail line travels through the study area. A CSX mainline track line runs north-south, paralleling KY 177 (Decoursey Pike) west of the Kenton/Campbell County line and the Licking River. This rail line bisects KY 536 (Creektrace Road), connecting southern Kenton County to Ohio.

Purpose of this Document
The purpose of this Final Report is to summarize the process followed in this study and to present the findings and recommended alternative for upgrading KY 536 between KY 17 and the Campbell County line.
Figure 1. KY 536 Study Area
Review of Other Transportation Projects and Studies

While this study focuses on a specific section of the KY 536 corridor, the route extends through Boone, Kenton, and Campbell counties and is recognized as a critical east-west facility in terms of mobility, connectivity, and economic vitality. A full review of previously completed transportation projects, plans, and studies has been compiled for reference purposes.

1. Hathaway Road (west of Old Union Road) to I-71/75, Boone County; Kentucky Transportation Cabinet (KYTC) Project 6-158.00: KY 536 will be improved and widened to five lanes with multi-use paths on each side. Currently, KYTC is acquiring right-of-way along the project corridor.

2. Tiburon Drive (west of I-71/75) to US 25 (Dixie Highway), Boone County; KYTC Project 6-14.00: The KY 536 (Zion Road) Interchange at I-71/75 will be reconstructed to a Double Crossover Diamond; nine lanes wide at Sam Neace Boulevard to two lanes east of US 25. Currently, KYTC is in the preliminary design phase of the project.

3. Boone/Kenton County line to KY 17, Kenton County; KYTC Project 6-162.00: KY 536 will be improved as a four-lane controlled-access urban facility with raised medians, roundabouts, and multi-use paths. Currently, KYTC is in the preliminary design phase of the project and has not yet reached the right-of-way phase. This project is broken into four subsections for funding and construction purposes.
   a. KY 1303 (Turkeyfoot Road) from Beechgrove Elementary to KY 536 - This subsection will be five lanes with bicycle lanes and sidewalk matching Turkeyfoot Road to the north.
   b. East end of Norfolk Southern railroad bridge (Boone County) to KY 1303 (Turkeyfoot Road). This subsection will be a four-lane controlled-access urban facility with raised medians, roundabouts, and multi-use paths.
   c. KY 1303 (Turkeyfoot Road) to Williamswood Road/Calvary Drive. This subsection will be a four-lane controlled-access urban facility with raised medians, roundabouts, and multi-use paths.
   d. Williamswood Road/Calvary Drive to KY 17. This subsection will be a four-lane controlled-access urban facility with raised medians, roundabouts, and multi-use paths.

4. KY 17 (Madison Pike) to Kenton/Campbell County line, Kenton County: The KY 536 Scoping Study has identified improvements for a 6.5 mile segment. KYTC
studied possible improvements to this section of KY 536 in 2000, however a preferred alternative was not identified. The 6.5-mile Kenton County segment of KY 536 from KY 17 to the Kenton/Campbell County line was the only one of these sections for which a preferred alternative had not yet been identified. This KY 536 Scoping Study has determined a recommended alternative.

5. Kenton/Campbell County line to US 27: This section of KY 536 was previously reconstructed over 20 years ago. While local planning documents have identified this section for reconstruction, there are no plans for additional improvements at this time.

6. US 27 to KY 9 (AA Highway), Campbell County; KYTC Project 6-352.00: KY 536 will be a two-lane road with shoulders, traveling on new alignment. Truck climbing lanes may be provided, but to date, bicycle paths and pedestrian facilities are not part of the project’s design. Currently, KYTC is in the preliminary design phase of this project.

While these projects further the goal of improving safety and enhancing east-west connectivity, they are different in their roadway characteristics. Each individual project along KY 536 has a roadway typical section that adapts to the context of the area and the projected traffic volumes. The nature of the roadway varies from urban to rural depending on its location, with urban sections found in Boone County and western Kenton County, while rural sections are found in eastern Kenton County and Campbell County. The number of proposed lanes also varies depending upon the traffic volume. This KY 536 Scoping Study has recommended whether the segment of KY 536 from KY 17 to the Campbell County line should be urban, rural, or a combination of both, as well as recommended the number of lanes needed. Recommendations also include whether multi-modal accommodations should be provided.

In addition to reviewing other transportation projects for KY 536 in the region, a review of several transportation and comprehensive plans and studies was completed to gather as much existing information as possible. This effort assisted in developing proposed alternates so that a consensus can be reached on a recommended alternative.

- **Kentucky Transportation Cabinet (KYTC) Six Year Highway Plan.** Every two years, the Kentucky General Assembly approves a Six Year Highway Plan. KYTC submits the recommended plan to the Legislature which then reviews, modifies, and approves the plan as part of the biennial budget process. Adjacent sections of the overall KY 536 corridor have been identified in the 2012 Six Year Highway Plan (KY 536 from Boone/Kenton County Line to KY 17) and in 2014 (I-75 interchange at Mt. Zion Road and KY 536 from west of US 42 to I-75).

- **Direction 2030: Your Voice. Your Choice (Kenton County Comprehensive Plan) (2014).** The Kenton County Planning Commission and Planning and Development Services of Kenton County (PDS) staff created a long range comprehensive plan for all of Kenton County. This plan includes goals and recommendations for mobility, land use, environment, economy, housing and
others. One of the main mobility goals of the plan is to “improve east/west connectivity that links Boone, Kenton and Campbell counties.” Further, the plan identified specific sections of the overall KY 536 corridor as recommended projects, including reconstructing the portion from KY 17 (Madison Pike) to KY 16 (Taylor Mill Road) and constructing a new connection from KY 16 to KY 177 (Decoursey Pike). A goal identified in the plan is to enhance and expand the effectiveness of the transportation system by promoting multimodal approaches. Recommendations for mobility include using access management on roadways; improve safety and facilities for cyclists and pedestrians; and improve safety along rural roads. Land use recommendations note that land classified as agricultural and rural should be maintained for low intensity uses.

- **2010 Boone County Comprehensive Plan (adopted June 2012).** The Boone County Planning Commission oversaw the comprehensive planning process to plan to the year 2035. The plan included recommendations for community policies, goals, and objectives. This plan included the recommendations from the Boone County Transportation Plan 2030 (November 2005). The transportation plan included a recommendation for improving east-west mobility and extending connectivity between the new Camp Ernst Road, I-71/75, and Dixie Highway by widening KY 536 (Hathaway Road) from two to four lanes.

- **Campbell County Comprehensive Plan Update (2008).** The Comprehensive Plan Update, from the 2000 plan, was done to direct and manage development and preservation of significant resources. Campbell County is currently in the process of updating the comprehensive plan. The KY 536 extension from US 27 to KY 9/AA Highway is listed as programmed in this plan.

- **Kenton County Transportation Plan (2003).** The Ohio-Kentucky-Indiana Regional Council of Governments (OKI) Board adopted this plan in March 2003. The purpose of the plan was to meet Kenton County’s transportation needs to year 2030. All sections of the overall KY 536 corridor are addressed in this plan. The section from the Boone County line to KY 17 (Madison Pike) was a committed project at that time and the section from KY 17 (Madison Pike) to KY 16 (Taylor Mill Road) was listed as a priority recommendation. The section from KY 16 (Taylor Mill Road) to KY 177 (Decoursey Pike) is shown as “needed.”

- **Kenton County Transportation Plan (June 2014).** Conducted by OKI, this plan is an update to the 2003 Kenton County Transportation Plan to accommodate changes in population, land use, and economics. The KY 536 Scoping Study is listed as a high priority for implementation in this plan. Construction of the KY 536 section immediately to the west of the KY 536 Scoping Study area is also listed as a high priority recommendation.

- **Campbell County Transportation Plan (September 2003).** The Campbell County plan, conducted by OKI, listed unscheduled needs projects on KY 536. The projects were to include reconstruction of KY 536 with a new bridge over the Licking River to KY 1936/Pond Creek Road and reconstruction of KY 536 from KY 1936 to KY 915.

- **OKI 2040 Regional Transportation Plan (June 2012).** OKI’s current long range plan also shows all sections of the overall KY 536 corridor, specifically calling out
the need for KY 536 from KY 16 to KY 177, on its non-fiscally constrained needs list.

- **OKI Regional Freight Plan (August 2011).** This OKI plan provided recommendations for the regional freight network based on strengths, deficiencies, and needs of the existing framework. The plan noted the lack of major east-west access for freight movement, narrow lanes and numerous difficult intersections on KY 536, and congestion due to development in Independence. The plan recommended improved truck access south of I-275, and KY 536 improvements to address truck access problems in the area.

- **KY 237-Camp Ernst Road-KY 536 Corridor Improvements: Boone, Kenton, and Campbell Counties (The “2000 Study”).** The KY 536 segment from KY 17 (Madison Pike) to the Kenton/Campbell County line was included in the “2000 Study” managed by KYTC; however a preferred alternative was not identified. Therefore, the 6.5-mile Kenton County segment of KY 536 from KY 17 to the Kenton/Campbell County line remains the only one of these four sections for which a preferred alternative has not yet been identified.

- **Independence Community Small Area Study (July 2007).** The small area study was conducted to create a vision and land use plan for the community after experiencing rapid growth from the “new” KY 17. The desire was to revitalize the historic downtown. The plan does note that the intersection of KY 17 and KY 536 needs to balance access needs for commercial areas with capacity.

- **Independence Zoning Update (2012).** The zoning update was developed to implement the recommended land use plan in the Independence Community Small Area Study. Three new zoning districts were adopted in downtown Independence.

- **City of Alexandria 2004 Comprehensive Plan.** The transportation section of this plan was based on the OKI 2030 Regional Transportation Plan. The City of Alexandria identified the need to complete the extension of KY 536. Reconstruction of KY 536 from KY 177 to Pond Creek was not programmed but identified as a high priority and Pond Creek to KY 915 was identified as a medium priority.

- **South Kenton County Land Use Preferences Survey (April 2014).** The southern portion of Kenton County is generally considered the areas south of KY 16 (Taylor Mill Road) and unincorporated areas east of Marshall Road and KY 177. Conducted by PDS, the survey results indicated that households in southern Kenton County have a desire to maintain the rural and agricultural character in the area.
Summary of Existing Conditions and Environmental Overview

A review of the study area’s existing conditions was performed and detailed in the Existing Conditions Report, found in Appendix B, and the Environmental Overview/Red Flag Summary, detailed in Appendix C. These were used to develop a Purpose and Need Statement, available in Appendix D. Existing KY 536 data acquired included information such as lane widths, shoulder widths, horizontal and vertical curvature, speed limits, bridge information, traffic volumes, traffic level of service, travel time, number of crashes, crash type, utility information, freight information, railroad operations, and pedestrian/bicycle/transit usage. Environmental studies included cultural and historic resources, human environment, natural environment, land usage, utility locations, air quality, noise, hazardous material, Section 4(f) and 6(f) resources, permits, aesthetics, and agency coordination. Maps of the Community Facilities, Prime Farmland, and Environmental Constraints are found in Figures 2 through 4.

In general, KY 536 in this area is a narrow two lane road with 10 foot lanes and no shoulders. Drop-offs occur throughout the length of the corridor. Horizontal and vertical deficiencies are found along the entire corridor as well. They are illustrated in Figure 5. No environmental issues were identified which would significantly impact the development of alternatives.

Figure 2. KY 536 Community Facilities
Figure 3. KY 536 Prime Farmland

Figure 4. KY 536 Environmental Constraints
Figure 5. KY 536 Horizontal and Vertical Deficiency Locations
The deficiencies of the physical roadway contribute to high crash rates, traffic operational issues, and increased travel times. Critical crash rates over 1.0 indicate a section of roadway whose crash rate is higher than the statewide average for similar roadway sections across Kentucky. These locations are identified in Figure 6.

Figure 6. KY 536 Crash Rate Analysis

Roadway traffic operations are rated utilizing a traffic analysis designation developed under the Highway Capacity Manual. The evaluation includes measures of effectiveness such as Level of Service (LOS) and volume to capacity (v/c) ratio. LOS is used to provide a rating scale for congestion and operations of a roadway. LOS A represents the highest and best performing roadway with little time spent following another vehicle and plenty of opportunities for passing on a two-lane facility. With each subsequent level of service, percent time spent following increases and opportunities to pass and travel speeds decrease. Conditions deteriorate until reaching LOS F, which represents a congested roadway that is in gridlock with no opportunities to pass, resulting in low travel speeds. V/c ratio is a measure used to determine the capacity of a given roadway or segment. Locations with a v/c ratio of 1.0 are considered at capacity.

The KY 536 study area shows a degraded LOS in many areas. However, this is not due to high traffic volumes, as verified by the low v/c ratio, because there is plenty of capacity. Rather, the low travel speed throughout the corridor, coupled with a lack of passing opportunities, creates an extended travel time from KY 17 to the Campbell County line because of the time spent following other vehicles. It is this travel delay and the lack of
passing opportunities which gives the corridor degraded levels of service. This information is provided in Table 1 and Table 2.

### Table 1. KY 536 Existing Traffic Operations

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### Table 2. Existing Travel Times

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<tr>
<td>4:22 PM</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>5:00 PM</td>
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<td>24</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>53</td>
</tr>
</tbody>
</table>

Other factors to consider when analyzing the KY 536 corridor are the at-grade railroad crossing east of KY 177, the Licking River and Visalia Bridge, various streams, farmland, environmental resources, residences/businesses, electric towers and other utilities, and the steep Visalia Hill.
Alternatives Development

Typical Section Characteristics
Based upon the information obtained in the Existing Conditions Report, the Environmental Overview/Red Flag Summary, and the Purpose and Need Statement, separate typical roadway sections for KY 536 were developed for the urban area and the rural area. The urban area extends from KY 17 to KY 16, while the rural area extends from KY 16 to the Campbell County line. The distinctly different land use areas create a different feel, leading to a change from the urban curb and gutter roadway west of KY 16 to a rural roadway with full shoulders east of KY 16. The urban section is projected at a 45 mph design speed, while the rural area is projected at 55 mph, as is typical for a rural Kentucky roadway.

Existing traffic volume information and growth projections were used to determine the recommended number of lanes within each section. The existing traffic volumes obtained from the Existing Conditions Report were forecasted to the year 2035 by utilizing OKI’s Travel Demand Model. The model was run for all alternatives developed. This analysis resulted in projected highest Average Daily Traffic of 1,300 between KY 17 and KY 16, and, 240 between KY 16 and the Campbell County line, as shown in Table 3. The guidance provided in KYTC’s Highway Design Manual for determining the basic number of through lanes on a corridor is based on the methodology presented in the Highway Capacity Manual. This process involves determining a Volume/Capacity (v/c) ratio. The targeted v/c ratio is 1.0 for urban areas and 0.9 for rural areas. For a two lane facility with typical conditions, this ratio is approached when the design year ADT is approximately 30,000. This means that a four lane facility would not be appropriate, unless the design year volume exceeded 30,000 vehicles per day. Since the forecasted traffic in the year 2035 is only 1,300 vehicles per day, one thru lane in each direction is sufficient to handle the projected traffic volumes, with turn lanes as needed.

In an effort to minimize the roadway width for cost considerations, 11 foot wide lanes are recommended rather than 12 foot. This width will accommodate truck traffic along the route when the facility is upgraded.

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Highest Average Daily Traffic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative 1 (No Build/Spot Improvements)</td>
<td>920</td>
</tr>
<tr>
<td>Alternative 2</td>
<td>1,040</td>
</tr>
<tr>
<td>Alternative 3</td>
<td>1,235</td>
</tr>
<tr>
<td>Alternative 4</td>
<td>1,270</td>
</tr>
<tr>
<td>Alternative 5</td>
<td>1,300</td>
</tr>
<tr>
<td>Alternative 6</td>
<td>1,270</td>
</tr>
<tr>
<td>Alternative 7</td>
<td>1,280</td>
</tr>
<tr>
<td>Alternative 8</td>
<td>1,270</td>
</tr>
</tbody>
</table>
During the initial creation of alternatives, questions arose regarding how to accommodate other modes of traffic such as pedestrians and bicyclists. The proposed preliminary drawings for the KY 536 project west of KY 17 includes a multi-use path to accommodate children/families and bicyclists. KY 536 west of KY 16 is classified as urban with curb and gutter and includes White’s Tower Elementary School. During the detailed design phase for this project, it is recommended that two eight foot multi-use paths be considered for this urban section of KY 536 west of KY 16 since this corridor is an integral connection to the regional trail network in Northern Kentucky.

In the rural segment of KY 536 east of KY 16, accommodation for multiple modes of traffic was not as clear cut. KYTC usually considers the paved full shoulder as a place where pedestrians and bicyclists can travel through the corridor. As such, the study’s initial alternatives did not include a separate multi-use path. This approach was presented to the study’s PDT and the general public via the eight initially developed alternatives. Based upon PDT recommendation and strong public input during Phase three of the study, during the detailed design phase for this project, it is recommended that a 10 foot multi-use path be considered for this rural section of KY 536 east of KY 16 since this corridor is an integral connection to the regional trail network in Northern Kentucky.

Lastly, in accordance with KYTC policy, the location of new alternatives in relation to the existing roadway determined whether a center turn lane to access homes and businesses was recommended in the typical section. Due to the number of residences in the urban area between KY 17 and KY 16, a center two way left turn lane was included. In the rural area east of KY 16, the use of a center turn lane depended upon whether the alternative followed the existing roadway corridor or was designed off the existing roadway (off alignment). The alternative that followed the existing roadway included a center, dual left turn lane for improved, safe access to homes and businesses. For those alternatives that are located off of the existing roadway, no center turn lane was included since there are no residences or businesses on the relocated roadway. The typical sections for the urban and rural segments for the eight initial alternatives are shown in Figure 7.

![Figure 7. KY 536 Proposed Typical Sections](image-url)
Alternatives Concepts
Certain guiding principles were used in developing the alternatives. With the exception of Alternative 1, all alternatives resolve safety issues by bringing KY 536 up to current state and federal roadway design standards, including lane widths, shoulder widths, horizontal and vertical curvature, and side slopes. Alternative 1 only reconstructs three high crash rate locations, with no upgrades to the remainder of the existing KY 536 roadway.
Each alternative was developed to avoid impacts to buildings and farms as much as possible. In addition, each alternative, with the exception of Alternatives 1 and 2 that stay on the current roadway, were designed to minimize roadway length and eliminate the turning movements necessary to traverse the corridor, reducing the travel time between KY 17 and the Campbell County line. Alternative 2 reconstructs KY 536 in the exact location of the existing road. As such, the existing six turning movements necessary to travel through the corridor would remain, extending the required travel time.

All alternatives were designed in an effort to maintain the rural character of the area east of KY 16 as much as possible. The land use of the area east of KY 16 is currently agricultural and is slated to remain as such in the current Kenton County Comprehensive Plan Direction 2030. Also, the local residents desire it to remain rural in character. Information from the Environmental Review/Red Flag Summary was used to ensure that the alternatives did not significantly impact human, natural, cultural, or historic resources.

Finally, the issue of the Visalia Bridge over the Licking River posed unique challenges. During the course of this study, KYTC determined that the Visalia Bridge will need to be replaced during construction due to structural issues and project timelines. As a result, all alternatives included replacement of the Visalia Bridge.

**Alternatives**

Appendix E illustrates the eight initial alternatives developed with this Scoping Study. The OKI travel demand model was used to determine travel times from KY 17 to the Campbell County line for each alternative. The roadway geometry, along with new intersections, speed limits and functional classification for each of the alternatives was coded into the OKI model. With this new data, the model was run for each alternative. This provided an estimate of future travel times and traffic volumes along each improved segment. The segment travel times and traffic volumes were then compared to determine the relative impact to traffic operations associated with each alternative.

Also calculated for each alternative was the level of service (LOS) and volume to capacity ratio (v/c). The Highway Capacity Software 2010 (based on the Highway Capacity Manual 2010) was used to calculate these values. As discussed in the Existing Traffic Operations section of the Existing Conditions Report, LOS is used to provide a rating scale for congestion and operations of a roadway. LOS A represents free-flow with LOS F assigned to failing operations. The v/c ratio is a measure used to determine the capacity of a given roadway or segment. Locations with a v/c ratio of 1.0 are considered at capacity. The majority of the segments for all of the alternatives operate at a LOS D, with the v/c ratio less than 1.0.

Alternative 1 only addressed three high crash rate locations. This alternative did not bring the remainder of the road to current standards or address safety concerns outside of the three high crash rate locations. Alternative 2 reconstructed KY 536 in its current location throughout the entire corridor, bringing it to current roadway standards. It did
not address the discontinuity of the corridor or the six turning movements required to travel from KY 17 to Campbell County. Alternatives 3-8 were potential corridors that met current roadway standards and eliminated turning movements. These provided a significant reduction in travel time in addition to addressing safety issues. They varied in their impacts to homes, farmlands, streams, and trees. The comparison of each alternative in terms of traffic operations is illustrated in Table 4.

Table 4. KY 536 Alternatives’ Traffic Operations

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Begin</th>
<th>End</th>
<th>Volume (#)</th>
<th>Speed (mph)</th>
<th>HCS V/C</th>
<th>LOS</th>
<th>Travel Time (minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>KY 17</td>
<td>KY 16</td>
<td>920</td>
<td>37</td>
<td>0.15</td>
<td>A</td>
<td>14.6</td>
</tr>
<tr>
<td></td>
<td>Harris</td>
<td>Visalia (KY 16)</td>
<td>1,590</td>
<td>45</td>
<td>0.57</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>KY 16</td>
<td>Staffordsburg</td>
<td>475</td>
<td>23</td>
<td>0.21</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Staffordsburg</td>
<td>Klein</td>
<td>450</td>
<td>25</td>
<td>0.18</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Klein</td>
<td>KY 177</td>
<td>435</td>
<td>26</td>
<td>0.17</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Visalia</td>
<td>Creektrace (KY 177)</td>
<td>645</td>
<td>21</td>
<td>0.24</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>KY 177</td>
<td>County Line</td>
<td>680</td>
<td>28</td>
<td>0.23</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>KY 17</td>
<td>KY 16</td>
<td>1,040</td>
<td>45</td>
<td>0.18</td>
<td>A</td>
<td>8.0</td>
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<tr>
<td></td>
<td>Harris</td>
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<td>54</td>
<td>0.22</td>
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</tr>
<tr>
<td></td>
<td>Staffordsburg</td>
<td>Klein</td>
<td>510</td>
<td>54</td>
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<tr>
<td></td>
<td>Klein</td>
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<td>490</td>
<td>54</td>
<td>0.18</td>
<td>C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Visalia</td>
<td>Creektrace (KY 177)</td>
<td>730</td>
<td>21</td>
<td>0.26</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>KY 177</td>
<td>County Line</td>
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<td>E</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>KY 17</td>
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</tr>
<tr>
<td></td>
<td>KY 16</td>
<td>Staffordsburg</td>
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<td>53</td>
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</tr>
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<td></td>
<td>Staffordsburg</td>
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<tr>
<td></td>
<td>Connector Road</td>
<td>Mann</td>
<td>785</td>
<td>54</td>
<td>0.35</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mann</td>
<td>KY 177</td>
<td>765</td>
<td>28</td>
<td>0.33</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>KY 177</td>
<td>County Line</td>
<td>965</td>
<td>28</td>
<td>0.33</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>KY 17</td>
<td>KY 16</td>
<td>1,270</td>
<td>45</td>
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<td>A</td>
<td>7.0</td>
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<td></td>
<td>KY 16</td>
<td>Staffordsburg</td>
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<td>0.47</td>
<td>D</td>
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<td></td>
<td>Staffordsburg</td>
<td>Connector Road</td>
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<td>54</td>
<td>0.40</td>
<td>D</td>
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<tr>
<td></td>
<td>Connector Road</td>
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<td>930</td>
<td>54</td>
<td>0.35</td>
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</tr>
<tr>
<td></td>
<td>Mann</td>
<td>KY 177</td>
<td>795</td>
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<tr>
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<td>965</td>
<td>28</td>
<td>0.33</td>
<td>E</td>
<td></td>
</tr>
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</table>
The alternative were presented to the PDT on June 30, 2015 and to the public at an Open House on July 6, 2015. The information presented also included an Evaluation Matrix to rate how the individual alternatives met the Scoping Study’s goals.

The PDT members requested time to review the eight alternatives before deciding on a recommendation of which two alternatives should progress forward. As a result, a PDT meeting was scheduled for July 31, 2015 to discuss the eight alternatives. In the interim and based upon public and PDT feedback, the engineering team developed a ninth alternative that utilized more of the existing KY 536 roadway corridor. This alternative has a similar projected average daily traffic as the other alternatives and is illustrated in Appendix E. This Alternative 9 was sent to PDT members prior to the July 31, 2015 meeting for their review. In addition, an updated Evaluation Matrix that was tied to the Scoping Study’s goals was provided, as shown in Figure 8.

Other proposed alternatives from the PDT members were evaluated from an engineering perspective and not progressed forward either because they posed engineering problems or were similar to other proposals.
In the July 31, 2015 PDT meeting, the members discussed the nine alternatives and decided to move forward with two alternatives, desiring an On-Alignment Alternative and an Off-Alignment Alternative. The On-Alignment Alternative was similar to Alternative 9. The Off-Alignment Alternative was to be a hybrid of the other alternatives. There was an overall consensus to move KY 536 away from White’s Tower Elementary School to keep traffic away from the school. Also, many PDT members requested consideration that the rural typical sections include a separate multi-use path away from the paved shoulder. The project team included it in the final two alternatives. The PDT meeting minutes and the public’s feedback were captured and used to move to the next phase of the study, reducing the initial eight alternatives down to two.

### On-Alignment and Off-Alignment Alternatives

Three main themes about the alternatives were identified from the PDT and public meetings. The first was that both the PDT and the public would like to move KY 536 away from White’s Tower Elementary for the safety of the children, teachers, and staff. The second theme was that many members of the rural community value their land more than their homes. If there is to be an impact to their property, they would rather save the land at the expense of their home. Lastly, KYTC does not want to maintain two roadways in the future, (new KY 536 and the old KY 536) due to cost considerations. The study team created a hybrid alternative to satisfy these three themes as much as possible. This hybrid became the Off Alignment Alternative.
The proposed roadway approaching KY 16 for both alternatives was located north, away from White’s Tower Elementary. Secondly, the roadway for both alternatives was located to avoid bisecting farms. At the suggestion of several PDT members, every effort was made to minimize farmland impacts. This caused the number of residential impacts to increase. Lastly, to address KYTC’s concerns regarding two roadways, the proposed Off-Alignment Alternative followed the existing KY 536 corridor until one-half mile west of Staffordsburg Connector. From there, the Off-Alignment Alternative curves to the north, away from the existing roadway, to align with the Visalia Bridge.

The On-Alignment and Off-Alignment Alternatives were sent to the PDT prior to the September 25, 2015 PDT meeting. The information included an Evaluation Matrix and an estimated cost for each of the two alternatives, including Engineering, Right-of-Way, Utility, and Construction costs. The Evaluation Matrix is shown in Figure 9.

![Figure 9. Evaluation Matrix for Off-Alignment and On-Alignment Alternatives](image)

The On-Alignment and Off-Alignment alternatives are illustrated in Appendix G. The information also included a new Typical Section for the On-Alignment Alternative that included a multi-use path in the rural section east of KY 16. In addition, the impact of this path on structures, land, and cost was included in the Evaluation Matrix.

Based upon public and PDT member feedback regarding White’s Tower Elementary School, both alternatives were designed exactly the same west of KY 16. The roadway would follow existing KY 536 from KY 17 until it approached KY 16. At this point, the proposed roadway would shift to the north and create a new intersection with KY 16 near Maverick Drive. This segment is similar to the previous Alternative 4.

The design of the segment from KY 16 to one-half mile west of Staffordsburg Road was also the same for both the On-Alignment and Off-Alignment Alternatives. This was based upon KYTC feedback that they were not open to maintaining two separate roadways of significant length. As a result, the Off-Alignment Alternative would follow...
the existing KY 536 corridor until one-half mile west of Staffordsburg Road Connector, where it would curve to the north and align with the Visalia Bridge.

As it relates to the On-Alignment Alternative, the PDT and public feedback was to relocate KY 536 away from its existing location on the Visalia Hill and better align it with the Visalia Bridge, due to the high crash rates of the Visalia Hill and the unstable hillside. As a result, the On-Alignment Alternative would follow existing KY 536 from KY 16 until one-half mile west of Klein Road, where it would curve to the north and align with the Visalia Bridge.

The rational for each alternative was presented to the PDT on September 25, 2015. At this meeting, there was significant debate regarding whether a multi-use path should be included east of KY 16. Since the corridor is a critical connection in the regional trail network and the belief that using the paved shoulder for pedestrians and bicyclists is not conducive, nor safe, the majority of PDT members voiced that the path should be included in both the On-Alignment and Off-Alignment Alternatives and presented to the public for further comment. The feedback from the PDT team, detailed in meeting minutes, indicated a desire for a multi-use path separate from the paved shoulder, similar to what was constructed on Aero Parkway in Boone County, KY. As such, a separate multi-use path for bicyclists and pedestrians, that follows the natural topography and is an extended distance from the roadway, is included in the recommendations. The revised typical sections for the rural area east of KY 16 are shown in Figure 10. An image from Aero Parkway is shown in Figure 11.

Figure 10. Revised Rural Typical Sections
At the September 25, 2015 meeting, there was also agreement from the PDT that the multi-use path issue should be included in the questionnaire that was to be provided to the public at the October 5, 2015 Public Open House and also posted to the OKI project website.

At the September 25, 2015 PDT meeting, the members reached a consensus that the Off-Alignment Alternative should be the recommended alternative for further development in the next phase of this project. These recommendations were presented at the final Public Open House on October 5, 2015.
Final Recommendations

The Study included a 30-day public comment period for the recommended alternative, which ended on November 6, 2015. Public comments can be found in Appendix H.

The results show that 61.44% of respondents believe that the Off-Alignment Alternative should be advanced as the recommended alternative, as opposed to 23.49% in favor of the On-Alignment Alternative. In addition to comments regarding the alternatives, the public did not show a significant desire for a 55 mph roadway east of KY 16. Only 42.86% of respondents are in favor of a 55 mph section, with 16.23% unsure. The responses included 40.91% of those who believe the speed limit should be lower than 55 mph.

The final question to the public asked for feedback regarding the separate multi-use path east of KY 16. Results showed that 66.01% favor including a separate 10 foot wide multi-use path on one side of the road, compared to 25.49% who do not desire the path.

A final PDT meeting was held on November 16, 2015 to confirm the recommendation and conclude the study. Based upon the public comments received and PDT guidance, including KYTC, the scoping study concluded by developing the following final recommendations:

1) The Off-Alignment Alternative should be advanced.
2) The roadway should include multi-use paths on both sides of KY 536 between KY 17 and KY 16. In addition, a separate multi-use path on one side of the road should be included east of KY 16.
Future Considerations

Re-Evaluation of Design Assumptions
As the corridor moves into the next phase of development, engineering and design assumptions made during this study should be continually evaluated. These items are based upon PDT and public feedback:

1) Re-visit the design speed assumption of the segment east of KY 16. Consideration should be given to creating a 45 mph roadway rather than 55 mph in the area between KY 16 and the Staffordsburg Connector due to the close proximity of residences.

2) In order to reduce the project’s footprint and preserve the rural feel, the following items should be re-visited:
   a. Lowering the design speed east of KY 16 from 55 mph to 45 mph
   b. Changing the shoulders in the rural section from 12 feet to 8 feet
   c. Modifying the front and back slopes from 6:1 to 4:1
   d. Using a combination of a two foot paved shoulder and a six foot stabilized earth shoulder in the rural section to provide the emergency pull-off while minimizing the width of pavement

Corridor Project Packages
Due to the 6.5 mile length of the corridor and resulting cost considerations, the segment of KY 536 from KY 17 to the Campbell County line could be broken into separate projects for implementation.

For Design, Right-of-Way, and Utility Relocation activities, one option would be to break the corridor into two projects:

1) KY 17 to east of the Staffordsburg Connector
2) East of the Staffordsburg Connector to the Campbell County line

<table>
<thead>
<tr>
<th></th>
<th>KY 17 to Staffordsburg</th>
<th>Staffordsburg to Campbell County Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>$800,000</td>
<td>$1,200,000</td>
</tr>
<tr>
<td>Right-of-Way</td>
<td>$8,000,000</td>
<td>$4,000,000</td>
</tr>
</tbody>
</table>
The project could be broken into three construction projects due to cost, continuing the same general theme of progressing west to east on KY 536 as was followed in Boone County and the western side of Kenton County. In addition, the portion from KY 17 to KY 16 has been KYTC’s primary priority for KY 536 east of KY 17.

1) **KY 17 to KY 16** - connects two major state routes and completes the urban section
2) **KY 16 to east of the Staffordsburg Connector** - completes the segment remaining on the existing KY 536 roadway and provides a clean tie-in point, while rectifying the two highest crash rate locations and completing most of the residential relocations
3) **East of Staffordsburg Road to Campbell County** - completes the entire off-alignment segment

<table>
<thead>
<tr>
<th></th>
<th>KY 17 to KY 16</th>
<th>KY 16 to Staffordsburg</th>
<th>Staffordsburg to Campbell County</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>$12,500,000</td>
<td>$8,540,000</td>
<td>$46,960,000</td>
</tr>
</tbody>
</table>

If monies allow, the construction segments could mirror the design segments.

The drawback of proceeding west to east is that KY 536 on the Visalia Hill (high accident location) would remain open for the longest duration. Any increase in traffic volumes as a result of an improved roadway to the west would have to traverse the hill if heading east. Also, failure to address the Visalia Hill would discourage use of KY 536 as a regional roadway until the situation is rectified.

In contrast, the drawback of constructing east to west is that the portion from Staffordsburg Connector to Campbell County requires a large portion of the overall corridor’s construction costs. This could delay any improvements to the overall corridor. In addition, it does not adhere to KYTC’s priority of upgrading KY 536 from KY 17 to KY 16.
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