

US 31W / KY 446 Study Warren County, KY



*Old Porter Pike to KY 957
(Plum Springs Loop)*

October 2016



Groundbreaking by Design.

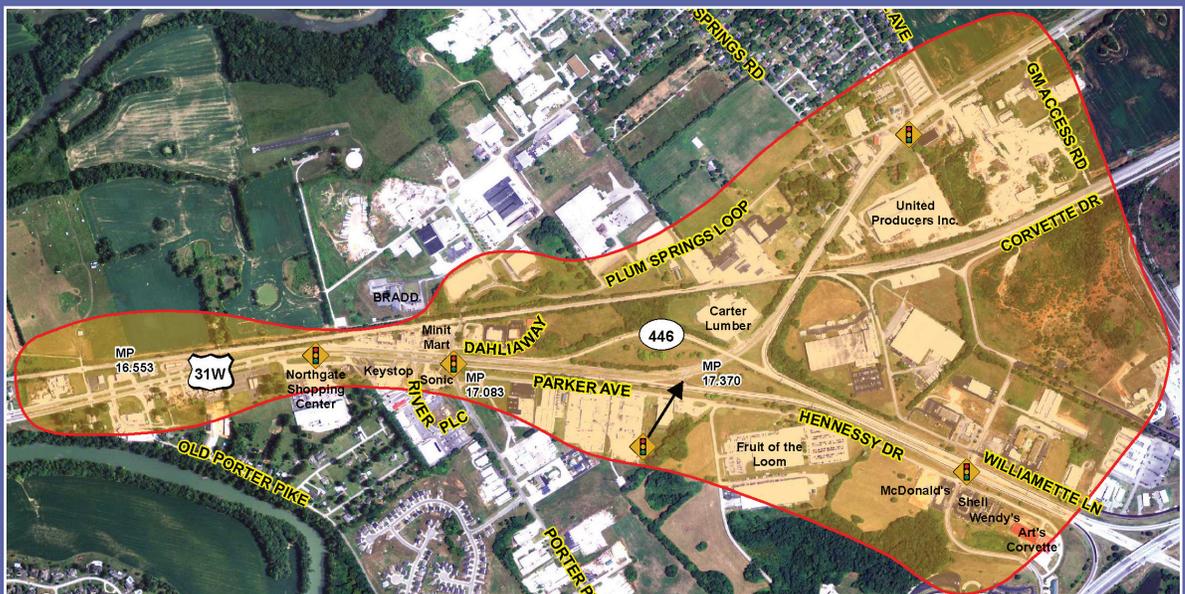
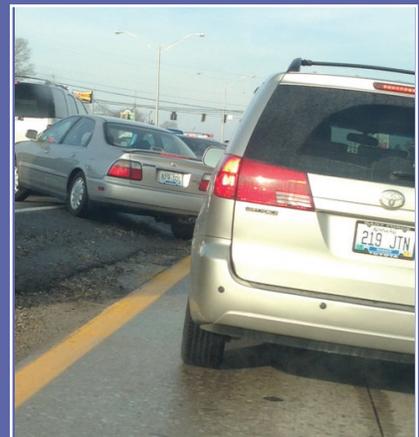


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EXECUTIVE SUMMARY

INTRODUCTION

The Kentucky Transportation Cabinet (KYTC) initiated a scoping study to examine the US 31W corridor (**ES Figure 3**) from Old Porter Pike to KY 957 (Plum Springs Road) and KY 446 toward I-65. The study's main focus was the US 31W/KY 446 interchange, which was built in the 1950s as part of a road meant to serve as a connector between I-65 and the city of Bowling Green. Since then the area has built up with a mixture of major developments, including the Corvette manufacturing plant, museum, and tourism-related developments. US 31W and KY 446 now serve as access to these developments and a gateway to Bowling Green instead of connector roads. Consequently, the interchange is no longer fitting.

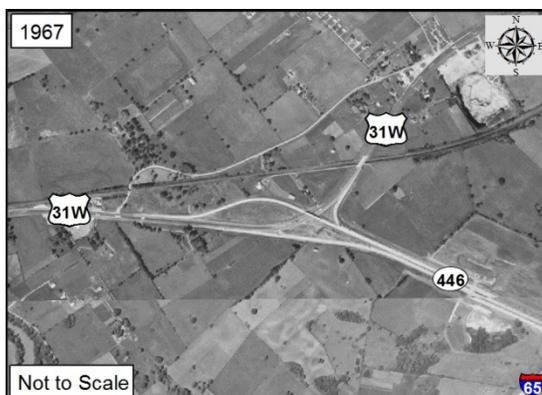
As summarized below, this study process documented existing conditions, identified a Purpose and Need Statement, developed a traffic model to simulate future conditions, and identified and recommended short-, medium-, and long-term solutions.

PROJECT PURPOSE AND NEED

The **Purpose** for the proposed project is to (1) make the transportation network in the study area functional for the existing mixed urban land uses—which include regional tourist attractions and major industries—rather than for the rural landscape that existed when the road was built, (2) improve traffic operations, which are congested and forecasted to worsen, and (3) improve safety in an effort to reduce high crash rates.

The **Needs** to be addressed are based on the following issues that support the three elements of the project's Purpose:

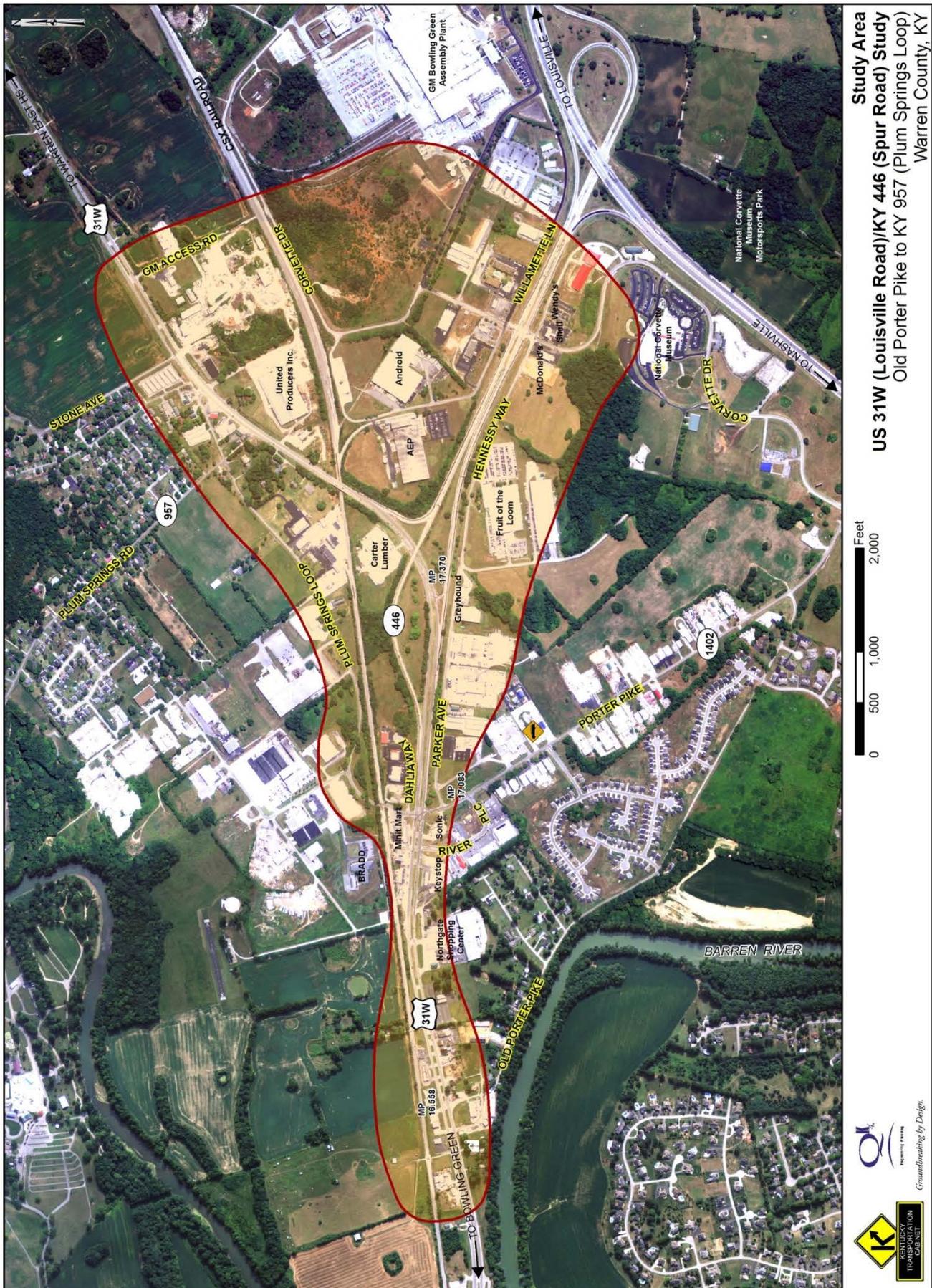
1. US 31W and KY 446 are arterials in Bowling Green, providing a gateway for southbound motorists from I-65 to access the GM Assembly Plant, the National Corvette Museum (NCM), the NCM Motorsports Park, Beech Bend Park, and downtown Bowling Green. Nearly 50 years ago, the roadway was constructed as a **rural** four-lane facility with a grassy median and partially controlled access, and it traversed farmland (**ES Figure 1**). The US 31W corridor still includes a high-speed, **rural-type interchange** with the KY 446 connection to I-65. However, increased commercial, residential, industrial, and tourism development in this area has changed the setting from rural to urban. Since the construction, Bowling Green has annexed the land and it has become a major economic development corridor (**ES Figure 2**).



ES Figure 1: Study Area in 1967



ES Figure 2: Study Area in 2012



ES Figure 3: Study Area

- Over the years commercial buildings and centers have developed along US 31W, which was originally built as a rural four-lane partially controlled access corridor with grassy medians that separate opposing traffic. On US 31W between Porter Pike and Old Porter Pike, for example, 14 median openings, one intersection with a flashing beacon and two signalized intersections exist along a 0.5-mile section (**ES Figure 4**). These access points contribute to congestion, crashes, and confusion for motorists. The result is a less-than-efficient roadway network.



ES Figure 4: Median Openings Along US 31W

At the end of the business day for Fruit of The Loom (FOTL), the GM Assembly Plant, and other major industries, traffic queues at the KY 446/Corvette Drive, US 31W/Porter Pike, and Porter Pike/Parker Avenue intersections, sometimes takes 25 minutes to clear. Adding to the congestion, the National Corvette Museum (NCM) schedules over 250 events each year, while in 2015 alone, the NCM Motorsports Park had over 56,000 visitors.

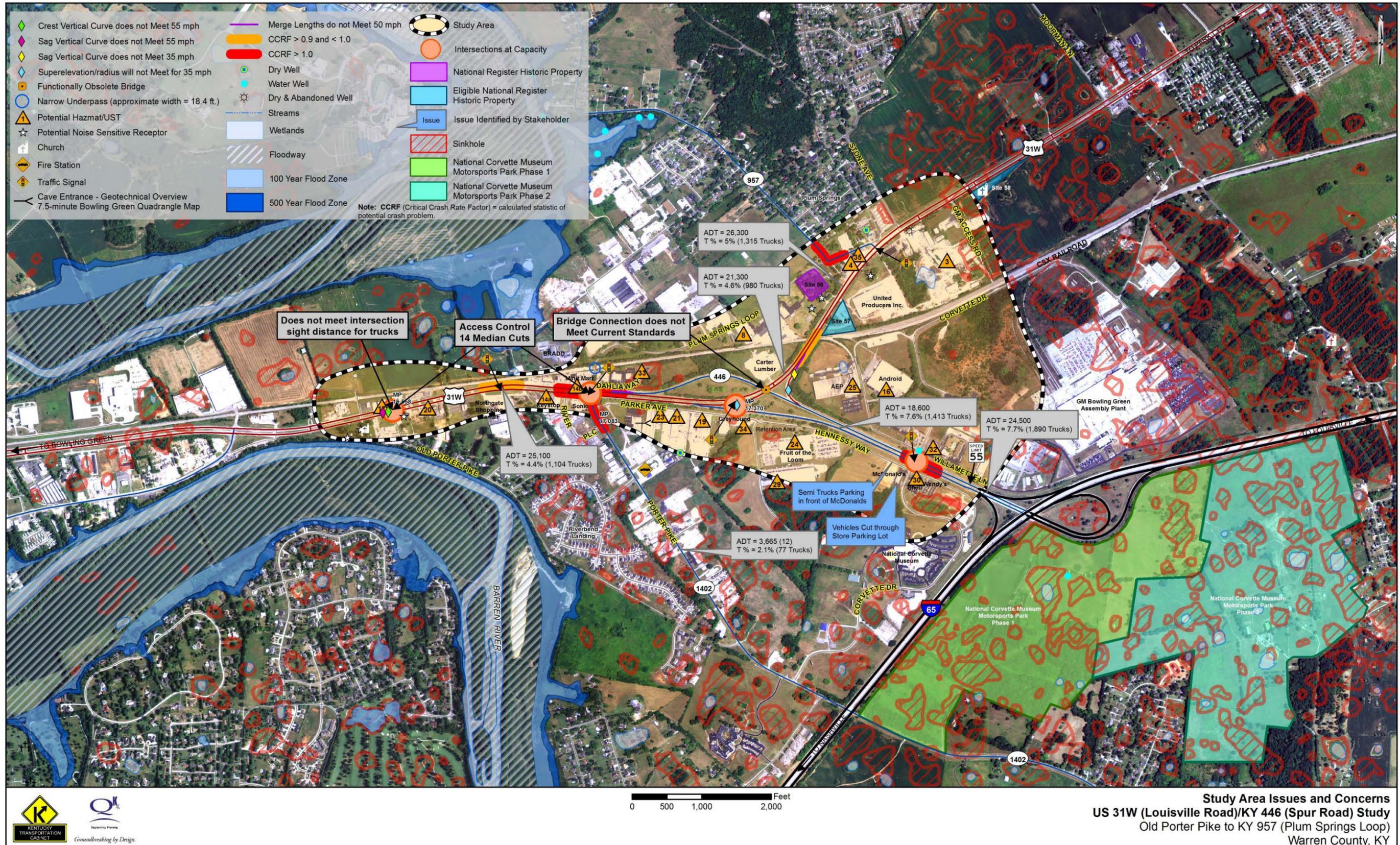
Existing average daily traffic (ADT) volumes on US 31W range from 25,100 to 26,300 vehicles per day (vpd) and traffic on KY 446 is approximately 24,500 vpd. Currently the intersections of KY 446/Corvette Drive, US 31W/Old Porter Pike, and US 31W/Porter Pike, and US 31W southbound to KY 446 eastbound have movements that are either level of service (LOS) E or F. Using a 0.5% annual growth rate established by KYTC, the 2040 forecasted traffic will increase and congestion will continue to worsen.

In addition, just north of US 31W, Plum Springs Loop narrows to a 19-foot width to pass under the CSX Railroad (**ES Figure 5**). The narrow passageway discourages a passenger car and a tractor-trailer to pass through the underpass simultaneously and leads to traffic backups into the US 31W/Plum Springs Loop intersection.



ES Figure 5: Plum Springs Loop

- The study area has a history of high crash rates. Contributing elements include areas where the stopping sight distance is hindered, substandard curves, and drainage problems. A road originally built for higher speeds now has numerous access points and six traffic signals. The results of these conditions, coupled with notable congestion, are higher than average crash rates. Crash records were analyzed for a five-year period from January 1, 2009, to December 31, 2013. The analysis identified seven areas where the Critical Crash Rate Factor (CCRF) is greater than 1.0 and two additional spots that have CCRFs approaching 1.0. A CCRF of 1.0 or above indicates crashes may not be occurring randomly as they are more frequent than statewide averages for similar roads. The high crash spots and other areas of concern are identified in **ES Figure 6**.



ES Figure 6: Study Area Issues and Concerns

Existing conditions that support these needs and other elements considered during the planning process are illustrated on **ES Figure 6**.

OTHER TRANSPORTATION PROJECTS

Identified during the planning process, two current roadway projects have an effect on traffic in the study area:

- KYTC Project Item No. 03-16.00 will be a new I-65 interchange and 2.3-mile connecting road to US 31W, about three miles north of KY 446. It will open to traffic in 2017 and is expected to divert traffic from the US 31W/KY 446 interchange area. (This was taken into account in the traffic model for the study area.)
- KYTC Project Item No. 03-8632.00 is a new signalized, full access point constructed on KY 446 near the Fruit of the Loom (FOTL) facility. This project opened to traffic in early summer of 2015 and was considered temporary for purposes of this study.

ALTERNATIVES DEVELOPMENT

The alternatives development and screening process was evolutionary and the recommendations include phased priorities. To arrive at these decisions, four project team, two local officials, and two public meetings were held over the course of the study to review, present and receive input on existing conditions and proposed alternatives/options.

The first local officials and public meetings were held to present existing conditions and gauge issues and concerns. Congestion (72%) and Safety (61%) were the greatest concerns expressed. In addition, the interchange movements from US 31W Southbound to Bowling Green and KY 446 Westbound to US 31W North were identified as concerns.

The purpose of the second project team meeting was to review a broad-range of initial improvement options that included: three 4-way intersections; two continuous Green “T” intersections; two modified interchanges; one flyover; three roundabouts; and improved access management on US 31W between Old Porter Pike and Porter Pike by reducing median openings from 14 to three, as well as other improvement options. Based on initial intersection capacity analysis performance and geometrics, the Project Team selected four build alternative concepts and four improvement options, as well as the No-Build option, to move forward.

Alternatives and Improvement Options were examined in more depth and low-cost options were developed. A traffic simulation model was developed for each alternative to determine how traffic would interact with adjacent intersections. Each alternative provided improvements at two known high crash areas.

Project Team Recommendations/Decisions

Summaries of the alternatives and improvement options screening process and decisions are provided in **ES Tables 1** and **2**.

ES Table 1: Alternative Screening Process Summary

Alternative		1	2	3	4	4a
	No Build	Reconstruct Existing Interchange	Continuous Green "T" Intersection*	4-Way Intersection	Roundabout	Roundabout with Porter Pike Extension
Recommendation	Eliminated in lieu of "Quick Win"	Eliminated	Eliminated	Recommended as "Quick Win" along with a new Signal System (Short-Term Priority 1)	Eliminated	Recommended as Long-Term Priority
Reasons for Decision	Maintenance (i.e. pavement rehabilitation) of ramps is more expensive than Alternative 3.	Does not meet Purpose and Need for urban context.	Does not perform as well as Alts 4 and 4a, has geometric considerations, and not as preferred by the public.	Meets drivers' expectations, fitting for urban context, cost-effective solution and could be phased to the long term roundabout recommendation.	Less desirable than Alternative 4a	Preferred by public, performs well, provides additional access to development along Porter Pike, and may eliminate the need to improve existing Porter Pike.
Decision Point	PTM 3	PTM 3	PTM 4	PTM 3	PTM 4	PTM 4
Rank by Travel Time	4	3	5	6	1	2
Rank by Delay	3	4	5	6	1	2
Conflict Points (US 31W/KY 446)	10	10	15	41	26	26
Delay in Minutes (2040 PM Peak Hour)	5,979	6,557	10,490	11,275	5,160	5,316
Travel Time in minutes (2040 PM Peak Hour)	12,062	11,327	16,274	17,119	10,225	10,391
Cost (\$ million)	\$0.00	\$7.51	\$7.62	\$6.01	\$13.76	\$21.24
High Crash Spots Eliminated (2 possible)	0	2	2	2	2	2

Delay = total network delay (from model)

Travel Time = total network travel time at posted speed limit (from model)

*Heaviest movement US 31W southbound is a continuous flow.

Conflict Points = the number of times vehicles cross paths

PTM = Project Team Meeting

Note: Pink selected for next project phase by the Project Team

ES Table 2: Improvement Options Summary

		A	B	C	D	Low-Cost Improvements**	
Improvement Options	No Build	Access Management from Old Porter Pike to Porter Pike	Realign KY 957 Intersection with US 31W*	Parker Avenue Realignment	Reconfiguration of Corvette Drive/ Duntov Way	Raise the Grade of US 31W near Old Porter Pike	Construct a Sidewalk Along Parker Avenue
Recommendation	Future Option	Short-Term Priority 4	Short-Term Priority 2	Short-Term Priority 3 (Local Project)	Eliminated	Short-Term Priority 5	Short-Term Priority 6 (Local Project)
Reasons for Decision		Reduces conflicts, expected to reduce crashes and improve traffic flow, and supported by the public.	Supported by public (the component to close the Plum Springs Loop Underpass was eliminated because it was opposed by the public).	Provides for additional traffic storage on Porter Pike between US 31W and Parker Avenue.	Opposition by Local Stakeholders.	Improves intersection sight distance for southbound left-turning vehicles onto Old Porter Pike.	Provides connection from Porter Pike to the Greyhound Bus Station
Decision Point	PTM 4	PTM 4	PTM 4	PTM 4	PTM 4	PTM 4	PTM 4
Cost (\$ million)	\$0.00	\$7.23	\$2.28	\$2.56	\$1.38	\$1.01***	\$0.15***

* “Close Plum Springs Loop Underpass” component was eliminated and option renamed “Realign KY 957 Intersection with US 31W.”

**Identified after Project Team Meeting No. 2.

*** Right-of-Way and Utility estimates were provided by KYTC for alternatives and improvement options only.

PTM = Project Team Meeting

PRIORITIZATION AND RECOMMENDATIONS

The following recommendations and priorities resulted from the fourth and final Project Team meeting:

- Construct a 4-way intersection in the immediate future, conceptually similar to Alternative 3. Additional public involvement should take place when the US 31W/KY 446 interchange is removed.
- Eliminate the component of Option B to "Close Plum Springs Loop Underpass" due to public opposition and advance only the component to "Realign KY 957 with Intersection of US 31W." Option B was renamed "Realign KY 957 with Intersection of US 31W."
- Remove Option D ("Reconfiguration of Corvette Drive/Duntov Way") due to opposition from stakeholders and the lack of notable support from the public.
- Recommend an Adaptive Signal Control system with the "Quick Win" (Alternative 3).

A. Recommended Options (Short-Term) – Listed in Priority Order

1. Install and Calibrate Sub-Area Signal System: \$0.30 million
2. Option B – Realign KY 957 with Intersection of US 31W: \$2.28 million
3. Option C – Parker Avenue Realignment at Porter Pike: \$2.56 million
4. Option A – Implement Access Management Strategy on US 31W: \$7.23 million

B. Medium-Term Priority – Re-evaluate the US 31W/KY 446 Intersection Following its Construction

C. Long-Term Priority – Implement Alternative 4a

D. Low-Cost Improvements

5. Raise the Grade at Old Porter Pike to Improve Intersection Sight Distance: \$1.01 million
6. Pedestrian accommodations were desired for Parker Avenue between Porter Pike and the Greyhound Bus Station with a construction cost of \$150,000. Since the project would be implemented by the city, the recommendation will be referred to the MPO for consideration.

All final recommended alternatives and options should be incorporated in the Unscheduled Needs List and also into the planning documents of the Bowling Green/Warren County MPO.

Phase costs and prioritized recommendations are shown in **ES Table 3** and illustrated in **ES Figure 7, ES Figure 8, and ES Figure 9**.

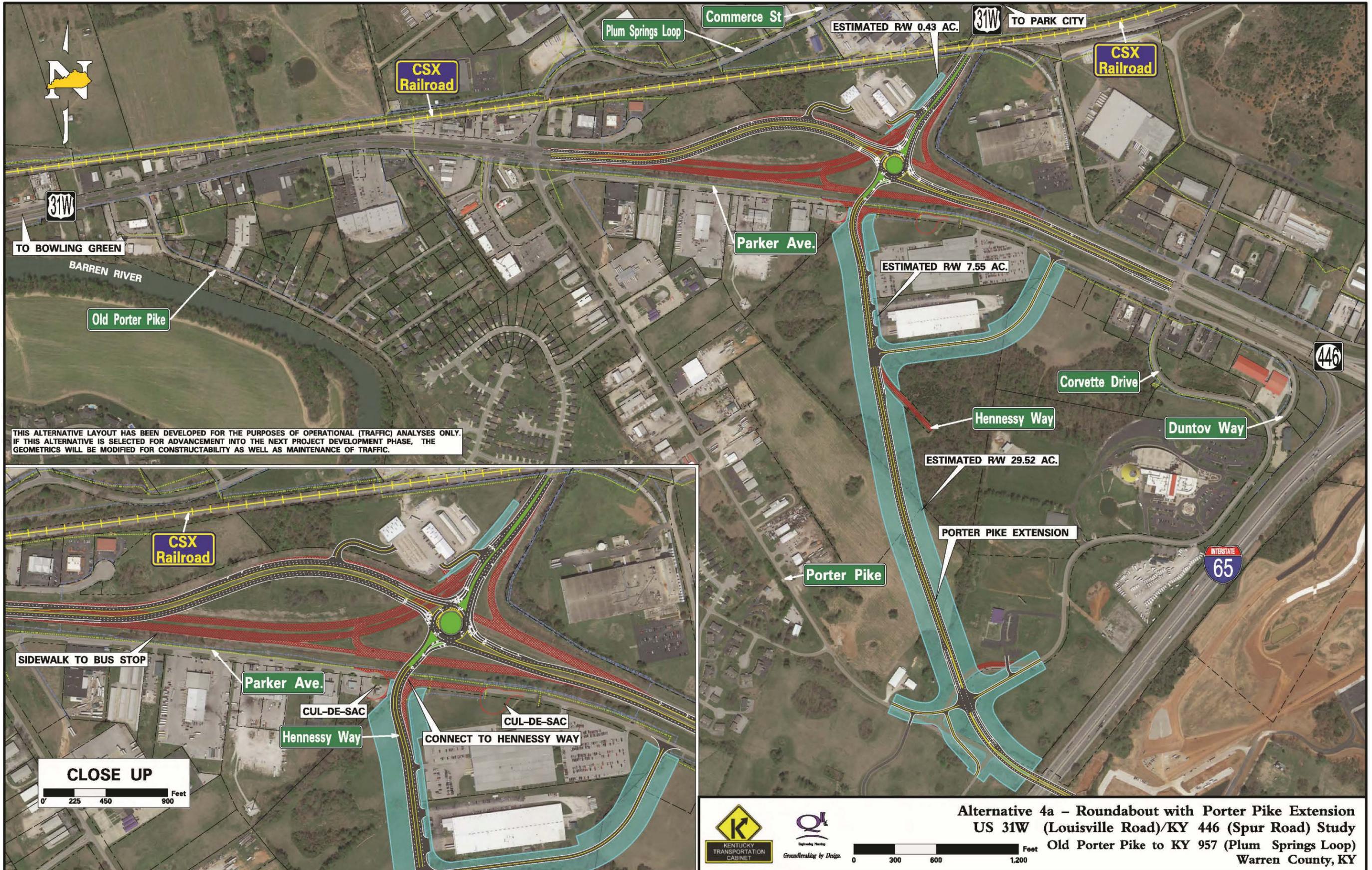
ES Table 3: Summary of Recommendations and Cost Estimates

	Alternatives		Improvement Options				Low-Cost Improvements	
	3	4a	Signal System	B	C	A	Raise Grade of US 31W	Construct a Sidewalk Along Parker Avenue
Priority	“Quick Win”	Long-Term	Short-Term 1	Short-Term 2	Short-Term 3	Short-Term 4	Short-Term 5	Short-Term 6
Responsible	KYTC	KYTC	KYTC	KYTC	Local	KYTC	KYTC	Local
Short Description	4-way Intersection	Roundabout with Porter Pike Extension	Signal System	Realign KY 957 with Intersection of US 31W	Parker Avenue Realignment	Access Management from Old Porter Pike to Porter Pike	Raise Grade of US 31W Near Old Porter Pike	From Porter Pike to the Greyhound Bus Station
Design	\$420,000	\$2,100,000	\$300,000	\$100,000	\$100,000	\$320,000	\$100,000	\$0
Right-of-Way	\$825,000	\$3,600,000	\$0	\$375,000	\$1,175,000	\$1,475,000	\$0	\$0
Utilities	\$565,000	\$1,835,000	\$0	\$1,180,000	\$550,000	\$2,240,000	\$0	\$0
Construction	\$4,200,000	\$13,700,000	\$0	\$630,000	\$730,000	\$3,200,000	\$910,000	\$0
Total	\$6,010,000	\$21,235,000	\$300,000	\$2,285,000	\$2,555,000	\$7,235,000	\$1,010,000	\$150,000

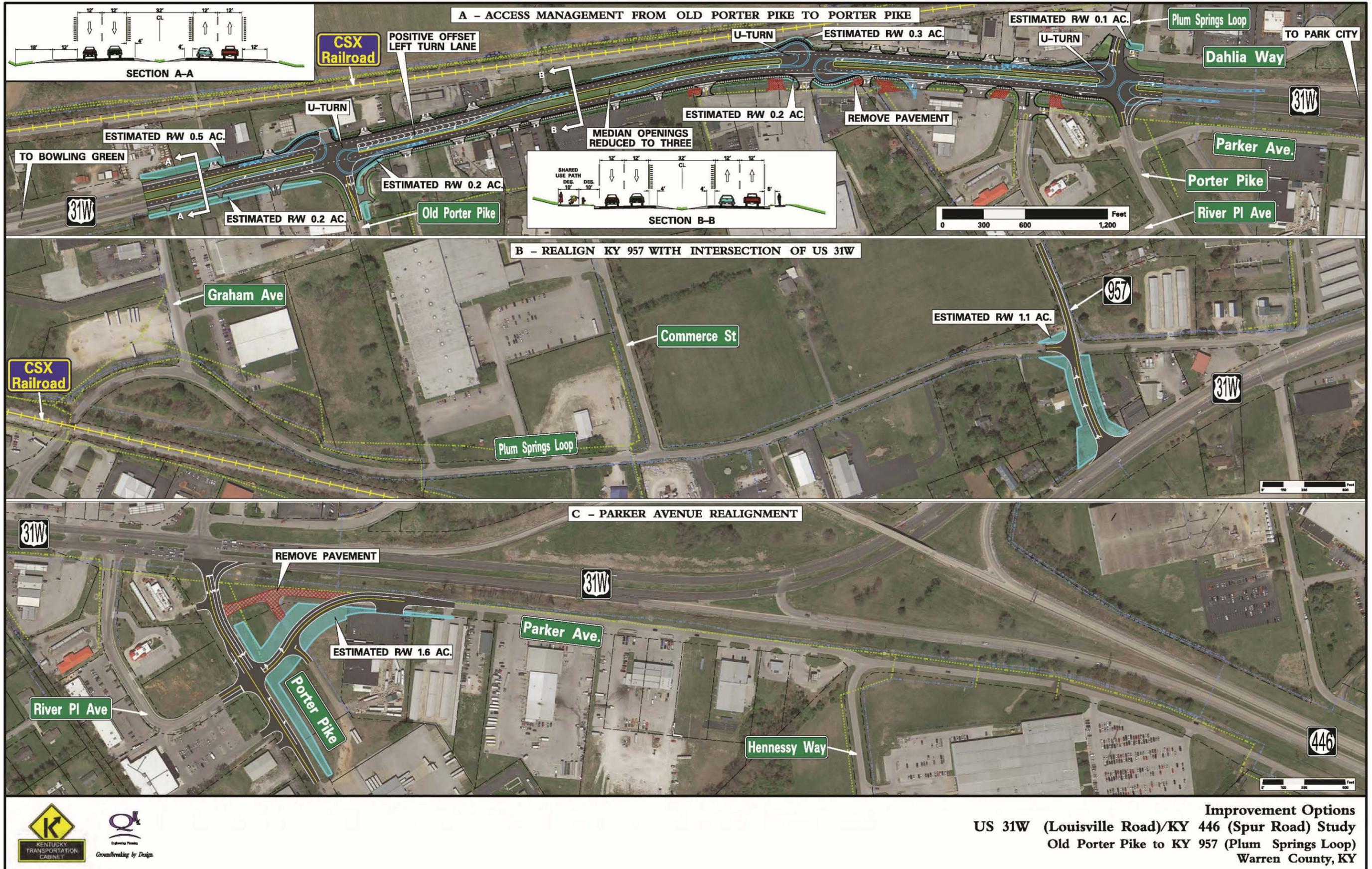
*Right-of-Way and Utility estimates were provided by KYTC for alternatives and improvement options only.



ES Figure 7: Alternative 3 - 4-Way Intersection "Quick Win"



ES Figure 8: Alternative 4a - Roundabout With Porter Pike Extension (Long-Term)



ES Figure 9: Improvement Options (Short-Term)

1.0 INTRODUCTION

KYTC initiated a study to examine the US 31W/KY 446 study area from Old Porter Pike to KY 957 (Plum Springs Road). The study's main focus is the US 31W/KY 446 interchange and improvement alternatives to address the study area's urban nature. The study documents existing conditions utilizing a traffic model that simulates existing and future conditions and recommends potential short term or "quick wins" and long term solutions. The planning process included meetings with elected officials, stakeholders, the public, and the KYTC Project Team.

US 31W (Louisville Road) serves as a major urban and regional connection in Bowling Green, Kentucky. The route provides a gateway for southbound I-65 and KY 446 (Spur Road) motorists to access the General Motors Bowling Green Assembly Plant, National Corvette Museum Activities Center, Beech Bend Park, Western Kentucky University, and downtown Bowling Green (**Figure 1**).

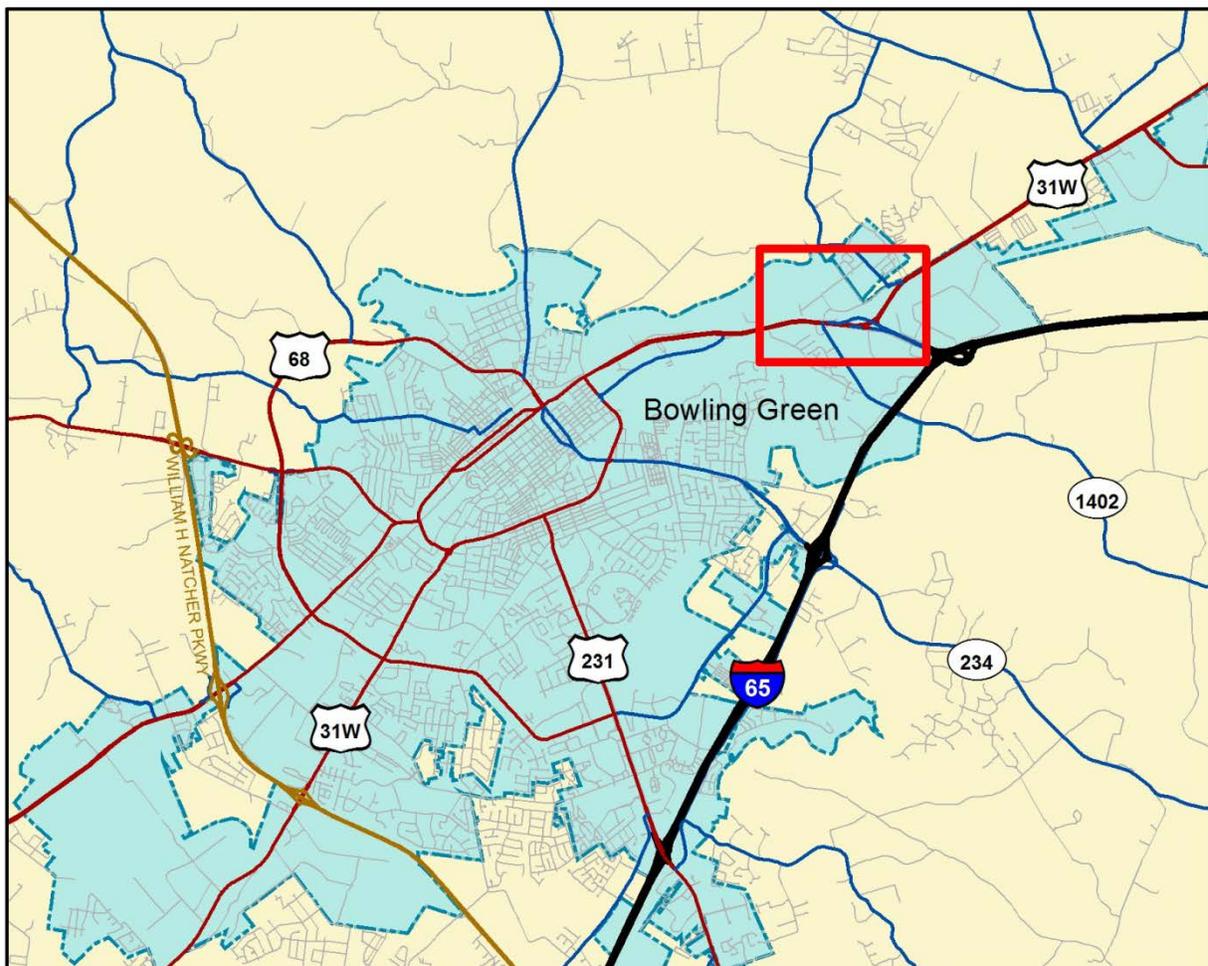


Figure 1: Project Location

2.0 PROJECT HISTORY

US 31W was constructed over 50 years ago as a rural four-lane facility with a grassy median and a partially controlled access connection to I-65 via KY 446. When built, the area was very rural, with no development. The study area (**Figure 2**) has experienced tremendous growth leaving a high-speed, rural interchange in the middle of an urban area. Increased commercial, residential, and industrial development has created safety and mobility issues along US 31W and KY 446 located in the northeast area of Bowling Green (**outlined in red in Figures 1 and 2**).

Just north on US 31W, the Kentucky Transportation Cabinet (KYTC) initiated the US 31W/I-65 Interchange project (KYTC Project Item No. 03-16.00) that will help relieve some congestion issues in the US 31W/KY 446 study area. The I-65 Interchange project begins with the construction of a “trumpet” style interchange on I-65 near MP 30.6, then proceeds northeast 2.8 miles to intersect with US 31W (**Figure 3, p. 4**). The interchange is currently under construction and is anticipated to be open to traffic in 2017. Employees traveling to/from work and residents living in this area will use this new interchange to access I-65, thereby reducing the amount of traffic utilizing the I-65/KY 446 exit (Exit 28) and the US 31W/KY 446 interchange. However with expected residential growth near Moorman Lane (just north of the study area on US 31W), and the development of the new NCM Motorsports Park, traffic is still expected to increase.

During the 2009 alternatives analysis for KYTC Project Item No. 03-16.00, an option to rebuild US 31W and KY 446 was examined, but was eliminated due to right-of-way impacts and because it would not have met the Purpose and Need of that project. The impacts would have come from rebuilding 3.3 miles of US 31W, parts of the I-65/KY 446 interchange, and reconstruction of the KY 446 interchange area.

The genesis of this study is related to the traffic congestion in the area that generates numerous complaints and inquiries from the public and elected officials. Transportation and land use planners in Bowling Green and Warren County, including the Bowling Green Metropolitan Planning Organization (MPO), have long-identified a need to study options to improve traffic flow. The first Project Identification Form (Control Number 03 114 B0031W 16.00) generated by KYTC for this study was completed in October 2011.

3.0 PROJECT PURPOSE AND NEED

The purpose and need for the proposed project has evolved through the development of this study, as new information and input was received and from what was presented in early meeting materials.

The **Purpose** for the proposed project is to (1) make the transportation network in the study area functional for the existing mixed urban land uses—which include regional tourist attractions and major industries—rather than for the rural landscape that existed when the road was built, (2) improve traffic operations, which are congested and forecasted to worsen, and (3) improve safety in an effort to reduce high crash rates.



Figure 2: Study Area

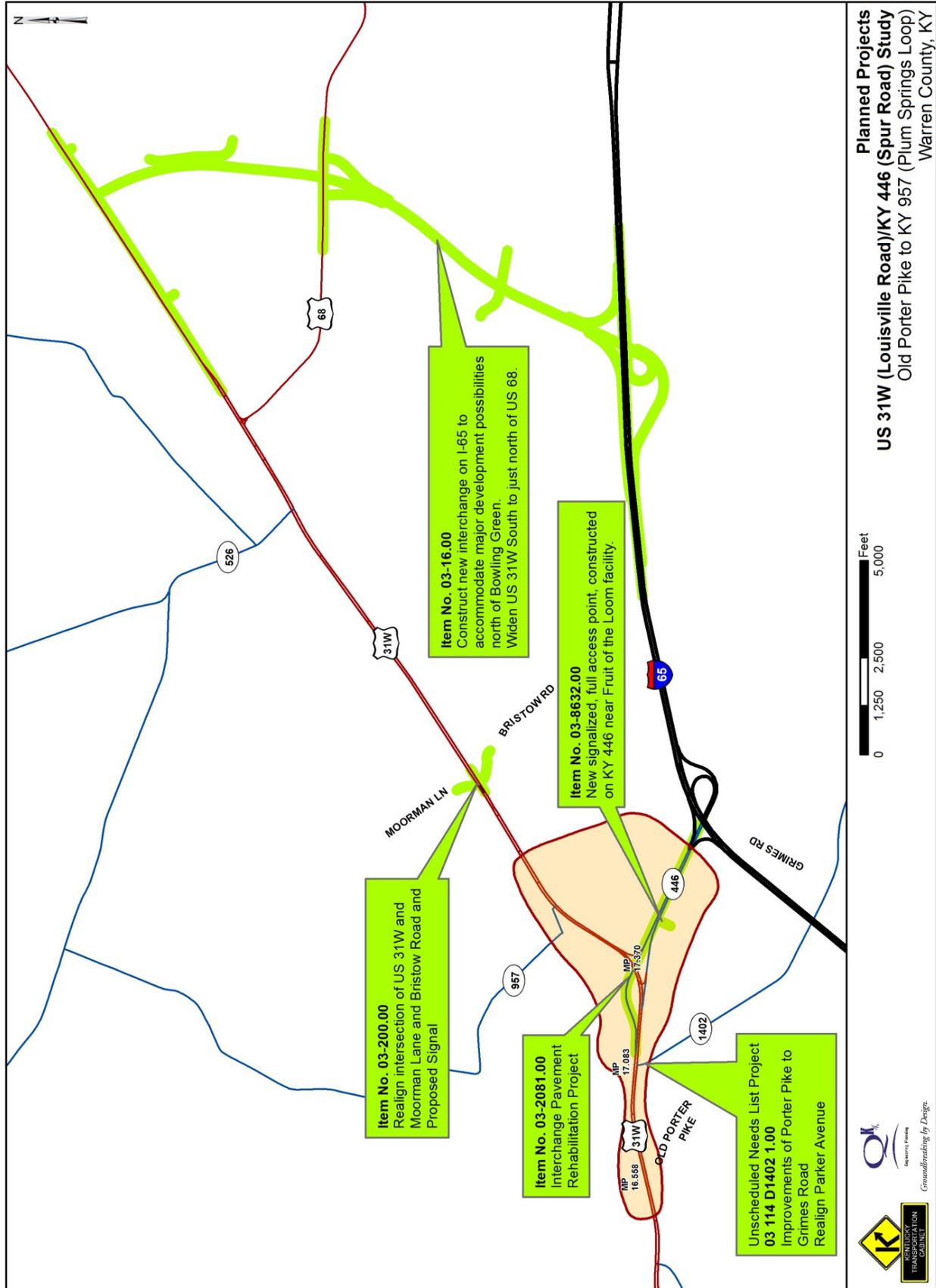


Figure 3: Existing Projects Near Study Area

The **Needs** to be addressed are based on the following issues that support the three elements of the project’s Purpose:

1. US 31W and KY 446 are arterials in Bowling Green, providing a gateway for southbound motorists from I-65 to access the GM Assembly Plant, the National Corvette Museum (NCM), the NCM Motorsports Park, Beech Bend Park, and downtown Bowling Green. Nearly 50 years ago, the roadway was constructed as a **rural** four-lane facility with a grassy median and partially controlled access, and it traversed farmland (**Figure 4**). The US 31W corridor still includes a high-speed, **rural-type interchange** with the KY 446 connection to I-65. However, increased commercial, residential, industrial, and tourism development in this area has changed the setting from rural to urban. Since the construction, Bowling Green has annexed the land and it has become a major economic development corridor (**Figure 5**).

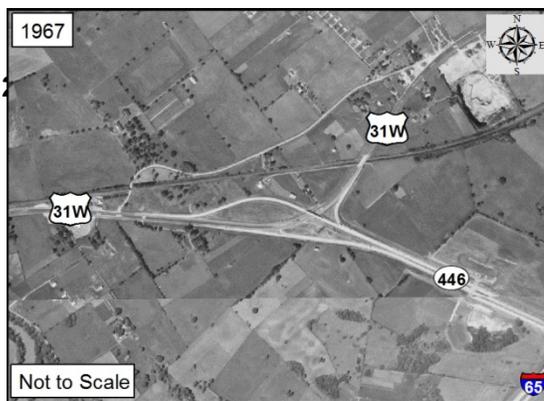


Figure 4: Study Area in 1967

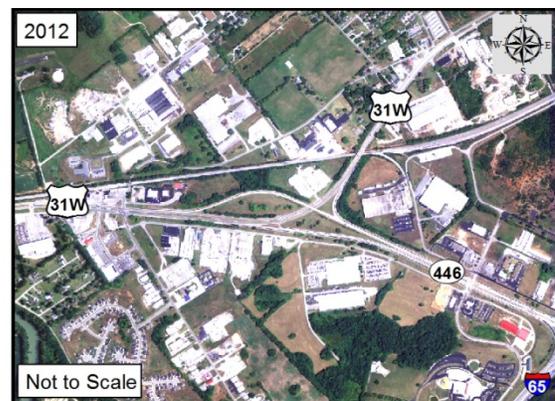


Figure 5: Study Area in 2012

2. Over the years commercial buildings and centers have developed along US 31W, which was originally built as a rural four-lane partially controlled access corridor with grassy medians that separate opposing traffic. On US 31W between Porter Pike and Old Porter Pike, for example, 14 median openings, one intersection with a flashing beacon and two signalized intersections exist along a 0.5-mile section (**Figure 6**). These access points contribute to congestion, crashes, and confusion for motorists. The result is a less-than-efficient roadway network.



Figure 6: Median Openings Along US 31W

At the close of the business day for Fruit of The Loom (FOTL), the GM Assembly Plant, and other major industries, traffic queues at the KY 446/Corvette Drive, US 31W/Porter Pike, and Porter Pike/Parker Avenue intersections, sometimes take 25 minutes to clear. Adding to the congestion, the National Corvette Museum (NCM) schedules over 250 events each year, while in 2015 alone, the NCM Motorsports Park had over 56,000 visitors.

Existing average daily traffic (ADT) volumes on US 31W range from 25,100 to 26,300 vehicles per day (vpd) and traffic on KY 446 is approximately 24,500 vpd. Currently the intersections of KY 446/Corvette Drive, US 31W/Old Porter Pike, and US 31W/Porter Pike, and the US 31W southbound to KY 446 eastbound have movements operating at either level of service (LOS) E or F. Using a 0.5% annual growth rate established by KYTC, the 2040 forecasted traffic will increase and congestion will continue to worsen.

In addition, just north of US 31W, Plum Springs Loop narrows to a 19-foot width to pass under the CSX Railroad. The narrow passageway discourages a passenger car and a tractor-trailer to pass through the underpass simultaneously and leads to traffic backups at the US 31W/Plum Springs Loop intersection.

3. The study area has a history of high crash rates. Contributing elements include areas where the stopping sight distance is hindered, substandard curves, and drainage problems. A road originally built for higher speeds now has numerous access points and six traffic signals. The results of these conditions, coupled with notable congestion, are higher than average crash rates. Crash records were analyzed for a five-year period from January 1, 2009, to December 31, 2013. The directional analysis identified seven areas where the Critical Crash Rate Factor (CCRF) is greater than 1.0 and two additional spots that have CCRFs approaching 1.0. A CCRF of 1.0 or above indicates crashes may not be occurring randomly as they are more frequent than statewide averages for similar roads.

4.0 REVIEW AND SUMMARIZATION OF PREVIOUS WORK

Existing roadway deficiencies, crash history, existing traffic demand, and environmental concerns were identified in order to develop alternative recommendations intended to address the project's purpose and need.

4.1 Project Identification Form (PIF)

During 2011, KYTC developed one PIF (03 114 B0031W 16.0) along US 31W. The purpose statement was to reconstruct US 31W from Old Porter Pike (MP 16.559) to KY 957 (MP 18.085) including reconstruction of the interchange with KY 446. A copy of the PIF is located in **Appendix A**.

4.2 Projects in the Study Area

Five projects in KYTC's 2014–2020 Six Year Highway Plan in or near the study area are listed on the following page and their locations are shown in **Figure 3 (p. 4)**.

- **KYTC Project Item No. 03-16.00** will be a new interchange on I-65 and 2.3-mile connecting road with US 31W, about three miles north of KY 446. It will open to traffic in 2017 and is expected to divert traffic from the US 31W/KY 446 interchange area. (This was taken into account in the traffic model for the study area.)
- **KYTC Project Item No. 03-200.00** will realign US 31W/Moorman Lane/Bristow Road and provide for a signal.
- **KYTC Project Item No. 03-8632.00** is a new signalized, full access point constructed on KY 446 near the FOTL facility. This project opened to traffic in early summer of 2015 and was considered temporary for purposes of this study.
- **Unscheduled Needs List Project (03 114 D1402 1.00)** will address improvements of KY 1402 (Porter Pike) from US 31W to Grimes Road that includes the realignment of Parker Avenue to provide more queuing length at Porter Pike.
- **KYTC Project Item No. 03-2081.00** is a rehabilitation project that will replace the existing concrete driving lanes on KY 446 and with full depth asphalt pavement between I-65 and US 31W. This project is in essence a No-Build option when considering long-term reconstruction options for KY 446, including the KY 446/US 31W interchange.

5.0 EXISTING CONDITIONS

The following sections describe the existing conditions in the study area.

5.1 Roadway Characteristics

US 31W is part of the US 68 Heritage Corridor and is designated as part of the Duncan Hines Scenic Byway (**Figure 7**). This 67-mile scenic tour begins at the Duncan Hines historical marker in front of the structure that Hines built in 1940 as his home/office at 3098 Louisville Road (US 31W). Today this building serves as the Hardy and Son Funeral Home. The Scenic Byway continues north on US 31W through Warren and Edmonson counties.



Figure 7: Duncan Hines Scenic Byway

As shown in **Figure 8**, **US 31W** is functionally classified as a four-lane divided, Urban Principal Arterial from Old Porter Pike to KY 446. From KY 446 to KY 957 (Plum Springs Road), it is classified as an Urban Minor Arterial Street. The speed limit on US 31W north of KY 446 is 55 miles per hour (mph) and 45 mph from Old Porter Pike to KY 446 (**Table 1, p. 9**). Between Old Porter Pike and Porter Pike 14 median openings and 25 access points exist in the 0.5-mile section of US 31W. The US 31W median in the project area changes width five times in 2.1 miles.

In the eastern part of the study area, **KY 446** connects US 31W with I-65. KY 446 is a four-lane divided, Urban Principal Arterial that begins at an interchange with US 31W and continues east for approximately 1.0 mile to its terminus at the Exit 28 interchange of I-65. KY 446 provides access to the NCM and GM Assembly Plant. The road is known locally as Spur Road.

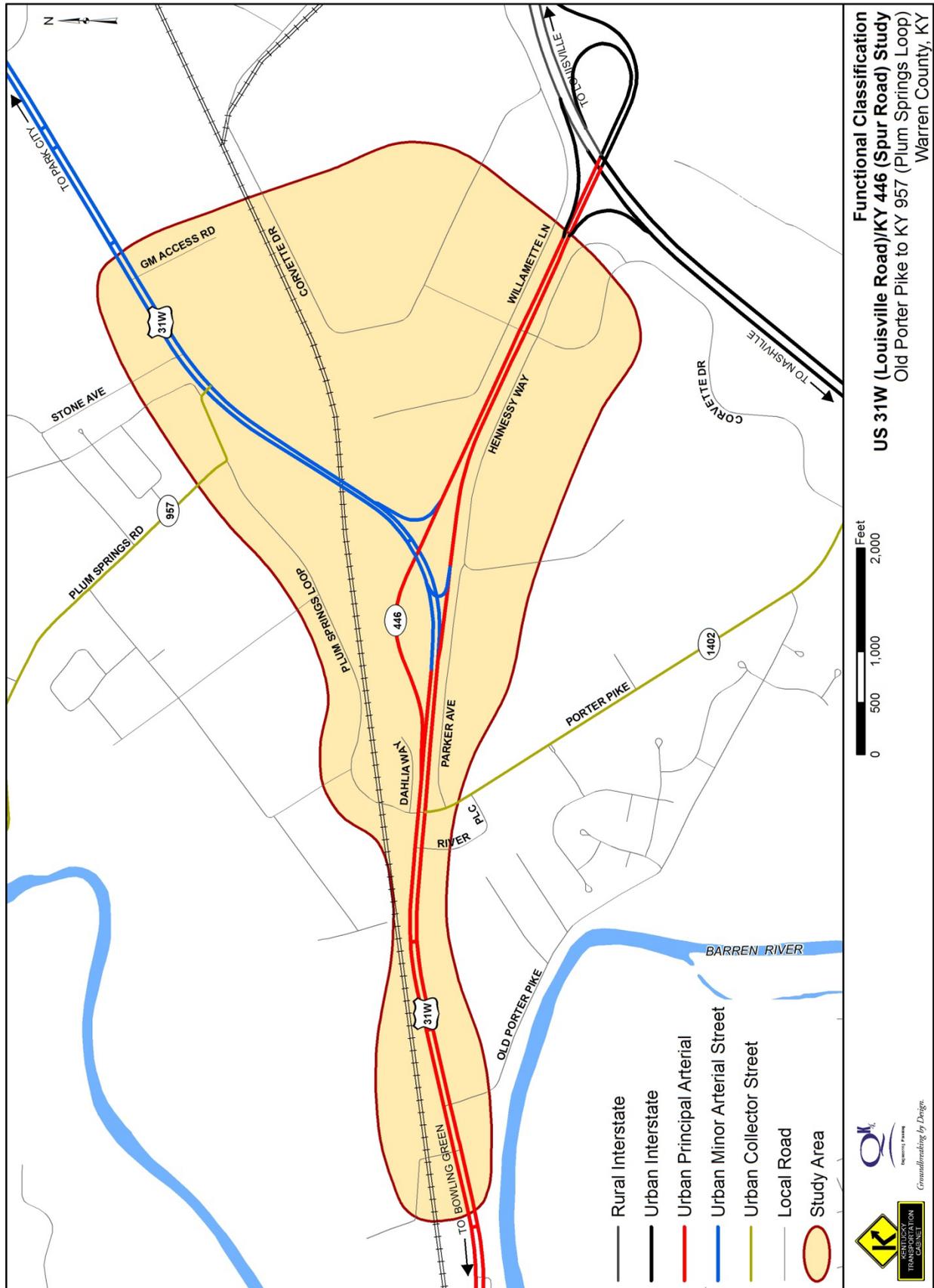


Figure 8: Functional Classification

Table 1: Existing Conditions Inventory

DESCRIPTION						GENERAL INFORMATION										ROADWAY TYPICAL SECTION											
ROUTE	BEGIN MP	BEGINNING FEATURE	END MP	ENDING FEATURE	LENGTH	BICYCLE AND PEDESTRIAN FACILITIES (YES OR NO)	TYPE OF OPERATION (DIRECTION)	TRUCK WEIGHT CLASS (LBS)	SPEED LIMIT (MPH)	ACCESS DRIVEWAYS (EB/WB) or (NB/SB)	# OF MEDIAN ACCESS POINTS	ACCESS CONTROL	# OF LANES	LANE WIDTH	PAVEMENT TYPE	AUXILIARY LANES		MEDIAN	LEFT SHOULDER		RIGHT SHOULDER						
																AUXILIARY LANES (DIRECTION) ^{1,2,3,4}	WIDTH (FT)		MEDIAN TYPE	MEDIAN WIDTH (FEET)	SHOULDER TYPE	SHOULDER WIDTH (FT)	SHOULDER TYPE	SHOULDER WIDTH ² (FT)			
US 31W	16.200	STUDY AREA BOUNDARY	16.232	SMOKEY PIG ROAD & CONTOF OF ACCESS CHANGE	0.032				55			PARTIAL				CR	12	DEPRESSED	PAVED WITH BITUMINOUS MATERIAL	2	PAVED WITH BITUMINOUS MATERIAL	10					
	16.232	SMOKEY PIG ROAD & CONTOF OF ACCESS CHANGE	16.320	SPEED LIMIT CHANGE	0.098																						
	16.320	SPEED LIMIT CHANGE	16.472	RIGHT SHOULDER WIDTH CHANGE	0.152					9	4																
	16.472	RIGHT SHOULDER WIDTH CHANGE	16.526	TURN LANE	0.054																						
	16.526	TURN LANE	16.558	OLD PORTER PIKE	0.032											CR	9										
	16.558	OLD PORTER PIKE	16.604	TURN LANE CHANGE	0.046											NCL	9										
	16.604	TURN LANE CHANGE	16.749	SCENIC BYWAY CHANGE	0.145																						
	16.749	SCENIC BYWAY CHANGE	16.856	SHOPPING CENTER ENTRANCE	0.107																						
	16.856	SHOPPING CENTER ENTRANCE	16.871	TURN LANE CHANGE	0.015																						
	16.871	TURN LANE CHANGE	16.941	TURN LANE CHANGE	0.070					25	14																
	16.941	TURN LANE CHANGE	17.022	RIVER PLACE AVENUE	0.081																						
	17.022	RIVER PLACE AVENUE	17.064	TURN LANE CHANGE	0.032																						
	17.064	TURN LANE CHANGE	17.088	KY 1402 (PORTER PIKE)PLUM SPRINGS LOOP	0.034											CL	9										
	17.088	KY 1402 (PORTER PIKE)PLUM SPRINGS LOOP	17.187	TURN LANE AND SPEED LIMIT CHANGE	0.099											CL/CR	9/9										
	17.187	TURN LANE AND SPEED LIMIT CHANGE	17.370	KY 446	0.183					3		BY PERMIT	4			NCL	10										
	17.370	KY 446	17.490	US 31W Ramp	0.120																						
	17.490	US 31W Ramp	17.561	BEGIN LEFT SIDE CURB	0.071																						
	17.561	BEGIN LEFT SIDE CURB	17.599	TURN LANE CHANGE	0.038																						
	17.599	TURN LANE CHANGE	17.608	TURN LANE CHANGE	0.009																						
	17.608	TURN LANE CHANGE	17.764	DEPRESSED TO MOUNTABLE MEDIAN	0.156																						
17.764	DEPRESSED TO MOUNTABLE MEDIAN	17.805	MOUNTABLE MEDIAN TO FLUSH	0.041				55									RAISED MOUNTABLE	6		CURB	1						
17.805	MOUNTABLE MEDIAN TO FLUSH	17.865	FLUSH MEDIAN TO NONE	0.080																							
17.865	FLUSH MEDIAN TO NONE AND MIDDLE TURN LANE	17.896	MIDDLE TURN LANE	0.031																							
17.896	MIDDLE TURN LANE	18.084	KY 957	0.188																							
18.084	KY 957	18.160	STONE LANE	0.076																							
18.160	STONE LANE	18.325	GM ACCESS ROAD	0.165																							
18.325	GM ACCESS ROAD	18.400	STUDY AREA BOUNDARY	0.075																							
KY 446	0.000	US 31W	0.172	LEFT SHOULDER CHANGE	0.172													DEPRESSED	>36		PAVED WITH BITUMINOUS MATERIAL	1					
	0.172	LEFT SHOULDER CHANGE	0.565	TRANSITION DEPRESSED MEDIAN TO RAISED NON-MOUNTABLE	0.393					1	NA	PARTIAL	4	12				DEPRESSED			PAVED WITH BITUMINOUS MATERIAL	4					
	0.565	TRANSITION DEPRESSED MEDIAN TO RAISED MOUNTABLE	0.632	CORVETTE DRIVE	0.067																CURB	0					
	0.632	CORVETTE DRIVE	0.674	AUXILIARY LANE	0.042																NCLNCR	10/11					
	0.674	AUXILIARY LANE	0.691	TRANSITION TO RAISED NON MOUNTABLE TO DEPRESSED MEDIAN	0.017																NCL	10					
	0.691	TRANSITION TO RAISED NON MOUNTABLE TO DEPRESSED MEDIAN	0.707	SHOULDER WIDTH CHANGE	0.016					1											NCL	10					
0.707	SHOULDER WIDTH CHANGE	0.800	STUDY AREA BOUNDARY	0.093																	DEPRESSED	36					
KY 957	0.000	US 31 W	0.027	PROCTOR TRAIL	0.027				55	2	NA	BY PERMIT	2	10	MIXED BITUMINOUS												
	0.027	PROCTOR TRAIL	0.145	PLUM SPRINGS LOOP	0.118					6																	
	0.145	PLUM SPRINGS LOOP	0.290	JENKINS DRIVE	0.145				35	8																	
KY 1402	0.000	US 31 W	0.036	TURN LANE	0.039					1	NA	BY PERMIT	2	11	MIXED BITUMINOUS												
	0.036	TURN LANE	0.039	PARKER AVENUE	0.004																						
	0.039	PARKER AVENUE	0.072	TURN LANE	0.053					0																	
	0.072	TURN LANE	0.092	RIVER PLACE AVENUE	0.053																						
	0.092	RIVER PLACE AVENUE	0.100	STUDY AREA BOUNDARY	0.008					0																	

- NOTES:
 1. CL-Cardinal Left
 2. CR-Cardinal Right
 3. NCL-Non Cardinal Left
 4. NCR-Non Cardinal Right

KY 1402 is known locally as Porter Pike. Porter Pike is a two-lane Urban Collector street that intersects US 31W at a junction with Plum Springs Loop. From its intersection with US 31W, Porter Pike proceeds southeast through an area dotted by small businesses and new residential development for 1.2 miles before the I-65 overpass. This road provides access to the new NCM Motorsports Park on the east side of I-65.

Old Porter Pike is a two-lane Local road that primarily provides access to residential uses and intersects with Porter Pike approximately 0.35 mile northwest of the I-65 underpass. Old Porter Pike intersects with US 31W as an un-signalized intersection approximately 0.5-mile west of Porter Pike. A crest curve along US 31W at the intersection with Old Porter Pike presents a sight distance issue for vehicles approaching the intersection. A flashing signal beacon helps warn approaching motorists on US 31W of the upcoming intersection and possible cross street traffic. This intersection meets 45 miles per hour (mph) only for passenger cars and single-unit trucks.

Hennessy Way is a two-lane Local road that connects with Parker Avenue to provide access to the FOTL plant, BADA Industries and the businesses (i.e., McDonald's, Huck's Fuel Center, Shell Service Station, etc.) located at the intersection of Hennessy Way and Corvette Drive. When the study began, Hennessy Way and Parker Avenue were used by FOTL employees to access I-65 and US 31W.

Duntov Way from Corvette Drive near the intersection at KY 446 to Corvette Drive near the Corvette Museum is a two-lane Local road that provides access for Wendy's, Art's Corvette Sales, and a Shell Service Station.

Corvette Drive from KY 446 to the intersection of KY 1402 is a two-lane Local road that provides access to the National Corvette Museum and Duntov RV Center and intersects with KY 1402 (Porter Pike) to provide a link to the NCM Motorsports Park.

Parker Avenue is a two-lane Local road that connects Porter Pike and Hennessy Way and provides access to a number of businesses including Marlins Furniture Outlet, Tri-state International Trucks, and Greyhound Bus Lines. Prior to the installation of the new traffic signal, Parker Avenue was used by FOTL employees to access US 31W.

KY 957 is known locally as Plum Springs Road. KY 957 serves as a two-lane Urban Collector Street. KY 957 intersects Plum Springs Loop at milepoint (MP) 0.145 just west of US 31W. The section of KY 957 (0.13 mile) from the intersection of Plum Springs Loop to US 31W is also labeled as Plum Springs Loop. The intersection of KY 957 and US 31W is a skewed intersection which causes issues for large trucks. A business located at this intersection has an open driveway and motorists use this as a "cut-through."

Plum Springs Loop is a two-lane Local road that traverses under the CSX railway with a roadway width measuring 19 feet that discourages a passenger car and a tractor-trailer to pass through the underpass simultaneously. This can lead to backup queues at the US 31/Plum Spring Loop intersection exceeding over 500 feet from the intersection, and beyond the underpass. The eastbound right turn lane to US 31W is short which also results in queues. In addition, motorists use a driveway entrance into a Marathon service station just south of the underpass, as a "cut through" to US 31W. The railway clearance over Plum Springs Loop is 14.8 feet (**Figure 9**).



Figure 9: Plum Springs Loop Underpass

5.2 Horizontal and Vertical Geometry

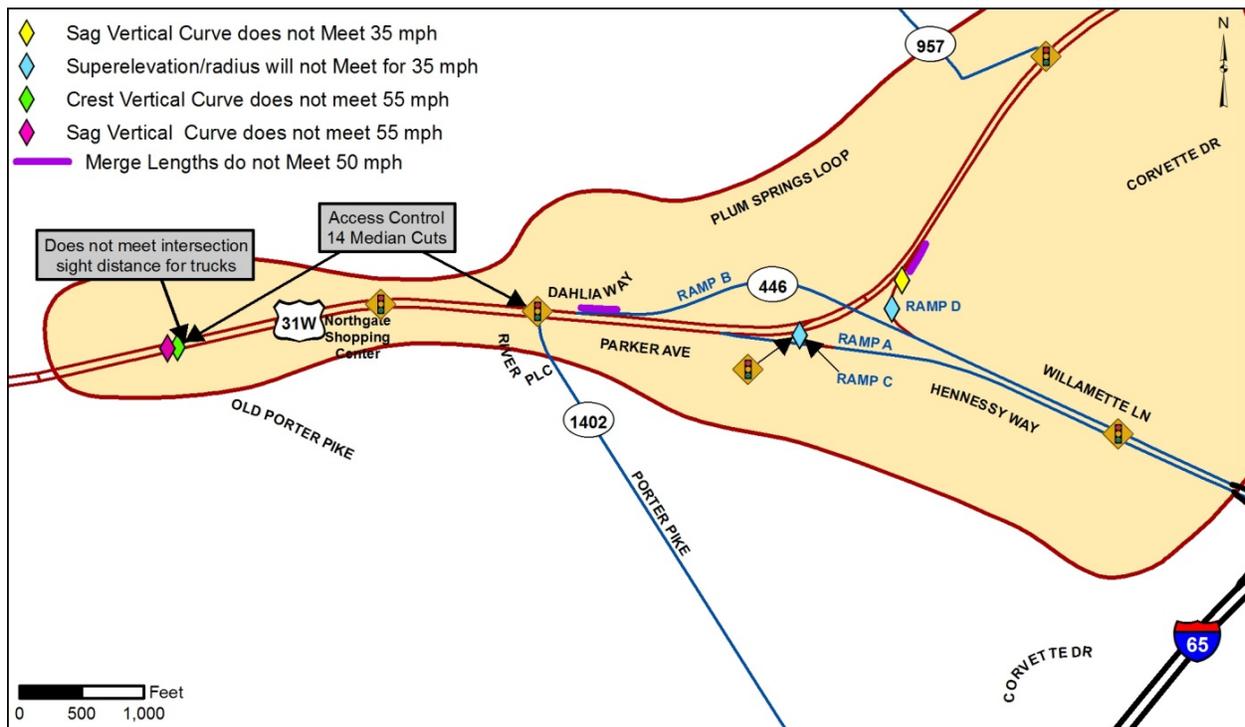


Figure 10: Geometric Issues

Based on available as-built plans and KYTC's Highway Information System (HIS), the horizontal and vertical geometry was assessed for US 31W and its interchange with KY 446. Utilizing the Green Book¹ US 31W appears to meet current 55 mph design criteria for horizontal and vertical geometrics except for two vertical curves immediately south of Old Porter Pike (**Figure 10**). Both curves meet 45 mph design speed. In addition, the US 31W/Old Porter Pike intersection does not meet sight distance for 55 mph and meets 45 mph only for passenger cars and single-unit trucks.

For the US 31W/KY 446 interchange:

- **Ramp A (from US 31W Northbound toward I-65).** The posted speed warning for Ramp A is 45 mph and meets 55 mph design speed for both horizontal and vertical alignment.
- **Ramp B (KY 446 from I-65 to US 31W Southbound).** The posted speed warning for Ramp B is 45 mph. One horizontal curve has a design speed of 50 mph and another curve has 60 mph. The superelevation does not meet design standards normally used. Both curves and the existing vertical alignment will meet current design standards for 50 mph.
- **Ramp D (KY 446 WB to US 31W Northbound).** Ramp D has a posted exit speed warning for Ramp D of 25 mph and a design speed of 35 mph. The radius and superelevation will not meet current design standards of 35 mph. The existing plans do

¹ *A Policy on Geometric Design of Highways and Streets 2011* (known as the *Green Book*). American Association of State Highway Transportation Officials (AASHTO).

not have vertical alignment for this ramp, just an elevation development sheet. The elevations on this plan sheet were used to approximate curves. Based on this approximation, the sag curve near the tie-in to US 31W does not meet headlight sight distance for 35 mph.

- **Existing Merge Taper Lengths for Ramp B and Ramp D.** Merge taper lengths are insufficient based on Green Book standards for free-flow entrance ramps. Currently, both movements are signed as a YIELD condition, which appears to be appropriate based on the insufficient taper length.
- **Ramp C (US 31W Southbound to KY 446 Eastbound).** While Ramp C is not technically a “ramp,” the turning radius is 65 feet and is considered less than desirable.

Appendix B illustrates the deficiencies in detail on the as-built plans.

5.3 Access Management

According to the Transportation Research Board (TRB) 2014 Access Management Manual and the Federal Highway Administration (FHWA), Access Management is the proactive management of the location, spacing, design, and operation of driveways, median openings, interchanges and street connections. The purpose of access management is to balance mobility and access on US 31W and KY 446. Studies show that implementing access management can provide three major benefits:

- Increased roadway capacity
- Reduced crashes
- Shortened travel time for motorists

As stated earlier, US 31W is functionally classified as an urban principal arterial between Old Porter Pike (MP 16.558) and Porter Pike (MP 17.088) with 25 access points (driveways) and 14 median openings located between them. As shown in **Figure 11**, arterials are more intended for mobility versus access. With these conditions and high traffic volumes, the recommended spacing is 2,400 feet for a median opening and 1,200 feet for a directional opening. In addition the signal spacing should be 2,400 feet².

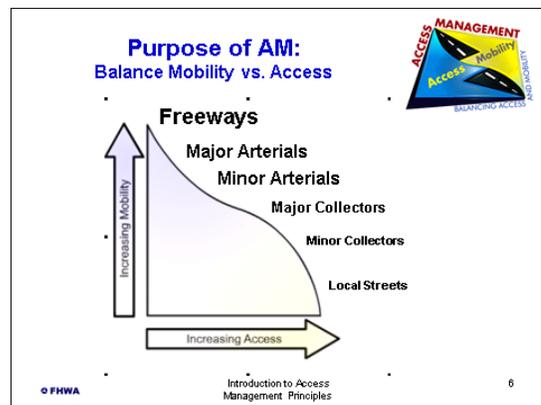


Figure 11: Purpose of Access Management

² Kentucky's Proposed Access Management Program-Executive Summary: <http://transportation.ky.gov/Congestion-Toolbox/Documents/Access%20Management%20Implementation%20Report%202008.pdf>

Table 2: Existing Conditions Inventory Continued

ROUTE	DESCRIPTION					TRAFFIC				ADEQUACY RATINGS					CRASHES																									
	BEGINNING MP	BEGINNING FEATURE	ENDING MP	ENDING FEATURE	LENGTH	STUDY COUNTS		HIS TRAFFIC		PAVEMENT CONDITION	SAFETY	SERVICE	COMPOSITE	PERCENTILE	IRI ¹	CCRF ²	NUMBER OF CRASHES	NUMBER OF FATAL CRASHES	NUMBER OF INJURY CRASHES	NUMBER OF PDOs ³																				
						2014 ADT	2014 TRUCK% (COMBO)	2013 ADT	2013 TRUCK %																															
US 31W	16.200	STUDY AREA BOUNDARY	16.232	SMOKEY PIG ROAD & CONTROL OF ACCESS CHANGE	0.032	25,100	4.4% (1,104 trucks)	28,275	3.5	30.00	30.60	25.65	86.25	66.76	67.00	0.17	2	0	1	1																				
	16.232	SMOKEY PIG ROAD & CONTROL OF ACCESS CHANGE	16.320	SPEED LIMIT CHANGE	0.088											0.10	6	0	0	6																				
	16.320	SPEED LIMIT CHANGE	16.472	RIGHT SHOULDER WIDTH CHANGE	0.152											0.40	10	0	3	7																				
	16.472	RIGHT SHOULDER WIDTH CHANGE	16.526	TURN LANE	0.054											0.74	52	0	9	43																				
	16.526	TURN LANE	16.558	OLD PORTER PIKE	0.032											1.12	48	0	11	37																				
	16.558	OLD PORTER PIKE	16.604	TURN LANE CHANGE	0.046											2.00	41	0	5	36																				
	16.604	TURN LANE CHANGE	16.749	SCENIC BYWAY CHANGE	0.145											1.19	80	0	11	69																				
	16.749	SCENIC BYWAY CHANGE	16.856	SHOPPING CENTER ENT	0.107											0.36	9	0	2	7																				
	16.856	SHOPPING CENTER ENT	16.871	TURN LANE CHANGE	0.015											0.90	44	0	16	28																				
	16.871	TURN LANE CHANGE	16.941	TURN LANE CHANGE	0.070											0.48	13	0	5	8																				
	16.941	TURN LANE CHANGE	17.022	RIVER PLACE AVENUE	0.081											0.47	17	0	6	11																				
	17.022	RIVER PLACE AVENUE	17.054	TURN LANE CHANGE	0.032											0.79	14	0	2	12																				
	17.054	TURN LANE CHANGE	17.088	KY 1402 (PORTER PIKE)PLUM SPRINGS LOOP	0.034											0.12	4	0	1	3																				
	17.088	KY 1402 (PORTER PIKE)PLUM SPRINGS LOOP	17.187	TURN LANE AND SPEED LIMIT CHANGE	0.099											0.06	1	0	1	0																				
	17.187	TURN LANE AND SPEED LIMIT CHANGE	17.370	KY 446	0.183																																			
	17.370	KY 446	17.490	US 31W RAMP	0.120											21,300	4.6% (980 trucks)									0.07	2	0	1	1										
	17.490	US 31W RAMP	17.561	BEGIN LEFT SIDE CURB	0.071											26,300	5% (1,315 trucks)	20,196	7.8	30.00	40.70	20.00	90.70	92.26	62.00	0.46	29	0	8	21										
	17.561	BEGIN LEFT SIDE CURB	17.599	TURN LANE CHANGE	0.038																					0.59	16	0	2	14										
	17.599	TURN LANE CHANGE	17.608	TURN LANE CHANGE	0.009																																			
	17.608	TURN LANE CHANGE	17.764	DEPRESSED TO MOUNTABLE MEDIAN	0.166																																			
17.764	DEPRESSED TO MOUNTABLE MEDIAN	17.805	MOUNTABLE MEDIAN TO FLUSH	0.041																																				
17.805	MOUNTABLE MEDIAN TO FLUSH	17.865	FLUSH MEDIAN TO NONE	0.060																																				
17.865	FLUSH MEDIAN TO NONE AND MIDDLE TURN LANE	17.896	MIDDLE TURN LANE	0.031																																				
17.896	MIDDLE TURN LANE	18.084	KY 957	0.188																																				
18.084	KY 957	18.160	STONE LANE	0.076																																				
18.160	STONE LANE	18.325	GM ACCESS ROAD	0.165																																				
18.325	GM ACCESS ROAD	18.400	STUDY AREA BOUNDARY	0.075																																				
KY 446	0.000	US 31W	0.172	LEFT SHOULDER CHANGE	0.172	24,500	7.7% (1,890 trucks)	6.60	30.00	40.70	20.00	90.70	92.60	81.00	0.07	2	0	1	1																					
	0.172	LEFT SHOULDER CHANGE	0.565	TRANSITION DEPRESSED MEDIAN TO RAISED NON-MOUNTABLE	0.393										0.46	29	0	8	21																					
	0.565	TRANSITION DEPRESSED MEDIAN TO RAISED MOUNTABLE	0.632	CORVETTE DRIVE	0.067																																			
	0.632	CORVETTE DRIVE	0.674	AUXILIARY LANE	0.042																																			
	0.674	AUXILIARY LANE	0.691	TRANSITION TO RAISED NON MOUNTABLE TO DEPRESSED MEDIAN	0.017																																			
	0.691	TRANSITION TO RAISED NON MOUNTABLE TO DEPRESSED MEDIAN	0.707	SHOULDER WIDTH CHANGE	0.016																																			
0.707	SHOULDER WIDTH CHANGE	0.800	STUDY AREA BOUNDARY	0.093																																				
KY 957	0.000	US 31 W	0.027	PROCTOR TRAIL	0.027										1.40	4	0	0	4																					
	0.027	PROCTOR TRAIL	0.145	PLUM SPRINGS LOOP	0.118			2,900	6	30.00	30.00	15.00	75.00	69.53	1.06	7	0	0	7																					
	0.145	PLUM SPRINGS LOOP	0.290	JENKINS DRIVE	0.145										1.06	8	0	1	7																					
KY 1402	0.000	US 31 W	0.035	TURN LANE	0.039										4.57	18	0	3	15																					
	0.035	TURN LANE	0.039	PARKER AVENUE	0.004										2.13	10	0	0	10																					
	0.039	PARKER AVENUE	0.072	TURN LANE	0.053			3,665	14.3	30.00	40.00	20.00	90.00	89.89	2.74	5	0	3	2																					
	0.072	TURN LANE	0.092	RIVER PLACE AVENUE	0.053																																			
	0.092	RIVER PLACE AVENUE	0.100	STUDY AREA BOUNDARY	0.008																																			

NOTES:

IRI - International Roughness Index—Worldwide index for comparing pavement smoothness

CCRF - Critical Crash Rate Factor—A CCRF of 1.0 or greater may indicate that crashes are happening due to circumstances not attributed to random occurrence.

PDO - Property Damage Only

5.4 Adequacy Ratings

As shown in **Table 2 (p. 14)**, KYTC uses roadway adequacy ratings as a tool in its efforts to evaluate highway conditions. These ratings have three components:

- A measure of the roadway pavement condition.
- A measure of safety.
- A measure of service (congestion).

The three component measures are combined into an overall quantitative measure allowing roadway segments to be ranked. The points allocated to the three components vary by functional class.

- For an Urban Principal Arterial, there are 30 points for pavement condition, 35 points for safety (lane width, shoulder width, median type, alignment, and critical rate factor), and 35 points for service (volume-to-capacity [v/c] ratio and access control) to equal 100.
- For an Urban Minor Arterial, there are 30 points for pavement condition, 45 points for safety, and 25 points for service.

Each roadway is then ranked with others in Kentucky.

The composite rating for US 31W from Old Porter Pike to KY 446 is 86.25. The percentile rating for the section of US 31W from Old Porter Pike to KY 446 is 66.76, meaning approximately 33% of the similar roadways in Kentucky operate better than this roadway. The deficiency is due largely to congestion.

The composite rating on US 31W from KY 446 to the GM access road is 90.70 and the percentile rating is 92.26.

5.5 Bicycle/Pedestrian Accommodations

As currently documented in the 2014 Greenways Master Plan for Bowling Green/Warren County, no bicycle or pedestrian facilities are identified within the study area. A KYTC review of bicycle/pedestrian accommodations within the study area indicated the following:

- According to the KYTC Bicycle and Pedestrian Review for US 31W, there is no shoulder space on US 31W except along a 0.3-mile section near Old Porter Pike that has a 6-foot shoulder. The Bicyclists Comfort Index (BCI) is E, which is considered the lowest.
- A recent review of a STRAVA heat map³ shows there is bicycle usage along Plum Springs Road, Old Porter Pike, Porter Pike and US 31W (Louisville Road).
- The full review is located in **Appendix C**.

³ Strava is a data service providing where people ride and run. Millions of GPS-tracked activities are uploaded to Strava every week from around the globe. These activities create billions of data points. Strava users track their rides and runs with a smartphone or with a GPS device.

5.6 Existing Structures

An inventory of existing structures along the route is provided in **Table 3**.

Table 3: Structure Characteristics

Structure Characteristics															
Feature Carried	Mile Point	Bridge No.	Features Intersected	Year Built	Length (Ft.)	Width (Ft.) (Curb To Curb)	Sufficiency Rating	Structurally Deficient (Yes or No)	Functionally Obsolete (Yes or No)	Design Load	Inventory Rating (Tons)	Operating Rating (Tons)	Structural Evaluation		
													Structural* Evaluation	Deck* Geometry	Under Clearance* Vertical & Horizontal
KY 446	0.19	114 B0003 4N	US 31W	1965	247.0	23.0	79.1	No	Yes	2	75.0	110.0	7	7	8
US 31W	17.8	114 B0000 5N	CSX Railroad	1954	200.0	54.0	81.0	No	No	2	36.0	36.0	7	7	7
CSX RR	0.08	114 R006 02N	Plum Springs Loop	N/A	29.5	17.0 Curb-to-Curb 19.0 Horizontal	CSX Bridge - Inspection Only. No Rating Analysis Performed								

Notes: *Condition Ratings—Bridges

8: Very Good—No problems noted.

7: Good—Some minor problems; structural elements show some minor deterioration.

6: Satisfactory—Structural elements show some minor deterioration.

5: Fair—All primary structural elements are sound but may have minor section loss, cracking, spalling, or scour.

4: Poor—Advanced section loss, deterioration, spalling, or scour.

Three structures in the study area are as follows:

- **KY 446 ramp over US 31W.** The bridge was constructed in 1965 and has a sufficiency rating of 79.1. The bridge is considered functionally obsolete (FO). Typical reasons for being classified as FO include inadequate lane or shoulder widths or inadequate vertical clearance for oversized vehicles. Presently the bridge is a single lane structure with a 23-foot curb to curb roadway width which should be adequate as long as it remains a single lane. The vertical clearance is less than 16 feet but should be adequate for this roadway. Curbs on the structure and guardrail connections are no longer consistent with standard KYTC practice.
- **US 31W over the CSX Railroad.** This bridge was constructed in 1954 and is approximately 200 feet in length. It has a sufficiency rating of 81.0 and is not considered structurally deficient or functionally obsolete. The KY 446 to US 31W northbound merge lane directly south of this bridge is too short, and lengthening it would require widening the existing bridge over the CSX railroad. Since the bridge is over 60 years old, KYTC may want to consider replacing the bridge rather than widening if the structure is affected by a recommended improvement.
- **Plum Springs Loop Underpass.** The underpass at the railroad crossing has approximately 14.8 feet of vertical clearance and 19.0 feet of horizontal clearance according to the inspection report. Preliminary indications are that this bridge can be lengthened but would likely require a railroad detour estimated to be \$2.5 million (includes lengthening the opening). The longer the span, the deeper the beams would have to be, in turn reducing the amount of vertical clearance over Plum Springs Loop. Due to the number of trains per day (20–30) this railroad corridor could not be taken out of service.

KYTC Bridge Inspection Reports are located in **Appendix D**.

5.7 Known Utilities

For purposes of cost estimates and alternatives' development, major known utilities were identified in the study area. These utilities included water, sewer, overhead utilities, and light poles (**Figure 12**). Based upon review of the Kentucky Infrastructure Authority's Water Resource Information System (WRIS) for Kentucky Water and Wastewater Mapping, numerous water distribution lines and wastewater collection lines owned by the Warren County Water District exist throughout the study area. Additional utility coordination was beyond the scope of this planning study.

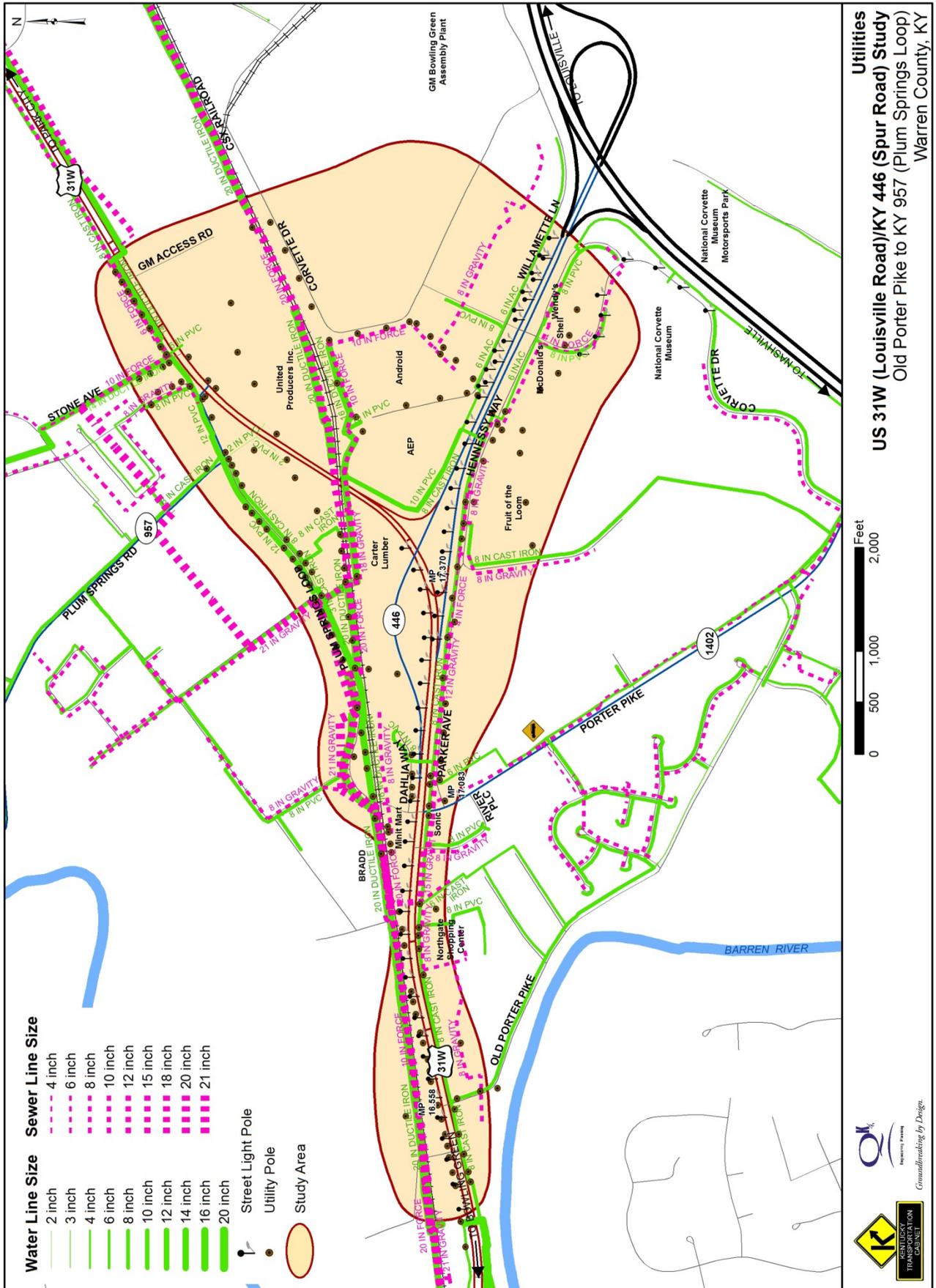


Figure 12: Known Utilities

5.8 Crashes

The purpose of this crash analysis is to identify locations encountering above average crash rates for similar type roadways in Kentucky utilizing a methodology identified in the Kentucky Transportation Center's (KTC) *Analysis of Traffic Crash Data in Kentucky (2009-2013)*⁴. Five years of recorded crashes along study area routes was utilized from January 1, 2009 through December 31, 2013.

5.8.1 Methodology

The KTC's above methodology and the *Kentucky State Police's Collision Database* were used to identify segments and 0.1-mile roadway spots with Actual Crash Rates exceeding the Critical Crash Rates. A Critical Crash Rate is the maximum crash rate expected to occur on a roadway section, given the statewide Average Crash Rate for that functional road class, the average daily traffic (ADT) volume, and the roadway segment length. The ratio of these two rates produces a Critical Crash Rate Factor (CCRF), a measure of crash frequency for each spot. If the roadway spot's Actual Crash Rate exceeds the Critical Crash Rate (i.e., the CCRF is greater than 1.0), the segment or spot is identified as a potential high-crash location. A CCRF of 1.0 or greater indicates crashes may be occurring due to circumstances not attributed to random occurrence. In addition, crash reports were reviewed to discern potential crash patterns and causes cited by the investigating officer.

5.8.2 Results

The results of the segment analysis are shown in **Table 2 (p. 14)**. US 31W, KY 1402, and KY 957 have segment CCRFs greater than 1.0 indicating a potential crash concern. Therefore, a 0.1-mile spot analysis utilizing the same methodology was performed.

The majority of crashes on US 31W and KY 446 were either angle or rear-ends collisions. These crash types are commonly observed in congested areas. On KY 957 just southwest of US 31W, the primary manner of collision was single vehicle crashes. A crash analysis by direction yielded seven areas where the CCRF is greater than 1.0 and two additional spots where the CCRF is approaching 1.0, indicating a need to monitor those areas. Those were calculated by direction and are summarized in **Table 4** and mapped on **Figure 13 (p. 21)**. **Figure 14 (p. 22)** illustrates crashes by crash type. Each crash spot ID number in Table 4 is labelled in the figures.

The US 31W/KY 446 interchange southbound ramp toward I-65 and the signalized intersection crossing of KY 446 was also analyzed. There were 11 reported crashes with 9 injuries and no fatalities occurring during the five-year period. Between 2011 and 2013, only two crashes occurred. Although four crashes did occur in 2014, this location was not considered statistically significant for the time period.

All calculations and a dataset of all crashes are shown in **Appendix E**.

⁴ http://www.ktc.uky.edu/files/2014/09/KTC_14_07_KSP2_13_1F_.pdf

Table 4: Locations with High Crashes

ID# Route	Beg MP	End MP	Location	Direction	CCRF	Total Crashes	Summary of Most Prominent Officer Comments
1 US 31W	16.8	16.9	Approaching Northgate Shopping Center Signal	Southbound	0.93	16	(Few actual reports at this location). Crashes were mainly rear-end collisions. It should be noted that 58% of the crashes were suspected of having alcohol or drug impairment, or resulted from drowsy or distracted driving.
2 US 31W	17.0	17.1	KY 1402 (Porter Pike)	Southbound	3.46	56	This spot included the intersection with Porter Pike, as well as un-channelized access to development on the east side of US 31W located south of KY 1402. Vehicles entering or exiting development, or changing lanes in an attempt to access development, frequently were cited by investigating officer, as well as improper driver behavior at KY 1402 signal. Forty percent of crashes were due to wet conditions.
3 US 31W	17.1	17.2	KY 446 to Just North of KY 1402	Southbound	1.73	28	This spot includes the entrance ramp from KY 446 to US 31W southbound, and the approach to the signal at KY 1402. Improper merging, sudden lane changes, and failure to slow for traffic stopped at signal frequently cited by investigating officer. Sixty-four percent of crashes were due to wet conditions.
4 US 31W	17.7	17.8	KY 446 WB Merge onto US 31W NB	Northbound	0.94	18	This spot included rear-end crashes of vehicles attempting to merge onto northbound US 31W from the KY 446 ramp. This spot had Injury crashes and crashes involving an impaired driver, although there was no obvious correlation between those two factors.
5 KY 957 (Plum Springs Road)	0.1	0.2		Both	1.85	11	Just southwest of the KY 957/US 31W intersection, in the northern part of the study area, intersection crashes were often caused or partially caused by vehicle malfunction, driver inattention, and/or wet pavement.
6 US 31W	17.0	17.1	KY 1402 (Porter Pike)	Northbound	1.99	38	This spot included intersections with both River Place and Porter Pike, as well as two access points to development on the east side of US 31W near the intersection with River Place. Vehicles entering or exiting development were frequently cited by investigating officer, and improper driver behavior at KY 1402 signal.
7 KY 1402 (Porter Pike)	0	0.1		Both	4.34	30	The closely spaced intersections with Parker Avenue and River Place, and congestion at the US 31W signal contributed to a high number of rear-end and angle crashes. Although not shown in Figure 13, many crashes involved either drivers with suspected alcohol or drug impairment or drowsy or distracted driving.
8 KY 446	0.6	0.7	At Corvette Drive	Eastbound	1.12	15	Eastbound crashes involved either one unit rear-ending another at a red light, often a left-turn red; or one vehicle accelerating during the signal change to green faster than a car in front.
9 KY 446	0.6	0.7	At Corvette Drive	Westbound	1.40	18	Westbound crashes were predominantly rear-end and sideswipe. Over one-half involved failure of one vehicle to comply with a red signal.

Note: A/D/D/D is "Alcohol and/or drug involvement or drowsy or distracted driving" as indicated by officer investigating the crash.

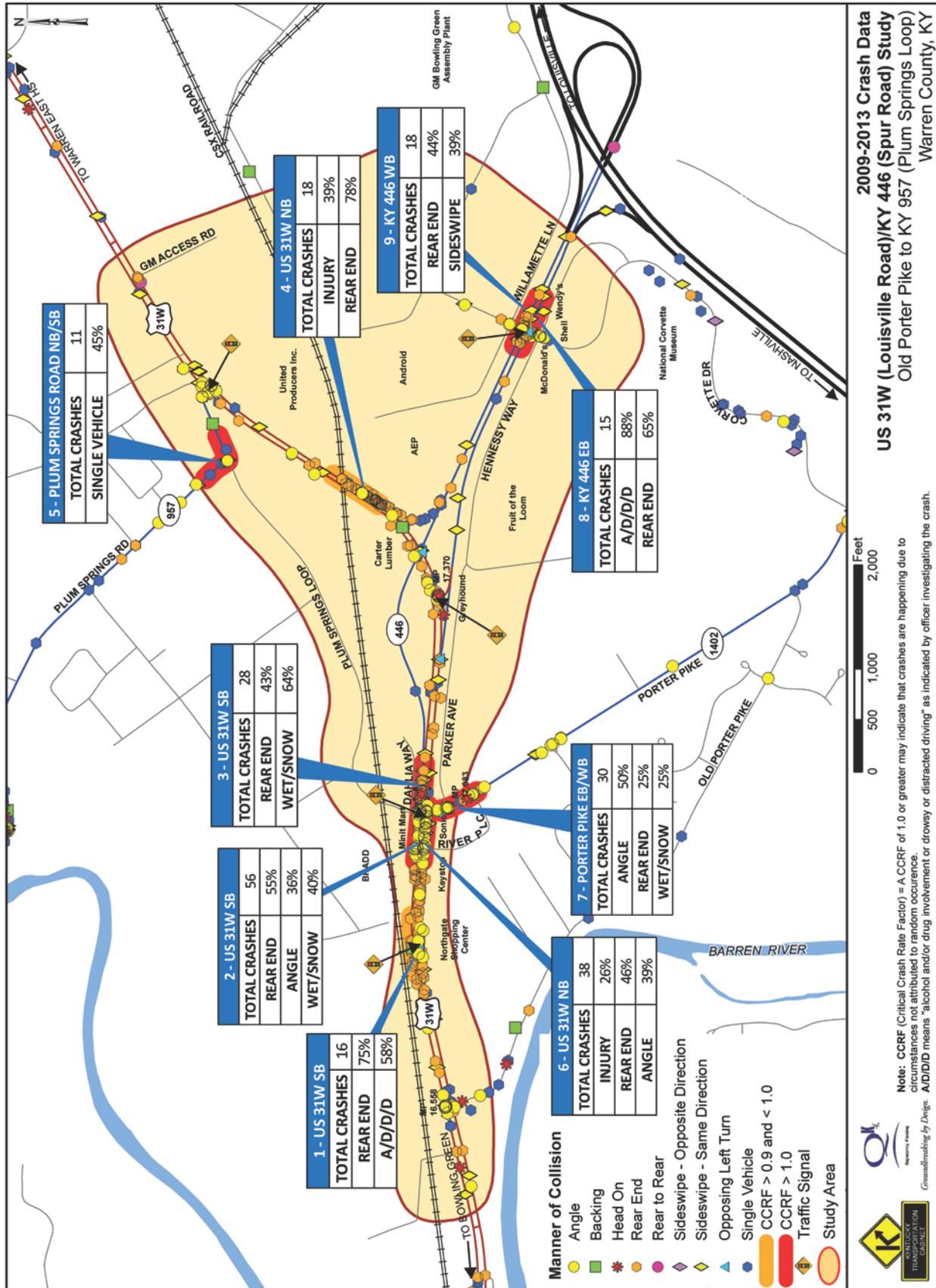


Figure 13: Manner of Collision

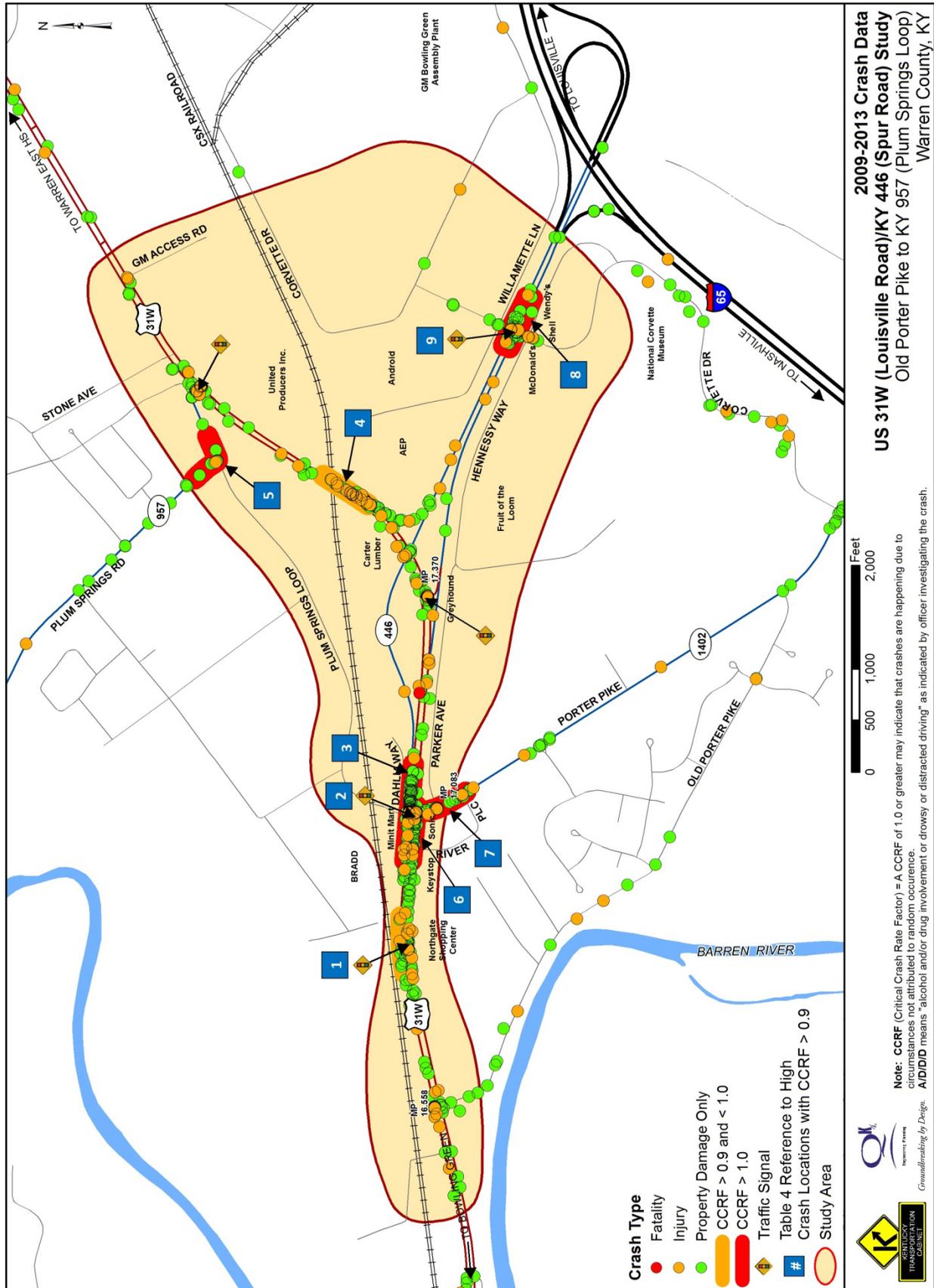


Figure 14: Crash Type

6.0 TRAFFIC

This section addresses how the traffic simulation model was developed, the traffic operations were analyzed, how future year 2040 traffic was forecasted, and the results of the forecast.

6.1 Model Calibration

The model was calibrated based on traffic data collected for this study, interviews with major traffic generators in the area, and KYTC-provided signal timing data, speed data, and acceleration data.

6.1.1 Traffic Data

To assess existing traffic, 48-hour volume and classification counts and 12-hour camera-detection intersection counts were conducted (**Figure 15**). Cameras were used on US 31W between Old Porter Pike and Porter Pike to capture traffic at median openings and queues at Porter Pike and US 31W. This information was used to perform intersection capacity analyses, develop a microsimulation model of the existing corridor, and develop possible solutions.

6.1.2 Interviews with Stakeholders

Interviews were conducted with representatives of five industries/traffic generators: MAGNA Cosma International, NCM, Greyhound Bus, FOTL, and the GM Assembly Plant. The interviews were to obtain number of employees, employee travel patterns, plans for future expansions, and study area concerns. Completed interviews are located in **Appendix F**.

The KY 446/Corvette Drive/ Hennessy Way intersection (high crash areas ID #s 8 and 9, **Figure 14, p. 22**) was considered the most congested intersection by industry representatives. At the close of the business day for FOTL and the GM Assembly Plant, traffic can take up to 25 minutes to clear the area. At times, vehicles wait on Hennessy Way to access KY 446 via Corvette Drive for four or five signal cycles. Also, motorists on Hennessy Way “cut through the parking lot” (corner of Hennessy Way and Corvette Drive) to Corvette Drive rather than wait in the queue on Hennessy Way, which adds to driver frustration.

At Porter Pike, vehicles queuing on Parker Avenue cannot exit north onto Porter Pike and then to US 31W because of the close proximity of Parker Avenue to US 31W.

Based on the input, the Project Team decided to add portions of Parker Avenue and Hennessy Way to the model along with the Parker Avenue/Hennessy Way and Hennessy Way/Corvette Drive intersections. Since turning movements were not collected for those intersections, assumptions were made to distribute traffic based on existing tube counts, available turning movement counts, and information gained during interviews. The actual traffic splits at these intersections may vary from what was modeled.

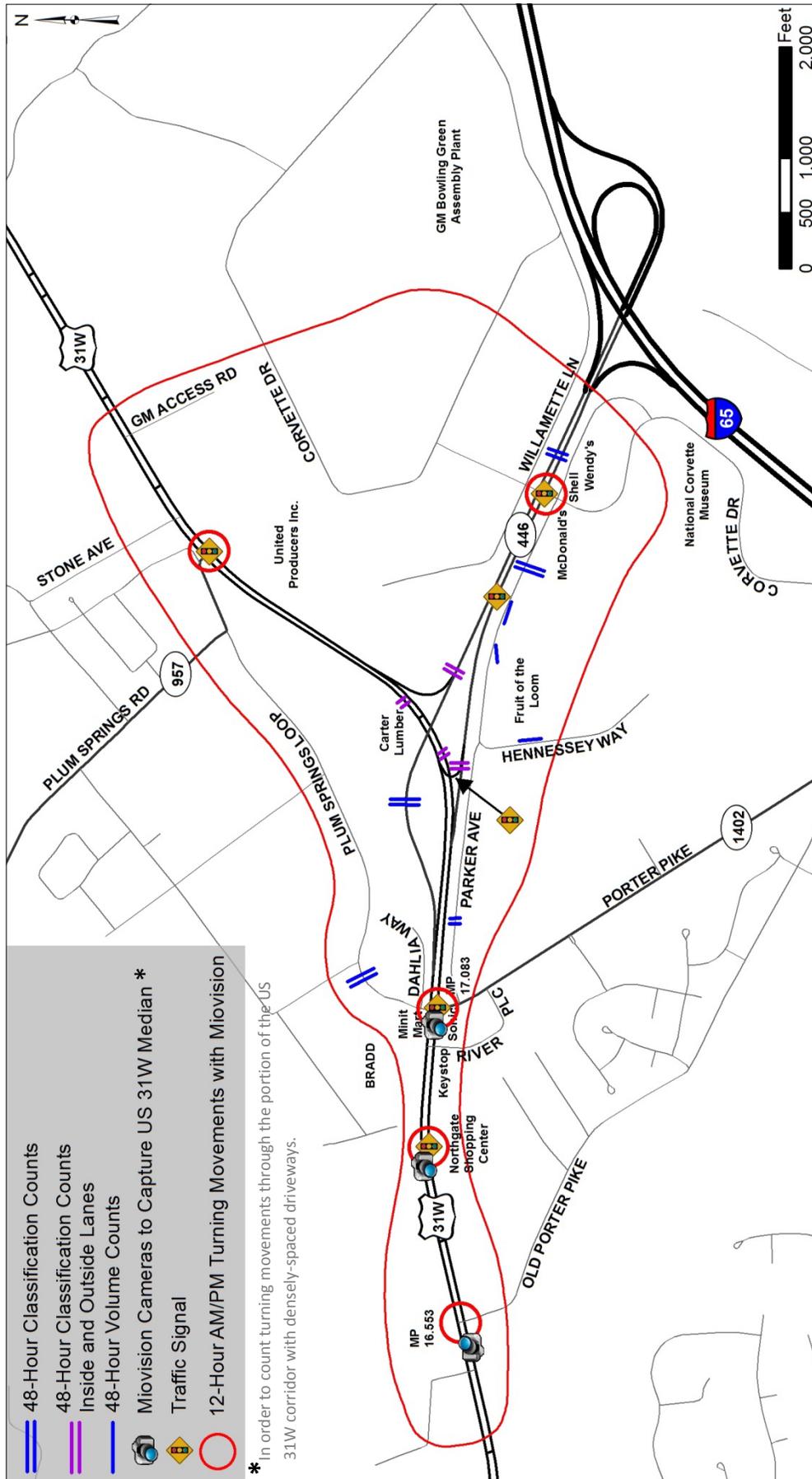


Figure 15: Traffic Data Collection Locations

6.1.3 Signal Data

Signal timings for the existing and no-build scenarios were based on existing signal timings received from KYTC for all study area intersections. The model was also calibrated using queues observed during the video capture of turning movement data. Headways were also observed and used to help calibrate the model.

A new signal was installed on KY 446 near the FOTL parking lot (Spring 2015), after existing traffic data was collected (December 2014). Installing the new signal at this intersection diverts traffic from the existing KY 446/Corvette Drive and US 31W/Porter Pike intersections; therefore, assumptions were made as to the amount of traffic diverted based on turning movement counts conducted at the Fruit of the Loom entrances. These assumptions are reflected in the 2040 traffic forecast.

6.2 Existing Traffic Operational Analysis

Existing ADT volumes on US 31W (**Figure 16**) range from 25,100 to 26,300 vpd. Existing traffic on KY 446 is approximately 24,500 vpd. Also shown in **Figure 16** are peak-hour turning movement volumes at key intersections within the study corridor, those intersections currently operating at Level of Service⁵ (LOS) E or F are highlighted in red (LOS D is desirable). KY 446/Corvette Drive, US 31W/Old Porter Pike, US 31W/KY 446, and US 31W/Porter Pike, and US 31W/KY 446 have existing movements that are either LOS E or F in one or both peak hours. The traffic videos show long queues in the AM peak hour. However, all traffic currently on US 31W clears the traffic signal in one phase which is an acceptable level of service for an urban intersection.

6.3 Growth Rates for Design Year 2040

Using the recently updated Bowling Green traffic model, KYTC analyzed traffic both with and without the new I-65/US 31W interchange and connector road (KYTC Project Item No. 03-16.00) for both current and future years. (Note that the analysis considered the new Transpark development and additional employment, and the new NCM Motorsports Park.) Although new traffic will be generated in the area, KYTC determined that with the opening of the new I-65/US 31W interchange and connector road, a majority of the new traffic would bypass the study area and use the new I-65 interchange. Therefore, the growth rate was assumed to be low and was established at 0.5% per year. **Appendix G** contains various growth rate outputs from the model.

6.4 2040 No-Build Traffic

The future-year traffic data, calculated using 0.5% growth rate, is shown in **Figure 17 (p. 27)**. Capacity analysis for 2040 No-Build AM and PM peak hour traffic is also shown. Even with the advent of the new I-65/US 31W interchange and connector road, US 31W/Old Porter Pike intersection delay is expected to significantly increase for 2040 AM and PM peak hours.

⁵ Level of service is a qualitative measure of expected traffic conflicts, delay, driver discomfort, and congestion. Levels of service are described according to a letter rating system ranging from LOS "A" (free flow, minimal or no delays—best conditions) to LOS "F" (stop and go conditions, very long delays—worst conditions).

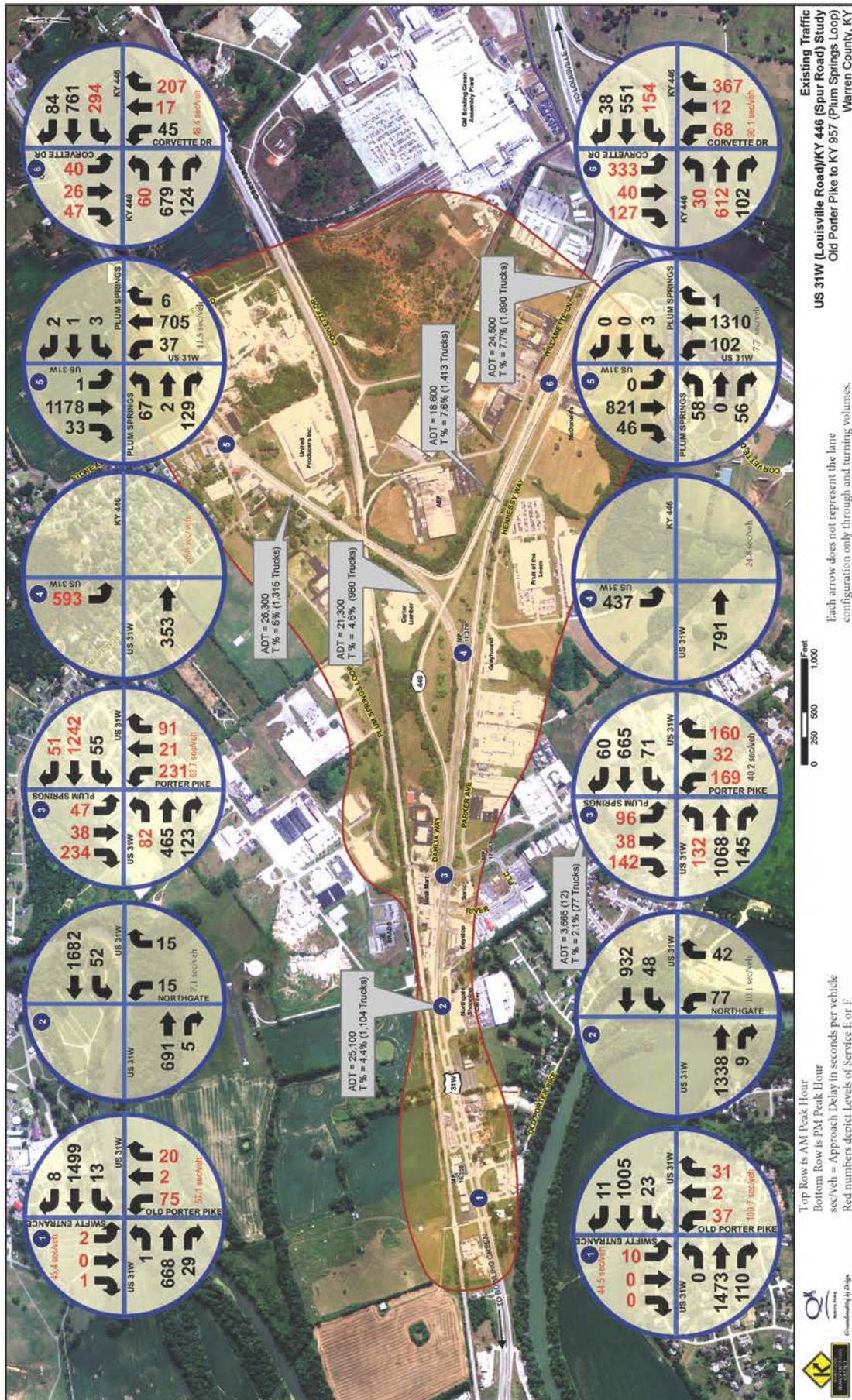


Figure 16: Existing Traffic

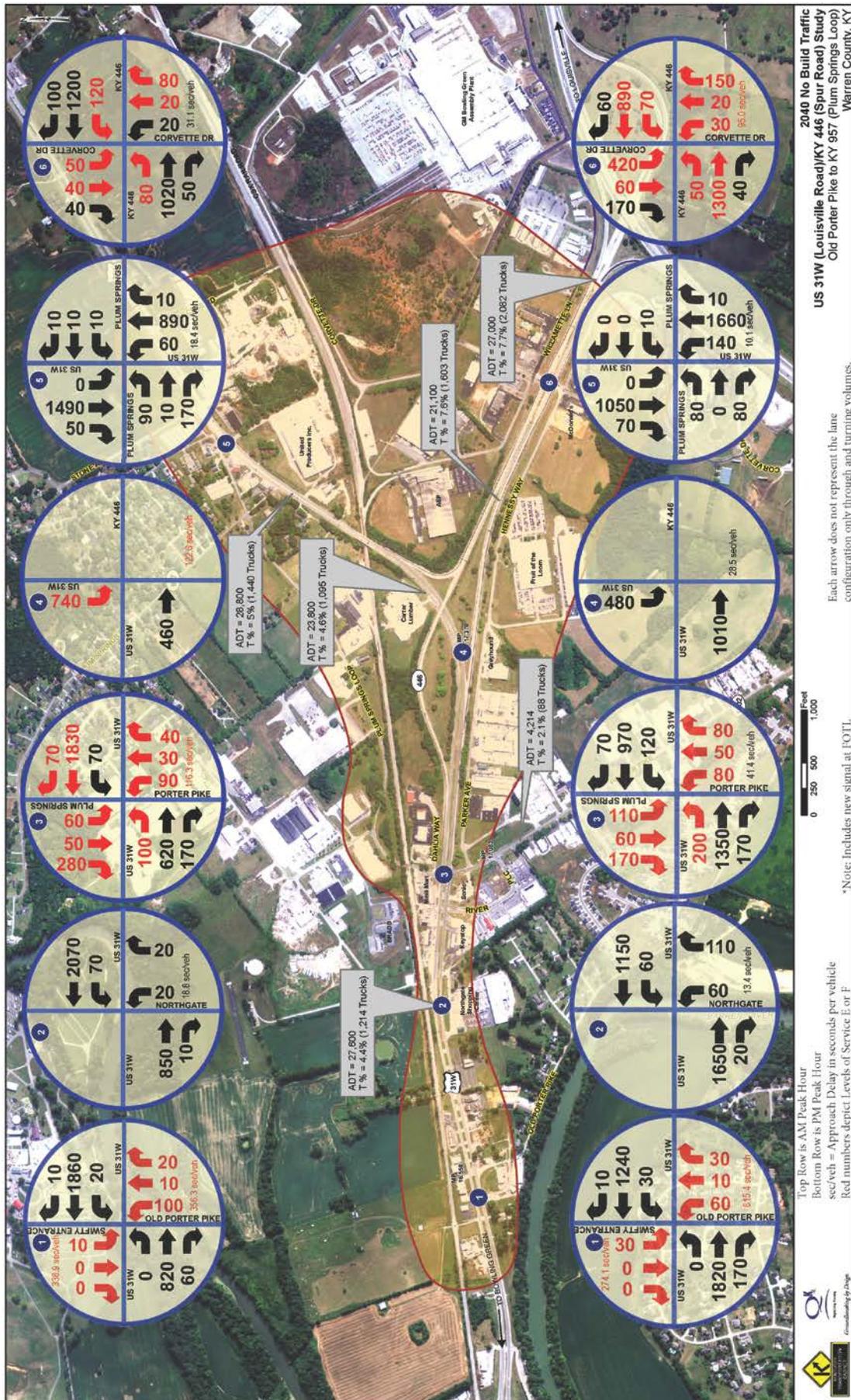


Figure 17: 2040 No-Build Traffic

The US 31W/Old Porter Pike intersection does not currently warrant a traffic signal, however, it should be monitored due to the 2040 projected AM and PM peak hour approach delays.

The KY 446/Corvette Drive intersection is expected to have several additional movements (as compared to existing conditions) operating at LOS E or F. Similar delays are expected to occur at the US 31W southbound/KY 446 intersection. The US 31W/Porter Pike intersection delay for the AM peak hour is expected to double in 2040.

The 2040 No Build Traffic analysis includes the opening of a new signal and access point near FOTL onto KY 446 (KYTC Project Item No. 03-8632.00)

7.0 ENVIRONMENTAL OVERVIEW

An Environmental Overview has been prepared to review current socioeconomic, natural and geotechnical conditions, potential UST/HAZMAT sites, and air quality and noise issues. In 2009 an Environmental Impact Statement (FEIS) was prepared for the new I-65 Interchange and connector road north of the current study area (KYTC Project Item No. 03-16.00). The EIS evaluated alternatives within the US 31W/KY 446 interchange area; therefore, where the environmental information from the 2009 FEIS remains valid, excerpts from it have been incorporated into this study.

Major concerns in the study area are anticipated to be impacts to business, sites with hazardous material, karst topography, and historic sites. Potential issues are shown in **Figure 18** along with other existing conditions. Issues are summarized as follows:

- Karst terrain dominates the project area and many caves are likely to be interconnected through underground streams. The subsurface water within the groundwater basins of the sinkhole plain is highly susceptible to pollution carried by runoff.
- Nineteen potential HAZMAT/UST sites.
- Six potential noise sensitive receptor sites.
- One water well, one gas well, and several dry wells
- Approximately three potential wetlands (according to the National Wetland Inventory).
- One historic resource is listed in the National Register of Historic Places (NRHP), and two resources are eligible for the NRHP. All three sites are located north of the CSX railroad.
- Environmental Justice (EJ) concerns.
- One fire station.
- Two residential subdivisions on the periphery of the study area.
- Greyhound bus station.
- One church (plus one additional just north of the study area)
- One cave entrance

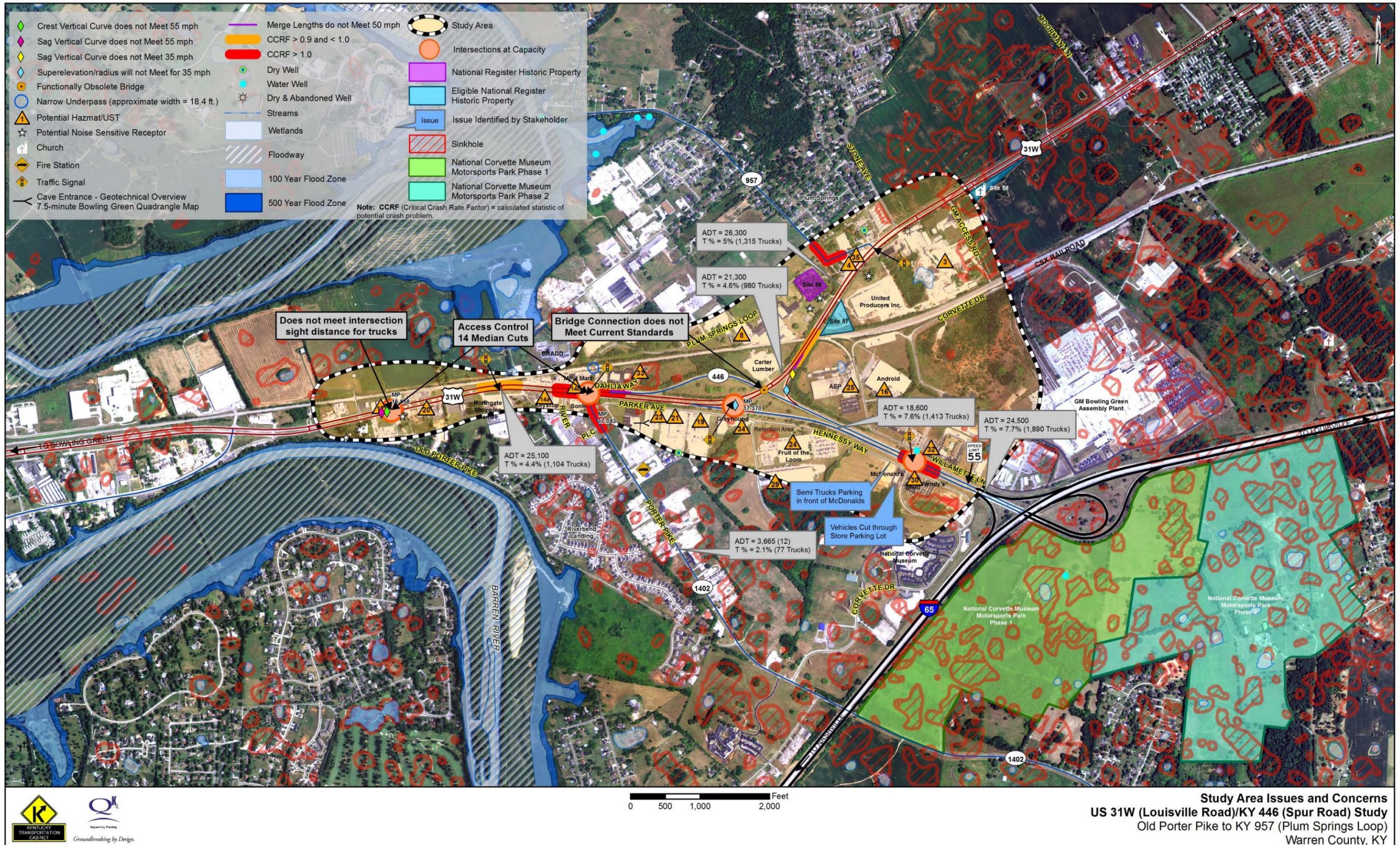


Figure 18: Study Area Issues

The following sections provide more detail into each area of concern.

7.1 Air Quality

Warren County is in attainment for all of National Ambient Air Quality Standards (NAAQS) for the six major air quality pollutants including particulate matter (PM), sulfur dioxide (SO₂), carbon monoxide (CO), ozone (O₃), nitrogen dioxide (NO₂), and lead (Pb). Mobility issues along with recent growth in the project area have led to excessive delays and vehicle idling being experienced at key intersections. Traffic delays and vehicle idling can lead to increased emissions, especially in terms of CO and Mobile Source Air Toxics (MSAT). EPA regulations for vehicle engines and fuels will cause overall MSAT emissions to decline significantly over the next several decades. This will both reduce the background level of MSAT as well as the possibility of MSAT emissions created from this project.

Overall travel delay and travel time within the corridor should be revisited once the I-65/US 31W interchange (KYTC Project Item No. 03-16.00) is constructed and opened to traffic to determine if traffic patterns have substantially changed and if traffic flow has improved. If any projects resulting from this planning study are constructed with federal funds, they would most likely be categorized as a “Project with Low Potential MSAT Effects.” For these project types, a qualitative assessment of emissions projections should be conducted. This qualitative assessment would compare the expected effect of the project on traffic volumes, vehicle mix, or routing of traffic, and associated changes in MSATs for the project, based on VMT, vehicle mix, and speed.

Likewise, any such projects should be included in the Bowling Green MPO TIP and undergo the associated air quality conformity analysis.

7.2 Noise

Simply put, noise is unwanted sound. The study area is primarily located in an urbanized commercial and/or industrial corridor, or in an area undergoing transition to urban commercial. As a result, only a few, isolated noise sensitive receptors (residences) are within the study area. No large noise sensitive areas (NSAs) such as residential neighborhoods, schools, hospitals, or public parks are present. Given urban environmental, and the existing and projected future traffic volumes, vehicle mix, and travel speeds, it is not anticipated that future noise levels associated with the any reconstruction projects that result from this planning study would be greater than those without the project. Those potential noise sensitive receptors are identified on **Figure 18 (p. 29)**.

7.3 Natural Resources

Natural resources occurring in the study area include groundwater and streams, geology, and threatened and endangered species.

7.3.1 Watershed/Groundwater/and Streams

The project area is located in the Barren River Basin (8-digit HUC 05110002) within the upper Green River Basin and encompasses approximately 1,850 square miles of south-central Kentucky. The Barren River Basin flows to the northwest towards its confluence with the Green

River northwest of Bowling Green and just southeast of Morgantown. The floodplains and wetlands surrounding Barren River are illustrated on **Figure 18 (p. 29)**.

Karst terrain dominates the project area, while perennial and intermittent surface streams are generally lacking. Surface drainage feeds into the numerous sinkhole depressions throughout the landscape, shown in red hatched areas on **Figure 18 (p. 29)**. Once the precipitation and runoff water infiltrates through the soil it flows through cracks, crevices and solution channels in the limestone bedrock toward larger groundwater conduits, which act as underground streams or trunk drainage routes.

Many of the caves within the study area are likely connected to one another through underground streams or smaller lateral subsurface conduits. Unlike surface streams, karst groundwater may travel in unpredictable paths underground since there is more than one level of water flow possible within the bedrock.

The subsurface water within the groundwater basins of the sinkhole plain is highly susceptible to pollution carried by runoff. Groundwater sensitivity of an area is defined by the ease and speed with which a contaminant can move into and through a groundwater system. Most groundwater in karst areas moves through openings in the rock faster, more concentrated, and less predictably than ground water movement in non-karst regions. It is difficult to determine locations and directions of flow of all groundwater conduits in an area, and in the event of a hazardous materials spill, the effects could be rapid and unpredictable. Pollutants can travel many miles underground in an unknown direction, in a single day, in a relatively undiluted state, making containment, cleanup, and public protection virtually impossible. Unless contained, or filtered in some way at the source, roadway runoff will be released directly into these groundwater sensitivity areas and could affect the groundwater quality of the Graham Springs Basin, located northeast of the project study area and Barren River.

7.3.2 Geotechnical Overview

The purpose of this overview was to identify potential geotechnical concerns and provide anticipated typical parameters for design throughout the defined study area. A complete overview is found in **Appendix H** of this report. It was conducted during December 2014 and January 2015 and included field reconnaissance and geologic research of available geologic and topographic quadrangle maps; *Soil Survey of Warren County, Kentucky*, and multiple resources available from the Kentucky Geological Survey and the United States Geological Survey. Past reports from geotechnical investigations for roadways and structures in and near the current study area were also reviewed.

Topography of the study area is typically described as gently rolling to rolling and is largely defined by underlying limestone bedrock. As discussed previously, this area is known for its karst landscape and numerous sinkholes and depressions. Numerous surface depressions were noted within the study area both from review of geologic mapping and during field reconnaissance. However, much of the study area is also highly developed, which can mask the existence of karst features such as sinkholes and surface depressions.

Development in highly karstic areas can result in significant issues. On February 12, 2014, a cave collapsed and a 40-foot wide sinkhole opened under the National Corvette Museum within

the study area. The collapse swallowed eight cars from within the museum and attracted international news coverage.

At least one existing cave entrance (**Figure 18, p. 29**) just south of US 31W was mapped on the 7.5-minute Bowling Green Quadrangle map. A karst potential map inclusive of the study area is also included in **Appendix H**.

While any new construction within the study area will not likely be at any greater risk to ground subsidence or other impact from karst than existing roadways and structures that lie within the study area, a site specific geotechnical investigation will provide critical information with regard to karst potential, problematic soils and other pertinent information during future project development phases.

7.3.3 Threatened and/or Endangered Species

Kentucky Department of Fish and Wildlife Resources (KDFWR) provided the following information regarding federally listed threatened and/or endangered species known to occur in proximity to the project corridor. Species shown in **Table 5** appear on the 2016 U.S. Fish and Wildlife Service (USFWS) list of protected species known to occur in Warren County.

Table 5: USFWS Threatened/Endangered Species—Warren County

Group	Common Name	Scientific Name	Status	Listing Agency
Mammals	Gray Bat	<i>Myotis grisescens</i>	E	USFWS
	Indiana Bat	<i>Myotis sodalis</i>	E	
	Northern Long-eared Bat	<i>Myotis septentrionalis</i>	T	
Plants	Price's Potato-bean	<i>Apios priceana</i>	T	
Crustacean	Kentucky Cave Shrimp	<i>Palaemonias ganteri</i>	E	
Mussels	Northern Riffleshell	<i>Epioblasma torulosa rangi</i>	E	
	Orangefoot Pimpleback	<i>Plethobasus cooperianus</i>	E	
	Pink Mucket	<i>Lampsilis abrupta</i>	E	
	Rabbitsfoot	<i>Quadrula cylindrica</i>	E	
	Catspaw	<i>Epioblasma o. obliquata</i>	E	
	Clubshell	<i>Pleurobema clava</i>	E	
	Fanshell	<i>Cyprogenia stegaria</i>	E	
	Ring Pink	<i>Obovaria retusa</i>	E	
	Rough Pigtoe	<i>Pleurobema plenum</i>	E	
	Sheepnose	<i>Plethobasus cyphyus</i>	E	
	Snuffbox	<i>Epioblasma triquetra</i>	E	
	Spectaclecase	<i>Cumberlandia monodonta</i>	E	

T = Threatened

E = Endangered

If federal funds are used or permits are required for any build alternatives that are advanced, consultation with USFWS under Section 7 of the Endangered Species Act must be initiated prior to construction. Depending on whether a protected species would be impacted by a project, the agency could require a Biological Assessment (BA) to address potential impacts and identify mitigation measures.

The U.S. Department of Agriculture-Natural Resources Conservation Service included a map of four areas within the project study area that may still be considered farmland. This correspondence is found in **Appendix M**.

7.4 Socioeconomic Review

Title VI of the 1964 Civil Rights Act requires each Federal agency to ensure that “no person, on the ground of race, color, or national origin, be excluded from participating in, denied the benefits of, or subjected to discrimination” under any program or activity receiving Federal Aid. Title VI implications on the transportation planning process were further refined on February 11, 1994, in Executive Order 12898 titled Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations. The President’s Executive Order requires each Federal department and agency to “identify and address disproportionately high and adverse human health or environmental effects of their policies, programs and activities on minority populations or low income populations.”

Subsequent requirements include the June 14, 2012, FHWA-issued USDOT Order 5610.2(a), Department of Transportation Actions to Address Environmental Justice in Minority Populations and Low-Income Populations directive, which established policies and procedures for FHWA to use in complying with Executive Order 12898.

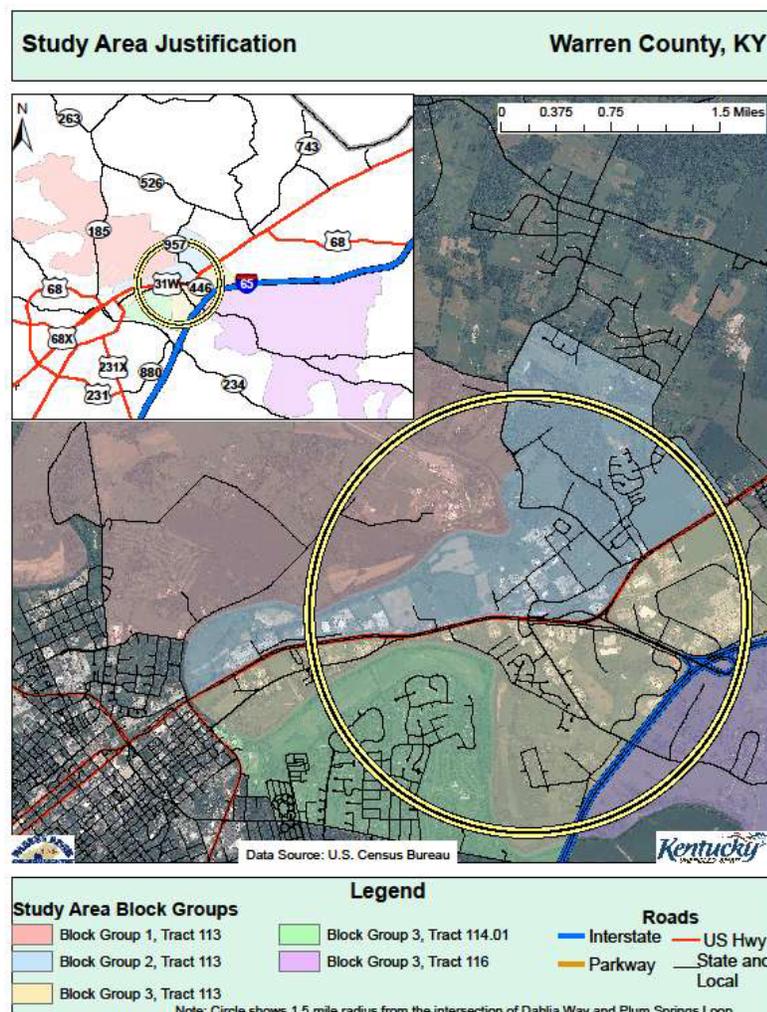


Figure 19: All Block Groups Within 1.5 Miles Radius

use in complying with Executive Order 12898.

Two key criteria determine whether an action will cause a disproportionately high and adverse effect on minority populations or low-income populations: (1) an adverse effect that is predominantly borne by a minority or low-income population, or (2) an adverse effect that will be suffered by a minority or low-income population and is appreciably more severe or greater in magnitude than the adverse effect that will be suffered by the non-minority or non-low-income population. US Census Bureau data is a key means of identifying and evaluating potential impacts to EJ populations.

The Barren River Area Development District (BRADD) reviewed U.S. Census data for this project. **Figure 19** shows the Census Tracts (CTs) and Block

Groups (BGs) within 1.5 miles of the project study area. The more narrowly defined project study corridor is within CT 113—BGs 2 and 3.⁶

According to the 2013 Census Bureau American Community Survey (**Table 6**), BG 2 or 3 show potential concern areas in every category except population over 65 years old. The full Socioeconomic Review is located in **Appendix I**.

During future phases of any project development that results from this planning study, a more detailed analysis may be required for the National Environmental Policy Act (NEPA) documentation when assessing the potential for adverse and disproportionate impacts to low-income and minority populations.

Table 6: Socioeconomic Summary

Category	Kentucky Average (%)	Warren County Average (%)	Block Group	Block Group Average (%)
Minority	13.98%	19.19%	2	14.77%
			3	19.09%
Poverty Level (Persons Below Poverty Line)	20.11%	22.80%	2	10.80%
			3	24.25%
Median Income	\$ 44,458	\$ 45,996	2	\$ 38,512
			3	\$ 37,692
Population Over 65 Years Old	14.57%	12.03%	2	6.29%
			3	5.93%
English Speaking Proficiency Less Than Very Well	1.93%	5.55%	2	2.03%
			3	0.56%
Disabled	16.45%	13.85%	2	6.26%
			3	22.18%

 Areas of Potential Concern

7.5 Land Use

The study area is highly developed and contains several commercial properties, including restaurants, retail stores, an old quarry, at least one small cemetery, factories and part of the North Industrial Park. Currently the study area is dissected by numerous roadways, existing roadway structures and a railway.

Any projects that result from this planning study are not anticipated to change land use or land use patterns along the corridor; rather, one of the elements of the Purpose and Need Statement is make the roadway more fitting to the land use in the corridor.

⁶ Data Source: U.S. Census Bureau

7.6 Hazardous Materials

Contaminated and potentially hazardous materials are a concern in the US 31W/KY 446 corridor due to the presence of existing and former gas stations and several large automobile-related industries that could be a concern for underground storage tanks (UST) leakage. Federal, state, and local database record searches were conducted in order to investigate potential locations that may contain USTs and hazardous materials that might pose substantial costs and liabilities for right-of-way acquisition and cleanup. No detailed site inspections, interviews, sampling or testing, or in depth document research was conducted, as these were beyond the scope of the current study. Environmental Data Resources Inc. (EDR), a commercial provider of environmental risk information, provided the electronic review of applicable environmental database searches consisting of 54 federal records, 20 state and local records, 5 tribal records and 5 EDR proprietary records within the study area. A copy of the report is contained in **Appendix J**.

The EDR database searches identified and mapped 31 listed sites; however, after further investigation only 19 were found to be within the study area. These sites are shown in **Figure 18, (p. 29)** and **Table 7**. Also, the report listed 50 unmapped orphan sites potentially located within the study area; however, due to poor or inadequate address information, the exact locations of these sites are unknown and could not be accurately mapped. Regular internet searches and field visits did not yield additional information regarding these orphan sites. It is recommended that additional interviews/investigation of the orphan sites be provided during subsequent project development phases to locate these sites and determine if they present environmental concerns.

7.7 Section 4(f)

Section 4(f) of the U.S. Department of Transportation (USDOT) Act of 1966 requires that, prior to the use of any of the resource types listed below, it must be determined either (1) that there is no prudent and feasible alternative that avoids such use and that the project includes all possible planning to minimize harm resulting from such use, or (2) that the use will result in a *de minimis* (i.e., minimal) impact on the resource protected under Section 4(f). Resources protected under Section 4(f) include:

- A publicly owned and officially designated park;
- A publicly owned and officially designated recreation area;
- A publicly owned and officially designated wildlife or waterfowl refuge; and
- A historic property, either publicly or privately owned, that is listed in or eligible for inclusion in the NRHP, except for archeological resources that are important chiefly because of what can be learned by data recovery and have minimal value for preservation in place. [CFR 774.13(b)(1)]

No known publicly owned designated parks, recreation areas, or wildlife or waterfowl refuges are present in the study area. However, as described previously, three historic properties are

Table 7: UST/Hazardous Materials Search

EDR Site #	Site Name	Address	EDR Database Listings	Notes	Street View or Other Image
3	Kenway Contracting	4520 Louisville Road (Adjacent to the east side of US 31W, north of the RR)	KY SWF/FL, KY NPDES, KY AIRS, KY HIST LF, KY SWRCY, RCRA-CESQG, KY SPILLS	Operating landfill, recycling center, waste tire, transfer station, quarry, asphalt mixture, ready mix concrete, etc.	
4	Southern Environmental Services d/b/a Meguirk Oil Company	4369 Louisville Road (Adjacent to west side of US 31W north of the RR)	KY SPILLS, KYT UST, FINDS, RCRA Non-Gen/NLR, KY NPDES	Some violations reported.	
8	Southern States Corp.	640 Plum Springs Loop	ERNS, KY NPDES, HMIRS, FINDS,	Violations for release of chemicals into soil, and hazardous materials incidents	
14a	JR Food Mart	3380 Louisville Road (Adjacent to south side of US 31W)	KY UST, FINDS KY SPILLS	USTs and Piping. No reported violations.	
14b	Mini Mart. & Poinciana Laundry & Tanning	3411 Louisville Road (Adjacent to north side of US 31W)	FINDS, RCRA NonGen NLR, Hist Cleaners, KY UST, US Hist Auto Sta.	USTs and Piping. Dry cleaner on west side. No reported violations.	
16	Weyerhaeuser Co.	120 Willamette Way (north of KY 446, east of US 31W)	RCRA NonGen / NLR	Handler of hazardous waste, not a generator. No violations reported.	
17	Swiftly Gas Station	2937 Louisville Road (Adjacent to north side of US 31W)	KY UST, FINDS, Hist Auto Stat,	Leaky UST reported on FINDS database (110043838586)	
19	Kenworth of Bowling Green Former Reynolds Auto Repair	131 Parker Avenue (Adjacent to south side of Parker Ave)	US Hist Auto Stat., FINDS	No violations reported	
20	Top Notch Paint & Auto Body Former; Beards Auto Sales and Collision, and, AAA Auto Center	3006 Louisville Road (Adjacent to south side of US 31W)	EDR Hist Auto Stat.	No violations reported	
21	Bowling Green International Truck Inc.	191 Parker Avenue (Adjacent to south side of Parker Ave)	KY NPDES	No violations reported	
23	Brooks Auto Service	233 Parker Avenue (Adjacent to south side of Parker Ave)	Hist Auto Stat., FINDS	No violations reported	
24	Fruit of the Loom	675 Hennessy Way (south of KY 446)	FINDS, KY NPDES (for additional parking)	No violations reported	
25	AEP Industries; Sun Chemical Corp; Cellobag Co; Mercury Plastics; Willamette Industries; Android Industries	123 and 120 Willamette Lane (Adjacent to north side of KY 446 and west side of US 31W)	ERNS, KY SPILLS, KY AIRS, RCRA NonGen / NLR, RCRA-LQG, FINDS, US AIRS, KY UST	Large Quantity Generator of Hazardous Waste. Numerous reports of various activities, including releases of chemicals into soil.	
29	Hennessy Industries -- BADA Division	759 Hennessy Way (south of Fruit of the Loom, outside of Environmental Footprint area)	KY NPDES, KY AIRS, TRIS, RCRA-CESQG, FINDS, US AIRS,	Large Quantity Generator of Hazardous Waste. Numerous reports of various activities.	
30	IGA Express Shell Gas	553 Duntov Way (south of KY 446)	KY UST, KY SB193, FINDS, KY SPILLS	Former spill of cleaning materials. No violations reported	
Other Potential Sites					
32	Former BP gas station	NW quadrant of Corvette Drive and Willamette Lane	N/A	Identified during site visit. No stained soils or UST piping identified.	
33	Bluegrass Uniforms	NW Quadrant of US 31 SB Ramp	N/A	Potential Dry Cleaners. No interview or records check made.	
34	Comfuel	SW quadrant of Parker Ave and Hennessy Way. East of Grayhound bus station.	N/A	Active UST gas station	
35	Likely Former Gas Station	SW quadrant of US 31W and Plumb Springs Loop	N/A	Current Liquor Station	

*Numerous sites were listed in the Database as being within the area. However, after a detailed analysis, those that had incorrect addresses, are just outside the study area, or applied only for NPDES (National Pollution Discharge and Elimination System) permits for construction activities, are not included within this table or the exhibit. Areas of potential concern for the roadway project are in **bold**.

either currently listed or are potentially eligible for inclusion in the NRHP. The location of each site is shown in **Figure 18 (p. 29)**. It is anticipated that none of the properties will be affected by the project and, therefore, no anticipated Section 4(f) impacts will be associated with this project.

7.8 Cultural Historic and Archaeological Resources

Based on an extract from the *I-65/US 31W interchange Environmental Impact Statement* (KYTC Project Item No. 03-16.00), the following potential historic resources (**Figures 20–22**) were identified in the project corridor:

7.8.1 Historic Site—NRHP Listed

Site 56: William Gossom House (WA-73), 812 Plum Springs Loop, listed in 1979. Site 56 (**Figure 20**) was listed in the NRHP, with a boundary consisting of one acre centered between the house and springhouse. According to the NRHP form, “this house is one of six highly significant Federal style brick houses in the county based on the hall and parlor type. Later additions and alterations have not obscured the classic two-story, three-bayed form common in such houses. The significance of the house is increased by the survival of a nearby stone springhouse, by the prominent location at the intersection of several main highways, and by the connections of the son-in-law of the original owner with Barren River commerce.”



Figure 20: William Gossom House

7.8.2 Sites Meeting NRHP Criteria

Site 57: Gossom-Roberts Cemetery (WA-449), Louisville Road. Site 57 is potentially eligible for NRHP listing (**Figure 21**). This site has a known association with William Gossom, a person of significance in the early history of Warren County. Historic archaeological analysis has determined the site to have yielded or may be likely to yield, information important in history or prehistory.



Figure 21: Gossom Roberts Cemetery

Site 58: Mt. Hebrew Cumberland Presbyterian Church and Cemetery (WA-450), Louisville Road. Site 58 is potentially eligible for NRHP listing (**Figure 22**). The site has an association with an African American congregation, embodies the distinctive characteristics of a type and period, and investigations and analysis have determined the site to have yielded or may be likely to yield, information important in history or prehistory.



Figure 22: Mt. Hebrew Cumberland Presbyterian Church and Cemetery

8.0 INITIAL PROJECT TEAM AND STAKEHOLDER COORDINATION-EXISTING CONDITIONS

During the course of this study, meetings were held early to present and review existing conditions and then present proposed alternatives. Those meetings are summarized as follows:

8.1 Project Team Meeting No. 1

The first Project Team meeting was held on February 27, 2015 (**Appendix L**), to present existing conditions (summarized in Sections 5.0, 6.0, and 7.0) and to identify design criteria for alternative concepts to be studied (summarized below).

8.1.1 Typical Sections/Design Speed

Build alternative concepts will be based on the following design guidance:

- Interchange—45 MPH
- Roundabout—25 MPH
- Access Management between Old Porter Pike and Porter Pike—provide the following elements:
 - A rural typical section with three median openings and opportunities for “bulb-outs” and U-turns retaining the depressed median,
 - A curb and gutter option with an 8-foot-wide sidewalk on the eastern side of US 31W, and
 - Improved drainage issues across from Keystop gas station—since inlets have been paved over; the area does not drain properly and is prone to flooding.

8.1.2 Multimodal Considerations

The Project Team discussed consideration of bicycle/pedestrian facilities. Bicycle facilities are non-existent in the study area and there are no mapped bicycle routes. Safety for bicyclists was expressed as a concern due to the high traffic volumes and the interchange, which does not lend itself to safe bicycle use.

KYTC Bicycle and Pedestrian Review provided the following levels of improvements for consideration:

- **Best.** Construct a 10-foot or wider shared-use path along the southeastern section of US 31W for the entire length of the project. This would provide a safer connection to the proposed greenways system, Weldon Peete Park, commercial businesses, and current routes to outlying rural secondary roads used by recreational road cyclists. The shared-use path would serve both pedestrians and cyclists. This would improve the BCI to A for this section of roadway.
- **Good.** Construct an 8-foot or wider shoulder and provide a 10-foot gap space in the rumble strip every 40 feet. This would improve the BCI to a D. Construct a sidewalk (five feet or wider) on the southeastern section of US 31W for the entire length of the project.

- **Fair.** Construct an eight-foot or wider shoulder and provide a 10-foot-wide gap in the rumble strip every 40 feet. This would improve the BCI to a D.

In addition, the following recommendations were provided for pedestrian crossings:

- Provide marked crosswalks at all signalized intersections.
- Extend crosswalk lines across the full width of the pavement (to discourage diagonal walking between crosswalks).
- Mark crosswalks at all intersections that have “substantial conflict between vehicular and pedestrian movements.”
- Provide crosswalk markings at points of pedestrian concentration, such as at loading islands, midblock pedestrian islands, and/or where pedestrians need assistance in determining the proper place to cross the street.
- Consider constructing sidewalks along Parker Avenue near the Greyhound Bus Station or Hennessy Way.

8.1.3 Purpose and Need Review

The Project Team agreed the US 31W/KY 446 interchange should remain the main focus of project study, rather than access management, drainage issues, or improved Hennessy Way access. Many of mobility the issues stem from the presence of the high speed rural interchange within an urban context—improvement of which is a key element in the project Purpose and Need Statement.

8.2 Local Officials Meeting No. 1

A local officials meeting was held prior to the first public meeting to present existing conditions and to gather issues or concerns in the study area. A full set of minutes is located in **Appendix K**.

A representative of the Bowling Green-Warren County Planning Commission noted the following:

- The west side of the railroad tracks directly across from Northgate Shopping Center is zoned Industrial. Preliminary plans add a fourth leg to the Northgate Shopping Center intersection, and with a railroad underpass/or overpass provide access to the industrial property between US 31W and the Barren River. This proposal was to encourage improved access management along US 31W, and remove truck traffic from Plum Springs Loop underpass.
- There is confusion as to whether U-turns are currently allowed along US 31W for access to businesses.
- Left-hand deceleration lanes may be warranted along US 31W.
- Although crash data does not show a problem at the southbound US 31W to eastbound KY 446 left turn, the location has experienced violent crashes.
- Closing the existing Plum Springs Loop underpass would be met with opposition. Employees working at industries along Plum Springs Loop access US 31W from the US

31W/Porter Pike/Plum Springs Loop intersection for lunch activities. Also, it provides redundant access for emergency vehicles.

- Difficulty with left turns from Old Porter Pike. The residential development is very dense and a signal has been requested.
- Concerned with businesses underserved by median cuts. Motorists make U-turns to access properties at locations that do not line up with existing business entrances. A couple of businesses do not have access from the opposite side of US 31W.
- Consider a flyover from southbound US 31W to KY 446 to eliminate the existing signal.
- Interest in improving access to Beach Bend Park, (500,000 visitors a year) perhaps with better access, encouraging expansion of the park.

8.3 Public Meeting No. 1—Existing Conditions

The first public meeting was held March 31, 2015, to present existing conditions and gauge public issues and concerns in the study area. Each attendee was provided a survey, and colored dots to indicate their greatest concerns and issues. In addition, an on-line survey was provided for persons unable to attend the meeting. Live twitter feeds, variable message boards, and radio and TV interviews were placed and conducted prior to and during the meeting. There were 57 people in attendance. Including those from the local officials' meeting, a total of 61 surveys were received (nine on-line). Ninety percent of the respondents were from Warren County, most used the study corridor roads to travel to work, and nearly one-half traveled the study area several times a day. Congestion (72%) and Safety (61%) were the greatest concerns expressed. The ramp maneuver from KY 446 westbound to northbound US 31W is the movement that presents drivers the most difficulty. The second movement that provided concern was the narrow underpass at the rail crossing overpass of Plum Springs Loop. Sinkholes/Groundwater ranked as the greatest concern in the environmental area, with business impacts placing second. This information is located in **Appendix K**.

In addition, meeting attendees placed red and yellow dots on maps indicating their areas of greatest concern (red) and secondary concerns (yellow). Each participant received two red and two yellow dots. Public meeting attendees identified the overwhelming problem area—the US 31W/KY 446 interchange area with a total of 50 dots, 30 for the movement from westbound KY 446 to northbound US 31W. Ranking of problem areas by the public were as follows:

1. US 31W/KY 446 interchange (KY 446 westbound to US 31W northbound most prevalent)
2. KY 446/Corvette Drive intersection
3. US 31W/Porter Pike intersection
4. Plum Springs Loop underpass at rail crossing

Open-ended questions on both the electronic and paper surveys were captured at the public meeting and summarized. The results of the electronic and paper surveys supported and validated the existing conditions and were presented at the first Project Team meeting.

9.0 ALTERNATIVES DEVELOPMENT AND SCREENING PROCESS

Throughout the planning process many build alternative options and components were considered for the study area. It was a complex and evolving process equivalent to the complexity of the transportation problems and the differing issues. As the study progressed, new problems and possible solutions were identified. Meeting minutes and summaries capture the details of the sequential process.

Section 9.1 presents the initial options and components considered and Section 9.2 presents a short-list of alternatives and options presented to the public and studied in greater detail.

9.1 Broad-Range of Alternatives and Options

This section discusses initial build options considered early with the study process for the US 31W interchange and additional issues in the study area.

The No-Build Alternative would leave the existing conditions described in this study as is with only routine maintenance. It should be noted KYTC Project Item No. 03-2081.00 (KY 446 Pavement Rehabilitation Project), although it would result in short-term improvements, is in essence a No-Build option when considering long-term reconstruction options.

9.1.1 US 31W/KY 446 Interchange Options

As noted above, the Project Team agreed the US 31W/KY 446 interchange was the main focus of project study. Many of the issues stem from the presence of the high-speed rural interchange within the urban context.

Interchange Options:

The original scope of this study included improvements to or total reconstruction of the US 31W/KY 446 interchange. The following four Build Options for the US 31W/KY 446 interchange were:

- New interchange configuration
- At-grade intersection
- Roundabout
- Improvements to the existing interchange

During the course of the study process, other options appeared to have merit and are as follows:

- A 4-way intersection or roundabout, with the fourth leg being an extension south to Hennessy Way and/or Porter Pike.
- The 3-way intersection alternative was expanded to either “T” KY 446 into US 31W or “T” US 31W into KY 446. Kight Home Center (formerly Carter Lumber) is situated within the existing US 31W/KY 446 interchange and provides complications as far as maintaining continued access.

- In an effort to maintain the heaviest movement (US 31W southbound), two concepts of maintaining continuous US 31W movement flow (Green T intersection) were also considered.

In all, eight interchange reconstruction concepts were considered for the existing US 31W/KY 446 interchange—five intersection options (Options 1, 2, 3, 4, 5), two total reconstruction interchange options (Options 6 and 7), one KY 446 flyover interchange (Option 8), one option for access management on US 31W (Option 9), and three roundabout concepts (Roundabout Options 1, 2, and 3). A brief description of each and its operational characteristics are outlined in **Table 8 (p. 43)**. Illustrations are provided in **Appendix L**.

A traffic operations analysis was performed for the US 31W/KY 446 intersection and interchange concepts. Due to the amount of traffic using the existing US 31W/KY 446 interchange, complicated by the access to Kight Home Center (formerly Carter Lumber site) and the purpose to provide a more urban context, identifying an alternative that maintained an acceptable level of service (LOS) of D or above, proved challenging.

Low-Cost Interchange Improvements:

Given KYTC budget constraints, high crash locations, geometric deficiencies, and public input regarding the movements with the most concerns, low-cost enhancements to the existing interchange in lieu of total or partial reconstruction were identified.

- Employ traffic calming measures on the KY 446 flyover ramp, such as striping and signage. This improvement could be implemented to slow motorists traveling from high-speed I-65 to KY 446 (lower speed urban area).
- Extend the westbound KY 446 to northbound US 31W merge distance over the railroad crossing. This improvement was identified by the public as an area of concern, and is a 0.1-mile crash spot with a CCRF approaching 1.0 (number 4 in **Table 4, p. 20**).
- Extend the ramp of westbound KY 446 to southbound US 31W through the US 31W/Porter Pike intersection. This improvement was identified by the public as an area of concern, and is a 0.1-mile crash spot with a CCRF greater than 1.0 (number 3 in **Table 4, p. 20**).

9.1.2 Non-Interchange Components

The Project Team identified the following components that could be implemented independent of the interchange reconstruction:

- Provide access management along US 31W between Old Porter Pike to Porter Pike. **(See Option 9 in Table 8, and Table 9, Option A.)**
- Close Plum Springs Loop at US 31W across from Porter Pike and realign KY 957/Plum Springs Loop intersection with US 31W. To provide room for trucks, the Plum Springs Loop/KY 957 T-intersection may need additional turn storage space should Plum Springs Loop be closed at its southern end. **(See Table 9, Option B.)**
- Realign Parker Avenue at Porter Pike to provide additional queuing space on Porter Pike between US 31W and Parker Avenue. **(See Table 9, Option C.)**

Table 8: Broad-Range of Initial Options

Option 1—4-Way Intersection US 31W, KY 446, Hennessy Way	Option 2—4-Way Intersection US 31W, KY 446, Hennessy Way	Option 3—4-Way Intersection US 31W, KY 446, and Carter Lumber	Option 4—Continuous Green T Intersection US 31W, KY 446	Option 5—Continuous Green T Intersection	Option 6—Interchange (one loop)
 <ul style="list-style-type: none"> • Uses existing infrastructure for bypass lanes • Free flow through movements are: <ul style="list-style-type: none"> - US 31W southbound to Bowling Green - KY 446 westbound to US 31W northbound - US 31W from Bowling Green to realigned Hennessy Way • Only one westbound through lane from I-65 to US 31W southbound • Removes access to Parker Avenue • Realigns access to Hennessy Way south of FOTL • Provides former Carter Lumber site with right-in/right-out • 2040 Traffic Operations LOS E in the PM Peak Hour 	 <ul style="list-style-type: none"> • Two through lanes westbound from I-65 to US 31W south • Removes access to Parker Avenue • Removes access to Hennessy Way • No access to former Carter Lumber site • Does not restrict access to the corner property near Corvette Drive • 2040 traffic operations are improved over Option 1, however the southbound lefts and through movements will operate at LOS E in the 2040 PM peak hour • Sight distance issues for vehicles traveling southbound on US 31W through the sweeping curve may be an issue with all options. It also may be an issue with adding a signal 	 <ul style="list-style-type: none"> • Takes advantage of the existing infrastructure • US 31W is the through movement • Provides full access to former Carter Lumber site • Provides for a connector from KY 446 to Willamette Lane • The 2040 traffic operations result in an intersection LOS C 	 <ul style="list-style-type: none"> • US 31W is the through movement • An acceleration lane is provided for westbound motorists from KY 446 turning southbound onto US 31W • Provides modified access to US 31W for former Carter Lumber site closer to Porter Pike • Provides modified connection to Dahlia Way from US 31W • The 2040 traffic operations result in an intersection LOS C 	 <ul style="list-style-type: none"> • Takes advantage of existing infrastructure • KY 446 is the through movement • Provides for US 31W southbound free flow movement utilizing the existing infrastructure • Only one through lane for KY 446 westbound from I-65 • Provides full access to former Carter Lumber site • 2040 traffic operations are projected to be LOS E and F for this option 	 <ul style="list-style-type: none"> • Removes US 31W southbound to KY 446 eastbound short ramp and provides 25 mph loop • Provides over 900 feet as opposed to 200 feet at present for the movement from SB US 31W to turn left at Porter Pike and eliminates the merge to US 31W southbound • One lane northbound from Bowling Green to northbound US 31W to remove the merge issue near the bridge over the railroad on US 31W north • Tightens KY 446 flyover ramp to US 31W southbound to allow more merge room for southbound vehicles • Maintains access to former Carter Lumber • All ramps will require only one lane for projected 2040 traffic.
Option 7—Interchange (two loops)	Option 8—KY 446 Flyover	Roundabout Option 1 US 31W, KY 446 (3-way roundabout)	Roundabout Option 2 US 31W, KY 446 (3-way roundabout)	Roundabout Option 3 US 31W, KY 446, Hennessy Way (4-way roundabout)	Option 9—US 31W Access Management from Old Porter Pike to Porter Pike
 <ul style="list-style-type: none"> • Removes southbound US 31W to eastbound KY 446 short ramp and provides loop ramp • Removes the KY 446 to US 31W southbound flyover ramp and replaces it with a loop • Provides right-in/right-out for Hennessy Way • All ramps require only one lane for projected 2040 traffic. 	 <ul style="list-style-type: none"> • KY 446 flyover ramp then connection to Porter Pike with a 4-way intersection • US 31W is the through movement • Loop road access to Hennessy Way • 2040 traffic operations are expected to operate at LOS D in the AM peak hour and C in the PM peak hour. The left turns to and from US 31W are expected to both operate at LOS E. 	 <ul style="list-style-type: none"> • 3-way roundabout option using part of the existing infrastructure with full bypass lanes • With bypass lanes this option pushes movements a little closer to the adjacent KY 446/Corvette Drive intersection. • This option has only two lanes on US 31W approaching the roundabout circle from Porter Pike • 2040 traffic operations result in LOS A in both the AM and PM peak hours. 	 <ul style="list-style-type: none"> • Pulls right turn lanes of each approach in adjacent to the roundabout circle • Utilizes free-flow slip lanes for right turn movements. This concept allows for the US 31W approach and KY 446 westbound approach right turns to be considered as yielding partial bypass lanes • Provides access/regress for FOTL • Provides for greater distance between decision points such as intersections and before the US 31W northbound bridge over the railroad. • Provides two lanes on US 31W from Porter Pike approaching the roundabout • Prohibits Parker Avenue access to Hennessy Way • 2040 traffic operations result in LOS A for AM and PM peak hours. If the free flow slip lane from US 31W northbound is modified to a yielding right turn slip lane the LOS decreases to B in the PM peak hour 	 <ul style="list-style-type: none"> • Utilizes non-yielding slip lanes for US 31W SB and KY 446 westbound to US 31W northbound. Utilizes partial right turn slip lanes for US 31W NB to Carter Lumber Entrance and from Carter Lumber Entrance southbound to KY 446 where traffic yields to exiting traffic. • Provides potential to address right turn vehicles from KY 446 to US 31W northbound via a yielding double lane • Provides three lanes on US 31W from Porter Pike to the roundabout • Prohibits Parker Avenue access to Hennessy Way • 2040 traffic operations result in an intersection LOS A in the AM peak hour and LOS B in the PM peak hour. • Provides an option for an extension to Porter Pike 	 <ul style="list-style-type: none"> • Reduces the median openings from 14 to three • Provides for 3 U-turn areas: <ul style="list-style-type: none"> - Porter Pike - Old Porter Pike - Northgate Shopping Center entrance (bulb out had to be adjusted due to the railroad) • Offset left turn on US 31W at Old Porter Pike • Shared use path on east side of US 31W • Sidewalk on west side of US 31W

Note: Pink selected for Next Phase by the Project Team

- Add a right-in/right-out option for Hennessy Way and reconfigure Corvette Drive/Duntov Way. This improvement was developed in response to the congestion and conflicts resulting from KY 446 motorists turning left into development nearly adjacent to KY 446 at Corvette Drive conflicting with employees from FOTL. **(See Table 9, Option D.)**

Associated costs for Non-Interchange Components are located in Table 10.

9.1.3 Low-Cost Improvements

- Raise the grade of US 31W near Old Porter Pike to improve sight distance for southbound motorists turning into Old Porter Pike. The low-cost improvement was preferred over an offset left-turn lane on US 31W at Old Porter Pike.
- Construct a sidewalk from Porter Pike to the Greyhound Bus Station on the existing roadbed.

9.1.4 Screening of Broad-Range Alternatives and Options

The Project Team at Project Team Meeting No. 2 selected options to advance to the next study phase and for presentation to the public. Decisions made regarding the initial options studied are summarized as follows and depicted in **Table 8 (p. 43)** and in exhibits located in **Appendix L**.

US 31W/KY 446 Options **Eliminated** From Further Consideration (green color in **Table 8**)

- **Intersection Options 1, 2, and 5** were eliminated based upon the unfavorable 2040 traffic operations analysis and geometrics.
- **Interchange Option 7** was eliminated due to truck traffic concerns on the KY 446 to US 31W southbound ramp and the short weaving distance (900 feet) between the two loop ramps.
- **Intersection Option 8** was eliminated due to the unfavorable 2040 traffic operations of the left turns from US 31W northbound to and US 31W southbound.
- **Roundabout Option 1** was eliminated based on these concerns:
 1. The merge point on US 31W northbound before the railroad overpass is a current concern and would be unchanged.
 2. The merge point on KY 446 eastbound is less desirable than existing conditions.
 3. The speed differential from US 31W southbound between the bypass lanes (higher speeds) and the roundabout circle (much lower speeds) was a concern.
- **Roundabout Option 2** was eliminated because the FOTL access point was essentially an offset fourth leg, and it was better addressed in Roundabout Option 3.

US 31W/KY 446 Options **Advanced** For Further Consideration (pink color in **Table 8**)

- **Intersection Options 3 and 4** were selected to move forward with the addition of a merge/acceleration lane from KY 446 to US 31W north.

- **Interchange Option 6** was selected to move forward due to the ease of construction and improvement of its connection to US 31W southbound at Porter Pike (a high crash location).
- **Roundabout Option 3** was selected to move forward because it:
 1. Includes a future connection to Porter Pike south.
 2. Provides 2040 build v/c ratios less than 0.8 and LOS B or better.
 3. Further achieves the objective of slowing down motorists' speed.
- **Option 9**, US 31W Access Management, was selected to move forward.

Renumbered Build Alternatives and Options

Following Project Team Meeting 2, the design concepts to advance for further study and public input were renumbered. The design concepts associated with the interchange are hereinafter referred to as “alternatives,” and the “non-interchange components” that could be a part of the interchange alternatives or be stand-alone were labeled “options.” To clarify further the renaming and renumbering of alternatives, **Table 9** shows the correlation between the old and new names.

Table 9: Short-List of Alternatives and Improvement Options

Former Name	New Name
Option 6—Reconstruct Existing Interchange	Alternative 1
Option 4—Continuous Green T Intersection	Alternative 2
Option 3—4-Way Intersection	Alternative 3
Roundabout	Alternative 4
Roundabout with Porter Pike Extension	Alternative 4a
US 31W Access Management	Option A
Close Plum Springs Loop Underpass and Realign KY 957 at US 31W	Option B
Parker Avenue Realignment	Option C
Reconfigure Corvette Drive/Duntov Way	Option D

The Alternatives and Improvement Options were examined in more depth. A traffic simulation model was developed for each alternative to determine how each would interact with adjacent intersections. A travel time and delay summary for each alternative was also developed.

9.2 Short-List of Alternatives and Options

The following provides a summary of the alternatives and options, and low-cost improvements that moved to the next phase of this study (**Table 9**), which included the development of cost estimates (**Table 10, p. 47**), traffic simulations, and presentation to the public. Each alternative is illustrated and advantages and disadvantages of each alternative and improvement option are illustrated and described at the end of Section 9.0.

9.2.1 US 31W/KY 446 Interchange Alternatives

The paragraphs as follows summarize each alternative. Build Alternatives 1–4a are shown in **Figures 23–27 (pp. 51–55)** and advantages and disadvantages outlined in **Table 13 (p. 57)**.

No-Build Alternative

As stated previously, the No-Build Alternative would leave the existing conditions described in this study as is with only routine maintenance. KYTC Project Item No. 03-2081.00 (KY 446 Pavement Rehabilitation Project) is an example of such routine maintenance and is in essence a No-Build option when considering long-term reconstruction options.

Alternative 1—Reconstruct Existing Interchange

This alternative would provide a loop ramp for southbound US 31W to eastbound KY 446, reconfigure the KY 446 westbound to US 31W northbound ramp to eliminate the merge onto northbound US 31W, and reconstruct the merge of the KY 446 westbound ramp into US 31W southbound to provide greater distance before the traffic light at Porter Pike. The total estimated cost of Alternative 1 is \$7.50 million.

Alternative 2—Continuous Green T Intersection

The US 31W southbound movement would be a continuous flow with two lanes separate from the intersection. Each of the other movements would have a stop condition, with exclusive right-turns. This alternative would address concerns provided by the public and resource agencies. A relocated access point to Kight Home Center (formerly Carter Lumber) towards Porter Pike would be included. The new traffic signal on US 31W at FOTL could remain in place with this alternative, but the traffic backups to this proposed US 31W/KY 446 intersection would need to be monitored. The total estimated cost of Alternative 2 is \$7.62 million.

Alternative 3—4-Way Intersection

With this alternative, all motorists would encounter a traffic signal and Kight Home Center (formerly Carter Lumber) and therefore have direct access to it as the fourth intersection leg. The total estimated cost of Alternative 3 is \$6.01 million.

Alternative 4—Roundabout

Several roundabouts were examined. The Project Team decided due to the operational analysis to pursue the two-lane roundabout with a third lane between US 31W and northbound Hennessy Way. The total estimated cost of Alternative 4 is \$13.76 million.

Alternative 4a—Roundabout with Porter Pike Extension

Alternative 4a is the same roundabout configuration as Alternative 4, but, due to the growth along Porter Pike to the south, an extension to Porter Pike is included. This extension could take the place of the Unscheduled Needs List Project (03 114 D1402 1.00) in **Figure 3 (p. 4)** which includes widening Porter Pike. The total estimated cost of Alternative 4a is \$21.23 million.

Table 10: Cost Estimates—Short-List of Alternatives, Non-Interchange Improvement Options, and Low Cost Improvements

	ALTERNATIVES				
	1	2	3	4	4a
Phases	Reconstruct Existing Interchange	Continuous “Green T” Intersection	4-Way Intersection	Roundabout	Roundabout with Porter Pike Extension
Design	\$560,000	\$500,000	\$420,000	\$1,720,000	\$2,100,000
Right-of-Way*	\$800,000	\$1,850,000	\$825,000	\$2,100,000	\$3,600,000
Utilities*	\$545,000	\$370,000	\$565,000	\$1,340,000	\$1,835,000
Construction	\$5,600,000	\$4,900,000	\$4,200,000	\$8,600,000	\$13,700,000
Total	\$7,505,000	\$7,620,000	\$6,010,000	\$13,760,000	\$21,235,000

	NON-INTERCHANGE IMPROVEMENT OPTIONS			
	A	B	C	D
Phases	Access Management	Close Plum Springs Loop Underpass and Realign KY 957/US 31W	Parker Avenue Realignment	Reconfigure Corvette Drive/ Duntov Way
Design	\$320,000	\$100,000	\$100,000	\$100,000
Right-of-Way*	\$1,475,000	\$375,000	\$1,175,000	\$275,000
Utilities*	\$2,240,000	\$1,180,000	\$550,000	\$500,000
Construction	\$3,200,000	\$630,000	\$730,000	\$500,000
Total	\$7,235,000	\$2,285,000	\$2,555,000	\$1,375,000

	LOW-COST IMPROVEMENTS				
	Improvements to Existing Interchange if it is to Remain in Place			US 31W/Old Porter Pike Intersection	Parker Avenue
Phases	Calming Measures on Existing Flyover Ramp	Ramp Extension (KY 446 WB to NB US 31W)	Ramp Extension (KY 446 WB Ramp to SB US 31W)	Raise Grade of US 31W Near Old Porter Pike	Construct a Sidewalk Along Parker Avenue from Porter Pike to Greyhound Bus Station
Design	\$1,800	\$132,000	\$75,000	\$100,000	\$0
Right-of-Way*	\$0	\$0	\$0	\$0	\$0
Utilities*	\$0	\$0	\$0	\$0	\$0
Construction	\$18,000	\$1,320,000	\$540,000	\$910,000	\$150,000
Total	\$19,800	\$1,452,000	\$615,000	\$1,010,000	\$150,000

*Right-of-Way and Utility estimates were provided by KYTC for alternatives and improvement options only.

9.2.2 Non-Interchange Improvement Options

The improvement options focused on periphery improvements beyond the US 31W/KY 446 interchange.

Option A—Access Management.

Between Old Porter Pike and Porter Pike, 14 median openings exist within a 0.5-mile section of US 31W. This option would reduce the 14 median openings to 3 and provide “bulb-outs” for U-turns. This option also includes a sidewalk on the west side of US 31W and a shared use path on the east side. The total estimated cost of Option A is \$7.23 million.

Option B—Close Plum Springs Loop Underpass and Realign KY 957 at US 31W.

This option would include closing the railroad underpass and realigning Plum Springs Loop (KY 957) at US 31W. It would improve congestion at the US 31W/Porter Pike intersection by allowing significant retiming of the traffic signal. The total estimated cost of Option B is \$2.28 million. All traffic simulations and 2040 analysis included this option.

Option C—Parker Avenue Realignment.

This option would provide more queuing length on Porter Pike between Parker Avenue and its intersection with US 31W. High estimated right-of-way costs (\$1.17 million) may render this option infeasible. The total cost of Option C with right-of-way costs is \$2.56 million. This would be a local, not a KYTC, project.

Option D—Reconfiguration of Corvette Drive/Duntov Way.

This option would create a one-way in and one-way out alignment that would improve traffic flow by reducing conflicts at the KY 446/Corvette Drive intersection, and the Hennessy Way/Corvette Drive/Duntov Way intersection. The total estimated cost of Option D is \$1.37 million. This would be a local, not a KYTC, project.

Low-Cost Improvement—Raise the grade of US 31W near Old Porter Pike to Improve Sight Distance.

As stated earlier, intersection sight distance is not met at the intersection of US 31W/Old Porter Pike for trucks larger than a single unit truck. The offset southbound left turn lane into Old Porter Pike proposed as part of Option A improves sight distance at this intersection. Other considerations to improve sight distance are to raise the US 31W grade at this location or signalize the intersection. It currently does not meet warrants for a traffic signal; however, the situation should be monitored. The total estimated cost for this Low-Cost Improvement (raise the grade) would be approximately \$1.01 million (excluding right-of-way and utility costs).

Low-Cost Improvement—Construct a Sidewalk from Porter Pike to the Greyhound Bus Station on the Existing Roadbed.

To address pedestrian movement, the Project Team identified the need for a sidewalk along Parker Avenue to the Greyhound bus station. The cost estimate for this option would be \$150,000. This would be a local, not a KYTC, project.

Improvement options are shown in **Figure 28** (p. 56) and corresponding advantages and disadvantages are shown in **Table 13** (p. 57).

9.2.3 2040 Traffic Operations and Analysis

Improving mobility and safety are the primary purposes of this project, therefore a travel time summary comparison of alternatives is presented in **Tables 12** including a summary of the model total travel times and delay for each build alternative. Cost, safety components and an initial ranking of all alternatives are also depicted in **Table 12**. **Table 11** focuses on the LOS and study area intersection delays resulting from each build alternative.

All build traffic simulations included the various "options," the elimination of the new signal at FOTL, and were for the worst case scenario, i.e., the PM peak hour. The No-Build and build options' simulations were conducted for Year 2040 traffic. Each build alternative's metrics was simulated using the posted speed limit and included Option B Close Plum Springs Loop Underpass and Realign KY 957 at US 31W.

Mobility

A travel time summary of each remaining alternative was provided from the traffic model to analyze total travel time and delay as well as delay per vehicle for key movements. Alternative 4 resulted in the least overall delay. Delay and travel time metrics for the No-Build Alternative compared favorably with several of the Build Alternatives. An economic analysis of the user benefits compared with implementation cost was beyond the scope of the current study. All alternatives removed the newly installed traffic signal at FOTL (KYTC Project Item No. 03-8632.00 (**Figure 3**, p. 4). **Table 11** provides the intersection delay and LOS for the study area intersections with each alternative calculated using the latest version of the Highway Capacity Software. Red shading shows where intersections will worsen with a build alternative and green shading illustrates where intersection delay is expected to improve with the various build alternatives. Travel time summary detail is located in **Appendix N**.

Safety

Safety is also a key element of the Purpose and Need Statement. Each alternative addresses two high crash spots and additional safety concerns, including sight distance and conflict points.

The Transportation Research Board (TRB) Crash Modification Factor (CMF) Clearinghouse indicates that reducing the number of median openings from 14 to three may reduce crashes by as much as 60%; however, the Transportation Research Board Access Management Manual has a more conservative estimate of 17%.

The current interchange has, and Alternative 1 would have, 10 conflict points. Alternatives 2, 3, 4, and 4a would have 15, 41, 26, and 26 conflict points, respectively (**Table 11**). Conflict points are the number of times vehicles cross paths at each intersection.

Table 11: Alternatives Comparison Summary

Alternative	No-Build	Alternative 1 Reconstruct Existing Interchange	Alternative 2 Continuous Green T Intersection	Alternative 3 4-Way Intersection	Alternative 4 Roundabout	Alternative 4a Roundabout with Porter Pike Extension
Rank by Travel Time	4	3	5	6	1	2
Rank by Delay	3	4	5	6	1	2
Conflict Points (at US 31W/KY 446)	10	10	15	41	26	26
Delay in Minutes 2040 PM Peak Hour	5,979	6,557	10,490	11,275	5,160	5,316
Travel Time in minutes (2040 PM Peak Hour)	12,062	11,327	16,274	17,119	10,225	10,391
Estimated Cost (\$ million)	\$0.00	\$7.51	\$7.62	\$6.01	\$13.76	\$21.24
High Crash Spots Eliminated (2 possible)	0	2	2	2	2	2

Delay = total network delay (from model) Travel Time = total network travel time at posted speed limit (from model)

Table 12: Summary of Intersection Delay and LOS for Each Alternative

	US 31W/Northgate				US 31W/Plum Springs Loop				US 31W/Old Porter Pike*			
	AM	Delay	PM	Delay	AM	Delay	PM	Delay	AM	Delay	PM	Delay
2015	A	7	B	10	B	12	A	8	F	57	F	101
No-Build 2040	B	19	B	13	B	18	B	10	F	356	F	815
Alternative 1	B	19	B	13	F	112	D	45	F	356	F	815
Alternative 2	B	19	B	13	F	112	D	45	F	356	F	815
Alternative 3	B	19	B	13	F	112	D	45	F	356	F	815
Alternative 4	B	19	B	13	F	112	D	45	F	356	F	815
Alternative 4a*	B	19	B	13	F	112	D	45	F	356	F	815
	KY 446/Corvette Drive				US 31W/Porter Pike				US 31W/KY 446			
	AM	Delay	PM	Delay	AM	Delay	PM	Delay	AM	Delay	PM	Delay
2015	D	48	F	90	E	64	D	40	E	57	C	25
No-Build 2040	C	31	F	95	F	116	D	41	F	123	C	29
Alternative 1	D	49	F	140	E	75	D	42				
Alternative 2	D	49	F	140	E	75	D	42	D	36	D	43
Alternative 3	D	49	F	140	E	75	D	42	F	245	F	152
Alternative 4	C	31	F	95	F	116	D	41	A	9	B	12
Alternative 4a*	C	31	F	95	F	116	D	41	A	9	B	12

NOTES:

1. Delay is intersection delay in seconds/vehicle.
 2. All intersection delays include the removal of the FOTL signal on KY 446, and the closing of the Plum Springs Loop Underpass.
 3. Red shading indicates delay or LOS worsened over No-Build 2040, green shading shows improvement.
- *For this study, Intersection LOS and delay are assumed to be similar for this alternative as for Alternative 4.

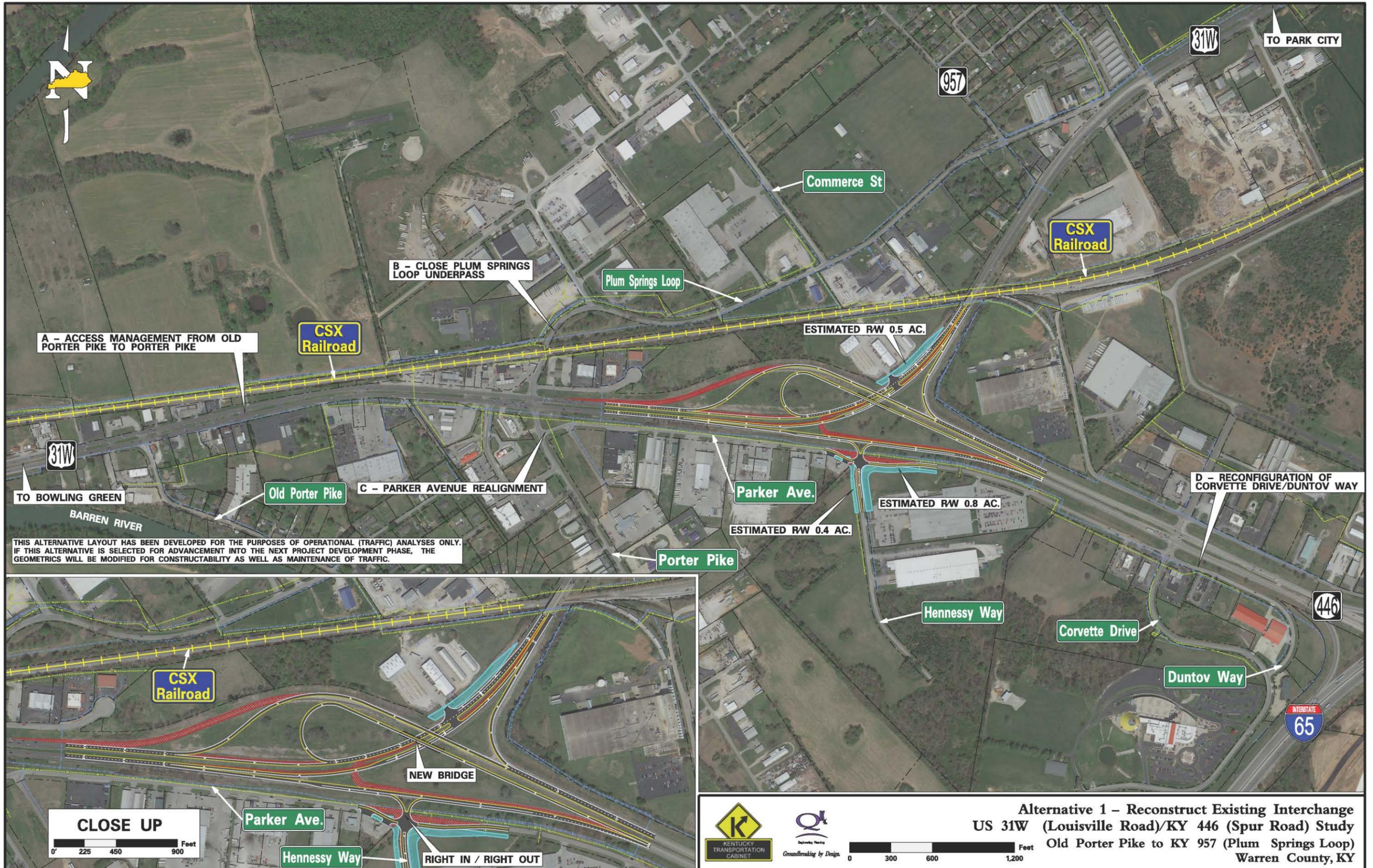


Figure 23: Alternative 1—Reconstruct Existing Interchange

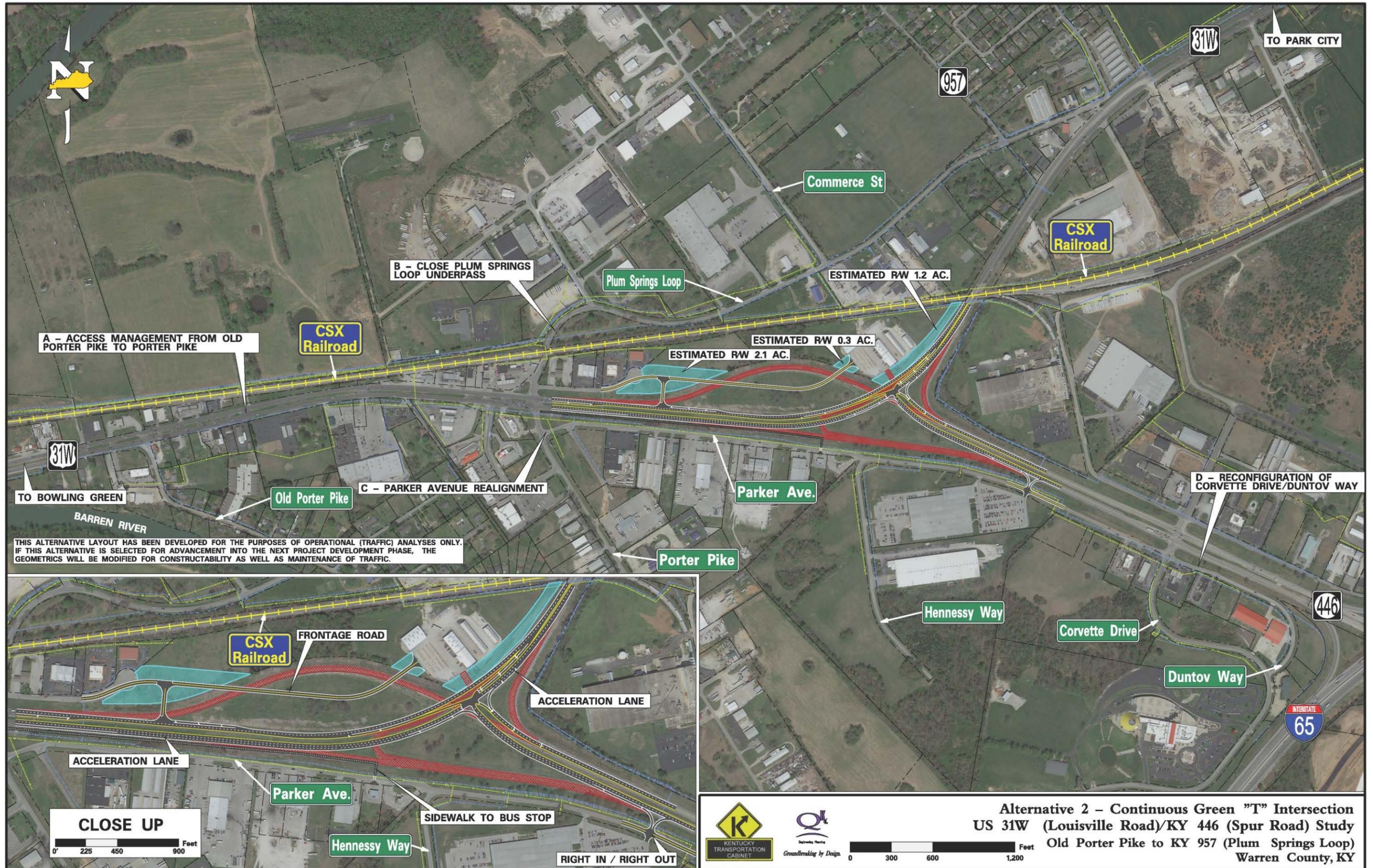


Figure 24: Alternative 2—Continuous Green T Intersection



Figure 25: Alternative 3—4-Way Intersection

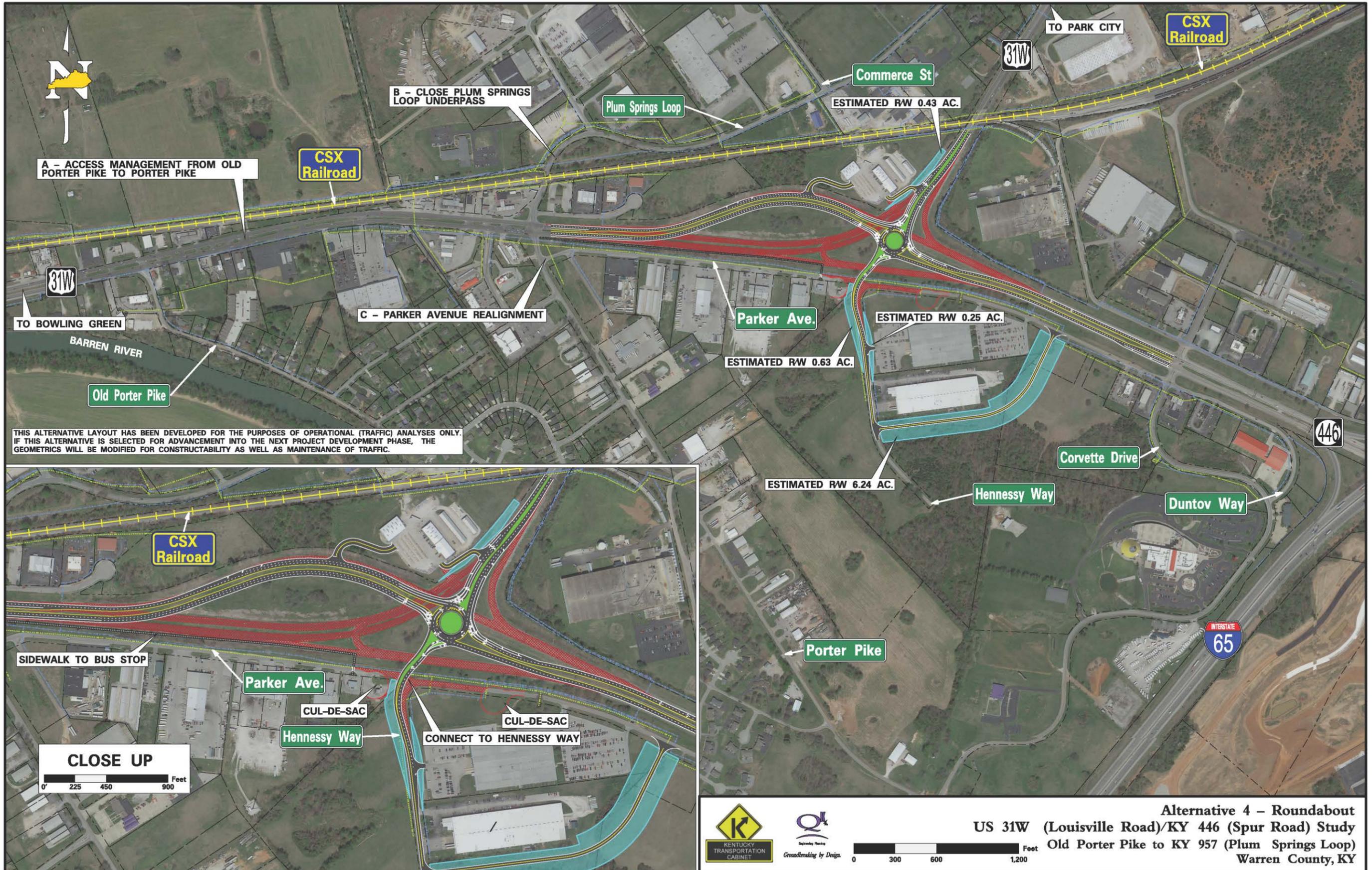


Figure 26: Alternative 4—Roundabout

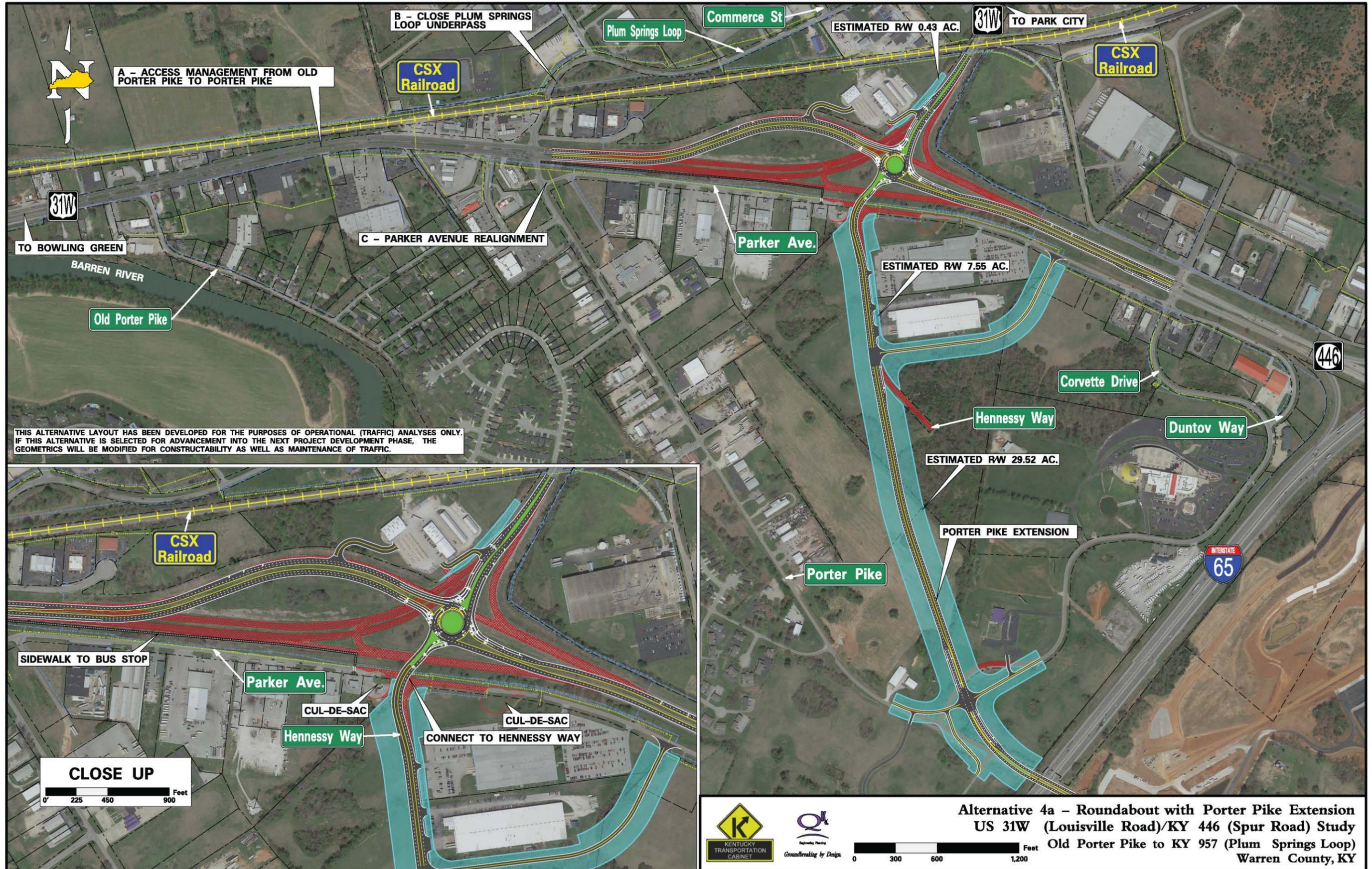
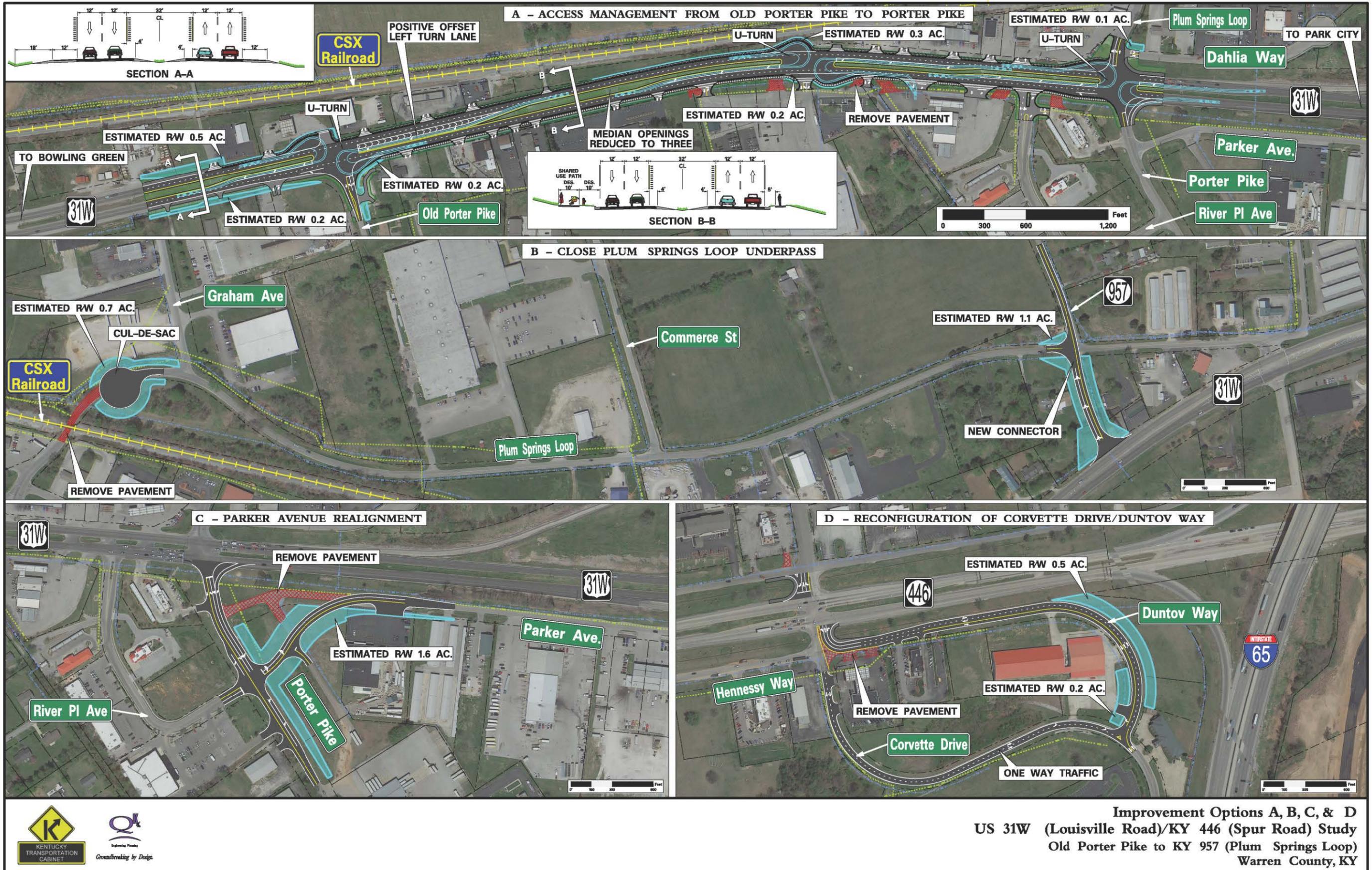


Figure 27: Alternative 4a—Roundabout with Porter Pike Extension



Improvement Options A, B, C, & D
 US 31W (Louisville Road)/KY 446 (Spur Road) Study
 Old Porter Pike to KY 957 (Plum Springs Loop)
 Warren County, KY

Figure 28: Improvement Options



Table 13: Advantages and Disadvantages of Build Alternatives and Improvement Options

Alternative 1—Reconstruct the Existing US 31W/KY 446 Interchange	Alternative 2—Continuous Green T Intersection	Alternative 3—4-Way Intersection	Alternative 4—Roundabout	Alternative 4a—Roundabout with Porter Pike Extension
Advantages	Advantages	Advantages	Advantages	Advantages
<ul style="list-style-type: none"> • 600 feet of additional merge length for the movement from KY 446 WB to US 31W SB toward Bowling Green at the Porter Pike/US 31W intersection. • Eliminates the merge from KY 446 WB to US 31W NB • Eliminates the merge from KY 446 WB to US 31W SB • Eliminates signal at US 31W SB Ramp to KY 446 EB (or I-65) and provides a free-flow movement • Free Flow movements 	<ul style="list-style-type: none"> • Provides urban context • US 31W SB to Bowling Green is continuous (heaviest movement) • Continuous right turn from US 31W to KY 446 • 330 feet of additional merge length for the movement from KY 446 WB to US 31W SB toward Bowling Green • Improves the movement from KY 446 WB to US 31W NB by providing a 180' long parallel acceleration/ merge lane • Less conflict points than a 4-way intersection (Alternative 3) • Has less total delay than Alternative 3 • Eliminates two major safety concerns (merge from US 31W SB to Porter Pike and merge from KY 446 WB to US 31W NB) 	<ul style="list-style-type: none"> • Least expensive • Provides urban context • Reduces speeds • Consistent driver expectations • Eliminates two major safety concerns (merge from US 31W SB to Porter Pike and merge from KY 446 WB to US 31W NB) • Fits within Pavement Rehab Project (KYTC Project Item No. 03-2081.00) • Exclusive right turn lanes for NB US 31W to KY 446 EB and KY 446 WB to US 31W NB • Provides additional left turn storage from KY 446 WB to US 31W SB 	<ul style="list-style-type: none"> • Least total delay • Provides urban context • Keeps motorists moving • Reduces speeds • Reduces conflict points when compared to Alternative 3. According to FHWA, reduces crashes by at least 29% over a conventional four-way intersection 	<ul style="list-style-type: none"> • Provides Extension to Porter Pike • Provides access for the expected visitation at the NCM Motorsports Park. • Least total delay except for Alternative 4 • Provides urban context • Keeps motorists moving • Reduces speeds • May eliminate the need to widen existing Porter Pike • According to FHWA, reduces crashes by at least 29% over a conventional four-way intersection
Disadvantages	Disadvantages	Disadvantages	Disadvantages	Disadvantages
<ul style="list-style-type: none"> • Traffic backups on US 31W ramp toward Bowling Green in the PM peak hour • Does not slow motorists down as much as other alternatives • Does not provide for urban context • Does not meet driver expectation with an interchange between two at-grade intersections. • Requires KYTC to remove the new intersection just constructed for FOTL 	<ul style="list-style-type: none"> • The continuous traffic flow along US 31W SB could potentially be moving at a higher speed causing safety concerns for the KY 446 WB merging traffic • KY 446 WB to US 31W SB (toward Bowling Green) is one of the highest volume movements and the single left turn lane would cause traffic to back up onto KY 446 prior to the signal • NB US 31W traffic will still have a signal 	<ul style="list-style-type: none"> • Most total delay • Most conflict points 	<ul style="list-style-type: none"> • Complex and may be confusing to drivers • Expensive • FOTL traffic backs up in PM peak hour due to motorists “finding” gaps in traffic to head north on US 31W or south on US 31W toward Bowling Green. Therefore the newly installed signal may need to be left in place • Multilane roundabouts are less safe for pedestrians and bicyclist 	<ul style="list-style-type: none"> • Complex and may be confusing to drivers • Most expensive • FOTL traffic backs up in PM peak hour due to motorist “finding” gaps in traffic to head north on US 31W or south on US 31W toward Bowling Green. Therefore the newly installed signal may need to be left in place
Option A Access Management	Option B Close Plum Springs Loop Underpass and Realign KY 957 at US 31W	Option C Parker Avenue Realignment	Option D Reconfiguration of Corvette Drive/Duntov Way	Raise the Grade of US 31W Near Old Porter Pike to Improve Sight Distance
Advantages	Advantages	Advantages	Advantages	Advantages
<ul style="list-style-type: none"> • Reduces conflicts • Expected to reduce crashes 17% • Improves sight distance at Old Porter Pike (if included with raise the grade at US 31W and Old Porter Pike) • Channelizes some business access/parking lots • Helps with drainage 	<ul style="list-style-type: none"> • Relieves congestion at US 31W/Porter Pike and Porter Pike/Dahlia Way intersections • Eliminates cost of widening railroad bridge • Realigns Plum Springs Loop and KY 957 at US 31W North 	<ul style="list-style-type: none"> • Additional 550 feet of queue length on Porter Pike between Parker Avenue and Porter Pike • Aligns Parker Avenue with River Place/Porter Pike intersection • May be an opportunity for donated right-of-way. 	<ul style="list-style-type: none"> • Reduces conflicts from Hennessy Way and businesses close to KY 446 • Channelizes business entrances • Moves Shell station entrance to Corvette Drive • Moves business entrance at Corvette Drive/Hennessy Way to Hennessy Way • Improves travel flow at the KY 446/Corvette Drive intersection 	<ul style="list-style-type: none"> • Improves intersection sight distance
Disadvantages	Disadvantages	Disadvantages	Disadvantages	Disadvantages
<ul style="list-style-type: none"> • Changes driver expectation • Removes median access for some businesses 	<ul style="list-style-type: none"> • Additional travel time for industry employees • Additional travel time for emergency vehicles if a removable barricade is not used 	<ul style="list-style-type: none"> • Expensive right-of-way costs 	<ul style="list-style-type: none"> • Adverse travel to some businesses. 	<ul style="list-style-type: none"> • Maintenance of traffic • Cost

10.0 ADDITIONAL MEETINGS/PUBLIC INVOLVEMENT

Meetings were held to present proposed alternatives and options to the Project Team, Local Officials, and the general public. Those meetings are summarized as follows:

10.1 Project Team Meeting No. 2

The second Project Team meeting was held to review survey results and comments received at the first local officials and public meetings. A broad range of alternatives options were presented. These were narrowed (see Section 9.1) to a short-list (see Section 9.2) to be carried forward to the public and resource agencies.

10.2 Resource Agency Coordination

Resource Agency coordination was initiated following Project Team Meeting No. 2. This coordination was conducted by email and included an electronic survey. Those agencies wishing to receive paper copies were also afforded that option; and were directed to the on-line survey. The Kentucky Department of Fish and Wildlife Resources provided a list of endangered species, and the U.S. Department of Agriculture-Natural Resources Conservation Service included a map of four areas within project study area that may still be considered farmland. Several local officials expressed concern regarding the closing of Plum Springs Loop underpass as an option, citing the redundancy of emergency response access and adverse travel for employees and business patrons. A summary of this coordination is located in **Appendix M** along with each agency's comments and results of the electronic survey.

10.3 Project Team Meeting No. 3

The purpose of Project Team Meeting No. 3 was to review resource agency comments, short list of options and alternatives, travel time summaries, and traffic simulations in preparation for the second public meeting.

At this meeting KYTC provided an update for KYTC Project Item No. 03-2081.00 (**Figure 3, p. 4; KY 446 Pavement Rehabilitation Project**), which would have notable changes to the alternatives studied in this planning process. Following are the key issues:

- The concrete pavement on KY 446 is approximately 50 years old and needs to be replaced.
- The cost for rehabilitating concrete pavement on the KY 446 westbound to US 31W southbound flyover ramp is significant, and is more than the cost to remove the US 31W/KY 446 interchange and construct an at-grade intersection (**similar to Alternative 3, Figure 25, p. 53**).
- This major pavement rehabilitation project is funded.

- Removing the US 31W/KY 446 interchange and replacing it with an at-grade intersection would save money, reconstruct two high-crash locations, but would increase delay.
- If funds are used to replace the concrete on the ramp, in the future if any of the interchange Build Alternatives are carried forward, the rehabilitation improvements would be removed and the benefit of those expended funds not fully realized.
- Likewise, if pavement rehabilitation funds are used to replace the ramp with an at-grade intersection and in the future a roundabout, “continuous green T,” or other interchange alternative is advanced, then the improvements could be removed and the benefit of those funds would not be fully realized.

As a result of these complexities, KYTC decided at Project Team Meeting No. 3 to incorporate elements of Alternative 3 (**Figure 29, p. 62**), into the design of the rehabilitation project. This decision would leave Alternatives 2, 4, and 4a and all options as viable long-term alternatives, and realize the benefits of some, if not most, of the pavement rehabilitation project.

Due to the influence of the pavement rehabilitation project, Alternative 1 (Reconstruct Existing Interchange) and the low-cost improvements to the interchange were eliminated from further consideration since the current interchange would be removed.

In summary, the decision was to implement Alternative 3 as a “quick win.” This decision would be conveyed to local officials and the public at meetings held September 29, 2015. Their comment regarding the implementation of Alternative 3 and input/preference for the remaining future alternatives and options would also be gathered. Additional information can be found in **Appendix K**.

10.4 Public Meeting No. 2/Local Officials Meeting No. 2

The second local officials meeting and public meeting were held on September 29, 2015. The goals were to present as a “quick win,” the decision to construct the 4-way intersection as part of a larger pavement rehabilitation project along with advantages and disadvantages. Also, attendee preferences were sought among the remaining future Alternatives (No-Build beyond Alternative 3, Build Alternatives 2, 4, and 4a) and Options (A, B, C, and D).

Two officials attended the local officials meeting, and 56 people attended the public meeting. Each attendee was provided a survey and colored dots. A pink dot signified not preferred, orange somewhat preferred and green preferred (**Table 14**). Each person received two sets of dots; one set for alternatives, one set for options. Two thirds of the survey respondents had no concerns about the “quick win” conversion of the existing interchange to a 4-way intersection (Alternative 3). One comment stated it will improve access to businesses along US 31W north of the intersection because people will be moving slower and will feel safer. In addition, it will provide better access to Kight Home Center (formerly Carter Lumber).

Table 14: Alternatives/Improvement Options Public Input Summary

	PREFERRED	SOMEWHAT PREFERRED	NOT PREFERRED
ALTERNATIVES			
2—Continuous Green “T” Intersection	4	6	12
4—Roundabout	0	18	4
4a—Roundabout with Porter Pike Extension	29	2	0
IMPROVEMENT OPTIONS			
A—Access Management from Old Porter Pike to Porter Pike	25	3	2
B—Close Plum Springs Loop Underpass*	0	3	30*
C—Parker Avenue Realignment	4	24	0
D—Reconfiguration of Corvette Drive/Duntov Way	8	4	8
No-Build	5	0	4

NOTE: Bold numbers represent the most popular alternatives/improvement options preferences.

* The component of Option B to realign KY 957 was not a public concern—only closing the underpass met with opposition.

Following the public meeting, three letters were received:

1. National Corvette Museum—Concern with the “quick win” creating a significant backlog at times that will extend past both traffic lights the new FOTL signal and the KY 446/Corvette Drive signal adding even more delays. Factoring in Beech Bend Park traffic, the queues could extend farther. KYTC’s response was they will monitor the situation to minimize backups in traffic.
2. Wendy’s—Strongly opposed Option D to reconfigure Corvette Drive. They felt it would adversely affect their business by not allowing their customers direct access to the restaurant.
3. Citizen—Suggests using the existing southbound ramp from KY 446 to southbound US 31W and existing right-of-way to connect Dahlia Way with the entrance to Kight Home Center (formerly Carter Lumber). It was felt this would eliminate excess traffic coming onto Plum Springs Loop.

The presentation, survey summary, and other pertinent information from this meeting are found in **Appendix K**.

10.5 Project Team Meeting No. 4

The fourth Project Team Meeting was held to present preliminary recommendations for the KYTC Project Team to discuss and consider. The minutes for the meeting and preliminary

recommendations are located in **Appendix L**. After open discussion by the Project Team, it was agreed to make the following changes:

- Due to public opposition of Option B Close Plum Springs Loop Underpass, rename Option B to "Realign KY 957 with Intersection of US 31W," and remove "Close Plum Springs Loop Underpass." The cost estimate would remain the same since most of the investment is with the realignment of KY 957.

It was noted an alternative to closing the Plum Springs Loop Underpass is to lengthen the CSX bridge; however, this was not preferred by the Project Team due to the high cost (\$2.5 million) and low foreseen benefit. It is not a safety problem today and could see less usage in the future with the option to realign the KY 957 intersection. KYTC also noted that, with the pavement rehabilitation project, in the future Dahlia Way is proposed to be connected to US 31W, which could change the traffic volume at the underpass.

- Eliminate Option D—"Reconfigure Corvette Drive/Duntov Way" due to the noted opposition from stakeholders in the area, and the lack of notable support from the public.
- Alternative 4a Roundabout with Porter Pike Extension was selected as the preferred Long-Term Priority. Although delay and LOS are similar, survey respondents favored Alternative 4a over Alternative 4. Alternative 4a could be constructed in phases (roundabout using the footprint of the new intersection, then the extension to Porter Pike). Alternative 4a is also expected to provide an improved LOS at the KY 446/Corvette Drive intersection during the AM peak period. This alternative could also eliminate the need for the Unscheduled Needs List project **Unscheduled Needs List Project (03 114 D1402 1.00)** in **Figure 3, p. 4** that will address improvements of KY 1402 (Porter Pike) from US 31W to Grimes Road including the realignment of Parker Avenue to provide more queuing length at Porter Pike.
- The Project Team recommended the Planning Study include a statement regarding the use of an Adaptive Signal Control System, for the "Quick Win" implementation of the pavement rehabilitation project. This would be the responsibility of KYTC's Division of Traffic who would make the traffic signal-related decision based on current policies.

11.0 PRIORITIZATION AND RECOMMENDATIONS

The following recommendations and priorities resulted from the fourth and final Project Team Meetings:

11.1 Immediate Priority—"Quick Win"

Construct a 4-way intersection (**Figure 29**) in the immediate future, conceptually similar to Alternative 3. The concrete pavement on KY 446 is approximately 50 years old and needs to be replaced, which has resulted in a major pavement rehabilitation project programmed for funding by KYTC. This project is identified as KYTC Project Item No. 03-2081.00.

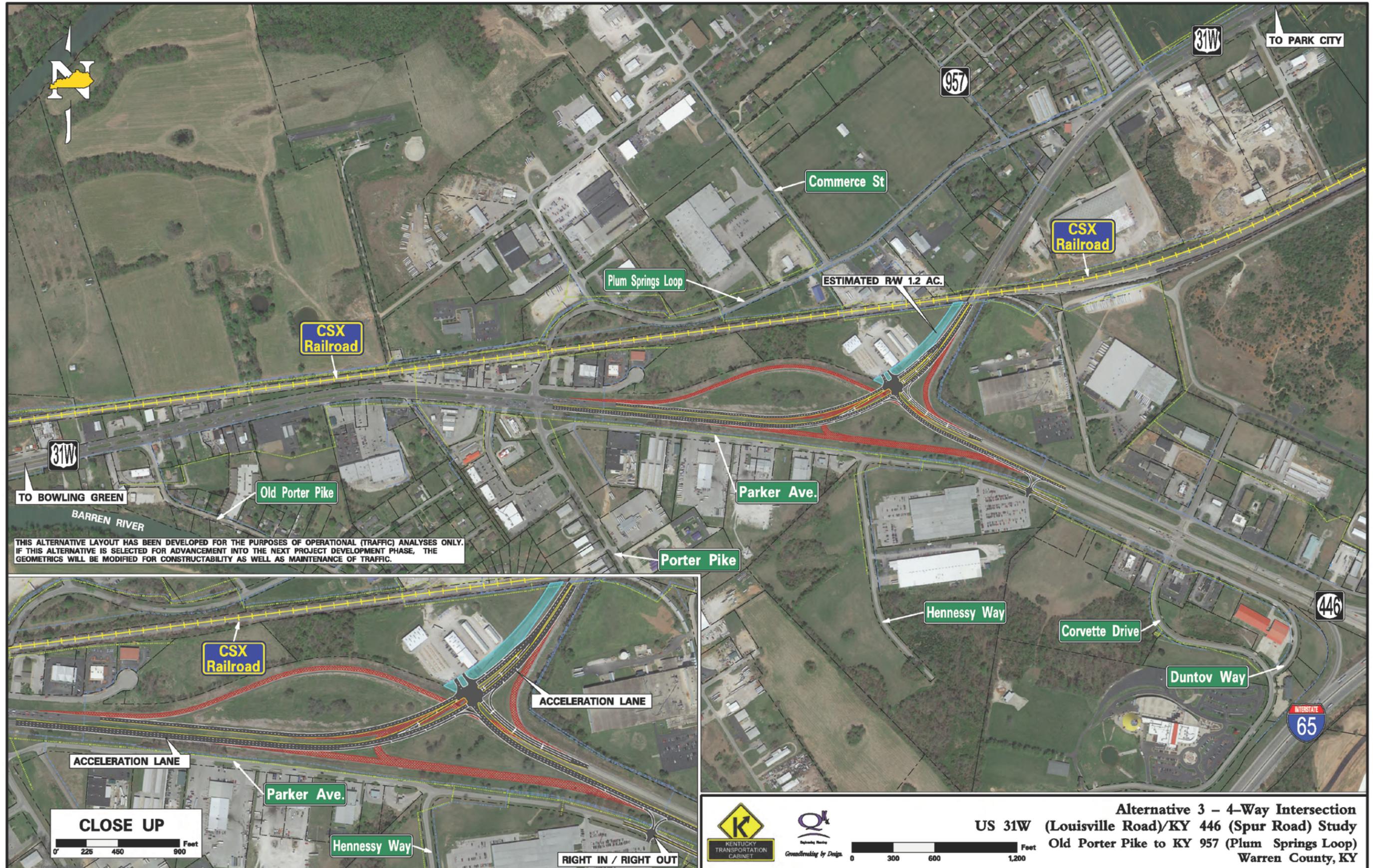


Figure 29: Immediate Priority "Quick Win"

However, as a result of state spending exceeding revenues since FY 2014, KYTC has introduced the “Pause-50 Plan⁷,” which is designed to slow or delay the start of new projects in order to pay current expenditures, recuperate lost revenue and rebuild the funding base. KYTC Project Item No. 03-2081.00 is currently funded with state funds and may be delayed as a result of “Pause-50.”

If this option is implemented, maintenance of traffic during construction will be a major concern. Driver expectations will change during construction, perhaps multiple times. KYTC District 3 should initiate a major public involvement campaign prior to the beginning of construction. Additional public involvement should take place when the US 31W KY 446 interchange is removed.

11.2 Short-Term Priorities

Short-term projects were identified as those that could be implemented in 1–6 years. The recommended short-term projects are listed in priority order.

Install and Calibrate Sub-Area Signal System: \$0.30 Million

Due to the Quick Win implementation, to optimize the efficiency along the entire corridor an interconnected traffic signal system should be designed and installed. This signal system should include, if possible, the following individual traffic signals:

- KY 446/Corvette Drive
- KY 446/ FOTL entrance
- US 31W/KY 446
- US 31W/KY 957
- US 31W/Porter Pike
- US 31W/Northgate Shopping Center

The optimum signal timing parameters would be based on the opening date of the 4-way intersection, and updated traffic counts and projections. This project would optimize travel time and minimum delay for all movements in the study area. Care should be taken to continuously monitor the functionality of this signal system. However, certain benchmark events that may call for a reevaluation. These include:

- 30 days after the US 31W/KY 446 intersection has opened to traffic;
- After the implementation of any of the improvement options; and
- When the I-65/US 31W Interchange and connector road (KYTC Project Item No. 03-16.00) has opened to traffic (assuming that event occurs later than the opening of the 4-way intersection “Quick Win”).

The following short-term priorities are shown on **Figure 30 (p. 65)**.

⁷ <http://transportation.ky.gov/Pages/PressReleasePage.aspx?&FilterField1=ID&FilterValue1=187>

Option B—Realign KY 957 With Intersection Of US 31W: \$2.28 Million

This option drew interest with those attending the second public meeting. A feature of Option B included closing the underpass. However, due to public opposition to closing the underpass, that part was dropped from further consideration and renamed by the Project Team at Project Team Meeting No. 4.

Option C—Parker Avenue Realignment At Porter Pike: \$2.56 Million

This option was popular among survey respondents at the second public meeting and among Resource Agency representatives that responded to the coordination mailing, although not as much as the access management strategy (Option A). This option is less expensive than implementing access management and less controversial than closing the Plum Springs Loop underpass. This action will address some congestion issues at the US 31W/Porter Pike intersection, which has a spillback effect on the US 31W/KY 446 interchange. Also, there may be an opportunity for a right-of-way trade at this location. This project would be a local project.

Option A—Access Management Strategy On US 31W: \$7.23 Million

As noted, this option was popular among survey respondents at the second public meeting and among Resource Agencies that responded to the agency coordination mailings. However, this option is relatively costly. Estimates vary, but there is potential to reduce 30 crashes annually in the 0.5-mile stretch of US 31W between Porter Pike and old Porter Pike. Additional access management opportunities may exist beyond closing the median openings in this stretch of US 31W, and should be examined during the next project development phase.

Low-Cost Improvement—Raise Grade Of US 31W Near Old Porter Pike: \$0.15 Million

This option (not illustrated) would ensure adequate sight distance is met at the US 31W/Old Porter Pike intersection for southbound trucks making a left turn into Old Porter Pike and could be included with the implementation of Option A.

This option was preferred by respondents at the second public meeting and second public officials meeting as part of Option A.

Low-Cost Improvement—Construct a Sidewalk Along Parker Avenue: \$0.15 Million

Construct a sidewalk along Parker Avenue between Porter Pike and the Greyhound Bus Station.

11.3 Medium-Term Priority—Reevaluate the US 31W/KY 446 Intersection

The construction for the 4-way intersection (“Quick Win”) as part of the pavement rehabilitation project is a practical, but perhaps interim, solution. Analysis of the alternative has indicated potential delays may occur at that location. Development of a sub-area signal system is recommended as a short-term priority to improve the overall operations. As long as the proposed US 31W/KY 446 intersection operates in an acceptable manner, no further action is recommended. If, however, congestion and delay exceed signal system limitations, other actions may be necessary.

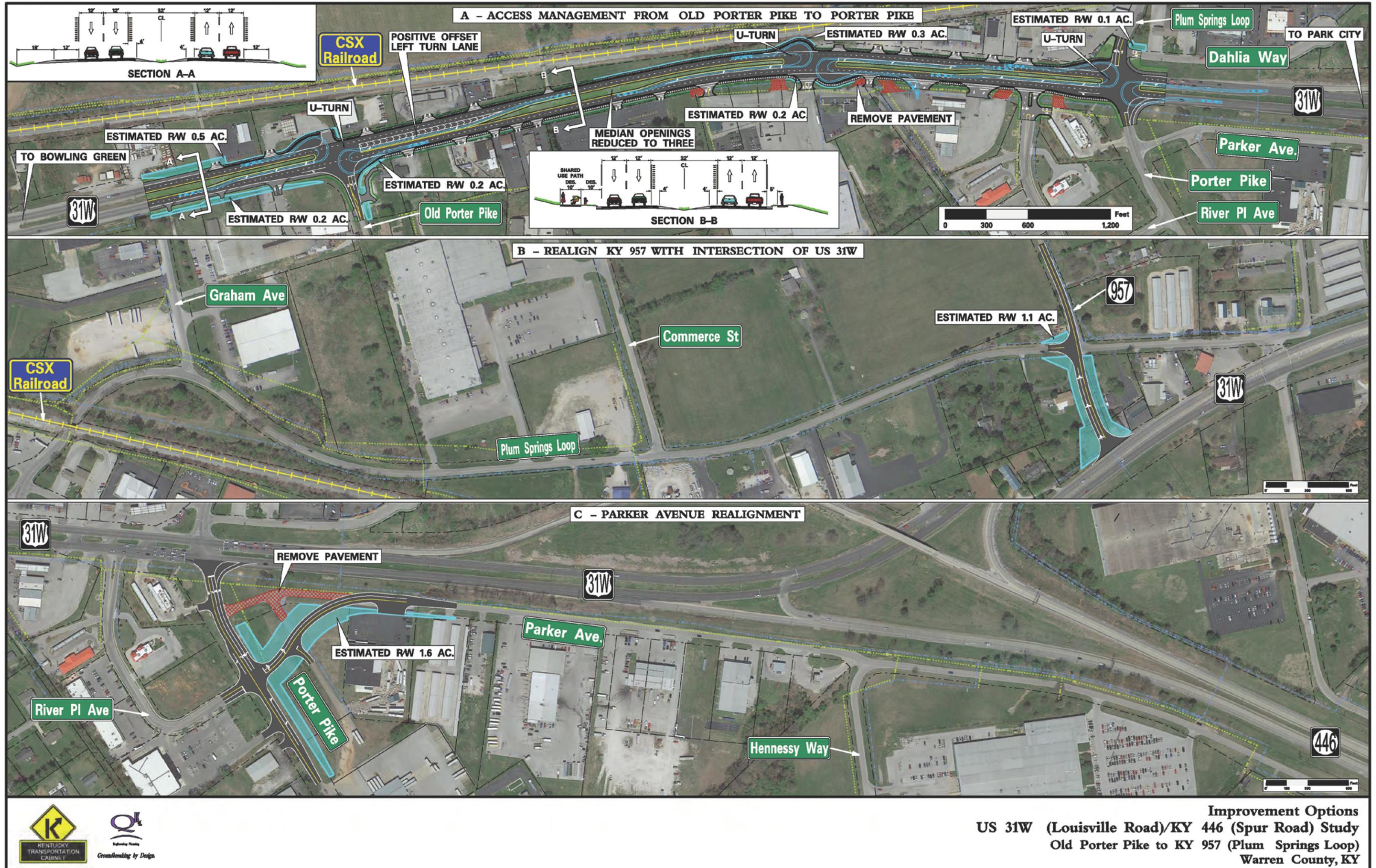


Figure 30: Recommended Improvement Options

11.4 Long-Term Priority

Based on the current study, the long-term priority was chosen as Alternative 4a (Roundabout with Porter Pike Extension). Alternate 4a (**Figure 31**) is projected to provide improved LOS at the US 31W/KY 446 junction when compared to the 4-way intersection (**Table 15**).

The National Cooperative Highway Research Program (NCHRP) Report 672 2nd Edition, provides comparisons on the safety effects of roundabout conversions in the United States. Before-and-after conversion data was collected at 55 locations with variations in previous intersection treatment, environment, and number of circulating lanes. Overall, there is an observed reduction of 35% and 76% in total and injury crashes, respectively, following conversion of intersections to a roundabout. For urban intersections signalized intersection converted to a roundabout the injury plus fatal crashes recognized a 60.1% reduction in crashes (standard error 11.6).⁸

The most current Highway Safety Manual has a similar crash reduction for injury crashes for converting a signalized intersection into a modern roundabout in an urban area.⁹

Table 15: Comparative Metrics between Alternatives 3 and 4a

Metrics	Alternative 3 “Quick Win”	Alternative 4a Long-Term Priority
	4-Way Intersection	Roundabout with Porter Pike Extension
Cost (millions)	\$6.01	\$21.24
Total Delay (minutes)	11,275	5,316
Total Travel Time (minutes)	17,119	10,391
Ranking (1=Best)		
Based on Total Delay	6	2
Based on Total Travel Time	6	2
High Crash Spots Eliminated (2 possible)	2	2
Conflict Points (at US 31W/KY 446)	41	26
US 31W/KY 446 Intersection LOS		
2040 LOS AM		
EB	D	C
WB	F	A
NB	F	A
SB	F	A
2040 LOS PM		
EB	F	C
WB	D	A
NB	F	C
SB	F	A

⁸ http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_672.pdf

⁹ Highway Safety Manual 1st Edition 2010

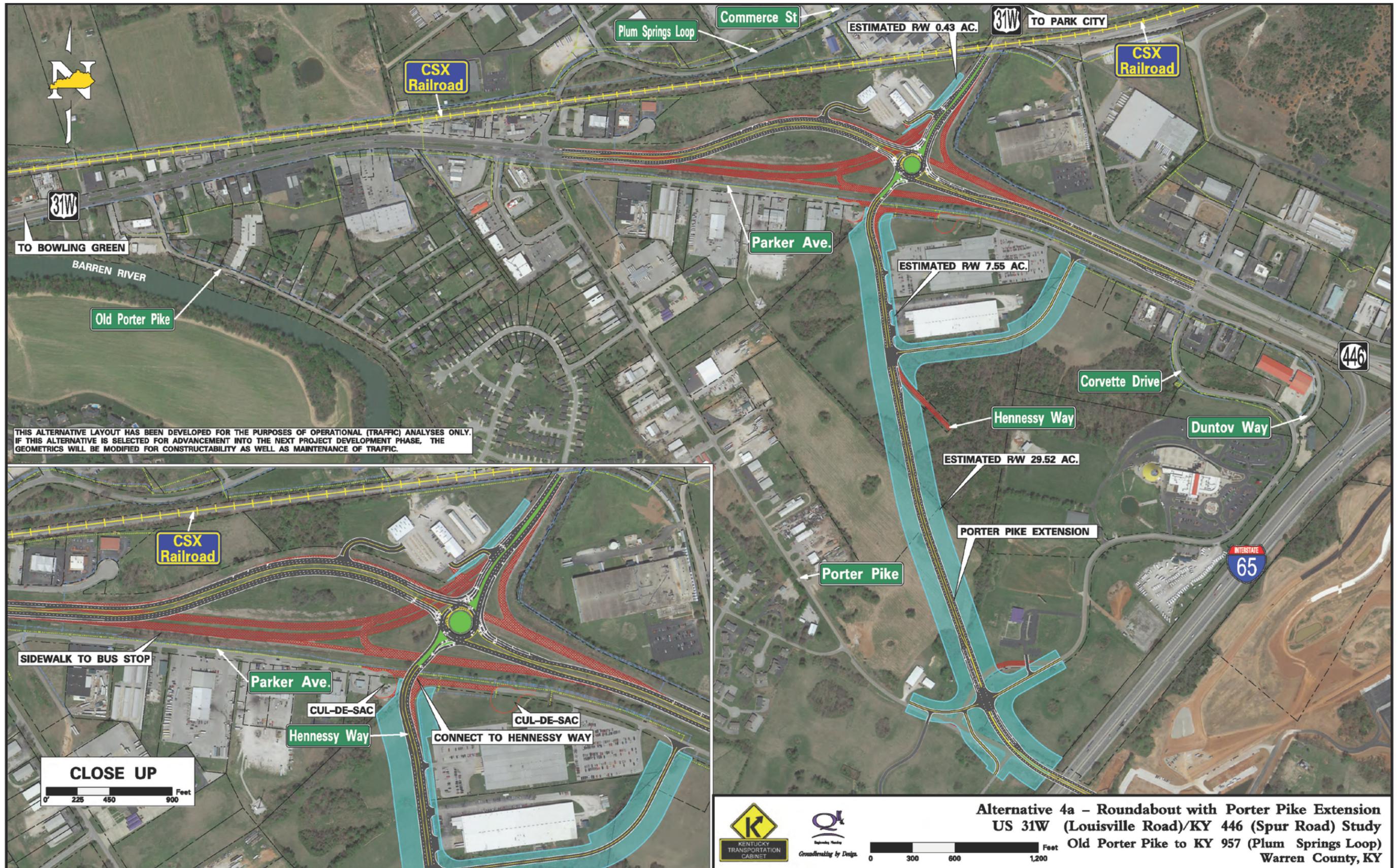


Figure 31: Recommended Future Alternative 4a

A PIF should be generated that includes the roundabout and accommodates a future Porter Pike Extension. The Porter Pike Extension will remain a future project, but as a separate PIF. The Porter Pike Extension should not be advanced without the roundabout. Both PIFs should refer to one another.

Overall travel delay and travel time within the corridor should be revisited once the I-65/US 31W interchange (KYTC Project Item No. 03-16.00) and the “Quick Win” are constructed and opened to traffic to determine if and how traffic patterns have substantially changed and if traffic flow has improved. If any projects resulting from this planning study are constructed with federal funds, they should be included in the Bowling Green MPO TIP and undergo associated air quality conformity analysis.

In addition, the US 31W/Old Porter Pike intersection should be monitored regularly due to the expected increase in delay as a result of future traffic growth.

11.5 Cost Estimates by Phase

For programming purposes, Table 16 illustrates the 2015 phase cost estimates for the recommended alternatives and improvement options.

Table 16: Phase Costs of Future Alternatives and Improvement Options

	Alternatives		Improvement Options				Low-Cost Improvements	
	3	4a	Signal System	B	C	A	Raise Grade of US 31W	Construct a Sidewalk Along Parker Avenue
Priority	“Quick Win”	Long-Term	Short-Term 1	Short-Term 2	Short-Term 3	Short-Term 4	Short-Term 5	Short-Term 6
Responsible	KYTC	KYTC	KYTC	KYTC	Local	KYTC	KYTC	Local
Short Description	4-way Intersection	Roundabout with Porter Pike Extension	Signal System	Realign KY 957 with Intersection of US 31W	Parker Avenue Realignment	Access Management from Old Porter Pike to Porter Pike	Raise Grade of US 31W Near Old Porter Pike	From Porter Pike to the Greyhound Bus Station
Design	\$420,000	\$2,100,000	\$300,000	\$100,000	\$100,000	\$320,000	\$100,000	\$0
Right-of-Way*	\$825,000	\$3,600,000	\$0	\$375,000	\$1,175,000	\$1,475,000	\$0	\$0
Utilities*	\$565,000	\$1,835,000	\$0	\$1,180,000	\$550,000	\$2,240,000	\$0	\$0
Construction	\$4,200,000	\$13,700,000	\$0	\$630,000	\$730,000	\$3,200,000	\$910,000	\$0
Total	\$6,010,000	\$21,235,000	\$300,000	\$2,285,000	\$2,555,000	\$7,235,000	\$1,010,000	\$150,000

* Right-of-Way and Utility estimates were provided by KYTC for alternatives and improvement options only.

12.0 CONTACTS/ADDITIONAL INFORMATION

Written requests for additional information regarding this study should be sent to:

John Moore, PE
Director
KYTC Division of Planning
200 Mero Street
Frankfort, Kentucky 40622

Additional information regarding the US 31W/KY 446 Study can also be obtained from the KYTC District 3 Project Manager, at 900 Morgantown Road, Bowling Green, Kentucky 42101, (270) 746-7898 or via email at deneatra.henderson@ky.gov.