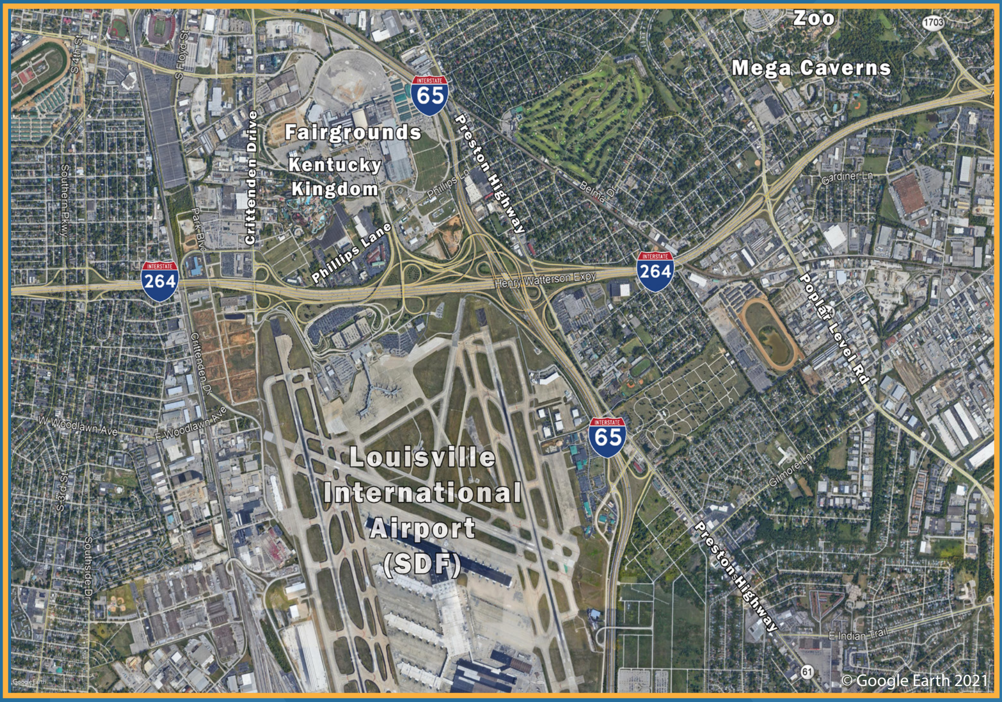
Kentucky Transportation Cabinet

I-65/I-264 Interchange Planning Study

Final Report

PROJECT NO.: 05-559

May 2021



Prepared for:

KENTUCKY TRANSPORTATION CABINET

In partnership with:

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EXECUTIVE SUMMARY

The Kentucky Transportation Cabinet (KYTC) initiated a planning study to identify potential concepts to improve safety and reduce congestion through the I-65/I-264 Interchange in Louisville, Kentucky. The study area encompasses I-65 from Mile Point (MP) 129.3 to MP 131.6 and I-264 from MP 10.6 to MP 13.4. The study includes both short-term and long-term improvement strategies that KYTC and other local agencies may use for further project development and implementation. The study area is shown in **Figure ES-1.**

The goals of this study are to improve safety for all users, manage and reduce roadway congestion where appropriate, ensure timely and efficient movement of freight entering, departing, and through the region, and reduce and/or mitigate negative environmental impacts, including climate change. Based on existing conditions data that was collected, objectives were developed as summarized below:

- Examine existing traffic, roadway, environmental, and safety conditions along the existing routes.
- Identify roadway problems and/or deficiencies.
- Define the study's purpose, goals, and objectives.
- Develop a list of improvement strategies (projects).
- Evaluate the list of improvement strategies, considering transportation, community, environmental, geotechnical, and economic benefits and impacts, as well as local official/stakeholder (LO/S) and public input.
- Provide recommendations based on the Study's identified purpose, goals, and objectives.
- Develop a draft Purpose and Need statement for any feasible project(s) chosen for further development following KYTC and FHWA guidance. The Purpose and Need statement will clearly identify project issues, goals, and needs within the study area.
- Prioritize projects to allow for a phased implementation approach, if applicable.

While KYTC has the ultimate responsibility for constructing and maintaining safe and efficient highways, KYTC desires to incorporate LO/S and public input into the evaluation and decision-making process. Therefore, all eight study objectives were completed in coordination with input from the LO/S and the public.

Figure ES-1: Major Destinations near Study Area

The consultant team conducted a detailed inventory that examined existing roadway characteristics, interchange signing, lighting, guardrail, right of way, existing and future traffic volumes, level of service (LOS), capacity, and crash data. The project team identified areas of concern with regards to roadway features and traffic operations and performed a safety analysis to identify significant contributors to crashes in the study area. Additionally, a robust public involvement process ensured local elected officials, stakeholders, and the public were able to provide input by helping identify issues in the study area and provide feedback on potential improvement strategies.

Seven low cost improvement strategies were developed to address the safety concerns and infrastructure deficiencies identified in the safety analysis and during the public involvement process. These are described in detail below.

GUIDE SIGNAGE

Install new guide signage to help drivers identify their destination by incorporating improved messaging, high-visibility retroreflective sheeting, symbols for popular destinations, consistent designations for exit-only lanes, and overhead arrow-per-lane signage. The improved signage will help drivers identify proper lane position to navigate the study area and reduce unnecessary/last minute lane changes.

HIGH FRICTION SURFACE TREATMENT

Install skid-resistant pavement treatment and diagonal pavement markings along the shoulders of the curves of the ramps from northbound I-65 to westbound I-264 and from westbound I-264 to southbound I-65. The High Friction Surface Treatment prevents roadway departures and the diagonal pavement markings give drivers visual cues to slow down in the curve. **Figure ES-2** identifies locations where the High Friction Surface Treatment is recommended.

Figure ES-2: Segments benefitting from High Friction Surface Treatments

ELONGATED PAVEMENT MARKINGS (PAVEMENT TATTOOS)

Install shield markings directly on the roadway to identify destinations without drivers needing to look away from the roadway. To improve visibility of the markings consider using a black background and avoid installation on downward slopes. This improvement strategy should be used in conjunction with guide signing to help drivers identify proper lane position to navigate the interchange and reduce unnecessary/last minute lane changes.

ENHANCED STRIPING

Update roadway markings to improve delineation in places where drivers make decisions including merges, diverges, and places where lanes are added or dropped. The new striping should include dotted lane line extensions and chevron markings in the gore areas. The recommended striping will improve delineation and reduce crashes at decision points throughout the interchange.

BLACK CONTRAST STRIPING

Install black contrast striping over the current roadway markings to improve visibility of lane markings in areas where pavement is lightly colored and subject to glare from the sun. Black contrast striping helps drivers see lane markings.

GUARDRAIL

Replace all existing guardrail and end treatments throughout the study area. New guardrail should adhere to the current KYTC standards. The upgraded guardrail will improve roadside safety and reduce crash severity in the event of a roadway departure.

LIGHTING

Install new LED lighting along ramps that are not included in the statewide lighting contract to improve interstate lighting. This includes the ramps from northbound I-65 to westbound I-264, southbound I-65 to eastbound I-264, and westbound I-264 to southbound I-65. The new system will include new standard cobra arm mounted LED fixtures, new LED wall pack lighting under bridges, new conduit, wiring, and light pole bases, and additional items to address the possibility of encountering rock. Increased lighting levels improve visibility for drivers at night and upgraded uniformity will reduce the occurrence of blind spots that result from sudden changes in lighting levels.

Table ES-1 highlights the public feedback received for each short-term potential improvement strategy cost, and either the number of crashes that must be reduced to have a positive return on investment or benefit/cost (B/C) ratio. Green denotes the highest ranking, orange denotes a middle ranking, and red denotes the lowest ranking performance in each category. The project team reviewed the rankings along with public feedback to determine the final priority ranking of each potential improvement solution.

Table ES-1: Short Term Potential Improvement Strategy Evaluation Matrix

Potential Improvement Strategy	Public Feedback	Cost	# of Crashes for Positive ROI	B/C
Improve Guide Signs	High	$2,100,000	31	--
High Friction Surface Treatment	Medium	$1,150,000	--	2.4
Pavement Tattoos	High	$750,000	13	--
Enhanced Striping	Medium	$1,370,000	22	--
Black Contrast Striping	Low	$575,000	15	--
Upgrade Guardrail	Medium	$2,300,000	2*	--
LED Lighting Upgrade	High	$280,000	4	--

** Denotes the the number of crashes that must be reduced in severity (from fatal or severe injury to property damage only) to realize a positive return on investment.*

Long-term potential improvement strategies were developed based on the detailed analyses of roadway conditions and deficiencies, the traffic operations and safety analysis, comments received from the public, and a project team brainstorming session. Three major improvement strategies were identified to address the deficiencies of the I-65/I-264 interchange. Each of the three potential strategies address different needs in the study area:

POTENTIAL IMPROVEMENT STRATEGY A

Potential Improvement Strategy A addresses issues along I-264 eastbound including movements onto the Collector-Distributor (CD) prior to I-65 and the merge onto I-264 eastbound from I-65 and the I-65 Northbound CD. Three variations of Potential Improvement Strategy A were modeled to evaluate the change in congestion on I-65 northbound by modifying the access to I-264 eastbound from Preston Highway.

- Potential Improvement Strategy A-1 (***Figures ES-2*** & ***ES-4***) closes the northbound I-65/eastbound I-264 ramp from Preston Highway. The ramp from I-65 northbound to I-264 eastbound is widened to two lanes and the I-65 southbound traffic merges directly onto I-264 eastbound, west of the current merge location.
- Potential Improvement Strategy A-2 (***Figures ES-2*** & ***ES-5***) moves the on-ramp from Preston Highway to I-264 eastbound to the north, making it part of a partial tight diamond interchange. The I-65 northbound exit ramp to I-264 eastbound is widened to two lanes in this scenario as well. Vehicles from I-65 northbound merge with the traffic from I-65 southbound as they currently do, without the merge from Preston Highway.
- Potential Improvement Strategy A-3 does not close the Preston Highway ramp access or widen the I-65 northbound ramp to I-264 eastbound to two lanes but moves the I-65 southbound ramp to merge with I-264 eastbound to the west of the current merge location. The I-65 northbound and Preston Highway ramp remains as a two-lane on-ramp to merge with I-264 eastbound.

POTENTIAL IMPROVEMENT STRATEGY B

Potential Improvement Strategy B (***Figure ES-6***) addresses an issue identified by both the collected data and public feedback: slow vehicle traffic occurs regularly on I-264 westbound due to the tight radius of the I-264 westbound ramp to I-65 southbound. This strategy improves the radius of the loop ramp from I-264 westbound to I-65 southbound and moves the traffic using this ramp from Exit 12, I-264 westbound to Preston Highway / I-65, to Exit 11, I-264 westbound to Crittenden Drive and Airport / Fair / Expo Center. The loop ramp would become an add lane of traffic to I-65 southbound just north of the bridge over I-264. By improving the radius of the loop ramp and separating this exit from the Preston Highway and I-65 northbound exit, sight distances would be improved and the weave between Poplar Level Road and I-65 would be improved, which would reduce driver confusion and result in better traffic flow. A positive with this improvement strategy is that the I-65 southbound to I-264 eastbound ramp can use the bridge from the I-264 westbound to I-65 southbound loop ramp to improve the radius and sight distance.

POTENTIAL IMPROVEMENT STRATEGY C

Potential Improvement Strategy C addresses I-65 southbound in the northern section of the study area. Data and public opinion suggest driver confusion is a serious issue on southbound I-65 approaching the exit ramps to I-264. This potential improvement strategy reconfigures the I-65 southbound exits to I-264 westbound and eastbound. The I-264 westbound exit is removed from Exit 131B and joins with the I-264 eastbound Exit 131A, just north of its existing location on southbound I-65. This results in two exits: Exit 131-B to the Fair/Expo Center and Exit 131A to I-264 westbound and I-264 eastbound. The improvement allows more time and distance for better driver decision making for the ramp movements.

The long-term potential improvement strategies were evaluated using criteria that includes traffic, safety, environmental, right of way, constructability, public feedback, cost estimates, and benefit-cost ratio (B/C). Traffic and safety analyses are the quantitative data used to calculate B/C. Environmental and right of way impacts, constructability, public feedback, and cost estimates are qualitative measures used in determining their feasibility. **Table ES-2** shows the matrix comparing the long-term potential improvement strategies with green ranking the highest, orange ranking in the middle, and red ranking the lowest performance in each category.

Table ES-2: Long Term Potential Improvement Strategy Evaluation Matrix

Potential Improvement Strategy	Environmental Impact	ROW Impact	Constructability	Public Feedback	Delay Savings	Safety Benefit	Cost	B/C
A-1	Low	Low	Good	High	$10,510,086	$181,590	$14,480,000	11.8
A-2	Low	Low	Medium	Medium	$7,603,269	$181,590	$14,075,000	8.8
A-3	Low	Low	Medium	Low	$2,604,245	$163,431	$13,635,000	3.2
B-1	Low	Low	Medium	High	$23,606,836	$0	$11,130,000	33.9
C-1	Low	Low	Poor	Low	$497,488	$0	$4,995,000	1.6

The project team used the results of the evaluation of potential improvement strategies to identify those to advance into the next phase of project development. All seven of the short-term safety improvement strategies yield positive ROI (Return on Investment) and are recommended to be carried forward. Long-term Improvement Strategy A-1 has that highest B/C of the "A" improvement strategies, and ranked highest in public feedback and constructability, and is recommended to be carried forward. Additionally, due to previous public feedback with regards to closing the Preston Highway Ramp, it is recommended that Potential Improvement Strategy A-2 be moved forward to Phase 1 Design for another round of public involvement. Potential Improvement Strategy A-3 is not recommended to move forward due to low scores from public feedback as well as a low benefit to cost ratio. Potential Improvement Strategy B-1 has the highest B/C of all the long-term potential improvement strategies due to the significant reduction in delay. It also received positive feedback from the public, thus it is recommended to move forward. Potential Improvement Strategy C-1 does have a positive B/C, however it was not highly favored by the public, and the benefit for the cost is low comparatively, therefore C-1 is not recommended to move forward. All long-term improvement strategies that are recommended as part of this study can be moved forward concurrently or independently. ***Figures ES-3***, ***ES-4***, ***ES-5***, and ***ES-6*** show the long-term strategies recommended to be moved forward to Phase 1 Design.

Figure ES-3: CD Modification for Potential Improvement Strategy A

Figure ES-4: Potential Improvement Strategy A-1

Figure ES-5: Potential Improvement Strategy A-2

Figure ES-6: Potential Improvement Strategy B

1 INTRODUCTION

The Kentucky Transportation Cabinet (KYTC) initiated a planning study to identify potential concepts to improve safety and reduce congestion through the I-65/I-264 Interchange in Louisville, Kentucky. The study area encompasses I-65 from Mile Point (MP) 129.3 to MP 131.6 and I-264 from MP 10.6 to MP 13.4. The study includes both short-term and long-term improvement strategies that KYTC and other local agencies may use for further project development and implementation.

Members of the project team included KYTC District 5, KYTC Central Office Divisions of Planning, Highway Design, and Environmental Analysis, the Kentuckiana Regional Planning Development Agency (KIPDA), the Federal Highway Administration (FHWA), and the WSP Consultant Team.

1.1 Project Location and Study Area

The study area is shown on ***Figure 1***. There are numerous major destinations within 1.5 miles of the interchange:

- Louisville Muhammad Ali International Airport (formerly known as Louisville International Airport)
- The Louisville Exposition Center and Fairgrounds
- Kentucky Kingdom & Hurricane Bay Theme Park
- Churchill Downs
- Residential and Commercial Zones
- Louisville Zoo
- University of Louisville
- Louisville Mega Cavern

Figure 1: Major Destinations near Study Area

1.2 Study Purpose

The purpose of the I-65/I-264 Interchange Planning Study is to identify short-term and long-term improvement strategies for the interchange system that could reduce congestion and improve safety. Peak hour traffic creates large queues that extend onto mainline I-65 and I-264 causing extreme speed differentials. The I-65/I-264 Interchange was ranked as the number one highest crash interchange in the KIPDA Metropolitan Planning Organization region. This planning study addresses the following issues:

- *Safety* – Increase safety for all users.
- *Roadway Deficiencies* – Eliminate and/or decrease geometric deficiencies within the study area.
- *Travel Time Reliability* – Ensure timely and efficient movement of freight through, departing, and entering the region.
- *Access/Connectivity* – Improve access to destinations within the interchange while reducing and/or mitigating negative environmental impacts, including climate change.
- *Mobility* – Provide for enhanced mobility in and around the interstate interchange.

1.3 Study Goals and Objectives

The goals of this study are to improve safety for all users, manage and reduce roadway congestion where appropriate, ensure timely and efficient movement of freight through, departing, and entering the region, and reduce and/or mitigate negative environmental impacts, including climate change.

Based on existing conditions data that was collected, objectives were developed as summarized below:

- Examine existing traffic, roadway, environmental, and safety conditions along the existing routes.
- Identify roadway problems and/or deficiencies.
- Define the study's purpose, goals and objectives.
- Develop a list of improvement strategies (projects).
- Evaluate the list of improvement strategies, considering transportation, community, environmental, geotechnical, and economic benefits and impacts, as well as local official/ stakeholder (LO/S) and public input.
- Provide recommendations based on the Study's identified purpose, goals and objectives.
- Develop a draft Purpose and Need statement for any feasible project(s) chosen for further development following KYTC and FHWA guidance. The Purpose and Need statement will clearly identify project issues, goals, and needs within the study area.
- Prioritize projects to allow for a phased implementation approach, if applicable.

While KYTC has the ultimate responsibility for constructing and maintaining safe and efficient highways, KYTC desires to incorporate LO/S and public input into the evaluation and decision-making process. Therefore, all eight study objectives were completed in coordination with input from the LO/S and the public.

1.4 Study Process

The study process used to evaluate potential improvement projects consists of six major elements:

- Define the goals and objectives of the study.
- Examine existing conditions and evaluate potential deficiencies
  - Develop potential improvement options.
  - Evaluate the improvement strategies based on the study goals and objectives
  - Provide a recommendation for improvements.
  - Develop individual project purpose and need for each improvement strategy.

The subsequent chapters of this report following this introductory section explain these steps, with additional detail provided in the appendices. The existing conditions documentation was used to confirm the purpose and need and provide a basis for the development of possible improvements.

In addition to the technical analysis, LO/S and public input were gathered as part of the study process.

1.5 Review of Ongoing and Identified Transportation Projects

Although there are no current ***Kentucky FY 2020 – FY 2026 Highway Plan*** projects occurring within the study area, there is a current statewide Maintenance/Traffic improvement project being implemented that will modify all existing roadway lighting. Lighting is being upgraded from existing high-pressure sodium (HPS) fixtures to LED and is expected to be complete by the end of 2021. Additionally, a study of I-65 is ongoing (KYTC Item No. 5-569) that will evaluate and make recommendations for improvement strategies beginning at the northern limits of this study and ending near E. Jefferson Street and is expected to be complete in Fall 2021.

2

EXISTING CONDITIONS

The Consultant Team conducted a detailed inventory that examined existing roadway characteristics, existing and future traffic volumes, level of service (LOS), capacity, and crash data. The following sections provide more detail about each of these topics.

2.1 Existing Roadway Characteristics

An inventory of roadway characteristics was completed to identify factors contributing to the safety and congestion issues along the I-65/I-264 Interchange. The entire study area is considered an urban interstate with the functional class of 1 (Interstate) throughout. The posted speed limit is 55 miles per hour (mph), with some of the ramps and collector-distributors (CD) having advisory speeds posted due to horizontal curves.

2.1.1 Highway Information System

The KYTC Highway Information System (HIS) maintains information on all aspects of roadway segments across the state where data is available. Seven main categories with several subcategories make up the HIS system including:

- Highway System
- Roadway Information
- Roadway Features
- Traffic Counts
- Route Log
- Non-highway Modes
- Boundaries

The urban interstate highway system shows the main routes for certain types of vehicles. For this study, the truck networks both at the national level and the state level were investigated. Only one route, I-65, is considered part of the Kentucky and National Freight Networks. I-65 is one of the main truck networks in the country, linking Indianapolis, Indiana, Louisville, Kentucky, and Nashville, Tennessee. Other key features extracted from the HIS data include surface type, median type, auxiliary lanes, horizontal and vertical curves, and shoulder widths. Details are included in the Roadway Characteristics **Appendix A**. The data extracted from the HIS system is intended to be evaluated further through the safety and infrastructure sections in this document.

2.1.2 Deficiencies

ROADWAY

To identify locations with potential safety issues, a roadway deficiency scoring guide was created based on the information obtained from HIS. The roadway deficiency scores were based on the following criteria: shoulder width less than six feet (both left side and right side), lane width less than 12 feet, segments with a lane drop occurring, and advisory speeds posted. Segments were given one point for each deficiency. These guidelines are based on the common geometric design guidance given in the American Association of State Highway and Transportation Officials (AASHTO) Geometric Design of Highways and Streets Chapter 3. ***Figure 2*** shows the overall deficiency rating by segment with green being the best segments with no deficiencies and dark red being the worst segments with three deficiencies.

HORIZONTAL ALIGNMENT

Horizontal alignment data was only available (in degrees) for the mainline segments. All mainline segments met AASHTO Geometric Design of Highways and Streets 2018 guidelines and were under 4.0 degrees in curvature for a 55 mph speed limit. The ramps have a speed limit of 55 miles per hour and data was collected through Google Earth for advisory speeds on ramps. Superelevation data was not available for ramps. Table 3-8 from the AASHTO Design Guide 2018 states that any ramp with superelevation of 4.0 percent, the highest superelevation permitted in urban areas, needs to have a radius of curvature of at least 1,190 feet. ***Figure 3*** shows ramps that do not meet the criteria for a 4.0 percent superelevation or lower at 55 miles per hour.

VERTICAL ALIGNMENT

Mainline segments all met the vertical curvature criteria for roadway design per the AASHTO Design Guide 2018. Each segment was less than a 4.0 percent grade. However, vertical curvature data was not readily available through HIS for ramp segments. The data was collected and evaluated through as-built plans. Most ramps passed the design criteria of vertical grade, but six ramps were deficient and will need to be reevaluated to pass current design guidelines. Per the AASHTO Design Guide 2018, crest vertical grades need a stopping sight distance of 495 feet at 55 miles per hour with a 114 foot rate of vertical curvature (Table 3-35) and sag vertical grades need a stopping sight distance of 495 feet at 55 miles per hour and a 115 foot rate of vertical curvature (Table 3-37). ***Figure 4*** shows locations with vertical curve deficiencies in the study area.

Figure 2: Roadway Deficiency Results

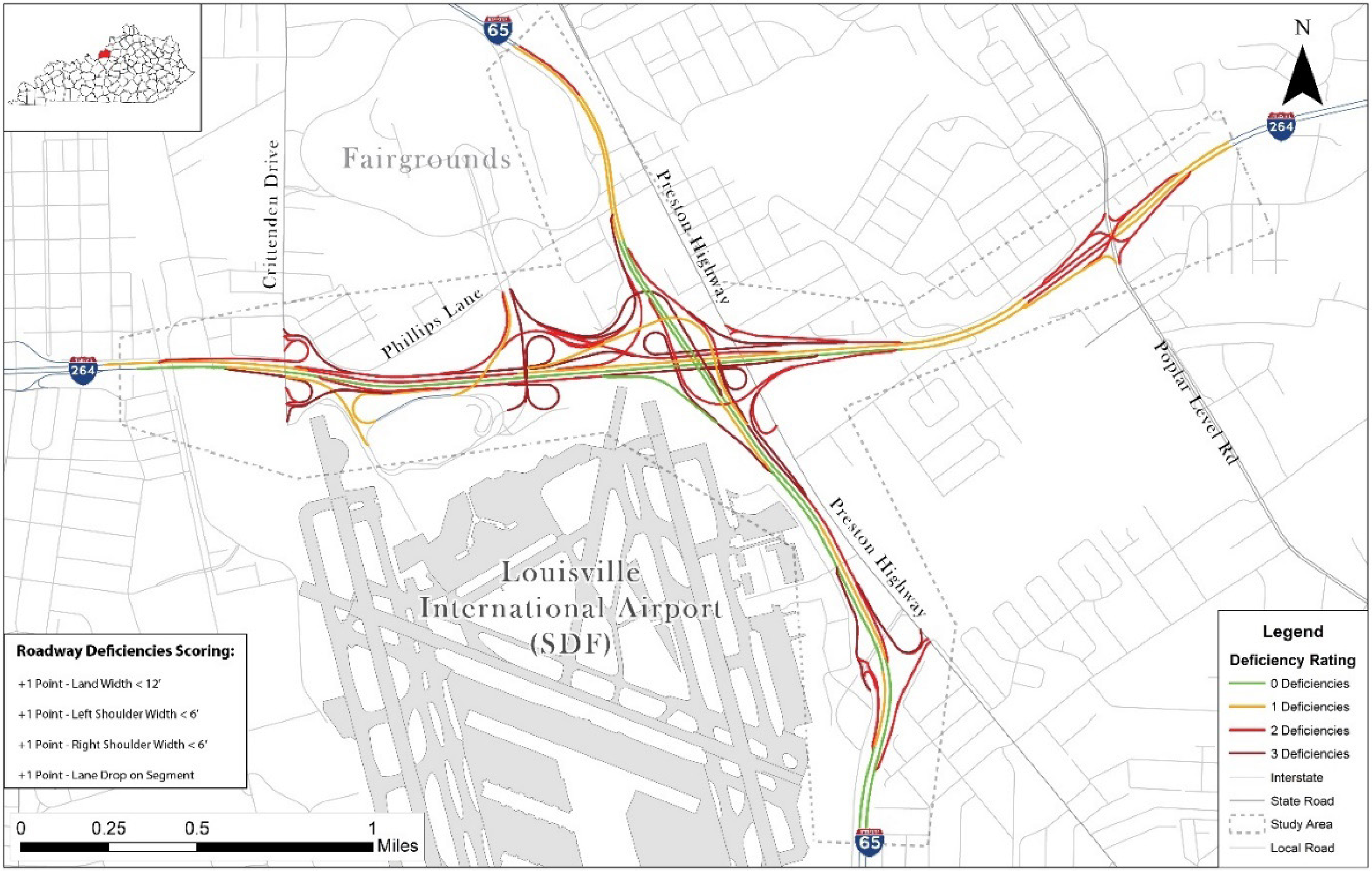


Figure 3: Horizontal Curve Deficiency Map

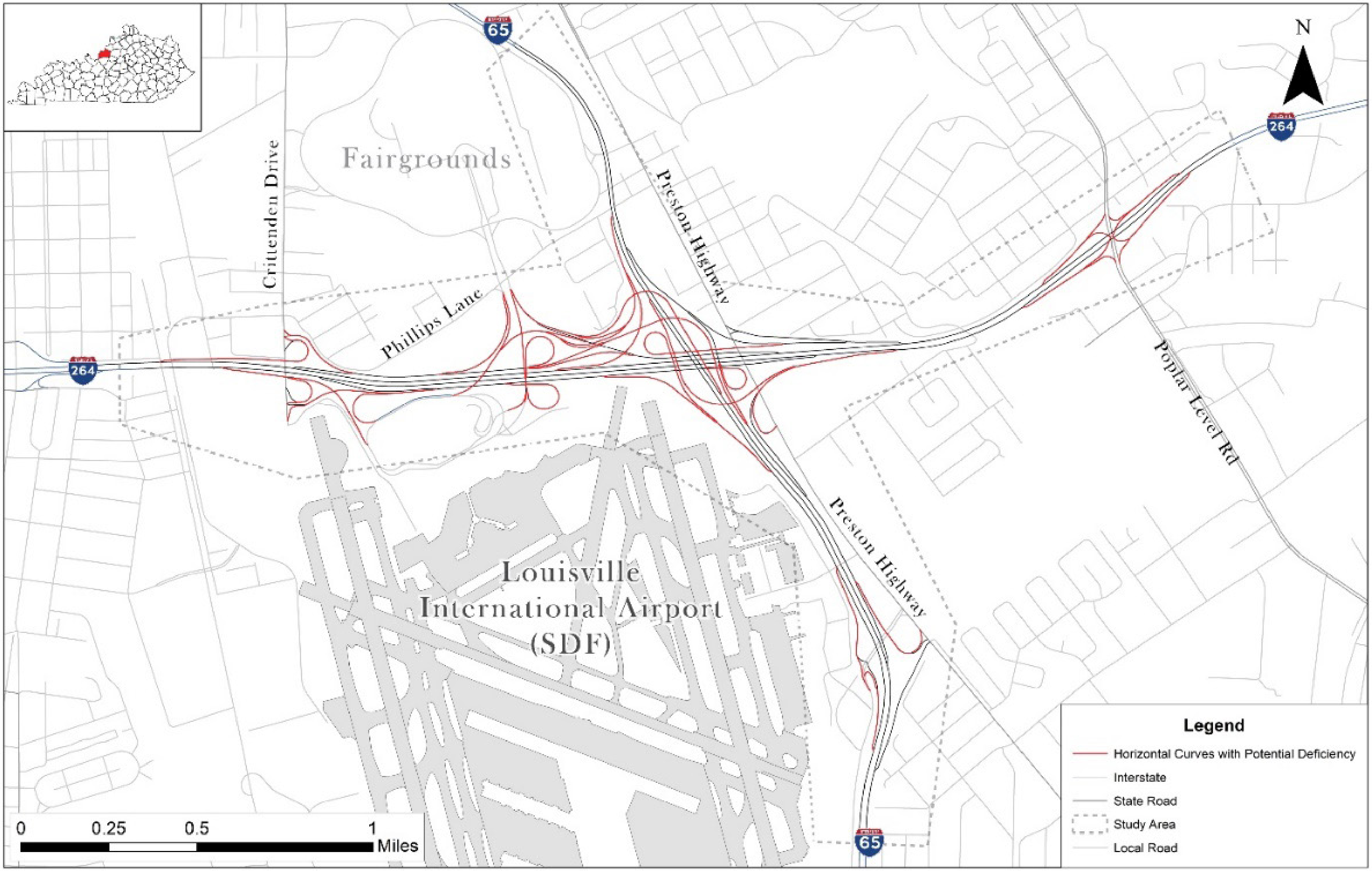
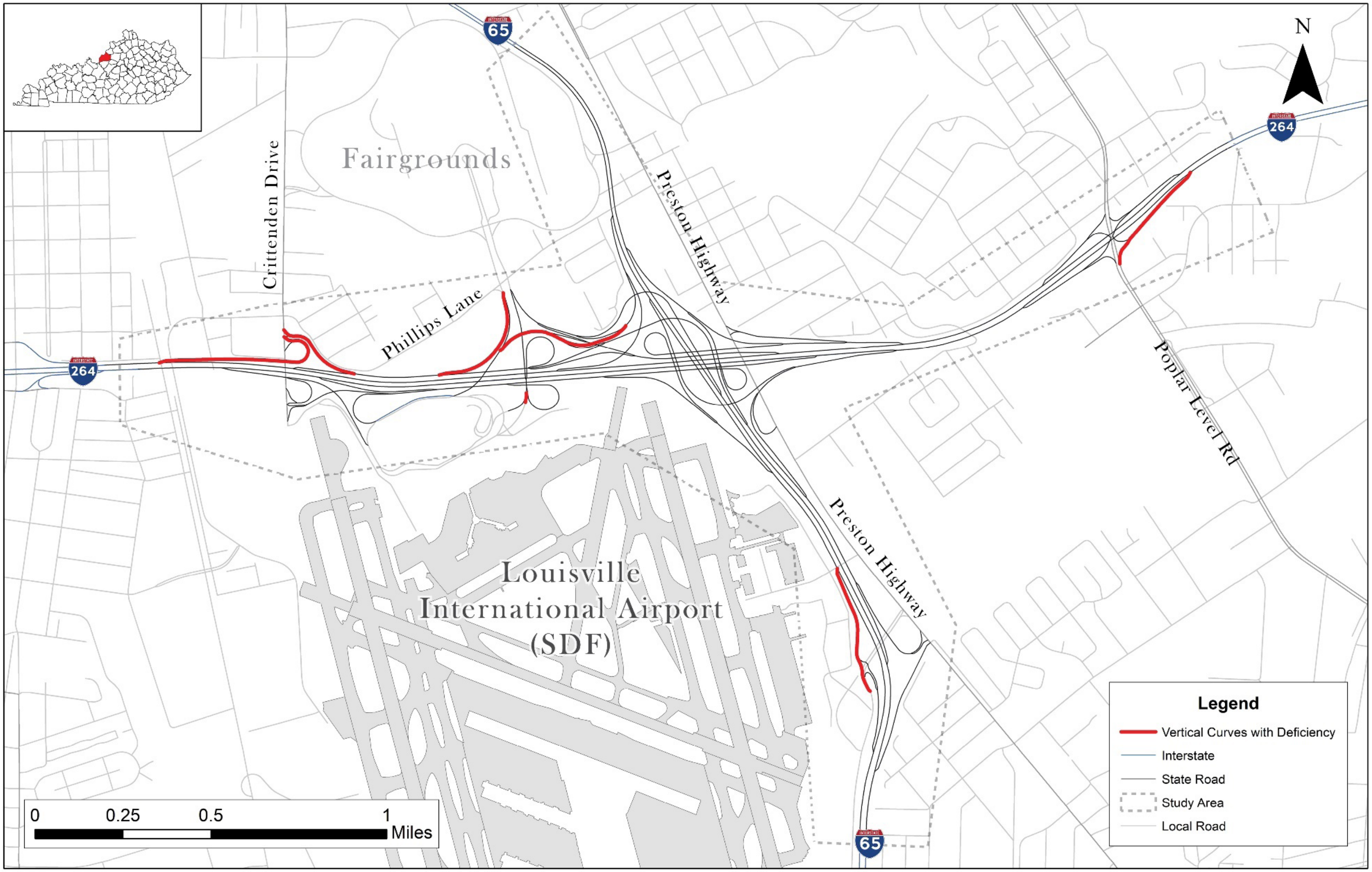


Figure 4: Vertical Curve Deficiency Map



2.1.3 Acceleration/Deceleration Lane Lengths

Acceleration and deceleration lanes require a certain length to allow vehicles to properly adjust speeds and merge or diverge from the freeway. The study area has 20 acceleration and deceleration lanes with varying lengths. Each lane was measured from the first curve in the ramp to where the lane terminates. **Table 1** shows the lengths of each ramp and whether the ramp passed the standard length for interstates with a posted speed limit of 55 mph per the AASHTO Design Guide 2018. Only one ramp, Crittenden Drive to I-264 westbound CD road, did not meet the standard length and will need to be evaluated further. All lane widths were 12 feet, qualifying each ramp as following standard lane width for interstates with a posted speed limit of 55 mph per the AASHTO Design Guide 2018.

Table 1: Acceleration/Deceleration Lanes

Segment	Acceleration/Deceleration Lane Lengths	Deficient
I-264 Eastbound Ramp to Crittenden	630	No
I-264 Eastbound to Phillips Lane	230	No
I-264 Westbound Exit to Poplar Level	310	No
I-264 Westbound Ramp to Phillips Lane	510	No
I-65 Northbound Exit to Grade Lane	310	No
I-65 Northbound to I-264 Eastbound	1,500	No
I-65 Northbound Exit to I-264 Westbound	220	No
Phillips Lane Exit from I-65 Southbound	220	No
I-65 Southbound to I-264	80	No
I-264 Eastbound CD Ramp to I-65 SB	340	No
I-65 Southbound CD Ramp to I-65 Northbound	310	No
I-65 Northbound b/w I-264 Eastbound and Westbound Ramps	500	No
I-264 Eastbound from Airport	300	No
Poplar Level Road On Ramp to I-264 Eastbound	440	No
I-65 Southbound Merge with I-264 Westbound	550	No
Phillips Lane On Ramp to I-264 Westbound	1,000	No
Crittenden Dr On Ramp to I-264 Westbound	500	No
I-264 to I-65 Northbound	1,260	No
Grade Lane merge to I-65 Southbound	Continuous Lane	No
Crittenden to I-264 Westbound CD	530	Yes

2.1.4 Bridges

Bridges and bridge maintenance are critical components of transportation infrastructure. KYTC is actively improving the safety and soundness of bridges across the Commonwealth with the Bridging Kentucky Program. The bridge data in this study includes KYTC updated sufficiency ratings. Bridges have a National Bridge Inspection (NBI) rating to determine whether a bridge is deficient or not. Of the 29 bridges in the study area and according to the NBI ratings, none of the bridges are deficient.

2.1.5 Lighting

Figure 5 shows existing lighting in the study area. Lighting exists throughout the study area, however at the time it was surveyed, there were numerous light poles missing or knocked over and laying on the side of the road. Areas with multiple light poles missing include the ramps from I-65 northbound to I-264 westbound, I-65 southbound to I-264 westbound, I-264 westbound to I-65 northbound, I-264 westbound to I-65 southbound, I-264 westbound to the Airport/Crittenden Drive ramp, and the Poplar Level Road interchange. Upon further discussion with KYTC, it was noted that approximately 200 light poles are struck throughout the study area every year and require replacement. The areas where poles were noted as missing in the existing conditions review generally corresponded with areas where poles are often struck. Existing lighting plans for the study area are included in **Appendix A.**

2.1.6 Signage

Signage is a key element of the study area. The interchange serves as a system interchange for two interstate routes while also providing access to several arterials and major traffic generators. The multiple origins and destinations served result in a complex interchange with several locations including weaves, merges, diverges, lane drops, and add lanes. Additionally, there is a presumed increase in the proportion of unfamiliar drivers due to the adjacent airport and fairgrounds. The mix of unfamiliar drivers with a complex interchange further emphasizes the importance of signage and wayfinding.

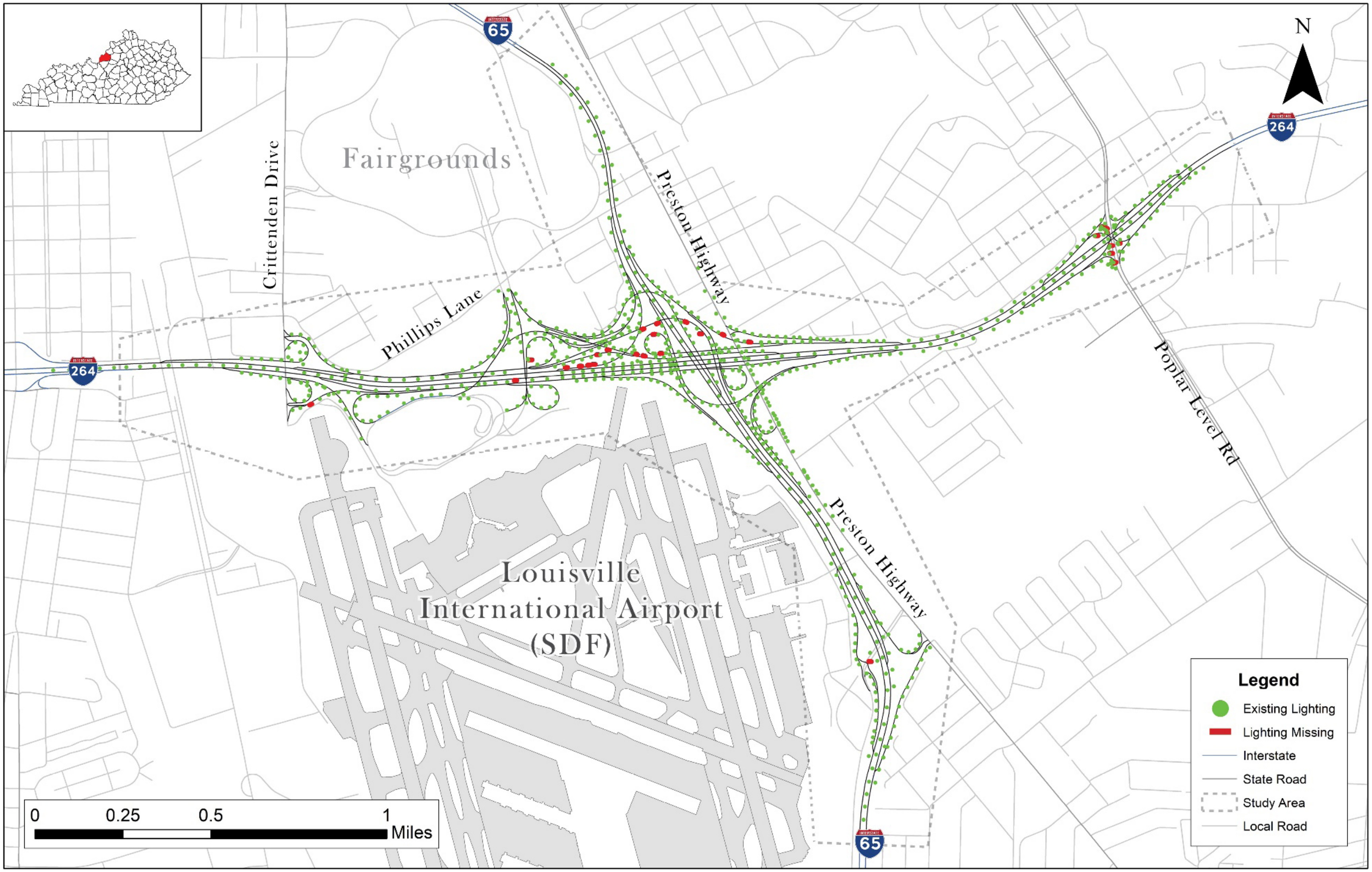
The existing signage was surveyed, and the locations of panel signs and standard signs are summarized in ***Figure 6***. A review of the existing signage identified the following:

- Many of the existing panel signs were no longer in compliance with KYTC standards and/or the current Manual on Uniform Traffic Control Devices.
- Sign messaging was not consistent, including delineation of "exit only" lanes and the destinations shown on the signs.
- Standard ground mounted signs along the ramps were often knocked down and in need of replacement.

2.1.7 Guardrail

Guardrail is a necessary component of urban interstate systems and plays an important role in preventing roadway departure crashes where clear zone cannot be achieved. Guardrail is present throughout the study area, particularly in areas with sharp curves or drop-offs along bridges and overpasses. However, the existing guardrail is outdated and does not meet KYTC's updated standards that reflect the latest testing processes as outlined by the Manual for Assessing Safety Hardware (MASH), published by AASHTO. ***Figure 7*** illustrates the locations of existing guardrail within the study area based on a survey of the study area.

Figure 5: Lighting within Study Area[1]



[1] *The locations of missing lights are from a field survey and representative of a single point in time. The location of missing light poles is likely to change.*

Figure 6: Signage in Study Area

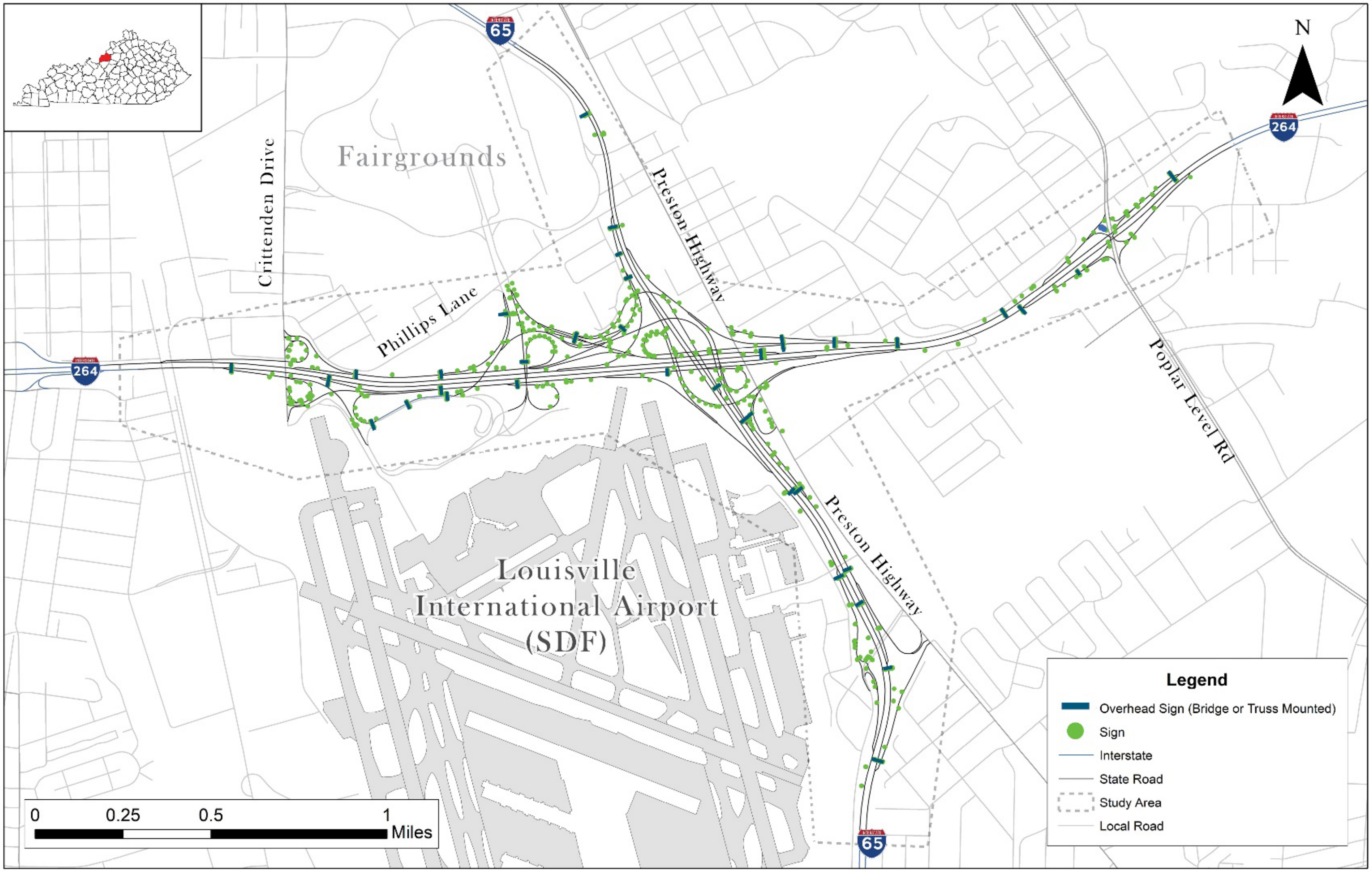
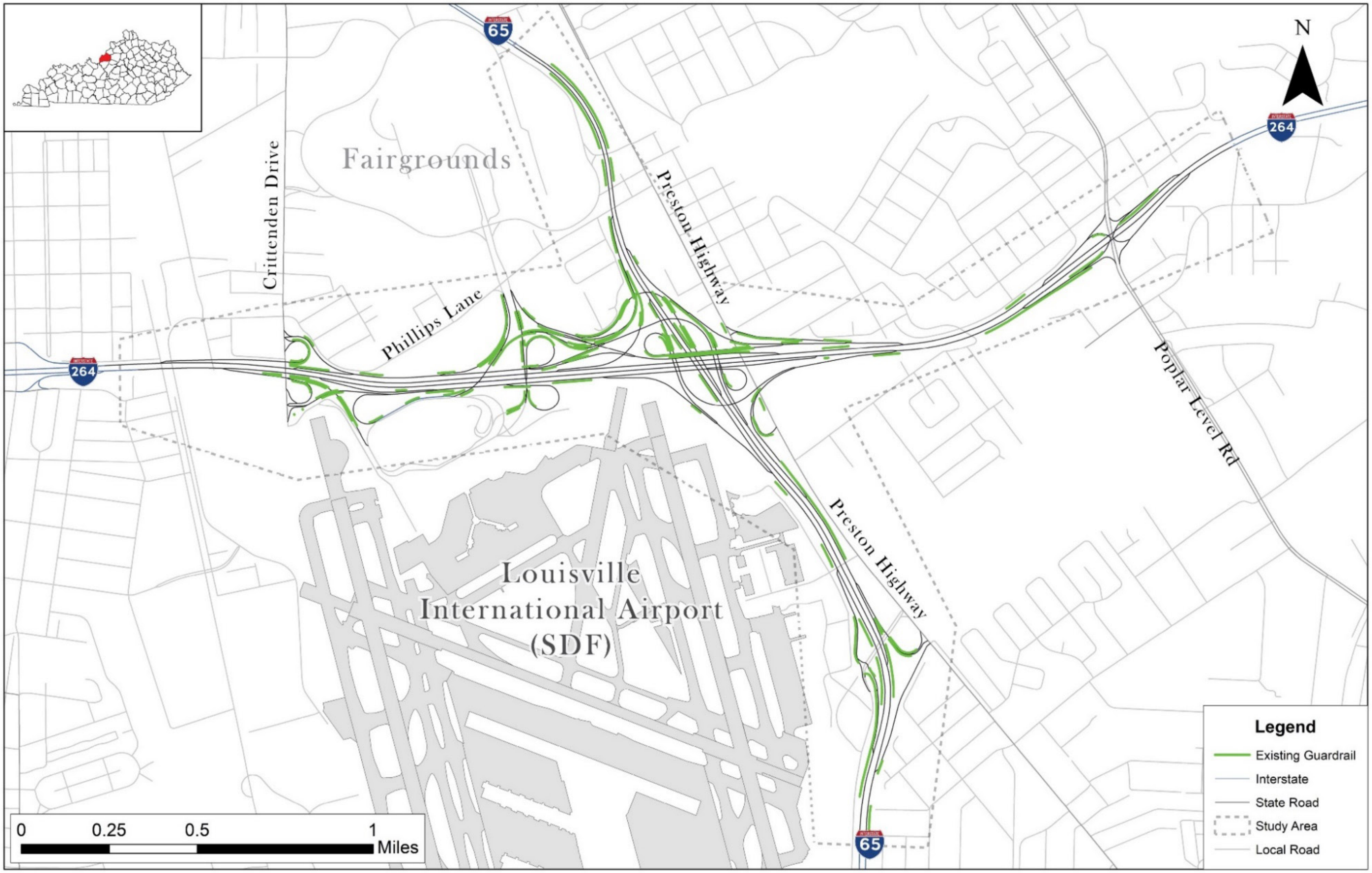


Figure 7: Existing Guardrail Locations



2.1.8 Intelligent Transporation System

Traffic Response and Incident Management Assisting the River Cities (TRIMARC) provided information regarding reference markers and posts located in the study area, as well as the locations of potential Intelligent Transportation System (ITS) devices that they would like to add. This information is included in **Appendix A**.

2.1.9 Right Of Way

As potential improvement strategies are evaluated and recommended, accurate identification of right of way boundaries is critical for improvement projects. Staying within existing interstate right of way whenever possible generally minimizes overall cost of an improvement and reduces environmental impacts.

During the initial phase of the study, it was determined that property boundary records for the area between I-264 and the Louisville Muhammad Ali International Airport property were not complete, and a detailed investigation was necessary. Courthouse records review and KYTC archived plan checks were performed to determine and establish accurate right of way limits. **Figure 8** shows the established boundary between I-264 and the airport property to the south of I-264. Supplemental survey information is in **Appendix B.**

Figure 8: Existing Right of Way: South of I-264 at Airport

2.2 Traffic Volumes, Level of Service, and Capacity

Traffic counts were collected from KYTC count stations as well as turning movement and ramp counts using Miovision Datalink. Traffic counts were collected between 2:00 PM and 8:00 PM on a Friday, which was chosen as it represents a typical worst-case scenario for traffic volumes and safety. The peak hour was determined to be from 4:00 PM to 5:00 PM. Traffic counts, Streetlight Data, and balanced existing (2020) and future (2045) volumes are provided in the Traffic Forecast Report found in **Appendix C.**

Existing peak hour traffic operations were evaluated using Highway Capacity Software (HCS) freeway facilities module. Level of Service (LOS), a qualitative measure of traffic operations with a range from LOS A, free flowing to LOS F, severe congestion (**Figure 9**), and Volume-to-Capacity (V/C) ratios were calculated using HCS. ***Figure 10*** illustrates the HCS LOS results. Segments with values of E or F are considered undesirable. ***Figure 11*** shows the HCS V/C ratio for the same segments. V/C ratios above 1.0 are considered failing. Full results of the HCS analyses are included in **Appendix D**. HCS files were submitted electronically to KYTC.

Figure 9: Level of Service Scale

Level of Service (LOS)		
LOS	DESCRIPTION	EXAMPLE
A	No Congestion, No Delay	
B	Slight Congestion. Slight Delay	
C	Moderate Congestion, Moderate Delay	
D	Unstable Congestion without Excessive Backups	
E	Unstable, Very Congested	
F	Stop and Go Traffic	

Figure 10: Segment (HCS) LOS Existing PM Peak Evaluation Results

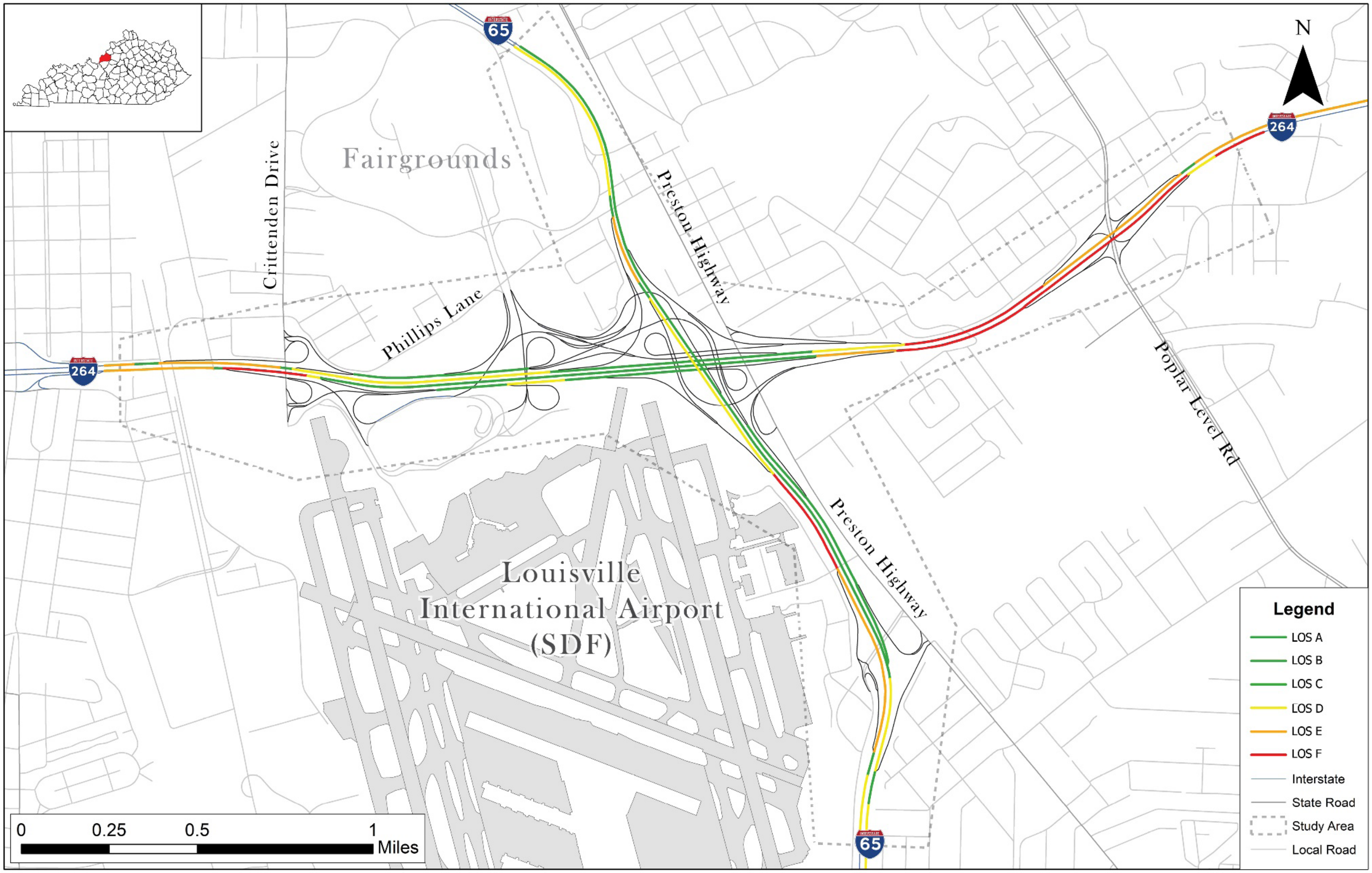
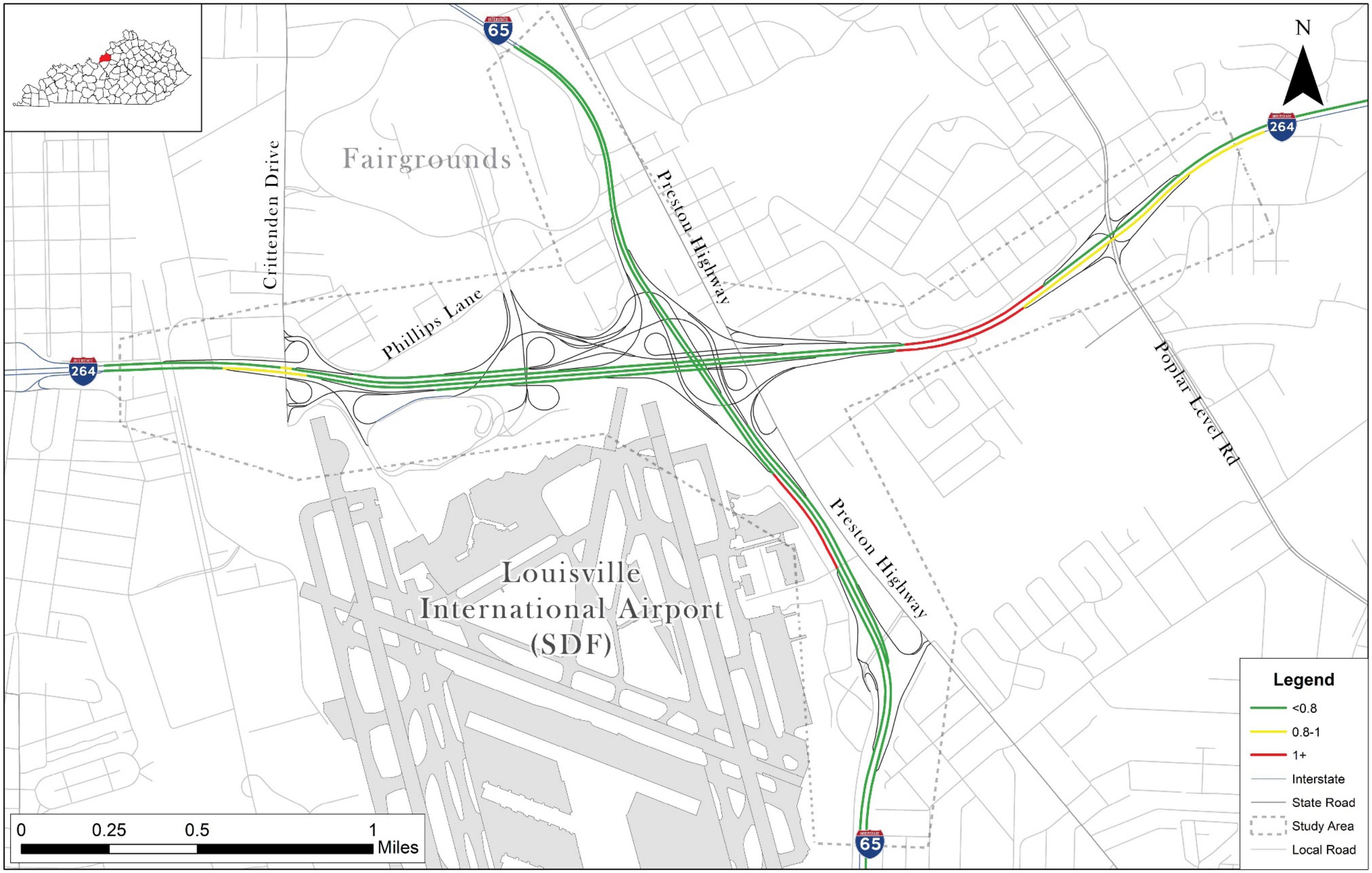


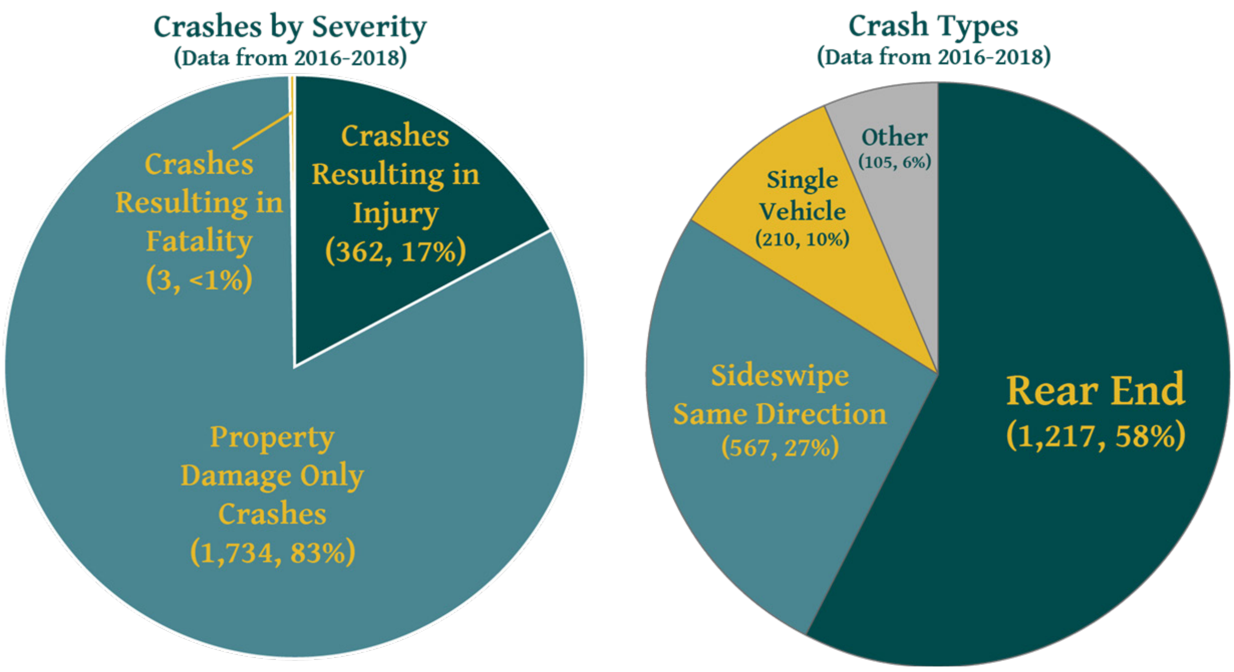
Figure 11: Segment (HCS) V/C Ratio Existing PM Peak Evaluation Results



2.3 Crash Analysis

The I-65/I-264 interchange was identified as the number one highest crash interchange in the KIPDA region. To identify countermeasures that will potentially reduce crashes at the interchange, the project team examined the types of crashes that occurred and potential factors that contributed to those crashes. The project team gathered data from the Kentucky State Police Collision Analysis Database for crashes that occurred between January 1, 2016 and December 31, 2018. This three-year study period was used to gather sufficient data to establish crash trends and was representative of the current conditions in the study area. A total of 2,099 crashes occurred within the study area in that time frame. Crash data is summarized in **Figure 12**. ***Figure 13*** identifies locations with the greatest concentration of crashes using a heat map, where locations with higher concentrations of crashes are shown in red.

Figure 12: Crashes by Severity and Top Crash Types



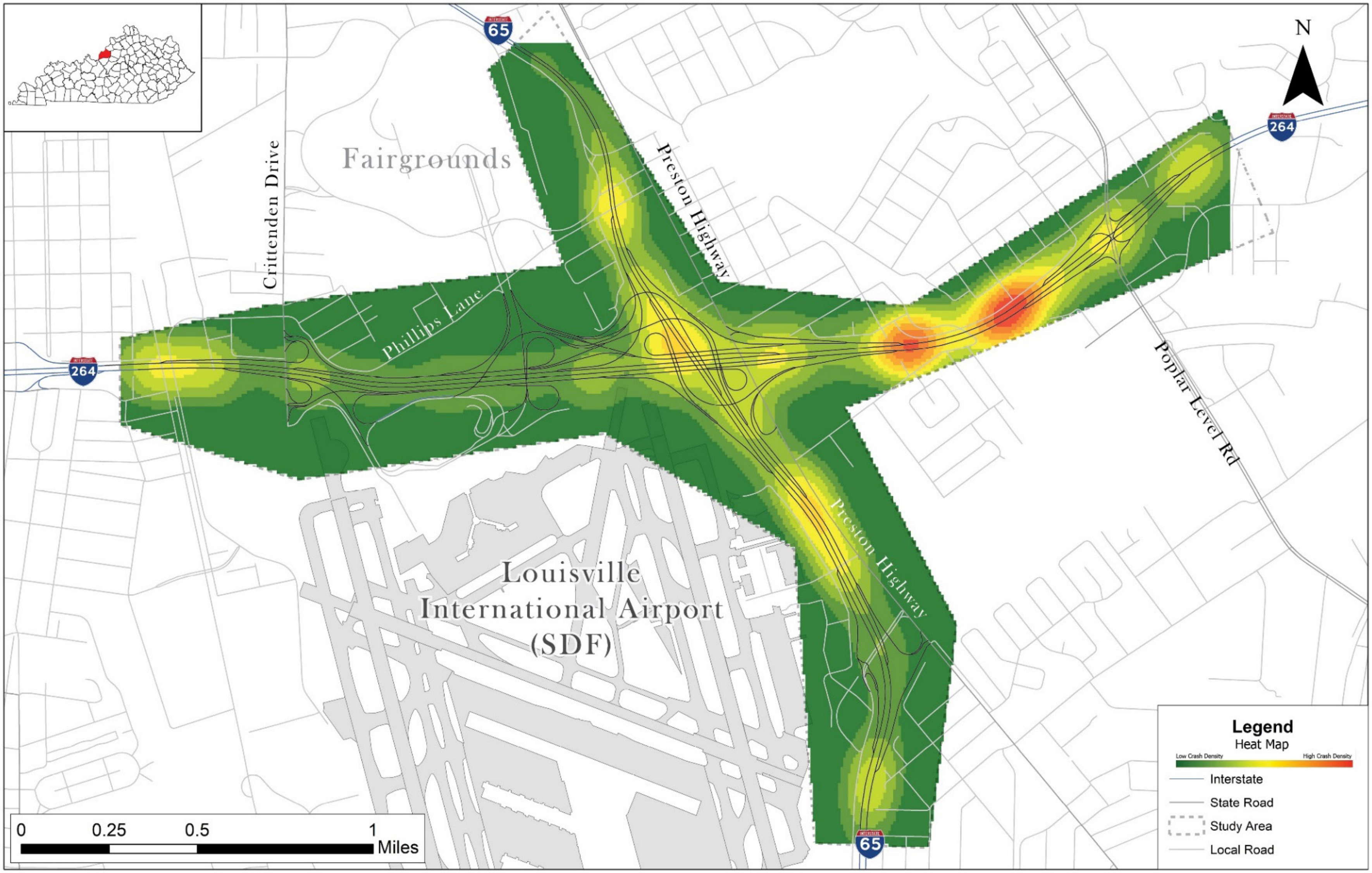
2.3.1 Crash Analysis by Segment

The I-65/I-264 interchange is complex, with varying conditions throughout. To understand the factors that contribute to crashes, the study area was divided into 121 different segments. The safety performance of each segment was examined to identify specific areas with the worst safety performance and potential factors that contribute to crashes.

The Kentucky Transportation Center (KTC) annually completes research titled *Analysis of Traffic Crash Data in Kentucky*, which examines the most recent five years of available crash data. The most recent version of this analysis was available for crashes that occurred from 2014 through 2018. As part of this research, KTC divided state and federal roadways into segments. KTC provided the segments that were used in their evaluation to the project team, so that the analysis completed for this study could be coordinated with research completed by KTC. This will provide the framework for future analysis, to examine how specific countermeasures impact safety performance.

To develop countermeasures with the highest benefit/cost (B/C) ratio, the study identified 24 segments with the worst safety performance. By focusing analysis on these locations, the project team could more efficiently determine the main contributing factors to crashes. A detailed safety analysis was completed on each of these segments and is included in **Appendix E**.

Figure 13: Heat Map of Crashes within the Study Area



The 24 segments with the worst safety performance were identified by evaluating four criteria on each of the 121 segments: Critical Rate Factor (CRF), Excess Expected Crashes (EEC), the number of severe crashes (crashes involving a fatality (K) or suspected serious injury (A)), and the locations with fatal crashes. The results of this evaluation indicated that nearly all 121 segments met the criteria that defines high crash segments. However, outlying segments could be identified by reviewing the results of these calculations and developing criteria to define a "hot spot" segment. This analysis resulted in 24 segments with the largest concentration of crashes and accepted by the project team at the Project Kickoff Meeting on December 2, 2019. Full EEC, CRF, KA, and fatality data can be found in **Appendix E**. Segments within the network with values above the following thresholds were flagged for detailed crash analysis:

- CRF = 9 or higher
- EEC = 20 crashes or more
- KA = 3 crashes or more
- Fatal Crash = 1 or more

Figure 14 shows the location of these 24 "hot spot" segments that were reviewed in more detail.

The CRF represents a ratio of the crash rate of a segment in comparison to the Critical Crash Rate (CCR) for similar roadways, as determined by KYTC. KYTC uses a systematic procedure to identify locations having high crash rates. The actual number of crashes, as obtained from KYTC's database, occurring within a roadway segment is used to calculate the Actual Crash Rate using the roadway length, annualized ADT, and the number of years for which crash data are being examined. Using an analysis procedure from the KTC and referenced in The Analysis of Traffic Crash Data in Kentucky (2014–2018), Actual Crash Rates are compared to the Critical Crash Rate for similar types of Kentucky roadways. The Critical Crash Rate is the rate that is statistically greater than the average crash rate for similar roadways and represents a rate above which crashes may be occurring in a non-random fashion. This ratio of Actual Crash Rate to the Critical Crash Rate is the Critical Crash Rate Factor (CCRF). A CCRF greater than 1.0 indicates crashes may be occurring more often than can be attributed to random occurrence. This procedure is a screening technique indicating locations where further analysis may be needed. It is neither a definitive statement of nor a measurement of a crash problem. As defined in the KTC methodology report, two analysis types exist: "segments" and "spots." Segments vary in length and are divided along roadways as geometry or traffic volumes change.

KYTC and the KTC developed a more refined statistical methodology based on the Highway Safety Manual (HSM) to rank safety needs of projects included in the 2020 Strategic Highway Investment Formula for Tomorrow (SHIFT) process. EEC is based on a crash prediction model estimating the number of crashes expected on an average roadway segment of a given type and length. It represents the number of excess crashes a segment is experiencing compared to other roadways of its type, adjusting for statistical correction.

The data shows that 21 of the 121 segments have EEC values greater than zero. To capture the segments with the highest EEC, the project team discussed with KYTC and decided to include segments with EEC values of 20 or greater, the highest values in the data. This means that there are 20 or more crashes per year over what is expected. To capture the safety performance of the entire study area, EEC values for each segment were summed. The total EEC for the study area is 1,466 crashes.

Crash severity is categorized as Killed (K), Suspected Serious Injury (A), Suspected Minor Injury (B), Possible Injury (C), and No Apparent Injury (O). KA data represents crashes that involved a fatality (K) or a suspected serious injury (A). The CRF and EEC calculations show where more crashes are occurring than expected, whereas this data helps to identify where severe crashes are occurring. Upon discussions with KYTC, segments with KA values of three or greater were identified to be analyzed further. However, due to the KA data being grouped in five-year data queries, the KA data provided for this study included a different date range (2014 through 2018) than the three-year study period used for the EEC and CRF calculations (2016 through 2018).

Three crashes resulted in a fatality during the three-year study period (2016 through 2018) within the study area. These crashes are shown in ***Figure 15***.

Figure 14: 24 "Hot Spot" segments

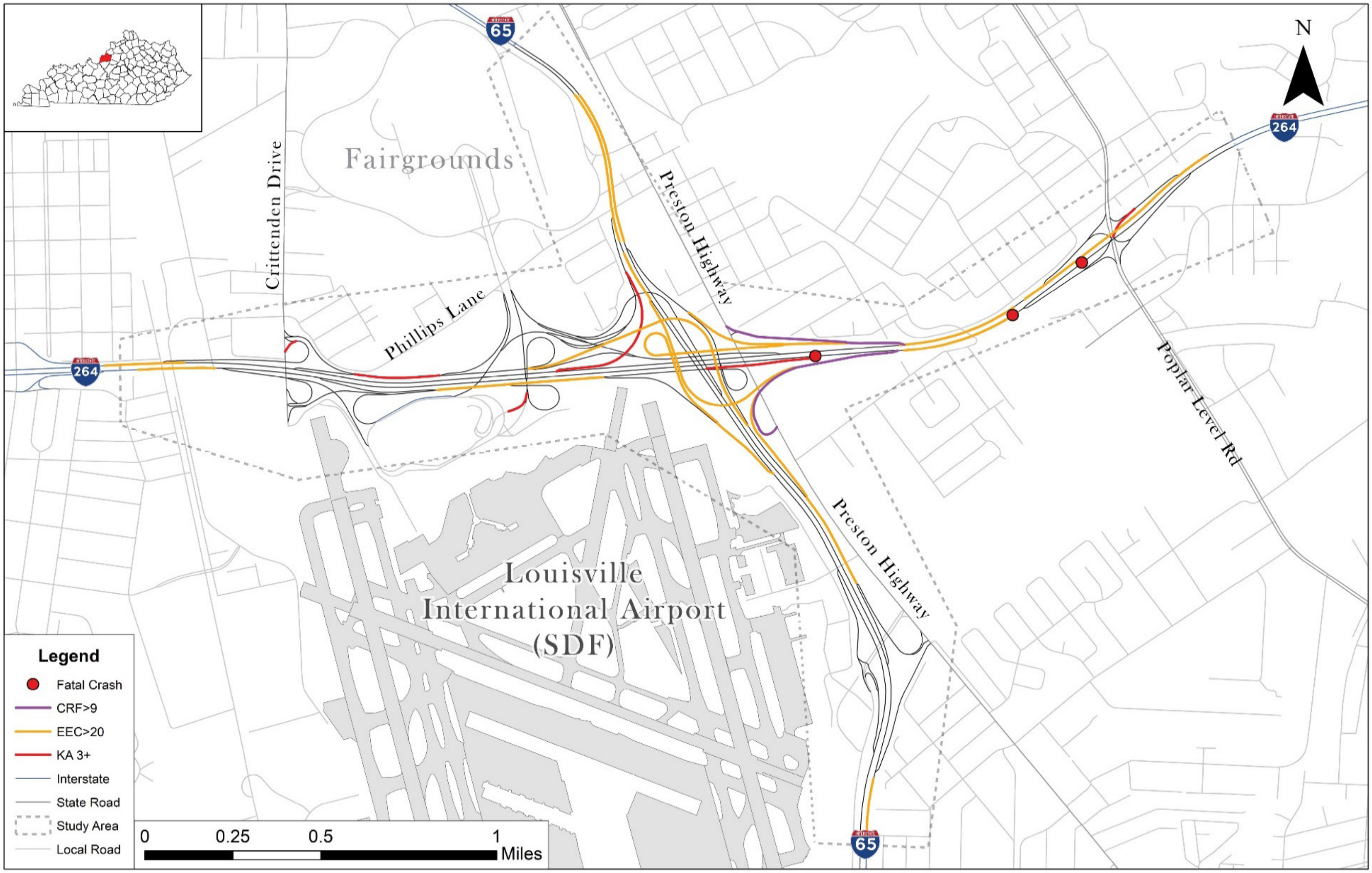
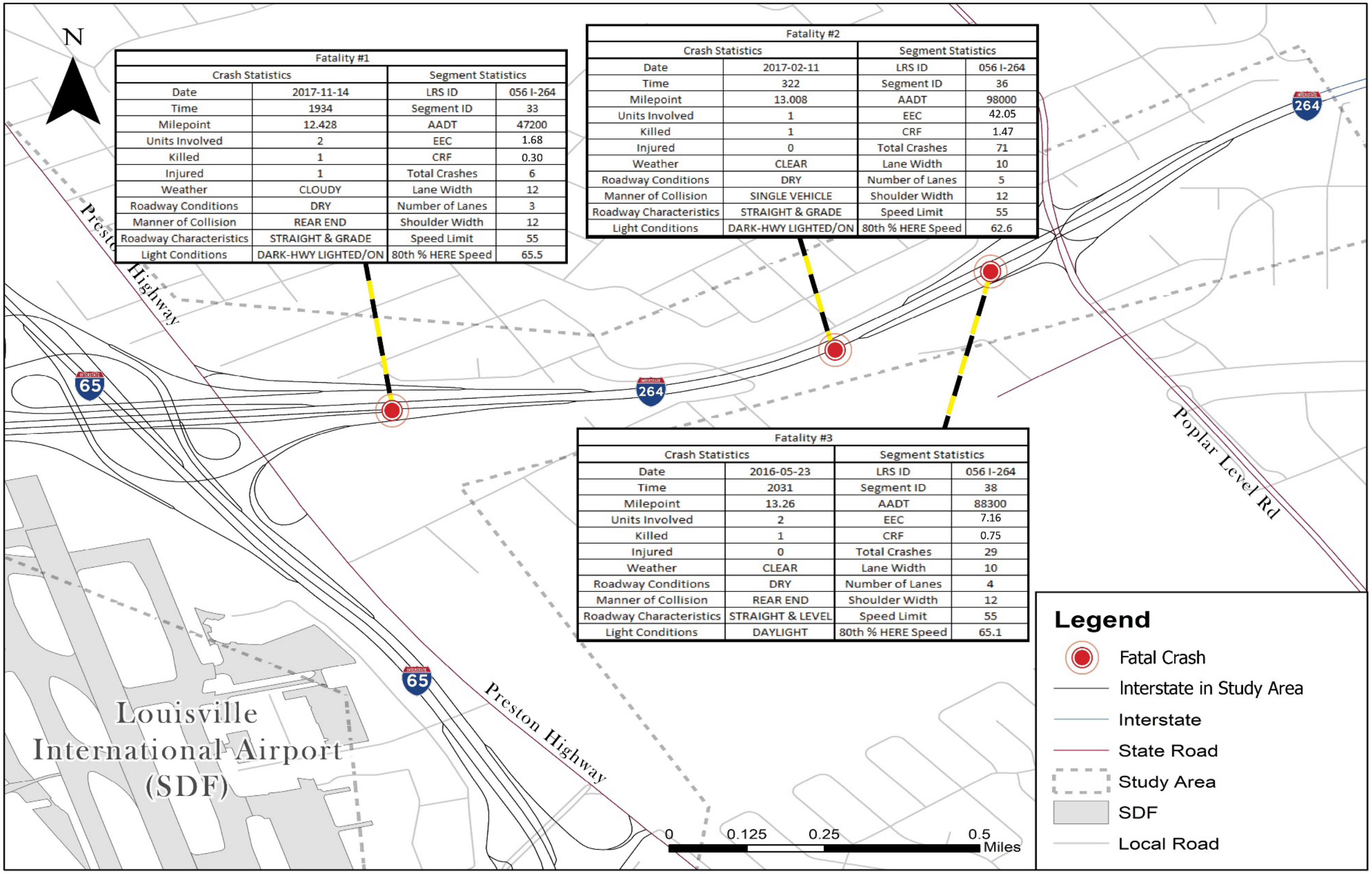


Figure 15: Fatal Crashes within the Study Area from 2016 through 2018



Fatality #1			
Crash Statistics		Segment Statistics	
Date	2017-11-14	LRS ID	056 I-264
Time	1934	Segment ID	33
Milepoint	12.428	AADT	47200
Units Involved	2	EEC	1.68
Killed	1	CRF	0.30
Injured	1	Total Crashes	6
Weather	CLOUDY	Lane Width	12
Roadway Conditions	DRY	Number of Lanes	3
Manner of Collision	REAR END	Shoulder Width	12
Roadway Characteristics	STRAIGHT & GRADE	Speed Limit	55
Light Conditions	DARK-HWY LIGHTED/ON	80th % HERE Speed	65.5

Fatality #2			
Crash Statistics		Segment Statistics	
Date	2017-02-11	LRS ID	056 I-264
Time	322	Segment ID	36
Milepoint	13.008	AADT	98000
Units Involved	1	EEC	42.05
Killed	1	CRF	1.47
Injured	0	Total Crashes	71
Weather	CLEAR	Lane Width	10
Roadway Conditions	DRY	Number of Lanes	5
Manner of Collision	SINGLE VEHICLE	Shoulder Width	12
Roadway Characteristics	STRAIGHT & GRADE	Speed Limit	55
Light Conditions	DARK-HWY LIGHTED/ON	80th % HERE Speed	62.6

Fatality #3			
Crash Statistics		Segment Statistics	
Date	2016-05-23	LRS ID	056 I-264
Time	2031	Segment ID	38
Milepoint	13.26	AADT	88300
Units Involved	2	EEC	7.16
Killed	1	CRF	0.75
Injured	0	Total Crashes	29
Weather	CLEAR	Lane Width	10
Roadway Conditions	DRY	Number of Lanes	4
Manner of Collision	REAR END	Shoulder Width	12
Roadway Characteristics	STRAIGHT & LEVEL	Speed Limit	55
Light Conditions	DAYLIGHT	80th % HERE Speed	65.1

2.3.2 Detailed Safety Analysis

A detailed safety analysis was completed for each of the 24 "hot spot" segments. This analysis examined the distribution of crash types, crash severity, traffic operations through the segment, and the physical conditions of the roadway to identify factors that contributed to crashes within the segment.

The safety analysis identified two contributing factors to crashes within the study area; congestion and interchange complexity. Additionally, conditions at three specific locations were identified that impact safety. These locations include the loop ramps from westbound I-264 to southbound I-65, southbound I-65 at the dropped lane to eastbound I-264, and the location where the ramps from southbound I-65, northbound I-65 and KY 61 (Preston Highway) converge. The full safety analysis is provided in **Appendix E.**

CONGESTION

Congestion was identified as a major factor contributing to crashes within the study area. Congested areas often result in speed differentials between travel lanes and towards the end of traffic queues. Therefore, areas with congestion related safety issues often have higher percentages of rear end, side swipe crashes, and some single vehicle crashes from drivers avoiding a conflict with another vehicle. ***Figure 16*** shows hot spot segments where congestion is a primary contributing factor.

INTERCHANGE COMPLEXITY

The interchange is very complex. The systems interchange serves I-65 and I-264 as well as several major locations such as the Louisville Muhammad Ali International Airport, the Kentucky Air National Guard headquarters, and the Louisville Fairgrounds. To support access to these locations, the interchange is comprised of several CD roads, weaving areas, added lanes, dropped lanes, merges, and diverges. These components require drivers to make multiple decisions to navigate the interchange which leads to increased opportunities for distraction and last minute/unnecessary lane changes. As a result, interchange complexity was identified as a contributing factor to rear end and sideswipe crashes.

"Hot spot" locations with high percentages of rear end and sideswipe crashes were reviewed to determine if interchange complexity contributed to crashes. The segments were reviewed to identify if crashes were concentrated around decision points such as weaving areas, dropped lanes, or merges. The project team also considered the number of destinations served by specific movements. Components of interchange complexity (weaving areas, added lanes, dropped lanes, and merges) were identified as a contributing factor in 12 of the 24 "hot spots." ***Figure 17*** shows locations where interchange complexity contributed to crashes within a "hot spot" segment.

Figure 16: Hot Spot Segments with Congestion Determined as a Primary Contributor to Crashes

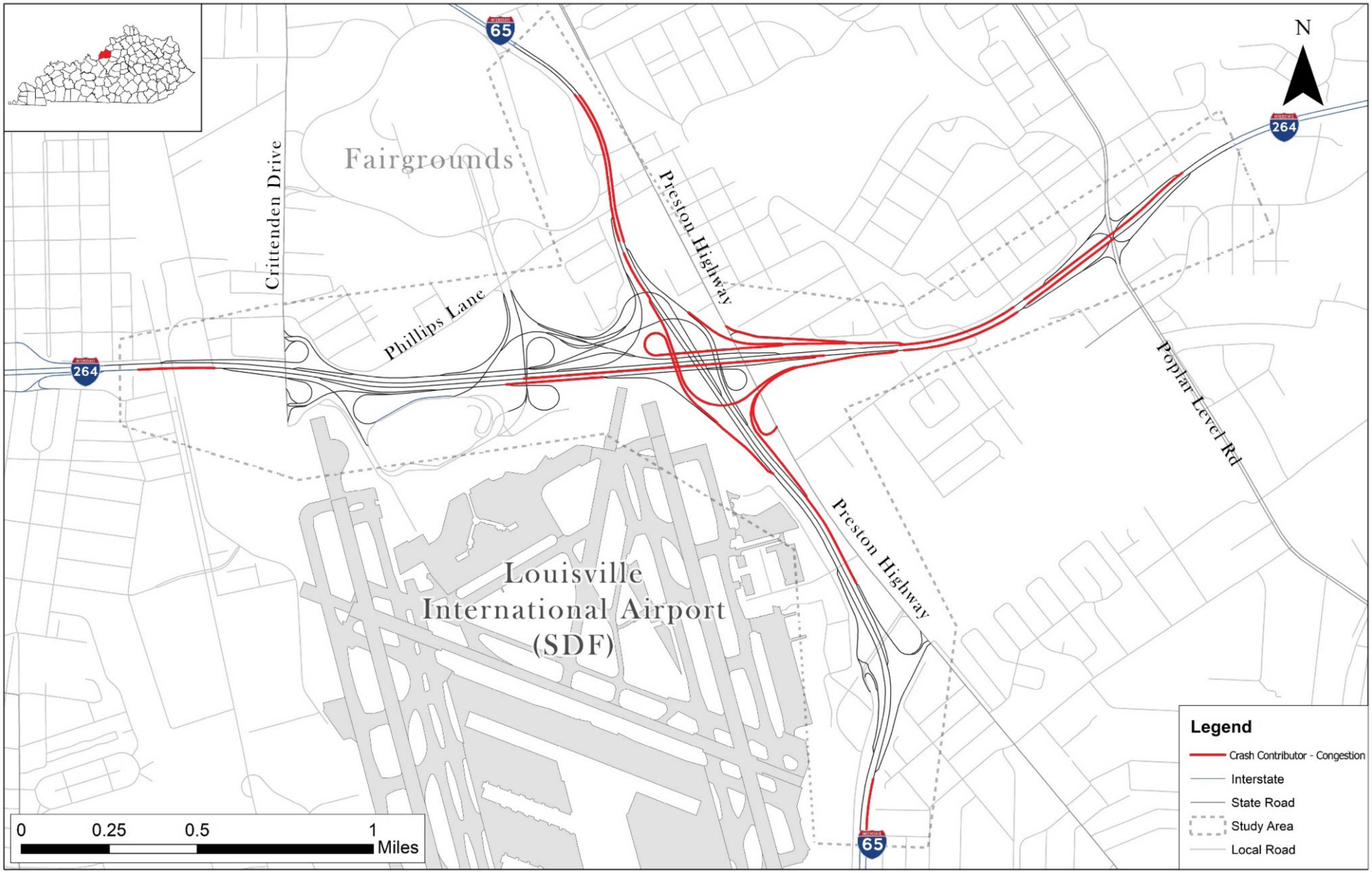
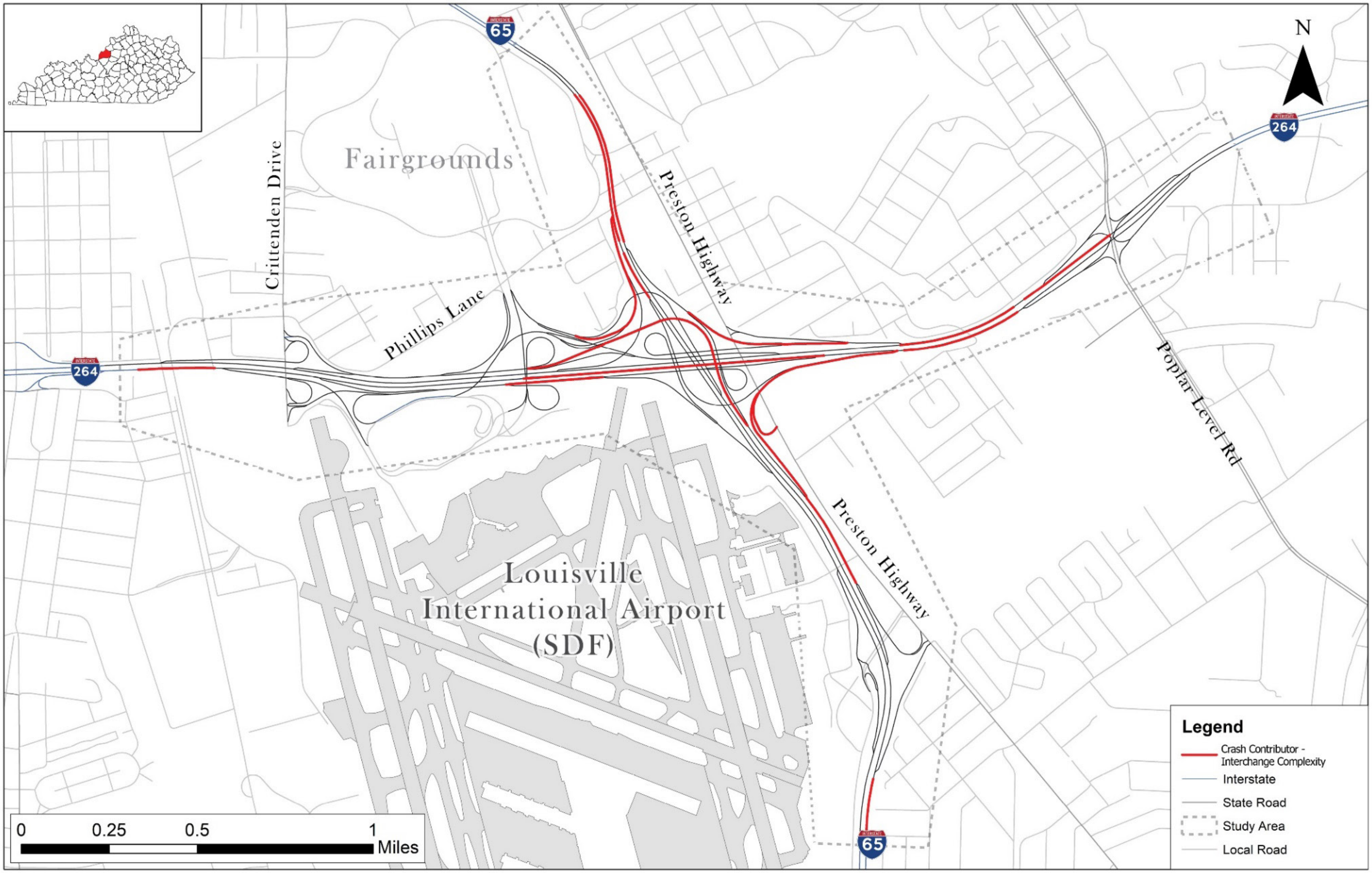


Figure 17: Hot Spot Segments with Interchange Complexity Determined as a Primary Contributing Factor to Crashes



LOOP RAMP WESTBOUND I-264 TO SOUTHBOUND I-65

The loop ramp from westbound I-264 to southbound I-65 has the highest volume of vehicles during peak hours as compared to the other ramps within the study area (≈1,500 vehicles per hour [vph] in peak hours). However, this loop ramp has a posted 25 mph advisory speed, which hinders the vehicles moving efficiently through the ramp. A queue of vehicles regularly develops in peak hours, often extending to KY 864 (Poplar Level Road). This creates speed differentials at the end of traffic queues and between mainline travel lanes, which contributes to rear-end and sideswipe crashes in these segments. Additionally, the tight curvature of the loop ramp contributes to single-vehicle crashes. This location is shown as a red line in ***Figure 18***.

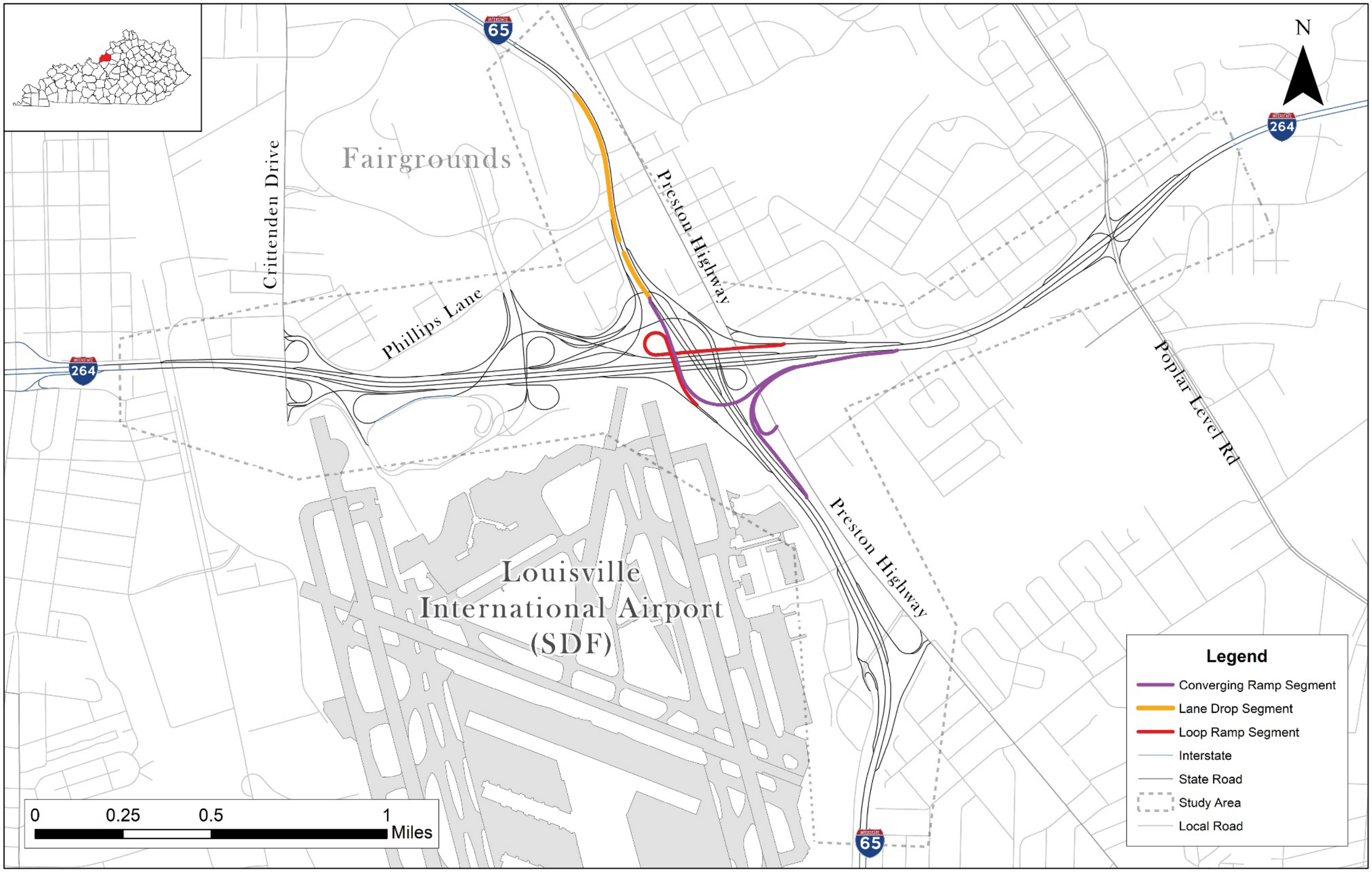
SOUTHBOUND I-65 LANE DROP TO EASTBOUND I-264

Southbound I-65 at the ramp to eastbound I-264 is a drop lane condition, approximately 1,500 feet past the ramp to westbound I-264. Since signage for the lane drop cannot be placed until after the exit to westbound I-264, drivers have a limited space to access the appropriate lane. Additionally, this ramp serves approximately 1,100 vph during peak hours, which regularly generates queues of traffic that sometimes spill onto mainline southbound I-65. This creates speed differentials at the end of the queue and between travel lanes on southbound I-65. This condition contributes to the rear-end and side-swipe crashes within these segments. This location is shown as a yellow line in ***Figure 18***.

CONVERGING RAMPS SOUTHBOUND I-65, NORTHBOUND I-65 AND KY 61 (PRESTON HIGHWAY)

In this location, the ramps from southbound I-65, the CD that runs parallel to northbound I-65, and the ramp from KY 61 (Preston Highway) converge just prior to the weaving area on eastbound I-264 between I-65 and KY 864 (Poplar Level Road). Drivers are required to navigate the added lanes and merges in this area, and then quickly identify the correct lane position to navigate the weave on eastbound I-264. This requires a high level of driver effort, concentration, and decision making to complete these maneuvers safely. This is even more complicated for drivers on northbound I-65 or from KY 61 (Preston Highway), who are required to navigate the weave on the CD approaching from the south. The complex configuration leads to increased sideswipe and rear end crashes. This location is shown as a purple line in ***Figure 18***.

Figure 18: Specific Locations within the Study Area that Significantly Impact Safety



3

ENVIRONMENTAL OVERVIEW

3.1 Environmental Overview Summary

An Environmental Overview was performed to identify environmental resources that warrant consideration during the development of short-term and long-term improvement concepts to the study area and would need to be further addressed during a future project development process. The Environmental Overview was completed using desktop analysis, agency coordination, and field reconnaissance to identify the following:

- Jurisdictional and special use water resources
- Threatened and endangered (T&E) species habitat
- Socioeconomic conditions/Environmental Justice
- Hazardous materials
- Noise
- Cultural/Historic and Archaeological resources
- Section 4(f)/Section 6(f) resources

Natural and human environmental resources within the study area were identified from Geographic Information System (GIS) analysis of publicly available mapping, aerial imagery, and occurrence data that was used preliminarily to identify and quantify known environmental features within the study area. A field reconnaissance via windshield survey from publicly available roadways was subsequently conducted to field-verify features identified during desktop analysis and document previously unreported resources.

More detailed environmental studies will be required as any identified future project proceeds into preliminary planning and design. If a project advances using federal funds, the National Environmental Policy Act (NEPA) requires that environmental impacts be avoided or minimized to the extent possible. Mitigation for unavoidable impacts may also be necessary.

It is anticipated that much of the proposed improvements would occur within existing right of way. The following provides a summary of the potentially impacted environmental resources in this area. The complete Environmental Overview including mapping and discussions all potentially impacted resources in the study area is provided in **Appendix F.**

The study area is primarily interstate highway right of way with adjacent commercial, industrial, and residential development. The study area is in an intensively developed urban setting. Several hotels and the Kentucky Fair and Exposition Center are northwest of the I-65/I-264 interchange. The Louisville Muhammad Ali International Airport complex is southwest of the interchange, and the Kentucky Air National Guard headquarters is on the south side of the airport. These major facilities are just beyond the study area and are not expected to be directly impacted by the project. Residential development is adjacent to both sides of I-264 west of Crittenden Drive at the far western end of the study area.

Preston Highway (KY 61) is a major north-south route east of, and roughly parallel to, I-65. Extensive commercial development occurs between I-65 and Preston Highway northeast of the study area. Residential areas are on the east side of Preston Highway adjacent to the westbound exit ramps from I-264 to Preston Highway and northbound I-65. Camp Taylor Memorial Park is north of I-264, just west of Poplar Level Road. Allgeier Park is north of I-264, just beyond the eastern end of the study area. Residential development is adjacent to I-264 southeast of the I-65/I-264 interchange. Preston Highway becomes closer to I-65 in this area, with development occurring east of Preston Highway, except for several commercial facilities between I-65 and Preston Highway near the Grade Lane overpass. Male High School, Evergreen Funeral Home and Cemetery, and commercial facilities are on the east side of Preston Highway.

3.2 Natural Resources

Natural environment resources include surface streams, floodplains, wetlands, ponds, groundwater, threatened, endangered, and special concern species and habitat, and woodland and terrestrial areas. Through a literature/database review and field reconnaissance, potentially sensitive resources that affect the natural environment were identified in the study area and are discussed below. A full discussion of potentially impacted natural environment resources, including a discussion of species, is included in **Appendix F**.

The project occurs within the heavily urbanized area of Louisville and occurs within the Mill Creek Cutoff-Ohio River watershed and the Northern Ditch watershed. ***Table 2*** summarizes the natural resources identified within the study area. The US Fish & Wildlife Services (USFWS) federal listed species that were considered as part of the Environmental Overview[1] include:

- Three (3) species of bats (Indiana, gray and northern long-eared bat)
- Two (2) species of birds (piping plover and least tern)
- One (1) insect (American burying beetle)
- One (1) plant (running buffalo clover)

Known or potential occurrence records for 31 state-listed species in Jefferson County were reported including three (3) bats, nine (9) birds, four (4) plants, three (3) insects, and one (1) snake.

[1] Species such as mussels and crayfish occur within streams. Since no streams are present within the study area, they were not considered for this Environmental Overview but are described in Appendix F.

Table 2: Natural Resource Summary

Resource	Description	Resources within the study area
Jurisdictional wetlands, waters or special use water resources	Resources that would be under the jurisdiction of the US Army Corps of Engineers	None identified within the study area
Floodplains	Regulated floodplains/floodways under the jurisdiction of the Federal Emergency Management Agency	None identified within the study area
Federally Protected Species	Species under the protection of the Endangered Species Act and requires coordination with the US Fish & Wildlife Service if impacted	-
Indiana bat	Federal: Endangered State: Endangered	No potential winter hibernacula (e.g., caves or mines) are known to occur, or were identified, within 0.5 mile of the study area. However, potential summer roosting habitat for Indiana bat was observed within the 15.4 acres of forest throughout the study area. The forested acreage contains trees that are of a habitable diameter (≥ 5 inches), but only a small percentage of the trees contain summer roost characteristics. Scattered throughout the forested areas are several broken limbs on live trees that exhibit summer habitat characteristics. There are also several standing dead trees (snags) with broken or loose bark. Unavoidable impacts to the forested.
Gray bat	Federal: Endangered State: Threatened	No potential habitat identified within the study area.
Northern long-eared bat	Federal: Endangered State: Endangered	The 15.4 acres of forest throughout the study area represent suitable summer roosting habitat for the northern long-eared bat. The forested acreage contains trees that are of a habitable diameter (≥ 3 inches), but only a small percentage exhibit summer roost characteristics. Scattered throughout the forested areas are several broken limbs on live trees that exhibit summer habitat characteristics. There are also several standing snags with broken or loose bark.
Piping Plover	Federal: Endangered	No potential habitat identified within the study area.
Least tern	Federal: Endangered State: Endangered	No potential habitat identified within the study area.
American Burying Beetle	Federal: Endangered State: Presumed Extinct	No potential habitat identified within the study area
Running Buffalo clover	Federal: Endangered	One (1) area of potential habitat encompassing approximately 0.75 acre was identified within the study area, within the Evergreen Funeral Home and Cemetery.
State Protected Species	Species under the protection of the Office of Kentucky Nature Preserves (OKNP) or the Kentucky Department of Fish and Wildlife Resources (KDFWR) and require a presence/absence survey will be required during final design should projects impacts be unavoidable.	-
Lyre-leaf Rockcress	State: Endangered	Potential habitat was identified within the study area.
Wood's Bunchflower	State: Threatened	No potential habitat was identified within the study area.

Resource	Description	Resources within the study area
Barn Owl	State: Special Concern	Airport and highway properties within the study area represent potential hunting habitat, while several buildings and forested areas could be used as nesting habitat
Black-crowned Night-heron	State: Threatened	No potential habitat was identified within the study area
Loggerhead Shrike	Federal: Species of Management Concern State: Special Concern	Potential habitat was identified within the study area.
Northern Oak Hairstreak	State: Special Concern	Forest tracts containing oaks identified within the study area represent potential habitat.
Kirtland's Snake	State: Threatened	Potential habitat was identified within the study area.
Peregrine Falcon	State: Endangered	Urban areas within the study area provide large structures for nesting and large populations of pigeons and starlings as food sources
Northern Harrier	State: Threatened	No potential habitat was identified within the study area
Bewick's Wren	State: Special Concern	Residential areas within the study area represent potential habitat.
Savannah Sparrow	State: Special Concern	Open areas within the study area represent potential habitat.

3.3 Human Environment

The human environment is defined as what we live in and around and what we have built. Through review of secondary source information and field reconnaissance, potentially sensitive resources that affect the human environment were identified in the impacted study area and are discussed below.

3.3.1 Socioeconomic Conditions/Environmental Justice

The U.S. Census data were reviewed to obtain relevant state, city, and census tract (CT) data related to minority and low-income populations in the study area. The study area includes small sections of eight (8) individual CTs adjacent to I-264 and I-65. CT 9801 has no population, as it encompasses the Louisville Muhammad Ali International Airport area and there are no residences. Additionally, there are no residences near the airport in the northwest corner of CT 9801 and northern end of CT 118. There are no single or multi-family residences in the segments of CT 118, CT 113.01, or CT 71 within the study area. CT 114.03, CT 94, CT 56, and CT 41 have multiple residences within the study area.

Table 3 summarizes minority and poverty statistics for the CTs within the study area as compared to those for Kentucky and Jefferson County.

Table 3: Minority and Poverty Statistics for the Study Area

Statistic[1]	Percent Minority	Percent of Population in Poverty
Kentucky	13.6	18.3
Jefferson County	28.3	15.0
**Census Tract 114.03	7.1	8.6
**Census Tract 94	8.6	20.0
**Census Tract 56	66.8	28.5
**Census Tract 41	42.9	35.8
Census Tract 9801[2]	NA	NA
Census Tract 118[3]	36.8	10.9
Census Tract 113.01[3]	63.5	17.7
Census Tract 71[3]	33.4	31.8

*** Denotes CTs with residences located within the study area*
[1]Source: US Census Bureau, 2013-2017 American Fact Finder 5-Year Estimates
[2]CT-9801 encompasses the Louisville Muhammad Ali International Airport area and has no residents
[3]CTs 118, 113.01 and 71 do not have signal or multi-family residences in the area.

Single family homes along Durrett Lane east of Carroll Avenue (CT 114.03) and along Lucas Avenue, Lucas Court, Curtis Avenue, and the southwestern part of Farmdale Avenue and Springdale Drive (CT 94). CT 114.03 (south of I-264 and east of I-65) and CT 94 (north of I-264 and east of I-65) have relatively low minority population percentages (7.1 percent and 8.6 percent respectively) that are well below the minority percentages for Kentucky and Jefferson County.

The percentage of population in poverty for CT 114.03 is low (8.6 percent), and the poverty percentage for CT 94 (20 percent) is just below the greater-than-20-percent threshold for being considered high. CT 114.03 has a lower poverty percentage than Kentucky or Jefferson County, but CT 94 has a higher percentage than the state and the county.

Single family homes between E. Southern Heights Avenue and I-264 (CT 56) and along E. Adair Street adjacent to I-264 (CT 41), and single and multi-family homes along E. Florence Avenue and between E. Florence Avenue and E. Adair Street (CT 41). CT 56 (south of I-264 and west of I-65) and CT 41 (north of I-264 and west of I-65) have high minority population percentages (66.8 percent and 42.9 percent respectively) and high population in poverty percentages (28.5 percent and 35.8 percent respectively). The minority and poverty percentages for both CTs are considerably higher than those of Kentucky and Jefferson County. The probability for disproportionate impact to minority and low-income residents within CTs 56 and 41 is high should residential relocations be required.

Under current KYTC guidelines, if a project will require more than one (1) residential relocation, environmental justice analysis is required to determine if there will be disproportionate impacts on minority and/or low-income populations.

3.3.2 Hazardous Materials

For purposes of this report, "recognized environmental condition" is defined as: The presence or likely presence of any hazardous substances or petroleum products in, on, or at a property: (1) due to release to the environment; (2) under conditions indicative of a release to the environment; or (3) under conditions that pose a material threat of a future release to the environment (ASTM Standard E1527-13 3.2.78).

Environmental Data Resources, Inc. (EDR) conducted a search of available environmental records to meet the search requirements of the US Environmental Protection Agency (EPA) Standards and Practices for All Appropriate Inquiries (40 CFR Part 312) and the American Society of Testing Methods (ASTM) Standard Practice for Limited Environmental Due Diligence: Transaction Screen Process (E 1528-14). A total of 365 sites were identified by EDR as located within, or in proximity to, the study area. Of these, based on a limited field reconnaissance, 87 sites that represent a potential recognized environmental condition (**Appendix F**) would need to be considered as any future project proceeds through the project development process.

3.3.3 Noise

Based on current KYTC noise policy, consideration is given to noise receptors within 500 feet of interstates or 200 feet of non-interstate roadways. The project is expected to meet Kentucky Transportation Cabinet (KYTC) criteria requiring a project-specific Traffic Noise Impact Analysis to determine if noise impacts will occur. The KYTC Noise Analysis and Abatement Policy requires that noise abatement measures be considered when traffic noise impacts are identified. Noise Abatement Criteria are broken into activity categories by description of land use and evaluation location (exterior or interior). Noise receptors identified in the study area are depicted on mapping found in **Appendix F.**

Most noise sensitive receptors identified within the study area meet the criteria for Activity Category B which includes exterior areas of residences where traffic noise would interfere with normal conversation, such as on balconies, patios, or backyards.

There are five Activity Category C noise receptors such as amphitheaters, auditoriums, schools, parks, and places of worship within the study area. These include: Evergreen Funeral Home and Cemetery, Louisville Male High School, Camp Taylor Memorial Park, Spirit of the Living God Church and the Kentucky Fair and Exposition Center.

There are four Activity Category E noise receptors in the study area and include: Marriott Residence Inn, Hampton Inn, Sleep Inn, and La Quinta Inn and Suites. Other hotels, motels, and restaurants are located within the study area but are not considered noise sensitive since there are no outside seating areas, outdoor pools, or other outdoor areas of frequent use. Based on current KYTC noise policy, consideration is given to noise receptors within 500 feet of interstates or 200 feet of non-interstate roadways. Such distances may be utilized to minimize potential noise impacts in the selection of improvement projects.

Additional traffic noise monitoring and analysis will be required upon selection of a future preferred improvement project as the project proceeds through the development process.

3.3.4 Cultural/Historic and Archaeological Resources

Large portions of the study area and surrounding areas have been previously surveyed for both archaeological and cultural-historic resources. No previously identified archaeological resources were identified within the study area; two (2) historical archaeological sites were identified within proximity to the western edge of the study area. Of the known cultural-historic resources identified within the study area, two have been demolished. Wilder Park and Beechmont-Meridale Historic District are in the northwest corner of the study area and are possibly National-Register of Historic (NRHP)-eligible. Two (2) other NRHP-listed districts (Audubon Park and Southern Heights) lie along the border of the study area. A portion of Evergreen Cemetery located on the east side of Preston Highway, south of I-264, is within the study area. No other known cemeteries were identified. A Phase I archaeological survey is recommended within areas of undisturbed or ambiguously disturbed areas within any future final project disturbance limits to precede ground disturbance related to completion of the project.

In addition, as the project advances and a preferred improvement concept is selected, architectural historic surveys will be completed to identify potential impacts to historic resources.

3.3.5 Section 4(f)/Section 6(f)

Section 4(f), as established by the U.S. Department of Transportation (USDOT) Act of 1966 and amended in 1989 (49 USC Section 303), states that all historic sites, park and recreation lands, and wildlife and waterfowl refuges must be considered during development of transportation projects. Historic resources are protected by Section 4(f) if they are listed or eligible for listing in the NRHP.

As any future concept advances and a preferred improvement project is selected, archaeological and architectural historic surveys will be completed to identify potential impacts to any historic resources protected by Section 4(f). In addition to historic sites, Camp Taylor Memorial Park and the Kentucky Fair and Exposition Center are considered 4(f) resources as public recreation areas. Any impacts to 4(f) resources will require further assessment and documentation.

In regard to Section 6(f) of the Land and Water Conservation Fund Act (LWCFA) of 1965 (16 U.S.C. 4601-4) which applies to transportation projects that propose impacts to, or the permanent conversion of, outdoor recreation property that was acquired or developed with LWCFA grant assistance, no Section 6(f) properties were identified in the study area **(Appendix F).**

3.4 Geotechnical Overview

The purpose of the geotechnical overview report is to summarize potential geotechnical issues that may affect transportation decisions within the study area in general conformance with Section GT-801 of the KYTC ***Geotechnical Guidance Manual***. The project team performed the overview which included a preliminary site reconnaissance on January 14, 2020, a review of published geologic mapping of the area, a review of previously completed KYTC geotechnical reports in the area, and preparation of the report included in **Appendix G**.

The overall site topography was observed to be primarily flat to gently sloping. The majority of the roadway alignments along I-65 and I-264 appeared to be built near original grade with minor grading. More substantial grading was evident at interchange and bridge locations. The majority of the interchanges and bridges were constructed by raising the new roadways with fill over roadways and railroads that were previously constructed. The exception being the I-65/I-264 Interchange, which was constructed predominately with cuts to lower I-264 below I-65. Bedrock in the area of this interchange appeared to consist primarily of limestone with a relatively shallow cap of overburden soil. The bedrock appeared to mostly be cut near-vertical with only minor degradation/weathering of the cut faces and with minor accumulation of fallen rock material at the cut bottoms. The overview also included a review and reference to geotechnical structure reports for several bridges previously completed within the project study area.

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4

PUBLIC AND STAKEHOLDER INVOLVEMENT

The project team developed a meaningful public involvement process to educate and engage key stakeholders and the public in order to collect valuable and relevant feedback to best inform the study process. By collecting information through surveys and comments and reaching a broad spectrum of area residents, motorists, businesses, and other stakeholders, the project team was able to build awareness and support for the study while obtaining valuable feedback.

A variety of outreach tools were utilized to allow for a dynamic public involvement process. The project team originally planned to promote outreach tools in-person and online throughout the project, however due to Covid-19, the outreach process was modified to rely on virtual tools only. These included:

- Project web page
- Social media promotion
- E-newsletter and e-mail database
- Fact sheets and maps posted online
- Online Surveys
- Virtual presentations via Zoom
- Photos and videos posted online
- Public meeting summaries

A detailed summary of the public outreach activities is included in the Public Involvement Notebook in **Appendix H**.

4.1 Stakeholder Outreach

Many groups, legislators, and businesses have an interest in the I-65/I-264 Interchange Planning Study. In advance of each public meeting, a virtual meeting was held with key stakeholders and elected officials to preview planned meeting information and gather feedback. The stakeholder meetings addressed the same topics and presentations as the subsequent public meeting. Feedback from stakeholders was used to update planned public meeting content. The first virtual stakeholder meeting was held on May 14, 2020 and the second virtual stakeholder meeting was held on October 20, 2020.

In addition to these virtual stakeholder meetings, several smaller meetings with individual stakeholder groups were held to gather additional feedback. These included meetings with the Kentucky Air National Guard (July 1, 2020), The Kentucky Fair and Expo Center (Kentucky Venues) (August 10, 2020), the Louisville Muhammad Ali International Airport (June 10, 2020), and UPS (June 17, 2020).

4.2 Public Involvement/Meetings

Two public involvement period/meeting opportunities were held over the course of the study, the first was to gather feedback with regards to existing conditions, and the second to gather feedback with regards to the potential improvement strategies. Both open public involvement periods were held virtually and allowed for review of the project information during a 30-day period. During each public involvement period, the public had opportunity to receive project information and provide feedback. The public meeting details are included in the Public Involvement Notebook in **Appendix H.**

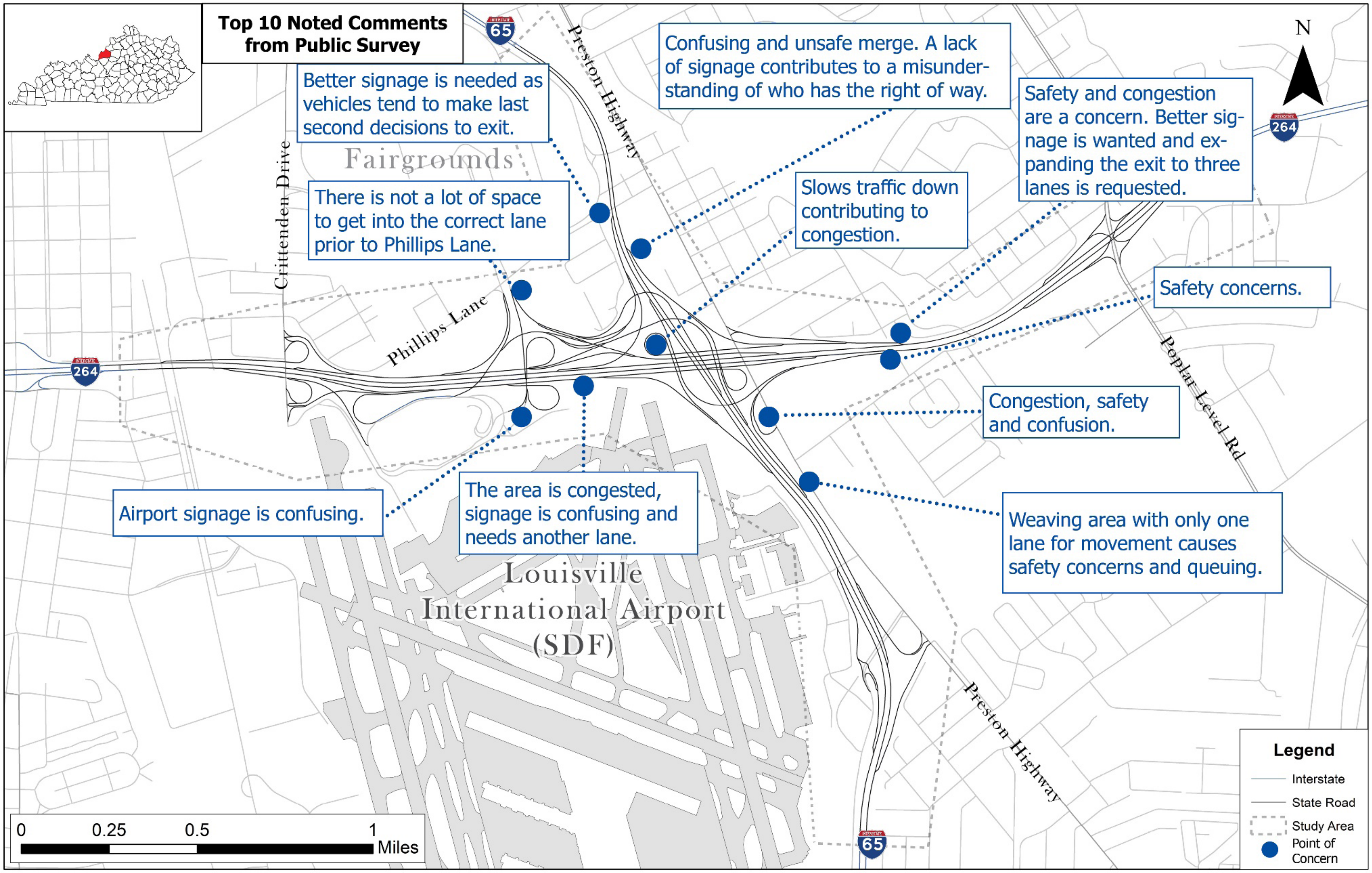
4.2.1 Public involvement/Meeting #1

The first public involvement phase was held from May 20, 2020 until June 20, 2020. The project team produced a video that gave an overview of the project as well as information outlining existing conditions. Both were made available on KYTC's website, along with a MetroQuest survey that allowed the public to identify issues in the study area as well as to rank priorities. More than 1,000 people watched the project overview video and there were 360 responses to the MetroQuest survey. ***Figure 19*** shows the top issues identified by the public.

4.2.2 Public involvement/Meeting #2

The second public involvement phase was held from October 21, 2020 until November 22, 2020. Information available for review outlined concept development and presented the potential improvements for the study area. The project team produced fact sheets that outlined both short- and long-term potential improvement solutions, as well as several short videos that provided additional detail. The videos and brief descriptions were housed on a Question Pro website, which gave participants the opportunity to provide feedback on the potential improvement strategies. The videos received over 3,100 views and 106 unique surveys were completed.

Figure 19: Top Issues Identified by the Public



4.3 Resource Agency Coordination

Resource agency coordination was important for the study and included coordinating with state, local, and federal agencies. The project team developed a list of agencies and contacts which include both resource agencies and stakeholders. The stakeholders are representatives of businesses, city services, elected officials, and local groups and entities including: City of Audubon Park, City of Lynnview, Greater Louisville Inc., Jefferson County Public Schools, Kentucky Chamber of Commerce, Kentucky Trucking Association, Louisville Independent Business Alliance, Louisville Tourism, and the South Louisville Business Association. A project summary and map to summarize the environmental overview was provided to the Resource Agencies so they could provide comment. Resource Agency/Stakeholder Listing and Agency response comments are included in **Appendix I**.

4.3.1 Summary of Resource Agency Responses

The following agencies provided a response to the request for comment. A brief summary is provided. Full summaries/responses from each agency are included in **Appendix I**.

- Cabinet for Health and Family Services (CFHS), Division of Prevention and Quality Improvement – Response from Troy Hearn, Health Program Administrator.
  - Troy provided a very detailed Health Impact Assessment.
- Kentucky Heritage Council (KHC), State Historic Preservation Office – Response from Craig Potts, Executive Director and State Historic Preservation Officer.
  - Suggested contacting KHC and Office of State Archaeology for preliminary site checks.
- Kentucky State Police – Response from Major Matthew J. Johnson, West Operations Division Director.
  - Requested that efforts be made to reduce high congestion in this area, particularly with special event dates.
- U.S. Dept. of Agriculture, Natural Resources Conservation Service – Response from C. Gregory Stone, State Conservationist and Perri Pedley, Soil Scientist.
  - Requested that additional information be provided once projects are moved into study or draft design stages.
- Federal Motor Carrier Safety Administration – Response from Linda Goodman, Division Administrator.
  - No comments regarding the project.
- Kentucky Department of Natural Resources, Division of Conservation – Response from Paulette Akers.
  - No purchase of agricultural conservation easements or agricultural districts in the area of potential the construction.
- Kentucky Energy and Environment Cabinet, Department for Environmental Protection – Response from Louanna Aldridge, Staff Assistant in the Office of the Commissioner.
  - Provided contact listing for Division of Water and Division of Waste Management Branches.
- U. S. Army Corps of Engineers, Louisville District – Response from Norma Castillo Condra, Project Manager.
  - Provided details for obtaining Department of Army Permit for work in or near "waters of the U.S.".

5

LOW-COST SAFETY COUNTERMEASURES

5.1 Low-Cost Safety Improvement Strategy Development

Seven low-cost improvement strategies were developed to address the safety concerns and infrastructure deficiencies identified in the safety analysis and during the public involvement process. These improvement strategies address crashes that are attributed to interchange complexity and single vehicle crashes in the study area. Additionally, the proposed improvements are expected to improve the specific safety concern on southbound I-65 at the lane drop to eastbound I-264.

The seven low-cost safety improvement strategies identified for this project are listed in the following sections. Project sheets that summarize each improvement strategy are included in Chapter 8.

5.1.1 Guide Signage

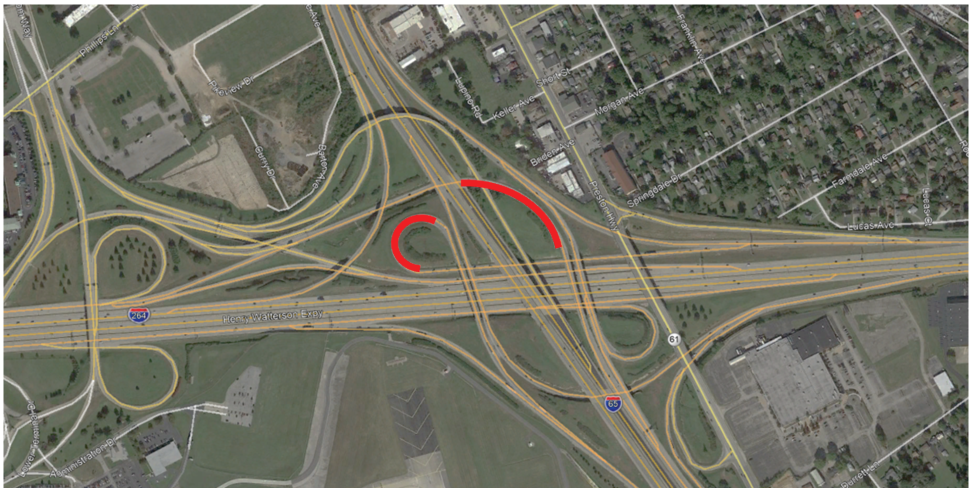
Install new guide signage to help drivers identify their destination by incorporating improved messaging, high-visibility retroreflective sheeting, symbols for popular destinations, consistent designations for exit-only lanes, and overhead arrow-per-lane signage. The improved signage will help drivers identify proper lane position to navigate the study area and reduce unnecessary/last minute lane changes. An example guide sign is provided in **Figure 20**.

Figure 20: Guide Sign Example

5.1.2 High Friction Surface Treatment

Install skid-resistant pavement treatment and diagonal pavement markings along the shoulders of the curves of the ramps from northbound I-65 to westbound I-264 and from westbound I-264 to southbound I-65. The High Friction Surface Treatment will prevent roadway departures and the diagonal pavement markings would give drivers visual cues to slow down in the curve. The proposed High Friction Surface Treatment locations are identified in **Figure 21**.

Figure 21: Segments benefitting from High Friction Surface Treatments



5.1.3 Elongated Pavement Markings (Pavement Tattoos)

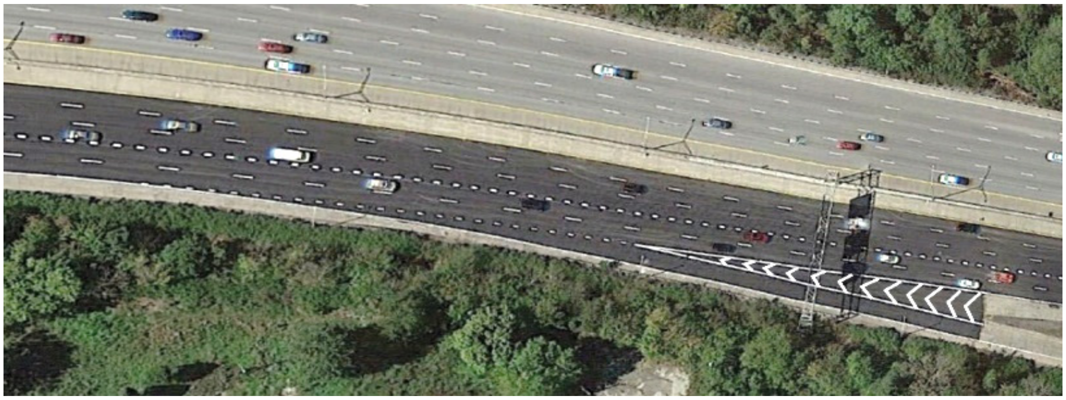
Install shield markings directly on the roadway to identify destinations without drivers needing to look away from the roadway. An example of these pavement tattoos is provided in **Figure 22.** To improve visibility of the markings consider using a black background and avoid installation on downward slopes. This improvement strategy should be used in conjunction with guide signing to help drivers identify proper lane position to navigate the interchange and reduce unnecessary/last minute lane changes.

Figure 22: Elongated Pavement Marking (Pavement Tattoo)

5.1.4 Enhanced Striping

Update roadway markings to improve delineation in places where drivers make decisions including merges, diverges, and places where lanes are added or dropped. An example of enhanced striping is provided in **Figure 23**. The new striping should include dotted lane line extensions and chevron markings in the gore areas. The recommended striping would improve delineation and reduce crashes at decision points throughout the interchange.

Figure 23: Enhanced Striping



5.1.5 Black Contrast Striping

Install black contrast striping over the current roadway markings to improve visibility of lane markings in areas where pavement is lightly colored and subject to glare from the sun as depicted in **Figure 24**. Black contrast striping would help drivers see lane markings.

Figure 24: Black Contrast Striping

5.1.6 Guardrail

Replace all existing guardrail and end treatments throughout the study area. New guardrail should adhere to the current KYTC and MASH standards. The upgraded guardrail would improve roadside safety and reduce crash severity in the event of a roadway departure.

5.1.7 Lighting

Install new LED lighting along ramps that are not included in the statewide lighting contract to improve interstate lighting. This includes the ramps from northbound I-65 to westbound I-264, southbound I-65 and Poplar Level Road Interchange to eastbound I-264, and westbound I-264 to southbound I-65. The new system will include new standard cobra arm mounted LED fixtures, new LED wall pack lighting under bridges, new conduit, wiring, and light pole bases, and additional items to address the possibility of encountering rock. Increased lighting levels improve visibility for drivers at night and upgraded uniformity will reduce the occurrence of blind spots that result from sudden changes in lighting levels.

Safety concerns that could not be addressed with low-cost improvements are addressed with the long-term improvement strategies as discussed in Chapter 6.

6 POTENTIAL LONG-TERM IMPROVEMENT STRATEGIES DEVELOPMENT

Potential long-term improvement strategies were developed based on the detailed analyses of roadway conditions and deficiencies, the traffic operations and safety analysis, comments received from the public, and a project team brainstorming session. Three major improvement strategies were identified to address the deficiencies of the I-65/I-264 interchange. Each of the three potential strategies address different needs in the study area:

- Potential Improvement Strategy A addresses issues along I-264 eastbound including movements onto the Collector-Distributor (CD) prior to I-65 and the merge onto I-264 eastbound from I-65 and the I-65 northbound CD. There are three variations that were explored.
- Potential Improvement Strategy B addresses a major generator of congestion in the study area, the westbound I-264 to I-65 southbound loop ramp.
- Potential Improvement Strategy C addresses safety, congestion, and driver confusion on I-65 southbound by reconfiguring the I-65 southbound exits to I-264 westbound and eastbound.

Each of these solutions are described in further detail in the following section.

6.1 Potential Improvement Strategy A

Three variations of Potential Improvement Strategy A were modeled to evaluate the change in congestion on I-65 northbound by modifying the access to I-264 eastbound from Preston Highway. As part of the "A" improvement strategies, the existing location of the I-264 eastbound CD merge onto the I-264 eastbound mainline is relocated. Exit 12, I-264 eastbound to the eastbound CD, as it exists, merges onto the CD from the left. Improvement Strategy A realigns Exit 12 to fly over the CD roadway before merging from the right to lower the number of vehicles weaving at the ramp entering eastbound 264 from the airport. Finally, the CD's on-ramp back to the mainline I-264 eastbound is relocated, proposed to merge before crossing under the overpass for I-65 southbound. All of the improvement strategies at Preston Highway were developed in conjunction with the change to the eastbound CD. The CD modification for Potential Improvement Strategy A is shown in ***Figure 25***.

Potential Improvement Strategy A-1 (***Figures ES-2*** & ***ES-4***) closes the northbound I-65/eastbound I-264 ramp from Preston Highway. The ramp from I-65 northbound to I-264 eastbound is widened to two lanes. Lastly, the I-65 southbound traffic merges directly onto I-264 eastbound, west of the current merge location, changing the merging pattern. ***Figure 26*** shows Potential Improvement Strategy A-1.

Potential Improvement Strategy A-2 (***Figures ES-2*** & ***ES-5***) moves the on-ramp from Preston Highway to I-264 eastbound to the north, making it part of a partial tight diamond interchange. The I-65 northbound exit ramp to I-264 eastbound is widened to two lanes in this scenario as well. Vehicles from I-65 northbound merge with the traffic from I-65 southbound as they currently do, without the merge from Preston Highway. Potential Improvement Strategy A-2 is shown in ***Figure 27.***

Potential Improvement Strategy A-3 does not close the Preston Highway ramp access or widen the I-65 northbound ramp to I-264 eastbound to two lanes but moves the I-65 southbound ramp to merge with I-264 eastbound to the west of the current merge location. The I-65 northbound and Preston Highway ramp remains as a two-lane on-ramp to merge with I-264 eastbound as shown in ***Figure 28***.

Figure 25: CD Modification for Potential Improvement Strategy A

Figure 26: Potential Improvement Strategy A-1

Figure 27: Potential Improvement Strategy A-2

Figure 28: Potential Improvement Strategy A-3

6.2 Potential improvement Strategy B

Potential Improvement Strategy B (***Figure ES-6***) addresses an issue identified by both the collected data and public feedback: slow vehicle traffic regularly on I-264 westbound due to the tight radius of the I-264 westbound ramp to I-65 southbound. This strategy improves the radius of the loop ramp from I-264 westbound to I-65 southbound and moves the traffic using this ramp from Exit 12, I-264 westbound to Preston Highway/I-65, to Exit 11, I-264 westbound to Crittenden Drive and Airport/Fair/Expo Center. The loop ramp would become an add lane of traffic to I-65 southbound just north of the bridge over I-264. By improving the radius of the loop ramp and separating this exit from the Preston Highway and I-65 northbound exit, sight distances would be improved and the weave between Poplar Level Road and I-65 would be improved, which would reduce driver confusion and result in better traffic flow. A positive with this improvement strategy is that the I-65 southbound to I-264 eastbound ramp can use the bridge from the I-264 westbound to I-65 southbound loop ramp to improve the radius and sight distance. ***Figure 29*** shows Potential Improvement Strategy B.

6.3 Potential Improvement Strategy C

Potential Improvement Strategy C addresses I-65 southbound in the northern section of the study area. Data and public opinion suggest driver confusion is a serious issue on southbound I-65 approaching the exit ramps to I-264. This potential improvement strategy reconfigures the I-65 southbound exits to I-264 westbound and eastbound. The I-264 westbound exit is removed from Exit 131B and joins with the I-264 eastbound Exit 131A, just north of its existing location on southbound I-65. This results in two exits: Exit 131B to the Fair/Expo Center and Exit 131A to I-264 westbound and I-264 eastbound. The improvement allows more time and distance for better driver decision making and smoother ramp movements. Potential Improvement Strategy C is shown in ***Figure 30***.

Figure 29: Potential Improvement Strategy B

Figure 30: Potential Improvement Strategy C

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7

POTENTIAL IMPROVEMENT STRATEGIES EVALUATION

The potential improvement strategies were evaluated using criteria that includes traffic, safety, environmental, right of way, constructability, public feedback, cost estimates, and benefit-cost ratio. Traffic and safety analyses are the quantitative data used to calculate the B/C ratio. Environmental and right of way impacts, constructability, public feedback, and cost estimates are qualitative measures used in determining their feasibility and whether solutions are short- or long-term projects. The criteria are discussed in the following sections.

7.1 Traffic Analysis

The traffic analysis included collecting traffic volume data along the interstate mainlines and ramps as well as StreetLight origin-destination (O-D) data. Traffic volumes were balanced throughout the study area and forecasted to design year 2045. A growth rate was calculated based on the KIPDA regional travel demand model. A linear growth rate of 0.21 percent was used for the study area. The Traffic Forecast Report is found in **Appendix C**.

A dynamic assignment microsimulation traffic model was developed in VISSIM 10 utilizing a multi-resolution modeling approach. This KIPDA regional travel demand model was used to extract a subarea network that incorporates the travel patterns of the region. StreetLight data was acquired and an iterative process that accounts for the travel patterns from the KIPDA model, the origins and destinations from StreetLight, and the balanced network traffic volumes, was performed to create a seed matrix for the dynamic assignment traffic model. The model was then coded into VISSIM and run multiple times until an equilibrium was reached, providing base year O-D matrices. The microsimulation model underwent several layers of calibration, both quantitative and qualitative, to ensure the best possible reflection of existing network conditions to model conditions. A Model Calibration memo in **Appendix J** describes the efforts taken. Base model conditions and the results of the existing condition models are also discussed in the Model Calibration memo. Model files were submitted to KYTC electronically.

Once the base year model was calibrated, the growth rate developed in the traffic forecast was applied to model entry volumes, and the dynamic assignment model was run again to establish design year O-D matrices. Design year traffic volumes are included in **Appendix C** and were used as the basis for the design year traffic analysis. The model results from each potential improvement strategy are discussed in Section 7.1.1. The following symbols denote positive, negative, and neutral results.

- Positive Results
- Neutral Impact
- Negative Results

7.1.1 2045 Model Results

Five potential improvement strategies were modeled in addition to the No-Build, under three main improvement strategy objectives, detailed in Section 6. An in-depth build analysis of the models is found in the 2045 Interchange Model Results in **Appendix J**. Data collected to evaluate effectiveness includes volume throughput, speed, density, and an overall network performance evaluation. To gain an understanding of the impacts of the potential improvements, only the segments that are directly affected by each build model were compared to the equivalent segments in the No-Build model. For example, Potential Improvement Strategy A aims to improve the I-264 eastbound weave and the upstream segments leading into it, as well as the I-65 northbound CD weave approaching the exit to I-264 eastbound. Therefore, the only segments evaluated in Potential Improvement Strategy A are those segments directly impacted by the proposed geometric changes and where it ties back in with the No-Build conditions.

POTENTIAL IMPROVEMENT STRATEGY A SUMMARY

Figure 31 shows the segments affected by the "A" improvement strategies and ***Table 4*** details the peak hour measures of effectiveness (MOEs) with respect to density, speed, and volume along those segments. ***Table 5*** compares the following metrics for the entire model network for each potential improvement strategy:

- Average delay per vehicle
- Average number of stops per vehicle
- Average speed per vehicle
- Number of vehicles that have reached their destination before the end of the simulation.

Potential Improvement Strategy A-1

- Improves LOS (E to B and C), speed (upwards of 40 mph), and volume throughput (upwards of 20 percent) along the I-65 northbound CD and weave section approaching the exit ramp to I-264 eastbound.
- Reduces level of service and speeds decrease by approximately 10 mph on each of the freeway and merge segments at the new location of the I-65 southbound merge onto I-264 eastbound, however volume throughput is not impacted.
- Average delay across all vehicles in the network decreases by approximately 60 seconds, average number of stops per vehicle decrease by approximately 35 percent, and the average vehicle speeds increase by 20 percent.

Potential Improvement Strategy A-2

- Improves LOS (E to B and C), speed (upwards of 38 mph), and volume throughput (upwards of 17 percent) along the I-65 northbound CD and weave section approaching the exit ramp to I-264 eastbound.
- Reduces level of service on the freeway segment between the Preston Highway merge and the I-65 merge onto I-264 eastbound, however volume throughput is not impacted.
- Speeds along the I-264 eastbound CD decrease between 8 and 15 mph prior to the merge from the CD road onto I-264 eastbound mainline, however volume throughput is not impacted.
- Average delay across all vehicles in the network decreases by approximately 40 seconds, average number of stops per vehicle decrease by approximately 30 percent, and average vehicle speeds increase by 15 percent.

Potential Improvement Strategy A-3

- Improves speed on the weaving segment between I-65 and Poplar Level Road by 7 mph.
- Reduces level of service and speeds by approximately 15 mph on the freeway segment between the I-65 southbound and I-65 northbound/Preston Highway merge onto I-264 eastbound, however volume throughput is not impacted.
- Volume throughput along the I-65 northbound CD and weave section approaching the exit ramp to I-264 eastbound is improved, however is still 10 percent below demand.
- Average delay across all vehicles in the network decreases by approximately 20 seconds, average number of stops per vehicle decrease by approximately 10 percent, and average vehicle speeds increase by 7 percent.

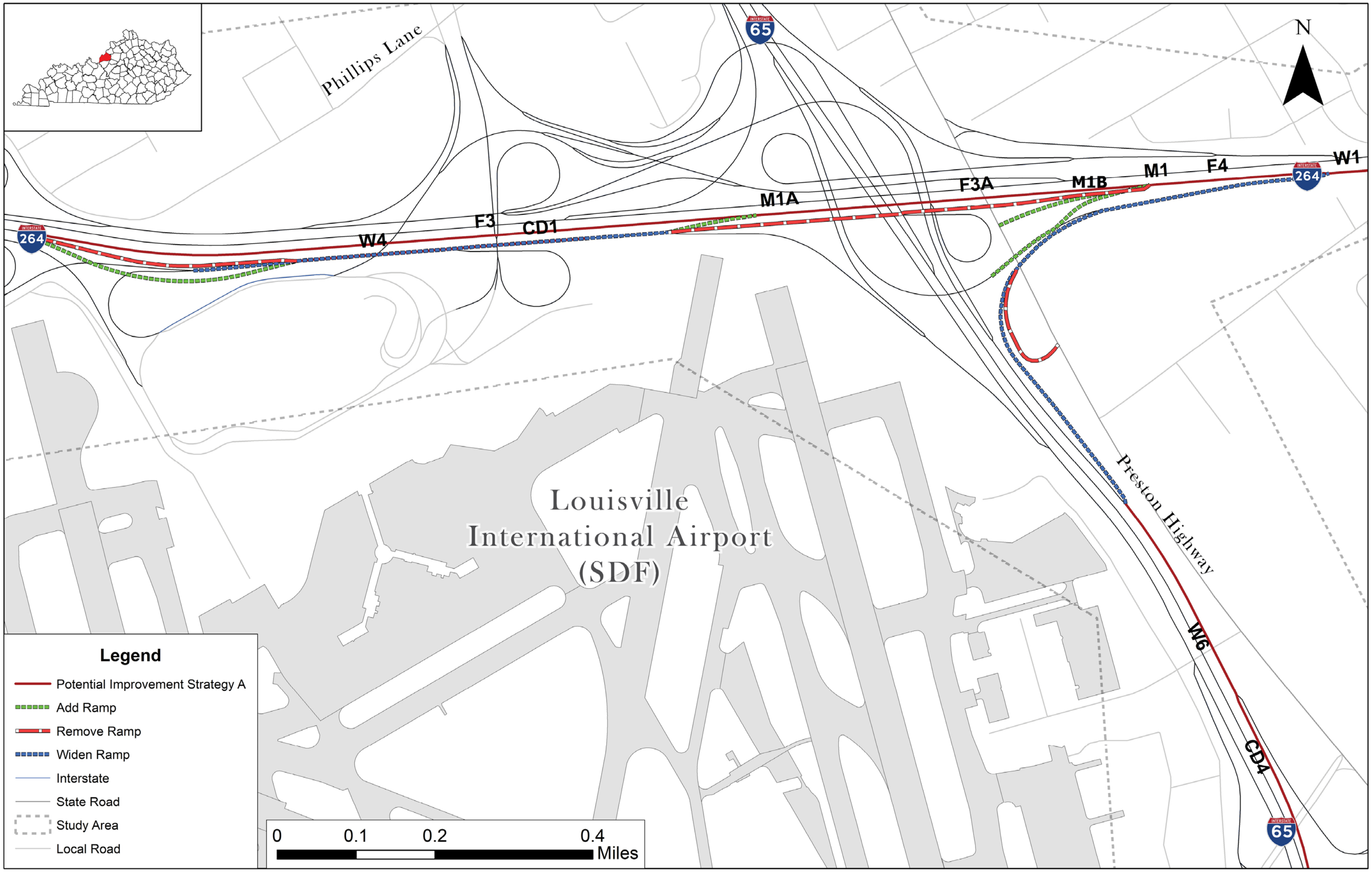
Table 4: Potential Improvement Strategy A Segment Comparison Results

Potential Improvement Strategy A			Density				Speed							Volume				
			No-Build LOS	Strategy A-1 LOS	Strategy A-2 LOS	Strategy A-3 LOS	No-Build	Strategy A-1 Speed	Strategy A-1 Speed Differential	Strategy A-2 Speed	Strategy A-2 Speed Differential	Strategy A-3 Speed	Strategy A-3 Speed Differential	No-Build	No-Build Processed vs. Expected	Strategy A-1 Proc. vs. Exp.	Strategy A-2 Proc. vs. Exp.	Strategy A-3 Proc. vs. Exp.
Key Segments	W4	I-264 EB CD Road b/w 3rd and Crittenden	E	E	E	E	34.0	34.1	0%	19.1	-44%	38.7	14%	3156	-2.1%	-1.9%	-2.2%	-1.4%
	CD1	I-264 EB CD Road	E	E	E	E	20.0	20.5	3%	12.6	-37%	22.6	13%	3037	-3.4%	-3.3%	-4.7%	-2.7%
	M1A	I-264 EB from PROPOSED CD Ramp	--	C	C	C	--	--	--	--	--	--	--	--	--	-0.8%	-1.5%	-0.8%
	F3/F3A	I-264 EB	C	D	C	C	58.5	49.9	-15%	56.5	-3%	57.0	-3%	3301	1.8%	-0.8%	-1.4%	-0.7%
	M1/M1B	I-264 EB from Airport	D	E	C	E	41.4	30.4	-27%	38.4	-7%	40.3	-3%	3959	-2.9%	-1.5%	-2.2%	-0.4%
	F4	I-264 EB	C	F	E	D	52.5	39.4	-25%	36.0	-31%	50.0	-5%	4052	-0.6%	-1.2%	-1.5%	-0.5%
	W1	I-264 EB between I-65 and Poplar Level Rd	E	E	E	E	35.8	30.9	-14%	21.4	-40%	43.0	20%	7212	-3.0%	0.0%	-1.4%	-0.9%
	CD4	I-65 NB b/w Preston Ramps	E	B	B	E	5.5	51.5	845%	50.7	830%	7.3	34%	2088	-23.4%	-2.8%	-3.1%	-10.1%
	W6	I-65 NB CD b/w Preston Hwy and I-264 EB Ramp	E	C	C	E	5.6	47.8	752%	43.8	682%	6.6	18%	2703	-20.3%	-2.4%	-2.5%	-10.8%

Table 5: Potential Improvement Strategy A Network Comparison Results

2045 Network Results	Avg Delay (s)	Avg Stops	Avg Speed (mph)	Vehicles Arrived
No-Build	200.2	21.7	23.0	33053
A-1	146.4	14.3	27.6	34146
A-2	158.0	15.4	26.4	33884
A-3	178.5	19.6	24.6	33439

Figure 31: Potential Improvement Strategy A Study Area Segments



POTENTIAL IMPROVEMENT STRATEGY B SUMMARY

Figure 32 shows the segments affected by Potential Improvement Strategy B and ***Table 6*** details the MOEs with respect to density, speed, and volume along those segments. ***Table 7*** compares metrics for the entire network and shows improvements in average delay, average number of stops, average speed, and the number of vehicles arrived (processed throughput). A summary of the findings is listed below.

Potential Improvement Strategy B

- In the 2045 No-Build, the weave along I-264 westbound prior to the exit to Preston Highway and I-65 experiences failure and single digit speeds and is unable to process over 20 percent of the vehicular demand. Potential Improvement Strategy B increases the networks ability to process the demand and improves the weave LOS from E to C, and increases average vehicle speeds by nearly 40 mph. The freeway segment past the I-65 northbound and Preston Highway exit sees a reduction in LOS from B to D, which is still acceptable, however speeds decrease by only 3 mph and the vehicular demand can be processed. The diverge from I-264 westbound to the Fairgrounds, Airport, Crittenden Drive, and I-65 southbound also experiences a reduction in LOS from B to E, and speeds are slowed to 32 mph, however there is an improvement of nearly 20 percent in processing vehicular demand. In summary, operations are greatly improved to the east of the I-65 interchange, and while the area between the Preston Highway/I-65 northbound and Fairgrounds/Airport/Crittenden Drive/I-65 southbound exits does experience increased density and reduced speeds and LOS, all of the vehicular demand is able to be processed through the interchange.

- LOS and speeds along I-65 southbound at the new merge location with the ramp from I-264 westbound do experience some reduction, however all vehicular demand is able to be processed and LOS and speeds are still at an acceptable level (LOS D and speeds close to 50 mph).

- Average delay across all vehicles in the network decreases by over 100 seconds, average number of stops per vehicle decrease by over 67 percent, and average vehicle speeds increase by over 40 percent.

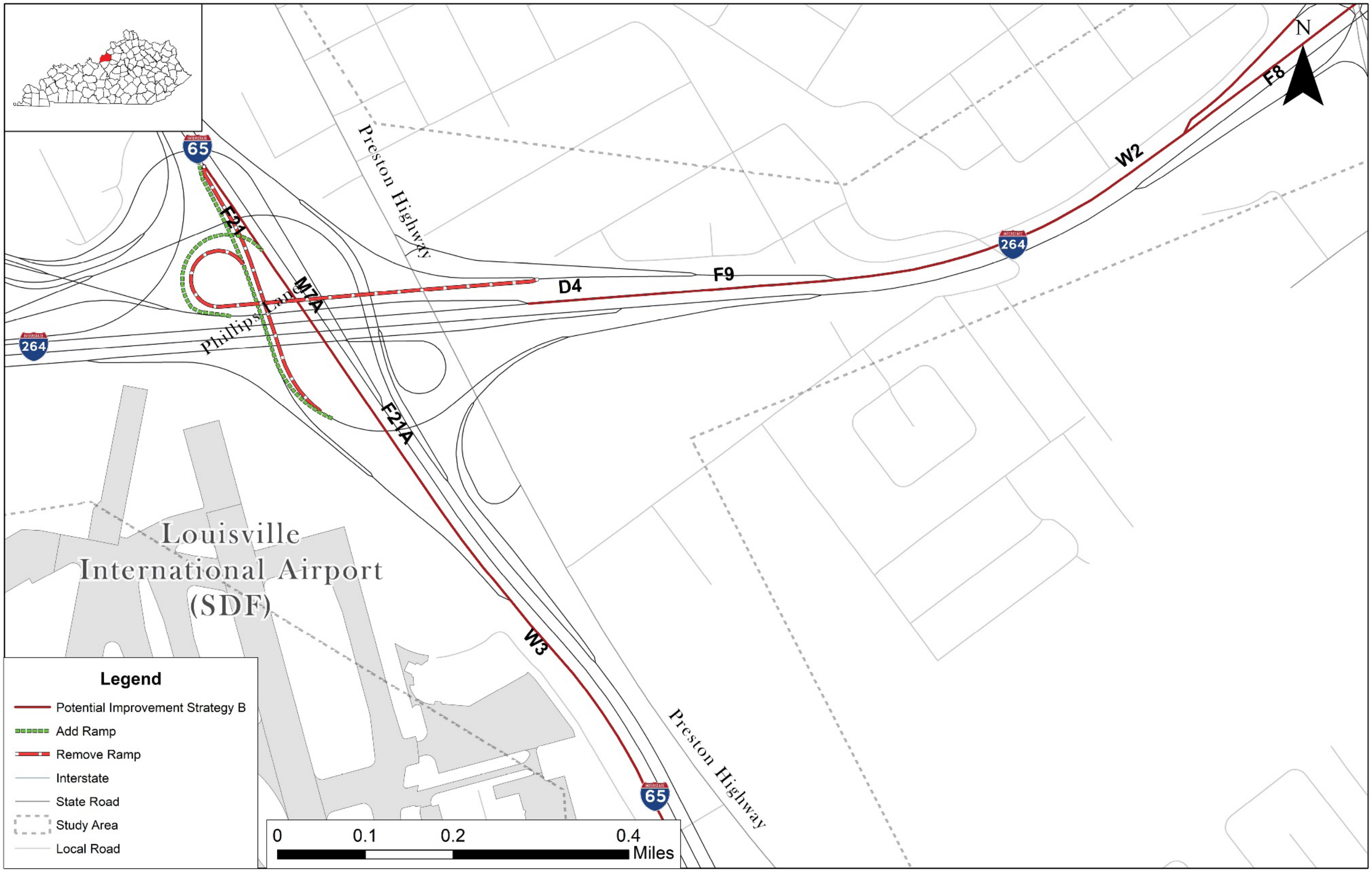
Table 6: Potential Improvement Strategy B Lane-Segment Comparison Results

Potential Improvement Strategy B			Density		Speed		Volume		
			No-Build LOS	Strategy B LOS	No-Build	Strategy B	No-Build	No-Build Processed vs. Expected	Strategy B Processed vs. Expected
Key Segments	F8	I-264 WB between Poplar Level Ramps	F	C	6.2	58.2	3584	-26.3%	-0.1%
	Acc. Lane at Poplar Level		E	C	5.4	51.7	4734	-22.8%	0.0%
	W2	I-264 WB between Poplar Level and I-65	E	C	8.5	47.2	4703	-23.3%	-0.4%
	F9	I-264 WB between I-65 and Phillips Lane	B	D	52.3	49.2	2852	-23.4%	-0.5%
	D4	I-264 WB Ramp to Phillips Lane	B	E	57.8	32.3	2811	-24.5%	-5.1%
	M7A	I-264 WB to I-65 SB	--	D	--	--	--	--	-0.6%
	F21/F21A	I-65 SB before I-264 EB Merge	C	D	57.2	49.2	4091	-0.6%	-0.6%
	W3	I-264 to I-65 SB	C	D	55.2	48.3	7091	-7.2%	-0.4%

Table 7: Potential Improvement Strategy B Network Comparison Results

2045 Network Results	Avg Delay (s)	Avg Stops	Avg Speed (mph)	Vehicles Arrived
No-Build	200.2	21.7	23.0	33053
B	98.1	7.1	33.2	34549

Figure 32: Potential Improvement Strategy B Study Area Segments



POTENTIAL IMPROVEMENT STRATEGY C SUMMARY

Figure 33 shows the segments affected by Potential Improvement Strategy C and *Table 8* details the MOEs with respect to density, speed, and volume along those segments. *Table 9* compares metrics for the entire network and shows improvements in average delay, average number of stops, average speed, and the number of vehicles arrived (processed throughput). A summary of the findings is listed below.

Potential Improvement Strategy C

- The diverge segment to the new combined I-264 exit ramp experienced an improvement in LOS from E to C as well as a nearly 20 mph speed improvement.
- Average delay across all vehicles in the network decreases by over 10 seconds, average number of stops per vehicle decrease by 6 percent, and average vehicle speeds increase by 3 percent.
- The main issue this potential improvement strategy addresses is driver confusion, which is difficult to recreate in microsimulation modeling due to vehicles running in a deterministic fashion, rather than how people function in real-life, which is much less predictable. Therefore, the tangible results of this strategy are not as obvious from the model results.

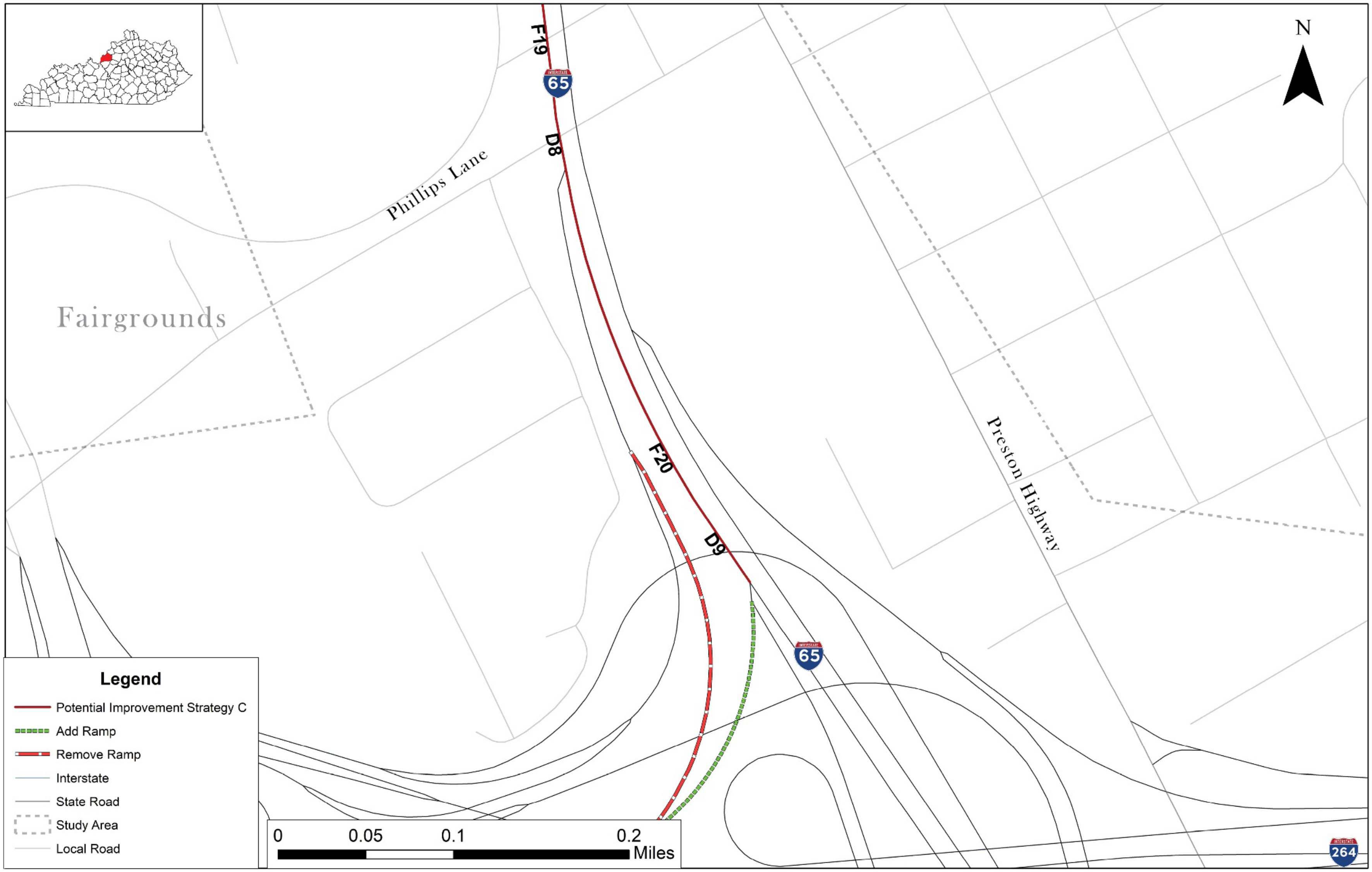
Table 8: Potential Improvement Strategy C Lane-Segment Comparison Results

Potential Improvement Strategy C				Density		Speed		Volume		
				No-Build LOS	Strategy C LOS	No-Build	Strategy C	No-Build	No-Build Processed vs. Expected	Strategy C Processed vs. Expected
Key	Segments	F19	I-65 SB before Phillips Lane Exit	C	C	58.4	58.3	5664	-0.1%	0.2%
		D8	Phillips Lane Exit from I-65 SB	C	C	57.2	57.5	5656	-0.2%	0.3%
		F20	I-65 SB after Phillips Lane Exit	D	D	52.1	47.1	5233	-0.8%	-0.7%
		D9	I-65 SB to I-264 EB	E	C	32.3	50.2	1181	2.1%	1.3%

Table 9: Potential Improvement Strategy C Network Comparison Results

2045 Network Results	Avg Delay (s)	Avg Stops	Avg Speed (mph)	Vehicles Arrived
No-Build	200.2	21.7	23.0	33053
C	189.9	20.3	23.7	32793

Figure 33: Potential Improvement Strategy C Study Area Segments



7.1.2 Delay Savings

Table 10 summarizes the realized delay savings along the network for each individual potential improvement strategy modeled, compared to the 2045 No-Build. The delay savings is calculated using the number of vehicles served over the evaluated peak hour in each model, multiplied by the average delay experienced over the same time. A time factor is used to adjust the vehicle-hours for the entire day. A weighted average delay cost rate is used to add a monetary value to the savings realized in the delay improvement. The delay savings, Person-$, is defined as the total cost saved by reduction in delay for all vehicles served in the model. The calculation utilizes two factors from the microsimulation model: vehicles served and average delay. The weighted factors for delay cost per vehicle type were derived from the FHWA and Consumer Price Index (CPI), updated in 2020.

Potential Improvement Strategy B experienced the greatest increase in vehicles served, as well as the greatest decrease in delay, resulting in the greatest delay savings. Throughout the study area, I-264 westbound approaching the interchange has been the greatest area of need for improvement. Realigning the I-264 westbound exit to I-65 southbound to increase the speed along the curve of the exit and relieving a portion weaving to the right at a single exit alleviates much of the issue in the existing conditions in the westbound direction causing the current level of queuing and delay.

Potential Improvement Strategy A shows successful results as well, in relieving the delay experienced by users in the network. A-1, which closes the Preston Highway ramp to I-264 eastbound and moves the expected volume from that ramp to the south to use the Preston Highway to I-65 northbound ramp, experiences the greatest improvement in delay and vehicles served. Improving the conflicting movements as vehicles progress from both northbound and southbound I-65 to I-264 eastbound as they approach the weave to Poplar Level Road is vital to serving vehicles in the network.

Potential Improvement Strategy C also illustrates the improvement that can be realized in the simple realignment of the I-65 southbound ramps to I-264.

Table 10: Potential Improvement Strategy Delay Savings Summary

	Future No-Build	Future Build	Daily		Yearly	
Potential Improvement Strategy	Total Peak Period Delay (veh-hrs)	Total Peak Period Delay (veh-hrs)	Daily Delay Savings (veh-hrs)	Daily Delay Savings (Person-$)	Yearly Delay Savings (veh-hrs)	Yearly Delay Savings (Person-$)
A-1	6,112	4,858	1,254	$42,552	313,509	$10,637,998
A-2		5,205	907	$30,783	226,801	$7,695,804
A-3		5,802	311	$10,544	77,683	$2,635,940
B		3,296	2,817	$95,577	704,177	$23,894,140
C		6,053	59	$2,014	14,840	$503,543

7.2 Safety Analysis

To prioritize the short-term safety improvement strategies, the project team reviewed the return on investment (ROI) while considering input from stakeholders and the public. The return on investment analysis was completed for each of the short-term improvement strategies outlined in Chapter 5. A safety analysis to determine the cost savings realized by the long-term potential improvement strategies was also performed.

7.2.1 Return On Investment Methodology For Short-Term Safety Improvement Strategies

The return on investment (ROI) analysis for short-term safety improvement strategies was completed by comparing the cost to implement the improvement strategy to the cost savings from the expected reduction in crashes. Cost estimates were developed that included the design, right of way, utility, and construction phases of the project. The cost savings from the expected reduction in crashes is derived from the cost of crashes by severity and the expected reduction in crashes for specific improvement strategies. This calculation assumed a five-year life span of the improvement strategy, before maintenance or re-installation would need to occur.

Research for low-cost safety improvement strategies is limited, therefore several strategies did not have sufficient data to estimate the associated reduction in crashes. For improvement strategies with limited data, the project team calculated the number of crashes to avoid realizing a positive ROI.

ROI for each short-term safety improvement strategy is summarized in **Table 11** and **Table 12**.

Table 11: Number of Crashes to Realize a Positive Return on Investment for Short-Term Improvement Strategies

Short-Term Safety Improvement Strategy	# of Crashes for Positive ROI* (no crash reduction information available)
Guide Signage	34
Elongated Pavement Markings	13
Enhanced Striping	22
Black Contrast Striping	15
Upgrade Guardrail	Reduce severity of 2 crashes from fatality or severe injury to property damage only. (Although upgraded guardrail will not reduce the number of crashes, it is expected to reduce the likelihood of a severe injury or fatality in the event of a roadway departure.)
Improve Lighting	4

* *Insufficient data to determine the amount of crashes that would be reduced by applying the countermeasure. The magnitude of the safety impact was shown by calculating the number of crashes that would need to be avoided to realize a positive return on investment.*

Table 12: Return on Investment for Short-Term Improvement Strategies

Short-Term Safety Improvement Strategy	ROI
High Friction Surface Treatment	2.4 (Both Ramps), 1.2 (westbound I-264 to southbound I-65), 3.3 (northbound I-65 to westbound I-264)

7.2.2 Long-Term Potential Improvement Strategies

The long-term potential improvement strategies are shown in Chapter 6. The safety analysis for the improvement strategies is shown in ***Table 13***. Crash modification factors (CMFs) are given for different improvement strategies. A different number of CMFs are associated with each improvement strategy, so the crashes per improvement is shown. To calculate the potential crash savings, the number of crashes on a given segment was multiplied by the CMF to find the reduction in crashes. That number was then subtracted from the total number of crashes, showing the number of crashes saved over a three-year timeline. To show the number of crashes saved per year, the previous number was then divided by three. To find the number of crashes saved per improvement strategy, all the crashes saved per improvement were summed. The average crash cost in the state of Kentucky, without a fatality or serious injury, is $18,159.[2] The cost savings for each improvement strategy was calculated by multiplying the number of crashes by the average crash cost.

[2] *Crash cost data was provided by KYTC Office of Highway Safety.*

Potential Improvement Strategy A has three variations, where A-1 and A-2 have the highest number of crash savings. Potential Improvement Strategies B and C could reduce crashes, but a CMF was not given for the improvements, thus the crash savings is $0.

Table 13: Long-Term Potential Improvement Strategy Crash Savings

Potential Improvement Strategy	Alternate Description	3-Year Crashes Along Segment	CMF Calcula-tion	Crashes Saved	Per Year		Cost Savings
A-1	Remove on ramp from Preston Highway	3.0	0.0	3.0	1.0	**10.1**	**$181,590.00**
	Widen ramp from one lane to two lanes	92.0	0.8	19.3	6.4		
	Ramp merges with I-264 eastbound directly, not with I-65 northbound/I-264 eastbound ramp	10.0	0.9	1.1	0.4		
	Remove off ramp; new off ramp as flyover to right side merge instead of left side merge	11.0	0.9	1.2	0.4		
	Long merge instead of through lane	28.0	0.9	3.1	1.0		
	Remove merge	24.0	0.9	2.6	0.9		
	Merge before I-65 instead of after	16.0	1.0	0.0	0.0		
A-2	Remove on ramp from west side of Preston Highway, add on ramp on east side of Preston Highway merging directly with I-264 eastbound	3.0	0.0	3.0	1.0	**9.8**	**$181,590.00**
	Widen ramp from one lane to two lanes	92.0	0.8	19.3	6.4		
	Remove off ramp; new off ramp as flyover to right side merge instead of left side merge	11.0	0.9	1.2	0.4		
	Long merge instead of through lane	28.0	0.9	3.1	1.0		
	Remove merge	24.0	0.9	2.6	0.9		
	Merge before I-65 instead of after	16.0	1.0	0.0	0.0		
A-3	Widen ramp from one lane to two lanes at Pres-ton Highway on ramp	92.0	0.8	19.3	6.4	**9.1**	**$163,431.00**
	Ramp merges with I-264 eastbound directly, not with I-65 northbound/I-264 eastbound ramp	10.0	0.9	1.1	0.4		
	Remove off ramp; new off ramp as flyover to right side merge instead of left side merge	11.0	0.9	1.2	0.4		
	Long merge instead of through lane	28.0	0.9	3.1	1.0		
	Remove merge	24.0	0.9	2.6	0.9		
	Merge before I-65 instead of after	16.0	1.0	0.0	0.0		
B-1	Remove off ramp combined with I-264 west-bound/I-65 northbound; New off ramp directly from I-264 westbound and connects directly to I-65 southbound	48.0	1.0	0.0	0.0	0.0	-
	Realignment of ramp to accommodate the other alternates.	17.0	1.0	0.0	0.0		
C-1	Remove ramp to I-264 westbound and realign to start with the I-264 eastbound	4	1	0	0	0.0	-

7.3 Constructability

Constructability was evaluated qualitatively, based on maintenance of traffic for construction. Factors taken into consideration include the amount of lane closures and length of time for construction. **Table 14** shows the ranking of each potential improvement strategy with regards to construction. A high ranking indicates that there will be more lane closures and longer construction time, while low indicates fewer lane closures and shorter construction time.

Table 14: Constructability of Long-Term Improvement Strategies

Improvement Strategy	Lane Closures	Length of Time	Overall Ranking
A-1	Medium	Medium	Medium
A-2	Medium	Medium	Medium
A-3	Medium	Medium	Medium
B-1	High	High	High
C-1	Low	Low	Low

7.4 Cost Estimates

Cost estimates were developed for both short- and long-term potential improvement strategies. **Table 15** shows planning level cost estimates for the short-term potential improvement strategies, and **Table 16** shows planning level cost estimates for the long-term potential improvement strategies. All costs are in 2021 dollars.

Table 15: Short-Term Potential Improvement Strategy Cost Estimates (2021 dollars)

Improvement Strategy	Design	Right of Way	Util-ities	Construction	Total
Improve Guide Signs	$250,000	$0	$0	$1,850,000	$1,900,000
High Friction Surface Treatment	$150,000	$0	$0	$1,000,000	$1,150,000
Pavement Tattoos	$100,000	$0	$0	$650,000	$750,000
Enhanced Striping	$170,000	$0	$0	$1,200,000	$1,370,000
Black Contrast Striping	$75,000	$0	$0	$500,000	$575,000
Guardrail	$300,000	$0	$0	$2,000,000	$2,300,000
Lighting Upgrade	$30,0000	$0	$0	$250,000	$280,000

Table 16: Long-Term Potential Improvement Strategy Cost Estimates (2021 dollars)

Improvement Strategy	Design	Right of Way	Utilities	Construction	Total
A-1	$1,875,000	$0	$105,000	$12,500,000	$14,480,000
A-2	$1,270,000	$0	$105,000	$12,700,000	$14,075,000
A-3	$1,230,000	$0	$105,000	$12,300,000	$13,635,000
B-1	$1,440,000	$0	$90,000	$9,600,000	$11,130,000
C-1	$645,000	$0	$50,000	$4,300,000	$4,995,000

7.5 Evaluation of Potential Improvement Strategies

An evaluation matrix was developed to highlight the comparison of quantitative and qualitative analyses results for each potential improvement strategy. Short-term countermeasures were prioritized based on the estimated total project cost, ROI, and comments from the stakeholders and other members of the public, and are included in **Table 17**, with green ranking the highest, orange ranking in the middle, and red ranking the lowest performance in each category**.**

Table 17: Short-Term Potential Improvement Strategy Evaluation Matrix

Potential Improvement Strategy	Public Feedback	Cost	# of Crashes for Positive ROI	B/C
Improve Guide Signs	High	$2,100,000	31	--
High Friction Surface Treatment	Medium	$1,150,000	--	2.4
Pavement Tattoos	High	$750,000	13	--
Enhanced Striping	Medium	$1,370,000	22	--
Black Contrast Striping	Low	$575,000	15	--
Upgrade Guardrail	Medium	$2,300,000	2*	--
LED Lighting Upgrade	High	$280,000	4	--

** Denotes the the number of crashes that must be reduced in severity (from fatal or severe injury to property damage only) to realize a positive return on investment.*

In addition to the detailed traffic and safety analysis, each long-term improvement strategy was evaluated qualitatively to determine the impacts to the environment and right of way, ease of constructability, and public feedback. These qualitative factors, along with the B/C ratio calculated from the traffic and safety analyses were used to select the potential improvement strategies to move forward to the next project phase. **Table 18** shows the matrix comparing the long-term potential improvement strategies, with green ranking the highest, orange ranking in the middle, and red ranking the lowest performance in each category.

Table 18: Long-Term Potential Improvement Strategy Evaluation Matrix

Potential Improvement Strategy	Environmental Impact	ROW Impact	Constructability	Public Feedback	Delay Savings	Safety Benefit	Cost	B/C
A-1	Low	Low	Good	High	$10,510,086	$181,590	$14,480,000	11.8
A-2	Low	Low	Medium	Medium	$7,603,269	$181,590	$14,075,000	8.8
A-3	Low	Low	Medium	Low	$2,604,245	$163,431	$13,635,000	3.2
B-1	Low	Low	Medium	High	$23,606,836	$0	$11,130,000	33.9
C-1	Low	Low	Poor	Low	$497,488	$0	$4,995,000	1.6

7.5.1 FHWA Performance-Based Measures

An additional consideration for the evaluation of potential improvement strategies is the impact each would have on the performance-based measures that Kentucky reports to FHWA. These measures include pavement and bridge condition, travel time reliability, excessive delay, non-single occupancy vehicle travel, and emissions. The purpose of the short-term strategies is to improve safety with low-cost countermeasures that can be implemented quickly with potential available Maintenance or Traffic funding, therefore these are not likely to greatly contribute to the FHWA performance-based measures. The long-term potential improvement strategies were evaluated with regards to delay and all five strategies resulted in a decrease in vehicle delay, with Potential Improvement Strategy A-1 reducing yearly vehicle delay by over 313,000 hours, and Potential Improvement Strategy B-1 reducing yearly delay by over 704,000 hours. Implementing these improvement strategies would provide a positive benefit to Kentucky's performance-based measures that relate to delay reduction, and by reducing delay would also reduce emissions.

7.5.2 Improvement Strategies to Move Forward

The project team used the results of the evaluation of potential improvement strategies to determine those to advance into the next phase of project development. **All seven of the short-term safety improvement strategies yield positive ROI (Return on Investment) and are recommended to be carried forward**. Long-term **Improvement Strategy A-1** has that highest B/C of the "A" improvement strategies, and ranked highest in public feedback and constructability, and is recommended to be carried forward. Additionally, due to previous public feedback with regards to closing the Preston Highway Ramp and the potential development of the Preston Highway area, it is recommended that Potential **Improvement Strategy A-2** be moved forward to Phase 1 Design for another round of public involvement. Potential Improvement Strategy A-3 is not recommended to move forward due to low scores from public feedback as well as a low benefit to cost ratio. Potential **Improvement Strategy B-1** has the highest B/C of all the long-term potential improvement strategies due to the significant reduction in delay. It also received positive feedback from the public, thus it is recommended to move forward. Potential Improvement Strategy C-1 does have a positive B/C, however it was not highly favored by the public, and the benefit for the cost is low comparatively, therefore C-1 is not recommended to move forward. All long-term improvement strategies that are recommended as part of this study can be moved forward concurrently or independently.

8

RECOMMENDED IMPROVEMENT STRATEGY PROJECT SHEETS

Project sheets were developed for each recommended improvement strategy. Each sheet includes information pertaining to the issue that the strategy addresses, details of what is included in the improvement strategy, the benefits realized by the improvement strategy, cost estimates, and a priority ranking. The intent of the short-term safety improvement strategies is to provide a safety improvement at a lower cost, before the long-term improvement strategies can be implemented. Therefore, these were ranked as either medium or high priority. The long-term improvement strategies are ranked in order of recommended priority for construction.

Improvement Strategy: Improve Guide Signage   Priority: High

Purpose: Improve safety at decision points through the I-65/264 interchange between mile points 129.3 and 131.6 on I-65 and mile points 10.6 and 13.4 on I-264.

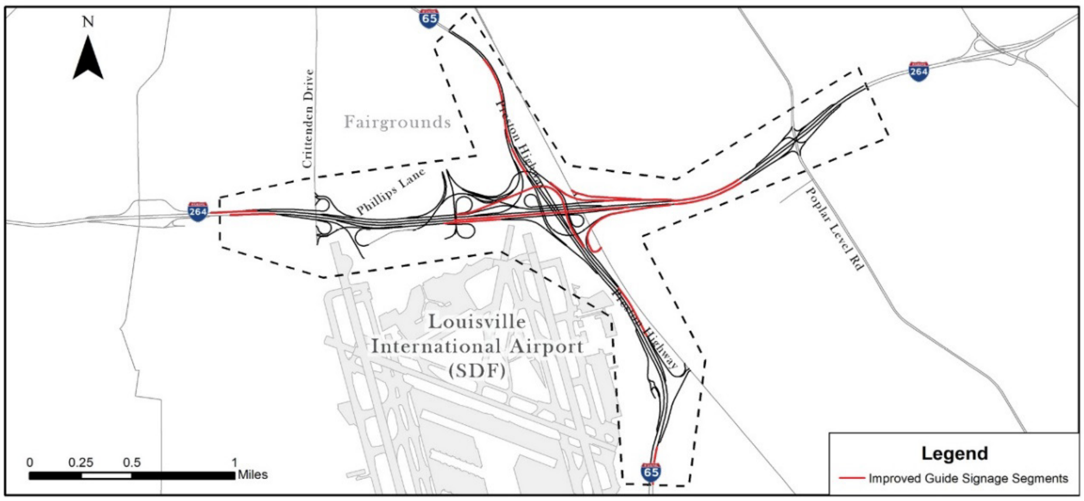
Identified Needs:

Safety

- Highest crash interchange in the KIPDA region (2016-2018, crashes = 2,099; EEC = 1,466)
- Interchange complexity identified as a major contributing factor to crashes at the interchange
- High crash segments 2016-2018 with dropped lanes or weaving areas:
    - Total crashes = 700 crashes, EEC = 550
- Public comments included confusion using guide signs to travel to the Airport and to the Fairgrounds.

Economic Growth

- The interchange serves major employers including: Muhammad Ali Louisville International Airport, UPS Worldport, Louisville Fairgrounds, Kentucky Kingdom, and the Kentucky Air National Guard.
- This systems interchange connects the UPS Worldport facility, an international air hub with the interstate system.



High crash segments that include dropped lanes or weaving areas (left).

Improvement Strategy: Install new guide signage throughout the interchange. New signs should use ASTM Type II sheeting, incorporate the airport symbol, improve message consistency, provide consistent use of exit only panels, and include new arrow per lane signage where appropriate.
This includes overhead, side panel, and directional signs. Limited sign truss and post replacement was assumed.

Return on Investment:

- No applicable CMF. However, improved signage will help drivers identify proper lane position to navigate the interchange and reduce unnecessary / last minute lane changes.
- Based on projected costs of crashes for 2020 and the distribution of crash severity within segments with dropped lanes or weaves, 34 crashes (1.6% of crashes of the overall interchange, and 4.8% of total crashes within segments with dropped lanes or weaving areas from 2016-2018) will need to be avoided to realize a positive return on investment.

Cost Estimate:

D: $250,000
U: $0
R: $0
C: $1,850,000

Total: $2,100,000

Improvement Strategy: High Friction Surface Treatment (HFST)

Priority: High

Purpose: Improve safety within the curves on the two ramps from Westbound I-264 to Southbound I-65 and Northbound I-65 to Westbound I-264 in Jefferson County.

Identified Needs:

Safety

- Highest crash interchange in the KIPDA region (2016-2018, crashes = 2,099, EEC = 1,466)
- Single Vehicle crashes listed as a top crash type for ramps from WB I-264 to SB I-65 and NB I-65 to WB I-264.
  - Total single vehicle crashes within these segments = 48
  - EEC of these Segments = 112
- Light poles frequently knocked over along these ramps, indicating single vehicle crashes may be under-represented.

Economic Growth

- The interchange serves major employers including: Muhammad Ali Louisville International Airport, UPS Worldport, Louisville Fairgrounds, Kentucky Kingdom, and the Kentucky Air National Guard.
- This systems interchange connects the UPS Worldport facility, an international air hub with the interstate system.

Conceptual locations for HFST along the ramps from WB I-264 to SB I-65 and NB I-65 to WB I-264 are shown in red (left).

Improvement Strategy: Install High Friction Surface Treatment (HFST) to increase traction along the ramps from WB I-264 to SB I-65 and NB I-65 to WB I-264. Additionally, install diagonal pavement markings along the shoulders of the curve to improve delineation and provide a visual cue to slow down.

Return on Investment (ROI):

- KY CMF 10341 – Install HFST on Ramps
- CMF = 0.202, Std. Error = +/- 0.018 (Single Vehicle Crashes)

ROI of HFST (5 – 8-year service life)

- Both Ramps = 2. 4 – 3.9
- WB I-264 to SB I-65 = 1.2 – 1.9
- NB I-65 to WB I-264 = 3.3 – 5.3

Cost Estimate Both Ramps:

D: $250,000
U: $0
R: $0
C: $1,750,000

Total: $2,000,000

Cost Estimate WB I-264 to SB I-65:

D: $100,000
U: $0
R: $0
C: $750,000

Total: $850,000

Cost Estimate NB I-65 to WB I-264:

D: $150,000
U: $0
R: $0
C: $1,000,000

Total: $1,150,000

Improvement Strategy: I-65/264 Elongated Pavement Markings (Pavement Tattoos)

Priority: High

Purpose: Improve safety by reducing crashes in dropped lanes and weaving areas at the I-65/264 interchange between mile points 129.3 and 131.6 on I-65 and mile points 10.6 and 13.4 on I-264.

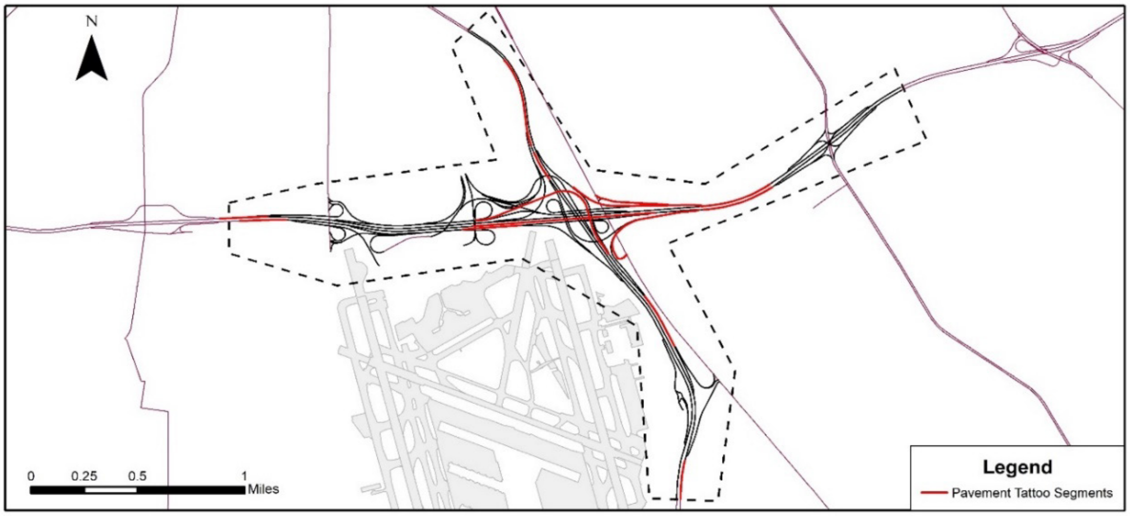
Identified Needs:

Safety

- Highest crash interchange in the KIPDA region (2016-2018, crashes = 2,099, EEC = 1,466)
- Interchange complexity identified as a major contributing factor to crashes at the interchange
- High crash segments 2016-2018 with dropped lanes or weaving areas:
  - Total crashes = 700 crashes, EEC = 550
- Public comments included confusion navigating the interchange.

Economic Growth

- The interchange serves major employers including: Muhammad Ali Louisville International Airport, UPS Worldport, Louisville Fairgrounds, Kentucky Kingdom, and the Kentucky Air National Guard.
- This systems interchange connects the UPS Worldport facility, an international air hub with the interstate system.



High crash segments that include dropped lanes or weaving areas (left).

Improvement Strategy: Install pavement tattoos to help drivers identify the correct lane to better navigate the interchange. Consider including a black background where possible, to improve the visibility of the marking. Avoid installation on downward slopes, to improve visibility. The pavement tattoos would be installed upstream of all dropped lanes and splits within the study area. The cost estimate assumes 50 individual markings.

Return on Investment:

- No applicable CMF. Pavement tattoos allow drivers to identify the correct lane of travel without looking away from the roadway and reduce unnecessary lanes changes and driver workload.
- Example sites include I-64/I-75 Interchange in Lexington, KY; I-64/I-65/I-71 Ohio River Bridges in Louisville, KY; I-71/I-75 at Brent Spence Bridge in Northern KY
- Based on projected costs of crashes for 2020 and the distribution of crash severity within segments with dropped lanes or weaves, 13 crashes (0.6% of total crashes, and 1.9% of crashes within segments with dropped lanes or weaving areas from 2016-2018) will need to be avoided to realize a positive return on investment.

Cost Estimate:

D: $100,000
U: $0
R: $0
C: $650,000

Total: $750,000

Improvement Strategy: Enhanced Striping   Priority: Medium

Purpose: Improve safety at decision points throughout the I-65/264 interchange between mile points 129.3 and 131.6 on I-65 and mile points 10.6 and 13.4 on I-264.

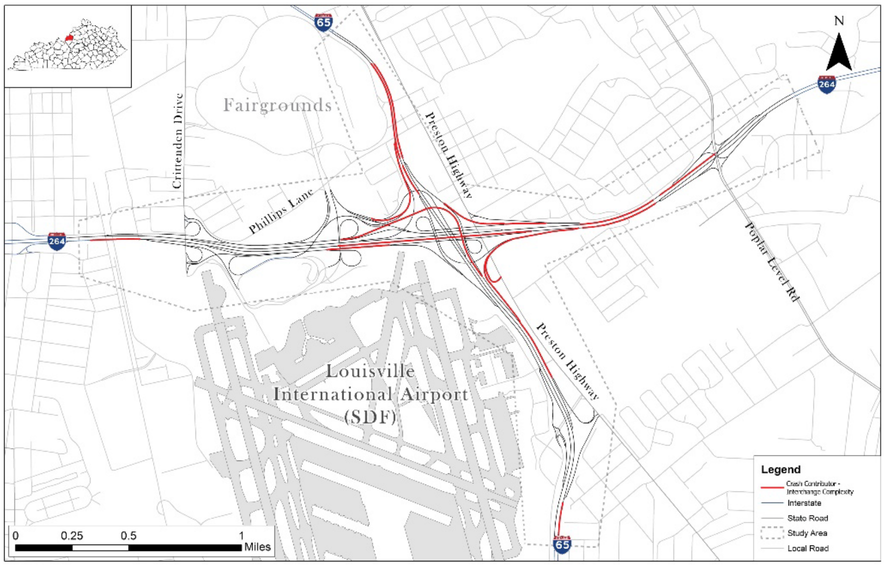
Identified Needs:

Safety

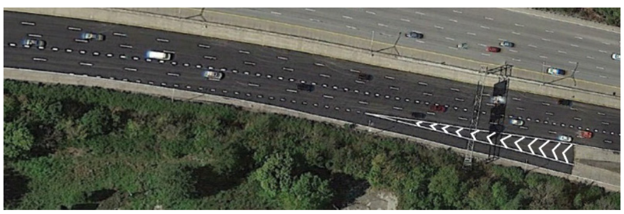
- Highest crash interchange in the KIPDA region (2016-2018, crashes = 2,099, EEC = 1,466)
- Interchange complexity was identified as a major contributing factor to crashes at the interchange
- High crash segments 2016-2018 with dropped lanes, added lanes, weaving areas, merges and diverges:
    - Total Crashes = 1,075, EEC = 834
- Enhanced striping has been implemented at select locations

Economic Growth

- The interchange serves major employers including: Muhammad Ali Louisville International Airport, UPS Worldport, Louisville Fairgrounds, Kentucky Kingdom, and the Kentucky Air National Guard.
- This systems interchange connects the UPS Worldport facility, an international air hub with the interstate system.



High crash segments that include dropped lanes, added lanes, weaving areas, merges and diverges (left).



Improvement Strategy: Update the striping at decision points (merges, diverges, add / drop lanes), per the most recent KYTC standard drawings. This will include the installation of skip markings, lane line extensions, and chevron markings to improve delineation and provide consistency at these locations.

Return on Investment:

- No applicable CMF. However, the updated striping will help drivers navigate the interchange, and prompt the appropriate responses at decision points.
- Based on projected costs of crashes for 2020 and the distribution of crash severity within segments with dropped lanes or weaves, 22 crashes (1% of total crashes, and 2% of total crashes within segments with dropped lanes or weaving areas for 2016-2018) will need to be avoided to realize a positive return on investment.

Cost Estimate:

D: $170,000
U: $0
R: $0
C: $1,200,000

Total: $1,370,000

Improvement Strategy: Black Contrast Striping Priority: Medium

Purpose: Improve safety at the I-65/264 interchange between mile points 129.3 and 131.6 on I-65 and mile points 10.6 and 13.4 on I-264.

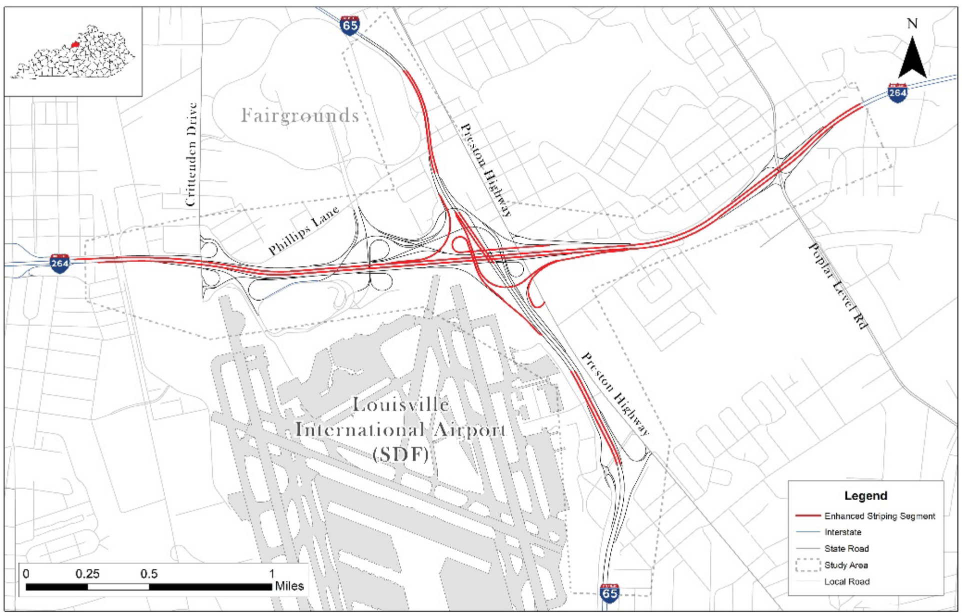
Identified Needs:

Safety

- Highest crash interchange in the KIPDA region (2016-2018, crashes = 2,099, EEC = 1,466)
- Sideswipe – Same Direction was the second highest crash type, representing 28% (593) of Total Crashes from 2016-2018

Economic Growth

- The interchange serves major employers including: Muhammad Ali Louisville International Airport, UPS Worldport, Louisville Fairgrounds, Kentucky Kingdom, and the Kentucky Air National Guard.
- This systems interchange connects the UPS Worldport facility, an international air hub with the interstate system.



Locations proposed for enhanced striping (left).

Improvement Strategy: Install black contrast striping on eastbound/westbound I-264 from MP 10.8 to 13.4, and on concrete surfaces on northbound/southbound I-65 at various locations between MP 130.0 and 131.2. The new striping will improve visibility of pavement markings on lightly colored pavement surfaces and in locations subject to sun glare.

Return on Investment:

- No applicable CMF. Improved visibility of striping will help drivers identify appropriate lane positions while navigating the interchange.
- Based on projected costs of crashes for 2020 and the distribution of crash severity within segments with dropped lanes or weaves, 15 crashes (0.7% of total crashes for 2016-2018) will need to be avoided to realize a positive return on investment.

Cost Estimate:

D: $75,000
U: $0
R: $0
C: $500,000

Total: $575,000

Improvement Strategy: Upgrade Guardrail — Priority: Medium

Purpose: Reduce severity of lane departures throughout the I-65/264 interchange between mile points 129.3 and 131.6 on I-65 and mile points 10.6 and 13.4 on I-264.

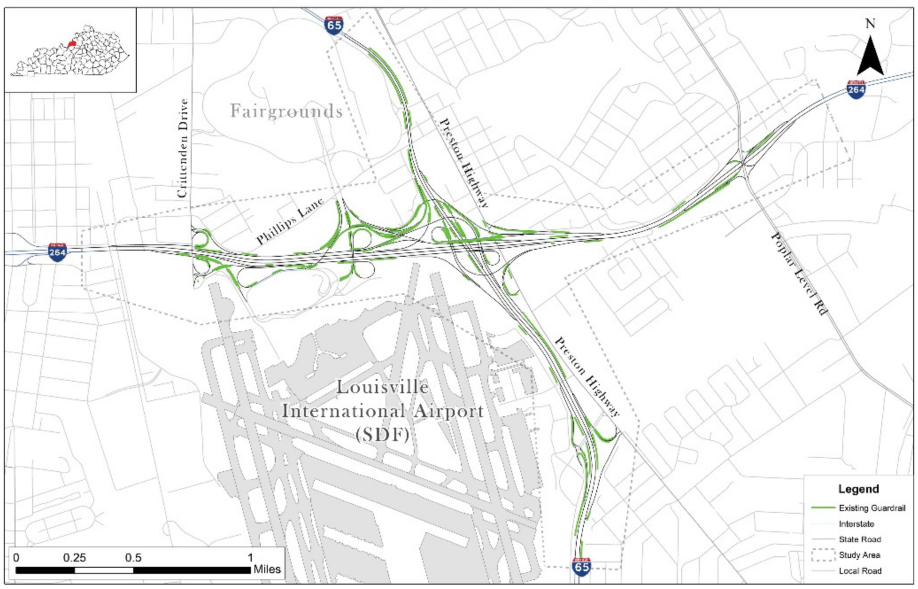
Identified Needs:

Safety

- Highest crash interchange in the KIPDA region (2016-2018, crashes = 2,099, EEC = 1,466)
- The Single Vehicle crash type represents approximately 11% of the total crashes (223)
- Existing guardrail infrastructure is aging, and pre-dates the Manual for Assessing Safety Hardware (MASH)

Economic Growth

- The interchange serves major employers including: Muhammad Ali Louisville International Airport, UPS Worldport, Louisville Fairgrounds, Kentucky Kingdom, and the Kentucky Air National Guard.
- This systems interchange connects the UPS Worldport facility, an international air hub with the interstate system.



Existing guardrail locations (left).

Improvement Strategy: Replace all existing guardrail and end treatments throughout the interchange. New guardrail should adhere to the latest KYTC standards. The new standards reflect the latest state of the practice for crash testing of safety hardware devices used on the national highway system.

Return on Investment:

- No applicable CMF.
- Although this improvement strategy is not expected to reduce the number of crashes, it is expected to reduce the likelihood of a severe injury or fatality event of a roadway departure.
- To realize a positive return on investment, the severity of two total crashes would need to be reduced from a fatality or severe injury to a property damage only.

Cost Estimate:

D: $300,000
U: $0
R: $0
C: $2,000,000

Total: $2,300,000

<u>Improvement Strategy:</u> Improved Lighting

Priority: High

Purpose: Improve safety during dark conditions throughout the I-65/264 interchange between milepoints 129.3 and 131.6 on I-65 and milepoints 10.6 and 13.4 on I-264.

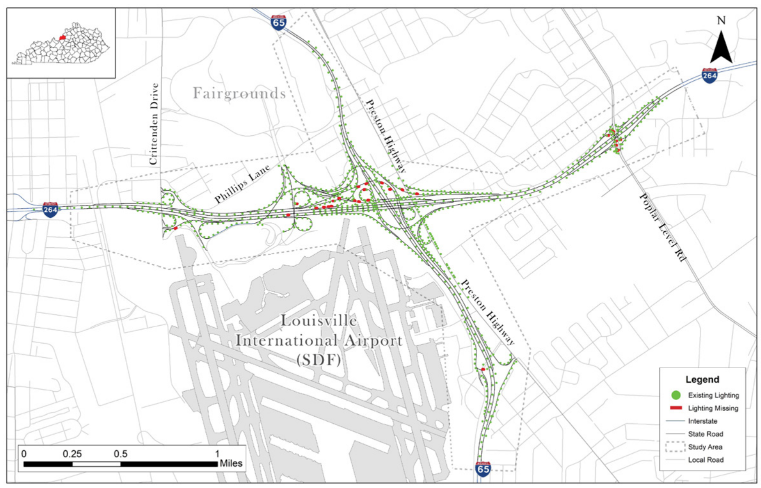
Identified Needs:

Safety

- Highest crash interchange in the KIPDA region (2016-2018 Total Crashes = 2,099, EEC = 1,466)
- Existing lighting system is outdated.
- Public comments and field observations indicate variations in lighting levels resulting in dark sections and poor uniformity.
- Light poles are frequently struck and difficult to maintain.
- There is an existing statewide lighting contract to improve interstate lighting. The project area was reviewed by District 5 to identify ramps that were not included in the scope of this project, but were identified as "Hot Spot" segments within the project area. This includes the ramps from northbound I-65 to westbound I-264, southbound I-65 to eastbound I-264, and westbound I-264 to southbound I-65 (segments 76, 89 and 80). (2016-2018 Total Crashes = 167, EEC = 148)

Economic Growth

- The interchange serves major employers including: Muhammad Ali Louisville International Airport, UPS Worldport, Louisville Fairgrounds, Six Flags Kentucky Kingdome, and the Kentucky Army National Guard.
- This systems interchange connects the UPS Worldport facility, an international air hub with the interstate system.



Locations of existing light poles and poles that have been knocked down (above).

Improvement Strategy: Install a new lighting system in along the ramps from northbound I-65 to westbound I-264, southbound I-65 to eastbound I-264, and westbound I-264 to southbound I-65. The new system will include new LED cobrahead lighting, new LED wall pack lighting under bridges, new conduit, new wiring, new light pole bases, and additional items to address the possibility of encountering rock.

Return on Investment:

- No applicable CMF. However, increased lighting levels improve visibility for drivers at night. Additionally, upgraded uniformity will reduce the occurrence of blind spots that result from sudden changes in lighting levels.
- Based on projected costs of crashes for 2020 and the distribution of crash severity within the segments included in the improvement strategy, 4 crashes (0.2% of crashes of the overall interchange, and 2.3% of total crashes along the three ramps included in this improvement strategy from 2016-2018) will need to be avoided to realize a positive return on investment.

***Cost Estimate*:**

D: $30,000

U: $0

R: $0

C: $250,000

<u>Total: $280,000</u>

Improvement Strategy A

Priority: 2

Purpose: Improve safety and reduce congestion of mainline I-65 northbound and the I-65 northbound to I-264 eastbound ramp by lane adjustments which will improve traffic flow.

Identified Needs:

Safety

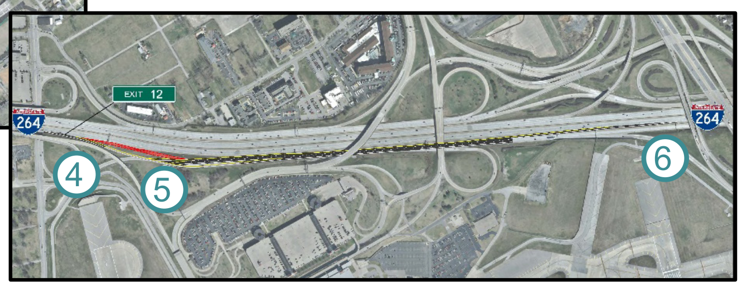
- Interchange complexity and multiple merge points identified as a major contributing factor to crashes.
- The dropped lanes or merging areas on the I-264 EB collector-distributor and I-65 NB to I-264 EB ramp totaled 266 crashes from 2016-2018.
- Public comments included confusion navigating the interchange.

Traffic Congestion

- Current Level of Service (LOS) F at the weave between I-65 and Poplar Level Road
- Average travel speeds are dropped by 10 mph on the I-65 SB to I-264 EB ramp during the peak hour, while the I-65 NB collector speeds are dropped by 25 mph.

Economic Growth

- The interchange serves major employers including: Muhammad Ali Louisville International Airport, UPS Worldport, Louisville Fairgrounds, Kentucky Kingdom, the Kentucky Air National Guard and connects the UPS Worldport facility with the interstate system.



The proposed concept [above] reduces merge areas and lane drops and relocates the entry from Preston Highway to I-264 EB. The proposed concept [right] reduces conflicting weave movements by introducing I-264 EB traffic on the right side of the C-D road.

*Improvement Strategy**:*

1. Remove ramp from Preston Highway to I-264 EB
2. Widen I-65 NB to I-264 EB ramp from one lane to two lanes
3. I-65 SB to I-264 EB ramp merges with I-264 before I-65 NB ramp to I-264 EB merges with I-264
4. Replace off ramp from I-264 EB to the Collector-Distributor with a flyover ramp to right side merge
5. Extend Crittenden Drive merge instead of through lane; removal of Terminal Drive merge
6. Collector-Distributor to merge with I-264 EB before I-65

**Numbering is used to identify the location of strategies, not to indicate priority or phasing.

Return on Investment:

- All merging related crashes from Preston Highway will be removed at this location.
- Crash Modification Factor (CMF) of 0.79 for improvement strategy #2 and CMF of 0.89 for improvement strategies #3, #4, and #5.
- With the CMF improvements, 10 crashes are projected to be avoided per year, resulting in a yearly savings of $181,590.
- VISSIM models show an average delay reduction of 41.5 seconds/vehicle, resulting in a yearly savings of $10.6 million.
- The total benefit/cost ratio is 11.8 for the 16-year project lifespan.

Cost Estimate:

D: $1,875,000
U: $105,000
R: $0
C: $12,500,000

Total:$14,480,000*

* Cost estimate includes the addition of a Preston Hwy ramp that merges onto I-264 EB as shown in Strategy A-2.

Improvement Strategy: B

Priority: 1

Purpose: Improve safety, traffic flow, and reduce driver confusion along I-264 westbound by adjusting the I-264 westbound to I-65 southbound loop ramp.

Identified Needs:

Safety

- Interchange congestion and complexity were identified as major contributing factors to crashes.
- The loop ramp from I-264 WB to I-65 SB causes heavy congestion resulting in 116 crashes from 2016-2018.

Economic Growth

- The interchange serves major employers including: Muhammad Ali Louisville International Airport, UPS Worldport, Louisville Fairgrounds, Kentucky Kingdom, the Kentucky Air National Guard and connects the UPS Worldport facility with the interstate system.

Traffic Congestion

- Current Level of Service (LOS) of F affecting the ramps, I-264 WB before the ramp, and I-65 SB after the ramp.
- Average travel speeds dropped by 25 mph during the peak hour on the I-264 WB segment leading into the loop ramp
- Public comments included frustration due to congestion and delay.

The proposed concept (right) improves the radius of the I-264 WB to I-65 SB ramp and the I-65 SB to I-264 EB ramp.

Improvement Strategy:*

1. Remove existing I-264 WB off ramp to I-65 SB; proposed off ramp from I-264 WB connects directly to I-65 SB with a wider radius.
2. Realignment of I-65 SB to I-264 EB ramp to improve sight distance and widen the curve.

*Numbering is used to identify the location of strategies, not to indicate priority or phasing.

Return on Investment:

- No Crash Modification Factor (CMF) available for improvement strategy #1 or #2.
- The proposed design improves conflicting weave movements and lane changes, which are the main factors contributing to crashes on this segment.
- VISSIM models show an average delay reduction of 89 seconds/vehicle, resulting in a yearly savings of $23.6 million.
- The total benefit/cost ratio is 33.9 for the 16-year project lifespan.

Cost Estimate:

D: $1,440,000
U: $90,000
R: $0
C: $9,600,000

Total: $11,130,000

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NEXT STEPS

Next steps following this study include identifying funding sources for recommended short-term improvement strategies, and Preliminary Engineering and Environmental Analysis for recommended long-term improvement strategies. Funding for the long-term improvement strategies will need to be included in Kentucky's FY 2020 – FY 2026 Highway Plan before additional development can begin.

9.1 Contacts / Additional information

Written requests for additional information should be sent to Mikael Pelfrey, P.E., Director, KYTC Division of Planning, 200 Mero Street, Frankfort, KY 40622. Additional information regarding this study can also be obtained from the KYTC District 5 Project Manager, Amanda Desmond, P.E., at 502-210-5400.

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