Purpose & Need Study
PLANNING FOR PROGRESS

I-44 Purpose and Need Statement

Purpose & Need | Technical Memos | Map Book

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I-44 Purpose and Need Statement

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Planning for Progress

The Interstate Highway System is often considered one of the most significant accomplishments of the 20th century. Interstate Route 44 (I-44) is one of the nation's oldest freeways and is a vital east-west link across Missouri. Started in 1956 and completed in 1966, I-44 has served Missouri well. Over the last few years, MoDOT has invested substantial resources in maintaining its existing operating condition. The "Smooth Roads Initiative" has kept roadway surfaces in good condition, has improved signage, and has installed guard cables. But none of these improvements have focused on how I-44 should be configured to meet the needs of Missourians in the future. Building on the experience accumulated from the *Improve I-70*[1] program, MoDOT has initiated the *Improve I-44* program.

How we are Studying I-44

MoDOT has committed itself to a comprehensive examination of I-44. Because of its statewide and national importance, I-44 needs to be investigated in a manner that permits the establishment and documentation of problems and for all options to be fully considered.

Consequently, the first product of the *Improve I-44* program is a Purpose and Need Statement – a document defining the magnitude of the transportation problems that affect I-44. The study area for this work extends across the state, from the outskirts of St. Louis to Oklahoma.

The definition of problems will allow for informed decision-making. Along with identifying the transportation problems that affect the I-44 transportation corridor, the Purpose and Need Statement also:

- Identifies the parameters that will be important for determining how well future alternatives address the identified transportation problems
- Investigates whether modal strategies have the potential for addressing the transportation problems
- Establishes logical termini
- Presents important environmental, planning, engineering, and traffic background data

The Problems on I-44

The Purpose and Need Statement identifies six main categories of transportation problems affecting I-44:

1) Roadway capacity is becoming inadequate for the expected demand.

2) There is a degrading safety environment on I-44.

3) Interchanges along I-44 have safety and operation issues and are inconsistent with current design standards.

4) Increases in freight (trucks) are altering operations on I-44.

5) Evolving engineering standards result in many portions of I-44 being inconsistent with current design standards.

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[1] See *Improvei70.org* for extensive information of how MoDOT has examined Interstate Route 70.

6) Improvements to I-44 will have both positive and negative impacts to some of the State's most valuable economic and natural resources. Balancing these impacts will be an important factor that must be considered when selecting solutions.

The Importance and Effects of Truck Travel on I-44

The effects of truck traffic on the operation of I-44 are wide-ranging. They represent a fundamental presence in at least three of the transportation problems identified in the I-44 Purpose and Need Statement. Relative to *roadway design*, I-44 is located through the rolling terrain of the Ozarks. In some locations, the uphill grades are long and steep enough to cause heavy vehicles to slow down markedly. Similarly, any other geometric issue tends to have the greatest impact on heavier and less maneuverable trucks. Truck traffic is also an important determinant in the *operational quality* of I-44. Because trucks are larger and slower, trucks have a disproportionately higher negative impact on traffic flow. Relative to the *crash environment*, the large number of trucks expressed itself not in the frequency of crashes, but in their severity. The likelihood of disabling injury crashes and fatal crashes doubles when trucks are involved.

Notwithstanding the disproportionate impact of trucks, the efficient movement of goods is essential to the American economy, and I-44 plays an important role in the shipment of materials. Moving goods by truck is the dominant mode of moving freight today because it provides fast, reliable, and competitively priced freight transportation service that can be tailored to the needs of shippers and receivers.

Nationally, I-44 is a key commercial trucking corridor as it, along with I-40, is part of an interstate connection between Missouri and southern California. Within Missouri, I-44 is part of an important commercial trucking corridor because of the link it provides to St. Louis, a major multimodal freight hub.

Freight trucking is a vital element of Missouri's economy and a key component of the I-44 traffic stream. As such, future I-44 studies should investigate solutions that best accommodate the anticipated truck volumes.

Other Key Facts about I-44 Truck Traffic

- Freight moved by trucks in Missouri is expected to reach 542 million tons per year, with a value of 730 billion dollars, by 2020.
- In Missouri, approximately 70 percent of all freight, by tons and value, is moved by trucks.
- Currently, the I-44 traffic stream is comprised of approximately 27 percent trucks.
- Along some sections of I-44, truck volumes in 2035 are expected to approach 23,000 trucks per day; (a 162 percent increase).
- Due to their physical and operational characteristics, trucks disproportionally affect traffic congestion, safety, and travel experience of non-truck drivers.
- Operationally, the overall effect of one truck is equivalent to between two and five passenger cars.
- Commercial vehicles can be 40 or more times heavier than the other vehicles in the traffic stream.
- Public input during the development of the I-44 Purpose and Need Statement consistently raised the issue of travel delays and safety concerns resulting from the high volumes of truck traffic

on I-44.

- The percentage of disabling injury crashes and fatal crashes approximately doubles when trucks are involved.
- The number of severe crashes on I-44 is comparable to that of I-70.
- Between 2002 and 2006, there were 210 truck crashes on I-44 resulting in disabling injuries (outside of the St. Louis urban area). This number is greater than the total number of disabling injury truck crashes along the entire length of I-70 (including the urban areas of Kansas City and St. Louis) during the same time period.
- Between 2002 and 2006, there were 74 fatal truck crashes on I-44 (not including the St. Louis urban area). This number is comparable to the total number of fatal truck crashes along the entire length of I-70 (including the urban areas of Kansas City and St. Louis) during the same time period.

Given the importance of freight trucking to the economies of both Missouri and the nation, future I-44 studies will be challenged to thoroughly investigate solutions that effectively manage freight traffic on I-44.

Next Steps

One thing that the Purpose and Need Statement does not do is examine solutions. The decision to begin the comprehensive evaluation of I-44 with an investigation of its transportation problems was selected because of its flexibility. With the problems confronting I-44 well established, it is possible for decision-makers to chart an informed course through the Project Development Process. This course of action may be best implemented by focusing actions on portions of the corridor having similar characteristics, or it may be best implemented through a corridor-wide approach.

Focusing actions on portions of the corridor having common characteristics is similar to the approach being taken at I-70; with its Sections of Independent Utility. This approach allows for targeting high priority concerns on I-44. For instance, traffic congestion deficiencies are more acute in Rolla than in Marshfield. This type of apportionment also acknowledges that it is appropriate to consider improvements within the individual context of the region. After all, there is great diversity across the 257 miles that I-44 covers in Missouri. Additionally, apportionment may allow for multiple technical teams to be mobilized to simultaneously work on the project, without significant inefficiencies.

On the other hand, the problems of I-44 may be better approached on a corridor-wide basis. As discussed above, I-44 has a unique role in facilitating interstate commerce. The problems arising from high volumes of truck traffic are felt across the state. Addressing these issues may require uniform action. Currently, the *Improve I-70* program is examining truck-only facilities. As a result of this work it has become clear that a comprehensive/ corridor-wide focus has its advantages.

This Purpose and Need Statement is organized such that MoDOT is in the position to consider either approach when it moves forward with improving the I-44 corridor. The question of which approach is most appropriate to utilize will be the first question addressed in the next phase of the *Improve I-44* program.

The technical data collected in the Purpose and Need Statement will form the basis to evaluate which conceptual alternatives are superior. All things being equal, the solutions that best solve the transportation problems will be viewed as superior. This concept will guide the *Improve I-44* program through several iterations of developing and evaluating alternatives. The typical progression through the alternatives is from conceptual alternatives to reasonable alternatives to the preferred alternative. At each step, more detailed data is available to assist in the decision-making process. Within this process, public involvement and stakeholder involvement is vital. It allows MoDOT to better understand the goals and desires of those most closely affected by the project.

EXECUTIVE SUMMARY

1. Project Purpose

The Missouri Department of Transportation (MoDOT) has undertaken the I-44 Purpose and Need Study to define the magnitude of the problems that affect the portion of Interstate 44 (I-44) from the St. Louis/Franklin County line to the Oklahoma state line. The definition of problems will allow for informed decision-making. This “Pre-NEPA” document will not look at solutions and is not intended as a corridor-planning study. The specific goals of the I-44 Purpose and Need Study are to:

- Identify the transportation problems that affect the I-44 transportation corridor.
- Investigate the parameters that may be important for determining how well future alternatives address the identified transportation problems.
- Conceptually investigate whether modal strategies have the potential for addressing the transportation problems.
- Establish logical termini and develop Future Study Sections (FSSs) that may ultimately lead to the establishment of appropriate sections of independent utility (SIUs).
- Present the environmental, planning, engineering, and traffic data that affect the transportation problems, modal strategies, and logical termini.

This document is organized into the following components:

- Section A – Project Purpose and Project Background
- Section B – Transportation Problems that Exist on I-44
- Section C – Logical Termini/Future Study Sections
- Appendix A – Technical Memos (TMs) Used to Guide and Document I-44 Conditions
- Appendix B – Map Book Developed to Visually Present Some of the Analyses

2. Purpose & Need Elements

Analysis of the 257-mile I-44 corridor identified 6 main categories of transportation problems affecting I-44 today and into the future. These categories are:

- Roadway Capacity becoming Inadequate for Expected Demand
- Degrading Safety Environment on I-44
- Interchanges along I-44 have Safety and Operation Issues and are Inconsistent with Current Design Standards
- Increases in Freight are Altering Operations on I-44
- Evolving Engineering Standards Result in Roadway that is Inconsistent with Current Design Standards
- Balancing Access, Economic Development, and Human/Natural Resources

The following pages provide a summary of the major elements related to each of these categories as well as the important trends that define that transportation problem.

a. Roadway Capacity becoming Inadequate for Expected Demand

Traffic on I-44 has experienced substantial growth and will continue to grow at a rapid pace. Public input consistently raised the issue of congestion and travel delays. Between 2005 and 2035, nearly every portion of I-44 is expected to experience a doubling of the number of vehicles it handles. In some instances, the increases are expected to be as high as 45,000 vehicles per day. Relative to roadway capacity, the important trends that define this transportation problem include:

- Based on a capacity analysis using existing traffic counts, current conditions are generally acceptable; although a limited number of areas of congestion are known to exist.
- Using the statewide traffic model to predict future volumes, conditions are expected to deteriorate measurably by the design year of 2035. Roughly 85 percent of the 257 miles of I-44 are expected to be incapable of meeting the established level of service (LOS) threshold levels by 2035.
- Additionally, most of I-44 is expected to degrade to LOS F well before the design year of 2035. Roughly 30 percent of the I-44 roadway segments are expected to degrade to LOS F by 2015.

b. Degrading Safety Environment on I-44

Safety is an essential measure of performance for any transportation facility. The MoDOT Engineering Policy Guide clearly dictates that MoDOT will not compromise safety; every project is required to leave the roadway safer after it is completed. The crash evaluation conducted for this project has concluded that the crash environment has intensified in conjunction with the urbanization of the roadway. Additionally, the severity of the crashes along I-44 has increased. These results represent a valid transportation problem that any emerging I-44 project will need to address. Relative to safety, the important trends that define this transportation problem include:

- Among the important crash rate trends within the urban portions of I-44 is the number of and severity of the crashes. For example, fatal crashes in the urban portions of Newton County exceed the statewide average by 166 percent. In Rolla (Phelps County), the area associated with the U.S. Route 63 South, the Route E and the U.S. Route 63 interchanges have general crash rates several times the statewide averages.
- Among the important trends within the rural portions of I-44 are the generally high crash rates. The total crash rates in urbanizing counties, such as Newton, Phelps, Crawford, and Franklin are noticeably higher than traditionally rural counties.
- Relative to crash types, the important trend is the public's perception that I-44 is an extremely dangerous place. This seems to be the result of truck operations. While *total crashes* involving trucks are less frequent on I-44 than comparable Interstates in Missouri, such as I-70, the number of *severe crashes* on I-44 is comparable to that of I-70.

c. Interchanges along I-44 have Safety and Operation Issues and are Inconsistent with Current Design Standards

The operation and condition of each of the 78 interchanges along this portion of I-44 is unique. However, it is expected that they will all exhibit deficiencies. Three factors were used to evaluate I-44's interchanges: safety, traffic operations, and geometric design. Relative to interchange safety, operation and geometric design, the important trends that define this transportation problem include:

- Fifty-one of the interchanges exceed at least one of the crash criteria (total crash rates, fatal crash rates, and crash hotspots) established for the project. Eight interchanges exceed the crash-related criteria for all three crash criteria.
- Currently, only 6 of the 324 interchange ramps evaluated were found to exceed the operational criteria (LOS E or F). By the design year (2035), most interchanges are expected to have at least one ramp operating at LOS F. Approximately one-third of all interchanges are expected to be deficient in all of the measured traffic operation criteria.
- Seven design features were evaluated to investigate whether interchanges meet MoDOT's current design standards. Forty percent of the study area's interchanges have at least one geometric design element that does not meet current design standards.

d. Increases in Freight are Altering Operations on I-44

The location of I-44 makes it a vital crossroad in the heart of America's economy. Based on current trends, the freight-related demands on I-44 are expected to continue to increase. The accommodation of freight traffic represents a valid transportation problem that any emerging I-44 project will need to address. Relative to freight, the important trends that define this transportation problem include:

- The efficient movement of goods is essential to the modern American economy. Interstate 44 plays an important role in the shipment of materials.
- The affects of trucks on I-44 are wide ranging: they exacerbate congestion, they are sensitive to design-related issues, and they constitute a substantial component of the crash environment.

e. Evolving Engineering Standards Result in Roadway that is Inconsistent with Current Design Standards

Built more than 40 years ago, there are design elements of I-44 that no longer meet *current* design standards. These standards apply to the "geometry" of the road, that is, dimensions such as lane and shoulder widths, median width, vertical clearances, and horizontal curvature. The original design standards assumed lower traffic and fewer heavy trucks than are currently using I-44. One of the purposes for any project associated with the I-44 corridor will be to address those geometric elements that affect the ability for safe and efficient movement of people, goods, and services. Relative to engineering standards, the important trends that define this transportation problem include:

- Except at bridge locations, the roadway dimensions along I-44 are generally within the current design standards and meet driver expectations. Bridge curb-to-curb width is occasionally out of compliance with current criteria. Correcting these conditions typically require complete replacement.

- Horizontal curves along I-44 that are inconsistent with typical design criteria are widespread. Most can be improved without realignment. Three areas may require realignment because of the nature of the horizontal curvatures.
- Steep grades negatively affect operations, especially truck operations. There are 10 steep grades along I-44 that currently do not have climbing lanes and have critical grade lengths that reduce the speed of low-performance trucks to 10 mph below the average running speed of the remaining traffic.
- Increasing median widths improve safety. Interstate 44 was designed in an era when narrower medians were typical. Consequently, nearly all of I-44 fails to meet MoDOT's preferences. However, the 2006 installation of median cable guard along I-44 has proven to be very effective in reducing fatalities resulting from crossover crashes. In 2007, MoDOT reported only one crossover related fatality compared with 25 in 2005.
- Local roadways generally parallel I-44. Inadequate clear zones between the roads and minimal fencing are inconsistent with current design standards. It is notable that while the outer roads at these locations are within 30 feet of I-44, the study did not find any corresponding I-44 safety issues related to their proximity.
- The vast majority of existing pavement along the I-44 corridor is in Good or Very Good condition. The vast majority of bridges have components that are rated in Satisfactory or Good condition.

f. Balancing Access, Economic Development, and Human/Natural Resources

During the evaluation of the I-44 corridor, its close relationship with some of the State's most valuable economic and natural resources became clear. First, I-44 provides the best access to many important natural and recreational destinations in southern Missouri. Second, the availability of high-speed travel made these destinations attractive and profitable. Finally, it became evident that improvements to I-44 could have both a positive and negative impact on these resources. Relative to balancing accessibility with potential resource impacts, the important trends that define this transportation problem include:

- Avoiding the rerouting of the agreed upon course of **Historic Route 66** should satisfy most stakeholders. Attention and coordination consistent with the Engineering Policy Guide will appropriately balance the access that I-44 provides with the economic development and the unique values that Historic Route 66 represents.
- The emerging commercial **river floating** industry in southern Missouri should be considered a stakeholder and an excellent source of information on river conditions. Project planners should recognize that project-related stream impacts not only have biological impacts but may also potentially impact outdoor recreation dependent on the quality of the streams including floating, a uniquely Missourian pastime.
- I-44 is essential to the expanding tourist population visiting **Branson**, and serves as a main artery for the transportation of supplies to and from the city. Future improvements to I-44 should study and consider any project impact to the vacation travel stream.
- Like Branson, maintaining appropriate access from I-44 is essential to many of **Missouri's commercial caves**. However, project planners should also do adequate investigations to ensure that they do not inadvertently damage caves during the execution of their projects.

- I-44 projects in the vicinity of the Houston-Rolla District will need to engage the **Mark Twain National Forest** as a stakeholder.
- Coordination with local businesses, including wineries, will help decrease the potential impacts to tourism and profitability of **Missouri wineries**.
- I-44 is essential to **Fort Leonard Wood** by providing a direct, safe, and controlled route for transporting military personnel, vehicles, and supplies. Since alterations to I-44 may negatively impact military processes, future improvement projects should study and consider potential impacts to Fort Leonard Wood, as well as to the nearby businesses dependent on the fort.

3. Future Study Sections

Using the data collected during the I-44 Purpose and Need Study, in conjunction with the FHWA guidance on independent utility, logical termini, and major projects, it was possible to identify areas along I-44 where problems, conditions, and needs were demonstrably similar. These areas might logically be considered Future Study Sections (FSS). **Section C** discusses the regulatory framework for subdividing a long corridor like I-44, outlines the factors used here to propose FSSs, presents the FSSs themselves, and presents an assessment of the transportation problems, organized by FSS.

Figure C-1 presents a graphic depiction of the proposed Future Study Sections. **Table C-9** presents a tabular summary of the important transportation trends distributed by FSS.

Section C also discusses the recommended prioritization of each Future Study Section. The FSSs are categorized as High, Medium and Low priority based on the severity of the problems within the section and the relative timeframe for considering improvements. A summary of the Future Study Sections, along with the key issues within each FSS is presented in the **Table ES-1** below. Of the four key issues listed in, *Inadequate Roadway Capacity* and *Degrading Safety Environment* were assumed to be of the greatest importance and essential to overall prioritization.

Table ES-1

Key Issues

FSS	Location	Length	Priority	Inadequate Roadway Capacity	Degrading Safety Environment	Interchange Safety and Operation Issues and are Inconsistent with Current Design Standards	Increases in Freight
1	Western terminus to Joplin	19 miles	Medium	o	+	+	+
2	Between Joplin and Springfield	49 miles	Low	o	-	-	+
3	Springfield	22 miles	Medium	+	o	+	+
4	Between Springfield and St. Robert	63 miles	Low	o	-	-	o
5	St. Robert to Rolla	37 miles	Medium	o	+	o	-
6	Rolla to Sullivan	34 miles	High	+	+	o	o
7	Sullivan to Pacific	34 miles	High	+	+	+	+

"+" Denotes high impact on FSS

"o" Denotes moderate impact on FSS

"-" Denotes low impact on FSS

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Acronyms and Abbreviations

AADT	average annual daily traffic
AASHTO	American Association of State Highway and Transportation Officials
AVO	average vehicle occupancy
EB	eastbound
EIS	environmental impact statement
EPG	engineering policy guide
FAF	freight analysis framework
FHWA	Federal Highway Administration
FLW	Fort Leonard Wood
FTA	Federal Transit Administration
FSS	future study sections
GDP	gross national product
HCM	highway capacity manual
I-44	Interstate 44
IRI	International Roughness Index
LOS	level of service
MDC	Missouri Department of Conservation
MDNR	Missouri Department of Natural Resources
MM	mile marker
MoDOT	Missouri Department of Transportation
MOSM	Missouri statewide travel model
NAFTA	North American Free Trade Agreement
NBI	national bridge inventory
NWI	National Wetland Inventory
PDO	property damage only
PSR	pavement serviceability rating
RPC	regional planning commission
SAFETEA-LU	Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users
SIU	sections of independent utility
SSD	stopping sight distance
STA	state transportation agency
TM	technical memo
TNC	The Nature Conservancy
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VPD	vehicles per day
WB	Westbound
WRP	wetland reserve program

Section A: Introduction

1. Project Purpose

The Missouri Department of Transportation (MoDOT) has undertaken the I-44 Purpose and Need Study to define the magnitude of the problems that affect the portion of Interstate 44 (I-44) from the St. Louis/Franklin County line to the Oklahoma state line (see **Figure A-1**). The definition of problems will allow for informed decision-making. This document is considered a “Pre-NEPA” document. It will not look at solutions and is not intended as a corridor-planning study. The specific goals of the I-44 Purpose and Need Study are to:

- Identify the transportation problems that affect the I-44 transportation corridor.
- Investigate the parameters that may be important for determining how well future alternatives address the identified transportation problems.
- Conceptually investigate whether modal strategies have the potential for addressing the transportation problems.
- Establish logical termini and develop Future Study Sections (FSSs) that may ultimately lead to the establishment of appropriate Sections of Independent Utility (SIUs).
- Present the environmental, planning, engineering and traffic data that affects the transportation problems, modal strategies and logical termini.

This document presents the results of the I-44 Purpose and Need Study. It is organized into the following components:

Section A of this document will discuss the project purpose and project background.

Section B of this document will discuss the transportation problems that exist on I-44.

Section C will discuss the categorization of the I-44 study area into zones that experience similar demands and have similar conditions. These sections are called Future Study Sections (FSSs). They may eventually emerge as Sections of Independent Utility (SIUs).

Appendix A contains the technical memos (TMs) used to guide and document the technical analysis used during the development of the I-44 Purpose and Need Study.

Appendix B contains a map book developed to visually present some of the analyses performed for this project.

Figure A-1
Vicinity Map: Study Area for the I-44 Purpose and Need Study

Source: MoDOT TMS 2002-2006

2. Project Background

Text Boxes Used in this Document

Two different types of text boxes are used in this document. The *light bulb* symbol denotes a text box intended to provide a summary of important information. The *checklist* symbol denotes a text box intended to identify the important trends associated with the transportation problems discussed in this Purpose and Need Statement.

Since 2000, MoDOT has been studying its major east-west corridor (I-70) with the desire that any required improvements would be performed in a coordinated manner. It is commonly noted that the conditions and issues that prompted the study of I-70 are now affecting the I-44 corridor as well. To identify the needs of the I-44 corridor, MoDOT initiated the purpose and need study using the I-70 experience as a guide.

Of the different methods MoDOT could have used to study I-44 they selected a purpose and need study because it provided MoDOT with the most flexibility. A purpose and need study defines the magnitude of the problems, which is the initial elements of any NEPA study. However, it does not develop and evaluate solutions. Based on the needs identified in this study, MoDOT could move forward with any of the other options—feasibility study, planning study, first-tier EIS, traditional EIS, or take no further action if there is no identified need.

The remainder of this section will provide some historic perspective on I-44, outline the scope of the work conducted pursuant to this effort and establish and justify this project's study area.

a. Background/History of I-44

Interstate 44 is one of seven interstate routes serving the state of Missouri. It runs diagonally from the state's southwest corner and proceeds northeast across the state to St. Louis. West of Missouri, I-44 is part of the I-44/I-40 corridor that extends to Oklahoma City and ultimately to California. The western terminus of I-44 is in Wichita Falls, Texas. The eastern terminus of I-44 is in St. Louis, at Interstate 55 (I-55). I-44 is one of five interstates across the United States built to bypass/replace U.S. Route 66 (U.S. 66).

Interstate 44 enters Missouri southwest of Joplin at a point near the corner of Oklahoma, Missouri, and Kansas. The road continues through the south edge of Joplin, and then continues east to Mount Vernon. At Mount Vernon, I-44 heads northeast through Springfield (on the north side of the city) and continues northeast. At Waynesville, I-44 enters a hilly region until it passes Rolla. In addition to the hilly terrain, this portion of I-44 is also notable for its numerous, sometimes sharp, horizontal curves. At Pacific, I-44 begins to widen initially to six lanes and then later to eight lanes. The interstate continues into the suburbs of St. Louis, finally ending near the Mississippi River at the intersection with I-55. Interstate 44 is one of seven interstate routes serving the state of Missouri.

In Missouri, I-44 extends through 11 counties (Newton, Jasper, Lawrence, Greene, Webster, Laclede, Pulaski, Phelps, Crawford, Franklin, and St. Louis) and is approximately 290 miles in length. The larger communities adjacent to I-44 include Joplin, Springfield, Marshfield, Lebanon, St. Robert, Rolla, Sullivan, Pacific, and St. Louis. Between Joplin and Pacific, I-44 is the primary west-east facility in the transportation network of southcentral Missouri. Existing I-44 links the St. Louis Metropolitan Area to the largest tourist attraction in the state, the City of Branson. It also connects other communities, such as Joplin, Springfield, and Lebanon, in southwest Missouri.

The primary north-south facilities that intersect I-44 are U.S. 71 (from Joplin to the Kansas City Metropolitan Region), U.S. 65 (from Springfield to Branson), Route 5 (from Lebanon to the Lake of the Ozarks region), and U.S. 63 (running from Rolla through Vienna to Jefferson City). I-70 is located north of the corridor, and connects St. Louis with Kansas City through central Missouri.

The study area, which is 257 miles long, is primarily in rural areas of Missouri, but also includes urban areas such as Rolla, Springfield, Joplin, and other smaller communities. The surrounding landscape in the rural portions of the corridor is largely a mixture of agricultural and forested land. Development at rural interchanges in the study area includes truck stops, gas stations, and small chain or family-owned restaurants. The urban interchanges often contain industrial parks, commercial development, and peripheral institutional uses, such as hospitals.

The corridor crosses Mark Twain National Forest between the City of Rolla and the City of Lebanon in Phelps and Pulaski Counties. Additionally, several recreation and tourist facilities are located within close proximity to the study area; however, none of these facilities are located within the actual corridor. State parks are located both south and north of the corridor. Specifically, south of I-44 near the City of Stanton in Pulaski County is Meramec State Park. Farther west along the corridor at Lebanon, Bennet Spring State Park is located north of I-44. The Lake of the Ozarks, located north of I-44, is a major destination for tourists and Missouri residents alike with I-44 utilized as a major access route to roadways entering this year-round destination. Another major tourist destination is the City of Branson and Table Rock Lake, located south of I-44 and the City of Springfield on U.S. 65.

One distinct physiographic division, of the three present in Missouri, is found within the study area. This division, the Ozark Plateau, lies between the Mississippi Alluvial Plain and the Central Lowland, northwest of Joplin to the southeast corner of Kansas. The majority of this physiographic region is located south of the I-44 corridor and features rugged and highly dissected parts of the Missouri Ozarks. The famed Shepherd of the Hills region, near Branson, lies within this rugged area.

A unique institutional use immediately adjacent to the I-44 corridor is Fort Leonard Wood (FLW). Fort Leonard Wood is located south of the I-44 study area in Pulaski County, near St. Robert. According to the Information Paper provided by FLW personnel, the FLW military reservation has a population of 24,000, with both Army National Guard and Army Reserve facilities on the installation supporting over 130 units. Other major institutional uses in the general vicinity of I-44 include the Missouri State University in Springfield and the Missouri University of Science and Technology in Rolla.

There are five rest areas along the I-44 corridor from St. Louis to Joplin. According to the 2007 Missouri Welcome Center Plan, the future I-44 corridor will consist of a Safety Welcome Center at Joplin, a Safety Welcome Center at Conway, a Safety Rest Area at St. Clair or a Safety Welcome Center at mile marker 265 and Parking Only—No Services facilities at both Doolittle and Halltown.

The study area spans several local government entities. Four MoDOT districts, 6, 7, 8, and 9, are represented within the study area. Four regional planning commissions (RPCs) traverse the corridor. They are the Harry S. Truman Coordinating Council of Governments in Webb City, Southwest Missouri Council of Governments in Springfield, Lake Ozark Council of Local Governments in Camdenton and Meramec Regional Planning Commission in St. James. The metropolitan planning organizations (MPO) within the study area are located near the western and eastern termini and the City of Springfield. The three MPOs include the Joplin Area Study Transportation Organization, the Ozark Transportation Organization, and the East-West Gateway Council of Governments. Additionally, three highway patrol troops police the entire I-44 corridor. The troops represented in the study area are Troops C, I, and D.

Summary of Project Scope

TASK 1—CORRIDOR CHARACTERISTICS
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1.2 Definition of Logical Termini
1.3 Geometric and Functional Use Data Collection
1.4 Physical Geometric and Functional Use Analysis

TASK 2—ENVIRONMENTAL PLANNING
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2.2 Natural Resource Data Collection
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2.4 Cultural Resources Documentation
2.5 Perform a High-Level Air Quality Review/Discussion

TASK 3—TRAFFIC and SAFETY STUDIES
3.1 Traffic Data
3.2 Traffic Forecasts
3.3 Traffic Operations Analysis
3.4 Safety Analysis

TASK 4—SOCIAL AND ECONOMIC STUDIES
4.1 Coordinate with Agencies
4.2 Review Census Data
4.3 Community/Social Institutions and Services
4.4 Analysis to Identify Transportation Deficiencies

TASK 5—DEFINING LOGICAL TERMINI
5.1 Definition of Logical Termini

TASK 6—STUDY DOCUMENTS
6.1 Purpose and Need Study Document

TASK 7—COMMUNITY INVOLVEMENT PROGRAM
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7.3 Land Use Forum
7.4 Management and Coordination

TASK 8—PROJECT MANAGEMENT & COORDINATION
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8.2 Meetings
8.3 Quality Reviews
8.4 Agency Approvals
8.5 Project Management
8.6 Administration and Cost Control
8.7 Project Team Management Website

b. Scope of Work

To evaluate deficiencies, the I-44 Purpose and Need Study has been developed in accordance with FHWA Regulation 23 CFR 771, the procedures outlined in the FHWA Technical Advisory T6640.8A, FHWA's Purpose and Need Policy Memorandum dated September 18, 1990, the joint FHWA/FTA Memorandum dated July 23, 2003 and SAFETEA-LU Section(s): [6002-6005, 6007, 6009, 6010]. The scope of work for this project included:

- Data gathering and analysis—this was the primary study task. Data was gathered for traffic forecasts and crash data, existing vertical and horizontal alignment, interchange data, natural resources, cultural resources, hazardous waste, and a range of socioeconomic data including census data, sensitive communities, schools, emergency services, and hospitals along the corridor.
- Community involvement—a series of public meetings were held in each county along the study corridor presenting the public the opportunity to voice their concerns and needs regarding I-44. Additionally, newsletters and a MoDOT website were created to document the progress of the project.
- Land Use Forum—a series of land use forums were held to solicit input on existing and future land use from local and regional planners.
- Agency coordination—obtained input

from state and federal review agencies on natural resources, socio-economic features, and other constraints along the study corridor.

Technical Memos

To guide and document the development of the I-44 Purpose and Need Study, a series of technical memorandums (TMs) were produced. These technical memos are contained in **Appendix A**.

Two basic types of TMs were produced. One type of TM outlined the process or methodology that would be used to conduct a given analysis. The intent was to allow for consultation to ensure that the studies were conducted appropriately. As an example, the *Geometric Analysis Methods and Assumptions Technical Memo* discussed how design guidelines were to be established and how deficiencies were to be identified. The second type of TM was results-oriented. The results of a given analysis were presented in these TMs. Below is a brief summary of the available TMs:

- Logical Termini TM (A-1)—This memo identified the logical eastern and western termini for the I-44 Purpose and Need Study. This essentially established the study area for the project.
- Corridor Evaluation Methodology TM (A-2)—This memo discussed the “macroscopic” elements associated with the project’s design guidelines and performance thresholds. Only after the fundamental method’s and assumptions were set could the existing and future performance of the corridor be determined.
- Crash Analysis TM (A-3)—The methodology and results of the analysis of I-44’s crash environment were summarized into a single technical memo. Crash rates were calculated for various roadway sections throughout the corridor. For this study, 2002 through 2006 crash data was used. Crash rates for the study corridor are compared to relevant statewide average crash rates. A crash hotspot analysis was also conducted.
- Freeway Traffic Analysis, Methods, Assumptions and Results TM (A-4)—The methodology and results used in the freeway traffic operations analysis were summarized into a single technical memo. In general, the chief assumptions were how the passenger car equivalent flow rates and the average car speeds were calculated. Level of service (LOS) was the primary results output.
- Environmental Justice TM (A-5)—As a precursor to project-related NEPA work, an investigation of populations, along I-44, that might qualify for consideration under Environmental Justice provisions was conducted.
- Cultural Resources TM (A-6)—A screening level review of resources potentially eligible for the National Register of Historic Places (NRHP) was conducted.
- Natural Resources TM (A-7)—As a precursor to project-related NEPA work, an investigation of wetlands, endangered species, and other relevant natural resources was conducted.
- Interchange Evaluation Analysis TM (A-8)—The methodology and results used in the interchange traffic operations analysis are summarized here.
- Bridge Summary TM (A-9)—The results of the bridge evaluation are presented here.
- Geometric Analysis Methods and Assumptions TM (A-10)—The results of the roadway geometric analysis evaluation are presented here.

- Modal Services Deficiency TM (A-11)—This TM investigated the extent to which improved mass transit might reduce the number of vehicles on I-44.
- Springfield Intersection Delay TM (A-12)—Traffic, at several interchanges in Springfield, backs up onto I-44. This TM investigated the conditions at those interchanges.
- Climbing Lane Review TM (A-13)—Portions of I-44 are hilly and several existing truck climbing lanes currently exist. This TM investigated conditions, relative to truck traffic operation, for all portions of I-44 with a grade in excess of four percent.
- Future Study Sections TM (A-14)—As a precursor to the establishment of Sections of Independent Utility, this TM investigated logical/independent components within the portion of I-44 under consideration.
- Traffic Modeling Summary TM (A-15)—Investigates the methodological details associated with modifying the Missouri Statewide Traffic Model for use during the I-44 Purpose and Need Study.
- Public Involvement Summary TM (A-16) —Presents a summary of the public involvement/agency coordination activities conducted during the I-44 Purpose and Need Study.

Logical Termini for the I-44 Purpose and Need Study

The Exit 1 interchange is the logical western terminus for the I-44 Purpose and Need Study because:

- The influence area of the interchange extends to the Oklahoma and Kansas State lines.
- I-44 transitions from a rural 4-lane typical section with grassy median in Missouri to a 4-lane typical section with a narrow, concrete median on the Will Rogers' Turnpike in Oklahoma.
- This interchange represents the transition between the untolled portion of I-44 and the tolled portion of the Will Rogers' Turnpike.

The Exit 257 interchange is the logical eastern terminus because:

- I-44 transitions from a 4-lane rural section to a 6-lane urban section creating a natural separation in the geometry of the roadway when traveling from the west to the St. Louis Metropolitan Region.
- Traffic volumes change markedly at this location. Traffic volumes in Franklin County (located within the area of the proposed east terminus) range from 34,000 to 52,000 vehicles per day while traffic volumes in St. Louis County (located outside of the east terminus) range from 60,000 to 122,000 vehicles per day. In addition, this interchange is a notable traffic generator serving Historic Route 66 and surrounding development in the City of Pacific.

Map Book

In order to concisely and visually present the analyses performed for this project, a map book for the entire corridor was produced. This document shows the existing roadway through an aerial map section. Overlain on the aerial are select annotation and point data. Also presented, through color-coded ratings, are the various deficiencies identified during the analysis. The map book (and a TM outlining its features) is presented in **Appendix B.**

Administrative Record/GIS Database

Not attached, but available in the project's Technical Files are the GIS database and associated analysis files. In addition to GIS data, these files contain public involvement summaries, environmental data collection, complete traffic and crash analysis, modeling results, and so forth. These materials will be an important asset to any future I-44 work.

The public involvement process associated with the I-44 Purpose and

Need Study was developed to be consistent with the regulations of Section 6002 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU). This process is summarized in a technical memo (**Appendix A)**. All public involvement materials are available in the project's administrative record.

c. Study Area (Logical Termini for Study)

As noted in *The Development of Logical Project Termini* (FHWA, November 1993), FHWA regulations (23 CFR 771.111(f)) require that an action evaluated in an environmental impact statement or finding of no significant impact shall:

- Connect logical termini and be of sufficient length to address environmental matters on a broad scope
- Have independent utility or independent significance, i.e., be usable and be a reasonable expenditure even if no additional transportation improvements are made in the area
- Not restrict consideration of alternatives for other reasonably foreseeable transportation improvements

Using this background, the study area/logical termini for the I-44 Purpose and Need Study were established. The western terminus is the I-44/U.S. Highway 166/400 interchange, located five miles west of Joplin. This interchange (Exit 1) is located approximately 0.5 mile from the Missouri/Oklahoma border.

The study's proposed eastern terminus is the I-44/Business Loop 44 (Historic Route 66) interchange (Exit 257) in the City of Pacific, 1-1/2 miles east of the Franklin County-St. Louis County line.

Identifying the study's west and east termini is related to, but not the same as, identifying the logical termini for the Future Study Sections (FSSs).

Section B: Transportation Problems

The main focus of the I-44 Purpose and Need Study was to identify the transportation problems associated with I-44. These problems will be discussed in this section and can be summarized as:

1. The **roadway capacity** of I-44 is becoming inadequate to accommodate the expected demand.
2. As traffic and congestion along I-44 continues to increase, the number and severity of crashes has led to a degradation of the **safety** environment in those areas.
3. The **interchanges** along I-44 have safety & operation issues and are inconsistent with current design standards.
4. **Freight** traffic represents an essential element of the traffic stream on I-44.
5. Evolving design standards have resulted in inconsistent **roadway designs** along I-44.
6. Because of its location and function, I-44 requires a balancing of its access and economic development functions with the components of the **human/natural environment** to which it provides access.

Each of these transportation problems will be evaluated in this section, through an individual subsection. The data collection/analysis that underlies each subject will be summarized. More detailed explanations are available in the technical memos contained in **Appendix A**. The majority of the discussion contained in this section will focus on the important trends that define the transportation problems. These trends are summarized in text boxes. Where specific deficiencies are identified, they represent the most severe instances identified in the study area. Less severe, but problematic conditions are identifiable within the data by examining the attached information. The ultimate goal is to clearly define the problems that affect I-44 on facility-wide basis, as well as to allow future project planners the opportunity to use this report to identify all conditions that future projects should consider addressing.

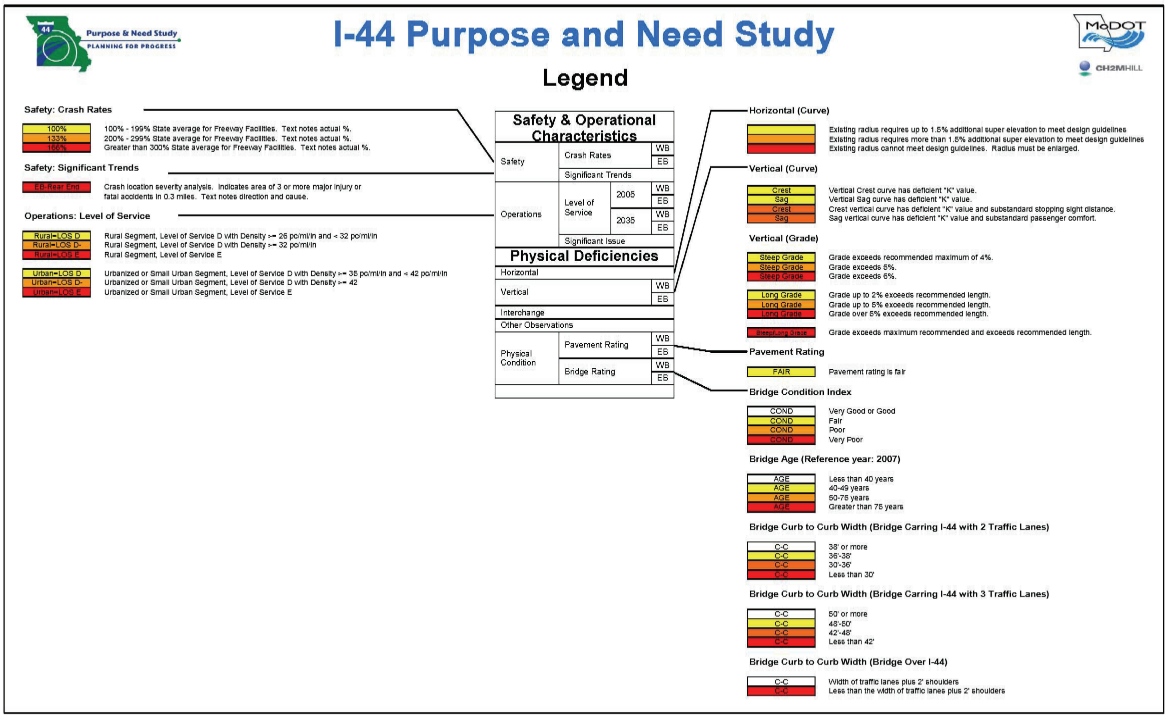
Identifying Important Trends Associated with I-44's Transportation Problems

The *checklist* symbol ✓ denotes a text box intended to identify an important trend associated with the transportation problems discussed in this purpose and need statement.

Where specific deficiencies are identified, they represent the most severe instances encountered, project-wide. Contained within the supporting data is a more wide-ranging discussion of the deficiencies encountered.

Another aid to the users of this document is the Map Book (**Appendix B).** The Map Book contains aerial photographs of the entire 257-mile long study area. Consisting of 99 sheets at a scale of 1 inch equals 1,000 feet, the Map Book also provides visual depictions of many of the safety and operational deficiencies uncovered during the project. The Map Book also provides for an opportunity to simultaneously view deficiencies that are often described separately, for instance crash hot spots and geometric deficiencies. **Table B-1** is a reference index for the components of the Map Book.

Figure B-1
Appendix B Map Book Example



Safety: Crash Rates

100%	100% - 199% State average for Freeway Facilities. Text notes actual %.
133%	200% - 299% State average for Freeway Facilities. Text notes actual %.
166%	Greater than 300% State average for Freeway Facilities. Text notes actual %.

Safety: Significant Trends

EB-Rear End	Crash location severity analysis. Indicates area of 3 or more major injury or fatal accidents in 0.3 miles. Text notes direction and cause.

Operations: Level of Service

Rural=LOS D	Rural Segment, Level of Service D with Density >= 26 pc/mi/ln and < 32 pc/mi/ln
Rural=LOS D-	Rural Segment, Level of Service D with Density >= 32 pc/mi/ln
Rural=LOS E	Rural Segment, Level of Service E
Urban=LOS D	Urbanized or Small Urban Segment, Level of Service D with Density >= 35 pc/mi/ln and < 42 pc/mi/ln
Urban=LOS D-	Urbanized or Small Urban Segment, Level of Service D with Density >= 42
Urban=LOS E	Urbanized or Small Urban Segment, Level of Service E

Horizontal (Curve)

🟨	Existing radius requires up to 1.5% additional super elevation to meet design guidelines
🟧	Existing radius requires more than 1.5% additional super elevation to meet design guidelines
🟥	Existing radius cannot meet design guidelines. Radius must be enlarged.

Vertical (Curve)

Crest	Vertical Crest curve has deficient "K" value.
Sag	Vertical Sag curve has deficient "K" value.
Crest	Crest vertical curve has deficient "K" value and substandard stopping sight distance.
Sag	Sag vertical curve has deficient "K" value and substandard passenger comfort.

Vertical (Grade)

Steep Grade	Grade exceeds recommended maximum of 4%.
Steep Grade	Grade exceeds 5%.
Steep Grade	Grade exceeds 6%.
Long Grade	Grade up to 2% exceeds recommended length.
Long Grade	Grade up to 5% exceeds recommended length.
Long Grade	Grade over 5% exceeds recommended length.
Steep/Long Grade	Grade exceeds maximum recommended and exceeds recommended length.

Pavement Rating

FAIR	Pavement rating is fair

Bridge Condition Index

COND	Very Good or Good
COND	Fair
COND	Poor
COND	Very Poor

Bridge Age (Reference year: 2007)

AGE	Less than 40 years
AGE	40-49 years
AGE	50-75 years
AGE	Greater than 75 years

Bridge Curb to Curb Width (Bridge Carring I-44 with 2 Traffic Lanes)

C-C	38' or more
C-C	36'-38'
C-C	30'-36'
C-C	Less than 30'

Bridge Curb to Curb Width (Bridge Carring I-44 with 3 Traffic Lanes)

C-C	50' or more
C-C	48'-50'
C-C	42'-48'
C-C	Less than 42'

Bridge Curb to Curb Width (Bridge Over I-44)

C-C	Width of traffic lanes plus 2' shoulders
C-C	Less than the width of traffic lanes plus 2' shoulders

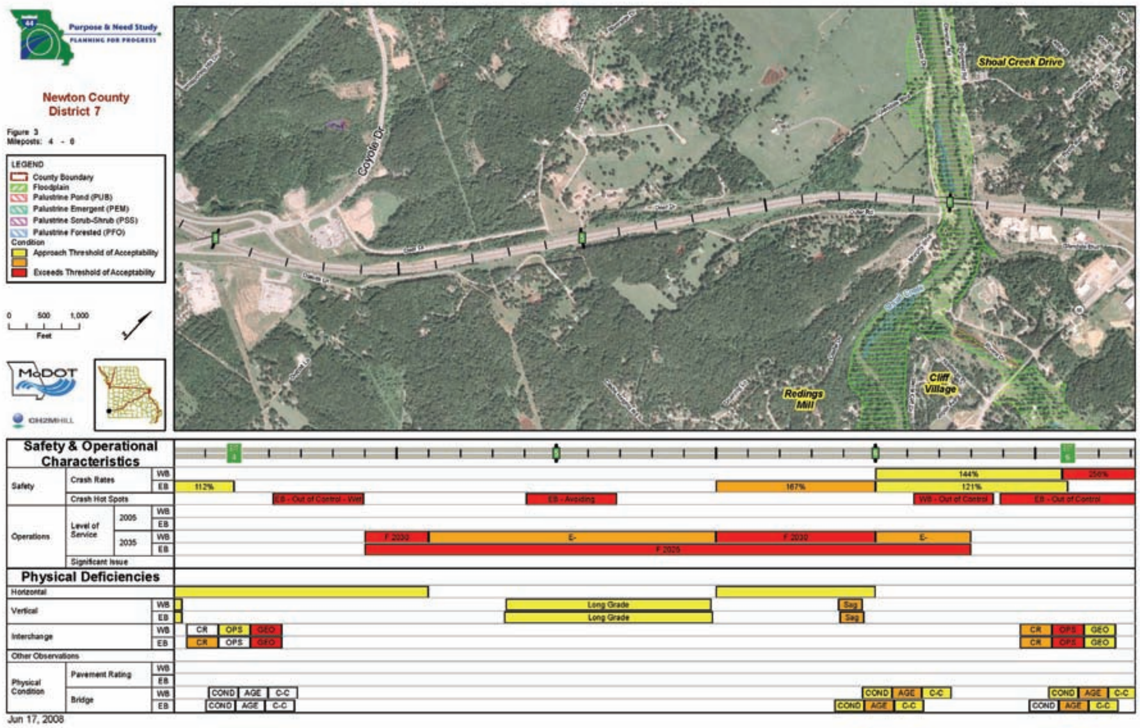
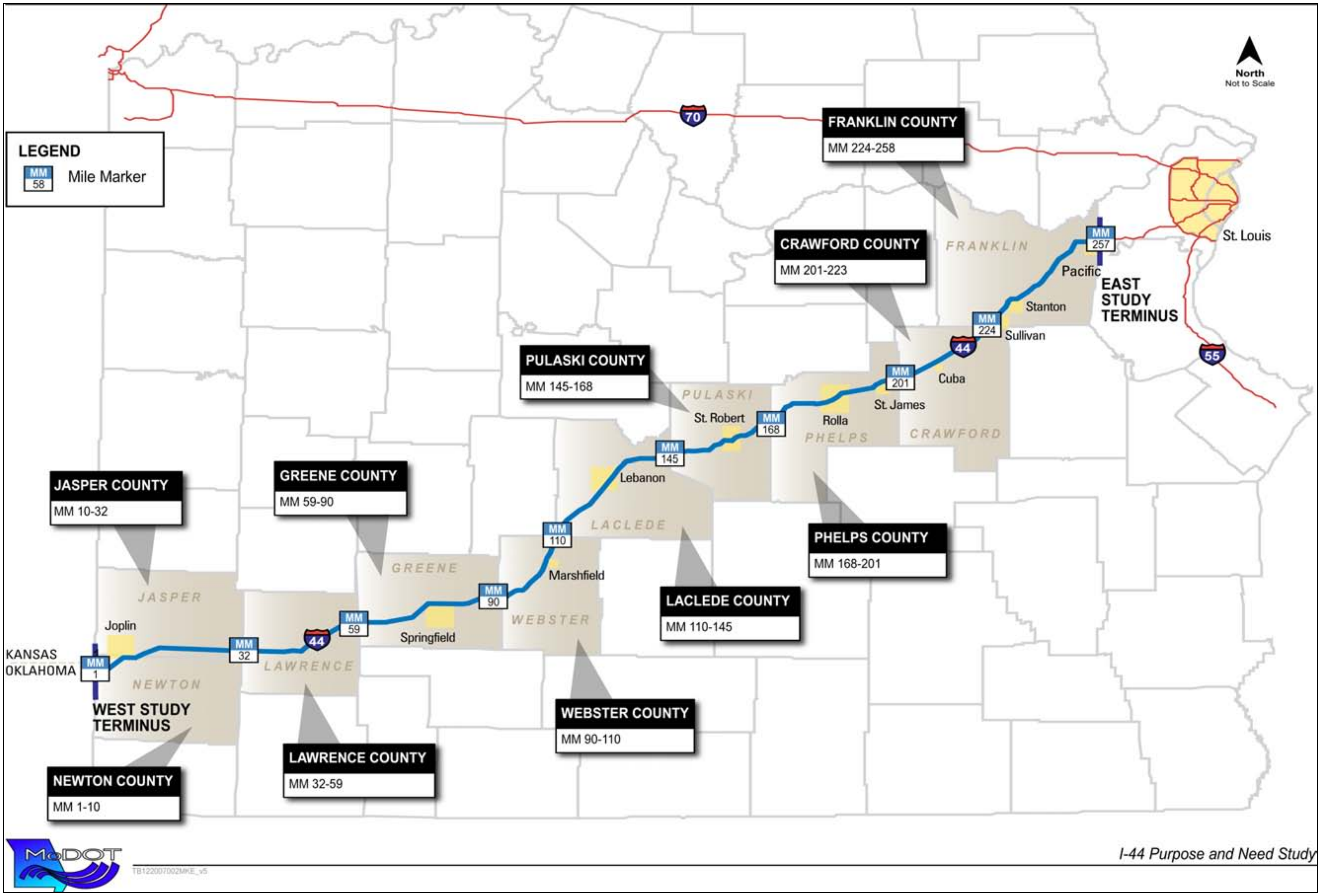


Table B-1

Map Book Index

County	Map Book Figures	Mile Markers	Interchanges	Adjacent Communities
Newton	1–5	1–10	1, 4, 6, and 8	Joplin
Jasper	5–13	10–32	11, 15, 18, 22, 26, and 29	Sarcoxie
Lawrence	14–24	32–59	33, 38, 44, 46, 49, 57, and 58	Mount Vernon
Greene	24-36	59–90	61, 67, 69, 70, 72, 75, 77, 80, 82, 84, and 88	Springfield
Webster	36–44	90–111	96, 100, and 107	Marshfield
Laclede	44–57	111–145	113, 118, 123, 127, 129, 130, 135, and 140	Lebanon
Pulaski	57–66	145–168	145, 150, 153, 156, 159,161, and 163	Waynesville and St. Robert
Phelps	66–78	168–201	169, 172, 176, 179, 184, 185, 186, 189, and 195	Rolla and St. James
Crawford	78–86	201–223	203, 208, 210, 214, and 218	Cuba
Franklin	86–99	224–258	225, 226, 230, 239, 240, 242, 247, 251, 253, and 257	Sullivan, St. Clair, Gray Summit, and Pacific

Figure B-2
Vicinity Map: Major Mile Marker Designations for the I-44 Purpose and Need Study



1. Roadway Capacity Inadequate for Expected Demand

Consistent with nationwide trends for interstates, traffic on I-44 has been increasing. Public input during the development of this purpose and need study has consistently raised the issue of travel delays and the high volumes of truck traffic associated with I-44.

Except for site-specific safety improvements, the configuration of I-44 has remained relatively constant since its construction. The continuation of the traffic volume increases will eventually begin to deteriorate the operational characteristics of I-44. Consequently, a freeway traffic analysis was conducted as part of the I-44 Purpose and Need Study. Using existing traffic counts to represent current volumes and the statewide traffic model to predict future volumes, it was possible to evaluate the operational characteristics along I-44. This analysis focused on level of service (LOS) for the freeway portions of I-44, both for current conditions (2005) and in the future (2035). More detailed descriptions of the freeway traffic analysis can be found in **Appendix A**. A similar operational analysis was conducted for the interchanges along I-44. The conditions at the interchanges are discussed in **Section B.3**.

Summary of the Roadway Capacity Transportation Problems Affecting I-44

Based on a capacity analysis using existing traffic counts, current conditions are generally acceptable; although localized areas of congestion are known to exist.

Using the statewide traffic model to predict future volumes, conditions are expected to deteriorate measurably by the design year of 2035. Roughly 85 percent of the 257 miles of I-44 are expected to be incapable of meeting the LOS threshold levels established for this project: D or better in rural areas, E or better in urban areas.

The results of the freeway traffic analysis revealed that, without improvement, LOS along I-44 will deteriorate measurably:

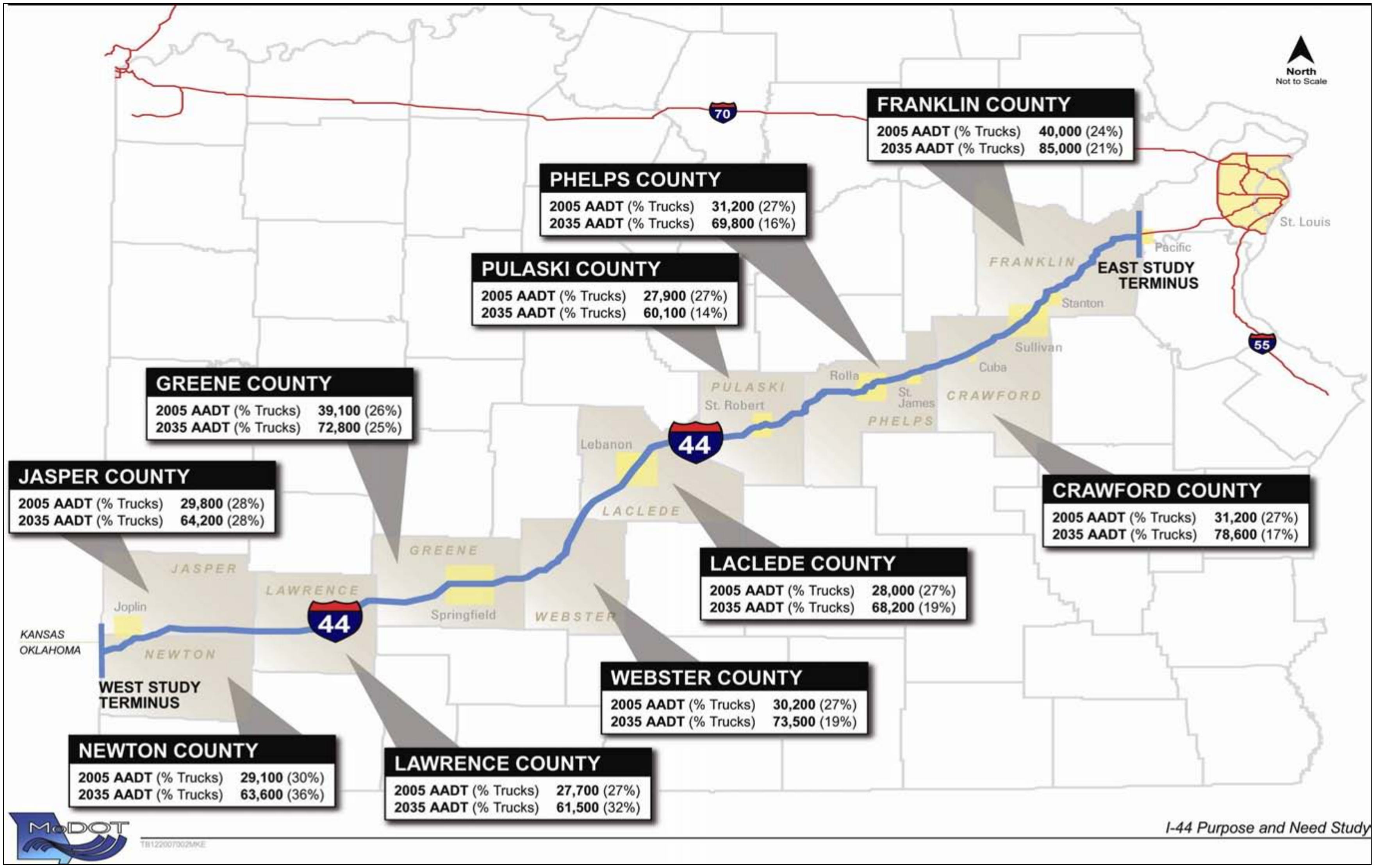
- Currently, based on a capacity analysis using existing traffic counts, current conditions are generally acceptable. The only location where the roadway fails to meet thresholds is in the vicinity of Villa Ridge/Gray Summit/Pacific in Franklin County.

- Study team members utilized actual traffic trend data to calibrate the statewide traffic model to predict future volumes. The model reveals that using the established LOS thresholds, nearly the entire corridor will experience unacceptable congestion. Of the 79 roadway segments (sections between crossroad interchanges) that constitute the study area, 52 are expected to operate at the worst possible level of service category of LOS F. These 52 segments correspond to roughly 70 percent of the 257 miles of I-44.

Reduced travel efficiency and reliability increases transportation costs for commuters, commercial trips, and most other travelers. **Figure B-3** is a summary of the two-way traffic volumes on I-44, distributed by county for both 2005 and 2035. Truck percentages of the total volume are also shown for both 2005 and 2035. A lower truck percentage in 2035 may still indicate an increase in the number of trucks.

Figure B-3

Summary of Two-Way Traffic and Percentage of Trucks on I-44



a. Introduction to Freeway Traffic Analysis

The methods and assumptions used in the freeway traffic analysis are discussed extensively in the *Freeway Traffic Analysis, Methods, Assumptions and Results Technical Memo* contained in **Appendix A**. Below is a summary of the most important concepts.

Highway Capacity Manual

A standard evaluation method for determining if a given facility will be able to adequately handle future traffic volumes is a LOS analysis. LOS is the term used to describe the operational quality of a given roadway design. The *Highway Capacity Manual, Special Report 209, 2000 edition* (HCM) is the transportation profession's reference document for characterizing highway operations. Levels of service range from A (very good operations) to F (gridlock conditions; breakdown in traffic flow). This methodology measures level of service based on density (passenger cars/mile/lane). The calculation of freeway density involves the passenger car equivalent flow rate and the average passenger car speed.

How would a fully operational multimodal transportation network influence traffic volumes on I-44?

As a part of the I-44 Purpose and Need Study, an analysis of how a fully operational multimodal transportation network would influence traffic volumes on I-44 was conducted. Specifically, the potential contribution of intercity bus service and passenger rail to traffic volume reductions on I-44 was investigated.

It was concluded that intercity bus service and passenger rail would have only a minor positive effect on reducing traffic volumes on I-44. On average, it was estimated that a fully operational multimodal system could reduce daily traffic volumes on I-44 by approximately 3 to 4 percent on rural sections and 1 to 2 percent on most urban sections. The daily volume of passenger vehicles could be reduced by approximately 1,100 on I-44 in the year 2035, if intercity bus service and passenger rail service were fully functional.

Additional details about this analysis can be found in the *Modal Service Deficiencies Technical Memorandum* in **Appendix A**.

Area Type (Rural or Urban)

One assumption that will impact the passenger car equivalent flow rate and the average passenger car speed is the area-type classification. For the purposes of the freeway traffic analysis, the I-44 corridor was divided into three area types based on definitions contained in AASHTO, *A Policy on Geometric Design of Highways and Streets, 2004*. These area types are urbanized, small urban, and rural.

The Urban Portions of I-44 (pursuant to the freeway traffic analysis):

- Joplin: Mile Marker 2.9–11.9
- Springfield: Mile Marker 67.1–84.6
- Marshfield: Mile Marker 101.0–107.6
- Lebanon: Mile Marker 126.7–130.8
- St. Robert: Mile Marker 159.9–163.9
- Rolla: Mile Marker 183.9–190.0
- Sullivan: Mile Marker 224.0–226.1
- Pacific: Mile Marker 255.1–253.4

Volume Data

The passenger car equivalent flow rate is determined from the design hour volume, the peak hour factor, the number of lanes, an adjustment for heavy vehicles and the demographics.

Existing average annual daily traffic (AADT) volumes for the I-44 eastbound and westbound freeway segments were provided by MoDOT. Segments went from one crossroad interchange to the next crossroad interchange. The AADT volumes reflect average travel conditions on a particular highway rather than daily or seasonal variations. Truck AADT volume data were also provided.

Forecast volumes were obtained from the MoDOT statewide model. The model was adjusted as part of this study to reflect growth trends developed for the study area. *The Traffic Modeling Technical Memo* (**Appendix A**) documents how the study team utilized the statewide model for this project.

Heavy Vehicle Adjustments and Specific Grade Analysis

To reflect the influence of heavy vehicles in the traffic stream, the HCM methodology applies a heavy-vehicle adjustment factor to the design hourly volume. The heavy vehicle adjustment factor is a function of the percentage of trucks, RVs, and passenger car equivalent factors for trucks and RVs. The values for passenger car equivalents are based on a specific roadway grade and its length combined with the percentage of trucks. The HCM methodology recommends performing a specific grade analysis in locations that contain any upgrade longer than 0.5 mile, or any upgrade greater than or equal to 3 percent that is also longer than 0.25 mile. The grade analysis conducted for the I-44 Purpose and Need Study is discussed in **Section B.5**.

Recommended LOS Thresholds

The MoDOT *Engineering Policy Guide* (Category: 232 Facility Selection) discusses the recommended design year LOS for both rural and urban land use types. The design year for major routes is generally based on 20-year traffic projections; however, because of the very preliminary nature of this study, 30-year traffic projections were determined to be more appropriate and thus were used in the analysis. For urban settings the recommended LOS is E in the peak hour and D in off-peak hours. For rural settings the recommended LOS is D in the peak hour and C in off-peak hours. Because the I-44 corridor is generally more rural in nature, there is not a significant distinction on a daily basis between peak hours and off-peak hours. As a result, a standard approach when analyzing corridors of this type is to select a design hour (often the 30th highest hourly volume for the year) rather than peak and off-peak hours. For the urban sections within the I-44 corridor, a peak hour/off-peak hour approach would be appropriate; however, due to limitations of available data and the preliminary nature of the study, only the peak hour was evaluated. A more detailed explanation of design hour volume determination can be found in the technical memo in **Appendix A**. All of the data discussed in this document pertains to either design hour or peak hour data, both of which are compared against peak hour LOS thresholds. Therefore, the appropriate LOS thresholds are: LOS D or better in rural sections and LOS E or better in urban sections.

Key Analysis Thresholds (Level of Service)

The level of service thresholds were:

- Rural sections: LOS D or better
- Urban sections: LOS E or better

b. Existing and Future Traffic Volumes

Existing traffic (2005) and forecast traffic for 2035 (Design Year) show that traffic is expected to increase notably over time. Overall, existing two-way traffic volumes vary from 27,700 AADT (in Lawrence County) to 40,000 AADT (in Franklin County). In 2035, two-way volumes would vary from 60,100 (in Pulaski County) to 85,000 (in Franklin County). **Table B-2** summarizes the existing and forecast traffic, on a county-wide basis.

Existing and Future Traffic Volumes

Between 2005 and 2035, nearly every portion of I-44 will experience a doubling in the number of vehicles. In some instances, the increases are expected to be as high as 45,000 vehicles per day.

Nearly every county will experience a doubling in the number of vehicles on I-44. Crawford, Laclede, and Webster counties are expected to experience the greatest percentage increases. The highest total increases in traffic volumes are expected to occur in Franklin County. Attributable to its proximity to St. Louis, Franklin County is expected to experience increases of 45,000 vehicles per day.

Table B-2

Existing and Design Year Traffic Comparison

I-44 Section	Existing Two-Way AADT (2005)	Design Year Two-Way AADT (2035)	Percent Increase
Newton County	29,100	63,600	119 percent
Jasper County	29,800	64,200	115 percent
Lawrence County	27,700	61,500	122 percent
Greene County	39,100	72,800	86 percent
Webster County	30,200	73,500	143 percent
Laclede County	28,000	68,200	144 percent
Pulaski County	27,900	60,100	115 percent
Phelps County	31,200	69,800	124 percent
Crawford County	31,200	78,600	152 percent
Franklin County	40,000	85,000	113 percent

Without adequate capacity, drivers experience travel uncertainty caused by slower travel speeds. Reduced travel efficiency and reliability increases transportation costs for commuters, commercial operators, and all other travelers through the affected area. Inadequate capacity also affects interchanges; making it more difficult to enter/exit. Inadequate capacity also reduces safe passing opportunities, thereby increasing the potential for accidents.

Truck Traffic

The number of heavy trucks in the traffic stream affects traffic operations and contributes disproportionately to the level of congestion. Heavy trucks are slower entering and exiting highways, they occupy more roadway space, their operating speeds are more affected by long and/or steep grades, and, in general, they have a greater effect on the roadway than passenger vehicles. Also, as noted in the crash evaluation discussion (**Section B.2**), another concern with trucks is their role in the severity of crashes. The overall effect of one truck is equivalent to between two to five passenger cars. Thus, the larger the proportion of trucks in the traffic stream, the greater the traffic load and highway capacity required (Transportation Research Board 2000). **Table B-3** summarizes existing and future truck percentages.

Table B-3

Truck Percentages in the Study Area

County	2005	2035
Newton	30 percent	36 percent
Jasper	28 percent	28 percent
Lawrence	27 percent	32 percent
Greene	26 percent	25 percent
Webster	27 percent	19 percent
Laclede	27 percent	19 percent
Pulaski	27 percent	14 percent
Phelps	27 percent	16 percent
Crawford	27 percent	17 percent
Franklin	24 percent	21 percent

Trucks currently account for 24 to 30 percent of study area traffic. There is little variability in the percentage of truck traffic by direction or among counties. The high percentage of trucks using I-44 confirms its importance as a major commercial route and important connection in the regional transportation system. The freight movement discussion in **Section B.4** discusses the importance of I-44 as a commercial trucking corridor. On an average weekday, existing truck traffic varies from about 8,300 trucks at the west end of the study corridor (Newton County) to 10,000 trucks at the east end (Franklin County). In 2035, truck traffic is expected to grow considerably throughout the I-44 corridor. When looking at percentage of trucks within the traffic stream, the western portions of the corridor are expected to see an increase while the eastern portions are expected to show a decrease. The percentage of trucks in Newton, Jasper and Lawrence counties is expected to increase to between 28 and 36 percent of traffic. The truck percentages in the seven counties east of Lawrence County, which currently have 24 to 27 percent truck traffic, are expected to decline to between 14 and 25 percent. In 2035, the volume of trucks would be expected to increase to approximately 23,000 trucks per day at the west end of the study corridor and to18,000 per day at the east end. This general trend of truck percentages may be attributable to the shifting of distribution routes for locations towards Springfield. This shift in routes occurs when the overall area growth and costs of transport result in suppliers adding closer distribution depots. The predicted increase in truck traffic would increase the number of potential conflicts between trucks and other vehicles throughout the corridor and the overall level of congestion.

Table B-4

Level of Service Characteristics

Level of Service (LOS)	Characteristics
A	• Unrestricted free flow • Drivers virtually unaffected by others • High level of freedom to select speed and maneuver • Excellent level of driver comfort and convenience
B	• Slightly restricted stable flow • Driver aware of use by others • Slight restriction in speed and maneuvering • Good level of driver comfort and convenience
C	• Moderately restricted stable flow • Driver operation significantly affected by others • Moderate restriction in speed and maneuvering • Fair level of comfort
D	• Heavily restricted flow • Driver operation completely affected by others • Severe restriction in speed and maneuvering • Poor level of driver comfort and convenience
E	• Unstable flow • Slow speeds and traffic backups; some stoppage • Total restriction in vehicle maneuvering • High driver frustration
F	• Forced flow • Stop and go movements with long backups and delays • Forced vehicle maneuvers • Maximum driver frustration

c. Highway Operations

Level of service (LOS) is a qualitative description based on quantitative calculations of operational conditions within a traffic stream. A designated LOS is described in terms of average travel speed, density, traffic interruptions, comfort, convenience, and safety. More detailed information about the methods and assumptions that were used to develop the existing and future levels of service are found in the *Freeway Traffic Analysis, Methods, Assumptions and Results Technical Memo* in **Appendix A**.

Truck Traffic on I-44

Between 2005 and 2035, the **percentage** of trucks is expected to increase in the western portions of the corridor and decrease in the eastern portions. Nevertheless, the **total volume** of trucks will continue to increase corridor-wide and have a disproportionate influence on traffic operations.

Guidelines for appropriate LOS on various types of highways have been established by the Transportation Research Board. LOS designations range from “A” to “F,” with “A” representing free-flow traffic and “F” gridlock conditions. The characteristics of the LOS designations are summarized in **Table B-4**.

Table B-5 summarizes the LOS analysis for I-44. Each of the 79 roadway segments are identified, along with the county, exit, and rural/urban identifiers. The two-way ADTs for

2005 and 2035 are shown, along with the LOS for that segment. Those segments that do not achieve the appropriate LOS thresholds (LOS D or better in rural sections and LOS E or better in urban sections) are highlighted in yellow.

Table B-5

Two-Way Daily Travel Demand/ Roadway LOS and Anticipated Year to LOS F

		Section Start/Finish		2005		2035		Anticipated Year for LOS F	
Location		Exit	Exit	Two-Way Volume (ADT)	LOS EB/WB	Two-Way Volume (ADT)	LOS EB/WB	East Bound	West Bound
Newton County									
1. Oklahoma to U.S. 166	Rural	--	1	19,375	B/B	55,119	E/E	N/A	N/A
2. U.S. 166 to Rest Area	Rural	1	RA	23,885	B-C/B-C	57,521	E-F/E	2030	N/A
3. Rest Area to Weigh Station	Rural	RA	WS	27,245	B-C/B-C	57,521	E/E	N/A	N/A
4. Weigh Station to Route 43	Urban	WS	4	28,804	C/B	57,521	C-D/D	N/A	N/A
5. Route 43 to Route 86	Urban	4	6	30,625	C/B	74,057	F/E-F	2025	2030
6. Route 86 to Business Rte 71	Urban	6	8	34,457	C/C	89,978	F/F	2015	2015
7. Business Route 71 to US-71	Urban	8	11	30,111	C/B	49,643	C/C	N/A	N/A
Jasper County									
8. U.S. 71 to Loop 44/Route 66	Rural	11	15	33,210	C/C	49,643	D/D	N/A	N/A
9. Route 66 to U.S. 71 N	Rural	15	18	35,442	C-D/C-D	71,055	F/F	2025	2020
10. U.S. 71 N to 10th Road.	Rural	18	22	28,055	C/C	73,354	F/F	2030	2020
11. 10th Road. to Route 37	Rural	22	26	28,055	C/C	73,213	F/F	2025	2025
12. Route 37 to Route U	Rural	26	29	27,094	B-C/B-C	73,488	F/F	2025	2025
13. Route U to Route 97 S	Rural	29	33	25,948	B-C/B-C	50,673	E/E-F	NA	2035
Lawrence County									
14. Route 97 S to Route 97	Rural	33	38	25,948	B-C/B-C	55,673	E/E	N/A	N/A
15. Route 97 to Route H	Rural	38	44	27,974	B-C/B-C	58,603	E/E	N/A	N/A
16. Route H to Route 265/39	Rural	44	46	26,231	B-C/B-C	57,381	E/E	N/A	N/A
17. Route 265/39 to Route 174	Rural	46	49	29,986	C/C	67,013	F/F	2030	2030
18. Route 174 to Rest Area	Rural	49	RA	27,444	B-C/C	65,333	F/F	2030	2030
19. Rest Area to Route 96	Rural	RA	57	30,589	B-C/C	65,333	F/F	2025	2025
20. Route 96 to Route Z/O	Rural	57	58	32,525	C/C	71,810	F/F	2015	2015
21. Route Z/O to Route K/PP	Rural	58	61	31,919	C/C	92,989	F/F	2010	2010
Greene County									
22. Route K/PP to Route T/N	Rural	61	67	30,258	C/C	49,807	D/D	N/A	N/A

Table B-5

Two-Way Daily Travel Demand/ Roadway LOS and Anticipated Year to LOS F

		Section Start/Finish		2005		2035		Anticipated Year for LOS F	
Location		Exit	Exit	Two-Way Volume (ADT)	LOS EB/WB	Two-Way Volume (ADT)	LOS EB/WB	East Bound	West Bound
23. Route T/N to Route 360	Urban	67	69	35,401	C/C	59,377	D/D	N/A	N/A
24. Route 360 to Route B/MM	Urban	69	70	36,303	B/C	59,377	C-D/D	N/A	N/A
25. Route B/MM to Route 266	Urban	70	72	30,819	B/B	81,097	F/F	2030	2030
26. Route 266 to N. Eldon Ave.	Urban	72	74	28,385	B/C	74,971	E/E	N/A	N/A
27. N. Eldon Ave. to U.S. 160	Urban	74	75	32,484	B/C	53,928	D/D	N/A	N/A
28. U.S. 160 to Route 13	Urban	75	77	54,955	D/C	75,337	E/F	NA	2035
29. Route 13 to Route H	Urban	77	80	58,288	D/D	99,528	F/F	2010	2010
30. Route H to U.S. 65	Urban	80	82	55,560	D/C	96,557	F/F	2010	2010
31. U.S. 65 to Route 744	Urban	82	84	46,290	D/C	80,495	F/E	2025	NA
32. Route 744 to Route 125	Urban	84	88	36,723	C-D/C-D	89,236	F/F	2010	2010
33. Route 125 to Route B	Rural	88	96	33,121	C-D/C-D	77,925	F/F	2020	2020
Webster County									
34. Route B to Route 38	Rural	96	100	32,424	C-D/C-D	80,115	F/F	2015	2015
35. Route 38 to Sampson Rd.	Urban	100	107	27,423	C/C	67,968	D-E/C-D	N/A	N/A
36. Sampson Rd. to Rest Area	Rural	107	RA	28,152	C-D/B-C	79,058	F/F	2020	2025
37. Rest Area to Route Y/J	Rural	RA	113	28,152	C-D/B-C	79,058	F/F	2015	2025
Laclede County									
38. Route Y/J to Route C	Rural	113	118	27,991	C-D/B-C	77,162	F/F	2020	2025
39. Route C to Route W	Rural	118	123	30,006	C/B-C	74,212	F/F	2025	2025
40. Route W to Elm St.	Urban	123	127	39,112	C/C	74,212	F/F	2025	2025
41. Elm St. to Route 64/5/32	Urban	127	129	39,799	D/C	74,735	F/F	2035	2035
42. Route 64/5/32 to Route MM	Urban	129	130	33,194	C/C	49,345	C-D/D	N/A	N/A
43. Route MM to Route F	Rural	130	135	27,041	B-C/B-C	64,558	E/E	N/A	N/A
44. Route F to Route T/N	Rural	135	140	21,470	B-C/B-C	60,279	D-E/E	N/A	N/A
45. Route T/N to Route 133	Rural	140	145	23,804	B-C/B-C	70,343	F/F	2030	2030
46. Route 133 to Route 7/P	Rural	145	150	26,220	B-C/B-C	68,033	F/F	2035	2030
Pulaski County									
47. Route 7/P to Route 17	Rural	150	153	24,118	B-C/B-C	68,033	F/F	2035	2035

Table B-5

Two-Way Daily Travel Demand/ Roadway LOS and Anticipated Year to LOS F

		Section Start/Finish		2005		2035		Anticipated Year for LOS F	
Location		Exit	Exit	Two-Way Volume (ADT)	LOS EB/WB	Two-Way Volume (ADT)	LOS EB/WB	East Bound	West Bound
48. Route 17 to Route H	Rural	153	156	28,291	B-D/C	59,754	E-F/D-E	2035	NA
49. Route H to I-44 BI	Rural	156	159	32,554	C-D/B-D	55,417	E/D	N/A	N/A
50. I-44 BI to Route Y	Urban	159	161	30,297	C/C	64,020	D/E	N/A	N/A
51. Route Y to Route 28	Urban	161	163	28,936	C/C	51,968	C-D/C-D	N/A	N/A
52. Route 28 to Route J	Rural	163	169	27,210	B-D/B-C	62,416	C-E/E	N/A	N/A
Phelps County									
53. Route J to Route D	Rural	169	172	27,054	C/B-C	71,454	F/D-F	2030	2030
54. Route D to Sugar Tree Rd.	Rural	172	176	28,976	B-C/C	71,317	C-F/F	2030	2025
55. Sugar Tree to Rest Area	Rural	176	RA	28,976	C/C	53,774	D-E/D-E	N/A	N/A
56. Rest Area to Route T/C	Rural	RA	179	28,976	C/C	53,774	E/D	N/A	N/A
57. Route T/C to King's Hwy	Rural	179	184	35,049	C/B-D	65,204	E-F/D-F	2035	2035
58. King's Highway to Route E	Urban	184	185	41,108	C/D	55,285	C/D	N/A	N/A
59. Route E to U.S. 63	Urban	185	186	33,928	D/C	54,527	C-D/C-D	N/A	N/A
60. U.S. 63 to Route V	Urban	186	189	38,479	E/C	81,131	F/F	2030	2030
61. Route V to Route. 68/8	Urban	189	195	31,403	C-D/C-D	85,434	F/F	2015	2015
62. Route 68/8 to Route F	Rural	195	203	30,956	C-D/C-D	81,459	F/F	2025	2015
Crawford County									
63. Route F to Route 19	Rural	203	208	29,521	C/C-D	79,017	F/F	2025	2025
64. Route 19 to Route UU	Rural	208	210	30,546	C/C-D	80,328	F/F	2025	2025
65. Route UU to Route H	Rural	210	214	32,560	C-D/C-D	80,574	F/F	2025	2025
66. Route H to Route C/N	Rural	214	218	31,130	C-D/C-D	81,140	F/F	2025	2025
67. Route C/N to Route 185	Urban	218	225	32,502	B-D/B-D	85,589	F/F	2015	2020
Franklin County									
68. Route 185 to Route 185 S	Urban	225	226	35,862	D/D	87,039	F/F	2015	2020
69. Route 185 S to Route JJ/W	Rural	226	230	30,052	D/D	83,095	F/F	2015	2020
70. Route JJ/W to Rest Area	Rural	230	235	37,041	D/D	90,832	F/F	2010	2010
71. Rest Area to Weigh Station	Rural	235	238	37,041	D/D	90,832	F/F	2010	2010

Table B-5

Two-Way Daily Travel Demand/ Roadway LOS and Anticipated Year to LOS F

		Section Start/Finish		2005		2035		Anticipated Year for LOS F	
Location		Exit	Exit	Two-Way Volume (ADT)	LOS EB/WB	Two-Way Volume (ADT)	LOS EB/WB	East Bound	West Bound
72. Weigh Station to Route 30	Rural	238	239	36,180	D/D	90,832	F/F	2010	2015
73. Route 30 to Route 47	Rural	239	240	36,180	C-D/D	81,615	F/F	2020	2025
74. Route 47 to Route AH	Rural	240	242	35,053	C-D/C-D	80,832	F/F	2020	2020
75. Route 66 to U.S. 50	Rural	242	247	36,433	C-D/C-D	80,832	F/F	2015	2015
76. U.S. 50 to Route 100 West	Rural	247	251	42,490	D-E/D	87,872	F/F	2010	2010
77. Route 100 W - Route 100 E	Urban	251	253	50,288	D-E/D-F	115,124	F/F	2010	2010
78. Route 100 E to Loop 44	Urban	253	257	53,741	E/F	92,416	F/F	2015	2010
79. Loop 44 - St. Louis County	Urban	257	--	68,867	F/F	102,588	F/F	2010	2010

Highlighted areas exceed LOS thresholds (LOS E in rural sections and LOS F in urban sections)

Volume ADTs are two-way (eastbound plus westbound)

As shown in **Table B-5**, existing levels of service, during peak traffic conditions, are generally acceptable (meeting the LOS thresholds). The only location that fails to meet current LOS thresholds is in the vicinity of Villa Ridge/Gray Summit/Pacific in Franklin County.

Existing Roadway Capacity

Based on a capacity analysis, the current conditions along I-44 are generally acceptable.

All but the following sections completely meet the established LOS thresholds:

- U.S. Route 50 to Route 100 West
- Route 100 West to Route 100 East
- Route 100 East to Loop 44
- Loop I-44 to St. Louis County

Under 2035 peak traffic conditions, there would be a substantial and uniform decline in LOS in urban and rural areas such that nearly all of the study area would exceed the LOS thresholds. There would be short segments in Joplin, Springfield and Rolla that meet standards; however, the traffic increases described above make these segments the exception in the study area. Of particular note is the approximately 69-mile stretch of I-44 from the east side of Rolla to the east project limit that would be LOS F (gridlock conditions). It appears that the increasing urbanization moving from St. Louis County into Franklin County and beyond is responsible for this trend. It should be noted that while LOS E for urban areas meets acceptable standards, LOS E is approaching or at maximum capacity. Traffic flow under those conditions is unstable, minor disruptions may cause traffic backups and freedom to maneuver safely is compromised. In all, only 14 segments are expected to meet the LOS thresholds by the year 2035. This means that approximately 82 percent of the study area (approximately 210 miles) is not expected to meet LOS thresholds by the year 2035. No portions of Lawrence, Crawford, or Franklin Counties would meet the LOS thresholds.

Table B-5 presents the roadway LOS evaluation, including the identification of roadway segments that are expected to fail to achieve the applicable thresholds by the design year (2035). Because the majority of roadway segments are expected to fail by the design year, additional analyses were conducted to investigate when each segment of the I-44 corridor is projected to degrade to LOS F. **Table B-5** also presents this data.

Future Roadway Capacity

Based on a capacity analysis, the future conditions along I-44 are expected to materially deteriorate. In fact, of the 79 roadway segments that constitute the study area, 54 are expected to operate in the worst possible LOS category (LOS F). These segments correspond to roughly 77 percent of the 257 miles of I-44.

Roadway capacity will need to be addressed across the breadth of I-44.

Based on these analyses, it was estimated that most roadway segments will reach LOS F earlier than 2035 (68 percent, 54 of the 79 roadway segments). Of the 54 segments, roughly 20 percent (n=11) will degrade to LOS F by 2010. Another 20 percent (n=10) are expected to degrade to LOS F by 2015. Only about 11 percent (n=6) are expected to delay degrading to LOS F until the design year (2035). The balance (n=27) will degrade to LOS F between 2020 and 2030.

The data presented in **Table B-5** also provides insight into localized issues affecting various locations along the I-44 corridor. Analysis performed on segments show notable fluctuations from previous or subsequent sections and determine the local factors that influence the projected ADT. The segments and the probable cause for the ADT fluctuations are noted below.

- *Joplin area – Weigh Station to Route 43 (segment 4) and Route 86 to Business Route 71 (segment 6)*—The 17,000 AADT volume increase from segment 4 to 5 results from an influx of traffic using the Route 43 interchange (exit 4) and traveling to/from destinations in Joplin. The LOS C-D/D result for segment 4 results mostly from the “urban” classification of that segment. The drop in AADT between segments 6 and 7 results mainly from the heavy use of I-44 for local trips between Route 86 and Business Route 71 (exits 6 and 8).

- *Sarcoxie area – Route U to Rout 97 South (segment 13)*—Segment 13 shows a decrease of 22,000 in ADT resulting mostly from the residents of the Sarcoxie area using Route U (exit 29) as their main access to I-44. Most of the travel from this interchange is destined to the west towards Joplin.

- *Springfield area – Route B/MM to Route 266 (segment 25)*—The increase in ADT from Route B/MM to Route 266 (exits 70 and 72) can be attributed to the numerous trips to and from the south side of I-44 using the Route B/MM interchange to travel to/from I-44 and the James River Freeway, Route 60 and Route 13.

- *Springfield area – N. Eldon Avenue to U.S. 160 (segment 27)*—The decrease in ADT between N. Eldon Avenue and Route 160 (exits 74 and 75) is attributed to the very close spacing of the two interchanges. Traffic desiring to enter/exit I-44 from either direction will utilize the first of the two interchanges they reach resulting in a decrease in ADT between the two interchanges.

- *Springfield area – U.S. 65 to Route 744*—The decrease between Route 65 and Route 744 (exits 82 and 84) is attributed to, in part, the close spacing of interchanges serving destinations on the east side of Springfield. This is similar to the issue between Exits 74 and 75. Also, Route 65 draws a significant amount of eastbound I-44 traffic off of the interstate.

- *Lebanon area – Route 64/5/32 to Route MM (segment 42)*—A notable decrease in ADT between Routes 64/5/32 and Route MM (exits 129 and 130) is mainly due to the closely spaced interchanges serving Lebanon. Similar to Springfield, traffic to/from either direction on I-44 is using the closest interchange creating a localized drop in ADT between the interchanges.

- *St. Robert area – Route Y to Route 28 (segment 51)*—Traffic on this segment is approximately 10,000 vehicles per day less than adjacent segments. This can be attributed to traffic from the west destined for St. Robert using the Route Y interchange (exit 161) and a fair amount of traffic from the east using the Route 28 interchange (exit 163) to access the commercial and residential destinations at and north of that interchange.

- *Doolittle/Rolla area – Route T/C to King's Highway (segment 57)*—The relatively high ADT projected for this segment primarily results from "local" trips between the smaller community of Doolittle and Rolla.

- *Gray's Summit area – Route 100 West to Route 100 East (segment 77)*—The sharp increase in ADT on this segment can be attributed to the use of I-44 as a "short cut" between Route 100 West (exit 251) and Route 100 East (exit 253). Traffic traveling in either direction on Route 100 tends to enter I-44 at one interchange and exit at the next interchange in order to stay on Route 100.

Expected Dates for I-44 Operations to Degrade to LOS F

For those sections of I-44 performing at LOS F in the design year (2035), analyses were conducted to determine when those respective sections will actually reach LOS F.

Sections with Portions Expected to Degrade to LOS F as early as 2010

- 21 - Route Z/O to Route K/PP - Exit 58 to Exit 61 (Lawrence County)
- 29 - Route 13 to Route H - Exit 77 to Exit 80 (Greene County)
- 30 - Route H to U.S. 65 - Exit 80 to Exit 82 (Greene County)
- 32 - Route 744 to Route 125 - Exit 84 to Exit 88 (Greene County)
- 70 - Route JJ/W to Rest Area – Exit 230 to Exit 235 (Franklin County)
- 71 - Rest Area to Weigh Station – Exit 235 to 238 (Franklin County)
- 72 - Weigh Station to Route 30 – Exit 238 to 239 (Franklin County)
- 76 - U.S. 50 to Route 100 West – Exit 247 to 251 (Franklin County)
- 77 - Route 100 W to Route 100 East – Exit 251 to Exit 253 (Franklin County)
- 78 - Route 100 E to Loop 44 – Exit 253 to Exit 257 (Franklin County)
- 79 - Loop 44 to St. Louis County – Exit 257 to Termini (Franklin County)

Sections with Portions Expected to Degrade to LOS F as early as 2015

- 6 - Route 86 to Business Route 71 - Exit 6 to Exit 8 (Newton County)
- 20 - Route 96 to Route Z/O - Exit 57 to Exit 58 (Lawrence County)
- 34 - Route B to Route 38 - Exit 96 to Exit 100 (Webster County)
- 37 - Rest Area to Route Y/J – Rest Area to Exit 113 (Webster County)
- 61 - Route V to Route 68/8 – Exit 189 to Exit 195 (Phelps County)
- 62 - Route 68/8 to Route F – Exit 195 to 203 (Phelps County)
- 67 - Route C/N to Route 185 – Exit 218 to 225 (Crawford County)
- 68 - Route 185 to Route 185 S – Exit 225 to 226 (Franklin County)
- 69 - Route 185 S to Route JJ/W – Exit 226 to 230 (Franklin County)
- 75 - Route 66 to U.S. 50 – Exit 242 to 247 (Franklin County)

2. Degrading Safety Environment on I-44

Safety is an essential measure of performance for any transportation facility. Examination of safety in the form of historical crash trends for an existing transportation system helps agencies to identify current and potential future safety issues and consequently is one of several elements that influence future project investment for a given location. The MoDOT *Engineering Policy Guide* clearly dictates that MoDOT will not compromise safety; every project is required to leave the roadway safer after it is completed. With this concept in mind, the I-44 Purpose and Need Study undertook an extensive investigation of the crash environment along I-44 to ensure that future project development along the corridor addresses any safety issues that might exist along the facility. The crash investigation is discussed throughout this section.

There are on average roughly 2,000 crashes each year within the portion of I-44 covered by this project. To better understand the underlying trends and potential causes of these crashes, the I-44 Purpose and Need Study examined all available crash records for the most recent 5 years of record (2002–2006). A variety of traditional crash rate and type analyses were conducted. Additionally, the I-44 Purpose and Need Study sought to coordinate its crash investigation with its geometric (roadway design) evaluation. Just as a crash location does not automatically denote a physical roadway problem, roadway geometrics that do not meet current standards do not necessarily represent a safety hazard. **Section B.5** summarizes the geometric evaluation. **Appendix A** contains the technical memos covering the breadth of the I-44 evaluations conducted. They also discuss some of the correlations between crash rates and other I-44 conditions.

Summary of Crash-Related Transportation Problems Affecting I-44

In addition to the public perception that travel on I-44 is becoming increasingly dangerous, the crash evaluation conducted for this project has concluded that the crash environment has intensified in conjunction with the urbanization of the roadway. Additionally, the severity of the crashes along I-44 has increased. These results represent a valid transportation problem that any emerging I-44 project will need to address.

a. Introduction to the Crash Evaluation

The crash evaluation conducted for the I-44 Purpose and Need Study consists of four major elements outlined below.

Crash Rate Analysis

Standard calculations of the number of crashes per hundred million vehicle miles of travel were conducted for a wide range of segments across the 257-mile long corridor. Segments of analysis were established with sensitivity to the numerous unique conditions that occur over the hundreds of miles of the study area. Each segment was then evaluated based on the amount of traffic it carried (AADT) and the number of crashes that occurred over that segment, during a given time period (in this case, the 5 years between 2002 and 2006).The basic formula for crash rate calculation is:

$$\text{Crash Rate} = \frac{(\text{Number of Crashes}) \times (100{,}000{,}000)}{(\text{Number of Years}) \times (\text{AADT}) \times (\text{Length}) \times (365\ \text{days/year})}$$

Crash Type Analysis

Evaluation of crash data by type of crash was done to determine if any key trends emerged in the corridor. Utilizing data from MoDOT, the team examined severity trends, type of crash trends, truck crash trends, and a variety of other characteristics available through the data provided.

Crash Location Density Analysis (crash hotspots)

In addition to the calculation of crash rates, a location density analysis was conducted in an effort to identify areas of concentrated crashes. These are colloquially known as crash hotspots. The crash hotspot methodology focused on identifying three or more disabling injury or fatality crashes within any 0.3-mile segment of roadway. This methodology is similar to many applied across the United States by agencies seeking to understand the most problematic crash hotspots within their jurisdictions.

Safety Characteristics Mapping (Map Book)

Visually depicting crash trends across the corridor has been done to enhance the understanding of where particularly problematic areas exist. The safety characteristics Map is intended to graphically display the results of the safety analysis. This mapping is presented in the Map Book in **Appendix B**.

b. Crash Rate Analysis

A total of 10,275 crashes occurred in the study area from 2002 through 2006; with 2006 having the highest number of total crashes overall, but also the lowest number of fatalities (**Table B-6**)[1].

Table B-6

Total Crashes (2002-2006)

By Severity	**All Crashes by Year**					
	2002	***2003***	***2004***	***2005***	***2006***	***TOTAL***
Property Damage Only	1,426	1,508	1,520	1,406	1,579	**7,439**
Minor Injury	395	388	395	383	372	**1,933**
Disabling Injury	162	143	145	135	142	**727**
Fatal	33	37	34	46	26	**176**
Total:	2,016	2,076	2,094	1,970	2,119	**10,275**

Crash Rates vs. Statewide Averages

To more accurately portray the crash environment, the study area was divided into rural and urban areas and crash rates were developed for each. Urban areas were considered to be communities with a population of 5,000 or more, and rural areas are those portions of the

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[1] MoDOT maintains data on crashes that occur on the interstate and state highway system. The data in this section is derived from those MoDOT databases. This information is also the source of the statewide average crash rates for urban and rural highways. Unless otherwise noted, crash rates are expressed as the number of crashes per 100 million vehicle miles traveled.

corridor not within the boundary of an urban area. 2000 Census data was used to establish the populations of study area communities. **Table B-7** depicts the urban/rural divisions used during the crash evaluation.

Table B-7

Urban Area boundaries used in the Crash Analysis

I-44 Mile Marker Begin	I-44 Mile Marker End	City (County)	Population (2000 Census)
6.0	10.5	Joplin (Newton)	45,504
72.5	86.0	Springfield (Greene)	151,580
101.0	104.3	Marshfield (Webster)	5,720
126.7	130.3	Lebanon (Laclede)	12,155
153.4	163.9	Ft. Leonard Wood/St. Robert (Pulaski)	16,426
183.9	190.0	Rolla (Phelps)	16,367
224.0	226.1	Sullivan (Crawford and Franklin)	6,351
253.4	258.3	Pacific (Franklin)	5,479

The 5-year average I-44 crash rates for the 10 counties within the study area are listed in **Tables B-8 and B-9.** The overall urban and rural crash rates (which includes fatal, non-fatal-injury, and property-damage-only crashes), injury crash rates (includes minor injury and disabling injury) are compared in each table. County crash rates that are higher than the average for all interstate routes in Missouri are highlighted.

Urban Crash Rate Trends

Phelps County (Rolla) exceeded the statewide total crash rates for all crash types except fatal crashes. Phelps County exceeded the total crash rate by 40 percent, the property damage only (PDO) rate by 39 percent and the injury rate by 51 percent. This is not unexpected given the rolling terrain and sharp horizontal curvature through many sections of Phelps County. It is important to note that some recent improvements through area and will likely improve I-44 safety performance in Phelps County.

Table B-8

I-44 Crash Rate for the Urban Portions of the 10 Counties within the Study Corridor

County	All Crashes	PDO	Minor Injury	Disabling Injury	Fatality
Newton	90.34	65.40	16.18	5.20	3.56
Jasper (no urban segments)	-	-	-	-	-
Lawrence (no urban segments)	-	-	-	-	-
Greene	75.60	51.24	20.57	2.80	1.00
Webster	39.93	31.91	5.16	2.37	0.48
Laclede	83.86	59.26	15.42	9.18	0.00
Pulaski	100.60	77.46	12.70	9.53	0.90
Phelps	168.82	127.49	32.34	8.19	0.81
Crawford	27.99	20.26	7.73	0.00	0.00
Franklin	49.25	41.47	5.14	2.11	0.53
I-44 Corridor	**96.01**	**71.82**	**17.49**	**5.67**	**1.04**
State Average	**120.09**	**91.9**	**26.8***		**1.34**

Source: MoDOT TMS, 2002 - 2006. All Rates Expressed in Number of Crashes per Hundred Million Vehicle Miles Traveled

Highlighted Text Indicates Rates Higher Than State Averages for Similar Facilities

** rate shown is for all injuries; it is comparable to the minor injury rate and disabling injury rate*

While Newton County (Joplin) does not have an extremely high number of crashes, the crashes are severe in nature and exceed the statewide average fatal crash rate by 166 percent. This high fatal crash rate is attributed, in part, to the 70 mph speed limit and the closely spaced interchanges in Joplin. With the exception of Phelps (Rolla) and Newton (Joplin) counties, no other urban area in the project area exceeded the statewide average for any crash type.

As discussed in **Section B.3** interchanges and their “influence areas” are often the focus of crash problems along interstate routes. For instance, the crash rates in Phelps County (Rolla) are influenced by traffic operations at the U.S. Route 63 South, Route E and U.S. Route 63 interchanges; as well as the areas upstream and downstream of those interchanges. In the eastbound direction, the U.S. Route 63 South, Route E and U.S. Route 63 interchange areas have total crash rates of 135.38, 220.33, and 421.71, respectively. The U.S Route 63 South interchange also had a fatal crash rate of 3.30 in the eastbound direction. It is also worth noting that the U.S. Route 63 eastbound merge ramp currently operates at LOS F (gridlock) in the peak hour. That ramp is one of the very few ramps in the entire study area found to be currently deficient. In the westbound direction U.S. Route 63 South and U.S. Route 63 interchange areas have total crash rates of 160.04 and 380.42, respectively. As in the eastbound direction, U.S. Route 63 South has a fatal crash rate (3.14). All of these rates are well in excess of the Missouri interstate average.

In Joplin (Newton County), the eastbound Route 86 and Business Loop I-44 interchanges have fatal crash rates of 3.19 and 3.11, respectively. In the westbound direction the fatal crash rates for those interchanges increases to 9.83 and 6.57. The Route 86 interchange is a cloverleaf configuration that creates conflicts between the slower moving traffic entering and exiting I-44 and the faster moving through traffic.

Important Urban Crash Rate Trends

Phelps County (Rolla)—The area associated with the U.S. Route 63 South, the Route E and the U.S. Route 63 interchanges have crash rates several times the statewide averages.

Newton County (Joplin)—The Route 86 and Business Loop I-44 interchanges have fatal crash rates well above statewide averages.

More information about interchange operations are found in **Section B.3**. Additional detail supporting the interchange analysis discussion can also be found in the *Interchange Evaluation Analysis Technical Memorandum* in **Appendix A**.

Rural Crash Rate Trends

The project area's rural crash rate data is found in **Table B-9**. Like the preceding urban section discussion, the rural crash rates are organized by county. There are several interesting trends in the rural county areas:

- Three counties, Newton at the west end of the study area as well as Phelps and Franklin (at the east end) exceeded the statewide average rates for all crash types.
- Crawford County, located between Phelps and Franklin counties, exceeded the statewide average for all crash types except fatal crashes.
- Five of the remaining six counties; Jasper, Lawrence, Greene, Webster, and Laclede counties only exceeded the statewide fatal crash rate; and Pulaski County only exceeded the statewide PDO rate.

Important Rural Crash Rate Trends

The total crash rates in urbanizing counties, such as Newton, Phelps, Crawford and Franklin are noticeably higher than traditionally rural counties. This trend should be carefully considered by project planners in the future. Land use projections can help in the selection of appropriate design standards.

Table B-9

I-44 Crash Rates for the Rural Portions of the 10 Counties within the Study Corridor

County	All Crashes	PDO	Minor Injury	Disabling Injury	Fatality
Newton	78.56	53.47	18.53	5.26	1.31
Jasper	54.93	37.57	13.34	2.43	1.59
Lawrence	48.68	33.39	10.24	3.78	1.28
Greene	36.98	23.36	9.95	2.02	1.64
Webster	44.86	31.18	7.86	4.64	1.19
Laclede	57.33	42.76	8.81	4.48	1.28
Pulaski	65.41	52.38	6.57	6.29	0.17
Phelps	83.26	56.95	17.70	7.27	1.34
Crawford	70.11	49.75	12.58	6.85	0.94
Franklin	78.00	59.07	12.16	5.61	1.16
I-44 Corridor	**61.79**	**44.06**	**11.64**	**4.86**	**1.22**
State Average	**66.66**	**48.8**	**16.7 ***		**1.13**

Source: MoDOT TMS, 2002–2006. All Rates Expressed in Number of Crashes per Hundred Million Vehicle Miles Traveled

Highlighted Text Indicates Rates Higher Than State Averages for Similar Facilities

** rate shown is for all injuries; it is comparable to minor injury rate and disabling injury rate*

Interchange crash trends provide a partial explanation for the trends noted above. As might be expected Newton, Phelps, Crawford, and Franklin counties had interchange areas with high crash rates. It should be noted that Newton County only had one rural interchange (U.S. 166) and because it had a total crash rate of 274.26 and a fatal crash rate of 5.17, it strongly influenced the county's rural crash picture.

The total crash rates at interchanges in Jasper, Lawrence, Greene, Webster, Laclede, and Pulaski counties were noticeably lower than those in Newton, Phelps, Crawford, and Franklin counties. In sharp contrast to the total crash rate trend in these counties, the fatal crash rates were, in a number of locations, comparable to the fatal rates for Newton, Phelps, Crawford, and Franklin counties. Lawrence County is an example of the differing trends between total crash rates and fatal crash rates. More information about interchange operations in rural areas is found in **Section B.3** as well as in the Interchange Evaluation Analysis Technical Memorandum in **Appendix A**.

c. Crash Types

To gain a better understanding of physical elements that might be contributing to certain crash trends, crash data for 2002-2005 were evaluated for crash type patterns. **Table B-10** provides an overview of the most prevalent crash types in the corridor.

Table B-10

Percentage of Crashes by Type (2002-2006)

Crash Type	PDO	Minor Injury	Disabling Injury	Fatal
Head-On	0	2	3	11
Other	17	4	2	1
Out-of-Control	34	51	58	47
Passing	13	6	5	3
Pedestrian	0	0	1	10
Rear-End	20	25	18	14
All Other Categories	16	12	13	14

Source: MoDOT TMS, 2002 - 2006

Out-of-control and rear-end crashes are the two most common causes for the four types of crashes noted in **Table B-11**. Together, out-of-control and rear-end crashes accounted for 6,139 crashes or 60 percent of all study area crashes from 2002 through 2006. It is worth noting that out-of-control crashes make up a slightly larger percentage of disabling injury crashes than minor injury crashes. For fatal crashes, the percentage of head-on crashes (11 percent) and crashes involving pedestrians (10 percent) are notable. The percentage of pedestrian crashes validates the perception that I-44 is an extremely dangerous place for people to walk, hitchhike, work, or change tires.

Tables B-11 and B-12 examine the nature of out-of-control and rear-end crashes more extensively. Particularly noteworthy is that out-of-control crashes account for nearly half (83 out of a total 176) of the fatal crashes and more than half (421 out of a total 727) of the disabling injury crashes in the corridor. Further analysis of the underlying causes of these types of crashes will be an important component of the next phase of study in the I-44 corridor.

Table B-11

Out-of-Control Crashes (2002-2006)

Severity	Eastbound	Westbound	Total	I-44 Total
PDO	1,300	1,248	2,548	7,439
Minor Injury	493	496	989	1,933
Disabling Injury	215	206	421	727
Fatal	46	37	83	176
Total:	**2,054**	**1,987**	**4,041**	**10,275**

Table B-12				
Rear-End Crashes (2002-2006)				
Severity	**Eastbound**	**Westbound**	**Total**	**I-44 Total**
PDO	699	764	1,463	7,439
Minor Injury	229	252	481	1,933
Disabling Injury	64	66	130	727
Fatal	11	13	24	176
Total:	**1,003**	**1,095**	**2,098**	**10,275**

Truck Crashes

Although commercial trucks on I-44 make up about 30 percent of the total number of vehicles on I-44, they were involved in only 16 percent of the crashes. **Table B-13** compares the number and severity of truck crashes on Missouri's five interstate routes. The I-44 data includes Missouri totals as well as the results excluding the St. Louis area. This is roughly the project study area and is depicted in parentheses.

Because I-44 and I-70 are of similar length, have similar traffic volumes (including the percentage of commercial vehicles) and function similarly within the freight system, the focus of the truck crash analysis is a comparison between I-44 and I-70.

Table B-13						
Truck Crashes on Missouri Interstate Routes						
		Interstate Routes in Missouri				
Year	**Crash Type**	**I-29**	**I-35**	**I-55**	**I-44Total (Study Area)**	**I-70**
2002	PDO	119	201	372	204 (162)	984
	Minor Injury	23	41	86	92 (76)	228
	Disabling Injury	8	7	19	54 (53)	46
	Fatal	1	2	8	16 (15)	16
2003	PDO	117	187	286	212 (183)	937
	Minor Injury	20	33	60	116 (91)	223
	Disabling Injury	9	14	15	45 (40)	31
	Fatal	2	2	7	16 (16)	18
2004	PDO	122	198	328	253 (206)	970
	Minor Injury	26	49	71	104 (88)	219
	Disabling Injury	5	6	27	36 (32)	52

Table B-13

Truck Crashes on Missouri Interstate Routes

Year	**Crash Type**	**Interstate Routes in Missouri**				
		I-29	**I-35**	**I-55**	**I-44Total (Study Area)**	**I-70**
	Fatal	1	2	6	13 (12)	12
2005	PDO	147	151	359	213 (168)	937
	Minor Injury	24	23	93	133 (105)	215
	Disabling Injury	4	7	19	47 (43)	38
	Fatal	4	3	5	26 (21)	14
2006	PDO	133	192	302	213 (179)	896
	Minor Injury	23	34	63	151 (94)	176
	Disabling Injury	5	4	16	46 (42)	34
	Fatal	1	3	5	14 (10)	17
Total Truck Crashes		794	1,159	2,147	2,004 (1,636)	6,063
Route Length (miles)		124	114	209	290 (258)	251

Source: MoDOT Office of Transportation Management Systems

As noted in **Table B-13**, I-70 had three times as many truck crashes as all of I-44 and nearly four times as many crashes as I-44 in the study area. On both interstate routes, PDO and minor injury crashes account for the majority of all truck crashes. Interstate 70 had 4,724 PDO crashes and 1,061 minor injuries while I-44 in the project area had 898 PDO crashes and 470 minor injury crashes.

In sharp contrast to the disparity between the numbers of PDO and minor injury crashes on I-70 and I-44 are the numbers of disabling injury and fatal crashes involving trucks. In 2002, 2003, 2005, and 2006, I-44 in the study area had more disabling injury truck crashes than the entire length of I-70. I-44 also had comparable numbers of fatal truck crashes as I-70 during the analysis period. These data suggest that while trucks are involved in far fewer total crashes on I-44 than on I-70, the percentage of severe truck crashes on I-44 is higher than on I-70. A possible explanation for the difference in the severity of truck crashes may be the geometric characteristics of the two interstates. The geometry of I-70 is generally straight and flat while I-44 is more curvilinear and rolling, particularly east of Springfield.

Important Crash Type Trends

Fatal crash references punctuate the analysis. This trend should be carefully considered by project planners in the future.

Head-on and pedestrian crashes are notable. They tend to validate the public's perception that I-44 can be a dangerous place.

While total crashes involving trucks are less frequent on I-44 than comparable Interstates, such as I-70, the number of severe crashes on I-44 is comparable to that of I-70.

Given that commercial vehicles can be 40 or more times heavier than the other vehicles in the traffic stream it is, perhaps, not unexpected that truck crashes on I-44 were more severe than crashes that did not involve trucks. As noted in **Table 14**, the percentage of disabling injury crashes and fatal crashes approximately doubles when trucks are involved.

Table B-14

Severity of Crash Comparison (2002-2006)

Severity	All Crashes	Commercial Vehicle Crashes
Property Damage Only	72 percent	54 percent
Minor Injury	19 percent	28 percent
Disabling Injury	7 percent	13 percent
Fatal	2 percent	5 percent

d. Crash Location Density Analysis (Crash Hotspots)

Because the study area has a fatal crash rate above the statewide average and a history of severe crashes involving commercial trucks, a crash location severity analysis was conducted for the I-44 corridor. The analysis identifies areas where three or more disabling injury crashes and/or fatal crashes occur within 0.3 mile of each other.

A total of 84 crash hotspots were identified. No clear directional differentiation was identified with 44 hotspots in the eastbound direction and 40 in the westbound direction. These areas are noted in the Map Book in **Appendix B**. Of the 84 locations, 46 are located in proximity to interchanges. Within the interchange areas about 60 percent of the hotspots were located in the vicinity of entrance ramps and the remainder at exit ramps. In some instances, there was a long grade associated with the entrance ramp. There were 24 hotspots located away from interchange areas that did not have any obvious geometric feature that could be a causal factor in the crash. The list of interchanges that had hotspots is found in the *Interchange Evaluation Analysis Technical Memorandum* in **Appendix A**. **Figure B-4** presents a graphic summary of the crash hotspots.

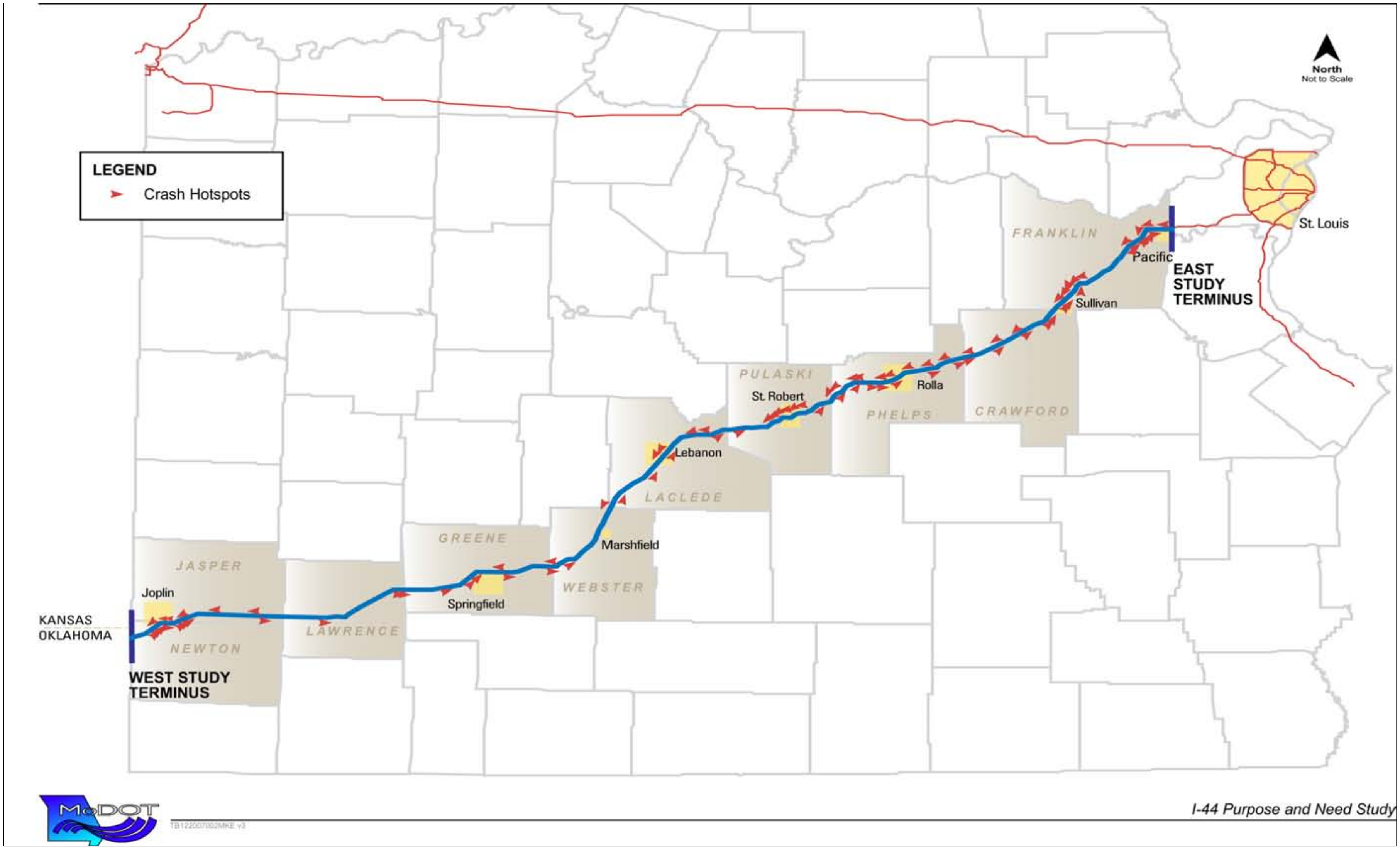
Important Crash Hotspot Trends

The crash hotspot analysis tends to confirm the other trends identified during the crash analysis. The Map Book (**Appendix B**) provides a ready reference for project planners.

There were a total of 727 disabling crashes and 176 fatal crashes that occurred from 2002 through 2006 throughout the study area. The following general points are worth noting:

- The predominant causes of crashes in the hotspots are the same for crashes outside of the hotspots, out-of-control and rear-end crashes.
- Among eastbound hotspots out-of-control crashes accounted for 56 percent of the crashes and rear-end crashes accounted for 22 percent.
- Among westbound hotspots, out-of-control crashes accounted for 54 percent of the crashes and rear-end crashes accounted for 22 percent.
- 280 out of the corridor’s 727 disabling crashes (39 percent) occurred within a crash hotspot.
- 57 out of the corridor’s 176 total fatal crashes (32 percent) occurred within a crash hotspot.

Figure B-4
Crash Location Density Analysis (Crash Hotspots)



Geographic Crash Hotspot Trends

As part of the crash hotspot analysis, the project team examined trends across various geographic areas of the corridor to determine if any correlations could be made between severe crashes and location along the corridor.

Figure B-5

Crash Hotspots by County

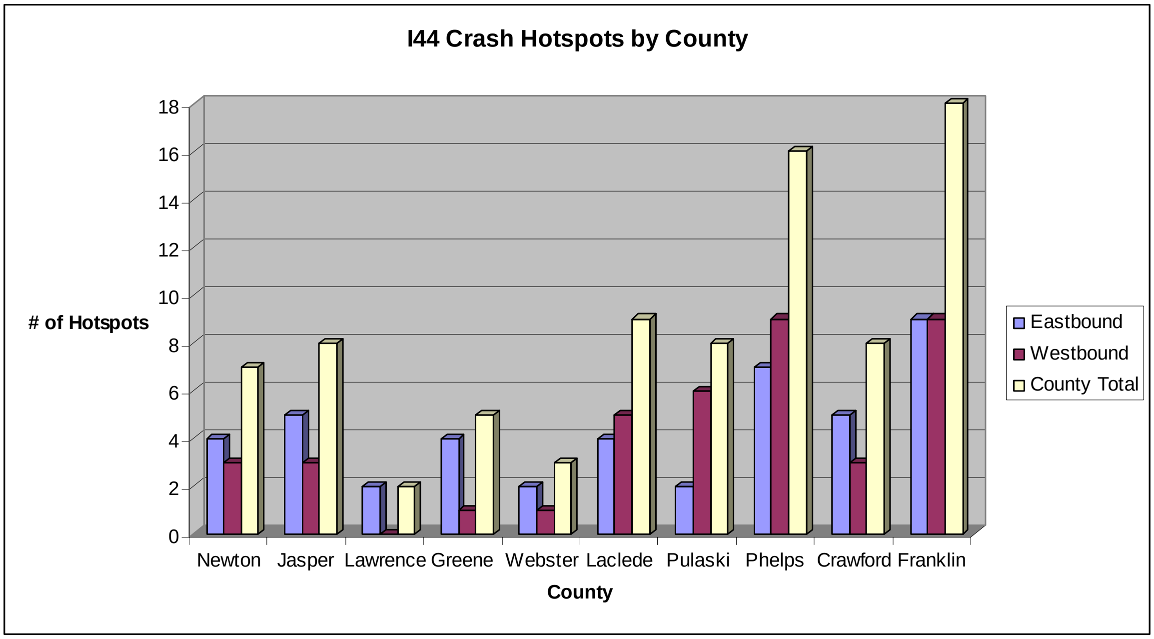
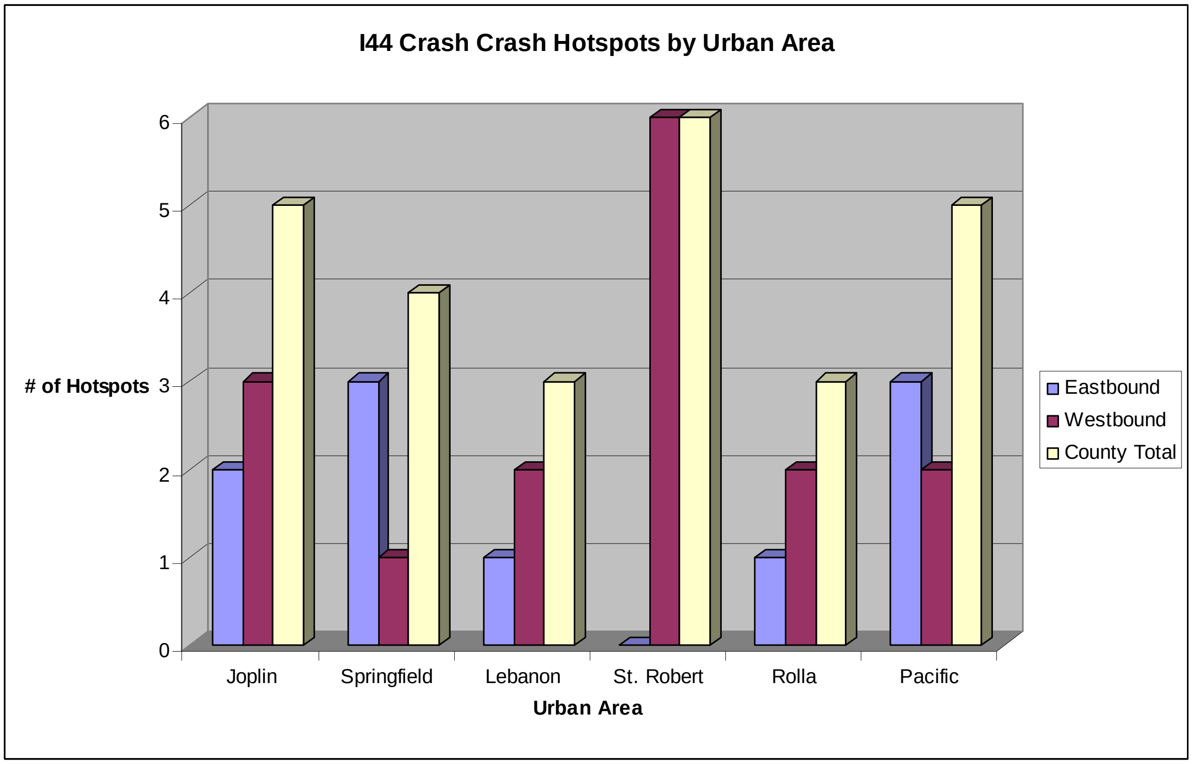


Figure B-5 presents the number of crash hotspots by county in both directions. Of note is the high number of crash hotspots within Franklin (18) and Phelps (16) counties. These two counties account for roughly 40 percent of all crash hotspots in the corridor. Another trend of note is the difference in number of hotspots on the western portion of the corridor (Newton to Webster County) and those on the eastern portion (Laclede to Franklin County). The west half accounts for 25 crash hotspots, and the east half account for 59. This in part is a reflection of the difference in terrain and geometry between the two halves of the corridor. The east half of the corridor exists in primarily rolling terrain and is often combined with areas of sharp horizontal curvature, whereas the west half is relatively level and straight.

Figure B-6 depicts the crash hotspots that occur within one of the seven urban areas along the corridor. Nearly 31 percent of all crash hotspots occur within one of these seven areas. St. Robert alone accounts for roughly 7 percent of all crash hotspots across the study corridor. As noted previously, 25 crash hotspots exist from Webster County west to the state line. Of those, 9 occur in the immediate vicinities of Joplin and Springfield. East of Webster County, 59 crash hotspots were found. Of those, 17 occur in the immediate vicinities of Lebanon, St. Robert, Rolla, and Pacific. Two key observations can be noted from these findings:

1. From Webster County to the western study limit, 36 percent of the crash hotspots occur in or near the urban areas along I-44.
2. East of Webster County, 71 percent of crash hotspots occur away from the urban areas along I-44.

Figure B-6
Crash Hotspots by Urban Area



Ten Worst Crash Hotspots in the Study Corridor

To enhance the understanding of the crash hotspot, the 10 most severe crash hotspots are examined below. A brief summary of the various characteristics within each of the 10 areas is also provided. While these characteristics cannot be automatically linked to the crash severity issues, they may help shed light on potential relationships between certain physical existing conditions and crash trends.

1. In Pulaski County between log miles 155 and 160, 6 crash hotspots were found. Within these crash hotspots, 32 severe crashes (4 fatal, 28 disabling) occurred. All 6 of these crash hotspots and their respective crashes occurred in the westbound direction. Two of the 6 crash hotspots are immediately adjacent to one another (between log mile 159.6 and log mile 161.2) and were responsible for 18 of the 32 crashes in this 5-mile section. It stretches between two interchanges in the St. Roberts area: Business Loop 44 on the west and State Highway Y on the east. The two interchanges are closely spaced, and I-44 is curvilinear and rolling between them. Exit 161 has a disabling and fatal crash rate twice that of the state average. The basic freeway LOS goes from C before and after exit 161, changing to B-D after exit 159 and remaining so until leaving exit 156 where it chances to C. The merge and diverge ramps for exit 156 and 159 are all LOS D. The diverge for exit 161 rated well at a LOS of B, and the merge was not included in the model. All three exits have interchange deficiencies.

2. In Franklin County, 4 crash hotspots are situated between log miles 251.6 and 254.8 going eastbound. At this location there were 16 severe crashes (13

disabling, 3 fatal). Two of these crash hotspots occur in the vicinity of exit 251(Route P/7) while 1 crash hotspot occurs around exit 253 (Route 17/Spruce Rd). Between these two exits, 9 disabling and 3 fatal crashes were accounted for. Exit 251 (for both crash hotspots) has a fatal crash rate twice that of the statewide average. Basic freeway LOS going eastbound starts as D-E into and out of Exit 251 and remains that was until past exit 253, where it goes to E through the remaining area. All merge and diverge ramp LOS for both exits are F. Both interchanges have deficiencies of taper/accel/decel length and mainline SSD on ramp nose approach, while just exit 253 has a ramp/outer road interchange spacing problem. In this section, a deficient horizontal curve resides around exit 251 (251.8 through 252.5).

3. This area also deals with exit 251(Route P/7) and 253 (Route 17/Spruce Rd), only on the westbound side. Also in Franklin County, 2 adjacent crash hotspots were found between 252.0 and 252.3. At this location there were 12 severe crashes (11 disabling, 1 fatal). The overall truck involvement is 4 crashes. Six of these crashes are associated with exit 251 and the remaining 6 occur around exit 253. Basic freeway LOS is F going into exit 253, D-F between exit 253 and 251, and goes to D leaving exit 251. All merge and diverge ramp LOS for both exits are F. Both interchanges have deficiencies of taper/accel/decel length and mainline SSD on ramp nose approach, while just exit 253 has a ramp/outer road interchange spacing problem.

4. In Phelps County, 2 adjacent crash hotspots going westbound were identified between log miles 171.9 and 173.1. At this location there were 11 severe crashes (10 disabling, 1 fatal). Two of these crashes involved trucks. Four of these crashes are associated with exit 172 (Route D). Along with the 4 crashes at exit 172, the disabling and fatal crash rates were both twice that of the state average. Basic freeway LOS going into exit 172 is C while exiting and beyond in this section is B-C. Exit 172 had interchange deficiencies such as ramp/outer road interchange spacing and taper/accel/decel length problems. Steep grades were also a problem in this area. A vertical curve occurs at 172.4 through 172.7 where the grade goes from 1 percent to 4 percent. The grade changes from a 4-percent grade to a 6-percent grade between 172.0 and 172.3. In this instance, a climbing lane exists from 171.8 to 172.5. Unfortunately, the exiting taper for this lane is deficient at a ratio of 21:1. Deficient horizontal curvature also happens in this section. The curves at 171.8 through 172.2 and 172.3 through 172.5 do not meet AASHTO requirements with the first not able to be resolved unless rebuilt.

5. In Franklin County, 2 adjacent crash hotspots in the eastbound direction were identified between log miles 246.5 and 247.8. At this location there were 10 severe crashes (7 disabling, 3 fatal). Trucks were involved in 1 crash. Seven of these crashes are associated with exit 247. Along with the 7 crashes at exit 247 (US 50), the disabling and fatal crash rate were both twice that of the state average. Basic freeway LOS starts at C-D going into exit 247 while leaving the exit and for the remaining section is D-E. The weave section going eastbound has an LOS of D. Interchange deficiencies for exit 247 include degree of curvature, taper/accel/decel length, and weaving length problems. A horizontal curve is identified at 246.9 through 247.4 and cannot be resolved to meet AASHTO requirements unless rebuilt.

6. In Crawford County, a crash hotspot is identified between log miles 214.5 through 214.9 (exit 214, Route H) with 8 severe crashes (7 disabling, 1 fatal). Overall truck involvement includes 1 crash. Along with the 8 crashes at exit 214, the disabling and fatal crash rate were both twice that of the state average. Basic freeway LOS into and out of the exit is C-D. The merge and diverge ramp LOS is F. Interchange deficiencies include ramp/outer road interchange spacing and taper/accel/decel length problems. A horizontal curve does not meet AASHTO requirements at log miles 214.4 through 214.7.

7. In Greene County, a crash hotspot is identified between log miles 72.34 through 72.53 (exit 72, Route 266) with 6 severe crashes (4 disabling, 2 fatal) going eastbound. Overall truck involvement includes 3 truck crashes. Along with the 6 crashes at exit 72, the fatal crash rate is twice that of the state average. Basic freeway LOS into the and out of the exit is B. The merge and diverge ramp LOS is D. Interchange deficiencies include degree of curvature, ramp/outer road interchange spacing and taper/accel/decel length problems.

8. This hotspot deals with exit 172 in the eastbound direction. In Phelps County, a crash hotspot is identified at log miles 172.45-173.05 (exit 172, Route D) with 6 severe crashes (5 disabling, 1 fatal). Trucks were involved in 3 of these crashes. Basic freeway LOS into the exit is C and out of the exit is B-C. The merge ramp LOS is F while the diverge ramp LOS is E. Interchange deficiencies include ramp/outer road interchange spacing and taper/accel/decel length problems. A series of horizontal curves do not meet AASHTO requirements at the following log mile locations: 172.5-172.7, 172.7-172.9, and 172.9-173.5.

9. In Franklin County, a crash hotspot is identified between log miles 231.812-232.2 (between Route JJ/W and Route 30) in the eastbound direction with 6 severe crashes (6 disabling). Trucks were involved in 3 of these crashes. The basic freeway LOS in this section is D. Horizontal curvature does not meet AASHTO requirements at 231.6 through 232.0.

10. In Phelps County, a crash hotspot is identified between log miles 193.673 and 193.999 (between Route V and Route 68/8) in the westbound direction with 6 severe crashes (6 disabling). Two of these crashes involved trucks. The basic freeway LOS in this section is C-D.

3. Interchanges along I-44 have Safety & Operation Issues and are Inconsistent with Current Design Standards

Since the operation and condition of each of the 78 interchanges along the study area portion of I-44 is unique, the evaluation of transportation problems requires treating each interchange individually. The analysis focused on three factors: safety, traffic operations, and geometric design. The evaluation was conducted for both the eastbound and westbound segments of the study area's 78 interchanges. More detailed descriptions of the interchange evaluation are found in the *Interchange Evaluation Technical Memorandum* in **Appendix A**.

a. Interchange Safety Analysis

For each interchange across the corridor, crash rates were calculated for the 1 mile segments that begin 0.5 mile upstream and end 0.5 mile downstream of the respective crossroad. Total crash rates and fatal crash rates were calculated for each interchange segment. In addition, an evaluation was performed to determine if any crash hotspots[1] were located within the interchange segments. These I-44 interchange crash rates were then compared to the statewide averages for rural and urban freeways.

Based on the total crash-rate analysis, the fatal crash-rate analysis, and the crash location severity analysis criteria were established to assist in the identification of interchanges that have particularly problematic safety performance. In general, an interchange was considered to have crash-related issues if any of the following criteria were met:

- A total crash rate at least two times higher than the statewide average for urban (120.9) or rural (66.66) freeway segments
- A fatal crash rate at least two times higher than the statewide average for urban (1.34) or rural (1.13) freeway segments
- Having one or more of the crash hotspots within the interchange segment

Summary of Interchange Crash-Related Transportation Problems

Table B-15 contains a summary of the interchanges that have crash-related conditions exceeding at least one of the established criteria (total crash rates, fatal crash rates and crash hotspots). The complete results are contained in the technical memos in **Appendix A**. The following interchanges exceed the crash-related criteria for all three criteria:

- Exit 6—Route 86 (Newton County)
- Exit 8—Business Route 71 (Newton County)
- Exit 11—U.S. 71 South, Route 249 North (Jasper county)
- Exit 18—U.S. 71 North, Route 59 South (Jasper County)
- Exit 161—Route Y (Pulaski County)
- Exit 172—Route D (Phelps County)
- Exit 214—Route H (Crawford County)
- Exit 247—U.S. 50 (Franklin County)

Figure B-7 depicts the general location of these interchanges.

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[1] Based on a location density analysis, the crash hotspot methodology focused on identifying three or more major disabling injuries or fatality crashes within any 0.3 mile segment of roadway. See **Section B.2.d**.

The criterion for total crash rates and fatal crash rates was set at two times the statewide average for several reasons. First, interchanges by nature will typically not perform as well as non-interchange areas of freeways because they introduce significantly more points of conflict at ramp merge, diverge, and weave areas. While these areas can certainly perform in a safe manner when designed appropriately, they inherently present a greater crash risk due to the increased number of conflicts. Secondly, when summing the crash rates for each of the 78 interchanges across the corridor and taking the average, that number is roughly 1.6 times the statewide average crash rate. As a result, simply comparing the individual interchange averages against the statewide average alone is not as meaningful. Setting the measure of evaluation at two times the statewide average provides a more effective relative comparison across the corridor.

Table B-15 summarizes the interchange crash rate and crash-hotspot characterization. The bolded entries denote interchanges that exceed the applicable crash criteria. The shaded interchanges exceed all three of the crash criteria.

Table B-15

Interchange Safety Analysis Results: Interchanges that Meet One or More of the Crash Criteria

Exit	Interchange	Urban or Rural	Total Crash Rate (EB/WB)	Fatal Crash Rate (EB/WB)	One or more crash hotspots within the interchange segment
1	U.S. 166	Rural	**274.26**/40.84	**5.17**/0.00	No
4	Route 43	Rural	**133.95**/104.62	0.00/0.00	**Yes**
6	Route 86	Urban	92.53/**163.87**	**3.19/9.83**	**Yes**
8	Business Route 71	Urban	158.83/**177.35**	**3.11/6.57**	**Yes**
11	U.S. 71 South, Route 249 North	Rural	**273.78**/133.45	**3.42/3.34**	**Yes**
18	U.S. 71 North/Route 59 South	Rural	12631/**174.11**	0.00/**6.70**	**Yes**
22	10th Road	Rural	84.18/93.95	0.00/**3.76**	No
26	Route 37	Rural	63.48/117.47	0.00/0.00	**Yes**
44	Route H	Rural	57.70/81.50	**4.12/4.29**	No
46	Route 265, Route 39	Rural	82.51/**144.97**	0.00/**4.26**	No
49	Route 174	Rural	52.98/58.78	0.00/**4.20**	No
58	Route Z, Route O	Rural	115.02/127.36	**3.97**/0.00	No
67	Route T, Route N	Rural	58.89/39.48	**3.68**/0.00	No
69	Route 360–James River	Rural	40.88/25.09	**3.72**/0.00	No
70	Route B, Route MM	Rural	54.13/48.25	**3.61**/0.00	No
72	Route 266	Urban	53.95/63.09	**4.15**/0.00	**Yes**

Table B-15

Interchange Safety Analysis Results: Interchanges that Meet One or More of the Crash Criteria

Exit	Interchange	Urban or Rural	Total Crash Rate (EB/WB)	Fatal Crash Rate (EB/WB)	One or more crash hotspots within the interchange segment
74	N/A	Urban	49.32/71.55	2.05/**3.11**	**Yes**
75	U.S. 160	Urban	66.97/142.30	1.63/**2.85**	No
80	Loop 44/Route H	Urban	57.56/170.74	0.00/**6.57**	**Yes**
82	U.S. 65	Urban	104.98/**462.76**	2.10/2.54	**Yes**
88	Route 125	Rural	72.13/90.17	0.00/**6.22**	No
96	Route B	Rural	110.87/83.64	0.00/**2.99**	**Yes**
113	Route Y, Route J	Rural	57.35/47.45	**3.82**/0.00	No
118	Route A, Route C	Rural	62.98/64.13	**3.94**/0.00	No
129	Route 64, Route 5, Route	Urban	109.79/132.51	0.00/0.00	**Yes**
130	Route MM	Urban	70.50/106.16	0.00/**4.08**	**Yes**
140	Route T, Route N	Rural	102.34/109.27	0.00/0.00	**Yes**
156	Route H	Urban	105.07/89.19	0.00/**3.57**	**Yes**
159	Loop 44	Urban	136.54/219.24	0.00/0.00	**Yes**
161	Route Y	Urban	201.38/**277.13**	0.00/**3.80**	**Yes**
163	Route 28	Urban	155.25/93.54	**4.20**/0.00	No
169	Route J	Rural	**137.79**/56.57	0.00/0.00	No
172	Route D	Rural	**215.86/145.19**	**3.85/4.03**	**Yes**
176	Sugar Tree Road.	Rural	123.48/83.90	**3.86**/0.00	**Yes**
178	Rest Area	Rural	54.06/65.09	0.00/**7.66**	**Yes**
179	Route T, Route C	Rural	49.54/63.48	**3.81/3.53**	No
184	U.S. Route 63 South	Urban	135.38/160.04	**3.30/3.14**	**Yes**
185	Route E	Urban	220.33/97.69	0.00/0.00	**Yes**
186	U.S. Route 63	Urban	**421.71/380.42**	0.00/0.00	No
195	Route 68, Route 8	Rural	97.78/105.06	0.00/**3.39**	No
203	Route F, Route ZZ	Rural	64.89/88.43	0.00/**3.54**	No
208	Route 19	Rural	**186.44**/114.56	0.00/0.00	**Yes**
214	Route H	Rural	**222.00**/112.74	**3.22/7.05**	**Yes**
218	Route C, Route J, Route	Rural	92.94/51.75	**3.44/6.90**	No
226	Route 185 South	Urban	223.18/222.38	**3.28/3.32**	**Yes**

Table B-15

Interchange Safety Analysis Results: Interchanges that Meet One or More of the Crash Criteria

Exit	Interchange	Urban or Rural	Total Crash Rate (EB/WB)	Fatal Crash Rate (EB/WB)	One or more crash hotspots within the interchange segment
230	Route JJ, Route W	Rural	113.35/77.93	**6.30**/0.00	**Yes**
239	Route 30, Route WW,	Rural	133.19/116.00	**3.03**/0.00	No
240	Route 47	Rural	**156.83/135.34**	0.00/0.00	No
247	U.S. 50	Rural	**247.84/181.21**	**2.88**/0.00	**Yes**
251	Route 100 West	Rural	113.54/53.70	**5.16**/0.00	**Yes**
253	Route 100 East	Urban	112.68/149.49	0.00/0.00	**Yes**
257	Loop 44	Urban	**259.60/161.52**	0.00/0.00	No

The bolded entries denote interchanges that exceed the applicable crash criteria. The shaded interchanges exceed all three of the crash criteria.

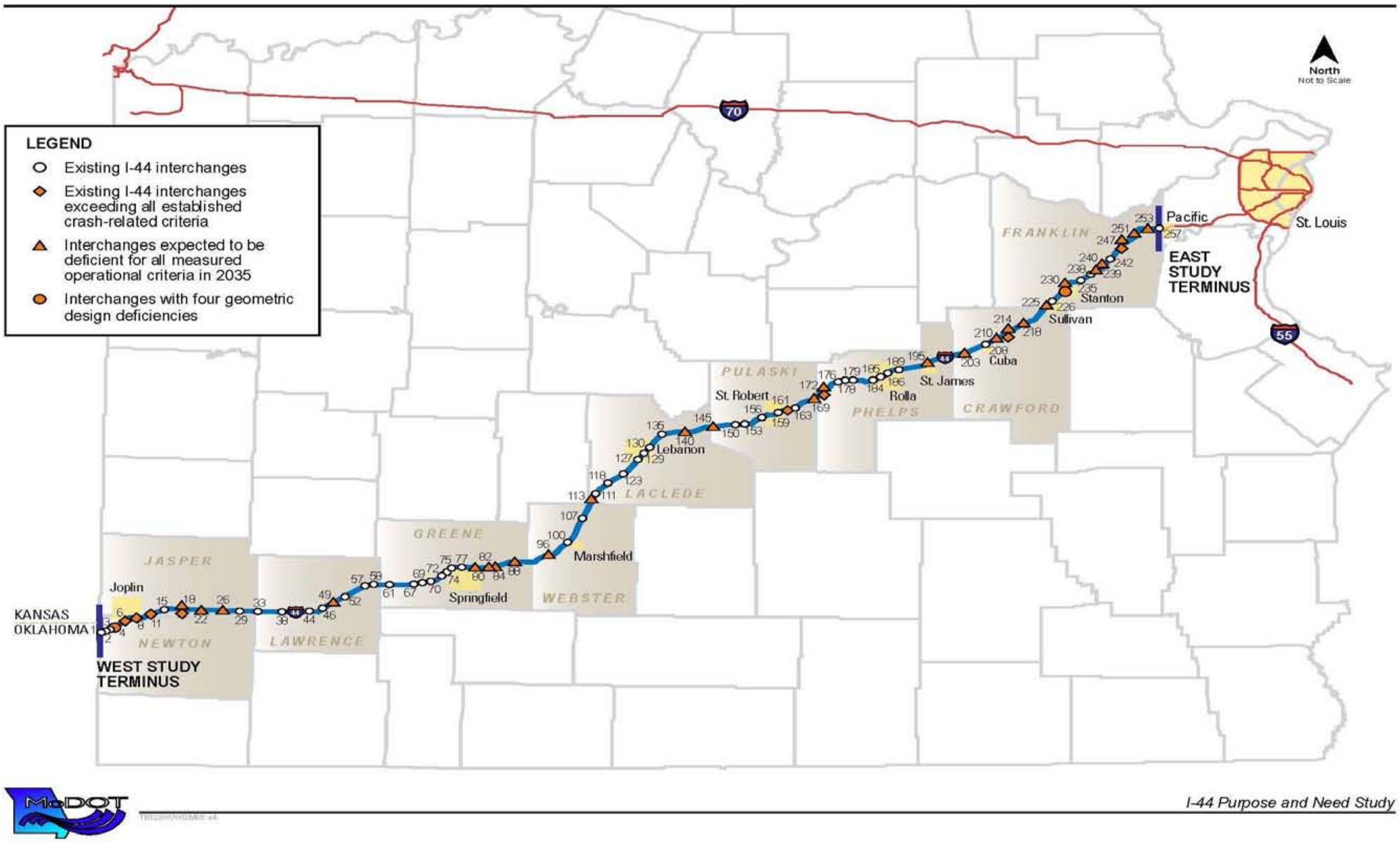
Using the full analysis (EB/WB), only one interchange exceeded each crash-related criterion both eastbound and westbound: Exit 172 - Route D. As this is a low-volume interchange, the high crash rates are attributed to mainline geometric issues including horizontal geometries that do not meet current design standards and steep grades on both approaches to the interchange.

Of the 78 interchanges, 17 (22 percent) exceeded the established total crash-rate criteria and 50 percent (39 interchanges) exceeded the established fatal crash-rate criteria. Approximately 37 percent (29 interchanges) had crash hotspots. Roughly 32 percent (25 interchanges) exceed two of the three established criteria. When examining crash and fatal crash rates against the statewide averages, 46 interchanges (59 percent) exceeded at least one statewide average.

Of the urban interchanges, 6 had total crash rates above the established total crash-rate criteria (23 percent). Of the rural interchanges, 11 had total crash rates above the established total crash-rate criteria (21 percent).

Among the eight interchanges that exceed the crash-related criteria for all three criteria, four are clustered in the Joplin-area: Exit 6 - Route 86, Exit 8 – Business Route 71, Exit 11 – U.S. 71 South, Route 249 North and Exit 18 – U.S. 71 North, Route 59 South. (See **Figure B-7**).

Figure B-7
Summary of Crash, Operations, and Geometric Evaluations for I-44 Interchanges



b. Interchange Traffic Operation Analysis

A standard method for evaluating existing traffic operations performance and determining if a given facility will be able to adequately handle future traffic volumes is a LOS analysis. For I-44, The *Highway Capacity Manual 2000* (HCM) methodology was used to characterize current and future highway operations.

Levels of service range from A (very good operations) to F (gridlock conditions; breakdown in traffic flow). The methodologies described in *Chapter 24: Freeway Weaving and Chapter 25: Ramps* and *Ramp Junctions* of the HCM were utilized in the interchange traffic operations analysis.

The MoDOT *Engineering Policy Guide Category: 232—Facility Selection* discusses the recommended design year LOS for rural and urban land uses. Based on those guidelines, an urban interchange with a weaving segment, ramp merge, or ramp diverge operating worse than LOS E in 2005 or 2035 would be identified as having a traffic operations issue. A rural interchange with a weaving segment, ramp merge or ramp diverge operating worse than LOS D in 2005 or 2035 would be identified as having a traffic operations issue.

Operational Analyses Performed

Most of the interchanges along I-44 in the study corridor are diamond interchanges that are not located in close proximity to the nearest upstream or downstream interchange. For these situations, only the ramp merge and diverge LOS analyses were needed. However, in seven locations, where either the interchange configuration or the proximity of an interchange ramp to the nearest upstream or downstream interchange ramp is such that an auxiliary lane exists between the two ramps, a weaving condition is created. For these situations, a weaving LOS analysis was performed in addition to the ramp merge and diverge analyses. The list below describes locations where a weaving condition exists. All other locations contain only ramp merge and ramp diverge conditions.

Summary of Existing (2005) Interchanges with Peak Hour Traffic Operation Problems

Of the 324 ramps evaluated, only six were found to have LOS F:

- Exit 18, US 71 North–Eastbound Weave LOS F (Jasper County)
- Exit 77, Route 13–Eastbound Merge LOS F (Greene County)
- Exit 82, US 65–Westbound Weave LOS F * (Greene County)
- Exit 251, Route 100 West–Eastbound Merge LOS F (Franklin County)
- Exit 251, Route 100 West–Westbound Diverge LOS F (Franklin County)
- Exit 253, Route 100 East–Westbound Merge LOS F (Franklin County) *

* These interchanges were recently reconstructed to address these operational issues

All of the interchange ramp traffic volumes used in the base year (2005) and the design year (2035) LOS analyses came from the statewide traffic model. Therefore, if a ramp was not included in the statewide model, no traffic analyses were able to be performed. Of the 324 ramps within the study corridor, 75 were not included in the statewide traffic model. Of these 75, several were ramps to and from rest areas and weigh stations. In all, 17 interchange ramps were not included in the model.

2005 Interchange Traffic Operations

In the base year (2005), most of the existing interchanges operate well, with only four ramps and two weaving segments operating at levels of service worse than the recommended thresholds. Of the ramps, one was located in Springfield, the eastbound merge at Route 13, and the other three were located at the eastern end of the corridor in Franklin County, the eastbound merge and westbound diverge at Route 100 West and the westbound merge at Route 100 East. The two weaving segments found to be operating worse than recommended thresholds were the eastbound weave at the U.S. 71 North/Route 59 South cloverleaf, and the westbound weave at the recently improved U.S. 65 partial directional interchange. The complete results of this analysis are contained in **Appendix A**.

2035 Interchange Traffic Operations

In the design year (2035), the existing interchange ramps operate considerably worse than in the base year, with most of the interchanges having at least one ramp operating at LOS F. However, it's worth noting that congestion on mainline freeway segments has a direct influence on ramp LOS. If the traffic volumes on the freeway segments upstream/downstream of a ramp merge/diverge are beyond maximum volume thresholds, the ramp LOS will automatically be F. Thus, a ramp operating at an undesirable LOS is not necessarily an indication of a problem with the interchange itself, but could actually be the result of mainline capacity limitations (not enough mainline lanes).

Interchanges with Expected (2035) Traffic Operation Problems

In the design year (2035), most interchanges are expected to have at least one ramp operating at LOS F. Approximately one-third of all interchanges are expected to be deficient in all of the measured traffic operation criteria (see **Table B-16**).

Operations at weaving segments also deteriorate in the design year. By 2035, it is anticipated that all of the weaving segments in the corridor that were able to be analyzed as part of this study, will be operating at LOS E or F.

Table B-16 presents the predicted 2005 and 2035 interchange operations for the study area's 78 interchanges. Locations in which the freeway traffic volumes upstream and/or downstream of a given ramp are such that they may be influencing ramp LOS are shown with an asterisk. Ramps are highlighted. **Table B-17** presents the 2005 and 2035 weaving operations. Deficient segments (2035) are highlighted.

Table B-16

2005 and 2035 Interchange Traffic Operations

Exit	Interchange	Urban or Rural	Merge LOS 2005 (2035)		Diverge LOS 2005 (2035)	
			EB	WB	EB	WB
1	US 166	Rural	--	--	--	B (E)
2	Rest Area	Rural	--	--	--	--
3	Weigh Station	Rural	--	--	--	--
4	Route 43	Urban	--	B (D)	B (C)	B (C)
6	Route 86	Urban	D (F*)	B (F*)	B (D)	B (F)
8	Business Route 71	Urban	B (F*)	C (F*)	C (F*)	B (C)
11	US 71 South, Route 249 North	Urban	--	--	--	--
15	Loop 44, Route 66	Rural	D (E)	--	--	--
18	US 71 North/Route 59 South	Rural	B (F*)	C (F*)	C (F*)	B (F*)
22	10th Road	Rural	B (F*)	C (F*)	B (F*)	B (F*)
26	Route 37	Rural	C (F*)	C (F*)	B (F*)	B (F*)
29	Route U	Rural	B (E)	C (F*)	B (D)	B (D)
33	Route 97 South	Rural	--	--	--	--
38	Route 97	Rural	C (F*)	B (E)	B (D)	B (D)
44	Route H	Rural	C (F)*	C (E)	B (D)	B (D)
46	Route 265, Route 39	Rural	C (F*)	C (E)	B (D)	B (D)
49	Route 174	Rural	B (F*)	C (F*)	C (F*)	B (F*)
52	Rest Area	Rural	--	--	--	--
57	Route 96	Rural	--	--	--	--
58	Route Z, Route O	Rural	C (F*)	--	--	C (F*)
61	Route K, Route PP	Rural	C (D)	C (D)	C (D)	C (D)
67	Route T, Route N	Rural	C (D)	C (D)	C (D)	C (C)
69	Route 360 - James River Freeway	Urban	--	--	--	--
70	Route B, Route MM	Urban	C (F*)	C (D)	B (C)	B (F)
72	Route 266	Urban	B (D)	C (F*)	B (D)	B (D)
74	Kearney Street	Urban	--	--	--	--

Table B-16

2005 and 2035 Interchange Traffic Operations

Exit	Interchange	Urban or Rural	Merge LOS 2005 (2035)		Diverge LOS 2005 (2035)	
			EB	WB	EB	WB
75	US 160	Urban	E (E)	C (F*)	B (D)	C (C)
77	Route 13	Urban	F* (F*)	D (F*)	D (D)	C (F)
80	Loop 44/Route H	Urban	D (F*)	D (F*)	D (F*)	D (F*)
82	US 65	Urban	D (F*)	D (F*)	D (F*)	B (F*)
84	Route 744	Urban	C (F*)	C (F*)	C (F*)	C (F*)
88	Route 125	Rural	C (F*)	C (F*)	C (F*)	A (F*)
96	Route B	Rural	C (F*)	C (F*)	C (F*)	B (F*)
100	Route 38, Route W	Rural	B (D)	D (F*)	C (F)	B (C)
107	Sparkle Brooke Road/Sampson Rd.	Urban	C (F*)	B (D)	B (D)	B (C)
111	Rest Area	Rural	--	--	--	--
113	Route Y, Route J	Rural	C (F*)	C (F*)	C (F*)	B (F*)
118	Route A, Route C	Rural	C (F*)	C (F*)	B (E)	B (D)
123	County Road	Rural	--	--	--	--
127	Elm St., Morgan Road	Urban	C (F*)	C (F*)	C (F*)	C (D)
129	Route 64, Route 5, Route 32	Urban	C (D)	C (F*)	C (F*)	B (C)
130	Route MM	Urban	B (D)	B (C)	C (C)	B (C)
135	Route F	Urban	B (D)	C (F*)	B (D)	B (D)
140	Route T, Route N	Rural	B (F*)	--	B (E)	B (E)
145	Route 133, Route AB	Rural	B (F*)	B (F*)	B (F*)	B (F*)
150	Route 7, Route P	Rural	--	--	--	--
153	Route 17	Rural	C (E)	C (F*)	B (D)	C (D)
156	Route H	Rural	B (F*)	C (D)	B (E)	B (D)
159	Loop 44	Rural	NA	C (D)	C (E)	B (D)
161	Route Y	Urban	B (C)	--	B (B)	B (B)
163	Route 28	Urban	C (E)	B (C)	B (C)	B (D)
169	Route J	Rural	C (F*)	B (F*)	B (F*)	B (E)
172	Route D	Rural	C (F*)	--	C (E)	--

Table B-16

2005 and 2035 Interchange Traffic Operations

Exit	Interchange	Urban or Rural	Merge LOS 2005 (2035)		Diverge LOS 2005 (2035)	
			EB	WB	EB	WB
176	Sugar Tree Road	Rural	--	C (F*)	B (D)	--
178	Rest Area	Rural	--	--	--	--
179	Route T, Route C	Rural	C (F*)	C (D)	C (D)	B (D)
184	US Route 63 South	Urban	C (C)	D (D)	C (C)	B (B)
185	Route E	Urban	B (C)	C (C)	C (C)	B (C)
186	US Route 63	Urban	D (F*)	B (C)	C (C)	B (F)
189	Route V	Urban	D (F*)	B (F*)	D (F*)	B (D)
195	Route 68, Route 8	Rural	C (F*)	D (F*)	C (F)	C (E)
203	Route F, Route ZZ	Rural	C (F*)	B (F*)	C (F*)	B (F*)
208	Route 19	Rural	C (F*)	C (F*)	B (D)	B (D)
210	Route UU	Rural	C (F*)	C (F*)	B (F*)	B (F*)
214	Route H	Rural	C (F*)	C (F*)	C (F*)	C (F*)
218	Route C, Route J, Route N	Rural	C (F*)	C (F*)	C (F*)	C (F*)
225	Route 185 North	Urban	C (F*)	B (F*)	B (F*)	B (F*)
226	Route 185 South	Urban	C (F*)	C (F*)	B (D)	B (D)
230	Route JJ, Route W	Rural	D (F*)	C (F*)	B (F*)	C (F*)
235	Rest Area	Rural	--	--	--	--
238	Weigh Station	Rural	--	--	--	--
239	Route 30/Route WW/Route AB	Rural	D (F*)	D (F*)	C (F*)	C (F*)
240	Route 47	Rural	C (F*)	D (F*)	C (F*)	C (F*)
242	Route AH	Rural	--	--	--	--
247	US 50	Rural	--	D (F*)	--	C (F)
251	Route 100 West	Rural	F* (F*)	C (F*)	C (F*)	F (F*)
253	Route 100 East	Rural	C (F*)	F* (F*)	D (F*)	C (F*)
257	Loop 44	Urban	--	--	--	--

--Denotes ramps that either were not included in the traffic model, do not exist, or were analyzed as part of the weaving analysis

Highlighted segments show deficient ramp LOS for the Urban/Rural designation in 2035.

** Denotes where the upstream and/or downstream LOS effects the ramp LOS.*

Table B-17

2005 and 2035 Weaving Operations

Exit	**Interchange**	**Weaving Analysis LOS 2005 (2035)**	
		Eastbound	**Westbound**
8	Business Route 71	C (F)	B (E)
11	US 71 South/Route 249 North	Not in Model	NA
18	US 71 North/Route 59 South	F (F)	D (F)
57/58	Route 96 and Route Z/Route O	B (F)	B (E)
80	Loop 44/Route H	D (F)	D (F)
82	US 65	E (F)	F (F)
247	US 50	Not in Model	NA

Not in Model = not included in state-wide model

NA = weave does not exist

Highlighted segments show deficient ramp LOS for the Urban/Rural designation in 2035.

c. Geometric Design

To determine whether the study area's interchanges meet MoDOT's current design standards, seven key design features were identified at each interchange, two relating to access management and five relating to horizontal and vertical geometry. These features, and the interchange configurations they apply to, are listed below.

Access Management Features

- Spacing between ramp termini intersections and outer road intersections (service interchanges)

- Spacing between a given interchange and the next closet downstream interchange (all interchanges)

Horizontal and Vertical Geometry Features

- Degree of curvature of entry/exit curve on ramp (all interchanges)

- Length of taper on taper type ramp or acceleration/deceleration length on parallel type ramp (all interchanges without auxiliary lanes)

Summary of Interchange Geometric Design Analysis

Seven design features were evaluated to investigate whether interchanges met current design standards.

Forty percent of the study area's interchanges do not meet one current design standard. The following interchanges do not meet four current design standards:

- Exit 4 - Route 43 (Newton County)

- Exit 230 - Route JJ/W (Franklin County)

- Mainline Stopping Sight Distance in advance of ramp gore nose
- Radius of loop ramp curvature (cloverleaf or partial cloverleaf interchange)
- Length of weaving segment (all interchanges with auxiliary lanes)

A more complete discussion of the guidelines used to evaluate the interchange design features are contained in the technical memos (**Appendix A)**.

Geometric Design Evaluation Results

A rating system, explained in more detail in the *Interchange Evaluation Analysis Technical Memorandum*, was used to rate the design features for each interchange. One point was assigned for each element that did not meet current design standards, while a “sufficient” rating was assigned zero points. Because of limitations in the available data, all seven design features were not evaluated for each interchange. In addition, where a design feature did not apply to a given interchange, no rating was provided.

Thirty-one (40 percent) interchanges did not meet one current design standard, 27 (35 percent) interchanges do not meet two current design standards, 18 (23 percent) do not meet three current design standards and two (3 percent) interchanges do not meet four current design standards. These two interchanges are Route 43 (exit 4, Newton County) and Route JJ/W (exit 230, Franklin County). Interchanges that do not meet two, three, or four current design standards are indicated in the I-44 Purpose and Need Study map book found in **Appendix B**.

4. Freight Traffic Represents an Essential Element of the Traffic Stream on I-44

Summary of the Freight-Related Transportation Problems Affecting I-44

I-44's location makes it a vital crossroad in the heart of Missouri's and America's economy. Based on current trends, the freight-related demands on I-44 are expected to continue to increase. The accommodation of freight traffic represents a valid transportation problem that any emerging I-44 project will need to address.

The effects of truck traffic on the operation of I-44 are wide-ranging. Relative to *roadway design*, I-44 is located through the rolling terrain of the Ozarks. In some locations, the uphill grades are long and steep enough to cause heavy vehicles to slow down markedly. This has resulted in separate, dedicated climbing lanes at eight uphill grades to minimize the impairment of traffic flow by slow moving trucks. Similarly, any other geometric deficiency tends to have the greatest impact on heavier and less maneuverable trucks. The geometric-related transportation problems associated with I-44 are discussed more thoroughly in **Section B.5**.

Truck traffic is also an important determinant in the *operational quality* of I-44 because the traffic stream is comprised of approximately 30 percent trucks—roughly 9,000 trucks per day. The standard method for determining how well a roadway is able to handle traffic is a LOS analysis. LOS is the term used to describe the operational quality of a given roadway design. This methodology is based on density (passenger cars/mile/lane). In general, the calculation of freeway density for a given segment involves determining two variables—passenger car equivalent flow rate and the average passenger car speed. Because trucks are larger and slower, trucks have a disproportionately higher negative impact on operational quality. The LOS-related transportation problems are discussed more thoroughly in **Sections B.1 and B.3**.

Relative to the *crash environment*, the large number of trucks expressed itself not in the frequency of crashes, but in their severity. Commercial trucks were involved in only 16 percent of the I-44 crashes from 2002 through 2006. However, truck crashes were more severe than crashes that did not involve trucks. For example, the percentage of disabling injury crashes and fatal crashes doubles when trucks are involved. The safety-related transportation problems associated with I-44 are discussed more thoroughly in **Section B.2**.

This section will examine the role of truck traffic as it relates to freight movement. The efficient movement of goods is essential to the American economy, and I-44 plays an important role in the shipment of materials. Consequently, allowing I-44 to accomplish its role relative to the movement of freight is an element of the I-44 Purpose and Need.

a. National Trends in Freight Movement

At the national level, commercial trucking plays an increasingly important role in meeting the shipping needs of an expanding economy. The increasing reliance on commercial trucking is due to at least four factors: a growing U.S. economy and population, a reduction in the cost of shipping, a growing interdependence of economies across the globe, and a changing paradigm in how shippers use commercial trucking.

The U.S. Gross Domestic Product (GDP) is expected to grow almost 3 percent per year, driven in part by a population that is expected to increase from the current 300 million people to 380 million by 2035, resulting in even greater future demands for freight transportation. This estimate is derived from the fact that the U.S. population grew by 30 percent between 1980 and 2005 while the economy, measured by GDP, more than doubled in real terms. Other indicators of economic growth such as employment and household income have also risen by 40 percent and 15 percent, respectively (U.S. Dept. of Transportation, FHWA, 2007).

Lower transportation costs have also contributed to the increasing reliance on commercial trucking. Logistics costs rose through the 1960s and 1970s to a high of about 16 percent of GDP in 1980, then declined through the 1980s and 1990s. Total logistics costs today are estimated to be about 8 percent of GDP. A major factor in the decline in total logistics cost has been lower truck, rail, air, and water freight transportation costs.

Freight Transportation Costs are Low Because:

- Economic deregulation and the subsequent restructuring of the freight transportation industry in the 1980s triggered strong competition and lower shipping prices.
- Public sector investment in the interstate highway system in the 1980s and early 1990s reduced travel time and improved trip reliability for motor carriers.
- Adoption of new technologies such as intermodal freight containers, computers and related information technologies, bar coding, radio-frequency-identification tags, and satellite communications by shippers.

Source: *An Initial Assessment of Freight Bottlenecks on Highways*, FHWA, 2005

The availability of a more cost-effective freight system has resulted in a growing interdependence of economies. Companies and consumers in the U.S. and around the world increasingly rely on international trade to satisfy their demand for goods and services. In addition to lower transportation costs, several factors have spurred this growth, including the liberalization of trade policies such as the North American Free Trade Agreement (NAFTA), the internationalization of supply chains to take advantage of lower parts and labor costs, and changes in both transportation and information technologies that make possible the global organization of production and consumption. As a share of GDP, nominal U.S. exports and imports have grown from 9 percent in 1960 to 24 percent in 1999. Foreign trade grew faster than the overall economy, quadrupling in real value between 1980 and 2005, reflecting unprecedented global interconnectivity. United States international trade is forecast to reach 37 percent of GDP by 2025 (FHWA, *The Freight Story: A National Perspective on Enhancing Freight Transportation*, 2002).

There has also been a broad shift in business logistics practices from manufacture-to-supply or inventory-based logistics (push logistics) to manufacture-to-order or replenishment-based logistics (pull logistics). Push logistics rely on careful maintenance of large inventories—between parts suppliers and manufacturers, between manufacturers and wholesalers, and between wholesalers and retailers—to buffer unanticipated surges in supply and demand and guard against stockouts along the supply chain. Pull logistics rely less on expensive inventory and more on accurate information and timely transportation to match supply and demand and prevent stockouts. Better coordinated pull logistics is the underpinning of just-in-time manufacturing and just-in-time retailing. Pull logistics has produced a tightly integrated and very efficient freight transportation network, generating enormous savings for

U.S. businesses, expanding the choice of goods and services available to consumers, and allowing U.S. manufacturers to compete effectively in global markets.

The change in product manufacturing and delivery increases the demand for more long distance, more reliable, and more frequent freight transportation. According to FHWA's *Freight Facts and Figures 2007,* the U.S. transportation system (all modes) moved, on average, 53 million tons of freight worth $36 billion each day in 2002. The freight analysis framework (FAF) forecasts that the total volume of goods transported will almost double by 2035. Moreover, because of changes in the makeup of the U.S. economy and the dramatic growth in international trade, goods are being transported over longer distances in contrast to a few decades ago (FHWA, *The Freight Story: A National Perspective on Enhancing Freight Transportation,* 2002). Consequently, the freight transportation network today is tightly strung and very sensitive to disruption (FHWA, *An Initial Assessment of Freight Bottlenecks on Highways*, 2005).

Freight Shipments are Increasing

The Freight Analysis Framework (FAF) forecasts that the total volume of goods transported by truck will almost double, from nearly 21 billion tons in 2006 to over 37 billion tons in 2035.

Trucking is the dominant mode today because it provides fast, reliable, and competitively priced freight transportation service that can be tailored to the needs of shippers and receivers. The movement of bulk goods, such as grains, coal, and ores still comprises a large share of the tonnage moved on the U.S. freight network. However, lighter and more valuable goods, such as computers and office equipment, now make up an increasing proportion of freight. According to the 2002 Commodity Flow Survey, trucks carried 67 percent of domestic shipments by tons, 74 percent by value, and 40 percent by ton-miles. The reliance on trucks makes the interstate highway network integral to an efficient and reliable nationwide freight system.

b. Missouri Freight Trends

Missouri's location in the nation's center makes it a major crossroads in the movement of goods. **Table B-18** presents information on freight shipments that have either an origin or a destination in Missouri. Trucks move the largest percentage of goods by both tonnage and value.

Table B-18

Freight Shipments To, From, and Within Missouri 1998, 2010, and 2020

	Tons (millions)			**Value (billions $)**		
	1998	**2010**	**2020**	**1998**	**2010**	**2020**
State Total	453	635	761	341	636	989
By Mode						
Air	<1	1	1	31	72	125
Highway	310	446	542	251	470	730
Other[a]	<1	<1	<1	<1	<1	<1

Table B-18

Freight Shipments To, From, and Within Missouri 1998, 2010, and 2020

	Tons (millions)			**Value (billions $)**		
	1998	**2010**	**2020**	**1998**	**2010**	**2020**
State Total	453	635	761	341	636	989
Rail	104	137	159	56	87	125
Water	38	51	58	4	6	9
By Destination/Market						
Domestic	433	604	718	326	605	935
International	20	31	43	15	30	54

Note: Due to rounding, model numbers may not add up to state totals.

[a] The "Other" category includes international shipments that moved via pipeline or by an unspecified mode.

Source: FHWA, *Freight Management and Operations – State Profile – Missouri,* April 2006.

Both the amount and value of truck delivered freight in Missouri is expected to increase over the next 20 years. Tonnage is expected to grow by 18 percent and the value by 55 percent. The top commodities, by weight, in Missouri will continue to be minerals and farm products. Missouri's top trading partners will continue to be its neighboring states. **Table B-19** shows the state's top trading partners in 2002 and the estimated growth in trade for 2035.

Table B-19

Top Trading Partners 2002 and 2035

(2002) Tons (millions)			**(2002) Value ($ millions)**		
	Number	**Percent**		**Number**	**Percent**
Total	347.1	100	**Total**	322,359.8	100
Foreign	11.8	3	**Foreign**	12,962.0	4
IL	83.1	24	**IL**	61,540.5	19
KS	47.5	14	**KS**	32,210.5	10
WY	32.6	9	**OH**	17,640.8	5
AR	28.2	8	**AR**	15,733.2	5
(2035) Tons (millions)			**(2035) Value ($ millions)**		
	Number	**Percent**		**Number**	**Percent**
Total	730.9	100	**Total**	894,192.4	100
Foreign	27.9	4	**Foreign**	40,980.0	5
IL	152.4	21	**IL**	134,962.2	15
KS	132.0	18	**CA**	126,337.8	14
WY	62.9	9	**KS**	89,649.7	10
AR	49.0	7	**MI**	48,229.6	5

Source: FHWA, *Freight Management and Operations – State Profile – Missouri,* April 2006

c. Commercial Freight Movements on I-44

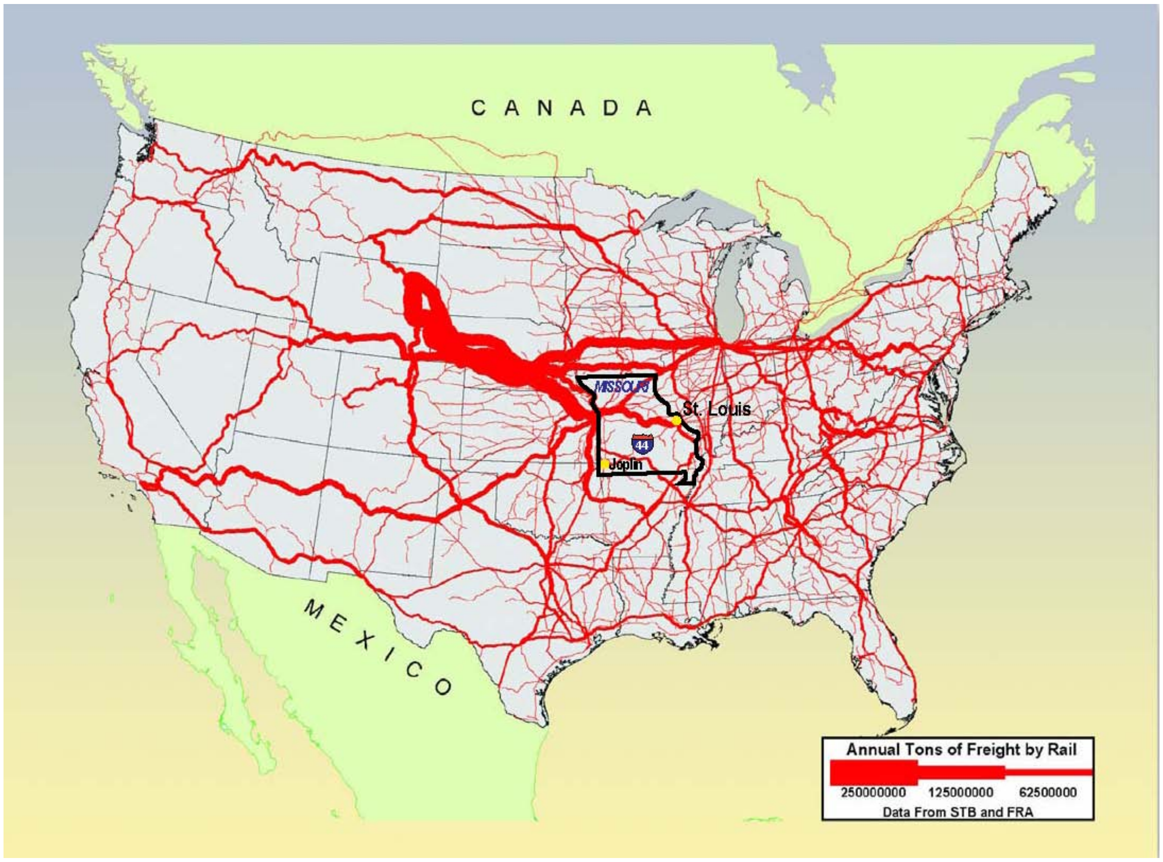
Interstate 44 is an important commercial trucking corridor because of the link it provides to St. Louis, a major multimodal freight hub. St. Louis is a major shipping port for freight by air, rail, and water.

Although St. Louis is not among the top freight rail centers, it is part of the rail corridor that stretches across the Midwest. The I-44/I-40 interstate corridor provides the best automobile and truck routes to the St. Louis rail centers for a large area. **Figure B-8** shows the rail network in the vicinity of I-44.

St. Louis is also among the top 25 water ports (by weight) in the country. As can be seen in **Figure B-9**, St. Louis is the collection point for river freight coming from the upper Missouri River, Illinois River, and upper Mississippi River; it is the starting point for the high volume barge traffic that characterizes the Mississippi River to the south. Commercial trucking is the primary carrier of bulk goods, such as grains, between the St. Louis rail and river ports and the users/suppliers to the southwest. St. Louis is also home to several airports, including Lambert International Airport, MidAmerica Airport, Spirit of St. Louis Airport, and the Scott Air Force Base. While the total amount of goods shipped via air is small, it is a valuable and growing market.

Figure B-8

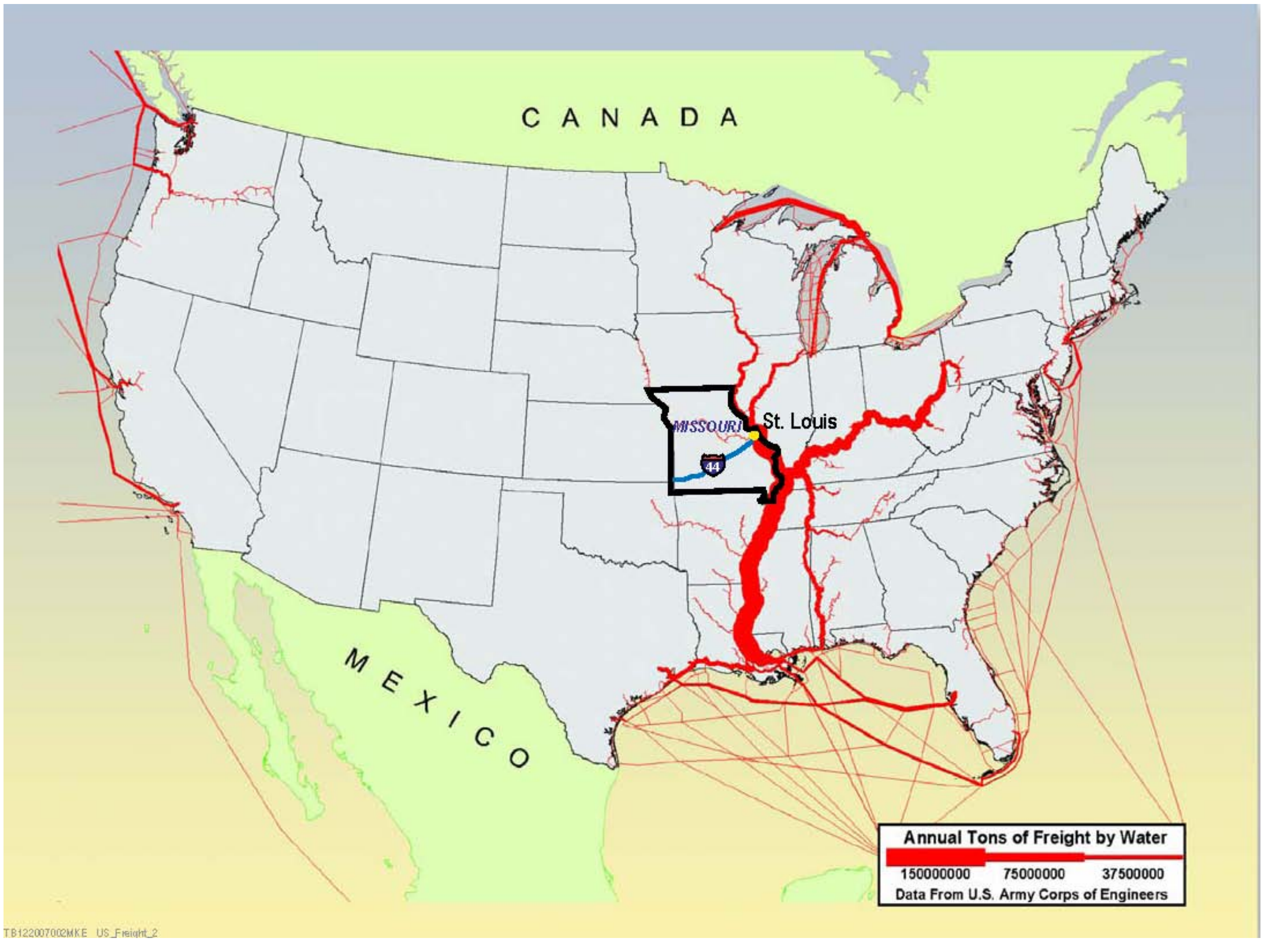
Tonnage on Railroad Network: 2005



Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, 2007; based on Surface Transportation Board, Annual Carload Waybill Sample; and rail freight flow assignments done by Oak Ridge National Laboratory (U.S. Dept. Of Transportation FHWA, 2007)

Figure B-9

Tonnage on Domestic Waterway Network: 2005

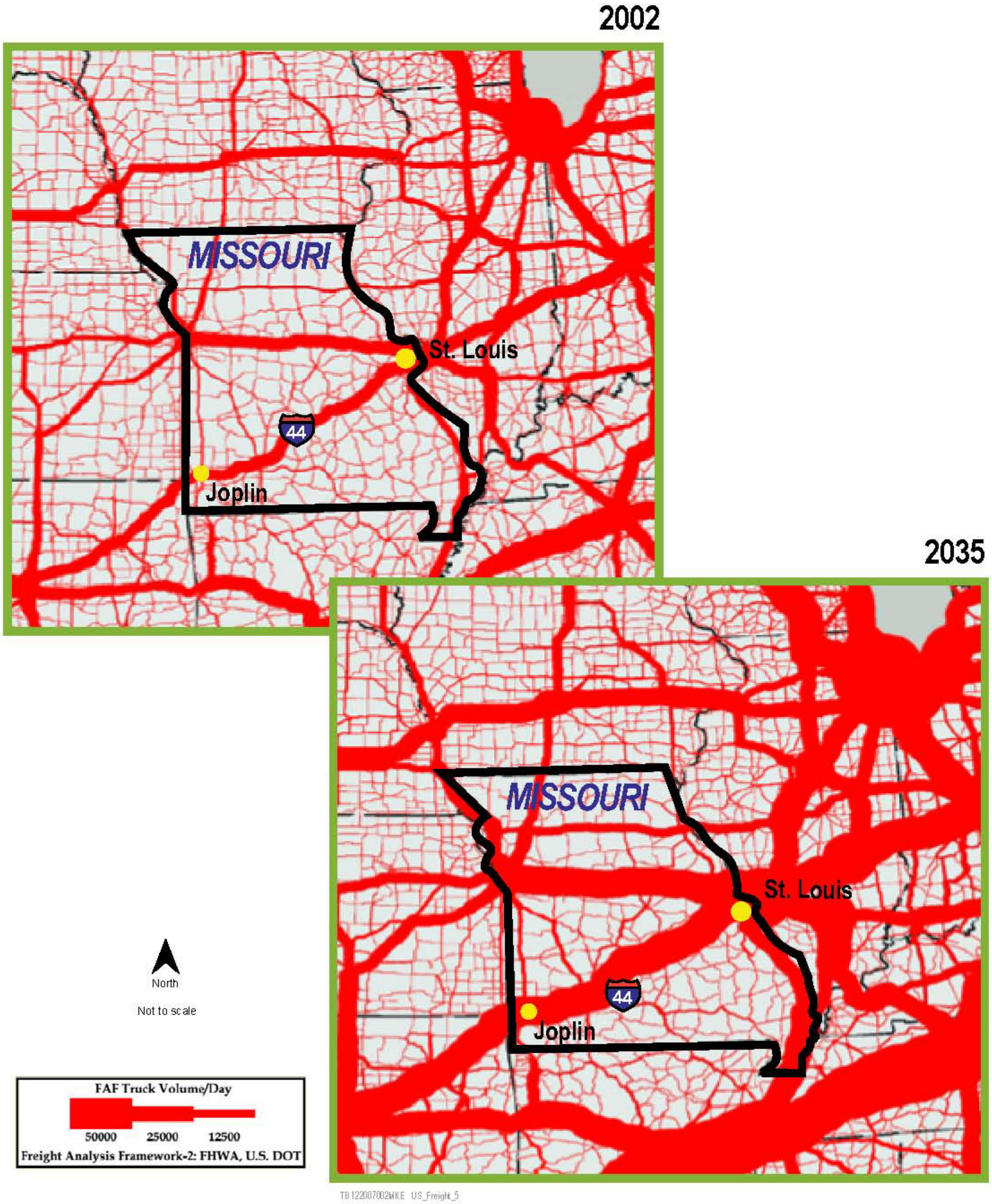


Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, 2007; based on U.S. Army Corps of Engineers (USACE), Annual Vessel Operating Activity and Lock Performance Monitoring System data, as processed for USACE by the Tennessee Valley Authority; and USACE, Institute for Water Resources, Waterborne Foreign Trade Data. (U.S. Dept. Of Transportation FHWA, 2007)

The air, rail, and port facilities draw goods via I-44. Also contributing to the importance of I-44 as a key commercial trucking corridor is how it, along with I-40, is part of an interstate connection between Missouri and southern California. **Figure B-10** depicts the value of this connection by showing the volume of long-haul trucks that traveled I-44 in 2002. This volume is expected to continue to increase in the future. The values for 2035 are also shown in **Figure B-10**. Based on these estimates, I-44 is among the most valuable long-haul trucking routes in the U.S. It is also interesting to note the difference in the connections that I-44 and I-70 make west of the state. While I-70 is unquestionably an important commercial trucking corridor in Missouri, it is part of a shorter and lesser traveled commercial truck corridor. This is evident in the portion of the roadway system shown on **Figure B-10**. Interstate 44 becomes part of a shorter and less major trucking corridor traveling towards the Oklahoma City area. Nevertheless, the maintenance of both the I-44 and I-70 corridors are of critical importance to the nation.

Figure B-10

Estimated Average Daily Long-Haul Truck Traffic on National Highway System: 2002 and 2035

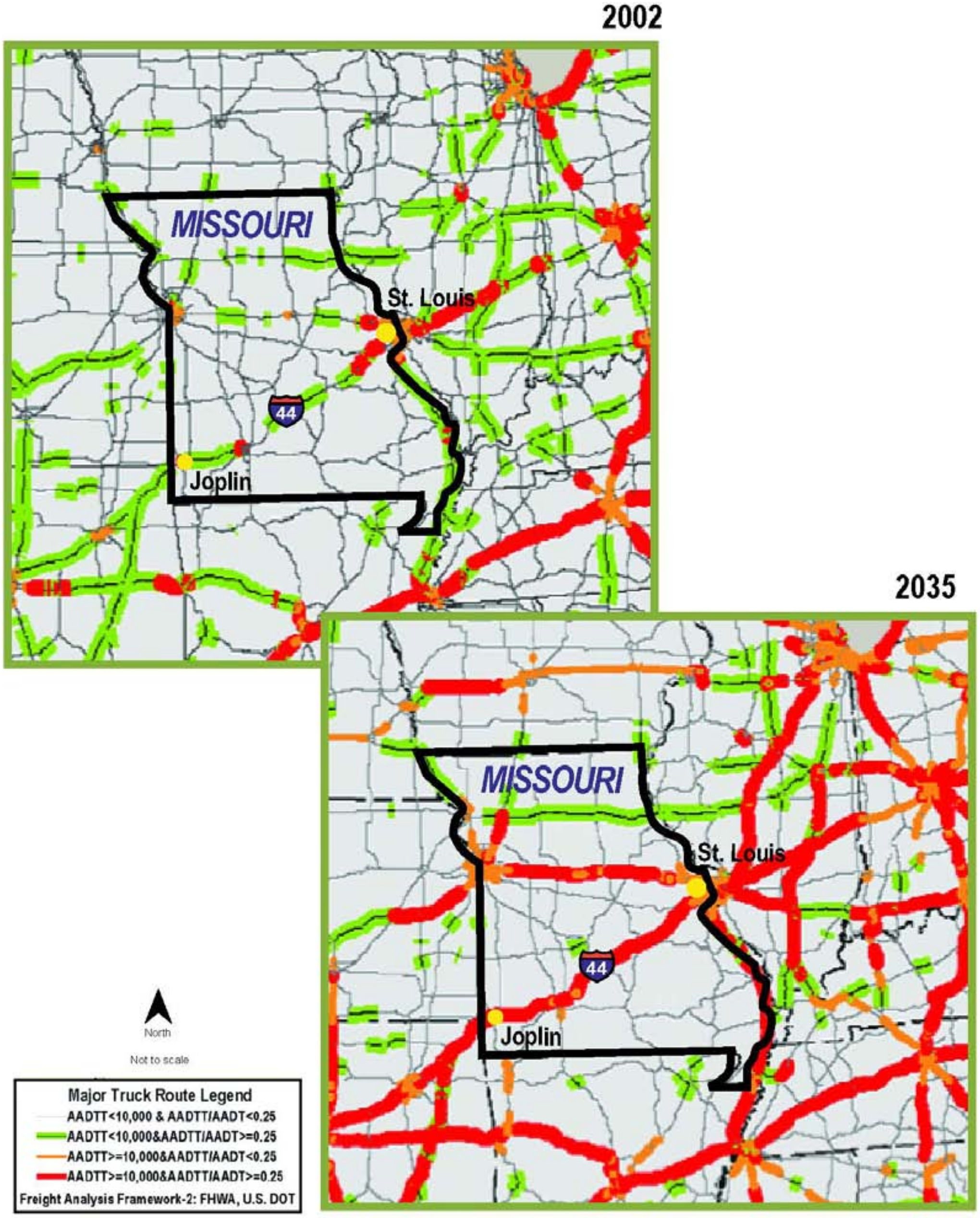


Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, Version 2.2, 2007.

The importance of the I-44 corridor to commercial trucking is also apparent in the total volume of trucks, expressed either as an absolute number or as a proportion of the total traffic stream (**Figure B-11**). It is interesting to note that, as of 2002, I-44 appears to have a greater proportion of trucks over its length than I-70. Both the volume and proportion of commercial vehicles on I-44 are expected to increase in the future.

Figure B-11

Major Truck Routes on the National Highway System: 2002 and 2035



Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, Version 2.2. 2007. (U.S. Dept. Of Transportation FHWA, 2007)

d. Challenges to Commercial Trucking in the Study Corridor

Congestion hinders commercial truck traffic and leads to longer travel times, increased costs, and less reliable pick-up and delivery times for truck operators. To compensate, motor carriers typically add vehicles and drivers and extend their hours of operation. Over time, most of these costs are passed along to shippers and consumers. The FHWA estimates that increases in travel time cost shippers and carriers an additional $25 to $200 per hour depending on the product carried. The cost of unexpected truck delays can add another 50 percent to 250 percent (*An Initial Assessment of Freight Bottlenecks on Highways*, FHWA Oct. 2005).

Congestion is a major concern for I-44. The project's freeway traffic operations analysis (See **Section B.1)** indicates that, while most of the study corridor currently operates at an acceptable LOS, large segments of the corridor will experience substantial congestion by 2035 if capacity is not expanded.

Increases in congestion on I-44 is supported widely in the literature and is part of a statewide trend. For example, the report, *Future Mobility in Missouri: Meeting the State's Need for Safe and Efficient Mobility* (TRIP, June 2007) states that traffic congestion levels in Missouri are rising, as vehicle travel on the state's roadways has increased seven times faster than additional roadway capacity has been added. The report noted that while Missouri's population increased about 13 percent between 1990 and 2005, vehicle miles traveled increased 35 percent over the same time period. Vehicle miles traveled are expected to increase another 30 percent by 2020. Other current research, while predicting increases, cites different rates.

FHWA's *Freight Facts 2007* provides additional confirmation that congestion levels will become increasingly problematic on I-44 between now and by 2035 (**Figure B-12**).

Figure B-12

Peak-Period Congestion on Segments of the National Highway System with more than 10,000 Trucks per Day: 2002 and 2035

Source: U.S. Department of Transportation, Federal Highway Administration, Office of Freight Management and Operations, Freight Analysis Framework, Version 2.2. 2007. (U.S. Dept. Of Transportation FHWA, 2007)

Nationally, the FHWA estimates that about 40 percent of highway congestion is caused by bottlenecks—recurring congestion at locations where the volume of traffic routinely exceeds the capacity of the roadway, resulting in stop-and-go traffic flow and long backups (*Initial Assessment of Freight Bottlenecks on Highways,* FHWA October. 2005). The bottlenecks that affect trucks include interchanges, steep grades, signalized intersections, and lane drops. **Section B.1** discusses the congestion expected on I-44. Nationally, the FHWA also estimates that another 25 percent of congestion is estimated to be caused by crashes. As noted in **Section B.2**, crash hotspots occur throughout I-44.

The Relationship between Truck Traffic and Congestion, Crashes, and Design

Trucks have wide-ranging affects on I-44: they exacerbate congestion, they are sensitive to design-related issues, and they constitute a substantial component of the crash environment.

Both crashes and congestion have a relationship with geometric deficiencies. Many of the deficiencies along the I-44 corridor are associated with the project area's rolling terrain. In some locations, the uphill grades are long and steep enough to cause heavy vehicles to slow down significantly. Separate, dedicated climbing lanes are employed at some uphill grades of 4 percent or greater to minimize the impairment of traffic flow by the slow moving trucks. Some of these climbing lanes have substandard taper lengths, which may lead to higher crash rates at these locations. There are several deficient steep grades along the I-44 corridor that have no climbing lanes. **Section B.5** discusses the design-related transportation problems affecting I-44.

Congestion, crashes, and design-related deficiencies have all been identified as transportation problems affecting I-44. Congestion, crashes, and design are affected by truck operations. The efficient operation of the freight system is critical to the American economy. Consequently, the accommodation of freight traffic represents a valid transportation problem that any emerging I-44 project will need to address.

5. Evolving Engineering Standards Result in Inconsistent Roadway Designs

Built more than 40 years ago, there are design elements of I-44 that no longer meet current design standards. These standards apply to the “geometry” of the road, that is, dimensions such as lane and shoulder widths, median width, vertical clearances, and horizontal curvature. The original design standards assumed lower traffic and fewer heavy trucks than are currently typical for I-44.

Current design standards are presented in MoDOT’s *Engineering Policy Guide*, the American Association of State Highway and Transportation Officials’ (AASHTO) 2004 edition of *A Policy on Geometric Design of Highways and Streets* (the “Green Book”), and the Highway Capacity Manual 2000. Design standards for an interstate highway vary depending on the design speed of the road. As defined by the Green Book, “Design speed is the maximum safe speed that can be maintained over a specified section of highway when conditions are so favorable that the design features of the highway govern.” The selection of design speed is made based on a variety of factors: functional classification, terrain type, density and character of adjacent land uses, expected traffic volumes, and economic and environmental considerations. Once selected, the design speed directly dictates a variety of roadway features, including horizontal curvature, superelevation, sight distance, and vertical grade, and curvature. It also influences most other design elements of the roadway.

Design speed has traditionally been set higher than the posted speed limit in most jurisdictions. In Missouri, however, MoDOT recently decided to equate the design speed to the posted speed limit. Specific to the analyses conducted for this I-44 study, the existing facility was consequently measured against the design standards appropriate for the existing posted speed limits across the corridor. The vast majority of the corridor has a speed limit of 70 mph. There are two segments of the corridor where the posted speed limit drops to 60 mph:

- In Springfield, from Mile Marker 76.5 to 81.2
- In Rolla, from Mile Marker 184.5 to 187.2

Using these design speed definitions to establish appropriate measures of effectiveness, the I-44 Purpose and Need Study undertook a broad evaluation of the physical conditions of I-44. The existing conditions were compared against relevant design guidelines to identify existing geometric elements which could impede the efficient movement of people, goods and services[1]. Among the design elements investigated were:

Summary of the Design-Related Transportation Problems Affecting I-44

One of the purposes for any project associated with the I-44 corridor will be to eliminate those geometric elements that impede the safe and efficient movement of people, goods, and services.

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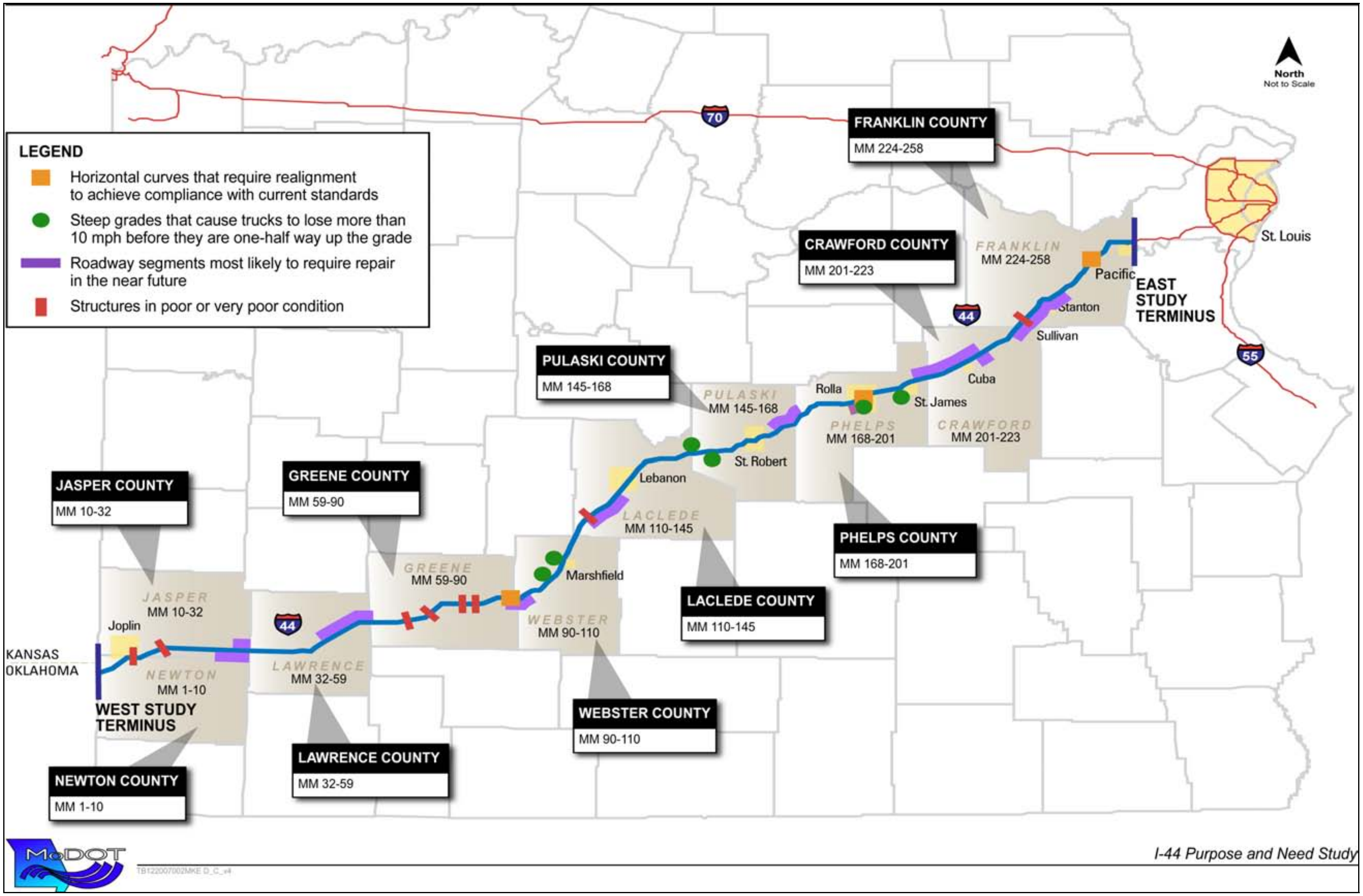
[1] Safety is always an essential element for success on any project and MoDOT’s *Engineering Policy Guide* dictates that MoDOT will not compromise safety. Every project must be safer after its completion. However, it is important to remember that areas that contain design elements that do not meet specific standards are not considered safety concerns unless there is also a documented history of problems to support that decision.

- Lane and shoulder widths
- Horizontal and vertical curvature
- Vertical grade/climbing lanes
- Horizontal and vertical clearances
- Interchange geometry
- Outer road separation
- Pavement and structure conditions

Appendix A contains the *Corridor Evaluation Methodology TM*, the *Bridge Summary TM*, the *Geometric Analysis Methods and Assumptions TM* and the *Climbing Lane Review TM* which address the geometric evaluations conducted as part of the I-44 Purpose and Need Study. The other geometric evaluations are contained within the project technical file. The graphic results of various evaluations are in **Appendix B**. **Figure B-13** provides a graphic summary of some of the geometric deficiencies discussed in this section.

There are areas of I-44 that are out of compliance with the applicable standards. This section summarizes the evaluations and identifies those areas determined to be “critical.” One of the purposes for any project associated with the I-44 corridor will be to eliminate geometric elements that impede the safe and efficient movement of people, goods and services. The evaluation criteria to determine how well alternatives accomplish this goal will emerge from this discussion.

Figure B-13
Geometric Deficiencies



a. Lane and Shoulder Widths

Improving Lane and Shoulder Widths

Except at bridge locations, the roadway dimensions along I-44 are generally within the current design standards and meet driver expectations.

Bridge curb-to-curb width is widely out of compliance with standard criteria. Correcting these conditions typically require complete replacement.

Generally, the I-44 corridor consists of two, 12-foot wide lanes in each direction (eastbound and westbound), with 10-foot wide outside shoulders and 4-foot wide inside shoulders[2]. These dimensions are within the current design standards and meet driver expectations. They provide adequate width for safe operation and for removing disabled vehicles from the travel lanes. There are few exceptions to the standard lane and shoulder configuration. Where exceptions exist, they are typically associated with portions of I-44 with numerous bridge overpasses and underpasses.

For bridges carrying I-44 over another feature, the bridge curb-to-curb width, as listed in the National Bridge Inventory (NBI) database, was evaluated using 12-foot lane widths, 4-foot left shoulders and 10-foot right shoulders as the design criteria. There are 97 bridges that carry I-44 over another feature. Of the 97 bridges, 52 bridges (54 percent) do not meet the criteria. One bridge (Eastbound I-44 over Big Piney River, Mile Marker 165.6, Pulaski County) was particularly narrow, having a curb-to-curb width that allows for only the 3 travel lanes and less than a 2-foot shoulder on each side. The Map Book in **Appendix B** depicts the locations of bridges that do not meet design criteria.

For bridges carrying another roadway over I-44, the curb–to-curb width was compared to the width of the approach roadway. Of the 90 bridges evaluated, 20 (22 percent) did not meet this criterion. The Map Book in **Appendix B** depicts the locations of bridges that do not meet the criterion of the curb to curb width being at least as wide as the approach roadway. Information about bridges that carry another roadway over I-44 is presented for information only as their characteristics and/or deficiencies do not affect mainline operations on I-44.

Improving Horizontal Curvature

Horizontal curves along I-44 inconsistent with typical design criteria are widespread. Most can be improved without realignment.

Three areas have been identified as having horizontal curvatures out of conformance with applicable standards to an extent that will require realignment.

- Mile Marker 92.3 – 92.9, Webster County
- Mile Marker 186.2 – 186.4, Phelps County
- Mile Marker 246.9 – 247.4, Franklin County

b. Horizontal Curvature

The design for the horizontal curvature of a roadway is determined by the design speed, and is defined in terms of the radius of the curve (or how “sharp” the curve is), and the superelevation, or slant of the roadway at the curve. Within limits, a higher speed can be maintained through a curve with a shorter radius (a sharper curve) by slanting the roadway slightly toward the center of the curve. As a freeway-type facility, I-44 has a maximum allowable superelevation of 8 percent with a

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[2] In several areas, an additional climbing lane is present for heavy trucks on long, steep inclines. These lanes are dedicated for these slow moving vehicles, and are considered auxiliary lanes, not main through lanes. See **Section B.5.e**.

design speed of 70 mph in rural areas, and a maximum allowable superelevation of 6 percent and a design speed of 60 mph in more urbanized areas.

Horizontal curves along I-44 that are inconsistent with these guidelines are widespread. To help categorize the extent of the individual curve's inconsistency, the radius and superelevation of each curve along I-44 were compared to current standards and placed into one of four categories, in order of increasing seriousness and difficulty to correct. These are summarized in **Table B-20** and depicted in the Map Book in **Appendix B**. The first category includes curves that currently meet recommendations. Curves that, given the existing radius, need to increase the superelevation by more than 1.5 percent to meet the guidelines, up to a maximum of 8 percent, are grouped. All of these curves are capable of meeting the guidelines given the existing radius. Finally, the curves that cannot meet the guidelines with the given radius, even with a maximum 8-percent superelevation are grouped. These curves would require a realignment of the existing roadway to reduce the "sharpness" of the existing curvature.

The analysis showed the majority of the curves along the roadway do not meet the current design standards. Two-thirds fall in the lowest of the improvement categories, requiring minor correction of the superelevation. About 20 percent require a more significant alteration.

Table B-20

Horizontal Curve Geometry Assessment

Recommended Action	Number of Curves Evaluated	Percent of Total
No Action	25	16 percent
Increase Superelevation up to 1.5 percent	103	65 percent
Increase Superelevation by more than 1.5 percent	28	18 percent
Increase radius	3	2 percent
Totals	**159**	**100 percent**

The project Map Book that accompanies this document depicts the locations associated with the Horizontal Curve Geometry Assessment.

Due to rounding the numbers may not add up to exactly 100 percent

c. Vertical Curvature

I-44 passes through rolling hills, and its vertical curvature, or the amount of up and down change in the roadway, can affect safety. On flat or level terrain, vertical curvature is modest and often unnoticeable to the driver. On rolling and mountainous terrain, roadways are built on significant inclines and declines, or "grades," requiring more significant vertical curvature that can affect driver comfort and safety if not designed correctly.

Generally, a K-value is used to design a vertical curve. K is the relationship of the length of the vertical curve over the algebraic difference in grades in and out of the curve. The lower the K-value, the more abruptly the roadway is going to transition into a sag (valley) curve or traverse over a crest (hill) curve. Therefore, higher K-values are preferred because they

Improving Vertical Curvature

Most of the I-44 corridor is satisfactory with regards to vertical curvature.

mean a gentle transition across hills and valleys. K-values are calculated for each high and low spot along the roadway. Allowable K-values differ between crest curves and sag curves. The standard crest K-value for areas with a posted speed limit of 70 mph is 730 or greater. The standard K-value for areas with a posted speed limit of 60 mph is 570 or greater. The corresponding sag curve K-values for 70 mph speed limit is 181 or greater and 136 or greater for a speed limit of 60 mph.

K-values were calculated for each vertical curve along the corridor and were compared to the standards. If a crest K-value was too low, then the stopping sight distance (SSD) was evaluated relative to AASHTO standards. A crest that is too “sharp” will limit a driver’s ability to see ahead; therefore, if there is a slowed or stopped vehicle ahead, the approaching driver won’t be able to see it in time to avoid an incident. If a sag K-value was too low, then the passenger comfort was evaluated. If a vehicle is approaching and leaving the dip too steeply, the passengers experience a “sinking feeling” type of discomfort. In severe cases, SSD may become a factor at night, given that headlights may be unable to illuminate far enough out in front of the vehicle.

Results of the vertical curve evaluation are summarized in **Table B-21** and depicted in the Map Book in **Appendix B**.

Table B-21

Vertical Curvature Geometry Assessment

Eastbound Vertical Curve Condition Deficiencies	**Number**	**Percent**
Meets Guidelines	400	76
Exceeds K Value Standard	128	24
Exceeds K Value and Crest SSD	37	7
Exceeds K Value and Sag Passenger Discomfort	26	5
Westbound Vertical Curve Condition Deficiencies	**Number**	**Percent**
Meets Guidelines	396	73
Exceeds K Value Standard	140	27
Exceeds K Value and Crest SSD	46	9
Exceeds K Value and Sag Passenger Discomfort	28	5

Note: Some areas of I-44 have a split profile which results in minor differences in the number of eastbound and westbound curves.

Most of the highway is within the current standards, although 25 percent or more of the vertical curves in each direction exceed the K-value standard. Of greater importance are vertical curves that either do not meet the crest SSD or exceed the sag discomfort criteria, thereby posing a possible safety risk at 74 locations westbound and 63 locations eastbound.

d. Vertical Grade

According to the AASHTO guidelines, both urban and rural interstate roadways ideally have no grades steeper than 4 percent. This guide establishes a maximum acceptable grade without any consideration of length of grade. However, some sections of I-44 have grades that are steeper than 4 percent because of the rolling terrain. These steep uphill grades are primarily of concern because they cause trucks to slow down. For the I-44 corridor, the average daily traffic is comprised of approximately 30 percent trucks. This high percentage of trucks could impair traffic flow on long uphill grades. Also, vehicles that are moving slowly compared to the running speed of other traffic tend to become involved in crashes more often.

Each uphill grade that was greater than 4 percent was evaluated based on the total length of the grade compared to the critical length of grade. Critical length of grade is defined by AASHTO as the length of grade that causes a truck to reduce its speed by 10 mph or more. To evaluate when a grade “goes critical,” the length over which the 10-mph reduction is experienced relative to the overall length of grade will determine how long a truck will stay at or below the 10-mph speed reduction. For example, if the grade is steep enough to cause the 10-mph reduction at the beginning of a long grade, trucks will travel at the reduced speed for a significantly longer period of time (and potentially continue to lose speed, depending on the specific condition) than those traveling up a longer, flatter grade where the critical grade speed reduction is not experienced until later along the hill.

Of the 27 eastbound grades over 4 percent, 8 have grades longer than their critical lengths. Six of these eight eastbound grades do not have climbing lanes. Of the 21 westbound grades over 4 percent, 7 have grades longer than their critical lengths. Four of these seven westbound grades do not have climbing lanes. Thus, slow moving trucks are considered a potential issue along the 10 grades that currently do not have climbing lanes.

Improving Vertical Grade

Steep grades negatively affect operations, especially truck operations. The 10 steep grades along I-44 that do not have climbing lanes are listed in Table B-22. Of those 10 steep grades, the following 5 steep grades have critical grade lengths that cause trucks to lose more than 10 mph at a point less than half way up the grade:

1) EB Mile Marker 149.3 – 149.7 Pulaski County
2) EB Mile Marker 184.7 – 186.7 Phelps County
3) EB Mile Marker 194.0 – 194.2 Phelps County
4) WB Mile Marker 101.5 – 101.8 Webster County
5) WB Mile Marker 144.4 – 145.4 Laclede County

Table B-22 lists the 10 grades longer than their critical lengths that currently do not have climbing lanes. Of note in **Table B-22** is the data presented in the *Approach Grade* column. The *Grade Effect* noted, either “Yes” or “No”, states whether the approach grade leading into each of the 10 steep grades has the potential to affect a vehicle’s speed as it enters the steep grade. A “Yes” rating dictates that the vehicle is already slowing prior to entering the steep grades noted in the table.

Table B-22

Evaluation of Existing Steep Grades with Critical Lengths

Direction (Eastbound/ Westbound)	Grade				Approach Grade		Critical Length		Existing Climbing Lane
	Beginning[1] Mile Marker	End Mile Marker	Slope (Percent)	Length (feet)	Slope (Percent)	Grade Effect	Length (feet)	Critical Length to Total Grade Length (Percent)	
Eastbound	149.3	149.7	5.00	2059	1.07	Yes	473	23 percent	No
Eastbound	158.6	158.8	6.00	1162	0.00	No	760	65 percent	No
Eastbound	169.4	169.6	5.00	686	1.20	Yes	533	78 percent	No
Eastbound	184.7	186.7	4.13	10613	2.71	Yes	680	6 percent	No
Eastbound	194.0	194.2	4.00	1003	2.00	Yes	67	7 percent	No
Eastbound	235.7	235.9	4.98	1056	-0.37	No	960	91 percent	No
Westbound	101.5	101.8	4.00	1531	1.67	Yes	607	40 percent	No
Westbound	144.4	145.4	4.12	5386	-3.94	No	1193	22 percent	No
Westbound	172.4	172.7	4.00	1478	1.00	No	1233	83 percent	No
Westbound	190.1	190.7	5.00	2851	0.40	No	1788	63 percent	No

[1] *I-44 mile markers are posted in an eastbound direction. Thus, westbound traffic flow experiences the mile markers from higher to lower. Because of this, the beginning mile marker is the ending mile marker and vice versa for westbound.*

e. Existing Climbing Lane Geometry

Climbing lanes have been constructed at eight locations along existing I-44. The geometry of the existing climbing lanes was compared to the Green Book guidelines. The climbing lane should extend beyond the crest of a hill far enough to allow a truck to recover speed so that it can return to the normal lane without interfering with other traffic. Typically, for a freeway, the climbing lane should extend 300 feet beyond the crest, with a minimum 600-foot long taper (50:1) beyond that. All existing climbing lanes meet the minimum length of 300 feet over the crest of the hill. However, 3 out of the 8 climbing lanes do not meet the minimum 600-foot exiting taper length, meaning trucks are likely to be moving very slowly at the crest of the hill with inadequate roadway length for speed recovery and merging.

Improving Existing Climbing Lanes

Climbing lanes greatly enhance truck operations. There are three existing climbing lanes that do not conform to design criteria (minimum 600-foot exiting taper length).

1) WB Mile Marker 105.3 to 106.1
2) WB Mile Marker 107.3 to 108.3
3) WB Mile Marker 171.8 to 172.3

f. Clear Zone

Clear zones are unobstructed and traversable roadside areas that allow motorists who inadvertently leave the roadway to recover and bring the vehicle under control. For an interstate facility, with a maximum slope angle of 1 foot of vertical drop over 6 feet of horizontal distance (6:1), AASHTO's Roadside Design Guide recommends a minimum clear zone of 30 feet from edge of pavement. If conditions warrant construction of a slope steeper than 6:1, then the steepest slope that can be counted as contributing to the clear zone width is 1 foot of vertical drop over 4 feet of horizontal distance (4:1). A 4:1 slope requires a larger clear zone (38'). As a result of the rolling terrain, much of I-44 is in a cut section through rock. In accordance with the design standards in effect during the time of original construction, many of the side slopes and clear zones do not meet current recommendations. Rock cuts along the side of the road are vertically faced, and are within the clear zone. These rock faces are distributed across the corridor. However, there is no evidence to suggest a connection between these rock faces and crashes.

Improving Median Widths

Increasing median widths improve safety. I-44 was designed in an era when narrower medians were typical. Consequently, nearly all of I-44 fails to meet MoDOT’s preferences. Portions of existing I-44 with a concrete barrier wall and narrow shoulders in the median are as follows:

- Mile Marker 159.2 to 160.3 – near St. Robert
- Mile Marker 185.8 to 187.0 – Rolla area
- Mile Marker 244.3 to 247.0
- Mile Marker 255.6 to 265.3 – approaching the urban area limit of St. Louis

Widely throughout the I-44 corridor, the outside foreslopes are in excess of the maximum recommended 4:1 side slope. Typically, the center median also has foreslopes steeper than the recommended maximum slope. In areas of split grade profile one side of I-44’s slope will often be significantly steeper than 4:1.

g. Median Width

A wide separation between traffic in opposing directions has proven to be safer for motorists. The median width is measured between the edges of the inside travel lane for each direction. MoDOT's preferred median width for new interstate construction, including the inside shoulders, is 60 feet. Generally, the I-44 corridor has a median less than 60 feet. Due to the standards in place at the time of original construction, the median is largely 40 feet throughout the corridor. The median is mostly a traditional grass median with a center depression for drainage. The 2006 installation of median cable guard along I-44 has proven to be very effective in reducing fatalities resulting from crossover crashes. In 2007, MoDOT reported only one crossover related fatality compared with 25 in 2005.

h. Overpass Horizontal Clearance

Most of the overpasses (bridges over I-44) are 4-span bridges with a pier near the center of the grass median. Piers for these medians are located just off the right shoulder at a distance of 8 and 16 feet. Some of the newer overpasses are 2-span bridges with a pier near the center of the grass median and spill slopes located at each abutment.

In general, the existing horizontal clearances beneath overpasses are adequate, although the shoulder width is reduced by bridge piers at some locations (as noted previously in this section in the *lane and shoulder width* discussion). If the addition of a travel lane is needed in the future, the overpasses could accommodate an additional inside lane, but the widening would require a narrower median. Generally, the addition of an outside lane with a 10-foot shoulder or the reconstruction of the roadway with a 60-foot wide median would not be feasible without reconstruction of most of the overpasses.

i. Vertical Clearance

The vertical clearance of a bridge over a roadway or railroad must meet minimum standards to ensure specified design vehicles will pass. As listed in the NBI database, the vertical clearance of each bridge in the corridor was compared to guidelines in the MoDOT *Engineering Policy Guide*. This guideline specifies a minimum vertical clearance of 16 feet and 6 inches for bridges over interstate highways and state routes over 1,700 vehicles per day (vpd), and a minimum of 23 feet and 0 inches for bridges over railroads.

- There are 90 bridges that carry a roadway or railroad over I-44; 11 (12 percent) have a vertical clearance of less than 16 feet 0 inches. The lowest vertical clearance happens at the only railroad bridge to occur over I-44 and stands at 14 feet and 11 inches.
- There are 42 bridges that carry I-44 over another roadway; 30 (71 percent) have a vertical clearance of 16 feet 0 inches or less.
- There are 12 bridges that carry I-44 over a railroad; 6 (50 percent) have a vertical clearance of less than 23 feet and 0 inches.

Improving Outer Roads

Local roadways are generally parallel I-44. Inadequate clear zones between the roads and minimal fencing are inconsistent with current design standards. While these conditions exist throughout the corridor, the study did not find any corresponding I-44 safety issues related to their proximity.

Improvements to sections of I-44 near these bridges would likely require reconstruction of the bridge or the roadway to correct these clearances. These elements are depicted in the Map Book in **Appendix B**.

j. Interchange Geometry

The geometry of the existing interchanges was compared to the design guidelines in the MoDOT *Engineering Policy Guide* and the AASHTO Green Book. Seven key features were evaluated – two relating to access management and five relating to horizontal and vertical geometry. A summary of these evaluations are in **Section B.3**.

k. Outer Road Separation

Local roadways parallel I-44 at a number of locations in both urban and rural areas. At several locations, these outer roads potentially pose issues to the safe operation of the interstate.

Encroachment into the Clear Zone

AASHTO's Roadside Design Guide recommends a minimum clearance zone for an interstate to be 30-feet wide from edge of pavement. Dependent on the slope of the ground, a wider clear zone may be needed at a particular location. Most of the outer roadways have a clear zone of approximately 25 to 30 feet between them and I-44; while that exceeds the minimum guideline, it still places most of these roadways unusually close, especially considering that most of I-44 does not have the barrier fence along interstate highways. For comparison, the average median width is about 40 feet. Thus the outer roads are closer to a driver than the oncoming interstate traffic. **Table B-23** identifies locations where the outer road location encroaches within approximately 30 feet or less from the mainline. It should be noted that while the outer roads at these locations are within 30 feet of I-44, the study did not find any corresponding I-44 safety issues related to their proximity.

Table B-23

Outer Road Separation of Less than 30 Feet

Direction	Log Mile Begin	Log Mile End	County
EB	89.70	89.80	Greene
EB	90.40	90.60	Greene
EB	142.60	142.70	Laclede
EB	156.50	156.60	Pulaski
EB	168.70	168.80	Pulaski
EB	168.80	168.90	Phelps
EB	169.30	169.40	Phelps
EB	181.00	182.80	Phelps
EB	183.40	183.50	Phelps
EB	183.50	183.60	Phelps
EB	183.90	184.10	Phelps
EB	189.60	189.70	Phelps
EB	217.50	217.80	Crawford
EB	219.90	221.30	Crawford
EB	224.70	224.80	Franklin
EB	240.60	240.70	Franklin
WB	42.90	43.30	Lawrence
WB	43.50	43.80	Lawrence
WB	88.60	88.70	Greene
WB	153.80	153.90	Pulaski
WB	153.90	154.20	Pulaski
WB	154.40	154.50	Pulaski
WB	156.50	156.60	Pulaski
WB	169.40	169.50	Phelps
WB	189.50	189.60	Phelps
WB	210.90	211.00	Crawford
WB	211.00	211.10	Crawford
WB	220.50	220.90	Crawford
WB	237.90	238.10	Franklin

Unlimited Access

The close proximity of the outer roads to I-44, as well as the absence of any type of rail or fence system to separate I-44 from the outer roads, leads to a high occurrence of illegal access to and from the interstate. There are numerous locations along the corridor where motorists travel across the grass clear zones between I-44 and the outer roadways. Unlimited access is counter to the safe operation of a high-speed interstate highway, where drivers expect entering and exiting traffic only at interchanges.

Uncontrolled access is inconsistent with current design standards. Fencing and other structures can correct these conditions.

I. Pavement Conditions

MoDOT evaluates pavement conditions by four different rating systems. The *Ride Comfort Index* (RCI) is a rating system based on a scale of 0 to 10 given the ride experienced while traveling over the pavement. A value of 10 would be a pavement in optimal condition. *Condition* is a rating system based on a scale of 0 to 20. This rating is a compilation of several other factors. A value of 20 is a pavement in optimal condition. *Pavement Serviceability Rating (PSR)* is a subjective rating system based on a scale of 0 to 40. This evaluates the service to the transportation system that the pavement is providing. A value of 40 is a pavement in optimal condition. *International Roughness Index (IRI)* measures the cumulative deviation from a smooth surface in inches per mile. The IRI is a subjective rating system based on a scale of 0 to in excess of 170. A value of 0 is a pavement in optimal condition. As shown on **Table B-24**, in 2006 most of the pavement along the I-44 corridor was Good or Very Good.

Improving Pavement Condition

The vast majority of the pavement along the I-44 corridor is rated as good or very good. The following roadway segments are the most likely to require repair in the near future:

- Eastbound

Mile Marker 26.46 to 32.94; Jasper County

Mile Marker 89.50 to 95.54; Greene County

Mile Marker 115.60 to 126.68; Laclede County

Mile Marker 184.23 to 184.85; Phelps County

Mile Marker 212.74 to 215.46; Crawford County

Mile Marker 223.99 to 238.63 Franklin County

- Westbound

Mile Marker 28.51 to 32.83; Jasper County

Mile Marker 47.85 to 60.06; Lawrence County

Mile Marker 163.01 to 173.33; Pulaski-Phelps County

Mile Marker 200.70 to 213.82; Crawford County

Table B-24

2006 Pavement Condition Summary

Rating	Ride Comfort Index	Condition	Pavement Serviceability Rating	International Roughness Index
Eastbound Pavement Condition				
Very Good	58 percent	83 percent	70 percent	62 percent
Good	31 percent	3 percent	18 percent	28 percent
Fair	7 percent	6 percent	8 percent	5 percent
Poor	1 percent	2 percent	2 percent	3 percent
Very Poor	2 percent	5 percent	1 percent	2 percent
Westbound Pavement Condition				
Very Good	58 percent	79 percent	69 percent	60 percent
Good	34 percent	6 percent	19 percent	31 percent
Fair	6 percent	9 percent	9 percent	4 percent
Poor	1 percent	1 percent	2 percent	3 percent
Very Poor	1 percent	6 percent	1 percent	1 percent

Percentages represent the amount of pavement to meet the designated ratings.

On a section-by-section basis, the study team combined the scores of all four indices and assigned a rating system to help identify which areas of pavement along I-44 may be in need of repair in the near future.

Much of I-44 was repaved recently (2006-2007) as part of MoDOT’s “Smoother, Safer, Sooner” plan, and as a result is in good condition. This program consisted of highway pavement patching of both existing asphalt and concrete driving surfaces and a new driving surface of asphalt pavement. Only small sections were left unpaved, likely because they were in the best condition before the recent reconstruction.

Westbound lanes generally appear to have experienced more patching and reconstruction than eastbound lanes. This is likely due to the fact that the westbound lanes have been in service longer. Based on the 2006 version of these indices, about 16 percent (82 miles) of the roadway pavement is in need of repair in the near future.

m. Structure Conditions

There are 223 structures in the I-44 corridor, including: 36 box culverts that carry I-44 over a waterway, 97 bridges that carry I-44 over another a route, waterway, or railroad, and 90 bridges that carry a route or railroad over I-44.

The box culverts are all reinforced concrete. The bridge superstructure types include steel and concrete beam/girder bridges, concrete T-beam bridges, and concrete slab bridges.

The original bridges along I-44 have an expected design life of 50 years. According to the NBI database, over 70 percent of the structures were built in the 1950s or 1960s. As of 2007, 45 of the 223 structures (20 percent) are over 50 years in age and an additional 5 (2 percent) box culverts are over 75 years in age. Another 52 percent are 40-49 years in age. The Map Book in **Appendix B** depicts the locations where bridges exceed 40 years of age.

The condition of all bridges (excluding the railroad bridge) is evaluated by individually rating their structural elements (bridge deck, superstructure, and substructure) using a numerical system developed by the FHA. Box culverts are rated separately using the same system. Elements that have a rating of 4 or less are considered structurally deficient.

Bridge Component Condition Ratings

Rating	Description
9	Excellent Condition
8	Very Good Condition – May need minor preventative maintenance
7	Good Condition – May need minor maintenance
6	Satisfactory Condition – May need major maintenance
5	Fair Condition – May need minor rehabilitation
4	Poor Condition – May need major rehabilitation
3	Serious Condition – Requires immediate repair or rehabilitation
2	Critical Condition – Facility closed – needs urgent repair or rehabilitation
1	Imminent Failure Condition – Facility closed – study to determine if repairs are possible
0	Failed Condition – Facility is closed and out of service

The vast majority of bridges (70-80 percent) have components that are rated in satisfactory condition (may need major maintenance) or good condition (may need minor maintenance). None of the components on any of the bridges are rated 2 (Critical Condition) or less. The lowest rating for all components was 3 (Serious Condition). The summary also shows that the decks are in the most need of repair, having more low ratings than other components. For a complete county by county list of the structural component ratings, see the *Bridge Summary Technical Memorandum* in **Appendix A.**

Bridge functionality was also rated, independent of bridge condition, based on the ability of the bridges to accommodate the current traffic loads. For the I-44 project, functionality was assessed based on the bridge roadway curb-to-curb width (discussed previously in *Lane and Shoulder Widths*), and the horizontal and vertical clearances beneath (discussed above under *Horizontal Clearances and Vertical Clearances*). Based on these assessments, 54 percent of the bridges along I-44 are not wide enough to have shoulders that meet the current standard.

Further calculations for the I-44 bridges included sufficiency ratings which summarize the various assessments of structure and function. Sufficiency ratings are based on a percentage, in which 100 percent represents an entirely sufficient bridge and 0 percent represents an entirely insufficient and deficient bridge. The value is a combination of the structural adequacy and safety (55 percent maximum), serviceability and functional obsolescence (30 percent maximum), and essentiality for public use (15 percent maximum). According to FHWA, highway bridges considered structurally deficient or functionally obsolete and with a sufficiency rating of less than 50 are eligible for replacement or rehabilitation, and those with a sufficiency rating of 80 or less are eligible for rehabilitation. Comparing the sufficiency ratings, it appears that the structures over I-44 are in considerably worse condition than bridges along I-44. On average:

Improving Structure Condition

The following structures were determined to be in Poor or Very Poor condition:

VERY POOR

- Southbound Route H over I-44, Mile Marker 80.4*
- Northbound Route H over I-44, Mile Marker 80.4*
- Southbound Route A over I-44, Mile Marker 118.0
- Northbound Route A over I-44, Mile Marker 118.0

POOR

- Eastbound I-44 over Route 71, Mile Marker 8.8
- Westbound I-44 over Route 71, Mile Marker 8.8
- MO 66 over I-44, Mile Marker 15.2
- Route N over I-44, Mile Marker 67.0
- Route B over I-44, Mile Marker 70.2
- Westbound I-44 over Winsel Creek, Mile Marker 227.9

** Programmed for replacement FY09*

- The structures along I-44 have an average sufficiency rating of 86.4.
- The structures over I-44 have an average sufficiency rating of 72.3.
- The box culvert structures have an average sufficiency rating of 76.7.

Notably, 12 of the overpass bridges (13 percent) have a sufficiency rating of less than 50, while none of the bridges along I-44 are in that poor of condition.

Averaging by county, the ratings show that Greene County has the lowest overall average sufficiency rating (71.6). For bridges over I-44, Greene County has an average sufficiency rating of 58.5, which is significantly below the average of all counties (79.2). Also, while there are bridges with sufficiency ratings less than 50 spread throughout the corridor, Greene County has the most bridges (6) with a sufficiency rating less than 50. A complete county by county list of the sufficiency ratings is provided in the *Bridge Summary Technical Memorandum* in **Appendix A**.

Based on these evaluations, MoDOT has assigned an overall structural condition index rating to each bridge, which prioritizes bridges for rehabilitation or replacement: Very Good, Good, Fair, Poor, and Very Poor. Bridges with Poor or Very Poor rating are typically in need of replacement or rehabilitation.

Despite their ages, most bridges are in fair (65 percent), good (24 percent) or very good (5 percent) condition. Eleven (6 percent) of the bridges are considered to be in Poor or Very Poor condition. These bridges are in need of replacement or significant rehabilitation in the near future. The Map Book in **Appendix B** depicts the locations of bridges in Fair, Poor, or Very Poor condition.

In some locations, the addition of another travel lane may be needed. The superstructure types of all of the bridges that carry I-44 are suitable for widening of the bridge deck. However, 69 (71 percent) have a condition index of Fair, Poor, or Very Poor. Further, 62 (64 percent) of the bridges are 45-55 years old and were designed for smaller truck loads. The cost of rehabilitating these bridges to make them suitable for the wider decks and/or heavier loads could comprise a substantial portion of the cost of replacement. Given their expected remaining life spans, such investment in the existing bridges may not be cost-effective over the long term. A structural evaluation would be needed for each bridge to determine if widening or strengthening the bridge would be feasible and cost-effective.

6. Balancing Access, Economic Development and Human/Natural Resources

During the I-44 corridor evaluation, it became clear that I-44 has a close relationship with some of Missouri's most valuable economic and natural resources:

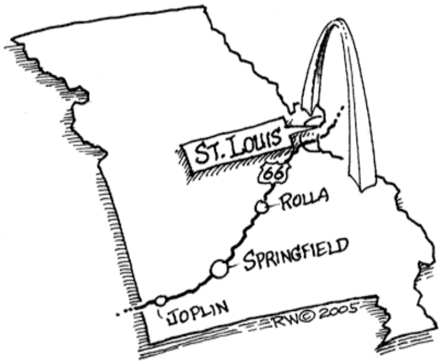
- Interstate 44 provides access to many important natural and recreational destinations in Missouri. For example, many visitors traveling to Branson use I-44. Similarly, most river float trips use I-44 to get to their portage site.

- The availability of high-speed travel makes these destinations attractive and profitable. Branson markets itself as a day trip from nearly anywhere in the Midwest. Travelers interested in Historic Route 66 can get there quickly on the adjacent interstate system.

- Improvements to I-44 could have both a positive and negative impact on these resources.

This section will examine how balancing the access that I-44 provides to important resources with the economic development that these resources generate and the potential for detrimental impacts to these unique resources combine to form an element of the I-44 Purpose and Need Study.

a. Historic Route 66

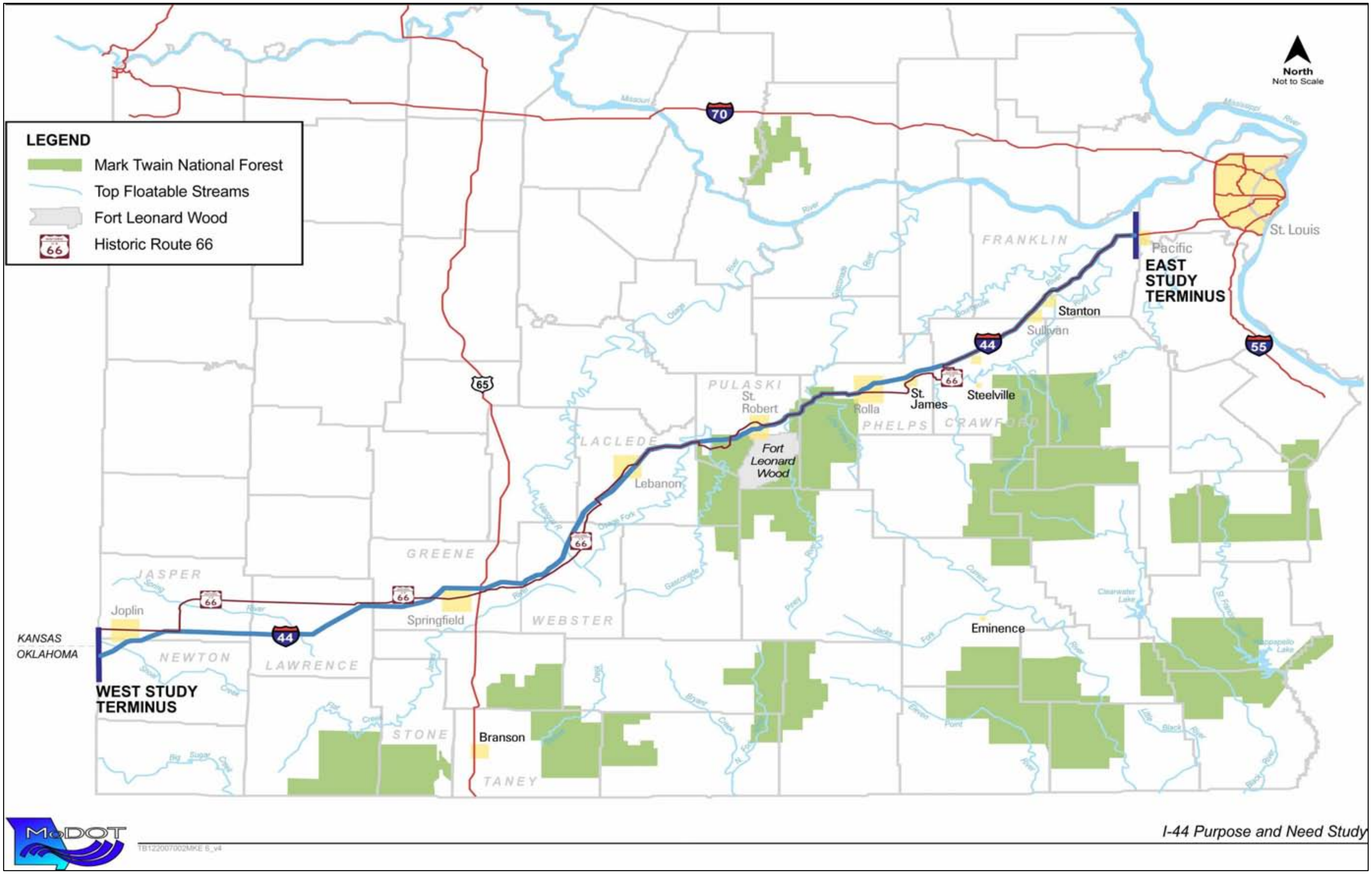


Known by many names, Route 66, U.S. Route 66, The Main Street of America, The Mother Road, and the Will Rogers Highway, this ribbon of highway may be the most famous road in the world. In Missouri, I-44 parallels, and has largely replaced, this roadway.

As the website, Legends of America proclaims, (www.legendsofamerica.com), *"The old highway closely follows the route of an ancient pre-civil war stage line and today, it parallels and zigzags across Interstate 44. Many signs of the old highway survive on the stretches of the original ribbon of highway, but if you prefer the interstate, every exit will land you within a moment's drive of original Route 66."*

This short statement summarizes the issue well: Route 66 is a landmark which provides important access to the I-44 corridor for visitors. This proximity also raises the possibility that improvements to I-44 can negatively impact Route 66.

Figure B-14
Important Resources within the I-44 Study Area



Summary of Resource

One of the original federal routes, US 66 was established on November 11, 1926. It originally ran from Chicago, Illinois to Los Angeles, California for a total of 2,448 miles.

Figure B-15

Route 66 Across the United States

Source: www. Historic66.com

Route 66 underwent many improvements and realignments over its lifetime. Ultimately it was decommissioned on June 27, 1985, replaced by the Interstate Highway System. Nevertheless, the roadway had become ingrained into the psyche of the nation. Among its cultural implications are its representation of the optimism of the American Spirit, the freedom of the open road and the manifestation of major population distributions that characterize the 20th century. Route 66 Associations have been established across the country, working to preserve this cultural icon. Largely a volunteer effort, these associations are keeping the spirit of the roadway alive.

Portions of the road have been designated National Scenic Byways. In Missouri, upwards of 300 miles of old Route 66 remains. A very large portion of what was once Route 66 in Missouri is still under state jurisdiction as either primary or secondary state highways. While its “official” state designation may not always be “66,” Missouri has more miles of the old highway under state management than any other state. On July 10, 1990, the Governor of Missouri signed House Bill 1629 designating Old U.S. Highway 66 as a historic highway in Missouri, and allowing the Missouri Department of Transportation (MoDOT) to post appropriate signs along the right-of-way. This joint project between MoDOT and the Route 66 Association of Missouri resulted in the installation of Historic Route 66 signs along the entire length of Historic Route 66 in Missouri. Another joint effort between MoDOT and the Route 66 Association of Missouri installed directional signs and arrows at strategic places along old U.S. 66 and I-44 to assist the traveling public in navigating Route 66 in Missouri.

Economic Values

While largely a volunteer effort, Route 66 casts a large economic footprint - mostly through the tourist trade. *The Route 66 News* lists 46 separate events (festivals/rallies/car shows) for 2008. Additionally, the road serves a quasi-pilgrimage route for antique car enthusiasts and those nostalgic for mid-20th century America. Along the way, visitors will find hotels, restaurants, museums and other attractions. While the “dollars and cents” benefits of this type of heritage tourism are difficult to quantify, tourism is a powerful economic development tool. Tourism creates jobs, provides new business opportunities, and strengthens local economies.

Cultural heritage tourism can have a tremendous economic impact on local economies. In addition to economic benefits like new businesses, jobs and higher property values, tourism adds less tangible—but equally important—payoffs. A well-managed tourism program improves the quality of life as residents take advantage of the services and attractions that tourism adds. It promotes community pride, which grows as people work together to develop a thriving tourist industry.

An area that develops its potential for cultural heritage tourism creates opportunities for tourists to gain an understanding of an unfamiliar place, people, or time, which increases the opportunities for preservation. Well-interpreted sites teach visitors their importance, and by extension, the importance of preserving other such sites elsewhere.

Perhaps the biggest benefit of cultural heritage tourism is that opportunities increase for diversified economies, ways to prosper economically while holding on to the characteristics that make communities special.

Access Provided by I-44

Figure B-14 depicts the spatial relationship between I-44 and Historic Route 66. Interstate 44 is the quickest route to almost any place on Historic Route 66.

How Alterations to I-44 Might Impact Historic Route 66

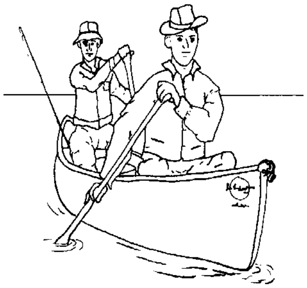
All of the public involvement events held as part of the I-44 Purpose and Need Study were attended by members of the Route 66 Association of Missouri. This provided ample opportunity to evaluate the varied goals of the group's membership. The membership seems equally split between business people and cultural historians, nostalgia seekers and car buffs. The goal they share is the preservation of the existing route. For the business community it provides a client base. For the others, a tangible link to the past. Because the Route 66 community splits on most other aspects of how I-44 might impact Historic Route 66, future projects should focus on the impacts to the existing pavement. Avoiding the rerouting of the agreed upon course of Historic Route 66 should satisfy most stakeholders. The risk of realignment impacts occurs primarily where Historic Route 66 (1) crosses I-44, (2) lies immediately adjacent to an I-44 interchange/overpass, or (3) is immediately adjacent to a long portion of I-44 mainline.

I-44 and Historic Route 66

- ✓ Avoiding the rerouting of the agreed upon course of Historic Route 66 should satisfy most stakeholders.
- ✓ Attention and coordination, consistent with the *Engineering Policy Guide*, will appropriately balance the access that I-44 provides with the economic development and the unique values that Historic Route 66 represents.

Attention and coordination, consistent with the MoDOT *Engineering Policy Guide*, will appropriately balance the access that I-44 provides with the economic development and the unique values that Historic Route 66 represents.

b. River Floats



“Where the rivers run" is a fitting slogan for Missouri. The following section describes the importance of river floats to Missouri. Interstate 44 is close to several of these rivers and provides access to many of the communities that promote river-related activities.

Summary of Resource

The state is crisscrossed with 50,000 miles of rivers and streams, including the Mississippi and Missouri rivers, plus many lakes, including Lake of the Ozarks, one of the largest manmade lakes in the world. Missouri also is home to the Ozark National Scenic Riverways, the nation’s first national park area to protect a free flowing wild river system, established in 1964. The park is comprised of 134 miles of the Current and Jacks Fork Rivers which flow through a pristine landscape, rich in history, geology, and unique plant and animal life. The riverways' gentle wilderness is a favorite canoeing, kayaking, and tubing destination.

Missouri rivers support over 200 species of fish, over 40 of which are game fish species. Several outstanding streams and rivers cross I-44, specifically, the Niangua River, the Big Piney River, the Gasconade River, and Roubidoux Creek. I-44 crosses (or is near) seven state-designated spawning stream segments, that is, streams that are particularly important in providing spawning habitat; the Osage Fork of the Gasconade River, the Gasconade River, Roubidoux Creek, the Big Piney River, the Bourbeuse River, the Spring River, and Blue Springs Creek. All of these streams, and others in the corridor, are high quality or drain into rivers and streams that are high-quality, ecologically diverse waters, and that are important sport fishing and floating sites. **Table B-25** shows the high quality streams and their characteristics in the I-44 corridor.

Table B-25		
Select High Quality Streams Along the I-44 Corridor		
County	**Stream Name**	**Stream Characteristics**
Newton	Shoal Creek	Biologically significant stream, public water consumption, recreational, local fishery, livestock watering, Shoal Creek Conservation Opportunity Area lies on both sides of Shoal Creek where it crosses I-44
Jasper	Center Creek	Cold water fishery (trout stream)
Lawrence	Spring River	State-designated spawning stream.
Webster	Niangua River	Cold water fishery (trout stream), habitat for Niangua darter (Federally Threatened).
Laclede	Gasconade River	Cold water fishery. Recreational resource. State-designated spawning stream
Pulaski	Roubidoux Creek	Cold water fishery; reaches are categorized as “White Ribbon” and “Red Ribbon” fisheries Portion are within Trout Special management Area (TSMA). State-designated spawning stream
	Big Piney River	State-designated spawning stream
Phelps	Little Piney Creek	Cold water fishery. Portions are within Wild Trout Management Area (WTMA).
Franklin	Bourbeuse River	State-designated spawning stream
Source: http://mdc.mo.gov/fish/watershed/niangua/contents/		

Economic Values

The economic value derived from floating, fishing, and other ecotourism is important to Missouri floating towns, such as St. James, Steelville, and Eminence, located off the I-44 corridor. River floats provide both economic and community benefits. The river floats in Missouri create attractive riverfronts to businesses and ultimately enhance regional tourism, both of which lead to increased local tax revenues. The towns and cities along these rivers also draw upon the economic benefit of this Missouri summer tradition. The river float and lodging providers benefit from those who float the mid-Missouri rivers as well as the local businesses and restaurants serving the transportation networks leading to the rivers. Many local communities are beginning to focus on the activity provided by the rivers as an opportunity to attract more tourists and businesses and coincidentally improve the quality of life for their residents.

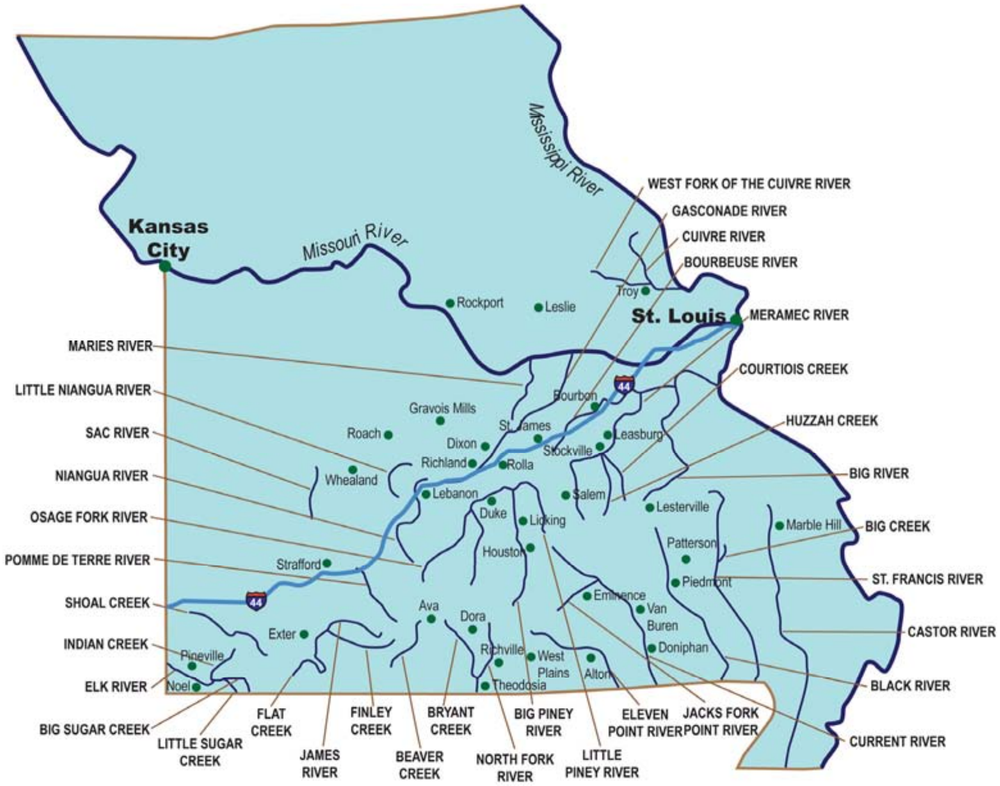
Sportfishing, hunting, and other outdoor recreation is an important economic value to the region. The January 2008 report by the American Sportfishing Association estimated over 1 million fishermen in Missouri. For 2006, these anglers generated $1.2 billion in retail revenue, ranking Missouri in the top ten states for sportfishing expenditures. This included $600 million in wages, and $122 million in state income taxes (http://www.asafishing.org/asa/statistics/reports/). A lot of the sportfishing resources are located in the Ozark and southwestern regions of the state. The popularity of fishing and other outdoor sports in southwestern Missouri is proven by the reported 4 million annual visitors to the Bass Pro Shop Outdoor World, billed as Missouri's number one tourist attraction, in Springfield.

Access Provided by I-44

River floats and fishing are an easy weekend vacation for most Missouri residents. Most of Missouri's river floats are located in the southern half of the state (see **Figure B-16**). Of these, most are accessed from the I-44 corridor. The largest reservoirs in Missouri, which attract many fishermen, are located in the southern half of the state within an hour's drive of I-44. The Missouri Department of Conservation (MDC) lists a total of 120 public fishing sites in their Ozark region, and 154 in their Southwest region.

Figure B-16

Missouri's Important Floatable Rivers



Source: www. Missouricanoe.org

Possible Impacts

Among the most common comments received while conducting this study were comments focused on the importance of preserving the natural environment along I-44. River floats provide a way for many Missourians to connect to the natural environment and are important tourism attractions. In addition to providing access, I-44 also crosses or falls within the immediate watershed along many of the state’s most popular floatable rivers, including the Meramec River, the Little Piney Creek, the Osage Fork River and others. Some segments are major float routes, others are used intermittently. Even if they are not crossed by I-44 or used commercially for floats, all streams represent an important natural resource, both ecologically and economically as sportfishing sites. Consequently, I-44 related stream crossings should be planned with this resource in mind.

I-44 and River Floats

- ✓ The emerging commercial river floating industry in southern Missouri should be considered a stakeholder and an excellent source of information on river conditions.
- ✓ Future improvements to I-44 should consider impacts to the vacation travel stream and their impact on a uniquely Missourian pastime.

c. Branson

The Ozarks is home to Branson, the music show phenomenon and one of the nation's top vacation destinations. According to a recent survey by the National Motorcoach Network, Branson was selected as one of the top three destinations in the country for tour and travel in 2007. Branson was ranked above Nashville, Chicago, and New York. Interstate 44 is a major pathway to Branson.

Summary of Resource

The city of Branson is located within the heart of the Ozark Mountains. Branson is located in Taney County and serves as the job, service and shopping center for a two county area with over 75,000 year round residents. The city also hosts 7.8 million visitors annually. Branson was first settled in the early 1800s as a stop along the White river, just east of the present historic downtown area. The town spread westward, and by the 1950s and 1960s, a variety of music shows were opening, playing to tourists who came to visit man-made Lake Taneycomo.

Branson is a major vacation destination, boasting 52 live performance theatres, 3 lakes, 12 championship golf courses, several theme parks, and a full range of shopping and dining options. Branson strives to combine small-town charm with big-city music and entertainment.

As Branson’s reputation as a destination increases, nearby communities have begun to enter the tourist trade. For example, Springfield, just north of Branson, has one of the state's largest tourist attractions—Bass Pro Shops Outdoor World. This megastore includes museums, aquariums, a 4-story waterfall, shooting range, restaurants, and more. Next door is Wonders of Wildlife and the American National Fish and Wildlife Museum and Aquarium. Each of these adds to Branson’s ability to attract more and more tourists each year.

Economic Values

Situated within a day's drive of 30 percent of the U.S. population, Branson and the Tri-Lakes Area (Taney and Stone counties) has up to 70,000 visitors daily. Tourism annually injects almost $2 billion into the local economy.

According to the city's economic development department, in 2006, the city assisted in the location of 24 new companies and the expansion and retention of 13 existing businesses that created new capital investment in excess of $215 million. These companies created and retained more than 3,000 employment opportunities in Branson during 2006. Furthermore, the value of new construction in the city for 2006 set an all-time record. Since the opening of the $420 million Branson Landing along the lakefront in 2005, a domino effect has occurred as developers, investors, and businesses now want to be a part of the increased national attention and capture the additional visitors that the waterfront project has generated. This kind of growth and enhanced economic activity benefits the community by providing greater business opportunities, more employment prospects for residents, a higher standard of living for citizens, and even more reasons for people to visit Branson.

Access Provided by I-44

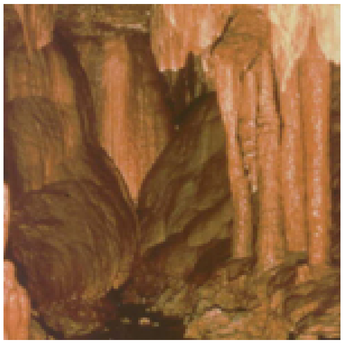
According to the City of Branson's website (CityofBranson.org), U.S. Highway 65 is the main route to Branson with over 70 percent of motorists coming from the north through Springfield. Southwest Missouri's primary east-west thoroughfare, I-44, intersects with U.S. 65 in Springfield, north of Branson. I-44 is the closest interstate roadway system to Branson, and provides efficient access to customers and suppliers across the United States.

I-44 and Branson

- ✓ I-44 is essential to the expanding tourist population visiting Branson, and serves as a main artery for transportation of supplies to and from the city.
- ✓ Future improvements to I-44 should study and consider any project's impact to the vacation travel stream.

Possible Impacts

I-44 is an important lifeline to Branson. It not only provides a direct access point to other parts of Missouri for local residents and tourists alike, but also provides the quickest means for the delivery of supplies. The roadway capacity of I-44 will be important to maintain or improve. Planning of construction phasing to minimize delays during peak tourist times will also be important.



d. Caverns

The natural beauty that characterizes Missouri is more than skin deep. Missouri, the Cave State, has more than 5,600 caves, and some of the state's most scenic natural wonders lie beneath the surface—in caves.

Summary of Resource

The southern half of Missouri is "cave country." I-44 is within close proximity to dozens of known caves, including popular tourist attractions such as Fantastic Caverns near Springfield and Meramec Caverns at Stanton.

Fantastic Caverns, just northwest of Springfield, Missouri, is a two level benchwork cave, with Jeep tours provided on the dry upper level – the only cave that offers a riding tour. Visitors find I-44 a convenient route to Fantastic Caverns and to other nearby attractions, including Branson.

Meramec Caverns is located off I-44 at Exit 230 in Stanton. The Meramec Caverns cave system was discovered by a French explorer in 1720, and is said to be the largest commercial cave in the state. The Meramec Caverns website (Americascave.com) suggests this cave offers the rarest and largest cave formations in the world. Presently, seven levels of this cave system are toured on a daily basis.

The natural caves of Missouri are sensitive, unique natural habitats and are home to a number of rare and unusual species, including rare cavefish, arthropods, and two species of federally listed bats.

Economic Values

Like tourism to other sites, such as Branson, visitors to the cave region provide an important input into the local and regional economy. The city of Springfield estimates that they host as many as 3 million overnight guests annually, and that 15 percent of them (450,000) visit the Fantastic Cavern (http://www.springfieldmo.org/). Thus, these cave tours are an important, even essential, part of the local and regional economy.

Access Provided by I-44

The goal of any successful tourism site is to keep visitors engaged and provide a memorable experience. I-44 is essential in the continued success of the caverns in Missouri—it is the main access link to the two most commercialized caves in the state. I-44 provides an affordable means for advertising to passersby and simple access to the sites.

Possible Impacts

Like Branson, changes to I-44 could affect access to Missouri's caves. The two most commercialized caves, Fantastic Caverns and Meramec Caverns support adjoining communities and are especially dependent on ready access for their economy. Additionally, I-44 serves as a major promotional venue for these caves, as the highway is well populated with their billboards. Future actions along I-44 should consider access to these tourist attractions.

I-44 and Caverns

✓ Like Branson, maintaining appropriate access from I-44 is essential to many of Missouri's commercial caves. However, project planners should also do adequate investigations to ensure that they do not inadvertently damage caves during the execution of their projects.

In addition to access, project planners should investigate the location of any caves within their general project area, in order to minimize inadvertent disruptions to these sensitive habitats. Caves and sinkholes can create direct connections to the groundwater from the surface, increasing the risk of contamination of the high quality groundwater upon which cave dwelling species depend. The MDC has designated cave focus areas which are particularly sensitive to surface disturbance. Five cave focus areas have been identified in and near the I-44 project area which incorporate a number of caves with known rare species populations. Project teams are encouraged to reach out to speleological groups and landowners during their public involvement efforts to locate all caves within their study areas.

e. Mark Twain National Forest

Mark Twain National Forest comprises nine separate areas in the southern half of Missouri. This national forest covers approximately 1.5 million acres, including 78,000 acres of Wilderness. Mark Twain National Forest spans 29 counties and represents nearly 11 percent of all forested land in Missouri. Ninety percent of the national forest lands are located near or south of the I-44 corridor, meaning I-44 is a key access highway for visitors to the forest.

Summary of Resource

This National Forest extends from the St. Francois Mountains in southeast Missouri across the foothills and plateaus of the Ozarks to the glades and balds in the southwest. The Mark Twain National Forest is traversed by rivers and streams, some fed by the largest springs in the country. Unique to Mark Twain National Forest is the Greer Spring which is the largest spring on national forest land, pumping an average of 222 million gallons of water per day.

Mark Twain National Forest is also diverse in vegetation, geological features, water resources, and wildlife. It includes seven federally designated wildernesses and numerous historical and archaeological sites. This National Forest is also said to contain over 500 native wildlife species, including bald eagles, black bears, and the Ozark hellbender.

According to the United States Department of Agriculture (USDA) Forest Service website (www.fs.fed.us), the National Forest's supervisor's office is located in Rolla, with additional ranger districts in other cities along the I-44 corridor, including Willow Springs, Doniphan, Winona, Fredericktown, Houston, Van Buren, Salem, Potosi, Poplar Bluff, Houston, and Cedar Creek. The National Forest is bisected by I-44 in the Rolla area.

Economic Values

The National Forest's large land base is many things to many people, containing some of Missouri's most beautiful and desirable landscapes and providing natural settings critical for the tourism industry around this forest. Over 45 million people are said to be within a day's drive of its unique features and recreational opportunities. Outdoor activities available at the National Forest include all terrain vehicles trails, biking, camping, canoeing, fishing, geocaching, hiking, horseback riding, hunting, and picnicking. The forest draws approximately 819,000 visitors per year, meaning the National Forest is a major tourist destination in southern Missouri. Per the USDA forest service website, visitors are estimated to spend $10–15 million annually (http://www.fs.fed.us/recreation/programs/nvum/). Thus, tourism is one major economic value provided by this National Forest.

This National Forest has other economic dimensions. One additional economic benefit is that private property located near the forest is more valuable than that located farther away. This occurs because scenic views, proximity to recreational opportunities, and other aspects of the forest are capitalized into private land prices. Furthermore, planners and local public officials are discovering that economic development follows when people stay in or relocate to areas with a high quality of life, including scenic, recreational, and other environmental amenities. Research indicates, retirees and businesses bring dollars and opportunities to areas with high-quality amenities.

A lower public service cost is yet another economic benefit of National Forests. Open space typically generates local tax revenue in excess of the costs of the public services that such land requires.

A National Forest also provides things that nature, particularly intact ecosystems, provide for free that people might otherwise have to provide, including watershed protection and carbon storage capacity of forests to lessen the impacts of global climate change.

Some economists believe people get economic benefits from National Forests even if they never set foot in them. This is the benefit that derives from people’s desire to conserve the option of visiting or using the forest in the future, of passing that option on to future generations, or simply knowing that these places exist.

Access Provided by I-44

More than half of Mark Twain National Forest is located within one hour’s drive from I-44, including the Ozark National Scenic Riverways.

I-44 and Mark Twain National Forest

✓ I-44 Projects in the vicinity of the Houston-Rolla District will need to engage the Mark Twain National Forest as an important stakeholder.

Possible Impacts

Since the Houston-Rolla District of the National Forest is bisected by I-44, direct project related impacts are possible. These impacts could include temporary or permanent right-of-way acquisitions. Project-related indirect impacts are probably also limited to the Houston-Rolla District. Agency coordination, consistent with the MoDOT *Engineering Policy Guide*, will appropriately safeguard the important values that the Mark Twain National Forest provides.

f. Wineries

While Missouri's most popular wine district lies in the Missouri River Valley, several wineries have become successful in the Ozarks, especially those in the vicinity of St. James, Missouri.

Summary of Resource

Known also as the "Ozark Highlands" region, as well as the "Little Italy of the Ozarks," St. James boasts a number of local vineyards, including establishments like Ferrigno Winery and Heinrichshaus. The most easily accessible grape-growers from I-44 are St. James Winery and Meramec Vineyards.

St. James Winery is approximately 100 miles west of St. Louis, just off I-44. St. James Winery has been family owned and operated by the Hofherrs since the 1970s. According to their website, www.stjameswinery.com, St. James Winery produces more than 130,000 cases of wine per year and distributes them around the country.

Meramec Vineyards is located 3 miles south of I-44 in close proximity to St. James. Meramec Vineyards was founded in 1980 with a 15-acre Concord vineyard first planted by the Tessaros, one of the original Italian families that migrated to St. James.

Economic Values

There is a direct, indirect, and induced economic value of wineries because they require the use of people, goods, and services to create a finished product. The direct value Missouri wineries provide is the employment of local people, increasing the employment base. A strong employment base of any community is beneficial to the overall economic viability. The indirect economic value is a result of the goods and supplies needed to create the final product. For example, a winery may purchase bottles, labels, chemicals for fermentation, etc. in order to actually make the product retail ready. The induced economic value occurs as those people employed by the wineries spend their personal income for goods and services in the local area.

While the indirect and induced economic values discussed above reflect the impact of Missouri's wineries on related sectors, a large economic value is in the businesses that benefit from the wineries. Most importantly are the hospitality and tourism businesses that operate near the wineries. This would include restaurants and cafes, hotels and Bed & Breakfasts, festivals, state historical and cultural sites, state parks, and shopping centers.

I-44 and Wineries

- ✓ Coordination with local businesses, including wineries, will help decrease the potential impacts to tourism and profitability of Missouri wineries.

Access Provided by I-44 and Possible Impacts

I-44 provides the main east-west route for national and statewide tourists visiting the St. James wineries. The individual success of these wineries is dependent on I-44. Without an easy means for transporting their product or retrieving supplies, prices and even the final product could be impacted.

g. Fort Leonard Wood

Fort Leonard Wood is located halfway between the cities of Lebanon and Rolla, near Waynesville and St. Robert on the south side of I-44. The base covers approximately 61,410 acres in Pulaski County. Fort Leonard Wood is where all chemical engineer and military police soldiers, plus many Marines, Airmen, Sailors, Coastguardsmen, and international students from allied nations receive training

Summary of Resource

The history of Fort Leonard Wood dates back to before World War II, with official designation of the installation by the War Department in early January 1941. The post is named for Major General Leonard Wood, a distinguished American Soldier whose service spanned 40 years.

According to the Fort Leonard Wood base guide, the population of Fort Leonard Wood is nearly 30,000 persons including military personnel, dependents, and civilians. The median household income is just over $41,000. As of 2005, the fort employed 14,431 personnel including 11,423 active duty military and 3,008 civilian personnel. The total payroll outlays for personnel working in the fort accounts to $611 million. The fort contributes over $2 billion annually to the state economy. One thousand troops are expected to be added by 2013.

Coordination with representatives of the Fort revealed that not only does I-44 provide access for soldiers destined for training but also serves as a proving ground for driver training. Also heavy equipment convoys are common, as men and materials are shipped to duty stations world-wide.

Economic Values

The presence of the military has a considerable impact on the economy. Fort Leonard Wood provides direct employment by the Department of Defense to thousands of military jobs, but also adds numerous civilian jobs. In turn, these employees generate large amounts of expenditures on retail trade, accommodations, and food services. Thus, the civilian and military personnel purchase goods and homes adding to the local tax revenues in local communities.

With numerous military personnel locating to the base for permanent assignment, or participating in scheduled training classes, the economic benefit at local hotel and restaurants is also evident. In addition, a military installation attracts frequent visitors, government and foreign dignitaries, and family members—also contributing to local hotels and eateries.

The substantial contracting needs of a military base also can be an important economic benefit. The military procures a large amount of contract work from the private sector for maintenance, supplies, construction, manufacturing, equipment, materials, transportation, communications, and health and food services.

I-44 and Fort Leonard Wood

- ✓ I-44 is essential to Fort Leonard Wood by providing a direct, safe, controlled route for transporting military personnel, vehicles and supplies.
- ✓ Since alterations to I-44 may negatively impact military processes, future improvement projects to I-44 should study and consider potential impacts to Fort Leonard Wood.

Tourism is another economic benefit of Fort Leonard Wood. With an effective program, the Pulaski County Tourism Board has successfully marketed to military reunions and individuals seeking the history of military installations.

Access Provided by I-44

I-44 is essential to the functionality and essential operations of Fort Leonard Wood. It is utilized as an efficient way to transport military personnel, supplies, and products to and from the military installation. Visitors to the base also use this interstate as a major access point in reaching the base destination.

Possible Impacts

The importance of I-44 for Fort Leonard Wood was described by several stakeholders at various public involvement events during this study, resulting in direct coordination with the Fort's public involvement personnel. The interstate provides a safe, controlled route to transport personnel and military effects. Without I-44, large military vehicles would have to travel over nondirect, less geometrically suitable routes.

Further, modifications to the I-44 system could have a negative impact on the economy supported by the military installation. Numerous businesses depend on their location near I-44 interchanges that are utilized by base personnel and visitors. Any modifications to traffic flow and accessibility along the major thoroughfares near the interchanges would need to consider and minimize potential impacts to these businesses.

7. Conclusions

As discussed earlier in **Section B**, the main focus of the I-44 Purpose and Need Study was to identify the transportation problems associated with I-44. The conclusions below provided focus on the important trends that define the transportation problems. As only the most important deficiencies are summarized below, less critical, but still problematic, conditions are identifiable within the bulk of the data.

a. Roadway Capacity Inadequate for Expected Demand

Based on a capacity analysis using existing traffic counts, current conditions are generally acceptable although localized areas of congestion exist in the eastern most 10-mile section of I-44.

Using the state-wide traffic model to predict future volumes, conditions are expected to deteriorate measurably by the design year of 2035. Almost 90 percent of the 257 miles of I-44 are expected to be incapable of meeting the LOS threshold levels by 2035. The roadway capacity analysis, distributed across the I-44, can be summarized as:

- Inadequate *existing* roadway capacity (LOS E in rural areas or LOS F in urban areas) currently exists in far eastern portion of I-44 between U.S. 50 and the St. Louis County line.
- Inadequate *future* roadway capacity is predicted throughout the corridor. **Table B-5** presents this analysis on a segment basis.
  - Twenty-nine percent of the I-44 corridor is expected to exceed LOS thresholds by 2015.
  - Eighty-eight percent of the I-44 corridor is expected to exceed LOS thresholds by 2035.
  - The portion of I-44 traveling through Franklin County is expected to experience heavy congestion in the near future. Traffic projections dictate that by 2010, 56 percent of I-44 through Franklin County is expected to exceed LOS thresholds, and by 2020, 100 percent of this portion of I-44 is expected to exceed LOS thresholds.
  - By 2035, the 69-mile stretch of I-44 from the east side of Rolla to the east project limit is expected to operate at LOS F (gridlock conditions).

b. Degrading Safety Environment on I-44

In addition to the public perception that travel on I-44 is becoming increasingly dangerous, the crash evaluation conducted for this project concluded that the crash environment has intensified in conjunction with increased traffic volumes. Additionally, the severity of the crashes along I-44 is notable. These results represent a valid transportation problem that any emerging I-44 project will need to address.

- The crash *rate* analysis concludes that Joplin-area interchanges have fatal crash rates well above statewide averages. Similarly, the Rolla-area interchanges have general crash rates several times higher than statewide averages.

- The crash *type* analysis concluded that while crashes involving trucks are less frequent (corridor-wide) on I-44 than comparable interstates, such as I-70, the number of severe crashes on I-44 is comparable to that of I-70.
- The crash hotspot analysis identified many areas where three or more disabling injury crashes and/or fatal crashes occur within 0.3 mile of each other. This led to the identification of the top 10 hotspot concentrations. Almost all of these hotspot concentrations occur in the eastern 100 miles of the I-44 corridor.

c. Interchanges along I-44 have Safety & Operation Issues and are Inconsistent with Current Design Standards

Since the operation and condition of each of the 78 interchanges along the study area portion of I-44 is unique, the evaluation of transportation problems required treating each interchange individually. The analysis focused on the three factors: safety, traffic operations, and geometric design. Issues are widespread and will require future additional (individual) analysis to determine remedies.

- Crash-related conditions at the I-44 interchanges were evaluated using total crash, fatal crash, and crash hotspot criteria. Fifty-one of the interchanges exceed at least one of the crash criteria (total crash rates, fatal crash rates, and crash hotspots) established for the project.
  - Interchanges at Route 86 (exit 6), Business Route 71 (exit 8), U.S. 71 South/249 North (exit 11), U.S. 71 North/59 South (exit 18), Route Y (exit 161), Route D (exit 172), Route H (exit 214) and U.S. 50 (exit 247) exceed all crash-related criteria.
- Operation-related conditions were based on the interchange ramps. In the design year (2035), most interchanges are expected to have at least one ramp operating at LOS F.
  - Interchanges at U.S. 71 North (exit 18), Route 13 (exit 77), U.S. 65 (exit 82), Route 100 West (exit 251), and Route 100 East (exit 253) are currently deficient in all measured traffic-operation criteria by 2035.
  - Approximately one-third of all interchanges are expected to be deficient in all of the measured traffic-operation criteria by 2035.
- Geometric-related conditions were evaluated pursuant to their ability to meet seven basic geometric standards. Forty percent of the study area’s interchanges have at least one geometric design deficiency.
  - Interchanges at Route 43 (exit 4) and Route JJ/W (exit 230) each do not meet four current design standards.

d. Freight Traffic Represents an Essential Element of the Traffic Stream on I-44

I-44’s location makes it a vital crossroad in the heart of Missouri’s and America’s economy. Based on current trends, the freight-related demands on I-44 are expected to continue to increase. The accommodation of freight traffic represents a valid transportation problem that any emerging I-44 project will need to address.

- Using the state-wide traffic model the total *percentage* of trucks contained within the 2035 traffic stream was predicted.

  - Truck volumes are expected to increase to over 9,000 trucks per day in the central part of the corridor to almost 18,000 trucks per day in the eastern portion of the corridor and over 20,000 trucks per day in the Joplin and Springfield areas.

- Using the state-wide traffic model the total *number* of trucks contained within the 2035 traffic stream was predicted.
  - Truck percentages are expected to range from 15 percent in the central part of the corridor to over 20 percent in the eastern portion of the corridor and almost 35 percent in the Joplin area.

e. Evolving Engineering Standards Result in Inconsistent Roadway Designs

One of the purposes for any future project associated with the I-44 corridor will be to eliminate those geometric deficiencies that impede the safe and efficient movement of people, goods, and services.

- Except at bridge locations, the roadway dimensions along I-44 are generally within the current design standards and meet driver expectations.
- Horizontal curves along I-44 inconsistent with typical design criteria are widespread. Most can be improved without realignment.
  - Horizontal curves on I-44 east of Strafford, west of U.S. 63 in Rolla and U.S. 50 have been identified as not meeting current standards to an extent that will require realignment.
- Steep grades negatively affect operations, especially truck operations.
  - Steep grades with critical grade lengths that cause trucks to loose more than 10 mph at a point less than half way up the grade, which do not currently have climbing lanes are located at near Marshfield (2), east of Route 133, west of Route 7, east of Doolittle, and west of St. James.
- The vast majority of the pavement along the I-44 corridor is Good or Very Good. The roadway segments that may require repair in the near future are distributed throughout the I-44 corridor.
- There are a few structures rated as in Very Poor condition. All of the Very Poor structures go over I-44 and therefore do not affect I-44 operations.
  - Very Poor rated structures over I-44 are located on Route H (2) and on Route A (2). It should be noted that the Route H bridges are programmed for replacement in fiscal year 2009.

f. Balancing Access, Economic Development, and Human/Natural Resources

This purpose and need element examines how balancing the access to important resources that I-44 provides with the economic development that these resources generate and the potential for detrimental impacts to these unique resources.

- Attention and coordination, consistent with the MoDOT *Engineering Policy Guide*, will appropriately balance the access that I-44 provides with the economic development and the unique values that **Historic Route 66** represents (entire I-44 corridor).

- The emerging commercial **river floating** industry in southern Missouri should be considered a “stakeholder” and impacts will affect a uniquely Missourian pastime along I-44 (east of Springfield to the St. Louis County line).
- Essential to the expanding tourist population visiting **Branson**, I-44 serves as a main artery for transportation of supplies to and from the city (Springfield/Greene County).
- Interstate 44 projects in the vicinity of the Houston-Rolla District will need to engage the **Mark Twain National Forest** as an important stakeholder (Rolla area).
- Future improvement I-44 should study and consider potential impacts to **Fort Leonard Wood** (entire I-44 corridor).

Section C: Logical Termini/Future Study Sections

Evaluating all of the potentially appropriate conceptual solutions to the problems outlined in the I-44 Purpose and Need Study will be the next key decision for the *Improve I-44* program. The technical data collected in this Purpose and Need Statement will form the basis to evaluate which conceptual alternatives are superior and worthy of continued consideration.

The decision to begin the comprehensive evaluation of I-44 with an investigation of its transportation problems was selected because of its flexibility. With the problems confronting I-44 well established, it is possible for decision-makers to chart an informed course through the Project Development Process. This course of action may be best implemented by focusing actions on portions of the corridor having similar characteristics, or it may be best implemented through a corridor-wide approach.

Focusing actions on portions of the corridor having common characteristics is similar to the approach being taken at I-70; with its Sections of Independent Utility. This approach allows for targeting high priority concerns on I-44. For instance, traffic congestion is more acute in Rolla than in Marshfield. This type of apportionment also acknowledges that it is appropriate to consider improvements within the individual context of the region and eliminates the concern that issues in an unrelated portion of the study will delay other study sections. Additionally, apportionment may allow for multiple technical teams to be mobilized to simultaneously work on the project, without significant inefficiencies.

On the other hand, the problems of I-44 may be better approached on a corridor-wide basis. Clearly, I-44 has a unique role in facilitating interstate commerce. The problems arising from high volumes of truck traffic are felt across the state. Addressing these issues may require uniform action. Currently, the *Improve I-70* program is examining truck-only facilities. As a result of this work it has become clear that comprehensive/ corridor-wide planning has its advantages. Approaching I-44 on a corridor-wide basis will also allow more efficient and economical coordination with resource agencies and project stakeholders.

Question: *Does the identification of Future Study Sections preclude corridor-wide options?*

Answer: *No*

The intent of the FSSs was to identify where problems, conditions, and needs were demonstrably similar. This principally provided a mechanism to categorize and prioritize the vast amount of data presented in this Purpose and Need Statement. While it might be logical to seek solutions along the FSS model, it does not preclude corridor-wide options.

Ultimately, the future of I-44 in Missouri will be based on leaders utilizing this technical background to appropriately guide Missouri toward a future based on our principles, policies and resources.

This Purpose and Need Statement is organized such that MoDOT is in the position to consider either approach when it moves forward with improving the I-44 corridor. The question of which approach is most appropriate to utilize will be the first question addressed in the next phase of the *Improve I-44* program.

The remaining portion of this section of the I-44 Purpose and Need Statement will discuss the regulatory framework for subdividing a long corridor like I-44, outline the factors used here to propose Future Study Sections (FSSs), present the FSSs themselves, present an assessment of the transportation problems organized by FSS and present a discussion of prioritization.

1. Regulatory Setting for Establishing Future Study Sections

a. Regulatory Setting—Major Projects

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) made several important changes to the requirements associated with Major Projects. One of these changes is that the Federal Highway Administration (FHWA) will expand its role in the management of Major Projects. For Major Projects, FHWA is not limiting its role to tracking progress and ensuring Title 23 compliance. Rather, FHWA is developing mechanisms to allow its staff to focus its skills, talents, and experiences to strengthen the state transportation agency's (STA) decision making. The scope of this FHWA role is still emerging.

The new threshold for Major Projects are those projects receiving federal financial assistance with an estimated cost of at least $500 million or as a result of special interest has been identified by the Secretary of the Department of Transportation as being "Major." Because of the length of I-44 through Missouri, the costs associated with addressing its transportation problems will almost certainly satisfy the new threshold for being a major project.

Relative to this purpose and need study, an exception to Major Project status may exist if the "NEPA-defined" project scope is comprised of distinct and operationally independent elements. The FHWA may determine that each separate, operationally independent and nonconcurrent phase of construction be defined as separate "projects" for the purpose of assigning Major Project status. Consequently, as a pre-NEPA study, the investigation of independent elements is an appropriate topic for consideration in the I-44 Purpose and Need Study.

b. Regulatory Setting—Logical Termini

Guidance for the development of these FSSs is provided in *The Development of Logical Project Termini* (FHWA, November 1993). FHWA regulations (23 CFR 771.111(f)) require that the action evaluated in each environmental impact statement or finding of no significant impact shall:

- Connect logical termini and be of sufficient length to address environmental matters on a broad scope
- Have independent utility or independent significance, and for example, be usable and be a reasonable expenditure even if no additional transportation improvements in the area are made
- Not restrict consideration of alternatives for other reasonably foreseeable transportation improvements

2. Factors Used in Identifying Future Study Sections

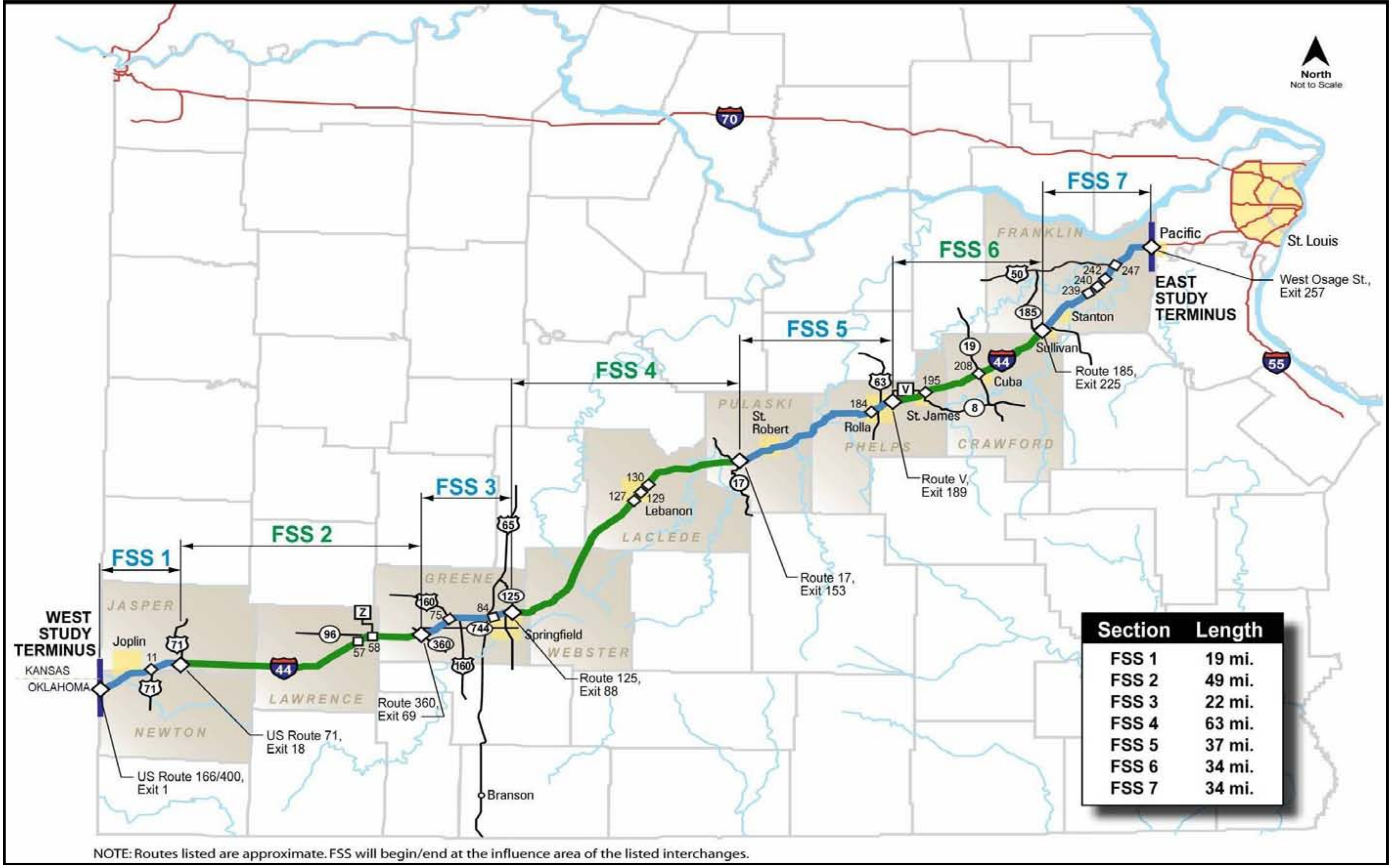
The extent of the transportation problems identified during the purpose and need study vary across the corridor. For instance, while some areas along I-44 are urbanized, there are also large portions of the corridor that are rural. This variability in conditions drives the desire to categorize I-44 into zones that experience similar demands, have similar conditions, and might logically be viewed as proposed FSSs. The factors used to establish the FSSs are defined in **Table C-1**.

Table C-1

Primary Factors Used in the Establishment of the Future Study Sections

Jurisdictional Similarities	Roadways under common administrative or jurisdictional control are generally subject to common planning strategies and are, therefore, logical to group together. Among the jurisdictions considered were metropolitan planning organizations (MPOs), various municipal jurisdictions such as counties, cities, and townships.
Traffic Volume Similarities	Roadways that handle similar volumes of vehicular traffic often have common problems whose solutions need to be considered collectively. Consequently, major breaks in traffic volumes were considered in the establishment of the FSSs.
Traffic Composition Similarities	Similarly, the types of vehicles that make up the traffic stream can influence problems and solutions. Common issues of this type include commuter traffic and truck traffic.
Traffic Destination Similarities	Incorporating the entire trip into a transportation solution is often key to adequately addressing it.
Landscape Similarities	On a statewide scale, there can often be important terrain differences to consider. Addressing these challenges in a comprehensive way can have benefits in the design, construction, and maintenance cycle as well as maximizing driver expectations regarding roadway design.
Crash Hotspot Similarities	Generally, there are three elements to safe roadway design: traffic, geometrics and crashes. The crash hotspots were utilized in determining the FSSs, as a means for determining the origin of vehicular safety issues.
Roadway Condition Similarities	Roadways are under continual maintenance. Grouping roadway sections in ways that acknowledge the existing condition of the roadway and the future maintenance projects can maximize the effectiveness of public expenditures. Operational similarities such as common speed limit and design features are also important.

Figure C-1
Proposed Future Study Sections—With Referenced Roads and Interchanges Shown



Section	Length
FSS 1	19 mi.
FSS 2	49 mi.
FSS 3	22 mi.
FSS 4	63 mi.
FSS 5	37 mi.
FSS 6	34 mi.
FSS 7	34 mi.

NOTE: Routes listed are approximate. FSS will begin/end at the influence area of the listed interchanges.

3. Potential Future Study Sections

Using the data collected during the I-44 Purpose and Need Study, in conjunction with the FHWA guidance on independent utility, logical termini, and Major Projects, it was possible to identify areas along I-44 where problems, conditions, and needs were demonstrably similar. These areas might logically be considered FSSs.

a. Western Terminus to East of Joplin (FSS 1)

The first proposed FSS begins at the purpose and need study's western termini, Exit 1, U.S. Route 166/400 near the Oklahoma and Missouri state line and extends approximately 19 miles eastward to Exit 18, U.S. Route 71 North.

This section of I-44 includes all of the Joplin area. It also includes a portion of U.S. Route 71, a major north-south route. Interstate 44 also carries the U.S. Route 71 designation between Exit 11 and Exit 18.

Currently, traffic volumes are constant throughout this FSS at approximately 31,000 average annual daily traffic (AADT). Volumes decrease by approximately 20 percent to the east of Exit 18. Directionally, traffic volume is distributed equally between eastbound and westbound. Overall, approximately 30 percent of the traffic stream is composed of trucks. For comparison, **Figure C-2** includes predicted 2035 traffic conditions.

Geometrically, this FSS has three typical diamond interchanges, two regular cloverleaf interchanges, one cloverleaf interchange with one directional ramp, and a modified "T" interchange that only allows limited access. The three cloverleaf interchanges are identifiable crash hotspots. Additionally, the severity of crashes, within the weave areas of the cloverleaf sections, is notable. The terrain is relatively flat and the alignment is straight. There are no significant alignment issues in need of attention.

This portion of I-44 will be strongly influenced by the future expansion of Joplin. The rapid planned and expected growth within Joplin's light industrial business community is a factor. Another issue is the MoDOT proposal to upgrade U.S. Route 71 to an interstate facility connecting Arkansas to Kansas City. The exact route of this facility is unknown, especially in the Joplin area. This improvement could warrant a system interchange.

Figure C-2

FSS 1 with Two-Way 2035 Traffic Characteristics

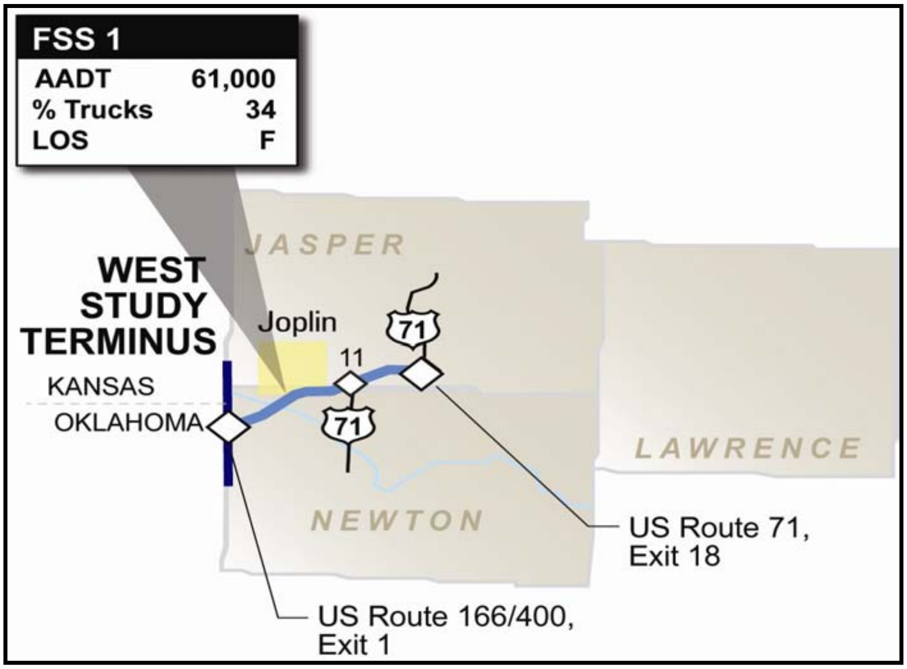
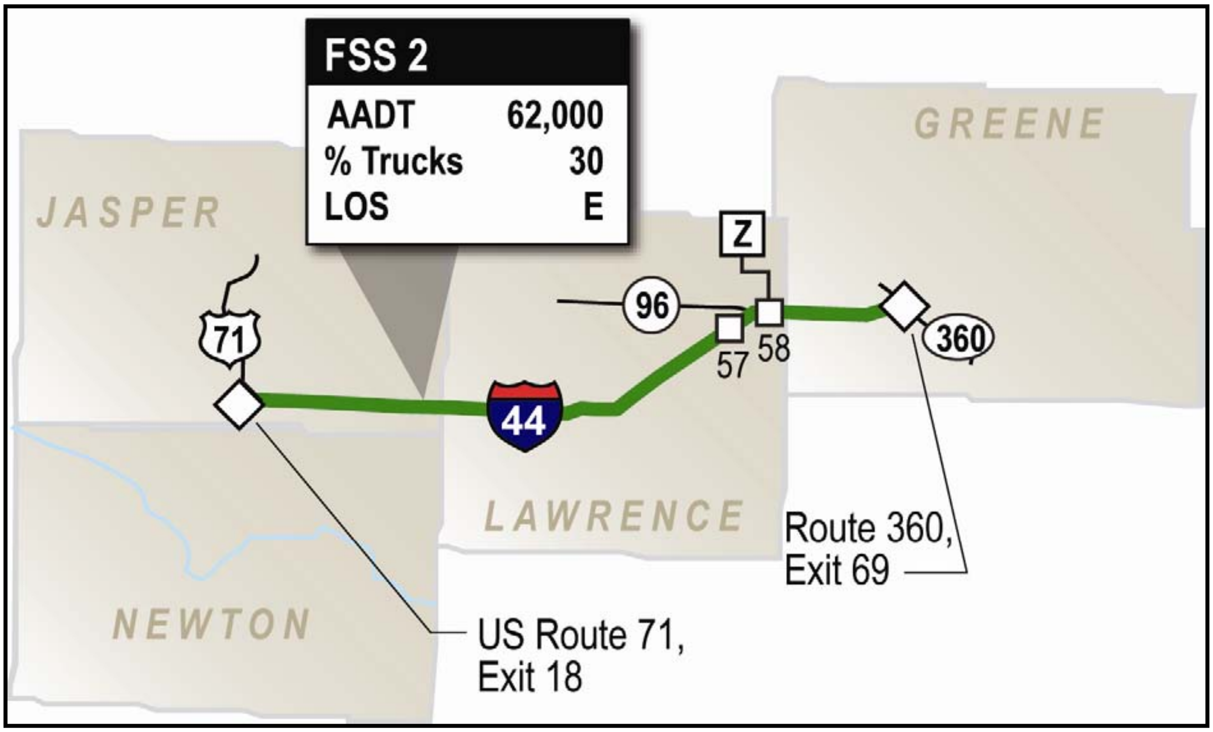


Table C-2	
Summary of Factors used in the Establishment of FSS 1	
Jurisdictional Similarities	Incorporates the Joplin Area Transportation Study Organization.
Traffic Volume Similarities	Consistently high volumes—AADT approximately 31,000 (2005).
Traffic Composition Similarities	30 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Major destinations include: Joplin area, north-south via U.S. Route 71 and east-west via I-44.
Landscape Similarities	Completely contained within the gentle topography of the Springfield Plateau.
Roadway Condition Similarities	Crash rates highly correlated to close spacing of interchanges and the resultant designs caused by spacing.

b. Between Joplin and Springfield (FSS 2)

The second proposed FSS begins at Exit 18, U.S. Route 71, and extends approximately 49 miles eastward to Exit 69, Route 360, also known as the James River Freeway. This portion of I-44 is the rural section between Joplin and Springfield. There are no major urbanized areas within this section.

Figure C-3
FSS 2 with Two-Way 2035 Traffic Characteristics



In this area, current traffic volumes vary between approximately 28,000 and 33,000. Overall, 52 percent of vehicles travel westbound. The largest fluctuation in volume along this portion of I-44 is at Exit 57, Route 96. East of Route 96, traffic volumes on I-44 are approximately 18 percent higher than west of Route 96. Currently, approximately 27 percent of the overall traffic stream is composed of trucks. For comparison, **Figure C-3** includes predicted 2035 traffic conditions.

Geometrically, this section is flat and has no major alignment issues. There are 10 typical diamond interchanges, all rural in nature. There is a nonstandard interchange, Exit 57, which services Route 96. This interchange only serves westbound I-44 traffic traveling westbound on Route 96 and eastbound Route 96 traffic traveling eastbound on I-44. Another nonstandard interchange exists at Exit 58, Route Z, near Halltown. This structure has some tight radius loop ramps with short acceleration and deceleration lanes.

There are numerous crash hotspots in this area. Most are associated with the two nonstandard interchanges. These conditions affect both eastbound and westbound traffic. Since these two interchanges are so close together, it is unclear whether a single factor creates the difficulties.

Another common element is that minimal development is expected to occur within this area.

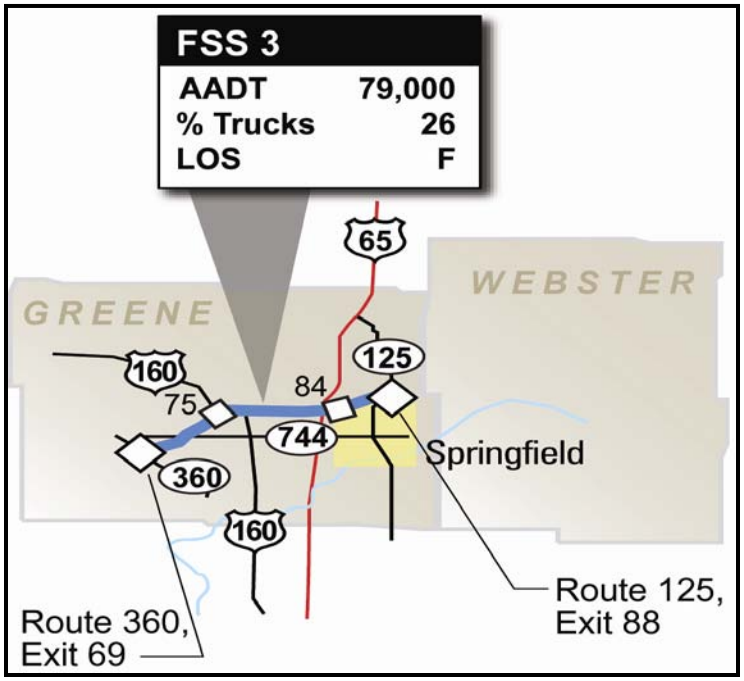
Table C-3	
Summary of Factors used in the Establishment of FSS 2	
Jurisdictional Similarities	Incorporates the numerous rural communities between Joplin and Springfield. Includes all of Lawrence County.
Traffic Volume Similarities	Average volumes - AADT approximately 28,000 (2005).
Traffic Composition Similarities	27 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Major destinations include: Joplin area and points west via I-44.
Landscape Similarities	Completely contained within the gentle topography of the Springfield Plateau.
Roadway Condition Similarities	Long stretches of rural highway punctuated with interchanges designed for very low volumes of users.

c. Springfield (FSS 3)

The third proposed FSS begins at Exit 69, Route 360, the James River Freeway, and extends approximately 22 miles eastward to Exit 88, Route 125, near Strafford. This portion of I-44 encompasses all of the city of Springfield.

Figure C-4

FSS 3 with Two-Way 2035 Traffic Characteristics



There is a reduction in speed through much of Springfield due to the mandated speed reduction (MoDOT design guidelines) for urban areas, as well as the close spacing of interchanges. While each end of this FSS is primarily rural, the transition to an urban configuration is clearly occurring. This section also includes a major north-south route, U.S. Route 65, which services the popular tourist destination of Branson, Missouri.

Currently, traffic volumes through this portion of I-44 vary greatly, with the highest volumes found in the city of Springfield. The western portion (from Exit 69, Route 360 to Exit 75, U.S. Route 160) has an AADT of approximately 31,000, with 53 percent of vehicles traveling westbound. From Exit 75, U.S. Route 160 to Exit 84, Route 744, the average AADT is approximately 55,700 with 53 percent of vehicles traveling eastbound. This is an increase in overall traffic volume on I-44 by 80 percent. Traffic volume from Exit 84, Route 744 to Exit 88, Route 125 has an average AADT of approximately 35,900 with an even number of vehicles traveling in each direction. Overall, approximately 24 percent of the traffic stream is composed of trucks. For comparison, **Figure C-4** includes predicted 2035 traffic conditions.

This portion of I-44 contains five regular diamond interchanges, one trumpet style “T” interchange, one irregular diamond interchange, two cloverleaf interchanges and one single entrance ramp, near the airport. The cloverleaf interchanges experience crash patterns commonly seen in urbanized areas. Some of these crash hotspots are considered severe. Currently, one cloverleaf interchange is complete and includes a directional ramp. The other cloverleaf interchange is under design to be converted to a diamond interchange. The average spacing between the Springfield interchanges is roughly two miles. While this is a somewhat tight spacing it is not accompanied by identifiably high crash rates.

The entire Springfield area is continuing to develop and expand. This proposed FSS is intended to encompass all of I-44 predominately influenced by Springfield.

Table C-4

Summary of Factors used in the Establishment of FSS 3

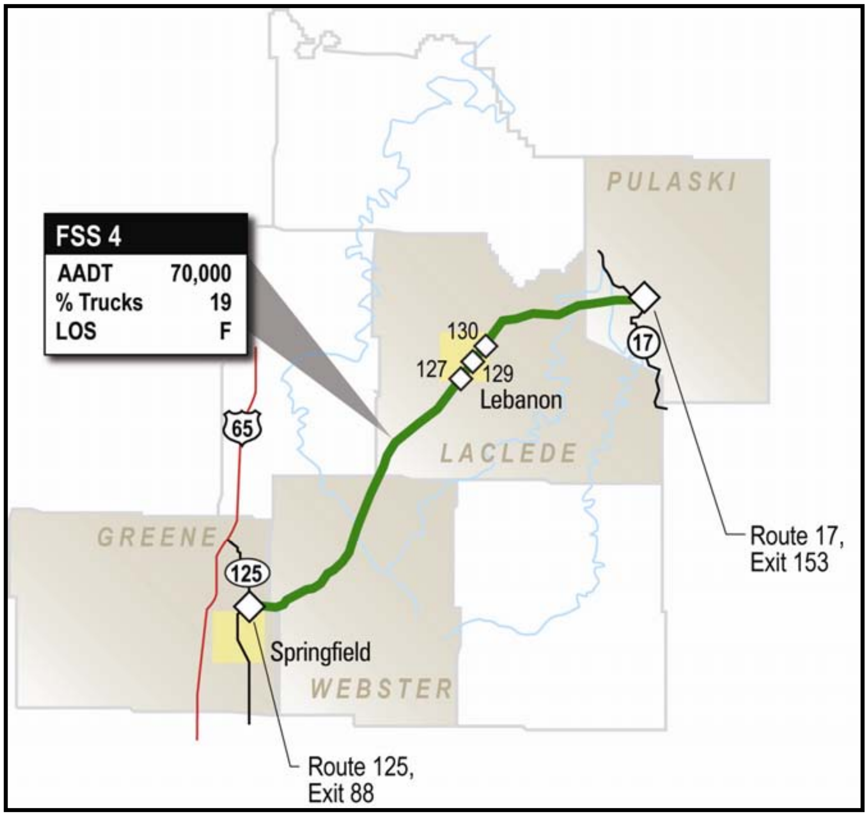
Jurisdictional Similarities	Incorporates the Springfield Area Transportation Study Organization. Includes much of Greene County.
Traffic Volume Similarities	Average volumes - AADT approximately 43,000 (2005).
Traffic Composition Similarities	24 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Major destinations include the Springfield area and Branson via Route 65.
Landscape Similarities	Completely contained within the gentle topography of the Springfield Plateau.
Roadway Condition Similarities	Evolving and urbanizing infrastructure.

d. Lebanon (FSS 4)

The fourth proposed FSS begins at Exit 88, Route 125, and extends approximately 63 miles eastward to Exit 153, Route 17. This portion of I-44 is primarily rural. The largest city along this portion of I-44 is Lebanon. There are three Lebanon Exits: 127, 129, and 130.

Figure C-5

FSS 4 with Two-Way 2035 Traffic Characteristics



Traffic volumes decline outside of Springfield. Currently, from Exit 88, Route 125, to Exit 127, West Elm Street, the AADT is 29,800, with an even distribution between eastbound and westbound travel. From Exit 127, West Elm Street, to Exit 130, Millcreek Road, the AADT is 37,700 with 52 percent of traffic volume traveling eastbound. From Exit 130, Millcreek Road, to Exit 153, Route 17, the AADT is 25,000, with an even distribution of eastbound and westbound travel. Overall, approximately 27 percent of the traffic stream is composed of trucks. For comparison, **Figure C-5** includes predicted 2035 traffic conditions.

This portion of I-44 contains 12 typical diamond interchanges. The topography is increasingly that of a rolling terrain. Vertical curvature becomes an issue throughout the entire section, and many grades are steep and long when compared to design guidelines. Horizontal alignment has many curves that do not meet current design recommendations, and they are often coupled with vertical alignment issues.

Crash rates increase in the vicinity of Lebanon. Severe crashes near the Lebanon interchanges are common. Additionally, growth is expected in the vicinity of Lebanon. For example, efforts are currently underway to increase industrial park development on properties near I-44. Nevertheless, the commonalities in traffic volumes, terrain and destinations support the inclusion of Lebanon into this proposed FSS.

Table C-5

Summary of Factors used in the Establishment of FSS 4

Jurisdictional Similarities	Incorporates the rural communities between Springfield and Waynesville/St. Robert. Contains all areas influenced by Lebanon.
Traffic Volume Similarities	Average volumes—AADT approximately 28,000 (2005).
Traffic Composition Similarities	27 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Typical rural traffic and destination pattern.
Landscape Similarities	Outside the Springfield Plateau the terrain, as typical of the Ozark Uplands, becomes noticeably hillier.
Roadway Condition Similarities	Long stretches of rural highway punctuated with interchanges designed for very low volumes of users.

e. Waynesville/St. Robert, Rolla, and Fort Leonard Wood (FSS 5)

The fifth proposed FSS begins at Exit 153, Route 17, and extends approximately 37 miles eastward to Exit 189, State Highway V. This portion of I-44 contains two urbanized areas interspersed with rural areas. The first urbanized area is Waynesville/St. Robert which is located near the western end of this portion of I-44. Near the eastern end of this proposed FSS, Rolla is the other urbanized area. In the vicinity of Rolla, U.S. Route 63 crosses I-44 and provides access to Jefferson City to the north.

Between these two areas, the corridor is rural in nature. Fort Leonard Wood is located within this FSS, near the Waynesville/St. Robert area.

Current traffic volumes are constant throughout the section from Exit 153, Route 17 to Exit 184, Kings Highway Street, at an AADT of approximately 30,000 with an even distribution of traffic volumes eastbound and westbound. For comparison, **Figure C-6** includes predicted 2035 traffic conditions.

In the Rolla area, from Exit 184, Kings Highway Street, to Exit 189, Route V, and current AADT is approximately 37,000, with 53 percent traveling eastbound. This is an approximate 29 percent increase in volume on I-44 in this section.

Overall, approximately 27 percent of the current traffic stream is composed of trucks.

There are 12 regular diamond interchanges in this FSS. This section has the most diverse topography in the study corridor. This area has a high concentration of vertical curves that do not meet design guidelines, and most of the horizontal alignment does not meet design guidelines. Often the horizontal and vertical geometry deficiencies are combined.

Throughout this section, I-44 experiences higher than average crash rates, both eastbound and westbound. Additionally, there are numerous localized crash hotspots.

Figure C-6

FSS 5 with Two-Way 2035 Traffic Characteristics

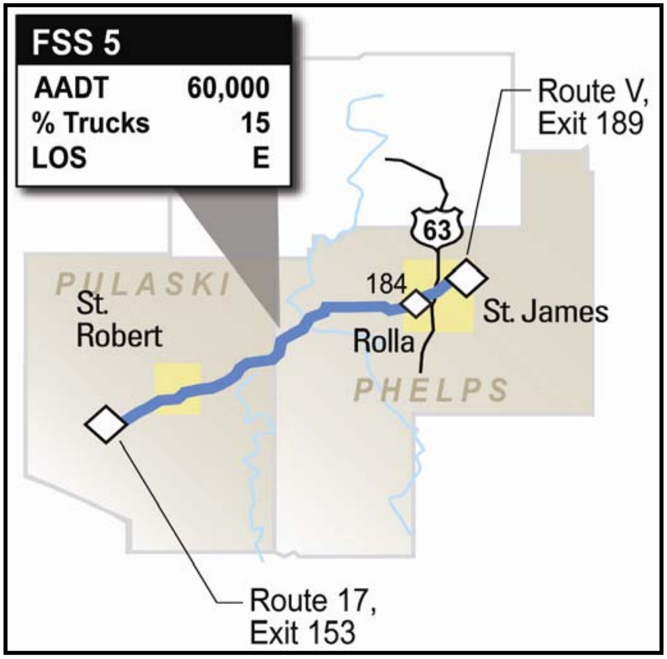


Table C-6	
Summary of Factors used in the Establishment of FSS 5	
Jurisdictional Similarities	Incorporates the inter-related communities of Waynesville/St. Robert, Fort Leonard Wood, and Rolla.
Traffic Volume Similarities	Average volumes—AADT approximately 30,000 (2005).
Traffic Composition Similarities	27 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	The inter-related communities of Waynesville/St. Robert, Fort Leonard Wood, and Rolla form a consolidated set of destinations.
Landscape Similarities	Typical rugged topography of the Ozark Uplands.
Roadway Condition Similarities	Alignment deficiencies and crash issues permeate the entire section.

f. Between Rolla and Sullivan (FSS 6)

The sixth proposed FSS begins at Exit 189, Route V and continues approximately 34 miles eastward to Exit 225, Route 185. This portion of I-44 is primarily rural in nature with two communities along I-44, St. James, located at Exit 195 (Route 8), and Cuba located at Exit 208 (Route 19).

Current traffic volumes are constant throughout this section, and the AADT is 32,000, with an even distribution of traffic volume eastbound and westbound. Overall, approximately 27 percent of the traffic stream is composed of trucks. For comparison, **Figure C-7** includes predicted 2035 traffic conditions.

This portion of I-44 has six diamond interchanges and some localized areas with vertical curvature and vertical grade deficiencies.

There are no corridor-wide crash issues associated with this section; however, there are several localized crash hotspots, and these locations often correlate with the areas of problematic vertical curvature.

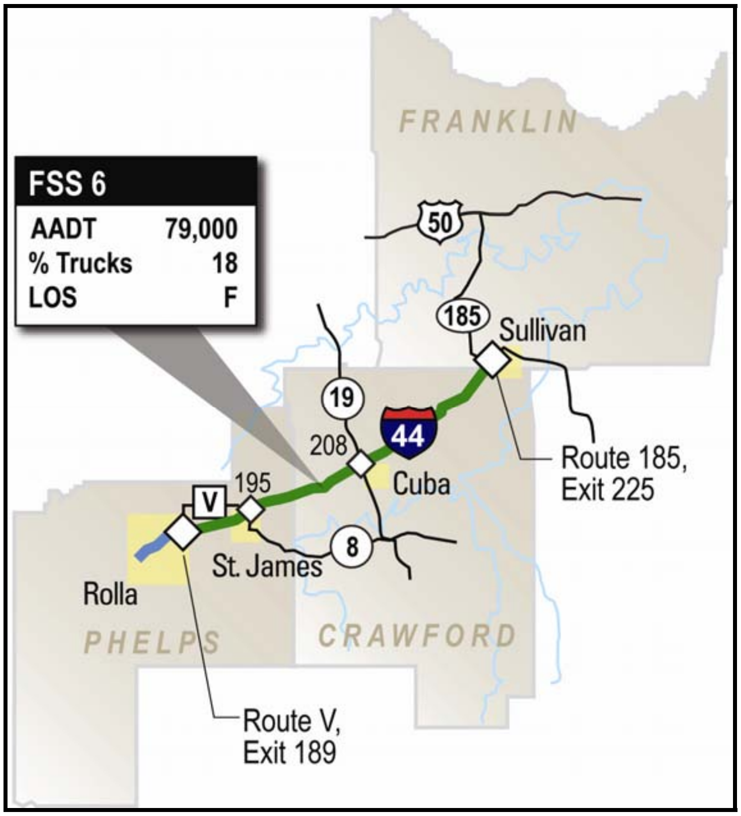
Table C-7

Summary of Factors used in the Establishment of FSS 6

Jurisdictional Similarities	Incorporates the rural communities outside the influence of St. Louis.
Traffic Volume Similarities	Average volumes - AADT approximately 32,000 (2005).
Traffic Composition Similarities	27 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Rural traffic and destination pattern, outside of the influence of St. Louis.
Landscape Similarities	Predominantly consists of the rolling plains topography of the Ozark Uplands.
Roadway Condition Similarities	Long stretches of rural highway punctuated with diamond interchanges.

Figure C-7

FSS 6 with Two-Way 2035 Traffic Characteristics

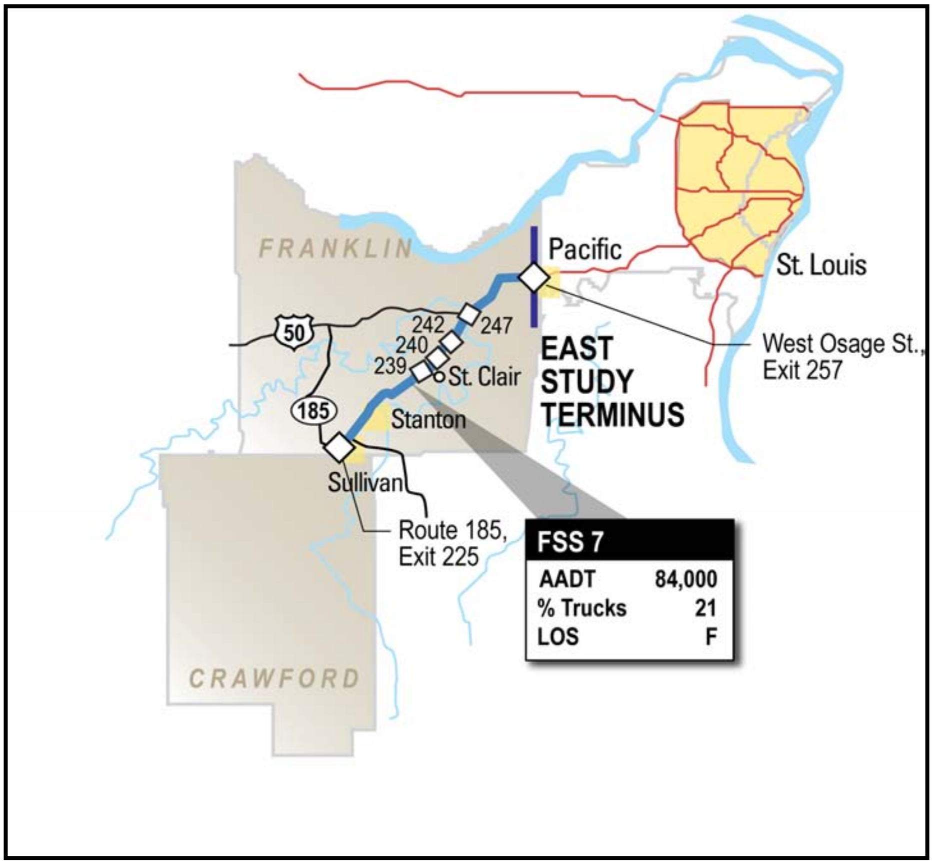


g. Sullivan to Eastern Terminus (FSS 7)

The seventh FSS begins at Exit 225, Route 185, and continues eastward approximately 34 miles to Exit 257, the Business Loop 44 (Historic Route 66) interchange in The City of Pacific. The east terminus is approximately 1.5 miles west of the Franklin County and St. Louis county line.

Figure C-8

FSS 7 with Two-Way 2035 Traffic Characteristics



This section is primarily rural, but is transitioning to suburban and urban uses particularly at the east end. The most notable communities along I-44 are Sullivan, which uses Exits 225 and 226, St. Clair, which uses Exits 239, 240,242, and Pacific, 1.5 miles east of the Franklin County and St. Louis County line. U.S. Route 50 connects with I-44 at Exit 247. U.S. Route 50 provides access to Jefferson City and Kansas City.

Traffic volumes vary along this portion of I-44. Current traffic volumes from the west end of this FSS to Exit 247 (U.S. Route 50) are approximately 32,900 AADT, with 52 percent of all vehicles traveling westbound. From Exit 247 to the eastern limit of this section, current traffic volumes increase approximately 38 percent to 45,500 with an even distribution of traffic volume eastbound and westbound. Overall, approximately 24 percent of the current traffic stream is composed of trucks. For comparison, **Figure C-8** includes predicted 2035 traffic conditions.

This proposed FSS is the only section of the I-44 corridor where LOS is consistently poor. This section generally functions at LOS D.

This section has nine regular diamond interchanges and one “T” interchange with a directional-Y configuration. This section has a few localized areas with vertical and horizontal alignment deficiencies.

Crash rates are an issue throughout this section; the result of rapid change as much as from the traffic volumes or geometric issues. Nevertheless, there are also hotspots associated with vertical or horizontal alignment geometric issues.

This section of I-44 is closely linked to the St. Louis Metropolitan Region and is likely to continue to grow and urbanize.

Table C-8

Summary of Factors used in the Establishment of FSS 7

Jurisdictional Similarities	Incorporates all of Franklin County and all of the I-44 study area within the East-West Gateway Coordinating Council (St Louis’ MPO).
Traffic Volume Similarities	Average volumes — AADT approximately 39,000 (2005).
Traffic Composition Similarities	24 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Major component of the St. Louis Metropolitan Region.
Landscape Similarities	The rapidly urbanizing nature of this area is its most prominent defining feature.
Roadway Condition Similarities	Alignment deficiencies and crashes permeate the entire section.

The logical eastern terminus for the I-44 Purpose and Need Study was established at Exit 257 for the following reasons:

- I-44 transitions from a 4-lane rural section to a 6-lane urban section creating a natural separation in the geometry of the roadway when traveling from the west to the St. Louis Metropolitan Region.
- Traffic volumes change markedly at this location. Traffic volumes in Franklin County, located within the area of the proposed east terminus, range from 34,000 to 52,000 AADT, while traffic volumes in St. Louis County, located outside of the east terminus, range from 60,000 to 122,000 AADT. In addition, this interchange is a notable traffic generator serving Historic Route 66 and surrounding development in the City of Pacific.
- This interchange is roughly at the boundary of Franklin and St. Louis Counties.

4. Transportation Problems in the Future Study Sections

The main focus of the I-44 Purpose and Need Study was to identify the transportation problems[1] associated with I-44 in Missouri. These are discussed throughout **Section B** of

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[1] These problems can be summarized as: 1) The **roadway capacity** of I-44 is becoming inadequate to accommodate the expected demand. 2) As I-44 has become increasingly urban, the number and severity of crashes has led to a degradation of

this document. Each of the transportation problems are evaluated in its own subsection. The data is summarized focusing on the important trends that define the transportation problems. Specific deficiencies are identified and are generally identified relative their location, usually on a mile marker or county-basis. The discussion here will focus on a distribution on a FSS-basis. Of course, only the most important deficiencies will be covered in this reformulation. Less critical, but still problematic, conditions are identifiable within the bulk of the data. The goal here is to present a succinct summary that might be useful to future project planners.

Table C-9 presents a tabular summary of the Important Transportation Trends Distributed by FSS. These will be discussed below:

a. Roadway Capacity Inadequate for Expected Demand

Summary: Based on a capacity analysis using existing traffic counts, current conditions are generally acceptable; although localized areas of congestion are known to exist. Using the state-wide traffic model to predict future volumes, conditions are expected to deteriorate measurably by the design year of 2035. Roughly 85 percent of the 257 miles of I-44 are expected to be incapable of meeting the LOS threshold levels established for this project. The roadway capacity analysis, distributed across the FSSs, can be summarized as:

- Inadequate *existing* roadway capacity (LOS E in rural areas or LOS F in urban areas) only exists in FSS 7.
- Inadequate *future* roadway capacity is predicted throughout the corridor. There are no FSSs that avoid exceeding the applicable thresholds. **Table C-9** presents the data on mileage basis. **Table B-5** presents this analysis on a section basis.
- With so much of the study area exceeding the applicable LOS thresholds, an analysis of when LOS F would be achieved was undertaken. By 2015, 21 roadway sections are predicted to be at LOS F. These are concentrated in FSS 7, but occur throughout the study area.

b. Degrading Safety Environment on I-44

Summary: In addition to the public perception that travel on I-44 is becoming increasingly dangerous, the crash evaluation conducted for this project has concluded that the crash environment has intensified in conjunction with increased traffic volumes. Additionally, the severity of the crashes along I-44 is notable. These results represent a valid transportation problem that any emerging I-44 project will need to address.

- The crash *rate* analysis concludes that Joplin-area interchanges (FSS 1) have fatal crash rates well above statewide averages. Similarly, the Rolla-area interchanges (FSS 5) have general crash rates several times higher than statewide averages.
- The crash *type* analysis concluded that while crashes involving trucks are less frequent (corridor-wide) on I-44 than comparable Interstates, such as I-70, the number of severe crashes on I-44 is comparable to that of I-70.

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the **safety** environment along I-44. 3) The **interchanges** along I-44 have safety, operation and geometric design deficiencies. 4) **Freight traffic** represents an essential element of the traffic stream on I-44. 5) Evolving design standards have resulted in inconsistent/inappropriate **roadway designs** along I-44. 6) Because of its location and function, I-44 requires a balancing of its access and economic development functions with the components of the **human/natural environment** to which it provides access.

- The crash hotspot analysis identified areas where three or more disabling injury crashes and/or fatal crashes occur within 0.3 mile of each other. Many of these hotspots occur in close proximity to one another. This led to the identification of the top 10 hotspot concentrations. Almost all of these hotspot concentrations occur in FSS 5 through FSS 7.

c. Interchanges have Safety & Operation Issues and are Inconsistent with Current Design Standards

Summary: Since the operation and condition of each of the 78 interchanges along the study area portion of I-44 is unique, the evaluation of transportation problems required treating each interchange individually. The analysis focused on the three factors: safety, traffic operations, and geometric design. Deficiencies are wide-spread but require additional (individual) analysis to determine remedies.

- Crash-related conditions at the I-44 interchanges were evaluated using total crash, fatal crash, and crash hotspot criteria. **Table C-9** presents the location of interchanges that exceed all of the crash-related criteria. Most of these occur in FSS 1.
- Operation-related conditions were based on the interchange ramps. In the design year (2035), most interchanges are expected to have at least one ramp operating at LOS F. Twenty-three interchanges are expected to be deficient in all of the traffic operation criteria. FSS 6 and FSS 7 have the most nonconforming interchanges.
- Geometric-related conditions were evaluated pursuant to their ability to meet seven basic geometric standards. Forty percent of the study area’s interchanges do not meet one current design standard. These are shown on **Table C-9**.

d. Freight Traffic Represents an Essential Element of the Traffic Stream on I-44

Summary: I-44’s location makes it a vital crossroad in the heart of Missouri’s and America’s economy. Based on current trends, the freight-related demands on I-44 are expected to continue to increase. The accommodation of freight traffic represents a valid transportation problem that any emerging I-44 project will need to address.

- Using the state-wide traffic model the total *percentage* of trucks contained within the 2035 traffic stream was predicted. **Table C-9** identifies the estimated truck percentages for the FSSs.
- Using the state-wide traffic model the total *number* of trucks contained within the 2035 traffic stream was predicted. **Table C-9** identifies the estimated truck numbers for the FSSs.

e. Evolving engineering standards result in a roadway that is inconsistent with current design standards.

Summary: One of the purposes for any project associated with the I-44 corridor will be to eliminate those geometric elements that impede the safe and efficient movement of people, goods, and services.

- Except at bridge locations, the roadway dimensions along I-44 are generally within the current design standards and meet driver expectations.
- Horizontal curves along I-44 that are inconsistent with typical design criteria are widespread. Most can be improved without realignment. Three areas have been

identified as having horizontal curvatures out of conformance with current standards to an extent that will require realignment (FSSs 4, 5 and 7).

- Steep grades negatively affect operations, especially truck operations. There are 10 steep grades along I-44 that currently do not have climbing lanes and have critical grade lengths that reduce the speed of low-performance trucks to 10 mph below the average running speed of the remaining traffic (FSSs 4, 5, 6, and 7).
- The vast majority of the pavement along the I-44 corridor is Good or Very Good. The roadway sections that may require repair in the near future are distributed in nearly all FSSs.
- There are few structures rated as in Very Poor condition. All of the very poor structures go over I-44 and therefore do not affect I-44 operations. They are all located in FSS 3 and 4.

f. Balancing Access, Economic Development, and Human/Natural Resources

Summary: This purpose and need element examines how balancing the access to important resources that I-44 provides with the economic development that these resources generate, and the potential for detrimental impacts to these unique resources combine to form an element of the I-44 Purpose and Need Study.

- Attention and coordination, consistent with the Engineering Policy Guide, will appropriately balance the access that I-44 provides with the economic development and the unique values that **Historic Route 66** represents (all FSSs).
- The emerging commercial **river floating** industry in southern Missouri should be considered a stakeholder and impacts will affect a uniquely Missourian pastime (FSS 4 through 7).
- Essential to the expanding tourist population visiting **Branson**, I-44 serves as a main artery for transportation of supplies to and from the city (FSS 3).
- Interstate 44 projects in the vicinity of the Houston-Rolla District will need to engage the **Mark Twain National Forest** as an important stakeholder (FSS 4 and 5).
- Future improvement I-44 should study and consider potential impacts to **Fort Leonard Wood** (all FSSs).

5. Prioritization of Future Study Sections

While the entire I-44 corridor may be addressed as one project, the potential for addressing the issues affecting I-44 may also be addressed by individual FSSs. The prioritization of the FSSs is provided below to assist MoDOT in planning for future improvements.

Table C-9 summarizes the six purpose and need elements as well as the key issues affecting each of the seven FSSs identified for the I-44 corridor. Of the purpose and need elements, roadway capacity, safety, interchanges, and freight increases are the most significant. Corridor wide, all seven FSSs will require significant capacity and operational enhancements to the mainline and a number of interchanges, as well as attention to the mix of passenger vehicles and the increasing numbers of trucks expected on the interstate.

The seven FSSs have been categorized into three priority categories ranging from high to low in order of importance. The categories and FSSs are discussed below.

a. High Priority Future Study Sections

Future Study Section 6 and FSS 7 are categorized as high priority sections indicating that issues affecting these FSSs suggest improvements be considered in the short term. Future Study Sections are described in order of importance within this category (most critical FSS is listed first).

Future Study Section 7

Future Study Section 7, stretching from exits 225 to 257, is the highest priority FSS within the I-44 corridor. As it is on the far western end of the St. Louis metropolitan area, this section is experiencing traffic volume growth and congestion associated with more urban sections of the interstate. Currently in this section I-44 is a 4-lane section with a grass median. Although outside of the study corridor, I-44 to the east of this section is a 6-lane section with a concrete barrier median reflecting the higher traffic volumes and urban nature of interstate use. As the influence of the St. Louis region continues to grow westward, I-44 is expected to continue to see significant growth in passenger traffic and truck traffic in this section. In addition to mainline capacity, a number of key interchanges in this section are currently experiencing safety and/or operational issues. The key elements for rating FSS 7 as the highest priority section are noted below.

Roadway Capacity

Currently the eastern portion of this section of I-44, between U.S. 50 and the St. Louis County line, does not meet level of service (LOS) thresholds. By 2010, 56 percent of FSS 7 is expected to exceed LOS thresholds. This number increases to 85 percent by 2015 and by 2020, 100 percent of the mainline along this section of I-44 is expected to exceed LOS thresholds.

Safety

Of the top 10 concentration of crash hotspots identified along I-44, 4 are found in FSS 7. A crash hotspot is identified as an area where three or more disabling injury crashes and/or fatal crashes occurred within 0.3 mile of each other. The locations, along with the most probable cause(s) for the crashes at these locations, are as follows:

- Eastbound I-44 east of Route JJ/W (Stanton) – eastbound traffic travels through a long, relatively sharp horizontal curve
- Eastbound I-44 at U.S. 50 – high volumes of traffic in conjunction with a relatively steep slope and the nontraditional configuration of the U.S. 50/I-44 interchange
- Eastbound I-44 between Route 100 West and Route 100 East – the high volumes and close proximity of the two interchanges along with local traffic using the interstate between the two interchanges
- Westbound I-44 between Route 100 West and Route 100 East – the high volumes and close proximity of the two interchanges along with local traffic using the interstate between the two interchanges

Interchanges
The U.S. 50 interchange (exit 247) currently exceeds all crash-related criteria. This can be attributed, in part, to high volumes of traffic in conjunction with a relatively steep slope on I-44 traveling through the interchange and the nontraditional configuration of the U.S. 50/I-44 interchange.

The Route 100 West (exit 251) and Route 100 East (exit 253) interchanges are expected to be deficient in all measured traffic operation criteria by 2035.

Increases in Freight
Truck traffic, both existing volumes and projected volumes, are of concern in this FSS. Truck traffic in this section is expected to increase from approximately 9,000 trucks per day in the current year to approximately 17,600 trucks per day in 2035. The safe and efficient movement of goods is essential to the American economy and future efforts on I-44 should consider the operational and safety issues related to truck traffic.

Future Study Section 6

Future Study Section 6, which covers approximately 34 miles through the eastern portion of the I-44 corridor, also falls into the high priority category. While FSS 6 traverses through mostly rural areas of Missouri, it does provide access to St. James, Cuba, and Sullivan.

Roadway Capacity
By 2015, 38 percent of this section is expected to exceed LOS thresholds. By 2025, the entire 34-mile length of I-44 in this section is expected to exceed LOS thresholds.

Safety
Of the top ten crash hotspot concentrations, two are found in FSS 6. The locations, along with the most probable cause(s) of the crashes at these locations, are as follows:

- Westbound I-44 west of St. James – a long, relatively steep downgrade as traffic travels westbound from the City of St. Robert
- Eastbound I-44 at Route H (exit 214) – a steep downgrade as traffic is entering the eastbound direction of I-44

Interchanges
The Route H interchange (exit 214) currently exceeds all crash-related criteria. This may be attributed to the steep down grade as traffic enters I-44 in the eastbound direction.

Increases in Freight
Truck traffic, both existing volumes and projected volumes, are of concern in this FSS. Truck traffic in this section is expected to increase from approximately 8,000 trucks per day in the current year to approximately 14,000 trucks per day in 2035. The safe and efficient movement of goods is essential to the American economy and future efforts on I-44 should consider the operational and safety issues of truck traffic.

b. Medium Priority Future Study Sections

Future Study Section 1, FSS 3, and FSS 5 are categorized as medium priority FSSs indicating that issues affecting these FSSs suggest improvements be considered in the relative short term but are not as urgent as those required for the high priority FSSs. Future

Study Sections in this category are described in order of importance (most critical FSS is listed first).

Future Study Section 3

Future Study Section 3 covers approximately 22 miles centered on the City of Springfield. FSS 3 travels mostly through a rural setting. As the Springfield area continues to grow, and travel destinations such as Branson continue to draw more visitors, this section of I-44 will continue to display increased congestion and reduced levels of operations.

Roadway Capacity
By 2010, 41 percent of this section is expected to exceed LOS thresholds. By 2035, 77 percent of the mainline along this section of I-44 is expected to exceed LOS thresholds.

Safety
Of the top ten crash hotspot concentrations identified along I-44, one of these locations is found in this FSS. This location is in the eastbound direction of I-44 at the West Chestnut Expressway (Route 266) interchange. The high frequency of crashes at this location is most likely attributable to the interchange configuration (partial loop interchange) and the skewed angle of the interchange.

Interchanges
The Route 13 (exit 77) and U.S. 65 (exit 82) interchanges are expected to be deficient in all measured traffic operation criteria by 2035. Recently, MoDOT completed a partial fly-over ramp for northbound U.S. 65 to westbound I-44 at the U.S. 65 interchange. This directional ramp will considerably improve the operations and safety of this movement.

Increases in Freight
Truck traffic, both existing volumes and projected volumes, are of concern in this FSS. Truck traffic in this section is expected to increase from approximately 10,000 trucks per day in the current year to approximately 20,000 trucks per day in 2035. The safe and efficient movement of goods is essential to the American economy and future efforts on I-44 should consider the operational and safety issues of truck traffic.

Future Study Section 5

Future Study Section 5 covers the east-central portion of the I-44 corridor. This section includes St. Robert and Rolla. Much of this FSS is rural in nature while the portions around St. Robert and Rolla are becoming more urbanized. St. Robert is the gateway to Fort Leonard Wood while Rolla is home to the Missouri University of Science and Technology, formerly University of Missouri-Rolla. The main issues affecting this section are related to safety.

Roadway Capacity
By 2030, 27 percent of this section is expected to exceed LOS thresholds. This percentage increases to 84 percent by 2035.

Safety
The Rolla area interchanges have crash rates several times the statewide averages.

Of the top 10 crash hotspot concentrations identified along I-44, 3 of these locations are found within this FSS. A crash hotspot is identified as an area where 3 or more disabling injury crashes and/or fatal crashes occurred within 0.3 mile of each other. The locations, along with the most probable cause(s) of the crashes at these locations, are as follows:

- Westbound I-44 through Waynesville – urban nature of the corridor, steep downgrade followed by a steep upgrade in conjunction with relatively sharp horizontal curves
- Westbound I-44 near Route D (exit 172) – relatively steep grade along I-44
- Eastbound I-44 near Route D (exit 172) – relatively steep grade along I-44

Interchanges
Interchanges at Route Y (exit 161) and Route D (exit 172) exceed all crash-related criteria. Probable causes of the high crash incidences include the use of I-44 for local trips along with high volumes of traffic using the Route Y interchange in St. Robert and the relatively steep grade through the interchange at Route D.

Increases in Freight
Truck traffic, both existing volumes and projected volumes, is not a major concern in this FSS. Truck traffic in this section is expected to increase from approximately 7,500 trucks per day in the current year to 9,000 by 2035. The relatively low increase in truck traffic through this section may be attributable to the shifting distribution routes for locations such as Lebanon and places west towards Springfield. This shift in routes may occur when the overall area growth and costs of transport result in suppliers adding closer distribution depots. The remaining truck volumes through FSS 5 represents through trucking.

Future Study Section 1

Future Study Section 1 covers the far western portion of the I-44 corridor and includes the City of Joplin. Approximately half of FSS 1 is rural in nature while the remainder is becoming more urbanized. Safety on the mainline and at interchanges along with interchange operations are the most pressing issues in this FSS.

Roadway Capacity
By 2020, 26 percent of this section is expected to exceed LOS thresholds. This percentage increases to 37 percent by 2025 and by 2035, 60 percent of the mainline along this section of I-44 is expected to exceed LOS thresholds.

Safety
The Joplin area interchanges have fatal crash rates well above the statewide averages. None of the top ten crash hotspot concentrations identified along I-44 are located in this section.

Interchanges
Interchanges at Route 86 (exit 6), Business Route 71 (exit 8), Route 71 South/249 North (exit 11), and Route 71 North/59 South (exit 18) all exceed crash-related criteria. Probable causes of the high crash incidences include interchange skew angle (Route 86), weaving at clover leaf interchange configurations (Business Route 71 and Route 71 South/249 North), and non-traditional interchange configuration (Route 71 North/59 South).

Increases in Freight
Truck traffic, both existing volumes and projected volumes, are of concern in this FSS. Truck traffic in this section is expected to increase from approximately 8,000 trucks per day in the current year to approximately 21,000 trucks per day by 2035. The safe and efficient

movement of goods is essential to the American economy and future efforts on I-44 should consider the operational and safety issues of truck traffic.

c. Low Priority FSSs

Future Study Section 2 and 4 are categorized as low priority FSSs indicating that the issues affecting these FSSs suggest improvements may not be as critical in the short term. Both of these Sections are very long, 49 and 63 miles respectively, and rural in nature. FSSs in this category are described in order of importance (most critical FSS is listed first).

Future Study Section 2

Future Study Section 2 covers the portion of I-44 between Joplin and Springfield. The entire length of this FSS is rural in nature. Lack of future capacity is the primary issue affecting this section.

Roadway Capacity
By 2025, 39 percent of this section is expected to exceed LOS thresholds. This percentage increases to 86 percent by the year 2035.

Safety
There are no significant safety issues identified within this section. None of the top 10 crash hotspot concentrations identified along I-44 are located in this section.

Interchanges
All of the interchanges in this section do not exceed crash-related criteria and are expected to operate at acceptable Levels of Service into the year 2035.

Increases in Freight
Truck traffic, both existing volumes and projected volumes, are of concern in this FSS. Truck traffic in this section is expected to increase from approximately 8,000 trucks per day in the current year to 19,000 by 2035. The safe and efficient movement of goods is essential to the American economy and future efforts on I-44 should consider the operational and safety issues of truck traffic.

Future Study Section 4

Future Study Section 4 covers the portion of I-44 between Springfield and St. Robert. The City of Lebanon is located in the middle of this FSS. The entire length of this 63-mile section is rural in nature. Lack of future capacity is the primary issue affecting this section.

Roadway Capacity
By 2020, 30 percent of this section is expected to exceed LOS thresholds. This percentage increases to 78 percent by the year 2025 and to 88 percent by 2035.

Safety
There are no significant safety issues identified within this section. None of the top 10 crash hotspot concentrations identified along I-44 are located in this section.

Interchanges
All of the interchanges in this section do not exceed crash-related criteria and are expected to operate at acceptable Levels of Service into the year 2035.

Increases in Freight

Truck traffic, both existing volumes and projected volumes, are of moderate concern in this FSS. Truck traffic in this section is expected to increase from approximately 8,000 trucks per day in the current year to 13,000 by 2035. The safe and efficient movement of goods is essential to the American economy and future efforts on I-44 should consider the operational and safety issues of truck traffic.

Table C-9

Important Transportation Trends Distributed by Future Study Sections

	FSS 1	**FSS 2**	**FSS 3**	**FSS 4**	**FSS 5**	**FSS 6**	**FSS 7**
1. Roadway Capacity Becoming Inadequate for Expected Demand							
Inadequate Existing Roadway Capacity *- Roadway Segments that Based on 2005 Volumes Do Not Meet LOS Threshold (LOS E-Rural/LOS F-Urban)*	-	-	-	-	-	-	Route 50 to Rte 100 (W) Rte 100 (W) to Rte 100 (E) Rte 100 East to Loop 44 Loop I-44 to St. Louis County
Inadequate Future Roadway Capacity *- Percent of Roadway Miles that in 2035 are Not Expected to Meet LOS Threshold (LOS E-Rural/LOS F-Urban)*	60 percent (11 of 19 Miles)	86 percent (42 of 49 Miles)	81 percent (18 of 22 Miles)	88 percent (55 of 63 Miles)	84 percent (31 of 37 Miles)	100 percent (34 of 34 Miles)	100 percent (34 of 34 Miles)
Timing to LOS F *- Roadway Sections that are Expected to be at LOS F by 2015*	Exit 6 to Exit 8	Exit 58 to Exit 61 Exit 57 to Exit 58	Exit 77 to Exit 80 Exit 80 to Exit 82 Exit 84 to Exit 88	Exit 96 to Exit 100 Rest Area to Exit 113	-	Exit 189 to Exit 195 Exit 195 to Exit 203 Exit 218 to Exit 225	Exit 225 to Exit 226 Exit 226 to Exit 230 Exit 230 to Exit 235 Exit 235 to Exit 238 Exit 238 to Exit 239 Exit 242 to Exit 247 Exit 247 to Exit 251 Exit 251 to Exit 253 Exit 253 to Exit 257 Exit 257 to Termini
2. Degrading Safety Environment on I-44							
Urban Crash Rate Analysis *- Summary of Key Results*	The Joplin-area interchanges have fatal crash rates well above statewide averages	-	-	-	The Rolla-area interchanges have crash rates several times the statewide averages	-	-
Rural Crash Rate Analysis *- Summary of Key Results*	The total crash rates in urbanizing counties are noticeably higher than traditionally rural counties	-	-	-	The total crash rates in urbanizing counties are noticeably higher than traditionally rural counties	The total crash rates in urbanizing counties are noticeably higher than traditionally rural counties	The total crash rates in urbanizing counties are noticeably higher than traditionally rural counties
Crash Type Analysis *- Summary of Key Results*	Fatal crash references punctuate the analysis. Head-on and pedestrian crashes are notable. They tend to validate the public's perception that I-44 can be a dangerous place. While total crashes involving trucks are less frequent on I-44 than comparable interstates, such as I-70, the number of severe crashes on I-44 is comparable to that of I-70. These trends should be carefully considered by project planners in the future.						
Crash Hotspot Analysis *- Top Ten Crash Hotspot Concentrations*	-	-	Eastbound 72.3 to 72.5	-	Westbound 155.0 to 160.0 Westbound 171.9 to 173.1 Eastbound 172.5 to 173.1	Eastbound 214.5 to 214.9 Westbound 193.7 to 194.0	Eastbound - 251.6 to 254.8 Westbound 251.0 to 253.0 Eastbound 246.5 to 247.8 Eastbound 231.8 to 232.2
3. Interchanges along I-44 have Safety and Operation Issues and are Inconsistent with Current Design Standards							
Interchange Safety *- Interchanges that Exceed All Established Crash-Related Criteria*	Exit 6—Route 86 Exit 8—Business Route 71 Exit 11—71 (S)/249 (N) Exit 18—71 (N)/59 (S)	-	-	-	Exit 161—Route Y Exit 172—Route D	Exit 214—Route H	Exit 247—US 50
Interchange Operation *- Interchanges with Ramps that Experience LOS F Operation (2005)*	Exit 18 -- US 71 North	-	Exit 77 -- Route 13 Exit 82 -- US 65	-	-	-	Exit 251 -- Route 100 West Exit 253 -- Route 100 East
Interchange Operation *- Number of Interchanges Expected to be Deficient in All Traffic Operation Criteria (2035)*	1 of 9 Interchanges	3 of 14 Interchanges	4 of 9 Interchanges	3 of 15 Interchanges	1 of 13 Interchanges	6 of 7 Interchanges	5 of 11 interchanges

Table C-9

Interchange Geometrics *- Interchanges that do not meet four Current Design Standards*	Exit 4--Route 43	-	-	-	-	-	Exit 230--Route JJ/W
4. Increases in Freight are Altering Operations on I-44							
Movement of Goods Essential to American Economy *- 2035 Percent of Truck Traffic*	34 percent	30 percent	26 percent	19 percent	15 percent	18 percent	21 percent
Trucks Exacerbate Congestion *- 2035 Total Truck Traffic*	20,700	18,600	20,500	13,300	9,000	14,200	17,600
5. Evolving Engineering Standards Result in Roadway that is Inconsistent with Current Design Standards							
Horizontal and Vertical Curvature *- Curves Expected to Require Realignment*	-	-	-	MM 92.3 – 92.9	MM 186.2 – 186.4	-	MM 246.9 – 247.4
Vertical Grades *- Steep with Critical Grade Lengths*	-	-	-	EB, MM 149.3 - 149.7 WB, MM 101.5 - 101.8 WB, MM 105.7 - 106.2 WB, MM 144.4 - 145.4	EB, MM 184.7 - 186.7	EB, MM 194.0 - 194.2	-
Existing Climbing Lanes *- With Nonconforming Elements*	-	-	-	WB, MM 105.3 - 106.1 WB, MM 107.3 - 108.3	WB, MM 171.8 - 172.3	-	-
Median Widths *- With Barriers/Narrow Shoulders*	-	-	-	-	MM 159.2 - 160.3 MM 185.8 - 187.0	-	MM 244.3 - 247.0 MM 255.6 - 265.3
Pavement Condition *- Near Future Repair Likely*	-	EB, MM 26.46 - 32.94 WB, MM 28.51 - 32.83 WB, MM 47.85 - 60.06	-	EB, MM 89.50 - 95.54 EB, MM 115.60 - 126.68	EB, MM 184.23 - 184.85 WB, MM 163.01 - 173.33	EB, MM 212.74 - 215.46 WB, MM 200.70 - 213.82	EB, MM 223.99 - 238.63
Structure Condition *- Very Poor*	-	-	SB, Route H over I-44* NB, Route H over I-44* ** Programmed for replacement in FY09*	SB, Route A over I-44 NB, Route A over I-44	-	-	-
6. Balancing Access, Economic Development, and Human/Natural Resources							
Historic Route 66 *- Overpassing or Adjacent Sections (Yes/No)*	Yes	Yes	Yes	Yes	Yes	Yes	Yes
River Floating *- High Quality Streams in Section (Yes/No)*	Yes	Yes	-	Yes	Yes	Yes	Yes
Branson *- in FSS (Yes/No)*	-	-	Yes	-	-	-	-
Missouri's Commercial Caves *- in FSS (Yes/No)*	-	-	Yes	-	-	-	Yes
Mark Twain National Forest *- in FSS (Yes/No)*	-	-	-	Yes	Yes	-	-
Missouri Wineries *- in FSS (Yes/No)*	-	-	-	-	-	Yes	-
Fort Leonard Wood *- in FSS (Yes/No)*	-	-	-	-	Yes	-	-

EB= Eastbound; WB= Westbound; SB= Southbound; NB= Northbound; MM= Mile Marker

APPENDIX A
Technical Memos

To document and guide the development of the I-44 Purpose and Need Study, a series of technical memos were produced. The detailed explanations associated with the data collection/analysis that underlies the I-44 Purpose and Need Study is contained here. Any analysis not contained here is available in the projects technical file. The technical memos contained in this appendix include:

- Logical Termini TM (A-1)—This memo identified the logical eastern and western termini for the I-44 Purpose and Need Study. This essentially established the study area for the project.
- Corridor Evaluation Methodology TM (A-2)—This memo discussed the “macroscopic” elements associated with the project’s design guidelines and performance thresholds. Only after the fundamental method’s and assumptions were set could the existing and future performance of the corridor be determined.
- Crash Analysis TM (A-3)—The methodology and results of the analysis of I-44’s crash environment were summarized into a single technical memo. Crash rates were calculated for various roadway segments throughout the corridor. For this study, the latest five years of available crash data was used. The segments analyzed have been no less than 0.5 mile and no more than 3.0 miles in length. The crash rates for the study corridor were then compared to relevant statewide average crash rates. A crash hotspot analysis was also conducted.
- Freeway Traffic Analysis, Methods, Assumptions and Results TM (A-4)—The methodology and results used in the freeway traffic operations analysis were summarized here. In general, the chief assumptions were how the passenger car equivalent flow rates and the average car speeds were calculated. Level of service (LOS) was the primary results output.
- Environmental Justice TM (A-5)—As a precursor to project-related NEPA work, an investigation of populations, along I-44, that might qualify for consideration under Environmental Justice provisions was conducted.
- Cultural Resources TM (A-6)—A screening level review of resources potentially eligible for the National Register of Historic Places (NRHP) was conducted.
- Natural Resources TM (A-7)—As a precursor to project-related NEPA work, an investigation of wetlands, endangered species and other relevant natural resources was conducted.
- Interchange Evaluation Analysis TM (A-8)—The methodology and results used in the interchange traffic operations analysis are summarized here.
- Bridge Evaluation Assumptions TM (A-9)—The methodology used in the evaluation of the condition of the bridges, box culverts, and overpasses are summarized here.
- Geometric Analysis Methods and Assumptions TM (A-10)—The results of the roadway geometric analysis evaluation are presented here.

- Modal Services Deficiency TM (A-11)—This technical memo investigated the extent to which improved mass transit might reduce the number of vehicles on I-44.
- Springfield Intersection Delay TM (A-12)—Traffic, at several interchanges in Springfield, backs up onto I-44. This technical memo investigated the conditions at those interchanges.
- Climbing Lane Review TM (A-13)—Portion of I-44 are hilly and several existing truck climbing lanes currently exist. This technical memo investigated conditions, relative to truck traffic operation, for all portions of I-44 with a grade in excess of four percent.
- Future Study Sections TM (A-14)—As a precursor to the establishment of Sections of Independent Utility, this technical memo investigated logical/independent components within the portion of I-44 under consideration.
- Traffic Modeling Summary (A-15)—This technical memo investigated the methodological details associated with modifying the Missouri State-wide Traffic Model for use in the I-44 Purpose and Need Study.
- Public Involvement and Agency Coordination Summary (A-16) Presents summary of the public involvement and agency coordination activities conducted during the I-44 Purpose and Need Study.

Interstate 44 (I-44) Purpose and Need Study: Logical Termini (A-1)

PREPARED FOR: MoDOT
PREPARED BY: CH2M HILL
ORIGINAL SUBMISSION DATE: December 24, 2007
REVISION SUBMISSION DATE: February 29, 2008

Introduction

This memorandum identifies the logical west and east termini for the I-44 Purpose and Need Study and discusses why the termini are logical endpoints.

Identifying the study's west and east termini is related to, but not the same as, identifying the logical termini for the proposed future study sections (FSSs). By establishing the west and east study limits, this memorandum, in effect, identifies the west terminus for the project's first FSS and the east terminus for the last FSS. With that said, this memorandum does not reproduce the full justification that will be necessary to divide the study area into FSSs.

As noted in *The Development of Logical Project Termini* (FHWA, November 1993), FHWA regulations (23 CFR 771.111(f)) require that the action evaluated in each environmental impact statement or finding of no significant impact shall:

- Connect logical termini and be of sufficient length to address environmental matters on a broad scope
- Have independent utility or independent significance, i.e., be usable and be a reasonable expenditure even if no additional transportation improvements in the area are made
- Not restrict consideration of alternatives for other reasonably foreseeable transportation improvements

Because the purpose of this memorandum is simply to establish study area termini rather than the termini for a National Environmental Policy Act action (transportation project), this memorandum only outlines why its west and east termini are rational study endpoints. The fuller discussion of how the project's FSSs meet FHWA's above-mentioned criteria is outlined in a separate technical memorandum.

Study Area Background

The I-44 Purpose and Need Study extends through the southern half of Missouri and includes the larger communities, from west to east, of Joplin, Springfield, Lebanon, St. Robert, Rolla, St. James, Sullivan, and Pacific. I-44 is the primary east-west route connecting the St. Louis Metropolitan Area with recreational areas and communities such as Springfield and Joplin in southwest Missouri. It also provides a link between St. Louis and Branson, the largest tourist attraction in the state.

The primary north-south facilities in the corridor are U.S. 71 (from Joplin north to the Kansas City Metropolitan Region, and south to Bentonville, AK), U.S. 65 (from Springfield to Branson), Route 5 (from Lebanon to the Lake of the Ozarks region), and U.S. 63 (running from Rolla through Vienna to Jefferson City).

Study Area Termini

The study's proposed western terminus is the I-44/U.S. Highway 166/400 interchange located 5 miles west of Joplin. This interchange is located approximately 1/2 mile from the Missouri/Oklahoma border. This interchange (exit 1) is the proposed western terminus because:

- The influence area of the interchange extends to the Oklahoma and Kansas State lines.
- I-44 transitions from a rural 4-lane typical section with grassy median in Missouri to a 4-lane typical section with a narrow, concrete median on the Will Rogers' Turnpike in Oklahoma.
- This interchange represents the transition between the un-tolled portion of I-44 and the tolled portion of the Will Rogers' Turnpike.

The study's proposed eastern terminus is the I-44/Business Loop 44 (Historic Route 66) interchange in the City of Pacific, 1 1/2 miles east of the Franklin County-St. Louis County line. This interchange (Exit 257) is the proposed eastern terminus because:

- I-44 transitions from a 4-lane rural section to a 6-lane urban section[1] creating a natural separation in the geometry of the roadway when traveling from the west to the St. Louis Metropolitan Region.
- Traffic volumes change markedly at this location. Traffic volumes in Franklin County (located within the area of the proposed east terminus) range from 34,000 to 52,000 average daily traffic (ADT) while traffic volumes in St. Louis County (located outside of the east terminus) range from 60,000 to 122,000 ADT. In addition, this interchange is a notable traffic generator serving Historic Route 66 and surrounding development in the City of Pacific.
- This interchange is roughly at the boundary of Franklin and St. Louis Counties.

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[1] Although Legacy 2035, the East-West Gateway's Long-Range Plan, recommends widening I-44 from Pacific to the Route 100 interchange, the next interchange to the west, there are no current plans for or funding allocated to the project.

Interstate 44 (I-44) Purpose and Need Study: Corridor Evaluation Methodology (A-2)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	April 2, 2007
REVISION SUBMISSION DATE:	January 29, 2008

Introduction

The purpose of this memo is to discuss the design guidelines and performance thresholds for evaluation of the existing I-44 corridor. This discussion is intentionally broad and "macroscopic" for the purpose of gaining consensus on major elements before developing the more "microscopic" elements. The major topics discussed in this memo include safety, design speed, and level of service (LOS) thresholds. While this study will not be developing future solutions for I-44, the study team will utilize the principles of Practical Design in evaluating the condition of the existing system. This will require the establishment of fundamental methods and assumptions to guide the measurement of the existing corridor's performance. As such, key principles related to the elements to be analyzed must be established.

Design Standards

The physical attributes of the roadway will be analyzed and evaluated based on the acceptable guidelines included in MoDOT's *Engineering Policy Guide* and those published in American Association of State Highway and Transportation Official's (AASHTO) *A Policy on Geometric Design of Highways and Streets*. The documentation and evaluation of the physical attributes will be used to identify areas that may need correction or modification if they can be shown to correlate with operational or safety concerns identified in the corridor.

Safety (as Measured by Performance)

Safety is an essential element for success on any project, and one of MoDOT's Practical Design ground rules is **"Safety will not be compromised. Every project we do will make the facility safer after its completion."** Relative to the purpose and need study, this means that the existing corridor will be thoroughly examined to determine the areas that contain documented safety concerns. Areas that contain design elements that do not meet specific standards are not considered safety concerns unless there is also a documented history of problems to support that decision. Therefore, the study will define safety concerns as only those that are based on actual performance. For example, if a road has a horizontal curve with a radius of 500 feet and the standard calls for a minimum of 600 feet, then the curve would not be considered unsafe unless it has a documented crash or operational problem.

Consequently, traditional crash rate analyses will be performed across the corridor for the most current five years of data available. A variety of segments will be evaluated to ensure that the safety performance of the existing corridor is understood. Interchange areas, segments between interchanges, and other shorter segments will be analyzed to understand crash trends. Safety performance will also be evaluated based on severity, specifically examining fatal and disabling injury crash rates and trends.

This approach is consistent with *Missouri's Blueprint for Safer Roadways* (November 2004), which shifts Missouri's safety efforts to focus on strategies to eliminate crashes that result specifically in fatalities and serious injuries. Nevertheless, minor injury and property-damage-only crash data will also be used to bolster the project's crash analysis.

Design Speed

Design speed is a choice made by the designer and is traditionally selected to guide the planning, design, and implementation of future construction. For this study, the selected design speed will be used to measure the effectiveness of the existing physical conditions with consideration of what the future design speed will be. In order to help select the most appropriate design speed(s) for the I-44 corridor, the latest research and data will be consulted. Several of these sources relate design speed to facility type, land use, and terrain type. Below is summary of the sources and their guidance. Note that because I-44 is part of the interstate system, a facility type of "freeway" is utilized.

MoDOT Engineering Policy Guide

The MoDOT Engineering Policy Guide states, **"Highways will be designed to their anticipated posted speed as opposed to an arbitrary design speed."**

Federal Highway Administration (FHWA) Flexibility in Highway Design

Table 4.2 in the FHWA Flexibility in Highway Design Manual lists the following criteria for freeway facilities:

- Level terrain: rural land use, 70-80 mph; urban land use, 70 mph
- Rolling terrain: rural land use, 60-70 mph; urban land use, 60-70 mph
- Mountainous terrain: rural land use, 50-60 mph; urban land use, 50-60 mph

AASHTO, A Policy on Geometric Design of Highways and Streets 2004

Chapter 8 of the 2004 AASHTO green book (page 503) discusses rural and urban freeway design speeds. A design speed of 60-70 mph is recommended for urban freeways; however design speeds as low as 50 mph are acceptable. For rural freeways, a design speed of 70 mph is encouraged; however, in mountainous terrain design speeds between 50-60 mph are acceptable.

Recommended Design Speed for Evaluation

After reviewing the guidance from the sources described above, it is recommended that the current posted speed for the majority of the corridor, 70 mph, should be used as the design speed/anticipated posted speed for the I-44 corridor evaluation. Urban areas carry a posted speed of 60 mph and the design speed will be reduced accordingly. This is consistent with MoDOT, FHWA, and AASHTO guidance for both rural and urban freeways in both level and rolling terrain.

Again, it is important to emphasize that the 70 mph design speed is simply a measure used to evaluate the existing corridor. This purpose and need study is only the first of many steps that will be necessary to determine the future requirements for the corridor. Once the existing deficiencies are understood, subsequent phases will be able to plan, evaluate, and design the future improvements accordingly.

Traffic Operations Analysis (Level of Service)

Level of service analysis is a standard evaluation method for determining how a given facility handles existing and/or future traffic volumes. Level of service is the term used to describe the operational quality of a given roadway design. The *Highway Capacity Manual, Special Report 209, 2000 edition* (HCM) is the standard reference document for characterizing highway operations. Levels of service range from LOS A (very good operations) to LOS F (gridlock conditions; breakdown in traffic flow). Different roadway types have different measures for LOS. Freeway LOS is measured in terms of density.

MoDOT Engineering Policy Guide

The MoDOT Engineering Policy Guide Category: 232 Facility Selection discusses the recommended design year LOS for both rural and urban land use types. The design year for major routes is stated to be based on 20-year traffic projections, and for urban settings the recommended LOS is E in the peak hour and D in off peak hours. For rural settings the recommended LOS is D in the peak hour and C in off peak hours.

AASHTO, A Policy on Geometric Design of Highways and Streets 2004

Chapter 2 of the AASHTO green book (pages 84-85) discusses design LOS, and Exhibit 2-32 lists recommended LOS based on land use type, terrain type and facility type. Rural freeways in both level and rolling terrain types are recommended to operate at LOS B in the design year. Urban freeways of all terrain types are recommended to operate at LOS C in the design year. The text also states that LOS D may be appropriate for freeways in heavily developed sections of metropolitan areas, but that this level should be used sparingly.

Recommended LOS thresholds

For most facilities in Missouri, adherence to the guidance in MoDOT's Engineering Policy Guide for LOS thresholds would be recommended for design year evaluation. Specifically, the following thresholds are recommended:

- Rural Sections: LOS D or better

- Urban Sections: LOS E or better

Conclusion

The recommendations set forth in this memo are intended to establish the fundamental assumptions that will guide the analyses associated with the I-44 Purpose and Need Study. Based on these “global” methods and assumptions, additional “more detailed” methods will be developed to investigate the finer points of each category (safety, design speed/geometry, and operations).

Interstate 44 (I-44) Purpose and Need Study: Crash Analysis (A-3)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	May 7, 2007
REVISED SUBMISSION DATE	March 2, 2008

Introduction

The purpose of this memorandum is to summarize the results of the crash analysis performed on I-44. The study area includes the portion of I-44 between the U.S. Highway 166/400 interchange near Joplin (Newton County) and the Business Loop 44 (Historic Route 66) interchange near Pacific (Franklin County). The crash data used in this memorandum was provided by the Missouri Department of Transportation (MoDOT) and covers 2002 through 2006. The crash analysis focused on three elements: crash rates, crash type, and crash hotspots.

Crash Rate Analysis

Total Crashes

A total of 10,275 crashes occurred in the study area from 2002 through 2006; with 2006 having the highest number of total crashes overall, but also the lowest number of fatalities (**Table 1**)[1].

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[1] MoDOT maintains data on crashes that occur on the interstate and state highway system. The data in this section is derived from those MoDOT databases. This information is also the source of the statewide average crash rates for urban and rural highways. Unless otherwise noted, crash rates are expressed as the number of crashes per 100 million vehicle miles traveled.

TABLE 1

Total Crashes (2002-2006)

Severity	**All Crashes by Year**					
	2002	***2003***	***2004***	***2005***	***2006***	***TOTAL***
Property Damage Only	1,426	1,508	1,520	1,406	1,579	**7,439**
Minor Injury	395	388	395	383	372	**1,933**
Disabling Injury	162	143	145	135	142	**727**
Fatal	33	37	34	46	26	**176**
Total:	2,016	2,076	2,094	1,970	2,119	**10,275**

Crash Rates vs. Statewide Averages

To more accurately portray the crash environment, the study area was divided into rural and urban areas and crash rates were developed for each[2]. Urban areas were considered to be communities with a population of 5,000 or more, and rural areas are those portions of the corridor not within the boundary of an urban area. 2000 Census data was used to establish the populations of study area communities. **Table 2** shows the urban/rural divisions used during the crash evaluation.

TABLE 2

Urban Areas in the I-44 Study Corridor for the Crash Analysis

I-44 Mile Marker Begin	**I-44 Mile Marker End**	**City (County)**	**Population (2000 Census)**
6.0	10.5	Joplin (Newton)	45,504
72.5	86.0	Springfield (Greene)	151,580
100.2	104.3	Marshfield (Webster)	5,720
126.7	130.3	Lebanon (Laclede)	12,155
153.4	163.9	Ft. Leonard Wood/St. Robert (Pulaski)	16,426
183.9	190.0	Rolla (Phelps)	16,367
224.0	226.1	Sullivan (Crawford and Franklin)	6,351
253.4	258.3	Pacific (Franklin)	5,479

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[2] A major distinction in many of the project's analyses is whether a particular segment of roadway is rural or urban. The urban and rural classification is based on the MoDOT state of the system database. Other analyses use different criteria.

The average I-44 crash rates for 10 counties within the study area are listed in **Tables 3 and 4.** The overall urban and rural crash rates (which includes fatal, non-fatal-injury, and property-damage-only crashes), injury crash rates (includes minor injury and disabling injury) and are listed in **Table 3** and fatal crash rates are compared in each table listed in the **Table 4**. County crash rates that are higher than the average for all interstate routes in Missouri average are shown in red.

Urban Crash Rate Trends

Among the 10 counties, Phelps County (Rolla) exceeded the statewide total crash rates for all crash types except fatal crashes. Phelps County exceeded the total crash rate by 40 percent, the property damage only (PDO) rate by 39 percent, and the injury rate by 51 percent. Within the injury rate crash type, Phelps County's minor injury crash rate was almost twice as high as the statewide average. This is not unexpected given the rolling terrain and sharp horizontal curvature through many sections of Phelps County. It is important to note that some recent improvements have been constructed through this area and will likely improve the safety performance of I-44 in Phelps County.

TABLE 3

I-44 Rate for the Urban Portions of the 10 Counties within the Study Corridor

County (Urban Area)	**All Crashes**	**PDO**	**Minor Injury**	**Disabling Injury**	**Fatality**
Newton (Joplin)	90.34	65.40	16.18	5.20	3.56
Jasper (no urban segments)	-	-	-	-	-
Lawrence (no urban segments)	-	-	-	-	-
Greene (Springfield)	75.60	51.24	20.57	2.80	1.00
Webster (Marshfield)	39.93	31.91	5.16	2.37	0.48
Laclede (Lebanon)	83.86	59.26	15.42	9.18	0.00
Pulaski (Ft. Leonard Wood/St. Robert)	100.60	77.46	12.70	9.53	0.90
Phelps (Rolla)	168.82	127.49	32.34	8.19	0.81
Crawford (Sulivan)	27.99	20.26	7.73	0.00	0.00
Franklin (Pacific)	49.25	41.47	5.14	2.11	0.53
I-44 Corridor	**96.01**	**71.82**	**17.49**	**5.67**	**1.04**
State Average	**120.09**	**91.9**	**26.8**		**1.34**

Source: MoDOT TMS, 2002 - 2006. All Rates Expressed in Number of Crashes per Hundred Million Vehicle Miles Traveled

Red Text Indicates Rates Higher Than State Averages for Similar Facilities

Newton County (Joplin) exceeded the statewide average fatal crash rate by 170 percent. With the exception of Phelps (Rolla) and Newton (Joplin) counties, no other urban area in the project area exceeded the statewide average for any crash type.

Interchanges and their "influence areas" are often the focus of crash problems along interstate routes. For instance, the crash rates in Phelps County (Rolla) are influenced by traffic operations at the U.S. Route 63 South, Route E and U.S. Route 63 interchanges; as well as the areas upstream and downstream of those interchanges. In the eastbound direction, the U.S. Route 63 South, Route E and U.S. Route 63 interchange areas have total crash rates of 135.31, 220.33 and 421.71, respectively. The U.S. Route 63 South interchange also had a fatal crash rate of 3.30 in the eastbound direction. It is also worth noting that the U.S. Route 63 eastbound merge ramp currently operates at LOS F (gridlock) in the peak hour. That ramp is of the very few ramps in the entire study area found to be currently deficient. In the westbound direction U.S. Route 63 South and U.S. Route 63 interchange areas have total crash rates of 160.04 and 380.42, respectively. In the eastbound direction, U.S. Route 63 South has a fatal crash rate of 3.14.

In Joplin (Newton County), the eastbound Route 86 and Business Loop I-44 interchanges have fatal crash rates of 3.19 and 3.11, respectively. In the westbound direction the fatal crash rates for those interchanges increases to 9.83 and 6.57, respectively. The Route 86 interchange is a cloverleaf configuration that creates conflicts between the slower moving traffic entering and exiting I-44 and the faster moving through traffic.

Rural Crash Rate Trends

The project area's rural crash rate data is found in **Table 4**. Like the preceding urban section discussion, the rural crash rates are organized by county. There are several interesting trends in the rural county areas:

- Three counties, Newton at the west end of the study area as well as Phelps and Franklin (at the east end) exceeded the statewide average rates for all crash types.
- Crawford County, located between Phelps and Franklin counties, exceeded the statewide average for all crash types except fatal crashes.
- Five of the remaining six counties, Jasper, Lawrence, Greene, Webster and Laclede counties only exceeded the statewide fatal crash rate; and Pulaski County exceeded only the statewide PDO rate.

Table 4

I-44 Crash Rates for the Rural Portions of the 10 Counties within the Study Corridor

County	All Crashes	PDO	Minor Injury	Disabling Injury	Fatality
Newton	78.56	53.47	18.53	5.26	1.31
Jasper	54.93	37.57	13.34	2.43	1.59
Lawrence	48.68	33.39	10.24	3.78	1.28
Greene	36.98	23.36	9.95	2.02	1.64
Webster	44.86	31.18	7.86	4.64	1.19
Laclede	57.33	42.76	8.81	4.48	1.28
Pulaski	65.41	52.38	6.57	6.29	0.17
Phelps	83.26	56.95	17.70	7.27	1.34
Crawford	70.11	49.75	12.58	6.85	0.94
Franklin	78.00	59.07	12.16	5.61	1.16
I-44 Corridor	**61.79**	**44.06**	**11.64**	**4.86**	**1.22**
State Average	**66.66**	**48.8**	**16.7**		**1.13**

Source: MoDOT TMS, 2002 - 2006. All Rates Expressed in Number of Crashes per Hundred Million Vehicle Miles Traveled
Red Text Indicates Rates Higher Than State Averages for Similar Facilities

Interchange crash trends provide a partial explanation for the trends noted above. As might be expected Newton, Phelps, Crawford, and Franklin counties had interchange areas with high crash rates. It should be noted that Newton County only had one rural interchange (U.S. 166) and because it had a total crash rate of 274.26 and a fatal crash rate of 5.17, it strongly influenced the county's rural crash picture.

The total crash rates at interchanges in Jasper, Lawrence, Greene, Webster, Laclede, and Pulaski counties were noticeably lower than those in Newton, Phelps, Crawford and Franklin counties. In sharp contrast to the total crash rate trend in these counties, the fatal crash rates were, in a number of locations, comparable to the fatal rates for Newton, Phelps, Crawford, and Franklin counties. Lawrence County is an example of the differing trends between total crash rates and fatal crash rates.

Crash Type Analysis

In addition to calculating crash rates, the crash data were further examined in order to determine the most common causes for property damage only, minor injury, disabling injury and fatal crashes in the project area.

Property Damage Only Crashes (PDO)

The most common causes of PDO crashes are "out of control" (34 percent) and "rear end" (20 percent) followed by "other" (17 percent) and "passing" (13 percent). See **Table 5**. Out of control crashes are defined as vehicles traveling too fast for conditions and colliding with another vehicle or object. These crashes were distributed evenly in both directions. Rear end crashes, the second most common crash type, are also distributed evenly in both directions.

Table 5

Property Damage Only Crash Types (2002-2006)

	I-44 Eastbound		**I-44 Westbound**		**I-44 Total**	
TOTAL	**3,691**		**3,748**		**7,439**	
Animal other than deer	31	1 percent	46	1 percent	77	1 percent
Avoiding	59	2 percent	65	2 percent	124	2 percent
Backing	21	1 percent	21	1 percent	42	1 percent
Changing Lanes	107	3 percent	96	3 percent	203	3 percent
Cross Median	15	0 percent	11	0 percent	26	0 percent
Deer	178	5 percent	183	5 percent	361	5 percent
Dual Rights Collide	2	0 percent	2	0 percent	4	0 percent
Fixed Object	37	1 percent	43	1 percent	80	1 percent
Head On	8	0 percent	5	0 percent	13	0 percent
Jackknife	0	0 percent	0	0 percent	0	0 percent
Left Turn	7	0 percent	9	0 percent	16	0 percent

Table 5

Property Damage Only Crash Types (2002-2006)

	I-44 Eastbound		**I-44 Westbound**		**I-44 Total**	
Left Turn Right Angle Collision	16	0 percent	13	0 percent	29	0 percent
Other	634	17 percent	646	17 percent	1,280	17 percent
Out of Control	1,300	35 percent	1,248	33 percent	2,548	34 percent
Parking or parked car	66	2 percent	68	2 percent	134	2 percent
Passing	475	13 percent	495	13 percent	970	13 percent
Pedalcycle	1	0 percent	1	0 percent	2	0 percent
Pedestrian	1	0 percent	0	0 percent	1	0 percent
Rear End	699	19 percent	764	20 percent	1,463	20 percent
Right Angle	13	0 percent	12	0 percent	25	0 percent
Right Turn	5	0 percent	4	0 percent	9	0 percent
Right Turn Right Angle Collision	4	0 percent	8	0 percent	12	0 percent
Sideswipe	7	0 percent	5	0 percent	12	0 percent
Towed Unit Disconnects	0	0 percent	0	0 percent	0	0 percent
U-Turn	5	0 percent	2	0 percent	7	0 percent
Wrong Way on Divided Highway	0	0 percent	1	0 percent	1	0 percent

Source: MoDOT Office of Transportation Management Systems

Minor Injury Crashes

For crashes resulting in minor injuries, two crash types were responsible for 76 percent of all crashes: "out of control" (51 percent) and "rear end" (25 percent). See **Table 6**. The rear end crashes may be caused by: 1) changing travel speeds throughout the corridor due to the inconsistent geometric design; and 2) unanticipated traffic congestion resulting from work zones, crash incidents, or to a lesser extent ramp backups.

Table 6

Minor Injury Crash Types (2002-2006)

	I-44 Eastbound		**I-44 Westbound**		**I-44 Total**	
TOTAL	**946**		**987**		**1,933**	
Animal other than deer	2	0 percent	5	1 percent	7	0 percent
Avoiding	24	3 percent	33	3 percent	57	3 percent
Backing	1	0 percent	0	0 percent	1	0 percent
Changing Lanes	10	1 percent	15	2 percent	25	1 percent
Cross Median	15	2 percent	13	1 percent	28	1 percent
Deer	8	1 percent	6	1 percent	14	1 percent
Dual Rights Collide	0	0 percent	0	0 percent	0	0 percent
Fixed Object	6	1 percent	16	2 percent	24	1 percent
Head On	16	2 percent	15	2 percent	31	2 percent
Jackknife	1	0 percent	0	0 percent	1	0 percent
Left Turn	3	0 percent	3	0 percent	6	0 percent
Left Turn Right Angle Collision	5	1 percent	3	0 percent	8	0 percent
Other	41	4 percent	41	4 percent	82	4 percent
Out of Control	493	52 percent	496	50 percent	989	51 percent
Parking or parked car	13	1 percent	19	2 percent	32	2 percent
Passing	69	7 percent	56	6 percent	125	6 percent
Pedalcycle	0	0 percent	0	0 percent	0	0 percent
Pedestrian	1	0 percent	2	0 percent	3	0 percent
Rear End	229	24 percent	252	26 percent	481	25 percent
Right Angle	4	0 percent	6	1 percent	10	1 percent
Right Turn	0	0 percent	0	0 percent	0	0 percent
Right Turn Right Angle Collision	1	0 percent	3	0 percent	4	0 percent
Sideswipe	3	0 percent	2	0 percent	5	0 percent
Towed Unit Disconnects	0	0 percent	0	0 percent	0	0 percent
U-Turn	1	0 percent	1	0 percent	2	0 percent
Wrong Way on Divided Highway	0	0 percent	0	0 percent	0	0 percent

Source: MoDOT Office of Transportation Management Systems

Disabling Injury Crash Types

Out of control and rear end crashes account for 76 percent of all disabling injury crashes (**Table 7**). The directional split is generally even. It is worth noting that out of control crashes make up a slightly larger percentage of disabling injury crashes than minor injury crashes. As noted, the rear-end crashes are likely a reflection of two corridor characteristics: 1) changing travel speeds throughout the corridor due to the inconsistent geometric design; and 2) unanticipated traffic congestion resulting from work zones, crash incidents, or to a lesser extent ramp backups.

Table 7

Disabling Injury Crash Types (2002-2006)

	I-44 Eastbound		**I-44 Westbound**		**I-44 Total**	
TOTAL	**369**		**358**		**727**	
Animal other than deer	0	0 percent	1	0 percent	1	0 percent
Avoiding	13	4 percent	6	2 percent	19	3 percent
Backing	0	0 percent	0	0 percent	0	0 percent
Changing Lanes	8	2 percent	9	3 percent	17	2 percent
Cross Median	9	2 percent	9	3 percent	18	2 percent
Deer	0	0 percent	3	1 percent	3	0 percent
Dual Rights Collide	0	0 percent	0	0 percent	0	0 percent
Fixed Object	4	1 percent	3	1 percent	7	1 percent
Head On	12	3 percent	9	3 percent	21	3 percent
Jackknife	0	0 percent	0	0 percent	0	0 percent
Left Turn	2	1 percent	0	0 percent	2	0 percent
Left Turn Right Angle Collision	0	0 percent	0	0 percent	0	0 percent
Other	11	3 percent	5	1 percent	16	2 percent
Out of Control	215	58 percent	206	58 percent	421	58 percent
Parking or parked car	6	2 percent	14	4 percent	20	3 percent
Passing	15	4 percent	19	5 percent	34	5 percent
Pedalcycle	1	0 percent	0	0 percent	1	0 percent
Pedestrian	2	1 percent	5	1 percent	7	1 percent
Rear End	64	17 percent	66	18 percent	130	18 percent
Right Angle	2	1 percent	2	1 percent	4	1 percent
Right Turn	2	0 percent	0	0 percent	2	0 percent
Right Turn Right Angle Collision	0	0 percent	0	0 percent	0	0 percent

Table 7

Disabling Injury Crash Types (2002-2006)

	I-44 Eastbound		I-44 Westbound		I-44 Total	
Sideswipe	3	1 percent	0	0 percent	3	0 percent
Towed Unit Disconnects	0	0 percent	0	0 percent	0	0 percent
U-Turn	1	0 percent	1	0 percent	2	0 percent
Wrong Way on Divided Highway	0	0 percent	0	0 percent	0	0 percent

Source: MoDOT Office of Transportation Management Systems

Fatal Injury Crashes

Out of control (47 percent) and rear end (14 percent) crashes account for the majority of fatal crashes (**Table 8**). The percentage of head on crashes (11 percent) and crashes involving pedestrians (10 percent) are also notable. The percentage of pedestrian crashes validates the perception that I-44 is an extremely dangerous place for pedestrians to walk, hitchhike, work, or change tires.

Table 8

I-44 Fatal Crash Types (2002-2006)

	I-44 Eastbound		I-44 Westbound		I-44 Total	
TOTAL	**87**		**89**		**176**	
Animal other than deer	0	0 percent	0	0 percent	0	0 percent
Avoiding	4	5 percent	2	2 percent	6	3 percent
Backing	0	0 percent	0	0 percent	0	0 percent
Changing Lanes	3	3 percent	1	1 percent	4	2 percent
Cross Median	2	2 percent	4	4 percent	6	3 percent
Deer	0	0 percent	0	0 percent	0	0 percent
Dual Rights Collide	0	0 percent	0	0 percent	0	0 percent
Fixed Object	1	1 percent	0	0 percent	1	1 percent
Head On	5	6 percent	14	16 percent	19	11 percent
Jackknife	0	0 percent	0	0 percent	0	0 percent
Left Turn	0	0 percent	1	1 percent	1	1 percent
Left Turn Right Angle Collision	0	0 percent	0	0 percent	0	0 percent
Other	2	2 percent	0	0 percent	2	1 percent
Out of Control	46	53 percent	37	42 percent	83	47 percent
Parking or parked car	3	3 percent	2	2 percent	5	3 percent
Passing	1	1 percent	4	4 percent	5	3 percent
Pedalcycle	0	0 percent	0	0 percent	0	0 percent

Table 8

I-44 Fatal Crash Types (2002-2006)

	I-44 Eastbound		**I-44 Westbound**		**I-44 Total**	
Pedestrian	9	10 percent	9	10 percent	18	10 percent
Rear End	11	13 percent	13	15 percent	24	14 percent
Right Angle	0	0 percent	0	0 percent	0	0 percent
Right Turn	0	0 percent	0	0 percent	0	0 percent
Right Turn Right Angle Collision	0	0 percent	0	0 percent	0	0 percent
Sideswipe	0	0 percent	1	1 percent	1	1 percent
Towed Unit Disconnects	0	0 percent	0	0 percent	0	0 percent
U-Turn	0	0 percent	1	1 percent	1	1 percent
Wrong Way on Divided Highway	0	0 percent	0	0 percent	0	0 percent

Source: MoDOT Office of Transportation Management Systems

As noted in **Tables 5** through **8**, out of control and rear end crashes are the two most common causes for the four types of crashes analyzed in this memorandum. Together out of control and rear end crashes accounted for 6,139 crashes or 60 percent of all study area crashes from 2002 through 2006. See **Tables 9** and **10.** Particularly noteworthy is that out of control crashes account for nearly half (83 out of a total 176) of the fatal crashes and more than half (421 out of a total 727) of the disabling injury crashes across the corridor. Further analysis of the underlying causes of these types of crashes will be an important component of the next phase of study in the I-44 corridor.

Table 9

Out of Control Crashes (2002-2006)

	I-44 Eastbound	**I-44 Westbound**	**I-44 Total**
PDO	1,300	1,248	2,548
Minor Injury	493	496	989
Disabling Injury	215	206	421
Fatal	46	37	83

Table 10

Rear End Crashes (2002-2006)

	I-44 Eastbound	I-44 Westbound	I-44 Total
PDO	699	764	1,463
Minor Injury	229	252	481
Disabling Injury	64	66	130
Fatal	11	13	24

Truck Crashes

Given the relatively high percentage of commercial vehicles on I-44 in the study area (roughly 30 percent) and the fact that the project corridor has a fatal crash rate higher than the statewide average, it was decided to investigate the role of commercial trucks in the severity of study area crashes. **Table 11** provides data on the number and type of truck crashes on Missouri’s five interstate routes. The data includes rural and urban segments of the interstate routes. Data for the rural portion of I-44 (the study area) is found in parentheses.

Because I-44 and I-70 are of similar length, have similar traffic volumes (including the percentage of commercial vehicles) and because it is acknowledged that the scale of the problems on I-44 is approaching that of I-70, the focus of the truck crash analysis is a comparison between I-44 and I-70.

As noted in **Table 11**, I-70 has three times as many truck crashes as all of I-44 and nearly four times as many crashes as I-44 in the study area. On both interstate routes, property damage only and minor injury crashes account for the majority of all truck crashes. I-70 had 4,724 property damage only crashes and 1,061 minor injuries while I-44 in the project area had 898 property damage only crashes and 470 minor injury crashes.

In sharp contrast to the disparity between the numbers of property damage only and minor injury crashes on I-70 and I-44, are the numbers of disabling injury and fatal crashes involving trucks. In 2002, 2003, 2005, and 2006, I-44 in the study area had more disabling injury crashes than the entire length of I-70. I-44 also had comparable numbers of fatal crashes as I-70 during the analysis period. These data suggest that while trucks are involved in far fewer total crashes on I-44 than on I-70, truck crashes on I-44 are more severe than those on I-70. A possible explanation for the difference in the severity of truck crashes may be the geometric characteristics of the two interstates. The geometry of I-70 is generally straight and flat while I-44 is more curvilinear and rolling. There are many sections of the I-44 corridor where the geometry is incompatible with the speed limit, a condition that will typically result in more severe crashes, especially when large trucks are involved.

Table 11

Truck Crashes on Missouri Interstate Routes

Year	Crash Type	Interstate Routes				
		I-29	**I-35**	**I-55**	**I-44 (study area)**	**I-70**
2002	PDO	119	201	372	204 (162)	984
	Minor Injury	23	41	86	92 (76)	228
	Disabling Injury	8	7	19	54 (53)	46
	Fatal	1	2	8	16 (15)	16
2003	PDO	117	187	286	212 (183)	937
	Minor Injury	20	33	60	116 (91)	223
	Disabling Injury	9	14	15	45 (40)	31
	Fatal	2	2	7	16 (16)	18
2004	PDO	122	198	328	253 (206)	970
	Minor Injury	26	49	71	104 (88)	219
	Disabling Injury	5	6	27	36 (32)	52
	Fatal	1	2	6	13 (12)	12
2005	PDO	147	151	359	213 (168)	937
	Minor Injury	24	23	93	133 (105)	215
	Disabling Injury	4	7	19	47 (43)	38
	Fatal	4	3	5	26 (21)	14
2006	PDO	133	192	302	213 (179)	896
	Minor Injury	23	34	63	151 (94)	176
	Disabling Injury	5	4	16	46 (42)	34
	Fatal	1	3	5	14 (10)	17
Total Truck Crashes		794	1,159	2,147	2004 (1,636)	6063
Route Length (miles)		124	114	209	290 (258)	251
Crashes Prorated to 100 Miles	PDO	515	815	788	378 (348)	1882
	Minor Injury	94	158	178	205 (176)	423
	Disabling Injury	25	33	46	81 (79)	80
	Fatal	7	11	15	29 (29)	31
	Total	640	1017	1027	634	2416

Source: MoDOT Office of Transportation Management Systems. The data include rural and urban segments of the interstate routes. Data for the rural portion of I-44 (roughly the study area) are found in parentheses.

Although commercial trucks were involved in only 16 percent of the I-44 crashes from 2002 through 2006, it is not unexpected that truck crashes were more severe than crashes that did not involve trucks. As noted in the two figures below, the percentage of disabling injury crashes and fatal crashes doubles when trucks are involved.

Figure 1: Severity of all crashes

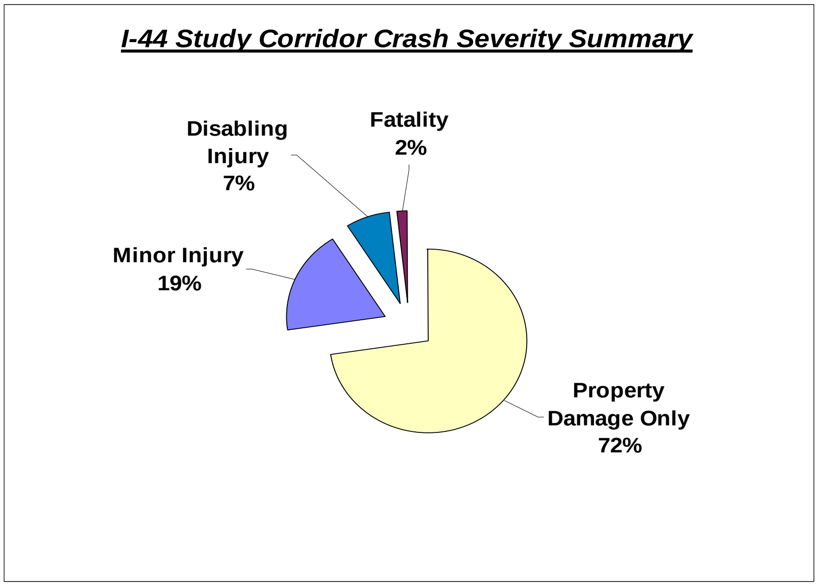
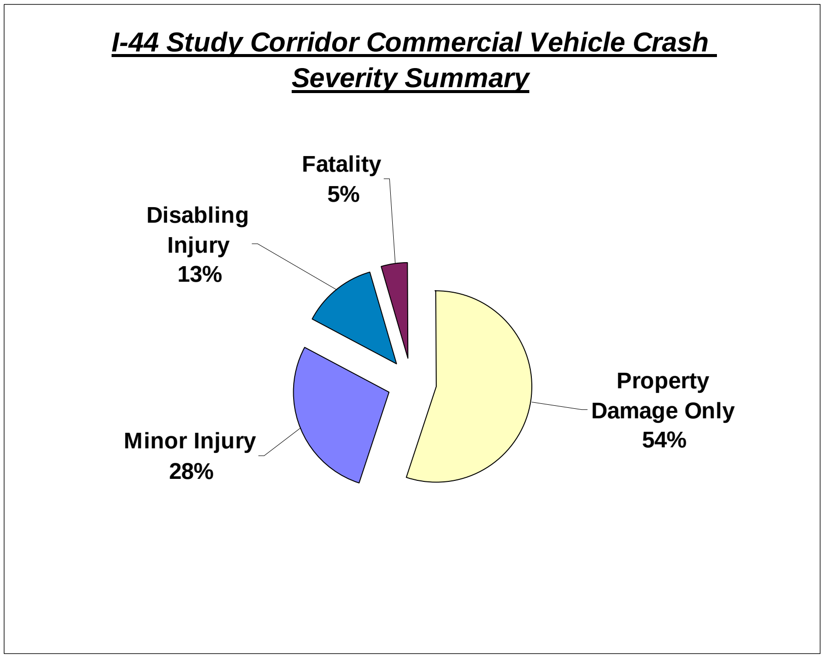


Figure 2: Severity when commercial vehicles are involved:



Crash Hotspot Analysis

Because the study area has a fatal crash rate above the statewide average and a history of severe crashes involving commercial trucks, a crash location severity analysis was conducted for the I-44 corridor. The analysis identifies areas where three or more disabling injury crashes or fatal crashes occur within 0.3 mile of each other. It should be noted that this analysis did not take traffic volume into account, resulting in more "hotspots" where there are higher traffic volumes.

A total of 84 locations, or "hotspots," were identified that met the criteria described above, see **Table 12**. No clear directional differentiation was identified with 44 hotspots on eastbound lanes and 40 on westbound lanes. Of the 84 locations, 29 are located in areas with horizontal and/or vertical curves that are either deficient or cause passenger discomfort and 46 are located in interchange areas. Within the interchange areas about 60 percent of the hotspots were located in the vicinity of entrance ramps and the remainder at exit ramps. In some instances, there was a long grade associated with the entrance ramp. There were 24 hotspots located away from interchange areas that did not have any obvious geometric feature that could be a causal factor in the crash.

Franklin County had the highest number of hotspots (18), followed by Phelps County (16) and Laclede County (9). These three counties account for just over half of all the hotspot locations in the corridor. In Pulaski County, in the westbound lanes, there is a heavy concentration of 6 hotspots over a 5-mile section of I-44 between 155 and 160. This is the highest concentration of severe crashes in the entire corridor.

Of the 727 disabling crashes and 176 fatal crashes that occurred from 2002 through 2006 throughout the study area, hotspots accounted for 280 disabling crashes (39 percent) and 57 fatal crashes (32 percent). Of the 280 disabling injuries, 79 involved trucks. Of the 57 fatal crashes, 20 involved trucks and cars. The combined length of all eastbound hotspots take is about 15.5 miles, and the lenth of the westbound hotspots is about 14.1 miles. With the study area length being about 258 miles, the total length of eastbound hotspots is about 6 percent of the corridor and westbound hotspots make up about 5.5 percent of the corridor.

The predominant causes of crashes in the hotspots are the same for crashes outside of the hotspots, out of control and rear end crashes. Among eastbound hotspots out of control crashes accounted for 56 percent of the crashes and rear end crashes 22 percent. Among westbound hotspots out of control crashes accounted for 54 percent of the crashes and rear end crashes 22 percent.

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Eastbound	Newton	4.112	4.397	1		Right Angle	3	0	1 Out of Control, 1 Pedestrian, 1 Right Angle
Eastbound	Newton	4.112	4.397	1		Pedestrian			
Eastbound	Newton	4.112	4.397	1		Out of Control			
Eastbound	Newton	4.905	5.19		1	Avoiding	2	1	1 Avoiding, 1 Out of Control, 1 Rear End
Eastbound	Newton	4.905	5.19	1		Rear End			
Eastbound	Newton	4.905	5.19	1		Out of Control			
Eastbound	Newton	6.39	6.846		1	Head On	3	1	1 Head On, 2 Out of Control, 1 Passing
Eastbound	Newton	6.39	6.846	1		Out of Control			
Eastbound	Newton	6.39	6.846	1		Passing			
Eastbound	Newton	6.39	6.846	1		Out of Control			
Eastbound	Newton	8.5	9.2	1		Passing	4	1	1 Out of Control, 1 Passing, 2 Rear End, 1 Right Turn
Eastbound	Newton	8.5	9.2	1		Rear End			
Eastbound	Newton	8.5	9.2	1		Right Turn			
Eastbound	Newton	8.5	9.2	1		Rear End			
Eastbound	Newton	8.5	9.2		1	Out of Control			
Eastbound	Jasper	10.622	10.865	1		Parking or Parked Car	2	1	1 Out of Control, 1 Paking or Parked Car, 1 Rear End
Eastbound	Jasper	10.622	10.865		1	Out of Control			
Eastbound	Jasper	10.622	10.865	1		Rear End			
Eastbound	Jasper	11.681	11.905	2		Rear End	2	0	2 Rear End
Eastbound	Jasper	11.906	12.5	1		Out of Control	2	1	3 Out of Control

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Eastbound	Jasper	11.906	12.5	1		Out of Control			
Eastbound	Jasper	11.906	12.5		1	Out of Control			
Eastbound	Jasper	28.898	29.137	1		Rear End	1	2	1 Out of Control, 2 Rear End
Eastbound	Jasper	28.898	29.137		1	Rear End			
Eastbound	Jasper	28.898	29.137		1	Out of Control			
Eastbound	Jasper	41.216	41.444	1		Parking or Parked Car	2	1	2 Out of Control, 1 Paking or Parked Car
Eastbound	Jasper	41.216	41.444	1		Out of Control			
Eastbound	Jasper	41.216	41.444		1	Out of Control			
Eastbound	Lawrence	58.705	58.902	1		Rear End	3	1	1 Fixed Object, 1 Out of Control, 1 Pedestrian, 1 Rear End
Eastbound	Lawrence	58.705	58.902		1	Pedestrian			
Eastbound	Lawrence	58.705	58.902	1		Fixed Object			
Eastbound	Lawrence	58.705	58.902	1		Out of Control			
Eastbound	Lawrence	59.705	59.993	1		Out of Control	3	0	1 Out of Control, 1 Rear End, 1 Sideswipe
Eastbound	Lawrence	59.705	59.993	1		Rear End			
Eastbound	Lawrence	59.705	59.993	1		Sideswipe			
Eastbound	Greene	67.887	68.183	2		Out of Control	3	0	1 Cross Median, 2 Out of Control
Eastbound	Greene	67.887	68.183	1		Cross Median			
Eastbound	Greene	72.34	72.53	1		Rear End	4	2	1 Changing Lane, 2 Head On, 2 Out of Control, 1 Rear End
Eastbound	Greene	72.34	72.53		1	Out of Control			
Eastbound	Greene	72.34	72.53	1		Changing Lane			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Eastbound	Greene	72.34	72.53		1	Out of Control			
Eastbound	Greene	72.34	72.53	1		Head On			
Eastbound	Greene	72.34	72.53	1		Head On			
Eastbound	Greene	74.383	74.643	1		Out of Control	3	0	2 Out of Control, 1 Rear End
Eastbound	Greene	74.383	74.643	1		Out of Control			
Eastbound	Greene	74.383	74.643	1		Rear End			
Eastbound	Greene	82.453	82.724	1		Out of Control	3	1	1 Changing Lane, 1 Other, 1 Out of Control, 1 Pedestrian
Eastbound	Greene	82.453	82.724		1	Pedestrian			
Eastbound	Greene	82.453	82.724	1		Other			
Eastbound	Greene	82.453	82.724	1		Changing Lane			
Eastbound	Webster	91.12	91.65	1		Left Turn	2	1	1 Left Turn, 1 Out of Control, 1 Pedestrian
Eastbound	Webster	91.12	91.65		1	Pedestrian			
Eastbound	Webster	91.12	91.65	1		Out of Control			
Eastbound	Webster	95.53	96.081	1		Rear End	5	0	1 Head On, 2 Out of Control, 1 Passing, 1 Rear End
Eastbound	Webster	95.53	96.081	1		Passing			
Eastbound	Webster	95.53	96.081	1		Out of Control			
Eastbound	Webster	95.53	96.081	1		Out of Control			
Eastbound	Webster	95.53	96.081	1		Head On			
Eastbound	Laclede	114.393	114.683	1		Out of Control	3	0	2 Rear End, 1 Out of Control
Eastbound	Laclede	114.393	114.683	1		Rear End			
Eastbound	Laclede	114.393	114.683	1		Rear End			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Eastbound	Laclede	123.923	124.223		1	Out of Control	4	1	4 Out of Control, 1 Rear End
Eastbound	Laclede	123.923	124.223	1		Out of Control			
Eastbound	Laclede	123.923	124.223	1		Out of Control			
Eastbound	Laclede	123.923	124.223	1		Rear End			
Eastbound	Laclede	123.923	124.223	1		Out of Control			
Eastbound	Laclede	130.0	130.6	1		Out of Control	4	0	3 Out of Control, 1 Rear End
Eastbound	Laclede	130.0	130.6	1		Rear End			
Eastbound	Laclede	130.0	130.6	1		Out of Control			
Eastbound	Laclede	130.0	130.6	1		Out of Control			
Eastbound	Laclede	142.731	143.004	1		Rear End	4	1	3 Out of Control, 2 Rear End
Eastbound	Laclede	142.731	143.004	1		Rear End			
Eastbound	Laclede	142.731	143.004	1		Out of Control			
Eastbound	Laclede	142.731	143.004		1	Out of Control			
Eastbound	Laclede	142.731	143.004	1		Out of Control			
Eastbound	Pulaski	147.944	148.181	1		Out of Control	3	0	3 Out of Control
Eastbound	Pulaski	147.944	148.181	1		Out of Control			
Eastbound	Pulaski	147.944	148.181	1		Out of Control			
Eastbound	Pulaski	167.044	16.52	1		Out of Control	5	0	3 Out of Control, 1 Rear End, 1 Right Angle
Eastbound	Pulaski	167.044	16.52	2		Out of Control			
Eastbound	Pulaski	167.044	16.52	1		Right Angle			
Eastbound	Pulaski	167.044	16.52	1		Rear End			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Eastbound	Phelps	172.45	173.05	1		Out of Control	5	1	4 Out of Control, 1 Passing, 1 Rear End
Eastbound	Phelps	172.45	173.05	1		Out of Control			
Eastbound	Phelps	172.45	173.05		1	Rear End			
Eastbound	Phelps	172.45	173.05	2		Out of Control			
Eastbound	Phelps	172.45	173.05	1		Passing			
Eastbound	Phelps	176.888	177.163	3		Out of Control	4	1	4 Out of Control, 1 Passing
Eastbound	Phelps	176.888	177.163		1	Passing			
Eastbound	Phelps	176.888	177.163	1		Out of Control			
Eastbound	Phelps	180.3	180.7	1		Changing Lane	2	1	1 Changing Lane, 1 Out of Control, 1 Rear End
Eastbound	Phelps	180.3	180.7	1		Rear End			
Eastbound	Phelps	180.3	180.7		1	Out of Control			
Eastbound	Phelps	182.332	182.74	1		Out of Control	4	0	4 Out of Control
Eastbound	Phelps	182.332	182.74	1		Out of Control			
Eastbound	Phelps	182.332	182.74	2		Out of Control			
Eastbound	Phelps	185.672	185.941	1		Parking or Parked Car	4	0	2 Out of Control, 1 Parking or Parked Car, 1 Rear End
Eastbound	Phelps	185.672	185.941	1		Out of Control			
Eastbound	Phelps	185.672	185.941	1		Out of Control			
Eastbound	Phelps	185.672	185.941	1		Rear End			
Eastbound	Phelps	194.04	194.23	1		Rear End	3	0	1 Out of Control, 2 Rear End
Eastbound	Phelps	194.04	194.23	1		Rear End			
Eastbound	Phelps	194.04	194.23	1		Out of Control			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Eastbound	Phelps	199.636	199.892	2		Out of Control	3	0	2 Out of Control, 1 Passing
Eastbound	Phelps	199.636	199.892	1		Passing			
Eastbound	Crawford	202.093	202.584	1		Out of Control	4	0	1 Other, 2 Out of Control, 1 Rear End
Eastbound	Crawford	202.093	202.584	1		Out of Control			
Eastbound	Crawford	202.093	202.584	1		Rear End			
Eastbound	Crawford	202.093	202.584	1		Other			
Eastbound	Crawford	208.309	208.537	1		Rear End	3	0	1 Out of Control, 2 Rear End
Eastbound	Crawford	208.309	208.537	1		Rear End			
Eastbound	Crawford	208.309	208.537	1		Out of Control			
Eastbound	Crawford	214.5	214.931	2		Out of Control	7	1	1 Avoiding, 6 Out of Control, 1 Rear End
Eastbound	Crawford	214.5	214.931	1		Out of Control			
Eastbound	Crawford	214.5	214.931	1		Avoiding			
Eastbound	Crawford	214.5	214.931	1		Rear End			
Eastbound	Crawford	214.5	214.931		1	Out of Control			
Eastbound	Crawford	214.5	214.931	1		Out of Control			
Eastbound	Crawford	214.5	214.931	1		Out of Control			
Eastbound	Crawford	220.44	220.68		1	Out of Control	2	1	2 Out of Control, 1 Passing
Eastbound	Crawford	220.44	220.68	1		Passing			
Eastbound	Crawford	220.44	220.68	1		Out of Control			
Eastbound	Crawford	221.17	221.97	1		Avoiding	3		1 Avoiding, 1 Out of Control, 1 Rear End
Eastbound	Crawford	221.17	221.97	1		Rear End			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Eastbound	Crawford	221.17	221.97	1		Out of Control			
Eastbound	Franklin	225.861	226.052	1		Rear End	1	1	2 Rear End
Eastbound	Franklin	225.861	226.052		1	Rear End			
Eastbound	Franklin	226.052	226.351	1		Out of Control	2	1	3 Out of Control
Eastbound	Franklin	226.052	226.351	1		Out of Control			
Eastbound	Franklin	226.052	226.351		1	Out of Control			
Eastbound	Franklin	231.812	232.2	1		Rear End	6	0	4 Out of Control, 2 Rear End
Eastbound	Franklin	231.812	232.2	1		Out of Control			
Eastbound	Franklin	231.812	232.2	2		Out of Control			
Eastbound	Franklin	231.812	232.2	1		Out of Control			
Eastbound	Franklin	231.812	232.2	1		Rear End			
Eastbound	Franklin	246.518	247.116	1		Out of Control	4	3	7 Out of Control
Eastbound	Franklin	246.518	247.116		1	Out of Control			
Eastbound	Franklin	246.518	247.116	1		Out of Control			
Eastbound	Franklin	246.518	247.116		1	Out of Control			
Eastbound	Franklin	246.518	247.116	1		Out of Control			
Eastbound	Franklin	246.518	247.116		1	Out of Control			
Eastbound	Franklin	246.518	247.116	1		Out of Control			
Eastbound	Franklin	247.518	247.785	1		Rear End	3	0	1 Fixed Object, 1 Out of Control, 1 Rear End
Eastbound	Franklin	247.518	247.785	1		Out of Control			
Eastbound	Franklin	247.518	247.785	1		Fixed Object			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Eastbound	Franklin	251.67	251.93	1		Out of Control	3	2	1 Avoiding, 1 Out of Control, 1 Parking or Parked Car, 1 Passing, 1 Rear End
Eastbound	Franklin	251.67	251.93	1		Rear End			
Eastbound	Franklin	251.67	251.93		1	Parking or Parked Car			
Eastbound	Franklin	251.67	251.93		1	Avoiding			
Eastbound	Franklin	251.67	251.93	1		Passing			
Eastbound	Franklin	252.3	252.525	3		Out of Control	3	1	4 Out of Control
Eastbound	Franklin	252.3	252.525		1	Out of Control			
Eastbound	Franklin	253.0	253.35	1		Rear End	3	0	1 Out of Control, 2 Rear End
Eastbound	Franklin	253.0	253.35	1		Rear End			
Eastbound	Franklin	253.0	253.35	1		Out of Control			
Eastbound	Franklin	254.47	254.8	1		Out of Control	4	0	4 Out of Control
Eastbound	Franklin	254.47	254.8	3		Out of Control			
Westbound	Newton	6.12	6.37		1	Out of Control	1	2	3 Out of Control
Westbound	Newton	6.12	6.37	1		Out of Control			
Westbound	Newton	6.12	6.37		1	Out of Control			
Westbound	Newton	8.5	9.2		1	Left Turn	1	2	1 Fixed Object, 1 Left Turn, 1 U-Turn
Westbound	Newton	8.5	9.2	1		Fixed Object			
Westbound	Newton	8.5	9.2		1	U-Turn			
Westbound	Newton	9.321	9.544	2		Out of Control	2	1	3 Out of Control
Westbound	Newton	9.321	9.544		1	Out of Control			
Westbound	Jasper	11.906	12.5	1		Parking or Parked Car	2	1	1 Out of Control, 1

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Westbound	Jasper	11.906	12.5	1		Out of Control			Parking or Parked Car, 1 Rear End
Westbound	Jasper	11.906	12.5		1	Rear End			
Westbound	Jasper	18.42	18.7		1	Rear End	2	1	2 Out of Control, 1 Rear End
Westbound	Jasper	18.42	18.7	2		Out of Control			
Westbound	Jasper	26.45	26.7	1		Out of Control	3	0	2 Out of Control, 1 Rear End
Westbound	Jasper	26.45	26.7	1		Out of Control			
Westbound	Jasper	26.45	26.7	1		Rear End			
Westbound	Greene	80.35	80.63	1		Rear End	3	1	2 Out of Control, 1 Passing, 1 Rear End
Westbound	Greene	80.35	80.63	1		Passing			
Westbound	Greene	80.35	80.63	1		Out of Control			
Westbound	Greene	80.35	80.63		1	Out of Control			
Westbound	Webster	91.12	91.65	1		Head On	2	1	1 Cross Median, 1 Head On, 1 Out of Control
Westbound	Webster	91.12	91.65	1		Out of Control			
Westbound	Webster	91.12	91.65		1	Cross Median			
Westbound	Laclede	111.976	112.263	1		Rear End	4	0	1 Out of Control, 1 Passing, 2 Rear End
Westbound	Laclede	111.976	112.263	1		Passing			
Westbound	Laclede	111.976	112.263	1		Rear End			
Westbound	Laclede	111.976	112.263	1		Out of Control			
Westbound	Laclede	128.693	129.118	1		Rear End	5	0	2 Out of Control, 1 Pedestrian, 2 Rear End
Westbound	Laclede	128.693	129.118	2		Out of Control			
Westbound	Laclede	128.693	129.118	1		Rear End			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Westbound	Laclede	128.693	129.118	1		Pedestrian			
Westbound	Laclede	130.0	130.6	1		Pedestrian	4	1	1 Avoiding, 1 Out of Control, 1 Pedestrian, 1 Rear End, 1 Right Angle
Westbound	Laclede	130.0	130.6	1		Right Angle			
Westbound	Laclede	130.0	130.6	1		Rear End			
Westbound	Laclede	130.0	130.6	1		Avoiding			
Westbound	Laclede	130.0	130.6		1	Out of Control			
Westbound	Laclede	137.993	138.284		1	Out of Control	3	1	4 Out of Control
Westbound	Laclede	137.993	138.284	1		Out of Control			
Westbound	Laclede	137.993	138.284	1		Out of Control			
Westbound	Laclede	137.993	138.284	1		Out of Control			
Westbound	Laclede	139.512	139.802	2		Out of Control	4	0	3 Out of Control, 1 Rear End
Westbound	Laclede	139.512	139.802	1		Rear end			
Westbound	Laclede	139.512	139.802	1		Out of Control			
Westbound	Pulaski	155.657	156.066	1		Out of Control	3	1	1 Head On, 2 Out of Control, 1 Rear End
Westbound	Pulaski	155.657	156.066		1	Rear End			
Westbound	Pulaski	155.657	156.066	1		Head On			
Westbound	Pulaski	155.657	156.066	1		Out of Control			
Westbound	Pulaski	156.3	156.63	1		Out of Control	4	0	3 Out of Control, 1 Rear End
Westbound	Pulaski	156.3	156.63	1		Out of Control			
Westbound	Pulaski	156.3	156.63	1		Out of Control			
Westbound	Pulaski	156.3	156.63	1		Rear End			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Westbound	Pulaski	157.3	157.54	1		Out of Control	3	0	2 Out of Control, 1 Rear End
Westbound	Pulaski	157.3	157.54	1		Out of Control			
Westbound	Pulaski	157.3	157.54	1		Rear End			
Westbound	Pulaski	158.53	158.84	1		Out of Control	2	1	3 Out of Control
Westbound	Pulaski	158.53	158.84	1		Out of Control			
Westbound	Pulaski	158.53	158.84		1	Out of Control			
Westbound	Pulaski	159.632	160.216	3		Rear End	7	1	5 Out of Control, 3 Rear End
Westbound	Pulaski	159.632	160.216	1		Out of Control			
Westbound	Pulaski	159.632	160.216	2		Out of Control			
Westbound	Pulaski	159.632	160.216	1		Out of Control			
Westbound	Pulaski	159.632	160.216		1	Out of Control			
Westbound	Pulaski	160.73	161.23	2		Out of Control	9	1	1 Changing Lane, 1 Head On, 3 Out of Control, 1 Passing, 4 Rear End
Westbound	Pulaski	160.73	161.23	2		Rear End			
Westbound	Pulaski	160.73	161.23		1	Head On			
Westbound	Pulaski	160.73	161.23	1		Passing			
Westbound	Pulaski	160.73	161.23	1		Out of Control			
Westbound	Pulaski	160.73	161.23	2		Rear End			
Westbound	Pulaski	160.73	161.23	1		Changing Lane			
Westbound	Phelps	171.906	172.232	2		Out of Control	7	0	5 Out of Control, 2 Rear End
Westbound	Phelps	171.906	172.232	1		Rear End			
Westbound	Phelps	171.906	172.232	1		Rear End			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Westbound	Phelps	171.906	172.232	1		Out of Control			
Westbound	Phelps	171.906	172.232	1		Out of Control			
Westbound	Phelps	171.906	172.232	1		Out of Control			
Westbound	Phelps	172.45	173.05	1		Rear end	3	1	3 Out of Control, 1 Rear End
Westbound	Phelps	172.45	173.05	1		Out of Control			
Westbound	Phelps	172.45	173.05		1	Out of Control			
Westbound	Phelps	172.45	173.05	1		Out of Control			
Westbound	Phelps	176.63	176.87	1		Other	3	0	1 Other, 2 Out of Control
Westbound	Phelps	176.63	176.87	1		Out of Control			
Westbound	Phelps	176.63	176.87	1		Out of Control			
Westbound	Phelps	177.708	178.026		1	Passing	2	2	2 Out of Control, 1 Parking or Parked Car, 1 Passing
Westbound	Phelps	177.708	178.026		1	Parking or Parked Car			
Westbound	Phelps	177.708	178.026	2		Out of Control			
Westbound	Phelps	183.53	183.819		1	Out of Control	3	1	1 Other, 1 Out of Control, 1 Parking or Parked Car, 1 Rear End
Westbound	Phelps	183.53	183.819	1		Other			
Westbound	Phelps	183.53	183.819	1		Rear End			
Westbound	Phelps	183.53	183.819	1		Parking or Parked Car			
Westbound	Phelps	184.473	184.728	2		Out of Control	2	1	2 Out of Control, 1 Pedestrian
Westbound	Phelps	184.473	184.728		1	Pedestrian			
Westbound	Phelps	188.42	188.68	2		Out of Control	3	0	3 Out of Control
Westbound	Phelps	188.42	188.68	1		Out of Control			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Westbound	Phelps	193.673	193.999	2		Out of Control	6	0	1 Cross Median, 4 Out of Control, 1 Rear End
Westbound	Phelps	193.673	193.999	1		Out of Control			
Westbound	Phelps	193.673	193.999	1		Rear End			
Westbound	Phelps	193.673	193.999	1		Cross Median			
Westbound	Phelps	193.673	193.999	1		Out of Control			
Westbound	Phelps	197.33	197.62	1		Rear End	1	2	2 Pedestrian, 1 Rear End
Westbound	Phelps	197.33	197.62		1	Pedestrian			
Westbound	Phelps	197.33	197.62		1	Pedestrian			
Westbound	Crawford	202.72	202.94	2		Out of Control	3	0	3 Out of Control
Westbound	Crawford	202.72	202.94	1		Out of Control			
Westbound	Crawford	209.515	209.793	1		Rear End	3	0	3 Rear End
Westbound	Crawford	209.515	209.793	1		Rear End			
Westbound	Crawford	209.515	209.793	1		Rear End			
Westbound	Crawford	214.1	214.5	1		Rear End	3	2	1 Cross Median, 2 Out of Control, 1 Passing, 1 Rear End
Westbound	Crawford	214.1	214.5		1	Out of Control			
Westbound	Crawford	214.1	214.5		1	Out of Control			
Westbound	Crawford	214.1	214.5	1		Cross Median			
Westbound	Crawford	214.1	214.5	1		Passing			
Westbound	Franklin	226.904	227.199	1		Passing	2	1	1 Cross Median, 1 Out of Control, 1 Passing
Westbound	Franklin	226.904	227.199	1		Cross Median			
Westbound	Franklin	226.904	227.199		1	Out of Control			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Westbound	Franklin	229.671	229.962	1		Out of Control	4	0	3 Out of Control, 1 Passing
Westbound	Franklin	229.671	229.962	1		Passing			
Westbound	Franklin	229.671	229.962	1		Out of Control			
Westbound	Franklin	229.671	229.962	1		Out of Control			
Westbound	Franklin	231.452	231.81		1	Sideswipe	2	2	1 Cross Median, 2 Out of Control, 1 Sideswipe
Westbound	Franklin	231.452	231.81	1		Out of Control			
Westbound	Franklin	231.452	231.81		1	Cross Median			
Westbound	Franklin	231.452	231.81	1		Out of Control			
Westbound	Franklin	232.201	232.6	1		Out of Control	3	0	1 Cross Median, 1 Out of Control, 1 Parking or Parked Car
Westbound	Franklin	232.201	232.6	1		Cross Median			
Westbound	Franklin	232.201	232.6	1		Parking or Parked Car			
Westbound	Franklin	232.73	232.99	2		Out of Control	4	0	4 Out of Control
Westbound	Franklin	232.73	232.99	1		Out of Control			
Westbound	Franklin	232.73	232.99	1		Out of Control			
Westbound	Franklin	248.054	248.584	1		Changing Lane	5	0	1 Changing Lane, 2 Out of Control, 1 Parking or Parked Car, 1 Rear End
Westbound	Franklin	248.054	248.584	1		Rear End			
Westbound	Franklin	248.054	248.584	1		Out of Control			
Westbound	Franklin	248.054	248.584	1		Parking or Parked Car			
Westbound	Franklin	248.054	248.584	1		Out of Control			
Westbound	Franklin	252.068	252.3	1		Out of Control	5	1	1 Changing Lane, 3 Out of Control, 1 Parking or Parked
Westbound	Franklin	252.068	252.3	1		Out of Control			

TABLE 12

Hotspot Analysis

Direction	County	Begin Log Mile	End Log Mile	Disabling Accidents	Fatal Accidents	Crash Type	Total Disabling Accidents	Total Fatal Accidents	Generic Description
Westbound	Franklin	252.068	252.3	1		Out of Control			Car, 1 Pedestrian
Westbound	Franklin	252.068	252.3		1	Pedestrian			
Westbound	Franklin	252.068	252.3	1		Parking or Parked Car			
Westbound	Franklin	252.068	252.3	1		Changing Lane			
Westbound	Franklin	253.35	253.639	1		Avoiding	6	0	1 Avoiding, 2 Out of Control, 1 Pedestrian, 2 Rear End
Westbound	Franklin	253.35	253.639	1		Pedestrian			
Westbound	Franklin	253.35	253.639	1		Out of Control			
Westbound	Franklin	253.35	253.639	1		Rear End			
Westbound	Franklin	253.35	253.639	1		Rear End			
Westbound	Franklin	253.35	253.639	1		Out of Control			
Westbound	Franklin	257.77	258.04	1		Out of Control	3	1	1 Out of Control, 3 Rear End
Westbound	Franklin	257.77	258.04	1		Rear End			
Westbound	Franklin	257.77	258.04	1		Rear End			
Westbound	Franklin	257.77	258.04		1	Rear End			

Interstate 44 (I-44) Purpose and Need Study: Freeway Traffic Analysis Methods, Assumptions, and Results (A-4)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	March 21, 2007
REVISION SUBMISSION DATE	January 31, 2008

Introduction

The purpose of this memo is to document the primary methods and assumptions used in the freeway traffic operations analysis portion of the I-44 Purpose and Need Study.

Highway Capacity Manual

A standard evaluation method for determining if a given facility will be able to adequately handle future traffic volumes is a level of service (LOS) analysis. Level of Service is the term used to describe the operational quality of a given roadway design. The *Highway Capacity Manual, Special Report 209, 2000 edition* (HCM) is the transportation profession's reference document for characterizing highway operations. Levels of service range from A (very good operations) to F (gridlock conditions; breakdown in traffic flow). The methodology described in *Chapter 23 Basic Freeway Segments,* which measures LOS based on density (passenger cars/mile/lane), was used in the I-44 freeway traffic operations analysis.

In general, the calculation of freeway density for a given segment involves determining two variables – passenger car equivalent flow rate and the average passenger car speed. The sections of the memo below describe the assumptions made to calculate these two variables.

Area Type (Rural, Urban)

One assumption that will impact the passenger care equivalent flow rate and the average passenger car speed is the area type classification. In the absence of actual peak-period traffic volume count data and field measurements of speed, the area type (land use) must be used to select default values for several components of the analysis. These components include design-hour volume, peak-hour factor, base free-flow speed, and the reduction in free-flow speed for number of lanes. All of these components are discussed in greater detail below.

For the purposes of the freeway traffic analysis, the I-44 corridor was divided into three area types based on definitions contained in AASHTO, *A Policy on Geometric Design of Highways and Streets, 2004*. These area types are urbanized, small urban, and rural.

- **Urbanized areas** are those sections of the corridor within the boundary of a city with a population greater than 50,000.

- **Small urban areas** are those sections of the corridor within the boundary of a city with a population between 5,000 and 50,000.
- **Rural areas** are those sections of the corridor not within the boundary of an urban area.

CH2M HILL used the 2000 Census to determine populations for cities along the I-44 corridor. Urban area boundaries were estimated from a combination of MoDOT traffic volume maps and engineering judgment.

Table 1 shows the sections of the corridor classified as either urbanized or small urban for the purposes of the freeway traffic analysis. All other sections were classified as rural. Joplin was considered urbanized despite the population being slightly under 50,000.

TABLE 1

Land Use Types within I-44 Study Area: Urbanized and Small Urban

I-44 Log Mile Begin	I-44 Log Mile End	City Name	Population (2000 Census)	Land Use Type
2.9	11.9	Joplin	45,504	urbanized
67.1	84.6	Springfield	151,580	urbanized
101.0	107.6	Marshfield	5,720	small urban
126.7	130.8	Lebanon	12,155	small urban
159.9	163.9	Fort Leonard Wood/St. Robert	16,426	small urban
183.9	190.0	Rolla	16,367	small urban
224.0	226.1	Sullivan	6,351	small urban
253.4	258.3	Pacific	5,479	small urban

Passenger Car Equivalent Flow Rate

The passenger car equivalent flow rate is determined from the design-hour volume, the peak-hour factor, the number of lanes, an adjustment for heavy vehicles, and the driver population factor. Assumptions made in determining these values are discussed below.

Volume Data

Existing average annual daily traffic (AADT) volumes for the I-44 eastbound and westbound freeway segments were provided by MoDOT. Segments went from one crossroad interchange to the next crossroad interchange. Truck AADT volume data were also provided.

Design Hour Volume

In order to convert MoDOT's AADT data into a design-hour volume to be used in the operations analysis, a variety of assumptions were made. A standard method for determining the design hour volume for a rural facility is to use the 30th highest hour volume (30 HV). In the absence of actual count data for all hours of the year, the 30 HV can be estimated as a percentage of the average daily traffic (ADT). This percentage is called a K-value. Chapter 2 of the AASHTO Green Book (pages 58-62) discusses the 30 HV and states that typical values for the 30 HV on a rural arterial are between 12 and 18 percent of the ADT, with 15 percent being a typical value used in analysis. In urban areas, the standard method for determining the design hour volume is to look at the repetitive weekday peak periods. In the absence of specific peak period counts, the 30 HV can also be a reasonable representation of the design hour volume. Values typically range from 8 to 12 percent of the ADT. Based on this, the following initial assumptions were made:

- K-value of 15 percent in rural areas
- K-value of 10 percent in urbanized areas
- K-value of 12.5 percent in small urban areas

These K-values were used in the initial traffic analyses and the LOS shown at the fall 2007 public information meetings. After these meetings, additional traffic data was provided by MoDOT from permanent counters at two locations along the I-44 corridor. The locations of the permanent counters and data they collected for the 30 HV as a percentage of AADT is shown in the **Table 2**.

TABLE 2

Traffic Data from Permanent Counters Along the I-44 Corridor

Counter Location	Direction	Area Classification	20th highest hour volume as percent of AADT
0.3 miles without weight scales–Newton County	Eastbound	Rural	10.2 percent
0.3 miles without weight scales–Newton County	Westbound	Rural	10.7 percent
1.9 miles without 125–Green County	Eastbound	Urban	10.3 percent
1.9 miles without 125–Green County	Westbound	Urban	8.9 percent

Based on these data, the initial assumptions for the K-value were revised in order to more closely reflect the actual I-44 conditions, while still being somewhat conservative given that the available data was limited because only two counter locations, both of which are on the western end of the project, were used. **Table 3** lists the original K-value assumptions, the actual K-value determined from the counters, and the revised K-value assumptions that were used in the final traffic operations analyses.

TABLE 3
Evolution of K-Value Assumptions

	Original Assumption	**Average from Counter Data**	**Revised Assumption**
Rural Section	15.0 percent	10.5 percent	12.0 percent
Urbanized Sections	10.0 percent	9.6 percent	10.0 percent
Small Urban Sections	12.5 percent	--	10.0 percent

Peak Hour Factor

In the absence of actual peak period 15-minute count data, default values for peak hour factor (PHF) may be applied. The HCM *Chapter 13 Freeway Concepts,* recommends using a value of 0.88 for rural areas and a value of 0.92 for urban areas. Again, in an attempt to account for the small urban areas being somewhat of a combination of the urban and rural environments, a value of 0.90 was used.

Heavy Vehicle Adjustments

To reflect the influence of heavy vehicles in the traffic stream, the HCM methodology applies a heavy-vehicle adjustment factor to the design hourly volume. The heavy vehicle adjustment factor is a function of the percentage of trucks, recreational vehicles (RVs), and passenger car equivalent factors for trucks and RVs. The values for passenger car equivalents are based on either a specific roadway grade along with its length combined with the percentage of trucks or RVs, or, in the absence of actual vertical alignment data, it can be based on the assumed terrain type.

Terrain Type

A level terrain type was assumed for the I-44 corridor from log mile 0.00 (Oklahoma state line, Newton County) to log mile 86.00 (east of Springfield, Greene County). A terrain type of rolling was assumed for all other sections of the I-44 corridor. These assumptions were based on field experience in the corridor. The terrain type designation will only be used in locations where vertical alignment data are not available.

Specific Grade

The HCM methodology recommends performing a specific grade analysis in locations that contain any upgrade longer than 0.5 mile, or any upgrade greater than or equal to 3 percent that’s also longer than 0.25 mile. The HCM methodology also recommends performing a specific grade analysis for downgrades in locations where the grade is 4 percent or steeper. In locations along the I-44 corridor where these conditions were met, heavy vehicle factors based on specific grades were used. In addition, heavy vehicle factors based on specific grade were used everywhere that vertical alignment data was available. However, because these additional locations did not meet the grade criteria for requiring a specific grade analysis, the resulting truck factors were simply the default values for a level terrain type designation.

Composite Grade

In order to determine the effect of a series of upgrades, segments with multiple upgrades in a row were identified and a composite grade was determined. A segment's composite grade was the average grade across the length of the segment. Passenger car equivalent values based on the composite grade that were found to be greater than the values determined based on specific grade were used in the analysis.

Percent Trucks

The AADT volumes provided by MoDOT included truck volumes that were used to calculate the truck percentage for all I-44 segments. The truck percentages calculated are between 18 percent and 30 percent. The passenger car equivalent tables in the HCM do not include any values for percent trucks greater than 25 as that was the highest percentage of trucks observed in the development of the methodology. Thus, technically the value for the truck passenger car equivalent for many segments of the I-44 corridor is not known. For the purpose of this analysis, a passenger car equivalent value based on 25 percent trucks was used for all segments either at or above that percentage. The actual calculated truck percentages were used in the calculation of the heavy vehicle adjustment factor, as the percentage of trucks is a variable in the equation just as the passenger car equivalent value is a variable in the equation.

Percent RVs

The ADT volumes provided by MoDOT did not include RVs. Field visits to the corridor didn't seem to indicate significant RV traffic, and thus a value of 0 percent was assumed.

Driver Population Adjustment

For the purposes of the driver population adjustment, the freeway segments were classified as having either recreational traffic characteristics or nonrecreational traffic characteristics. Per *HCM Chapter 13 Freeway Concepts*, freeway segments with a significant portion of recreational traffic can warrant the use of driver population adjustment as low as 0.85. The standard assumption for freeway segments with nonrecreational traffic characteristics is 1.0. While some segments of the study area do serve recreational users, it was determined that it was not a significant enough portion of the traffic stream to warrant the classification of the segment as recreational and using a driver population factor less than 1.0. Thus, all segments of the I-44 corridor were classified as nonrecreational, and a driver population factor of 1.0 was used in the analyses.

Average Passenger Car Speed

The average passenger car speed of a freeway segment is determined from the free-flow speed (FFS). The FFS of a freeway segment (mean speed of passenger cars measured during low to moderate flows) can be either field measured or, if field measurements aren't available, can be estimated by applying reduction factors to a base free-flow speed (BFFS).

Base Free-Flow Speed

The BFFS, which is used as a starting point in the estimation of FFS, was selected based on default values for area types in combination with the design speed of specific geometric elements.

Area Type

Chapter 23 of the HCM guidance provides default values for BFFS based on area type, with urban areas having a default BFFS of 70 mph and rural areas having a default BFFS of 75 mph. Small urban areas were assumed to have the same BFFS as urbanized areas, and thus a value of 70 mph was used.

Geometry

The BFFS values determined from the HCM Chapter 23 defaults were used as a starting point; however, the design speed of the existing horizontal and vertical geometry was also considered. In segments where the design speed of the existing geometry was lower than the default value based on area type, the lower value was used as the BFFS. It should be noted that a minimum value for BFFS of 55 mph was used in order to be consistent with HCM methodology.

Adjustment Factors

Once the BFFS was established, the reduction factors based on the elements described below were applied in order to determine the FFS used in the analysis.

Lane Width

The lane width for all segments of the I-44 corridor is 12 feet. This results in no reduction to the BFFS.

Lateral Clearance

The right shoulder width for all segments of the I-44 corridor is greater than or equal to 6 feet. This results in no reduction to the BFFS.

Number of Lanes

The number of lanes (directional) used in the analysis was two with the exception of segments that contained climbing lanes. The reduction in BFFS for number of lanes was only taken into account in urbanized areas and small urban areas. Per HCM guidance, there was no reduction in BFFS due to number of lanes in rural areas.

Interchange Density

In order to determine a value for interchange density for a given freeway segment, a 6-mile section of freeway containing the segment was evaluated (approximately 3 miles east and 3 miles west of the center of the segment). The number of interchanges within this section was divided by six to calculate the number of interchanges per mile used in the analysis. The use of a 6-mile section is per *HCM Chapter 13 Freeway Concepts* guidance.

Levels of Service

Table 4 lists the existing (2005) and future (2035) levels of service for the I-44 study area. The 16 segments listed in **Table 4** are the segments based on the land use types present along I-44 (see **Table 1**). The balance of this section is a more detailed description of the results found in **Table 4.**

TABLE 4

Existing and Future Level of Service

Location	Level of Service			
	Eastbound 2005	**Westbound 2005**	**Eastbound 2035**	**Westbound 2035**
Oklahoma State Line to Joplin	B	B	E/F	E/F
Through Joplin	B/C. LOS C is associated with horizontal curves	B/C	C – F. East of Route 43 and west of Business 71 LOS F. East of Business 71 LOS C/D	C – F. Sections west of Business 71 and east of Route 43 LOS E or F. East of Business 71 LOS C and D
Between Joplin and Springfield	B/C. LOS C is associated with horizontal curves.	B/C. There is a segment containing a horizontal curve with a LOS D.	D - F. Between Cimmaron Road and Route PP LOS E or F. West of Cimmaron Road and east of Route PP LOS D.	D - F. The section between Cimmaron Road and Route PP LOS E or F. West of Cimmaron Road and east of Route PP LOS D.
Through Springfield	D - Between US 160 and US 65. East and west of this section LOS B and C.	LOS D - Between MO 13 (Kansas Expressway) and Loop 44/Route H (Glenstone). East and west of this section LOS B/C.	E - F. West of Route MM LOS D. East of Route MM LOS E-F.	E - F. West of Route MM, LOS D. East of Route MM LOS E - F.
Between Springfield and Marshfield	B - D	B - C	F	F
Through Marshfield	B	A - B. One horizontal curve resulted in LOS B.	D - E. LOS E are in locations with horizontal or vertical curves	C - E. LOS E are in locations with horizontal or vertical curves LOS C is in a location with a climbing lane.
Between Marshfield and Lebanon	B. Steep grades and higher traffic contribute to LOS C.	A – C. One horizontal curve resulted in LOS C.	F.	F.
Through Lebanon	B - C	B - C	D - F. West of Route 5/Route 32 LOS F. East of Route 5/Route 32 LOS D.	D - F. West of Route 5/Route 32 LOS F. East of Route 5/Route 32 LOS improve to D.
Between Lebanon and St. Robert/Fort Leonard Wood	A - C. Horizontal and/or vertical curves resulted in LOS C.	B - C. Horizontal curves resulted in LOS C.	E - F. Few sections with less volume result in LOS D.	E - F. Few sections with less volume result in LOS D.

TABLE 4

Existing and Future Level of Service

Location	Level of Service			
	Eastbound 2005	**Westbound 2005**	**Eastbound 2035**	**Westbound 2035**
Through St. Robert/Fort Leonard Wood	B - C. Steep grades are associated with LOS C.	B - C. One horizontal curve resulted in LOS C.	C - D	C - D. West of Route Y, section with horizontal curve resulted in LOS E.
Between St. Robert/Fort Leonard Wood and Rolla	A - C. Horizontal curves resulted in LOS C.	A - C. Horizontal and/or vertical curves resulted in LOS C.	E - F. Between Sugar Tree Road and Route T/C LOS D. Two sections with climbing lanes LOS C.	E - F. Between Sugar Tree Road and Route T/C LOS D. Three sections with climbing lanes LOS C - D.
Through Rolla	C - D. Horizontal curve resulted in LOS E.	B - C. Horizontal curves resulted in LOS C.	LOS C /D West of U.S. 63. East of U.S. 63 LOS F.	LOS C /D West of U.S. 63. East of U.S. 63 LOS F.
Between Rolla and Sullivan	B - C	B. Sections with horizontal and/or vertical curves result in LOS D.	F	F
Through Sullivan	B/C. Few sections with horizontal or vertical curves resulted in LOS C.	B/C. Few sections with horizontal or vertical curves resulted in LOS C.	F	F
Between Sullivan and Pacific	B - D. Several sections with horizontal and vertical curves result in LOS C or worse.	B – D. East of the Route 100 LOS D. Sections with horizontal curves result in LOS C - D.	F	F
Through Pacific to the east study limit	LOS C West of 44. LOS E East of 44.	D	F	F

Level of Service Eastbound I-44

Oklahoma State Line to Joplin

2005: Operations are generally good with all sections operating at LOS B.

2035: Operations are congested with all sections operating at LOS E or F.

Through Joplin

2005: Operations are generally good with LOS between B and C. Level of service C is associated with horizontal curves.

2035: Operations are generally fair to congested with levels of service ranging from C to F. Sections east of Route 43 and west of Business 71 experience more congestion and for the most part operate at LOS F. East of Business 71 there is a reduction in volume and operations improve to LOS C and D.

Between Joplin and Springfield

2005: For the most part operations are generally good with levels of service between B and C. Level of service C is associated with horizontal curves.

2035: Operations are generally fair to congested with a levels of service ranging from D to F. The section between Cimmaron Road and Route PP experiences the most congestion and operates at levels of service E or F. West of Cimmaron Road and east of Route PP there is less volume and operations improve to LOS D for most sections.

Through Springfield

2005: The section through the heart of Springfield, between U.S. 160 and U.S. 65, has high enough volumes to create a somewhat congested condition at LOS D. The sections of Springfield east and west of this section have generally good operations, ranging between LOS B and C.

2035: Operations are generally congested with most sections operating at LOS E or F. West of Route MM, there is significantly less traffic volume and levels of service are at D. All sections east of Route MM are at LOS E or F.

Between Springfield and Marshfield

2005: Operations are slightly worse in this section than the rural section between Joplin and Springfield due to slightly higher volumes and a large number of horizontal curves that result in reduced base free-flow speeds. There are also a few vertical curves that result in reduced base free-flow speeds. Levels of service in this section range from B to D.

2035: Operations are generally congested with all sections operating at LOS F. Multiple occasions exist in which horizontal curves reduce the free-flow speed to 55 mph.

Through Marshfield

2005: Operations are generally good with levels of service at B.

2035: Operations are generally fair to congested with levels of service ranging from D to E. The sections operating at LOS E are in locations where horizontal or vertical curves result in reduced free-flow speeds.

Between Marshfield and Lebanon

2005: Operations are generally good with levels of service for most sections at LOS B. Steep grades and higher traffic contributes to some areas having a LOS C.

2035: Operations are congested, with all sections operating at LOS F.

Through Lebanon

2005: Operations are generally good with LOS between B to C.

2035: Operations are generally congested with a LOS between D to F. West of Route 5/Route 32 operations are at LOS F. East of Route 5/Route 32, volumes are less and levels of service improve to D.

Between Lebanon and St. Robert/Fort Leonard Wood

2005: For the most part, operations are generally good with levels of service between A and C. There are several sections with horizontal and/or vertical curves which were analyzed with 55 or 60 mph base free-flow speeds that resulted in LOS C.

2035: Operations are generally congested with LOS between E to F. There are a few sections with less volume that result in LOS D.

Through St. Robert/Fort Leonard Wood

2005: Operations are generally good with levels of service between B and C. Steep grades are associated with LOS C.

2035: Operations are generally fair with LOS between C and D.

Between St. Robert/Fort Leonard Wood and Rolla

2005: Operations are generally good with levels of service between A and C. There are segments containing horizontal curves which were analyzed with a 55 mph base free-flow speed that resulted in LOS C.

2035: Operations are generally congested with most sections operating at LOS E and F. In the section between Sugar Tree Road and Route T/C, volumes are reduced and operations improve to LOS D. In addition, there are two sections which contain climbing lanes that operate at LOS C.

Through Rolla

2005: Operations are generally fair to somewhat congested with almost all sections operating at LOS C or D. There is one section containing a horizontal curve that was analyzed with a 55 mph base free-flow speed and a 4 percent upgrade that resulted in LOS E.

2035: West of U.S. 63, operations are generally fair with levels of service between C and D. East of U.S. 63 volumes increase and operations become congested at LOS F. Almost all sections have horizontal or vertical curvature that result in reduced free-flow speeds.

Between Rolla and Sullivan

2005: Operations are generally good, with most sections operating at LOS between B and C. There are several sections with horizontal and/or vertical curves that were analyzed with reduced free-flow speeds.

2035: Operations are congested with all sections operating at LOS F.

Through Sullivan

2005: Operations are generally good, with sections operating at LOS B or C. There are a few sections with horizontal or vertical curves which were analyzed with a base free-flow speed of 55 mph which resulted in LOS C.

2035: Operations are congested with all sections operating at LOS F.

Between Sullivan and Pacific

2005: Operations are generally good to somewhat congested with all sections operating at levels of service between B and D. There are several sections where horizontal and vertical curves were analyzed with a base free-flow speed of 55 mph which resulted in LOS C or worse.

2035: Operations are congested with all sections operating at LOS F.

Through Pacific to the East Study Limit

2005: Operations are generally somewhat congested, with all sections west of Loop 44 operating at LOS C. East of Loop 44 volumes increase to the point that operations deteriorate to LOS E.

2035: Operations are congested with all sections operating at LOS of F.

Level of Service Westbound I-44

Okalahoma State Line to Joplin

2005: Operations are generally good with levels of service at B.

2035: Operations are congested with all sections operating at LOS E or F.

Through Joplin

2005: Operations are generally good with levels of service between B and C. Most segments with horizontal curvature were analyzed with base free-flow speeds of 55 mph.

2035: Operations are generally fair to congested with levels of service ranging from C to F. Sections west of Business 71 and east of Route 43 experience more congestion and operate at LOS E or F. East of Business 71 there is a reduction in volume and operations improve to LOS C and D.

Between Joplin and Springfield

2005: For the most part, operations are generally good with levels of service between B and C. There is a segment containing a horizontal curve which was analyzed with a 55 mph base free-flow speed that resulted in LOS D.

2035: Operations are generally fair to congested with a levels of service ranging from D to F. The section between Cimmaron Road and Route PP experiences the most congestion and operates at levels of service E or F. West of Cimmaron Road and east of Route PP there is less volume and operations improve to LOS D for all sections.

Through Springfield

2005: The section between the interchange at MO 13 (Kansas Expressway) and Loop 44/Route H (Glenstone) has high enough volumes to create a somewhat congested condition at LOS D. The sections of Springfield east and west of this section have generally good operations, ranging between LOS B and C.

2035: Operations are generally congested with most sections operating at LOS E or F. West of Route MM, there is significantly less traffic volume and LOS are at D. All sections east of Route MM are at LOS E or F.

Between Springfield and Marshfield

2005: Operations are slightly worse in this section than the rural section between Joplin and Springfield due to slightly higher volumes and a large number of horizontal curves that result in reduced base free-flow speeds. There are also a few vertical curves that result in reduced base free-flow speeds. Levels of service in this section range from B to C.

2035: Operations are generally congested with all sections operating at LOS F. Multiple occasions exist in which horizontal curves reduce the free-flow speed to 55 mph.

Through Marshfield

2005: Operations are generally good with levels of service between A and B. One horizontal curve was analyzed with a base free-flow speed of 55 mph which resulted in a LOS of B.

2035: Operations are generally fair to congested with LOS ranging from C to E. The sections operating at LOS E are in locations where horizontal or vertical curves result in reduced free-flow speeds. The section operating at LOS C is in a location where a climbing lane exists.

Between Marshfield and Lebanon

2005: Operations are generally good with levels of service between A and C, with the vast majority being B. One horizontal curve was analyzed with a base free-flow speed of 55 mph which resulted in a LOS of C.

2035: Operations are congested, with almost all sections operating at LOS F.

Through Lebanon

2005: Operations are generally good with the LOS falling between B to C.

2035: Operations are generally congested with levels of service between D and F. West of Route 5/Route 32 operations are at LOS F. East of Route 5/Route 32, volumes are less and LOS improves to D.

Between Lebanon and St. Robert/Fort Leonard Wood

2005: For the most part operations are generally good with levels of service between B and C. There are a few sections with horizontal curves that were analyzed with 55 or 60 mph base free-flow speeds that resulted in LOS C.

2035: Operations are generally congested with levels of service between E and F. There are a few sections with less volume that result in LOS D.

Through St. Robert/Fort Leonard Wood

2005: Operations are generally good with LOS between B and C. One horizontal curve was analyzed with a base free-flow speed of 55 mph which resulted in a LOS of C.

2035: Operations are generally fair with levels of service between C and D for most sections. West of Route Y, where volumes are higher, there is a section with horizontal curvature that resulted in LOS E when analyzed with a reduced free-flow speed.

Between St. Robert/Fort Leonardwood and Rolla

2005: Operations are generally good with levels of service between A and C. There are some sections where horizontal and/or vertical curves were analyzed with 55-60 mph base free-flow speeds that resulted predominately with LOS C.

2035: Operations are generally congested with most sections operating at LOS E and F. In the section between Sugar Tree Road and Route T/C, volumes are reduced and operations improve to LOS D. In addition, there are three sections which contain climbing lanes that operate at LOS C or D.

Through Rolla

2005: Operations are generally good with levels of service between B and C. There are some sections where horizontal curves were analyzed with 55-60 mph base free-flow speeds that resulted predominately with LOS C.

2035: West of U.S. 63, operations are generally fair with levels of service between C and D. East of U.S. 63 volumes increase and operations become congested at LOS F. Almost all sections have horizontal or vertical curvature that result in reduced free-flow speeds.

Between Rolla and Sullivan

2005: Operations are generally fair, with most sections operating at LOS B. There are several sections with horizontal and/or vertical curves which were analyzed with a base free-flow speed of 55 mph, resulting in LOS D.

2035: Operations are congested with all sections operating at LOS F.

Through Sullivan

2005: Operations are generally good, with most sections operating at LOS B or C. There are a few sections with horizontal or vertical curves which were analyzed with a base free-flow speed of 55-60 mph which resulted in LOS C.

2035: Operations are congested with all sections operating at LOS F.

Between Sullivan and Pacific

2005: Operations are generally fair to somewhat congested with most sections operating at LOS C, although some are at LOS B and D. East of the Route 100 interchange, increased volumes result in operations worsening to LOS D as well as having sections where horizontal curves were analyzed at 55 mph, resulting in a LOS between C to D.

2035: Operations are congested with all sections operating at LOS F.

Through Pacific to the East Study Limit

2005: Operations are generally somewhat congested with all sections operating at LOS D.

2035: Operations are congested with all sections operating at LOS F.

Break Point Year Analysis

Many segments of the I-44 study area were found to be operating at LOS F in the 2035. For this reason, a supplemental traffic analysis was performed for the year 2025 with traffic volumes predicted by the Missouri statewide traffic model. These results, in combination with the 2005 and 2035 results, were used to approximate at what intermediate year the segments failing in 2035 would reach LOS F. For the purposes of this analysis, I-44 was broken into segments between interchanges.

In order to approximate each segments "break point" year, the average density across a segment (as calculated during LOS analyses) for each of the three analysis years (2005, 2025, and 2035), was plotted verses time. From these three points, a best fit curve was developed. The break-point year was approximated by determining the year (rounded to the nearest 5 year) at which the best fit density curve crossed the LOS F threshold.

A limitation of this methodology is that any calculated value for density beyond the threshold for LOS F is technically impossible because the density value at LOS F is the maximum density that the freeway can handle. Because of this, engineering judgment had to be used, and factors had to be applied to the calculated densities that were larger than the maximum.

Table 5 below lists those segments of I-44 performing at LOS F in the design year 2035 along with approximate year that each segment is expected to degrade to LOS F. While some segments do not degrade to LOS F until 2035, others will likely do so much earlier.

TABLE 5

Segments of I-44 Performing at LOS F in the Design Year 2035

Location					**Approximate Year Operations at LOS F**	
			Section Begin	Section End	Eastbound I-44	Westbound I-44
2	U.S. 166 to Rest Area	Rural	Exit 1	Rest	2030	NA
5	Route 43 to Route 86	Urban	Exit 4	Exit 6	2025	2030
6	Route 86 to Business Route 71	Urban	Exit 6	Exit 8	2015	2015
9	Route 66 to U.S. 71 N	Rural	Exit 15	Exit 18	2025	2020
10	U.S. 71 N to 10th Road.	Rural	Exit 18	Exit 22	2030	2020
11	10th Road. to Route 37	Rural	Exit 22	Exit 26	2025	2025
12	Route 37 to Route U	Rural	Exit 26	Exit 29	2025	2025
13	Route U to Route 97 S	Rural	Exit 29	Exit 33	NA	2035
17	Route 265/39 to Route 174	Rural	Exit 46	Exit 49	2030	2030
18	Route 174 to Rest Area	Rural	Exit 49	Rest	2030	2030
19	Rest Area to Route 96	Rural	Rest	Exit 57	2025	2025
20	Route 96 to Route Z/O	Rural	Exit 57	Exit 58	2015	2015
21	Route Z/O to Route K/PP	Rural	Exit 58	Exit 61	2010	2010
25	Route B/MM to Route 266	Urban	Exit 70	Exit 72	2030	2030
28	U.S. 160 to Route 13	Urban	Exit 75	Exit 77	NA	2035
29	Route 13 to Route H	Urban	Exit 77	Exit 80	2010	2010
30	Route H to U.S. 65	Urban	Exit 80	Exit 82	2010	2010
31	U.S. 65 to Route 744	Urban	Exit 82	Exit 84	2025	NA
32	Route 744 to Route 125	Urban	Exit 84	Exit 88	2010	2010
33	Route 125 to Route B	Rural	Exit 88	Exit 96	2020	2020
34	Route B to Route 38	Rural	Exit 96	100	2015	2015
36	Sampson Rd. to Rest Area	Rural	107	Rest	2020	2025
37	Rest Area to Route Y/J	Rural	Rest	113	2015	2025
38	Route Y/J to Route C	Rural	113	118	2020	2025
39	Route C to Route W	Rural	118	123	2025	2025

TABLE 5

Segments of I-44 Performing at LOS F in the Design Year 2035

Location					**Approximate Year Operations at LOS F**	
			Section Begin	Section End	Eastbound I-44	Westbound I-44
40	Route W to Elm St.	Urban	123	127	2025	2025
41	Elm St. to Route 64/5/32	Urban	127	129	2035	2035
45	Route T/N to Route 133	Rural	140	145	2030	2030
46	Route 133 to Route 7/P	Rural	145	150	2035	2030
47	Route 7/P to Route 17	Rural	150	153	2035	2035
48	Route 17 to Route H	Rural	153	156	2035	NA
53	Route J to Route D	Rural	169	172	2030	2030
54	Route D to Sugar Tree Rd.	Rural	172	176	2030	2025
57	Route T/C to King's Highway	Rural	179	184	2035	2035
60	U.S. 63 to Route V	Urban	186	189	2030	2030
61	Route V to Route. 68/8	Urban	189	195	2015	2015
62	Route 68/8 to Route F	Rural	195	203	2025	2015
63	Route F to Route 19	Rural	203	208	2025	2025
64	Route 19 to Route UU	Rural	208	210	2025	2025
65	Route UU to Route H	Rural	210	214	2025	2025
66	Route H to Route C/N	Rural	214	218	2025	2025
67	Route C/N to Route 185	Urban	218	225	2015	2020
68	Route 185 to Route 185 S	Urban	225	226	2015	2020
69	Route 185 S to Route JJ/W	Rural	226	230	2015	2020
70	Route JJ/W to Rest Area	Rural	230	235	2010	2010
71	Rest Area to Weigh Station	Rural	235	238	2010	2010
72	Weigh Station to Route 30	Rural	238	239	2010	2015
73	Route 30 to Route 47	Rural	239	240	2020	2025
74	Route 47 to Route AH	Rural	240	242	2020	2020

TABLE 5

Segments of I-44 Performing at LOS F in the Design Year 2035

Location					**Approximate Year Operations at LOS F**	
			Section Begin	Section End	Eastbound I-44	Westbound I-44
75	Route 66 to U.S. 50	Rural	242	247	2015	2015
76	U.S. 50 to Route 100 West	Rural	247	251	2010	2010
77	Route 100 W to Route 100 East	Urban	251	253	2010	2010
78	Route 100 E to Loop 44	Urban	253	257	2015	2010
79	Loop 44 to St. Louis County	Urban	257	--	2010	2010

Segments expected to operate at LOS F in at least one direction by approximately 2010 are shown in orange.
Segments expected to operate at LOS F in at least one direction by approximately 2015 are shown in yellow.

Interstate 44 (I-44) Purpose and Need Study: Environmental Justice (A-5)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
DATE:	January 18, 2008
PROJECT NUMBER	355821

Introduction

The purpose of this technical memorandum is to identify potential Environmental Justice (EJ) issues along I-44 as part of the statewide I-44 Purpose and Need Study. Compliance with EJ is mandated by Title VI of the Civil Rights Act of 1964, Executive Order 12898, and several other laws and guidance for transportation projects receiving federal funds. The following are key legal excerpts concerning EJ:

> "Each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations."
> ***- Executive Order 12898* (1994).**
>
> "No person in the United States shall, on the ground of race, color, or national origin be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance."
> ***- Title VI of the Civil Rights Act of 1964*.**

The MoDOT Engineering Policy Guide, specifically Section 127.3 – Community Impact Assessment provides additional legal background and guidance related to EJ analysis.

This technical memorandum assesses potential EJ issues along the I-44 corridor, analyzed at the census-tract level. Potential EJ issues include the potential for disproportionate transportation related impacts to minorities, the elderly, aged 65 and greater, those living under the poverty threshold, and the disabled. Compliance with EJ also requires that disadvantaged groups be given appropriate notification of public involvement and project development. Special needs of disadvantaged groups such as appropriate language translation, handicapped accessibility, and ease of venue access for elderly should be accommodated throughout the public involvement and project development processes.

This technical memorandum does not assess EJ impacts. Impacts can only be assessed after evaluating opportunities for minimization and avoidance, when alternatives are developed as part of the National Environmental Policy Act (NEPA) process. The Federal Highway Administration (FHWA) requires that EJ be considered throughout the roadway planning process, though study detail increases as planning progresses.

Methodology

A Geographic Information System (GIS) layer of census tracts was overlain on a GIS layer of I-44 from the St. Louis County and Franklin County Line, Mile Marker 258.3, southwest to the Oklahoma state line, Mile Marker 0.0. See **Figures 1a, 1b, and 1c**. Those census tracts that were adjacent to either eastbound or westbound I-44 were included in this analysis.

Summaries of census data for counties along the I-44 corridor and at the statewide level were downloaded from the U.S. Census Bureau at http://quickfacts.census.gov/qfd/ststaes/29000.html. County and statewide racial and elderly data are based on 2005 estimates of population characteristics. County and statewide data concerning persons living below the poverty level are based on 2003 estimates. Summaries of census data for relevant census tracts were downloaded from the U.S. Census Bureau at http://factfinder.census.gov. Census-tract level data for race is based on the 1990 and 2000 Census.

For Census 2000 data, the data set “Census 2000 Summary File 1 (SF1) 100-Percent Data,” was used. Census-tract level data identifying populations aged 65 or greater was downloaded as “Table P12. Sex by Age [49] – Universe: Total Population”. Census-tract data identifying populations living below the poverty line is based on the 2000 Census, based on data collected in 1999, specifically the data set “Census 2000 Summary File 4 (SF 4) – Sample Data.”

For Census 1990 data, the data set “Census 1990 Summary Tape File 1 (STF1) 100-Percent Data” was used for racial data and downloaded as Table P006. Persons of Hispanic Origin data was downloaded as Table P008 and age data was downloaded as Table QT-P1A. For poverty data, the “1990 Summary Tape File 3 (STF3) – Sample Data” was used and downloaded as Table P118.

In order to identify potential EJ issues, census tract data for disadvantaged groups were compared to county and statewide data for these protected groups. See **Tables 1** and **2**. For purposes of this technical memorandum, demographic thresholds indicating potential EJ issues are described as follows:

- Where a census tract elderly or impoverished group population percentage was >10 percent more than the county average for that disadvantaged group, the census tract was identified as a potential EJ issue.
- Where a census tract aggregated minority population that is, all minority groups combined was greater than the aggregated minority population of the relevant county, the census tract was identified as a potential EJ issue.

Aggregated data are depicted on **Figures 1a, 1b, and 1c** and represent potential EJ issues. Disaggregated data, highlighted yellow, are shown in **Tables 1 and 2** for illustrative purposes only and are not intended to represent potential EJ issues.

Poverty thresholds vary by household size and the number of persons in the household under 18 years of age and are presumed nonwage earners. Further, thresholds vary by year with respect to the Consumer Price Index. For the purposes of this technical memorandum, census-tract level poverty data are from 1989, summarized in the 1990 Census and 1999, summarized in the 2000 Census. County and statewide poverty data are from 1989, summarized in 1990 census and 2003. At all levels of data, census tract, county, and state, the "persons below poverty (percent)" is the metric used for comparison.

Results

In **Tables 1 and 2**, census tracts identified as having a disproportionate population of a disadvantaged group are coded with highlighting or hatching as follows:

- High minority, all minority populations combined, census tracts are highlighted in green.
- High minority, individual minority populations, census tracts, are not highlighted although individual minority groups are highlighted in yellow.
- High elderly census tracts are red hatched.
- High poverty census tracts are blue hatched.

Several census tracts have been identified as having potential EJ issues resulting from more than one disadvantaged group, such as "high-minority" and "high-elderly" — those census tracts are coded appropriately.

TABLE 1

2000 Census Population Characteristics in the I-44 Project Area By Census Tract Compared To County and the State of Missouri

	Percentages								
State/ County/ Census Tract	Persons Below Poverty	Under 18	Over 65	White	Black	American Indian	Asian or Pacific Islander	Hispanic	Tot. Min.
Missouri (statewide)	11.6	23.8	13.3	85.4	11.5	0.4	1.4	2.7	16.0
Newton County	12.2	24.2	13.9	94.0	0.8	2.1	1.1	2.8	6.8
206	9.7	--	10.5	93.6	0.69	2.8	0.21	1.2	4.9
205	7.2		17.3	94.2	0.93	1.6	0.80	1.9	5.2
Jasper County	14.9	25.1	13.3	94.1	1.7	1.3	0.9	5.2	9.1
104	10.4		21.3	94.2	0.54	1.6	1.4	1.6	5.1
119	19.4	--	10.6	93.9	0.70	1.4	0.83	1.7	4.6
120	16.5	--	13.1	95.9	0.31	0.82	0.16	1.5	2.8
Lawrence County	13.7	25.3	15.1	97.4	0.4	0.8	0.3	4.6	6.1
9703	17.7	--	5.4	90.7	0.42	0.85	0.21	10.6	12.1
9702	10.5	--	19.3	97.0	0.44	0.82	0.29	1.16	2.7
9701	12.0	--	13.8	98.2	0.11	0.58	0.25	1.1	2.0
9705	14.3	--	8.8	97.2	0.11	0.58	0.25	1.1	2.0

TABLE 1

2000 Census Population Characteristics in the I-44 Project Area By Census Tract Compared To County and the State of Missouri

State/ County/ Census Tract	Percentages								
	Persons Below Poverty	Under 18	Over 65	White	Black	American Indian	Asian or Pacific Islander	Hispanic	Tot. Min.
Greene County	12.5	21.2	13.8	93.9	2.5	0.7	1.3	2.2	6.7
49	6.1	--	10.8	98.1	0.11	0.52	0.05	0.45	1.1
48.01	7.6	--	13.1	96.7	0.27	0.34	0.11	0.95	1.7
43.02	12.7	--	12.5	95.9	0.68	0.82	0.32	1.1	2.9
44	8.3	--	19.1	95.1	1.7	0.55	0.66	1.6	4.5
22	17.1	--	12.5	91.2	4.6	0.88	0.68	2.2	8.4
37	2.7	--	14.6	96.0	1.3	0.39	0.88	0.74	3.3
45	8.7	--	13.5	95.6	1.5	0.95	0.11	1.3	3.9
36	19.0		12.5	93.3	1.9	1.1	0.65	1.9	5.6
56	12.2		18.3	94.9	1.6	0.72	0.62	1.2	4.1
46	9.2	--	10.4	97.8	0.16	0.47	0.11	1.2	1.9
Webster County	13.9	26.2	11.8	96.9	1.2	0.7	0.2	1.2	3.3
9701	11.0	--	10.4	97.6	0.18	0.51	0.29	1.0	2.0
9702	9.8	--	15.6	97.9	0.19	0.35	0.30	1.7	2.5
9703	23.5	--	7.7	96.7	0.46	0.72	0.34	0.89	2.4
Laclede County	14.3	24.4	14.6	97.2	0.6	0.5	0.3	1.6	3.0
9601	13.9	--	11.7	97.2	0.18	0.51	0.29	1.0	2.0
9603	10.1	--	13.1	98.1	0.15	0.38	0.18	1.1	1.8
9606	13.8	--	14.4	94.5	0.82	0.91	0.41	2.1	4.2
9605	16.6	--	17.9	96.2	0.44	0.46	0.81	1.6	3.3
9602.98	15.6	--	12.2	98.2	0.09	0.42	0.09	0.81	1.4
Pulaski County	12.3	25.3	7.8	80.8	12.3	0.9	2.7	6.6	22.5
9705	16.2	--	13.9	94.2	1.2	0.75	0.87	2.0	4.8
9704	11.4	--	11.2	80.7	9.9	1.2	3.1	3.7	17.9
9702.85	11.0	--	7.7	72.4	15.4	0.82	4.6	4.8	25.6
Phelps County	14.1	21.6	13.7	94.0	1.9	0.5	2.1	1.6	6.1
9906	16.7	--	14.4	96.9	0.18	0.81	0.48	0.85	2.3
9905	11.7	--	14.4	97.0	0.28	0.82	0.34	0.79	2.2
9903	23.5		16.6	90.3	3.7	0.41	3.2	1.8	9.1
9907	15.1	--	13.3	96.0	0.30	0.85	1.0	0.85	3.0
9908	23.3	--	12.0	93.1	2.5	0.51	2.1	0.91	6.0
9904	36.7	--	7.4	84.4	2.8	0.67	9.3	1.8	14.6
9901	9.6	--	11.8	96.1	1.4	0.63	0.38	0.88	3.3

TABLE 1

2000 Census Population Characteristics in the I-44 Project Area By Census Tract Compared To County and the State of Missouri

State/ County/ Census Tract	Percentages								
	Persons Below Poverty	Under 18	Over 65	White	Black	American Indian	Asian or Pacific Islander	Hispanic	Tot. Min.
9902	14.0	--	22.6	94.7	0.31	0.48	0.26	0.75	1.8
Crawford County	14.5	23.8	15.9	98.5	0.2	0.4	0.2	1.5	2.3
9503	17.9	--	18.9	98.0	0.26	0.39	0.23	1.0	1.9
9501	11.9	--	13.9	98.6	0.05	0.33	0.10	0.90	1.4
9502	19.4	--	12.8	98.9	0.05	0.36	0.15	0.36	0.92
Franklin County	8.4	24.6	12.4	97.8	0.9	0.2	0.3	1.0	2.4
8011	9.9	--	16.3	98.3	0.17	0.21	0.66	1.1	2.1
8005	5.9	--	12.7	98.6	0.06	0.17	0.29	0.53	1.1
8008	10.0		9.1	95.2	2.5	0.34	0.26	0.83	3.9
8010	9.1	--	9.1	97.9	0.66	0.17	0.22	0.33	1.4
8009	9.1	--	12.5	97.9	0.65	0.32	0.17	0.59	1.7
8006.02	3.6	--	10.5	98.0	0.73	0.18	0.13	0.78	1.8
8007.01	12.6	--	11.1	94.8	2.5	0.41	0.32	0.95	4.2
8001	5.1	--	9.8	97.4	0.99	0.30	0.29	0.69	2.3
8007.02	7.0	--	8.1	95.4	2.2	0.19	0.22	0.71	3.3

Source: U.S. Census Bureau, Census 2000

Table Key:

🟩	= Census Tract with all minority populations (aggregated) higher than county average.
🟨	= Census Tract with an individual minority population higher than county average
🟦	= Census Tract with impoverished population higher than county average
🟥	= Census Tract with elderly population (aged >=65) higher than county average

TABLE 2

1990 Census Population Characteristics in the I-44 Project Area By Census Tract Compared To County and the State of Missouri

State/ County/ Census Tract	Percentages								
	Persons Below Poverty	Under 18	Over 65	White	Black	American Indian	Asian or Pacific Islander	Hispanic	Tot. Min.
Missouri (statewide)	13.0	--	14.0	87.7	10.7	0.4	0.8	1.2	13.1
Newton County	13.8	--	14.5	96.7	0.4	2.1	0.5	0.8	3.8
206	14.2	--	9.9	96.9	0.29	2.3	0.29	0.71	3.6
205	7.2	--	15.5	97.1	0.35	1.7	0.66	0.95	3.7
Jasper County	15.0	--	15.6	96.3	1.3	1.7	0.6	0.9	4.5
104	9.8	--	19.4	97.3	0.32	1.3	0.92	1.3	3.8
119	14.9	--	9.6	97.3	0.29	2.0	0.35	0.76	3.4
120	13.2	--	14.5	96.9	0.07	2.8	0.19	0.61	3.7
Lawrence County	15.7	--	17.8	98.6	0.08	0.9	0.2	0.7	1.9
9703	12.7	--	13.7	98.5	0.10	0.75	0.18	0.75	1.8
9702	12.8	--	20.8	98.4	0.25	0.97	0.25	1.1	2.6
9701	24.5	--	15.9	99.0	0.0	0.83	0.03	0.41	1.3
9705	16.7	--	16.7	97.9	0.0	1.8	0.16	0.49	2.5
Greene County	13.4	--	13.3	96.6	1.8	0.6	0.7	0.9	4.0
49	9.7	--	10.1	99.1	0.07	0.79	0.05	0.43	1.3
48.01	10.3	--	11.4	98.8	0.05	0.72	0.27	0.67	1.7
43.02	9.0	--	10.2	99.3	0.16	0.19	0.08	0.82	1.3
44	14.6	--	16.9	97.2	1.7	0.33	0.59	0.72	3.3
22	14.9	--	11.5	93.5	3.5	0.89	2.0	0.65	7.0
37	1.6	--	9.9	98.4	0.36	0.28	0.72	0.45	1.8
45	5.3	--	8.1	97.9	0.97	0.70	0.22	1.1	3.0
36	20.6	--	10.1	95.9	2.4	0.38	0.82	0.85	4.5
56	--	--	--	--	--	--	--	--	--
46	8.2	--	9.5	99.1	0.04	0.67	0.06	0.57	1.3
Webster County	18.5	--	12.9	98.2	0.8	0.6	0.2	0.6	2.2
9701	17.7	--	10.4	98.7	0.08	0.80	0.15	0.62	1.7
9702	16.7	--	19.1	99.0	0.02	0.61	0.16	0.56	1.4
9703	23.6	--	8.8	99.0	0.10	0.62	0.13	0.63	1.5
Laclede County	16.5	--	15.3	98.7	0.4	0.5	0.3	0.5	1.7
9601	17.8	--	12.0	98.7	0.08	0.76	0.36	0.46	1.7
9603	9.5	--	11.5	99.1	0.15	0.48	0.15	0.48	1.3

TABLE 2

1990 Census Population Characteristics in the I-44 Project Area By Census Tract Compared To County and the State of Missouri

State/ County/ Census Tract	Percentages								
	Persons Below Poverty	Under 18	Over 65	White	Black	American Indian	Asian or Pacific Islander	Hispanic	Tot. Min.
9606	27.2	--	18.3	98.1	1.0	0.58	0.20	0.61	2.4
9605	13.8	--	21.9	98.7	0.21	0.52	0.50	0.54	1.8
9602.98	18.7	--	11.8	99.2	0.06	0.43	0.22	0.37	1.1
Pulaski County	12.6	--	6.8	80.2	13.6	0.6	2.9	4.7	21.8
9705	20.9	--	14.5	97.9	0.72	0.47	0.49	1.2	2.9
9704	11.9	--	9.2	86.7	7.7	0.82	3.6	3.3	15.4
9702.85	17.6	--	6.4	78.8	13.9	0.67	6.4	4.0	25.0
Phelps County	17.2	--	13.8	95.9	1.1	0.4	2.2	0.9	4.6
9906	24.0	--	13.0	99.0	0.16	0.43	0.23	0.59	1.4
9905	19.8	--	12.8	98.6	0.29	0.73	0.32	0.48	1.8
9903	17.9	--	17.2	98.8	1.5	0.27	2.9	0.90	5.6
9907	14.3	--	9.6	98.5	0.16	0.79	0.51	0.63	2.1
9908	21.2	--	11.0	85.2	2.0	0.41	2.2	0.96	5.6
9904	36.4	--	8.9	87.2	3.1	0.30	9.0	1.6	14.0
9901	11.5	--	12.8	98.2	1.1	0.39	0.27	0.51	2.3
9902	15.1	--	24.2	98.8	0.39	0.24	0.34	0.64	1.6
Crawford County	15.9	--	17.2	99.6	0.02	0.2	0.2	0.6	1.0
9503	13.4	--	20.0	99.6	0.0	0.19	0.08	0.56	0.83
9501	11.1	--	15.1	99.5	0.05	0.08	0.27	0.97	1.37
9502	24.4	--	15.3	99.3	0.0	0.54	0.18	0.15	0.87
Franklin County	8.1	--	12.1	98.5	0.9	0.2	0.2	0.5	1.8
8011	10.7	--	17.4	99.5	0.0	0.2	0.3	0.37	0.87
8005	10.7	--	12.0	99.4	0.13	0.10	0.22	0.38	0.83
8008	6.8	--	8.8	95.9	3.1	0.32	0.34	0.63	4.4
8010	12.2	--	10.0	98.7	0.56	0.36	0.13	0.79	1.8
8009	13.9	--	13.0	98.6	0.71	0.37	0.15	0.39	1.6
8006.02	9.6	--	12.0	98.4	1.1	0.17	0.24	0.69	2.2
8007.01	7.4	--	9.7	96.6	0.33	0.12	0.29	0.79	1.5
8001	7.0	--	8.4	99.4	0.19	0.14	0.24	0.28	0.9
8007.02	--	--	--	--	--	--	--	--	--

Source: U.S. Census Bureau, Census 1990

Table Key:

🟩	= Census Tract with all minority populations (aggregated) higher than county average.
🟨	= Census Tract with an individual minority population higher than county average
▨	= Census Tract with impoverished population higher than county average
▨	= Census Tract with elderly population (aged >=65) higher than county average

Conclusions

We conclude that based on Census 2000 data, 33 of 50 census tracts analyzed may have potential EJ issues. Of the 33 census tracts with potential EJ issues, 9 census tracts have disproportionately high minority populations, 13 have a disproportionately high elderly population, and 22 have a disproportionately high impoverished population.

We conclude that based on Census 1990 data, 30 of 49 census tracts analyzed had potential EJ issues. Of the 30 census tracts with potential EJ issues, 15 census tracts have disproportionately high minority populations, 12 have disproportionately high elderly populations, and 18 have a disproportionately high percentage of residents living under the poverty level.

Table 3 summarizes changes in census-tract level demographics of disadvantaged groups from 1990 to 2000 in the I-44 project area.

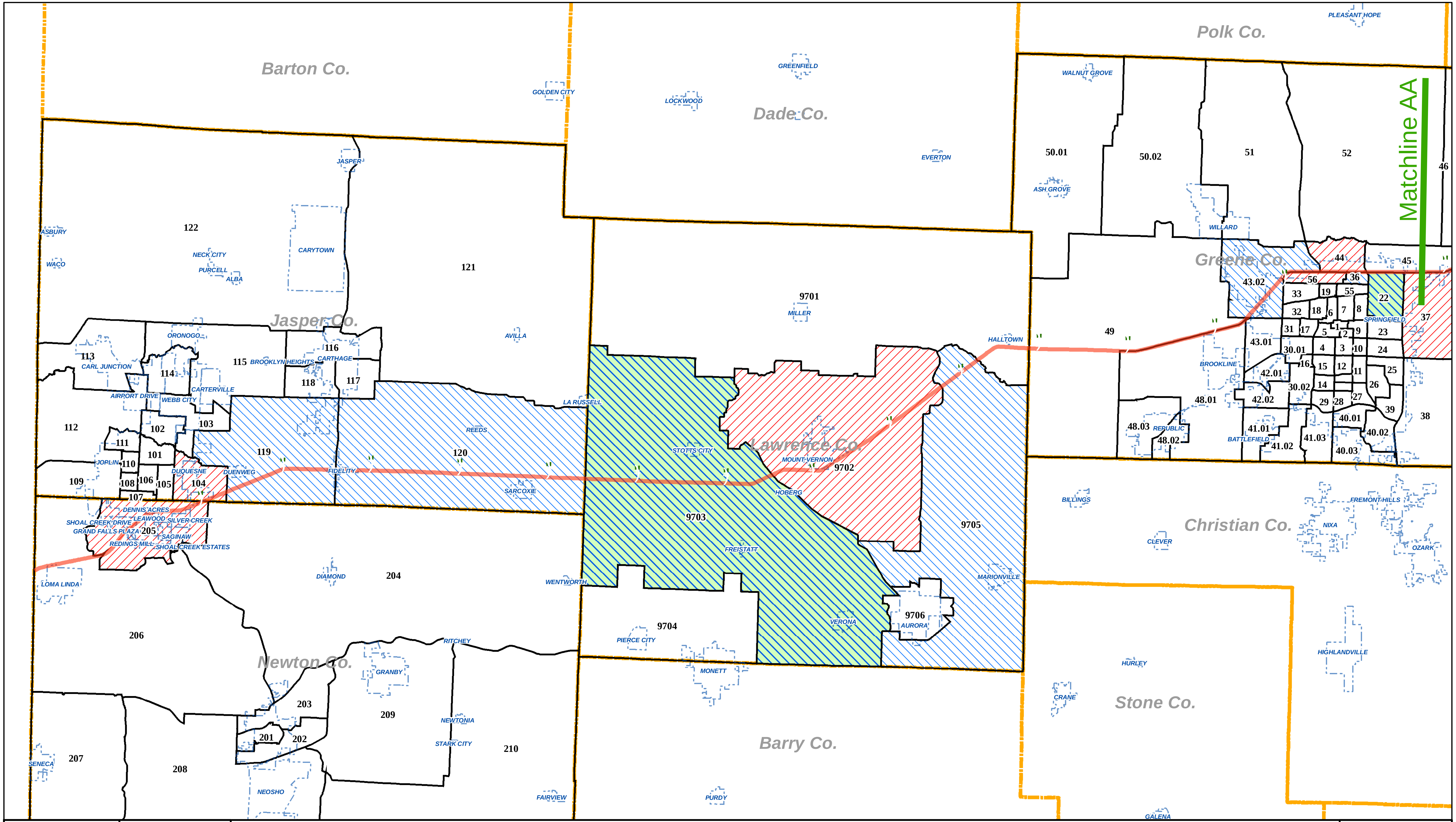
TABLE 3

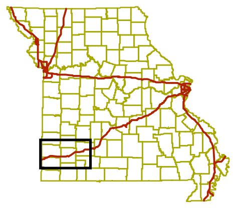
Summary of Changing Demographics of Disadvantaged Groups in the I-44 Project Area (1990 – 2000)

	Percentage of Census Tracts with Potential EJ Issues	
Disadvantaged Group	**1990**	**2000**
Minority (aggregated)	31 percent	18 percent
Elderly (over 65 years of age)	24 percent	26 percent
Impoverished	37 percent	44 percent
Total (all disadvantaged groups)	61 percent	66 percent

Source: 1990 and 2000 Census Data

A disproportionate population of disadvantaged groups identified in census tracts does not necessarily mean that individual census blocks would have the same population characteristics. Further, for those census tracts identified as having no EJ issues in this technical memorandum, we cannot conclude that individual census blocks within them have no potential EJ issues.





MoDOT

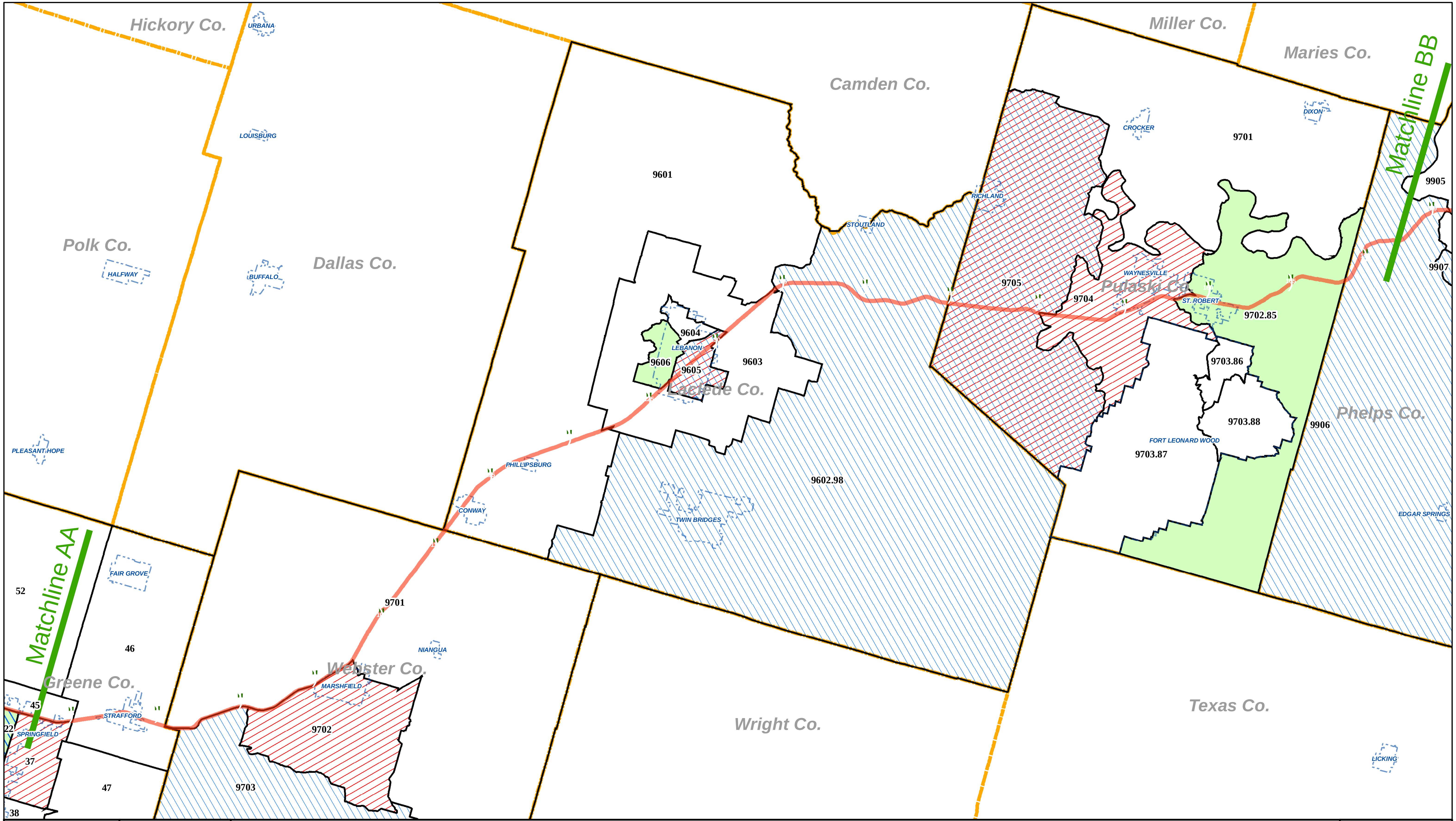
CH2MHILL

Figure 1A: Environmental Justice Map (Year 2000 Census)

Legend

- ▬ Interstate 44
- ᵛ Mile Markers
- ⬚ County Boundary
- ⬚ City Limits
- ☐ Census Tract
- ▨ Census Tract with Impoverished Population Higher than County Average
- ▨ Census Tract with Elderly Population (Age >= 65) Higher than County Average
- 🟩 Census Tract with All Minority Populations (Aggregated) Higher than County Average

SCALE: 1 IN = 5 MI



MoDOT

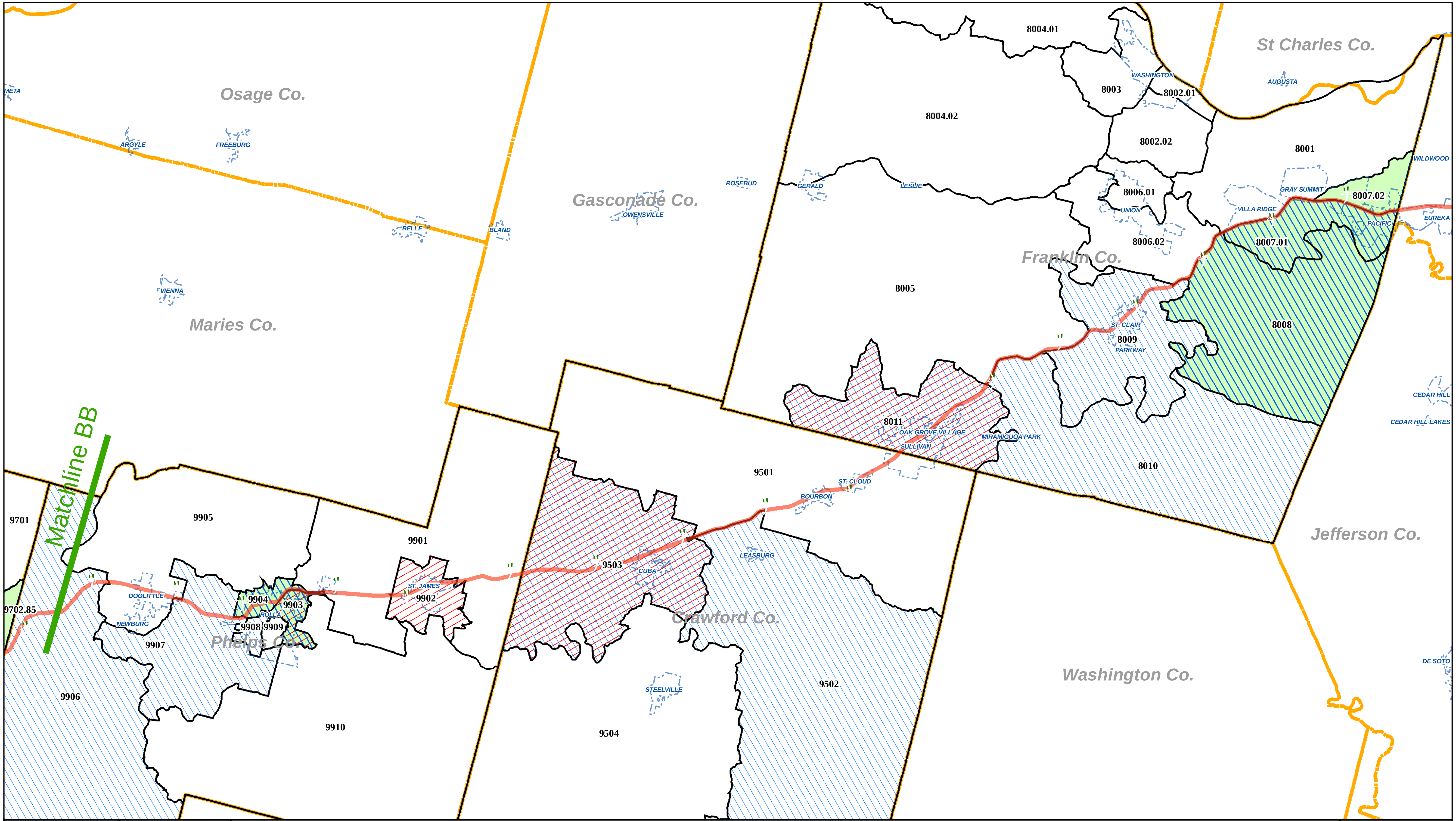
CH2MHILL

Figure 1B: Environmental Justice Map (Year 2000 Census)

Legend

▬	Interstate 44
ˈˈ	Mile Markers
⬚	County Boundary
⬚	City Limits
☐	Census Tract
▧	Census Tract with Impoverished Population Higher than County Average
▨	Census Tract with Elderly Population (Age >= 65) Higher than County Average
🟩	Census Tract with All Minority Populations (Aggregated) Higher than County Average

SCALE: 1 IN = 5 MI



MoDOT

CH2MHILL

Figure 1C: Environmental Justice Map (Year 2000 Census)

Legend

━ Interstate 44

ᐧ Mile Markers

⬚ County Boundary

⬚ City Limits

☐ Census Tract

▨ Census Tract with Impoverished Population Higher than County Average

▨ Census Tract with Elderly Population (Age >= 65) Higher than County Average

🟩 Census Tract with All Minority Populations (Aggregated) Higher than County Average

SCALE: 1 IN = 5 MI

CULTURAL RESOURCE EVALUATION

INTERSTATE 44 CORRIDOR NEED STUDY
ST. LOUIS COUNTY TO THE OKLAHOMA STATE LINE

Prepared for:
CH2M HILL, MISSOURI DEPARTMENT OF TRANSPORTATION, and
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

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Research Report #431 April, 2007

CULTURAL RESOURCES

INTRODUCTION

The Missouri Department of Transportation (MoDOT) and the Federal Highway Administration (FHWA), are conducting a Purpose and Need Study to identify the transportation deficiencies of Interstate 44 within Missouri. The proposed study corridor extends from the St. Louis and Franklin county line to the Oklahoma border, or roughly 251 miles. A corridor of 250 feet on each side of the existing interstate right of way was included within this study with slightly wider areas to encompass a standard interchange. In order to meet future transportation needs, it may be necessary to improve this roadway. The construction could have an adverse affect on potentially significant cultural resources. Cultural resources include prehistoric and historic archaeological sites, cemeteries, National Register properties, potentially significant architectural properties, and significant bridges. The destruction of these resources could result in the loss of a significant portion of Missouri’s cultural heritage.

In order to prevent an inadvertent impact to significant cultural resources, an initial archival search was performed to identify known resources near the interstate. Information from this study was also intended to produce a predictive model in an attempt to identify locations likely to have significant resources. The model also can be used to better estimate the costs and develop strategies to better manage the cultural resources that may be affected by the proposed interstate improvements.

SUMMARY OF CULTURAL RESOURCES WITHIN THE INTERSTATE 44 CORRIDOR STUDY

ARCHAEOLOGICAL RESOURCES

Information on archaeological resources was obtained from the Missouri Department of Natural Resources, State Historic Preservation Office (SHPO) in Jefferson City. The locations of these sites were mapped on ARCGIS 9.2. Site information was placed within Microsoft Access tables. These tables list all known archaeological sites within the I-44 study area, along with locational information: township, range, section, quarter sections, northing, easting, USGS quadrangle, nearest waterway, topography, and elevation. The tables also listed site type, size, cultural information, ASM author(s), relevant reports describing the site, and the site's potential significance.

The archival search revealed that surprisingly few archaeological resources have been recorded within the I-44 corridor, as only nine archaeological sites have been previously recorded. This could be due to the small area being examined for the corridor study (ca. 250 feet either side of the interstate) and the lack of archaeological investigations performed near the interstate. The sites identified within the study area are summarized in Table 1.

Table 1: Archaeological Sites Identified within the I-44 Study Area

Site	Topographical Setting	Site Size (m^2)	Site Type	Cultural Affiliation	Material
FR289	Floodplain	24,360	Prehistoric Habaitation	Late Archaic?	Lithics/Tools
FR511*	Ridge	9,600	Lithic Scatter	Late Archaic?	Lithics/Tools
FR513	Ridge	4,000	Lithic Scatter	Prehistoric	Lithics
LC114	N/A	N/A	N/A	N/A	N/A
LC185	Slope	607	Historic Habitation	Historic	Historic
JP 184*	Hill	1,617	Historic Habitation	Urban/Industrial (1900-1960)	N/A
JP185	Hill	1,800	Lithic Scatter	Prehistoric	Lithics
JP186	Hill	6,961	Prehistoric Habitation	Prehistoric	Lithics
JP187*	Hill	7,490	Mound/Cairn	Prehistoric	Lithics

* sites considered potentially significant

Site 23FR289 was identified during a survey of a 6.1 acre tract for the proposed Vista Ridge Apartments (Browman 1985). During the survey, two flakes were found on the floodplain just west of an intermittent stream that empties into Brush Creek about 3/4 of a mile to the south. The landowner recalled finding two projectile points and a drill near this same location. The projectile points were both corner notched with a broad or a long blade, suggesting that the spear points were utilized during the Late Archaic Period (3500-600B.C.). The few artifacts recovered from this site could suggest that it had been destroyed or was only a limited use, special function camp with few intact remains. No further work was recommended on this site.

Sites 23FR5 11 and 23FR5 13 were identified during a cultural resource survey for proposed improvements to Route 100 from St. Albans Road in St. Louis County to the City of Washington in Franklin County (Cramer, Naglich, and Hixson 2001). Both sites were located on a broad ridge top near a proposed new interchange with I-44 just east of the City of Gray Summit. Site 23FR5 11 was a large site with a moderate scatter of artifacts including flaking debris, cores, a hammerstone, a biface fragment, and a drill fragment. The landowners collected Late Archaic projectile points off of their property, but were uncertain as to where the points were found. This site could have intact subsurface deposits and was considered potentially significant. Site 23FR5 13 produced only three artifacts suggesting that this was only a short term, special function camp. The short term use of this site probably resulted in few subsurface deposits; no further work was recommended on this site.

Two sites were located along the I-44 corridor in Laclede County. Site 23LC114 was located on a ridge top just north of the interstate by a local collector. Unfortunately, no information about this site was provided on the site form. Site 23LC 185 was found during a cultural resource survey of a proposed industrial park located near Lebanon (Powell 2001a). Four sites were identified during this survey (23LC182 - 23LC185) but only the latter site was within the I-44 corridor. Site 23LC185 contained the remains of a mid 20th century home that was not considered significant.

In Jasper County, four sites were identified during a survey for the proposed relocation of Route 71 located near Duenweg, Missouri (Powell 2001b). Site 23JP184 contained a moderate scatter of historic debris dating to the 20th century on a west facing hill slope overlooking an intermittent stream. This scatter was modern and was not considered significant. Site 23JP186 was situated on a hill top just south of Interstate 44. A light scatter of flaking debris and a biface fragment were recovered from this site. This material was considered to represent a significant site, and it was recommended that the site be tested or avoided by construction. Site 23JP185, located just to the south, contained a light scatter of artifacts exposed on a hill top. The soils of this area were deflated by past farming activities and no further work was recommended at this site. Site 23JP187 was located on a hill top just south of Interstate 44. This site appeared to contain a series of three carins overlooking a small drainage. It was recommended that construction avoid these mounds or that they be tested to better assess whether they contained human remains or not.

CEMETERIES, CHURCHES, and SCHOOLS

Cemeteries are another crucial resource that needed to be identified in order to produce a better planning document. The locations of cemeteries were identified by examining USGS quadrangle maps and by examining historical county atlases dating between 1870 and the 1930s at the State Historical Society in Columbia and at the Missouri Historical Society in St. Louis. A Microsoft Access table of these cemeteries was prepared and they are depicted on GIS maps. There are many historic cemeteries and family plots that are no longer depicted on the USGS maps, but are likely to still contain graves. Experience has shown that even though graves were supposedly removed, many burials still exist (Harl 2004). In order to prevent unexpected delays in future construction when unmarked human remains are discovered, the locations of historic cemeteries were mapped. Only three burial grounds were located within the I-44 study area; these are summarized in Table 2.

During this archival review, since unmarked burial grounds could exist near historic churches, these resources were also documented by using historical atlases and summarized in Table 2. Whether or not these sites contained graveyards, they do represent religious sites, which may be considered significant for the unique information on the changing role of religion and churches they contain. Three churches were located within the study area, not including Property 1, which had a recorded cemetery associated with it. Schools represent another unique cultural resource, providing insights into the changing role of education in the community. Four schools were identified in the study area based on the use of historical atlases, which are summarized in Table 2, not including Historic Property 1 that also contained a known cemetery.

Table 2: Cemeteries, Churches, and Schools Identified within the I-44 Study Area

Site	**Type**	**Township**	**Range**	**Atlas Found**	**Topo Quad**	**County**
Historic Property 1	School, Church & Cemetery	43N	2E	1878	Gray Summit	Franklin
Historic Property 2	School	35N	14W	1912	Richland	Laclede
Historic Property 3	Bear Creek School	35N	15W	1912	Stoutland	Laclede
Historic Property 4	Cemetery	35N	15W	1912	Stoutland	Laclede
Historic Property 5	Cemetery	35N	15W	1912	Oakland	Laclede
Historic Property 6	Moravian Church	33N	17W	1912	Phillipsburg	Laclede
Historic Property 7	School	29N	22W	1876	Springfield	Greene
Historic Property 8	School	27N	32W	1895	Joplin East	Jasper
Historic Property 9	St. Moss Church	27N	31W	1895	Fidelity	Jasper
Historic Property 10	Church	27N	31W	1895	Fidelity	Jasper

U.S. ROUTE 66 STUDIES

A survey for significant architectural properties that were once associated with U.S. Route 66 was performed for the Route 66 Association of Missouri in 1992 and 1993 (Johnson 1993). This survey was of the entire length of Route 66 across the state. A set of four criteria were developed for identifying resources and determining their significance.

1. A building, structure, site or object which was designed or used to serve the travel trade on U.S. Route 66 and was constructed between the years 1926-1955.
2. A building, structure, site or object which may be eligible for individual National Register listing.

3. A building, structure, site or object which contributes to the highway corridor’s sense of time and place and historical development and may therefore be a contributing resource in a National Register district.

4. A building, structure, site or object which is necessary to fully develop and evaluate the highway’s historic context or associated property types.

(Johnson 1993)

Based on these criteria, 266 resources were identified, although inventory forms were completed on only 173 of these properties. A brief summary of the results of the survey was also prepared.

Becky Snider and Debbie Sheals (2003) conducted another survey of the Route 66 corridor referred to as a Phase II survey. The goals of this study were:

> The Phase II survey was aimed at two primary objectives: evaluation of the resources that were identified, but not evaluated in the Phase I survey and development of a survey report summarizing the findings of the two phases of the survey of Route 66 resources in Missouri. In both phases of the survey, the identification and evaluation of resources was limited to the transportation-related resources along Route 66 in Missouri. Additional goals established for the Phase II survey included the evaluation of the historic resources along Route 66 in terms of eligibility for listing on the National Register of Historic Places and the creation of a database of survey properties. Both of these objectives are aimed at providing the State Historic Preservation Office and the Route 66 Association of Missouri with a planning tool for the management and promotion of the historic resources along Route 66 in Missouri.
>
> (Snider and Sheals 2003)

Snider and Sheals entered all of the resources identified during the original survey into a data base including resources that were visited but not inventoried during the Phase I survey. They also identified more than 75 previously unrecorded resources including transportation-related resources associated with Route 66 consisting mostly of bridges, which have been inventoried as part of Historic American Engineering Record survey.

As a result of the Phase II survey, out of the 348 resources evaluated, 163 were determined to be potentially significant. Those resources near the current I-44 study area are listed in Tables 3 - 5.

Table 3: Individual Properties Potentially Eligible for the National Register of Historic Places

Inventory #	City	Name	Integrity/Condition
CR 001	Sullivan	Shamrock Motel	little changed excellent
CR 012	Cuba	Delano Station/Charley’s Auto Service	little changed excellent
GR 032	Elwood vicinity	Moore’s Filling Station and cabins	little changed fair
GR 034	Parkaway	Camp and O'Dell Station	little changed good
GR 145	Springfield	Original Road Section	little changed good
GR 152	Springfield	Steak ’n Shake	little changed excellent
GR 153	Springfield	Tile Commercial Building	little changed good
JP 001	Avilla	Log City Camp	little changed poor
JP 002c	Avilla	Hardesty Cabin	little changed good
JP 005	Avilla	State Route 96 Commercial Building	little changed poor
JP 006	Avilla	Barbato’s Garage	little changed poor
JP 007	Forest Mills	State Route 96 Filling Station	little changed poor
JP 021	Webb City	902 W. Broadway Garage	little changed good
JP 022	Joplin	Royal Heights Apartments	little changed excellent
JP 028	Joplin	2311 W. 7th St. Building Divine Motors	little changed fair
LA 005	Halltown	218 Main St. Building	little changed good
LA 007	Halltown	Main St. Commercial Building	little changed good
LA 008	Halltown	Main St. Service Station	little changed good
LA 012	Paris Springs	Paris Springs Junction Garage	little changed excellent
LA 013	Paris Springs	Gay Parita Store	little changed good
LA 014	Paris Springs	Highway 266/Paris Springs Jct Garage #2	little changed fair
LA 019	Albatross State	Route 96 Service Station	little changed good
LC 007	Lebanon	Wrink’s Food Market	little changed excellent
LC 009	Lebanon	Camp Joy	little changed good
LC 012	Lebanon	State Highway and Transportation Building	little changed excellent
LC 128	Lebanon	Woods DX	little changed fair
LC 134		County Slab Bridge F772	little changed good
LC 136	Phillipsburg	Stl-SF Railroad Underpass	little changed fair
PH 006	St. James	American Way Motor Court/ S&K Cottages	little changed good
PH 014	Doolittle	Doolittle Service Station	little changed good
PH 022	Clementine	Fisher’s Filling Station	little changed poor
PU 026	Gascozark	Gascozark store	little changed poor

Table 3, continued

Inventory #	City	Name	Integrity/Condition
PU 128	Devils Elbow	Concrete Deck!Arch Bridge (L35-1942)	little changed fair
PU 129	Devils Elbow	Thru-Truss Bridge	little changed fair
PU 130	Devils Elbow	McCoy's Market! Station! Cabins	little changed fair
PU 140	Waynesville	Concrete Deck! Arch Bridge (G455A-1923)	little changed fair
WB 001	Niangua	Abbylee Court	little changed good
WB 004	Niangua	Highway CC Filling Station	little changed poor

Table 4: Potential National Register Districts

Inventory #	City	Name	Recommendation
PU 022	Lacquey	Commercial Center Rte 66 and Shrine Rd	future study
LA 012-014	Paris Springs	Crossroads Community	future study
LA 015	Spencer	Commercial District	future study
LA 027	Between Rescue and Plew	Shadyside Camp Tourist Court	cultural landscape
JP 004-006	Avilla	Commercial District	cultural landscape
JP 030-033	Central City	Old 66 Bypass	future study

Table 5: Potential Rural Historic Landscapes

Inventory #	Location	Highway	Recommendation
GR037 and GR038, LA001-LA0 15, and JP001	Greene, Lawrence, and Jasper Counties	Highway 266 west of intersection with AB, and Highway 96 to Carthage	Recommended for future study
PU 00 1-PU 008, PU 130 - 132	Pulaski County	Highway Z	Recommended for future study
PH 010-015	Between Rolla and Doolittle	Route 66 Martin Springs/ Eisenhower Drive	Recommended for future study
PU017-PU026	Buckhorn to Lacquey	Highway 17	Recommended for future study
WB 00 1-006	Phillipsburg to Marshfield	Highway CC	Recommended for future study

Of these properties, only the concrete slab bridge (bridge designation #F772, Inventory #LC 134) was located within the current I-44 study area. This bridge, constructed for the original Route 66, is in good condition and located along Route W, just south of the city of Lebanon and north of Interstate 44. Also in Phillipsburg is the St. Louis and San Francisco Railroad underpass (Inventory #LC136), which is located just outside the current I-44 study area.

As part of the Phase II survey, three properties were nominated to the National Register of Historic Places with their period of significance being associated with Route 66 use, 1925 to 1974. These include the 66 Drive-In located at 17231 Old 66 Blvd. in Carthage, nominated for entertainment and recreation; the Rock Fountain Hotel Court Historic District located at 2400 W. College Street, Springfield, nominated for commerce and architecture; and the Wagon Wheel Motel, Cafe and Station located at 901-905 E. Washington Street in Cuba, nominated for commerce and architecture. However, none of these National Register districts are within the current I-44 study area.

NATIONAL REGISTER OF HISTORIC PLACES

A list of properties on the National Register Historic Places listed prior to March 2007 was also obtained from SHPO. None of these properties, however, are within the proposed I-44 corridor study.

POTENTIALLY SIGNIFICANT BRIDGE RESOURCES

A review of potentially significant bridge resources was obtained from Environmental and Historic Preservation Section of the Missouri Department of Transportation in Jefferson City. This review showed that no previously recorded bridges have been placed on the National Register of Historic Places within the study area according to the Fraserdesign study (Fraser 1996) and the Historic Bridges of the U.S. (http://bridgehunter.com/mo). However as indicated above, Snider and Sheals (2003) did identify within the study area, a concrete slab bridge just south of the city of Lebanon, which they considered significant because it was in good condition and was originally constructed as part of Route 66. They also considered the St. Louis and San Francisco Railroad underpass as being potentially eligible, which was constructed as part of Route 66 in the city of Phillipsburg.

PREHISTORIC CULTURAL OVERVIEW

Since so few prehistoric sites were identified along the I-44 corridor study area, an assessment of potential cultural resources was obtained examining cultural overviews of the state prepared by Carl Chapman (1975, 1980) and more recently by O'Brien and Wood (1998). Information from these overviews was supplemented by data obtained from recent archaeological investigations associated primarily with cultural resource management studies.

PRE-CLOVIS PERIOD
(? - 9500 B.C.)

The earliest defined cultural period is the Pre-Clovis Period. Sites dating to this time are extremely rare and are usually controversial. People probably lived in small, widely scattered groups, resulting in an elusive archaeological record. It is assumed that these first human settlers were nomadic groups, pursuing megafaunal species such as mastodon, mammoth, muskox, ground sloth, and horse. However, like most hunters and gatherers, their subsistence base was probably more diversified, consisting of a variety of plant and animal resources.

The first people in this region probably used a settlement strategy similar to that utilized by later Paleoindian groups. These groups were probably nomadic and established camp sites often placed on bluff tops or high terraces near major waterways. Elevated locations allowed people to monitor resources in the surrounding area. Only one potential Pre-Clovis site has been identified within southwestern Missouri, the Big Eddy site (23CE426) located along the lower Sac River in Cedar County, Missouri (Ray and Lopinot 2000). Flakes and charcoal flecks, radiocarbon dated roughly between 11,000 and 13,000 B.C. (corrected dates), were found near the base of excavations. These flakes, however, could have been redeposited from the upper deposits which contained cultural materials, or they could have been formed by natural processes; many of the flakes were associated with natural gravel bars. Some large rocks that appeared to have been used as anvilstones were also discovered. These stones were not local, although they could have been transported by the river to this location. When subjected to microwear analysis using a high powered electronic microscope, Tom Dillehay (2000:229), who performed the analysis concluded:

> The majority of the surfaces on the chert and sandstone cobbles show naturally "unfresh" and water worn cortex that often formed a bright heavily stained polish and striae that may have been produced by ancient cultural agency or by modern scars showing fresh modification.
>
> Possible human-modified areas showed more sheen combined with particle residues and generally distinctive frosty, ruffled, grainy, and darkened matte areas, either resulting from human-induced grinding or hammering or from an unknown source of natural action . . . Viewed from the perspective of micro-

use-wear analysis, none of these interpretations should be considered conclusive until more systematic experimental, taphonomic, and comprehensive studies are carried out on the archaeological assemblage from the Big Eddy site.

PALEOINDIAN PERIOD
(9500 - 8900 B.C.)

Few sites dating to the Paleoindian Period have been excavated and information about these people is limited. Chapman (1975:60-69) and Shippee (1964) suggested that Paleoindians lived in small nomadic groups and relied on large Pleistocene animals for subsistence. People hunted these animals using collaterally flaked and fluted projectile points or lanceolates (Chapman 1975:79-93). The view that Paleoindian groups relied heavily on large animals for subsistence has been challenged by archaeologists who maintain that subsistence strategies were much more diversified (Meltzer and Smith 1985). At the few sites where flotation samples have been obtained, the subsistence base was varied, including small and large faunal species as well as a variety of flora, especially fruits and nuts. Sites of this period are typically located on upland ridge tops. Ridge top sites allowed occupants to monitor resources in the surrounding river and creek valleys. In addition, these areas had better air circulation, and were less infested with biting insects than locations within the bottomlands. The few Paleoindian kill sites that have been identified in the state are generally found near waterways and marshy areas attractive to megafaunal species (O'Brien and Wood 1998:64-65). Paleoindian hunters could watch these locations, attacking weaker members of the herd or scavenging animals killed by other predators.

DALTON PERIOD
(8900 - 7800 B.C.)

The Dalton Period is characterized as a time of transition from a wide-ranging nomadic subsistence strategy to hunting and gathering within a more restricted territory. The shift was perhaps precipitated by a climatic change that produced a drier and warmer environment which, together with over-hunting by Paleoindian hunters, may have contributed to the extinction of megafaunal species. Game was hunted using snares, traps, and spears thrown with the aid of atlatls. Utilized during the period were partially fluted Dalton points, lanceolates, snub-nosed scrapers and bone tools. Plant resources were important as indicated by tools such as gouges, diggers, adzes, spokeshaves, drills, and milling and nutting stones. Dalton Period sites are generally located in the uplands overlooking the major waterways (Chapman 1975:105-107), although interior upland and bottomland sites were also utilized.

EARLY ARCHAIC PERIOD
(7800 - 5000 B.C.)

Trends that began during the Dalton Period continued during the Early Archaic Period. Subsistence strategies were based on a broad spectrum approach as reflected in the varied artifact assemblage (Chapman 1975:127-129). A diversity of hafting styles used on projectile points were adopted including varieties such as Breckenridge, Rice Lanceolate, Rice Lobed, Graham Cave, and Hidden Valley points in the central and western half of the state, and Hardin Barbed, St. Charles Notched, and Thebes within the eastern half. Dalton points continued to be produced into the first part of this period, but fluted types gradually dropped out. Diverse tools needed to process plants were used, which suggests the importance of flora in the subsistence system. Ray and Lopinot (2005a) suggested that in southwestern Missouri there was a difference in when the points were utilized, with Breckenridge and Dalton points utilized between 7800 - 7700 B.C., Scottsbluff between 7700 and 7500 B.C., Cache River points between 7000 - 6600 B.C., Graham Cave points between 6600 - 6200 B.C., Rice Lobed points utilized between 6200 and 6000 B.C. and contracting stemmed Hidden Valley points utilized between 5900 - 5200 B.C. These latter points usually lacked a beveled blade on the left side common on the earlier points.

Early Archaic people generally lived in small groups of less than 50 people. Utilizing a residential mobility pattern as part of a seasonal round within a restricted territory, sites tended to be clustered near desired resources. Many sites were located near the bluffs and ridge tops overlooking major waterways. More Early Archaic sites are located within the interior uplands than during the following prehistoric periods because a climate milder than that of today ensured a greater number of usable resources.

MIDDLE ARCHAIC PERIOD
(5000 - 3000 B.C.)

The Middle Archaic Period coincides with the Hypsithermal Climatic Episode which peaked around 5000 B.C. At that time, the climate was slightly dryer than today, resulting in the maximum expansion of prairies. Chapman (1975:172) suggests that groups may have moved out of the prairie uplands and opted for locations nearer to the major waterways.

There appears to have been a shift in the settlement strategy during this time. Most sites were placed on terraces within the bottomlands of major waterways or near the bluff margins when terraces were absent. Archaeological investigations within Illinois indicate that riverine environments were heavily exploited by Middle Archaic populations because of the varied resources available in backwater areas (Brown and Vierra 1983; Jeffries and Lynch 1983; Lewis 1983). Asch et al. (1972) have argued that the lower Illinois River valley, and by analogy the waterways in Missouri, acted as a buffer against the drying climate. In addition, these areas were in marginal zones between the forest, prairie, and riverine environments, providing a variety of resources for the inhabitants of these settlements. As the water table dropped, more locations within the bottoms became habitable. The shallower streams supported a greater diversity of plant and animal resources making these bottomlands desirable for exploitation.

Overall, there tends to be a higher site density along creek valleys, as opposed to river valleys. This disparity seems unexpected, because more diverse resources would be found in a larger river valley. Also, habitations along a river would have been nearer to main lines of travel, communications and trade. There are a number of possible explanations for the difference in site densities in these two areas. First, creek valleys are narrower than river valleys, and thus have smaller floodplains; sites may simply be packed tighter in these narrow spaces than they are in expansive river valleys. Second, the creek valleys may have been more protected from the elements, making them more suitable for habitation, especially during the winter. Flooding may have been less of a problem within narrow creek bottoms as well. Third, the lower density of prehistoric sites along the rivers could also be due to post-depositional events. The rivers, with their stronger currents, may have destroyed some sites and buried others.

Although diverse resources were still utilized, groups increasingly focused on obtaining favored foods. Resource selectivity is indicated by the quantity of certain species such as nuts (especially hickory), fish, and mussel shells found at some sites. Specialized tools and techniques were developed to procure and process preferred foods more effectively. For example, using basins filled with boiling water, Middle Archaic groups could process large quantities of hickory nuts in a short period of time. The tool assemblage was varied (Chapman 1975: 158-159), consisting of full grooved axes, various woodworking tools, and numerous styles of projectile points dominated by side notched (e.g., Burkett and Big Sandy) and expanding stemmed forms (e.g., Jakie Stemmed and Helton). People developed this expanded tool kit to improve their ability to obtain and process preferred foods. Evidence also suggests that people experimented with domesticating plants during this period (Asch and Asch 1982). The first cultivated plants were gourds (Cucurbita pepo), which were probably more important for uses other than food as its rind could be used as a container or a net float.

LATE ARCHAIC PERIOD
(3000 - 600 B.C.)

The Late Archaic Period is characterized by a greater diversity and number of sites than identified during the previous cultural periods. It has been suggested that a relatively rapid increase in human population levels forced people to exploit resources within smaller territories, resulting in greater site diversity, the development of specialized tools, and regional differentiation (Chapman 1975:195). Although this may have been the case, another explanation is possible. A preference for certain resources may have led Late Archaic groups to concentrate their efforts within a smaller territory and develop specialized tools in order to more effectively procure and process the selected resources. With improved efficiency, available resources could have supported a greater number of people and spurred population growth.

A clearer understanding of the changes that occurred during the Late Archaic Period could be obtained by dividing this period into various phases. Ray and Lopinot (2005b) suggested dividing this period into various phases based on changes in the use of projectile points. For example, the Williams points utilized between 2040 and 1905 B.C. Harl (1999) indicated that a change in settlement stratigies also occurred during this time. Groups continued to use a seasonal round, but established base camps, usually within river or large creek valleys, where several groups would coalesce to spend the winters and exchange information.

This is followed by the use of Smith Basal Notched/Etley points 2180 - 1500 B.C. The broad bladed Williams point was replaced by long bladed styles or even by lanceolates. McMillan (1971:187) and Chapman (1975:184) argue, based on the presence of the lanceolate-like objects and long bladed spear points, that there was a movement of Plains groups into this region, probably in response to the effects of the Hypsithermal Climatic Episode. This drier climatic period had subsided by 3000 B.C., nearly 800 years before the start of this phase. Recent archaeological investigations within the Plains and in Missouri have shown no mass movement of people out of the prairies. Other than the presence of long bladed projectile points and lanceolates, the lifestyle of Missouri groups does not appear to have been altered drastically. The use of long bladed points does not reflect a movement of new groups into this area, but social changes within indigenous groups. Long bladed points were more conspicuous, providing the user with increased prestige and status (Harl 1995a). Long distance exchanges occurred during this time with Burlington chert being brought into the I-44 area and exchanged for rhyolite, galena, and hematite.

During the final phase(s) of the Late Archaic Period, Kings corner notched and Afton notched points were utilized (ca. 1770 - 600 B.C.). The use of long bladed projectile points decreased in popularity in favor of these smaller, dart varieties. In addition to changes in projectile point styles, archaeological investigations within western Illinois (Fortier et al. 1984) and eastern Missouri (Harl 1995b:123-129) suggest people occupied some settlements on a permanent basis, constructing larger, more permanent dwellings and larger storage facilities. The long distance exchanges, however, appear to have ceased during this time, with people relying more on local resources. Formal burial grounds with marked graves are often associated with these communities. These communities were generally placed on terraces or near the bluff margins of major waterways.

EARLY WOODLAND PERIOD
(600 - 200 B.C.)

The Early Woodland Period is characterized by a refinement of Late Archaic cultural traits. Sites dating to this period tend to be situated within the lowlands and represent small residential habitations (Martin 1999:88-89). Although the number of Early Woodland sites is limited, it is assumed that population density continued to increase.

The artifact assemblage appears to have remained relatively unchanged, except for the addition of contracting stem projectile points such as Burkett, Adena, and Gary Stemmed varieties. Also, medium sized points with long stems, such as Kramer points, were produced during this time.

Another hallmark of the Early Woodland Period is the introduction of pottery (i.e. Marion Thick and Black Sand). Pottery vessels may have first been utilized within the Nebo Hill Complex of the Late Archaic Period in western Missouri. Some sites associated with that complex have produced small clay particles that may be fiber or sand tempered sherds, but these may have been associated with other activities. Obvious pottery vessels have been found at sites in Missouri during the Early Woodland Period. The technology could have been brought to this region by the movement of groups from the south or east. However, there is no substantial evidence for a migration at this time and the new technology could have been spread to this area.

Few Early Woodland sites have been identified in Missouri. It may be that portions of the state were abandoned during this period, however, it is more likely that people continued to utilize a Late Archaic lifestyle, making Early Woodland sites difficult to distinguish. Although pottery may have been known, it may not have been popular with these groups. Baskets and gourd vessels could have continued to satisfy the need for containers. Further work is needed in order to better understand this period of prehistory.

MIDDLE WOODLAND PERIOD

(200 B.C. - A.D. 300)

The Middle Woodland Period is characterized by the widespread adoption of pottery manufacturing. A wide variety of vessel styles were produced with plain, cordmarked, or otherwise decorated surfaces. Projectile points distinctive of this period include contracting stemmed forms (e.g., Dickson and Langtrys) and ovate points (such as Snyders and Mankers). A number of Middle Woodland sites, including large villages, have been identified in the Kansas City and Big Bend area along the Missouri River (Kay 1979 and 1980), and along the Mississippi River. Johnson (1979) argues for a migration of people from the Illinois River Valley, but Reid (1980) suggests that local populations were taking advantage of trade and communications along the river.

Extensive trade networks were established at this time as evidenced by the widepread use of exotic goods such as copper ornaments, conch shells, obsidian tools, and buffalo skulls. Raw materials such as galena, copper, mica, obsidian, hematite, and chert were also exchanged. Some sites located near the rivers may have served as market or redistribution centers for raw materials and manufactured goods obtained from smaller settlements situated along the upper portions of tributary drainages (Kay 1979;1980). The importance of these sites is suggested by the frequent presence of adjacent burial mounds. Shared ideas are implied by the widespread construction of these mounds, which may have served to integrate populations on a local scale.

For most of the I-44 study area, there is little evidence of Middle Woodland habitation. It is possible that groups in this region maintained a Late Archaic type of existence. However, resources within this region such as lead and hematite were widely traded during this time and it is unlikely that this area was completely untouched by the broader Middle Woodland developments.

LATE WOODLAND PERIOD
(A.D. 300 - 1000)

During the Late Woodland Period, native seed cultigens were the primary crops. Most people lived in small farming communities that were established within river or creek valleys, the exchange of exotic goods waned, and pottery became less elaborately decorated. Vessels had only cordmarked exteriors, with occasional cordwrapped or plain dowel impressions on the lip.

Generally, it is assumed that this was a period of cultural degeneration or social isolation. Braun (1977), however, has argued that it was a time of continued evolutionary development with increasing social interaction. He suggests that the similarity of pottery styles throughout the Midwest was due to widespread trade and communication throughout the region. However, traders tended to favor luxury goods that yielded a high profit. The relatively undecorated conical vessels typical of the period could have been produced anywhere. The low demand for these undecorated pieces would not offset the cost of transportation or the risk of entering new territories. Instead, the changes in pottery style, the decline in exotic goods, and less elaborate burials could represent a change in social attitudes away from objects that reflected individual success towards those that emphasized community cohesion and a more egalitarian society.

Several new innovations were adopted during the Late Woodland Period. Hunting was improved by the rapid and widespread adoption of the bow and arrow around A.D. 600. After this time, small (<2cm long) Scallorn points were popular in this region. Grier (1974) suggests that groups in central Missouri continued to rely on hunting and gathering. Reeder (1982:469), however, reported finding seeds of *Polygonum, Chenopodium*, *Iva*, and maize at the Feeler Site. The lack of sites producing cultigens is probably due to the lack of archaeological excavations, and flotation techniques have been applied at only a small number of excavated sites. When flotation is utilized, cultigens such as the starchy seed plants (maygrass, knotweed, chenopodium, and little barley) and oily seed plants (marshelder and sunflower) have proven to be an important part of the diet. Although maize was known since the Middle Woodland Period when it was probably introduced into this region as a luxury item, it was not widely grown. Maize may not have been popular due to its original association with high status, which was de-emphasized during this time.

Farming communities were generally smaller and more dispersed than settlements occupied during the Middle Woodland Period. These settlements occurred within a variety of topographic zones, including both upland and bottomland contexts. The majority of these sites, however, were situated along the major waterways.

TERMINAL LATE WOODLAND or MISSISSIPPIAN PERIOD
(A.D. 1000 - 1400)

After A.D. 1000, groups along major rivers re-established trade networks of exotic goods and created numerous large communities with powerful leaders. The settlement system ranged from isolated farmsteads to large civic-ceremonial centers. Larger communities, present primarily along the Mississippi and Missouri rivers, were highly organized and often contained a variety of mound types. Most people resided within smaller farming hamlets or isolated farmsteads generally located near fertile soils (Milner et al 1984:186). The inhabitants of these isolated communities were involved in and benefitted from the expanded trade system. Although its been suggested that Mississippian culture did not extend into Missouri, the evidence for a Mississippian lifeways is evident within this area.

Away from the rivers, where most of the I-44 corridor is situated, only isolated Mississippian sites have been found. These sites were identified generally on the presence of triangular projectile points. It is assumed that a Late Woodland type of existence was maintained within these regions. However, plain and loop handled vessels have been found at these sites probably representing local examples of Mississippian vessels. Lead, hematite, fire clays, granite, and salt from this region were also widely popular and exchanged during the Mississippian Period. It is unlikely that these groups were completely untouched by the Mississippian culture, although they seemed to have maintained many aspects of their indigenous culture. Much more work is needed within this region in order to better understand how these various groups developed and how they related to each other, as well as to groups in the larger centers to the east and west. The latter is especially important for understanding the overall Mississippian cultural system.

PROTOHISTORIC PERIOD
(A.D. 1400 - 1700s)

The Protohistoric Period began with the disintegration of the larger Mississippian centers around A.D. 1400, and lasted until the arrival of European-Americans. The Mississippian economic system seems to have declined during this time, although it continued to thrive in the southern and southeastern U.S. Groups in central Missouri may have continued a Terminal Late Woodland/Mississippian lifestyle, with some people continuing to rely on agriculture, and others returning to a hunter-gatherer style of subsistence. The Osage arrived into the western part of the state about this time, probably from the northern Plains. The eastern half of the state, on the other hand, appears to have been almost completely abandoned. Early European/American settlers reported that area served as an open territory utilized for hunting and trapping by various Native American tribes who lived at the outer edges of the state.

HISTORICAL CULTURAL OVERVIEW

COLONIAL PERIOD
(1700s-1803)

French missionaries and trappers were the first to penetrate the central portion of North America during the 17th and 18th centuries. Father Jacques Marquette and Louis Joliet located the mouth of the Missouri River in 1673. By the 1680s, French fur traders, many without legal permission, had made their way up the Missouri and established contact with local Native American groups. As early as 1700, French trappers and miners were drawn to the Missouri Ozarks in search of lead, iron, and furs (Foley 1989:1-11). The first successful community in what would become Missouri was Ste. Genevieve, established around 1750. This community served as a local center from which miners and trappers explored the Ozarks.

After the Treaty of Paris of 1763, colonial control of the region passed to Spain, but traders operating along the rivers continued to be predominantly French in derivation. St. Louis was established by French Colonists in 1764 and was soon followed by other French communities established primarily along the Missouri and Mississippi Rivers. Individual French Colonial settlers may have established short term habitation sites within the Ozarks near where they mined lead, iron, or salt, or near Native American villages.

The first important ingress of settlers from the United States occurred during the late colonial period, in the last years of the 18th century. Attracted by promises of free land from the Spanish regime, the new American emigrants for the most part bypassed existing settlements, and spread out into the surrounding countryside. They created large farmsteads within prime agricultural areas. Many built homes of simple log construction upon first arrival, replacing them with more substantial vernacular frame or masonry homes as circumstances permitted. Primarily farmers raised hogs and corn, although some erected mills to process the harvest, while others built distilleries to process the grain into whiskey, a valuable and easily transported commodity.

With their farmsteads spread across the hinterlands, the American emigrants had effected significant change by the end of the colonial period. According to one Spanish period governor, they possessed a “wandering spirit” and easy methods of subsistence that allowed them to form new settlements readily. “When a family grows tired of one place,” he wrote, “it moves to another” (Peterson 1993:47). Sometimes eyed with suspicion by their French Colonial neighbors, the Americans quickly became the dominant population on the regional frontier.

TERRITORIAL PERIOD
(1803-1821)

In 1803, the territory west of the Mississippi River was acquired by the United States under the terms of the Louisiana Purchase. The Spanish regime had technically ended three years earlier by a secret treaty in which control of this area had been ceded back to France. President Thomas Jefferson learned of the agreement and, fearing French expansionism, quickly negotiated a purchase. In 1804, Amos Stoddard arrived in St. Louis to oversee installation of an American territorial government.

The transfer of power to the United States found relations between the wave of new European American settlers and Native Americans increasingly strained, establishing an agricultural economy increasingly independent of the Indian trade. Intermittent violence sometimes erupted between these two groups (National Historical Company 1883:180). Then in 1810, hostilities escalated primarily due to the provocation of British agents. Fighting on the frontier was well underway when, in 1812, war was officially declared between the United States and Great Britain. Local militia forces were quickly mobilized and small forts or blockhouses were built at many isolated frontier settlements.

As the conflict came to a close in 1815, settlement began in earnest, with emigrants from Kentucky, Tennessee, the Carolinas, and Virginia arriving “like an avalanche” (Peck 1965:146). Many were small-scale farmers attracted by promises of cheap and fertile land, often settling at prairie/forest margins. Others were slaveholders seeking a new territory without anti-slavery restrictions. A few were educated Virginians of substantial means, planters seeking the undepleted soil of the frontier. Utilizing a slave work force to produce tobacco and hemp for export, they sought to replicate the lifestyle they had left behind (Foley 1989).

Native American tribes displaced by American incursions east of the Mississippi River came west, first to escape American rule and after 1803 in an attempt to find a place to live within the new American territory. Shawnee established a community just south of I-44 near Union, along the Bourbeuse River. A group of Kickapoo and Delaware established communities within and around what would become Springfield. The Osage continued to reside within the western half of the state, but they began to feel the growing encroachment of newly arriving Americans as other tribes were given land concessions in this area.

ANTEBELLUM PERIOD
(1821-1861)

Missouri was admitted as a slave state in 1821 by the terms of the Missouri Compromise, the hard won product of protracted debate in the United States Congress and the first in a series of legislative battles over slavery that culminated in the Civil War. Slaveowners and their supporters were in the ascendency in Missouri, comprising a controlling power block. New emigrants from the Upper South arrived, pushing the fringe of settlements farther west.

To make way for these newly arriving Americans, the Osage and the displaced tribes were eventually forced off their lands and by the 1830s were expelled from Missouri. It was during this time (1837-1839) that the forced migrations of Cherokees passed through the state. The northern route taken by the majority of Cherokees passed close to sections of the Interstate 44 corridor. In particular, sections near St. James, from just east of Rolla to St. Roberts, from the western edge of Ft. Leonard Wood to the Gasconade River, from Route 38 to just east of Northview, and from just west of Northview to just east of Stafford. If any remnants of the original trail or of camp sites still exist, these would be considered culturally significant sites and should be avoided by any proposed construction associated with I-44. It is estimated that as many as 3000 - 4000 Cherokee died during this forced removal, so it is also possible that isolated graves could exist anywhere along this trail. These graves are protected by Missouri state statutes.

Competing with the settlers from the Upper South and often opposed to slavery was an increasing number of German immigrants. The first major influx of German immigrants began in the 1830s, attracted to Missouri by the writings of Gottfried Duden who had lived near Lake Creek in Warren County during the 1820s. Returning to Germany, he published a book containing detailed observations on the new land, as well as advice to prospective immigrants. Not just a booster's laudatory promotional tract, Duden's book addressed the negative aspects of life in Missouri. Nevertheless, it was for the most part a strong endorsement of German immigration to the American frontier. In the decade following release of Duden's book, Germans by the thousands followed his lead. Most were farmers, but professionals, craftsmen, and merchants came as well, from German provinces including Westphalia, Hanover, and Hessen-Darmstadt. Many felt the pressure of an economic squeeze in Germany where agricultural production lagged behind population growth (Walker 1964:46-49). Often they attempted to abide by Duden's advice, selecting farmstead locations on open hills above the river. "If one constructs one's buildings on hills, far from swamps," he argued, "one will be affected by the climate as little as in Germany" (Duden 1980:122). They typically established small farmsteads around the larger farms owned by residents from the Upper South.

The new German settlers were likely to reside within substantial masonry houses, although most emulated their neighbors of Southern origins, building log homes, which were replaced later by frame dwellings (van Ravenswaay 1977). Most German immigrant farmers likewise adopted the farming practices prevalent among Missouri's Southern population, emphasizing hog raising and grain production. One German was surprised to learn that corn "can be eaten as a vegetable with butter. Corn is to the American what the potato is to the German" (Mallinckrodt 1994:132).

The Germans were followed by a wave of Irish immigrants which crested during the 1840s and 1850s, in the wake of the potato blight which created a famine that peaked in 1847. The Irish crowded cities like St. Louis and performed manual labor jobs, but they also found their way into rural agricultural areas within the Ozarks (Hurt 1992:53). Following a sojourn in rural Missouri, Father John O'Hanlon returned to his native Ireland and in 1851 published a guide for fellow immigrants. Admitting that most Irish were unfamiliar with log building techniques, he nevertheless advised them to emulate the practices of the settlers who had preceded them. “It mostly happens that new settlers only design the first log house of their erection for a temporary dwelling; when they are enabled to recover themselves somewhat, this is converted to a kitchen, a meat house, or some such office, and a better house... is erected on the adjoining ground.” He counseled that, although expensive, weatherboards, plaster, shingles, and a porch were necessary for a “comfortable house” (Maguire 1976:147,150).

Near the end of the antebellum period, some of the major communities along the I-44 corridor were established such as Sullivan, St. James, Rolla, Lebanon, Marshfield, Springfield, and Neosho. The St. Louis-San Francisco Railway, often referred to as the “Frisco Line” was chartered in St. Louis on March 12, 1849 by the Missouri legislature (Stratton n.d., Frisco Veterans Reunion 1960). The first rails where not laid until July 4, 1851. The “Southwestern Branch” of that line was begin in June, 1955, reaching Rolla by 1860, which represented the southern terminus of the Southwestern Branch until the Civil War. This rail system made it easier for farmers to ship their surplus crops and livestock to larger markets. These lines also aided in the shipment of lead and zinc mined in this region.

CIVIL WAR PERIOD
(1861-1865)

Following the beginning of the Civil War in April, 1861, both Confederate and Union military units assembled across Missouri. Reflecting the closely divided nature of state politics at the time, Missourians first elected a pro-secession governor and state legislature, and then in a separate election of delegates to a secession convention, voted in a majority of candidates who were opposed to the measure. On June 14, 1861, General Nathaniel Lyon captured Jefferson City with a force of Union troops, after abandonment of the capital by Governor Claiborne Jackson and troops of his Missouri State Guard under command of Sterling Price (Parrish 1973:23). Soon after the war’s commencement, pro-Union German immigrants formed local militia units.

The largest engagement near the project area occurred at Wilson’s Creek, just southwest of Springfield, on August 10, 1861. Federal troops under General Nathaniel Lyon met Confederates commanded by General Sterling Price and General Benjamin McCulloch. The battle, costing about 2400 casualties, ended with the death of Lyon (the first general to die in the war) and the defeat of Union forces who retreated first to Springfield and then to Rolla. President Lincoln was determined to hold Rolla at all costs because the terminus of the Frisco Line could be used to supply troops and equipment to the surrounding region. Federal troops seized the town in June, 1861 (Bradbury 1997). A large federal encampment was established at the outskirts of the community and two forts were subsequently erected (Missouri Historical Society 1998:412). Rolla became an important supply distribution center, handling tons of war material. Union troops built warehouses, offices, loading docks, and wagon repair facilities within the town (Bradbury 1997:1-5).

After the Battle of Wilson's Creek, the Confederates seized Springfield, but were soon driven out by Federal forces in February, 1862 (Missouri Historical Society Press 1998:433). The Confederate forces were unable to maintain a large force, which General John S. Marmaduke became aware of in Arkansas and who devised a plan to take this important community. He attacked Springfield on January 8, 1863, but was repelled by Union forces who were joined by the local militias and even patients from the local hospitals, organized by the Union surgeons. The main fighting took place on the southwestern quarter of the community, away from the I-44 corridor.

Near the end of the war in 1864, Sterling Price again tried to raid Missouri with the intent of capturing St. Louis. But after failing to capture the Union troops at Fort Davidson near Pilot Knob and suffering heavy losses, he decided to take Kansas City instead and sent a portion of his force east to burn railroad bridges. The raiders made it as far east as Pacific, before they were turned back by union and militia forces. The battle took place just south of Interstate 44. Near Kansas City, Price's forces were trapped between two Union armies and had to escape through Kansas.

Throughout the Civil War, most of the atrocities that occurred were the result of guerrilla warfare. One of the controversies precipitating the war concerned the issue of slavery in the proposed state of Kansas, with pro-slavery Missourians crossing over the border to participate in guerrilla violence even before the war started. In the wake of declared war, guerrilla activity intensified. Union garrisons established in several towns struggled to contain the insurgency. Local slaveholders were soon targeted for retaliatory responses by federal troops. Rebel bushwhackers depended on the aid of a sympathetic populous especially in the rural areas of southern Missouri.

POST CIVIL WAR PERIOD
(1865-1900)

Following the end of the Civil War, Missouri residents returned to agricultural production. The Pacific Railroad defaulted on its interest payments and the railway was taken over by the state of Missouri. The Southwestern Branch was sold to General John C. Fremont, but he was also unable to meet payments and in 1868 a group of investors known as the South Pacific Railroad Company took over. The line was completed between Rolla and Lebanon in 1869 and the following year from Springfield and to Piece City. In October of 1870, the company was forced to sell the franchise to the Atlantic and Pacific Railway Company, who completed the line to Seneca at the Missouri-Oklahoma border. This route roughly runs along the Interstate-44 corridor, with the two intersecting at several points. During the late 1800s, this line and various spur lines served even the more remote corners of the state. The economic health of the Missouri agricultural system fostered by this railroad construction experienced cycles of growth and decline over the course of the post-war period. In the months after the close of the Civil War, Rolla saw a brief decline as a fire destroyed a large section of the town in 1865, followed by epidemic diseases. In 1871, the construction of the Missouri School of Mines revived the fortunes of the community.

A surge in federal land sales occurred after the war. New arrivals joined a growing trend toward greater farm size, and increased corn, wheat, and livestock production. Particularly important in the new economy was the Missouri mule, the state becoming the number one mule raiser in the nation by 1870. In 1873, however, tightening markets produced a decline in farm prices, followed by decreased production. During this time, the mining of lead and zinc intensified within the southwestern portion of the I-44 corridor, especially west of Springfield. In the mid 1800s, lead was identified in Newton and Jasper Counties, attracting a rush of miners to the area. One of the waste products dumped from this mining was “black jack”, which was later learned to be zinc, starting another mining rush in the 1880s. Zinc was used in the production of galvanized steel and to make brass. It was during this time that Joplin was founded serving the local farmers and miners of extreme southwestern Missouri.

Struggling to establish themselves in the post-war economy were former slaves, many of whom could not afford to own the land they farmed. Most were living marginally as agricultural laborers and farm renters. Some among them did, however, manage to acquire their own land.

By the 1890s, the size of Missouri farms continued to increase, while the number of farms decreased. Reliance on grain crops continued, although corn yields per acre declined; livestock, particularly mules, remained an important element in the economy. Fluctuating prices created a volatile situation in which many farmers lost their property in sheriff’s sales. Consumerism was on the rise, with small towns, typically located on railroads, becoming important links between farmers and markets, manufacturers and consumers (Christensen and Kremer 1988:103). Agriculture and moderate scale family farms still, however, reigned supreme in the Missouri economy.

MODERN PERIOD
(1900-2007)

The 20th century saw a greatly accelerated pace of technological advances that brought profound change to the Missouri economy, population distribution, and landscape. During the course of the century automotive travel encouraged population concentration in urban industrial centers and surrounding suburban areas.

By the 1910s, automobiles had evolved beyond the experimental stage and rapidly become a major means of transportation. The roads on which they operated, however, remained inferior, lacking any national or state-wide organization. In 1912, Carl G. Fisher organized the Lincoln Highway Association which explored and marked the first transcontinental highway route in the United States, piecing it together from existing roadways. Other associations followed, basically operating in the same fashion, connecting any two major destinations via a marked route cobbled together from existing roads. The associations drew their profits by soliciting contributions from towns and businesses along the route. The roads were often circuitous, in order to pass by as many businesses as possible, and association efforts rarely involved road improvement work (Stewart 1953:11-13).

It was not until 1925 that federal authorities created a national road numbering system. Among the new roads thus created was U.S. Highway 66, which was created in 1927. Although it would take until 1938 before Highway 66 was completely paved, the section through Missouri was paved by 1931. This highway would eventually extend from Chicago to Los Angeles. Along this thoroughfare were established a number of family owned businesses to serve the needs of travelers including service stations, restaurants, and motor courts. The new roadway also served local farmers who could truck their surplus crops to nearby markets, saving on the railroad costs. During the Depression of the 1930s, this roadway was traveled by many farming families (in particular those from Oklahoma, Kansas, and Texas) who lost their lands and headed west for agricultural jobs in California. The highway also served military personnel during World War II. The section of the highway near Fort Leonard Wood was even upgraded to a divided highway to accommodate the increased military traffic. The decline in U.S. Highway 66 occurred in 1950s when the new interstate system was developed.

As early as 1938, consideration was given by the federal government to an interstate highway network. A report resulting from the Federal Highway Act of that year recommended construction of a 26,000-mile inter-regional system consisting of two or four lane highways, some with controlled access. The plan remained dormant until the Federal Highway Act of 1944 authorized the designation of select existing highways as part of an interstate system. The act called for improvement of these designated roads, but made no provision for increased federal funding. Lack of money and uniform design standards slowed progress on the project over the following years. Although funding increased with the Federal Highway Act of 1952, only 6000 miles of highway had been completed by 1953 (Weingroff 1996).

In an address prepared for a governors conference in 1954, President Dwight Eisenhower declared that the highway system then in place was totally inadequate, causing needless death and injury, creating delay in the transportation of goods, and placing the nation at risk in the event of major disaster or war. He called for federal and state cooperation in the creation of a modern interstate network, paid for by a revamped system of financing that would avoid debt. Installed over a period of 10 years, the highway program would, according to Eisenhower, cost $50 billion. A presidential advisory committee headed by General Lucius Clay subsequently determined that modernization of 36,402 miles of designated highway could be achieved in 10 years at a cost of $27 billion (Weingroff 1996).

The Federal Highway Act of 1956 substantially enacted Eisenhower’s proposal and initiated the current interstate highway system. The act instituted construction on a network 39,600 miles in extent and authorized $25 billion for the project, to be spent between 1957 and 1969. Existing toll roads meeting system standards could be integrated into the interstate system. Inherent in the terms of the act was the idea that the interstate system would evolve and improve over time and that initial construction would be altered or replaced in the future as need arose. The original act permitted two-lane interstate segments with at-grade intersections in low traffic rural areas, but called for the adoption of minimum standards aimed at the eventual elimination of these segments. Legislation passed in 1966 ultimately did require all interstates to be at least four lanes and have no at-grade intersections. According to the 1956 act, interstates were to be constructed according to standards accommodating traffic forecasted for 1975. Subsequent legislation amended this requirement so that highway design would tolerate traffic estimates for a maximum of 20 years (Federal Highway Administration 1976:476; Weingroff 1996).

The 1956 act started a public works project that was the most expensive and wide-scale in United States history, surpassing any program undertaken during the New Deal era, with approximately 75% of the new interstate system constructed on new right-of-way (Lewis 1997:126). It was endorsed by fiscally conservative members of the Eisenhower cabinet, men including Secretary of the Treasury George M. Humphrey who argued that “America lives on wheels, and we have to provide the highways to keep... the kind and form of life we want” (Davies 1975:4). Initial construction of the interstate system was in fact greeted with wide-ranging support. It was not until the 1960s that significant opposition to the program mounted, with criticisms centering on the displacement of residents and the destruction of urban neighborhoods caused by highway construction (Seely 1987:232).

Interstate 44 was first established in 1958 as the Turner Turnpike linking Oklahoma City and Tulsa and the Will Rogers Turnpike linking Tulsa and the Missouri state line southwest of Joplin. It would eventually extend 645 miles from St. Louis, Missouri to Wichita Falls, Texas. Missouri is sometimes credited as the first state to initiate interstate highway construction, because on August 2, 1956, the Missouri State Highway Commission approved contracts for three interstate projects, two sections of Interstate 70 and a stretch of Interstate 44 in Laclede County. The interstate was finally completed in the late 1960s. It roughly follows old U.S. Highway 66. Since Route 66 was decertified as a highway in 1985, public interest has grown in preserving this highway and the remaining establishments that served it. In 1990, a Route 66 Association was established in Missouri with its mission statement of “to preserve, promote and develop old Route 66 - The Main Street of America” (Route 66 Association, www.missouri66.org). The same year Route 66 was declared a “State Historic Route”. Sections of the old highway still serve as the outer road for Interstate 44 and as business loops. Two surveys of the Route 66 corridor by Johnson (1993), and Snider and Sheals (2003) identified a number of resources that still existed along the original route, although the majority of these, except for a bridge and possible a railroad underpass, were outside of the I-44 corridor study.

PREDICTIVE MODEL

The archival study provided an understanding of the cultural resources within 250 feet on either side of the existing Interstate 44. Based on this information, a predictive model was developed in order to identify locations having a high potential for as of yet unidentified resources. This predictive model can also be used to estimate the amount of time and potential costs involved in documenting these resources.

PREHISTORIC COMPONENT

Many gaps exist in our knowledge of prehistoric settlement patterns. Although collectors know of many sites, they rarely bother to report them. In addition, collectors tend to limit their searches to locations that have good visibility (e.g. agricultural fields and caves/rockshelters). The information collectors have recorded is limited, usually only consisting of a brief listing of highly prized artifacts, like projectile points. In the past 30 years professional archaeologists have become more involved with recording sites in Missouri. These investigations resulted in the survey of a wide range of areas (including forests and fields covered by dense brush). Attempts were also made to locate deeply buried sites with no surficial evidence. The archaeological sites identified varied from large, permanent settlements to small, special function camps, as well as various historical archaeological sites.

Archaeological surveys suggest that prehistoric inhabitants preferred elevated locations near the rivers and their major tributaries for habitation. These locations were at marginal zones between riverine, bottomland, and upland resources providing the greatest diversity of plant and animal resources and serving as a predictable means of subsistence. In addition, the waterways served as the main avenues of travel, communication, and commerce. Using watercraft, people could easily transport resources back to their habitations. These avenues allowed prehistoric groups to form social ties, through which local inhabitants could learn of new resources, technologies and ideas. The waterways also allowed people to obtain luxury goods, some coming from as far away as the Rocky Mountains, the Great Lakes, and the Gulf of Mexico, improving their economic and social standing.

The I-44 study area consists primarily of uplands with few bottomland crossings, minimizing the number of cultural resources that might be encountered. Highly sensitive areas that are within the study area include the valleys and adjacent bluff tops near major waterways, which are summarized in Table 3.

Table 3: Major Drainages Crossing the Interstate 44 Corridor

River/Creek Drainage	County	Nearest Town/Landmark
Bourbeuse River	Franklin	Near Highway 50 interchange
Spring Creek	Franklin	Sullivan
Gasconade River and Mill Creek	Phelps	Jerome
Big Piney River	Pulaski	Devils Elbow
Roubidoux Creek	Pulaski	Waynesville
Gasconade River and Osage Fork continuing to Bear Creek	Laclede	Near Laclede and Pulaski county line
Niangua River, East and West Forks	Webster	Marshfield
Pond and Picherel Creeks	Greene	Halfway between Springfield and Greene/Lawrence county line
Upper ends of several tributaries of Turnback Creek	Lawrence	Chesapeke
Spring River	Lawrence	Between Mt. Vernon and Hoberg
Center Creek	Jasper	Sarcoxie
Jones Creek	Jasper	Just east of Fidelity
Upper ends of two tributaries of Center Creek	Jasper	Atlas
Shoal Creek	Newton	Readings Mill

Long and short term habitation sites are likely to have a diversity of remains reflecting various aspects of people's culture and likely having intact subsurface features making them highly significant. Habitation sites were often placed along the major waterways, especially on terraces and upland margins. Habitation sites are also likely to have unmarked burials, either within the communities or just outside of them. Burials are sensitive locations that should be avoided if at all possible. Only one of these possible burial sites has been identified, three possible cairns recorded at site 23JP187 in Jasper County. The cairns were just as important as territorial markers, as well as reflections of civic pride. As such, most mounds were placed on bluff or ridge tops visible for great distances across the valleys below.

Other sensitive resources that should be avoided include caves and rockshelters. These formations were used by prehistoric groups as a place for temporary shelter, as they hunted or collected resources. Caves and rockshelters may have been used for storage, as they offered natural protection from the elements and cooler temperatures to store goods and could be easily refound to retrive the stored items. The repeated use of these natural formations has resulted in deep, stratified deposits of cultural remains that are crucial to our understanding of how people changed their cultures over time. Caves and rockshelters may have also had religious significance, representing portals to the underworld. They are often associated with petroglyphs and pictographs, and burials were often placed within their deeper recesses. A number of these formations are known to exist along most of the I-44 corridor. Caves and rockshelters are likely to have significant cultural information and should be avoided if possible.

Lead and iron resources could also exist near the I-44 corridor. Prehistoric groups are known to have mined these resources, with lead from this region traded as far away as the mouth of the Mississippi River nearly 4000 years ago (Walthal 1981). If prehistoric mines or quarry pits are found they could represent important cultural resources. These mines are likely to occur on the sides of steeper ridge slopes and were at least preliminarily worked on the nearby ridge top or within nearby stream valleys.

Shorter term camp sites could exist at any location along the I-44 corridor. These small sites were typically utilized for only a short durations to collect local resources. Since they were used for such a short duration, few remains are typically left at these locations. In general, these sites would not be considered significant, although these sites need to be evaluated on an individual basis.

The settlement pattern utilized by prehistoric groups varied through time. The earliest sites, dating to the Paleoindian through Early Archaic Periods, are rare in Missouri. The lack of these sites could indicate that locations within Missouri were rarely utilized during this time, but it is more likely that these smaller, more emphermal sites have just been overlooked. Large sections of Missouri have not had intensive archaeological surveys and even when these sites are identified it is rare to find diagnostic artifacts at them. As such any sites, even small ones that can be dated to these periods, should be considered because so little is known about them.

In many parts of Missouri, there was a major shift towards the use of bottomland during the Middle Archaic Period. This period is associated with the warmer climate of the Hypsithermal Climatic Episode. It is expected that most of the major sites dating to this period will be located near waterways either on terraces or on the adjacent bluff margins.

A greater number and diversity of sites are associated with the Late Archaic Period within the corridor area. During this time, there appears to have been a shift from people occupying short term camps as part of a seasonal round to a logistical mobility pattern in which some settlements were occupied on a semi-permanent to permanent basis. The permanent settlements would be larger and have a greater diversity of artifacts than other types of sites, making them easier for collectors and archaeologists to identify. They were generally placed on terraces, at the base of ridge slopes, and near the margins of the uplands. These settlements would be considered significant as they reflect the first use of permanent occupations. With the longer occupation of some communities, it is more likely that unmarked graves could be found within their confines or nearby. Extraction camps utilized by work parties from these communities would be occupied for only short durations in order to obtain needed resources. These sites are likely to be found in a wide range of environmental and topographical settings. Although these camps would have few intact subsurface deposits and would not be considered significant, some special purpose sites (e.g., quarry sites or rockshelters) could provide unique insights into the Late Archaic economy and could be considered significant.

There appears to have been a drastic decrease in the number of sites associated with the Early Woodland Period. Portions of Missouri may have been abandoned during this time, but it is more likely that these sites have been under-recorded, as they are difficult to distinguish from Late Archaic sites. Most of the sites that are associated with the early Woodland period are small, short term camps and habitations. As suggested by Martin (1999), the majority of the Early Woodland sites were placed within the bottoms of major waterways. Because so little is known about this time period, all sites dating to this time could be considered significant.

There is only a slight decrease in the number of sites associated with the Middle Woodland Period as compared to the Late Archaic (further suggesting that Early Woodland population levels probably did not decrease). Part of the drop in the number of sites could be due to a population cluster at major market centers. Middle Woodland settlements were generally placed within the bottomlands, or on the adjacent ridge/bluff tops where there was poor terrace formation. Major communities are often associated with burial mounds or rock cairns. A number of smaller permanent hamlet or village sites occurred along the smaller creeks and tributaries. All habitation sites, regardless of size, could be considered significant as they could provide insights into the overall Middle Woodland economic/social pattern.

Past researchers have suggested a rapid increase of human populations during the Late Woodland Period, with people subsisting primarily by hunting and gathering and some horticulture. Recent investigations suggest, however, that agriculture was more important than previously believed. Instead of a drastic increase, Late Woodland population levels could have remained steady and people lived in a more dispersed settlement pattern. Small farming communities were placed near fertile soils within the bottomlands or on the adjacent bluff or ridge tops. The large scale trade network in exotic goods ceased at this time. Without this economic stimulus, communities may have been established in a wider variety of topographic/ environmental contexts within both bottomland and upland areas. Although more “Late Woodland” sites have been investigated in Missouri than any other time periods, there is much that is still not known about this time and its social/political system.

Changes may have occurred after A.D. 1000 during the Terminal Late Woodland or Mississippian Period. Although these groups appear to have lived a lifestyle similar to previous Late Woodland groups, there were changes in the pottery they produced (plain vessels with loop handles). There were also likely other changes in their society as well. Lead, hematite, fire clay, basalt, and salt were important materials traded out of the Ozarks into the greater Mississippian trade networks. It is unlikely given this trade that local groups remained untouched by the Mississippian societies. Although, like people living within the Ozarks during Historic times, these groups may have rejected many of the changes that were taking place along the greater rivers in order to maintain a sense of independence and freedom. Just what changes occurred during this time and how it fits into the overall Mississippian economic and social system is still unclear. All of the major farming communities dating to this time could be considered significant because they could provide insights into the overall economic and political system which is poorly understood at this time. Some special function sites (e.g., mineral quarries) could also be considered significant as little is known about this industry.

No sites dating to the Protohistoric Period have been identified within the I-44 corridor. It is possible that early settlements of the Osage or other historic tribes could exist near this corridor, especially within the western portion of the study area. Since so little is known about these people at the end of the Prehistoric Era, all sites associated with this time would be considered significant.

HISTORIC COMPONENT

French settlement during the Colonial Period (1673 to 1803) clustered primarily near major waterways that served as primary avenues of travel and trade at that time. These locations contained fur bearing animals that were trapped or hunted by the French Colonists. These early settlers were also attracted to this region by lead and iron. Within the study area, individual French settlers may have established residence at isolated locations near exploitable resources or adjacent to Native American villages. These cabins were only used for a short time, but the French Colonists could have built a simple vertical log or horizontal log (*piece sur piece*) cabin. Archaeological remnants of such isolated residences would be extremely small, perhaps consisting of foundation trenches, a few yard features, and a limited scatter of associated artifacts. All sites dating to this time would be considered significant.

At the end of the Colonial Period, after 1790, settlers from the Upper South arrived, establishing general farms located primarily in the eastern portion of the study area. Most of these farmsteads were placed along waterways where more fertile soils were available. Many built homes of horizontal log construction upon first arrival, replacing them with more substantial homes of vernacular frame or masonry construction as circumstances permitted. Archaeological sites marking their farmstead locations could consist of minimal subsurface deposits, with possible features including shallow root cellars, stone building footings, and privy pits. Little is presently known about these early farmers and all of their sites would be considered significant.

During the Territorial Period, 1804 to 1821, the influx of emigrants from the Upper South continued, some establishing farms near previously established settlers. Others pushed into the western part of the state. Remains of residences from the Territorial Period will likely be sparse consisting of only shallow pit features and a possible house foundation.

During the Antebellum Period (1821 to 1861), the front line of settlement pushed further west. During this time, Native Americans were forced out of the state. Others forced to move from the eastern U.S. passed through the area. One of the trails followed by the Cherokee passed very close to portions of the I-44 corridor. Any camp sites associated with this forced migration would be considered significant. Also there is a possibility of unmarked graves along this trail, which are protected by state statutes.

People of Upper Southern origin established a successful slave agricultural economy at this time throughout Missouri. A small number of planters, owning substantial numbers of slaves, established within this area large farms on which a diversity of crops and livestock were raised, but the main cash crops were hemp and tobacco. Often living in substantial homes of frame or masonry construction, planters typically housed slaves in cruder quarters separated from the main residence. These residences were sometimes placed near the agricultural fields. The archaeological footprint of such farmsteads should cover a large area, with subsurface features including residence foundations, cisterns, wells, privies, and outbuilding remnants. The potential significance of archaeological sites and historic properties dating to this time will have to be individually evaluated. Slave quarters, however, would be considered significant for they could provide insights into the lives of these individuals, which is poorly understood at this time.

Substantial numbers of German and Irish immigrants settled inside the study area. Many German immigrants established farmsteads where land was available, favoring no particular type of topography. German immigrants were, according to some accounts, more likely to employ substantial masonry construction, although many emulated their neighbors of Southern origin, building notched log homes as an expedient resodemces to be replaced later by frame dwellings. Irish immigrants of the period adopted similar settlement patterns and building construction methods. German and Irish immigrants established general farms differing little from those established by the bulk of the Upper Southern population during this time period, all leaving behind a similar archaeological signature, including cellars, foundations, privies, well, cisterns, and hog scalding pits. These sites will need to be evaluated on an individual basis.

During the Civil War, 1861 to 1865, several military engagements were fought near the study area. Widespread within the study area, guerrilla warfare forced the abandonment or involved the destruction of many homes and farmsteads. Any camp sites occupied by troops would be considered significant.

Thereafter, during the Post Civil War Period (1865 to 1900), a major new influx of settlers took place, new arrivals occupying many rural areas within the study area that were previously unclaimed. Concurrently, a major railroad building program commenced, with several lines constructed across the study area. Numerous towns grew up at stops along the new routes. The railroads transported a wide variety of goods to previously isolated areas, including the lumber used in balloon frame houses, a construction technique that became widely adopted during this period. Vernacular building types continued to prevail, although during the course of this period an increasing number of buildings were constructed in an identifiable Victorian style. Archaeological sites of the Post Civil War Period contain a variety of features similar to those found on antebellum sites. The quantity of artifacts, particularly bottle glass, tends, however, to be much greater, given the increased availability of disposable goods and the rise in consumerism during this period. These cultural resources need to be evaluated on an individual basis.

In the Modern Period (1900 to 2007) technological change, including a revolution in automotive travel, led to a redistribution of the population away from rural agricultural areas and towards urban industrial centers and surrounding suburban areas. Important to the development of automotive travel was the creation, in 1925, of a numbered federal highway system. U.S. Highway 66, completed in Missouri between 1927 and 1931, extends along nearly the entire length of the I-44 corridor. Numerous businesses, to serve the traveling public, were soon established along this highway, many built or decorated in a new fashion, designed to catch the attention of passing motorists. These places could be considered significant. An even greater impact on the economy resulted from the creation of the federal interstate system, including Interstate 44 started in 1956 and completed in the late 1960s.

Although vernacular construction continued to be widespread, there was a rise of pattern book and prefabricated house construction during the first half of the 20th century, and buildings built after a discernible eclectic or modern style became increasingly popular. Some of these buildings may be considered eligible for inclusion into the National Register of Historic Places. Concrete construction was increasingly employed, particularly for the subsurface portion of buildings, making it a dominant component in most of the widespread archaeological sites dating from this time period.

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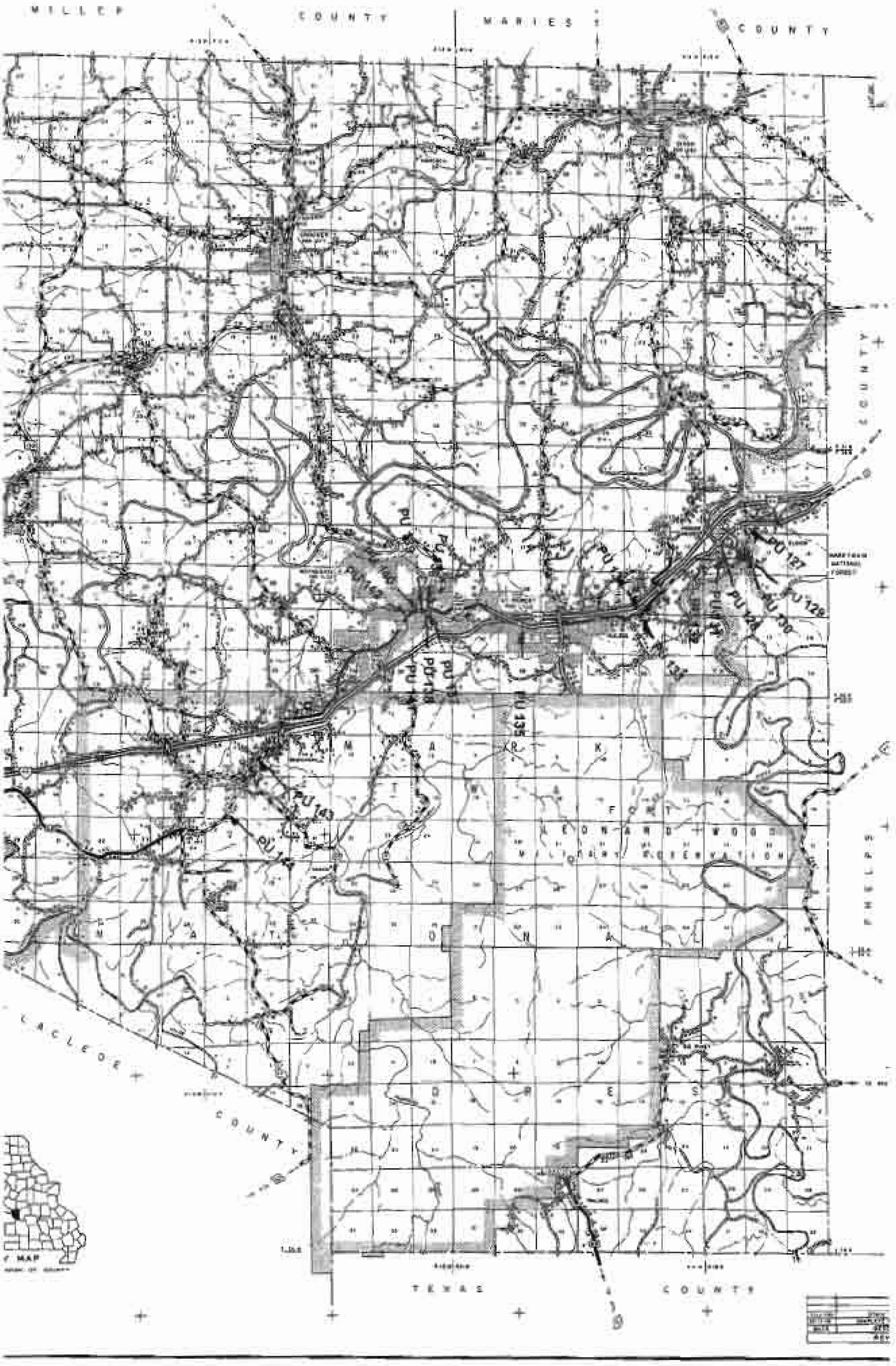
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LACLEDE COUNTY
FORT LEONARD WOOD MILITARY RESERVATION
MARK TWAIN NATIONAL FOREST
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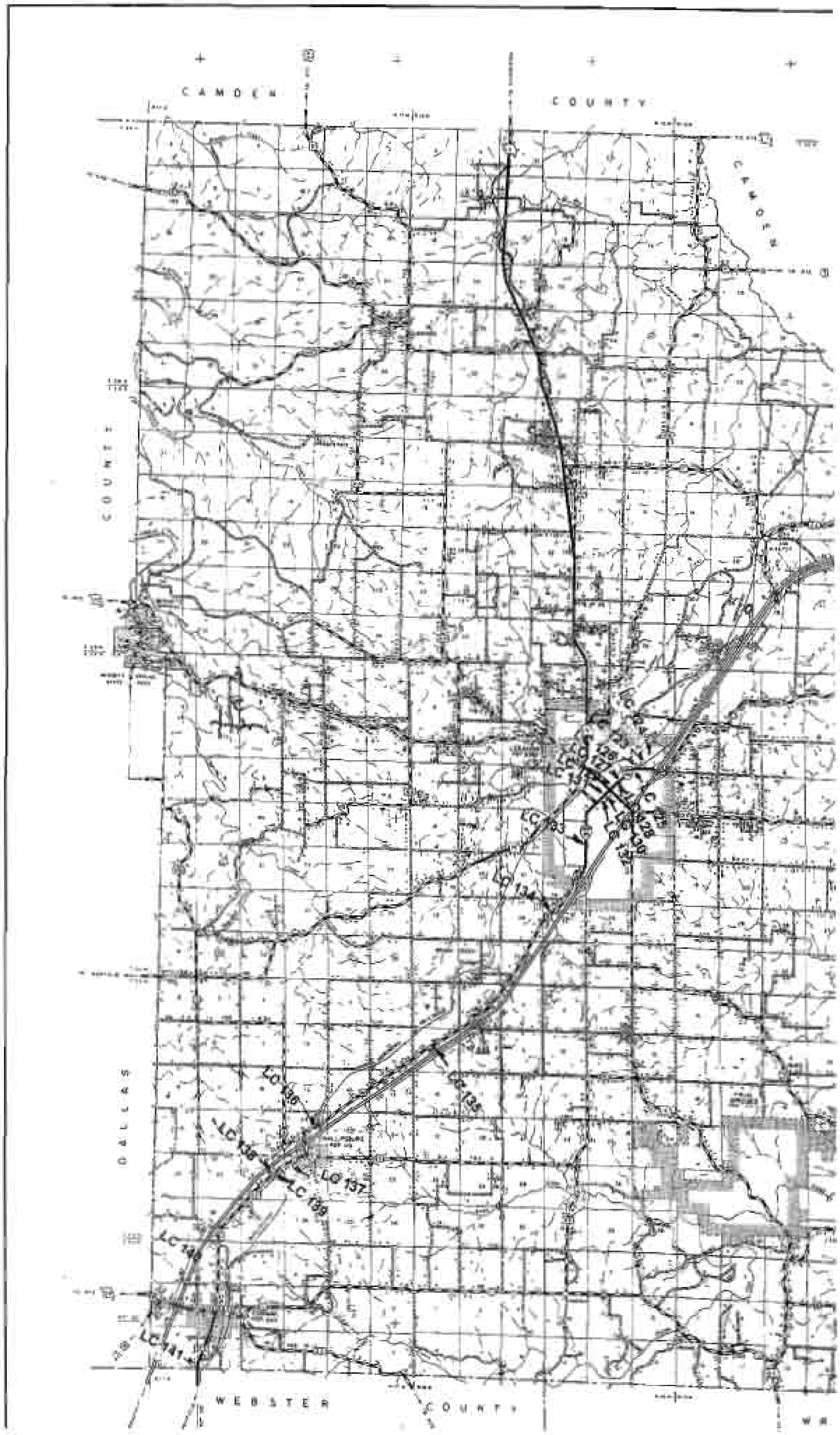
PU 144
MAP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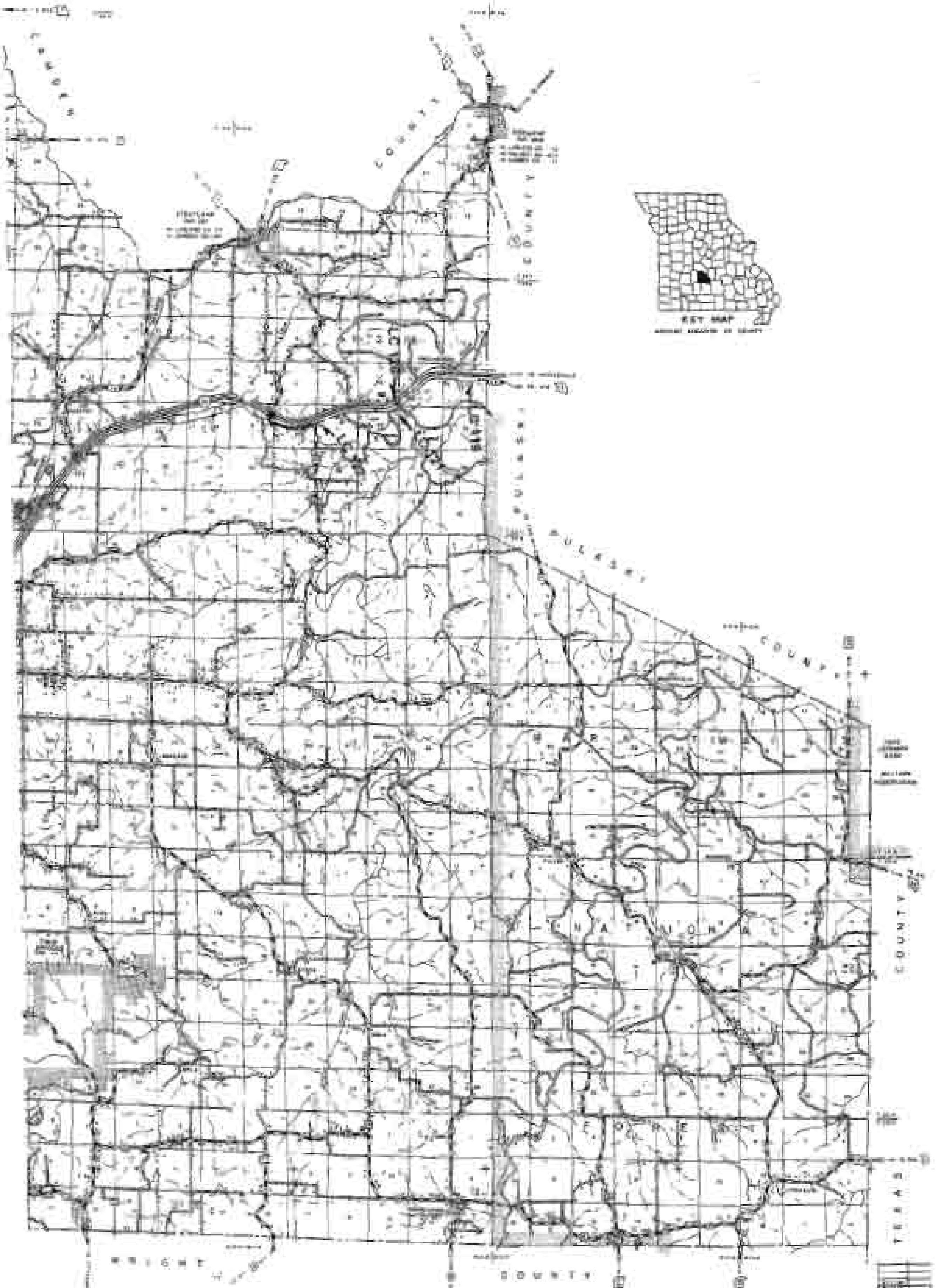
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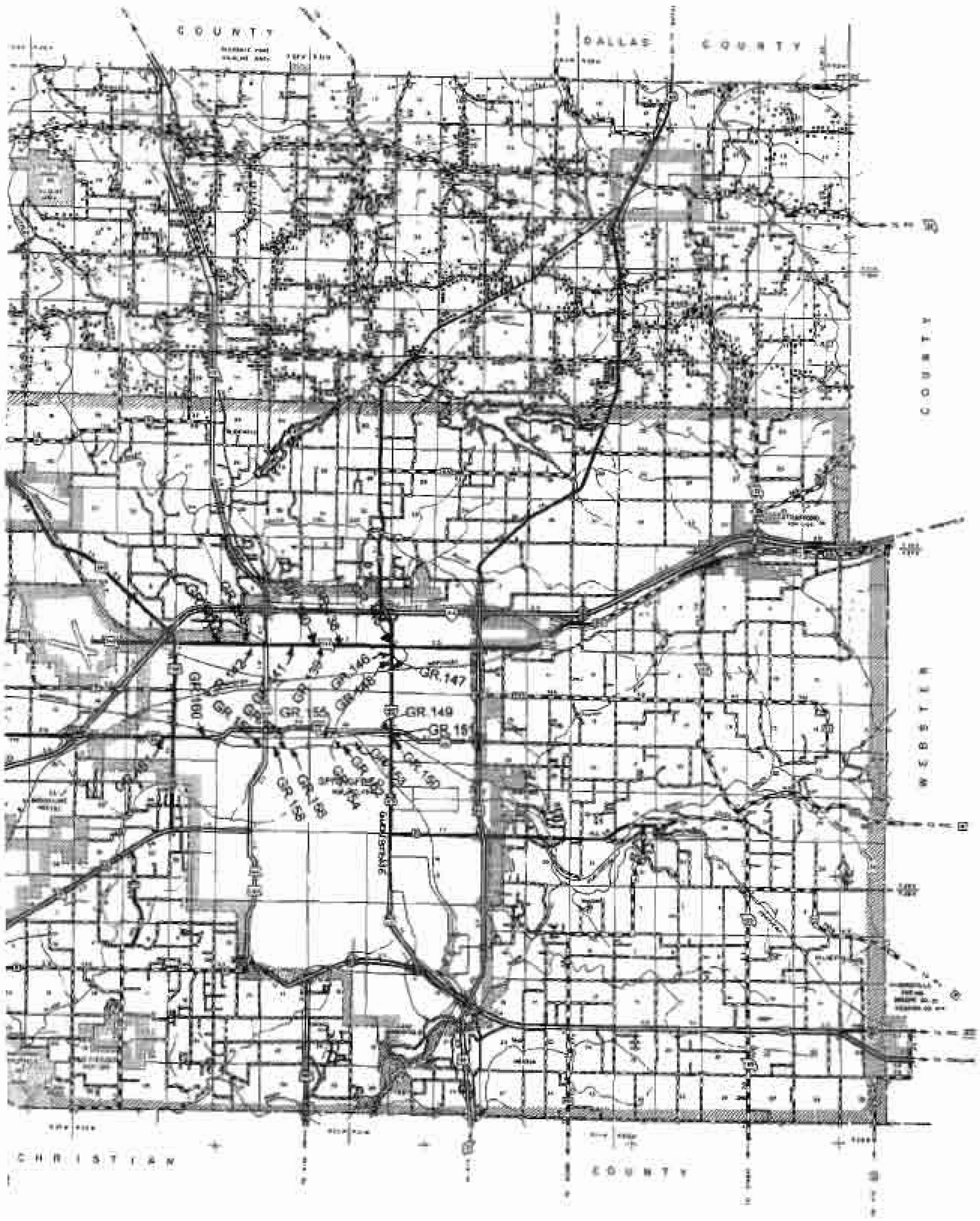
TEXAS COUNTY
WRIGHT COUNTY
COUNTY
KEY MAP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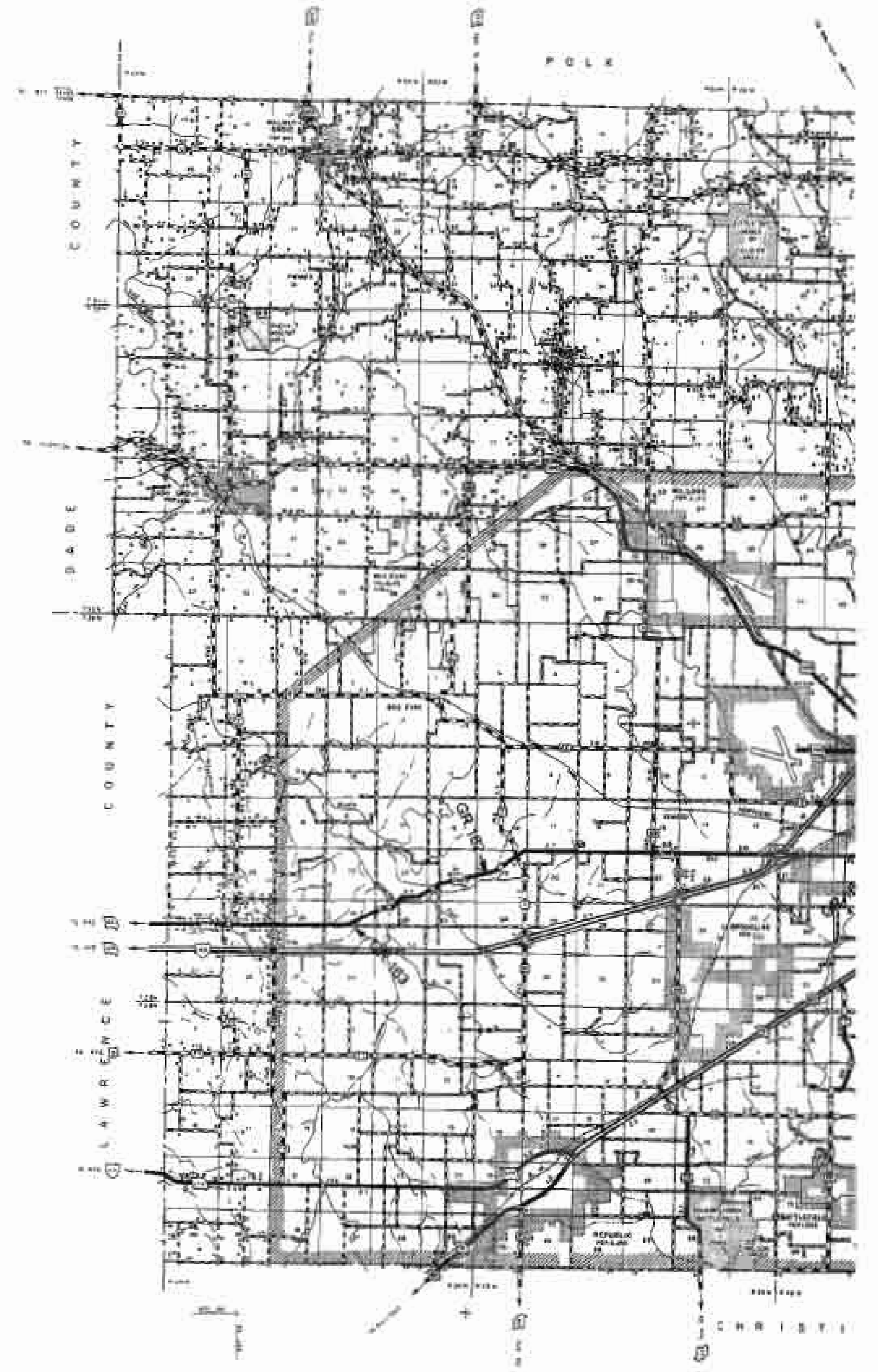
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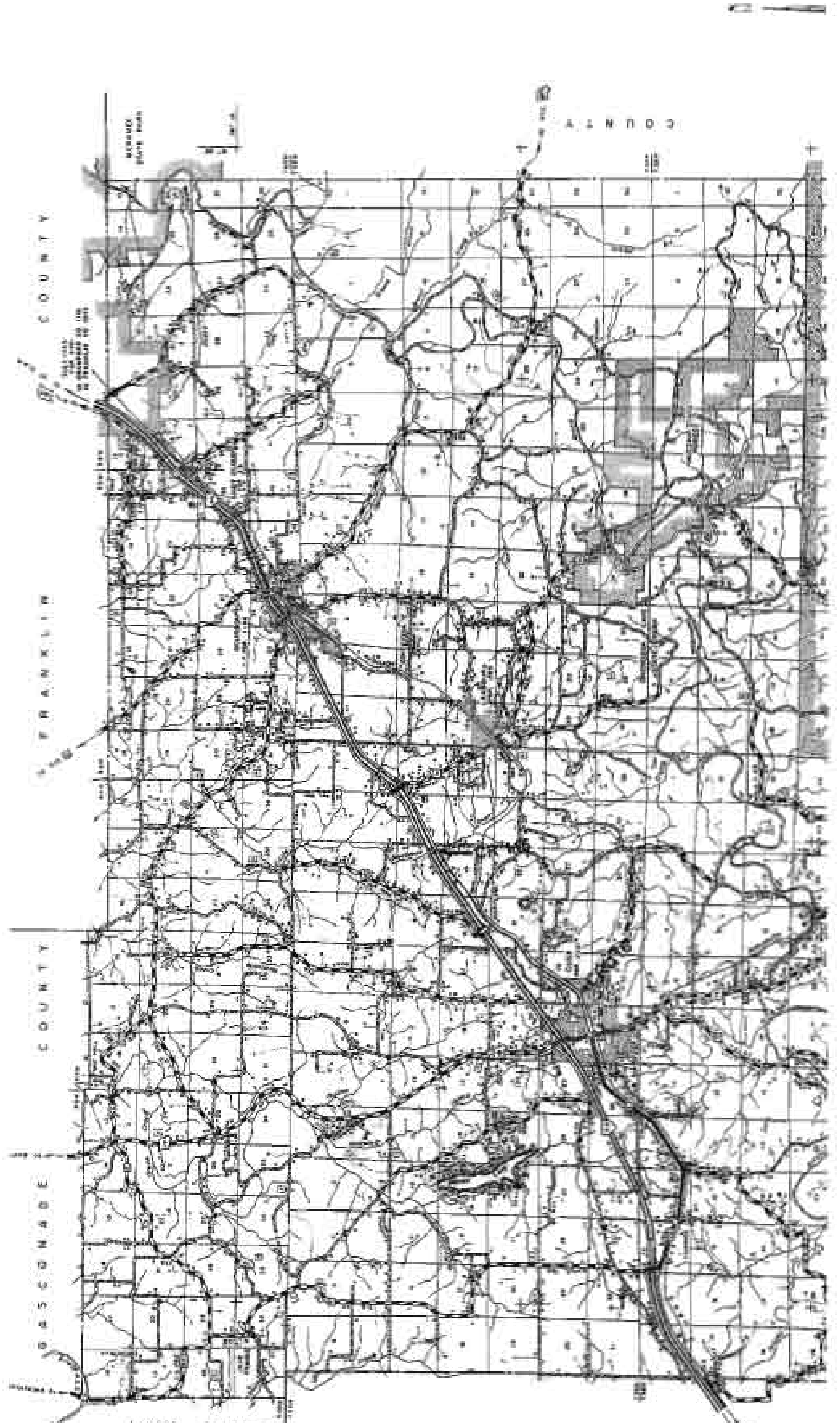
FRANKLIN COUNTY
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COUNTY
MERAMEC STATE PARK

Interstate 44 (I-44) Purpose and Need Study: Natural Resources Review (A-7)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	August 1, 2007
REVISION SUBMISSION DATE:	February 29,2008

Introduction

The purpose of this Technical Memorandum is to summarize potential natural resources and related issues along the I-44 corridor. Relevant issues include wetlands, species listed with federal or state status, species of special concern, spawning streams, habitats and plant communities, conservation opportunity areas, cave focus areas, public lands, and conservation areas. Data summarized herein is based on literature review and coordination with agencies including Missouri Department of Conservation (MDC), Missouri Department of Natural Resources (MDNR), the U.S. Fish and Wildlife Service (USFWS), the U.S. Geological Survey (USGS), and The Nature Conservancy (TNC).

The Heritage Review Report, generated by the MDC, was used in determining the locations of potential natural resource issues along I-44. This report and a corresponding figure can be found in the technical files associated with the I-44 Purpose and Need Study.

Wetlands

Wetland resources within the I-44 corridor were assessed with review of the National Wetland Inventory (NWI) and a cursory windshield survey.

Land along the I-44 corridor is rolling to steeply sloping; therefore, wetlands are not prominent on the landscape. Natural palustrine wetlands in the I-44 corridor tend to be concentrated adjacent to streams and rivers. Natural linear palustrine wetlands adjacent to waterways are in a landscape position to perform a typical suite of functions associated with wetlands, for example, wildlife habitat and migration corridors, sediment and nutrient filtration, and floodflow retention and desynchronization, and potentially groundwater recharge.

Ponds, some naturally occurring and some impounded for agricultural use, are scattered throughout the I-44 corridor. Most ponds within 500 feet of the I-44 pavement are less than 2 acres in size. Heavily vegetated ponds provide wildlife habitat, may serve to filter sediments and nutrients before reaching groundwater, and may provide groundwater recharge. Hydrologically isolated ponds typically do not express the function of floodflow retention and desynchronization. Typically livestock watering impoundments provide little wildlife habitat and if lined with an impermeable layer provide little groundwater recharge.

Table 1 summarizes wetland resources within the I-44 corridor based on National Wetland Inventory (NWI) data.

TABLE 1

Summary of Wetland Resources Within the I-44 Corridor [1]

Wetland Type	Westbound (acres)	Eastbound (acres)	Total Acres
Palustrine emergent (PEM)	2.7	7.4	10.1
Palustrine scrub-shrub or forested (PSS or PFO)	8.1	2.7	10.8
Palustrine Pond(PUB)	43.8	58.4	102.2
Total	**54.6**	**68.5**	**123.1**

[1] The I-44 corridor is defined as 500 feet from existing pavement edge.

Species Listed With Federal or State Status

Data concerning state, federal, or candidate species with potential occurrences in or near the I-44 corridor is based entirely on agency correspondence from the U.S. Fish and Wildlife Service (USFWS 2007) and the MDC (2007).

Federally endangered species for which occurrence records exist near the I-44 project area include the Indiana bat (*Myotis sodalis*), the scaleshell mussel (*Leptodea leptodon*), and the running buffalo clover (*Trifolium stolonifera*).

Federally threatened species known to have been observed near the I-44 project area are the decurrent false aster (*Boltonia decurrens*), western prairie fringed orchid (*Platanthera praeclara*), the Ozark cavefish (*Amblyopsis rosae*), and the Niangua darter (*Etheostoma nianguae*).

Federal Candidate species collected near the project area are the sheepnose mussel (*Plethobasus cyphyus*), the Neosho mucket mussel (*Lampsilis rafinesquii*), the spectaclecase mussel (*Cumberlandia monodonta*), and the Arkansas darter (fish) (*Etheostoma cragini*).

State Endangered species (with no federal status) known to have occurred near I-44 include the black-tailed jackrabbit (*Lepus californicus*), the snuff box mussel (*Epioblasma triquetra*), the crystal darter (fish) (*Crystallaria asprella*), the eastern hellbender (*Cryptobranchus alleganiensis*), and the lake sturgeon (*Acipenser fulvescens*).

In addition to specific natural heritage records of rare species, several other rare species are known to occur near I-44, summarized as follows:

- **The Bald Eagle** (*Haliaeetus leucocephalus*), recently de-listed from the federal Endangered Species Act but still state endangered, is known to winter along edges of several of the larger rivers in the project area.

- **The Ozark Hellbender** (*Cryptobranchus alleganiensis bishopi,* and *C.a. alleganiensis*) (state endangered and candidate for federal listing) is known to occur in the Gasconade River.

- **The Indiana Bat** (*Myotis sodalis*) may use several caves near I-44 for wintering habitat. It is possible that forested areas near I-44 may also provide summer habitat for the Indiana bat. They often roost and raise young in trees (dead, dying, or alive) with slabs of loose, peeling bark, or containing cracks or crevices. Trees suitable for summer habitat of the Indiana bat should not be taken down between April and September.

- **The Gray Bat** (*Myotis grisescens*) is known to occur throughout much of the I-44 project area where it occupies caves and forages along streams and rivers.

- **The Greater Prairie Chicken** (*Tympanuchus cupido*) (state endangered) has been observed in booming grounds (courtship areas) in portions of Newton, Jasper, and Lawrence counties. The Greater Prairie Chicken may nest and forage in grasslands near I-44, several miles distant from their booming grounds.

- **The Missouri Bladderpod** (*Lesquerella filiformis*) (federally threatened, state endangered) could occur in the northern and western portions of Greene County associated with limestone rock outcrops.

Critical Habitat

There is no critical habitat, as designated by the USFWS, in or near the I-44 project area. The nearest USFWS-designated critical habitat to I-44 is for the Niangua darter approximately 4 miles north of I-44. The state considers cave recharge areas as "critical habitat" if the Ozark cavefish (*Amblyopsis rosae*) has been documented to occur in them. Much of the portion of I-44 traversing Greene County is within a cave recharge area that is known to provide refugia for the Ozark cavefish.

Rare Habitats and Plant Communities

Locations of several rare habitats and plant communities have been recorded in or near the I-44 project area including Creeks and small rivers (Ozark), Headwater streams (Ozark), Dolomite glades, Dry-mesic sandstone forest, Mesic limestone/ dolomite forest, Sinkhole pond (Ozark), Dry-mesic chert prairie, Chert glade, and Dry chert cliff. Where significant rare habitats or plant communities are identified, MoDOT will develop strategies to avoid these areas where at all possible and minimize impacts.

Table 2 summarizes the rare habitats and plant communities located near the I-44 project area.

TABLE 2

Summary of Rare Habitats and Plant Communities Near the I-44 Project Area

County	Habitat/ Community
Franklin	Creeks and small rivers (Ozark)
Crawford	Headwater Streams (Ozark)
Phelps	Dolomite Glade
Phelps	Dolomite Glade
Phelps	Dolomite Glade
Phelps	Dry-mesic sandstone forest
Phelps	Mesic limestone/ dolomite forest
Phelps	Sinkhole pond
Laclede	Creeks and small rivers (Ozark)
Laclede	Creeks and small rivers (Ozark)
Lawrence	Dry-mesic chert prairie
Jasper	Dry-mesic chert prairie
Jasper	Creeks and small rivers (Ozark)
Jasper	Creeks and small rivers (Ozark)
Newton	Chert Glade
Newton	Dry chert cliff
Newton	Creeks and small rivers (Ozark)

Source: Missouri Department of Conservation (Heritage Review Report – See I-44 technical files for more information).

Several other rare habitats and plant communities are near the project area, though impacts to them are not anticipated as a result of improvements to I-44. These are Halltown Glade, a sandstone glade in Lawrence County; Wildcat City Park, a xeric chert forest and dry chert cliffsin the City of Joplin (Newton County), Diamond Grove Prairie Natural Area, a dry chert prairie/dry-mesic chert prairie in Newton County; Wildcat Glade Natural Area, a chert glade in Newton County; Woodson K. Woods Bottomland Forest Natural Area, a mesic bottomland forest in Phelps County; and Tunnel Cave, an influent cave in Pulaski County.

Conservation Opportunity Areas

The I-44 corridor passes through three (of a statewide 35) conservation opportunity areas (COAs) that were identified based on the richness of diversity identified within them. Characteristics of COAs in the project area, including Middle Meramec, Upper Gasconade, and Shoal Creek are summarized in **Table 3**.

TABLE 3

Summary of Characteristics of Conservation Opportunity Areas (COA) in and near the I-44 Project Area

COA	Mile Marker	Features
Middle Meramec	195 to 235, south side	Large contiguous forest with several known rare species or rare habitats within it; included priority aquatic and cave resources.
Upper Gasconade	144 to 160	Priority aquatic elements and mussel beds
Shoal Creek	4 to 7, 12, all on south side	Chert glade/ woodland complexes, and several large prairies.

Source: MDC Heritage Review Reports

Cave Focus Areas

Cave focus areas are located in karst landscapes where surface water may come into contact with groundwater. Five cave focus areas have been identified in and near the I-44 project area. See **Table 4**.

TABLE 4

Summary of Characteristics of Cave Focus Areas in and near I-44.

Cave Focus Area	Mile Marker	Characteristics
Ozark cavefish Focus 1	27.5 to 32	4 Ozark cavefish sites, 2 likely Grey Bat Sites
Ozark cavefish Focus 2	51 to 62	4 Ozark cavefish sites
Ozark cavefish Focus 3	72 to 78	Many important caves, cavefish, and cave crayfish
Gasconade R. Cave Focus	170 to 172	7 important caves, gray bats, Indiana bats, springs, biodiversity
Roubidoux Spring	158, north side	Magnitude 2 spring with groundwater fauna

Additional karst features, such as caves, springs, and sinkholes, not identified in the MDC Heritage Review Reports may be present in the project area. Where karst areas are close to proposed road improvements and construction staging areas, special precautions should be taken to prevent contaminants from reaching groundwater resources.

Public Lands and Conservation Areas

There are no state parks or national parks within the I-44 project area. Three areas owned by the MDC are adjacent to I-44, summarized in **Table 5**.

TABLE 5
Summary of Public Lands in and Near I-44

Name	Mile Marker	Characteristics
MDC Tower Site	116	Tower is within wooded area, near south side of I-44
Fort Leonard Wood Tower Site	162.5	Tower is within wooded area, near south side of I-44
MDC Boat landing at Bourbeuse River	247.5	South side of I-44

The northern edge of the Houston-Rolla District of the Mark Twain National Forest is in close proximity to I-44 in Laclede, Pulaski, and Phelps Counties.

A search of the data available from the Missouri Spatial Data Information Service (MSDIS) was conducted to determine if any local/municipal parks or public schools were located within the project vicinity. Only one local/municipal park was found within the study area - Wildcat Park in Newton County, near mile marker 6. Four schools were found during the database searches (**Table 6)**.

TABLE 6
Summary of Public Schools Near I-44

Name	Closest Mile Marker	County
Meramec Valley Middle School	257	Franklin
Coleman Elementary	252	Franklin
Freemont Elementary	80	Greene
Willard South Elementary	74	Greene

Source: MSDIS GIS Data, 2007

Streams and Rivers

Several outstanding streams and rivers cross I-44, specifically, the Niangua River, the Big Piney River, the Gasconade River, and Roubidoux Creek. The I-44 project area crosses 5 of the 138 state-designated spawning stream segments; the Osage Fork of the Gasconade River, the Gasconade River, Roubidoux Creek, the Big Piney River, and the Bourbeuse River. The project area comes close to an additional two rivers with this designation: Spring River, and Blue Springs Creek.

Construction activities should be curtailed during a seasonal window for designated spawning streams, described further in **Table 7**.

TABLE 7

Streams and stream characteristics by county along the I-44 corridor

County	Stream Name	Stream Characteristics
Newton	Shoal Creek (perennial).	Biologically significant stream, public water consumption, recreational, local fishery, livestock watering, Shoal Creek Conservation Opportunity Area lies on both sides of Shoal Creek where it crosses I-44, potential for contamination from mine tailings.
Jasper	Turkey Creek (perennial).	Missouri Stream Class “P” (maintains flow throughout the year). 7.0 miles are impaired [on the 303(d) List] as a result of mining-related cadmium and zinc pollution. Impaired use is “protection of aquatic resources”.
	Grove Creek (intermittent).	No data.
	Jones Creek (perennial).	No data
	Jenkins Creek (perennial).	No data.
	Center Creek (perennial).	Cold water fishery (trout stream), high measured concentrations of cadmium, zinc, and lead (mining-related), Missouri Stream Class “P” (maintains flow throughout the year), 12.8 miles of stream are impaired. Impaired use is “protection of aquatic life”. WBID 3203.
Lawrence	Spring River (perennial).	State-designated spawning stream. Avoid activity between November 15 and February 15.
	Goose Creek (perennial).	No data.
	Turnback Creek (intermittent).	No data.
Greene	Pickerel Creek (intermittent/ perennial).	No data.
	Dry Branch (intermittent).	No data.
	Pond Creek (intermittent).	No data.
Webster	Niangua River (perennial).	Cold water fishery (trout stream), habitat for Niangua darter (Federally Threatened).
	Sarah Branch (intermittent).	No data
Laclede	Bear Creek (intermittent/ perennial).	No data.
	Gasconade River (perennial).	De-listed from 2002 303(d) List. Cold water fishery. Recreational resource. State-designated spawning stream; avoid activity between March 15 and June 15.
Pulaski	Roubidoux Creek (perennial).	Cold water fishery; reaches are categorized as “White Ribbon” and “Red Ribbon” fisheries. Stocked with rainbow and brown trout. Portion are within Trout Special management Area (TSMA). State-designated spawning stream; avoid activity between November 15 and February 15.
	Big Piney River (perennial).	State-designated spawning stream; avoid activity between March 15 and June 15.

TABLE 7

Streams and stream characteristics by county along the I-44 corridor

County	Stream Name	Stream Characteristics
Phelps	Little Piney Creek (perennial).	Most is cold water fishery. Self-sustaining rainbow trout population. Portions are within Wild Trout Management Area (WTMA).
Crawford	(None).	--
Franklin	Bourbeuse River (perennial).	De-listed from 2002 303(d) List. State-designated spawning stream; avoid activity between March 15 and June 15.

Source: http://mdc.mo.gov/fish/watershed/niangua/contents/

Interstate 44 (I-44) Purpose and Need Study: Interchange Evaluation Analysis (A-8)

PREPARED FOR: MoDOT
PREPARED BY: CH2M HILL
ORIGINAL SUBMISSION DATE: May 18, 2007
REVISION SUBMISSION DATE January 31, 2008

Introduction

This memo summarizes the results of the interchange deficiency analyses conducted as part of the I-44 Purpose and Need Study. The analyses focused on three factors: safety, traffic operations and geometric design. The evaluations were conducted for the eastbound and westbound segments of the study area's 78 interchanges.

The guidelines and methodologies used in the evaluation include the Missouri Department of Transportation Engineering Policy Guide, the Missouri Department of Transportation Practical Design Guide, A Policy on Geometric Design of Highways and Streets 2004 (AASHTO Green Book), and the Highway Capacity Manual 2000.

Safety Analysis

The safety component of this evaluation focuses on substantive safety, or the actual safety performance over time at the study area's 78 interchanges. A nominal safety analysis, which examines the degree to which an interchange meets standards and guidelines, is discussed in the geometric design component of the evaluation.

To determine which interchanges have potential safety issues, crash rates were calculated for one mile segments that begin 0.5 mile upstream and end 0.5 mile downstream of an interchange. Total crash rates and fatal crash rates were calculated for each interchange segment. In addition, an evaluation was performed to determine if any crash hotspots identified in the *Crash Analysis Technical Memorandum* (**Appendix A**) were located within the interchange segments. The hotspots are defined as 0.3 mile segments along I-44 where three or more disabling injury or fatal crashes occurred.

Design Guidelines Used for Evaluation

For each interchange across the corridor, crash rates were calculated for the 1-mile segments that begin 0.5 mile upstream and end 0.5 mile downstream of the respective crossroad. Total crash rates and fatal crash rates were calculated for each interchange segment. In addition, an evaluation was performed to determine if any crash hotspots[1] were located within the interchange segments. These I-44 interchange crash rates were then compared to the statewide averages for rural and urban freeways.

Based on the total crash rate analysis, the fatal crash rate analysis, and the crash location severity analysis depicted in the preceding table, criteria were established to assist in the identification of interchanges that have particularly problematic safety performance. In general, an interchange was considered to have crash-related issues if any of the following criteria were met:

- A total crash rate at least two times higher than the statewide average for urban (120.9) or rural (66.66) freeway segments
- A fatal crash rate at least two times higher than the statewide average for urban (1.34) or rural (1.13) freeway segments
- Having one or more of the crash hotspots within the interchange segment

Of note are the first two criteria. Both of these measures were set at two times the statewide average for the total crash rate and fatal crash rate. This delta beyond the statewide average was used for several reasons. First, interchanges by their nature will typically not perform as well as noninterchange areas of freeways because they introduce significantly more points of conflict at ramp merge, diverge, and weave areas. While these areas can certainly perform in a safe manner when designed appropriately, they inherently present a greater crash risk due to the increased number of conflict. Secondly, when summing the crash rates for each of the 78 interchanges across the corridor and taking the average, that number is roughly 1.6 times the statewide average crash rate. As a result, simply comparing the individual interchange averages against the statewide average alone is not as meaningful. Setting the measure of evaluation at two times the statewide average provides a more effective relative comparison across the corridor.

Safety Analysis Results

Tables 1 and 2 summarize the results of the interchange safety analysis. Interchanges with safety issues (as defined above) are shaded and the criteria contributing to the safety problem are shown in bold text. The table also rates interchanges based on the number of criteria violated at the interchange.

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[1] Based on a location density analysis, the crash hotspot methodology focused on identifying three or more major disabling Injury or fatality crashes within any 0.3 mile segment of roadway.

TABLE 1

Interchange Safety Analysis Results

Exit	Interchange EB I-44	Interchange EB I-44			Interchange WB I-44		
		Total Crash Rate	Fatal Crash Rate	Crash Hotspot Present	Total Crash Rate	Fatal Crash Rate	Crash Hotspot Present
1	U.S. 166	274.26	5.17	No	40.84	0.00	No
2	Rest Area	32.98	0.00	No	22.99	0.00	No
3	Weigh Station	33.51	0.00	No	30.55	0.00	No
4	Route 43	133.95	0.00	Yes	104.62	0.00	No
6	Route 86	92.53	3.19	Yes	163.87	9.83	Yes
8	Business Route 71	158.83	3.11	Yes	177.35	6.57	Yes
11	U.S. 71 South, Route 249 North	273.78	3.42	Yes	113.45	3.34	Yes
15	Loop 44, Route 66	53.91	0.00	No	62.50	0.00	No
18	U.S. 71 North/Route 59 South	126.31	0.00	No	174.11	6.70	Yes
22	10th Road	84.18	0.00	No	93.95	**3.76**	No
26	Route 37	63.48	0.00	No	117.47	0.00	Yes
29	Route U	45.67	0.00	No	44.40	0.00	No
33	Route 97 south	71.30	0.00	No	37.30	0.00	No
38	Route 97	46.03	0.00	No	64.85	0.00	No
44	Route H	57.70	4.12	No	81.50	4.29	No
46	Route 265, Route 39	82.51	0.00	No	144.97	4.26	No
49	Route 174	52.98	0.00	No	58.78	4.20	No
52	Rest Area	39.57	0.00	No	52.38	0.00	No
57	Route 96	73.79	0.00	No	56.92	0.00	No
58	Route Z, Route O	115.02	3.97	No	127.36	0.00	No
61	Route K, Route PP	61.69	0.00	No	73.43	0.00	No
67	Route T, Route N	58.89	3.68	No	39.48	0.00	No
69	Route 360 – James River Fwy	40.88	3.72	No	25.09	0.00	No
70	Route B, Route MM	54.13	3.61	No	48.25	0.00	No
72	Route 266	53.95	4.15	Yes	63.09	0.00	No
74	N/A	49.32	2.05	Yes	71.55	3.11	No
75	U.S. 160	66.97	1.63	No	142.30	2.85	No

TABLE 1

Interchange Safety Analysis Results

Exit	Interchange EB I-44	Interchange EB I-44			Interchange WB I-44		
		Total Crash Rate	Fatal Crash Rate	Crash Hotspot Present	Total Crash Rate	Fatal Crash Rate	Crash Hotspot Present
77	Route 13	80.14	1.86	No	160.41	2.23	No
80	Loop 44/Route H	57.56	0.00	No	170.74	6.57	Yes
82	U.S. 65	104.98	2.10	Yes	462.76	2.54	No
84	Route 744	47.26	0.00	No	63.93	0.00	No
88	Route 125	72.13	0.00	No	90.17	6.22	No
96	Route B	110.87	0.00	Yes	83.64	2.99	No
100	Route 38, Route W	117.85	0.00	No	50.68	0.00	No
107	Sparkle Brook, Sampson	55.91	0.00	No	79.58	0.00	No
111	Rest Area	36.26	0.00	No	51.60	0.00	No
113	Route Y, Route J	57.35	3.82	No	47.45	0.00	No
118	Route A, Route C	62.98	3.94	No	64.13	0.00	No
123	County Road	69.02	0.00	No	51.37	0.00	No
127	Elm St., Morgan Road.	55.78	0.00	No	107.66	0.00	No
129	Route 64, Route 5, Route 32	109.79	0.00	No	132.51	0.00	Yes
130	Route MM	70.50	0.00	Yes	106.16	4.08	Yes
135	Route F	56.83	0.00	No	118.12	0.00	No
140	Route T, Route N	102.34	0.00	No	109.27	0.00	Yes
145	Route 133, Route AB	75.94	0.00	No	47.88	0.00	No
150	Route 7, Route P	65.08	0.00	No	74.83	0.00	No
153	Route 17	68.27	0.00	No	60.86	0.00	No
156	Route H	105.07	0.00	No	89.19	3.57	Yes
159	Loop 44	136.54	0.00	No	219.24	0.00	Yes
161	Route Y	201.38	0.00	No	277.13	**3.80**	Yes
163	Route 28	155.25	4.20	No	93.54	0.00	No
169	Route J	137.79	0.00	No	56.57	0.00	No
172	Route D	215.86	3.85	Yes	145.19	4.03	Yes
176	Sugar Tree Road	123.48	3.86	Yes	83.90	0.00	Yes
178	Rest Area	54.06	0.00	No	65.09	7.66	Yes
179	Route T, Route C	49.54	3.81	No	63.48	3.53	No

TABLE 1

Interchange Safety Analysis Results

Exit	Interchange EB I-44	Interchange EB I-44			Interchange WB I-44		
		Total Crash Rate	Fatal Crash Rate	Crash Hotspot Present	Total Crash Rate	Fatal Crash Rate	Crash Hotspot Present
184	U.S. Route 63 South	135.38	3.30	No	160.04	3.14	Yes
185	Route E	220.33	0.00	Yes	97.69	0.00	No
186	U.S. Route 63	421.71	0.00	No	380.42	0.00	No
189	Route V	88.98	0.00	No	91.04	0.00	No
195	Route 68, Route 8	97.78	0.00	No	105.06	3.39	No
203	Route F, Route ZZ	64.89	0.00	No	88.43	3.54	No
208	Route 19	186.44	0.00	Yes	114.56	0.00	No
210	Route UU	96.46	0.00	No	66.02	0.00	No
214	Route H	222.00	3.22	Yes	112.74	**7.05**	Yes
218	Route C, Route J, Route N	92.94	3.44	No	51.75	6.90	No
225	Route 185 North	123.16	0.00	No	91.51	0.00	No
226	Route 185 South	223.18	3.28	Yes	222.38	3.32	No
230	Route JJ, Route W	113.35	**6.30**	No	77.93	0.00	Yes
235	Rest Area	80.44	0.00	No	39.87	0.00	No
238	Weigh Station	86.19	0.00	No	54.52	0.00	No
239	Routes 30/WW/AB	133.19	3.03	No	116.00	0.00	No
240	Route 47	156.83	0.00	No	135.34	0.00	No
242	Route AH	69.34	0.00	No	63.53	0.00	No
247	U.S. 50	247.84	2.88	Yes	181.21	0.00	No
251	Route 100 West	113.54	5.16	Yes	53.70	0.00	No
253	Route 100 East	112.68	0.00	Yes	149.49	0.00	Yes
257	Loop 44	259.60	0.00	No	161.52	0.00	No
	Average	106.41	1.28	18	103.53	1.58	19

Using the full analysis, only one interchange exceeded each crash-related criterion both eastbound and westbound: Exit 172 - Route D.

Of the 78 interchanges, 17 (22 percent) exceeded the established total crash rate criteria. Fifty percent (39 interchanges) exceeded the established fatal crash rate criteria. Approximately 37 percent (29 interchanges) had crash hotspots. Roughly 32 percent (25 interchanges) exceed two of the three established criteria. When examining crash and fatal crash rates against the statewide averages, 46 interchanges (59 percent) exceeded at least one statewide average.

Of the 27 urban interchanges, six had total crash rates above the established total crash rate criteria (23 percent). Of the 51 rural interchanges, 11 had total crash rates above the established total crash rate criteria (21 percent).

Traffic Operations

A standard method for evaluating existing traffic operations performance and determining if a given facility will be able to adequately handle future traffic volumes is a level of service (LOS) analysis. For I-44, The *Highway Capacity Manual 2000* (HCM) methodology was used to characterize current and future highway operations.

Levels of service range from A (very good operations) to F (gridlock conditions; breakdown in traffic flow). The methodologies described in *Chapter 24: Freeway Weaving and Chapter 25: Ramps and Ramp Junctions* of the HCM were utilized in the interchange traffic operations analysis. The LOS at ramp termini intersections were not evaluated because the development of the necessary turning movement traffic volumes is beyond the capabilities of the traffic model used in this analysis. It is anticipated that those areas will be evaluated as part of a subsequent phase (Tier I or Tier II).

For both the freeway weaving analysis and the ramp merge/diverge analysis, LOS was evaluated for the design hour, which was taken as the 30th highest hourly volume. More information about how the 30th highest hourly volume was calculated for the study area is found in the Freeway Traffic Analysis Technical Memorandum in **Appendix A**.

Design Guidelines Used for Evaluation

The MoDOT *Engineering Policy Guide Category: 232 - Facility Selection* discusses the recommended design year LOS for rural and urban land uses. The design year for major routes is based on 20-year traffic projections. Since the I-44 project is very early in the project development process, this analysis used a design year based on 30-year traffic projections. For the design year in urban areas LOS E is recommended as the maximum acceptable threshold in the peak hour and LOS D in off peak hours. For rural areas, LOS D is recommended as the maximum acceptable threshold in the peak hour and LOS C in off-peak hours. Because the I-44 corridor is generally more rural in nature, there is not a significant distinction on a daily basis between peak hours and off-peak hours. As a result, a standard approach when analyzing corridors of this type is to select a design hour (often the 30th highest hourly volume for the year) rather than peak and off peak hours. For the urban sections within the I-44 corridor, a peak hour/off peak hour approach would be appropriate; however due to limitations of available data and the preliminary nature of the study, only the peak hour was evaluated.

Based on these guidelines and assumptions, an interchange violating any one of the following design hour LOS criteria would be identified as having a traffic operations issue.

Urbanized Areas

- Ramp merge operating worse than LOS E in 2035.

- Ramp diverge operating worse than LOS E in 2035.
- Freeway weaving segment operating worse than LOS E in 2035.

Small Urban or Rural Areas

- Ramp merge operating worse than LOS D in 2035.
- Ramp diverge operating worse than LOS D in 2035.
- Freeway weaving segment operating worse than LOS D in 2035.

Ramp Merge and Diverge Analysis

The methodology described in HCM *Chapter 25: Ramps and Ramp Junctions* measures LOS based on density of the merge or diverge influence area (passenger cars/mile/lane). This density is calculated using computed traffic volume flow rates for both the ramp and the portion of the upstream freeway within the ramp influence area, along with the acceleration or deceleration length. The computed flow rates must also be compared with known capacity values for merge and diverge areas because once capacity has been reached, the density calculation is no longer applicable (density cannot get any higher than the value at capacity) and LOS is defined as LOS F.

The computation of the various flow rates involves several factors and assumptions which are documented, along with their source, in the **Table 3**.

TABLE 3

Flow-Rate Computations

Factor	**Determination Method**
Ramp Demand Flow Rate	Calculated based on design hour volume (DHV), peak hour factor (PHF), heavy vehicle adjustment factor (fHV), and driver population factor (fP)
Ramp Design Hour Volume	Calculated based on AADT and K-value (percent of AADT in the design hour)
Ramp AADT	From Traffic Models
K-value	Assumed value based on Land Use type, K=12 percent (rural), 10 percent (small urban), and 10 percent (urbanized)
Ramp Peak Hour Factor	Assumed value based on Land Use type, PHF=0.88 (rural), 0.90 (small urban), and 0.92 (urbanized)
Land Use Type	Classification chosen based on AASHTO definitions of rural, small urban, and urbanized (based on population)
Ramp Heavy Vehicle Factor	Calculated based on percent trucks, percent RVs, and passenger car equivalent values for trucks and RVs
Ramp Percent Trucks	From traffic model
Ramp percent RVs	Assumed to be 0
Passenger Car Equivalent Trucks	Assumed to be the same as the value determined for the freeway segment at the ramp gore
Passenger Car Equivalent RVs	Assumed to be the same as the value determined for the freeway segment at the ramp gore
Ramp Driver Population Factor	Assumed value based on Recreational classification, fP=1.0 (NonRec) and fP=0.85 (Rec)

TABLE 3

Flow-Rate Computations

Factor	Determination Method
Recreational/Nonrecreational	Classification chosen based on engineering judgment and field observation
Accel/Decel Length	Determined from As-Builts
Ramp Number of lanes	Determined from As-Builts
Ramp Free Flow Speed	Assumed to be equal to the design speed of the ramp entry or exit radius
Right/Left Entrance/Exit	Determined from As-Builts
Adjacent Ramp Type	Determined from As-Builts
Distance to Adjacent Ramp	Determined from As-Builts
Adjacent Ramp Demand Flow Rate	Calculated in same manner as ramp being analyzed (see above)
Freeway Demand Flow Rate	From freeway segment analysis

Freeway Weaving Analysis

The methodology described in HCM *Chapter 24: Freeway Weaving* measures LOS based on density within the freeway weaving segment (passenger cars/mile/lane). This density is calculated using the computed total flow rate in the weaving segment, and the computed space mean speed of all vehicles in the weaving segment, along with the number of lanes in the weaving segment. In order to calculate the total flow rate and the space mean speed for all vehicles in the weaving segment, both weaving and nonweaving flow rates and speeds must be evaluated.

The computation of both the total flow rate in the weaving segment and the space mean speed of all vehicles in the weaving segment involve several factors and assumptions which are documented along with their source in the table below.

TABLE 4

Flow Rate Computations in Weaving Segments

Factor	Determination Method
Weaving Flow Rate	Calculated based on DHV, PHF, fHV, and fP
Nonweaving Flow Rate	Calculated based on DHV, PHF, fHV, and fP
Weaving Design Hour Volume	Calculated based on AADT and K-value (percent of AADT in the design hour)
Nonweaving Design Hour Volume	Calculated based on AADT and K-value (percent of AADT in the design hour)
Weaving AADT	From traffic model
Nonweaving AADT	From traffic model
K-value (all volumes)	Based on Land Use type, K=12 percent (rural), 10 percent (small urban), and 10 percent (urban)
Peak Hour Factor (all volumes)	Based on Land Use type, PHF=0.88 (rural), 0.90 (small urban), & 0.92 (urban)
Land Use Type (applies to all volumes)	Based on AASHTO definitions of rural, small urban, and urban
Heavy Vehicle Factor (Weaving volume)	Based on percent trucks, percent RVs, and passenger car equivalent values
Heavy Vehicle Factor (Nonweaving)	Based on percent trucks, percent RVs, and passenger car equivalent values
Weaving Volume Percent Trucks	From traffic model
Nonweaving Volume Percent Trucks	From traffic model
Weaving Volume Percent RVs	Assumed to be 0
Nonweaving Volume Percent RVs	Assumed to be 0
Passenger Car Equivalent Trucks	Value determined for the freeway segment in weaving section
Passenger Car Equivalent RVs	Value determined for the freeway segment in weaving section
Ramp Driver Population Factor	Based on Recreational classification, fP=1.0 (NonRec) and fP=0.85 (Rec)
Recreational/Nonrecreational (Weaving)	Classification chosen based on engineering judgment and field observation
Recreational/Nonrecreational (Nonweaving)	Classification chosen based on engineering judgment and field observation
Weaving Length	Determined from As-Builts
Number of lanes in Weaving Segment	Determined from As-Builts
Freeway Free Flow Speed	From freeway segment analysis
Freeway Demand Flow Rate	From freeway segment analysis

Operational Analyses Performed on the I-44 Study Corridor

Most of the interchanges along I-44 in the study corridor are diamond interchanges that are not located in close proximity to the nearest upstream or downstream interchange. For these situations, only the ramp merge and diverge LOS analyses were needed. The situation does exist however, in seven locations, where either the interchange configuration or the proximity of an interchange ramp to the nearest upstream or downstream interchange ramp, is such that an auxiliary lane exists between the two ramps, thus creating a weaving condition. For these situations, a weaving LOS analysis was performed in addition to the ramp merge and diverge analyses. The list below describes locations where a weaving condition exists. All other locations contain only ramp merge and ramp diverge conditions.

- Exit 8, Business Route 71, Cloverleaf interchange
- Exit 11, U.S. 71 South/Route 249 North, Modified Cloverleaf interchange (EB only)
- Exit 18, U.S. 71 North/Route 59 South, Cloverleaf interchange
- Exit 57/58, Route 96 and Route Z/Route O, Auxiliary lane between ramps
- Exit 80, Loop 44/Route H, Cloverleaf interchange
- Exit 82, U.S. 65, Partial directional interchange (improvements recently completed)
- Exit 247, U.S. 50 and Route O, Auxiliary lane between ramps (EB only)

Traffic Model Ramp Volumes

All of the interchange ramp traffic volumes used in the base year (2005) and the design year (2035) LOS analyses came from the statewide traffic model. Therefore if a ramp was not included in the statewide model, no traffic analyses were performed. Of the 324 ramps within the study corridor, 75 were not included in the statewide traffic model. Of this 75, several were ramps to and from rest areas and weigh stations. The actual interchange ramps **not** included in the model are listed below.

- Exit 1, U.S. 166, all movements except westbound off ramp
- Exit 11, U.S. 71 South/Route 249 North, all movements
- Exit 15, Loop 44/Route 66, westbound off ramp
- Exit 33, Route 97 South, all movements
- Exit 69, Route 360, all movements
- Exit 72, Route 266, westbound on ramp (loop)
- Exit 74, Kearney St., westbound on ramp
- Exit 123, County Road, all movements
- Exit 140, Route T/Route N, westbound on ramp
- Exit 150, Route 7/Route P, all movements
- Exit 159, Loop 44, eastbound on ramp
- Exit 161, Route Y, westbound on ramp
- Exit 172, Route D, westbound off ramp
- Exit 176, Sugar Tree Road, eastbound on ramp and westbound off ramp
- Exit 242, Route AH, all movements
- Exit 247, U.S. 50, eastbound off ramp
- Exit 257, Loop 44, all movements

Table 5 below provides a summary of the AADT volumes for both the base year and the design year predicted by the statewide model. These volumes were used in the ramp merge and diverge analyses. **Table 6** below provides the same for the weaving analyses.

TABLE 5

Summary of the AADT 2005 (2035)

		On Ramp (Merge) AADT 2005		Off Ramp (Diverge) AADT 2005	
		Eastbound	**Westbound**	**Eastbound**	**Westbound**
1	U.S. 166	Not in Model	Not in Model	Not in Model	1700 (3800)
2	Rest Area	Not in Model	Not in Model	Not in Model	Not in Model
3	Weigh Station	Not in Model	Not in Model	Not in Model	Not in Model
4	Route 43	5200 (12000)	1900 (4900)	1300 (3600)	5300 (13000)
6	Route 86	9100 (19800)	4700 (11200)	4400 (12300)	9800 (19600)
8	Business Route 71	500 (1300)	8400 (17800)	2700 (6500)	2000 (5400)
11	U.S. 71 (S)/Route 249 (N)	Not in Model	Not in Model	Not in Model	Not in Model
15	Loop 44, Route 66	4700 (10400)	NA	NA	Not in Model
18	U.S. 71 North/Route 59 (S)	2500((6000)	3000 (7900)	1700 (4400)	4000 (9000)
22	10th Road	1300 (2800)	1100 (2900)	1100 (2900)	1300 (2800)
26	Route 37	2700 (7000)	2500 (6900)	2600 (6900)	2700 (7100)
29	Route U	1800 (4600)	4900 (13600)	5000 (13700)	1900 (4800)
33	Route 97 South	Not in Model	Not in Model	Not in Model	Not in Model
38	Route 97	2500 (7000)	2300 (5200)	2300 (5000)	2300 (6200)
44	Route H	1800 (5200)	2400 (5400)	2500 (5800)	1600 (4800)
46	Route 265, Route 39	4700 (13100)	3600 (8500)	3700 (8800)	5000 (13900)
49	Route 174	1200 (3200)	1500 (4400)	1200 (3500)	1100 (3000)
52	Rest Area	Not in Model	Not in Model	Not in Model	Not in Model
57	Route 96	Weave	NA	NA	Weave
58	Route Z, Route O	4100 (10600)	Weave	Weave	4900 (11000)
61	Route K, Route PP	1300 (3500)	2100 (5700)	2000 (5500)	1400 (3600)
67	Route T, Route N	3600 (7000)	1200 (2500)	1300 (2500)	3500 (7600)
69	Route 360-James River	Not in Model	Not in Model	Not in Model	Not in Model

TABLE 5

Summary of the AADT 2005 (2035)

		On Ramp (Merge) AADT 2005		**Off Ramp (Diverge) AADT 2005**	
		Eastbound	**Westbound**	**Eastbound**	**Westbound**
70	Route B, Route MM	7300 (15700)	1900 (4900)	1600 (4600)	7700 (15500)
72	Route 266	1400 (4400)	5600 (10600)	5200 (10500)	2800 (6500)
74	Kearney Street	NA	Not in Model	NA	NA
75	U.S. 160	5400 (9100)	2100 (10700)	2100 (10400)	7200 (12400)
77	Route 13	16000 (23400)	6500 (11800)	6500 (9900)	14600 (22500)
80	Loop 44/Route H	6200 (10200)	7000 (10300)	4900 (8300)	5600 (6400)
82	U.S. 65	7200 (14600)	5100 (9900)	7600 (10600)	4700 (9100)
84	Route 744	1500 (4700)	1800 (2800)	4300 (3300)	1500 (10200)
88	Route 125	2000 (4800)	3900 (10200)	4200 (10700)	2300 (4700)
96	Route B	2100 (5400)	1900 (5000)	1800 (4600)	2200 (6300)
100	Route 38, Route W	4000 (10000)	7000 (16800)	6500 (16000)	4300 (10700)
107	Sparkle Brooke/Sampson	3700 (11100)	2300 (6100)	2100 (5400)	4000 (11500)
111	Rest Area	Not in Model	Not in Model	Not in Model	Not in Model
113	Route Y, Route J	2100 (6600)	2900 (8000)	2600 (7500)	2200 (7000)
118	Route A, Route C	3300 (9200)	3800 (10800)	3800 (10800)	3400 (9500)
123	County Road	Not in Model	Not in Model	Not in Model	Not in Model
127	Elm St., Morgan Road	2100 (5400)	2000 (6300)	1800 (5500)	2800 (6900)
129	Routes 64/5/32	3500 (6400)	6300 (16200)	6300 (15400)	4000 (6100)
130	Route MM	2400 (7900)	1300 (2200)	900 (3700)	2000 (6900)
135	Route F	2100 (5200)	2600 (7400)	2600 (7500)	2000 (5400)
140	Route T, Route N	2600 (6900)	Not in Model	800 (2200)	2700 (7600)
145	Route 133, Route AB	1100 (2900)	2400 (4500)	2000 (3800)	1100 (3100)
150	Route 7, Route P	Not in Model	Not in Model	Not in Model	Not in Model
153	Route 17	4700 (5300)	3600 (10900)	2900 (8000)	4600 (5300)
156	Route H	1000 (2700)	1700 (3100)	2000 (3900)	1100 (2800)
159	Loop 44	Not in Model	1000 (1700)	300 (800)	3800 (8300)

TABLE 5

Summary of the AADT 2005 (2035)

		On Ramp (Merge) AADT 2005		**Off Ramp (Diverge) AADT 2005**	
		Eastbound	**Westbound**	**Eastbound**	**Westbound**
161	Route Y	3100 (8600)	Not in Model	6300 (11900)	2300 (7300)
163	Route 28	2300 (5300)	600 (1100)	400 (700)	2700 (6500)
169	Route J	4100 (8000)	1400 (3400)	1800 (4000)	4300 (8400)
172	Route D	3400 (5100)	NA	2700 (5200)	Not in Model
176	Sugar Tree Road	Not in Model	4200 (9700)	3500 (7900)	Not in Model
178	Rest Area	Not in Model	Not in Model	Not in Model	Not in Model
179	Route T, Route C	2600 (8600)	1400 (3200)	1200 (2700)	3400 (8800)
184	U.S. Route 63 South	1000 (6100)	4600 (14000)	4500 (11200)	1100 (9100)
185	Route E	1100 (7200)	3300 (4800)	3200 (6700)	1200 (3400)
186	U.S. Route 63	9800 (15400)	1100 (2900)	1200 (3000)	10100 (17100)
189	Route V	3300 (9800)	3500 (7600)	3300 (7000)	3100 (9100)
195	Route 68, Route 8	4400 (11700)	5900 (13700)	6000 (13800)	4500 (11800)
203	Route F, Route ZZ	1500 (4400)	200 (500)	300 (700)	1500 (4200)
208	Route 19	4200 (12200)	4200 (11100)	4300 (11500)	4100 (11800)
210	Route UU	1300 (3900)	1200 (3700)	1300 (4000)	1400 (4000)
214	Route H	2100 (5100)	1600 (4800)	1600 (5000)	2200 (5300)
218	Routes C/J/N	3600 (9500)	2500 (7400)	2500 (7200)	3500 (9500)
225	Route 185 North	4000 (9800)	2100 (8600)	2100 (9300)	4000 (9600)
226	Route 185 South	3800 (10400)	5600 (12700)	5700 (12100)	3900 (10500)
230	Route JJ, Route W	2700 (6600)	1400 (2900)	1300 (2900)	2600 (6900)
235	Rest Area	Not in Model	Not in Model	Not in Model	Not in Model
238	Weigh Station	Not in Model	Not in Model	Not in Model	Not in Model
239	Routes 30/WW/AB	6400 (10700)	5600 (15500)	5600 (15000)	6400 (10500)
240	Route 47	2600 (9700)	4800 (10000)	4900 (10200)	2600 (9700)
242	Route AH	Not in Model	Not in Model	Not in Model	Not in Model
247	U.S. 50	Weave	3400 (11400)	Weave	9200 (15300)

TABLE 5

Summary of the AADT 2005 (2035)

		On Ramp (Merge) AADT 2005		**Off Ramp (Diverge) AADT 2005**	
		Eastbound	**Westbound**	**Eastbound**	**Westbound**
251	Route 100 West	12600 (16300)	1300 (3100)	1200 (2800)	12300 (16900)
253	Route 100 East	2500 (4100)	10900 (13200)	10400 (14500)	2400 (900)
257	Loop 44	Not in Model	Not in Model	Not in Model	Not in Model

Not in Model = not included in statewide model
Weave = weaving analysis performed for this movement
NA = ramp doesn't exist

TABLE 6

Summary of the AADT 2005 (2035) for Weaving Analysis

Exit	**Interchange**	**Weaving Analysis AADT Eastbound 2005 (2035)**		**Weaving Analysis AADT Westbound 2005 (2035)**	
		Entering	**Exiting**	**Entering**	**Exiting**
8	Business Route 71	2500 (6300)	10400 (20300)	5300 (11000)	900 (2300)
11	U.S. 71 South/Route 249 North	Not in Model	Not in Model	NA	NA
18	U.S. 71 North/Route 59 South	6800 (16400)	6400 (17100)	4800 (13300)	5500 (13700)
57/5	Route 96 and Route Z/Route O	2600 (7400)	1500 (3900)	1600 (4400)	2600 (7400)
80	Loop 44/Route H	4000 (3900)	6000 (6400)	4600 (2700)	4500 (4200)
82	U.S. 65	4700 (7200)	6600 (10000)	10600 (14700)	6300 (14100)
247	U.S. 50	9600 (15700)	Not in Model	NA	NA

Not in Model = not included in statewide model
NA = weave doesn't exist

Results of Interchange Traffic Operations

In the base year (2005), most of the existing interchanges operate well, with only four ramps and two weaving segments operating at levels of service worse than the recommended thresholds. Of the ramps, one was located in Springfield, the eastbound merge at Route 13, and the other three were located at the eastern end of the corridor in Franklin County, the eastbound merge and westbound diverge at Route 100 West and the westbound merge at Route 100 East. The two weaving segments found to be operating worse than recommended thresholds were the eastbound weave at the U.S. 71 North/Route 59 South cloverleaf, and the westbound weave at the U.S. 65 partial directional interchange (improvements recently completed at this interchange have addressed this situation).

In the design year (2035), the existing interchange ramps operate considerably worse than in the base year, with the most of interchanges having at least one ramp operating at LOS F. It is worth noting that congestion on mainline freeway segments has a direct influence on ramp level of service. If the traffic volumes on the freeway segments upstream/downstream of a ramp merge/diverge are beyond maximum volume thresholds, the ramp LOS will automatically be F. Thus, a ramp operating at an undesirable LOS is not necessarily an indication of a problem with the interchange itself, but could actually be the result of mainline capacity limitations (not enough mainline lanes).

Operations at weaving segments also deteriorate in the design year. By 2035, it's anticipated that all of the weaving segments in the corridor that were able to be analyzed as part of this study, will be operating at LOS E or F.

Table 7 lists the predicted 2005 and 2035 interchange operations for the study area's 78 interchanges. Locations in which the freeway traffic volumes upstream and/or downstream of a given ramp are such that they may be influencing ramp LOS are shown with an asterisk. Ramps considered deficient based on the guidelines for urban and rural design year LOS mentioned previously for are shown shaded. **Table 8** lists the 2005 and 2035 weaving operations with deficient segments shown shaded.

TABLE 7

2005 and 2035 Interchange Traffic Operations

Exit	Interchange	Urban or Rural	Merge LOS 2005 (2035)		Diverge LOS 2005 (2035)	
			EB	**WB**	**EB**	**WB**
1	U.S. 166	Rural	--	--	--	B (E)
2	Rest Area	Rural	--	--	--	--
3	Weigh Station	Rural	--	--	--	--
4	Route 43	Urban	--	B (D)	B (C)	B (C)
6	Route 86	Urban	D (F*)	B (F*)	B (D)	B (F)
8	Business Route 71	Urban	B (F*)	C (F*)	C (F*)	B (C)
11	U.S. 71 South, Route 249 North	Urban	--	--	--	--
15	Loop 44, Route 66	Rural	D (E)	--	--	--
18	U.S. 71 North/Route 59 South	Rural	B (F*)	C (F*)	C (F*)	B (F*)
22	10th Road	Rural	B (F*)	C (F*)	B (F*)	B (F*)
26	Route 37	Rural	C (F*)	C (F*)	B (F*)	B (F*)
29	Route U	Rural	B (E)	C (F*)	B (D)	B (D)
33	Route 97 South	Rural	--	--	--	--
38	Route 97	Rural	C (F*)	B (E)	B (D)	B (D)
44	Route H	Rural	C (F)*	C (E)	B (D)	B (D)
46	Route 265, Route 39	Rural	C (F*)	C (E)	B (D)	B (D)
49	Route 174	Rural	B (F*)	C (F*)	C (F*)	B (F*)
52	Rest Area	Rural	--	--	--	--
57	Route 96	Rural	--	--	--	--
58	Route Z, Route O	Rural	C (F*)	--	--	C (F*)
61	Route K, Route PP	Rural	C (D)	C (D)	C (D)	C (D)
67	Route T, Route N	Rural	C (D)	C (D)	C (D)	C (C)
69	Route 360 - James River	Urban	--	--	--	--
70	Route B, Route MM	Urban	C (F*)	C (D)	B (C)	B (F)
72	Route 266	Urban	B (D)	C (F*)	B (D)	B (D)
74	Kearney St.	Urban	--	--	--	--
75	U.S. 160	Urban	E (E)	C (F*)	B (D)	C (C)
77	Route 13	Urban	F* (F*)	D (F*)	D (D)	C (F)
80	Loop 44/Route H	Urban	D (F*)	D (F*)	D (F*)	D (F*)

TABLE 7

2005 and 2035 Interchange Traffic Operations

Exit	Interchange	Urban or Rural	Merge LOS 2005 (2035)		Diverge LOS 2005 (2035)	
			EB	WB	EB	WB
82	U.S. 65	Urban	D (F*)	D (F*)	D (F*)	B (F*)
84	Route 744	Urban	C (F*)	C (F*)	C (F*)	C (F*)
88	Route 125	Rural	C (F*)	C (F*)	C (F*)	A (F*)
96	Route B	Rural	C (F*)	C (F*)	C (F*)	B (F*)
100	Route 38, Route W	Rural	B (D)	D (F*)	C (F)	B (C)
107	Sparkle Brooke Rd, Sampson Rd.	Urban	C (F*)	B (D)	B (D)	B (C)
111	Rest Area	Rural	--	--	--	--
113	Route Y, Route J	Rural	C (F*)	C (F*)	C (F*)	B (F*)
118	Route A, Route C	Rural	C (F*)	C (F*)	B (E)	B (D)
123	County Road	Rural	--	--	--	--
127	Elm Street, Morgan Road	Urban	C (F*)	C (F*)	C (F*)	C (D)
129	Route 64, Route 5, Route 32	Urban	C (D)	C (F*)	C (F*)	B (C)
130	Route MM	Urban	B (D)	B (C)	C (C)	B (C)
135	Route F	Urban	B (D)	C (F*)	B (D)	B (D)
140	Route T, Route N	Rural	B (F*)	--	B (E)	B (E)
145	Route 133, Route AB	Rural	B (F*)	B (F*)	B (F*)	B (F*)
150	Route 7, Route P	Rural	--	--	--	--
153	Route 17	Rural	C (E)	C (F*)	B (D)	C (D)
156	Route H	Rural	B (F*)	C (D)	B (E)	B (D)
159	Loop 44	Rural	NA	C (D)	C (E)	B (D)
161	Route Y	Urban	B (C)	--	B (B)	B (B)
163	Route 28	Urban	C (E)	B (C)	B (C)	B (D)
169	Route J	Rural	C (F*)	B (F*)	B (F*)	B (E)
172	Route D	Rural	C (F*)	--	C (E)	--
176	Sugar Tree Road	Rural	--	C (F*)	B (D)	--
178	Rest Area	Rural	--	--	--	--
179	Route T, Route C	Rural	C (F*)	C (D)	C (D)	B (D)
184	U.S. Route 63 South	Urban	C (C)	D (D)	C (C)	B (B)
185	Route E	Urban	B (C)	C (C)	C (C)	B (C)
186	U.S. Route 63	Urban	D (F*)	B (C)	C (C)	B (F)

TABLE 7

2005 and 2035 Interchange Traffic Operations

Exit	**Interchange**	**Urban or Rural**	**Merge LOS 2005 (2035)**		**Diverge LOS 2005 (2035)**	
			EB	**WB**	**EB**	**WB**
189	Route V	Urban	D (F*)	B (F*)	D (F*)	B (D)
195	Route 68, Route 8	Rural	C (F*)	D (F*)	C (F)	C (E)
203	Route F, Route ZZ	Rural	C (F*)	B (F*)	C (F*)	B (F*)
208	Route 19	Rural	C (F*)	C (F*)	B (D)	B (D)
210	Route UU	Rural	C (F*)	C (F*)	B (F*)	B (F*)
214	Route H	Rural	C (F*)	C (F*)	C (F*)	C (F*)
218	Route C, Route J, Route N	Rural	C (F*)	C (F*)	C (F*)	C (F*)
225	Route 185 North	Urban	C (F*)	B (F*)	B (F*)	B (F*)
226	Route 185 South	Urban	C (F*)	C (F*)	B (D)	B (D)
230	Route JJ, Route W	Rural	D (F*)	C (F*)	B (F*)	C (F*)
235	Rest Area	Rural	--	--	--	--
238	Weigh Station	Rural	--	--	--	--
239	Routes 30/WW/RAB	Rural	D (F*)	D (F*)	C (F*)	C (F*)
240	Route 47	Rural	C (F*)	D (F*)	C (F*)	C (F*)
242	Route AH	Rural	--	--	--	--
247	U.S. 50	Rural	--	D (F*)	--	C (F)
251	Route 100 West	Rural	F* (F*)	C (F*)	C (F*)	F (F*)
253	Route 100 East	Rural	C (F*)	F* (F*)	D (F*)	C (F*)
257	Loop 44	Urban	--	--	--	--

-- denotes ramps that either were not included in the traffic model, do not exist, or were analyzed as part of the weaving analysis

TABLE 8

2005 and 2035 Weaving Operations

Exit	Interchange	Weaving Analysis LOS 2005 (2035)	
		Eastbound	**Westbound**
8	Business Route 71	C (F)	B (E)
11	U.S. 71 South/Route 249 North	Not in Model	NA
18	U.S. 71 North/Route 59 South	F (F)	D (F)
57/58	Route 96 and Route Z/Route O	B (F)	B (E)
80	Loop 44/Route H	D (F)	D (F)
82	U.S. 65	E (F)	F (F)
247	U.S. 50	Not in Model	NA

Not in Model = not included in statewide model
NA = weave doesn’t exist

Geometric Design Analysis

To determine whether the study area’s interchanges meet appropriate geometric standards, seven key design features were evaluated at each interchange, two relating to access management and five relating to horizontal and vertical geometry. These features, and the interchange configurations they apply to, are listed below.

Access Management features

- Spacing between ramp termini intersections and outer road intersections (service interchanges)
- Spacing between a given interchange and the next closet downstream interchange (all interchanges)

Horizontal and Vertical Geometry features

- Degree of curvature of entry/exit curve on ramp (all interchanges)
- Length of taper on taper type ramp or acceleration/deceleration length on parallel type ramp (all interchanges without auxiliary lanes)
- Mainline Stopping Sight Distance in advance of ramp gore nose
- Radius of loop ramp curvature (cloverleaf or partial cloverleaf interchange)
- Length of weaving segment (all interchanges with auxiliary lanes)

Design Guidelines Used for Evaluation

Design guidelines used to evaluate the interchange design features came from the MoDOT *Engineering Policy Guide* and the AASHTO Green Book. **Table 9** lists the feature evaluated, along with the recommended design guideline for that feature and the source.

TABLE 9

Design guidelines used to evaluate the interchange design features

Design Feature	Design Guidance	Source
Ramp/Outer Road intersection Spacing	Major Areas 1320'-2640' Other Areas 350'	MoDOT Engineering Policy Guide, Category:940.3 (Major Areas) AASHTO Chapter 10 pg.778
Interchange Spacing	2-3 miles urban setting 2-5 miles rural setting	MoDOT Engineering Policy Guide, Category:940.2
Degree of curvature -- Entry/Exit Curve on Ramp	6 degrees	MoDOT Engineering Policy Guide, Category:234
Acceleration/Deceleration Lane Length	variable depending on design speeds and grades.	MoDOT Engineering Policy Guide, Category:234 AASHTO Exhibits 10-70,71, and 73
Mainline Stopping Sight Distance in Advance of Ramp Gore	1.25 times SSD for Freeway Design Speed	MoDOT Engineering Policy Guide Category:234.2.1.4
Radius of Loop Curvature	170'	MoDOT Engineering Policy Guide, Category:234
Weaving Length	1600', service to service interchange 2000', system to service interchange variable depending on loop radius and traffic volumes, cloverleaf	AASHTO Exhibit 10-68 MoDOT Engineering Policy Guide, Category:234.5

Note that the radius of the entry/exit curve in combination with its superelevation can be used to determine the design speed of the ramp. The ramp design speed in combination with the mainline design speed and the mainline profile grade are used to determine the necessary taper length. At locations where data was not available for the entry/exit curve and/or the superelevation, an assumed ramp design speed of 35 mph was used in order to determine whether or not the acceleration/deceleration length was adequate.

Geometric Design Evaluation

Table 10 evaluates six design features for each I-44 interchange. If a design feature (in either direction) at an interchange was found to be deficient, it is marked as such. Design features that meet the guidelines discussed above are marked as "sufficient." Because of limitations in the available data, all seven design features were not evaluated for each interchange. In addition, where a design feature does not apply to a given interchange, the field is shown with a star (*).

Interchange spacing was rated sufficient (0 points) for nearly all interchanges. Only the Route 96 interchange (exit 57, Lawrence County), West Kearney Street interchange, (exit 74, Greene County and the weigh station (exit 238, Franklin County) were scored as deficient. Taper/acceleration/deceleration lengths were scored as deficient (1 point) for most interchanges. The scoring for the other four design criteria was fairly mixed.

The deficiency scale ranges from one to four for the 78 intersections. Thirty one (40 percent) interchanges had one geometric design deficiency, 27 (35 percent) interchanges had two deficiencies, 18 (23 percent) had three deficiencies, and two (3 percent) interchanges had four (4) deficiencies. The two interchanges with four deficiencies are Route 43 (exit 4, Newton County) and Route JJ/W (exit 230, Franklin County).

Overall Geometric Summary

As noted in **Table 10**, interchange spacing was rated sufficient for nearly all interchanges. Only the Route 96 interchange (exit 57, Lawrence County), West Kearney Street interchange (exit 74, Greene County and the weigh station (exit 238, Franklin County) were deficient.

Taper/acceleration/deceleration lane length was deficient for most interchanges.

Ares of concentration of interchanges with more severe design deficiencies include Exit 4 (Route 43), Exit 6 (Route 86), Exit 8 (Business Route 71), all in Newton County near Joplin. Other areas include all exits between Exit 214 (Route H, Crawford County) and Exit 257 (Loop 44, Franklin County). This area is primarily Franklin County and includes all the exits within Franklin County.

TABLE 10

Geometric Design Evaluation

Exit #	Interchange	Ramp/ Outer Rd Intersection Spacing	Interchange Spacing	Degree Of Curvature Entry/Exit curve on Ramp	Taper/Accel/ Decel Length	Mainline SSD on ramp nose approach	Radius of loop curvature	Weaving Length
1	U.S. 166	Sufficient	Sufficient	Deficient	Deficient	Deficient	*	*
2	Rest Area	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
3	Weigh Station	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
4	Route 43	Deficient	Sufficient	Deficient	Deficient	Deficient	*	*
6	Route 86	Sufficient	Sufficient	Deficient	Deficient	Sufficient	*	*
8	Business Route 71	*	Sufficient	Deficient	Deficient	Sufficient	Deficient	Cloverleaf
11	U.S. 71 South, Route 249 North	*	Sufficient	Sufficient	Deficient	Sufficient	Sufficient	Cloverleaf
15	Loop 44, Route 66	*	Sufficient	Sufficient	Deficient	Sufficient	*	*
18	U.S. 71 North, Route 59 South	*	Sufficient	Sufficient	Deficient	Sufficient	Sufficient	Cloverleaf
22	10th Road	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
26	Route 37	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
29	Route U	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
33	Route 97 South	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*
38	Route 97	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
44	Route H	Sufficient	Sufficient	Deficient	Deficient	Sufficient	*	*
46	Route 265, Route 39	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
49	Route 174	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
52	Rest Area	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*

TABLE 10

Geometric Design Evaluation

Exit #	Interchange	Ramp/ Outer Rd Intersection Spacing	Interchange Spacing	Degree Of Curvature Entry/Exit curve on Ramp	Taper/Accel/ Decel Length	Mainline SSD on ramp nose approach	Radius of loop curvature	Weaving Length
57	Route 96	*	Deficient	Sufficient	Sufficient	Sufficient	*	Sufficient
58	Route Z, Route O	Sufficient	Sufficient	Deficient	Deficient	Sufficient	Deficient	*
61	Route K, Route PP	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
67	Route T, Route N	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
69	Route 360 – James River Fwy	*	Sufficient	Sufficient	Deficient	Sufficient	Sufficient	*
70	Route B, Route MM	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
72	Route 266	*	Sufficient	Deficient	Deficient	Deficient	Sufficient	*
74	W. Kearney St.	*	Deficient	Sufficient	Deficient	Sufficient	*	*
75	U.S. 160	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
77	Route 13	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
80	Loop 44, Route H	*	Sufficient	Sufficient	Deficient	Sufficient	Deficient	Cloverleaf
82	U.S. 65 (recent improvements to this partial directional interchange have addressed the weave issue)	*	Sufficient	Deficient	Deficient	Deficient	Sufficient	Cloverleaf
84	Route 744	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
88	Route 125	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
96	Route B	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
100	Route 38, Route W	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
107	Sparkle Brooke/Sampson Road	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*

TABLE 10

Geometric Design Evaluation

Exit #	Interchange	Ramp/ Outer Rd Intersection Spacing	Interchange Spacing	Degree Of Curvature Entry/Exit curve on Ramp	Taper/Accel/ Decel Length	Mainline SSD on ramp nose approach	Radius of loop curvature	Weaving Length
111	Rest Area	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
113	Route Y, Route J	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
118	Route A, Route C	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
123	County Road	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
127	Elm St., Morgan Rd.	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
129	Route 64, Route 5, Route 32	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
130	Route MM	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
135	Route F	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
140	Route T, Route N	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
145	Route 133, Route AB	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
150	Route 7, Route P	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
153	Route 17	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*
156	Route H	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
159	Loop 44	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*
161	Route Y	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
163	Route 28	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
169	Route J	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
172	Route D	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
176	Sugar Tree Rd.	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*

TABLE 10

Geometric Design Evaluation

Exit #	Interchange	Ramp/ Outer Rd Intersection Spacing	Interchange Spacing	Degree Of Curvature Entry/Exit curve on Ramp	Taper/Accel/ Decel Length	Mainline SSD on ramp nose approach	Radius of loop curvature	Weaving Length
178	Rest Area	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
179	Route T, Route C	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
184	U.S. Route 63 South	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
185	Route E	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*
186	U.S. Route 63	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*
189	Route V	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
195	Route 68, Route 8	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
203	Route F, Route ZZ	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*
208	Route 19	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
210	Route UU	Sufficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
214	Route H	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
218	Route C, Route J, Route N	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*
225	Route 185 North	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
226	Route 185 South	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*
230	Route JJ, Route W	Deficient	Sufficient	Deficient	Deficient	Deficient	*	*
235	Rest Area	Sufficient	Sufficient	Deficient	Deficient	Deficient	*	*
238	Weigh Station	Sufficient	Deficient	Deficient	Deficient	Sufficient	*	*
239	Route 30, Route WW, Route AB	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
240	Route 47	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*

TABLE 10

Geometric Design Evaluation

Exit #	Interchange	Ramp/ Outer Rd Intersection Spacing	Interchange Spacing	Degree Of Curvature Entry/Exit curve on Ramp	Taper/Accel/ Decel Length	Mainline SSD on ramp nose approach	Radius of loop curvature	Weaving Length
242	Route AH	Deficient	Sufficient	Sufficient	Deficient	Sufficient	*	*
247	U.S. 50	*	Sufficient	Deficient	Deficient	Sufficient	*	Deficient
251	Route 100 West	Sufficient	Sufficient	Sufficient	Deficient	Deficient	*	*
253	Route 100 East	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*
257	Loop 44	Deficient	Sufficient	Sufficient	Deficient	Deficient	*	*

Ramp/Outer Road Intersection Spacing: Roughly 60 percent of the 78 interchanges have existing conditions that do no violate the access management guidelines regarding spacing between ramp termini and the nearest intersection away from the interchange. Roughly 30 percent were in violation of the criteria. Most of these were within the more urbanized areas of the corridor. For 14 percent of locations, data was not available.

Interchange Spacing: Given the predominantly rural nature of the corridor, very few of the existing interchanges were found to be in violation of the established criteria for spacing between interchanges along I-44. Of the 78 interchanges, only 8 percent were spaced too closely to an adjacent interchange. Those locations are:

- Route 96 and Route Z/O
- West Kearney Street and U.S. 160 in Springfield
- Weigh Station and Route WW

Degree of Curvature: The large majority of existing ramps in the corridor, 85 percent, were found to have sufficient degree of curvature in the ramp gore areas.

Acceleration/Deceleration Length: Nearly all (99%) interchanges in the corridor were found to have ramps with deficient acceleration and deceleration lengths at the merge and diverge areas. As most of the existing ramps were built decades ago, it is not surprising that only one interchange was found to be in compliance with current standards.

SSD: Stopping sight distance on mainline I-44 was found to be deficient at roughly 37 percent of the existing interchanges.

Loop Ramp Curvature: There are three interchanges in the corridor that have loop ramp configurations. Ninety-six of them are sufficient.

Weaving Length: Only a small number of locations (7 weaves), most within the urban areas of the corridor that have actual weaving segments. Of those, approximately 50 percent were found to be deficient. Additionally, several cloverleaf interchanges exist within the corridor. By their nature, they have weaving lengths that are almost always deficient per design standards.

Interstate 44 (I-44) Purpose and Need Study: Bridge Summary (A-9)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	August 14, 2007
REVISION SUBMISSION DATE:	February 29, 2008

Introduction

Existing bridges on mainline I-44 within this study's limits of the Oklahoma/Missouri state line (Mile 0) and the eastern limit near the western St. Louis County line (exit 257) were reviewed to evaluate their compliance with acceptable standards as defined by MoDOT and AASHTO. Over 70 percent of the bridges on this stretch of I-44 were built in the 1950s or 1960s. The bridge superstructure types include: Box culverts, Steel and Concrete Beam/Girder bridges, Concrete T-Beam bridges, and Concrete Slab bridges.

There are 223 bridges on or over mainline I-44 in the corridor. The breakdown of the bridges includes the following:

- 89 bridges carry a route over I-44
- 1 bridge carries a railroad over I-44
- 10 bridges carry I-44 over a railroad
- 43 bridges carry I-44 over a waterway (box culverts are not included)
- 36 box culverts carry I-44 over a waterway
- 36 bridges carry I-44 over a route
- 6 bridges carry I-44 over a route and a waterway
- 2 bridges carry I-44 over a railroad and a waterway

Using data provided by MoDOT, the structures were evaluated relative to the current design standards in the following categories:

- Bridge Age
- Bridge Structural Condition
- Bridge Roadway Width (Curb-to-Curb)
- Vertical Clearance

The bridges were also evaluated for their suitability for widening I-44. This evaluation considered the suitability of widening the structures that carry I-44 and the horizontal clearances beneath the bridges that pass over I-44.

Bridge Age Evaluation

The year constructed, as provided by MoDOT, is listed as Item 27 in the National Bridge Inventory (NBI) database. The age of each bridge was evaluated using a reference year of 2007. All 223 structures, bridges, and box culverts were evaluated for age.

In general, the analysis confirms that the bridge infrastructure is approaching its useful design life, and a substantial portion has exceeded it. Forty-five of the 223 structures (20 percent) are 50–74 years old, and another 52 percent are 40–49 years old. Five (2 percent) of the 223 structures are 75 years old or older (**Table 1**).

TABLE 1

Structures that are 75 Years Old or Older (as of 2007)

Description	Log Mile	County	Age
I-44 Box Culvert over Fidelity Creek	18.500	Jasper	81 years
I-44 Box Culvert over Cave Springs Branch	32.967	Lawrence	75 years
I-44 Box Culvert over Little Beaver Creek	182.298	Phelps	82 years
WB I-44 Box Culvert over Hamilton Branch	234.826	Franklin	82 years
I-44 Box Culvert over Branch of Bourbeuse River	243.522	Franklin	82 years

Bridge Structural Condition Evaluation

Bridge sufficiency ratings and structural evaluations (deck, superstructure and substructure) were supplied by MoDOT and reviewed to assess the general condition of bridges along the corridor, the bridge components that are in the most need of repair, and the distribution of the bridges along the corridor that are in the most need of repair.

Sufficiency Ratings

Comparing the sufficiency ratings by category, it appears that the structures over I-44 are generally in poorer condition than bridges along I-44 **(Table 2**). On average:

- The structures along I-44 have a sufficiency rating of 86.4 percent.
- The structures over I-44 have a sufficiency rating of 72.3 percent.
- The box culvert structures have a sufficiency rating of 76.7 percent.

Notably, 12 of the structures over I-44 have a sufficiency rating of less than 50, while none of the bridges along I-44 are in that poor of condition.

Averaging by county, the ratings show:

- For bridges along I-44, the county with the lowest average is Lawrence County at 77.3.
- For bridges over I-44, Greene County has the most bridges and the lowest sufficiency average at 58.5, making it significantly below the average of all counties.
- While bridges with ratings less than 50 are spread throughout the corridor, Greene County has the most bridges in this category (18 percent of bridges going over I-44).

- For Box Culverts, Pulaski County has the lowest sufficiency rating average at 72.4 percent.
- Taking all the bridges into consideration, Greene County has the lowest overall sufficiency rating at 71.6.

TABLE 2

Existing Bridge Sufficiency Ratings Summary

County	Number of Bridges	Average Age	Average Sufficiency Rating	Number with Sufficiency Rating Less than 50
BRIDGES ALONG I-44				
Newton	10	49	86.2	0
Jasper	16	46	94.3	0
Lawrence	18	44	77.3	0
Greene	16	42	84.5	0
Webster	4	55	92.3	0
Laclede	6	48	83.5	0
Pulaski	6	34	88.4	0
Phelps	6	40	90.4	0
Crawford	1	41	91.1	0
Franklin	14	33	87.9	0
Overall Corridor	97	43	86.4	0
BRIDGES OVER I-44				
Newton	2	21	79.8	0
Jasper	9	30	76.8	2
Lawrence	8	44	58.9	0
Greene	16	37	58.5	5
Webster	4	37	78.4	0
Laclede*	9	34	76.5	1
Pulaski	10	40	80.5	1
Phelps	11	36	80.0	0
Crawford	8	40	72.7	1
Franklin	12	32	75.9	1
Overall Corridor	89	36	72.3	12
BOX CULVERTS				
Newton	0	---	---	---

TABLE 2

Existing Bridge Sufficiency Ratings Summary

County	Number of Bridges	Average Age	Average Sufficiency Rating	Number with Sufficiency Rating Less than 50
Jasper	3	57	77.7	0
Lawrence	5	51	80.4	0
Greene	3	47	72.8	0
Webster	2	57	75.7	0
Laclede	3	53	73.8	0
Pulaski	5	52	72.4	0
Phelps	4	59	80.8	0
Crawford	5	49	82.2	0
Franklin	6	67	73.2	0
Overall Corridor	36	55	76.7	0
COMBINED (ALL BRIDGES)				
Newton	12	45	85.1	0
Jasper	28	42	86.9	2
Lawrence	31	45	73.0	0
Greene	36	40	71.6	5
Webster	10	48	83.4	0
Laclede*	18	42	78.4	1
Pulaski	21	41	80.8	1
Phelps	21	41	83.1	0
Crawford	14	43	77.4	1
Franklin	32	39	80.6	1
Overall Corridor	222	42	79.2	12

*The sufficiency rating for the railroad bridge was not included due to lack of information.

Structural Component Ratings

A summary of structural ratings (**Table 3**) by component shows the vast majority (70–80 percent) of bridges have components that are rated 6 or 7. The summary also shows that decks are the components in the most need of repair. Only 6 percent of bridges have decks that are considered in excellent or very good condition, requiring no repairs. The lowest rating for all components is 3. Four bridges (2 percent) have decks in this category, and nine bridges (5 percent) have decks with ratings of 3 or 4 (structurally deficient). Six bridges (4 percent) have superstructures with ratings of 3 or 4. One bridge has a substructure in this range. Five culverts have a rating of 5, the lowest rating in this category.

TABLE 3

Bridges Component Ratings Summary*

Rating	Description	Deck		Super-structure		Sub-structure		Culvert	
9	Excellent Condition	3	2%	7	4%	10	5%	0	0%
8	Very Good Condition – May need minor preventative maintenance	8	4%	30	16%	17	9%	0	0%
7	Good Condition – May need minor maintenance	49	26%	65	35%	69	37%	7	19%
6	Satisfactory Condition – May need major maintenance	100	54%	66	35%	84	45%	24	67%
5	Fair Condition – May need minor rehabilitation	17	9%	12	6%	5	3%	5	14%
4	Poor Condition – May need major rehabilitation	5	3%	3	2%	1	1%	0	0%
3	Serious Condition – Requires immediate repair or rehabilitation	4	2%	3	2%	0	0%	0	0%
2	Critical Condition – Facility closed – Needs urgent repair or rehabilitation	0	0%	0	0%	0	0%	0	0%
1	Imminent Failure Condition – Facility closed – Study to determine if repairs are possible	0	0%	0	0%	0	0%	0	0%
0	Failed Condition – Facility is closed and out of service	0	0%	0	0%	0	0%	0	0%

*The Bridge Component Ratings for the railroad bridge was not included due to lack of information.

A breakdown of the structural component ratings by county shows there are bridges with decks and superstructures in the 3 to 4 range in several counties, a pattern replicated by the sufficiency ratings as noted in **Table 4**. Also similar to the sufficiency ratings, Greene County (which has the most bridges) has more bridges with decks and superstructures in the 3 to 4 range than other counties.

TABLE 4

Bridge Structural Component Ratings by County

County	Number of Bridges by Rating									
	0	1	2	3	4	5	6	7	8	9
BRIDGE DECKS										
Newton	0	0	0	0	2	0	5	5	0	0
Jasper	0	0	0	0	1	0	18	4	2	0
Lawrence	0	0	0	0	0	4	15	7	0	0
Greene	0	0	0	3	2	5	8	12	2	0
Webster	0	0	0	0	0	1	6	1	0	0
Laclede*	0	0	0	1	0	2	11	0	1	0
Pulaski	0	0	0	0	0	1	7	8	0	0
Phelps	0	0	0	0	0	1	12	2	1	1
Crawford	0	0	0	0	0	0	5	4	0	0
Franklin	0	0	0	0	0	3	13	6	2	2
Overall Corridor	0	0	0	4	5	17	100	49	8	3
Percent of Total	0%	0%	0%	2%	3%	9%	54%	26%	4%	2%
SUPERSTRUCTURE										
Newton	0	0	0	0	0	0	4	4	4	0
Jasper	0	0	0	0	1	0	9	4	8	3
Lawrence	0	0	0	0	0	2	7	8	9	0
Greene	0	0	0	3	2	3	10	12	2	0
Webster	0	0	0	0	0	1	4	2	1	0
Laclede*	0	0	0	0	0	0	6	7	1	1
Pulaski	0	0	0	0	0	2	5	8	1	0
Phelps	0	0	0	0	0	1	9	5	1	1
Crawford	0	0	0	0	0	0	4	5	0	0
Franklin	0	0	0	0	0	3	8	10	3	2
Overall Corridor	0	0	0	3	3	12	66	65	30	7
Percent of Total	0%	0%	0%	2%	2%	6%	35%	35%	16%	4%

TABLE 4

Bridge Structural Component Ratings by County

County	**Number of Bridges by Rating**									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
SUBSTRUCTURE										
Newton	0	0	0	0	0	2	2	6	2	0
Jasper	0	0	0	0	0	1	11	6	6	1
Lawrence	0	0	0	0	0	0	16	10	0	0
Greene	0	0	0	0	0	0	9	19	3	1
Webster	0	0	0	0	0	0	6	2	0	0
Laclede*	0	0	0	0	0	0	11	3	0	1
Pulaski	0	0	0	0	0	0	7	9	0	0
Phelps	0	0	0	0	0	0	10	5	0	2
Crawford	0	0	0	0	0	0	6	3	0	0
Franklin	0	0	0	0	1	2	6	6	6	5
Overall Corridor	0	0	0	0	1	5	84	69	17	10
Percent of Total	0%	0%	0%	0%	1%	3%	45%	37%	9%	5%
BOX CULVERTS										
Newton	0	0	0	0	0	0	0	0	0	0
Jasper	0	0	0	0	0	1	2	0	0	0
Lawrence	0	0	0	0	0	0	3	2	0	0
Greene	0	0	0	0	0	0	2	1	0	0
Webster	0	0	0	0	0	0	2	0	0	0
Laclede	0	0	0	0	0	1	2	0	0	0
Pulaski	0	0	0	0	0	1	2	2	0	0
Phelps	0	0	0	0	0	0	4	0	0	0
Crawford	0	0	0	0	0	0	5	0	0	0
Franklin	0	0	0	0	0	2	2	2	0	0
Overall Corridor	0	0	0	0	0	5	24	7	0	0
Percent of Total	0%	0%	0%	0%	0%	14%	67%	19%	0%	0%

*Excludes Railroad Bridge due to lack of information.

Bridge Condition Index

The Bridge Condition Index for all of the bridges, except the box culverts and a railroad bridge over I-44 in Laclede County, were provided by MoDOT.

A total of 186 bridges were evaluated. In summary, the bridges were assigned the following condition ratings:

- Very Good – 5 percent
- Good – 24 percent
- Fair – 65 percent
- Poor – 3 percent
- Very Poor – 3 percent.

Bridges with "Poor" or "Very Poor" index are typically in need of replacement or rehabilitation. These bridges are listed in **Table 5**.

TABLE 5

Bridges in Need of Rehabilitation or Replacement

Description	Condition	Log Mile	County
Eastbound I-44 over BU 71	Poor	8.813	Newton
Westbound I-44 over BU 71	Poor	8.824	Newton
MO 66 over I-44	Poor	15.248	Jasper
Route N over I-44	Poor	67.015	Greene
Route B over I-44	Poor	70.170	Greene
Southbound Route H over I-44*	Very Poor	80.373	Greene
Northbound Route H over I-44*	Very Poor	80.376	Greene
Southbound Route A over I-44	Very Poor	117.961	Laclede
Northbound Route A over I-44	Very Poor	118.037	Laclede
Westbound I-44 over Winsel Creek	Poor	227.896	Franklin

* Scheduled for replacement in FY09

Bridge Roadway Width (Curb-to-Curb) Evaluation

The bridge curb-to-curb roadway width is defined as the most restrictive minimum distance between the faces of the bridge barrier curbs or bridge rails. The bridge curb-to-curb roadway width is listed as Item 51 in the NBI database and this was provided by MoDOT for all bridges, except the box culverts.

For bridges carrying I-44 over a feature, the curb-to-curb width was evaluated using 12-foot lane widths, a 4-foot left shoulder, and a 10-foot right shoulder (**Table 6**). These dimensions are based on AASHTO criteria from Chapter 8 "Freeways." There are 97 bridges that carry I-

44 over a feature. Of the 97 bridges, 52 bridges (54 percent) did not meet the criteria for 10-foot right shoulders and 4-foot left shoulders.

TABLE 6

Bridge Curb-to-Curb Width Summary, I-44 over Other Features

Bridge Width Accommodates:	Number	Percent of Total
12-foot wide lanes, minimal shoulders	1	1 percent
12-foot wide lanes, plus 2-foot left shoulder and 4-foot right shoulder	29	30 percent
12-foot wide lanes, plus 2-foot left shoulder and 10-foot right shoulder	22	23 percent
12-foot wide lanes, plus 4-foot left shoulder and 10-foot right shoulder	45	46 percent
Total	97	100 percent

One bridge (eastbound I-44 over Big Piney River, mile marker 165.566, Pulaski County) is particularly narrow. This 3-lane bridge has a total curb-to-curb width of 39.5 feet, allowing for less than a 2-foot wide shoulder on each side.

For bridges carrying a route over I-44, the curb–to-curb width was evaluated using a simpler criterion, which compared the curb-to-curb width of the bridge to the width of the approach roadway. The curb-to-curb width was not evaluated for the railroad bridge over I-44 in Laclede County. Of the 90 bridges that were evaluated, 20 (22.2 percent) did not meet the criterion.

Vertical Clearance Evaluation

The vertical clearance for each bridge is listed as Item 54 in the National Bridge Inventory (NBI) database and was provided by MoDOT. The MoDOT Engineering Policy Guide specifies a minimum vertical clearance of 16-feet by 6-inches for bridges over interstate highways and state routes with more than 1,700 vehicles per day (vpd), and a minimum of 23-feet by 0-inches for bridges over a railroad. The AASHTO Standard Specifications for Highway Bridges require a minimum clearance of 16-feet by 0-inches with an allowance for resurfacing for all interstate bridges. The criteria used in this evaluation were to meet a vertical clearance of 16-feet by 0-inches for a bridge over a route and 23-feet by 0-inches for a bridge over a railroad.

In summary, the evaluation showed:

- Of the 90 bridges that carry a route or railroad over I-44, 11 (12.2 percent) have a vertical clearance of less than 16-feet by 0-inches.
- Of the 42 bridges that carry I-44 over a route, 30 (71.4 percent) have a vertical clearance of less than 16-feet by 0-inches.
- Of the 12 bridges that carry I-44 over a railroad, six (50.0 percent) have a vertical clearance of 23-feet by 0-inches or less (**Table 7**).

TABLE 7

I-44 Bridges over Railroads with Sub-Standard Vertical Clearance

Description	Log Mile	County	Vertical Clearance
Eastbound I-44 over KCS RR	9.720	Newton	22-feet by 6-inches
Westbound I-44 over KCS RR	9.779	Newton	22-feet by 6-inches
Eastbound I-44 over BNSF RR	29.191	Jasper	22-feet by 11-inches
Westbound I-44 over Little Piney River & BNSF RR	173.994	Phelps	22-feet by 11-inches
Eastbound I-44 over UP RR	253.974	Franklin	22-feet by 11-inches
Westbound I-44 over UP RR	254.063	Franklin	22-feet by 11-inches

Evaluation of a Wider Interstate Cross-Section at Bridge Overpasses

There are 89 bridges that carry a route over I-44 and one bridge that carries a railroad over I-44. A majority of these bridges are 4-span bridges with a pier near the center of a grass median and piers located just off the right shoulder. Some of the newer bridges are 2-span bridges with a center pier and spill slopes located at the abutment.

At most locations bridges over I-44 could accommodate an additional inside traffic lane in each direction. In the areas where the median is more than 40 feet, an inside lane could be added within current design criteria, depending on the center bridge pier location. However, most of the existing section for I-44 consists of a 40-foot wide median. A standard 12-foot wide lane could be added to the inside in each direction, but it would require an urban section with a narrow median. The inside shoulder in this section would be between 5-feet by 0-inches and 8-feet by 0-inches depending on the center pier column width. Typically, an urban section requires a minimum lateral clearance of 5-feet by 6-inches. In the areas where the median is less than 40 feet, an inside lane could not be added without modification or replacement of the bridge.

On the other hand, a generic addition of an outside traffic lane is problematic at most overpasses. At a minimum, widening I-44 to the outside would require an additional 22 feet from the existing edge of the traffic lane: the 12-foot lane plus a 10-foot shoulder. About 80 percent of the overpasses are 4-span bridges with a pier located on or near the edge of the existing right shoulder, at a distance of 8 to 16 feet off the edge of the traffic lane and the pier are protected by either guardrail or concrete barrier. In some cases, these piers would not allow the additional lane width, and none of the bridges would allow adequate space for a new lane and an outside shoulder. Some of the locations with a 2-span bridge could allow for an added lane, but may require revised drainage or spill slope modifications, or both at the abutment.

Widening the median throughout the corridor to the current 60-foot standard, without additional lanes, would have similar problems to adding an outside lane. The travel lanes would need to be shifted 10 feet to each side for most of the corridor, as the existing median is predominantly 40 feet wide. This shift would be compromised by most bridges, which have piers along the outside edge of the shoulders. In the locations where 2-span bridges exist, there may be enough room for the lane shift but it may require revised drainage or spill slope modifications, or both at the abutment.

In summary, while some bridges may allow for widening of I-44 to either the inside or outside, or a combination, the median width of 40 feet in most locations would require an urban section with a narrow median. In many cases, adding a lane will result in either substandard shoulder widths at the overpass or will require modification to the overpass. Adding travel lanes in conjunction with widening the median to current standards would require reconstruction of most structures over I-44.

Evaluation of a Wider Interstate Cross-Section for Bridges along I-44

There are 97 bridges that carry I-44 over another route, railroad, or waterway. The 97 bridges consist of three superstructure types: 15 are Slab bridges, 13 are T-Beam bridges, and 69 are Stringer/Beam bridges. All three superstructure types are typically suitable for widening of the bridge deck, but a structural evaluation of the superstructure and substructure would need to be conducted for each bridge to determine if an additional traffic lane could be added. In particular, bridges that are in Poor or Very Poor condition (**Table 5**), or bridges that already have a posted weight limit (**Table 8**) would need to have a detailed structural evaluation conducted.

TABLE 8

Bridges with a Posted Weight Limit

Description	Log Mile	County	Weight Limit
Westbound I-44 over BNSF RR	73.235	Greene	65 Ton
Eastbound I-44 over BNSF RR	73.237	Greene	65 Ton
Westbound I-44 over MO 744, Abandoned RR	75.132	Greene	65 Ton
Eastbound I-44 over CST Broadway Ave.	78.209	Greene	65 Ton
Westbound I-44 over CST Broadway Ave.	78.230	Greene	65 Ton
Eastbound I-44 over CST Grant Ave.	78.456	Greene	60 Ton
Westbound I-44 over CST Grant Ave.	78.481	Greene	60 Ton
Eastbound I-44 over CST National Ave.	79.710	Greene	65 Ton
Westbound I-44 over CST National Ave.	79.734	Greene	65 Ton

Given that 62 of the bridges (64 percent) are 45 to 55 years old, 69 of the bridges (71 percent) have a condition index of “Fair” or “Poor,” and most of the bridges were designed for truck loads that are less than the current standard, a detailed investigation of each structure would be required to determine if, (1) the substructure would be able to support the additional load, and (2) if the widening would be cost-effective relative to a total structure replacement.

There are also 36 box culverts that carry I-44. Generally, a box culvert can be lengthened on each end to accommodate a wider section. However, a hydraulic review would be required to evaluate the hydraulic capacity of the revised structures.

Interstate 44 (I-44) Purpose and Need Study: Geometric Analysis Methods and Assumptions (A-10)

PREPARED FOR: MoDOT

PREPARED BY: CH2M HILL

ORIGINAL SUBMISSION DATE: April 27, 2007

REVISION SUBMISSION DATE March 5, 2008

Introduction

The purpose of this technical memo is to document the methods and assumptions used in the geometric analysis portion of the I-44 Purpose and Need Study. This memo encompasses both horizontal and vertical alignments.

The geometric analysis described in this memo only considers geometric issues relative to accepted standards. This memo does not consider the impacts of geometric deficiencies to any other issue, specifically safety. Refer to the *I-44 Corridor Evaluation Methodology* Memo for a more in-depth discussion of how geometric deficiencies may relate to safety.

The evaluations discussed below are all summarized in tables. For further, more site specific evaluation, refer to the project's GIS mapbook, which visually displays the safety, operations, and geometric findings of the study graphically.

Horizontal Curve Criteria

Posted Speed Limit

Design guidelines vary between the two posted speed limits along I-44, 70 mph and 60 mph. For the geometric evaluation, all areas were evaluated as 70 mph except for the two areas where the speed limit is posted at 60 mph. The first of these areas is in Springfield, from Log Mile 76.5 to 81.2. The second area of speed reduction is in Rolla, from Log Mile 184.5 to 187.2.

Design Guidelines

As a freeway type facility posted at 70 mph, I-44 has a maximum allowable super elevation of 8 percent, as recommended on Page 144 of AASHTO's 2004 edition of *A Policy on Geometric Design of Highways and Streets* (AASHTO Policy). Where posted at 60 mph, I-44 has a maximum allowable super elevation of 6 percent, as recommended on Page 145 of the AASHTO Policy. Recommended minimum radii for a curve are given in Exhibit 3-27 on page 170 of the AASHTO Policy. These recommendations will be considered the design guidelines for horizontal curves.

Evaluation Criteria

Any curve that does not meet the AASHTO design guidelines is considered deficient for purposes of this evaluation. If a curve was deficient, it was evaluated with the assumption of maintaining the existing radius and determining how deficient the super elevation is compared to the guidelines.

TABLE 1

Horizontal Curve Geometry Assessment

Action Required	**Number of Curves Evaluated**	**Percent of Total**
No Action	**25**	**16 percent**
Increase Superelevation up to 1.5 percent	103	65 percent
Increase Superelevation by more than 1.5 percent	28	18 percent
Must Increase radius	3	2 percent
Totals:	159	100 percent

The project Map Book (Appendix B) that accompanies this document depicts the locations associated with the Horizontal Curve Geometry Assessment.

Vertical Curve Criteria

Posted Speed Limit

Design guidelines vary between the two posted speed limits along I-44, 70 mph and 60 mph. For the geometric evaluation, all areas were evaluated as 70 mph except for the two areas where the speed limit is posted at 60 mph. The first of these areas is in Springfield, from Log Mile 76.5 to 81.2. The second area of speed reduction is in Rolla, from Log Mile 184.5 to 187.2.

Design Guidelines

Generally, a K-value is used to design a vertical curve. K is the relationship of the length of the vertical curve over the algebraic difference in grade. Exhibit 3-72 on page 272 of AASHTO's Policy gives appropriate K-values for vertical crest curves given the design speed. For this project, areas which have a posted speed of 70 mph, should have a K-value of 247 or greater. Areas which have a posted speed of 60 mph, should have a K-value of 151 or greater. Sag vertical curves are given in Exhibit 3-75 on page 277. Seventy mph areas, should have a K-value of 181 or greater and 60 mph areas should have a K-value of 136 or greater.

In addition, crest vertical curve sight distance should be at least the minimum acceptable stopping sight distance (SSD) for the posted speed. Exhibit 3-72 on page 272 of AASHTO's Policy gives appropriate SSD values for vertical curves given the design speed. For 60 mph areas, a SSD of at least 570 feet is required. For 70 mph areas, a SSD of at least 730 feet is required. SSD Equations 3-43 and 3-44 on page 268 were used to calculate the existing SSDs of the I-44 vertical curves. The existing SSDs were compared to the AASHTO Policy.

Sag curve passenger comfort is the centripetal acceleration a passenger feels in a sag curve. The equation for evaluating this discomfort is given in equation 3-51 on page 274 of AASHTO's Policy. These equations are a function of design speed and the algebraic difference in grades.

Evaluation Criteria

All crest and vertical curves were evaluated initially based on the accepted K-factor. If any curve had a deficient K-value, it was further evaluated. Any curves not having a deficient K-value were considered acceptable.

Crest curves which have a deficient K-value were evaluated by SSD.

Sag curves which had a deficient K-value were then evaluated by the passenger comfort criteria.

Results of the vertical curve evaluation are summarized in **Tables 2** and **3**. Some areas of I-44 have a split profile which results in some minor differences between eastbound and westbound alignments.

TABLE 2

Eastbound Vertical Curve Condition Deficiencies

Deficiency	Number	Percent of Total
K-Value	128	24
K-Value + Crest Sight Distance	37	7
K-Value + Sag Passenger Discomfort	26	5

TABLE 3

Westbound Vertical Curve Condition Deficiencies

Deficiency	Number	Percent of Total
K-Value	140	27
K-Value + Crest Sight Distance	46	9
K-Value + Sag Passenger Discomfort	28	5

Geographically, the curves that are identified in the tables above as not meeting design criteria are grouped more densely in some areas than others. These curves are scattered sporadically across the corridor, but have severe concentration in the following areas. Mile Marker 101 to 115, in Webster and Laclede Counties and Mile Marker 140 to 160, Laclede and Pulaski Counties. Sporadic density increases from Mile Marker 177 to the study termini at Mile Marker 257, but there is no one area that is denser than the rest.

Vertical Grade Criteria

Posted Speed Limit

Design guidelines vary between the two posted speed limits along I-44, 70 mph and 60 mph. For the geometric evaluation, all areas were evaluated as 70 mph except for the two areas where the speed limit is posted at 60 mph. The first of these areas is in Springfield, from Log Mile 76.5 to 81.2. The second area of speed reduction is in Rolla, from Log Mile 184.5 to 187.2.

Terrain

The I-44 corridor is approximately 258 miles in length and has varying terrain. Rolling terrain is the most suitable classification to characterize the corridor as a whole.

Rolling terrain is defined on page 231 of AASHTO's Policy is where… "natural slopes consistently rise above and fall below the road or street grade, and occasional steep slopes offer some restriction to normal horizontal and vertical roadway alignment."

The Highway Capacity Manual 2000 (HCM) defines rolling terrain as "any combination of grades and horizontal or vertical alignment that causes heavy vehicles to reduce their speeds substantially below those of passenger cars but that does not cause heavy vehicles to operate at crawl speeds for any significant length of time or at frequent intervals."

Design Guidelines

For rolling terrain, Exhibit 8-1 on page 506 of AASHTO's Policy gives appropriate maximum grades for given design speeds. According to this table, the study area should have no grades steeper than 4 percent, regardless of 60 or 70 mph posted speed. This guide establishes a maximum acceptable grade without consideration to the length of the grade.

However, length of grade should be evaluated given the high percentage of truck traffic on I-44 currently and the anticipated growth in the future. On page 231 AASHTO notes that, "In general, rolling terrain generates steeper grades than level terrain, causing trucks to reduce speeds below those of passenger cars…."A 10 mph speed reduction of heavy vehicles for determining critical lengths of grades on page 239.

The speed differential experienced on rolling terrain must be evaluated using a combination of grade steepness and length of grade. Exhibit 3-59 on page 242 of AASHTO's Policy provides maximum length of grades for a given percent of grade. Those values and their corresponding conditions, as assigned by CH2M HILL, are summarized in **Table 6**.

TABLE 6

Critical Length of Grade Criteria

Grade (percent)	Critical Length (in miles)
2 percent	0.57
3 percent	0.33
4 percent	0.23

TABLE 6

Critical Length of Grade Criteria

Grade (percent)	Critical Length (in miles)
5 percent	0.18
6 percent	0.15
7 percent	0.13

Evaluation Criteria

Grades were evaluated based on two main criteria. First, the grade steepness was evaluated against the AASHTO specified maximum of 4 percent. In an attempt to determine relative steepness of the grades, grades were broken out in categories in 1percent increments. Thus, grades from 4 to 5 percent were in a class, 5 to 6 percent were in a class, and anything over 6 percent was in a class. The results are summarized in **Tables 7** and **8**. Eastbound and westbound have minor differences due to areas of split profile.

TABLE 7

Eastbound Maximum Grade Condition Evaluation

Condition	Number	Miles	Percent of Total
Meets Guidelines	495	252.9	98 percent
4 percent < Grade < 5 percent	16	3.2	1 percent
5 percent < Grade < 6 percent	13	1.6	1 percent
6 percent < Grade	4	0.4	0 percent
Totals:	528	258.2	100 percent

TABLE 8

Westbound Maximum Grade Condition Evaluation

Condition	Number	Miles	Percent of Total
Meets Guidelines	504	252.4	98 percent
4 percent < Grade < 5percent	17	3.1	1 percent
5 percent < Grade < 6 percent	14	2.0	1 percent
6 percent < Grade	4	0.8	0 percent
Totals:	539	258.2	100 percent

Geographically, the grades that are identified in the tables above as not meeting design criteria are grouped more densely in some areas than others. These grades are scattered sporadically across the corridor, but have severe concentration in the following area: Mile markers 140 to 160, Laclede and Pulaski Counties.

Second, critical lengths of grades were evaluated based on the criteria summarized in **Table 6**. Results are summarized in **Tables 9** and **10**. Again, there are minor differences between eastbound and westbound due to areas of split profile.

TABLE 9

Eastbound Critical Length of Grade Condition Evaluation

Condition	**Number**	**Miles**	**Percent of Total**
Meets Guidelines	501	244.3	95 percent
Critical Length is a Factor	27	13.9	5 percent
Totals:	528	258.2	100 percent

TABLE 10

Westbound Critical Length of Grade Condition Evaluation

Condition	**Number**	**Miles**	**Percent of Total**
Meets Guidelines	515	245.7	95 percent
Critical Length is a Factor	24	12.5	5 percent
Totals:	539	258.2	100 percent

Geographically, the grades that have critical length issues are identified in the tables above as not meeting design criteria are grouped more densely in some areas than others. These grades are scattered sporadically across the corridor, but have severe concentration in the following area: Mile markers 140 to 180, Laclede, Pulaski, and Phelps Counties.

A more detailed analysis of vertical grades, including critical length and when truck climbing lanes may be justified is discussed in the *I-44 Climbing Lane Evaluation* Technical Memo.

Conclusion

Upon evaluating vertical geometry by the previously discussed criteria, and noting areas of concentration where existing conditions do not meet design guidelines, the following area is common to all three evaluations: Mile markers 140 to 160, Laclede and Pulaski Counties.

Interstate 44 (I-44) Purpose and Need Study: Modal Service Deficiencies (A-11)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	February 20, 2008
PROJECT NUMBER:	355821

Introduction

The purpose of this memorandum is to summarize existing and projected modal transportation uses along the I-44 corridor and analyze how a fully operational multimodal transportation network influences traffic volumes on I-44. Modal transportation discussed in this technical memorandum includes intercity bus service and passenger train service. The "*Missouri Statewide Passenger Transportation Study*" (MoDOT 2004) estimates that only one-half of the multimodal transportation demand is met in Missouri's urban areas and only one-third of the demand is met in rural areas.

This memorandum discusses the effect of average vehicle occupancy (AVO) on traffic volumes, intercity bus service, and passenger rail service in the study area, including the 2035 ridership capacity projections and the potential contribution of intercity bus service and passenger rail to traffic volume reductions on I-44.

Average Vehicle Occupancy

In assessing the influence of multimodal transportation on traffic volumes it is important to understand the concept of AVO. In this memorandum, the AVO is used to convert ridership on intercity buses and passenger rail (proposed) to the equivalent number of automobiles and noncommercial trucks. Thus, the reduction in the number of vehicles on the road from ridership on mass transit can be estimated. More passenger trips on mass transportation mean fewer vehicles on the road.

Average vehicle occupancy varies with respect to several key variables such as time of travel (peak *versus* nonpeak periods), season (tourism peaks), gas prices, proximity to urban areas, type of roadway, and purpose of travel (tourism *versus* business travel). In *2002 Vehicle Occupancy Study for the Kansas City [MO] Metropolitan Area* (Mid-America Regional Council, 2002), the AVO for freeways/expressways during the AM and PM peak hours was 1.19 and 1.14, respectively. Despite the fact that these data are more than 5 years old, these AVOs appear to be reasonably representative of the I-44 corridor. It may be reasonable to assume that tourism-related travel has a higher AVO than does business travel. It may also be reasonable to assume that the proposed passenger rail line along I-44 would be primarily used for tourism given the proximity of the line to key tourism destinations; hence a higher

AVO ridership conversion factor may be warranted. Similarly, several key rider groups, such as college students and military personnel, on intercity buses may tend to travel together to their respective destinations thereby warranting a higher AVO ridership conversion factor for intercity bus travel. However, for simplicity throughout this technical memorandum, we use an AVO of 1.17, the average of the Kansas City Freeway/Expressway AM and PM peak AVOs, for both intercity bus service and for passenger rail. Thus, 100 bus or rail passengers would equate to approximately 85 automobiles and noncommercial trucks on I-44.

Based on the Kansas City study, AVOs for freeways/expressways increased by 0.17 percent - 0.35 percent annually in the period from 1997-2002; however, in a larger time frame (1989-2002), they have risen and fallen. In our analysis, there appears to be no compelling reason to assume that the AVO will grow annually. Therefore, in the projections (See **Tables 1, 2,** and **3**) the AVO conversion is constant at 1.17 through 2035[1].

Intercity Bus Service

The MoDOT Organizational Results Research Report *Impact of Declining Intercity Bus Service in Missouri* (MoDOT 2006) identified Greyhound Lines, Inc. as the only scheduled intercity bus service that serves the I-44 corridor from St. Louis to Oklahoma. Based on personal communication with Greyhound staff (Greyhound, 2007), during the period May 1, 2006 to April 30, 2007 (365 days), 1,540 Greyhound busses departed St. Louis along westbound I-44 and 1,561 busses traveled along eastbound I-44 from the Oklahoma state line to St. Louis. Thus, an average of 4.2 busses embarked daily westbound and 4.3 busses embarked daily eastbound during this period.

Each Greyhound bus has 55 seats; on average 38 (69 percent) of them are full. Thus, each bus trip has on average 38 passengers. With 1,540 westbound trips, 58,520 riders are transported westward annually. With 1,561 eastbound trips, 59,318 riders are transported eastward annually.

Intercity Bus Service Deficiencies

Many factors influence ridership on intercity bus service. Some factors are clearly private sector factors, such as expendable income, gas prices, and financial decisions by private bus services. Other factors affecting bus service are more amenable to influence by public decision-makers. These include:

- **Declining Number of Intercity Bus Stops** - Currently Greyhound Lines makes stops in St. Louis, Rolla, Ft. Leonard Wood, and Lebanon. The long distances between bus stops make intercity bus service less accessible.
- **Inadequate signage** - Locations of smaller bus stations may be difficult to find. Improved signage on I-44 and adjacent thoroughfares would better direct travelers to the stations and provide visibility to the community that intercity bus service exists.

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[1] Rising gas prices may tend to increase the AVO though a more fuel-efficient fleet may counteract this tendency.

- **Difficulty in Purchasing Tickets** - Often bus tickets cannot be purchased at smaller bus stops. Aligning bus stop locations with ticket purchase locations would make intercity bus service a less frenetic experience.
- **Poor Track Record of On-Time Arrivals and Departures** - Late arrivals and departures of intercity busses may cause riders to miss other modal departures at a later leg of their trip. Expectations of inadequate service may cause potential riders to choose alternate transportation.
- **Inadequate Focus on Significant Ridership Groups** - The *Impact of Declining Intercity Bus Service in Missouri"* identified five rider groups that make up a large percentage of intercity bus ridership: people of Hispanic origin, military personnel, Amish, correctional parolees, and college students. Focusing on ridership groups and their intercity bus service needs would likely be effective in increasing ridership. Based on Census 2000 (2005 estimates) data and personal communication, populations of significant rider groups are described as follows:
  - ***People of Hispanic Origin***. Four counties along the I-44 corridor have Hispanic populations greater than the state average of 2.7 percent: Newton County (2.8 percent, Hispanic population 1,556), Jasper County (5.2 percent, Hispanic population 5,752), Lawrence County (4.6 percent, Hispanic population 1,708), and Pulaski County (6.6 percent, Hispanic population 2,916). The combined Hispanic population of these four counties is 11, 932. The Hispanic population of all counties adjacent to the I-44 corridor is 20,442.
  - ***Military Personnel***. Fort Leonard Wood is the only military installation in close proximity to the I-44 corridor. Fort Leonard Wood is by far the largest military installation in Missouri with approximately 11,566 personnel, based on 2004 data summarized in *Impact of Declining Intercity Bus Service in Missouri* (MoDOT 2006).
  - ***Amish Settlements***. Amish settlements are located in several counties adjacent to the I-44 corridor, summarized as follows: Lawrence County (~2.1 percent, Amish pop. 739), Pulaski County (~2.1 percent, Amish pop. 864), Webster County (~2.1 percent, Amish pop. 652). The combined Amish population in these three counties is 2,255.
  - ***Correctional Parolees***. Based on 2005 data summarized in "*Impact of Declining Bus Service in Missouri*" (MoDOT 2006), parolees are escorted to three bus stops along (or potentially destined for) the I-44 corridor. These include stops at Rolla, Springfield, and St. Louis. In 2005, the South Central Correctional Center (Licking, MO) released 83 parolees to the Rolla bus stop. The Ozark Correctional Center (Fordland, MO) released 249 parolees to the Springfield stop. Clearly, those released to the Rolla and Springfield stops were destined to ride on I-44. Several correctional facilities in the vicinity of St. Louis released 1,273 parolees to the St. Louis bus stop – only a fraction of which (estimated at 7 percent or 89 riders) would be destined to travel along I-44.

- ***College Students***. As summarized in *Impact of Declining Intercity Bus Service in Missouri,* many students from colleges and universities near I-44 use intercity bus stops at Springfield, St. Louis, St. Louis – Lambert, Joplin, and Rolla (MoDOT 2006). The total student population of colleges and universities within 50 miles of these bus stops is 106,862. Student ridership is highest at semester breaks, holidays, and weekends.

Table 1 summarizes intercity bus ridership along I-44 for the year 2006-2007 and estimated ridership for the year 2035. Based on rider surveys summarized in *Impact of Declining Intercity Bus Service in Missouri* it is estimated that if bus service deficiencies were corrected, then approximately 54 percent of riders (70 percent of very satisfied riders, 39 percent of somewhat satisfied riders, and 42.9 percent of unsatisfied riders) would ride the bus more often. For purposes of this memorandum it is assumed that "more often" translates to 33 percent more trips. Therefore, assuming the deficiencies were corrected, ridership could reduce the current daily traffic along I-44 by 325 vehicles and by as many as 716 vehicles in 2035. These numbers represent about 2 to 3 percent of the current and projected traffic volumes in rural areas, and about 1 percent of the volumes in urban areas.

TABLE 1

Summary of Intercity Bus Ridership (Eastbound and Westbound) Along I-44

Current Ridership (2007)				**Ridership Projections (to 2035)**	
Average Annual (Daily) Ridership (2006 - 2007) [1]	**Average Annual (Daily) Traffic Equivalency (2006 - 2007)** [2]	**Estimated Annual (Daily) Ridership with Deficiencies Corrected (2006 - 2007)** [3]	**Estimated Annual (Daily) Traffic Equivalency with Deficiencies Corrected (2006 - 2007)**	**Projected Annual (Daily) Traffic Equivalency (2035)** [4]	**Projected Annual (Daily) Traffic Equivalency with Deficiencies Corrected (2035)** [3]
117,838 (323)	100,716 (276)	138,836 (380)	118,663 (325)	221,818 (608)	261,345 (716)

Notes:

[1] The period May 1, 2006 through April 30, 2007 (365 days).

[2] Conversion from bus ridership to the equivalent number of vehicles uses a conversion factor of 1.17 average vehicle occupancy (AVO).

[3] For purposes of this memorandum ridership with improvements is calculated as follows:
Ridership + ((54 percent of Ridership) x 0.33) = Ridership with Improvements; 54 percent of the riders would ride the bus 33 percent more often if improvements were made. This equates to about an 18 percent increase.

[4] Projections assumed a growth rate of 2.76 percent increase per year to 2035, based on the growth rate of Missouri non-metro transit passengers from 2001-2005 (MoDOT Tracker July 2006).

Passenger Rail

Currently the only state-supported passenger rail service in Missouri is the Amtrak line from St. Louis to Kansas City, Missouri. No service is currently provided along the I-44 corridor. Amtrak has proposed one daily round trip from St. Louis to Springfield, mostly along I-44 using Burlington Northern – Santa Fe (BNSF) owned tracks. Though the future of this Amtrak line is uncertain in the short term, stops are being considered at St. Louis, Kirkwood, Fort Leonard Wood, Sullivan, Rolla, Lebanon, and Springfield. Amtrak estimates an annual ridership of 34,000 on the proposed St. Louis to Springfield line.

Nationwide, Amtrak ridership from October 2005 – September 2006 increased one percent. On Amtrak's state-supported and short-distance services, ridership increased 4.5 percent over the same period. The Midwest Interstate Passenger Rail Commission reports that several Midwestern lines have had notable recent ridership increases from 2005 to 2006: the Chicago – Milwaukee Hiawatha line, up 10 percent, and the Chicago-Detroit/Pontiac Wolverine, up 22 percent, (2006). According to *Missouri Advance Planning – Missouri's Long-Range Transportation Plan* (MoDOT 2006) and the *July 2006 Tracker – Easily Accessible Modal Choices* (MoDOT 2007), two state-subsidized Amtrak round trips run between St. Louis and Kansas City daily. Annual ridership on this line was 121,000 in 1980; 207,000 in 2001; and 174,000 in 2006. Despite the drop from 2001 to 2006, over the period of 2004 to 2006, ridership on this state-subsidized line has grown on average about 3 percent annually. While other passenger rail service exists in Missouri it is outside of the purview of MoDOT and it will not be considered further in this technical memorandum.

Table 2 shows estimated 2008 and 2035 passenger rail ridership and average daily traffic equivalencies, using an AVO of 1.17 and assuming one daily round trip, for the proposed St. Louis to Springfield line. It is unknown at this time the extent to which the proposed line from St. Louis to Springfield would draw its ridership from existing intercity bus riders or from existing automobile-based travelers. The 2008 ridership is taken from a study by Amtrak for the proposed line, based on a national ridership model plus current baseline forecast for existing Missouri state-supported rail passenger service from St. Louis to Kansas City (Amtrak, 2007). In order to project Amtrak ridership to year 2035, a growth rate of 4.5 percent annually is used.

Current ridership on the St. Louis – Kansas City line may be somewhat hampered by insufficient publicity, unreliability of service as a result of track maintenance, inadequate train stop facilities, and a generally poor on-time arrival and departure record. Brian Weiler (MoDOT) posits that the Missouri passenger rail ridership could increase by as much as 44 percent if on-time performance and reliability could be improved. Under this assumption, the effect (benefit) that the proposed passenger rail line would have on I-44 traffic volumes increases to about 115 vehicles for 2008 and 376 for 2035. These numbers represent only about 1 percent of the current and projected traffic volumes in rural areas, and less than 1 percent of the volumes in urban areas.

TABLE 2

Estimated current and projected passenger rail ridership on the proposed St. Louis to Springfield line

2008 Estimated Annual (Daily) Ridership	**2008 Average Annual (Daily) Traffic Equivalency**	**2008 Estimated Annual (Daily) Ridership with Deficiencies Corrected [1]**	**2008 Average Annual (Daily) Traffic Equivalency with Deficiencies Corrected**	**Projected 2035 Average Annual (Daily) Traffic Equivalency [2]**	**Projected 2035 Average Annual (Daily) Traffic Equivalency with Deficiencies Corrected [3]**
34,000 (93)	29,059 (80)	48,960 (134)	41,846 (115)	95,374 (261)	137,339 (376)

Notes: Assumes one round trip daily.

[1] Assumes a 44 percent increase in ridership if passenger rail deficiencies are corrected. This is based on ridership analysis (MoDOT – Brian Weiler) of the existing St. Louis to Kansas City line.

[2] Based on a projected annual (daily) 2035 ridership (without deficiencies corrected) of 111,588 (306).

[3] Based on a projected annual (daily) 2035 ridership (with deficiencies corrected) of 160,687 (440).

Limited train ridership is often attributed to lengthy travel times. Even assuming a significant track improvement to shorten the route, the train speeds would still be considerably less than vehicular traffic on I-44 because of the hilly terrain and track curvature. The resultant travel time from St. Louis to Springfield would be 6 hours, compared to about 3 hours for car travel on I-44.

There are also fiscal constraints to initiating this type of passenger rail service. The cost of providing the service is estimated to be $4.1 million annually, while ticket revenue would account for only about $700,000, meaning the state would need to invest approximately $3.4 million annually. Further, there is a lack of available station infrastructure at proposed train stops in Sullivan, Rolla, Lebanon, and Springfield. It could cost several million dollars per stop to construct the required station infrastructure according to federal regulations.

Conclusion

In summary, the two alternative modes of transportation, intercity and rail, analyzed for the I-44 corridor would have only minor positive effect on reducing traffic volumes. **Table 3** summarizes the effects of fully functional intercity bus service and passenger rail service on transportation demand of I-44 projected to 2035. On average, it is estimated that a fully operational multimodal system could reduce daily traffic volumes on I-44 by approximately 3 to 4 percent on rural sections and 1 to 2 percent on most urban sections. The daily volume of domestic vehicles could be reduced by 1,092 on I-44 in the year 2035, if intercity bus service and passenger rail service were fully functional.

TABLE 3

Current and Projected Traffic Volumes on I-44 [1]

Road Segment	2005 Average Daily Volume	2035 Projected Daily Volume [2]	2035 Projected Daily Volume with Fully Functional Intercity Bus Service [2]	2035 Projected Daily Volume with Passenger Rail (St. Louis to Springfield) [2]	2035 Projected Daily Volume with Fully Functional Intercity Bus Service and Passenger Rail (St. Louis to Springfield) [2]
44-A (Joplin)	15,840	41,200	40,875	40,484	40,108
44-B (Mt. Vernon)	17,820	30,200	29,875	29,484	29,108
44-C (Springfield)	42,340	54,400	54,075	53,684	53,308
44-D (Sullivan)	20,800	65,700	65,375	64,984	64,608

Source: *Adapted from "Missouri Advance Planning – Missouri's Long-Range Transportation Plan*" (MoDOT 2006)

[1] Estimated truck volume has been subtracted from all data in **Table 3**.

[2] Values are based traffic volume modeling updated in November 2007. The low and high values represent a reasonable range of projected traffic volume.

The intercity bus, operated by Greyhound, is the more effective of the two modes. The bus line currently operates at approximately 69 percent of capacity. Improvements to accessibility and on-time performance could increase ridership by as much as 18 percent. At that rate, it is estimated that combined eastbound and westbound bus ridership could reduce the daily traffic volumes along I-44 by as much as 2 to 3 percent in rural areas where there are lower total traffic volumes and by about 1 percent in urban areas where there are higher total traffic volumes.

The other alternative mode, a state-supported Amtrak passenger rail line along an existing railway parallel to I-44, would provide minimal additional benefit to I-44 over the intercity bus line. Even if the rail line realizes its full potential, it would reduce traffic volume by only about 1 percent. A major limiter to ridership would be the travel time which, even with improvements, is estimated at as much as twice the travel time by car. The minor benefit to traffic volumes hardly outweighs the cost of improving the rail for speed, constructing stations at larger cities along the route, and operating the line.

Based on these analyses, multimodal solutions provide a minor, corridor-wide reduction in traffic volumes, but will not substantially offset the projected annual traffic growth rate of 2 to 4 percent on I-44.

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TECHNICAL MEMORANDUM **CH2MHILL**

Interstate 44 (I-44) Purpose and Need Study: Springfield Intersection Traffic Delay Study (A-12)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	January 16, 2008
PROJECT NUMBER:	355821

Introduction

As part of the I-44 Purpose and Need Study, MoDOT identified study benefits of on-site investigations of the operations of three diamond interchanges in the Springfield area. This technical memo presents a summary of this investigation. The analysis focused on travel time and delays pertaining to how traffic moves off of the interstate and through the ramp termini during the AM and PM peak travel periods. These three interchanges, identified by MoDOT District staff were Exit 75 [Route 160], Exit 77 [Route 13] and Exit 88 [Route 125]. They were identified because they had the potential for traffic on the exit ramps backing up onto the interstate, resulting in a dangerous safety situation.

Figure 1 Springfield Intersection Study Area

The Highway Capacity Manual 2000 (HCM) describes the unique operations of signalized diamond interchanges in Chapter 26, page 4. One of the most important findings in the HCM is that the two intersections at the ramp termini do not operate in isolation, each affects the other. While not all of the ramp termini evaluated were signalized, this evaluation assumes that this conclusion holds true for the unsignalized ramp termini evaluated as well.

The HCM describes queuing characteristics for a signalized diamond interchange as generally falling within three major operational categories:

1. Conditions at the downstream intersection are not severe enough to affect the upstream intersection.

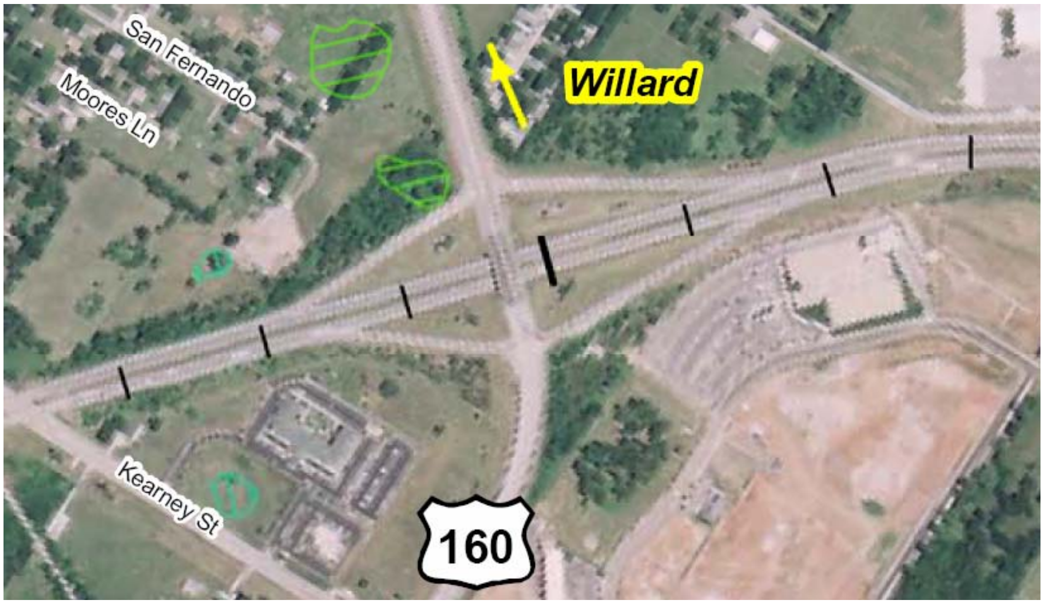
2. Queuing from the downstream intersection does not completely block the upstream discharge but reduces its rate due to the proximity of the back of the queue.
3. Queuing from the downstream intersection effectively blocks the discharge from the upstream signal during portions of its green period.

The effects of queuing on a diamond interchange ramp termini section can be affected by several factors, including the timing patterns of the signals on each end, the number of lanes of travel, available queue length, and number of turn lanes. Also, the proximity of other signalized intersections and the associated timing can affect ramp termini operations.

Also important to note is that the phasing of all the intersections is continuously iterative, and intersections can quickly go from functioning quite well to poorly.

The purpose of this evaluation was solely to evaluate these interchanges on a “typical” working day in order to make broad assumptions about their operation during the AM and PM peak periods. Adjustments for factors that can affect traffic such as time of season and weather were admittedly not taken into consideration. The three interchanges were observed from May 22 to May 24, 2007. The AM peak was observed from 6:00 AM to 9:00 AM. The PM peak was observed from 3:00 PM to 6:00 PM. The field work included selecting a random exiting vehicle to collect data from, recording the time of day, the direction of travel (turning north or south), the time that it took the vehicle to traverse from the ramp gore point through the ramp terminal, and if necessary, the time for the vehicle to travel through the second ramp terminal, and finally the time for the vehicle to clear the next signalized intersection north or south of the interchange. Miscellaneous comments were also recorded such as which vehicles encountered free flow conditions through the interchange or did not clear the queue at the ramp terminal.

Figure 2 Exit 75, Route 160



Exit 75, at Route 160, is a traditional diamond interchange. The eastbound exit ramp is a single lane facility approximately 850 feet in length. The eastbound ramp termini are an unsignalized intersection, as cross traffic does not stop. The westbound exit ramp is approximately 1150 feet in length total, but is divided up into separate turn lanes for the 425 feet near the termini. This intersection is signalized.

The ramp termini are spaced approximately 600 feet apart, slightly less than the 700 feet recommended by the MoDOT Engineering Policy Guide (EPG). There are four lanes of traffic between the ramp termini with an additional left turn only lane on each end.

This interchange serves as the I-44 exit for travelers headed to the Springfield-Branson National Airport.

AM Peak

- Westbound Exiting Traffic

During the AM Peak, the major movement observed was for I-44 westbound traffic exiting to move southbound into Springfield on Route 160. Generally, vehicles experienced little to no delay at the ramp termini while making a right turn. The westbound I-44 exit ramp experienced substantially higher volumes than the eastbound ramp. Most vehicles were proceeding southbound into Springfield on Route 160 with a left turn at the signal. Approximately one-third of the vehicles traveled northbound on Route 160 with a simple right hand turn. These vehicles experienced little queue and delay time.

The left turn movement experienced some queue lengths of up to four vehicles, but the queue cleared during every signal cycle. The travel time from ramp termini to ramp termini was constant; indicating the roadway segment between the ramp termini was functioning appropriately.

- Eastbound Exiting Traffic

The eastbound I-44 exit ramp traffic was extremely light and only experienced sporadic queuing of two to three vehicles to make a left turn. Generally, vehicles experienced little to no delay at the ramp termini while making a right turn. The travel time from ramp termini to ramp termini was constant; indicating the roadway segment between the ramp termini was functioning appropriately.

PM Peak

- Westbound Exiting Traffic

The westbound I-44 exit ramp traffic experienced an even split between southbound and northbound direction onto Route 160. Between 3:30 and 4:00, Route 160’s northbound volume increased noticeably, causing an increase in delay for vehicles making the right turn and an approximate 210 foot queue formed but cleared during the next recorded vehicle.

- Eastbound Exiting Traffic

The eastbound I-44 exit ramp experienced extremely low volumes as most of the traffic was moving southbound into Springfield on Route 160. Southbound Route 160's traffic was steady and the time from termini to termini was consistent, indicating a well functioning configuration.

Summary

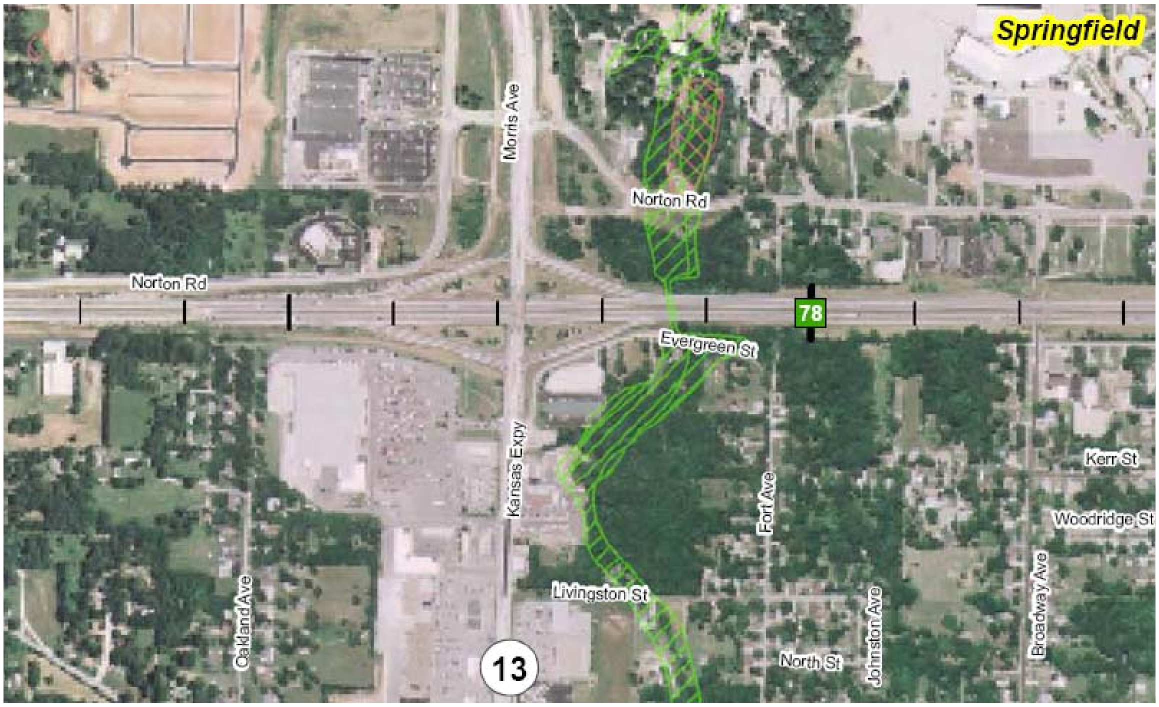
Based on the AM and PM peak evaluations on this day (May 23, 2007), the existing configuration and signal timing at this interchange appears to be working well.

TABLE 1

AM and PM Peak Evaluations for Interchange 75

Interchange Number	Time Period	Exiting Vehicle Direction	Number of Vehicles Recorded	Number of Vehicles not Passing Queue	Average Queue Length
75	AM	EASTBOUND	12	0	0'
75	AM	WESTBOUND	33	0	0'
75	PM	EASTBOUND	17	0	0'
75	PM	WESTBOUND	31	0	20'

Figure 3 Exit 77, Route 13



Exit 77, at Route 13, is a traditional diamond interchange configuration. The eastbound exit ramp is approximately 950 feet long and the last 300 feet is divided into two lanes, one for northbound Route 13 and one for southbound Route 13. There is a signal at the eastbound exit ramp termini. The westbound exit ramp is 1050 feet long and the last 500 feet is divided into two lanes and then further divides into three lanes, two for northbound Route 13 and one for southbound Route 13. There is a signal at the westbound ramp exit termini.

The ramp termini are spaced approximately 550 feet apart, which is less than the EPG recommended 700 feet. Route 13 has four lanes of through traffic, with a left turn lane in the middle, giving a total width of five lanes. To the north of the westbound termini approximately 700 feet is a signalized intersection that primarily services a big-box retailer. To the south of the eastbound ramp termini 315 feet is a signalized intersection, also primarily servicing a different big-box retailer. Given the proximity of these intersections, there are four traffic signals within a 0.3 mile segment.

AM Peak

- Westbound Exiting Traffic

Westbound traffic experienced a small delay during the heaviest volumes between 6:45 AM and 7:45 AM. Approximately 25 percent of the traffic went northbound on Route 13; the rest went southbound into Springfield. Northbound traffic experienced free flow speeds moving through the traffic signal. Traffic moving southbound experienced the greatest delays while on the exit ramp, and experienced free flow speeds through the other signals once making the turning movement. There were several times that the traffic signal did not allow the queue to clear completely for the southbound movement. Often, it took a signal cycle or two to clear. The signal cycle did not clear all traffic at approximately 6:50 am, 7:20 am, and 7:45 am. In these three instances, a commercial vehicle was traveling through the intersection at extremely low speeds, thus greatly reducing the number of vehicles that could have moved through during those signal phases. Queue lengths for the southbound movement were constant at 425 feet or roughly eight vehicles during the peak.

- Eastbound Exiting Traffic

During the AM peak at this interchange, eastbound traffic experienced little delay. The traffic movement was equally distributed between northbound and southbound onto Route 13. There was only one instance where the signal for northbound movement did not clear the entire queue (at approximately 8:00 am). The subsequent signal cycle cleared the queue. There was little to no queue experienced throughout the evaluation time period. The southbound movement was essentially free-flow, resulting in little delay for these vehicles.

PM Peak

- Westbound Exiting Traffic

Westbound traffic only experienced one queue event that did not clear for the southbound movement at approximately 5:00 pm. The southbound movement experienced an average queue of approximately 200 feet to 425 feet from 4:00 pm to 5:00 pm.

- Eastbound Exiting Traffic

Eastbound traffic experienced a peak of delay and queue length at approximately 5:30 pm. At this time, only one cycle phase on the northbound queue did not clear. Approximately 60 percent of the traffic was proceeding northbound. The southbound movement did not experience any consistent queuing, and experienced near free-flow speeds throughout the entire time frame.

Summary

The interchange was working at acceptable levels of service as observed by the study team. The close proximity of four traffic signals is less than desirable, but the signal timing appears to be maximized for optimum operations.

We note however, that this intersection appears to be operating at near capacity during both the AM and PM peak periods. The shear volume of traffic using the interchange, combined with the frequency of large commercial vehicles, notably caused queues to lengthen and delays to increase.

TABLE 2

AM and PM Peak Evaluations for Interchange 75

Interchange Number	Time Period	Exiting Vehicle Direction	Number of Vehicles Recorded	Number of Vehicles not Passing Queue	Average Queue Length
77	AM	EASTBOUND	26	1	2015’
77	AM	WESTBOUND	52	6	8075’
77	PM	EASTBOUND	39	1	50’
77	PM	WESTBOUND	50	1	60’

Figure 4 Exit 88, Route 125

Exit 88, at Route 125, near Strafford is a traditional diamond interchange. This interchange is the main access to Strafford from I-44. The eastbound exit ramp is 1325 feet in length, and is a single lane facility. The westbound exit ramp is 950 feet in length, and is a single lane facility. Neither of the ramp terminals is signalized. The ramp terminals are spaced 650 feet apart, slightly less than the EPG recommended 700 feet. Both north quadrants of the interchange serve either trucking terminals or large truck stops.

AM Peak

- Exiting Traffic

Truck activity at the interchange was noticeably higher during the early portions of the AM peak period. This included several trucks parked on shoulders of three ramps. The delays, however, were typically caused by trucks taking an unusually long time traversing through the interchange.

Between 7:15AM and 7:30AM, a noticeable increase in commuters traveling southbound on Route 125 to WESTBOUND I-44 was observed.

- Eastbound Exiting Traffic

During the AM peak, there was no observed delay for eastbound traffic exiting I-44. Approximately 66 percent of the traffic proceeded northbound during the AM peak.

- Westbound Exiting Traffic

Westbound exiting traffic experienced little to no delay. Approximately 75 percent of the vehicles exiting westbound I-44 proceeded northbound and experience very little

PM Peak

- Eastbound Exiting Traffic

During the PM peak. There were more observed delays for exiting eastbound traffic, largely due to the extra time associated with trucks maneuvering through an intersection from a stop. The average queue length was approximately 210 feet, or approximately two trucks. During this observation, approximately 66 percent of the vehicles exiting I-44 eastbound proceeded northbound on Route 125. Those vehicles that proceeded southbound experienced little delay.

- Westbound Exiting Traffic

Westbound traffic exiting I-44 experienced little to no delay while 63 percent of the traffic proceeded northbound. There was no queue length observed during the study time.

Summary

This interchange is functioning well within acceptable levels of service. Isolated delays occur when large trucks take extra time to clear the intersections. The effect of these delays was generally very short lived.

TABLE 3

AM and PM Peak Evaluations for Interchange 89

Interchange Number	Time Period	Exiting Vehicle Direction	Number of Vehicles Recorded	Number of Vehicles not Passing Queue	Average Queue Length
89	AM	EASTBOUND	35	0	10’
89	AM	WESTBOUND	29	0	0’
89	PM	EASTBOUND	51	0	150’
89	PM	WESTBOUND	35	0	40’

Interstate 44 (I-44) Purpose and Need Study: Climbing Lane Review (A-13)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	February 20, 2008
PROJECT NUMBER:	355821

Introduction

The I-44 corridor within Missouri is located through a rolling terrain. In some locations, the uphill grades are long and steep enough to cause heavy vehicles to slow down markedly, as compared to passenger cars. Separate, dedicated climbing lanes are often employed at uphill grades of 4 percent or greater, per HCM 20-8, to minimize the impairment of traffic flow by the slow moving trucks. The I-44 corridor climbing lanes are being evaluated because the average daily traffic is comprised of approximately 30 percent trucks. This high percentage of trucks impairs traffic flow on long uphill grades. Also, an increase in crashes is correlated to the running speed reduction of trucks compared to the running speed of all other traffic.

Uphill grades along I-44 that are steeper than 4 percent were evaluated to determine the need for climbing lanes, including locations where climbing lanes already exist. Climbing lanes have been constructed at eight locations along existing I-44 corridor under study — two eastbound and six westbound. This evaluation focused on the "critical length of grade" concept as defined in *A Policy on Geometric Design of Highways and Streets* (Green Book, AASHTO, 2004).

Critical Length Evaluation

Critical length of grade is the first criterion for evaluating the need for climbing lanes. A critical length of grade is "…the length of a particular upgrade that reduces the speed of low-performance trucks to 10 mph below the average running speed of the remaining traffic…." If the critical length of grade is less than the length of grade being evaluated, consideration of a climbing lane is warranted." (Green Book, page 245).

The relationship of speed reduction to length depends on the type of vehicle and its approach speed. Examples of these relationships for loaded heavy trucks and recreational vehicles are taken from the Green book and provided in the following exhibits, 3-59 and 3-60.

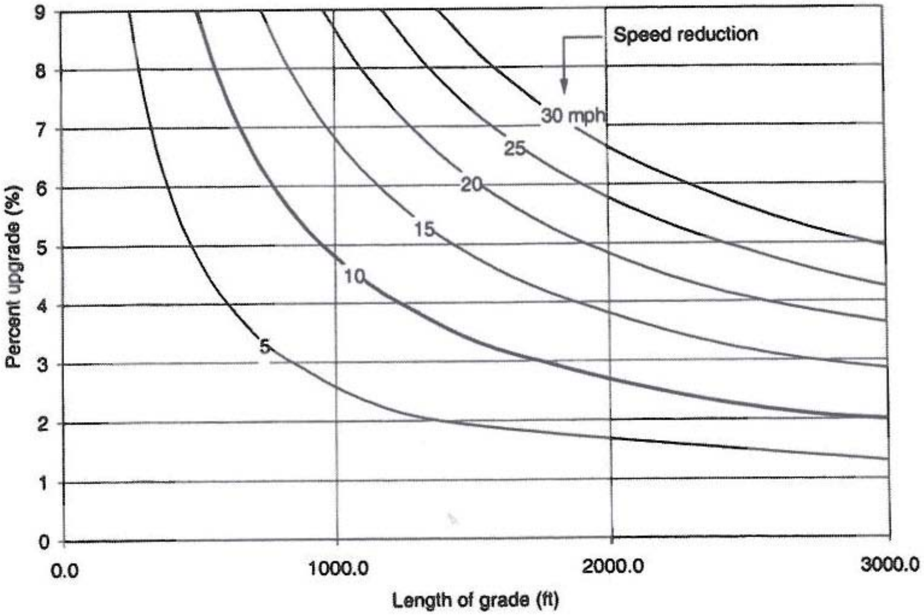


Exhibit 3-59. Critical Lengths of Grade for Design, Assumed Typical Heavy Truck of 120 kg/kW [200 lb/hp], Entering Speed = 110 km/h [70 mph]

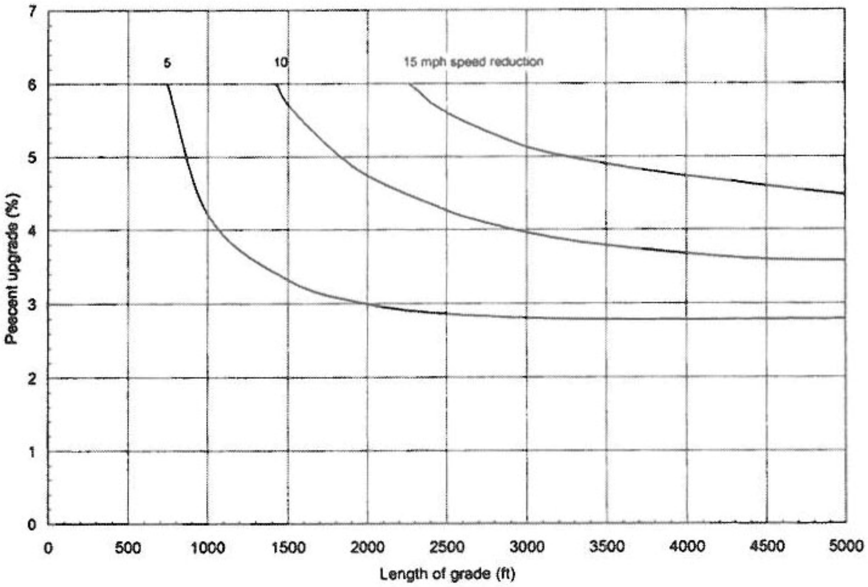


Exhibit 3-60. Critical Lengths of Grade Using an Approach Speed of 90 km/h [55 mph] for Typical Recreational Vehicle (40)

Exhibits taken from *A Policy on Geometric Design of Highways and Streets* ("Green Book," AASHTO, 2004).

All grades along existing I-44 that have an uphill grade of 4 percent or greater are shown in **Table 1**. Based on the critical lengths of grade curves provided by the Green Book for typical heavy trucks, a critical length was estimated for each location. An important factor to determining the critical length is the running speed of the vehicle approaching the climb. Thus, the affect of the grade of the highway approaching the climb, as it may affect heavy vehicle running speed, was also evaluated. The base free flow speed was taken from previously conducted traffic analysis.

TABLE 1

Existing Steep Uphill Grades (greater than 4 percent) along I-44 Corridor

Direction (EB/ WB)	**Grade**				**Approach Grade**		**Critical Length**		**Existing Climbing Lane**
	Beginning Mile Marker	**End Mile Marker**	**Slope (Percent)**	**Length (feet)**	**Slope (Percent)[a]**	**Grade Effect**	**Length (feet)**	**Length Present**	
EB	108.5	108.7	4.00	792	1.32	No	NA	No	No
EB	109.4	109.5	5.00	211	2.29	No	NA	No	No
EB	140.8	141.0	4.08	1056	-3.82	No	NA	No	No
EB	143.5	143.9	4.64	1848	0.30	No	NA	No	No
EB	**149.3**	**149.7**	**5.00**	**2059**	**1.07**	**Yes**	**473**	**Yes**	**No**
EB	152.1	152.2	5.00	158	-0.66	No	NA	No	No
EB	156.6	156.6	4.70	53	-4.00	No	NA	No	No
EB	**158.6**	158.8	**6.00**	**1162**	**0.00**	**No**	**760**	**Yes**	**No**
EB	159.1	159.1	6.00	106	1.00	No	NA	No	No
EB	159.4	159.5	6.00	634	1.44	No	NA	No	No
EB	**167.3**	**168.4**	**4.00**	**5755**	**0.00**	**No**	**1233**	**Yes**	**Yes**
EB	**169.4**	169.6	**5.00**	**686**	**1.20**	**Yes**	**533**	**Yes**	**No**
EB	**173.8**	174.6	**4.40**	**4171**	**0.00**	**No**	**1133**	**Yes**	**Yes**
EB	179.1	**179.3**	4.00	1003	-1.84	No	NA	No	No
EB	183.6	183.7	5.00	581	1.28	No	NA	No	No
EB	**184.7**	186.7	**4.13**	**10613**	**2.71**	**Yes**	**680**	**Yes**	**No**
EB	**194.0**	**194.2**	**4.00**	**1003**	**2.00**	**Yes**	**67**	**Yes**	**No**
EB	201.7	**201.7**	4.43	422	0.66	No	NA	No	No
EB	212.9	**213.0**	4.19	528	1.22	No	NA	No	No
EB	215.3	215.4	4.43	528	1.59	No	NA	No	No
EB	219.9	220.0	4.31	317	-2.76	No	NA	No	No
EB	**235.7**	**235.9**	**4.98**	**1056**	**-0.37**	**No**	**960**	**Yes**	**No**
EB	239.3	**239.4**	4.00	370	-5.00	No	NA	No	No
EB	240.0	240.1	4.00	528	-4.16	No	NA	No	No

TABLE 1

Existing Steep Uphill Grades (greater than 4 percent) along I-44 Corridor

Direction (EB/ WB)	Grade				Approach Grade		Critical Length		Existing Climbing Lane
	Beginning Mile Marker	End Mile Marker	Slope (Percent)	Length (feet)	Slope (Percent)[a]	Grade Effect	Length (feet)	Length Present	
EB	242.3	242.5	4.58	845	0.66	No	NA	No	No
EB	243.9	244.0	5.00	950	0.66	No	NA	No	No
EB	257.9	258.1	5.00	845	-5.00	No	NA	No	No
WB	95.7	95.8	5.00	211	3.00	No	NA	No	No
WB	**101.5**	**101.8**	**4.00**	**1531**	**1.67**	**Yes**	**607**	**Yes**	**No**
WB	**105.7**	**106.2**	**4.50**	**2482**	**0.00**	**No**	**1087**	**Yes**	**Yes**
WB	**107.9**	**108.1**	**5.00**	**1214**	**-1.32**	**No**	**960**	**Yes**	**Yes**
WB	142.8	142.8	5.00	475	2.5	No	NA	No	No
WB	**144.4**	**145.4**	**4.12**	**5386**	**-3.94**	**No**	**1193**	**Yes**	**No**
WB	150.9	151.1	4.00	950	0.57	No	NA	No	No
WB	151.7	151.7	5.00	53	0.66	No	NA	No	No
WB	**172.0**	**172.3**	**6.00**	**1954**	**4.00**	**Yes**	**0**	**Yes**	**Yes**
WB	**172.4**	**172.7**	**4.00**	**1478**	**1.00**	**No**	**1233**	**Yes**	**No**
WB	175.0	175.1	4.00	581	-3.25	No	NA	No	No
WB	182.2	182.2	6.00	317	-2.11	No	NA	No	Yes
WB	**190.1**	**190.7**	**5.00**	**2851**	**0.40**	**No**	**1788**	**Yes**	**No**
WB	213.8	213.9	4.74	634	-2.50	No	NA	No	No
WB	214.5	214.6	4.80	581	0.00	No	NA	No	No
WB	222.3	222.5	4.50	792	-1.42	No	NA	No	No
WB	234.7	234.7	4.56	211	-2.55	No	NA	No	No
WB	237.6	237.6	4.00	106	0.15	No	NA	No	No
WB	239.1	239.1	5.00	211	-4.00	No	NA	No	No
WB	239.8	239.8	4.16	475	-4.00	No	NA	No	No
WB	257.7	257.7	5.00	10	-5.00	No	NA	No	No

[a] A positive number denotes an uphill grade approaching the climb; a negative number denotes a downhill grade approaching the climb.

Bold denotes those slopes that satisfy the Critical Length of Grade criteria for a climbing lane.

These slopes are further analyzed in Table 2.I-44 mile markers are posted in an eastbound direction. Thus, westbound traffic flow experiences the mile markers from higher to lower. Because of this, the beginning mile marker is the ending mile marker and vice versa for westbound. Mile marker 172.0-172.3 shows a critical length of zero because the previous grade had already slowed the trucks down 10 mph. Thus, it had already reached its critical length before it hit the critical grade.

Out of 27 eastbound grades over 4 percent, 8 grades had critical length problems. Seven of the 21 westbound grades had critical lengths present. It is interesting to note that of the eight climbing lanes that currently exist along I-44, only five appear on **Table 1**. The others do not have slopes greater than 4 percent or no data was available about the slope. Additionally, there is one section (with an existing climbing lane that appears on **Table 1)** that did not meet the critical length of grade criterion for climbing lanes. This highlights the fact that, climbing lanes are warranted based on other factors, such as level of service or safety. Some of these factors are described in the Additional Climbing Lane Criteria section on page 7.

Uphill grades that were found to satisfy the critical length of grade criterion were qualitatively rated. This rating is summarized in **Table 2** and based on four criteria:

- **Slope:** All examined grades are 4 percent or greater in slope, with the highest slope reaching 6 percent. The greater the slope, the more likely it is that a truck's speed will be reduced. This relationship is shown by Exhibit 3-59 and 3-60. Thus, higher grades received a higher, more severe, qualitative rating.
- **Grade Length:** The greater the length of the climb, the more likely trucks will slow down enough to disrupt traffic. Therefore, longer grades received a higher qualitative rating due to the increased likelihood that trucks will slow down to a dangerous level.
- **Critical Length of Grade relative to Total Grade Length:** It was considered important to determine how much farther upslope a truck would need to travel after it had slowed by at least 10 mph. If the percentage of critical length to overall length is low, then the truck is more likely to have an effect on the level of service. In this situation, the truck would reach its slow speed lower on the grade and would still have the remaining grade to traverse, thereby causing the truck to continue to slow down and remain slow for a longer time. High percentages indicate that a truck would still reduce speed on the hill, but would be closer to the end of the steep grade, and therefore closer to the recovery speed, and would impair traffic movement for a shorter length of time. Thus, low percentages were rated more severe than higher percentages.
- **Affect of Approach Grade:** The approach grade has the potential to affect a vehicle's speed coming into the steep grade. Because of this, ratings have to be given to account for previous grade interference so that one gets a complete picture of the critical length. When this is the case, the critical length that was affected by the previous grade received a higher rating so that the actual distance that the truck had to take to reduce speed was not down played.

TABLE 2

Evaluation of Existing Steep Grades with Critical Lengths

Direction (Eastbound/ Westbound)	Grade				Approach Grade		Critical Length		Existing Climbing Lane?
	Beginning Mile Marker	End Mile Marker	Slope (Percent)	Length (feet)	Slope (Percent)	Grade Effect?	Length (feet)	Critical Length to Total Grade Length (Percent)	
EB	149.3	149.7	5.00	2059	1.07	Yes	473	23%	No
EB	158.6	158.8	6.00	1162	0.00	No	760	65%	No
EB	167.3	168.4	4.00	5755	0.00	No	1233	21%	Yes
EB	169.4	169.6	5.00	686	1.20	Yes	533	78%	No
EB	173.8	174.6	4.40	4171	0.00	No	1133	27%	Yes
EB	184.7	186.7	4.13	10613	2.71	Yes	680	6%	No
EB	194.0	194.2	4.00	1003	2.00	Yes	67	7%	No
EB	235.7	235.9	4.98	1056	-0.37	No	960	91%	No
WB	101.5	101.8	4.00	1531	1.67	Yes	607	40%	No
WB	105.7	106.2	4.50	2482	0.00	No	1087	44%	Yes
WB	107.9	108.1	5.00	1214	-1.32	No	960	79%	Yes
WB	144.4	145.4	4.12	5386	-3.94	No	1193	22%	No
WB	172.0	172.3	6.00	1954	4.00	Yes	0	0%	Yes
WB	172.4	172.7	4.00	1478	1.00	No	1233	83%	No
WB	190.1	190.7	5.00	2851	0.40	No	1788	63%	No

I-44 mile markers are posted in an eastbound direction. Thus, westbound traffic flow experiences the mile markers from higher to lower. Because of this, the beginning mile marker is the ending mile marker and vice versa for westbound.Mile marker 172.0-172.3 shows a critical length of zero because the previous grade had already slowed the trucks down 10 mph. Thus, it had already reached its critical length before it hit the critical grade.

Existing Climbing Lane Geometry

The geometry of the existing climbing lanes was compared to the Green Book guidelines. The climbing lane should extend beyond the crest of a hill far enough to allow a slow moving truck to recover to a speed that will allow it to return to the normal lane without interfering with other traffic. Typically, for a multilane highway, the climbing lane should extend 300 feet beyond the crest, with an additional 50:1 taper that is at least 600 feet long beyond that. **Table 3** is a summary of the existing climbing lanes and their geometries.

TABLE 3

Evaluation of Existing Climbing Lanes

Direction (Eastbound/ Westbound)	Beginning Mile Marker	Ending Mile Marker	Exiting Taper Ratio	Length Over Hill (feet)	Grade In (Percent)	Grade Out (Percent)
EB	166.8	168.1	50:1	1,483.70	0.00	4.00
EB	174.0	174.9	50:1	900.00	0.00	4.40
WB[a]	105.3	106.1	20:1	1,979.70	-0.60	3.58
WB[a]	107.3	108.3	20:1	1,700.00	-1.32	5.00
WB	164.5	165.6	50:1	2,035.80	No Data	No Data
WB[a]	171.8	172.3	21:1	4,030.00	4.00	6.00
WB	180.8	181.6	50:1	1,100.00	-2.80	3.60
WB	182.0	182.4	50:1	1,206.60	-2.11	6.00

[a] denotes those existing climbing lanes that do not meet the 50:1 exiting length to width ratio.

I-44 mile markers are posted in an eastbound direction. Thus, westbound traffic flow experiences the mile markers from higher to lower. Because of this, the beginning mile marker is the ending mile marker and vice versa for westbound.

All existing climbing lanes meet the minimum length of 300 feet over the crest of the hill. However, three of the eight climbing lanes do not meet the 50:1 exiting length to width ratio. This, of course, is a potential safety issue associated with evolving geometric standards. In general, insufficient exiting tapers are associated with elevated crash rates.

Additional Climbing Lane Criteria

In addition to critical length, climbing lanes can also be justified for other reasons. For multilane highways, these are generally associated with the effects of slow moving trucks on the level of service and for safety.

According to the Green Book, to justify a climbing lane without a critical length issue, the directional traffic volume for the uphill grade should be LOS D or lower. Also, “If the flow rate on the grade exceeds the service flow rate of the next poorer LOS, consideration of a climbing lane is warranted” (Green Book, Page 249).

Interstate 44 (I-44) Purpose and Need Study: Proposed Future Study Sections (A-14)

PREPARED FOR: MoDOT

PREPARED BY: CH2M HILL

ORIGINAL SUBMISSION DATE: February 3, 2008

REVISION SUBMISSION DATE: March 5, 2008

Introduction to I-44 Purpose and Need Study

Interstate 44 (I-44) extends 645 miles from St. Louis, Missouri to Wichita Falls, Texas. It is one of seven interstate highways serving the state of Missouri. In Missouri, I-44 runs diagonally from the state's southwest corner, near Joplin, and proceeds northeast to St. Louis[1]. The interstate was completed in the late 1960s and roughly follows the route of old U.S. Route 66.

In 2006, MODOT determined that I-44 would be best evaluated through a corridor-wide purpose and need study. This framework would allow MoDOT to establish the existing conditions and stage future improvements that are compatible with the ultimate framework of an improved facility. It would provide justification for spot improvements as well as be a planning tool for future projects. The transportation problems identified in the I-44 Purpose and Need Statement can be summarized as:

- Roadway capacity on I-44 is inadequate to accommodate expected future traffic demands.
- There is a widespread perception that the safety environment on I-44 is rapidly degrading.
- Demand for access to I-44 (interchange operation and spacing) exceeds supply.
- Increases in truck volumes are altering the operational characteristics on I-44.
- Roadway geometry varies widely across the I-44 corridor creating operational difficulties.
- I-44 affects the human and natural environment both positively and negatively.

Purpose of this Technical Memo

The extent of the transportation problems identified during the Purpose and Need Study vary across the corridor. For instance, while some areas along I-44 are urbanized, there are also large portions of the corridor that are rural. This variability in conditions drives

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[1] Following convention, I-44 will be discussed as running west to east.

the desire to categorize I-44 into zones that experience similar demands, have similar conditions, and might logically be viewed as proposed ″Future Study Sections ″ (FSSs). That is the subject of this technical memo.

The factors used to establish the FSSs discussed in this Technical Memo are defined in **Table 1**.

TABLE 1

Primary Factors used in the Establishment of the Proposed Future Study Sections

Jurisdictional Similarities	Roadways under common administrative or jurisdictional control are generally subject to common planning strategies and are, therefore, logical to group together. Among the jurisdictions considered were Metropolitan Planning Organizations (MPOs), various municipal jurisdictions such as counties, cities, and townships.
Traffic Volume Similarities	Roadways that handle similar volumes of vehicular traffic often have common problems whose solutions need to be considered collectively. Consequently, major breaks in traffic volumes were considered in the establishment of the FSSs.
Traffic Composition Similarities	Similarly, the types of vehicles that make up the traffic stream can influence problems and solutions. Common issues of this type include commuter traffic and truck traffic.
Traffic Destination Similarities	Incorporating the entire trip into a transportation solution is often key to adequately addressing it.
Landscape Similarities	On a statewide scale, there can often be important terrain differences to consider. Addressing these challenges in a comprehensive way can have benefits in the design, construction, and maintenance cycle as well as maximizing driver expectations regarding roadway design.
Crash Hotspot Similarities	Generally, there are three elements to safe roadway design: traffic, geometrics, and crashes. The crash hotspots were utilized in determining the FSSs, as a means for determining the origin of vehicular safety issues.
Roadway Condition Similarities	Roadways are under continual maintenance. Grouping roadway sections in ways that acknowledge the existing condition of the roadway and the future maintenance projects can maximize the effectiveness of public expenditures. Operational similarities such as common speed limit and design features are also important.

Regulatory Setting—Major Projects

The Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU) made several important changes to the requirements associated with Major Projects. One of these changes is that the Federal Highway Administration (FHWA) will expand its role in the management of Major Projects. For Major Projects, FHWA is not limiting its role to tracking progress and ensuring Title 23 compliance. Rather, FHWA is developing mechanisms to allow its staff to focus its skills, talents and experiences to strengthen the state transportation agency's (STA) decision making. The scope of this FHWA role is still emerging.

The new threshold for Major Projects are those projects receiving Federal financial assistance with an estimated cost of at least $500 million or as a result of special interest has been identified by the Secretary of Transportation as being "Major". Because of the length of I-44 through Missouri, the costs associated with addressing its transportation problems will almost certainly satisfy the new threshold for being a Major Project.

Relative to this purpose and need study, an exception to Major Project status may exist if the "NEPA-defined" project scope is comprised of distinct and operationally independent elements. FHWA may determine that each separate, operationally independent and non-concurrent phase of construction be defined as separate "projects" for the purpose of assigning Major Project status. Consequently, as a pre-NEPA study, the investigation of independent elements is an appropriate topic for consideration in the I-44 Purpose and Need Study.

Regulatory Setting—Logical Termini

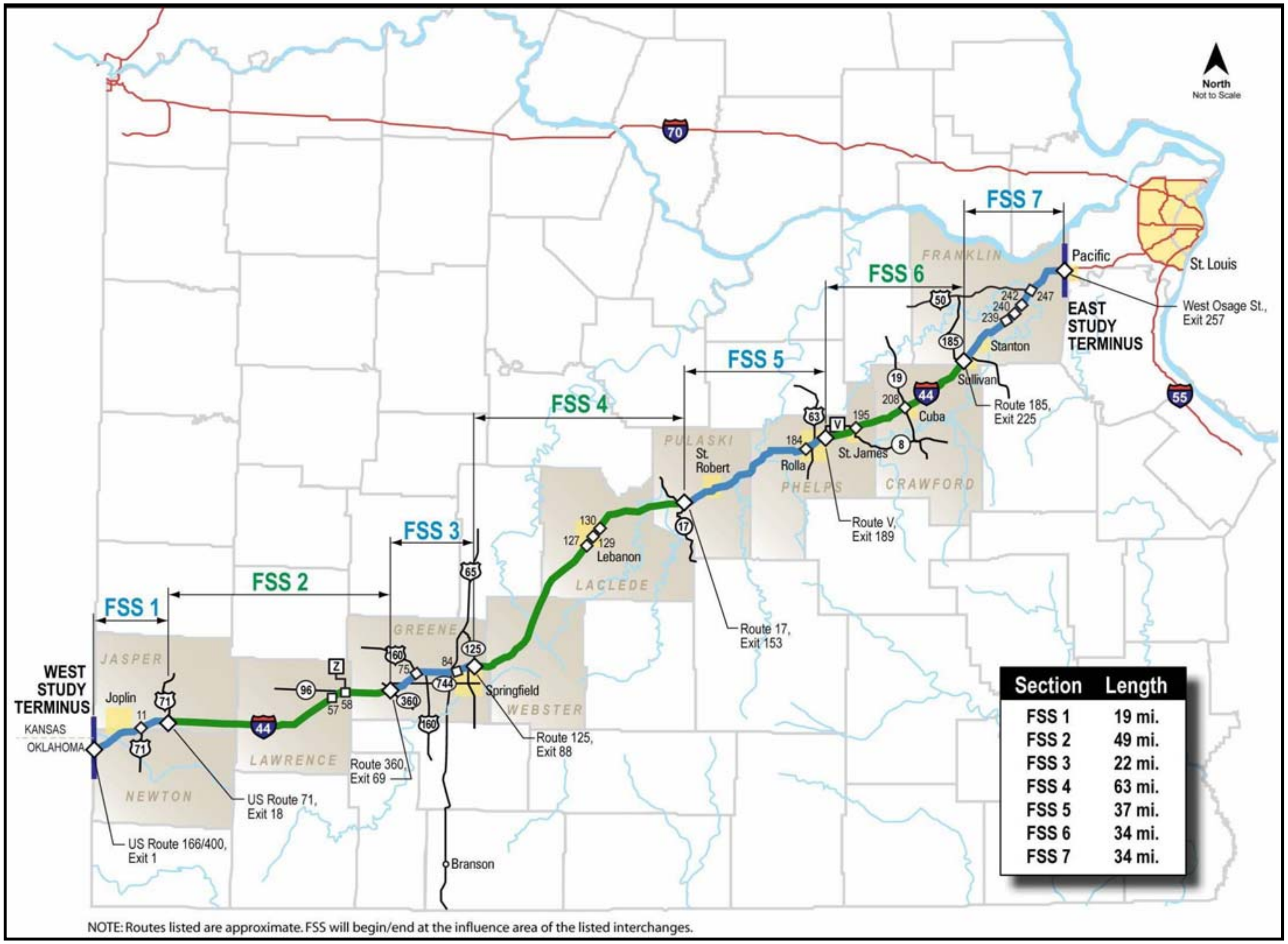
Guidance for the development of these FSSs is provided in *The Development of Logical Project Termini* (FHWA, November 1993). FHWA regulations (23 CFR 771.111(f)) require that the action evaluated in each environmental impact statement or finding of no significant impact shall:

- Connect logical termini and be of sufficient length to address environmental matters on a broad scope.
- Have independent utility or independent significance. For example, be usable and be a reasonable expenditure even if no additional transportation improvements in the area are made.
- Not restrict consideration of alternatives for other reasonably foreseeable transportation improvements.

The logical termini for the overall I-44 Purpose and Need Study have been established on the west as near Exit 1, just east of the Missouri and Oklahoma State line and on the east as near Exit 257, just west of the Franklin and St. Louis County line. The establishment of the overall study’s termini is the subject of a separate technical memo.

Within the study area for the I-44 Purpose and Need Study, data collection included traffic projections, roadway conditions, crash analyses, operational assessments, future use projections, environmental data collection, and various functional analyses. Using the data derived from the I-44 Purpose and Need Study, the FHWA guidance on independent utility, logical termini and major projects it was possible to identify areas along I-44 where problems, conditions and needs were demonstrably similar. These areas might logically be considered FSSs.

Figure 1
I-44 Proposed Future Study Sections – With Referenced Roads and Interchanges Shown



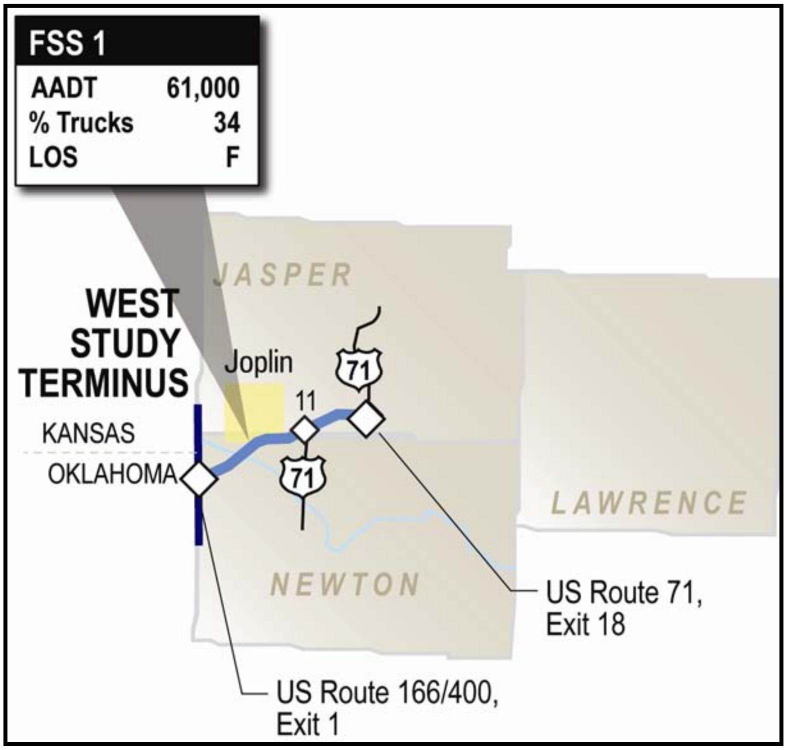
Section	Length
FSS 1	19 mi.
FSS 2	49 mi.
FSS 3	22 mi.
FSS 4	63 mi.
FSS 5	37 mi.
FSS 6	34 mi.
FSS 7	34 mi.

NOTE: Routes listed are approximate. FSS will begin/end at the influence area of the listed interchanges.

Western Terminus to East of Joplin (FSS 1)

The first proposed FSS begins at the I-44 Purpose and Need Study's western termini, Exit 1, U.S. Route 166/400 near the Oklahoma and Missouri State Line and extends approximately 19 miles eastward to Exit 18, U.S. Route 71 North.

Figure 2
FSS 1 with Two-Way 2035 Traffic Characteristics



This section of I-44 includes all of the Joplin area. It also includes a portion of U.S. Route 71, a major north-south route. Interstate 44 also carries the U.S. Route 71 designation between Exit 11 and Exit 18.

Currently, traffic volumes are constant, throughout this FSS, at approximately 31,000 annual average daily traffic (AADT). Volumes decrease by approximately 20 percent to the east of Exit 18. Directionally, traffic volume is distributed equally between eastbound and westbound. Overall, approximately 30 percent of the traffic stream is composed of trucks. For comparison, **Figure 2** includes predicted 2035 traffic conditions.

Geometrically, this FSS has three standard diamond interchanges, two regular cloverleaf interchanges, a cloverleaf interchange with one directional ramp, and a modified "T" interchange that only allows limited access. The three cloverleaf interchanges are identifiable crash hotspots. Additionally, the severity of crashes, within the weave areas of the cloverleaf sections, is notable. The terrain is relatively flat and the alignment is straight. There are no significant alignment issues in need of attention.

This portion of I-44 will be strongly influenced by the future growth and expansion of Joplin. The rapid planned and expected growth in the Joplin light industrial business community is a factor through this area. Another issue is the MoDOT proposal to upgrade U.S. Route 71 to an interstate facility connecting Arkansas to Kansas City. The exact route of this facility is unknown, especially in the Joplin area. This improvement could warrant a system interchange.

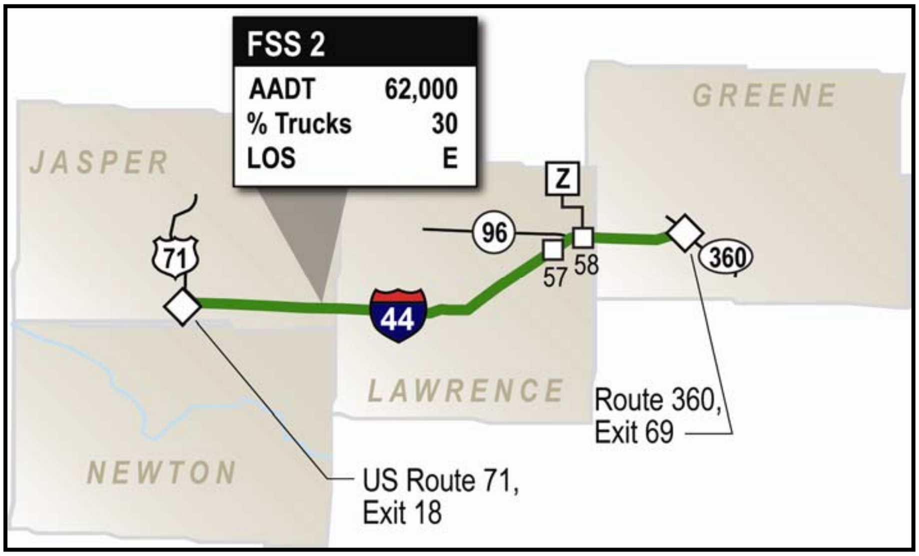
TABLE 2
Summary of Factors used in the Establishment of FSS 1

Jurisdictional Similarities	Incorporates the Joplin Area Transportation Study Organization.
Traffic Volume Similarities	Consistently high volumes — AADT approximately 31,000 (2005).
Traffic Composition Similarities	30 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Major destinations include: Joplin area, north-south via U.S. Route 71 and east-west via I-44.
Landscape Similarities	Completely contained within the gentle topography of the Springfield Plateau.
Roadway Condition Similarities	Crash rates highly correlated to close spacing of interchanges and the resultant designs caused by spacing.

Between Joplin and Springfield (FSS 2)

The second proposed FSS begins at Exit 18, U.S. Route 71, and extends approximately 49 miles eastward to Exit 69, Route 360, also known as the James River Freeway. This portion of I-44 is the rural section between Joplin and Springfield. There are no major urbanized areas within this section.

Figure 3
FSS 2 with Two-Way 2035 Traffic Characteristics



In this area, current traffic volumes vary between approximately 28,000 and 33,000. Overall, 52 percent of vehicle travel is westbound. The largest fluctuation in volume along this portion of I-44 is at Exit 57, Route 96. East of Route 96, traffic volumes on I-44 are approximately 18 percent higher than west of Route 96. Currently, approximately 30 percent of the overall traffic stream is composed of trucks. For comparison, **Figure 3** includes predicted 2035 traffic conditions.

Geometrically, this section is flat and has no major alignment issues. There are 10 standard diamond interchanges, all rural in nature. There is a nonstandard interchange, Exit 57 that services Route 96. This interchange only serves westbound I-44 traffic traveling westbound on Route 96 and eastbound Route 96 traffic traveling eastbound on I-44. Another nonstandard interchange exists at Exit 58, Route Z, near Halltown. This structure has some tight radius loop ramps with short acceleration and deceleration lanes.

There are numerous crash hotspots in this area. Most are associated with the two nonstandard interchanges. These conditions affect both eastbound and westbound traffic. Since these two interchanges are so close together, it is unclear whether a single factor creates the difficulties.

Another common element in this area is that based on input from land use forums conducted with local planning partners, minimal development is expected to occur within this area.

TABLE 3

Summary of Factors used in the Establishment of FSS 2

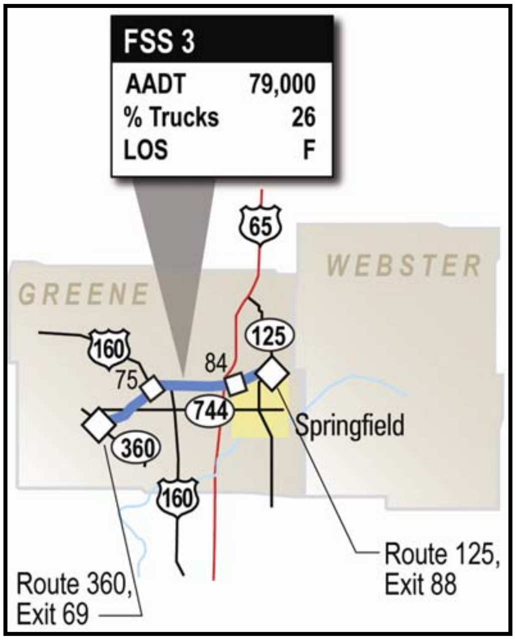
Jurisdictional Similarities	Incorporates the numerous rural communities between Joplin and Springfield.. Includes all of Lawrence County.
Traffic Volume Similarities	Average volumes - AADT approximately 28,000 (2005).
Traffic Composition Similarities	30 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Major destinations include: Joplin area and points west via I-44.
Landscape Similarities	Completely contained within the gentle topography of the Springfield Plateau.
Roadway Condition Similarities	Long stretches of rural highway punctuated with interchanges designed for very low volumes of users.

Springfield (FSS 3)

The third proposed FSS begins at Exit 69, Route 360, the James River Freeway, and extends approximately 22 miles eastward to Exit 88, Route 125, near Strafford. This portion of I-44 encompasses all of the city of Springfield.

There is a reduction in speed through much of Springfield due to the mandated speed reduction (MoDOT design guidelines) for urban areas, as well as the close spacing of interchanges. While each end of this FSS is currently primarily rural, the transition to an urban configuration is clearly occurring. This section also includes a major north-south route, U.S. Route 65, which services the popular tourist destination of Branson, Missouri.

Figure 4
FSS #3 with Two-Way 2035 Traffic Characteristics



Currently, traffic volumes through this portion of I-44 vary greatly, with the highest volumes found in the city of Springfield. The eastern portion (from Exit 69, Route 360 to Exit 75, U.S. Route 160) has an average AADT of approximately 31,000, with 53 percent of vehicles traveling westbound. From Exit 75, U.S. Route 160 to Exit 84, Route 744, the average AADT is approximately 55,700 with 53 percent of vehicles traveling eastbound. This is an increase in overall traffic volume on I-44 by 80 percent. Traffic volume from Exit 84, Route 744 to Exit 88, Route 125 has an average AADT of approximately 35,900 with an even number of vehicles traveling each direction. Overall, approximately 30 percent of the traffic stream is composed of trucks. For comparison, **Figure 4** includes predicted 2035 traffic conditions.

This portion of I-44 contains five regular diamond interchanges, one trumpet style "T" interchange, one irregular diamond interchange, two cloverleaf interchanges and one single entrance ramp, near the airport. The cloverleaf interchanges experience crash patterns commonly seen in urbanized areas. Some of these crash hotspots are considered severe. Currently, one of the cloverleaf interchanges is under construction for modification to include at least one directional ramp. The other cloverleaf interchange is under design to be converted to a diamond interchange. The average spacing between the Springfield interchanges is roughly two miles. While this is a somewhat tight spacing it is not accompanied by identifiably high crash rates.

The entire Springfield area is continuing to develop and expand. This proposed FSS is intended to encompass all of I-44 predominately influenced by Springfield.

TABLE 4
Summary of Factors used in the Establishment of FSS 3

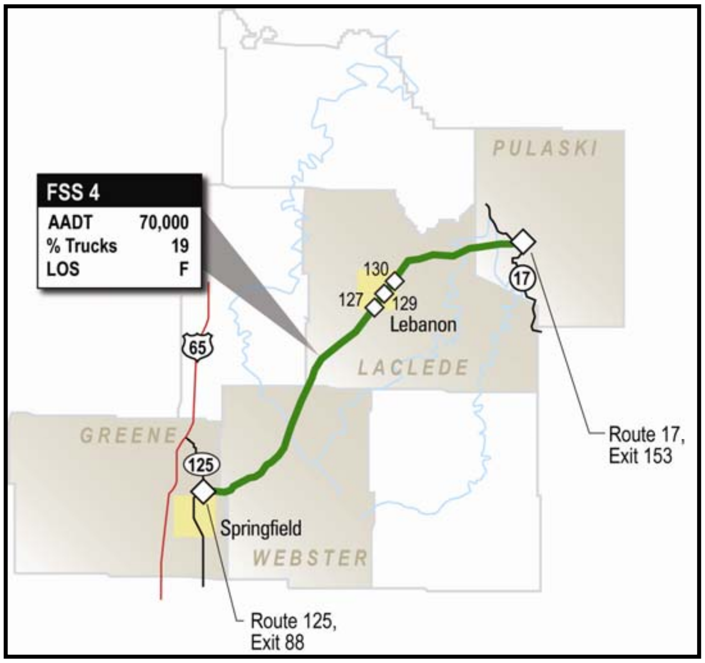
Traffic Volume Similarities	Average volumes - AADT approximately 43,000 (2005).
Jurisdictional Similarities	Incorporates the Springfield Area Transportation Study Organization (SATSO). Includes much of Greene County/
Traffic Composition Similarities	30 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Major destinations include the Springfield area and Branson via Route 65.
Landscape Similarities	Completely contained within the gentle topography of the Springfield Plateau.
Roadway Condition Similarities	Evolving and urbanizing infrastructure.

Lebanon (FSS 4)

The fourth proposed FSS begins at Exit 88, Route 125, and extends approximately 63 miles eastward to Exit 153, Route 17. This portion of I-44 is primarily rural in nature. The largest city along this portion of I-44 is Lebanon. There are three Lebanon Exits: 127, 129, and 130.

Traffic volumes decline outside of Springfield. Currently, from Exit 88, Route 125, to Exit 127, West Elm Street, the average AADT is 28,000, with an even distribution between eastbound and westbound travel. From Exit 127, West Elm Street, to Exit 130, Millcreek Road, the average AADT is 37,700 with 52 percent of traffic volume traveling eastbound. From Exit 130, Millcreek Road, to Exit 153, Route 17, the average AADT is 25,000, with an even distribution of eastbound and westbound travel. Overall, approximately 30 percent of the traffic stream is composed of trucks. For comparison, **Figure 5** includes predicted 2035 traffic conditions.

Figure 5
FSS 4 with Two-Way Traffic Characteristics



This portion of I-44 contains 12 typical diamond interchanges. The topography is increasingly that of a rolling terrain. Vertical curvature is an issue throughout the entire section, and many grades are steep and long when compared to design guidelines. Horizontal alignment has many curves that do not meet current design recommendations, and they are often coupled with vertical alignment issues.

Crash rates increase in the vicinity of Lebanon. Severe crashes near the Lebanon interchanges are common. Additionally, growth is expected in the vicinity of Lebanon. For example, efforts are currently underway to increase industrial park development on properties near I-44. Nevertheless, the commonalities in traffic volumes, terrain and destinations support the inclusion of Lebanon into this proposed FSS.

TABLE 5

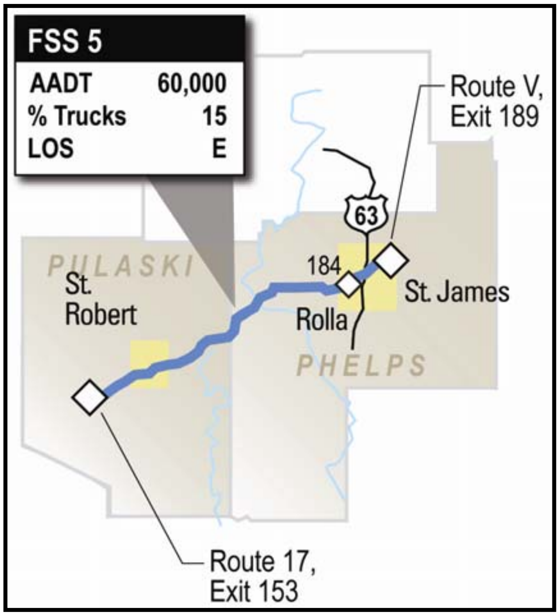
Summary of Factors used in the Establishment of FSS 4

Jurisdictional Similarities	Incorporates the rural communities between Springfield and Waynesville/St. Robert. Contains all areas influenced by Lebanon.
Traffic Volume Similarities	Average volumes - AADT approximately 28,000 (2005).
Traffic Composition Similarities	30 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Typical rural traffic and destination pattern.
Landscape Similarities	Outside the Springfield Plateau the terrain, as typical of the Ozark Uplands, becomes noticeably hillier.
Roadway Condition Similarities	Long stretches of rural highway punctuated with interchanges designed for very low volumes of users.

Waynesville/St. Robert, Rolla and Fort Leonard Wood (FSS 5)

The fifth proposed FSS begins at Exit 153, Route 17, and extends approximately 37 miles eastward to Exit 189, Route V. This portion of I-44 contains two urbanized areas interspersed with rural areas. The first urbanized area is Waynesville/St. Robert which is located near the western end of this portion of I-44. Near the eastern end of this proposed FSS, Rolla is the other urbanized area.

Figure 6
FSS 5 with Two-Way 2035 Traffic Characteristics



In the vicinity of Rolla, U.S. Route 63 crosses I-44 and provides access to Jefferson City and Columbia to the north.

Between these two areas, the corridor is rural in nature. Fort Leonard Wood is located within this FSS, near the Waynesville/St. Robert area.

Current traffic volumes are constant throughout the section from Exit 153, Route 17 to Exit 184, Kings Highway Street, at an AADT of approximately 30,000 with an even distribution of traffic volume eastbound and westbound. For comparison, **Figure 6** includes predicted 2035 traffic conditions.

In the Rolla area, from Exit 184, Kings Highway Street, to Exit 189, State Highway V, and current AADT is approximately 37,000, with 53 percent traveling eastbound. This is an approximate 29 percent increase in volume on I-44 in this section.

Overall, approximately 30 percent of the current traffic stream is composed of trucks.

There are 12 regular diamond interchanges in this FSS. This section has the most diverse topography in the study corridor. This area has a high concentration of vertical curves that do not meet design guidelines, and most of the horizontal alignment does not meet design guidelines. Often the horizontal and vertical geometry deficiencies are combined.

Throughout this section, I-44 experiences higher than average crash rates, both eastbound and westbound. Additionally, there are numerous localized crash hotspots.

TABLE 6
Summary of Factors used in the Establishment of FSS 5

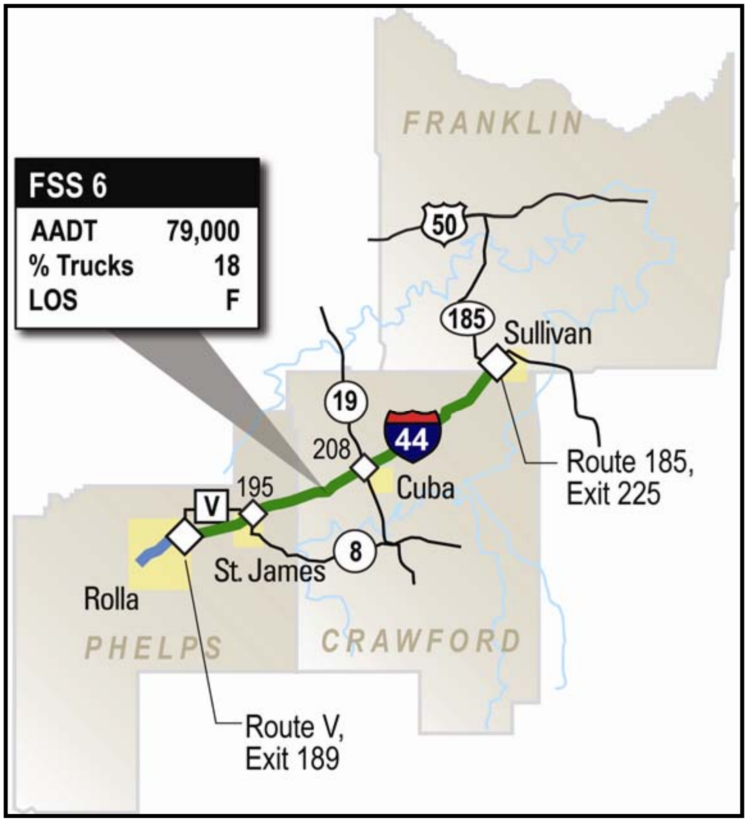
Jurisdictional Similarities	Incorporates the inter-related communities of Waynesville/St. Robert, Fort Leonard Wood and Rolla.
Traffic Volume Similarities	Average volumes — AADT approximately 30,000 (2005).
Traffic Composition Similarities	30 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	The inter-related communities of Waynesville/St. Robert, Fort Leonard Wood and Rolla form a consolidated set of destinations.
Landscape Similarities	Typical rugged topography of the Ozark Uplands.
Roadway Condition Similarities	Alignment deficiencies and crash issues permeate the entire section.

Between Rolla and Sullivan (FSS 6)

The sixth proposed FSS begins at Exit 189, Route V and continues approximately 34 miles eastward to Exit 225, Route 185. This portion of I-44 is primarily rural in nature with two communities along I-44, Saint James, located at Exit 195 (Route 8) and Cuba located at Exit 208 (Route 19).

Current traffic volumes are constant throughout this section, and the average AADT is 32,000, with an even distribution of traffic volume eastbound and westbound. Overall, approximately 30 percent of the traffic stream is composed of trucks. For comparison, **Figure 7** includes predicted 2035 traffic conditions.

Figure 7
FSS 6 with Two-Way 2035 Traffic Characteristics



This portion of I-44 has six standard diamond interchanges and some localized areas with vertical curvature and vertical grade deficiencies.

There are no corridor-wide crash issues associated with this section, however there are several localized crash hotspots, and these locations often correlate with the areas of problematic vertical curvature.

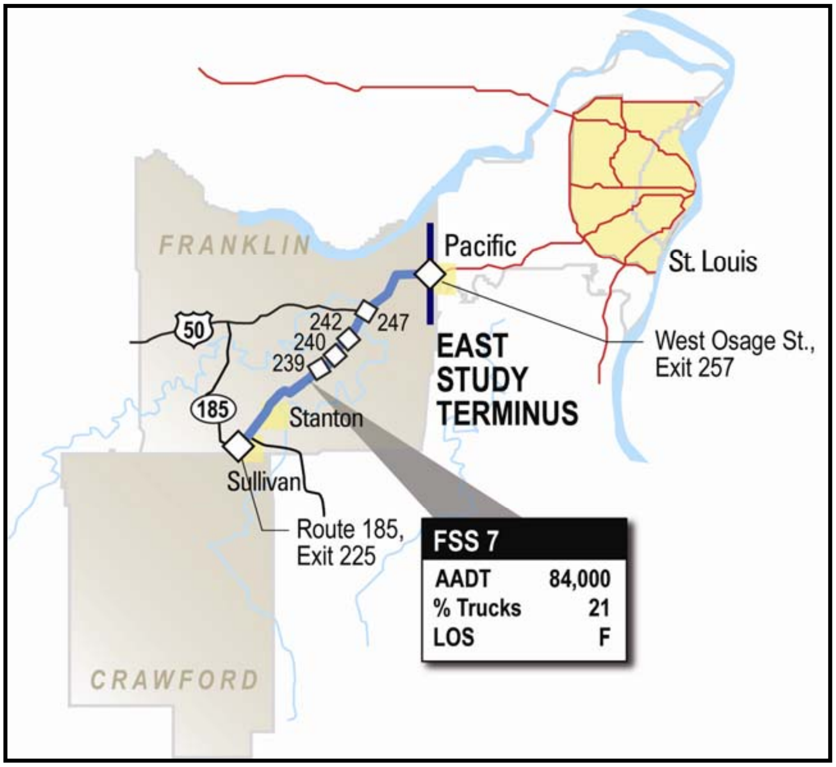
TABLE 7
Summary of Factors used in the Establishment of FSS 6

Jurisdictional Similarities	Incorporates the rural communities outside the influence of St. Louis.
Traffic Volume Similarities	Average volumes - AADT approximately 32,000 (2005).
Traffic Composition Similarities	30 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Rural traffic and destination pattern, outside of the influence of St. Louis.
Landscape Similarities	Predominantly consists of the rolling plains topography of the Ozark Uplands.
Roadway Condition Similarities	Long stretches of rural highway punctuated with diamond interchanges.

Sullivan to East Terminus (FSS 7)

The seventh FSS begins at Exit 225, Route 185, and continues eastward approximately 34 miles to Exit 257, the Business Loop 44 (Historic Route 66) interchange in the City of Pacific. The east terminus is approximately 1.5 miles west of the Franklin County and St. Louis County line.

Figure 8
FSS 7 with Two-Way 2035 Traffic Characteristics



This section is primarily rural in nature, but is transitioning to suburban and urban uses particularly at the east end. The most notable communities along I-44 are Saint Clair, which uses Exits 239, 240, and 242 and Pacific, 1.5 miles east of the Franklin County and St. Louis County line. U.S. Route 50 connects with I-44 at Exit 247. U.S. Route 50 provides access to Jefferson City and Kansas City.

Traffic volumes vary along this portion of I-44. Current traffic volumes from the west end of this FSS to Exit 247 (U.S. Route 50) are approximately 32,900 AADT, with 52 percent of all vehicles traveling westbound. From Exit 247 to the eastern limit of this section, current traffic volumes increase approximately 38 percent to 45,500 with an even distribution of traffic volume eastbound and westbound. Overall, approximately 30 percent of the current traffic stream is composed of trucks. For comparison, **Figure 8** includes predicted 2035 traffic conditions.

This proposed FSS is the only section of the I-44 corridor where LOS is consistently poor. This section generally functions at LOS D.

This section has nine standard diamond interchanges and one “T” interchange with a Directional-Y configuration. This section has a few localized areas with vertical and horizontal alignment deficiencies.

Crash rates are an issue throughout this section; the result of rapid change as much as from the traffic volumes or geometric issues. Nevertheless, there are also hotspots associated with vertical or horizontal alignment geometric issues.

This section of I-44 is closely linked to the St. Louis Metropolitan Region and is likely to continue to grow and urbanize.

TABLE 8

Summary of Factors used in the Establishment of FSS 6

Jurisdictional Similarities	Incorporates all of Franklin County and all of the I-44 study area within the East-West Gateway Coordinating Council (St Louis's MPO).
Traffic Volume Similarities	Average volumes — AADT approximately 39,000 (2005).
Traffic Composition Similarities	30 percent of traffic composed of trucks (2005).
Traffic Destination Similarities	Major component of the St. Louis Metropolitan Region.
Landscape Similarities	The rapidly urbanizing nature of this area is its most prominent defining feature.
Roadway Condition Similarities	Alignment deficiencies and crashes permeate the entire section.

The logical eastern terminus for the I-44 Purpose and Need Study was established at Exit 257 for the following reasons:

- I-44 transitions from a four-lane rural section to a 6-lane urban section creating a natural separation in the geometry of the roadway when traveling from the west to the St. Louis Metropolitan Region.
- Traffic volumes change markedly at this location. Traffic volumes in Franklin County (located within the area of the proposed east terminus) range from 34,000 to 52,000 ADT while traffic volumes in St. Louis County (located outside of the east terminus) range from 60,000 to 122,000 ADT. In addition, this interchange is a notable traffic generator serving Historic Route 66 and surrounding development in the City of Pacific.
- This interchange is roughly at the boundary of Franklin and St. Louis Counties.

Interstate 44 (I-44) Purpose and Need Study: Travel Modeling Summary (A-15)

PREPARED FOR:	MoDOT
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	March 18, 2008
PROJECT NUMBER	355821

As part of the I-44 Purpose and Need Study and assessment, traffic forecasts for a range of vehicle types were developed. First, model projections for an existing baseline condition (year 2000) were made to establish and refine estimated vs. actual traffic volumes specifically in the I-44 corridor. Second, parallel forecasts were developed for the corridor representing a horizon year of 2035. All forecasts produced were based on the Missouri Statewide Travel Model (MOSM) and project specific adjustments made to the procedures and assumptions used in that model. These adjustments and procedures have been documented extensively in supporting technical memoranda and notes. Relevant supporting documents are included at the end of this overview.

The purpose of this document is to summarize the process used for modeling the corridor and to provide citations for references to more detailed supporting documents.

Context and Baseline Development

Per direction from MoDOT, the previously developed MOSM travel model and associated data files and assumptions were used as the basis for all forecasts. Application of this model uncovered certain problems and inconsistencies using the model to forecast specifically for I-44 and connecting facilities and ramps. To address this issue, a supplemental procedure was developed to utilize the **adaptive traffic assignment** to adjust the input origin-destination tables to better match observed roadway volumes. Due to numerous fluctuations both for annual and for specific segment volumes, counted volumes to be matched were smoothed along the corridor to better represent known traffic conditions. Both the volume smoothing process and the adaptive traffic assignment process were applied on a vehicle class and time period specific basis using category stratifications assumed in the MOSM. More detailed documentation of supplemental adjustments and methodology used is provided in the attached supporting materials. The methodology and traffic count adjustment procedures and outcomes were developed and reviewed jointly with MoDOT traffic planning staff.

As part of developing a reliable baseline, model network and development assumptions in the vicinity of I-44 were reviewed for consistency with known conditions and reasonableness. Minor adjustments were made to the network to better reflect actual roadway and interchange configurations.

Utilizing the procedures and input datasets described above, an initial set of baseline (year 2000) projections were developed and compared to the "smoothed" traffic count data in the I-44 corridor. Using this process, the baseline modeling process was validated for application in making future forecasts.

Alternative Forecasting

The initial 2035 forecasts were based on a process of merging MOSM estimates of travel growth and the established baseline origin-destination tables developed through the adaptive traffic assignment model. This was done by:

- Calculating the expected trip growth for each origin-destination interchange in the MOSM model as the difference between the estimated 2035 trips and the baseline 2000 trips by vehicle class and time of day period
- Calculating the growth factor representing the percentage of expected growth from 2000 to 2035 as predicted by the MOSM
- Multiplying that factor times the project's 2000 adjusted baseline origin-destination tables to develop the adjusted 2035 origin-destination interchange volumes

The comparative traffic growth by vehicle class as predicted directly by MOSM and by the procedure described above is shown in Table 1.

TABLE 1 SUMMARY GROWTH STATISTICS

MOSM vs. Growth Factored "Adjusted" Trip Tables

Missouri Statewide Travel Model			
Vehicle Mode	**2000**	**2035**	**Average Annual Growth**
Medium Trucks	480,162	623,665	0.854 percent
Heavy Trucks	173,210	225,514	0.863 percent
External	128,315	158,991	0.683 percent
Auto & Light Truck	17,640,679	21,916,752	0.693 percent
Total	18,422,366	22,924,922	0.698 percent
Re-estimated Model Trip Tables	**2005**	**2035**	
Medium Trucks	477,190	610,717	0.933 percent
Heavy Trucks	225,381	275,363	0.739 percent
External	127,995	156,023	0.730 percent
Auto & Light Truck	17,749,577	21,444,476	0.694 percent
Total	18,580,143	22,486,579	0.701 percent

Initial reviews of the I-44 corridor traffic volumes were significant under prediction of expected growth in the corridor when compared to MoDOT trend based forecasts.

Discussions with MoDOT staff resulted in a modified process to forecast the expected future traffic. The MoDOT trend forecasts were used to generate “threshold” volumes for selected links along I-44. The origin-destination growth-based tables were then adjusted to match expected growth along these segments. This process was applied iteratively until the best fit was obtained. Following these adjustments, the standard MOSM traffic assignment model and procedures were used with the 2035 adjusted triptables to generate new traffic volumes in the corridor.

Relevant supporting documents for the travel modeling efforts are provided on the following pages.

Interstate 44 (I-44) Purpose and Need Study: Methodology for Developing Baseline (2005) Traffic Projections Using MoDOT's Statewide Traffic Model

PREPARED FOR: MoDOT
PREPARED BY: CH2M HILL
DATE: August 29, 2007
PROJECT NUMBER: 355821

A review of available traffic count data has uncovered a number of discrepancies which limit direct application in the I-44 Purpose and Need Study.

1. In a number of locations, AADT volumes for both total and commercial vehicles show significant directional differences and skewing. The nature of a 4-step travel demand model is that this skewing cannot be duplicated when making daily traffic projections. To address this, directional splits in the corridor are assumed to be equal with 50 percent of all vehicles on parallel segments in each direction. This situation is assumed for both auto and commercial traffic.
2. Although overall growth of traffic in the corridor is consistent with expected annual growth rates (about 1.8 percent per year), individual segments range from negative growth of 5 percent per year to positive growth of up to approaching 8 percent per year when comparing count data from 2005 to parallel count data from 2000. Data for immediate years shows considerable variation in annual growth fluctuations.
3. The proportion of commercial vehicles (i.e. trucks) shown on connecting segments of I-44 varies significantly along the length of the corridor.

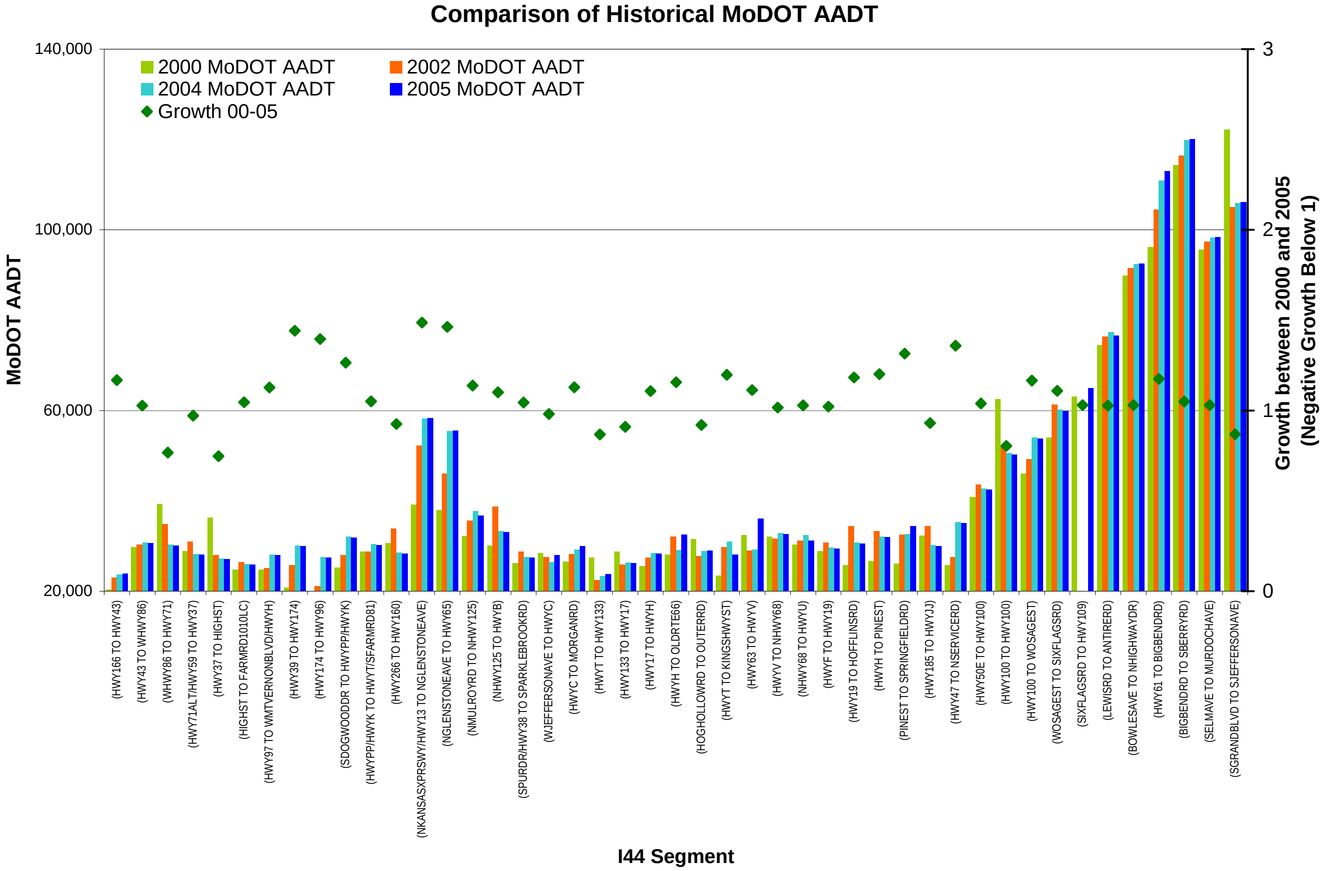
While some variations can normally be expected due to the different roles and usage rates of interchanges, a revised methodology has been developed to provide volume estimates which will support the necessary operational and design analysis associated with this project. The goal of the methodology is to reflect significant growth along specific sections in the corridor while establishing a baseline for all segments consistent with reasonable overall growth both in terms of other similar corridors and specifically in terms of calculated overall growth in the corridor. The details of the methodology are discussed below under the heading *Growth Estimates and Smoothing of 2005 Traffic Count Data*. These **rationalized** traffic volumes will serve as the baseline calibration/validation target for developing a **model baseline** which will allow estimate of corridor traffic growth and future expected volumes.

To allow development of traffic-volume projections consistent with the established baseline, special techniques known as **Link-OD Estimation** will be used to develop a calibrated baseline scenario. This approach uses input traffic volumes/counts (which can and will be stratified by vehicle class) to adjust the input triptable and produce a traffic assignment consistent with the input volumes/counts. This will establish the baseline for generation of future volume forecasts. Future forecasts will be based on measuring growth in origin-destination activity using the triptables from the existing MoDOT Statewide Transportation Model and the already established future-year scenarios, and adding that growth to the adjusted triptables coming out of the above Link-OD Estimation process. Using this procedure will ensure that existing trip patterns and, hence, vehicle class specific traffic volumes are consistent with the assumed freeway segment counts.

Growth Estimates and Smoothing of 2005 Traffic Count Data

Currently statewide traffic-count data is available for autos and trucks for 2000, 2002, 2004, and 2005. **Figure 1** shows the variations in AADT throughout the years, and locations of negative growth between 2000 and 2005. Discrepancies in count data could be a result of construction, or drastic changes in land use between the various years.

Figure 1: Comparison of Historical MoDOT AADT



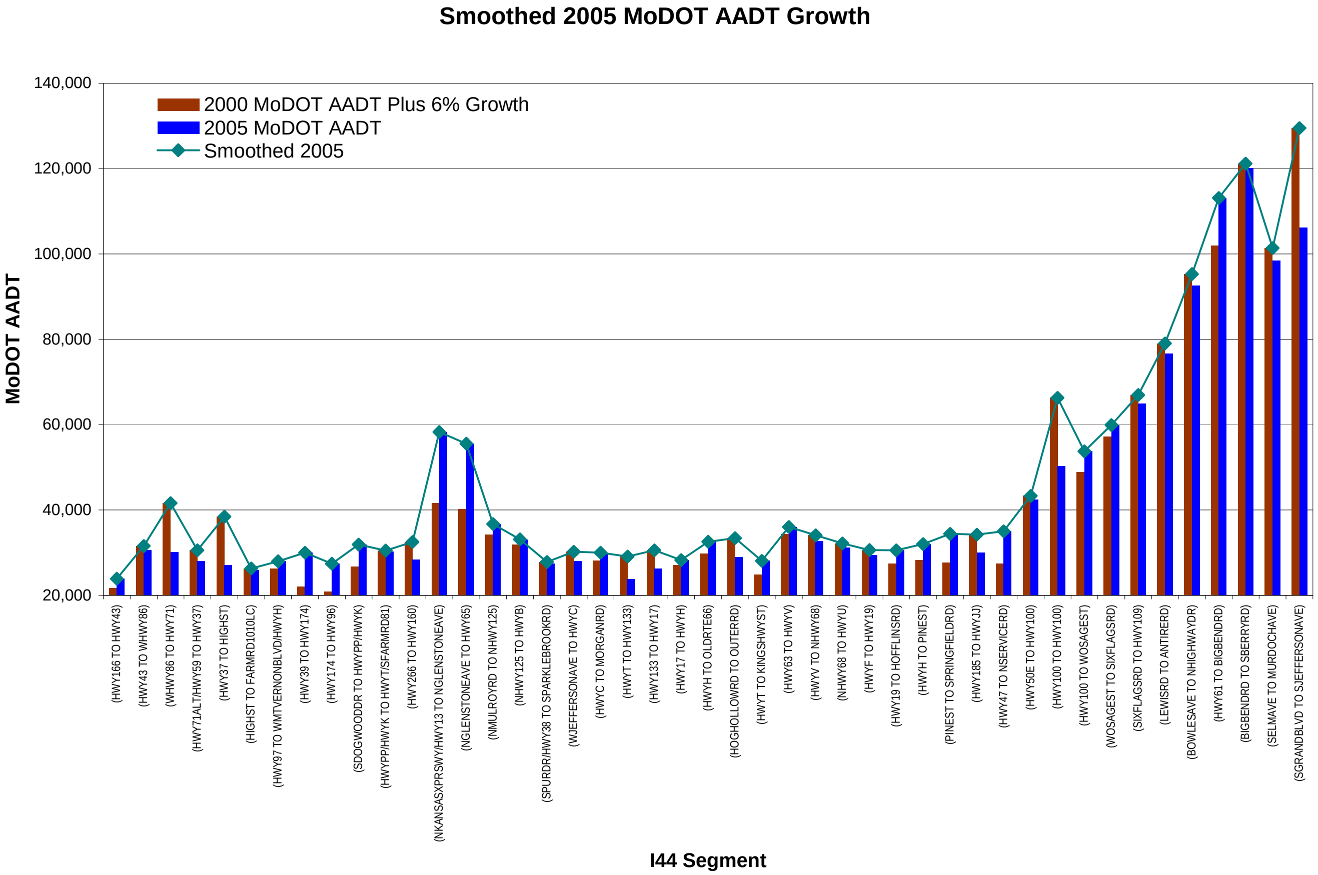
The inconsistencies in growth along the corridor are systematic, and appear at random. Many locations have significant negative growth, and 2000 AADT counts are occasionally greater than counts from 2002, 2004, or 2005. Due to the inconsistent growth (sometimes negative) along the corridor, the following assumptions have been used in formulating a revised methodology that creates a smooth relationship between the assumed and calculated growth between 2000 and 2005 along certain segments of the corridor.

1. Counts along the corridor are two-direction, and will be assumed to have a 50/50 split for eastbound and westbound traffic.
2. The minimum auto/light truck, and commercial truck growth along the corridor is 6 percent based upon growth in traffic along the entire corridor. Any location

showing growth less than 6 percent will be revised to the 6 percent growth from 2000.

Figure 2 shows 2000 AADT counts with 6 percent growth, 2005 AADT counts, and the "Smoothed 2005 AADT" that will be input serve as the baseline for validation. Sections of I-I-44 with significant growth between 2000 and 2005 are assumed to represent actual conditions, and the count will not be revised. Twenty-four locations along the corridor will be revised to incorporate 6 percent growth from 2000, which is greater than the available 2005 AADT count.

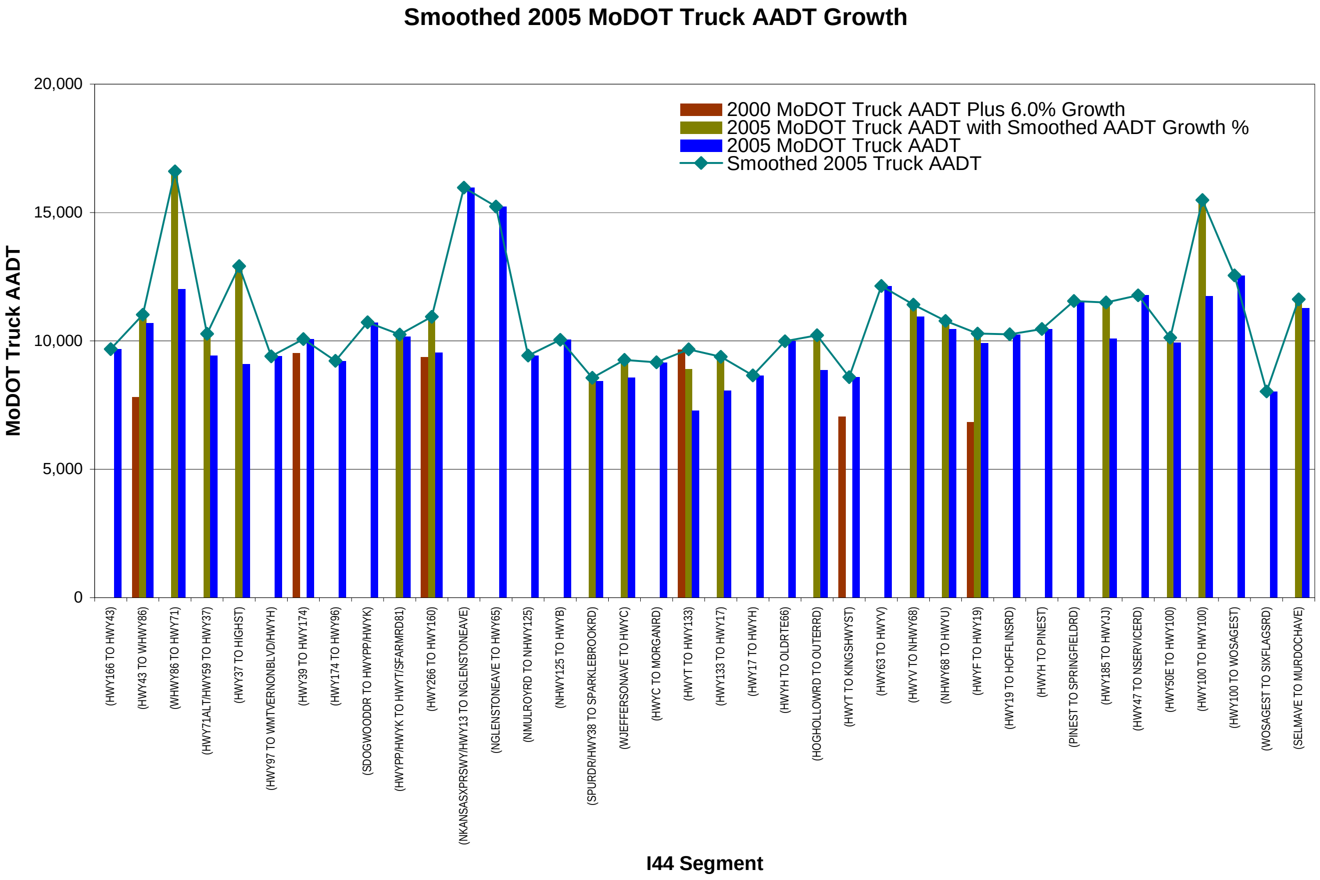
Figure 2: Smoothed 2005 MoDOT AADT Growth



In order to obtain a reasonable validation, commercial vehicle counts will be "smoothed" in a similar manner. However, there are significantly fewer locations with 2000 commercial vehicle count data than 2005, but classified information for 2005 is available along the entire corridor. The first step in realistically smoothing trucks is to look at the revised growth for overall AADT along the corridor and grow the 2005 Truck AADT by the same percentage. Comparing the 2000 Truck AADT with 6 percent growth, the 2005 Truck AADT with the smoothed growth from the overall AADT, and the classified count 2005 AADT, we are able to smooth the 2005 trucks to realistic values.

Figure 3 shows 2000 Truck AADT counts with 6 percent growth, 2005 Truck AADT counts grown to correspond with the smoothed overall AADT growth, actual 2005 MoDOT Truck AADT counts, and the "Smoothed 2005 Truck AADT" will serve as the baseline for validation. Sections of I-44 with significant growth between 2000 and 2005 are assumed to represent actual conditions, and the count will not be revised. Seventeen segments along the corridor are revised to the smoothed growth percentage from the overall AADT smoothing process in **Figure 2**, one location along the corridor will be revised to truck growth of 6 percent from 2000 Truck AADT counts, and the remaining segments will retain 2005 MoDOT classified AADT volumes.

Figure 3: Smoothed 2005 MoDOT Truck AADT Growth



This methodology will "smooth" the rough spots in the available count data to better reflect realistic and significant growth along specific sections in the corridor while establishing a baseline for all segments consistent with reasonable overall growth. The revised 2005 counts will be manually input into the MoDOT Statewide Transportation Model and used in model re-estimation for 2005 using the Link-OD Estimation process.

Interstate 44 (I-44) Purpose and Need Study: Public Involvement and Agency Coordination Summary (A-16)

PREPARED FOR:	MODOT Staff
PREPARED BY:	CH2M HILL
ORIGINAL SUBMISSION DATE:	March 18, 2008
PROJECT NUMBER	355821

MoDOT's efforts in soliciting stakeholder involvement and agency input on issues affecting I-44 in conjunction with the establishment of the project's Purpose & Need were consistent with the requirements of Section 6002 of SAFETEA-LU relating to stakeholder and agency input at key steps during the NEPA process. A synopsis of the stakeholder involvement and agency coordination efforts is outlined below.

Details of the public involvement and agency coordination activities associated with the I-44 Purpose and Need Study are contained in the project's administrative record.

Public Information Meetings

Public involvement meetings were conducted at eight locations along I-44 during early October, 2007. The meetings were held in Joplin, Mt. Vernon, Springfield, Lebanon, Waynesville, Rolla, Cuba, and St. Clair. All meetings were intended to inform the public of data gathered by the I-44 Study team and to solicit input on I-44 existing and future need elements. A total of 141 people signed in at the meetings.

At each meeting 19 core display boards were presented providing the public a brief description of the I-44 Study, NEPA, purpose and need, and an introduction to the engineering data. The displays also presented future activities for the I-44 Purpose and Need Study as well as subsequent required NEPA, design, and eventually construction efforts.

The study team developed county-based level of service (LOS), crash, and environmental resources data boards for all counties along the I-44 study corridor. At each public meeting, the county in which the meeting was being held, as well as the neighboring county in each direction was displayed.

The study team sought comments from the public orally and in writing. A written comment form and a large roll plot map of the county, respective to the meeting location, were provided for written comments.

Land Use Forums

Land use forums were conducted at five locations within the project area. Both the public and the local/regional planning agencies were invited to participate. The forums were held in July and August 2007 at the following locations: Joplin (MoDOT District 7 Office), Springfield (District 8 Office), St. Robert City Hall, St. James (MRPC Building) and St. Clair (MoDOT Area Engineer Office). The intent of these forums is to understand the local land use context associated with the portions of I-44 within the study area. Specifically these meetings:

- Shared information about the study of I-44.
- Gathered information about plans for land use and economic development along I-44.
- Discussed how investments or improvements to I-44 could affect those plans.
- Discussed land use issues, opportunities, and problems that may affect the purpose and need statement for the corridor and how changes to I-44 could affect that vision.

Project Website and Newsletters

As part of the public involvement process, a project website and project newsletters were used. The website is located at http://www.modot.org/i44planningforprogress/. The websites includes the following sections: Events, Schedule, Contacts, Comments, Links, Public Involvement Meeting Displays, and Newsletters. In addition to the newsletters being available on the website, they were distributed to a stakeholders list of approximately 350 people and organizations.

Agency Coordination Letters

In preparation for the selection of participating and cooperating agencies, agency coordination letters were distributed to all appropriate resource and regulatory agencies. The goals were to inform and solicit input. These agencies were also included in the stakeholders list. This began the iterative process of agency coordination. The levels of involvement, data sharing and coordination varied depending on the agency.

APPENDIX B
Map Book

The figures in the map book were created as supporting documents for the I-44 Purpose and Need Study. Per the scope of work, inventoried information/conditions and analysis results will be maintained in a database designed to provide an access point for all data quarries. The graphical representation of the all-encompassing data within the database is depicted in the **Appendix B** map book. Furthermore, the map book is a visual display of the three main categories being analyzed in the I-44 Purpose and Need document; safety, operations, and geometrics. The map book specifically illustrates the analyses of geometrics (horizontal curves, and vertical curves, and grades), bridges (condition, roadway, and age), interchange deficiencies (safety, operations and design), and crash data.

The map book was created utilizing an Access database and GIS software (ArcMap 9.2). First, the database was merged with the GIS files and incorporated into the GIS working platform. The data was then quarried to depict the three categories being analyzed in a uniform illustration. An aerial view of the corridor creates the top-half of each figure in the map book, while the lower-half of the figure shows the specific outcome of the various analyses previously mentioned. Both portions of the figure are spatially identified along the corridor by mile marker. This process was completed for all 257 miles of the corridor, with approximately 2.5 miles depicted in each figure, for a total of 100 figures. The following table (**Table 1**) is a reference index of the map book by county.

Table 1

Map Book Index

County	Map Book Figures	Mile Markers	Interchanges	Urban Areas
Newton	1-5	1-10	1, 2, 3, 4, 6, and 8	Joplin
Jasper	5-13	10-32	11, 15, 18, 22, 26, and 29	Sarcoxie
Lawrence	14-24	32-59	33, 38, 44, 46, 49, 57, and 58	Mount Vernon
Greene	24-36	59-90	61, 67, 69, 70, 72, 75, 77, 80, 82, 84, and 88	Springfield
Webster	36-44	90-111	96, 100, and 107	Marshfield
Laclede	44-57	111-145	113, 118, 123, 127, 129, 130, 135, and 140	Lebanon
Pulaski	57-66	145-168	145, 150, 153, 156, 159,161, and 163	Waynesville and St. Robert
Phelps	66-78	168-201	169, 172, 176, 179, 184, 185, 186, 189, and 195	Rolla and St. James
Crawford	78-86	201-223	203, 208, 210, 214, and 218	Cuba
Franklin	86-99	224-258	225, 226, 230, 239, 240, 242, 247, 251, 253, and 257	Sullivan, St. Clair, Gray Summit, and Pacific

The color-coded system for the map book is a simple color scheme utilizing three colors; yellow, orange and red for items that do not meet current design guidelines. Technical documents often incorporate this color scheme into documents because of its familiarity to users. In the map book, an associated color was assigned indicating the relative severity of each aspect. Yellow represents minor aspects, orange represents mid-range, or moderate, aspects that are neither minor or severe, and red represents severe issues were present. All areas that do not display yellow, orange, or red are compliant with design guidelines. Although there is no display associated with these areas, the data for these areas resides in the database.

The guidelines, criteria, and methodologies used in completing each of the analyses discussed in this technical memorandum are documented in separate technical memorandums, per topic, and can be found in **Appendix A**. Sources for all depicted data are also identified in these technical memorandums. For a complete list of associated technical memorandums, please refer to the Table of Contents.

The following sections of this technical memorandum are ordered as they appear in the map book on each of the 100 figures.

A. Crash Analysis

Crash rates were calculated for segments along the study corridor that vary in length from 0.5 miles to 3.0 miles. Chosen by the study team in an attempt to best represent areas along the corridor, the intent was to not mask a localized crash issue by making lengths too long, but also to not make areas appear inflated because of to short of a length of roadway.

The calculated crash rates were compared to the statewide average for interstate facilities, given urban or rural locations. Crash rates less than the respective state average do not display on the map book, however the data resides in the database. Crash rates greater than the state average, up to 1.5 times the average are shown in yellow. Crash rates greater than 1.5 times to 2.0 times the respective state average are shown in orange. Crash rates greater than 2.0 times the respective state average are shown in red. The corresponding percent rates, relative to the state average, are also shown in the map book for the aforementioned three categories.

The results of this analysis are shown in **Tables 2 and 3** below:

Table 2

Crash Rate Analysis Eastbound Summary

Percent Relative to State Average	Condition	Total Miles	Percent of Total Length
Rate < 100 percent	None	187.9	72.8 percent
101 percent < Rate < 150 percent	Yellow	45.1	17.5 percent
151 percent < Rate < 200 percent	Orange	9.3	3.6 percent
201 percent < Rate	Red	15.9	6.1 percent
	Totals:	258.2	100 percent

Table 3

Crash Rate Analysis Westbound Summary

Percent Relative to State Average	**Condition**	**Total Miles**	**Percent of Total Length**
Rate < 100 percent	None	186.9	72.4 percent
101 percent < Rate < 150 percent	Yellow	51.8	20.0 percent
151 percent < Rate < 200 percent	Orange	12.1	4.7 percent
201 percent < Rate	Red	7.4	2.9 percent
	Totals:	258.2	100 percent

1. Crash Hotspots

This section depicts crash hotspots in the map book for easy comparison of their location to other factors along the corridor. The hotspots are all represented by the color red, as they all contain disabling injury and fatality crashes. The text associated explains eastbound or westbound direction of travel and the most predominant cause of the accident. For a detailed summary of the significant safety trends see the *Crash Technical Memorandum A-3* in **Appendix A**.

b. Operations Analysis

In completing the operations analysis, roadway segments were assigned a level of service (LOS) value of A, B, C, D, E, or F.

For rural areas, LOS A, B, and C are not shown in the map book. Level of service D is shown as yellow, D is shown as orange, and LOS E and F are shown as red.

For urban areas, LOS A, B, C and D are not shown in the map book. Level of service E is shown as yellow, E is shown as orange and LOS F is shown as red.

B. Geometric Analysis

1. Horizontal Curves

Horizontal curves have been divided into four categories, and when displayed graphically, they have been assigned a color.

Curves shown in yellow, given the existing radius, need up to an additional 1.5 percent of super elevation to meet the guidelines.

Curves shown in orange, given the existing radius, need more than an additional 1.5 percent of superelevation to meet the guidelines, but no more than the maximum allowable 8 percent. Given the existing radius, these curves are capable of meeting the guidelines.

Curves that cannot meet the guidelines with the given radius, even with a maximum 8 percent superelevation, are colored red. These curves would require a realignment of the existing roadway which is a more involved solution than simply increasing superelevation.

The first category of horizontal curves includes those curves which satisfy the guidelines of the analysis. Note, satisfactory curves are not displayed in the map book.

The results of the horizontal curve analysis are summarized below in **Table 4**.

Table 4

Horizontal Curve Condition Assessment by Superelevation

Additional Super Elevation Required (Percent)	Condition	Number	Percent of Total
0.0	None	25	16 percent
< 1.5 percent	Yellow	103	65 percent
> 1.5 percent to 8 percent	Orange	28	18 percent
>8 percent (Must Increase Radius)	Red	3	2 percent
Totals:		159	100 percent

2. Vertical Curves

Like the horizontal curve evaluation, vertical curves have been divided into four categories and assigned a color, based on severity, for graphical depictions. For difference purposes, the vertical curves are labeled “Crest” or “Sag.”

The first category of vertical curves is those curves which satisfy the guidelines; however, these curves are not displayed in the map book.

Vertical curves which only are deficient by the K value evaluation, but satisfy appropriate stopping sight distance (SSD) and driver comfort, are coded in yellow.

Crest vertical curves which are deficient in K value, and do not satisfy SSD requirements discussed above, are coded in orange. Similarly, sag vertical curves with the same criteria, are coded in orange as well.

Curves depicted in red are reserved for vertical curves that greatly exceed the AASHTO guidelines. Currently, no vertical curves have been assigned a condition of red.

The results of this evaluation are summarized in **Tables 5** and **6.**

Table 5 **Eastbound Vertical Curve Condition Assessment**		
Condition	**Number**	**Percent of Total**
Meets Guidelines	400	76 percent
Yellow	65	12 percent
Orange	63	12 percent
Red	0	0 percent
Total:	528	100 percent

Table 6 **Westbound Vertical Curve Condition Assessment**		
Condition	**Number**	**Percent of Total**
Meets Guidelines	396	73 percent
Yellow	68	13 percent
Orange	75	14 percent
Red	0	0 percent
Total:	539	100 percent

3. Vertical Grades

Like the horizontal and vertical curves, vertical grades are shown graphically in four color-coded categories, based on the severity of the deficiency. The assigned condition of each grade takes into account both the maximum grade steepness and critical length criteria. The first category includes those grades that satisfy the guidelines of both criteria and are not shown in the map book.

Grades displayed as yellow are grades that meet either the maximum grade criterion or the critical length criterion. The map book will have text on the yellow area indicating “steep grade” or “long grade,” to further identify the pertinent issue.

Grades displayed as orange result from either a yellow condition in both the maximum grade criterion and the critical length criterion, or an orange condition in one criterion or the other. These grades also include text to help the viewer easily identify the pertinent issue.

Grades displayed as red result from an orange or red condition for both the maximum grade and critical length criterion. Most red condition grades are a result of two issues, very steep grades of six percent or more or steep grades in conjunction with long lengths.

Tables 7 and **8** summarize the final grade condition assessment for vertical grades.

Table 7

Eastbound Final Grade Condition Assessment

Condition	Number	Miles	Percent of Total
Meets Guidelines	474	241.8	94 percent
Yellow	32	12.6	5 percent
Orange	15	2.7	1 percent
Red	6	1.0	0 percent
Totals:	527	258.2	100 percent

Table 8

Westbound Final Grade Condition Assessment

Condition	Number	Miles	Percent of Total
Meets Guidelines	488	243.7	94 percent
Yellow	28	9.9	4 percent
Orange	15	2.6	1 percent
Red	7	1.9	1 percent
Totals:	538	258.2	100 percent

C. Interchange Deficiency Analysis

1. Map Book

The interchange deficiency analysis focused on three factors: safety, traffic operations and geometric design. The evaluations were conducted for the eastbound and westbound segments of the study area's 78 interchanges. The guidelines and methodologies used in these evaluations can be found in the *Interchange Evaluation Analysis Technical Memorandum* (see Appendix A).

The *Interchange Evaluation Analysis Technical Memorandum* outlines, in detail, the individual aspects for each of the three categories per interchange; however, the following table (**Table 9**) depicts a summary of this data as it is depicted in the map book.

Table 9

Interchange Analysis Summary: Safety, Operations and Geometric Design

Exit	Interchange	Safety		Operations		Design
		EB	WB	EB	WB	
1	US 166	Orange			Orange	Orange
2	Rest Area					
3	Weigh Station					
4	Route 43	Orange			Yellow	Red
6	Route 86	Orange	Red	Red	Red	Yellow
8	Business Route 71	Red	Red	Red	Red	Orange
11	US 71 South, Route 249 North	Red	Orange			
15	Loop 44, Route 66			Orange	Red	
18	US 71 North/Route 59 South		Red	Red	Red	
22	10th Road		Yellow	Red	Red	
26	Route 37		Yellow	Red	Red	
29	Route U			Orange	Red	Yellow
33	Route 97 south					Orange
38	Route 97			Red	Orange	Yellow
44	Route H	Yellow	Yellow	Red	Orange	Yellow
46	Route 265, Route 39		Orange	Red	Orange	
49	Route 174		Yellow	Red	Red	Yellow
52	Rest Area					
57	Route 96				Red	
58	Route Z, Route O	Yellow		Red	Red	Orange
61	Route K, Route PP			Red	Red	
67	Route T, Route N	Yellow		Yellow	Yellow	
69	Route 360 – James River Freeway	Yellow				
70	Route B, Route MM	Yellow		Red	Red	
72	Route 266	Orange		Yellow	Red	Orange
74	N/A	Yellow	Yellow			Yellow
75	US 160		Yellow	Orange	Red	

Table 9

Interchange Analysis Summary: Safety, Operations and Geometric Design

Exit	Interchange	Safety		Operations		Design
		EB	WB	EB	WB	
77	Route 13			Red	Red	Yellow
80	Loop 44/Route H		Orange	Red	Red	Yellow
82	US 65	Yellow	Yellow	Red	Red	Orange
84	Route 744			Red	Red	
88	Route 125		Yellow	Red	Red	
96	Route B	Yellow	Yellow	Red	Red	Yellow
100	Route 38, Route W			Red	Red	Yellow
107	Sparkle Brook Rd., Sampson Rd.			Red	Yellow	Yellow
111	Rest Area					
113	Route Y, Route J	Yellow		Red	Red	
118	Route A, Route C	Yellow		Red	Red	
123	County Road					
127	Elm St., Morgan Rd.			Red	Red	
129	Route 64, Route 5, Route 32		Yellow	Red	Red	
130	Route MM	Yellow	Orange	Yellow		
135	Route F			Yellow	Red	Yellow
140	Route T, Route N		Yellow	Red	Red	Yellow
145	Route 133, Route AB			Red	Red	Yellow
150	Route 7, Route P					
153	Route 17			Orange	Red	Orange
156	Route H		Orange	Red	Yellow	Yellow
159	Loop 44	Yellow	Orange	Orange	Yellow	Orange
161	Route Y	Yellow	Red			
163	Route 28	Orange		Orange	Yellow	Yellow
169	Route J	Yellow		Red	Red	
172	Route D	Red	Red	Red		Yellow
176	Sugar Tree Rd.	Orange	Yellow	Yellow	Red	Yellow

Table 9

Interchange Analysis Summary: Safety, Operations and Geometric Design

Exit	Interchange	Safety		Operations		Design
		EB	WB	EB	WB	
178	Rest Area		Orange			Yellow
179	Route T, Route C	Yellow	Yellow	Red	Yellow	
184	US Route 63 South	Orange	Red		Yellow	Yellow
185	Route E	Orange				Orange
186	US Route 63	Yellow	Yellow	Red	Red	Orange
189	Route V			Red	Red	Yellow
195	Route 68, Route 8		Yellow	Red	Red	
203	Route F, Route ZZ		Yellow	Red	Red	Orange
208	Route 19	Orange		Red	Red	
210	Route UU			Red	Red	
214	Route H	Red	Orange	Red	Red	Yellow
218	Route C, Route J, Route N	Yellow	Yellow	Red	Red	Orange
225	Route 185 North			Red	Red	Yellow
226	Route 185 South	Red	Orange	Red	Red	Orange
230	Route JJ, Route W	Yellow	Yellow	Red	Red	Red
235	Rest Area					Orange
238	Weigh Station					Orange
239	Route 30, Route WW, Route AB	Yellow		Red	Red	Yellow
240	Route 47	Yellow	Yellow	Red	Red	Orange
242	Route AH					Yellow
247	US 50	Red	Yellow	Yellow	Red	Yellow
251	Route 100 West	Orange		Red	Red	Yellow
253	Route 100 East	Yellow	Orange	Red	Red	Orange
257	Loop 44	Yellow	Yellow		Red	Orange

D. Other Observations

This section of the map book has a few observations that the study team considered worth displaying to possibly help explain other crash issues taking place in the same locations. These items include observations such as the outer roadway being too close to the interstate, and extremely reduced median widths (including center median walls).

E. Pavement Rating

Pavement ratings depicted in the map book were taken directly from MoDOT's Statewide Traffic Database. The values for pavement rating were Very Good, Good, Fair, Poor, and Very Poor. Values of Very Good and Good are not displayed in the map book but Fair values are shown as yellow, Poor values are shown as orange and Very Poor values are shown as red. All values are displayed as text in the associated boxes.

F. Bridge Condition Index Criteria

All bridges that are either over I-44 or carry I-44 were included in the evaluation of Bridge Condition Index. The Bridge Condition Index for all of the bridges, except box culverts and a railroad bridge over I-44 in Laclede County, were provided by MoDOT. The bridges were given one of the following condition index ratings as listed from best to worst: Very Good, Good, Fair, Poor, and Very Poor. The Bridge Condition Index ratings for the bridges in the corridor were divided into eastbound and westbound and are summarized in **Table 10**.

Table 10

Bridge Condition Index Summary

Bridge Condition Index	**Condition Color Code**	**Eastbound**		**Westbound**	
		Number	**Percent of Total**	**Number**	**Percent of Total**
Very Poor	Red	4	2 percent	4	2 percent
Poor	Orange	4	2 percent	5	3 percent
Fair	Yellow	90	53 percent	88	52 percent
Very Good and Good	None	40	23 percent	40	23 percent
Box Culverts	None	33	19 percent	33	19 percent
Railroad over I-44	None	1	1 percent	1	1 percent
Totals:		172	100 percent	171	100 percent

The ratings were divided into four color-coded categories (see **Table 10**) that are displayed graphically in the map book. The I-44 corridor has been color-coded to identify bridge conditions according to the conditions color code. Color codes assigned based on the Bridge Condition Index are differentiated with the text "COND".

G. Bridge Roadway Curb-to-Curb Width Criteria

The bridge roadway curb-to-curb width is defined as the most restrictive minimum distance between the faces of the bridge barrier curbs or bridge rails. The bridge curb-to-curb width is listed as Item 51 in the National Bridge Inventory (NBI) database and this information was provided by MoDOT for each bridge.

For bridges carrying I-44 over another feature, the curb-to-curb width was evaluated using 12-foot lane widths, 4-foot left shoulders, and 10-foot right shoulders, which are based on AASHTO criteria from the AASHTO Policy on Geometric Design of Highways and Streets, Chapter 8 “Freeways.” The results of the bridge roadway curb-to-curb width analysis are divided into eastbound and westbound and sorted by number of traffic lanes in **Table 11**.

Like the bridge condition index ratings, the curb-to-curb conditions for bridges that carry I-44 were divided into four color-coded categories that represent the range of variation from the AASHTO standards. **Table 11** summarizes the criteria and the color-coded “condition” of the bridges for 2-lane and 3-lane roadways.

Table 11

Curb-to-Curb Width Evaluation Criteria – I-44 over another Feature

		Eastbound		**Westbound**	
Curb-to-Curb Width Range	**Condition**	**Number**	**Percent of Total**	**Number**	**Percent of Total**
Two Lane Bridges					
24 feet to 29.99 feet (2 Lanes = 24 feet)	Red	0	0 percent	0	0 percent
30 feet to 35.99 feet (2 Lanes + 2 feet + 4 feet = 30 feet)	Orange	15	33 percent	13	28 percent
36 feet to 37.99 feet (2 Lanes + 2 feet + 10 feet = 36 feet)	Yellow	11	24 percent	11	24 percent
Greater than 38 feet (2 Lanes + 4 feet + 10 feet = 38 feet)	None	20	43 percent	22	48 percent
Total:		46	100 percent	46	100 percent
Three Lane Bridges					
36 feet to 41.99 feet (3 Lanes = 36 feet)	Red	1	33 percent	0	0 percent
42 feet to 47.99 feet (3 Lanes + 2 feet + 4 feet = 42 feet)	Orange	1	33 percent	0	0 percent
48 feet to 49.99 feet (3 Lanes + 2 feet + 10 feet = 48 feet)	Yellow	0	0 percent	0	0 percent
Greater than 50 feet (3 Lanes + 4 feet + 10 feet = 50 feet)	None	1	33 percent	2	100 percent

Table 11

Curb-to-Curb Width Evaluation Criteria – I-44 over another Feature

Curb-to-Curb Width Range	**Condition**	**Eastbound**		**Westbound**	
		Number	**Percent of Total**	**Number**	**Percent of Total**
Total:		3	100 percent	2	100 percent
Total of All Bridges					
	Red	1	2 percent	0	0 percent
	Orange	16	33 percent	13	27 percent
	Yellow	11	22 percent	11	23 percent
	None	21	43 percent	24	50 percent
GRAND TOTAL:		49	100 percent	48	100 percent

For bridges carrying a roadway over I-44, the curb–to-curb width was evaluated using a simpler criterion, which compared the curb-to-curb width of the bridge to the approach roadway width. Any bridge was not as wide as the approach roadway width did not meet this criterion and were classified as a “Red” condition. All those that met the criterion were given a “none” condition. The curb-to-curb width was not evaluated for the railroad bridge over I-44 in Laclede County.

The bridge curb-to-curb width conditions are color-coded and are displayed graphically in the map book. The map of the I-44 corridor has been color-coded to identify bridge curb-to-curb width according to this color code. Color codes assigned based on the curb-to-curb width criteria are differentiated with the text “C-C”.

H. Bridge Age Criteria

The year built, as provided by MoDOT, is listed as Item 27 in the NBI database. The age of each bridge was evaluated using a reference year of 2007. The results of the bridge age analysis are divided into eastbound and westbound and are summarized in **Table 12.**

Table 12

Bridge and Box Culvert Age Summary

Age	**Condition**	**Eastbound**		**Westbound**	
		Number	**Percent of Total**	**Number**	**Percent of Total**
Greater than or equal to 75 years	Red	4	2 percent	5	3 percent

50 to 74 years	Orange	33	19 percent	34	20 percent
40 to 49 years	Yellow	85	50 percent	82	48 percent
Less than 40 years	None	50	29 percent	50	29 percent
Total:		172	100 percent	171	100 percent

Like the other criteria, the bridge age criteria are divided into four color-coded condition categories as shown in **Table 12,** and are displayed graphically in the map book. The map of the I-44 corridor has been color-coded to identify bridge age according to this color code. Color codes assigned based on the bridge age criteria are differentiated with the text “AGE”.

I-44 Purpose and Need Study

Existing Condition Summary Map Book
Appendix B

44
Purpose & Need Study
PLANNING FOR PROGRESS

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Purpose & Need Study
PLANNING FOR PROGRESS

I-44 Purpose and Need Study

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Legend

Safety: Crash Rates

🟨 100%	100% - 149% State average for freeway facilities. Text notes actual percentage.
🟧 150%	150% - 199% State average for freeway facilities. Text notes actual percentage.
🟥 200%	Greater than 200% State average for freeway facilities. Text notes actual percentage.

Safety: Crash Hot Spots

🟥 EB-Rear End	Crash location severity analysis. Indicates area of 3 or more major injury or fatal accidents in 0.3 miles. Text notes direction and cause.

Operations: Level of Service

🟨 Rural=LOS D	Rural Segment, Level of Service D with Density >= 26 pc/mi/ln and < 32 pc/mi/ln
🟧 Rural=LOS D-	Rural Segment, Level of Service D with Density >= 32 pc/mi/ln
🟥 Rural=LOS E	Rural Segment, Level of Service E
🟨 Urban=LOS D	Urbanized or Small Urban Segment, Level of Service D with Density >= 35 pc/mi/ln and < 42 pc/mi/ln
🟧 Urban=LOS D-	Urbanized or Small Urban Segment, Level of Service D with Density >= 42
🟥 Urban=LOS E	Urbanized or Small Urban Segment, Level of Service E

Crash Analysis

Interchange Crash Analysis was performed on 3 criteria:
1) Total Crash Rate 2 times state average.
2) Fatal Crash Rate 2 times state average.
3) Crash Hotspot present.

🟨 CR	Meets 1 of the conditions above
🟧 CR	Meets 2 of the conditions above
🟥 CR	Meets 3 of the conditions above

Operations Analysis

🟨 OPS	Level of Service D
🟧 OPS	Level of Service E
🟥 OPS	Level of Service F

Geometric Analysis

🟨 GEO	2 criteria are deficient
🟧 GEO	3 criteria are deficient
🟥 GEO	4 criteria are deficient

Safety & Operational Characteristics

Safety	Crash Rates		WB
			EB
	Crash Hot Spots		
Operations	Level of Service	2005	WB
			EB
		2035	WB
			EB
	Significant Issue		

Physical Deficiencies

Horizontal		
Vertical		WB
		EB
Interchange		WB
		EB
Other Observations		
Physical Condition	Pavement Rating	WB
		EB
	Bridge	WB
		EB

Horizontal (Curve)

🟨	Existing radius requires up to 1.5% additional super elevation to meet design guidelines.
🟧	Existing radius requires more than 1.5% additional super elevation to meet design guidelines.
🟥	Existing radius cannot meet design guidelines. Radius must be enlarged.

Vertical (Curve)

🟨 Crest	Vertical Crest curve has deficient "K" value.
🟨 Sag	Vertical Sag curve has deficient "K" value.
🟧 Crest	Crest vertical curve has deficient "K" value and substandard stopping sight distance.
🟧 Sag	Sag vertical curve has deficient "K" value and substandard passenger comfort.

Vertical (Grade)

🟨 Steep Grade	Grade exceeds recommended maximum of 4%.
🟧 Steep Grade	Grade exceeds 5%.
🟥 Steep Grade	Grade exceeds 6%.
🟨 Long Grade	Grade exceeds recommended length, reducing truck speeds by 10 mph.
🟥 Steep/Long Grade	Grade exceeds maximum recommended and exceeds recommended length.

Pavement Rating

🟨 FAIR	Pavement rating is fair

Bridge Condition Index

⬜ COND	Very Good or Good
🟨 COND	Fair
🟧 COND	Poor
🟥 COND	Very Poor

Bridge Age (Reference year: 2007)

⬜ AGE	Less than 40 years
🟨 AGE	40-49 years
🟧 AGE	50-75 years
🟥 AGE	Greater than 75 years

Bridge Curb to Curb Width (Bridge Carrying I-44 with 2 Traffic Lanes)

⬜ C-C	38' or more
🟨 C-C	36'-38'
🟧 C-C	30'-36'
🟥 C-C	Less than 30'

Bridge Curb to Curb Width (Bridge Carrying I-44 with 3 Traffic Lanes)

⬜ C-C	50' or more
🟨 C-C	48'-50'
🟧 C-C	42'-48'
🟥 C-C	Less than 42'

Bridge Curb to Curb Width (Bridge Over I-44)

⬜ C-C	Bridge is as wide as approach roadway
🟥 C-C	Bridge is not as wide as approach roadway

Newton County

Purpose & Need Study
PLANNING FOR PROGRESS

Newton County
District 7

Figure 1
Mileposts: 0 - 1

LEGEND
- ▨ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

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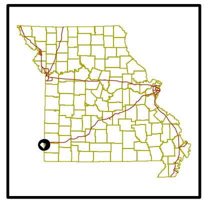
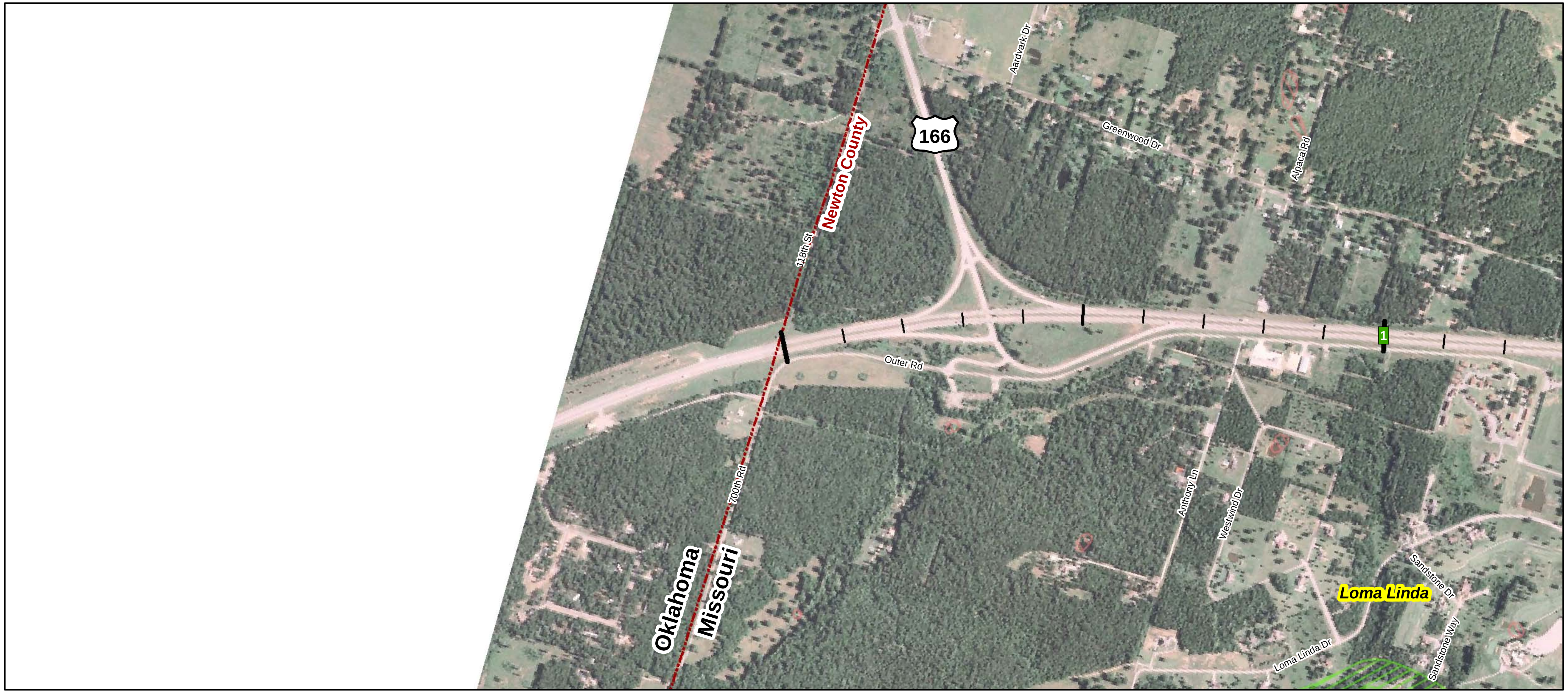
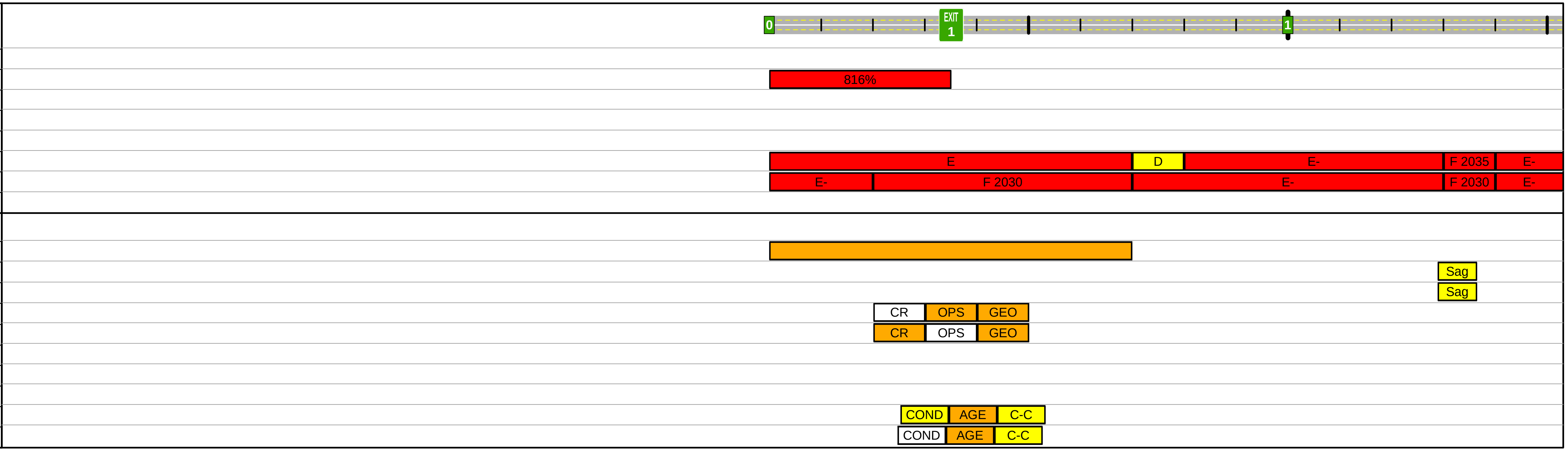




Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	816%
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E D E- F 2035 E-
			EB	E- F 2030 E- F 2030 E-
	Significant Issue			

Physical Deficiencies

Horizontal			🟧
Vertical		WB	Sag
		EB	Sag
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C
		EB	COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Newton County
District 7

Figure 2
Mileposts: 2 - 3

LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

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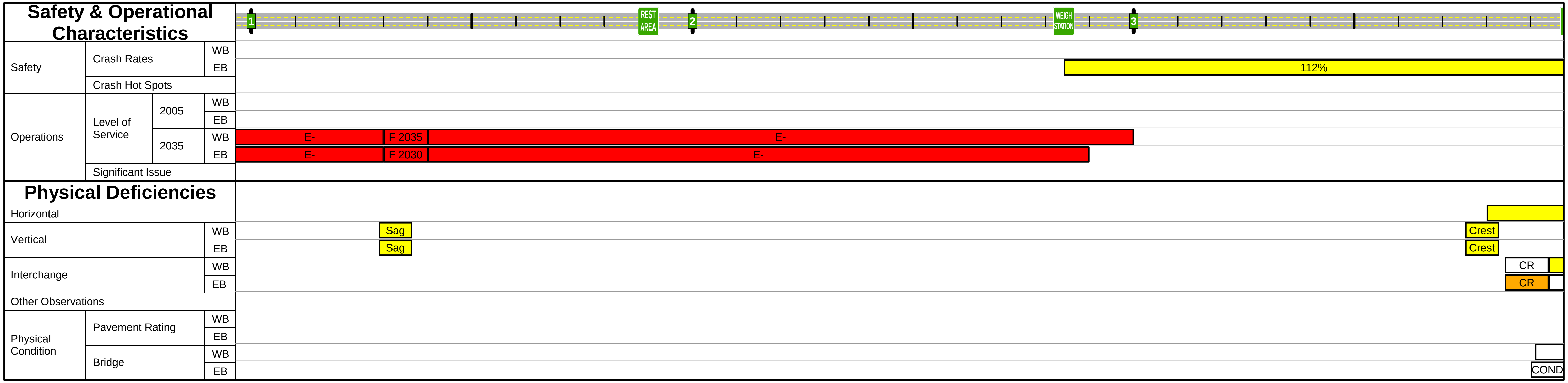

Safety & Operational Characteristics				1 · REST AREA · 2 · WEIGH STATION · 3
Safety	Crash Rates		WB	
			EB	112%
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E- · F 2035 · E-
			EB	E- · F 2030 · E-
	Significant Issue			
Physical Deficiencies				
Horizontal				
Vertical			WB	Sag · Crest
			EB	Sag · Crest
Interchange			WB	CR
			EB	CR
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	
			EB	COND

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Purpose & Need Study
PLANNING FOR PROGRESS

Newton County
District 7

Figure 3
Mileposts: 4 - 6

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

MoDOT

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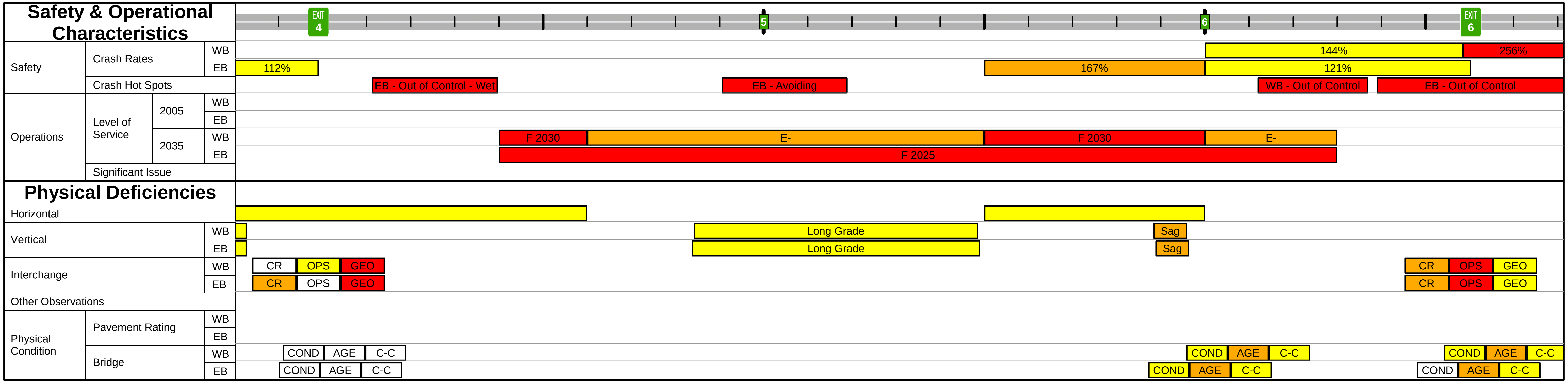

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Purpose & Need Study
PLANNING FOR PROGRESS

Newton County
District 7

Figure 4
Mileposts: 7 - 9

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

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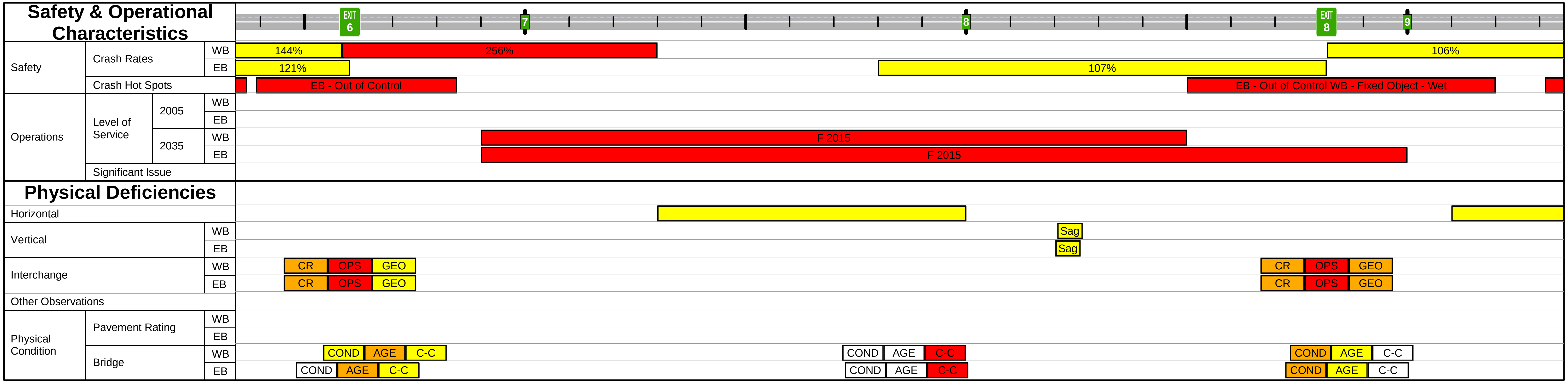
Safety & Operational Characteristics

Physical Deficiencies



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Jasper County

Purpose & Need Study
PLANNING FOR PROGRESS

Newton County
Jasper County
District 7

Figure 5
Mileposts: 10 - 11

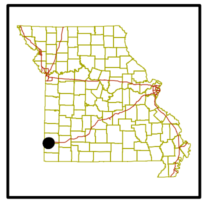
LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

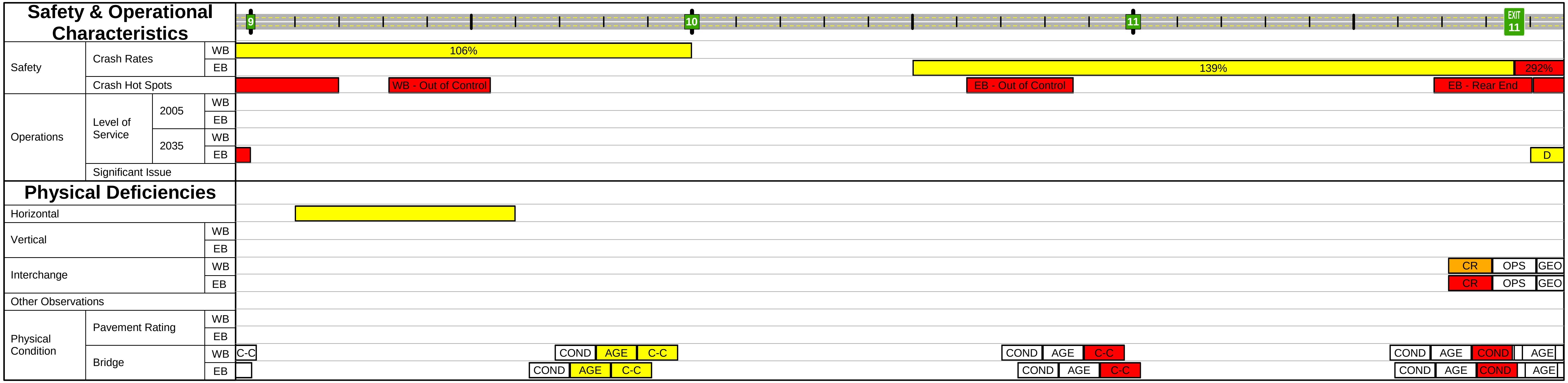
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

MoDOT

CH2MHILL





Safety & Operational Characteristics

Safety	Crash Rates		WB	106%
			EB	139% 292%
	Crash Hot Spots			WB - Out of Control EB - Out of Control EB - Rear End
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	
			EB	D
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	C-C COND AGE C-C COND AGE C-C COND AGE COND AGE
		EB	COND AGE C-C COND AGE C-C COND AGE COND AGE

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Purpose & Need Study
PLANNING FOR PROGRESS

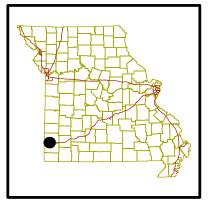
Jasper County
District 7

Figure 6
Mileposts: 12 - 14

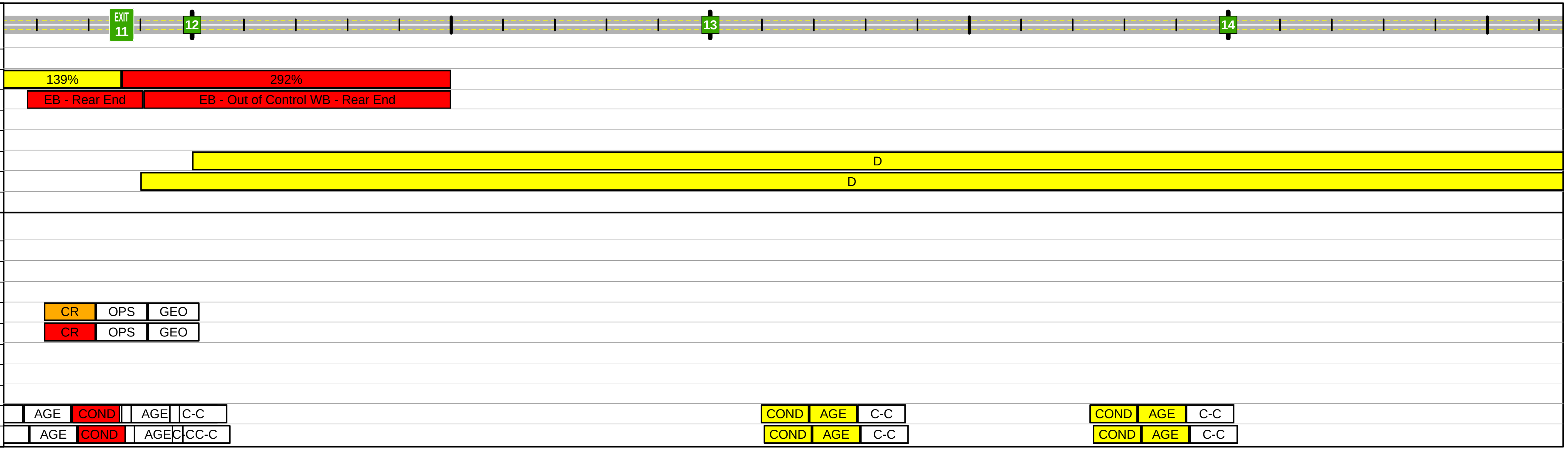
LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N



Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	139% 🟨 · 292% 🟥
	Crash Hot Spots			EB - Rear End 🟥 · EB - Out of Control WB - Rear End 🟥
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	D 🟨
			EB	D 🟨
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR 🟧 · OPS · GEO
		EB	CR 🟥 · OPS · GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	AGE · COND 🟥 · AGE · C-C · COND 🟨 · AGE 🟨 · C-C · COND 🟨 · AGE 🟨 · C-C
		EB	AGE · COND 🟥 · AGE · C · C-C · COND 🟨 · AGE 🟨 · C-C · COND 🟨 · AGE 🟨 · C-C

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PLANNING FOR PROGRESS

Jasper County
District 7

Figure 7
Mileposts: 15 - 17

LEGEND
- County Boundary
- Floodplain
- Palustrine Pond (PUB)
- Palustrine Emergent (PEM)
- Palustrine Scrub-Shrub (PSS)
- Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

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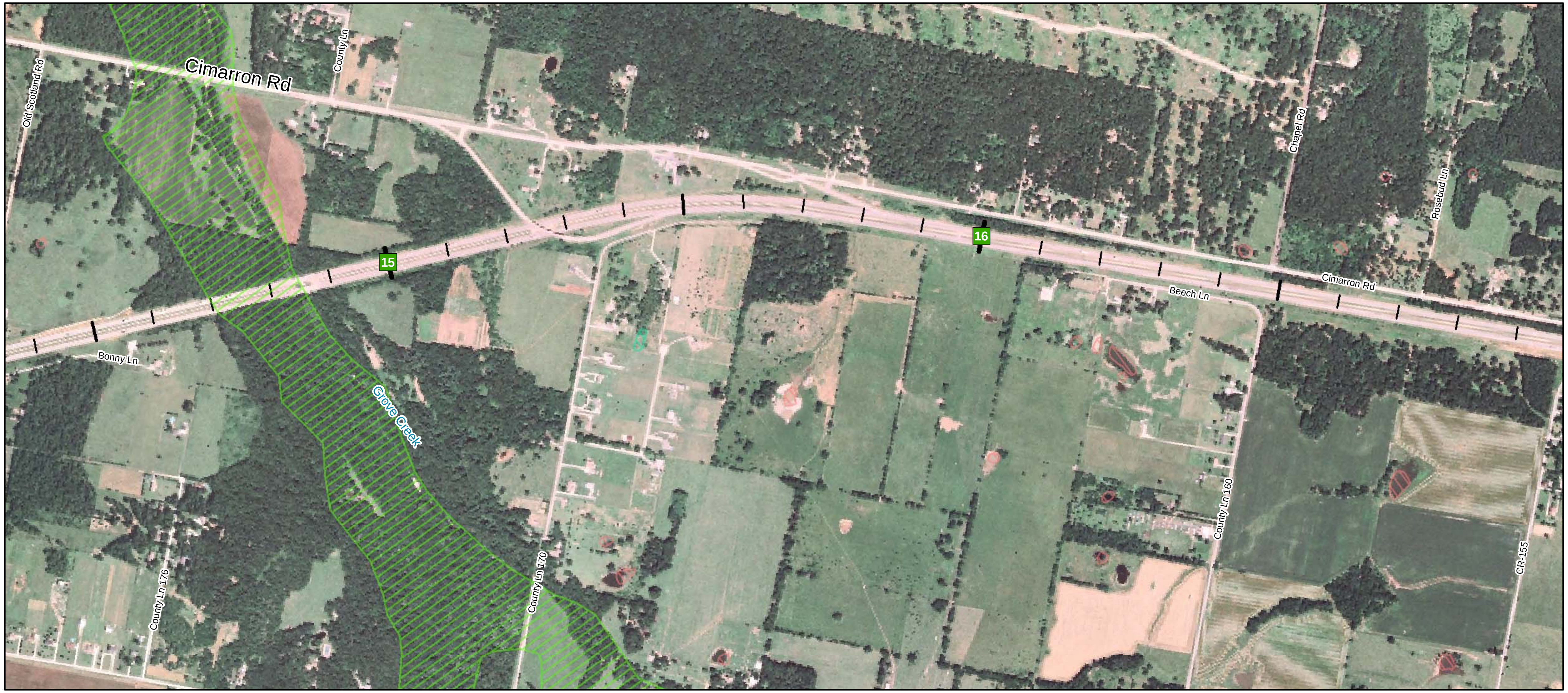
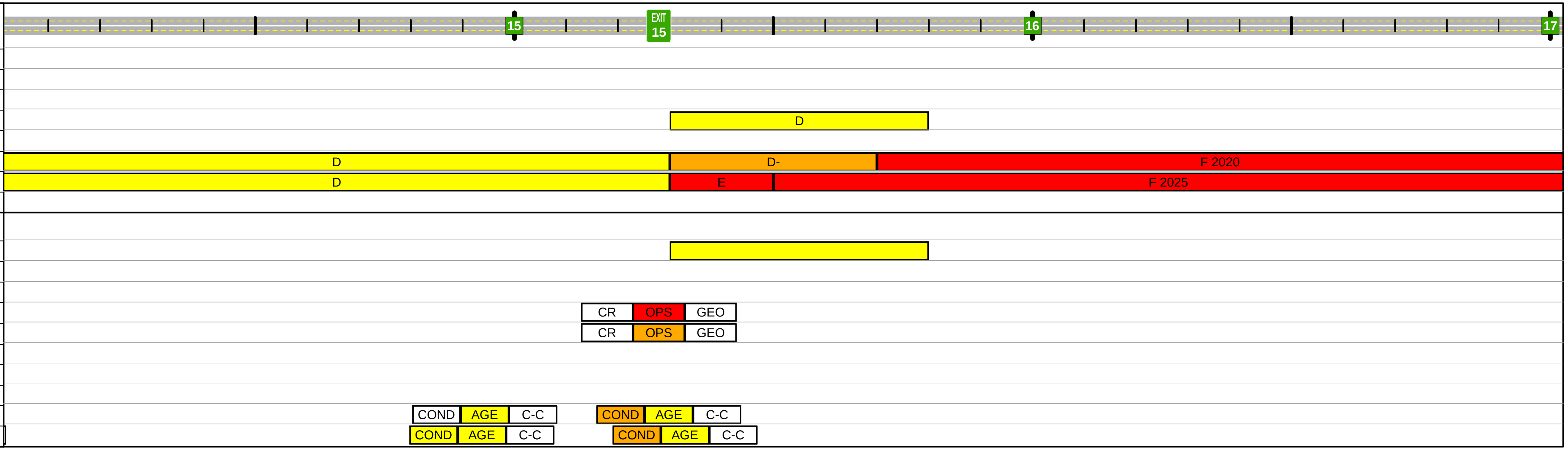


Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	D
			EB	
		2035	WB	D D- F 2020
			EB	D E F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			🟨
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C

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44 Purpose & Need Study
PLANNING FOR PROGRESS

Jasper County
District 7

Figure 8
Mileposts: 17 - 19

LEGEND
- ▨ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

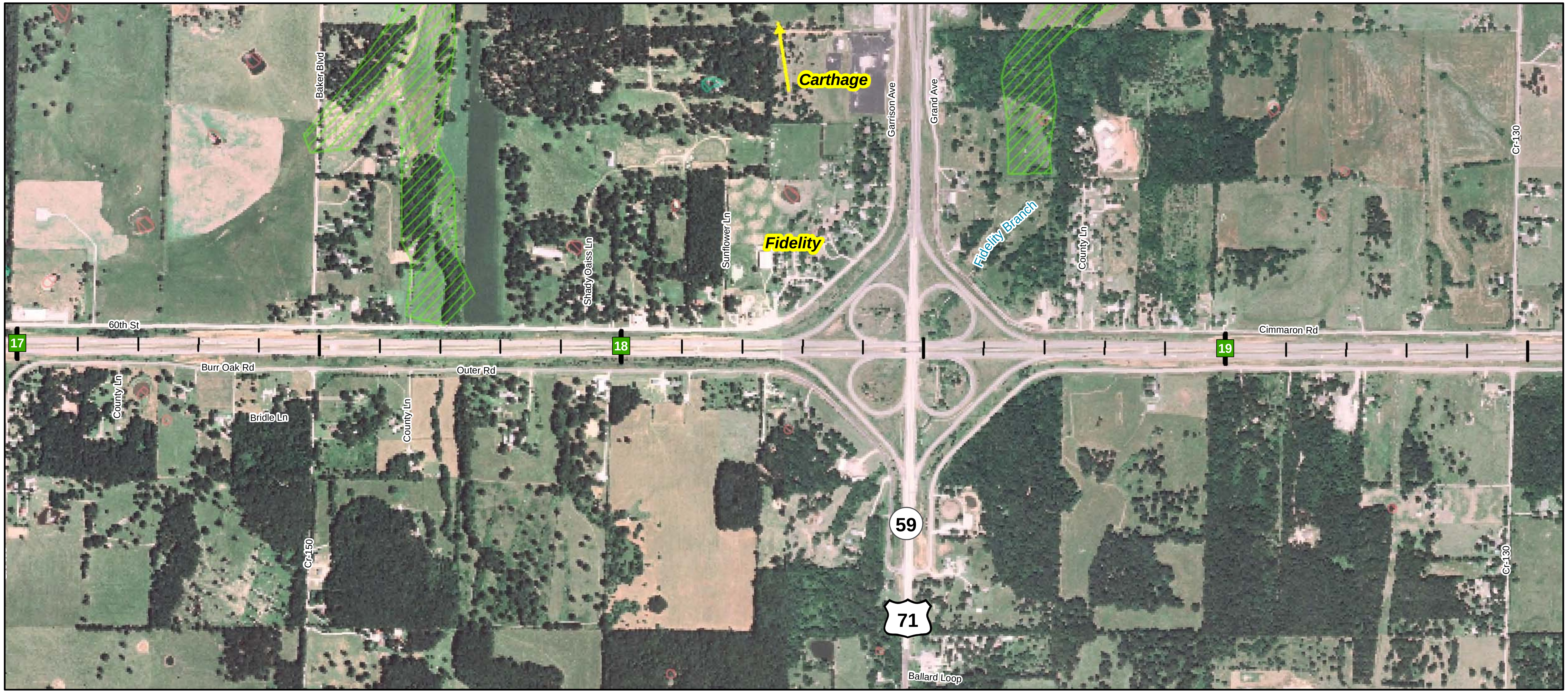
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

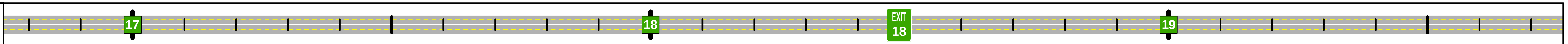
N

MoDOT

CH2MHILL



Safety & Operational Characteristics



Safety	Crash Rates		WB	152%
			EB	107%
	Crash Hot Spots			WB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2020 · D- · F 2025 · D- · F 2020
			EB	F 2025 · E- · F 2030
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR · OPS · GEO
		EB	CR · OPS · GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND · AGE · C-C
		EB	COND · AGE · AGE · C-C · C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Jasper County
District 7

Figure 9
Mileposts: 20 - 22

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

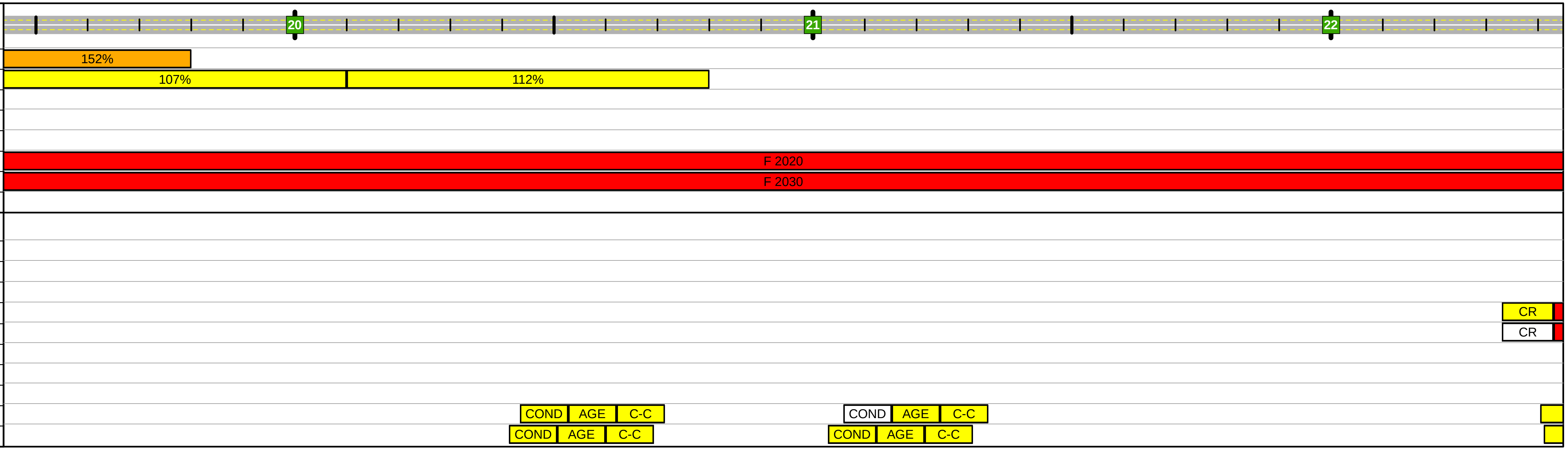
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



Safety & Operational Characteristics				
Safety	Crash Rates		WB	152%
			EB	107% 112%
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2020
			EB	F 2030
	Significant Issue			
Physical Deficiencies				
Horizontal				
Vertical			WB	
			EB	
Interchange			WB	CR
			EB	CR
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND AGE C-C COND AGE C-C
			EB	COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Jasper County
District 7

Figure 10
Mileposts: 23 - 24

LEGEND
- County Boundary
- Floodplain
- Palustrine Pond (PUB)
- Palustrine Emergent (PEM)
- Palustrine Scrub-Shrub (PSS)
- Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

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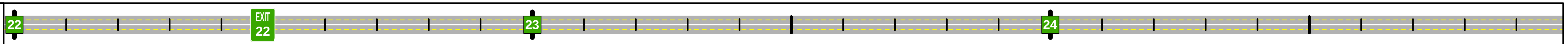
Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟥 F 2020
			EB	🟥 F 2030
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	🟨 CR 🟥 OPS GEO
		EB	CR 🟥 OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	🟨 COND 🟨 AGE C-C
		EB	🟨 COND 🟨 AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Jasper County
District 7

Figure 11
Mileposts: 25 - 27

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet
N

MoDOT

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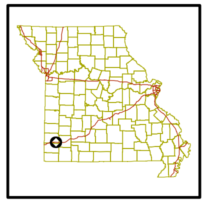
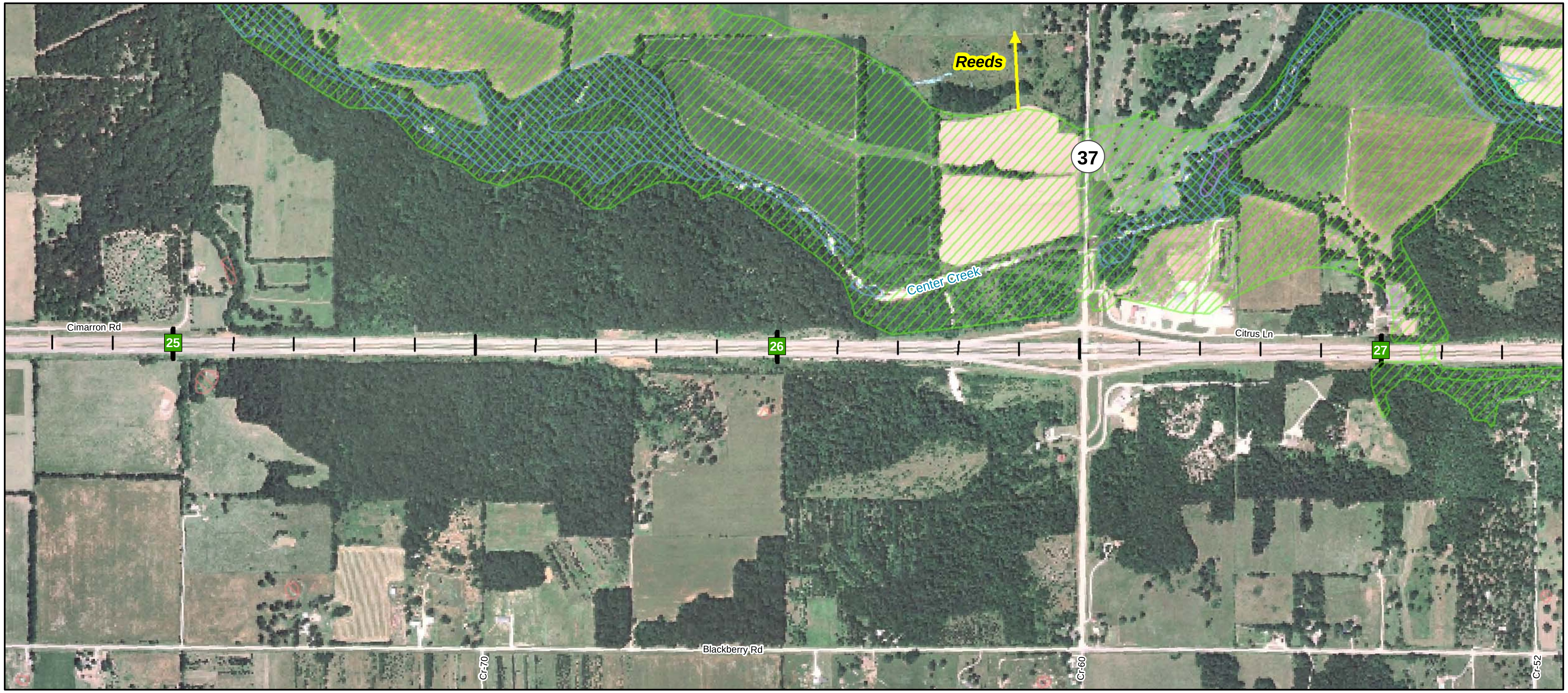
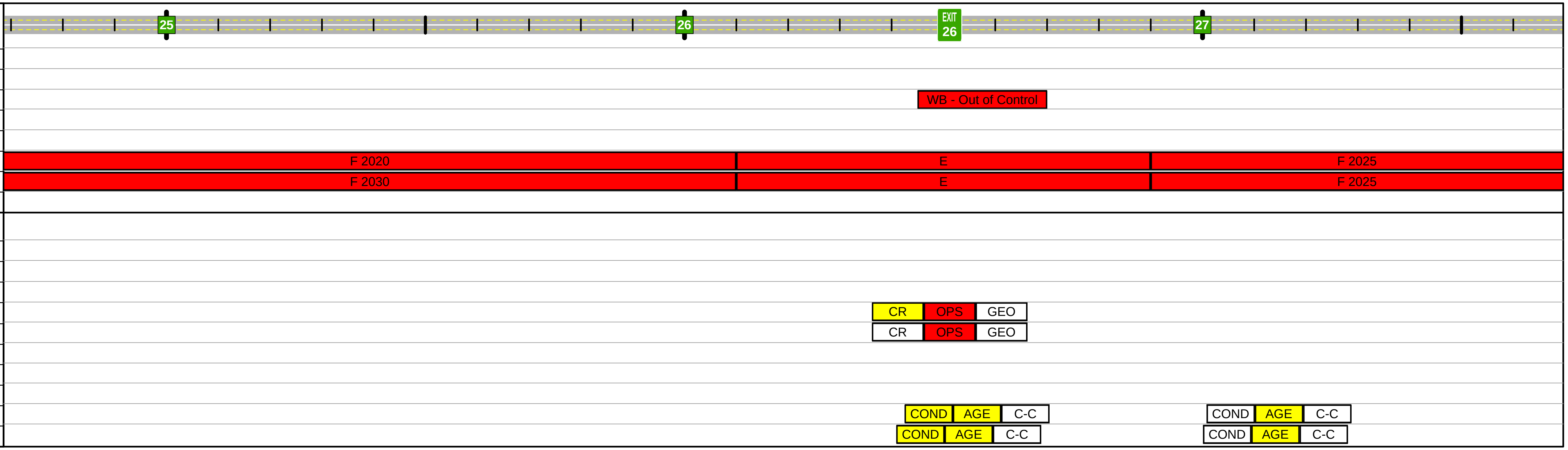




Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			WB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2020 E F 2025
			EB	F 2030 E F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Jasper County
District 7

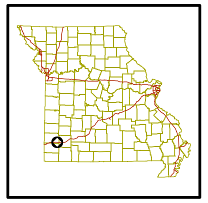
Figure 12
Mileposts: 28 - 29

LEGEND
- County Boundary
- Floodplain
- Palustrine Pond (PUB)
- Palustrine Emergent (PEM)
- Palustrine Scrub-Shrub (PSS)
- Palustrine Forested (PFO)

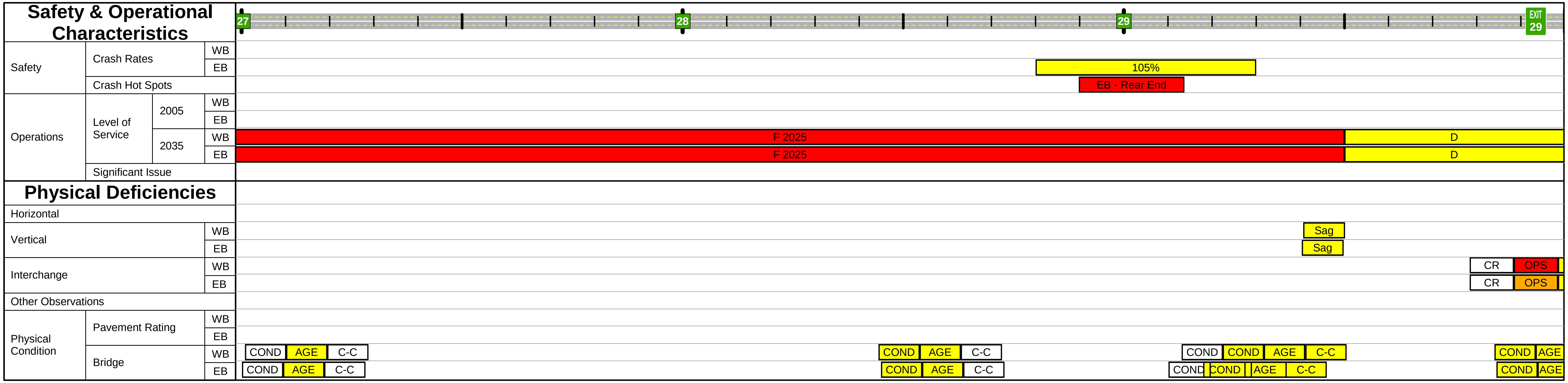
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet
N

MoDOT
CH2MHILL



Safety & Operational Characteristics



Safety — Crash Rates — WB
Safety — Crash Rates — EB: 105%
Safety — Crash Hot Spots: EB - Rear End
Operations — Level of Service — 2005 — WB
Operations — Level of Service — 2005 — EB
Operations — Level of Service — 2035 — WB: F 2025; D
Operations — Level of Service — 2035 — EB: F 2025; D
Significant Issue

Physical Deficiencies

Horizontal
Vertical — WB: Sag
Vertical — EB: Sag
Interchange — WB: CR; OPS
Interchange — EB: CR; OPS
Other Observations
Physical Condition — Pavement Rating — WB
Physical Condition — Pavement Rating — EB
Physical Condition — Bridge — WB: COND AGE C-C; COND AGE C-C; COND COND AGE C-C; COND AGE
Physical Condition — Bridge — EB: COND AGE C-C; COND AGE C-C; COND COND AGE C-C; COND AGE

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PLANNING FOR PROGRESS

Jasper County
District 7

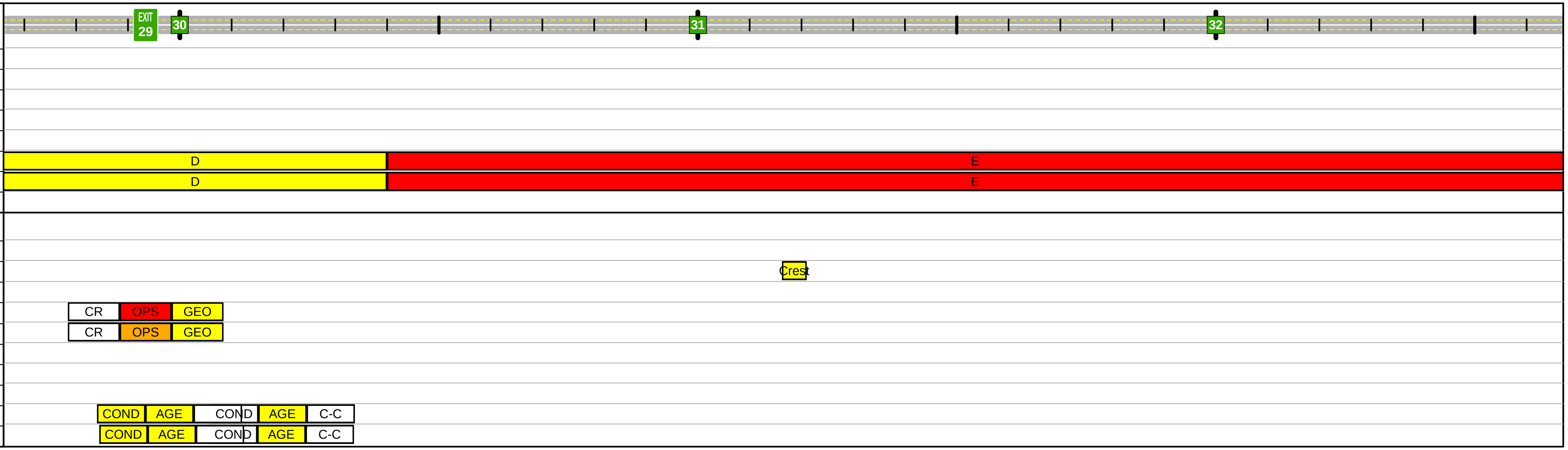
Figure 13
Mileposts: 30 - 32

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet
N

Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	D E
			EB	D E
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Crest
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE COND AGE C-C
		EB	COND AGE COND AGE C-C

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Lawrence County

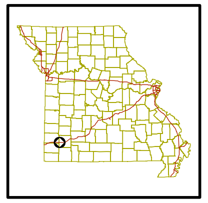
Purpose & Need Study
PLANNING FOR PROGRESS

Lawrence County
District 7

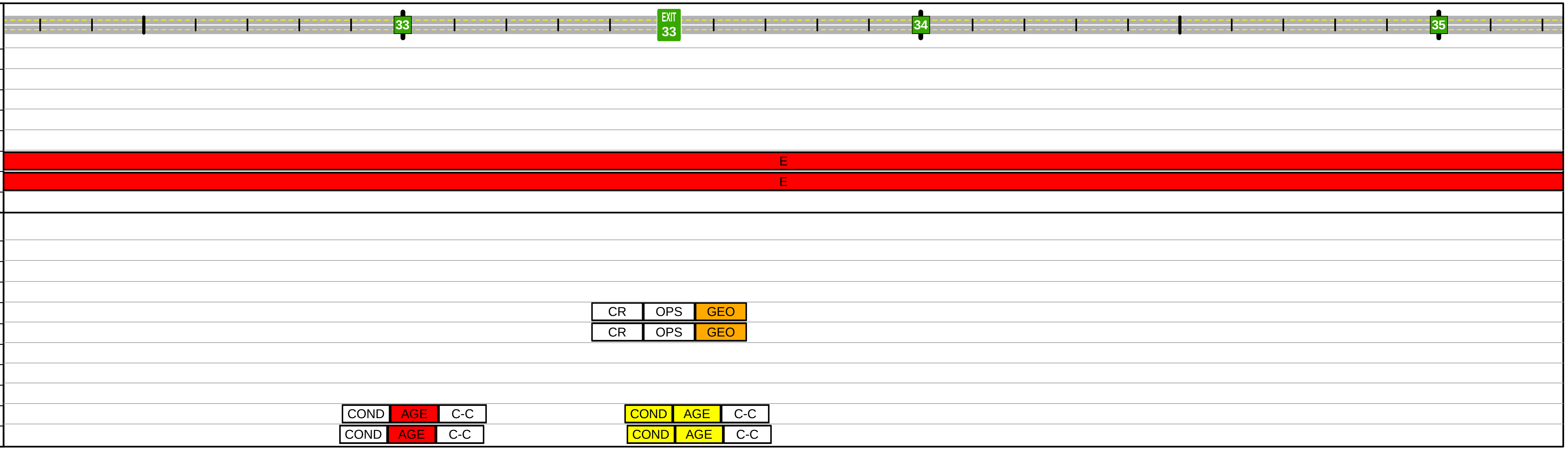
Figure 14
Mileposts: 33 - 35

LEGEND

▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)
Condition	
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability



MoDOT
CH2MHILL



Safety & Operational Characteristics				33 · EXIT 33 · 34 · 35
Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟥 E
			EB	🟥 E
	Significant Issue			
Physical Deficiencies				
Horizontal				
Vertical			WB	
			EB	
Interchange			WB	CR OPS 🟧 GEO
			EB	CR OPS 🟧 GEO
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND 🟥 AGE C-C 🟨 COND 🟨 AGE C-C
			EB	COND 🟥 AGE C-C 🟨 COND 🟨 AGE C-C

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PLANNING FOR PROGRESS

Lawrence County
District 7

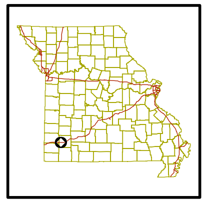
Figure 15
Mileposts: 36 - 37

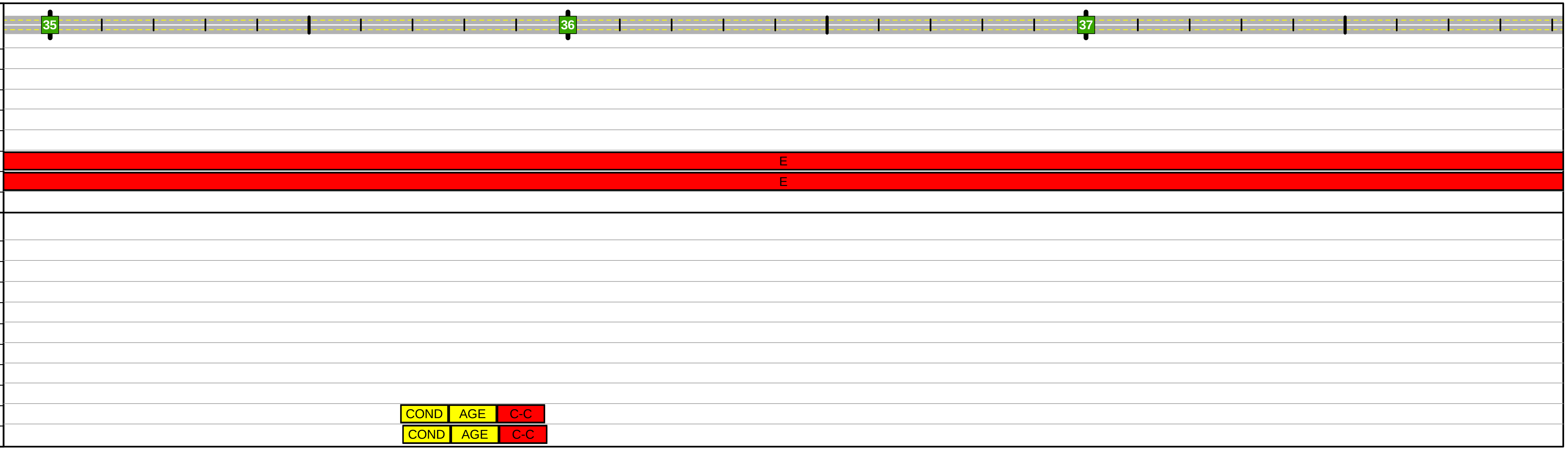
LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N





Safety & Operational Characteristics

				35–37
Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟥 E
			EB	🟥 E
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	
		EB	
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	🟨 COND 🟨 AGE 🟥 C-C
		EB	🟨 COND 🟨 AGE 🟥 C-C

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PLANNING FOR PROGRESS

Lawrence County
District 7

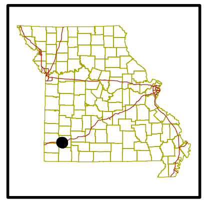
Figure 16
Mileposts: 38 - 40

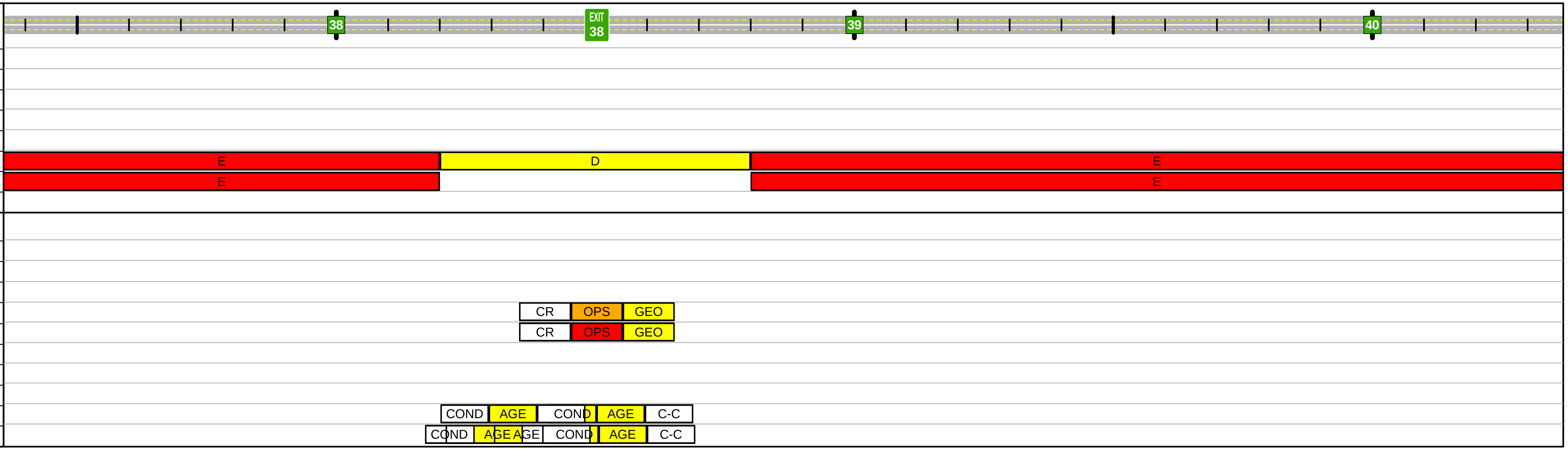
LEGEND
▨ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet
N

MoDOT

CH2MHILL





Safety & Operational Characteristics				
Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E | D | E
			EB	E | E
	Significant Issue			
Physical Deficiencies				
Horizontal				
Vertical			WB	
			EB	
Interchange			WB	CR | OPS | GEO
			EB	CR | OPS | GEO
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND | AGE | COND | AGE | C-C
			EB	COND | AGE | AGE | COND | AGE | C-C

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PLANNING FOR PROGRESS

Lawrence County
District 7

Figure 17
Mileposts: 41 - 42

LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

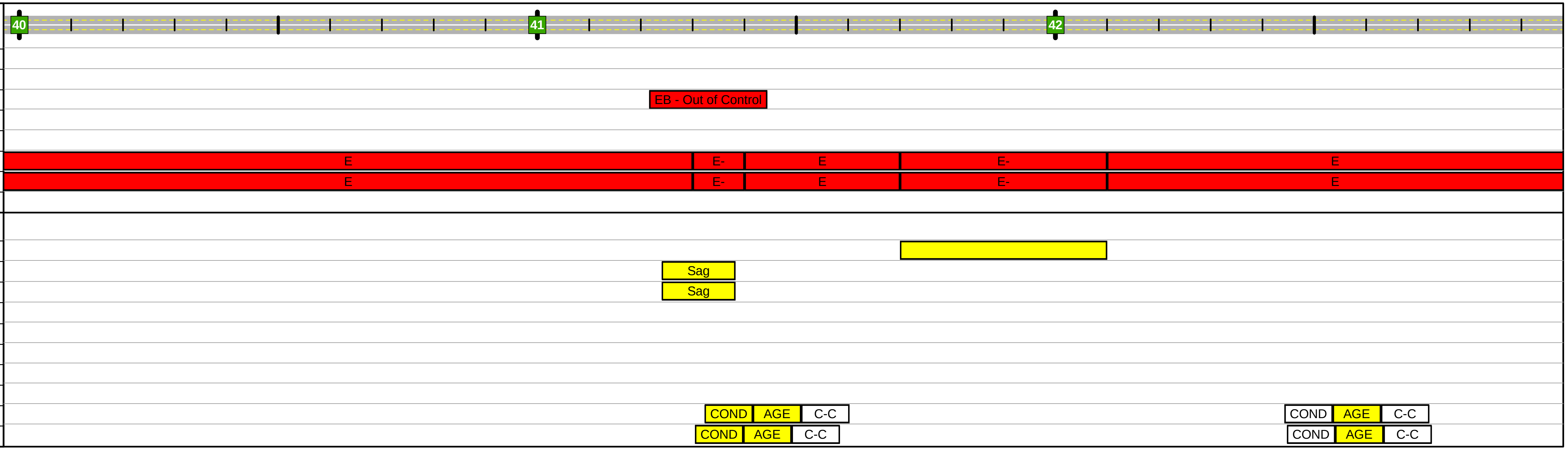
0 500 1,000
Feet

N

MoDOT

CH2MHILL

Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E | E- | E | E- | E
			EB	E | E- | E | E- | E
	Significant Issue			

Physical Deficiencies

Horizontal				🟨
Vertical			WB	Sag
			EB	Sag
Interchange			WB	
			EB	
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND AGE C-C COND AGE C-C
			EB	COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

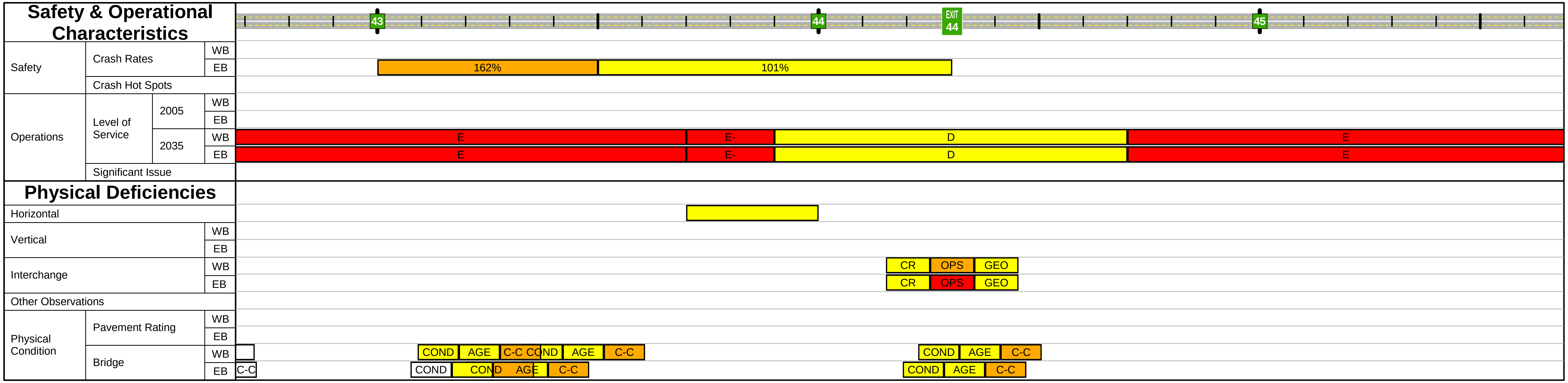
Lawrence County
District 7

Figure 18
Mileposts: 43 - 45

LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N



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Purpose & Need Study
PLANNING FOR PROGRESS

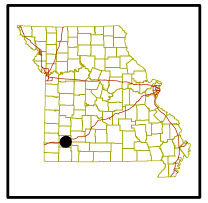
Lawrence County
District 7

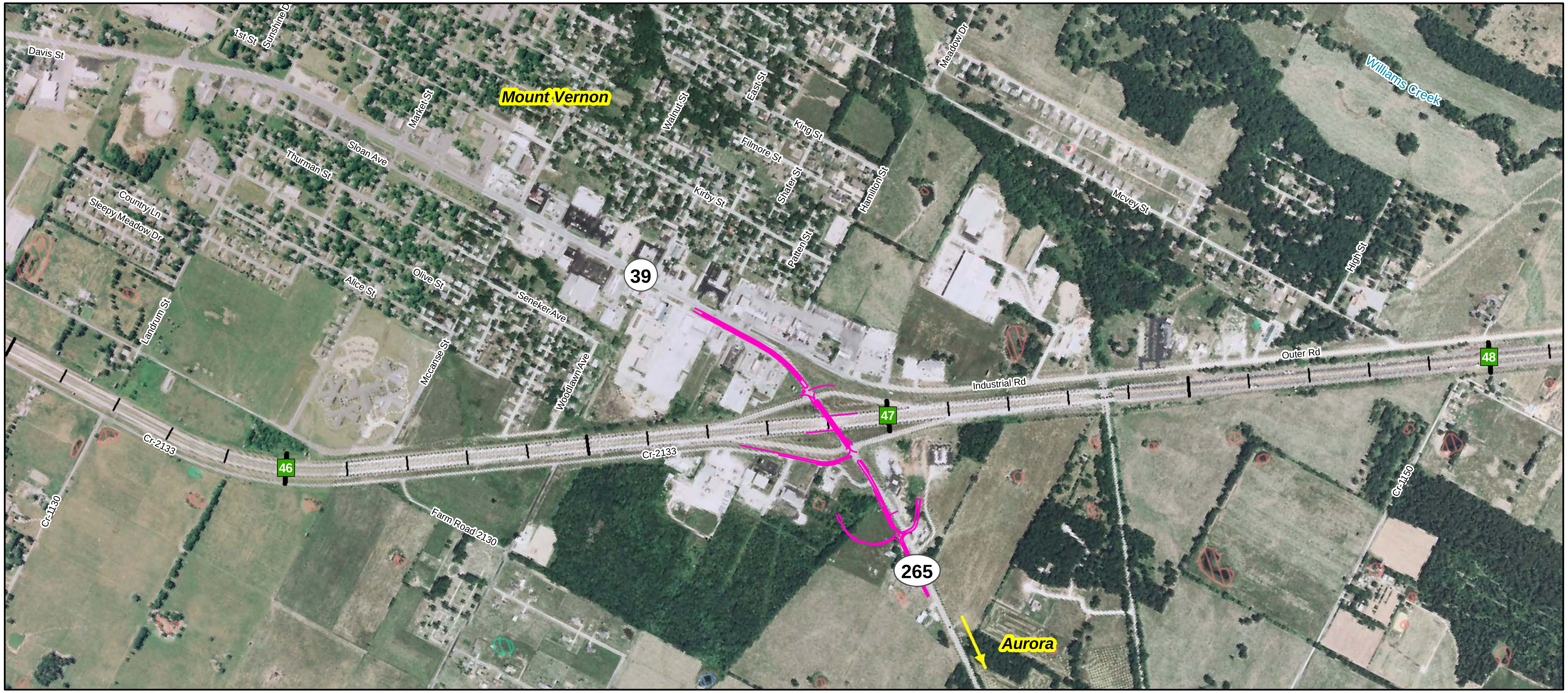
Figure 19
Mileposts: 46 - 48

LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

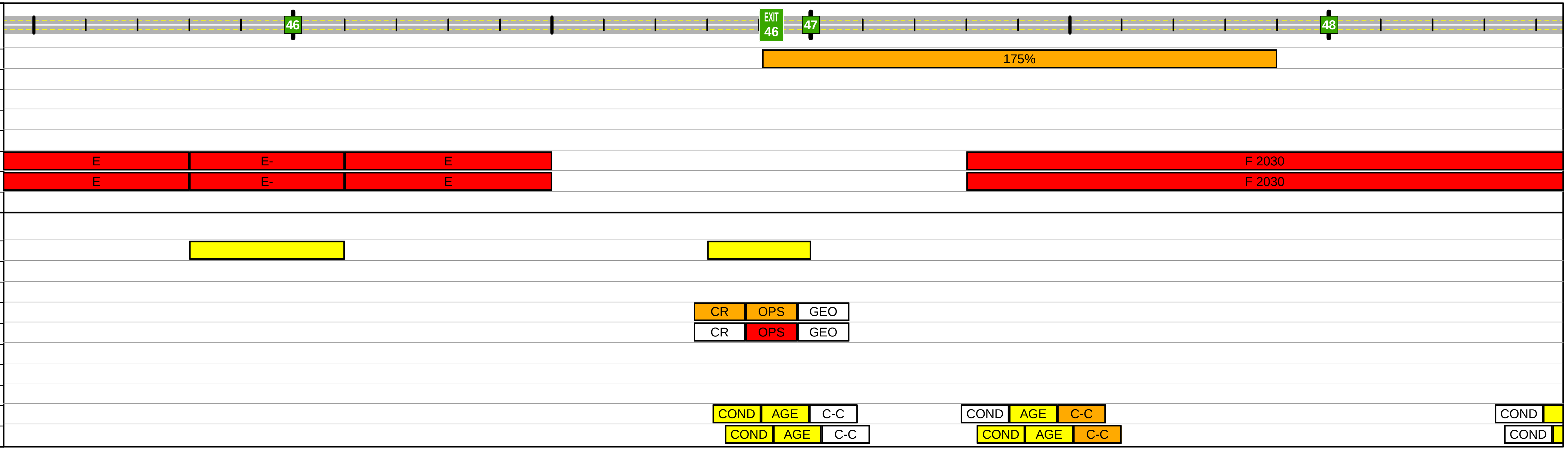
0 500 1,000
Feet

MoDOT
CH2MHILL





Safety & Operational Characteristics



Safety	Crash Rates		WB	175%
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E E- E F 2030
			EB	E E- E F 2030
	Significant Issue			

Physical Deficiencies

Horizontal			🟨 🟨
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C COND
		EB	COND AGE C-C COND AGE C-C COND

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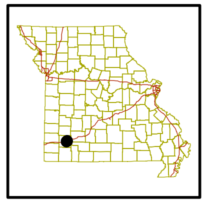
Lawrence County
District 7

Figure 20
Mileposts: 49 - 50

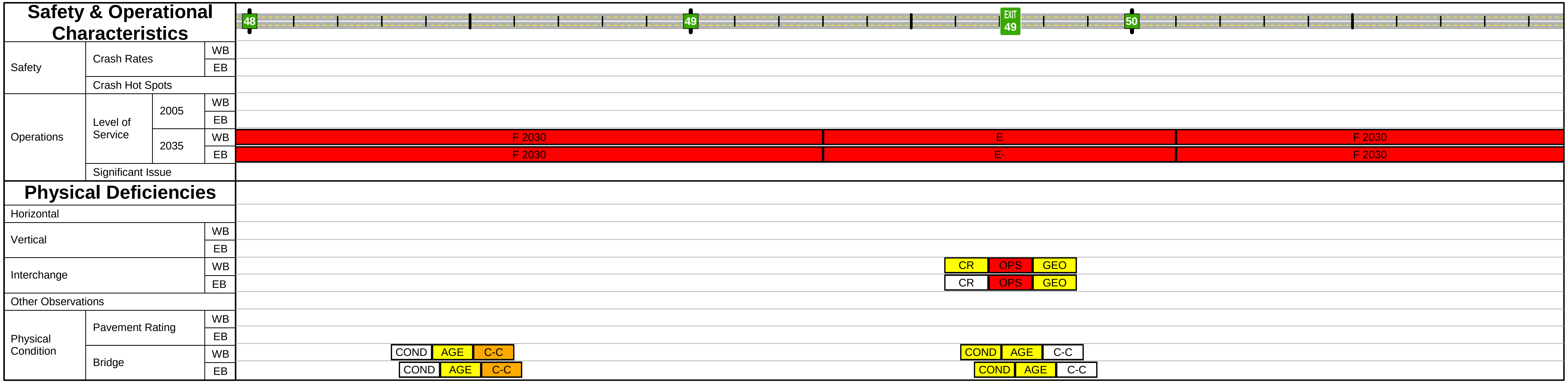
LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N



MoDOT
CH2MHILL



Safety & Operational Characteristics

Safety	Crash Rates		WB			
			EB			
	Crash Hot Spots					
Operations	Level of Service	2005	WB			
			EB			
		2035	WB	F 2030	E	F 2030
			EB	F 2030	E-	F 2030
	Significant Issue					

Physical Deficiencies

Horizontal				
Vertical		WB		
		EB		
Interchange		WB		CR OPS GEO
		EB		CR OPS GEO
Other Observations				
Physical Condition	Pavement Rating	WB		
		EB		
	Bridge	WB	COND AGE C-C	COND AGE C-C
		EB	COND AGE C-C	COND AGE C-C

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PLANNING FOR PROGRESS

Lawrence County
District 7

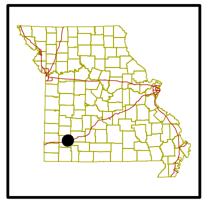
Figure 21
Mileposts: 51 - 53

LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

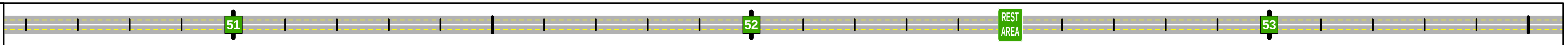
0 500 1,000
Feet

MoDOT

CH2MHILL



Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟥 F 2030
			EB	🟥 F 2030
	Significant Issue			

Physical Deficiencies

Horizontal				
Vertical		WB	🟨 Crest	🟨 Long Grade
		EB	🟨 Crest	🟨 Long Grade
Interchange		WB		
		EB		
Other Observations				
Physical Condition	Pavement Rating	WB		
		EB		
	Bridge	WB		
		EB		

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Purpose & Need Study
PLANNING FOR PROGRESS

Lawrence County
District 7

Figure 22
Mileposts: 54 - 55

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

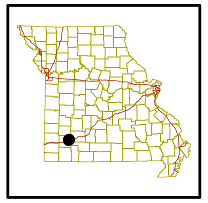
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL

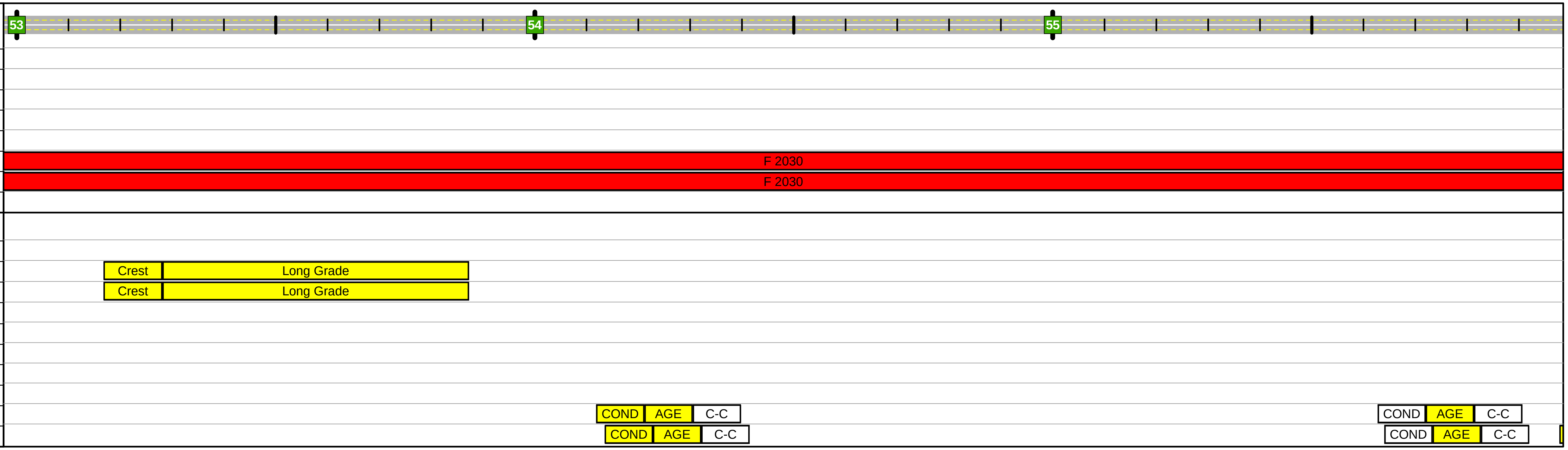


Safety & Operational Characteristics

- Safety
  - Crash Rates: WB, EB
  - Crash Hot Spots
- Operations
  - Level of Service
    - 2005: WB, EB
    - 2035: WB, EB
  - Significant Issue

Physical Deficiencies

- Horizontal
- Vertical: WB, EB
- Interchange: WB, EB
- Other Observations
- Physical Condition
  - Pavement Rating: WB, EB
  - Bridge: WB, EB



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Purpose & Need Study
PLANNING FOR PROGRESS

Lawrence County
District 7

Figure 23
Mileposts: 56 - 58

LEGEND

▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)

Condition

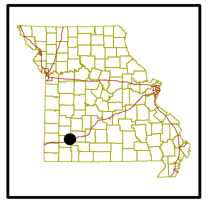
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

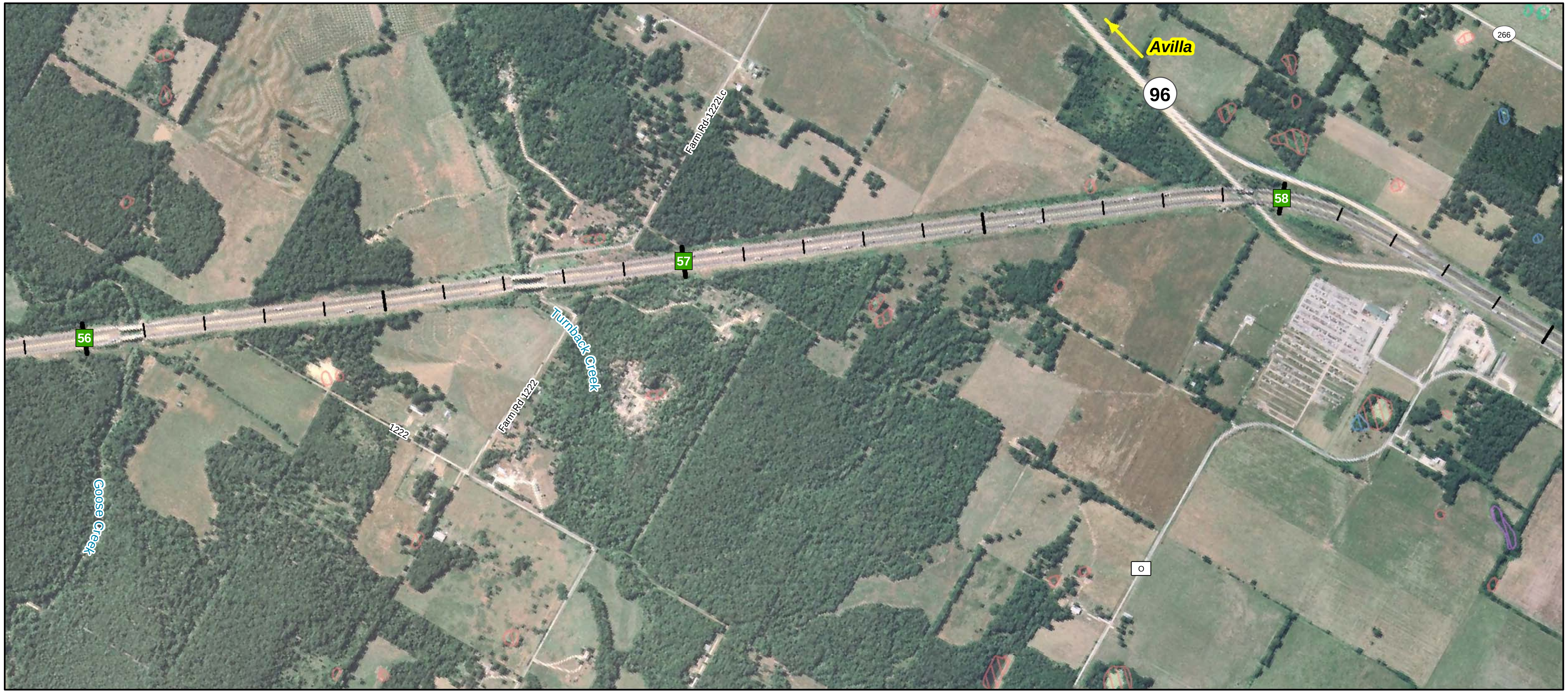
0 500 1,000
Feet

N

MoDOT

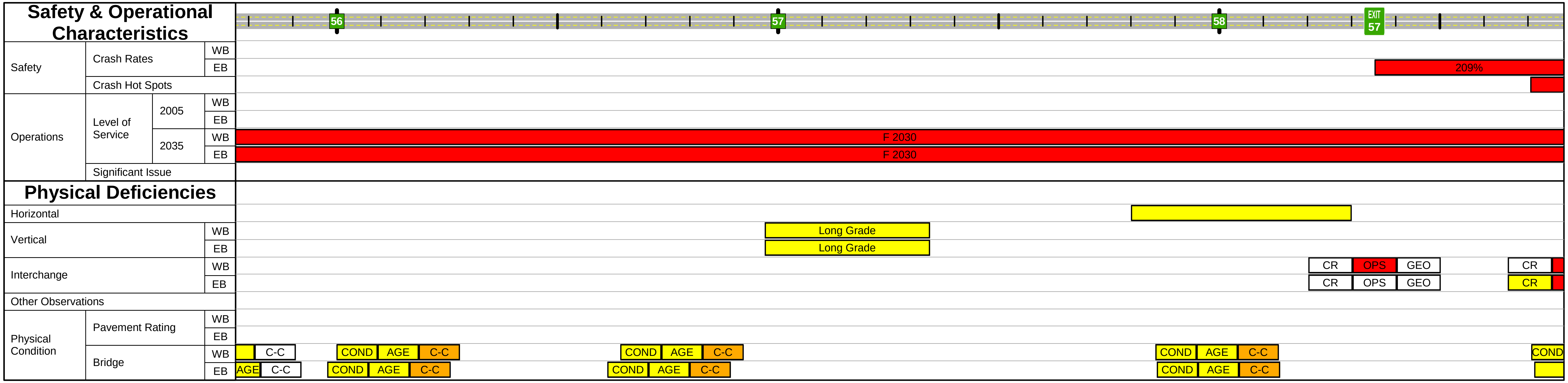
CH2MHILL





Safety & Operational Characteristics

Physical Deficiencies



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Greene County

Purpose & Need Study
PLANNING FOR PROGRESS

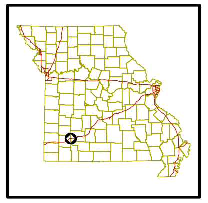
Lawrence County
Greene County
District 7 & 8

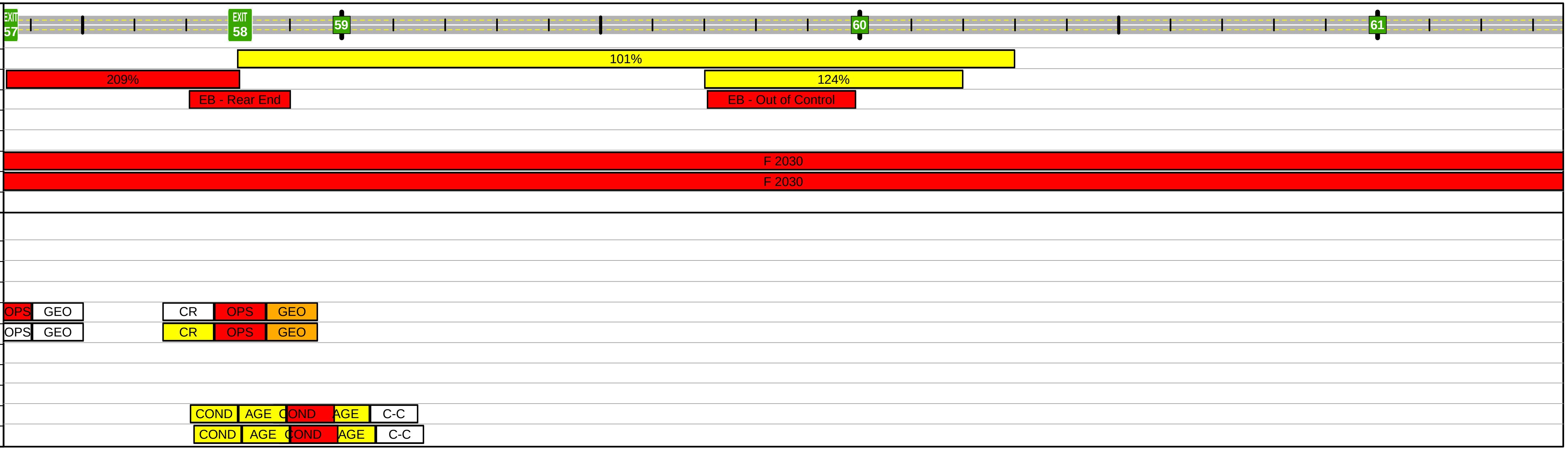
Figure 24
Mileposts: 59 - 61

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet
N





Safety & Operational Characteristics				
Safety	Crash Rates		WB	101%
			EB	209% 124%
	Crash Hot Spots			EB - Rear End EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2030
			EB	F 2030
	Significant Issue			
Physical Deficiencies				
Horizontal				
Vertical			WB	
			EB	
Interchange			WB	OPS GEO CR OPS GEO
			EB	OPS GEO CR OPS GEO
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND AGE COND AGE C-C
			EB	COND AGE COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Greene County
District 8

Figure 25
Mileposts: 62 - 63

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

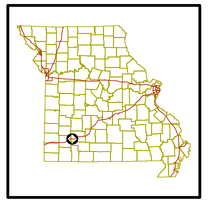
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

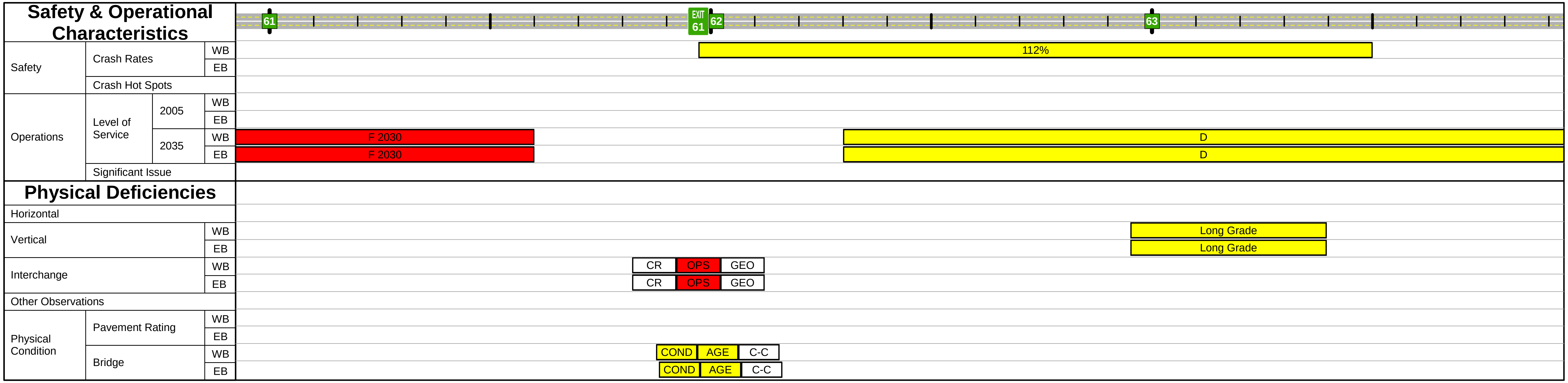
N

MoDOT

CH2MHILL



Safety & Operational Characteristics



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Purpose & Need Study
PLANNING FOR PROGRESS

Greene County
District 8

Figure 26
Mileposts: 64 - 66

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

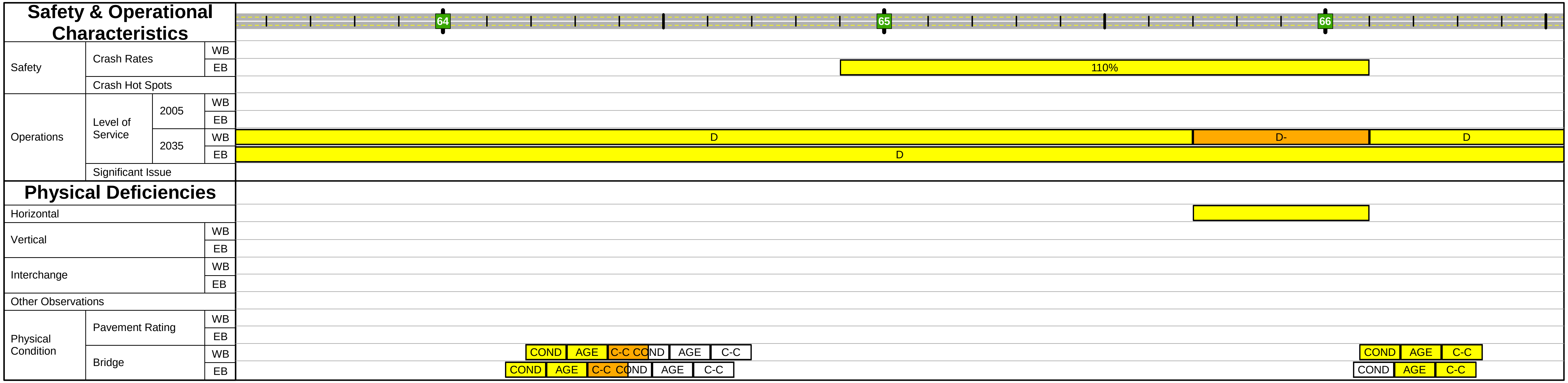
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



Jun 17, 2008

Purpose & Need Study
PLANNING FOR PROGRESS

Greene County
District 8

Figure 27
Mileposts: 67 - 68

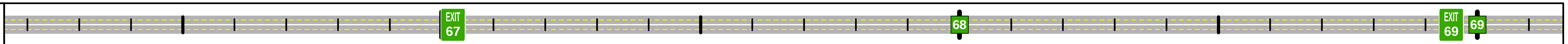
LEGEND
- 🟥 County Boundary
- 🟩 Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

MoDOT
CH2MHILL

Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	D; D
			EB	D
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR; OPS; GEO; CR; OPS; GEO
		EB	CR; OPS; GEO; CR; OPS; GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	AGE; C-C; COND; AGE; C-C; COND; AGE; C-C
		EB	AGE; C-C; COND; AGE; C-C; COND; AGE; C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Greene County
District 8

Figure 28
Mileposts: 69 - 71

LEGEND

⬚	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)

Condition

🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

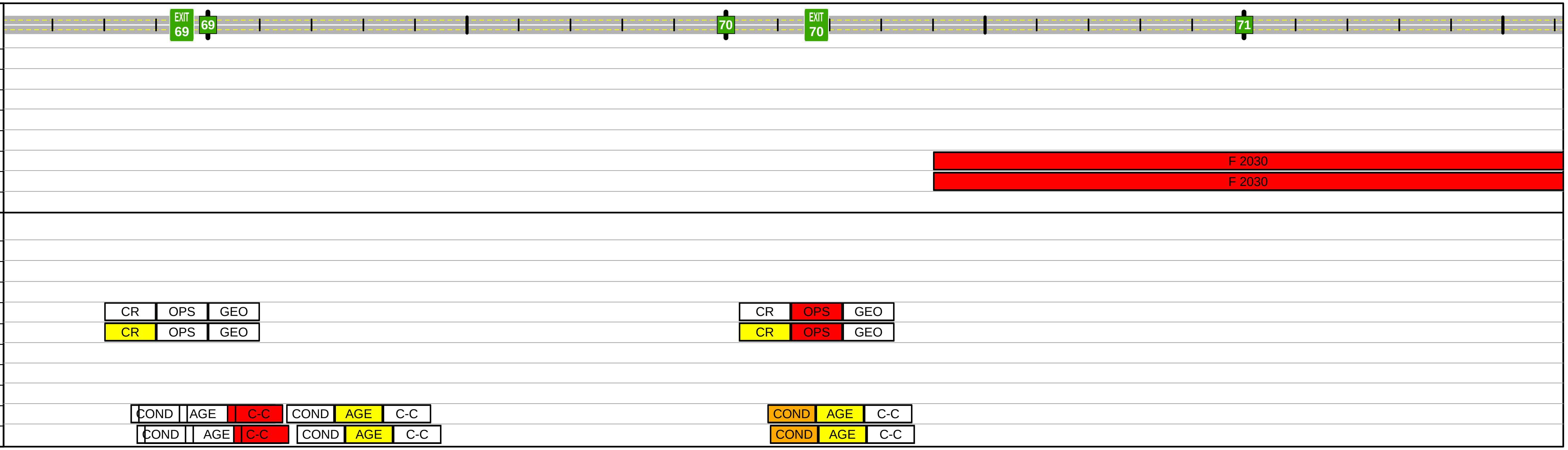
0 500 1,000
Feet

N

MoDOT

CH2MHILL

Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟥 F 2030
			EB	🟥 F 2030
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO CR 🟥 OPS GEO
		EB	🟨 CR OPS GEO 🟨 CR 🟥 OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE 🟥 C-C COND 🟨 AGE C-C 🟧 COND 🟨 AGE C-C
		EB	COND AGE 🟥 C-C COND 🟨 AGE C-C 🟧 COND 🟨 AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Greene County
District 8

Figure 29
Mileposts: 72 - 74

LEGEND

▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)

Condition

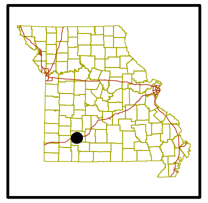
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

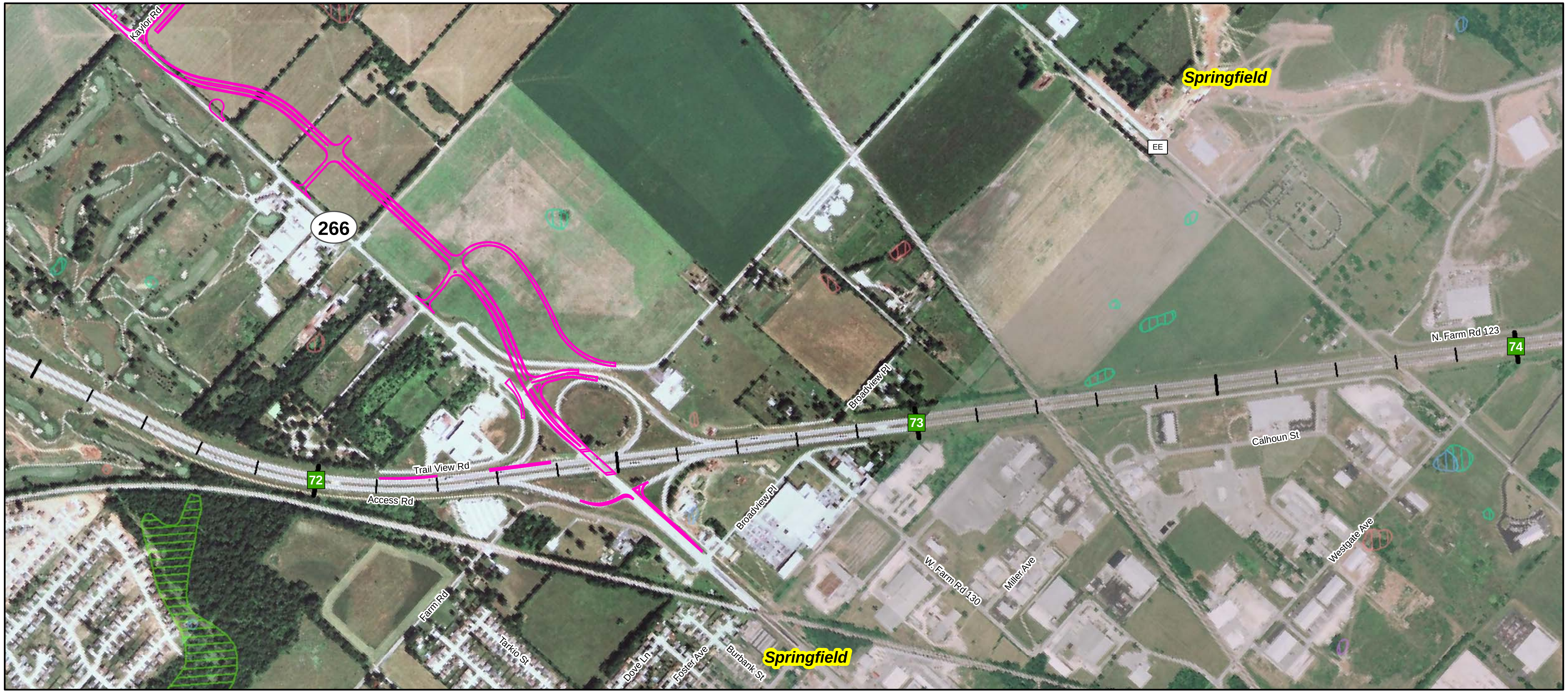
0 500 1,000
Feet

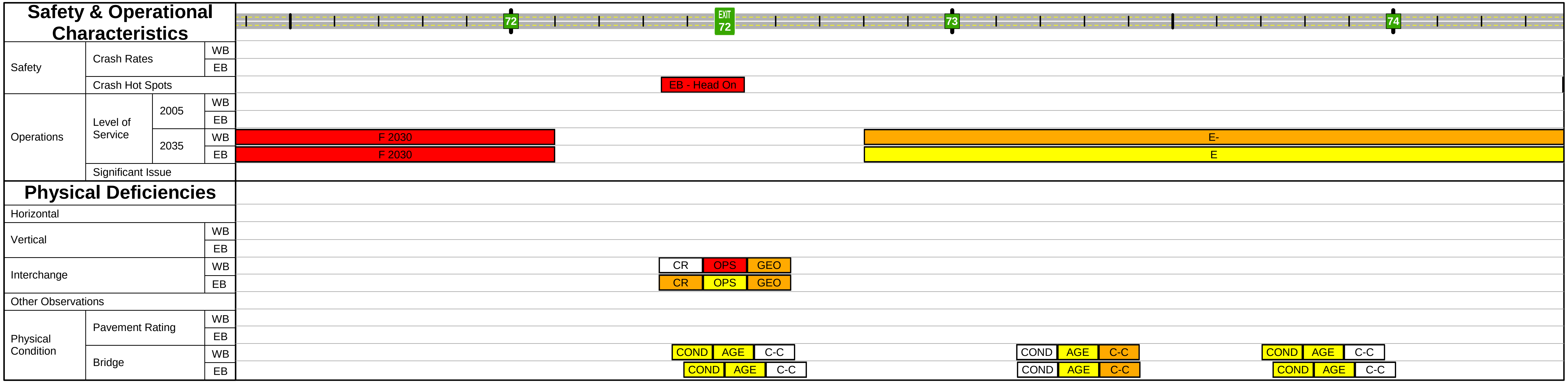
N

MoDOT

CH2MHILL







Safety & Operational Characteristics

Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			EB - Head On
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2030 E-
			EB	F 2030 E
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C COND AGE C-C

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PLANNING FOR PROGRESS

Greene County
District 8

Figure 30
Mileposts: 75 - 76

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

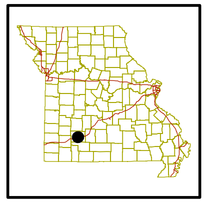
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

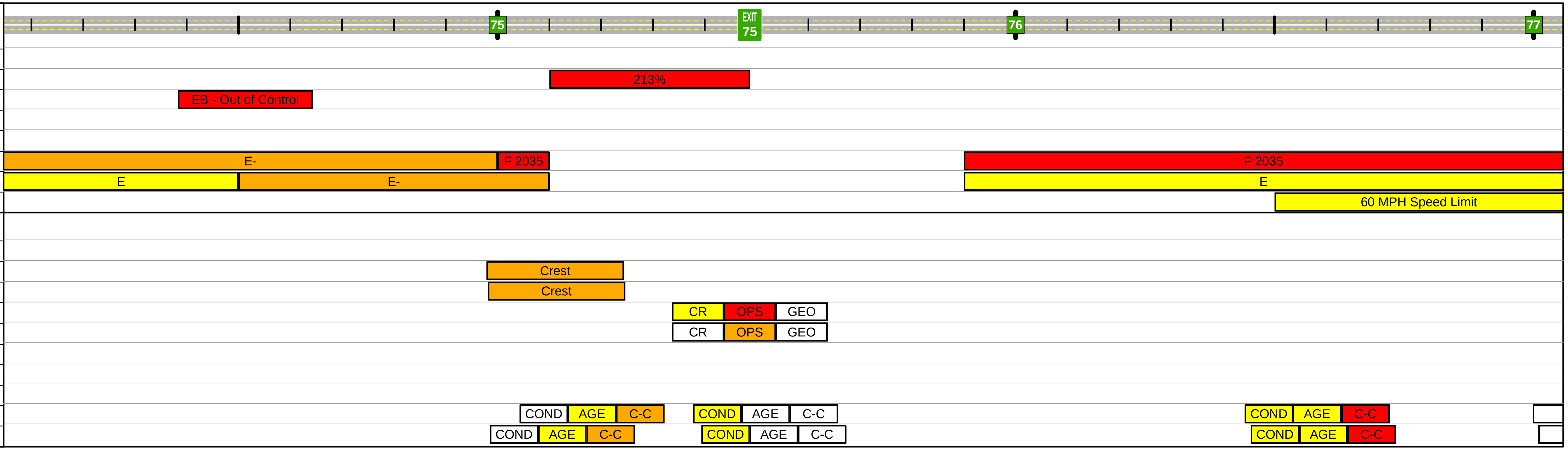
N

MoDOT

CH2MHILL



Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	213%
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E- · F 2035 · F 2035
			EB	E · E- · E
	Significant Issue			60 MPH Speed Limit

Physical Deficiencies

Horizontal			
Vertical		WB	Crest
		EB	Crest
Interchange		WB	CR · OPS · GEO
		EB	CR · OPS · GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND · AGE · C-C · COND · AGE · C-C · COND · AGE · C-C
		EB	COND · AGE · C-C · COND · AGE · C-C · COND · AGE · C-C

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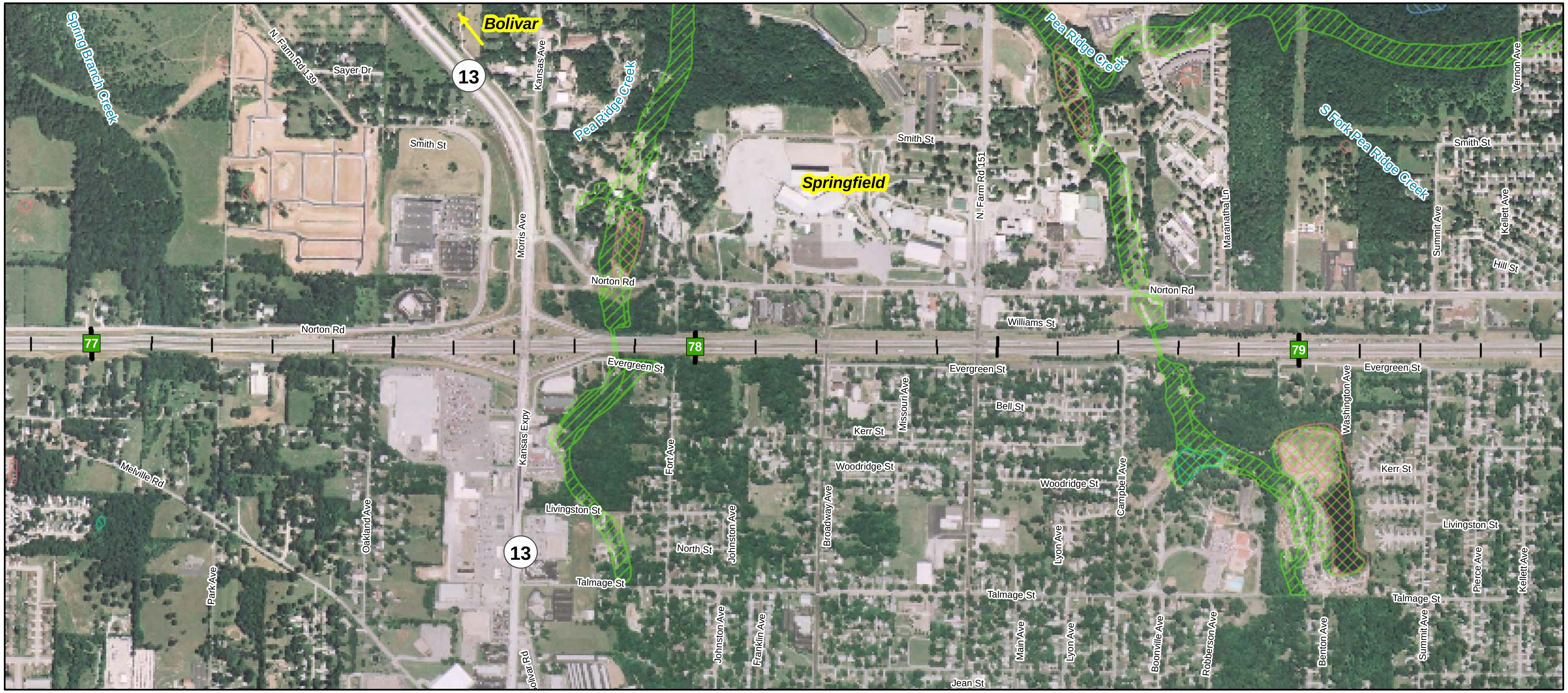
Purpose & Need Study
PLANNING FOR PROGRESS

Greene County
District 8

Figure 31
Mileposts: 77 - 79

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability



MoDOT

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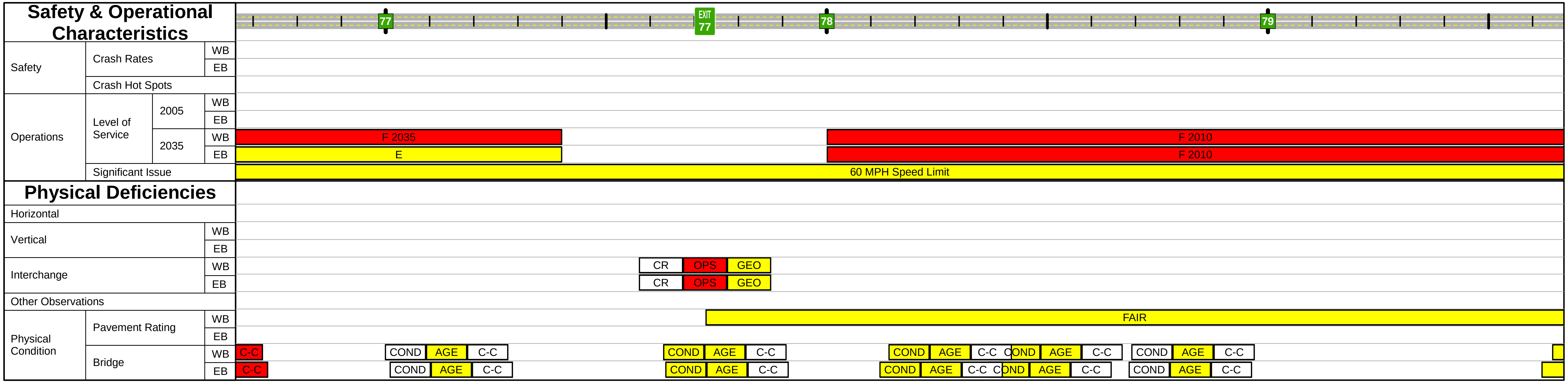
Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2035 F 2010
			EB	E F 2010
	Significant Issue			60 MPH Speed Limit

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR
		EB	
	Bridge	WB	C-C COND AGE C-C COND AGE C-C COND AGE C-C COND AGE C-C COND AGE C-C
		EB	C-C COND AGE C-C COND AGE C-C COND AGE C-C COND AGE C-C COND AGE C-C

Jun 17, 2008

Purpose & Need Study
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Greene County
District 8

Figure 32
Mileposts: 80 - 82

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

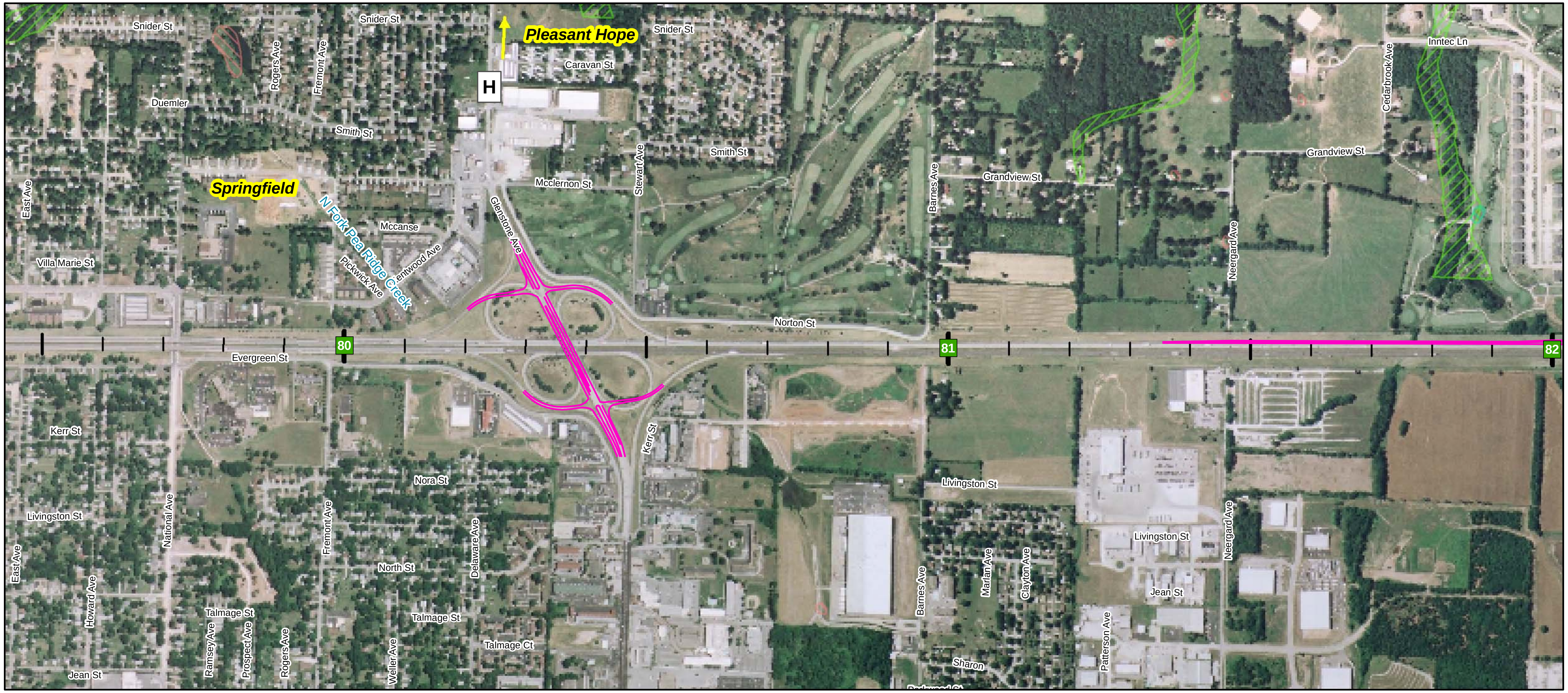
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

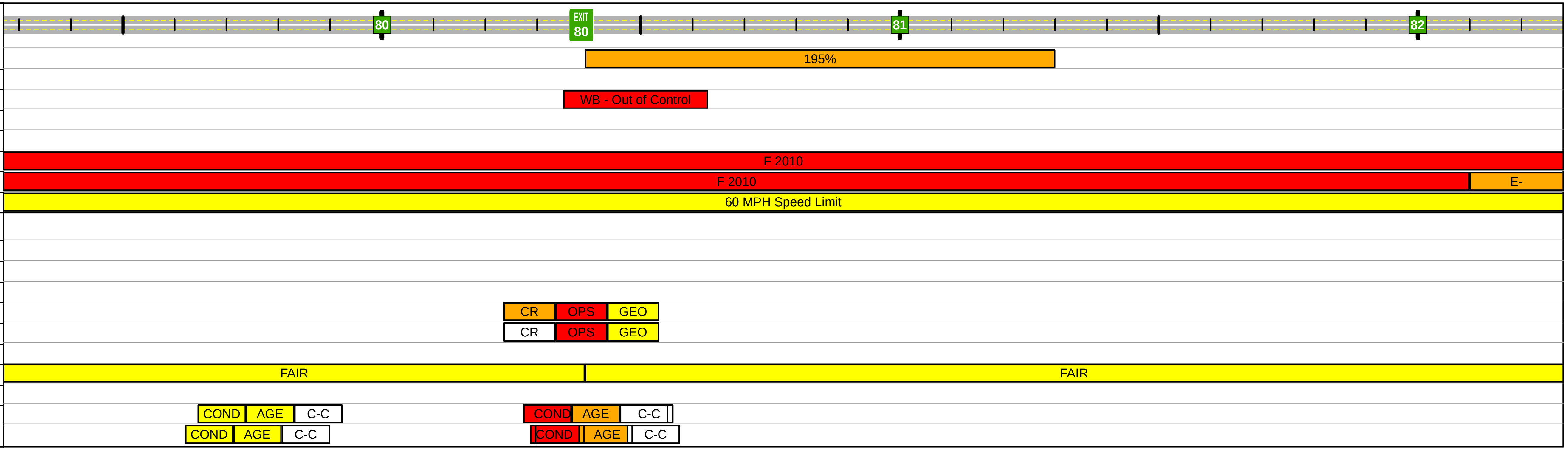
0 500 1,000
Feet

N

MoDOT

CH2MHILL





Safety & Operational Characteristics

Safety	Crash Rates		WB	195%
			EB	
	Crash Hot Spots			WB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2010
			EB	F 2010 E-
	Significant Issue			60 MPH Speed Limit

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR FAIR
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Greene County
District 8

Figure 33
Mileposts: 83 - 84

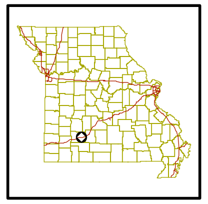
LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

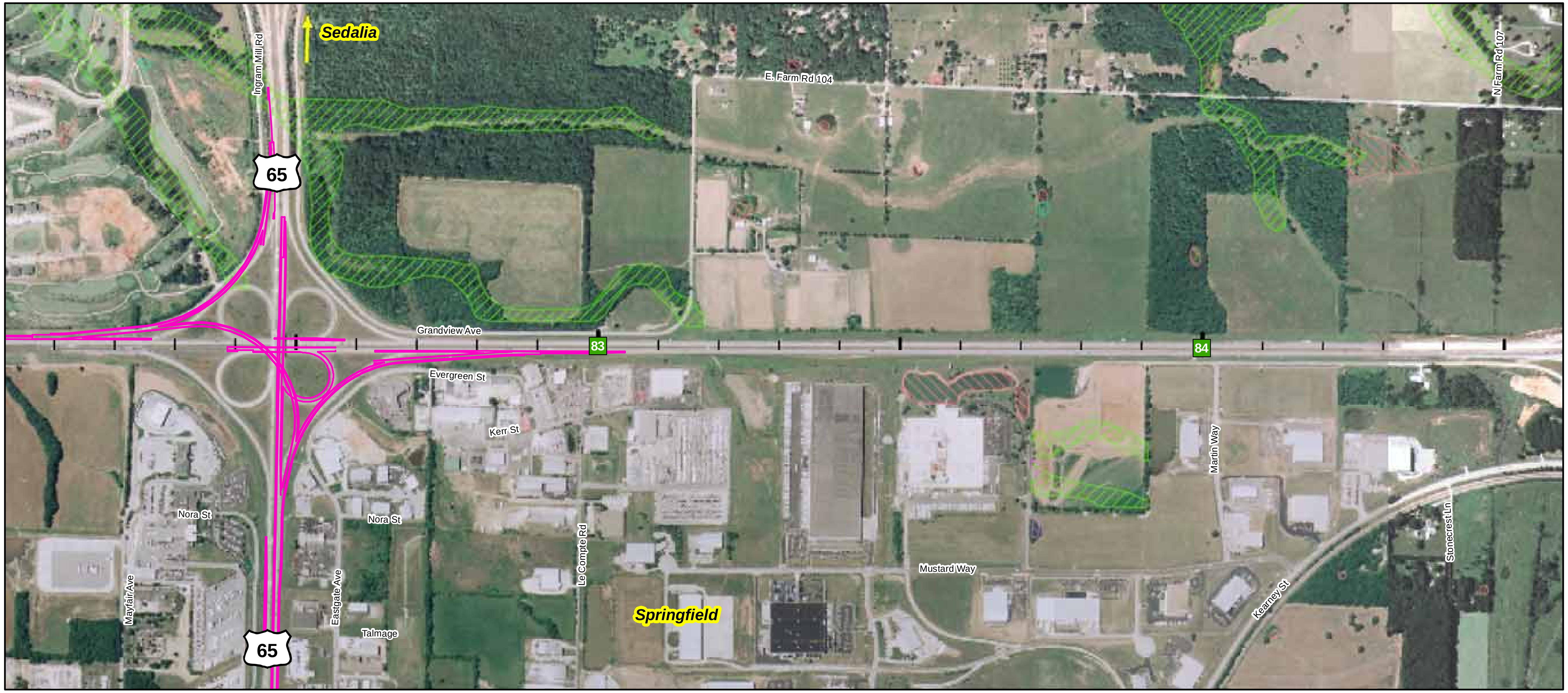
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

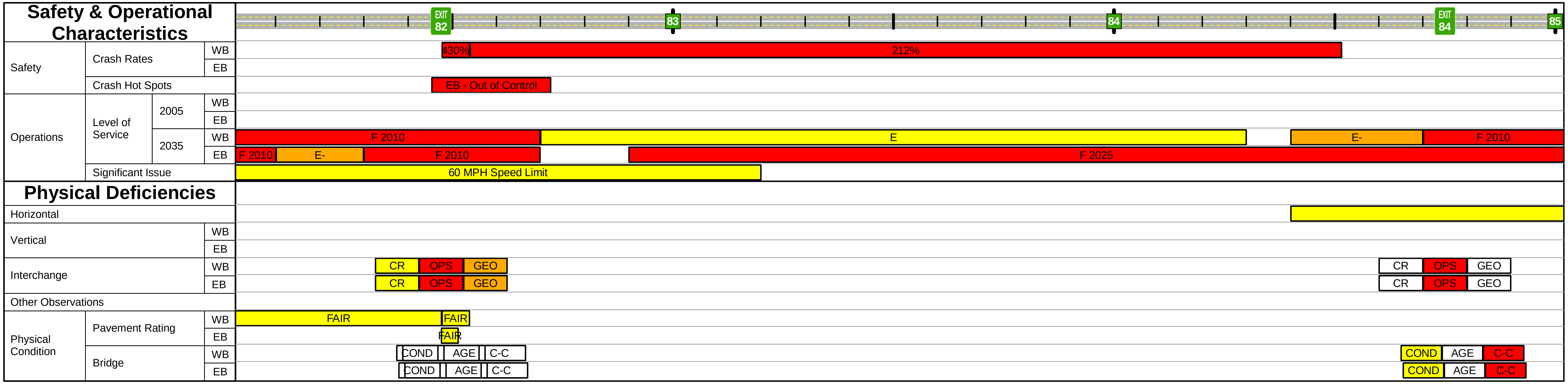
0 500 1,000
Feet
N

MoDOT

CH2MHILL







Safety & Operational Characteristics

Safety	Crash Rates		WB	430% 212%
			EB	
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2010 E E- F 2010
			EB	F 2010 E- F 2010 F 2025
	Significant Issue			60 MPH Speed Limit

Physical Deficiencies

Horizontal			🟨
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO CR OPS GEO
		EB	CR OPS GEO CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR FAIR
		EB	FAIR
	Bridge	WB	COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C

Jul 14, 2008

Purpose & Need Study
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Greene County
District 8

Figure 34
Mileposts: 85 - 87

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

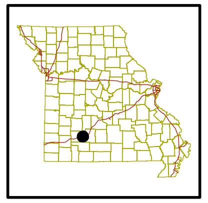
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

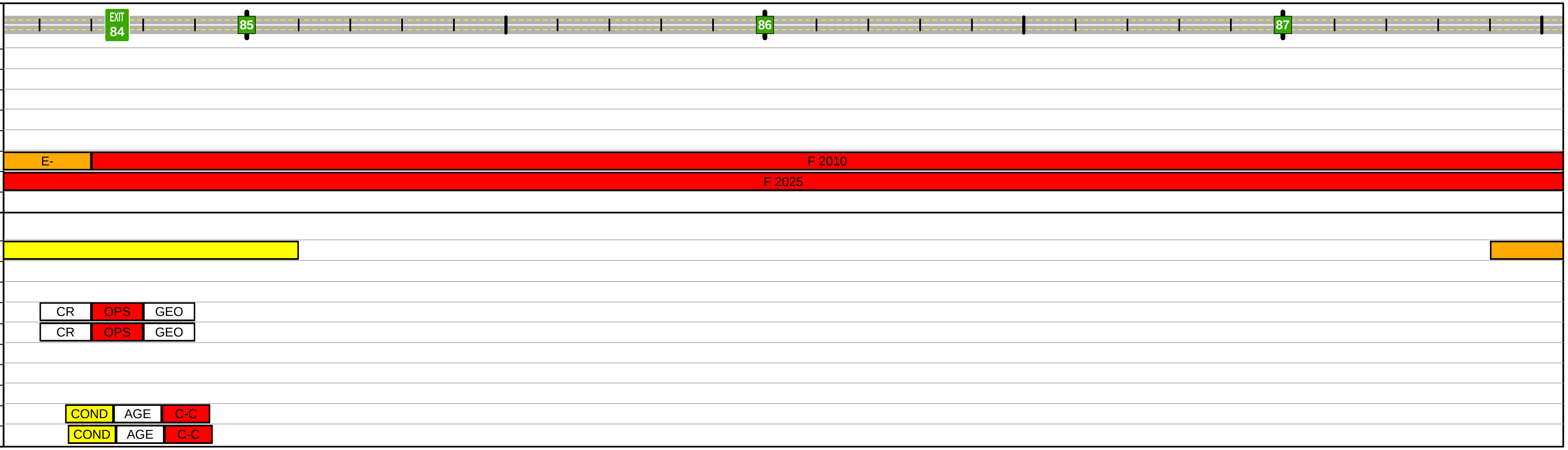
N

MoDOT

CH2MHILL



Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟧 E- 🟥 F 2010
			EB	🟥 F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			🟨 🟧
Vertical		WB	
		EB	
Interchange		WB	CR 🟥 OPS GEO
		EB	CR 🟥 OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	🟨 COND AGE 🟥 C-C
		EB	🟨 COND AGE 🟥 C-C

Jun 17, 2008

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PLANNING FOR PROGRESS

Greene County
District 8

Figure 35
Mileposts: 88 - 89

LEGEND

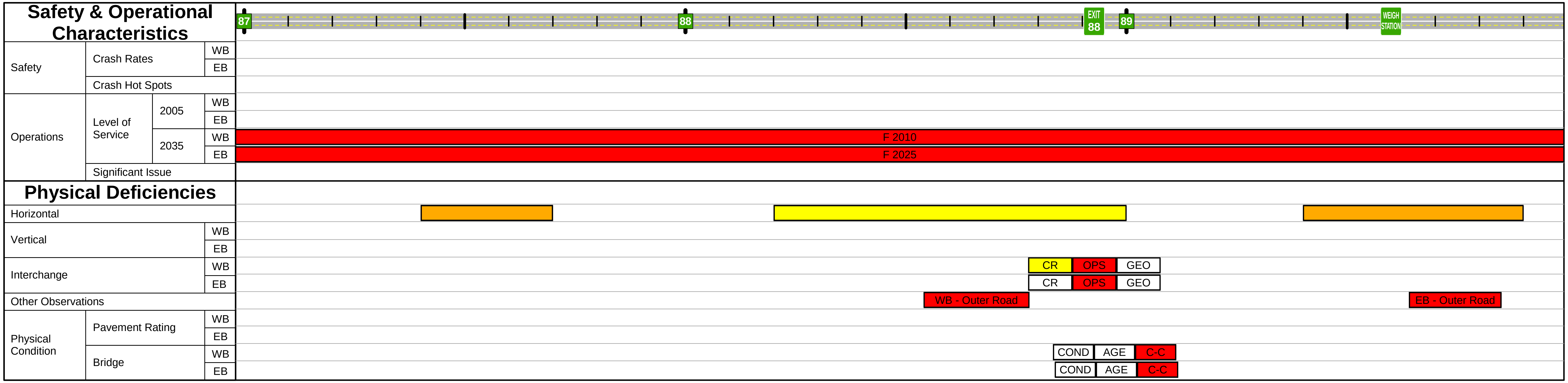
▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)
Condition	
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



Safety & Operational Characteristics

Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2010
			EB	F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			🟧 🟨 🟧
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			WB - Outer Road EB - Outer Road
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C
		EB	COND AGE C-C

Jun 17, 2008

Webster County

Purpose & Need Study
PLANNING FOR PROGRESS

Greene County
Webster County
District 8

Figure 36
Mileposts: 90 - 92

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

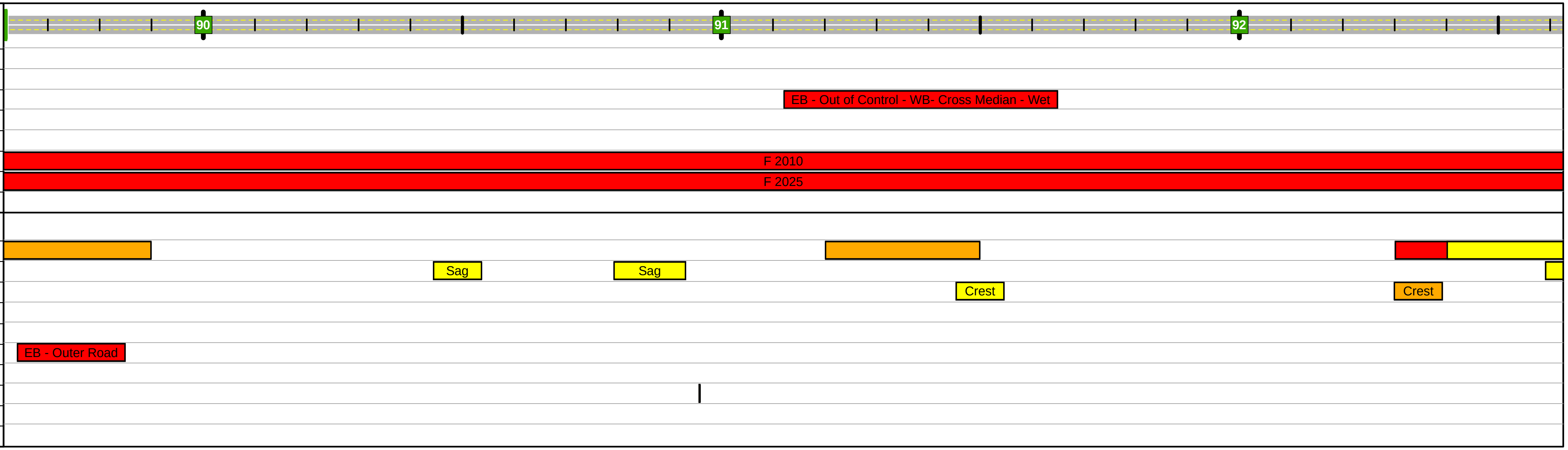
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



Safety & Operational Characteristics

Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			EB - Out of Control - WB- Cross Median - Wet
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2010
			EB	F 2025
	Significant Issue			

Physical Deficiencies

Horizontal				🟧 🟧 🟥 🟨
Vertical			WB	Sag Sag 🟨
			EB	Crest Crest
Interchange			WB	
			EB	
Other Observations				EB - Outer Road
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	
			EB	

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Purpose & Need Study
PLANNING FOR PROGRESS

Webster County
District 8

Figure 37
Mileposts: 93 - 95

LEGEND

⬚	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)

Condition

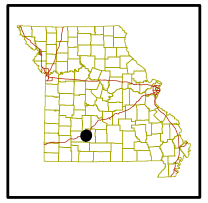
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

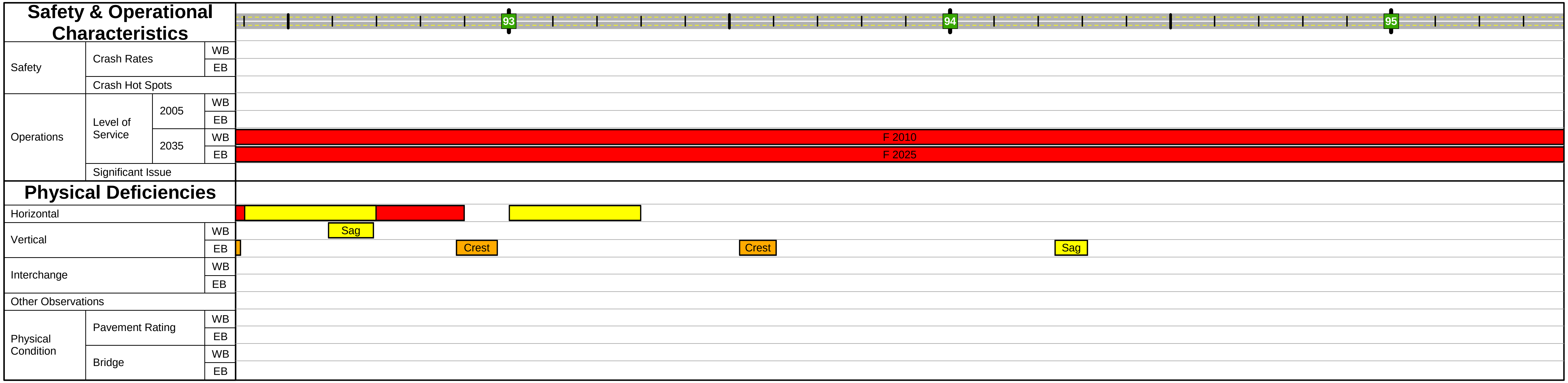
0 500 1,000
Feet

N

MoDOT

CH2MHILL





Jun 17, 2008

Purpose & Need Study
PLANNING FOR PROGRESS

Webster County
District 8

Figure 38
Mileposts: 96 - 97

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

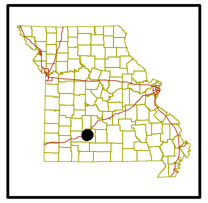
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

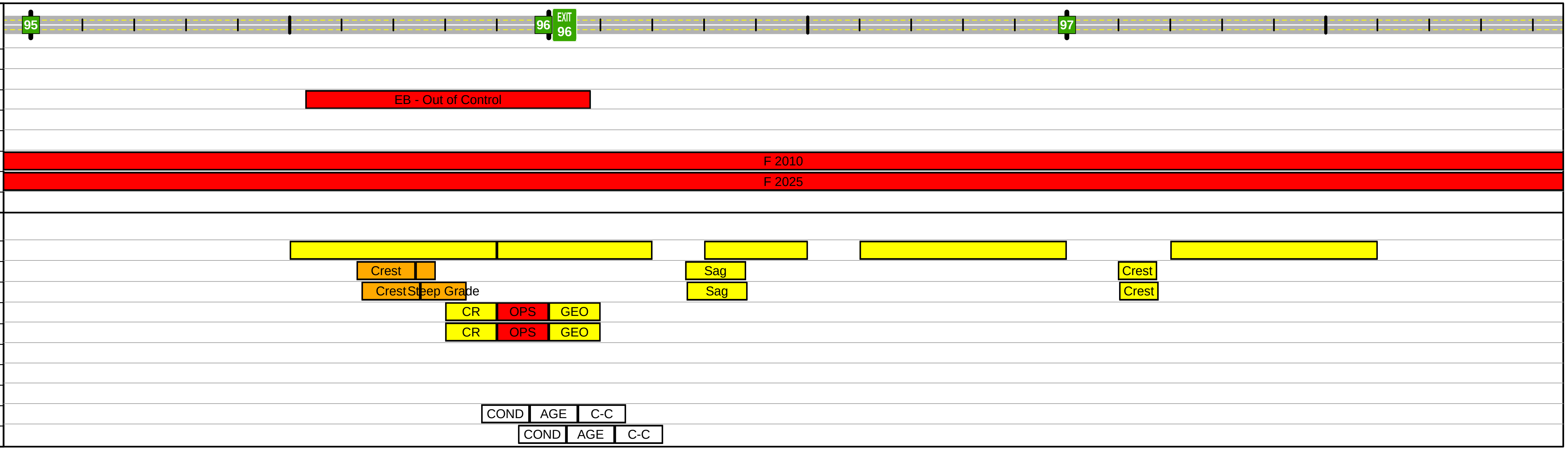
N

MoDOT

CH2MHILL



Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2010
			EB	F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Crest Sag Crest
		EB	Crest Steep Grade Sag Crest
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C
		EB	COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Webster County
District 8

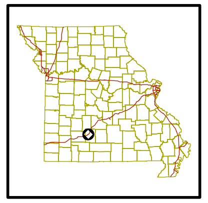
Figure 39
Mileposts: 98 - 100

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N



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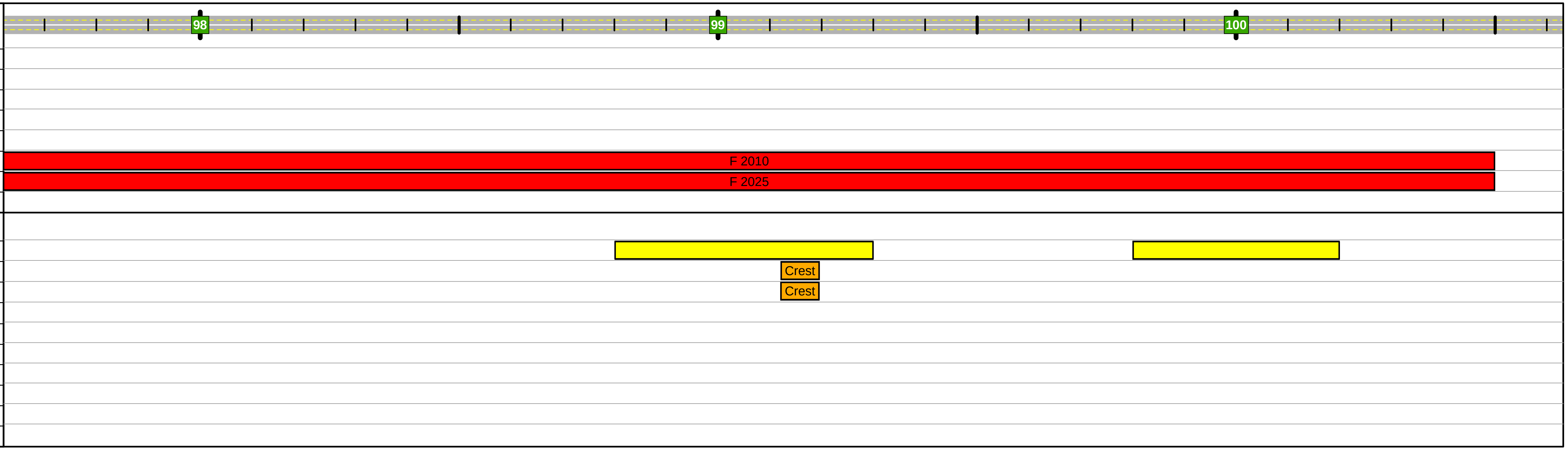

Safety & Operational Characteristics

Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2010
			EB	F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			🟨 🟨
Vertical		WB	Crest
		EB	Crest
Interchange		WB	
		EB	
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	
		EB	

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PLANNING FOR PROGRESS

Webster County
District 8

Figure 40
Mileposts: 100 - 103

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

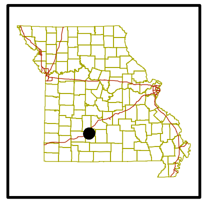
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

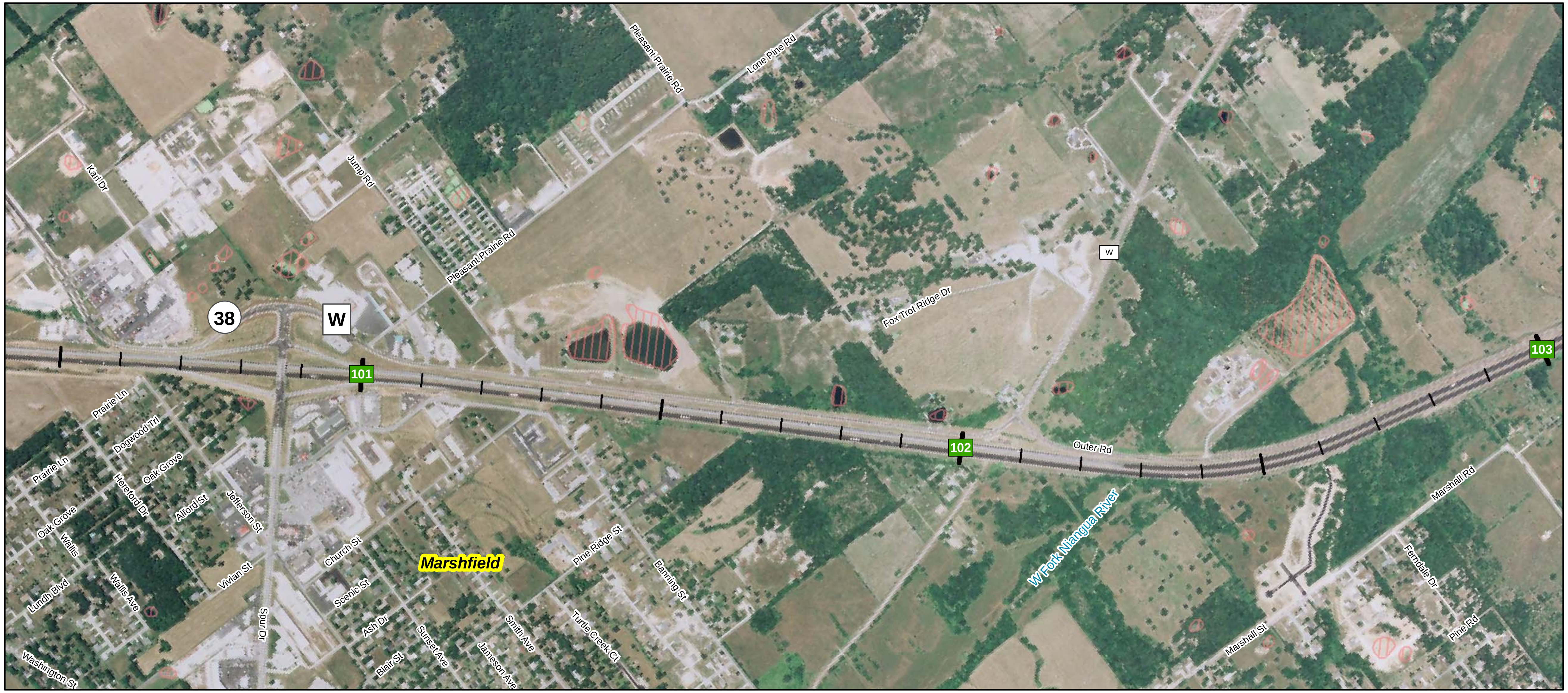
0 500 1,000
Feet

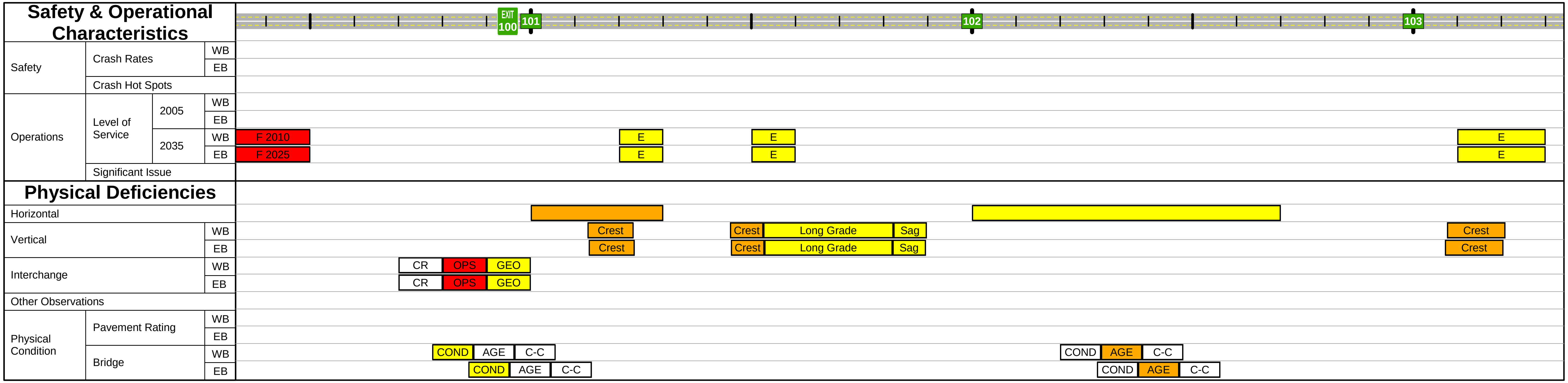
N

MoDOT

CH2MHILL







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Purpose & Need Study
PLANNING FOR PROGRESS

Webster County
District 8

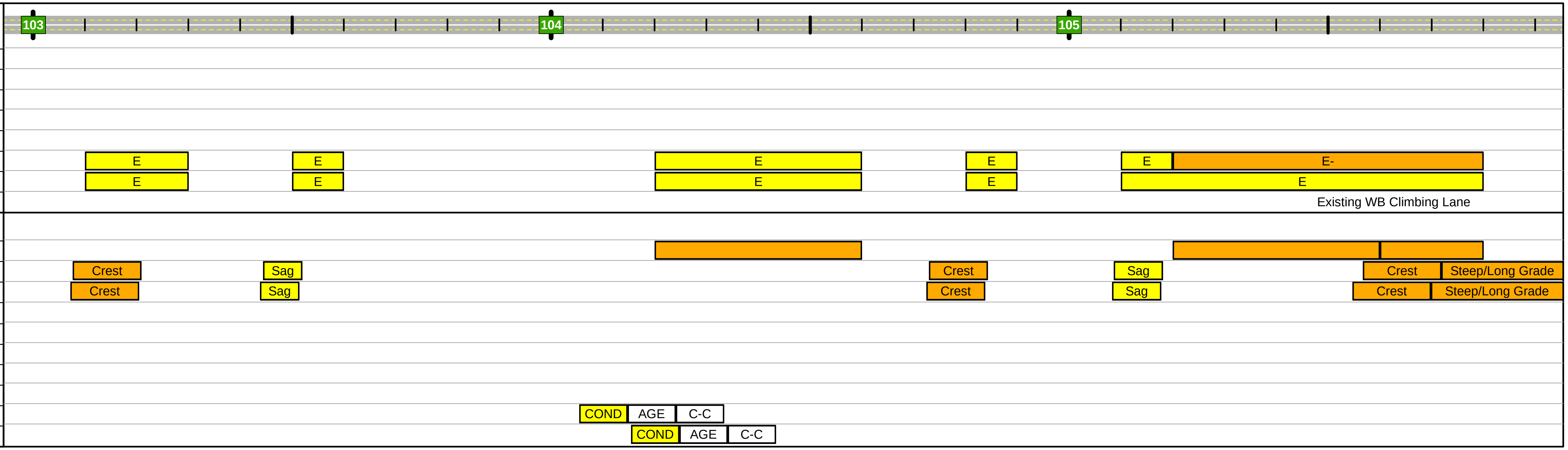
Figure 41
Mileposts: 104 - 105

LEGEND
- County Boundary
- 🟩 Floodplain
- 🟥 Palustrine Pond (PUB)
- 🟩 Palustrine Emergent (PEM)
- 🟪 Palustrine Scrub-Shrub (PSS)
- 🟦 Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E E E E E E-
			EB	E E E E E
	Significant Issue			Existing WB Climbing Lane

Physical Deficiencies

Horizontal			
Vertical		WB	Crest Sag Crest Sag Crest Steep/Long Grade
		EB	Crest Sag Crest Sag Crest Steep/Long Grade
Interchange		WB	
		EB	
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C
		EB	COND AGE C-C

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PLANNING FOR PROGRESS

Webster County
District 8

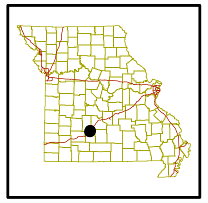
Figure 42
Mileposts: 106 - 108

LEGEND
- ▨ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

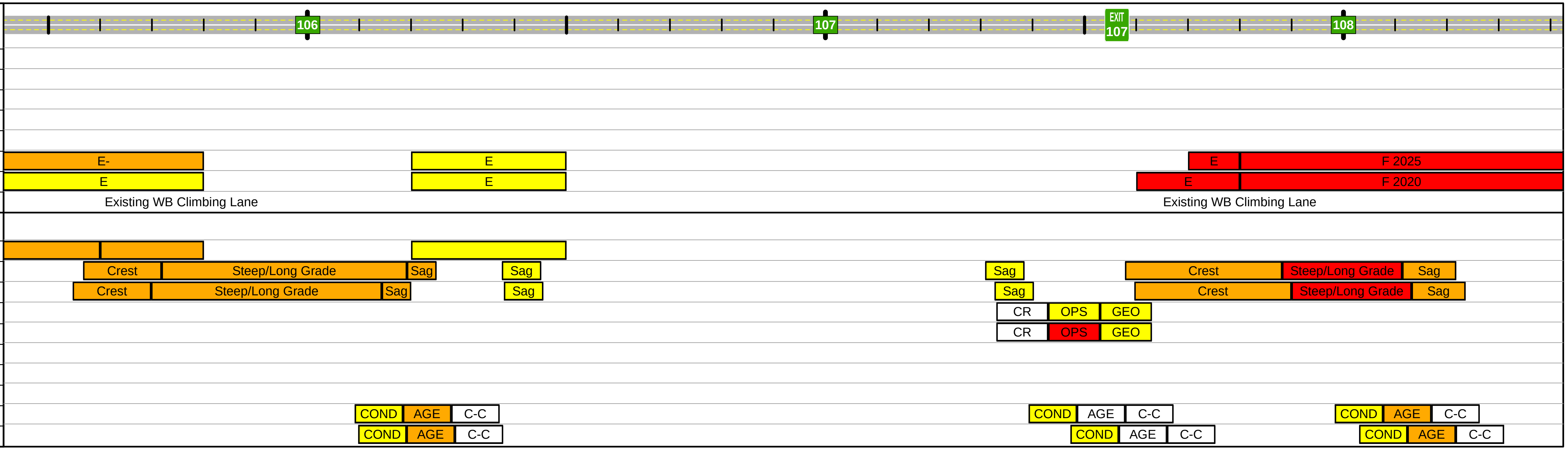
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

MoDOT
CH2MHILL



Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E-; E; E; F 2025
			EB	E; E; E; F 2020
	Significant Issue			Existing WB Climbing Lane; Existing WB Climbing Lane

Physical Deficiencies

Horizontal			🟧 🟧 🟨
Vertical		WB	Crest; Steep/Long Grade; Sag; Sag; Sag; Crest; Steep/Long Grade; Sag
		EB	Crest; Steep/Long Grade; Sag; Sag; Sag; Crest; Steep/Long Grade; Sag
Interchange		WB	CR; OPS; GEO
		EB	CR; OPS; GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C; COND AGE C-C; COND AGE C-C
		EB	COND AGE C-C; COND AGE C-C; COND AGE C-C

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Webster County
District 8

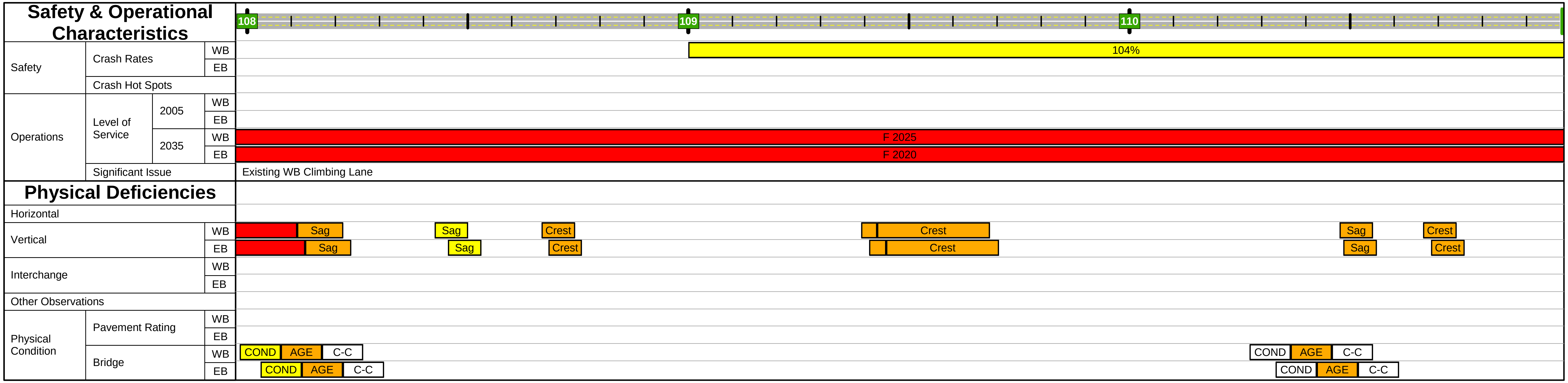
Figure 43
Mileposts: 109 - 110

LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

MoDOT
CH2MHILL

Safety & Operational Characteristics



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Purpose & Need Study
PLANNING FOR PROGRESS

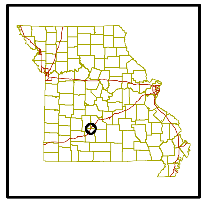
Webster County
Laclede County
District 8

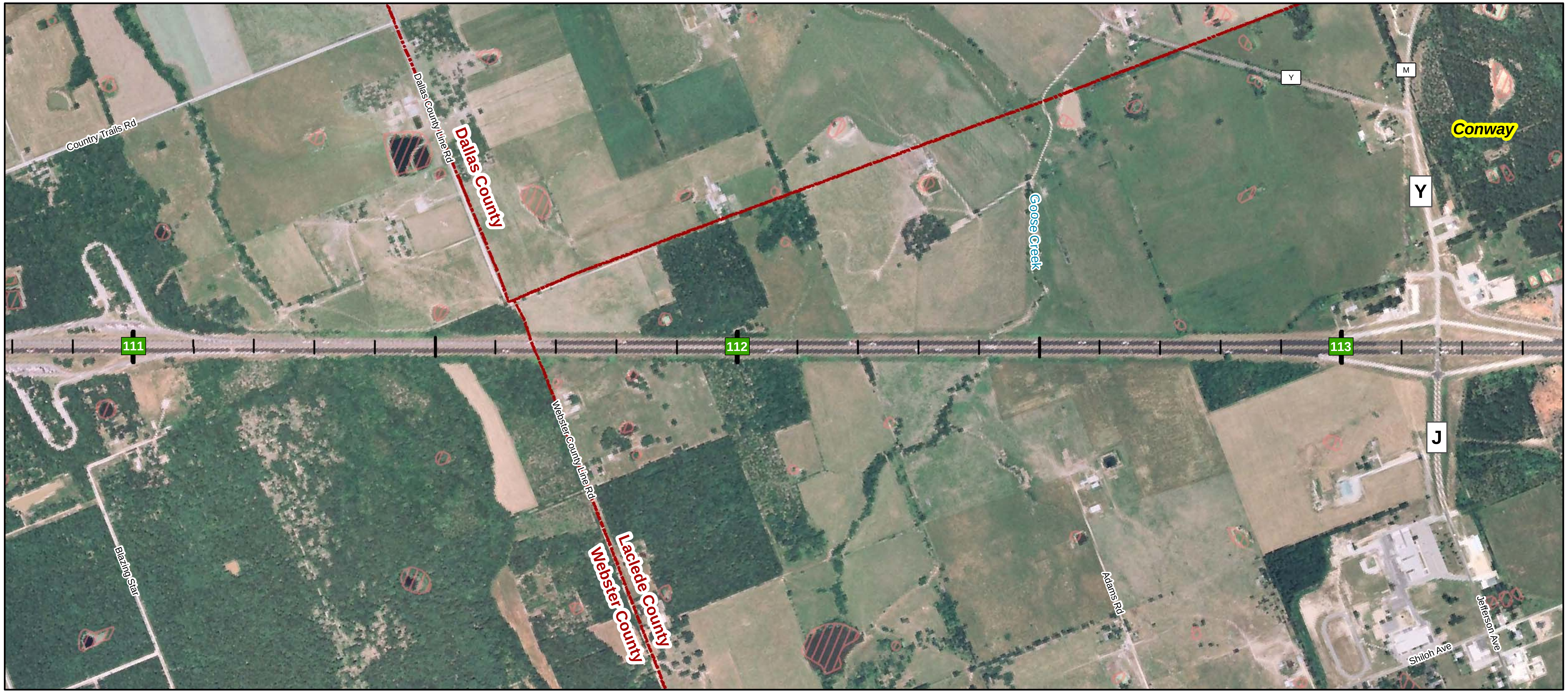
Figure 44
Mileposts: 111 - 113

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

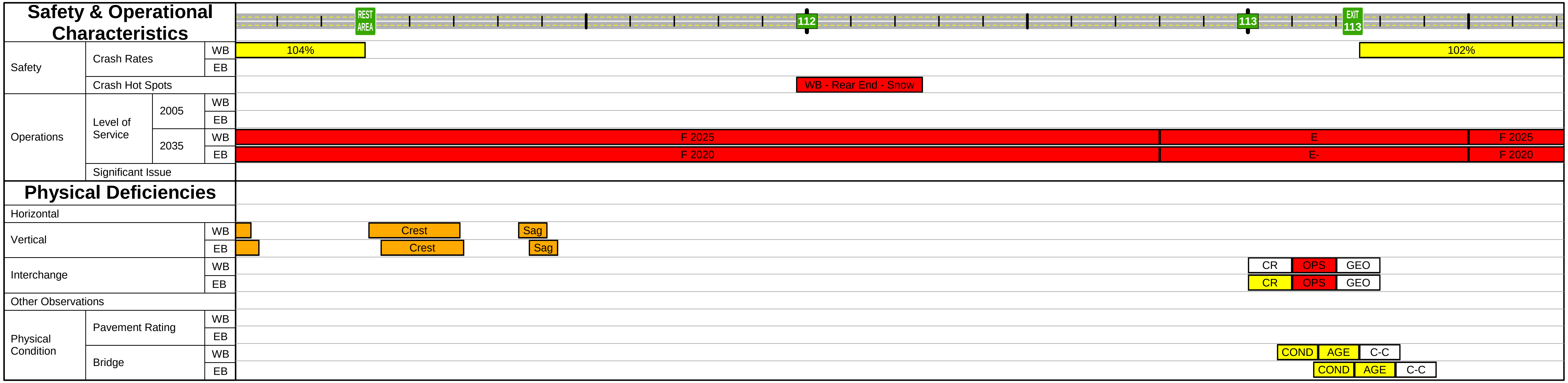
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet





MoDOT
CH2MHILL



Safety & Operational Characteristics

Safety	Crash Rates		WB	104%; 102%
			EB	
	Crash Hot Spots			WB - Rear End - Snow
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2025; E; F 2025
			EB	F 2020; E-; F 2020
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	🟧; Crest; Sag
		EB	🟧; Crest; Sag
Interchange		WB	CR; OPS; GEO
		EB	CR; OPS; GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND; AGE; C-C
		EB	COND; AGE; C-C

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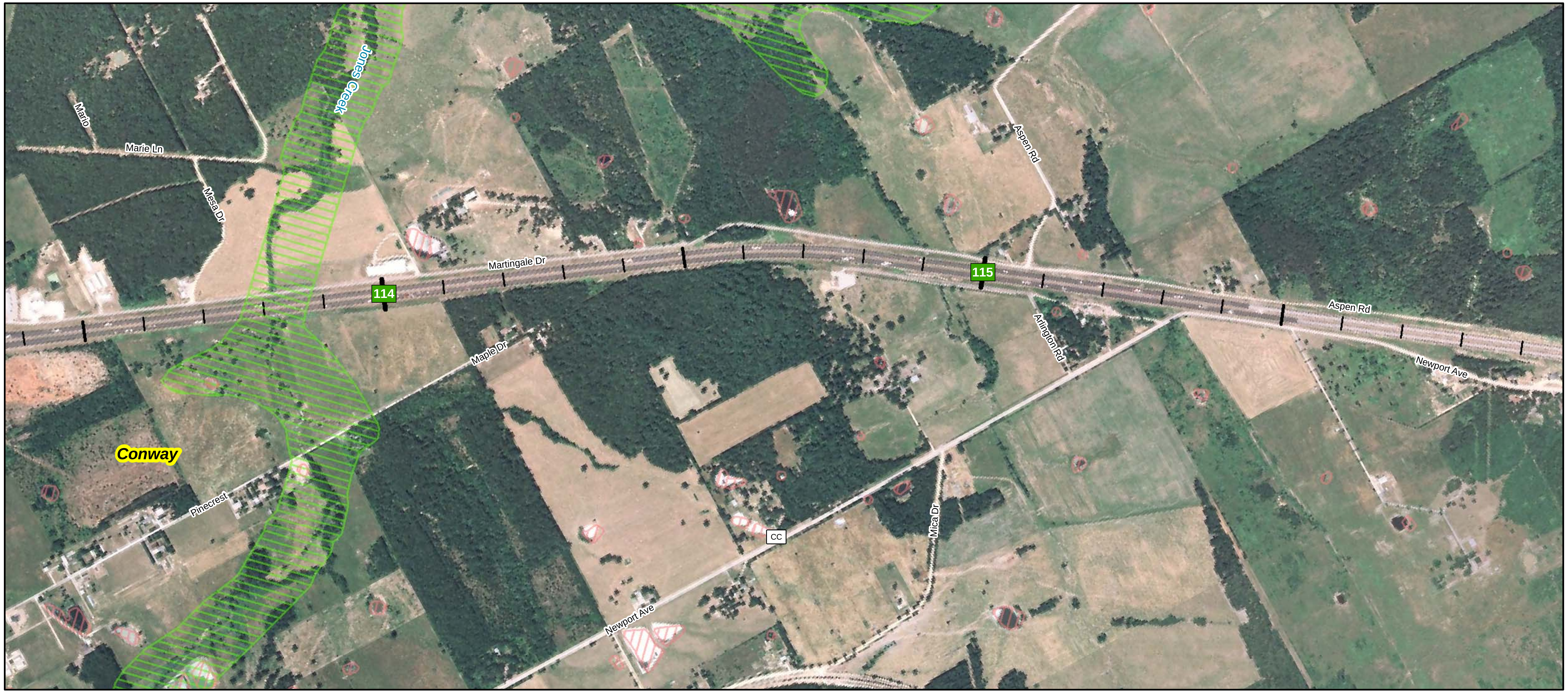
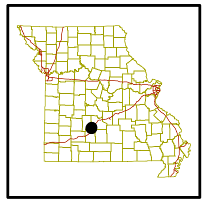
Laclede County
District 8

Figure 45
Mileposts: 114 - 115

LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet



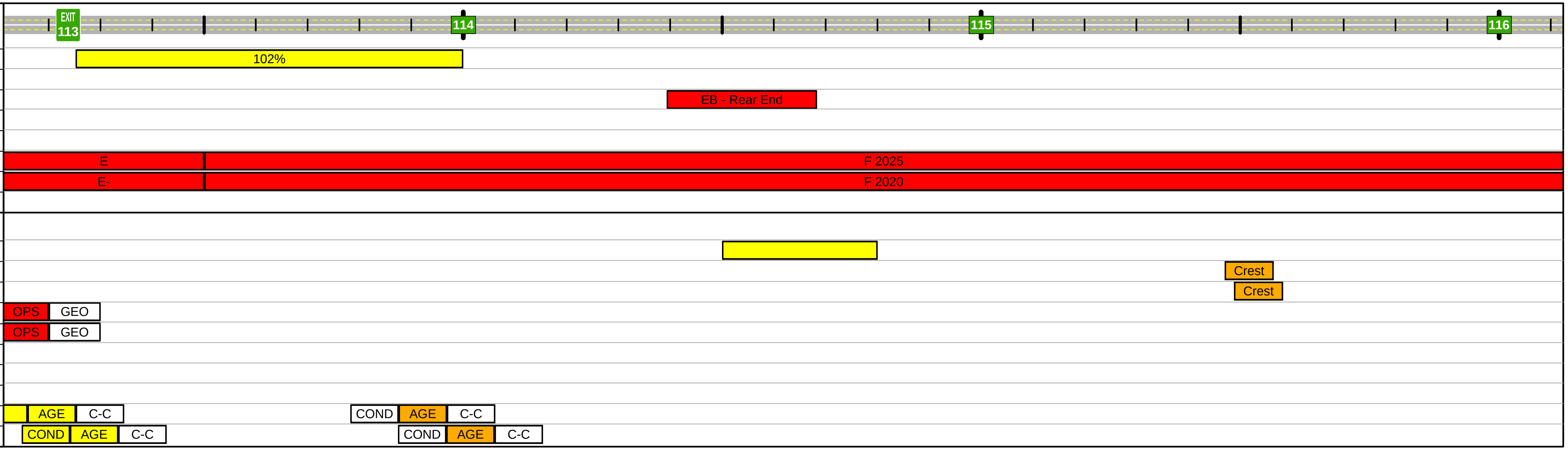


Safety & Operational Characteristics

Safety	Crash Rates		WB	102%
			EB	
	Crash Hot Spots			EB - Rear End
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E F 2025
			EB	E- F 2020
	Significant Issue			

Physical Deficiencies

Horizontal			🟨
Vertical		WB	Crest
		EB	Crest
Interchange		WB	OPS GEO
		EB	OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	🟨 AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C



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Purpose & Need Study
PLANNING FOR PROGRESS

Laclede County
District 8

Figure 46
Mileposts: 116 - 118

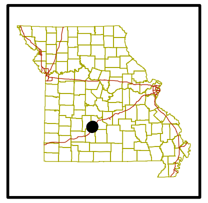
LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

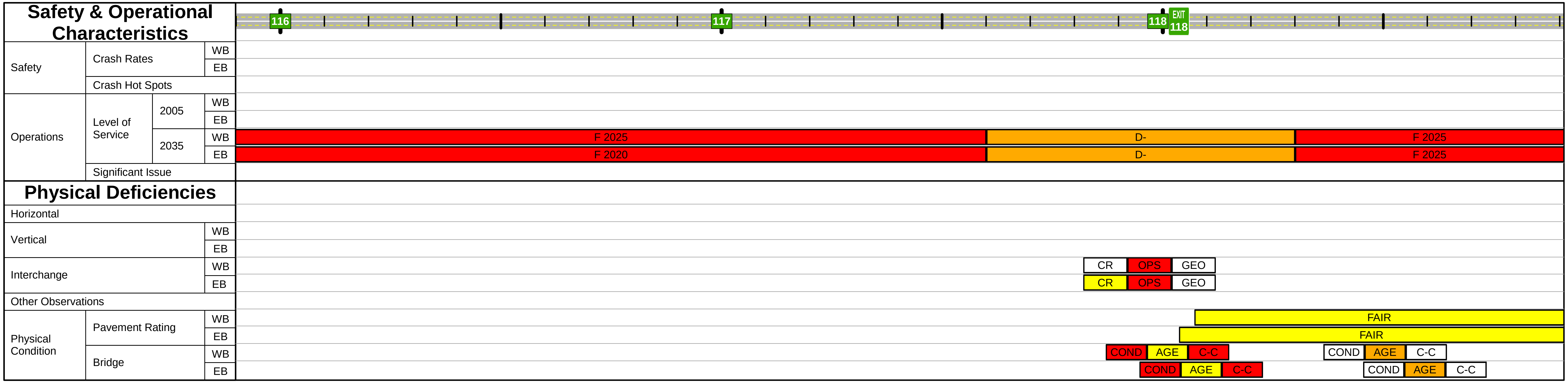
0 500 1,000
Feet

N

MoDOT

CH2MHILL





Safety & Operational Characteristics				116 117 118 EXIT 118
Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟥 F 2025 🟧 D- 🟥 F 2025
			EB	🟥 F 2020 🟧 D- 🟥 F 2025
	Significant Issue			
Physical Deficiencies				
Horizontal				
Vertical			WB	
			EB	
Interchange			WB	CR 🟥 OPS GEO
			EB	🟨 CR 🟥 OPS GEO
Other Observations				
Physical Condition	Pavement Rating		WB	🟨 FAIR
			EB	🟨 FAIR
	Bridge		WB	🟥 COND 🟨 AGE 🟥 C-C COND 🟧 AGE C-C
			EB	🟥 COND 🟨 AGE 🟥 C-C COND 🟧 AGE C-C

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Laclede County
District 8

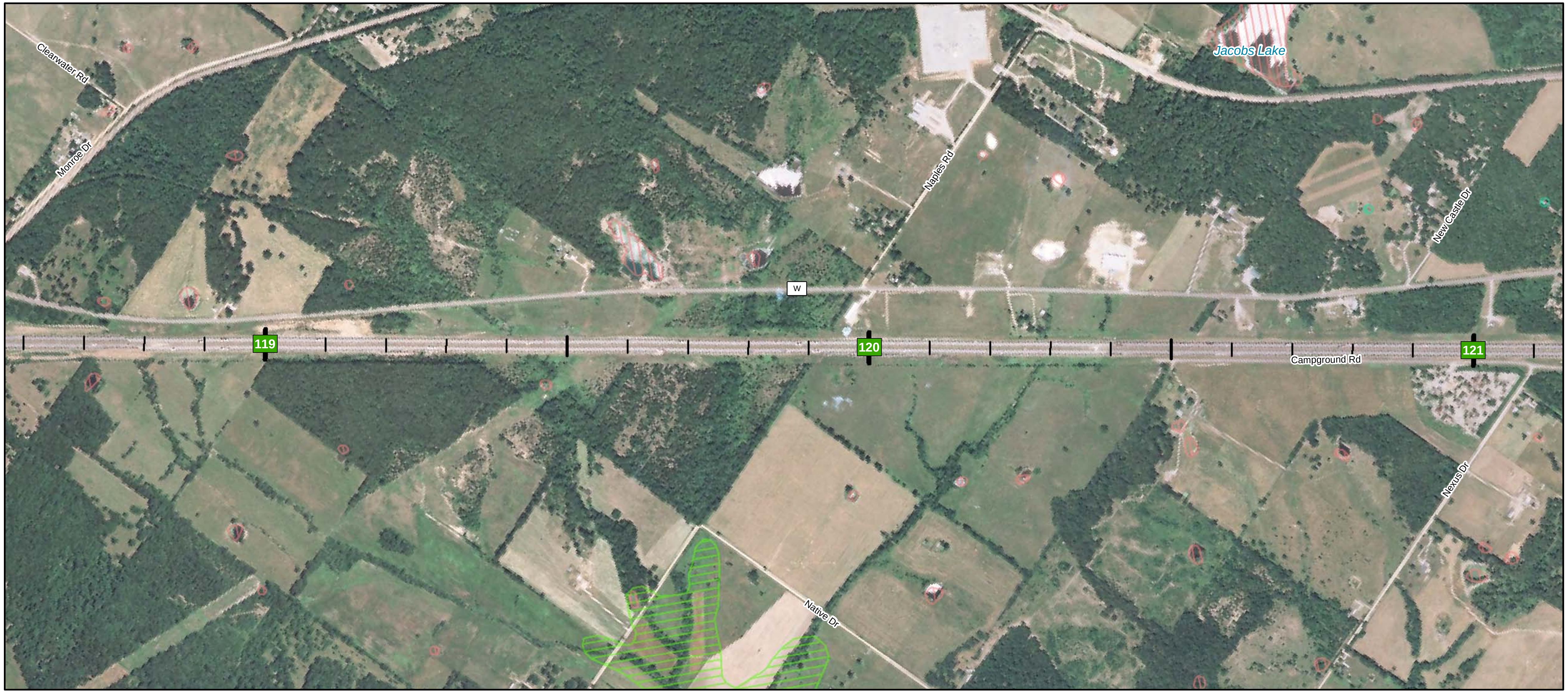
Figure 47
Mileposts: 119 - 121

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N



Safety & Operational Characteristics

				119 – 120 – 121
Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2025
			EB	F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	
		EB	
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR
		EB	FAIR
	Bridge	WB	AGE C-C
		EB	COND AGE C-C

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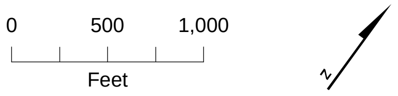
Laclede County
District 8

Figure 48
Mileposts: 122 - 123

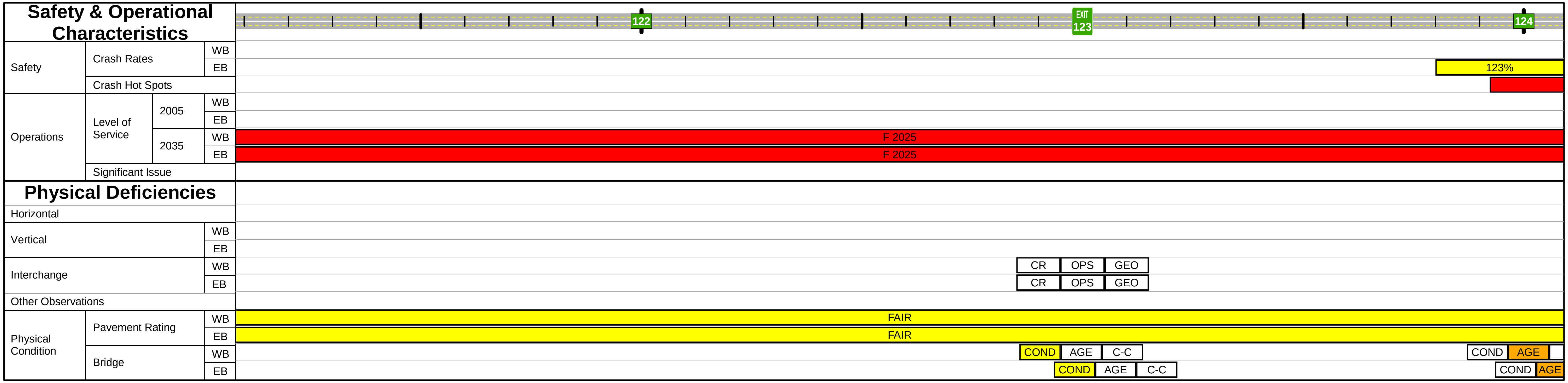
LEGEND
- County Boundary
- 🟩 Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability



MoDOT

CH2MHILL



Safety & Operational Characteristics

				122 – EXIT 123 – 124
Safety	Crash Rates		WB	
			EB	123%
	Crash Hot Spots			🟥
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2025
			EB	F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR
		EB	FAIR
	Bridge	WB	COND AGE C-C COND AGE
		EB	COND AGE C-C COND AGE

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Laclede County
District 8

Figure 49
Mileposts: 124 - 126

LEGEND
- 🟥 County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

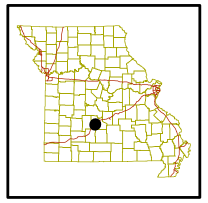
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

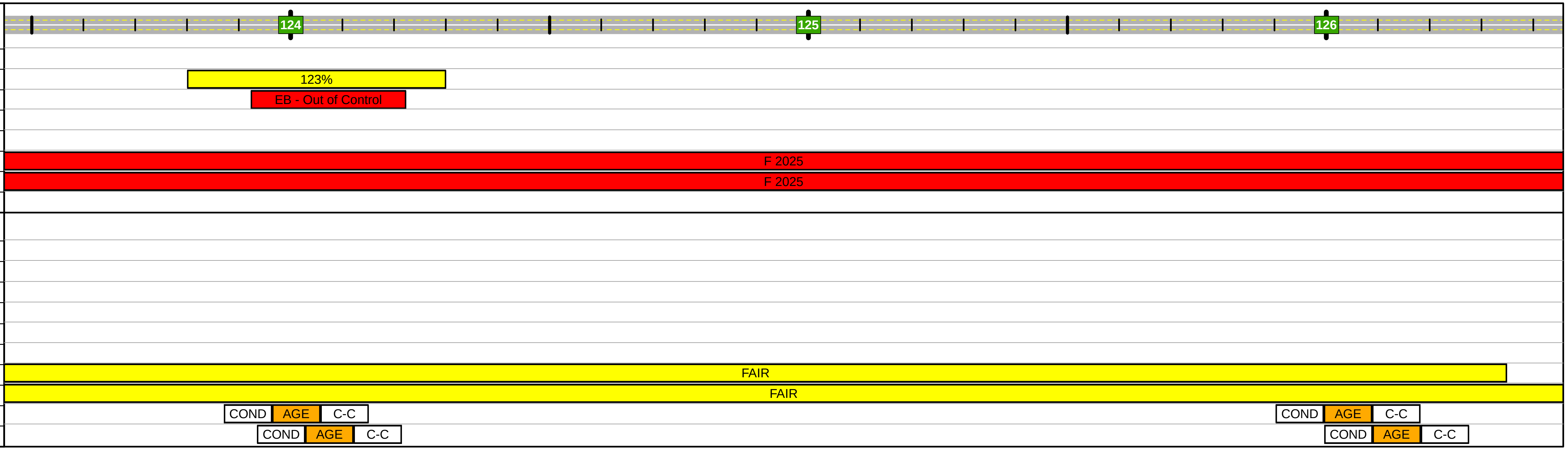
N

MoDOT

CH2MHILL



Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	123%
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2025
			EB	F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	
		EB	
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR
		EB	FAIR
	Bridge	WB	COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C

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Laclede County
District 8

Figure 50
Mileposts: 127 - 128

LEGEND

▨	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)

Condition

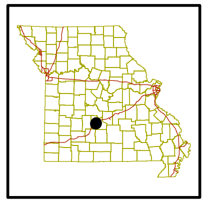
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

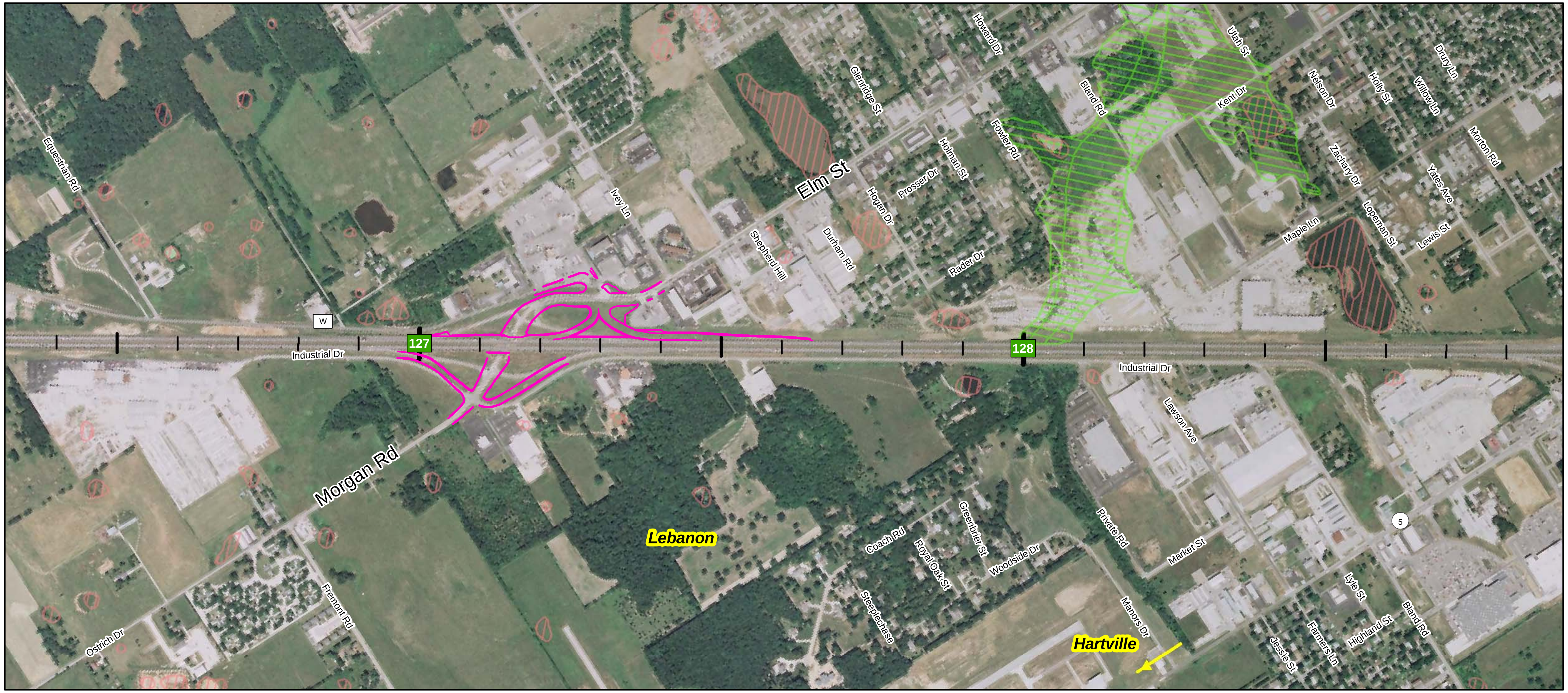
0 500 1,000
Feet

N

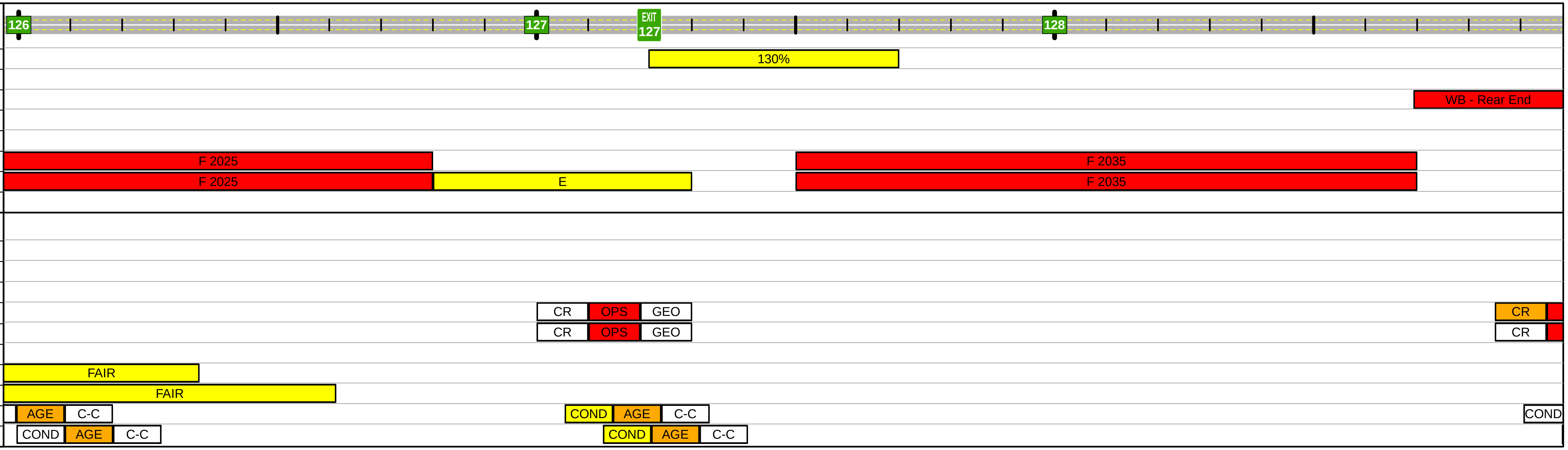
MoDOT

CH2MHILL





Safety & Operational Characteristics



Safety	Crash Rates		WB	130%
			EB	
	Crash Hot Spots			WB - Rear End
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2025 F 2035
			EB	F 2025 E F 2035
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	
Interchange		WB	CR OPS GEO CR
		EB	CR OPS GEO CR
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR
		EB	FAIR
	Bridge	WB	AGE C-C COND AGE C-C COND
		EB	COND AGE C-C COND AGE C-C

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Laclede County
District 8

Figure 51
Mileposts: 129 - 131

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

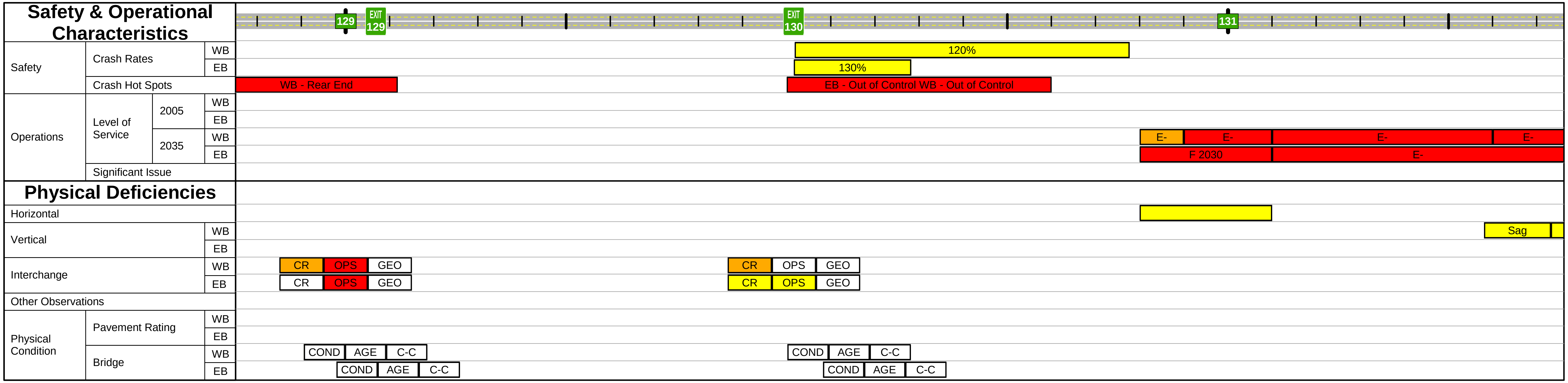
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



Safety & Operational Characteristics				
Safety	Crash Rates		WB	120%
			EB	130%
	Crash Hot Spots			WB - Rear End EB - Out of Control WB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E- E- E- E-
			EB	F 2030 E-
	Significant Issue			
Physical Deficiencies				
Horizontal				🟨
Vertical			WB	Sag
			EB	
Interchange			WB	CR OPS GEO CR OPS GEO
			EB	CR OPS GEO CR OPS GEO
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND AGE C-C COND AGE C-C
			EB	COND AGE C-C COND AGE C-C

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District 8

Figure 52
Mileposts: 132 - 134

LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL

Safety & Operational Characteristics

				132 – 133 – 134
Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E- | E- | E- | E- | E-
			EB	E-
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Sag | Steep Grade | Crest
		EB	
Interchange		WB	
		EB	
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	
		EB	

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District 8

Figure 53
Mileposts: 135 - 136

LEGEND

▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)

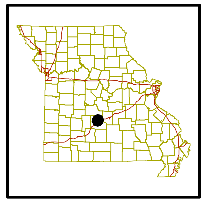
Condition

🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

0 500 1,000
Feet

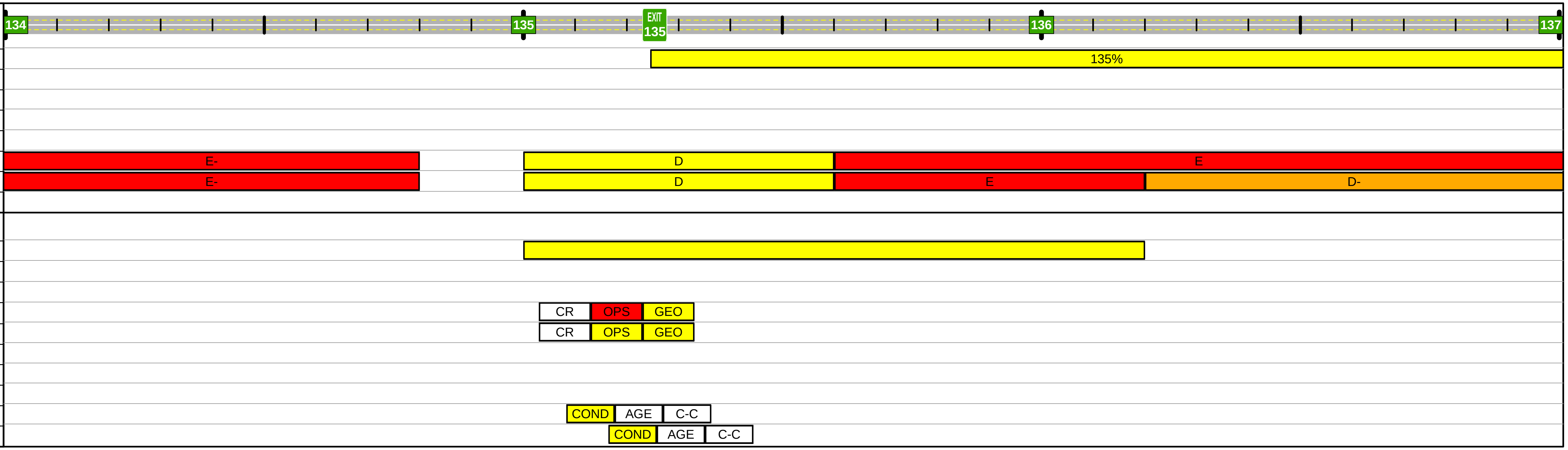
N

MoDOT



CH2MHILL

Safety & Operational Characteristics



Safety	Crash Rates		WB	135%
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E- D E
			EB	E- D E D-
	Significant Issue			

Physical Deficiencies

Horizontal				🟨
Vertical			WB	
			EB	
Interchange			WB	CR OPS GEO
			EB	CR OPS GEO
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND AGE C-C
			EB	COND AGE C-C

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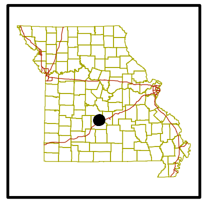
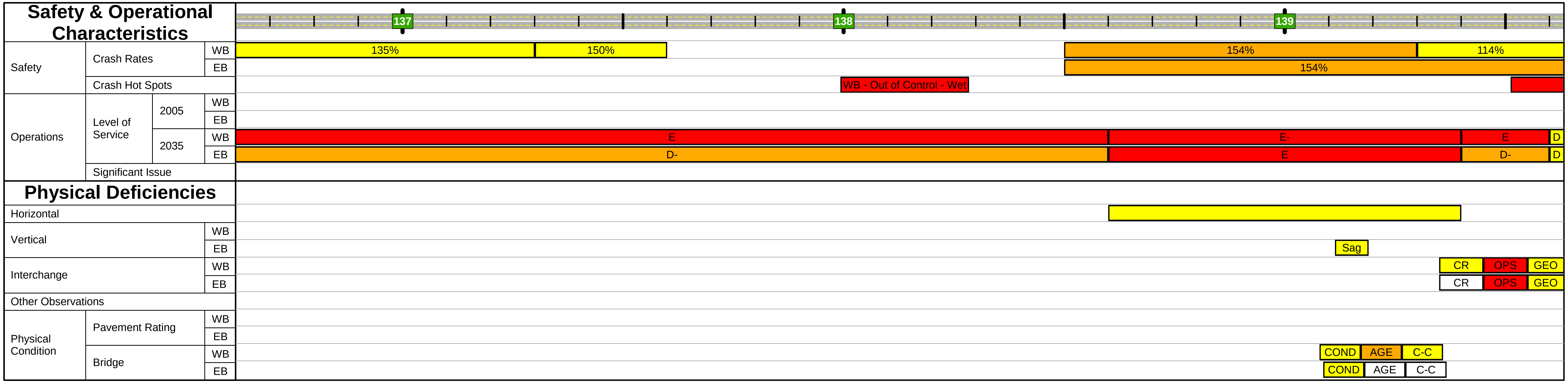
Figure 54
Mileposts: 137 - 139

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet





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Laclede County
District 8

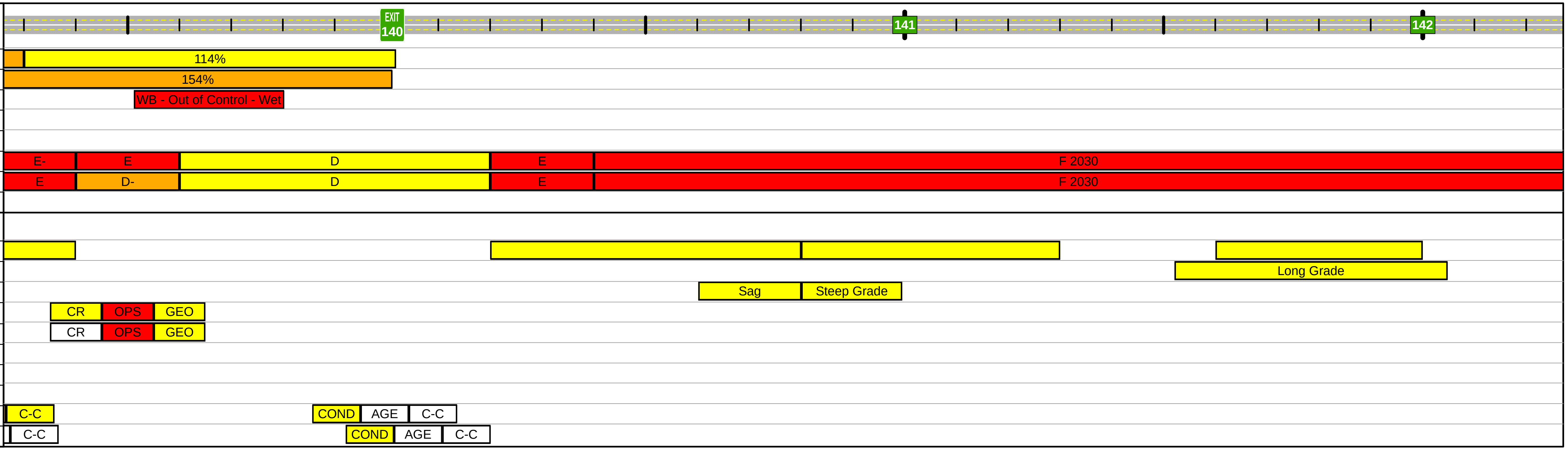
Figure 55
Mileposts: 140 - 142

LEGEND

▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)
Condition	
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

0 500 1,000
Feet
N

Safety & Operational Characteristics



Safety	Crash Rates		WB	114%
			EB	154%
	Crash Hot Spots			WB - Out of Control - Wet
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E- E D E F 2030
			EB	E D- D E F 2030
	Significant Issue			

Physical Deficiencies

Horizontal				
Vertical			WB	Long Grade
			EB	Sag Steep Grade
Interchange			WB	CR OPS GEO
			EB	CR OPS GEO
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	C-C COND AGE C-C
			EB	C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Laclede County
District 8

Figure 56
Mileposts: 143 - 144

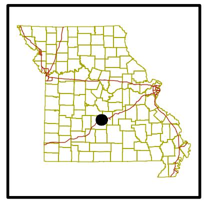
LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

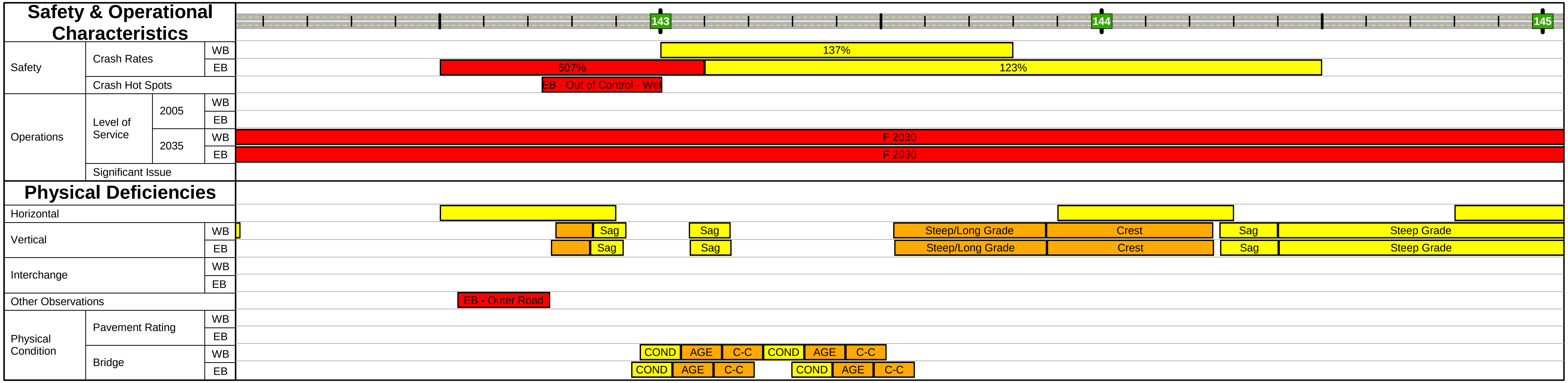
N

MoDOT

CH2MHILL



Safety & Operational Characteristics



Jun 17, 2008

Pulaski County

Purpose & Need Study
PLANNING FOR PROGRESS

Laclede County
Pulaski County
District 8 & 9

Figure 57
Mileposts: 145 - 147

LEGEND

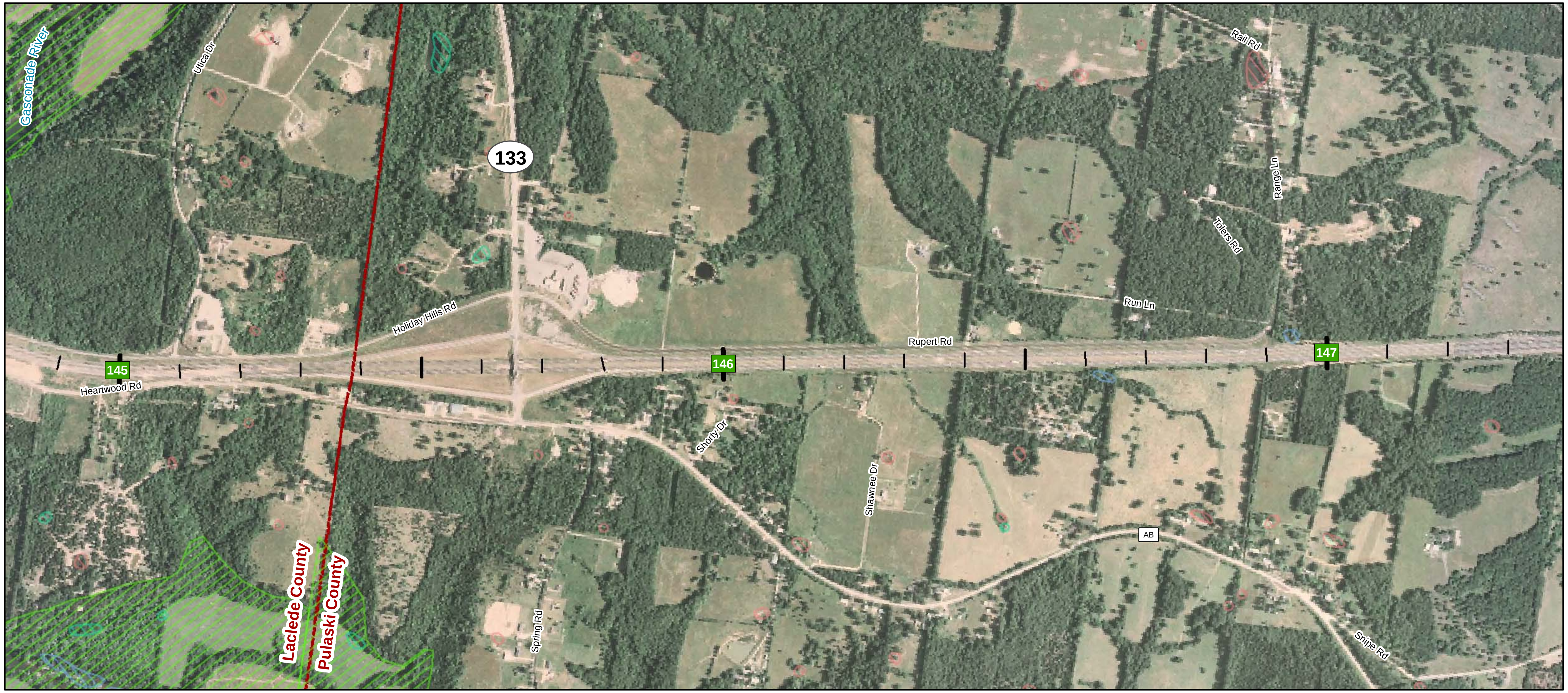
⬚	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)
Condition	
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

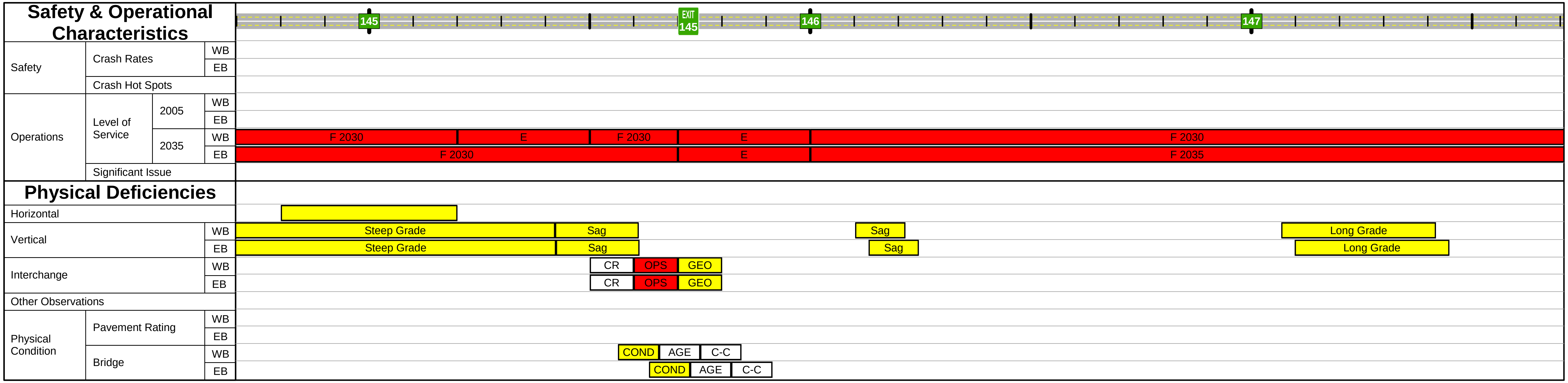
0 500 1,000
Feet

N

MoDOT

CH2MHILL





Safety & Operational Characteristics

Safety	Crash Rates		WB					
			EB					
	Crash Hot Spots							
Operations	Level of Service	2005	WB					
			EB					
		2035	WB	F 2030	E	F 2030	E	F 2030
			EB	F 2030	E	F 2035		
	Significant Issue							

Physical Deficiencies

Horizontal			🟨			
Vertical		WB	Steep Grade	Sag	Sag	Long Grade
		EB	Steep Grade	Sag	Sag	Long Grade
Interchange		WB	CR	OPS	GEO	
		EB	CR	OPS	GEO	
Other Observations						
Physical Condition	Pavement Rating	WB				
		EB				
	Bridge	WB	COND	AGE	C-C	
		EB	COND	AGE	C-C	

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PLANNING FOR PROGRESS

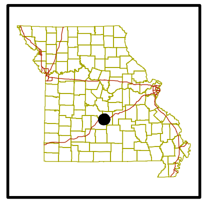
Pulaski County
District 9

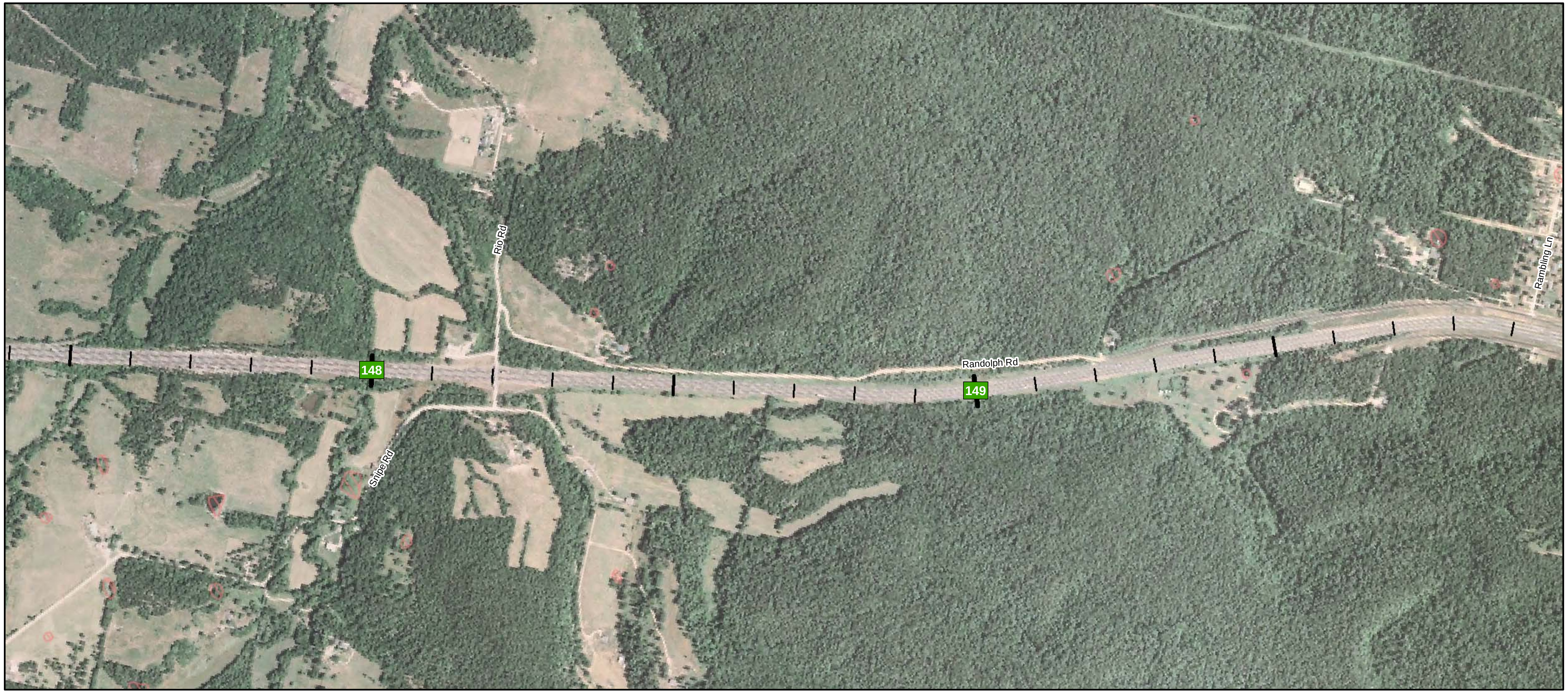
Figure 58
Mileposts: 148 - 149

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

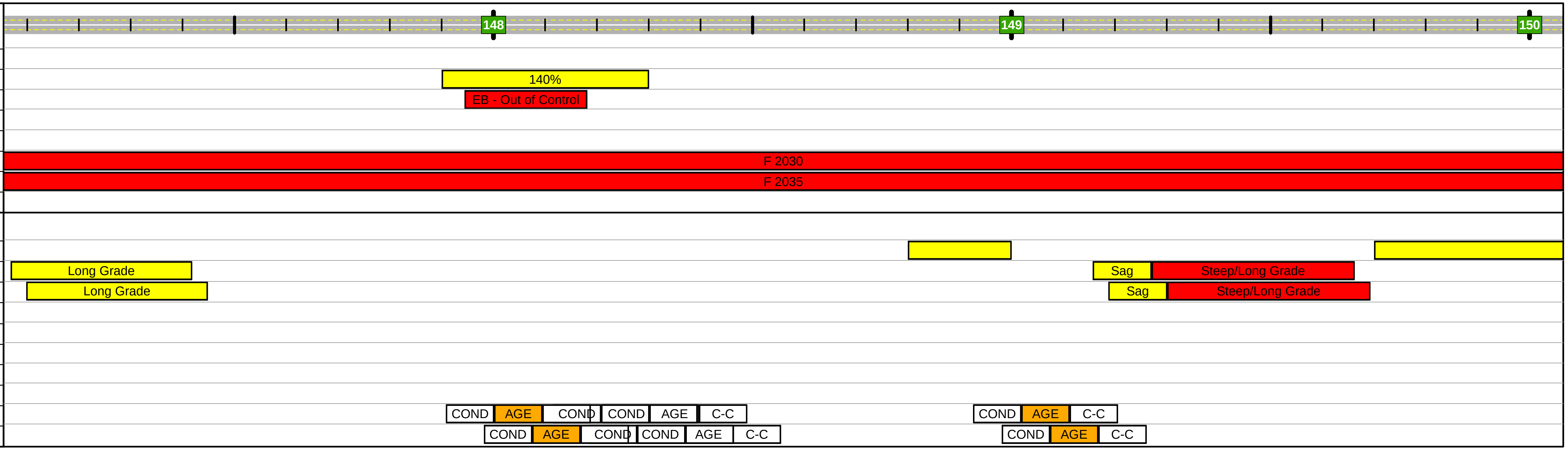
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet





Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	🟨 140%
	Crash Hot Spots			🟥 EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟥 F 2030
			EB	🟥 F 2035
	Significant Issue			

Physical Deficiencies

Horizontal				🟨 🟨
Vertical			WB	🟨 Long Grade 🟨 Sag 🟥 Steep/Long Grade
			EB	🟨 Long Grade 🟨 Sag 🟥 Steep/Long Grade
Interchange			WB	
			EB	
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND 🟧 AGE COND COND AGE C-C COND 🟧 AGE C-C
			EB	COND 🟧 AGE COND COND AGE C-C COND 🟧 AGE C-C

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PLANNING FOR PROGRESS

Pulaski County
District 9

Figure 59
Mileposts: 150 - 152

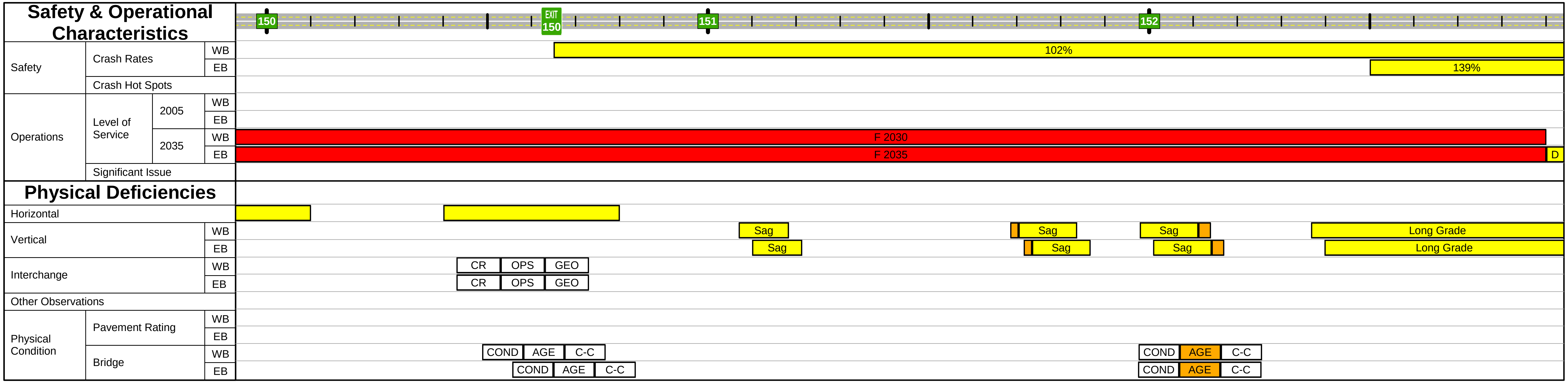
LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT
CH2MHILL



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PLANNING FOR PROGRESS

Pulaski County
District 9

Figure 60
Mileposts: 153 - 155

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

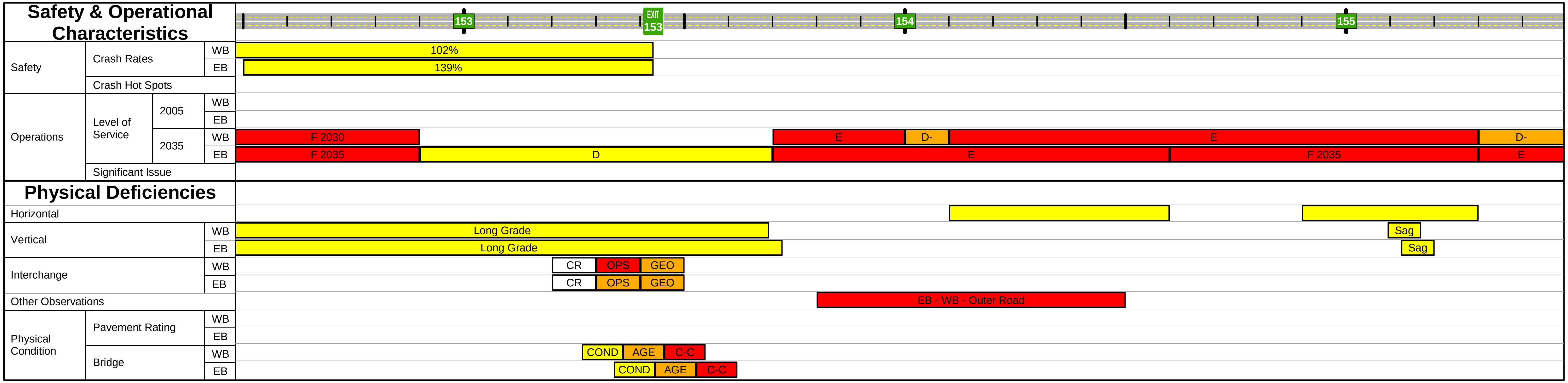
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



Safety & Operational Characteristics

Safety	Crash Rates		WB	102%
			EB	139%
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2030 E D- E D-
			EB	F 2035 D E F 2035 E
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Long Grade Sag
		EB	Long Grade Sag
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			EB - WB - Outer Road
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C
		EB	COND AGE C-C

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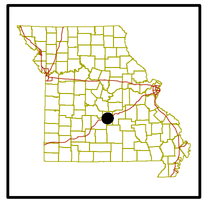
Pulaski County
District 9

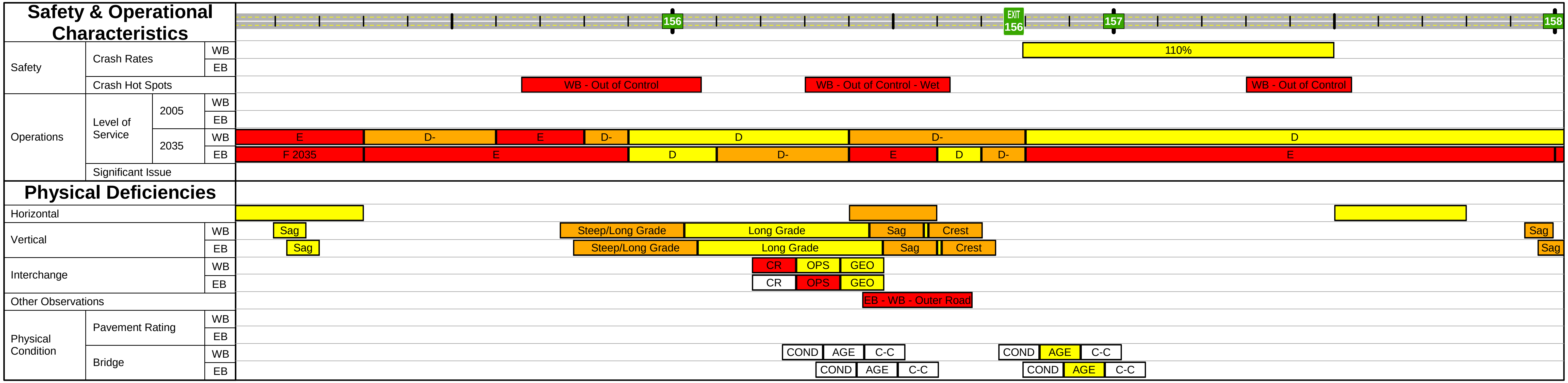
Figure 61
Mileposts: 156 - 157

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet





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Purpose & Need Study
PLANNING FOR PROGRESS

Pulaski County
District 9

Figure 62
Milepost: 158 - 160

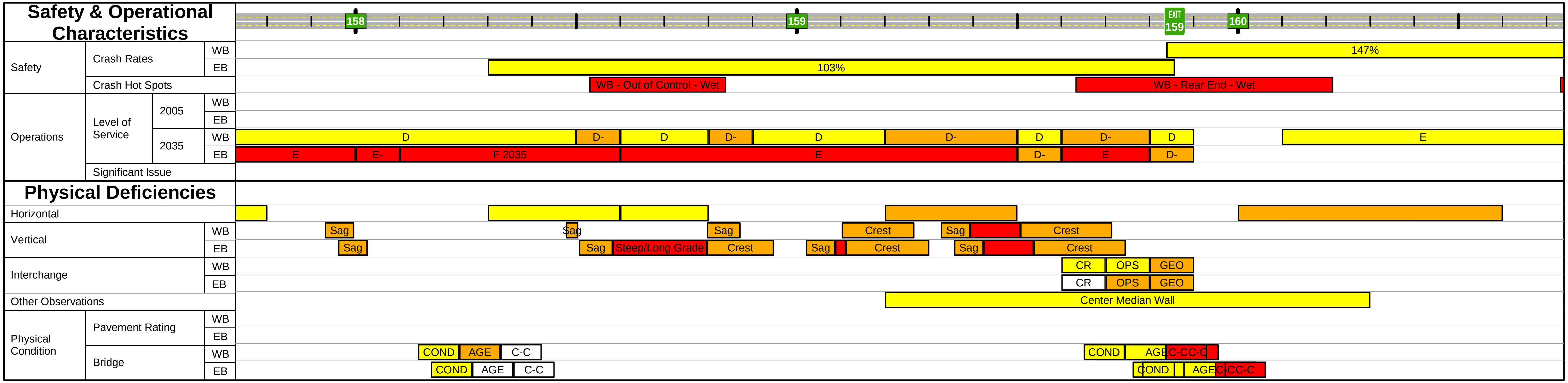
LEGEND

- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition

- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet



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PLANNING FOR PROGRESS

Pulaski County
District 9

Figure 63
Mileposts: 161 - 163

LEGEND
- ▨ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

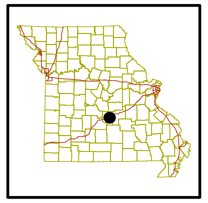
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

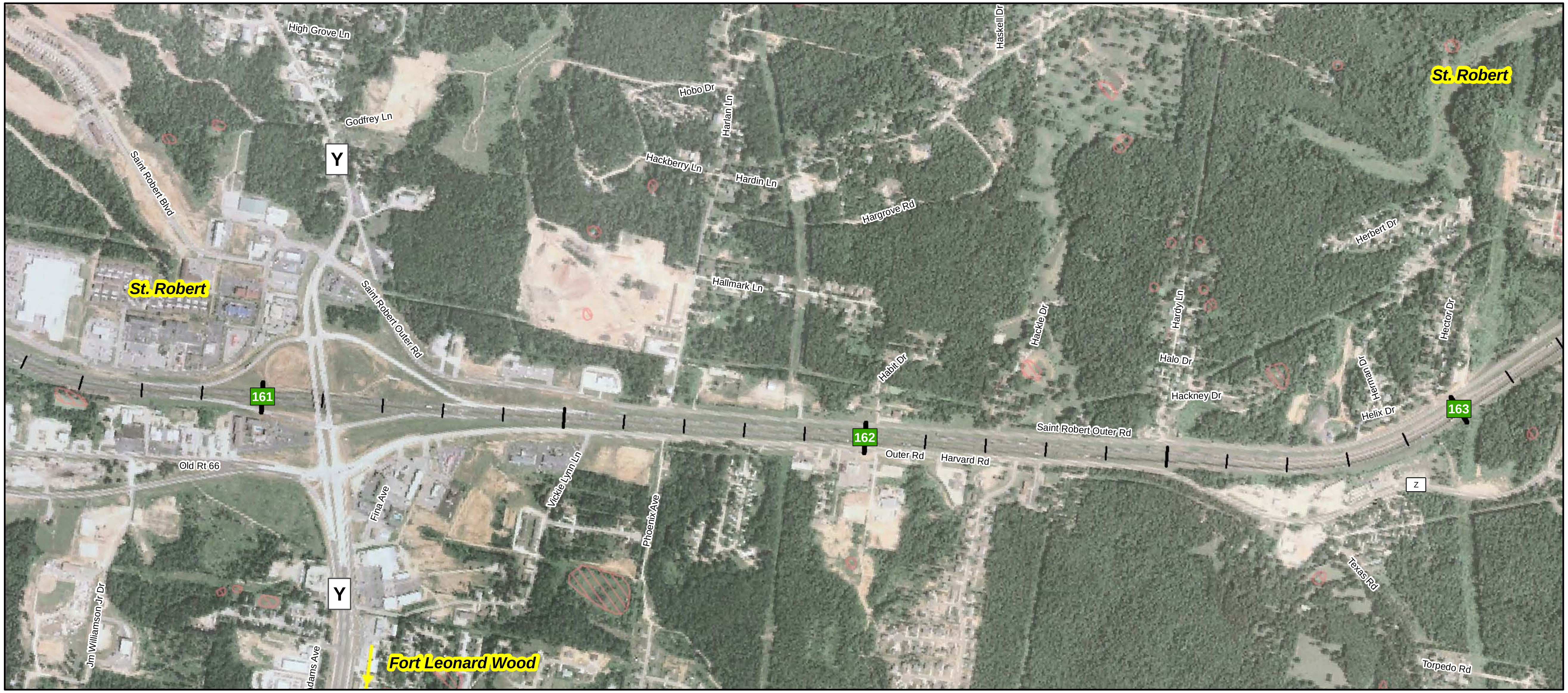
0 500 1,000
Feet

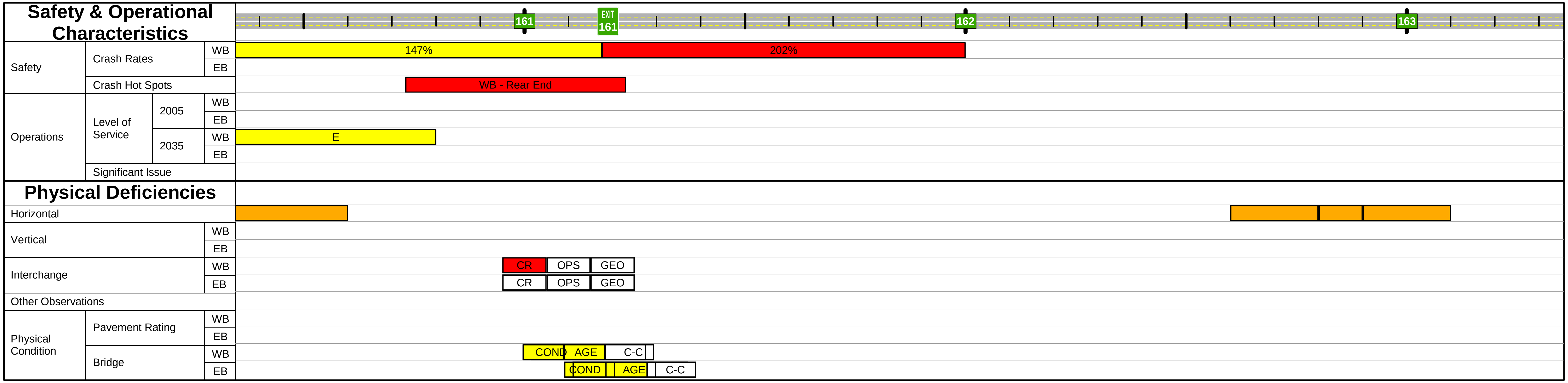
N

MoDOT

CH2MHILL







Safety & Operational Characteristics

Safety	Crash Rates		WB	🟨 147% 🟥 202%
			EB	
	Crash Hot Spots			🟥 WB - Rear End
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟨 E
			EB	
	Significant Issue			

Physical Deficiencies

Horizontal			🟧 🟧 🟧 🟧
Vertical		WB	
		EB	
Interchange		WB	🟥 CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	🟨 COND 🟨 AGE C-C
		EB	🟨 COND 🟨 AGE C-C

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Pulaski County
District 9

Figure 64
Mileposts: 164 - 165

LEGEND

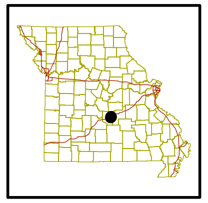
⬚	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)
Condition	
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

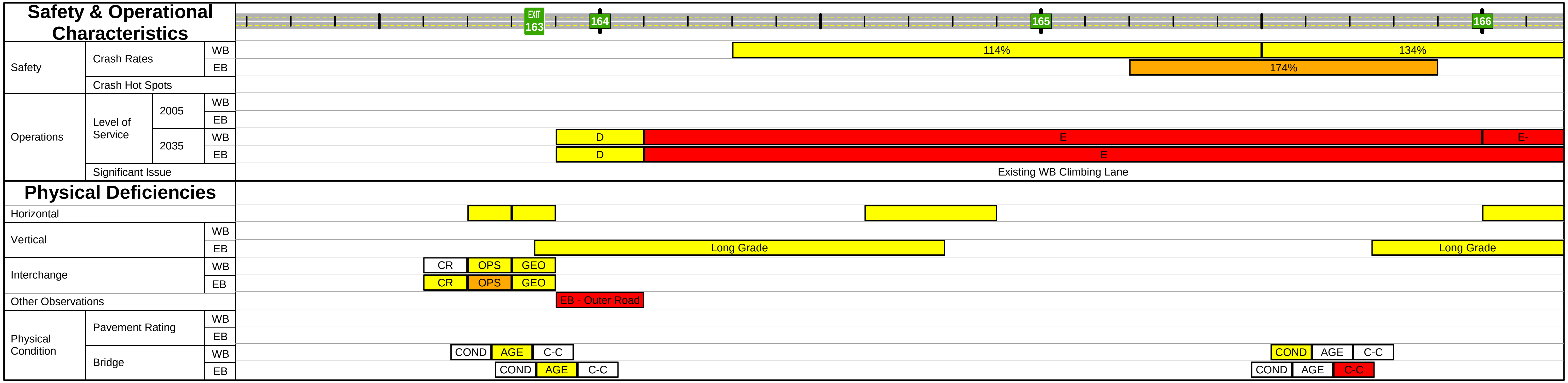
0 500 1,000
Feet

N

MoDOT

CH2MHILL





Safety & Operational Characteristics

Safety	Crash Rates		WB	114% 134%
			EB	174%
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	D E E-
			EB	D E
	Significant Issue			Existing WB Climbing Lane

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	Long Grade Long Grade
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			EB - Outer Road
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C

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Pulaski County
District 9

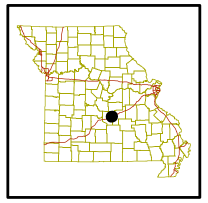
Figure 65
Mileposts: 166 - 168

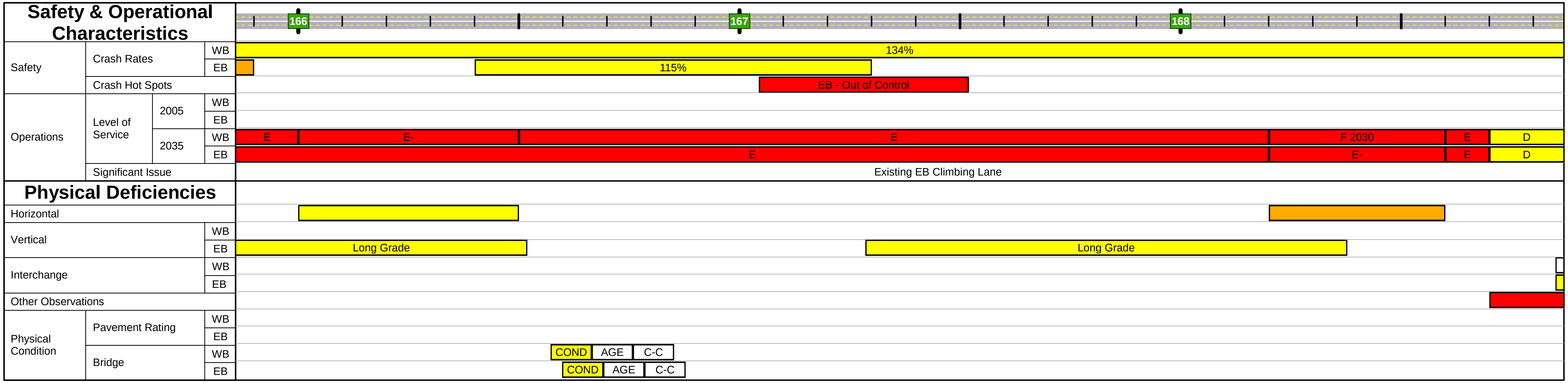
LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet
N

MoDOT
CH2MHILL





Safety & Operational Characteristics

Safety	Crash Rates		WB	134%
			EB	115%
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E E- E F 2030 E D
			EB	E E- E D
	Significant Issue			Existing EB Climbing Lane

Physical Deficiencies

Horizontal			
Vertical		WB	
		EB	Long Grade Long Grade
Interchange		WB	
		EB	
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C
		EB	COND AGE C-C

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Phelps County

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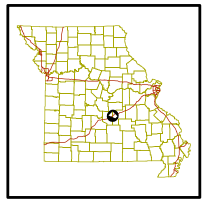
Pulaski County
Phelps County
District 9

Figure 66
Mileposts: 169 - 171

LEGEND

▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)
Condition	
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

0 500 1,000
Feet



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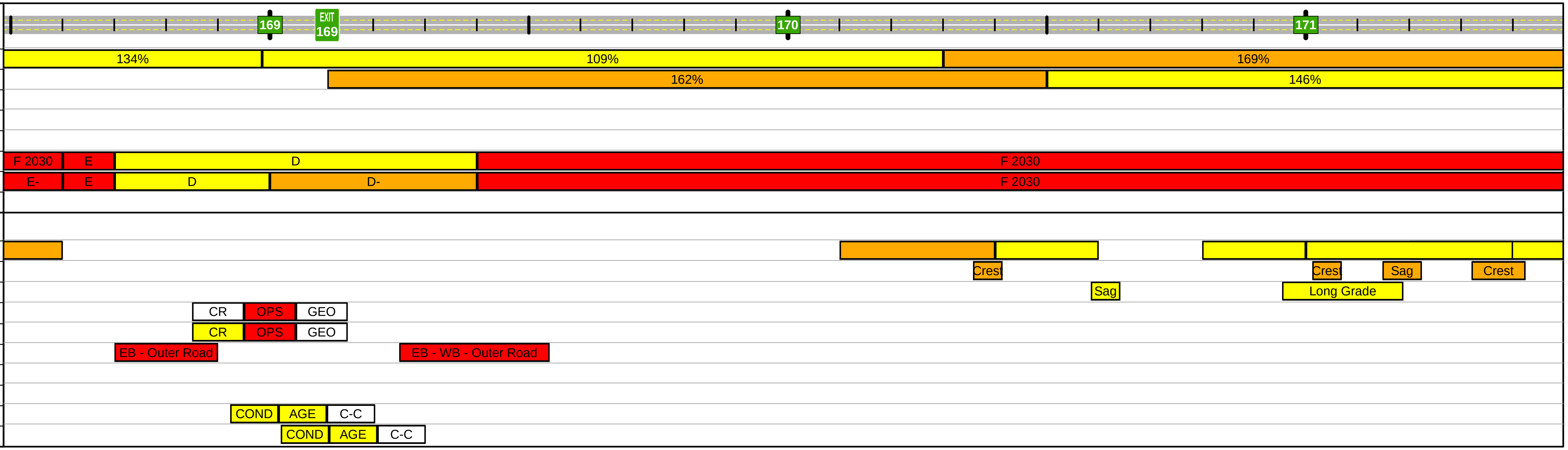
Safety & Operational Characteristics



Safety	Crash Rates		WB	134% 109% 169%
			EB	162% 146%
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2030 E D F 2030
			EB	E- E D D- F 2030
	Significant Issue			

Physical Deficiencies

Horizontal				
Vertical			WB	Crest Crest Sag Crest
			EB	Sag Long Grade
Interchange			WB	CR OPS GEO
			EB	CR OPS GEO
Other Observations				EB - Outer Road EB - WB - Outer Road
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND AGE C-C
			EB	COND AGE C-C

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District 9

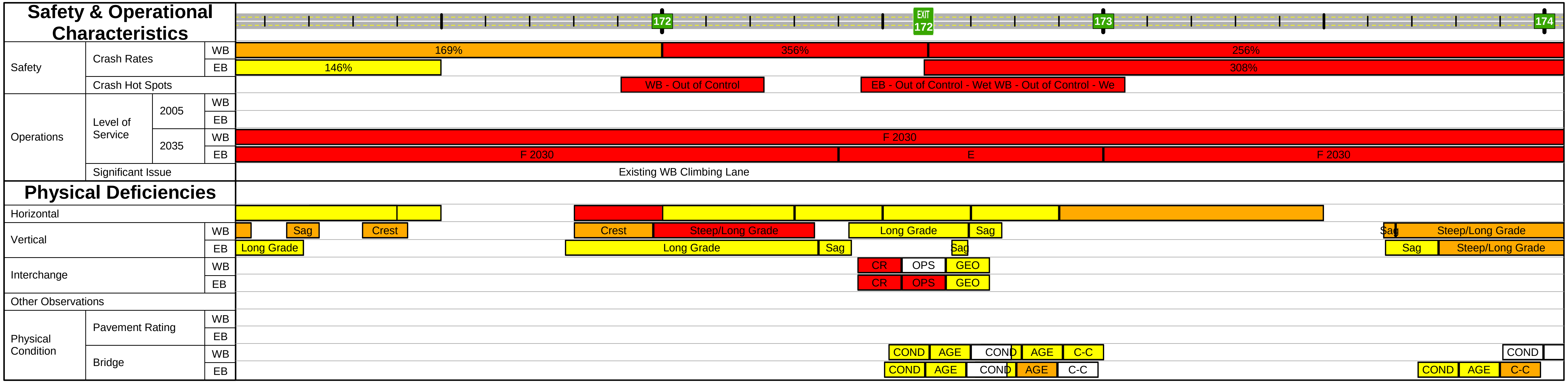
Figure 67
Mileposts: 172 - 173

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N



Safety & Operational Characteristics

Safety	Crash Rates		WB	169% 356% 256%
			EB	146% 308%
	Crash Hot Spots			WB - Out of Control EB - Out of Control - Wet WB - Out of Control - We
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2030
			EB	F 2030 E F 2030
	Significant Issue			Existing WB Climbing Lane

Physical Deficiencies

Horizontal			
Vertical		WB	Sag Crest Crest Steep/Long Grade Long Grade Sag Sag Steep/Long Grade
		EB	Long Grade Long Grade Sag Sag Sag Steep/Long Grade
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE COND AGE C-C COND
		EB	COND AGE COND AGE C-C COND AGE C-C

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District 9

Figure 68
Mileposts: 174 - 176

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

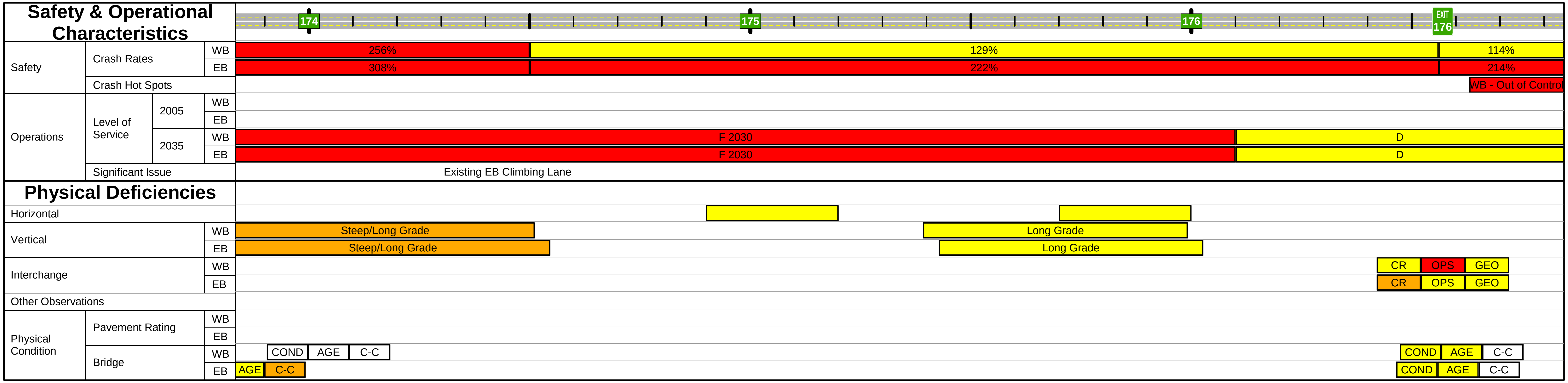
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



Safety & Operational Characteristics

Safety	Crash Rates		WB	🟥 256% · 🟨 129% · 🟨 114%
			EB	🟥 308% · 🟥 222% · 🟥 214%
	Crash Hot Spots			🟥 WB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	🟥 F 2030 · 🟨 D
			EB	🟥 F 2030 · 🟨 D
	Significant Issue			Existing EB Climbing Lane

Physical Deficiencies

Horizontal			🟨 · 🟨
Vertical		WB	🟧 Steep/Long Grade · 🟨 Long Grade
		EB	🟧 Steep/Long Grade · 🟨 Long Grade
Interchange		WB	🟨 CR · 🟥 OPS · 🟨 GEO
		EB	🟧 CR · 🟨 OPS · 🟨 GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND · AGE · C-C · 🟨 COND · 🟨 AGE · C-C
		EB	🟨 AGE · 🟧 C-C · 🟨 COND · 🟨 AGE · C-C

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Phelps County
District 9

Figure 69
Mileposts: 177 - 179

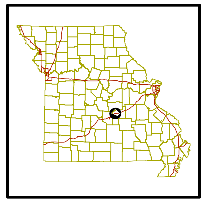
LEGEND
▨ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

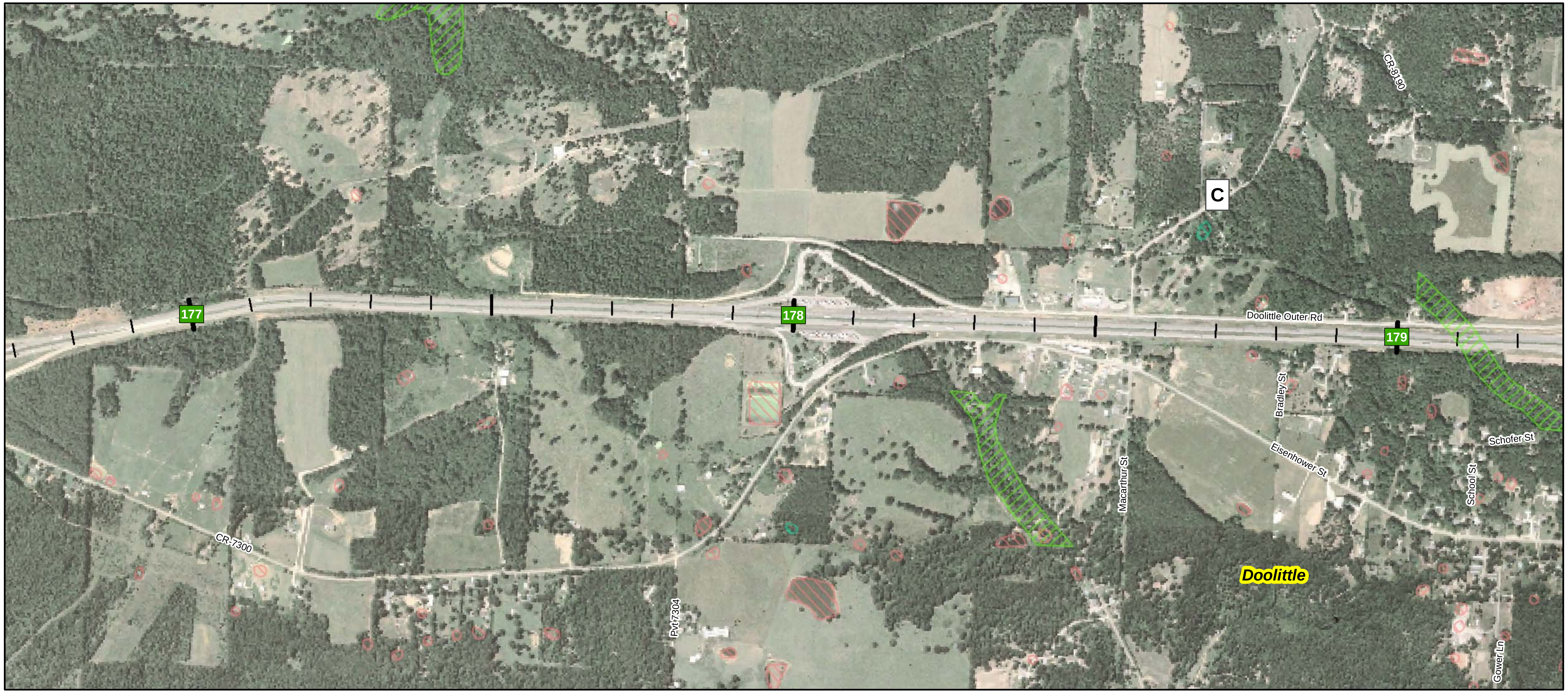
0 500 1,000
Feet

N

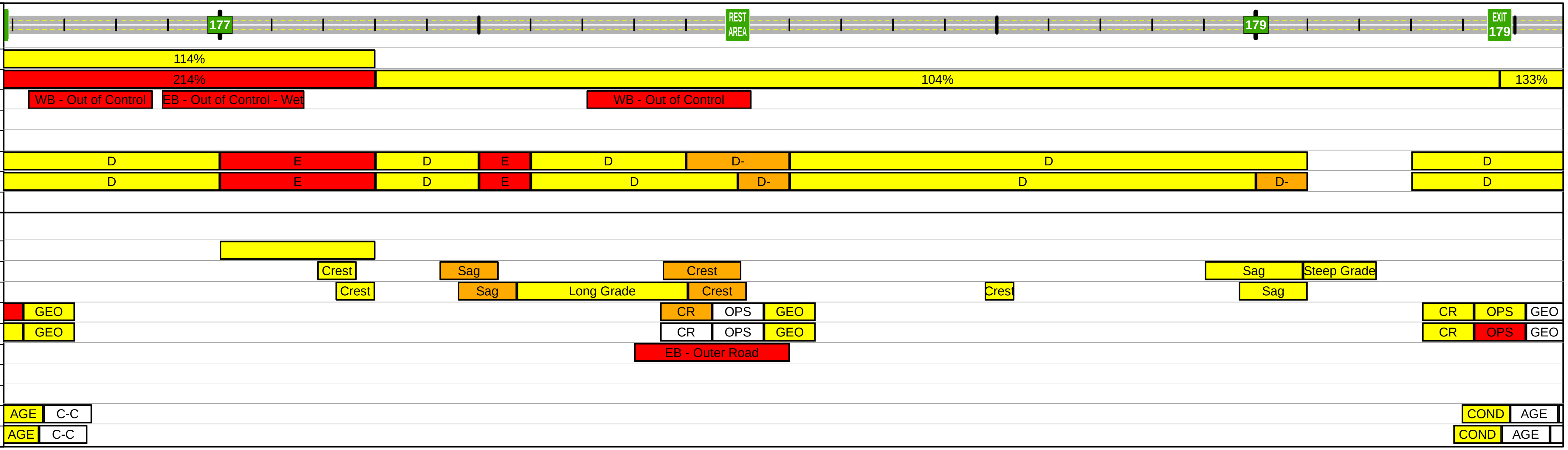
MoDOT

CH2MHILL





Safety & Operational Characteristics



Safety	Crash Rates	WB	114%
		EB	214% 104% 133%
	Crash Hot Spots		WB - Out of Control EB - Out of Control - Wet WB - Out of Control
Operations	Level of Service 2005	WB	
		EB	
	Level of Service 2035	WB	D E D E D D- D D
		EB	D E D E D D- D D- D
	Significant Issue		

Physical Deficiencies

Horizontal			🟨
Vertical		WB	Crest Sag Crest Sag Steep Grade
		EB	Crest Sag Long Grade Crest Crest Sag
Interchange		WB	🟥 GEO CR OPS GEO CR OPS GEO
		EB	🟨 GEO CR OPS GEO CR OPS GEO
Other Observations			EB - Outer Road
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	AGE C-C COND AGE
		EB	AGE C-C COND AGE

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Phelps County
District 9

Figure 70
Mileposts: 180 - 181

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

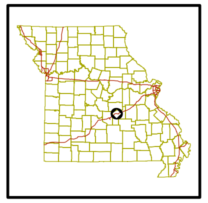
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

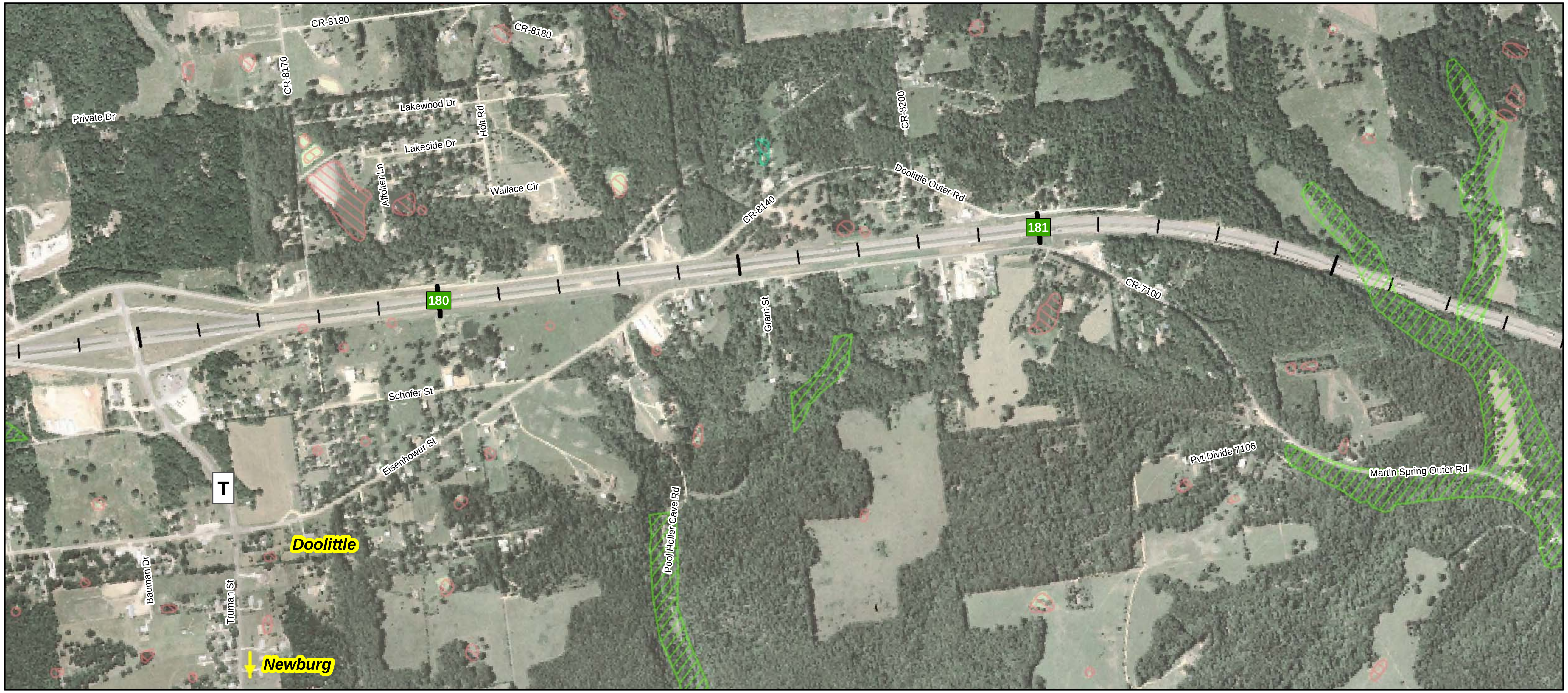
0 500 1,000
Feet

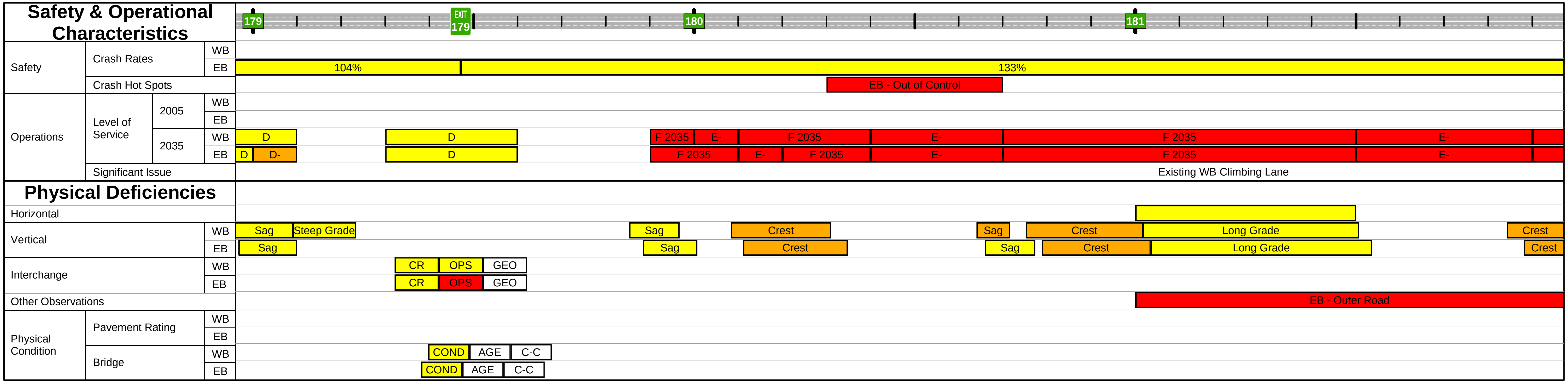
N

MoDOT

CH2MHILL







Safety & Operational Characteristics

Safety	Crash Rates		WB	
			EB	104% 133%
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	D D F 2035 E- F 2035 E- F 2035 E-
			EB	D D- D F 2035 E- F 2035 E- F 2035 E-
	Significant Issue			Existing WB Climbing Lane

Physical Deficiencies

Horizontal			
Vertical		WB	Sag Steep Grade Sag Crest Sag Crest Long Grade Crest
		EB	Sag Sag Crest Sag Crest Long Grade Crest
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			EB - Outer Road
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C
		EB	COND AGE C-C

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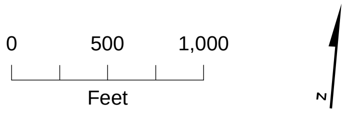
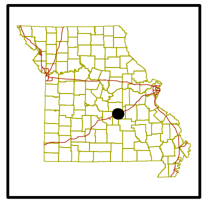
Purpose & Need Study
PLANNING FOR PROGRESS

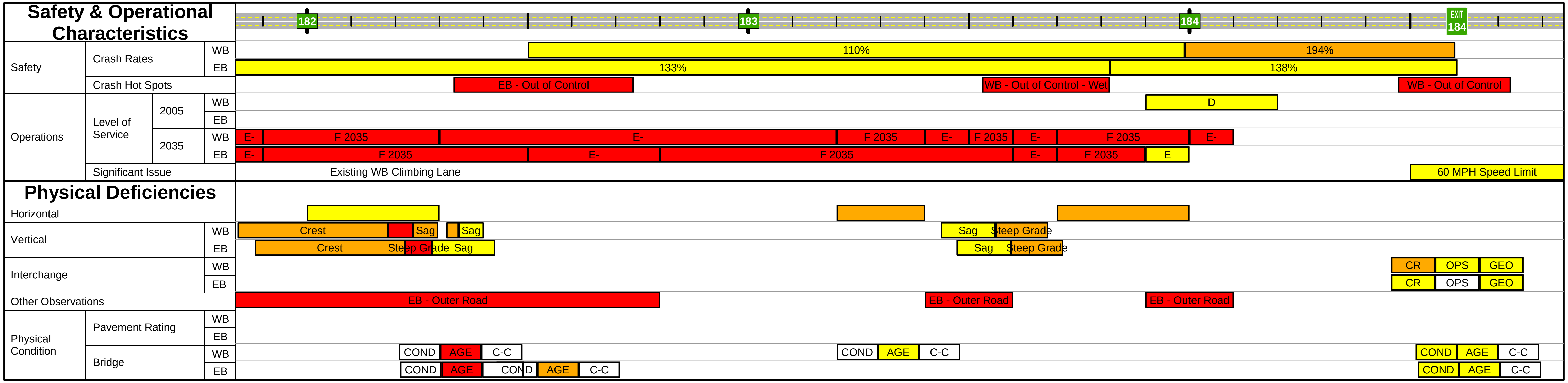
Phelps County
District 9

Figure 71
Mileposts: 182 - 184

LEGEND
▨ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability







Safety & Operational Characteristics

			Milepost	182 · 183 · 184 · EXIT 184
Safety	Crash Rates		WB	110% 194%
			EB	133% 138%
	Crash Hot Spots			EB - Out of Control WB - Out of Control - Wet WB - Out of Control
Operations	Level of Service	2005	WB	D
			EB	
		2035	WB	E- F 2035 E- F 2035 E- F 2035 E- F 2035 E-
			EB	E- F 2035 E- F 2035 E- F 2035 E
	Significant Issue			Existing WB Climbing Lane 60 MPH Speed Limit

Physical Deficiencies

Horizontal			
Vertical		WB	Crest Sag Sag Sag Steep Grade
		EB	Crest Steep Grade Sag Sag Steep Grade
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			EB - Outer Road EB - Outer Road EB - Outer Road
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C COND AGE C-C
		EB	COND AGE COND AGE C-C COND AGE C-C

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PLANNING FOR PROGRESS

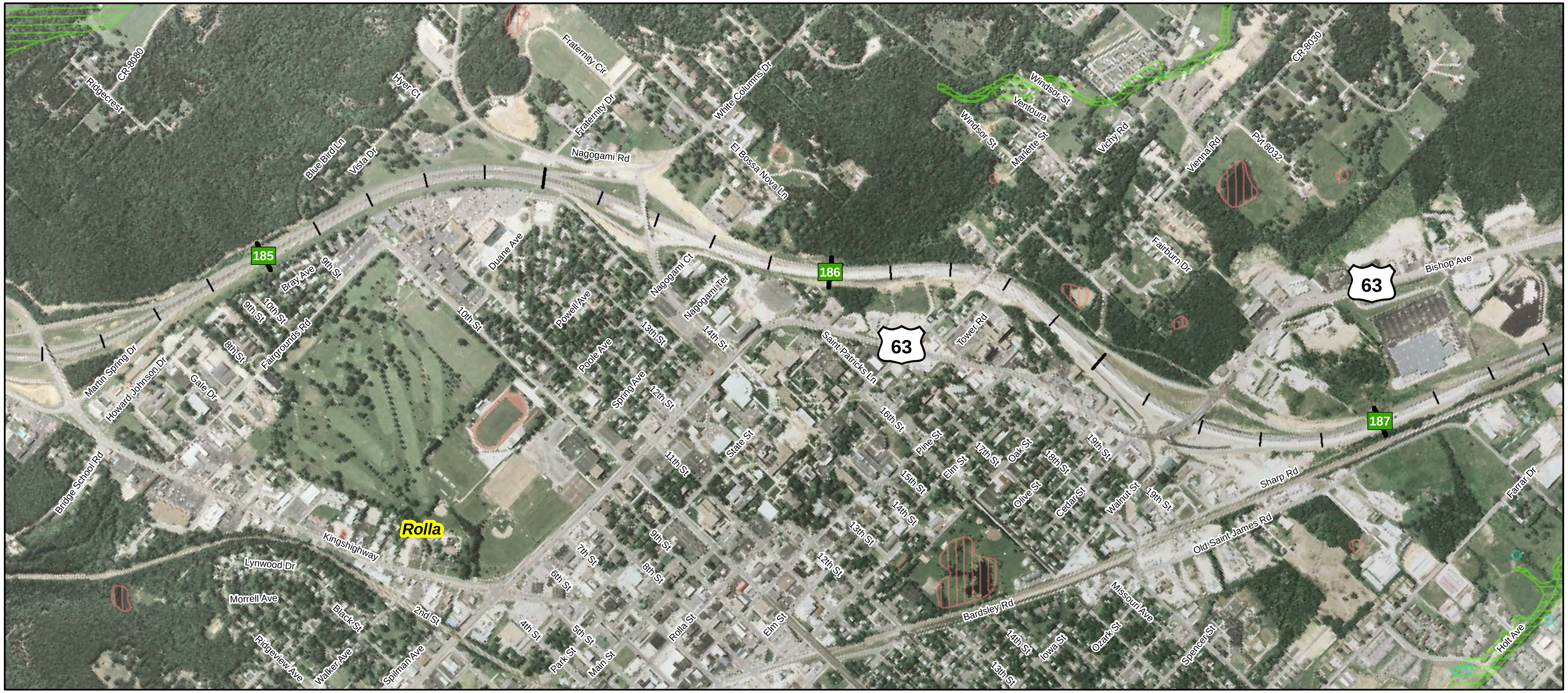
Phelps County
District 9

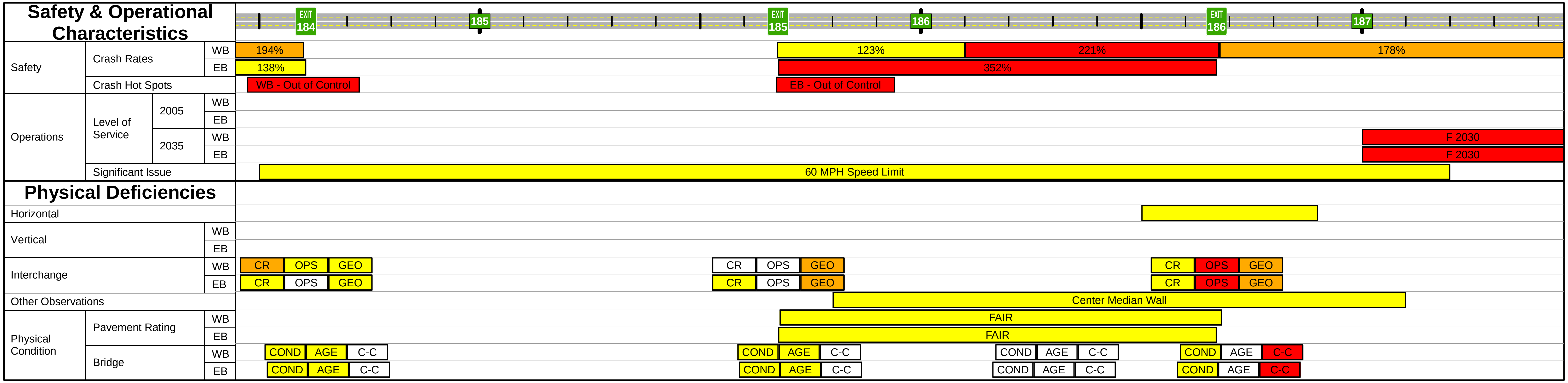
Figure 72
Mileposts: 185 - 187

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet





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Purpose & Need Study
PLANNING FOR PROGRESS

Phelps County
District 9

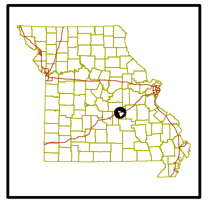
Figure 73
Mileposts: 188 - 190

LEGEND
- ▨ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

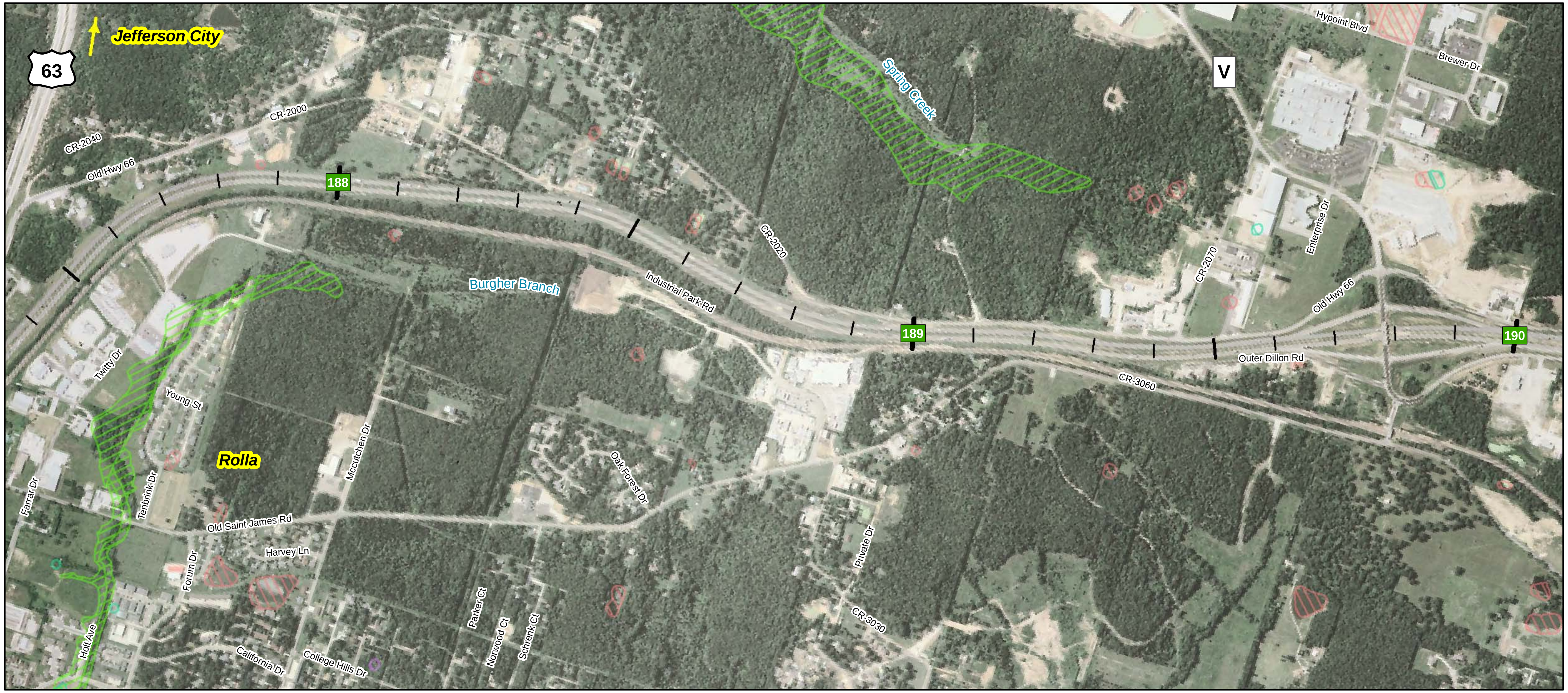
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

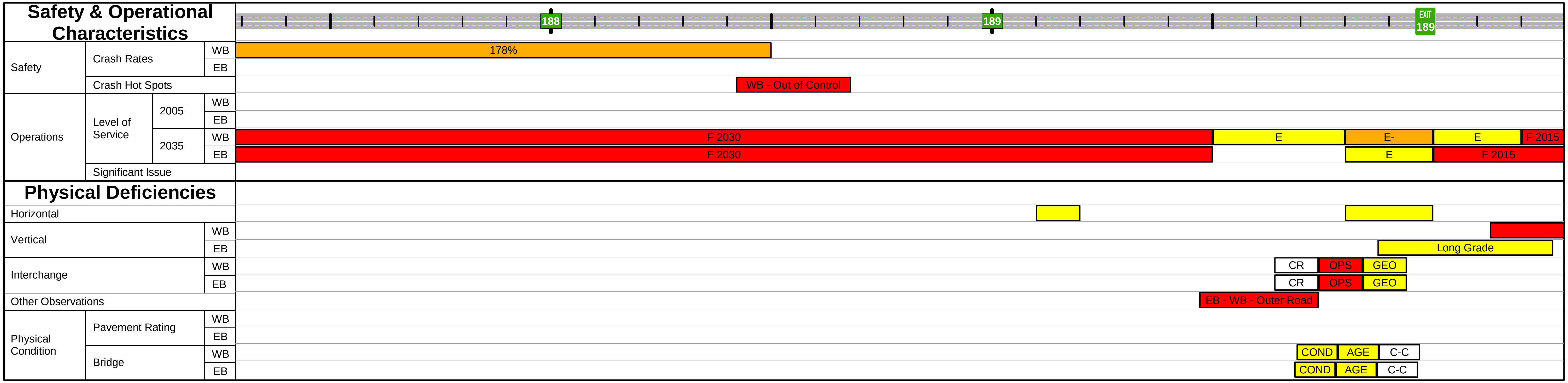
0 500 1,000
Feet

N



CH2MHILL





Safety & Operational Characteristics				
Safety	Crash Rates		WB	178%
			EB	
	Crash Hot Spots			WB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2030 · E · E- · E · F 2015
			EB	F 2030 · E · F 2015
	Significant Issue			
Physical Deficiencies				
Horizontal				🟨 · 🟨
Vertical			WB	🟥
			EB	Long Grade
Interchange			WB	CR · OPS · GEO
			EB	CR · OPS · GEO
Other Observations				EB - WB - Outer Road
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND · AGE · C-C
			EB	COND · AGE · C-C

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PLANNING FOR PROGRESS

Phelps County
District 9

Figure 74
Mileposts: 191 - 192

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

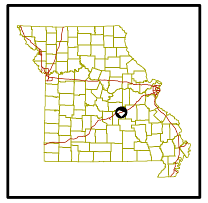
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

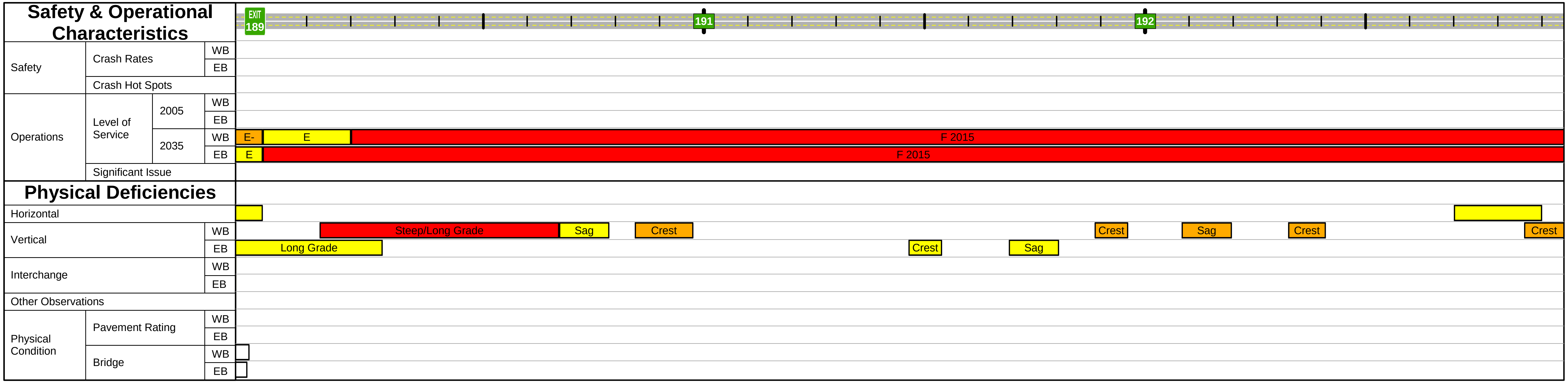
0 500 1,000
Feet

N

MoDOT

CH2MHILL





Safety & Operational Characteristics				
Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	E- E F 2015
			EB	E F 2015
	Significant Issue			
Physical Deficiencies				
Horizontal				🟨 🟨
Vertical			WB	Steep/Long Grade Sag Crest Crest Sag Crest Crest
			EB	Long Grade Crest Sag
Interchange			WB	
			EB	
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	☐
			EB	☐

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Purpose & Need Study
PLANNING FOR PROGRESS

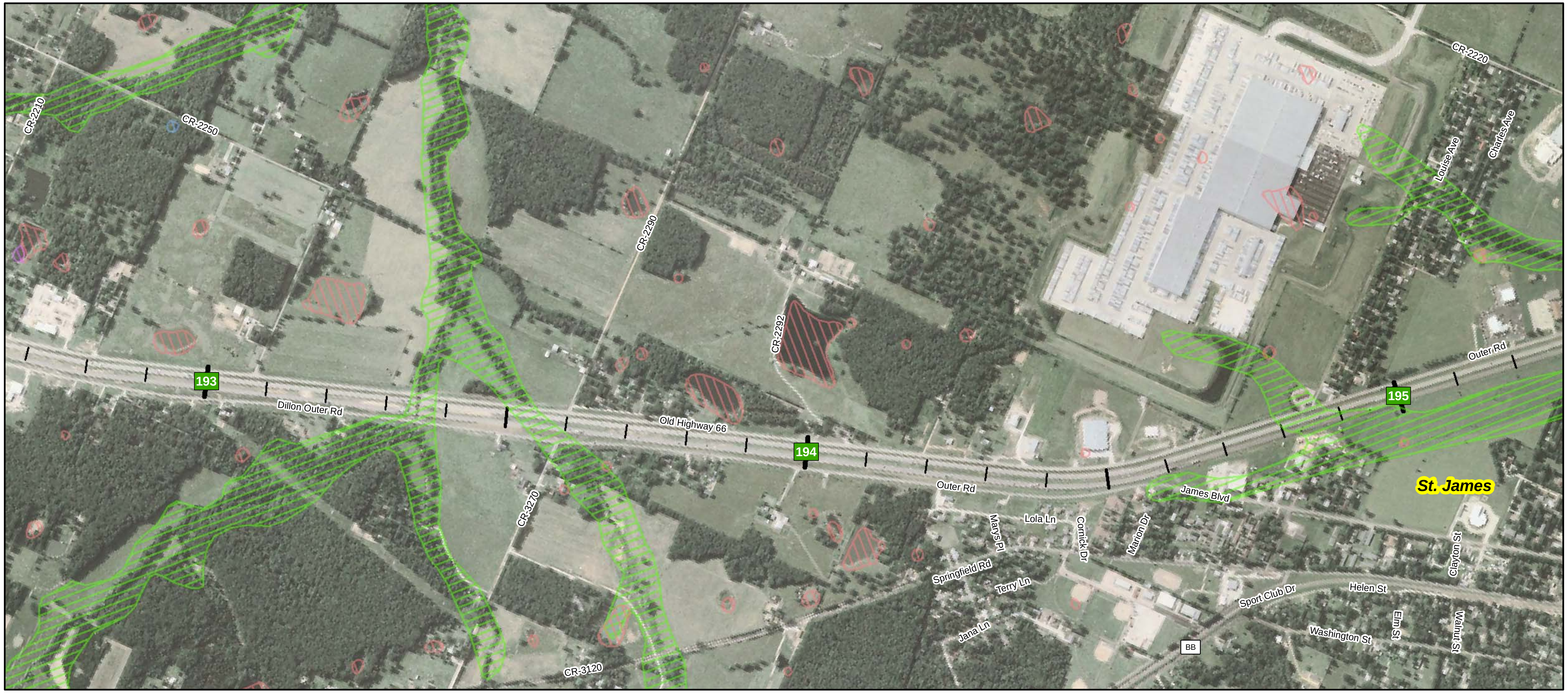
Phelps County
District 9

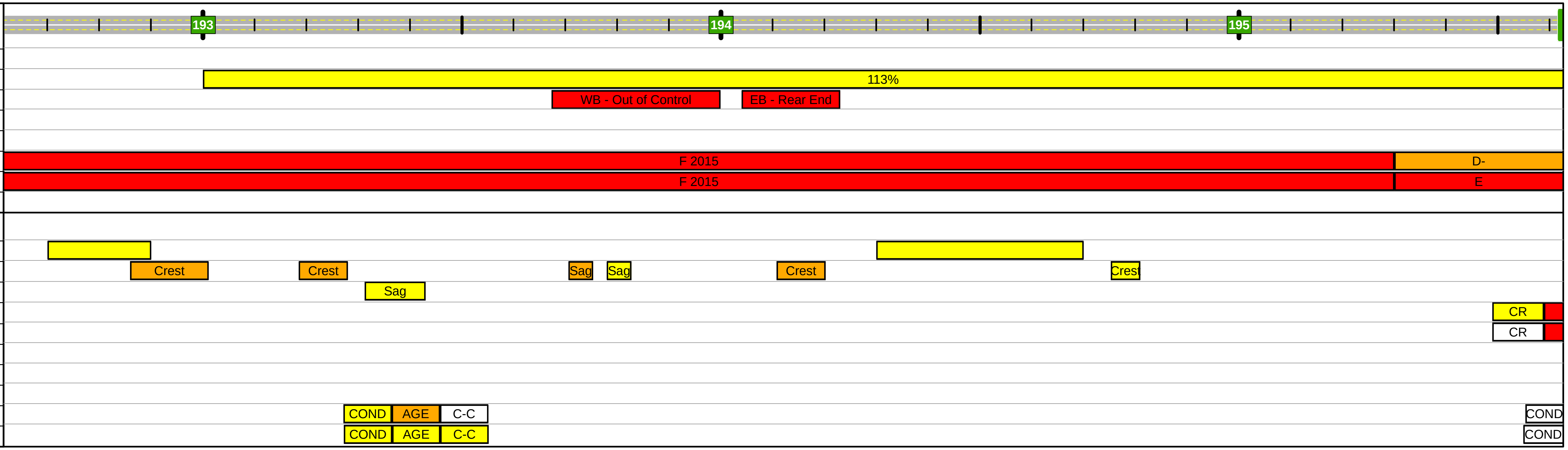
Figure 75
Mileposts: 193 - 195

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet





Safety & Operational Characteristics

Safety	Crash Rates		WB	
			EB	113%
	Crash Hot Spots			WB - Out of Control; EB - Rear End
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2015; D-
			EB	F 2015; E
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Crest; Crest; Sag; Sag; Crest; Crest
		EB	Sag
Interchange		WB	CR
		EB	CR
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND; AGE; C-C; COND
		EB	COND; AGE; C-C; COND

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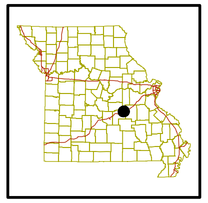
Purpose & Need Study
PLANNING FOR PROGRESS

Phelps County
District 9

Figure 76
Mileposts: 196 - 197

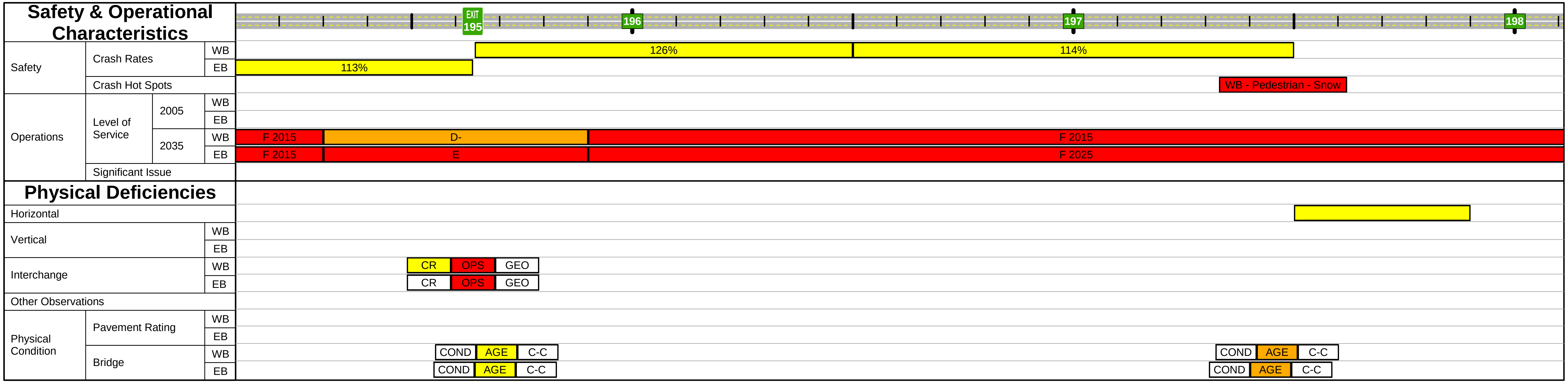
LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet



Safety & Operational Characteristics

Physical Deficiencies



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Purpose & Need Study
PLANNING FOR PROGRESS

Phelps County
District 9

Figure 77
Mileposts: 198 - 200

LEGEND

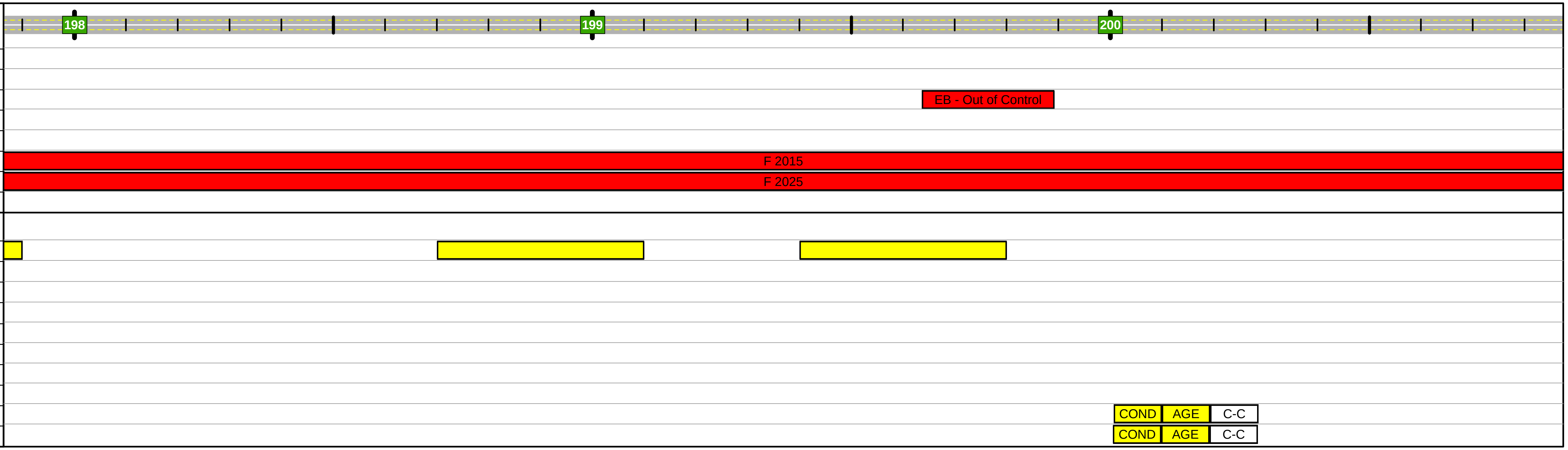
▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)
Condition	
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



Safety & Operational Characteristics				
Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2015
			EB	F 2025
	Significant Issue			
Physical Deficiencies				
Horizontal				🟨 🟨 🟨
Vertical			WB	
			EB	
Interchange			WB	
			EB	
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND AGE C-C
			EB	COND AGE C-C

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Crawford County

Purpose & Need Study
PLANNING FOR PROGRESS

Phelps County
Crawford County
District 9

Figure 78
Mileposts: 201 - 203

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

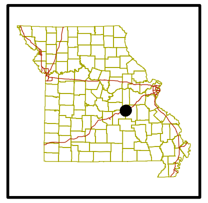
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

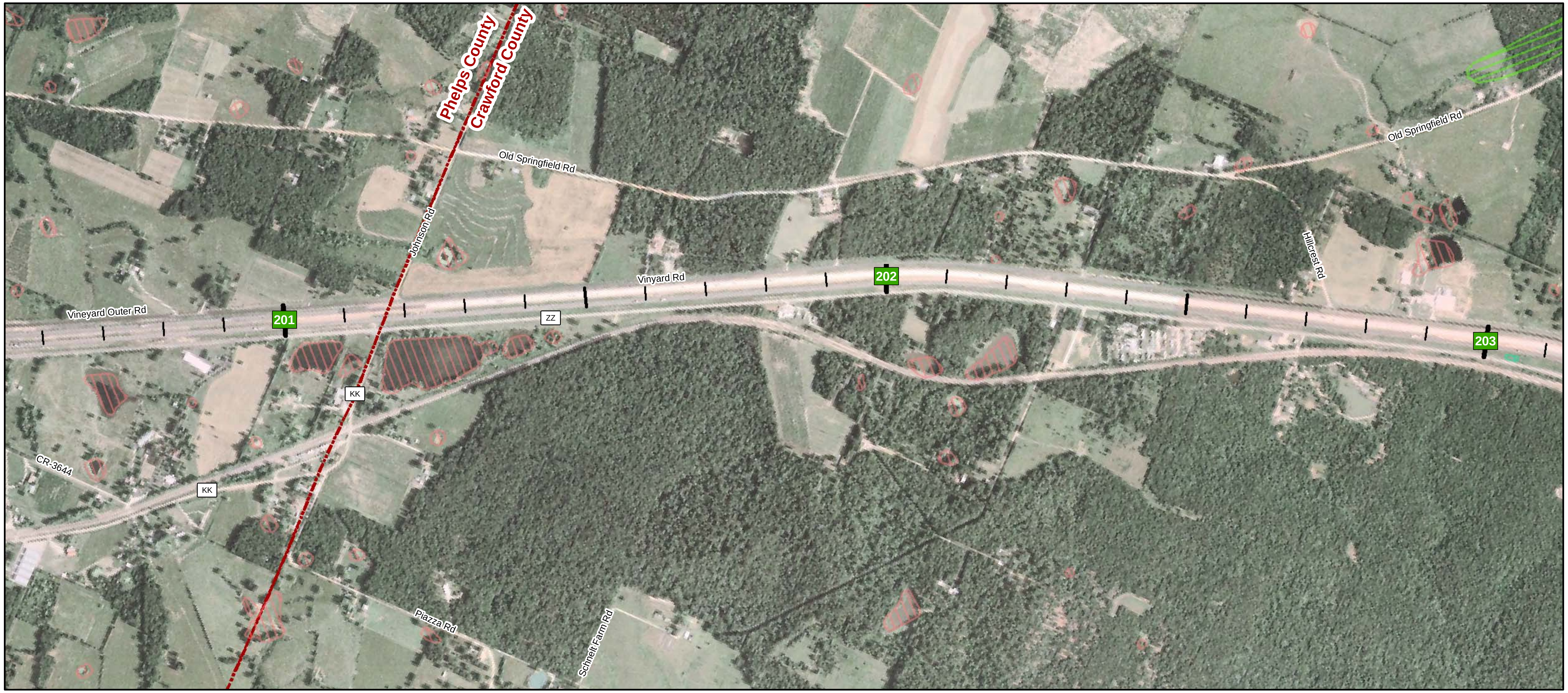
0 500 1,000
Feet

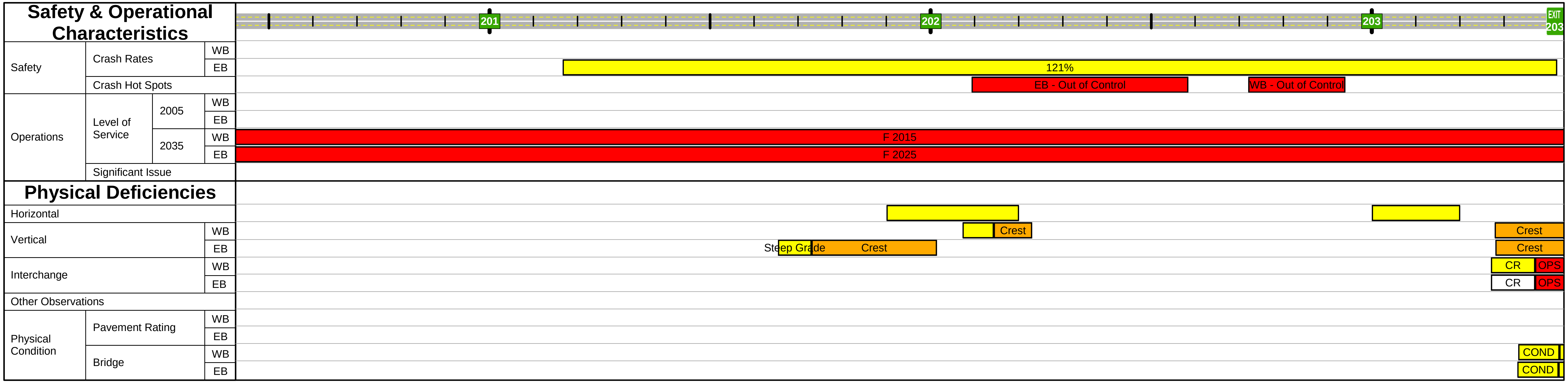
N

MoDOT

CH2MHILL







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Purpose & Need Study
PLANNING FOR PROGRESS

Crawford County
District 9

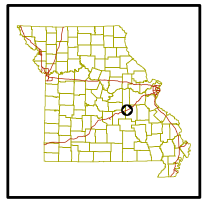
Figure 79
Mileposts: 204 - 205

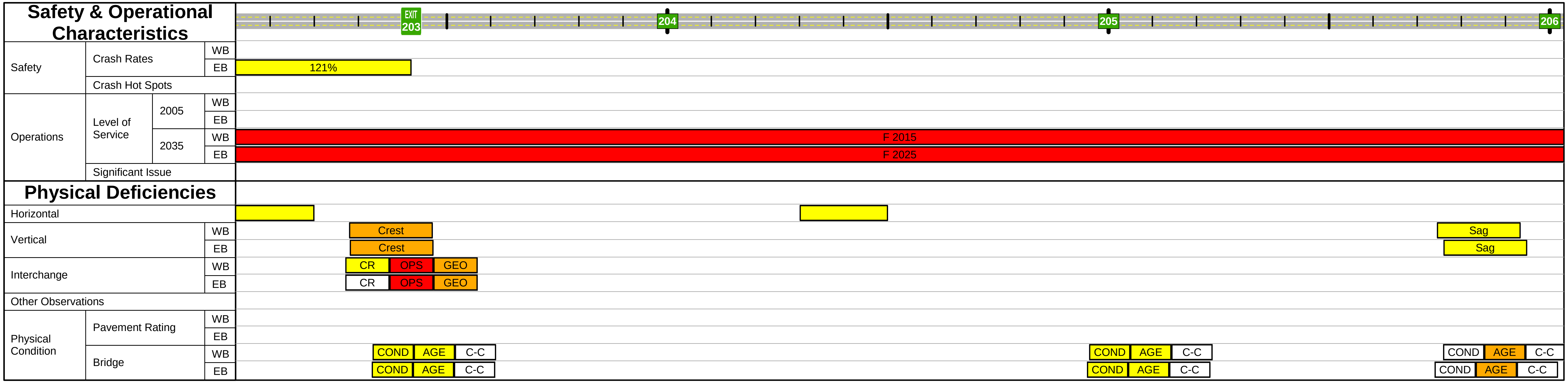
LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N





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Purpose & Need Study
PLANNING FOR PROGRESS

Crawford County
District 9

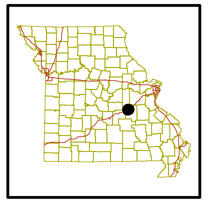
Figure 80
Mileposts: 206 - 208

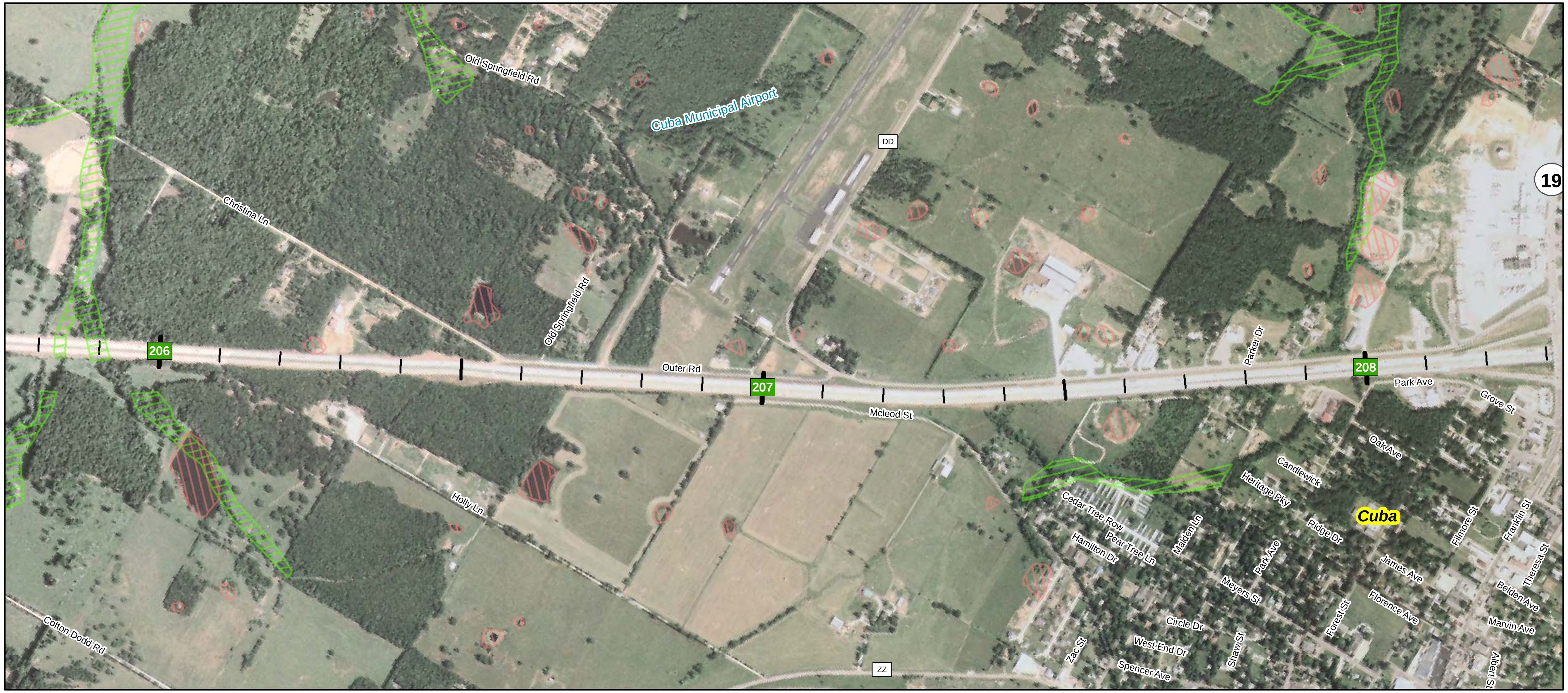
LEGEND
- County Boundary
- Floodplain
- Palustrine Pond (PUB)
- Palustrine Emergent (PEM)
- Palustrine Scrub-Shrub (PSS)
- Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

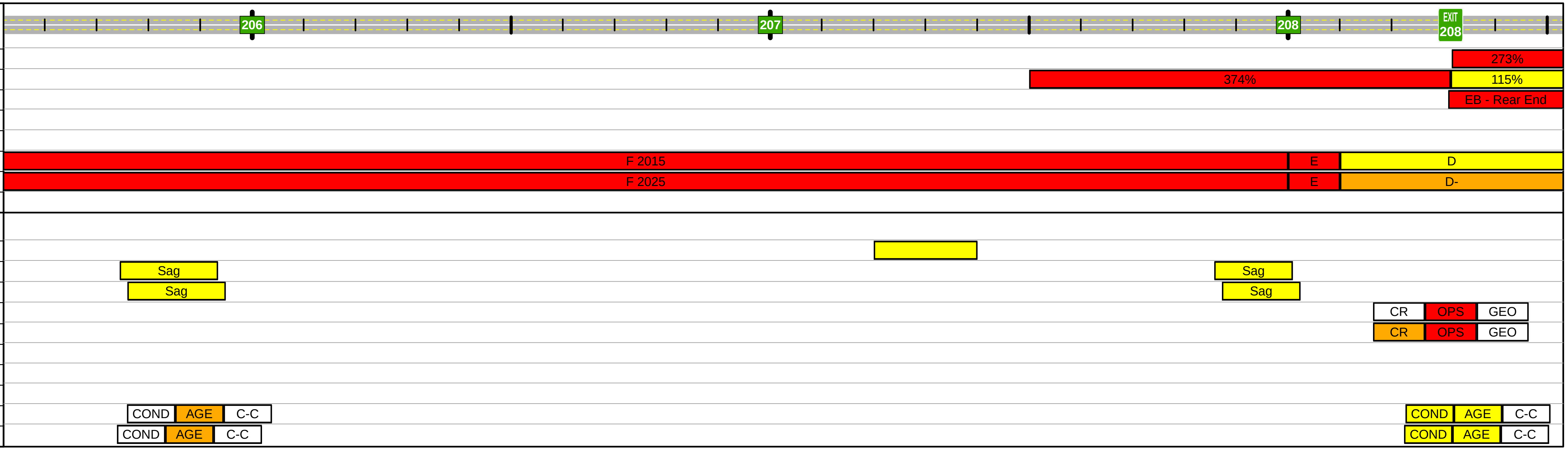
0 500 1,000
Feet

MoDOT
CH2MHILL





Safety & Operational Characteristics



Safety	Crash Rates		WB	273%
			EB	374%; 115%
	Crash Hot Spots			EB - Rear End
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2015; E; D
			EB	F 2025; E; D-
	Significant Issue			

Physical Deficiencies

Horizontal			🟨
Vertical		WB	Sag; Sag
		EB	Sag; Sag
Interchange		WB	CR; OPS; GEO
		EB	CR; OPS; GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND; AGE; C-C COND; AGE; C-C
		EB	COND; AGE; C-C COND; AGE; C-C

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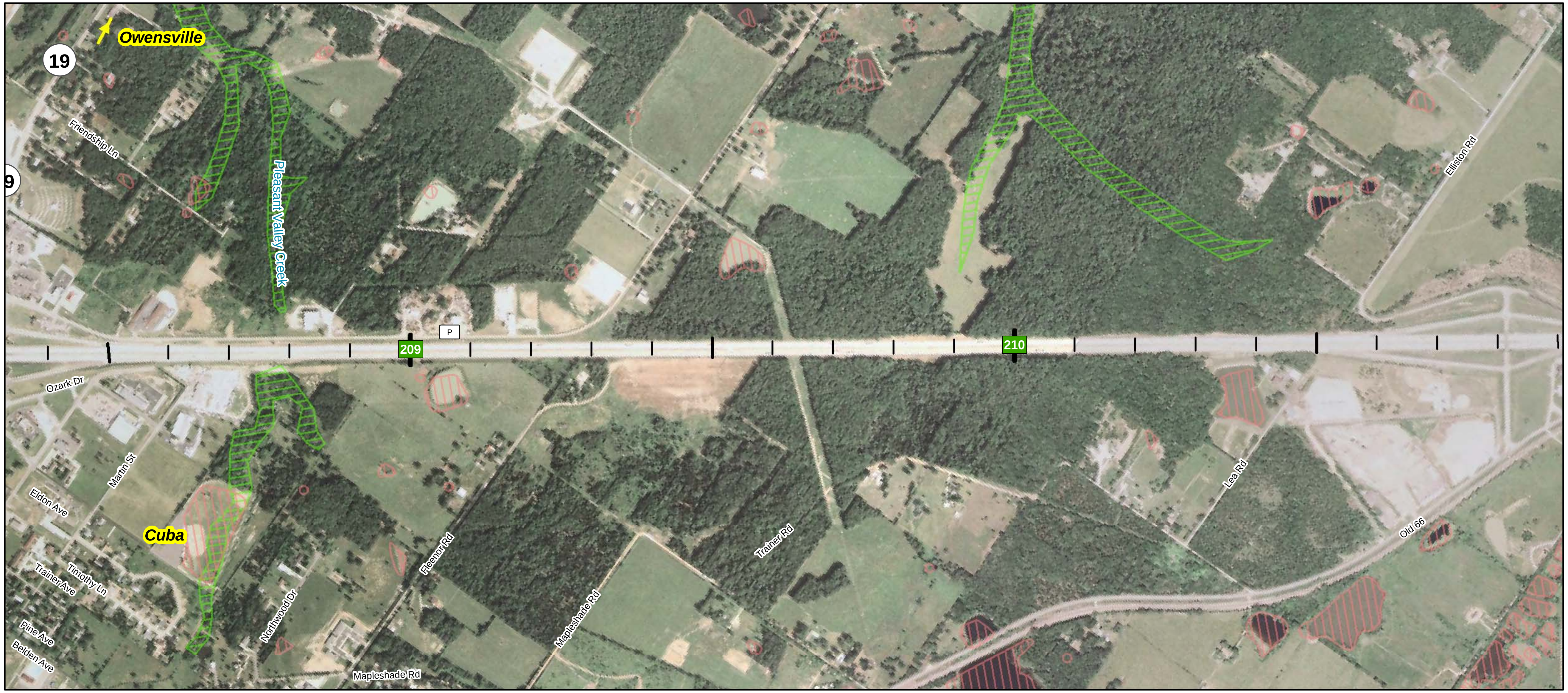
Purpose & Need Study
PLANNING FOR PROGRESS

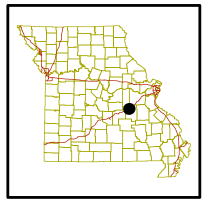
Crawford County
District 9

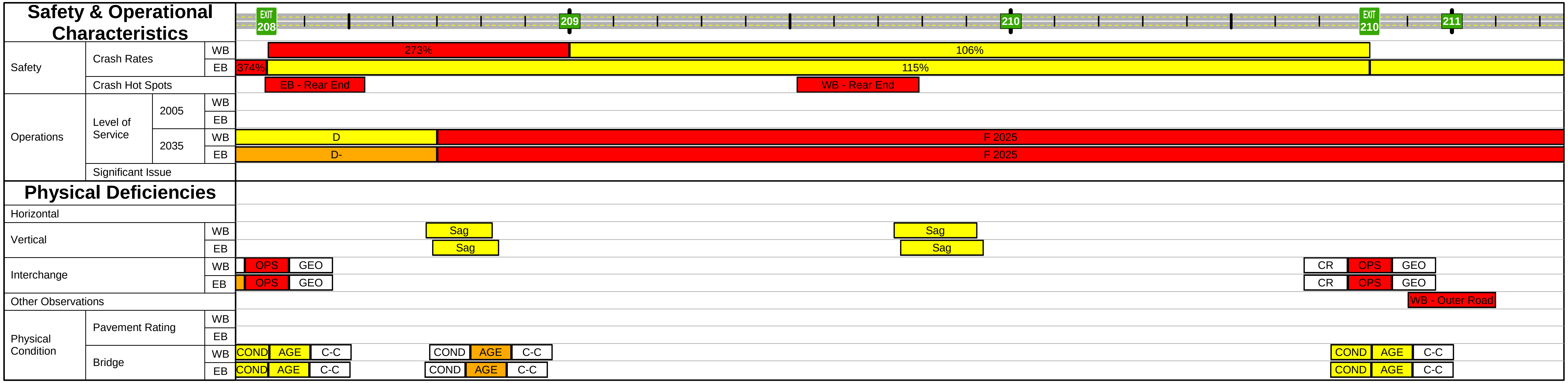
Figure 81
Mileposts: 209 - 210

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability







Safety & Operational Characteristics

Safety	Crash Rates		WB	273% 106%
			EB	374% 115%
	Crash Hot Spots			EB - Rear End WB - Rear End
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	D F 2025
			EB	D- F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Sag Sag
		EB	Sag Sag
Interchange		WB	OPS GEO CR OPS GEO
		EB	OPS GEO CR OPS GEO
Other Observations			WB - Outer Road
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Crawford County
District 9

Figure 82
Mileposts: 211 - 213

LEGEND

▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)

Condition

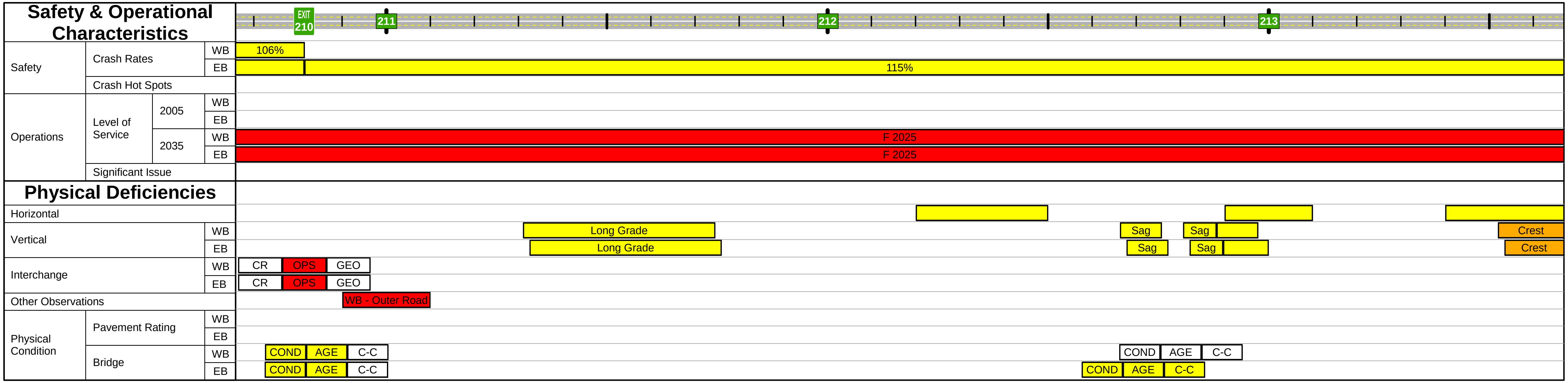
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



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Purpose & Need Study
PLANNING FOR PROGRESS

Crawford County
District 9

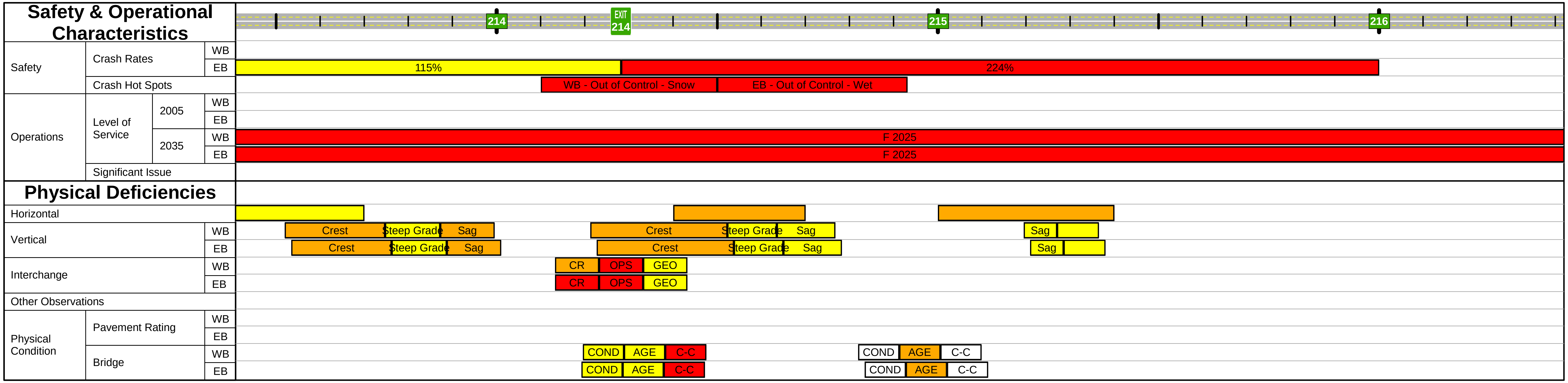
Figure 83
Mileposts: 214 - 216

LEGEND

▭	County Boundary
🟩	Floodplain
🟥	Palustrine Pond (PUB)
🟩	Palustrine Emergent (PEM)
🟪	Palustrine Scrub-Shrub (PSS)
🟦	Palustrine Forested (PFO)
Condition	
🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

0 500 1,000
Feet

N



Safety & Operational Characteristics

				214 · EXIT 214 · 215 · 216
Safety	Crash Rates		WB	
			EB	115% 224%
	Crash Hot Spots			WB - Out of Control - Snow EB - Out of Control - Wet
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2025
			EB	F 2025
	Significant Issue			

Physical Deficiencies

Horizontal			🟨 🟧 🟧
Vertical		WB	Crest Steep Grade Sag Crest Steep Grade Sag Sag
		EB	Crest Steep Grade Sag Crest Steep Grade Sag Sag
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

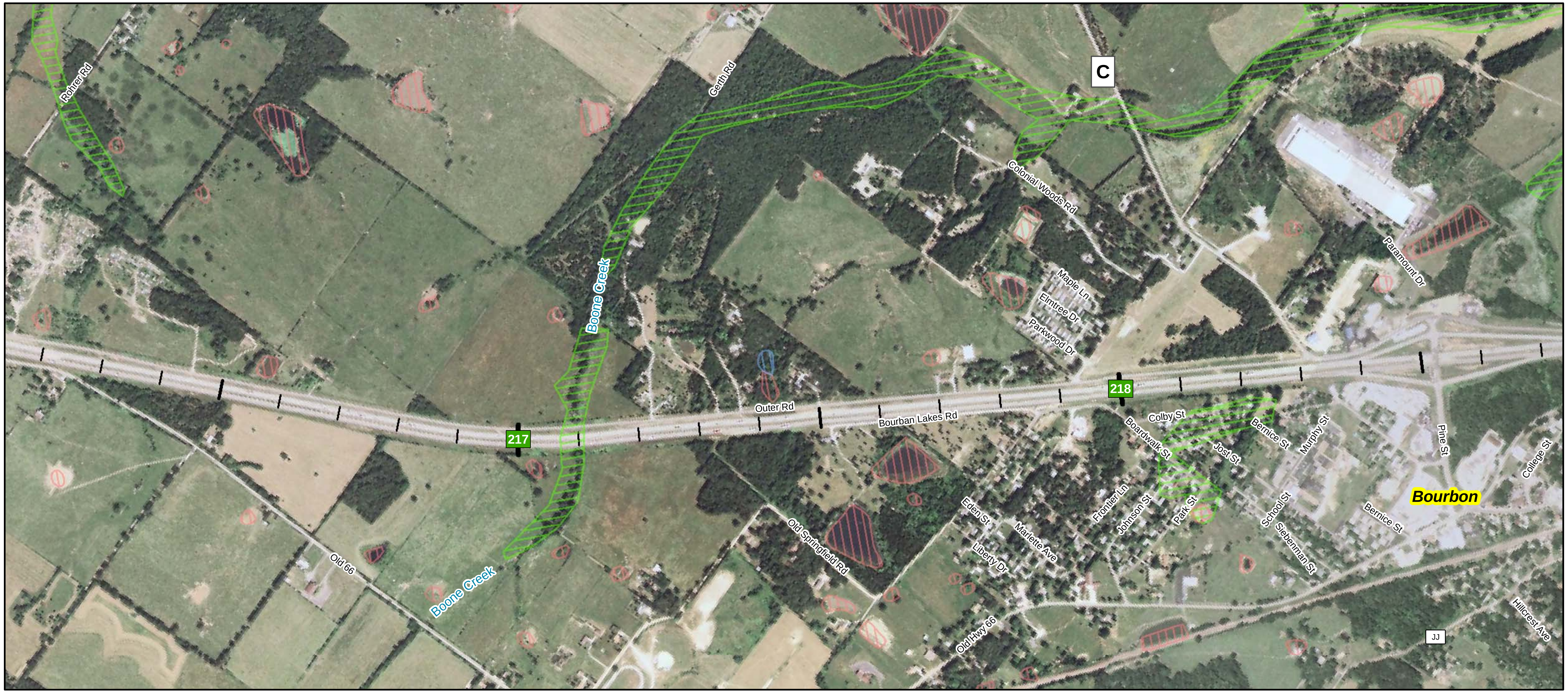
Crawford County
District 9

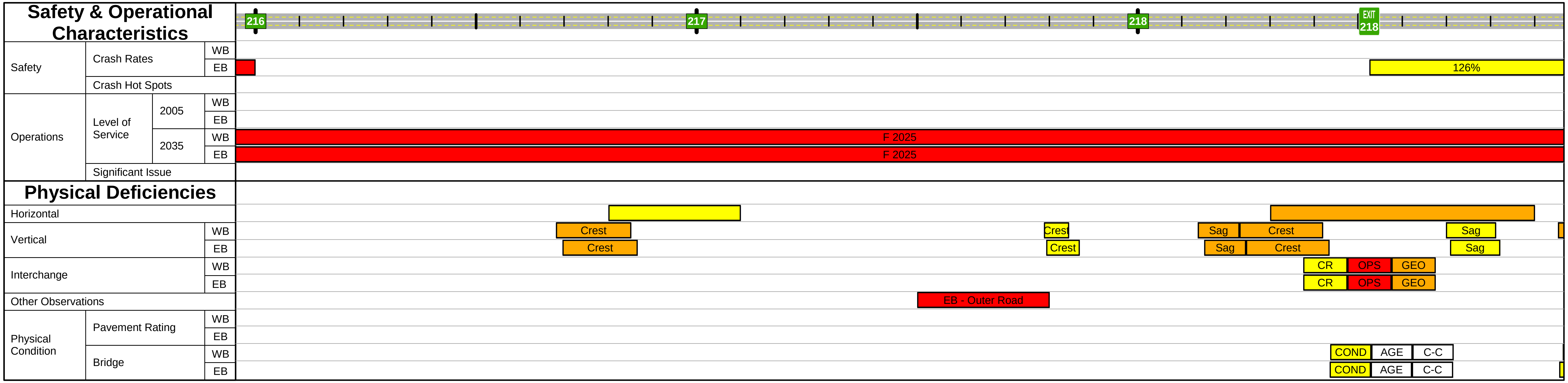
Figure 84
Mileposts: 217 - 218

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet





Jun 17, 2008

Purpose & Need Study
PLANNING FOR PROGRESS

Crawford County
District 9

Figure 85
Mileposts: 219 - 221

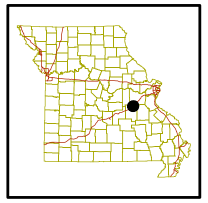
LEGEND
▭ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

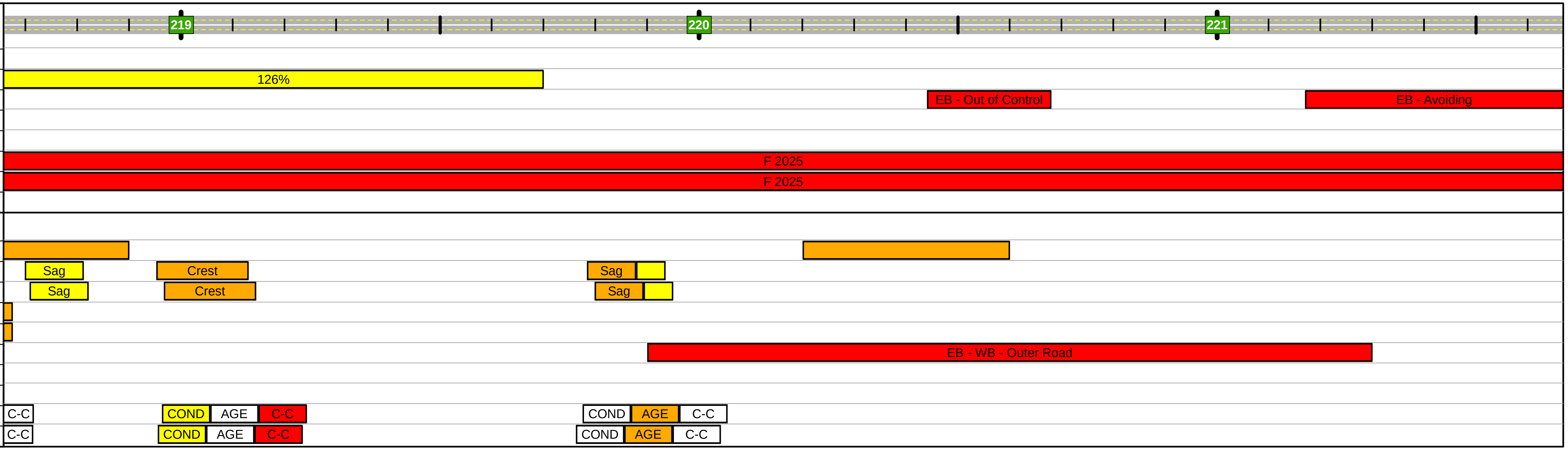
0 500 1,000
Feet

N

MoDOT

CH2MHILL





Safety & Operational Characteristics				
Safety	Crash Rates		WB	
			EB	126%
	Crash Hot Spots			EB - Out of Control EB - Avoiding
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2025
			EB	F 2025
	Significant Issue			
Physical Deficiencies				
Horizontal				
Vertical			WB	Sag Crest Sag
			EB	Sag Crest Sag
Interchange			WB	
			EB	
Other Observations				EB - WB - Outer Road
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	C-C COND AGE C-C COND AGE C-C
			EB	C-C COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
Crawford County
District 6 & 9

Figure 86
Mileposts: 222 - 224

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

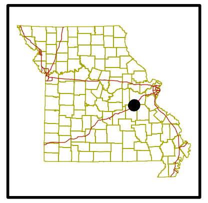
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

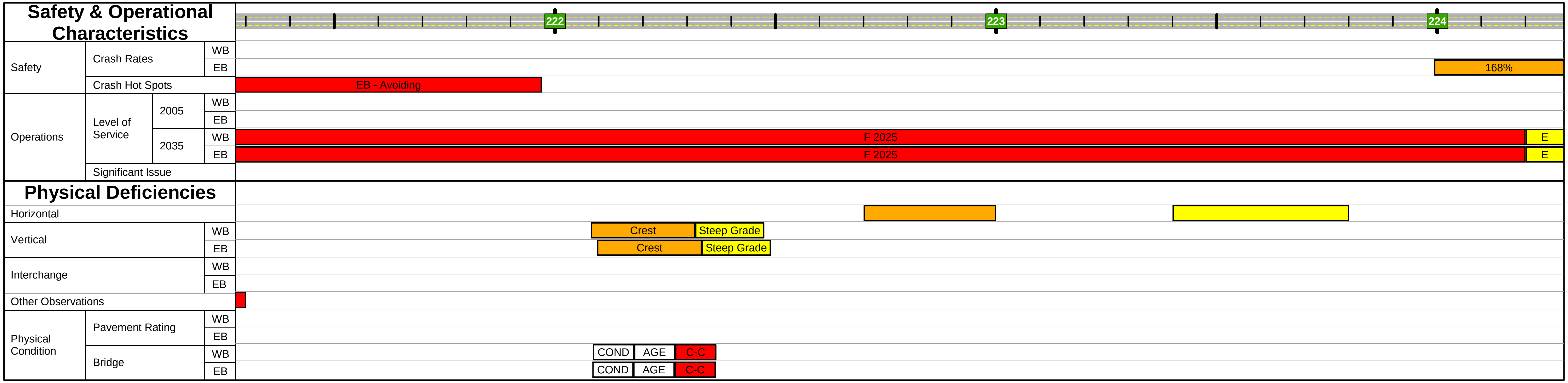
0 500 1,000
Feet

N

MoDOT

CH2MHILL





Jun 17, 2008

Franklin County

Purpose & Need Study
PLANNING FOR PROGRESS

Crawford County
Franklin County
District 6 & 9

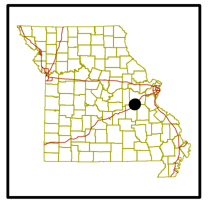
Figure 87
Mileposts: 225 - 226

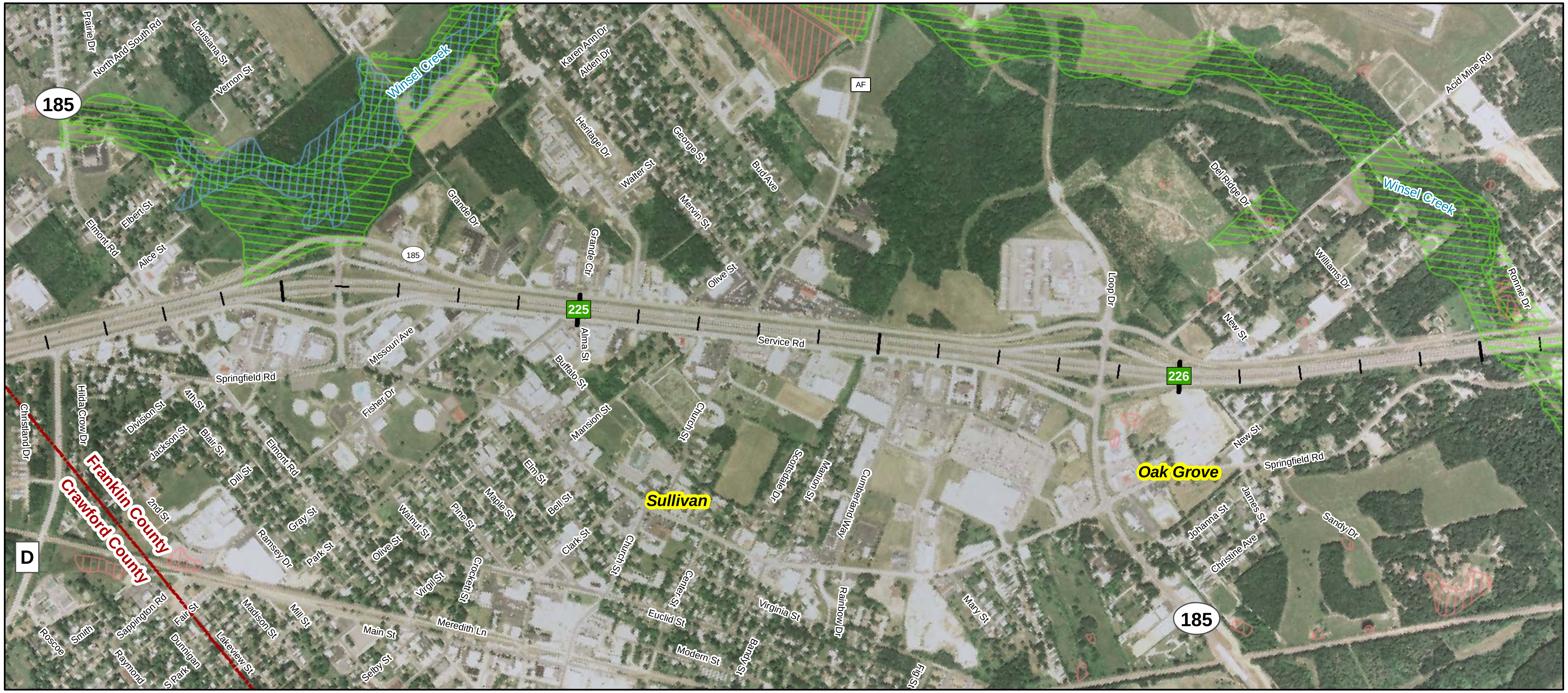
LEGEND
🟥 County Boundary
🟩 Floodplain
🟥 Palustrine Pond (PUB)
🟩 Palustrine Emergent (PEM)
🟪 Palustrine Scrub-Shrub (PSS)
🟦 Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

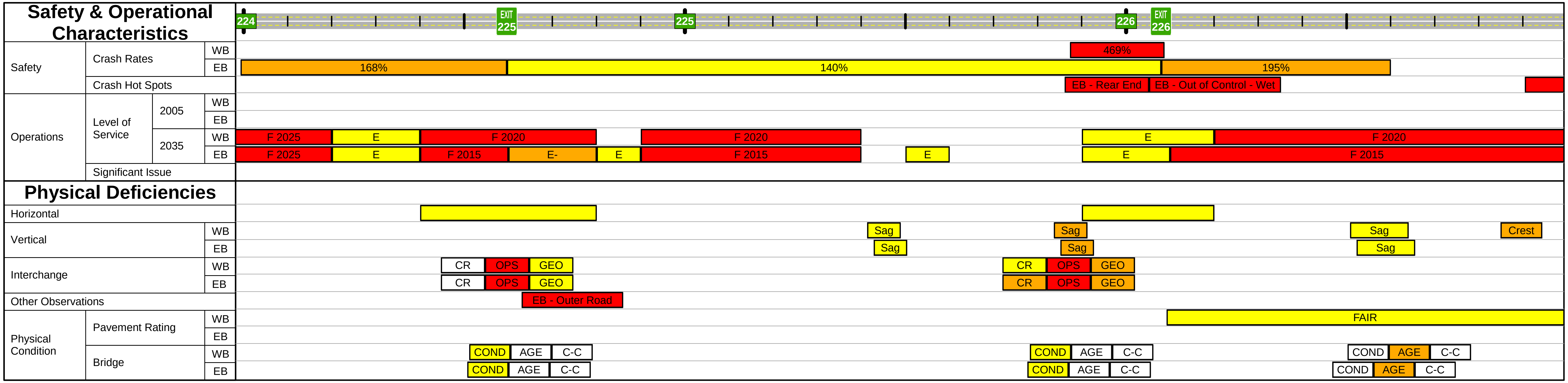
0 500 1,000
Feet

MoDOT

CH2MHILL







Jun 17, 2008

Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

Figure 88
Mileposts: 227 - 229

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

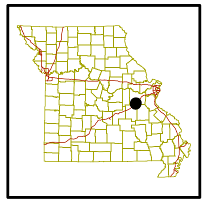
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

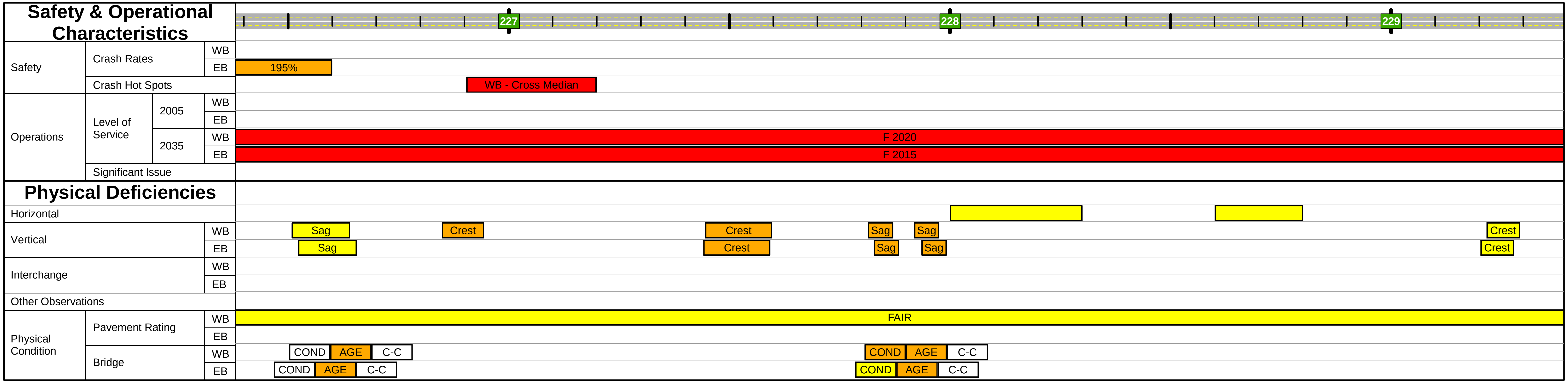
0 500 1,000
Feet

N

MoDOT

CH2MHILL





Jun 17, 2008

Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

Figure 89
Mileposts: 230 - 231

LEGEND
- County Boundary
- Floodplain
- Palustrine Pond (PUB)
- Palustrine Emergent (PEM)
- Palustrine Scrub-Shrub (PSS)
- Palustrine Forested (PFO)

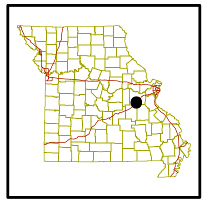
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

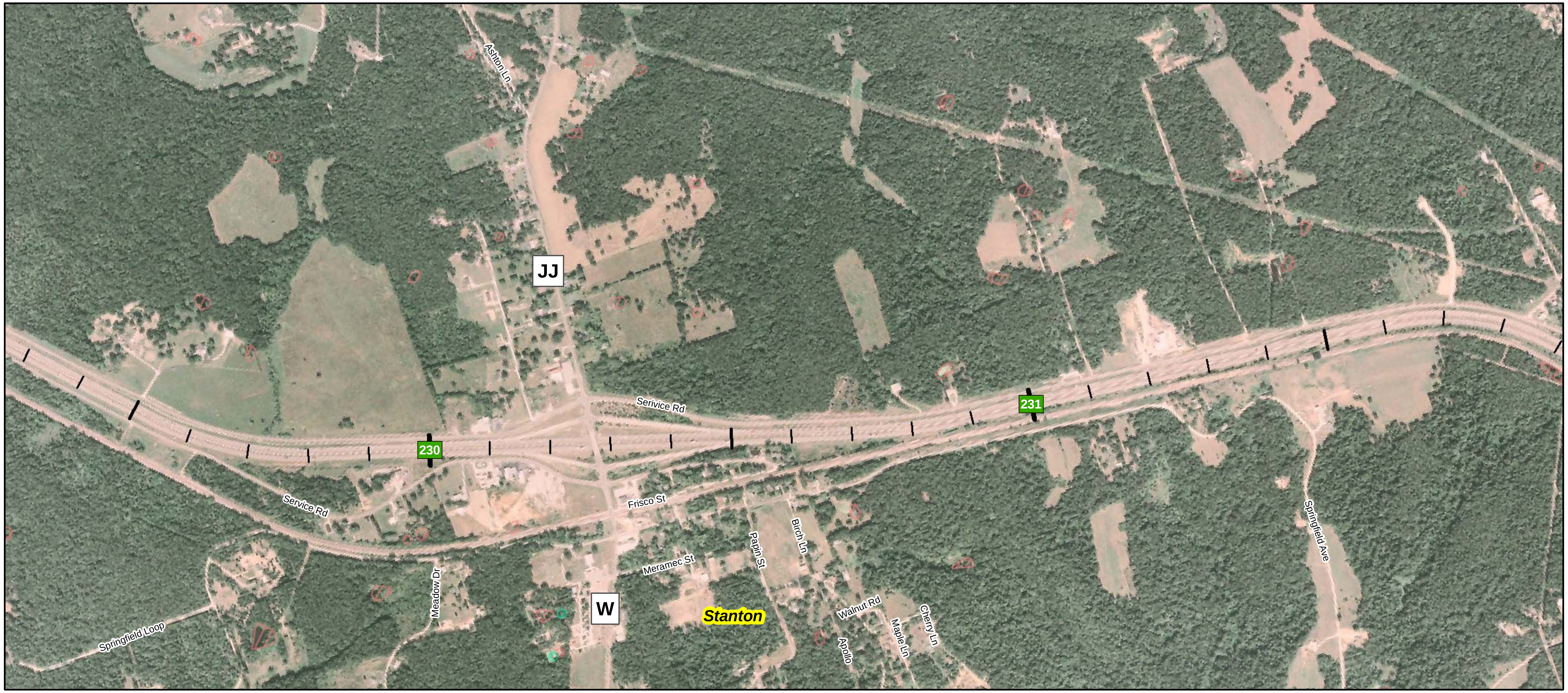
0 500 1,000
Feet

N

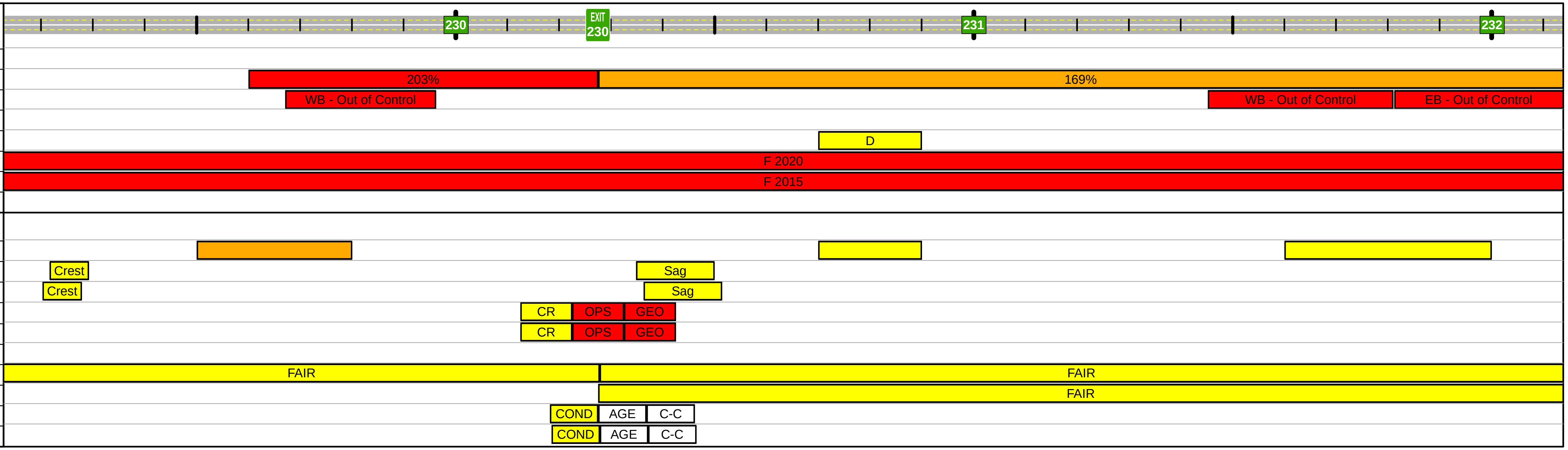
MoDOT

CH2MHILL





Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	203% 169%
	Crash Hot Spots			WB - Out of Control WB - Out of Control EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	D
		2035	WB	F 2020
			EB	F 2015
	Significant Issue			

Physical Deficiencies

Horizontal			🟧 🟨 🟨
Vertical		WB	Crest Sag
		EB	Crest Sag
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR FAIR
		EB	FAIR
	Bridge	WB	COND AGE C-C
		EB	COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

Figure 90
Mileposts: 232 - 234

LEGEND

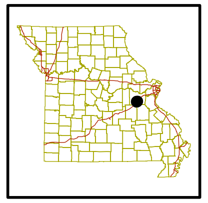
▭	County Boundary
▨	Floodplain
▨	Palustrine Pond (PUB)
▨	Palustrine Emergent (PEM)
▨	Palustrine Scrub-Shrub (PSS)
▨	Palustrine Forested (PFO)

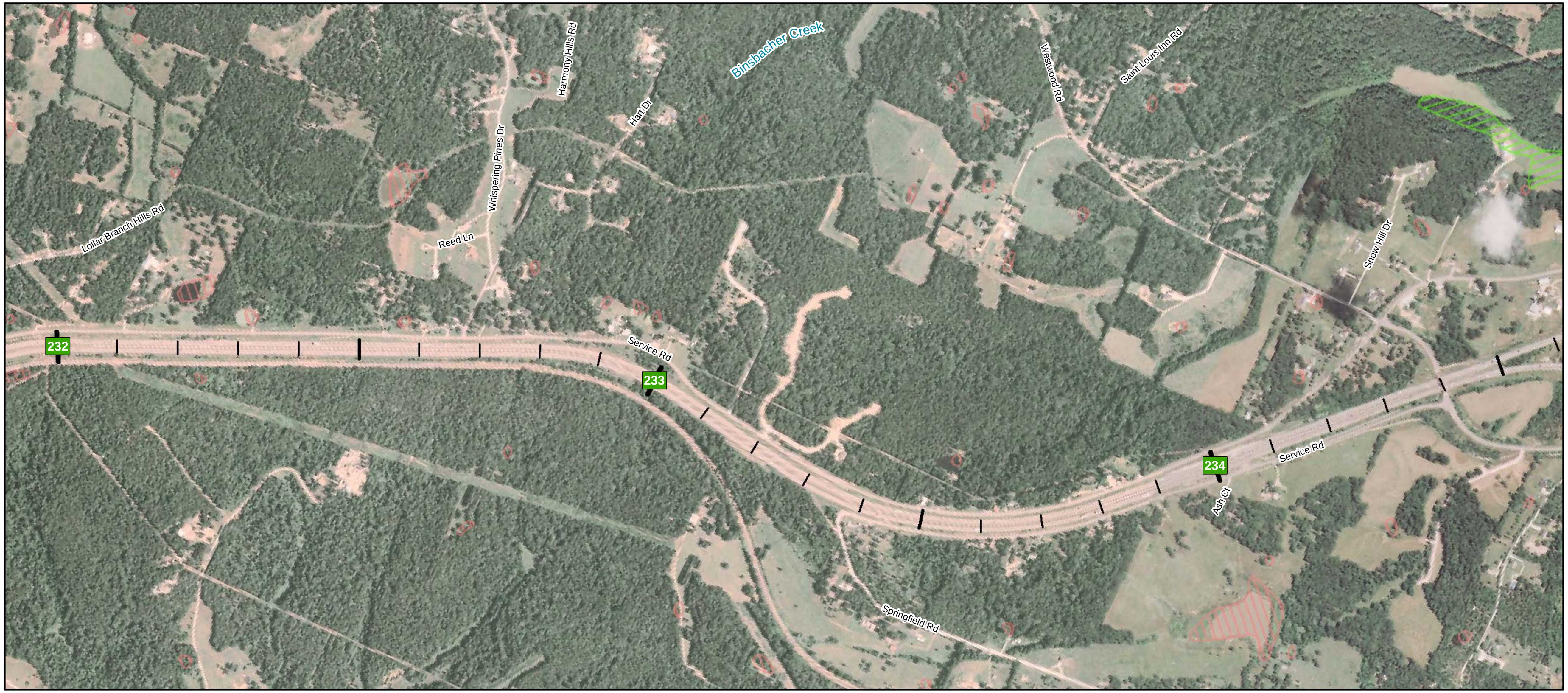
Condition

🟨	Approach Threshold of Acceptability
🟧	
🟥	Exceeds Threshold of Acceptability

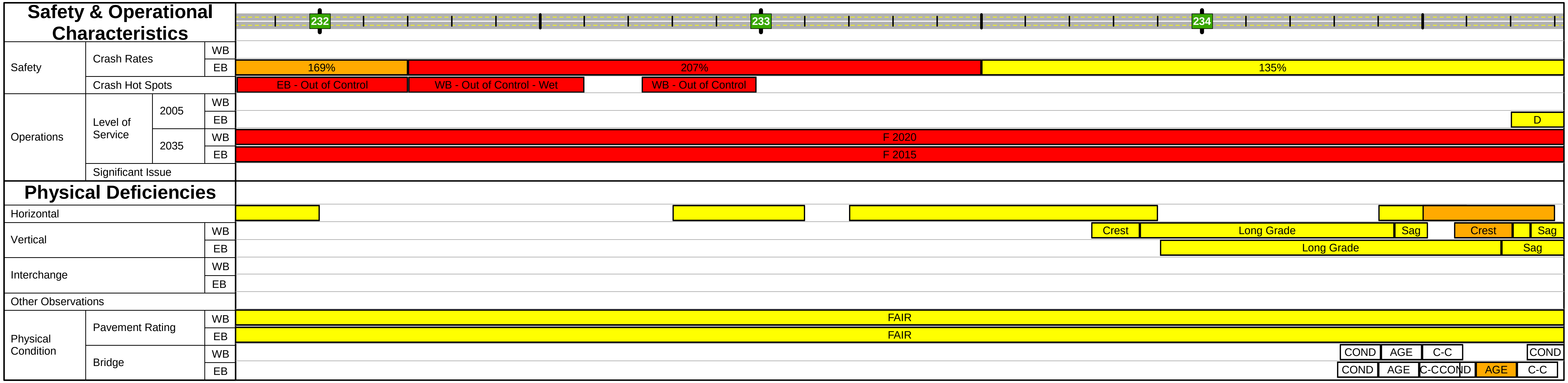
0 500 1,000
Feet

MoDOT
CH2MHILL





Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	169% 207% 135%
	Crash Hot Spots			EB - Out of Control WB - Out of Control - Wet WB - Out of Control
Operations	Level of Service	2005	WB	
			EB	D
		2035	WB	F 2020
			EB	F 2015
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Crest Long Grade Sag Crest Sag
		EB	Long Grade Sag
Interchange		WB	
		EB	
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR
		EB	FAIR
	Bridge	WB	COND AGE C-C COND
		EB	COND AGE C-CCOND AGE C-C

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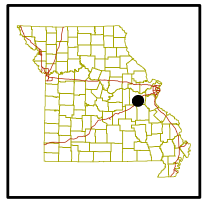
Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

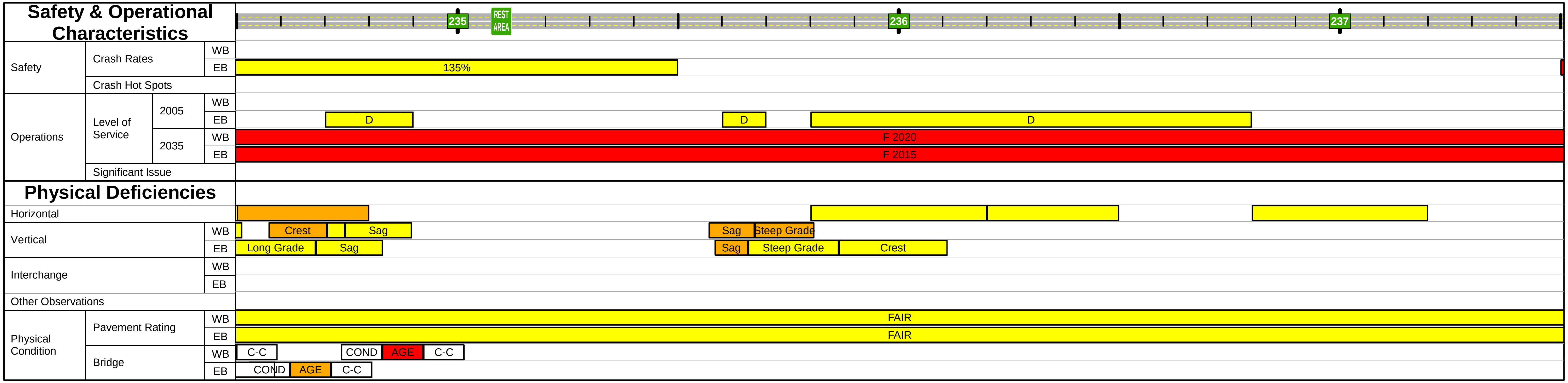
Figure 91
Mileposts: 235 - 237

LEGEND
▨ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet
N



Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	135% 🟥
	Crash Hot Spots			
Operations	Level of Service	2005	WB	
			EB	D; D; D
		2035	WB	F 2020
			EB	F 2015
	Significant Issue			

Physical Deficiencies

Horizontal			🟧 🟨 🟨 🟨
Vertical		WB	🟨 Crest 🟧 Sag; Sag Steep Grade
		EB	Long Grade Sag; Sag Steep Grade Crest
Interchange		WB	
		EB	
Other Observations			
Physical Condition	Pavement Rating	WB	FAIR
		EB	FAIR
	Bridge	WB	C-C; COND AGE C-C
		EB	COND AGE C-C

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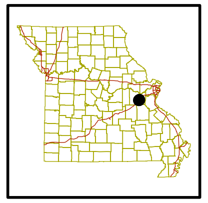
Purpose & Need Study
PLANNING FOR PROGRESS

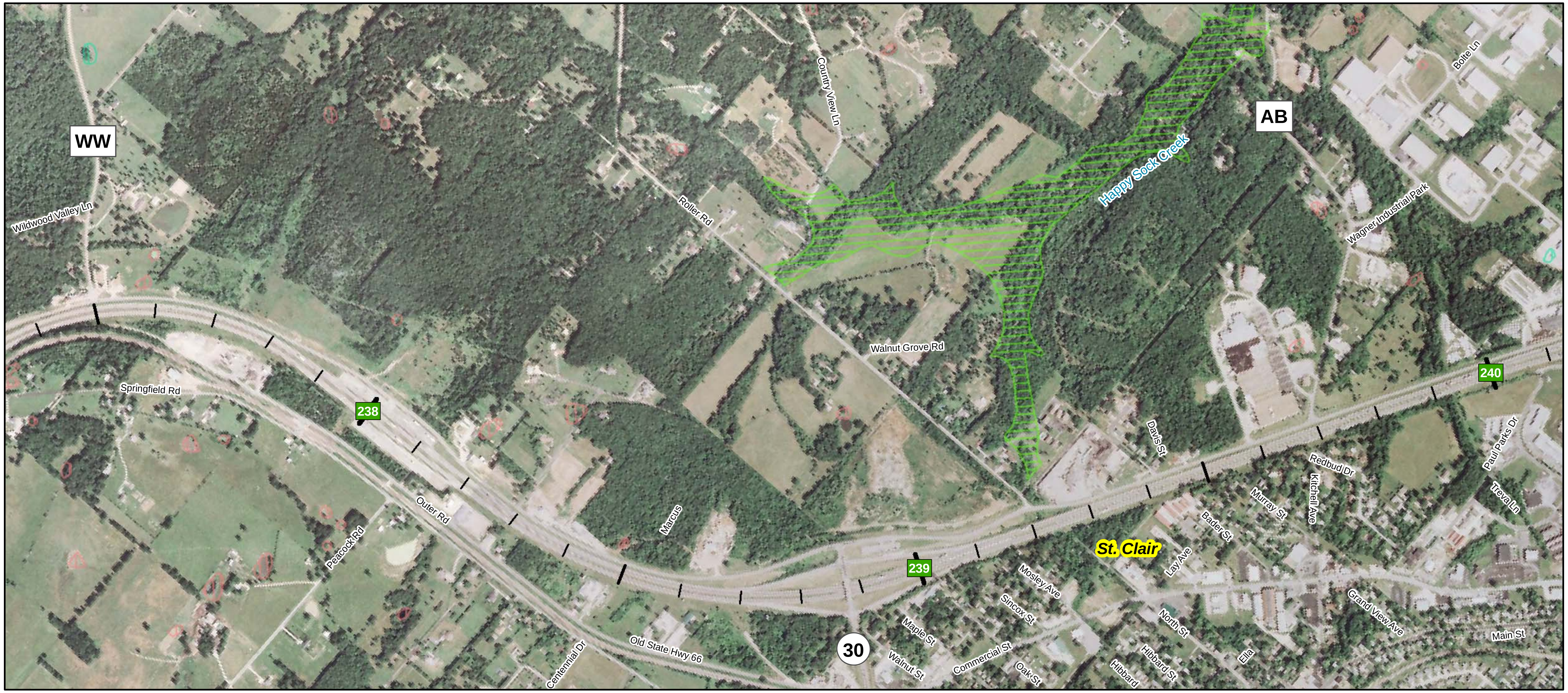
Franklin County
District 6

Figure 92
Mileposts: 238 - 240

LEGEND
⬚ County Boundary
▨ Floodplain
▨ Palustrine Pond (PUB)
▨ Palustrine Emergent (PEM)
▨ Palustrine Scrub-Shrub (PSS)
▨ Palustrine Forested (PFO)
Condition
🟨 Approach Threshold of Acceptability
🟧
🟥 Exceeds Threshold of Acceptability

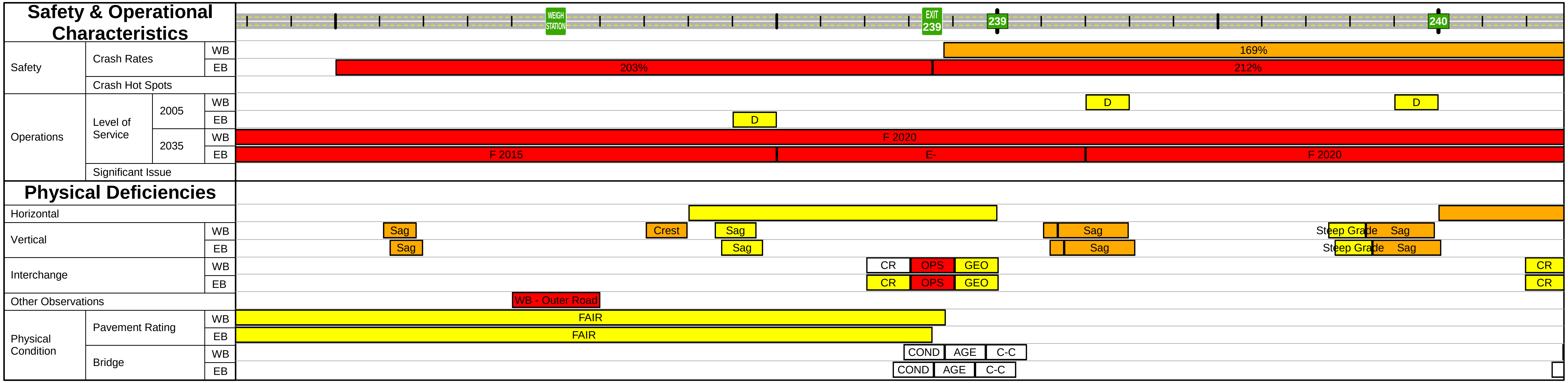
0 500 1,000
Feet





Safety & Operational Characteristics

Physical Deficiencies



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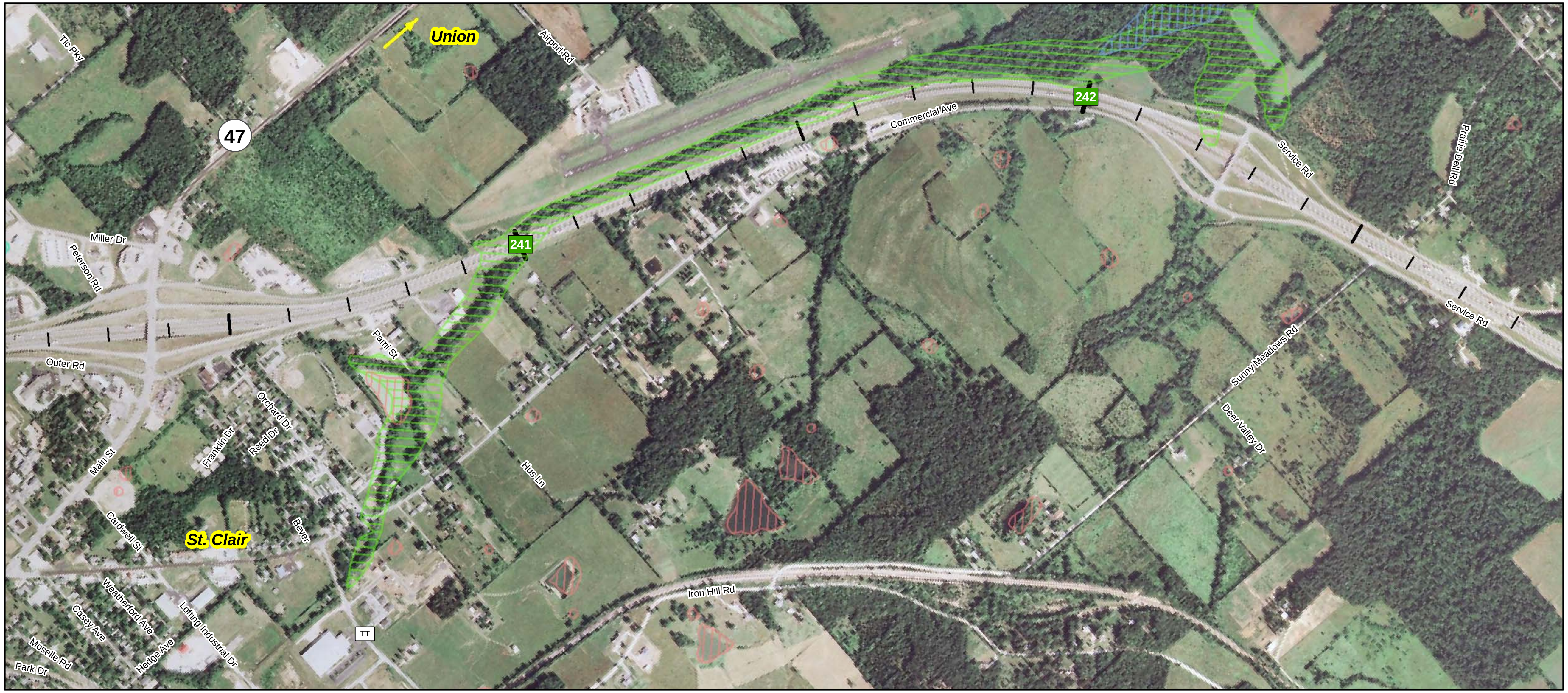
Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

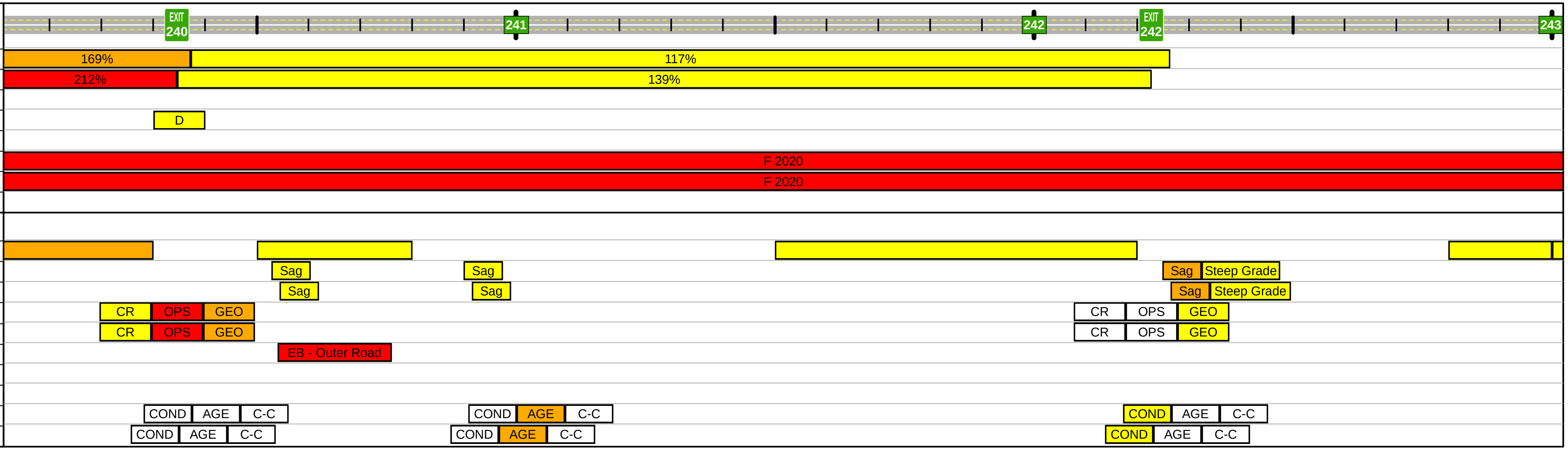
Figure 93
Mileposts: 241 - 242

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability



CH2MHILL



Safety & Operational Characteristics

Safety	Crash Rates		WB	169% 117%
			EB	212% 139%
	Crash Hot Spots			
Operations	Level of Service	2005	WB	D
			EB	
		2035	WB	F 2020
			EB	F 2020
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Sag Sag Sag Steep Grade
		EB	Sag Sag Sag Steep Grade
Interchange		WB	CR OPS GEO CR OPS GEO
		EB	CR OPS GEO CR OPS GEO
Other Observations			EB - Outer Road
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

Figure 94
Mileposts: 243 - 245

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

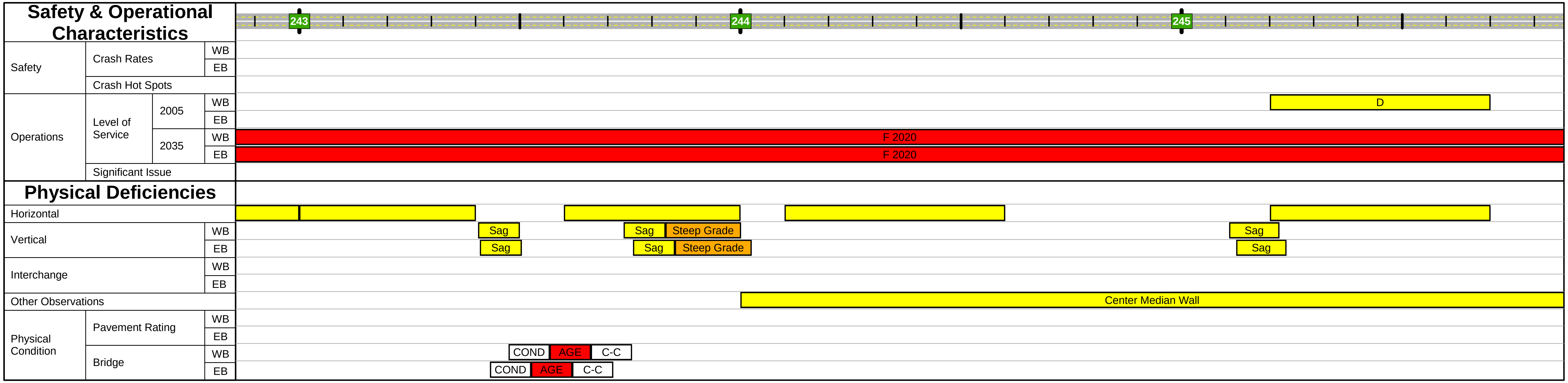
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT

CH2MHILL



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Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

Figure 95
Mileposts: 246 - 248

LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

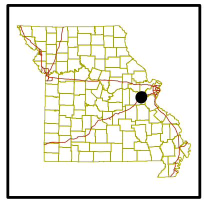
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

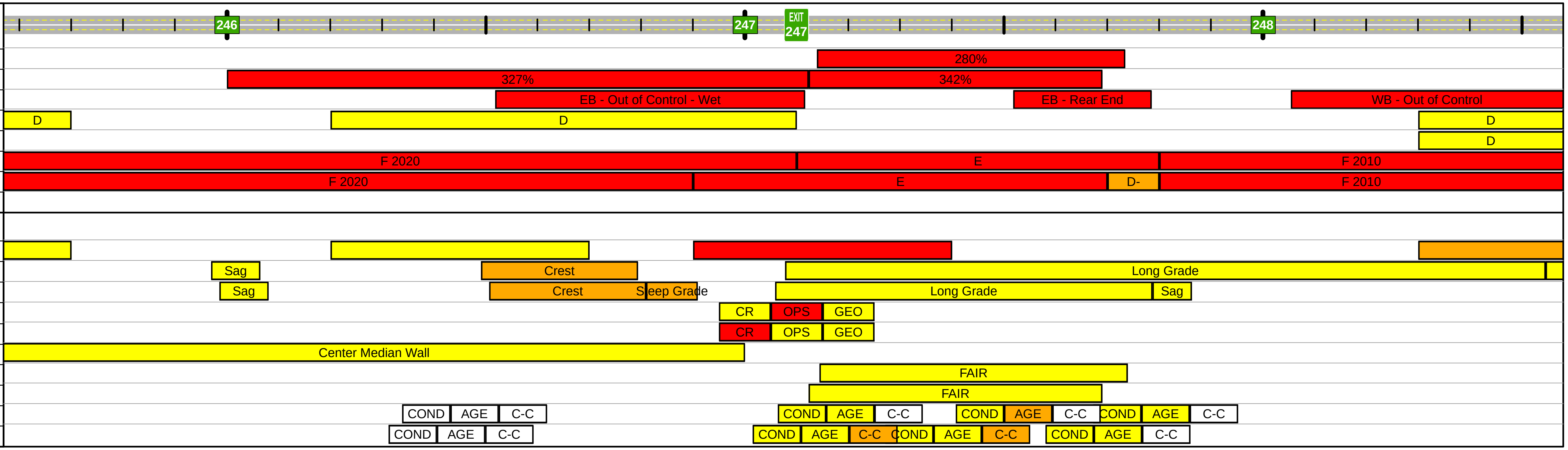
N

MoDOT

CH2MHILL



Safety & Operational Characteristics



Safety	Crash Rates		WB	280%
			EB	327% 342%
	Crash Hot Spots			EB - Out of Control - Wet EB - Rear End WB - Out of Control
Operations	Level of Service	2005	WB	D D D
			EB	D
		2035	WB	F 2020 E F 2010
			EB	F 2020 E D- F 2010
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Sag Crest Long Grade
		EB	Sag Crest Steep Grade Long Grade Sag
Interchange		WB	CR OPS GEO
		EB	CR OPS GEO
Other Observations			Center Median Wall
Physical Condition	Pavement Rating	WB	FAIR
		EB	FAIR
	Bridge	WB	COND AGE C-C COND AGE C-C COND AGE C-C COND AGE C-C
		EB	COND AGE C-C COND AGE C-C COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

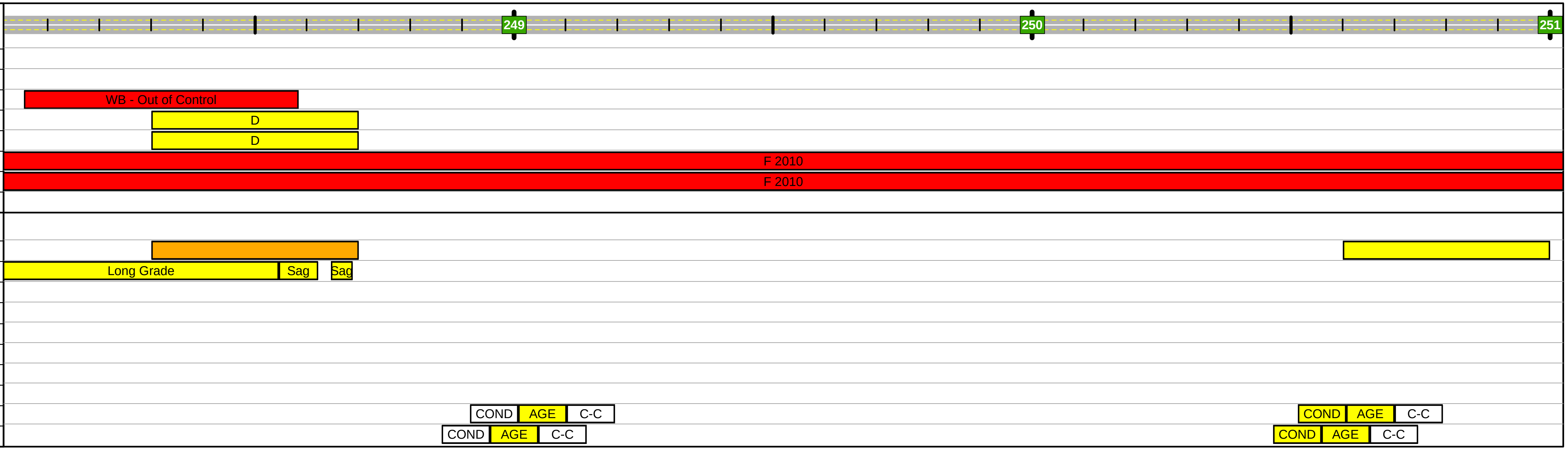
Figure 96
Mileposts: 249 - 250

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

Safety & Operational Characteristics



Safety	Crash Rates		WB	
			EB	
	Crash Hot Spots			WB - Out of Control
Operations	Level of Service	2005	WB	D
			EB	D
		2035	WB	F 2010
			EB	F 2010
	Significant Issue			

Physical Deficiencies

Horizontal				
Vertical			WB	Long Grade Sag Sag
			EB	
Interchange			WB	
			EB	
Other Observations				
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND AGE C-C COND AGE C-C
			EB	COND AGE C-C COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

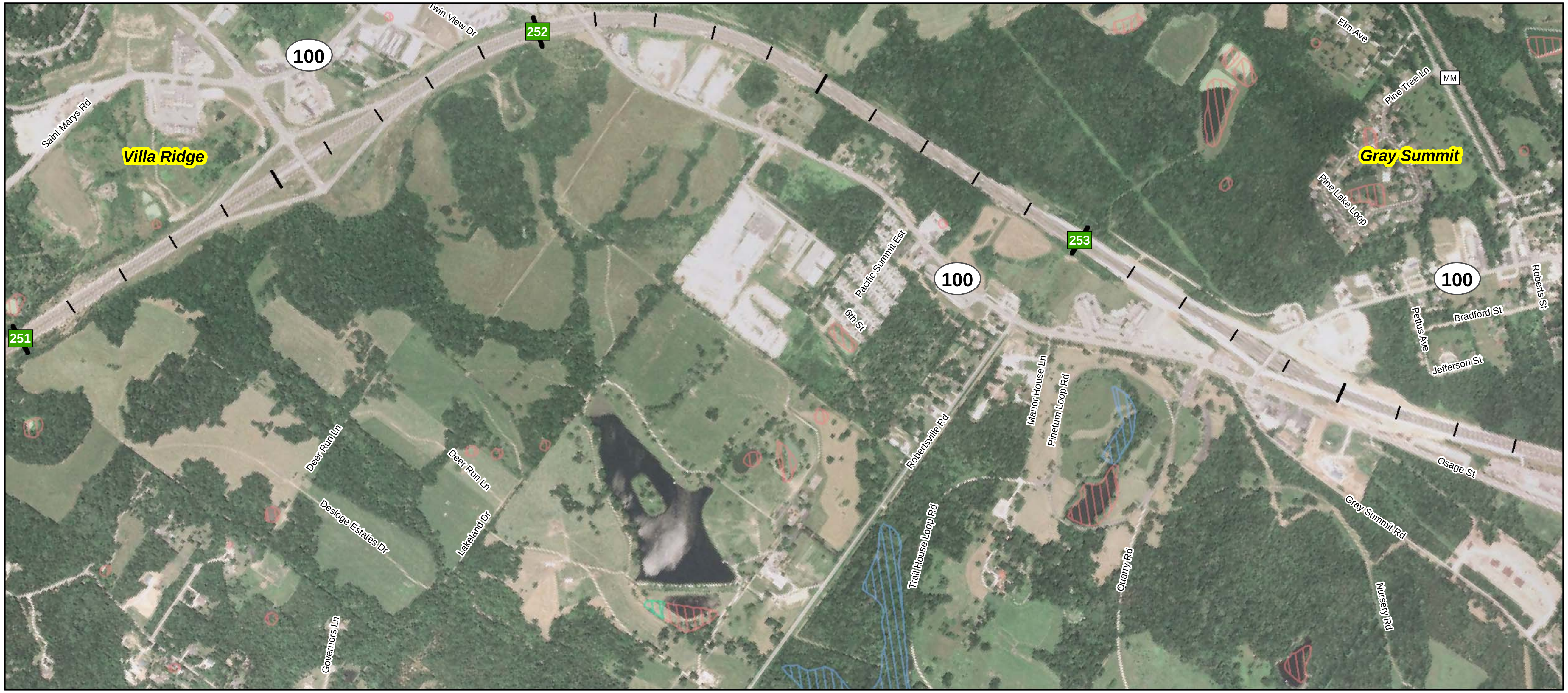
Figure 97
Mileposts: 251 - 253

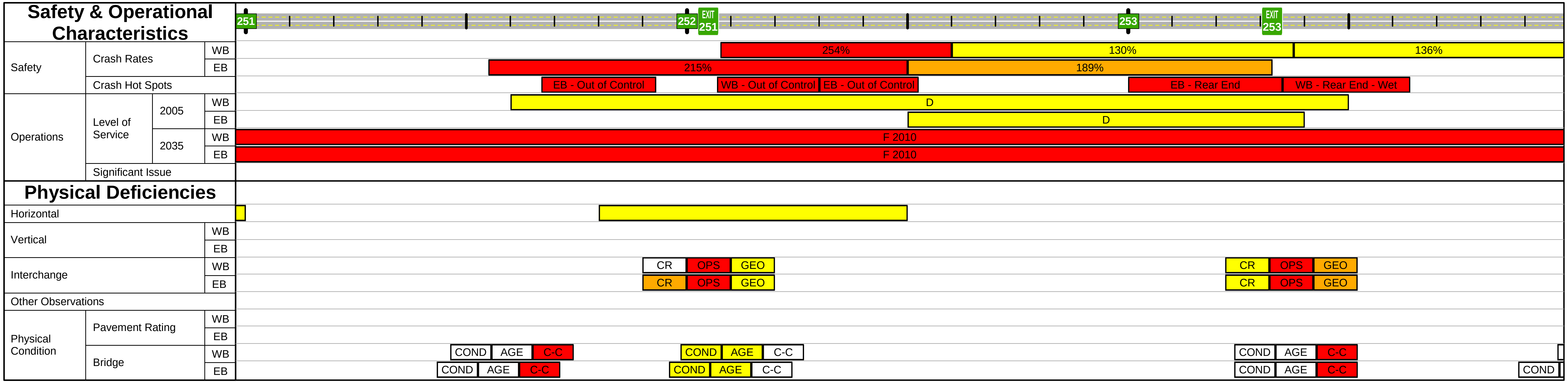
LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

MoDOT
CH2MHILL





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Purpose & Need Study
PLANNING FOR PROGRESS

Franklin County
District 6

Figure 98
Mileposts: 254 - 256

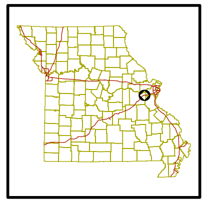
LEGEND
- ▭ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

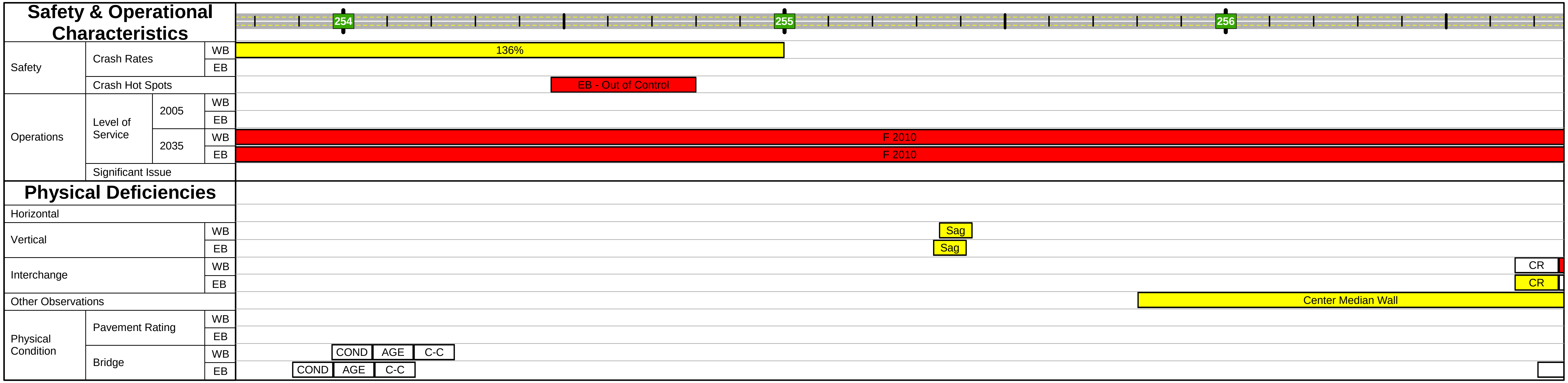
Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N

MoDOT
CH2MHILL





Safety & Operational Characteristics				
Safety	Crash Rates		WB	136%
			EB	
	Crash Hot Spots			EB - Out of Control
Operations	Level of Service	2005	WB	
			EB	
		2035	WB	F 2010
			EB	F 2010
	Significant Issue			
Physical Deficiencies				
Horizontal				
Vertical			WB	Sag
			EB	Sag
Interchange			WB	CR
			EB	CR
Other Observations				Center Median Wall
Physical Condition	Pavement Rating		WB	
			EB	
	Bridge		WB	COND AGE C-C
			EB	COND AGE C-C

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Purpose & Need Study
PLANNING FOR PROGRESS

St. Louis County
Franklin County
District 6

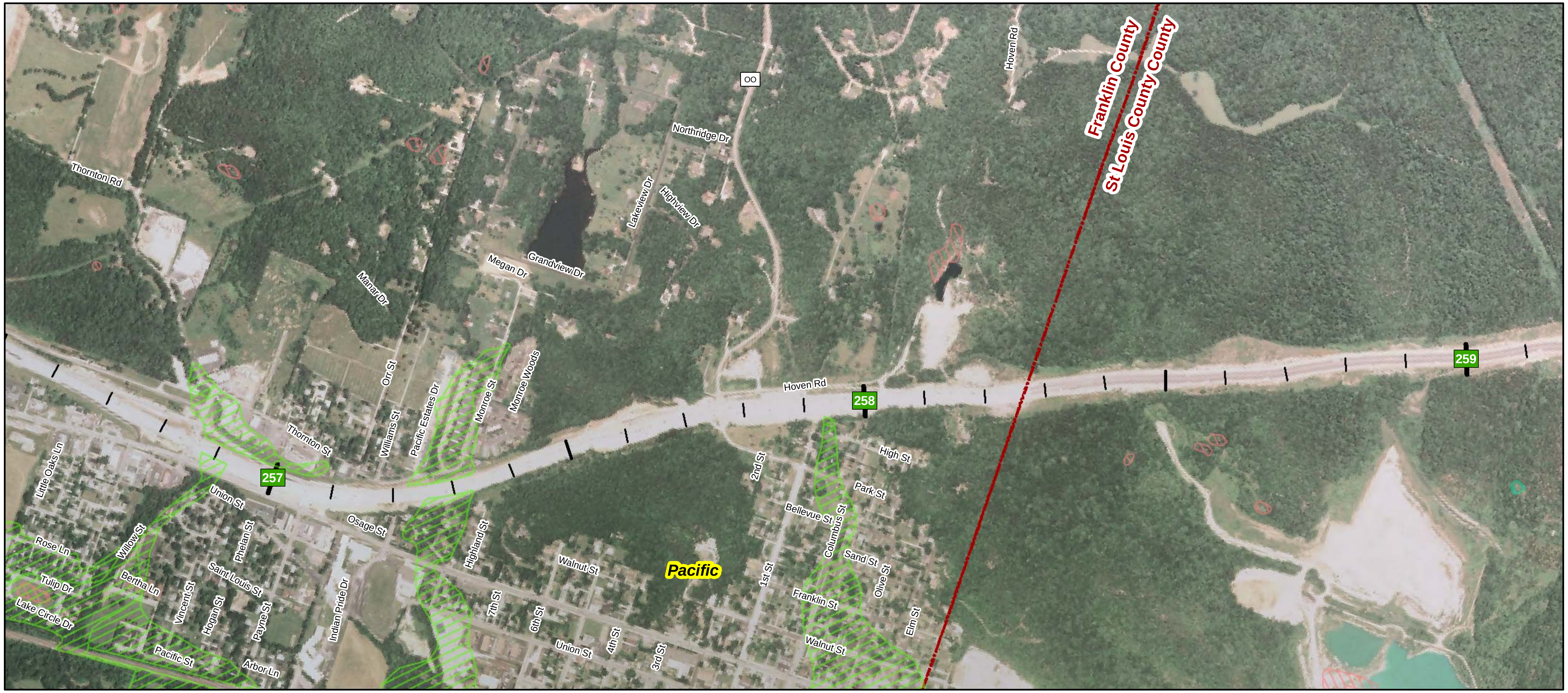
Figure 99
Mileposts: 257 - 259

LEGEND
- ⬚ County Boundary
- ▨ Floodplain
- ▨ Palustrine Pond (PUB)
- ▨ Palustrine Emergent (PEM)
- ▨ Palustrine Scrub-Shrub (PSS)
- ▨ Palustrine Forested (PFO)

Condition
- 🟨 Approach Threshold of Acceptability
- 🟧
- 🟥 Exceeds Threshold of Acceptability

0 500 1,000
Feet

N



MoDOT

CH2MHILL

Safety & Operational Characteristics

				EXIT 257 · 257 · 258 · 259
Safety	Crash Rates		WB	
			EB	101%
	Crash Hot Spots			WB - Rear End - Wet
Operations	Level of Service	2005	WB	
			EB	F E
		2035	WB	
			EB	F 2010
	Significant Issue			

Physical Deficiencies

Horizontal			
Vertical		WB	Steep Grade
		EB	Crest Sag Steep Grade Crest
Interchange		WB	OPS GEO
		EB	OPS GEO
Other Observations			Center Median Wall
Physical Condition	Pavement Rating	WB	
		EB	
	Bridge	WB	COND AGE C-C COND AGE C-C
		EB	AGE C-C COND AGE C-C

Jun 17, 2008