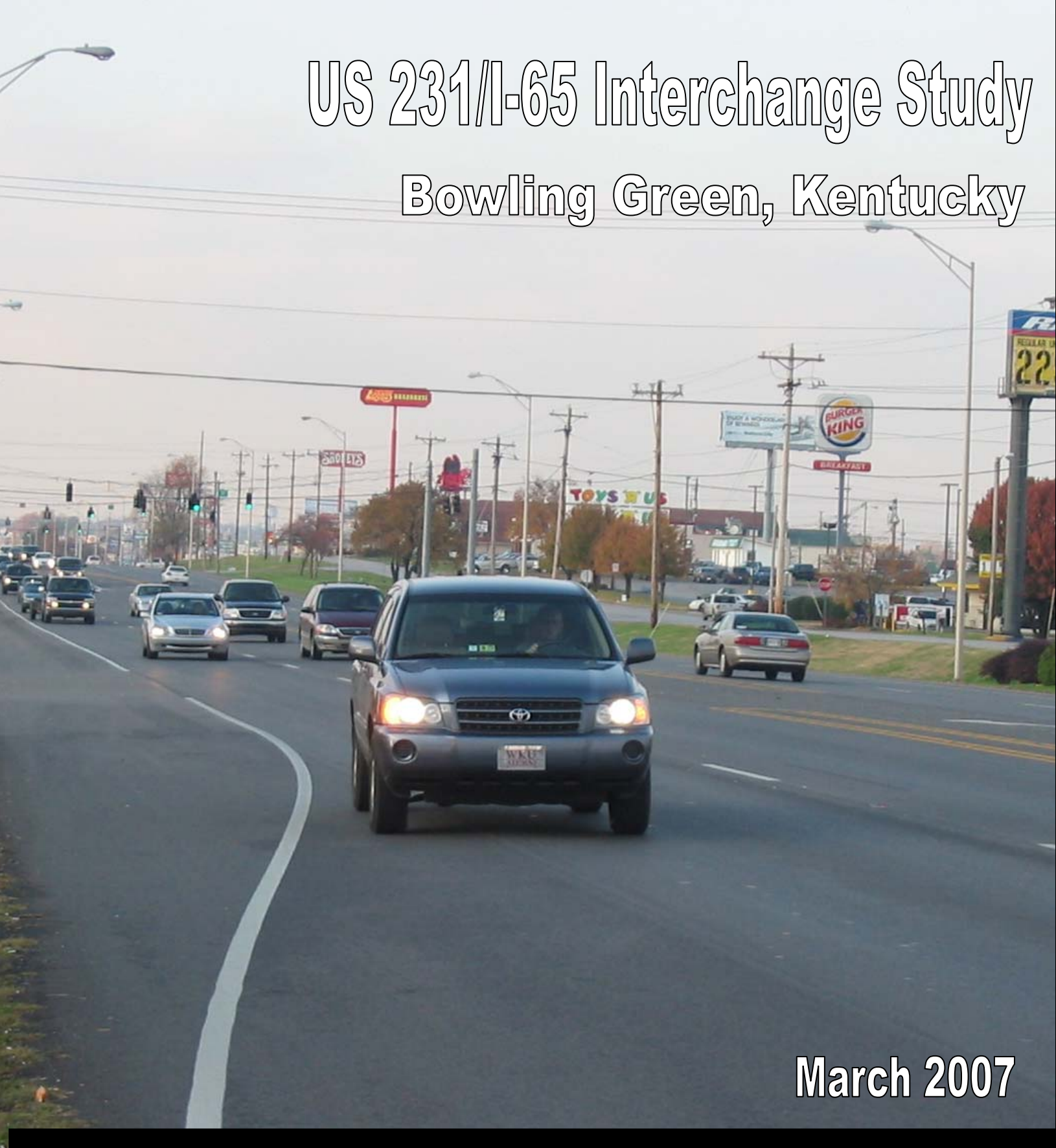
US 231/I-65 Interchange Study

Bowling Green, Kentucky



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Prepared for:

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1.0 INTRODUCTION

Wilbur Smith Associates (WSA) was retained by the Kentucky Transportation Cabinet (KYTC) to evaluate traffic operations and access management on either side of a proposed new I-65/Scottsville Road (US 231) interchange in Bowling Green, Kentucky. The study area is shown on **Figure 1**. This study originated after concerns were raised that while a proposed new interchange would significantly improve interchange operations, the two adjacent signalized intersections would continue to have operational problems and could impact the operations of the interchange and I-65. In addition, access management in the immediate area of the interchange could be improved. This study is intended to identify any potential problems resulting from the closely spaced intersections and less-than-ideal access management and determine what strategies could be developed to alleviate or improve those identified problems.

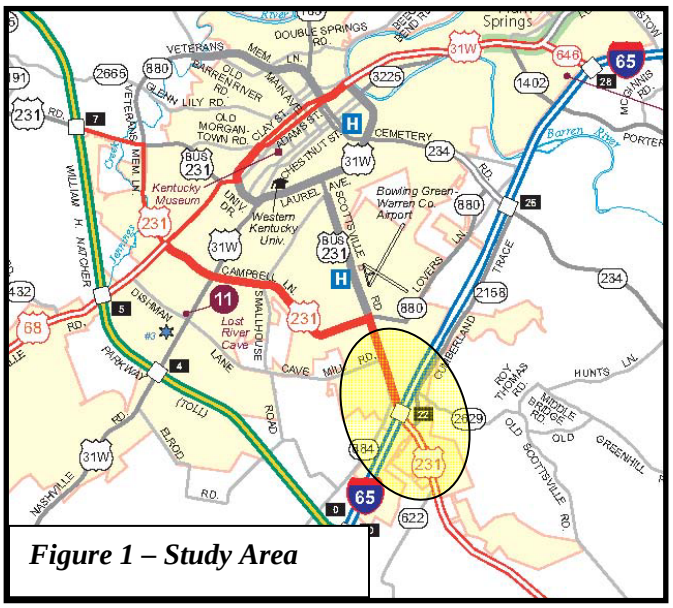


Figure 1 – Study Area

Specifically the project goals are:

- Establish a "Long-Term Vision" for the corridor
- Identify implications of the "Long-Term Vision" as it relates to the current I-65/Scottsville Road (US-231) Interchange Design Project
- Develop a set of Next Steps to achieve the "Long-Term Vision"

Current Conditions

US-231 @ Three Springs Rd. /Ken Bale Blvd.

Along Scottsville Road (US-231) in the study area, there are four 12 foot driving lanes (two lanes for traffic traveling northbound and two lanes for traffic traveling southbound). On the west side of the interchange are a drivable 15 foot paved median that is used for left-turn lanes at intersections and two 10 foot paved shoulders that are used as a right turning lane. There are no sidewalks, curbs, or bicycle paths along the west portion of Scottsville Road. On the east side of the interchange are two lanes in each direction with left turn lanes at intersections, sidewalks, and curb and gutter. The average daily traffic (ADT) for this portion of

Scottsville Road is between 26,000 vehicles and 39,200 vehicles, and land use is primarily dense commercial.

Between Pasco Boulevard and Cherry Farm Lane there are six signalized intersections and a diamond interchange which connects Scottsville Road to I-65. More specifically, there are signalized intersections at Cherry Farm Lane, Cumberland Trace/Mel Browning Street, I-65 Northbound ramps, I-65 Southbound ramps, Three Springs Road/Ken Bale Boulevard, and Pasco Boulevard. Signal spacing ranges between 420 feet and 1,580 feet. In addition to the signalized intersections, there are also many entrances and driveways that connect drivers on Scottsville Road directly to local businesses and/or frontage roads. Between Pasco Boulevard and the I-65 Southbound ramps there are seven access points in addition to the three signalized intersections. These access points connect drivers directly to businesses or to two frontage roads that run on both sides of Scottsville Road between Pasco Boulevard and Three Springs Road. Between the I-65 Northbound ramps and Cherry Farm Lane there are eight access points in addition to the three signalized intersections. Overall, there are 21 access points and an interchange along this 6,500 foot portion of Scottsville Road.

US-231 @ Cherry Farm Lane

2.0 EXISTING NEEDS AND DEFICIENCIES

In order to understand the existing operational conditions along the corridor, WSA undertook an existing needs and deficiencies analysis focused primarily on intersection operations (capacity) and safety. Following is a summary of that effort.

Data Collection

Initially, WSA reviewed the following reports:

- American Engineers, Inc's US 231 and I-65 Interchange Reconstruction Project Summary for Warren County Item No's 3-9.00 and 3-17.00 dated August 25, 2006
- KYTC's Traffic Forecast Report for Warren County Natcher Parkway Extension Item No. 3-53.00
- KYTC's Warren County Traffic Forecast Major Widening of KY 884 (Three Springs Road) from Flealand to US 231 (Scottsville Road) Item No. 3-102.10 dated November 27, 2006.

WSA made recommendations to KYTC for additional traffic count data. Due to the time constraints of the project, only a portion of the requested data was received. In addition, WSA received mapping for the area from the local Metropolitan Planning Organization (MPO) and received crash data along the study corridor.

Existing Traffic Operations

Using available information in conjunction with the new traffic counts, WSA developed a set of existing traffic volumes for the interchange of Scottsville Road (US-231) and I-65 as well as the following additional intersections along Scottsville Road:

- Pasco Boulevard
- Wall Street
- Three Springs Road/Ken Bale Boulevard
- Cumberland Trace/Mel Browning Street
- Greenwood Way
- Cherry Farm Lane/Gator Drive

KYTC reviewed these volumes for accuracy and recommended they be seasonally adjusted using a 12.5 percent factor. The adjusted volumes would more accurately reflect design hour volumes (DHV). These volumes are presented in **Appendix A**.

Using these volumes, the existing geometric configuration, and the existing traffic signal phasing, WSA undertook intersection capacity analysis using Synchro Version 7 traffic analysis software, which uses standard methodologies presented in the Highway Capacity Manual (HCM). The HCM outlines the accepted practices for evaluating the operations of intersections, and defines a qualitative measure of operation known as Level of Service (LOS). The LOS is based on the total average intersection delay per vehicle as calculated by the HCM procedures. LOS is defined by a ranking scale beginning with A and going through F. A represents the best operating condition and F represents the worst. Levels of service for signalized intersections are a function of the traffic volumes approaching the intersection, number and type of lanes, signal timing, and how well signals along an arterial are coordinated. **Table 1** shows the HCM descriptions and criteria for signalized intersection levels of service.

TABLE 1
Level of Service Definitions for Signalized Intersections

LOS Variable	Signalized Intersections	Control Delay (Sec/Veh)
A	Most vehicles do not stop at all; little or no delay.	≤ 10.0
B	More vehicles stop than with LOS A, causing more delay.	> 10.0 and ≤ 20.0
C	Most vehicles stop but some still pass through intersection.	> 20.0 and ≤ 35.0
D	The influence of congestion becomes more noticeable.	> 35.0 and ≤ 55.0
E	More than 75% of vehicles stop – poor progression.	> 55.0 and ≤ 80.0

F	More vehicles stop than with LOS E, causing more delay.	> 80.0

Table 2 summarizes the existing LOS and average overall intersection delay for the intersections along Scottsville Road.

Table 2 – Existing (2006) Signalized Intersection Operations

US-231 Intersection with		Approach				Intersection
		Side Street		US-231		
		EB	WB	NB	SB	
Cherry Farm Rd.	AM	D/41	D/39	A	A	A
	PM	E/67	E/61	A	A	A
Cumberland Trace (KY 2158) /Mel Browning St.	AM	F/81	F/81	D/40	C/34	D/48
	PM	E/79	E/68	C/27	C/23	C/33
I-65 Northbound Ramps	AM	E/65	-	E/73	B	D/53
	PM	F/102	-	C/20	A	C/30
I-65 Southbound Ramps	AM	-	E/58	A	B	B
	PM	-	E/76	E/60	D/42	D/55
Three Springs Rd./ Ken Bale Blvd.	AM	C/30	D/45	B	B	C/21
	PM	D/46	F/92	D/36	D/36	D/41
Pasco Blvd.	AM	D/45	C/30	A	A	B
	PM	E/66	E/62	A	B	B

Although none of the signalized intersections have an overall intersection Level of Service (LOS) of E or F under the existing conditions, there are concerns relative to queuing at specific intersections. The particular locations with queuing concerns are:

- Scottsville Road/Cumberland Trace – the major concern is the limited distance (approximately 400 feet) between Cumberland Trace and the I-65 Northbound ramps. Analysis shows that the I-65 Northbound ramp traffic signal is metering traffic arriving at the Cumberland Trace intersection (by design of the traffic signal coordination), which helps reduce the frequency of queues backing up and blocking the Scottsville Road through-lanes and potentially the I-65 Northbound ramp.
- The Scottsville Road left-turn onto the I-65 Northbound ramp has a left turn pocket of approximately 300 feet. Analysis shows that the lane fills to capacity almost 50 percent of the time. Field visits confirmed that this storage lane does fill up, and even backs out into the Scottsville Road through-traffic, particularly during the afternoon peak.

Existing Crash Analysis (Safety Evaluation)

US 231 (Scottsville Road) in Warren County has been identified by KYTC as in the top five percent of state-maintained roadways with the highest fatalities and most serious injuries. The portion of this route in the study area is a congested roadway in an urban

setting with a high density of cross-street turning opportunities, a condition that often leads to high crash rates. The crash history data fully supports that these factors are playing a significant role in traveler safety.

To capture the impact of safety concerns on traffic, WSA undertook a multi-tiered safety analysis exercise, initially locating accidents within the area, then focusing on KYTC-defined sections, and finally detailing accident statistics along the primary route of interest. This process and the accompanying trends are detailed in the following section.

Initially, WSA collected crash data from the KYTC database along the portion of US 231 in the study area, along with adjacent sections of I-65 and KY 884. Data covered reported vehicle crashes from January 2002 through September 2006. This data was analyzed using the methodology developed by the Kentucky Transportation Center (KTC). This analysis locates roadway "segments" based upon traffic volumes and geometric characteristics to identify crash concentrations. It also determines the location of 1/10 mile "spots" which demonstrate high crash frequencies. Each segment or spot is assigned a critical rate factor (CRF) based on formulas published by KTC. The CRF is one measure of the safety of a road. It shows the accident rate as a ratio to the average accident rate for sections of roadway of the same functional classification throughout the state. If the rate is above 1.00, it is assumed that crashes are happening due to circumstances that cannot be attributed to random occurrence. Once a location has been determined to be over the critical rate, it should be studied more specifically to ascertain if there are remedial actions that should be taken to improve the overall safety of the facility. Computations for the study area were generated using the segments and spots along the primary roadways as developed by KYTC and are summarized in **Appendix B**.

Review of this data reveals that during the evaluation period, a total of 1,025 crashes were reported along US 231 between milepoints 7.980 (near Cypress Wood Lane) and 9.955 (near Cave Mill Road). Of these, there were five (5) fatalities (review of the data indicates there were two separate crashes resulting in five fatalities—one fatality in one crash and four in the other) and 199 reported injuries. The analysis indicated that three segments had a CRF above 1.0, including the segment that contains the existing interchange, which has a CRF of 3.33.

Because the analysis indicated that this corridor warrants additional analysis, WSA undertook a more detailed investigation to identify what the potential causes of these crashes are. For each of the three study roadways, crashes were assigned to one of four main categories:

- Rear Ends – one car impacts the rear end of another that may be stopped or moving;
- Collisions with Objects – car impacts an external object but not another vehicle;
- Turning – one car is making a turning movement to/from a perpendicular side road or entrance (this category was omitted for interstate analysis);
- Run-Off Road – for interstate analysis only, any car leaving the driving lanes resulting in an incident; and
- Other – all other accident types.

Crashes were also detailed by year to determine whether crash rates were decreasing over time. These results are found in **Appendix B**. The analysis shows an extremely high number of rear-end incidents along US 231 and I-65 north of the interchange. There is also a concentration of turn-related crashes along US 231. Over time, the frequency of crashes seems to be decreasing on all segments.

Because the KYTC segments cover a large portion of US 231, WSA undertook a more detailed investigation along US 231 itself. Spots were reselected to correspond with key intersections, with smaller segments spanning the sections between these. Each length was considered, detailing incidents by severity, type, year, and directional split. This analysis is depicted in **Appendix B**. This data supports earlier findings that rear-end crashes compose a significant portion of reported crashes: 65 percent of all crashes for the entire length involve a rear-end type impact, with turning crashes accounting for 21 percent. There is also a minor skew showing more northbound incidents. All sections north of the intersection with Greenwood Lane had a CRF greater than 1.

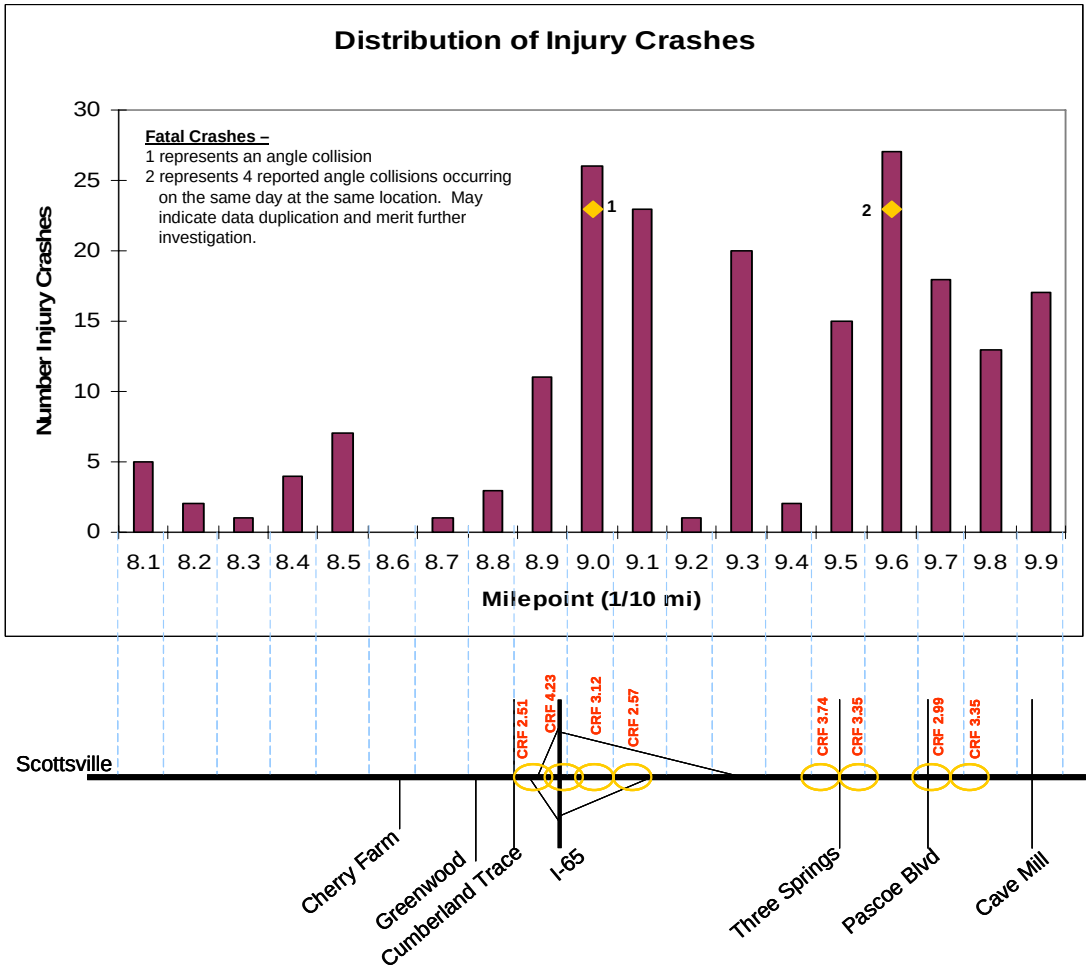
Because the route is cited as in the top five percent of locations with high injury and fatality, WSA performed a supplemental study to verify that injury crashes exhibited the same distribution as non-injury crashes. Comparing the division between incident types for injury accidents alongside all severity levels demonstrates that there is no significant difference in severity patterns, as illustrated in **Table 3** below. This data supports the assumption that injury crashes along the route follow a similar distribution between types. It is important to note, however, that the increase in percentage of turning crashes that involve injuries warrants additional consideration when developing potential solutions.

Table 3 – Crash Types by Severity Distribution

Crash Type	# Injury Crashes	Injury Percent	# All Crashes	Overall Percent
Collision	6	3%	19	2%
Turning	59	30%	208	21%
Rear End	112	57%	652	65%
Other	19	10%	128	13%
Total	**196**	**100%**	**1007**	**100%**

WSA also looked at a distribution of injury crashes along the US 231 corridor. **Figure 2** shows that injury crashes are focused in the interchange area as well at near intersections.

Figure 2 – Location of
Injury Crashes alongside High Crash Spots

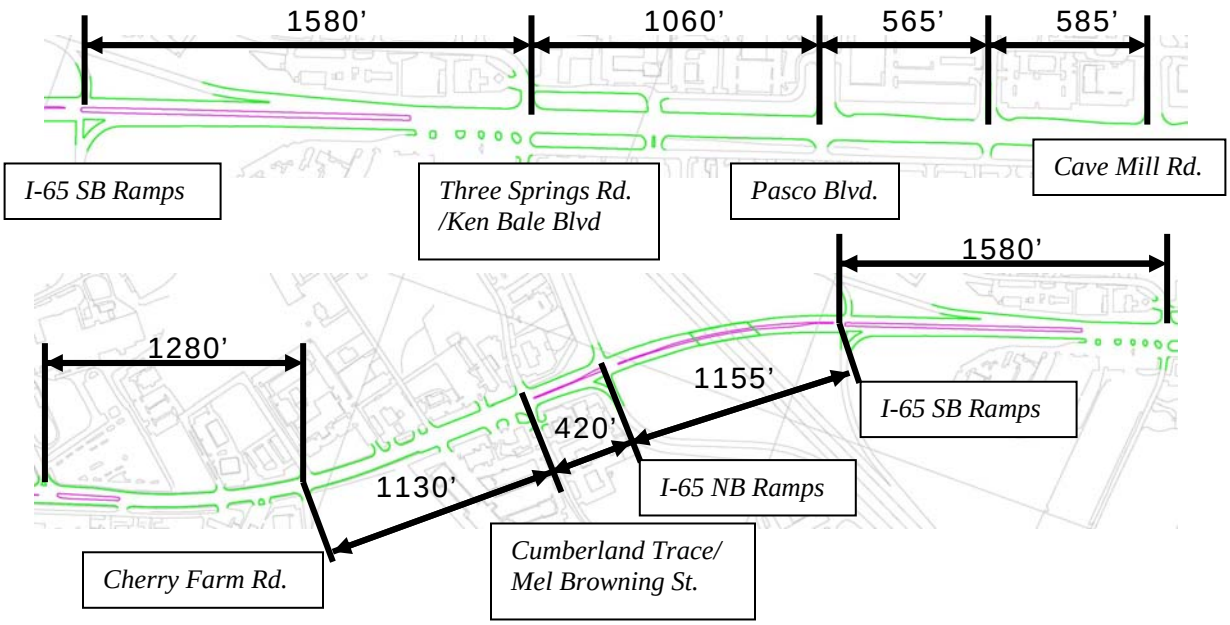


Geometric Deficiencies Related to Access Management/Signal Operations

WSA reviewed US 231 in the study area relative to traffic signal operations, particularly traffic signal coordination and access management. Following is a summary of the issues identified.

- One of the key elements to optimizing the capacity of a group of signalized intersections is the spacing of the traffic signals. Depending on the speed of traffic, uniform spacing of signals between ¼ of a mile and ½ of a mile is generally considered desirable. **Figure 3** shows that signal spacing along US 231 ranges from a short distance of 420 feet to a maximum of 1580 feet, clearly not optimal for traffic signal operations.

Figure 3 – Signal Spacing along Scottsville Road



- Another consideration is the number and location of access points along a particular corridor. Research has shown that the more access points per mile there are, the greater the crash rate will be (TRB Access Management Manual, 2003). While there is a median, the numbers of median openings as well as driveway access points on US 231 are beyond what is considered acceptable. The locations of particular concern are at the intersection of Ken Bale Boulevard and Scottsville Road (US 231) as shown on **Figure 4**. This location is also critical because it is between the interchange ramps and the first signalized intersection, a transition area from a high speed interstate facility to an urbanized section of roadway.

Figure 4 – Example of Driveway Access along Scottsville Road

- North of the interchange on Scottsville Road (US-231) there are frontage roads on both the east and west side. These present operational problems at the intersections because of their close proximity to the roadway. Anytime there is an intersection with a major arterial like Scottsville Road, best practice is to provide corner clearances so that intersection operations are not interrupted by turning vehicles not associated with movement at that intersection. At the Ken Bale US-231 intersection, a median has been installed, restricting movements from US-231 to the frontage road. These frontage roads, however, provide access to many of the businesses that front along US-231, so maintaining access to these business is important.

Summary of Existing Deficiencies

While the overall traffic operations along this segment of Scottsville Road have several deficiencies, it is clear that its crash history should be addressed along with any operational improvements. These are summarized below:

- The close proximity of the Cumberland Trace/Mel Browning Street intersection to the I-65 Northbound ramps is the major contributing factor to the congestion experienced at these two intersections.
- The present left turn lane from Scottsville Road to the I-65 Northbound ramps is not long enough to accommodate present-day movements, causing queue spillback into the eastbound Scottsville Road through-lanes.
- Given the classification of Scottsville Road (Major Arterial), the number of access points (particularly driveways) along some segments exceeds recommended conditions.
- Rear-end collisions represent the majority of accidents along the Scottsville Road corridor in the study area. While this appears to be a decreasing trend, it still remains at a level that should be addressed.
- Injury and fatal accidents along the corridor have moved this facility into the top five percent of all roadways in Kentucky with accidents of this level of severity.
- The spacing of traffic signals is such that achieving optimal traffic capacity through traffic signal coordination is not possible.
- Overall LOS for signalized intersections along the US 231 (Scottsville Road) corridor is acceptable. However, individual approaches experience LOS E or F at all of the signalized intersections.

3.0 FUTURE CONDITIONS ASSESSMENT

As traffic volumes change over time, additional concerns can arise relative to the traffic operations of Scottsville Road. The future conditions assessment is intended to help identify the potential issues and provide a base for evaluating future improvements and their relative benefit to the No-Build condition.

Future Planned Improvements/Developments

In developing future projects, WSA considered proposed roadway improvements in the general vicinity of the study area as well as known or planned significant developments. The Bowling Green travel demand model was used as a tool to evaluate future growth patterns. The following roadway improvements were added to the future year (2030) model and considered as part of the No-Build analysis:

- Extension of the Natcher Parkway to Scottsville Road
- Additional interchange along the Natcher Parkway at Elrod Road
- Three Springs Road widening to five lanes
- Extension of Ken Bale Boulevard to Lovers Lane
- Cumberland Trace widening to three lanes

Major commercial and office development is expected south of Greenwood Lane and was also considered as part of this effort. Access would be provided to the development from Greenwood Lane, Natcher Parkway, and Plano Road.

Future Traffic Volumes/Operations

To develop a growth rate for the study area, the Bowling Green travel demand model was used. The existing year (1999) and future year (2030) model runs were compared by individual roadway segment within the study area. They varied by segment from approximately one percent (1%) to three percent (3%). As a starting point to develop future year (2030) volumes, a uniform growth rate of two percent (2%) was applied to Scottsville Road, I-65, and all cross streets. Then, in order to more accurately account for higher-than-expected growth along certain roadways, individual adjustments were made. The following modifications were made:

- Three Springs Road, Ken Bale Boulevard, Mel Browning Street, Cumberland Trace, and Greenwood Way were adjusted using a 2.6 percent growth rate.
- I-65 south of Scottsville Road was adjusted using a 2.2 percent growth rate.
- An additional 800 peak trips were added to Mel Browning Street and Greenwood Way to account for the anticipated commercial/office growth in the area. This was based on a percentage of trips generated by the travel demand model and preliminary information provided by the developer.

Future volumes were then re-balanced and additional adjustments were made. These adjustments were made to account for the roadway improvements discussed above. The adjustments were supported by the following conclusions:

- Traffic would be diverted from Scottsville Road and I-65 as a result of the Natcher Parkway Extension and Elrod Interchange.
- More traffic would be diverted from Scottsville Road south of I-65 than north of I-65.
- Traffic would increase along Three Springs Road and Ken Bale Boulevard as a result of the Three Springs Road widening project and Ken Bale Boulevard extension.

The impact of the regional roadway improvements will result in trips being diverted away from the Scottsville Road (US-231) corridor. This diversion was developed using the travel demand model and was quantified as daily trips initially, and then converted to hourly trips. Once these adjustments were made, a future year set of volumes for the AM and PM peak periods were established and reviewed by the KYTC. The volumes were compared to the Three Springs Road Traffic Forecast and found to reasonably match the results, further validating the future volumes.

Using these future volumes, the existing geometric configuration, and the existing traffic signal phasing, WSA undertook intersection capacity analysis using the same methodology employed in the existing conditions analysis. **Table 4** summarizes LOS and average intersection delay from this analysis.

Table 4 – Future (2030) Signalized Intersection Operations

US-231 Intersection with		Approach				Intersection
		Side Street		US-231		
		EB	WB	NB	SB	
Cherry Farm Rd.	AM	D/51	D/46	A	A	A
	PM	D/54	D/41	A	B	B
Cumberland Trace (KY 2158) /Mel Browning St.	AM	F/268	F/278	F/227	F/130	F/212
	PM	F/232	F/138	F/105	F/329	F/238
I-65 Northbound Ramps	AM	F/138	-	F/135	F/80	F/119
	PM	F/84	-	F/120	F/127	F/118
I-65 Southbound Ramps	AM	-	F/114	F/100	B	E/75
	PM	-	F/244	E/60	F/304	F/207
Three Springs Rd./ Ken Bale Blvd.	AM	E/75	F/268	F/233	C/21	F/163
	PM	C/27	F/266	F/262	F/348	F/276
Pasco Blvd.	AM	E/77	B	F/252	B	F/162
	PM	F/125	F/208	C/34	F/104	F/83

This analysis indicates that, with the exception of Cherry Farm Lane, all intersections will operate at a LOS E or F under the future traffic volumes with no improvements. In addition to a concern about poor LOS, traffic queues become a concern at each intersection as well. There is also concern that the I-65 off-ramps have the potential, under these conditions, to back up onto the interstate itself.

4.0 PROJECT GOALS AND OBJECTIVES

In order to develop potential solutions to the problems that have been identified for both existing and future years, overall goals for the Scottsville Road (US 231) corridor were established as follows:

- Improve Capacity (Reduce Delay) and Operations
  - Address existing capacity constraints
  - Provide for future growth

  - Create corridor roadway flexibility (alternative routes that do not require the use of Scottsville Road [US 231])
  - Improve existing operational deficiencies
- Improve Safety
  - Reduce crash frequency
  - Reduce accident severity

Additionally, specific traffic operational improvements were identified that would help optimize the existing system and improve safety. These included:

- Consider better use of the existing medians
- Reduce the number of traffic signal phases
- Improve traffic signal spacing
- Insure adequate vehicle queue storage
- Remove/consolidate access points
- Insure adequate corner clearance at intersections

Another key element was the creation of additional interconnectivity along the Scottsville Road corridor to provide drivers other options for moving around the corridor. Options included the use of backage roads and property interconnectivity.

While not specifically reviewed as part of this project, the following elements should be considered as work continues along the corridor:

- Pedestrian corridors and connectivity
- Bicycle lanes
- Roundabouts
- Land use planning

5.0 INITIAL ALTERNATIVES DEVELOPMENT

In order to develop the initial alternatives for analysis and consideration, a meeting was held in the KYTC District 3 Office in Bowling Green with the following key stakeholders present:

J.M. Yowell	City-County Planning Commission
Andrew Gillies	City-County Planning Commission
Jeff Lashlee	Bowling Green Public Works
Melissa Cansler	Bowling Green Public Works
Gene Becker	Barren River Area Development District
Adam Kirk	Kentucky Transportation Center
Shane Blankenship	KYTC District 3, Chief District Engineer
John Moore	KYTC District 4, Design
Jeff Moore	KYTC District 3, Planning
Allen Cox	KYTC District 3, Permits

Scott Pedigo	KYTC District 3, Traffic
Steve James	KYTC District 3, Pre-Construction
Kent Gilley	KYTC District 3, Construction
Dawn Boyd	KYTC Central Office, Traffic
Telma Lightfoot	KYTC Central Office, Traffic
Staci Timol	KYTC Central Office, Traffic
James Simpson	KYTC Central Office, Design
Andre Johannes	KYTC Central Office, Design
Barry House	KYTC Central Office, Planning
Brent Sweger	KYTC Central Office, Planning

The meeting began with a discussion of the project goals and objectives and the existing deficiencies, then finished with group discussion on what should be considered as potential solutions that address the issues and meet the project goals.

Based on the input gathered from the stakeholders, projected traffic volumes, and turning movements and crash data, WSA created three different alternatives. Following is a brief discussion of each of the alternatives. Each alternative is broken into a northern section and southern section separated by the I-65 interchange. For this initial alternative discussion, the interchange itself was not specifically discussed, but interchange alternatives would be considered in conjunction with the selected US-231 (Scottsville Road) alternative.

Given the accident experience and the existing operational characteristics, a non-traversable median was considered an essential part of the design. For Alternative 3, the median width was selected to match the recommended alternative for the new interchange. For Alternatives 1 and 2, a wide median with adequately spaced median openings was selected to address the safety and operational issues. This was done recognizing that national research recommends a non-traversable median for conditions where there is a multi-lane arterial with ADT over 24,000 vehicles as well as on the approaches of the crossroads in the vicinity of the interchange.

Alternative 1

The overall approach to this alternative was to limit access to Scottsville Road as much as possible, provide a wide median, maintain the existing frontage roads, create adequate spacing of traffic signals, and provide rear connecting roadways.

The northern section would include the closing of the existing intersection of Scottsville Road and Three Springs Road, providing the connection through a four-lane backage road connecting to Pasco Boulevard and Cave Mill Road at the existing mall entrance. Additionally, the median opening between Three Springs Road and Pasco Boulevard would be closed, and existing movements from Pasco Boulevard and the driveway to the Kmart shopping center would be eliminated and replaced with U-turn movements at adjacent median openings.

The major components of the southern section would be the closure of the median at Cumberland Trace/Mel Browning Road and Greenwood Way and the creation of a new full intersection connecting Cumberland Trace to Greenwood Way at the existing Cherry Farm Lane intersection. This would be done to remove the left-turn/crossing movements from these intersections so that they do not interfere with interchange operations, at the same time providing a new high-capacity intersection to accommodate future development coming down Greenwood Way.

Sketches of this alternative can be found in **Appendix C**.

On the northerly segment, while traffic signal spacing is improved and turning movements restricted along the entire length, the relocation of left turns into U-turns creates capacity problems at the U-turn locations, which also cause queues to back up out of some of the storage lanes. While the connection of Three Springs Road with Pasco Boulevard and Cave Mill Road creates greater connectivity, the lack of connection at the existing intersection only relocates the traffic congestion to other locations, specifically the left-turns from US-231 onto Three Springs that are now forced to move to other locations and are required to make two left-turns instead of one. The anticipated capacity and operations benefit of a three leg intersection at Ken Bale Boulevard was not as great as would have been hoped. On the southerly segment, the relocation of Greenwood Lane to Gator Drive and restriction of turning movements at Cumberland Trace/Mel Browning and Greenwood provided good operational improvements. The relocation of Cumberland Trace did, however, create a greater distance of travel for some of the people using Cumberland Trace to/from the north.

Alternative 2

Alternative 2 also provides a wide median, maintains the existing frontage roads, creates adequate spacing of traffic signals, and provides rear connecting roadways, but restricts the amount of left-turns/crossing movements on US-231 while maintaining a connection between Three Springs Road and Scottsville Road (US-231). This concept would involve restricting movements at most of the cross-streets and requiring left-turn and through movements from the side streets to use adjacent median cuts to make U-turns. The design of the south side would use logic similar to that employed in Alternative 1, but would locate the Greenwood/Cumberland Trace intersection at a location with better spacing between adjacent intersections and with less of a reverse curve.

Sketches of this alternative can be found in **Appendix D**.

This alternative is a system-wide solution that would limit the opportunities for staged implementation. In addition, it requires an additional median cut between Three Springs Road and the interchange to adequately address traffic movements. Like Alternative 1, the removal of the left-turns from US-231 to Three Springs Road causes capacity issues where the U-turns are required and cause the queue to back up out of the turn pocket. While the southern segment has the best signal spacing, and the alignment of the new

Greenwood Lane is further away from the high school and a more direct path, its right-of-way impacts are the greatest.

Alternative 3

The intent of Alternative 3 was to design an alternative that impacted as little as possible while still meeting the projects goals and objectives. On the northern section, there would be some driveway closures and the closing of the median opening between Three Springs and Pasco Boulevard. The southern section would make Greenwood Way a three-way intersection only with Scottsville Road, while also making Cumberland Trace a three-way intersection only.

Sketches of this alternative can be found in **Appendix E**.

This alternative was designed so that Three Springs/Ken Bale Boulevard could operate at an acceptable level of service. Additionally, the median opening between Three Springs and Pasco Boulevard was closed. Traffic signal spacing on the southern segment was poor, and the narrowness of the median restricted the opportunities for double left-turns protected by an adjacent non-traversable median.

Traffic Operation Evaluation of Alternatives 1, 2, and 3

WSA, using the Synchro model and the afternoon peak hour volumes, evaluated each of the three alternatives from a traffic perspective. Each had its own operational difficulties/challenges (as discussed above), with particular concern about the high level of left turns at mid-block locations, especially in Alternatives 1 and 2. This information was used to avoid the same operational difficulties in the development of the preferred alternative.

6.0 SELECTION OF A PREFERRED ALTERNATIVE

WSA presented the three alternatives to the stakeholders via a video conference between KYTC's Frankfort Conference Room and KYTC District 3 on December 20, 2006. After the alternatives were presented, there was discussion of each alternative, and it was decided to move forward with more detailed analysis of a combination of Alternative 1 for the southern section with a combination of Alternatives 2 and 3 for the northern section that would address the traffic operations/capacity concerns.

A sketch of Alternative 4 (preferred alternative) can be found in **Appendix F**.

Alternative 4 along the entire stretch of US-231 has a wide median with median openings for full intersections and partial intersections only. Driveway access would be restricted to the side roads or backage roads. Full intersections (intersections that allow for all movements) are located at the following intersections with US-231 (all would have traffic signals):

- Cypress Wood Lane

- Relocated Cumberland Trace/Relocated Greenwood Lane
- At-grade Interchange Ramps
- Three Springs Road/Ken Bale Boulevard
- Cave Mill Road/Shive Lane

Additionally, left turns into side street approaches would be permitted at the following locations (these would have separate two-phase traffic signals for each direction of travel):

- Existing Mel Browning Street/Existing Driveway
- Wall Street/Frontage Road Connection
- Pasco Boulevard/Frontage Road Connection
- Existing Kmart Shopping Center/Frontage Road Connection

This results in intersection spacing between the full intersections of approximately:

- 1,100 feet between Cypress Wood Lane and Relocated Cumberland Trace/Relocated Greenwood Lane
- 4,800 feet between Relocated Cumberland Trace/Relocated Greenwood Lane and Three Springs Road/Ken Bale Boulevard, which would include the interchange ramps as follows:
  - For a single point urban interchange, there would be 2,350 feet from Relocated Cumberland Trace/Relocated Greenwood Lane to the interchange traffic signal, and 2,450 feet from the proposed interchange traffic signal to Three Springs Road/Ken Bale Boulevard.
  - For a diamond interchange, it would be 1,700 feet from Relocated Cumberland Trace/Relocated Greenwood Lane intersection to the north bound ramps, 1,225 feet between the existing north bound and south bound ramps, and 1,550 feet from the existing south bound ramps to Three Springs Road/Ken Bale Boulevard.
- 2,200 feet between Three Springs Road/Ken Bale Boulevard and Cave Mill Road/Shive Lane

While the 1,100 feet between Cypress Wood Lane and the new Cumberland Trace/Greenwood Lane intersection is short of the ideal 1,200 or more, the final design of the new intersection could provide additional distance between these two. Additionally, Cypress Wood Lane is a tee intersection, so it would be more easily coordinated with the new intersection. The partial intersections, since they are two-phase signals and only stop one direction of travel, are able to be coordinated perfectly with the full intersection coordination plan.

This plan results in a significant reduction in conflict points along US-231 (Scottsville Road) as well as increases the ability to effectively provide for coordinated traffic signal timings. Using Synchro and the future traffic volumes, WSA updated the traffic analysis to reflect the geometrics of Alternative 4. All intersections operate at LOS D or better along Scottsville Road; however some approach movements do have LOS of E or F in the peak hour of traffic. These results are summarized in the next section.

While not completely identified, there are several backage road connections that are depicted on Alternative 4. These backage roads and internal connecting roadways are critical to support the efficiencies of Scottsville Road. These allow traffic to move between properties without having to access Scottsville Road to make the connection. This helps reduce the amount of turning movements to/from Scottsville Road.

Note that this plan does not address pedestrian or bicycle accommodations along the US-231 (Scottsville Road) corridor or any of the side roadways. A final plan should directly address how these users are provided safe movement through the corridor in conjunction with the regional planning of these elements.

This plan provides the following benefits to the study corridor:

- Overall operations of the intersection is LOS D or better during the AM and PM peak periods
- Improved traffic signal spacing (maximized corridor throughput capacity through improved signal coordination and reduction in the number of stops resulting in less opportunities for rear-end accidents)
- Reduced conflict points through improved medians, channelization, and turn reductions (improved safety)
- No direct access at the functional area of the intersections (improved safety)
- Adequate storage areas for all left-turning movements from US-231 (prevents queue spillback into through-lanes, resulting in increased safety and capacity)
- Will operate successfully no matter the interchange type selected.

7.0 SCOTTSVILLE ROAD (US-231)/I-65 INTERCHANGE OPERATIONS WITH ALTERNATIVE 4

Alternative 4 established an overall vision for Scottsville Road in the study area. Since the operations of Alternative 4 also need to fit within the context of its interchange with I-65, WSA undertook traffic analysis of three interchanges with Alternative 4: American Engineering Incorporated (AEI) Alternative 6, a Single Point Urban Interchange (SPUI), and a diamond interchange. Specifically, the segment of US-231 that includes the interchange and the Cumberland Trace/Mel Browning Street intersection was reviewed for overall delay on US-231. Because there is no guarantee that the US-231 Cumberland Trace/Mel Browning Street intersection will be restricted to right-turn in/right-turn out as in Alternative 4, WSA conducted additional traffic analysis assuming that Cumberland Trace/Mel Browning Street operated as a full intersection. **Table 5** provides a comparison of these three alternatives.

The yellow highlighted lines in the table represent the controlling factors that led to the recommendations. Each of these items is discussed below:

Intersection LOS and Delay – This is a measure of how well each of these individual intersections operate. They include all movements and approaches at the intersection. The analysis indicated that the controlling features relative to traffic operations along the US-231 corridor are the intersections of US-231 with Three Springs Road/Ken Bale

Boulevard and the US-231 intersection with Cumberland Trace/Mel Browning or the relocated intersection of Alternative 4. Any of the interchange options would operate at an acceptable LOS.

Average Vehicle Delay – This measure is strictly a measure of operations along US-231. This measure is an average of the delay a vehicle would experience undertaking either a northbound trip beginning south of Cherry Farm or a southbound trip beginning north of Three Springs Road/Ken Bale Boulevard, and traveling through the corridor (or traveling through the corridor until it exits the corridor to a side road). Based on this measure, the type of interchange has little effect on the overall US-231 operations if the Cumberland Trace intersection is relocated and left-turn movements are restricted. If, however, Cumberland Trace is not relocated, the existing diamond configuration would clearly be the least desirable of the three.

Table 5 – Alternative 4 Interchange Summary

		AEI Alt. 6	SPUI	Diamond
PM Intersection LOS and Delay (Relocated Cumberland Trace/Greenwood Lane Intersection)				
US 231 and	Cherry Farm	D / 44	D / 43	D / 44
	Cumberland Trace	Unsignalized Intersection (Right-In, Right-Out)		
	Northbound Ramp	B / 10	C / 21	C / 23
	Southbound Ramp	B / 17		B / 15
	Three Springs Road	D / 39	D / 38	D / 36
PM Intersection LOS and Delay (Existing Cumberland Trace Intersection)				
US 231 and	Cherry Farm	A / 10	B / 12	A / 10
	Cumberland Trace	D / 43	D / 47	D / 43
	Northbound Ramp	B / 18	B / 19	C / 24
	Southbound Ramp	B / 20		B / 12
	Three Springs Road	D / 53	D / 46	D / 54
Average Vehicle Delay on US-231 (pm peak hour)	Relocated Cumberland Trace	NB: 115 sec/veh SB: 208 sec/veh	NB: 129 sec/veh SB: 240 sec/veh	NB: 157 sec/veh SB: 189 sec/veh
	Existing Cumberland Trace Location	NB: 299 sec/veh SB: 353 sec/veh	NB: 164 sec/veh SB: 365 sec/veh	NB: 249 sec/veh SB: 413 sec/veh
Average Travel Speed on US-231 (pm peak hour)	Relocated Cumberland Trace	NB: 22 MPH SB: 18 MPH	NB: 21 MPH SB: 17 MPH	NB: 19 MPH SB: 19 MPH
	Existing Cumberland Trace Location	NB: 12 MPH SB: 13 MPH	NB: 18 MPH SB: 13 MPH	NB: 14 MPH SB: 12 MPH
Intersection Spacing	Relocated Cumberland Trace	Good	Best	Good
	Existing Cumberland Trace Location	Poor	Best	Poor
Number of Interchange Traffic Signals		2	1	2
US-231 Through Lanes		3	3	3

Adequate Queue Storage Lanes	Relocated Cumberland Trace	Yes	Yes	Yes
	Existing Cumberland Trace Location	No	Yes	No
Median Width on US-231		To match future US-231 design likely a wide median		
Number of Bridges		2	1 (complex)	1
Levels to the Interchange		3	2	2
Cost		$14 Million	$11 Million	$9 Million

Average Travel Speed – Average travel speed is also a US-231 corridor-specific measure that reflects the overall speed moving along the corridor and includes the actual time traveling, the delay, and the starting and stopping time.

Intersection Spacing – Intersection spacing is a critical element in optimizing the existing capacity of a corridor. Spacing may also be a cause of congestion and gridlock, as traffic queues can back up and block adjacent intersections. If Alternative 4 is implemented, specifically with the relocation of Cumberland Trace and the restricted turning movements at the various locations where there are full movements today, all three interchange options would have good intersection spacing. If, however, the relocation of Cumberland Trace is not achieved, the spacing between the existing northbound I-65 ramps and Cumberland Trace would be significantly less than desirable and indeed would effect overall traffic operations. AEI Alternative 6 and the diamond interchange would operate less effectively than the SPUI.

Adequate Queue Storage Lanes – Queue storage lanes are important to safe and efficient operations along US-231 because if there is not adequate storage, vehicles will back up into through-lanes, creating a potential safety hazard. Under Alternative 4, adequate storage is provided for all movements along US-231. If, however, Cumberland Trace is not relocated and left turns restricted, both AEI Alternative 6 and the existing diamond do not have adequate storage between the I-65 Northbound ramps and the Cumberland Trace intersection.

Cost – The costs used are from two separate sources: the AEI Alternative 6 cost was taken from the AEI report, while the SPUI and diamond were calculated by WSA using the same factors and approach as AEI. This was done to allow for similar comparisons of cost. These costs, while acceptable for comparison, will likely be higher once an actual design/construction cost estimate is completed. The diamond carries additional cost because, in order to accommodate future traffic volumes, the existing bridge and roadway along US-231 would need to be widened. Improvements to the existing ramps would also need to be addressed. For the SPUI, in addition to a new bridge and realigned ramps, the mainline of US-231 would likely need to be adjusted to cross I-65 at an angle closer to 90 degrees. The AEI Alternative 6, in addition to a new, wider bridge over I-65, requires a third level flyover as well as ramp realignments.

8.0 RECOMMENDATIONS

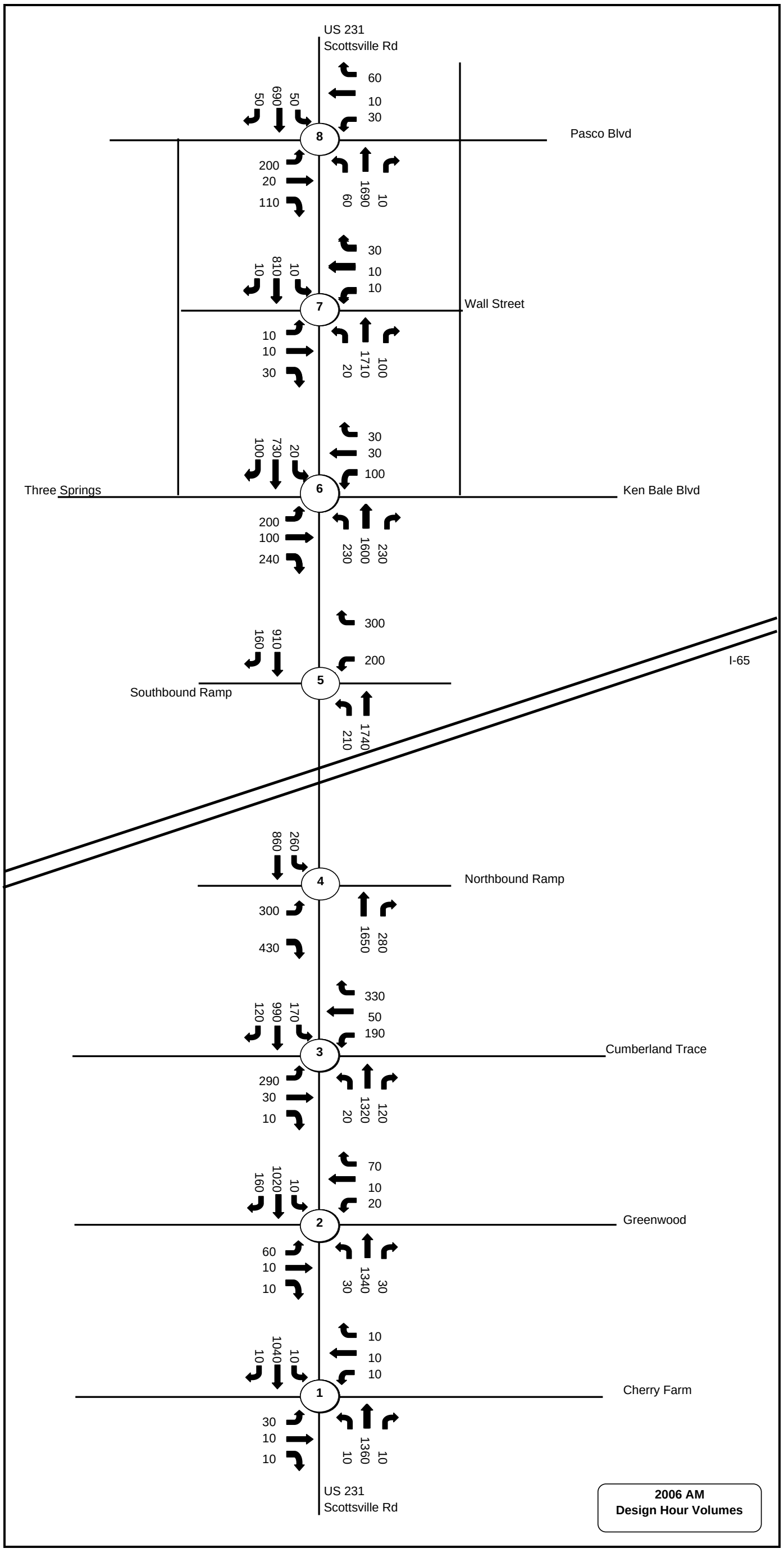
Based on review of the information and the input from the stakeholders, WSA recommends the following:

1. Alternative 4 should be considered as a "vision" for the Scottsville Road corridor, to be implemented either in one project or in sections over time as opportunities for funding become available. The "vision" for Scottsville Road should be considered beyond the limits of the study area.
2. The SPUI should move forward as the recommended interchange because:
    a. Without a guarantee that the Cumberland Trace/Mel Browning Street Intersection becomes a right-turn in/right-turn out with an appropriate median, the SPUI performs best in terms of traffic operations.
    b. If the Cumberland Trace/Mel Browning Street intersection is relocated, the SPUI still provides the best signal spacing and still operates at acceptable levels.
    c. This interchange, while not the least expensive, is less expensive than the previous recommended alternative and fits better in the urban environment of Scottsville Road (US-231).
    d. Long-term maintenance of a single bridge with one or two spans associated with the SPUI will be cheaper than the recommended alternative with two bridges, one being a long flyover structure.
    e. The complex decision-making required for exiting vehicles from I-65 associated with the recommended alternative would be eliminated.
3. As part of the new interchange design the following should be considered:
    a. The median for the interchange should be wide enough to be compatible with any proposed improvements in conjunction with Alternative 4. The median width should be a minimum of 28 feet (two 12-foot lanes and a 4-foot median separator) up to 60 feet (desirable from an operations and U-turn perspective).
    b. All access points between the interchange and the first cross street should be eliminated.
    c. Accommodations for pedestrians/bicycles (sidewalks, bicycle lanes, multi-use paths) should be considered through the interchange.
4. KYTC should undertake a safety audit of Scottsville Road in the study area, and potentially beyond, to determine specific, short-term/low cost improvements that would tie into the long-term vision of Alternative 4. These improvements could be instituted to help reduce accident frequency and severity, since there are no immediate plans for implementing Alternative 4.
5. Given the potential for major development off of Greenwood Lane, the realignment and improvement of both Greenwood Lane and Cumberland Trace should be considered as part of the development plan and constructed before traffic operations worsen at the existing Cumberland Trace/Mel Browning Street intersection with Scottsville Road.
6. While Alternative 4 is a "vision" for Scottsville Road, its evaluation is based on traffic data for only those intersections close to the interchange. Given the

importance of this corridor to the long-term economic condition of this area, a more detailed corridor evaluation should be undertaken, beginning to the east of the new Natcher Parkway intersection with Scottsville Road and continuing all the way into Bowling Green. This should include the following:

a. A comprehensive data collection effort to include all cross streets and driveways on Scottsville Road, including:
    i. Intersection turning movement counts (intersections/driveways) during the AM and PM peak period. Consider limited evaluation during the heavy shopping period between the Thanksgiving and Christmas holidays around the mall area.
    ii. Vehicle classification counts at several locations to determine the level of truck activity along the corridor
    iii. Travel time runs along the corridor to better calibrate the traffic models.
    iv. Crash records along the corridor, including the development of collision diagrams.
b. A detailed review of traffic volumes and operations (existing and future) in light of future land use changes related to vacant parcel development and redevelopment and considering the future roadway improvements, such as the new interchange between Elrod Road and the Natcher Parkway
c. A comprehensive look at pedestrian and bicycle accommodations along the corridor and in conjunction with other local and regional initiatives
d. A comprehensive safety review of the operations along the corridor
e. Recommendations for both short-term and long-term operational improvements that are consistent along the entire corridor in light of the proposals in Alternative 4
f. The Bowling Green Planning Commission should consider the development of a land-use vision and creation of an overlay zone to reflect that vision. The overlay zone could include requirements for land-use types and densities, building size and location standards, streetscape design, landscaping requirements, and access management improvements including shared access, property interconnection, and backage roads
g. Examine the potential for transit system improvements, including a review of bus stop locations, development of a Bus Rapid Transit (BRT) service along Scottsville Road that might include upgraded bus stops, traffic signal priority, and the use of transit hubs.

US 231/I-65 Interchange Study
Appendix A
Traffic Volumes


US 231
Scottsville Rd
Pasco Blvd
Wall Street
Three Springs
Ken Bale Blvd
I-65
Southbound Ramp
Northbound Ramp
Cumberland Trace
Greenwood
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Scottsville Rd
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160 910
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210 1740
860 260
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1650 280
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120 990 170
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20 1320 120
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160 1020 10
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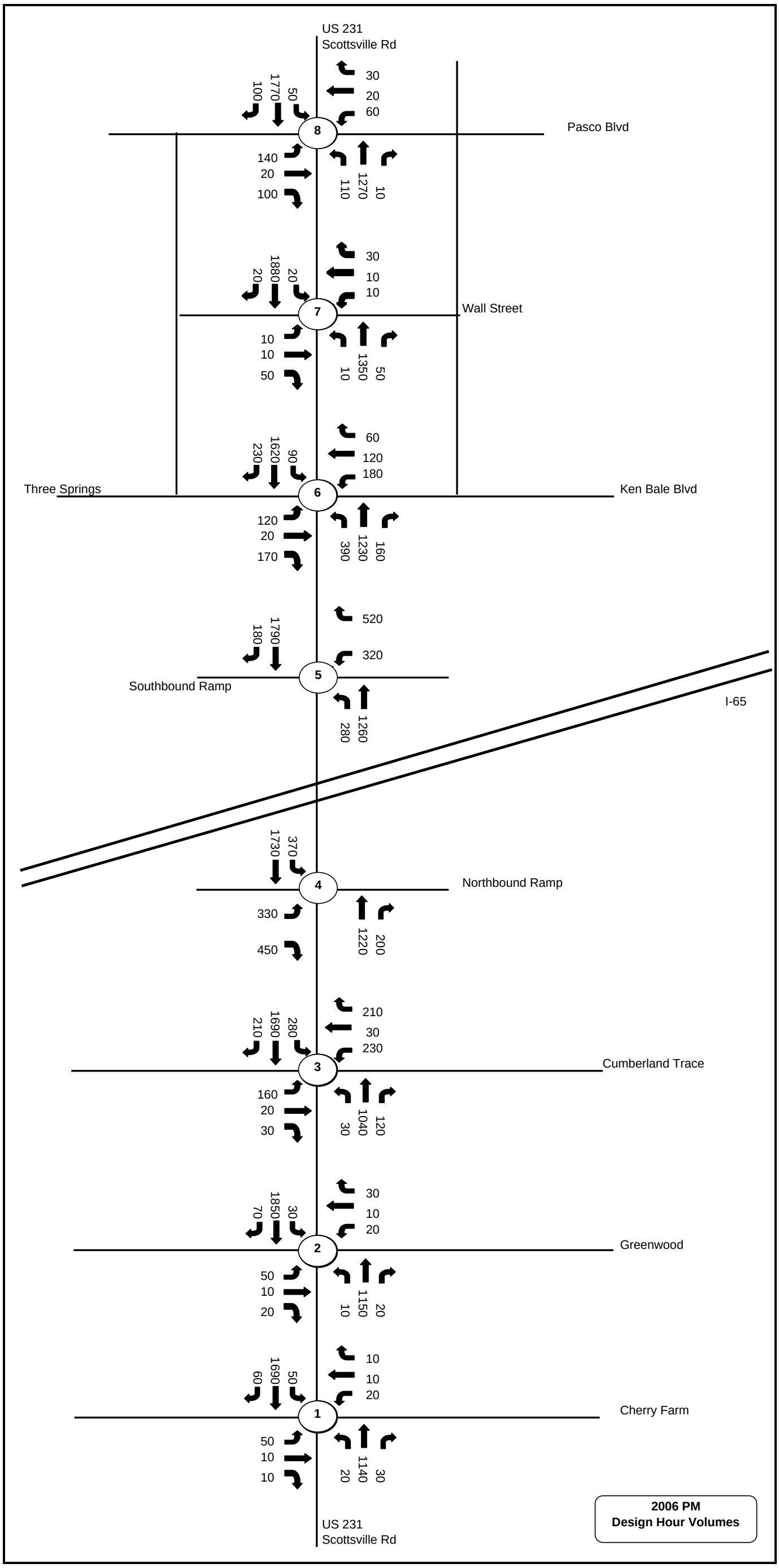
2006 AM
Design Hour Volumes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Pasco Blvd
Wall Street
Three Springs
Ken Bale Blvd
Southbound Ramp
I-65
Northbound Ramp
Cumberland Trace
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140 20 100
110 1270 10
20 1880 20
30 10 10
10 10 50
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230 1620 90
60 120 180
120 20 170
390 1230 160
180 1790
520 320
280 1260
1730 370
330 450
1220 200
210 1690 280
210 30 230
160 20 30
1040 120
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30 10 20
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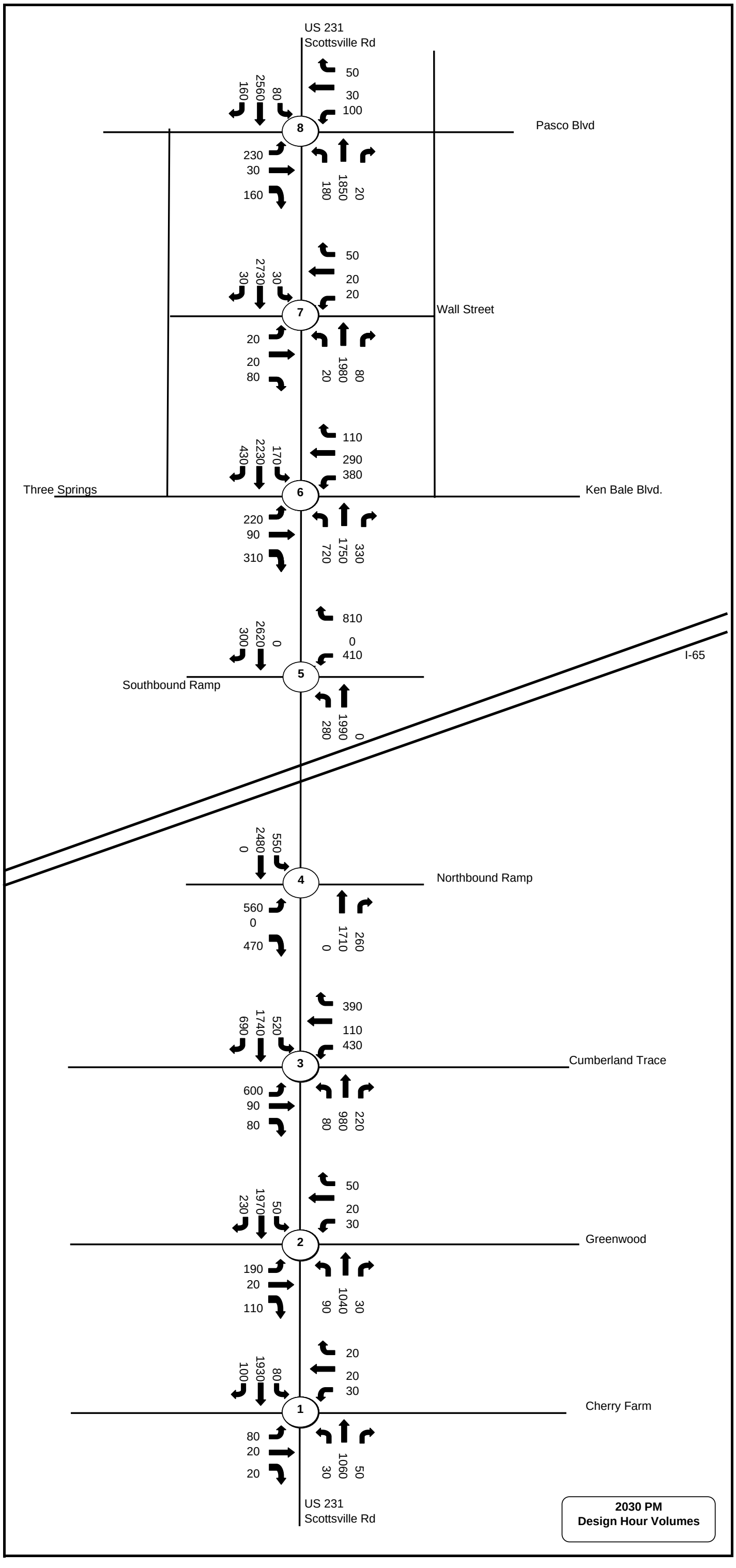
20 1140 30
2006 PM
Design Hour Volumes


US 231
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Southbound Ramp
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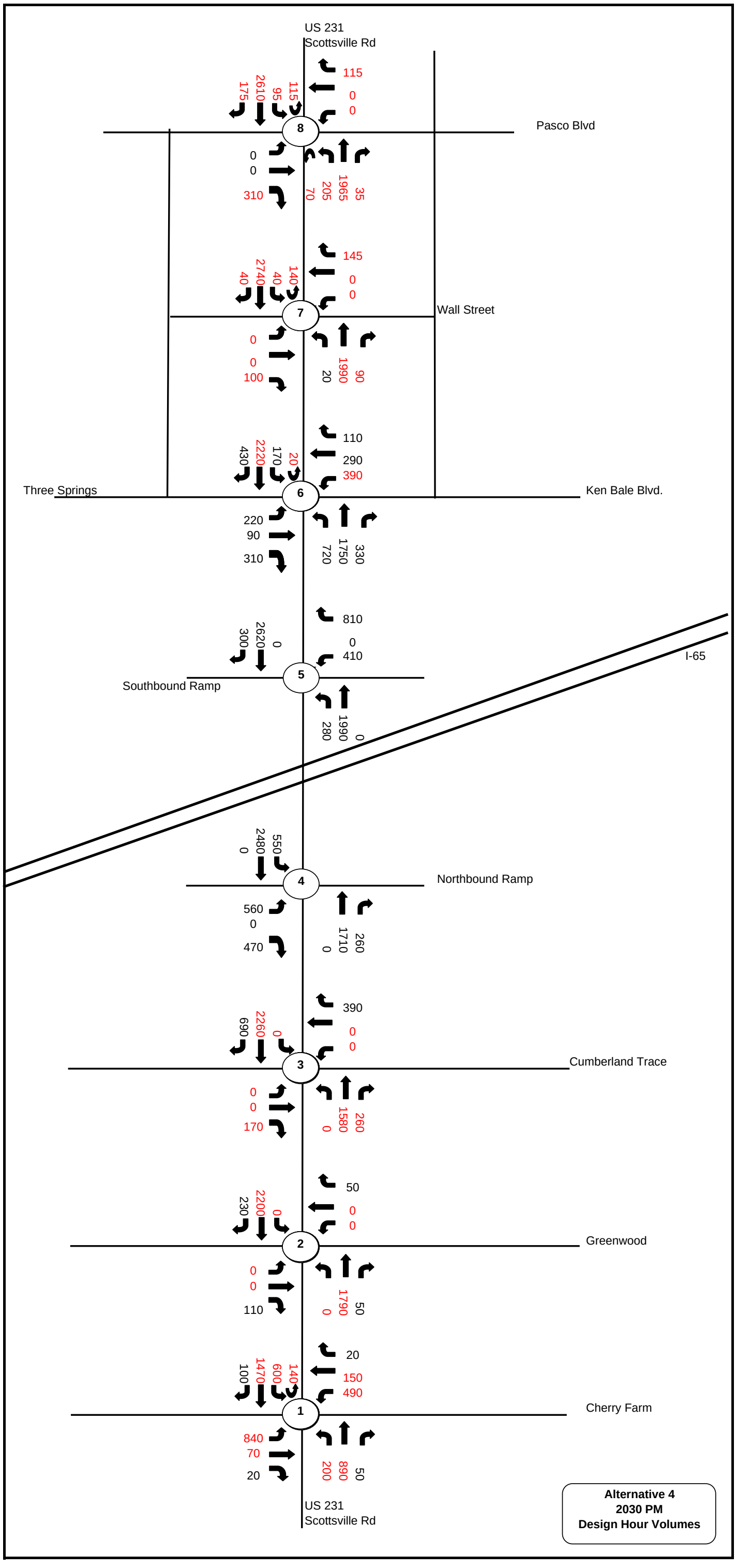
50 30 100
230 30 160
180 1850 20
30 2730 30
50 20 20
20 20 80
20 1980 80
430 2230 170
110 290 380
220 90 310
720 1750 330
300 2620 0
810 0 410
280 1990 0
2480 0 550
560 0 470
0 1710 260
690 1740 520
390 110 430
600 90 80
80 980 220
230 1970 50
50 20 30
190 20 110
90 1040 30
100 1930 80
20 20 30
80 20 20
30 1060 50
2030 PM
Design Hour Volumes


US 231
Scottsville Rd
Pasco Blvd
Wall Street
Three Springs
Ken Bale Blvd.
I-65
Southbound Ramp
Northbound Ramp
Cumberland Trace
Greenwood
Cherry Farm
US 231
Scottsville Rd
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115 0 0
0 0 310
70 205 1965 35
145 0 0
40 2740 40 140
0 0 100
20 1990 90
110 290 390
430 2220 170 20
220 90 310
720 1750 330
810 0 410
300 2620 0
280 1990 0
2480 0 550
560 0 470
0 1710 260
390 0 0
690 2260 0
0 1580 260
50 0 0
230 2200 0
110 0 0
0 1790 50
20 150 490
100 1470 600 140
840 70 20
200 890 50
Alternative 4
2030 PM
Design Hour Volumes

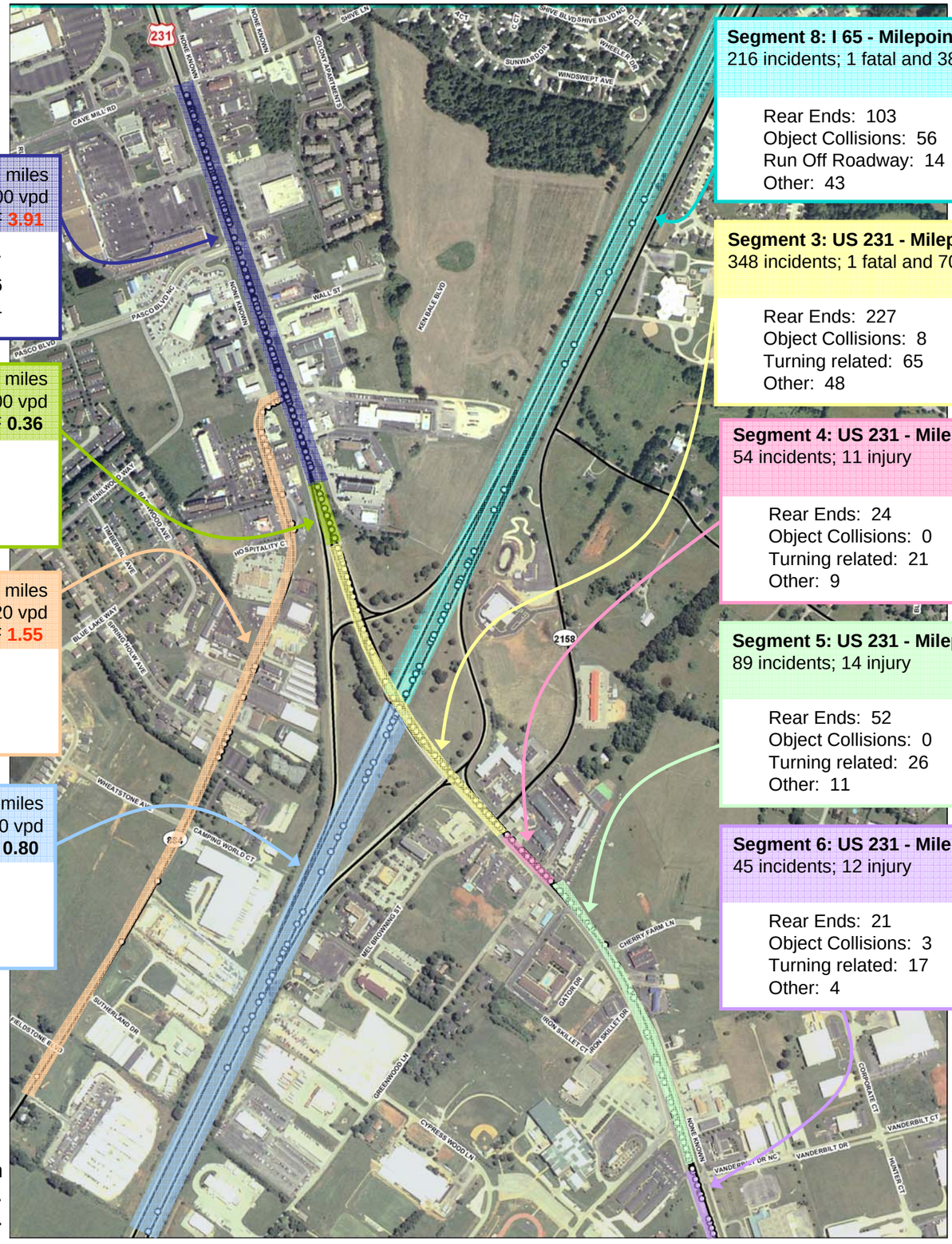
US 231/I-65 Interchange Study
Appendix B
Crash Analysis

Table B-1 High Crash Segment Calculations along US 231, Warren County																				
Route	Begin MP	End MP	Length (Miles)	ADT	Number of Lanes	Divided Undivided	Rural Urban	Avg. Veh. Crash Rate	Critical Veh. Crash Rate	Vehicle Crashes				HMVM	Rates per HMVM				Critical Rate Factor
										Fatal	Injury	PDO	Total		Fatal	Injury	PDO	Total	
US 231	7.958	8.391	0.433	19000	4	Undivided	Urban	458	607.476	0	12	33	45	0.14	0.00	84.13	231.36	315.49	0.52
US 231	8.391	8.852	0.461	26000	4	Undivided	Urban	458	581.340	0	14	75	89	0.21	0.00	67.37	360.91	428.28	0.74
US 231	8.852	8.958	0.106	26000	4	Divided	Urban	281	489.009	0	11	43	54	0.05	0.00	230.21	899.92	1130.13	2.31
US 231	8.958	9.381	0.423	39200	4	Divided	Urban	281	363.276	1	70	277	348	0.29	3.48	243.49	963.53	1210.50	3.33
US 231	9.381	9.455	0.074	39200	4	Undivided	Urban	458	713.767	0	2	11	13	0.05	0.00	39.77	218.72	258.49	0.36
US 231	9.455	9.958	0.503	39200	4	Divided	Urban	281	356.317	4	90	382	476	0.34	11.70	263.27	1117.44	1392.41	3.91
KY 884	8.631	9.631	1.000	7720	2	Undivided	Rural	244	357.722	0	12	62	74	0.13	0.00	89.66	463.22	552.88	1.55
I-65	20.539	22.349	1.810	49100	4	Divided	Urban	93	113.338	2	34	104	140	1.54	1.30	22.07	67.50	90.86	0.80
I-65	22.349	25.664	3.315	48400	4	Divided	Urban	93	108.074	1	38	177	216	2.78	0.36	13.66	63.63	77.65	0.72

Table B-2 High Crash Spot Calculations along US 231, Warren County																				
Route	Begin MP	End MP	Length (Miles)	ADT	Number of Lanes	Divided/ Undivided	Rural/ Urban	Avg. Veh. Crash Rate	Critical Veh. Crash Rate	Vehicle Crashes				MVM	Rates per MVM				Critical Rate Factor
										Fatal	Injury	PDO	Total		Fatal	Injury	PDO	Total	
US 231	8.350	8.450	0.100	22000	4	Undivided	Urban	0.440	0.730	0	4	14	18	38.14	0.00	0.10	0.37	0.47	0.65
US 231	8.450	8.550	0.1	26000	4	Undivided	Urban	0.44	0.706	0	7	39	46	45.08	0.00	0.16	0.87	1.02	1.45
US 231	8.862	8.962	0.1	26000	4	Divided	Urban	0.28	0.494	0	10	46	56	45.08	0.00	0.22	1.02	1.24	2.51
US 231	8.972	9.072	0.1	39200	4	Divided	Urban	0.28	0.453	1	26	103	130	67.96	0.01	0.38	1.52	1.91	4.23
US 231	9.076	9.176	0.1	39200	4	Divided	Urban	0.28	0.453	0	23	73	96	67.96	0.00	0.34	1.07	1.41	3.12
US 231	9.185	9.285	0.1	39200	4	Divided	Urban	0.28	0.453	0	14	65	79	67.96	0.00	0.21	0.96	1.16	2.57
US 231	9.448	9.548	0.1	39200	4	Divided	Urban	0.28	0.453	0	16	99	115	67.96	0.00	0.24	1.46	1.69	3.74
US 231	9.548	9.648	0.1	39200	4	Divided	Urban	0.28	0.453	4	27	72	103	67.96	0.06	0.40	1.06	1.52	3.35
US 231	9.698	9.798	0.1	39200	4	Divided	Urban	0.28	0.453	0	14	78	92	67.96	0.00	0.21	1.15	1.35	2.99
US 231	9.800	9.900	0.1	39200	4	Divided	Urban	0.28	0.453	0	19	84	103	67.96	0.00	0.28	1.24	1.52	3.35

Crash Overview:
US 231 in Warren County

High Crash Segments along Key Routes



Segment 1: US 231 - Milepoints 9.455 to 9.958
476 incidents; 4 fatal and 90 injury
0.503 miles
ADT: 39,200 vpd
CRF **3.91**

Rear Ends: 330
Object Collisions: 8
Turning related: 84
Other: 54

By Year
2002: 114
2003: 108
2004: 117
2005: 86
2006: 51

Segment 2: US 231 - Milepoints 9.381 to 9.455
13 incidents; 2 injury
0.074 miles
ADT: 39,200 vpd
CRF **0.36**

Rear Ends: 8
Object Collisions: 1
Turning related: 1
Other: 3

By Year
2002: 2
2003: 3
2004: 7
2005: 1
2006: 0

Segment 7: KY 884 - Milepoints 8.631 to 9.631
74 incidents; 12 injury
1.000 miles
ADT: 7,720 vpd
CRF **1.55**

Rear Ends: 19
Object Collisions: 11
Turning related: 16
Other: 28

By Year
2002: 12
2003: 22
2004: 18
2005: 15
2006: 7

Segment 9: I 65 - Milepoints 20.539 to 22.349
140 incidents; 2 fatal and 34 injury
1.810 miles
ADT: 49,100 vpd
CRF **0.80**

Rear Ends: 39
Object Collisions: 54
Run Off Roadway: 11
Other: 36

By Year
2002: 30
2003: 35
2004: 25
2005: 27
2006: 23

Segment 8: I 65 - Milepoints 22.349 to 25.664
216 incidents; 1 fatal and 38 injury
3.315 miles
ADT: 48,400 vpd
CRF **0.72**

Rear Ends: 103
Object Collisions: 56
Run Off Roadway: 14
Other: 43

By Year
2002: 54
2003: 37
2004: 44
2005: 51
2006: 30

Segment 3: US 231 - Milepoints 8.958 to 9.381
348 incidents; 1 fatal and 70 injury
0.423 miles
ADT: 39,200 vpd
CRF **3.33**

Rear Ends: 227
Object Collisions: 8
Turning related: 65
Other: 48

By Year
2002: 85
2003: 61
2004: 81
2005: 76
2006: 45

Segment 4: US 231 - Milepoints 8.852 to 8.958
54 incidents; 11 injury
0.106 miles
ADT: 26,000 vpd
CRF **2.31**

Rear Ends: 24
Object Collisions: 0
Turning related: 21
Other: 9

By Year
2002: 8
2003: 11
2004: 13
2005: 13
2006: 9

Segment 5: US 231 - Milepoints 8.391 to 8.852
89 incidents; 14 injury
0.461 miles
ADT: 26,000 vpd
CRF **0.74**

Rear Ends: 52
Object Collisions: 0
Turning related: 26
Other: 11

By Year
2002: 14
2003: 18
2004: 23
2005: 20
2006: 14

Segment 6: US 231 - Milepoints 7.958 to 8.391
45 incidents; 12 injury
0.433 miles
ADT: 19,000 vpd
CRF **0.52**

Rear Ends: 21
Object Collisions: 3
Turning related: 17
Other: 4

By Year
2002: 12
2003: 12
2004: 10
2005: 5
2006: 6

Highways are divided into segments based on changes in traffic volumes and physical geometry. Critical Rate Factors (CRF) are based on KYTC standards.

US 231 within the study area represents 2 miles of roadway and 1, 025 crashes between January 2002 and September 2006. This includes 5 fatal crashes and 199 injury crashes covering 298 injured persons.

Crash Spots are defined as 0.1 mile long locations centered on the given mile point.
Segments can be any length, with natural breaks where traffic volumes or lane configurations change.

Reported data covers January 2002 through September 2006.

A single pedestrian collision is reported, dated April 2004, occurring at milepoint 9.41 on US 231.

Spot A – MP 8.4
18 Crashes; 4 Injury
ADT: 22,000 vpd
CRF **0.65**

Rear Ends: 10	2002:	2
Sideswipe: 0	2003:	2
Turning: 7	2004:	5
Other: 1	2005:	4
NB: 67%, SB: 33%	2006:	5

Spot F – Milepoint 9.235
79 Crashes; 14 Injury
ADT: 39,200 vpd
CRF **2.57**

Rear Ends: 58	2002:	20
Sideswipe: 6	2003:	16
Turning: 11	2004:	22
Other: 4	2005:	16
NB: 58%, SB: 42%	2006:	5

Segment 1 – MP 8.550 to 8.862
32 Crashes; 5 Injury
ADT: 26,000 vpd Length: 0.312 mi
CRF **0.37**

Rear Ends: 23	2002:	1
Sideswipe: 3	2003:	12
Turning: 5	2004:	4
Other: 4	2005:	9
NB: 50%, SB: 50%	2006:	6

Spot B – Milepoint 8.500
46 Crashes; 7 Injury
ADT: 26,000 vpd
CRF **1.45**

Rear Ends: 25	2002:	12
Sideswipe: 4	2003:	5
Turning: 14	2004:	14
Other: 3	2005:	9
NB: 54%, SB: 46%	2006:	6

Spot G – Milepoint 9.498
115 Crashes; 16 Injury
ADT: 39,200 vpd
CRF **3.74**

Rear Ends: 74	2002:	34
Sideswipe: 9	2003:	27
Turning: 22	2004:	26
Other: 10	2005:	17
NB: 46%, SB: 54%	2006:	11

Segment 2 – MP 9.288 to 9.420
45 Crashes; 8 Injury
ADT: 39,200 vpd Length: 0.132 mi
CRF **1.16**

Rear Ends: 38	2002:	10
Sideswipe: 4	2003:	5
Turning: 1	2004:	12
Other: 2	2005:	10
NB: 67%, SB: 33%	2006:	8

Spot C – Milepoint 8.912
56 Crashes; 10 Injury
ADT: 26,000 vpd
CRF **2.51**

Rear Ends: 24	2002:	9
Sideswipe: 3	2003:	10
Turning: 23	2004:	14
Other: 6	2005:	13
NB: 63%, SB: 37%	2006:	10

Spot H – Milepoint 9.598
103 Crashes; 4 Fatal and 27 Injury
ADT: 39,200 vpd
CRF **3.35**

Rear Ends: 73	2002:	20
Sideswipe: 7	2003:	21
Turning: 17	2004:	23
Other: 6	2005:	23
NB: 54%, SB: 46%	2006:	16

Segment 3 – MP 9.662 to 9.694
17 Crashes; 4 Injury
ADT: 39,200 vpd Length: 0.032 mi
CRF **1.31**

Rear Ends: 15	2002:	3
Sideswipe: 0	2003:	7
Turning: 2	2004:	4
Other: 0	2005:	1
NB: 82%, SB: 18%	2006:	2

Spot D – Milepoint 9.022
130 Crashes; 1 Fatal and 26 Injury
ADT: 39,200 vpd
CRF **4.23**

Rear Ends: 74	2002:	37
Sideswipe: 12	2003:	19
Turning: 29	2004:	27
Other: 15	2005:	28
NB: 58%, SB: 42%	2006:	19

Spot I – Milepoint 9.748
92 Crashes; 19 Injury
ADT: 39,200 vpd
CRF **2.99**

Rear Ends: 67	2002:	26
Sideswipe: 5	2003:	25
Turning: 15	2004:	24
Other: 5	2005:	12
NB: 62%, SB: 38%	2006:	5

Segment 4 – MP 9.908 to 9.955
54 Crashes; 11 Injury
ADT: 39,200 vpd Length: 0.047 mi
CRF **3.14**

Rear Ends: 40	2002:	15
Sideswipe: 3	2003:	14
Turning: 10	2004:	13
Other: 1	2005:	10
NB: 52%, SB: 48%	2006:	2

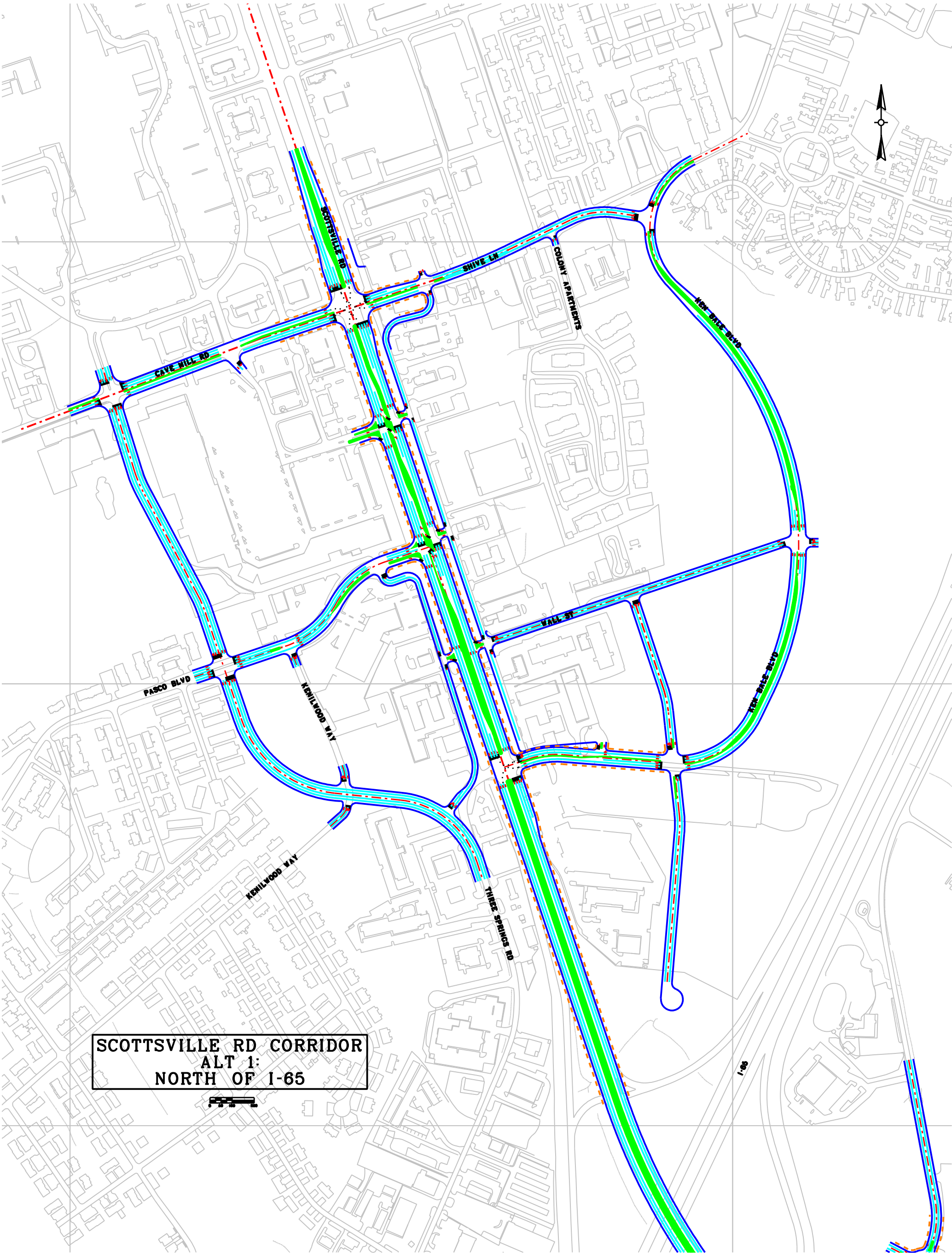
Spot E – Milepoint 9.126
96 Crashes; 23 Injury
ADT: 39,200 vpd
CRF **3.12**

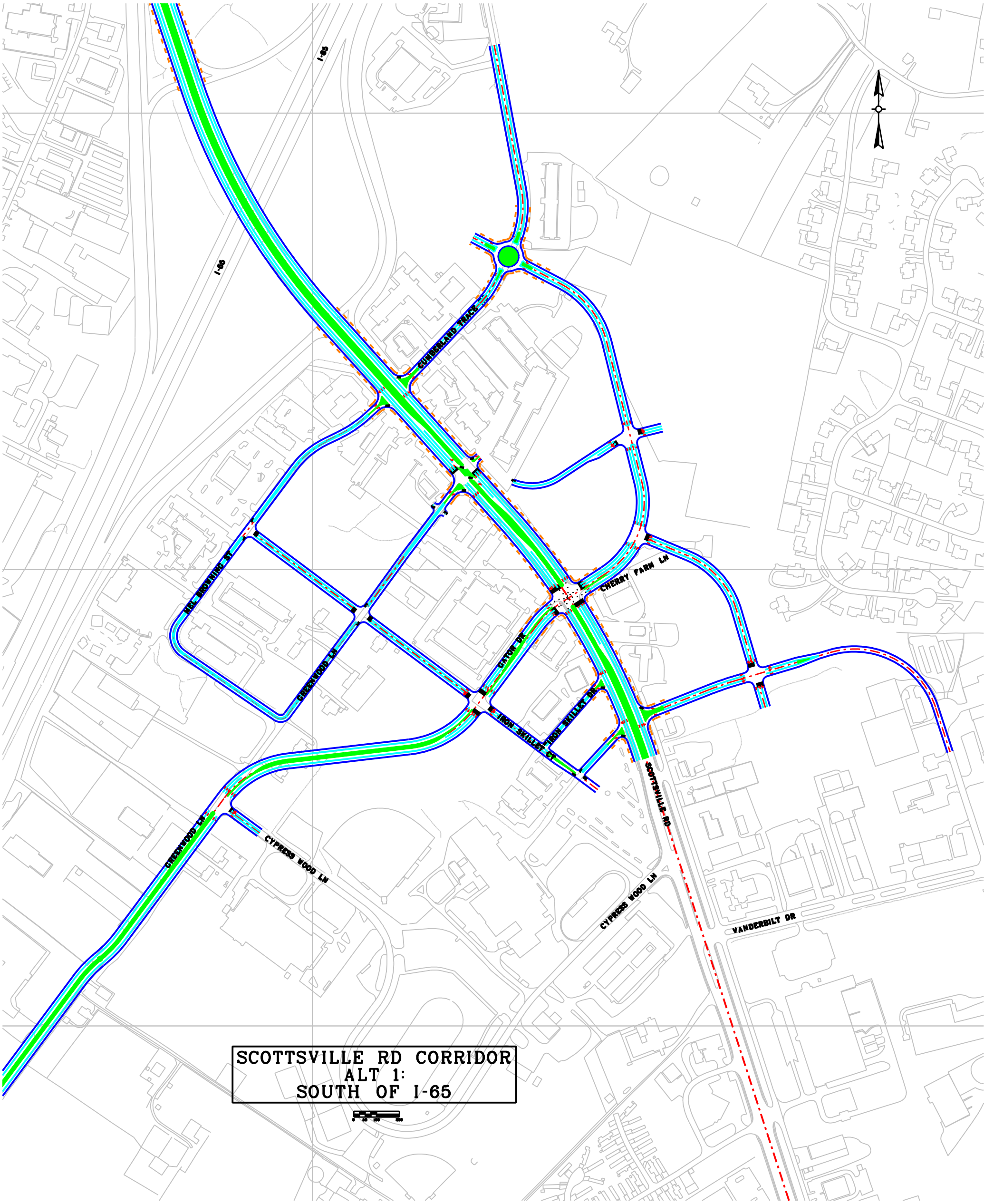
Rear Ends: 58	2002:	17
Sideswipe: 9	2003:	21
Turning: 22	2004:	23
Other: 7	2005:	23
NB: 52%, SB: 48%	2006:	12

Spot J – Milepoint 9.850
103 Crashes; 19 Injury
ADT: 39,200 vpd
CRF **3.35**

Rear Ends: 67	2002:	18
Sideswipe: 7	2003:	17
Turning: 19	2004:	30
Other: 10	2005:	23
NB: 68%, SB: 32%	2006:	15

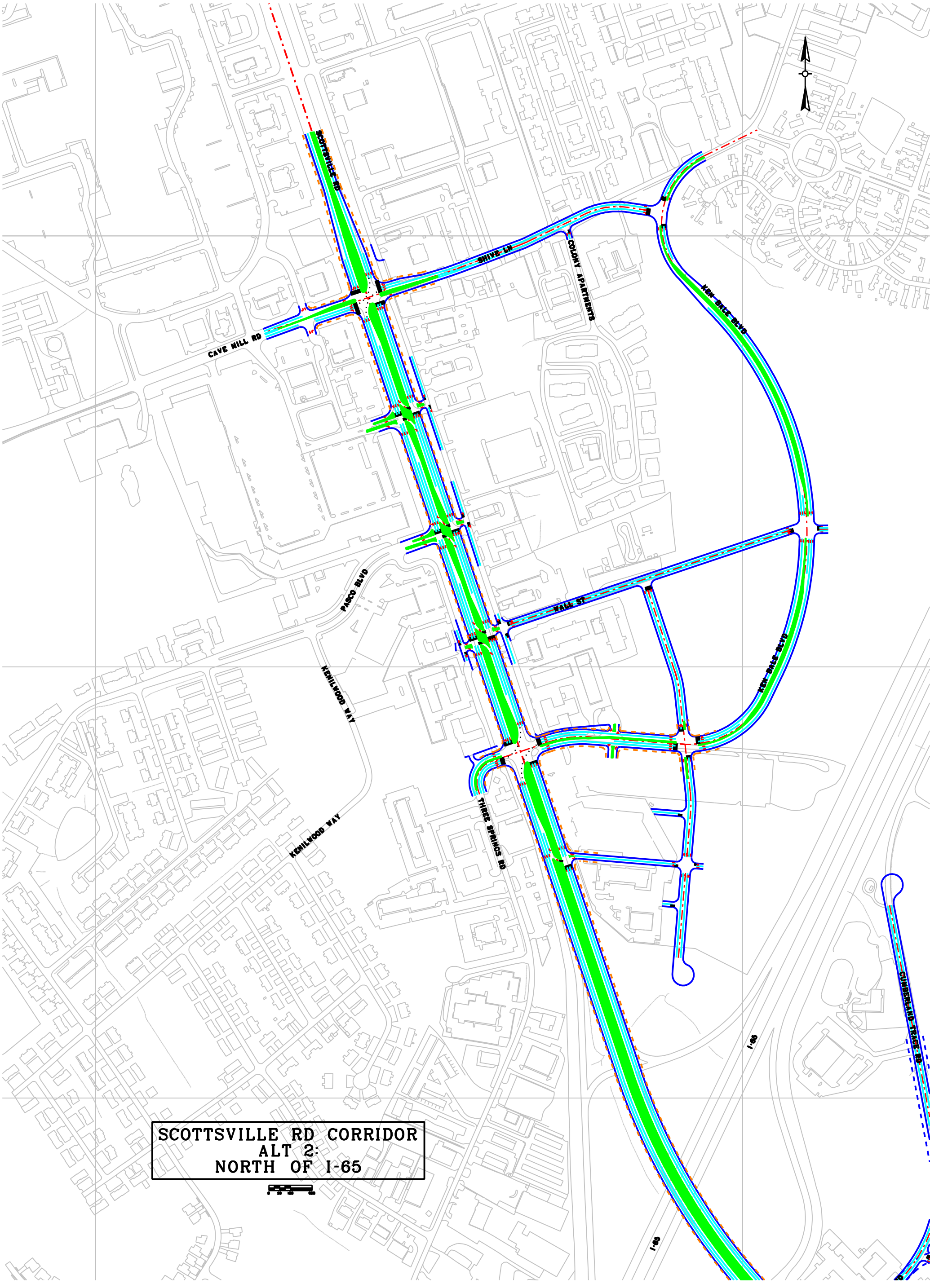
US 231/I-65 Interchange Study
Appendix C
Alternative 1


SCOTTSVILLE RD
SHIVE LN
COLONY APARTMENTS
KEW GRAS BLVD
CAVE MILL RD
PASCO BLVD
KENILWOOD WAY
KENILWOOD WAY
WALL ST
KEW GRAS BLVD
THREE SPRINGS RD
I-65
SCOTTSVILLE RD CORRIDOR
ALT 1:
NORTH OF I-65

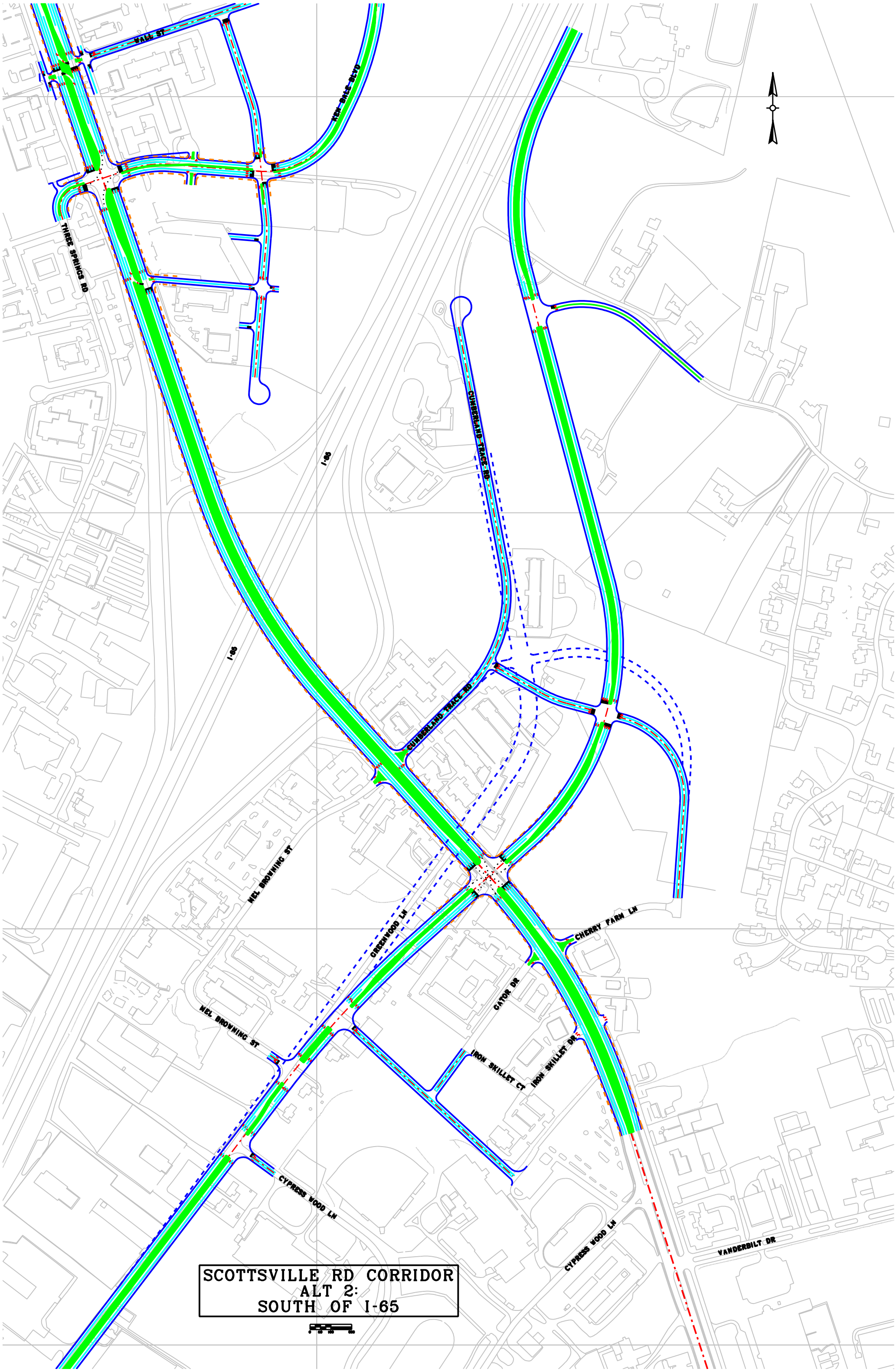


SCOTTSVILLE RD CORRIDOR
ALT 1:
SOUTH OF I-65

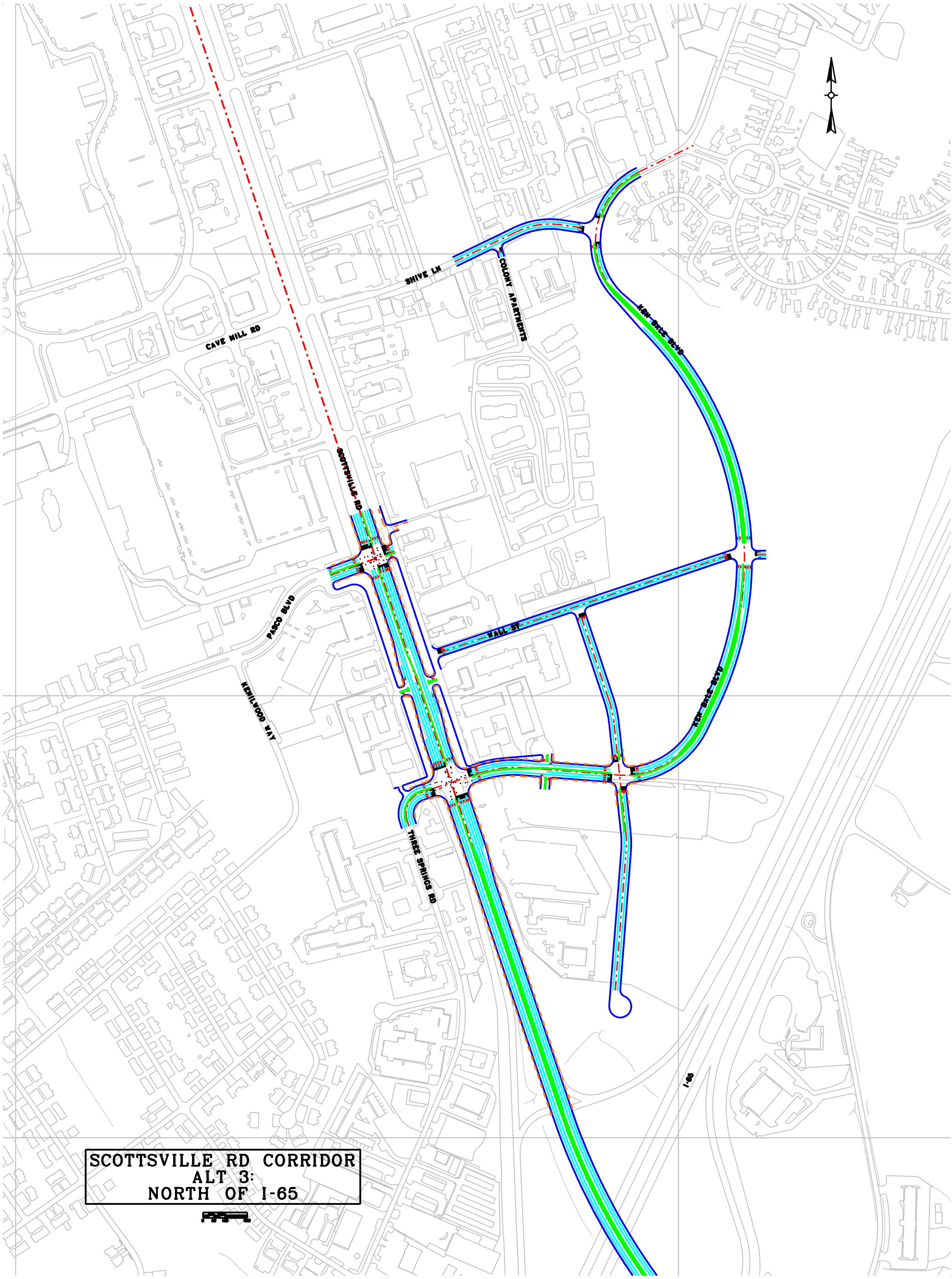
US 231/I-65 Interchange Study
Appendix D
Alternative 2

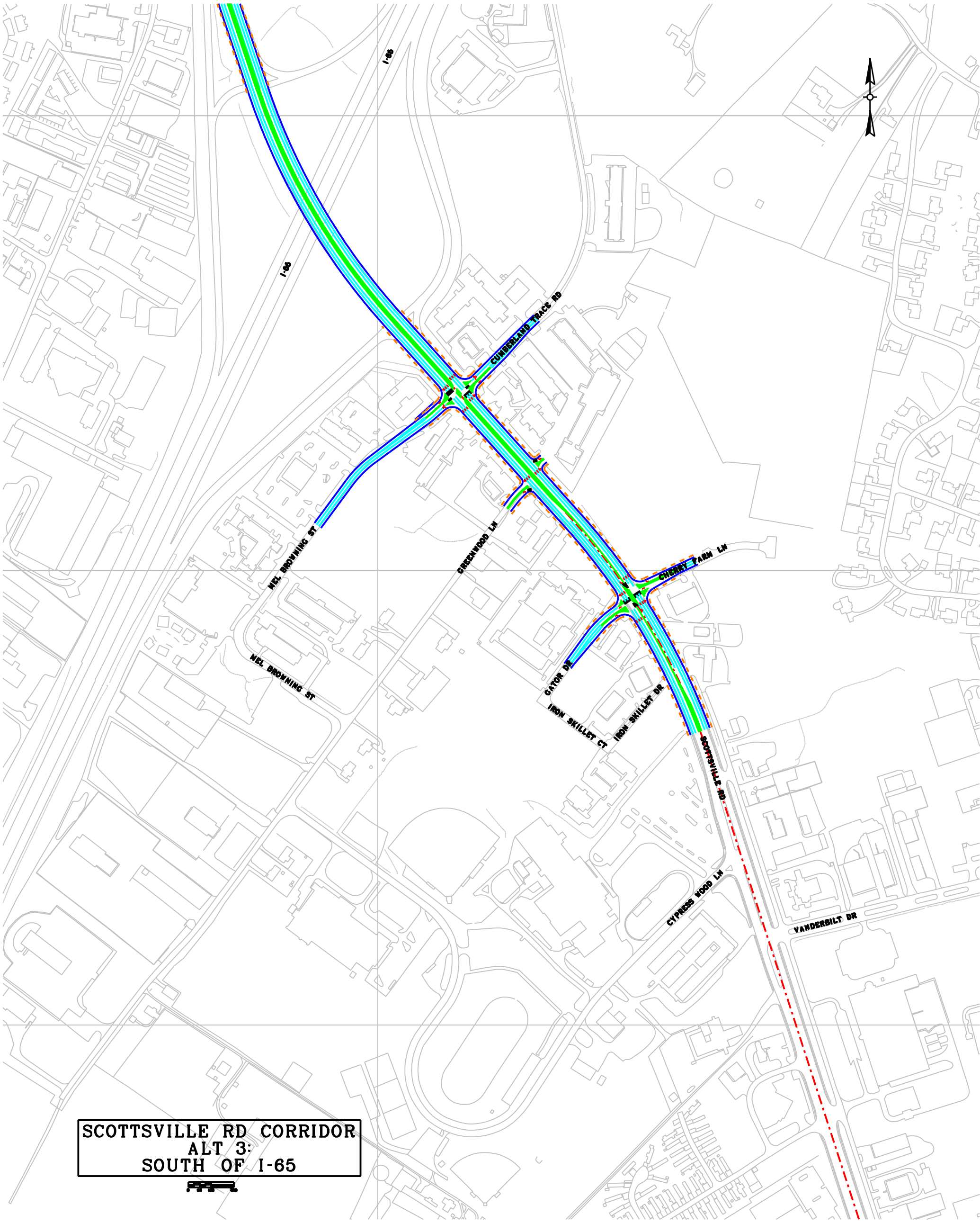


SCOTTSVILLE RD CORRIDOR
ALT 2:
NORTH OF I-65


BALL ST
IRON BALE BLVD
THREE SPRINGS RD
I-65
CUMBERLAND TRACE RD
MEL BROWNING ST
GREENWOOD LN
CHERRY FARM LN
GATOR DR
IRON SKILLET CT
IRON SKILLET DR
CYPRESS WOOD LN
VANDERBILT DR
SCOTTSVILLE RD CORRIDOR
ALT 2:
SOUTH OF I-65

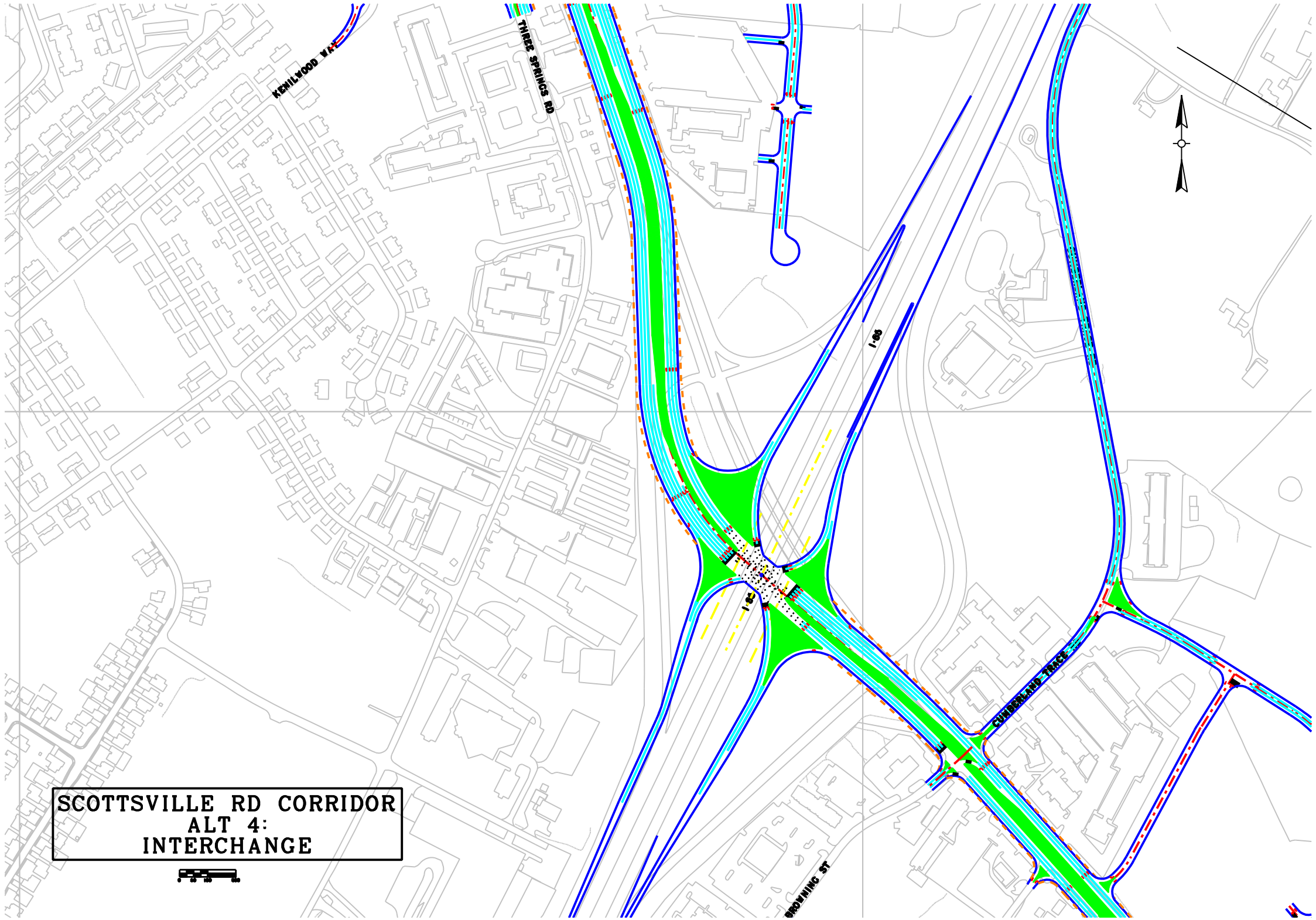
US 231/I-65 Interchange Study
Appendix E
Alternative 3

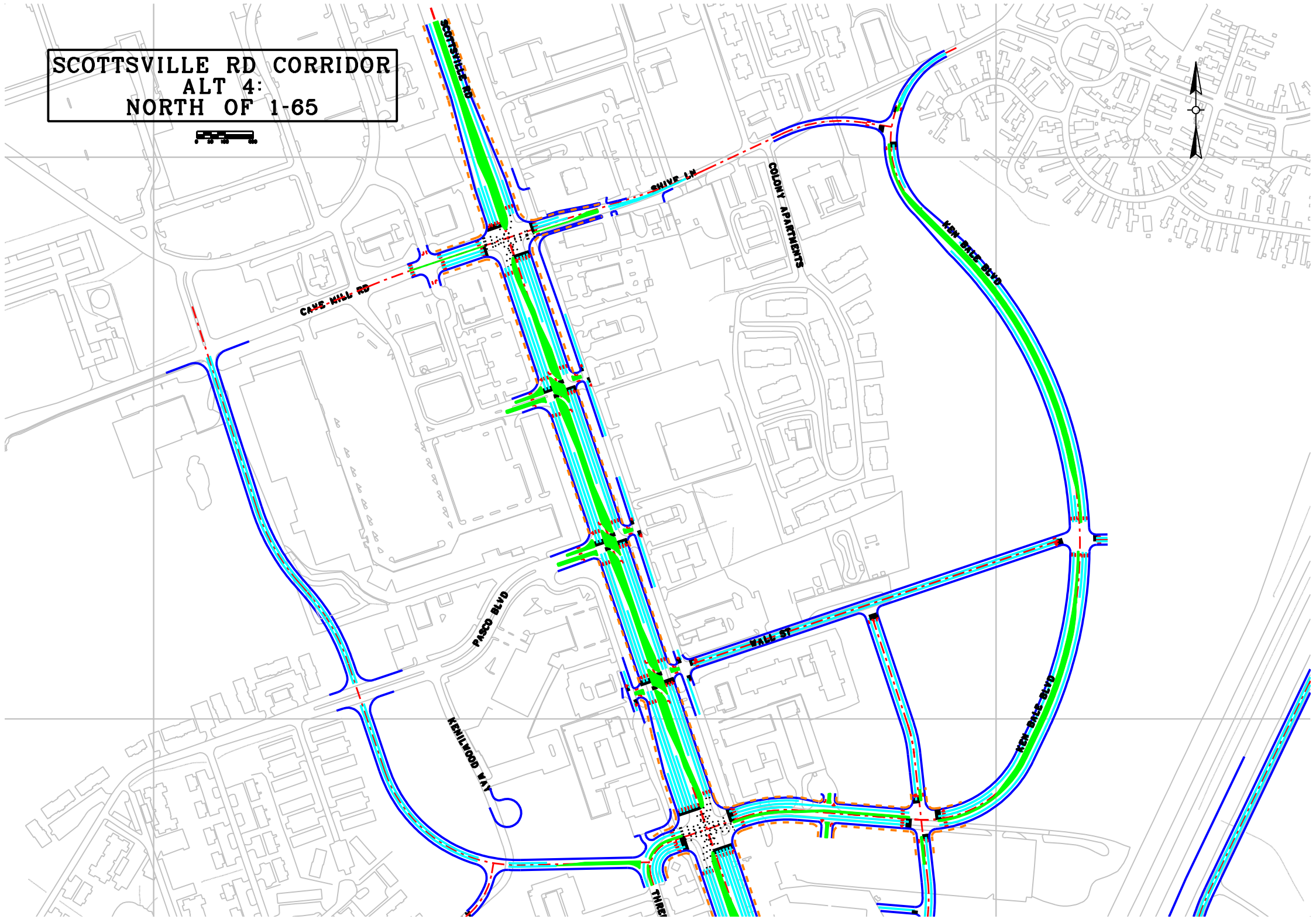

SHIVE LN
COLONY APARTMENTS
KEN DALE BLVD
CAVE MILL RD
SCOTTSVILLE RD
PASCO BLVD
WALL ST
KENILWOOD WAY
THREE SPRINGS RD
I-65
SCOTTSVILLE RD CORRIDOR
ALT 3:
NORTH OF I-65

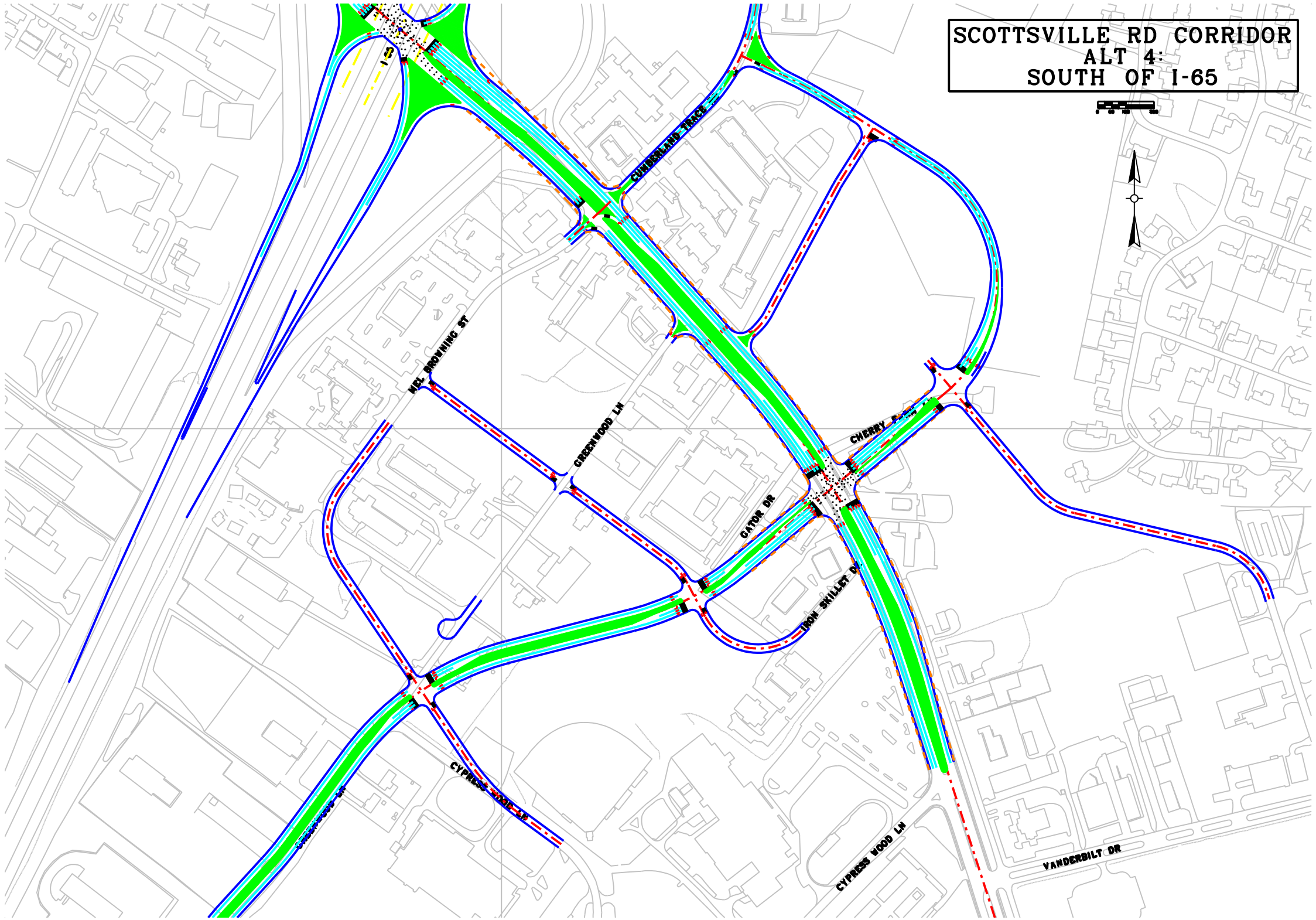


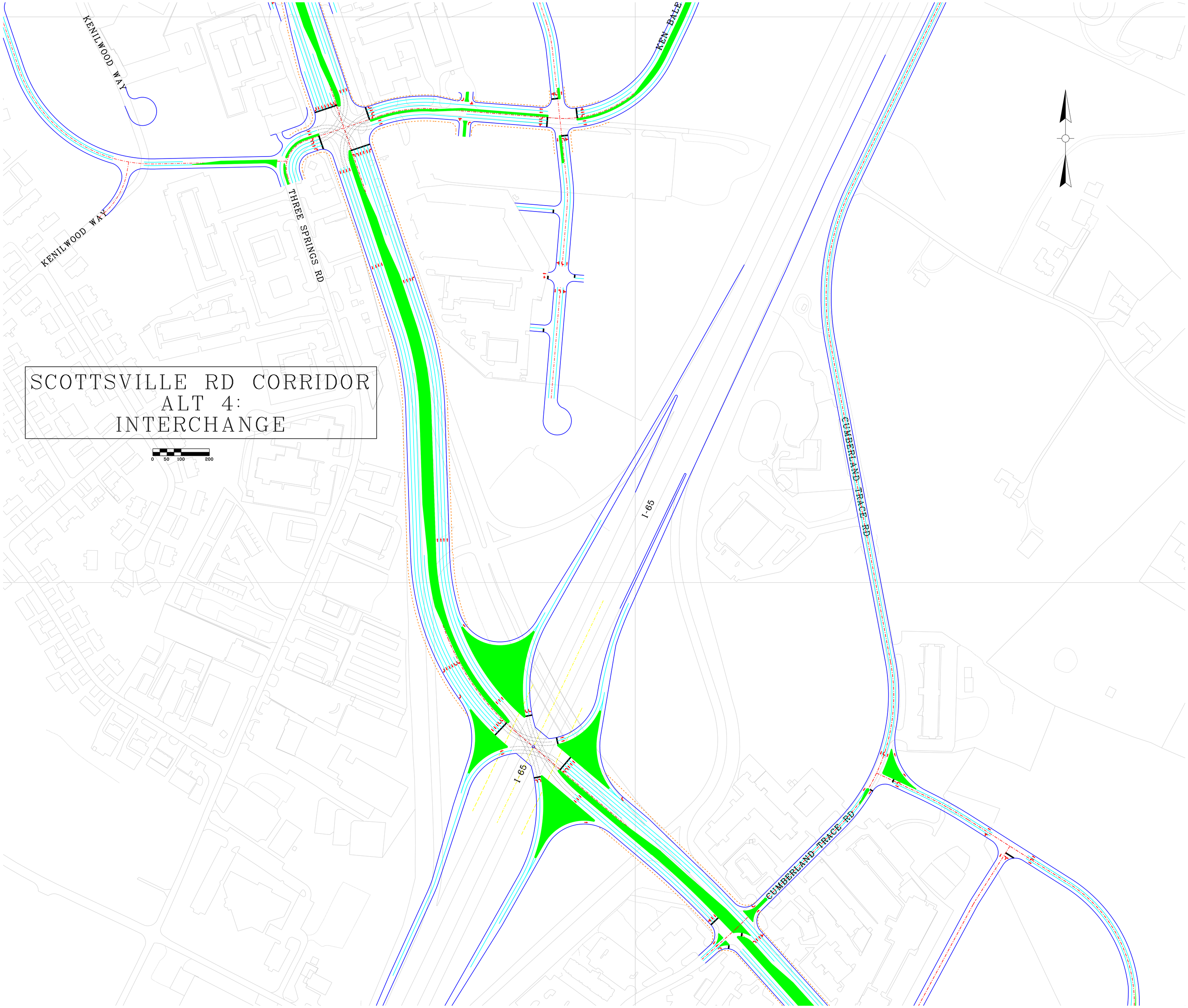
SCOTTSVILLE RD CORRIDOR
ALT 3:
SOUTH OF I-65

US 231/I-65 Interchange Study
Appendix F
Alternative 4


KENILWOOD WAY
THREE SPRINGS RD
I-65
CUMBERLAND TRACE
BROADMOOR ST
SCOTTSVILLE RD CORRIDOR
ALT 4:
INTERCHANGE


SCOTTSVILLE RD CORRIDOR
ALT 4:
NORTH OF I-65
SCOTTSVILLE RD
SHIVE LN
COLONY APARTMENTS
NEW BELT BLVD
CANE MILL RD
PASCO BLVD
KENILWOOD WAY
WARE ST
NEW BASF BLVD


SCOTTSVILLE RD CORRIDOR
ALT 4:
SOUTH OF I-65
CUMBERLAND TRACE
MGL BROWNING ST
GREENWOOD LN
CHERRY
GATOR DR
IRON SKILLET DR
CYPRESS WOOD LN
VANDERBILT DR


KENILWOOD WAY
KENILWOOD WAY
THREE SPRINGS RD
KEN BALE
I-65
I-65
CUMBERLAND TRACE RD
CUMBERLAND TRACE RD
SCOTTSVILLE RD CORRIDOR
ALT 4:
INTERCHANGE
0 50 100 200

SCOTTSVILLE RD CORRIDOR
ALT 4:
NORTHERN SECTION

0 50 100 200

SCOTTSVILLE RD

SHIVE LN

COLONY APARTMENTS

KEN BALE BLVD

CAVE MILL RD

PASCO BLVD

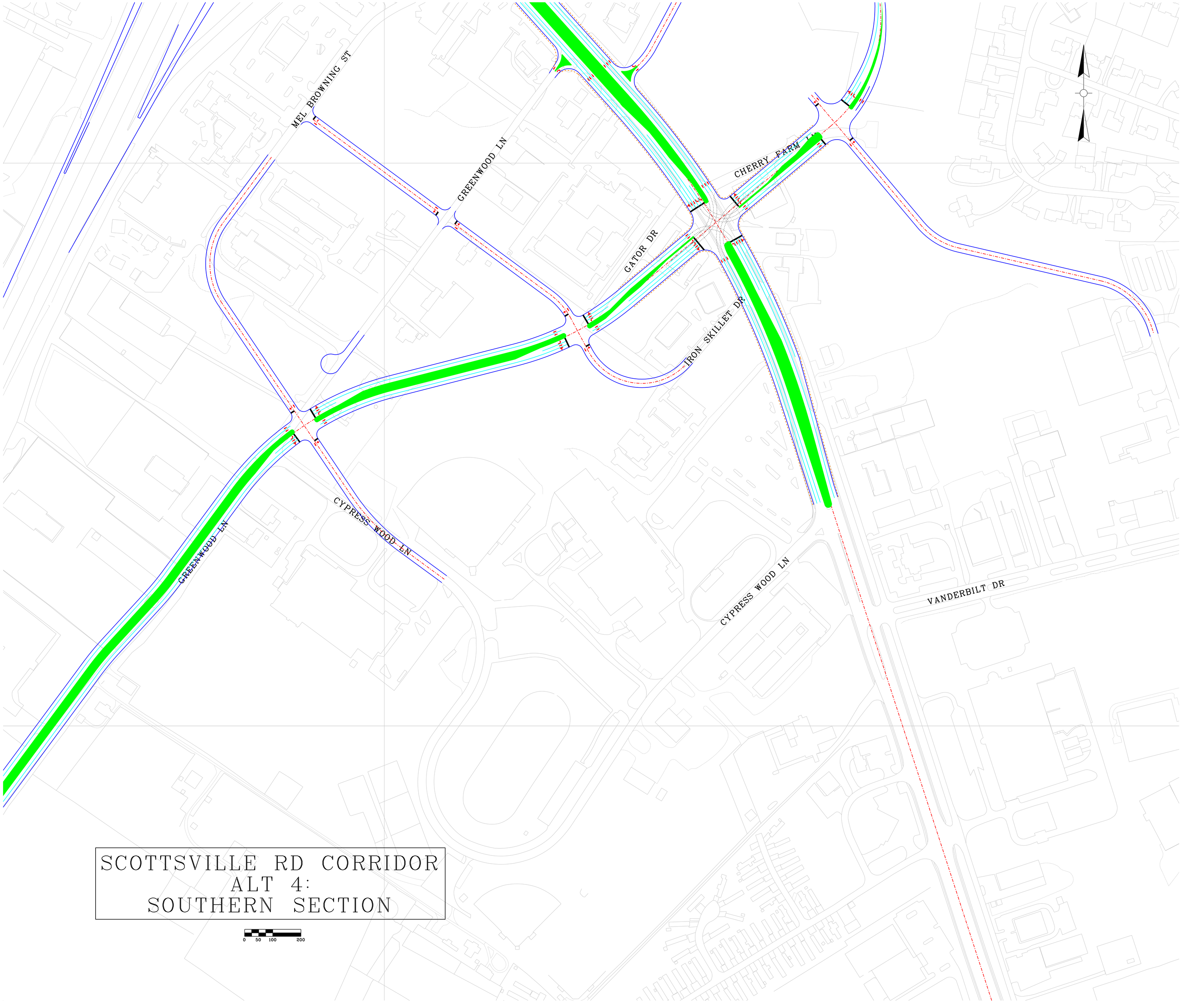
KENILWOOD WAY

KENILWOOD WAY

WALL ST

KEN BALE BLVD

THREE SPRINGS RD


MEL BROWNING ST
GREENWOOD LN
GATOR DR
CHERRY FARM LN
IRON SKILLET DR
GREENWOOD LN
CYPRESS WOOD LN
CYPRESS WOOD LN
VANDERBILT DR
SCOTTSVILLE RD CORRIDOR
ALT 4:
SOUTHERN SECTION
0 50 100 200