Interstate 85 Widening Phase III
Interchange Modification Report
Exit 98 – Frontage Road Off-Ramp

Cherokee County, SC

Prepared for:
South Carolina Department of Transportation

Prepared by:
Stantec Consulting Services Incorporated

4969 Centre Point Drive, Suite 200
North Charleston SC, 29418

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EXECUTIVE SUMMARY

Interstate 85 (I-85) provides a major travel corridor running north-south between Virginia and Alabama. The increasingly busy trucking corridor connects the upstate of South Carolina with the metropolitan areas of Charlotte, North Carolina to the north and Atlanta, Georgia to the south. In addition to serving as a major route between urban areas, the I-85 study area in Cherokee County serves other specific needs, including:

- Daily commuting routes for intra- and interstate travelers;
- Access to Automated Distribution Systems and Cherokee Speedway at Exit 96;
- Access to Blacksburg Aggregate Quarry and Flying J Travel Plaza at Exit 102;
- Access to South Carolina Welcome Center and Rest Area at MM 103 Southbound;
- Access to Atlas Industrial Park, Love's Truck Stop and Shelton Fireworks at Exit 104;
- Access to Wilco Hess Truck Stop and North Carolina State Line at Exit 106

The South Carolina Department of Transportation (SCDOT) proposes multiple improvements to the I-85 corridor designed to increase capacity, upgrade interchanges to meet design requirements, and replace overpass bridges for improved interchange geometry and expanded vertical clearance. Specifically, SCDOT proposes widening I-85 from four to six lanes from the Broad River Bridge, 1.5 miles north of Exit 96 – Shelby Highway, to the southernmost ramps at Exit 106 – E. Cherokee Street. The new outside lane in the northbound direction will serve as an exit only lane at Exit 106. The southbound on-ramp lane at Exit 106 will merge with I-85 becoming the third lane in the southbound direction. Along the approximately 10 mile study area located in Cherokee County interchanges at Exit 100 – Blacksburg Highway, Exit 102 – N. Mountain Street, Exit 104 – Tribal Road, and Exit 106 – E. Cherokee Street will be reconfigured to improve traffic flow and correct any compliance issues that exist. The overpass bridges at Exit 100 – Blacksburg Highway, Exit 102 – N. Mountain Street, Exit 104 – Tribal Road, and Exit 106 – E. Cherokee Street will be replaced by bridges with improved alignment for the new interchange geometry.

The proposed project has two primary purposes: increase roadway capacity to address the projected increased traffic volumes and improve geometric deficiencies along the mainline and at several interchanges and overpasses in this section of I-85 by bringing them into compliance with current state and federal design standards. The secondary purpose is to improve safety which will be enhanced by improving the geometric design of the facility.

This interchange modification report (IMR) presents information for the proposed removal of the Exit 98 – Frontage Road northbound off-ramp located in Cherokee County, SC. Today, Exit 98 serves as an independent off–ramp to a frontage road that terminates at Blacksburg Highway. Exit 98 is not part of a larger interchange. This exit is signed with the text "Frontage Road."

Information discussed in the report is derived from the following projects report: *Interstate 85 Widening Traffic Analysis Report: I-85 Widening Project MM 96 to MM 106.*

Exit 98 is projected to be removed as part of this project. No alternatives were developed that would retain the use of this frontage road exit.

1.0 INTRODUCTION

I-85 is a north-south Interstate highway that begins at I-65 in Montgomery, Alabama. From Montgomery, I-85 runs generally to the northeast through Alabama, Georgia, South Carolina, North Carolina and Virginia, where it terminates south of Richmond at I-95 in Petersburg, Virginia. Along its 668 mile length, I-85 provides access to Montgomery, Alabama; Atlanta, Georgia; Greenville and Spartanburg, South Carolina; Charlotte, Greensboro, and Durham, North Carolina; and Petersburg, Virginia.

In South Carolina, I-85 covers about 106 miles, and provides connections to I-385 (outside of Greenville), and I-26 (outside of Spartanburg). Within the study area, I-85 crosses a portion of Cherokee County and provides access to the town of Blacksburg, SC and Grover, NC. Throughout the study area, I-85 currently provides two lanes in each direction and a posted speed limit of 65 miles per hour.

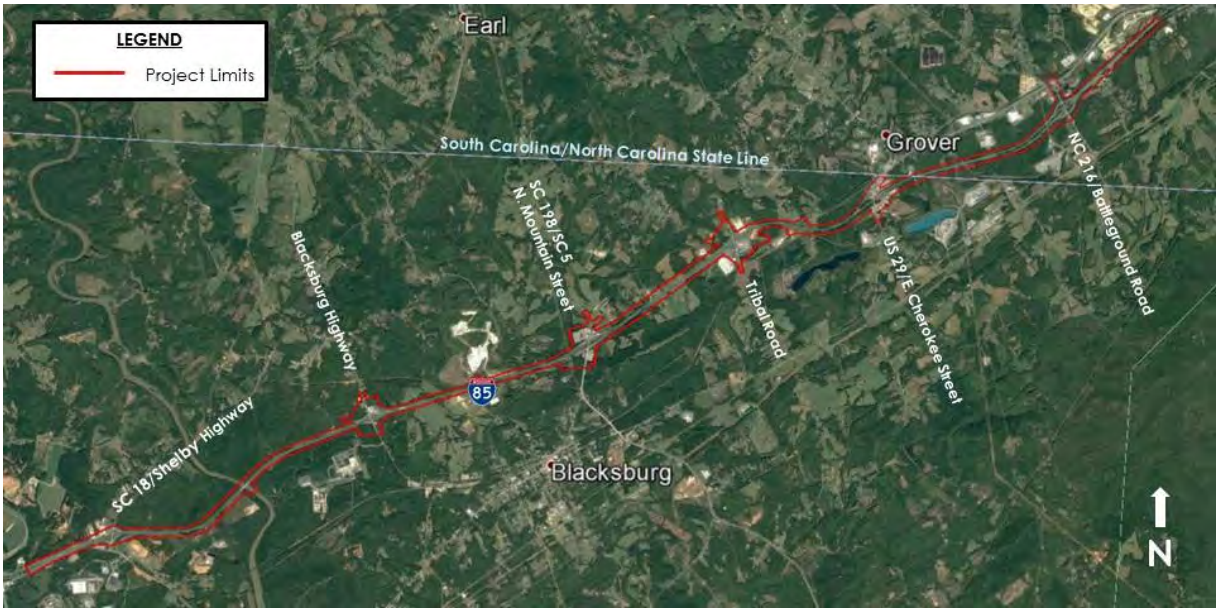
In general, interstate routes can be characterized as having level, rolling, or mountainous terrain. Within the study area along I-85, the interstate grades fluctuate between a maximum -4.70 percent down grade and a maximum 5.04 percent upgrade. Based on these grades, the portion of I-85 within the study area can be characterized as having a *rolling terrain*.

A parallel frontage road system is present at portions of both sides of I-85 throughout the study area.

1.1 OVERALL PROJECT

SCDOT is proposing multiple improvements to the I-85 corridor from mile marker 96 to mile marker 106 designed to increase capacity, upgrade interchanges to meet design requirements, and expand vertical clearance at overpass bridges. Specifically, SCDOT proposes widening I-85 from four to six lanes from the Broad River Bridge, 1.5 miles north of Exit 96 – Shelby Highway, to the southernmost ramps at Exit 106 – E. Cherokee Street. The new outside lane in the northbound direction will serve as an exit only lane at Exit 106. The southbound on-ramp lane at Exit 106 will merge with I-85 becoming the third lane in the southbound direction. Along the approximately 10-mile project area located in Cherokee County, interchanges at Exit 100 – Blacksburg Highway (S-83), Exit 102 – N. Mountain Street (SC 5/SC 198), Exit 104 – Tribal Road (S-99) and Exit 106 – E. Cherokee Street (US 29) will be improved to bring them into compliance with design requirements. Exit 98 – Frontage Road will be removed, redirecting traffic downstream to Exit 100 – Blacksburg Highway (S-83). **Figure 1** on the following page depicts the study area for the overall I-85 Widening project.

Figure 1 – I-85 Study Area



1.2 EXIT 98 – FRONTAGE ROAD ACCESS RAMP

The northbound off-ramp at Exit 98 is a short ramp with a 300 foot long tapered deceleration lane. The ramp ties directly into a frontage road that terminates at Blacksburg Highway to the north.

1.3 EXISTING CONDITIONS

The sections of I-85 within the vicinity of Exits 98 and 106 currently consist of a four-lane interstate with a grassed median for most of its length.

The Exit 98 –Frontage Road ramp ties directly into a two-way frontage road that runs parallel to the mainline lanes. The northbound off-ramp diverges from I-85 with a 300 foot long tapered deceleration lane, and has a length of approximately 275 feet from the painted gore point to the tie-in at Frontage Road.

The exit is signed in the northbound direction with the text “Frontage Road.” The existing configuration of the ramp is shown in **Figure 2** on the following page.

Figure 2 – Exit 98 Existing Ramp Configuration

1.4 PURPOSE AND NEED

The proposed project has two primary purposes: increase roadway capacity to address the projected increased traffic volumes and improve geometric deficiencies along the mainline and at several interchanges and overpasses in this section of I-85 by bringing them into compliance with current SCDOT and federal design standards. The secondary purpose is to improve safety, which will be enhanced by improving the geometric design of the facility.

The needs for this project were identified through a comprehensive review of previous studies along with the analysis of current data compiled for this study. This includes information in the Traffic Analysis Report and the Accident Analysis Report, as well as data collected through meetings with SCDOT; federal, state and local agencies; project stakeholders, and the public.

1.5 INTERCHANGE MODIFICATION REPORT APPLICANT

The interchange policy is administered by the Federal Highway Administration (FHWA). Therefore, FHWA is required to approve all new access or changes in access points pursuant to this policy.

As the owner and operator of the Interstate System, SCDOT is responsible for submitting a formal request to the FHWA in the form of an IMR that documents the analysis, the rationale for the proposed change in access, and the recommended action.

SCDOT is the sponsoring agency for the I-85 Widening project.

2.0 STUDY AREA

In South Carolina, I-85 covers approximately 106 miles, and provides connection I-385 outside of Greenville, and I-26 outside of Spartanburg. Within the study area shown previously in **Figure 1**, I-85 crosses a portion of Cherokee County, and provides access to the towns of Blacksburg, SC and Grover, NC.

2.1 DEMOGRAPHICS

The United States Census Bureau's decennial data for 2000 and 2010 were used to determine the demographic composition of the state and Cherokee County. **Table 1** presents race, age, poverty, and growth percentages for South Carolina and Cherokee County.

Table 1: Population Demographic

	South Carolina	Cherokee County
Percent that is white	64.1%	74.0%
Percent that is minority	35.9%	26.0%
Percent age 65 and Over	13.7%	13.4%
*Percent income below poverty level	14.1%	13.9%
Percent Change in Population (2000-2010)	15.3%	5.3%

Source: Census.gov (2010 data); *Decennial Census 2000 data

Comparisons of the data indicate the percentage minority population Cherokee County (26.0%) is below the reported State percentage (35.9%). The population age 65 and older is nearly the same when comparing Cherokee County (13.4%) to South Carolina as a whole (13.7%). The percent of the population with an income below the poverty level is slightly lower for Cherokee County (13.9%) compared to South Carolina (14.1%).

Although Cherokee County experienced population growth between 2000 and 2010, growth in the county was less than the 15.3% growth experienced by South Carolina as a whole.

2.2 LAND USE

Cherokee County has historically been rural with an economy based on agriculture until highway retail and commercial facilities began to develop near the interstates and major highways in the county. Due to these types of development demands, land uses have been converted from agricultural and open lands to commercial and industrial uses throughout the county in recent years.

According to the 2010 Census, Cherokee County has approximately 55,000 residents. The county has seen a steady increase in population since the 1950's. Between 2000 and 2010, Cherokee County saw a five percent increase in population. According to the South Carolina Revenue and Fiscal Affairs Office, Cherokee County is expected to continue to see a gradual population growth between 2010 and 2030 of 3.5 percent. **Table 2** on the following page presents the population growth and projection for Cherokee County.

Table 2: Cherokee County Population Growth					
County	2000 Population	2010 Population	2030 Population	2000-2010 % Growth	2010-2030 % Growth
Cherokee	52,537	55,342	57,300	5.3%	3.5%

Exits 98 – Frontage Road is located within unincorporated areas of Cherokee County. The land uses surrounding Exit 98 are limited to wooded land and a single commercial business.

2.3 TRANSPORTATION SYSTEM

The project study area roadway transportation system is part of the I-85 Widening study previously depicted in **Figure 1**. This region of Cherokee County is accessed via I-85, which is a north-south freeway (but physically more northeast-southwest) connecting the Charlotte and Atlanta metros.
For this IMR, a focused roadway system was evaluated. It consisted of the I-85 mainline and Exit 98 – Frontage Road. Specifically, the I-85 northbound mainline segment at Exit 98 – Frontage Road was evaluated for traffic conditions during different hours of the day.

It should be noted that this IMR study area is a subset of the broader study area that was analyzed during the *Interstate 85 Widening Traffic Analysis Report*. The I-85 Widening study evaluated the current and future traffic volumes on I-85 mainline and interchanges between mile markers 96 and the State Line. The focus of this IMR is on I-85 Exit 98 – Frontage Road.

3.0 METHODOLOGY

3.1 SCENARIOS ANALYZED

Analyses were performed for existing conditions (existing traffic, intersection traffic control and geometry), 2040 No-Build conditions (2040 traffic, and existing intersection traffic control and geometry) and 2040 Build Alternatives (2040 traffic and modified intersection traffic control and geometry reflecting the interchange improvement alternative). The removal of Exit 98 has negligible impacts on the downstream interchange, Exit 100 – Blacksburg Highway (S-83). The ramp removal will add 2 and 4 vehicles to the Exit 100 northbound off-ramp volumes in the morning and afternoon peak hours respectively.

The interchanges adjacent to Exit 98 are Exit 96 and Exit 100. Exit 96 – Shelby Highway (SC 18) is located approximately 2.0 miles south of Exit 98. Exit 100 – Blacksburg Highway (S-83) is the next adjacent interchange to the north of Exit 98. The interaction of the removal of Exit 98 with the adjacent interchanges was initially analyzed and is included in the I-85 Widening Traffic Analysis Report.

3.2 TRAFFIC FORECASTS

A proposed average annual growth rate was estimated based on a comparison of the AADT average annual growth rates (between 1990 and 2015) and the South Carolina Statewide Model (SCSWM) average annual growth rates for each of the segments. This proposed growth rate would be applied to all mainline and ramp movement volumes within the study area to generate the design year peak hour volumes for use in the alternatives analysis. Interchange cross streets were analyzed separately to determine the growth rate for the arterial turning

movements at each interchange. In setting the growth rate, an annual percentage that is comparable to, but higher than the observed growth rates is often desirable so a conservative analysis of future traffic conditions may be attained.

Many of the segments in the study area had estimated growth rates exceeding 1.0 percent per year. Several of the rates estimated using the historic data exceeded 1.25 percent per year. Based on these estimates and how they compare to the growth percentages an on adjacent widening study on I-85, an average annual growth rate of 1.5 percent per year was selected to be applied to develop the design year volumes throughout the study area. An annual growth rate of 1.5 percent per year would provide a conservative estimate of future traffic volumes on all freeway segments in the study area. The 1.5 percent year growth rate was applied to the freeway and ramp traffic to develop projections of the 2040 No-Build and 2040 Build Conditions traffic volumes.

3.3 TRAFFIC ANALYSIS

A series of capacity analyses were performed based on the methodologies and guidelines contained in the Transportation Research Board's publication *HCM 2010 Highway Capacity Manual* (HCM). Various software analysis and simulation packages based on the HCM were used in performing the analyses.

These included:

a. McTrans' *HCS 2010*
   - Freeway Segments
   - Ramp Merge/Diverge Areas
   - Weaving Segments

b. Trafficware's *Synchro*
   - Unsignalized Intersections
   - Signalized Intersections

The analysis methodologies contained in the HCM for the various facility types and users describe the operational conditions in terms of a Level of Service (LOS). The HCM defines LOS as:

"…a quality measure describing operations conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience. Six LOS are defined for each type of facility that has analysis procedures available. Letters designate each level, from A to F, with LOS A representing the best operating conditions and LOS F the worst. Each level of service represents a range of operating conditions and the driver's perception of those conditions. Safety is not included in the measures that establish service levels."

The following discussions and tables describe the HCM LOS criteria for the freeway segments, ramp merge/diverge segments, weaving segments, unsignalized intersections and signalization intersections.

Freeway Segments

The HCM characterizes the capacity of a basic freeway segment "*...by three performance measures: density in passenger cars per mile per lane (pc/mi/ln), space mean speed in miles per hour (mi/h), and the ratio of demand flow rate to capacity (v/c). Each of these measures is an indication of how well traffic is being accommodated by the basic freeway segment.*" LOS F occurs when either the segment density exceeds 45 pc/mi/ln or when the segment v/c ratio exceeds 1.0 (regardless of the segment density). **Table 3**, on the following page, shows the HCM LOS criteria for basic freeway segments.

Table 3 – Freeway Segment LOS Criteria

Basic Freeway Segments	
LOS	**Density (pc/mi/ln)**
A	< 11
B	> 11-18
C	> 18-26
D	> 26-35
E	> 35-45
F	> 45 v/c > 1.0

Ramp Merge and Diverge Area

Ramp-freeway junctions occur when merging maneuvers occur (on-ramps) or when diverging maneuvers occur (off-ramps). The operation of these merge and diverge areas are affected by a number of factors, including the operation of the adjacent freeway segment and the proximity and flow on adjacent ramps. Typically, the influence area of the ramps is 1,500 feet upstream of a diverge point and downstream from a merge point. As with freeway segments and weaving segments, the LOS of a merge or diverge area is related to the density of the segment. Regardless of the density, the merge or diverge areas are considered to operate at LOS F when the freeway demand exceeds the capacity of the upstream freeway segment (at diverge areas) or the downstream freeway segment (at merge areas), as well as when the ramp demand exceeds the ramp capacity. **Table 4** shows the HCM LOS criteria for ramp merge and diverge areas.

Table 4 – Merge/Diverge LOS Criteria

Merge/Diverge Areas	
LOS	**Density (pc/mi/ln)**
A	< 10
B	> 10-20
C	> 20-28
D	> 28-35
E	> 35
F	v/c > 1.0

Unsignalized Intersections

The LOS for unsignalized intersections is based on the average control delay per vehicle. Since major street traffic is seldom controlled by stops signs (except at intersections with all-way stop control or in special circumstances), major street traffic generally will experience virtually no delay. Most of the delay will be encountered by traffic on approaches controlled by stop signs. Under certain conditions, delay will also be encountered by left turning traffic on the major street waiting for appropriate sized gaps in the opposing traffic flow to complete their turn. Therefore, the delay experienced by stop controlled movements and major street left turns, rather than the entire average intersection delay, are used to identify the critical LOS at these intersections. **Table 5**, on the following page, shows the HCM LOS criteria for unsignalized intersections.

Table 5 – Unsignalized Intersection LOS Criteria

Unsignalized Intersections	
LOS	**Control Delay (sec/veh)**
A	< 10
B	> 10-15
C	> 15-25
D	> 25-35
E	> 35-50
F	> 50

Signalized Intersections

The LOS for signalized intersections is based on the average control delay per vehicle. LOS can be identified for the entire intersection, individual intersection approaches, and each movement/lane-group. **Table 6** shows the HCM LOS criteria for signalized intersections.

Table 6 – Signalized Intersection LOS Criteria

Signalized Intersections	
LOS	**Control Delay (sec/veh)**
A	< 10
B	> 10-20
C	> 20-35
D	> 35-55
E	> 55-80
F	> 80

4.0 TRAFFIC VOLUMES

This section presents the traffic volumes utilized in preparing the IMR for Exit 98. The volumes were first prepared for existing (2015) conditions, and then for the future (2040) no-build and build conditions. The average daily traffic count data is provided in **Appendix A**.

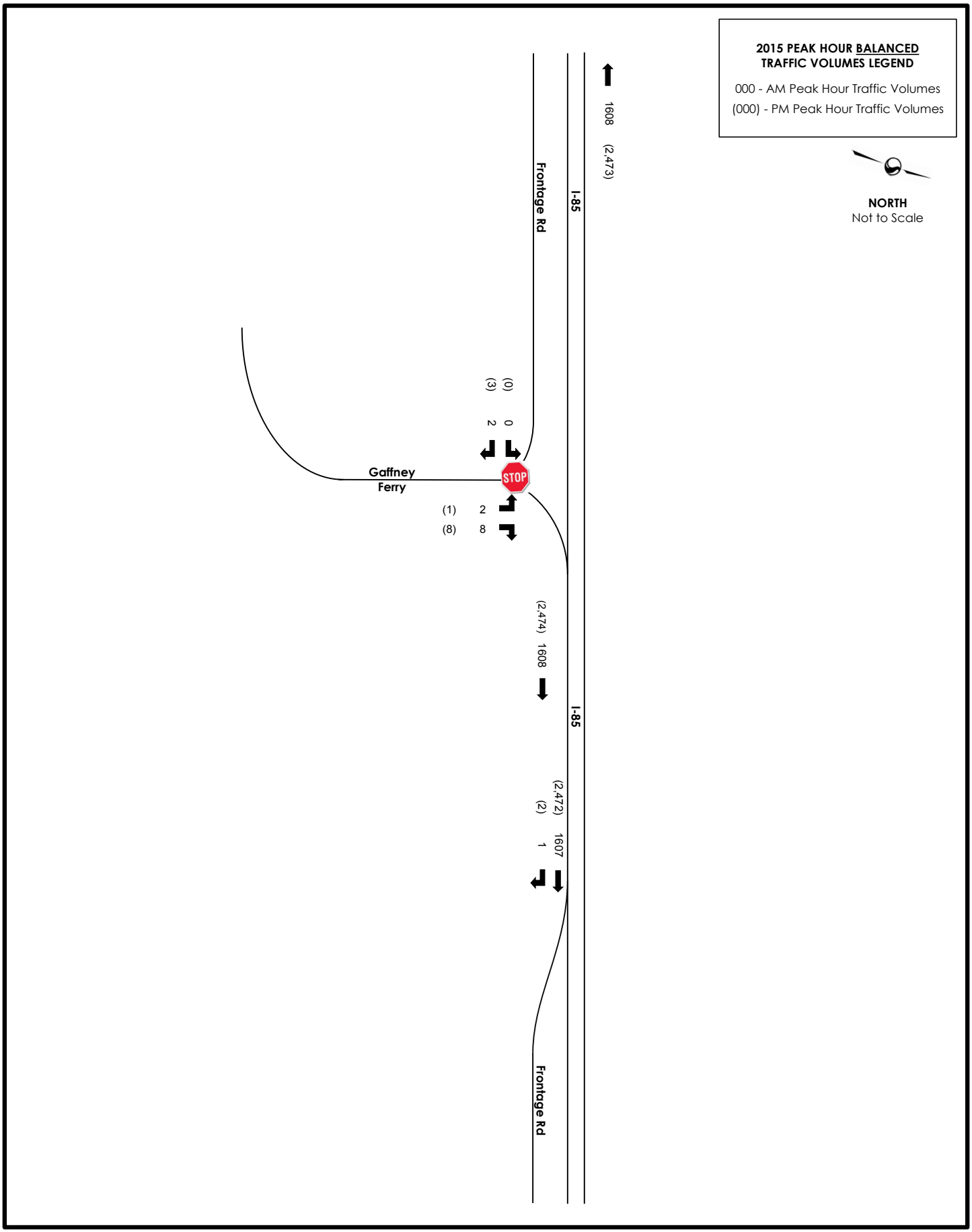
4.1 EXISTING 2015 TRAFFIC VOLUMES

The traffic count data for the ramp termini in the area of Exit 98 was evaluated and reviewed. The morning and afternoon peak hour volumes at the ramp termini were identified and the traffic balanced with the mainline. The balanced morning and afternoon peak hour volumes for Exit 98 are shown in **Figure 3**.

4.2 2040 TRAFFIC VOLUMES

An annual growth rate of 1.5 percent was applied to the freeway and ramp traffic. The ramp traffic volumes at Exit 98 used the conservative growth rate of 1.5 percent to develop projections of the 2040 No-Build Design Hour Traffic Volumes. The 2040 estimated peak hour volumes on the existing (no-build) network at the Exit 98 are shown in **Figure 4**.

The 2040 estimated peak hour ramp volumes for the Exit 98 off-ramp were balanced into the Exit 100 – Blacksburg Highway interchange downstream to reflect the removal of the ramp under the 2040 Build Conditions.



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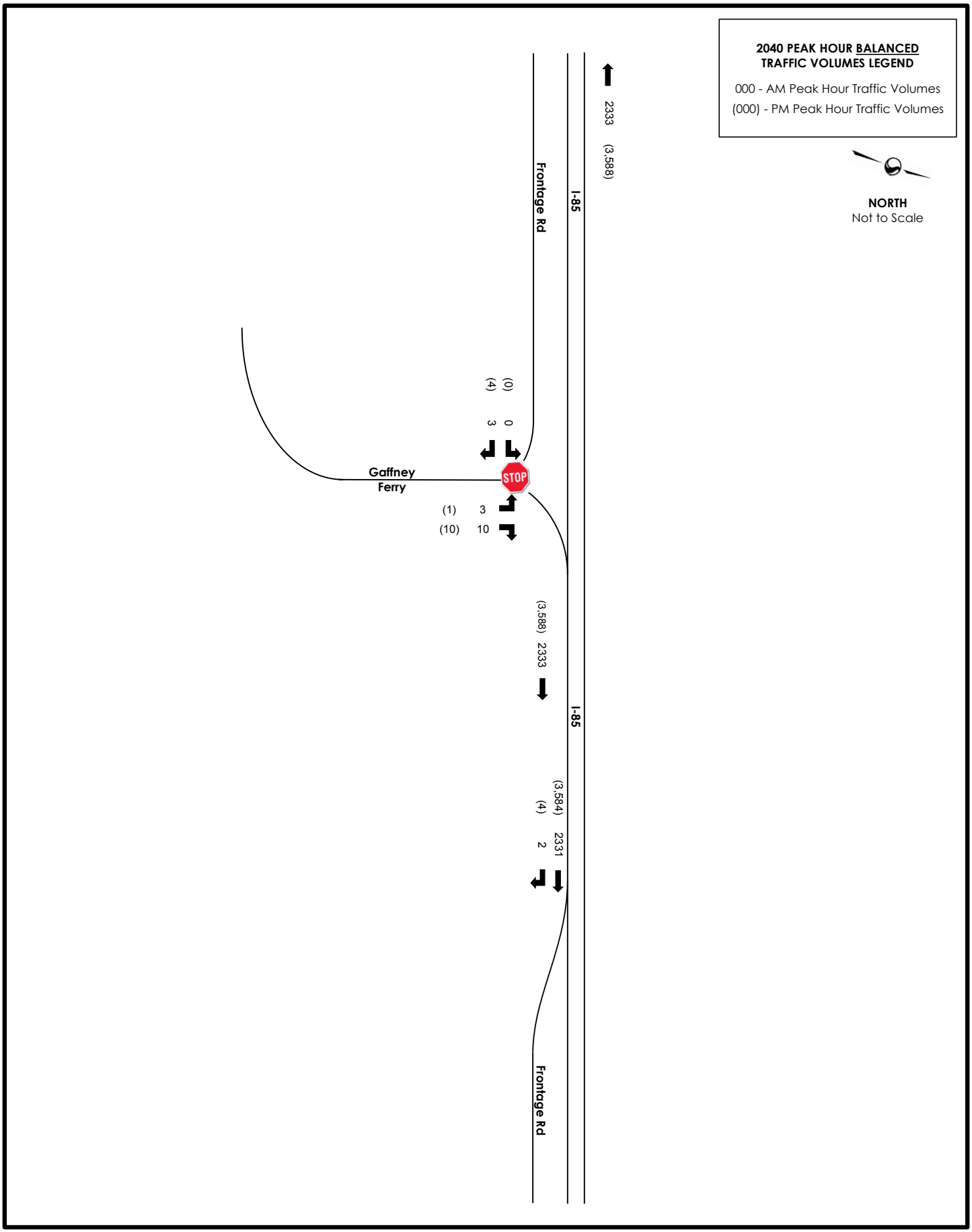
I-85 Widening Mile Marker 96-106
Figure 3 - 2015 Existing Conditions
Peak Hour Traffic Volumes



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I-85 Widening Mile Marker 96-106
Figure 4 - 2040 No Build Conditions
Peak Hour Traffic Volumes

5.0 TRAFFIC OPERATIONS

5.1 FREEWAY AND RAMP MERGE/DIVERGE SEGMENT ANALYSIS

The analysis of basic freeway segments within the study area were performed for Existing (2015) conditions and for Future (2040) No-Build and Build conditions. The following criteria were identified through discussions with SCDOT and used for various inputs within the freeway segment analysis:

- The approved peak hour volumes (8:00-9:00AM and 2:00-3:00PM) based on the P-132 ATR count station data were balanced through the system and used for the freeway segment mainline volumes.
- To develop future (2040) traffic volumes, a 1.5 percent annual growth rate was applied to existing interstate volumes in the study area.
- A peak hour factor of 0.94 was used for freeway segments and ramp areas.
- The proportion of trucks and buses traveling on the freeway segments and ramp movements, based on averaged SCDOT data from the two mainline count locations within the corridor limits, is 30 percent.
- Based on the grades through the study area, the terrain was selected as "Rolling", instead of "Level" or "Mountainous".
- Free-flow speed was set at the posted speed limit along the segment.

Freeway Segment Analysis

The existing condition and 2040 No-Build condition analyses were performed using the existing number of freeway lanes present on the segments within the study area. The 2040 Build condition analysis was performed assuming I-85 would provide three lanes in each direction on all segments within the study area. The Basic Freeway Segment Analysis outputs are provided in **Appendix B** and a summary of results is shown in **Table 7**.

2015 Existing Conditions

Using the design hour volumes for the morning and afternoon peak hours, the analysis results indicate that:

- During the morning peak hour, the freeway segment at Exit 98 operates at LOS B.
- During the afternoon peak hour, the freeway segment at Exit 98 operates at LOS D.

2040 No-Build Conditions

With traffic volumes projected to increase within the corridor at an annual rate of 1.5 percent per year, if I-85 is not widened, the increased traffic volumes traveling on the existing interstate capacity will result in increased density and reductions of freeway segment LOS.

- During the morning peak hour, the freeway segment at Exit 98 operates at LOS D.
- During the afternoon peak hour, the freeway segment at Exit 98 operates at LOS F.

2040 Build Conditions

With traffic volumes projected to increase within the corridor at an annual rate of 1.5 percent per year, if I-85 is not widened, the increased traffic volumes traveling on the existing interstate capacity will result in increased density and reductions of freeway segment LOS. The addition of a third travel lane in each direction on I-85 is expected to improve the LOS on each segment.

- During the morning peak hour, the freeway segment at Exit 98 operates at LOS B.
- During the afternoon peak hour, the freeway segment at Exit 98 operates at LOS D.

Table 7 – Freeway Segment Capacity Analysis

Basic Freeway Segment Analysis Results													
		AM Peak Hour						PM Peak Hour					
	Segment	2015 Existing		2040 No-Build		2040 Build		2015 Existing		2040 No-Build		2040 Build	
		LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density
NB	Exit 96-100	B	17.7	D	27.3	B	17.3	D	29.7	F	66.4	D	28.3

Ramp Diverge Area Analysis

The Ramp Diverge Analyses outputs are provided in **Appendix B** and the summary results are shown in **Table 8**. The analysis results for the ramp merge areas indicate the following:

2015 Existing Conditions

Using the design hour volumes for the morning and afternoon peak hours, the analysis results indicate that:

- During the morning peak hour, the ramp diverge areas at Exit 98 operates at LOS C.
- During the afternoon peak hour, the ramp diverge area at Exit 98 operates at LOS D.

2040 No-Build Conditions

With traffic volumes projected to increase within the corridor at an annual rate of 1.5 percent per year, and if I-85 is not widened, the increased traffic volumes traveling on the existing interstate capacity will result in increased density and reductions of ramp area LOS.

- During the morning peak hour, the ramp diverge areas at Exit 98 operates at LOS D.
- During the afternoon peak hour, the ramp diverge area at Exit 98 operates at LOS F.

2040 Build Conditions

With traffic volumes projected to increase within the corridor at an annual rate of 1.5 percent per year, and if I-85 is not widened, the increased traffic volumes traveling on the existing interstate capacity will result in increased density and reductions of freeway segment LOS. The addition of a third travel lane in each direction on I-85 is expected to improve the LOS on each segment.

- During the morning peak hour, the northbound ramp diverge area at Exit 100 operates at LOS C.
- During the afternoon peak hour, the northbound ramp diverge area at Exit 100 operates at LOS D.

Table 8 – Ramp Diverge Capacity Analysis Results

Freeway Diverge Analysis Results													
		AM Peak Hour						PM Peak Hour					
	Merge Location	2015 Existing		2040 No-Build		2040 Build		2015 Existing		2040 No-Build		2040 Build	
		LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density	LOS	Density
NB	Exit 98	C	21.7	D	33.3	Removed		D	33.1	F	47.9	Removed	
NB	Exit 100	C	22.3	D	30.4	C	21.7	D	34.2	F	45.3	D	30.0

5.2 EXISTING AND 2040 NO BUILD INTERSECTION ANALYSIS

As an independent ramp, there were no reported results for an unsignalized intersection capacity analysis for 2015 existing conditions and the 2040 No-Build conditions Exit 98 – Frontage Road.

5.3 2040 BUILD ANALYSIS – EXIT 100 (BLACKSBURG HIGHWAY)

The removal of Exit 98 –Frontage road is expected to have a negligible impact on the downstream Exit 100 interchange. The additional traffic volumes that will be added to the northbound off-ramp at the adjacent interchange have an insignificant impact on the efficiency of the ramp termini under the 2040 Build conditions. The northbound ramps intersection at Exit 100 –Blacksburg Highway will operate at LOS C in the morning peak hour and LOS B during the afternoon peak hour. The LOS outputs are provided in **Table 9.**

Table 9 – 2040 Intersection Capacity Analysis Results – Exit 100 – Blacksburg Highway

	Intersection Name	2040 No Build Conditions				2040 Build Conditions			
		AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
		LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)	LOS	Delay (s)
Exit 100 (Blacksburg Hwy/S-83) Alternative 4									
	Blacksburg Hwy & I-85 NB Ramps/Frontage Rd	C	18.3	B	14.3				
	Blacksburg Hwy & I-85 Northbound Ramps	Added in Build Conditions				C	15.3	B	11.6

6.0 INTERCHANGE JUSTIFICATION

A policy statement for justifying the need for additional or modified access to the existing sections of an Interstate System was first published in the Federal Register on October 22, 1990 entitled "Access to the Interstate System". It was then modified and updated on February 11, 1998 and on August 27, 2009. The objectives of this policy are to ensure that all new or revised access points do not adversely impact the operations and safety of the Interstate System, and all new or revised access points have been vetted through a systematic evaluation process.

In order to explain the intent and requirements of this new policy, FHWA published the Interstate System Access Information Guide in August 2010. This FHWA Guide was followed in preparing the current Interchange Modification Report (IMR) for the I-85/Exit 98 off-ramp in Cherokee County, South Carolina.

6.1 POLICY POINT 1

The need being addressed by the request cannot be adequately satisfied by existing interchanges to the Interstate, and/or local roads and streets in the corridor can neither provide the desired access, nor can they be reasonably improved (such as access control along surface streets, improving traffic control, modifying ramp terminals and intersections, adding turn bays or lengthening storage) to satisfactorily accommodate the design-year traffic demands (23 CFR 625.2 (a)).

This policy point is not applicable to the Exit 98 ramp removal.

6.2 POLICY POINT 2

The need being addressed by the request cannot be adequately satisfied by reasonable transportation system management (such as ramp metering, mass transit, and HOV facilities), geometric design, and alternative improvements to the Interstate without the proposed change(s) in access (23 CFR 625.2(a)).

The intent of Policy Point 2 is to demonstrate that a new access point would be needed in cases where transportation system management or alternative improvements to the existing interstate system would be inadequate.

Transportation System Management (TSM) can include improvements such as carpooling, ramp metering, reversible lanes, mass transit and high-occupancy vehicle (HOV) lanes to maximize the capacity and efficiency of the existing roadway network.

Typically, the TSM alternatives would be implemented to reduce or eliminate the need for new facility construction. However, the TSM alternative would not satisfy the project's Purpose and Need since it would not increase capacity, upgrade an obsolete interchange to meet current design requirements, and expand vertical clearances at overpass bridges. The provision of HOV facilities would still require widening mainline I-85 and constructing the proposed modifications to the existing interchange. Mass transit services in the I-85 corridor do not exist to the extent that transit could provide a reasonable alternative to relieve congestion in either the near term or for design year travel demand. Therefore, TSM strategies would not be effective in relieving delay and congestion, or addressing the Purpose and Need of the project.

6.3 POLICY POINT 3

An operational and safety analysis has concluded that the proposed change in access does not have a significant adverse impact on the safety and operation of the Interstate facility (which includes mainline lanes, existing, new, or modified ramps, ramp intersections with crossroad) or on the local street network based on both the current and the planned future traffic projections. The analysis shall, particularly in urbanized areas, include at least the first adjacent existing or proposed interchange on either side of the proposed change in access (23 CFR 625. 2(a), 655. 603(d) and 771. 111(f)). The crossroads and the local street network, to at least the first major intersection on either side of the proposed change in access, shall be included in this analysis to the extent necessary to fully evaluate the safety and operational impacts that the proposed change in access and other transportation improvements may have on the local street network (23 CFR 625.2(a) and 655.603(d)). Requests for a proposed change in access must include a description and assessment of the impacts and ability of the proposed changes to safely and efficiently collect, distribute and accommodate traffic on the Interstate facility, ramps, intersection of ramps with crossroad, and local street network (23 CFR 625.2(a) and 655.603(d)). Each request must also include a conceptual plan of the type and location of the signs proposed to support each design alternative (23 U.S.C. 109(d) and 23 CFR 655.603(d)).

The intent of the Policy Point 3 is to require detailed operational and safety analysis of the relevant interstate segments and provide a comparison of the no-build and build conditions that are anticipated to occur through the design year of the project.

The analysis of the interstate facility and Exit 98 is an extension of the project-wide traffic operations and safety analysis as summarized in the *I-85 Widening Traffic Analysis Report* and the *I-85 Widening Project MM 96 -MM 106 Accident Analysis Report*.

The analysis of the interstate facility includes the portion of I-85 between Broad River Bridge (1.5 miles north of Exit 96) and the North Carolina/South Carolina State Line, including the proposed removal of Exit 98 – Frontage Road. The analysis was performed using methodologies and procedures outlined in the Transportation Research Board's *Highway Capacity Manual* and used the HCS-2010 analysis modeling software.

The analysis of the 2040 Build condition of the preferred alternative (Alternative 4) at the adjacent Exit 100 – Blacksburg Highway (S-83) interchange illustrates that the removal of the Exit 98 off-ramp would not have any significant negative impact of the safety and the operation of the facilities within the project area. The analysis shows Interstate 85 mainline operations and ramp merge/diverge areas are estimated to operate at LOS C or better during the 2040 morning peak hour and LOS D or better during the 2040 afternoon peak hour. Without the proposed improvement, the freeway segments and ramp merge/diverge areas would operate at LOS D or better during the 2040 No-Build morning peak hour and at LOS D or worse during the 2040 No-Build afternoon peak hour.

6.4 POLICY POINT 4

The proposed access connects to a public road only and will provide for all traffic movements. Less than "full interchanges" may be considered on a case-by-case basis for applications requiring special access for managed lanes (e.g., transit, HOVs, HOT lanes) or park and ride lots. The proposed access will be designed to meet or exceed current standards (23 CFR 625.2(a), 625.4(a) (2), and 655.603 (d)).

This policy point is not applicable to the Exit 98 ramp removal.

6.5 POLICY POINT 5

The proposal considers and is consistent with local and regional land use and transportation plans. Prior to receiving final approval, all requests for new or revised access must be included in an adopted Metropolitan Transportation Plan, in the adopted Statewide or Metropolitan Transportation Improvement Program (STIP or TIP), and the Congestion Management Process within transportation management areas, as appropriate, and as specified in 23 CFR part 450, and the transportation conformity requirements of 40 CFR parts 51 and 93.

The intent of Policy Point 5 is to ensure consistency of the access request with local and regional plans.

As part of the proposed I-85 widening between mile markers 96 and 106, the removal of Exit 98 is consistent with SCDOT's Statewide Transportation Improvement Program (STIP) for Cherokee County. A source of funding for bridge, resurfacing and mainline interstate projects is available through Act 98 of 2013. Act 98 provides an annual appropriation of $50 million to SCDOT, which in turn transfers an equivalent amount to the South Carolina Transportation Infrastructure Bank (SCTIB) to be utilized to finance an estimated $550 million of interstate improvements. This I-85 Improvement (Cherokee County – Phase III of I-85 Widening Preliminary Engineering) project is fully funded by approximately $171 million of the $550 million SCTIB funds.

6.6 POLICY POINT 6

In corridors where the potential exists for future multiple interchange additions, a comprehensive corridor or network study must accompany all requests for new or revised access with recommendations that address all of the proposed and desired access changes within the context of a longer-range system or network plan (23 U.S.C. 109(d), 23 CFR 625.2(a), 655.603(d), and 771.111.

The intent of Policy Point 6 is to ensure coordinated network study and evaluation of cumulative effects for those cases when multiple new access requests are involved within the same vicinity.

This IMR study area is an extension of the broader study area that was analyzed during the *Interstate 85 Widening Traffic Analysis Report*. The I-85 Widening study evaluated the current and future traffic volumes on I-85 mainline and interchanges between mile markers 96 and the State Line. The northbound single exit ramp at Exit 98 is expected to be removed as part of this project. No other known proposed or desired access changes are anticipated in the vicinity of this interchange.

6.7 POLICY POINT 7

When a new or revised access point is due to a new, expanded, or substantial change in current or planned future development or land use, requests must demonstrate appropriate coordination has occurred between the development and any proposed transportation system improvements (23 CFR 625.2(a) and 655.603(d)). The request must describe the commitments agreed upon to assure adequate collection and dispersion of the traffic resulting from the development with the adjoining local street network and Interstate access point (23 CFR 625.2(a) and 655.603(d)).

The intent of Policy Point 7 is to ensure coordination and cooperation with relevant stakeholders when the need for interchange is primarily due to new developments.

The analysis assesses the Interstate network and evaluates the improvements required to accommodate the regional growth in traffic. The growth in freeway and local traffic results from incremental changes in land use over time, as represented by the annual growth rate applied to existing traffic to obtain 2040 traffic volumes. The proposed removal of Exit 98 is not due to a new expansion or change in current or future development in the vicinity of the interchange.

6.8 POLICY POINT 8

The proposal can be expected to be included as an alternative in the required environmental evaluation, review and processing. The proposal should include supporting information and current status of the environmental processing (23 CFR 771.111).

The intent of the Policy Point 8 is to ensure that the National Environmental Policy Act (NEPA) process is completed for environmental evaluation.

This IMR study area is an extension of the project-wide study that was summarized in the *Interstate 85 Widening Traffic Analysis Report*. That analysis considered the Interstate network, the proposed interstate widening, and proposed interchange modifications throughout the corridor and was developed concurrently with the preparation of the Environmental Assessment for the proposed improvements. The Environmental Assessment makes use of the same traffic data and improvement alternatives discussed in the project-wide study, including the removal of Exit 98.

APPENDIX A

AVERAGE DAILY COUNT DATA

All Traffic Data Services, Inc

1336 Farmer Road
Conyers, GA 30012
alltrafficdata.net

Site Code: 7
Station ID: 7
I-85 NB OFF RAMP TO FRONTAGE ROAD

Latitude: 0' 0.0000 Undefined

Start	27-May-15	NB		Hour Totals		Direction 2		Hour Totals		Combined Totals	
Time	Wed	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon	Morning	Afternoon
12:00		0	0			0	0				
12:15		0	2			0	2				
12:30		0	0			0	0				
12:45		0	0	0	2	0	0	0	2	0	4
01:00		0	0			0	0				
01:15		0	2			0	2				
01:30		0	1			0	1				
01:45		0	0	0	3	0	0	0	3	0	6
02:00		2	4			2	4				
02:15		0	0			0	0				
02:30		0	1			0	1				
02:45		0	1	2	6	0	1	2	6	4	12
03:00		0	1			0	1				
03:15		0	2			0	2				
03:30		0	3			0	3				
03:45		2	1	2	7	2	1	2	7	4	14
04:00		0	4			0	4				
04:15		1	1			1	1				
04:30		0	0			0	0				
04:45		0	0	1	5	0	0	1	5	2	10
05:00		0	4			0	4				
05:15		1	2			1	2				
05:30		0	1			0	1				
05:45		0	1	1	8	0	1	1	8	2	16
06:00		0	0			0	0				
06:15		0	0			0	0				
06:30		0	1			0	1				
06:45		1	0	1	1	1	0	1	1	2	2
07:00		0	0			0	0				
07:15		4	0			4	0				
07:30		0	1			0	1				
07:45		0	0	4	1	0	0	4	1	8	2
08:00		1	0			1	0				
08:15		1	1			1	1				
08:30		3	0			3	0				
08:45		2	1	7	2	2	1	7	2	14	4
09:00		1	2			1	2				
09:15		4	2			4	2				
09:30		1	1			1	1				
09:45		2	0	8	5	2	0	8	5	16	10
10:00		4	0			4	0				
10:15		2	1			2	1				
10:30		2	2			2	2				
10:45		0	0	8	3	0	0	8	3	16	6
11:00		0	2			0	2				
11:15		1	0			1	0				
11:30		1	1			1	1				
11:45		0	2	2	5	0	2	2	5	4	10
Total		36	48			36	48			72	96
Percent		42.9%	57.1%			42.9%	57.1%			42.9%	57.1%

All Traffic Data Services, Inc

1336 Farmer Road
Conyers, GA 30012
alltrafficdata.net

Site Code: 7
Station ID: 7
I-85 NB OFF RAMP TO FRONTAGE ROAD

Latitude: 0' 0.0000 Undefined

Start Time	28-May-15 Thu	NB Morning	NB Afternoon	Hour Totals Morning	Hour Totals Afternoon	Direction 2 Morning	Direction 2 Afternoon	Hour Totals Morning	Hour Totals Afternoon	Combined Totals Morning	Combined Totals Afternoon
12:00		0	0			0	0				
12:15		2	2			2	2				
12:30		0	0			0	0				
12:45		0	0	2	2	0	0	2	2	4	4
01:00		0	1			0	1				
01:15		0	0			0	0				
01:30		2	4			2	4				
01:45		0	1	2	6	0	1	2	6	4	12
02:00		0	0			0	0				
02:15		0	4			0	4				
02:30		0	3			0	3				
02:45		0	0	0	7	0	0	0	7	0	14
03:00		0	0			0	0				
03:15		0	0			0	0				
03:30		0	2			0	2				
03:45		0	2	0	4	0	2	0	4	0	8
04:00		0	1			0	1				
04:15		0	0			0	0				
04:30		0	0			0	0				
04:45		0	2	0	3	0	2	0	3	0	6
05:00		0	1			0	1				
05:15		0	2			0	2				
05:30		0	2			0	2				
05:45		0	2	0	7	0	2	0	7	0	14
06:00		0	2			0	2				
06:15		4	0			4	0				
06:30		0	0			0	0				
06:45		0	0	4	2	0	0	4	2	8	4
07:00		1	2			1	2				
07:15		0	0			0	0				
07:30		0	0			0	0				
07:45		0	0	1	2	0	0	1	2	2	4
08:00		0	1			0	1				
08:15		0	0			0	0				
08:30		3	0			3	0				
08:45		1	0	4	1	1	0	4	1	8	2
09:00		0	1			0	1				
09:15		1	4			1	4				
09:30		0	0			0	0				
09:45		2	0	3	5	2	0	3	5	6	10
10:00		0	0			0	0				
10:15		2	0			2	0				
10:30		0	0			0	0				
10:45		0	0	2	0	0	0	2	0	4	0
11:00		0	0			0	0				
11:15		3	0			3	0				
11:30		1	2			1	2				
11:45		1	0	5	2	1	0	5	2	10	4
Total		23	41			23	41			46	82
Percent		35.9%	64.1%			35.9%	64.1%			35.9%	64.1%
Grand Total		59	89			59	89			118	178
Percent		39.9%	60.1%			39.9%	60.1%			39.9%	60.1%
ADT		ADT 148		AADT 148							

APPENDIX B

FREEWAY SEGMENT HCS ANALYSIS

2015 EXISTING CONDITIONS
FREEWAY SEGMENT HCS ANALYSIS

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/8/2016
Analysis Time Period:	8:00AM-9:00AM
Freeway/Direction:	I-85 Northbound
From/To:	Gaffney Ferry To Frontage Rd
Jurisdiction:	SCDOT
Analysis Year:	2015 Existing Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	1608	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	428	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1240	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.00	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.2	mi/h
Free-flow speed, FFS	70.3	mi/h

LOS and Performance Measures

Flow rate, vp	1240	pc/h/ln
Free-flow speed, FFS	70.3	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.7	pc/mi/ln
Level of service, LOS	B	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/8/2016
Analysis Time Period:	8:00AM-9:00AM
Freeway/Direction:	I-85 Northbound
From/To:	Frontage Rd to Blacksburg Hwy
Jurisdiction:	SCDOT
Analysis Year:	2015 Existing Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	1607	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	427	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1239	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.3	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	69.8	mi/h

LOS and Performance Measures

Flow rate, vp	1239	pc/h/ln
Free-flow speed, FFS	69.8	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	2	
Density, D	17.7	pc/mi/ln
Level of service, LOS	B	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/9/2016
Analysis Time Period:	2:00PM-3:00PM
Freeway/Direction:	I-85 Northbound
From/To:	Gaffney Ferry to Frontage Rd
Jurisdiction:	SCDOT
Analysis Year:	2015 Existing Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	2474	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	658	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1908	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.00	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.2	mi/h
Free-flow speed, FFS	70.3	mi/h

LOS and Performance Measures

Flow rate, vp	1908	pc/h/ln
Free-flow speed, FFS	70.3	mi/h
Average passenger-car speed, S	64.2	mi/h
Number of lanes, N	2	
Density, D	29.7	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/9/2016
Analysis Time Period:	2:00PM-3:00PM
Freeway/Direction:	I-85 Northbound
From/To:	Frontage Rd to Blacksburg Hwy
Jurisdiction:	SCDOT
Analysis Year:	2015 Existing Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	2472	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	657	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1907	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.3	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	69.8	mi/h

LOS and Performance Measures

Flow rate, vp	1907	pc/h/ln
Free-flow speed, FFS	69.8	mi/h
Average passenger-car speed, S	64.2	mi/h
Number of lanes, N	2	
Density, D	29.7	pc/mi/ln
Level of service, LOS	D	

2040 NO-BUILD CONDITIONS
FREEWAY SEGMENT HCS ANALYSIS

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/8/2016
Analysis Time Period:	8:00AM-9:00AM
Freeway/Direction:	I-85 Northbound
From/To:	Gaffney Ferry To Frontage Rd
Jurisdiction:	SCDOT
Analysis Year:	2040 No Build Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	2333	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	620	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1799	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.00	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.2	mi/h
Free-flow speed, FFS	70.3	mi/h

LOS and Performance Measures

Flow rate, vp	1799	pc/h/ln
Free-flow speed, FFS	70.3	mi/h
Average passenger-car speed, S	65.8	mi/h
Number of lanes, N	2	
Density, D	27.3	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/8/2016
Analysis Time Period:	8:00AM-9:00AM
Freeway/Direction:	I-85 Northbound
From/To:	Frontage Rd to Blacksburg Hwy
Jurisdiction:	SCDOT
Analysis Year:	2040 No Build Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	2331	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	620	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1798	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.3	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	69.8	mi/h

LOS and Performance Measures

Flow rate, vp	1798	pc/h/ln
Free-flow speed, FFS	69.8	mi/h
Average passenger-car speed, S	65.9	mi/h
Number of lanes, N	2	
Density, D	27.3	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/9/2016
Analysis Time Period:	2:00PM-3:00PM
Freeway/Direction:	I-85 Northbound
From/To:	Gaffney Ferry to Frontage Rd
Jurisdiction:	SCDOT
Analysis Year:	2040 No Build Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	3588	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	954	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	2767	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.00	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.2	mi/h
Free-flow speed, FFS	70.3	mi/h

LOS and Performance Measures

Flow rate, vp	2767	pc/h/ln
Free-flow speed, FFS	70.3	mi/h
Average passenger-car speed, S	41.5	mi/h
Number of lanes, N	2	
Density, D	66.6	pc/mi/ln
Level of service, LOS	F	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/9/2016
Analysis Time Period:	2:00PM-3:00PM
Freeway/Direction:	I-85 Northbound
From/To:	Frontage Rd to Blacksburg Hwy
Jurisdiction:	SCDOT
Analysis Year:	2040 No Build Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	3584	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	953	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	2764	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.3	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	2	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	69.8	mi/h

LOS and Performance Measures

Flow rate, vp	2764	pc/h/ln
Free-flow speed, FFS	69.8	mi/h
Average passenger-car speed, S	41.6	mi/h
Number of lanes, N	2	
Density, D	66.4	pc/mi/ln
Level of service, LOS	F	

2040 BUILD CONDITIONS
FREEWAY SEGMENT HCS ANALYSIS

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/8/2016
Analysis Time Period:	8:00AM-9:00AM
Freeway/Direction:	I-85 Northbound
From/To:	Gaffney Ferry To Frontage Rd
Jurisdiction:	SCDOT
Analysis Year:	2040 Build Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	2333	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	620	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1200	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.00	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.2	mi/h
Free-flow speed, FFS	70.3	mi/h

LOS and Performance Measures

Flow rate, vp	1200	pc/h/ln
Free-flow speed, FFS	70.3	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	17.1	pc/mi/ln
Level of service, LOS	B	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/8/2016
Analysis Time Period:	8:00AM-9:00AM
Freeway/Direction:	I-85 Northbound
From/To:	Frontage Rd to Blacksburg Hwy
Jurisdiction:	SCDOT
Analysis Year:	2040 Build Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	2331	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	620	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1199	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.3	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	69.8	mi/h

LOS and Performance Measures

Flow rate, vp	1199	pc/h/ln
Free-flow speed, FFS	69.8	mi/h
Average passenger-car speed, S	70.0	mi/h
Number of lanes, N	3	
Density, D	17.1	pc/mi/ln
Level of service, LOS	B	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/9/2016
Analysis Time Period:	2:00PM-3:00PM
Freeway/Direction:	I-85 Northbound
From/To:	Gaffney Ferry to Frontage Rd
Jurisdiction:	SCDOT
Analysis Year:	2040 Build Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	3588	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	954	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1845	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.0	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.00	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.2	mi/h
Free-flow speed, FFS	70.3	mi/h

LOS and Performance Measures

Flow rate, vp	1845	pc/h/ln
Free-flow speed, FFS	70.3	mi/h
Average passenger-car speed, S	65.2	mi/h
Number of lanes, N	3	
Density, D	28.3	pc/mi/ln
Level of service, LOS	D	

Phone: Fax:
E-mail:

Operational Analysis

Analyst:	
Agency or Company:	Stantec
Date Performed:	11/9/2016
Analysis Time Period:	2:00PM-3:00PM
Freeway/Direction:	I-85 Northbound
From/To:	Frontage Rd to Blacksburg Hwy
Jurisdiction:	SCDOT
Analysis Year:	2040 Build Conditions
Description:	

Flow Inputs and Adjustments

Volume, V	3584	veh/h
Peak-hour factor, PHF	0.94	
Peak 15-min volume, v15	953	v
Trucks and buses	30	%
Recreational vehicles	0	%
Terrain type:	Rolling	
Grade	-	%
Segment length	-	mi
Trucks and buses PCE, ET	2.5	
Recreational vehicle PCE, ER	2.0	
Heavy vehicle adjustment, fHV	0.690	
Driver population factor, fp	1.00	
Flow rate, vp	1843	pc/h/ln

Speed Inputs and Adjustments

Lane width	11.3	ft
Right-side lateral clearance	6.0	ft
Total ramp density, TRD	1.17	ramps/mi
Number of lanes, N	3	
Free-flow speed:	Base	
FFS or BFFS	75.4	mi/h
Lane width adjustment, fLW	1.9	mi/h
Lateral clearance adjustment, fLC	0.0	mi/h
TRD adjustment	3.7	mi/h
Free-flow speed, FFS	69.8	mi/h

LOS and Performance Measures

Flow rate, vp	1843	pc/h/ln
Free-flow speed, FFS	69.8	mi/h
Average passenger-car speed, S	65.2	mi/h
Number of lanes, N	3	
Density, D	28.3	pc/mi/ln
Level of service, LOS	D	

APPENDIX B

RAMP DIVERGE HCS ANALYSIS

2015 EXISTING CONDITIONS
RAMP DIVERGE AREAS - HCS ANALYSIS

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	
Agency/Co.:	Stantec
Date performed:	11/9/2016
Analysis time period:	8:00AM-9:00AM
Freeway/Dir of Travel:	I-85 Northbound
Junction:	I-85 NB Off Ramp to Frontage
Jurisdiction:	SCDOT
Analysis Year:	2015 Existing Conditions
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.3	mph
Volume on freeway	1607	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1	vph
Length of first accel/decel lane	453	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	8	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	4730	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1607	1	8	vph
Peak-hour factor, PHF	0.94	0.94	0.94	
Peak 15-min volume, v15	427		2	v
Trucks and buses	30	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	1.5	1.5	
Recreational vehicle PCE, ER	2.0	1.2	1.2	

Heavy vehicle adjustment, fHV	0.690	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2479	1	9	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2479 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2479	4800	No
$v_{FO} = v_F - v_R$	2478	4800	No
v_R	1	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 2479 (Equation 13-15, 13-16, 18, or 19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2479	4400	No

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 21.5 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable, D_S = 0.428

Space mean speed in ramp influence area, S_R = 58.2 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 58.2 mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	
Agency/Co.:	Stantec
Date performed:	11/9/2016
Analysis time period:	8:00AM-9:00AM
Freeway/Dir of Travel:	I-85 Northbound
Junction:	I-85 NB Off Ramp to Frontage
Jurisdiction:	SCDOT
Analysis Year:	2015 Existing Conditions
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.3	mph
Volume on freeway	1607	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	1	vph
Length of first accel/decel lane	435	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	215	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	6362	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	1607	1	215	vph
Peak-hour factor, PHF	0.94	0.94	0.94	
Peak 15-min volume, v15	427		57	v
Trucks and buses	30	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	1.5	1.5	
Recreational vehicle PCE, ER	2.0	1.2	1.2	

Heavy vehicle adjustment, fHV	0.690	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	2479	1	229	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 2479 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	2479	4800	No
$v_{FO} = v_F - v_R$	2478	4800	No
v_R	1	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34}	> 2700 pc/h?	No	
Is v_3 or v_{av34}	> 1.5 v_{12} /2	No	

If yes, v_{12A} = 2479 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	2479	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 21.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence C

Speed Estimation

Intermediate speed variable,	D_S = 0.428	
Space mean speed in ramp influence area,	S_R = 58.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 58.2	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:
Agency/Co.: Stantec
Date performed: 11/10/2016
Analysis time period: 2:00PM-3:00PM
Freeway/Dir of Travel: I-85 Northbound
Junction: I-85 NB Off Ramp to Frontage
Jurisdiction: SCDOT
Analysis Year: 2015 Existing Conditions
Description:

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.3	mph
Volume on freeway	2472	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2	vph
Length of first accel/decel lane	453	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	8	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	4730	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway		Ramp		Adjacent Ramp		
Volume, V (vph)	2472		2		8		vph
Peak-hour factor, PHF	0.94		0.94		0.94		
Peak 15-min volume, v15	657		1		2		v
Trucks and buses	30		0		0		%
Recreational vehicles	0		0		0		%
Terrain type:	Rolling		Level		Level		
Grade	0.00	%	0.00	%	0.00	%	
Length	0.00	mi	0.00	mi	0.00	mi	
Trucks and buses PCE, ET	2.5		1.5		1.5		
Recreational vehicle PCE, ER	2.0		1.2		1.2		

Heavy vehicle adjustment, fHV	0.690	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3813	2	9	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3813 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3813	4800	No
$v_{FO} = v_F - v_R$	3811	4800	No
v_R	2	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 3813 (Equation 13-15, 13-16, 18, or 19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3813	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_D$ = 33.0 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.428	
Space mean speed in ramp influence area,	S_R = 58.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 58.2	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	
Agency/Co.:	Stantec
Date performed:	11/10/2016
Analysis time period:	2:00PM-3:00PM
Freeway/Dir of Travel:	I-85 Northbound
Junction:	I-85 NB Off Ramp to Frontage
Jurisdiction:	SCDOT
Analysis Year:	2015 Existing Conditions
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.3	mph
Volume on freeway	2472	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2	vph
Length of first accel/decel lane	435	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	155	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	6362	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2472	2	155	vph
Peak-hour factor, PHF	0.94	0.94	0.94	
Peak 15-min volume, v15	657	1	41	v
Trucks and buses	30	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	1.5	1.5	
Recreational vehicle PCE, ER	2.0	1.2	1.2	

Heavy vehicle adjustment, fHV	0.690	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3813	2	165	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3813 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3813	4800	No
$v_{FO} = v_F - v_R$	3811	4800	No
v_R	2	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 3813 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3813	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 33.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.428	
Space mean speed in ramp influence area,	S_R = 58.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 58.2	mph

2040 NO BUILD CONDITIONS
RAMP DIVERGE AREAS - HCS ANALYSIS

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	
Agency/Co.:	Stantec
Date performed:	11/9/2016
Analysis time period:	8:00AM-9:00AM
Freeway/Dir of Travel:	I-85 Northbound
Junction:	I-85 NB Off Ramp to Frontage
Jurisdiction:	SCDOT
Analysis Year:	2040 No Build Conditions
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.3	mph
Volume on freeway	2331	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2	vph
Length of first accel/decel lane	453	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	10	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	4730	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2331	2	10	vph
Peak-hour factor, PHF	0.94	0.94	0.94	
Peak 15-min volume, v15	620	1	3	v
Trucks and buses	30	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	1.5	1.5	
Recreational vehicle PCE, ER	2.0	1.2	1.2	

Heavy vehicle adjustment, fHV	0.690	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3596	2	11	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3596 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3596	4800	No
$v_{FO} = v_F - v_R$	3594	4800	No
v_R	2	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 3596 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3596	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 31.1 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.428	
Space mean speed in ramp influence area,	S_R = 58.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 58.2	mph

HCS 2010: Freeway Merge and Diverge Segments Release 6.60

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	
Agency/Co.:	Stantec
Date performed:	11/9/2016
Analysis time period:	8:00AM-9:00AM
Freeway/Dir of Travel:	I-85 Northbound
Junction:	I-85 NB Off Ramp to Frontage
Jurisdiction:	SCDOT
Analysis Year:	2015 Existing Conditions
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.3	mph
Volume on freeway	2331	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	2	vph
Length of first accel/decel lane	435	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	399	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	6362	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	2331	2	399	vph
Peak-hour factor, PHF	0.94	0.94	0.94	
Peak 15-min volume, v15	620	1	106	v
Trucks and buses	30	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	1.5	1.5	
Recreational vehicle PCE, ER	2.0	1.2	1.2	

Heavy vehicle adjustment, fHV	0.690	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	3596	2	424	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 3596 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	3596	4800	No
$v_{FO} = v_F - v_R$	3594	4800	No
v_R	2	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 3596 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	3596	4400	No

Level of Service Determination (if not F)

Density, $D = 4.252 + 0.0086\, v_R - 0.009\, L_{12}$ = 31.3 pc/mi/ln

Level of service for ramp-freeway junction areas of influence D

Speed Estimation

Intermediate speed variable,	D_S = 0.428	
Space mean speed in ramp influence area,	S_R = 58.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 58.2	mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	
Agency/Co.:	Stantec
Date performed:	11/10/2016
Analysis time period:	2:00PM-3:00PM
Freeway/Dir of Travel:	I-85 Northbound
Junction:	I-85 NB Off Ramp to Frontage
Jurisdiction:	SCDOT
Analysis Year:	2040 No Build Conditions
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.3	mph
Volume on freeway	3584	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	4	vph
Length of first accel/decel lane	453	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	10	vph
Position of adjacent ramp	Upstream	
Type of adjacent ramp	On	
Distance to adjacent ramp	4730	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3584	4	10	vph
Peak-hour factor, PHF	0.94	0.94	0.94	
Peak 15-min volume, v15	953	1	3	v
Trucks and buses	30	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	1.5	1.5	
Recreational vehicle PCE, ER	2.0	1.2	1.2	

Heavy vehicle adjustment, fHV	0.690	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5529	4	11	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 5529 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5529	4800	Yes
$v_{FO} = v_F - v_R$	5525	4800	Yes
v_R	4	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	
Is v_3 or v_{av34} > 2700 pc/h?		No	
Is v_3 or v_{av34} > 1.5 v_{12} /2		No	

If yes, v_{12A} = 5529 (Equation 13-15, 13-16, 18, or 19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	5529	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 47.7 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable, D_S = 0.428

Space mean speed in ramp influence area, S_R = 58.2 mph

Space mean speed in outer lanes, S_0 = N/A mph

Space mean speed for all vehicles, S = 58.2 mph

Phone: Fax:
E-mail:

Diverge Analysis

Analyst:	
Agency/Co.:	Stantec
Date performed:	11/10/2016
Analysis time period:	2:00PM-3:00PM
Freeway/Dir of Travel:	I-85 Northbound
Junction:	I-85 NB Off Ramp to Frontage
Jurisdiction:	SCDOT
Analysis Year:	2040 No Build Conditions
Description:	

Freeway Data

Type of analysis	Diverge	
Number of lanes in freeway	2	
Free-flow speed on freeway	70.3	mph
Volume on freeway	3584	vph

Off Ramp Data

Side of freeway	Right	
Number of lanes in ramp	1	
Free-Flow speed on ramp	35.0	mph
Volume on ramp	4	vph
Length of first accel/decel lane	435	ft
Length of second accel/decel lane		ft

Adjacent Ramp Data (if one exists)

Does adjacent ramp exist?	Yes	
Volume on adjacent ramp	287	vph
Position of adjacent ramp	Downstream	
Type of adjacent ramp	Off	
Distance to adjacent ramp	6362	ft

Conversion to pc/h Under Base Conditions

Junction Components	Freeway	Ramp	Adjacent Ramp	
Volume, V (vph)	3584	4	287	vph
Peak-hour factor, PHF	0.94	0.94	0.94	
Peak 15-min volume, v15	953	1	76	v
Trucks and buses	30	0	0	%
Recreational vehicles	0	0	0	%
Terrain type:	Rolling	Level	Level	
Grade	0.00 %	0.00 %	0.00 %	
Length	0.00 mi	0.00 mi	0.00 mi	
Trucks and buses PCE, ET	2.5	1.5	1.5	
Recreational vehicle PCE, ER	2.0	1.2	1.2	

Heavy vehicle adjustment, fHV	0.690	1.000	1.000	
Driver population factor, fP	1.00	1.00	1.00	
Flow rate, vp	5529	4	305	pcph

Estimation of V12 Diverge Areas

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 Using Equation 0

$v_{12} = v_R + (v_F - v_R) P_{FD}$ = 5529 pc/h

Capacity Checks

	Actual	Maximum	LOS F?
$v_{Fi} = v_F$	5529	4800	Yes
$v_{FO} = v_F - v_R$	5525	4800	Yes
v_R	4	2000	No
v_3 or v_{av34}	0 pc/h	(Equation 13-14 or 13-17)	

Is v_3 or v_{av34} > 2700 pc/h? No

Is v_3 or v_{av34} > 1.5 v_{12} /2 No

If yes, v_{12A} = 5529 (Equation 13-15, 13-16, 13-18, or 13-19)

Flow Entering Diverge Influence Area

	Actual	Max Desirable	Violation?
v_{12}	5529	4400	Yes

Level of Service Determination (if not F)

Density, $D_R = 4.252 + 0.0086\, v_{12} - 0.009\, L_D$ = 47.9 pc/mi/ln

Level of service for ramp-freeway junction areas of influence F

Speed Estimation

Intermediate speed variable,	D_S = 0.428	
Space mean speed in ramp influence area,	S_R = 58.2	mph
Space mean speed in outer lanes,	S_0 = N/A	mph
Space mean speed for all vehicles,	S = 58.2	mph