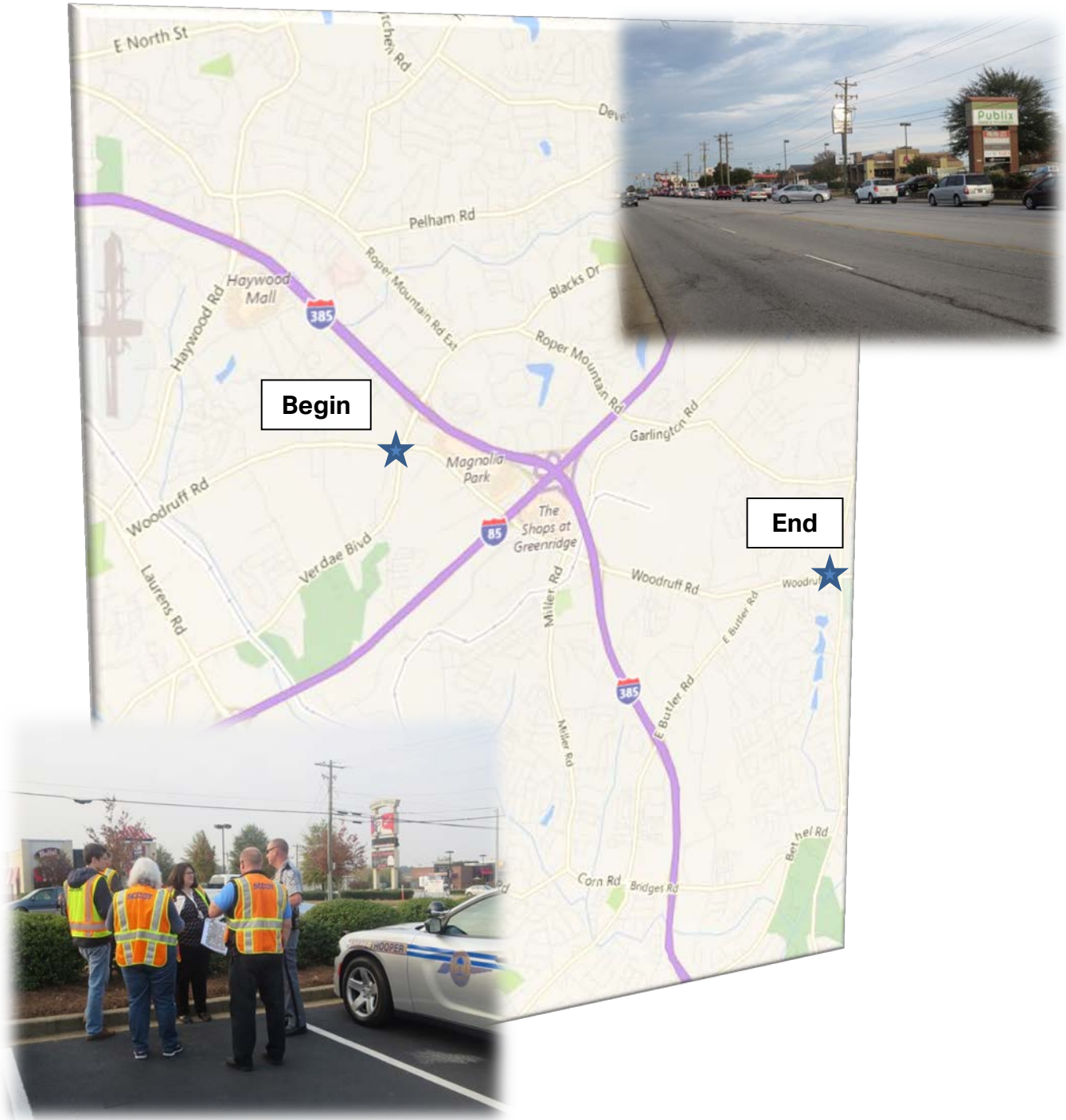


Road Safety Assessment Greenville County, South Carolina SC 146 (Woodruff Rd) from MP 1.9 to 5.0



August 2017
AECOM Technical Services, Inc.
10 Patewood Drive, Building VI, Suite 500, Greenville, SC 29615

TABLE OF CONTENTS

	<u>Page</u>
1.0 INTRODUCTION.....	1
1.1 BACKGROUND.....	1
1.2 OBJECTIVE	2
1.3 ROAD SAFETY ASSESSMENT TEAM SUMMARY	2
2.0 RELEVANT DATA REVIEW.....	3
2.1 SITE CHARACTERISTICS.....	3
2.2 CRASH DATA	4
2.3 VOLUME DATA.....	5
2.4 RECENT & PLANNED IMPROVEMENTS	5
3.0 FINDINGS AND RECOMMENDATIONS.....	6
3.1 POSITIVE MEASURES.....	6
3.2 CONSIDERATIONS	12
3.2.1 SC 146 & Roper Mountain Rd (S-153) / Verdae Blvd.....	12
3.2.2 SC 146 & Woodruff Industrial Ln / Magnolia Park	13
3.2.3 SC 146 & I-85 SB Ramps	14
3.2.4 SC 146 & Carolina Point Pkwy	15
3.2.5 SC 146 & Market Point Dr	16
3.2.6 SC 146 & Miller Rd (S-564) / Garlington Rd (S-564)	17
3.2.7 SC 146 & I-385 Ramps.....	18
3.2.8 SC 146 & Sam's Club Driveway	19
3.2.9 SC 146 & Merovan Center / Applebee's.....	21
3.2.10 SC 146 & Chick-Fil-A Driveway	23
3.2.11 SC 146 & Smith Hines Rd	24
3.2.12 SC 146 & Hendrix Dr / Wal-Mart.....	25
3.2.13 SC 146 & Spinx Gas Station near Tanner Rd (S-655)	26
3.2.14 SC 146 & Verdin Rd (S-333) / Feaster Rd (S-333).....	27
3.2.15 SC 146 & Publix Driveway.....	29
3.2.16 SC 146 & E Butler Rd (S-107)	30
3.2.17 SC 146 & Bagwell Rd (S-654)	32
4.0 SUMMARY OF COSTS	33

TABLES

TABLE 1: TRAFFIC SIGNAL FINDINGS AND CONSIDERATIONS (CORRIDOR WIDE).....	8
TABLE 2: ACCESS MANAGEMENT FINDINGS AND CONSIDERATIONS.....	9
TABLE 3: SIGNS & PAVEMENTS MARKINGS FINDINGS AND CONSIDERATIONS	10
TABLE 4: PEDESTRIAN FINDINGS AND CONSIDERATIONS.....	11
TABLE 5: SHORT TERM IMPROVEMENT COSTS	35
TABLE 6: MID TERM IMPROVEMENT COSTS	36
TABLE 7: LONG TERM IMPROVEMENT COSTS.....	37
TABLE 8: IMPROVEMENT COSTS SUMMARY TABLE	38

FIGURES

FIGURE 1: STUDY AREA	1
FIGURE 2: CRASHES BY TIME OF DAY	4
FIGURE 3: SCDOT AADT	5
FIGURE 4: OVERVIEW MAP OF SC 146 SEGMENTS	7

APPENDICES

APPENDIX A – RSA SUMMARY PACKET
APPENDIX B –TEAM MEETING SIGN IN SHEET
APPENDIX C – COLLISION DIAGRAMS
APPENDIX D –ADAPTIVE SIGNAL TIMING INFORMATION
APPENDIX E –PLANNED SC 146 ROADWAY IMPROVEMENTS FROM I-85 TO I-385

1.0 INTRODUCTION

1.1 BACKGROUND

SC 146 (Woodruff Road) is located in Greenville County, South Carolina. It is a 5-lane minor arterial that provides access to many commercial sites, residential developments, and provides access to two major interstates (I-85 and I-385). The portion of SC 146 that is being analyzed runs from mile post (MP) 1.9 to MP 5.0 or from just west of S-183 (Roper Mountain Road) / Verdae Boulevard to Paddock Club Drive. According to data provided by SCDOT, 2,325 crashes have been reported in this section of SC 146 from January 2010 to December 2014.



Figure 1 – General Cross Section of SC 146 (Woodruff Rd)

1.2 OBJECTIVE

The purpose of a road safety assessment is to examine the safety of a roadway by an independent, multi-disciplinary team. The team identifies areas of concern based on crash data analysis and observations in the field. After the field visit, the team categorizes potential areas of improvement along the study corridor.

1.3 ROAD SAFETY ASSESSMENT TEAM SUMMARY

The multidisciplinary team for the SC 146 (Woodruff Rd) Road Safety Assessment consisted of engineers from AECOM, SCDOT, and FHWA. Law enforcement representation consisted of SC Highway Patrol. The team and stakeholders met on Tuesday, November 8, 2016 and Wednesday, November 9, 2016.

RSA Team

1. **Joey Riddle** – SCDOT HQ Traffic
2. **Jana Potvin** – SCDOT HQ Traffic
3. **Eric Dillon** – SCDOT District 3 Traffic
4. **Dan Hinton** – FHWA
5. **Matt Johnson** – SC Highway Patrol
6. **Dwayne Tedder** – AECOM
7. **Ryan Eckenrode** – AECOM
8. **Emily Swearingen** – AECOM
9. **Jacob Nelson** – AECOM



The stakeholders consisted of additional representation from Metropolitan (MPO), Greenville-Pickens Area Transportation Study (GPATS), City of Greenville, Greenville County, and SCDOT.

Stakeholders

10. **Carol Jones** – SCDOT HQ Operations
11. **Emily Toler** – SCDOT HQ Traffic
12. **Tommy Elrod** - SCDOT
13. **Brandon Wilson** – SCDOT District 3 Maintenance
14. **Valerie Holmes** – City of Greenville Traffic
15. **Clint Link** – City of Greenville Engineering
16. **Kurt Walters** – Greenville County Transportation
17. **Keith Brockington** – Greenville County MPO (GPATS)
18. **Asangwua Ikein** – Greenville County MPO (GPATS)

2.0 RELEVANT DATA REVIEW

2.1 SITE CHARACTERISTICS

SC 146 (Woodruff Road) is an east/west minor arterial roadway that is used by different types of traffic such as commuter, commercial, residential, and school traffic. This roadway experiences high traffic volume during the peak hours and weekends, often resulting in delays and queuing. The roadway consists of five (5) lanes, two (2) in each direction and a center lane used as a median, turn lane, and two-way left-turn lane. There are multiple large shopping centers located in this area that generate a high volume of traffic entering and exiting these developments. There are 17 traffic signals located within the study area. These locations are listed below from west to east:

1. SC 146 (Woodruff Rd) & S-183 (Roper Mountain Rd) / Verdae Blvd
2. SC 146 (Woodruff Rd) & Ketron Ct / Costco Entrance
3. SC 146 (Woodruff Rd) & Green Heron Rd / Magnolia Park Main Entrance
4. SC 146 (Woodruff Rd) & Woodruff Industrial Ln / Magnolia Park
5. SC 146 (Woodruff Rd) & I-85 SB Off Ramp
6. SC 146 (Woodruff Rd) & I-85 NB Off Ramp
7. SC 146 (Woodruff Rd) & Carolina Point Pkwy
8. SC 146 (Woodruff Rd) & Market Point Dr
9. SC 146 (Woodruff Rd) & S-564 (Miller Rd / Garlington Rd)
10. SC 146 (Woodruff Rd) & I-385 SB Off Ramp
11. SC 146 (Woodruff Rd) & I-385 NB Off Ramp
12. SC 146 (Woodruff Rd) & Merovan Center / Applebee's
13. SC 146 (Woodruff Rd) & Smith Hines Rd
14. SC 146 (Woodruff Rd) & Hendrix Dr / Wal-Mart
15. SC 146 (Woodruff Rd) & S-333 (Verdin Rd / Feaster Rd)
16. SC 146 (Woodruff Rd) & S-107 (E Butler Rd)
17. SC 146 (Woodruff Rd) & Bell Rd

Two (2) major interstates have interchanges on SC 146 (Woodruff Rd). These are I-85 and I-385. There is one (1) active railroad crossing located between S-565 (Miller Rd) and the I-385 SB Ramps. Sidewalk is present from the I-85 NB ramps throughout the remainder of the study area heading east. There is no existing sidewalk to the west of the I-85 NB ramps.

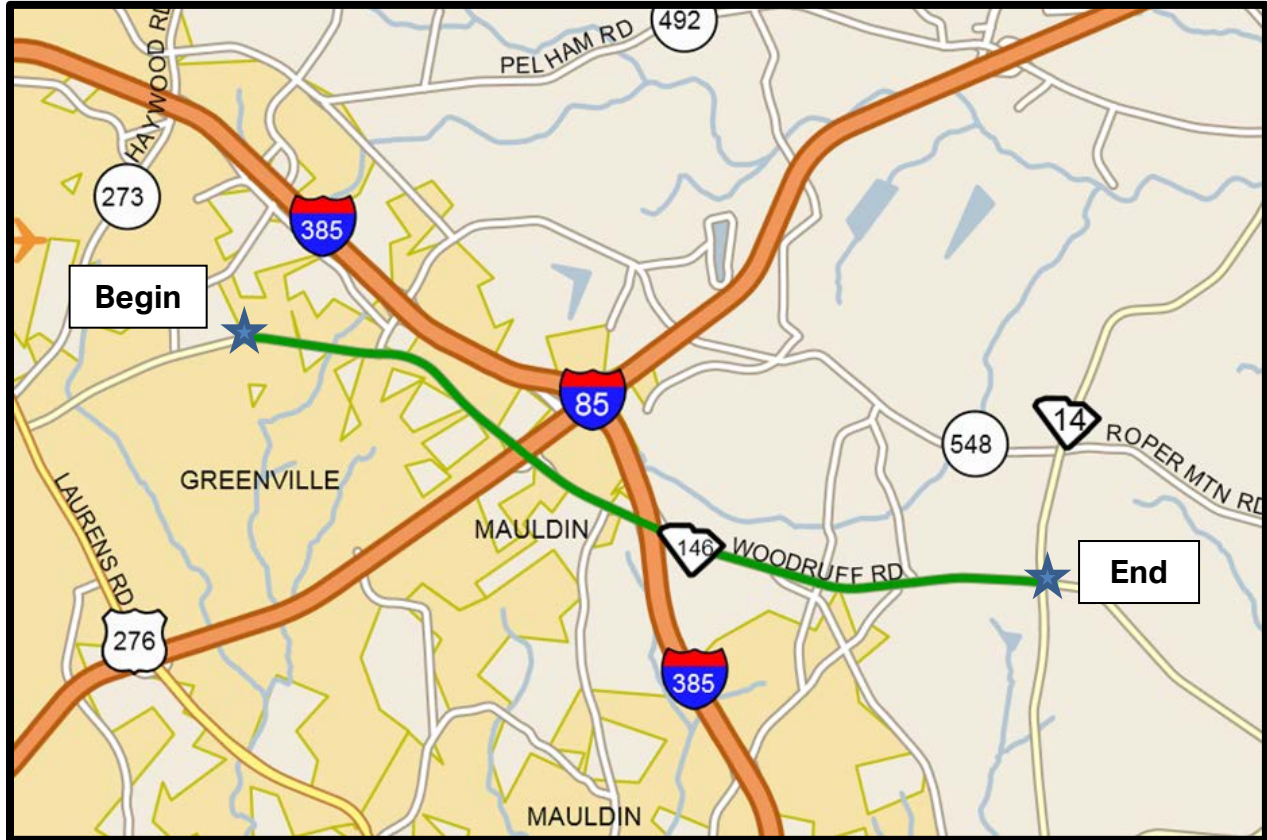


Figure 2 – Study Area – SC 146 (Woodruff Rd)

2.2 CRASH DATA

Crash data for this section of roadway was obtained by SCDOT over a five-year period from January 1, 2010 to December 31, 2014. There were 2,325 crashes along this corridor during this time period. Based on this data, the predominant type of crash was a rear end collision accounting for 1,302 crashes or 56% of all crashes. This was followed by angle crashes (807 crashes, 35%) and sideswipe crashes (138 crashes, 6%). Of the 2,325 crashes, 14% of them involved some type of injury. There was one (1) collision resulting in a fatality.

Crashes during the late night and early morning hours from 10 PM to 7 AM were low. A small rise in the crash number is seen from 7 AM to 9 AM likely due to increased volume on the corridor caused by school and commuter traffic. The lunch peak hour 11 AM to 1 PM had more crashes than the morning peak hour. The majority of crashes occur in the afternoon with the highest number between 4 PM and 5 PM. As discussed, this is most likely due to increased volume caused by commuter traffic. The other afternoon hours from 12 PM to 6 PM range from 212 crashes to 234 crashes. The number of collisions decline throughout the evening. Data indicates 83% of the crashes happen during the daylight hours.

The most prevalent crash type is non-injury or property damage only (indicated as 0) at 86% of crashes. This is followed by a possible injury (1) at 11% of crashes. The remaining crashes fall into the injury categories of non-incapacitating injury (2) at 3%, incapacitating injury (3) at <1%, and fatality (4) at <1%.

Fridays had the highest number of crashes by far with 486 crashes, 147 crashes higher than the next highest crash total. Monday through Saturday had significantly more crashes than Sundays. This road safety assessment was conducted in the month of November, which is the second highest month in regard to total crashes. The RSA field review was conducted on Wednesday, November 8, 2016 and Thursday, November 9, 2016. No speed study was conducted due to the number of signals and congested conditions equating to low speeds.

2.3 VOLUME DATA

Average annual daily traffic (AADT) data was collected over ten years from 2006 to 2015 using an SCDOT count station located within the limits of the study corridor. There was one station within the limits of the study area. Station 235 is located approximately halfway between S-107 (E Butler Rd) and S-333 (Verdin Rd / Feaster Rd). Figure 3 shows the historical AADT data based on information obtained from SCDOT.

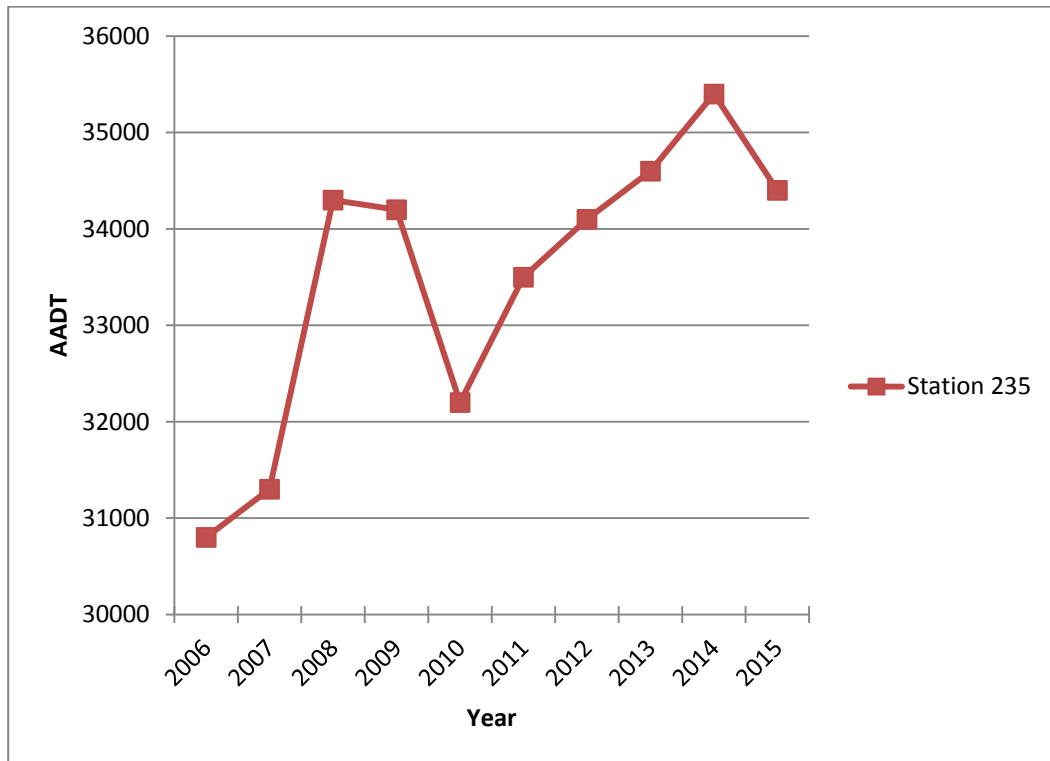


Figure 3 – SC 146 (Woodruff Rd) AADT Data (Source: SCDOT)

2.4 RECENT & PLANNED IMPROVEMENTS

SCDOT provided a list of traffic signals that are to be rebuilt and connected in a coordinated signal system. This system will employ the Synchro Green Traffic Adaptive Signal System as shown in Appendix D. A total of seven (7) signals will be rebuilt and seventeen (17) signals will be in the system. All signals will utilize stop bar detection and advanced detection where appropriate.

The RSA team also provided additional considerations for the planned I-85 / I-385 Improvement plans along SC 146 (Woodruff Road) as described below and shown in Appendix E.

- Install a concrete median on SC 146 (Woodruff Rd) that forces vehicles exiting the Shoppes at Greenridge (the new right-in / right-out unsignalized driveway) to the I-85 NB On Ramp
- Install overhead lane assignment signs on the Carolina Point Parkway approach to SC (Woodruff Road).
- Install a concrete median on SC 146 (Woodruff Rd) that extends from Market Point Drive to S-564 (Miller Rd / Garlington Rd)
- Install a concrete median on SC 146 (Woodruff Rd) that extends to S-564 (Miller Rd / Garlington Rd) to I-385 Off Ramp.

3.0 FINDINGS AND RECOMMENDATIONS

3.1 POSITIVE MEASURES

- The signal spacing between S-183 (Roper Mountain Rd) and I-85 is good.
- There is existing sidewalk from I-385 to S-107 (Butler Rd).
- Backplates are present on signals at some intersections as well as pedestrian countdown heads.
- Severity of crashes is low along the study corridor.

Below is a breakdown of locations with potential for improvement at each intersection. Improvements strategies were categorized into time frame and costs. Time frame is divided into Short-term (<1 year), Mid-term (1-3 years), and Long-term (>3 years). Costs are separated into three orders of magnitude. The cost categories include Low (maintenance staff assignments or low-cost improvements), Medium (Minor to moderate new construction), and High (significant new construction).

Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0

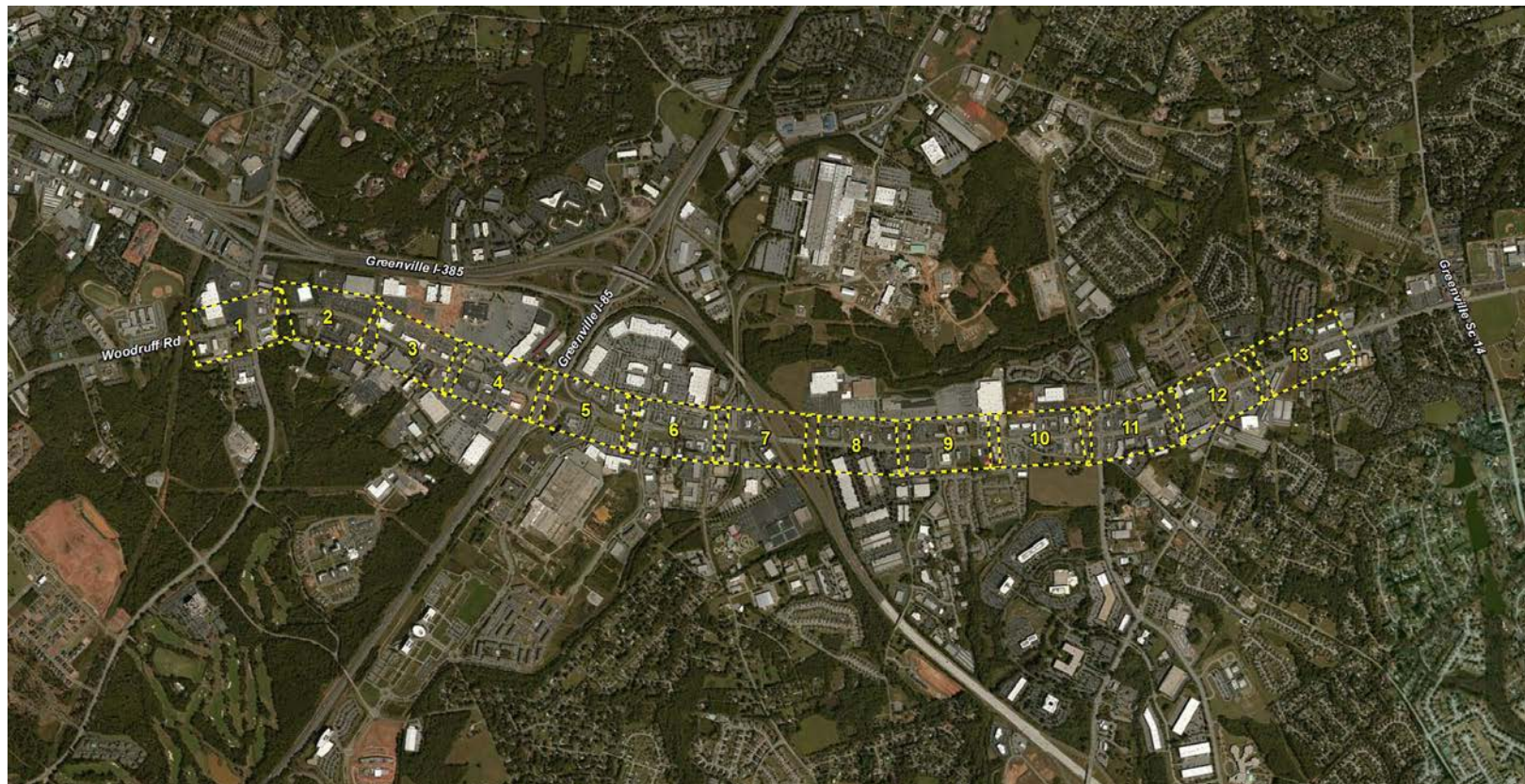


Figure 4 – Overview Map of SC 146 Segments

Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0

Findings	Examples	Improvements and Considerations
<p><u>Traffic Signals</u></p> <p>Not all intersections are fully equipped with backplates on each signal head. These include (# of backplates):</p> <ul style="list-style-type: none"> • SC 146 @ Merovan Center (8) • SC 146 @ Smith Hines Rd (6) • SC 146 @ Hendrix Dr (8) • SC 146 @ Butler Rd (10) <p>Some locations would benefit from the installation of a nearside signal head to become more visible to drivers:</p> <ul style="list-style-type: none"> • SC 146 @ Verdin Rd / Feaster Rd <p>Install flashing yellow arrow signal heads :</p> <ul style="list-style-type: none"> • SC 146 @ Merovan Center (4) • SC 146 @ Verdin / Feaster Rd (4) • SC 146 @ Butler Rd (2) 	 <p style="text-align: center;"><i>Some signals are not equipped with backplates.</i></p>  <p style="text-align: center;"><i>Install flashing yellow arrow signals where necessary.</i></p>	<p>Install backplates on signal heads. Anticipated cost: \$10,400</p> <p>Install nearside signal heads. Anticipated Cost: \$1,000</p> <p>Make use of flashing yellow arrow signals; add where needed. Anticipated Cost: Previously installed by SCDOT District 3</p>

Table 1 – Traffic Signal Findings and Considerations

Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0



Findings	Examples	Improvements and Considerations
<p><u>Access Management, Driveway Geometry, & Sight Distance</u></p> <p>Some locations have multiple full access driveways along SC 146 (Woodruff Rd).</p> <p>Medians would prevent left turns from some unsignalized side streets and driveways.</p> <p>Some locations have existing structures that impede sight distance.</p>	 <p><i>Implement a right-in / right-out turn on the Bagwell Rd approach of the intersection with SC 146 (Woodruff Rd).</i></p>  <p><i>The brick wall along Woodruff Rd at the western driveway of Publix do not provide adequate sight distance for drivers turning onto Woodruff Rd.</i></p>	<p>Construct new or extend existing concrete medians to restrict access to driveways especially near signals. (3,175 feet total) Anticipated Cost: \$232,750</p> <p>There would be approximately 16 total driveways affected by the addition of the proposed concrete medians along SC 146 (Woodruff Rd).</p> <p>Convert 3 access points to right- in/right-out access only. Anticipated Cost: \$9,150</p> <ul style="list-style-type: none"> • Chickfila Driveway (median also installed for \$57,000, cost included with medians) • Publix Driveway • Bagwell Rd

Table 2 – Access Management Findings and Considerations

Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0



Findings	Examples	Improvements and Considerations
<p><u>Signs & Pavement Markings</u></p> <p>Some locations need signs and markings to indicate turning movements. This includes “no left turn” signs and pavement markings such as “right turn only” and stop bars.</p> <p>Install overhead street name signs at all signalized intersections.</p> <p>Ensure visibility of all signs along the corridor.</p>	 <p><i>The driveway exiting the Sam’s Club development does not have a sign to indicate “no left turn”.</i></p>  <p><i>The exit from the development at the intersection of Woodruff Rd and Butler Rd lacks a painted stop bar (southbound intersection approach).</i></p>	<p>Install overhead street signs at all signalized intersections along SC 146 (Woodruff Rd). Anticipated Cost: \$17,000*</p> <p>Restripe stop bars, and provide pavement markings where necessary for entire corridor. Anticipated Cost: \$20,000*</p> <p>(*) – These costs were incorporated in the Long Term improvements table located on Page 60. The total is reflected in the row called “Corridor Wide Improvements.”</p>

Table 3 – Signs & Pavements Markings Findings and Considerations

Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0



Findings	Examples	Improvements and Considerations
<p><u>Pedestrian Accommodation</u></p> <p>Countdown pedestrian signals are not present at all signalized intersections with crosswalks.</p> <ul style="list-style-type: none"> • SC 146 at Verdae Blvd (8) • SC 146 at Merovan Center (8) • SC 146 at Smith Hines Rd (4) • SC 146 at Hendrix Dr (6) • SC 146 at Butler Rd (4) <p>Crosswalks are not present in all locations where pedestrian signals are installed.</p> <ul style="list-style-type: none"> • SC 146 at Verdae Blvd • SC 146 at Merovan Center • SC 146 at Verdin/Feaster <p>Not ADA compliant:</p> <ul style="list-style-type: none"> • SC 146 at Verdae Blvd • SC 146 at Sam's Entrance • SC 146 at Merovan Center • SC 146 at Smith Hines Rd • SC 146 at Hendrix Dr • SC 146 at Butler Rd 	 <p><i>The intersection of SC 146 with the Sam's Entrance does not have ADA compliant ramps. The photograph also shows sidewalk damage.</i></p>  <p><i>Example of damaged sidewalk along SC 146 (Woodruff Rd).</i></p>	<p>Install / Upgrade existing pedestrian signal heads to countdown pedestrian signals. Anticipated Cost: \$30,000</p> <p>Install new and restripe existing crosswalks where necessary. Assumed 17 intersections, 600 LF of 8" striping per intersection. Anticipated Cost: \$20,400*</p> <p>Upgrade all ramps and pedestrian accommodations to be ADA compliant. (30 ramps proposed in total, 25 SY per ramp) Anticipated Cost: \$112,500</p> <p>Additionally, there are some locations with damaged sidewalk that would be problematic for pedestrians. Assuming 400 LF of sidewalk to be replaced: Anticipated Cost: \$13,000*</p> <p>(*) – These costs were incorporated in the Long Term improvements table located on Page 60. The total is reflected in the row called "Corridor Wide Improvements."</p>

Table 4 – Pedestrian Findings and Considerations

3.2 CONSIDERATIONS

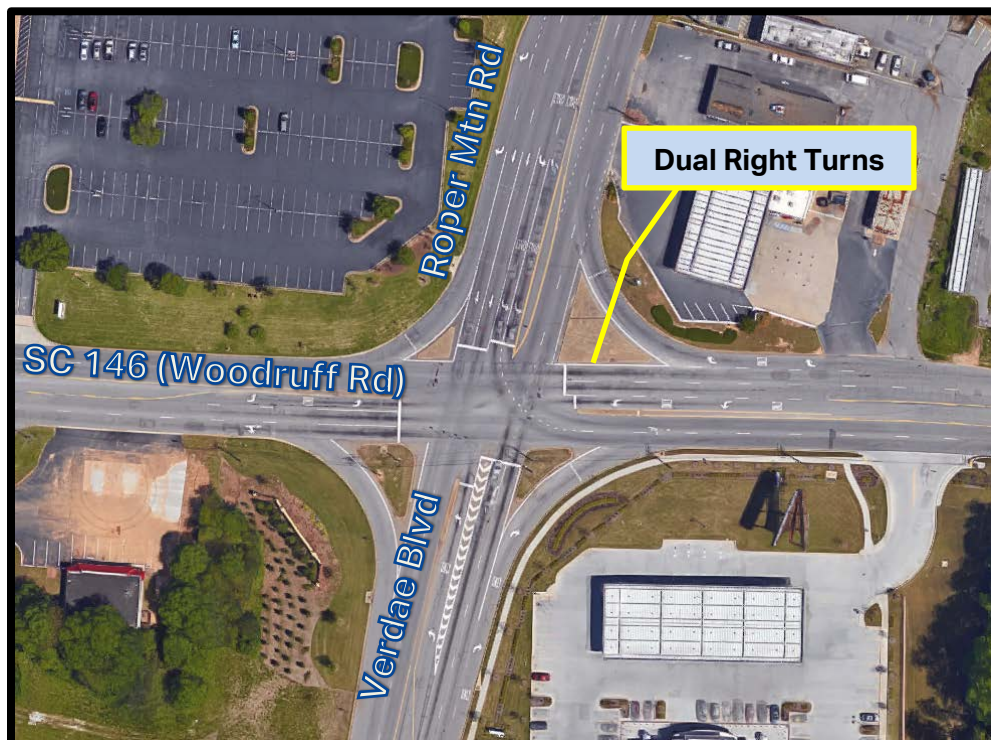
3.2.1 SC 146 & Roper Mountain Rd (S-153) / Verdae Blvd

Concerns

- There is a high volume of westbound right turns at this intersection.
- Sight distance and rear-end collisions with the channelized right turns.
- ADA and pedestrian accommodations are not present at this intersection.

Considerations

- **Mid Term** – Remove channelization and Install dual right turn lanes on westbound Woodruff Rd.
 - *Anticipated Cost to Implement: \$100,000*
- **Mid Term** – Make intersection ADA compliant with ramps and sidewalks.
 - *Anticipated Cost to Implement: \$48,750*
- **Mid Term** – Install pedestrian accommodations (countdown pedestrian heads, crosswalks)
 - *Anticipated Cost to Implement: \$10,000*
- **Long Term** – Bring all right turn lanes to stop bar and eliminate the yield condition.
 - *Anticipated Cost to Implement: \$150,000 for 3 approaches since WB approach is improved in previous consideration.*



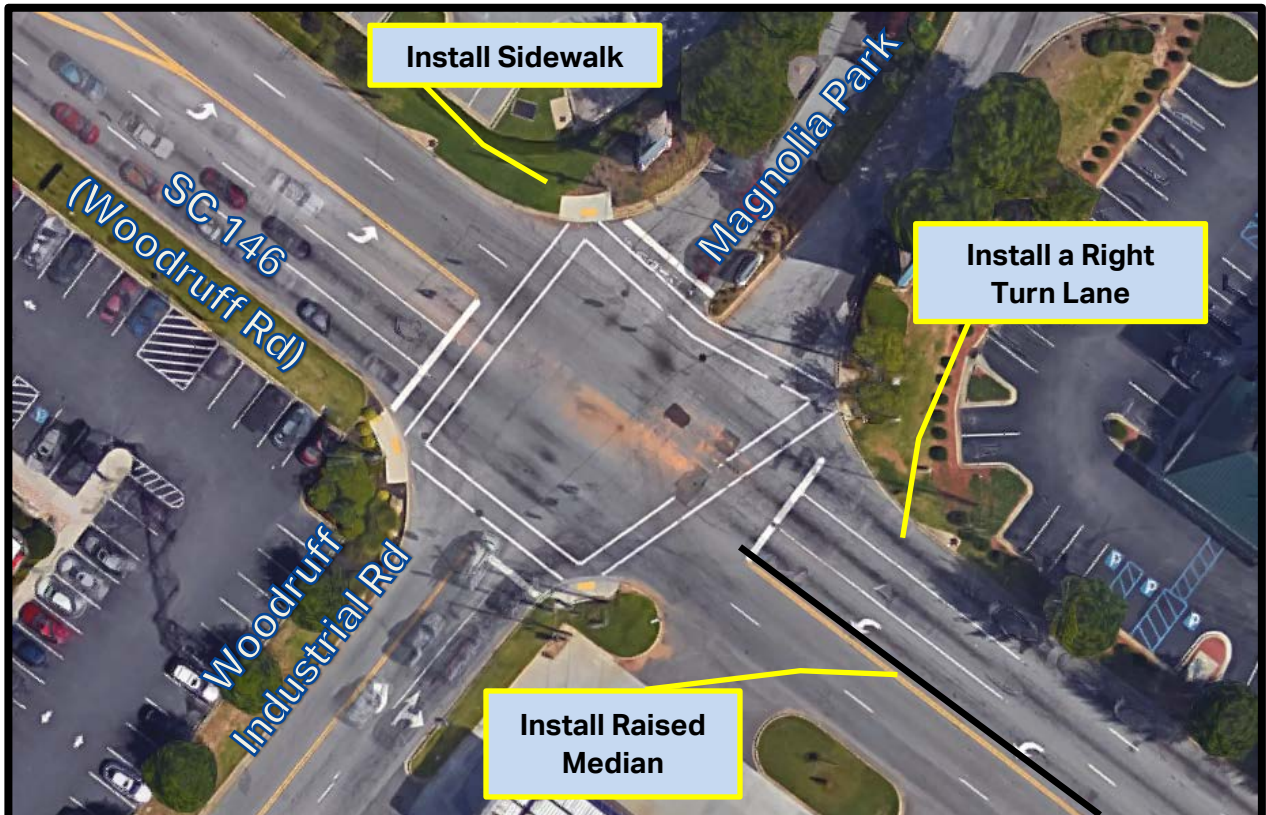
3.2.2 SC 146 & Woodruff Industrial Ln / Magnolia Park

Concerns

- There is a concentration of full access driveways east and west of the intersection and there were 251 angle crashes in segment 3 during the study period.
- There appears to be a path in the grass indicating pedestrian traffic.
- There is westbound queuing into Magnolia Park with queuing extending back to I-85.

Considerations

- **Mid Term** – A raised median on SC 146 (Woodruff Rd) from I-85 to Woodruff Industrial being installed as part of a future City of Greenville Project.
 - *Anticipated Cost to Implement: **To be implemented by SCDOT***
- **Mid Term** – Install a sidewalk on north side of road from Verdae Blvd / Roper Mountain Rd (S-153) to I-85.
 - *Anticipated Cost to Implement: **To be implemented by City of Greenville***
- **Long Term** – Install a right turn lane to accommodate the WB right turns into Magnolia Park.
 - *Anticipated Cost to Implement:*
 - **\$85,000 for construction; \$200,000 cost obtain area required to construct a new lane**



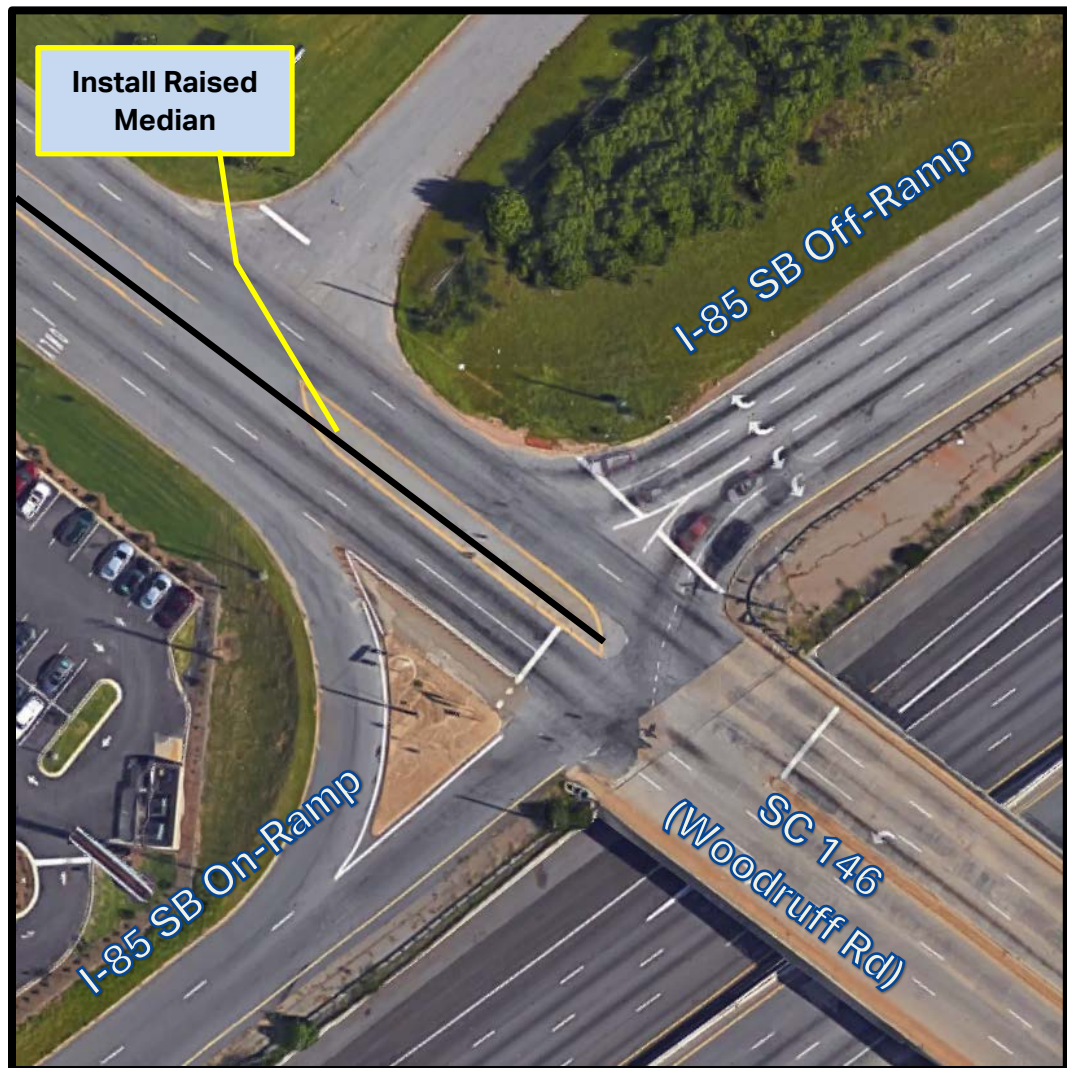
3.2.3 SC 146 & I-85 SB Ramps

Concerns

- There is a full access side road located less than 150' from the signalized intersection.
- There are no pedestrian accommodations at this intersection.

Considerations

- **Mid Term** – A raised median from I-85 being installed to Woodruff Industrial as part of a future City of Greenville Project.
 - *Anticipated Cost to Implement: **To be implemented by SCDOT***
- **Mid Term** – Make the location ADA compliant by installing 4 ramps on the northern side of the road (2 at Old Country Rd, 2 at I-85 SB Off-Ramp) as part of sidewalk.
 - *Anticipated Cost to Implement: **To be implemented by City of Greenville***



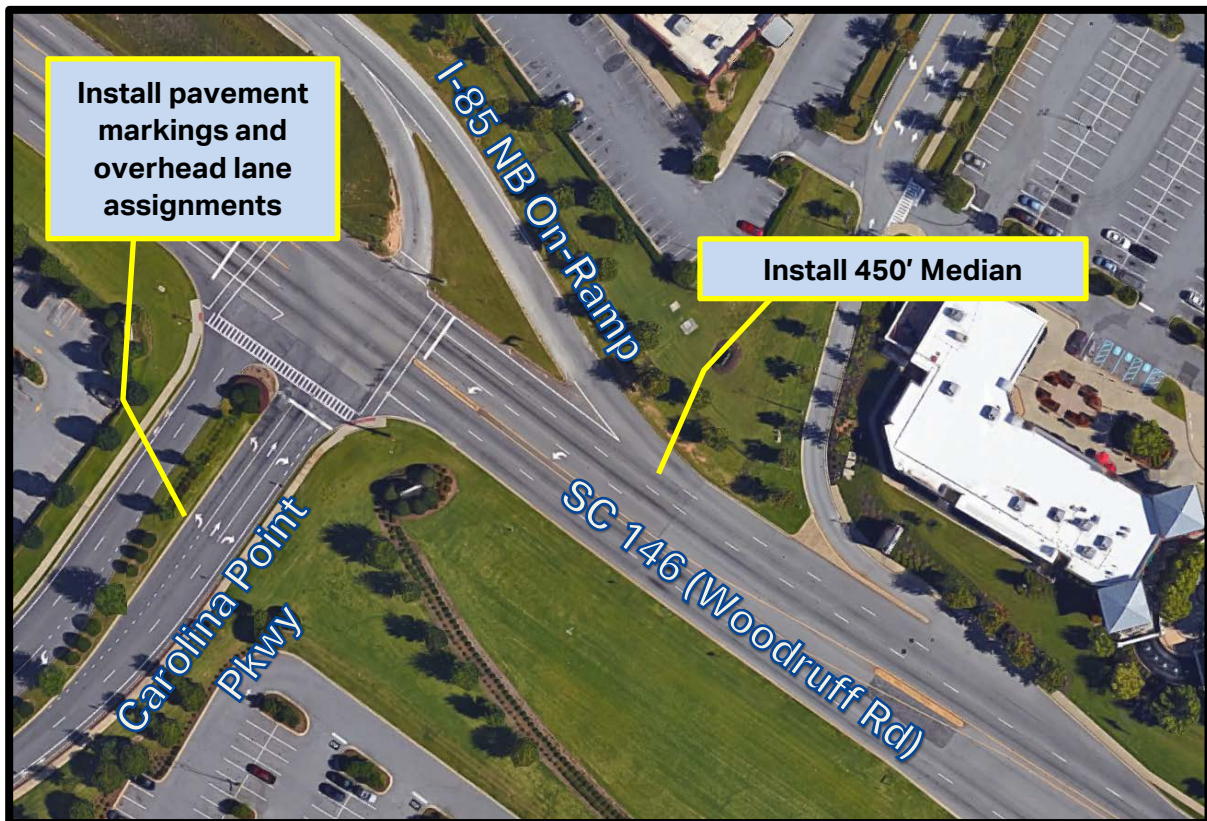
3.2.4 SC 146 & Carolina Point Pkwy

Concerns

- Weaving between the new driveway from the Shoppes of Greenridge and the new I-85 interchange ramp.
- Poor pavement markings for the turning movements onto Woodruff Road.
- Improved signage may be needed to guide vehicles to left and right turns on to Woodruff Rd and I-85 in advance of intersection.

Considerations

- **Short Term** – Install pavement markings on Carolina Point Pkwy approach.
 - *Anticipated Cost to Implement: \$500*
- **Short Term** – Install overhead lane assignment signs for Carolina Point Pkwy approach.
 - *Anticipated Cost to Implement: \$4,000*
- **Mid Term** – Install a 450' foot concrete median starting at the future I-85 on-ramp.
 - *Anticipated Cost to Implement: \$12,150 – see Appendix E.*



3.2.5 SC 146 & Market Point Dr

Concerns

- Queuing for the westbound left-turn lane on Woodruff Rd.

Considerations

- **Short Term** – Restripe and install dual left turns on WB approach. Review nose of median on Market Point Drive to ensure both turn lanes clear median.
 - *Anticipated Cost to Implement: \$3,000*



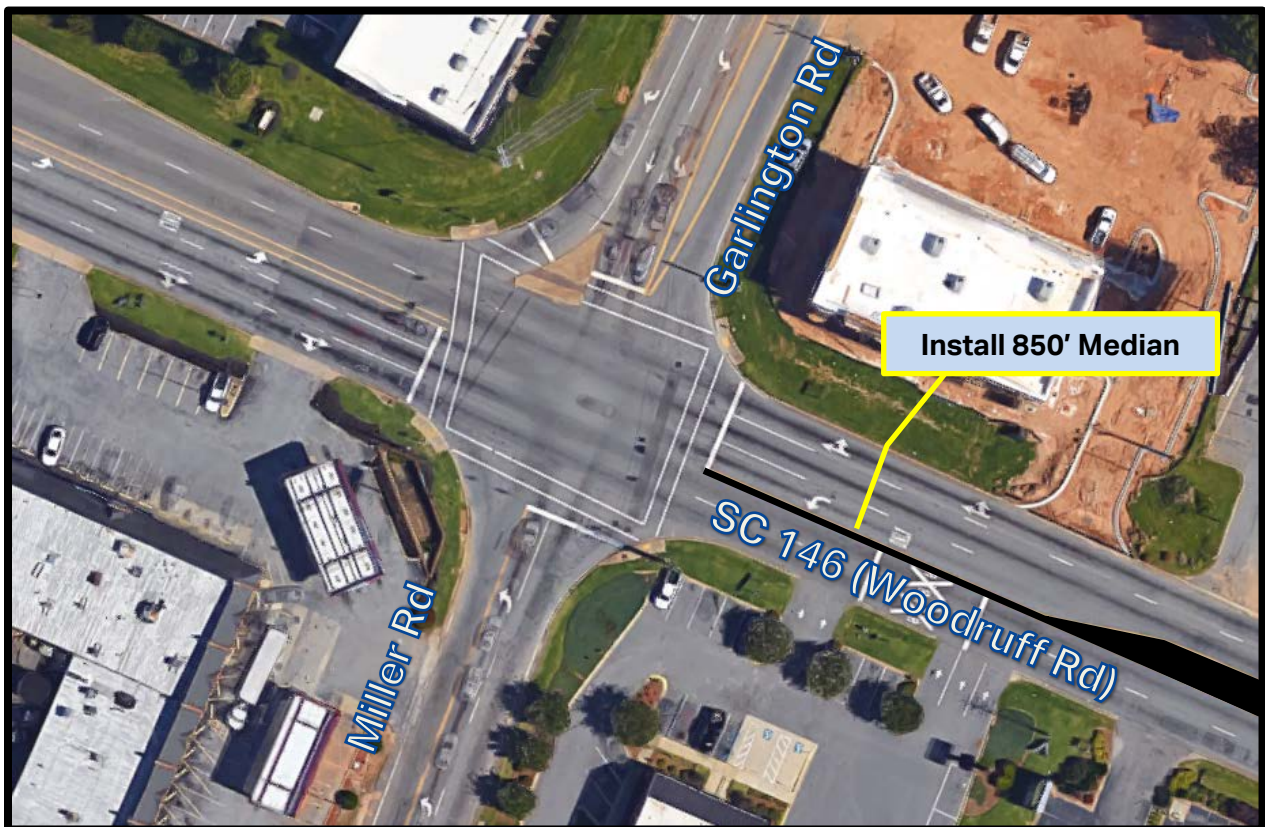
3.2.6 SC 146 & Miller Rd (S-564) / Garlington Rd (S-564)

Concerns

- There are full access driveways close to the intersection.
- Review storage for left turn lane on Woodruff Rd WB.

Considerations

- **Mid Term** – Install an 850 foot concrete median from Miller Rd /Garlington Rd to the I-385 Ramp intersection.
 - *Anticipated Cost to Implement: \$63,200 (See Appendix E)*



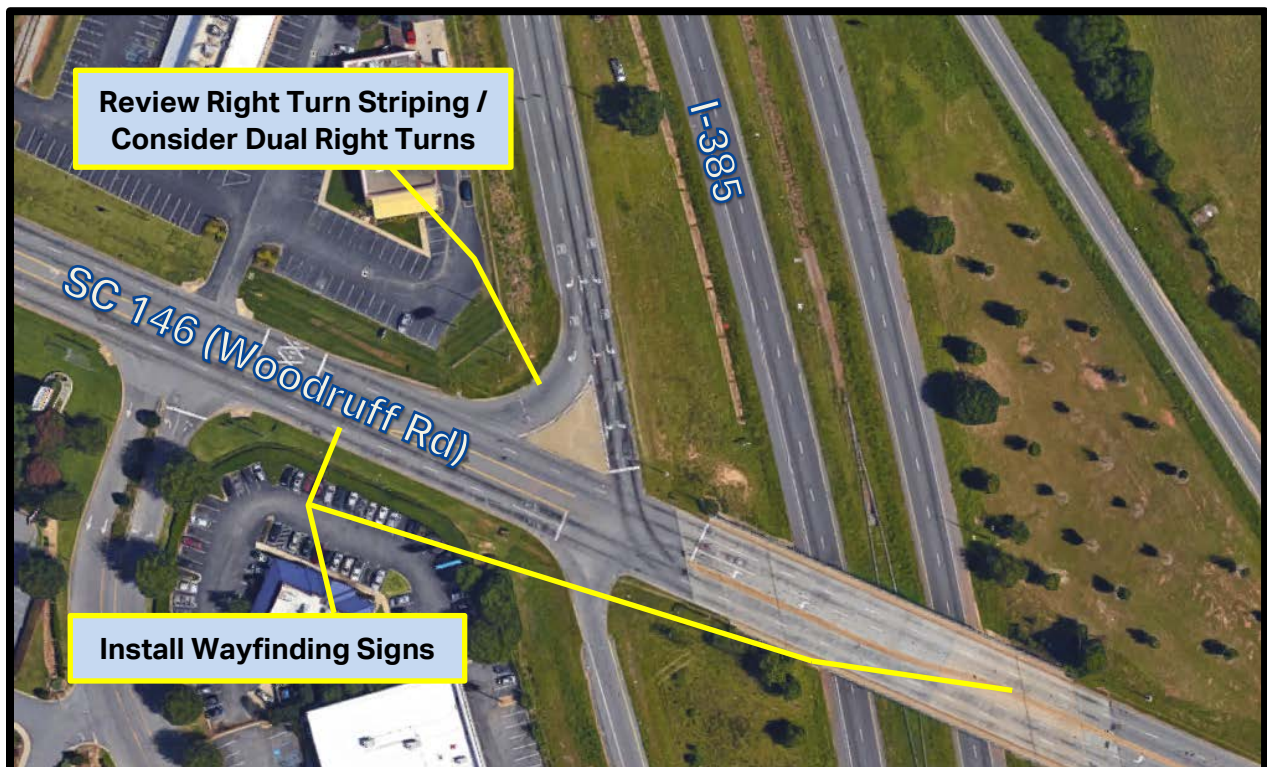
3.2.7 SC 146 & I-385 Ramps

Concerns

- I-385 SB off-ramp is very wide and causes some confusion for drivers.
- Long queues on Woodruff Road in advance of I-385
- Pavement striping is worn.

Considerations

- **Short Term** – Improve striping.
 - *Anticipated Cost to Implement: **To be implemented by SCDOT as part of I-85 / I-385 project***
- **Short Term** – Review right turn lane from I-385 onto Woodruff Road. Install additional striping to indicate to drivers that it is not a dual right turn.
 - *Anticipated Cost to Implement: **\$500***
- **Mid Term** – Install overhead lane use (wayfinding signs) in both direction along Woodruff Road prior to I-385.
 - *Anticipated Cost to Implement: **\$15,000***
- **Mid Term** – Consider dual right turn lanes off of I-385 SB off-ramp.
 - *Anticipated Cost to Implement: **\$75,000***



3.2.8 SC 146 & Sam's Club Driveway

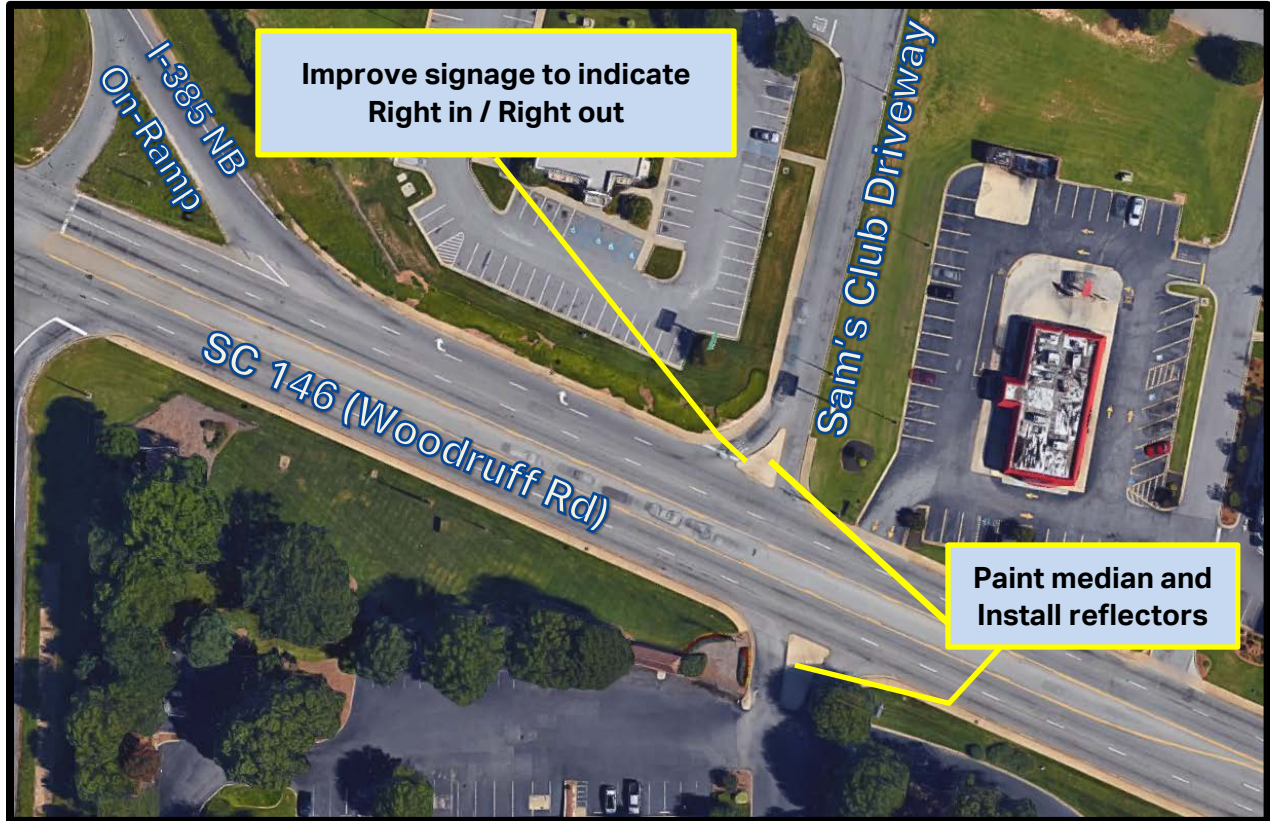
Concerns

- The median in the northern approach is unclear as to whether the driveway should be right in / right out only.
- No pedestrian accommodations to make the location ADA compliant.
- The radius on the right turns on the EB and WB approaches are small and requires drivers to reduce speed to enter safely.
- The raised medians on the NB and SB approaches have poor visibility.
- There is a WB weaving movement between Sam's Club Driveway and I-385 NB On - Ramp

Considerations

- **Short Term** – Improve signage at the Sam's driveway to indicate a right in / right out driveway only.
 - *Anticipated Cost to Implement: \$1,250*
- **Short Term** – Install “No Left Turn” signs on the NB and SB approaches.
 - *Anticipated Cost to Implement: \$500*
- **Short Term** – Install reflectors and paint the base of the medians located on the NB and SB approaches.
 - *Anticipated Cost to Implement: \$500*
- **Mid Term** – Make the location ADA compliant.
 - *Anticipated Cost to Implement: \$30,000*
- **Mid Term** – Provide larger radius for right turns from Woodruff into development.
 - *Anticipated Cost to Implement: \$2,750*
- **Long Term** – As traffic volumes increase, consider closing Sam's Club Driveway to remove weaving movement.
 - *Anticipated Cost to Implement: \$50,000*

Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0



3.2.9 SC 146 & Merovan Center / Applebee's

Concerns

- There are no pedestrian signals present at this intersection but existing crosswalks are present.
- The ramps at this intersection are not ADA compliant.
- Signal heads do not have backplates (8).
- It would be beneficial to implement flashing yellow arrows signals at this intersection.
- Crosswalks need to be repainted.
- The base of the existing median needs to be repainted to increase visibility.
- The median in the driveway on the northern leg should be extended closer to the intersection in order to block the left turns into the businesses located close to the intersection.

Considerations

- **Short Term** – Install countdown pedestrian signals (8).
 - *Anticipated Cost to Implement: \$8,000*
- **Short Term** – Implement Flashing Yellow Arrow signals on all approaches.
 - *Anticipated Cost to Implement: Installed by SCDOT District 3*
- **Short Term** – Install 8 backplates on existing signal heads.
 - *Anticipated Cost to Implement: \$2,600*
- **Short Term** – Restripe all crosswalks.
 - *Anticipated Cost to Implement: \$1,900*
- **Short Term** – Restripe the base of the existing median.
 - *Anticipated Cost to Implement: \$250*
- **Mid Term** – Make intersection ADA compliant. Install 4 ramps with detectable warning surface.
 - *Anticipated Cost to Implement: \$15,000*
- **Mid Term** – Extend the median by 75 feet on the northern leg to the stop of the intersection.
 - *Anticipated Cost to Implement: \$6,500*

Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0



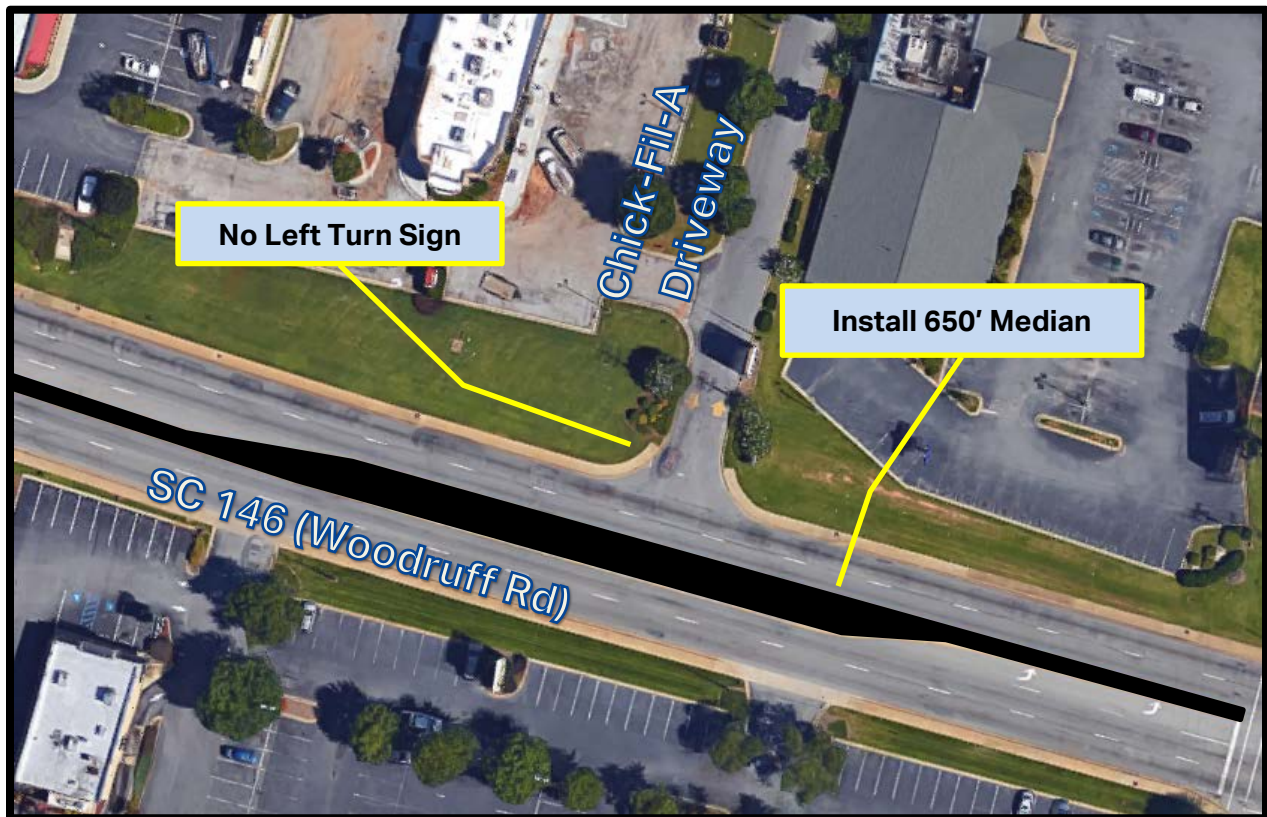
3.2.10 SC 146 & Chick-Fil-A Driveway

Concerns

- Left turns out of the Chick-Fil-A Driveway cause delays for those leaving the development and may contribute to the angle crashes.
- There are many angle crashes coming from the side road accessing Chick-Fil-A.

Considerations

- **Short Term** – Install no left turn sign on road coming from Chick-Fil-A.
 - *Anticipated Cost to Implement: \$150*
- **Mid Term** – Install 650-foot median on Woodruff road extending from the Merovan Center intersection to Smith Hines Rd to restrict left turns entering and exiting the Chick-Fil-A driveway.
 - *Anticipated Cost to Implement: \$57,000*



3.2.11 SC 146 & Smith Hines Rd

Concerns

- No backplates present on signal heads (6).
- No pedestrian signals present.
- The intersection is not ADA compliant.

Considerations

- **Short Term** – Install backplates on signal heads (6).
 - Anticipated Cost to Implement: **\$1,950**
- **Short Term** – Install countdown pedestrian signals.
 - Anticipated Cost to Implement: **\$4,000**
- **Mid Term** – Make intersection ADA compliant.
 - Anticipated Cost to Implement: **\$11,250**



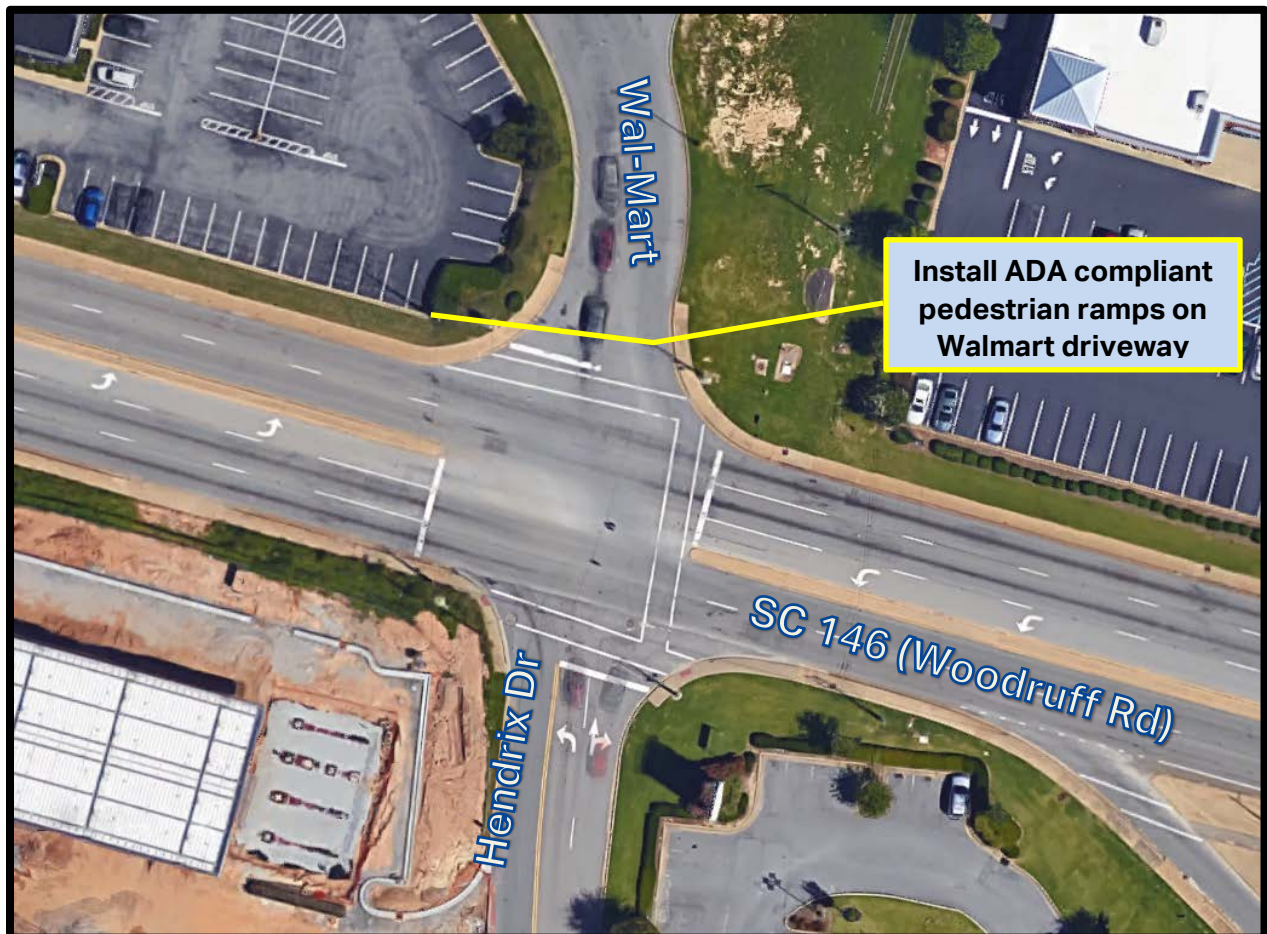
3.2.12 SC 146 & Hendrix Dr / Wal-Mart

Concerns

- No backplates are present on signal heads (8).
- Ramps on northern side of roadway are not ADA compliant.

Considerations

- **Short Term** – Install backplates on signal heads (8).
 - *Anticipated Cost to Implement: \$2,600*
- **Short Term** – Install countdown pedestrian signals (6).
 - *Anticipated Cost to Implement: \$6,000*
- **Mid Term** – Make intersection ADA compliant.
 - *Anticipated Cost to Implement: \$7,500*



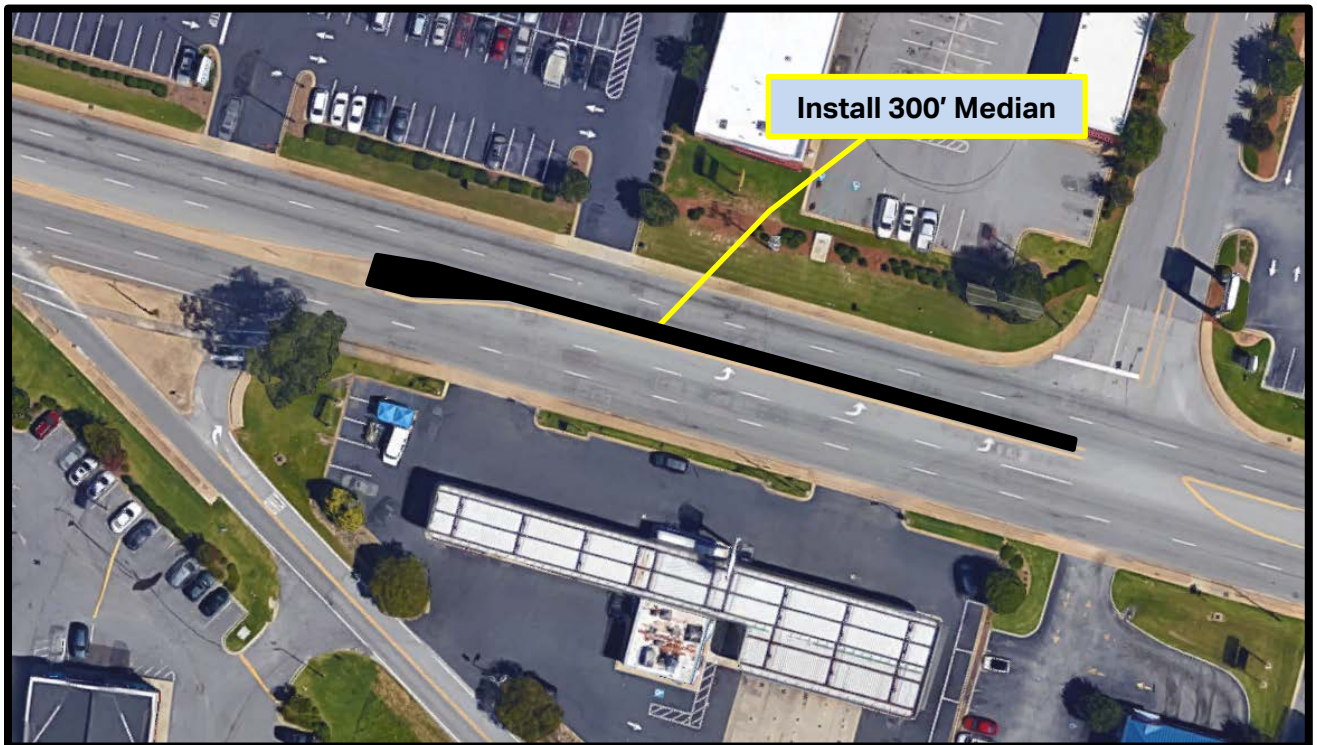
3.2.13 SC 146 & Spinx Gas Station near Tanner Rd (S-655)

Concerns

- The Spinx has two full access driveways on SC 146 (Woodruff Rd).

Considerations

- **Mid Term** – Extend the existing median that begins at Hendrix Dr by 300 feet to block the left turns in and out of the Spinx Gas station.
 - *Anticipated Cost to Implement: \$18,650*



3.2.14 SC 146 & Verdin Rd (S-333) / Feaster Rd (S-333)

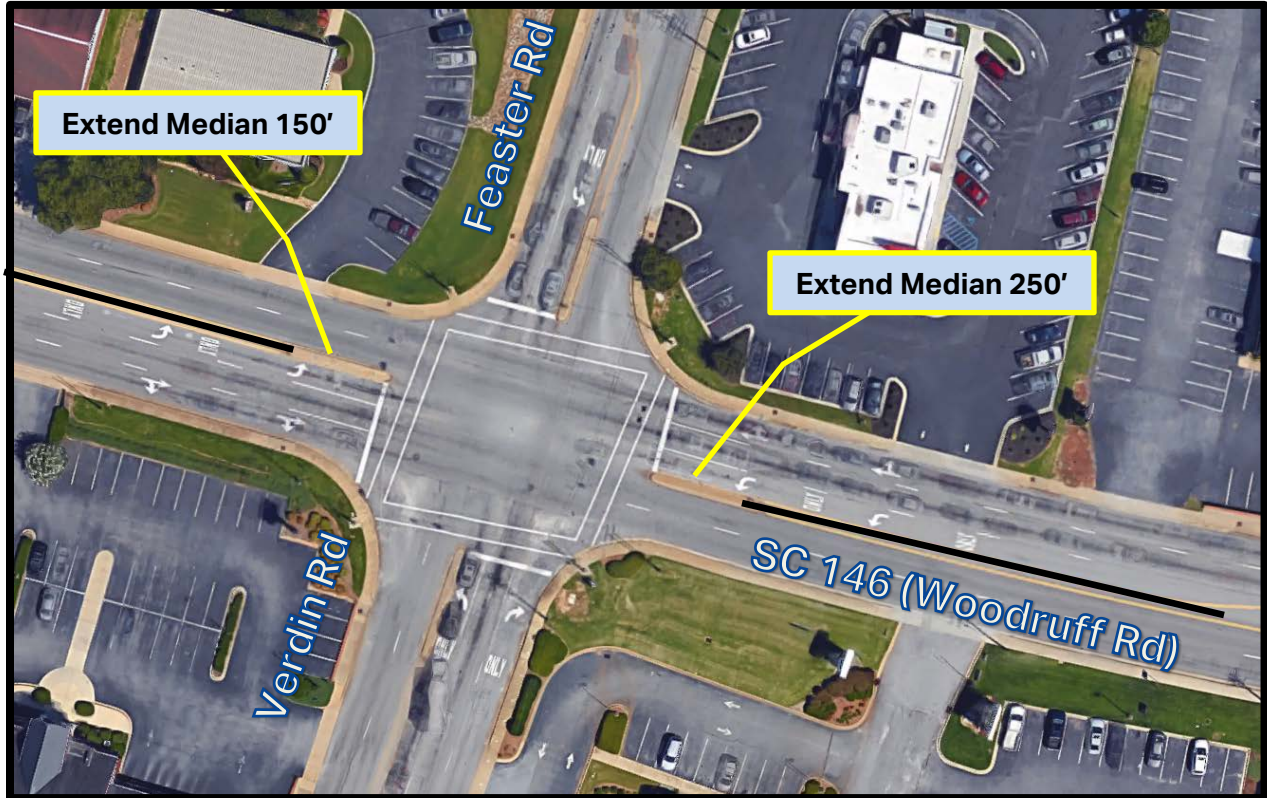
Concerns

- Signal sight distance is poor for the westbound Woodruff Rd approach.
- Crosswalks are faded.
- The visibility of the left turning vehicles onto SC 146 (Woodruff Rd) is limited due to the slight negative offset of the left turn lanes.
- There are unsignalized driveways before the signalized intersection for which the left turn lanes are used.

Considerations

- **Short Term** – Install a nearside signal head on the WB approach of SC 146 (Woodruff Rd).
 - *Anticipated Cost to Implement: \$1,000*
- **Short Term** – Implement Flashing Yellow Arrows on all approaches at this intersection.
 - *Anticipated Cost to Implement: Installed by SCDOT District 3*
- **Short Term** – Restripe all crosswalks.
 - *Anticipated Cost to Implement: \$600*
- **Mid Term** – Extend the concrete medians on SC 146 (Woodruff Rd) through the storage in the left turn lanes to make the vehicles turning left into the surrounding businesses utilize Verdin Rd and Feaster Rd. Extend the EB leg by 150 feet and extend the WB leg by 250 feet.
 - *Anticipated Cost to Implement: \$20,250*
- **Mid Term** – Realign left-turn lanes on the minor street approach by restriping shifting medians to create a positive offset.
 - *Anticipated Cost to Implement: \$7,500*

Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0



3.2.15 SC 146 & Publix Driveway

Concerns

- There are many points of conflict for vehicles utilizing the TWLTL along this segment of roadway in front of the Publix.
- Sight distance is poor from Publix driveway.

Considerations

- **Short Term** – Clear the vegetation from the sidewalk / roadway so that any existing vegetation does not interfere with visibility for vehicles.
 - *Anticipated Cost to Implement: \$5,000*
- **Short Term** – Install a sign prohibiting left-turns from Publix driveway.
 - *Anticipated Cost to Implement: \$500*
- **Mid Term** – Extend the median 150 feet from the Children's Care Center to Aldi and create a R-cut configuration into the Aldi driveway. This will restrict left turn movements entering and exiting Aldi and Publix.
 - *Anticipated Cost to Implement: \$40,000*



3.2.16 SC 146 & E Butler Rd (S-107)

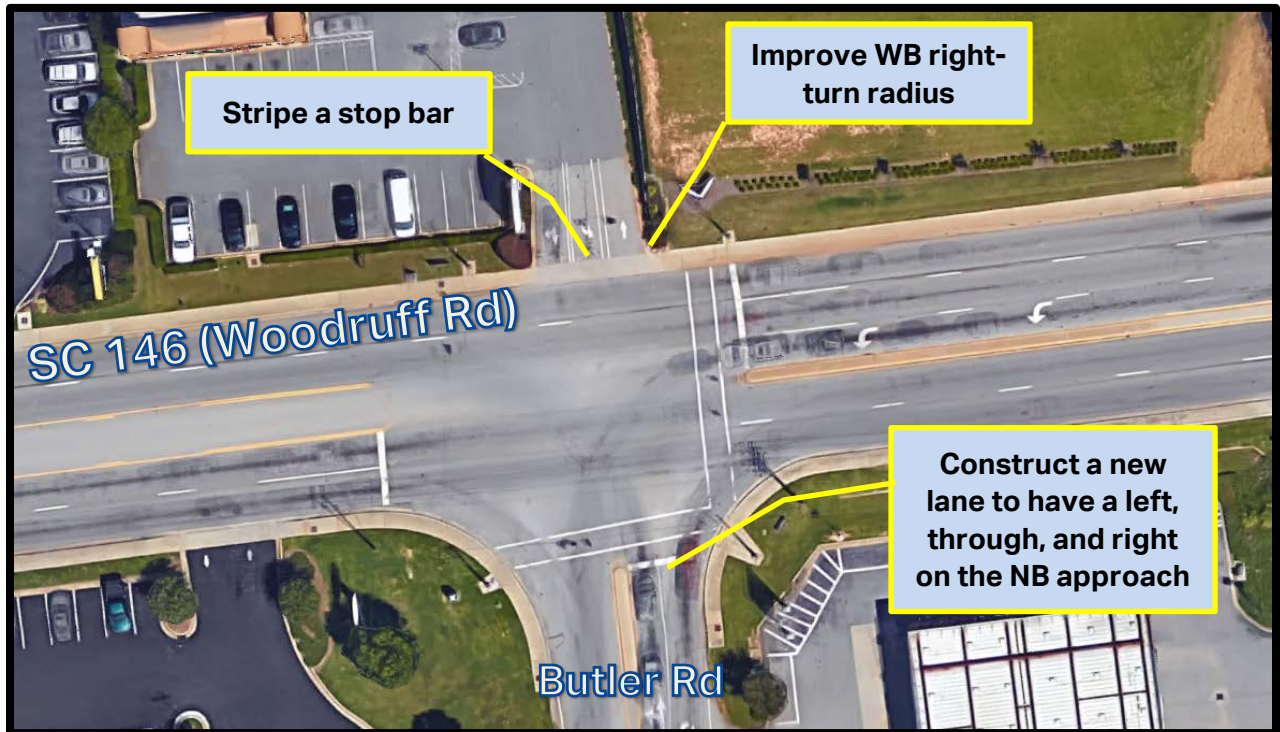
Concerns

- There are no pedestrian signals present at this intersection.
- There are no pedestrian ramps on the northern side of SC 146 (Woodruff Rd).
- There are no object markers on the median on the NB (Butler Rd) approach.
- There are no backplates on the existing signals.
- There is no stop bar on the SB approach.
- The intersection would benefit from implementation of flashing yellow arrow signals.
- Review the left turn lengths for the intersection clearance timings.
- Consider split phasing for the NB and SB approaches.
- The radius for the WB right turn into the development is very tight and requires vehicles to slow down before making a right turn.

Considerations

- **Short Term** – Install countdown pedestrian signals (4).
 - *Anticipated Cost to Implement: \$4,000*
- **Short Term** – Install object markers on the median of the Butler Rd approach.
 - *Anticipated Cost to Implement: \$800*
- **Short Term** – Install backplates on signals (10).
 - *Anticipated Cost to Implement: \$3,250*
- **Short Term** – Install a stop bar on the southbound approach.
 - *Anticipated Cost to Implement: \$300*
- **Short Term** – Implement split phasing for NB and SB approaches.
 - *Anticipated Cost to Implement: \$1,450*
- **Short Term** – Implement flashing yellow arrow signals along Woodruff Road.
 - *Anticipated Cost to Implement: Installed by SCDOT District 3*
- **Mid Term** – Make the intersection ADA compliant.
 - *Anticipated Cost to Implement: \$10,000*
- **Mid Term** – Implement a larger radius for WB right turns into the development.
 - *Anticipated Cost to Implement: \$3,000*
- **Long Term** – Make the NB (Butler Rd) approach a left / through / right.
 - *Anticipated Cost to Implement: \$75,000*

Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0



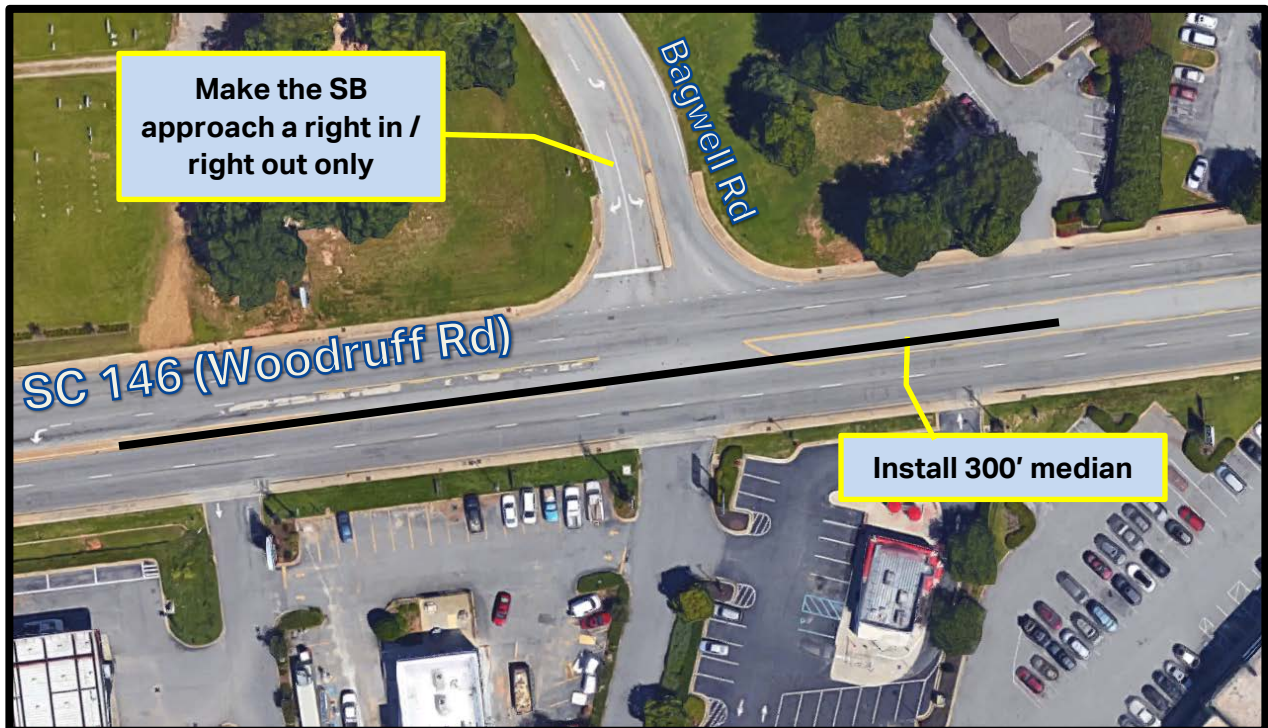
3.2.17 SC 146 & Bagwell Rd (S-654)

Concerns

- Update all pavement markings at this intersection.
- Queuing from adjacent signal blocking intersection.
- There is significant sediment build up and debris in the gutters.

Considerations

- **Short Term** – Update pavement markings (left turn arrows & right turn arrows)
 - *Anticipated Cost to Implement: \$500*
- **Short Term** – Limit Bagwell Rd to right turns out only using a concrete median channelization.
 - *Anticipated Cost to Implement: \$8,500*
- **Short Term** – Clean sediment and debris from sidewalk, gutters, and roadway.
 - *Anticipated Cost to Implement: \$5,000*
- **Mid Term** – Install a 300 foot concrete median extending in front of Bagwell Rd.
 - *Anticipated Cost to Implement: \$15,000*



4.0 SUMMARY OF COSTS

To help prioritize the improvements, cost summaries are provided at each intersection categorized into low, medium, and high. Low magnitude improvements are expected to be performed by maintenance staff or be of low cost. Medium improvements may include minor to moderate new construction and High improvements are those that would require significant new construction.

1 - SC 146 & Roper Mountain Rd (S-153) / Verdae Blvd

- **Medium – \$158,750**
- **High – \$150,000**
- Total: \$308,750**

2 - SC 146 & Woodruff Industrial Ln / Magnolia Park

- **High – \$285,000**
- Total: \$285,000**

3 - SC 146 & I-85 SB Ramps

Total: \$0

4 - SC 146 & Carolina Point Pkwy

- **Low – \$4,500**
- **Medium – \$12,150**
- Total: \$16,650**

5 - SC 146 & Market Point Dr

- **Low – \$3,000**
- Total: \$3,000**

6 - SC 146 & Miller Rd (S-564) / Garlington Rd (S-564)

- **Medium – \$63,200**
- Total: \$63,200**

7 - SC 146 & I-385 Ramps

- **Low – \$500**
- **Medium – \$15,000**
- **High – \$75,000**
- Total: \$90,500**

8 - SC 146 & Sam's Club Driveway

- **Low – \$2,250**
- **Medium – \$32,750**
- **High – \$50,000**
- Total: \$85,000**

**Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0**

9 – SC 146 & Merovan Center / Applebee's

- **Low – \$12,750**
- **Medium – \$21,500**
- Total: \$34,250**

10 - SC 146 & Chick-Fil-A Driveway

- **Low – \$150**
- **Medium – \$57,000**
- Total: \$57,150**

11 - SC 146 & Smith Hines Rd

- **Low – \$5,950**
- **Medium – \$11,250**
- Total: \$17,200**

12 - SC 146 & Hendrix Dr / Wal-Mart

- **Low – \$8,600**
- **Medium – \$7,500**
- Total: \$16,100**

13 - SC 146 & Spinx Gas Station near Tanner Rd (S-655)

- **Medium – \$18,650**
- Total: \$18,650**

14 - SC 146 & Verdin Rd (S-333) / Feaster Rd (S-333)

- **Low – \$1,600**
- **Medium – \$27,750**
- Total: \$29,350**

15 - SC 146 & Publix Driveway

- **Low – \$5,500**
- **Medium – \$40,000**
- Total: \$45,500**

16 - SC 146 & E Butler Rd (S-107)

- **Low – \$9,800**
- **Medium – \$13,000**
- **High – \$75,000**
- Total: \$97,800**

17 - SC 146 & Bagwell Rd (S-654)

- **Low – \$14,000**
- **Medium – \$15,000**
- Total: \$29,000**

Corridor Wide Improvements

Total: \$70,400

**Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0**

#: Primary Intersection	Costs
1: SC 146 & Roper Mountain Rd (S-153) / Verdae Blvd	\$0
2: SC 146 & Woodruff Industrial Ln / Magnolia Park	\$0
3: SC 146 & I-85 SB Ramps	\$0
4: SC 146 & Carolina Point Pkwy	\$4,500
5: SC 146 & Market Point Dr	\$3,000
6: SC 146 & Miller Rd (S-564) / Garlington Rd (S-564)	\$0
7: SC 146 & I-385 Ramps	\$500
8: SC 146 & Sam's Club Driveway	\$2,250
9: SC 146 & Merovan Center / Applebee's	\$12,750
10: SC 146 & Chick-Fil-A Driveway	\$150
11: SC 146 & Smith Hines Rd	\$5,950
12: SC 146 & Hendrix Dr / Wal-Mart	\$8,600
13: SC 146 & Spinx Gas Station near Tanner Rd (S-655)	\$0
14: SC 146 & Verdin Rd (S-333) / Feaster Rd (S-333)	\$1,600
15: SC 146 & Publix Driveway	\$5,500
16: SC 146 & E Butler Rd (S-107)	\$9,800
17: SC 146 & Bagwell Rd (S-654)	\$14,000
Subtotal	\$68,600
Mobilization, Bonds, Insurance, Traffic Control , etc. at 30%	\$20,580
Subtotal	\$89,180
Contingencies at 20%	\$17,836
Total	\$107,016

Table 5 – Short Term Improvement Costs

**Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0**

#: Primary Intersection	Costs
1: SC 146 & Roper Mountain Rd (S-153) / Verdae Blvd	\$158,750
2: SC 146 & Woodruff Industrial Ln / Magnolia Park	\$0
3: SC 146 & I-85 SB Ramps	\$0
4: SC 146 & Carolina Point Pkwy	\$12,150
5: SC 146 & Market Point Dr	\$0
6: SC 146 & Miller Rd (S-564) / Garlington Rd (S-564)	\$63,200
7: SC 146 & I-385 Ramps	\$15,000
8: SC 146 & Sam's Club Driveway	\$32,750
9: SC 146 & Merovan Center / Applebee's	\$21,500
10: SC 146 & Chick-Fil-A Driveway	\$57,000
11: SC 146 & Smith Hines Rd	\$11,250
12: SC 146 & Hendrix Dr / Wal-Mart	\$7,500
13: SC 146 & Spinx Gas Station near Tanner Rd (S-655)	\$18,650
14: SC 146 & Verdin Rd (S-333) / Feaster Rd (S-333)	\$27,750
15: SC 146 & Publix Driveway	\$40,000
16: SC 146 & E Butler Rd (S-107)	\$13,000
17: SC 146 & Bagwell Rd (S-654)	\$15,000
Subtotal	\$493,500
Mobilization, Bonds, Insurance, Traffic Control , etc. at 30%	\$148,050
Subtotal	\$641,550
Contingencies at 20%	\$128,310
Total	\$769,860

Table 6 – Mid Term Improvement Costs

**Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0**

#: Primary Intersection	Costs
1: SC 146 & Roper Mountain Rd (S-153) / Verdae Blvd	\$150,000
2: SC 146 & Woodruff Industrial Ln / Magnolia Park	\$285,000
3: SC 146 & I-85 SB Ramps	\$0
4: SC 146 & Carolina Point Pkwy	\$0
5: SC 146 & Market Point Dr	\$0
6: SC 146 & Miller Rd (S-564) / Garlington Rd (S-564)	\$0
7: SC 146 & I-385 Ramps	\$75,000
8: SC 146 & Sam's Club Driveway	\$50,000
9: SC 146 & Merovan Center / Applebee's	\$0
10: SC 146 & Chick-Fil-A Driveway	\$0
11: SC 146 & Smith Hines Rd	\$0
12: SC 146 & Hendrix Dr / Wal-Mart	\$0
13: SC 146 & Spinx Gas Station near Tanner Rd (S-655)	\$0
14: SC 146 & Verdin Rd (S-333) / Feaster Rd (S-333)	\$0
15: SC 146 & Publix Driveway	\$0
16: SC 146 & E Butler Rd (S-107)	\$75,000
17: SC 146 & Bagwell Rd (S-654)	\$0
Corridor Wide Improvements	\$70,400
Subtotal	\$705,400
Mobilization, Bonds, Insurance, Traffic Control , etc. at 30%	\$211,620
Subtotal	\$917,020
Contingencies at 20%	\$183,404
Total	\$1,100,424

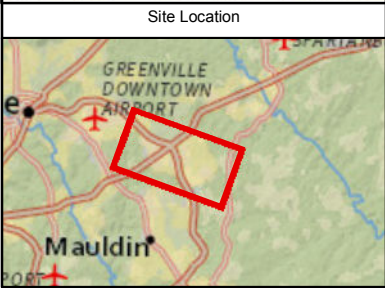
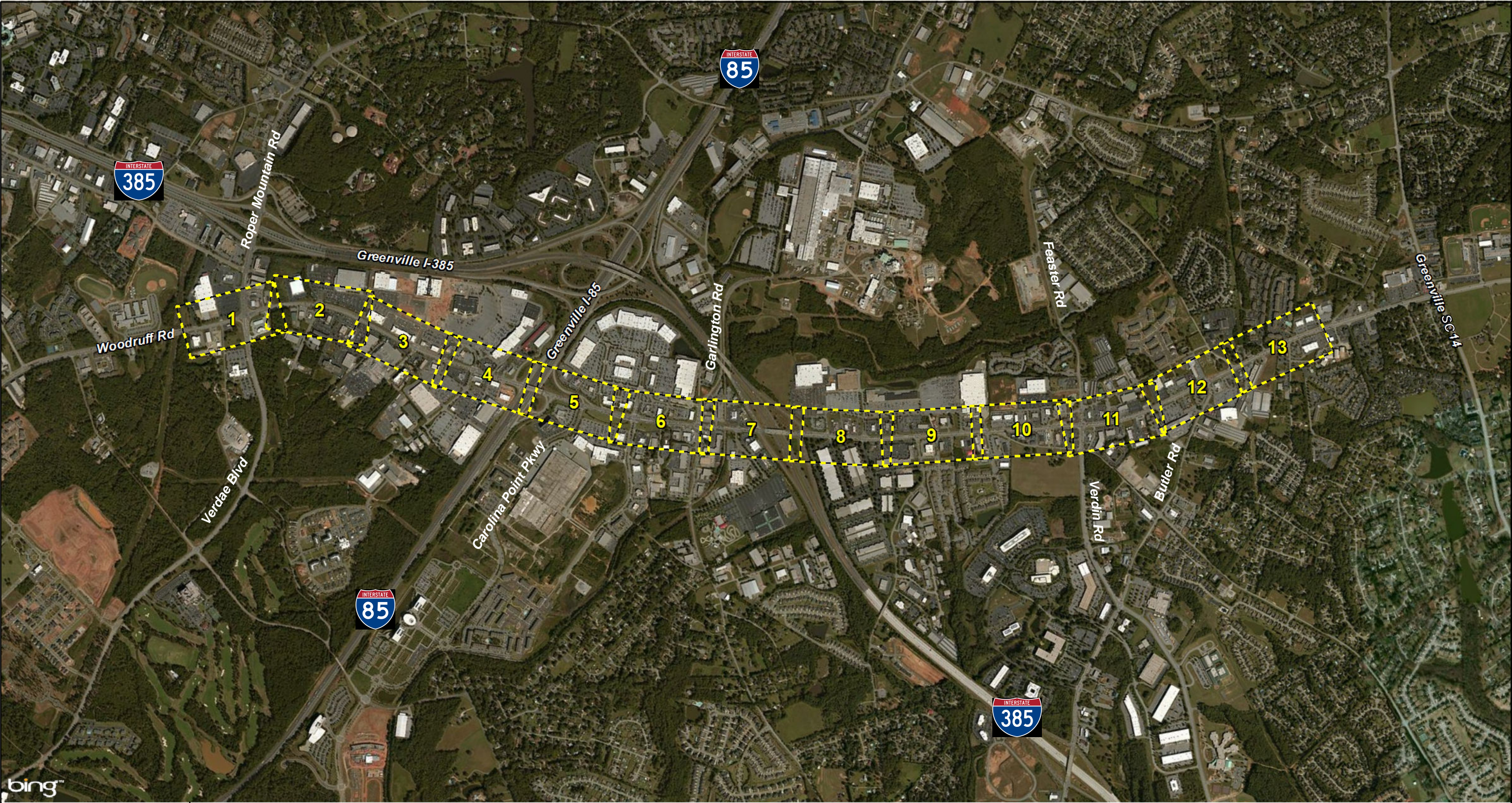
Table 7 – Long Term Improvement Costs

**Greenville County Road Safety Assessment: SC 146 (Woodruff Rd)
From MP 1.9 to 5.0**

Category	Cost
Short Term	\$107,016
Mid Term	\$769,860
Long Term	\$1,100,424
Total	\$1,977,300

Table 8 – Improvement Costs Summary Table

APPENDIX A – RSA SUMMARY PACKET



Legend

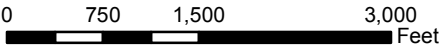
Map Sheet Pages



Sources:
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane

SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0



1 inch = 1,500 feet

AECOM

November 2016

Figure 1

SC 146 (Woodruff Road) - Crash Analysis Results

- 1. Rear end crashes are the predominant crash type along the corridor making up 56% of all crashes.
- 2. There are eight (8) driveways between the signalized intersections of Woodruff Industrial Lane and the I-85 SB Ramps (0.2 miles). There is a high concentration of angle crashes in this area.
- 3. Crash rates are highest from 12 PM to 6 PM, peaking from 4PM-5PM with 234 crashes.
- 4. There was 1 fatal crash on the corridor over the 5 year study period (Segment 1).
- 5. Crashes are primarily property damage only and result in no injury (86% of total crashes)
- 6. Segments 4 – 12 have a high number of crashes.

Crashes by Year

2010: 247
2011: 352
2012: 484
2013: 614
2014: 628

Crashes by Type

Angle: 807 (35%)
Rear End: 1302 (56%)
Sideswipe: 138 (6%)
Head On: 17 (<1%)
Non-Motor Vehicle: 34 (1%)
Other: 27 (1%)

Crashes by Severity

No Injury: 2000
Injury: 325
Fatal: 1

Crashes by Time of Day

Day: 1927
Night: 398

Crashes by Month:

January: 149
February: 171
March: 175
April: 173
May: 200
June: 184
July: 177
August: 199
September: 176
October: 232
November: 224
December: 265

SC 146 (Woodruff Road) AADT:

AADT in the study area is 35,400 in the study area.

SC 146 (Woodruff Road) Speed Limit:

The speed limit from Roper Mountain Road to the I-385 interchange is 35 mph. The speed limit increases after the interchange to 45 mph throughout the remainder of the study area.

Recent and Planned Projects:

- Interchange Improvements at I-85/Woodruff Road (plans prepared by CECS)
- Adaptive Signal Installation (as part of I-85/385 project)
- Sidewalk Project on Woodruff Road from Roper Mountain Road to I-85 (by City of Greenville)
- Intersection safety improvements at Roper Mountain Road and Woodruff Road (by City of Greenville)
- Intersection improvements from I-385 / Woodruff Road to I-85 / Woodruff Road
- Additional WB lane from I-385 to I-85
- Magnolia Park Improvements
- PNG Connector

Crash Types, Conditions, and Year
SC 146 (Woodruff Road)
Greenville, SC

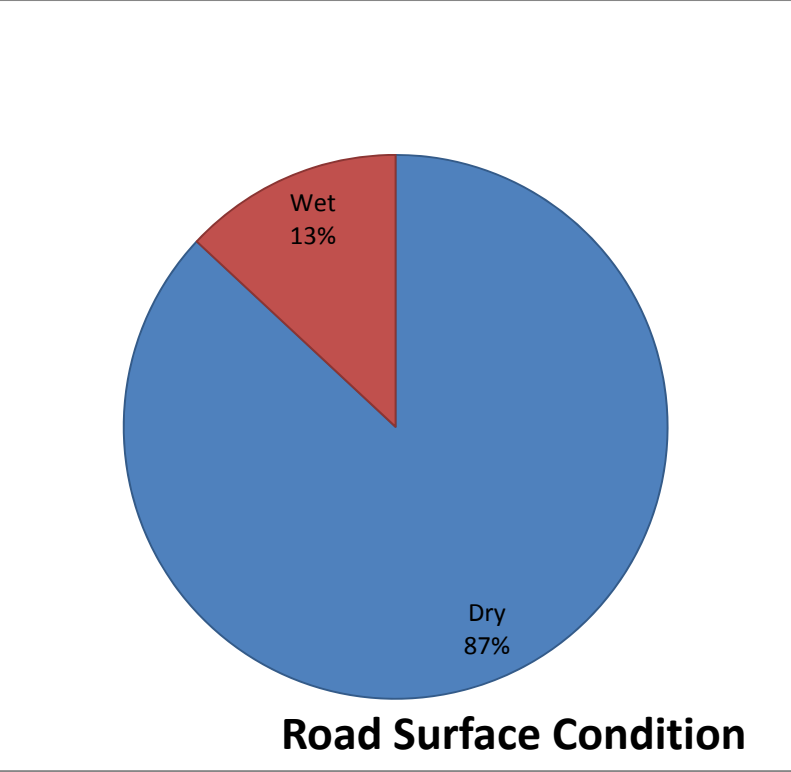
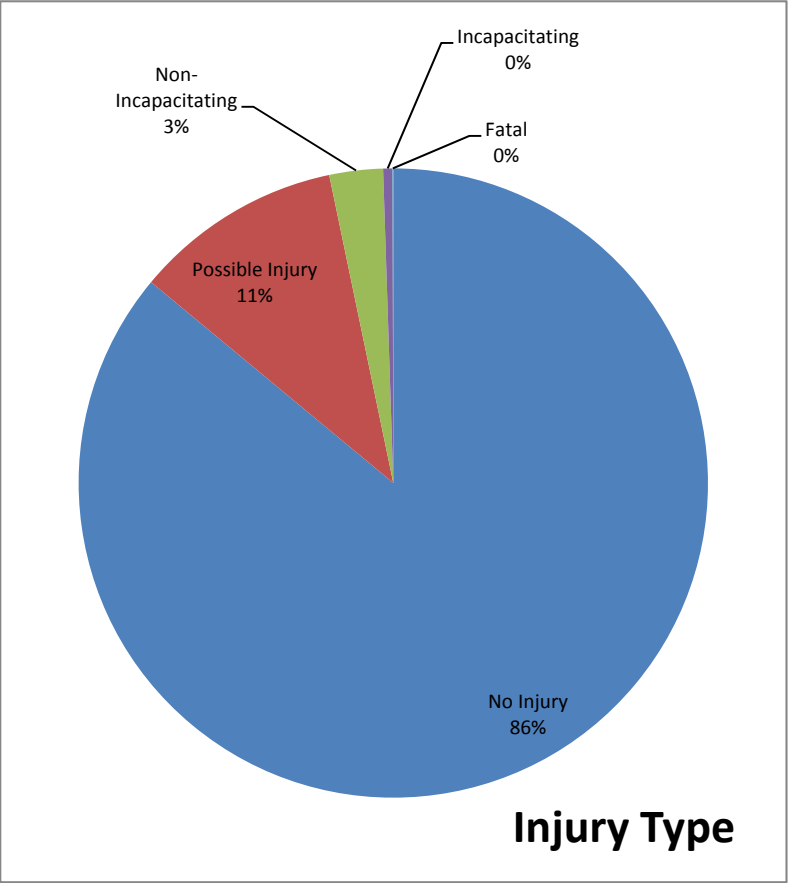
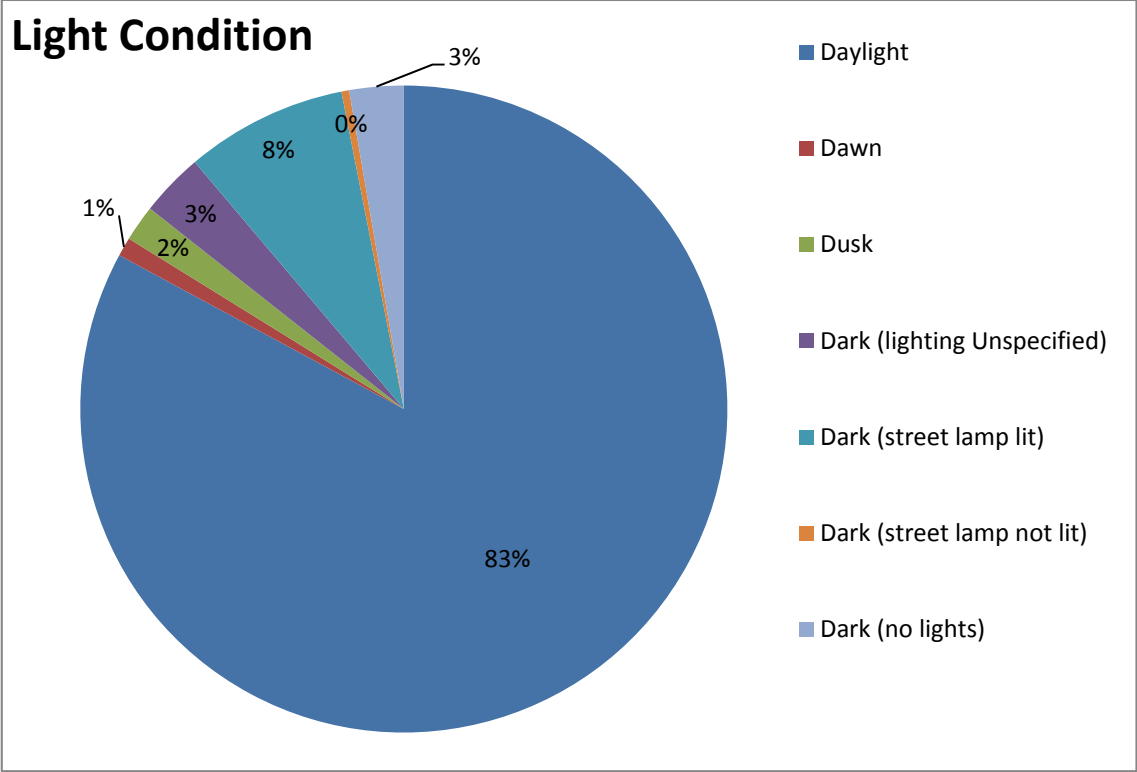
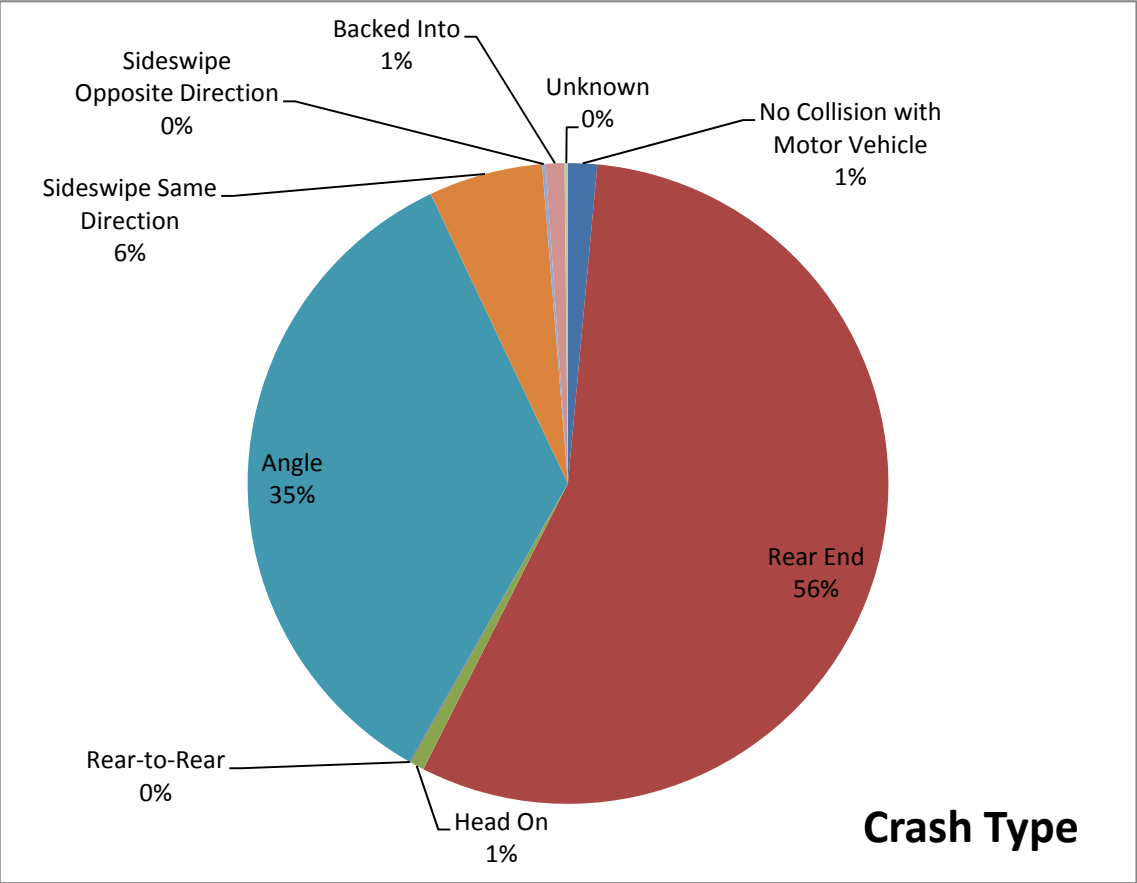
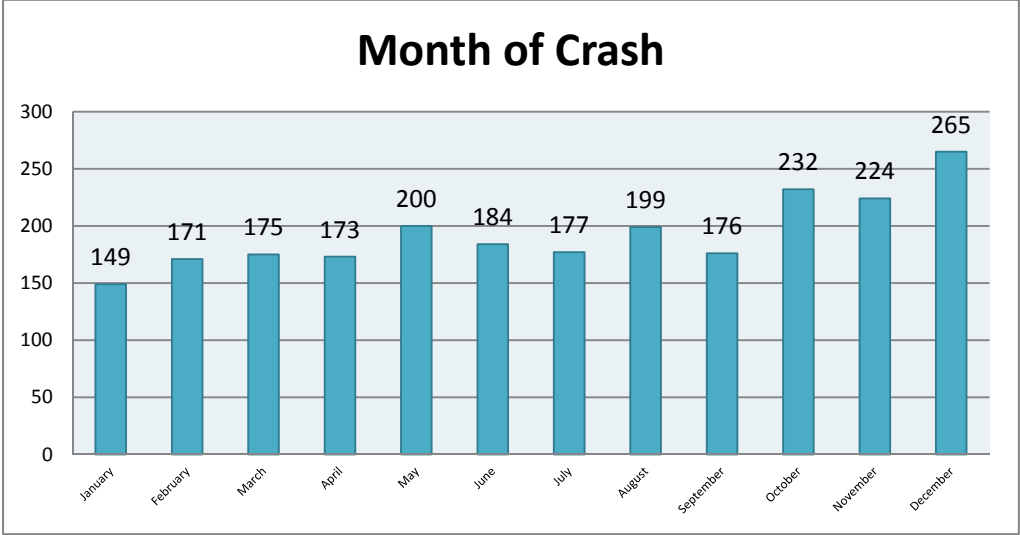
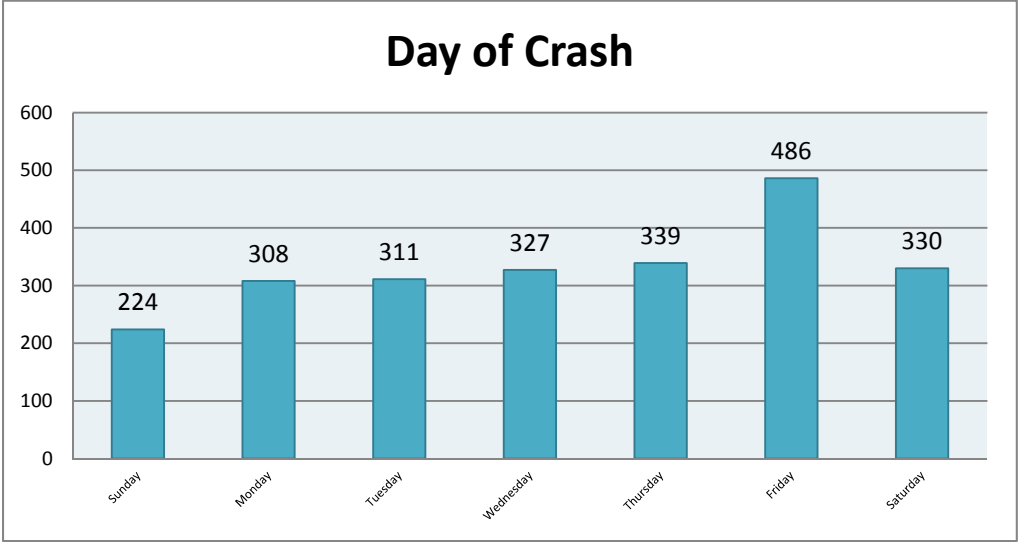
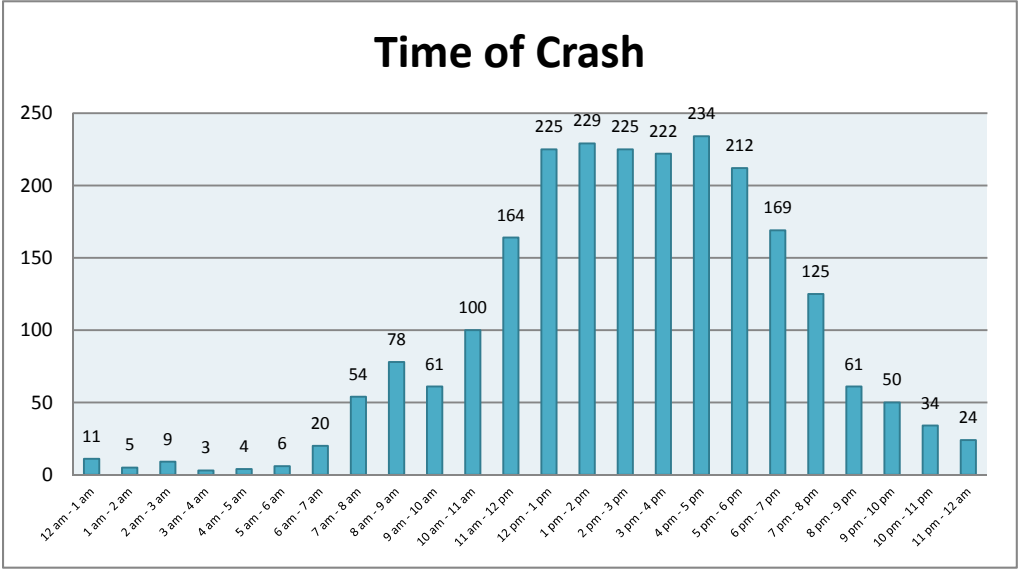
				Crash Type								Light Condition		Road Surface Condition		Year				
Segment	# Crashes	# Injury Crashes	# Fatal	# DUI	# Pedestrian Crashes	# Angle	# Rear End	# Sideswipe	# Head On	# Non Motor Vehicle Crashes	# Other Crash Types	# Daytime	# Night	# Wet Conditions	# Dry Conditions	# 2010	# 2011	# 2012	# 2013	# 2014
1	112	20	1	1	0	22	80	5	1	1	3	81	31	11	101	0	0	18	41	53
2	39	7	0	2	0	17	16	4	0	1	1	34	5	2	37	2	0	5	13	19
3	47	10	0	0	0	16	20	8	1	1	1	41	6	7	40	2	0	4	20	21
4	379	60	0	1	0	251	100	21	2	2	3	303	76	32	347	31	53	67	112	116
5	123	15	0	0	0	37	70	11	1	1	3	99	24	20	103	3	7	16	46	51
6	186	21	0	2	0	37	128	17	0	2	2	157	29	25	161	6	17	35	64	64
7	343	45	0	8	1	76	248	10	2	4	3	278	65	44	299	54	62	78	85	64
8	203	24	0	2	1	48	131	20	1	3	0	176	27	35	168	23	44	45	48	43
9	311	56	0	5	0	96	188	13	4	6	4	265	46	42	269	42	61	75	66	67
10	183	23	0	3	0	60	113	6	0	2	2	161	22	25	158	27	38	45	39	34
11	138	12	0	3	0	50	75	8	1	3	1	115	23	24	114	8	25	34	38	33
12	232	31	0	4	0	92	112	13	4	7	4	195	37	37	195	43	39	56	37	57
13	29	1	0	0	0	5	21	2	0	1	0	22	7	5	24	6	6	6	5	6
Total	2325	325	1	31	2	807	1302	138	17	34	27	1927	398	309	2016	247	352	484	614	628

Crashes by Month and Day of Week
SC 146 (Woodruff Road)
Greenville, SC

	Month												Day of Week							
Segment	# January	# February	# March	# April	# May	# June	# July	# August	# September	# October	# November	# December	# Sunday	# Monday	# Tuesday	# Wednesday	# Thursday	# Friday	# Saturday	
1	7	5	4	9	7	5	18	12	12	11	7	15	10	15	16	17	21	21	12	
2	2	1	0	1	3	4	2	5	4	9	2	6	5	5	4	7	6	6	6	
3	3	4	3	4	1	1	2	5	3	6	6	9	1	4	4	11	2	9	16	
4	22	25	29	24	26	28	23	42	35	32	44	49	43	44	42	32	51	84	83	
5	4	9	12	6	12	4	7	8	7	23	17	14	11	14	13	12	16	31	26	
6	5	14	13	9	20	15	21	16	14	17	26	16	21	28	24	17	29	41	26	
7	28	18	23	24	31	42	19	25	38	32	22	41	39	43	49	33	54	76	49	
8	11	20	20	14	17	18	17	19	10	18	20	19	19	23	21	33	34	45	28	
9	17	25	39	32	28	23	25	24	12	24	32	30	28	38	39	59	47	61	39	
10	14	13	11	14	17	16	15	17	8	16	21	21	19	24	31	32	27	39	11	
11	13	15	6	4	16	14	8	9	11	15	9	18	12	19	29	23	14	28	13	
12	22	20	14	32	20	14	19	12	20	24	13	22	12	45	35	44	35	41	20	
13	1	2	1	0	2	0	1	5	2	5	5	5	4	6	4	7	3	4	1	
Total	149	171	175	173	200	184	177	199	176	232	224	265	224	308	311	327	339	486	330	

Crash Statistics for SC 146 (Woodruff Road)

From MP 1.9 to 5.0





Crash Type	Total
● Angle	22
● Rear End	80
● Sideswipe	5
● Other	5
Total	112

Night and Day
Night = 31
Day = 81
Road Conditions
Wet = 11
Dry = 101

Severity Type	Total
Not Injured	92
Possibly Injured	16
Non-Incapacitating	3
Incapacitating	0
★ Fatal	1

**Total Crashes
Segment #1
112**

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane



SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

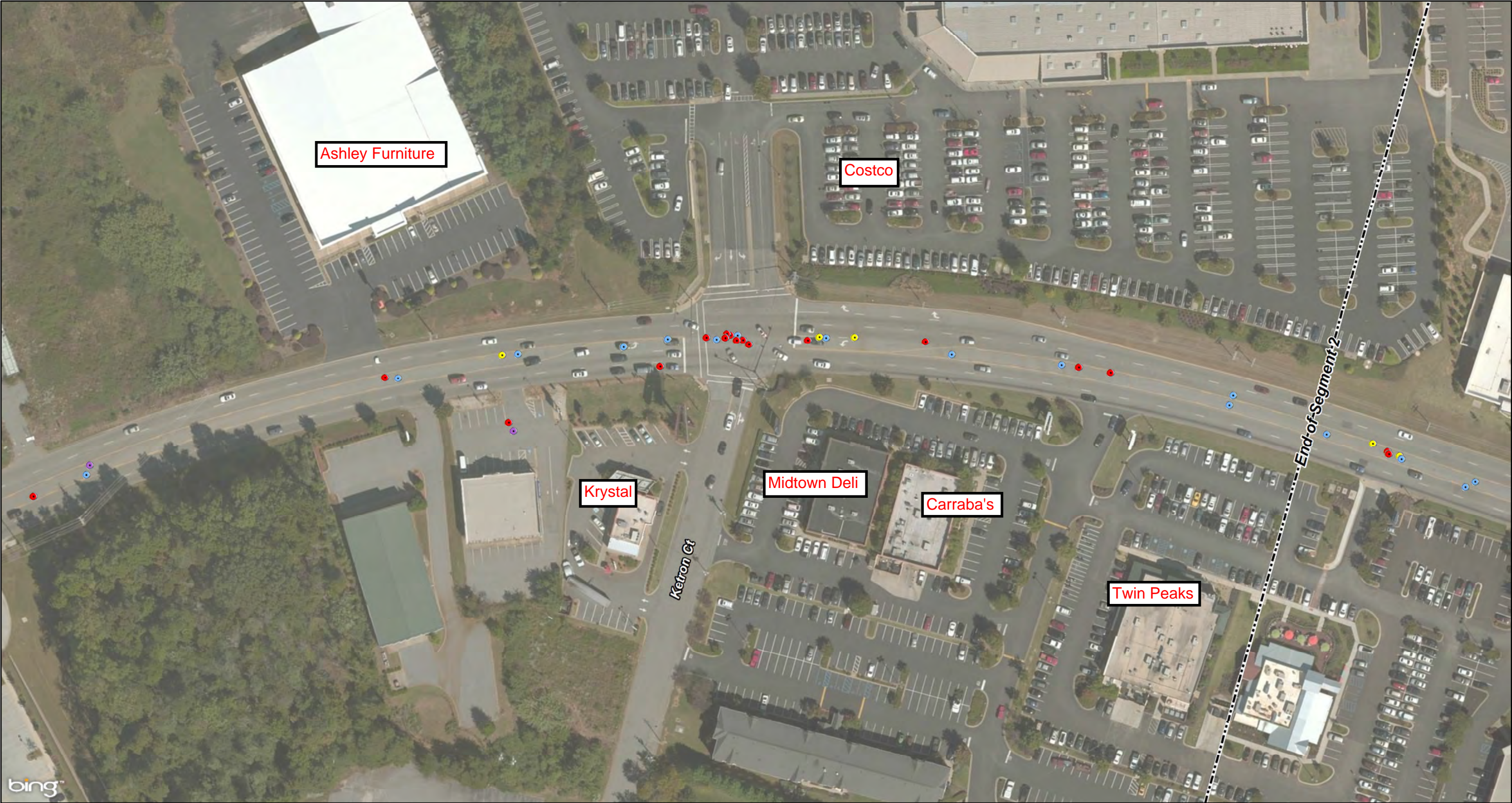
Feet

1 inch = 100 feet

AECOM

November 2016

Segment 1 of 13



Crash Type	Total	Night and Day	Severity Type	Total
● Angle	17	Night = 5	Not Injured	32
● Rear End	16	Day = 34	Possibly Injured	6
● Sideswipe	4	Road Conditions	Non-Incapacitating	1
● Other	2	Wet = 2	Incapacitating	0
Total	39	Dry = 37	★ Fatal	0

Total Crashes Segment #2

39

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane

SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

Feet

1 inch = 100 feet

AECOM

November 2016

Segment 2 of 13



Crash Type	Total	Night and Day	Severity Type	Total
● Angle	16	Night = 6	Not Injured	37
● Rear End	20	Day = 41	Possibly Injured	7
● Sideswipe	8	Road Conditions	Non-Incapacitating	2
● Other	3		Incapacitating	1
Total	47		★ Fatal	0
		Wet = 7		
		Dry = 40		

Total Crashes
Segment #3
47



Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane

SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

Feet

1 inch = 100 feet

AECOM

November 2016

Segment 3 of 13



Crash Type		Total	Night and Day		Severity Type	Total
●	Angle	251	Night = 76		Not Injured	319
●	Rear End	100	Day = 303		Possibly Injured	43
●	Sideswipe	21	Road Conditions		Non-Incapacitating	15
●	Other	7			Incapacitating	2
Total		379	Wet = 32		★ Fatal	0
			Dry = 347			

Total Crashes
Segment #4
379

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane



SC-146 (Woodruff Road)
Road Safety Audit from MP 1.9 - 5.0

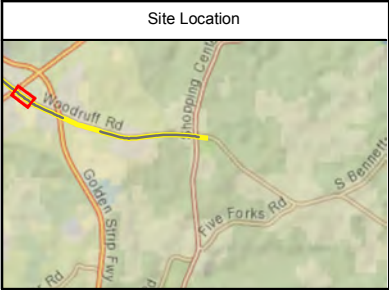
050100200
Feet

1 inch = 100 feet

AECOM

November 2016

Segment 4 of 13



Crash Type	Total	Night and Day	Severity Type	Total
● Angle	37	Night = 24	Not Injured	108
● Rear End	70	Day = 99	Possibly Injured	6
● Sideswipe	11	Road Conditions	Non-Incapacitating	8
● Other	5	Wet = 20	Incapacitating	1
Total	123	Dry = 103	★ Fatal	0

Total Crashes Segment #5

123

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane

SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

0 50 100 200 Feet





1 inch = 100 feet

AECOM

November 2016

Segment 5 of 13



Crash Type		Total	Night and Day		Severity Type		Total
	Angle	37	Night = 29		Not Injured		165
	Rear End	128	Day = 157		Possibly Injured		20
	Sideswipe	17	Road Conditions		Non-Incapacitating		1
	Other	4			Incapacitating		0
Total		186			★ Fatal		0
			Wet = 25		<div><div>Total Crashes Segment #6 186</div><div>Sources: Roads and Accident Data: SCDOT Aerial: Bing Maps through ESRI Map Projection: SC State Plane</div></div>		
			Dry = 161				

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane



SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

Feet

1 inch = 100 feet

AECOM

November 2016

Segment 6 of 13



Crash Type	Total
● Angle	76
● Rear End	248
● Sideswipe	10
● Other	9
Total	343

Night and Day
Night = 65
Day = 278
Road Conditions
Wet = 44
Dry = 299

Severity Type	Total
Not Injured	298
Possibly Injured	34
Non-Incapacitating	10
Incapacitating	1
★ Fatal	0

**Total Crashes
Segment #7
343**

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane



SC-146 (Woodruff Road)
Road Safety Audit from MP 1.9 - 5.0

050100200
Feet

1 inch = 100 feet

AECOM

November 2016

Segment 7 of 13



Crash Type	Total	Night and Day	Severity Type	Total
● Angle	48	Night = 27	Not Injured	179
● Rear End	131	Day = 176	Possibly Injured	21
● Sideswipe	20	Road Conditions	Non-Incapacitating	3
● Other	4	Wet = 35	Incapacitating	0
Total	203	Dry = 168	★ Fatal	0

**Total Crashes
Segment #8
203**

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane



SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

Feet

1 inch = 100 feet

AECOM

November 2016

Segment 8 of 13



Crash Type	Total	Night and Day	Severity Type	Total
● Angle	96	Night = 46	Not Injured	255
● Rear End	188	Day = 265	Possibly Injured	47
● Sideswipe	13	Road Conditions	Non-Incapacitating	9
● Other	14		Incapacitating	0
Total	311		★ Fatal	0
		Wet = 42		
		Dry = 269		

**Total Crashes
Segment #9
311**

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane



SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

Feet

1 inch = 100 feet

AECOM

November 2016

Segment 9 of 13



Crash Type	Total
● Angle	60
● Rear End	113
● Sideswipe	6
● Other	4
Total	183

Night and Day
Night = 22
Day = 161
Road Conditions
Wet = 25
Dry = 158

Severity Type	Total
Not Injured	160
Possibly Injured	17
Non-Incapacitating	4
Incapacitating	2
★ Fatal	0

**Total Crashes
Segment #10
183**

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane



SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

Feet

1 inch = 100 feet

AECOM

November 2016

Segment 10 of 13



Crash Type	Total	Night and Day	Severity Type	Total
● Angle	50	Night = 23	Not Injured	126
● Rear End	75	Day = 115	Possibly Injured	7
● Sideswipe	8	Road Conditions	Non-Incapacitating	4
● Other	5	Wet = 24	Incapacitating	1
Total	138	Dry = 114	★ Fatal	0

Total Crashes Segment #11 138

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane

SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

Feet

1 inch = 100 feet

AECOM

November 2016

Segment 11 of 13



Crash Type	Total
● Angle	92
● Rear End	112
● Sideswipe	13
● Other	15
Total	232

Night and Day
Night = 37
Day = 195
Road Conditions
Wet = 37
Dry = 195

Severity Type	Total
Not Injured	201
Possibly Injured	24
Non-Incapacitating	4
Incapacitating	3
★ Fatal	0

**Total Crashes
Segment #12
232**

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane



SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

Feet

1 inch = 100 feet

AECOM

November 2016

Segment 12 of 13



Crash Type	Total
● Angle	5
● Rear End	21
● Sideswipe	2
● Other	1
Total	29

Night and Day
Night = 7
Day = 22
Road Conditions
Wet = 5
Dry = 24

Severity Type	Total
Not Injured	28
Possibly Injured	1
Non-Incapacitating	0
Incapacitating	0
★ Fatal	0

**Total Crashes
Segment #13
29**

Sources:
Roads and Accident Data: SCDOT
Aerial: Bing Maps through ESRI
Map Projection: SC State Plane



SC-146 (Woodruff Road)

Road Safety Audit from MP 1.9 - 5.0

050100200

Feet

1 inch = 100 feet

AECOM

November 2016

Segment 13 of 13

PROMPT LIST 6 (1 OF 2)

Existing Road Audit									
Road Function, Classification, Environment	Road Alignment and Cross Section	Auxiliary Lanes	Intersections	Interchanges	Signs and Lighting	Marking and Delineation	Barriers and Clear Zones	Traffic Signals	Pedestrians and Bicyclists
	1 Visibility, sight distance	1 Tapers	1 Location	1 Visibility, sight distance	1 Lighting	1 General issues	1 Clear zones	1 Operations	1 General issues
	2 Design speed	2 Shoulders	2 Visibility, sight distance	2 Lanes, shoulders	2 General signs issues	2 Centerlines, edge-lines, lane lines	2 Barriers	2 Visibility	2 Pedestrians
	3 Speed limit/speed zoning	3 Signs and markings	3 Signing and marking	3 Signing, marking, delineation	3 Sign legibility	3 Guideposts and reflectors	3 End treatments /Crash cushions	3 Placement of signal heads	3 Bicyclists
	4 Passing	4 Turning traffic	4 Layout and 'readability' (perception) by drivers	4 Pedestrians, bicyclists	4 Sign supports	4 Curve warning and delineation	4 Pedestrian railing		4 Public transport
	5 'Readability' (perception) of the alignment by drivers		5 Pedestrians, bicyclists	5 Lighting			5 Visibility of barriers and fences		
	6 Human factors		6 Lighting						
	7 Widths								
	8 Shoulders								
	9 Cross slopes								
	10 Side slopes								
	11 Drains								
	12 Combinations of features								

PROMPT LIST 6 (2 OF 2)

Existing Road Audit						
Older Drivers	Bridges and Culverts	Pavement	Parking	Provision For Heavy Vehicles	Floodways and Causeways	Other Safety Issues
1 Turning operations (receiving lane widths, radii)	1 Design features	1 Pavement defects		1 Design issues	1 Ponding and flooding	1 Landscaping
	2 Barriers	2 Skid resistance		2 Pavement/shoulder quality	2 Safety of devices	2 Temporary works
2 Channelization, opposing left turn lanes	3 Pedestrian and recreational facilities, delineation	3 Ponding/icing/snow accumulation				3 Headlight glare
3 Sight triangles		4 Loose stones/material				4 Roadside activities
4 Signing, marking and delineation		5 Manholes				5 Signs of possible problems (pavement, roadside)
5 Traffic signals						6 Rest areas
						7 Environment
						8 Median curbing

APPENDIX B – TEAM MEETING SIGN IN SHEET

11/9

Woodruff Rd RSA

Name

Firm

Jacob Nelson

AECOM

Clint Link

City of Greenville

Matt Johnson

SCITP

Jana Potvin

SCDOT

Joey Riddle

SCDOT

Emily Swearingen

AECOM

ERIC DILLON

SCDOT

Kelli Broadington

Greenville County / GPATS

Valerie Holmes

City

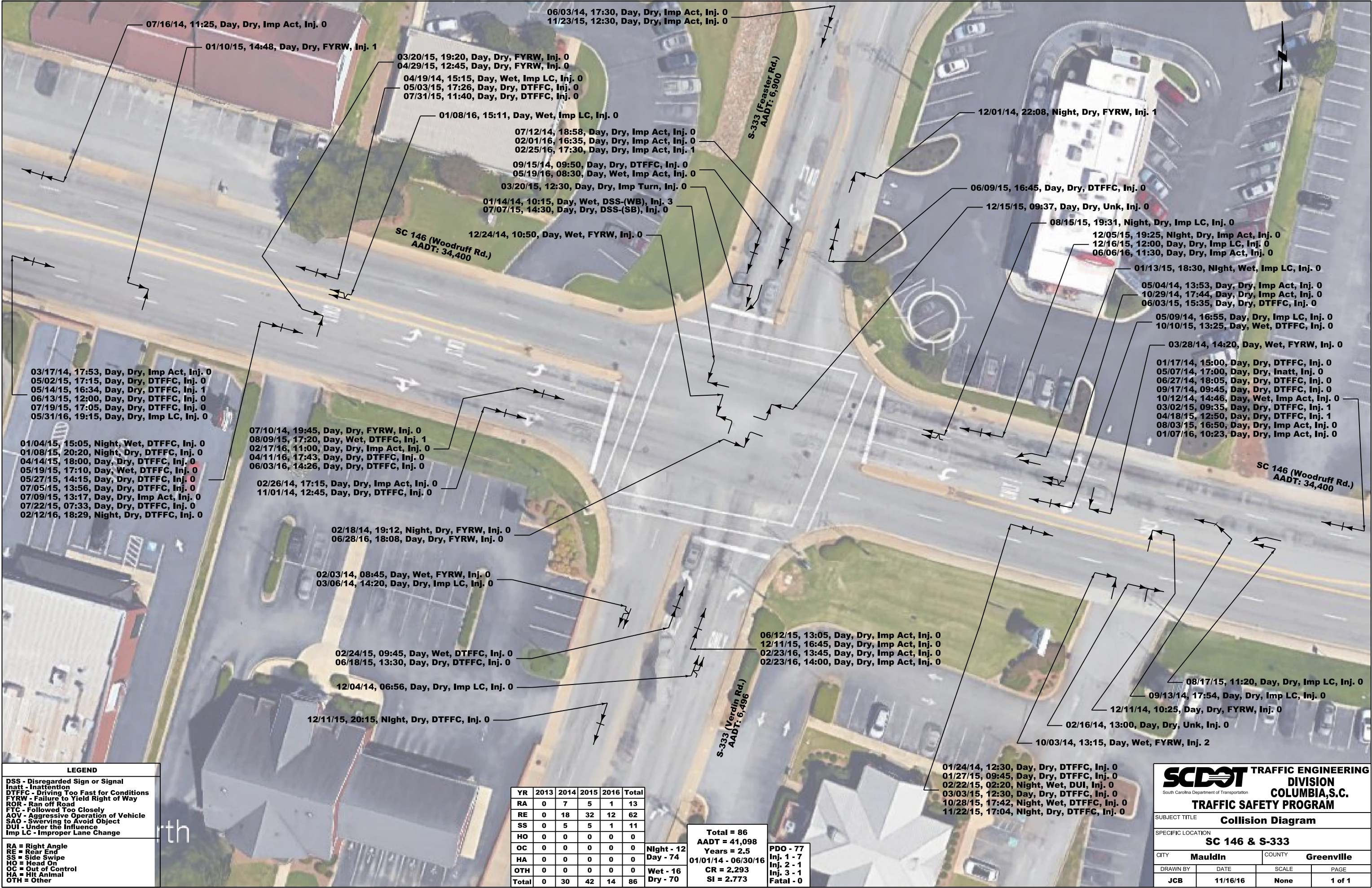
KIRI WALTERS

GV COUNTY

Tommy ELROD

SCDOT

APPENDIX C – COLLISION DIAGRAMS



LEGEND

DSS - Disregarded Sign or Signal
Inatt - Inattention
DTFFC - Driving Too Fast for Conditions
FYRW - Failure to Yield Right of Way
ROR - Ran off Road
FTC - Followed Too Closely
AOV - Aggressive Operation of Vehicle
SAO - Swerving to Avoid Object
DUI - Under the Influence
Imp LC - Improper Lane Change

RA = Right Angle
RE = Rear End
SS = Side Swipe
HO = Head On
OC = Out of Control
HA = Hit Animal
OTH = Other

YR	2013	2014	2015	2016	Total
RA	0	7	5	1	13
RE	0	18	32	12	62
SS	0	5	5	1	11
HO	0	0	0	0	0
OC	0	0	0	0	0
HA	0	0	0	0	0
OTH	0	0	0	0	0
Total	0	30	42	14	86

Night - 12
Day - 74
Wet - 16
Dry - 70

Total = 86
AADT = 41,098
Years = 2.5
01/01/14 - 06/30/16
CR = 2.293
SI = 2.773

PDO - 77
Inj. 1 - 7
Inj. 2 - 1
Inj. 3 - 1
Fatal - 0

SCDOT

South Carolina Department of Transportation

TRAFFIC ENGINEERING
DIVISION
COLUMBIA, S.C.
TRAFFIC SAFETY PROGRAM

SUBJECT TITLE
Collision Diagram

SPECIFIC LOCATION
SC 146 & S-333

CITY
Mauldin

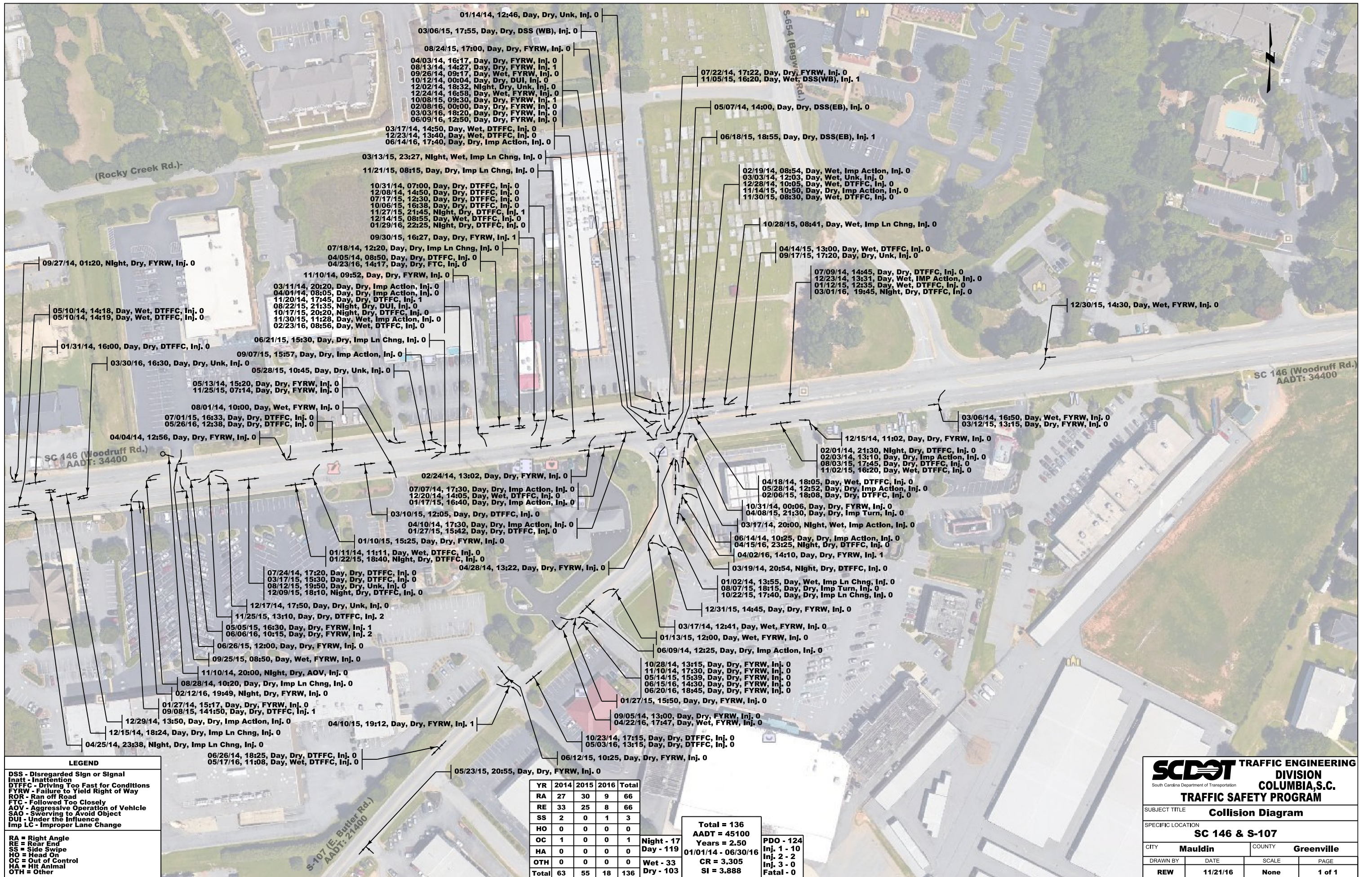
COUNTY
Greenville


DRAWN BY
JCB

DATE
11/16/16

SCALE
None

PAGE
1 of 1





TRAFFIC ENGINEERING
DIVISION
COLUMBIA, S.C.
TRAFFIC SAFETY PROGRAM

SUBJECT TITLE

Collision Diagram

SPECIFIC LOCATION

SC 146 & S-107

CITY

Mauldin

COUNTY

Greenville

DRAWN BY

REW

DATE

11/21/16

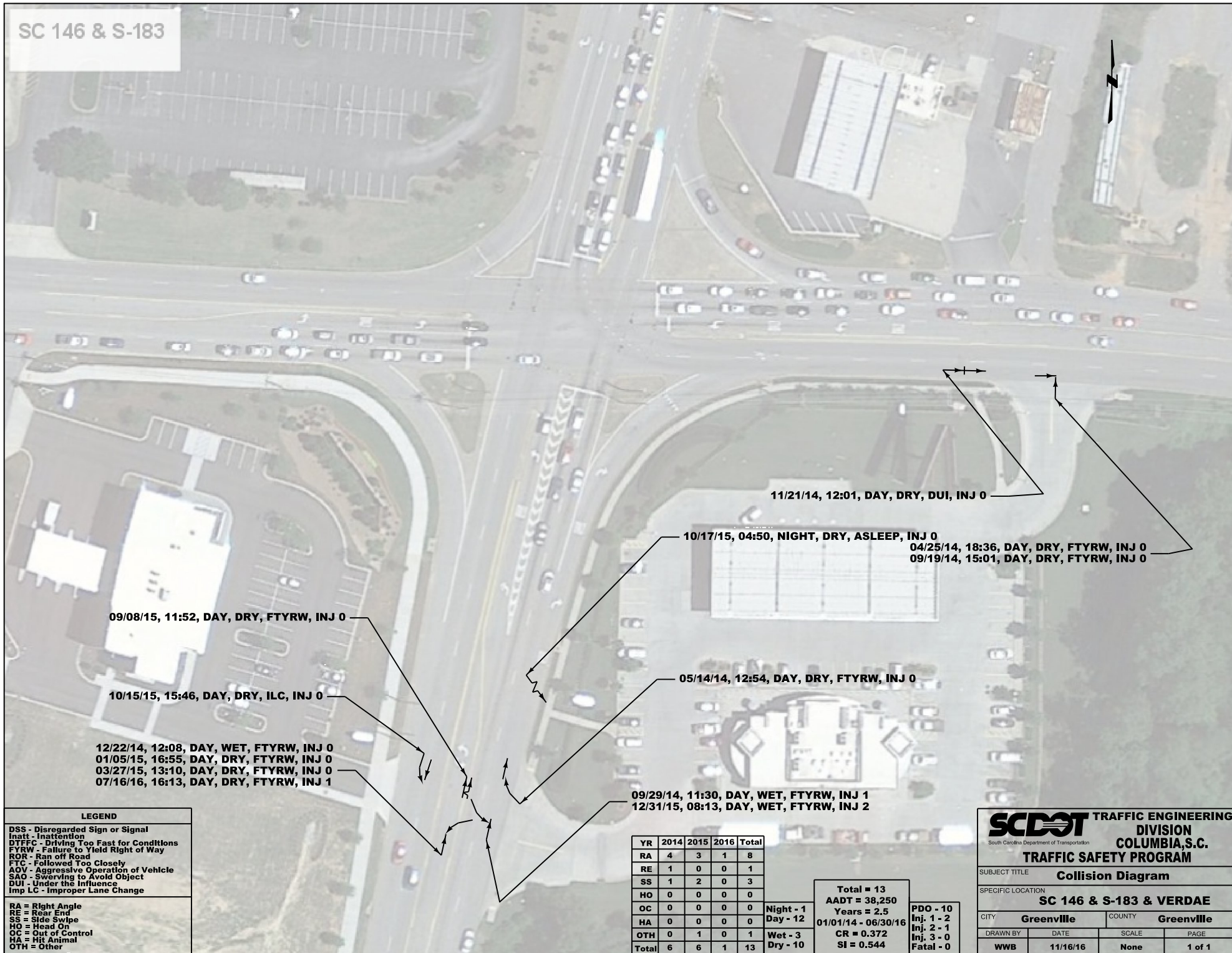
SCALE

None

PAGE

1 of 1

SC 146 & S-183



09/08/15, 11:52, DAY, DRY, FTYRW, INJ 0

10/15/15, 15:46, DAY, DRY, ILC, INJ 0

12/22/14, 12:08, DAY, WET, FTYRW, INJ 0
 01/05/15, 16:55, DAY, DRY, FTYRW, INJ 0
 03/27/15, 13:10, DAY, DRY, FTYRW, INJ 0
 07/16/16, 16:13, DAY, DRY, FTYRW, INJ 1

10/17/15, 04:50, NIGHT, DRY, ASLEEP, INJ 0

04/25/14, 18:36, DAY, DRY, FTYRW, INJ 0
 09/19/14, 15:01, DAY, DRY, FTYRW, INJ 0

05/14/14, 12:54, DAY, DRY, FTYRW, INJ 0

09/29/14, 11:30, DAY, WET, FTYRW, INJ 1
 12/31/15, 08:13, DAY, WET, FTYRW, INJ 2

11/21/14, 12:01, DAY, DRY, DUI, INJ 0

LEGEND

DSS - Disregarded Sign or Signal
 Inatt - Inattention
 DTFWC - Driving Too Fast for Conditions
 FTYRW - Failure to Yield Right of Way
 ROR - Ran off Road
 FTC - Followed Too Closely
 AOV - Aggressive Operation of Vehicle
 SAO - Swerving to Avoid Object
 DUI - Under the Influence
 Imp LC - Improper Lane Change

RA = Right Angle
 RE = Rear End
 SS = Side Swipe
 HO = Head On
 OC = Out of Control
 HA = Hit Animal
 OTH = Other

YR	2014	2015	2016	Total
RA	4	3	1	8
RE	1	0	0	1
SS	1	2	0	3
HO	0	0	0	0
OC	0	0	0	0
HA	0	0	0	0
OTH	0	1	0	1
Total	6	6	1	13

Night - 1
 Day - 12
 Wet - 3
 Dry - 10

Total = 13
 AADT = 38,250
 Years = 2.5
 01/01/14 - 06/30/16
 CR = 0.372
 SI = 0.544

PDO - 10
 Inj. 1 - 2
 Inj. 2 - 1
 Inj. 3 - 0
 Fatal - 0

SCDOT South Carolina Department of Transportation		TRAFFIC ENGINEERING DIVISION COLUMBIA, S.C.	
TRAFFIC SAFETY PROGRAM			
SUBJECT TITLE Collision Diagram			
SPECIFIC LOCATION SC 146 & S-183 & VERDAE			
CITY Greenville	COUNTY Greenville		
DRAWN BY WWB	DATE 11/16/16	SCALE None	PAGE 1 of 1

DRAWN BY	DATE	SCALE	PAGE
WWB	11/14/16	None	1 of 1

APPENDIX) – °) ° hu@ - 'o@V° Ou@ @8@7^ kU ° u@V

General Info

System Map

Locations and Communication

Locations

MASTER
LOCATION

17 SIGNALS IN SYSTEM

(Carolina Point Parkway is missing in TEAMS, currently operated on same controller as I-85 NB)

- 2070 CONTROLLERS
- FIBER OPTIC COMMUNICATIONS
- UPGRADED TO ETHERNET

Revised signal plans and upgrades will be needed for the 7 signals on Woodruff Road between I-85 SB ramp & I-385 NB ramp;

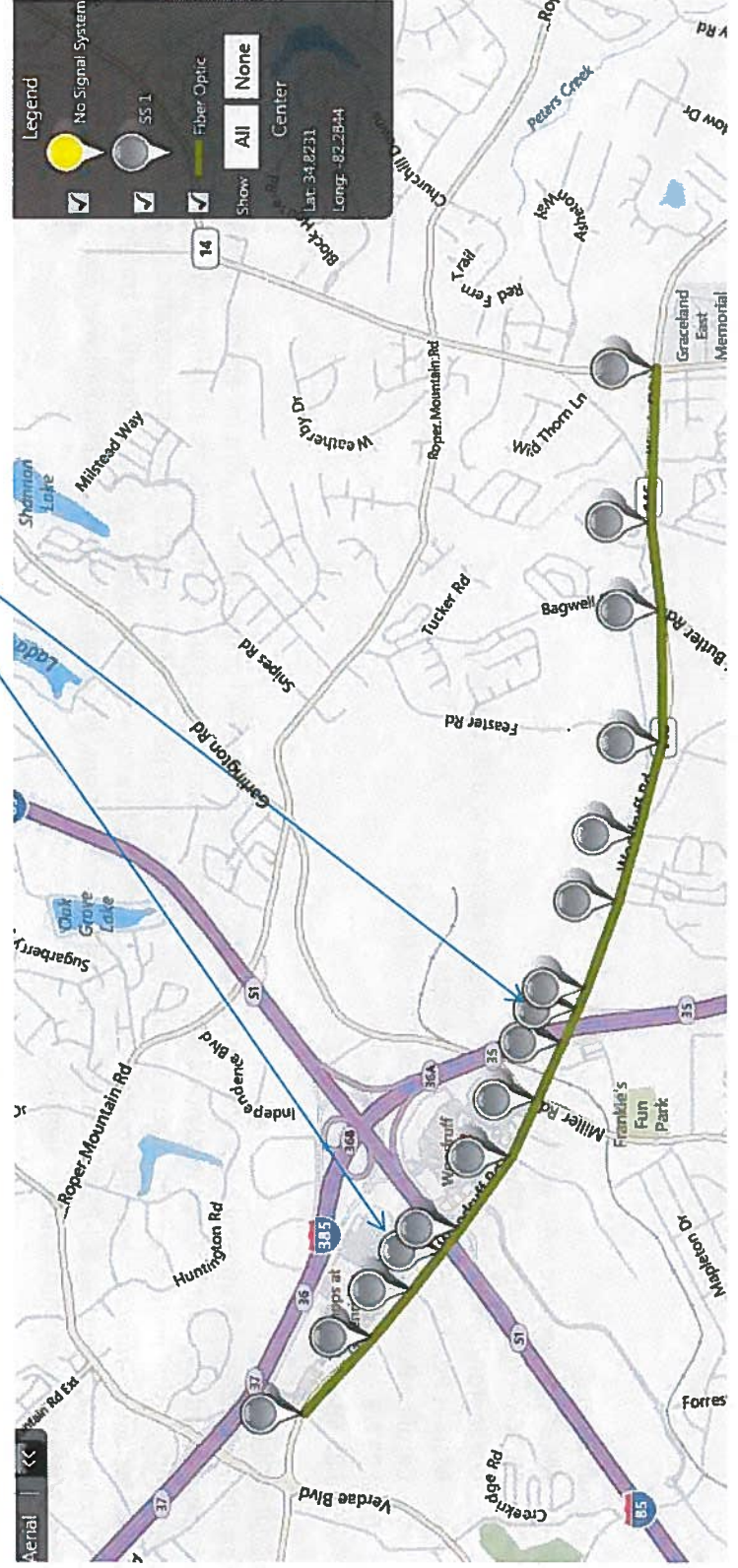


EXHIBIT 4d – Part 3 – TRAFFIC SIGNALS

1. LIST OF TRAFFIC SIGNALS WITHIN PROJECT

Intersection No.	Intersection Name	Description of Signal Work
1	Woodruff Rd @ I-385 NB	Full signal rebuild - span wire
2	Woodruff Rd @ I-385 SB	Full signal rebuild - span wire
3	Woodruff Rd @ Garlington/Miller	Full signal rebuild - span wire
4	Woodruff Rd @ Market Place Dr	Full signal rebuild - span wire
5	Woodruff Rd @ Carolina Point Pkwy	Full signal rebuild - span wire
6	Woodruff Rd @ I-85 NB	Full signal rebuild - span wire
7	Woodruff Rd @ I-85 SB	Full signal rebuild - span wire
*	Woodruff Rd btwn I-85 SB and I-385 NB	Fiber Interconnect between all 7 signals
*	Woodruff Rd btwn Ketron Ct and SC 14	Synchro Green Traffic Adaptive Signal System installation

2. PROJECT DESCRIPTION

- a. This Project is a Design-Build construction project and involves the signal construction of the above intersections along Woodruff Road (SC 146) in and around the city of Greenville, South Carolina. The intersections involved are shown on the above "List of Traffic Signals within Project".
- b. Specific Description of the signal work:

Signal Scope

Rebuild 7 traffic signals utilizing black powder coated (over galvanized) steel poles with span wire for existing span wire configurations and black powder coated (over galvanized) steel poles with mast arms for existing mast arm configurations, including new cabinet/controller, signal heads, signal cable, and overhead signs; Install pedestrian treatments in accordance with SCDOT policy. Fiber optic cable connecting traffic signals is existing. Signal design should include re-running underground fiber optic cable along section affected by construction project to reconnect all 17 traffic signals in signal system. Controller at Woodruff Rd & I-85 NB currently operates 2 intersections, NB ramp and Carolina Point Parkway. Signal design should separate out these 2 intersections with separate signal controllers.

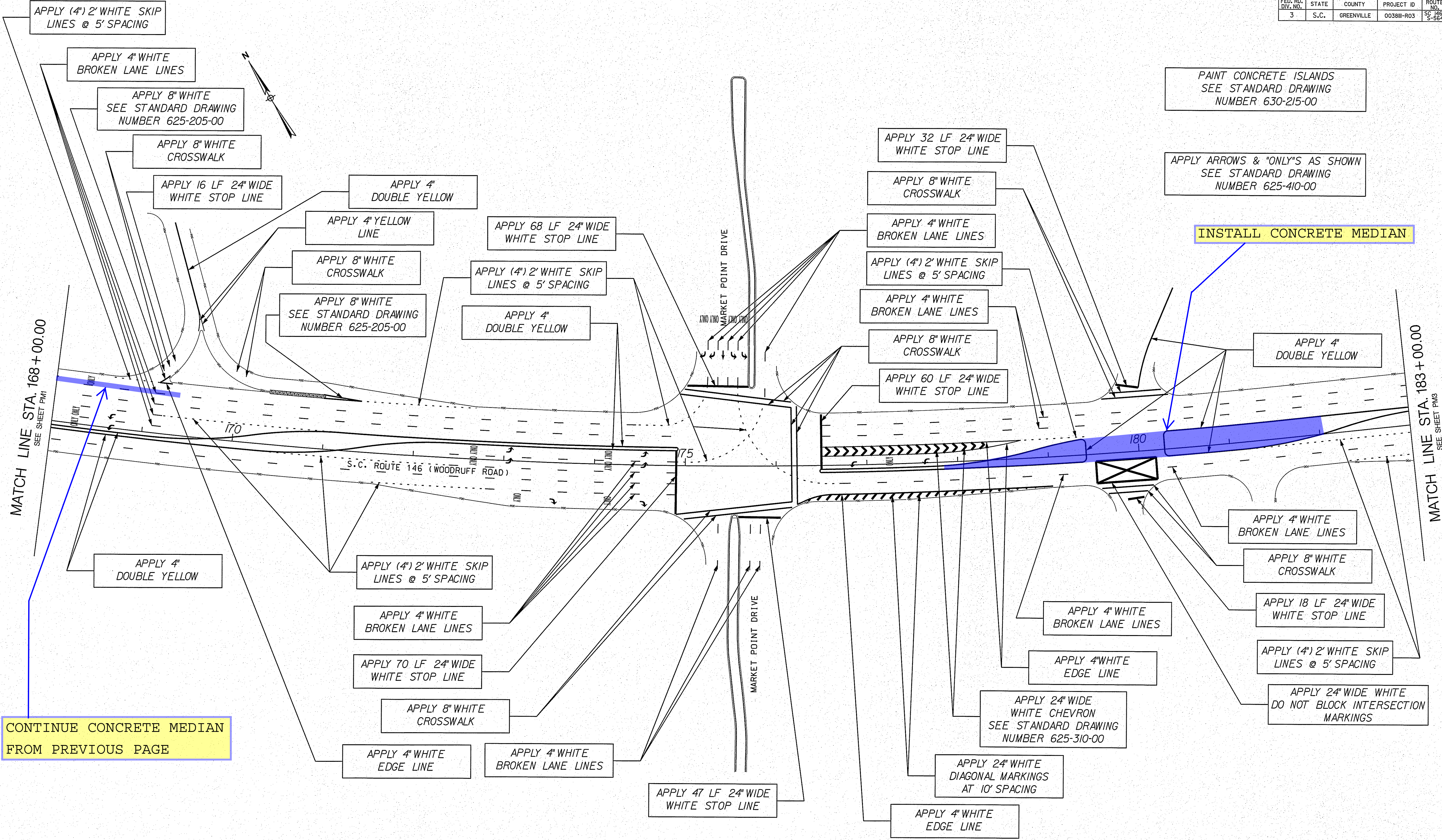
Synchro Green Traffic Adaptive Signal System

Install (purchase and deploy) Enterprise version of Synchro Green traffic adaptive software for the 17 signals in the Woodruff Road signal system, prior to and during construction of I-385/I-85 ramps. Temporary stop bar detection shall be utilized for the 7 signals affected by the construction project, for ease of varying detection zones during the various phases of traffic control. Install permanent stop bar detection at each of the 17 signals; Two signals on Woodruff Rd @SC 14 and @Ketron Ct) shall have flush mounted detection on the mainline approaches in each lane, at the stop bar, in accordance with requirements below. Four signals (Woodruff Rd @I-385 NB, @I-385 SB, @I-85 NB, @I-85 SB) shall have flush mounted detection on both the mainline approaches and the side street approaches in each lane, at the stop bar, in accordance with requirements below. Detection at the other signals shall be designed to accommodate needed information for Synchro Green Adaptive Signal System, as indicated below.

- Stop bar detection – Stop bar detection is required on every lane on every approach where adaptive is installed. Each detector must have a separate input channel into the controller. The stop bar detectors are typically placed near the stop bar and are small enough to pick up gaps between vehicles. Typically an equivalent loop size of 6'x15' works well. Stop Bar Detection can consist of inductive loops, video detection, and flush mounted wireless detection.
- Advanced detection – Advanced detection is required on the mainline through lanes only. Each detector should be approximately 6'x6' and each detector should be placed on a separate input channel into the controller. The advanced detectors should be placed between 250'-500' upstream of the intersection stop bar. Where intersection spacing is less than 1000', advanced detection is not required. Advanced Detection can consist of inductive loops or flush mounted wireless detection.

APPENDIX E – PLANNED SC 146 ROADWAY
IMPROVEMENTS FROM I-85 TO I-385

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	GREENVILLE	00388-R03	SC 146 / S-564	PM2



REVISIONS				REVISIONS					
NO.	DATE	DESCRIPTION	BY	CHECKED	NO.	DATE	DESCRIPTION	BY	CHECKED

FLATIRON

Civil Engineering Consulting Services, Inc.

ZACHRY

a joint venture

Civil Engineering Consulting Services, Inc.

08/4/15

050100

0

50

100

150

200

SCALE: 1" = 50' HORIZ

Civil Engineering Consulting Services, Inc.

08/4/15

Professional Engineer

Robert Lee Drummond

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

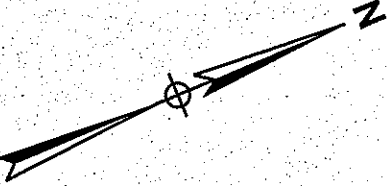
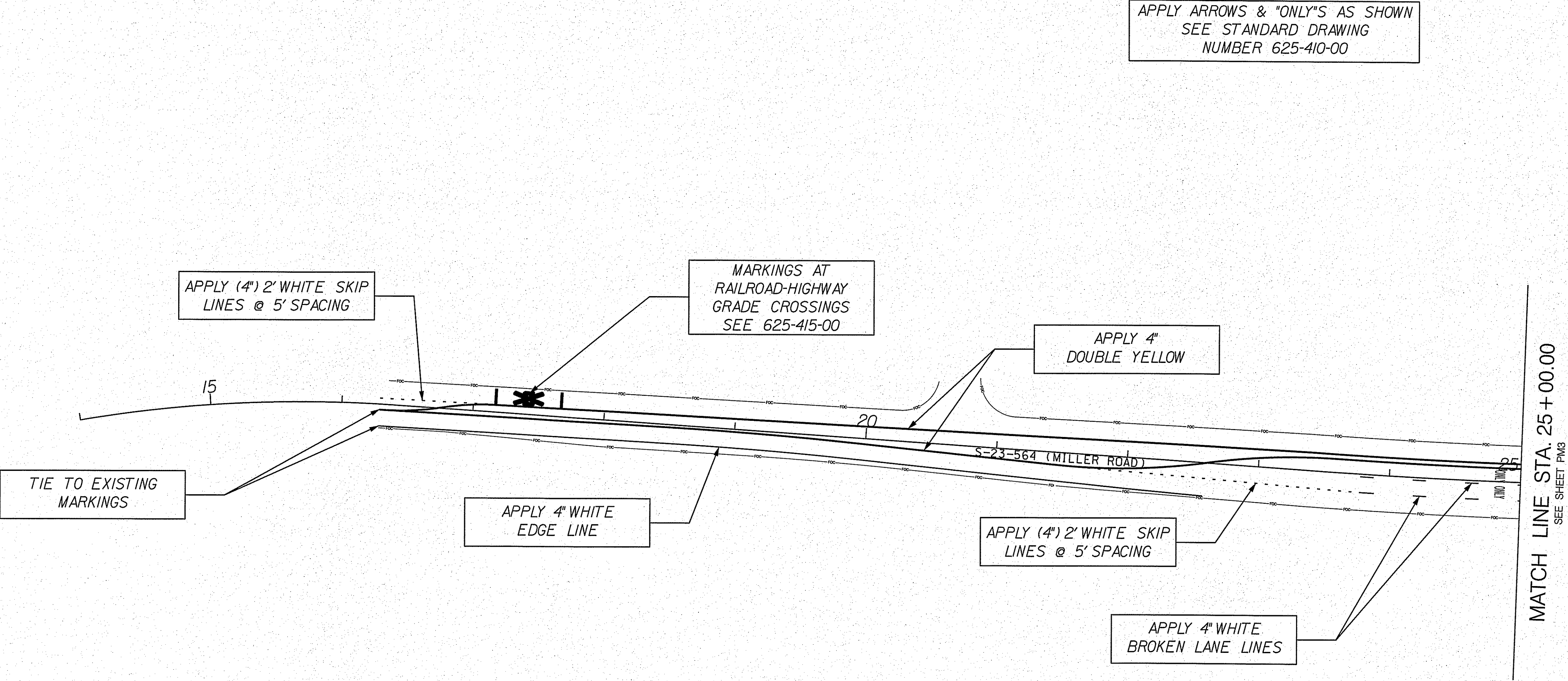
S.C. ROUTE 146 (WOODRUFF ROAD)

S-23-564 (GARLINGTON ROAD & MILLER ROAD)

PAVEMENT MARKING PLAN SHEET

STA. 168+00.00 TO STA. 183+00.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	GREENVILLE	00388-R03	SC 146 / S-564	PM4



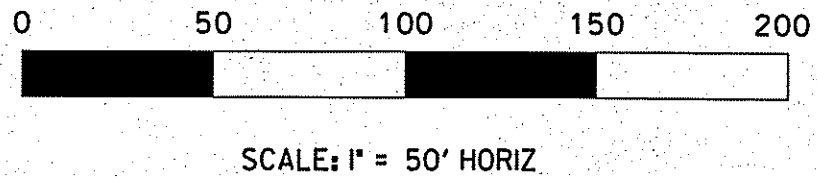
REVISIONS				REVISIONS			
NO.	DATE	DESCRIPTION	BY	CHECKED	NO.	DATE	DESCRIPTION

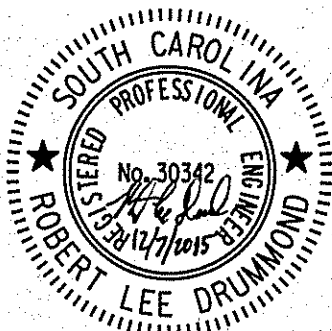
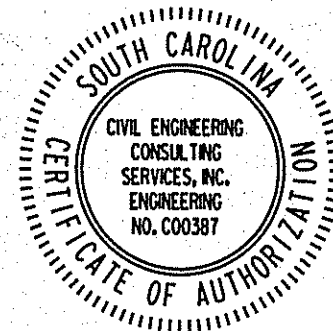
DRAWN BY :	R.L.D.
DATE :	12/16/14
REVIEWED BY :	B.A.H.
DATE :	04/18/15
APPROVED BY :	B.G.N.
DATE :	08/4/15


a joint venture




CIVIL ENGINEERING
CONSULTING SERVICES, INC.





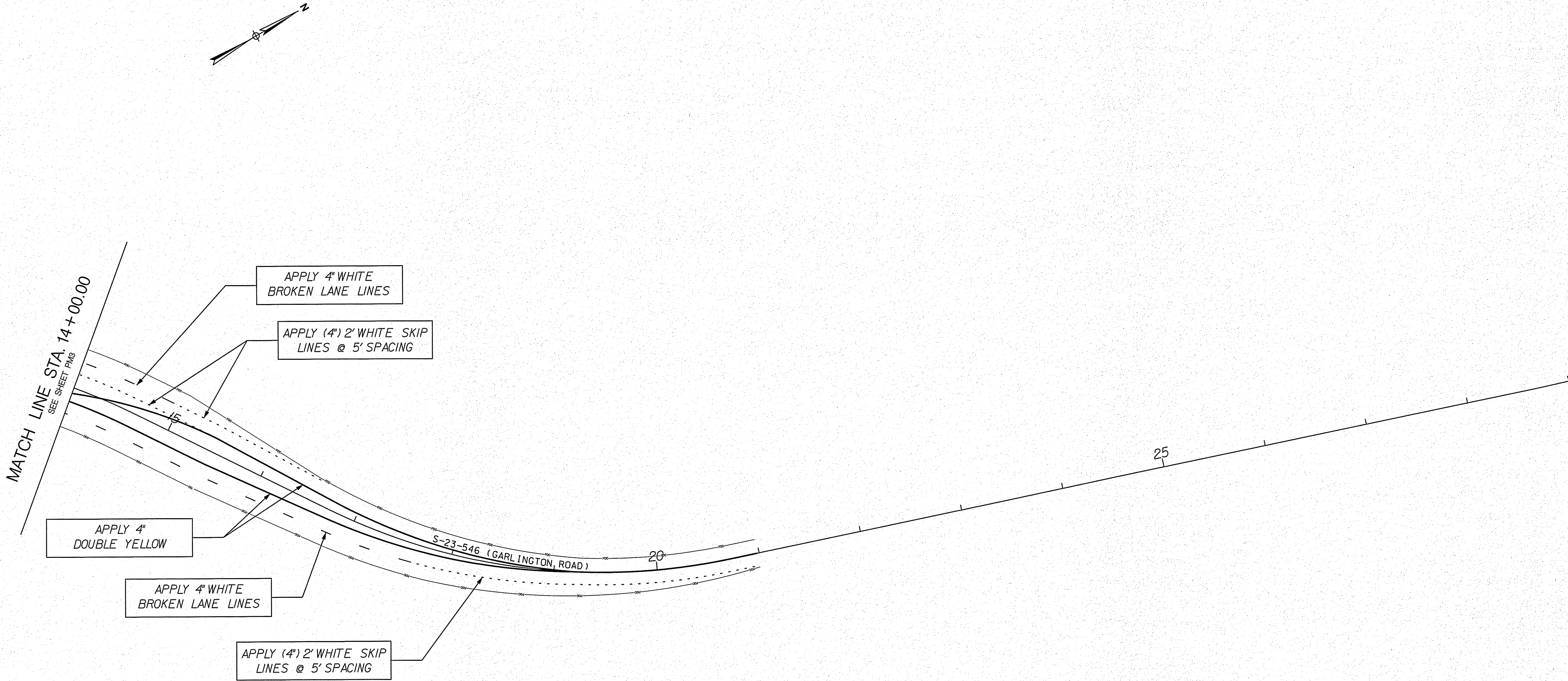
SOUTH CAROLINA DEPARTMENT
OF TRANSPORTATION



S.C. ROUTE 146 (WOODRUFF ROAD)
S-23-564 (GARLINGTON ROAD & MILLER ROAD)

PAVEMENT MARKING PLAN SHEET
STA. 16+28.91 TO STA. 25+00.00

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROUTE NO.	SHEET NO.
3	S.C.	GREENVILLE	0038III-R03	S-23-564	PM5



REVISIONS		DESCRIPTION	BY	CHECKED	REVISIONS		DESCRIPTION	BY	CHECKED	DRAWN BY : R.L.D. DATE : 12/16/14
NO.	DATE				NO.	DATE				
										<div><div>FLATIRON</div><div>ZACHRY</div><div>CIVIL ENGINEERING CONSULTING SERVICES, INC.</div></div> <div><div>CE</div><div>CS</div></div> <div>DRAWN BY : B.A.H. DATE : 04/18/15</div> <div>DRAWN BY : B.G.N. DATE : 08/4/15</div>

0

50

100

150

200

SCALE: 1" = 50' HORIZ

SOUTH CAROLINA

CIVIL ENGINEERING CONSULTING SERVICES, INC.

ENGINEERING NO. 30342

CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA

PROFESSIONAL ENGINEER

NO. 30342

ROBERT LEE DRUMMOND

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

S.C. ROUTE 146 (WOODRUFF ROAD)
S-23-564 (GARLINGTON ROAD & MILLER ROAD)

PAVEMENT MARKING PLAN SHEET
STA. 14+00.00 TO STA. 20+98.12