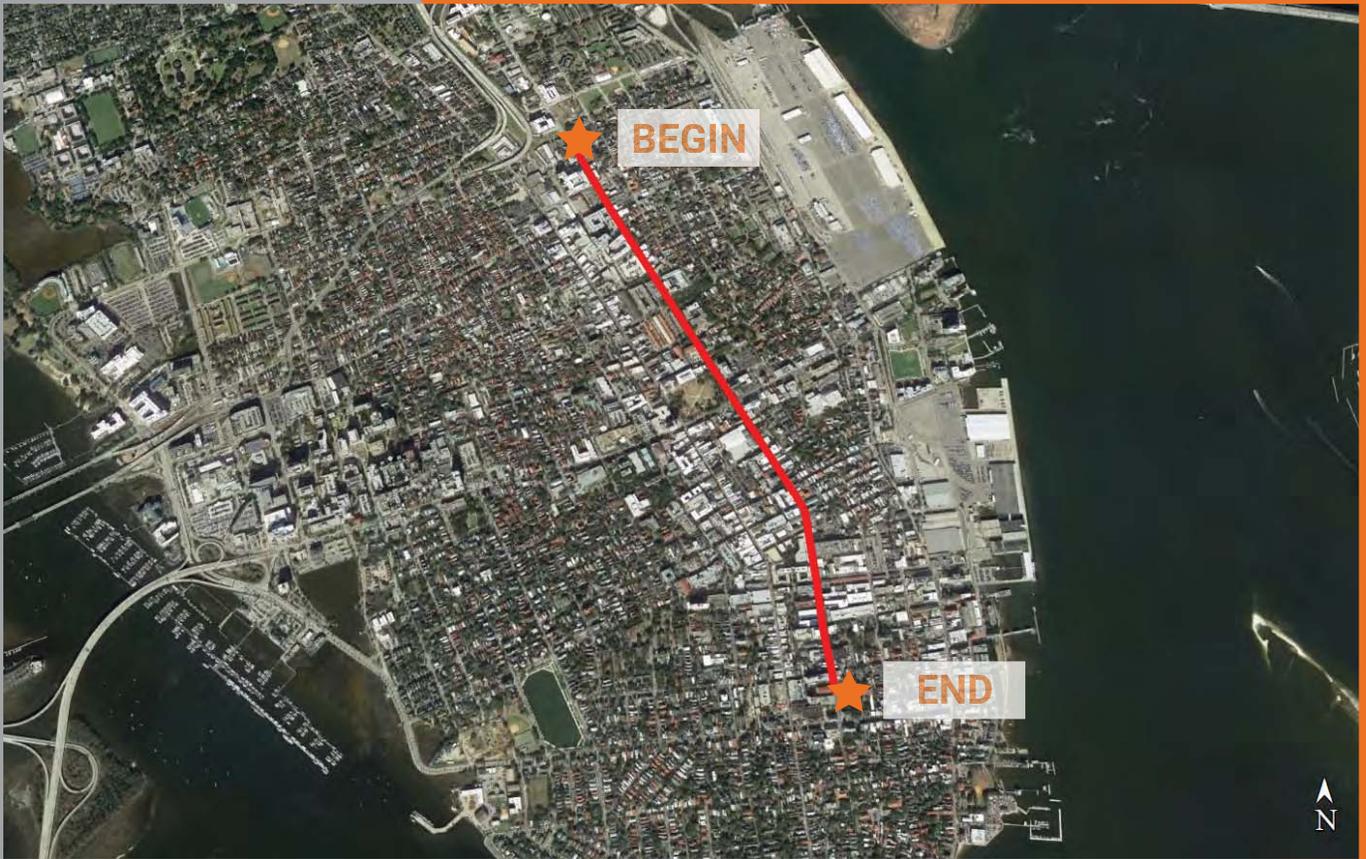


# S-107 MEETING STREET

## Bicycle and Pedestrian Road Safety Audit Charleston, SC



MAY 2020



**S-107 Meeting Street**

**Bicycle and Pedestrian Road Safety Audit**

Charleston, South Carolina

Prepared for:

South Carolina Department of Transportation  
(SCDOT)

Prepared by:

Stantec Consulting Services Inc.

Project Number: 171002154

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## 1.0 INTRODUCTION

### 1.1 Background

Effective bicycle and pedestrian programs often consider the six “Es”:

- Evaluation – Review and analysis of crash data and information from surveys, walking audits, and other research to determine strategies for improving safety
- Engineering – Design of physical infrastructure to improve safety
- Enforcement – Engagement of law enforcement to patrol problem locations and increase community awareness of safety issues
- Education – Methods to teach motorists and pedestrians about their responsibilities and traffic rules
- Encouragement – Strategies that develop awareness and build enthusiasm for cycling and walking
- Equity – Consideration for the diverse needs of all roadway users

This Bicycle and Pedestrian Road Safety Audit covers the first “E”, Evaluation. The RSA process identifies safety issues through an intensive and collaborative forum and uses brainstorming and local knowledge to enhance analysis findings in developing a range of improvement ideas. This RSA provides specific recommendations for Engineering, but also recognizes Enforcement, Education, Encouragement and Equity needs. A multi-disciplinary team performed the RSA, bringing a variety of perspectives to the study. Detailed crash data from the most recent six years along with extensive analyses was used to identify high crash patterns and/or rates throughout the study area to share with the study team.

### 1.2 Project Overview

In 2018, SCDOT identified S-107 (Meeting Street), as a high crash corridor involving non-motorized users, i.e. bicyclists and pedestrians. The corridor was #2 in the statewide ranking of SCDOT’s non-motorized safety project list, which was based on the total number of bike / pedestrian crashes per mile. Between 2013 and 2018, there were 36 crashes along S-107 involving bicycles and pedestrians. Of these 36 crashes, 30 resulted in injuries and one resulted in a fatality. 19 crashes involved bicycles, while the remaining 17 involved pedestrians.

The original analysis area is a 1.4-mile section of Meeting Street, which begins at Line Street and extends southward to Chalmers Street. However, based on field conditions, the study was extended to Broad Street in the southern end. Over the six-year period, 699 crashes have been reported along the study area, at a rate of approximately 116 crashes per year. Of the 699 crashes, 180 resulted in injuries and 2 resulted in fatalities. The number and severity of these crashes warranted a closer evaluation for potential safety improvements for drivers, bicyclists and pedestrians.

The RSA process identifies safety issues through an intensive and collaborative forum and uses brainstorming and local knowledge to enhance analysis findings in developing a range of improvement ideas. A multi-disciplinary team performed the road safety audit, bringing a variety of perspectives to the

study. Detailed crash data from the most recent six years, along with extensive analysis, was used to identify high crash patterns and/or rates throughout the study area to share with the study team.

### 1.3 Road Safety Assessment Interdisciplinary Team

A multidisciplinary team was formed to evaluate safety needs and identify the recommended improvements. The team consisted of engineers, law enforcement, and local municipality representatives. The team conducted field visits on August 5 and 6, 2019. The members of the RSA team were as follows:

- Shawn Salley – SCDOT
- Joey Riddle – SCDOT
- Robert Amick – SCDOT
- Josh Johnson – SCDOT
- Eric Hall – SCDOT
- Keith Benjamin – City of Charleston
- Belen Vitello – City of Charleston
- Michael Mathis – City of Charleston
- Allen Davis – City of Charleston
- Troy Mitchell - City of Charleston
- Robert Somerville – City of Charleston
- Kristy McFadden - Charleston PD
- Katie Zimmerman – Charleston Moves
- Savannah Brennan – Charleston Moves
- Jordan Amaker – Lowcountry Local First
- Bret Gillis – Stantec Consulting Services
- Stuart Day – Stantec Consulting Services
- Nabarjun Vashisth – Stantec Consulting Services

### 1.4 Report Objectives

The purpose of this Road Safety Assessment is to evaluate safety issues and other areas of concern along S-107 between Line Street and Broad Street including the intersections located along the route. The study identifies opportunities for improving bicycle, pedestrian and vehicular safety.

The assessment has three basic components:

- Pre-assessment

- Analyze crash data – Crash data over a six-year period were analyzed, with results based on different crash types and trends depicted through various charts, tables and spreadsheets.
- Speed Study - Conduct speed study of the corridor at 3 different locations to gauge average and 85<sup>th</sup> percentile speeds during non-rush hour traffic.
- The audit team reviews location characteristics and crash analysis
- Field meeting/Site visit
  - Study team gathers to review/discuss crash details and share local knowledge of existing issues and concerns.
  - Study team walks the corridor to examine conditions along the corridor.
- Post-assessment – The study team gathers to share findings and develop a list of issues and potential strategies.

## 2.0 EXISTING CONDITIONS

### 2.1 PROJECT LOCATION

The project study area begins at the intersection of Line Street in the northern end and extends southward to Broad Street. These limits are shown below in Figure 2.1. S-107 has active bicycle, pedestrian, vehicular, and transit traffic. It serves residential, office and retail properties, with several attractions for both tourists and local residents. In addition to numerous shops and restaurants, some popular destinations along this corridor include Washington Square, Marion Square, Visitors Center, Gibbes Museum of Art and Charleston City Market. The College of Charleston is also nearby, adding to nonvehicular and vehicular traffic when school is in session.

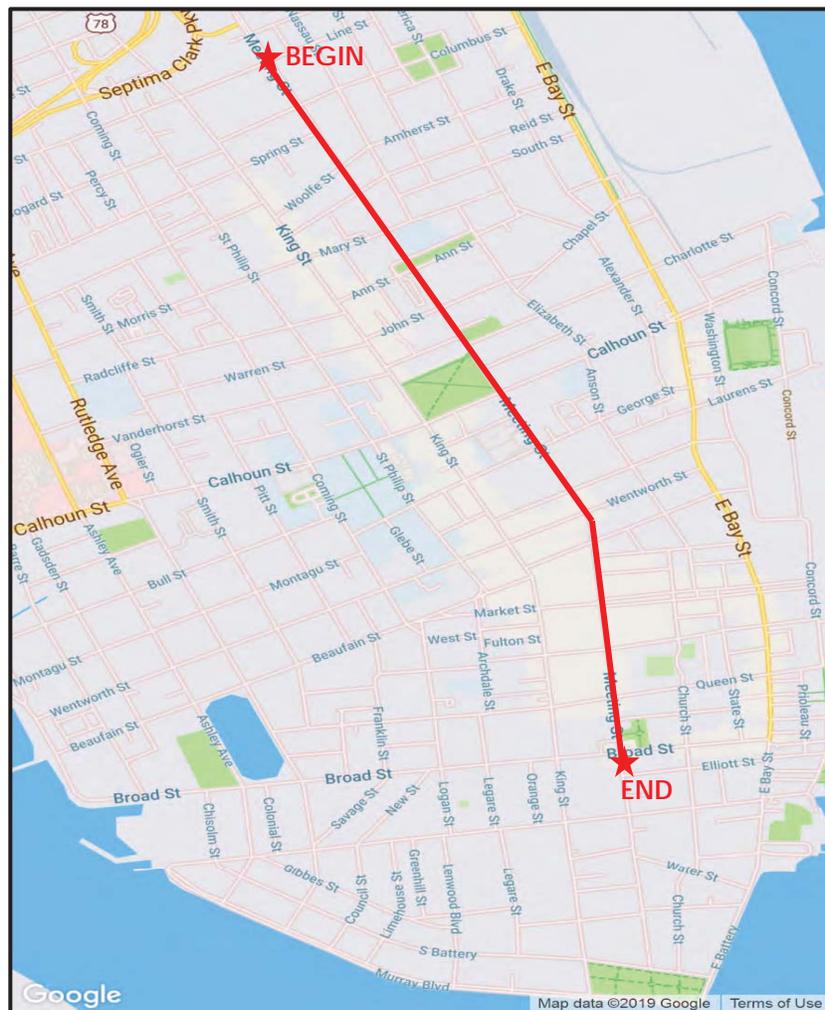


Figure 2.1- Project Study Area

## 2.2 EXISTING ROADWAYS

**Meeting St.** is a four-lane minor arterial roadway that serves residential and commercial traffic. Northbound Meeting St. has two lanes. Southbound Meeting St. also has two lanes, but the outside lane is used for parking in segments from John St. to Henrietta St., from George St. to Society St., from Wentworth St. to Hasell St. and from Market St. to Chalmers St. The posted speed limit from the north end is 30 mph and reduces to 25 mph towards the south end of the corridor. There are existing traffic signals at the intersections of Line St, Columbus St, Woolfe St, Mary St, Wragg Square, Ann St, John St, Calhoun St, George St, Wentworth St, Hasell St, Market St, Horlbeck Alley and Queen St. Sidewalk exists on both sides of the roadway, throughout the study area. Signalized pedestrian crossings along this corridor exist at most of the signalized intersections in the study area. The 2018 AADT was 19,800 vehicles per day (vpd).

Key intersections include:

- **Columbus St.** is a two-lane major collector in the north end of the study area. The posted speed limit is 20 mph and 2018 AADT was 4,000 vehicles per day (vpd).
- **Spring St.** is a two-lane (one-way) minor arterial in the north end of the study area. The posted speed limit is 25 mph. The 2018 AADT was 6,200 vpd.
- **Calhoun St.** is a four-lane principle arterial. The posted speed limit is 25 mph and 2018 AADTs were: 20,100 vpd at the west end of the road, 18,800 vpd from Barre St to Rutledge Ave, 16,300 vpd from Rutledge Ave to East Bay St and 5,200 vpd from East Bay St to Concord St, at its eastern end.
- **Wentworth St.** is a two-lane major collector towards the south end of the study area. The posted speed limit is 25 mph on the west side of the intersection and 20 mph on the east side. The 2018 AADT was 4,200 vehicles per day (vpd).
- **Hasell St.** is a two-lane major collector towards the end of the study area. The posted speed limit is 20 mph. The 2018 AADTs were: 4,600 vpd from King St to Meeting St and 2,900 from Meeting St to East Bay St.

## 2.3 CRASH DATA

Crash data for the study corridor was provided by SCDOT for a six-year period between January 2013 and December 2018. The crash data supplied by SCDOT was grouped into street blocks (from north to south), and then reviewed to identify trends in collision types and locations that experienced a high crash frequency. In total, there were 699 reported crashes along the entire route.

See summaries of the crash data in Figures 2.3.1-2.3.16 below, as well as in tabular form in Appendix A.

*Note that the 2013-2018 time frames used in this section and Appendices A and B are different from the 2012-2018 time frames used in Appendix C- Crash Diagrams- Specific Intersections and Appendix D- Bicycle and Pedestrian Crash Diagram. Appendix C uses a 1-1-2016 to 3-31-2019 time frame, while Appendix D uses a 1-1-12 to 3-31-2018 time frame.*

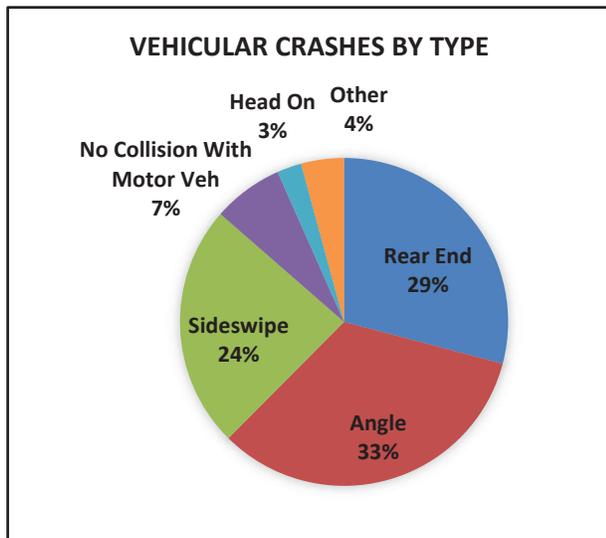


Figure 2.3.1- S-107 Crashes by Type

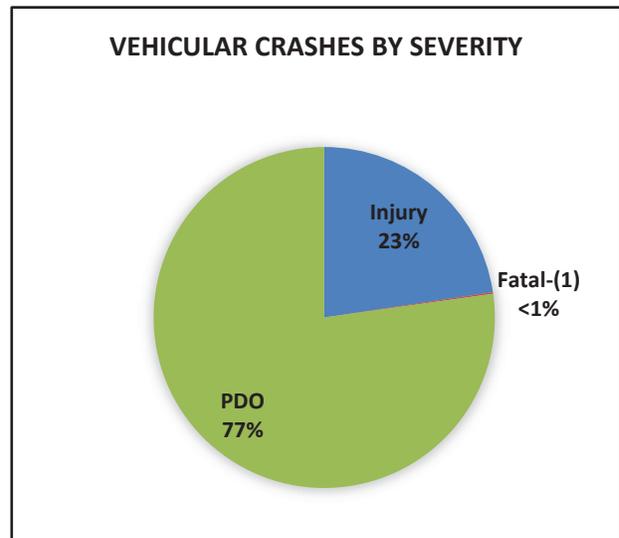


Figure 2.3.2 - S-107 Crashes by Severity

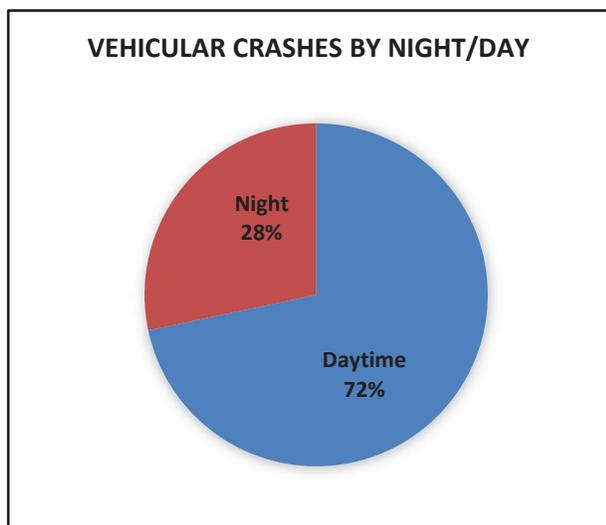


Figure 2.3.3 - S-107 Crashes by Day/Night

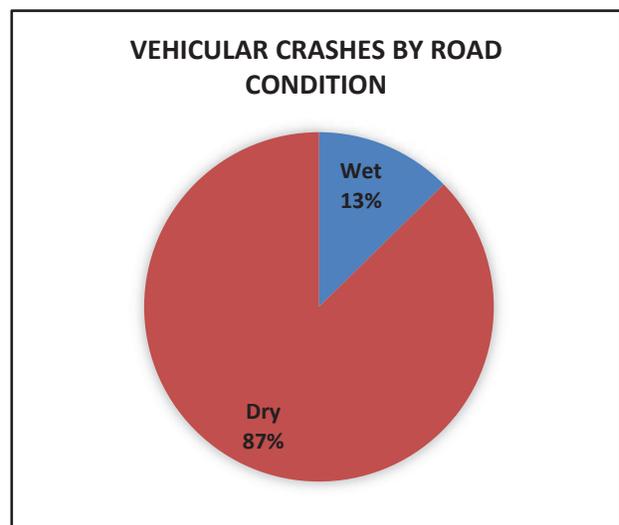


Figure 2.3.4 - S-107 Crashes by Road Condition

As seen in Figure 2.3.1, angle crashes are the most common type, at 33% of all vehicular crashes. Crashes designated as no collision with motor vehicle are typically collisions with a fixed object. Figure 2.3.2 depicts vehicular crashes by severity along the study area, which shows 23% of all crashes resulted in injuries. Around 77% of the crashes were reported to be property damage only (PDO). Two fatal crashes were reported over the entire period. One fatal vehicular crash occurred between Line Street and Columbus Street, which was reported as an angle crash, caused by disregarding signs and signals. One fatal bicycle crash occurred between George Street and Society Street. The contributing factor reported was the bicyclist being “illegally in the roadway”.

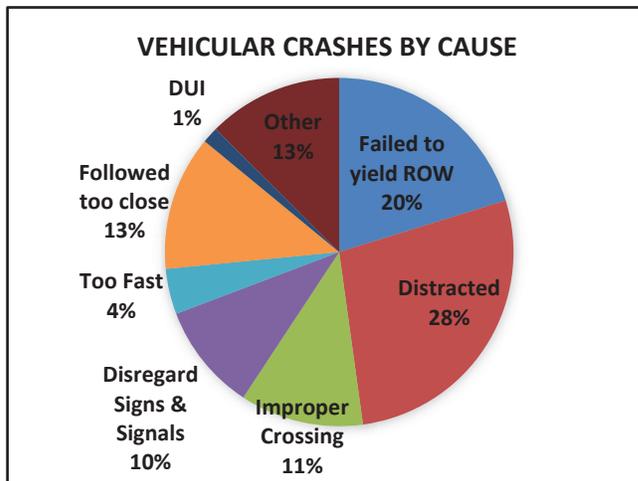


Figure 2.3.5 - S-107 Crashes by Cause

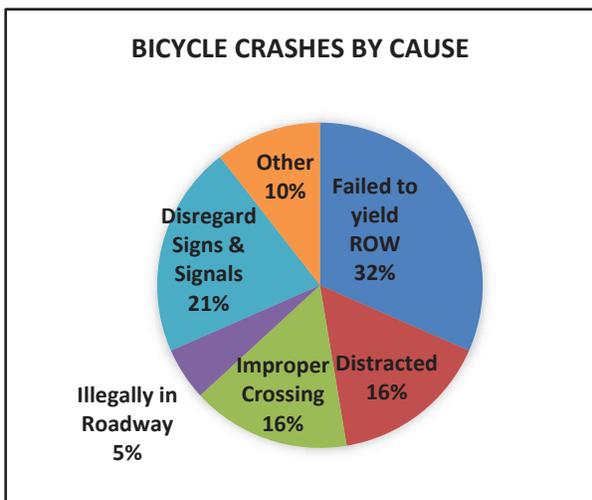


Figure 2.3.6 - S-107 Bicycle Crashes by Cause

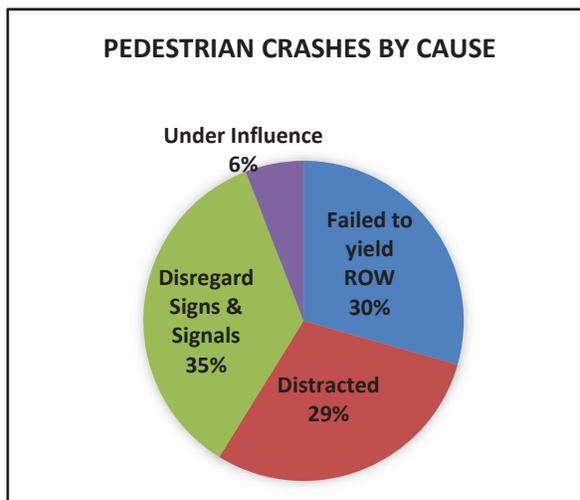


Figure 2.3.7 - S-107 Pedestrian Crashes by Cause

Figures 2.3.6 and 2.3.7 depict bicycle and pedestrian crashes by probable cause, respectively along the study area. Most of the crashes are caused by some form of improper maneuver (Failed to Yield Right of Way, Disregard Signs and Signals, Illegally in Roadway, and Improper Crossings). Bicycle and pedestrian crashes occurring due to failure to yield right of way account for 32% and 30% of the crashes respectively.

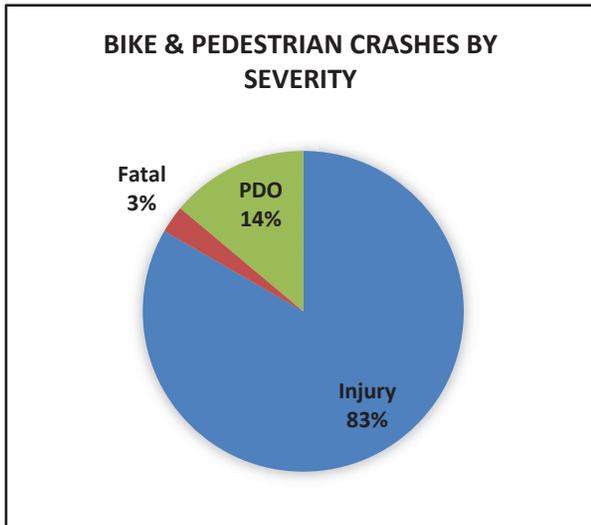


Figure 2.3.8 - S-107 Bicycle and Pedestrian Crashes by Severity

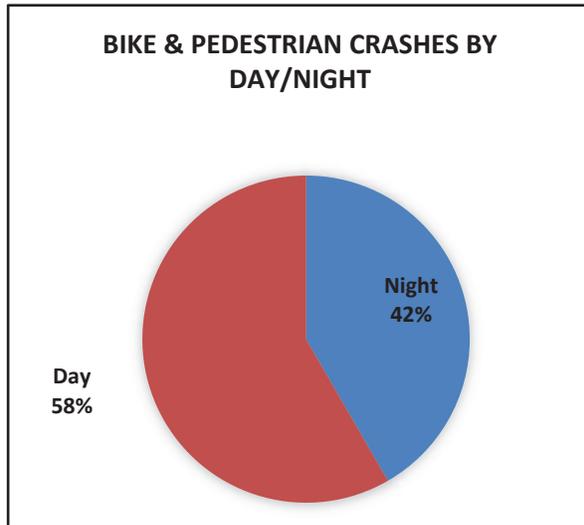


Figure 2.3.9 - S-107 Bicycle and Pedestrian Crashes by Day/Night

Figures 2.3.8 and 2.3.9 depict bicycle and pedestrian crashes by severity and day/night, respectively along the study area. 30 of the 36 crashes resulted in injuries and one bicycle crash resulted in a fatality. 42% of the bicycle and pedestrian crashes occurred at night.

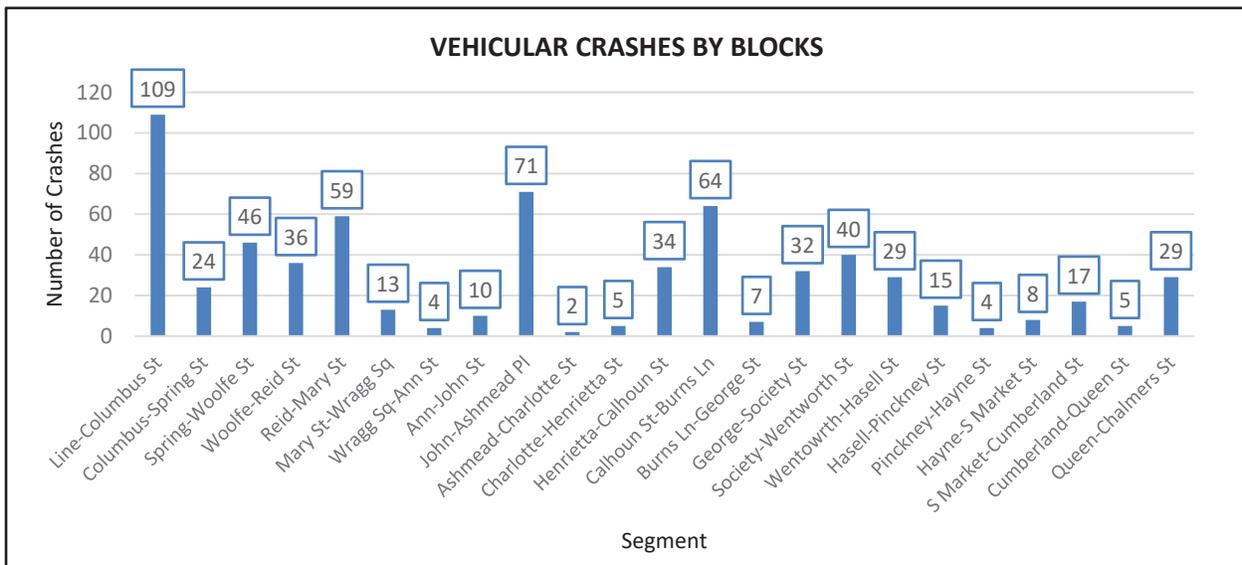


Figure 2.3.10- S-107 Vehicular Crashes by Block

Figure 2.3.10 shows that Line Street to Columbus Street had the highest number of crashes overall, followed by John Street to Ashmead Place.

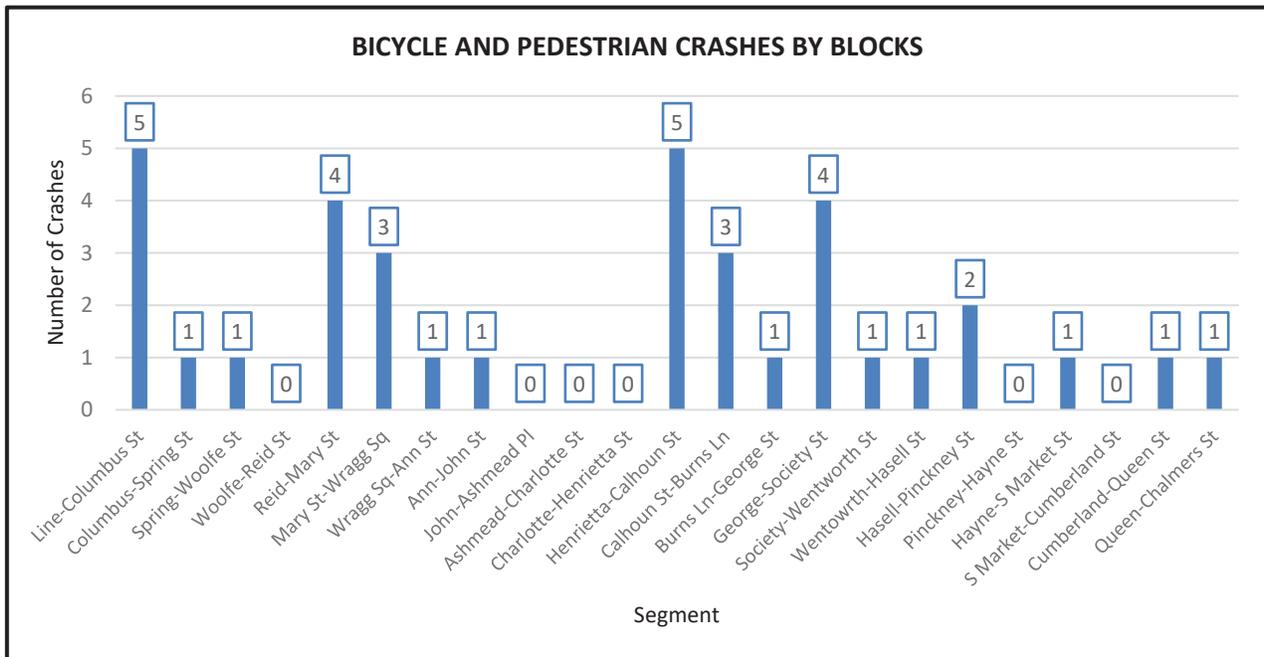


Figure 2.3.11- S-107 Bicycle and Pedestrians Crashes by Block

As seen from Figure 2.3.11, bicycle and pedestrian crashes occur along the length of the study corridor.

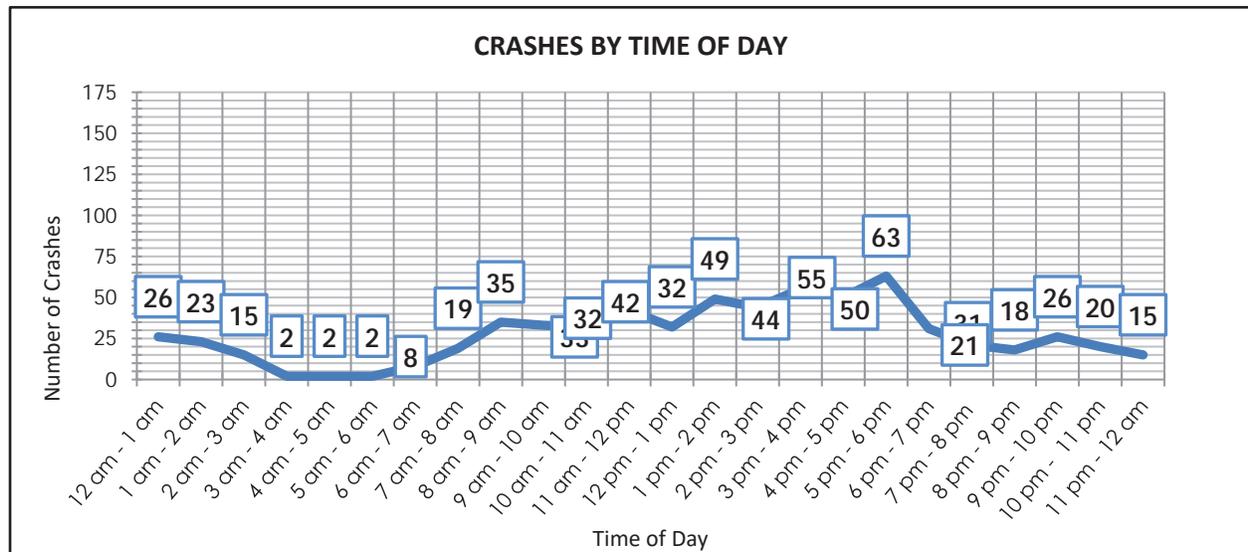


Figure 2.3.12 - S-107 Crashes by Time of Day

As seen in Figure 2.3.12, the majority of the crashes occur between 8:00 AM and 7:00 PM, but night-time crashes continue until 3:00 AM. This is likely due to higher overall traffic and pedestrian volumes, with a lot of movements around popular restaurants and bars at night. Figure 2.3.13 below shows that bicycle and pedestrian crashes occur from 6:00 AM to 1:00 AM.

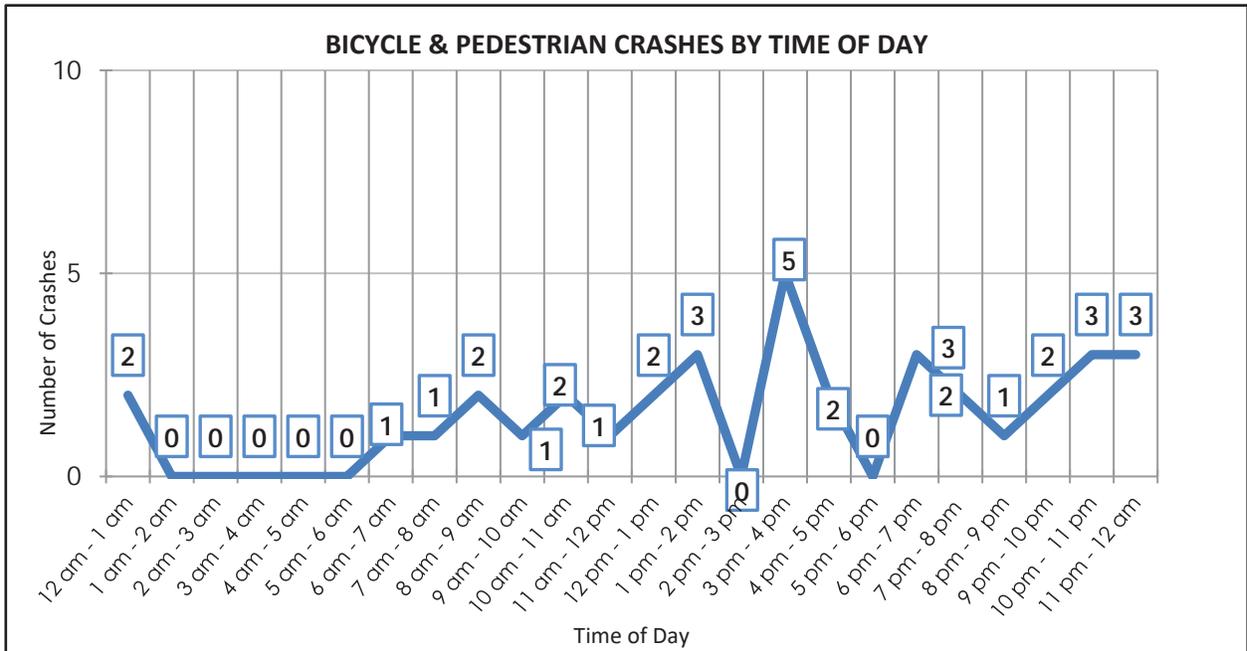


Figure 2.4.13- S-107 Bicycle & Pedestrian Crashes by Time of Day

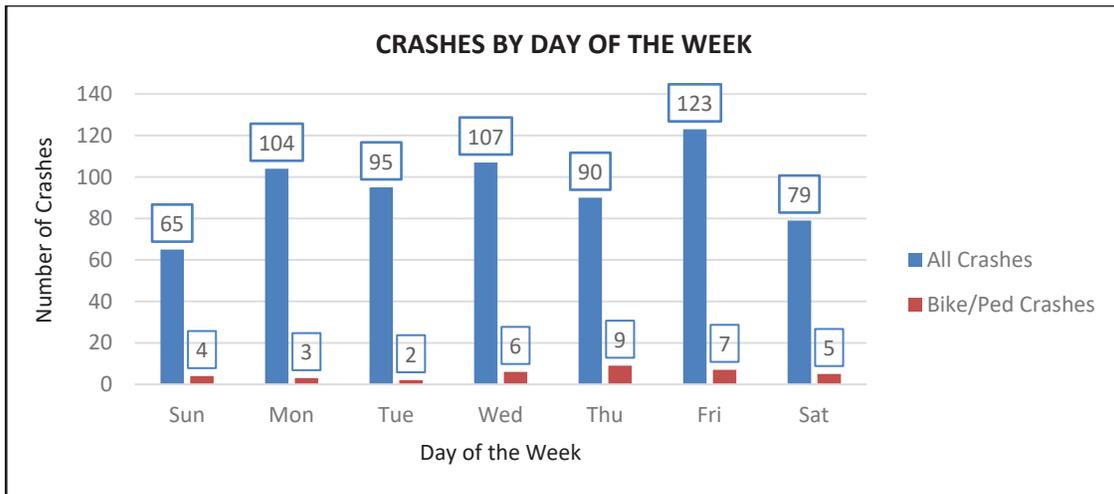


Figure 2.3.14 - S-107 Crashes by Day of the Week

As seen in Figure 2.3.14, most crashes are spread throughout the week, with the least number of crashes on Sundays. Bicycle and pedestrian crashes decrease on Mondays and Tuesdays, when retail businesses tend to decrease.

Crashes by month are depicted in Figure 2.3.15 below. Crashes decrease in the winter months when tourism declines.

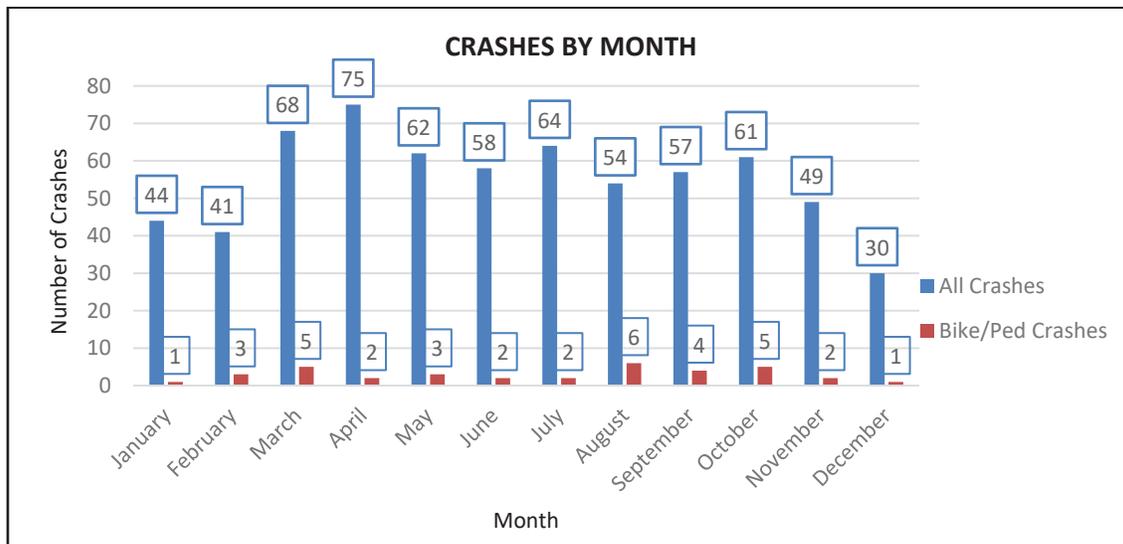


Figure 2.3.15 - S-107 Crashes by Month

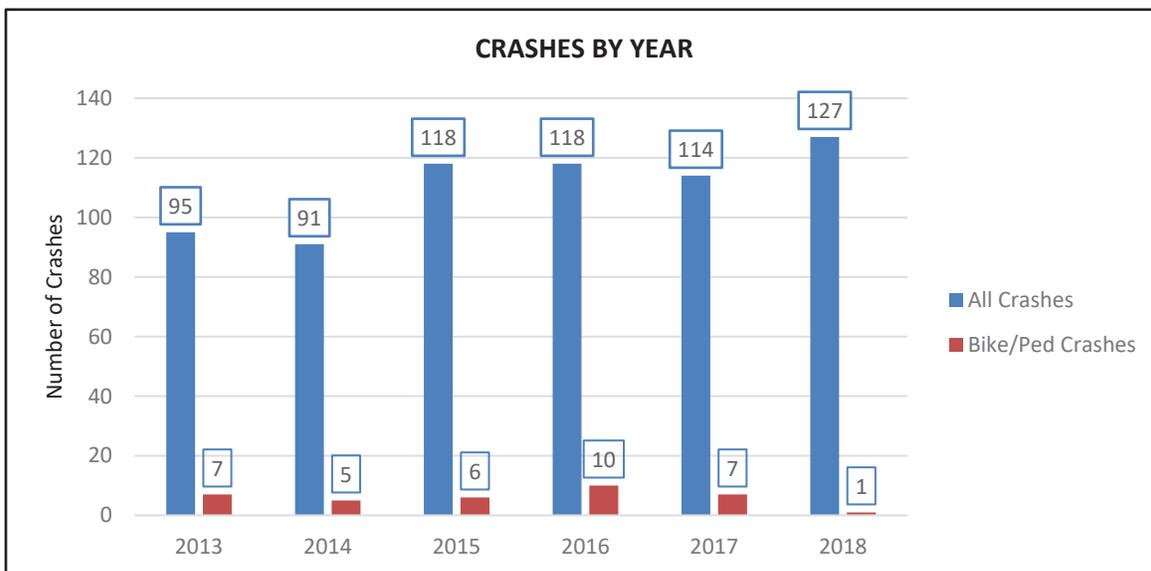


Figure 2.3.16 - S-107 Crashes by Year

Crashes by year are depicted in Figure 2.3.16. A cause for the 2018 decrease in bicycle and pedestrian crashes has not been identified.

## 2.4 SPEED STUDY

A speed study at 3 different locations along the corridor was conducted to gauge normal speed variations during non-rush hours. As seen from Figure 2.4.1 and Table 2.1, average and 85<sup>th</sup> percentile speeds are slightly higher at the north end of the study area. The posted speed limit is 30 mph from the beginning of the study area and decreases to 25 mph beyond the Calhoun Street intersection at the southern end, where bicycle and pedestrian volumes increase.

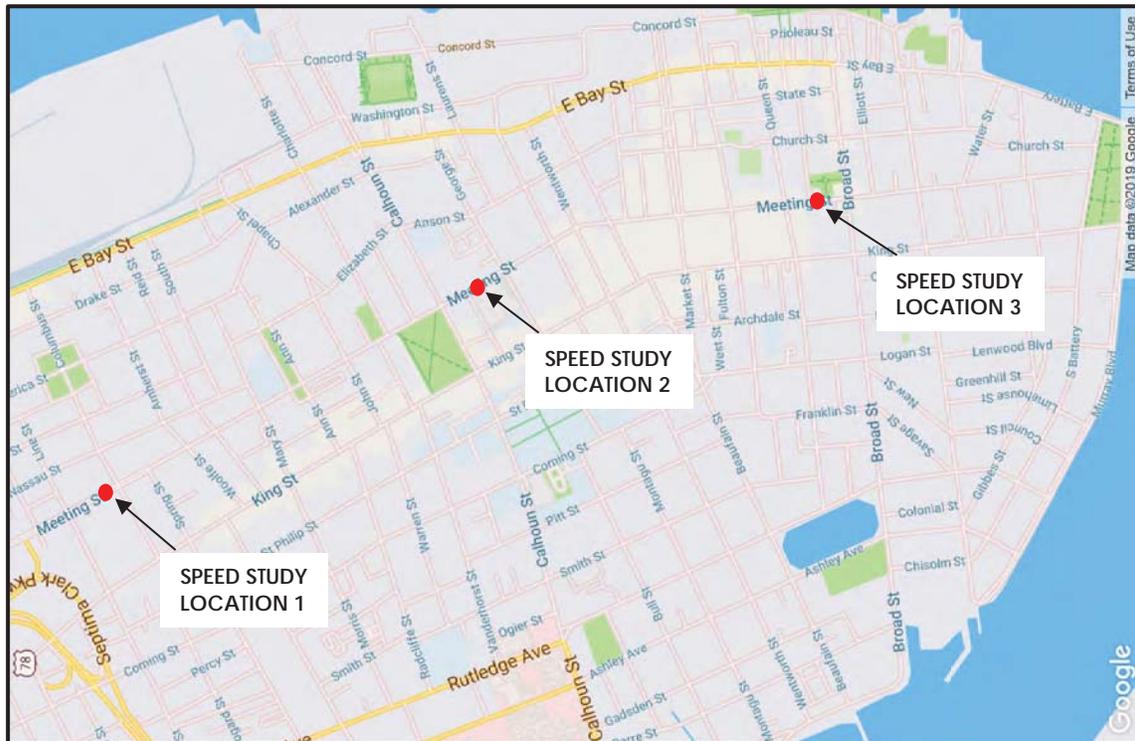


Figure 2.4.1- S-107 Speed Study Locations

Location	1	2	3
Time	11:30 to 11:45am	11:45 to 12:00pm	12:00 to 12:15pm
Limit (mph)	30	25	25
Average	22	20	20
85th percentile	24	22	22

Table 2.1 – S-107 Speed Limits & Study Results

Results of the speed study show mid-day 85<sup>th</sup> percentile speeds below the posted speed limits. This aligns with Figures 2.3.5 to 2.3.7, which shows only 4% of vehicular crashes and none of the bicycle or pedestrian crashes were caused by “driving too fast for conditions”.

## 2.5 OTHER IMPROVEMENTS AND STUDIES

### **Traffic Signal Mast Arms**

Traffic signals at the intersections of Meeting Street & Mary Street, Meeting Street & Wragg Square, Meeting Street & John Street and Meeting Street & Hasell Street had pedestal mounted signal heads replaced with mast arms between October 2015 and October 2016.

### **Lowcountry Rapid Transit (LCRT) Project**

BCDCOG's LCRT project is planned for the peninsula. One of the alternative alignments under consideration routes the project along Meeting Street, from Line Street to Calhoun Street.

### **Holy Spokes**

The Charleston bike share system, Holy Spokes, was launched in May 2017. Hubs on or closest to Meeting Street include 367 Meeting Street, 1883 Ann Street, and 80 Broad Street.

### **People Pedal Plan**

The City's People Pedal Plan provides recommendations for bicycle and pedestrian improvements throughout the peninsula (Figure 2.5.1). The plan does not include improvements for Meeting Street itself, but only for side streets that cross it. Those side street improvements will occur as separate projects, with the S-107 recommendations in the study developed to avoid conflicts with those improvements. The plan shows 85<sup>th</sup> percentile speeds that are close to those listed in this study. In both cases, the speed data collected only represents short periods of time for a given day. The plan is shown in Appendix F.

### **Charleston Comprehensive Parking Study**

Published in January 2019, the study provided a comprehensive analysis and set of recommendations for the city's parking system.



Figure 2.5.1- People Pedal Plan

## 2.6 EXISTING ROADWAY SAFETY FEATURES

The following were identified as positive measures and features that are already in place within the study area that enhance road user safety:

- Continuous sidewalks: Sidewalks within the corridor are continuous and provide a generally comfortable walking environment.
- Vehicular speed along the corridor is largely controlled.
- Sight triangles: Intersection sight distance was not obstructed by signs or other obstacles for most of the intersection approaches.
- Crosswalks are present at most intersections, including ladder-style crosswalks in some intersections
- Pavement markings: The roadway markings and existing pedestrian crosswalks were in generally good condition.
- Sidewalks at intersections have ramps.
- Existing bus stops were well marked and appear to be heavily used
- Meeting Street has adequate capacity and width for vehicular traffic.
- Most traffic signals have pedestrian signals
- Acceptable traffic volumes for existing lane alignments.
- Good access control at most locations.
- The corridor has lighting.

## 3.0 RECOMMENDATIONS

Recommendations for improving safety along S-107 are provided under two categories:

1. Improvements to be applied along the corridor
2. Intersection specific improvements

### 3.1 CORRIDOR IMPROVEMENTS

This section provides findings and recommendations for improvements to be applied along the S-107 corridor.

#### BICYCLE & PEDESTRIAN ACCOMMODATIONS

This study recognizes the need to provide safe pedestrian crossings that reflect pedestrian routing demand. Efforts are made to provide direct crossing routes as feasible. The exhibits on the following page show existing and proposed pedestrian crossings for the S-107 corridor using signalized crosswalks, stop controlled crosswalks, pedestrian refuge islands, curb extensions, and Rectangular Rapid Flashing Beacons (RRFBs). These safety countermeasures address both side street approach crossings and mainline S-107 crossings. Each countermeasure is recommended where found to be applicable per FHWA, MUTCD, NACTO guidelines, and engineering judgement.

FHWA guidance states that for multi-lane roadways like S-107 with ADT volumes over 10,000 vehicles per day, uncontrolled marked crosswalks alone are typically not sufficient. More substantial crossing improvements such as refuge islands, Pedestrian Hybrid Beacons (PHBs), and RRFBs are also needed to prevent an increase in pedestrian crash potential. Therefore, each S-107 crossing shown includes one of these measures.

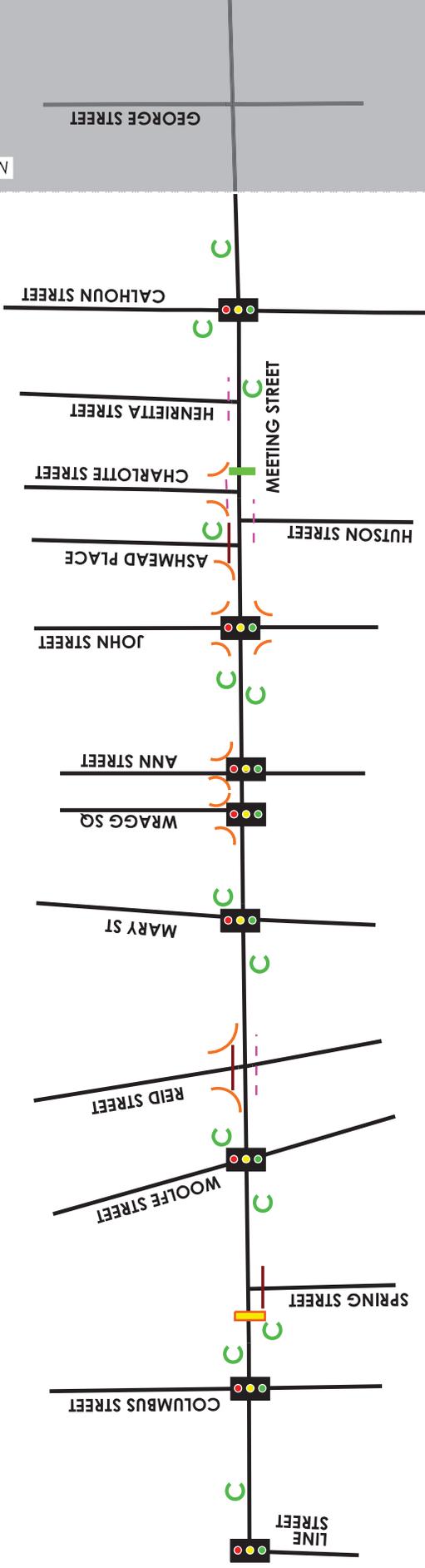


*S-107 Midblock Typical Section*

The following exhibits focus solely on pedestrian crossing routes. For simplicity, they exclude Leading Pedestrian Intervals, ramps, and various other safety improvements listed elsewhere in this report.

# MEETING STREET PEDESTRIAN CROSSINGS

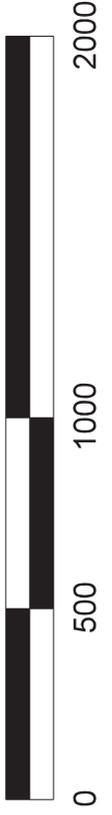
MATCHLINE A



## LEGEND

-  SIGNAL WITH CROSSWALK UPGRADES
-  STOP-CONTROLLED CROSSWALK (UPGRADE)
-  STOP-CONTROLLED CROSSWALK (NEW)
-  PEDESTRIAN REFUGE ISLAND (NEW)
-  CURB EXTENSION (NEW)
-  RRFB (NEW)
-  CARTA BUS STOP

SCALE IN FEET

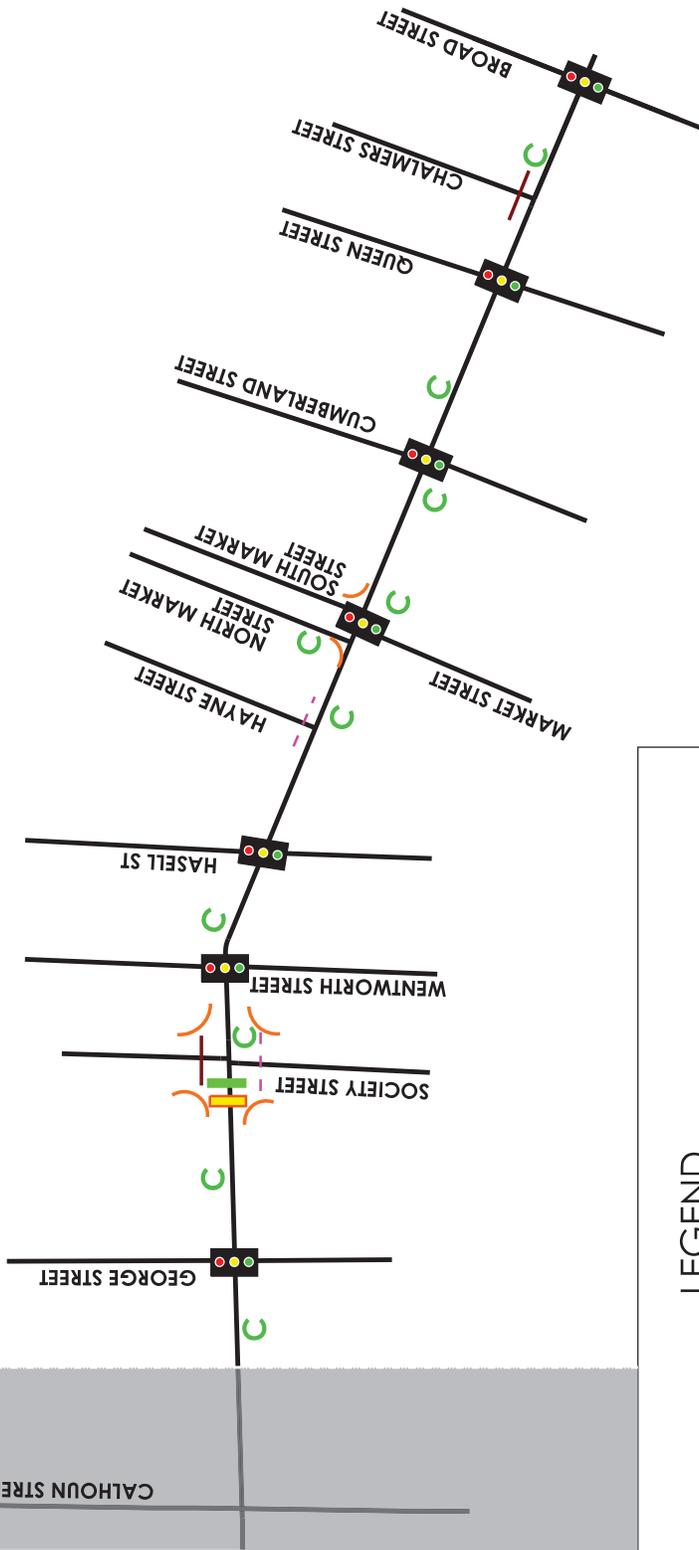


SHEET 1

# MEETING STREET PEDESTRIAN CROSSINGS

MATCHLINE B

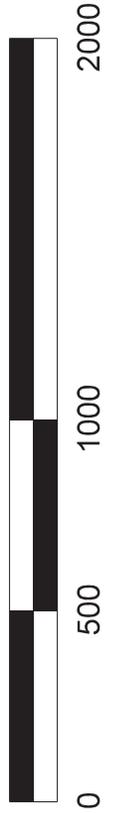
CALHOUN STREET



## LEGEND

-  SIGNAL WITH CROSSWALK UPGRADES
-  STOP-CONTROLLED CROSSWALK (UPGRADE)
-  STOP-CONTROLLED CROSSWALK (NEW)
-  PEDESTRIAN REFUGE ISLAND (NEW)
-  CURB EXTENSION (NEW)
-  RRFB (NEW)
-  CARTA BUS STOP

SCALE IN FEET



SHEET 2



## BICYCLE & PEDESTRIAN ACCOMMODATIONS

### FINDINGS:

Crosswalks are missing across several stop-controlled side streets approaches.



*Missing crosswalk at Reid St.*

### IMPROVEMENTS:

Consider adding ladder-style crosswalks to the side street approaches that don't have them (or decorative stamped asphalt crosswalks) already. (Approximately 6 approaches)

*Typical pedestrian crash reduction of 50% for installation of crosswalks*

### FINDINGS:

Some crosswalks along the corridor could be shortened to reduce pedestrian exposure time while crossing.

### IMPROVEMENTS:

Consider constructing curb extensions at intersection corners as shown in the Pedestrian Crossings map to reduce crosswalk lengths. The following pages show two representative concept sketches of the curb extensions. Each curb extension should be designed to account for CARTA bus turning movements, drainage, and utilities. In order to materially reduce crosswalk lengths, some crosswalks will need to be relocated away from the intersection as shown in the concepts. The concepts show raised concrete curb extensions, but thermoplastic paint and bollards may be considered as well. The paint and bollard option simplifies construction of the extension itself, but still may require crosswalk relocation.

Truck turning movements, drainage, and utility issues may prove to make curb extensions prohibitive at some locations. Detailed design and coordination will be needed prior to implementation.

# CURB EXTENSIONS AT ANN STREET

CATCH BASIN (TYP.)

ANN ST

PROPOSED CURB EXTENSION (TYP.)

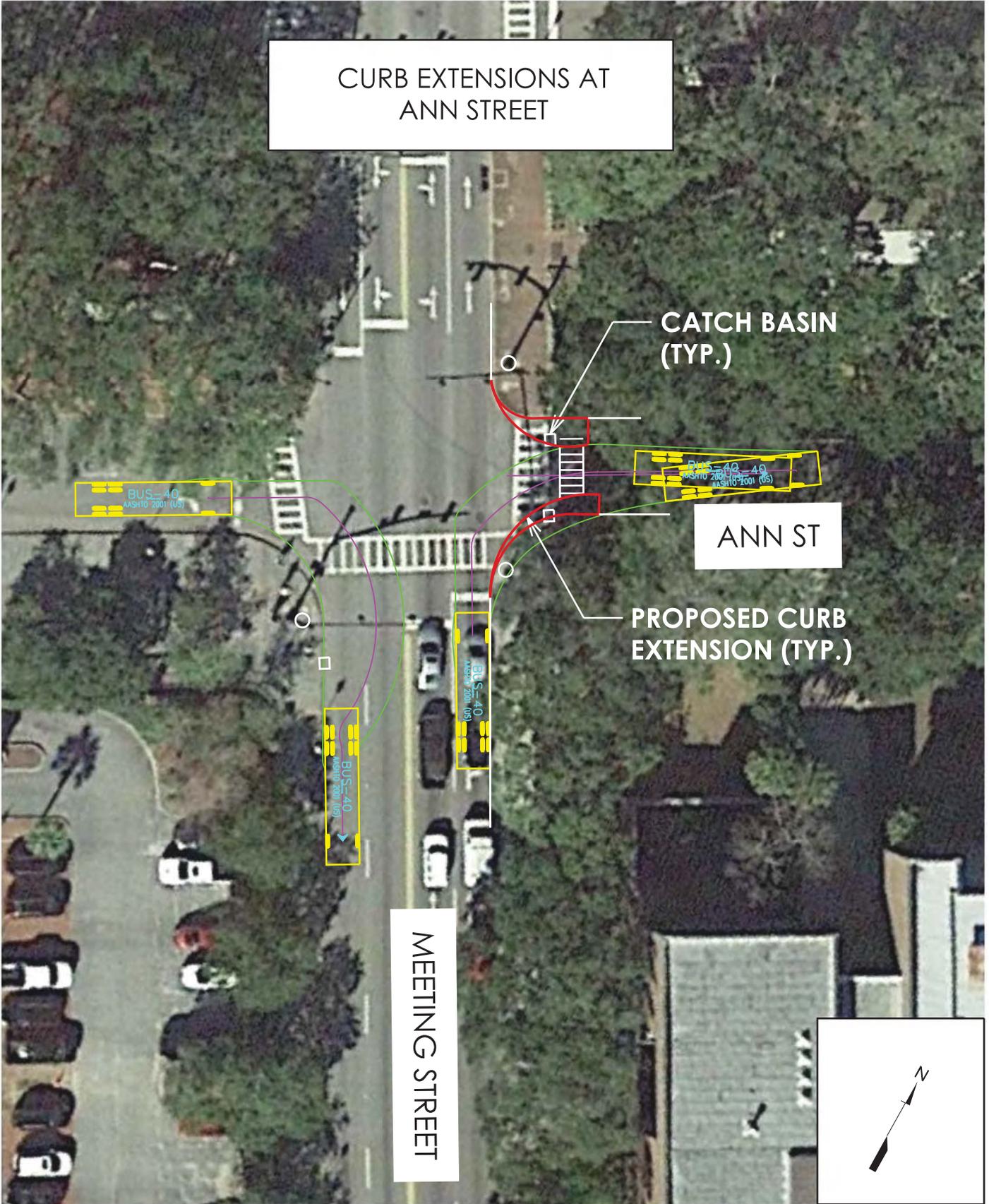
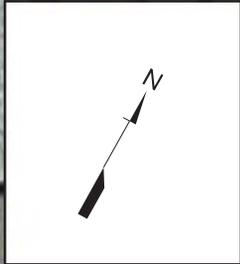
BUS-40  
ASH10-2001 (US)

BUS-40  
ASH10-2001 (US)

BUS-40  
ASH10-2001 (US)

BUS-40  
ASH10-2001 (US)

MEETING STREET



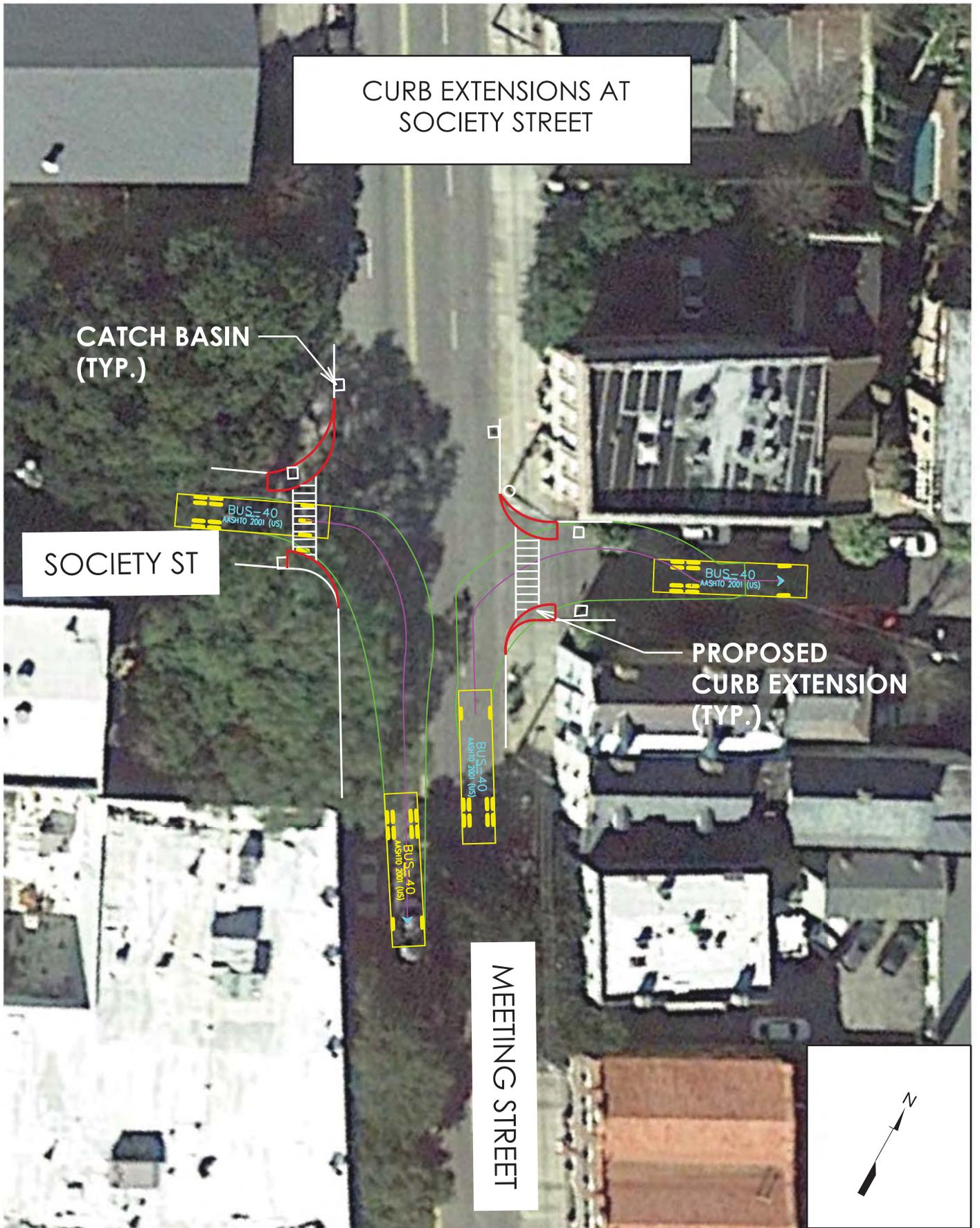
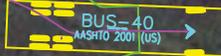
CURB EXTENSIONS AT SOCIETY STREET

CATCH BASIN (TYP.)

SOCIETY ST

PROPOSED CURB EXTENSION (TYP.)

MEETING STREET



## BICYCLE & PEDESTRIAN ACCOMMODATIONS

### FINDINGS:

Pedestrians crossing the signalized intersections are dependent on right turning vehicles yielding to them. Also, more visible crosswalks could help alert drivers of their presence.

### IMPROVEMENTS:

To enhance pedestrian safety, consider implementing Leading Pedestrian Intervals (LPIs) for the signalized pedestrian crossings. LPIs give pedestrians the opportunity to enter a signalized intersection 4–7 seconds before vehicles are given green indications. With this head start, pedestrians can better establish their presence in the crosswalk before vehicles begin entering the intersection. A traffic analysis study is needed to verify LPIs will not materially affect congestion and delays.

*Typical pedestrian crash reduction of 59% for installation of LPIs.*

### FINDINGS:

Detectable warning surfaces are missing at several locations throughout the corridor.



*Sidewalk without detectable warning surface at John St.*

### IMPROVEMENTS:

Consider adding detectable warning surfaces on ADA ramps at the signalized intersections and unsignalized side street crossings. (Approximately 8 ramps)

### FINDINGS:

Bicyclists routinely use S-107, but it has no designated bicycle facilities. In the 7-year period from 2012-2018, 25 bicycle crashes occurred.

### IMPROVEMENTS:

With nominal 10-foot lane widths, constrained right of way, and high traffic volumes, creation of dedicated bicycle facilities is difficult. Also, the LCRT project alternate requires full width from curb to curb to accommodate buses. The city's People Pedal Plan did not call for bicycle improvements on S-107, but specified them for other North-South Streets instead. This study concurs with the People Pedal Plan, that improving alternate routes for bicycle accommodations is the most viable solution for improving safety on S-107.

### PAVEMENT MARKINGS AND SIGNING

**FINDINGS:**

Pavement marking and RPM markings in several sections are worn out.



*Existing pavement markings worn out*

**IMPROVEMENTS:**

Consider upgrading pavement markings and RPM throughout the corridor, including travel lane and bike lane markings.

*Typical crash reduction of 5% for installation of RPMs.*

**FINDINGS:**

Some stop bars appear too far from their respective crosswalks.



*Stop bar placement at Meeting & Line St intersection (SB)*

**IMPROVEMENTS:**

Evaluate relocating stop bars based on turning movement templates. Locations include southbound S-107 approaches at: Line Street, Woolfe Street, Mary Street, Wragg Square, Calhoun Street and George Street. The upcoming resurfacing project should cover this southward from Wentworth St to South Battery. However, coordination with recommendations of this study is needed.

*Typical crash reduction of 5% for stop bar relocation.*

**FINDINGS:**

The speed data suggests the 30mph speed limit posting might be reduced to 25mph.

**IMPROVEMENTS:**

Perform a complete speed study to further evaluate speeds. Consider reducing speed limits, if determined appropriate.

## MAINTENANCE

### FINDINGS:

Some sidewalk and pedestrian ramps have debris and/or need repairs. Additionally, tree limbs along the corridor block visibility for drivers.



*Sidewalk at Mary St approach needs to be repaired.*

### IMPROVEMENTS:

Consider repairing and cleaning sidewalks. Also, consider pruning trees for better visibility.

## ACCESS MANAGEMENT

### FINDINGS:

Church's Chicken at the intersection has four closely spaced driveways, which create turning movement conflicts.



*4 existing driveways outside Church's Chicken.*

### IMPROVEMENTS:

Consider closing the two driveways closest to the intersection.

### FINDINGS:

Several rear-end, sideswipe and angle crashes were observed between Line and Columbus Street (96) and Columbus-Spring St. (22), likely due to illegal turns and movements by drivers, pedestrians and bicyclists. The northbound left-turn storage onto Columbus St. is reported to be fully adequate.

### IMPROVEMENTS:

Consider constructing a raised median between Columbus and Spring Street, as shown in the following exhibit. Extend the median southward and channelize it to accommodate northbound left turns onto Spring Street but enforce left-turn restrictions from Spring St. This can help enforce Right-in/Right-out access for the western driveway as intended. It will also convert the two eastern driveways, where left turns involve crossing the left turn lane. The concrete median can be used to provide a pedestrian refuge. It appears this median would not conflict with the LCRT project alternate, but it should be verified before implementation. The northbound left-turn storage onto Columbus Street is reported to have adequate storage capacity without queueing into the striped median.

*Typical driveway related crash reduction of 40% for access management improvements.*



Proposed Raised Median Concept Sketch

## DRAINAGE

### FINDINGS:

Storm drain inlets are in the roadway, causing drivers and cyclists to avoid using 2-3 feet of the outside travel lanes. This can contribute to sideswipe crashes. Approximately 9 of 24 bicycle crashes occurred at midblock locations involving through movement vehicles. Outside lane narrowing may contribute to these crashes.



*Existing storm drain inlets on the travel lane.*

### IMPROVEMENTS:

Consider replacing the existing inlet grates with bicycle friendly grates that are flush with the pavement surface.

## TRAFFIC SIGNALS AND SIGNING

### FINDINGS:

Certain intersection signals (Line St., Woolfe St and Market St.) are currently programmed to flash at night, beginning at 10pm.



*Existing Line St. signal heads.*

### IMPROVEMENTS:

Consider programming these intersection signals to have timed phasing to align with national practices. Cycle lengths will be short.

*Typical crash reduction of 30% for signal timing changes.*

### TRAFFIC SIGNALS AND SIGNING

#### FINDINGS:

The following signalized intersections lack reflective backplates: Line St., Columbus St., Woolfe St./Amherst St., Calhoun St., George St. and Wentworth St.



*Existing Calhoun St. signal heads without retroreflective backplates.*

#### IMPROVEMENTS:

Consider installing reflective backplates to improve signal head visibility.

*Typical total crash reduction of 15%.*

#### FINDINGS:

The following intersection approaches appear to have 8" signal heads, which are no longer MUTCD compliant:

- Market Street
- Cumberland Street
- Queen Street
- Broad Street

#### IMPROVEMENTS:

Evaluate the viability of replacing each approach with 12" signal heads as per MUTCD requirements. Data on utility attachment heights and vertical clearances will be needed, as well as coordination with Dominion Energy and telecom providers.

## EDUCATION AND OUTREACH

### FINDINGS:

Several of the bicycle and pedestrian crashes list “Improper Crossing” or “Wrong Side” as the contributing factor. These crashes and possibly others result in part because of cyclists and pedestrians crossing either at undesignated locations or at undesignated times (when pedestrian signal head doesn’t display the “Walk” signal). Likewise, other crashes appear to result from drivers failing to yield to cyclists and pedestrians. Improvements in behavior of all users are needed.

### IMPROVEMENTS:

Education and outreach programs for bicycles and pedestrians are designed to alert roadway users on the importance of safe travel practices, educate them on safe practices, and encourage active transportation modes for a healthy lifestyle. Typically, these programs are local initiatives, led by a combination of local governments, schools, and community groups. Various municipalities across the US have developed and implemented their own education and outreach programs. Among the typical elements that may be appropriate for this corridor area include:

- Public Awareness Campaigns – Intermittent educational / advertising programs that notify the public on the program’s initiatives and importance. They can be delivered through local media such as radio, television, billboards, and transit vehicle ads, as well as non-media methods such as classroom programs and partnering with community events. Targeting specific age and ethnic groups has demonstrated effective results for some programs. Targeted campaigns have helped pedestrians understand how to interpret traffic signals, how to be more visible at night, how to be more aware of turning vehicles at intersections, and how to travel defensively through techniques like making eye contact with a driver. For drivers, these campaigns often focus on yielding to pedestrians and expanding awareness of bicycling and crosswalk laws.
- Public Service Announcements (PSAs) – Social media, radio, and/or television are used to promote safe cycling, walking, and driving behaviors.
- Promotional Items – Tote bags, T-shirts, magnets, coffee cup sleeves, or other items with printed logos and content can be distributed to the public.
- Partnerships – Government organizations, schools, non-profits, universities, businesses groups, and community groups combine efforts to interact with the public.
- Community Events – Safety education can be included at public events like festivals, school events, and health fairs.
- Skills Practice – Lectures, videos, and/or on-street simulations for college students, school children, and older adults.
- How-To Guides – Printed brochures or internet content.
- Budgeting – Many program components require funding. Social media and volunteer efforts can be very cost effective.

## ENFORCEMENT

### FINDING:

Crash data involving bicyclists and pedestrians show that most crashes were caused by some form of improper maneuver by drivers, pedestrians, or bicyclists (Failed to Yield Right of Way, Disregard Signs and Signals, Wrong Way, Darting or Illegal Crossings). Each of these above can potentially be mitigated with targeted enforcement.

### IMPROVEMENTS:

While design improvements can provide safer infrastructure, enforcement is still beneficial to change these behaviors. Increased enforcement can play a critical role in the reduction of crashes along the corridor.

## 3.2 INTERSECTION SPECIFIC IMPROVEMENTS

The following sections contain findings and recommendations for improvements at individual intersections.

### **S-107 and Line St.:**

Findings:

- There are no pavement markings at the repaved eastern approach of Line St intersection.
- The sidewalk in front of Greystar Corp is damaged.
- This intersection lacks pedestrian signal heads

Improvements:

- Install pavement markings at the repaved eastern approach of Line St intersection.
- Repair damaged sidewalk in front of Greystar Corp.
- Install countdown pedestrian signal heads at this intersection.

*Typical bicycle and pedestrian crash reduction of 70% for installation of pedestrian signal heads.*

### **S-107 and Columbus St.:**

Findings:

- Sight distance for Columbus St. eastbound is limited by adjacent building. The through /right lane has experienced 10 right angle crashes.

Improvements:

- Install a “No Right Turn on Red” sign for this movement.

*Typical angle crash reduction of 30% for installation of “No Right Turn on Red” sign.*

### **S-107 and Woolfe St./Amherst St.:**

Findings:

- This intersection lacks pedestrian signal heads. During site observations, very few pedestrians used the intersection’s crosswalks to cross S-107. Instead, they continued south along S-107 before finding a gap in traffic to cross S-107. Pedestrians were observed to cross S-107 at the Mary Street signalized crosswalks, but not at the Woolfe Street crosswalks.

Note: A bus shelter install has been identified for Woolfe St. This may be an opportunity for education of the proper use of crosswalks.

Improvements:

- Install countdown pedestrian signal heads at this intersection, to encourage safe crossing of S-107. Subsequent evaluation may be warranted to confirm the issue is resolved as intended. Otherwise, an additional crosswalk with RRFB at the Reid Street intersection may be considered.

*Typical bicycle and pedestrian crash reduction of 70% for installation of pedestrian signal heads.*

**S-107 and Reid St.**

## Findings:

- The eastern approach of Reid St. has no crosswalk.

## Improvements:

- Add a "No Right Turn" sign for northbound S-107 to help enforce one-way operation of Reid St.
- Add a ladder-style crosswalk to the eastern approach of Reid St. Also, add a R1-6 Yield to Pedestrian sign on-street.

**S-107 and Mary St.:**

## Findings:

- Sidewalk ramp in the NW corner of the intersection is damaged. Also, there are no detectable warning surfaces at the NE and SW corners of the intersection.
- Sidewalk is uprooted in front of the former SOL Southwest Kitchen.
- Mary Street eastbound has limited sight distance due to buildings.

## Improvements:

- Repair damaged ADA ramps and add missing detectable warning surfaces at the Mary St intersection.
- Repair uprooted sidewalk
- Clean the W3-3 sign between Reid St and Mary St. or replace it.
- Add sign to restrict right turn on red for the Mary Street eastbound approach.

**S-107 and John St.:**

## Findings:

- The outside southbound lane turns into a right turn lane onto John St., catching drivers on Meeting St. off guard.
- There are no detectable warning surfaces in the NW and SW corners of the intersection. Also, sidewalk ramp at the NE corner needs to be repaired

## Improvements:

- Improve driver notification by adding right turn arrows and Right Turn ONLY symbols. Also add "Right Lane Must Turn Right" sign.
- Install detectable warning surfaces at the NW and SW corners of the intersection. Repair sidewalk ramp at the NE corner.

**S-107 and Charlotte St:**

## Findings:

- The uncontrolled crosswalk near the Charlotte St intersection has alternating signals that flash constantly, which appears to cause drivers to not notice when a pedestrian is actually present. Additionally, parking spots adjacent to the uncontrolled crosswalk at the Charlotte St intersection confuse drivers and hinder visibility.

## Improvements:

- This crossing has been evaluated for crosswalk improvements. The existing crosswalk is a high visibility crosswalk with alternating signals that flash constantly, and W11-2 Pedestrian signs with W16-7P diagonal arrow signs. S-107 has two lanes northbound, one lane southbound with adjacent parking, and is currently posted for 30 mph. To improve the crosswalk, a Rectangular Rapid Flashing Beacon (RRFB) is considered. Among the guidance documents used were:
  - FHWA's Field Guide for Selecting Countermeasures of Uncontrolled Pedestrian Crossing Locations
  - NCHRP Report 562: Improving Pedestrian Safety at Unsignalized Crossings.

FHWA's Field Guide provides a matrix with guidance on when each safety countermeasure is a candidate treatment for a marked, uncontrolled crossing location and when each countermeasure should be considered. The matrix lists an RRFB as a candidate treatment for this scenario.

The Field Guide gives additional considerations for the use of RRFBs:

- Noted conflicts at crossing locations
- Inadequate conspicuity/visibility of the crosswalk and pedestrian
- Insufficient pedestrian separation from traffic

NCHRP Report 562 provides the following guidance on implementing an RRFB:

- A pedestrian beacon is proposed to be considered for installation at a midblock location that does not meet other traffic signal warrants to facilitate pedestrian crossings. The pedestrian phase for a pedestrian beacon would be activated by a pedestrian.
- If gaps in traffic are not adequate to permit reasonably safe pedestrian crossings, or if the speed for vehicles approaching on the major street is too high to permit reasonably safe street crossings for pedestrians, or if pedestrian delay is excessive.

A two-hour pedestrian count study was performed with the following results:

15-min Intervals	Pedestrian Counts
1:30 to 1:45 pm	3
1:45 to 2:00 pm	8
2:00 to 2:15 pm	6
2:15 to 2:30 pm	7
2:30 to 2:45 pm	5
2:45 to 3:00 pm	3

3:00 to 3:15 pm	5
3:15 to 3:30 pm	4
<b>TOTAL</b>	<b>41</b>

Peak Hour Count: 26 pedestrians (1:45pm to 2:45pm)

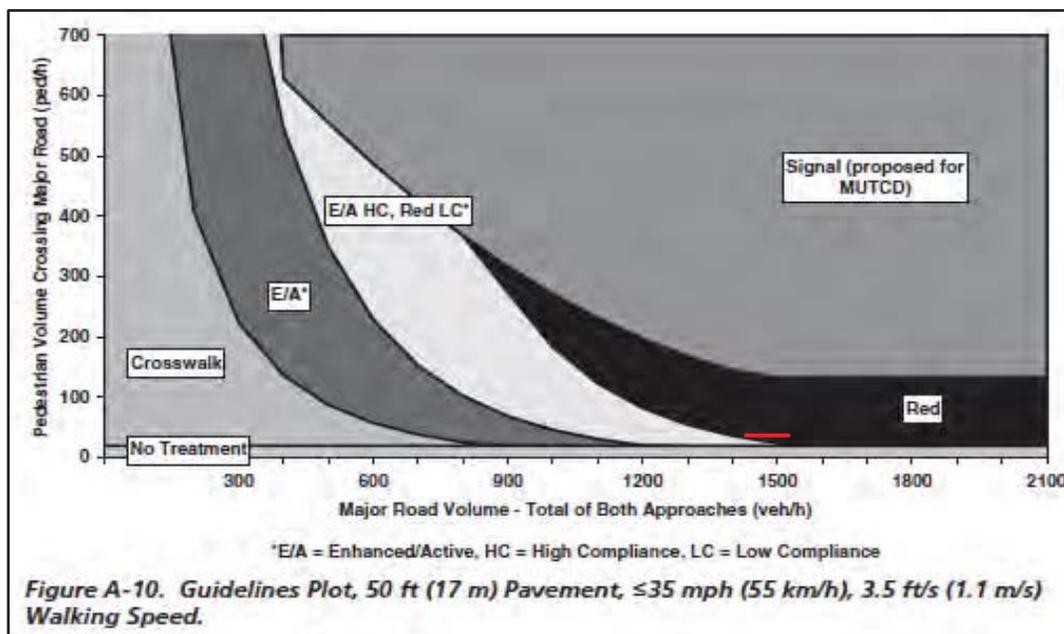


Figure 3.2.1- Pedestrian Volume Analysis (NCHRP report)

— Count Period: 1:45 PM to 2:45 PM, with estimated volume

Based on these results,

- An RRFB appears warranted and is recommended. Also, Yield bars with R1-5 Yield Here to Pedestrian signs are recommended on Meeting St. approaching the crosswalk at this location.  
*Typical pedestrian crash reduction of 50% for installation of RRFB.*
- Also, consider removing parking space adjacent to the uncontrolled crosswalk to improve visibility.

**S-107 and Calhoun St:**

Findings:

- The northbound left turn lane queues back into through lane.
- The NW corner of the intersection is susceptible to flooding during heavy rains.

Improvements:

- Restripe northbound left turn lane to extend its storage.

- Evaluate ramp adjustments at the NW corner of the intersection to prevent flooding.
- Perform a traffic study to check if an all pedestrian signal phase is warranted. If implemented, upgrades to the intersection pavement and crosswalks would be warranted.

### **S-107 and George St:**

#### Findings:

- The intersection has pedestrian push buttons, but no pedestrian signal heads. The City of Charleston cited issues with push buttons getting damaged by pedestrians.
- Trees limit visibility for the drivers.
- Sidewalk at the southeastern corner is damaged from encroachment by truck traffic.

#### Improvements:

- As per SCDOT, this intersection is being upgraded with pedestrian signal heads and push buttons, with anticipated completion by December 31, 2019. The design plan was completed by the City of Charleston and the required equipment will be installed by SCDOT.  
*Typical pedestrian crash reduction of 50% for installation of pedestrian signal heads.*
- Trim tree branches at the western side of the George St intersection to improve visibility.
- Replace damaged sidewalk with 6" concrete and compacted subgrade.

### **S-107 and Society St.:**

#### Findings:

- There is no crosswalk at the westbound approach of the intersection.
- S-107 and Society Street is a four-legged intersection where crossings would naturally occur, but there is no dedicated crossing for S-107.
- Society Street eastbound has limited sight distance to the north due to parked vehicles and limited sight distance to the south due to trees and curved roadway alignment.

#### Improvements:

- Add crosswalk at the westbound approach of the intersection. Also, add a R1-6 Yield to Pedestrian sign on-street.
- This crossing has been evaluated for a Rectangular Rapid Flashing Beacon (RRFB). Its evaluation is similar to that of Charlotte Street intersection crossing.

A two-hour pedestrian count study was performed with the following results:

15-min Intervals	Pedestrian Counts
4:00 to 4:15 pm	3
4:15 to 4:30 pm	6
4:30 to 4:45 pm	0

4:45 to 5:00 pm	3
5:00 to 5:15 pm	8
5:15 to 5:30 pm	12
5:30 to 5:45 pm	5
5:45 to 6:00 pm	6
<b>TOTAL</b>	<b>43</b>

Peak Hour Count: 31 pedestrians (5pm to 6pm)

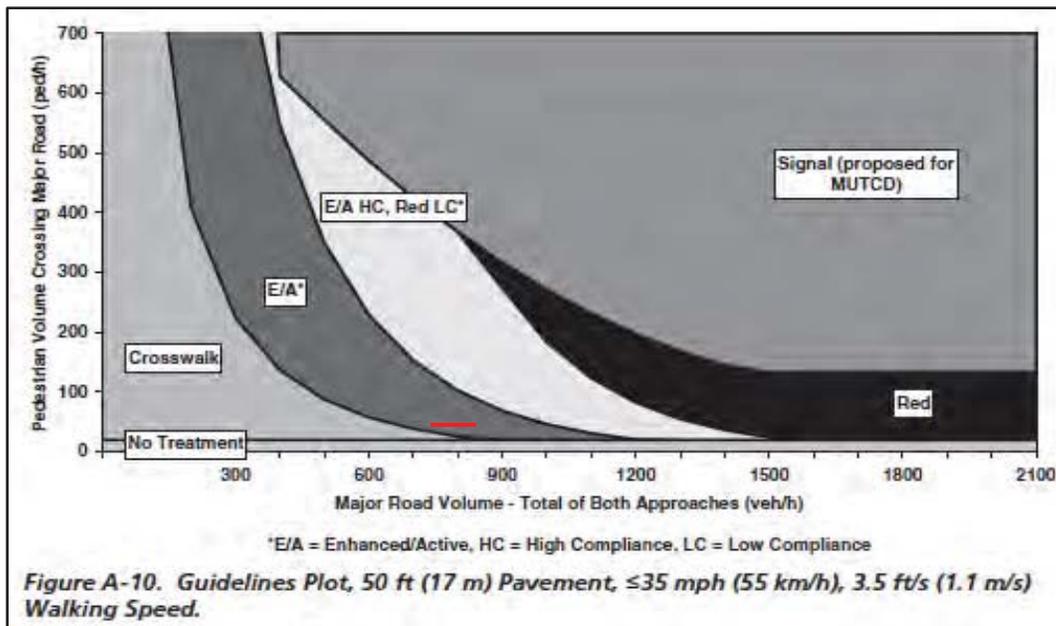


Figure 3.2.1- Pedestrian Volume Analysis (NCHRP report)

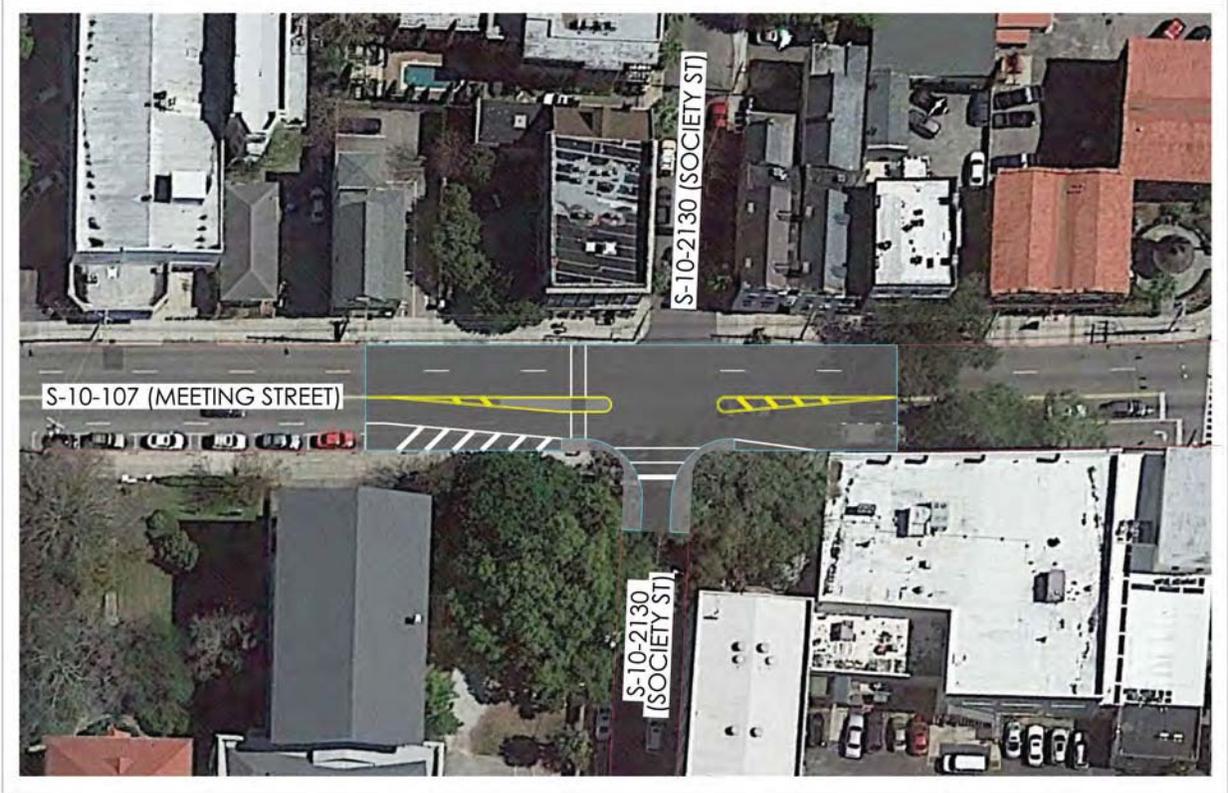
— Count Period: 4:00 PM to 6:00 PM, with estimated volume

Results of the analysis show an RRFB is warranted.

Based on these results,

- An RRFB appears warranted and is recommended. The following concept sketch shows a pedestrian refuge island to be included with the RRFB, along with the Society Street stop bar relocated to improve sight distance. Also, Yield bars with R1-5 Yield Here to Pedestrian signs are recommended on Meeting St. approaching the crosswalk at this location.

*Typical pedestrian crash reduction of 50% for installation of RRFB.*



Society Street Concept Sketch

**S-107 and Wentworth St.:**

## Findings:

- The outside southbound lane turns into a right turn lane, catching drivers on Meeting St. off guard.
- This intersection has pedestrian signal heads but lacks pedestrian push buttons.

## Improvements:

- Improve driver notification by adding right turn arrows and ONLY symbols to southbound Meeting St. Also add "Right Lane Must Turn Right" sign.
- Add pedestrian push buttons at this intersection.

**S-107 and Hassell St.:**

## Findings:

- Ramp at the NE corner is damaged.

## Improvements:

- Consider ramp replacement at the NE corner of the intersection.

**S-107 and Hayne St.:**

## Findings:

- There are no detectable warning surfaces present at the side street approach.
- Ramp slopes are not ADA compliant.

## Improvements:

- Add detectable warning surfaces on ramps at the side street approach.
- Reconstruct ramps.

**S-107 and Market St:**

## Findings:

- The inside southbound lane turns into a left turn lane, catching Meeting St. drivers off guard.
- This intersection has heavy pedestrian activity. One pedestrian crash occurred in 7 years.

## Improvements:

- Improve driver notification by adding left turn arrows and ONLY symbols to Meeting St. southbound.

- Perform a traffic study to check if an all pedestrian signal phase is warranted. If implemented, upgrades to the intersection pavement and crosswalks would be warranted.

**S-107 and Cumberland St.:**

Findings:

- S-107 southbound through lane drops into a left turn lane, requiring a sudden lane shift as vehicles pass the on-street parking spots.

Improvements:

- Upgrade pavement markings to show lane shift as shown below in, to guide southbound through traffic.



Cumberland Street Lane Shift Concept Sketch

**S-107 and Queen St.:**

Findings:

- Queen St. westbound has limited sight visibility due to the buildings.

Improvements:

- Add sign to restrict right turn on red for the Queen St. westbound approach.  
*Typical angle crash reduction of 30% for installation of "No Right Turn on Red" sign.*

**S-107 and Broad St.:**

Findings:

- There are no detectable warning surfaces present at the NE, SE and SW corners of the intersection.

Improvements:

- Add detectable warning surfaces on ramps at the three corners of the intersection.

## 4.0 SUMMARY OF CONSTRUCTION COSTS

Probable construction costs for the recommended improvements are provided below. Note these costs do not include preliminary engineering, right of way, utility relocation or CE&I costs.

CORRIDOR RECOMMENDATIONS (SECTION 3.1)	
IMPROVEMENT	COST
Add crosswalks to side street approaches. (Approx. 6 approaches)	\$4,500
Install curb extensions. (Up to 19 intersection corners)	\$228,000
Consider implementing leading Pedestrian Intervals (LPIs) (Approx. 14 signals)	\$42,000
Add detectable warning surfaces to ADA ramps at signalized and unsignalized side street crossings. (Approx. 8 ramps)	\$3,000
Upgrade pavement markings and raised pavement markers. (Includes some crosswalks)	\$56,000
Relocate stop bars. (Approx. 6 approaches)	\$3,500
Revise speed limits.	\$4,000
Close two driveways at Church's Chicken closest to the intersection.	\$20,000
Construct raised median, with a pedestrian refuge between the Columbus St. and Spring St. intersections for access management.	\$50,000
Replace drain inlet grates with bicycle friendly grates flush with pavement.	\$30,000
Convert signals from night-time flash to timed phasing. (Approx. 3 intersections)	\$300
Install retroreflective backplates to improve signal head visibility. Note: Utility pole availability must be coordinated with Dominion Energy. (Approx. 6 intersections)	\$9,600
Replace 8" signal heads with 12" signal heads, as per MUTCD. Note: Utility pole availability must be coordinated with Dominion Energy. (Approx. 4 intersections)	\$73,000
	Subtotal
	\$523,900
	Contingency (30%)
	\$157,170
INTERSECTION SPECIFIC IMPROVEMENTS (SECTION 3.2)	
IMPROVEMENT	COST
Line St. - Repair damaged sidewalk in front of Greystar Corp and install pedestrian signal heads (other improvements included in section 3.1).	\$17,500
Columbus St. - Install a "No Right Turn on Red" sign.	\$250
Spring St. – Improvement included in section 3.1	N/A
Woolfe St./Amherst St. - Install pedestrian signal heads	\$15,000
Reid St. - Install "No Right Turn on Red" sign and R1-6 Yield to Pedestrian sign (other improvements included in section 3.1).	\$250
Mary St. – Install "No Right Turn on Red" (other improvements included in section 3.1).	\$250
John St. - Add "Right Lane Must Turn Right" sign, arrows and symbols, and repair sidewalk ramp at the NE corner.	\$9,000
Charlotte St. - Install RRFB, yield bars, and "Right Lane Must Turn Right" and "Left Turn Only" signs (other improvements included in section 3.1).	\$42,000
Calhoun St. - Reconstruct ramp to improve drainage. Potential improvements for pedestrian scramble phase (other improvements included in section 3.1).	\$30,000
George St. – Repair sidewalk.	\$5,000
Society St. – Install RRFB with yield bars and pedestrian refuge island (other improvements included in section 3.1).	\$80,000
Wentworth St. - Install "Right Lane Must Turn Right" sign, arrows and symbols, repair ramp, add pedestrian push buttons (other improvements included in section 3.1).	\$5,000
Hassell St. - Replace ramp in NE corner.	\$500

INTERSECTION SPECIFIC IMPROVEMENTS (SECTION 3.2)	
Hayne St. – Reconstruct ramps.	\$3,000
Market St. – Install left turn arrows and symbols. Potential improvements for pedestrian scramble phase.	\$30,000
Cumberland St. – Upgrade pavement markings to show lane shift.	\$7,000
Queen St. - Install "No Right Turn On Red" sign.	\$250
Broad St - Improvements included in section 3.1	N/A
Subtotal	\$245,000
Contingency (30%)	\$73,500
<b>Total (Sections 3.1-3.2)</b>	<b>\$999,570</b>

## 5.0 PRIORITIZATION

Appendix E shows the annualized cost and benefit for each improvement, as applicable. Costs are based on conceptual construction costs only. Costs are annualized based on the following life cycle of improvements:

- Thermoplastic pavement markings – 5 years
- Roadway signs – 10 years
- Other items – 20 years

Benefits are based on the estimated savings from potential crash reductions. The predictions for crash reductions used in the analysis are based on national research of engineering studies that used crash data to quantify the safety effect of the corresponding countermeasure. Application of the crash modification factors to this particular corridor is somewhat subjective, so the computed benefits should only be considered as generally applicable. This report also recognizes some improvements have intangible benefits beyond crash reductions. For example, improvements to bicycle and pedestrian facilities can provide a level of comfort for its users. They can also lead to increased usage, providing public convenience, health, and/or economic benefits from the improved transportation system.

In this section, each suggested improvement is evaluated based on its cost, ease of construction, impacts, benefit-cost (B/C) ratio, and how it relates to other improvements. Based on these evaluations, improvements are grouped into potential short term and long-term categories. These categories are for planning purposes only and can be subject to change based on funding and other factors. The B/C ratios are calculated for each improvement individually. So, cumulative benefits from performing all the recommended improvements may be less than what is shown.

SHORT TERM		
IMPROVEMENT	COST	B/C
Add crosswalks to side street approaches. (Approx. 6 approaches)	\$4,500	47.39
Implement leading Pedestrian Intervals (LPis) (Approx. 14 signals)	\$42,000	22.62
Add detectable warning surfaces to ADA ramps at signalized and unsignalized side street crossings. (Approx. 8 ramps)	\$3,000	N/A
Upgrade pavement markings and raised pavement markers. (Includes some crosswalks)	\$56,000	22.87
Relocate stop bars. (Approx. 6 approaches)	\$3,500	32.80
Revise speed limits.	\$4,000	N/A
Close two driveways at Church's Chicken closest to the intersection.	\$20,000	23.09
Raised Median between Columbus St. and Spring St.	\$50,000	11.50
Replace drain inlet grates with bicycle friendly grates flush with pavement.	\$30,000	N/A
Convert signals from night-time flash to timed phasing. (Approx. 3 intersections)	\$300	>100
Install retroreflective backplates to improve signal head visibility. (Approx. 6 intersections)	\$9,600	>100

Replace 8" signal heads with 12" signal heads, as per MUTCD. Note: Utility pole availability must be coordinated with Dominion Energy. (Approx. 4 intersections)	\$73,000	3.73
Line St. - Repair damaged sidewalk in front of Greystar Corp and install pedestrian signal heads (other improvements included in section 3.1).	\$17,500	>100
Columbus St. - Install a "No Right Turn on Red" sign.	\$250	>100
Spring St. – Improvement included in section 3.1	N/A	N/A
Woolfe St./Amherst St. - Install pedestrian signal heads	\$15,000	65.42
Reid St. - Install "No Right Turn on Red" sign and R1-6 Yield to Pedestrian sign (other improvements included in section 3.1).	\$250	0.00
Mary St. - Install "No Right Turn on Red" (other improvements included in section 3.1).	\$250	0.00
John St. - Add "Right Lane Must Turn Right" sign, arrows and symbols, and repair sidewalk ramp at the NE corner.	\$9,000	N/A
Charlotte St. - Install RRFB, yield bars, and "Right Lane Must Turn Right" and "Left Turn Only" signs (other improvements included in section 3.1).	\$42,000	0.00
Calhoun St. - Reconstruct ramp to improve drainage. Potential improvements for pedestrian scramble phase (other improvements included in section 3.1).	\$30,000	33.15
George St. – Repair sidewalk.	\$5,000	N/A
Society St. – Install RRFB with yield bars and pedestrian refuge island (other improvements included in section 3.1).	\$80,000	2.51
Wentworth St. - Install " Right Lane Must Turn Right " sign, arrows and symbols, repair ramp, add pedestrian push buttons (other improvements included in section 3.1).	\$5,000	0.00
Hassell St. - Replace ramp in NE corner.	\$500	N/A
Hayne St. – Reconstruct ramps.	\$3,000	N/A
Market St. – Install left turn arrows and symbols. Potential improvements for pedestrian scramble phase.	\$30,000	N/A
Cumberland St. – Upgrade pavement markings to show lane shift.	\$7,000	N/A
Queen St. - Install "No Right Turn On Red" sign.	\$250	N/A
Broad St - Improvements included in section 3.1	N/A	N/A
Subtotal	\$540,900	
Contingency (30%)	\$162,270	
<b>Total</b>	<b>\$703,170</b>	

LONG TERM		
IMPROVEMENT	COST	B/C
Curb Extensions (Up to 19 intersection corners)	\$228,000	N/A
Subtotal	\$228,000	
Contingency (30%)	\$68,400	
<b>Total</b>	<b>\$296,400</b>	